

# Certifier40G Tier 1 Fiber Certification Kits

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## User's Guide

[www.jdsu.com/go/Certifier40G](http://www.jdsu.com/go/Certifier40G)





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**Low Voltage Directive Compliance** This product was tested and conforms to the Low Voltage Directive, 73/23/EEC as amended by 93/68/EEC. Conformity with this directive is based upon compliance with the harmonized safety standard, EN60950. A copy of the Declaration of Conformity is provided with this manual.

**CE-Mark** Instruments of this type comply with all the requirements for affixing the

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## **Laser Safety**



### **WARNING**

## **Dangerous laser radiation**

**Laser radiation can cause irreparable damage to the eye and skin.**

This device is a Class 1 Laser product according to DIN EN 60825-1:2001.



Observe the following instructions when working with this device and laser systems in general:

- !** Connect all optical fibers before switching on the radiation source.
  - !** Switch off the radiation source before disconnecting the optical fibers.
  - !** Never look directly into the output of a laser source or into an optical fiber connected to it.
  - !** Always cover unused ports.
  - !** Observe the normal precautions for working with laser radiation and follow any local regulations.
-

**Conventions** This guide uses naming conventions and symbols, as described in the following tables.

**Table 1** Symbol conventions



This symbol represents a general hazard.



This symbol represents a risk of electrical shock.



**NOTE**

This symbol represents a Note indicating related information or tip.

**Table 2** Safety definitions



**WARNING**

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



**CAUTION**

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

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# Introduction

# 1

Topics discussed in this chapter include the following:

- [“1.1 Features and Benefits” on page 3](#)
- [“1.2 What’s in the kit?” on page 4](#)

The Tier 1 Fiber Certification Kits contain all the necessary modules in conjunction with the Certifier40G kit to perform fiber optic network cable certification for loss and length measurements. The fiber cabling installation can be certified for various standards including TIA 568 C.3 and ISO 14763-3 for Tier1 testing.

Two add-on kits are available to add fiber test capabilities to an existing Certifier40G copper kit: one for single-mode and one for multimode certification. These kits can be ordered separately.

- The single-mode kit NGC-4500-SM2 is used for certifying single-mode networks at the wavelengths 1310 nm and 1550 nm.
- The multimode kit NGC-4500-MM2 certifies multimode installations at 850 nm and 1300 nm.

A Certifier40G copper plus multimode kit is available (NGC-4500-MM-xx) as is a copper plus multimode and single-mode kit (NGC-4500-MMSM-xx). Note that –xx refers to the country-specific power adapters (-NA, -UK, -EU, -AU)

## 1.1 Features and Benefits

The Certifier40G is a modular solution. This allows you to easily interchange between copper and fiber certification and reuse the base unit. Both multimode and single-mode kits may be ordered separately which allows you to choose the kit that meets your requirements.

The user interface is highly intuitive and very user friendly. It allows easy access to all operations within a couple of clicks. This increases the productivity tremendously and some of the complex certification jobs, such as bi-directional testing can be easily performed through precise guidance on the device without having to remember the steps and stages of testing.

One of the biggest advantages of using the Certifier40G optical solution is the ability to re-configure the remote unit to a local unit. This is especially beneficial when performing loopback testing. In the case of loopback testing, a single unit is sufficient to complete the certification. With the remote unit now configured as local, essentially you will have two units to perform certification independently. This reduces the time to finish the job by half.

Certifier40G is the fastest fiber certification tool in the market today. It performs Auto Test within 8 seconds. The optical loss budget calculation is completely automated and the limit is adjusted accordingly based on the information about number of connectors and splices entered. This eliminates the necessity to calculate limits on different links based on length and the connectors involved. Pass/Fail information is readily available with the click of a button.

## 1.2 What's in the kit?

NGC-4500-MM2 contains the following:

- Two Multimode modules
- Two 50 micron reference test cords
- Two mandrels

**Figure 1** Multimode Module Kit



NGC-4500-SM2 contains the following:

- Two single-mode modules
- Two single-mode reference test cords

**Figure 2** Single-Mode Module Kit





# Fiber Testing Basics

## 2

The topics discussed in this chapter are as follows:

- “2.1 Types of Optical Cables” on page 6
- “2.2 Launch Conditions” on page 8
- “2.3 Limits and Standards” on page 10
- “2.4 Fiber deployment” on page 11
- “2.5 Types of networks” on page 11
- “2.6 Permanent Link Testing” on page 12
- “2.7 Channel Testing” on page 12
- “2.8 Loss Measurement Techniques” on page 13

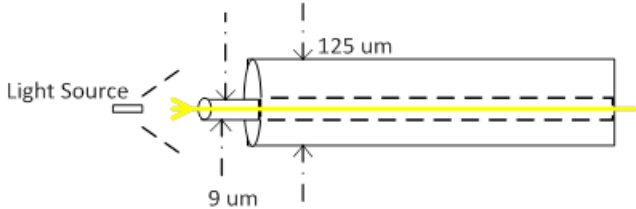
## 2.1 Types of Optical Cables

For optic communication networks, two types of cable are used, single-mode and multimode cables.

These are characterized by the modes in which the light or optical signal propagates through the cable. This also determines the maximum possible link lengths of communication.

**2.1.1 Single-Mode Cable** Typically used in long haul applications, single-mode fiber has a core diameter of 9  $\mu\text{m}$ . Since the core diameter is narrow, it allows only a single mode of optical light wave to enter the fiber. Depending on the type of fiber used and the applications, 1310 nm and 1550 nm are most popular wavelengths used for single-mode fiber (SMF).

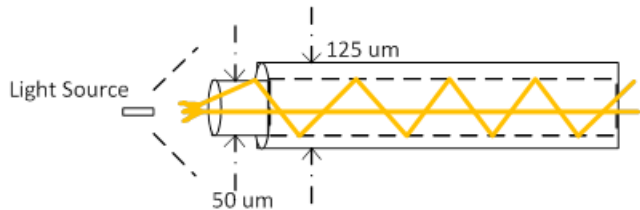
**Figure 3** Single-Mode Fiber



**2.1.2 Multimode Cable** Multimode fiber (MMF) cables are used for shorter distances and are less expensive compared to single-mode cables. The core diameter is typically 50  $\mu\text{m}$  though older standards dictate a 62.5  $\mu\text{m}$  cross section. Since it has a much larger core diameter compared to the single-mode fiber, more than one mode (path) of light travels through the cable. These multiple modes within the same cable result in certain types of dispersion putting a limitation on the maximum length of the communication channel.

