Agilent
Laser and Optics

User's Manual, Volume I

Agilent Technologies

Notices

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CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

User’s Manual

Agilent 5517A/B/C/D/DL/FL Laser Head
Agilent 5519A/B Laser Head
Agilent 5529A Dynamic Calibrator
Agilent 10567A Dual Beam Beam-Splitter
Agilent 10700A 33% Beam Splitter
Agilent 10700B 4% Beam Splitter
Agilent 10700C 15% Beam Splitter
Agilent 10701A 50% Beam Splitter
Agilent 10702A Linear Interferometer (and 10702A-001 with Windows)
Agilent 10703A Retroreflector
Agilent 10704A Retroreflector
Agilent 10705A Single Beam Interferometer
Agilent 10705A-080 Fiber Optic Receiver Adapter
Agilent 10706A Plane Mirror Interferometer
Agilent 10706A-080 Fiber Optic Receiver Adapter
Agilent 10706B High Stability Plane Mirror Interferometer
Agilent 10707A Beam Bender
Agilent 10710B Adjustable Mount
Agilent 10711A Adjustable Mount
Agilent 10713B/C/D Cube Corner
Agilent 10715A Differential Interferometer (and 10715A-001 Turned Configuration)
Agilent 10716A High Resolution Interferometer (and 10716A-001 Turned Configuration)
Agilent 10717A Wavelength Tracker
Agilent 10719A One-axis Differential Interferometer
Agilent 10719A-C02 One-axis Differential Interferometer (low thermal drift)
Agilent 10721A Two-axis Differential Interferometer
Agilent 10721A-C01 Two-axis Differential Interferometer (low thermal drift)
Agilent 10722A Plane Mirror Converter
Agilent 10723A High Stability Adapter
Agilent 10724A Plane Mirror Reflector
Agilent 10725A 50% Beam Splitter
Agilent 10725B 4% Beam Splitter
Agilent 10725C 15% Beam Splitter
Agilent 10726A Beam Bender
Agilent 10728A Plane Mirror
Agilent 10735A Three-axis Interferometer
Agilent 10736A Three-Axis Interferometer
Agilent 10736A-001 Three-Axis Interferometer / Beam Bender
Agilent 10737L, R Compact Three-axis Interferometers
Agilent 10753B Laser Tripod
Agilent 10759A Footspacing Kit
Agilent 10766A Linear Interferometer
Agilent 10767A Linear Interferometer
Agilent 10767B Lightweight Retroreflector
Agilent 10768A Diagonal Measurement Kit
Agilent 10769A Beam Steering Mirror
Agilent 10766A Linear Interferometer
Agilent 10767A Linear Interferometer
Agilent 10767B Lightweight Retroreflector
Agilent 10770A Angular Interferometer
Agilent 10771A Angular Retroreflector
Agilent 10772A Turning Mirror
Agilent 10773A Flatness Mirror
Agilent 10774A Short Range Straightness Optics
Agilent 10776A Straightness Accessory Kit
Agilent 10777A Optical Square
Agilent 10780C Receiver
Agilent 10780F Remote Receiver
Agilent 10790A/B/C Receiver Cable
Agilent 10880A/B/C Receiver Cable
Agilent 10881A/B/C Laser Head Cable
Agilent 10882A/B/C Laser Head Cable
Agilent 10884B Power Supply
Agilent E1705A Fiber Optic Cable
Agilent E1706A Remote Sensor
Agilent E1708A Remote Dynamic Receiver
Agilent E1709A Remote High-Performance Receiver
Agilent E1705A Fiber-Optic Cable
Agilent E1706A Remote Sensor
Agilent E1708A Remote Dynamic Receiver
Agilent E1709A Remote High-Performance Receiver

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Laser and Optics

User’s Manual

(Continued)

Agilent E1826E/F/G One-Axis Plane Mirror Interferometer
Agilent E1827A Two-Axis Vertical Beam Interferometer
Agilent E1837A Three-Axis Vertical Beam Interferometer
Agilent E1833C 15% Bare Beam Splitter
Agilent E1833E 33% Bare Beam Splitter
Agilent E1833G 50% Bare Beam Splitter
Agilent E1833J 67% Bare Beam Splitter
Agilent E1833M 100% Bare Beam Splitter (Beam Bender)
Agilent N1203C Precision Beam Translator
Agilent N1204C Precision Horizontal Beam Bender
Agilent N1207C Precision Vertical Beam Bender
Agilent N1208C 33% Bare Beam Splitter
Agilent N1208D 40% Bare Beam Splitter
Agilent N1208E 50% Bare Beam Splitter
Agilent N1208F 66% Bare Beam Splitter
Agilent N1208G 60% Bare Beam Splitter
Agilent N1250A/B High Performance Receiver Cable
Agilent N1251A/B High Performance Laser Head Cable
Agilent Z4399A Three-Axis Interferometer
Agilent Z4420B Five-Axis Interferometer

Certification and Warranty

Certification

Agilent Technologies certifies that this product met its published specification at the time of shipment from the factory. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (formerly National Bureau of Standards), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

Agilent warrants Agilent hardware, accessories and supplies against defects in materials and workmanship for a period specified by each product from date of shipment. If Agilent receives notice of such defects during the warranty period, Agilent will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or like-new.

Agilent warrants that Agilent software will not fail to execute its programming instructions, for the period specified above, due to defects in material and workmanship when properly installed and used. If Agilent receives notice of such defects during the warranty period, Agilent will replace software media which does not execute its programming instructions due to such defects.

For detailed warranty information, see back matter.

Safety Considerations

General

This product and related documentation must be reviewed for familiarization with this safety markings and instructions before operation.

This product is a safety Class I instrument (provided with a protective earth terminal).

Before Applying Power

Verify that the product is set to match the available line voltage and the correct fuse is installed.

Before Cleaning

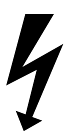
Disconnect the product from operating power before cleaning.

Safety Earth Ground

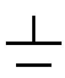
An uninterruptible safety earth ground must be provided from the mains power source to the product input wiring terminals or supplied power cable.

Warning Symbols That May Be Used In This Book

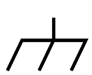
Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltages.



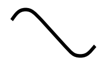
Indicates earth (ground) terminal.



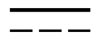
or

Indicates terminal is connected to chassis when such connection is not apparent.

Safety Considerations (contd)



Indicates Alternating current.



Indicates Direct current.

WARNING

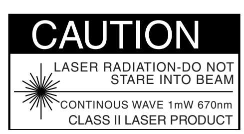
BODILY INJURY OR DEATH MAY RESULT FROM FAILURE TO HEED A WARNING. DO NOT PROCEED BEYOND A WARNING UNTIL THE INDICATED CONDITIONS ARE FULLY UNDERSTOOD AND MET.

CAUTION

Damage to equipment, or incorrect measurement data, may result from failure to heed a caution. Do not proceed beyond a CAUTION until the indicated conditions are fully understood and met.

These CAUTION labels are required by the United States Center for Devices and Radiological Health. Failure to follow their instructions may result in personal injury.

This symbol indicates laser radiation.



CAUTION: Laser radiation when open. DO NOT STARE INTO THE BEAM

For additional safety and acoustic noise information, see back matter.

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6 NGI Measurement Optics (General Information)

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1
About This Manual

Introduction

This Laser and Optics User's Manual is intended for system designers concerned with designing and installing the optics, laser heads, and receivers for Agilent laser measurement systems into precision measuring or positioning equipment. Typical applications are for equipment used in the integrated circuit, disk drive, and precision machine industries.

This manual does not provide detailed information about laser head or receiver electronics. That information is provided in the manual for the particular unit. Refer to the section titled "Manuals Available" at the end of this chapter for details.

Information about measurement system electronic components (such as printed circuit boards, and air and material temperature sensors) is also not in this manual. Contact Agilent Technologies for help in ordering the documentation you want.

How to Locate Information

The table of contents, list of figures, list of tables, and an alphabetical index of subjects help you locate information.

Manual Organization

This user's manual consists of two volumes.

Volume I is organized as follows:

Chapter 1, About this Manual (this chapter), introduces you to the content and organization of this manual and gives information about available supplementary manuals.

Chapter 2, Familiarization and Initial Operation, describes a typical single-axis laser interferometer positioning system. It provides a simple "Getting Started" procedure that describes how to quickly set up and operate an Agilent laser interferometer positioning system, using PC-based electronics. Only essential information is included.

Chapter 3, System Design Considerations, provides general information that you should know and consider when designing Agilent laser measurement systems. Topics include: the basic components of an Agilent laser measurement system, effect of motion of any of the components, accuracy considerations, measurement range, adjustment considerations, laser beam and optics protection, system grounding, mounting plane tolerance, fastening, clearance, pointing stability, thermal isolation, vibration isolation, magnetic shielding, effect of optics on measurement direction sense, and vacuum application.

Chapter 4, System Installation and Alignment, provides you with general procedures on how to install and align the various optics and accessories in various Agilent laser measurement systems. This chapter includes the alignment procedure for linear interferometers.

Chapter 5, Measurement Optics (General Information), introduces Agilent's measurement optics—interferometers, straightness optics, retroreflectors (also called cube corners)—available for Agilent Technologies laser measurement systems. The first part of this chapter presents material that should be useful to the user of any of the interferometers.

Detailed information on the individual interferometer types, including characteristics and specifications are described in chapters 18 through 30. Each of these chapters provide descriptions, specifications, installation, and (except for linear interferometers) alignment information for each interferometer that is available for Agilent laser measurement systems. The alignment procedure for linear interferometers is in Chapter 4 of this manual.

Chapter 6, NGI Measurement Optics (General Information), introduces Agilent's next generation interferometers (NGIs), and provides alignment, mounting, and fiber optics interface specifications.

Detailed information on the individual NGI types, including characteristics and specifications are described in chapters 31 through 34.

Chapter 7, Maintenance, provides general maintenance information and procedures for cleaning the lens of the Agilent 10780C, Agilent 10780F, Agilent E1708A, and Agilent E1709A receivers, the measurement optics, and the beam-directing optics. A "Before and After Service Product Safety Check" procedure is also provided.

Chapter 8, Troubleshooting, provides information to help you find defective components in an Agilent laser measurement system when a problem occurs. It can help determine whether the problem source is in the system electronics, environmental sensor, laser head, receiver, or the optics.

Chapter 9, Unpacking and Incoming Inspection, provides information for unpacking and inspection, and warranty claims.

Chapter 10, Packaging for Storage or Shipment, provides specific detailed information on packaging the laser tube assembly for storage or for shipment to Agilent for an exchange laser tube.

Chapter 11, Principles of Laser Interferometry, provides basic concepts, techniques, and principles that determine the overall measurement performance of Agilent laser measurement systems.

Chapter 12, Accuracy and Repeatability, provides basic concepts, techniques and principles that determine the overall measurement performance of Agilent laser measurement systems.

Chapter 13, WOL Compensation Numbers, provides tables of Wavelength-of-Light (WOL) compensation values for different environmental conditions, and step-by-step instructions on how to calculate the compensation factor if your system operates in an environment other than those covered by the tables.

Chapter 14, Material Expansion Coefficients, provides the linear thermal expansion coefficients of the most frequently used metals and alloys.

Chapter 15, Glossary

Volume II is organized as follows:

Chapter 16, Laser Heads, provides descriptions and specifications for each of the current nine Agilent laser heads (Agilent 5517A, Agilent 5517B, Agilent 5517BL, Agilent 5517C, Agilent 5517D, Agilent 5517DL, Agilent 5517FL, Agilent 5519A, and Agilent 5519B).

Chapter 17, Beam-Directing Optics, provides descriptions, specifications, and other information for the beam splitters, beam benders, and beam translator that are available for Agilent laser measurement systems.

Chapter 18, Agilent 10702A and 10766A Linear Interferometers, and Agilent 10703A and 10676A Retroreflectors

Chapter 19, Agilent 10705A Single Beam Interferometer and Agilent 10704A Retroreflector

Chapter 20, Agilent 10706A Plane Mirror Interferometer

Chapter 21, Agilent 10706B High Stability Plane Mirror Interferometer

Chapter 22, Agilent 10715A Differential Interferometer

Chapter 23, Agilent 10716A High-Resolution Interferometer

Chapter 24, Agilent 10717A Wavelength Tracker

Chapter 25, Agilent 10719A and 10719A-C02 One-Axis Differential Interferometers

Chapter 26, Agilent 10721A and 10721A-C01 Two-Axis Differential Interferometers

Chapter 27, Agilent 10735A, 10736A, and 10736A-001 Three-Axis Interferometers

Chapter 28, Agilent 10737L and Agilent 10737R Compact Three-Axis Interferometers

Chapter 29, Agilent 10770A Angular Interferometer with Agilent 10771A Angular Reflector

Chapter 30, Agilent 10774A Short Range Straightness Optics and Agilent 10775A Long Range Straightness Optics

Chapter 31, Agilent E1826E/F/G One-Axis Plane Mirror Interferometer

Chapter 32, Agilent E1827A Two-Axis Vertical Beam Interferometer

Chapter 33, Agilent Z4420B and Agilent Z4421B Five-Axis Interferometers

Chapter 34, Agilent E1837A, Z4399A, and Z4422B Three-Axis Interferometers

Chapter 35, Receivers, provides descriptions and system information for the Agilent 10780C, Agilent 10780F, Agilent E1708A, and Agilent E1709A receivers.

Chapter 36, Accessories, provides descriptions of hardware such as adjustable mounts, height adjuster/post, base, and cables. This chapter also provides descriptions, specifications, and system information for the optics which are not interferometers, and are not usually referred to as “beam-directing optics”, such as plane mirror reflectors.

Index

Manuals Available

Table 1 lists manuals currently available for Agilent laser heads and receivers. These manuals provide component-level troubleshooting and adjustment information.

In addition to these manuals, manuals are available describing the electronic components of a laser measurement system. Contact Agilent Technologies for help in ordering the information you need.

Table 1 Laser Head and Receiver Manuals

Product	Name of Manual	Current Agilent Part Number[1] (See NOTE below)
Agilent 5517A Laser Head	Agilent 5517A Laser Head Operating and Service Manual	05517-90046
Agilent 5517B Laser Head or Agilent 5517C Laser Head or Agilent 5517D Laser Head	Agilent 5517B/C/D Laser Head Operating and Service Manual	05517-90047

Table 1 Laser Head and Receiver Manuals

Product	Name of Manual	Current Agilent Part Number[1] (See NOTE below)
Agilent 5519A /B Laser Head	Agilent 5519A/B Laser Head Service Manual	05519-90006
Agilent 10780C Receiver or Agilent 10780F Remote Receiver	Agilent 10780C/F Operating and Service Manual	10780-90028
Agilent E1708A Remote Dynamic Receiver	Agilent E1707A/E1708A Operating Manual	E1708-90010
Agilent E1709A Remote High-Performance Receiver	Agilent E1709A Operating Manual	E1709-90006

[1]The Agilent part number of a manual may be changed when the manual is updated.

How to Order Manuals

The Agilent Part Number of this manual is given on the front title page and back inside cover. Use it to order additional copies of this manual.

2
Familiarization and Initial Operation

Introduction

Your laser interferometer positioning system is a set of optics, electronics, and electro-optical products that measure distance very accurately. This chapter provides basic information on how to set up a laser system to make measurements.

A one-axis example is used for simplicity

Each axis of a laser positioning system is set up, aligned, and operated in essentially the same way. A six-axis system is similar to a one-axis system; therefore, only a single-axis system will be described in this chapter. Additional axes are then operated like the axis in the example.

Basic steps apply to all laser systems

Specific products (identified by Agilent model number) are used in the example, but the installation and operation of other Agilent products are similar.

The example shows the use of PC-compatible electronics and a linear interferometer. If you are using a different interferometer, you may need to refer to the chapter in this manual that describes that interferometer for more details on optical alignment.

Regardless of the specific products you are using, the information and procedures presented in this chapter will help you get started quickly and easily.

Agilent laser interferometer positioning systems at a glance

Figure 1 shows the components of a typical single-axis Agilent laser system. All Agilent laser systems combine optics (interferometer and reflector), electronics, and opto-electronics (laser head and receiver) to make a highly accurate positioning system.

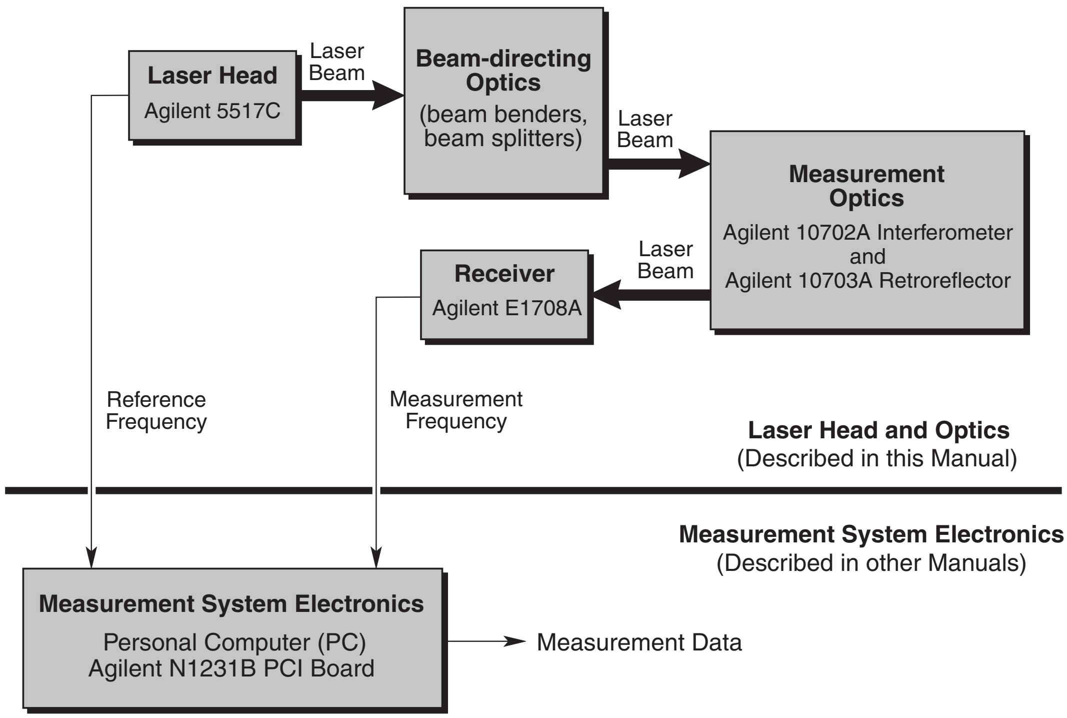

Figure 1 Typical single-axis Agilent Laser Interferometer Positioning System

All Agilent laser systems share a similar configuration

Figure 1 shows PC-compatible electronics and a linear interferometer, but the system configuration is the same for all types of Agilent electronics and interferometers.

All Agilent laser systems require a reference signal from the laser head and a measurement signal from the receiver to be connected to the electronics to determine relative movement between the optics.

All Agilent laser systems feature separate laser head, interferometer, and reflector. The laser beam must be aligned with the optical elements and the motion of the optics to preserve beam alignment and provide an accurate measurement. The optics and receiver must be aligned so the beam strikes the lens of the receiver to generate a measurement signal. Misalignment results in loss of the measurement signal.

A controller is required for all laser positioning systems

A controller is needed to control the system electronics and provide a display of the distance measured. The PC is the controller for PC-compatible electronics. Example and demo software programs are provided with the Agilent PC-compatible electronics to set up the system and display the measurement. VMEbus electronics require a separate controller.

What follows?

The remaining sections of this chapter describe how to quickly set up and operate an Agilent laser interferometer positioning system, using PC-based electronics. Only essential information is included. Details not covered in this chapter are found in other chapters of this manual or in the manual(s) for the specific system electronics you are using.

The first step in system setup is connecting the system electronics. This includes installing the electronics boards in their backplane, connecting the cables from the laser head and receiver, and starting the software program.

The second step in system setup is aligning the optics. This step includes aligning the beam from the laser head parallel to the optics motion and aligning the optics and receiver lens so the beam enters the receiver lens during the entire range of motion.

The last step in system operation is making a measurement. This requires the software to be running on the controller to display measurement results.

Problem-solving is the last part in this chapter. The most common problems and their solutions are presented to help you operate your system successfully.

Setting Up the System Electronics

WARNING The PC power cord must be unplugged to prevent personal injury and damage to the electronics.

Install the laser electronics board in the PC

CAUTION The Agilent N1231B board contains components that may be damaged by electrostatic discharge (ESD). Do not handle the Agilent N1231B board or any of its components without taking adequate measures to prevent damage due to electrostatic discharge (ESD).

The Agilent N1231B PCI Three-Axis Board can be installed in any full-length PCI I/O backplane slot.

1 Unplug the PC power cord.

2 Remove the cover on the PC.

   See the manual for your PC for specific instructions for this step and the next few steps.

3 Install the Agilent PC axis board in the PC.

4 Replace the PC cover.

5 Plug in the PC power cord, but leave the PC power off.

Install the API library and monitor program on computers used for program development

To Install the N1231B API library

1 Exit from all applications.

2 Insert the CD in an appropriate drive.

3 Navigate to the directory: `\N1231B API Development`.

4 Run `Setup.exe`.

5 Follow the instructions on the screen.

When asked to choose a Setup Type, the default choice of `Typical` is recommended. Other choices are `Compact` and `Custom`. The setup types are described below:

`Typical` installs all files.

`Compact` installs all files except those in the “User Files” directory.

`Custom` allows you to select the components to be installed.

6 If running under Windows NT and this is the first time the software has been installed, or if the software has been uninstalled prior to this installation, reboot the controller.

7 Perform the steps in the following subsection, “To Install the Agilent N1231B monitor program.”

To Install the Agilent N1231B monitor program

NOTE

See the readme.doc file on the CD for the latest installation information.

NOTE

If the Agilent N1231B API Library is not yet installed, follow the instructions above to install it before proceeding with this installation.

1 Exit from all applications.

2 Insert the CD in an appropriate drive.

3 Navigate to the directory: `\N1231B Monitor`.

4 Run `Setup.exe`.

5 Follow the instructions on the screen.

Connect the electronics cables

1 Connect the largest connector on the laser head cable to the back of the laser head.

2 Connect the smallest connector on the laser head cable to the Reference connector* on the Agilent N1231B PCI Three-Axis Board that you just installed in your PC.

3 Connect the Agilent 10884B Laser Power Supply to the remaining connector (the medium-size DIN connector) of the laser cable.

4 Connect the receiver cable to the back of the receiver and to one of the three MEASurement connectors* in the Agilent N1231B PCI Three-Axis Board.

Power up the laser head

1 Plug the Laser Power Supply into line power (nominally 110 V or 230 V ac) to start the laser.

All LEDs on the rear panel of the laser head should light except for the **READY** LED. The laser head should emit a red laser beam within 45 seconds after receiving power.

About halfway through the lock-up period, the **READY** LED blinks on and off to indicate that the laser is in the process of locking. When the head is ready for use, this LED remains on, indicating the laser has achieved lock and is generating a reference signal.

The laser head requires a period to stabilize the frequencies before a reliable measurement can be made. The length of the stabilization period depends on which model laser head is installed in the system.

WARNING Do not stare directly into the beam (or its reflection from a polished surface) or this could result in eye damage.

2 Now, align the optics as described in the following section titled "Aligning the Optics."

* To line up the connectors for the N1231B Ref and Meas cables, the red dot on the cable connector is to the right.

Aligning the Optics

The laser head, optics, and receiver must be aligned so the laser beam from the optics returns to the receiver lens.

1 Set the laser head on a stable surface and point the beam in the direction you intend to move the optics.

2 Set the interferometer in the laser beam path so the beam enters the interferometer aperture perpendicular to the aperture. You may need to fasten the interferometer in place with a clamping fixture.

3 Set the reflector in the laser beam line coming from the interferometer. Adjust the reflector to reflect the beam back into the interferometer.

4 Place the receiver parallel to the laser beam from the laser head to the interferometer. The lens must be facing the interferometer. Fasten the receiver in place with a fixture or clamp.

5 Adjust the reflector and receiver to get the return beam on the receiver lens. When the **Laser Ready** indicator comes on, the green LED on the receiver will light when the beam alignment is satisfactory.

6 Block the beam from the interferometer to the receiver. The green LED on the receiver should go out. Unblock the beam and the green LED should light again. If this happens, the basic optics alignment is complete, and you can skip step 7 of this procedure.

   If the receiver´s green LED stays on when the beam from the interferometer is blocked, the receiver gain is too high. Go to the next step.

7 With the beam blocked, turn the receiver’s gain adjustment control until the LED goes out. When the beam is unblocked, the LED should light again, indicating that the optics are aligned properly.

   If the green LED does not light, readjust beam alignment until it does light.

Making Measurements

NOTE

To make a measurement:

a the electronics must be connected and on

b the laser beam must be aligned

c the software program must be running in the controller.

1 Turn on the power to the controller (PC).

2 Press the **Start** button, located at the bottom left of the task bar in the Start menu window as shown in Figure 2.

3 Select **Programs**, then select **Agilent N1231B API** from the pop-up menu.

The **Agilent N1231B API** pop-up menu is displayed as shown in Figure 2.

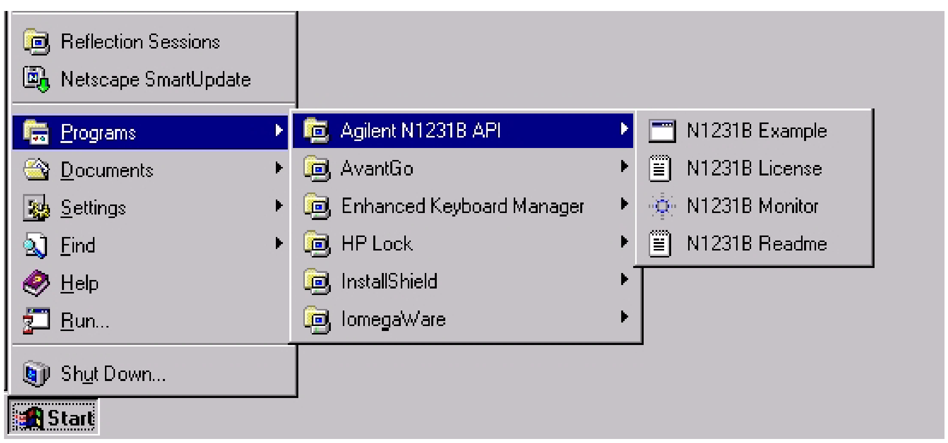

Figure 2 Start/Programs pop-up menu

4 From the **Agilent N1231B API** pop-up menu, click on the **N1231B Monitor** icon to open the Monitor application.

With no input signals connected to the Agilent N1231B board, the Agilent N1231B Monitor screen should appear as shown in Figure 3.

NOTE

The PCI bus and slot number may differ from those shown in Figure 3.

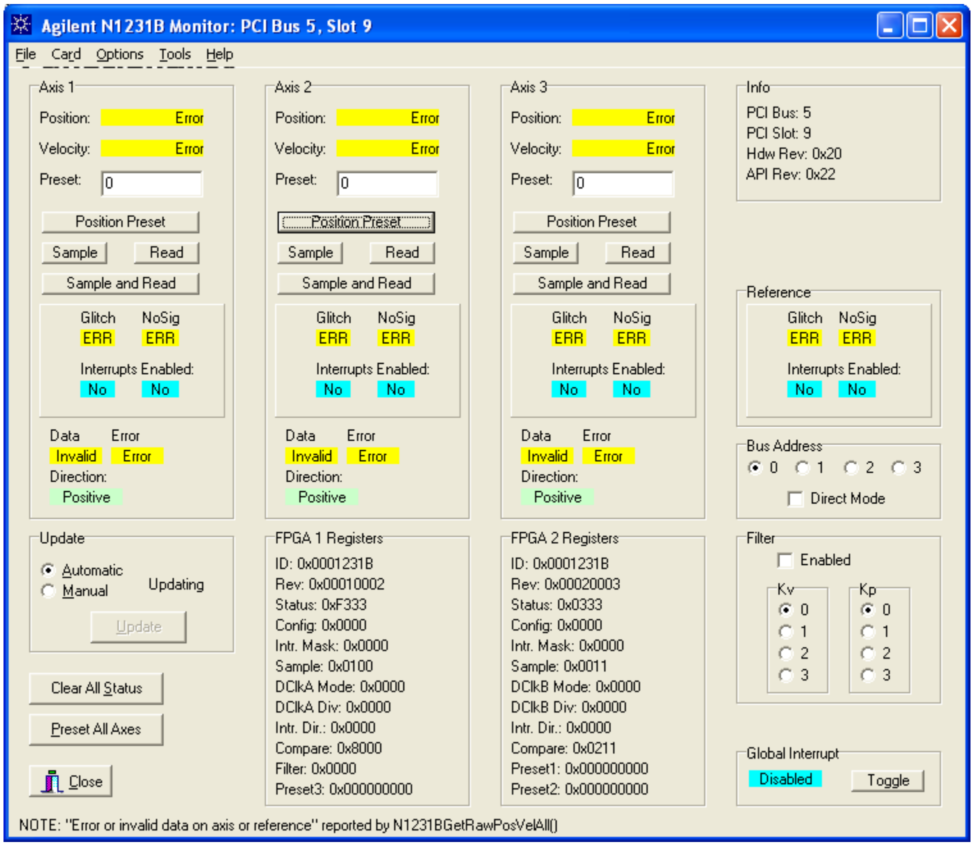

Figure 3 Monitor screen after opening the application

5 Press the **Clear All Status** button, and then the **Preset All Axes** button in the lower left of the screen.

The position in uncompensated raw lambda/2048 counts* can now be read in the Position boxes corresponding to axes that have valid measurement signals as shown in Axis 2 in Figure 4.

* These raw count values must be multiplied by 0.31nm/count and a compensation number (0.999728766 for standard air) to convert them into a measurement value.

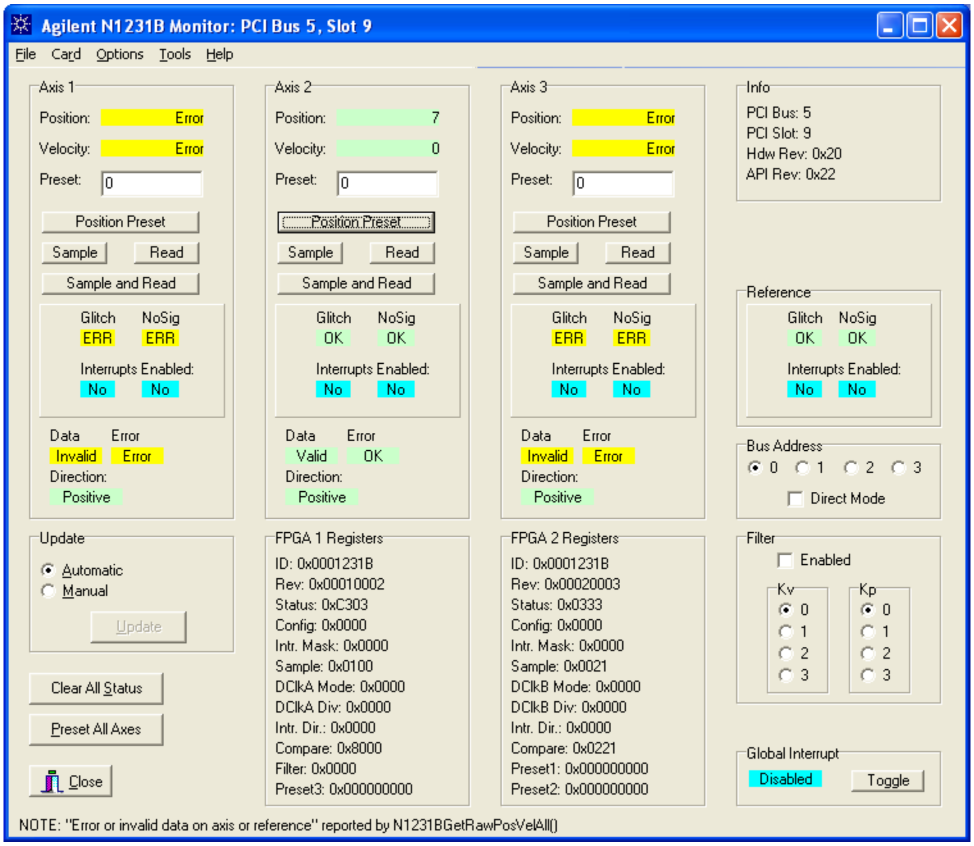

Figure 4 Measurement screen

To exit this application, click the **Close** button in the lower-left corner of the application's screen, or the close (X) button in the upper-right corner of the window.

Solving Problems

Here is information about three simple problems that may occur while you are trying to make a measurement.

- If there is no red beam from the laser head:
  - Ensure that the laser head cable is securely connected to the back of the laser head.
  - Ensure that the power supply is connected to the laser head cable.
  - Ensure that the power supply is plugged into an operating outlet and that the **POWER ON** light is illuminated.
- If the green LED on the receiver does not light:
  - Ensure that there is a red beam from the laser head and the **Ready** LED is illuminated.
  - Ensure that the laser beam passes through the large aperture in the laser head.
  - Ensure the laser head’s reference connector is connected to the electronics.
  - Ensure that the receiver cable is securely connected at the receiver and at the system electronics.
  - Ensure that the system electronics are connected to an operating power source and are turned on.
  - Ensure that the alignment of the laser head, optics, and receiver causes the beam from the interferometer to be centered on the receiver´s lens.
  - Block the beam between the interferometer and measurement reflector. The reference-path beam should be centered on the receiver’s lens. When you unblock the measurement-path beam, it should overlap the reference-path beam on the receiver lens.
  - If everything above seems correct, but the LED still doesn’t light, adjust the receiver’s gain control.
- If the controller does not indicate motion of the measurement reflector:
  - Ensure that there is a red beam from the laser head and the **Ready** LED is illuminated.
  - Ensure that the laser system electronics are powered.
  - Ensure that the laser beam is properly aligned and that the receiver’s green LED is lighted.
  - If the receiver’s green LED remains lighted when no measurement signal is present, reduce the receiver’s gain via its gain control.
  - Ensure that the controller is on and the program is running.

3
System Design Considerations

Introduction

Although there are many possible configurations of the laser and optics, all Agilent laser measurement systems have these basic parts in common:

- A laser source, to produce the two optical frequencies f_1 and f_2 and generate the reference signal. In discussions in this manual, f_1 is the lower frequency and f_2 is the higher.
- Beam-directing optics, to direct all or part of the laser beam to each measurement axis of the system, using right-angle bends.
- Measurement optics, to separate the two optical frequencies, direct them over the reference and measurement paths, and recombine them.
- One receiver per measurement axis, to detect the difference in optical frequencies and produce the measurement signal for that axis.
- Electronics to convert the measurement and reference signals into displacement data.

Two important characteristics of Agilent interferometers must be emphasized:

Only the change in relative position of the optics is detected.

Either optical component may move, as long as optical alignment is maintained. If the interferometer is fixed and the retroreflector is the moving component (toward or away from the interferometer), motion with respect to its original position is detected. Conversely, if the retroreflector is fixed, the interferometer can be the moving component.

Agilent laser position transducers can detect and measure all linear motions; that is, 3 degrees of the 18 degrees of freedom defined in the Glossary. Small angle measurements may be made by multiple measurements on the same axis.

The measurement system is relatively insensitive to all other motions, as briefly described below. See Figure 5.

POSSIBLE COMPONENT MOTIONS

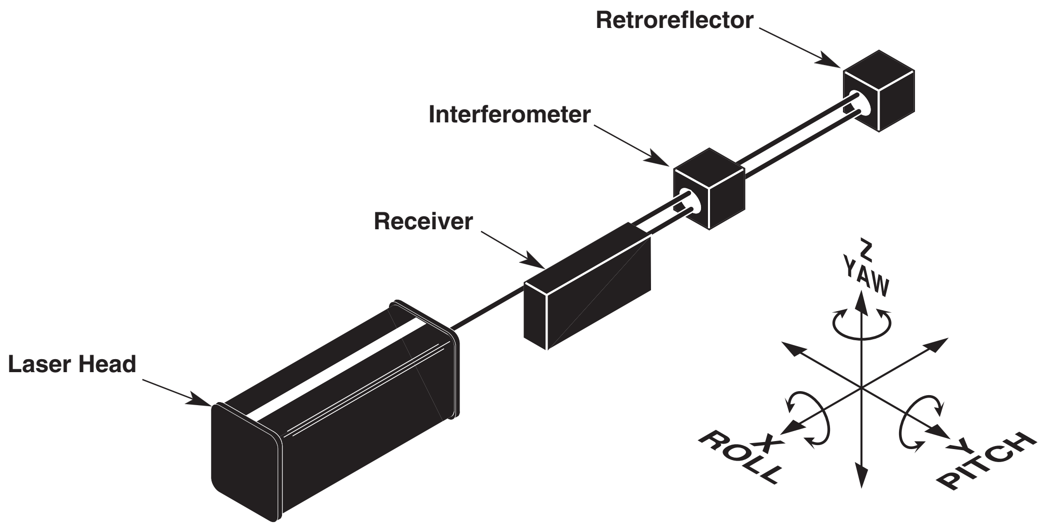

Figure 5 Possible component motions

1 Motion of the receiver or laser head along the beam path (X) has no effect on the measurement since both f_1 and f_2 would exhibit Doppler shift.

2 Small motions of the laser head, receiver, interferometer, or retroreflector in a direction perpendicular to the beam path (Y or Z) have no effect on the measurement. The only restriction is that sufficient light returns to the receiver.

3 Angular motion (pitch or yaw) of the laser head about the Z or Y axis has the effects described below:

4 It introduces a measurement error (cosine error).

5 It may displace the laser beam so that insufficient light returns to operate the receiver.

6 Although the laser head or the receiver may be rotated in 90° increments about the beam axis (roll), other roll deviations from the four optimum positions degrade the measurement signal. If either the laser head or receiver is rotated 45° about the beam axis, all position information will be lost because the receiver will not be able to distinguish between the two frequencies.

7 Angular motion of the receiver about the Y or Z axis has no effect on the measurement, within alignment limits specified for the receiver. (Receiver specifications are given in Chapter 35, Receivers," in Volume II of this manual.)

8 Angular motions of the interferometer and retroreflector depend on the particular components for limitations.

Accuracy Considerations

Several factors outside the laser measurement system can affect system accuracy. These factors (the measurement environment, machine and material temperature, and the optics installation) and their interrelationships must be understood in order to predict the performance of the system. Detailed descriptions and methods of compensation are given in Chapter 12, “Accuracy and Repeatability,” of this manual.

Generally, Agilent laser measurement systems offer automatic compensation for air environments and also for temperature changes of the work material. For a temperature-controlled environment (20 ±0.5° C), typical system accuracy using air sensor automatic compensation is 1.5 ppm. Using the Agilent 10717A Wavelength Tracker for compensation, the measurement repeatability is on the order of ±0.2 ppm, depending on the environment.

Determining What Equipment is Needed

First, sketch out your optical configuration. Remember:

- Each measurement axis (except for the Agilent 10717A Wavelength Tracker) requires an interferometer and associated retroreflector.
- Each measurement axis after the first one requires a beam splitter. The number of beam splitters required is n-1, where n is the number of measurement axes.
- If an Agilent 10717A Wavelength Tracker is used, it counts as a measurement axis.
- If a multiaxis interferometer, such as the Agilent 10721A, Agilent 10735A, Agilent 10736A, or Agilent 10737L,R is used, be sure the beam-directing optics you select will provide enough laser beam power to drive the receivers through the multiple measurement paths of the interferometer.
- Beam benders should be arranged so their exiting beams are perpendicular to one polarization plane of the incoming laser beam.
- Rotation of the beam during bending can result in problems due to the effects of polarization.
- Beam splitters should be arranged so:
    - one exiting beam is along the axis of the incoming beam, and the second beam is perpendicular to one polarization of the incoming beam, as described above for beam benders.
    - Each measurement axis requires an interferometer. The nature of the measurement(s) to be made influences the interferometer choice.

- Each measurement axis (including the Agilent 10717A Wavelength Tracker) requires a receiver. The interferometer used can influence the receiver choice. *Note that the Agilent 5519A and Agilent 5519B laser heads include a built-in receiver.*

Then, from your layout, determine your optics needs. Choose the Agilent laser head, optical and electronic components accordingly. Decide on a compensation scheme and, finally, select cables. Table 2 summarizes the equipment choices. For advice and help, contact Agilent Technologies.

Table 2 Equipment choices

Component	Comment(s)
Laser	**One required per system**
Agilent 5517A	Lowest velocity, largest size, 6 mm beam
Agilent 5517B/BL	25% higher velocity than Agilent 5517A, small size, 6 mm beam
Agilent 5517C Std 5517C-003 5517C-009	Higher velocity than Agilent 5517A and 5517B, small size 6 mm beam diameter 3 mm beam diameter 9 mm beam diameter
Agilent 5517D/DL	Higher velocity than Agilent 5517A/B/BL/C, small size, 6 mm beam
Agilent 5517FL Std 5517FL-009	Highest velocity, small size, 6 mm beam 6 mm beam diameter 9 mm beam diameter
Agilent 5519A	Largest size, built-in receiver and power supply used in the Agilent 5529A Dynamic Calibrator System and Metrology applications.
Agilent 5519B	Largest size, built-in receiver and power supply, higher velocity than Agilent 5519A; used in the Agilent 5529A Dynamic Calibrator System and Metrology applications.
Beam-Directing Optics	**Order as required to manipulate beam path to your configuration**
Agilent 10567A	Dual-Beam Beam Splitter, useful in vacuum applications
Agilent 10700A	33% Beam Splitter
Agilent 10700B	4% Beam Splitter
Agilent 10700C	15% Beam Splitter
Agilent 10701A	50% Beam Splitter
Agilent 10707A	Beam Bender
Agilent 10725A	50% Beam Splitter, no housing
Agilent 10725B	4% Beam Splitter, no housing
Agilent 10725C	15% Beam Splitter, no housing
Agilent 10726A	Beam Bender, no housing
Agilent E1833C	15% Bare Beam Splitter
Agilent E1833E	33% Bare Beam Splitter

Table 2 Equipment choices (continued)

Component	Comment(s)
Beam-Directing Optics (cont.)	
Agilent E1833G	50% Bare Beam Splitter
Agilent E1833J	67% Bare Beam Splitter
Agilent E1833M	100% Bare Beam Splitter
Agilent N1203C	Precision Beam Translator
Agilent N1204C	Precision Horizontal Beam Bender
Agilent N1207C	Precision Vertical Beam Bender
Agilent N1208C	33% Bare Beam Splitter
Agilent N1208D	40% Bare Beam Splitter
Agilent N1208E	50% Bare Beam Splitter
Agilent N1208F	66% Bare Beam Splitter
Agilent N1208G	60% Bare Beam Splitter
Agilent N1209A	RPT RTP (Beam) Manipulator
Measurement Optics	**One Interferometer-plus-Reflector pair required per axis**
Agilent 10702A	Linear Interferometer
Agilent 10702A-001	Same as above, but with wedge windows — required if interferometer is the moving component.
Agilent 10703A	Reflector — paired with Agilent 10702A
Agilent 10704A	Reflector — paired with Agilent 10705A
Agilent 10705A	Single Beam Interferometer
Agilent 10706A	Plane Mirror Interferometer
Agilent 10706B	High Stability Plane Mirror Interferometer
Agilent 10715A	Differential Interferometer
Agilent 10715A-001	Differential Interferometer, turned configuration
Agilent 10716A	High Resolution Interferometer
Agilent 10716A-001	High Resolution Interferometer, turned configuration
Agilent 10717A	Wavelength Tracker (requires measurement receiver and cable)
Agilent 10719A	One-Axis Differential Interferometer, requires 3 mm beam from Agilent 5517C-003
Measurement Optics (cont.)	**One Interferometer-plus-Reflector pair required per axis**
Agilent 10721A	Two-Axis Differential Interferometer, requires 3 mm beam from Agilent 5517C-003
Agilent 10724A	Plane Mirror Reflector
Agilent 10735A	Three-Axis Interferometer
Agilent 10736A	Three-Axis Interferometer
Agilent 10736A-001	Three-Axis Interferometer with Beam Bender

Table 2 Equipment choices (continued)

Component	Comment(s)
Measurement Optics (cont.)	**One Interferometer-plus-Reflector pair required per axis**
Agilent 10737L	Compact Three-Axis Interferometer, left
Agilent 10737R	Compact Three-Axis Interferometer, right
Agilent 10766A	Linear Interferometer
Agilent 10767A	Linear Retroreflector — paired with Agilent 10766A
Agilent 10767B	Lightweight Retroreflector
Agilent 10770A	Angular Interferometer
Agilent 10771A	Angular Retroreflector — paired with Agilent 10770A
Agilent 10774A	Short Range Straightness Optics (matched set)
Agilent 10775A	Long Range Straightness Optics (matched set)
Agilent E1826E	One-Axis Plane Mirror Interferometer (right)
Agilent E1826F	One-Axis Plane Mirror Interferometer (left)
Agilent E1826G	One-Axis Plane Mirror Interferometer (straight)
Agilent E1827A	Two-Axis Vertical Beam Interferometer
Agilent E1837A	Three-Axis Vertical Beam Interferometer
Agilent Z4399A	Three-Axis Interferometer
Agilent Z4420B	Five-Axis Interferometer
Agilent Z4421B	Five-Axis Interferometer
Agilent Z4422B	Three-Axis Interferometer
Optic Mounts	**Adjustable mounts simplify installation and alignment**
Agilent 10710B	Use with Agilent 10700A, 10701A, 10705A, 10707A
Agilent 10711A	Use with Agilent 10702A, 10706A, 10706B, 10715A, 10716A
Measurement Receivers	**One required per axis; one required with Agilent 10717A Wavelength Tracker (if used)**
Agilent 10780C	Receiver
Agilent 10780F	Remote Receiver
Agilent E1708A	Remote Dynamic Receiver
Agilent E1709A	Remote High-Performance Receiver
Receiver Cables for use with Agilent 10895A VME Axis board — one cable per system	
Agilent 10790A	5 meters long
Agilent 10790B	10 meters long
Agilent 10790C	20 meters long

Table 2 Equipment choices (continued)

Component	Comment(s)
Receiver Cables for use with Agilent 10885A or 10889B Axis boards or Agilent N1231A/B PCI Three-Axis Board — one cable per receiver	
Agilent 10880A	5 meters long
Agilent 10880B	10 meters long
Agilent 10880C	20 meters long
Laser Head Cables for Agilent 5517A/B/BL/C/D/DL/FL Laser Head used with Agilent 10885A, 10889B, or N1231A/B axis boards (cable has a DIN connector for connecting to the Agilent 10884B Power Supply to provide power to the laser head) — one cable per system	
Agilent 10881A	3 meters long
Agilent 10881B	7 meters long
Agilent 10881C	20 meters long
Laser Head Cables for Agilent 5517A/B/BL/C/D/DL/FL Laser Head used with Agilent 10885A, 10889B, or N1231A/B axis boards (cable has spade lugs for connection to a power supply to provide power to the laser head)— one cable per system	
Agilent 10881D	3 meters long
Agilent 10881E	7 meters long
Agilent 10881F	20 meters long
Laser Head Cables for Agilent 5519A/B Laser Head used with Agilent 10887P Programmable PC Calibrator Board in the Agilent 5529A/55292A system— one cable per system	
Agilent 10882A	3 meters long
Agilent 10882B	7 meters long
Agilent 10882C	20 meters long
Laser Head Cables for Agilent 5517A/B/BL/C/D/DL/FL Laser Head, with no reference leg, and carry power only. used with Agilent 10885A, 10889B, or N1231A/B axis boards (cable has spade lugs for connection to a power supply to provide power to the laser head)— one cable per system	
Agilent E1847A-060	3 meters long
Agilent E1847A-140	7 meters long
Agilent E1847A-200	10 meters long
Agilent E1847A-300	15 meters long
Agilent E1847A-400	20 meters long
Agilent E1848A-300	15 meters long
Agilent E1848B-060	3 meters long
Agilent E1848B-140	7 meters long
Agilent E1848B-200	10 meters long

Table 2 Equipment choices (continued)

Component	**Comment(s)**
Laser Head Cables for Agilent 5517A/B/BL/C/D/DL/FL Laser Head, with no reference leg, and carry power only. used with Agilent 10885A, 10889B, or N1231A/B axis boards (cable has spade lugs for connection to a power supply to provide power to the laser head)— one cable per system (Cont.)	
Agilent E1848B-300	15 meters long
Agilent E1848B-400	20 meters long
Accessory Reflectors	**Order as required for your application**
Agilent 10728A	Plane Mirror
Agilent 10769A	Beam Steering Mirror
Agilent 10772A	Turning Mirror
Agilent 10773A	Flatness Mirror
High Performance Laser Head Cable for Agilent 5517B/C/D Laser Head used with the Agilent 10897C and 10898A VME Axis boards, and N1231A/B PCI Axis board (cable has a DIN connector for connecting to the Agilent 10884B Power Supply to provide power to the laser head) — one cable per system	
Agilent N1251B	7 meters (23.0 feet)
High Performance Receiver Cables for use with Agilent 10897C and 10898A VME Axis boards, and N1231A/B PCI Axis board — one cable per receiver	
Agilent N1250A	5 meters (16.4 feet)
Agilent N1250B	10 meters (32.8 feet)

Electronic Components

Transducer Systems

There are three different types of electronics for Agilent laser transducer systems. These electronics use different backplanes and have different performance and outputs. Full details are given in the appropriate electronics system manuals.

PC-Based Electronics

The Agilent 10885A PC Axis Board and Agilent 10889B PC Servo-Axis Board are compatible with PC (ISA) backplanes.

Up to six Agilent 10885As may be used in a single system.

VME Compatible Electronics

The Agilent 10898A High Resolution VMEbus Dual Laser Axis Board, Agilent 10897C High Resolution VMEbus Laser Axis Board, and Agilent 10895A VMEbus Laser Axis Board are compatible with VME backplanes.

The Agilent 10896B VME Laser Compensation Board is also compatible with VME backplanes and works with the other Agilent VME Axis boards. Up to six Agilent 10895As and several Agilent 10896As (up to one for each Agilent 10895A) may be used in a single system.

PC-Based PCI Electronics

The Agilent N1231A PCI Three-Axis Board is optimized for connection to a PMAC motion control system from Delta Tau®. It is a full size, Universal (3.3V and 5.0V signaling compatibility), 32-bit, 33 MHz, PCI Rev. 2.2 compliant card for use in PC-compatible controllers as part of an Agilent laser interferometry position measurement system. The Agilent N1231B PCI Three-Axis Board with external sample has a generalized hardware interface and twice the resolution of the Agilent N1231A PCI Three-Axis Board.

Calibrator System Electronics

Agilent 5529A/55292A Dynamic Calibrator

The Agilent 5529A/55292A Dynamic Calibrator is a laser system used to ensure the accuracy of a machine's motion and positioning. Controlled through your PC (with Microsoft® Windows installed), the system is able to collect and analyze measurement data for a number of measurements. The Agilent 5529A/55292A Dynamic Calibrator typically includes the following electronic components:

- Agilent 5519A/B Laser Head
- Agilent 10886A PC Compensation board (optional, for automatic compensation)
- Agilent 10887B PC Calibrator Board
- Agilent 10751C/D Air sensor and Agilent 10757D/E/F Material Temperature sensor(s) (optional, as required)
- Agilent 10888A Remote Control units (optional)
- Agilent 55292A USB Expansion Module (optional, to house the PCI-ISA bus 10886A and 10887B boards and provide USB connectivity to them.)

The PC compensation boards provide the interfaces between the air and material temperature sensors and your PC. The boards convert the analog electrical voltages from the sensors to digital forms that the PC uses to calculate the compensation factors. These factors adjust for changes in the systems' operating environments. Typical sensors used with each Agilent 10886A PC Compensation board are the Agilent 10751C,D Air Sensor and one to three Agilent 10757D,E,F Material Temperature sensors.

The Agilent 10887B PC Calibrator Board enable the PC to perform laser calibrator-related functions with the Agilent 5529A calibrator software.

An Agilent Two-Axis 5529A/5529A Dynamic Calibrator and an Agilent 55292A USB Expansion Module are also available. The USB software hosts up to five axes on one computer.

Adjustment Considerations

In general, when aligning the Agilent optics, it will be necessary to adjust most or all of the optical components. Most optics are not referenced to their housings since simple adjustments by the user can usually provide optimum alignment. The Agilent 10710B and Agilent 10711A Adjustable Mounts should be used to provide the adjustment capability for most optical components.

For systems having many measurement axes, using the Agilent N1209A RPT beam maniplulator may pay for itself by reducing the time spent aligning the system. See Chapter 17, "Beam-Directing Optics" in Volume II for details on the Agilent N1209A RPT.

There are a few exceptions, however. Certain optics designed for multiaxis systems provide referenced housings. Installation and alignment of these optics depends on the optic; refer to specific instructions for these optics (Agilent 10719A, Agilent 10721A, Agilent 10735A, Agilent 10736A) elsewhere in this manual.

Other optics require you to fabricate your own mounts.

In general, the alignment procedures are performed with all optical components in place. Your measurement system design should allow for adjustment of the laser, optics, and receivers during alignment.

Laser beam and optics protection

The laser measurement system requires protection against unintentional laser beam blockage and air turbulence problems. In some applications, such as machine tools, protection should be provided to prevent metal chips or cutting fluid from interfering with the measurements. Also, the optical components usually require protection to prevent contamination of the optical surfaces by oil or cutting fluid. In applications which are considered "clean", protection may not be needed.

If protection of the laser beam and optical components is required, there are two general types: moving-component protection and stationary component protection.

In many applications, the only moving component is the interferometer or the reflector. Many of the beam benders are stationary and only direct the laser beam to the measurement axis. In these cases, it is only necessary to provide fixed tubing for the laser beam and some type of sealed enclosure for the optics. Since only one laser beam of approximately 6 mm (0.24 inch) in diameter is involved, relatively small diameter tubing can be used. Since either the interferometer or the reflector is moving during the measurement, protecting the laser beam and the moving components requires a telescoping cover or a cover that is self-sealing. A wide variety of commercially available protective covers are suitable for this purpose.

Figure 6 illustrates techniques for protecting the laser beam and optical components with different types of protective covering. Note that the cover for the retroreflector allows the retroreflector to be moved very close to the interferometer. This helps minimize the deadpath errors. Chapter 12, “Accuracy and Repeatability,” in this manual has more details on minimizing deadpath

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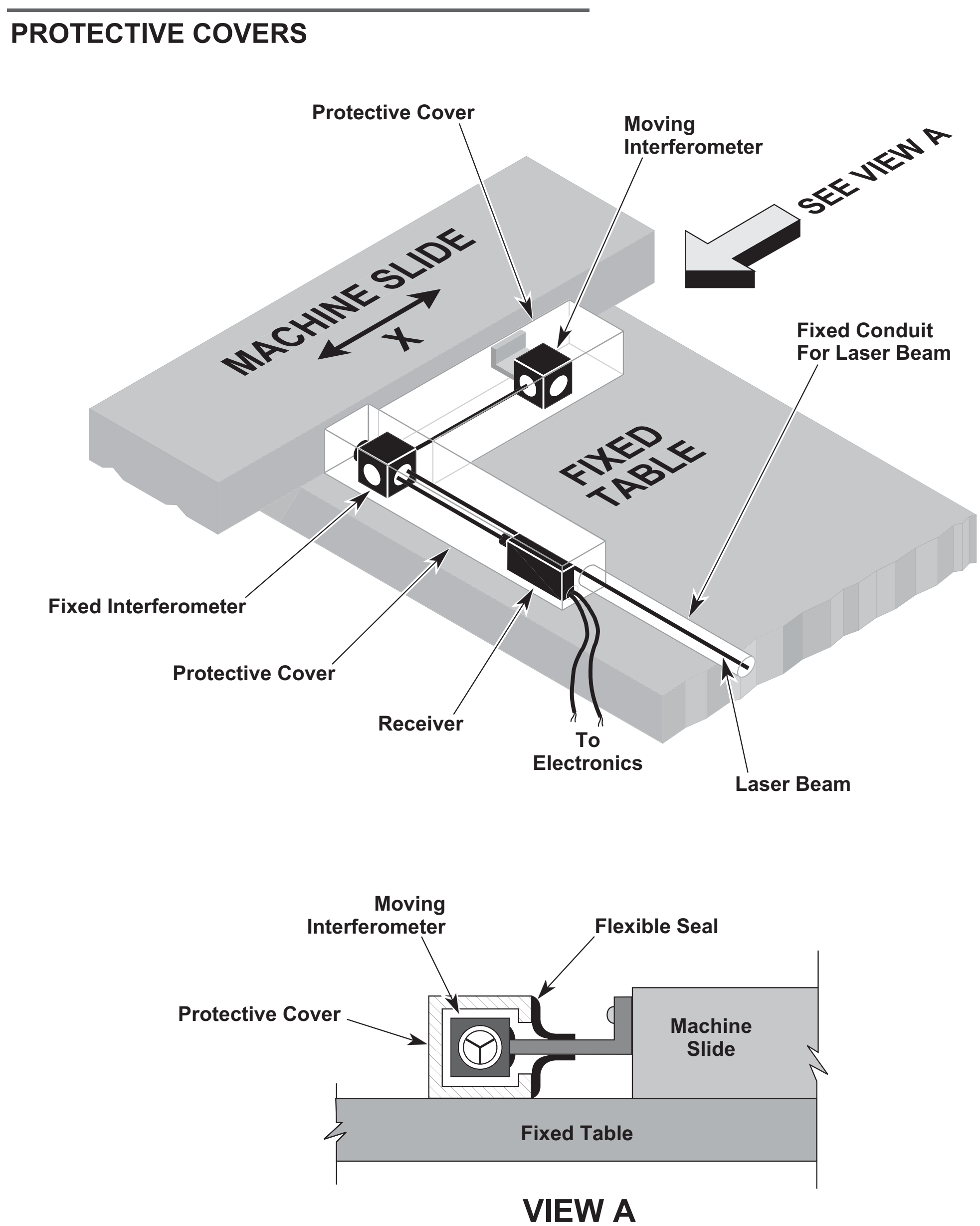


Figure 6 Protective covers for optics and laser beam

Figure 7 shows a different type of protective cover. Again, the mechanical arrangement allows the retroreflector to be close to the interferometer at the closest point of travel, even though the telescoping cover is not entirely collapsible. Another type of protective cover is the flexible bellows. This is generally used for short travel distances.

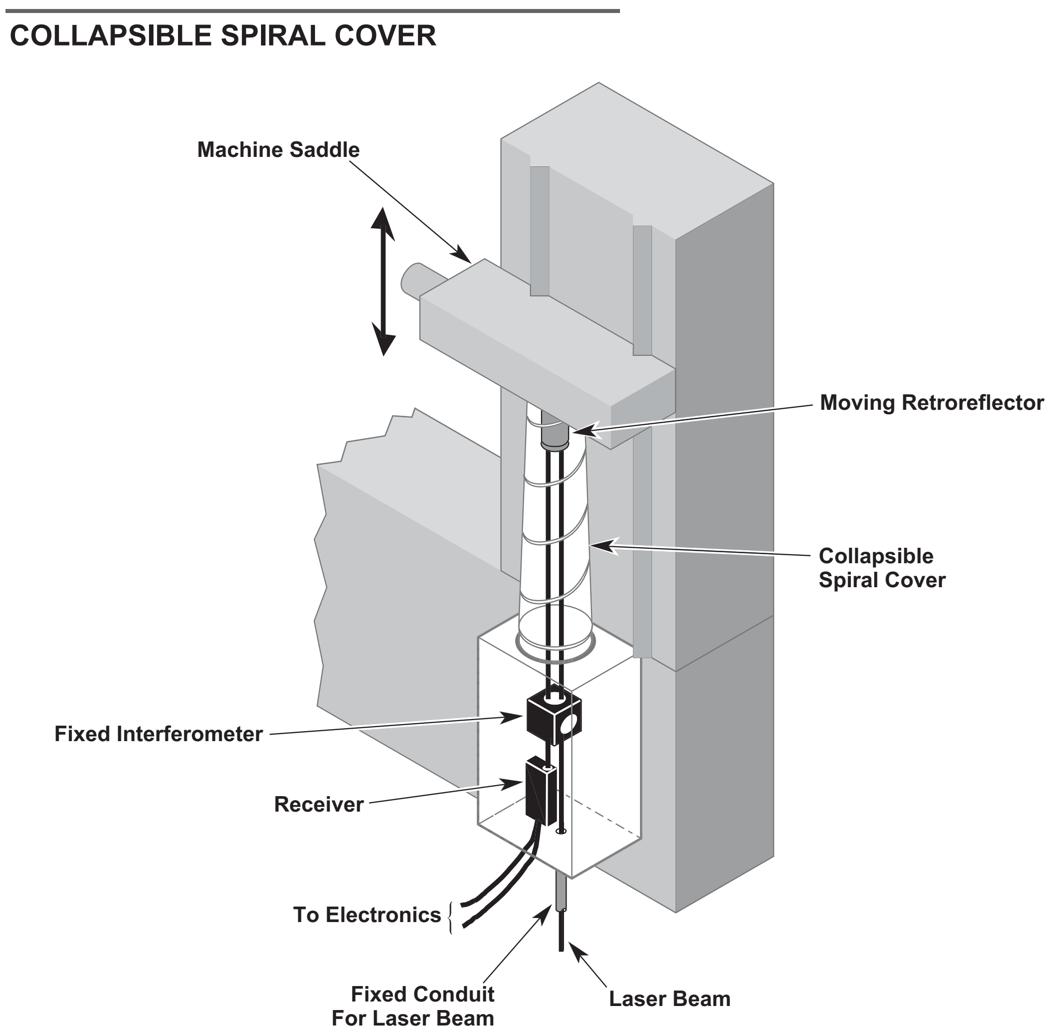


Figure 7 Collapsible spiral cover for movable retroreflector

System Grounding

Be sure to consider electrical grounding requirements as you plan and install your Agilent laser measurement. Grounding is important for safety reasons, but your grounding arrangement can also affect your laser system's performance.

Best practice requires that all system components that are connected to electrical ground should be connected to ground at a common point, not at separate points. Your electrical ground connections should radiate from a single point. Using more than one grounding point could create a ground loop, which could introduce an unacceptable level of electrical noise into the electronics.

Signal grounds on each Agilent laser head, each Agilent receiver and the Agilent laser measurement system electronics are all connected to their respective chassis. To prevent ground loops they all should be grounded through one common point.

The Agilent 10780C or Agilent 10780F receiver mounting is isolated from ground by using the nylon screws supplied.

A system using VME electronics (Agilent 10898A, Agilent 10897C, and Agilent 10895A axis boards), PC electronics (Agilent 10885A and Agilent 10889B axis boards) or PCI electronics (N1231A/B axis board) should be grounded through the electronics power line.

Laser Head

Orientation

An Agilent laser head may be mounted in any orientation as long as it is positioned to direct the beam into the optical system parallel to or orthogonal with the machine axes being measured. See Chapter 16, Laser Heads," in Volume II of this manual for more information about laser head orientation.

Mounting plane tolerance

The plane defined by the three mounting feet on the laser head must be parallel to either the bottom or sides of the beam-splitters and of the beam-bender housings to within ± 3°, and to the bottom or sides interferometers to within ± 11°. This ensures that the polarization axes of the interferometers are oriented properly relative to the polarization vectors of the laser beam (Figure 8). The laser head can be rotated in 90° increments about the beam axis (roll) without affecting the system performance, but the measurement direction sense will change with each 90° rotation.

Allow 50 mm (2 inches) clearance around the laser head for easy servicing. Allow at least 100 mm (4 inches) clearance at the back of the laser head for cable connections.

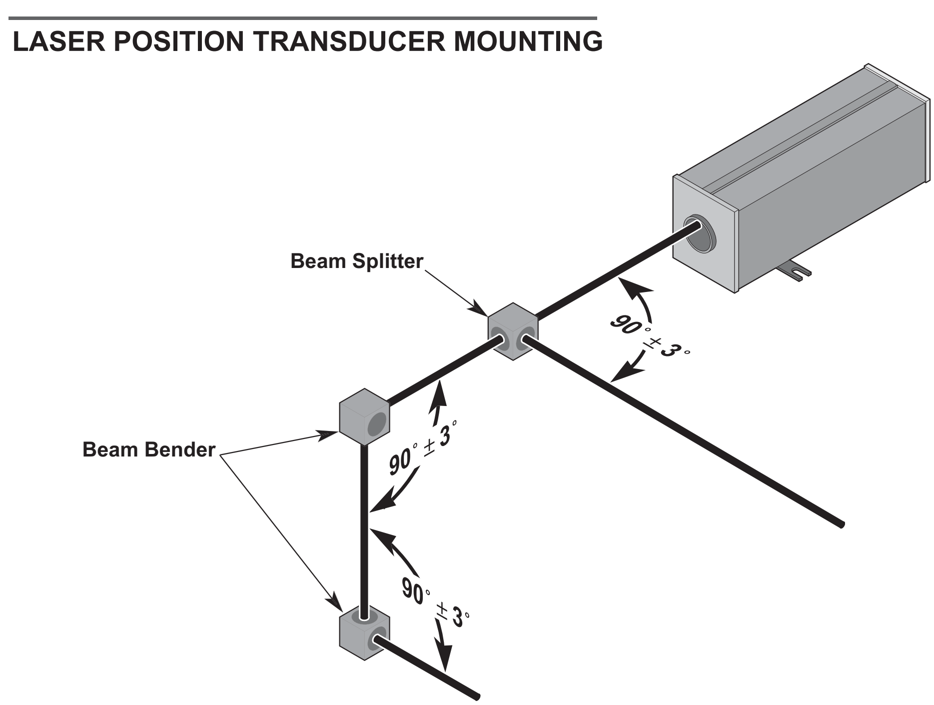


Figure 8 Laser position transducer mounting

Pointing stability

To maintain good pointing stability, it is good practice to use kinematic mounting principles. Refer to Chapter 16, Laser Heads," in Volume II of this manual for more information about laser head pointing stability.

Thermal isolation

Because there is some heat dissipation from the laser heads, you should choose the mounting method and location with care. Where possible, mount the laser head away from the measuring area, to avoid any thermal effects.

Vibration isolation

Since the system measures only the relative motion between the interferometer and reflector, measurements are not affected by vibration along the beam axis of the laser source or the receiver.

When vibration of the laser head causes displacement of the beam (perpendicular to beam axis) at an interferometer or receiver, the beam signal power can fluctuate. If this fluctuation is too great, insufficient beam signal will arrive at the receiver, causing a "measurement signal error."

Magnetic shielding

Agilent laser heads contain a permanent magnet. When installing an Agilent laser measurement system in an application sensitive to magnetic fields, shielding around the laser head may be required.

Mounting

See Chapter 16, Laser Heads," in Volume II of this manual for laser head installation and mounting instructions.

The laser source in Agilent 5517C-009 9-mm Laser Head is referenced to locations on the outside of the laser head, allowing the laser head to be installed in a predefined mounting location, minimizing the need for laser head alignment. A diagram of the mounting location for this laser head is presented in Figure 20.

Optics

Plane of orientation with respect to laser head

The mounting plane tolerance of the optics to the laser head is the same as discussed in the paragraph titled “Mounting plane tolerance,” above. That is, the bottom or sides of the interferometers should be parallel to within ± 1° of the plane defined by the laser head’s three mounting feet.

Effect of optics on measurement direction sense

The orientation and configuration of the interferometers affects the measurement direction sense. The direction sense depends on which frequency is in the measurement path of the interferometer. For example, if f_1 (lower frequency) is in the measurement path and f_2 (higher frequency) is in the reference path and the optics are moving away from each other, the fringe counts will be INCREASING. This corresponds to using an Agilent 5517A, Agilent 5517B, or Agilent 5517C Laser Head (mounting feet in horizontal plane) with an Agilent 10702A Linear Interferometer mounted with labels facing up and down (see Figure 9). Interchanging f_1 and f_2 (e.g., rotating interferometer 90°) in this example will result in the fringe counts DECREASING.

The optical schematics for the interferometers, in Chapter 5, “Measurement Optics (General Information),” show which frequency polarizations are in the measurement path.

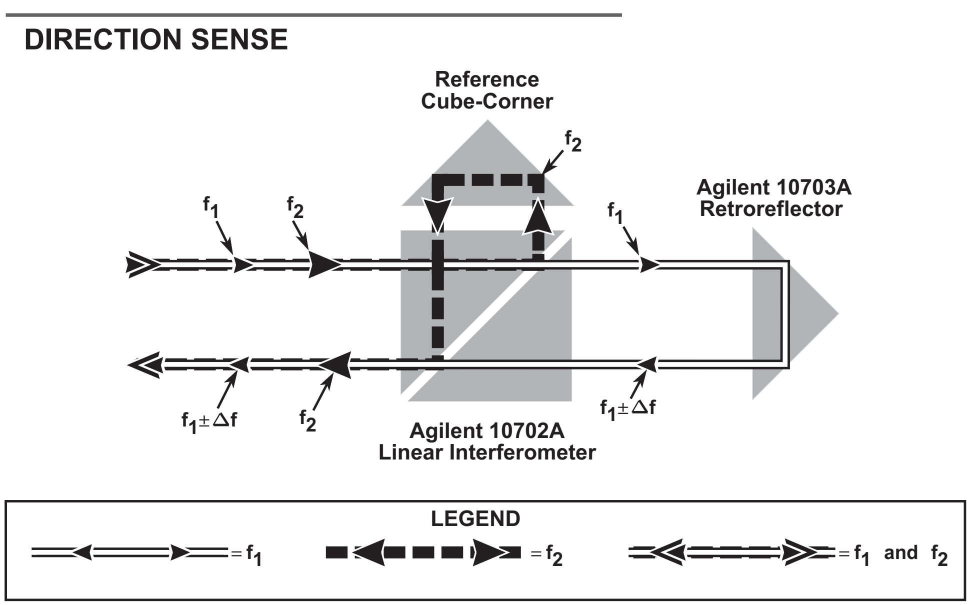


Figure 9 Direction sense - fringe counts increase as optics move apart

As with the laser heads, when the interferometers are rotated 90°, the measurement direction sense will change. This rotation causes switching of frequencies in the measurement path.

Configuration effects

Many of the distance-measuring interferometers can be configured to turn the beam at right angles. When configuring the linear, single-beam, and plane mirror interferometers to turn the beam, the measurement direction sense will be changed. This is because the measurement and reference paths are switched on the interferometers, therefore changing the direction sense. For more information, see the Chapter 5, “Measurement Optics (General Information),” in this manual.

Vibration isolation for optics

Vibration of the optics along the beam can cause the fringe count in the laser measurement system electronics to fluctuate rapidly. Vibrations along this axis constitute real, measurable, displacements; you will have to decide if these fluctuating measurements are acceptable in your application. In extreme cases, however, the velocity of the optics may momentarily exceed the velocity limitation of the laser system, causing an error.

When vibration occurs perpendicular to the beam, the beam signal power can fluctuate. If this fluctuation is too great, insufficient beam signal will arrive at the receivers, causing a “measurement signal error”.

Loose mounting can cause the optics to move inappropriately during a measurement, causing a measurement error or loss of beam power.

Elastic mounting can have the same effect as loose mounting. It can also be responsible for a “sag” offset in the optics’ positions. If there is vibration in the machine, an elastic mounting can transmit and amplify the vibration to the attached optic, possibly causing more errors. You should anticipate these effects and minimize them, if necessary, during the laser measurement system design process.

Certain interferometers are inherently less susceptible to vibration effects than others. This is particularly true of differential-style interferometers such as the Agilent 10715A, Agilent 10719A, and Agilent 10721A. The stability of these interferometers is due to the fact that both their reference beams and their measurement beams travel to external mirrors. Any motion of the interferometer itself that is common to both beams will not appear as a measurement. Of course, any vibration between the reference and measurement mirrors will constitute real, measurable, displacements.

Adjustable mounts for optics

The optical elements inside several of the Agilent laser measurement system optics are not precisely referenced to their housings. In most applications involving these optics, a few simple alignments during system installation can usually provide equal or better alignment than referencing the optics to their housings. Therefore, slight positioning adjustments of the unreferenced interferometers, beam splitters, and beam benders are needed for proper system alignment.

Positioning adjustments for most optics can be provided by using Agilent 10710B or Agilent 10711A Adjustable Mounts, as appropriate. These mounts allow adjustment of pitch and yaw of any attached optic. (Roll adjustment is typically not required, and can usually be avoided by careful optical system layout.)

For a listing of which Adjustable Mount supports which optic, see the Chapter 36, Accessories," in Volume II of this manual.

In some applications, referenced housings can provide significant advantages. For example, the alignment requirements for certain multiaxis applications can be difficult or impossible to achieve without referenced housings. In those cases, interferometers such as the Agilent 10719A, Agilent 10721A, Agilent 10735A, Agilent 10736A, and all of the NGI optics should be considered. These products have referenced housings and prealigned optical elements. Because they have individual mounting requirements, these products are not intended for use with the adjustable mounts described above. For more information about these optics, refer to Chapter 5, "Measurement Optics (General Information)," and Chapter 6, "NGI Measurement Optics (General Information) in this manual.

Fasteners for optics

Any optical component that fits an adjustable mount is supplied with mounting screws to mount it on the appropriate adjustable mount.

Vacuum applications

There are vacuum options for Agilent optical components, which are compatible with vacuum environments. Contact Agilent Call Center for information (telephone numbers of various call centers are listed on the "Service and Support" page at the back of this manual). The housings of these components are made of stainless steel and the optical elements are attached to these housings using a low volatility (space grade) adhesive. See the "Specifications" information for each optic for a list of materials used in the optic.

If the laser beam has to go through a window (for example into a vacuum chamber) the window must meet the following requirements:

1 A minimum window aperture of 25.4 mm (1 inch) with a minimum thickness of 8 mm (0.3 inch). If a larger window is used, it must be proportionally thicker to assure no distortion in the window when under differential pressures.
2 Transmitted wavefront distortion less than $\lambda/10$ (peak-valley, single-pass) over a 23 mm (0.9 inch) diameter.
3 Parallelism of faces less than ±2 arc-minutes, to reduce beam steering.
4 Surface quality 60-40 or better, per Mil-0-13830.
5 The window must be strain-free.

Differential measurements with interferometers

Several interferometers have the capability to make differential measurements. A differential measurement is one in which both the reference beam and the measurement beam travel to external mirrors outside the interferometer housing. This allows measurement of the relative positions of the two external mirrors, either or both of which may be moving. Viewed another way, this allows measuring the motion of one reflector relative to a reference datum elsewhere in the machine, external to the interferometer itself. This is unlike the typical interferometer configuration because usually the reference beam path length does not change; in differential configurations, it can.

One useful example of a differential measurement in a lithography application is for measuring the motion of the X-Y stage relative to the optical column. The Agilent 10719A One-Axis Differential Interferometer (shown in Figure 170 of Chapter 25 in Volume II) and the Agilent 10721A Two-Axis Differential Interferometer (shown in Figure 178 in Chapter 26) are ideally suited to this type of measurement, because they provide parallel reference and measurement paths which are offset vertically by 19 mm (0.750 inch). For such an application, a user-supplied reference plane mirror is required in addition to the measurement reflector on the X-Y stage.

The Agilent 10715A interferometer (shown in Figure 140 in Chapter 22 of Volume II) also permits differential measurements between two plane mirrors. However, instead of having an offset spacing as in the Agilent 10719A or Agilent 10721A, the Agilent 10715A permits the reference beams and the measurement beams to be aligned essentially coaxially. A specially-shaped reference plane mirror is supplied with the Agilent 10715A.

Customized differential configurations are possible with several other interferometers. However, considerable care should be exercised during design and layout to avoid introduction of alignment errors, thermal or mechanical instabilities, and potential deadpath problems. When making differential measurements, both reflectors (reference and measurement) should be of the same type (cube corner or plane mirror); this minimizes thermal drift problems with ambient temperature changes.

To use the Agilent 10702A, Agilent 10705A, or Agilent 10766A in a differential configuration, the reference cube corner can simply be detached from the interferometer housing and attached to the reference surface of interest. This is shown in Figure 106 in Chapter 18 of Volume II. Be aware that all installation and alignment requirements for the measurement reflector now apply also to the reference reflector.

To use the Agilent 10706A or Agilent 10706B interferometer in a differential configuration, a plane mirror is recommended as the reference reflector. Simply replace the reference cube corner (or high-stability adapter) with the Agilent 10722A Plane Mirror Converter and attach the reference plane mirror to the reference surface of interest. This is shown in Figure 122 in Chapter 20 of Volume II. Again, install and align the reference reflector the same as you would the measurement reflector.

Moving interferometer instead of reflector

When moving the interferometer instead of the measurement reflector is required, the Agilent 10702A-001 (or Agilent 10766A) should be used. In practice, for alignment reasons, these are the only interferometers (except the straightness interferometers) that can be moved while making measurements. For a detailed explanation of why this option is required, see Figure 101 in Chapter 18 of Volume II.

Introducing an offset into the laser beam

There may be an occasion when you will want to simply introduce an offset into your laser beam, to get it from the laser head to the interferometer without having to relocate either one of them. Figure 10 shows two ways in which this can be done.

To simply translate the beam, you can use two reflectors (such as the Agilent 10726A Beam Bender) as a “periscope”, as shown in Figure 10(A). Changing the spacing between the reflectors, or rotating the device can change the amount of offset.

To reverse the direction of the beam, you can use two reflectors in a “retroreflector” arrangement as shown in Figure 10(B).

Beam Path Loss Computation

Multiaxis positioning systems must be designed to allow sufficient optical power to reach each Agilent 10780C, Agilent 10780F, Agilent E1708A, or Agilent E1709A Receiver in the system.

Since all optics have an efficiency of less than 100%, an optical power loss budget must be created as a part of any multiaxis system design. This chapter defines optical efficiency as it relates to the signal loss through components. A method for computing the optical power loss in a system is described.

Considerations

The following considerations are important in designing a reliable multiaxis measuring system:

- When using the Agilent 10780C/F or Agilent E1708A receivers, typically up to four measurement axes can be easily implemented without optical power loss imposing significant constraints. A system of five or six axes is usually feasible, although closer attention to the power loss budget is required. A system having more than six axes is possible under certain circumstances (with PC- or VME-based electronics), but the optical power loss budget quickly becomes the limiting constraint. The Agilent E1709A receiver was designed for systems that have more than six measurement axes.
- Minimum laser output power is 120 microwatts for the laser heads. The typical laser output power is about 400 microwatts. The output power is relatively constant over the life of the tube, and tends to drop off immediately at the end.
- Higher laser output power is available upon request.

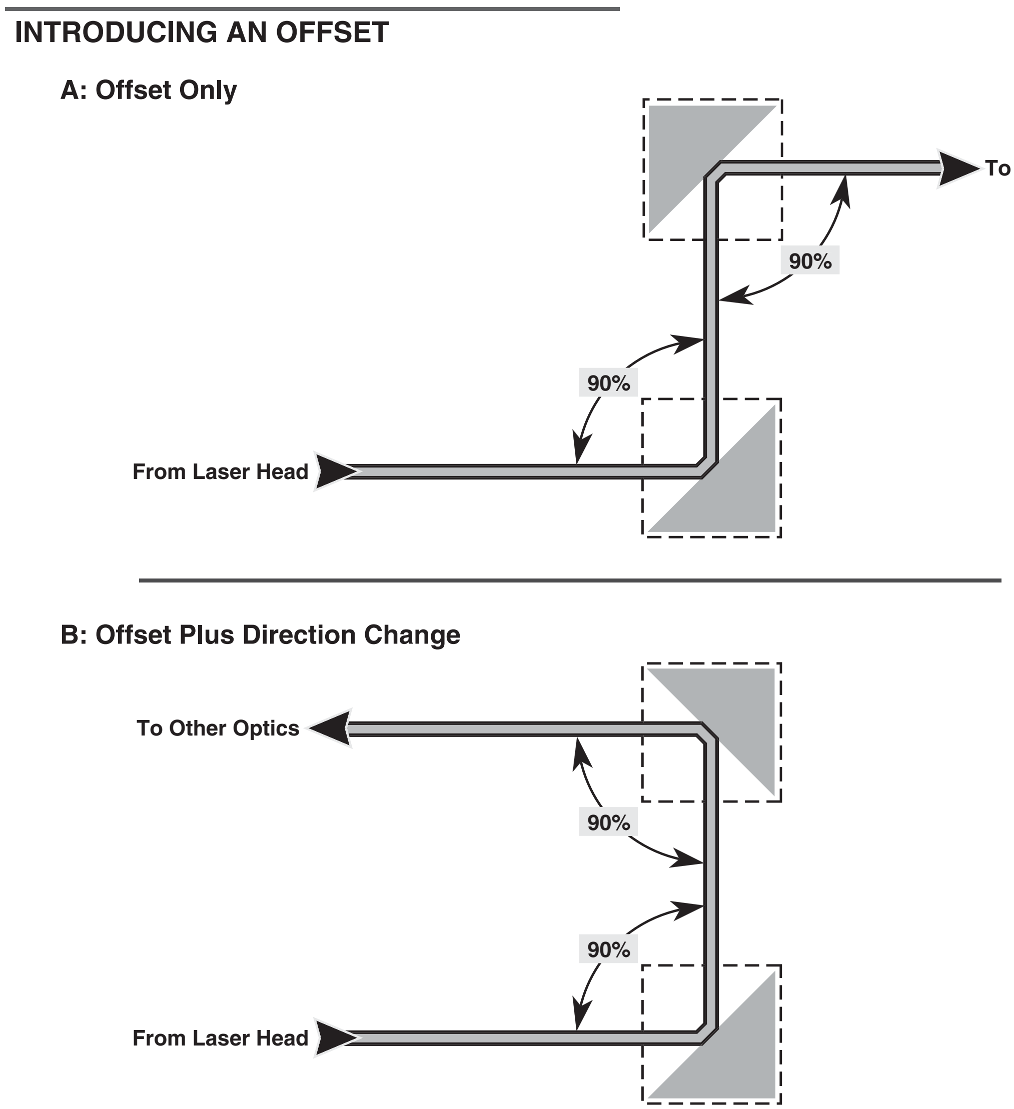


Figure 10 Introducing an offset into the laser beam

- Minimum required power at the Agilent 10780C Receiver is 1.5 microwatts. The Agilent 10780F Remote Receiver and Agilent E1708A Remote Dynamic Receiver require 2.2 microwatts with its standard 2-meter fiber-optic cable (more with longer cables). The Agilent E1709A Remote High-Performance Receiver requires a minimum of 0.20 to 0.80 microwatts, depending on the AC/DC ratio, with standard 2-meter plastic fiber-optic cable. (Adjustment of the receiver's gain is required to obtain this sensitivity. See the alignment and gain adjustment procedures in Chapter 35, Receivers," in Volume II of this manual.)

- The beam splitters have “worst-case” as well as “typical” transmission and reflection specifications. Refer to the paragraphs titled “Axis component efficiencies (worst case)” and “Axis component efficiencies (typical)” on the following pages, for these specifications.
- In addition, all optics have small reflection and absorption losses that occur at each internal interface or component, which is taken into account in their efficiency value.
- Fingerprints, dirt, or oil on a glass surface significantly reduce optical efficiency by increasing both reflection and absorption losses.
- System misalignment also reduces the amount of light reaching the receiver.
- Thermal gradients in the beam path can bend the beam and distort the wave front, both of which reduce optical signal strength at the receiver.

Calculation of signal loss

In order to assess the signal loss in a measurement system, each optical component has been characterized by both worst case and typical optical efficiencies. These efficiency values for each optical component are listed in the “Specifications” section for each optic (that is, the specifications section in Chapter 17, Beam-Directing Optics,” for beam splitters and chapters 18 through 34 in Volume II of this manual for interferometers.)

Optical efficiency is defined as:

$$Efficiency = \frac{Optical\ Power\ Out}{Optical\ Power\ In}$$

The optical efficiencies for the interferometers are given with the respective measurement reflector efficiency included. For example, the Agilent 10702A Linear Interferometer efficiency includes the efficiency of the Agilent 10703A Retroreflector.

The combined optical efficiency of a given measurement axis is the product of the efficiencies of the individual optics in the beam path. This combined efficiency times the minimum laser output power in microwatts yields the worst case optical power at the receiver. This value must be at least 1.5 microwatts for the Agilent 10780C Receiver, or 2.2 microwatts for the Agilent 10780F Remote Receiver and Agilent E1708A Remote Dynamic Receiver, or 0.20 to 0.80 microwatts for Agilent E1709A Remote High-Performance Receiver. A beam power safety factor of at least three is recommended even though worst case laser and optics are assumed. Creating a system with five or more axes of measurement may result in a beam power safety factor that is less than three.

As an example, consider a typical installation with two measurement axes and a Wavelength Tracker axis (Figure 165 in Chapter 24 of Volume II). Assume differential interferometers, good optical alignment, 98% efficient plane mirrors (on the stage), comparable path lengths, and use of any Agilent laser head.

The three axes — X, Y, and Wavelength Tracker (WT) — have the components listed in the following table.

Axis component efficiencies (worst case)

Axis	Component	Component Efficiencies (Worst Case)
X	Agilent 10700A (67% path)	61%
X	Agilent 10701A	39%
X	Agilent 10715A	25%
Y	Agilent 10700A (67% path)	61%
Y	Agilent 10701A	39%
Y	Agilent 10715A	25%
W	Agilent 10700A (33% path)	27%
W	Agilent 10707A	98%
W	Agilent 10717A	25%

Assuming a minimum laser power of 120 microwatts, you can calculate the worst-case power at the X, Y, and Wavelength Tracker receivers by multiplying the product of component efficiencies by the laser output power:

Power at X = $0.61 \times 0.39 \times 0.25 \times 120 = 7.1$

Power at Y = $0.61 \times 0.39 \times 0.25 \times 120 = 7.1$

Power at WT = $0.27 \times 0.98 \times 0.25 \times 120 = 7.9$

This system has a power safety factor of 4.7 at worst case (based on use of the Agilent 10780C Receiver, which requires 1.5 microwatts) for each axis resulting in reliable operation and easy alignment.

You can also calculate this safety factor using the typical optical efficiency values, listed in the following table.

Axis component efficiencies (typical)

Axis	Component	Component Efficiencies (Typical)
X	Agilent 10700A (67% path)	63%
X	Agilent 10701A	45%
X	Agilent 10715A	36%
Y	Agilent 10700A (67% path)	63%
Y	Agilent 10701A	45%
Y	Agilent 10715A	36%
W	Agilent 10700A (33% path)	30%
W	Agilent 10707A	99%
W	Agilent 10717A	36%

Using the typical laser power of 400 microwatts, you can calculate the typical power at the X, Y, and Wavelength Tracker receivers by multiplying the product of each component efficiency by the laser output power for each axis.

Power at X = $0.63 \times 0.45 \times 0.36 \times 400 = 40.8$

Power at Y = $0.63 \times 0.45 \times 0.36 \times 400 = 40.8$

Power at WT = $0.30 \times 0.99 \times 0.36 \times 400 = 42.8$

By using the typical efficiencies of the component, a safety factor greater than 28 is achieved (based on use of the Agilent 10780C Receiver, which requires 1.5 microwatts). The Agilent 10780F (2.2 microwatts), Agilent E1708A (2.2 microwatts), and Agilent E1709A (0.20 to 0.80 microwatts) receivers are more sensitive. Hence, can operate with more axes.

Receivers

General

When determining the receiver mounting locations and positions, keep the following points in mind:

1 At a 45° position (roll), the signal will go to zero.

2 The receiver typically dissipates 2.0 Watts, with a maximum dissipation of 2.7 Watts. Plastic pads keep an air gap around the receiver and act as thermal and electrical isolators.

CAUTION Use nylon screws only (Agilent 2360-0369). The receiver housing must be electrically isolated from the mounting fixture.

1 The remote sensor in the Agilent 10780F Remote Receiver, Agilent E1708A Remote Dynamic Receiver, and Agilent E1709A Remoter High-Performance Receiver does not dissipate any power. The remote sensor does not require a nylon screw.

2 Allow a 5 cm space at the rear of each receiver housing for each cable connection.

3 The fiber-optic sensor head of the Agilent 10780F, E1708A, and E1709A receivers may be mounted directly to certain interferometers (Agilent 10719A, Agilent 10721A, Agilent 10735A, Agilent 10736A, Agilent 10737L, R) or directly to optional adapter plates (Option 080) available for the Agilent 10702A, Agilent 10705A, and Agilent 10706A/B interferometers. Alignment pins are provided for easy installation and alignment. This eliminates the need for any other user-supplied mount for the sensor head.

4 Maintain a bend radius not less than 35 mm (1.4 inches) to prevent signal attenuation in the receiver´s fiber optic cable.

Clearance for laser beam

Figure 263 in Chapter 35 in Volume II of this manual shows the Agilent 10780C and Agilent 10780F receivers and the proper beam spacing.

Alignment adjustment required

The Agilent 10780C, Agilent 10780F, Agilent E1708A, or Agilent E1709A receiver requires an alignment relative to the input beam to maximize measurement signal strength. See the alignment and gain adjustment procedures in Chapter 35, “Receivers,” of this manual.

Example Configurations

Single-axis system for servo-track writing

Figure 11 shows a single-axis system to control servo-track writing. This system uses one each of:

- Agilent 5517A, 5517B, or 5517C Laser Head
- laser head cable
  - Use an Agilent N1251B High Performance Laser Head Cable to connect to Agilent 10898A VME electronics board or Agilent N1231A/B PCI electronics boards.
  - Use an Agilent 10881A/B/C Laser Head Cable to connect to Agilent 10885A or Agilent 10889B PC-compatible electronics boards.
  - Use an Agilent 10891A/B/C Laser Head Cable to connect to Agilent 10895A VME electronics boards.
- Agilent 10705A Single Beam Interferometer
- Agilent 10704A Reflector
- Agilent 10780C Receiver
- Receiver cable
  - Use an Agilent N1250A/B Receiver Cable to connect to Agilent N1231A/B PCI electronics boards, Agilent 10897C VME electronics board, or Agilent 10898A VME electronics board.
  - Use an Agilent 10880A/B/C Receiver Cable to connect to Agilent 10885A or Agilent 10889B PC-compatible electronics boards.
  - Use an Agilent 10790A/B/C Receiver Cable to connect to Agilent 10895A VME electronics boards..
- Agilent laser axis of measurement electronics (Agilent 10885A, 10889B, 10897C, 10898A, or N1231A/B)

SINGLE-AXIS SYSTEM

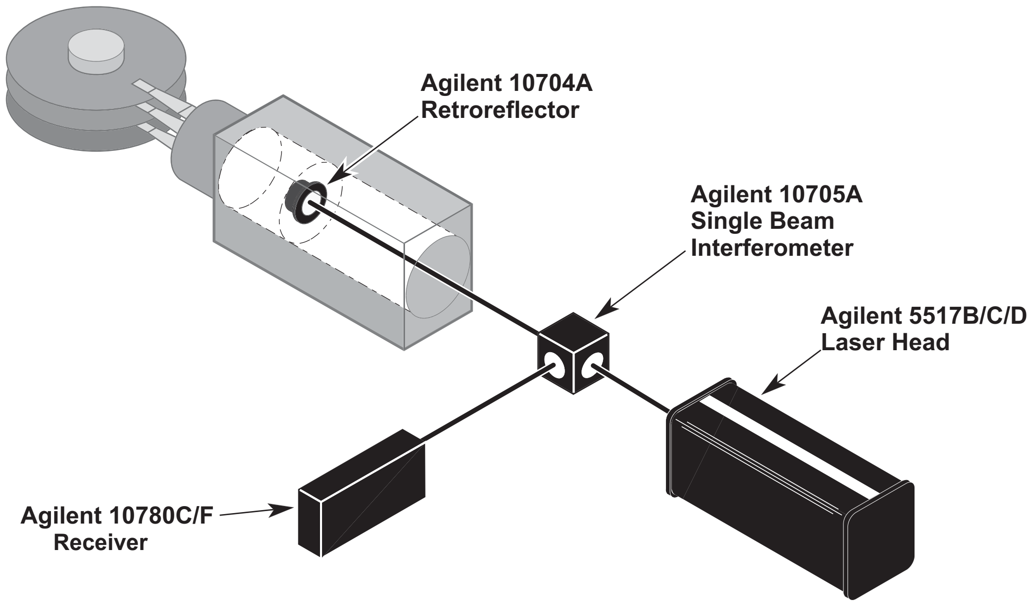


Figure 11 Single-axis system for servo-track writing

Multiaxis configurations

The maximum number of independent axes of displacement that can be measured using one laser head depends on: 1) the measurement system electronics, 2) the strength of the beam from the laser head, and 3) the sensitivity of the receivers used.

By using the proper combination of beam splitters, beam benders, and interferometers, the measurement axes can be established with a minimum number of components. The following paragraphs provide examples of routing the laser beam for multiaxis measurement configurations.

Multiaxis system for a precision x-y stage

Figure 12 shows a multiaxis system for a precision X-Y stage. This system uses:

- one Agilent 5517C Laser Head
- one laser head cable
  - Use an Agilent N1251A/B High Performance Laser Head Cable to connect to Agilent 10895A, Agilent 10897C, or Agilent 10898A VME electronic boards.
  - Use an Agilent 10881A/B/C Laser Head Cable to connect to Agilent 10885A, Agilent 10889B, or Agilent N1231A/B PC-compatible electronics.

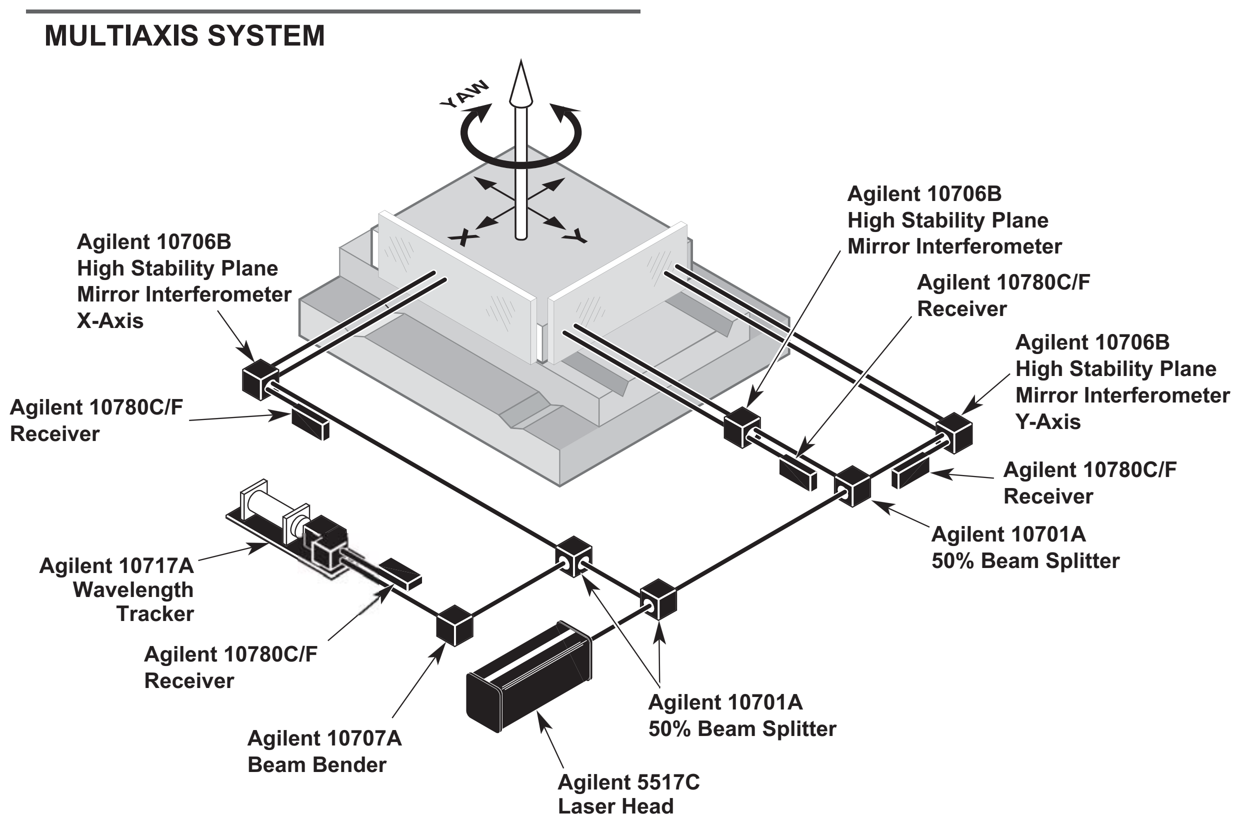


Figure 12 Multiaxis system for a precision x-y stage

- three Agilent 10701A 50% Beam splitters
- three Agilent 10706B High Stability Plane Mirror interferometers
- one Agilent 10707A Beam Bender
- one Agilent 10717A Wavelength Tracker

- four Agilent 10780F Remote receivers
- four receiver cables
    - Use Agilent 10790A/B/C Receiver cables to connect to Agilent 10895A VME electronics boards.
    - Use either the Agilent 10880A/B/C or the N1250A/B (high performance) Receiver cables to connect to Agilent 10885A, 10889B, or N1231A/B PC-compatible electronics boards or Agilent 10897C or Agilent 10898A VME electronics boards.
- four Agilent 10710B Optics mounts
- three Agilent 10711A Optics mounts
- three Agilent laser axis of measurement electronics (Agilent 10885A, Agilent 10889B, Agilent 10895A, Agilent 10897C, Agilent 10898A, or Agilent N1231A/B)

NOTE

The Agilent 10751A/A/B and Agilent 10757A/B/C sensors cannot be used with the Agilent 10886A PC-compatible electronics board, because the Agilent 10885A has different connectors. Use the Agilent 10751C/D and Agilent 10757D/E/F sensors instead.

- one Agilent Automatic Compensation Board

Four-axis linear configuration

Figure 13 shows a four-axis measurement configuration with all components aligned in one plane. Note that any of the components (beam benders, beam splitters, or interferometers) could be rotated in 90° increments to provide a three-dimensional configuration. Since interferometers can also bend the laser beam through 90°, the number of components can be minimized.

NOTE

In an application where the Agilent 10702A Linear Interferometer is the moving component and the Agilent 10703A Retroreflector is the fixed reference, the Agilent 10702A Linear Interferometer-001 must be used to eliminate alignment errors. If a right-angle beam bend is made through the Agilent 10702A, it must be the fixed component. When the Agilent 10705A Single Beam Interferometer is used, it must be the fixed component.

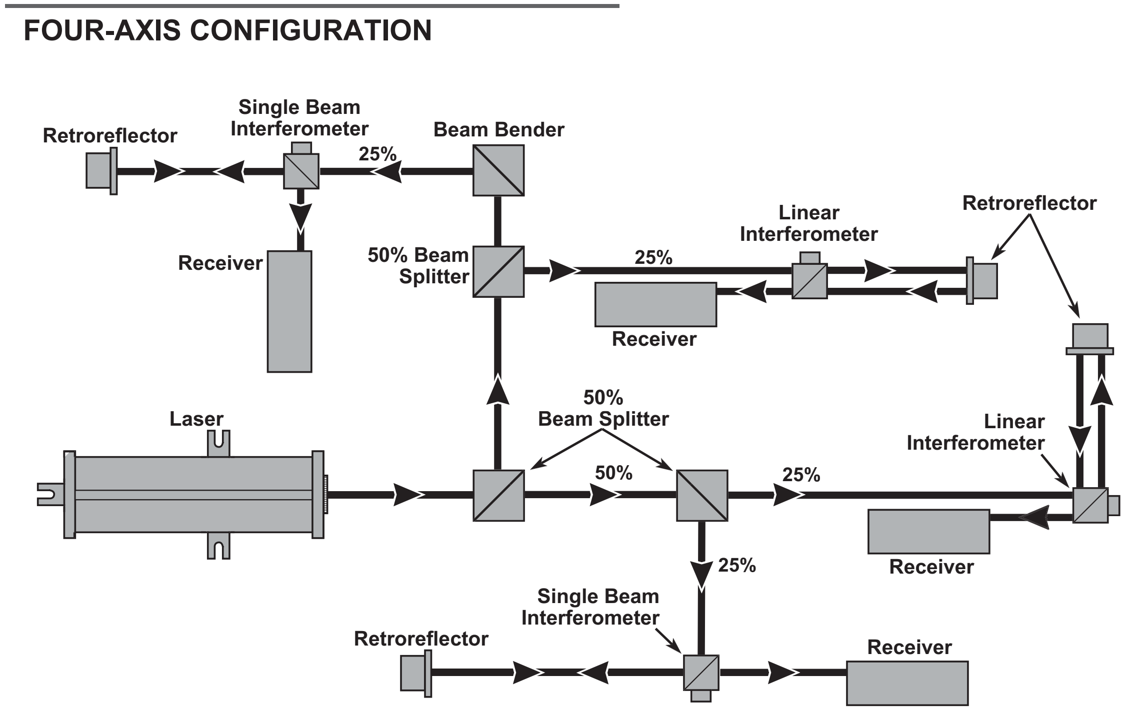


Figure 13 Four-axis configuration

Two-axis plane mirror

Figure 14 shows an X-Y stage measurement configuration using the Agilent 10706B High Stability Plane Mirror Interferometer. The X-Y stage has plane mirrors mounted at 90° to each other; these are the reflectors for the plane mirror interferometers. The advantages of this configuration are discussed in Chapter 12, “Accuracy and Repeatability,” of this manual. The Agilent 10706A Plane Mirror Interferometer is used to bend the laser beam.

Two-axis plane mirror in a vacuum

In an application where the X-Y stage is installed in a vacuum chamber, the configuration in Figure 14 may not be suitable. Figure 15 shows a configuration using the Agilent 10567A Dual Beam Beam-Splitter which allows the laser beam to enter and exit the chamber through one window. This allows the receivers to remain outside the chamber and leaves only the optics inside. For window specifications, refer to the “Vacuum applications" on page 56. If the Agilent 10567A is not used, two windows (and possibly additional beam splitters and benders) will be required.

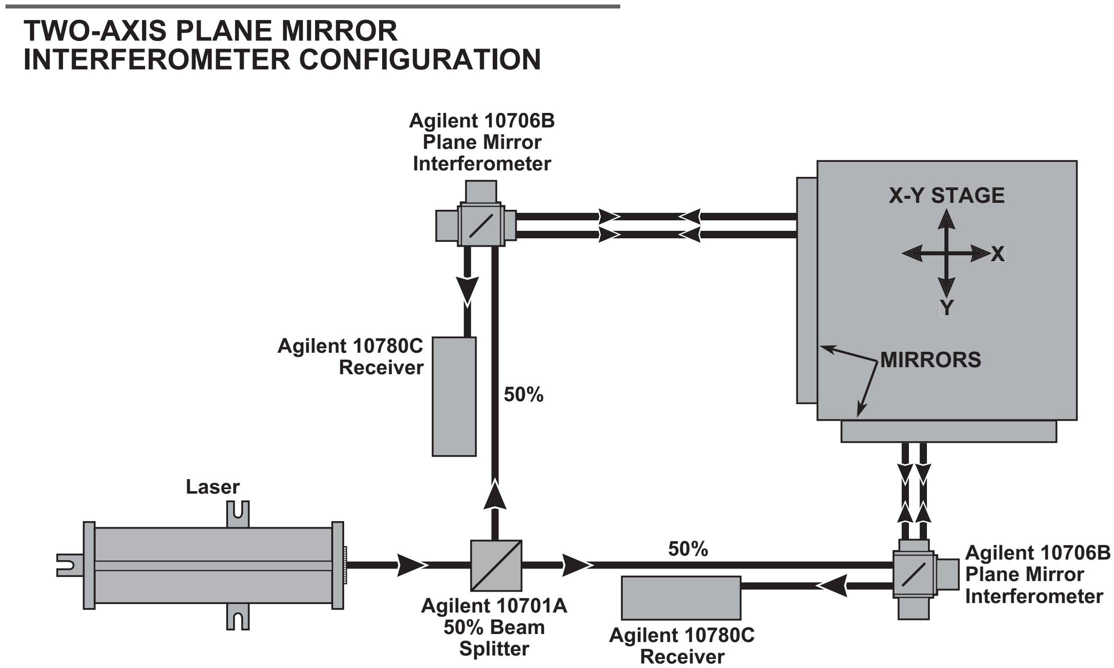


Figure 14 Two-axis plane mirror interferometer configuration

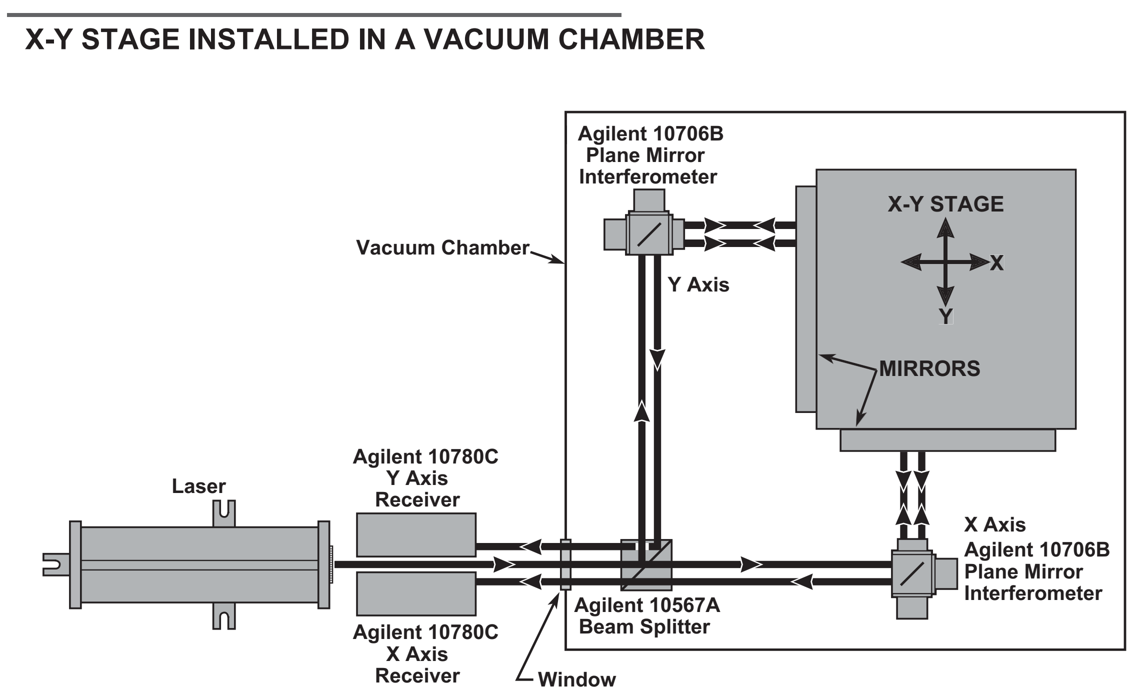


Figure 15 X-Y stage installed in a vacuum chamber

Two-axis measurement system using two Agilent 10715A differential interferometers

In X-Y stage applications where maximum measurement accuracy and stability are required, the Agilent 10715A Differential Interferometer can be used instead of the Agilent 10706A/B Plane Mirror Interferometer. In Figure 16, an X-Y stage using Agilent 10715A's is illustrated. As with plane mirror interferometers, the reflectors are plane mirrors mounted at 90° to each other on the stage.

Using the Agilent 10715A Differential Interferometer also requires mounting the reference mirror (supplied with the Agilent 10715) between the interferometer and measurement reflector. Mounting instructions for the reference mirror are given later in this chapter.

The Agilent 10715A-001 interferometer turns the beam as shown in Figure 16. This configuration requires use of opposite input apertures for each interferometer, resulting in reversed direction senses for the X and Y axes. The reversed direction sense must be corrected in the electronics or by software. Note that the receiver for each axis is above the input beam.

Three-axis measurement system using discrete plane mirror interferometers (X, Y, YAW)

Some X-Y stage applications require measurement or control of the stage yaw. Yaw is angular rotation of the stage about an axis (the Z-axis) perpendicular to the plane of the stage. With two interferometers on one axis of the stage, angular motion can be calculated. Figure 17, the yaw angle, THETA, is measured using axes Y and Y, and is calculated as follows:

$$THETA = arc\tan\frac{(Y - Y')}{D}$$

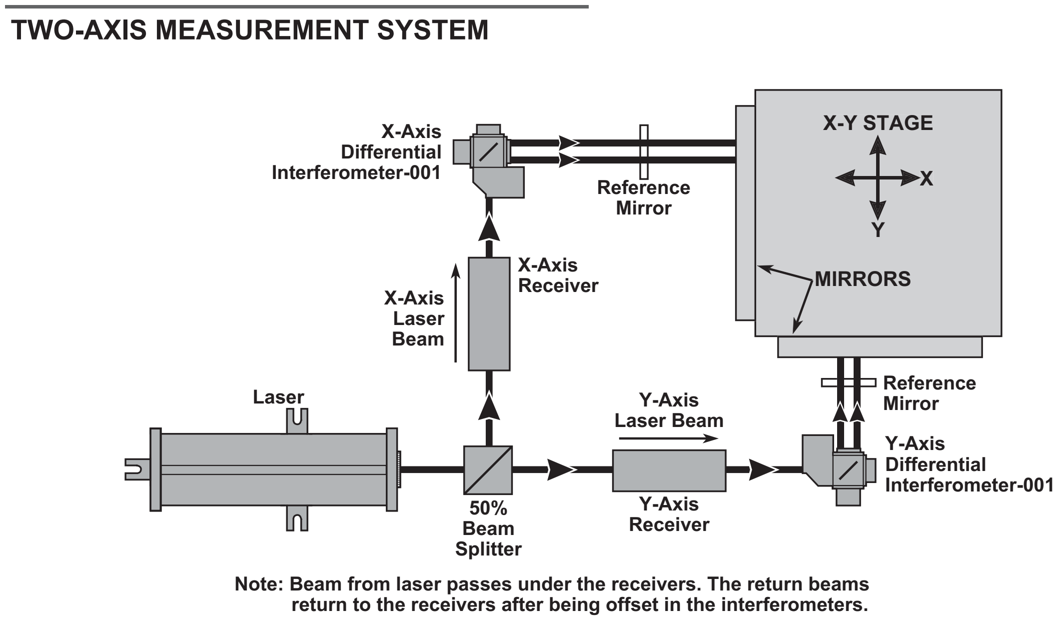


Figure 16 Two-axis system using two Agilent 10715A differential interferometers

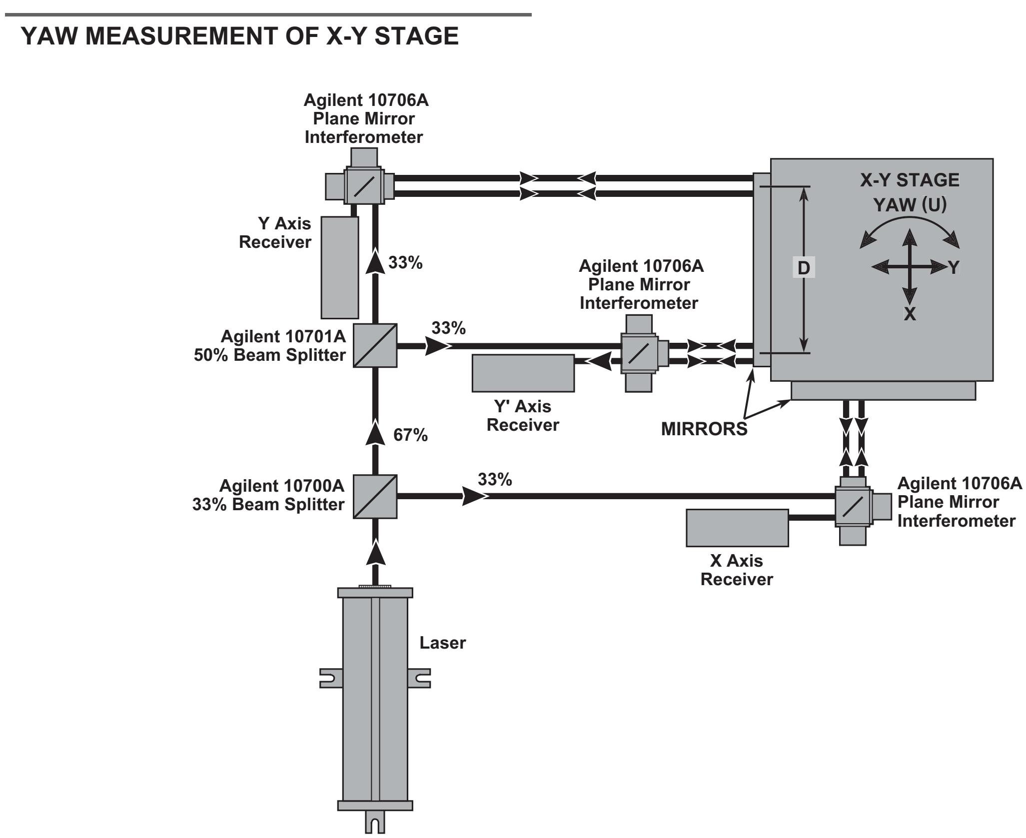


Figure 17 Yaw measurement of x-y stage using discrete plane mirror interferometers

The resulting angular measurement will only be as accurate as the measurement distance, “D”. However, even if “D” is not known precisely, this technique can provide extremely high-resolution or relative angular changes.

The resolution depends on “D”, and— with electronic resolution extension—can be well under 0.01 arc-seconds. For applications in which the stage is servo-controlled to its initial angle (THETA = 0), this high resolution is the key measurement consideration and the accuracy of D is not critical.

For applications in which accuracy and resolution are both critical, D may be determined precisely by rotating the stage through a known angle (“THETA”) and solving the above equation for D.

When installing this type of yaw-measuring system, take care to ensure the parallelism of the adjacent linear measurements to minimize cosine errors.

Angular rotation of the measurement mirror is limited to the “Alignment Requirement-vs-Distance” value for the interferometer used. See the “Specifications and Characteristics” section of Chapter 20, “Agilent 10706A Plane Mirror Interferometer,” in Volume II of this manual.

When yaw control of a stage must be done at high speeds using a closed-loop control system, the (Y-Y’) value needs to be obtained quickly. If the difference is calculated in software in the controller, it may be too slow. There are two methods to achieve a high-speed (Y-Y’) output:

- Electronically
- Optically

Electronic yaw calculation method This difference calculation can be done in hardware for both the Y and the Y’ axes. A custom servo board could be designed to accept position information from both Y and Y’ and perform a fast angular calculation, yielding an input for the yaw servo. See the appropriate electronics documentation for servo-loop interfacing.

Optical yaw calculation method There are optical configurations that will allow direct output of the difference between Y and Y’, for example on the Y’ axis receiver. This is shown in Figures 18 and 19, both using the Agilent 10706A Plane Mirror Interferometer.

