

OM5110
46 GBaud Multi-Format Optical Transmitter
User Manual



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Tektronix

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46 GBaud Multi-Format Optical Transmitter
User Manual

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Contacting Tektronix

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Beaverton, OR 97077
USA

For product information, sales, service, and technical support:

- In North America, call 1-800-833-9200.
- Worldwide, visit www.tektronix.com to find contacts in your area.

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Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product. Parts, modules and replacement products used by Tektronix for warranty work may be new or reconditioned to like new performance. All replaced parts, modules and products become the property of Tektronix.

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Important safety information

This manual contains information and warnings that must be followed by the user for safe operation and to keep the product in a safe condition.

To safely perform service on this product, additional information is provided at the end of this section. (See page vi, *Service safety summary*.)

General safety summary

Use the product only as specified. Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. Carefully read all instructions. Retain these instructions for future reference.

Comply with local and national safety codes.

For correct and safe operation of the product, it is essential that you follow generally accepted safety procedures in addition to the safety precautions specified in this manual.

The product is designed to be used by trained personnel only.

Only qualified personnel who are aware of the hazards involved should remove the cover for repair, maintenance, or adjustment.

Before use, always check the product with a known source to be sure it is operating correctly.

This product is not intended for detection of hazardous voltages.

Use personal protective equipment to prevent shock and arc blast injury where hazardous live conductors are exposed.

When incorporating this equipment into a system, the safety of that system is the responsibility of the assembler of the system.

To avoid fire or personal injury

Use proper power cord. Use only the power cord specified for this product and certified for the country of use.

Do not use the provided power cord for other products.

Ground the product. This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, make sure that the product is properly grounded.

Do not disable the power cord grounding connection.

Power disconnect. The power cord disconnects the product from the power source. See instructions for the location. Do not position the equipment so that it

is difficult to disconnect the power cord; it must remain accessible to the user at all times to allow for quick disconnection if needed.

Observe all terminal ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Do not float the common terminal above the rated voltage for that terminal.

The measuring terminals on this product are not rated for connection to mains or Category II, III, or IV circuits.

Do not operate without covers. Do not operate this product with covers or panels removed, or with the case open. Hazardous voltage exposure is possible.

Avoid exposed circuitry. Do not touch exposed connections and components when power is present.

Do not operate with suspected failures. If you suspect that there is damage to this product, have it inspected by qualified service personnel.

Disable the product if it is damaged. Do not use the product if it is damaged or operates incorrectly. If in doubt about safety of the product, turn it off and disconnect the power cord. Clearly mark the product to prevent its further operation.

Examine the exterior of the product before you use it. Look for cracks or missing pieces.

Use only specified replacement parts.

Replace batteries properly. Replace batteries only with the specified type and rating.

Use proper fuse. Use only the fuse type and rating specified for this product.

Wear eye protection. Wear eye protection if exposure to high-intensity rays or laser radiation exists.

Do not operate in wet/damp conditions. Be aware that condensation may occur if a unit is moved from a cold to a warm environment.

Do not operate in an explosive atmosphere.

Keep product surfaces clean and dry. Remove the input signals before you clean the product.

Provide proper ventilation. Refer to the installation instructions in the manual for details on installing the product so it has proper ventilation.

Slots and openings are provided for ventilation and should never be covered or otherwise obstructed. Do not push objects into any of the openings.

Provide a safe working environment. Always place the product in a location convenient for viewing the display and indicators.

Avoid improper or prolonged use of keyboards, pointers, and button pads. Improper or prolonged keyboard or pointer use may result in serious injury.

Be sure your work area meets applicable ergonomic standards. Consult with an ergonomics professional to avoid stress injuries.

Use care when lifting and carrying the product.

Warning- Use correct controls and procedure. Use of controls, adjustments, or procedures other than those listed in this document may result in hazardous radiation exposure.

Do not directly view laser output. Under no circumstances should you use any optical instruments to view the laser output directly.

Service safety summary

The *Service safety summary* section contains additional information required to safely perform service on the product. Only qualified personnel should perform service procedures. Read this *Service safety summary* and the *General safety summary* before performing any service procedures.

To avoid electric shock. Do not touch exposed connections.

Do not service alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Disconnect power. To avoid electric shock, switch off the product power and disconnect the power cord from the mains power before removing any covers or panels, or opening the case for servicing.

Use care when servicing with power on. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

Verify safety after repair. Always recheck ground continuity and mains dielectric strength after performing a repair.

Terms in this manual

These terms may appear in this manual:



WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*



CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Symbols and terms on the product

These terms may appear on the product:

- DANGER indicates an injury hazard immediately accessible as you read the marking.
- WARNING indicates an injury hazard not immediately accessible as you read the marking.
- CAUTION indicates a hazard to property including the product.



When this symbol is marked on the product, be sure to consult the manual to find out the nature of the potential hazards and any actions which have to be taken to avoid them. (This symbol may also be used to refer the user to ratings in the manual.)

The following symbol(s) may appear on the product:



CAUTION
Refer to Manual



Protective Ground
(Earth) Terminal



Mains Disconnected
OFF (Power)

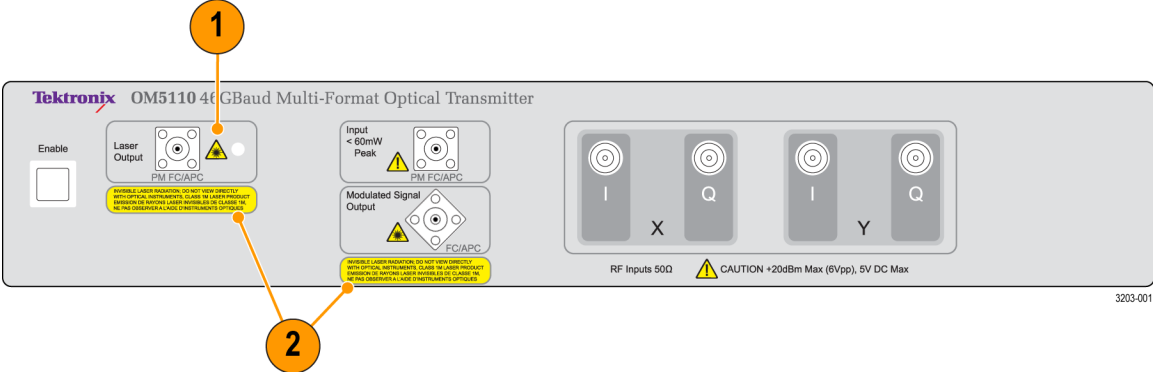



Mains Connected
ON (Power)



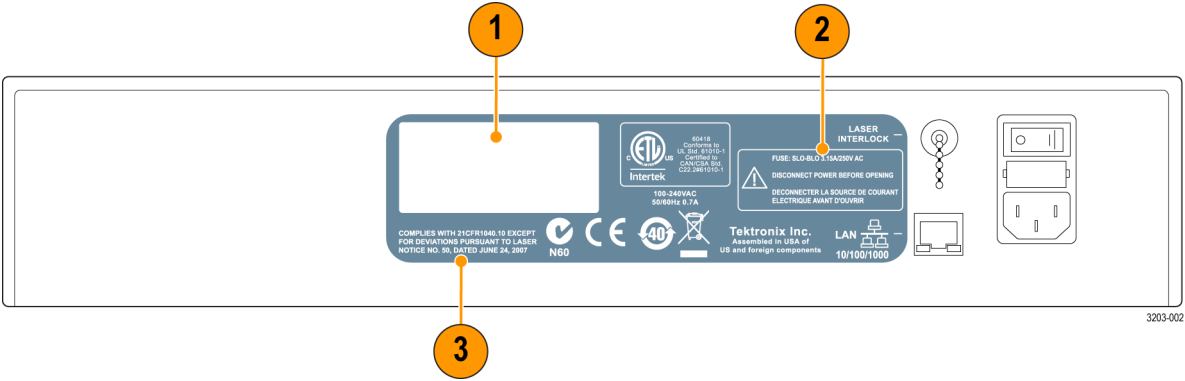
Invisible Laser
Radiation

Front panel labels



Item	Description
1	 Indicates the location of laser apertures
2	<div> INVISIBLE LASER RADIATION; DO NOT VIEW DIRECTLY WITH OPTICAL INSTRUMENTS, CLASS 1M LASER PRODUCT EMISSION DE RAYONS LASER INVISIBLES DE CLASSE 1M, NE PAS OBSERVER A L'AIDE D'INSTRUMENTS OPTIQUES </div>

Rear panel labels



Item	Description
1	Instrument model and serial number label
2	Fuse safety information
3	COMPLIES WITH 21CFR1040.10 EXCEPT FOR DEVIATIONS PURSUANT TO LASER NOTICE NO. 50, DATED JUNE 24, 2007

Compliance information

This section lists the EMC (electromagnetic compliance), safety, and environmental standards with which the instrument complies.

