User’s Guide

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For Safety information, Warranties, and Regulatory information, see the pages at the end of this manual.

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Infiniium Option 100 and E2625A Telecommunications Mask Template Kit
This Telecommunications Mask Template Kit User’s Guide contains the following information:

**Introduction to Option 100 and E2625A Telecommunications Mask Template Kit**
Chapter 1 introduces specific product information about the Mask Template Kit. It also discusses the recommended oscilloscope configuration, and shows an overview of the Mask Test Setup dialog box.

**Getting Started and Using Masks**
Chapter 2 describes Mask Testing and shows you ways to use the standard masks to verify compliance of your instrument waveforms.

**Standard Masks**
Chapter 3 lists file names for the standard masks in the Telecommunications Mask Template Kit, along with line impedances and bit rates. The templates for each standard mask are also shown.
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Introduction to Option 100 and E2625A Telecommunications Mask Template Kit
Introduction to Option 100 and E2625A Telecommunications Mask Template Kit

The Infinium Oscilloscopes Option 100 Telecommunications Mask Template Kit includes the materials necessary for you to verify that your instrument waveforms comply with industry standards. Option 100 provides a quick method for you to certify waveform integrity during early development and later during manufacturing tests.

This manual helps you use the standard masks supplied with Option 100. It shows you how to load standard waveform masks into Infinium Oscilloscopes and use them to test the compliance of your waveforms. All of the standard masks supplied are shown in Chapter 3.

Adding Option 100 to an existing Infinium Oscilloscope

The Option 100 Telecommunications Mask Template Kit is orderable as E2625A for customers who already have an Infinium Oscilloscope. Adding E2625A to any Infinium Oscilloscope requires that you upgrade the Infinium application software to Version A.03.00 or later.
Introduction to Option 100 and E2625A Telecommunications Mask Template Kit

Supplied items

The Option 100 Telecommunications Mask Template Kit contains the following items:

<table>
<thead>
<tr>
<th>Mask Template Kit Item</th>
<th>Description</th>
<th>Separately Orderable Agilent Part Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floppy disk</td>
<td>Mask template library floppy disk (Requires Version A.03.00 software or later.)</td>
<td>E2626A</td>
</tr>
<tr>
<td>Adapter</td>
<td>100/110/120 Ω differential impedance adapter with bantam (f) connector, bantam (m) to Siemens (f) adapter cable</td>
<td>E2621A</td>
</tr>
<tr>
<td>Adapter cable</td>
<td>Bantam (m) to Siemens (f) adapter cable</td>
<td>E2623A</td>
</tr>
<tr>
<td>Adapter</td>
<td>75 Ω single-ended impedance adapter with BNC (f) connector</td>
<td>E2622A</td>
</tr>
<tr>
<td>Adapter cable</td>
<td>Dual-bantam (f) to RJ 48C (m) adapter cable</td>
<td>E2624A</td>
</tr>
<tr>
<td>Adapter coupler</td>
<td>RJ 48C (f) to RJ 48C (f)</td>
<td>E2627A</td>
</tr>
<tr>
<td>Adapter</td>
<td>Bantam (m) to BNC (f); for system verification of E2621A adapter and Infiniium oscilloscope</td>
<td>E2628A</td>
</tr>
<tr>
<td>Adapter</td>
<td>BNC (m) to BNC (f) 50-to-75 ohm adapter; for system verification of E2622A adapter and Infiniium oscilloscope</td>
<td>E2629A</td>
</tr>
<tr>
<td>Cable</td>
<td>BNC (m) to BNC (m) cable; 30 cm long</td>
<td>8120-1838</td>
</tr>
<tr>
<td>Storage case</td>
<td>Hard-shell case for storage of all kit accessories</td>
<td>E2625-45501</td>
</tr>
</tbody>
</table>

Recommended accessories

Other Agilent accessories recommended for use in mask testing include:

<table>
<thead>
<tr>
<th>Agilent Part Number</th>
<th>Accessory Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E2630A</td>
<td>Patch cable</td>
<td>Bantam (m) to bantam (m) patch cable</td>
</tr>
<tr>
<td>E2632A</td>
<td>Patch cable</td>
<td>Siemens (m) to Siemens (m) patch cable</td>
</tr>
</tbody>
</table>
Introduction to Option 100 and E2625A Telecommunications Mask Template Kit

Things to know

If you are adding the Mask Test capability to an Infinium Oscilloscope, make sure that the system software is upgraded to Version A.03.00 or later.