The optical wavelengths used for communication over multimode cable are typically 850 nm or 1300 nm depending on the type of cable and the equipment that is used. Laser-optimized MMF (OM3 and OM4) are meant to be used with VCSELs.

**Figure 4** Multimode Fiber

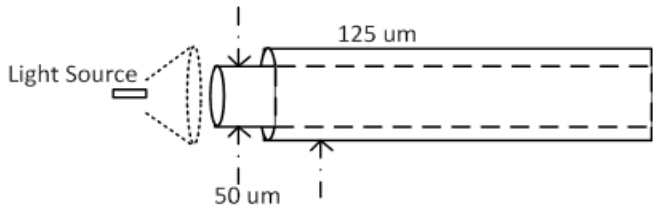


**2.1.2.1 VCSEL vs. LED** LEDs and VCSELs are cheaper alternatives to expensive laser diodes as light sources. They are part of the reason why multimode deployments are a cheaper alternative compared to single-mode deployments. When light travels through multimode fiber it travels through multiple modes. The modes that are close to the center of the fiber are called lower order modes and the modes towards the cladding are called higher order modes. The higher order modes get attenuated highly compared to lower order modes. The causes of attenuation could be bending of fiber, splicing, etc.

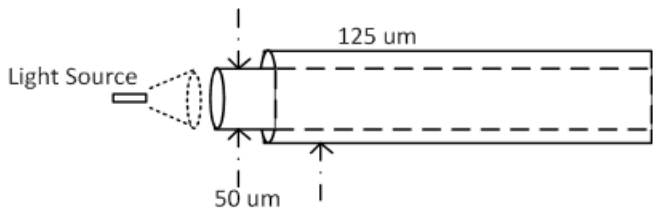
## 2.2 Launch Conditions

**2.2.1 Numerical Aperture** Launch condition determines the optical power that gets coupled from the light source to the fiber. The launch condition can be characterized using a mathematical quantity called numerical aperture (NA). NA can be thought of as the radius of the cone of light that gets coupled into the fiber. In other words, all the light that is launched within the NA of the optical fiber will go into the fiber and everything outside it will be lost. It is also a function of the refractive index of the fiber.

**Figure 5** Overfilled Launch



**Figure 6** Slightly Underfilled Launch



**2.2.2 Modal Power Distribution (MPD)** Since the different modes, higher or lower, have different behavior inside the fiber the other parameter that determines the performance and quality of medium is mode power distribution (MPD). The distribution of optical power in the higher order modes and the lower order modes is known as mode power distribution. This phenomenon is one of the primary reasons for non-repeatability of loss measurements in multimode fiber. Higher order modes tend to suffer significant losses depending on the length of the fiber and stress on the fiber. When many higher order modes are launched, there will be a higher variability in loss measurement. There is a couple of ways of determining MPD. The legacy method is to use the coupled power ratio (CPR) measurement to determine the quality of launch.

**2.2.3 Coupled Power Ratio** Coupled power ratio is a way to quantify the amount of power distributed in the tightly coupled modes or the lower order modes. The measurement is done by measuring the difference between the power coupled to the multimode fiber (MMF) into an optical receiver against the power coupled through a single-mode fiber to the receiver keeping the launch condition similar. Since the tightly coupled modes are closer to the center of the core, these modes are more likely to pass through a single-mode fiber.

**2.2.4 Encircled Flux** Encircled Flux (EF) is a measure of the distribution of light in the multimode fiber. Typically, it is calculated as the amount of light contained within two concentric circles centered on the core of the fiber. For instance, IEEE 802.3ae specifies an EF template for 10G BASE-SR that requires about less than 30% of light to be within 4.5  $\mu\text{m}$  around the axis of the fiber and about 86% within 19  $\mu\text{m}$  radius. Encircled flux provides a repeatable way of measuring loss since the launch is well defined and the higher order modes are mostly removed. VCSELs and LEDs alike will comply to EF when used with a mode conditioner device.

**2.2.5 Use of mandrels** One of the traditional methods of performing mode conditioning is by the use of mandrels.

Mandrels induce excessive stress on the multimode fiber under test. This excessive stress results in filtering of the higher order modes. Use of mandrels has proven to provide repeatable launch conditions for multimode cabling and is a requirement for testing multimode cabling according to the standards. Mandrels are specific to the type of multimode cabling used (62.5  $\mu\text{m}$  or 50  $\mu\text{m}$ ).

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## 2.3 Limits and Standards

For testing installed cabling, the standards can be broadly classified into cabling standards and network standards. The cabling standards focus more on the physical quality of the cabling and network standards focus on the applications that run on the cabling.

**2.3.1 Premise Cabling Standards** There are two major standardization bodies in certifying installed fiber cabling in premise networks. The ISO/IEC organization maintains the ISO/IEC 11801 standard. EIA/TIA maintains the TIA 568 C.3 standard. Tier 1 certification of fiber involves testing the insertion loss of the installed links and link length measurements. The installed plant is then certified to be compliant against a standard. The limits for determining Pass/Fail criteria for fiber cabling in premise networks come from TIA 568 C.3 standard or the ISO 11801 standard. For ISO standard, the limits are defined in an auxiliary document specifically for fiber known as the ISO 14763-3 standard. Likewise the test methodologies for the TIA standard are defined in the TIA 526-7 document for single-mode fiber and the TIA 526-14A for multimode fiber.

**2.3.2 Network Standards** The network standards are application specific standards mostly derived from the IEEE standards for Ethernet Networks and ANSI standards for Storage Area Networks like Fiber Channel. The loss limit specification in network limits is unlike the premise cabling standard. The network limits do not take into account the number of connectors, splices or the length of the link into consideration while arriving at the loss budget and hence the margins for clearance from the limit. They require an end-end loss measurement and calculate the PASS/FAIL criteria regardless of the nature of construction of the link.