EMC compliance

EC Declaration of Conformity – EMC

Meets intent of Directive 2004/108/EC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Communities:

EN 61326-1 2006. EMC requirements for electrical equipment for measurement, control, and laboratory use.^{1 2 3}

- CISPR 11:2003. Radiated and conducted emissions, Group 1, Class A
- IEC 61000-4-2:2001. Electrostatic discharge immunity
- IEC 61000-4-3:2002. RF electromagnetic field immunity
- IEC 61000-4-4:2004. Electrical fast transient / burst immunity
- IEC 61000-4-5:2001. Power line surge immunity
- IEC 61000-4-6:2003. Conducted RF immunity
- IEC 61000-4-11:2004. Voltage dips and interruptions immunity

EN 61000-3-2:2006. AC power line harmonic emissions

EN 61000-3-3:1995. Voltage changes, fluctuations, and flicker

European contact.

Tektronix UK, Ltd.
Western Peninsula
Western Road
Bracknell, RG12 1RF
United Kingdom

¹ This product is intended for use in nonresidential areas only. Use in residential areas may cause electromagnetic interference.

² Emissions which exceed the levels required by this standard may occur when this equipment is connected to a test object.

³ For compliance with the EMC standards listed here, high quality shielded interface cables should be used.

Australia / New Zealand Declaration of Conformity – EMC

Complies with the EMC provision of the Radiocommunications Act per the following standard, in accordance with ACMA:

- CISPR 11:2003. Radiated and Conducted Emissions, Group 1, Class A, in accordance with EN 61326-1:2006.

Australia / New Zealand contact.

Baker & McKenzie
Level 27, AMP Centre
50 Bridge Street
Sydney NSW 2000, Australia

Safety compliance

This section lists the safety standards with which the product complies and other safety compliance information.

EU declaration of conformity – low voltage

Compliance was demonstrated to the following specification as listed in the Official Journal of the European Union:

Low Voltage Directive 2006/95/EC.

- EN 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- EN 60825-1. Safety of Laser Products - Part 1: Equipment classification and requirements.

U.S. nationally recognized testing laboratory listing

- UL 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

Canadian certification

- CAN/CSA-C22.2 No. 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.

Additional compliances

- IEC 61010-1. Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements.
- IEC 60825-1. Safety of Laser Products - Part 1: Equipment classification and requirements.
- This laser product complies with 21CFR1040.10 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

Equipment type

Test and measuring equipment.

Safety class	Class 1 – grounded product.
Pollution degree descriptions	<p>A measure of the contaminants that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are rated.</p> <ul style="list-style-type: none"> ■ Pollution degree 1. No pollution or only dry, nonconductive pollution occurs. Products in this category are generally encapsulated, hermetically sealed, or located in clean rooms. ■ Pollution degree 2. Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service. ■ Pollution degree 3. Conductive pollution, or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind. ■ Pollution degree 4. Pollution that generates persistent conductivity through conductive dust, rain, or snow. Typical outdoor locations.
Pollution degree rating	Pollution degree 2 (as defined in IEC 61010-1). Rated for indoor, dry location use only.
IP rating	IP20 (as defined in IEC 60529).
Measurement and overvoltage category descriptions	<p>Measurement terminals on this product may be rated for measuring mains voltages from one or more of the following categories (see specific ratings marked on the product and in the manual).</p> <ul style="list-style-type: none"> ■ Category II. Circuits directly connected to the building wiring at utilization points (socket outlets and similar points). ■ Category III. In the building wiring and distribution system. ■ Category IV. At the source of the electrical supply to the building. <hr/> <p>NOTE. Only mains power supply circuits have an overvoltage category rating. Only measurement circuits have a measurement category rating. Other circuits within the product do not have either rating.</p> <hr/>
Mains overvoltage category rating	Overvoltage category II (as defined in IEC 61010-1).

Environmental considerations

This section provides information about the environmental impact of the product.

Product end-of-life handling

Observe the following guidelines when recycling an instrument or component:

Equipment recycling. Production of this equipment required the extraction and use of natural resources. The equipment may contain substances that could be harmful to the environment or human health if improperly handled at the product's end of life. To avoid release of such substances into the environment and to reduce the use of natural resources, we encourage you to recycle this product in an appropriate system that will ensure that most of the materials are reused or recycled appropriately.



This symbol indicates that this product complies with the applicable European Union requirements according to Directives 2002/96/EC and 2006/66/EC on waste electrical and electronic equipment (WEEE) and batteries. For information about recycling options, check the Support/Service section of the Tektronix Web site (www.tektronix.com).

Perchlorate materials. This product contains one or more type CR lithium batteries. According to the state of California, CR lithium batteries are classified as perchlorate materials and require special handling. See www.dtsc.ca.gov/hazardouswaste/perchlorate for additional information.

Restriction of hazardous substances

This product is classified as an industrial monitoring and control instrument, and is not required to comply with the substance restrictions of the recast RoHS Directive 2011/65/EU until July 22, 2017.

Preface

This manual describes how to install and operate the OM5110 46 GBaud Multi-Format Optical Transmitter.

Supported products

The information in this manual applies to the following Tektronix product:

- OM5110 46 GBaud Multi-Format Optical Transmitter

About this manual

This manual contains the following sections:

- *Getting started* shows you how to install and configure the OM5110 instrument.
- *Operating basics* provides an overview of the front- and rear-panel controls and connections, and basic operations.
- *Reference* provides further information about specific instrument or software operation.

Getting started

This section contains the following information to get you started using the instrument:

- Product description
- List of instrument accessories and options
- First product inspection
- Operating requirements (environmental, power)
- Software, network, and hardware setup

Product description

The OM5110 46 GBaud Multi-Format Optical Transmitter is a dual-polarization multi-format transmitter that can generate single and dual-polarization optical signals with BPSK, QPSK, QAM, or arbitrary modulation up to 46 GBaud.

A remote interlock for the laser, located on the rear of the unit, allows for remote locking of laser output.

Use the OM5110 instrument with a Tektronix OM4000 series Coherent Optical Signal Analyzer, Tektronix real-time and equivalent-time oscilloscopes, and coherent signal generators such as Tektronix AWG70001 or PPG3204 instruments, for a complete, end-to-end coherent optical testing solution.

Key features

- Baud rate up to 34 GBaud for arbitrary signals in small signal regime $< 0.5 V_{pp}$
- Baud rate up to 46 GBaud for NRZ bipolar signaling such as BPSK and QPSK with input amplitude of $1 V_{pp}$
- Up to four driven electrical inputs to provide 1- and 2-pol BPSK, QPSK, and 16-QAM modulation; support for other popular modulation formats
- Assisted modulation setup using application note and AWG input files
- Internal C- or L-band laser (option at time of order)
- Optical bias is manually or automatically controlled through UI
- Amplifier electrical bias is manually or automatically controlled through UI
- UI has automatic test interface (ATE)

Accessories

The following table lists the standard and optional accessories provided with the OM5110 instrument.

Table 1: Standard and optional accessories

Accessory	Std.	Opt.	Tektronix part number
OM5110 46 GBaud Mult-Format Optical Transmitter	•		Varies by option
OM5110 46 GBaud Mult-Format Optical Transmitter User Manual (this manual)	•		071-3203-xx
Software USB flashdrive	•		650-5730-xx
Ethernet cable, 7 ft.	•		174-6230-xx
RF Cable, 2.92 mm, 9 in. (4 cables)	•		174-6227-xx
Shorting cap for BNC interlock connector	•		131-8925-xx
Power cord (See page 3, <i>International power cord options</i> .)	•		Varies by option
Reply card	•		Not orderable
Cleaning swab	•		Not orderable
China RoHS sheet	•		Not orderable
Patch Cord, Fiber, APC/APC, 8 in.	•		174-6231-xx

Options

Use the following table to select options to order with the OM5110. See the *46 GBaud Mult-Format Optical Transmitter OM5110 Datasheet* (Tektronix part number 54W-29475-X) for a complete listing of options and recommended configurations.

Table 2: OM5110 options

Model	Option	Description
OM5110	C	One C-band laser
	L	One L-band laser
	NL	No laser

International power cord options

All of the available power cord options in the following list include a lock mechanism except as otherwise noted.

- Opt. A0 – North America power (standard)
- Opt. A1 – Universal EURO power
- Opt. A2 – United Kingdom power
- Opt. A3 – Australia power
- Opt. A4 – North America power (240 V)
- Opt. A5 – Switzerland power
- Opt. A6 – Japan power
- Opt. A10 – China power
- Opt. A11 – India power (no locking cable)
- Opt. A12 – Brazil power (no locking cable)

First product inspection

Do the following when you receive your instrument:

1. Inspect the shipping carton for external damage, which may indicate damage to the instrument.
2. Remove the OM5110 instrument from the shipping carton and check that the instrument was not damaged in transit. The instrument is thoroughly inspected for mechanical defects before shipment. The exterior should not have any scratches or impact marks.