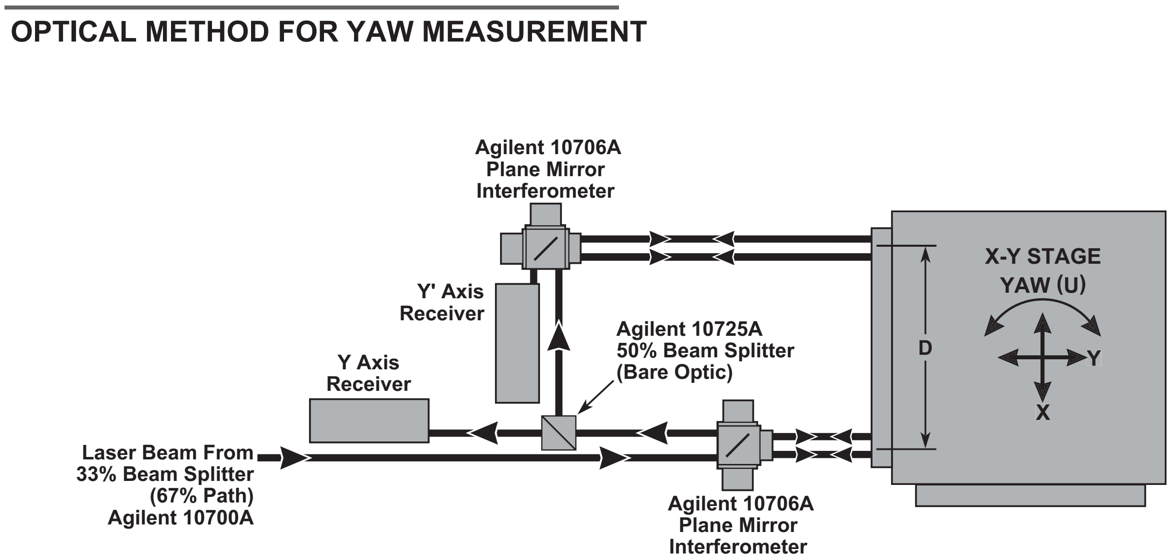


Figure 18 Optical Method for Yaw Measurement

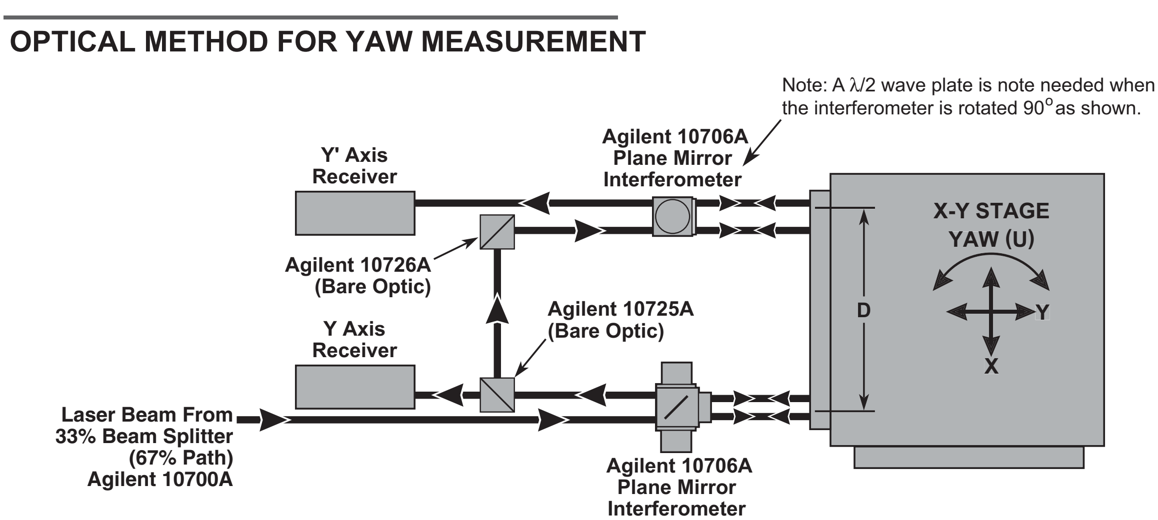


Figure 19 Optical Method for Yaw Measurement

Similar techniques can be used with the Agilent 10715A Differential Interferometer. This is done by splitting off part of the Y-axis combined measurement signal (after going completely through the interferometer) and using this as the input beam to the Y’ axis interferometer. This technique outputs (Y-Y’) information directly on the Y’-axis receiver.

Both of these optical configurations require some special optical components not available through Agilent Technologies. In both figures, a small 50% non-polarizing beam splitter is required. This beam splitter must be very small to avoid blocking or clipping the adjacent beam. This is also true for the beam bender required in the configuration shown in Figure 19.

Multiaxis systems using Agilent 10719A and Agilent 10721A interferometers

Multiaxis systems using Agilent 10719A and Agilent 10721A interferometers are described in Chapter 25, “Agilent 10719A One-Axis Differential Interferometer,” and Chapter 26, “Agilent 10721A Two-Axis Differential Interferometer,” in Volume II of this manual.

Multiaxis systems using Agilent 10735A and Agilent 10736A three-axis interferometers

Multiaxis systems using Agilent 10735A and Agilent 10736A interferometers are described in Chapter 27, “Agilent 10735A, 10736A, and 10736A-001 Three-Axis Interferometers,” in Volume II of this manual.

Optical Device Troubleshooting

Problems with the optical devices are usually caused by their misalignment. Refer to the alignment procedures in Chapter 4, “System Installation and Alignment,” of this manual for further information.

Air turbulence caused by ventilation equipment or temperature gradients near the laser beam path can also cause measurement problems. If this is suspected, shield the area around the laser beam and optical devices with cardboard tubing, plastic sheet, or other suitable material. Some problems with sporadic counting and drift can be traced to air turbulence around the measurement path. This should be considered as a possibility before troubleshooting other parts of the system.

The Agilent 10735A and Agilent 10736A interferometers are designed to use a 9-mm (nominal diameter) laser beam.

The required 9-mm beam is available from an Agilent 5517C-009 laser head. The laser tube in this laser head is referenced to the base of the laser head. The laser head base is different from that of the standard Agilent 5517C Laser Head, and requires a special mounting site configuration, as shown in Figure 20.

The standard Agilent beam-directing optics are designed for use with a 6-mm (maximum nominal diameter) laser beam. For use in 9-mm installations, Agilent offers the Agilent 10725A 9-mm Laser Beam Splitter and the Agilent 10726A 9-mm Laser Beam Bender. These two optical devices do not include mounting hardware. The 9-mm laser measurement system user, designer, or installer, must devise a mounting method that will hold the required optics in position without causing stress that may distort the optic.

The recommended receiver for 9 mm work is an Agilent 10780F Remote Receiver with a 9-mm lens on the fiber optic cable input. If you have an Agilent 10780F Remote Receiver with a 6-mm lens, you can order a 9-mm Replacement Lens Kit Assembly (Agilent part number 10780-67003) and a 9-mm Alignment Target (Agilent part number 10780-40009). The 9-mm lens can be used with any laser beam having a smaller diameter. The 9-mm lens can replace the 6-mm lens, if replacement becomes necessary; be sure to order the 9-mm Alignment Target, also.

The standard Agilent 10780C input aperture is designed for use with a 6-mm laser beam, so it is not recommended for use in a 9-mm laser system.

Site Preparation

Site preparation for laser head

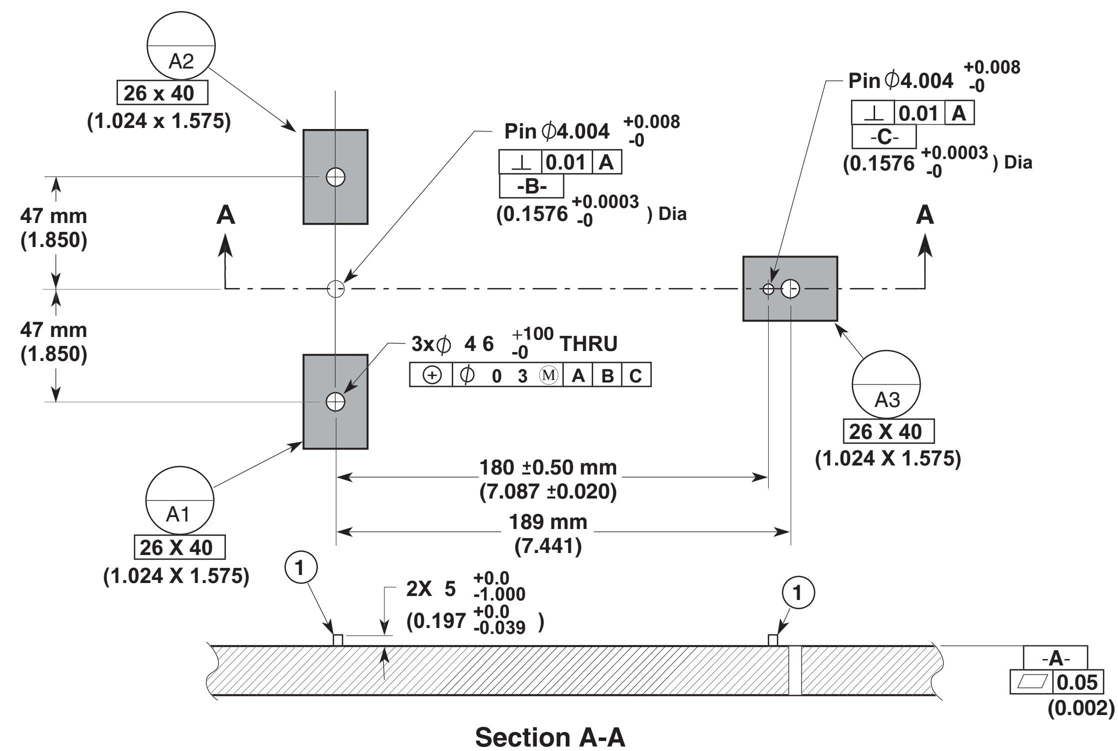
Generally, Agilent laser heads require no special site preparation other than providing appropriate mounting holes. The Agilent 5517C-009 Laser Head´s laser beam output is referenced to locations on its base. You can install this laser head simply by providing appropriate mounting holes, or you can create a specially prepared site to take advantage of its referenced output capability; specifications for a site for this latter use are given in Figure 20.

Site preparation for optical devices

Beam Benders such as the Agilent 10726A are used to create the laser path from the laser head to the interferometer. The Agilent 10726A Beam Benders are supplied by Agilent without mounting hardware. When you attach these optical pieces to their mounting hardware, use an attachment method that will not damage or distort them.

In a measurement system having more than one interferometer unit, a Beam Splitter such as the Agilent 10725A is used to create a second laser path to deliver the laser beam from the laser head to the second interferometer. Agilent 10726A Beam splitters are supplied by Agilent without mounting hardware. When you attach these optical pieces to their mounting hardware, use an attachment method that will not damage or distort them.

AGILENT 5517C-009 MOUNTING LOCATION



Notes:
1. Dowel Pin-steel, ∅4.004 - 4.012, 2 Places
2. Dimensioned in Accordance with ANSI Y14.5M - 1982

Figure 20 Agilent 5517C-009 Mounting Location - Dimensions

Site preparation for referenced interferometers

"Referenced" interferometers currently available from Agilent are listed in the following table.

For information about	See chapter (in Volume II)
Agilent 10719A One-Axis Differential Interferometer	25
Agilent 10719A-C02 One-Axis Differential Interferometer	25
Agilent 10721A Two-Axis Differential Interferometer	26
Agilent 10721A-C01 Two-Axis Differential Interferometer	26
Agilent 10735A Three-Axis Interferometer	27
Agilent 10736A Three-Axis Interferometer	27
Agilent 10736A Option 001 Three-Axis Interferometer with Beam Bender	27
Agilent E1826E One-Axis Plane Mirror Interferometer (right)	31
Agilent E1826F One-Axis Plane Mirror Interferometer (left)	31
Agilent E1826G One-Axis Plane Mirror Interferometer (straight)	31
Agilent E1827A Two-Axis Vertical Beam Interferometer	32
Agilent E1837A Three-Axis Vertical Beam Interferometer	33
Agilent Z4399A Three-Axis Interferometer	33
Agilent Z4420B Five-Axis Interferometer	34
Agilent Z4421B Five-Axis Interferometer	34
Agilent Z4422B Three-Axis Interferometer	33

The optics in a "referenced" interferometer are referenced to points on the outside of the case., This allows the interferometer to be installed in a predefined position and minimizes any alignment required with, respect to the measurement mirror(s) used with it.

Refer to Chapter 5, "Measurement Optics (General Information)," and Chapter 6, "NGI Measurement Optics (General Information)" in this manual for information that can help you design the mounting location for an Agilent "referenced" interferometer.

4
System Installation and Alignment

Introduction

This chapter provides information to help you install and align an Agilent laser measurement system. Information presented includes:

- Pre-installation checklist
- Installation of the laser heads and receivers
- Installation of optics
- Alignment procedures for the different interferometers
- Installation and alignment of the wavelength tracker

Pre-Installation Checklist

In addition to reading chapters 1 through 3 of this manual, complete the following items before installing a laser position transducer into any application.

- ☐ Complete Beam Path Loss Calculation (see the “Beam Path Loss Computation” section in Chapter 3, “System Design Considerations”).
- ☐ If you are using a plane mirror interferometer, you must supply the plane mirror reflector if the Agilent 10724A Plane Mirror Reflector will not work for your installation. See Chapter 5, “Measurement Optics (General Information),” and chapters 18 through 34 (in Volume II) of this manual for interferometer descriptions and mirror specifications. See Chapter 36, Accessories,” in Volume II of this manual for a description of the Agilent 10724A Plane Mirror.
- ☐ If you are using the Agilent 10715A Differential Interferometer, you must supply an adjustable mount for the reference mirror included with the Agilent 10715A.
- ☐ Determine laser head and interferometer orientation for required direction sensing. (See the Chapter 11, “Principles of Operation,” Chapter 3, “System Design Considerations,” and Chapter 5, “Measurement Optics (General Information),” in this manual.)
- ☐ If you are using an Agilent 10719A One-Axis Differential Interferometer or an Agilent 10721A Two-Axis Differential Interferometer, you must supply a suitable mounting arrangement for the interferometer. (See chapters 25 and 26 for recommendations.)
- ☐ If you are using an Agilent 10735A Three-Axis Interferometer, Agilent 10736A Three-Axis Interferometer, or an Agilent 10736A-001 Three-Axis Interferometer with Beam Bender, you must: 1) provide a

suitable mounting location that references the interferometer to the stage whose motion is being measured, and 2) make provision for adjusting the laser beam input to the interferometer by translating and turning the beam.

- ☐ Provide for aligning the optics, laser head, and receiver(s) on the machine.
- ☐ Be sure to allow for transmitted beam offset of beam splitters (Agilent 10700A and Agilent 10701A) in your design.

System Grounding

Most Agilent laser systems are grounded through the line cord. For these systems, additional grounding of the chassis is not required, but doing so shouldn’t interfere with normal operation. Refer to system grounding information in Chapter 3, “System Design Considerations,” of this manual.

External Cabling

The following paragraphs cover all external connections to the laser head and receiver. Each instrument is shipped with a set of color-coded labels.

These can be used to label both the cables and their respective rear-panel connectors for easy identification.

Laser head cables

For use with Agilent 10895A VME Axis Board

Agilent 10791A/B/C Laser Head Cable (has spade lugs for use with a power supply other than the Agilent 10884B) The Agilent 10791A/B/C Laser Head Cable connects an Agilent 5517A/B/BL/C/D/DL/FL to the Agilent 10895A VMEbus Aaxis Board. The Agilent 10791A/B/C Laser Head Cable has spade lugs for connecting the laser head to a customer-supplied power supply (see Figure 283 in Chapter 36 of Volume II).

For use with Agilent 10885A PC, 10889B PC, 10896B VME, 10897C VME, 10898A VME, or N1231A/B PCI axis board

Agilent 10881A/B/C Laser Head Cable (has a DIN for use with the Agilent 10884B Power Supply) The Agilent 10881A/B/C Laser Head Cable connects an Agilent 5517A/B/BL/C/D/DL/FL to the Agilent 10885A PC Axis Board, Agilent 10889B PC Servo Axis Board, Agilent 10896B VME Laser Compensation Board, Agilent 10897C VME High Resolution Laser Axis Board, Agilent 10898A VME High Resolution Dual Laser Axis Board, or Agilent N1231A/B PCI Three-Axis Board. The Agilent 10881A/B/C cable is “Y” shaped and has three connectors that are all different as shown in Figure 285 in Chapter 36 of Volume II. The connectors on the laser head end of the cable and the laser head are “keyed” to go together only one way. The Agilent logo will be “up” on the connector “boot” when the connection is correctly made. The cable connector has locking rings, which take about 1/3-turn clockwise to secure the cable to the mating connector.

Agilent 10881D/F/E Laser Head Cable (has spade lugs for use with a power supply other than the Agilent 10884B) The Agilent 10881D/F/E Laser Head Cable connects an Agilent 5517A/B/BL/C/D/DL/FL to the Agilent 10885A PC Axis Board, Agilent 10889B PC Servo Axis Board, Agilent 10896B VME Laser Compensation Board, Agilent 10897C VME High Resolution Laser Axis Board, Agilent 10898A VME High Resolution Dual Laser Axis Board, or Agilent N1231A/B PCI Three-Axis Board. The Agilent 10881D/E/F Laser Head Cable has spade lugs for connecting the laser head to a customer-supplied power supply (see Figure 286 in Chapter 36 of Volume II).

Agilent N1251B High Performance Laser Head Cable (has a DIN for use with the Agilent 10884B Power Supply) The Agilent N1251B High Performance Laser Head Cable connects an Agilent 5517A/B/BL/C/D/DL/FL to the Agilent 10897C VME High Resolution Laser Axis Board, Agilent 10898A VME High Resolution Dual Laser Axis Board, or Agilent N1231A/B PCI Three-Axis Board. As shown in Figure 289, the Agilent N1251B cable is “Y” shaped and has three connectors that are all different. The connectors on the laser head end of the cable and the laser head are “keyed” to go together only one way. The Agilent logo will be “up” on the connector “boot” when the connection is correctly made. The cable connector has locking rings, which take about 1/3-turn clockwise to secure the cable to the mating connector.

Receiver cables

See Chapter 35, “Receivers,” in Volume II of this manual for installation and alignment information.

CAUTION Each connector on the Agilent 10790A/B/C Receiver Cable has both a male and female half. Before making a connection, be sure the male half of the cable connector is properly aligned with the female half of the mating connector. Failure to align the pins prior to mating the connectors may result in damaged pins.

For use with Agilent 10895A VME Axis Board

Agilent 10790A/B/C Receiver Cable

The Agilent 10790A/B/C Receiver Cable is used to connect the Agilent receivers to the Agilent 10895A VME Axis Board, for both measurement and Wavelength Tracker axes. This cable's connectors are identical on either end as shown in Figure 282. The connectors on the cable and on the receiver and Agilent electronics are "keyed" to go together only one way. The connectors on the cable each have a locking ring, which take a 1/4-turn clockwise to secure the cable to its mating connector.

For use with Agilent 10885A PC, 10889B PC, 10896B VME, 10897C VME, 10898A VME, or N1231A/B PCI axis board

Agilent 10880A/B/C Receiver Cable

The Agilent 10880A/B/C Receiver Cable is used to connect the Agilent receivers to the Agilent 10885A PC Axis Board, Agilent 10889B PC Servo Axis Board, Agilent 10896B VME Laser Compensation Board, Agilent 10897C VME High Resolution Laser Axis Board, Agilent 10898A VME High Resolution Dual Laser Axis Board, or Agilent N1231A/B PCI Three-Axis Board, for both measurement and Wavelength Tracker axes. This cable's connectors are different as shown in Figure 284. One connector is a bayonet connector that inserts into the Agilent axis board. The other connector fits the connector on the receiver; this connector is "keyed" to go together only one way. This connector has a locking ring, which takes a 1/4-turn clockwise to secure the cable to its mating connector on the receiver.

Agilent N1250A/B High Performance Receiver Cable

The Agilent N1250A/B High Performance Receiver Cable is used to connect the measurement signal from an Agilent E1708A or E1709A Receiver to the Agilent 10897C VME High Resolution Laser Axis Board, Agilent 10898A VME High Resolution Dual Laser Axis Board, or Agilent N1231A/B PCI Three-Axis Board, for both measurement and Wavelength Tracker axes. This cable's connectors are different as shown in Figure 288. One connector is a bayonet connector that inserts into the Agilent axis board. The other connector fits the connector on the receiver; this connector is "keyed" to go together only one way. This connector has a locking ring, which takes a 1/4-turn clockwise to secure the cable to its mating connector on the receiver.

Mounting Optics

Adjustable mounts

Agilent 10710B and Agilent 10711A Adjustable Mounts provide a convenient means of mounting, aligning, and securely locking in position, the optical components of the laser position transducer (see Figure 21). Since both mounts allow some tilt and yaw adjustment, the need for custom fixturing is minimized. These mounts allow the optic being adjusted to be rotated about its optical centerline, simplifying installation.

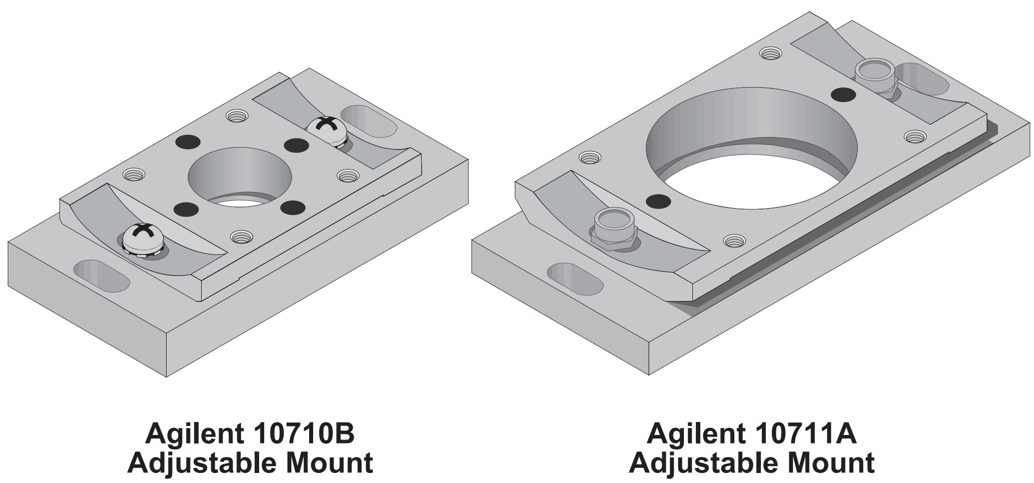


Figure 21 Agilent 10710B and Agilent 10711A adjustable mounts

Both mounts are made of 416 stainless steel. Its magnetic properties can be helpful at the design stage if magnetic clamps are used. However, in final installation, secure the mount with the screws provided.

The Agilent 10719A, Agilent 10721A, Agilent 10735A, and Agilent 10736A interferometers do not use adjustable mounts.

See Table 3 (in Chapter 5) or Table 80 in Volume II of this manual for a list of optics that can be used with these mounts.

Typical mounting of optics which use adjustable mounts

1 Figure 22 shows how to mount the beam splitting and beam bending optics or the single-beam interferometer in the horizontal plane, using the Agilent 10710B Adjustable Mount.

2 Figure 23 shows how to mount the beam splitting and beam bending optics or the single-beam interferometer in the vertical plane, using the Agilent 10710B Adjustable Mount.

3 Figure 24 shows how to mount certain linear, plane mirror, or differential interferometers in the horizontal plane, using the Agilent 10711A Adjustable Mount.

4 Figure 25 shows how to mount certain linear, plane mirror, or differential interferometers in the vertical plane, using the Agilent 10711A Adjustable Mount.

Fasteners

All optical components which are designed to be used with an Agilent 10710B or Agilent 10711A Adjustable Mount are supplied with English mounting hardware. The screws supplied with each optical component are those required to mount to its respective adjustable mount.

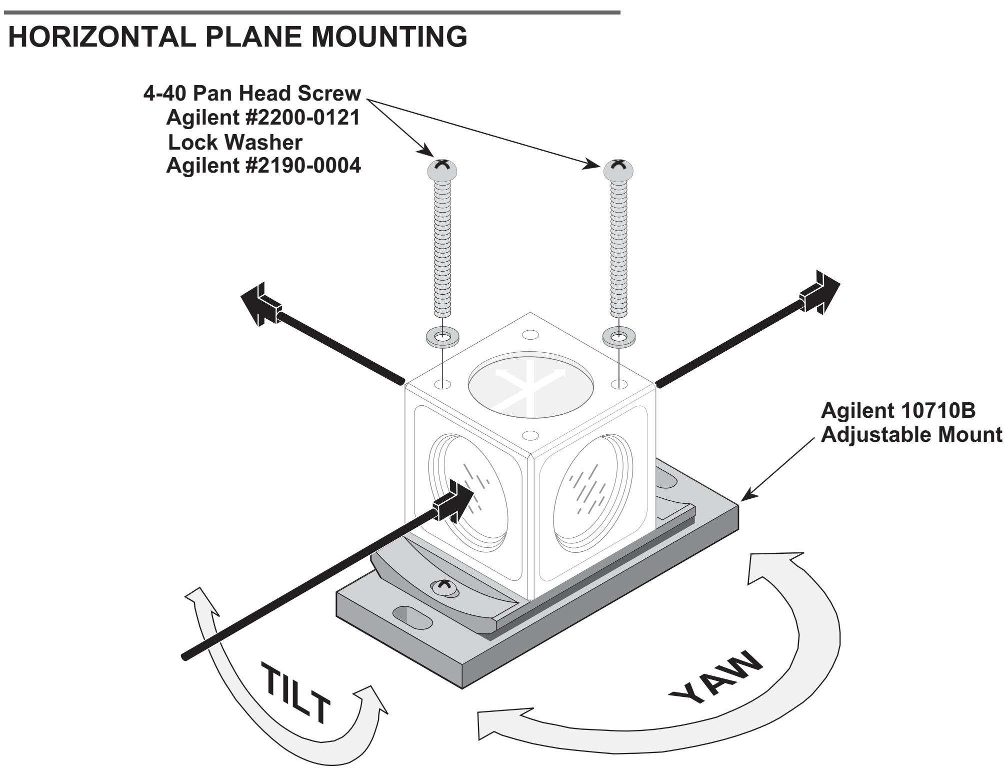


Figure 22 Horizontal plane mounting using the Agilent 10710B adjustable mount

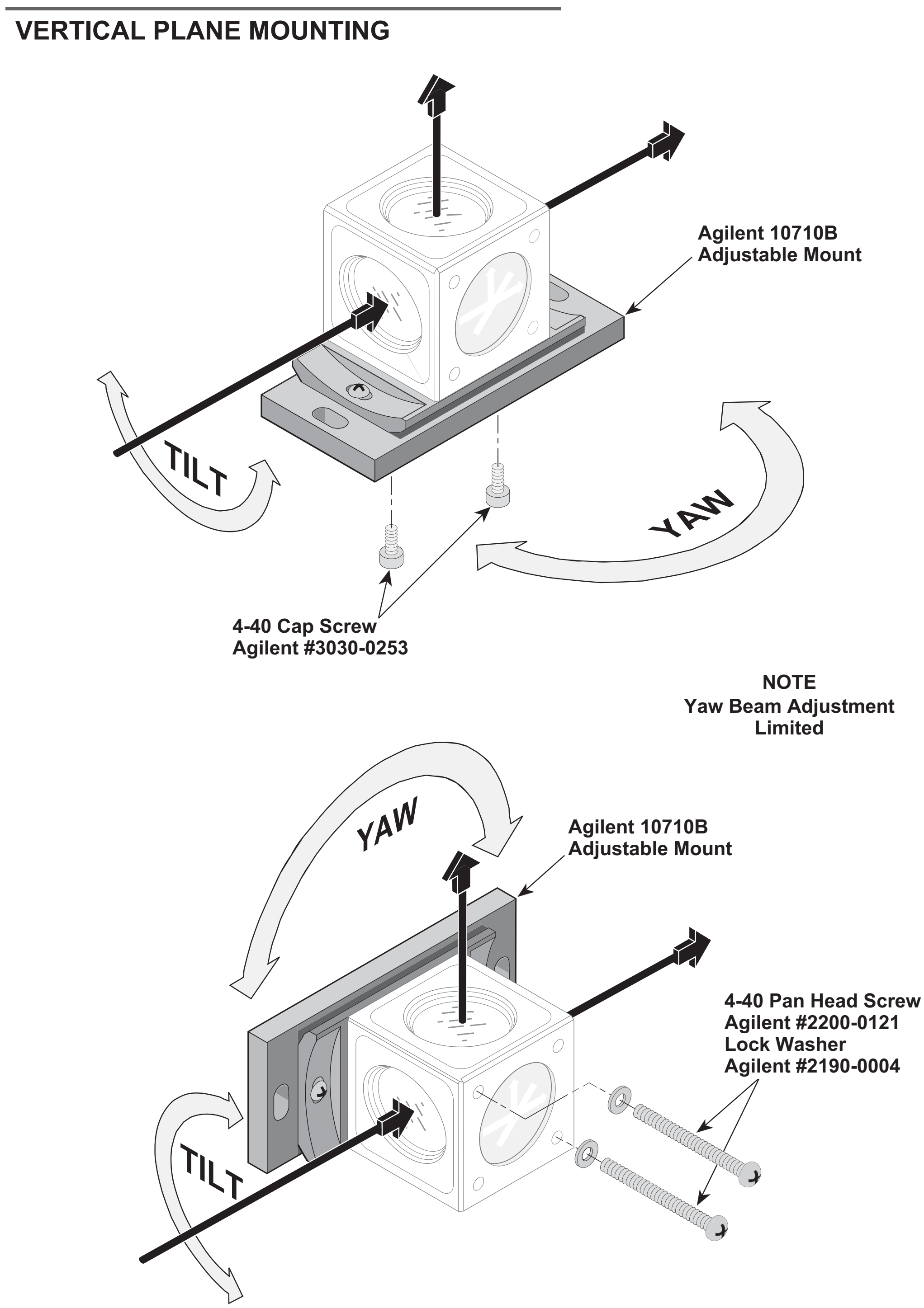


Figure 23 Vertical plane mounting using the Agilent 10710B adjustable mount

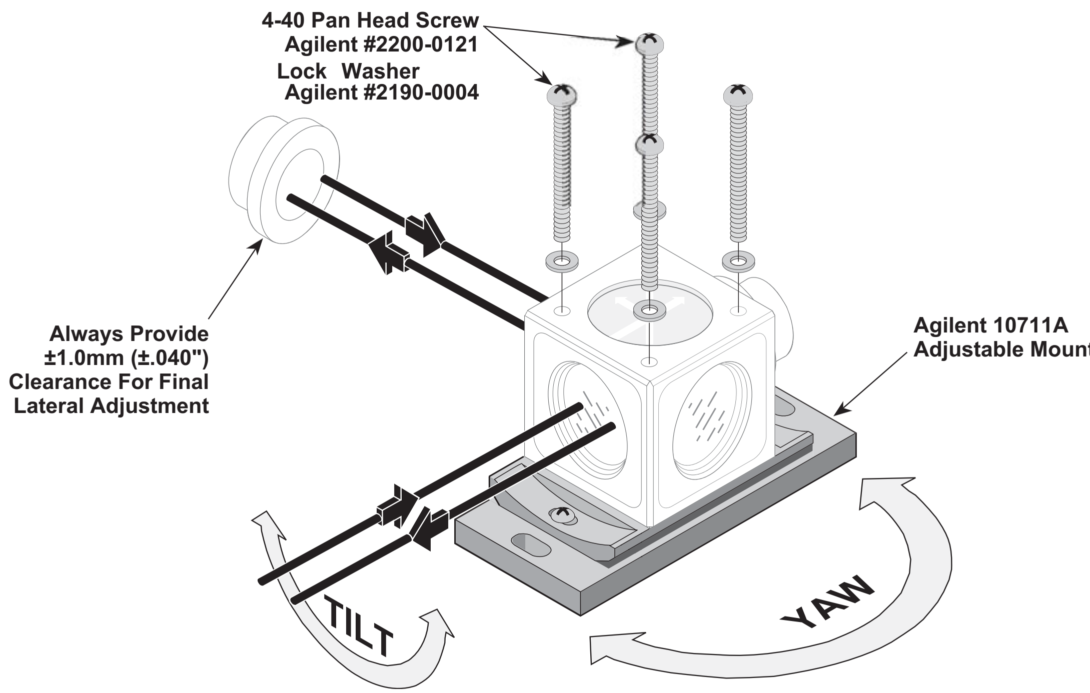


Figure 24 Horizontal plane mounting using the Agilent 10711A adjustable mount

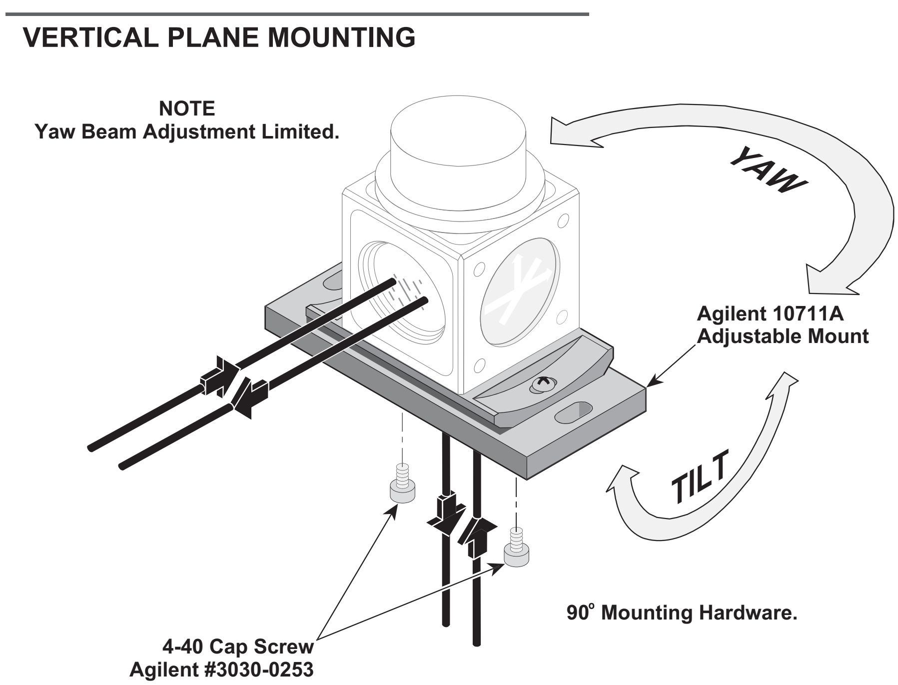


Figure 25 Vertical Plane Mounting Using the Agilent 10711A Adjustable Mount

Aligning Optics

General

When installed in a positioning system, any transducer must be aligned to ensure correct operation and minimum measurement error. The major objectives in aligning the laser system are: 1) maximizing the measurement signal at the receiver, and 2) minimizing cosine error.

In general,

1 the measurement signal at the receiver is maximized by aligning the optics to center the laser beam on the receiver input, and

2 cosine error is minimized by aligning the laser beam in the measurement axis parallel to the motion of travel.

Figure 26 shows a measurement axis where the laser beam is aligned parallel to the mechanical motion of travel of the retroreflector and centered on the receiver.

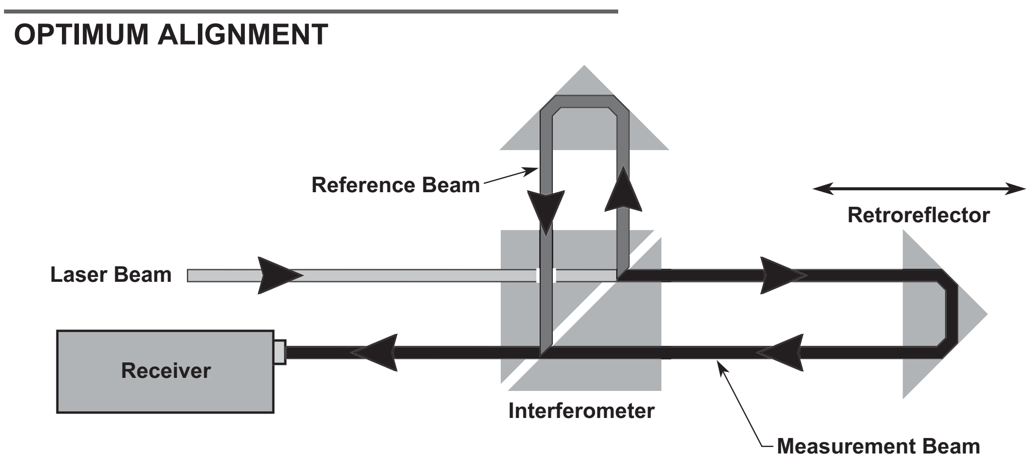


Figure 26 Optimum alignment

The receiver photodetector only measures the overlapping portion of the laser beams. For maximum signal, the interferometer and retroreflector are aligned so the reference beam from the interferometer and the measurement beam from the retroreflector exactly overlap upon recombination. These recombined laser beams then enter the receiver in the center of the lens aperture. From Figure 26, it is clear that if the recombined laser beams entering the receiver are not centered on the photodetector, measurement signal loss will occur. If the interferometer or the retroreflector are misaligned (Figure 27), the reference and measurement beams no longer completely overlap, resulting in signal loss.

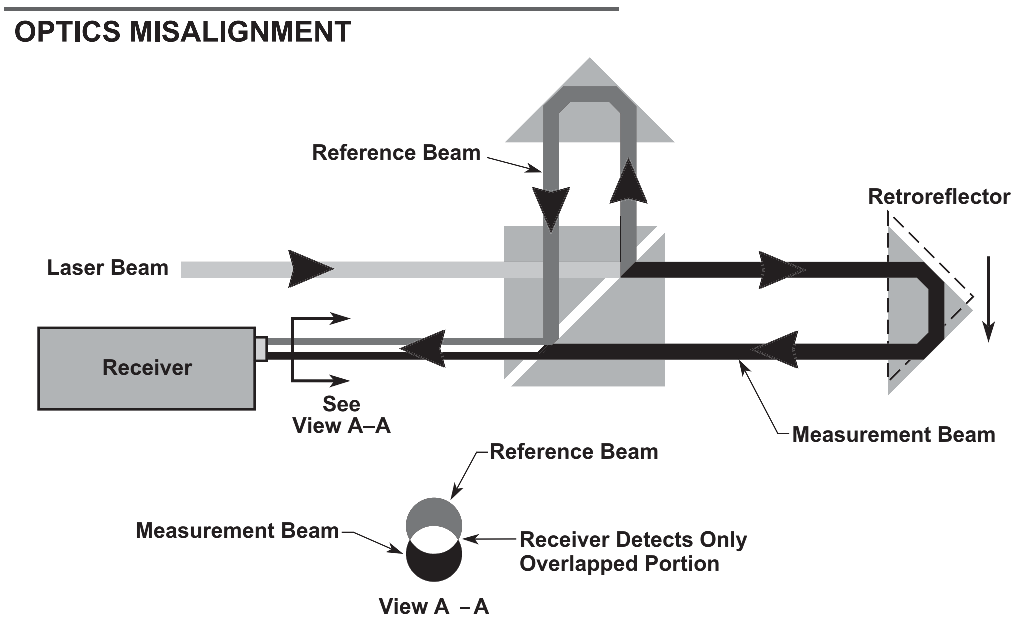


Figure 27 Effect of optics misalignment

Typically, a lateral offset of 1/4 of the beam diameter between the beams is allowable for an adequate measurement signal. However, you must make every effort to optimize the laser beam overlap for maximum performance.

If the measurement beam is not aligned parallel to the direction of retroreflector travel, there are two effects. First, a cosine error is generated of a magnitude directly related to the angle of misalignment. (For a complete description of cosine error, see Chapter 12, "Accuracy and Repeatability," in this manual.) Second, when movement occurs between the optics, the angular misalignment also causes a lateral displacement of the measurement beam with respect to the reference beam at recombination, resulting in additional signal loss. Figure 28 illustrates the result of angular misalignment.

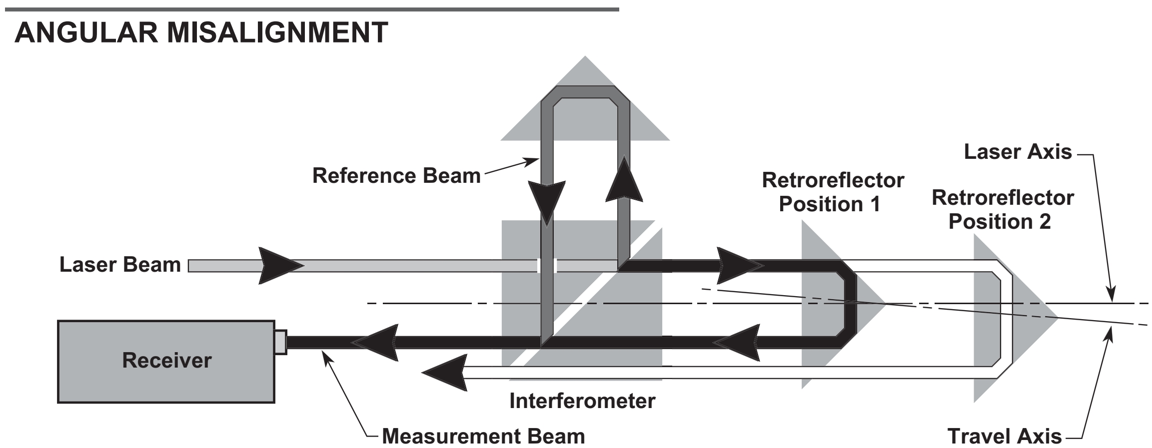


Figure 28 Effects of angular misalignment to the direction of travel

NOTE

The presence of measurement signal through the total length of travel does not guarantee that the measurement axis is aligned for minimum cosine error. Also, any angular misalignment of the laser beam to the direction of travel causes a decrease in the measurement signal strength.

Alignment principles

Before beginning any alignment procedure, you should understand the basic principles. The following information summarizes the various factors that affect the optical alignment of the laser system. While performing the alignment procedure, keep in mind:

1 In order to achieve maximum accuracy, the laser beam must be parallel to each axis of travel.

2 For most systems, start the alignment at the laser head and move out one component at a time until the last component on an axis is aligned and the laser beam impinges on the receiver aperture.

The exception to this principle will be systems using an Agilent 10719A, Agilent 10721A, Agilent 10735A, or Agilent 10736A interferometer; these are “referenced” interferometers, whose design and construction allows them to be installed in specified fixed locations relative to the measurement mirrors with which they will be used. For these systems, it will be necessary to provide adjustment of the laser beam relative to the interferometer, since the interferometer itself is not adjustable.

3 The angular direction of the beam can be aligned by moving the laser head or adjusting a beam bender.

4 The reflected beam can be aligned by adjusting a beam splitter or interferometer.

5 The angular direction of the beam will not be changed by adjusting a retroreflector. Similarly, the angular direction of a beam transmitted straight through a beam splitter or interferometer will not be changed by adjusting that component.

NOTE There will be up to a 30-arc-minute deviation of the beam when it passes through any interferometer except the Agilent 10702A-001, Agilent 10719A, Agilent 10721A, Agilent 10735A, Agilent 10736A, Agilent 10766A, or the NGI optics. (See the "Specifications" information in the appropriate chapter in this manual for specifications.)

6 The retroreflectors (also called cube corners) do not change the angular direction of the beam. However, they do displace the beam and reverse its direction. The laser beam remains parallel to its original path. In the case of the Agilent 10705A Single Beam Interferometer reference cube-corner and the Agilent 10704A Retroreflector, the displacement is zero because the beam hits the center of the cube-corner (when properly aligned)

7 On multiaxis configurations, the first axis to be adjusted is the axis whose angular adjustment of the laser beam requires adjustment of the laser head. After the first axis is aligned, the laser head is locked down and any angular adjustment of the laser beam in the other measurement axes is accomplished by rotating the optical components.

8 Properly aligned interferometers exhibit less sensitivity to temperature. See "Deadpath error" in Chapter 12, "Accuracy and Repeatability," of this manual for details.

9 Set up multiaxis systems with all legs of the laser beam orthogonal to each other and to the measurement mirrors. For ease of optical layout and alignment, you should keep the laser beams horizontal or vertical.

10 Define all beam legs (plane and direction) against machined surfaces known to be parallel or perpendicular to the stage plane. Use an auto reflection mirror with square sides (e.g., a metrologist's "true square").

11 Before installing the optics, define all beam bends (location and angle) with an optical square (Agilent 10777A) or pentaprism. This ensures the best possible starting point for the final adjustment of the laser system optics.

The remainder of this chapter has these major parts:

12 Receiver alignment and gain adjustment procedure, which is common to all measurement axes.

13 A discussion of the two major alignment methods: autoreflection and overlapping dots.

14 Specific alignment techniques for each type of interferometer.

Receiver Alignment and Gain Adjustment

See Chapter 35, “Receivers,” in this manual for this information.

There are two basic alignment techniques used with a laser measurement system: 1) Autoreflection, and 2) Overlapping Dots.

Autoreflection is the more accurate method, and is always preferred. Autoreflection should always be used: 1) for short travel applications, 2) measurements where cosine error must be reduced to the absolute minimum possible, and 3) when plane mirror reflectors are used.

Overlapping Dots is a satisfactory method in applications involving relatively long travel.

In general, regardless of the technique used, alignments are performed with all optical components in place.

Autoreflection Method Summary

The autoreflection method of alignment is recommended for all applications, especially those having less than 0.5 meter (20 inches) travel. It is based on the principle of aligning a reflecting surface normal to the direction of travel and aligning the laser beam perpendicular to this reflecting surface (that is, parallel to the direction of travel) to minimize cosine error. This technique is fast and is the best way to eliminate cosine error.

The principle steps used for the “Autoreflection” method of alignment are given below. A detailed autoreflection alignment procedure for a specific configuration of optics follows the autoreflection method and the overlapping dots method summaries.

1 Mount the laser head and optics in the desired locations and align the laser beam roughly parallel to the axes.
2 Provide a reflector, aligned perpendicular to the axis of travel. Place the reflector between the interferometer and retroreflector.

NOTE

Typical reflectors having required mirror flatness and referenced sides for autoreflection are:

- True Square
- Other precision angle plates or squares with a gage block wrung to the appropriate surface.

The mirrored surface should be perpendicular to its sides (or angle plate) within 15 arcseconds.

Typical means for aligning the mirrored surface perpendicular to the axis of travel are:

- Locating the mirror reference surfaces against fixed reference surfaces on the machine's positioning system (e.g., ways, rails, guides). (See Figure 29.)
- Measuring the reference surfaces on the mirror, true square, or gauge block with a dial indicator, and adjusting the pitch and yaw of the mirror surface. (See Figure 31.)

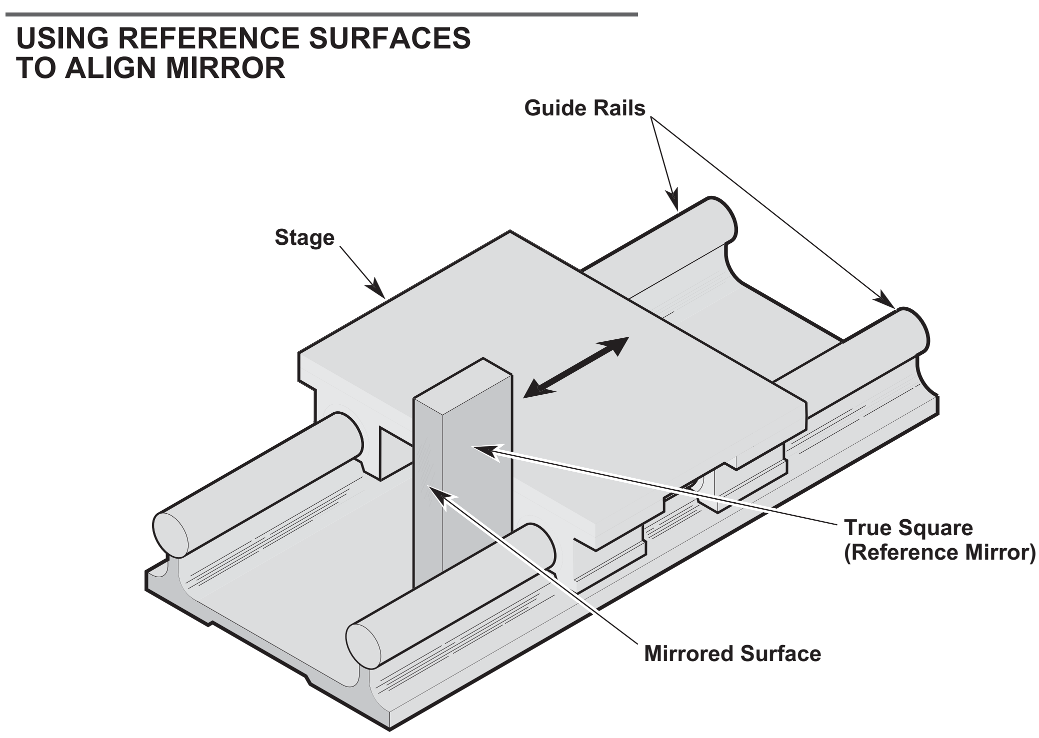


Figure 29 Using reference surfaces to align mirror

1 Place the perpendicular reflector at the far end of travel.

2 Select the small aperture on the laser head by rotating the front turret.

3 Adjust the laser beam so that the beam is reflected by the reflector back upon itself. Alignment is complete when the (small) return beam is centered on the small aperture of the laser head. This adjustment of the laser beam can be performed by moving the laser head, beam bender or interferometer, depending on the optical layout.

Overlapping Dots Method Summary

The overlapping dots alignment method uses the principle that if the measurement beam to the retroreflector is not parallel to the direction of travel, it is offset upon recombination with the reference beam of the interferometer (see Figure 30). When motion occurs between the retroreflector and interferometer along the measurement path, any angular misalignment causes a displacement (at the receiver) of one laser beam with respect to the other which can be visually observed. Since the human eye can resolve a displacement of the beam of approximately 300 micrometers (0.01 inch), this technique can be applied to reduce cosine error for measurement travel of 0.5 meter (20 inches) or longer. For travel less than this, the sensitivity of this technique is normally not sufficient and autoreflection should be used. Cosine error (E), in parts per million (ppm), can be calculated from the following formula:

$$E = \frac{S^2}{8D^2}$$

Where D is the distance measured in millimeters (inches) and S is the lateral offset of the returning beam in micrometers (thousands of an inch). For example, if the distance measured is 600 mm and this results in an offset of the return beam of 1.2 mm (1200 μ) then:

$$= \frac{(1200)^2}{(8) \times (600)^2} = 0.5 ppm, 0.5 \textit{ micrometer per meter of travel}$$

The following are the principle steps used for the “Overlapping Dots” method of alignment, followed by a detailed alignment procedure for a specific configuration.

1 Mount the laser head and optics in their desired locations.

2 Select the small beam aperture on the laser head.

3 With the optics as close together as possible, adjust any component (laser head, interferometer, or retroreflector) to get the dots (reference and measurement beams) to overlap at the receiver.

NOTE Placing a piece of translucent tape over the receiver lens will help in observing the incident beams.

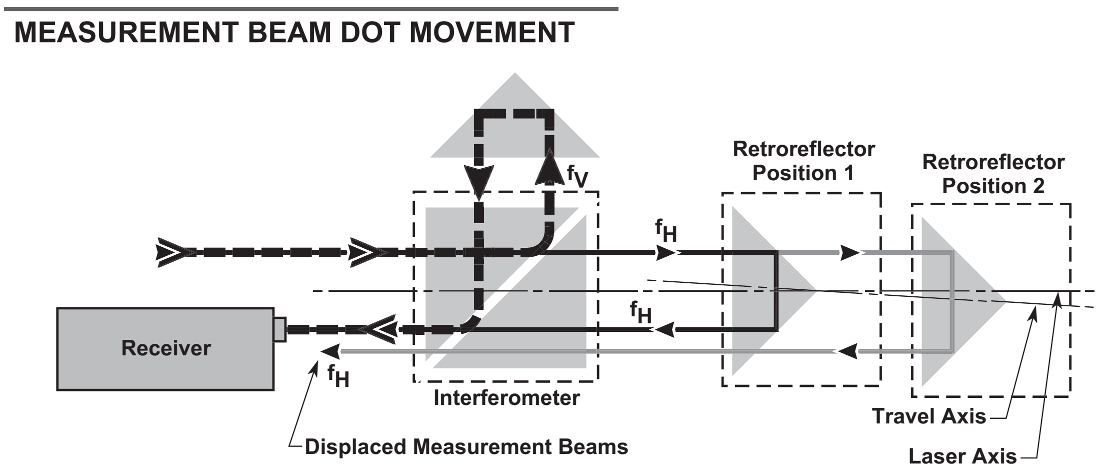


Figure 30 Measurement beam dot movement

4 Move the retroreflector away from the interferometer. If the laser beam is not parallel to the axis of travel, the measurement beam dot will begin to move away from the reference beam dot. The dot will move until the beam is cut off by the edge of the interferometer’s aperture. Stop moving the retroreflector before the beam is thus blocked, or when the end of travel is reached. Figure 30 shows why the measurement dot moves.

5 Figure 31 illustrates a typical two-dot pattern on the receiver that is seen after the optics have moved. Now rotate the beam until the dots again overlap at the receiver. This adjustment of the laser beam can be done by moving the laser head, beam bender, or interferometer, depending on the optical layout.

NOTE Lateral movement of either the laser head or interferometer may also be necessary to achieve alignment.

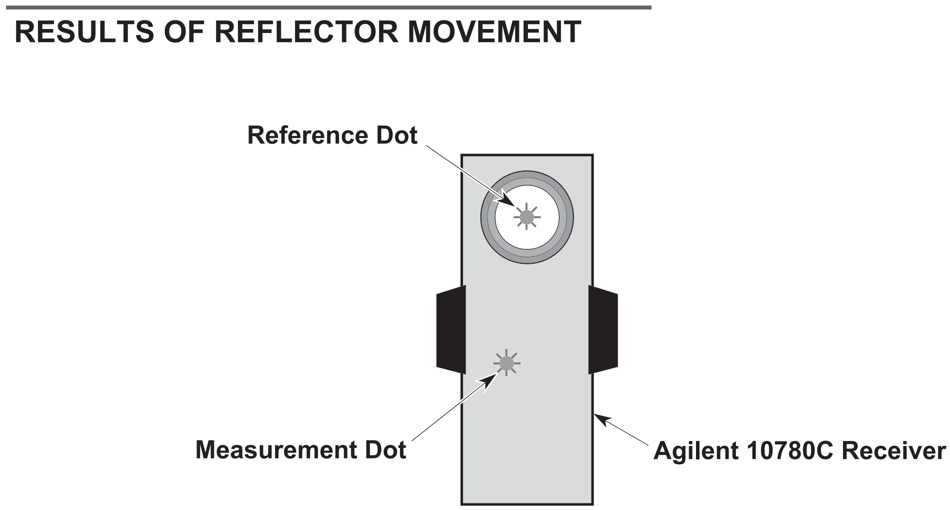


Figure 31 Results of reflector movement

Aligning the Agilent 10702A Linear, Agilent 10766A Linear, and Agilent 10705A Single Beam Interferometers

The alignment techniques for the linear and single-beam interferometers are nearly the same. Both use a retroreflector (cube-corner) as the measurement reflector.

Either the Autoreflection or the Overlapping Dots method may be used to maximize return measurement signal power and to minimize cosine error. The Autoreflection method is always preferred because it is more accurate. It must be used for measurement distances less than 0.5 meter (20 inches) and is strongly recommended for distances over 0.5 meter.

The Overlapping Dots method should only be used when the measurement distance is over 0.5 meter.

The choice of method used depends on convenience and the nature of the application. The goal for both of these alignment methods is to have the reference and measurement beams be coincident at the receiver throughout the measurement.

Alignment aids (for Agilent 10702A, Agilent 10766A, Agilent 10705A)

To help in aligning these interferometers, an alignment aid is included with each. They are:

- For Agilent 10702A and Agilent 10702A-001—Alignment target (Agilent Part Number 10702-60001). See Figure 32.
- For Agilent 10766A—Alignment target (Agilent Part Number 10767-60001). See Figure 32.
- For Agilent 10705A—Alignment Target (Agilent Part Number 10705-60001). See Figure 32.

These alignment aids are magnetic, to simplify positioning them on the interferometer. They are used on the input side of the interferometer to properly position the beam.

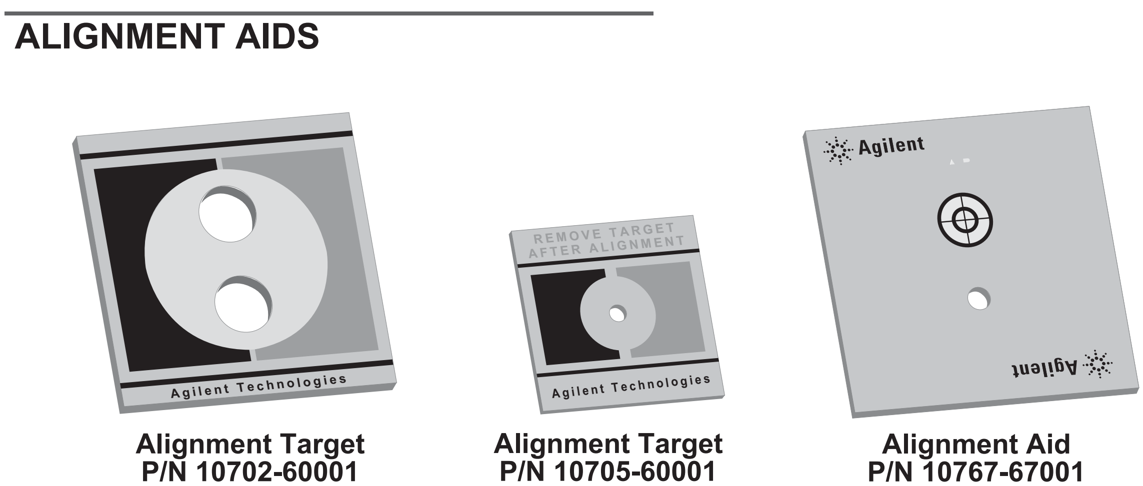


Figure 32 Linear and single-beam interferometer alignment aids

Autoreflection alignment procedure (for Agilent 10702A, Agilent 10766A, Agilent 10705A)

This procedure describes the autoreflection alignment method used on a two-axis system.

Figure 33 shows a measurement setup similar to Figure 34(A) except that the referenced mirrors (true squares) are included.

NOTE

Steps 1 through 11 constitute the X-axis autoreflection alignment procedure.

1 With all optical components in place, install the alignment targets on the interferometer and the receiver (Figure 34, position 1). Place a piece of opaque material, such as frosted tape, in front of the retroreflector.

2 With the laser beam passing through the 50% beam splitter, adjust the laser head and interferometer until the laser beam enters one hole of the alignment target and exits the other to hit the receiver alignment target centered on the hole over the photodetector.

NOTE

This is the reference beam that hits the receiver.

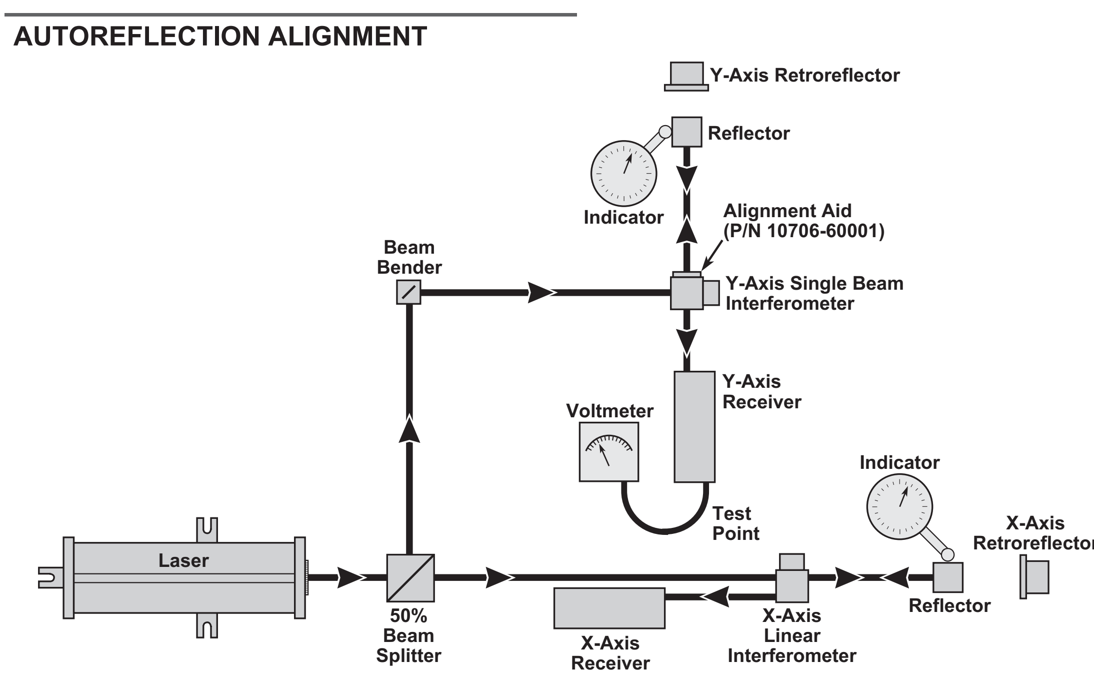


Figure 33 Autoreflection alignment

3 Place a referenced mirror (true square) between the interferometer and retroreflector so that the measurement beam from the interferometer hits its reflective surface. See Figure 33.

Align the referenced mirror (true square) with a precision indicator until its reflective surface is perpendicular to the direction of travel. See Figure 33.

4 Turn the front turret of the laser head to select the small aperture.

NOTE If the distance between the laser head and the reflector is 0.5 meter (20 inches) or more, the formula given above in the paragraph on Overlapping Dots determines the cosine error based on the offset of the return beam at the laser head. For example, a distance between the laser head and reflector of 0.5 meter and an offset of the return beam at the small aperture of the laser of 500 microns (0. 0202 inch) gives a cosine error of approximately 0.12 ppm.

5 Pitch and yaw the laser head until the beam reflects back on itself from the referenced mirror (true square) and is centered on the small aperture of the laser head. Slight side-to-side movements of the interferometer may be required to ensure that the reference beam from the interferometer is centered on the receiver alignment target.

NOTE For high-accuracy alignment or for installations where there is less than 0.5 meter (20 inches) between the laser head and reflector, perform steps 6 through 8.

6 Remove the receiver alignment target and interferometer alignment target and select the large aperture of the laser head.

7 With a fast-responding voltmeter (preferably an analog type) attached to the receiver test point and receiver case ground, pitch and yaw the laser beam (laser head or interferometer on this axis) until a signal is received on the receiver. (The voltmeter will suddenly jump to some value greater than 0.25 volt.) This is a critical adjustment and may initially require great care.

8 Adjust the laser beam in pitch and yaw to get the maximum voltmeter reading (which may be fluctuating). Now carefully readjust the interferometer until the voltage reading suddenly drops back down to about 0.3 volt.

NOTE The alignment should be adjusted such that the voltage reading from the receiver test point occurs just below the sudden jump up in voltage. If the alignment is fixed to sustain this peaked voltage, system operation will be degraded.

This procedure will align the laser beam to within ±1.2 arcminutes of the direction of travel, resulting in a cosine error of approximately 0.05 ppm. That is 0.05 micron per meter of travel (0.05 microinch per inch) of cosine error.

9 Fasten the laser head and interferometer securely, preserving the alignment. Remove the referenced mirror (true square) and the opaque material.

10 Reposition the retroreflector until the return measurement beam is centered on the receiver alignment target and overlaps the reference beam from the interferometer.

NOTE Placing a piece of translucent tape over the receiver lens will help in observing the incident beams.

11 Verify that the receiver's LED is ON and the voltage at the receiver test point is between 0.6 and 1.3 Vdc (for 10780C/F), or 1.5 and 8.0 Vdc (for E1708A), or 1.8 and 10.0 Vdc (for E1709A).

NOTE Steps 12 through 22 constitute the Y-axis autoreflection alignment.

12 Pitch and yaw the 50% beam splitter until the reflected laser beam is centered on the beam bender aperture. Slight side-to-side adjustments of the 50% beam splitter may be necessary to ensure there is no beam clipping. Fasten the 50% beam splitter securely.

13 Adjust the beam bender until the reflected beam is centered on the aperture of the single-beam interferometer. The single-beam interferometer alignment target can be used as an aid and then removed. Fasten the beam bender securely.

14 Place the receiver alignment target on the receiver and rotate the turret of the laser head to select the small aperture.

15 Place a referenced mirror (true square) between the interferometer and the retroreflector so that the measurement beam from the interferometer strikes its reflective surface. Align the referenced mirror with a precision indicator until its reflective surface is perpendicular to the direction of travel in both angular axes (arcseconds).

16 Place a single-beam interferometer alignment aid on the output side of the interferometer and adjust the single-beam interferometer in pitch and yaw until the beam 1) reflects back on itself and 2) is centered on the small aperture of the laser head. Slight side-to-side movement of the interferometer may be required to ensure that the reference beam from the

interferometer is still centered on the receiver alignment target. Do not adjust the laser head.

NOTE For high-accuracy alignment or for installations where there is less than 0.5 meter (20 inches) between the laser head and reflector, perform steps 17 through 19.

17 Remove the receiver alignment target and interferometer alignment target and select the large aperture of the laser head.

18 With a fast-responding voltmeter (preferably an analog type) attached to the receiver test point and receiver case ground, pitch and yaw the laser beam (laser head or interferometer on this axis) until a signal is received on the receiver. (The voltmeter will suddenly jump to some value greater than 0.25 volt.) This is a critical adjustment and may initially require great care.

19 Adjust the laser beam in pitch and yaw to get the maximum voltmeter reading (which may be fluctuating). Now carefully readjust the interferometer until the voltage reading suddenly drops back down to about 0.3 volt.

NOTE The alignment should be adjusted such that the voltage reading from the receiver test point occurs just below the sudden jump up in voltage. If the alignment is fixed to sustain this peaked voltage, system operation will be degraded.

This will align the laser beam to within ±1.2 arcminutes to the direction of travel, resulting in a cosine error of approximately 0.05 ppm. That is 0.05 micron per meter of travel (0.05 microinch per inch) of cosine error.

20 Fasten the single-beam interferometer and beam bender securely, making sure the alignment is preserved. Remove the reflector (true square).

21 Adjust the retroreflector until the return measurement beam is centered on the receiver and overlaps the reference beam from the interferometer.

NOTE Placing a piece of translucent tape over the receiver lens will help in observing the incident beams.

22 Verify that the receiver's LED is ON and the voltage at the receiver test point is between 0.6 and 1.3 Vdc (for 10780C/F), or 1.5 and 8.0 Vdc (for E1708A), or 1.8 and 10.0 Vdc (for E1709A).

Overlapping dot alignment procedure (for Agilent 10702A, Agilent 10766A, Agilent 10705A)

This subsection describes the overlapping dots alignment method used on a two-axis configuration. Figure 34 is a typical measurement configuration which includes a linear interferometer and a single-beam interferometer.

NOTE Steps 1 through 10 constitute the X-axis “Overlapping Dot” alignment procedure.

1 Place the interferometer alignment target on the laser side of the X-axis interferometer and place the receiver alignment target on the receiver so that it is not in the laser beam (see Figure 34, position 1). Place a piece of opaque material such as frosted tape between the interferometer and retroreflector.

2 With the retroreflector and interferometer at the closest point, adjust the laser head until the laser beam 1) passes through the 50% Beam Splitter, 2) enters one hole of the alignment target on the interferometer, and 3) exits the other hole to hit the receiver alignment target centered on the hole over the photodetector. A slight lateral adjustment of the interferometer or laser head may be required.

3 Remove the opaque material from between the retroreflector and interferometer and rotate the receiver alignment target to position 2 (see Figure 34).

4 Adjust the retroreflector to center the return measurement beam on the receiver alignment target.

5 Move the retroreflector to its furthest point of travel.

6 Pitch and yaw the laser head to center the return beam on the receiver alignment target.

7 Return the retroreflector to the point closest to the interferometer.

8 Repeat steps 4 through 7 until the return beam is centered on the receiver alignment target at both ends of travel. A lateral offset of 500 microns over a 0.5 meter travel is equal to a cosine error of 0.12 ppm or 0.12 micron per meter of travel (0.12 microinch per inch).

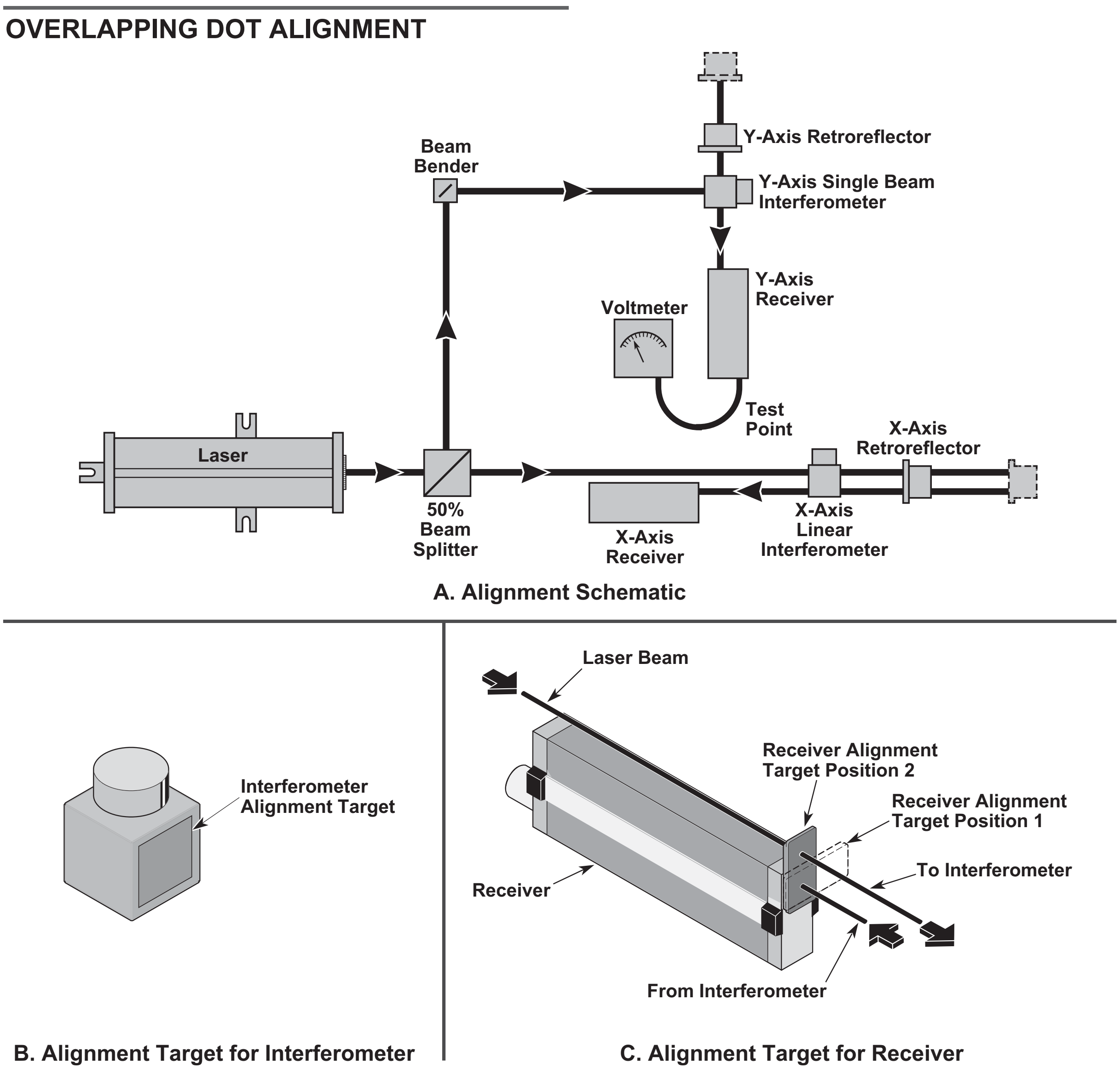


Figure 34 Overlapping dot alignment

9 If the reference beam returning from the interferometer is not centered on the receiver target, adjust the interferometer until both the reference and the measurement beams are centered.

NOTE In step 10, make sure the alignment is not disturbed.

10 Lock the laser head and X-axis optics down securely. Remove the receiver alignment target. Verify that the LED indicator on the receiver is lighted and that the voltage at the receiver test point is between 0.6 and 1.3 Vdc.

NOTE Steps 11 through 20 constitute the Y-axis “Overlapping Dot” alignment procedure

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11 Place the alignment target on the Y-axis single-beam interferometer and on the Y-axis receiver. Place a piece of opaque material between the single-beam interferometer and the retroreflector.

12 Pitch and yaw the 50% beam splitter until the reflected laser beam is centered in the beam bender entrance aperture. Slight lateral adjustments of the 50% beam splitter may be necessary to ensure there is no beam clipping. Fasten the 50% beam splitter securely.

13 Adjust the beam bender until the reflected beam is centered on the alignment target installed on the single-beam interferometer. Fasten the beam bender securely in place.

14 With the single-beam interferometer and retroreflector at their closest points, adjust the single-beam interferometer until the reference beam is centered on the receiver alignment target. Remove the opaque material.

15 Adjust the Y-axis retroreflector until the measurement beam is centered on the receiver alignment target.

16 Move the retroreflector to its furthest point of travel.

17 Pitch and yaw the single-beam interferometer to center the return beam from the retroreflector on the receiver alignment target. When aligning the single-beam interferometer, it may also be necessary to make slight lateral adjustments to ensure that the reference beam from the single-beam interferometer is also centered on the receiver alignment target.

18 Return the retroreflector to the point closest to the single-beam interferometer.

19 Repeat steps 15 through 18 until the return beam from the retroreflector is centered on the receiver alignment target at both extremes of travel. Secure the single-beam interferometer, preserving the alignment.

20 Remove the single-beam alignment target and the receiver alignment target. Verify that the receiver’s LED is ON and the voltage at the receiver test point is between 0.6 and 1.3 Vdc (for 10780C/F), or 1.5 and 8.0 Vdc (for E1708A), or 1.8 and 10.0 Vdc (for E1709A).

5
Measurement Optics (General Information)

General

Each laser measurement system's measurement axis must have an interferometer and a reflector. Machine design considerations determine which type of interferometer is best. The choice of the interferometer for each axis usually determines the reflector for that axis.

This chapter describes the Agilent Technologies measurement optics available for Agilent Technologies laser measurement systems. The first part of this chapter presents material that should be useful to the user of any of the interferometers. Following this introductory material, chapters 8 through 25 describe individual interferometer types, including characteristics and specifications.

Table 3 lists the measurement optics in order by Agilent Model Number (it doesn't list the Next Generation Interferometers, see Chapter 6, "NGI Measurement Optics (General Information),". Table 3 also: 1) identifies the chapter in which each measurement optic is described, 2) provides summary descriptions of the measurement optics, and 3) lists the reflectors and Agilent adjustable optics mounts with which the optics may be used. (The mounts are described in Chapter 36, "Accessories," in Volume II of this manual.)

Agilent Technologies beam-directing optics are described in Chapter 17, "Beam-Directing Optics," of this manual.

Agilent Technologies next generation interferometers (NGIs) are introduced in Chapter 6, "NGI Measurement Optics (General Information)," in this manual. Chapters 31 through 34 describes the different NGI interferometer models.

Other Agilent optics that are neither 1) interferometers nor 2) beam-directing optics are described in Chapter 36, "Accessories," in Volume II of this manual.

Table 3 Measurement Optics Summary

Manual Chapter	Model Number and Name	Application	System Resolution	Beam Separation	Config-uration	Reflector	Reflector Weight	Mount Used
8	Agilent 10702A Linear Interferometer	General Purpose	λ/64 (10 nm)	12.7 mm (0.5 in)	Straight-through or Turned	Agilent 10703A	42 g (1.5 oz)	Agilent 10711A
8	Agilent 10702A-001 Linear Interferometer	General Purpose	λ/64 (10 nm)	12.7 mm (0.5 in)	Straight-through or Turned	Agilent 10703A	42 g (1.5 oz)	Agilent 10711A
9	Agilent 10705A Single Beam Interferometer	Low-mass Limited space	λ/64 (10 nm)	Not Applicable (single beam)	Straight-through or Turned	Agilent 10704A	10.5 g (0.4 oz)	Agilent 10710B
10	Agilent 10706A Plane Mirror Interferometer	Plane Mirror	λ/128 (5 nm)	12.7 mm (0.5 in)	Straight-through or Turned	Agilent 10724A or user supplied	50 g (1.8 oz)	Agilent 10711A
11	Agilent 10706B High Stability Plane Mirror Interferometer	Plane Mirror	λ/128 (5 nm)	12.7 mm (0.5 in)	Straight-through or Turned	Agilent 10724A or user supplied	50 g (1.8 oz)	Agilent 10711A
12	Agilent 10715A Differential Interferometer	High Accuracy Plane Mirror	λ/128 (5 nm)	12.7 mm (0.5 in)	Straight-through or Turned	Agilent 10724A or user supplied	50 g (1.8 oz)	Agilent 10711A
12	Agilent 10715A-001 Differential Interferometer	High Accuracy Plane Mirror	λ/128 (5 nm)	12.7 mm (0.5 in)	Turned	Agilent 10724A or user supplied	50 g (1.8 oz)	Agilent 10711A
13	Agilent 10716A High Resolution Interferometer	High Resolution Plane Mirror	λ/256 (2.5 nm)	12.7 mm (0.5 in)	Straight-through or Turned	Agilent 10724A or user supplied	50 g (1.8 oz)	Agilent 10711A
14	Agilent 10717A Wavelength Tracker	Wavelength-of-light compensation	—	Not Applicable	Not Applicable	Built-in	Not Applicable	none
15	Agilent 10719A One-axis Differential Interferometer	One Linear Plane Mirror Measurement (Differential) or One Angular Measurement	λ/128 (5 nm) 0.054 arcsec (0.26 μrad)	See Specifications	Straight-through only	custom	custom	custom

Table 3 Measurement Optics Summary (continued)

Manual Chapter	Model Number and Name	Application	System Resolution	Beam Separation	Config- uration	Reflector	Reflector Weight	Mount Used
16	Agilent 10721A Two-axis Differential Interferometer	Two Linear Plane Mirror Measurements (Differential) Linear Yaw	λ/128 (5 nm) 0.08 arcsec (0.4 µrad)	See Specifications	Straight-through only	custom	custom	custom
17	Agilent 10735A Three-axis Interferometer	3 Linear Plane Mirror Measurements (Displacement, Yaw, Pitch)	λ/128 (5 nm) 0.04 arcsec, (0.2 µrad) 0.05 arcsec, (0.24 µrad)	See Specifications	Turned only	custom	custom	custom
17	Agilent 10736A Three-axis Interferometer	3 Linear Plane Mirror Measurements (Displacement, Yaw, Pitch)	λ/128 (5 nm) 0.04 arcsec, (0.2 µrad) 0.05 arcsec, (0.24 µrad)	See Specifications	Turned only	custom	custom	custom
17	Agilent 10736A- 001 Three-axis Interferometer with Beam Bender	3 Linear Plane Mirror Measurements (Displacement, Pitch)	λ/128 (5 nm) 0.05 arcsec, (0.24 µrad)	See Specifications	Turned only	custom	custom	custom

Table 3 Measurement Optics Summary (continued)

Manual Chapter	Model Number and Name	Application	System Resolution	Beam Separation	Config-uration	Reflector	Reflector Weight	Mount Used
18	Agilent 10737L/R Compact Three-axis Interfero-meters	3 Linear Plane Mirror Measurements (Displacement, Yaw, Pitch)	See Specs.	See Specs.	Turned only	Plane mirror or cube corners	Customer determined	Agilent 10711A
8	Agilent 10766A Linear Interferometer	General Purpose	$\lambda/64$ (10 nm)	11 mm (0.43 in)	Straight-through or Turned	Agilent 10767A	224 g (0.5 lb)	Agilent 10785A
19	Agilent 10770A Angular Interferometer	High Accuracy Plane Mirror	$\lambda/64$ (10 nm)	11 mm (0.43 in)	—	Agilent 10771A	650 g (1.5 lb)	Agilent 10785A
20	Agilent 10774A Short Range Straightness Optics	High Resolution Plane Mirror	—	Not Applicable	—	Included	800 g (1.8 lb)	Agilent 10776A
20	Agilent 10775A Long Range Straightness Optics	High Resolution Plane Mirror	—	Not Applicable	—	Included	800 g (1.8 lb)	Agilent 10776A

Resolution

The fundamental optical resolution for each interferometer type is listed in Table 4. Using electronic resolution extension, the system resolution is increased significantly. Depending on the system, additional resolution extension factors of 32 is available.

Table 4 Interferometer Resolutions

Interferometer Type	Fundamental Resolution
Linear	λ /2 0.316 micron (12.44 microinches)
Plane Mirror	λ /4 0.158 micron (6.32 microinches)
High Resolution Plane Mirror	λ /8 0.079 micron (3.12 microinches)

Range

The nominal optical measurement range for an Agilent laser measurement system is usually 40 meters (130 feet) for the sum of all axes. In calibrator systems, this range may be doubled with the Agilent 5519A/B optional long range kit.

The 3 mm diameter beam of the Agilent 5517C-003 Laser Head allows a maximum range of 10 meters (32 feet) for the sum of all axes.

Measurement Direction Sense

Direction sense depends on the relation of the optical frequencies in the interferometer’s reference and measurement paths. This, in turn, depends on: 1) the orientation of the laser head, 2) the effect of any beam-bending optics in the path between the laser head and the interferometer, 3) the interferometer's configuration (straight-through or turned), and 4) the orientation of the interferometer itself.

For example, if: 1) f_1 (the lower frequency from the laser head) is in the measurement path (that is, the path going to the measurement mirror), and 2) f_2 (the higher frequency from the laser head) is in the reference path (that is, the path going to the reference mirror), 3) the measurement optics are moving away from each other, the fringe counts will be INCREASING.

Interchanging f_1 and f_2 will reverse the direction sense, resulting in the fringe counts DECREASING as measurement optics move away from each other.

In this manual, “f_1” and “f_2” have been used to identify the two frequency components of the laser beam. However, because the components that left the laser head having horizontal and vertical orientations can have the opposite orientations when they arrive at an interferometer, “f_A” and “f_B” are used to identify the beam paths through the interferometers. Figure 35 shows how two parallel beams, derived from the same source, can have different polarization orientations at interferometer inputs. An interferometer using one of these beams will produce increasing counts as its measurement mirror moves away from it; an identical interferometer, parallel to the first, but using the second beam, will produce decreasing counts as its measurement mirror moves away.

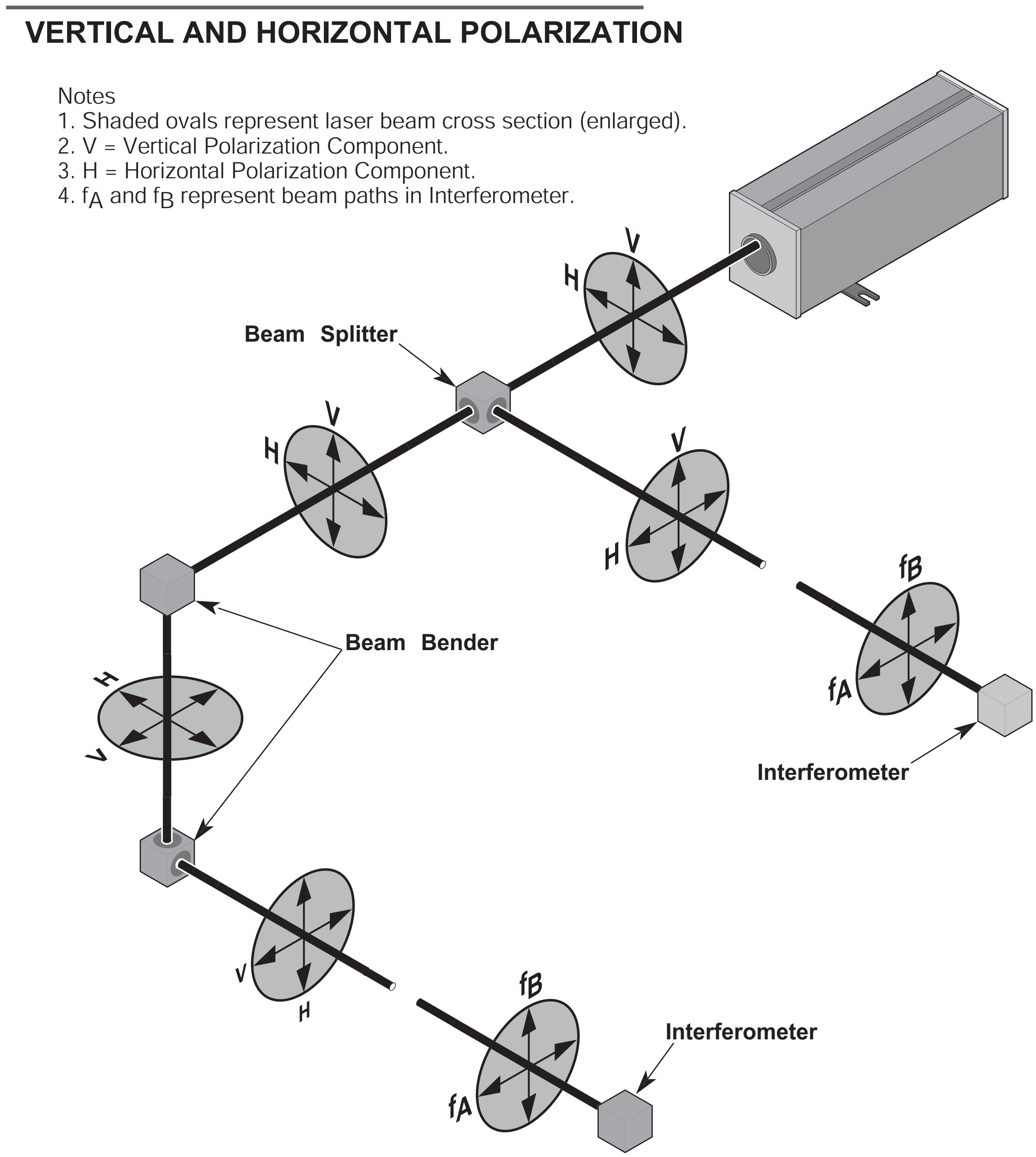

Figure 35 Effect of beam-directing optics on laser beam polarization orientations

Vibration Isolation

Vibration of the optics along the laser beam can cause the fringe count in the laser measurement system electronics to fluctuate rapidly. Vibrations along this axis constitute real, measurable, displacements; you will have to decide if these fluctuating measurements are acceptable in your application. In extreme cases, however, the velocity of the optics may momentarily exceed the velocity limitation of the laser measurement system, causing an error.

When vibration occurs perpendicular to the beam, the beam signal power can fluctuate. If this fluctuation is too great, insufficient beam signal will arrive at the receivers, causing a “measurement signal error.”

Loose mounting can cause the optics to move inappropriately during a measurement, causing a measurement error or loss of beam power.

Elastic mounting can have the same effect as loose mounting. It can also be responsible for a “sag” offset in the optics’ positions. If there is vibration in the machine, an elastic mounting can transmit and amplify the vibration to the attached optic, possibly causing more errors. You should anticipate these effects and minimize them, if necessary, during the laser measurement system design process.

Certain interferometers are inherently less susceptible to vibration effects than others. This is particularly true of differential-style interferometers such as the Agilent 10715A, Agilent 10719A, and Agilent 10721A. The stability of these interferometers is due to the fact that both their reference beams and their measurement beams travel to external mirrors. Any motion of the interferometer itself that is common to both beams will not appear as a measurement. Of course, any vibration between the reference and mirrors will constitute real, measurable, displacements.

Fasteners

Any optical component that fits an adjustable mount is supplied with mounting screws to mount it on the appropriate adjustable mount.

Vacuum Applications

Many of the optical components of the laser measurement system have vacuum options, which are compatible with vacuum environments. Contact Agilent Call Center for information (telephone numbers of various call centers are listed on the “Service and Support” page at the back of this manual). Typically, these components have housings made of stainless steel and optical elements attached to the housings using a lower volatility (vacuum-grade) adhesive. See the specifications for a list of materials used in the optics.

Use Through Window

If the laser beam has to go through a window (for example into a vacuum chamber) the window must meet the following requirements:

- A minimum window aperture of 25.4 mm (1 inch) with a minimum thickness of 8 mm (0.3 inch). If a larger window is used, it must be proportionally thicker to assure no distortion in the window when under differential pressures.
- Transmitted wavefront distortion less than $\lambda/10$ (peak-valley, single-pass) over a 23 mm (0.9 inch) diameter.
- Parallelism of faces less than ±2 arc-minutes, to reduce beam steering.
- Surface quality 60-40 or better, per Mil-0-13830.
- The window must be strain-free.

Differential Measurements with Interferometers

Several interferometers have the capability to make differential measurements. A differential, measurement is one in which both the reference beam and the measurement beam travel to external mirrors outside the interferometer housing. This allows measurement of the relative positions of the two external mirrors, either or both of which may be moving. Viewed another way, this allows measuring the motion of one reflector relative to a reference datum elsewhere in the machine, external to the interferometer itself. This is unlike the typical interferometer configuration because usually the *reference* beam path length does not change; in differential configurations, it can.

One useful example of a differential measurement in a lithography application is for measuring the motion of the X-Y stage relative to the optical column. The Agilent 10719A One-Axis Differential Interferometer and the Agilent 10721A Two-Axis Differential Interferometer are ideally suited to this type of measurement, because they provide parallel reference and measurement paths which are offset vertically by 19 mm (0.750 inch). For such an application, a user-supplied reference plane mirror is required in addition to the measurement reflector on the X-Y stage.

Differential measurements that can be made using an Agilent 10719A interferometer are shown in Figure 170 in Volume II of this manual. Differential measurements that can be made using an Agilent 10721A interferometer are shown in Figure 178.

The Agilent 10715A Differential Interferometer, instead of having an offset spacing as in the Agilent 10719A or Agilent 10721A interferometers, permits the reference beams and the measurement beams to be aligned essentially coaxially. A specially-shaped reference plane mirror (shown in Figure 144) is supplied with the Agilent 10715A. For more information about the Agilent 10715A, see Chapter 22, “Agilent 10715A Differential Interferometer,” in Volume II of this manual.

Customized differential configurations are possible with several other interferometers. However, considerable care should be exercised during design and layout to avoid introduction of alignment errors, thermal or mechanical instabilities, and potential deadpath problems. When making differential measurements, both reflectors (reference and measurement) should be of the same type (cube corner or plane mirror); this minimizes thermal drift problems with ambient temperature changes.

To use the Agilent 10702A, Agilent 10705A, or Agilent 10766A in a differential configuration, the reference cube corner can simply be detached from the interferometer housing and attached to the reference surface of interest. This is shown in Figure 105 in the Linear Interferometers chapter (Chapter 18) of this manual. Be aware that all installation and alignment requirements for the measurement reflector now apply also to the reference reflector.

To use the Agilent 10706A or Agilent 10706B interferometer in a differential configuration, a plane mirror is recommended as the reference reflector. Simply replace the reference cube corner (or high-stability adapter) with the Agilent 10722A Plane Mirror Converter and attach the reference plane mirror to the reference surface of interest. This is shown in Figure 121 in the plane mirror chapter (Chapter 20) of this manual. Again, install and align the reference reflector the same as you would the measurement reflector.

Moving Interferometer Instead of Reflector

When moving the interferometer instead of the measurement reflector is required, the Agilent 10702A-001 (or Agilent 10766A) should be used. In practice, for alignment reasons, these are the only interferometers (except the straightness interferometers) that can be moved while making measurements. For a detailed explanation of why this option is required, see Figure 100 in the Linear Interferometers chapter (Chapter 18) in Volume II of this manual.

6
NGI Measurement Optics (General Information)

Introduction

The Next Generation Interferometer (NGI) differs from previous interferometers due to its monolithic structure. The optical elements (i.e., quarter-wave plates, cube corners, and input rhomboids) are optically cemented or contacted directly onto the polarizing beam-splitter (PBS) surfaces. Also, the quarter-wave plates have highly reflective (HR) coatings that serve as reference mirrors. The reference beam path then remains inside the interferometer without crossing any air interfaces; hence, this eliminates most external mounting parts, and increases measurement stability by avoiding thermal expansion problems. The overall optical structure is condensed.

The input laser beam has two polarizations that are orthogonal to each other. Nonpolarizing beam-splitters composed of rhomboid/prism and sometimes spacer assemblies are used to split an input laser beam into two separate beams according to power level and beam pattern. An example beam-splitting percentage is 50% and 50%, where the ratio of S to P polarization is unaffected. The distance between separate beams is determined by the rhomboid length, which is adjustable for each design. The input splitting optics and coatings are configured (by design) to support many beam pattern and power level requirements.

This chapter provides:

- a list of next-generation measurement optics in order by Agilent Model Number (Table 5). The table also: 1) identifies the chapter in which each measurement optic is described, and 2) provides summary descriptions of the measurement optics
- an optical schematic of the Agilent NGI (Figure 36)
- a diagram of angular resolution of the Agilent NGI (Figure 37)
- procedures for aligning and mounting the NGI (page 123)
- fiber optics specifications (page 130)

Chapters 31 through 34, in Volume II of this manual, provide complete descriptions of the different NGI interferometer models.

Table 5 lists and summarizes the Agilent NGI interferometers. All of the NGIs products are *dual-pass interferometers* and hence have an optical resolution of $\lambda/4$. Depending on the resolution extension, the measurement resolution can go down to 0.15 nm.

Table 5 NGI Interferometers summary

Manual Chapter	Model Number and Name	Number Axes	Beam Diameter	Optical Resolution	Typical Optical Efficiency (Input power/axis output power)	Base Plate Material	Mass
31	Agilent E1826E/F/G	1	ϕ 9 mm, maximum (visible)	λ/4	65%	Invar (Option 070), Passivated 416 Stainless Steel (Option 071)	0.40 kg (.89 lbs)
32	Agilent E1827A	2	ϕ 9 mm, maximum (visible)	λ/4	All axes = 26%	Passivated 416 Stainless Steel	2.35 kg (5.22 lbs)
33	Agilent E1837A	3	ϕ 9 mm, maximum (visible)	λ/4	All axes = 18%	Passivated 416 Stainless Steel	2.67 kg (5.93 lbs)
33	Agilent Z4399A	3	ϕ 9 mm, maximum (visible)	λ/4	All axes = 18%	Invar	1.66 kg (3.65 lbs)
33	Agilent Z4422B	3	ϕ 9 mm, maximum (visible)	λ/4	Axis 3 = 13% Axes 1 and 2 = 18%	Passivated 416 Stainless Steel	1.95 kg (4.3 lbs)
34	Agilent Z4420B	5	ϕ 9 mm, maximum (visible)	λ/4	Axis 5 = 7% Axes 1 thru 4 = 10%	Passivated 416 Stainless Steel	3.13 kg (6.9 lbs)
34	Agilent Z4421B	5	ϕ 9 mm, maximum (visible)	λ/4	Axis 5 = 7% Axes 1 thru 4 = 10%	Passivated 416 Stainless Steel	3.15 kg (7 lbs)

NGI Optical Schematic

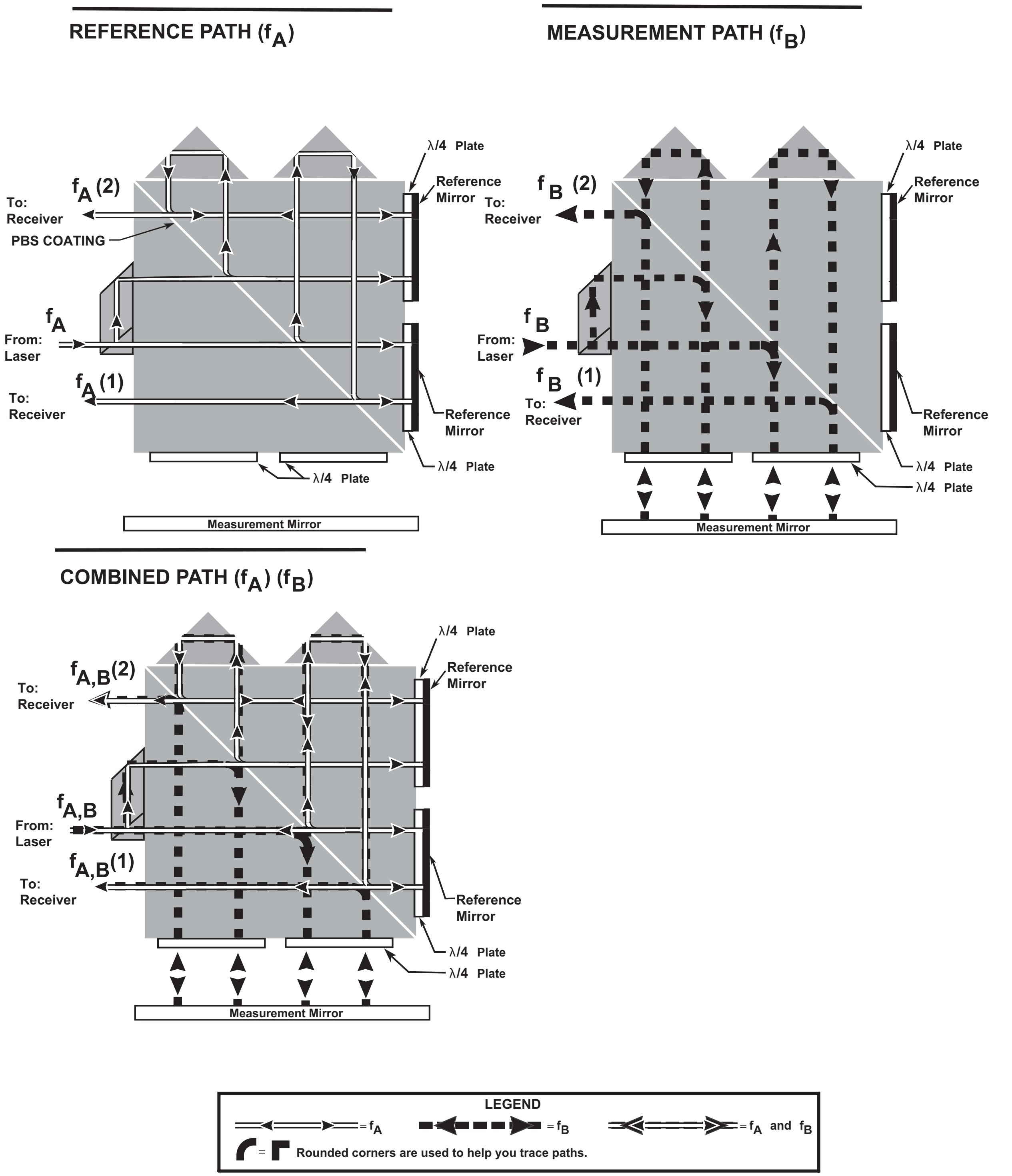

Figure 36 Next Generation Interferometer laser beam path

NGI Angular Resolution

The angular resolution can be calculated by using the following equation:

$$\alpha = \frac{\Delta x}{d} = \frac{\text{Linear resolution}}{\text{Beam separation}}$$

Where (see Figure 37 on page 122):

Δx = the position change of the stage (linear resolution)

d = the distant between the measure points (distance between the image at the cube corners' apexes on the measurement mirror)

The distance between the measurement points (d) will vary due to several factors. If you do not compensate for these factors with a system calibration step, you can estimate the angular resolution error by considering all of the contributing tolerances. The tolerances that affect the distance between the measurement points on the measurement mirror (where the image of the cube corners' apexes will be located on the measurement mirror) are as follows:

- error due to beam parallelism (e.g., 25 µradians)
- error due to beam primary to secondary parallelism (e.g., 15 µradians)
- error due to initial alignment (e.g., data alignment, input beam alignment)
- error due to cube corner positions (e.g., 50 µmeters)

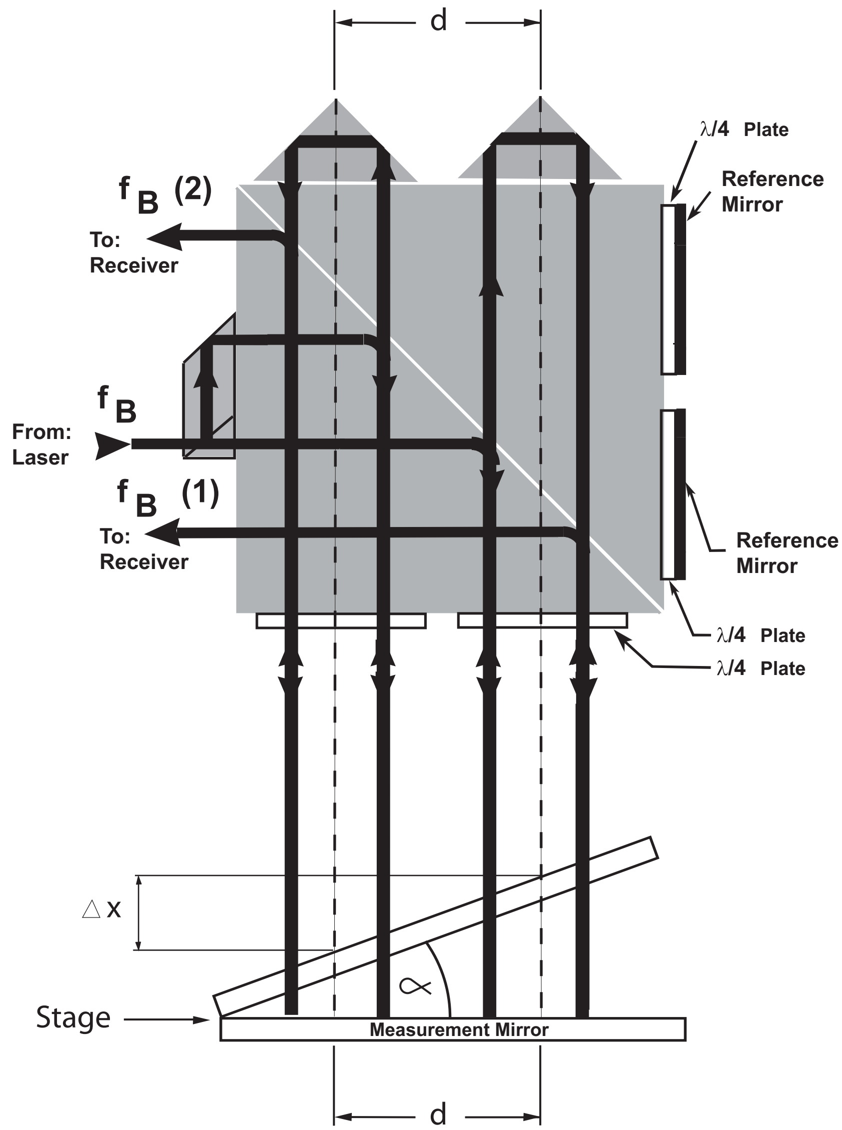

Figure 37 NGI Angular Resolution diagram

Alignment and Mounting

General

Before any interferometer is installed, a suitable mounting location must be prepared for it. The interferometer's mounting location defines the relationship of its measurement beams to the stage whose motion is to be measured. Preparing a proper mounting location minimizes initial beam walkoff. The following information in this section will allow you to design and build a mounting location for a next generation interferometer.

Procedure

The Agilent Next Generation interferometers installation can be performed in four parts.

1 Adjust stage angle to the system zero stage angles (see the "Ideal zero stage angles", "Determining system zero stage angles", and "Effect of misalignment" subsections).

2 Mount the interferometers (see the "Mounting the interferometers" subsection).

3 Adjust the input beam angle to be normal to the stage, see the "Adjusting the input beam angle" subsection).

4 Translate the input beam to the center of the primary remote sensor (see "Beam translation alignment" subsection).

Ideal zero stage angles

To minimize beam walkoff, the stage mirror should ideally be aligned to the ideal zero stage angle using the interferometer's datums; the ideal zero stage angle is when the stage mirror is normal to the A datum and parallel to the B datum of the interferometers as shown in Figure 38.

The mounting surface (A datum) shall be a similar material to the interferometer baseplate or have similar coefficients of thermal expansion (CTE). This mounting surface should be prepared to have a surface profile of 20 µm and surface finish of 0.4 µm or better. Please contact Agilent to discuss alternatives for mounting to materials that do not match the baseplate CTE.

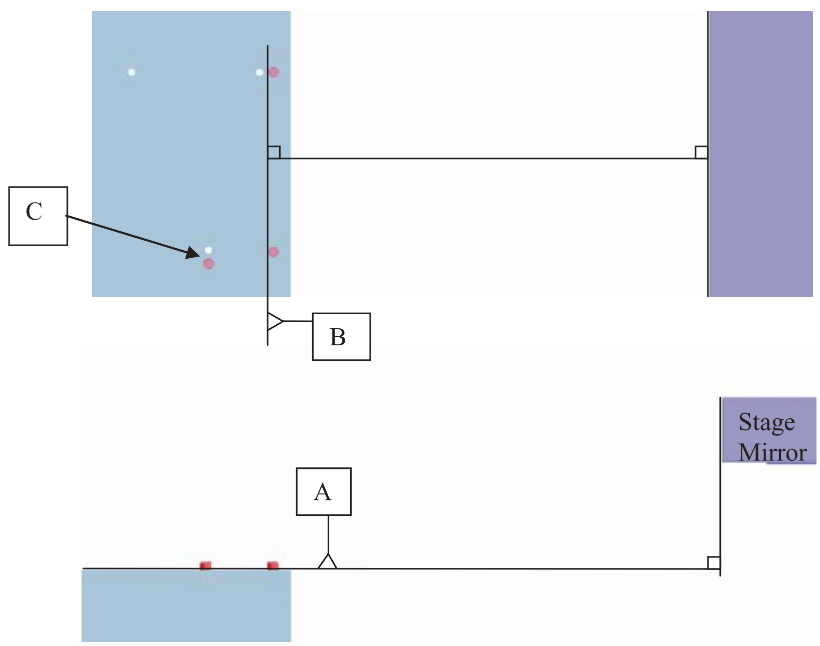

Figure 38 Interferometer datums relative to ideal zero stage angles

Determining system zero stage angles

Assuming the system zero stage angle is ideal, one method is to use large true squares as shown in Figure 39. First, position true squares firmly against the interferometers' datums, namely A and B. An autocollimator can then determine the relative angle between the true squares (representing the interferometer datums) and the stage mirror. The true squares are then removed and the interferometers mounted.

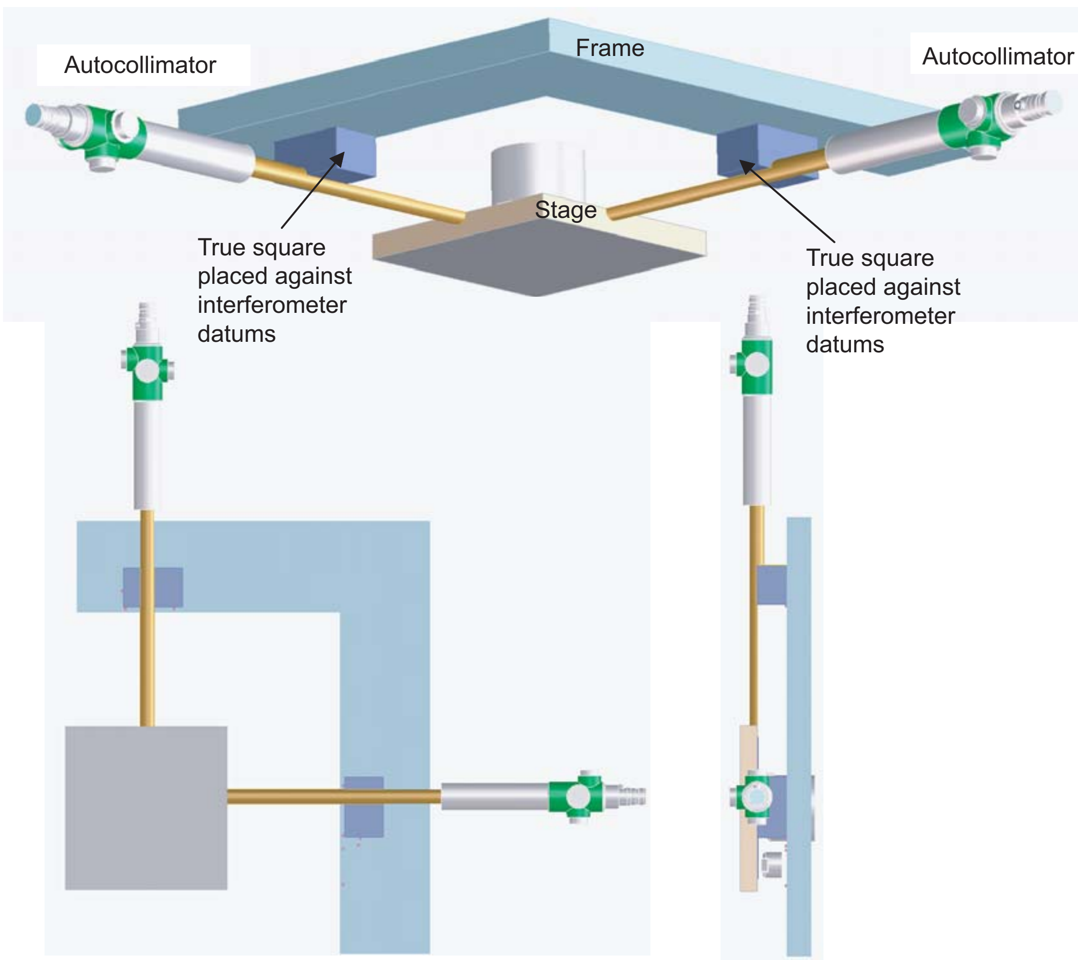

Figure 39 Setup for determining system zero stage angles

Effect of misalignment

The interferometers' datums will have slight tolerances between them. The two orthogonal mirrors on the stage will also have a tolerance on their orthogonality. Hence, the system zero stage angle between the stage mirror and the interferometer's datums will not be ideal.

Once the stage angle has been adjusted to the system zero stage angles, the stage angle range will be reduced 1 µrad for every 10 µrad of datum misalignment from ideal.

Mounting the interferometers

The Agilent interferometer is to be placed on the plane (A datum, the mounting surface), slid on the plane into position along the line (B datum, created by two dowels), and finally slid along the line, on the plane, to the stopping point (C datum, created by a single dowel). See Figure 40.

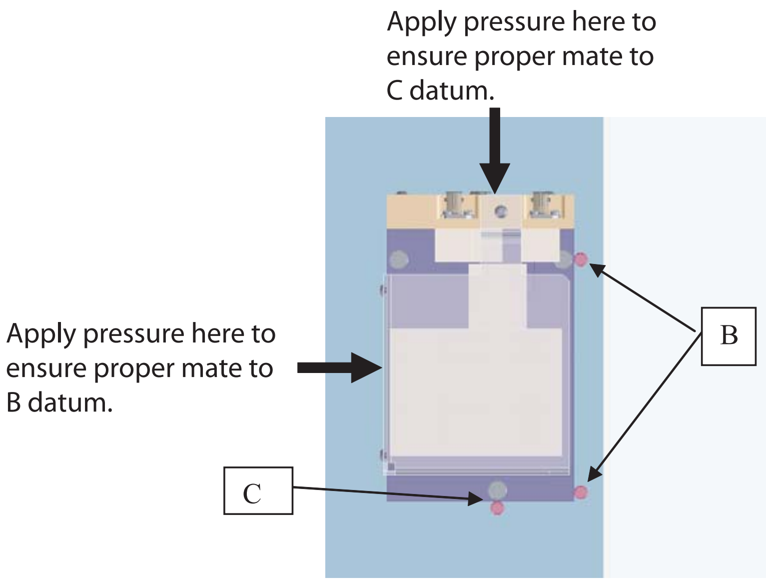

Figure 40 Interferometer mounting

The interferometers must stabilize to the frame temperature before mounting bolts are tightened[1].

Approximately 44 Newtons should be continuously applied on the interferometer in the two positions shown in Figure 40 to ensure proper mate to the B and C datums. Torque each of the three screws as listed in Table 6.

[1] The interferometer can be stabilized by attaching it to the frame, tightening screws to ~0.5 newton-m, and waiting >1 hour. Then loosen screw and tighten to final torque.

Table 6 Screw Torque Requirement

Screw Size	Torque
M3	1 Nm
M4	2.4 Nm
M5	5 Nm

Adjusting the input beam angle

Input beam angles for ideal zero stage angles Assuming the system zero stage angles are ideal, the input beam has a unique angle that is not perfectly normal due to glass tolerances. This unique input beam angle that minimizes initial beam walkoff and maximizes the stage angle range will fall within the input beam cone angle (IBCA). If the system zero stage angles are ideal, meaning that the stage mirror is square to the datums, the only input beam angular adjustment necessary would be the IBCA.

Assuming ideal zero stage angle, to find the unique input beam angle, two conditions must exist:

- The measurement mirror must be perpendicular to datum A and parallel to datum B of the mounting location, which is the ideal zero stage angle.
- The interferometer’s measurement axis’ primary beam must be perpendicular to the measurement mirror.

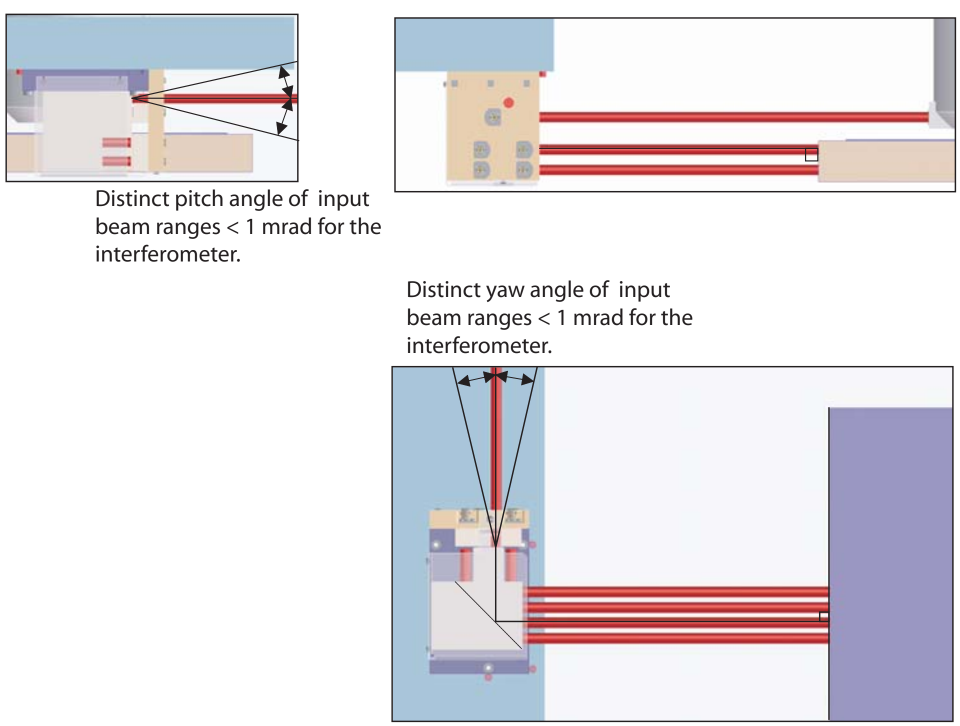

Figure 41 Input beam cone angle for ideal zero stage angles

Input beam angles for system zero stage angles There are still tolerances between the orthogonal stage measurement mirrors and the A and B datums, meaning that the system zero stage angle would not be ideal. Therefore, to account for both the tolerance in the glass and the tolerances in the system's alignment to the datums, this latter tolerance must be added to the IBCA. The beam directing optics must be able to manipulate the input laser beam such that its angular adjustment range includes the sum of the tolerances.

The stage angle range will be reduced 1 µrad for every 1 µrad of input beam misalignment.

Beam translation alignment The input beam position should be translated to the center of the input aperture once the input angle is set. This provides the maximum angular range.

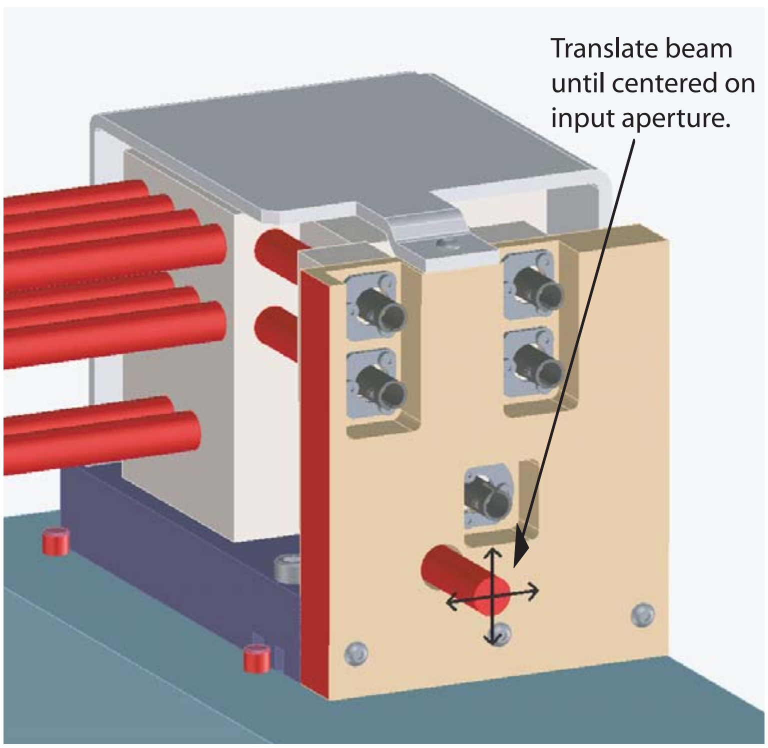

Figure 42 Input Beam Position Adjustment

Manipulator requirements The beam directing optics must be able to manipulate the input laser beam to the center of the interferometer's input aperture with total input beam angle.

Measure Point Tolerance

Measure point tolerance defines the tolerance of the location of the apex of each cube corner relative to each other (deviation tolerance) and their average locations to the interferometer datums (mean tolerance). The *mean offset* is defined by the average of all cube corner actual offsets relative to the datums in a multi-axis interferometer. Individual cube corner's *deviation offset* is defined by the distance each cube corner is actually located relative to its nominal position shifted by the mean offset.