After installing a new version of system software, you should recalibrate the oscilloscope. Calibrating the oscilloscope is explained in Chapter 2. Standard masks supplied are shown in Chapter 3, including file names and templates.

What not to do

You should not use the Mask Test master disk for daily use. Instead, you should use a copy of the master disk, as described in Chapter 2.

Oscilloscope models

You can use the Telecommunications Mask Template Kit with these Infinium Oscilloscopes:

<table>
<thead>
<tr>
<th>Agilent Model</th>
<th>Channels</th>
<th>Bandwidth</th>
<th>Sample Rate</th>
<th>Memory Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td>54810A</td>
<td>2</td>
<td>500 MHz</td>
<td>1 GSa/s</td>
<td>32k</td>
</tr>
<tr>
<td>54815A</td>
<td>4</td>
<td>500 MHz</td>
<td>1 GSa/s</td>
<td>32k</td>
</tr>
<tr>
<td>54820A</td>
<td>2</td>
<td>500 MHz</td>
<td>2 GSa/s</td>
<td>32k</td>
</tr>
<tr>
<td>54825A</td>
<td>4</td>
<td>500 MHz</td>
<td>2 GSa/s</td>
<td>32k</td>
</tr>
<tr>
<td>54835A</td>
<td>4</td>
<td>1.5 GHz</td>
<td>2 GSa/s — 4 ch</td>
<td>32k — 4 ch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 GSa/s — 2 ch</td>
<td>64k — 2 ch</td>
</tr>
<tr>
<td>54845A</td>
<td>4</td>
<td>1.5 GHz</td>
<td>4 GSa/s — 4 ch</td>
<td>32k — 4 ch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 GSa/s — 2 ch</td>
<td>64k — 2 ch</td>
</tr>
</tbody>
</table>
To access the Mask Test Setup dialog box

Select **Analyze**, then **Mask Test...** from the oscilloscope main menu, as shown here, to access the Mask Test Setup dialog box:
Overview of the Mask Test Setup dialog box

You will use the Mask Test Setup dialog box shown here to load and use masks with the Infinium Oscilloscope. Standard masks are shown in Chapter 3. How to load and use a mask is described in Chapter 2.

A Mask Test tab will appear when the Mask Test is enabled.

Check options to invert a mask, use the file setup when aligning a mask, or enable averaging to reduce noise.

Checkmark to enable the Mask Test.

Click to load a Mask.

Click to align or clear a Mask.

Conditionally run the Mask Test and stop on the first failure.

Click to start and stop the Mask Test.

See the Infinium help system to use Scaling and Automask.
Getting Started and Using Masks
Getting Started and Using Masks

Telecommunications (telecom) and data communications (datacom) industries have established standards for equipment manufacturers. One of these standards defines the electrical parameters for waveforms. By applying these standards, both telecom and datacom equipment manufacturers can ensure that their equipment will operate properly together by first certifying waveform integrity.

To verify waveform integrity during the equipment manufacturing phase, Infiniium Oscilloscopes have a feature called Mask Testing. Within seconds, you know whether your equipment’s waveform complies with the industry standard.

Introduction to Mask Testing

**What is a Mask?**
A mask is a template that you load into the oscilloscope used during mask testing. The mask shows the acceptable electrical parameters of a waveform by defining regions of the oscilloscope display where the waveform must not intersect. If the waveform crosses the boundary of a region of the mask, it fails the mask test.

The types of masks that you can use to test waveforms include:
- Industry standard masks
  - Industry standard masks are included in this Mask Template Kit.
- Automatically generated masks
- User-defined masks

**When to use Mask Testing**
You should use mask testing whenever your waveform must conform to an industry standard. You can do mask testing during manufacturing to ensure that your design meets the requirements of the telecom or datacom industries.
How Infiniium does Mask Testing
When you start the mask test, Infiniium creates a database that has unique locations for every pixel in the waveform viewing area. Each location in the database has a 21-bit counter for a maximum count of 2,097,151.
Each time a data point from a channel memory illuminates a pixel in the waveform viewing area, the counter for that pixel is incremented. During mask testing, any data point that illuminates a pixel in the mask violation region causes a mask test failure.
The oscilloscope’s database continues to build until the oscilloscope stops acquiring data or until mask testing is deactivated.
The oscilloscope’s database is also used for histogram analysis and color grade persistence. Refer to the Infiniium help system for detailed information about these other waveform analysis features.