NOTE. *Save the shipping carton and packaging materials for instrument repackaging in case shipment becomes necessary.*

3. Verify that the shipping carton contains the basic instrument, the standard accessories and any optional accessories that you ordered. (See Table 1.)

Contact your local Tektronix Field Office or representative if there is a problem with your instrument or if your shipment is incomplete.

Environmental operating requirements

Check that the location of your installation has the proper operating environment. (See Table 3.)



CAUTION. *Damage to the instrument can occur if this instrument is powered on at temperatures outside the specified ambient temperature range.*

Table 3: OM5110 environmental requirements

Parameter	Description	
Temperature	Operating	+10 °C to +35 °C
	Nonoperating	–20 °C to +60 °C
Relative Humidity	Operating	10% to 85% RH (Relative Humidity)
	Nonoperating	10% to 85% RH to +35°C Upper limit derates to 45% RH at +60°C
Altitude	Operating	To 3,000 m (9,840 feet) Maximum operating temperature decreases 1 °C each 300 m above 1.5 km.
	Nonoperating	To 12,000 m (39,360 feet)

There is a fan on the back left side of the box with an air intake under the left front. A 2 inch (51 mm) clearance must be maintained on the left side of the instrument, and a 0.5 inch (13 mm) clearance must be maintained on the bottom of the instrument, for forced air flow. The mainframe should never be operated on a bench with the feet removed, nor have any object placed nearby where it may be drawn against the air vents. Also, provide enough rear clearance (approximately 2 inches/51 mm) so that connected cables are not damaged by sharp bends.

Power requirements

Table 4: AC line power requirements

Parameter	Description
Line voltage range	100–240 V _{AC} , ±10%
Line frequency	50/60 Hz

Table 4: AC line power requirements (cont.)

Parameter	Description
Maximum current	0.7 A
Fuse rating	T3.15A, 250 V



WARNING. To reduce the risk of fire and shock, verify that the AC supply voltage fluctuations do not exceed $\pm 10\%$ of the operating voltage range.

To avoid the possibility of electrical shock, do not connect your OM5110 to a power source if there are any signs of damage to the instrument enclosure.



WARNING. Always connect the unit directly to a grounded power outlet. Operating the OM instrument without connection to a grounded power source could result in serious electrical shock.



CAUTION. Protective features of the OM5110 instrument may be impaired if the unit is used in a manner not specified by Tektronix.

PC requirements

The equipment and DUT used with the OM5110 determine the controller PC requirements.

If you are using the OM5110 as a stand-alone instrument, the LRCP software used with the OM5110 requires Windows 7 or Windows XP (32-bit or 64-bit) operating systems with NET 4.0.

The following are the requirements to use the OM5110 with the Tektronix OM4000 series Optical Modulation Analyzers and the OM2210 Coherent Receiver Calibration Source:

Item	Description
Operating system	U.S.A. Microsoft Windows 7 (32- or 64-bit) U.S.A. Microsoft Windows XP (32- or 64-bit) Service Pack 3 (.NET 4.0 required)
Processor	Intel i7, i5 or equivalent; min clock speed 2 GHz Minimum: Intel Pentium 4 or equivalent
RAM	Minimum: 4 GB 64-bit releases benefit from as much memory as is available
Hard Drive Space	Minimum: 20 GB >300 GB recommended for large data sets

Item	Description
Video Card	nVidia dedicated graphics board with 512+ MB minimum graphics memory NOTE. <i>The color grade display is not available when running the application on an oscilloscope or PC that does not use an nVidia graphics card</i>
Networking	Gigabit Ethernet (1 Gb/s) or Fast Ethernet (100 Mb/s)
Display	20" minimum flat screen recommended for displaying multiple graph types when using with the OM4000 series software
Other Hardware	2 USB 2.0 ports DVD optical drive
MATLAB Software (for use with OM4000 OUI software only)	For Windows 7 (64-bit): MATLAB version 2011b (64-bit) For Windows XP (32-bit): MATLAB version 2009a (32-bit), .NET version 4 or later. See the <i>OM4006D and OM4106D User Manual</i> for more information
Adobe Reader	Adobe reader required for viewing PDF format files (release notes, installation instructions, user manuals).

Software installation

Install the program listed in the following table. The program is on the OM5110 software USB flashdrive.

NOTE. *Read the installation notes or instructions that are in each application installation folder before installing each item of software. Only install the software that is appropriate for your OM instrument, PC, and oscilloscope configuration.*

NOTE. *If you are going to use the OM5110 as part of a test/calibration system including OM4000 and OM2210/2012 instruments and measurement oscilloscopes, do not install the software listed in the following table. Instead, use the software installation instructions that are in the “OM4006D and OM4106D Coherent Lightwave Signal Analyzer User Manual.” Those instructions include loading the LRCP software.*

Install software on the controller (PC or oscilloscope)

Table 5: Software install: controller device (PC or oscilloscope)

Item	Description	Path (from root directory of USB drive)
LRCP ¹	Laser Receiver Control Panel. Detects OM instruments on a network, controls laser and other hardware settings.	OM5110\Setup Tektronix LRCP_2.0.0.6105.exe
AWG file library	Files to use with Tektronix AWG70001A and AWG70002A Arbitrary Waveform Generators for generating standard and custom optical modulation signals. These files are precompensated to work with a typical AWG70001A and OM5110 combination. See the file <i>OM5110 app note.pdf</i> in the AWG Files folder for information on using the AWG library files with the OM5110.	OM5110\AWG Files

¹ The OM5110 requires LRCP version 2.0 or greater.

Set the instrument IP address

Use the Laser Receiver Control Panel (LRCP) application to verify and/or set the IP address of OM instruments (OM5110, OM4106D, OM4006D, OM2210, OM2012) if required for your network test setup. All OM instruments must be set to the same network subnet (DHCP-enabled networks do this automatically) to communicate with each other using the LRCP and OM4000 or OM5110 User Interface software.

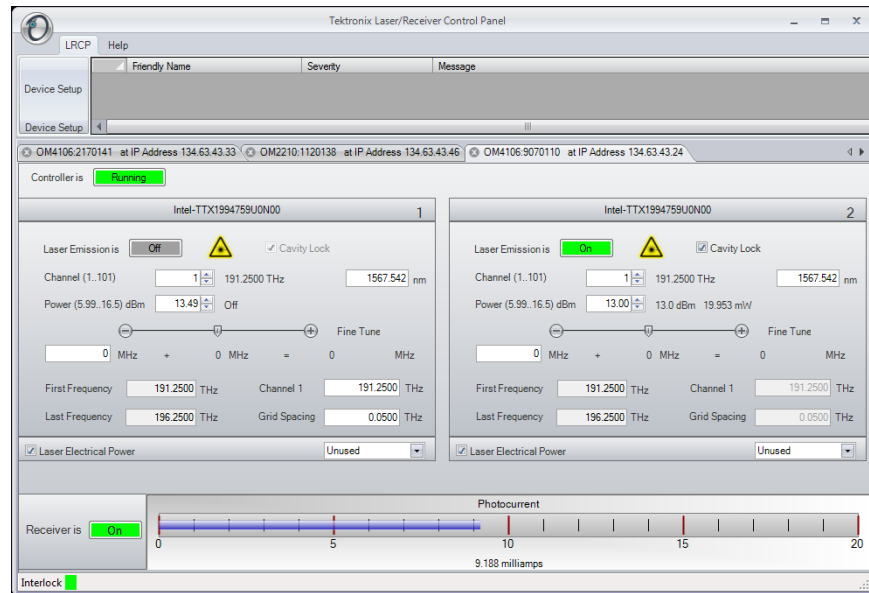


Figure 1: IP address setup (LRCP)

Before using LRCP, you must make sure that IP addresses of the OM series instruments are set correctly to communicate with LRCP on your network. The following sections describe how to set the OM instrument IP addresses for use on DHCP and non-DHCP networks.

Set IP address for DHCP-enabled network

The OM instruments are set with automatic IP assignment (DHCP) enabled by default. Therefore you do not need to specifically set the instrument IP address, as the DHCP server automatically assigns an IP address during instrument power-on when the rear-panel power switch is turned on.

The following procedure describes how to use LRCP software to verify connectivity of an OM instrument to a DHCP-enabled network.

Prerequisite: OM instrument, and the controller PC (with LRCP installed), both connected to the same DHCP-enabled network.

1. Connect the OM instrument to the DHCP-enabled network.
2. Power on the OM instrument with the rear power switch (set to 1). The instrument queries the DHCP server to obtain an IP address. Wait until the

front panel Enable/Standby button light turns off indicating it is ready. Push the front panel Enable/Standby button to enable the network connection (button light turns On).