This tolerance is important for achieving repeatable and known measure point positions from unit to unit on a customer system. The alignment system metrology may rely on this in order to define abbé offsets and define angles calculated by measurements made by two interferometer axes (i.e., Pitch or Yaw). The accuracy of the measure point locations also affects the beam locations and should be considered when sizing the measurement mirror(s).

The measure point mean and deviation tolerances are shown in Figure 43, using a five-axis interferometer as an example.

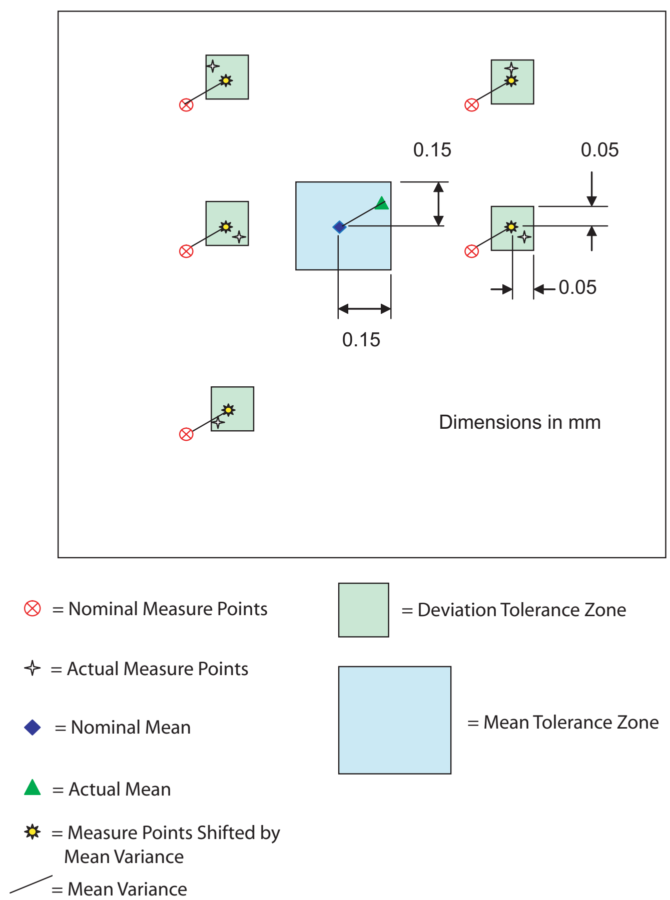

Figure 43 Measure Point Tolerance

Fiber Optic Interface Specifications

NGI interferometers have integral remote sensors with ST connectors, eliminating the need to mount separate remote sensors. The ST connectors are pre-aligned at the factory so the customer will only need to connect the fiber optic cables. Both plastic and glass fibers with ST connectors can be used, which can be obtained from Agilent. Multiple lengths are available for your requirements.

If an ST type bulk head feedthrough is necessary for connecting the fibers, customers can use AMP's 504021-1 Fiber Optic Connectors ST Coupling Receptacle.

Plastic Fibers:	
Bending radius	35 mm minimum
Connectors available	ST to V-pin (Agilent E1705B) and ST to ST (Agilent E1705C)
Attenuation	approximately 190 dB/km
Glass Fibers:	
Bending radius	47 mm minimum
Connectors available	ST to V-pin (Agilent E1705E) and ST to ST (Agilent E1705F)
Attenuation	approximately 12 dB/km

7
Maintenance

General

Periodically inspect the laser head, optical components, receivers, and associated items, for indication of mechanical or electrical defect. Look for signs of overheating, corrosion, accumulations of dust, oil, loose electrical connections, or broken parts. Also check the Agilent 10780F Remote Receiver, Agilent E1708A Dynamic Remote Receiver, and the Agilent E1709A Remote High-Performance Receiver for loose fiber optic connections at both ends of the fiber.

Repair any obvious defect. If necessary, clean the unit with dry, clean compressed air or a vacuum cleaner.

CAUTION Do not use compressed air on an Agilent 10719A, Agilent 10721A, Agilent 10735A, Agilent 10736A, or Agilent 10736A-001 interferometer. The units may be damaged by use of compressed air.

CAUTION To avoid scratching an optical device during cleaning, use the optics cleaning procedures below.

Periodically you may wish to verify proper beam alignment. Refer to Chapter 4, “System Installation and Alignment,” in this manual or the alignment procedure(s) for the optics in your measurement system for the appropriate procedure.

Procedures for Cleaning Optics

WARNING The following optical cleaning procedures do not apply to the optics of the laser head. Cleaning the laser head optics is rarely needed and requires access to the laser head interior where high voltages can be present. All laser head maintenance should be performed by a qualified Agilent technician who is aware of the hazards involved.

Agilent Receivers

Use a soft camel-hair lens brush or equivalent to remove dust from the optical surfaces. Dampen a few lens cleaning tissues with electronics grade methanol, shake off excessive methanol and wipe across the lens surface once. Use a fresh tissue dampened with methanol for each wipe. Allow the methanol to evaporate.

CAUTION Do not use any solvent, for any purpose, on the Agilent 10780F, E1708A, or E1709A receivers' fiber-optic cable. Using a solvent on the fiber-optic cable may damage the cable.

The ends of the Agilent 10780F, E1708A, and E1709A receivers' fiber-optic cable may be cleaned with a clean lint-free cloth.

Measurement optics and beam-directing optics

If the optical surfaces of an instrument are visibly dirty, the following cleaning procedures should be used.

The optics should be handled with care so nothing comes in contact with the optical surfaces. Fingerprints will collect dust and dirt which will attenuate and disperse the laser beam. Also, acids in fingerprints may etch glass or the optical coating. In general, preventing contamination of optics is preferable to cleaning them. Cleaning the optics should be avoided unless the signal intensity of the beam is noticeably reduced.

If cleaning the optics is required, be careful to avoid rubbing particles into the coated surfaces. Permanent reduction of signal intensity could result. If particles are observed on the optics surface, remove them by blowing off with clean pressurized air or (preferably) dry nitrogen. If these are unavailable, commercially available products such as Kodak® Laboratory Sprayer or Micro Duster TX 600 from the Texwipe Company® may be used.

CAUTION

Cleaning optics with tissues or pressurized air is recommended only for exposed glass surfaces that are easily accessible to the user. DO NOT TRY TO CLEAN ANY OPTICAL SURFACE LOCATED INSIDE AN OPTIC HOUSING. Some interferometers contain fragile optical components which are deliberately mounted internally for protection. DO NOT TRY TO DEFEAT THIS PROTECTION. Optical surfaces which cannot be easily viewed or reached should NEVER be cleaned, either with a tissue or with pressurized air.

Example 1:	The Agilent 10719A and Agilent 10721A interferometers have only ONE user-accessible optic—the external window facing the measurement and reference reflectors. This may be cleaned, if necessary, by wiping with lens tissue or cloth. DO NOT try to clean or blow into any other housing aperture, since this may cause damage to the internal optics.
Example 2:	The Agilent 10735A, Agilent 10736A, and Agilent 10736A-001 interferometers have NO user-accessible optics. DO NOT try to clean or blow into any housing aperture, since this may cause damage to the internal optics.

Lens tissue

CAUTION

For an Agilent 10735A, Agilent 10736A, or Agilent 10736A-001 interferometer, you must not try to clean or blow into any housing aperture, since doing so may damage the optics.

For an Agilent 10719A or Agilent 10721A interferometer, the only opening you may try to clean without possibly damaging the internal optics is the window facing the measurement and reference reflectors.

Some optics (see list below) are shipped with a package of lens tissue which is made specifically for cleaning optics. Use these tissues (or equivalent) with a pure industrial grade methanol in the following manner:

1 Fold the tissue into an approximate 1-inch (25 mm) square.
2 Wet the tissue with methanol (do not saturate) and gently wipe across the optical surfaces. Use only enough pressure to remove the contaminant.
3 Do not reuse the tissue.
4 For additional cleaning, repeat the process using a new tissue.

Except as described in the CAUTION above for the Agilent 10719A, Agilent 10721A, Agilent 10735A, Agilent 10736A, or Agilent 10736A-001 interferometers, which may be damaged by incorrect attempts at cleaning, for external optical surfaces that are hard to reach, the tissue may be held with a clamping tweezer such as a hemostatic forceps. Alternatively, a cotton-tipped swab may be used. Take care not to scratch the coated surface. Do not scrub the surface with a dry tissue.

Alcohol

Avoid alcohol contamination with the following precautions:

1 Use only new, previously unopened containers. Alcohol absorbs water if left exposed to air. This will result in water spots when the alcohol evaporates.
2 Transfer the alcohol to a squeeze bottle that can be capped and made airtight.
3 Never transfer alcohol back into the original container.

Maintenance Procedures

Each laser head and receiver are shipped with their own service manual, which contains the adjustments and checks required to keep each respective laser head and receiver at peak performance. Included in the manual are the test equipment required, equipment setups, and procedures to perform the adjustments.

Before and After Service Product Safety Check

The following safety checks must be performed after any troubleshooting and repair procedures have been completed, to ensure the safe operation of the instrument.

WARNING Resistance checks described below require that the power cord be connected to the instrument and that AC power be disconnected. Be sure that the power cord is not connected to power before performing any safety checks.

1. VISUAL INSPECTION. Visually inspect the interior of the serviced instrument for signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy the cause of any such condition.
2. GROUND CONTINUITY TEST. Plug the power cord into the Agilent electronics. DO NOT CONNECT THE INSTRUMENT TO AC POWER. Using a suitable ohmmeter, check the resistance from the enclosure (chassis) to the ground pin on the power cord. The reading should be less than 1 ohm. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist. The resistance check should be performed from the enclosure to the ground pin of the cord while flexing the interconnect cable.
3. Check any indicated front- or rear-panel ground terminals using the above procedures.
4. INSULATION RESISTANCE CHECK. Tie the line and neutral pins of the power cable together. Check resistance from the instrument enclosure (chassis) to line and neutral with the LINE switch ON and the power source disconnected. The minimum acceptable resistance is 2 Megohms. Replace any component that results in a failure.
5. POWER LINE MODULE CHECK. Check line fuse and line voltage selector in the electronics rear-panel power line module to verify that the correct fuse is installed and that the instrument is properly set for the AC source to be applied.

8
Troubleshooting

Introduction

This chapter provides information to help you find defective components in an Agilent laser measurement system when a problem occurs. It can help determine whether the problem source is in the system electronics, environmental sensor, laser head, receiver, or the optics.

Component-level troubleshooting and calibration should be performed by Agilent Technologies technicians only. However, component-level troubleshooting and calibration information is provided for selected assemblies. This chapter is structured as indicated in Table 7.

Table 7 Chapter content summary

Instrument	Type of Information
Laser Heads	System-level troubleshooting for isolating the fault to the laser head
Agilent 10780C, 10780F, E1708A, or E1709A	System-level troubleshooting for isolating the fault to a receiver
Agilent 107XX Optics	System-level troubleshooting for isolating the fault to the optical assemblies. The Agilent 107XX optics are repairable only by Agilent Technologies.

Additional information is provided in the manuals that are supplied with each instrument.

Troubleshooting Assumptions

The troubleshooting procedures assume that:

1 The system controller is operating properly. Before connecting the system controller to the Agilent electronics, check the controller by:

   a Booting the unit up and verifying appropriate responses,

   b Running your own known good programs, and

   c Executing any controller diagnostics unique to your particular controller.

2 All system controls have been double-checked to verify that they are in the proper positions. This includes the correct setting of all circuit board address and test switches. (See “Preliminary Checks” (or similar information) in the troubleshooting chapter of your electronics manual.)

3 All system cabling is configured correctly and that all cables are making proper electrical connection.

4 The system optics are clean. Refer to Chapter 7, “Maintenance,” in this manual.

5 Power to the system is removed before replacing any units or circuit boards.

6 You adhere to the precautions outlined in “Electrostatic Discharge (ESD)” section of this chapter.

7 The troubleshooting procedures cannot cover all possible malfunctions or combination of malfunctions. However, at the very minimum, these procedures will direct you to the general area of the problem.

WARNING Use of controls, adjustments, or procedures other than those specified herein may result in hazardous laser light exposure or exposure to high voltages.

Electrostatic Discharge (ESD)

Electronic components and assemblies can be permanently damaged by electrostatic discharge. To avoid damage caused by ESD, follow the following precautions:

1 Ensure that static-sensitive devices or assemblies are serviced at static-safe work stations providing the proper grounding for personnel (e.g., table mat with wrist strap).

2 Ensure that static-sensitive devices or assemblies are stored in static-shielding containers (e.g., antistatic poly bags).

3 Do not wear clothing subject to static charge build-up, such as wool or synthetic materials.

4 Do not handle components or assemblies in carpeted areas, Do not remove the component or assembly from its static protective container until you are ready to install it.

5 Avoid touching component leads or assembly edge connectors with your fingers.

Required Test Equipment

The equipment required to maintain the laser heads and receivers is listed in Table 8. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table. Refer to the appropriate electronics manual for a list of test equipment required for electronics maintenance and the calibration of environmental sensors (Agilent 10751C or Agilent 10751D Air Sensor and 10757D, Agilent 10757E, or Agilent 10757F Material Temperature Sensor).

Table 8 Recommended test equipment

Instrument Required	Characteristics	Model Number
Laser Power Meter	Range: 1 microwatt to 1 milliwatt Accuracy: ± 10%	Coherent Inc. ® Ultima Labmaster or equivalent
Digital Voltmeter	Range: –15V to +15V ± 0.01 Vdc NOTE: Accurary of ± 0.01 Vdc required for voltage adjustments.	Agilent 34401A
Oscilloscope	Ability to display signals between dc and 100 MHz.	Agilent 54624A
Clip-on DC Milliammeter	DC Current Range: 1mA to 10A (fullscale) Accuracy: ±3% of full scale ±0.15 mA	Agilent 34401A

Troubleshooting Information

The possible system problems that can occur can be divided into the following areas:

- Malfunction of the laser head.
- Malfunction of one or more receivers.
- Malfunction, misalignment, or improper application of the optical devices.
- Malfunction of the system controller or its improper programming.
- Malfunction of the Agilent system electronics.

If one of these areas is suspect as the source of the trouble, refer to the appropriate troubleshooting information and flowcharts (provided in this section) for that particular area.

Laser Head troubleshooting

Agilent 5517A/B/BL/C/D/DL/FL Laser Head

Laser heads are listed here in the same order in which they are listed in Chapter 16, “Laser Heads,” in Volume II of this manual.

Laser head adjustment procedures are given in the laser head’s own operating and service manual.

The following symptoms indicate problems with the Agilent 5517A, Agilent 5517B, Agilent 5517BL, Agilent 5517C, Agilent 5517D, Agilent 5517DL, or Agilent 5517FL Laser Head. If one or more of these symptoms are observed, use the Troubleshooting Tree, Figure 44, to assist in determining if the laser head is actually at fault. Detailed repair procedures are outlined in the laser head's operating and service manual.

- No laser light being emitted from the laser head exit port.
- Low power output from the laser head.
- LASER ON indicator not lit.
- READY indicator does not illuminate as expected. Normally, the indicator will start to blink on and off within three minutes of applying power to the laser head. This indicates that the laser head is in the process of warming up. When the 5517A, 5517B, 5517BL, 5517C, 5517D, 5517DL, or 5517FLLaser Head is ready for use, the indicator assumes a steady on condition.
- Absence of reference signal or bad reference signal.
- Agilent 5517B/BL/C/D/DL/FL Laser Head's **+15V POWER ON** or **-15V POWER ON** indicator is not lit.

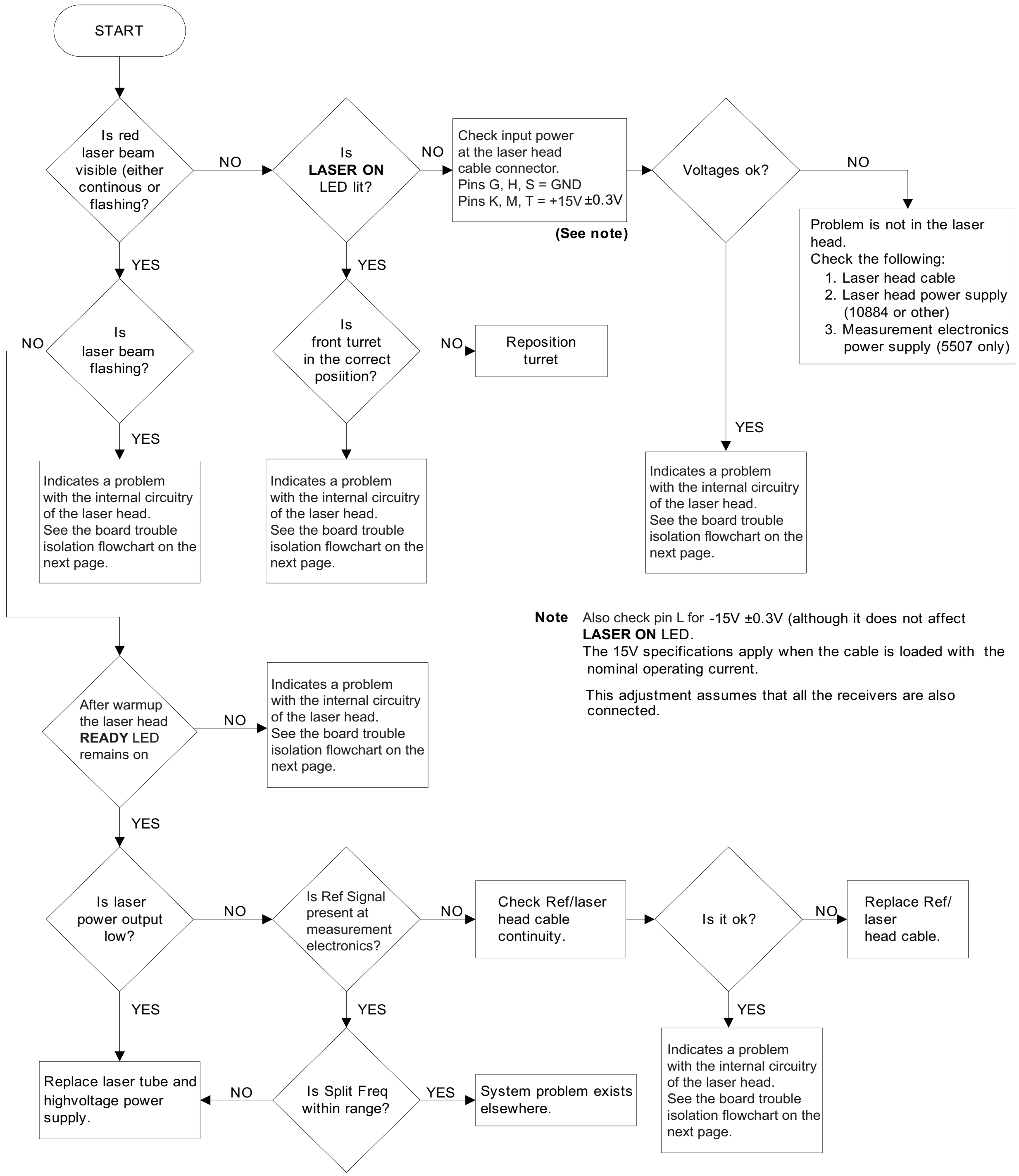

Figure 44 Agilent 5517A/B/C/D Laser Head—troubleshooting tree

Agilent 5519A/B Laser Head

See the *Agilent 5519A/B Laser Head Service Manual* for laser head troubleshooting information.

Receiver troubleshooting

Agilent 10780C, 10780F, E1708A, E1709A Receiver

NOTE

This section is basically written for troubleshooting the Agilent 10780C/F receiver, but many of the same techniques can be used to troubleshoot the Agilent E1708A or E1709A receiver. For troubleshooting information specific to the Agilent E1708A or E1709A receiver, see their respective operating manuals.

NOTE

Allow the laser head sufficient time to complete its tuning cycle prior to determining whether or not the Agilent 10780C, Agilent 10780F, Agilent E1708A, or Agilent E1709A receiver is working properly.

When the Agilent 10780C/F receiver photodetector receives an adequate laser beam signal, the LED indicator illuminates (located on the Receiver's top surface) and the DC voltage at the external beam monitor test point is greater than +0.7. See the "Alignment and Gain Adjustment Procedure" in Chapter 35, Receivers," in Volume II of this manual for procedures to adjust this test point voltage. The alignment and gain adjustment procedures for the Agilent E1708A or E1709A receiver can be found in their respective operating manuals.

If the MEASUREMENT SIGNAL ERROR indicator on the Agilent electronics illuminates, the problem may be with one of the system's measurement axis receivers. If a SYSTEM ERROR indicator illuminates and the system is equipped with a Wavelength Tracking Compensation system, the problem could be with the wavelength tracker axis receiver or the overall alignment of the Wavelength Tracking Compensation system components. By sending an error message query to the Agilent electronics via the system controller, the system will respond indicating which axis is generating the error message.

Improperly aligned optical devices in either a measurement or a wavelength tracking axis can also cause a receiver to appear bad. Check for this by either placing the receiver directly in the laser beam path from the laser head, or by reflecting the laser beam onto the receiver's photodetector using a retroreflector. This isolates all other optical devices from the system. Most systems contain more than one axis and, consequently, more than one receiver. If trouble is suspected with one particular receiver, exchange it with another receiver to verify the suspected malfunction. If you suspect problems with the alignment of a receiver, refer to Chapter 35, Receivers," and Chapter 5, "Measurement Optics (General Information)," in this manual for the appropriate alignment procedures.

A loose or broken fiber-optic connection at either the remote lens or electronics of the Agilent 10780F Remote Receiver, Agilent E1708A, or Agilent E1709A can also cause the receiver to appear bad.

The receiver LED indicator may remain on even if the beam between the interferometer and the retroreflector is blocked. This can occur occasionally with correct optical alignment if the measurement path is very short and few optical devices are used in the measurement path. If this situation occurs, refer to the receiver's operating and service manual.

The troubleshooting tree of Figure 45 will help you determine if the Agilent 10780C Receiver, Agilent 10780F Remote Receiver is faulty. Repair of the Agilent 10780C or Agilent 10780F is outlined in the *Agilent 10780C/F Operating and Service Manual*. Table 9 shows the Agilent 10780C/F Receiver signal chart.

Table 9 Agilent 10780C or Agilent 10780F Receiver signal chart

Receiver Input Output	**Signal Name**	
J1(1)	MEAS	
J1(2)	MEAS	
J1(3)	+15V Return RET	
J1(4)	+15V	
Pin	**Wire Color**	**Signal**
1	BLK	MEAS FREQ—
2	WHT	MEAS FREQ
3	WHT/GRA	+15V RETURN
4	WHT/GRA/GRN	+15V
NOTE: A dash (—) following a signal name indicates a negative-true signal.		

The receivers should be inspected at least twice a year, depending on their operating environment. Inspect as follows:

- VISUAL INSPECTION – Inspect the unit for indication of mechanical and electrical defects. Look for signs of overheating, corrosion, accumulations of dust, oil, loose electrical connections, or broken parts. Also check the Agilent 10780F Remote Receiver for loose fiber-optic connections at both ends of the fiber.
- REPAIR AND CLEANING – Repair any obvious defects; and if necessary, clean the unit with dry, clean compressed air or a vacuum cleaner.

CAUTION

To avoid scratching the lens during cleaning, the following procedure is recommended.

Use a soft camel-hair lens brush or equivalent to remove dust from the optical surfaces. Dampen a few lens cleaning tissues with electronics grade methanol, shake off excessive methanol and wipe across the lens surface once. Use a fresh tissue dampened with methanol for each wipe. Allow the methanol to evaporate.

The ends of the Agilent 10780F, Agilent E1708A, or Agilent E1709A fiber-optic cable may be cleaned with a clean lint free cloth.

Periodically you may wish to verify proper beam alignment. Refer to Chapter 35, Receivers," and in Volume II refer to Chapter 4, "System Installation and Alignment," and Chapter 5, "Measurement Optics (General Information)," for procedures.

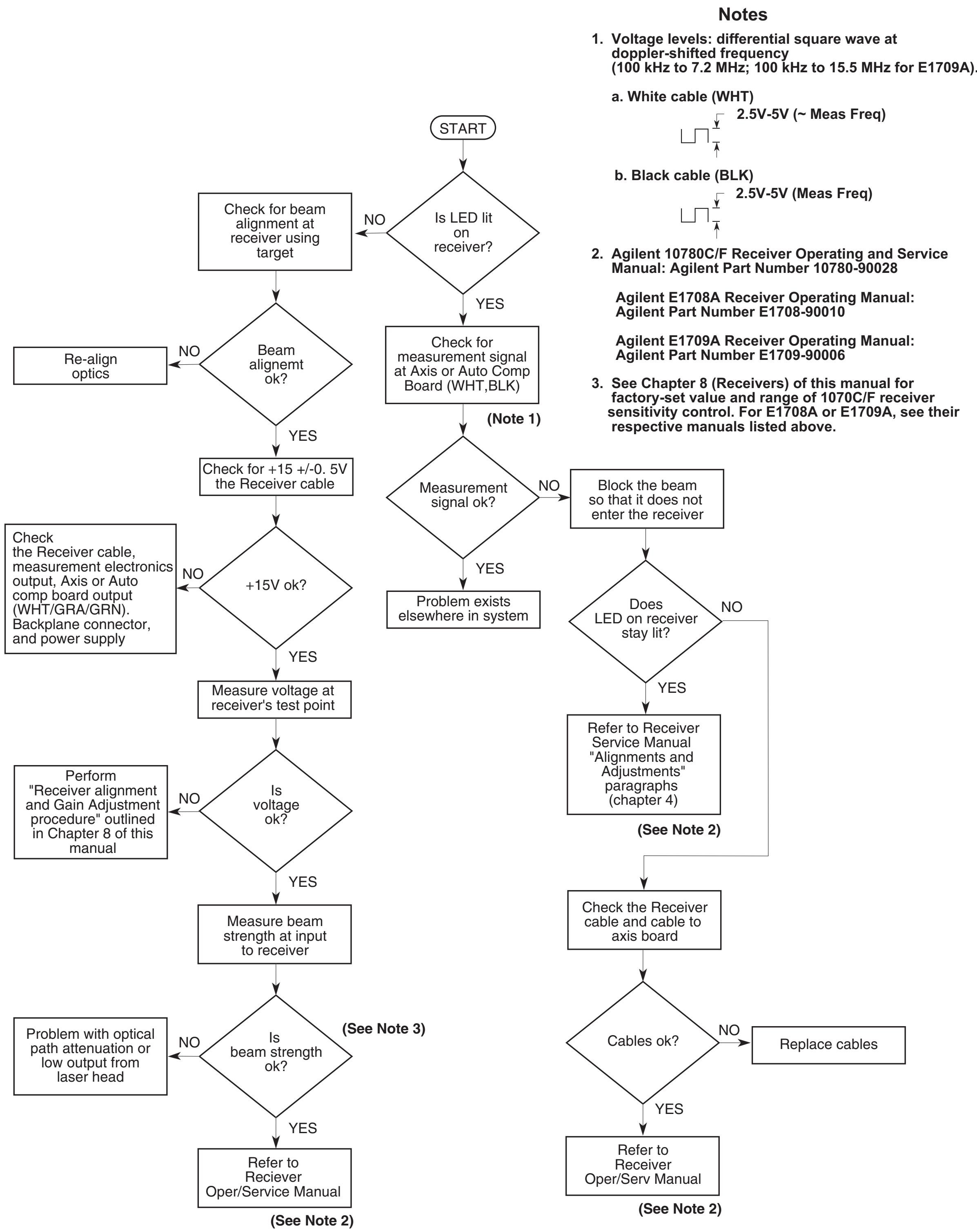

Figure 45 Agilent Receiver troubleshooting tree

Agilent 5519A/B Laser Head internal receiver

See the *Agilent 5519A/B Laser Head Service Manual* for internal receiver troubleshooting information.

Optical device troubleshooting

Problems with the optical devices are usually caused by their misalignment. Refer to the alignment procedures in this manual for further information. Air turbulence caused by ventilation equipment or temperature gradients near the laser beam path can also cause measurement problems. If this is suspected, shield the area around the laser beam and optical devices with cardboard tubing, plastic sheet, or other suitable material. Some problems with sporadic counting and drift can be traced to air turbulence around the measurement path. This should be considered as a possibility before troubleshooting other parts of the system.

NOTE

If the problem is traced back to dirty optics, refer to "Procedures for Cleaning Measurement Optics", in Chapter 7, "Maintenance," of this manual, before you try to clean them.

Defective measurement optics should be returned to Agilent Technologies where they will be evaluated for repair. Follow the procedures outlined in Chapter 10, "Packaging for Storage or Shipment" of this manual for packaging methods and procedures.

Procedures for cleaning optics are given in Chapter 7, "Maintenance," of this manual.

Agilent 10717A Wavelength Tracker troubleshooting

Troubleshooting the Agilent 10717A Wavelength Tracker involves proper interpretation of the Agilent laser system electronics front-panel annunciators, system- and board-level self tests, and knowing when the Wavelength Tracker requires realignment to the system optics. The main system problems that could occur include:

- Misalignment of the wavelength tracker, the receiver, the system optics, and system laser source
- Improper programming of system
- Malfunction of the receiver
- Malfunction of the Agilent system electronics (for example, the Agilent Automatic Compensation Board)

Troubleshooting trees (figures 45 and 46, respectively) will help you determine if the Agilent receiver or the Agilent 10717A Wavelength Tracker is faulty.

The front-panel LEDs, combined with the error messages listed in the appropriate electronics manuals, provide assistance with both programming and hardware problems. The SYSTEM ERROR LED illuminates when a problem occurs in the measurement or reference path of the Wavelength Tracker axis or when incorrect programming strings have been sent by the system controller. By sending an error message query to the Agilent electronics via the system controller, the system will respond indicating which board address is generating the error message, and provide a brief description of the error.

The Agilent 10717A Wavelength Tracker is an optical device and is prealigned at the factory. If found defective it should be returned to Agilent Technologies where it will be evaluated for repair. Follow the procedures outlined in Chapter 10, “Packaging for Storage or Shipment,” of this manual for packaging methods and procedures.

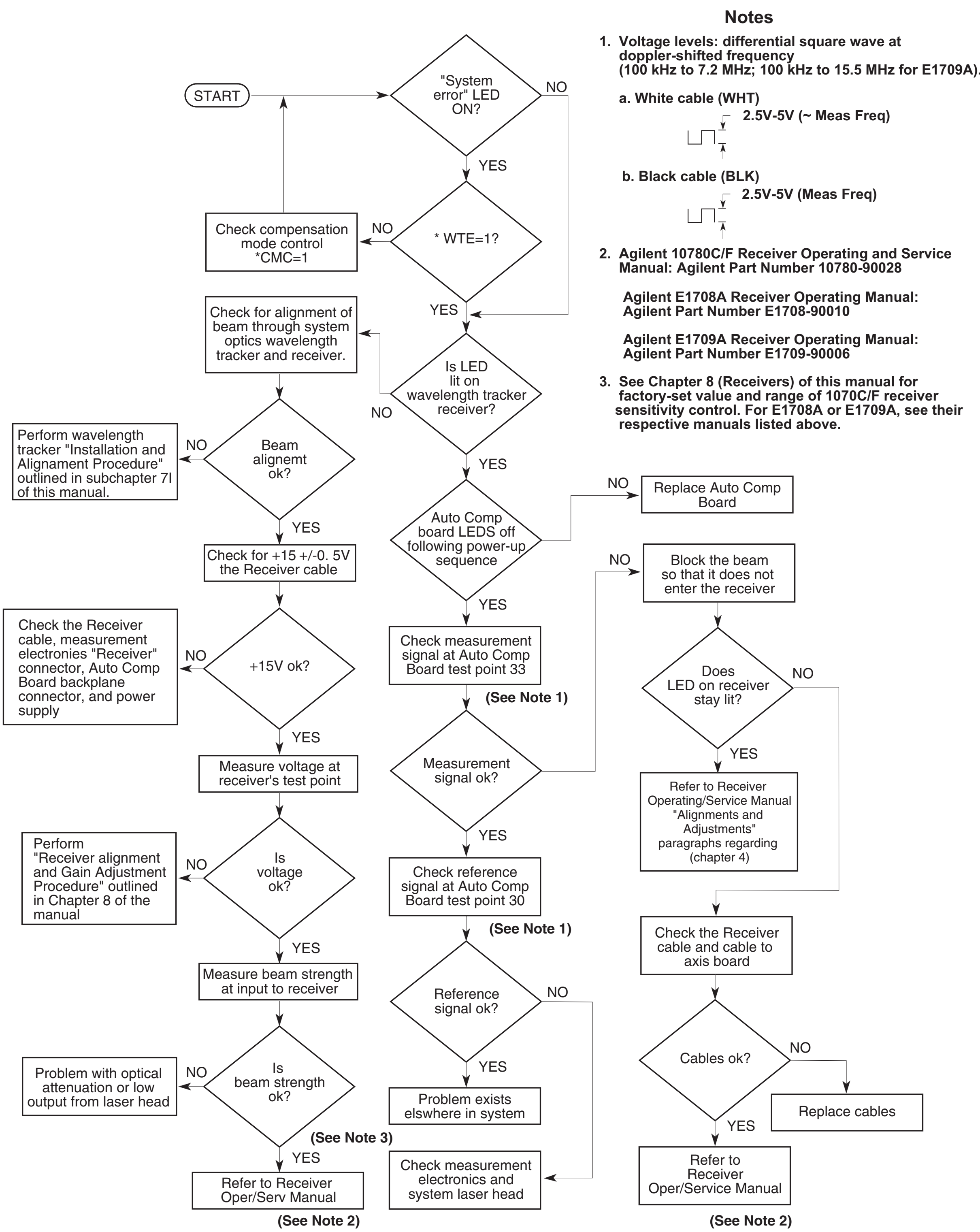

Figure 46 Agilent 10717A Wavelength Tracker troubleshooting tree

Before and After Service Product Safety Check

The following safety checks must be performed after any troubleshooting and repair procedures have been completed to ensure the safe operation of the instrument.

WARNING Resistance checks described below require that the power cord be connected to the instrument and that AC power be disconnected. Be sure that the power cord is not connected to power before performing any safety checks.

1 VISUAL INSPECTION. Visually inspect the interior of the serviced instrument for signs of abnormal internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and remedy the cause of any such condition.
2 GROUND CONTINUITY TEST. Plug the power cord into the Agilent electronics. DO NOT CONNECT THE INSTRUMENT TO AC POWER. Using a suitable ohmmeter, check the resistance from the enclosure (chassis) to the ground pin on the power cord. The reading should be less than 1 ohm. Flex the power cord while making this measurement to determine whether intermittent discontinuities exist. The resistance check should be performed from the enclosure to the ground pin of the cord while flexing the interconnect cable.
3 Check any indicated front or rear-panel ground terminals using the above procedures.
4 INSULATION RESISTANCE CHECK. Tie the line and neutral pins of the power cable together. Check resistance from the instrument enclosure (chassis) to line and neutral with the LINE switch ON and the power source disconnected. The minimum acceptable resistance is 2 Megohm. Replace any component that results in a failure.

POWER LINE MODULE CHECK. Check line fuse and line voltage selector in the electronics rear-panel power line module to verify that the correct fuse is installed and that the instrument is properly set for the AC source to be applied.

9
Unpacking and Incoming Inspection

Introduction

This chapter provides information for unpacking and inspection, and warranty claims.

Information about laser tube shipment, tagging for service, and packaging for reshipment is presented in Chapter 10, “Packaging for Storage or Shipment,” of this manual.

WARNING To avoid hazardous electric shock, do not perform electrical tests when there are signs of shipping damage to any portion of the outer enclosure (covers, panels, meters).

Unpacking and Incoming Inspection

Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been checked mechanically and electrically.

If the contents are incomplete, if there is mechanical damage or defect, or if the instrument or some component fails, notify the nearest Agilent Technologies Office. If the shipping container is damaged, or if the cushioning material shows signs of stress, notify the carrier as well as the Agilent Technologies office. Keep the shipping materials for the carrier’s inspection. The Agilent office will arrange for repair or replacement at Agilent’s option without waiting for a claim settlement.

Warranty Claims

Contact the nearest Agilent Sales and Service Office (see Certification and Warranty page at the front of this manual) for information relative to warranty claims.

10
Packaging for Storage or Shipment

Laser Tube

The laser tube assembly should be shipped in an Agilent container designed for that purpose. In addition, the container must indicate that the laser tube contains magnetic material. To exchange the laser tube assembly, first order the replacement assembly and then upon receipt, return the old assembly in the same container. If it is necessary to ship a laser assembly, contact your nearest Agilent Sales and Service Office for an approved container.

Tagging for Service

If a product is being returned to Agilent Technologies for service, please provide enough information to help us do what is needed and return the product to you. For best service results, be as explicit as possible when describing the assembly failure symptoms.

Original Packaging

Containers and materials identical to those used in factory packaging are available through any Agilent Technologies office. If the instrument is being returned to Agilent for servicing, attach a blue tag indicating the type of service required, return address, model number, and full serial number. Also mark the container “FRAGILE” to ensure careful handling. The laser head container should indicate the instrument contains magnetic material. In any correspondence, refer to the instrument by model number and full serial number.

Other Packaging

The following general instructions should be used for repacking system components with commercially available materials. These methods DO NOT apply to the laser tube assembly, or the Agilent 10735A or Agilent 10736A interferometers, which MUST be shipped in an Agilent approved container. If the laser assembly has not been removed from the laser head itself, the laser head may be packaged and shipped with the methods below.

1 Wrap the instrument in heavy paper or plastic. If the instrument is a circuit board, wrap it in anti-static material first, then add additional wrapping material. (If shipping to Agilent Technologies office or service center, attach

a tag indicating the service required, return address, model number, and full serial number).

2 Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.

3 Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inches thick around all sides of the instrument to provide firm cushioning and prevent movement inside the container. Protect the front panel with cardboard.

4 Seal shipping container securely.

5 Mark shipping container “FRAGILE” to ensure careful handling. Indicate if magnetic material (such as a laser head) is enclosed.

6 In any correspondence, refer to instrument by model number and full serial number.

11
Principles of Operation

Introduction

The measurements that an Agilent laser measurement system can make depend on the measurement optics (interferometers and retroreflectors) that are used.

The basic measurement made by all Agilent laser measurement systems is a linear measurement of the relative movement between an interferometer and its associated retroreflector, along the path of the laser beam. In most cases, the interferometer is the fixed optic and the retroreflector is the one that moves.

Agilent offers interferometers and retroreflectors that allow measurements of angles, flatness, and straightness to be made. However, all of these measurements represent special applications of the basic linear measurement. An angular measurement, for example, represents the difference in two linear measurements whose separation is precisely known.

The length standard for all of these measurements is the wavelength of laser light from the laser head. Relative motion between the interferometer and its retroreflector generates a series of interference fringes in the laser beam. The interference fringes are converted to electrical pulses in a receiver, and sent to the measurement electronics, which processes them as required to provide the desired measurement data.

The interferometric measurement system is sensitive enough that its measurements can be affected by changes in the measurement environment. These changes can affect both measurement accuracy and repeatability.

The wavelength of laser light, which is the length standard for measurements, can be affected by the characteristics of the environment between the interferometer and its associated measurement reflector. The process of determining the correct wavelength-of-light value for the measurement conditions is called compensation. Agilent offers devices (air sensor, wavelength tracker) which can be used to provide automatic compensation for the wavelength of light. Alternatively, wavelength-of-light compensation can be performed manually, by measuring the atmospheric temperature, pressure, and humidity, and calculating the compensation value or looking it up in a table. Additional information about wavelength-of-light compensation is provided in Chapter 13, “Wavelength-of-Light Compensation,” of this manual.

Another environmental factor that can affect the measurement is the temperature of the material being measured. Agilent offers material temperature sensors that can enable automatic compensation for the effects of temperature changes. Material temperature compensation can also be performed manually, by measuring the material temperature and calculating the effect of the difference between the standard temperature and the temperature at the time of the measurement. Chapter 14, “Material Expansion Coefficients,” in this manual provides expansion coefficient values for many commonly-used materials.

Measurement Technique

Introduction

Agilent laser measurement systems measure displacement by:

1 generating a two-frequency laser beam.

2 sampling part of the beam, to determine the frequency difference between the two frequencies in the beam. This difference frequency is sent to the measurement system electronics as the Reference Frequency.

3 sending the two-frequency laser beam to an interferometer that separates the beam into two single-frequency beams. Each beam has one of the two frequencies of the original beam.

4 sending one interferometer output beam to a non-moving reference retroreflector, or a plane mirror, that returns it to the interferometer.

5 sending the second interferometer output beam to a measurement retroreflector, or a plane mirror, that returns it to the interferometer.

6 within the interferometer, combining the beams returned from the two retroreflectors to produce a difference frequency beam that is used as the interferometer’s output.

7 sending the interferometer output to a receiver that converts the optical difference frequency from the interferometer to a series of electrical pulses at that frequency that is sent to the measurement system electronics for processing and any further use specified by the user and allowed by the electronics.

The main benefit of the two-frequency technique is that the distance information is carried on ac waveforms, or carriers, rather than in dc form. Since ac circuits are insensitive to changes in dc levels, a change in beam intensity cannot be interpreted as motion.

Creating the two-frequency laser beam

The ac signals representing distance change are analogous to the intermediate frequency carriers in FM heterodyne receivers. In the Agilent laser measurement system, the ac signal or “intermediate frequency” is produced by mixing two slightly different frequencies, near 5 × 1014 Hz (500,000 GHz), differing by only a few megahertz.

Using different sources to generate the two frequencies would require ultra-stable sources and periodic calibration. However, a laser can be forced to output a laser beam composed of two frequencies simultaneously, by applying an axial magnetic field. The two resultant frequencies are very close together, but have opposite circular polarizations. Both frequencies are extremely stable and do not require recalibration. Waveplates within the laser head convert the circularly polarized beam components to orthogonally polarized components before the beam leaves the laser head. A polarizing beam splitter in the interferometer is used to separate the two beams.

Using the two-frequency laser beam at the interferometer

One of the laser frequency components (f_1) is used as the measuring beam and reflects from the external cube corner back to the beam splitter. Here the measuring beam mixes with the second or reference frequency (f_2) to produce fringe patterns. These patterns are composed of alternate light and dark bands caused by successive reinforcement and cancellation (interference) of the beams. If the movable cube corner reflector remains stationary, the interference rate (beat frequency) will be the exact difference between the laser's two frequencies, about 1.5 to 3 million fringes per second, depending on the laser head used.

When the cube corner moves, the frequency of the returning beam shifts up or down by ($f_1 \pm \Delta f$), depending on the direction (and velocity) of the motion. A cube corner velocity of 300 millimeters per second (one-foot per-second) causes a frequency shift of approximately 1 MHz.

When a plane mirror interferometer is used, the measurement beam makes two passes to the measurement mirror. As a result, when the measurement mirror moves at 300 mm/second, the frequency shift seen in the measurement path is approximately 2 MHz.

The frequency shift is monitored by a photodetector and converted to an electrical signal ($f_2 - (f_1 \pm \Delta f)$). A second photodetector inside the laser head monitors the fringe frequency before the paths are separated, and provides a reference signal that corresponds to zero motion ($f_2 - f_1$).

Doppler frequency shifting

Frequency shifting that results from (or indicates) relative motion between the source and receiver (observer) is known as Doppler shift. One example often used is the apparent change in pitch of a whistle or horn as the distance between the it and the listener changes. Another example is the red shift in the spectrums of stars, indicating that the universe is expanding.

The two frequencies from the photodetectors are sent to a special counter. The counter counts up on the Doppler-shifted signal from the retroreflector and down from the reference signal. With no retroreflector motion, the frequencies are equal, and no net count is accumulated. When the retroreflector moves, the Doppler frequency increases or decreases to produce net positive or negative cumulative counts corresponding to the distance and direction traversed, in wavelengths of light.

Basic Measurement System

A basic Agilent laser measurement system consists of: 1) a laser head, 2) an interferometer and its associated retroreflector, 3) a measurement receiver, and 4) measurement and control electronics. See Figure 47.

Because it is often not possible to line up the laser head output with the interferometer input aperture, the system will also include beam-directing optics.

Additionally, the system may also include environment sensing or wavelength tracking devices or both.

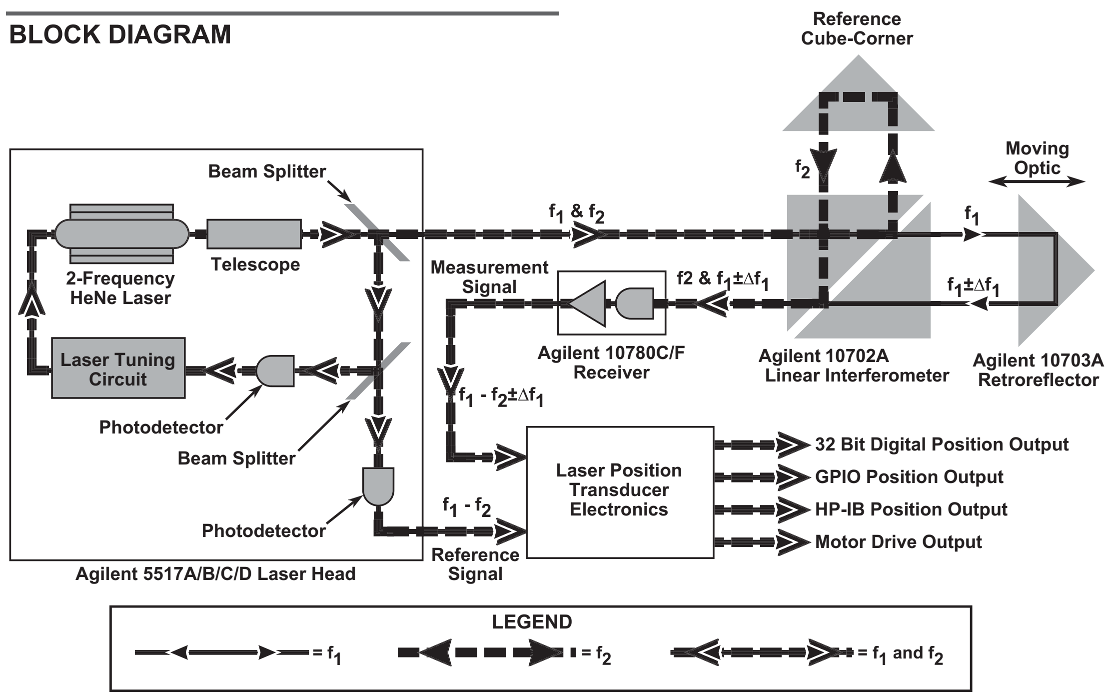

Figure 47 Typical (older) Agilent Laser Position Transducer block diagram

Basic Agilent Laser Measurement System Components

The laser head serves as the light beam and reference frequency source.

The optics and the measurement receiver use the laser beam to generate the measurement signal. The reference and measurement signals, along with the environment sensor signals, are used by the measurement electronics to generate linear displacement information.

The system controller can read and display this information. In addition, the controller can send destination input data to the measurement electronics, which outputs a real-time error signal representing the difference between the destination and the actual position. This error signal can be used in servo electronics to drive a stage's positioning motors.

Laser head

A low-power helium-neon laser emits a coherent light beam composed of two slightly different optical frequencies, $f_1$and f_2, of orthogonal linear polarizations. (See Figure 47.) Before exiting the laser assembly, the beam passes through a beam splitter where a small fraction of the beam is sampled. This portion of the beam is used both to generate a reference frequency and to provide an error signal to the laser cavity tuning system. The difference in the amplitudes of $f_1$and f_2 is used for tuning while the difference in frequency between $f_1$and f_2 (between 1.5 MHz and 3.0 MHz, depending on the model of the laser head) is used for the reference signal.

The wavelength of light from the laser head is used as the length standard for Agilent laser measurement systems. The laser head generates a coherent (all light waves in phase), collimated (all waves traveling parallel to one another) light beam consisting of two orthogonally polarized frequency components. The laser measurement system uses this beam to generate measurement signals (MEASurement Frequency). In addition to this beam, the laser head generates an electrical reference signal (REFerence FREQuency).

System optics

The major portion of the beam passes out of the laser head to an interferometer. The interferometer is a polarizing beam splitter that reflects one polarization (frequency) and transmits the other. The beam splitter is oriented such that the reflected and transmitted beams are at right angles to each other. The reflected beam (f_2) is reflected off a fixed retroreflector or mirror, usually mounted directly on the interferometer. The transmitted frequency (f_1) passes through the interferometer and is reflected back to the interferometer by a movable retroreflector or plane mirror. If the distance between the interferometer and the movable retroreflector remains fixed, the difference frequency (f_2-f_1) equals the reference signal. Under these conditions, the Agilent laser measurement system electronics detects no change in relative position of the interferometer and the movable retroreflector. When the movable retroreflector changes position relative to the fixed interferometer, a doppler frequency shift occurs. This Doppler-shifted frequency becomes $f_1 \pm \Delta f_1$ depending on the direction of reflector movement. The two frequency components, $f_1$and f_2, exit the interferometer as a coincident beam.

One of the two frequency components is directed toward the object whose motion is being measured. There it is reflected by a mirror or retroreflector (cube-corner) and returned to the interferometer.

The other frequency component travels a fixed path through the cube corner mounted directly to the interferometer, where both components recombine into a single beam. Both cube-corner retroreflectors offset their corresponding beams and return them parallel to the incoming beam path. Small rotations or perpendicular movements will not affect the accuracy of the measurement.

Each laser measurement system axis must have an interferometer and retroreflector. Machine design considerations determine which type of interferometer is optimum. The choice of the interferometer for each axis usually specifies the retroreflector or plane mirror for that axis.

The Agilent 10717A Wavelength Tracker is an interferometer and etalon (fixed-length reference cavity) combination that measures changes in laser wavelength, not displacement. It measures apparent change in a fixed distance, which is interpreted as a variation in the laser wavelength.

For more detailed information on the individual optical components available from Agilent, refer to chapters 18 through 34 (the interferometers chapters), Chapter 17, “Beam-Directing Optics,” and Chapter 36, “Accessories,” in Volume II of this manual.

Receiver

The coincident beam is directed to a receiver (e.g., Agilent 10780C or Agilent 10780F) where the two frequency components interfere (mix) at the receiver’s polarizing plate. This produces a difference frequency which is detected by the receiver's photodetector and converted to an electrical signal. The receiver Circuitry then amplifies the signal which becomes the measurement frequency. Displacement information is obtained in the measurement electronics by a comparison of both the measurement and reference signals.

Environment sensors

As described at the beginning of this manual chapter, the laser measuring system is sensitive enough that its measurements can be affected by environmental conditions during the measurement.

The Agilent 10751C or Agilent 10751D Air Sensor can be used with measurement electronics to automatically and continuously provide compensation for changes in the wavelength of laser light resulting from changes in the atmospheric conditions at the time of the measurement.

The Agilent 10757D, Agilent 10757E, or Agilent 10757F Material Temperature Sensor can be used with measurement electronics to automatically and continuously enable changes in measurement information based on changes in the temperature of the item being measured.

The Agilent 10717A Wavelength Tracker, described in Chapter 24 in Volume II of this manual, is also an environment sensor.

12
Accuracy and Repeatability

Introduction

This chapter introduces the basic concepts, techniques, and principles that determine the overall measurement performance of Agilent laser measurement systems. Two examples of modeling a laser system's accuracy and repeatability are provided.

Understanding the error components in the laser interferometer system will help you use the modeling technique described in this chapter. The measurement accuracy and repeatability is determined by summing the error components in the system's error budgets. Before proceeding with the discussion of each component in the accuracy and repeatability error budgets, review the definitions of accuracy and repeatability given below.

- **Accuracy:** The maximum deviation of a measurement from a known standard or true value.
- **Repeatability:** The maximum deviation between measurements under the same conditions and with the same measuring instrument. This also refers to how stable the measurement will be over time.

The Components of System Accuracy and Repeatability

The system measurement accuracy and repeatability error budgets share many of the same error components.

System measurement repeatability is divided into short-term and long-term repeatability. Short-term repeatability is the measurement stability over a period shorter than one hour; long-term repeatability is stability over a period longer than one hour. Error components that make up the accuracy and repeatability error budgets are shown in Table 10.

Table 10 Error components for accuracy and long- and short-term repeatability error budgets

Error Components by Category	System Error Budgets		
	Accuracy	Long-Term Repeatability	Short-term Repeatability
Intrinsic			
Laser Wavelength	X	X	X
Electronics Error	X	X	X
Optics Nonlinearity	X	X	X
Environmental			
Atmospheric Compensation	X	X	X
Material Thermal Expansion	X	X	
Optics Thermal Drift	X	X	
Installation			
Deadpath Error	X	X	X
Abbé Error	X	X	
Cosine Error	X		

Both the accuracy and the repeatability error budgets have several components. Some of these components are affected by the operating environment, while others are affected by the system installation. The error components can be categorized as either proportional or fixed terms.

Proportional error terms are generally specified in parts-per-million (ppm). The resulting measurement error is a function of the distance measured by the interferometer system.

Fixed error terms are noncumulative. Fixed terms are given in units of length, such as nanometers or microns. The resulting measurement errors are not a function of the measured distance.

Environmental and installation error components are often the largest contributors to the error budgets. Be sure to keep them in mind when designing and installing the laser interferometer system. A more detailed discussion of these error components follows.

Laser wavelength

An interferometer system generates optical fringes when relative movement occurs between the measurement optics of the system. Each fringe generated represents displacement by a fraction of the laser’s wavelength. However, fringes are also generated if the laser wavelength changes, causing an apparent distance change measurement even when there is no actual displacement of an optic. This apparent movement is measurement error.

The laser source of any interferometer system has some type of frequency stabilization to maintain its wavelength accuracy and repeatability.

A laser interferometer system's accuracy is fundamentally based on the laser's wavelength accuracy.

The system's repeatability is based on the laser's wavelength stability.

Laser wavelength accuracy and stability are specified in parts-per-million (ppm) of the laser frequency. They are proportional errors; that is, the measurement error is a function of the distance measured. All laser sources for Agilent laser transducer systems have the same wavelength accuracy and stability specifications. These values are specified in a vacuum.

Lifetime wavelength accuracy for the laser heads is ± 0.1 ppm standard and ± 0.02 ppm with optional calibration.

Wavelength stability of the laser heads is typically ± 0.02 ppm over their lifetime and ± 0.002 ppm over one hour.

Electronics error

Electronics error stems from the method used to extend basic optical measurement resolution in an interferometer system.

The basic resolution of an interferometer system is $\lambda/2$ (when using cube-corner optics). The resolution can be electronically or optically extended beyond $\lambda/2$.

In an Agilent laser measurement system, the electronics error equals the uncertainty of the least resolution count. That is, electronic error equals the measurement resolution. It is the quantization error of the electronic counter in the system. Other methods of electronic resolution extension can cause jitter and nonlinearity in measurement data, thus adding other errors.

The electronics error term is a fixed error equal to the least resolution count on Agilent systems. When using an Agilent laser measurement system, there are three possible linear measurement resolutions, depending on the interferometer chosen.

Table 11 lists the measurement resolutions for each interferometer available with this system when used with:

- the Agilent 10885A PC Axis Board,
- the Agilent 10895A VME Laser Axis Board,
- the Agilent 10897B High Resolution VMEbus Laser Axis Board, or
- the Agilent 10898A High Resolution VMEbus Dual Laser Axis Board

Table 11 System measurement resolution for each interferometer

Interferometer		Fundamental Optical Resolution	System Resolution (Note 1)	System Resolution (Note 2)
Agilent 10702A		λ/2 (316.5 nm, 12.5 µin)	λ/64 (10.0 nm, 0.4 µin)	λ/512 (1.2 nm, 0.047 µin)
Agilent 10705A		λ/2 (316.5 nm, 12.5 µin)	λ/64 (10.0 nm, 0.4 µin)	λ/512 (1.2 nm, 0.047 µin)
Agilent 10706A		λ/4 (158.2 nm, 6.2 µin)	λ/128 (5.0 nm, 0.2 µin)	λ/1024 (0.62 nm, 0.024 µin)
Agilent 10706B		λ/4 (158.2 nm, 6.2 µin)	λ/128 (5.0 nm, 0.2 µin)	λ/1024 (0.62 nm, 0.024 µin)
Agilent 10715A		λ/4 (158.2 nm, 6.2 µin)	λ/128 (5.0 nm, 0.2 µin)	λ/1024 (0.62 nm, 0.024 µin)
Agilent 10716A		λ/8 (79.1 nm, 3.1 µin)	λ/256 (2.5 nm, 0.1 µin)	λ/2048 (0.31 nm, 0.012 µin)
Agilent 10719A	Linear	λ/4 (158.2 nm, 6.2 µin)	λ/128 (5.0 nm, 0.2 µin)	λ/1024 (0.62 nm, 0.024 µin)
	Angular	(1.71 arcsec, 8.3 µrad)	(0.05 arcsec, 0.26 µrad)	(0.007 arcsec, 0.03 µrad)
Agilent 10721A	Linear	λ/4 (158.2 nm, 6.2 µin)	λ/128 (5.0 nm, 0.2 µin)	λ/1024 (0.62 nm, 0.024 µin)
	Angular	(2.56 arcsec, 12.4 µrad)	(0.08 arcsec, 0.39 µrad)	(0.01 arcsec, 0.05 µrad)
Agilent 10735A		Three axes, each the same as the Agilent 10706B. See listing above.		
	Linear		λ/128 on three axes	λ/1024 on three axes
	Yaw		0.04 arcsec, 0.2 µrad	0.005 arcsec, 0.025 µrad
	Pitch		0.05 arcsec, 0.24 µrad	0.006 arcsec, 0.03 µrad
Agilent 10736A		Three axes, each the same as the Agilent 10735A. See listing above.		
Agilent 10736A-001		Three axes, each the same as the Agilent 10735A. See listing above.		
Agilent 10766A		λ/2 (316.5 nm, 12.5 µin)	λ/64 (10.0 nm, 0.4 µin)	λ/512 (11.2 nm, 0.047 µin)
Agilent 10770A	Angular	(20.0 arcsec, 97.0 µrad)	(0.63 arcsec, 3.0 µrad)	(0.08 arcsec, 0.38 µrad)

Notes:

1. The system resolution is based on using 32X electronic resolution extension. This is available with the Agilent 10885A and Agilent 10895A.
2. The system resolution is based on using 256X electronic resolution extension. This is available with the Agilent 10897B and Agilent 10898A electronics.
3. The Agilent 10719A interferometer makes a single measurement, which may be either linear or angular (optically subtracted), depending on the installation. The linear and angular measurements are mutually exclusive and therefore not simultaneous.
4. The Agilent 10721A interferometer makes a two adjacent linear measurements which can be subtracted electronically to give an angular measurement with a linear measurement simultaneously.
5. The Agilent 10735A, Agilent 10736A, and Agilent 10736A-001 interferometers, make linear and angular measurements, so they have both linear and angular resolution specifications.

Optics nonlinearity

Optics nonlinearity occurs as a result of the optical leakage of one polarization component into the other.

The interferometer optical element in a laser interferometer system can contribute to measurement uncertainty because of its inability to perfectly separate the two laser beam components (vertical and horizontal polarizations).

Optics nonlinearity error is periodic, with a period of one wavelength of optical path change or a 360° phase shift between the reference and measurement frequencies. Nonlinearity caused by optical leakage affects all interferometer systems, whether they are single-frequency or two-frequency.

Leakage of one laser beam component into the other occurs for two reasons. First, the light leaving any laser source is not perfectly polarized linearly; instead, it is slightly elliptical. Second, the interferometer optical element is unable to perfectly separate the two laser beam components.

Figure 48 shows a computed error plot of nonlinearity versus optical path length change for worst-case conditions (when using a linear interferometer). The peak-to-peak phase error is 5.4°*, corresponding to a worst case peak-to-peak error of 4.8 nanometers of distance. Using a statistical model, the RSS (Root Sum of Squares) value is ±4.2 nanometers worst case peak-to-peak, including the contribution from the laser head. This nonlinearity error is a fixed term and is different for each interferometer.

*Quenelle, R.C., Nonlinearity in Interferometer Measurements, Agilent Technologies Journal, p.10, April 1983.

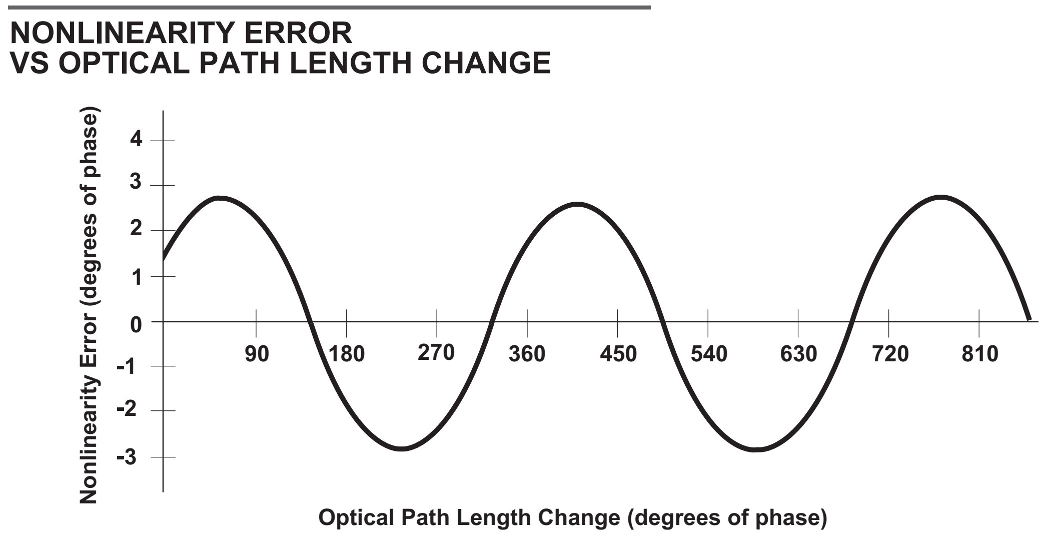

Figure 48 Worst-case error resulting from imperfect separation of two beam components

Atmospheric compensation

The atmospheric compensation error term is usually the single largest component in an error budget. The magnitude of this error depends on the accuracy of the compensation method, the atmospheric conditions in which the laser system is operating, and how much the atmospheric conditions change during a measurement.

The laser wavelength is specified as the vacuum wavelength, λ_V.

In vacuum, the wavelength is constant (to the degree specified by the stability specification), but in an air atmosphere the wavelength depends on the index-of-refraction of the atmosphere.

Since most laser interferometer systems operate in air, it is necessary to correct for the difference between λ_V and the wavelength in air, λ_A. This correction is referred to as atmospheric or wavelength-of-light (WOL) compensation. The index-of-refraction, n, of air is related to λ_V and λ_A by:

$$n = \frac{\lambda_V}{\lambda_A} \tag{1}$$

Any change in air density, which is a function of air temperature, air pressure, humidity, and composition, affects the index-of-refraction. Thus, a change in air density alters the required compensation of the laser measurement. Without proper compensation, system accuracy and repeatability will be degraded. For example, assuming a standard and homogeneous air composition, a one ppm error will result from any one of the following conditions:

- a 1°C (1.8 °F) change in air temperature,
- a 2.5 mm (0. 1 inch) of mercury change in air pressure,
- an 80% change in relative humidity.

The wavelength compensation number (WCN) is the inverse of the index-of-refraction, that is:

$$WCN = \frac{\lambda_A}{\lambda_V} \qquad (2)$$

Since the laser interferometer system counts the number of wavelengths of distance traveled, actual displacement can be determined as follows:

$$\text{Actual displacement} = (\text{wavelength counts}) \times \text{WCN} \times \lambda_V \qquad (3)$$

This equation shows that uncertainty in the wavelength compensation number directly affects the interferometer measurement. This error is a proportional term, and is specified in parts-per-million.

The wavelength compensation number can be derived by a direct measurement of index-of-refraction using a refractometer or by using empirical data.

Without a refractometer it is best simply to measure the air pressure, temperature, and relative humidity, and then relate this data to the refractive index using the formulas by Barrel & Sears[*] or Edlen[†] . The accuracy and repeatability of the compensation number derived by the empirical method depends on the accuracy of the formula used and the ability to measure the atmospheric conditions.

*Barrell, H. & Sears, J.E., (1939)Phil Trans. Roy. Society, A258, 1-64.

†Edlen, B., The Refractive Index of Air, Metrologia, 1966, 2, 71-80.

Birch K P, Downs MJ, Metrologia, 1993, 30, 155-162.

Birch K P, Downs MJ, Metrologia, 1994, 31, 315-316.

Estler, W Tyler, Applied Optics 24 #6, 1985, 808-815.

The empirical method suffers from the following disadvantages compared to using a refractometer:

- it is an indirect measurement, which is subject to sensor error,
- it is an approximation (good to only 0.05 ppm),
- it is slow in response, due to sensor time constants and calculation time,
- it requires periodic calibration of the sensors,
- it ignores air composition changes, such as:
  - Carbon dioxide and
  - Chemical vapors.

Agilent laser position transducer systems generally provide two methods of atmospheric compensation.

In the first method, an air sensor is available that: 1) measures air temperature and pressure, 2) allows a selectable humidity setting, and 3) calculates a compensation number for the system. This product, the Agilent 10751C/D Air Sensor, provides a compensation accuracy of ±1.4 ppm and a repeatability better than ±1.4 ppm, depending on the temperature range.

The second method of compensation uses a differential refractometer, the Agilent 10717A Wavelength Tracker. The wavelength tracker uses an optical technique to provide compensation repeatability as small as ±0.14 ppm. Since it is a differential refractometer, only changes in the air's index-of-refraction are measured. This means the initial compensation number must be determined from another source, which also determines the compensation accuracy. One popular method for accurately determining the initial compensation number is to measure a known standard or artifact with the laser system on the machine. Alternatively, high-accuracy external sensors or the Agilent 10751C/D Air Sensor can be used to obtain the initial compensation value.

The repeatability of the Agilent 10717A Wavelength Tracker's compensation number is given by the equation:

$$Repeatability = \pm\left[0.067ppm + \frac{0.06\,ppm}{degrees\ C} \times \Delta T + \frac{0.002\,ppm}{mmHg} \times \Delta P\right] \quad (4)$$

This equation shows that the compensation number's repeatability is a function of ambient temperature and pressure. This temperature and pressure dependency is based on the materials used to construct the Agilent 10717A Wavelength Tracker.

Additional information about wavelength-of-light compensation is provided in Chapter 13, "Wavelength-of-Light Compensation," of this manual.

Material thermal expansion

Since a part or machine's dimensions are a function of temperature, a correction for material expansion or contraction may be required. This correction relates the distance measurement back to a standard temperature of 20 °C (68 °F). To achieve this correction, the temperature of the part or machine (during the time of the measurement), and its coefficient of linear thermal expansion must be known.

The method of correction is to electronically change the effective laser wavelength (e.g., through the controller software) by an amount sufficient to correct for thermal expansion or contraction. This correction or compensation term is known as Material Temperature Compensation and is defined as:

$$\text{Material Temperature Compensation} = 1 - \alpha\,(\Delta T) \qquad (5)$$

where:

α = coefficient of linear thermal expansion

$\Delta T = T - 20°C$

Therefore, the compensated distance measurement (at standard temperature) is:

$$L_1 = L_2\,[\text{Material Temperature Compensation}] \qquad (6)$$

where:

L_1 = length at 20°C

L_2 = length at temperature T

Assuming a known coefficient of thermal expansion, the magnitude of this error is a function of the object's temperature and the temperature sensor's measurement accuracy and repeatability. This error term is also a proportional term specified in parts-per-million.

The material temperature sensor for Agilent laser systems is the Agilent 10757D/E/F Material Temperature Sensor. It has an accuracy of ±0.1°C and a measurement repeatability better than ±0.1°C.

Linear coefficients of expansion for various commonly used materials are presented in Chapter 14, "Material Expansion Coefficients," of this manual.

Optics thermal drift

In a laser interferometer system, changes in temperature of some optical components during the measurement can cause measurement uncertainty. This effect occurs in the measurement optic (the interferometer) in the form of a change in optical path length with temperature. This change in optical path length appears as an apparent distance change.

This optical path length change is caused by the two laser beam components (horizontal and vertical polarizations) passing through different amounts of glass, as shown in Figure 49.

With a conventional plane mirror interferometer, such as the Agilent 10706A, beam component f_A travels through more glass than does f_B. Beam component f_A makes twice as many trips through the polarizing beam splitter as does f_B. Component f_A also makes two round trips through the quarter-wave plate, whereas f_B does not pass through the quarter-wave plate at all.

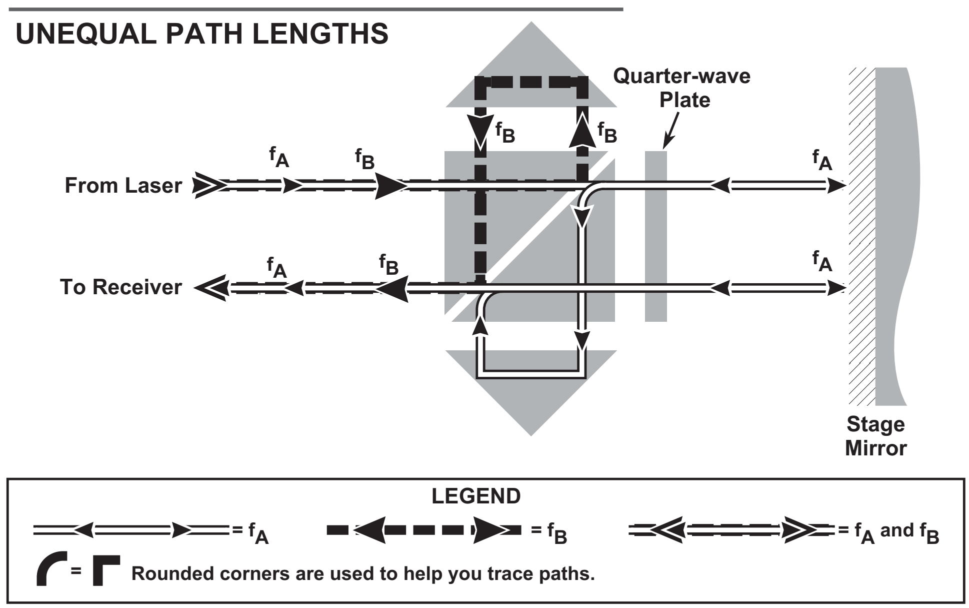

Figure 49 Conventional plane mirror interferometer with unequal path lengths that result in optics thermal drift

When a change in temperature occurs, the physical size of the optical elements changes, as does their index-of-refraction. Both changes contribute to an apparent change in distance. This type of interferometer has a typical thermal drift value of 0.5 micron per degree C. This measurement error is a fixed value and is only a function of the change in interferometer temperature, not the distance measured.

Optics thermal drift can be reduced by either controlling the temperature of the measurement environment or by using interferometers that are insensitive to temperature changes. To reduce the temperature sensitivity of an interferometer, the beam components need to travel through the same type and amount of glass.

Several interferometers available for Agilent laser measurement systems significantly reduce the optics thermal drift error.

- The Agilent 10715A Differential Interferometer has a thermal drift on the order of fractions of a nanometer per °C*.
- The Agilent 10706B High Stability Plane Mirror Interferometer has a thermal drift, optics that of a conventional plane mirror interferometer, typically 0.04 micron/°C. Other interferometers incorporating a similar high-stability design include the Agilent 10716A, Agilent 10719A, Agilent 10721A, Agilent 10735A, and Agilent 10736A.

Figure 50 is an optical schematic of the Agilent 10706B High Stability Plane Mirror Interferometer. In the Agilent 10706B, the reference beam cube comer has been replaced by a quarter-wave plate with a high-reflectance coating on the back. This optical design allows the measurement and reference beams to have the same optical path lengths in the glass, essentially eliminating measurement errors caused by temperature changes of the optics.

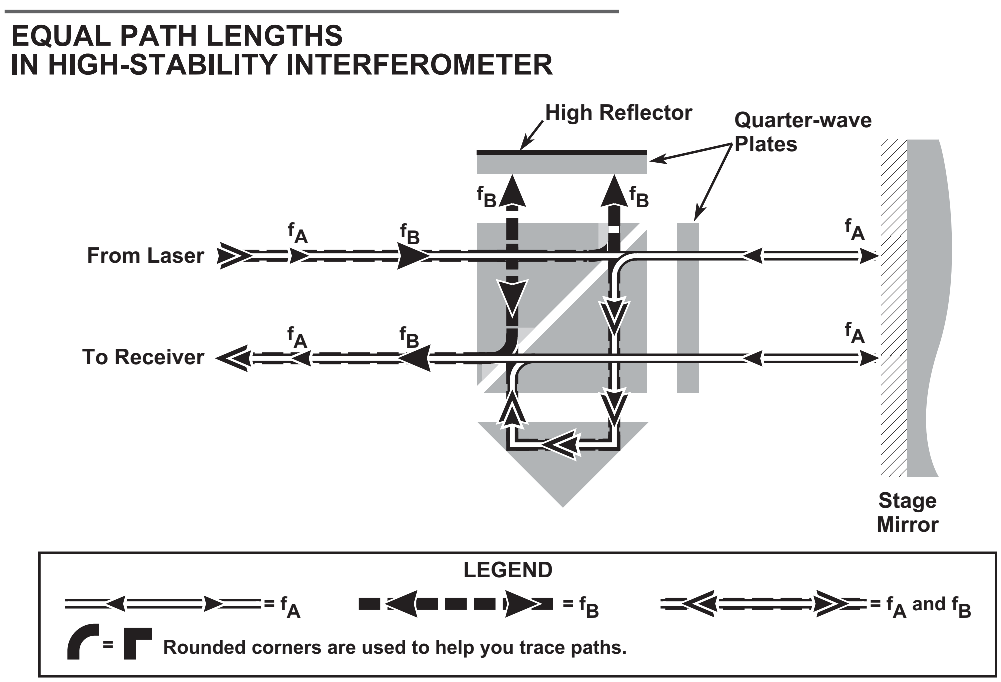

Figure 50 Agilent 10706B High Stability Plane Mirror Interferometer Beam Paths

The optical path lengths for the two beams may differ slightly, due to the normal dimensional tolerances in the thicknesses of the quarter-wave plates and in the geometry of the beam splitter. These small variations result in the

*Baldwin, D.R. & Siddall, G.J., A double pass attachment for the linear and plane mirror interferometer, Proc. SPIE, Vol. 480, p.78-83, 1984.

small thermal drift of the Agilent 10706B. Since either optical path length may be longer than the other, depending on the actual optical elements used, the thermal drift may be positive or negative.

Figure 51 is a plot of the thermal drift performance of the Agilent 10706B, Agilent 10716A, and Agilent 10715A interferometers as compared to a conventional plane mirror interferometer.

- The left vertical scale is thermal drift in microns.
- The right vertical scale is the interferometer's temperature in °C.
- The horizontal scale is time.
- The thermal drift of the conventional plane mirror interferometer (Agilent 10706A) closely tracks the optics temperature changes at a rate of approximately 0.5 micron per °C.
- The Agilent 10715A shows essentially zero drift.
- The Agilent 10706B and Agilent 10716A show much smaller drift than the conventional plane mirror interferometer, typically 0.04 micron per degree C.

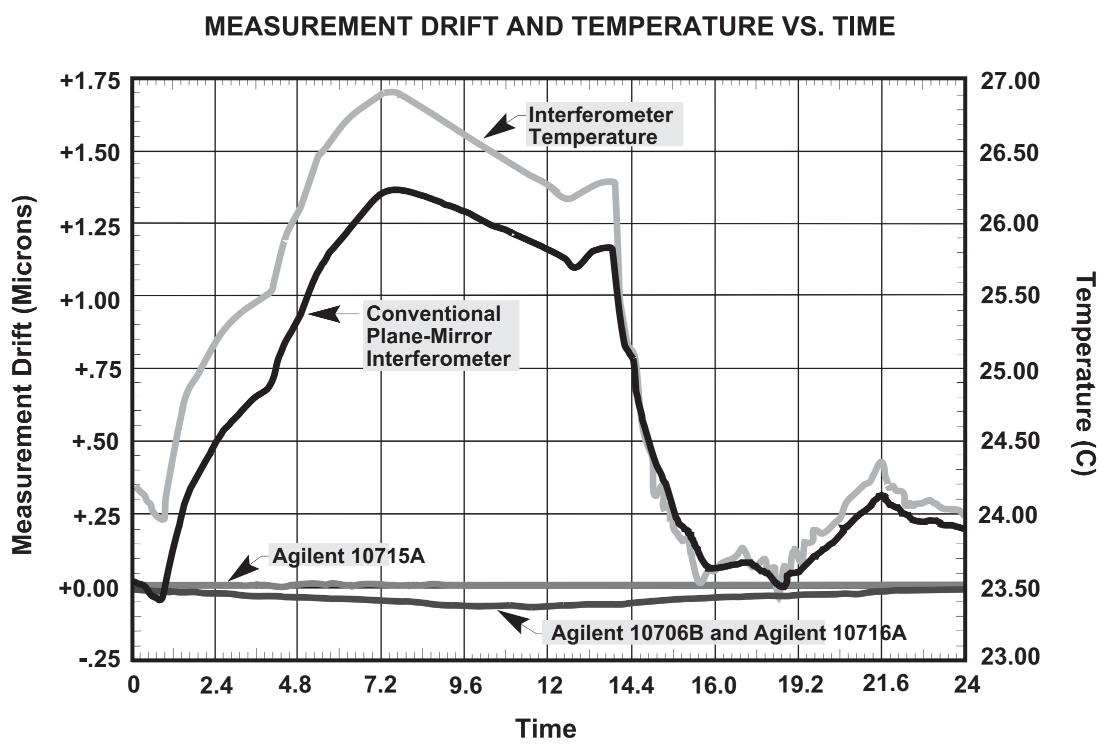

Figure 51 Comparison of optics thermal drift between Interferometers

Deadpath error

Deadpath error is caused by an uncompensated length of the laser beam between the interferometer and the measurement reflector, with the positioning stage or machine at its “zero” position (the position at which the laser system is reset).

The deadpath distance is the difference in the optical path lengths of the reference and measurement components of the laser beam at the zero position. If not properly compensated during changing environmental conditions, these unequal beam components can produce a measurement error.

Figure 52(A) shows the unequal path lengths for a conventional linear interferometer. The deadpath length is designated as “D”. In this diagram, the reference component is f_B, and the measurement component is f_A. The f_A optical path is longer than the f_B path, by “D”. Assume that the measurement reflector, a cube-corner in this example, moves the distance “L” (see Figure 52(B) to a new position and comes to rest.

Assume that, while the cube corner is at rest, the environmental conditions surrounding the laser beam change. The laser beam wavelength changes over the entire path (D + L) due to these environmental changes, and so should be compensated. Since a laser interferometer system measures only “wavelengths of motion”, which involves only the distance “L”, the system will not correct for the wavelength change over “D”. This will result in an apparent shift in the zero position on the machine. This zero shift is deadpath error, and occurs whenever environmental conditions change during a measurement.

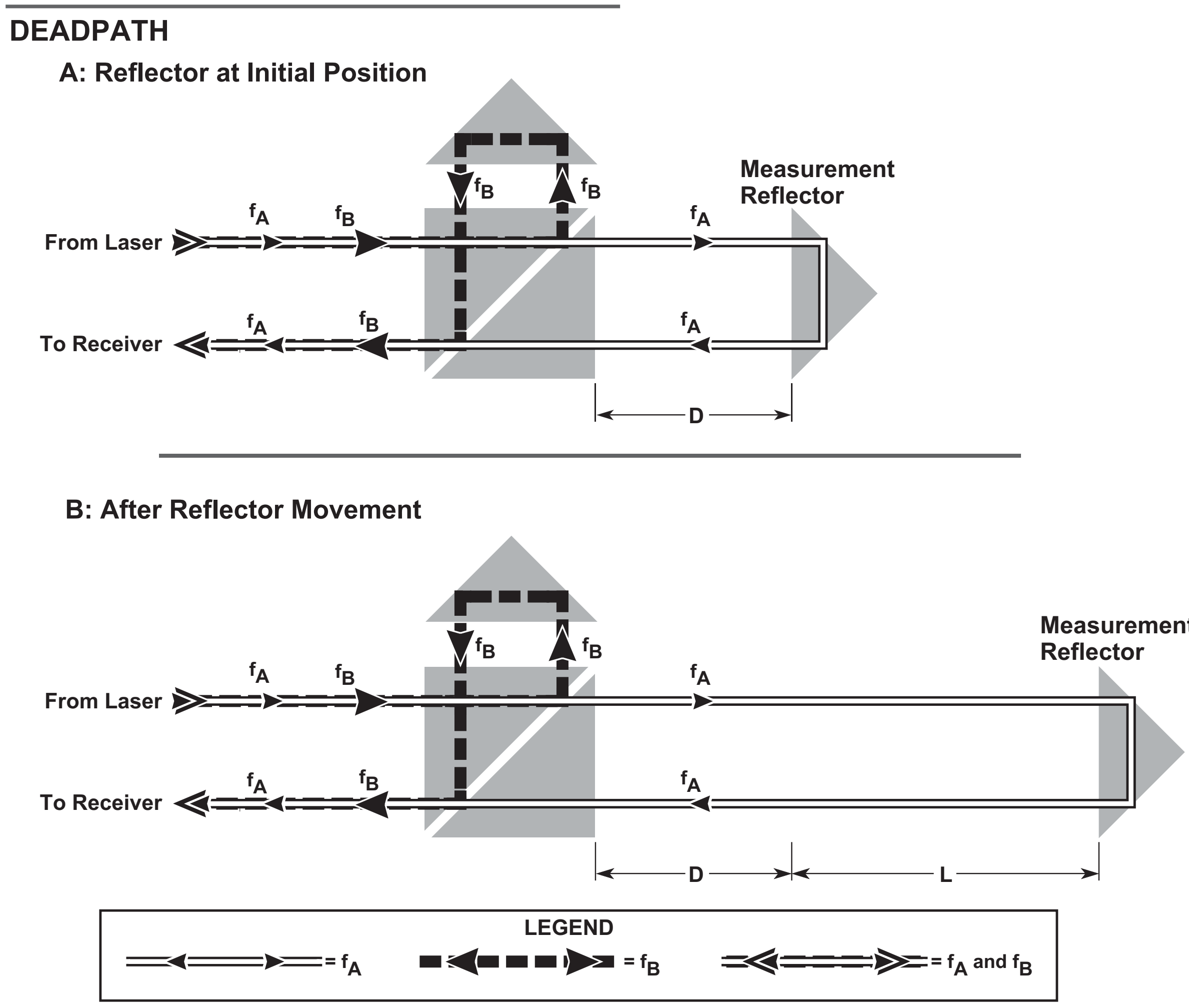

Figure 52 Deadpath caused by unequal lengths from initial point

Deadpath error can be represented as:

$$\text{Deadpath Error} = \text{Deadpath distance} \times \Delta\text{WCN} \qquad (7)$$

where:

ΔWCN = Change in wavelength compensation number during the measurement time.

Deadpath effects should be considered when designing a laser interferometer into an application or when using it.

Table 12 lists the minimum-deadpath mirror position(s), and the deadpath values, for Agilent interferometers.

Table 12Deadpath mirror positions and values for Agilent interferometers

Interferometer	Mirror Position for Minimal Deadpath	Deadpath Value
Agilent 10702A	Zero-deadpath condition exists when the measurement cube corner is flush with the interferometer's measurement face.	Distance between interferometer measurement face and cube corner face at measurement "zero" position.
Agilent 10705A	Zero-deadpath condition exists when the measurement cube corner is flush with the interferometer's; measurement face.	Distance between interferometer measurement face and cube corner face at measurement "zero" position.
Agilent 10706A	Zero-deadpath condition cannot be achieved with this interferometer. Because of interferometer design, zero-deadpath would require that measurement reflector be inside the interferometer 7.62 mm (0.300 inch) behind the measurement face.	Distance between interferometer measurement face and cube corner face at measurement "zero" position plus 7.62 mm (0.300 inch).
Agilent 10706B	Zero-deadpath condition exists when the measurement mirror is flush with the interferometer's; measurement face.	Distance between interferometer measurement face and cube corner face at measurement "zero" position.
Agilent 10715A	Zero-deadpath condition cannot be achieved with this interferometer design because the reference and measurement mirrors cannot be coplanar.	Distance between front face of reference mirror and front face of measurement mirror.
Agilent 10716A	Zero-deadpath condition exists when the measurement mirror is flush with the interferometer's; measurement face.	Distance between interferometer measurement face and measurement mirror, at measurement "zero" position.
Agilent 10719A	Zero-deadpath condition exists when the measurement mirror is 19.05 mm (0.750 inch) farther from the interferometer's measurement face than the reference mirror is.	M - R - 19.05 (metric),- or - M - R - 0.750 (English), - where: M = Measurement Mirror distance from interferometer* R = Reference Mirror distance from interferometer* *at measurement "zero" position
Agilent 10721A	Zero-deadpath condition exists when the measurement mirror is 19.05 mm (0.750 inch) farther from the interferometer's measurement face than the reference mirror is.	M - R - 19.05 (metric),- or - M - R - 0.750 (English), - where: M = Measurement Mirror distance from interferometer* R = Reference Mirror distance from interferometer* *at measurement "zero" position

Table 12Deadpath mirror positions and values for Agilent interferometers (continued)

Interferometer	Mirror Position for Minimal Deadpath	Deadpath Value
Agilent 10735A	Zero-deadpath condition cannot be achieved with this interferometer. Because of interferometer design, zero-deadpath would require that measurement reflector be inside the interferometer, 6.59 mm (0.259 inch) behind the measurement face.	Distance between interferometer measurement face and cube corner face at measurement “zero” position plus 6.59 mm (0.259 inch).
Agilent 10736A	Zero-deadpath condition cannot be achieved with this interferometer. Because of interferometer design, zero-deadpath would require that measurement reflector be inside the interferometer, 6.59 mm (0.259 inch) behind the measurement face.	Distance between interferometer measurement face and cube corner face at measurement “zero” position plus 6.59 mm (0.259 inch).
Agilent 10736A-001	Zero-deadpath condition cannot be achieved with this interferometer. Because of interferometer design, zero-deadpath would require that measurement reflector be inside the interferometer. For measurement axis #1 or measurement axis #3, zero-deadpath would require that the measurement reflector be inside the interferometer 6.59 mm (0.259 inch) behind the measurement face. For the bent measurement axis (measurement axis #2), zero-deadpath would require that the measurement reflector be inside the interferometer, 34.42 mm (1.355 inches) behind the measurement face.	For measurement axis #1 or measurement axis #3, distance between interferometer measurement face and measurement mirror, at measurement “zero” position, plus 6.59 mm (0.259 inch) behind the measurement face. For the bent measurement axis (measurement axis #2, distance between interferometer’s beam bender measurement face and measurement mirror, at measurement “zero” position, plus 34.42 mm (1.355 inches).
Agilent 10776A	Zero-deadpath condition exists when the measurement cube corner is flush with the interferometer’s measurement face.	Distance between interferometer measurement face and cube corner face at measurement “zero” position.
Agilent 10770A	Zero-deadpath condition exists when the angular reflector face is parallel to the interferometer’s measurement face.	Difference in beam path lengths between interferometer and angular reflector, at measurement “zero” position.
Agilent 10774A	When used with the straightness reflector, the reference and measurement beam paths are the same length in air.	Deadpath does not exist.
Agilent 10775A	When used with the straightness reflector, the reference and measurement beam paths are the same length in air.	Deadpath does not exist.

During system design, there are two key approaches to minimizing deadpath effects.

- One approach is to locate the stationary optic (typically the interferometer) as close as possible to the “zero” point of the moving optic. The zero point is established at the time the laser system is reset.

This will minimize or eliminate deadpath in most applications. This is shown in Figure 53, which shows how to eliminate deadpath in a basic optical layout for an interferometer system.

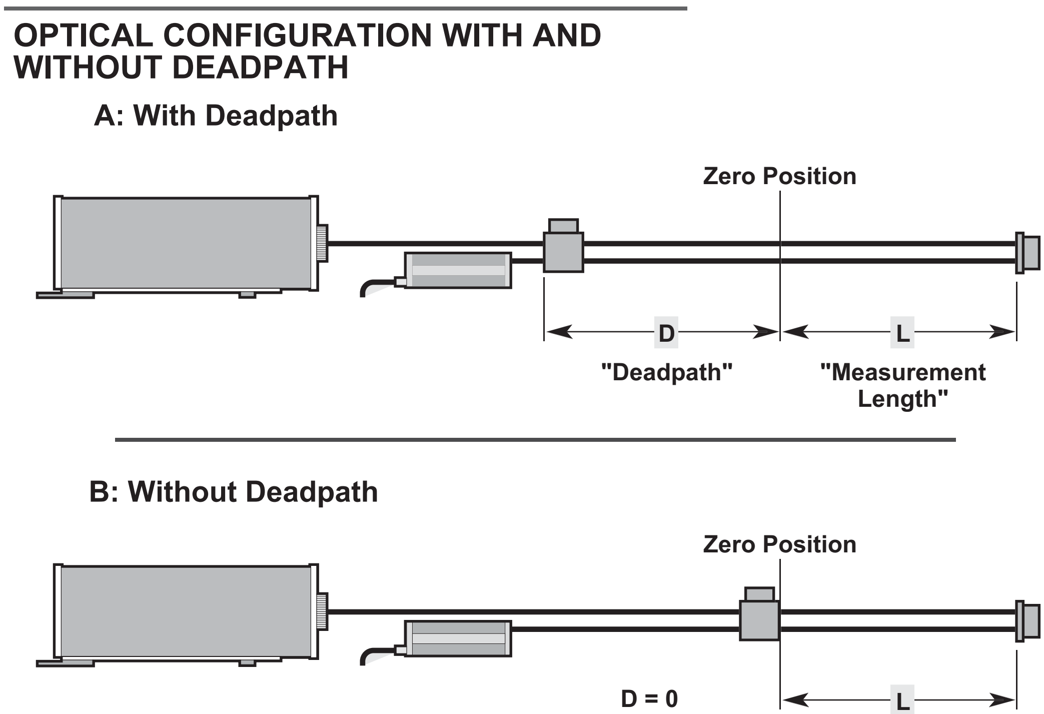

Figure 53 Optical configuration with and without deadpath

NOTE

It is important to understand that the zero-deadpath condition occurs when the reference and measurement optical paths have equal length. For some interferometers, this may NOT correspond simply to bringing the interferometer and measurement mirror as close as possible. For example, due to the differential design of the Agilent 10719A and Agilent 10721A interferometers, the zero-deadpath condition occurs when the mirror is 19 mm (0.750 inch) FARTHER from the interferometer than the reference mirror is located. This condition makes the reference and measurement path lengths equal because the reference beam travels an additional 19 mm (0.750 inch) inside the interferometer.

- The second approach is to choose an interferometer model which permits the minimum deadpath in the installation, wherever possible. While Agilent interferometers can usually be installed with essentially zero deadpath, the application itself sometimes imposes constraints. For example, in some cases, the Agilent 10715A may be the interferometer of choice because it has a remote reference mirror which minimizes deadpath when the interferometer itself cannot be located at the zero point.

During use of the interferometer system, there are two alternative methods to minimize deadpath effects.

- The first method is to always move the moving optic (typically the measurement reflector) to the position where the deadpath distance is zero (that is, where measurement path length equals reference path length), before resetting the laser system. This aligns the machine’s “zero” point to the zero-deadpath position. If you always do this, no further compensation will be required.
- The second method — which you should use when it is not possible to align the machine’s “zero” point to the zero-deadpath position at reset — is to provide deadpath compensation via software in the system controller.

Note that when using the Agilent 10719A in its angle-measuring configuration, the software correction is the only method possible since the measurement and reference path lengths are inherently unequal by 19.05 mm (0.750 inch).

By expanding Equation 3, the corrected actual displacement can be represented as:
Actual displacement = [(Accumulated Counts + Deadpath Counts):

$$\times \frac{\lambda v}{R} \times WCN_1 \Big] - Deadpath\ distance \qquad (8)$$

“Accumulated counts” is the displacement measured in units of LRCs (Least Resolution Counts). “Deadpath counts” is the deadpath distance in terms of compensated LRCs (using the initial compensation number, WCN0) “λ_V/R” is equal to the LRC in units of length, where “R” is the amount of resolution extension. The compensation number at the time of measurement is WCN_1.

In most cases, when you enter a deadpath distance into the software, a positive value corresponds to the case in which the measurement path length is longer than the reference path length. However, for the Agilent 10719A and Agilent 10721A differential interferometers, the deadpath distance sign depends on the measurement mirror position during reset. For example, if the measurement and reference mirrors are located coplanar during reset, the deadpath distance is −19 mm
(−0.750 inch).

Even with this correction, a small error still remains because of the repeatability of the compensation number determination. This deadpath correction error is given as:

Deadpath Correction Error = Deadpath Distance ×
Wavelength Compensation Number Repeatability (9)

The error in measuring the deadpath distance can generally be ignored if its measurement tolerance is within ±0.5 mm. Deadpath error and deadpath correction error are both proportional values that are specified in parts-per-million. However, the measurement error is a function of deadpath distance, rather than the distance measured by the interferometer.

Using the Agilent 10717A Wavelength Tracker and software correction, the deadpath correction error will be less than ±(0.14 ppm × deadpath distance).

Abbé error

Abbé error was first described by Dr. Ernst Abbé of Zeiss: "If errors of parallax are to be avoided, the measuring system must be placed co-axially (in line with) the line in which displacement (giving length) is to be measured on the work-piece".

In simple terms, Abbé error occurs when the measuring point of interest is displaced from the actual measuring scale location and unwanted angular motion occurs in the positioning system.

Abbé error makes the indicated position either shorter or longer than the actual position, depending on the angular offset. The Abbé error is a fixed term and can be represented as:

Abbé error = offset distance × tangent of offset angle = $A_0 \tan\theta$

Figure 54 shows an example of Abbé error, and illustrates the requirements for minimizing angular error and minimizing offset of the scale from the measurement path. In Figure 54(A), the carriage is positioned by a leadscrew and the measurement axis is at the leadscrew centerline. This figure illustrates the displacement (Abbé) error E, which is generated at the measurement probe tip due to unwanted angular motion (θ) of the carriage during the measurement. Figure 54(B) shows the same carriage motion as Figure 54(A), but with the measurement axis coincident with the probe path. Here, the measurement system measures the actual displacement, thus no Abbé error exists. In general, reducing the Abbé offset will reduce sensitivity to unwanted angular motions.

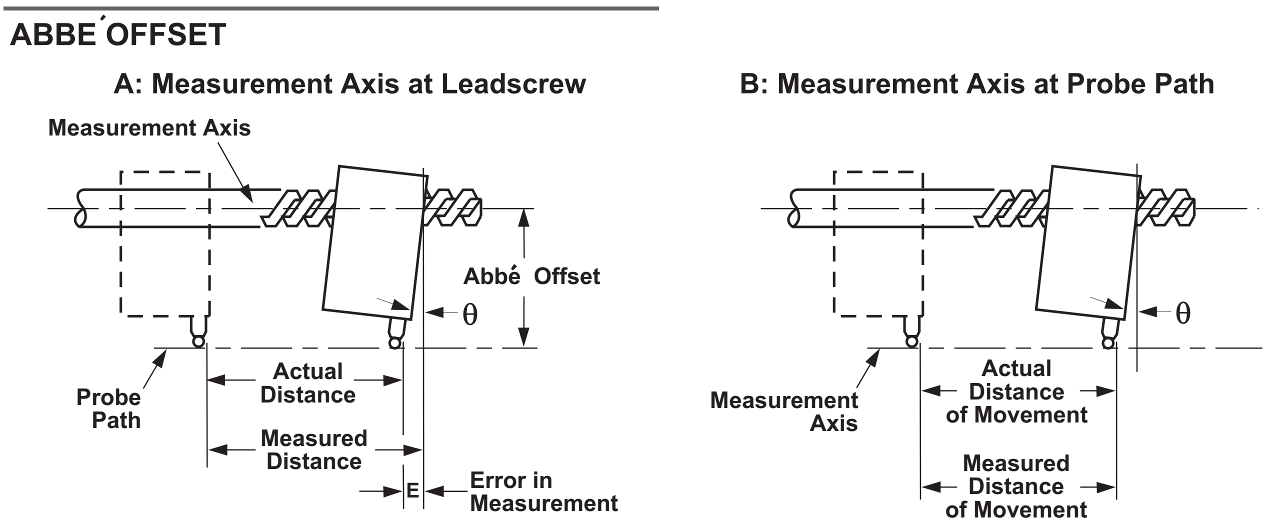

Figure 54 Abbé error

As a general rule, Abbé error is approximately 0.1 micron per 20 mm of offset for each arc-second of angular motion. Abbé error can occur with any type of displacement transducer.

In high-accuracy applications where it is not possible to completely eliminate the Abbé effect, you may measure the unwanted angular displacement directly, and then correct for Abbé errors via software. A variety of interferometers can serve this purpose – particularly the Agilent 10719A (when used as an angle-measuring optic), the Agilent 10735A, or the Agilent 10736A, for plane mirror of X-Y stage applications.

Cosine error

Misalignment of the measurement axis (the laser beam) to the mechanical axis of motion results in an error between the measured distance and the actual distance traveled. This error is called cosine error, because its magnitude is proportional to the cosine of the angle of misalignment. Cosine error is common to all position transducers. If the laser alignment is unchanged over time, the cosine error will not change. Therefore, cosine error is part of the accuracy budget, but not part of the repeatability budget. Figure 55 illustrates cosine error, using a ruler as a scale, with an angle θ between the measurement axis and the scale axis. Measured length, “L”, is related to scale length, “L_s”, by:

$$L = L_s \cos \theta \quad (11)$$

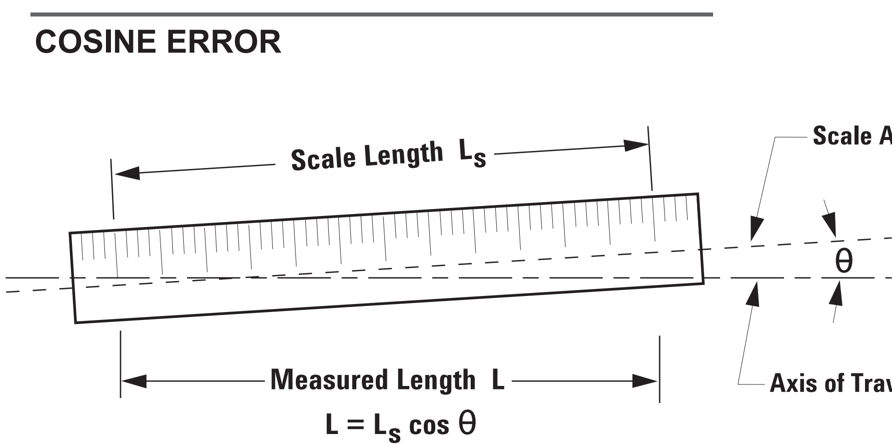

Figure 55 Cosine error

Cosine error is a proportional term; that is, the resulting measurement error is a function of the distance measured by the interferometer. Therefore, the cosine error can be represented, in parts-per-million, as:

$$\text{Cosine error in ppm} = (1 - \cos \theta) \times 10^6 \quad (12)$$

Cosine error can be eliminated by taking care to orient the measurement laser beam parallel to the actual axis of travel. Use the proper alignment procedures for each type of interferometer. For example:

- with interferometers using plane mirror reflectors (Agilent 10706A/B, Agilent 10715A, Agilent 10716A), the resulting cosine error is less than 0.05 ppm.
- with interferometers that use cube comer reflectors (Agilent 10702A, Agilent 10705A), the cosine error in parts-per-million is approximately equal to $31250/L^2$, where L is the measured distance in millimeters.

Determining System Accuracy and Repeatability

The measurement accuracy and repeatability of a laser interferometer system are determined by summing all the error components previously discussed. The error components used to determine the measurement repeatability are a subset of the accuracy components. Table 13 shows the list of components for these error budgets and how the totals are determined. As shown in Table 13, the only differences between the two error budgets are the laser wavelength terms and the cosine error not being part of the repeatability error budget.

Table 13 Laser interferometer system accuracy and repeatability error

	Laser Interferometer System	
	Accuracy is the Sum of	**Repeatability is the Sum of**
Proportional Terms	Laser Wavelength Accuracy	Laser Wavelength Stability
	Atmospheric Compensation	Atmospheric Compensation
	Material Thermal Expansion	Material Thermal Expansion
	Cosine Error	not applicable
	Deadpath Error	Deadpath Error
Fixed Terms	Electronics Error (Resolution)	Electronics Error (Resolution)
	Optics Non-Linearity	Optics Non-Linearity
	Optics Thermal Drift	Optics Thermal Drift
	Abbé Error	Abbé Error

All these terms can be directly summed to determine the worst-case system accuracy and repeatability. However, taking the vector sum of the individual components results in a more realistic or typical system performance*. Again, these components are categorized into proportional terms or fixed terms. The resulting measurement errors from proportional terms are a function of the distance measured. Fixed terms are noncumulative and the resulting measurement errors are not a function of the distance measured.

Repeatability error components can also be divided into short-term (< 1 hour) and long-term (> 1 hour) components. For short-term repeatability, only a subset of the total error components is included. Generally, the optics and material thermal effects are negligible over a short period of time, and these components are deleted from the short-term repeatability error budget. Additionally, short-term laser wavelength stability is used instead of long-term wavelength stability, and atmospheric changes, especially pressure, will also be smaller.

*Steinmetz, C.R., Displacement Measurement Repeatability in Tens of Manometers with Laser Interferometry, Proc. SPIE, Vol. 921, p.406-420, 1988.

Examples — Determining System Accuracy and Repeatability

The examples below illustrate the calculation of measurement accuracy and repeatability of Agilent laser measurement systems for two typical applications.

In the first example, the laser system is part of a precision coordinate measuring machine (CMM) and monitors the position of the touch probe on the machine. In this example, accuracy and long-term repeatability will be determined.

In the second example, the laser measurement system is built into an integrated circuit manufacturing system, such as a wafer stepper or inspection machine, and controls the position of the wafer stage. For this example, accuracy, long-term repeatability, and short-term repeatability will be determined. Short-term repeatability is calculated for the wafer stepper application because process time for wafer exposures is typically very short (< 2 minutes). Table 14 shows a list of parameters needed to calculate each error component.

Table 14 Parameters needed to calculate each error component

System Error Component	Parameters
Laser Wavelength	Measurement Distance (L), Laser Specifications
Atmospheric Compensation	Measurement Distance (L), Environmental Conditions, Compensation Performance
Material Thermal Expansion	Measurement Distance (L), Material Temperature, Material
Cosine Error	Measurement Distance (L), Interferometer Type, Misalignment Angle
Deadpath Error	Deadpath Distance, Environmental Conditions, Compensation Performance
Electronics Error (Resolution)	Interferometer Type, Electronics
Optics Non-Linearity	Interferometer Type
Optics Thermal Drift	Interferometer Type, Temperature Changes
Abbé Error	Abbé Offset, Angular Changes

Precision Coordinate Measuring Machine (CMM) example

The typical configuration for this application is shown in Figure 56. It uses Agilent 10716A High Resolution interferometers and the Agilent 10717A Wavelength Tracker. This CMM has a working measurement volume of 1.0 m × 1.0 m × 1.0 m.

Dimensions: see figure below
Maximum distance measured (L): 1.0 m
Deadpath distance (D): 0.1 m
Cosine Error: 0.05 ppm (Agilent 10716A aligned according to procedure in this manual)
Nonlinearity: ±1.0 nm (Agilent 10716A)
Abbé error: none (assume zero offset)
Measurement resolution: ±2.5 nanometers (Agilent 10716A)
ENVIRONMENT:
Temperature: 20 °C ±0.5° (temperature controlled environment)
Pressure: 760 mm Hg ±25 mm Hg (possible storm fronts during measurement, pressure not controlled)
Humidity: 50% ±10% (humidity controlled environment)

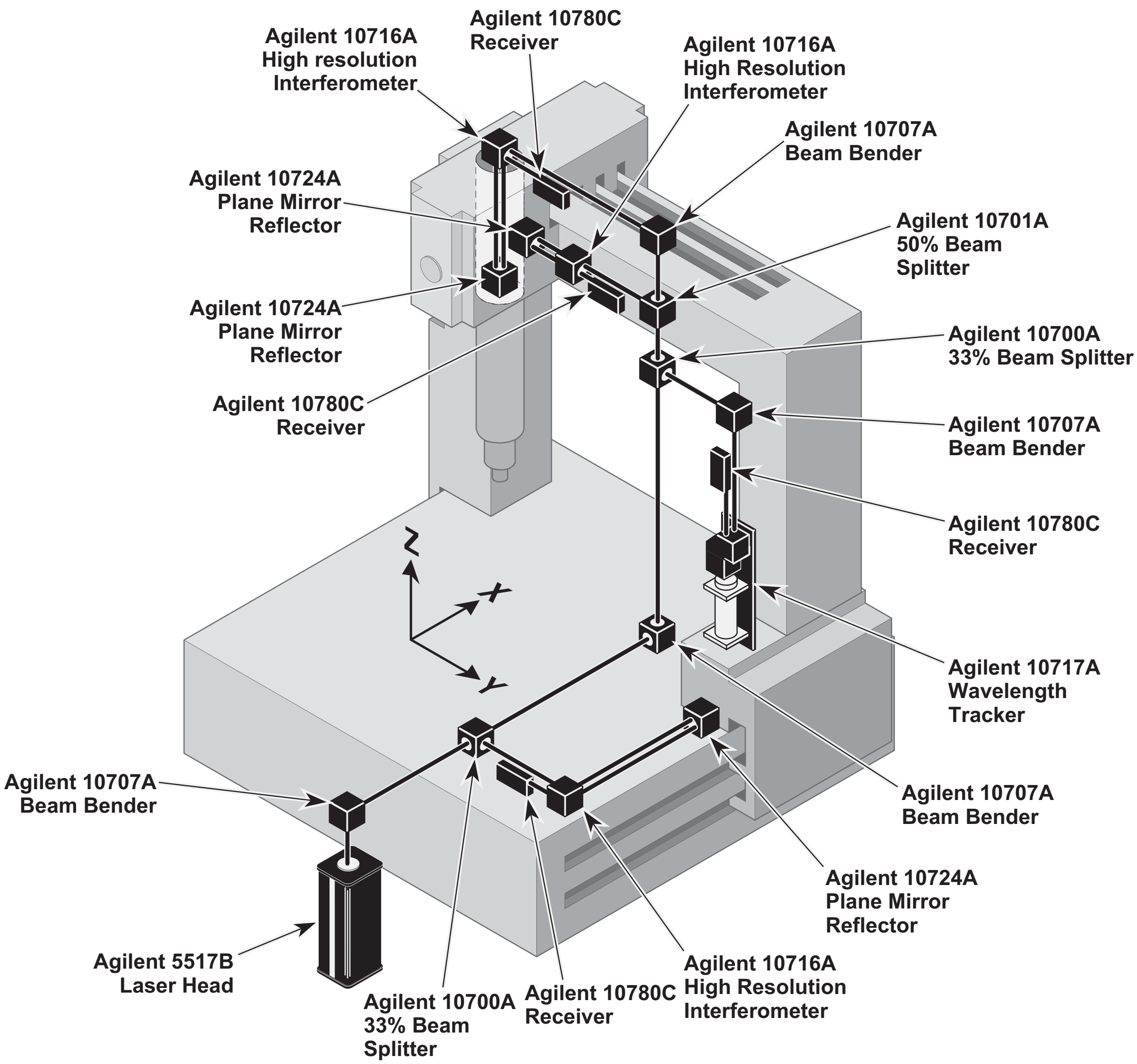

Figure 56 Laser system configuration for a precision Coordinate Measuring Machine (CMM)

A list of parameters needed to calculate the system's measurement accuracy and repeatability for this application is provided the following subsections. The laser head and optics' component specifications are taken from this manual, system resolution specifications for Agilent laser transducer electronics (Agilent 10885A, Agilent 10895A, Agilent 10897B, and Agilent 10898A) are taken from the manual of the respective electronic board, and the Agilent 10751C/D Air Sensor and Agilent 10757D/E/F Material Temperature Sensor environmental specifications are provided in this chapter.

Each error component is calculated individually and summed in the appropriate error budget to determine system accuracy and repeatability.

Laser wavelength error

When using a CMM, both accuracy and long-term repeatability need to be calculated.

Laser Wavelength Stability: ±0.02 ppm (long-term)

This translates to a maximum distance uncertainty of:

Laser Wavelength Stability Error = (1.0 m) $(\pm 0.02 \times 10^{-6})$
(long-term) = ±0.02 micron

Laser Wavelength Accuracy: ±0.02 ppm (with optional calibration)

Laser Wavelength Accuracy Error = (1.0 m) $(\pm 0.02 \times 10^{-6})$
= ±0.02 micron

Atmospheric compensation

Since the wavelength tracker provides relative compensation information, the initial compensation number from another source determines the compensation accuracy. In this example, the initial compensation number is derived from measuring a known artifact or standard with the laser system on the machine. The accuracy of measuring the artifact or standard is the sum of the laser system measurement repeatability, machine repeatability and touch probe accuracy. It is assumed that no error is induced in measuring the artifact. Consequently, in this example, accuracy and repeatability of atmospheric compensation information will be equal.

Using Equation 4 (given earlier in this chapter) and the specified environmental conditions, accuracy and repeatability of compensation information from wavelength tracker can be determined.

Compensation accuracy and repeatability =

$$\pm\left[0.067ppm + \frac{0.06\,ppm}{degree\ C} \times\ 0.5\ degree\ C + \frac{0.002\,ppm}{mm\ Hg} \times 25\ mm\ Hg\right]$$

$= \ \pm0.15$ ppm

At maximum distance the position uncertainty, due to compensation, will be:

Compensation Error = (1.0 m) ($\pm 0.15 \times 10^{-6}$) = ±0.15 micron.

With no atmospheric compensation, the error would be ±9.0 ppm. This translates to a position uncertainty, at the maximum distance of 1 m, of 9.0 microns.

Material thermal expansion

On a CMM, with a laser interferometer system used as the position scale, material compensation should be done to the measured part, not the machine. Therefore, the material temperature error term depends on the type of material being measured and the specifications of the temperature sensor. This can be a significant error if the temperature of the part is not tightly controlled or compensation is not adequate. For example, with a 0.5 m part made of steel (α = 0.00 ppm/°C) and using the Agilent 10757D/E/F Material Temperature Sensor, the resulting measurement accuracy and repeatability will be:

Measurement Accuracy = $\alpha \times$ temperature sensor repeatability × part length

$$= \frac{10.0\ ppm}{degree\ C}(\pm 0.1\ degree\ C \times\ 0.5m)$$

= ±0.5 micron

The Agilent 10757D/C/E temperature sensor has a measurement repeatability equal to its accuracy.

Measurement Repeatability = ±0.5 micron

Since this error is independent of the type of measurement scale but strongly dependent on the type of material and temperature sensor performance, specific errors will not be included in this example. However, this error should be included when calculating the error budget for an actual machine.

Material Thermal Expansion = 0 micron (assumed)

Deadpath error

Deadpath error is a function of deadpath distance, method of compensation, and environmental conditions. With no compensation for deadpath, Equation 7 determines the error.

Deadpath Error = (0. 1 m) ($\pm 9 \times 10^{-6}$) = ±0.9 micron

With deadpath correction and using Wavelength Tracking Compensation, Equation 9 determines the error.

Deadpath correction error = (0. 1 m) ($\pm 0.15 \times 10^{-6}$) = ±0.015 micron

Electronics error

With Agilent laser interferometer systems, the electronics error equals measurement resolution. When using the Agilent 10716A High Resolution Interferometer, system measurement resolution (for Agilent 10885A, Agilent 10895A, Agilent 10897B, or Agilent 10898A electronics) is:

Measurement Resolution = 0.0025 micron

Optics nonlinearity

Nonlinearity when using the Agilent 10716A High Resolution Interferometer is ±0.001 micron.

Optics thermal drift

This error term should be included when determining long-term repeatability. The error depends on the degree of thermal cycling that the interferometer experiences. With the Agilent 10716A in this application, typical thermal drift will be:

$$Optics\ Thermal\ Drift\ =\ \frac{0.04\ micron}{degree\ C} \times (\pm 0.5\ degree\ C) \times \pm 0.02\ micron$$

Abbé error

Since this error term is independent of the type of measurement scale used, but strongly dependent on how the machine is designed and built, specific errors will not be included in this example. However, the errors should be included when calculating the error budget for an actual machine when the Abbé offset is known and angular errors can be measured or estimated.

Abbé Error = 0 micron (assumed)

Cosine error

If the proper alignment procedure for the Agilent 10716A is followed, the worst-case cosine error is:

Cosine Error = ±0.05 ppm

Cosine Error (in microns) = (±0.05 ppm) (1.0 m) = ±0.05 micron

CMM system accuracy calculation

Now the appropriate components can be summed together to obtain system measurement accuracy and repeatability. Worst-case system accuracy and repeatability is determined by directly summing these components. However, a more realistic, but still conservative, system repeatability is the vector sum (RSS, Root Sum of Squares) of the individual components. System accuracy and repeatability will be calculated with and without atmospheric compensation to show the importance of compensating for changes in atmospheric conditions. The results are presented in Table 15.

Table 15 System accuracy with and without atmospheric compensation

	System Accuracy Calculation	
	With Atmospheric Compensation ±(microns)	**Without Atmospheric Compensation ±(microns)**
Laser Wavelength Error	0.02	0.02
Compensation Error	0.15*	9.0*
Material Thermal Expansion	0.0	0.0
Deadpath Error	0.015*	0.90*
Electronics Error	0.0025	0.0025
Optics Non-Linearity	0.001	0.001
Optics Thermal Drift	0.02	0.02
Abbé Error	0.0	0.0
Cosine Error	0.05 #	0.05 #
Direct Sum Total	±0.26 micron	±9.99 microns
RSS sum where *'s are not independent and # is an offset.	±0.22 micron	±9.95 microns

The following equation is used to calculate the RSS sum:

$$\text{RS sum} = [(\text{sum of squares of independent terms}) + (\text{sum of not independent terms}^2)]^{1/2} + \text{offset}$$

Figure 57 graphically presents this accuracy data and shows the importance of using atmospheric compensation. Figure 58 shows in more detail the relative magnitude of each component when using atmospheric compensation.