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## 2.4 Fiber deployment

Fiber cabling is typically deployed in cable links like the backbone network that are often longer than 100 m. This could be within a premise which is categorized under as structured cabling. This could be an enterprise network, data center or building infrastructure. They could also be used in long-haul networks spanning over a few thousands of miles or longer. The Certifier40G only addresses the premise networks segment and is usually not suited for long haul testing.

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## 2.5 Types of networks

The nature of networks and deployment depend on the application where the fiber cabling is going to be used. Two broadly used applications are Ethernet and Fiber Channel.

**2.5.1 Ethernet** This is the most widely used application on either copper or fiber cabling in an Enterprise. The standard is defined in IEEE 802.3. The standard keeps evolving over the years and different applications over Ethernet at varying link speeds have been defined.

**2.5.2 Fiber Channel** Fiber channel is a protocol used mainly in Storage Area Networks (SANs). This standard is developed by ANSI. It is mostly based on Point to Point protocol architecture and designed to support massive amounts of data transfer instead of supporting a more interactive networking applications.

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## 2.6 Permanent Link Testing

From a testing perspective, the fiber link deployments are classified as Permanent Links and Channels.

The permanent links as the name implies will have little variability after installation in terms of link construction. This would mean no additional patch cords will be added or removed from the link or no part of the link is replaced during the course of operation. Once a permanent link is certified for Tier1, there is very little that can go wrong through the course of time since the physical infrastructure remains the same. Note this assumes proper “inspect before you connect” (IBYC) processes are followed.

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## 2.7 Channel Testing

Channel testing is an end-end testing and provides insight into the loss as seen by the network equipment. Channel testing will take into consideration all of the movable cabling involved, such as the patch cords, cross-connects, etc. The channel results are more variable over the course of time depending on the changes that link undergoes.



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## 2.8 Loss Measurement Techniques

The basic principle of optical loss measurement is fairly straight forward. It requires the use of appropriate light source illuminating the fiber under test and a power meter at the other end to measure the loss of fiber. The light sources need to be different for multimode and single-mode.

The use of patch cords for launching the optical power into the link and tail cords induces several additional losses in performing the insertion loss measurement. These losses need to be referenced out and three methods of referencing are specified in both ISO and TIA standards. [Appendix A](#) provides detailed information on the various reference methods.

**2.8.1 Setting Reference** Setting reference is a way to eliminate the losses associated with the measurement setup, thereby reporting only the loss due to the link under test. TIA 568C.3 or ISO 14763-3 mandate one of three types of referencing schemes. They are referred to as one-jumper, two-jumper or three-jumper reference schemes. For all the referencing schemes, please use the reference cords supplied with the kit. Various regional field testing standards and best practices documents require a specific referencing method. JDSU recommends you consult your local requirements or vendor documentation to determine the correct reference method.

**2.8.1.1 One-Jumper Reference** As the name suggests, one-jumper reference uses only one jumper. This does not account for the two additional connectors that are present in the actual measurement and the limit calculation allows for the additional potential loss incurred due to the two additional connectors during the actual measurement. This addition to the limit allows plenty of margin for the link to pass, although the actual loss measurement will be higher than either the two-jumper or the three-jumper reference.

**2.8.1.2 Two-Jumper Reference** The limit calculation accounts for one additional connector because of its inclusion in the reference setting.

**2.8.1.3 Three-Jumper Reference** This is the most stringent reference setting specified in the standard. Since the reference is set according to actual deployment, no additions to the limit are allowed during the calculation of pass/fail margins. Though this is meant to be the most accurate way of testing the link, the errors due to the variations from connector to connector can result in a good link to be incorrectly displayed as Fail.

# Getting Started

## 3

The topics discussed in this chapter are as follows:

- [“3.1 Test Configurations” on page 16](#)
- [“3.2 Testing Steps” on page 16](#)

The Certifier40G can be operated completely through the touch screen. The user interface is very intuitive and most of the functions can be accomplished by less than three touches from any screen.

## 3.1 Test Configurations

Before beginning to certify a fiber installation it is important to know how you want to test. Some items to be considered:

- What type of reference is required?
- Should the test be performed head-to-head or to a loop-back?
- Will loss be measured in a single direction on each fiber or in both directions on each fiber (bi-directional)?
- What type of limit should be set?
- What is the maximum length the fiber should be?

The items above are critical to successful testing. In addition to these items, there are several important but less critical considerations:

- Who is the manufacturer of the cable and components?
- What is the labeling scheme?
- Who is the operator?
- What is the location?

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## 3.2 Testing Steps

In general, once the above considerations are taken into account, fiber testing/certification consists of the following steps:

- Setup for the test
- Perform the Auto Test
- Save the results
- Export the results to USB
- Import the results to the reporting software and generate a report

# Test Setup

# 4

Topics discussed in this chapter are as follows:

- [“4.1 Setup Screens” on page 18](#)
- [“4.2 Performing Reference” on page 24](#)

Setting up for a certification test is a critical step as it determines the overall test configuration, pass/fail margins as well as many informational items that will appear on the final report.

## 4.1 Setup Screens

When the device is first powered on, it will boot to the Setup screens. All critical setup items are entered at the local device. The Setup screen has three navigation tabs allowing you to configure different settings.

- The Test settings tab lets you setup the Auto Test configuration including the limits, cable type, labels for saving results etc.
- The System settings tab allows you to set the system settings like Date/Time, Auto sleep, Auto saving of results in the memory etc.
- The last navigation tab Information in the setup section gives the information like calibration status, adapter (probe) status and type of adapter etc.

Figure 7 Setup Screens



### 4.1.1 System Settings

Most of the settings on the System Settings page are “set and forget” – items that are set once and rarely changed. Most of these settings are identical to settings for copper certification testing and are explained in the Certifier40G copper manual. One notable exception is the “Device Type” setting that allows the user to change the local or remote personality of the

device. For fiber this is useful as tests to loopback can be performed from a local unit. If performing loopback testing, both units can be configured to be local units allowing for two testers to be active at one time. Note this setting will remain active if the copper modules replace the fiber modules.