3. On a PC connected to the same network as the OM instrument, start the **LRCP** program.
4. Enter password **1234** when requested.
5. When running LRCP for the first time after installation, click the **Configuration/Device Setup** link on the application screen to open the Device Setup window. Otherwise click the **LRCP** button and then the **Device Setup** button (upper left of application window).
6. In the **Device Setup** dialog box, click the **Auto Configure** button. LRCP searches the network and lists any OM instruments that it detects. If no devices are detected, work with your IT resource to resolve the connection problem.
7. (optional) Use the **Friendly Name** field to create a custom label for each instrument. There is no limit to the size of the name you enter.
8. Click **OK** to close the configuration dialog box and return to the LRCP main window. The main LRCP window displays a tab for each instrument detected. Click a tab to display the laser controls for that instrument. Refer to the LRCP documentation for help on using the software.

Set IP address for a non-DHCP network

To connect the OM series instrument to a non-DHCP network, you must reset the default IP address and related settings on the OM instrument to match those of your non-DHCP network. All devices on this network (OM instruments, PCs and other remotely accessed instruments such as oscilloscopes) need the same subnet values (first three number groups of the IP address) to communicate, and a unique instrument identifier (the fourth number group of the IP address) to identify each instrument.

Work with your network administrator to obtain a unique IP address for each device. Your network administrator may need the MAC addresses of the computer, oscilloscope, and OM instrument. The MAC address is located on the OM instrument rear panel label.

NOTE. *Make sure to record the IP addresses used for each OM instrument, or attach a label with the new IP address to the instrument.*

If you are setting up a new isolated network just for controlling OM and associated instruments, Tektronix recommends using the OM instrument default IP subnet address of **172.17.200.XXX**, where XXX is any number between 0 and 255. Use the operating systems of the oscilloscope and computer to set their IP addresses.

NOTE. *If you need to change the default IP address of more than one OM instrument, you must connect each instrument separately to change the IP address.*

There are two ways to change the IP address of an OM instrument:

- Use LRCP on a PC connected to a DHCP-enabled network (easiest)
- Use LRCP on a PC set to the same IP address subnet as the OM instrument to change the OM instrument IP address

Use DHCP network to change instrument IP address. To use a DHCP network to change the IP address of an OM series instrument:

1. Do steps 1 through 6 of the *Set network access (DHCP network)* procedure.
2. Enter (overwrite) the new IP address for your OM instrument in the corresponding "IP Address" field.
3. Click the corresponding **Set IP** button.
4. A warning dialog box appears indicating that the IP address will be changed and that you must record the new IP address. Losing the IP address will require connecting the instrument to a DHCP router.
5. Click **Yes** to set the IP address.
6. Exit the LRCP program.
7. Power off the OM instrument and connect it to the non-DHCP network.
8. Run LRCP and use the **Auto Config** button in the Device Setup dialog box to verify that the instrument is listed with the new IP address.

Use direct PC connection to change instrument IP address. To use a direct PC connection to change the default IP address of an OM series instrument, you need to:

- Install LRCP on the PC
- Use the Windows Network tools to set the IP address of the PC to match that of the current subnet setting of the OM series instrument whose IP address you need to change
- Connect the OM instrument directly to the PC, or through a hub or switch (not over a network)
- Use LRCP to change the OM instrument IP address

Do the following steps to use a direct PC connection to change the IP address of an OM series instrument:

NOTE. *The following instructions are for Windows 7.*

NOTE. *If you need to change the default IP address of more than one OM instrument using this procedure, you must connect each instrument separately to change the IP address.*

1. On the PC with LRCP installed, click **Start > Control Panel**.
2. Open the **Network and Sharing Center** link.
3. Click the **Manage Network Connections** link to list connections for your PC.
4. Right-click the **Local Area Connection** entry for the Ethernet connection and select **Properties** to open the Properties dialog box.
5. Select **Internet Protocol Version 4** and click **Properties**.
6. Enter a new IP address for your PC, using the same first three numbers as used by the OM instrument. For example, **172.17.200.200**. This sets your PC to the same subnet (first three number groups) as the default IP address setting for the OM series instruments.
7. Click **OK** to set the new IP address.
8. Click **OK** to exit the Local Area Connection dialog box.
9. Exit the **Control Panel** window.
10. Connect the OM instrument to the PC.
11. Power on the OM instrument with the rear power switch (set to **1**). Wait until front panel Enable/Standby button light turns off.
12. Push the **Enable/Standby** button again to enable the network connection (button light turns On).
13. On the PC, start the **LRCP** program.
14. Enter password **1234** when requested.
15. Select **LRCP > Device Setup** from the menu to open the Device Setup window.
16. Click the **Auto Configure** button. LRCP lists the OM-series instrument connected to the PC. If LRCP does not list the connected instrument, verify that you entered a correct IP address into the PC and your Ethernet cable is good. If the IP address was entered correctly, you may need to connect the OM instrument to a DHCP network to determine if the IP address you used to set the computer was correct.

17. (optional) Use the **Friendly Name** field to create a custom label for each instrument. There is no limit to the size of the name you enter. Friendly Names are retained and are associated with the MAC address of each instrument.
18. Enter (overwrite) the new IP address for your OM instrument in the corresponding "IP Address" field. For example, **172.17.200.040**
19. Click the **Set IP** button.
20. A warning dialog box appears indicating that the IP address will be changed and that you must record the new IP address.

NOTE. *If you change the instrument to an IP address that is different than the Subnet of the PC, and click Set IP, the instrument is no longer detectable or viewable to that PC and LRCP. You must connect the instrument to a DHCP router to reset the value.*

21. Click **Yes** to set the IP address.
22. Edit the Gateway and Net Mask (obtain this information from your network support).
23. Click **OK**.
24. Exit the LRCP program.
25. Disconnect the network cable from between the PC and the OM instrument.
26. Connect the OM instrument to the target network switch/router.
27. Run the LRCP software on the PC connected to the same network as the OM instrument.
28. Click **Device Setup**. Click **Auto Config** and verify that the instrument is detected and listed on the display.

Operating basics

OM5110 controls and connectors

Front panel

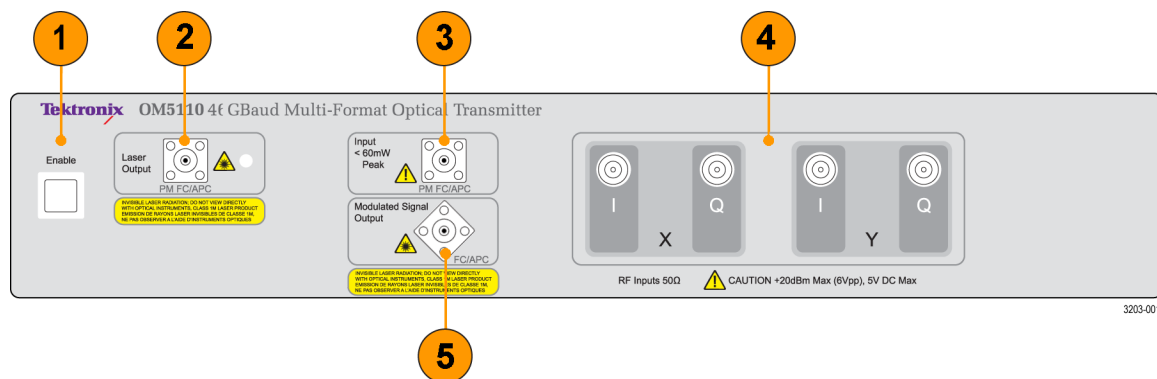


Figure 2: OM5110 front panel

1. Enable/Standby switch (hold for 10 seconds to reset instrument)
2. Laser output (PM FC/APC)
3. Optical Input (PM FC/APC input to the optical modulator)
4. X, Y I/Q inputs (2.92 mm RF connectors) to connect the signal generator
5. Modulated signal output (SMF FC/APC)

Rear panel

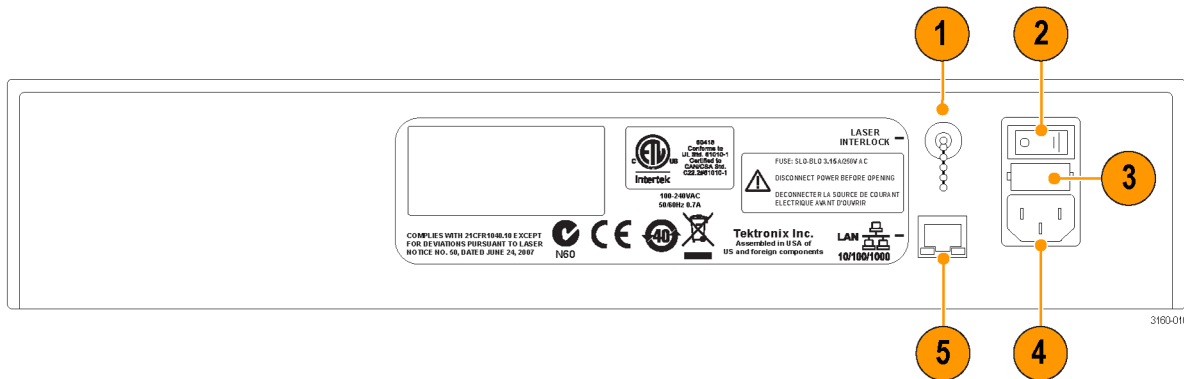


Figure 3: OM5110 rear panel

1. BNC connector for optional laser remote interlock to enable laser emission
2. Primary (AC) power switch
3. Fuse holder
4. Power cable connector
5. 10/100/1000 Ethernet port

Connect the power cable

NOTE. Make sure that the Primary power switch on the rear panel is set to Off (O) before attaching the power cord.