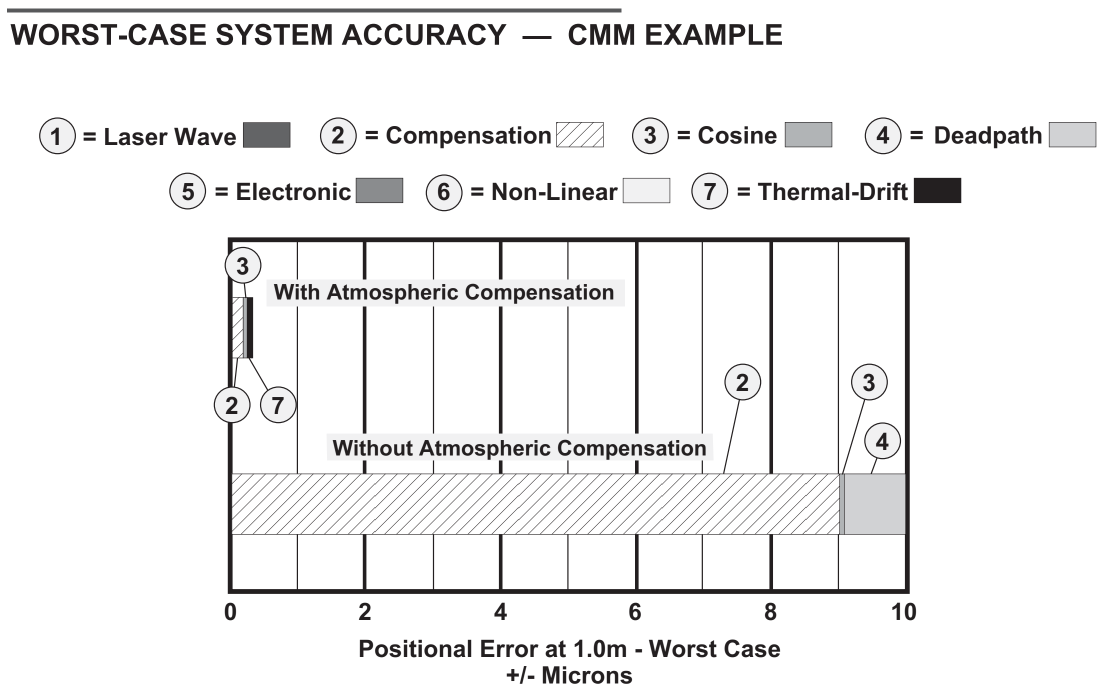

Figure 57 Worst-case System Accuracy with and without Atmospheric Compensation for the CMM example

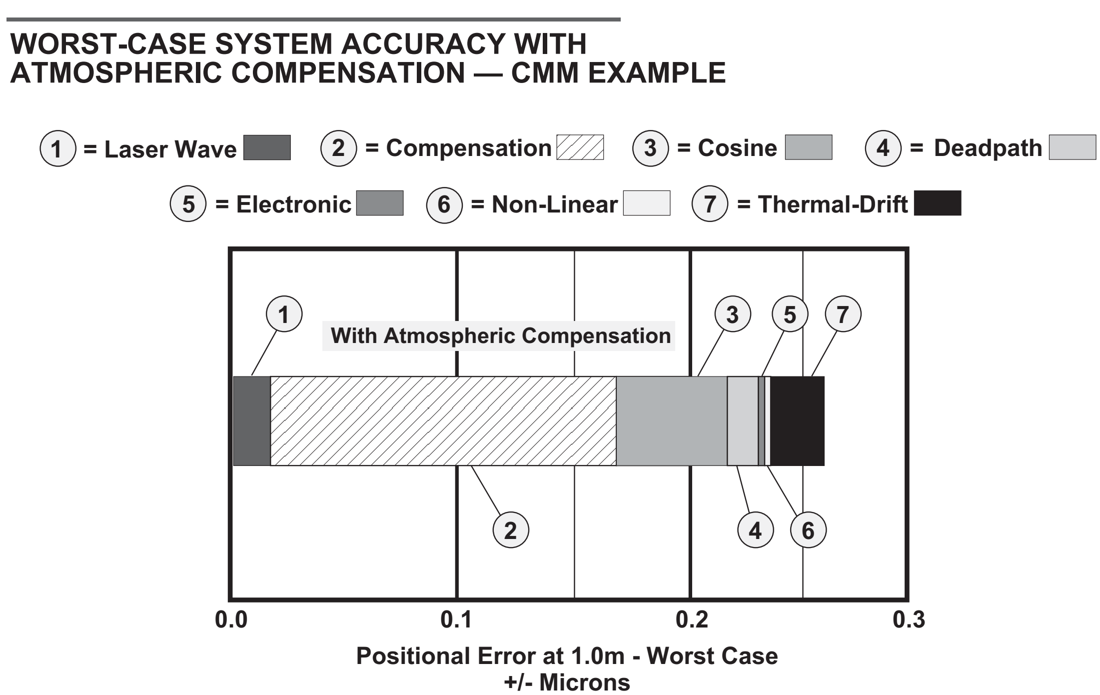

Figure 58 Worst-case System Accuracy with Atmospheric Compensation for the CMM example

CMM system repeatability calculation

Calculation of laser system long-term repeatability in this example is the same as system accuracy except that the cosine error term (±0.05 micron) is not included. Therefore, system repeatability in this example will be:

	With Atmospheric Compensation	Without Atmospheric Compensation
Direct Sum Total (Worst Case)	±0.21 micron	±9.94 microns
RSS sum (Typical)	±0.17 micron	±9.90 microns

Figure 59 is a graph of the worst-case repeatability. Again it shows the importance of atmospheric compensation. Figure 60 shows in more detail the worst-case repeatability with atmospheric compensation.

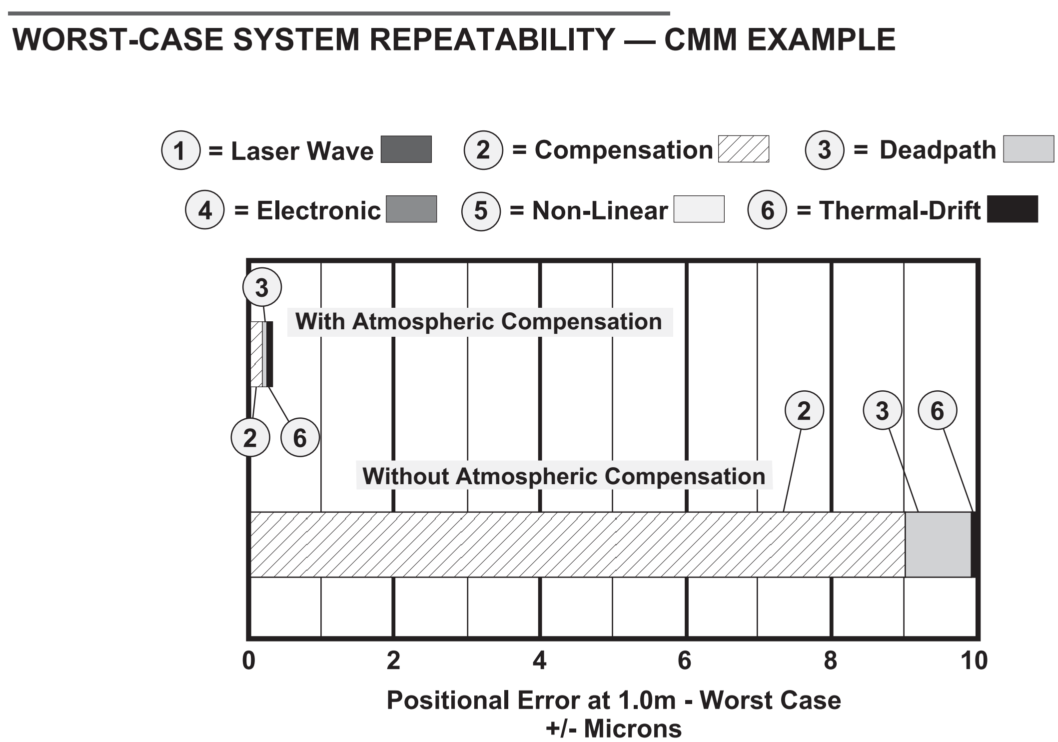

Figure 59 Worst-case System Repeatability with and without Atmospheric Compensation for the CMM example

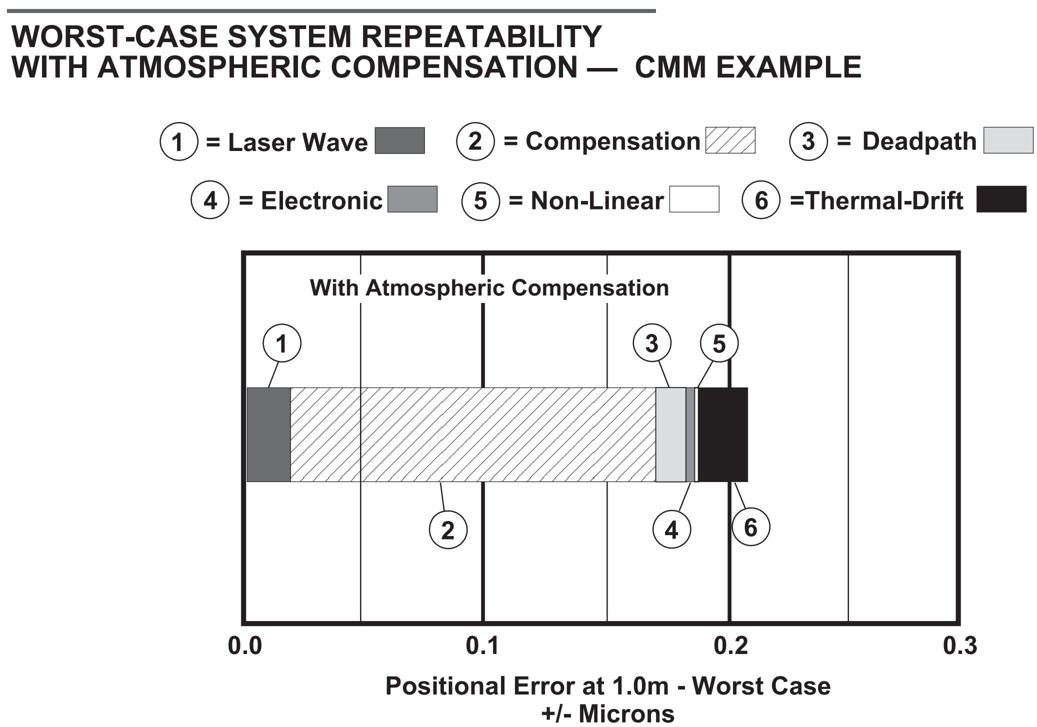

Figure 60 Worst-case System Repeatability with Atmospheric Compensation for the CMM example

IC Wafer Stepper example

In this example, the laser system is built into an Integrated Circuit Wafer Stepper and controls the position of the wafer stage. A typical configuration for this application is shown in Figure 61. It uses Agilent 10706B High Stability Plane Mirror Interferometers and an Agilent 10717A Wavelength Tracker. Following is a list of parameters needed to calculate the system accuracy and repeatability. The laser head and optics' component specifications are taken from this manual, system resolution specifications for Agilent laser transducer electronics (Agilent 10885A, Agilent 10895A, Agilent 10897B, and Agilent 10898A) are taken from the manual of the respective electronic board, and the Agilent 10751C/D Air Sensor and Agilent 10757D/E/F Material Temperature Sensor environmental specifications are provided in this chapter.

Dimensions: see figure below
Maximum distance measured (L): 0.2 m
Deadpath distance (D): 0.1 m
Cosine Error: 0.05 ppm (Agilent 10706B aligned according to procedure in this manual)
Nonlinearity: ±2.2 nm (Agilent 10706B)
Abbé error: none (assume zero offset)
Measurement resolution: ±5 nanometers (Agilent 10706B)
ENVIRONMENT:
Temperature: 20° C ±0.1° (temperature controlled environment)
Pressure: 760 mm Hg ±25 mm Hg (possible storm fronts during measurement, pressure not controlled)
Humidity: 50% ±10% (humidity controlled environment)

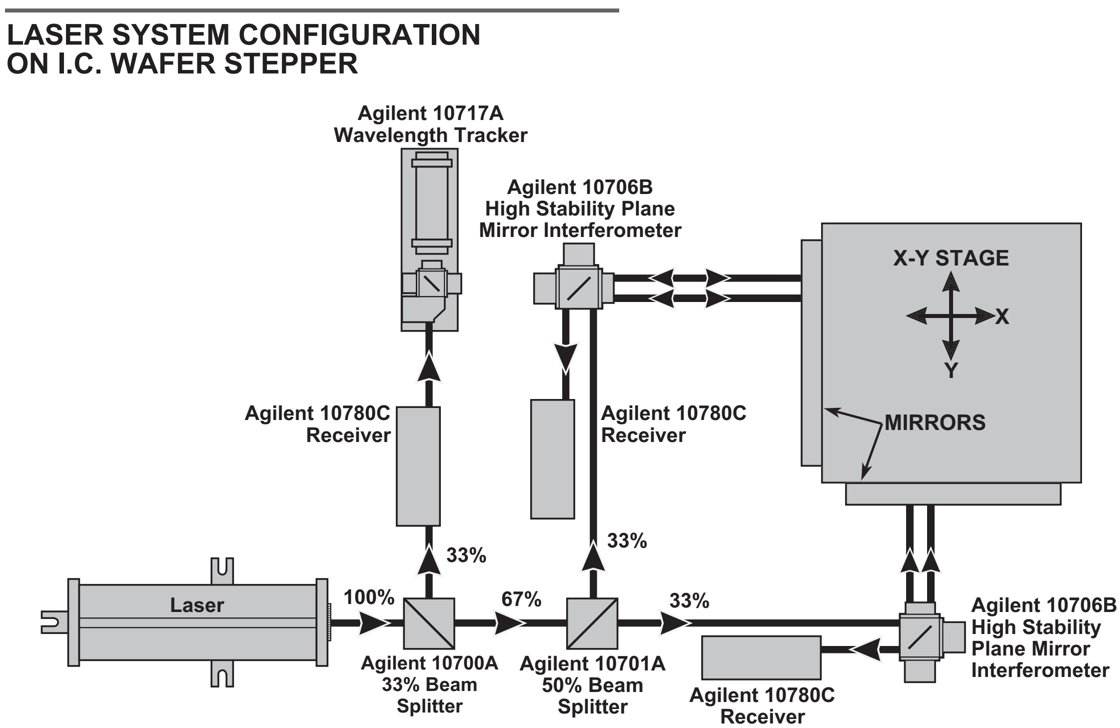

Figure 61 Laser System Configuration for an Integrated Circuit Wafer Stepper

Each error component will be calculated individually and then summed to determine system repeatability.

Laser wavelength error

The time required for an operation by IC fabrication equipment is often only a few minutes. Thus, accuracy, long-term stability, and short-term stability need to be calculated.

Laser Wavelength Stability: ±0.002 ppm (short-term)

This translates to a maximum distance error of:

Laser Wavelength Stability Error = ±0.2 m ($\pm 0.002 \times 10^{-6}$)
(short- term) = ±0.0004 micron

Laser Wavelength Stability: ±0.02 ppm (long-term)

Laser Wavelength Stability Error = 0.2 m ($\pm 0.02 \times 10^{-6}$)
(long-term) = ±0.004 micron

Laser Wavelength Accuracy: ±0.02 ppm (with optional calibration)

Laser Wavelength Accuracy Error = 0.2 m ($\pm 0.02 \times 10^{-6}$)
= ±0.004 micron

Atmospheric compensation

Since the wavelength tracker provides relative compensation information, the initial compensation number from another source determines the compensation accuracy. In this example, the initial compensation number is obtained by measuring a known artifact or standard with the laser system. The accuracy of measuring the artifact is the sum of the laser system measurement repeatability, machine repeatability, and the accuracy of the alignment mark sensing system. It is assumed that no error is induced in measuring the artifact on the machine. Consequently, in this example accuracy and repeatability of the atmospheric compensation information will be equal.

Using Equation 4 and the specified environmental conditions, accuracy and repeatability of compensation information from wavelength tracker can be determined.

Compensation accuracy and repeatability =

$$\pm\left[0.067 ppm + \frac{0.06\, ppm}{degree\ C} \times 0.1\ degree\ C + \frac{0.002\, ppm}{mm\ Hg} \times 25\ mm\ Hg\right]$$

$= \pm\ 0.14$ ppm

At maximum distance, the position error, due to compensation, will be:

Compensation Error = ($0.2\ m \times \pm 0.14 \times 10^{-6}$) = ±0.028 micron

With no atmospheric compensation, the error would be ±9.0 ppm. This translates into a position error of 1.8 microns.

Material thermal expansion

This error depends on the machine design and the position that is measured or controlled. On a wafer stepper, the wafer is positioned relative to the optical column. If the measurement axes are placed to allow measurements between the wafer and optical column (for example, using an Agilent 10719A or Agilent 10721A differential interferometer), material temperature effects may be ignored. This assumes the material expansion in the measurement path is equal to that in the reference path.

Material Thermal Expansion = 0 micron (assumed)

Deadpath error

Deadpath error is a function of deadpath distance, method of compensation, and environmental conditions. With no compensation for deadpath, Equation 7 determines the error.

Deadpath Error = (0. 1 m) × (±0.9 × 10^{-6}) = ±0.9 micron

With deadpath correction and the use of the wavelength tracker, Equation 9 determines the error.

Deadpath correction error = (0.1 m) × (±0.14 × 10^{-6}) = ±0.014 micron

Electronics error

With Agilent laser interferometer systems, the electronics error equals the measurement resolution. When using the Agilent 10706B High Stability Plane Mirror Interferometer, system measurement resolution (for the Agilent 10885A, Agilent 10895A, Agilent 10897B, or Agilent 10898A electronics) is:

Measurement Resolution = 0.005 micron

Optics nonlinearity

Nonlinearity when using the Agilent 10706B High Stability Plane Mirror Interferometer is ±0.0022 micron.

Optics thermal drift

Because the measurement repeatability of this piece of equipment is important, the effects of thermal changes of the interferometer should be included. With the Agilent 10706B High Stability Plane Mirror Interferometer, typical thermal drift will be:

$$Optics\ Thermal\ Drift\ =\ \frac{0.04\ micron}{degree\ C} \times (\pm 0.1\ degree\ C) = \pm 0.004\ micron$$

Abbé error

In X-Y stage applications, it is usually easy to have the interferometer measurement axis in line with the wafer. Therefore, Abbé offset will be zero and no Abbé error will occur.

Abbé Error = 0 micron

Cosine error

If the proper alignment procedure for the Agilent 10706B High Stability Plane Mirror Interferometer is followed, the worst-case cosine error is:

Cosine Error = ±0.05 ppm

Cosine Error (in microns) = ±0.05 ppm × 0.2 m = ±0.01 micron

IC Stepper System accuracy calculation

Now you can sum the appropriate components together to obtain system measurement accuracy and repeatability. Worst-case system accuracy and repeatability is determined by directly summing these components. However, a more realistic, but still conservative, system repeatability is the vector sum (RSS, Root Sum of Squares) of the individual components. System accuracy and repeatability will be calculated with and without atmospheric compensation to show the importance of compensating for changes in atmospheric conditions. The results are presented in Table 16.

Table 16 IC Stepper system accuracy with and without atmospheric compensation

	System Accuracy Calculation	
	With Atmospheric Compensation ±(microns)	**Without Atmospheric Compensation ±(microns)**
Laser Wavelength Error	0.004	0.004
Compensation Error	0.028*	1.8*
Material Thermal Expansion	0.0	0.0
Deadpath Error	0.014*	0.90*
Electronics Error	0.005	0.005
Optics Non-Linearity	0.0022	0.0022
Optics Thermal Drift	0.004	0.004
Abbé Error	0.0	0.0
Cosine Error	0.01 #	0.01 #

Table 16 IC Stepper system accuracy with and without atmospheric compensation

	System Accuracy Calculation	
Direct Sum Total	±0.067 micron	±2.725 microns
RSS sum where *'s are not independent and # is an offset.	±0.053 micron	±2.710 microns

Use the following equation to calculate the RSS sum:

$$\text{RS sum} = [(\text{sum of squares of independent terms}) + (\text{sum of not independent terms}^2)]^{1/2} + \text{offset}$$

Figure 62 graphically presents this accuracy data and shows the importance of using atmospheric compensation. Figure 63 shows in more detail the relative magnitude of each component when using atmospheric compensation.

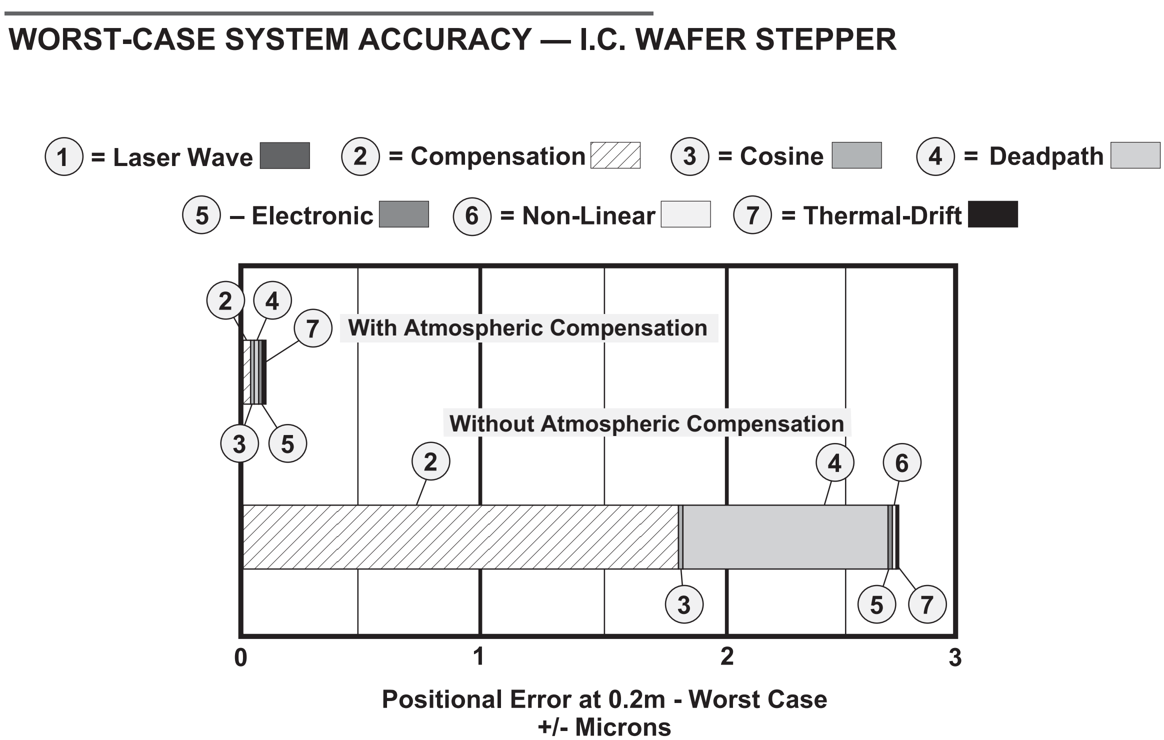

Figure 62 Worst-case System Accuracy with and without Atmospheric Compensation for the Wafer Stepper example

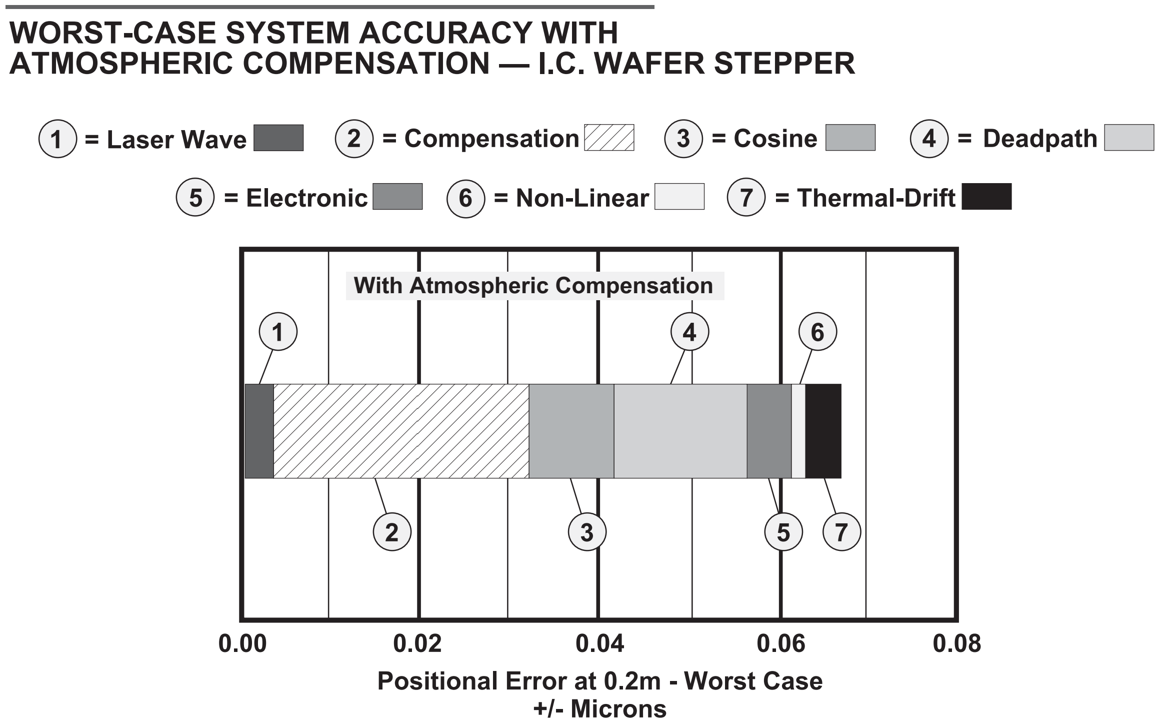

Figure 63 Worst-case System Accuracy with Atmospheric Compensation for the Wafer Stepper example

Another potential source of error that should be included in the total accuracy budget is the flatness of the measurement mirrors. In X-Y stage applications, long mirrors are attached to two sides of the stage, as shown in Figure 61. Because the mirrors are not perfectly flat, a measurement change occurs in one axis as the other axis is moved. Since a mirror flatness of $\lambda/20$ is recommended for correct operation of the laser system, this would induce a maximum measurement error of 0.03 micron. To compensate for this measurement error, map the mirror flatness, then make the correction via software in the controller.

IC Stepper system repeatability calculations

Long-term repeatability Calculation of laser system long-term repeatability in this example is the same as system accuracy, except that the cosine error term (±0.01 micron) is not included. Therefore, laser system long-term repeatability will be:

	With Atmospheric Compensation	Without Atmospheric Compensation
Direct Sum Total (Worst Case)	±0.057 micron	±2.715 microns
RSS sum (Typical)	±0.043 micron	±2.710 microns

Figure 64 is a graph of the worst-case long-term repeatability. Again, the importance of atmospheric compensation is shown. Figure 65 shows in more detail the worst-case long-term repeatability with atmospheric compensation.

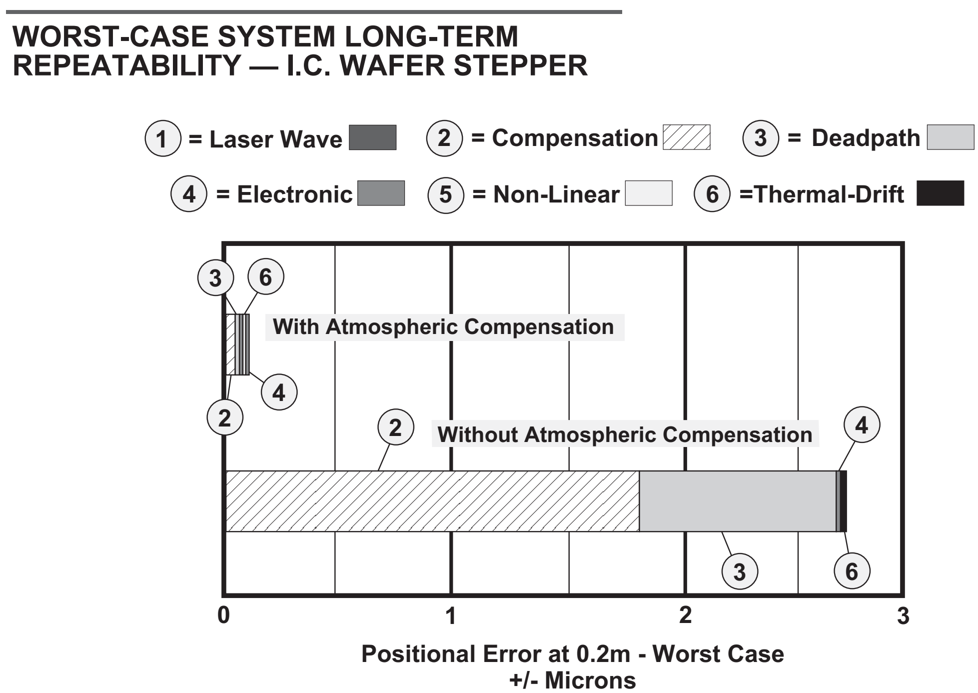

Figure 64 Worst-case System Long-term Repeatability with and without Atmospheric Compensation for the Wafer Stepper example

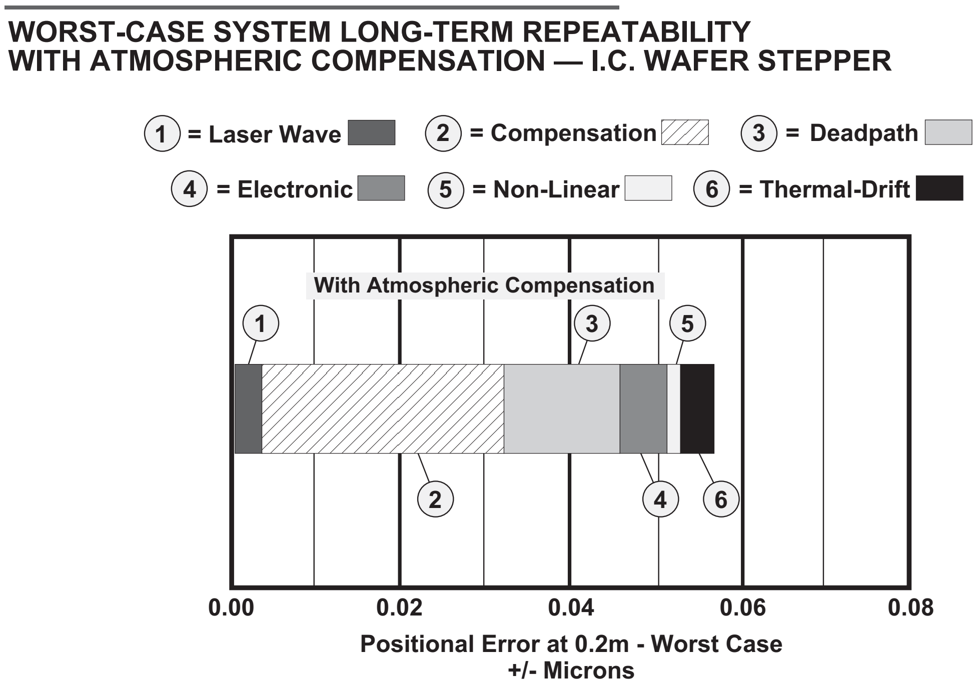

Figure 65 Worst-case System Long-term Repeatability with Atmospheric Compensation for the Wafer Stepper example

Short-term repeatability In this example, calculation of system short-term repeatability is the same as long-term repeatability except: 1) long-term laser wavelength error is replaced by short-term error, and 2) optics thermal drift is not included. The atmospheric compensation error is assumed to be the same. However, under normal operating conditions, atmospheric pressure changes would generally be substantially less than those used in this example for the short periods of interest in IC fabrication.

	With Atmospheric Compensation	Without Atmospheric Compensation
Direct Sum Total (Worst Case)	±0.050 micron	±2.708 microns
RSS sum (Typical)	±0.042 micron	±2.700 microns

As seen from these values, the difference between system long-term and short-term repeatability is only a few nanometers. If the assumed short-term environmental changes (especially atmospheric pressure) are much smaller, then short-term repeatability will be significantly smaller.

Achieving Optimum System Accuracy and Repeatability

To achieve the best measurement accuracy and repeatability from a laser interferometer system in your application:

1. Whenever possible, make the measurements in a tightly-controlled, stable environment. Also, use the appropriate compensation methods to correct for atmospheric and material temperature effects.
2. When designing a machine to use a laser interferometer system, minimize both deadpath distances and Abbé offsets. If a deadpath exists on the machine, correct for it during measurements.
3. For each measurement axis, be sure to properly align optical components during installation to minimize the amount of cosine error.
4. Use the proper components for the particular application. If significant changes in environmental conditions are expected, use automatic compensation and interferometers with minimal thermal drift.

Additional details are presented below.

Minimizing environmental effects

The relative importance of typical atmospheric effects and material temperature errors is shown in Figure 66. Measurement errors due to material temperature errors are especially important in many applications. Ideally, all distance measurements with the laser system would be made in a temperature-controlled room held at exactly 20°C (68° F), the standard temperature. Then the machine or part would be at its “true” size and the wavelength compensation number determined earlier could be used directly.

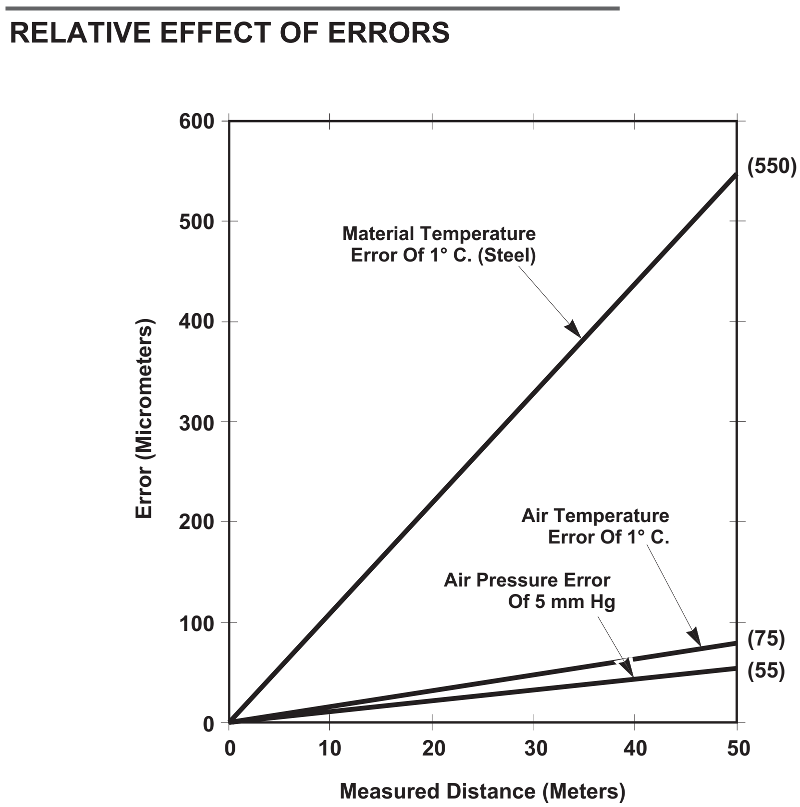

Figure 66 Relative effect of errors in atmospheric and material temperature

Laser measurement errors from environmental effects can be corrected by using a combined compensation term called the “Total Compensation Number” or “TCN”. It contains a Wavelength-of-Light compensation term (WCN) and a Material Temperature compensation term (MTC). These terms were described individually earlier in this chapter. The WCN is Equation 2, and the MTC is Equation 5. The TCN is determined from the WCN and MTC as follows:

$$\text{TCN} = \text{WCN} \times \text{MTC} \qquad (13)$$

Expanding the WCN and MTC terms, we get:

$$\text{TCN} = \overbrace{\frac{\text{air wavelength}}{\text{vacuum wavelength}}}^{\text{WCN}} \times \overbrace{[1 - (\text{Linear Thermal Coefficient}) \times (\text{Material Temperature} - \text{Standard Temperature})]}^{\text{MTC}} \qquad (14)$$

The Wavelength-of-Light term compensates for changes in the laser wavelength. The material temperature term corrects the measurement back to standard temperature.

Recall from the earlier section on atmospheric compensation that the laser position transducer counts the number of wavelengths of motion traveled. This measurement can then be corrected for atmospheric effects by multiplying the distance by a correction factor, the WCN. The result was given in Equation 3:

$$\text{Actual Displacement (true position)} = \text{(Wavelength counts)} \times \text{WCN} \times \text{vacuum Wavelength} \quad (3)$$

We can now combine the compensation for both atmospheric and material temperature effects and calculate the “true” length of the object at standard 20° C temperature. Using equations (3) and (13) we get:

$$\text{Actual Length} = \text{(Wavelength counts)} \times \text{TCN} \times \text{vacuum Wavelength} \quad (15)$$

Laser compensation capability

The laser system electronics can accept a manually-entered Total Compensation Number (TCN) or automatically determine the TCN, if a compensation board is installed.

Manual compensation

For manual compensation, the Total Compensation Number (TCN) is entered through the system controller to the Agilent laser electronics. The TCN can be calculated via Equation 13 or 14. See Chapter 13, “Wavelength-of-Light Compensation,” for Wavelength Compensation numbers and the method to calculate them manually. See Chapter 14, “Material Expansion Coefficients,” for information about Material Temperature compensation numbers.

Manual compensation can also be done without deriving or looking up the factors, by using the appropriate Agilent automatic compensation board for the Agilent laser electronics. The compensation board computes compensation factors from the environmental data (atmosphere and machine or part temperature) entered manually through the controller to the Agilent electronics.

Automatic compensation

With most Agilent laser electronics, the necessary information for wavelength compensation can be obtained automatically by using the appropriate Agilent automatic compensator board and environmental sensors. WOL compensation is provided by using either the Agilent 10751C/D Air Sensor to measure air temperature, pressure, and humidity, or the Agilent 10717A Wavelength Tracker to measure the laser wavelength change directly. The Agilent 10757D/E/F Material Temperature Sensor provides the temperature data for the “Material Temperature” term. The Agilent automatic compensation board automatically provides an updated total compensation number (TCN).

The Agilent 10717A Wavelength Tracker and its accompanying Agilent 10780C, Agilent 10780F, Agilent E1708A, or Agilent E1709A receiver provide the Agilent automatic compensation board with information indicating any changes in the laser wavelength. Unlike the air sensor, the wavelength tracker measures relative (differential) changes in the laser wavelength with respect to an initial value. The absolute accuracy is dependent on this initial value. Some methods of determining an initial compensation number are by:

- using an Agilent 10751C/D Air Sensor.
- using look-up tables (such as those in Chapter 13, “Wavelength-of-Light Compensation,” of this manual).
- measuring temperature, pressure and humidity, and then inputting these values into the automatic compensation board.
- measuring a known “standard” length.

To calculate the initial compensation number by measuring a known standard or artifact, use the following formula:

$$\text{Compensation Number} = \frac{\text{Measured length (from laser system on machine)}}{\text{Actual length (from a "Standards" laboratory)}} \qquad (14)$$

NOTE If relative compensation is satisfactory for your application, the default values of initial compensation may be used. See the laser electronics documentation for your system for details.

Sensor placement

To correct for the effects of air conditions on the laser reading, place the Agilent 10717A Wavelength Tracker or Agilent 10751C/D Air Sensor where it can accurately monitor the conditions influencing the laser beam. Mount the sensor as close as possible to the measurement path, so it monitors the condition of these laser beams.

Agilent 10717A Wavelength Tracker

When you use the wavelength tracker, mount the unit on a stable surface so that alignment is maintained.

Agilent 10751C/D Air Sensor

The air sensor should not be placed directly below the measurement beam path because the heat from the air sensor will affect the laser beam. The Agilent 10751C/D Air Sensor base contains a magnet to aid in securing it to magnetic materials. For permanent mounting, fasten the sensor using the #10-32 tapped hole on the bottom of the unit.

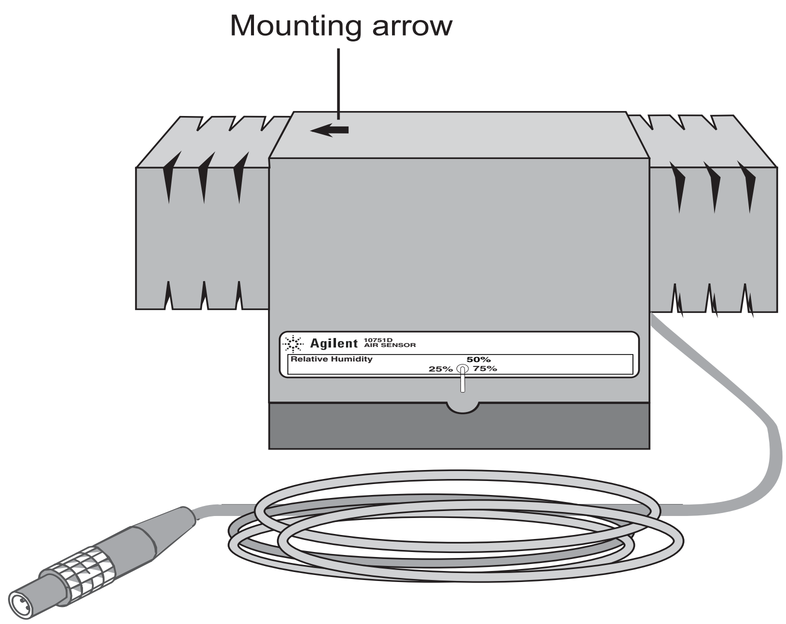

Figure 67 Air sensor orientation (Agilent 10751D shown)

NOTE The Air Sensor should be mounted with its arrow pointing up, to maximize accuracy, as shown in Figure 67.

Agilent 10757D/E/F Material Temperature Sensor

When monitoring material temperature to account for material expansion, the Agilent 10757D/E/F Material Temperature Sensor should be placed on the part of the machine closest to the workpiece.

The material temperature sensor contains a magnet to aid in securing it to ferrous materials. For permanent mounting, a clamp can be used to secure it. If two material temperature sensors are used, they should be placed to determine the average temperature of the workpiece. After attaching a probe to the workpiece, allow at least 10 minutes for the probe temperature to stabilize at the workpiece temperature.

WOL compensation method comparison

The method of atmospheric (WOL) compensation used is important in determining the overall laser system measurement accuracy. Table 17 summarizes the laser system accuracy for various methods of atmospheric compensation as a function of different atmospheric conditions.

Table 17 Laser system measurement accuracy comparison*

Environment: **Pressure:** 760 mm Hg ±25 mm Hg **Relative Humidity:** 50% ±10%			
Temperature Control	**±0.1°C**	**±1.0°C**	**±5.0°C**
No Compensation† (at 20°C)	±9.0 ppm	±9.9 ppm	±14.0 ppm
Compensation using Agilent 10751C/D Air Sensor (at 20° C)	±1.4 ppm	±1.5 ppm (typical)	±1.6 ppm
Wavelength Tracking Compensation‡	±0.15 ppm	±0.19 ppm	±0.44 ppm
Measurement in Vacuum	±0.1 ppm	±0.1 ppm	±0.1 ppm

* These accuracy specifications include the laser head term, but exclude electronics accuracy and interferometer nonlinearity terms.

† No compensation means that no correction in compensation number occurs during environmental changes.

‡ System accuracy equals these values (measurement repeatability) plus accuracy of initial compensation value.

Non-Uniform Environments

Compensation for environmental effects is practical only when the material being measured is at a constant temperature, and when the medium through which the measurement laser beam passes is not disturbed (such as by air turbulence).

Changing temperature conditions

Material temperature compensation is accurate only when the part and the machine are at thermal equilibrium with their surroundings. Changing temperature can change thermal gradients in both the machine and the part. In this case, the primary machine errors are due to complex bending effects which distort machine geometry, in addition to simple thermal expansion. These effects are extremely difficult, if not impossible, to describe mathematically.

Changing temperatures also affect the measurement optics, resulting in optics thermal drift as described earlier in this chapter. Therefore, if a machine is operated in a poor environment, its accuracy may be limited by its own geometry, thermal expansion, and optics thermal drift. In this case, the most practical solution is to improve the environment and use optics that are thermally stable.

Air turbulence

Air Turbulence is an important factor to be considered during installation of a laser system. It is usually caused by variations in air temperature. The major effect of air turbulence is reduction of amount of signal at the receiver. This reduction is due to either physical deflection of the laser beam or degradation of the beam's coherence. Excessive air turbulence may cause complete loss of measurement signal. This loss of signal will be detected by the Agilent electronics which will output an error signal.

One application where serious consideration must be given to air turbulence is a temperature-controlled environment. Although it would appear that such an environment would be ideal, temperature-controlled areas often exhibit greater air turbulence than non-controlled areas. This turbulence is caused by incomplete mixing of new air from the temperature control unit with existing air, creating thermal gradients or pockets. Although such environments are good for a machine's thermal stability, the short term fluctuations can cause measurement signal degradation in the laser system.

Reducing air turbulence

In an uncontrolled environment, the effects of air turbulence can be minimized by protecting the laser beam with some type of cover. Since this would normally be done for protection against beam interruption, air turbulence effects will usually not be a significant installation factor in a typical environment.

Protection against air turbulence problems which occur in a controlled environment depends largely on the specific application. For systems such as integrated circuit lithography equipment in small closely-controlled enclosures, it may be sufficient to provide constant air flow over the measurement paths. In other cases, such as large coordinate measuring machines, protecting the laser beams with covers prevents air turbulence effects from interfering with the measurement.

Avoiding thermal gradients

One source of air turbulence, which can affect both the laser system and also the accuracy of the machine itself, is thermal gradients created by localized heat sources (e.g., motors, electromagnetics, lamps, etc.) located on or near the machine. You should shield the measurement path from these types of heat sources. A key benefit of the Agilent 10780F, Agilent E1708A, and Agilent E1709A remote receivers is that they allow remote mounting of the receiver electronics, eliminating its 2 watts of heat from the measurement area. The remote (fiber-optic) pickup is entirely passive and dissipates no heat.

A local heat source which can affect the laser system enough to cause measurement signal loss also tends to degrade the geometric accuracy of the machine through warping or bending. Therefore, you should consider thermally isolating the heat source from the machine as well as the measurement path.

Optics installation effects

When planning the installation of the laser head and optics on a specific machine, important points to remember are:

- Install the interferometer and retroreflector to minimize deadpath errors.
- Align the laser beam path parallel to the axis of motion to minimize cosine errors.
- Select the measurement paths to minimize Abbé error.
- Use thermally stable optics.

These effects are not a concern for the optical axis used for the Agilent 10717A Wavelength Tracker. The components of the wavelength tracker are aligned at the factory to minimize any cosine or Abbé errors.

In many cases, it may not be possible to completely eliminate these sources of error, but every effort should be made to minimize them. The paragraphs below discuss methods of installing and compensating for these errors.

Minimizing deadpath errors

Deadpath error is an error introduced due to an uncompensated length of laser light between the interferometer and the retroreflector when the machine is at its “zero” position.

Deadpath is the difference in optical path lengths between the reference and measurement components of the beam when the positioning stage or machine is at its zero position, as defined by the machine’s coordinate system. Unequal beam components produce an optical path length difference that will not be properly compensated during changing environmental conditions, resulting in a measurement error. The optical path can differ due to unequal path lengths or different optics (thickness or composition) in the beam path.

Deadpath error can be minimized in most applications by a combination of the following:

- Minimize the distance “D”. Mount the interferometer as close to the retroreflector as possible when the machine is at its zero position as defined by its own coordinate system. This minimizes the unequal path length cases.
- Minimize unequal path treatments as much as possible. Minimize the number of optics, such as windows, used in the beam path.
- Use an Agilent 10715A Differential Interferometer or Agilent 10706B High Stability Plane Mirror Interferometer instead of the Agilent 10706A Plane Mirror Interferometer. Some unequal path treatment cannot be avoided with the Agilent 10706A Plane Mirror Interferometer. The other interferometers have negligible difference in their treatments. Figure 49 shows that component f_A travels through more glass than does f_B. It makes twice as many trips through the interferometer as does f_A, and also two round trips through the quarter-wave plate. This unequal treatment of f_A and f_B, causes deadpath errors under changing conditions.
- Correct the residual distance “D” in software in the controller.
- Equalize the path lengths of f_B and f_A by moving the reference cube-corner a distance “D” from the interferometer. (See Figure 68). Assuming the atmospheric conditions are equivalent and the distances between the cube-corners and the interferometer are equal, this configuration would not have deadpath errors due to unequal path lengths. Take care when using this method of reducing deadpath, because any drift in the position of the reference cube-corner will also show up as a measurement error. This drift can result from non-rigid mounting and thermal expansion, for example.

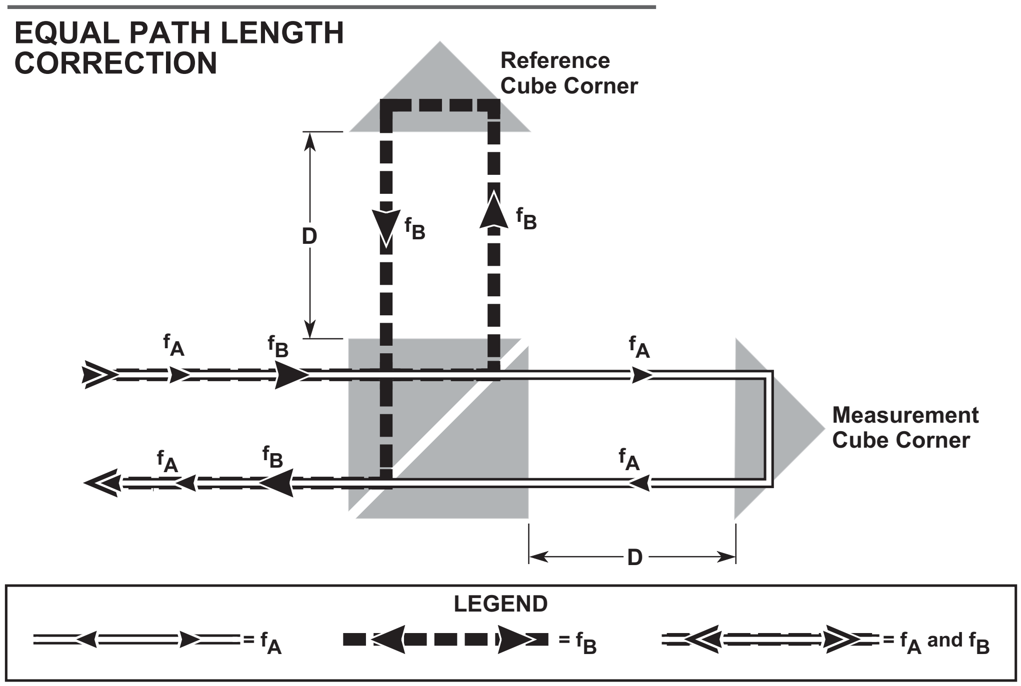

Figure 68 Equal path length correction

Compensation for deadpath errors

Correction for deadpath error (unequal path length) is necessary if there is a change in the laser wavelength due to environmental conditions. Compensation for deadpath error can be done by correcting for the deadpath distance "D" in software in the controller. In this case, the general relation:

True Position = Wavelength counts due to motion × vacuum wavelength × TCN

is expanded to be:

True Position = [(Accumulated Counts + Deadpath Counts) × Wavelength Conversion Factor × TCN] - (Deadpath in selected units)

Accumulated raw counts is the actual output from the electronics rather than the number of wavelengths.

For the Agilent 10716A interferometer, a displacement count equals $\lambda/256$, where λ is the wavelength of the laser in air, for Agilent laser electronics.

When using one of the interferometers listed below, an actual displacement count is equal to $\lambda/(4 \times$ Electronics Resolution Extension Factor), where λ is the wavelength of the laser in air, for Agilent laser electronics:

- Agilent 10706A/B Plane Mirror Interferometer
- Agilent 10715A Differential Interferometer
- Agilent 10719A One-Axis Differential Interferometer
- Agilent 10721A Two-Axis Differential Interferometer
- Agilent 10735A Three-Axis Differential Interferometer
- Agilent 10736A Three-Axis Differential Interferometer
- Agilent 10736A-001 Three-Axis Differential Interferometer with Beam Bender
- Agilent E1826E/F/G One-Axis Plane Mirror Interferometer
- Agilent E1827A Two-Axis Interferometer
- Agilent E1837A Three-Axis interferometer
- Agilent Z4399A Three-Axis interferometer
- Agilent Z4422B Three-Axis interferometer
- Agilent Z4420B Five-Axis interferometer
- Agilent Z4421B Five-Axis interferometer

For the interferometers listed below, a displacement count equals $\lambda/(2 \times$ Electronics Resolution Extension Factor).

- Agilent 10702A Linear Interferometer
- Agilent 10766A Linear Interferometer
- Agilent 10705A Single Beam Interferometer

Electronics Resolution Extension factors (ERX in equations below) are as follows:

- 32 for 10885, 10887, 10895, 10896
- 64 for 10889
- 256 for 10897 and 10898
- 512 for N1231A
- 1024 for N1231B

Deadpath counts is the deadpath length, “D”, in terms of counts. These counts have to be appropriate for the optics being used.

You must input the terms “Deadpath Counts” and “deadpath in selected units” with the correct conversion factor. These terms can be determined as follows:

For λ/8 optics:

$$\text{Deadpath Counts} = \frac{\text{ERX x } 1.26384033 \text{ x } 10^{4}}{\text{Initial TCN}}$$

For λ/4 optics:

$$\text{Deadpath Counts} = \frac{\text{ERX x } 6.31920164 \text{ x } 10^{3}}{\text{Initial TCN}}$$

For λ/2 optics:

$$\text{Deadpath Counts} = \frac{\text{ERX x } 3.15960082 \text{ x } 10^{3}}{\text{Initial TCN}}$$

where D is the deadpath distance measured in *millimeters*.

The wavelength conversion factor is also dependent on which measurement optics are used.

For λ/8 optics:

$$\text{Wavelength Conversion Factor} = \frac{7.91239193}{\text{ERX}} \text{ x } 10^{-5} \frac{\text{millimeters}}{\text{count}}$$

For λ/4 optics:

$$\text{Wavelength Conversion Factor} = \frac{1.58247839}{\text{ERX}} \text{ x } 10^{-4} \frac{\text{millimeters}}{\text{count}}$$

For λ/2 optics:

$$\text{Wavelength Conversion Factor} = \frac{3.16495677}{\text{ERX}} \text{ x } 10^{-4} \frac{\text{millimeters}}{\text{count}}$$

The deadpath distance (D) need not be measured with precision. The error in measuring “D” simply shows up as an uncompensated deadpath (ΔD). This value would be much smaller than the error due to D.

The ability to correct for deadpath error in software does not eliminate the necessity of minimizing deadpath for proper location of the interferometer wherever possible. If the deadpath (D) is large compared to the distance traveled (L), then the predominant error is a zero shift due to uncertainty in determining the change in air wavelength and this error cannot be eliminated in software.

Minimizing Abbé error

Abbé offset errors occurs when the measuring point of interest is displaced from the actual measuring scale location and there are angular errors in the positioning system. A very important advantage of laser systems is that the Abbé error evident in almost all positioning systems is very easily reduced.

Abbé offset error will make the indicated position either shorter or longer than the actual position, depending on the angular offset. The amount of measurement error resulting from Abbé offset is:

Offset distance × tangent of offset angle

Figure 54 illustrates Abbé error and demonstrates the requirement for minimizing angular error and placement of the measurement path. In Figure 54(A), the measurement axis is coincident with the leadscrew centerline and is measuring a displacement of the carriage at the leadscrew. This figure illustrates the displacement error E which is generated at the measurement probe tip due to angular motion (θ) of the carriage. Figure 54(B) shows the same carriage motion as Figure 54(A) but with the measurement axis coincident with the probe path. In this case, the measurement system measures the actual displacement and there is no offset error.

NOTE

A helpful rule of thumb for approximating the error attributable to angular motion is that for each arcsecond of angular motion, the error introduced is approximately 0.1 micron per 20 mm of offset (5 microinches per inch of offset).

When considering a specific application, make every effort to direct the measurement path as close as possible to the actual work area where the measurement process takes place. In Figure 69, a machine slide is shown with the interferometer and retroreflector placed to minimize Abbé error. The measurement axis is placed at approximately the same level as the work table and is also measuring down the center of the machine slide.

MINIMIZE ABBÉ ERROR

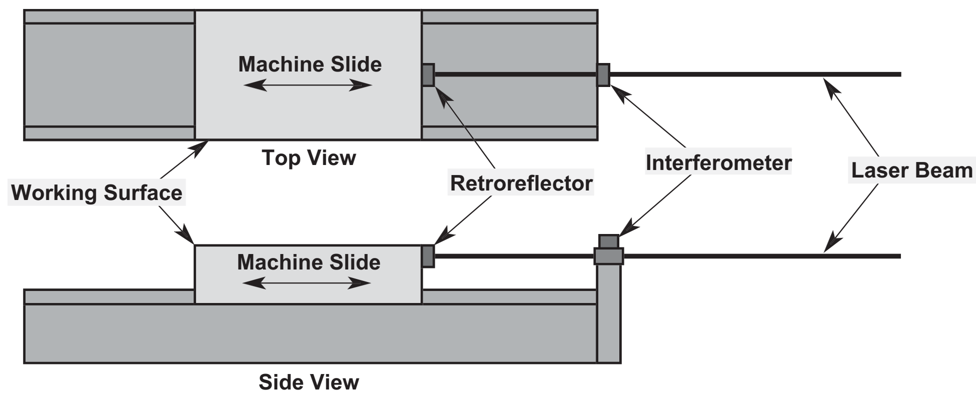

Figure 69 Positioning of measurement axis to minimize Abbé error

For X-Y stage applications, the laser system can minimize Abbé errors. Plane mirror interferometers used with plane mirrors, mounted at 90° to each other on the top edges of an X-Y stage, create a very accurate positioning system which eliminates Abbé error. Figure 70 shows a typical installation for an X-Y stage. The principal advantage of this type of positioning system is that the measurement in both X and Y axes takes place at the work surface plane. If there are angular errors in the cross slides of the stage, any displacement of the work surface due to these errors is measured by the laser.

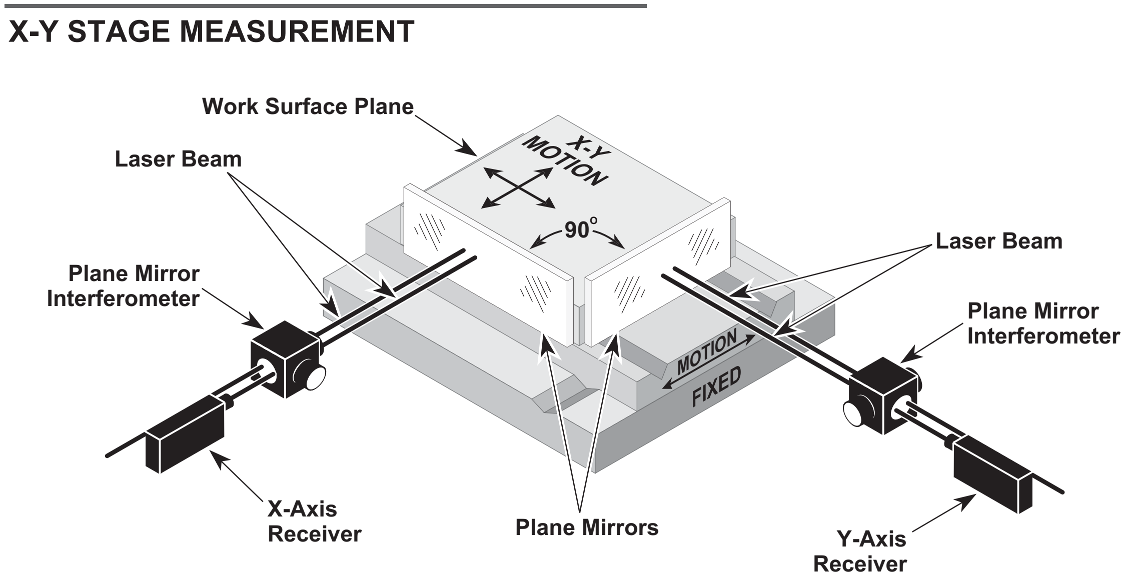

Figure 70 X-Y Stage measurement with Agilent 10706A Plane Mirror Interferometer

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13
Wavelength-of-Light Compensation

Introduction

This chapter provides the tables (tables 18 to 67) of Wavelength-of-Light (WOL) compensation values for different environmental conditions, and step-by-step instruction on how to calculate the compensation factor if your system operates in an environment other than those covered by the tables.

"Absolute" Pressure Versus "Barometric" Pressure

The ambient pressure used in determining your compensation factor must be "absolute" pressure, not the "barometric"" pressure (which is usually absolute pressure that has been "corrected to sea level").

"Barometric pressure", as defined, here, is the absolute pressure that would be measured at a given location, if that location was at sea level and the weather conditions were the same. Suppose, for example, that you were in Denver (Colorado, U.S.A.) at a time when the weather report said the barometric pressure was "762 mm" (30.00 inches) of mercury. Since Denver's altitude is about 1.5 km (5000 feet), the absolute air pressure there and then would be closer to 635 mm (25 inches) of mercury.

To measure pressure, you need an absolute pressure indicator, which is equivalent to a barometer that has not been corrected to sea level. When such a pressure indicator is not readily available, you can make a reasonable approximation to absolute pressure by reducing the barometric pressure obtained from the nearest weather station (at the local airport, for instance) by 2.5 mm (0.1 inch) of mercury of each 30 meters (100 feet) of altitude. That is —

$$P_A = P_B - \frac{\text{Altitude}}{30} \times 2.5 \qquad\qquad P_A = P_B - \frac{\text{Altitude}}{100} \times 0.1$$

For Metric Units — For English Units

where PA is the absolute pressure, and PB is the barometric pressure.

Note that the altitude of the weather station is not considered here, since the number they report has already been corrected to sea level by the station.

Calculation of Exact Wavelength-of-Light (WOL) Compensation Factor

If the Laser Position Transducer is being operated in an environment that is not included in the compensation factor tables in this manual, you can calculate the exact compensation factor to an accuracy of 0.1 ppm by using the following formulas.

CAUTION

The accuracy of your Laser Position Transducer is a function of your ability to provide it with the correct compensation factor for your measurement conditions. When determining the compensation factor by calculation rather than by using the compensation factor tables, the results you get depends on the resolution of the equipment on which you make your calculation and on your ability to operate it without error. You will be working with numbers that are very small and numbers that are very large; even the smallest error can have a significant effect on the accuracy of your answer, and any error is extremely difficult to detect or trace. We strongly suggest that you make a “practice” run, using values from any of the compensation factor tables, to get a feeling for what is required.

In the formulas below —

T = Air Temperature
P = Air Pressure
H = Relative Humidity
C = Compensation Factor, to be entered into the controller.

$$C = \frac{10^6}{N + 10^6}$$

where “N” is given in Metric and English systems by —

Metric: T in degrees Celsius, P in millimeters of mercury, H in %

$$N = 0.3836391P \times \left[\frac{1 + 10^{-6}(0.817 - 0.0133T)}{1 + 0.0036610T}\right] - 3.033 \times 10^{-3} \times H \times e^{0.05762T}$$

English: T in degrees Fahrenheit, P in inches of mercury, H in %

$$N = 9.74443P \times \left[\frac{1 + 10^{-6}P(26.7 - 0.187T)}{0.934915 + 0.00203389T}\right] - 1.089 \times 10^{-3} \times H \times e^{0.032015T}$$

EXAMPLE:

Using the “Standard” conditions, —

Humidity = 50% = “H”

Pressure (absolute) = 760 mm Hg = “P”

Temperature = 20° C = “T”

We will calculate the compensation factor, using the Metric formula for finding "N", and showing all our work.

$0.0133T = 0.266000000$	(#1)
$0.817 - (\#1) = 0.551000000$	(#2)
$P \text{ x } 10^{-6} \times (\#2) = 0.000418760$	(#3)
$1 + (\#3) = 1.000418760$	(#4) (Save)
$0.0036610T = 0.073220000$	(#5)
$1 + (\#5) = 1.073220000$	(#6)
$(\#4)(\#6) = 0.0932165591$	(#7)
$0.3836391 \times P \times (\#7) = 271.7875292$	(#8) (Save)
$e^{0.057627T} = 3.66224916$	(#9)
$H \text{ x } (\#9) = 158.3112458$	(#10)
$3.033 \text{ x } 10^{-3} \times (\#10) = 0.480158009$	(#11) (Save)
$(\#8) - (\#11) = 271.3963612$	(#12)
$(\#12) + 10^{6} = 1000271.307$	(#13)
$C = \frac{10^{6}}{(\#13)} = 0.999728766$	(#14)

For comparison, the answer we were looking for in this example just happens to be “0.9997288”.

Wavelength-of-Light (WOL) Compensation Tables

This chapter contains tables of WOL compensation values for a variety of operating conditions. The tables are divided into two groups; the Metric group (Tables 18 through 42), and the English group (Tables 43 through 67). Each group of tables (Metric or English is organized as follows:

Table 18 and Table 43 are wide-range charts, offering coarse compensation numbers for non precision measurements.

Tables 19 through 42, and Tables 44 through 67 are more detailed charts, progressing from “low” to “high” altitudes, and from “low” to “high” temperature and humidity.

To locate the appropriate table for your application, read the table heading for the percent humidity, pressure, and temperature range. The precise compensation number can be found where the temperature and pressure columns intersect.

The compensation numbers in Tables 18 through 67 represent the last four digits of a seven-digit fraction of the form “0.999abcd”. The wavelength-of-light (WOL) compensation number is entered in the form “0.999abcd”, where “abcd” is found in the tables.

Table 18 Metric—Wide-Range
(Temp = 2 to 50° C, Press = 525 to 800 mm, 50% Humidity)

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	TEMPERATURE IN DEGREES CELSIUS																
	2.0	5.0	8.0	11.0	14.0	17.0	20.0	23.0	26.0	29.0	32.0	35.0	38.0	41.0	44.0	47.0	50.0
800	6954	6987	7020	7052	7083	7114	7145	7175	7204	7233	7262	7291	7319	7347	7376	7404	7433
795	6973	7006	7038	7070	7102	7132	7162	7192	7222	7251	7279	7308	7336	7364	7392	7420	7449
790	6992	7025	7057	7089	7120	7150	7180	7210	7239	7268	7296	7325	7353	7381	7409	7437	7465
785	7011	7044	7076	7107	7138	7168	7198	7228	7257	7285	7314	7342	7370	7397	7425	7453	7481
780	7030	7063	7094	7126	7156	7186	7216	7245	7274	7303	7331	7359	7386	7414	7442	7470	7498
775	7049	7081	7113	7144	7175	7205	7234	7263	7292	7320	7348	7376	7403	7431	7458	7486	7514
770	7068	7100	7132	7163	7193	7223	7252	7281	7309	7337	7365	7393	7420	7447	7475	7502	7530
765	7087	7119	7150	7181	7211	7241	7270	7298	7327	7355	7382	7410	7437	7464	7491	7519	7546
760	7106	7138	7169	7199	7229	7259	7288	7316	7344	7372	7399	7427	7454	7481	7508	7535	7562
755	7125	7157	7188	7218	7248	7277	7306	7334	7362	7389	7417	7444	7471	7498	7524	7551	7579
750	7144	7176	7206	7236	7266	7295	7323	7352	7379	7407	7434	7461	7488	7514	7541	7568	7595
745	7163	7195	7225	7255	7284	7313	7341	7369	7397	7424	7451	7478	7504	7531	7557	7584	7611
740	7183	7213	7244	7273	7302	7331	7359	7387	7414	7441	7468	7495	7521	7548	7574	7600	7627
735	7202	7232	7262	7292	7321	7349	7377	7405	7432	7459	7485	7512	7538	7564	7590	7617	7643
730	7221	7251	7281	7310	7339	7367	7395	7422	7449	7476	7503	7529	7555	7581	7607	7633	7660
725	7240	7270	7299	7329	7357	7385	7413	7440	7467	7493	7520	7546	7572	7598	7623	7650	7676
720	7259	7289	7318	7347	7375	7403	7431	7458	7484	7511	7537	7563	7589	7614	7640	7666	7692
715	7278	7308	7337	7365	7394	7421	7449	7475	7502	7528	7554	7580	7605	7631	7657	7682	7708
710	7297	7326	7355	7384	7412	7439	7466	7493	7519	7545	7571	7597	7622	7648	7673	7699	7724
705	7316	7345	7374	7402	7430	7457	7484	7511	7537	7563	7588	7614	7639	7664	7690	7715	7741
700	7335	7364	7393	7421	7448	7475	7502	7528	7554	7580	7606	7631	7656	7681	7706	7731	7757
695	7354	7383	7411	7439	7467	7494	7520	7546	7572	7597	7623	7648	7673	7698	7723	7748	7773
690	7373	7402	7430	7458	7485	7512	7538	7564	7589	7615	7640	7665	7690	7714	7739	7764	7789
685	7392	7421	7449	7476	7503	7530	7556	7582	7607	7632	7657	7682	7706	7731	7756	7780	7806
680	7411	7440	7467	7495	7521	7548	7574	7599	7625	7649	7674	7699	7723	7748	7772	7797	7822
675	7430	7458	7486	7513	7540	7566	7592	7617	7642	7667	7691	7716	7740	7764	7789	7813	7838
670	7449	7477	7505	7531	7558	7584	7609	7635	7660	7684	7709	7733	7757	7781	7805	7830	7854
665	7468	7496	7523	7550	7576	7602	7627	7652	7677	7702	7726	7750	7774	7798	7822	7846	7870
660	7487	7515	7542	7568	7594	7620	7645	7670	7695	7719	7743	7767	7791	7814	7838	7862	7887
655	7506	7534	7561	7587	7613	7638	7663	7688	7712	7736	7760	7784	7807	7831	7855	7879	7903
650	7526	7553	7579	7605	7631	7656	7681	7705	7730	7754	7777	7801	7824	7848	7871	7895	7919
645	7545	7571	7598	7624	7649	7674	7699	7723	7747	7771	7794	7818	7841	7864	7888	7911	7935
640	7564	7590	7616	7642	7667	7692	7717	7741	7765	7788	7812	7835	7858	7881	7904	7928	7951
635	7583	7609	7635	7661	7686	7710	7735	7759	7782	7806	7829	7852	7875	7898	7921	7944	7968
630	7602	7628	7654	7679	7704	7728	7752	7776	7800	7823	7846	7869	7892	7914	7937	7960	7984
625	7621	7647	7672	7697	7722	7746	7770	7794	7817	7840	7863	7886	7908	7931	7954	7977	8000
620	7640	7666	7691	7716	7740	7764	7788	7812	7835	7858	7880	7903	7925	7948	7970	7993	8016
615	7659	7685	7710	7734	7759	7783	7806	7829	7852	7875	7897	7920	7942	7964	7987	8010	8032
610	7678	7703	7728	7753	7777	7801	7824	7847	7870	7892	7915	7937	7959	7981	8003	8026	8049
605	7697	7722	7747	7771	7795	7819	7842	7865	7887	7910	7932	7954	7976	7998	8020	8042	8065
600	7716	7741	7766	7790	7813	7837	7860	7882	7905	7927	7949	7971	7993	8015	8036	8059	8081
595	7735	7760	7784	7808	7832	7855	7878	7900	7922	7944	7966	7988	8010	8031	8053	8075	8097
590	7754	7779	7803	7827	7850	7873	7895	7918	7940	7962	7983	8005	8026	8048	8070	8091	8114
585	7773	7798	7822	7845	7868	7891	7913	7935	7957	7979	8000	8022	8043	8065	8086	8108	8130
580	7792	7816	7840	7864	7886	7909	7931	7953	7975	7996	8018	8039	8060	8081	8103	8124	8146
575	7811	7835	7859	7882	7905	7927	7949	7971	7992	8014	8035	8056	8077	8098	8119	8140	8162
570	7830	7854	7877	7900	7923	7945	7967	7989	8010	8031	8052	8073	8094	8115	8136	8157	8178
565	7849	7873	7896	7919	7941	7963	7985	8006	8027	8048	8069	8090	8111	8131	8152	8173	8195
560	7868	7892	7915	7937	7959	7981	8003	8024	8045	8066	8086	8107	8127	8148	8169	8190	8211
555	7887	7911	7933	7956	7978	7999	8021	8042	8062	8083	8104	8124	8144	8165	8185	8206	8227
550	7907	7930	7952	7974	7996	8017	8038	8059	8080	8100	8121	8141	8161	8181	8202	8222	8243
545	7926	7948	7971	7993	8014	8035	8056	8077	8097	8118	8138	8158	8178	8198	8218	8239	8259
540	7945	7967	7989	8011	8032	8053	8074	8095	8115	8135	8155	8175	8195	8215	8235	8255	8276
535	7964	7986	8008	8030	8051	8072	8092	8112	8133	8152	8172	8192	8212	8231	8251	8271	8292
530	7983	8005	8027	8048	8069	8090	8110	8130	8150	8170	8189	8209	8228	8248	8268	8288	8308
525	8002	8024	8045	8066	8087	8108	8128	8148	8168	8187	8207	8226	8245	8265	8284	8304	8324

Table 19 Metric—Low Alt, Low Temp, Low Humidity
(Temp = 5 to 13° C, Press = 720 to 800 mm, 20% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
800	6986	6991	6997	7002	7008	7013	7018	7024	7029	7034	7040	7045	7050	7055	7061	7066	7071
799	6990	6995	7001	7006	7011	7017	7022	7027	7033	7038	7043	7049	7054	7059	7064	7069	7075
798	6994	6999	7004	7010	7015	7020	7026	7031	7036	7042	7047	7052	7058	7063	7068	7073	7078
797	6997	7003	7008	7013	7019	7024	7030	7035	7040	7045	7051	7056	7061	7066	7072	7077	7082
796	7001	7006	7012	7017	7023	7028	7033	7039	7044	7049	7054	7060	7065	7070	7075	7080	7086
795	7005	7010	7016	7021	7026	7032	7037	7042	7048	7053	7058	7063	7069	7074	7079	7084	7089
794	7009	7014	7019	7025	7030	7035	7041	7046	7051	7057	7062	7067	7072	7077	7083	7088	7093
793	7012	7018	7023	7028	7034	7039	7044	7050	7055	7060	7066	7071	7076	7081	7086	7091	7097
792	7016	7022	7027	7032	7038	7043	7048	7053	7059	7064	7069	7074	7080	7085	7090	7095	7100
791	7020	7025	7031	7036	7041	7047	7052	7057	7062	7068	7073	7078	7083	7089	7094	7099	7104
790	7024	7029	7034	7040	7045	7050	7056	7061	7066	7071	7077	7082	7087	7092	7097	7102	7108
789	7027	7033	7038	7043	7049	7054	7059	7065	7070	7075	7080	7086	7091	7096	7101	7106	7111
788	7031	7037	7042	7047	7053	7058	7063	7068	7074	7079	7084	7089	7094	7100	7105	7110	7115
787	7035	7040	7046	7051	7056	7062	7067	7072	7077	7083	7088	7093	7098	7103	7108	7113	7119
786	7039	7044	7049	7055	7060	7065	7071	7076	7081	7086	7091	7097	7102	7107	7112	7117	7122
785	7043	7048	7053	7058	7064	7069	7074	7080	7085	7090	7095	7100	7105	7111	7116	7121	7126
784	7046	7052	7057	7062	7068	7073	7078	7083	7088	7094	7099	7104	7109	7114	7119	7124	7130
783	7050	7055	7061	7066	7071	7077	7082	7087	7092	7097	7103	7108	7113	7118	7123	7128	7133
782	7054	7059	7064	7070	7075	7080	7085	7091	7096	7101	7106	7111	7117	7122	7127	7132	7137
781	7058	7063	7068	7073	7079	7084	7089	7094	7100	7105	7110	7115	7120	7125	7130	7135	7141
780	7061	7067	7072	7077	7082	7088	7093	7098	7103	7109	7114	7119	7124	7129	7134	7139	7144
779	7065	7070	7076	7081	7086	7091	7097	7102	7107	7112	7117	7122	7128	7133	7138	7143	7148
778	7069	7074	7079	7085	7090	7095	7100	7106	7111	7116	7121	7126	7131	7136	7141	7147	7152
777	7073	7078	7083	7088	7094	7099	7104	7109	7114	7120	7125	7130	7135	7140	7145	7150	7155
776	7076	7082	7087	7092	7097	7103	7108	7113	7118	7123	7128	7134	7139	7144	7149	7154	7159
775	7080	7085	7091	7096	7101	7106	7112	7117	7122	7127	7132	7137	7142	7147	7152	7158	7163
774	7084	7089	7094	7100	7105	7110	7115	7120	7126	7131	7136	7141	7146	7151	7156	7161	7166
773	7088	7093	7098	7103	7109	7114	7119	7124	7129	7134	7140	7145	7150	7155	7160	7165	7170
772	7092	7097	7102	7107	7112	7118	7123	7128	7133	7138	7143	7148	7153	7158	7164	7169	7174
771	7095	7101	7106	7111	7116	7121	7127	7132	7137	7142	7147	7152	7157	7162	7167	7172	7177
770	7099	7104	7110	7115	7120	7125	7130	7135	7141	7146	7151	7156	7161	7166	7171	7176	7181
769	7103	7108	7113	7118	7124	7129	7134	7139	7144	7149	7154	7159	7165	7170	7175	7180	7185
768	7107	7112	7117	7122	7127	7133	7138	7143	7148	7153	7158	7163	7168	7173	7178	7183	7188
767	7110	7116	7121	7126	7131	7136	7141	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192
766	7114	7119	7125	7130	7135	7140	7145	7150	7155	7160	7166	7171	7176	7181	7186	7191	7196
765	7118	7123	7128	7133	7139	7144	7149	7154	7159	7164	7169	7174	7179	7184	7189	7194	7199
764	7122	7127	7132	7137	7142	7148	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198	7203
763	7125	7131	7136	7141	7146	7151	7156	7161	7167	7172	7177	7182	7187	7192	7197	7202	7207
762	7129	7134	7140	7145	7150	7155	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7210
761	7133	7138	7143	7148	7154	7159	7164	7169	7174	7179	7184	7189	7194	7199	7204	7209	7214
760	7137	7142	7147	7152	7157	7162	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213	7217
759	7141	7146	7151	7156	7161	7166	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221
758	7144	7149	7155	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225
757	7148	7153	7158	7163	7169	7174	7179	7184	7189	7194	7199	7204	7209	7214	7219	7224	7228
756	7152	7157	7162	7167	7172	7177	7182	7187	7193	7198	7203	7208	7212	7217	7222	7227	7232
755	7156	7161	7166	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236
754	7159	7165	7170	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7239
753	7163	7168	7173	7178	7184	7189	7194	7199	7204	7209	7214	7219	7224	7228	7233	7238	7243
752	7167	7172	7177	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247
751	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7250
750	7174	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7244	7249	7254
749	7178	7183	7188	7193	7199	7204	7209	7214	7219	7224	7228	7233	7238	7243	7248	7253	7258
748	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7261
747	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7255	7260	7265
746	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7244	7249	7254	7259	7264	7269
745	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248	7253	7258	7263	7268	7272
744	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262	7266	7271	7276
743	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7260	7265	7270	7275	7280
742	7205	7210	7215	7220	7225	7230	7235	7240	7245	7249	7254	7259	7264	7269	7274	7279	7283
741	7208	7213	7218	7223	7228	7233	7238	7243	7248	7253	7258	7263	7268	7273	7277	7282	7287
740	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7276	7281	7286	7291
739	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7265	7270	7275	7280	7285	7290	7294
738	7220	7225	7230	7235	7240	7245	7250	7255	7259	7264	7269	7274	7279	7284	7289	7293	7298
737	7223	7228	7233	7238	7243	7248	7253	7258	7263	7268	7273	7278	7283	7287	7292	7297	7302
736	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277	7281	7286	7291	7296	7301	7305
735	7231	7236	7241	7246	7251	7256	7261	7266	7271	7275	7280	7285	7290	7295	7300	7304	7309
734	7235	7240	7245	7250	7255	7260	7264	7269	7274	7279	7284	7289	7294	7298	7303	7308	7313
733	7239	7244	7248	7253	7258	7263	7268	7273	7278	7283	7288	7293	7297	7302	7307	7312	7316
732	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7291	7296	7301	7306	7311	7315	7320
731	7246	7251	7256	7261	7266	7271	7276	7281	7285	7290	7295	7300	7305	7309	7314	7319	7324
730	7250	7255	7260	7265	7270	7275	7279	7284	7289	7294	7299	7304	7308	7313	7318	7323	7327
729	7254	7259	7264	7268	7273	7278	7283	7288	7293	7298	7303	7307	7312	7317	7322	7326	7331
728	7257	7262	7267	7272	7277	7282	7287	7292	7297	7301	7306	7311	7316	7321	7325	7330	7335
727	7261	7266	7271	7276	7281	7286	7291	7295	7300	7305	7310	7315	7319	7324	7329	7334	7338
726	7265	7270	7275	7280	7285	7289	7294	7299	7304	7309	7314	7318	7323	7328	7333	7337	7342
725	7269	7274	7279	7283	7288	7293	7298	7303	7308	7313	7317	7322	7327	7332	7336	7341	7346
724	7272	7277	7282	7287	7292	7297	7302	7307	7311	7316	7321	7326	7331	7335	7340	7345	7349
723	7276	7281	7286	7291	7296	7301	7306	7310	7315	7320	7325	7329	7334	7339	7344	7348	7353
722	7280	7285	7290	7295	7300	7304	7309	7314	7319	7324	7328	7333	7338	7343	7347	7352	7357
721	7284	7289	7294	7298	7303	7308	7313	7318	7323	7327	7332	7337	7342	7346	7351	7356	7360
720	7288	7292	7297	7302	7307	7312	7317	7322	7326	7331	7336	7341	7345	7350	7355	7359	7364

Table 20 Metric—Low Alt, Low-Mid Temp, Low Humidity
(Temp = 13.5 to 21.5° C, Press = 720 to 800 mm, 20% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5
800	7076	7081	7086	7091	7097	7102	7107	7112	7117	7122	7127	7132	7137	7142	7147	7152	7157
799	7080	7085	7090	7095	7100	7105	7110	7115	7120	7125	7130	7135	7140	7145	7150	7155	7160
798	7083	7089	7094	7099	7104	7109	7114	7119	7124	7129	7134	7139	7144	7149	7154	7159	7164
797	7087	7092	7097	7102	7107	7113	7118	7123	7128	7133	7138	7143	7148	7152	7157	7162	7167
796	7091	7096	7101	7106	7111	7116	7121	7126	7131	7136	7141	7146	7151	7156	7161	7166	7171
795	7094	7100	7105	7110	7115	7120	7125	7130	7135	7140	7145	7150	7155	7160	7165	7169	7174
794	7098	7103	7108	7113	7118	7123	7128	7133	7138	7143	7148	7153	7158	7163	7168	7173	7178
793	7102	7107	7112	7117	7122	7127	7132	7137	7142	7147	7152	7157	7162	7167	7172	7177	7181
792	7105	7110	7116	7121	7126	7131	7136	7141	7146	7151	7156	7161	7165	7170	7175	7180	7185
791	7109	7114	7119	7124	7129	7134	7139	7144	7149	7154	7159	7164	7169	7174	7179	7184	7189
790	7113	7118	7123	7128	7133	7138	7143	7148	7153	7158	7163	7168	7173	7177	7182	7187	7192
789	7116	7121	7126	7132	7137	7142	7147	7152	7156	7161	7166	7171	7176	7181	7186	7191	7196
788	7120	7125	7130	7135	7140	7145	7150	7155	7160	7165	7170	7175	7180	7185	7190	7194	7199
787	7124	7129	7134	7139	7144	7149	7154	7159	7164	7169	7174	7178	7183	7188	7193	7198	7203
786	7127	7132	7137	7142	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192	7197	7201	7206
785	7131	7136	7141	7146	7151	7156	7161	7166	7171	7176	7181	7186	7191	7195	7200	7205	7210
784	7135	7140	7145	7150	7155	7160	7165	7170	7175	7179	7184	7189	7194	7199	7204	7209	7213
783	7138	7143	7148	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198	7203	7207	7212	7217
782	7142	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192	7196	7201	7206	7211	7216	7221
781	7146	7151	7156	7161	7166	7171	7175	7180	7185	7190	7195	7200	7205	7210	7215	7219	7224
780	7149	7154	7159	7164	7169	7174	7179	7184	7189	7194	7199	7204	7208	7213	7218	7223	7228
779	7153	7158	7163	7168	7173	7178	7183	7188	7193	7197	7202	7207	7212	7217	7222	7226	7231
778	7157	7162	7167	7172	7176	7181	7186	7191	7196	7201	7206	7211	7216	7220	7225	7230	7235
777	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7209	7214	7219	7224	7229	7234	7238
776	7164	7169	7174	7179	7184	7189	7194	7198	7203	7208	7213	7218	7223	7228	7232	7237	7242
775	7168	7173	7177	7182	7187	7192	7197	7202	7207	7212	7217	7222	7226	7231	7236	7241	7245
774	7171	7176	7181	7186	7191	7196	7201	7206	7211	7215	7220	7225	7230	7235	7239	7244	7249
773	7175	7180	7185	7190	7195	7200	7204	7209	7214	7219	7224	7229	7233	7238	7243	7248	7253
772	7179	7183	7188	7193	7198	7203	7208	7213	7218	7223	7227	7232	7237	7242	7247	7251	7256
771	7182	7187	7192	7197	7202	7207	7212	7217	7221	7226	7231	7236	7241	7245	7250	7255	7260
770	7186	7191	7196	7201	7206	7210	7215	7220	7225	7230	7235	7239	7244	7249	7254	7259	7263
769	7189	7194	7199	7204	7209	7214	7219	7224	7229	7233	7238	7243	7248	7253	7257	7262	7267
768	7193	7198	7203	7208	7213	7218	7223	7227	7232	7237	7242	7247	7251	7256	7261	7266	7270
767	7197	7202	7207	7212	7216	7221	7226	7231	7236	7241	7245	7250	7255	7260	7264	7269	7274
766	7200	7205	7210	7215	7220	7225	7230	7235	7239	7244	7249	7254	7259	7263	7268	7273	7277
765	7204	7209	7214	7219	7224	7229	7233	7238	7243	7248	7253	7257	7262	7267	7272	7276	7281
764	7208	7213	7218	7222	7227	7232	7237	7242	7247	7251	7256	7261	7266	7270	7275	7280	7285
763	7211	7216	7221	7226	7231	7236	7241	7245	7250	7255	7260	7265	7269	7274	7279	7283	7288
762	7215	7220	7225	7230	7235	7239	7244	7249	7254	7259	7263	7268	7273	7278	7282	7287	7292
761	7219	7224	7229	7233	7238	7243	7248	7253	7257	7262	7267	7272	7276	7281	7286	7291	7295
760	7222	7227	7232	7237	7242	7247	7252	7256	7261	7266	7271	7275	7280	7285	7289	7294	7299
759	7226	7231	7236	7241	7245	7250	7255	7260	7265	7269	7274	7279	7284	7288	7293	7298	7302
758	7230	7235	7239	7244	7249	7254	7259	7264	7268	7273	7278	7283	7287	7292	7297	7301	7306
757	7233	7238	7243	7248	7253	7258	7262	7267	7272	7277	7281	7286	7291	7295	7300	7305	7309
756	7237	7242	7247	7252	7256	7261	7266	7271	7276	7280	7285	7290	7294	7299	7304	7308	7313
755	7241	7246	7250	7255	7260	7265	7270	7274	7279	7284	7289	7293	7298	7303	7307	7312	7317
754	7244	7249	7254	7259	7264	7268	7273	7278	7283	7287	7292	7297	7302	7306	7311	7316	7320
753	7248	7253	7258	7262	7267	7272	7277	7282	7286	7291	7296	7300	7305	7310	7314	7319	7324
752	7252	7256	7261	7266	7271	7276	7280	7285	7290	7295	7299	7304	7309	7313	7318	7323	7327
751	7255	7260	7265	7270	7275	7279	7284	7289	7294	7298	7303	7308	7312	7317	7322	7326	7331
750	7259	7264	7269	7273	7278	7283	7288	7292	7297	7302	7307	7311	7316	7321	7325	7330	7334
749	7263	7267	7272	7277	7282	7287	7291	7296	7301	7305	7310	7315	7319	7324	7329	7333	7338
748	7266	7271	7276	7281	7285	7290	7295	7300	7304	7309	7314	7318	7323	7328	7332	7337	7341
747	7270	7275	7280	7284	7289	7294	7299	7303	7308	7313	7317	7322	7327	7331	7336	7340	7345
746	7274	7278	7283	7288	7293	7297	7302	7307	7312	7316	7321	7326	7330	7335	7339	7344	7349
745	7277	7282	7287	7292	7296	7301	7306	7310	7315	7320	7325	7329	7334	7338	7343	7348	7352
744	7281	7286	7290	7295	7300	7305	7309	7314	7319	7323	7328	7333	7337	7342	7347	7351	7356
743	7285	7289	7294	7299	7304	7308	7313	7318	7322	7327	7332	7336	7341	7346	7350	7355	7359
742	7288	7293	7298	7303	7307	7312	7317	7321	7326	7331	7335	7340	7345	7349	7354	7358	7363
741	7292	7297	7301	7306	7311	7316	7320	7325	7330	7334	7339	7344	7348	7353	7357	7362	7366
740	7296	7300	7305	7310	7314	7319	7324	7329	7333	7338	7342	7347	7352	7356	7361	7365	7370
739	7299	7304	7309	7313	7318	7323	7328	7332	7337	7341	7346	7351	7355	7360	7364	7369	7374
738	7303	7308	7312	7317	7322	7326	7331	7336	7340	7345	7350	7354	7359	7363	7368	7373	7377
737	7307	7311	7316	7321	7325	7330	7335	7339	7344	7349	7353	7358	7362	7367	7372	7376	7381
736	7310	7315	7320	7324	7329	7334	7338	7343	7348	7352	7357	7361	7366	7371	7375	7380	7384
735	7314	7319	7323	7328	7333	7337	7342	7347	7351	7356	7360	7365	7370	7374	7379	7383	7388
734	7317	7322	7327	7332	7336	7341	7346	7350	7355	7359	7364	7369	7373	7378	7382	7387	7391
733	7321	7326	7331	7335	7340	7345	7349	7354	7358	7363	7368	7372	7377	7381	7386	7390	7395
732	7325	7330	7334	7339	7344	7348	7353	7357	7362	7367	7371	7376	7380	7385	7389	7394	7398
731	7328	7333	7338	7343	7347	7352	7356	7361	7366	7370	7375	7379	7384	7388	7393	7397	7402
730	7332	7337	7341	7346	7351	7355	7360	7365	7369	7374	7378	7383	7388	7392	7397	7401	7406
729	7336	7340	7345	7350	7354	7359	7364	7368	7373	7377	7382	7387	7391	7396	7400	7405	7409
728	7339	7344	7349	7353	7358	7363	7367	7372	7376	7381	7386	7390	7395	7399	7404	7408	7413
727	7343	7348	7352	7357	7362	7366	7371	7376	7380	7385	7389	7394	7398	7403	7407	7412	7416
726	7347	7351	7356	7361	7365	7370	7375	7379	7384	7388	7393	7397	7402	7406	7411	7415	7420
725	7350	7355	7360	7364	7369	7374	7378	7383	7387	7392	7396	7401	7405	7410	7414	7419	7423
724	7354	7359	7363	7368	7373	7377	7382	7386	7391	7395	7400	7405	7409	7413	7418	7422	7427
723	7358	7362	7367	7372	7376	7381	7385	7390	7395	7399	7404	7408	7413	7417	7422	7426	7430
722	7361	7366	7371	7375	7380	7384	7389	7394	7398	7403	7407	7412	7416	7421	7425	7430	7434
721	7365	7370	7374	7379	7383	7388	7393	7397	7402	7406	7411	7415	7420	7424	7429	7433	7438
720	7369	7373	7378	7383	7387	7392	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7441

Table 21 Metric—Low Alt, Mid Temp, Low Humidity
(Temp = 22 to 30° C, Press = 720 to 800 mm, 20% Humidity)

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	TEMPERATURE IN DEGREES CELSIUS																
	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
800	7161	7166	7171	7176	7181	7186	7190	7195	7200	7205	7210	7214	7219	7224	7228	7233	7238
799	7165	7170	7175	7180	7184	7189	7194	7199	7204	7208	7213	7218	7223	7227	7232	7237	7241
798	7169	7173	7178	7183	7188	7193	7198	7202	7207	7212	7217	7221	7226	7231	7235	7240	7245
797	7172	7177	7182	7187	7191	7196	7201	7206	7211	7215	7220	7225	7229	7234	7239	7244	7248
796	7176	7180	7185	7190	7195	7200	7205	7209	7214	7219	7224	7228	7233	7238	7242	7247	7252
795	7179	7184	7189	7194	7198	7203	7208	7213	7218	7222	7227	7232	7236	7241	7246	7250	7255
794	7183	7188	7192	7197	7202	7207	7212	7216	7221	7226	7231	7235	7240	7245	7249	7254	7259
793	7186	7191	7196	7201	7206	7210	7215	7220	7225	7229	7234	7239	7243	7248	7253	7257	7262
792	7190	7195	7199	7204	7209	7214	7219	7223	7228	7233	7238	7242	7247	7252	7256	7261	7265
791	7193	7198	7203	7208	7213	7217	7222	7227	7232	7236	7241	7246	7250	7255	7260	7264	7269
790	7197	7202	7207	7211	7216	7221	7226	7230	7235	7240	7244	7249	7254	7259	7263	7268	7272
789	7200	7205	7210	7215	7220	7224	7229	7234	7239	7243	7248	7253	7257	7262	7267	7271	7276
788	7204	7209	7214	7218	7223	7228	7233	7237	7242	7247	7251	7256	7261	7265	7270	7275	7279
787	7208	7212	7217	7222	7227	7231	7236	7241	7246	7250	7255	7260	7264	7269	7274	7278	7283
786	7211	7216	7221	7225	7230	7235	7240	7244	7249	7254	7258	7263	7268	7272	7277	7282	7286
785	7215	7219	7224	7229	7234	7238	7243	7248	7253	7257	7262	7267	7271	7276	7280	7285	7290
784	7218	7223	7228	7233	7237	7242	7247	7251	7256	7261	7265	7270	7275	7279	7284	7289	7293
783	7222	7227	7231	7236	7241	7246	7250	7255	7260	7264	7269	7274	7278	7283	7287	7292	7297
782	7225	7230	7235	7240	7244	7249	7254	7258	7263	7268	7272	7277	7282	7286	7291	7295	7300
781	7229	7234	7238	7243	7248	7253	7257	7262	7267	7271	7276	7281	7285	7290	7294	7299	7304
780	7232	7237	7242	7247	7251	7256	7261	7265	7270	7275	7279	7284	7289	7293	7298	7302	7307
779	7236	7241	7245	7250	7255	7260	7264	7269	7274	7278	7283	7288	7292	7297	7301	7306	7310
778	7240	7244	7249	7254	7258	7263	7268	7272	7277	7282	7286	7291	7296	7300	7305	7309	7314
777	7243	7248	7253	7257	7262	7267	7271	7276	7281	7285	7290	7294	7299	7304	7308	7313	7317
776	7247	7251	7256	7261	7265	7270	7275	7279	7284	7289	7293	7298	7303	7307	7312	7316	7321
775	7250	7255	7260	7264	7269	7274	7278	7283	7288	7292	7297	7301	7306	7311	7315	7320	7324
774	7254	7258	7263	7268	7273	7277	7282	7287	7291	7296	7300	7305	7310	7314	7319	7323	7328
773	7257	7262	7267	7271	7276	7281	7285	7290	7295	7299	7304	7308	7313	7318	7322	7327	7331
772	7261	7266	7270	7275	7280	7284	7289	7294	7298	7303	7307	7312	7316	7321	7326	7330	7335
771	7264	7269	7274	7278	7283	7288	7292	7297	7302	7306	7311	7315	7320	7325	7329	7334	7338
770	7268	7273	7277	7282	7287	7291	7296	7301	7305	7310	7314	7319	7323	7328	7333	7337	7342
769	7271	7276	7281	7286	7290	7295	7299	7304	7309	7313	7318	7322	7327	7331	7336	7341	7345
768	7275	7280	7284	7289	7294	7298	7303	7308	7312	7317	7321	7326	7330	7335	7339	7344	7348
767	7279	7283	7288	7293	7297	7302	7306	7311	7316	7320	7325	7329	7334	7338	7343	7347	7352
766	7282	7287	7291	7296	7301	7305	7310	7315	7319	7324	7328	7333	7337	7342	7346	7351	7355
765	7286	7290	7295	7300	7304	7309	7314	7318	7323	7327	7332	7336	7341	7345	7350	7354	7359
764	7289	7294	7299	7303	7308	7312	7317	7322	7326	7331	7335	7340	7344	7349	7353	7358	7362
763	7293	7297	7302	7307	7311	7316	7321	7325	7330	7334	7339	7343	7348	7352	7357	7361	7366
762	7296	7301	7306	7310	7315	7319	7324	7329	7333	7338	7342	7347	7351	7356	7360	7365	7369
761	7300	7305	7309	7314	7318	7323	7328	7332	7337	7341	7346	7350	7355	7359	7364	7368	7373
760	7303	7308	7313	7317	7322	7327	7331	7336	7340	7345	7349	7354	7358	7363	7367	7372	7376
759	7307	7312	7316	7321	7325	7330	7335	7339	7344	7348	7353	7357	7362	7366	7371	7375	7380
758	7311	7315	7320	7324	7329	7334	7338	7343	7347	7352	7356	7361	7365	7370	7374	7379	7383
757	7314	7319	7323	7328	7333	7337	7342	7346	7351	7355	7360	7364	7369	7373	7378	7382	7386
756	7318	7322	7327	7331	7336	7341	7345	7350	7354	7359	7363	7368	7372	7377	7381	7386	7390
755	7321	7326	7330	7335	7340	7344	7349	7353	7358	7362	7367	7371	7376	7380	7385	7389	7393
754	7325	7329	7334	7339	7343	7348	7352	7357	7361	7366	7370	7375	7379	7384	7388	7392	7397
753	7328	7333	7338	7342	7347	7351	7356	7360	7365	7369	7374	7378	7383	7387	7391	7396	7400
752	7332	7336	7341	7346	7350	7355	7359	7364	7368	7373	7377	7382	7386	7391	7395	7399	7404
751	7335	7340	7345	7349	7354	7358	7363	7367	7372	7376	7381	7385	7390	7394	7398	7403	7407
750	7339	7344	7348	7353	7357	7362	7366	7371	7375	7380	7384	7389	7393	7397	7402	7406	7411
749	7343	7347	7352	7356	7361	7365	7370	7374	7379	7383	7388	7392	7397	7401	7405	7410	7414
748	7346	7351	7355	7360	7364	7369	7373	7378	7382	7387	7391	7396	7400	7404	7409	7413	7418
747	7350	7354	7359	7363	7368	7372	7377	7381	7386	7390	7395	7399	7403	7408	7412	7417	7421
746	7353	7358	7362	7367	7371	7376	7380	7385	7389	7394	7398	7403	7407	7411	7416	7420	7425
745	7357	7361	7366	7370	7375	7379	7384	7388	7393	7397	7402	7406	7410	7415	7419	7424	7428
744	7360	7365	7369	7374	7378	7383	7387	7392	7396	7401	7405	7410	7414	7418	7423	7427	7431
743	7364	7368	7373	7377	7382	7386	7391	7395	7400	7404	7409	7413	7417	7422	7426	7431	7435
742	7367	7372	7376	7381	7385	7390	7394	7399	7403	7408	7412	7417	7421	7425	7430	7434	7438
741	7371	7375	7380	7384	7389	7393	7398	7402	7407	7411	7416	7420	7424	7429	7433	7437	7442
740	7374	7379	7384	7388	7392	7397	7401	7406	7410	7415	7419	7423	7428	7432	7437	7441	7445
739	7378	7383	7387	7392	7396	7400	7405	7409	7414	7418	7423	7427	7431	7436	7440	7444	7449
738	7382	7386	7391	7395	7400	7404	7408	7413	7417	7422	7426	7430	7435	7439	7444	7448	7452
737	7385	7390	7394	7399	7403	7408	7412	7416	7421	7425	7430	7434	7438	7443	7447	7451	7456
736	7389	7393	7398	7402	7407	7411	7415	7420	7424	7429	7433	7437	7442	7446	7450	7455	7459
735	7392	7397	7401	7406	7410	7415	7419	7423	7428	7432	7437	7441	7445	7450	7454	7458	7463
734	7396	7400	7405	7409	7414	7418	7422	7427	7431	7436	7440	7444	7449	7453	7457	7462	7466
733	7399	7404	7408	7413	7417	7422	7426	7430	7435	7439	7444	7448	7452	7457	7461	7465	7469
732	7403	7407	7412	7416	7421	7425	7430	7434	7438	7443	7447	7451	7456	7460	7464	7469	7473
731	7406	7411	7415	7420	7424	7429	7433	7437	7442	7446	7451	7455	7459	7463	7468	7472	7476
730	7410	7414	7419	7423	7428	7432	7437	7441	7445	7450	7454	7458	7463	7467	7471	7476	7480
729	7414	7418	7422	7427	7431	7436	7440	7444	7449	7453	7457	7462	7466	7470	7475	7479	7483
728	7417	7422	7426	7430	7435	7439	7444	7448	7452	7457	7461	7465	7470	7474	7478	7482	7487
727	7421	7425	7430	7434	7438	7443	7447	7451	7456	7460	7464	7469	7473	7477	7482	7486	7490
726	7424	7429	7433	7437	7442	7446	7451	7455	7459	7464	7468	7472	7477	7481	7485	7489	7494
725	7428	7432	7437	7441	7445	7450	7454	7458	7463	7467	7471	7476	7480	7484	7489	7493	7497
724	7431	7436	7440	7445	7449	7453	7458	7462	7466	7471	7475	7479	7484	7488	7492	7496	7501
723	7435	7439	7444	7448	7452	7457	7461	7465	7470	7474	7478	7483	7487	7491	7496	7500	7504
722	7438	7443	7447	7452	7456	7460	7465	7469	7473	7478	7482	7486	7490	7495	7499	7503	7507
721	7442	7446	7451	7455	7459	7464	7468	7473	7477	7481	7485	7490	7494	7498	7502	7507	7511
720	7446	7450	7454	7459	7463	7467	7472	7476	7480	7485	7489	7493	7497	7502	7506	7510	7514

Table 22 Metric—Low Alt, High-Mid Temp, Low Humidity
(Temp = 30.5 to 38.5° C, Press = 720 to 800 mm, 20% Humidity)

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	TEMPERATURE IN DEGREES CELSIUS																
	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5
800	7242	7247	7252	7256	7261	7266	7270	7275	7279	7284	7289	7293	7298	7302	7307	7311	7316
799	7246	7251	7255	7260	7264	7269	7274	7278	7283	7287	7292	7296	7301	7305	7310	7314	7319
798	7249	7254	7259	7263	7268	7272	7277	7282	7286	7291	7295	7300	7304	7309	7313	7318	7322
797	7253	7257	7262	7267	7271	7276	7280	7285	7290	7294	7299	7303	7308	7312	7317	7321	7326
796	7256	7261	7266	7270	7275	7279	7284	7288	7293	7298	7302	7307	7311	7316	7320	7325	7329
795	7260	7264	7269	7274	7278	7283	7287	7292	7296	7301	7305	7310	7314	7319	7323	7328	7332
794	7263	7268	7272	7277	7282	7286	7291	7295	7300	7304	7309	7313	7318	7322	7327	7331	7336
793	7267	7271	7276	7280	7285	7290	7294	7299	7303	7308	7312	7317	7321	7326	7330	7335	7339
792	7270	7275	7279	7284	7288	7293	7298	7302	7307	7311	7316	7320	7325	7329	7334	7338	7342
791	7274	7278	7283	7287	7292	7296	7301	7306	7310	7315	7319	7324	7328	7333	7337	7341	7346
790	7277	7282	7286	7291	7295	7300	7304	7309	7313	7318	7322	7327	7331	7336	7340	7345	7349
789	7280	7285	7290	7294	7299	7303	7308	7312	7317	7321	7326	7330	7335	7339	7344	7348	7353
788	7284	7288	7293	7298	7302	7307	7311	7316	7320	7325	7329	7334	7338	7343	7347	7352	7356
787	7287	7292	7297	7301	7306	7310	7315	7319	7324	7328	7333	7337	7342	7346	7350	7355	7359
786	7291	7295	7300	7304	7309	7314	7318	7323	7327	7332	7336	7341	7345	7349	7354	7358	7363
785	7294	7299	7303	7308	7312	7317	7321	7326	7330	7335	7339	7344	7348	7353	7357	7362	7366
784	7298	7302	7307	7311	7316	7320	7325	7329	7334	7338	7343	7347	7352	7356	7361	7365	7369
783	7301	7306	7310	7315	7319	7324	7328	7333	7337	7342	7346	7351	7355	7360	7364	7368	7373
782	7305	7309	7314	7318	7323	7327	7332	7336	7341	7345	7350	7354	7358	7363	7367	7372	7376
781	7308	7313	7317	7322	7326	7331	7335	7340	7344	7349	7353	7357	7362	7366	7371	7375	7379
780	7312	7316	7321	7325	7330	7334	7339	7343	7348	7352	7356	7361	7365	7370	7374	7378	7383
779	7315	7320	7324	7329	7333	7338	7342	7346	7351	7355	7360	7364	7369	7373	7377	7382	7386
778	7318	7323	7327	7332	7336	7341	7345	7350	7354	7359	7363	7368	7372	7376	7381	7385	7390
777	7322	7326	7331	7335	7340	7344	7349	7353	7358	7362	7367	7371	7375	7380	7384	7389	7393
776	7325	7330	7334	7339	7343	7348	7352	7357	7361	7366	7370	7374	7379	7383	7388	7392	7396
775	7329	7333	7338	7342	7347	7351	7356	7360	7365	7369	7373	7378	7382	7387	7391	7395	7400
774	7332	7337	7341	7346	7350	7355	7359	7364	7368	7372	7377	7381	7386	7390	7394	7399	7403
773	7336	7340	7345	7349	7354	7358	7363	7367	7371	7376	7380	7385	7389	7393	7398	7402	7406
772	7339	7344	7348	7353	7357	7361	7366	7370	7375	7379	7384	7388	7392	7397	7401	7405	7410
771	7343	7347	7352	7356	7360	7365	7369	7374	7378	7383	7387	7391	7396	7400	7404	7409	7413
770	7346	7351	7355	7359	7364	7368	7373	7377	7382	7386	7390	7395	7399	7403	7408	7412	7416
769	7349	7354	7358	7363	7367	7372	7376	7381	7385	7389	7394	7398	7402	7407	7411	7416	7420
768	7353	7357	7362	7366	7371	7375	7380	7384	7388	7393	7397	7402	7406	7410	7415	7419	7423
767	7356	7361	7365	7370	7374	7379	7383	7387	7392	7396	7401	7405	7409	7414	7418	7422	7427
766	7360	7364	7369	7373	7378	7382	7386	7391	7395	7400	7404	7408	7413	7417	7421	7426	7430
765	7363	7368	7372	7377	7381	7385	7390	7394	7399	7403	7407	7412	7416	7420	7425	7429	7433
764	7367	7371	7376	7380	7384	7389	7393	7398	7402	7406	7411	7415	7419	7424	7428	7432	7437
763	7370	7375	7379	7383	7388	7392	7397	7401	7405	7410	7414	7418	7423	7427	7431	7436	7440
762	7374	7378	7383	7387	7391	7396	7400	7404	7409	7413	7418	7422	7426	7430	7435	7439	7443
761	7377	7382	7386	7390	7395	7399	7404	7408	7412	7417	7421	7425	7430	7434	7438	7442	7447
760	7381	7385	7389	7394	7398	7403	7407	7411	7416	7420	7424	7429	7433	7437	7442	7446	7450
759	7384	7388	7393	7397	7402	7406	7410	7415	7419	7423	7428	7432	7436	7441	7445	7449	7453
758	7387	7392	7396	7401	7405	7409	7414	7418	7422	7427	7431	7435	7440	7444	7448	7453	7457
757	7391	7395	7400	7404	7408	7413	7417	7422	7426	7430	7434	7439	7443	7447	7452	7456	7460
756	7394	7399	7403	7408	7412	7416	7421	7425	7429	7434	7438	7442	7446	7451	7455	7459	7464
755	7398	7402	7407	7411	7415	7420	7424	7428	7433	7437	7441	7446	7450	7454	7458	7463	7467
754	7401	7406	7410	7414	7419	7423	7427	7432	7436	7440	7445	7449	7453	7458	7462	7466	7470
753	7405	7409	7413	7418	7422	7427	7431	7435	7439	7444	7448	7452	7457	7461	7465	7469	7474
752	7408	7413	7417	7421	7426	7430	7434	7439	7443	7447	7451	7456	7460	7464	7469	7473	7477
751	7412	7416	7420	7425	7429	7433	7438	7442	7446	7451	7455	7459	7463	7468	7472	7476	7480
750	7415	7419	7424	7428	7432	7437	7441	7445	7450	7454	7458	7463	7467	7471	7475	7479	7484
749	7419	7423	7427	7432	7436	7440	7445	7449	7453	7457	7462	7466	7470	7474	7479	7483	7487
748	7422	7426	7431	7435	7439	7444	7448	7452	7457	7461	7465	7469	7474	7478	7482	7486	7490
747	7425	7430	7434	7438	7443	7447	7451	7456	7460	7464	7468	7473	7477	7481	7485	7490	7494
746	7429	7433	7438	7442	7446	7450	7455	7459	7463	7468	7472	7476	7480	7485	7489	7493	7497
745	7432	7437	7441	7445	7450	7454	7458	7462	7467	7471	7475	7479	7484	7488	7492	7496	7501
744	7436	7440	7444	7449	7453	7457	7462	7466	7470	7474	7479	7483	7487	7491	7496	7500	7504
743	7439	7444	7448	7452	7456	7461	7465	7469	7474	7478	7482	7486	7490	7495	7499	7503	7507
742	7443	7447	7451	7456	7460	7464	7468	7473	7477	7481	7485	7490	7494	7498	7502	7506	7511
741	7446	7450	7455	7459	7463	7468	7472	7476	7480	7485	7489	7493	7497	7501	7506	7510	7514
740	7450	7454	7458	7462	7467	7471	7475	7480	7484	7488	7492	7496	7501	7505	7509	7513	7517
739	7453	7457	7462	7466	7470	7474	7479	7483	7487	7491	7496	7500	7504	7508	7512	7517	7521
738	7456	7461	7465	7469	7474	7478	7482	7486	7491	7495	7499	7503	7507	7512	7516	7520	7524
737	7460	7464	7469	7473	7477	7481	7486	7490	7494	7498	7502	7507	7511	7515	7519	7523	7527
736	7463	7468	7472	7476	7480	7485	7489	7493	7497	7502	7506	7510	7514	7518	7522	7527	7531
735	7467	7471	7475	7480	7484	7488	7492	7497	7501	7505	7509	7513	7518	7522	7526	7530	7534
734	7470	7475	7479	7483	7487	7492	7496	7500	7504	7508	7513	7517	7521	7525	7529	7533	7538
733	7474	7478	7482	7487	7491	7495	7499	7503	7508	7512	7516	7520	7524	7528	7533	7537	7541
732	7477	7481	7486	7490	7494	7498	7503	7507	7511	7515	7519	7524	7528	7532	7536	7540	7544
731	7481	7485	7489	7493	7498	7502	7506	7510	7514	7519	7523	7527	7531	7535	7539	7543	7548
730	7484	7488	7493	7497	7501	7505	7509	7514	7518	7522	7526	7530	7534	7539	7543	7547	7551
729	7488	7492	7496	7500	7504	7509	7513	7517	7521	7525	7530	7534	7538	7542	7546	7550	7554
728	7491	7495	7499	7504	7508	7512	7516	7520	7525	7529	7533	7537	7541	7545	7549	7554	7558
727	7494	7499	7503	7507	7511	7516	7520	7524	7528	7532	7536	7540	7545	7549	7553	7557	7561
726	7498	7502	7506	7511	7515	7519	7523	7527	7531	7536	7540	7544	7548	7552	7556	7560	7564
725	7501	7506	7510	7514	7518	7522	7527	7531	7535	7539	7543	7547	7551	7555	7560	7564	7568
724	7505	7509	7513	7517	7522	7526	7530	7534	7538	7542	7547	7551	7555	7559	7563	7567	7571
723	7508	7512	7517	7521	7525	7529	7533	7538	7542	7546	7550	7554	7558	7562	7566	7570	7574
722	7512	7516	7520	7524	7528	7533	7537	7541	7545	7549	7553	7557	7562	7566	7570	7574	7578
721	7515	7519	7524	7528	7532	7536	7540	7544	7548	7553	7557	7561	7565	7569	7573	7577	7581
720	7519	7523	7527	7531	7535	7539	7544	7548	7552	7556	7560	7564	7568	7572	7576	7581	7585

Table 23 Metric—High Alt, Low Temp, Low Humidity
(Temp = 5 to 13° C, Press = 640 to 720 mm, 20% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
720	7288	7292	7297	7302	7307	7312	7317	7322	7326	7331	7336	7341	7345	7350	7355	7359	7364
719	7291	7296	7301	7306	7311	7316	7320	7325	7330	7335	7340	7344	7349	7354	7358	7363	7368
718	7295	7300	7305	7310	7315	7319	7324	7329	7334	7338	7343	7348	7353	7357	7362	7367	7371
717	7299	7304	7309	7313	7318	7323	7328	7333	7337	7342	7347	7352	7356	7361	7366	7370	7375
716	7303	7307	7312	7317	7322	7327	7332	7336	7341	7346	7351	7355	7360	7365	7369	7374	7379
715	7306	7311	7316	7321	7326	7331	7335	7340	7345	7350	7354	7359	7364	7368	7373	7378	7382
714	7310	7315	7320	7325	7329	7334	7339	7344	7349	7353	7358	7363	7367	7372	7377	7381	7386
713	7314	7319	7324	7328	7333	7338	7343	7348	7352	7357	7362	7366	7371	7376	7380	7385	7390
712	7318	7323	7327	7332	7337	7342	7347	7351	7356	7361	7365	7370	7375	7379	7384	7389	7393
711	7321	7326	7331	7336	7341	7346	7350	7355	7360	7364	7369	7374	7378	7383	7388	7392	7397
710	7325	7330	7335	7340	7344	7349	7354	7359	7363	7368	7373	7378	7382	7387	7391	7396	7401
709	7329	7334	7339	7343	7348	7353	7358	7362	7367	7372	7377	7381	7386	7391	7395	7400	7404
708	7333	7338	7342	7347	7352	7357	7361	7366	7371	7376	7380	7385	7390	7394	7399	7403	7408
707	7337	7341	7346	7351	7356	7360	7365	7370	7375	7379	7384	7389	7393	7398	7402	7407	7412
706	7340	7345	7350	7355	7359	7364	7369	7374	7378	7383	7388	7392	7397	7402	7406	7411	7415
705	7344	7349	7354	7358	7363	7368	7373	7377	7382	7387	7391	7396	7401	7405	7410	7414	7419
704	7348	7353	7357	7362	7367	7372	7376	7381	7386	7390	7395	7400	7404	7409	7414	7418	7423
703	7352	7356	7361	7366	7371	7375	7380	7385	7389	7394	7399	7403	7408	7413	7417	7422	7426
702	7355	7360	7365	7370	7374	7379	7384	7389	7393	7398	7402	7407	7412	7416	7421	7425	7430
701	7359	7364	7369	7373	7378	7383	7388	7392	7397	7402	7406	7411	7415	7420	7425	7429	7434
700	7363	7368	7372	7377	7382	7387	7391	7396	7401	7405	7410	7414	7419	7424	7428	7433	7437
699	7367	7371	7376	7381	7386	7390	7395	7400	7404	7409	7414	7418	7423	7427	7432	7436	7441
698	7370	7375	7380	7385	7389	7394	7399	7403	7408	7413	7417	7422	7426	7431	7436	7440	7445
697	7374	7379	7384	7388	7393	7398	7402	7407	7412	7416	7421	7426	7430	7435	7439	7444	7448
696	7378	7383	7387	7392	7397	7402	7406	7411	7415	7420	7425	7429	7434	7438	7443	7447	7452
695	7382	7386	7391	7396	7401	7405	7410	7415	7419	7424	7428	7433	7438	7442	7447	7451	7456
694	7386	7390	7395	7400	7404	7409	7414	7418	7423	7428	7432	7437	7441	7446	7450	7455	7459
693	7389	7394	7399	7403	7408	7413	7417	7422	7427	7431	7436	7440	7445	7449	7454	7458	7463
692	7393	7398	7402	7407	7412	7416	7421	7426	7430	7435	7439	7444	7449	7453	7458	7462	7467
691	7397	7402	7406	7411	7416	7420	7425	7429	7434	7439	7443	7448	7452	7457	7461	7466	7470
690	7401	7405	7410	7415	7419	7424	7429	7433	7438	7442	7447	7451	7456	7460	7465	7469	7474
689	7404	7409	7414	7418	7423	7428	7432	7437	7441	7446	7451	7455	7460	7464	7469	7473	7478
688	7408	7413	7418	7422	7427	7431	7436	7441	7445	7450	7454	7459	7463	7468	7472	7477	7481
687	7412	7417	7421	7426	7431	7435	7440	7444	7449	7453	7458	7463	7467	7472	7476	7480	7485
686	7416	7420	7425	7430	7434	7439	7443	7448	7453	7457	7462	7466	7471	7475	7480	7484	7489
685	7419	7424	7429	7433	7438	7443	7447	7452	7456	7461	7465	7470	7474	7479	7483	7488	7492
684	7423	7428	7433	7437	7442	7446	7451	7456	7460	7465	7469	7474	7478	7483	7487	7491	7496
683	7427	7432	7436	7441	7446	7450	7455	7459	7464	7468	7473	7477	7482	7486	7491	7495	7500
682	7431	7435	7440	7445	7449	7454	7458	7463	7467	7472	7477	7481	7485	7490	7494	7499	7503
681	7435	7439	7444	7448	7453	7458	7462	7467	7471	7476	7480	7485	7489	7494	7498	7503	7507
680	7438	7443	7448	7452	7457	7461	7466	7470	7475	7479	7484	7488	7493	7497	7502	7506	7511
679	7442	7447	7451	7456	7460	7465	7470	7474	7479	7483	7488	7492	7497	7501	7505	7510	7514
678	7446	7450	7455	7460	7464	7469	7473	7478	7482	7487	7491	7496	7500	7505	7509	7514	7518
677	7450	7454	7459	7463	7468	7473	7477	7482	7486	7491	7495	7499	7504	7508	7513	7517	7522
676	7453	7458	7463	7467	7472	7476	7481	7485	7490	7494	7499	7503	7508	7512	7516	7521	7525
675	7457	7462	7466	7471	7475	7480	7485	7489	7494	7498	7502	7507	7511	7516	7520	7525	7529
674	7461	7466	7470	7475	7479	7484	7488	7493	7497	7502	7506	7511	7515	7519	7524	7528	7533
673	7465	7469	7474	7478	7483	7487	7492	7496	7501	7505	7510	7514	7519	7523	7527	7532	7536
672	7468	7473	7478	7482	7487	7491	7496	7500	7505	7509	7514	7518	7522	7527	7531	7536	7540
671	7472	7477	7481	7486	7490	7495	7499	7504	7508	7513	7517	7522	7526	7530	7535	7539	7544
670	7476	7481	7485	7490	7494	7499	7503	7508	7512	7517	7521	7525	7530	7534	7539	7543	7547
669	7480	7484	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529	7533	7538	7542	7547	7551
668	7484	7488	7493	7497	7502	7506	7511	7515	7520	7524	7528	7533	7537	7542	7546	7550	7555
667	7487	7492	7496	7501	7505	7510	7514	7519	7523	7528	7532	7536	7541	7545	7550	7554	7558
666	7491	7496	7500	7505	7509	7514	7518	7523	7527	7531	7536	7540	7545	7549	7553	7558	7562
665	7495	7499	7504	7508	7513	7517	7522	7526	7531	7535	7539	7544	7548	7553	7557	7561	7566
664	7499	7503	7508	7512	7517	7521	7526	7530	7534	7539	7543	7548	7552	7556	7561	7565	7569
663	7502	7507	7511	7516	7520	7525	7529	7534	7538	7542	7547	7551	7556	7560	7564	7569	7573
662	7506	7511	7515	7520	7524	7529	7533	7537	7542	7546	7551	7555	7559	7564	7568	7572	7577
661	7510	7514	7519	7523	7528	7532	7537	7541	7546	7550	7554	7559	7563	7567	7572	7576	7580
660	7514	7518	7523	7527	7532	7536	7540	7545	7549	7554	7558	7562	7567	7571	7575	7580	7584
659	7517	7522	7526	7531	7535	7540	7544	7549	7553	7557	7562	7566	7570	7575	7579	7583	7588
658	7521	7526	7530	7535	7539	7543	7548	7552	7557	7561	7565	7570	7574	7578	7583	7587	7591
657	7525	7529	7534	7538	7543	7547	7552	7556	7560	7565	7569	7573	7578	7582	7586	7591	7595
656	7529	7533	7538	7542	7547	7551	7555	7560	7564	7568	7573	7577	7581	7586	7590	7594	7599
655	7533	7537	7541	7546	7550	7555	7559	7563	7568	7572	7576	7581	7585	7589	7594	7598	7602
654	7536	7541	7545	7550	7554	7558	7563	7567	7572	7576	7580	7584	7589	7593	7597	7602	7606
653	7540	7545	7549	7553	7558	7562	7567	7571	7575	7580	7584	7588	7592	7597	7601	7605	7609
652	7544	7548	7553	7557	7562	7566	7570	7575	7579	7583	7588	7592	7596	7600	7605	7609	7613
651	7548	7552	7556	7561	7565	7570	7574	7578	7583	7587	7591	7596	7600	7604	7608	7613	7617
650	7551	7556	7560	7565	7569	7573	7578	7582	7586	7591	7595	7599	7604	7608	7612	7616	7620
649	7555	7560	7564	7568	7573	7577	7581	7586	7590	7594	7599	7603	7607	7611	7616	7620	7624
648	7559	7563	7568	7572	7576	7581	7585	7590	7594	7598	7602	7607	7611	7615	7619	7624	7628
647	7563	7567	7571	7576	7580	7585	7589	7593	7598	7602	7606	7610	7615	7619	7623	7627	7631
646	7566	7571	7575	7580	7584	7588	7593	7597	7601	7606	7610	7614	7618	7623	7627	7631	7635
645	7570	7575	7579	7583	7588	7592	7596	7601	7605	7609	7614	7618	7622	7626	7630	7635	7639
644	7574	7578	7583	7587	7591	7596	7600	7604	7609	7613	7617	7621	7626	7630	7634	7638	7642
643	7578	7582	7587	7591	7595	7600	7604	7608	7612	7617	7621	7625	7629	7634	7638	7642	7646
642	7582	7586	7590	7595	7599	7603	7608	7612	7616	7620	7625	7629	7633	7637	7641	7646	7650
641	7585	7590	7594	7598	7603	7607	7611	7616	7620	7624	7628	7633	7637	7641	7645	7649	7653
640	7589	7593	7598	7602	7606	7611	7615	7619	7624	7628	7632	7636	7640	7645	7649	7653	7657