How to do Mask Testing
The remaining topics in this chapter show you how to do mask testing. Chapter 3 shows the standard masks supplied in the Mask Template Kit.

Make a copy of the Mask Test disk
A disk containing the standard masks is shipped with Infiniium Option 100 and E2625A. Before you install the Mask Test templates, you should make a copy of the Mask Test master disk and use the copy of the Mask Test disk for the installation.
To install the Standard Masks

Use the copy of the Mask Test disk to install standard masks onto the Infiniium hard drive. The Mask Test disk contains many of the available standard masks that you may need to use during mask testing.

1 Insert the copy of the Mask Test disk in the floppy drive.
2 From the oscilloscope main menu, select Analyze, then Mask Test.
3 In the Mask Test Setup dialog box, select the Enable Mask Test control.
4 In the Mask Test Setup dialog box, click the Load Mask... button.
   The Load Mask dialog box will resemble:

5 Click the Install Masks from A: button.
To calibrate the oscilloscope

Your Infinium should be at optimum performance when performing mask testing. If your Infinium has not been calibrated in the last year or if the Calibration ΔTemp is greater than ±5 °C, you should recalibrate the oscilloscope before performing a mask test. You can find the Calibration ΔTemp in the Calibration dialog box by clicking on the Utilities menu and selecting Calibration.

1 Make sure Infinium has warmed up for at least 30 minutes.
2 From the oscilloscope main menu click Utilities, then Calibration.
3 Make sure that the Cal Memory Protect check box is unchecked.

Cal Memory Protect  This option protects the oscilloscope’s calibration factors from accidentally being changed.

Details  When checked, this option displays a list of anything that has failed during the calibration. You can use the failure information to help repair the oscilloscope.

4 Click Start.

Infinium will display additional instructions and guide you through the step-by-step calibration procedure.
To choose a proper probe for Mask Testing

You can use any oscilloscope probe that fits your application. Depending on the type of waveform you are testing, you may need to use one of the probe adapters.

**Calibrating the probe adapter**

Depending on the requirements of your Telecom or Datacom industrial standard, you may need to use the E2622A 75 Ω probe adapter or the E2621A differential probe adaptor. Before performing a mask test, you should calibrate the probe adapter using the following instructions:

1. In the Channel Setup dialog box, click the **Probes...** button.
2. In the Probes Setup dialog box, click the **Calibration...** button.
3. Follow the step-by-step instructions to calibrate the probe.
To get your waveform on the oscilloscope display

When doing mask testing, you will try to fit the mask to your waveform. This is how you will verify whether your waveform meets the acceptable electrical parameters defined by the standard mask. By having your waveform displayed on the oscilloscope screen before doing mask testing, when you load and use the mask, you will know immediately if the waveform passes the mask test.

1. Display the waveform you want to test on the oscilloscope screen.
2. Begin mask testing using a standard mask, as described in the following topics.
To enable the Mask Test

1. Click **Analyze**, then **Mask Test** to access the Mask Test Setup dialog box.
2. In the Mask Test Setup dialog box, click **Enable Mask Test** to checkmark the box.

When enabled, a Mask Test tab appears beneath the waveform viewing area.
To load a Mask

1. Click **Analyze**, then **Mask Test** to access the Mask Test Setup dialog box.
2. Make sure the mask test is enabled.
3. Click the **Load Mask**... button.

4. In the Load Mask dialog box, click the **Mask Test Source** field to select an oscilloscope channel for the mask test. The active channel is the default.
5. Click the **Drive** field and select the drive where the mask you want to load is located. In the **List files of type** field, Mask Files will be displayed by default.
6. To load a standard mask from the Infiniium hard drive, make sure the **Folder** shows \scope\masks. Then view the list of standard masks by scrolling them in the **Files** field.
7. When you find the standard mask that you want to load, double-click the file in the **Files** field. The mask file name will be entered and highlighted in the **File name** field, and Infiniium will load the mask.

Chapter 3 lists the standard mask file names and shows the mask waveforms.
To align a Mask to the waveform

1. Access the Mask Test Setup dialog box and make sure the mask test is enabled.
2. Locate the **Use File Setup When Aligning** option.