**4.1.2 Test Settings Page** The test settings page is the most critical page as it defines the test configuration and certification limits. It also contains several informational settings that will be addressed first.

**4.1.2.1 Cable and Connector Information** Four settings identify the type of cable, connector and modal bandwidth.

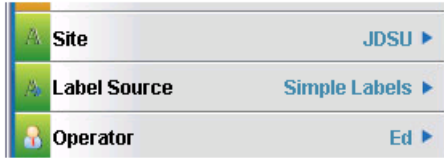
**Figure 8** Cable and Connector Information



Selecting cable manufacture displays the database of available cables that can be selected. Generic cable settings are also available. This setting will also determine the Cable Name. Modal bandwidth is a characteristic of multimode fiber that determines the information capacity or the bit rate of the fiber. No actual measurement is carried out for this setting and it is for information only. Connector Name provides a list of connectors that can be selected. Again, this is informational only.

**4.1.2.2 Site, Source and Operator** Three settings are critical to properly reporting the certification test results. These are Site, Label Source, and Operator.

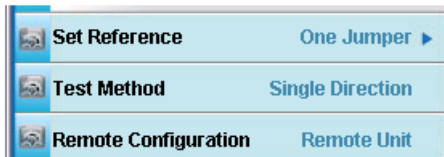
**Figure 9** Site, Source and Operator



These settings are identical to the choices available for copper testing. Please refer to the Certifier40G copper manual for more details.

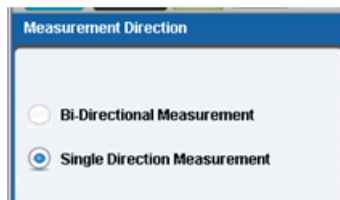
**4.1.2.3 Reference Type, Test Method and Remote Configuration** These three settings are configured all at once and are critical to correct test results.

**Figure 10** Reference, Test Method, and Remote Configuration



Tapping on the “Set Reference” will bring the user to a two screen wizard for setting all three items. The first item set is the Test Method with two choices: Bi-Directional Measurement or Single Direction Measurement.

**Figure 11** Measurement Direction

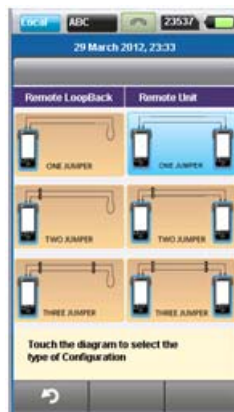




Selecting Bi-Directional Measurement will result in a two-step Auto-Test. The device will first measure loss on both fibers of the duplex pair in a single direction (Local to Remote for fiber one, Remote to Local for fiber two). The user will then be prompted to swap the reference leads at both ends. Loss will then be measured in the opposite direction. This type of measurement is not required by most regional and international standards. JDSU recommends you check local standards or vendor-specific instructions to see if this method is required. Single Direction measurement is a single-step auto test with loss of each fiber of the duplex pair being measured in a single direction (Local to Remote for fiber one, Remote to Local for fiber two).

Once the Measurement Direction is selected, the next screen allows the user to select the reference method and if a remote unit is used or if a loopback test is being performed.

**Figure 12** Reference and Loopback



Loopback testing is performed without a remote unit. The fiber pair must be manually looped at the far end. Loss and length are then measured from the local unit. Note that this test method may not be considered valid depending on local standards or vendor requirements. Tests with remote units require the remote unit to be connected at the far end. For either remote loopback or remote unit, the three reference methods

are presented. Note that changing these setting requires the units be re-referenced. After choosing one of the six options, the unit will return to the test settings page

**4.1.2.4 Test Limits** Setting the test limits determines the pass/fail limit and is critical to correct certification of fiber runs. There are two settings, Limit and Length Limit. Length Limit is set in the unit of measurement (feet or meters) selected on the System Settings page. Selecting Limit provides three choices: TIA, ISO, and Link Validation.

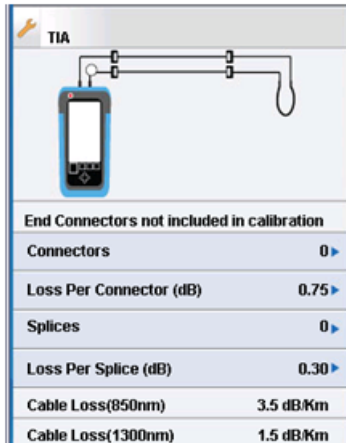
**Figure 13** Limit List



Link Validation allows the user to enter the maximum acceptable overall loss considered acceptable. This is useful if wanting to certify a fiber link is capable of carrying a specific technology. For example, 10GbE over OM3 MM fiber can have a maximum loss of 2.6 dB (and maximum distance of 300 meters). By selecting Link Validation and entering a value of 2.6 dB, any fiber link with a loss greater than 2.6 dB will fail an auto-test

Both TIA and ISO standard limits can also be chosen. Once the standard is selected, select the number of connectors and splices to be included in the link.

Figure 14 Setting Connector and Splice Information

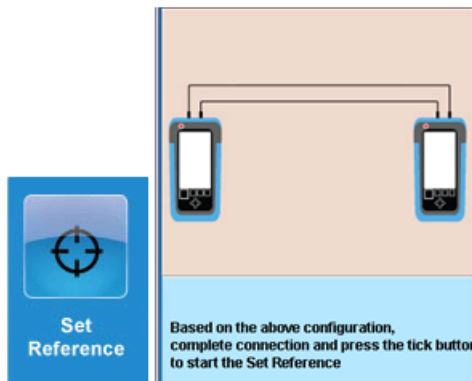


The number of connectors and splices determines the loss limit for the link as specified by the standard. The maximum permissible value for the connector loss is 0.75 dB per connector. The maximum permissible value for a splice loss is 0.3 dB. Note that local standards and vendor guidelines may tighten these requirements. Maximum loss per kilometer is wavelength-specific and not user adjustable. The limit for an auto test will be automatically adjusted based on the information entered in this screen and the measured length. Only enter the connectors that are not included in the reference setting. Refer to Appendix A for more information of reference methods and their impact on limits and loss measurements.