Table 24 Metric—High Alt, Low-Mid Temp, Low Humidity
(Temp = 13.5 to 21.5° C, Press = 640 to 720 mm, 20% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5
720	7369	7373	7378	7383	7387	7392	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7441
719	7372	7377	7382	7386	7391	7395	7400	7404	7409	7413	7418	7422	7427	7431	7436	7440	7445
718	7376	7381	7385	7390	7394	7399	7404	7408	7413	7417	7422	7426	7430	7435	7439	7444	7448
717	7380	7384	7389	7393	7398	7403	7407	7412	7416	7421	7425	7430	7434	7439	7443	7447	7452
716	7383	7388	7393	7397	7402	7406	7411	7415	7420	7424	7429	7433	7438	7442	7447	7451	7455
715	7387	7392	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7441	7446	7450	7454	7459
714	7391	7395	7400	7404	7409	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454	7458	7462
713	7394	7399	7403	7408	7413	7417	7422	7426	7431	7435	7440	7444	7448	7453	7457	7462	7466
712	7398	7403	7407	7412	7416	7421	7425	7430	7434	7439	7443	7448	7452	7456	7461	7465	7470
711	7402	7406	7411	7415	7420	7424	7429	7433	7438	7442	7447	7451	7456	7460	7464	7469	7473
710	7405	7410	7414	7419	7423	7428	7432	7437	7441	7446	7450	7455	7459	7464	7468	7472	7477
709	7409	7413	7418	7423	7427	7432	7436	7441	7445	7449	7454	7458	7463	7467	7472	7476	7480
708	7413	7417	7422	7426	7431	7435	7440	7444	7449	7453	7457	7462	7466	7471	7475	7479	7484
707	7416	7421	7425	7430	7434	7439	7443	7448	7452	7457	7461	7465	7470	7474	7479	7483	7487
706	7420	7424	7429	7433	7438	7442	7447	7451	7456	7460	7465	7469	7473	7478	7482	7487	7491
705	7424	7428	7433	7437	7442	7446	7451	7455	7459	7464	7468	7473	7477	7481	7486	7490	7494
704	7427	7432	7436	7441	7445	7450	7454	7459	7463	7467	7472	7476	7481	7485	7489	7494	7498
703	7431	7435	7440	7444	7449	7453	7458	7462	7467	7471	7475	7480	7484	7489	7493	7497	7502
702	7435	7439	7444	7448	7453	7457	7461	7466	7470	7475	7479	7483	7488	7492	7496	7501	7505
701	7438	7443	7447	7452	7456	7461	7465	7469	7474	7478	7483	7487	7491	7496	7500	7504	7509
700	7442	7446	7451	7455	7460	7464	7469	7473	7477	7482	7486	7491	7495	7499	7504	7508	7512
699	7445	7450	7454	7459	7463	7468	7472	7477	7481	7485	7490	7494	7499	7503	7507	7512	7516
698	7449	7454	7458	7463	7467	7471	7476	7480	7485	7489	7493	7498	7502	7506	7511	7515	7519
697	7453	7457	7462	7466	7471	7475	7480	7484	7488	7493	7497	7501	7506	7510	7514	7519	7523
696	7456	7461	7465	7470	7474	7479	7483	7488	7492	7496	7501	7505	7509	7514	7518	7522	7526
695	7460	7465	7469	7473	7478	7482	7487	7491	7496	7500	7504	7509	7513	7517	7521	7526	7530
694	7464	7468	7473	7477	7482	7486	7490	7495	7499	7503	7508	7512	7516	7521	7525	7529	7534
693	7467	7472	7476	7481	7485	7490	7494	7498	7503	7507	7511	7516	7520	7524	7529	7533	7537
692	7471	7476	7480	7484	7489	7493	7498	7502	7506	7511	7515	7519	7524	7528	7532	7536	7541
691	7475	7479	7484	7488	7492	7497	7501	7506	7510	7514	7519	7523	7527	7531	7536	7540	7544
690	7478	7483	7487	7492	7496	7500	7505	7509	7514	7518	7522	7526	7531	7535	7539	7544	7548
689	7482	7486	7491	7495	7500	7504	7508	7513	7517	7521	7526	7530	7534	7539	7543	7547	7551
688	7486	7490	7495	7499	7503	7508	7512	7516	7521	7525	7529	7534	7538	7542	7546	7551	7555
687	7489	7494	7498	7503	7507	7511	7516	7520	7524	7529	7533	7537	7542	7546	7550	7554	7558
686	7493	7497	7502	7506	7511	7515	7519	7524	7528	7532	7537	7541	7545	7549	7554	7558	7562
685	7497	7501	7505	7510	7514	7519	7523	7527	7532	7536	7540	7544	7549	7553	7557	7561	7566
684	7500	7505	7509	7514	7518	7522	7527	7531	7535	7539	7544	7548	7552	7557	7561	7565	7569
683	7504	7508	7513	7517	7522	7526	7530	7534	7539	7543	7547	7552	7556	7560	7564	7569	7573
682	7508	7512	7516	7521	7525	7529	7534	7538	7542	7547	7551	7555	7559	7564	7568	7572	7576
681	7511	7516	7520	7524	7529	7533	7537	7542	7546	7550	7555	7559	7563	7567	7571	7576	7580
680	7515	7519	7524	7528	7532	7537	7541	7545	7550	7554	7558	7562	7567	7571	7575	7579	7583
679	7519	7523	7527	7532	7536	7540	7545	7549	7553	7557	7562	7566	7570	7574	7579	7583	7587
678	7522	7527	7531	7535	7540	7544	7548	7553	7557	7561	7565	7570	7574	7578	7582	7586	7591
677	7526	7530	7535	7539	7543	7548	7552	7556	7560	7565	7569	7573	7577	7582	7586	7590	7594
676	7530	7534	7538	7543	7547	7551	7556	7560	7564	7568	7573	7577	7581	7585	7589	7593	7598
675	7533	7538	7542	7546	7551	7555	7559	7563	7568	7572	7576	7580	7585	7589	7593	7597	7601
674	7537	7541	7546	7550	7554	7558	7563	7567	7571	7575	7580	7584	7588	7592	7596	7601	7605
673	7541	7545	7549	7554	7558	7562	7566	7571	7575	7579	7583	7587	7592	7596	7600	7604	7608
672	7544	7549	7553	7557	7561	7566	7570	7574	7578	7583	7587	7591	7595	7599	7604	7608	7612
671	7548	7552	7557	7561	7565	7569	7574	7578	7582	7586	7590	7595	7599	7603	7607	7611	7615
670	7552	7556	7560	7564	7569	7573	7577	7581	7586	7590	7594	7598	7602	7607	7611	7615	7619
669	7555	7560	7564	7568	7572	7577	7581	7585	7589	7593	7598	7602	7606	7610	7614	7618	7623
668	7559	7563	7567	7572	7576	7580	7584	7589	7593	7597	7601	7605	7610	7614	7618	7622	7626
667	7563	7567	7571	7575	7580	7584	7588	7592	7596	7601	7605	7609	7613	7617	7621	7626	7630
666	7566	7570	7575	7579	7583	7587	7592	7596	7600	7604	7608	7613	7617	7621	7625	7629	7633
665	7570	7574	7578	7583	7587	7591	7595	7600	7604	7608	7612	7616	7620	7624	7629	7633	7637
664	7573	7578	7582	7586	7591	7595	7599	7603	7607	7611	7616	7620	7624	7628	7632	7636	7640
663	7577	7581	7586	7590	7594	7598	7603	7607	7611	7615	7619	7623	7627	7632	7636	7640	7644
662	7581	7585	7589	7594	7598	7602	7606	7610	7615	7619	7623	7627	7631	7635	7639	7643	7647
661	7584	7589	7593	7597	7601	7606	7610	7614	7618	7622	7626	7631	7635	7639	7643	7647	7651
660	7588	7592	7597	7601	7605	7609	7613	7618	7622	7626	7630	7634	7638	7642	7646	7650	7655
659	7592	7596	7600	7604	7609	7613	7617	7621	7625	7629	7634	7638	7642	7646	7650	7654	7658
658	7595	7600	7604	7608	7612	7616	7621	7625	7629	7633	7637	7641	7645	7649	7654	7658	7662
657	7599	7603	7608	7612	7616	7620	7624	7628	7633	7637	7641	7645	7649	7653	7657	7661	7665
656	7603	7607	7611	7615	7620	7624	7628	7632	7636	7640	7644	7648	7653	7657	7661	7665	7669
655	7606	7611	7615	7619	7623	7627	7632	7636	7640	7644	7648	7652	7656	7660	7664	7668	7672
654	7610	7614	7618	7623	7627	7631	7635	7639	7643	7647	7652	7656	7660	7664	7668	7672	7676
653	7614	7618	7622	7626	7630	7635	7639	7643	7647	7651	7655	7659	7663	7667	7671	7675	7679
652	7617	7622	7626	7630	7634	7638	7642	7646	7651	7655	7659	7663	7667	7671	7675	7679	7683
651	7621	7625	7629	7634	7638	7642	7646	7650	7654	7658	7662	7666	7670	7675	7679	7683	7687
650	7625	7629	7633	7637	7641	7645	7650	7654	7658	7662	7666	7670	7674	7678	7682	7686	7690
649	7628	7633	7637	7641	7645	7649	7653	7657	7661	7665	7670	7674	7678	7682	7686	7690	7694
648	7632	7636	7640	7644	7649	7653	7657	7661	7665	7669	7673	7677	7681	7685	7689	7693	7697
647	7636	7640	7644	7648	7652	7656	7660	7665	7669	7673	7677	7681	7685	7689	7693	7697	7701
646	7639	7643	7648	7652	7656	7660	7664	7668	7672	7676	7680	7684	7688	7692	7696	7700	7704
645	7643	7647	7651	7655	7660	7664	7668	7672	7676	7680	7684	7688	7692	7696	7700	7704	7708
644	7647	7651	7655	7659	7663	7667	7671	7675	7679	7683	7688	7692	7696	7700	7704	7707	7711
643	7650	7654	7659	7663	7667	7671	7675	7679	7683	7687	7691	7695	7699	7703	7707	7711	7715
642	7654	7658	7662	7666	7670	7674	7679	7683	7687	7691	7695	7699	7703	7707	7711	7715	7719
641	7658	7662	7666	7670	7674	7678	7682	7686	7690	7694	7698	7702	7706	7710	7714	7718	7722
640	7661	7665	7669	7674	7678	7682	7686	7690	7694	7698	7702	7706	7710	7714	7718	7722	7726

Table 25 Metric—High Alt, Mid Temp, Low Humidity
(Temp = 22 to 30° C, Press = 640 to 720 mm, 20% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
720	7446	7450	7454	7459	7463	7467	7472	7476	7480	7485	7489	7493	7497	7502	7506	7510	7514
719	7449	7453	7458	7462	7467	7471	7475	7480	7484	7488	7492	7497	7501	7505	7509	7514	7518
718	7453	7457	7461	7466	7470	7474	7479	7483	7487	7492	7496	7500	7504	7509	7513	7517	7521
717	7456	7461	7465	7469	7474	7478	7482	7487	7491	7495	7499	7504	7508	7512	7516	7521	7525
716	7460	7464	7468	7473	7477	7481	7486	7490	7494	7499	7503	7507	7511	7516	7520	7524	7528
715	7463	7468	7472	7476	7481	7485	7489	7494	7498	7502	7506	7511	7515	7519	7523	7527	7532
714	7467	7471	7476	7480	7484	7489	7493	7497	7501	7506	7510	7514	7518	7523	7527	7531	7535
713	7470	7475	7479	7483	7488	7492	7496	7501	7505	7509	7513	7518	7522	7526	7530	7534	7539
712	7474	7478	7483	7487	7491	7496	7500	7504	7508	7513	7517	7521	7525	7530	7534	7538	7542
711	7477	7482	7486	7490	7495	7499	7503	7508	7512	7516	7520	7525	7529	7533	7537	7541	7546
710	7481	7485	7490	7494	7498	7503	7507	7511	7515	7520	7524	7528	7532	7536	7541	7545	7549
709	7485	7489	7493	7498	7502	7506	7510	7515	7519	7523	7527	7532	7536	7540	7544	7548	7552
708	7488	7492	7497	7501	7505	7510	7514	7518	7522	7527	7531	7535	7539	7543	7548	7552	7556
707	7492	7496	7500	7505	7509	7513	7517	7522	7526	7530	7534	7539	7543	7547	7551	7555	7559
706	7495	7500	7504	7508	7512	7517	7521	7525	7529	7534	7538	7542	7546	7550	7555	7559	7563
705	7499	7503	7507	7512	7516	7520	7524	7529	7533	7537	7541	7545	7550	7554	7558	7562	7566
704	7502	7507	7511	7515	7519	7524	7528	7532	7536	7541	7545	7549	7553	7557	7561	7566	7570
703	7506	7510	7514	7519	7523	7527	7531	7536	7540	7544	7548	7552	7557	7561	7565	7569	7573
702	7509	7514	7518	7522	7527	7531	7535	7539	7543	7548	7552	7556	7560	7564	7568	7573	7577
701	7513	7517	7522	7526	7530	7534	7538	7543	7547	7551	7555	7559	7564	7568	7572	7576	7580
700	7517	7521	7525	7529	7534	7538	7542	7546	7550	7555	7559	7563	7567	7571	7575	7579	7584
699	7520	7524	7529	7533	7537	7541	7546	7550	7554	7558	7562	7566	7571	7575	7579	7583	7587
698	7524	7528	7532	7536	7541	7545	7549	7553	7557	7562	7566	7570	7574	7578	7582	7586	7590
697	7527	7531	7536	7540	7544	7548	7553	7557	7561	7565	7569	7573	7578	7582	7586	7590	7594
696	7531	7535	7539	7543	7548	7552	7556	7560	7564	7569	7573	7577	7581	7585	7589	7593	7597
695	7534	7539	7543	7547	7551	7555	7560	7564	7568	7572	7576	7580	7584	7589	7593	7597	7601
694	7538	7542	7546	7551	7555	7559	7563	7567	7571	7576	7580	7584	7588	7592	7596	7600	7604
693	7541	7546	7550	7554	7558	7562	7567	7571	7575	7579	7583	7587	7591	7596	7600	7604	7608
692	7545	7549	7553	7558	7562	7566	7570	7574	7578	7583	7587	7591	7595	7599	7603	7607	7611
691	7549	7553	7557	7561	7565	7569	7574	7578	7582	7586	7590	7594	7598	7602	7607	7611	7615
690	7552	7556	7560	7565	7569	7573	7577	7581	7585	7590	7594	7598	7602	7606	7610	7614	7618
689	7556	7560	7564	7568	7572	7577	7581	7585	7589	7593	7597	7601	7605	7609	7613	7618	7622
688	7559	7563	7568	7572	7576	7580	7584	7588	7592	7597	7601	7605	7609	7613	7617	7621	7625
687	7563	7567	7571	7575	7579	7584	7588	7592	7596	7600	7604	7608	7612	7616	7620	7624	7628
686	7566	7570	7575	7579	7583	7587	7591	7595	7599	7604	7608	7612	7616	7620	7624	7628	7632
685	7570	7574	7578	7582	7586	7591	7595	7599	7603	7607	7611	7615	7619	7623	7627	7631	7635
684	7573	7578	7582	7586	7590	7594	7598	7602	7606	7611	7615	7619	7623	7627	7631	7635	7639
683	7577	7581	7585	7589	7594	7598	7602	7606	7610	7614	7618	7622	7626	7630	7634	7638	7642
682	7580	7585	7589	7593	7597	7601	7605	7609	7613	7618	7622	7626	7630	7634	7638	7642	7646
681	7584	7588	7592	7596	7601	7605	7609	7613	7617	7621	7625	7629	7633	7637	7641	7645	7649
680	7588	7592	7596	7600	7604	7608	7612	7616	7620	7625	7629	7633	7637	7641	7645	7649	7653
679	7591	7595	7599	7604	7608	7612	7616	7620	7624	7628	7632	7636	7640	7644	7648	7652	7656
678	7595	7599	7603	7607	7611	7615	7619	7623	7627	7632	7636	7640	7644	7648	7652	7656	7660
677	7598	7602	7606	7611	7615	7619	7623	7627	7631	7635	7639	7643	7647	7651	7655	7659	7663
676	7602	7606	7610	7614	7618	7622	7626	7630	7634	7639	7643	7647	7651	7655	7659	7663	7667
675	7605	7609	7614	7618	7622	7626	7630	7634	7638	7642	7646	7650	7654	7658	7662	7666	7670
674	7609	7613	7617	7621	7625	7629	7633	7637	7642	7646	7650	7654	7658	7662	7666	7669	7673
673	7612	7617	7621	7625	7629	7633	7637	7641	7645	7649	7653	7657	7661	7665	7669	7673	7677
672	7616	7620	7624	7628	7632	7636	7640	7644	7649	7653	7657	7661	7665	7668	7672	7676	7680
671	7620	7624	7628	7632	7636	7640	7644	7648	7652	7656	7660	7664	7668	7672	7676	7680	7684
670	7623	7627	7631	7635	7639	7643	7647	7652	7656	7660	7664	7667	7671	7675	7679	7683	7687
669	7627	7631	7635	7639	7643	7647	7651	7655	7659	7663	7667	7671	7675	7679	7683	7687	7691
668	7630	7634	7638	7642	7646	7650	7655	7659	7663	7667	7670	7674	7678	7682	7686	7690	7694
667	7634	7638	7642	7646	7650	7654	7658	7662	7666	7670	7674	7678	7682	7686	7690	7694	7698
666	7637	7641	7645	7649	7653	7658	7662	7666	7670	7674	7677	7681	7685	7689	7693	7697	7701
665	7641	7645	7649	7653	7657	7661	7665	7669	7673	7677	7681	7685	7689	7693	7697	7701	7705
664	7644	7648	7652	7657	7661	7665	7669	7673	7677	7681	7684	7688	7692	7696	7700	7704	7708
663	7648	7652	7656	7660	7664	7668	7672	7676	7680	7684	7688	7692	7696	7700	7704	7708	7711
662	7651	7656	7660	7664	7668	7672	7676	7680	7684	7688	7691	7695	7699	7703	7707	7711	7715
661	7655	7659	7663	7667	7671	7675	7679	7683	7687	7691	7695	7699	7703	7707	7711	7714	7718
660	7659	7663	7667	7671	7675	7679	7683	7687	7691	7694	7698	7702	7706	7710	7714	7718	7722
659	7662	7666	7670	7674	7678	7682	7686	7690	7694	7698	7702	7706	7710	7714	7718	7721	7725
658	7666	7670	7674	7678	7682	7686	7690	7694	7698	7701	7705	7709	7713	7717	7721	7725	7729
657	7669	7673	7677	7681	7685	7689	7693	7697	7701	7705	7709	7713	7717	7721	7724	7728	7732
656	7673	7677	7681	7685	7689	7693	7697	7701	7705	7708	7712	7716	7720	7724	7728	7732	7736
655	7676	7680	7684	7688	7692	7696	7700	7704	7708	7712	7716	7720	7724	7728	7731	7735	7739
654	7680	7684	7688	7692	7696	7700	7704	7708	7712	7715	7719	7723	7727	7731	7735	7739	7743
653	7683	7687	7691	7695	7699	7703	7707	7711	7715	7719	7723	7727	7731	7734	7738	7742	7746
652	7687	7691	7695	7699	7703	7707	7711	7715	7719	7722	7726	7730	7734	7738	7742	7746	7749
651	7691	7695	7699	7702	7706	7710	7714	7718	7722	7726	7730	7734	7738	7741	7745	7749	7753
650	7694	7698	7702	7706	7710	7714	7718	7722	7726	7729	7733	7737	7741	7745	7749	7753	7756
649	7698	7702	7706	7710	7713	7717	7721	7725	7729	7733	7737	7741	7745	7748	7752	7756	7760
648	7701	7705	7709	7713	7717	7721	7725	7729	7733	7736	7740	7744	7748	7752	7756	7760	7763
647	7705	7709	7713	7717	7721	7724	7728	7732	7736	7740	7744	7748	7752	7755	7759	7763	7767
646	7708	7712	7716	7720	7724	7728	7732	7736	7740	7743	7747	7751	7755	7759	7763	7766	7770
645	7712	7716	7720	7724	7728	7731	7735	7739	7743	7747	7751	7755	7758	7762	7766	7770	7774
644	7715	7719	7723	7727	7731	7735	7739	7743	7747	7750	7754	7758	7762	7766	7770	7773	7777
643	7719	7723	7727	7731	7735	7739	7742	7746	7750	7754	7758	7762	7765	7769	7773	7777	7781
642	7723	7726	7730	7734	7738	7742	7746	7750	7754	7757	7761	7765	7769	7773	7777	7780	7784
641	7726	7730	7734	7738	7742	7746	7749	7753	7757	7761	7765	7769	7772	7776	7780	7784	7788
640	7730	7734	7737	7741	7745	7749	7753	7757	7761	7764	7768	7772	7776	7780	7783	7787	7791

Table 26 Metric—High Alt, High-Mid Temp, Low Humidity
(Temp = 30.5 to 38.5° C, Press = 640 to 720 mm, 20% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5
720	7519	7523	7527	7531	7535	7539	7544	7548	7552	7556	7560	7564	7568	7572	7576	7581	7585
719	7522	7526	7530	7535	7539	7543	7547	7551	7555	7559	7564	7568	7572	7576	7580	7584	7588
718	7526	7530	7534	7538	7542	7546	7550	7555	7559	7563	7567	7571	7575	7579	7583	7587	7591
717	7529	7533	7537	7541	7546	7550	7554	7558	7562	7566	7570	7574	7578	7583	7587	7591	7595
716	7532	7537	7541	7545	7549	7553	7557	7561	7566	7570	7574	7578	7582	7586	7590	7594	7598
715	7536	7540	7544	7548	7552	7557	7561	7565	7569	7573	7577	7581	7585	7589	7593	7597	7601
714	7539	7543	7548	7552	7556	7560	7564	7568	7572	7576	7580	7585	7589	7593	7597	7601	7605
713	7543	7547	7551	7555	7559	7563	7568	7572	7576	7580	7584	7588	7592	7596	7600	7604	7608
712	7546	7550	7555	7559	7563	7567	7571	7575	7579	7583	7587	7591	7595	7599	7603	7607	7611
711	7550	7554	7558	7562	7566	7570	7574	7578	7583	7587	7591	7595	7599	7603	7607	7611	7615
710	7553	7557	7561	7566	7570	7574	7578	7582	7586	7590	7594	7598	7602	7606	7610	7614	7618
709	7557	7561	7565	7569	7573	7577	7581	7585	7589	7593	7597	7602	7606	7610	7614	7618	7622
708	7560	7564	7568	7572	7576	7581	7585	7589	7593	7597	7601	7605	7609	7613	7617	7621	7625
707	7563	7568	7572	7576	7580	7584	7588	7592	7596	7600	7604	7608	7612	7616	7620	7624	7628
706	7567	7571	7575	7579	7583	7587	7591	7596	7600	7604	7608	7612	7616	7620	7624	7628	7632
705	7570	7574	7579	7583	7587	7591	7595	7599	7603	7607	7611	7615	7619	7623	7627	7631	7635
704	7574	7578	7582	7586	7590	7594	7598	7602	7606	7610	7614	7618	7622	7626	7630	7634	7638
703	7577	7581	7585	7590	7594	7598	7602	7606	7610	7614	7618	7622	7626	7630	7634	7638	7642
702	7581	7585	7589	7593	7597	7601	7605	7609	7613	7617	7621	7625	7629	7633	7637	7641	7645
701	7584	7588	7592	7596	7600	7605	7609	7613	7617	7621	7625	7629	7633	7637	7641	7645	7648
700	7588	7592	7596	7600	7604	7608	7612	7616	7620	7624	7628	7632	7636	7640	7644	7648	7652
699	7591	7595	7599	7603	7607	7611	7615	7619	7623	7627	7631	7635	7639	7643	7647	7651	7655
698	7595	7599	7603	7607	7611	7615	7619	7623	7627	7631	7635	7639	7643	7647	7651	7655	7659
697	7598	7602	7606	7610	7614	7618	7622	7626	7630	7634	7638	7642	7646	7650	7654	7658	7662
696	7601	7605	7610	7614	7618	7622	7626	7630	7634	7638	7642	7646	7650	7653	7657	7661	7665
695	7605	7609	7613	7617	7621	7625	7629	7633	7637	7641	7645	7649	7653	7657	7661	7665	7669
694	7608	7612	7616	7620	7624	7628	7632	7636	7640	7644	7648	7652	7656	7660	7664	7668	7672
693	7612	7616	7620	7624	7628	7632	7636	7640	7644	7648	7652	7656	7660	7664	7668	7671	7675
692	7615	7619	7623	7627	7631	7635	7639	7643	7647	7651	7655	7659	7663	7667	7671	7675	7679
691	7619	7623	7627	7631	7635	7639	7643	7647	7651	7655	7659	7663	7666	7670	7674	7678	7682
690	7622	7626	7630	7634	7638	7642	7646	7650	7654	7658	7662	7666	7670	7674	7678	7682	7685
689	7626	7630	7634	7638	7642	7646	7650	7654	7657	7661	7665	7669	7673	7677	7681	7685	7689
688	7629	7633	7637	7641	7645	7649	7653	7657	7661	7665	7669	7673	7677	7681	7684	7688	7692
687	7633	7637	7641	7644	7648	7652	7656	7660	7664	7668	7672	7676	7680	7684	7688	7692	7696
686	7636	7640	7644	7648	7652	7656	7660	7664	7668	7672	7676	7679	7683	7687	7691	7695	7699
685	7639	7643	7647	7651	7655	7659	7663	7667	7671	7675	7679	7683	7687	7691	7695	7698	7702
684	7643	7647	7651	7655	7659	7663	7667	7671	7675	7678	7682	7686	7690	7694	7698	7702	7706
683	7646	7650	7654	7658	7662	7666	7670	7674	7678	7682	7686	7690	7694	7697	7701	7705	7709
682	7650	7654	7658	7662	7666	7670	7673	7677	7681	7685	7689	7693	7697	7701	7705	7709	7712
681	7653	7657	7661	7665	7669	7673	7677	7681	7685	7689	7693	7696	7700	7704	7708	7712	7716
680	7657	7661	7665	7669	7672	7676	7680	7684	7688	7692	7696	7700	7704	7708	7711	7715	7719
679	7660	7664	7668	7672	7676	7680	7684	7688	7692	7695	7699	7703	7707	7711	7715	7719	7722
678	7664	7668	7671	7675	7679	7683	7687	7691	7695	7699	7703	7707	7710	7714	7718	7722	7726
677	7667	7671	7675	7679	7683	7687	7691	7694	7698	7702	7706	7710	7714	7718	7722	7725	7729
676	7670	7674	7678	7682	7686	7690	7694	7698	7702	7706	7710	7713	7717	7721	7725	7729	7733
675	7674	7678	7682	7686	7690	7694	7697	7701	7705	7709	7713	7717	7721	7724	7728	7732	7736
674	7677	7681	7685	7689	7693	7697	7701	7705	7709	7712	7716	7720	7724	7728	7732	7735	7739
673	7681	7685	7689	7693	7696	7700	7704	7708	7712	7716	7720	7724	7727	7731	7735	7739	7743
672	7684	7688	7692	7696	7700	7704	7708	7712	7715	7719	7723	7727	7731	7735	7738	7742	7746
671	7688	7692	7696	7699	7703	7707	7711	7715	7719	7723	7726	7730	7734	7738	7742	7746	7749
670	7691	7695	7699	7703	7707	7711	7715	7718	7722	7726	7730	7734	7738	7741	7745	7749	7753
669	7695	7699	7702	7706	7710	7714	7718	7722	7726	7729	7733	7737	7741	7745	7748	7752	7756
668	7698	7702	7706	7710	7714	7717	7721	7725	7729	7733	7737	7740	7744	7748	7752	7756	7759
667	7702	7705	7709	7713	7717	7721	7725	7729	7732	7736	7740	7744	7748	7751	7755	7759	7763
666	7705	7709	7713	7717	7720	7724	7728	7732	7736	7740	7743	7747	7751	7755	7759	7762	7766
665	7708	7712	7716	7720	7724	7728	7732	7735	7739	7743	7747	7751	7754	7758	7762	7766	7770
664	7712	7716	7720	7723	7727	7731	7735	7739	7743	7746	7750	7754	7758	7762	7765	7769	7773
663	7715	7719	7723	7727	7731	7735	7738	7742	7746	7750	7754	7757	7761	7765	7769	7772	7776
662	7719	7723	7727	7730	7734	7738	7742	7746	7749	7753	7757	7761	7765	7768	7772	7776	7780
661	7722	7726	7730	7734	7738	7741	7745	7749	7753	7757	7760	7764	7768	7772	7775	7779	7783
660	7726	7730	7733	7737	7741	7745	7749	7752	7756	7760	7764	7768	7771	7775	7779	7783	7786
659	7729	7733	7737	7741	7744	7748	7752	7756	7760	7763	7767	7771	7775	7778	7782	7786	7790
658	7733	7736	7740	7744	7748	7752	7756	7759	7763	7767	7771	7774	7778	7782	7786	7789	7793
657	7736	7740	7744	7748	7751	7755	7759	7763	7766	7770	7774	7778	7782	7785	7789	7793	7796
656	7739	7743	7747	7751	7755	7759	7762	7766	7770	7774	7777	7781	7785	7789	7792	7796	7800
655	7743	7747	7751	7754	7758	7762	7766	7770	7773	7777	7781	7785	7788	7792	7796	7799	7803
654	7746	7750	7754	7758	7762	7765	7769	7773	7777	7780	7784	7788	7792	7795	7799	7803	7806
653	7750	7754	7757	7761	7765	7769	7773	7776	7780	7784	7788	7791	7795	7799	7802	7806	7810
652	7753	7757	7761	7765	7768	7772	7776	7780	7784	7787	7791	7795	7798	7802	7806	7810	7813
651	7757	7761	7764	7768	7772	7776	7779	7783	7787	7791	7794	7798	7802	7806	7809	7813	7817
650	7760	7764	7768	7772	7775	7779	7783	7787	7790	7794	7798	7801	7805	7809	7813	7816	7820
649	7764	7767	7771	7775	7779	7783	7786	7790	7794	7797	7801	7805	7809	7812	7816	7820	7823
648	7767	7771	7775	7778	7782	7786	7790	7793	7797	7801	7805	7808	7812	7816	7819	7823	7827
647	7771	7774	7778	7782	7786	7789	7793	7797	7801	7804	7808	7812	7815	7819	7823	7826	7830
646	7774	7778	7782	7785	7789	7793	7797	7800	7804	7808	7811	7815	7819	7822	7826	7830	7833
645	7777	7781	7785	7789	7792	7796	7800	7804	7807	7811	7815	7818	7822	7826	7829	7833	7837
644	7781	7785	7788	7792	7796	7800	7803	7807	7811	7814	7818	7822	7826	7829	7833	7836	7840
643	7784	7788	7792	7796	7799	7803	7807	7810	7814	7818	7822	7825	7829	7833	7836	7840	7843
642	7788	7792	7795	7799	7803	7806	7810	7814	7818	7821	7825	7829	7832	7836	7840	7843	7847
641	7791	7795	7799	7802	7806	7810	7814	7817	7821	7825	7828	7832	7836	7839	7843	7847	7850
640	7795	7798	7802	7806	7810	7813	7817	7821	7824	7828	7832	7835	7839	7843	7846	7850	7854

Table 27 Metric—Low Alt, Low Temp, Med Humidity
(Temp = 5 to 13° C, Press = 720 to 800 mm, 50% Humidity)

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY / TEMPERATURE IN DEGREES CELSIUS

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
800	6987	6993	6998	7004	7009	7014	7020	7025	7031	7036	7041	7047	7052	7057	7062	7068	7073
799	6991	6996	7002	7007	7013	7018	7024	7029	7034	7040	7045	7050	7056	7061	7066	7071	7077
798	6995	7000	7006	7011	7016	7022	7027	7033	7038	7043	7049	7054	7059	7064	7070	7075	7080
797	6998	7004	7009	7015	7020	7026	7031	7036	7042	7047	7052	7058	7063	7068	7073	7079	7084
796	7002	7008	7013	7019	7024	7029	7035	7040	7045	7051	7056	7061	7067	7072	7077	7082	7088
795	7006	7011	7017	7022	7028	7033	7038	7044	7049	7054	7060	7065	7070	7076	7081	7086	7091
794	7010	7015	7021	7026	7031	7037	7042	7048	7053	7058	7063	7069	7074	7079	7084	7090	7095
793	7014	7019	7024	7030	7035	7041	7046	7051	7057	7062	7067	7072	7078	7083	7088	7093	7099
792	7017	7023	7028	7034	7039	7044	7050	7055	7060	7066	7071	7076	7081	7087	7092	7097	7102
791	7021	7027	7032	7037	7043	7048	7053	7059	7064	7069	7075	7080	7085	7090	7095	7101	7106
790	7025	7030	7036	7041	7046	7052	7057	7062	7068	7073	7078	7083	7089	7094	7099	7104	7109
789	7029	7034	7039	7045	7050	7056	7061	7066	7071	7077	7082	7087	7092	7098	7103	7108	7113
788	7032	7038	7043	7049	7054	7059	7065	7070	7075	7080	7086	7091	7096	7101	7106	7112	7117
787	7036	7042	7047	7052	7058	7063	7068	7074	7079	7084	7089	7095	7100	7105	7110	7115	7120
786	7040	7045	7051	7056	7061	7067	7072	7077	7083	7088	7093	7098	7103	7109	7114	7119	7124
785	7044	7049	7054	7060	7065	7070	7076	7081	7086	7092	7097	7102	7107	7112	7118	7123	7128
784	7047	7053	7058	7064	7069	7074	7079	7085	7090	7095	7100	7106	7111	7116	7121	7126	7131
783	7051	7057	7062	7067	7073	7078	7083	7088	7094	7099	7104	7109	7115	7120	7125	7130	7135
782	7055	7060	7066	7071	7076	7082	7087	7092	7097	7103	7108	7113	7118	7123	7129	7134	7139
781	7059	7064	7069	7075	7080	7085	7091	7096	7101	7106	7112	7117	7122	7127	7132	7137	7142
780	7063	7068	7073	7079	7084	7089	7094	7100	7105	7110	7115	7120	7126	7131	7136	7141	7146
779	7066	7072	7077	7082	7088	7093	7098	7103	7109	7114	7119	7124	7129	7134	7140	7145	7150
778	7070	7075	7081	7086	7091	7097	7102	7107	7112	7117	7123	7128	7133	7138	7143	7148	7153
777	7074	7079	7085	7090	7095	7100	7106	7111	7116	7121	7126	7132	7137	7142	7147	7152	7157
776	7078	7083	7088	7094	7099	7104	7109	7115	7120	7125	7130	7135	7140	7146	7151	7156	7161
775	7081	7087	7092	7097	7103	7108	7113	7118	7123	7129	7134	7139	7144	7149	7154	7159	7164
774	7085	7090	7096	7101	7106	7112	7117	7122	7127	7132	7137	7143	7148	7153	7158	7163	7168
773	7089	7094	7100	7105	7110	7115	7120	7126	7131	7136	7141	7146	7151	7157	7162	7167	7172
772	7093	7098	7103	7109	7114	7119	7124	7129	7135	7140	7145	7150	7155	7160	7165	7170	7175
771	7096	7102	7107	7112	7118	7123	7128	7133	7138	7143	7149	7154	7159	7164	7169	7174	7179
770	7100	7106	7111	7116	7121	7126	7132	7137	7142	7147	7152	7157	7163	7168	7173	7178	7183
769	7104	7109	7115	7120	7125	7130	7135	7141	7146	7151	7156	7161	7166	7171	7176	7181	7186
768	7108	7113	7118	7124	7129	7134	7139	7144	7149	7155	7160	7165	7170	7175	7180	7185	7190
767	7112	7117	7122	7127	7133	7138	7143	7148	7153	7158	7163	7169	7174	7179	7184	7189	7194
766	7115	7121	7126	7131	7136	7141	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192	7197
765	7119	7124	7130	7135	7140	7145	7150	7155	7161	7166	7171	7176	7181	7186	7191	7196	7201
764	7123	7128	7133	7139	7144	7149	7154	7159	7164	7169	7175	7180	7185	7190	7195	7200	7205
763	7127	7132	7137	7142	7147	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198	7203	7208
762	7130	7136	7141	7146	7151	7156	7162	7167	7172	7177	7182	7187	7192	7197	7202	7207	7212
761	7134	7139	7145	7150	7155	7160	7165	7170	7175	7181	7186	7191	7196	7201	7206	7211	7216
760	7138	7143	7148	7154	7159	7164	7169	7174	7179	7184	7189	7194	7199	7204	7209	7214	7219
759	7142	7147	7152	7157	7162	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213	7218	7223
758	7145	7151	7156	7161	7166	7171	7176	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227
757	7149	7154	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230
756	7153	7158	7163	7169	7174	7179	7184	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234
755	7157	7162	7167	7172	7177	7183	7188	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238
754	7161	7166	7171	7176	7181	7186	7191	7196	7201	7207	7212	7217	7222	7227	7232	7236	7241
753	7164	7170	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245
752	7168	7173	7178	7184	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249
751	7172	7177	7182	7187	7192	7197	7203	7208	7213	7218	7223	7228	7233	7238	7243	7247	7252
750	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256
749	7179	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260
748	7183	7188	7193	7199	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249	7254	7258	7263
747	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262	7267
746	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271
745	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7269	7274
744	7198	7203	7208	7214	7219	7224	7229	7234	7239	7244	7249	7254	7258	7263	7268	7273	7278
743	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282
742	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276	7280	7285
741	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7270	7274	7279	7284	7289
740	7213	7218	7223	7229	7234	7239	7244	7249	7254	7258	7263	7268	7273	7278	7283	7288	7293
739	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7292	7296
738	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276	7281	7285	7290	7295	7300
737	7225	7230	7235	7240	7245	7250	7255	7260	7265	7270	7274	7279	7284	7289	7294	7299	7304
736	7228	7233	7239	7244	7249	7254	7258	7263	7268	7273	7278	7283	7288	7293	7298	7303	7307
735	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7292	7297	7301	7306	7311
734	7236	7241	7246	7251	7256	7261	7266	7271	7276	7281	7286	7290	7295	7300	7305	7310	7315
733	7240	7245	7250	7255	7260	7265	7270	7275	7280	7284	7289	7294	7299	7304	7309	7314	7318
732	7244	7249	7254	7259	7263	7268	7273	7278	7283	7288	7293	7298	7303	7308	7312	7317	7322
731	7247	7252	7257	7262	7267	7272	7277	7282	7287	7292	7297	7302	7306	7311	7316	7321	7326
730	7251	7256	7261	7266	7271	7276	7281	7286	7291	7296	7300	7305	7310	7315	7320	7325	7329
729	7255	7260	7265	7270	7275	7280	7285	7289	7294	7299	7304	7309	7314	7319	7323	7328	7333
728	7259	7264	7269	7274	7278	7283	7288	7293	7298	7303	7308	7313	7317	7322	7327	7332	7337
727	7262	7267	7272	7277	7282	7287	7292	7297	7302	7307	7312	7316	7321	7326	7331	7336	7340
726	7266	7271	7276	7281	7286	7291	7296	7301	7306	7310	7315	7320	7325	7330	7334	7339	7344
725	7270	7275	7280	7285	7290	7295	7299	7304	7309	7314	7319	7324	7329	7333	7338	7343	7348
724	7274	7279	7284	7289	7293	7298	7303	7308	7313	7318	7323	7327	7332	7337	7342	7347	7351
723	7277	7282	7287	7292	7297	7302	7307	7312	7317	7322	7326	7331	7336	7341	7345	7350	7355
722	7281	7286	7291	7296	7301	7306	7311	7316	7320	7325	7330	7335	7340	7344	7349	7354	7359
721	7285	7290	7295	7300	7305	7310	7314	7319	7324	7329	7334	7339	7343	7348	7353	7358	7362
720	7289	7294	7299	7304	7308	7313	7318	7323	7328	7333	7337	7342	7347	7352	7357	7361	7366

Table 28 Metric—Low Alt, Low-Mid Temp, Med Humidity
(Temp = 13.5 to 21.5° C, Press = 720 to 800 mm, 50% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5
800	7078	7083	7088	7094	7099	7104	7109	7114	7119	7124	7129	7135	7140	7145	7150	7155	7160
799	7082	7087	7092	7097	7102	7108	7113	7118	7123	7128	7133	7138	7143	7148	7153	7158	7163
798	7085	7091	7096	7101	7106	7111	7116	7121	7127	7132	7137	7142	7147	7152	7157	7162	7167
797	7089	7094	7099	7105	7110	7115	7120	7125	7130	7135	7140	7145	7150	7155	7160	7165	7170
796	7093	7098	7103	7108	7113	7118	7124	7129	7134	7139	7144	7149	7154	7159	7164	7169	7174
795	7096	7102	7107	7112	7117	7122	7127	7132	7137	7142	7147	7152	7157	7162	7167	7172	7177
794	7100	7105	7110	7115	7121	7126	7131	7136	7141	7146	7151	7156	7161	7166	7171	7176	7181
793	7104	7109	7114	7119	7124	7129	7134	7139	7145	7150	7155	7160	7165	7170	7175	7180	7185
792	7107	7112	7118	7123	7128	7133	7138	7143	7148	7153	7158	7163	7168	7173	7178	7183	7188
791	7111	7116	7121	7126	7131	7137	7142	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192
790	7115	7120	7125	7130	7135	7140	7145	7150	7155	7160	7165	7170	7175	7180	7185	7190	7195
789	7118	7123	7129	7134	7139	7144	7149	7154	7159	7164	7169	7174	7179	7184	7189	7194	7199
788	7122	7127	7132	7137	7142	7147	7153	7158	7163	7168	7173	7178	7183	7188	7192	7197	7202
787	7126	7131	7136	7141	7146	7151	7156	7161	7166	7171	7176	7181	7186	7191	7196	7201	7206
786	7129	7134	7139	7145	7150	7155	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7209
785	7133	7138	7143	7148	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213
784	7137	7142	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192	7197	7202	7207	7212	7217
783	7140	7145	7150	7155	7161	7166	7171	7176	7181	7186	7191	7196	7200	7205	7210	7215	7220
782	7144	7149	7154	7159	7164	7169	7174	7179	7184	7189	7194	7199	7204	7209	7214	7219	7224
781	7148	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213	7217	7222	7227
780	7151	7156	7161	7166	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231
779	7155	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7229	7234
778	7159	7164	7169	7174	7179	7184	7189	7194	7199	7204	7209	7213	7218	7223	7228	7233	7238
777	7162	7167	7172	7177	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7241
776	7166	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221	7226	7230	7235	7240	7245
775	7170	7175	7180	7185	7190	7195	7200	7205	7209	7214	7219	7224	7229	7234	7239	7244	7249
774	7173	7178	7183	7188	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7242	7247	7252
773	7177	7182	7187	7192	7197	7202	7207	7212	7217	7222	7226	7231	7236	7241	7246	7251	7256
772	7180	7186	7191	7196	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7254	7259
771	7184	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234	7239	7243	7248	7253	7258	7263
770	7188	7193	7198	7203	7208	7213	7218	7223	7227	7232	7237	7242	7247	7252	7257	7262	7266
769	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7255	7260	7265	7270
768	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7244	7249	7254	7259	7264	7269	7273
767	7199	7204	7209	7214	7219	7224	7229	7233	7238	7243	7248	7253	7258	7263	7267	7272	7277
766	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7261	7266	7271	7276	7281
765	7206	7211	7216	7221	7226	7231	7236	7241	7246	7250	7255	7260	7265	7270	7275	7279	7284
764	7210	7215	7220	7225	7230	7234	7239	7244	7249	7254	7259	7264	7269	7273	7278	7283	7288
763	7213	7218	7223	7228	7233	7238	7243	7248	7253	7258	7262	7267	7272	7277	7282	7286	7291
762	7217	7222	7227	7232	7237	7242	7247	7251	7256	7261	7266	7271	7276	7280	7285	7290	7295
761	7221	7226	7231	7236	7240	7245	7250	7255	7260	7265	7270	7274	7279	7284	7289	7294	7298
760	7224	7229	7234	7239	7244	7249	7254	7259	7264	7268	7273	7278	7283	7288	7292	7297	7302
759	7228	7233	7238	7243	7248	7253	7257	7262	7267	7272	7277	7282	7286	7291	7296	7301	7305
758	7232	7237	7242	7246	7251	7256	7261	7266	7271	7276	7280	7285	7290	7295	7300	7304	7309
757	7235	7240	7245	7250	7255	7260	7265	7270	7274	7279	7284	7289	7294	7298	7303	7308	7313
756	7239	7244	7249	7254	7259	7263	7268	7273	7278	7283	7288	7292	7297	7302	7307	7311	7316
755	7243	7248	7252	7257	7262	7267	7272	7277	7282	7286	7291	7296	7301	7306	7310	7315	7320
754	7246	7251	7256	7261	7266	7271	7276	7280	7285	7290	7295	7300	7304	7309	7314	7319	7323
753	7250	7255	7260	7265	7269	7274	7279	7284	7289	7294	7298	7303	7308	7313	7317	7322	7327
752	7254	7259	7263	7268	7273	7278	7283	7288	7292	7297	7302	7307	7311	7316	7321	7326	7330
751	7257	7262	7267	7272	7277	7282	7286	7291	7296	7301	7306	7310	7315	7320	7325	7329	7334
750	7261	7266	7271	7276	7280	7285	7290	7295	7300	7304	7309	7314	7319	7323	7328	7333	7337
749	7265	7269	7274	7279	7284	7289	7294	7298	7303	7308	7313	7318	7322	7327	7332	7336	7341
748	7268	7273	7278	7283	7288	7292	7297	7302	7307	7312	7316	7321	7326	7331	7335	7340	7345
747	7272	7277	7282	7286	7291	7296	7301	7306	7310	7315	7320	7325	7329	7334	7339	7343	7348
746	7276	7280	7285	7290	7295	7300	7305	7309	7314	7319	7324	7328	7333	7338	7342	7347	7352
745	7279	7284	7289	7294	7299	7303	7308	7313	7318	7322	7327	7332	7337	7341	7346	7351	7355
744	7283	7288	7293	7297	7302	7307	7312	7317	7321	7326	7331	7335	7340	7345	7350	7354	7359
743	7287	7291	7296	7301	7306	7311	7315	7320	7325	7330	7334	7339	7344	7348	7353	7358	7362
742	7290	7295	7300	7305	7309	7314	7319	7324	7328	7333	7338	7343	7347	7352	7357	7361	7366
741	7294	7299	7303	7308	7313	7318	7323	7327	7332	7337	7342	7346	7351	7356	7360	7365	7370
740	7298	7302	7307	7312	7317	7321	7326	7331	7336	7340	7345	7350	7354	7359	7364	7368	7373
739	7301	7306	7311	7316	7320	7325	7330	7335	7339	7344	7349	7353	7358	7363	7367	7372	7377
738	7305	7310	7314	7319	7324	7329	7333	7338	7343	7348	7352	7357	7362	7366	7371	7376	7380
737	7308	7313	7318	7323	7328	7332	7337	7342	7347	7351	7356	7361	7365	7370	7375	7379	7384
736	7312	7317	7322	7326	7331	7336	7341	7345	7350	7355	7359	7364	7369	7373	7378	7383	7387
735	7316	7321	7325	7330	7335	7340	7344	7349	7354	7358	7363	7368	7372	7377	7382	7386	7391
734	7319	7324	7329	7334	7338	7343	7348	7353	7357	7362	7367	7371	7376	7381	7385	7390	7394
733	7323	7328	7333	7337	7342	7347	7352	7356	7361	7366	7370	7375	7380	7384	7389	7393	7398
732	7327	7332	7336	7341	7346	7350	7355	7360	7365	7369	7374	7379	7383	7388	7392	7397	7402
731	7330	7335	7340	7345	7349	7354	7359	7363	7368	7373	7377	7382	7387	7391	7396	7401	7405
730	7334	7339	7344	7348	7353	7358	7362	7367	7372	7376	7381	7386	7390	7395	7399	7404	7409
729	7338	7342	7347	7352	7357	7361	7366	7371	7375	7380	7385	7389	7394	7398	7403	7408	7412
728	7341	7346	7351	7356	7360	7365	7370	7374	7379	7384	7388	7393	7397	7402	7407	7411	7416
727	7345	7350	7355	7359	7364	7369	7373	7378	7383	7387	7392	7396	7401	7406	7410	7415	7419
726	7349	7353	7358	7363	7368	7372	7377	7382	7386	7391	7395	7400	7405	7409	7414	7418	7423
725	7352	7357	7362	7366	7371	7376	7381	7385	7390	7394	7399	7404	7408	7413	7417	7422	7426
724	7356	7361	7365	7370	7375	7379	7384	7389	7393	7398	7403	7407	7412	7416	7421	7425	7430
723	7360	7364	7369	7374	7378	7383	7388	7392	7397	7402	7406	7411	7415	7420	7424	7429	7434
722	7363	7368	7373	7377	7382	7387	7391	7396	7401	7405	7410	7414	7419	7424	7428	7433	7437
721	7367	7372	7376	7381	7386	7390	7395	7400	7404	7409	7413	7418	7423	7427	7432	7436	7441
720	7371	7375	7380	7385	7389	7394	7399	7403	7408	7412	7417	7422	7426	7431	7435	7440	7444

Table 29 Metric—Low Alt, Mid Temp, Med Humidity
(Temp = 22 to 30° C, Press = 720 to 800 mm, 50% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
800	7165	7170	7175	7179	7184	7189	7194	7199	7204	7209	7214	7219	7224	7228	7233	7238	7243
799	7168	7173	7178	7183	7188	7193	7198	7203	7208	7212	7217	7222	7227	7232	7237	7242	7246
798	7172	7177	7182	7187	7191	7196	7201	7206	7211	7216	7221	7226	7231	7235	7240	7245	7250
797	7175	7180	7185	7190	7195	7200	7205	7210	7215	7219	7224	7229	7234	7239	7244	7248	7253
796	7179	7184	7189	7194	7199	7203	7208	7213	7218	7223	7228	7233	7237	7242	7247	7252	7257
795	7182	7187	7192	7197	7202	7207	7212	7217	7222	7226	7231	7236	7241	7246	7251	7255	7260
794	7186	7191	7196	7201	7206	7210	7215	7220	7225	7230	7235	7240	7244	7249	7254	7259	7264
793	7189	7194	7199	7204	7209	7214	7219	7224	7229	7233	7238	7243	7248	7253	7258	7262	7267
792	7193	7198	7203	7208	7213	7218	7222	7227	7232	7237	7242	7247	7251	7256	7261	7266	7271
791	7197	7201	7206	7211	7216	7221	7226	7231	7236	7240	7245	7250	7255	7260	7264	7269	7274
790	7200	7205	7210	7215	7220	7225	7229	7234	7239	7244	7249	7254	7258	7263	7268	7273	7277
789	7204	7209	7213	7218	7223	7228	7233	7238	7243	7247	7252	7257	7262	7267	7271	7276	7281
788	7207	7212	7217	7222	7227	7232	7236	7241	7246	7251	7256	7261	7265	7270	7275	7280	7284
787	7211	7216	7221	7225	7230	7235	7240	7245	7250	7254	7259	7264	7269	7274	7278	7283	7288
786	7214	7219	7224	7229	7234	7239	7243	7248	7253	7258	7263	7268	7272	7277	7282	7287	7291
785	7218	7223	7228	7232	7237	7242	7247	7252	7257	7261	7266	7271	7276	7281	7285	7290	7295
784	7221	7226	7231	7236	7241	7246	7251	7255	7260	7265	7270	7274	7279	7284	7289	7293	7298
783	7225	7230	7235	7240	7244	7249	7254	7259	7264	7268	7273	7278	7283	7287	7292	7297	7302
782	7229	7233	7238	7243	7248	7253	7258	7262	7267	7272	7277	7281	7286	7291	7296	7300	7305
781	7232	7237	7242	7247	7251	7256	7261	7266	7271	7275	7280	7285	7290	7294	7299	7304	7309
780	7236	7240	7245	7250	7255	7260	7265	7269	7274	7279	7284	7288	7293	7298	7303	7307	7312
779	7239	7244	7249	7254	7259	7263	7268	7273	7278	7282	7287	7292	7297	7301	7306	7311	7315
778	7243	7248	7252	7257	7262	7267	7272	7276	7281	7286	7291	7295	7300	7305	7310	7314	7319
777	7246	7251	7256	7261	7266	7270	7275	7280	7285	7289	7294	7299	7304	7308	7313	7318	7322
776	7250	7255	7259	7264	7269	7274	7279	7283	7288	7293	7298	7302	7307	7312	7316	7321	7326
775	7253	7258	7263	7268	7273	7277	7282	7287	7292	7296	7301	7306	7311	7315	7320	7325	7329
774	7257	7262	7267	7271	7276	7281	7286	7290	7295	7300	7305	7309	7314	7319	7323	7328	7333
773	7260	7265	7270	7275	7280	7284	7289	7294	7299	7303	7308	7313	7318	7322	7327	7332	7336
772	7264	7269	7274	7278	7283	7288	7293	7297	7302	7307	7312	7316	7321	7326	7330	7335	7340
771	7268	7272	7277	7282	7287	7291	7296	7301	7306	7310	7315	7320	7324	7329	7334	7339	7343
770	7271	7276	7281	7285	7290	7295	7300	7304	7309	7314	7319	7323	7328	7333	7337	7342	7347
769	7275	7279	7284	7289	7294	7299	7303	7308	7313	7317	7322	7327	7331	7336	7341	7345	7350
768	7278	7283	7288	7293	7297	7302	7307	7311	7316	7321	7326	7330	7335	7340	7344	7349	7354
767	7282	7287	7291	7296	7301	7306	7310	7315	7320	7324	7329	7334	7338	7343	7348	7352	7357
766	7285	7290	7295	7300	7304	7309	7314	7319	7323	7328	7333	7337	7342	7347	7351	7356	7360
765	7289	7294	7298	7303	7308	7313	7317	7322	7327	7331	7336	7341	7345	7350	7355	7359	7364
764	7292	7297	7302	7307	7311	7316	7321	7326	7330	7335	7340	7344	7349	7353	7358	7363	7367
763	7296	7301	7306	7310	7315	7320	7324	7329	7334	7338	7343	7348	7352	7357	7362	7366	7371
762	7300	7304	7309	7314	7318	7323	7328	7333	7337	7342	7347	7351	7356	7360	7365	7370	7374
761	7303	7308	7313	7317	7322	7327	7331	7336	7341	7345	7350	7355	7359	7364	7369	7373	7378
760	7307	7311	7316	7321	7326	7330	7335	7340	7344	7349	7354	7358	7363	7367	7372	7377	7381
759	7310	7315	7320	7324	7329	7334	7338	7343	7348	7352	7357	7362	7366	7371	7375	7380	7385
758	7314	7318	7323	7328	7333	7337	7342	7347	7351	7356	7361	7365	7370	7374	7379	7384	7388
757	7317	7322	7327	7331	7336	7341	7345	7350	7355	7359	7364	7369	7373	7378	7382	7387	7392
756	7321	7326	7330	7335	7340	7344	7349	7354	7358	7363	7367	7372	7377	7381	7386	7390	7395
755	7324	7329	7334	7338	7343	7348	7352	7357	7362	7366	7371	7376	7380	7385	7389	7394	7398
754	7328	7333	7337	7342	7347	7351	7356	7361	7365	7370	7374	7379	7384	7388	7393	7397	7402
753	7332	7336	7341	7346	7350	7355	7360	7364	7369	7373	7378	7383	7387	7392	7396	7401	7405
752	7335	7340	7344	7349	7354	7358	7363	7368	7372	7377	7381	7386	7391	7395	7400	7404	7409
751	7339	7343	7348	7353	7357	7362	7367	7371	7376	7380	7385	7390	7394	7399	7403	7408	7412
750	7342	7347	7352	7356	7361	7365	7370	7375	7379	7384	7388	7393	7398	7402	7407	7411	7416
749	7346	7350	7355	7360	7364	7369	7374	7378	7383	7387	7392	7396	7401	7406	7410	7415	7419
748	7349	7354	7359	7363	7368	7372	7377	7382	7386	7391	7395	7400	7405	7409	7414	7418	7423
747	7353	7357	7362	7367	7371	7376	7381	7385	7390	7394	7399	7403	7408	7413	7417	7422	7426
746	7356	7361	7366	7370	7375	7380	7384	7389	7393	7398	7402	7407	7411	7416	7421	7425	7430
745	7360	7365	7369	7374	7378	7383	7388	7392	7397	7401	7406	7410	7415	7420	7424	7429	7433
744	7363	7368	7373	7377	7382	7387	7391	7396	7400	7405	7409	7414	7418	7423	7427	7432	7436
743	7367	7372	7376	7381	7385	7390	7395	7399	7404	7408	7413	7417	7422	7426	7431	7435	7440
742	7371	7375	7380	7384	7389	7394	7398	7403	7407	7412	7416	7421	7425	7430	7434	7439	7443
741	7374	7379	7383	7388	7393	7397	7402	7406	7411	7415	7420	7424	7429	7433	7438	7442	7447
740	7378	7382	7387	7391	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7441	7446	7450
739	7381	7386	7390	7395	7400	7404	7409	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454
738	7385	7389	7394	7399	7403	7408	7412	7417	7421	7426	7430	7435	7439	7444	7448	7453	7457
737	7388	7393	7398	7402	7407	7411	7416	7420	7425	7429	7434	7438	7443	7447	7452	7456	7461
736	7392	7396	7401	7406	7410	7415	7419	7424	7428	7433	7437	7442	7446	7451	7455	7460	7464
735	7395	7400	7405	7409	7414	7418	7423	7427	7432	7436	7441	7445	7450	7454	7459	7463	7468
734	7399	7404	7408	7413	7417	7422	7426	7431	7435	7440	7444	7449	7453	7458	7462	7467	7471
733	7403	7407	7412	7416	7421	7425	7430	7434	7439	7443	7448	7452	7457	7461	7466	7470	7475
732	7406	7411	7415	7420	7424	7429	7433	7438	7442	7447	7451	7456	7460	7465	7469	7474	7478
731	7410	7414	7419	7423	7428	7432	7437	7441	7446	7450	7455	7459	7464	7468	7473	7477	7481
730	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454	7458	7463	7467	7472	7476	7480	7485
729	7417	7421	7426	7430	7435	7439	7444	7448	7453	7457	7462	7466	7471	7475	7480	7484	7488
728	7420	7425	7429	7434	7438	7443	7447	7452	7456	7461	7465	7470	7474	7479	7483	7487	7492
727	7424	7428	7433	7437	7442	7446	7451	7455	7460	7464	7469	7473	7478	7482	7486	7491	7495
726	7427	7432	7436	7441	7445	7450	7454	7459	7463	7468	7472	7477	7481	7486	7490	7494	7499
725	7431	7435	7440	7444	7449	7453	7458	7462	7467	7471	7476	7480	7485	7489	7493	7498	7502
724	7435	7439	7444	7448	7453	7457	7461	7466	7470	7475	7479	7484	7488	7492	7497	7501	7506
723	7438	7443	7447	7452	7456	7461	7465	7469	7474	7478	7483	7487	7492	7496	7500	7505	7509
722	7442	7446	7451	7455	7460	7464	7468	7473	7477	7482	7486	7491	7495	7499	7504	7508	7513
721	7445	7450	7454	7459	7463	7468	7472	7476	7481	7485	7490	7494	7498	7503	7507	7512	7516
720	7449	7453	7458	7462	7467	7471	7476	7480	7484	7489	7493	7498	7502	7506	7511	7515	7519

Table 30 Metric—Low Alt, High-Mid Temp, Med Humidity (Temp = 30.5 to 38.5° C, Press = 720 to 800 mm, 50% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5
800	7248	7253	7257	7262	7267	7272	7276	7281	7286	7291	7295	7300	7305	7310	7314	7319	7324
799	7251	7256	7261	7266	7270	7275	7280	7285	7289	7294	7299	7304	7308	7313	7318	7322	7327
798	7255	7259	7264	7269	7274	7279	7283	7288	7293	7298	7302	7307	7312	7316	7321	7326	7331
797	7258	7263	7268	7272	7277	7282	7287	7291	7296	7301	7306	7310	7315	7320	7325	7329	7334
796	7262	7266	7271	7276	7281	7285	7290	7295	7300	7304	7309	7314	7318	7323	7328	7333	7337
795	7265	7270	7275	7279	7284	7289	7294	7298	7303	7308	7312	7317	7322	7327	7331	7336	7341
794	7268	7273	7278	7283	7287	7292	7297	7302	7306	7311	7316	7321	7325	7330	7335	7339	7344
793	7272	7277	7281	7286	7291	7296	7300	7305	7310	7315	7319	7324	7329	7333	7338	7343	7347
792	7275	7280	7285	7290	7294	7299	7304	7308	7313	7318	7323	7327	7332	7337	7341	7346	7351
791	7279	7284	7288	7293	7298	7302	7307	7312	7317	7321	7326	7331	7335	7340	7345	7349	7354
790	7282	7287	7292	7296	7301	7306	7311	7315	7320	7325	7329	7334	7339	7343	7348	7353	7357
789	7286	7290	7295	7300	7305	7309	7314	7319	7323	7328	7333	7337	7342	7347	7352	7356	7361
788	7289	7294	7299	7303	7308	7313	7317	7322	7327	7332	7336	7341	7346	7350	7355	7360	7364
787	7293	7297	7302	7307	7311	7316	7321	7326	7330	7335	7340	7344	7349	7354	7358	7363	7368
786	7296	7301	7305	7310	7315	7320	7324	7329	7334	7338	7343	7348	7352	7357	7362	7366	7371
785	7299	7304	7309	7314	7318	7323	7328	7332	7337	7342	7346	7351	7356	7360	7365	7370	7374
784	7303	7308	7312	7317	7322	7326	7331	7336	7340	7345	7350	7354	7359	7364	7368	7373	7378
783	7306	7311	7316	7320	7325	7330	7335	7339	7344	7349	7353	7358	7362	7367	7372	7376	7381
782	7310	7315	7319	7324	7329	7333	7338	7343	7347	7352	7357	7361	7366	7370	7375	7380	7384
781	7313	7318	7323	7327	7332	7337	7341	7346	7351	7355	7360	7365	7369	7374	7378	7383	7388
780	7317	7321	7326	7331	7335	7340	7345	7349	7354	7359	7363	7368	7373	7377	7382	7386	7391
779	7320	7325	7330	7334	7339	7344	7348	7353	7357	7362	7367	7371	7376	7381	7385	7390	7394
778	7324	7328	7333	7338	7342	7347	7352	7356	7361	7366	7370	7375	7379	7384	7389	7393	7398
777	7327	7332	7336	7341	7346	7350	7355	7360	7364	7369	7374	7378	7383	7387	7392	7397	7401
776	7331	7335	7340	7345	7349	7354	7358	7363	7368	7372	7377	7382	7386	7391	7395	7400	7405
775	7334	7339	7343	7348	7353	7357	7362	7366	7371	7376	7380	7385	7390	7394	7399	7403	7408
774	7337	7342	7347	7351	7356	7361	7365	7370	7375	7379	7384	7388	7393	7398	7402	7407	7411
773	7341	7346	7350	7355	7359	7364	7369	7373	7378	7383	7387	7392	7396	7401	7405	7410	7415
772	7344	7349	7354	7358	7363	7368	7372	7377	7381	7386	7391	7395	7400	7404	7409	7413	7418
771	7348	7352	7357	7362	7366	7371	7376	7380	7385	7389	7394	7398	7403	7408	7412	7417	7421
770	7351	7356	7361	7365	7370	7374	7379	7384	7388	7393	7397	7402	7406	7411	7416	7420	7425
769	7355	7359	7364	7369	7373	7378	7382	7387	7392	7396	7401	7405	7410	7414	7419	7424	7428
768	7358	7363	7367	7372	7377	7381	7386	7390	7395	7400	7404	7409	7413	7418	7422	7427	7431
767	7362	7366	7371	7375	7380	7385	7389	7394	7398	7403	7407	7412	7417	7421	7426	7430	7435
766	7365	7370	7374	7379	7383	7388	7393	7397	7402	7406	7411	7415	7420	7425	7429	7434	7438
765	7369	7373	7378	7382	7387	7391	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7442
764	7372	7377	7381	7386	7390	7395	7399	7404	7409	7413	7418	7422	7427	7431	7436	7440	7445
763	7375	7380	7385	7389	7394	7398	7403	7407	7412	7417	7421	7426	7430	7435	7439	7444	7448
762	7379	7383	7388	7393	7397	7402	7406	7411	7415	7420	7424	7429	7434	7438	7443	7447	7452
761	7382	7387	7391	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7441	7446	7450	7455
760	7386	7390	7395	7399	7404	7409	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454	7458
759	7389	7394	7398	7403	7407	7412	7417	7421	7426	7430	7435	7439	7444	7448	7453	7457	7462
758	7393	7397	7402	7406	7411	7415	7420	7424	7429	7434	7438	7443	7447	7452	7456	7461	7465
757	7396	7401	7405	7410	7414	7419	7423	7428	7432	7437	7441	7446	7450	7455	7459	7464	7468
756	7400	7404	7409	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454	7458	7463	7467	7472
755	7403	7408	7412	7417	7421	7426	7430	7435	7439	7444	7448	7453	7457	7462	7466	7471	7475
754	7406	7411	7416	7420	7425	7429	7434	7438	7443	7447	7452	7456	7461	7465	7470	7474	7479
753	7410	7414	7419	7424	7428	7433	7437	7442	7446	7451	7455	7460	7464	7468	7473	7477	7482
752	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454	7458	7463	7467	7472	7476	7481	7485
751	7417	7421	7426	7430	7435	7439	7444	7448	7453	7457	7462	7466	7471	7475	7480	7484	7489
750	7420	7425	7429	7434	7438	7443	7447	7452	7456	7461	7465	7470	7474	7479	7483	7488	7492
749	7424	7428	7433	7437	7442	7446	7451	7455	7460	7464	7469	7473	7478	7482	7486	7491	7495
748	7427	7432	7436	7441	7445	7450	7454	7459	7463	7468	7472	7476	7481	7485	7490	7494	7499
747	7431	7435	7440	7444	7449	7453	7458	7462	7466	7471	7475	7480	7484	7489	7493	7498	7502
746	7434	7439	7443	7448	7452	7457	7461	7465	7470	7474	7479	7483	7488	7492	7497	7501	7505
745	7438	7442	7447	7451	7455	7460	7464	7469	7473	7478	7482	7487	7491	7495	7500	7504	7509
744	7441	7445	7450	7454	7459	7463	7468	7472	7477	7481	7486	7490	7494	7499	7503	7508	7512
743	7444	7449	7453	7458	7462	7467	7471	7476	7480	7485	7489	7493	7498	7502	7507	7511	7515
742	7448	7452	7457	7461	7466	7470	7475	7479	7484	7488	7492	7497	7501	7506	7510	7514	7519
741	7451	7456	7460	7465	7469	7474	7478	7482	7487	7491	7496	7500	7505	7509	7513	7518	7522
740	7455	7459	7464	7468	7473	7477	7481	7486	7490	7495	7499	7504	7508	7512	7517	7521	7526
739	7458	7463	7467	7472	7476	7480	7485	7489	7494	7498	7503	7507	7511	7516	7520	7525	7529
738	7462	7466	7471	7475	7479	7484	7488	7493	7497	7502	7506	7510	7515	7519	7524	7528	7532
737	7465	7470	7474	7478	7483	7487	7492	7496	7501	7505	7509	7514	7518	7523	7527	7531	7536
736	7469	7473	7477	7482	7486	7491	7495	7500	7504	7508	7513	7517	7522	7526	7530	7535	7539
735	7472	7476	7481	7485	7490	7494	7499	7503	7507	7512	7516	7521	7525	7529	7534	7538	7542
734	7476	7480	7484	7489	7493	7498	7502	7506	7511	7515	7520	7524	7528	7533	7537	7541	7546
733	7479	7483	7488	7492	7497	7501	7505	7510	7514	7519	7523	7527	7532	7536	7540	7545	7549
732	7482	7487	7491	7496	7500	7504	7509	7513	7518	7522	7526	7531	7535	7539	7544	7548	7552
731	7486	7490	7495	7499	7503	7508	7512	7517	7521	7525	7530	7534	7538	7543	7547	7551	7556
730	7489	7494	7498	7503	7507	7511	7516	7520	7524	7529	7533	7537	7542	7546	7551	7555	7559
729	7493	7497	7502	7506	7510	7515	7519	7523	7528	7532	7537	7541	7545	7550	7554	7558	7563
728	7496	7501	7505	7509	7514	7518	7522	7527	7531	7536	7540	7544	7549	7553	7557	7562	7566
727	7500	7504	7508	7513	7517	7522	7526	7530	7535	7539	7543	7548	7552	7556	7561	7565	7569
726	7503	7507	7512	7516	7521	7525	7529	7534	7538	7542	7547	7551	7555	7560	7564	7568	7573
725	7507	7511	7515	7520	7524	7528	7533	7537	7541	7546	7550	7554	7559	7563	7567	7572	7576
724	7510	7514	7519	7523	7527	7532	7536	7540	7545	7549	7553	7558	7562	7566	7571	7575	7579
723	7513	7518	7522	7527	7531	7535	7540	7544	7548	7553	7557	7561	7566	7570	7574	7578	7583
722	7517	7521	7526	7530	7534	7539	7543	7547	7552	7556	7560	7565	7569	7573	7578	7582	7586
721	7520	7525	7529	7533	7538	7542	7546	7551	7555	7559	7564	7568	7572	7577	7581	7585	7589
720	7524	7528	7533	7537	7541	7546	7550	7554	7558	7563	7567	7571	7576	7580	7584	7589	7593

Table 31 Metric—High Alt, Low Temp, Med Humidity
(Temp = 5 to 13° C, Press = 640 to 720 mm, 50% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
720	7289	7294	7299	7304	7308	7313	7318	7323	7328	7333	7337	7342	7347	7352	7357	7361	7366
719	7293	7297	7302	7307	7312	7317	7322	7327	7332	7336	7341	7346	7351	7355	7360	7365	7370
718	7296	7301	7306	7311	7316	7321	7326	7330	7335	7340	7345	7350	7354	7359	7364	7369	7373
717	7300	7305	7310	7315	7320	7324	7329	7334	7339	7344	7349	7353	7358	7363	7368	7372	7377
716	7304	7309	7314	7319	7323	7328	7333	7338	7343	7347	7352	7357	7362	7366	7371	7376	7381
715	7308	7312	7317	7322	7327	7332	7337	7342	7346	7351	7356	7361	7365	7370	7375	7380	7384
714	7311	7316	7321	7326	7331	7336	7341	7345	7350	7355	7360	7364	7369	7374	7379	7383	7388
713	7315	7320	7325	7330	7335	7339	7344	7349	7354	7359	7363	7368	7373	7378	7382	7387	7392
712	7319	7324	7329	7334	7338	7343	7348	7353	7358	7362	7367	7372	7377	7381	7386	7391	7395
711	7323	7328	7332	7337	7342	7347	7352	7356	7361	7366	7371	7375	7380	7385	7390	7394	7399
710	7326	7331	7336	7341	7346	7351	7355	7360	7365	7370	7374	7379	7384	7389	7393	7398	7403
709	7330	7335	7340	7345	7350	7354	7359	7364	7369	7373	7378	7383	7388	7392	7397	7402	7406
708	7334	7339	7344	7348	7353	7358	7363	7368	7372	7377	7382	7387	7391	7396	7401	7405	7410
707	7338	7343	7347	7352	7357	7362	7367	7371	7376	7381	7386	7390	7395	7400	7404	7409	7414
706	7342	7346	7351	7356	7361	7366	7370	7375	7380	7385	7389	7394	7399	7403	7408	7413	7417
705	7345	7350	7355	7360	7365	7369	7374	7379	7384	7388	7393	7398	7402	7407	7412	7416	7421
704	7349	7354	7359	7363	7368	7373	7378	7383	7387	7392	7397	7401	7406	7411	7415	7420	7425
703	7353	7358	7362	7367	7372	7377	7382	7386	7391	7396	7400	7405	7410	7414	7419	7424	7428
702	7357	7361	7366	7371	7376	7381	7385	7390	7395	7399	7404	7409	7413	7418	7423	7427	7432
701	7360	7365	7370	7375	7380	7384	7389	7394	7398	7403	7408	7412	7417	7422	7426	7431	7436
700	7364	7369	7374	7378	7383	7388	7393	7397	7402	7407	7411	7416	7421	7425	7430	7435	7439
699	7368	7373	7377	7382	7387	7392	7396	7401	7406	7411	7415	7420	7424	7429	7434	7438	7443
698	7372	7376	7381	7386	7391	7395	7400	7405	7410	7414	7419	7424	7428	7433	7437	7442	7447
697	7375	7380	7385	7390	7394	7399	7404	7409	7413	7418	7423	7427	7432	7436	7441	7446	7450
696	7379	7384	7389	7393	7398	7403	7408	7412	7417	7422	7426	7431	7436	7440	7445	7449	7454
695	7383	7388	7392	7397	7402	7407	7411	7416	7421	7425	7430	7435	7439	7444	7448	7453	7458
694	7387	7392	7396	7401	7406	7410	7415	7420	7424	7429	7434	7438	7443	7448	7452	7457	7461
693	7391	7395	7400	7405	7409	7414	7419	7423	7428	7433	7437	7442	7447	7451	7456	7460	7465
692	7394	7399	7404	7408	7413	7418	7423	7427	7432	7436	7441	7446	7450	7455	7459	7464	7469
691	7398	7403	7408	7412	7417	7422	7426	7431	7436	7440	7445	7449	7454	7459	7463	7468	7472
690	7402	7407	7411	7416	7421	7425	7430	7435	7439	7444	7449	7453	7458	7462	7467	7471	7476
689	7406	7410	7415	7420	7424	7429	7434	7438	7443	7448	7452	7457	7461	7466	7470	7475	7480
688	7409	7414	7419	7423	7428	7433	7437	7442	7447	7451	7456	7460	7465	7470	7474	7479	7483
687	7413	7418	7423	7427	7432	7437	7441	7446	7450	7455	7460	7464	7469	7473	7478	7482	7487
686	7417	7422	7426	7431	7436	7440	7445	7450	7454	7459	7463	7468	7472	7477	7482	7486	7491
685	7421	7425	7430	7435	7439	7444	7449	7453	7458	7462	7467	7472	7476	7481	7485	7490	7494
684	7424	7429	7434	7438	7443	7448	7452	7457	7462	7466	7471	7475	7480	7484	7489	7493	7498
683	7428	7433	7438	7442	7447	7451	7456	7461	7465	7470	7474	7479	7484	7488	7493	7497	7502
682	7432	7437	7441	7446	7451	7455	7460	7464	7469	7474	7478	7483	7487	7492	7496	7501	7505
681	7436	7440	7445	7450	7454	7459	7464	7468	7473	7477	7482	7486	7491	7495	7500	7504	7509
680	7440	7444	7449	7453	7458	7463	7467	7472	7476	7481	7486	7490	7495	7499	7504	7508	7512
679	7443	7448	7453	7457	7462	7466	7471	7476	7480	7485	7489	7494	7498	7503	7507	7512	7516
678	7447	7452	7456	7461	7466	7470	7475	7479	7484	7488	7493	7497	7502	7506	7511	7515	7520
677	7451	7455	7460	7465	7469	7474	7478	7483	7488	7492	7497	7501	7506	7510	7515	7519	7523
676	7455	7459	7464	7468	7473	7478	7482	7487	7491	7496	7500	7505	7509	7514	7518	7523	7527
675	7458	7463	7468	7472	7477	7481	7486	7490	7495	7500	7504	7509	7513	7517	7522	7526	7531
674	7462	7467	7471	7476	7481	7485	7490	7494	7499	7503	7508	7512	7517	7521	7526	7530	7534
673	7466	7471	7475	7480	7484	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529	7534	7538
672	7470	7474	7479	7483	7488	7493	7497	7502	7506	7511	7515	7520	7524	7529	7533	7537	7542
671	7473	7478	7483	7487	7492	7496	7501	7505	7510	7514	7519	7523	7528	7532	7537	7541	7545
670	7477	7482	7486	7491	7496	7500	7505	7509	7514	7518	7523	7527	7531	7536	7540	7545	7549
669	7481	7486	7490	7495	7499	7504	7508	7513	7517	7522	7526	7531	7535	7540	7544	7548	7553
668	7485	7489	7494	7498	7503	7508	7512	7517	7521	7526	7530	7534	7539	7543	7548	7552	7556
667	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529	7534	7538	7543	7547	7551	7556	7560
666	7492	7497	7501	7506	7510	7515	7520	7524	7528	7533	7537	7542	7546	7551	7555	7559	7564
665	7496	7501	7505	7510	7514	7519	7523	7528	7532	7537	7541	7546	7550	7554	7559	7563	7567
664	7500	7504	7509	7513	7518	7522	7527	7531	7536	7540	7545	7549	7554	7558	7562	7567	7571
663	7504	7508	7513	7517	7522	7526	7531	7535	7540	7544	7548	7553	7557	7562	7566	7570	7575
662	7507	7512	7516	7521	7525	7530	7534	7539	7543	7548	7552	7557	7561	7565	7570	7574	7578
661	7511	7516	7520	7525	7529	7534	7538	7543	7547	7551	7556	7560	7565	7569	7573	7578	7582
660	7515	7519	7524	7528	7533	7537	7542	7546	7551	7555	7560	7564	7568	7573	7577	7581	7586
659	7519	7523	7528	7532	7537	7541	7546	7550	7554	7559	7563	7568	7572	7576	7581	7585	7589
658	7522	7527	7531	7536	7540	7545	7549	7554	7558	7563	7567	7571	7576	7580	7584	7589	7593
657	7526	7531	7535	7540	7544	7549	7553	7557	7562	7566	7571	7575	7579	7584	7588	7592	7597
656	7530	7534	7539	7543	7548	7552	7557	7561	7566	7570	7574	7579	7583	7587	7592	7596	7600
655	7534	7538	7543	7547	7552	7556	7561	7565	7569	7574	7578	7582	7587	7591	7595	7600	7604
654	7538	7542	7546	7551	7555	7560	7564	7569	7573	7577	7582	7586	7590	7595	7599	7603	7608
653	7541	7546	7550	7555	7559	7564	7568	7572	7577	7581	7586	7590	7594	7599	7603	7607	7611
652	7545	7550	7554	7558	7563	7567	7572	7576	7580	7585	7589	7594	7598	7602	7606	7611	7615
651	7549	7553	7558	7562	7567	7571	7575	7580	7584	7589	7593	7597	7602	7606	7610	7614	7619
650	7553	7557	7562	7566	7570	7575	7579	7584	7588	7592	7597	7601	7605	7610	7614	7618	7622
649	7556	7561	7565	7570	7574	7579	7583	7587	7592	7596	7600	7605	7609	7613	7618	7622	7626
648	7560	7565	7569	7573	7578	7582	7587	7591	7595	7600	7604	7608	7613	7617	7621	7625	7630
647	7564	7568	7573	7577	7582	7586	7590	7595	7599	7603	7608	7612	7616	7621	7625	7629	7633
646	7568	7572	7577	7581	7585	7590	7594	7598	7603	7607	7611	7616	7620	7624	7629	7633	7637
645	7571	7576	7580	7585	7589	7593	7598	7602	7606	7611	7615	7619	7624	7628	7632	7636	7641
644	7575	7580	7584	7588	7593	7597	7602	7606	7610	7615	7619	7623	7627	7632	7636	7640	7644
643	7579	7583	7588	7592	7597	7601	7605	7610	7614	7618	7623	7627	7631	7635	7640	7644	7648
642	7583	7587	7592	7596	7600	7605	7609	7613	7618	7622	7626	7631	7635	7639	7643	7647	7652
641	7587	7591	7595	7600	7604	7608	7613	7617	7621	7626	7630	7634	7638	7643	7647	7651	7655
640	7590	7595	7599	7603	7608	7612	7616	7621	7625	7629	7634	7638	7642	7646	7651	7655	7659

Table 32 Metric—High Alt, Low-Mid Temp, Med Humidity
(Temp = 13.5 to 21.5° C, Press = 640 to 720 mm, 50% Humidity)

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5
720	7371	7375	7380	7385	7389	7394	7399	7403	7408	7412	7417	7422	7426	7431	7435	7440	7444
719	7374	7379	7384	7388	7393	7398	7402	7407	7411	7416	7421	7425	7430	7434	7439	7443	7448
718	7378	7383	7387	7392	7397	7401	7406	7410	7415	7420	7424	7429	7433	7438	7442	7447	7451
717	7382	7386	7391	7396	7400	7405	7409	7414	7419	7423	7428	7432	7437	7441	7446	7450	7455
716	7385	7390	7395	7399	7404	7408	7413	7418	7422	7427	7431	7436	7440	7445	7449	7454	7458
715	7389	7394	7398	7403	7407	7412	7417	7421	7426	7430	7435	7439	7444	7449	7453	7458	7462
714	7393	7397	7402	7407	7411	7416	7420	7425	7429	7434	7439	7443	7448	7452	7457	7461	7466
713	7396	7401	7406	7410	7415	7419	7424	7429	7433	7438	7442	7447	7451	7456	7460	7465	7469
712	7400	7405	7409	7414	7418	7423	7428	7432	7437	7441	7446	7450	7455	7459	7464	7468	7473
711	7404	7408	7413	7417	7422	7427	7431	7436	7440	7445	7449	7454	7458	7463	7467	7472	7476
710	7407	7412	7416	7421	7426	7430	7435	7439	7444	7448	7453	7457	7462	7466	7471	7475	7480
709	7411	7416	7420	7425	7429	7434	7438	7443	7447	7452	7457	7461	7466	7470	7474	7479	7483
708	7415	7419	7424	7428	7433	7437	7442	7447	7451	7456	7460	7465	7469	7474	7478	7482	7487
707	7418	7423	7427	7432	7437	7441	7446	7450	7455	7459	7464	7468	7473	7477	7482	7486	7490
706	7422	7426	7431	7436	7440	7445	7449	7454	7458	7463	7467	7472	7476	7481	7485	7490	7494
705	7426	7430	7435	7439	7444	7448	7453	7457	7462	7466	7471	7475	7480	7484	7489	7493	7498
704	7429	7434	7438	7443	7447	7452	7457	7461	7466	7470	7474	7479	7483	7488	7492	7497	7501
703	7433	7437	7442	7447	7451	7456	7460	7465	7469	7474	7478	7483	7487	7491	7496	7500	7505
702	7436	7441	7446	7450	7455	7459	7464	7468	7473	7477	7482	7486	7491	7495	7499	7504	7508
701	7440	7445	7449	7454	7458	7463	7467	7472	7476	7481	7485	7490	7494	7499	7503	7507	7512
700	7444	7448	7453	7457	7462	7466	7471	7475	7480	7484	7489	7493	7498	7502	7507	7511	7515
699	7447	7452	7457	7461	7466	7470	7475	7479	7484	7488	7492	7497	7501	7506	7510	7515	7519
698	7451	7456	7460	7465	7469	7474	7478	7483	7487	7492	7496	7500	7505	7509	7514	7518	7522
697	7455	7459	7464	7468	7473	7477	7482	7486	7491	7495	7500	7504	7508	7513	7517	7522	7526
696	7458	7463	7467	7472	7477	7481	7485	7490	7494	7499	7503	7508	7512	7516	7521	7525	7530
695	7462	7467	7471	7476	7480	7485	7489	7494	7498	7502	7507	7511	7516	7520	7524	7529	7533
694	7466	7470	7475	7479	7484	7488	7493	7497	7502	7506	7510	7515	7519	7524	7528	7532	7537
693	7469	7474	7478	7483	7487	7492	7496	7501	7505	7510	7514	7518	7523	7527	7532	7536	7540
692	7473	7478	7482	7487	7491	7495	7500	7504	7509	7513	7518	7522	7526	7531	7535	7539	7544
691	7477	7481	7486	7490	7495	7499	7504	7508	7512	7517	7521	7526	7530	7534	7539	7543	7547
690	7480	7485	7489	7494	7498	7503	7507	7512	7516	7520	7525	7529	7534	7538	7542	7547	7551
689	7484	7489	7493	7497	7502	7506	7511	7515	7520	7524	7528	7533	7537	7541	7546	7550	7554
688	7488	7492	7497	7501	7506	7510	7514	7519	7523	7528	7532	7536	7541	7545	7549	7554	7558
687	7491	7496	7500	7505	7509	7514	7518	7522	7527	7531	7536	7540	7544	7549	7553	7557	7562
686	7495	7499	7504	7508	7513	7517	7522	7526	7530	7535	7539	7544	7548	7552	7557	7561	7565
685	7499	7503	7508	7512	7516	7521	7525	7530	7534	7538	7543	7547	7551	7556	7560	7564	7569
684	7502	7507	7511	7516	7520	7524	7529	7533	7538	7542	7546	7551	7555	7559	7564	7568	7572
683	7506	7510	7515	7519	7524	7528	7533	7537	7541	7546	7550	7554	7559	7563	7567	7572	7576
682	7510	7514	7519	7523	7527	7532	7536	7541	7545	7549	7554	7558	7562	7567	7571	7575	7579
681	7513	7518	7522	7527	7531	7535	7540	7544	7548	7553	7557	7561	7566	7570	7574	7579	7583
680	7517	7521	7526	7530	7535	7539	7543	7548	7552	7556	7561	7565	7569	7574	7578	7582	7587
679	7521	7525	7529	7534	7538	7543	7547	7551	7556	7560	7564	7569	7573	7577	7582	7586	7590
678	7524	7529	7533	7537	7542	7546	7551	7555	7559	7564	7568	7572	7577	7581	7585	7589	7594
677	7528	7532	7537	7541	7546	7550	7554	7559	7563	7567	7572	7576	7580	7584	7589	7593	7597
676	7532	7536	7540	7545	7549	7553	7558	7562	7567	7571	7575	7579	7584	7588	7592	7596	7601
675	7535	7540	7544	7548	7553	7557	7561	7566	7570	7574	7579	7583	7587	7592	7596	7600	7604
674	7539	7543	7548	7552	7556	7561	7565	7569	7574	7578	7582	7587	7591	7595	7599	7604	7608
673	7543	7547	7551	7556	7560	7564	7569	7573	7577	7582	7586	7590	7594	7599	7603	7607	7611
672	7546	7551	7555	7559	7564	7568	7572	7577	7581	7585	7590	7594	7598	7602	7607	7611	7615
671	7550	7554	7559	7563	7567	7572	7576	7580	7585	7589	7593	7597	7602	7606	7610	7614	7619
670	7554	7558	7562	7567	7571	7575	7580	7584	7588	7592	7597	7601	7605	7609	7614	7618	7622
669	7557	7562	7566	7570	7575	7579	7583	7587	7592	7596	7600	7605	7609	7613	7617	7621	7626
668	7561	7565	7570	7574	7578	7582	7587	7591	7595	7600	7604	7608	7612	7617	7621	7625	7629
667	7564	7569	7573	7578	7582	7586	7590	7595	7599	7603	7607	7612	7616	7620	7624	7629	7633
666	7568	7572	7577	7581	7585	7590	7594	7598	7603	7607	7611	7615	7620	7624	7628	7632	7636
665	7572	7576	7580	7585	7589	7593	7598	7602	7606	7610	7615	7619	7623	7627	7632	7636	7640
664	7575	7580	7584	7588	7593	7597	7601	7606	7610	7614	7618	7622	7627	7631	7635	7639	7643
663	7579	7583	7588	7592	7596	7601	7605	7609	7613	7618	7622	7626	7630	7634	7639	7643	7647
662	7583	7587	7591	7596	7600	7604	7609	7613	7617	7621	7625	7630	7634	7638	7642	7646	7651
661	7586	7591	7595	7599	7604	7608	7612	7616	7621	7625	7629	7633	7637	7642	7646	7650	7654
660	7590	7594	7599	7603	7607	7611	7616	7620	7624	7628	7633	7637	7641	7645	7649	7654	7658
659	7594	7598	7602	7607	7611	7615	7619	7624	7628	7632	7636	7640	7645	7649	7653	7657	7661
658	7597	7602	7606	7610	7615	7619	7623	7627	7631	7636	7640	7644	7648	7652	7656	7661	7665
657	7601	7605	7610	7614	7618	7622	7627	7631	7635	7639	7643	7648	7652	7656	7660	7664	7668
656	7605	7609	7613	7618	7622	7626	7630	7634	7639	7643	7647	7651	7655	7659	7664	7668	7672
655	7608	7613	7617	7621	7625	7630	7634	7638	7642	7646	7651	7655	7659	7663	7667	7671	7675
654	7612	7616	7621	7625	7629	7633	7637	7642	7646	7650	7654	7658	7663	7667	7671	7675	7679
653	7616	7620	7624	7628	7633	7637	7641	7645	7649	7654	7658	7662	7666	7670	7674	7678	7683
652	7619	7624	7628	7632	7636	7641	7645	7649	7653	7657	7661	7666	7670	7674	7678	7682	7686
651	7623	7627	7631	7636	7640	7644	7648	7653	7657	7661	7665	7669	7673	7677	7681	7686	7690
650	7627	7631	7635	7639	7644	7648	7652	7656	7660	7664	7669	7673	7677	7681	7685	7689	7693
649	7630	7635	7639	7643	7647	7651	7656	7660	7664	7668	7672	7676	7680	7685	7689	7693	7697
648	7634	7638	7642	7647	7651	7655	7659	7663	7667	7672	7676	7680	7684	7688	7692	7696	7700
647	7638	7642	7646	7650	7654	7659	7663	7667	7671	7675	7679	7683	7688	7692	7696	7700	7704
646	7641	7645	7650	7654	7658	7662	7666	7671	7675	7679	7683	7687	7691	7695	7699	7703	7707
645	7645	7649	7653	7658	7662	7666	7670	7674	7678	7682	7687	7691	7695	7699	7703	7707	7711
644	7649	7653	7657	7661	7665	7670	7674	7678	7682	7686	7690	7694	7698	7702	7706	7711	7715
643	7652	7656	7661	7665	7669	7673	7677	7681	7686	7690	7694	7698	7702	7706	7710	7714	7718
642	7656	7660	7664	7668	7673	7677	7681	7685	7689	7693	7697	7701	7705	7710	7714	7718	7722
641	7660	7664	7668	7672	7676	7680	7685	7689	7693	7697	7701	7705	7709	7713	7717	7721	7725
640	7663	7667	7672	7676	7680	7684	7688	7692	7696	7700	7705	7709	7713	7717	7721	7725	7729

Table 33 Metric—High Alt, Mid Temp, Med Humidity
(Temp = 22 to 30° C, Press = 640 to 720 mm, 50% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
720	7449	7453	7458	7462	7467	7471	7476	7480	7484	7489	7493	7498	7502	7506	7511	7515	7519
719	7452	7457	7461	7466	7470	7475	7479	7483	7488	7492	7497	7501	7505	7510	7514	7519	7523
718	7456	7460	7465	7469	7474	7478	7483	7487	7491	7496	7500	7505	7509	7513	7518	7522	7526
717	7459	7464	7468	7473	7477	7482	7486	7490	7495	7499	7504	7508	7512	7517	7521	7525	7530
716	7463	7467	7472	7476	7481	7485	7490	7494	7498	7503	7507	7512	7516	7520	7525	7529	7533
715	7466	7471	7475	7480	7484	7489	7493	7497	7502	7506	7511	7515	7519	7524	7528	7532	7537
714	7470	7474	7479	7483	7488	7492	7497	7501	7505	7510	7514	7519	7523	7527	7532	7536	7540
713	7474	7478	7482	7487	7491	7496	7500	7505	7509	7513	7518	7522	7526	7531	7535	7539	7544
712	7477	7482	7486	7490	7495	7499	7504	7508	7512	7517	7521	7525	7530	7534	7538	7543	7547
711	7481	7485	7490	7494	7498	7503	7507	7512	7516	7520	7525	7529	7533	7538	7542	7546	7551
710	7484	7489	7493	7497	7502	7506	7511	7515	7519	7524	7528	7532	7537	7541	7545	7550	7554
709	7488	7492	7497	7501	7505	7510	7514	7519	7523	7527	7532	7536	7540	7545	7549	7553	7557
708	7491	7496	7500	7505	7509	7513	7518	7522	7526	7531	7535	7539	7544	7548	7552	7557	7561
707	7495	7499	7504	7508	7512	7517	7521	7526	7530	7534	7539	7543	7547	7552	7556	7560	7564
706	7498	7503	7507	7512	7516	7520	7525	7529	7533	7538	7542	7546	7551	7555	7559	7564	7568
705	7502	7506	7511	7515	7520	7524	7528	7533	7537	7541	7546	7550	7554	7558	7563	7567	7571
704	7506	7510	7514	7519	7523	7527	7532	7536	7540	7545	7549	7553	7558	7562	7566	7571	7575
703	7509	7513	7518	7522	7527	7531	7535	7540	7544	7548	7553	7557	7561	7565	7570	7574	7578
702	7513	7517	7521	7526	7530	7534	7539	7543	7547	7552	7556	7560	7565	7569	7573	7577	7582
701	7516	7521	7525	7529	7534	7538	7542	7547	7551	7555	7560	7564	7568	7572	7577	7581	7585
700	7520	7524	7528	7533	7537	7541	7546	7550	7554	7559	7563	7567	7572	7576	7580	7584	7589
699	7523	7528	7532	7536	7541	7545	7549	7554	7558	7562	7567	7571	7575	7579	7584	7588	7592
698	7527	7531	7536	7540	7544	7549	7553	7557	7561	7566	7570	7574	7579	7583	7587	7591	7596
697	7530	7535	7539	7543	7548	7552	7556	7561	7565	7569	7574	7578	7582	7586	7591	7595	7599
696	7534	7538	7543	7547	7551	7556	7560	7564	7568	7573	7577	7581	7586	7590	7594	7598	7602
695	7538	7542	7546	7550	7555	7559	7563	7568	7572	7576	7580	7585	7589	7593	7597	7602	7606
694	7541	7545	7550	7554	7558	7563	7567	7571	7575	7580	7584	7588	7592	7597	7601	7605	7609
693	7545	7549	7553	7558	7562	7566	7570	7575	7579	7583	7587	7592	7596	7600	7604	7609	7613
692	7548	7552	7557	7561	7565	7570	7574	7578	7582	7587	7591	7595	7599	7604	7608	7612	7616
691	7552	7556	7560	7565	7569	7573	7577	7582	7586	7590	7594	7599	7603	7607	7611	7616	7620
690	7555	7560	7564	7568	7572	7577	7581	7585	7589	7594	7598	7602	7606	7611	7615	7619	7623
689	7559	7563	7567	7572	7576	7580	7584	7589	7593	7597	7601	7606	7610	7614	7618	7622	7627
688	7562	7567	7571	7575	7579	7584	7588	7592	7596	7601	7605	7609	7613	7618	7622	7626	7630
687	7566	7570	7574	7579	7583	7587	7592	7596	7600	7604	7608	7613	7617	7621	7625	7629	7634
686	7569	7574	7578	7582	7587	7591	7595	7599	7603	7608	7612	7616	7620	7624	7629	7633	7637
685	7573	7577	7582	7586	7590	7594	7599	7603	7607	7611	7615	7620	7624	7628	7632	7636	7640
684	7577	7581	7585	7589	7594	7598	7602	7606	7610	7615	7619	7623	7627	7631	7636	7640	7644
683	7580	7584	7589	7593	7597	7601	7606	7610	7614	7618	7622	7627	7631	7635	7639	7643	7647
682	7584	7588	7592	7596	7601	7605	7609	7613	7618	7622	7626	7630	7634	7638	7643	7647	7651
681	7587	7591	7596	7600	7604	7608	7613	7617	7621	7625	7629	7634	7638	7642	7646	7650	7654
680	7591	7595	7599	7603	7608	7612	7616	7620	7625	7629	7633	7637	7641	7645	7649	7654	7658
679	7594	7599	7603	7607	7611	7615	7620	7624	7628	7632	7636	7641	7645	7649	7653	7657	7661
678	7598	7602	7606	7611	7615	7619	7623	7627	7632	7636	7640	7644	7648	7652	7656	7661	7665
677	7601	7606	7610	7614	7618	7622	7627	7631	7635	7639	7643	7647	7652	7656	7660	7664	7668
676	7605	7609	7613	7618	7622	7626	7630	7634	7639	7643	7647	7651	7655	7659	7663	7667	7672
675	7609	7613	7617	7621	7625	7630	7634	7638	7642	7646	7650	7654	7659	7663	7667	7671	7675
674	7612	7616	7620	7625	7629	7633	7637	7641	7646	7650	7654	7658	7662	7666	7670	7674	7678
673	7616	7620	7624	7628	7632	7637	7641	7645	7649	7653	7657	7661	7666	7670	7674	7678	7682
672	7619	7623	7628	7632	7636	7640	7644	7648	7653	7657	7661	7665	7669	7673	7677	7681	7685
671	7623	7627	7631	7635	7639	7644	7648	7652	7656	7660	7664	7668	7673	7677	7681	7685	7689
670	7626	7630	7635	7639	7643	7647	7651	7655	7660	7664	7668	7672	7676	7680	7684	7688	7692
669	7630	7634	7638	7642	7647	7651	7655	7659	7663	7667	7671	7675	7679	7684	7688	7692	7696
668	7633	7638	7642	7646	7650	7654	7658	7662	7667	7671	7675	7679	7683	7687	7691	7695	7699
667	7637	7641	7645	7649	7654	7658	7662	7666	7670	7674	7678	7682	7686	7691	7695	7699	7703
666	7640	7645	7649	7653	7657	7661	7665	7669	7674	7678	7682	7686	7690	7694	7698	7702	7706
665	7644	7648	7652	7656	7661	7665	7669	7673	7677	7681	7685	7689	7693	7697	7702	7706	7710
664	7648	7652	7656	7660	7664	7668	7672	7676	7681	7685	7689	7693	7697	7701	7705	7709	7713
663	7651	7655	7659	7664	7668	7672	7676	7680	7684	7688	7692	7696	7700	7704	7708	7712	7717
662	7655	7659	7663	7667	7671	7675	7679	7683	7688	7692	7696	7700	7704	7708	7712	7716	7720
661	7658	7662	7667	7671	7675	7679	7683	7687	7691	7695	7699	7703	7707	7711	7715	7719	7723
660	7662	7666	7670	7674	7678	7682	7686	7691	7695	7699	7703	7707	7711	7715	7719	7723	7727
659	7665	7669	7674	7678	7682	7686	7690	7694	7698	7702	7706	7710	7714	7718	7722	7726	7730
658	7669	7673	7677	7681	7685	7689	7693	7698	7702	7706	7710	7714	7718	7722	7726	7730	7734
657	7672	7677	7681	7685	7689	7693	7697	7701	7705	7709	7713	7717	7721	7725	7729	7733	7737
656	7676	7680	7684	7688	7692	7696	7700	7705	7709	7713	7717	7721	7725	7729	7733	7737	7741
655	7680	7684	7688	7692	7696	7700	7704	7708	7712	7716	7720	7724	7728	7732	7736	7740	7744
654	7683	7687	7691	7695	7699	7703	7708	7712	7716	7720	7724	7728	7732	7736	7740	7744	7748
653	7687	7691	7695	7699	7703	7707	7711	7715	7719	7723	7727	7731	7735	7739	7743	7747	7751
652	7690	7694	7698	7702	7706	7711	7715	7719	7723	7727	7731	7735	7739	7743	7747	7751	7755
651	7694	7698	7702	7706	7710	7714	7718	7722	7726	7730	7734	7738	7742	7746	7750	7754	7758
650	7697	7701	7705	7709	7714	7718	7722	7726	7730	7734	7738	7742	7746	7750	7754	7758	7761
649	7701	7705	7709	7713	7717	7721	7725	7729	7733	7737	7741	7745	7749	7753	7757	7761	7765
648	7704	7708	7713	7717	7721	7725	7729	7733	7737	7741	7745	7749	7753	7757	7760	7764	7768
647	7708	7712	7716	7720	7724	7728	7732	7736	7740	7744	7748	7752	7756	7760	7764	7768	7772
646	7712	7716	7720	7724	7728	7732	7736	7740	7744	7748	7752	7756	7760	7763	7767	7771	7775
645	7715	7719	7723	7727	7731	7735	7739	7743	7747	7751	7755	7759	7763	7767	7771	7775	7779
644	7719	7723	7727	7731	7735	7739	7743	7747	7751	7755	7759	7763	7766	7770	7774	7778	7782
643	7722	7726	7730	7734	7738	7742	7746	7750	7754	7758	7762	7766	7770	7774	7778	7782	7786
642	7726	7730	7734	7738	7742	7746	7750	7754	7758	7762	7766	7769	7773	7777	7781	7785	7789
641	7729	7733	7737	7741	7745	7749	7753	7757	7761	7765	7769	7773	7777	7781	7785	7789	7793
640	7733	7737	7741	7745	7749	7753	7757	7761	7765	7769	7773	7776	7780	7784	7788	7792	7796

Table 34 Metric—High Alt, High-Mid Temp, Med Humidity
(Temp = 30.5 to 38.5° C, Press = 640 to 720 mm, 50% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5
720	7524	7528	7533	7537	7541	7546	7550	7554	7558	7563	7567	7571	7576	7580	7584	7589	7593
719	7527	7532	7536	7540	7545	7549	7553	7558	7562	7566	7570	7575	7579	7583	7588	7592	7596
718	7531	7535	7539	7544	7548	7552	7557	7561	7565	7570	7574	7578	7582	7587	7591	7595	7600
717	7534	7539	7543	7547	7551	7556	7560	7564	7569	7573	7577	7582	7586	7590	7594	7599	7603
716	7538	7542	7546	7551	7555	7559	7563	7568	7572	7576	7581	7585	7589	7593	7598	7602	7606
715	7541	7545	7550	7554	7558	7563	7567	7571	7575	7580	7584	7588	7593	7597	7601	7605	7610
714	7545	7549	7553	7557	7562	7566	7570	7575	7579	7583	7587	7592	7596	7600	7604	7609	7613
713	7548	7552	7557	7561	7565	7569	7574	7578	7582	7587	7591	7595	7599	7604	7608	7612	7616
712	7551	7556	7560	7564	7569	7573	7577	7581	7586	7590	7594	7598	7603	7607	7611	7615	7620
711	7555	7559	7563	7568	7572	7576	7581	7585	7589	7593	7598	7602	7606	7610	7615	7619	7623
710	7558	7563	7567	7571	7575	7580	7584	7588	7593	7597	7601	7605	7610	7614	7618	7622	7626
709	7562	7566	7570	7575	7579	7583	7587	7592	7596	7600	7604	7609	7613	7617	7621	7626	7630
708	7565	7570	7574	7578	7582	7587	7591	7595	7599	7604	7608	7612	7616	7621	7625	7629	7633
707	7569	7573	7577	7581	7586	7590	7594	7598	7603	7607	7611	7615	7620	7624	7628	7632	7637
706	7572	7576	7581	7585	7589	7593	7598	7602	7606	7610	7615	7619	7623	7627	7631	7636	7640
705	7576	7580	7584	7588	7593	7597	7601	7605	7610	7614	7618	7622	7626	7631	7635	7639	7643
704	7579	7583	7588	7592	7596	7600	7605	7609	7613	7617	7621	7626	7630	7634	7638	7642	7647
703	7582	7587	7591	7595	7599	7604	7608	7612	7616	7621	7625	7629	7633	7637	7642	7646	7650
702	7586	7590	7594	7599	7603	7607	7611	7616	7620	7624	7628	7632	7637	7641	7645	7649	7653
701	7589	7594	7598	7602	7606	7611	7615	7619	7623	7627	7632	7636	7640	7644	7648	7653	7657
700	7593	7597	7601	7606	7610	7614	7618	7622	7627	7631	7635	7639	7643	7648	7652	7656	7660
699	7596	7601	7605	7609	7613	7617	7622	7626	7630	7634	7638	7643	7647	7651	7655	7659	7663
698	7600	7604	7608	7612	7617	7621	7625	7629	7633	7638	7642	7646	7650	7654	7658	7663	7667
697	7603	7607	7612	7616	7620	7624	7628	7633	7637	7641	7645	7649	7653	7658	7662	7666	7670
696	7607	7611	7615	7619	7623	7628	7632	7636	7640	7644	7649	7653	7657	7661	7665	7669	7674
695	7610	7614	7619	7623	7627	7631	7635	7639	7644	7648	7652	7656	7660	7664	7669	7673	7677
694	7614	7618	7622	7626	7630	7635	7639	7643	7647	7651	7655	7659	7664	7668	7672	7676	7680
693	7617	7621	7625	7630	7634	7638	7642	7646	7650	7655	7659	7663	7667	7671	7675	7679	7684
692	7620	7625	7629	7633	7637	7641	7646	7650	7654	7658	7662	7666	7670	7675	7679	7683	7687
691	7624	7628	7632	7636	7641	7645	7649	7653	7657	7661	7666	7670	7674	7678	7682	7686	7690
690	7627	7632	7636	7640	7644	7648	7652	7656	7661	7665	7669	7673	7677	7681	7685	7690	7694
689	7631	7635	7639	7643	7647	7652	7656	7660	7664	7668	7672	7676	7681	7685	7689	7693	7697
688	7634	7638	7643	7647	7651	7655	7659	7663	7667	7672	7676	7680	7684	7688	7692	7696	7700
687	7638	7642	7646	7650	7654	7658	7663	7667	7671	7675	7679	7683	7687	7691	7696	7700	7704
686	7641	7645	7649	7654	7658	7662	7666	7670	7674	7678	7683	7687	7691	7695	7699	7703	7707
685	7645	7649	7653	7657	7661	7665	7669	7674	7678	7682	7686	7690	7694	7698	7702	7706	7711
684	7648	7652	7656	7660	7665	7669	7673	7677	7681	7685	7689	7693	7697	7702	7706	7710	7714
683	7652	7656	7660	7664	7668	7672	7676	7680	7684	7689	7693	7697	7701	7705	7709	7713	7717
682	7655	7659	7663	7667	7671	7676	7680	7684	7688	7692	7696	7700	7704	7708	7712	7717	7721
681	7658	7663	7667	7671	7675	7679	7683	7687	7691	7695	7699	7704	7708	7712	7716	7720	7724
680	7662	7666	7670	7674	7678	7682	7687	7691	7695	7699	7703	7707	7711	7715	7719	7723	7727
679	7665	7669	7674	7678	7682	7686	7690	7694	7698	7702	7706	7710	7714	7718	7723	7727	7731
678	7669	7673	7677	7681	7685	7689	7693	7697	7702	7706	7710	7714	7718	7722	7726	7730	7734
677	7672	7676	7680	7685	7689	7693	7697	7701	7705	7709	7713	7717	7721	7725	7729	7733	7737
676	7676	7680	7684	7688	7692	7696	7700	7704	7708	7712	7716	7721	7725	7729	7733	7737	7741
675	7679	7683	7687	7691	7695	7700	7704	7708	7712	7716	7720	7724	7728	7732	7736	7740	7744
674	7683	7687	7691	7695	7699	7703	7707	7711	7715	7719	7723	7727	7731	7735	7739	7743	7747
673	7686	7690	7694	7698	7702	7706	7710	7714	7719	7723	7727	7731	7735	7739	7743	7747	7751
672	7689	7694	7698	7702	7706	7710	7714	7718	7722	7726	7730	7734	7738	7742	7746	7750	7754
671	7693	7697	7701	7705	7709	7713	7717	7721	7725	7729	7733	7737	7741	7746	7750	7754	7758
670	7696	7700	7705	7709	7713	7717	7721	7725	7729	7733	7737	7741	7745	7749	7753	7757	7761
669	7700	7704	7708	7712	7716	7720	7724	7728	7732	7736	7740	7744	7748	7752	7756	7760	7764
668	7703	7707	7711	7715	7719	7724	7728	7732	7736	7740	7744	7748	7752	7756	7760	7764	7768
667	7707	7711	7715	7719	7723	7727	7731	7735	7739	7743	7747	7751	7755	7759	7763	7767	7771
666	7710	7714	7718	7722	7726	7730	7734	7738	7742	7746	7750	7754	7758	7762	7766	7770	7774
665	7714	7718	7722	7726	7730	7734	7738	7742	7746	7750	7754	7758	7762	7766	7770	7774	7778
664	7717	7721	7725	7729	7733	7737	7741	7745	7749	7753	7757	7761	7765	7769	7773	7777	7781
663	7721	7725	7729	7733	7737	7741	7745	7749	7753	7757	7761	7765	7769	7773	7777	7781	7784
662	7724	7728	7732	7736	7740	7744	7748	7752	7756	7760	7764	7768	7772	7776	7780	7784	7788
661	7727	7731	7735	7739	7743	7747	7751	7755	7759	7763	7767	7771	7775	7779	7783	7787	7791
660	7731	7735	7739	7743	7747	7751	7755	7759	7763	7767	7771	7775	7779	7783	7787	7791	7795
659	7734	7738	7742	7746	7750	7754	7758	7762	7766	7770	7774	7778	7782	7786	7790	7794	7798
658	7738	7742	7746	7750	7754	7758	7762	7766	7770	7774	7778	7782	7785	7789	7793	7797	7801
657	7741	7745	7749	7753	7757	7761	7765	7769	7773	7777	7781	7785	7789	7793	7797	7801	7805
656	7745	7749	7753	7757	7761	7765	7769	7772	7776	7780	7784	7788	7792	7796	7800	7804	7808
655	7748	7752	7756	7760	7764	7768	7772	7776	7780	7784	7788	7792	7796	7800	7804	7807	7811
654	7752	7756	7760	7764	7767	7771	7775	7779	7783	7787	7791	7795	7799	7803	7807	7811	7815
653	7755	7759	7763	7767	7771	7775	7779	7783	7787	7791	7795	7798	7802	7806	7810	7814	7818
652	7759	7762	7766	7770	7774	7778	7782	7786	7790	7794	7798	7802	7806	7810	7814	7818	7821
651	7762	7766	7770	7774	7778	7782	7786	7790	7793	7797	7801	7805	7809	7813	7817	7821	7825
650	7765	7769	7773	7777	7781	7785	7789	7793	7797	7801	7805	7809	7813	7816	7820	7824	7828
649	7769	7773	7777	7781	7785	7789	7792	7796	7800	7804	7808	7812	7816	7820	7824	7828	7832
648	7772	7776	7780	7784	7788	7792	7796	7800	7804	7808	7812	7815	7819	7823	7827	7831	7835
647	7776	7780	7784	7788	7791	7795	7799	7803	7807	7811	7815	7819	7823	7827	7830	7834	7838
646	7779	7783	7787	7791	7795	7799	7803	7807	7811	7814	7818	7822	7826	7830	7834	7838	7842
645	7783	7787	7791	7794	7798	7802	7806	7810	7814	7818	7822	7826	7829	7833	7837	7841	7845
644	7786	7790	7794	7798	7802	7806	7810	7813	7817	7821	7825	7829	7833	7837	7841	7844	7848
643	7790	7793	7797	7801	7805	7809	7813	7817	7821	7825	7828	7832	7836	7840	7844	7848	7852
642	7793	7797	7801	7805	7809	7813	7816	7820	7824	7828	7832	7836	7840	7843	7847	7851	7855
641	7796	7800	7804	7808	7812	7816	7820	7824	7828	7831	7835	7839	7843	7847	7851	7855	7858
640	7800	7804	7808	7812	7815	7819	7823	7827	7831	7835	7839	7843	7846	7850	7854	7858	7862