   When aligning a mask to the waveform, these settings are used:
   - Channel range and offset
   - Time base range and position
   - Trigger mode and level
   - Mask test scaling source, position(s), and delay

   You can either use the current oscilloscope settings, or you can use the standard settings defined in the mask file.
3. If you want to use the standard settings defined in the mask file, checkmark the **Use File Setup When Aligning** option.
4. If you want to use the current oscilloscope settings, do not checkmark this box.
5. Click the **Align** button to align the mask.
To start and stop the Mask Test

1. Access the Mask Test Setup dialog box and make sure the mask test is enabled.
2. At the bottom of the Mask Test Setup dialog box, locate the start and stop mask test buttons.
   - The green triangle starts the mask test.
   - The red square stops the mask test.
3. Click the green triangle to start the mask test.
   When you start a mask test, Infiniium also starts the acquisition system.
To understand the Mask Test tab description area

After you have enabled the mask test in the Mask Test Setup dialog box, you will see a Mask Test tab on the lower left of the oscilloscope screen, beneath the waveform viewing area. The description area below the Mask Test tab shows:

- Mask title
- Amplitude specifics (for ANSI T1.102 North American Standard Masks only)
- Total number of waveforms in the duration of the mask test
- Number of failed waveforms in the mask test
- Regions in the mask
- Waveform violations

When any of the ANSI T1.102 North American Standard Masks are loaded, the Mask Test tab description area will show minimum and maximum amplitude values. These values are the result of testing for specifics of the standard, and indicate the upper or lower limit that the standard allows.
To run the Mask Test conditionally

1. Access the Mask Test Setup dialog box and make sure the mask test is enabled.

2. Click the Run Until selection arrow to view the options.
   - If Stop on Failure is disabled, you can stop the mask test based on the following conditions:
     - Forever
       The mask test will run continuously. This is the default selection.
     - Number of Waveforms
       The mask test will run until the number of waveforms specified has been acquired. The number of waveforms is from 1 to 1,000,000,000.
     - Time
       The mask test will run until the amount of time specified has elapsed. The time is in seconds, from 0.1 minute to 1440.0 minutes. The default is 1.0 minute.
   - If Stop on Failure is enabled, the first time the waveform crosses the mask violation region, the mask test will stop. See the next topic.

3. Select the Run Until option you want to use for the mask test.
Getting Started and Using Masks

To stop the Mask Test on the first failure

1. Access the Mask Test Setup dialog box and make sure the mask test is enabled.
2. Click Stop On Failure to checkmark the box.
3. Run the mask test.

When the mask test encounters the first failure, the test will stop and the failure result will be displayed in the Mask Test tab description area.

Analyzing a failure

If your waveform crosses the boundary of the mask violation region, the waveform cross-over areas will be displayed in red. All waveform locations displayed in red indicate that the waveform fails the mask test in these areas. If the waveform just “touches” the boundary, the mask test fails.

Standard masks and the designated violation regions are shown in chapter 3. When you start the mask test with Stop On Failure enabled, if Infiniium encounters a failure, the oscilloscope acquisition system will be stopped.
Standard Masks
Standard Masks

The Infinium Option 100 and the E2625A Telecommunications Mask Template Kit disk contains standard masks used by the telecommunications and data communications industries. These are the masks you can load into the oscilloscope to test your waveform's compliance against industry standards.

To use any of these masks, follow the procedures in chapter 2.

**Standard Masks**

The types of standard masks include:

- ITU G.703 International Standard Masks
- ANSI T1.102 North American Standard Masks
- FCC Part 68.308 Options A, B, and C Masks
- Pre-Compliance SONET Masks
- IEEE 802.3 Masks