## 4.2 Performing Reference

Once all the settings are complete, it is necessary to reference the unit. If the auto-test button is pressed prior to a reference being performed the user will be prompted to reference the units. Alternatively the user can access the reference utility by selecting the tools button on the local unit and clicking on the reference icon.

**Figure 15** Set Reference Icon and initial screen



The initial reference screen will show the reference connectivity based on the reference type chosen (1-jumper, 2-jumper or 3-jumper). Ensure your configuration matches the display and then tap the tick button to start the set reference. If connected correctly, the device will show the “test in progress” screen followed by the “Set Reference Success” screen. Note that once the devices have been referenced it is imperative the fibers not be disconnected at the transmitters or the reference will no longer be valid.

# Performing Auto Tests

## 5

Topics discussed in this chapter are as follows:

- [“5.1 Auto Test” on page 26](#)
- [“5.2. Saving Results” on page 29](#)
- [“5.3. Exporting and Printing Results” on page 30](#)

## 5.1 Auto Test

Once the local and remote devices are set up and referenced, they can be connected to the fiber to be certified. Provided the audio settings have been set to allow for tones to be heard when the local and remote devices are connected together; the units will provide an audio signal that they are connected together. Pressing the Auto Test button will perform an auto test based on the test settings. Single direction and bi-directional auto tests with remote unit are described in the following sections.

**5.1.1 Single Direction Auto Test** A single direction auto test does not require any user intervention after the Auto Test button is pressed. While performing an auto test, the screen shows relevant information about the test.

**Figure 16** Auto Test in Progress



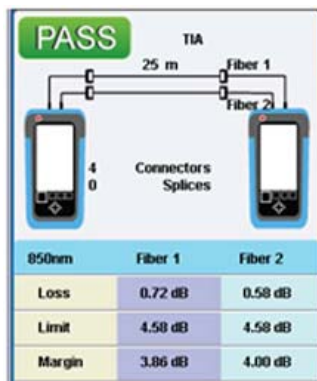
Once complete, the devices (both local and remote) will show the result summary. This screen shows overall pass or fail status, as well as wavelength margin and length specific pass/fail information. The number of connectors and splices as defined in the limit setup screens will also be shown.

Figure 17 Auto Test Summary Results



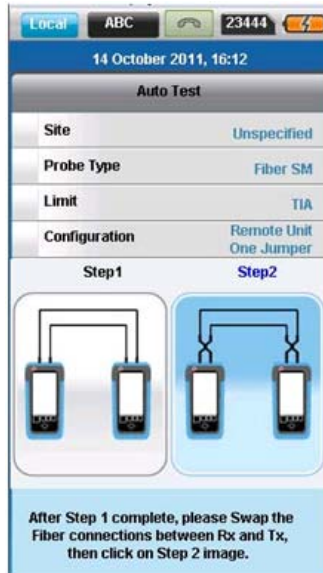
Tapping on either of the wavelengths (on either the local or remote device) will show details, such as loss, limit, and margin for each fiber. Note that Fiber 1 is from the local transmitter to the remote receiver and Fiber 2 is from the remote transmitter to the local receiver.

Figure 18 Auto Test Detailed Results



**5.1.2. Bi-Direction Auto Test** A bi-direction auto test is a two step process and requires the test leads to be swapped at both the local and remote ends before the second step. The user interface pauses after step 1, prompts for the leads to be swapped, and requires the user to tap the “Step 2” image.

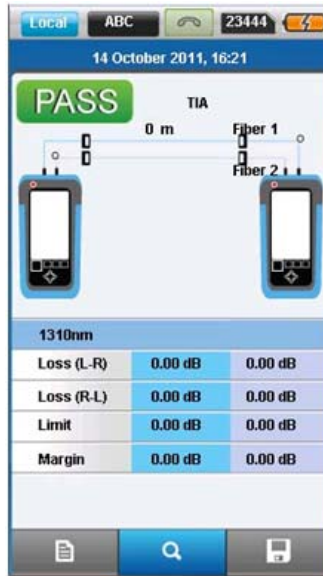
**Figure 19** Bi-Direction Auto Test Step 2 Prompt



After the Bi-Direction Auto Test is complete, the summary screen is shown. Tapping on either of the wavelengths (on either the local or remote device) shows details, such as loss, limit, and margin for each fiber in each direction (Local to Remote, Remote to Local).



Figure 20 Bi-Direction Auto Test Summary Screen



---

## 5.2. Saving Results

If Auto Save Results in the System Settings page is set to “Yes” then test results are automatically saved with the next label.

If Auto Save Results is set to “No” then the test results must be saved by tapping the “Save” icon (bottom right of screen). With Auto Save set to “No”, you have the option to use the next label in the sequence or to edit the label.

## **5.3. Exporting and Printing Results**

Once all fiber tests are completed, the test results can be copied to a USB thumb drive (included with the Certifier40G kit). Simply plug the USB thumb drive into the local unit and you will be prompted to copy the results. (Refer to the Certifier40G copper manual for details of this process).

Once test results are on a USB thumb drive, they can be imported into Certifier40G Reporter where they can be viewed and printed or exported to PDF. (Refer to the Certifier40G Reporter User's Guide for details).

# Customer Services and Warranty

## 6

Topics discussed in this chapter are as follows:

- “6.1 Customer Service (Standard Services)” on page 32
- “6.2 Technical Assistance” on page 32
- “6.3 Repair, Calibration and Upgrades” on page 33
- “6.4 Warranty Information” on page 35

This section provides a description of customer services available through JDSU (including returns policies and procedures) and warranty information.