Table 35 Metric—Low Alt, Low Temp, High Humidity
(Temp = 5 to 13° C, Press = 720 to 800 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
800	6988	6994	6999	7005	7010	7016	7021	7027	7032	7037	7043	7048	7054	7059	7064	7069	7075
799	6992	6998	7003	7009	7014	7020	7025	7030	7036	7041	7047	7052	7057	7063	7068	7073	7078
798	6996	7001	7007	7012	7018	7023	7029	7034	7040	7045	7050	7056	7061	7066	7072	7077	7082
797	7000	7005	7011	7016	7022	7027	7032	7038	7043	7049	7054	7059	7065	7070	7075	7080	7086
796	7003	7009	7014	7020	7025	7031	7036	7042	7047	7052	7058	7063	7068	7074	7079	7084	7089
795	7007	7013	7018	7024	7029	7034	7040	7045	7051	7056	7061	7067	7072	7077	7083	7088	7093
794	7011	7016	7022	7027	7033	7038	7044	7049	7054	7060	7065	7070	7076	7081	7086	7092	7097
793	7015	7020	7026	7031	7037	7042	7047	7053	7058	7063	7069	7074	7079	7085	7090	7095	7100
792	7019	7024	7029	7035	7040	7046	7051	7056	7062	7067	7072	7078	7083	7088	7094	7099	7104
791	7022	7028	7033	7039	7044	7049	7055	7060	7066	7071	7076	7081	7087	7092	7097	7103	7108
790	7026	7032	7037	7042	7048	7053	7059	7064	7069	7075	7080	7085	7090	7096	7101	7106	7111
789	7030	7035	7041	7046	7052	7057	7062	7068	7073	7078	7084	7089	7094	7099	7105	7110	7115
788	7034	7039	7044	7050	7055	7061	7066	7071	7077	7082	7087	7093	7098	7103	7108	7114	7119
787	7037	7043	7048	7054	7059	7064	7070	7075	7080	7086	7091	7096	7102	7107	7112	7117	7122
786	7041	7047	7052	7057	7063	7068	7073	7079	7084	7089	7095	7100	7105	7110	7116	7121	7126
785	7045	7050	7056	7061	7066	7072	7077	7083	7088	7093	7098	7104	7109	7114	7119	7125	7130
784	7049	7054	7060	7065	7070	7076	7081	7086	7092	7097	7102	7107	7113	7118	7123	7128	7133
783	7052	7058	7063	7069	7074	7079	7085	7090	7095	7101	7106	7111	7116	7121	7127	7132	7137
782	7056	7062	7067	7072	7078	7083	7088	7094	7099	7104	7109	7115	7120	7125	7130	7136	7141
781	7060	7065	7071	7076	7081	7087	7092	7097	7103	7108	7113	7118	7124	7129	7134	7139	7144
780	7064	7069	7075	7080	7085	7091	7096	7101	7106	7112	7117	7122	7127	7133	7138	7143	7148
779	7068	7073	7078	7084	7089	7094	7100	7105	7110	7115	7121	7126	7131	7136	7141	7147	7152
778	7071	7077	7082	7087	7093	7098	7103	7109	7114	7119	7124	7130	7135	7140	7145	7150	7155
777	7075	7080	7086	7091	7096	7102	7107	7112	7118	7123	7128	7133	7138	7144	7149	7154	7159
776	7079	7084	7090	7095	7100	7105	7111	7116	7121	7126	7132	7137	7142	7147	7152	7158	7163
775	7083	7088	7093	7099	7104	7109	7114	7120	7125	7130	7135	7141	7146	7151	7156	7161	7166
774	7086	7092	7097	7102	7108	7113	7118	7123	7129	7134	7139	7144	7149	7155	7160	7165	7170
773	7090	7096	7101	7106	7111	7117	7122	7127	7132	7138	7143	7148	7153	7158	7163	7169	7174
772	7094	7099	7105	7110	7115	7120	7126	7131	7136	7141	7147	7152	7157	7162	7167	7172	7177
771	7098	7103	7108	7114	7119	7124	7129	7135	7140	7145	7150	7155	7161	7166	7171	7176	7181
770	7101	7107	7112	7117	7123	7128	7133	7138	7144	7149	7154	7159	7164	7169	7174	7180	7185
769	7105	7111	7116	7121	7126	7132	7137	7142	7147	7152	7158	7163	7168	7173	7178	7183	7188
768	7109	7114	7120	7125	7130	7135	7141	7146	7151	7156	7161	7166	7172	7177	7182	7187	7192
767	7113	7118	7123	7129	7134	7139	7144	7150	7155	7160	7165	7170	7175	7180	7186	7191	7196
766	7117	7122	7127	7132	7138	7143	7148	7153	7158	7164	7169	7174	7179	7184	7189	7194	7199
765	7120	7126	7131	7136	7141	7147	7152	7157	7162	7167	7172	7178	7183	7188	7193	7198	7203
764	7124	7129	7135	7140	7145	7150	7155	7161	7166	7171	7176	7181	7186	7191	7197	7202	7207
763	7128	7133	7138	7144	7149	7154	7159	7164	7170	7175	7180	7185	7190	7195	7200	7205	7210
762	7132	7137	7142	7147	7153	7158	7163	7168	7173	7178	7184	7189	7194	7199	7204	7209	7214
761	7135	7141	7146	7151	7156	7162	7167	7172	7177	7182	7187	7192	7197	7203	7208	7213	7218
760	7139	7144	7150	7155	7160	7165	7170	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221
759	7143	7148	7153	7159	7164	7169	7174	7179	7184	7190	7195	7200	7205	7210	7215	7220	7225
758	7147	7152	7157	7162	7168	7173	7178	7183	7188	7193	7198	7203	7209	7214	7219	7224	7229
757	7150	7156	7161	7166	7171	7176	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232
756	7154	7159	7165	7170	7175	7180	7185	7190	7196	7201	7206	7211	7216	7221	7226	7231	7236
755	7158	7163	7168	7174	7179	7184	7189	7194	7199	7204	7209	7215	7220	7225	7230	7235	7240
754	7162	7167	7172	7177	7183	7188	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7243
753	7166	7171	7176	7181	7186	7191	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247
752	7169	7175	7180	7185	7190	7195	7200	7205	7210	7216	7221	7226	7231	7236	7241	7246	7251
751	7173	7178	7183	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249	7254
750	7177	7182	7187	7192	7197	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248	7253	7258
749	7181	7186	7191	7196	7201	7206	7211	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262
748	7184	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265
747	7188	7193	7198	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249	7254	7259	7264	7269
746	7192	7197	7202	7207	7212	7218	7223	7228	7233	7238	7243	7248	7253	7258	7263	7268	7273
745	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276
744	7199	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7270	7275	7280
743	7203	7208	7213	7219	7224	7229	7234	7239	7244	7249	7254	7259	7264	7269	7274	7279	7284
742	7207	7212	7217	7222	7227	7232	7238	7243	7248	7253	7258	7263	7268	7272	7277	7282	7287
741	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276	7281	7286	7291
740	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7270	7275	7280	7285	7290	7295
739	7218	7223	7229	7234	7239	7244	7249	7254	7259	7264	7269	7274	7279	7284	7288	7293	7298
738	7222	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7292	7297	7302
737	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276	7281	7286	7291	7296	7301	7306
736	7230	7235	7240	7245	7250	7255	7260	7265	7270	7275	7280	7285	7290	7295	7299	7304	7309
735	7233	7238	7244	7249	7254	7259	7264	7269	7274	7279	7284	7288	7293	7298	7303	7308	7313
734	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7292	7297	7302	7307	7312	7317
733	7241	7246	7251	7256	7261	7266	7271	7276	7281	7286	7291	7296	7301	7306	7311	7315	7320
732	7245	7250	7255	7260	7265	7270	7275	7280	7285	7290	7295	7300	7304	7309	7314	7319	7324
731	7248	7254	7259	7264	7269	7274	7279	7284	7288	7293	7298	7303	7308	7313	7318	7323	7328
730	7252	7257	7262	7267	7272	7277	7282	7287	7292	7297	7302	7307	7312	7317	7322	7326	7331
729	7256	7261	7266	7271	7276	7281	7286	7291	7296	7301	7306	7311	7315	7320	7325	7330	7335
728	7260	7265	7270	7275	7280	7285	7290	7295	7300	7305	7309	7314	7319	7324	7329	7334	7339
727	7264	7269	7274	7279	7284	7289	7293	7298	7303	7308	7313	7318	7323	7328	7333	7337	7342
726	7267	7272	7277	7282	7287	7292	7297	7302	7307	7312	7317	7322	7327	7331	7336	7341	7346
725	7271	7276	7281	7286	7291	7296	7301	7306	7311	7316	7321	7325	7330	7335	7340	7345	7350
724	7275	7280	7285	7290	7295	7300	7305	7310	7314	7319	7324	7329	7334	7339	7344	7348	7353
723	7279	7284	7289	7294	7299	7303	7308	7313	7318	7323	7328	7333	7338	7342	7347	7352	7357
722	7282	7287	7292	7297	7302	7307	7312	7317	7322	7327	7332	7336	7341	7346	7351	7356	7361
721	7286	7291	7296	7301	7306	7311	7316	7321	7326	7330	7335	7340	7345	7350	7355	7359	7364
720	7290	7295	7300	7305	7310	7315	7320	7324	7329	7334	7339	7344	7349	7354	7358	7363	7368

Table 36 Metric—Low Alt, Low-Mid Temp, High Humidity
(Temp = 13.5 to 21.5° C, Press = 720 to 800 mm, 80% Humidity)

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	TEMPERATURE IN DEGREES CELSIUS																
	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5
800	7080	7085	7091	7096	7101	7106	7111	7117	7122	7127	7132	7137	7142	7147	7153	7158	7163
799	7084	7089	7094	7099	7105	7110	7115	7120	7125	7131	7136	7141	7146	7151	7156	7161	7166
798	7087	7093	7098	7103	7108	7113	7119	7124	7129	7134	7139	7144	7150	7155	7160	7165	7170
797	7091	7096	7101	7107	7112	7117	7122	7127	7133	7138	7143	7148	7153	7158	7163	7168	7173
796	7095	7100	7105	7110	7116	7121	7126	7131	7136	7141	7146	7152	7157	7162	7167	7172	7177
795	7098	7104	7109	7114	7119	7124	7130	7135	7140	7145	7150	7155	7160	7165	7170	7175	7181
794	7102	7107	7112	7118	7123	7128	7133	7138	7143	7149	7154	7159	7164	7169	7174	7179	7184
793	7106	7111	7116	7121	7126	7132	7137	7142	7147	7152	7157	7162	7167	7172	7178	7183	7188
792	7109	7115	7120	7125	7130	7135	7140	7146	7151	7156	7161	7166	7171	7176	7181	7186	7191
791	7113	7118	7123	7129	7134	7139	7144	7149	7154	7159	7164	7170	7175	7180	7185	7190	7195
790	7117	7122	7127	7132	7137	7142	7148	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198
789	7120	7125	7131	7136	7141	7146	7151	7156	7161	7167	7172	7177	7182	7187	7192	7197	7202
788	7124	7129	7134	7139	7145	7150	7155	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205
787	7128	7133	7138	7143	7148	7153	7158	7164	7169	7174	7179	7184	7189	7194	7199	7204	7209
786	7131	7136	7142	7147	7152	7157	7162	7167	7172	7177	7182	7187	7192	7198	7203	7208	7213
785	7135	7140	7145	7150	7155	7161	7166	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216
784	7139	7144	7149	7154	7159	7164	7169	7174	7179	7185	7190	7195	7200	7205	7210	7215	7220
783	7142	7147	7153	7158	7163	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213	7218	7223
782	7146	7151	7156	7161	7166	7171	7177	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227
781	7150	7155	7160	7165	7170	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230
780	7153	7158	7163	7169	7174	7179	7184	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234
779	7157	7162	7167	7172	7177	7182	7187	7192	7198	7203	7208	7213	7218	7223	7228	7232	7237
778	7161	7166	7171	7176	7181	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241
777	7164	7169	7174	7179	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245
776	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248
775	7171	7177	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252
774	7175	7180	7185	7190	7195	7200	7206	7211	7216	7221	7226	7231	7235	7240	7245	7250	7255
773	7179	7184	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249	7254	7259
772	7182	7188	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248	7253	7257	7262
771	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266
770	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7269
769	7193	7198	7204	7209	7214	7219	7224	7229	7234	7239	7243	7248	7253	7258	7263	7268	7273
768	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277
767	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7265	7270	7275	7280
766	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249	7254	7259	7264	7269	7274	7279	7284
765	7208	7213	7218	7223	7228	7233	7238	7243	7248	7253	7258	7263	7268	7273	7277	7282	7287
764	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7261	7266	7271	7276	7281	7286	7291
763	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7270	7275	7280	7285	7290	7294
762	7219	7224	7229	7234	7239	7244	7249	7254	7259	7264	7269	7274	7278	7283	7288	7293	7298
761	7223	7228	7233	7238	7243	7248	7253	7258	7262	7267	7272	7277	7282	7287	7292	7297	7301
760	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276	7281	7286	7290	7295	7300	7305
759	7230	7235	7240	7245	7250	7255	7260	7265	7270	7275	7279	7284	7289	7294	7299	7304	7309
758	7234	7239	7244	7249	7254	7258	7263	7268	7273	7278	7283	7288	7293	7298	7302	7307	7312
757	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7292	7296	7301	7306	7311	7316
756	7241	7246	7251	7256	7261	7266	7271	7276	7280	7285	7290	7295	7300	7305	7310	7314	7319
755	7245	7250	7255	7260	7264	7269	7274	7279	7284	7289	7294	7299	7304	7308	7313	7318	7323
754	7248	7253	7258	7263	7268	7273	7278	7283	7288	7293	7297	7302	7307	7312	7317	7322	7326
753	7252	7257	7262	7267	7272	7277	7282	7286	7291	7296	7301	7306	7311	7316	7320	7325	7330
752	7256	7261	7265	7270	7275	7280	7285	7290	7295	7300	7305	7309	7314	7319	7324	7329	7333
751	7259	7264	7269	7274	7279	7284	7289	7294	7298	7303	7308	7313	7318	7323	7327	7332	7337
750	7263	7268	7273	7278	7283	7287	7292	7297	7302	7307	7312	7317	7321	7326	7331	7336	7341
749	7267	7272	7276	7281	7286	7291	7296	7301	7306	7311	7315	7320	7325	7330	7335	7339	7344
748	7270	7275	7280	7285	7290	7295	7300	7304	7309	7314	7319	7324	7329	7333	7338	7343	7348
747	7274	7279	7284	7289	7293	7298	7303	7308	7313	7318	7323	7327	7332	7337	7342	7347	7351
746	7278	7282	7287	7292	7297	7302	7307	7312	7317	7321	7326	7331	7336	7341	7345	7350	7355
745	7281	7286	7291	7296	7301	7306	7310	7315	7320	7325	7330	7335	7339	7344	7349	7354	7358
744	7285	7290	7295	7300	7304	7309	7314	7319	7324	7329	7333	7338	7343	7348	7352	7357	7362
743	7289	7293	7298	7303	7308	7313	7318	7323	7327	7332	7337	7342	7347	7351	7356	7361	7366
742	7292	7297	7302	7307	7312	7316	7321	7326	7331	7336	7341	7345	7350	7355	7360	7364	7369
741	7296	7301	7306	7310	7315	7320	7325	7330	7335	7339	7344	7349	7354	7358	7363	7368	7373
740	7299	7304	7309	7314	7319	7324	7329	7333	7338	7343	7348	7352	7357	7362	7367	7371	7376
739	7303	7308	7313	7318	7323	7327	7332	7337	7342	7347	7351	7356	7361	7366	7370	7375	7380
738	7307	7312	7317	7321	7326	7331	7336	7341	7345	7350	7355	7360	7364	7369	7374	7379	7383
737	7310	7315	7320	7325	7330	7335	7339	7344	7349	7354	7359	7363	7368	7373	7377	7382	7387
736	7314	7319	7324	7329	7333	7338	7343	7348	7353	7357	7362	7367	7372	7376	7381	7386	7390
735	7318	7323	7327	7332	7337	7342	7347	7351	7356	7361	7366	7370	7375	7380	7385	7389	7394
734	7321	7326	7331	7336	7341	7345	7350	7355	7360	7365	7369	7374	7379	7383	7388	7393	7398
733	7325	7330	7335	7340	7344	7349	7354	7359	7363	7368	7373	7378	7382	7387	7392	7396	7401
732	7329	7334	7338	7343	7348	7353	7358	7362	7367	7372	7376	7381	7386	7391	7395	7400	7405
731	7332	7337	7342	7347	7352	7356	7361	7366	7371	7375	7380	7385	7389	7394	7399	7404	7408
730	7336	7341	7346	7350	7355	7360	7365	7369	7374	7379	7384	7388	7393	7398	7402	7407	7412
729	7340	7345	7349	7354	7359	7364	7368	7373	7378	7383	7387	7392	7397	7401	7406	7411	7415
728	7343	7348	7353	7358	7362	7367	7372	7377	7381	7386	7391	7396	7400	7405	7410	7414	7419
727	7347	7352	7357	7361	7366	7371	7376	7380	7385	7390	7394	7399	7404	7408	7413	7418	7422
726	7351	7355	7360	7365	7370	7375	7379	7384	7389	7393	7398	7403	7407	7412	7417	7421	7426
725	7354	7359	7364	7369	7373	7378	7383	7388	7392	7397	7402	7406	7411	7416	7420	7425	7430
724	7358	7363	7368	7372	7377	7382	7386	7391	7396	7401	7405	7410	7415	7419	7424	7428	7433
723	7362	7366	7371	7376	7381	7385	7390	7395	7399	7404	7409	7413	7418	7423	7427	7432	7437
722	7365	7370	7375	7380	7384	7389	7394	7398	7403	7408	7412	7417	7422	7426	7431	7436	7440
721	7369	7374	7378	7383	7388	7393	7397	7402	7407	7411	7416	7421	7425	7430	7435	7439	7444
720	7373	7377	7382	7387	7392	7396	7401	7406	7410	7415	7420	7424	7429	7434	7438	7443	7447

Table 37 Metric—Low Alt, Mid Temp, High Humidity
(Temp = 22 to 30° C, Press = 720 to 800 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
800	7168	7173	7178	7183	7188	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248
799	7171	7176	7181	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7246	7251
798	7175	7180	7185	7190	7195	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255
797	7178	7184	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234	7239	7243	7248	7253	7258
796	7182	7187	7192	7197	7202	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7262
795	7186	7191	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7245	7250	7255	7260	7265
794	7189	7194	7199	7204	7209	7214	7219	7224	7229	7234	7239	7244	7249	7254	7259	7264	7269
793	7193	7198	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248	7252	7257	7262	7267	7272
792	7196	7201	7206	7211	7216	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7271	7276
791	7200	7205	7210	7215	7220	7225	7230	7235	7240	7245	7250	7254	7259	7264	7269	7274	7279
790	7203	7208	7213	7218	7223	7228	7233	7238	7243	7248	7253	7258	7263	7268	7273	7278	7283
789	7207	7212	7217	7222	7227	7232	7237	7242	7247	7252	7257	7261	7266	7271	7276	7281	7286
788	7210	7215	7220	7225	7230	7235	7240	7245	7250	7255	7260	7265	7270	7275	7280	7285	7289
787	7214	7219	7224	7229	7234	7239	7244	7249	7254	7259	7264	7268	7273	7278	7283	7288	7293
786	7218	7223	7227	7232	7237	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7291	7296
785	7221	7226	7231	7236	7241	7246	7251	7256	7261	7266	7270	7275	7280	7285	7290	7295	7300
784	7225	7230	7235	7240	7244	7249	7254	7259	7264	7269	7274	7279	7284	7289	7294	7298	7303
783	7228	7233	7238	7243	7248	7253	7258	7263	7268	7273	7277	7282	7287	7292	7297	7302	7307
782	7232	7237	7242	7247	7252	7256	7261	7266	7271	7276	7281	7286	7291	7296	7300	7305	7310
781	7235	7240	7245	7250	7255	7260	7265	7270	7275	7280	7284	7289	7294	7299	7304	7309	7314
780	7239	7244	7249	7254	7259	7263	7268	7273	7278	7283	7288	7293	7298	7303	7307	7312	7317
779	7242	7247	7252	7257	7262	7267	7272	7277	7282	7287	7291	7296	7301	7306	7311	7316	7321
778	7246	7251	7256	7261	7266	7271	7275	7280	7285	7290	7295	7300	7305	7309	7314	7319	7324
777	7249	7254	7259	7264	7269	7274	7279	7284	7289	7294	7298	7303	7308	7313	7318	7323	7327
776	7253	7258	7263	7268	7273	7278	7282	7287	7292	7297	7302	7307	7312	7316	7321	7326	7331
775	7257	7262	7266	7271	7276	7281	7286	7291	7296	7301	7305	7310	7315	7320	7325	7330	7334
774	7260	7265	7270	7275	7280	7285	7289	7294	7299	7304	7309	7314	7319	7323	7328	7333	7338
773	7264	7269	7274	7278	7283	7288	7293	7298	7303	7308	7312	7317	7322	7327	7332	7337	7341
772	7267	7272	7277	7282	7287	7292	7297	7301	7306	7311	7316	7321	7326	7330	7335	7340	7345
771	7271	7276	7281	7285	7290	7295	7300	7305	7310	7315	7319	7324	7329	7334	7339	7343	7348
770	7274	7279	7284	7289	7294	7299	7304	7308	7313	7318	7323	7328	7332	7337	7342	7347	7352
769	7278	7283	7288	7293	7297	7302	7307	7312	7317	7322	7326	7331	7336	7341	7346	7350	7355
768	7281	7286	7291	7296	7301	7306	7311	7315	7320	7325	7330	7335	7339	7344	7349	7354	7359
767	7285	7290	7295	7300	7304	7309	7314	7319	7324	7329	7333	7338	7343	7348	7352	7357	7362
766	7289	7293	7298	7303	7308	7313	7318	7322	7327	7332	7337	7342	7346	7351	7356	7361	7366
765	7292	7297	7302	7307	7311	7316	7321	7326	7331	7336	7340	7345	7350	7355	7359	7364	7369
764	7296	7301	7305	7310	7315	7320	7325	7329	7334	7339	7344	7349	7353	7358	7363	7368	7372
763	7299	7304	7309	7314	7319	7323	7328	7333	7338	7343	7347	7352	7357	7362	7366	7371	7376
762	7303	7308	7312	7317	7322	7327	7332	7336	7341	7346	7351	7356	7360	7365	7370	7375	7379
761	7306	7311	7316	7321	7326	7330	7335	7340	7345	7350	7354	7359	7364	7369	7373	7378	7383
760	7310	7315	7320	7324	7329	7334	7339	7343	7348	7353	7358	7363	7367	7372	7377	7382	7386
759	7313	7318	7323	7328	7333	7337	7342	7347	7352	7357	7361	7366	7371	7376	7380	7385	7390
758	7317	7322	7327	7331	7336	7341	7346	7351	7355	7360	7365	7370	7374	7379	7384	7388	7393
757	7321	7325	7330	7335	7340	7344	7349	7354	7359	7364	7368	7373	7378	7382	7387	7392	7397
756	7324	7329	7334	7338	7343	7348	7353	7358	7362	7367	7372	7376	7381	7386	7391	7395	7400
755	7328	7332	7337	7342	7347	7352	7356	7361	7366	7371	7375	7380	7385	7389	7394	7399	7404
754	7331	7336	7341	7346	7350	7355	7360	7365	7369	7374	7379	7383	7388	7393	7398	7402	7407
753	7335	7340	7344	7349	7354	7359	7363	7368	7373	7378	7382	7387	7392	7396	7401	7406	7410
752	7338	7343	7348	7353	7357	7362	7367	7372	7376	7381	7386	7390	7395	7400	7405	7409	7414
751	7342	7347	7351	7356	7361	7366	7370	7375	7380	7385	7389	7394	7399	7403	7408	7413	7417
750	7345	7350	7355	7360	7364	7369	7374	7379	7383	7388	7393	7397	7402	7407	7411	7416	7421
749	7349	7354	7358	7363	7368	7373	7377	7382	7387	7391	7396	7401	7406	7410	7415	7420	7424
748	7352	7357	7362	7367	7371	7376	7381	7386	7390	7395	7400	7404	7409	7414	7418	7423	7428
747	7356	7361	7366	7370	7375	7380	7384	7389	7394	7398	7403	7408	7413	7417	7422	7427	7431
746	7360	7364	7369	7374	7379	7383	7388	7393	7397	7402	7407	7411	7416	7421	7425	7430	7435
745	7363	7368	7373	7377	7382	7387	7391	7396	7401	7405	7410	7415	7419	7424	7429	7433	7438
744	7367	7371	7376	7381	7386	7390	7395	7400	7404	7409	7414	7418	7423	7428	7432	7437	7442
743	7370	7375	7380	7384	7389	7394	7398	7403	7408	7412	7417	7422	7426	7431	7436	7440	7445
742	7374	7379	7383	7388	7393	7397	7402	7407	7411	7416	7421	7425	7430	7435	7439	7444	7448
741	7377	7382	7387	7391	7396	7401	7405	7410	7415	7419	7424	7429	7433	7438	7443	7447	7452
740	7381	7386	7390	7395	7400	7404	7409	7414	7418	7423	7428	7432	7437	7442	7446	7451	7455
739	7384	7389	7394	7399	7403	7408	7413	7417	7422	7426	7431	7436	7440	7445	7450	7454	7459
738	7388	7393	7397	7402	7407	7411	7416	7421	7425	7430	7435	7439	7444	7448	7453	7458	7462
737	7392	7396	7401	7406	7410	7415	7420	7424	7429	7433	7438	7443	7447	7452	7457	7461	7466
736	7395	7400	7404	7409	7414	7418	7423	7428	7432	7437	7442	7446	7451	7455	7460	7465	7469
735	7399	7403	7408	7413	7417	7422	7427	7431	7436	7440	7445	7450	7454	7459	7463	7468	7473
734	7402	7407	7412	7416	7421	7425	7430	7435	7439	7444	7449	7453	7458	7462	7467	7472	7476
733	7406	7410	7415	7420	7424	7429	7434	7438	7443	7447	7452	7457	7461	7466	7470	7475	7480
732	7409	7414	7419	7423	7428	7433	7437	7442	7446	7451	7456	7460	7465	7469	7474	7478	7483
731	7413	7418	7422	7427	7431	7436	7441	7445	7450	7454	7459	7464	7468	7473	7477	7482	7487
730	7416	7421	7426	7430	7435	7440	7444	7449	7453	7458	7463	7467	7472	7476	7481	7485	7490
729	7420	7425	7429	7434	7438	7443	7448	7452	7457	7461	7466	7471	7475	7480	7484	7489	7493
728	7424	7428	7433	7437	7442	7447	7451	7456	7460	7465	7470	7474	7479	7483	7488	7492	7497
727	7427	7432	7436	7441	7446	7450	7455	7459	7464	7468	7473	7478	7482	7487	7491	7496	7500
726	7431	7435	7440	7444	7449	7454	7458	7463	7467	7472	7477	7481	7486	7490	7495	7499	7504
725	7434	7439	7443	7448	7453	7457	7462	7466	7471	7475	7480	7485	7489	7494	7498	7503	7507
724	7438	7442	7447	7452	7456	7461	7465	7470	7474	7479	7483	7488	7493	7497	7502	7506	7511
723	7441	7446	7450	7455	7460	7464	7469	7473	7478	7482	7487	7492	7496	7501	7505	7510	7514
722	7445	7449	7454	7459	7463	7468	7472	7477	7481	7486	7490	7495	7500	7504	7509	7513	7518
721	7448	7453	7458	7462	7467	7471	7476	7480	7485	7489	7494	7498	7503	7508	7512	7517	7521
720	7452	7457	7461	7466	7470	7475	7479	7484	7488	7493	7497	7502	7506	7511	7516	7520	7525

Table 38 Metric—Low Alt, High-Mid Temp, High Humidity
(Temp = 30.5 to 38.5° C, Press = 720 to 800 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5
800	7253	7258	7263	7268	7273	7278	7283	7288	7293	7297	7302	7307	7312	7317	7322	7327	7332
799	7256	7261	7266	7271	7276	7281	7286	7291	7296	7301	7306	7311	7316	7321	7326	7331	7335
798	7260	7265	7270	7275	7280	7285	7289	7294	7299	7304	7309	7314	7319	7324	7329	7334	7339
797	7263	7268	7273	7278	7283	7288	7293	7298	7303	7308	7313	7318	7322	7327	7332	7337	7342
796	7267	7272	7277	7282	7286	7291	7296	7301	7306	7311	7316	7321	7326	7331	7336	7341	7346
795	7270	7275	7280	7285	7290	7295	7300	7305	7310	7314	7319	7324	7329	7334	7339	7344	7349
794	7274	7279	7283	7288	7293	7298	7303	7308	7313	7318	7323	7328	7333	7338	7342	7347	7352
793	7277	7282	7287	7292	7297	7302	7307	7311	7316	7321	7326	7331	7336	7341	7346	7351	7356
792	7281	7285	7290	7295	7300	7305	7310	7315	7320	7325	7330	7334	7339	7344	7349	7354	7359
791	7284	7289	7294	7299	7304	7308	7313	7318	7323	7328	7333	7338	7343	7348	7353	7357	7362
790	7287	7292	7297	7302	7307	7312	7317	7322	7327	7331	7336	7341	7346	7351	7356	7361	7366
789	7291	7296	7301	7306	7310	7315	7320	7325	7330	7335	7340	7345	7350	7354	7359	7364	7369
788	7294	7299	7304	7309	7314	7319	7324	7329	7333	7338	7343	7348	7353	7358	7363	7368	7372
787	7298	7303	7308	7312	7317	7322	7327	7332	7337	7342	7347	7351	7356	7361	7366	7371	7376
786	7301	7306	7311	7316	7321	7326	7330	7335	7340	7345	7350	7355	7360	7365	7369	7374	7379
785	7305	7310	7314	7319	7324	7329	7334	7339	7344	7348	7353	7358	7363	7368	7373	7378	7383
784	7308	7313	7318	7323	7328	7332	7337	7342	7347	7352	7357	7362	7366	7371	7376	7381	7386
783	7312	7316	7321	7326	7331	7336	7341	7346	7350	7355	7360	7365	7370	7375	7380	7384	7389
782	7315	7320	7325	7330	7334	7339	7344	7349	7354	7359	7364	7368	7373	7378	7383	7388	7393
781	7319	7323	7328	7333	7338	7343	7348	7352	7357	7362	7367	7372	7377	7381	7386	7391	7396
780	7322	7327	7332	7336	7341	7346	7351	7356	7361	7365	7370	7375	7380	7385	7390	7394	7399
779	7325	7330	7335	7340	7345	7350	7354	7359	7364	7369	7374	7379	7383	7388	7393	7398	7403
778	7329	7334	7339	7343	7348	7353	7358	7363	7367	7372	7377	7382	7387	7392	7396	7401	7406
777	7332	7337	7342	7347	7352	7356	7361	7366	7371	7376	7380	7385	7390	7395	7400	7405	7409
776	7336	7341	7345	7350	7355	7360	7365	7369	7374	7379	7384	7389	7394	7398	7403	7408	7413
775	7339	7344	7349	7354	7358	7363	7368	7373	7378	7382	7387	7392	7397	7402	7407	7411	7416
774	7343	7347	7352	7357	7362	7367	7371	7376	7381	7386	7391	7395	7400	7405	7410	7415	7420
773	7346	7351	7356	7361	7365	7370	7375	7380	7384	7389	7394	7399	7404	7408	7413	7418	7423
772	7350	7354	7359	7364	7369	7374	7378	7383	7388	7393	7397	7402	7407	7412	7417	7421	7426
771	7353	7358	7363	7367	7372	7377	7382	7387	7391	7396	7401	7406	7410	7415	7420	7425	7430
770	7356	7361	7366	7371	7376	7380	7385	7390	7395	7399	7404	7409	7414	7419	7423	7428	7433
769	7360	7365	7369	7374	7379	7384	7389	7393	7398	7403	7408	7412	7417	7422	7427	7432	7436
768	7363	7368	7373	7378	7382	7387	7392	7397	7402	7406	7411	7416	7421	7425	7430	7435	7440
767	7367	7372	7376	7381	7386	7391	7395	7400	7405	7410	7414	7419	7424	7429	7433	7438	7443
766	7370	7375	7380	7385	7389	7394	7399	7404	7408	7413	7418	7423	7427	7432	7437	7442	7446
765	7374	7378	7383	7388	7393	7397	7402	7407	7412	7416	7421	7426	7431	7435	7440	7445	7450
764	7377	7382	7387	7391	7396	7401	7406	7410	7415	7420	7425	7429	7434	7439	7444	7448	7453
763	7381	7385	7390	7395	7400	7404	7409	7414	7419	7423	7428	7433	7437	7442	7447	7452	7456
762	7384	7389	7394	7398	7403	7408	7412	7417	7422	7427	7431	7436	7441	7446	7450	7455	7460
761	7388	7392	7397	7402	7406	7411	7416	7421	7425	7430	7435	7440	7444	7449	7454	7458	7463
760	7391	7396	7400	7405	7410	7415	7419	7424	7429	7433	7438	7443	7448	7452	7457	7462	7467
759	7394	7399	7404	7409	7413	7418	7423	7427	7432	7437	7442	7446	7451	7456	7460	7465	7470
758	7398	7403	7407	7412	7417	7421	7426	7431	7436	7440	7445	7450	7454	7459	7464	7469	7473
757	7401	7406	7411	7415	7420	7425	7430	7434	7439	7444	7448	7453	7458	7463	7467	7472	7477
756	7405	7409	7414	7419	7424	7428	7433	7438	7442	7447	7452	7456	7461	7466	7471	7475	7480
755	7408	7413	7418	7422	7427	7432	7436	7441	7446	7450	7455	7460	7465	7469	7474	7479	7483
754	7412	7416	7421	7426	7430	7435	7440	7445	7449	7454	7459	7463	7468	7473	7477	7482	7487
753	7415	7420	7425	7429	7434	7439	7443	7448	7453	7457	7462	7467	7471	7476	7481	7485	7490
752	7419	7423	7428	7433	7437	7442	7447	7451	7456	7461	7465	7470	7475	7479	7484	7489	7493
751	7422	7427	7431	7436	7441	7445	7450	7455	7459	7464	7469	7473	7478	7483	7487	7492	7497
750	7425	7430	7435	7440	7444	7449	7453	7458	7463	7467	7472	7477	7481	7486	7491	7496	7500
749	7429	7434	7438	7443	7448	7452	7457	7462	7466	7471	7476	7480	7485	7490	7494	7499	7504
748	7432	7437	7442	7446	7451	7456	7460	7465	7470	7474	7479	7484	7488	7493	7498	7502	7507
747	7436	7441	7445	7450	7454	7459	7464	7468	7473	7478	7482	7487	7492	7496	7501	7506	7510
746	7439	7444	7449	7453	7458	7463	7467	7472	7476	7481	7486	7490	7495	7500	7504	7509	7514
745	7443	7447	7452	7457	7461	7466	7471	7475	7480	7484	7489	7494	7498	7503	7508	7512	7517
744	7446	7451	7455	7460	7465	7469	7474	7479	7483	7488	7493	7497	7502	7506	7511	7516	7520
743	7450	7454	7459	7464	7468	7473	7477	7482	7487	7491	7496	7501	7505	7510	7514	7519	7524
742	7453	7458	7462	7467	7472	7476	7481	7485	7490	7495	7499	7504	7509	7513	7518	7522	7527
741	7457	7461	7466	7470	7475	7480	7484	7489	7493	7498	7503	7507	7512	7517	7521	7526	7530
740	7460	7465	7469	7474	7478	7483	7488	7492	7497	7501	7506	7511	7515	7520	7525	7529	7534
739	7463	7468	7473	7477	7482	7486	7491	7496	7500	7505	7510	7514	7519	7523	7528	7533	7537
738	7467	7472	7476	7481	7485	7490	7495	7499	7504	7508	7513	7517	7522	7527	7531	7536	7541
737	7470	7475	7480	7484	7489	7493	7498	7503	7507	7512	7516	7521	7525	7530	7535	7539	7544
736	7474	7478	7483	7488	7492	7497	7501	7506	7511	7515	7520	7524	7529	7533	7538	7543	7547
735	7477	7482	7486	7491	7496	7500	7505	7509	7514	7519	7523	7528	7532	7537	7541	7546	7551
734	7481	7485	7490	7494	7499	7504	7508	7513	7517	7522	7526	7531	7536	7540	7545	7549	7554
733	7484	7489	7493	7498	7502	7507	7512	7516	7521	7525	7530	7534	7539	7544	7548	7553	7557
732	7488	7492	7497	7501	7506	7510	7515	7520	7524	7529	7533	7538	7542	7547	7552	7556	7561
731	7491	7496	7500	7505	7509	7514	7518	7523	7528	7532	7537	7541	7546	7550	7555	7560	7564
730	7495	7499	7504	7508	7513	7517	7522	7526	7531	7536	7540	7545	7549	7554	7558	7563	7567
729	7498	7503	7507	7512	7516	7521	7525	7530	7534	7539	7543	7548	7553	7557	7562	7566	7571
728	7501	7506	7511	7515	7520	7524	7529	7533	7538	7542	7547	7551	7556	7560	7565	7570	7574
727	7505	7509	7514	7518	7523	7528	7532	7537	7541	7546	7550	7555	7559	7564	7568	7573	7578
726	7508	7513	7517	7522	7526	7531	7536	7540	7545	7549	7554	7558	7563	7567	7572	7576	7581
725	7512	7516	7521	7525	7530	7534	7539	7543	7548	7553	7557	7562	7566	7571	7575	7580	7584
724	7515	7520	7524	7529	7533	7538	7542	7547	7551	7556	7560	7565	7569	7574	7579	7583	7588
723	7519	7523	7528	7532	7537	7541	7546	7550	7555	7559	7564	7568	7573	7577	7582	7586	7591
722	7522	7527	7531	7536	7540	7545	7549	7554	7558	7563	7567	7572	7576	7581	7585	7590	7594
721	7526	7530	7535	7539	7544	7548	7553	7557	7562	7566	7571	7575	7580	7584	7589	7593	7598
720	7529	7534	7538	7543	7547	7552	7556	7561	7565	7570	7574	7579	7583	7588	7592	7597	7601

Table 39 Metric—High Alt, Low Temp, High Humidity
(Temp = 5 to 13° C, Press = 640 to 720 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	5.0	5.5	6.0	6.5	7.0	7.5	8.0	8.5	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0
720	7290	7295	7300	7305	7310	7315	7320	7324	7329	7334	7339	7344	7349	7354	7358	7363	7368
719	7294	7299	7304	7309	7314	7318	7323	7328	7333	7338	7343	7348	7352	7357	7362	7367	7372
718	7297	7302	7307	7312	7317	7322	7327	7332	7337	7342	7346	7351	7356	7361	7366	7370	7375
717	7301	7306	7311	7316	7321	7326	7331	7336	7340	7345	7350	7355	7360	7365	7369	7374	7379
716	7305	7310	7315	7320	7325	7330	7334	7339	7344	7349	7354	7359	7363	7368	7373	7378	7383
715	7309	7314	7319	7324	7328	7333	7338	7343	7348	7353	7358	7362	7367	7372	7377	7381	7386
714	7313	7318	7322	7327	7332	7337	7342	7347	7352	7356	7361	7366	7371	7376	7380	7385	7390
713	7316	7321	7326	7331	7336	7341	7346	7351	7355	7360	7365	7370	7375	7379	7384	7389	7394
712	7320	7325	7330	7335	7340	7345	7349	7354	7359	7364	7369	7373	7378	7383	7388	7392	7397
711	7324	7329	7334	7339	7343	7348	7353	7358	7363	7368	7372	7377	7382	7387	7391	7396	7401
710	7328	7333	7337	7342	7347	7352	7357	7362	7366	7371	7376	7381	7386	7390	7395	7400	7405
709	7331	7336	7341	7346	7351	7356	7361	7365	7370	7375	7380	7385	7389	7394	7399	7403	7408
708	7335	7340	7345	7350	7355	7360	7364	7369	7374	7379	7383	7388	7393	7398	7402	7407	7412
707	7339	7344	7349	7354	7358	7363	7368	7373	7378	7382	7387	7392	7397	7401	7406	7411	7415
706	7343	7348	7352	7357	7362	7367	7372	7377	7381	7386	7391	7396	7400	7405	7410	7414	7419
705	7346	7351	7356	7361	7366	7371	7376	7380	7385	7390	7395	7399	7404	7409	7413	7418	7423
704	7350	7355	7360	7365	7370	7374	7379	7384	7389	7394	7398	7403	7408	7412	7417	7422	7426
703	7354	7359	7364	7369	7373	7378	7383	7388	7393	7397	7402	7407	7411	7416	7421	7425	7430
702	7358	7363	7367	7372	7377	7382	7387	7391	7396	7401	7406	7410	7415	7420	7424	7429	7434
701	7362	7366	7371	7376	7381	7386	7390	7395	7400	7405	7409	7414	7419	7423	7428	7433	7437
700	7365	7370	7375	7380	7385	7389	7394	7399	7404	7408	7413	7418	7422	7427	7432	7436	7441
699	7369	7374	7379	7384	7388	7393	7398	7403	7407	7412	7417	7421	7426	7431	7436	7440	7445
698	7373	7378	7383	7387	7392	7397	7402	7406	7411	7416	7421	7425	7430	7435	7439	7444	7448
697	7377	7381	7386	7391	7396	7401	7405	7410	7415	7420	7424	7429	7434	7438	7443	7448	7452
696	7380	7385	7390	7395	7400	7404	7409	7414	7419	7423	7428	7433	7437	7442	7447	7451	7456
695	7384	7389	7394	7399	7403	7408	7413	7418	7422	7427	7432	7436	7441	7446	7450	7455	7459
694	7388	7393	7398	7402	7407	7412	7417	7421	7426	7431	7435	7440	7445	7449	7454	7459	7463
693	7392	7397	7401	7406	7411	7416	7420	7425	7430	7434	7439	7444	7448	7453	7458	7462	7467
692	7395	7400	7405	7410	7415	7419	7424	7429	7433	7438	7443	7447	7452	7457	7461	7466	7470
691	7399	7404	7409	7414	7418	7423	7428	7432	7437	7442	7446	7451	7456	7460	7465	7470	7474
690	7403	7408	7413	7417	7422	7427	7431	7436	7441	7445	7450	7455	7459	7464	7469	7473	7478
689	7407	7412	7416	7421	7426	7430	7435	7440	7445	7449	7454	7458	7463	7468	7472	7477	7481
688	7411	7415	7420	7425	7430	7434	7439	7444	7448	7453	7458	7462	7467	7471	7476	7481	7485
687	7414	7419	7424	7429	7433	7438	7443	7447	7452	7457	7461	7466	7470	7475	7480	7484	7489
686	7418	7423	7428	7432	7437	7442	7446	7451	7456	7460	7465	7470	7474	7479	7483	7488	7492
685	7422	7427	7431	7436	7441	7445	7450	7455	7459	7464	7469	7473	7478	7482	7487	7492	7496
684	7426	7430	7435	7440	7444	7449	7454	7458	7463	7468	7472	7477	7482	7486	7491	7495	7500
683	7429	7434	7439	7444	7448	7453	7458	7462	7467	7471	7476	7481	7485	7490	7494	7499	7503
682	7433	7438	7443	7447	7452	7457	7461	7466	7471	7475	7480	7484	7489	7493	7498	7503	7507
681	7437	7442	7446	7451	7456	7460	7465	7470	7474	7479	7483	7488	7493	7497	7502	7506	7511
680	7441	7445	7450	7455	7459	7464	7469	7473	7478	7483	7487	7492	7496	7501	7505	7510	7514
679	7444	7449	7454	7459	7463	7468	7472	7477	7482	7486	7491	7495	7500	7505	7509	7514	7518
678	7448	7453	7458	7462	7467	7472	7476	7481	7485	7490	7495	7499	7504	7508	7513	7517	7522
677	7452	7457	7461	7466	7471	7475	7480	7485	7489	7494	7498	7503	7507	7512	7516	7521	7525
676	7456	7460	7465	7470	7474	7479	7484	7488	7493	7497	7502	7507	7511	7516	7520	7525	7529
675	7460	7464	7469	7474	7478	7483	7487	7492	7497	7501	7506	7510	7515	7519	7524	7528	7533
674	7463	7468	7473	7477	7482	7487	7491	7496	7500	7505	7509	7514	7518	7523	7527	7532	7536
673	7467	7472	7476	7481	7486	7490	7495	7499	7504	7509	7513	7518	7522	7527	7531	7536	7540
672	7471	7476	7480	7485	7489	7494	7499	7503	7508	7512	7517	7521	7526	7530	7535	7539	7544
671	7475	7479	7484	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529	7534	7538	7543	7547
670	7478	7483	7488	7492	7497	7501	7506	7511	7515	7520	7524	7529	7533	7538	7542	7547	7551
669	7482	7487	7491	7496	7501	7505	7510	7514	7519	7523	7528	7532	7537	7541	7546	7550	7555
668	7486	7491	7495	7500	7504	7509	7513	7518	7523	7527	7532	7536	7541	7545	7549	7554	7558
667	7490	7494	7499	7504	7508	7513	7517	7522	7526	7531	7535	7540	7544	7549	7553	7558	7562
666	7493	7498	7503	7507	7512	7516	7521	7525	7530	7534	7539	7543	7548	7552	7557	7561	7566
665	7497	7502	7506	7511	7516	7520	7525	7529	7534	7538	7543	7547	7552	7556	7561	7565	7569
664	7501	7506	7510	7515	7519	7524	7528	7533	7537	7542	7546	7551	7555	7560	7564	7569	7573
663	7505	7509	7514	7519	7523	7528	7532	7537	7541	7546	7550	7555	7559	7563	7568	7572	7577
662	7509	7513	7518	7522	7527	7531	7536	7540	7545	7549	7554	7558	7563	7567	7572	7576	7580
661	7512	7517	7521	7526	7531	7535	7540	7544	7549	7553	7557	7562	7566	7571	7575	7580	7584
660	7516	7521	7525	7530	7534	7539	7543	7548	7552	7557	7561	7566	7570	7574	7579	7583	7588
659	7520	7524	7529	7534	7538	7543	7547	7552	7556	7560	7565	7569	7574	7578	7583	7587	7591
658	7524	7528	7533	7537	7542	7546	7551	7555	7560	7564	7569	7573	7577	7582	7586	7591	7595
657	7527	7532	7537	7541	7546	7550	7555	7559	7563	7568	7572	7577	7581	7586	7590	7594	7599
656	7531	7536	7540	7545	7549	7554	7558	7563	7567	7572	7576	7580	7585	7589	7594	7598	7602
655	7535	7539	7544	7549	7553	7557	7562	7566	7571	7575	7580	7584	7589	7593	7597	7602	7606
654	7539	7543	7548	7552	7557	7561	7566	7570	7575	7579	7583	7588	7592	7597	7601	7605	7610
653	7542	7547	7552	7556	7560	7565	7569	7574	7578	7583	7587	7592	7596	7600	7605	7609	7613
652	7546	7551	7555	7560	7564	7569	7573	7578	7582	7586	7591	7595	7600	7604	7608	7613	7617
651	7550	7555	7559	7564	7568	7572	7577	7581	7586	7590	7595	7599	7603	7608	7612	7616	7621
650	7554	7558	7563	7567	7572	7576	7581	7585	7589	7594	7598	7603	7607	7611	7616	7620	7624
649	7558	7562	7567	7571	7575	7580	7584	7589	7593	7598	7602	7606	7611	7615	7619	7624	7628
648	7561	7566	7570	7575	7579	7584	7588	7592	7597	7601	7606	7610	7614	7619	7623	7627	7632
647	7565	7570	7574	7579	7583	7587	7592	7596	7601	7605	7609	7614	7618	7622	7627	7631	7635
646	7569	7573	7578	7582	7587	7591	7596	7600	7604	7609	7613	7617	7622	7626	7630	7635	7639
645	7573	7577	7582	7586	7590	7595	7599	7604	7608	7612	7617	7621	7625	7630	7634	7638	7643
644	7576	7581	7585	7590	7594	7599	7603	7607	7612	7616	7620	7625	7629	7633	7638	7642	7646
643	7580	7585	7589	7594	7598	7602	7607	7611	7615	7620	7624	7628	7633	7637	7641	7646	7650
642	7584	7588	7593	7597	7602	7606	7610	7615	7619	7624	7628	7632	7636	7641	7645	7649	7654
641	7588	7592	7597	7601	7605	7610	7614	7619	7623	7627	7632	7636	7640	7644	7649	7653	7657
640	7591	7596	7600	7605	7609	7614	7618	7622	7627	7631	7635	7640	7644	7648	7652	7657	7661

Table 40 Metric—High Alt, Low-Mid Temp, High Humidity
(Temp = 13.5 to 21.5° C, Press = 640 to 720 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5
720	7373	7377	7382	7387	7392	7396	7401	7406	7410	7415	7420	7424	7429	7434	7438	7443	7447
719	7376	7381	7386	7390	7395	7400	7405	7409	7414	7419	7423	7428	7432	7437	7442	7446	7451
718	7380	7385	7389	7394	7399	7404	7408	7413	7418	7422	7427	7431	7436	7441	7445	7450	7454
717	7384	7388	7393	7398	7402	7407	7412	7416	7421	7426	7430	7435	7440	7444	7449	7453	7458
716	7387	7392	7397	7401	7406	7411	7415	7420	7425	7429	7434	7439	7443	7448	7452	7457	7462
715	7391	7396	7400	7405	7410	7414	7419	7424	7428	7433	7438	7442	7447	7451	7456	7461	7465
714	7395	7399	7404	7409	7413	7418	7423	7427	7432	7437	7441	7446	7450	7455	7460	7464	7469
713	7398	7403	7408	7412	7417	7422	7426	7431	7436	7440	7445	7449	7454	7459	7463	7468	7472
712	7402	7407	7411	7416	7421	7425	7430	7435	7439	7444	7448	7453	7458	7462	7467	7471	7476
711	7406	7410	7415	7420	7424	7429	7434	7438	7443	7447	7452	7457	7461	7466	7470	7475	7479
710	7409	7414	7419	7423	7428	7433	7437	7442	7446	7451	7456	7460	7465	7469	7474	7478	7483
709	7413	7418	7422	7427	7431	7436	7441	7445	7450	7455	7459	7464	7468	7473	7477	7482	7486
708	7417	7421	7426	7430	7435	7440	7444	7449	7454	7458	7463	7467	7472	7476	7481	7485	7490
707	7420	7425	7429	7434	7439	7443	7448	7453	7457	7462	7466	7471	7475	7480	7485	7489	7494
706	7424	7428	7433	7438	7442	7447	7452	7456	7461	7465	7470	7474	7479	7484	7488	7493	7497
705	7427	7432	7437	7441	7446	7451	7455	7460	7464	7469	7474	7478	7483	7487	7492	7496	7501
704	7431	7436	7440	7445	7450	7454	7459	7463	7468	7473	7477	7482	7486	7491	7495	7500	7504
703	7435	7439	7444	7449	7453	7458	7462	7467	7472	7476	7481	7485	7490	7494	7499	7503	7508
702	7438	7443	7448	7452	7457	7462	7466	7471	7475	7480	7484	7489	7493	7498	7502	7507	7511
701	7442	7447	7451	7456	7461	7465	7470	7474	7479	7483	7488	7492	7497	7501	7506	7510	7515
700	7446	7450	7455	7460	7464	7469	7473	7478	7482	7487	7491	7496	7501	7505	7510	7514	7518
699	7449	7454	7459	7463	7468	7472	7477	7481	7486	7491	7495	7500	7504	7509	7513	7518	7522
698	7453	7458	7462	7467	7471	7476	7481	7485	7490	7494	7499	7503	7508	7512	7517	7521	7526
697	7457	7461	7466	7471	7475	7480	7484	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529
696	7460	7465	7470	7474	7479	7483	7488	7492	7497	7501	7506	7510	7515	7519	7524	7528	7533
695	7464	7469	7473	7478	7482	7487	7491	7496	7500	7505	7509	7514	7518	7523	7527	7532	7536
694	7468	7472	7477	7481	7486	7491	7495	7500	7504	7509	7513	7518	7522	7526	7531	7535	7540
693	7471	7476	7481	7485	7490	7494	7499	7503	7508	7512	7517	7521	7526	7530	7535	7539	7543
692	7475	7480	7484	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529	7534	7538	7543	7547
691	7479	7483	7488	7492	7497	7501	7506	7510	7515	7519	7524	7528	7533	7537	7542	7546	7550
690	7482	7487	7491	7496	7500	7505	7510	7514	7518	7523	7527	7532	7536	7541	7545	7550	7554
689	7486	7491	7495	7500	7504	7509	7513	7518	7522	7527	7531	7535	7540	7544	7549	7553	7558
688	7490	7494	7499	7503	7508	7512	7517	7521	7526	7530	7535	7539	7544	7548	7552	7557	7561
687	7493	7498	7502	7507	7511	7516	7520	7525	7529	7534	7538	7543	7547	7552	7556	7560	7565
686	7497	7501	7506	7511	7515	7520	7524	7528	7533	7537	7542	7546	7551	7555	7559	7564	7568
685	7501	7505	7510	7514	7519	7523	7528	7532	7537	7541	7545	7550	7554	7559	7563	7567	7572
684	7504	7509	7513	7518	7522	7527	7531	7536	7540	7545	7549	7553	7558	7562	7567	7571	7575
683	7508	7512	7517	7521	7526	7530	7535	7539	7544	7548	7553	7557	7561	7566	7570	7575	7579
682	7512	7516	7521	7525	7530	7534	7538	7543	7547	7552	7556	7561	7565	7569	7574	7578	7583
681	7515	7520	7524	7529	7533	7538	7542	7547	7551	7555	7560	7564	7569	7573	7577	7582	7586
680	7519	7523	7528	7532	7537	7541	7546	7550	7555	7559	7563	7568	7572	7577	7581	7585	7590
679	7523	7527	7532	7536	7540	7545	7549	7554	7558	7563	7567	7571	7576	7580	7584	7589	7593
678	7526	7531	7535	7540	7544	7549	7553	7557	7562	7566	7571	7575	7579	7584	7588	7592	7597
677	7530	7534	7539	7543	7548	7552	7557	7561	7565	7570	7574	7579	7583	7587	7592	7596	7600
676	7534	7538	7542	7547	7551	7556	7560	7565	7569	7573	7578	7582	7586	7591	7595	7600	7604
675	7537	7542	7546	7551	7555	7559	7564	7568	7573	7577	7581	7586	7590	7594	7599	7603	7607
674	7541	7545	7550	7554	7559	7563	7567	7572	7576	7581	7585	7589	7594	7598	7602	7607	7611
673	7545	7549	7553	7558	7562	7567	7571	7575	7580	7584	7589	7593	7597	7602	7606	7610	7615
672	7548	7553	7557	7561	7566	7570	7575	7579	7583	7588	7592	7596	7601	7605	7609	7614	7618
671	7552	7556	7561	7565	7570	7574	7578	7583	7587	7591	7596	7600	7604	7609	7613	7617	7622
670	7555	7560	7564	7569	7573	7578	7582	7586	7591	7595	7599	7604	7608	7612	7617	7621	7625
669	7559	7564	7568	7572	7577	7581	7586	7590	7594	7599	7603	7607	7612	7616	7620	7624	7629
668	7563	7567	7572	7576	7580	7585	7589	7593	7598	7602	7607	7611	7615	7619	7624	7628	7632
667	7566	7571	7575	7580	7584	7588	7593	7597	7601	7606	7610	7614	7619	7623	7627	7632	7636
666	7570	7575	7579	7583	7588	7592	7596	7601	7605	7609	7614	7618	7622	7627	7631	7635	7639
665	7574	7578	7583	7587	7591	7596	7600	7604	7609	7613	7617	7622	7626	7630	7634	7639	7643
664	7577	7582	7586	7591	7595	7599	7604	7608	7612	7617	7621	7625	7629	7634	7638	7642	7647
663	7581	7585	7590	7594	7599	7603	7607	7612	7616	7620	7624	7629	7633	7637	7642	7646	7650
662	7585	7589	7593	7598	7602	7607	7611	7615	7619	7624	7628	7632	7637	7641	7645	7649	7654
661	7588	7593	7597	7601	7606	7610	7614	7619	7623	7627	7632	7636	7640	7644	7649	7653	7657
660	7592	7596	7601	7605	7609	7614	7618	7622	7627	7631	7635	7640	7644	7648	7652	7657	7661
659	7596	7600	7604	7609	7613	7617	7622	7626	7630	7635	7639	7643	7647	7652	7656	7660	7664
658	7599	7604	7608	7612	7617	7621	7625	7630	7634	7638	7642	7647	7651	7655	7659	7664	7668
657	7603	7607	7612	7616	7620	7625	7629	7633	7638	7642	7646	7650	7655	7659	7663	7667	7671
656	7607	7611	7615	7620	7624	7628	7633	7637	7641	7645	7650	7654	7658	7662	7667	7671	7675
655	7610	7615	7619	7623	7628	7632	7636	7640	7645	7649	7653	7657	7662	7666	7670	7674	7679
654	7614	7618	7623	7627	7631	7636	7640	7644	7648	7653	7657	7661	7665	7670	7674	7678	7682
653	7618	7622	7626	7631	7635	7639	7643	7648	7652	7656	7660	7665	7669	7673	7677	7681	7686
652	7621	7626	7630	7634	7638	7643	7647	7651	7656	7660	7664	7668	7672	7677	7681	7685	7689
651	7625	7629	7634	7638	7642	7646	7651	7655	7659	7663	7668	7672	7676	7680	7684	7689	7693
650	7629	7633	7637	7641	7646	7650	7654	7659	7663	7667	7671	7675	7680	7684	7688	7692	7696
649	7632	7637	7641	7645	7649	7654	7658	7662	7666	7671	7675	7679	7683	7687	7692	7696	7700
648	7636	7640	7645	7649	7653	7657	7662	7666	7670	7674	7678	7683	7687	7691	7695	7699	7703
647	7640	7644	7648	7652	7657	7661	7665	7669	7674	7678	7682	7686	7690	7695	7699	7703	7707
646	7643	7648	7652	7656	7660	7665	7669	7673	7677	7681	7686	7690	7694	7698	7702	7706	7711
645	7647	7651	7655	7660	7664	7668	7672	7677	7681	7685	7689	7693	7698	7702	7706	7710	7714
644	7651	7655	7659	7663	7668	7672	7676	7680	7684	7689	7693	7697	7701	7705	7709	7714	7718
643	7654	7658	7663	7667	7671	7675	7680	7684	7688	7692	7696	7701	7705	7709	7713	7717	7721
642	7658	7662	7666	7671	7675	7679	7683	7687	7692	7696	7700	7704	7708	7712	7717	7721	7725
641	7662	7666	7670	7674	7678	7683	7687	7691	7695	7699	7704	7708	7712	7716	7720	7724	7728
640	7665	7669	7674	7678	7682	7686	7690	7695	7699	7703	7707	7711	7715	7720	7724	7728	7732

Table 41 Metric—High Alt, Mid Temp, High Humidity
(Temp = 22 to 30° C, Press = 640 to 720 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY

	22.0	22.5	23.0	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0
720	7452	7457	7461	7466	7470	7475	7479	7484	7488	7493	7497	7502	7506	7511	7516	7520	7525
719	7455	7460	7465	7469	7474	7478	7483	7487	7492	7496	7501	7505	7510	7514	7519	7523	7528
718	7459	7464	7468	7473	7477	7482	7486	7491	7495	7500	7504	7509	7513	7518	7522	7527	7531
717	7463	7467	7472	7476	7481	7485	7490	7494	7499	7503	7508	7512	7517	7521	7526	7530	7535
716	7466	7471	7475	7480	7484	7489	7493	7498	7502	7507	7511	7516	7520	7525	7529	7534	7538
715	7470	7474	7479	7483	7488	7492	7497	7501	7506	7510	7515	7519	7524	7528	7533	7537	7542
714	7473	7478	7482	7487	7491	7496	7500	7505	7509	7514	7518	7523	7527	7532	7536	7541	7545
713	7477	7481	7486	7490	7495	7499	7504	7508	7513	7517	7522	7526	7531	7535	7540	7544	7549
712	7480	7485	7489	7494	7498	7503	7507	7512	7516	7521	7525	7530	7534	7539	7543	7548	7552
711	7484	7488	7493	7497	7502	7506	7511	7515	7520	7524	7529	7533	7538	7542	7547	7551	7556
710	7487	7492	7496	7501	7505	7510	7514	7519	7523	7528	7532	7537	7541	7546	7550	7555	7559
709	7491	7496	7500	7505	7509	7514	7518	7522	7527	7531	7536	7540	7545	7549	7554	7558	7563
708	7495	7499	7504	7508	7513	7517	7522	7526	7530	7535	7539	7544	7548	7553	7557	7562	7566
707	7498	7503	7507	7512	7516	7521	7525	7529	7534	7538	7543	7547	7552	7556	7561	7565	7569
706	7502	7506	7511	7515	7520	7524	7529	7533	7537	7542	7546	7551	7555	7560	7564	7569	7573
705	7505	7510	7514	7519	7523	7528	7532	7537	7541	7545	7550	7554	7559	7563	7568	7572	7576
704	7509	7513	7518	7522	7527	7531	7536	7540	7544	7549	7553	7558	7562	7567	7571	7575	7580
703	7512	7517	7521	7526	7530	7535	7539	7544	7548	7552	7557	7561	7566	7570	7574	7579	7583
702	7516	7520	7525	7529	7534	7538	7543	7547	7551	7556	7560	7565	7569	7574	7578	7582	7587
701	7519	7524	7528	7533	7537	7542	7546	7551	7555	7559	7564	7568	7573	7577	7581	7586	7590
700	7523	7527	7532	7536	7541	7545	7550	7554	7558	7563	7567	7572	7576	7581	7585	7589	7594
699	7527	7531	7535	7540	7544	7549	7553	7558	7562	7566	7571	7575	7580	7584	7588	7593	7597
698	7530	7535	7539	7543	7548	7552	7557	7561	7565	7570	7574	7579	7583	7587	7592	7596	7601
697	7534	7538	7542	7547	7551	7556	7560	7565	7569	7573	7578	7582	7587	7591	7595	7600	7604
696	7537	7542	7546	7550	7555	7559	7564	7568	7572	7577	7581	7586	7590	7594	7599	7603	7608
695	7541	7545	7550	7554	7558	7563	7567	7572	7576	7580	7585	7589	7594	7598	7602	7607	7611
694	7544	7549	7553	7558	7562	7566	7571	7575	7579	7584	7588	7593	7597	7601	7606	7610	7614
693	7548	7552	7557	7561	7565	7570	7574	7579	7583	7587	7592	7596	7600	7605	7609	7614	7618
692	7551	7556	7560	7565	7569	7573	7578	7582	7586	7591	7595	7600	7604	7608	7613	7617	7621
691	7555	7559	7564	7568	7573	7577	7581	7586	7590	7594	7599	7603	7607	7612	7616	7620	7625
690	7558	7563	7567	7572	7576	7580	7585	7589	7594	7598	7602	7607	7611	7615	7620	7624	7628
689	7562	7566	7571	7575	7580	7584	7588	7593	7597	7601	7606	7610	7614	7619	7623	7627	7632
688	7566	7570	7574	7579	7583	7587	7592	7596	7601	7605	7609	7614	7618	7622	7627	7631	7635
687	7569	7574	7578	7582	7587	7591	7595	7600	7604	7608	7613	7617	7621	7626	7630	7634	7639
686	7573	7577	7581	7586	7590	7594	7599	7603	7608	7612	7616	7621	7625	7629	7633	7638	7642
685	7576	7581	7585	7589	7594	7598	7602	7607	7611	7615	7620	7624	7628	7633	7637	7641	7646
684	7580	7584	7588	7593	7597	7602	7606	7610	7615	7619	7623	7627	7632	7636	7640	7645	7649
683	7583	7588	7592	7596	7601	7605	7609	7614	7618	7622	7627	7631	7635	7640	7644	7648	7652
682	7587	7591	7596	7600	7604	7609	7613	7617	7622	7626	7630	7634	7639	7643	7647	7652	7656
681	7590	7595	7599	7603	7608	7612	7616	7621	7625	7629	7634	7638	7642	7647	7651	7655	7659
680	7594	7598	7603	7607	7611	7616	7620	7624	7629	7633	7637	7641	7646	7650	7654	7659	7663
679	7598	7602	7606	7611	7615	7619	7623	7628	7632	7636	7641	7645	7649	7653	7658	7662	7666
678	7601	7605	7610	7614	7618	7623	7627	7631	7636	7640	7644	7648	7653	7657	7661	7665	7670
677	7605	7609	7613	7618	7622	7626	7630	7635	7639	7643	7648	7652	7656	7660	7665	7669	7673
676	7608	7612	7617	7621	7625	7630	7634	7638	7643	7647	7651	7655	7660	7664	7668	7672	7677
675	7612	7616	7620	7625	7629	7633	7638	7642	7646	7650	7655	7659	7663	7667	7672	7676	7680
674	7615	7620	7624	7628	7632	7637	7641	7645	7650	7654	7658	7662	7667	7671	7675	7679	7684
673	7619	7623	7627	7632	7636	7640	7645	7649	7653	7657	7662	7666	7670	7674	7679	7683	7687
672	7622	7627	7631	7635	7640	7644	7648	7652	7657	7661	7665	7669	7674	7678	7682	7686	7690
671	7626	7630	7635	7639	7643	7647	7652	7656	7660	7664	7669	7673	7677	7681	7685	7690	7694
670	7629	7634	7638	7642	7647	7651	7655	7659	7664	7668	7672	7676	7681	7685	7689	7693	7697
669	7633	7637	7642	7646	7650	7654	7659	7663	7667	7671	7676	7680	7684	7688	7692	7697	7701
668	7637	7641	7645	7649	7654	7658	7662	7666	7671	7675	7679	7683	7687	7692	7696	7700	7704
667	7640	7644	7649	7653	7657	7661	7666	7670	7674	7678	7683	7687	7691	7695	7699	7704	7708
666	7644	7648	7652	7656	7661	7665	7669	7673	7678	7682	7686	7690	7694	7699	7703	7707	7711
665	7647	7651	7656	7660	7664	7668	7673	7677	7681	7685	7690	7694	7698	7702	7706	7710	7715
664	7651	7655	7659	7664	7668	7672	7676	7680	7685	7689	7693	7697	7701	7706	7710	7714	7718
663	7654	7659	7663	7667	7671	7675	7680	7684	7688	7692	7696	7701	7705	7709	7713	7717	7722
662	7658	7662	7666	7671	7675	7679	7683	7687	7692	7696	7700	7704	7708	7713	7717	7721	7725
661	7661	7666	7670	7674	7678	7683	7687	7691	7695	7699	7703	7708	7712	7716	7720	7724	7729
660	7665	7669	7673	7678	7682	7686	7690	7694	7699	7703	7707	7711	7715	7719	7724	7728	7732
659	7669	7673	7677	7681	7685	7690	7694	7698	7702	7706	7710	7715	7719	7723	7727	7731	7735
658	7672	7676	7681	7685	7689	7693	7697	7701	7706	7710	7714	7718	7722	7726	7731	7735	7739
657	7676	7680	7684	7688	7692	7697	7701	7705	7709	7713	7717	7722	7726	7730	7734	7738	7742
656	7679	7683	7688	7692	7696	7700	7704	7708	7713	7717	7721	7725	7729	7733	7738	7742	7746
655	7683	7687	7691	7695	7699	7704	7708	7712	7716	7720	7724	7729	7733	7737	7741	7745	7749
654	7686	7690	7695	7699	7703	7707	7711	7715	7720	7724	7728	7732	7736	7740	7744	7749	7753
653	7690	7694	7698	7702	7707	7711	7715	7719	7723	7727	7731	7736	7740	7744	7748	7752	7756
652	7693	7698	7702	7706	7710	7714	7718	7723	7727	7731	7735	7739	7743	7747	7751	7756	7760
651	7697	7701	7705	7709	7714	7718	7722	7726	7730	7734	7738	7743	7747	7751	7755	7759	7763
650	7701	7705	7709	7713	7717	7721	7725	7730	7734	7738	7742	7746	7750	7754	7758	7762	7767
649	7704	7708	7712	7717	7721	7725	7729	7733	7737	7741	7745	7749	7754	7758	7762	7766	7770
648	7708	7712	7716	7720	7724	7728	7732	7737	7741	7745	7749	7753	7757	7761	7765	7769	7773
647	7711	7715	7719	7724	7728	7732	7736	7740	7744	7748	7752	7756	7761	7765	7769	7773	7777
646	7715	7719	7723	7727	7731	7735	7739	7744	7748	7752	7756	7760	7764	7768	7772	7776	7780
645	7718	7722	7727	7731	7735	7739	7743	7747	7751	7755	7759	7763	7768	7772	7776	7780	7784
644	7722	7726	7730	7734	7738	7742	7746	7751	7755	7759	7763	7767	7771	7775	7779	7783	7787
643	7725	7729	7734	7738	7742	7746	7750	7754	7758	7762	7766	7770	7774	7779	7783	7787	7791
642	7729	7733	7737	7741	7745	7749	7754	7758	7762	7766	7770	7774	7778	7782	7786	7790	7794
641	7732	7737	7741	7745	7749	7753	7757	7761	7765	7769	7773	7777	7781	7785	7790	7794	7798
640	7736	7740	7744	7748	7752	7756	7761	7765	7769	7773	7777	7781	7785	7789	7793	7797	7801

Table 42 Metric—High Alt, High-Mid Temp, High Humidity
(Temp = 30.5 to 38.5° C, Press = 640 to 720 mm, 80% Humidity)

TEMPERATURE IN DEGREES CELSIUS

BAROMETRIC PRESSURE IN MILLIMETERS OF MERCURY	30.5	31.0	31.5	32.0	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5
720	7529	7534	7538	7543	7547	7552	7556	7561	7565	7570	7574	7579	7583	7588	7592	7597	7601
719	7532	7537	7541	7546	7550	7555	7559	7564	7568	7573	7577	7582	7586	7591	7595	7600	7604
718	7536	7540	7545	7549	7554	7558	7563	7567	7572	7576	7581	7585	7590	7594	7599	7603	7608
717	7539	7544	7548	7553	7557	7562	7566	7571	7575	7580	7584	7589	7593	7598	7602	7607	7611
716	7543	7547	7552	7556	7561	7565	7570	7574	7579	7583	7588	7592	7597	7601	7606	7610	7615
715	7546	7551	7555	7560	7564	7569	7573	7578	7582	7587	7591	7595	7600	7604	7609	7613	7618
714	7550	7554	7559	7563	7568	7572	7577	7581	7585	7590	7594	7599	7603	7608	7612	7617	7621
713	7553	7558	7562	7567	7571	7575	7580	7584	7589	7593	7598	7602	7607	7611	7616	7620	7625
712	7557	7561	7566	7570	7574	7579	7583	7588	7592	7597	7601	7606	7610	7615	7619	7623	7628
711	7560	7565	7569	7573	7578	7582	7587	7591	7596	7600	7605	7609	7613	7618	7622	7627	7631
710	7564	7568	7572	7577	7581	7586	7590	7595	7599	7604	7608	7612	7617	7621	7626	7630	7635
709	7567	7571	7576	7580	7585	7589	7594	7598	7602	7607	7611	7616	7620	7625	7629	7634	7638
708	7570	7575	7579	7584	7588	7593	7597	7601	7606	7610	7615	7619	7624	7628	7633	7637	7641
707	7574	7578	7583	7587	7592	7596	7600	7605	7609	7614	7618	7623	7627	7631	7636	7640	7645
706	7577	7582	7586	7591	7595	7599	7604	7608	7613	7617	7622	7626	7630	7635	7639	7644	7648
705	7581	7585	7590	7594	7598	7603	7607	7612	7616	7621	7625	7629	7634	7638	7643	7647	7652
704	7584	7589	7593	7597	7602	7606	7611	7615	7620	7624	7628	7633	7637	7642	7646	7650	7655
703	7588	7592	7597	7601	7605	7610	7614	7619	7623	7627	7632	7636	7641	7645	7649	7654	7658
702	7591	7596	7600	7604	7609	7613	7618	7622	7626	7631	7635	7640	7644	7648	7653	7657	7662
701	7595	7599	7603	7608	7612	7617	7621	7625	7630	7634	7639	7643	7647	7652	7656	7661	7665
700	7598	7602	7607	7611	7616	7620	7624	7629	7633	7638	7642	7646	7651	7655	7660	7664	7668
699	7602	7606	7610	7615	7619	7623	7628	7632	7637	7641	7645	7650	7654	7658	7663	7667	7672
698	7605	7609	7614	7618	7622	7627	7631	7636	7640	7644	7649	7653	7657	7662	7666	7671	7675
697	7608	7613	7617	7622	7626	7630	7635	7639	7643	7648	7652	7656	7661	7665	7670	7674	7678
696	7612	7616	7621	7625	7629	7634	7638	7642	7647	7651	7655	7660	7664	7669	7673	7677	7682
695	7615	7620	7624	7628	7633	7637	7641	7646	7650	7655	7659	7663	7668	7672	7676	7681	7685
694	7619	7623	7627	7632	7636	7641	7645	7649	7654	7658	7662	7667	7671	7675	7680	7684	7688
693	7622	7627	7631	7635	7640	7644	7648	7653	7657	7661	7666	7670	7674	7679	7683	7687	7692
692	7626	7630	7634	7639	7643	7647	7652	7656	7660	7665	7669	7673	7678	7682	7686	7691	7695
691	7629	7633	7638	7642	7646	7651	7655	7659	7664	7668	7672	7677	7681	7686	7690	7694	7699
690	7633	7637	7641	7646	7650	7654	7659	7663	7667	7672	7676	7680	7685	7689	7693	7698	7702
689	7636	7640	7645	7649	7653	7658	7662	7666	7671	7675	7679	7684	7688	7692	7697	7701	7705
688	7639	7644	7648	7652	7657	7661	7665	7670	7674	7678	7683	7687	7691	7696	7700	7704	7709
687	7643	7647	7652	7656	7660	7664	7669	7673	7677	7682	7686	7690	7695	7699	7703	7708	7712
686	7646	7651	7655	7659	7664	7668	7672	7677	7681	7685	7689	7694	7698	7702	7707	7711	7715
685	7650	7654	7658	7663	7667	7671	7676	7680	7684	7689	7693	7697	7701	7706	7710	7714	7719
684	7653	7658	7662	7666	7670	7675	7679	7683	7688	7692	7696	7701	7705	7709	7713	7718	7722
683	7657	7661	7665	7670	7674	7678	7682	7687	7691	7695	7700	7704	7708	7713	7717	7721	7725
682	7660	7664	7669	7673	7677	7682	7686	7690	7694	7699	7703	7707	7712	7716	7720	7725	7729
681	7664	7668	7672	7676	7681	7685	7689	7694	7698	7702	7706	7711	7715	7719	7724	7728	7732
680	7667	7671	7676	7680	7684	7688	7693	7697	7701	7706	7710	7714	7718	7723	7727	7731	7736
679	7671	7675	7679	7683	7688	7692	7696	7700	7705	7709	7713	7717	7722	7726	7730	7735	7739
678	7674	7678	7683	7687	7691	7695	7700	7704	7708	7712	7717	7721	7725	7729	7734	7738	7742
677	7677	7682	7686	7690	7694	7699	7703	7707	7711	7716	7720	7724	7729	7733	7737	7741	7746
676	7681	7685	7689	7694	7698	7702	7706	7711	7715	7719	7723	7728	7732	7736	7740	7745	7749
675	7684	7689	7693	7697	7701	7706	7710	7714	7718	7723	7727	7731	7735	7740	7744	7748	7752
674	7688	7692	7696	7701	7705	7709	7713	7717	7722	7726	7730	7734	7739	7743	7747	7751	7756
673	7691	7695	7700	7704	7708	7712	7717	7721	7725	7729	7734	7738	7742	7746	7751	7755	7759
672	7695	7699	7703	7707	7712	7716	7720	7724	7729	7733	7737	7741	7745	7750	7754	7758	7762
671	7698	7702	7707	7711	7715	7719	7723	7728	7732	7736	7740	7745	7749	7753	7757	7762	7766
670	7702	7706	7710	7714	7718	7723	7727	7731	7735	7740	7744	7748	7752	7756	7761	7765	7769
669	7705	7709	7713	7718	7722	7726	7730	7735	7739	7743	7747	7751	7756	7760	7764	7768	7773
668	7709	7713	7717	7721	7725	7730	7734	7738	7742	7746	7751	7755	7759	7763	7767	7772	7776
667	7712	7716	7720	7725	7729	7733	7737	7741	7746	7750	7754	7758	7762	7767	7771	7775	7779
666	7715	7720	7724	7728	7732	7736	7741	7745	7749	7753	7757	7762	7766	7770	7774	7778	7783
665	7719	7723	7727	7731	7736	7740	7744	7748	7752	7757	7761	7765	7769	7773	7778	7782	7786
664	7722	7726	7731	7735	7739	7743	7747	7752	7756	7760	7764	7768	7773	7777	7781	7785	7789
663	7726	7730	7734	7738	7742	7747	7751	7755	7759	7763	7768	7772	7776	7780	7784	7789	7793
662	7729	7733	7738	7742	7746	7750	7754	7758	7763	7767	7771	7775	7779	7783	7788	7792	7796
661	7733	7737	7741	7745	7749	7753	7758	7762	7766	7770	7774	7779	7783	7787	7791	7795	7799
660	7736	7740	7744	7749	7753	7757	7761	7765	7769	7774	7778	7782	7786	7790	7794	7799	7803
659	7740	7744	7748	7752	7756	7760	7764	7769	7773	7777	7781	7785	7789	7794	7798	7802	7806
658	7743	7747	7751	7755	7760	7764	7768	7772	7776	7780	7785	7789	7793	7797	7801	7805	7810
657	7746	7751	7755	7759	7763	7767	7771	7775	7780	7784	7788	7792	7796	7800	7805	7809	7813
656	7750	7754	7758	7762	7766	7771	7775	7779	7783	7787	7791	7795	7800	7804	7808	7812	7816
655	7753	7758	7762	7766	7770	7774	7778	7782	7786	7791	7795	7799	7803	7807	7811	7815	7820
654	7757	7761	7765	7769	7773	7777	7782	7786	7790	7794	7798	7802	7806	7811	7815	7819	7823
653	7760	7764	7769	7773	7777	7781	7785	7789	7793	7797	7801	7806	7810	7814	7818	7822	7826
652	7764	7768	7772	7776	7780	7784	7788	7793	7797	7801	7805	7809	7813	7817	7821	7826	7830
651	7767	7771	7775	7780	7784	7788	7792	7796	7800	7804	7808	7812	7817	7821	7825	7829	7833
650	7771	7775	7779	7783	7787	7791	7795	7799	7803	7808	7812	7816	7820	7824	7828	7832	7836
649	7774	7778	7782	7786	7790	7795	7799	7803	7807	7811	7815	7819	7823	7827	7832	7836	7840
648	7778	7782	7786	7790	7794	7798	7802	7806	7810	7814	7818	7823	7827	7831	7835	7839	7843
647	7781	7785	7789	7793	7797	7801	7805	7810	7814	7818	7822	7826	7830	7834	7838	7842	7847
646	7784	7789	7793	7797	7801	7805	7809	7813	7817	7821	7825	7829	7833	7838	7842	7846	7850
645	7788	7792	7796	7800	7804	7808	7812	7816	7820	7825	7829	7833	7837	7841	7845	7849	7853
644	7791	7795	7799	7804	7808	7812	7816	7820	7824	7828	7832	7836	7840	7844	7848	7853	7857
643	7795	7799	7803	7807	7811	7815	7819	7823	7827	7831	7835	7840	7844	7848	7852	7856	7860
642	7798	7802	7806	7810	7814	7819	7823	7827	7831	7835	7839	7843	7847	7851	7855	7859	7863
641	7802	7806	7810	7814	7818	7822	7826	7830	7834	7838	7842	7846	7850	7854	7859	7863	7867
640	7805	7809	7813	7817	7821	7825	7829	7833	7838	7842	7846	7850	7854	7858	7862	7866	7870

Table 43 English—Wide Range
(Temp = 40 to 120° F, Press = 20 to 31 inches, 50% Humidity)

	TEMPERATURE IN DEGREES FAHRENHEIT																
BAROMETRIC PRESSURE IN INCHES OF MERCURY	40.0	45.0	50.0	55.0	60.0	65.0	70.0	75.0	80.0	85.0	90.0	95.0	100.0	105.0	110.0	115.0	120.0
31.00	7029	7059	7089	7117	7146	7174	7202	7229	7256	7282	7309	7335	7361	7387	7413	7439	7465
30.80	7048	7078	7107	7136	7164	7192	7220	7247	7273	7300	7326	7352	7378	7404	7429	7455	7481
30.60	7068	7097	7126	7155	7183	7210	7238	7265	7291	7317	7344	7369	7395	7421	7446	7472	7498
30.40	7087	7116	7145	7173	7201	7229	7256	7283	7309	7335	7361	7387	7412	7438	7463	7489	7514
30.20	7106	7135	7164	7192	7220	7247	7274	7300	7327	7353	7378	7404	7429	7455	7480	7505	7531
30.00	7125	7154	7183	7211	7238	7265	7292	7318	7344	7370	7396	7421	7446	7472	7497	7522	7547
29.80	7144	7173	7201	7229	7257	7284	7310	7336	7362	7388	7413	7438	7463	7488	7514	7539	7564
29.60	7164	7192	7220	7248	7275	7302	7328	7354	7380	7405	7431	7456	7481	7505	7530	7555	7580
29.40	7183	7211	7239	7266	7293	7320	7346	7372	7398	7423	7448	7473	7498	7522	7547	7572	7597
29.20	7202	7230	7258	7285	7312	7338	7364	7390	7415	7441	7465	7490	7515	7539	7564	7589	7613
29.00	7221	7249	7277	7304	7330	7357	7382	7408	7433	7458	7483	7507	7532	7556	7581	7605	7630
28.80	7240	7268	7295	7322	7349	7375	7401	7426	7451	7476	7500	7525	7549	7573	7598	7622	7646
28.60	7259	7287	7314	7341	7367	7393	7419	7444	7469	7493	7518	7542	7566	7590	7614	7639	7663
28.40	7279	7306	7333	7360	7386	7411	7437	7462	7486	7511	7535	7559	7583	7607	7631	7655	7680
28.20	7298	7325	7352	7378	7404	7430	7455	7480	7504	7529	7553	7577	7600	7624	7648	7672	7696
28.00	7317	7344	7371	7397	7423	7448	7473	7498	7522	7546	7570	7594	7618	7641	7665	7689	7713
27.80	7336	7363	7389	7415	7441	7466	7491	7516	7540	7564	7587	7611	7635	7658	7682	7705	7729
27.60	7355	7382	7408	7434	7459	7484	7509	7533	7557	7581	7605	7628	7652	7675	7698	7722	7746
27.40	7375	7401	7427	7453	7478	7503	7527	7551	7575	7599	7622	7646	7669	7692	7715	7739	7762
27.20	7394	7420	7446	7471	7496	7521	7545	7569	7593	7616	7640	7663	7686	7709	7732	7755	7779
27.00	7413	7439	7465	7490	7515	7539	7563	7587	7611	7634	7657	7680	7703	7726	7749	7772	7795
26.80	7432	7458	7483	7509	7533	7557	7581	7605	7628	7652	7675	7697	7720	7743	7766	7789	7812
26.60	7451	7477	7502	7527	7552	7576	7600	7623	7646	7669	7692	7715	7737	7760	7782	7805	7828
26.40	7470	7496	7521	7546	7570	7594	7618	7641	7664	7687	7709	7732	7754	7777	7799	7822	7845
26.20	7490	7515	7540	7564	7589	7612	7636	7659	7682	7704	7727	7749	7772	7794	7816	7839	7861
26.00	7509	7534	7559	7583	7607	7631	7654	7677	7699	7722	7744	7767	7789	7811	7833	7855	7878
25.80	7528	7553	7577	7602	7625	7649	7672	7695	7717	7740	7762	7784	7806	7828	7850	7872	7894
25.60	7547	7572	7596	7620	7644	7667	7690	7713	7735	7757	7779	7801	7823	7845	7867	7889	7911
25.40	7566	7591	7615	7639	7662	7685	7708	7731	7753	7775	7797	7818	7840	7862	7883	7905	7927
25.20	7586	7610	7634	7657	7681	7704	7726	7748	7770	7792	7814	7836	7857	7879	7900	7922	7944
25.00	7605	7629	7653	7676	7699	7722	7744	7766	7788	7810	7831	7853	7874	7896	7917	7939	7960
24.80	7624	7648	7672	7695	7718	7740	7762	7784	7806	7828	7849	7870	7891	7913	7934	7955	7977
24.60	7643	7667	7690	7713	7736	7758	7780	7802	7824	7845	7866	7887	7908	7929	7951	7972	7993
24.40	7662	7686	7709	7732	7754	7777	7799	7820	7842	7863	7884	7905	7926	7946	7967	7989	8010
24.20	7681	7705	7728	7751	7773	7795	7817	7838	7859	7880	7901	7922	7943	7963	7984	8005	8026
24.00	7701	7724	7747	7769	7791	7813	7835	7856	7877	7898	7919	7939	7960	7980	8001	8022	8043
23.80	7720	7743	7766	7788	7810	7831	7853	7874	7895	7915	7936	7956	7977	7997	8018	8039	8059
23.60	7739	7762	7784	7806	7828	7850	7871	7892	7913	7933	7953	7974	7994	8014	8035	8055	8076
23.40	7758	7781	7803	7825	7847	7868	7889	7910	7930	7951	7971	7991	8011	8031	8051	8072	8092
23.20	7777	7800	7822	7844	7865	7886	7907	7928	7948	7968	7988	8008	8028	8048	8068	8088	8109
23.00	7797	7819	7841	7862	7884	7904	7925	7946	7966	7986	8006	8026	8045	8065	8085	8105	8126
22.80	7816	7838	7860	7881	7902	7923	7943	7963	7984	8003	8023	8043	8062	8082	8102	8122	8142
22.60	7835	7857	7878	7900	7920	7941	7961	7981	8001	8021	8041	8060	8080	8099	8119	8138	8159
22.40	7854	7876	7897	7918	7939	7959	7979	7999	8019	8039	8058	8077	8097	8116	8136	8155	8175
22.20	7873	7895	7916	7937	7957	7978	7997	8017	8037	8056	8075	8095	8114	8133	8152	8172	8192
22.00	7892	7914	7935	7955	7976	7996	8016	8035	8055	8074	8093	8112	8131	8150	8169	8188	8208
21.80	7912	7933	7954	7974	7994	8014	8034	8053	8072	8091	8110	8129	8148	8167	8186	8205	8225
21.60	7931	7952	7972	7993	8013	8032	8052	8071	8090	8109	8128	8146	8165	8184	8203	8222	8241
21.40	7950	7971	7991	8011	8031	8051	8070	8089	8108	8127	8145	8164	8182	8201	8220	8238	8258
21.20	7969	7990	8010	8030	8049	8069	8088	8107	8126	8144	8163	8181	8199	8218	8236	8255	8274
21.00	7988	8009	8029	8048	8068	8087	8106	8125	8143	8162	8180	8198	8216	8235	8253	8272	8291
20.80	8008	8028	8048	8067	8086	8105	8124	8143	8161	8179	8197	8215	8234	8252	8270	8288	8307
20.60	8027	8047	8066	8086	8105	8124	8142	8161	8179	8197	8215	8233	8251	8269	8287	8305	8324
20.40	8046	8066	8085	8104	8123	8142	8160	8178	8197	8214	8232	8250	8268	8286	8304	8322	8340
20.20	8065	8085	8104	8123	8142	8160	8178	8196	8214	8232	8250	8267	8285	8303	8320	8338	8357
20.00	8084	8104	8123	8142	8160	8178	8196	8214	8232	8250	8267	8285	8302	8320	8337	8355	8373

Table 44 English—Low Alt, Low Temp, Low Humidity
(Temp = 40 to 56° F, Press = 27 to 31 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0
31.00	7028	7034	7040	7046	7052	7058	7064	7070	7075	7081	7087	7093	7098	7104	7110	7116	7121
30.95	7033	7039	7045	7051	7057	7063	7068	7074	7080	7086	7092	7097	7103	7109	7115	7120	7126
30.90	7038	7044	7050	7056	7061	7067	7073	7079	7085	7091	7096	7102	7108	7114	7119	7125	7131
30.85	7042	7048	7054	7060	7066	7072	7078	7084	7090	7095	7101	7107	7113	7118	7124	7130	7135
30.80	7047	7053	7059	7065	7071	7077	7083	7088	7094	7100	7106	7111	7117	7123	7129	7134	7140
30.75	7052	7058	7064	7070	7076	7082	7087	7093	7099	7105	7110	7116	7122	7128	7133	7139	7144
30.70	7057	7063	7069	7075	7080	7086	7092	7098	7104	7109	7115	7121	7127	7132	7138	7144	7149
30.65	7062	7068	7073	7079	7085	7091	7097	7103	7108	7114	7120	7126	7131	7137	7143	7148	7154
30.60	7066	7072	7078	7084	7090	7096	7102	7107	7113	7119	7125	7130	7136	7142	7147	7153	7158
30.55	7071	7077	7083	7089	7095	7101	7106	7112	7118	7124	7129	7135	7141	7146	7152	7157	7163
30.50	7076	7082	7088	7094	7099	7105	7111	7117	7123	7128	7134	7140	7145	7151	7157	7162	7168
30.45	7081	7087	7093	7098	7104	7110	7116	7122	7127	7133	7139	7144	7150	7156	7161	7167	7172
30.40	7086	7091	7097	7103	7109	7115	7121	7126	7132	7138	7143	7149	7155	7160	7166	7171	7177
30.35	7090	7096	7102	7108	7114	7120	7125	7131	7137	7142	7148	7154	7159	7165	7171	7176	7182
30.30	7095	7101	7107	7113	7118	7124	7130	7136	7141	7147	7153	7158	7164	7170	7175	7181	7186
30.25	7100	7106	7112	7117	7123	7129	7135	7140	7146	7152	7157	7163	7169	7174	7180	7185	7191
30.20	7105	7111	7116	7122	7128	7134	7139	7145	7151	7157	7162	7168	7173	7179	7185	7190	7196
30.15	7110	7115	7121	7127	7133	7139	7144	7150	7156	7161	7167	7172	7178	7184	7189	7195	7200
30.10	7114	7120	7126	7132	7138	7143	7149	7155	7160	7166	7172	7177	7183	7188	7194	7199	7205
30.05	7119	7125	7131	7137	7142	7148	7154	7159	7165	7171	7176	7182	7187	7193	7199	7204	7210
30.00	7124	7130	7136	7141	7147	7153	7158	7164	7170	7175	7181	7187	7192	7198	7203	7209	7214
29.95	7129	7135	7140	7146	7152	7158	7163	7169	7174	7180	7186	7191	7197	7202	7208	7213	7219
29.90	7134	7139	7145	7151	7157	7162	7168	7174	7179	7185	7190	7196	7201	7207	7213	7218	7223
29.85	7138	7144	7150	7156	7161	7167	7173	7178	7184	7190	7195	7201	7206	7212	7217	7223	7228
29.80	7143	7149	7155	7160	7166	7172	7177	7183	7189	7194	7200	7205	7211	7216	7222	7227	7233
29.75	7148	7154	7159	7165	7171	7176	7182	7188	7193	7199	7204	7210	7216	7221	7227	7232	7237
29.70	7153	7158	7164	7170	7176	7181	7187	7192	7198	7204	7209	7215	7220	7226	7231	7237	7242
29.65	7158	7163	7169	7175	7180	7186	7192	7197	7203	7208	7214	7219	7225	7230	7236	7241	7247
29.60	7162	7168	7174	7179	7185	7191	7196	7202	7208	7213	7219	7224	7230	7235	7241	7246	7251
29.55	7167	7173	7179	7184	7190	7195	7201	7207	7212	7218	7223	7229	7234	7240	7245	7251	7256
29.50	7172	7178	7183	7189	7195	7200	7206	7211	7217	7222	7228	7233	7239	7244	7250	7255	7261
29.45	7177	7182	7188	7194	7199	7205	7211	7216	7222	7227	7233	7238	7244	7249	7255	7260	7265
29.40	7182	7187	7193	7199	7204	7210	7215	7221	7226	7232	7237	7243	7248	7254	7259	7265	7270
29.35	7186	7192	7198	7203	7209	7214	7220	7226	7231	7237	7242	7248	7253	7258	7264	7269	7275
29.30	7191	7197	7202	7208	7214	7219	7225	7230	7236	7241	7247	7252	7258	7263	7269	7274	7279
29.25	7196	7202	7207	7213	7218	7224	7230	7235	7241	7246	7252	7257	7262	7268	7273	7279	7284
29.20	7201	7206	7212	7218	7223	7229	7234	7240	7245	7251	7256	7262	7267	7272	7278	7283	7289
29.15	7206	7211	7217	7222	7228	7233	7239	7245	7250	7255	7261	7266	7272	7277	7282	7288	7293
29.10	7210	7216	7222	7227	7233	7238	7244	7249	7255	7260	7266	7271	7276	7282	7287	7292	7298
29.05	7215	7221	7226	7232	7237	7243	7248	7254	7259	7265	7270	7276	7281	7286	7292	7297	7302
29.00	7220	7226	7231	7237	7242	7248	7253	7259	7264	7270	7275	7280	7286	7291	7296	7302	7307
28.95	7225	7230	7236	7241	7247	7252	7258	7263	7269	7274	7280	7285	7290	7296	7301	7306	7312
28.90	7229	7235	7241	7246	7252	7257	7263	7268	7274	7279	7284	7290	7295	7300	7306	7311	7316
28.85	7234	7240	7245	7251	7256	7262	7267	7273	7278	7284	7289	7294	7300	7305	7310	7316	7321
28.80	7239	7245	7250	7256	7261	7267	7272	7278	7283	7288	7294	7299	7305	7310	7315	7320	7326
28.75	7244	7249	7255	7260	7266	7271	7277	7282	7288	7293	7299	7304	7309	7315	7320	7325	7330
28.70	7249	7254	7260	7265	7271	7276	7282	7287	7292	7298	7303	7309	7314	7319	7324	7330	7335
28.65	7253	7259	7265	7270	7276	7281	7286	7292	7297	7303	7308	7313	7319	7324	7329	7334	7340
28.60	7258	7264	7269	7275	7280	7286	7291	7297	7302	7307	7313	7318	7323	7329	7334	7339	7344
28.55	7263	7269	7274	7280	7285	7290	7296	7301	7307	7312	7317	7323	7328	7333	7338	7344	7349
28.50	7268	7273	7279	7284	7290	7295	7301	7306	7311	7317	7322	7327	7333	7338	7343	7348	7354
28.45	7273	7278	7284	7289	7295	7300	7305	7311	7316	7321	7327	7332	7337	7343	7348	7353	7358
28.40	7277	7283	7288	7294	7299	7305	7310	7315	7321	7326	7331	7337	7342	7347	7352	7358	7363
28.35	7282	7288	7293	7299	7304	7309	7315	7320	7326	7331	7336	7341	7347	7352	7357	7362	7368
28.30	7287	7293	7298	7303	7309	7314	7320	7325	7330	7336	7341	7346	7351	7357	7362	7367	7372
28.25	7292	7297	7303	7308	7314	7319	7324	7330	7335	7340	7346	7351	7356	7361	7366	7372	7377
28.20	7297	7302	7308	7313	7318	7324	7329	7334	7340	7345	7350	7355	7361	7366	7371	7376	7381
28.15	7301	7307	7312	7318	7323	7328	7334	7339	7344	7350	7355	7360	7365	7371	7376	7381	7386
28.10	7306	7312	7317	7322	7328	7333	7339	7344	7349	7354	7360	7365	7370	7375	7380	7386	7391
28.05	7311	7316	7322	7327	7333	7338	7343	7349	7354	7359	7364	7370	7375	7380	7385	7390	7395
28.00	7316	7321	7327	7332	7337	7343	7348	7353	7359	7364	7369	7374	7379	7385	7390	7395	7400
27.95	7321	7326	7331	7337	7342	7347	7353	7358	7363	7369	7374	7379	7384	7389	7394	7400	7405
27.90	7325	7331	7336	7342	7347	7352	7357	7363	7368	7373	7378	7384	7389	7394	7399	7404	7409
27.85	7330	7336	7341	7346	7352	7357	7362	7367	7373	7378	7383	7388	7393	7399	7404	7409	7414
27.80	7335	7340	7346	7351	7356	7362	7367	7372	7377	7383	7388	7393	7398	7403	7408	7414	7419
27.75	7340	7345	7351	7356	7361	7366	7372	7377	7382	7387	7393	7398	7403	7408	7413	7418	7423
27.70	7345	7350	7355	7361	7366	7371	7376	7382	7387	7392	7397	7402	7408	7413	7418	7423	7428
27.65	7349	7355	7360	7365	7371	7376	7381	7386	7392	7397	7402	7407	7412	7417	7422	7427	7433
27.60	7354	7360	7365	7370	7375	7381	7386	7391	7396	7401	7407	7412	7417	7422	7427	7432	7437
27.55	7359	7364	7370	7375	7380	7385	7391	7396	7401	7406	7411	7416	7422	7427	7432	7437	7442
27.50	7364	7369	7374	7380	7385	7390	7395	7401	7406	7411	7416	7421	7426	7431	7436	7441	7446
27.45	7369	7374	7379	7384	7390	7395	7400	7405	7410	7416	7421	7426	7431	7436	7441	7446	7451
27.40	7373	7379	7384	7389	7394	7400	7405	7410	7415	7420	7425	7431	7436	7441	7446	7451	7456
27.35	7378	7383	7389	7394	7399	7404	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460
27.30	7383	7388	7393	7399	7404	7409	7414	7419	7425	7430	7435	7440	7445	7450	7455	7460	7465
27.25	7388	7393	7398	7404	7409	7414	7419	7424	7429	7434	7440	7445	7450	7455	7460	7465	7470
27.20	7393	7398	7403	7408	7413	7419	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474
27.15	7397	7403	7408	7413	7418	7423	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474	7479
27.10	7402	7407	7413	7418	7423	7428	7433	7438	7444	7449	7454	7459	7464	7469	7474	7479	7484
27.05	7407	7412	7417	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488
27.00	7412	7417	7422	7427	7432	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488	7493

Table 45 English—Low Alt, Low-Mid Temp, Low Humidity
(Temp = 57 to 73° F, Press = 27 to 31 inches, 20% Humidity)

BAROMETRIC PRESSURE IN INCHES OF MERCURY	TEMPERATURE IN DEGREES FAHRENHEIT																
	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.0	68.0	69.0	70.0	71.0	72.0	73.0
31.00	7127	7133	7138	7144	7149	7155	7160	7166	7171	7177	7182	7188	7193	7198	7204	7209	7215
30.95	7132	7137	7143	7148	7154	7159	7165	7170	7176	7181	7187	7192	7198	7203	7208	7214	7219
30.90	7136	7142	7147	7153	7158	7164	7170	7175	7180	7186	7191	7197	7202	7208	7213	7218	7224
30.85	7141	7146	7152	7158	7163	7169	7174	7180	7185	7190	7196	7201	7207	7212	7217	7223	7228
30.80	7145	7151	7157	7162	7168	7173	7179	7184	7190	7195	7200	7206	7211	7217	7222	7227	7233
30.75	7150	7156	7161	7167	7172	7178	7183	7189	7194	7200	7205	7210	7216	7221	7226	7232	7237
30.70	7155	7160	7166	7171	7177	7182	7188	7193	7199	7204	7210	7215	7220	7226	7231	7236	7242
30.65	7159	7165	7170	7176	7181	7187	7192	7198	7203	7209	7214	7219	7225	7230	7235	7241	7246
30.60	7164	7170	7175	7181	7186	7192	7197	7202	7208	7213	7219	7224	7229	7235	7240	7245	7251
30.55	7169	7174	7180	7185	7191	7196	7202	7207	7212	7218	7223	7229	7234	7239	7244	7250	7255
30.50	7173	7179	7184	7190	7195	7201	7206	7212	7217	7222	7228	7233	7238	7244	7249	7254	7260
30.45	7178	7183	7189	7194	7200	7205	7211	7216	7222	7227	7232	7238	7243	7248	7254	7259	7264
30.40	7183	7188	7194	7199	7204	7210	7215	7221	7226	7231	7237	7242	7247	7253	7258	7263	7269
30.35	7187	7193	7198	7204	7209	7215	7220	7225	7231	7236	7241	7247	7252	7257	7263	7268	7273
30.30	7192	7197	7203	7208	7214	7219	7225	7230	7235	7241	7246	7251	7257	7262	7267	7272	7278
30.25	7196	7202	7207	7213	7218	7224	7229	7234	7240	7245	7250	7256	7261	7266	7272	7277	7282
30.20	7201	7207	7212	7217	7223	7228	7234	7239	7244	7250	7255	7260	7266	7271	7276	7281	7287
30.15	7206	7211	7217	7222	7227	7233	7238	7244	7249	7254	7260	7265	7270	7275	7281	7286	7291
30.10	7210	7216	7221	7227	7232	7237	7243	7248	7254	7259	7264	7269	7275	7280	7285	7290	7296
30.05	7215	7220	7226	7231	7237	7242	7247	7253	7258	7263	7269	7274	7279	7284	7290	7295	7300
30.00	7220	7225	7231	7236	7241	7247	7252	7257	7263	7268	7273	7278	7284	7289	7294	7299	7304
29.95	7224	7230	7235	7241	7246	7251	7257	7262	7267	7273	7278	7283	7288	7293	7299	7304	7309
29.90	7229	7234	7240	7245	7251	7256	7261	7266	7272	7277	7282	7288	7293	7298	7303	7308	7313
29.85	7234	7239	7244	7250	7255	7260	7266	7271	7276	7282	7287	7292	7297	7303	7308	7313	7318
29.80	7238	7244	7249	7254	7260	7265	7270	7276	7281	7286	7291	7297	7302	7307	7312	7317	7322
29.75	7243	7248	7254	7259	7264	7270	7275	7280	7285	7291	7296	7301	7306	7312	7317	7322	7327
29.70	7247	7253	7258	7264	7269	7274	7280	7285	7290	7295	7301	7306	7311	7316	7321	7326	7331
29.65	7252	7257	7263	7268	7274	7279	7284	7289	7295	7300	7305	7310	7315	7321	7326	7331	7336
29.60	7257	7262	7267	7273	7278	7283	7289	7294	7299	7304	7310	7315	7320	7325	7330	7335	7340
29.55	7261	7267	7272	7277	7283	7288	7293	7299	7304	7309	7314	7319	7324	7330	7335	7340	7345
29.50	7266	7271	7277	7282	7287	7293	7298	7303	7308	7314	7319	7324	7329	7334	7339	7344	7349
29.45	7271	7276	7281	7287	7292	7297	7302	7308	7313	7318	7323	7328	7334	7339	7344	7349	7354
29.40	7275	7281	7286	7291	7297	7302	7307	7312	7317	7323	7328	7333	7338	7343	7348	7353	7358
29.35	7280	7285	7291	7296	7301	7306	7312	7317	7322	7327	7332	7337	7343	7348	7353	7358	7363
29.30	7285	7290	7295	7300	7306	7311	7316	7321	7327	7332	7337	7342	7347	7352	7357	7362	7367
29.25	7289	7295	7300	7305	7310	7316	7321	7326	7331	7336	7341	7347	7352	7357	7362	7367	7372
29.20	7294	7299	7304	7310	7315	7320	7325	7331	7336	7341	7346	7351	7356	7361	7366	7371	7376
29.15	7298	7304	7309	7314	7320	7325	7330	7335	7340	7345	7351	7356	7361	7366	7371	7376	7381
29.10	7303	7308	7314	7319	7324	7329	7335	7340	7345	7350	7355	7360	7365	7370	7375	7380	7385
29.05	7308	7313	7318	7324	7329	7334	7339	7344	7349	7355	7360	7365	7370	7375	7380	7385	7390
29.00	7312	7318	7323	7328	7333	7339	7344	7349	7354	7359	7364	7369	7374	7379	7384	7389	7394
28.95	7317	7322	7328	7333	7338	7343	7348	7353	7359	7364	7369	7374	7379	7384	7389	7394	7399
28.90	7322	7327	7332	7337	7343	7348	7353	7358	7363	7368	7373	7378	7383	7388	7393	7398	7403
28.85	7326	7332	7337	7342	7347	7352	7357	7363	7368	7373	7378	7383	7388	7393	7398	7403	7408
28.80	7331	7336	7341	7347	7352	7357	7362	7367	7372	7377	7382	7387	7392	7397	7402	7407	7412
28.75	7336	7341	7346	7351	7356	7361	7367	7372	7377	7382	7387	7392	7397	7402	7407	7412	7417
28.70	7340	7345	7351	7356	7361	7366	7371	7376	7381	7386	7391	7397	7402	7407	7412	7416	7421
28.65	7345	7350	7355	7360	7366	7371	7376	7381	7386	7391	7396	7401	7406	7411	7416	7421	7426
28.60	7349	7355	7360	7365	7370	7375	7380	7385	7391	7396	7401	7406	7411	7416	7421	7425	7430
28.55	7354	7359	7364	7370	7375	7380	7385	7390	7395	7400	7405	7410	7415	7420	7425	7430	7435
28.50	7359	7364	7369	7374	7379	7384	7390	7395	7400	7405	7410	7415	7420	7425	7430	7434	7439
28.45	7363	7369	7374	7379	7384	7389	7394	7399	7404	7409	7414	7419	7424	7429	7434	7439	7444
28.40	7368	7373	7378	7383	7389	7394	7399	7404	7409	7414	7419	7424	7429	7434	7439	7443	7448
28.35	7373	7378	7383	7388	7393	7398	7403	7408	7413	7418	7423	7428	7433	7438	7443	7448	7453
28.30	7377	7382	7388	7393	7398	7403	7408	7413	7418	7423	7428	7433	7438	7443	7448	7453	7457
28.25	7382	7387	7392	7397	7402	7407	7412	7417	7422	7427	7432	7437	7442	7447	7452	7457	7462
28.20	7387	7392	7397	7402	7407	7412	7417	7422	7427	7432	7437	7442	7447	7452	7457	7462	7466
28.15	7391	7396	7401	7406	7412	7417	7422	7427	7432	7437	7442	7446	7451	7456	7461	7466	7471
28.10	7396	7401	7406	7411	7416	7421	7426	7431	7436	7441	7446	7451	7456	7461	7466	7471	7475
28.05	7400	7406	7411	7416	7421	7426	7431	7436	7441	7446	7451	7456	7460	7465	7470	7475	7480
28.00	7405	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460	7465	7470	7475	7480	7484
27.95	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460	7465	7469	7474	7479	7484	7489
27.90	7414	7419	7425	7430	7435	7440	7445	7449	7454	7459	7464	7469	7474	7479	7484	7489	7493
27.85	7419	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474	7479	7483	7488	7493	7498
27.80	7424	7429	7434	7439	7444	7449	7454	7459	7464	7468	7473	7478	7483	7488	7493	7498	7502
27.75	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488	7492	7497	7502	7507
27.70	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7482	7487	7492	7497	7502	7507	7511
27.65	7438	7443	7448	7453	7458	7463	7467	7472	7477	7482	7487	7492	7497	7501	7506	7511	7516
27.60	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492	7496	7501	7506	7511	7516	7520
27.55	7447	7452	7457	7462	7467	7472	7477	7482	7486	7491	7496	7501	7506	7511	7515	7520	7525
27.50	7451	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7505	7510	7515	7520	7525	7529
27.45	7456	7461	7466	7471	7476	7481	7486	7491	7496	7500	7505	7510	7515	7520	7524	7529	7534
27.40	7461	7466	7471	7476	7481	7485	7490	7495	7500	7505	7510	7515	7519	7524	7529	7534	7538
27.35	7465	7470	7475	7480	7485	7490	7495	7500	7505	7509	7514	7519	7524	7529	7533	7538	7543
27.30	7470	7475	7480	7485	7490	7495	7500	7504	7509	7514	7519	7524	7528	7533	7538	7543	7547
27.25	7475	7480	7485	7489	7494	7499	7504	7509	7514	7519	7523	7528	7533	7538	7542	7547	7552
27.20	7479	7484	7489	7494	7499	7504	7509	7514	7518	7523	7528	7533	7537	7542	7547	7552	7556
27.15	7484	7489	7494	7499	7504	7508	7513	7518	7523	7528	7532	7537	7542	7547	7551	7556	7561
27.10	7489	7494	7498	7503	7508	7513	7518	7523	7527	7532	7537	7542	7547	7551	7556	7561	7565
27.05	7493	7498	7503	7508	7513	7518	7522	7527	7532	7537	7542	7546	7551	7556	7560	7565	7570
27.00	7498	7503	7508	7513	7517	7522	7527	7532	7537	7541	7546	7551	7556	7560	7565	7570	7574

Table 46 English—Low Alt, Mid Temp, Low Humidity
(Temp = 74 to 90° F, Press = 27 to 31 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0
31.00	7220	7225	7230	7236	7241	7246	7251	7257	7262	7267	7272	7277	7282	7288	7293	7298	7303
30.95	7224	7230	7235	7240	7245	7251	7256	7261	7266	7271	7277	7282	7287	7292	7297	7302	7307
30.90	7229	7234	7239	7245	7250	7255	7260	7266	7271	7276	7281	7286	7291	7296	7301	7306	7312
30.85	7233	7239	7244	7249	7254	7260	7265	7270	7275	7280	7285	7291	7296	7301	7306	7311	7316
30.80	7238	7243	7248	7254	7259	7264	7269	7274	7280	7285	7290	7295	7300	7305	7310	7315	7320
30.75	7242	7248	7253	7258	7263	7268	7274	7279	7284	7289	7294	7299	7304	7309	7315	7320	7325
30.70	7247	7252	7257	7263	7268	7273	7278	7283	7288	7294	7299	7304	7309	7314	7319	7324	7329
30.65	7251	7257	7262	7267	7272	7277	7283	7288	7293	7298	7303	7308	7313	7318	7323	7328	7333
30.60	7256	7261	7266	7271	7277	7282	7287	7292	7297	7302	7307	7313	7318	7323	7328	7333	7338
30.55	7260	7266	7271	7276	7281	7286	7291	7297	7302	7307	7312	7317	7322	7327	7332	7337	7342
30.50	7265	7270	7275	7280	7286	7291	7296	7301	7306	7311	7316	7321	7326	7331	7336	7341	7346
30.45	7269	7274	7280	7285	7290	7295	7300	7305	7310	7316	7321	7326	7331	7336	7341	7346	7351
30.40	7274	7279	7284	7289	7294	7300	7305	7310	7315	7320	7325	7330	7335	7340	7345	7350	7355
30.35	7278	7283	7289	7294	7299	7304	7309	7314	7319	7324	7329	7334	7340	7345	7350	7354	7359
30.30	7283	7288	7293	7298	7303	7308	7314	7319	7324	7329	7334	7339	7344	7349	7354	7359	7364
30.25	7287	7292	7298	7303	7308	7313	7318	7323	7328	7333	7338	7343	7348	7353	7358	7363	7368
30.20	7292	7297	7302	7307	7312	7317	7322	7328	7333	7338	7343	7348	7353	7358	7363	7368	7373
30.15	7296	7301	7306	7312	7317	7322	7327	7332	7337	7342	7347	7352	7357	7362	7367	7372	7377
30.10	7301	7306	7311	7316	7321	7326	7331	7336	7341	7346	7351	7356	7361	7366	7371	7376	7381
30.05	7305	7310	7315	7321	7326	7331	7336	7341	7346	7351	7356	7361	7366	7371	7376	7381	7386
30.00	7310	7315	7320	7325	7330	7335	7340	7345	7350	7355	7360	7365	7370	7375	7380	7385	7390
29.95	7314	7319	7324	7329	7335	7340	7345	7350	7355	7360	7365	7370	7375	7380	7384	7389	7394
29.90	7319	7324	7329	7334	7339	7344	7349	7354	7359	7364	7369	7374	7379	7384	7389	7394	7399
29.85	7323	7328	7333	7338	7343	7349	7354	7359	7364	7369	7374	7378	7383	7388	7393	7398	7403
29.80	7328	7333	7338	7343	7348	7353	7358	7363	7368	7373	7378	7383	7388	7393	7398	7403	7407
29.75	7332	7337	7342	7347	7352	7357	7362	7367	7372	7377	7382	7387	7392	7397	7402	7407	7412
29.70	7337	7342	7347	7352	7357	7362	7367	7372	7377	7382	7387	7392	7397	7401	7406	7411	7416
29.65	7341	7346	7351	7356	7361	7366	7371	7376	7381	7386	7391	7396	7401	7406	7411	7416	7420
29.60	7346	7351	7356	7361	7366	7371	7376	7381	7386	7391	7396	7400	7405	7410	7415	7420	7425
29.55	7350	7355	7360	7365	7370	7375	7380	7385	7390	7395	7400	7405	7410	7415	7419	7424	7429
29.50	7355	7360	7365	7370	7375	7380	7385	7390	7395	7399	7404	7409	7414	7419	7424	7429	7434
29.45	7359	7364	7369	7374	7379	7384	7389	7394	7399	7404	7409	7414	7419	7423	7428	7433	7438
29.40	7364	7369	7374	7379	7384	7389	7393	7398	7403	7408	7413	7418	7423	7428	7433	7437	7442
29.35	7368	7373	7378	7383	7388	7393	7398	7403	7408	7413	7418	7422	7427	7432	7437	7442	7447
29.30	7372	7378	7383	7387	7392	7397	7402	7407	7412	7417	7422	7427	7432	7437	7441	7446	7451
29.25	7377	7382	7387	7392	7397	7402	7407	7412	7417	7421	7426	7431	7436	7441	7446	7451	7455
29.20	7381	7386	7391	7396	7401	7406	7411	7416	7421	7426	7431	7436	7440	7445	7450	7455	7460
29.15	7386	7391	7396	7401	7406	7411	7416	7421	7425	7430	7435	7440	7445	7450	7454	7459	7464
29.10	7390	7395	7400	7405	7410	7415	7420	7425	7430	7435	7440	7444	7449	7454	7459	7464	7468
29.05	7395	7400	7405	7410	7415	7420	7425	7429	7434	7439	7444	7449	7454	7458	7463	7468	7473
29.00	7399	7404	7409	7414	7419	7424	7429	7434	7439	7444	7448	7453	7458	7463	7468	7472	7477
28.95	7404	7409	7414	7419	7424	7429	7433	7438	7443	7448	7453	7458	7462	7467	7472	7477	7481
28.90	7408	7413	7418	7423	7428	7433	7438	7443	7448	7452	7457	7462	7467	7472	7476	7481	7486
28.85	7413	7418	7423	7428	7433	7437	7442	7447	7452	7457	7462	7466	7471	7476	7481	7485	7490
28.80	7417	7422	7427	7432	7437	7442	7447	7452	7456	7461	7466	7471	7476	7480	7485	7490	7495
28.75	7422	7427	7432	7437	7441	7446	7451	7456	7461	7466	7470	7475	7480	7485	7489	7494	7499
28.70	7426	7431	7436	7441	7446	7451	7456	7460	7465	7470	7475	7480	7484	7489	7494	7499	7503
28.65	7431	7436	7441	7446	7450	7455	7460	7465	7470	7474	7479	7484	7489	7493	7498	7503	7508
28.60	7435	7440	7445	7450	7455	7460	7464	7469	7474	7479	7484	7488	7493	7498	7503	7507	7512
28.55	7440	7445	7450	7454	7459	7464	7469	7474	7479	7483	7488	7493	7498	7502	7507	7512	7516
28.50	7444	7449	7454	7459	7464	7469	7473	7478	7483	7488	7492	7497	7502	7507	7511	7516	7521
28.45	7449	7454	7459	7463	7468	7473	7478	7483	7487	7492	7497	7502	7506	7511	7516	7520	7525
28.40	7453	7458	7463	7468	7473	7477	7482	7487	7492	7497	7501	7506	7511	7515	7520	7525	7529
28.35	7458	7463	7467	7472	7477	7482	7487	7491	7496	7501	7506	7510	7515	7520	7524	7529	7534
28.30	7462	7467	7472	7477	7482	7486	7491	7496	7501	7505	7510	7515	7519	7524	7529	7533	7538
28.25	7467	7472	7476	7481	7486	7491	7496	7500	7505	7510	7514	7519	7524	7529	7533	7538	7542
28.20	7471	7476	7481	7486	7490	7495	7500	7505	7509	7514	7519	7524	7528	7533	7538	7542	7547
28.15	7476	7481	7485	7490	7495	7500	7504	7509	7514	7519	7523	7528	7533	7537	7542	7547	7551
28.10	7480	7485	7490	7495	7499	7504	7509	7514	7518	7523	7528	7532	7537	7542	7546	7551	7556
28.05	7485	7490	7494	7499	7504	7509	7513	7518	7523	7527	7532	7537	7541	7546	7551	7555	7560
28.00	7489	7494	7499	7504	7508	7513	7518	7522	7527	7532	7536	7541	7546	7550	7555	7560	7564
27.95	7494	7498	7503	7508	7513	7517	7522	7527	7532	7536	7541	7546	7550	7555	7559	7564	7569
27.90	7498	7503	7508	7512	7517	7522	7527	7531	7536	7541	7545	7550	7555	7559	7564	7568	7573
27.85	7503	7507	7512	7517	7522	7526	7531	7536	7540	7545	7550	7554	7559	7564	7568	7573	7577
27.80	7507	7512	7517	7521	7526	7531	7535	7540	7545	7549	7554	7559	7563	7568	7573	7577	7582
27.75	7512	7516	7521	7526	7531	7535	7540	7545	7549	7554	7559	7563	7568	7572	7577	7581	7586
27.70	7516	7521	7526	7530	7535	7540	7544	7549	7554	7558	7563	7568	7572	7577	7581	7586	7590
27.65	7521	7525	7530	7535	7539	7544	7549	7553	7558	7563	7567	7572	7577	7581	7586	7590	7595
27.60	7525	7530	7535	7539	7544	7549	7553	7558	7563	7567	7572	7576	7581	7585	7590	7595	7599
27.55	7530	7534	7539	7544	7548	7553	7558	7562	7567	7572	7576	7581	7585	7590	7594	7599	7603
27.50	7534	7539	7543	7548	7553	7557	7562	7567	7571	7576	7581	7585	7590	7594	7599	7603	7608
27.45	7539	7543	7548	7553	7557	7562	7567	7571	7576	7580	7585	7590	7594	7599	7603	7608	7612
27.40	7543	7548	7552	7557	7562	7566	7571	7576	7580	7585	7589	7594	7598	7603	7608	7612	7617
27.35	7548	7552	7557	7562	7566	7571	7575	7580	7585	7589	7594	7598	7603	7607	7612	7616	7621
27.30	7552	7557	7561	7566	7571	7575	7580	7584	7589	7594	7598	7603	7607	7612	7616	7621	7625
27.25	7557	7561	7566	7570	7575	7580	7584	7589	7593	7598	7603	7607	7612	7616	7621	7625	7630
27.20	7561	7566	7570	7575	7580	7584	7589	7593	7598	7602	7607	7612	7616	7621	7625	7629	7634
27.15	7565	7570	7575	7579	7584	7589	7593	7598	7602	7607	7611	7616	7620	7625	7629	7634	7638
27.10	7570	7575	7579	7584	7588	7593	7598	7602	7607	7611	7616	7620	7625	7629	7634	7638	7643
27.05	7574	7579	7584	7588	7593	7598	7602	7607	7611	7616	7620	7625	7629	7634	7638	7643	7647
27.00	7579	7584	7588	7593	7597	7602	7607	7611	7616	7620	7625	7629	7634	7638	7642	7647	7651