Connect the power cord to the instrument first, and then connect the power cord to the AC power source.

NOTE. Install or position the OM5110 instrument to provide fast access to the rear-panel Primary power switch.

Power on the instrument

1. Toggle the Primary power switch on the rear panel from Off to On. and
2. Push the front-panel Enable/Standby button.
3. After powering on, make sure that the fan on the left side of the instrument is working. If the fan is not working, Power off the instrument (Push the Enable/Standby button on front panel, then switch the rear panel Primary power switch to Off). Power on the instrument again. If the fan still does not work, repeat the power off sequence, disconnect the AC power cord, and contact your local Tektronix Field Office or representative for help.

Theory of operation

The OM5110 contains a dual-polarization IQ optical modulator capable of producing optical modulation at up to 46 Gbaud for binary modulation and 34 Gbaud for small-signal modulation. The optical modulator translates the RF input signals to the frequency of the Optical Input using dual nested Mach-Zehnder modulators to provide RF IQ modulation on two orthogonal polarizations at the Optical Output.

The linear two-stage amplifiers increase the RF input signals by 20 dB before going to the modulator. The amplifier gain reduces the input-referred V_{pi} voltages of the modulators to approximately 350 mV. Full-amplitude binary-phase-shift-keyed modulation (BPSK) is achieved with signals greater than 700 mV_{pp} but no more than 1 V_{pp} is required for complete saturation.

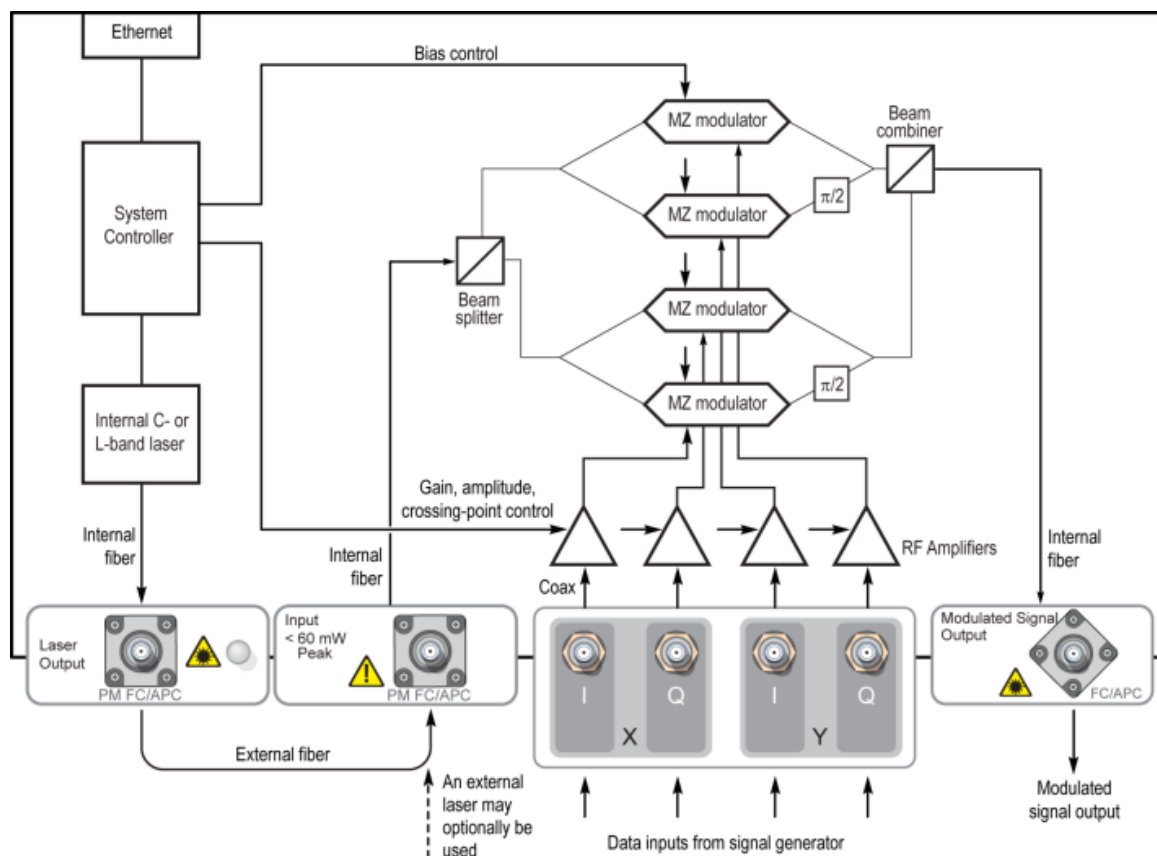


Figure 4: OM5110 block diagram

For 2-polarization IQ modulation, 4 RF input signals are required. If the OM5110 is used for other modulation types, only the necessary number of inputs need be connected, for example, a single RF data signal is required for 1-pol BPSK. The LRCP software is used to configure the optical modulator bias controller for the modulation type. The optical bias controller makes sure that each of the data modulators and IQ-phase control modulators are biased at the proper points for IQ modulation. Each IQ RF-input pair should have minimum correlation to obtain the best result with automatic optical bias control. For example, putting exactly the same signal on I and Q will not necessarily result in the expected IQ modulation unless manual optical bias control is used.

There are two primary modes of operation for the OM5110: large-signal and small-signal. Large-signal modulation occurs from around 500 mVpp to where the amplifier is completely saturated at 1 Vpp. In this range both the amplifier and modulator have a nonlinear characteristic that provide higher quality modulation for binary signals. As the amplifier becomes saturated, use the LRCP software to adjust the amplitude and duty-cycle distortion (crossing-point) provided by the amplifier's second stage of gain. Factory settings provide 2Vpi modulation amplitude and 50% crossing point, but you can adjust these to accommodate different signal sources.

The small signal mode of operation is most often used for multi-level inputs used to create QAM signals. The amplifier remains linear up to 500 mVpp so the amplitude and duty cycle adjustments will have little effect. In this case, you adjust the first amplifier gain stage to equalize the small signal gains of the different channels. The factory settings typically provide 2% amplitude matching between input channels. Use this mode of operation to convey baseband multi-level IQ signals such as 16-QAM to optical frequencies.

The OM5110 is ideally suited for use with the AWG70001A and RFXpress application software for creating arbitrary signals that are precompensated for the response of the AWG and the OM5110 to provide the desired modulated optical waveform. See the Application Note provided with the OM5110 AWG file library for further information on using the OM5110 with the AWG70001A and RFXpress.

Equipment setup

See the following figure for how to connect the OM5110 instrument.