## 6.1 Customer Service (Standard Services)

Customer Service accompanies the sale of every JDSU product. Customer Service services include:

- Technical Assistance (Business Hour)
- Instrument Repair (Under Warranty Repair, Calibration Services, and Upgrade Services)
- Immediate Return Authorizations

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## 6.2 Technical Assistance

Expert business hour technical support is included with your product. Please reach the technical support organization in your region:

North America:

1-855-ASK-JDSU (855-275-5378)

Europe, the Middle East & Africa:

49-7121-86-1345

E-mail: [nettechsupport@jdsu.com](mailto:nettechsupport@jdsu.com)

## 6.3 Repair, Calibration and Upgrades

Our service centers provide repair, calibration, and upgrade services for JDSU equipment. JDSU understands the impact of equipment down time on operations and is staffed to ensure a quick turnaround. Available services include the following:

**6.3.1 Repair** All equipment returned for service is tested to the same rigorous standards as newly manufactured equipment. This ensures products meet all published specifications, including any applicable product updates.

**6.3.2 Calibration** JDSU's calibration methods are ISO approved and based on national standards. JDSU recommended factory calibration interval of this product is 12 months. The stated confirmation interval shall be regarded as a recommendation. The real definition of the confirmation interval should be made by the user. The type of application and the environmental conditions should be taken into account. Contact a JDSU service center or customer service in your region regarding calibration.

**6.3.3 Factory Upgrades** Any unit returned for a hardware feature enhancement will also receive applicable product updates and will be thoroughly tested, ensuring peak performance of the complete feature set.

**6.3.4 Equipment Return Instructions** Please contact your regional Technical Assistance Center to get a Return or Reference Authorization to accompany your equipment.

For each piece of equipment returned for repair, attach a tag that includes the following information:

- Owner's name, address, and telephone number

- The serial number (if applicable), product type, and model
- Warranty status. (If you are unsure of the warranty status of your instrument, contact Technical Assistance)
- A detailed description of the problem or service requested
- The name and telephone number of the person to contact regarding questions about the repair
- The return authorization (RA) number (US customers), or reference number (European Customers)

If possible, return the equipment using the original shipping container and material. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit; when needed, appropriate packing materials can be obtained by contacting JDSU Technical Assistance. JDSU is not liable for any damage that may occur during shipping. The customer should clearly mark the JDSU-issued RA or reference number on the outside of the package and ship it prepaid and insured to JDSU.

## 6.4 Warranty Information

JDSU guarantees that its products will be free of all defects in material and workmanship. This warranty extends for the period of 12 months for test instruments and 3 months for cables from date of manufacture or purchase (proof of purchase required).

All products deemed defective under this warranty will be repaired or replaced at JDSU's discretion. No further warranties either implied or expressed will apply, nor will responsibility for operation of this device be assumed by JDSU.

The provision of hardware, services and/or software are subject to JDSU's standard terms and conditions available at [www.jdsu.com/terms](http://www.jdsu.com/terms).

**6.4.1 Warranty registration** Please register your product at [www.jdsu.com/know-register](http://www.jdsu.com/know-register)





# Fiber Reference Methods and Their Impact on Loss Limits

## A

Topics discussed in this appendix are as follows:

- [“Overview” on page 38](#)
- [“One-Jumper Reference” on page 40](#)
- [“Two-Jumper Reference” on page 42](#)
- [“Three-Jumper Reference” on page 44](#)
- [“Conclusion” on page 46](#)

## Overview

When performing Tier 1 fiber certification (loss and length), the loss of the fiber system under test must be measured and compared to a loss limit to provide a loss margin. The loss limit is the maximum allowable loss of the overall system and is based on the following factors:

- Length of the fiber
- Number of connectors
- Number of splices

Each of the above factors has a loss associated with it. Remembering that standards and requirements vary, here are generic Telecommunications Industry Association (TIA) maximums:

Loss per Km (Slope) is frequency dependant:

- 3.5 dB/km at 850 nm
- 1.5 dB/km at 1300 nm
- 1.0 dB/km at 1310 nm
- 1.0 dB/km at 1550 nm
- Loss per connector: 0.75 dB
- Loss per splice: 0.3 dB

For loss associated with length, the Certifier40G measures the length of the fiber system and then applies the slope (loss per km). For loss per connector and splice, the technician must indicate how many connectors and splices are present in the fiber system under test.

There are four additional connections required to perform a test:

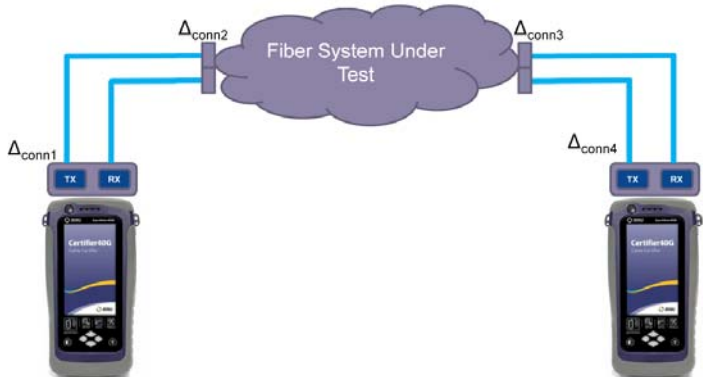
- a connection at the local device to the local reference jumper
- a connection from the local reference jumper to the fiber system under test
- a connection from the fiber system under test to the remote reference jumper

- a connection from the remote reference jumper to the remote device

The reference method chosen will determine how many of these connectors are included in the loss measurement and in the loss limit.

$$\Delta_{\text{conn1}} + \Delta_{\text{conn2}} + \text{fiber system under test} + \Delta_{\text{conn3}} + \Delta_{\text{conn4}}$$

**Figure 21** Measured Loss without Performing a Reference



Note that in the following procedures, the reference jumpers used are assumed to:

- be high quality and in good condition
- be equal in length and relatively short
- have no end-face damage or debris

Disconnecting the connection at the transmitter of the Certifier40G after a reference is performed invalidates the reference. Since the connection at the receiver is not glass-to-glass, it can be removed without affecting the reference. Any loss associated with the test-reference jumpers is negligible.