**ITU G.703 International Standard Masks**

<table>
<thead>
<tr>
<th>Mask File Name</th>
<th>Line Impedance</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1544kb_ITU_DS1.msk</td>
<td>100 Ω twisted pair</td>
<td>1.544 M bps</td>
</tr>
<tr>
<td>2M_b_ITU_120.msk</td>
<td>120 Ω twisted pair</td>
<td>2.048 M bps</td>
</tr>
<tr>
<td>2M_b_ITU_75.msk</td>
<td>75 Ω coax</td>
<td>2.048 M bps</td>
</tr>
<tr>
<td>6312kb_ITU_110_DS2.msk</td>
<td>110 Ω twisted pair</td>
<td>6.312 M bps</td>
</tr>
<tr>
<td>6312kb_ITU_75_DS2.msk</td>
<td>75 Ω coax</td>
<td>6.312 M bps</td>
</tr>
<tr>
<td>8M_b_ITU.msk</td>
<td>75 Ω coax</td>
<td>8.448 M bps</td>
</tr>
<tr>
<td>34M_b_ITU.msk</td>
<td>75 Ω coax</td>
<td>34.368 M bps</td>
</tr>
<tr>
<td>44736kb_ITU_DS3.msk</td>
<td>75 Ω coax</td>
<td>44.736 M bps</td>
</tr>
<tr>
<td>140M_b_ITU_0.msk</td>
<td>75 Ω coax</td>
<td>139.264 M bps</td>
</tr>
<tr>
<td>140M_b_ITU_1.msk</td>
<td>75 Ω coax</td>
<td>139.264 M bps</td>
</tr>
<tr>
<td>140M_b_ITU_1_INV.msk</td>
<td>75 Ω coax</td>
<td>139.264 M bps</td>
</tr>
<tr>
<td>155M_b_ITU_0.msk</td>
<td>75 Ω coax</td>
<td>155.520 M bps</td>
</tr>
<tr>
<td>155M_b_ITU_1.msk</td>
<td>75 Ω coax</td>
<td>155.520 M bps</td>
</tr>
<tr>
<td>155M_b_ITU_1_INV.msk</td>
<td>75 Ω coax</td>
<td>155.520 M bps</td>
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</tbody>
</table>
### ANSI T1.102 North American Standard Masks

<table>
<thead>
<tr>
<th>Mask File Name</th>
<th>Line Impedance</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>DS1_ANSI.msk</td>
<td>100 Ω twisted pair</td>
<td>1.544 M bps</td>
</tr>
<tr>
<td>DS1A_ANSI.msk</td>
<td>100 Ω twisted pair</td>
<td>2.048 M bps</td>
</tr>
<tr>
<td>DS1C_ANSI.msk</td>
<td>100 Ω twisted pair</td>
<td>3.152 M bps</td>
</tr>
<tr>
<td>DS2_ANSI.msk</td>
<td>110 Ω twisted pair</td>
<td>6.312 M bps</td>
</tr>
<tr>
<td>DS3_ANSI.msk</td>
<td>75 Ω coax</td>
<td>44.736 M bps</td>
</tr>
<tr>
<td>DS4NA_ANSI.msk</td>
<td>75 Ω coax</td>
<td>139.264 M bps</td>
</tr>
<tr>
<td>STS1_ANSI_EYE.msk</td>
<td>75 Ω coax</td>
<td>51.840 M bps</td>
</tr>
<tr>
<td>STS1_ANSI_PULSE.msk</td>
<td>75 Ω coax</td>
<td>51.840 M bps</td>
</tr>
<tr>
<td>STS3_ANSI.msk</td>
<td>75 Ω coax</td>
<td>155.520 M bps</td>
</tr>
<tr>
<td>STS3_ANSI_MAX.msk</td>
<td>75 Ω coax</td>
<td>155.520 M bps</td>
</tr>
</tbody>
</table>

### FCC Part 68.308 Options A, B, and C Masks

<table>
<thead>
<tr>
<th>Mask File Name</th>
<th>Line Impedance</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>FCC_68_OPT_A.msk</td>
<td>100 Ω twisted pair</td>
<td>1.544 M bps</td>
</tr>
<tr>
<td>FCC_68_OPT_B.msk</td>
<td>100 Ω twisted pair</td>
<td>1.544 M bps</td>
</tr>
<tr>
<td>FCC_68_OPT_C.msk</td>
<td>100 Ω twisted pair</td>
<td>1.544 M bps</td>
</tr>
</tbody>
</table>

### Pre-Compliance SONET Masks

<table>
<thead>
<tr>
<th>Mask File Name</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC1_SONET.msk</td>
<td>51.840 M bps</td>
</tr>
<tr>
<td>OC3_SONET.msk</td>
<td>155.520 M bps</td>
</tr>
<tr>
<td>OC12_SONET.msk</td>
<td>622.080 M bps</td>
</tr>
</tbody>
</table>