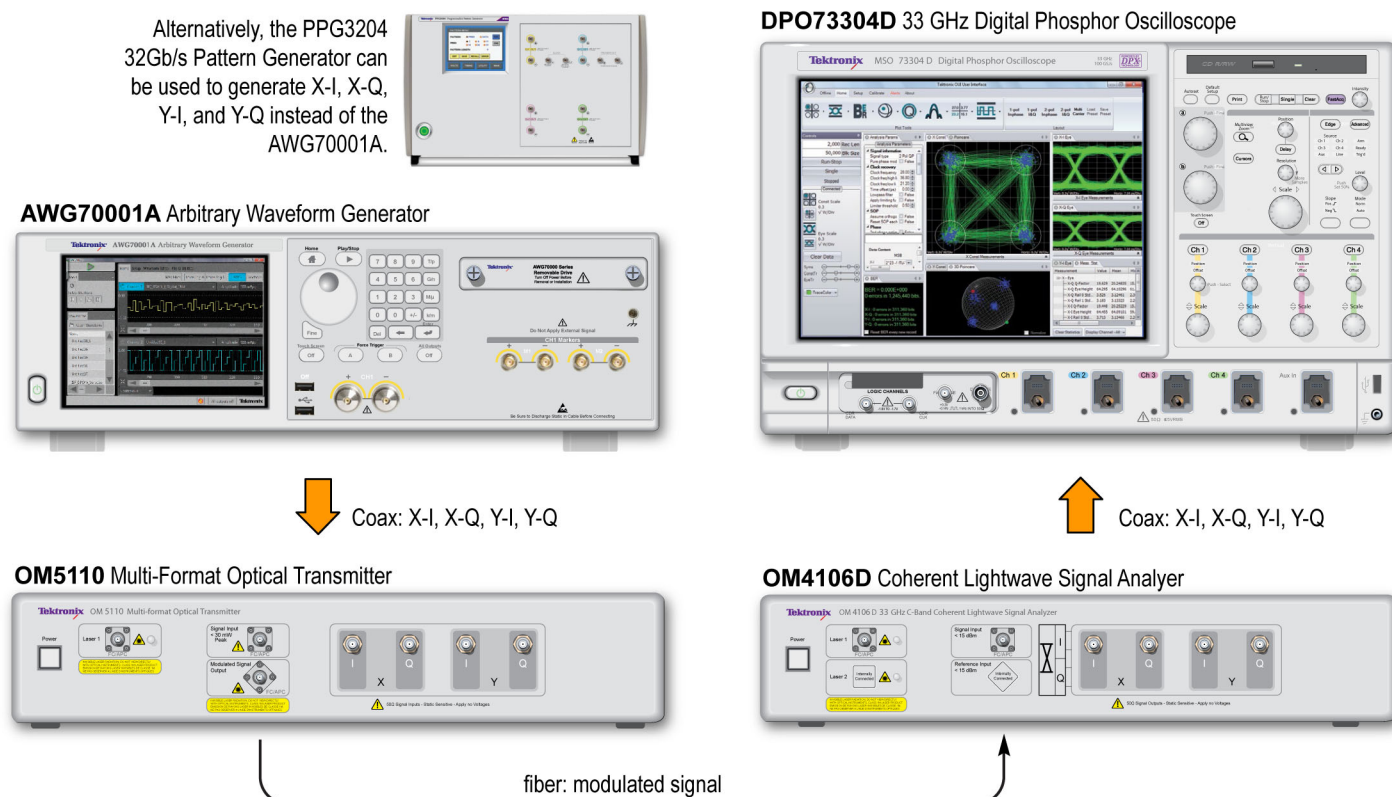


Figure 5: OM5110 connection diagram

Software overview

The OM5110 is controlled by the LRCP software. The LRCP automates locating and configuring all OM devices on the network. It also provides a Windows Communication Foundation (WCF) service interface to allow another local or remote process to operate the connected devices for ATE (automated test equipment) applications. The LRCP program can control any number of OM-series devices including the OM4000 and OM2000 series and the OM5110.

Each device that the LRCP controls is assigned a tab that is labeled with the device name and IP address. Clicking on the tab brings the control pane for that device to the front. The contents of the control pane depend on that tabs device. The following figure shows the pane for the OM5110.

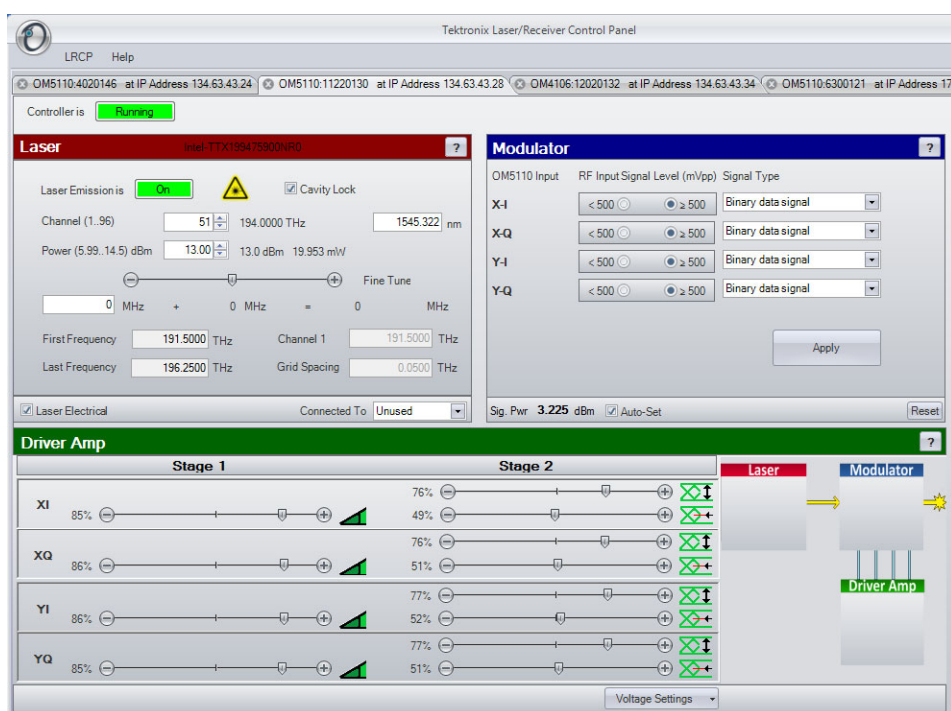


Figure 6: OM5110 controls (LRCP)

Device setup and auto configure

Click the LRCP and Device Setup button to open the Device Setup dialog box. Use this dialog box on first setup of the controllers and any time network configuration changes and devices are moved to a new IP address. Click the Auto Configure button to have LRCP search for and list detected OM devices. Make sure to exit the form by clicking the OK button to save changes.

An important setting on the Device Setup screen is the Friendly Name. The Friendly Name field is a way to attach custom labels for each device, to help you identify the type and/or location of the controllers. Friendly Names are retained in the LRCP and are tied to the corresponding MAC Address.

Use the Set IP button to manually set the instrument IP address. This is only necessary in a network environment that is not using DHCP to automatically assign IP Addresses. The Set IP button only changes the IP address and does not save other modified fields like Friendly Name. How you manage IP addresses in your network, namely with or without DHCP, determines the method you use to connect the LRCP and devices on your network. (See page 8, *Set the instrument IP address.*)

Connecting to your OM instruments

Once configured and detected, devices are listed as tabs on the main LRCP screen. They are listed with the friendly name and IP address to allow for easy identification. Lasers are numbered and once the controller is brought online the laser panels will populate with the laser manufacturer and model number.

Once the user presses the button that reads Offline the button will change colors as the control panel attaches to the OM4000 series or OM5110 instrument. First, the button will turn yellow and read "Connecting..." indicating that a physical network connection is being established over a socket. Second, the button will turn teal and read "Connected...". This indicates that a session is established between the device and Control Panel. Commands are sent to initialize the communications with the laser and identify their capabilities. Finally, the button turns bright green when the controller and lasers are ready.

NOTE. *The button color scheme (bright green = running or active, gray = off line or inactive, red = warning or error state) is consistent throughout the application.*

The very first time the LRCP connects to an OM5110, there is a delay while the LRCP calculates the initial modulator parameters so that they may be stored away in the LRCP Program Files directory. The modulator parameters, including null voltages and Vpi voltages for the various modulator sections, are needed to obtain proper optical bias for the modulator. The LRCP saves the current state of each OM5110 on first connection so that you can restore the parameters if needed. More information on setting the modulator parameters using the "Set Params" button may be found below.

Once the controller tab is active and the panels have populated with information received from the devices, you can change settings and turn on the laser if required. When the controller establishes the connection with the OM4000 series or OM5110 devices, it reads and displays the current state of the device in the panel. Any time you exit the application, the current state of the device is preserved by the device, including the emission state. If the device is powered down, it will return to its default power-on state when it is switched back on.

If the lasers are used with the OM4000 User Interface (OUI) Software, the laser usage type must be set using the dialog on the lower right corner of each laser panel. The OUI uses the setting to determine the laser from which frequency information is retrieved. A selected usage type (such as Reference) can only be selected once among all of the OM devices to which you are connected.

NOTE. *Only the Reference laser selection is important to OUI operation. The other selections are to help the user remember how each laser is being used.*

The Laser controls

The Laser control area of the LRCP software displays available laser control functions for the connected OM5110 (with optional internal laser).

Table 6: OM5110 Laser controls (LRCP)

Control	Description
Channel	Type a number or use the up/down arrows to choose a channel. The range of channels available will depend on the type of laser, the First Frequency, and the Grid. The finer the Grid, the more channels are available for a given laser. The channel range is indicated next to the word Channel. The laser channel can also be set by entering a wavelength in the text box to the right of the channel entry. The laser will tune to the nearest grid frequency.
Cavity Lock	The Intel/Emcore ITLA laser that is included in the OM5110 instrument has the ability to toggle its channel lock function. Ordinarily, Cavity Lock should be checked so that the laser is able to tune, change power level, and lock on to its frequency reference. However, once tuning is complete and the laser has stabilized, you can clear this box to turn off the frequency dither needed for locking the laser to its reference. The laser can hold its frequency for days without the benefit of the frequency dither. This feature is helpful where the lowest phase noise is required.
Power	Sets the laser power level. Type or use the up/down arrows to select the laser power level. The allowed power range is shown next to the control.
Fine Tune	Enables tuning the laser off grid up to 12 GHz. Change this value by typing a number in the text box or by dragging the slider. The sum of the text box and slider values is sent to the laser. Once the laser accepts the new value it is displayed after the '=' sign.
First Frequency	Readout only. The lowest frequency to which you can tune the laser.
Last Frequency	Readout only. The highest frequency to which you can tune the laser.
Channel 1	Settable when emission is off. This is the definition of Channel 1.
Grid Spacing	Settable (with 100 MHz resolution) when emission is off. 0.1, 0.05 or 0.01THz are typical choices. Use 0.01 THz if tuning to arbitrary (non-ITU-grid) frequencies. Using this grid plus Fine Tune, any frequency in the laser band is accessible.