## One-Jumper Reference

**Setting the Reference** This reference removes the losses at  $\Delta_{\text{conn1}}$  and  $\Delta_{\text{conn4}}$ .

**Figure 22** One-Jumper Reference Setup



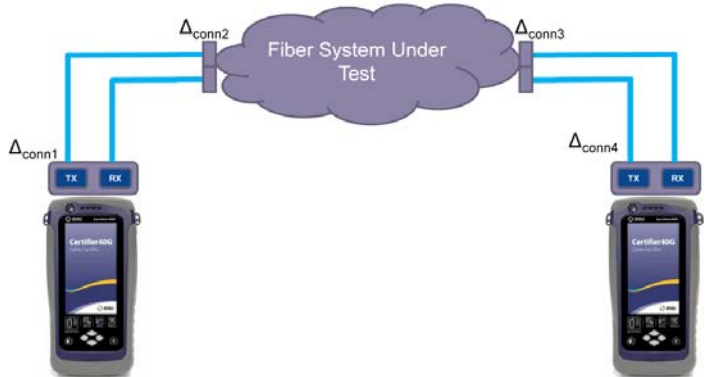
Loss measurement = fiber system under test +  $\Delta_{\text{conn2}}$  +  $\Delta_{\text{conn3}}$

Limit =  $\Delta_{\text{conn2}}$  +  $\Delta_{\text{conn3}}$  @ 0.75 dB each + connector/splice/  
length loss for fiber system under test

This reference removes any loss at the connection between the local unit's transmitter and the reference test jumper as well as the loss at the connection between the remote unit's transmitter and the reference test jumper. However, the loss at the connection from the local reference jumper to the fiber system under test and the connection from the fiber system under test to the remote reference jumper will not be referenced out.

Setting a one-jumper reference, the loss at these two connections is automatically added to the loss limit and will be included in the measured loss. For an accurate limit, enter any connectors and splices within the fiber system under test.

## Performing the Measurement **Figure 23** One-Jumper Connector Locations



The losses at  $\Delta_{conn1}$  and  $\Delta_{conn4}$  are referenced out, so the loss measurement is:

$$\Delta_{conn2} + \text{Fiber System Under Test} + \Delta_{conn3}$$

The limit will be based on the limit settings for connectors and splices plus the slope. Loss will be measured and a margin will be calculated. Margin is the amount of "headroom" in dB between the limit and the measured loss.

**850 nm Example** The fiber system under test is known to have 4 connectors. The user enters 4 connectors and 0 splices:

- limit = 1.5 dB ( $\Delta_{conn2} + \Delta_{conn3}$ )
- 4 connectors at 0.75 dB per connector = 3.0 dB
- limit due to connectors and splices = 4.5 dB

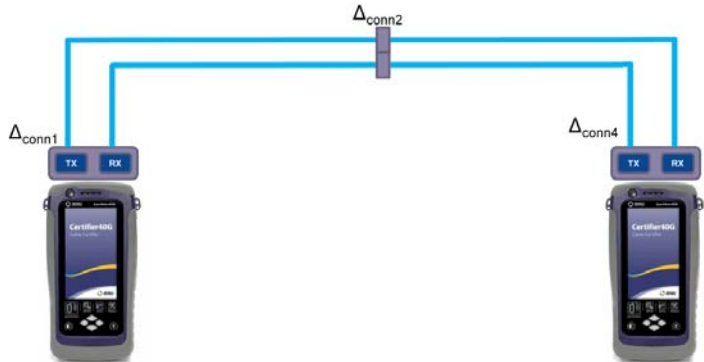
When performing a test, the length is measured and the slope is applied. If the fiber is 25 m, then at 3.5 dB per 1000 m, the maximum loss (limit) due to fiber length is 0.08 dB. This is then added to the limit due to connectors.

The total limit is 1.5 dB + 3.0 dB + 0.08 dB = 4.58 dB. Loss is measured and margin is calculated.

## Two-Jumper Reference

**Setting the Reference** This reference removes the losses at  $\Delta_{\text{conn1}} + \Delta_{\text{conn2}} + \Delta_{\text{conn4}}$  from the measurement.

**Figure 24** Two-Jumper Reference Setup



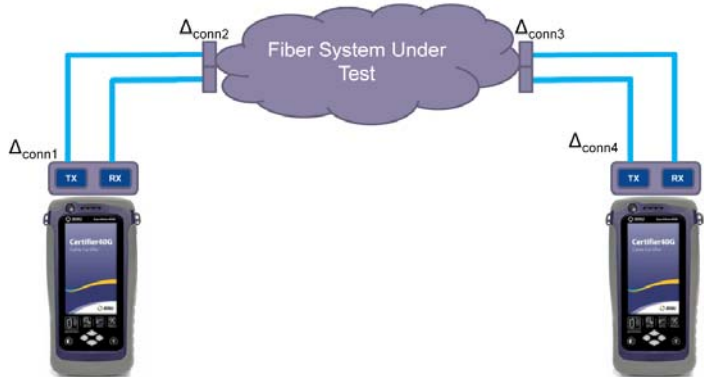
Loss measurement = fiber system under test +  $\Delta_{\text{conn3}}$

Limit =  $\Delta_{\text{conn3}}$  @ 0.75 dB + connector/splice/length loss for fiber system under test

This reference removes any loss at the connection between the local unit's transmitter and a reference test jumper plus the loss at one connection plus a second reference test jumper, as well as the loss at the connection between the remote unit's transmitter and the reference test jumper. The loss at the second connection that must be present to measure the fiber system under test will not be referenced out.

By setting a two-jumper reference, the loss at this one connection is automatically added to the loss limit and will be included in the measured loss. For an accurate limit, enter any connectors and splices within the fiber system under test.

## Performing the Measurement **Figure 25 Two-Jumper Connector Locations**



The losses at  $\Delta_{conn1} + \Delta_{conn2} + \Delta_{conn4}$  are referenced out, so the loss measurement is:

$$\text{fiber system under test} + \Delta_{conn3}$$

The limit will be based on the limit settings for connectors and splices plus the slope. Loss will be measured and a margin will be calculated. Margin is the amount of “headroom” in dB between the limit and the measured loss.