Table 47 English—Low Alt, High-Mid Temp, Low Humidity
(Temp = 91 to 107° F, Press = 27 to 31 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	91.0	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0
31.00	7308	7313	7318	7323	7328	7333	7338	7343	7348	7353	7358	7363	7368	7372	7377	7382	7387
30.95	7312	7317	7322	7327	7332	7337	7342	7347	7352	7357	7362	7367	7372	7377	7382	7386	7391
30.90	7317	7322	7327	7332	7337	7342	7347	7351	7356	7361	7366	7371	7376	7381	7386	7391	7396
30.85	7321	7326	7331	7336	7341	7346	7351	7356	7361	7366	7371	7375	7380	7385	7390	7395	7400
30.80	7325	7330	7335	7340	7345	7350	7355	7360	7365	7370	7375	7380	7385	7389	7394	7399	7404
30.75	7330	7335	7340	7345	7350	7355	7359	7364	7369	7374	7379	7384	7389	7394	7399	7403	7408
30.70	7334	7339	7344	7349	7354	7359	7364	7369	7374	7378	7383	7388	7393	7398	7403	7408	7412
30.65	7338	7343	7348	7353	7358	7363	7368	7373	7378	7383	7388	7392	7397	7402	7407	7412	7417
30.60	7343	7348	7353	7358	7363	7367	7372	7377	7382	7387	7392	7397	7402	7406	7411	7416	7421
30.55	7347	7352	7357	7362	7367	7372	7377	7382	7386	7391	7396	7401	7406	7411	7415	7420	7425
30.50	7351	7356	7361	7366	7371	7376	7381	7386	7391	7396	7400	7405	7410	7415	7420	7425	7429
30.45	7356	7361	7366	7371	7375	7380	7385	7390	7395	7400	7405	7410	7414	7419	7424	7429	7434
30.40	7360	7365	7370	7375	7380	7385	7390	7394	7399	7404	7409	7414	7419	7423	7428	7433	7438
30.35	7364	7369	7374	7379	7384	7389	7394	7399	7404	7408	7413	7418	7423	7428	7432	7437	7442
30.30	7369	7374	7379	7384	7388	7393	7398	7403	7408	7413	7418	7422	7427	7432	7437	7441	7446
30.25	7373	7378	7383	7388	7393	7398	7402	7407	7412	7417	7422	7427	7431	7436	7441	7446	7450
30.20	7377	7382	7387	7392	7397	7402	7407	7412	7416	7421	7426	7431	7436	7440	7445	7450	7455
30.15	7382	7387	7392	7396	7401	7406	7411	7416	7421	7426	7430	7435	7440	7445	7449	7454	7459
30.10	7386	7391	7396	7401	7406	7411	7415	7420	7425	7430	7435	7439	7444	7449	7454	7458	7463
30.05	7391	7395	7400	7405	7410	7415	7420	7424	7429	7434	7439	7444	7448	7453	7458	7463	7467
30.00	7395	7400	7405	7409	7414	7419	7424	7429	7434	7438	7443	7448	7453	7457	7462	7467	7472
29.95	7399	7404	7409	7414	7419	7423	7428	7433	7438	7443	7447	7452	7457	7462	7466	7471	7476
29.90	7404	7408	7413	7418	7423	7428	7433	7437	7442	7447	7452	7456	7461	7466	7471	7475	7480
29.85	7408	7413	7418	7422	7427	7432	7437	7442	7446	7451	7456	7461	7465	7470	7475	7480	7484
29.80	7412	7417	7422	7427	7432	7436	7441	7446	7451	7455	7460	7465	7470	7474	7479	7484	7488
29.75	7417	7421	7426	7431	7436	7441	7445	7450	7455	7460	7464	7469	7474	7479	7483	7488	7493
29.70	7421	7426	7431	7435	7440	7445	7450	7455	7459	7464	7469	7473	7478	7483	7488	7492	7497
29.65	7425	7430	7435	7440	7445	7449	7454	7459	7464	7468	7473	7478	7482	7487	7492	7496	7501
29.60	7430	7434	7439	7444	7449	7454	7458	7463	7468	7473	7477	7482	7487	7491	7496	7501	7505
29.55	7434	7439	7444	7448	7453	7458	7463	7467	7472	7477	7482	7486	7491	7496	7500	7505	7510
29.50	7438	7443	7448	7453	7457	7462	7467	7472	7476	7481	7486	7491	7495	7500	7505	7509	7514
29.45	7443	7447	7452	7457	7462	7467	7471	7476	7481	7485	7490	7495	7499	7504	7509	7513	7518
29.40	7447	7452	7457	7461	7466	7471	7476	7480	7485	7490	7494	7499	7504	7508	7513	7518	7522
29.35	7451	7456	7461	7466	7470	7475	7480	7485	7489	7494	7499	7503	7508	7513	7517	7522	7526
29.30	7456	7461	7465	7470	7475	7479	7484	7489	7494	7498	7503	7508	7512	7517	7521	7526	7531
29.25	7460	7465	7470	7474	7479	7484	7488	7493	7498	7503	7507	7512	7516	7521	7526	7530	7535
29.20	7464	7469	7474	7479	7483	7488	7493	7497	7502	7507	7511	7516	7521	7525	7530	7535	7539
29.15	7469	7474	7478	7483	7488	7492	7497	7502	7506	7511	7516	7520	7525	7530	7534	7539	7543
29.10	7473	7478	7483	7487	7492	7497	7501	7506	7511	7515	7520	7525	7529	7534	7538	7543	7548
29.05	7477	7482	7487	7492	7496	7501	7506	7510	7515	7520	7524	7529	7533	7538	7543	7547	7552
29.00	7482	7487	7491	7496	7501	7505	7510	7515	7519	7524	7529	7533	7538	7542	7547	7551	7556
28.95	7486	7491	7496	7500	7505	7510	7514	7519	7524	7528	7533	7537	7542	7547	7551	7556	7560
28.90	7491	7495	7500	7505	7509	7514	7519	7523	7528	7532	7537	7542	7546	7551	7555	7560	7565
28.85	7495	7500	7504	7509	7514	7518	7523	7528	7532	7537	7541	7546	7551	7555	7560	7564	7569
28.80	7499	7504	7509	7513	7518	7523	7527	7532	7536	7541	7546	7550	7555	7559	7564	7568	7573
28.75	7504	7508	7513	7518	7522	7527	7532	7536	7541	7545	7550	7554	7559	7564	7568	7573	7577
28.70	7508	7513	7517	7522	7527	7531	7536	7540	7545	7550	7554	7559	7563	7568	7572	7577	7581
28.65	7512	7517	7522	7526	7531	7535	7540	7545	7549	7554	7558	7563	7568	7572	7577	7581	7586
28.60	7517	7521	7526	7531	7535	7540	7544	7549	7554	7558	7563	7567	7572	7576	7581	7585	7590
28.55	7521	7526	7530	7535	7540	7544	7549	7553	7558	7562	7567	7572	7576	7581	7585	7590	7594
28.50	7525	7530	7535	7539	7544	7548	7553	7558	7562	7567	7571	7576	7580	7585	7589	7594	7598
28.45	7530	7534	7539	7544	7548	7553	7557	7562	7566	7571	7576	7580	7585	7589	7594	7598	7603
28.40	7534	7539	7543	7548	7552	7557	7562	7566	7571	7575	7580	7584	7589	7593	7598	7602	7607
28.35	7538	7543	7548	7552	7557	7561	7566	7570	7575	7580	7584	7589	7593	7598	7602	7607	7611
28.30	7543	7547	7552	7557	7561	7566	7570	7575	7579	7584	7588	7593	7597	7602	7606	7611	7615
28.25	7547	7552	7556	7561	7565	7570	7575	7579	7584	7588	7593	7597	7602	7606	7611	7615	7619
28.20	7551	7556	7561	7565	7570	7574	7579	7583	7588	7592	7597	7601	7606	7610	7615	7619	7624
28.15	7556	7560	7565	7569	7574	7579	7583	7588	7592	7597	7601	7606	7610	7615	7619	7623	7628
28.10	7560	7565	7569	7574	7578	7583	7587	7592	7596	7601	7605	7610	7614	7619	7623	7628	7632
28.05	7564	7569	7574	7578	7583	7587	7592	7596	7601	7605	7610	7614	7619	7623	7627	7632	7636
28.00	7569	7573	7578	7582	7587	7592	7596	7601	7605	7609	7614	7618	7623	7627	7632	7636	7641
27.95	7573	7578	7582	7587	7591	7596	7600	7605	7609	7614	7618	7623	7627	7632	7636	7640	7645
27.90	7578	7582	7587	7591	7596	7600	7605	7609	7614	7618	7622	7627	7631	7636	7640	7645	7649
27.85	7582	7586	7591	7595	7600	7604	7609	7613	7618	7622	7627	7631	7636	7640	7644	7649	7653
27.80	7586	7591	7595	7600	7604	7609	7613	7618	7622	7627	7631	7635	7640	7644	7649	7653	7657
27.75	7591	7595	7600	7604	7609	7613	7618	7622	7626	7631	7635	7640	7644	7649	7653	7657	7662
27.70	7595	7599	7604	7608	7613	7617	7622	7626	7631	7635	7640	7644	7648	7653	7657	7662	7666
27.65	7599	7604	7608	7613	7617	7622	7626	7631	7635	7639	7644	7648	7653	7657	7661	7666	7670
27.60	7604	7608	7613	7617	7622	7626	7630	7635	7639	7644	7648	7653	7657	7661	7666	7670	7674
27.55	7608	7612	7617	7621	7626	7630	7635	7639	7644	7648	7652	7657	7661	7666	7670	7674	7679
27.50	7612	7617	7621	7626	7630	7635	7639	7643	7648	7652	7657	7661	7665	7670	7674	7678	7683
27.45	7617	7621	7626	7630	7634	7639	7643	7648	7652	7657	7661	7665	7670	7674	7678	7683	7687
27.40	7621	7625	7630	7634	7639	7643	7648	7652	7656	7661	7665	7670	7674	7678	7683	7687	7691
27.35	7625	7630	7634	7639	7643	7648	7652	7656	7661	7665	7669	7674	7678	7683	7687	7691	7695
27.30	7630	7634	7639	7643	7647	7652	7656	7661	7665	7669	7674	7678	7682	7687	7691	7695	7700
27.25	7634	7638	7643	7647	7652	7656	7661	7665	7669	7674	7678	7682	7687	7691	7695	7700	7704
27.20	7638	7643	7647	7652	7656	7660	7665	7669	7674	7678	7682	7687	7691	7695	7700	7704	7708
27.15	7643	7647	7652	7656	7660	7665	7669	7674	7678	7682	7687	7691	7695	7700	7704	7708	7712
27.10	7647	7652	7656	7660	7665	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7717
27.05	7651	7656	7660	7665	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7717	7721
27.00	7656	7660	7665	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7717	7721	7725

Table 48 English—High Alt, Low Temp, Low Humidity
(Temp = 40 to 56° F, Press = 23 to 27 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0
27.00	7412	7417	7422	7427	7432	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488	7493
26.95	7417	7422	7427	7432	7437	7442	7447	7453	7458	7463	7468	7473	7478	7483	7488	7493	7498
26.90	7421	7427	7432	7437	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502
26.85	7426	7431	7436	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507
26.80	7431	7436	7441	7446	7452	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507	7512
26.75	7436	7441	7446	7451	7456	7461	7466	7472	7477	7482	7487	7492	7497	7501	7506	7511	7516
26.70	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506	7511	7516	7521
26.65	7445	7450	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506	7511	7516	7521	7525
26.60	7450	7455	7460	7465	7471	7476	7481	7486	7491	7496	7501	7506	7511	7515	7520	7525	7530
26.55	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535
26.50	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535	7539
26.45	7464	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7529	7534	7539	7544
26.40	7469	7474	7479	7485	7490	7495	7500	7505	7510	7515	7519	7524	7529	7534	7539	7544	7549
26.35	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7553
26.30	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7548	7553	7558
26.25	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534	7538	7543	7548	7553	7558	7563
26.20	7488	7494	7499	7504	7509	7514	7519	7524	7528	7533	7538	7543	7548	7553	7558	7562	7567
26.15	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7553	7558	7562	7567	7572
26.10	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7553	7557	7562	7567	7572	7577
26.05	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7552	7557	7562	7567	7572	7576	7581
26.00	7508	7513	7518	7523	7528	7533	7538	7542	7547	7552	7557	7562	7567	7572	7576	7581	7586
25.95	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7567	7571	7576	7581	7586	7591
25.90	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7566	7571	7576	7581	7586	7590	7595
25.85	7522	7527	7532	7537	7542	7547	7552	7557	7561	7566	7571	7576	7581	7586	7590	7595	7600
25.80	7527	7532	7537	7542	7547	7552	7556	7561	7566	7571	7576	7581	7585	7590	7595	7600	7604
25.75	7532	7537	7542	7547	7551	7556	7561	7566	7571	7576	7581	7585	7590	7595	7600	7604	7609
25.70	7536	7541	7546	7551	7556	7561	7566	7571	7576	7580	7585	7590	7595	7600	7604	7609	7614
25.65	7541	7546	7551	7556	7561	7566	7571	7576	7580	7585	7590	7595	7600	7604	7609	7614	7618
25.60	7546	7551	7556	7561	7566	7571	7575	7580	7585	7590	7595	7599	7604	7609	7614	7618	7623
25.55	7551	7556	7561	7566	7570	7575	7580	7585	7590	7595	7599	7604	7609	7614	7618	7623	7628
25.50	7556	7561	7565	7570	7575	7580	7585	7590	7595	7599	7604	7609	7614	7618	7623	7628	7632
25.45	7560	7565	7570	7575	7580	7585	7590	7594	7599	7604	7609	7614	7618	7623	7628	7632	7637
25.40	7565	7570	7575	7580	7585	7590	7594	7599	7604	7609	7613	7618	7623	7628	7632	7637	7642
25.35	7570	7575	7580	7585	7589	7594	7599	7604	7609	7613	7618	7623	7628	7632	7637	7642	7646
25.30	7575	7580	7585	7589	7594	7599	7604	7609	7613	7618	7623	7628	7632	7637	7642	7646	7651
25.25	7580	7584	7589	7594	7599	7604	7609	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656
25.20	7584	7589	7594	7599	7604	7609	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660
25.15	7589	7594	7599	7604	7609	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665
25.10	7594	7599	7604	7608	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665	7669
25.05	7599	7604	7608	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665	7670	7674
25.00	7604	7608	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665	7670	7674	7679
24.95	7608	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665	7670	7674	7679	7683
24.90	7613	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665	7670	7674	7679	7684	7688
24.85	7618	7623	7628	7632	7637	7642	7647	7651	7656	7661	7665	7670	7674	7679	7684	7688	7693
24.80	7623	7628	7632	7637	7642	7647	7651	7656	7661	7665	7670	7675	7679	7684	7688	7693	7697
24.75	7628	7632	7637	7642	7647	7651	7656	7661	7665	7670	7675	7679	7684	7688	7693	7697	7702
24.70	7632	7637	7642	7647	7651	7656	7661	7665	7670	7675	7679	7684	7688	7693	7698	7702	7707
24.65	7637	7642	7647	7651	7656	7661	7665	7670	7675	7679	7684	7689	7693	7698	7702	7707	7711
24.60	7642	7647	7651	7656	7661	7666	7670	7675	7679	7684	7689	7693	7698	7702	7707	7711	7716
24.55	7647	7651	7656	7661	7666	7670	7675	7680	7684	7689	7693	7698	7703	7707	7712	7716	7721
24.50	7652	7656	7661	7666	7670	7675	7680	7684	7689	7694	7698	7703	7707	7712	7716	7721	7725
24.45	7656	7661	7666	7670	7675	7680	7684	7689	7694	7698	7703	7707	7712	7716	7721	7725	7730
24.40	7661	7666	7671	7675	7680	7685	7689	7694	7698	7703	7708	7712	7717	7721	7726	7730	7735
24.35	7666	7671	7675	7680	7685	7689	7694	7698	7703	7708	7712	7717	7721	7726	7730	7735	7739
24.30	7671	7675	7680	7685	7689	7694	7699	7703	7708	7712	7717	7721	7726	7730	7735	7739	7744
24.25	7675	7680	7685	7690	7694	7699	7703	7708	7713	7717	7722	7726	7731	7735	7740	7744	7748
24.20	7680	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753
24.15	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726	7731	7736	7740	7744	7749	7753	7758
24.10	7690	7695	7699	7704	7708	7713	7718	7722	7727	7731	7736	7740	7745	7749	7754	7758	7762
24.05	7695	7699	7704	7709	7713	7718	7722	7727	7731	7736	7740	7745	7749	7754	7758	7763	7767
24.00	7699	7704	7709	7713	7718	7723	7727	7732	7736	7741	7745	7750	7754	7758	7763	7767	7772
23.95	7704	7709	7714	7718	7723	7727	7732	7736	7741	7745	7750	7754	7759	7763	7768	7772	7776
23.90	7709	7714	7718	7723	7727	7732	7737	7741	7746	7750	7755	7759	7763	7768	7772	7777	7781
23.85	7714	7718	7723	7728	7732	7737	7741	7746	7750	7755	7759	7764	7768	7772	7777	7781	7786
23.80	7719	7723	7728	7732	7737	7741	7746	7751	7755	7759	7764	7768	7773	7777	7782	7786	7790
23.75	7723	7728	7733	7737	7742	7746	7751	7755	7760	7764	7769	7773	7777	7782	7786	7791	7795
23.70	7728	7733	7737	7742	7746	7751	7755	7760	7764	7769	7773	7778	7782	7787	7791	7795	7800
23.65	7733	7738	7742	7747	7751	7756	7760	7765	7769	7774	7778	7782	7787	7791	7796	7800	7804
23.60	7738	7742	7747	7751	7756	7760	7765	7769	7774	7778	7783	7787	7791	7796	7800	7805	7809
23.55	7743	7747	7752	7756	7761	7765	7770	7774	7779	7783	7787	7792	7796	7801	7805	7809	7814
23.50	7747	7752	7757	7761	7766	7770	7774	7779	7783	7788	7792	7797	7801	7805	7810	7814	7818
23.45	7752	7757	7761	7766	7770	7775	7779	7784	7788	7792	7797	7801	7806	7810	7814	7819	7823
23.40	7757	7762	7766	7771	7775	7779	7784	7788	7793	7797	7802	7806	7810	7815	7819	7823	7827
23.35	7762	7766	7771	7775	7780	7784	7789	7793	7797	7802	7806	7811	7815	7819	7824	7828	7832
23.30	7767	7771	7776	7780	7785	7789	7793	7798	7802	7807	7811	7815	7820	7824	7828	7832	7837
23.25	7771	7776	7780	7785	7789	7794	7798	7803	7807	7811	7816	7820	7824	7829	7833	7837	7841
23.20	7776	7781	7785	7790	7794	7798	7803	7807	7812	7816	7820	7825	7829	7833	7838	7842	7846
23.15	7781	7785	7790	7794	7799	7803	7808	7812	7816	7821	7825	7829	7834	7838	7842	7846	7851
23.10	7786	7790	7795	7799	7804	7808	7812	7817	7821	7825	7830	7834	7838	7843	7847	7851	7855
23.05	7791	7795	7799	7804	7808	7813	7817	7821	7826	7830	7834	7839	7843	7847	7852	7856	7860
23.00	7795	7800	7804	7809	7813	7817	7822	7826	7831	7835	7839	7843	7848	7852	7856	7860	7865

Table 49 English—High Alt, Low-Mid Temp, Low Humidity
(Temp = 57 to 73° F, Press = 23 to 27 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.0	68.0	69.0	70.0	71.0	72.0	73.0
27.00	7498	7503	7508	7513	7517	7522	7527	7532	7537	7541	7546	7551	7556	7560	7565	7570	7574
26.95	7503	7507	7512	7517	7522	7527	7532	7536	7541	7546	7551	7555	7560	7565	7569	7574	7579
26.90	7507	7512	7517	7522	7527	7531	7536	7541	7546	7550	7555	7560	7565	7569	7574	7579	7583
26.85	7512	7517	7522	7526	7531	7536	7541	7546	7550	7555	7560	7564	7569	7574	7579	7583	7588
26.80	7516	7521	7526	7531	7536	7541	7545	7550	7555	7560	7564	7569	7574	7578	7583	7588	7592
26.75	7521	7526	7531	7536	7540	7545	7550	7555	7559	7564	7569	7574	7578	7583	7588	7592	7597
26.70	7526	7531	7535	7540	7545	7550	7555	7559	7564	7569	7573	7578	7583	7587	7592	7597	7601
26.65	7530	7535	7540	7545	7550	7554	7559	7564	7569	7573	7578	7583	7587	7592	7597	7601	7606
26.60	7535	7540	7545	7549	7554	7559	7564	7568	7573	7578	7583	7587	7592	7596	7601	7606	7610
26.55	7540	7544	7549	7554	7559	7564	7568	7573	7578	7582	7587	7592	7596	7601	7606	7610	7615
26.50	7544	7549	7554	7559	7563	7568	7573	7578	7582	7587	7592	7596	7601	7606	7610	7615	7619
26.45	7549	7554	7558	7563	7568	7573	7577	7582	7587	7591	7596	7601	7605	7610	7615	7619	7624
26.40	7554	7558	7563	7568	7573	7577	7582	7587	7591	7596	7601	7605	7610	7615	7619	7624	7628
26.35	7558	7563	7568	7572	7577	7582	7587	7591	7596	7601	7605	7610	7614	7619	7624	7628	7633
26.30	7563	7568	7572	7577	7582	7586	7591	7596	7601	7605	7610	7614	7619	7624	7628	7633	7637
26.25	7567	7572	7577	7582	7586	7591	7596	7600	7605	7610	7614	7619	7624	7628	7633	7637	7642
26.20	7572	7577	7582	7586	7591	7596	7600	7605	7610	7614	7619	7623	7628	7633	7637	7642	7646
26.15	7577	7581	7586	7591	7596	7600	7605	7610	7614	7619	7623	7628	7633	7637	7642	7646	7651
26.10	7581	7586	7591	7596	7600	7605	7610	7614	7619	7623	7628	7633	7637	7642	7646	7651	7655
26.05	7586	7591	7595	7600	7605	7609	7614	7619	7623	7628	7633	7637	7642	7646	7651	7655	7660
26.00	7591	7595	7600	7605	7609	7614	7619	7623	7628	7633	7637	7642	7646	7651	7655	7660	7664
25.95	7595	7600	7605	7609	7614	7619	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669
25.90	7600	7605	7609	7614	7619	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673
25.85	7605	7609	7614	7619	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673	7678
25.80	7609	7614	7619	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673	7678	7682
25.75	7614	7618	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673	7678	7682	7687
25.70	7618	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673	7678	7682	7687	7691
25.65	7623	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673	7678	7682	7687	7691	7696
25.60	7628	7632	7637	7642	7646	7651	7655	7660	7664	7669	7673	7678	7682	7687	7691	7696	7700
25.55	7632	7637	7642	7646	7651	7655	7660	7664	7669	7674	7678	7683	7687	7691	7696	7700	7705
25.50	7637	7642	7646	7651	7655	7660	7665	7669	7674	7678	7683	7687	7692	7696	7700	7705	7709
25.45	7642	7646	7651	7655	7660	7665	7669	7674	7678	7683	7687	7692	7696	7700	7705	7709	7714
25.40	7646	7651	7655	7660	7665	7669	7674	7678	7683	7687	7692	7696	7701	7705	7709	7714	7718
25.35	7651	7655	7660	7665	7669	7674	7678	7683	7687	7692	7696	7701	7705	7710	7714	7718	7723
25.30	7656	7660	7665	7669	7674	7678	7683	7687	7692	7696	7701	7705	7710	7714	7718	7723	7727
25.25	7660	7665	7669	7674	7678	7683	7687	7692	7696	7701	7705	7710	7714	7719	7723	7727	7732
25.20	7665	7669	7674	7678	7683	7688	7692	7697	7701	7705	7710	7714	7719	7723	7727	7732	7736
25.15	7669	7674	7679	7683	7688	7692	7697	7701	7706	7710	7714	7719	7723	7728	7732	7736	7741
25.10	7674	7679	7683	7688	7692	7697	7701	7706	7710	7715	7719	7723	7728	7732	7736	7741	7745
25.05	7679	7683	7688	7692	7697	7701	7706	7710	7715	7719	7724	7728	7732	7737	7741	7745	7750
25.00	7683	7688	7692	7697	7701	7706	7710	7715	7719	7724	7728	7732	7737	7741	7745	7750	7754
24.95	7688	7693	7697	7702	7706	7710	7715	7719	7724	7728	7733	7737	7741	7746	7750	7754	7759
24.90	7693	7697	7702	7706	7711	7715	7720	7724	7728	7733	7737	7742	7746	7750	7755	7759	7763
24.85	7697	7702	7706	7711	7715	7720	7724	7729	7733	7737	7742	7746	7750	7755	7759	7763	7768
24.80	7702	7706	7711	7715	7720	7724	7729	7733	7737	7742	7746	7751	7755	7759	7764	7768	7772
24.75	7707	7711	7716	7720	7724	7729	7733	7738	7742	7746	7751	7755	7759	7764	7768	7772	7777
24.70	7711	7716	7720	7725	7729	7733	7738	7742	7747	7751	7755	7760	7764	7768	7773	7777	7781
24.65	7716	7720	7725	7729	7734	7738	7742	7747	7751	7756	7760	7764	7769	7773	7777	7781	7786
24.60	7720	7725	7729	7734	7738	7743	7747	7751	7756	7760	7764	7769	7773	7777	7782	7786	7790
24.55	7725	7730	7734	7738	7743	7747	7752	7756	7760	7765	7769	7773	7778	7782	7786	7790	7795
24.50	7730	7734	7739	7743	7747	7752	7756	7761	7765	7769	7774	7778	7782	7786	7791	7795	7799
24.45	7734	7739	7743	7748	7752	7756	7761	7765	7769	7774	7778	7782	7787	7791	7795	7799	7804
24.40	7739	7743	7748	7752	7757	7761	7765	7770	7774	7778	7783	7787	7791	7795	7800	7804	7808
24.35	7744	7748	7752	7757	7761	7766	7770	7774	7779	7783	7787	7791	7796	7800	7804	7808	7813
24.30	7748	7753	7757	7761	7766	7770	7775	7779	7783	7787	7792	7796	7800	7804	7809	7813	7817
24.25	7753	7757	7762	7766	7770	7775	7779	7783	7788	7792	7796	7801	7805	7809	7813	7817	7822
24.20	7758	7762	7766	7771	7775	7779	7784	7788	7792	7797	7801	7805	7809	7813	7818	7822	7826
24.15	7762	7767	7771	7775	7780	7784	7788	7793	7797	7801	7805	7810	7814	7818	7822	7826	7831
24.10	7767	7771	7776	7780	7784	7789	7793	7797	7801	7806	7810	7814	7818	7823	7827	7831	7835
24.05	7771	7776	7780	7785	7789	7793	7797	7802	7806	7810	7814	7819	7823	7827	7831	7835	7840
24.00	7776	7780	7785	7789	7793	7798	7802	7806	7811	7815	7819	7823	7827	7832	7836	7840	7844
23.95	7781	7785	7789	7794	7798	7802	7807	7811	7815	7819	7824	7828	7832	7836	7840	7844	7849
23.90	7785	7790	7794	7798	7803	7807	7811	7815	7820	7824	7828	7832	7836	7841	7845	7849	7853
23.85	7790	7794	7799	7803	7807	7812	7816	7820	7824	7828	7833	7837	7841	7845	7849	7853	7858
23.80	7795	7799	7803	7808	7812	7816	7820	7825	7829	7833	7837	7841	7846	7850	7854	7858	7862
23.75	7799	7804	7808	7812	7816	7821	7825	7829	7833	7838	7842	7846	7850	7854	7858	7862	7867
23.70	7804	7808	7812	7817	7821	7825	7830	7834	7838	7842	7846	7850	7855	7859	7863	7867	7871
23.65	7809	7813	7817	7821	7826	7830	7834	7838	7843	7847	7851	7855	7859	7863	7867	7871	7876
23.60	7813	7817	7822	7826	7830	7834	7839	7843	7847	7851	7855	7860	7864	7868	7872	7876	7880
23.55	7818	7822	7826	7831	7835	7839	7843	7847	7852	7856	7860	7864	7868	7872	7876	7881	7885
23.50	7822	7827	7831	7835	7839	7844	7848	7852	7856	7860	7864	7869	7873	7877	7881	7885	7889
23.45	7827	7831	7836	7840	7844	7848	7852	7857	7861	7865	7869	7873	7877	7881	7885	7890	7894
23.40	7832	7836	7840	7844	7849	7853	7857	7861	7865	7869	7874	7878	7882	7886	7890	7894	7898
23.35	7836	7841	7845	7849	7853	7857	7862	7866	7870	7874	7878	7882	7886	7890	7894	7899	7903
23.30	7841	7845	7849	7854	7858	7862	7866	7870	7874	7879	7883	7887	7891	7895	7899	7903	7907
23.25	7846	7850	7854	7858	7862	7867	7871	7875	7879	7883	7887	7891	7895	7899	7903	7908	7912
23.20	7850	7854	7859	7863	7867	7871	7875	7879	7884	7888	7892	7896	7900	7904	7908	7912	7916
23.15	7855	7859	7863	7867	7872	7876	7880	7884	7888	7892	7896	7900	7904	7908	7913	7917	7921
23.10	7860	7864	7868	7872	7876	7880	7885	7889	7893	7897	7901	7905	7909	7913	7917	7921	7925
23.05	7864	7868	7873	7877	7881	7885	7889	7893	7897	7901	7905	7909	7914	7918	7922	7926	7930
23.00	7869	7873	7877	7881	7885	7890	7894	7898	7902	7906	7910	7914	7918	7922	7926	7930	7934

Table 50 English—High Alt, Mid Temp, Low Humidity
(Temp = 74 to 90° F, Press = 23 to 27 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0
27.00	7579	7584	7588	7593	7597	7602	7607	7611	7616	7620	7625	7629	7634	7638	7642	7647	7651
26.95	7583	7588	7593	7597	7602	7606	7611	7615	7620	7625	7629	7633	7638	7642	7647	7651	7656
26.90	7588	7593	7597	7602	7606	7611	7615	7620	7624	7629	7633	7638	7642	7647	7651	7656	7660
26.85	7592	7597	7602	7606	7611	7615	7620	7624	7629	7633	7638	7642	7647	7651	7656	7660	7664
26.80	7597	7601	7606	7611	7615	7620	7624	7629	7633	7638	7642	7647	7651	7656	7660	7664	7669
26.75	7601	7606	7611	7615	7620	7624	7629	7633	7638	7642	7647	7651	7656	7660	7664	7669	7673
26.70	7606	7610	7615	7620	7624	7629	7633	7638	7642	7647	7651	7655	7660	7664	7669	7673	7678
26.65	7610	7615	7619	7624	7629	7633	7638	7642	7647	7651	7655	7660	7664	7669	7673	7677	7682
26.60	7615	7619	7624	7628	7633	7638	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686
26.55	7619	7624	7628	7633	7637	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691
26.50	7624	7628	7633	7637	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691	7695
26.45	7628	7633	7637	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691	7695	7699
26.40	7633	7637	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691	7695	7699	7704
26.35	7637	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691	7695	7699	7704	7708
26.30	7642	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691	7695	7699	7704	7708	7712
26.25	7646	7651	7655	7660	7664	7669	7673	7677	7682	7686	7691	7695	7699	7704	7708	7712	7717
26.20	7651	7655	7660	7664	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7717	7721
26.15	7655	7660	7664	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7713	7717	7721	7725
26.10	7660	7664	7669	7673	7678	7682	7686	7691	7695	7700	7704	7708	7713	7717	7721	7725	7730
26.05	7664	7669	7673	7678	7682	7686	7691	7695	7700	7704	7708	7713	7717	7721	7726	7730	7734
26.00	7669	7673	7678	7682	7686	7691	7695	7700	7704	7708	7713	7717	7721	7726	7730	7734	7738
25.95	7673	7678	7682	7687	7691	7695	7700	7704	7708	7713	7717	7721	7726	7730	7734	7739	7743
25.90	7678	7682	7687	7691	7695	7700	7704	7709	7713	7717	7722	7726	7730	7734	7739	7743	7747
25.85	7682	7687	7691	7695	7700	7704	7709	7713	7717	7722	7726	7730	7735	7739	7743	7747	7752
25.80	7687	7691	7696	7700	7704	7709	7713	7717	7722	7726	7730	7735	7739	7743	7747	7752	7756
25.75	7691	7696	7700	7704	7709	7713	7717	7722	7726	7730	7735	7739	7743	7748	7752	7756	7760
25.70	7696	7700	7704	7709	7713	7718	7722	7726	7731	7735	7739	7743	7748	7752	7756	7760	7765
25.65	7700	7705	7709	7713	7718	7722	7726	7731	7735	7739	7744	7748	7752	7756	7761	7765	7769
25.60	7705	7709	7713	7718	7722	7726	7731	7735	7739	7744	7748	7752	7756	7761	7765	7769	7773
25.55	7709	7713	7718	7722	7727	7731	7735	7740	7744	7748	7752	7757	7761	7765	7769	7774	7778
25.50	7714	7718	7722	7727	7731	7735	7740	7744	7748	7752	7757	7761	7765	7769	7774	7778	7782
25.45	7718	7722	7727	7731	7735	7740	7744	7748	7753	7757	7761	7765	7770	7774	7778	7782	7786
25.40	7723	7727	7731	7736	7740	7744	7749	7753	7757	7761	7766	7770	7774	7778	7782	7787	7791
25.35	7727	7731	7736	7740	7744	7749	7753	7757	7761	7766	7770	7774	7778	7783	7787	7791	7795
25.30	7732	7736	7740	7745	7749	7753	7757	7762	7766	7770	7774	7779	7783	7787	7791	7795	7799
25.25	7736	7740	7745	7749	7753	7758	7762	7766	7770	7775	7779	7783	7787	7791	7796	7800	7804
25.20	7741	7745	7749	7753	7758	7762	7766	7771	7775	7779	7783	7787	7792	7796	7800	7804	7808
25.15	7745	7749	7754	7758	7762	7766	7771	7775	7779	7783	7788	7792	7796	7800	7804	7808	7813
25.10	7749	7754	7758	7762	7767	7771	7775	7779	7784	7788	7792	7796	7800	7805	7809	7813	7817
25.05	7754	7758	7763	7767	7771	7775	7780	7784	7788	7792	7796	7801	7805	7809	7813	7817	7821
25.00	7758	7763	7767	7771	7776	7780	7784	7788	7792	7797	7801	7805	7809	7813	7817	7822	7826
24.95	7763	7767	7772	7776	7780	7784	7788	7793	7797	7801	7805	7809	7814	7818	7822	7826	7830
24.90	7767	7772	7776	7780	7784	7789	7793	7797	7801	7805	7810	7814	7818	7822	7826	7830	7834
24.85	7772	7776	7780	7785	7789	7793	7797	7802	7806	7810	7814	7818	7822	7826	7831	7835	7839
24.80	7776	7781	7785	7789	7793	7798	7802	7806	7810	7814	7818	7823	7827	7831	7835	7839	7843
24.75	7781	7785	7789	7794	7798	7802	7806	7810	7815	7819	7823	7827	7831	7835	7839	7843	7847
24.70	7785	7790	7794	7798	7802	7806	7811	7815	7819	7823	7827	7831	7835	7840	7844	7848	7852
24.65	7790	7794	7798	7803	7807	7811	7815	7819	7823	7828	7832	7836	7840	7844	7848	7852	7856
24.60	7794	7799	7803	7807	7811	7815	7820	7824	7828	7832	7836	7840	7844	7848	7852	7856	7860
24.55	7799	7803	7807	7811	7816	7820	7824	7828	7832	7836	7840	7845	7849	7853	7857	7861	7865
24.50	7803	7808	7812	7816	7820	7824	7828	7833	7837	7841	7845	7849	7853	7857	7861	7865	7869
24.45	7808	7812	7816	7820	7825	7829	7833	7837	7841	7845	7849	7853	7857	7861	7865	7870	7874
24.40	7812	7817	7821	7825	7829	7833	7837	7841	7845	7850	7854	7858	7862	7866	7870	7874	7878
24.35	7817	7821	7825	7829	7833	7838	7842	7846	7850	7854	7858	7862	7866	7870	7874	7878	7882
24.30	7821	7825	7830	7834	7838	7842	7846	7850	7854	7858	7862	7867	7871	7875	7879	7883	7887
24.25	7826	7830	7834	7838	7842	7846	7851	7855	7859	7863	7867	7871	7875	7879	7883	7887	7891
24.20	7830	7834	7839	7843	7847	7851	7855	7859	7863	7867	7871	7875	7879	7883	7887	7891	7895
24.15	7835	7839	7843	7847	7851	7855	7859	7864	7868	7872	7876	7880	7884	7888	7892	7896	7900
24.10	7839	7843	7848	7852	7856	7860	7864	7868	7872	7876	7880	7884	7888	7892	7896	7900	7904
24.05	7844	7848	7852	7856	7860	7864	7868	7872	7876	7880	7884	7889	7893	7896	7900	7904	7908
24.00	7848	7852	7856	7861	7865	7869	7873	7877	7881	7885	7889	7893	7897	7901	7905	7909	7913
23.95	7853	7857	7861	7865	7869	7873	7877	7881	7885	7889	7893	7897	7901	7905	7909	7913	7917
23.90	7857	7861	7865	7869	7874	7878	7882	7886	7890	7894	7898	7902	7906	7910	7914	7918	7921
23.85	7862	7866	7870	7874	7878	7882	7886	7890	7894	7898	7902	7906	7910	7914	7918	7922	7926
23.80	7866	7870	7874	7878	7882	7887	7891	7895	7899	7903	7907	7910	7914	7918	7922	7926	7930
23.75	7871	7875	7879	7883	7887	7891	7895	7899	7903	7907	7911	7915	7919	7923	7927	7931	7935
23.70	7875	7879	7883	7887	7891	7895	7899	7903	7907	7911	7915	7919	7923	7927	7931	7935	7939
23.65	7880	7884	7888	7892	7896	7900	7904	7908	7912	7916	7920	7924	7928	7932	7935	7939	7943
23.60	7884	7888	7892	7896	7900	7904	7908	7912	7916	7920	7924	7928	7932	7936	7940	7944	7948
23.55	7889	7893	7897	7901	7905	7909	7913	7917	7921	7925	7929	7932	7936	7940	7944	7948	7952
23.50	7893	7897	7901	7905	7909	7913	7917	7921	7925	7929	7933	7937	7941	7945	7949	7952	7956
23.45	7898	7902	7906	7910	7914	7918	7922	7926	7930	7933	7937	7941	7945	7949	7953	7957	7961
23.40	7902	7906	7910	7914	7918	7922	7926	7930	7934	7938	7942	7946	7950	7953	7957	7961	7965
23.35	7907	7911	7915	7919	7923	7927	7930	7934	7938	7942	7946	7950	7954	7958	7962	7966	7969
23.30	7911	7915	7919	7923	7927	7931	7935	7939	7943	7947	7951	7954	7958	7962	7966	7970	7974
23.25	7916	7920	7924	7928	7931	7935	7939	7943	7947	7951	7955	7959	7963	7967	7970	7974	7978
23.20	7920	7924	7928	7932	7936	7940	7944	7948	7952	7956	7959	7963	7967	7971	7975	7979	7982
23.15	7925	7929	7932	7936	7940	7944	7948	7952	7956	7960	7964	7968	7972	7975	7979	7983	7987
23.10	7929	7933	7937	7941	7945	7949	7953	7957	7960	7964	7968	7972	7976	7980	7984	7987	7991
23.05	7934	7937	7941	7945	7949	7953	7957	7961	7965	7969	7973	7976	7980	7984	7988	7992	7996
23.00	7938	7942	7946	7950	7954	7958	7962	7965	7969	7973	7977	7981	7985	7988	7992	7996	8000

Table 51 English—High Alt, High-Mid Temp, Low Humidity (Temp = 91 to 107° F, Press = 23 to 27 inches, 20% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	91.0	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0
27.00	7656	7660	7665	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7717	7721	7725
26.95	7660	7665	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729
26.90	7664	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7734
26.85	7669	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7733	7738
26.80	7673	7678	7682	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7733	7738	7742
26.75	7678	7682	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7733	7738	7742	7746
26.70	7682	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7733	7738	7742	7746	7750
26.65	7686	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7734	7738	7742	7746	7750	7755
26.60	7691	7695	7699	7704	7708	7712	7716	7721	7725	7729	7734	7738	7742	7746	7750	7755	7759
26.55	7695	7699	7704	7708	7712	7716	7721	7725	7729	7734	7738	7742	7746	7750	7755	7759	7763
26.50	7699	7704	7708	7712	7717	7721	7725	7729	7734	7738	7742	7746	7751	7755	7759	7763	7767
26.45	7704	7708	7712	7717	7721	7725	7729	7734	7738	7742	7746	7751	7755	7759	7763	7767	7772
26.40	7708	7712	7717	7721	7725	7729	7734	7738	7742	7746	7751	7755	7759	7763	7767	7772	7776
26.35	7712	7717	7721	7725	7729	7734	7738	7742	7746	7751	7755	7759	7763	7767	7772	7776	7780
26.30	7717	7721	7725	7730	7734	7738	7742	7747	7751	7755	7759	7763	7768	7772	7776	7780	7784
26.25	7721	7725	7730	7734	7738	7742	7747	7751	7755	7759	7763	7768	7772	7776	7780	7784	7788
26.20	7725	7730	7734	7738	7742	7747	7751	7755	7759	7764	7768	7772	7776	7780	7784	7789	7793
26.15	7730	7734	7738	7742	7747	7751	7755	7759	7764	7768	7772	7776	7780	7784	7789	7793	7797
26.10	7734	7738	7743	7747	7751	7755	7759	7764	7768	7772	7776	7780	7785	7789	7793	7797	7801
26.05	7738	7743	7747	7751	7755	7760	7764	7768	7772	7776	7781	7785	7789	7793	7797	7801	7805
26.00	7743	7747	7751	7755	7760	7764	7768	7772	7776	7781	7785	7789	7793	7797	7801	7805	7810
25.95	7747	7751	7756	7760	7764	7768	7772	7777	7781	7785	7789	7793	7797	7801	7806	7810	7814
25.90	7751	7756	7760	7764	7768	7773	7777	7781	7785	7789	7793	7797	7802	7806	7810	7814	7818
25.85	7756	7760	7764	7768	7773	7777	7781	7785	7789	7793	7798	7802	7806	7810	7814	7818	7822
25.80	7760	7764	7769	7773	7777	7781	7785	7789	7794	7798	7802	7806	7810	7814	7818	7822	7826
25.75	7764	7769	7773	7777	7781	7785	7790	7794	7798	7802	7806	7810	7814	7818	7823	7827	7831
25.70	7769	7773	7777	7781	7786	7790	7794	7798	7802	7806	7810	7815	7819	7823	7827	7831	7835
25.65	7773	7777	7782	7786	7790	7794	7798	7802	7806	7811	7815	7819	7823	7827	7831	7835	7839
25.60	7778	7782	7786	7790	7794	7798	7802	7807	7811	7815	7819	7823	7827	7831	7835	7839	7843
25.55	7782	7786	7790	7794	7799	7803	7807	7811	7815	7819	7823	7827	7831	7835	7839	7844	7848
25.50	7786	7790	7795	7799	7803	7807	7811	7815	7819	7823	7827	7832	7836	7840	7844	7848	7852
25.45	7791	7795	7799	7803	7807	7811	7815	7820	7824	7828	7832	7836	7840	7844	7848	7852	7856
25.40	7795	7799	7803	7807	7811	7816	7820	7824	7828	7832	7836	7840	7844	7848	7852	7856	7860
25.35	7799	7803	7808	7812	7816	7820	7824	7828	7832	7836	7840	7844	7848	7852	7856	7860	7864
25.30	7804	7808	7812	7816	7820	7824	7828	7832	7836	7841	7845	7849	7853	7857	7861	7865	7869
25.25	7808	7812	7816	7820	7824	7829	7833	7837	7841	7845	7849	7853	7857	7861	7865	7869	7873
25.20	7812	7816	7821	7825	7829	7833	7837	7841	7845	7849	7853	7857	7861	7865	7869	7873	7877
25.15	7817	7821	7825	7829	7833	7837	7841	7845	7849	7853	7857	7861	7865	7869	7873	7877	7881
25.10	7821	7825	7829	7833	7837	7841	7846	7850	7854	7858	7862	7866	7870	7874	7878	7882	7886
25.05	7825	7829	7834	7838	7842	7846	7850	7854	7858	7862	7866	7870	7874	7878	7882	7886	7890
25.00	7830	7834	7838	7842	7846	7850	7854	7858	7862	7866	7870	7874	7878	7882	7886	7890	7894
24.95	7834	7838	7842	7846	7850	7854	7858	7862	7866	7870	7874	7878	7882	7886	7890	7894	7898
24.90	7838	7842	7847	7851	7855	7859	7863	7867	7871	7875	7879	7883	7887	7891	7895	7899	7903
24.85	7843	7847	7851	7855	7859	7863	7867	7871	7875	7879	7883	7887	7891	7895	7899	7903	7907
24.80	7847	7851	7855	7859	7863	7867	7871	7875	7879	7883	7887	7891	7895	7899	7903	7907	7911
24.75	7851	7856	7860	7864	7868	7872	7876	7880	7884	7888	7892	7896	7899	7903	7907	7911	7915
24.70	7856	7860	7864	7868	7872	7876	7880	7884	7888	7892	7896	7900	7904	7908	7912	7915	7919
24.65	7860	7864	7868	7872	7876	7880	7884	7888	7892	7896	7900	7904	7908	7912	7916	7920	7924
24.60	7865	7869	7873	7877	7881	7885	7889	7892	7896	7900	7904	7908	7912	7916	7920	7924	7928
24.55	7869	7873	7877	7881	7885	7889	7893	7897	7901	7905	7909	7913	7916	7920	7924	7928	7932
24.50	7873	7877	7881	7885	7889	7893	7897	7901	7905	7909	7913	7917	7921	7925	7929	7932	7936
24.45	7878	7882	7886	7890	7894	7897	7901	7905	7909	7913	7917	7921	7925	7929	7933	7937	7941
24.40	7882	7886	7890	7894	7898	7902	7906	7910	7914	7918	7921	7925	7929	7933	7937	7941	7945
24.35	7886	7890	7894	7898	7902	7906	7910	7914	7918	7922	7926	7930	7933	7937	7941	7945	7949
24.30	7891	7895	7899	7903	7906	7910	7914	7918	7922	7926	7930	7934	7938	7942	7945	7949	7953
24.25	7895	7899	7903	7907	7911	7915	7919	7923	7926	7930	7934	7938	7942	7946	7950	7954	7957
24.20	7899	7903	7907	7911	7915	7919	7923	7927	7931	7935	7939	7942	7946	7950	7954	7958	7962
24.15	7904	7908	7912	7915	7919	7923	7927	7931	7935	7939	7943	7947	7951	7954	7958	7962	7966
24.10	7908	7912	7916	7920	7924	7928	7932	7935	7939	7943	7947	7951	7955	7959	7962	7966	7970
24.05	7912	7916	7920	7924	7928	7932	7936	7940	7944	7947	7951	7955	7959	7963	7967	7971	7974
24.00	7917	7921	7925	7928	7932	7936	7940	7944	7948	7952	7956	7959	7963	7967	7971	7975	7979
23.95	7921	7925	7929	7933	7937	7941	7944	7948	7952	7956	7960	7964	7968	7971	7975	7979	7983
23.90	7925	7929	7933	7937	7941	7945	7949	7953	7956	7960	7964	7968	7972	7976	7979	7983	7987
23.85	7930	7934	7938	7941	7945	7949	7953	7957	7961	7965	7968	7972	7976	7980	7984	7987	7991
23.80	7934	7938	7942	7946	7950	7953	7957	7961	7965	7969	7973	7976	7980	7984	7988	7992	7995
23.75	7938	7942	7946	7950	7954	7958	7962	7965	7969	7973	7977	7981	7985	7988	7992	7996	8000
23.70	7943	7947	7951	7954	7958	7962	7966	7970	7974	7977	7981	7985	7989	7993	7996	8000	8004
23.65	7947	7951	7955	7959	7963	7966	7970	7974	7978	7982	7985	7989	7993	7997	8001	8004	8008
23.60	7951	7955	7959	7963	7967	7971	7975	7978	7982	7986	7990	7994	7997	8001	8005	8009	8012
23.55	7956	7960	7964	7967	7971	7975	7979	7983	7986	7990	7994	7998	8002	8005	8009	8013	8017
23.50	7960	7964	7968	7972	7976	7979	7983	7987	7991	7995	7998	8002	8006	8010	8013	8017	8021
23.45	7965	7968	7972	7976	7980	7984	7987	7991	7995	7999	8003	8006	8010	8014	8018	8021	8025
23.40	7969	7973	7977	7980	7984	7988	7992	7996	7999	8003	8007	8011	8014	8018	8022	8026	8029
23.35	7973	7977	7981	7985	7988	7992	7996	8000	8004	8007	8011	8015	8019	8022	8026	8030	8033
23.30	7978	7981	7985	7989	7993	7997	8000	8004	8008	8012	8015	8019	8023	8027	8030	8034	8038
23.25	7982	7986	7990	7993	7997	8001	8005	8008	8012	8016	8020	8023	8027	8031	8035	8038	8042
23.20	7986	7990	7994	7998	8001	8005	8009	8013	8016	8020	8024	8028	8031	8035	8039	8042	8046
23.15	7991	7994	7998	8002	8006	8010	8013	8017	8021	8024	8028	8032	8036	8039	8043	8047	8050
23.10	7995	7999	8003	8006	8010	8014	8018	8021	8025	8029	8032	8036	8040	8044	8047	8051	8055
23.05	7999	8003	8007	8011	8014	8018	8022	8026	8029	8033	8037	8040	8044	8048	8052	8055	8059
23.00	8004	8007	8011	8015	8019	8022	8026	8030	8034	8037	8041	8045	8048	8052	8056	8059	8063

Table 52 English—Low Alt, Low Temp, Med Humidity
(Temp = 40 to 56° F, Press = 27 to 31 inches, 50% Humidity)

BAROMETRIC PRESSURE IN INCHES OF MERCURY	TEMPERATURE IN DEGREES FAHRENHEIT																
	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0
31.00	7029	7035	7041	7047	7053	7059	7065	7071	7077	7083	7089	7094	7100	7106	7112	7117	7123
30.95	7034	7040	7046	7052	7058	7064	7070	7076	7082	7087	7093	7099	7105	7111	7116	7122	7128
30.90	7039	7045	7051	7057	7063	7069	7075	7080	7086	7092	7098	7104	7110	7115	7121	7127	7133
30.85	7044	7050	7056	7062	7067	7073	7079	7085	7091	7097	7103	7108	7114	7120	7126	7131	7137
30.80	7048	7054	7060	7066	7072	7078	7084	7090	7096	7102	7107	7113	7119	7125	7130	7136	7142
30.75	7053	7059	7065	7071	7077	7083	7089	7095	7100	7106	7112	7118	7124	7129	7135	7141	7146
30.70	7058	7064	7070	7076	7082	7088	7094	7099	7105	7111	7117	7123	7128	7134	7140	7145	7151
30.65	7063	7069	7075	7081	7087	7092	7098	7104	7110	7116	7121	7127	7133	7139	7144	7150	7156
30.60	7068	7074	7079	7085	7091	7097	7103	7109	7115	7120	7126	7132	7138	7143	7149	7155	7160
30.55	7072	7078	7084	7090	7096	7102	7108	7114	7119	7125	7131	7137	7142	7148	7154	7159	7165
30.50	7077	7083	7089	7095	7101	7107	7112	7118	7124	7130	7136	7141	7147	7153	7158	7164	7170
30.45	7082	7088	7094	7100	7106	7111	7117	7123	7129	7135	7140	7146	7152	7157	7163	7169	7174
30.40	7087	7093	7099	7104	7110	7116	7122	7128	7134	7139	7145	7151	7156	7162	7168	7173	7179
30.35	7092	7097	7103	7109	7115	7121	7127	7132	7138	7144	7150	7155	7161	7167	7172	7178	7184
30.30	7096	7102	7108	7114	7120	7126	7131	7137	7143	7149	7154	7160	7166	7171	7177	7183	7188
30.25	7101	7107	7113	7119	7125	7130	7136	7142	7148	7153	7159	7165	7170	7176	7182	7187	7193
30.20	7106	7112	7118	7124	7129	7135	7141	7147	7152	7158	7164	7169	7175	7181	7186	7192	7198
30.15	7111	7117	7122	7128	7134	7140	7146	7151	7157	7163	7169	7174	7180	7185	7191	7197	7202
30.10	7116	7121	7127	7133	7139	7145	7150	7156	7162	7168	7173	7179	7184	7190	7196	7201	7207
30.05	7120	7126	7132	7138	7144	7149	7155	7161	7167	7172	7178	7184	7189	7195	7200	7206	7211
30.00	7125	7131	7137	7143	7148	7154	7160	7166	7171	7177	7183	7188	7194	7199	7205	7211	7216
29.95	7130	7136	7142	7147	7153	7159	7165	7170	7176	7182	7187	7193	7199	7204	7210	7215	7221
29.90	7135	7141	7146	7152	7158	7164	7169	7175	7181	7186	7192	7198	7203	7209	7214	7220	7225
29.85	7140	7145	7151	7157	7163	7168	7174	7180	7185	7191	7197	7202	7208	7213	7219	7225	7230
29.80	7144	7150	7156	7162	7167	7173	7179	7184	7190	7196	7201	7207	7213	7218	7224	7229	7235
29.75	7149	7155	7161	7166	7172	7178	7184	7189	7195	7201	7206	7212	7217	7223	7228	7234	7239
29.70	7154	7160	7165	7171	7177	7183	7188	7194	7200	7205	7211	7216	7222	7228	7233	7239	7244
29.65	7159	7164	7170	7176	7182	7187	7193	7199	7204	7210	7216	7221	7227	7232	7238	7243	7249
29.60	7164	7169	7175	7181	7186	7192	7198	7203	7209	7215	7220	7226	7231	7237	7242	7248	7253
29.55	7168	7174	7180	7186	7191	7197	7203	7208	7214	7219	7225	7230	7236	7242	7247	7252	7258
29.50	7173	7179	7185	7190	7196	7202	7207	7213	7218	7224	7230	7235	7241	7246	7252	7257	7263
29.45	7178	7184	7189	7195	7201	7206	7212	7218	7223	7229	7234	7240	7245	7251	7256	7262	7267
29.40	7183	7188	7194	7200	7205	7211	7217	7222	7228	7233	7239	7245	7250	7256	7261	7266	7272
29.35	7188	7193	7199	7205	7210	7216	7221	7227	7233	7238	7244	7249	7255	7260	7266	7271	7277
29.30	7192	7198	7204	7209	7215	7221	7226	7232	7237	7243	7248	7254	7259	7265	7270	7276	7281
29.25	7197	7203	7208	7214	7220	7225	7231	7237	7242	7248	7253	7259	7264	7270	7275	7280	7286
29.20	7202	7208	7213	7219	7225	7230	7236	7241	7247	7252	7258	7263	7269	7274	7280	7285	7290
29.15	7207	7212	7218	7224	7229	7235	7240	7246	7252	7257	7263	7268	7273	7279	7284	7290	7295
29.10	7211	7217	7223	7228	7234	7240	7245	7251	7256	7262	7267	7273	7278	7284	7289	7294	7300
29.05	7216	7222	7228	7233	7239	7244	7250	7255	7261	7266	7272	7277	7283	7288	7294	7299	7304
29.00	7221	7227	7232	7238	7244	7249	7255	7260	7266	7271	7277	7282	7288	7293	7298	7304	7309
28.95	7226	7232	7237	7243	7248	7254	7259	7265	7270	7276	7281	7287	7292	7298	7303	7308	7314
28.90	7231	7236	7242	7247	7253	7259	7264	7270	7275	7281	7286	7291	7297	7302	7308	7313	7318
28.85	7235	7241	7247	7252	7258	7263	7269	7274	7280	7285	7291	7296	7302	7307	7312	7318	7323
28.80	7240	7246	7251	7257	7263	7268	7274	7279	7285	7290	7295	7301	7306	7312	7317	7322	7328
28.75	7245	7251	7256	7262	7267	7273	7278	7284	7289	7295	7300	7306	7311	7316	7322	7327	7332
28.70	7250	7255	7261	7267	7272	7278	7283	7289	7294	7299	7305	7310	7316	7321	7326	7332	7337
28.65	7255	7260	7266	7271	7277	7282	7288	7293	7299	7304	7310	7315	7320	7326	7331	7336	7342
28.60	7259	7265	7271	7276	7282	7287	7293	7298	7303	7309	7314	7320	7325	7330	7336	7341	7346
28.55	7264	7270	7275	7281	7286	7292	7297	7303	7308	7314	7319	7324	7330	7335	7340	7346	7351
28.50	7269	7275	7280	7286	7291	7297	7302	7307	7313	7318	7324	7329	7334	7340	7345	7350	7356
28.45	7274	7279	7285	7290	7296	7301	7307	7312	7318	7323	7328	7334	7339	7344	7350	7355	7360
28.40	7279	7284	7290	7295	7301	7306	7312	7317	7322	7328	7333	7338	7344	7349	7354	7360	7365
28.35	7283	7289	7294	7300	7305	7311	7316	7322	7327	7332	7338	7343	7348	7354	7359	7364	7369
28.30	7288	7294	7299	7305	7310	7316	7321	7326	7332	7337	7342	7348	7353	7358	7364	7369	7374
28.25	7293	7299	7304	7309	7315	7320	7326	7331	7336	7342	7347	7352	7358	7363	7368	7374	7379
28.20	7298	7303	7309	7314	7320	7325	7330	7336	7341	7347	7352	7357	7362	7368	7373	7378	7383
28.15	7303	7308	7314	7319	7324	7330	7335	7341	7346	7351	7357	7362	7367	7372	7378	7383	7388
28.10	7307	7313	7318	7324	7329	7335	7340	7345	7351	7356	7361	7367	7372	7377	7382	7387	7393
28.05	7312	7318	7323	7329	7334	7339	7345	7350	7355	7361	7366	7371	7376	7382	7387	7392	7397
28.00	7317	7322	7328	7333	7339	7344	7349	7355	7360	7365	7371	7376	7381	7386	7392	7397	7402
27.95	7322	7327	7333	7338	7343	7349	7354	7359	7365	7370	7375	7381	7386	7391	7396	7401	7407
27.90	7327	7332	7337	7343	7348	7354	7359	7364	7370	7375	7380	7385	7391	7396	7401	7406	7411
27.85	7331	7337	7342	7348	7353	7358	7364	7369	7374	7380	7385	7390	7395	7400	7406	7411	7416
27.80	7336	7342	7347	7352	7358	7363	7368	7374	7379	7384	7389	7395	7400	7405	7410	7415	7421
27.75	7341	7346	7352	7357	7362	7368	7373	7378	7384	7389	7394	7399	7405	7410	7415	7420	7425
27.70	7346	7351	7357	7362	7367	7373	7378	7383	7388	7394	7399	7404	7409	7414	7420	7425	7430
27.65	7351	7356	7361	7367	7372	7377	7383	7388	7393	7398	7404	7409	7414	7419	7424	7429	7435
27.60	7355	7361	7366	7371	7377	7382	7387	7393	7398	7403	7408	7413	7419	7424	7429	7434	7439
27.55	7360	7366	7371	7376	7382	7387	7392	7397	7403	7408	7413	7418	7423	7428	7434	7439	7444
27.50	7365	7370	7376	7381	7386	7392	7397	7402	7407	7412	7418	7423	7428	7433	7438	7443	7448
27.45	7370	7375	7380	7386	7391	7396	7402	7407	7412	7417	7422	7428	7433	7438	7443	7448	7453
27.40	7375	7380	7385	7390	7396	7401	7406	7412	7417	7422	7427	7432	7437	7442	7448	7453	7458
27.35	7379	7385	7390	7395	7401	7406	7411	7416	7421	7427	7432	7437	7442	7447	7452	7457	7462
27.30	7384	7389	7395	7400	7405	7411	7416	7421	7426	7431	7436	7442	7447	7452	7457	7462	7467
27.25	7389	7394	7400	7405	7410	7415	7420	7426	7431	7436	7441	7446	7451	7456	7462	7467	7472
27.20	7394	7399	7404	7410	7415	7420	7425	7430	7436	7441	7446	7451	7456	7461	7466	7471	7476
27.15	7399	7404	7409	7414	7420	7425	7430	7435	7440	7445	7451	7456	7461	7466	7471	7476	7481
27.10	7403	7409	7414	7419	7424	7430	7435	7440	7445	7450	7455	7460	7465	7471	7476	7481	7486
27.05	7408	7413	7419	7424	7429	7434	7439	7445	7450	7455	7460	7465	7470	7475	7480	7485	7490
27.00	7413	7418	7423	7429	7434	7439	7444	7449	7454	7460	7465	7470	7475	7480	7485	7490	7495

Table 53 English—Low Alt, Low-Mid Temp, Med Humidity
(Temp = 57 to 73° F, Press = 27 to 31 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.0	68.0	69.0	70.0	71.0	72.0	73.0
31.00	7129	7135	7140	7146	7152	7157	7163	7168	7174	7180	7185	7191	7196	7202	7207	7212	7218
30.95	7134	7139	7145	7151	7156	7162	7167	7173	7179	7184	7190	7195	7201	7206	7212	7217	7222
30.90	7138	7144	7150	7155	7161	7166	7172	7178	7183	7189	7194	7200	7205	7211	7216	7222	7227
30.85	7143	7149	7154	7160	7165	7171	7177	7182	7188	7193	7199	7204	7210	7215	7221	7226	7231
30.80	7147	7153	7159	7164	7170	7176	7181	7187	7192	7198	7203	7209	7214	7220	7225	7231	7236
30.75	7152	7158	7163	7169	7175	7180	7186	7191	7197	7202	7208	7213	7219	7224	7230	7235	7240
30.70	7157	7162	7168	7174	7179	7185	7190	7196	7201	7207	7212	7218	7223	7229	7234	7240	7245
30.65	7161	7167	7173	7178	7184	7189	7195	7200	7206	7211	7217	7222	7228	7233	7239	7244	7249
30.60	7166	7172	7177	7183	7188	7194	7199	7205	7210	7216	7221	7227	7232	7238	7243	7249	7254
30.55	7171	7176	7182	7187	7193	7199	7204	7210	7215	7221	7226	7231	7237	7242	7248	7253	7258
30.50	7175	7181	7186	7192	7198	7203	7209	7214	7220	7225	7231	7236	7241	7247	7252	7258	7263
30.45	7180	7186	7191	7197	7202	7208	7213	7219	7224	7230	7235	7241	7246	7251	7257	7262	7267
30.40	7185	7190	7196	7201	7207	7212	7218	7223	7229	7234	7240	7245	7250	7256	7261	7267	7272
30.35	7189	7195	7200	7206	7211	7217	7222	7228	7233	7239	7244	7250	7255	7260	7266	7271	7276
30.30	7194	7199	7205	7210	7216	7221	7227	7232	7238	7243	7249	7254	7260	7265	7270	7276	7281
30.25	7198	7204	7210	7215	7221	7226	7232	7237	7242	7248	7253	7259	7264	7269	7275	7280	7285
30.20	7203	7209	7214	7220	7225	7231	7236	7242	7247	7252	7258	7263	7269	7274	7279	7285	7290
30.15	7208	7213	7219	7224	7230	7235	7241	7246	7252	7257	7262	7268	7273	7278	7284	7289	7294
30.10	7212	7218	7223	7229	7234	7240	7245	7251	7256	7262	7267	7272	7278	7283	7288	7294	7299
30.05	7217	7223	7228	7234	7239	7244	7250	7255	7261	7266	7271	7277	7282	7287	7293	7298	7303
30.00	7222	7227	7233	7238	7244	7249	7254	7260	7265	7271	7276	7281	7287	7292	7297	7303	7308
29.95	7226	7232	7237	7243	7248	7254	7259	7264	7270	7275	7281	7286	7291	7297	7302	7307	7312
29.90	7231	7236	7242	7247	7253	7258	7264	7269	7274	7280	7285	7290	7296	7301	7306	7312	7317
29.85	7236	7241	7247	7252	7257	7263	7268	7274	7279	7284	7290	7295	7300	7306	7311	7316	7321
29.80	7240	7246	7251	7257	7262	7267	7273	7278	7284	7289	7294	7300	7305	7310	7315	7321	7326
29.75	7245	7250	7256	7261	7267	7272	7277	7283	7288	7293	7299	7304	7309	7315	7320	7325	7330
29.70	7249	7255	7260	7266	7271	7277	7282	7287	7293	7298	7303	7309	7314	7319	7324	7330	7335
29.65	7254	7260	7265	7270	7276	7281	7287	7292	7297	7303	7308	7313	7318	7324	7329	7334	7339
29.60	7259	7264	7270	7275	7280	7286	7291	7296	7302	7307	7312	7318	7323	7328	7333	7339	7344
29.55	7263	7269	7274	7280	7285	7290	7296	7301	7306	7312	7317	7322	7327	7333	7338	7343	7348
29.50	7268	7273	7279	7284	7290	7295	7300	7306	7311	7316	7321	7327	7332	7337	7342	7348	7353
29.45	7273	7278	7283	7289	7294	7300	7305	7310	7315	7321	7326	7331	7337	7342	7347	7352	7357
29.40	7277	7283	7288	7293	7299	7304	7309	7315	7320	7325	7331	7336	7341	7346	7351	7357	7362
29.35	7282	7287	7293	7298	7303	7309	7314	7319	7325	7330	7335	7340	7346	7351	7356	7361	7366
29.30	7287	7292	7297	7303	7308	7313	7319	7324	7329	7334	7340	7345	7350	7355	7361	7366	7371
29.25	7291	7297	7302	7307	7313	7318	7323	7328	7334	7339	7344	7349	7355	7360	7365	7370	7375
29.20	7296	7301	7307	7312	7317	7323	7328	7333	7338	7344	7349	7354	7359	7364	7370	7375	7380
29.15	7301	7306	7311	7317	7322	7327	7332	7338	7343	7348	7353	7359	7364	7369	7374	7379	7384
29.10	7305	7310	7316	7321	7326	7332	7337	7342	7347	7353	7358	7363	7368	7373	7379	7384	7389
29.05	7310	7315	7320	7326	7331	7336	7342	7347	7352	7357	7362	7368	7373	7378	7383	7388	7393
29.00	7314	7320	7325	7330	7336	7341	7346	7351	7357	7362	7367	7372	7377	7382	7388	7393	7398
28.95	7319	7324	7330	7335	7340	7345	7351	7356	7361	7366	7372	7377	7382	7387	7392	7397	7402
28.90	7324	7329	7334	7340	7345	7350	7355	7361	7366	7371	7376	7381	7386	7392	7397	7402	7407
28.85	7328	7334	7339	7344	7349	7355	7360	7365	7370	7375	7381	7386	7391	7396	7401	7406	7411
28.80	7333	7338	7344	7349	7354	7359	7364	7370	7375	7380	7385	7390	7395	7401	7406	7411	7416
28.75	7338	7343	7348	7353	7359	7364	7369	7374	7379	7385	7390	7395	7400	7405	7410	7415	7420
28.70	7342	7348	7353	7358	7363	7368	7374	7379	7384	7389	7394	7399	7404	7410	7415	7420	7425
28.65	7347	7352	7357	7363	7368	7373	7378	7383	7389	7394	7399	7404	7409	7414	7419	7424	7429
28.60	7352	7357	7362	7367	7372	7378	7383	7388	7393	7398	7403	7408	7414	7419	7424	7429	7434
28.55	7356	7361	7367	7372	7377	7382	7387	7393	7398	7403	7408	7413	7418	7423	7428	7433	7438
28.50	7361	7366	7371	7376	7382	7387	7392	7397	7402	7407	7412	7418	7423	7428	7433	7438	7443
28.45	7365	7371	7376	7381	7386	7391	7397	7402	7407	7412	7417	7422	7427	7432	7437	7442	7447
28.40	7370	7375	7380	7386	7391	7396	7401	7406	7411	7416	7422	7427	7432	7437	7442	7447	7452
28.35	7375	7380	7385	7390	7395	7401	7406	7411	7416	7421	7426	7431	7436	7441	7446	7451	7456
28.30	7379	7385	7390	7395	7400	7405	7410	7415	7421	7426	7431	7436	7441	7446	7451	7456	7461
28.25	7384	7389	7394	7400	7405	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460	7465
28.20	7389	7394	7399	7404	7409	7414	7419	7425	7430	7435	7440	7445	7450	7455	7460	7465	7470
28.15	7393	7398	7404	7409	7414	7419	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474
28.10	7398	7403	7408	7413	7418	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474	7479
28.05	7403	7408	7413	7418	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483
28.00	7407	7412	7417	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488
27.95	7412	7417	7422	7427	7432	7437	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492
27.90	7416	7422	7427	7432	7437	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492	7497
27.85	7421	7426	7431	7436	7441	7447	7452	7457	7462	7467	7472	7477	7482	7486	7491	7496	7501
27.80	7426	7431	7436	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506
27.75	7430	7435	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486	7491	7496	7500	7505	7510
27.70	7435	7440	7445	7450	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515
27.65	7440	7445	7450	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505	7509	7514	7519
27.60	7444	7449	7454	7459	7464	7469	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524
27.55	7449	7454	7459	7464	7469	7474	7479	7484	7489	7494	7499	7504	7509	7514	7518	7523	7528
27.50	7454	7459	7464	7469	7474	7479	7484	7489	7494	7499	7503	7508	7513	7518	7523	7528	7533
27.45	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7518	7523	7528	7532	7537
27.40	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7517	7522	7527	7532	7537	7542
27.35	7467	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537	7541	7546
27.30	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7531	7536	7541	7546	7551
27.25	7477	7482	7487	7492	7497	7502	7507	7511	7516	7521	7526	7531	7536	7541	7546	7550	7555
27.20	7481	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7540	7545	7550	7555	7560
27.15	7486	7491	7496	7501	7506	7511	7516	7521	7526	7530	7535	7540	7545	7550	7555	7559	7564
27.10	7491	7496	7501	7506	7510	7515	7520	7525	7530	7535	7540	7545	7549	7554	7559	7564	7569
27.05	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7544	7549	7554	7559	7564	7568	7573
27.00	7500	7505	7510	7515	7520	7525	7529	7534	7539	7544	7549	7554	7559	7563	7568	7573	7578

Table 54 English—Low Alt, Mid Temp, Med Humidity
(Temp = 74 to 90° F, Press = 27 to 31 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0
31.00	7223	7229	7234	7240	7245	7250	7256	7261	7266	7272	7277	7282	7288	7293	7298	7303	7309
30.95	7228	7233	7239	7244	7249	7255	7260	7265	7271	7276	7281	7287	7292	7297	7303	7308	7313
30.90	7232	7238	7243	7249	7254	7259	7265	7270	7275	7281	7286	7291	7296	7302	7307	7312	7317
30.85	7237	7242	7248	7253	7258	7264	7269	7274	7280	7285	7290	7295	7301	7306	7311	7316	7322
30.80	7241	7247	7252	7257	7263	7268	7273	7279	7284	7289	7295	7300	7305	7310	7316	7321	7326
30.75	7246	7251	7257	7262	7267	7273	7278	7283	7288	7294	7299	7304	7310	7315	7320	7325	7330
30.70	7250	7256	7261	7266	7272	7277	7282	7288	7293	7298	7303	7309	7314	7319	7324	7330	7335
30.65	7255	7260	7265	7271	7276	7281	7287	7292	7297	7303	7308	7313	7318	7324	7329	7334	7339
30.60	7259	7265	7270	7275	7281	7286	7291	7296	7302	7307	7312	7317	7323	7328	7333	7338	7344
30.55	7264	7269	7274	7280	7285	7290	7296	7301	7306	7311	7317	7322	7327	7332	7337	7343	7348
30.50	7268	7274	7279	7284	7290	7295	7300	7305	7311	7316	7321	7326	7331	7337	7342	7347	7352
30.45	7273	7278	7283	7289	7294	7299	7305	7310	7315	7320	7325	7331	7336	7341	7346	7351	7357
30.40	7277	7283	7288	7293	7298	7304	7309	7314	7319	7325	7330	7335	7340	7345	7351	7356	7361
30.35	7282	7287	7292	7298	7303	7308	7313	7319	7324	7329	7334	7339	7345	7350	7355	7360	7365
30.30	7286	7292	7297	7302	7307	7313	7318	7323	7328	7333	7339	7344	7349	7354	7359	7365	7370
30.25	7291	7296	7301	7307	7312	7317	7322	7327	7333	7338	7343	7348	7353	7359	7364	7369	7374
30.20	7295	7300	7306	7311	7316	7321	7327	7332	7337	7342	7347	7353	7358	7363	7368	7373	7378
30.15	7300	7305	7310	7315	7321	7326	7331	7336	7342	7347	7352	7357	7362	7367	7372	7378	7383
30.10	7304	7309	7315	7320	7325	7330	7336	7341	7346	7351	7356	7361	7367	7372	7377	7382	7387
30.05	7309	7314	7319	7324	7330	7335	7340	7345	7350	7356	7361	7366	7371	7376	7381	7386	7391
30.00	7313	7318	7324	7329	7334	7339	7344	7350	7355	7360	7365	7370	7375	7380	7386	7391	7396
29.95	7318	7323	7328	7333	7339	7344	7349	7354	7359	7364	7370	7375	7380	7385	7390	7395	7400
29.90	7322	7327	7333	7338	7343	7348	7353	7358	7364	7369	7374	7379	7384	7389	7394	7399	7404
29.85	7327	7332	7337	7342	7347	7353	7358	7363	7368	7373	7378	7383	7389	7394	7399	7404	7409
29.80	7331	7336	7342	7347	7352	7357	7362	7367	7372	7378	7383	7388	7393	7398	7403	7408	7413
29.75	7336	7341	7346	7351	7356	7361	7367	7372	7377	7382	7387	7392	7397	7402	7407	7413	7418
29.70	7340	7345	7350	7356	7361	7366	7371	7376	7381	7386	7392	7397	7402	7407	7412	7417	7422
29.65	7345	7350	7355	7360	7365	7370	7376	7381	7386	7391	7396	7401	7406	7411	7416	7421	7426
29.60	7349	7354	7359	7365	7370	7375	7380	7385	7390	7395	7400	7405	7410	7416	7421	7426	7431
29.55	7354	7359	7364	7369	7374	7379	7384	7389	7395	7400	7405	7410	7415	7420	7425	7430	7435
29.50	7358	7363	7368	7373	7379	7384	7389	7394	7399	7404	7409	7414	7419	7424	7429	7434	7439
29.45	7363	7368	7373	7378	7383	7388	7393	7398	7403	7409	7414	7419	7424	7429	7434	7439	7444
29.40	7367	7372	7377	7382	7388	7393	7398	7403	7408	7413	7418	7423	7428	7433	7438	7443	7448
29.35	7371	7377	7382	7387	7392	7397	7402	7407	7412	7417	7422	7427	7432	7437	7442	7447	7452
29.30	7376	7381	7386	7391	7396	7402	7407	7412	7417	7422	7427	7432	7437	7442	7447	7452	7457
29.25	7380	7386	7391	7396	7401	7406	7411	7416	7421	7426	7431	7436	7441	7446	7451	7456	7461
29.20	7385	7390	7395	7400	7405	7410	7415	7421	7426	7431	7436	7441	7446	7451	7456	7461	7465
29.15	7389	7395	7400	7405	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460	7465	7470
29.10	7394	7399	7404	7409	7414	7419	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474
29.05	7398	7404	7409	7414	7419	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474	7479
29.00	7403	7408	7413	7418	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483
28.95	7407	7412	7418	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7472	7477	7482	7487
28.90	7412	7417	7422	7427	7432	7437	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492
28.85	7416	7421	7426	7432	7437	7442	7447	7452	7456	7461	7466	7471	7476	7481	7486	7491	7496
28.80	7421	7426	7431	7436	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486	7491	7495	7500
28.75	7425	7430	7435	7440	7445	7450	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505
28.70	7430	7435	7440	7445	7450	7455	7460	7465	7470	7475	7480	7485	7489	7494	7499	7504	7509
28.65	7434	7439	7444	7449	7454	7459	7464	7469	7474	7479	7484	7489	7494	7499	7504	7509	7513
28.60	7439	7444	7449	7454	7459	7464	7469	7474	7479	7484	7488	7493	7498	7503	7508	7513	7518
28.55	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7512	7517	7522
28.50	7448	7453	7458	7463	7468	7473	7478	7483	7487	7492	7497	7502	7507	7512	7517	7522	7526
28.45	7452	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507	7511	7516	7521	7526	7531
28.40	7457	7462	7467	7472	7477	7482	7486	7491	7496	7501	7506	7511	7516	7521	7526	7530	7535
28.35	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506	7510	7515	7520	7525	7530	7535	7540
28.30	7466	7471	7476	7481	7486	7490	7495	7500	7505	7510	7515	7520	7525	7529	7534	7539	7544
28.25	7470	7475	7480	7485	7490	7495	7500	7505	7510	7514	7519	7524	7529	7534	7539	7543	7548
28.20	7475	7480	7485	7490	7494	7499	7504	7509	7514	7519	7524	7529	7533	7538	7543	7548	7553
28.15	7479	7484	7489	7494	7499	7504	7509	7514	7518	7523	7528	7533	7538	7543	7547	7552	7557
28.10	7484	7489	7494	7498	7503	7508	7513	7518	7523	7528	7532	7537	7542	7547	7552	7557	7561
28.05	7488	7493	7498	7503	7508	7513	7518	7522	7527	7532	7537	7542	7547	7551	7556	7561	7566
28.00	7493	7498	7502	7507	7512	7517	7522	7527	7532	7536	7541	7546	7551	7556	7560	7565	7570
27.95	7497	7502	7507	7512	7517	7522	7526	7531	7536	7541	7546	7551	7555	7560	7565	7570	7574
27.90	7502	7507	7511	7516	7521	7526	7531	7536	7541	7545	7550	7555	7560	7564	7569	7574	7579
27.85	7506	7511	7516	7521	7526	7530	7535	7540	7545	7550	7555	7559	7564	7569	7574	7578	7583
27.80	7511	7516	7520	7525	7530	7535	7540	7545	7549	7554	7559	7564	7568	7573	7578	7583	7587
27.75	7515	7520	7525	7530	7535	7539	7544	7549	7554	7559	7563	7568	7573	7578	7582	7587	7592
27.70	7520	7524	7529	7534	7539	7544	7549	7553	7558	7563	7568	7572	7577	7582	7587	7591	7596
27.65	7524	7529	7534	7539	7543	7548	7553	7558	7563	7567	7572	7577	7582	7586	7591	7596	7601
27.60	7529	7533	7538	7543	7548	7553	7557	7562	7567	7572	7577	7581	7586	7591	7595	7600	7605
27.55	7533	7538	7543	7548	7552	7557	7562	7567	7571	7576	7581	7586	7590	7595	7600	7605	7609
27.50	7538	7542	7547	7552	7557	7562	7566	7571	7576	7581	7585	7590	7595	7600	7604	7609	7614
27.45	7542	7547	7552	7556	7561	7566	7571	7576	7580	7585	7590	7594	7599	7604	7609	7613	7618
27.40	7547	7551	7556	7561	7566	7570	7575	7580	7585	7589	7594	7599	7604	7608	7613	7618	7622
27.35	7551	7556	7561	7565	7570	7575	7580	7584	7589	7594	7599	7603	7608	7613	7617	7622	7627
27.30	7556	7560	7565	7570	7575	7579	7584	7589	7594	7598	7603	7608	7612	7617	7622	7626	7631
27.25	7560	7565	7570	7574	7579	7584	7589	7593	7598	7603	7607	7612	7617	7621	7626	7631	7635
27.20	7564	7569	7574	7579	7584	7588	7593	7598	7602	7607	7612	7616	7621	7626	7630	7635	7640
27.15	7569	7574	7578	7583	7588	7593	7597	7602	7607	7612	7616	7621	7626	7630	7635	7639	7644
27.10	7573	7578	7583	7588	7592	7597	7602	7607	7611	7616	7621	7625	7630	7635	7639	7644	7648
27.05	7578	7583	7587	7592	7597	7602	7606	7611	7616	7620	7625	7630	7634	7639	7644	7648	7653
27.00	7582	7587	7592	7597	7601	7606	7611	7615	7620	7625	7629	7634	7639	7643	7648	7653	7657

Table 55 English—Low Alt, High-Mid Temp, Med Humidity
(Temp = 91 to 107° F, Press = 27 to 31 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	91.0	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0
31.00	7314	7319	7324	7330	7335	7340	7345	7350	7356	7361	7366	7371	7376	7382	7387	7392	7397
30.95	7318	7323	7329	7334	7339	7344	7350	7355	7360	7365	7370	7375	7381	7386	7391	7396	7401
30.90	7323	7328	7333	7338	7343	7349	7354	7359	7364	7369	7375	7380	7385	7390	7395	7400	7406
30.85	7327	7332	7337	7343	7348	7353	7358	7363	7368	7374	7379	7384	7389	7394	7399	7405	7410
30.80	7331	7336	7342	7347	7352	7357	7362	7368	7373	7378	7383	7388	7393	7399	7404	7409	7414
30.75	7336	7341	7346	7351	7356	7362	7367	7372	7377	7382	7387	7393	7398	7403	7408	7413	7418
30.70	7340	7345	7350	7356	7361	7366	7371	7376	7381	7386	7392	7397	7402	7407	7412	7417	7422
30.65	7344	7350	7355	7360	7365	7370	7375	7380	7386	7391	7396	7401	7406	7411	7416	7422	7427
30.60	7349	7354	7359	7364	7369	7374	7380	7385	7390	7395	7400	7405	7410	7416	7421	7426	7431
30.55	7353	7358	7363	7369	7374	7379	7384	7389	7394	7399	7404	7410	7415	7420	7425	7430	7435
30.50	7357	7363	7368	7373	7378	7383	7388	7393	7398	7404	7409	7414	7419	7424	7429	7434	7439
30.45	7362	7367	7372	7377	7382	7387	7393	7398	7403	7408	7413	7418	7423	7428	7433	7438	7444
30.40	7366	7371	7376	7381	7387	7392	7397	7402	7407	7412	7417	7422	7427	7433	7438	7443	7448
30.35	7370	7376	7381	7386	7391	7396	7401	7406	7411	7416	7422	7427	7432	7437	7442	7447	7452
30.30	7375	7380	7385	7390	7395	7400	7405	7411	7416	7421	7426	7431	7436	7441	7446	7451	7456
30.25	7379	7384	7389	7394	7400	7405	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460
30.20	7383	7389	7394	7399	7404	7409	7414	7419	7424	7429	7434	7439	7444	7450	7455	7460	7465
30.15	7388	7393	7398	7403	7408	7413	7418	7423	7428	7434	7439	7444	7449	7454	7459	7464	7469
30.10	7392	7397	7402	7407	7413	7418	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473
30.05	7397	7402	7407	7412	7417	7422	7427	7432	7437	7442	7447	7452	7457	7462	7467	7472	7477
30.00	7401	7406	7411	7416	7421	7426	7431	7436	7441	7446	7451	7456	7461	7467	7472	7477	7482
29.95	7405	7410	7415	7420	7425	7431	7436	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486
29.90	7410	7415	7420	7425	7430	7435	7440	7445	7450	7455	7460	7465	7470	7475	7480	7485	7490
29.85	7414	7419	7424	7429	7434	7439	7444	7449	7454	7459	7464	7469	7474	7479	7484	7489	7494
29.80	7418	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488	7493	7498
29.75	7423	7428	7433	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503
29.70	7427	7432	7437	7442	7447	7452	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507
29.65	7431	7436	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506	7511
29.60	7436	7441	7446	7451	7456	7461	7466	7471	7476	7481	7486	7491	7496	7500	7505	7510	7515
29.55	7440	7445	7450	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520
29.50	7444	7449	7454	7459	7464	7469	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524
29.45	7449	7454	7459	7464	7469	7474	7479	7484	7488	7493	7498	7503	7508	7513	7518	7523	7528
29.40	7453	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7517	7522	7527	7532
29.35	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537
29.30	7462	7467	7472	7477	7482	7487	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541
29.25	7466	7471	7476	7481	7486	7491	7496	7501	7506	7511	7515	7520	7525	7530	7535	7540	7545
29.20	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7534	7539	7544	7549
29.15	7475	7480	7485	7490	7495	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7553
29.10	7479	7484	7489	7494	7499	7504	7509	7514	7518	7523	7528	7533	7538	7543	7548	7553	7558
29.05	7483	7488	7493	7498	7503	7508	7513	7518	7523	7528	7533	7537	7542	7547	7552	7557	7562
29.00	7488	7493	7498	7503	7507	7512	7517	7522	7527	7532	7537	7542	7547	7551	7556	7561	7566
28.95	7492	7497	7502	7507	7512	7517	7522	7526	7531	7536	7541	7546	7551	7556	7561	7565	7570
28.90	7497	7501	7506	7511	7516	7521	7526	7531	7536	7540	7545	7550	7555	7560	7565	7570	7575
28.85	7501	7506	7511	7516	7520	7525	7530	7535	7540	7545	7550	7554	7559	7564	7569	7574	7579
28.80	7505	7510	7515	7520	7525	7530	7534	7539	7544	7549	7554	7559	7564	7568	7573	7578	7583
28.75	7510	7514	7519	7524	7529	7534	7539	7544	7548	7553	7558	7563	7568	7573	7578	7582	7587
28.70	7514	7519	7524	7529	7533	7538	7543	7548	7553	7558	7562	7567	7572	7577	7582	7587	7591
28.65	7518	7523	7528	7533	7538	7543	7547	7552	7557	7562	7567	7572	7576	7581	7586	7591	7596
28.60	7523	7527	7532	7537	7542	7547	7552	7557	7561	7566	7571	7576	7581	7585	7590	7595	7600
28.55	7527	7532	7537	7542	7546	7551	7556	7561	7566	7570	7575	7580	7585	7590	7595	7599	7604
28.50	7531	7536	7541	7546	7551	7555	7560	7565	7570	7575	7580	7584	7589	7594	7599	7604	7608
28.45	7536	7541	7545	7550	7555	7560	7565	7569	7574	7579	7584	7589	7593	7598	7603	7608	7613
28.40	7540	7545	7550	7554	7559	7564	7569	7574	7578	7583	7588	7593	7598	7602	7607	7612	7617
28.35	7544	7549	7554	7559	7564	7568	7573	7578	7583	7588	7592	7597	7602	7607	7611	7616	7621
28.30	7549	7554	7558	7563	7568	7573	7578	7582	7587	7592	7597	7601	7606	7611	7616	7620	7625
28.25	7553	7558	7563	7567	7572	7577	7582	7587	7591	7596	7601	7606	7610	7615	7620	7625	7629
28.20	7557	7562	7567	7572	7577	7581	7586	7591	7596	7600	7605	7610	7615	7619	7624	7629	7634
28.15	7562	7567	7571	7576	7581	7586	7590	7595	7600	7605	7609	7614	7619	7624	7628	7633	7638
28.10	7566	7571	7576	7580	7585	7590	7595	7599	7604	7609	7614	7618	7623	7628	7633	7637	7642
28.05	7570	7575	7580	7585	7590	7594	7599	7604	7608	7613	7618	7623	7627	7632	7637	7642	7646
28.00	7575	7580	7584	7589	7594	7599	7603	7608	7613	7618	7622	7627	7632	7636	7641	7646	7651
27.95	7579	7584	7589	7593	7598	7603	7608	7612	7617	7622	7627	7631	7636	7641	7645	7650	7655
27.90	7584	7588	7593	7598	7602	7607	7612	7617	7621	7626	7631	7635	7640	7645	7650	7654	7659
27.85	7588	7593	7597	7602	7607	7612	7616	7621	7626	7630	7635	7640	7644	7649	7654	7659	7663
27.80	7592	7597	7602	7606	7611	7616	7621	7625	7630	7635	7639	7644	7649	7653	7658	7663	7668
27.75	7597	7601	7606	7611	7615	7620	7625	7630	7634	7639	7644	7648	7653	7658	7662	7667	7672
27.70	7601	7606	7610	7615	7620	7624	7629	7634	7638	7643	7648	7653	7657	7662	7667	7671	7676
27.65	7605	7610	7615	7619	7624	7629	7633	7638	7643	7647	7652	7657	7661	7666	7671	7675	7680
27.60	7610	7614	7619	7624	7628	7633	7638	7642	7647	7652	7656	7661	7666	7670	7675	7680	7684
27.55	7614	7619	7623	7628	7633	7637	7642	7647	7651	7656	7661	7665	7670	7675	7679	7684	7689
27.50	7618	7623	7628	7632	7637	7642	7646	7651	7656	7660	7665	7670	7674	7679	7684	7688	7693
27.45	7623	7627	7632	7637	7641	7646	7651	7655	7660	7665	7669	7674	7678	7683	7688	7692	7697
27.40	7627	7632	7636	7641	7646	7650	7655	7660	7664	7669	7673	7678	7683	7687	7692	7697	7701
27.35	7631	7636	7641	7645	7650	7655	7659	7664	7668	7673	7678	7682	7687	7692	7696	7701	7706
27.30	7636	7640	7645	7650	7654	7659	7664	7668	7673	7677	7682	7687	7691	7696	7701	7705	7710
27.25	7640	7645	7649	7654	7659	7663	7668	7672	7677	7682	7686	7691	7696	7700	7705	7709	7714
27.20	7644	7649	7654	7658	7663	7668	7672	7677	7681	7686	7691	7695	7700	7704	7709	7714	7718
27.15	7649	7653	7658	7663	7667	7672	7676	7681	7686	7690	7695	7699	7704	7709	7713	7718	7722
27.10	7653	7658	7662	7667	7672	7676	7681	7685	7690	7695	7699	7704	7708	7713	7717	7722	7727
27.05	7657	7662	7667	7671	7676	7680	7685	7690	7694	7699	7703	7708	7713	7717	7722	7726	7731
27.00	7662	7666	7671	7676	7680	7685	7689	7694	7698	7703	7708	7712	7717	7721	7726	7731	7735

Table 56 English—High Alt, Low Temp, Med Humidity
(Temp = 40 to 56° F, Press = 23 to 27 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0
27.00	7413	7418	7423	7429	7434	7439	7444	7449	7454	7460	7465	7470	7475	7480	7485	7490	7495
26.95	7418	7423	7428	7433	7439	7444	7449	7454	7459	7464	7469	7474	7480	7485	7490	7495	7500
26.90	7423	7428	7433	7438	7443	7449	7454	7459	7464	7469	7474	7479	7484	7489	7494	7499	7504
26.85	7427	7433	7438	7443	7448	7453	7458	7464	7469	7474	7479	7484	7489	7494	7499	7504	7509
26.80	7432	7437	7443	7448	7453	7458	7463	7468	7473	7478	7483	7489	7494	7499	7504	7509	7513
26.75	7437	7442	7447	7452	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7518
26.70	7442	7447	7452	7457	7462	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7518	7523
26.65	7446	7452	7457	7462	7467	7472	7477	7482	7488	7493	7498	7503	7508	7513	7518	7522	7527
26.60	7451	7456	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532
26.55	7456	7461	7466	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537
26.50	7461	7466	7471	7476	7481	7486	7492	7497	7502	7507	7512	7517	7522	7527	7532	7536	7541
26.45	7466	7471	7476	7481	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541	7546
26.40	7470	7476	7481	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541	7546	7551
26.35	7475	7480	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541	7546	7550	7555
26.30	7480	7485	7490	7495	7500	7505	7511	7516	7521	7526	7530	7535	7540	7545	7550	7555	7560
26.25	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545	7550	7555	7560	7565
26.20	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545	7550	7555	7560	7564	7569
26.15	7494	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545	7550	7554	7559	7564	7569	7574
26.10	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7554	7559	7564	7569	7574	7579
26.05	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7554	7559	7564	7569	7574	7578	7583
26.00	7509	7514	7519	7524	7529	7534	7539	7544	7549	7554	7559	7564	7568	7573	7578	7583	7588
25.95	7514	7519	7524	7529	7534	7539	7544	7549	7554	7558	7563	7568	7573	7578	7583	7588	7592
25.90	7518	7523	7528	7534	7538	7543	7548	7553	7558	7563	7568	7573	7578	7583	7588	7592	7597
25.85	7523	7528	7533	7538	7543	7548	7553	7558	7563	7568	7573	7578	7583	7587	7592	7597	7602
25.80	7528	7533	7538	7543	7548	7553	7558	7563	7568	7573	7577	7582	7587	7592	7597	7602	7606
25.75	7533	7538	7543	7548	7553	7558	7563	7568	7572	7577	7582	7587	7592	7597	7602	7606	7611
25.70	7538	7543	7548	7553	7558	7562	7567	7572	7577	7582	7587	7592	7597	7601	7606	7611	7616
25.65	7542	7547	7552	7557	7562	7567	7572	7577	7582	7587	7592	7596	7601	7606	7611	7616	7620
25.60	7547	7552	7557	7562	7567	7572	7577	7582	7587	7591	7596	7601	7606	7611	7615	7620	7625
25.55	7552	7557	7562	7567	7572	7577	7582	7586	7591	7596	7601	7606	7611	7615	7620	7625	7630
25.50	7557	7562	7567	7572	7577	7581	7586	7591	7596	7601	7606	7611	7615	7620	7625	7630	7634
25.45	7562	7567	7571	7576	7581	7586	7591	7596	7601	7606	7610	7615	7620	7625	7629	7634	7639
25.40	7566	7571	7576	7581	7586	7591	7596	7601	7605	7610	7615	7620	7625	7629	7634	7639	7644
25.35	7571	7576	7581	7586	7591	7596	7601	7605	7610	7615	7620	7625	7629	7634	7639	7644	7648
25.30	7576	7581	7586	7591	7596	7600	7605	7610	7615	7620	7625	7629	7634	7639	7643	7648	7653
25.25	7581	7586	7591	7595	7600	7605	7610	7615	7620	7624	7629	7634	7639	7643	7648	7653	7658
25.20	7586	7590	7595	7600	7605	7610	7615	7620	7624	7629	7634	7639	7643	7648	7653	7657	7662
25.15	7590	7595	7600	7605	7610	7615	7620	7624	7629	7634	7639	7643	7648	7653	7657	7662	7667
25.10	7595	7600	7605	7610	7615	7619	7624	7629	7634	7639	7643	7648	7653	7657	7662	7667	7671
25.05	7600	7605	7610	7615	7619	7624	7629	7634	7639	7643	7648	7653	7657	7662	7667	7671	7676
25.00	7605	7610	7614	7619	7624	7629	7634	7638	7643	7648	7653	7657	7662	7667	7671	7676	7681
24.95	7610	7614	7619	7624	7629	7634	7638	7643	7648	7653	7657	7662	7667	7671	7676	7681	7685
24.90	7614	7619	7624	7629	7634	7638	7643	7648	7653	7657	7662	7667	7671	7676	7681	7685	7690
24.85	7619	7624	7629	7634	7638	7643	7648	7653	7657	7662	7667	7671	7676	7681	7685	7690	7695
24.80	7624	7629	7634	7638	7643	7648	7653	7657	7662	7667	7672	7676	7681	7685	7690	7695	7699
24.75	7629	7634	7638	7643	7648	7653	7657	7662	7667	7672	7676	7681	7686	7690	7695	7699	7704
24.70	7634	7638	7643	7648	7653	7657	7662	7667	7672	7676	7681	7686	7690	7695	7699	7704	7709
24.65	7638	7643	7648	7653	7657	7662	7667	7672	7676	7681	7686	7690	7695	7700	7704	7709	7713
24.60	7643	7648	7653	7657	7662	7667	7672	7676	7681	7686	7690	7695	7700	7704	7709	7713	7718
24.55	7648	7653	7657	7662	7667	7672	7676	7681	7686	7690	7695	7700	7704	7709	7713	7718	7723
24.50	7653	7657	7662	7667	7672	7676	7681	7686	7690	7695	7700	7704	7709	7714	7718	7723	7727
24.45	7657	7662	7667	7672	7676	7681	7686	7691	7695	7700	7704	7709	7714	7718	7723	7727	7732
24.40	7662	7667	7672	7677	7681	7686	7691	7695	7700	7705	7709	7714	7718	7723	7727	7732	7736
24.35	7667	7672	7677	7681	7686	7691	7695	7700	7705	7709	7714	7718	7723	7728	7732	7737	7741
24.30	7672	7677	7681	7686	7691	7695	7700	7705	7709	7714	7719	7723	7728	7732	7737	7741	7746
24.25	7677	7681	7686	7691	7695	7700	7705	7709	7714	7719	7723	7728	7732	7737	7741	7746	7750
24.20	7681	7686	7691	7696	7700	7705	7710	7714	7719	7723	7728	7732	7737	7742	7746	7751	7755
24.15	7686	7691	7696	7700	7705	7710	7714	7719	7723	7728	7733	7737	7742	7746	7751	7755	7760
24.10	7691	7696	7700	7705	7710	7714	7719	7724	7728	7733	7737	7742	7746	7751	7755	7760	7764
24.05	7696	7701	7705	7710	7715	7719	7724	7728	7733	7737	7742	7747	7751	7756	7760	7765	7769
24.00	7701	7705	7710	7715	7719	7724	7728	7733	7738	7742	7747	7751	7756	7760	7765	7769	7774
23.95	7705	7710	7715	7719	7724	7729	7733	7738	7742	7747	7751	7756	7760	7765	7769	7774	7778
23.90	7710	7715	7720	7724	7729	7733	7738	7743	7747	7752	7756	7761	7765	7770	7774	7779	7783
23.85	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770	7774	7779	7783	7788
23.80	7720	7724	7729	7734	7738	7743	7747	7752	7757	7761	7766	7770	7774	7779	7783	7788	7792
23.75	7725	7729	7734	7738	7743	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7792	7797
23.70	7729	7734	7739	7743	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802
23.65	7734	7739	7743	7748	7753	7757	7762	7766	7771	7775	7780	7784	7789	7793	7797	7802	7806
23.60	7739	7744	7748	7753	7757	7762	7766	7771	7775	7780	7784	7789	7793	7798	7802	7806	7811
23.55	7744	7748	7753	7758	7762	7767	7771	7776	7780	7785	7789	7793	7798	7802	7807	7811	7815
23.50	7749	7753	7758	7762	7767	7771	7776	7780	7785	7789	7794	7798	7803	7807	7811	7816	7820
23.45	7753	7758	7763	7767	7772	7776	7781	7785	7790	7794	7798	7803	7807	7812	7816	7820	7825
23.40	7758	7763	7767	7772	7776	7781	7785	7790	7794	7799	7803	7808	7812	7816	7821	7825	7829
23.35	7763	7768	7772	7777	7781	7786	7790	7795	7799	7803	7808	7812	7817	7821	7825	7830	7834
23.30	7768	7772	7777	7781	7786	7790	7795	7799	7804	7808	7813	7817	7821	7826	7830	7834	7839
23.25	7773	7777	7782	7786	7791	7795	7800	7804	7808	7813	7817	7822	7826	7830	7835	7839	7843
23.20	7777	7782	7786	7791	7795	7800	7804	7809	7813	7818	7822	7826	7831	7835	7839	7844	7848
23.15	7782	7787	7791	7796	7800	7805	7809	7813	7818	7822	7827	7831	7835	7840	7844	7848	7853
23.10	7787	7791	7796	7800	7805	7809	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857
23.05	7792	7796	7801	7805	7810	7814	7819	7823	7827	7832	7836	7840	7845	7849	7853	7858	7862
23.00	7797	7801	7806	7810	7814	7819	7823	7828	7832	7836	7841	7845	7849	7854	7858	7862	7867

Table 57 English—High Alt, Low-Mid Temp, Med Humidity
(Temp = 57 to 73° F, Press = 23 to 27 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.0	68.0	69.0	70.0	71.0	72.0	73.0
27.00	7500	7505	7510	7515	7520	7525	7529	7534	7539	7544	7549	7554	7559	7563	7568	7573	7578
26.95	7505	7509	7514	7519	7524	7529	7534	7539	7544	7549	7553	7558	7563	7568	7573	7577	7582
26.90	7509	7514	7519	7524	7529	7534	7539	7544	7548	7553	7558	7563	7568	7572	7577	7582	7587
26.85	7514	7519	7524	7529	7533	7538	7543	7548	7553	7558	7563	7567	7572	7577	7582	7586	7591
26.80	7518	7523	7528	7533	7538	7543	7548	7553	7557	7562	7567	7572	7577	7581	7586	7591	7596
26.75	7523	7528	7533	7538	7543	7548	7552	7557	7562	7567	7572	7576	7581	7586	7591	7595	7600
26.70	7528	7533	7538	7542	7547	7552	7557	7562	7567	7571	7576	7581	7586	7590	7595	7600	7605
26.65	7532	7537	7542	7547	7552	7557	7562	7566	7571	7576	7581	7586	7590	7595	7600	7604	7609
26.60	7537	7542	7547	7552	7556	7561	7566	7571	7576	7581	7585	7590	7595	7600	7604	7609	7614
26.55	7542	7547	7551	7556	7561	7566	7571	7576	7580	7585	7590	7595	7599	7604	7609	7613	7618
26.50	7546	7551	7556	7561	7566	7571	7575	7580	7585	7590	7594	7599	7604	7609	7613	7618	7623
26.45	7551	7556	7561	7565	7570	7575	7580	7585	7589	7594	7599	7604	7608	7613	7618	7622	7627
26.40	7556	7560	7565	7570	7575	7580	7584	7589	7594	7599	7603	7608	7613	7618	7622	7627	7632
26.35	7560	7565	7570	7575	7579	7584	7589	7594	7599	7603	7608	7613	7617	7622	7627	7631	7636
26.30	7565	7570	7574	7579	7584	7589	7594	7598	7603	7608	7613	7617	7622	7627	7631	7636	7641
26.25	7569	7574	7579	7584	7589	7593	7598	7603	7608	7612	7617	7622	7627	7631	7636	7640	7645
26.20	7574	7579	7584	7589	7593	7598	7603	7608	7612	7617	7622	7626	7631	7636	7640	7645	7650
26.15	7579	7584	7588	7593	7598	7603	7607	7612	7617	7622	7626	7631	7636	7640	7645	7650	7654
26.10	7583	7588	7593	7598	7602	7607	7612	7617	7621	7626	7631	7635	7640	7645	7649	7654	7659
26.05	7588	7593	7598	7602	7607	7612	7617	7621	7626	7631	7635	7640	7645	7649	7654	7659	7663
26.00	7593	7597	7602	7607	7612	7616	7621	7626	7631	7635	7640	7645	7649	7654	7658	7663	7668
25.95	7597	7602	7607	7612	7616	7621	7626	7630	7635	7640	7644	7649	7654	7658	7663	7668	7672
25.90	7602	7607	7611	7616	7621	7626	7630	7635	7640	7644	7649	7654	7658	7663	7667	7672	7677
25.85	7607	7611	7616	7621	7625	7630	7635	7640	7644	7649	7654	7658	7663	7667	7672	7677	7681
25.80	7611	7616	7621	7625	7630	7635	7639	7644	7649	7653	7658	7663	7667	7672	7676	7681	7686
25.75	7616	7621	7625	7630	7635	7639	7644	7649	7653	7658	7663	7667	7672	7676	7681	7686	7690
25.70	7620	7625	7630	7635	7639	7644	7649	7653	7658	7663	7667	7672	7676	7681	7685	7690	7695
25.65	7625	7630	7635	7639	7644	7649	7653	7658	7662	7667	7672	7676	7681	7685	7690	7695	7699
25.60	7630	7634	7639	7644	7649	7653	7658	7662	7667	7672	7676	7681	7685	7690	7695	7699	7704
25.55	7634	7639	7644	7648	7653	7658	7662	7667	7672	7676	7681	7685	7690	7695	7699	7704	7708
25.50	7639	7644	7648	7653	7658	7662	7667	7672	7676	7681	7685	7690	7694	7699	7704	7708	7713
25.45	7644	7648	7653	7658	7662	7667	7672	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717
25.40	7648	7653	7658	7662	7667	7672	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717	7722
25.35	7653	7658	7662	7667	7672	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726
25.30	7658	7662	7667	7671	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726	7731
25.25	7662	7667	7671	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726	7731	7735
25.20	7667	7671	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740
25.15	7671	7676	7681	7685	7690	7694	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744
25.10	7676	7681	7685	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749
25.05	7681	7685	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753
25.00	7685	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753	7758
24.95	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753	7758	7762
24.90	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753	7758	7762	7767
24.85	7699	7704	7708	7713	7718	7722	7727	7731	7736	7740	7744	7749	7753	7758	7762	7767	7771
24.80	7704	7708	7713	7718	7722	7727	7731	7736	7740	7745	7749	7753	7758	7762	7767	7771	7776
24.75	7709	7713	7718	7722	7727	7731	7736	7740	7745	7749	7754	7758	7762	7767	7771	7776	7780
24.70	7713	7718	7722	7727	7731	7736	7740	7745	7749	7754	7758	7763	7767	7771	7776	7780	7785
24.65	7718	7722	7727	7731	7736	7740	7745	7749	7754	7758	7763	7767	7772	7776	7780	7785	7789
24.60	7722	7727	7732	7736	7741	7745	7749	7754	7758	7763	7767	7772	7776	7780	7785	7789	7794
24.55	7727	7732	7736	7741	7745	7750	7754	7759	7763	7767	7772	7776	7781	7785	7789	7794	7798
24.50	7732	7736	7741	7745	7750	7754	7759	7763	7768	7772	7776	7781	7785	7789	7794	7798	7803
24.45	7736	7741	7745	7750	7754	7759	7763	7768	7772	7776	7781	7785	7790	7794	7798	7803	7807
24.40	7741	7746	7750	7754	7759	7763	7768	7772	7777	7781	7785	7790	7794	7799	7803	7807	7812
24.35	7746	7750	7755	7759	7764	7768	7772	7777	7781	7786	7790	7794	7799	7803	7807	7812	7816
24.30	7750	7755	7759	7764	7768	7773	7777	7781	7786	7790	7795	7799	7803	7808	7812	7816	7821
24.25	7755	7759	7764	7768	7773	7777	7782	7786	7790	7795	7799	7803	7808	7812	7816	7821	7825
24.20	7760	7764	7768	7773	7777	7782	7786	7791	7795	7799	7804	7808	7812	7817	7821	7825	7829
24.15	7764	7769	7773	7778	7782	7786	7791	7795	7799	7804	7808	7812	7817	7821	7825	7830	7834
24.10	7769	7773	7778	7782	7787	7791	7795	7800	7804	7808	7813	7817	7821	7826	7830	7834	7838
24.05	7773	7778	7782	7787	7791	7796	7800	7804	7809	7813	7817	7822	7826	7830	7834	7839	7843
24.00	7778	7783	7787	7791	7796	7800	7804	7809	7813	7817	7822	7826	7830	7835	7839	7843	7847
23.95	7783	7787	7792	7796	7800	7805	7809	7813	7818	7822	7826	7831	7835	7839	7843	7848	7852
23.90	7787	7792	7796	7801	7805	7809	7814	7818	7822	7827	7831	7835	7839	7844	7848	7852	7856
23.85	7792	7796	7801	7805	7810	7814	7818	7823	7827	7831	7835	7840	7844	7848	7853	7857	7861
23.80	7797	7801	7805	7810	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7861	7865
23.75	7801	7806	7810	7814	7819	7823	7827	7832	7836	7840	7845	7849	7853	7857	7862	7866	7870
23.70	7806	7810	7815	7819	7823	7828	7832	7836	7841	7845	7849	7853	7858	7862	7866	7870	7874
23.65	7811	7815	7819	7824	7828	7832	7837	7841	7845	7849	7854	7858	7862	7866	7871	7875	7879
23.60	7815	7820	7824	7828	7833	7837	7841	7845	7850	7854	7858	7862	7867	7871	7875	7879	7883
23.55	7820	7824	7829	7833	7837	7841	7846	7850	7854	7859	7863	7867	7871	7875	7880	7884	7888
23.50	7824	7829	7833	7837	7842	7846	7850	7855	7859	7863	7867	7872	7876	7880	7884	7888	7892
23.45	7829	7833	7838	7842	7846	7851	7855	7859	7863	7868	7872	7876	7880	7884	7889	7893	7897
23.40	7834	7838	7842	7847	7851	7855	7859	7864	7868	7872	7876	7881	7885	7889	7893	7897	7901
23.35	7838	7843	7847	7851	7856	7860	7864	7868	7873	7877	7881	7885	7889	7893	7898	7902	7906
23.30	7843	7847	7852	7856	7860	7864	7869	7873	7877	7881	7885	7890	7894	7898	7902	7906	7910
23.25	7848	7852	7856	7860	7865	7869	7873	7877	7882	7886	7890	7894	7898	7903	7907	7911	7915
23.20	7852	7857	7861	7865	7869	7874	7878	7882	7886	7890	7895	7899	7903	7907	7911	7915	7919
23.15	7857	7861	7865	7870	7874	7878	7882	7887	7891	7895	7899	7903	7907	7912	7916	7920	7924
23.10	7862	7866	7870	7874	7879	7883	7887	7891	7895	7900	7904	7908	7912	7916	7920	7924	7928
23.05	7866	7870	7875	7879	7883	7887	7892	7896	7900	7904	7908	7912	7916	7921	7925	7929	7933
23.00	7871	7875	7879	7884	7888	7892	7896	7900	7904	7909	7913	7917	7921	7925	7929	7933	7937

Table 58 English—High Alt, Mid Temp, Med Humidity
(Temp = 74 to 90° F, Press = 23 to 27 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0
27.00	7582	7587	7592	7597	7601	7606	7611	7615	7620	7625	7629	7634	7639	7643	7648	7653	7657
26.95	7587	7592	7596	7601	7606	7610	7615	7620	7625	7629	7634	7638	7643	7648	7652	7657	7662
26.90	7591	7596	7601	7606	7610	7615	7620	7624	7629	7634	7638	7643	7647	7652	7657	7661	7666
26.85	7596	7601	7605	7610	7615	7619	7624	7629	7633	7638	7643	7647	7652	7656	7661	7666	7670
26.80	7600	7605	7610	7614	7619	7624	7628	7633	7638	7642	7647	7652	7656	7661	7665	7670	7675
26.75	7605	7610	7614	7619	7624	7628	7633	7638	7642	7647	7651	7656	7661	7665	7670	7674	7679
26.70	7609	7614	7619	7623	7628	7633	7637	7642	7647	7651	7656	7660	7665	7670	7674	7679	7683
26.65	7614	7619	7623	7628	7633	7637	7642	7646	7651	7656	7660	7665	7669	7674	7679	7683	7688
26.60	7618	7623	7628	7632	7637	7642	7646	7651	7655	7660	7665	7669	7674	7678	7683	7687	7692
26.55	7623	7627	7632	7637	7641	7646	7651	7655	7660	7664	7669	7674	7678	7683	7687	7692	7696
26.50	7627	7632	7637	7641	7646	7651	7655	7660	7664	7669	7673	7678	7683	7687	7692	7696	7701
26.45	7632	7636	7641	7646	7650	7655	7660	7664	7669	7673	7678	7682	7687	7692	7696	7701	7705
26.40	7636	7641	7646	7650	7655	7659	7664	7669	7673	7678	7682	7687	7691	7696	7700	7705	7709
26.35	7641	7645	7650	7655	7659	7664	7668	7673	7678	7682	7687	7691	7696	7700	7705	7709	7714
26.30	7645	7650	7655	7659	7664	7668	7673	7677	7682	7687	7691	7696	7700	7705	7709	7714	7718
26.25	7650	7654	7659	7664	7668	7673	7677	7682	7686	7691	7695	7700	7705	7709	7714	7718	7723
26.20	7654	7659	7663	7668	7673	7677	7682	7686	7691	7695	7700	7704	7709	7713	7718	7722	7727
26.15	7659	7663	7668	7673	7677	7682	7686	7691	7695	7700	7704	7709	7713	7718	7722	7727	7731
26.10	7663	7668	7672	7677	7682	7686	7691	7695	7700	7704	7709	7713	7718	7722	7727	7731	7736
26.05	7668	7672	7677	7681	7686	7691	7695	7700	7704	7709	7713	7718	7722	7727	7731	7736	7740
26.00	7672	7677	7681	7686	7690	7695	7699	7704	7709	7713	7718	7722	7726	7731	7735	7740	7744
25.95	7677	7681	7686	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749
25.90	7681	7686	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753
25.85	7686	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7749	7753	7757
25.80	7690	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7748	7753	7757	7762
25.75	7695	7699	7704	7708	7713	7717	7722	7726	7731	7735	7740	7744	7748	7753	7757	7762	7766
25.70	7699	7704	7708	7713	7717	7722	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770
25.65	7704	7708	7713	7717	7722	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775
25.60	7708	7713	7717	7722	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779
25.55	7713	7717	7722	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784
25.50	7717	7722	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788
25.45	7722	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788	7792
25.40	7726	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788	7792	7797
25.35	7731	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788	7792	7797	7801
25.30	7735	7739	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788	7792	7797	7801	7805
25.25	7740	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788	7792	7797	7801	7805	7810
25.20	7744	7748	7753	7757	7762	7766	7770	7775	7779	7784	7788	7792	7797	7801	7805	7810	7814
25.15	7749	7753	7757	7762	7766	7771	7775	7779	7784	7788	7792	7797	7801	7805	7810	7814	7818
25.10	7753	7757	7762	7766	7771	7775	7779	7784	7788	7792	7797	7801	7805	7810	7814	7818	7823
25.05	7757	7762	7766	7771	7775	7779	7784	7788	7793	7797	7801	7806	7810	7814	7818	7823	7827
25.00	7762	7766	7771	7775	7780	7784	7788	7793	7797	7801	7806	7810	7814	7819	7823	7827	7831
24.95	7766	7771	7775	7780	7784	7788	7793	7797	7801	7806	7810	7814	7819	7823	7827	7832	7836
24.90	7771	7775	7780	7784	7788	7793	7797	7801	7806	7810	7814	7819	7823	7827	7832	7836	7840
24.85	7775	7780	7784	7789	7793	7797	7802	7806	7810	7815	7819	7823	7827	7832	7836	7840	7845
24.80	7780	7784	7789	7793	7797	7802	7806	7810	7815	7819	7823	7828	7832	7836	7840	7845	7849
24.75	7784	7789	7793	7797	7802	7806	7810	7815	7819	7823	7828	7832	7836	7840	7845	7849	7853
24.70	7789	7793	7798	7802	7806	7811	7815	7819	7823	7828	7832	7836	7841	7845	7849	7853	7858
24.65	7793	7798	7802	7806	7811	7815	7819	7824	7828	7832	7836	7841	7845	7849	7853	7858	7862
24.60	7798	7802	7807	7811	7815	7819	7824	7828	7832	7837	7841	7845	7849	7854	7858	7862	7866
24.55	7802	7807	7811	7815	7820	7824	7828	7832	7837	7841	7845	7850	7854	7858	7862	7866	7871
24.50	7807	7811	7815	7820	7824	7828	7833	7837	7841	7845	7850	7854	7858	7862	7867	7871	7875
24.45	7811	7816	7820	7824	7829	7833	7837	7841	7846	7850	7854	7858	7863	7867	7871	7875	7879
24.40	7816	7820	7824	7829	7833	7837	7842	7846	7850	7854	7858	7863	7867	7871	7875	7880	7884
24.35	7820	7825	7829	7833	7837	7842	7846	7850	7854	7859	7863	7867	7871	7876	7880	7884	7888
24.30	7825	7829	7833	7838	7842	7846	7850	7855	7859	7863	7867	7871	7876	7880	7884	7888	7892
24.25	7829	7834	7838	7842	7846	7851	7855	7859	7863	7867	7872	7876	7880	7884	7888	7893	7897
24.20	7834	7838	7842	7847	7851	7855	7859	7863	7868	7872	7876	7880	7884	7889	7893	7897	7901
24.15	7838	7843	7847	7851	7855	7859	7864	7868	7872	7876	7880	7885	7889	7893	7897	7901	7906
24.10	7843	7847	7851	7855	7860	7864	7868	7872	7877	7881	7885	7889	7893	7897	7902	7906	7910
24.05	7847	7851	7856	7860	7864	7868	7873	7877	7881	7885	7889	7893	7898	7902	7906	7910	7914
24.00	7852	7856	7860	7864	7869	7873	7877	7881	7885	7890	7894	7898	7902	7906	7910	7914	7919
23.95	7856	7860	7865	7869	7873	7877	7881	7886	7890	7894	7898	7902	7906	7911	7915	7919	7923
23.90	7861	7865	7869	7873	7878	7882	7886	7890	7894	7898	7903	7907	7911	7915	7919	7923	7927
23.85	7865	7869	7874	7878	7882	7886	7890	7894	7899	7903	7907	7911	7915	7919	7923	7928	7932
23.80	7870	7874	7878	7882	7886	7891	7895	7899	7903	7907	7911	7915	7920	7924	7928	7932	7936
23.75	7874	7878	7883	7887	7891	7895	7899	7903	7907	7912	7916	7920	7924	7928	7932	7936	7940
23.70	7879	7883	7887	7891	7895	7899	7904	7908	7912	7916	7920	7924	7928	7932	7937	7941	7945
23.65	7883	7887	7891	7896	7900	7904	7908	7912	7916	7920	7925	7929	7933	7937	7941	7945	7949
23.60	7888	7892	7896	7900	7904	7908	7913	7917	7921	7925	7929	7933	7937	7941	7945	7949	7953
23.55	7892	7896	7900	7905	7909	7913	7917	7921	7925	7929	7933	7937	7942	7946	7950	7954	7958
23.50	7897	7901	7905	7909	7913	7917	7921	7925	7930	7934	7938	7942	7946	7950	7954	7958	7962
23.45	7901	7905	7909	7913	7918	7922	7926	7930	7934	7938	7942	7946	7950	7954	7958	7962	7967
23.40	7906	7910	7914	7918	7922	7926	7930	7934	7938	7943	7947	7951	7955	7959	7963	7967	7971
23.35	7910	7914	7918	7922	7927	7931	7935	7939	7943	7947	7951	7955	7959	7963	7967	7971	7975
23.30	7915	7919	7923	7927	7931	7935	7939	7943	7947	7951	7955	7959	7963	7968	7972	7976	7980
23.25	7919	7923	7927	7931	7935	7940	7944	7948	7952	7956	7960	7964	7968	7972	7976	7980	7984
23.20	7924	7928	7932	7936	7940	7944	7948	7952	7956	7960	7964	7968	7972	7976	7980	7984	7988
23.15	7928	7932	7936	7940	7944	7948	7952	7956	7961	7965	7969	7973	7977	7981	7985	7989	7993
23.10	7933	7937	7941	7945	7949	7953	7957	7961	7965	7969	7973	7977	7981	7985	7989	7993	7997
23.05	7937	7941	7945	7949	7953	7957	7961	7965	7969	7973	7977	7981	7985	7989	7993	7997	8001
23.00	7941	7946	7950	7954	7958	7962	7966	7970	7974	7978	7982	7986	7990	7994	7998	8002	8006