### IEEE 802.3 Masks

<table>
<thead>
<tr>
<th>Mask File Name</th>
<th>Bit Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>10BASE_T_IDL.msk</td>
<td>10 M bps</td>
</tr>
<tr>
<td>10BASE_T_LINK.msk</td>
<td>10 M bps</td>
</tr>
<tr>
<td>100BASE_TX_STP.msk</td>
<td>100 M bps</td>
</tr>
<tr>
<td>100BASE_TX UTP.msk</td>
<td>100 M bps</td>
</tr>
</tbody>
</table>
ITU G.703 International Standard Masks

The ITU G.703 International Standard Masks resemble the following:

1544kb_ITU_DS1.msk

2Mb_ITU_120.msk
Standard Masks
ITU G.703 International Standard Masks

2Mb_ITU_75.msk

6312kb_ITU_110_DS2.msk
Standard Masks
ITU G.703 International Standard Masks

6312kb_ITU_75_DS2.msk

8Mb_ITU.msk
Standard Masks
ITU G.703 International Standard Masks

34M_b_ITU.msk

44736kb_ITU_DS3.msk
Standard Masks
ITU G.703 International Standard Masks

140Mb_ITU_0.msk

140Mb_ITU_1.msk
Standard Masks
ITU G.703 International Standard Masks

140Mb_ITU_1_INV.msk

155Mb_ITU_0.msk
Standard Masks
ITU G.703 International Standard Masks

155M b_ITU_1.msk

155M b_ITU_1_INV.msk
ANSI T1.102 North American Standard Masks

The ANSI T1.102 North American Standard Masks resemble the following:

**DS1_ANSI.msk**

![Diagram of DS1_ANSI.msk](image1)

**DS1A_ANSI.msk**

![Diagram of DS1A_ANSI.msk](image2)
Standard Masks

ANSI T1.102 North American Standard Masks

DS1C_ANSI.msk

DS2_ANSI.msk
DS3_ANSI.msk

DS4NA_ANSI.msk
Standard Masks

ANSI T1.102 North American Standard Masks

DS4NA_ANSI_MAX.msk

STS1_ANSI_EYE.msk
Standard Masks

ANSI T1.102 North American Standard Masks

STS3_ANSI_MAX.msk
Standard Masks

FCC Part 68.308 Options A, B, and C Masks

FCC_68_OPT_A.msk

FCC_68_OPT_B.msk
Standard Masks
FCC Part 68.308 Options A, B, and C Masks

FCC_68_OPT_C.msk
Pre-Compliance SONET Masks

The Pre-Compliance SONET Masks resemble the following:

**OC1_SONET.msk**

**OC3_SONET.msk**
Standard Masks
Pre-Compliance SONET Masks

OC12_SONET.msk
IEEE 802.3 Masks

The IEEE 802.3 Masks resembles the following:

10BASE_T_IDL.msk

10BASE_T_LINK.msk
Standard Masks
IEEE 802.3 Masks

100BASE_TX_STP

100BASE_TX_UTP
Document Warranty

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Safety

This apparatus has been designed and tested in accordance with IEC Publication 1010, Safety Requirements for Measuring Apparatus, and has been supplied in a safe condition. This is a Safety Class I instrument (provided with terminal for protective earthing). Before applying power, verify that the correct safety precautions are taken (see the following warnings). In addition, note the external markings on the instrument that are described under “Safety Symbols.”

Warning

- Before turning on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. You must not negate the protective action by using an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock of fire hazard.
- Service instructions are for trained service personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.
- If you energize this instrument by an auto transformer (for voltage reduction), make sure the common terminal is connected to the earth terminal of the power source.
- Whenever it is likely that the ground protection is impaired, you must make the instrument inoperative and secure it against any unintended operation.
- Do not operate the instrument in the presence of flammable gasses or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Capacitors inside the instrument may retain a charge even if the instrument is disconnected from its source of supply.

Safety Symbols

Instruction manual symbol: the product is marked with this symbol when it is necessary for you to refer to the instruction manual in order to protect against damage to the product.

Hazardous voltage symbol.

Earth terminal symbol: Used to indicate a circuit common connected to grounded chassis.

Warning

The Warning sign denotes a hazard. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in personal injury. Do not proceed beyond a Warning sign until the indicated conditions are fully understood and met.

Caution

The Caution sign denotes a hazard. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product. Do not proceed beyond a Caution symbol until the indicated conditions are fully understood or met.
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New editions are complete revisions of the manual. Many product updates do not require manual changes; and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one-to-one correspondence between product updates and manual updates.

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