**850 nm Limit Example** The fiber system under test is known to have 4 connectors. The user enters 4 connectors and 0 splices:

- limit due to two-jumper reference = 0.75 dB ( $\Delta_{conn3}$ )
- 4 connectors at 0.75 dB per connector = 3.0 dB
- limit due to connectors and splices = 3.75 dB

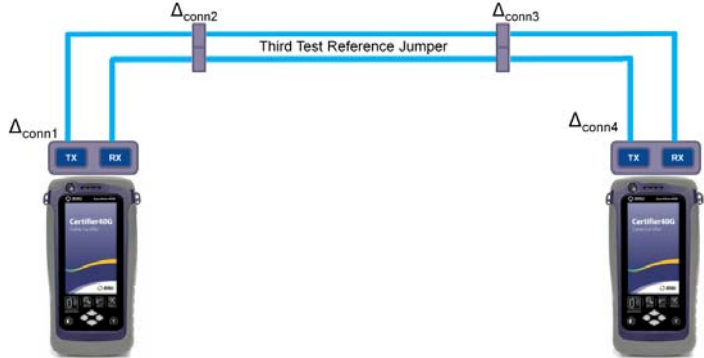
When performing a test, the length is measured and the slope is applied. If the fiber is 25 m, then at 3.5 dB per 1000 m, the maximum loss (limit) due to fiber length is 0.08 dB. This is then added to the limit due to connectors.

The total Limit = 0.75 dB + 3.0 dB + 0.08 dB = 3.83 dB. The loss is measured and the margin is calculated.

## Three-Jumper Reference

**Setting the Reference** This reference removes the loss at  $\Delta_{\text{conn1}} + \Delta_{\text{conn2}} + \Delta_{\text{conn3}} + \Delta_{\text{conn4}}$  from the measurement.

**Figure 26** Three-Jumper Reference Setup



Loss measurement = fiber system under test

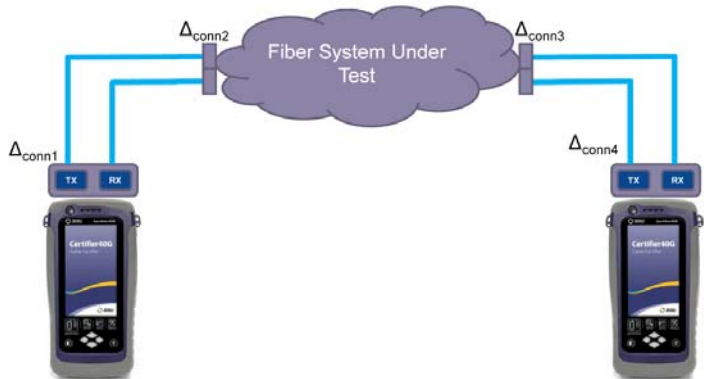
Limit = connector/splice/length loss for fiber system under test

This reference removes any loss at all the connections. A third reference jumper is used. Just as with the other test jumpers, the loss of this short reference jumper will not affect the loss measurement.

By using a three-jumper reference, no connector loss is added to the limit. Enter any connectors and splices within the fiber system under test.



## Performing the Measurement **Figure 27** Three-Jumper Connector Locations



The losses at  $\Delta_{conn1} + \Delta_{conn2} + \Delta_{conn3} + \Delta_{conn4}$  are referenced out, so the measurement is the fiber system under test only.

The limit will be based on the limit settings for connectors and splices plus the slope. Loss will be measured and a margin will be calculated. Margin is the amount of "headroom" in dB between the limit and the measured loss.

**850nm Limit Example** The fiber system under test is known to have 4 connectors. The user enters 4 connectors and 0 splices:

- limit due to three-jumper reference = 0.0 dB
- 4 connectors at 0.75 dB per connector = 3.0 dB
- limit due to connectors and splices = 3.0 dB

When performing a test, the length is measured and the slope is applied. If the fiber is 25 m, then at 3.5 dB per 1000 m, the maximum loss (limit) due to fiber length is 0.08 dB. This is then added to the limit due to connectors.

The total Limit = 0.0 dB + 3.0 dB + 0.08 dB = 3.08 dB. The loss is measured and the margin is calculated.

## Conclusion

Certifier40G can be used to perform Tier 1 fiber certification. In Tier 1 fiber certification, loss and length are measured and compared to a limit to determine pass or fail. The loss limit is partially determined by the chosen reference method.

When using the JDSU Certifier40G for Tier 1 fiber certification, local standards and vendor recommendations dictate which of the three reference methods is most appropriate. Depending on the reference method chosen, additional connectors may need to be added to connect to the fiber system under test. The maximum allowed loss for these connectors is automatically added to the loss limit. The user needs to enter any additional connectors or splices when setting up the limit.

The final factor for determining the overall loss limit is the maximum loss permitted for the length of the fiber. The Certifier40G measures the length of the fiber and then applies the standard slope to the loss limit. The overall loss limit = <losses defined for the connectors required due to the reference method> + <connectors and splices set in limit> + <slope loss>.

The Certifier40G measures the loss each fiber of the overall fiber system under test, applies the loss limit, shows the margin, and indicates if the fiber system under test passed or failed the limit.

# Glossary

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## C

**coupled power ratio** — A way to quantify the amount of power distributed in the tightly coupled modes or the lower order modes. The measurement is done by measuring the difference between the power coupled to the multimode fiber (MMF) into an optical receiver against the power coupled through a single-mode fiber to the receiver keeping the launch condition similar.

---

## E

**encircled flux** — a measure of the distribution of light in the multimode fiber. Typically, it is calculated as the amount of light contained within two concentric circles centered on the core of the fiber.

---

## M

**margin** — The amount of “headroom” between the limit and the measured loss. Margin is measured in dB.

**mode power distribution** — A measure of the performance and quality of medium caused by behavioral differences of modes (higher order modes and lower order modes) inside the fiber.

---

## O

**OM3/OM4** — These are types of multimode optical fiber generally used for communication over short distances. These fibers have a core size of 62.5  $\mu\text{m}$  and a cladding diameter of 125  $\mu\text{m}$ .

---

**S**

**slope** — Loss per kilometer. This is a frequency dependant value.

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**V**

**VCSEL** — A Vertical Cavity Surface Emitting Laser is a light source that is used as a cheaper alternative to laser diodes.

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