Table 6: OM5110 Laser controls (LRCP) (cont.)

Control	Description
Laser Electrical Power	This should normally be checked. Unchecking this box turns off electrical power to the laser module. This should only be needed to reset the laser to its power-on state, or to preserve laser lifetime if a particular laser is never used.
Emission	Click to turn on or off front panel laser emission. The emission status is indicated both by the green background of the button and by the corresponding green LED on the OM5110 instrument front panel.
Connected To	Use the drop-down to select where this laser is connected. The control software needs to know if this laser is being used as the Reference for a coherent receiver. Select Reference if this laser is connected to the Reference (LO) input of a coherent receiver.

The Modulator controls

The Modulator section of the LRCP software is used to control the optical bias settings of the optical modulator in the OM5110.

**Auto settings view
(Auto-Set check box
selected)**

The Auto-Set check box, at the bottom of the control area, enables or disables the modulator automatic optical bias function settings screen. When the check box is selected, settings are controlled automatically based on the specified signal level and type. When Auto-Set is cleared, you can manually enter modulator settings.

Table 7: OM5110 Modulator controls (Auto-Set mode) (LRCP)

Control	Description
RF Input Signal Level (mVpp)	Set whether the input signal to each OM5110 input (X-I, X-Q, Y-I, and Y-Q) is less than or greater than the listed value.
Signal Type	Sets the input signal type. Valid types are No Signal, Binary data signal, and Multi-level data signal.
Apply	Send the settings to the OM5110. When the wait circle disappears, your settings have been applied. The OM5110 retains these settings until they are changed. No settings are sent or retained by the OM5110 until you click the Apply button.
Sig. Pwr	(Readout only) The Modulated Output Signal power (abbreviated Sig. Pwr.) readout at the bottom of the Modulator control area. If the output is too high or too low, it may temporarily affect the controller circuits of the OM5110. In this case the power readout changes color and mouse-over text is available to indicate that optical bias and power readout may not be precise. There is no harm operating like this if the input optical power is within the specified range.
Reset	Sets the optical bias control voltages to the default values. This is helpful whenever a major change is made to the system such as turning on the laser or input signals. Clicking Reset generally helps the system reach steady-state operation the fastest.

Manual settings view (Auto-Set check box cleared)

The Manual Settings View provides the greatest degree of control flexibility, but is more complex than Automatic Settings View. Since each setting may take five seconds to be stored in the OM5110 and possibly several minutes to reach steady state, it is best to use the Automatic Settings View where all the settings are established at once. The Manual Settings View is helpful when it is necessary to make fine adjustments to optimize a signal, or when it is desirable to impair the signal.

The following controls are available in the manual modulator view:

Table 8: OM5110 Modulator controls (manual mode) (LRCP)

Control	Description
Slope	Usually - for > 500 mVpp inputs and + for < 500 mVpp inputs. The - causes lock at minimum attenuation and the + at maximum attenuation.
Control Mode	Auto to use automatic optical bias control based on feedback from the output optical signal. Manual to set the optical modulator bias voltage to a particular value.
Voltage/Offset	The slider control is used to set the desired voltage when in Manual mode or to set the Offset when in Auto mode. Offset is the amount to offset the bias from where it would normally be in Auto mode. The units are arbitrary and vary based on Optical Input power. The Offset must be tuned while observing the Modulated Optical Output signal on an appropriate optical signal analyzer to obtain the desired signal behavior.
Actual	This column shows the voltages at the optical modulator bias inputs. The value in parentheses is the actual Offset value.
Signal Mode	The optical bias controller behaves differently depending on the type of electrical signal input. Binary signals require 2-pol QPSK mode. QAM signals generally require QAM mode. Again it is best to use the Automatic Settings View which chooses the most appropriate Signal Mode automatically.
Set Modulator Parameters	The 6 modulator sections of the OM5110 modulator (X-I, X-Q, Y-I, YQ, XP, and YP), each have particular null voltages where that section outputs minimum optical power, and Vpi voltages, the voltage difference between null and peak transmission. This information is needed by the OM5110 optical bias controller to properly control the modulator sections. The OM5110 is preprogrammed at the factory. The null voltages do change with time, and are different for different RF drive levels. It is not important for these values to be very precise. You should update your modulator parameters only if the OM5110 fails to achieve proper optical bias within a few minutes. Providing a better set of null voltages speeds the time to proper optical bias. The Vpi voltages do not change appreciably with time or temperature and may be left at their factory-set values.

To determine the optimal Null Voltage values:

1. Connect the OM5110 to an analyzer, such as the OM4106D, that will report the signal quality of the OM5110. Connect the necessary signal inputs and turn on the laser source.
2. Use the **Modulator Auto-Set** view to set up the OM5110 for the required signal types and drive levels. Click **Apply**. Wait for this step to complete.
3. Deselect the **Auto-Set** box to see the Manual Settings view. Wait for the analyzer to report that the optical bias is correct.
4. If the optical bias does not meet your requirements, use the Manual Control Mode or the Offset function to correct the optical bias.
5. Record the voltages shown on the Manual Settings view once the optical bias value meets your requirements.
6. Click **Set Params**. Enter the voltages shown in the Manual Settings view (step 5) as the Null Voltages in the Set Parameters dialog box.

NOTE. *If using Set Params results in worse values, click **Restore Initial Values** to reload the settings originally detected by the LRCP at first connection to the OM5110.*

7. Click **OK**.
8. To verify the Null Voltage values, change every segment to **Manual Control Mode** and click **Reset**. The voltages shown should match those found in step 5) to within 0.01 V.
9. Return to the Auto-Set view and click **Apply** to return to automatic control.

The Driver Amp controls

The Driver Amp control area of the LRCP software controls the behavior of the optical modulator RF Input electrical amplifier. This two-stage amplifier can work in both linear and nonlinear modes to enable both linear electrical-to-optical conversion and binary optical signal generation which is insensitive to the electrical input signal level.

Table 9: OM5110 Driver Amp controls (LRCP)

Control	Description
Stage 1	First stage of electrical amplification. You can adjust the gain of each Stage 1 amplifier. This should not be needed for most applications, but can be helpful to balance the amplitude of I-Q signals when operating in the linear range (< 500 mVpp electrical input).
Stage 2	Second stage of electrical amplification. When operating with >500 mVpp electrical input, you can adjust the crossing point and amplitude of the signal driving the optical modulator. These controls are not effective in the linear range (< 500 mVpp) and can be left at their default values.
Voltage Settings	<p>Save current voltages as power-on defaults, which stores all of the current Driver Amp settings in the OM5110 as the new defaults.</p> <p>Restore to factory defaults, which loads the factory default values for the Driver Amp, overriding the current values.</p> <p>When the OM5110 is turned on and off by the rear-panel Primary power switch, or when it loses mains power, only the “power-on default settings,” and “factory defaults” are retained.</p>

Each of the adjustments for linear gain, nonlinear crossing point, and nonlinear amplitude are indicated by a value in percent. This value is provided to help documentation of the amplifier settings. The control is not strictly proportional to this value, so these settings must be determined experimentally using the appropriate optical signal analyzer.

Appendix A: The automated test equipment (ATE) interface

LRCP has two types of WCF interface to allow control from a user application. Both types of interface provide full functionality and compatibility with simple interfaces such as MATLAB and client application programs.

The LRCP ATE interface

The Automated Test Equipment (ATE) interface exposes the LRCP functionality through a Windows Communication Foundation (WCF) service. As the LRCP is used with all OM4000 series or OM5110 instruments, its interface exposes more commands than those used by the instrument CLSA.

Basic/Advanced WCF service interface for the LRCP

The WCF services (basic and advanced) are available on port 9000 in the machine that is running the LRCP. The service (basic and advanced) interface was developed for incorporation into an ATE client application that you can develop in your choice of .NET language, typically C# or VB.NET. Both services expose most of the functionality that is available through the LRCP's user interface.

The basic service, implemented using a `wsBasicHTTPBinding`, exposes the same subset of commands as the advanced service. It was implemented using a simpler binding for compatibility with applications like MATLAB (See page 37, *ATE functionality in MATLAB*.) or Labview that only support the `wsBasicHTTPBinding`. The basic service is referenced at the following URL: http://localhost:9000/LaserReceiverControlPanel/Laser_ReceiverServiceBasic/

The advanced service, implemented using a `wsHTTPBinding`, (and which is not available in MATLAB) was developed for use with an ATE client application and uses events to provide a time-efficient interface.