Table 59 English—High Alt, High-Mid Temp, Med Humidity
(Temp = 91 to 107° F, Press = 23 to 27 inches, 50% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	91.0	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0
27.00	7662	7666	7671	7676	7680	7685	7689	7694	7698	7703	7708	7712	7717	7721	7726	7731	7735
26.95	7666	7671	7675	7680	7684	7689	7694	7698	7703	7707	7712	7716	7721	7726	7730	7735	7739
26.90	7670	7675	7680	7684	7689	7693	7698	7703	7707	7712	7716	7721	7725	7730	7734	7739	7744
26.85	7675	7679	7684	7689	7693	7698	7702	7707	7711	7716	7720	7725	7730	7734	7739	7743	7748
26.80	7679	7684	7688	7693	7697	7702	7707	7711	7716	7720	7725	7729	7734	7738	7743	7747	7752
26.75	7684	7688	7693	7697	7702	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756
26.70	7688	7692	7697	7702	7706	7711	7715	7720	7724	7729	7733	7738	7742	7747	7751	7756	7760
26.65	7692	7697	7701	7706	7710	7715	7719	7724	7728	7733	7738	7742	7747	7751	7756	7760	7765
26.60	7697	7701	7706	7710	7715	7719	7724	7728	7733	7737	7742	7746	7751	7755	7760	7764	7769
26.55	7701	7705	7710	7715	7719	7724	7728	7733	7737	7742	7746	7751	7755	7760	7764	7769	7773
26.50	7705	7710	7714	7719	7723	7728	7732	7737	7741	7746	7750	7755	7759	7764	7768	7773	7777
26.45	7710	7714	7719	7723	7728	7732	7737	7741	7746	7750	7755	7759	7764	7768	7773	7777	7782
26.40	7714	7718	7723	7727	7732	7736	7741	7745	7750	7754	7759	7763	7768	7772	7777	7781	7786
26.35	7718	7723	7727	7732	7736	7741	7745	7750	7754	7759	7763	7768	7772	7777	7781	7786	7790
26.30	7723	7727	7732	7736	7741	7745	7750	7754	7759	7763	7767	7772	7776	7781	7785	7790	7794
26.25	7727	7732	7736	7740	7745	7749	7754	7758	7763	7767	7772	7776	7781	7785	7790	7794	7798
26.20	7731	7736	7740	7745	7749	7754	7758	7763	7767	7772	7776	7780	7785	7789	7794	7798	7803
26.15	7736	7740	7745	7749	7754	7758	7762	7767	7771	7776	7780	7785	7789	7794	7798	7802	7807
26.10	7740	7745	7749	7753	7758	7762	7767	7771	7776	7780	7785	7789	7793	7798	7802	7807	7811
26.05	7744	7749	7753	7758	7762	7767	7771	7776	7780	7784	7789	7793	7798	7802	7807	7811	7815
26.00	7749	7753	7758	7762	7767	7771	7775	7780	7784	7789	7793	7797	7802	7806	7811	7815	7820
25.95	7753	7758	7762	7766	7771	7775	7780	7784	7789	7793	7797	7802	7806	7811	7815	7819	7824
25.90	7757	7762	7766	7771	7775	7780	7784	7788	7793	7797	7802	7806	7810	7815	7819	7824	7828
25.85	7762	7766	7771	7775	7779	7784	7788	7793	7797	7801	7806	7810	7815	7819	7823	7828	7832
25.80	7766	7771	7775	7779	7784	7788	7793	7797	7801	7806	7810	7815	7819	7823	7828	7832	7837
25.75	7771	7775	7779	7784	7788	7792	7797	7801	7806	7810	7814	7819	7823	7828	7832	7836	7841
25.70	7775	7779	7784	7788	7792	7797	7801	7806	7810	7814	7819	7823	7827	7832	7836	7841	7845
25.65	7779	7784	7788	7792	7797	7801	7805	7810	7814	7819	7823	7827	7832	7836	7840	7845	7849
25.60	7784	7788	7792	7797	7801	7805	7810	7814	7819	7823	7827	7832	7836	7840	7845	7849	7853
25.55	7788	7792	7797	7801	7805	7810	7814	7818	7823	7827	7831	7836	7840	7845	7849	7853	7858
25.50	7792	7797	7801	7805	7810	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7862
25.45	7797	7801	7805	7810	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7862	7866
25.40	7801	7805	7810	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7862	7866	7870
25.35	7805	7810	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7862	7866	7870	7875
25.30	7810	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7861	7866	7870	7874	7879
25.25	7814	7818	7823	7827	7831	7836	7840	7844	7849	7853	7857	7861	7866	7870	7874	7879	7883
25.20	7818	7823	7827	7831	7836	7840	7844	7848	7853	7857	7861	7866	7870	7874	7879	7883	7887
25.15	7823	7827	7831	7836	7840	7844	7848	7853	7857	7861	7866	7870	7874	7879	7883	7887	7891
25.10	7827	7831	7836	7840	7844	7849	7853	7857	7861	7866	7870	7874	7878	7883	7887	7891	7896
25.05	7831	7836	7840	7844	7849	7853	7857	7861	7866	7870	7874	7878	7883	7887	7891	7896	7900
25.00	7836	7840	7844	7849	7853	7857	7861	7866	7870	7874	7878	7883	7887	7891	7896	7900	7904
24.95	7840	7844	7849	7853	7857	7861	7866	7870	7874	7878	7883	7887	7891	7896	7900	7904	7908
24.90	7844	7849	7853	7857	7861	7866	7870	7874	7879	7883	7887	7891	7896	7900	7904	7908	7913
24.85	7849	7853	7857	7862	7866	7870	7874	7879	7883	7887	7891	7896	7900	7904	7908	7913	7917
24.80	7853	7857	7862	7866	7870	7874	7879	7883	7887	7891	7896	7900	7904	7908	7913	7917	7921
24.75	7857	7862	7866	7870	7874	7879	7883	7887	7891	7896	7900	7904	7908	7913	7917	7921	7925
24.70	7862	7866	7870	7875	7879	7883	7887	7891	7896	7900	7904	7908	7913	7917	7921	7925	7929
24.65	7866	7870	7875	7879	7883	7887	7892	7896	7900	7904	7908	7913	7917	7921	7925	7929	7934
24.60	7871	7875	7879	7883	7887	7892	7896	7900	7904	7908	7913	7917	7921	7925	7929	7934	7938
24.55	7875	7879	7883	7888	7892	7896	7900	7904	7909	7913	7917	7921	7925	7930	7934	7938	7942
24.50	7879	7883	7888	7892	7896	7900	7904	7909	7913	7917	7921	7925	7930	7934	7938	7942	7946
24.45	7884	7888	7892	7896	7900	7905	7909	7913	7917	7921	7925	7930	7934	7938	7942	7946	7951
24.40	7888	7892	7896	7900	7905	7909	7913	7917	7921	7926	7930	7934	7938	7942	7946	7951	7955
24.35	7892	7896	7901	7905	7909	7913	7917	7921	7926	7930	7934	7938	7942	7946	7951	7955	7959
24.30	7897	7901	7905	7909	7913	7917	7922	7926	7930	7934	7938	7942	7947	7951	7955	7959	7963
24.25	7901	7905	7909	7913	7918	7922	7926	7930	7934	7938	7943	7947	7951	7955	7959	7963	7967
24.20	7905	7909	7914	7918	7922	7926	7930	7934	7939	7943	7947	7951	7955	7959	7963	7968	7972
24.15	7910	7914	7918	7922	7926	7930	7935	7939	7943	7947	7951	7955	7959	7963	7968	7972	7976
24.10	7914	7918	7922	7926	7931	7935	7939	7943	7947	7951	7955	7959	7964	7968	7972	7976	7980
24.05	7918	7922	7927	7931	7935	7939	7943	7947	7951	7955	7960	7964	7968	7972	7976	7980	7984
24.00	7923	7927	7931	7935	7939	7943	7947	7952	7956	7960	7964	7968	7972	7976	7980	7984	7989
23.95	7927	7931	7935	7939	7944	7948	7952	7956	7960	7964	7968	7972	7976	7980	7985	7989	7993
23.90	7931	7936	7940	7944	7948	7952	7956	7960	7964	7968	7972	7977	7981	7985	7989	7993	7997
23.85	7936	7940	7944	7948	7952	7956	7960	7964	7969	7973	7977	7981	7985	7989	7993	7997	8001
23.80	7940	7944	7948	7952	7956	7961	7965	7969	7973	7977	7981	7985	7989	7993	7997	8001	8006
23.75	7944	7949	7953	7957	7961	7965	7969	7973	7977	7981	7985	7989	7993	7997	8002	8006	8010
23.70	7949	7953	7957	7961	7965	7969	7973	7977	7981	7985	7990	7994	7998	8002	8006	8010	8014
23.65	7953	7957	7961	7965	7969	7973	7978	7982	7986	7990	7994	7998	8002	8006	8010	8014	8018
23.60	7958	7962	7966	7970	7974	7978	7982	7986	7990	7994	7998	8002	8006	8010	8014	8018	8022
23.55	7962	7966	7970	7974	7978	7982	7986	7990	7994	7998	8002	8006	8010	8014	8019	8023	8027
23.50	7966	7970	7974	7978	7982	7986	7990	7994	7999	8003	8007	8011	8015	8019	8023	8027	8031
23.45	7971	7975	7979	7983	7987	7991	7995	7999	8003	8007	8011	8015	8019	8023	8027	8031	8035
23.40	7975	7979	7983	7987	7991	7995	7999	8003	8007	8011	8015	8019	8023	8027	8031	8035	8039
23.35	7979	7983	7987	7991	7995	7999	8003	8007	8011	8015	8019	8023	8027	8031	8035	8040	8044
23.30	7984	7988	7992	7996	8000	8004	8008	8012	8016	8020	8024	8028	8032	8036	8040	8044	8048
23.25	7988	7992	7996	8000	8004	8008	8012	8016	8020	8024	8028	8032	8036	8040	8044	8048	8052
23.20	7992	7996	8000	8004	8008	8012	8016	8020	8024	8028	8032	8036	8040	8044	8048	8052	8056
23.15	7997	8001	8005	8009	8013	8017	8021	8025	8029	8033	8036	8040	8044	8048	8052	8056	8060
23.10	8001	8005	8009	8013	8017	8021	8025	8029	8033	8037	8041	8045	8049	8053	8057	8061	8065
23.05	8005	8009	8013	8017	8021	8025	8029	8033	8037	8041	8045	8049	8053	8057	8061	8065	8069
23.00	8010	8014	8018	8022	8026	8030	8033	8037	8041	8045	8049	8053	8057	8061	8065	8069	8073

Table 60 English—Low Alt, Low Temp, High Humidity
(Temp = 40 to 56° F, Press = 27 to 31 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0
31.00	7030	7036	7043	7049	7055	7061	7067	7072	7078	7084	7090	7096	7102	7108	7114	7119	7125
30.95	7035	7041	7047	7053	7059	7065	7071	7077	7083	7089	7095	7101	7107	7112	7118	7124	7130
30.90	7040	7046	7052	7058	7064	7070	7076	7082	7088	7094	7100	7105	7111	7117	7123	7129	7134
30.85	7045	7051	7057	7063	7069	7075	7081	7087	7093	7098	7104	7110	7116	7122	7128	7133	7139
30.80	7050	7056	7062	7068	7074	7080	7085	7091	7097	7103	7109	7115	7121	7126	7132	7138	7144
30.75	7054	7060	7066	7072	7078	7084	7090	7096	7102	7108	7114	7120	7125	7131	7137	7143	7148
30.70	7059	7065	7071	7077	7083	7089	7095	7101	7107	7113	7118	7124	7130	7136	7142	7147	7153
30.65	7064	7070	7076	7082	7088	7094	7100	7106	7111	7117	7123	7129	7135	7140	7146	7152	7158
30.60	7069	7075	7081	7087	7093	7099	7104	7110	7116	7122	7128	7134	7139	7145	7151	7157	7162
30.55	7074	7080	7086	7091	7097	7103	7109	7115	7121	7127	7133	7138	7144	7150	7156	7161	7167
30.50	7078	7084	7090	7096	7102	7108	7114	7120	7126	7131	7137	7143	7149	7155	7160	7166	7172
30.45	7083	7089	7095	7101	7107	7113	7119	7124	7130	7136	7142	7148	7153	7159	7165	7171	7176
30.40	7088	7094	7100	7106	7112	7118	7123	7129	7135	7141	7147	7152	7158	7164	7170	7175	7181
30.35	7093	7099	7105	7111	7116	7122	7128	7134	7140	7146	7151	7157	7163	7169	7174	7180	7186
30.30	7098	7103	7109	7115	7121	7127	7133	7139	7144	7150	7156	7162	7167	7173	7179	7185	7190
30.25	7102	7108	7114	7120	7126	7132	7138	7143	7149	7155	7161	7166	7172	7178	7184	7189	7195
30.20	7107	7113	7119	7125	7131	7137	7142	7148	7154	7160	7165	7171	7177	7183	7188	7194	7200
30.15	7112	7118	7124	7130	7135	7141	7147	7153	7159	7164	7170	7176	7182	7187	7193	7199	7204
30.10	7117	7123	7129	7134	7140	7146	7152	7158	7163	7169	7175	7181	7186	7192	7198	7203	7209
30.05	7122	7127	7133	7139	7145	7151	7157	7162	7168	7174	7180	7185	7191	7197	7202	7208	7213
30.00	7126	7132	7138	7144	7150	7156	7161	7167	7173	7179	7184	7190	7196	7201	7207	7213	7218
29.95	7131	7137	7143	7149	7154	7160	7166	7172	7178	7183	7189	7195	7200	7206	7212	7217	7223
29.90	7136	7142	7148	7153	7159	7165	7171	7177	7182	7188	7194	7199	7205	7211	7216	7222	7227
29.85	7141	7147	7152	7158	7164	7170	7176	7181	7187	7193	7198	7204	7210	7215	7221	7226	7232
29.80	7146	7151	7157	7163	7169	7175	7180	7186	7192	7197	7203	7209	7214	7220	7226	7231	7237
29.75	7150	7156	7162	7168	7174	7179	7185	7191	7196	7202	7208	7213	7219	7225	7230	7236	7241
29.70	7155	7161	7167	7173	7178	7184	7190	7195	7201	7207	7212	7218	7224	7229	7235	7240	7246
29.65	7160	7166	7172	7177	7183	7189	7194	7200	7206	7211	7217	7223	7228	7234	7240	7245	7251
29.60	7165	7170	7176	7182	7188	7193	7199	7205	7211	7216	7222	7227	7233	7239	7244	7250	7255
29.55	7169	7175	7181	7187	7193	7198	7204	7210	7215	7221	7227	7232	7238	7243	7249	7254	7260
29.50	7174	7180	7186	7192	7197	7203	7209	7214	7220	7226	7231	7237	7242	7248	7254	7259	7265
29.45	7179	7185	7191	7196	7202	7208	7213	7219	7225	7230	7236	7242	7247	7253	7258	7264	7269
29.40	7184	7190	7195	7201	7207	7212	7218	7224	7229	7235	7241	7246	7252	7257	7263	7268	7274
29.35	7189	7194	7200	7206	7212	7217	7223	7229	7234	7240	7245	7251	7256	7262	7268	7273	7279
29.30	7193	7199	7205	7211	7216	7222	7228	7233	7239	7244	7250	7256	7261	7267	7272	7278	7283
29.25	7198	7204	7210	7215	7221	7227	7232	7238	7244	7249	7255	7260	7266	7271	7277	7282	7288
29.20	7203	7209	7214	7220	7226	7231	7237	7243	7248	7254	7259	7265	7271	7276	7282	7287	7292
29.15	7208	7214	7219	7225	7231	7236	7242	7247	7253	7259	7264	7270	7275	7281	7286	7292	7297
29.10	7213	7218	7224	7230	7235	7241	7247	7252	7258	7263	7269	7274	7280	7285	7291	7296	7302
29.05	7217	7223	7229	7234	7240	7246	7251	7257	7262	7268	7274	7279	7285	7290	7296	7301	7306
29.00	7222	7228	7234	7239	7245	7250	7256	7262	7267	7273	7278	7284	7289	7295	7300	7306	7311
28.95	7227	7233	7238	7244	7250	7255	7261	7266	7272	7277	7283	7288	7294	7299	7305	7310	7316
28.90	7232	7238	7243	7249	7254	7260	7266	7271	7277	7282	7288	7293	7299	7304	7309	7315	7320
28.85	7237	7242	7248	7254	7259	7265	7270	7276	7281	7287	7292	7298	7303	7309	7314	7320	7325
28.80	7241	7247	7253	7258	7264	7269	7275	7281	7286	7292	7297	7303	7308	7313	7319	7324	7330
28.75	7246	7252	7257	7263	7269	7274	7280	7285	7291	7296	7302	7307	7313	7318	7323	7329	7334
28.70	7251	7257	7262	7268	7273	7279	7284	7290	7296	7301	7306	7312	7317	7323	7328	7334	7339
28.65	7256	7261	7267	7273	7278	7284	7289	7295	7300	7306	7311	7317	7322	7327	7333	7338	7344
28.60	7261	7266	7272	7277	7283	7288	7294	7299	7305	7310	7316	7321	7327	7332	7337	7343	7348
28.55	7265	7271	7277	7282	7288	7293	7299	7304	7310	7315	7321	7326	7331	7337	7342	7348	7353
28.50	7270	7276	7281	7287	7292	7298	7303	7309	7314	7320	7325	7331	7336	7341	7347	7352	7357
28.45	7275	7281	7286	7292	7297	7303	7308	7314	7319	7325	7330	7335	7341	7346	7351	7357	7362
28.40	7280	7285	7291	7296	7302	7307	7313	7318	7324	7329	7335	7340	7345	7351	7356	7361	7367
28.35	7285	7290	7296	7301	7307	7312	7318	7323	7329	7334	7339	7345	7350	7355	7361	7366	7371
28.30	7289	7295	7300	7306	7311	7317	7322	7328	7333	7339	7344	7349	7355	7360	7365	7371	7376
28.25	7294	7300	7305	7311	7316	7322	7327	7333	7338	7343	7349	7354	7359	7365	7370	7375	7381
28.20	7299	7305	7310	7316	7321	7326	7332	7337	7343	7348	7353	7359	7364	7369	7375	7380	7385
28.15	7304	7309	7315	7320	7326	7331	7337	7342	7347	7353	7358	7364	7369	7374	7379	7385	7390
28.10	7309	7314	7320	7325	7331	7336	7341	7347	7352	7358	7363	7368	7374	7379	7384	7389	7395
28.05	7313	7319	7324	7330	7335	7341	7346	7351	7357	7362	7368	7373	7378	7384	7389	7394	7399
28.00	7318	7324	7329	7335	7340	7345	7351	7356	7362	7367	7372	7378	7383	7388	7393	7399	7404
27.95	7323	7328	7334	7339	7345	7350	7356	7361	7366	7372	7377	7382	7388	7393	7398	7403	7409
27.90	7328	7333	7339	7344	7350	7355	7360	7366	7371	7376	7382	7387	7392	7398	7403	7408	7413
27.85	7333	7338	7343	7349	7354	7360	7365	7370	7376	7381	7386	7392	7397	7402	7407	7413	7418
27.80	7337	7343	7348	7354	7359	7364	7370	7375	7380	7386	7391	7396	7402	7407	7412	7417	7423
27.75	7342	7348	7353	7358	7364	7369	7375	7380	7385	7390	7396	7401	7406	7412	7417	7422	7427
27.70	7347	7352	7358	7363	7369	7374	7379	7385	7390	7395	7400	7406	7411	7416	7421	7427	7432
27.65	7352	7357	7363	7368	7373	7379	7384	7389	7395	7400	7405	7410	7416	7421	7426	7431	7436
27.60	7357	7362	7367	7373	7378	7383	7389	7394	7399	7405	7410	7415	7420	7426	7431	7436	7441
27.55	7361	7367	7372	7377	7383	7388	7393	7399	7404	7409	7415	7420	7425	7430	7435	7441	7446
27.50	7366	7372	7377	7382	7388	7393	7398	7404	7409	7414	7419	7425	7430	7435	7440	7445	7450
27.45	7371	7376	7382	7387	7392	7398	7403	7408	7414	7419	7424	7429	7434	7440	7445	7450	7455
27.40	7376	7381	7386	7392	7397	7402	7408	7413	7418	7423	7429	7434	7439	7444	7449	7455	7460
27.35	7381	7386	7391	7397	7402	7407	7412	7418	7423	7428	7433	7439	7444	7449	7454	7459	7464
27.30	7385	7391	7396	7401	7407	7412	7417	7422	7428	7433	7438	7443	7448	7454	7459	7464	7469
27.25	7390	7395	7401	7406	7411	7417	7422	7427	7432	7438	7443	7448	7453	7458	7463	7469	7474
27.20	7395	7400	7406	7411	7416	7421	7427	7432	7437	7442	7447	7453	7458	7463	7468	7473	7478
27.15	7400	7405	7410	7416	7421	7426	7431	7437	7442	7447	7452	7457	7462	7468	7473	7478	7483
27.10	7404	7410	7415	7420	7426	7431	7436	7441	7447	7452	7457	7462	7467	7472	7477	7483	7488
27.05	7409	7415	7420	7425	7430	7436	7441	7446	7451	7456	7462	7467	7472	7477	7482	7487	7492
27.00	7414	7419	7425	7430	7435	7440	7446	7451	7456	7461	7466	7471	7477	7482	7487	7492	7497

Table 61 English—Low Alt, Low-Mid Temp, High Humidity
(Temp = 57 to 73° F, Press = 27 to 31 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.0	68.0	69.0	70.0	71.0	72.0	73.0
31.00	7131	7137	7142	7148	7154	7160	7165	7171	7177	7182	7188	7193	7199	7205	7210	7216	7221
30.95	7136	7141	7147	7153	7158	7164	7170	7175	7181	7187	7192	7198	7204	7209	7215	7220	7226
30.90	7140	7146	7152	7157	7163	7169	7174	7180	7186	7191	7197	7203	7208	7214	7219	7225	7230
30.85	7145	7151	7156	7162	7168	7173	7179	7185	7190	7196	7201	7207	7213	7218	7224	7229	7235
30.80	7150	7155	7161	7167	7172	7178	7184	7189	7195	7200	7206	7212	7217	7223	7228	7234	7239
30.75	7154	7160	7166	7171	7177	7183	7188	7194	7199	7205	7211	7216	7222	7227	7233	7238	7244
30.70	7159	7164	7170	7176	7181	7187	7193	7198	7204	7210	7215	7221	7226	7232	7237	7243	7248
30.65	7163	7169	7175	7180	7186	7192	7197	7203	7209	7214	7220	7225	7231	7236	7242	7247	7253
30.60	7168	7174	7179	7185	7191	7196	7202	7208	7213	7219	7224	7230	7235	7241	7246	7252	7257
30.55	7173	7178	7184	7190	7195	7201	7207	7212	7218	7223	7229	7234	7240	7245	7251	7256	7262
30.50	7177	7183	7189	7194	7200	7205	7211	7217	7222	7228	7233	7239	7244	7250	7255	7261	7266
30.45	7182	7188	7193	7199	7204	7210	7216	7221	7227	7232	7238	7243	7249	7254	7260	7265	7271
30.40	7187	7192	7198	7203	7209	7215	7220	7226	7231	7237	7242	7248	7253	7259	7264	7270	7275
30.35	7191	7197	7202	7208	7214	7219	7225	7230	7236	7241	7247	7252	7258	7263	7269	7274	7280
30.30	7196	7202	7207	7213	7218	7224	7229	7235	7240	7246	7252	7257	7262	7268	7273	7279	7284
30.25	7201	7206	7212	7217	7223	7228	7234	7240	7245	7251	7256	7262	7267	7272	7278	7283	7289
30.20	7205	7211	7216	7222	7228	7233	7239	7244	7250	7255	7261	7266	7272	7277	7282	7288	7293
30.15	7210	7215	7221	7227	7232	7238	7243	7249	7254	7260	7265	7271	7276	7282	7287	7292	7298
30.10	7214	7220	7226	7231	7237	7242	7248	7253	7259	7264	7270	7275	7281	7286	7291	7297	7302
30.05	7219	7225	7230	7236	7241	7247	7252	7258	7263	7269	7274	7280	7285	7291	7296	7301	7307
30.00	7224	7229	7235	7240	7246	7251	7257	7262	7268	7273	7279	7284	7290	7295	7300	7306	7311
29.95	7228	7234	7239	7245	7251	7256	7262	7267	7272	7278	7283	7289	7294	7300	7305	7310	7316
29.90	7233	7239	7244	7250	7255	7261	7266	7272	7277	7282	7288	7293	7299	7304	7310	7315	7320
29.85	7238	7243	7249	7254	7260	7265	7271	7276	7282	7287	7292	7298	7303	7309	7314	7319	7325
29.80	7242	7248	7253	7259	7264	7270	7275	7281	7286	7292	7297	7302	7308	7313	7319	7324	7329
29.75	7247	7252	7258	7263	7269	7274	7280	7285	7291	7296	7302	7307	7312	7318	7323	7328	7334
29.70	7252	7257	7263	7268	7274	7279	7284	7290	7295	7301	7306	7311	7317	7322	7328	7333	7338
29.65	7256	7262	7267	7273	7278	7284	7289	7294	7300	7305	7311	7316	7321	7327	7332	7337	7343
29.60	7261	7266	7272	7277	7283	7288	7294	7299	7304	7310	7315	7321	7326	7331	7337	7342	7347
29.55	7265	7271	7276	7282	7287	7293	7298	7304	7309	7314	7320	7325	7330	7336	7341	7346	7352
29.50	7270	7276	7281	7286	7292	7297	7303	7308	7314	7319	7324	7330	7335	7340	7346	7351	7356
29.45	7275	7280	7286	7291	7297	7302	7307	7313	7318	7323	7329	7334	7340	7345	7350	7355	7361
29.40	7279	7285	7290	7296	7301	7307	7312	7317	7323	7328	7333	7339	7344	7349	7355	7360	7365
29.35	7284	7289	7295	7300	7306	7311	7317	7322	7327	7333	7338	7343	7349	7354	7359	7364	7370
29.30	7289	7294	7299	7305	7310	7316	7321	7326	7332	7337	7342	7348	7353	7358	7364	7369	7374
29.25	7293	7299	7304	7310	7315	7320	7326	7331	7336	7342	7347	7352	7358	7363	7368	7373	7379
29.20	7298	7303	7309	7314	7320	7325	7330	7336	7341	7346	7352	7357	7362	7367	7373	7378	7383
29.15	7303	7308	7313	7319	7324	7329	7335	7340	7346	7351	7356	7361	7367	7372	7377	7382	7388
29.10	7307	7313	7318	7323	7329	7334	7339	7345	7350	7355	7361	7366	7371	7376	7382	7387	7392
29.05	7312	7317	7323	7328	7333	7339	7344	7349	7355	7360	7365	7370	7376	7381	7386	7391	7397
29.00	7316	7322	7327	7333	7338	7343	7349	7354	7359	7364	7370	7375	7380	7386	7391	7396	7401
28.95	7321	7326	7332	7337	7343	7348	7353	7358	7364	7369	7374	7380	7385	7390	7395	7400	7406
28.90	7326	7331	7336	7342	7347	7352	7358	7363	7368	7374	7379	7384	7389	7395	7400	7405	7410
28.85	7330	7336	7341	7346	7352	7357	7362	7368	7373	7378	7383	7389	7394	7399	7404	7409	7415
28.80	7335	7340	7346	7351	7356	7362	7367	7372	7377	7383	7388	7393	7398	7404	7409	7414	7419
28.75	7340	7345	7350	7356	7361	7366	7372	7377	7382	7387	7393	7398	7403	7408	7413	7419	7424
28.70	7344	7350	7355	7360	7366	7371	7376	7381	7387	7392	7397	7402	7407	7413	7418	7423	7428
28.65	7349	7354	7360	7365	7370	7375	7381	7386	7391	7396	7402	7407	7412	7417	7422	7428	7433
28.60	7354	7359	7364	7369	7375	7380	7385	7391	7396	7401	7406	7411	7417	7422	7427	7432	7437
28.55	7358	7363	7369	7374	7379	7385	7390	7395	7400	7406	7411	7416	7421	7426	7431	7437	7442
28.50	7363	7368	7373	7379	7384	7389	7394	7400	7405	7410	7415	7420	7426	7431	7436	7441	7446
28.45	7367	7373	7378	7383	7389	7394	7399	7404	7409	7415	7420	7425	7430	7435	7440	7446	7451
28.40	7372	7377	7383	7388	7393	7398	7404	7409	7414	7419	7424	7430	7435	7440	7445	7450	7455
28.35	7377	7382	7387	7393	7398	7403	7408	7413	7419	7424	7429	7434	7439	7444	7449	7455	7460
28.30	7381	7387	7392	7397	7402	7408	7413	7418	7423	7428	7433	7439	7444	7449	7454	7459	7464
28.25	7386	7391	7396	7402	7407	7412	7417	7423	7428	7433	7438	7443	7448	7453	7458	7464	7469
28.20	7391	7396	7401	7406	7412	7417	7422	7427	7432	7437	7443	7448	7453	7458	7463	7468	7473
28.15	7395	7401	7406	7411	7416	7421	7427	7432	7437	7442	7447	7452	7457	7462	7467	7473	7478
28.10	7400	7405	7410	7416	7421	7426	7431	7436	7441	7447	7452	7457	7462	7467	7472	7477	7482
28.05	7405	7410	7415	7420	7425	7431	7436	7441	7446	7451	7456	7461	7466	7471	7477	7482	7487
28.00	7409	7414	7420	7425	7430	7435	7440	7445	7451	7456	7461	7466	7471	7476	7481	7486	7491
27.95	7414	7419	7424	7429	7435	7440	7445	7450	7455	7460	7465	7470	7475	7480	7486	7491	7496
27.90	7418	7424	7429	7434	7439	7444	7449	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500
27.85	7423	7428	7433	7439	7444	7449	7454	7459	7464	7469	7474	7479	7485	7490	7495	7500	7505
27.80	7428	7433	7438	7443	7448	7453	7459	7464	7469	7474	7479	7484	7489	7494	7499	7504	7509
27.75	7432	7438	7443	7448	7453	7458	7463	7468	7473	7478	7483	7489	7494	7499	7504	7509	7514
27.70	7437	7442	7447	7452	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7518
27.65	7442	7447	7452	7457	7462	7467	7472	7477	7482	7488	7493	7498	7503	7508	7513	7518	7523
27.60	7446	7451	7457	7462	7467	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527
27.55	7451	7456	7461	7466	7471	7476	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532
27.50	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536
27.45	7460	7465	7470	7475	7481	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541
27.40	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545
27.35	7469	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545	7550
27.30	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7554
27.25	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7554	7559
27.20	7483	7488	7493	7499	7504	7509	7514	7519	7524	7529	7534	7538	7543	7548	7553	7558	7563
27.15	7488	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7553	7558	7563	7568
27.10	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7552	7557	7562	7567	7572
27.05	7497	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7567	7572	7577
27.00	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7566	7571	7576	7581

Table 62 English—Low Alt, Mid Temp, High Humidity
(Temp = 74 to 90° F, Press = 27 to 31 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0
31.00	7227	7232	7238	7243	7249	7254	7260	7265	7271	7276	7282	7287	7293	7298	7304	7309	7314
30.95	7231	7237	7242	7248	7253	7259	7264	7270	7275	7281	7286	7292	7297	7303	7308	7313	7319
30.90	7236	7241	7247	7252	7258	7263	7269	7274	7280	7285	7291	7296	7301	7307	7312	7318	7323
30.85	7240	7246	7251	7257	7262	7268	7273	7279	7284	7290	7295	7300	7306	7311	7317	7322	7328
30.80	7245	7250	7256	7261	7267	7272	7278	7283	7289	7294	7299	7305	7310	7316	7321	7326	7332
30.75	7249	7255	7260	7266	7271	7277	7282	7288	7293	7298	7304	7309	7315	7320	7325	7331	7336
30.70	7254	7259	7265	7270	7276	7281	7287	7292	7297	7303	7308	7314	7319	7324	7330	7335	7341
30.65	7258	7264	7269	7275	7280	7286	7291	7296	7302	7307	7313	7318	7323	7329	7334	7340	7345
30.60	7263	7268	7274	7279	7285	7290	7295	7301	7306	7312	7317	7322	7328	7333	7339	7344	7349
30.55	7267	7273	7278	7284	7289	7294	7300	7305	7311	7316	7321	7327	7332	7338	7343	7348	7354
30.50	7272	7277	7283	7288	7293	7299	7304	7310	7315	7320	7326	7331	7337	7342	7347	7353	7358
30.45	7276	7282	7287	7293	7298	7303	7309	7314	7320	7325	7330	7336	7341	7346	7352	7357	7362
30.40	7281	7286	7292	7297	7302	7308	7313	7319	7324	7329	7335	7340	7345	7351	7356	7361	7367
30.35	7285	7291	7296	7301	7307	7312	7318	7323	7328	7334	7339	7344	7350	7355	7360	7366	7371
30.30	7290	7295	7301	7306	7311	7317	7322	7327	7333	7338	7343	7349	7354	7359	7365	7370	7375
30.25	7294	7300	7305	7310	7316	7321	7326	7332	7337	7343	7348	7353	7359	7364	7369	7375	7380
30.20	7299	7304	7309	7315	7320	7326	7331	7336	7342	7347	7352	7358	7363	7368	7374	7379	7384
30.15	7303	7309	7314	7319	7325	7330	7335	7341	7346	7351	7357	7362	7367	7373	7378	7383	7389
30.10	7308	7313	7318	7324	7329	7334	7340	7345	7350	7356	7361	7366	7372	7377	7382	7388	7393
30.05	7312	7318	7323	7328	7334	7339	7344	7350	7355	7360	7366	7371	7376	7381	7387	7392	7397
30.00	7317	7322	7327	7333	7338	7343	7349	7354	7359	7365	7370	7375	7380	7386	7391	7396	7402
29.95	7321	7326	7332	7337	7342	7348	7353	7358	7364	7369	7374	7380	7385	7390	7395	7401	7406
29.90	7326	7331	7336	7342	7347	7352	7358	7363	7368	7373	7379	7384	7389	7395	7400	7405	7410
29.85	7330	7335	7341	7346	7351	7357	7362	7367	7373	7378	7383	7388	7394	7399	7404	7409	7415
29.80	7335	7340	7345	7351	7356	7361	7366	7372	7377	7382	7388	7393	7398	7403	7409	7414	7419
29.75	7339	7344	7350	7355	7360	7366	7371	7376	7381	7387	7392	7397	7402	7408	7413	7418	7423
29.70	7344	7349	7354	7359	7365	7370	7375	7381	7386	7391	7396	7402	7407	7412	7417	7423	7428
29.65	7348	7353	7359	7364	7369	7374	7380	7385	7390	7396	7401	7406	7411	7416	7422	7427	7432
29.60	7353	7358	7363	7368	7374	7379	7384	7389	7395	7400	7405	7410	7416	7421	7426	7431	7436
29.55	7357	7362	7368	7373	7378	7383	7389	7394	7399	7404	7410	7415	7420	7425	7430	7436	7441
29.50	7362	7367	7372	7377	7383	7388	7393	7398	7404	7409	7414	7419	7424	7430	7435	7440	7445
29.45	7366	7371	7377	7382	7387	7392	7398	7403	7408	7413	7418	7424	7429	7434	7439	7444	7450
29.40	7370	7376	7381	7386	7391	7397	7402	7407	7412	7418	7423	7428	7433	7438	7444	7449	7454
29.35	7375	7380	7385	7391	7396	7401	7406	7412	7417	7422	7427	7432	7438	7443	7448	7453	7458
29.30	7379	7385	7390	7395	7400	7406	7411	7416	7421	7426	7432	7437	7442	7447	7452	7457	7463
29.25	7384	7389	7394	7400	7405	7410	7415	7420	7426	7431	7436	7441	7446	7451	7457	7462	7467
29.20	7388	7394	7399	7404	7409	7415	7420	7425	7430	7435	7440	7446	7451	7456	7461	7466	7471
29.15	7393	7398	7403	7409	7414	7419	7424	7429	7434	7440	7445	7450	7455	7460	7465	7471	7476
29.10	7397	7403	7408	7413	7418	7423	7429	7434	7439	7444	7449	7454	7459	7465	7470	7475	7480
29.05	7402	7407	7412	7417	7423	7428	7433	7438	7443	7448	7454	7459	7464	7469	7474	7479	7484
29.00	7406	7412	7417	7422	7427	7432	7437	7443	7448	7453	7458	7463	7468	7473	7479	7484	7489
28.95	7411	7416	7421	7426	7432	7437	7442	7447	7452	7457	7462	7468	7473	7478	7483	7488	7493
28.90	7415	7421	7426	7431	7436	7441	7446	7451	7457	7462	7467	7472	7477	7482	7487	7492	7497
28.85	7420	7425	7430	7435	7440	7446	7451	7456	7461	7466	7471	7476	7481	7487	7492	7497	7502
28.80	7424	7430	7435	7440	7445	7450	7455	7460	7465	7471	7476	7481	7486	7491	7496	7501	7506
28.75	7429	7434	7439	7444	7449	7455	7460	7465	7470	7475	7480	7485	7490	7495	7500	7505	7511
28.70	7433	7438	7444	7449	7454	7459	7464	7469	7474	7479	7484	7490	7495	7500	7505	7510	7515
28.65	7438	7443	7448	7453	7458	7463	7469	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519
28.60	7442	7447	7453	7458	7463	7468	7473	7478	7483	7488	7493	7498	7503	7508	7513	7519	7524
28.55	7447	7452	7457	7462	7467	7472	7477	7482	7488	7493	7498	7503	7508	7513	7518	7523	7528
28.50	7451	7456	7461	7467	7472	7477	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532
28.45	7456	7461	7466	7471	7476	7481	7486	7491	7496	7501	7506	7512	7517	7522	7527	7532	7537
28.40	7460	7465	7470	7476	7481	7486	7491	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541
28.35	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545
28.30	7469	7474	7479	7484	7489	7495	7500	7505	7510	7515	7520	7525	7530	7535	7540	7545	7550
28.25	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534	7539	7544	7549	7554
28.20	7478	7483	7488	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7553	7558
28.15	7483	7488	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548	7553	7558	7563
28.10	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7567
28.05	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7567	7572
28.00	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541	7546	7551	7556	7561	7566	7571	7576
27.95	7501	7506	7511	7516	7521	7526	7531	7536	7541	7546	7551	7555	7560	7565	7570	7575	7580
27.90	7505	7510	7515	7520	7525	7530	7535	7540	7545	7550	7555	7560	7565	7570	7575	7580	7585
27.85	7510	7515	7520	7525	7530	7535	7540	7544	7549	7554	7559	7564	7569	7574	7579	7584	7589
27.80	7514	7519	7524	7529	7534	7539	7544	7549	7554	7559	7564	7569	7574	7579	7583	7588	7593
27.75	7519	7524	7529	7534	7538	7543	7548	7553	7558	7563	7568	7573	7578	7583	7588	7593	7598
27.70	7523	7528	7533	7538	7543	7548	7553	7558	7563	7568	7573	7577	7582	7587	7592	7597	7602
27.65	7528	7533	7538	7542	7547	7552	7557	7562	7567	7572	7577	7582	7587	7592	7597	7601	7606
27.60	7532	7537	7542	7547	7552	7557	7562	7567	7572	7576	7581	7586	7591	7596	7601	7606	7611
27.55	7537	7542	7546	7551	7556	7561	7566	7571	7576	7581	7586	7591	7596	7600	7605	7610	7615
27.50	7541	7546	7551	7556	7561	7566	7571	7575	7580	7585	7590	7595	7600	7605	7610	7615	7619
27.45	7546	7550	7555	7560	7565	7570	7575	7580	7585	7590	7595	7599	7604	7609	7614	7619	7624
27.40	7550	7555	7560	7565	7570	7575	7579	7584	7589	7594	7599	7604	7609	7614	7618	7623	7628
27.35	7555	7559	7564	7569	7574	7579	7584	7589	7594	7599	7603	7608	7613	7618	7623	7628	7633
27.30	7559	7564	7569	7574	7579	7583	7588	7593	7598	7603	7608	7613	7617	7622	7627	7632	7637
27.25	7563	7568	7573	7578	7583	7588	7593	7598	7602	7607	7612	7617	7622	7627	7632	7636	7641
27.20	7568	7573	7578	7583	7587	7592	7597	7602	7607	7612	7617	7621	7626	7631	7636	7641	7646
27.15	7572	7577	7582	7587	7592	7597	7602	7606	7611	7616	7621	7626	7631	7635	7640	7645	7650
27.10	7577	7582	7587	7592	7596	7601	7606	7611	7616	7621	7625	7630	7635	7640	7645	7649	7654
27.05	7581	7586	7591	7596	7601	7606	7611	7615	7620	7625	7630	7635	7639	7644	7649	7654	7659
27.00	7586	7591	7596	7600	7605	7610	7615	7620	7625	7629	7634	7639	7644	7649	7653	7658	7663

Table 63 English—Low Alt, High-Mid Temp, High Humidity
(Temp = 91 to 107° F, Press = 27 to 31 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	91.0	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0
31.00	7320	7325	7331	7336	7342	7347	7353	7358	7363	7369	7374	7380	7385	7391	7396	7402	7407
30.95	7324	7330	7335	7341	7346	7351	7357	7362	7368	7373	7379	7384	7389	7395	7400	7406	7411
30.90	7329	7334	7339	7345	7350	7356	7361	7367	7372	7377	7383	7388	7394	7399	7405	7410	7416
30.85	7333	7338	7344	7349	7355	7360	7365	7371	7376	7382	7387	7393	7398	7403	7409	7414	7420
30.80	7337	7343	7348	7354	7359	7364	7370	7375	7381	7386	7391	7397	7402	7408	7413	7419	7424
30.75	7342	7347	7352	7358	7363	7369	7374	7379	7385	7390	7396	7401	7406	7412	7417	7423	7428
30.70	7346	7351	7357	7362	7368	7373	7378	7384	7389	7395	7400	7405	7411	7416	7422	7427	7432
30.65	7350	7356	7361	7366	7372	7377	7383	7388	7393	7399	7404	7410	7415	7420	7426	7431	7437
30.60	7355	7360	7365	7371	7376	7382	7387	7392	7398	7403	7408	7414	7419	7425	7430	7436	7441
30.55	7359	7364	7370	7375	7380	7386	7391	7397	7402	7407	7413	7418	7424	7429	7434	7440	7445
30.50	7363	7369	7374	7379	7385	7390	7396	7401	7406	7412	7417	7422	7428	7433	7439	7444	7449
30.45	7368	7373	7378	7384	7389	7394	7400	7405	7411	7416	7421	7427	7432	7437	7443	7448	7454
30.40	7372	7377	7383	7388	7393	7399	7404	7409	7415	7420	7426	7431	7436	7442	7447	7452	7458
30.35	7376	7382	7387	7392	7398	7403	7408	7414	7419	7424	7430	7435	7441	7446	7451	7457	7462
30.30	7381	7386	7391	7397	7402	7407	7413	7418	7423	7429	7434	7439	7445	7450	7456	7461	7466
30.25	7385	7390	7396	7401	7406	7412	7417	7422	7428	7433	7438	7444	7449	7454	7460	7465	7471
30.20	7389	7395	7400	7405	7411	7416	7421	7427	7432	7437	7443	7448	7453	7459	7464	7469	7475
30.15	7394	7399	7404	7410	7415	7420	7426	7431	7436	7442	7447	7452	7458	7463	7468	7474	7479
30.10	7398	7403	7409	7414	7419	7425	7430	7435	7441	7446	7451	7456	7462	7467	7472	7478	7483
30.05	7403	7408	7413	7418	7424	7429	7434	7440	7445	7450	7455	7461	7466	7471	7477	7482	7487
30.00	7407	7412	7417	7423	7428	7433	7439	7444	7449	7454	7460	7465	7470	7476	7481	7486	7492
29.95	7411	7416	7422	7427	7432	7438	7443	7448	7453	7459	7464	7469	7475	7480	7485	7491	7496
29.90	7416	7421	7426	7431	7437	7442	7447	7452	7458	7463	7468	7474	7479	7484	7489	7495	7500
29.85	7420	7425	7430	7436	7441	7446	7451	7457	7462	7467	7473	7478	7483	7488	7494	7499	7504
29.80	7424	7430	7435	7440	7445	7450	7456	7461	7466	7472	7477	7482	7487	7493	7498	7503	7509
29.75	7429	7434	7439	7444	7450	7455	7460	7465	7471	7476	7481	7486	7492	7497	7502	7507	7513
29.70	7433	7438	7443	7449	7454	7459	7464	7470	7475	7480	7485	7491	7496	7501	7506	7512	7517
29.65	7437	7443	7448	7453	7458	7463	7469	7474	7479	7484	7490	7495	7500	7505	7511	7516	7521
29.60	7442	7447	7452	7457	7463	7468	7473	7478	7483	7489	7494	7499	7504	7510	7515	7520	7525
29.55	7446	7451	7456	7462	7467	7472	7477	7482	7488	7493	7498	7503	7509	7514	7519	7524	7530
29.50	7450	7456	7461	7466	7471	7476	7482	7487	7492	7497	7502	7508	7513	7518	7523	7529	7534
29.45	7455	7460	7465	7470	7475	7481	7486	7491	7496	7501	7507	7512	7517	7522	7528	7533	7538
29.40	7459	7464	7469	7475	7480	7485	7490	7495	7501	7506	7511	7516	7521	7527	7532	7537	7542
29.35	7463	7469	7474	7479	7484	7489	7494	7500	7505	7510	7515	7520	7526	7531	7536	7541	7547
29.30	7468	7473	7478	7483	7488	7494	7499	7504	7509	7514	7519	7525	7530	7535	7540	7546	7551
29.25	7472	7477	7482	7488	7493	7498	7503	7508	7513	7519	7524	7529	7534	7539	7545	7550	7555
29.20	7476	7482	7487	7492	7497	7502	7507	7513	7518	7523	7528	7533	7538	7544	7549	7554	7559
29.15	7481	7486	7491	7496	7501	7507	7512	7517	7522	7527	7532	7537	7543	7548	7553	7558	7563
29.10	7485	7490	7495	7501	7506	7511	7516	7521	7526	7531	7537	7542	7547	7552	7557	7562	7568
29.05	7490	7495	7500	7505	7510	7515	7520	7525	7531	7536	7541	7546	7551	7556	7562	7567	7572
29.00	7494	7499	7504	7509	7514	7519	7525	7530	7535	7540	7545	7550	7555	7561	7566	7571	7576
28.95	7498	7503	7508	7514	7519	7524	7529	7534	7539	7544	7549	7555	7560	7565	7570	7575	7580
28.90	7503	7508	7513	7518	7523	7528	7533	7538	7543	7549	7554	7559	7564	7569	7574	7579	7585
28.85	7507	7512	7517	7522	7527	7532	7537	7543	7548	7553	7558	7563	7568	7573	7578	7584	7589
28.80	7511	7516	7521	7527	7532	7537	7542	7547	7552	7557	7562	7567	7572	7578	7583	7588	7593
28.75	7516	7521	7526	7531	7536	7541	7546	7551	7556	7561	7566	7572	7577	7582	7587	7592	7597
28.70	7520	7525	7530	7535	7540	7545	7550	7555	7561	7566	7571	7576	7581	7586	7591	7596	7601
28.65	7524	7529	7534	7539	7545	7550	7555	7560	7565	7570	7575	7580	7585	7590	7595	7601	7606
28.60	7529	7534	7539	7544	7549	7554	7559	7564	7569	7574	7579	7584	7589	7595	7600	7605	7610
28.55	7533	7538	7543	7548	7553	7558	7563	7568	7573	7578	7584	7589	7594	7599	7604	7609	7614
28.50	7537	7542	7547	7552	7557	7563	7568	7573	7578	7583	7588	7593	7598	7603	7608	7613	7618
28.45	7542	7547	7552	7557	7562	7567	7572	7577	7582	7587	7592	7597	7602	7607	7612	7617	7623
28.40	7546	7551	7556	7561	7566	7571	7576	7581	7586	7591	7596	7601	7606	7612	7617	7622	7627
28.35	7550	7555	7560	7565	7570	7575	7580	7586	7591	7596	7601	7606	7611	7616	7621	7626	7631
28.30	7555	7560	7565	7570	7575	7580	7585	7590	7595	7600	7605	7610	7615	7620	7625	7630	7635
28.25	7559	7564	7569	7574	7579	7584	7589	7594	7599	7604	7609	7614	7619	7624	7629	7634	7640
28.20	7563	7568	7573	7578	7583	7588	7593	7598	7603	7608	7613	7618	7624	7629	7634	7639	7644
28.15	7568	7573	7578	7583	7588	7593	7598	7603	7608	7613	7618	7623	7628	7633	7638	7643	7648
28.10	7572	7577	7582	7587	7592	7597	7602	7607	7612	7617	7622	7627	7632	7637	7642	7647	7652
28.05	7576	7581	7586	7591	7596	7601	7606	7611	7616	7621	7626	7631	7636	7641	7646	7651	7656
28.00	7581	7586	7591	7596	7601	7606	7611	7616	7621	7626	7631	7636	7641	7646	7651	7656	7661
27.95	7585	7590	7595	7600	7605	7610	7615	7620	7625	7630	7635	7640	7645	7650	7655	7660	7665
27.90	7590	7594	7599	7604	7609	7614	7619	7624	7629	7634	7639	7644	7649	7654	7659	7664	7669
27.85	7594	7599	7604	7609	7614	7619	7624	7628	7633	7638	7643	7648	7653	7658	7663	7668	7673
27.80	7598	7603	7608	7613	7618	7623	7628	7633	7638	7643	7648	7653	7658	7663	7668	7673	7678
27.75	7603	7607	7612	7617	7622	7627	7632	7637	7642	7647	7652	7657	7662	7667	7672	7677	7682
27.70	7607	7612	7617	7622	7627	7631	7636	7641	7646	7651	7656	7661	7666	7671	7676	7681	7686
27.65	7611	7616	7621	7626	7631	7636	7641	7646	7651	7655	7660	7665	7670	7675	7680	7685	7690
27.60	7616	7621	7625	7630	7635	7640	7645	7650	7655	7660	7665	7670	7675	7680	7684	7689	7694
27.55	7620	7625	7630	7635	7640	7644	7649	7654	7659	7664	7669	7674	7679	7684	7689	7694	7699
27.50	7624	7629	7634	7639	7644	7649	7654	7659	7663	7668	7673	7678	7683	7688	7693	7698	7703
27.45	7629	7634	7638	7643	7648	7653	7658	7663	7668	7673	7677	7682	7687	7692	7697	7702	7707
27.40	7633	7638	7643	7648	7652	7657	7662	7667	7672	7677	7682	7687	7692	7697	7701	7706	7711
27.35	7637	7642	7647	7652	7657	7662	7667	7671	7676	7681	7686	7691	7696	7701	7706	7711	7716
27.30	7642	7647	7651	7656	7661	7666	7671	7676	7681	7685	7690	7695	7700	7705	7710	7715	7720
27.25	7646	7651	7656	7661	7665	7670	7675	7680	7685	7690	7695	7699	7704	7709	7714	7719	7724
27.20	7650	7655	7660	7665	7670	7675	7679	7684	7689	7694	7699	7704	7709	7713	7718	7723	7728
27.15	7655	7660	7664	7669	7674	7679	7684	7689	7693	7698	7703	7708	7713	7718	7723	7728	7732
27.10	7659	7664	7669	7674	7678	7683	7688	7693	7698	7703	7707	7712	7717	7722	7727	7732	7737
27.05	7663	7668	7673	7678	7683	7688	7692	7697	7702	7707	7712	7717	7721	7726	7731	7736	7741
27.00	7668	7673	7677	7682	7687	7692	7697	7701	7706	7711	7716	7721	7726	7730	7735	7740	7745

Table 64 English—High Alt, Low Temp, High Humidity
(Temp = 40 to 56° F, Press = 23 to 27 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	40.0	41.0	42.0	43.0	44.0	45.0	46.0	47.0	48.0	49.0	50.0	51.0	52.0	53.0	54.0	55.0	56.0
27.00	7414	7419	7425	7430	7435	7440	7446	7451	7456	7461	7466	7471	7477	7482	7487	7492	7497
26.95	7419	7424	7429	7435	7440	7445	7450	7456	7461	7466	7471	7476	7481	7486	7491	7496	7502
26.90	7424	7429	7434	7439	7445	7450	7455	7460	7465	7471	7476	7481	7486	7491	7496	7501	7506
26.85	7428	7434	7439	7444	7449	7455	7460	7465	7470	7475	7480	7486	7491	7496	7501	7506	7511
26.80	7433	7439	7444	7449	7454	7459	7465	7470	7475	7480	7485	7490	7495	7500	7505	7510	7515
26.75	7438	7443	7449	7454	7459	7464	7469	7474	7480	7485	7490	7495	7500	7505	7510	7515	7520
26.70	7443	7448	7453	7459	7464	7469	7474	7479	7484	7489	7495	7500	7505	7510	7515	7520	7525
26.65	7448	7453	7458	7463	7468	7474	7479	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529
26.60	7452	7458	7463	7468	7473	7478	7484	7489	7494	7499	7504	7509	7514	7519	7524	7529	7534
26.55	7457	7462	7468	7473	7478	7483	7488	7493	7498	7504	7509	7514	7519	7524	7529	7534	7539
26.50	7462	7467	7472	7478	7483	7488	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543
26.45	7467	7472	7477	7482	7488	7493	7498	7503	7508	7513	7518	7523	7528	7533	7538	7543	7548
26.40	7472	7477	7482	7487	7492	7497	7502	7508	7513	7518	7523	7528	7533	7538	7543	7548	7553
26.35	7476	7482	7487	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557
26.30	7481	7486	7492	7497	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562
26.25	7486	7491	7496	7501	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7567
26.20	7491	7496	7501	7506	7511	7516	7521	7526	7531	7537	7542	7546	7551	7556	7561	7566	7571
26.15	7496	7501	7506	7511	7516	7521	7526	7531	7536	7541	7546	7551	7556	7561	7566	7571	7576
26.10	7500	7506	7511	7516	7521	7526	7531	7536	7541	7546	7551	7556	7561	7566	7571	7576	7580
26.05	7505	7510	7515	7520	7526	7531	7536	7541	7546	7551	7556	7561	7566	7570	7575	7580	7585
26.00	7510	7515	7520	7525	7530	7535	7540	7545	7550	7555	7560	7565	7570	7575	7580	7585	7590
25.95	7515	7520	7525	7530	7535	7540	7545	7550	7555	7560	7565	7570	7575	7580	7585	7590	7594
25.90	7520	7525	7530	7535	7540	7545	7550	7555	7560	7565	7570	7575	7580	7584	7589	7594	7599
25.85	7524	7529	7535	7540	7545	7550	7555	7560	7565	7569	7574	7579	7584	7589	7594	7599	7604
25.80	7529	7534	7539	7544	7549	7554	7559	7564	7569	7574	7579	7584	7589	7594	7599	7604	7608
25.75	7534	7539	7544	7549	7554	7559	7564	7569	7574	7579	7584	7589	7594	7598	7603	7608	7613
25.70	7539	7544	7549	7554	7559	7564	7569	7574	7579	7584	7589	7593	7598	7603	7608	7613	7618
25.65	7544	7549	7554	7559	7564	7569	7574	7578	7583	7588	7593	7598	7603	7608	7613	7617	7622
25.60	7548	7553	7558	7563	7568	7573	7578	7583	7588	7593	7598	7603	7608	7613	7617	7622	7627
25.55	7553	7558	7563	7568	7573	7578	7583	7588	7593	7598	7603	7607	7612	7617	7622	7627	7632
25.50	7558	7563	7568	7573	7578	7583	7588	7593	7598	7602	7607	7612	7617	7622	7627	7631	7636
25.45	7563	7568	7573	7578	7583	7588	7592	7597	7602	7607	7612	7617	7622	7627	7631	7636	7641
25.40	7568	7573	7578	7582	7587	7592	7597	7602	7607	7612	7617	7622	7626	7631	7636	7641	7646
25.35	7572	7577	7582	7587	7592	7597	7602	7607	7612	7617	7621	7626	7631	7636	7641	7645	7650
25.30	7577	7582	7587	7592	7597	7602	7607	7612	7616	7621	7626	7631	7636	7641	7645	7650	7655
25.25	7582	7587	7592	7597	7602	7607	7611	7616	7621	7626	7631	7636	7640	7645	7650	7655	7659
25.20	7587	7592	7597	7602	7606	7611	7616	7621	7626	7631	7636	7640	7645	7650	7655	7659	7664
25.15	7592	7596	7601	7606	7611	7616	7621	7626	7631	7635	7640	7645	7650	7655	7659	7664	7669
25.10	7596	7601	7606	7611	7616	7621	7626	7631	7635	7640	7645	7650	7655	7659	7664	7669	7673
25.05	7601	7606	7611	7616	7621	7626	7630	7635	7640	7645	7650	7654	7659	7664	7669	7673	7678
25.00	7606	7611	7616	7621	7625	7630	7635	7640	7645	7650	7654	7659	7664	7669	7673	7678	7683
24.95	7611	7616	7620	7625	7630	7635	7640	7645	7649	7654	7659	7664	7669	7673	7678	7683	7687
24.90	7616	7620	7625	7630	7635	7640	7645	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692
24.85	7620	7625	7630	7635	7640	7645	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697
24.80	7625	7630	7635	7640	7644	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697	7701
24.75	7630	7635	7640	7644	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697	7701	7706
24.70	7635	7640	7644	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711
24.65	7639	7644	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715
24.60	7644	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720
24.55	7649	7654	7659	7664	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720	7725
24.50	7654	7659	7663	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720	7725	7729
24.45	7659	7663	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720	7725	7729	7734
24.40	7663	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720	7725	7729	7734	7738
24.35	7668	7673	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720	7725	7729	7734	7739	7743
24.30	7673	7678	7683	7687	7692	7697	7701	7706	7711	7716	7720	7725	7729	7734	7739	7743	7748
24.25	7678	7683	7687	7692	7697	7702	7706	7711	7716	7720	7725	7729	7734	7739	7743	7748	7752
24.20	7683	7687	7692	7697	7702	7706	7711	7716	7720	7725	7730	7734	7739	7743	7748	7752	7757
24.15	7687	7692	7697	7702	7706	7711	7716	7720	7725	7730	7734	7739	7743	7748	7753	7757	7762
24.10	7692	7697	7702	7706	7711	7716	7720	7725	7730	7734	7739	7744	7748	7753	7757	7762	7766
24.05	7697	7702	7706	7711	7716	7721	7725	7730	7734	7739	7744	7748	7753	7757	7762	7766	7771
24.00	7702	7707	7711	7716	7721	7725	7730	7735	7739	7744	7748	7753	7757	7762	7767	7771	7776
23.95	7707	7711	7716	7721	7725	7730	7735	7739	7744	7748	7753	7758	7762	7767	7771	7776	7780
23.90	7711	7716	7721	7725	7730	7735	7739	7744	7749	7753	7758	7762	7767	7771	7776	7780	7785
23.85	7716	7721	7726	7730	7735	7740	7744	7749	7753	7758	7762	7767	7772	7776	7781	7785	7790
23.80	7721	7726	7730	7735	7740	7744	7749	7753	7758	7763	7767	7772	7776	7781	7785	7790	7794
23.75	7726	7730	7735	7740	7744	7749	7754	7758	7763	7767	7772	7776	7781	7785	7790	7794	7799
23.70	7731	7735	7740	7745	7749	7754	7758	7763	7767	7772	7777	7781	7786	7790	7795	7799	7803
23.65	7735	7740	7745	7749	7754	7758	7763	7768	7772	7777	7781	7786	7790	7795	7799	7804	7808
23.60	7740	7745	7749	7754	7759	7763	7768	7772	7777	7781	7786	7790	7795	7799	7804	7808	7813
23.55	7745	7750	7754	7759	7763	7768	7773	7777	7782	7786	7791	7795	7800	7804	7809	7813	7817
23.50	7750	7754	7759	7764	7768	7773	7777	7782	7786	7791	7795	7800	7804	7809	7813	7818	7822
23.45	7755	7759	7764	7768	7773	7777	7782	7787	7791	7796	7800	7805	7809	7813	7818	7822	7827
23.40	7759	7764	7769	7773	7778	7782	7787	7791	7796	7800	7805	7809	7814	7818	7823	7827	7831
23.35	7764	7769	7773	7778	7782	7787	7792	7796	7801	7805	7809	7814	7818	7823	7827	7832	7836
23.30	7769	7774	7778	7783	7787	7792	7796	7801	7805	7810	7814	7819	7823	7827	7832	7836	7841
23.25	7774	7778	7783	7787	7792	7796	7801	7805	7810	7814	7819	7823	7828	7832	7837	7841	7845
23.20	7779	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850
23.15	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7833	7837	7841	7846	7850	7855
23.10	7788	7793	7797	7802	7806	7811	7815	7820	7824	7829	7833	7837	7842	7846	7851	7855	7859
23.05	7793	7797	7802	7807	7811	7815	7820	7824	7829	7833	7838	7842	7846	7851	7855	7860	7864
23.00	7798	7802	7807	7811	7816	7820	7825	7829	7834	7838	7842	7847	7851	7856	7860	7864	7869

Table 65 English—High Alt, Low-Mid Temp, High Humidity
(Temp = 57 to 73° F, Press = 23 to 27 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	57.0	58.0	59.0	60.0	61.0	62.0	63.0	64.0	65.0	66.0	67.0	68.0	69.0	70.0	71.0	72.0	73.0
27.00	7502	7507	7512	7517	7522	7527	7532	7537	7542	7547	7552	7557	7562	7566	7571	7576	7581
26.95	7507	7512	7517	7522	7527	7532	7537	7541	7546	7551	7556	7561	7566	7571	7576	7581	7586
26.90	7511	7516	7521	7526	7531	7536	7541	7546	7551	7556	7561	7566	7571	7575	7580	7585	7590
26.85	7516	7521	7526	7531	7536	7541	7546	7551	7556	7560	7565	7570	7575	7580	7585	7590	7595
26.80	7520	7525	7530	7535	7540	7545	7550	7555	7560	7565	7570	7575	7580	7585	7589	7594	7599
26.75	7525	7530	7535	7540	7545	7550	7555	7560	7565	7570	7574	7579	7584	7589	7594	7599	7604
26.70	7530	7535	7540	7545	7550	7555	7559	7564	7569	7574	7579	7584	7589	7594	7598	7603	7608
26.65	7534	7539	7544	7549	7554	7559	7564	7569	7574	7579	7584	7588	7593	7598	7603	7608	7613
26.60	7539	7544	7549	7554	7559	7564	7569	7573	7578	7583	7588	7593	7598	7603	7607	7612	7617
26.55	7544	7549	7554	7558	7563	7568	7573	7578	7583	7588	7593	7597	7602	7607	7612	7617	7622
26.50	7548	7553	7558	7563	7568	7573	7578	7583	7587	7592	7597	7602	7607	7612	7616	7621	7626
26.45	7553	7558	7563	7568	7573	7577	7582	7587	7592	7597	7602	7607	7611	7616	7621	7626	7631
26.40	7558	7562	7567	7572	7577	7582	7587	7592	7597	7601	7606	7611	7616	7621	7625	7630	7635
26.35	7562	7567	7572	7577	7582	7587	7592	7596	7601	7606	7611	7616	7620	7625	7630	7635	7640
26.30	7567	7572	7577	7582	7586	7591	7596	7601	7606	7611	7615	7620	7625	7630	7635	7639	7644
26.25	7571	7576	7581	7586	7591	7596	7601	7606	7610	7615	7620	7625	7629	7634	7639	7644	7649
26.20	7576	7581	7586	7591	7596	7600	7605	7610	7615	7620	7624	7629	7634	7639	7644	7648	7653
26.15	7581	7586	7590	7595	7600	7605	7610	7615	7619	7624	7629	7634	7639	7643	7648	7653	7658
26.10	7585	7590	7595	7600	7605	7610	7614	7619	7624	7629	7634	7638	7643	7648	7653	7657	7662
26.05	7590	7595	7600	7605	7609	7614	7619	7624	7629	7633	7638	7643	7648	7652	7657	7662	7667
26.00	7595	7600	7604	7609	7614	7619	7624	7628	7633	7638	7643	7647	7652	7657	7662	7666	7671
25.95	7599	7604	7609	7614	7619	7623	7628	7633	7638	7642	7647	7652	7657	7661	7666	7671	7675
25.90	7604	7609	7614	7618	7623	7628	7633	7638	7642	7647	7652	7656	7661	7666	7671	7675	7680
25.85	7609	7613	7618	7623	7628	7633	7637	7642	7647	7652	7656	7661	7666	7670	7675	7680	7684
25.80	7613	7618	7623	7628	7632	7637	7642	7647	7651	7656	7661	7666	7670	7675	7680	7684	7689
25.75	7618	7623	7627	7632	7637	7642	7647	7651	7656	7661	7665	7670	7675	7679	7684	7689	7693
25.70	7622	7627	7632	7637	7642	7646	7651	7656	7661	7665	7670	7675	7679	7684	7689	7693	7698
25.65	7627	7632	7637	7641	7646	7651	7656	7660	7665	7670	7675	7679	7684	7689	7693	7698	7702
25.60	7632	7637	7641	7646	7651	7656	7660	7665	7670	7674	7679	7684	7688	7693	7698	7702	7707
25.55	7636	7641	7646	7651	7655	7660	7665	7670	7674	7679	7684	7688	7693	7698	7702	7707	7711
25.50	7641	7646	7651	7655	7660	7665	7669	7674	7679	7683	7688	7693	7697	7702	7707	7711	7716
25.45	7646	7650	7655	7660	7665	7669	7674	7679	7683	7688	7693	7697	7702	7707	7711	7716	7720
25.40	7650	7655	7660	7664	7669	7674	7679	7683	7688	7693	7697	7702	7707	7711	7716	7720	7725
25.35	7655	7660	7664	7669	7674	7678	7683	7688	7693	7697	7702	7706	7711	7716	7720	7725	7729
25.30	7660	7664	7669	7674	7678	7683	7688	7692	7697	7702	7706	7711	7716	7720	7725	7729	7734
25.25	7664	7669	7674	7678	7683	7688	7692	7697	7702	7706	7711	7716	7720	7725	7729	7734	7738
25.20	7669	7674	7678	7683	7688	7692	7697	7702	7706	7711	7715	7720	7725	7729	7734	7738	7743
25.15	7673	7678	7683	7688	7692	7697	7702	7706	7711	7715	7720	7725	7729	7734	7738	7743	7747
25.10	7678	7683	7687	7692	7697	7701	7706	7711	7715	7720	7725	7729	7734	7738	7743	7747	7752
25.05	7683	7687	7692	7697	7701	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756
25.00	7687	7692	7697	7701	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761
24.95	7692	7697	7701	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765
24.90	7697	7701	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770
24.85	7701	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770	7774
24.80	7706	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770	7774	7779
24.75	7711	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770	7774	7779	7783
24.70	7715	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770	7774	7779	7783	7788
24.65	7720	7724	7729	7734	7738	7743	7747	7752	7756	7761	7765	7770	7774	7779	7783	7788	7792
24.60	7724	7729	7734	7738	7743	7747	7752	7756	7761	7766	7770	7775	7779	7783	7788	7792	7797
24.55	7729	7734	7738	7743	7747	7752	7757	7761	7766	7770	7775	7779	7784	7788	7792	7797	7801
24.50	7734	7738	7743	7747	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7801	7806
24.45	7738	7743	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7810
24.40	7743	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7810	7815
24.35	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7811	7815	7819
24.30	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7811	7815	7819	7824
24.25	7757	7761	7766	7771	7775	7780	7784	7788	7793	7797	7802	7806	7811	7815	7820	7824	7828
24.20	7762	7766	7771	7775	7780	7784	7789	7793	7798	7802	7806	7811	7815	7820	7824	7828	7833
24.15	7766	7771	7775	7780	7784	7789	7793	7798	7802	7807	7811	7815	7820	7824	7829	7833	7837
24.10	7771	7775	7780	7784	7789	7793	7798	7802	7807	7811	7815	7820	7824	7829	7833	7837	7842
24.05	7775	7780	7784	7789	7793	7798	7802	7807	7811	7816	7820	7824	7829	7833	7838	7842	7846
24.00	7780	7785	7789	7794	7798	7802	7807	7811	7816	7820	7825	7829	7833	7838	7842	7847	7851
23.95	7785	7789	7794	7798	7803	7807	7812	7816	7820	7825	7829	7834	7838	7842	7847	7851	7855
23.90	7789	7794	7798	7803	7807	7812	7816	7821	7825	7829	7834	7838	7842	7847	7851	7856	7860
23.85	7794	7799	7803	7807	7812	7816	7821	7825	7829	7834	7838	7843	7847	7851	7856	7860	7864
23.80	7799	7803	7808	7812	7816	7821	7825	7830	7834	7838	7843	7847	7852	7856	7860	7865	7869
23.75	7803	7808	7812	7817	7821	7825	7830	7834	7839	7843	7847	7852	7856	7860	7865	7869	7873
23.70	7808	7812	7817	7821	7826	7830	7834	7839	7843	7848	7852	7856	7861	7865	7869	7874	7878
23.65	7813	7817	7821	7826	7830	7835	7839	7843	7848	7852	7856	7861	7865	7869	7874	7878	7882
23.60	7817	7822	7826	7830	7835	7839	7844	7848	7852	7857	7861	7865	7870	7874	7878	7883	7887
23.55	7822	7826	7831	7835	7839	7844	7848	7853	7857	7861	7866	7870	7874	7878	7883	7887	7891
23.50	7826	7831	7835	7840	7844	7848	7853	7857	7861	7866	7870	7874	7879	7883	7887	7892	7896
23.45	7831	7836	7840	7844	7849	7853	7857	7862	7866	7870	7875	7879	7883	7888	7892	7896	7900
23.40	7836	7840	7845	7849	7853	7858	7862	7866	7871	7875	7879	7883	7888	7892	7896	7901	7905
23.35	7840	7845	7849	7854	7858	7862	7867	7871	7875	7879	7884	7888	7892	7897	7901	7905	7909
23.30	7845	7849	7854	7858	7862	7867	7871	7875	7880	7884	7888	7893	7897	7901	7905	7910	7914
23.25	7850	7854	7858	7863	7867	7871	7876	7880	7884	7889	7893	7897	7901	7906	7910	7914	7918
23.20	7854	7859	7863	7867	7872	7876	7880	7885	7889	7893	7897	7902	7906	7910	7914	7919	7923
23.15	7859	7863	7868	7872	7876	7881	7885	7889	7893	7898	7902	7906	7910	7915	7919	7923	7927
23.10	7864	7868	7872	7877	7881	7885	7889	7894	7898	7902	7906	7911	7915	7919	7923	7928	7932
23.05	7868	7873	7877	7881	7885	7890	7894	7898	7903	7907	7911	7915	7919	7924	7928	7932	7936
23.00	7873	7877	7881	7886	7890	7894	7899	7903	7907	7911	7916	7920	7924	7928	7932	7937	7941

Table 66 English—High Alt, Mid Temp, High Humidity
(Temp = 74 to 90° F, Press = 23 to 27 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY

	74.0	75.0	76.0	77.0	78.0	79.0	80.0	81.0	82.0	83.0	84.0	85.0	86.0	87.0	88.0	89.0	90.0
27.00	7586	7591	7596	7600	7605	7610	7615	7620	7625	7629	7634	7639	7644	7649	7653	7658	7663
26.95	7590	7595	7600	7605	7610	7615	7619	7624	7629	7634	7639	7643	7648	7653	7658	7663	7667
26.90	7595	7600	7605	7609	7614	7619	7624	7629	7633	7638	7643	7648	7653	7657	7662	7667	7672
26.85	7599	7604	7609	7614	7619	7623	7628	7633	7638	7643	7647	7652	7657	7662	7667	7671	7676
26.80	7604	7609	7614	7618	7623	7628	7633	7638	7642	7647	7652	7657	7661	7666	7671	7676	7680
26.75	7608	7613	7618	7623	7628	7632	7637	7642	7647	7651	7656	7661	7666	7671	7675	7680	7685
26.70	7613	7618	7622	7627	7632	7637	7642	7646	7651	7656	7661	7665	7670	7675	7680	7684	7689
26.65	7617	7622	7627	7632	7636	7641	7646	7651	7656	7660	7665	7670	7675	7679	7684	7689	7694
26.60	7622	7627	7631	7636	7641	7646	7650	7655	7660	7665	7669	7674	7679	7684	7688	7693	7698
26.55	7626	7631	7636	7641	7645	7650	7655	7660	7664	7669	7674	7679	7683	7688	7693	7697	7702
26.50	7631	7636	7640	7645	7650	7655	7659	7664	7669	7674	7678	7683	7688	7692	7697	7702	7707
26.45	7635	7640	7645	7650	7654	7659	7664	7669	7673	7678	7683	7687	7692	7697	7702	7706	7711
26.40	7640	7645	7649	7654	7659	7663	7668	7673	7678	7682	7687	7692	7696	7701	7706	7711	7715
26.35	7644	7649	7654	7658	7663	7668	7673	7677	7682	7687	7691	7696	7701	7706	7710	7715	7720
26.30	7649	7653	7658	7663	7668	7672	7677	7682	7686	7691	7696	7701	7705	7710	7715	7719	7724
26.25	7653	7658	7663	7667	7672	7677	7682	7686	7691	7696	7700	7705	7710	7714	7719	7724	7728
26.20	7658	7662	7667	7672	7677	7681	7686	7691	7695	7700	7705	7709	7714	7719	7723	7728	7733
26.15	7662	7667	7672	7676	7681	7686	7690	7695	7700	7704	7709	7714	7718	7723	7728	7732	7737
26.10	7667	7671	7676	7681	7685	7690	7695	7700	7704	7709	7714	7718	7723	7727	7732	7737	7741
26.05	7671	7676	7681	7685	7690	7695	7699	7704	7709	7713	7718	7723	7727	7732	7736	7741	7746
26.00	7676	7680	7685	7690	7694	7699	7704	7708	7713	7718	7722	7727	7732	7736	7741	7746	7750
25.95	7680	7685	7690	7694	7699	7704	7708	7713	7717	7722	7727	7731	7736	7741	7745	7750	7755
25.90	7685	7689	7694	7699	7703	7708	7713	7717	7722	7726	7731	7736	7740	7745	7750	7754	7759
25.85	7689	7694	7698	7703	7708	7712	7717	7722	7726	7731	7736	7740	7745	7749	7754	7759	7763
25.80	7694	7698	7703	7708	7712	7717	7721	7726	7731	7735	7740	7745	7749	7754	7758	7763	7768
25.75	7698	7703	7707	7712	7717	7721	7726	7731	7735	7740	7744	7749	7754	7758	7763	7767	7772
25.70	7703	7707	7712	7717	7721	7726	7730	7735	7740	7744	7749	7753	7758	7763	7767	7772	7776
25.65	7707	7712	7716	7721	7726	7730	7735	7739	7744	7749	7753	7758	7762	7767	7771	7776	7781
25.60	7712	7716	7721	7725	7730	7735	7739	7744	7748	7753	7758	7762	7767	7771	7776	7780	7785
25.55	7716	7721	7725	7730	7734	7739	7744	7748	7753	7757	7762	7767	7771	7776	7780	7785	7789
25.50	7721	7725	7730	7734	7739	7744	7748	7753	7757	7762	7766	7771	7775	7780	7785	7789	7794
25.45	7725	7730	7734	7739	7743	7748	7753	7757	7762	7766	7771	7775	7780	7784	7789	7794	7798
25.40	7730	7734	7739	7743	7748	7752	7757	7762	7766	7771	7775	7780	7784	7789	7793	7798	7802
25.35	7734	7739	7743	7748	7752	7757	7761	7766	7771	7775	7780	7784	7789	7793	7798	7802	7807
25.30	7739	7743	7748	7752	7757	7761	7766	7770	7775	7779	7784	7789	7793	7798	7802	7807	7811
25.25	7743	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7811	7815
25.20	7748	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7811	7815	7820
25.15	7752	7757	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7811	7815	7820	7824
25.10	7756	7761	7766	7770	7775	7779	7784	7788	7793	7797	7802	7806	7811	7815	7820	7824	7829
25.05	7761	7765	7770	7775	7779	7784	7788	7793	7797	7802	7806	7810	7815	7819	7824	7828	7833
25.00	7765	7770	7774	7779	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7833	7837
24.95	7770	7774	7779	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7833	7837	7842
24.90	7774	7779	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7833	7837	7842	7846
24.85	7779	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7833	7837	7841	7846	7850
24.80	7783	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7855
24.75	7788	7792	7797	7801	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7855	7859
24.70	7792	7797	7801	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7855	7859	7863
24.65	7797	7801	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7855	7859	7863	7868
24.60	7801	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7854	7859	7863	7868	7872
24.55	7806	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7854	7859	7863	7868	7872	7876
24.50	7810	7815	7819	7824	7828	7832	7837	7841	7846	7850	7854	7859	7863	7868	7872	7876	7881
24.45	7815	7819	7824	7828	7832	7837	7841	7846	7850	7854	7859	7863	7868	7872	7876	7881	7885
24.40	7819	7824	7828	7833	7837	7841	7846	7850	7855	7859	7863	7868	7872	7876	7881	7885	7890
24.35	7824	7828	7833	7837	7841	7846	7850	7855	7859	7863	7868	7872	7876	7881	7885	7890	7894
24.30	7828	7833	7837	7841	7846	7850	7855	7859	7863	7868	7872	7876	7881	7885	7890	7894	7898
24.25	7833	7837	7842	7846	7850	7855	7859	7863	7868	7872	7876	7881	7885	7890	7894	7898	7903
24.20	7837	7842	7846	7850	7855	7859	7863	7868	7872	7877	7881	7885	7890	7894	7898	7903	7907
24.15	7842	7846	7850	7855	7859	7864	7868	7872	7877	7881	7885	7890	7894	7898	7903	7907	7911
24.10	7846	7851	7855	7859	7864	7868	7872	7877	7881	7885	7890	7894	7898	7903	7907	7911	7916
24.05	7851	7855	7859	7864	7868	7872	7877	7881	7885	7890	7894	7898	7903	7907	7911	7916	7920
24.00	7855	7860	7864	7868	7873	7877	7881	7886	7890	7894	7899	7903	7907	7911	7916	7920	7924
23.95	7860	7864	7868	7873	7877	7881	7886	7890	7894	7899	7903	7907	7912	7916	7920	7924	7929
23.90	7864	7869	7873	7877	7881	7886	7890	7894	7899	7903	7907	7912	7916	7920	7925	7929	7933
23.85	7869	7873	7877	7882	7886	7890	7895	7899	7903	7907	7912	7916	7920	7925	7929	7933	7937
23.80	7873	7877	7882	7886	7890	7895	7899	7903	7908	7912	7916	7920	7925	7929	7933	7938	7942
23.75	7878	7882	7886	7891	7895	7899	7903	7908	7912	7916	7921	7925	7929	7933	7938	7942	7946
23.70	7882	7886	7891	7895	7899	7904	7908	7912	7916	7921	7925	7929	7933	7938	7942	7946	7951
23.65	7887	7891	7895	7899	7904	7908	7912	7917	7921	7925	7929	7934	7938	7942	7946	7951	7955
23.60	7891	7895	7900	7904	7908	7912	7917	7921	7925	7930	7934	7938	7942	7947	7951	7955	7959
23.55	7896	7900	7904	7908	7913	7917	7921	7925	7930	7934	7938	7942	7947	7951	7955	7959	7964
23.50	7900	7904	7909	7913	7917	7921	7926	7930	7934	7938	7943	7947	7951	7955	7960	7964	7968
23.45	7905	7909	7913	7917	7922	7926	7930	7934	7939	7943	7947	7951	7955	7960	7964	7968	7972
23.40	7909	7913	7918	7922	7926	7930	7934	7939	7943	7947	7951	7956	7960	7964	7968	7972	7977
23.35	7914	7918	7922	7926	7930	7935	7939	7943	7947	7952	7956	7960	7964	7968	7973	7977	7981
23.30	7918	7922	7927	7931	7935	7939	7943	7948	7952	7956	7960	7964	7969	7973	7977	7981	7985
23.25	7923	7927	7931	7935	7939	7944	7948	7952	7956	7960	7965	7969	7973	7977	7981	7986	7990
23.20	7927	7931	7935	7940	7944	7948	7952	7956	7961	7965	7969	7973	7977	7982	7986	7990	7994
23.15	7932	7936	7940	7944	7948	7952	7957	7961	7965	7969	7973	7978	7982	7986	7990	7994	7998
23.10	7936	7940	7944	7949	7953	7957	7961	7965	7969	7974	7978	7982	7986	7990	7994	7999	8003
23.05	7940	7945	7949	7953	7957	7961	7966	7970	7974	7978	7982	7986	7991	7995	7999	8003	8007
23.00	7945	7949	7953	7958	7962	7966	7970	7974	7978	7982	7987	7991	7995	7999	8003	8007	8012

Table 67 English—High Alt, High-Mid Temp, High Humidity
(Temp = 91 to 107° F, Press = 23 to 27 inches, 80% Humidity)

TEMPERATURE IN DEGREES FAHRENHEIT

BAROMETRIC PRESSURE IN INCHES OF MERCURY	91.0	92.0	93.0	94.0	95.0	96.0	97.0	98.0	99.0	100.0	101.0	102.0	103.0	104.0	105.0	106.0	107.0
27.00	7668	7673	7677	7682	7687	7692	7697	7701	7706	7711	7716	7721	7726	7730	7735	7740	7745
26.95	7672	7677	7682	7687	7691	7696	7701	7706	7711	7715	7720	7725	7730	7735	7740	7744	7749
26.90	7677	7681	7686	7691	7696	7700	7705	7710	7715	7720	7724	7729	7734	7739	7744	7749	7754
26.85	7681	7686	7690	7695	7700	7705	7710	7714	7719	7724	7729	7734	7738	7743	7748	7753	7758
26.80	7685	7690	7695	7700	7704	7709	7714	7719	7723	7728	7733	7738	7743	7747	7752	7757	7762
26.75	7690	7694	7699	7704	7709	7713	7718	7723	7728	7732	7737	7742	7747	7752	7757	7761	7766
26.70	7694	7699	7703	7708	7713	7718	7722	7727	7732	7737	7742	7746	7751	7756	7761	7766	7770
26.65	7698	7703	7708	7712	7717	7722	7727	7732	7736	7741	7746	7751	7755	7760	7765	7770	7775
26.60	7703	7707	7712	7717	7722	7726	7731	7736	7741	7745	7750	7755	7760	7764	7769	7774	7779
26.55	7707	7712	7716	7721	7726	7731	7735	7740	7745	7750	7754	7759	7764	7769	7774	7778	7783
26.50	7711	7716	7721	7725	7730	7735	7740	7744	7749	7754	7759	7763	7768	7773	7778	7783	7787
26.45	7716	7720	7725	7730	7734	7739	7744	7749	7753	7758	7763	7768	7772	7777	7782	7787	7792
26.40	7720	7725	7729	7734	7739	7744	7748	7753	7758	7762	7767	7772	7777	7781	7786	7791	7796
26.35	7724	7729	7734	7738	7743	7748	7753	7757	7762	7767	7771	7776	7781	7786	7790	7795	7800
26.30	7729	7733	7738	7743	7747	7752	7757	7762	7766	7771	7776	7780	7785	7790	7795	7800	7804
26.25	7733	7738	7742	7747	7752	7756	7761	7766	7771	7775	7780	7785	7789	7794	7799	7804	7809
26.20	7737	7742	7747	7751	7756	7761	7765	7770	7775	7780	7784	7789	7794	7798	7803	7808	7813
26.15	7742	7746	7751	7756	7760	7765	7770	7774	7779	7784	7789	7793	7798	7803	7807	7812	7817
26.10	7746	7751	7755	7760	7765	7769	7774	7779	7783	7788	7793	7798	7802	7807	7812	7816	7821
26.05	7750	7755	7760	7764	7769	7774	7778	7783	7788	7792	7797	7802	7806	7811	7816	7821	7825
26.00	7755	7759	7764	7769	7773	7778	7783	7787	7792	7797	7801	7806	7811	7815	7820	7825	7830
25.95	7759	7764	7768	7773	7778	7782	7787	7792	7796	7801	7806	7810	7815	7820	7824	7829	7834
25.90	7763	7768	7773	7777	7782	7787	7791	7796	7801	7805	7810	7815	7819	7824	7829	7833	7838
25.85	7768	7772	7777	7782	7786	7791	7796	7800	7805	7809	7814	7819	7823	7828	7833	7838	7842
25.80	7772	7777	7781	7786	7791	7795	7800	7804	7809	7814	7818	7823	7828	7832	7837	7842	7847
25.75	7777	7781	7786	7790	7795	7800	7804	7809	7813	7818	7823	7827	7832	7837	7841	7846	7851
25.70	7781	7785	7790	7795	7799	7804	7808	7813	7818	7822	7827	7832	7836	7841	7846	7850	7855
25.65	7785	7790	7794	7799	7804	7808	7813	7817	7822	7827	7831	7836	7841	7845	7850	7855	7859
25.60	7790	7794	7799	7803	7808	7812	7817	7822	7826	7831	7836	7840	7845	7849	7854	7859	7863
25.55	7794	7798	7803	7808	7812	7817	7821	7826	7831	7835	7840	7844	7849	7854	7858	7863	7868
25.50	7798	7803	7807	7812	7817	7821	7826	7830	7835	7839	7844	7849	7853	7858	7863	7867	7872
25.45	7803	7807	7812	7816	7821	7825	7830	7835	7839	7844	7848	7853	7858	7862	7867	7871	7876
25.40	7807	7812	7816	7821	7825	7830	7834	7839	7843	7848	7853	7857	7862	7866	7871	7876	7880
25.35	7811	7816	7820	7825	7829	7834	7839	7843	7848	7852	7857	7861	7866	7871	7875	7880	7885
25.30	7816	7820	7825	7829	7834	7838	7843	7847	7852	7857	7861	7866	7870	7875	7880	7884	7889
25.25	7820	7825	7829	7834	7838	7843	7847	7852	7856	7861	7865	7870	7875	7879	7884	7888	7893
25.20	7824	7829	7833	7838	7842	7847	7851	7856	7861	7865	7870	7874	7879	7883	7888	7893	7897
25.15	7829	7833	7838	7842	7847	7851	7856	7860	7865	7869	7874	7879	7883	7888	7892	7897	7901
25.10	7833	7838	7842	7847	7851	7856	7860	7865	7869	7874	7878	7883	7887	7892	7896	7901	7906
25.05	7837	7842	7846	7851	7855	7860	7864	7869	7873	7878	7882	7887	7892	7896	7901	7905	7910
25.00	7842	7846	7851	7855	7860	7864	7869	7873	7878	7882	7887	7891	7896	7900	7905	7910	7914
24.95	7846	7851	7855	7860	7864	7868	7873	7877	7882	7887	7891	7896	7900	7905	7909	7914	7918
24.90	7850	7855	7859	7864	7868	7873	7877	7882	7886	7891	7895	7900	7904	7909	7913	7918	7923
24.85	7855	7859	7864	7868	7873	7877	7882	7886	7891	7895	7900	7904	7909	7913	7918	7922	7927
24.80	7859	7864	7868	7873	7877	7881	7886	7890	7895	7899	7904	7908	7913	7917	7922	7926	7931
24.75	7863	7868	7872	7877	7881	7886	7890	7895	7899	7904	7908	7913	7917	7922	7926	7931	7935
24.70	7868	7872	7877	7881	7886	7890	7894	7899	7903	7908	7912	7917	7921	7926	7930	7935	7939
24.65	7872	7877	7881	7885	7890	7894	7899	7903	7908	7912	7917	7921	7926	7930	7935	7939	7944
24.60	7877	7881	7885	7890	7894	7899	7903	7908	7912	7916	7921	7925	7930	7934	7939	7943	7948
24.55	7881	7885	7890	7894	7899	7903	7907	7912	7916	7921	7925	7930	7934	7939	7943	7948	7952
24.50	7885	7890	7894	7898	7903	7907	7912	7916	7921	7925	7929	7934	7938	7943	7947	7952	7956
24.45	7890	7894	7898	7903	7907	7912	7916	7920	7925	7929	7934	7938	7943	7947	7952	7956	7961
24.40	7894	7898	7903	7907	7912	7916	7920	7925	7929	7934	7938	7942	7947	7951	7956	7960	7965
24.35	7898	7903	7907	7911	7916	7920	7925	7929	7933	7938	7942	7947	7951	7956	7960	7965	7969
24.30	7903	7907	7911	7916	7920	7925	7929	7933	7938	7942	7947	7951	7955	7960	7964	7969	7973
24.25	7907	7911	7916	7920	7924	7929	7933	7938	7942	7946	7951	7955	7960	7964	7969	7973	7978
24.20	7911	7916	7920	7924	7929	7933	7938	7942	7946	7951	7955	7960	7964	7968	7973	7977	7982
24.15	7916	7920	7924	7929	7933	7937	7942	7946	7951	7955	7959	7964	7968	7973	7977	7982	7986
24.10	7920	7924	7929	7933	7937	7942	7946	7950	7955	7959	7964	7968	7972	7977	7981	7986	7990
24.05	7924	7929	7933	7937	7942	7946	7950	7955	7959	7964	7968	7972	7977	7981	7986	7990	7994
24.00	7929	7933	7937	7942	7946	7950	7955	7959	7963	7968	7972	7977	7981	7985	7990	7994	7999
23.95	7933	7937	7942	7946	7950	7955	7959	7963	7968	7972	7976	7981	7985	7990	7994	7998	8003
23.90	7937	7942	7946	7950	7955	7959	7963	7968	7972	7976	7981	7985	7989	7994	7998	8003	8007
23.85	7942	7946	7950	7955	7959	7963	7968	7972	7976	7981	7985	7989	7994	7998	8002	8007	8011
23.80	7946	7950	7955	7959	7963	7968	7972	7976	7981	7985	7989	7994	7998	8002	8007	8011	8016
23.75	7950	7955	7959	7963	7968	7972	7976	7981	7985	7989	7994	7998	8002	8007	8011	8015	8020
23.70	7955	7959	7963	7968	7972	7976	7981	7985	7989	7993	7998	8002	8006	8011	8015	8020	8024
23.65	7959	7963	7968	7972	7976	7981	7985	7989	7993	7998	8002	8006	8011	8015	8019	8024	8028
23.60	7964	7968	7972	7976	7981	7985	7989	7993	7998	8002	8006	8011	8015	8019	8024	8028	8032
23.55	7968	7972	7976	7981	7985	7989	7993	7998	8002	8006	8011	8015	8019	8024	8028	8032	8037
23.50	7972	7976	7981	7985	7989	7993	7998	8002	8006	8011	8015	8019	8024	8028	8032	8037	8041
23.45	7977	7981	7985	7989	7994	7998	8002	8006	8011	8015	8019	8023	8028	8032	8036	8041	8045
23.40	7981	7985	7989	7994	7998	8002	8006	8011	8015	8019	8023	8028	8032	8036	8041	8045	8049
23.35	7985	7989	7994	7998	8002	8006	8011	8015	8019	8023	8028	8032	8036	8041	8045	8049	8054
23.30	7990	7994	7998	8002	8006	8011	8015	8019	8023	8028	8032	8036	8041	8045	8049	8053	8058
23.25	7994	7998	8002	8007	8011	8015	8019	8023	8028	8032	8036	8040	8045	8049	8053	8058	8062
23.20	7998	8003	8007	8011	8015	8019	8024	8028	8032	8036	8040	8045	8049	8053	8058	8062	8066
23.15	8003	8007	8011	8015	8019	8024	8028	8032	8036	8041	8045	8049	8053	8058	8062	8066	8070
23.10	8007	8011	8015	8020	8024	8028	8032	8036	8041	8045	8049	8053	8058	8062	8066	8070	8075
23.05	8011	8016	8020	8024	8028	8032	8036	8041	8045	8049	8053	8058	8062	8066	8070	8075	8079
23.00	8016	8020	8024	8028	8032	8037	8041	8045	8049	8053	8058	8062	8066	8070	8075	8079	8083

14
Material Expansion Coefficients

Linear Thermal Expansion Coefficients of Metals and Alloys

Table 68 provides the linear thermal expansion coefficients of the most frequently used metals and allows.

Table 68 Linear thermal expansion coefficients of metals and alloys

Alloys	Coefficient of Expansion	
	ppm/°C	ppm/°F
ALUMINUM AND ALUMINUM ALLOYS		
Aluminum (99.996%)	23.6	13.1
Wrought Alloys		
EC 1060 and 1100	23.6	13.1
2011 and 2014	23.0	12.8
2024	22.8	12.7
2218	22.3	12.4
3003	23.2	12.9
4032	19.4	10.8
5005, 5050, and 5052	23.8	13.3
5056	24.1	13.4
5083	23.4	13.0
5086	23.9	13.3
5154	23.9	13.3
5357	23.7	13.2
5456	23.9	13.3
6061 and 6063	23.4	13.0
6101 and 6151	23.0	12.8
7075	23.2	12.9
7090 and 7178	23.4	13.0

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion ppm/°C	Coefficient of Expansion ppm/°F
ALUMINUM AND ALUMINUM ALLOYS (Continued)		
Casting Alloys		
A13	20.4	11.4
43 and 108	22.0	12.3
A108	21.5	12.0
A132	19.0	10.6
D132	20.5	11.4
F132	20.7	11.5
138	21.4	11.9
142	22.5	12.5
195	23.0	12.8
B195	22.0	12.3
214	24.0	13.4
220	25.0	13.9
319	21.5	12.0
355	22.0	12.3
356	21.5	12.0
360	21.0	11.7
750	23.1	12.9
40E	24.7	13.8
COPPER AND COPPER ALLOYS		
Wrought Coppers		
Pure Copper	16.5	9.2
Electrolytic Tough Pitch Copper (ETP)	16.8	9.4
Deoxidized Copper, High Residual Phosphorous (DHP)	17.7	9.9
Oxygen-Free Copper	17.7	9.9
Free-Machining Copper 0.5% Te or 1% Pb	17.7	9.9

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion	
	ppm/°C	ppm/°F
COPPER AND COPPER ALLOYS (Continued)		
Wrought Alloys (Continued)		
Gilding, 95%	18.1	10.1
Commercial Bronze, 90%	18.4	10.3
Jewelry Bronze, 87.5%	18.6	10.4
Red Brass, 85%	18.7	10.4
Low Brass, 80%	19.1	10.6
Cartridge Brass, 70%	19.9	11.1
Yellow Brass	20.3	11.2
Muntz Metal	20.8	11.5
Leaded Commercial Bronze	18.4	10.2
Low-Leaded Brass	20.2	11.3
Medium-Leaded Brass	20.3	11.3
High-Leaded Brass	20.3	11.3
Extra-High-Leaded Brass	20.5	11.4
Free-Cutting Brass	20.5	11.4
Leaded Muntz Metal	20.8	11.6
Forging Brass	20.7	11.5
Architectural Bronze	20.9	11.6
Inhibited Admiralty	20.2	11.3
Naval Brass	21.2	11.8
Leaded Naval Brass	21.2	11.8
Manganese Bronze (A)	21.2	11.8
Phosphorous Bronze, 5% (A)	17.8	9.9
Phosphorous Bronze, 8% (C)	18.2	10.1
Phosphorous Bronze, 10%(D)	18.4	10.3
Phosphorous Bronze, 1.25%	17.8	9.9

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion	
	ppm/°C	**ppm/°F**
COPPER AND COPPER ALLOYS (Continued)		
Wrought Alloys (Continued)		
Free-Cutting Phosphorous Bronze	17.3	9.6
Cupro-Nickel, 30%	16.2	9.0
Cupro-Nickel, 10%	17.1	9.5
Nickel Silver, 65-18	16.2	9 0
Nickel Silver, 55-18	16.7	9.3
Nickel Silver, 65.12	16.2	9.0
High-Silicon Bronze (A)	18.0	10.0
Low-Silicon Bronze (B)	179	10.0
Aluminum Bronze (3)	16.4	9.2
Aluminum-Silicon Bronze	18.0	10.0
Aluminum Bronze	16.8	9.4
Beryllium Copper	17.8	9.9
Casting Alloys		
88 Cu-8 SN-4 Zn	18.0	10.0
88 Cu-11 Sn	18.4	10.3
88 Cu-6 Sn-1.5 Pb-4.5 Zn	18.5	10.3
87 Cu-8 Sn-1 Pb-4 Zn	18.0	10.0
87 Cu-10 Sn-1 Pb-2 Zn	18.0	10.0
80 Cu-10 Sn-10 Pb	18.5	10.3
78 Cu-7 Sn-15 Pb	18.5	10.3
85 Cu-5 Sn-5 Pb-5 Zn	18.1	10.0
72 Cu-1 Sn-3 Pb-24 Zn	20.7	11.5
67 Cu-1 Sn-3 Pb-29 Zn	20.2	11.3
61 Cu-1 Sn-1 Pb-37 Zn	21.6	12.0
Manganese Bronze (60,000 psi)	20.5	11.4

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion ppm/°C	ppm/°F
COPPER AND COPPER ALLOYS (Continued)		
Casting Alloys (Continued)		
Manganese Bronze (65,000 psi)	21.6	12.0
Manganeze Bronze (110,000 psi)	19.8	11.0
Aluminum Bronze (Alloy 9A)	17.0	9.5
Aluminum Bronze (Alloy 9B)	17.0	9.5
Aluminum Bronze (Alloys 9C & 9D)	16.2	9.0
IRON AND IRON ALLOYS		
Pure Iron	11.7	6.5
Fe-C Alloys		
0.06% C	11.7	6.5
0.22% C	11.7	6.5
0.40% C	11.3	6.3
0.56% C	11.0	6.1
1.08% C	10.8	6.0
1.45% C	10.1	5.6
Invar (36 Ni)	0 to 2	to 1.1
13 Mn-1.2 C	18.0	10.0
13 Cr-0.35 C	10.0	5.6
12.0 Cr-0.4 Ni-0.09 C	9.8	5.5
17.7 Cr-9.6 Ni-0.06 C	16.5	9.2
18. W-4 Cr-1 V	11.2	6.2
Gray Cast Iron	10.5	5.7
Malleable Iron (Pearlitic)	12.0	6.7
LEAD AND LEAD ALLOYS		
Corroding Lead (99.73+% Pb)	29.3	16.3
5-95 Solder	28.7	16.0
20-80 Solder	26.5	14.8
50-50 Solder	23.4	13.0

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion ppm/°C	Coefficient of Expansion ppm/°F
LEAD AND LEAD ALLOYS (Continued)		
1% Antimonial Lead	28.8	16.1
Hard Lead (96 Pb, 4 Sb)	27.8	15.5
Hard Lead (94Pb, 6 Sb)	27.2	15.2
8% Antimonial Lead	26.7	14.9
9% Antimonial Lead	26.4	14.7
Lead-Base Babbitt:		
SAE 14	19.6	10.9
Alloy 8	24.0	13.4
MAGNESIUM AND MAGNESIUM ALLOYS		
Magnesium (99.8%)	25.2	14.1
Casting Alloys		
AM100A	25.2	14.1
AZ63A	26.1	14.6
AZ91A, B, C	26.0	14.5
AZ92A	25.2	14.1
HZ32A	26.7	14.9
ZH42	27.0	15.1
ZH62A	27.1	15.1
AK51A	26.1	14.6
EZ33A	26.1	14.6
EK30A and EK41A	26.1	14.6
Wrought Alloys		
M1A and A3A	26.0	14.5
AZ31B and PE	26.0	14.5
AZ61A and AZ80A	26.0	14.5
ZK60A, B	26.0	14.5
HM31A	26.1	14.6

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion	
	ppm/°C	ppm/°F
NICKEL AND NICKEL ALLOYS		
Nickel (99.95% Ni-+Co)	13.3	7.4
Duranickel	13.0	7.2
Monel	14.0	7.8
Monel (cast)	12.9	7.2
Inconel	11.5	6.4
Ni-o-nel	12.9	7.2
Hastelloy B	10.0	5.6
Hastelloy C	11.3	6.3
Hastelloy D	11.0	6.1
Hastelloy F	14.2	7.9
Hastelloy N	10.4	5.8
Hastelloy W	11.3	6.3
Hastelloy X	13.8	7.7
Illium G	12.19	6.8
Illium R	12.0	26.7
80 Ni-20 Cr	17.3	9.6
60 Ni-24 Fe-16Cr	17.0	9.5
35 Ni-45 Fe-20 Cr	15.8	8.8
Constantan	18.8	10.5
STAINLESS STEELS		
301	16.9	9.4
302	17.3	9.6
302B	16.2	9.0
303	17.3	9.6
304	17.3	9.6
305	17.3	9.6
308	17.3	9.6

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion	
	ppm/°C	ppm/°F
STAINLESS STEELS (Continued)		
309	14.9	8.3
310	14.4	8.0
314	15.1	8.4
316	16.0	8.9
317	16.0	8.9
321	16.7	9.3
347	16.7	9.3
501	11.15	6.2
502	11.15	6.2
403	9.9	5.5
405	10.8	6.0
410	11.0	6.1
416	9.9	5.5
420	10.25	5.7
430	10.45	5.8
430F	10.45	5.8
431	11.7	6.5
440A	10.1	5.6
440B	10.1	5.6
440C	10.1	5.6
446	10.6	5.9
TITANIUM AND TITANIUM ALLOYS		
99.9% Ti	8.41	4.7
99.0% Ti	8.55	4.76
Ti-5 A1-2.5 Sn	9.36	5.2
Ti-8 Mn	8.64	4.8

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion	
	ppm/°C	ppm/°F
ZINC AND ZINC ALLOYS		
Pure Zinc	39.7	22.1
AG40A Alloy	27.4	15.3
AC41A Alloy	27.4	15.3
Commercial Rolled Zinc:		
0.08 Pb	32.5	18.1
03 Pb, 0.3 Cd	33.9*	18.9
Rolled Zinc Allow (1Cu, 0.010 Mg)	34.8**	19.4
An-Cu-Ti Alloy (0.8 Cu, 0.15 Ti)	24.9***	13.9
*With the grain; 23.4 across the grain ** With the grain; 21.1 across the grain ***With the grain; 19.4 across the grain		
PURE METALS		
Beryllium	11.6	6.5
Cadmium	29.8	16.6
Calcium	22.3	12.4
Chromium	6.2	3.5
Cobalt	13.8	7.7
Gold	14.2	7.9
Iridium	6.8	3.8
Lithium	56.0	31.0
Manganese	22.0	12.3
Palladium	11.76	6.6
Platinum	8.9	5.0
Rhenium	6.7	3.7
Rhodium	8.3	4.6
Ruthenium	9.1	5.1
Silicon	5.0	2.8

Table 68 Linear thermal expansion coefficients of metals and alloys (continued)

Alloys	Coefficient of Expansion	
	ppm/°C	**ppm/°F**
PURE METALS (Continued)		
Silver	19.68	11.0
Tungsten	4.6	2.7
Vanadium	8.3	4.6
Zirconium	5.85	3.3

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Glossary

Abbé error — Abbé error occurs when the measuring point of interest is displaced from the actual measuring scale location and unwanted angular motion occurs in the positioning system.

Abbé error makes the indicated position either shorter or longer than the actual position, depending on the angular offset.

AC interferometer — A two-frequency interferometer.

Accuracy — The maximum deviation of a measurement from a known standard or true value.

Air deadpath — The most frequently encountered form of interferometer deadpath is the difference in *air* path lengths between the reference and measurement arms when the stage is at its zero or home position.

Axis electronics — The modular electronics needed to run one axis of measurement.

Beam splitter — A device to separate and direct light beams, sending the beams straight through, reflecting them at a right angle, or both.

CMM — A precision coordinate measuring machine.

Compensation, Wavelength-of-Light — Correction for the small changes in the wavelength of light due to changes in the refractive index of air.

Cosine error — An error between the measured distance and the actual distance traveled. The error results from misalignment of the measurement axis (the laser beam) to the mechanical axis of motion. This error is called cosine error because its magnitude is proportional to the cosine of the angle of misalignment.

Cube corner — Also called a retroreflector. A mirror assembly that always reflects the light beam parallel to the incoming beam.

DC interferometer — A single-frequency interferometer.

Deadpath — The difference in OPL (optical path length) between the reference and measurement arms of an interferometer when the stage is at its zero or home position.

Deadpath error— If interferometer deadpath exists and is not compensated, the measurement stage zero point or home position will appear to move around with changes in air temperature, pressure, humidity and/or with changes in temperature of glass components and the metrology frame.

Differential interferometer — An interferometer assembly in which the fixed reference mirror can be remotely mounted, allowing a differential measurement.

Differential measurement — A measurement in which both the reference beam and the measurement beam travel to external mirrors outside the interferometer housing.

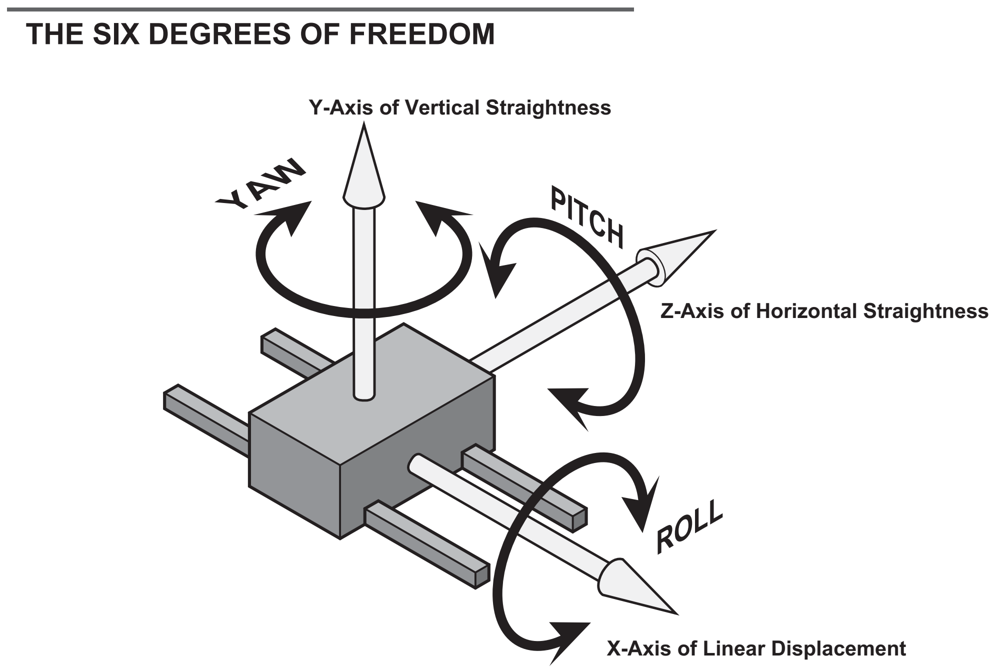

Figure 71 Degrees of freedom (for X-Axis)

Degrees of freedom — Possible motions.

Generally, there are six degrees of freedom for each axis as shown in Figure 71. Three of the degrees of freedom are translational. Three of the degrees of freedom are rotational.

ESD — Electrostatic Discharge. A natural phenomenon which, while possibly insignificant on a human scale, can ruin a static-sensitive electronic component. For ESD-avoidance steps, see the Chapter 8, “Troubleshooting,” in this manual.

Etalon — An etalon is an optical reference cavity. When used in the wavelength tracker, the etalon provides a fixed physical distance reference to the differential interferometer. Any length change measured in the etalon is presumed to be due to a change in the optical path length through the air in the cavity, rather than a change in the cavity size

f_1 — The lower one of the two frequencies in the laser beam.

f_2 — The higher one of the two frequencies in the laser beam.

f_A, f_B — Frequency paths in an interferometer.

Half-wave plate — An optical element which introduces a relative phase shift of 180 degrees between the orthogonal components of a wave. This changes the handedness of elliptical and circular light, changing right to left and vice-versa.

HEX — Short for Hexadecimal. See Number systems.

Interferometer — The term interferometer may be applied to any optical arrangement where a beam of light from a light source is separated into two or more paths by a beam splitter and the parts are subsequently recombined after traversing different optical paths. The two components then produce interference.

Kinematic mounting — Kinematic means that all six degrees of freedom (3 translational, 3 rotational) are uniquely and unambiguously restricted.

For kinematic mounting uses a locating plane, a locating line, and a locating point.

The locating plane will be the surface to which the top or the bottom of the interferometer is bolted.

The locating line should be a 2-point contact (or rail) which aligns the front face of the interferometer.

The locating point should be a 1-point contact (or pad) which constrains side-to-side translations of the interferometer.

When installing the interferometer, press it firmly against its locating plane, line, and point while torquing down the mounting screws. If the platform is made with reasonable accuracy, this mounting method can completely eliminate the need to adjust or align a referenced interferometer during installation. Then only the laser beam itself will need to be aligned to its proper position.

Laser — An acronym for “Light Amplification by Stimulated Emission of Radiation.” A laser is a device that uses the natural oscillations of atoms or molecules between energy levels for generating coherent light.

Laser Head — The laser source with its focusing and polarization components.

Laser Interferometry — A technique for measuring distance using the wavelength of laser light by observing and counting optical interference patterns. It can also refer to devices using interferometric techniques to measure surface flatness.

Linear interferometer — An interferometer designed to use cube corners (retroreflectors) as opposed to plane mirrors.

Measurement frequency — The frequency of interference wavefronts detected by the receiver.

MTC — Material Temperature Compensation term.

Number systems – Number systems used in dealing with the computer are typically one (or more) of the following: binary, octal, decimal, or hexadecimal (hex). To help you understand the relationship of these number systems, refer to Table 69. Calculators and computer programs that can convert from one of these number systems to another are available from Agilent Technologies and other sources.

Throughout this manual, numbers may be represented in binary (base 2), octal (base 8), decimal (base 10), or hexadecimal (base 16) number systems. Where it is necessary to specify the number system used in order to reduce the possibility of confusion, a base number will be indicated as a subscript or in brackets ("[ ]") at the end of the number.

For example, 100[16] = 256[10] = 400[8] = 100000000[2].

Table 69 Number systems

Base	Binary 2	Octal 8	Hexa-decimal 16	Decimal 10
	0 000 0 001 0 010 0 011	0 0 0 1 0 2 0 3	0 1 2 3	0 1 2 3
	0 100 0 001 0 110 0 111	0 4 0 5 0 6 0 7	4 5 6 7	4 5 6 7
	1 000 1 001 1 010 1 011	1 0 1 1 1 2 1 3	8 9 A B	8 9 10 11
	1 100 1 001 1 110 1 111	1 4 1 5 1 6 1 7	C D E F	12 13 14 15
Note that any one or more of the hexadecimal values shown here as "A" through "F" may be represented in lower case ("a", "b", etc).				

Parallelism measurement – A parallelism measurement consists of two straightness measurements made along the same axis from the same straightness reflector.

Parallelism is calculated by comparing the slopes of the two straightness measurements.

Plane mirror interferometer – An interferometer designed to use plane (flat) mirrors to measure motion.

Proportional error – A laser wavelength error that is a function of the distance measured.

Quarter-wave plate — An optical element which introduces a relative phase shift of 90 degrees between the orthogonal components of a wave. This converts linear polarized light to elliptical light and vice versa.

Receiver — The detector, mixer, and electronics to convert the optical signal to an electrical signal.

Reference frequency — The laser Reference Frequency is the difference in frequency between the two orthogonally polarized frequency components of the laser beam. The higher the reference frequency, the greater the measurement velocity or slew rate allowed during a measurement (except as limited by system electronics).

The Reference Frequency may also be referred to as the split frequency.

Referenced interferometer — An interferometer having internal optical components and laser beam paths whose positions are related to reference surfaces on its housing in specified ways.

Repeatability — The maximum deviation between measurements under the same conditions and with the same measuring instrument. This also refers to how stable the measurement will be over time.

Retroreflector — Also called a cube corner. A mirror assembly that always reflects light back parallel to the incoming beam.

Split frequency — Another name for the Reference Frequency.

The difference between the two frequencies in a two-frequency laser system.

Straightness — Straightness is a measurement of displacement perpendicular to the axis of intended motion of the optics.

TCN — Total Compensation Number.

This is a combined compensation term that contains a Wavelength-of-Light compensation term (WCN) and a Material Temperature compensation term (MTC).

Wavelength tracker — A device with an interferometer and a fixed measurement path that is immune to ambient temperature and pressure changes. By monitoring the apparent changes in this fixed pathlength, wavelength changes can be very accurately detected (and corrected).

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