The advanced service is referenced at the following URL: http://localhost:9000/LaserReceiverControlPanel/Laser_ReceiverService/

NOTE. *For safety reasons, you cannot activate a laser from the basic or advanced services; you can only activate a laser from the LRCP user interface.*

LRCP service interface function list

The following are the available commands in both the basic and advanced service interfaces and show their functionality using the MATLAB syntax.

- **int AvailableLasers(classname);**
 Description: Returns the count of available lasers on the active controller.
 Controller Types: All
 Example: `AvailableLasers(Obj);`
 Returns: `ans = 2`

- **bool Calibrate();**
 Description: Performs an automatic modulator calibration to determine the optimal modulator parameters. These are the same parameters that are manually set using the user interface Set Params button, or the `SetManualCalibration()` function.

 Calibrate() is an automatic calibration that requires the modulator control mode (see `GetActualModulatorMode()`) be set to 2-pol QPSK and that >500 mVpp binary signals are applied to all four inputs. Longer patterns are better (2³¹ PRBS is optimal). Each of the four input patterns should be different in some way: a different pattern, the same pattern delayed, or a different seed.

 The modulator must receive adequate input power levels to produce a signal power that is high enough to avoid a power level warning. If these conditions are not met the resulting calibration can result in unstable optical bias. See the section on Set Parameters to restore these values to initial (factory) values.
 Controller Types: OM5110
 Example: `Calibrate(Obj);`
 Returns: `ans = true/false`

- **bool Connect(classname);**
 Description: Connects to the active controller, starts controller running.
 Controller Types: All
 Example: `Connect(Obj);`
 Returns: `ans = true`

- **bool Disconnect(classname);**
 Description: Disconnects from the active controller, takes offline.
 Controller Types: All
 Example: `Disconnect(Obj);`
 Returns: `ans = true`

- **bool GetActualCavityLock(classname);**
 Description: Returns the actual cavity lock state for the active controller/laser.
 Locked = True.
 Controller Types: All
 Example: `GetActualCavityLock(Obj);`
 Returns: `ans = true`

- **double GetActualChannel(classname);**
 Description: Returns the actual channel number for the active controller/laser.
 Controller Types: All
 Example: `GetActualChannel(Obj);`
 Returns: `ans = 1`
- **double GetActualChannel1(classname);**
 Description: Returns the actual channel 1 frequency (in THz) for the active laser.
 Controller Types: All
 Example: `GetActualChannel1(Obj);`
 Returns: `ans = 191.5`
- **controlmode GetActualControlMode(classname, modulatorenum);**
 Description: Returns the control mode for the modulator that is passed in the 'modulator' parameter.
 Controller Types: OM5110
 Example: `GetActualControlMode(obj, modulatorenum.YQ);`
 Returns: `ans = one of the following:`
`controlmode.automatic`
`controlmode.manual`
`controlmode.notset`
- **float GetActualCurrent(classname, string);**
 Description: Returns current (mA) associated with the specified input voltage.
 Controller Types: OM5110
 Example: `GetActualCurrent(obj, "YQ G1");`
 Returns: `ans = 30`

 The following are valid string values:

`"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2" "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"`
- **bool GetActualEmitting(classname);**
 Description: Returns the emission status of the active laser. Emitting = True.
 Controller Types: All
 Example: `GetActualEmitting(Obj);`
 Returns: `ans = true`
- **byte GetActualFactoryDefault(classname, string);**
 Description: Returns the factory default value for the specified voltage, in the range of 0 to 255.
 Controller Types: OM5110
 Example: `GetActualFactoryDefault(obj, "XQ D2");`
 Returns: `ans = 0`

 The following are valid string values:

`"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2" "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"`

■ **short GetActualFineTuneFrequency(classname);**

Description: Returns the actual fine tune frequency (in MHz) of the active laser.

Controller Types: All

Example: `GetActualFineTuneFrequency(obj);`

Returns: `ans = 0`

■ **double GetActualGridSpacing(classname);**

Description: Returns the actual grid spacing (in THz) of the active laser.

Controller Types: All

Example: `GetActualGridSpacing(obj);`

Returns: `ans = 0.05`

■ **byte GetActualMaxPotSetting(classname, string);**

Description: Returns the maximum allowed step setting value for the specified voltage, in the range of 0 to 255

Controller Types: OM5110

Example: `GetActualMaxPotSetting(obj, "XI G1");`

Returns: `ans = 100`

The following are valid string values:

"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"

■ **float GetActualMaxVoltage(classname, string);**

Description: Returns the maximum voltage value for the specified voltage, in Volts.

Controller Types: OM5110

Example: `GetActualMaxVoltage(obj, "YI D2");`

Returns: `ans = 10.2`

The following are valid string values:

"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"

■ **byte GetActualMinPot(classname, string);**

Description: Returns the minimum allowed step setting value for the specified voltage, in the range of 0 to 255

Controller Types: OM5110

Example: `GetActualMinPot(obj, "XI G2");`

Returns: `ans = 100`

The following are valid string values:

"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"

■ **float GetActualMinVoltage(classname, string);**

Description: Returns the minimum voltage value for the specified voltage, in Volts.

Controller Types: OM5110

Example: `GetActualMinVoltage(obj, "YQ G1");`

Returns: ans = 5.5

The following are valid string values:

"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"

■ **modulatormode GetActualModulatorMode();**

Description: Returns the modulator mode (notset, dpqpsk, qam, or arbitrary)

Controller Types: OM5110

Example: `GetActualModulatorMode(obj);`

Returns: ans = one of the following:

modulatormode.notset

modulatormode.dpqpsk

modulatormode.qam

modulatormode.arbitrary

■ **double GetActualOffset(modulatorenenum);**

Description: Returns the offset voltage adjustment value for the modulator that is in Automatic mode.

Controller Types: OM5110

Example: `GetActualOffset(obj);`

Returns: ans = offset value

■ **double GetActualPower(classname);**

Description: Returns the actual power (in dBm) of the active laser.

Controller Types: All

Example: `GetActualPower(Obj);`

Returns: ans = 14.5

■ **byte GetActualPowerOnDefault(classname, string);**

Description: Returns the power-on default setting for the specified voltage, in the range of 0 to 255.

Controller Types: OM5110

Example: `GetActualPowerOnDefault(obj, "YQ G1");`

Returns: ans = 150

The following are valid string values:

"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"

■ **slope GetActualSlope(classname, modulatorenum);**

Description: Returns the slope setting (positive, negative, or notset) of the specified modulator (XI, XQ, YI, YQ).

Controller Types: OM5110

Example: `GetActualSlope(obj, modulatorenum.XQ);`

Returns: ans = one of the following:

slope.notset
slope.positive
slope.negative

■ **byte GetActualStep(classname, string);**

Description: Returns the step setting for the specified voltage, in the range of 0 to 255.

Controller Types: OM5110

Example: `GetActualStep(obj, "YQ G1");`

Returns: ans = 10

■ **double GetActualVoltage(classname, modulatorenum);**

Description: Returns the voltage setting of the specified modulator (XI, XQ, YI, YQ), in Volts.

Controller Types: OM5110

Example: `GetActualVoltage(obj, modulatorenum.YQ);`

Returns: ans = setting in Volts

■ **double GetCalculatedFrequency(classname, laserusagetype);**

Description: Searches all of the connected controllers for the first laser of the specified laser usage type and returns the calculated frequency (in THz).

Valid usage types are: unused, signalx, signaly, signalxy, reference.

Controller Types: All

Example: `GetCalculatedFrequency(Obj, reference);`

Returns: ans = 191.5

■ **string[] GetControllers(classname);**

Description: Returns a list (array) of controller devices (strings) that are being controlled by the serving application.

Example: `Controllers = GetControllers(Obj);`

Returns:

'OM5110:Prototype1'

'OM2210:8180123'

'OM4006:6300121'

■ **double GetFirstFrequency(classname);**

Description: Returns the first frequency (in THz) of the active laser.

Controller Types: All

Example: `GetFirstFrequency(Obj);`

Returns: ans = 191.5

- **bool GetInterlock(classname);**
Description: Returns the current interlock state of the active controller. The normal, working state is TRUE. If the interlock is disconnected from the back of the instrument or if the instrument is powered off, this function returns FALSE.
Controller Types: All
Example: `GetInterlock(Obj);`
Returns: `ans = true`
- **string GetIP(classname);**
Description: Returns the IP Address (as a string) for the active controller.
Controller Types: All
Example: `Address = GetIP(Obj);`
Returns: `Address = '172.17.200.114'`
- **double GetLastFrequency(classname);**
Description: Returns the last frequency (in THz) of the active laser.
Controller Types: All
Example: `GetLastFrequency(Obj);`
Returns: `ans = 196.25`
- **double GetOpticalPower(classname);**
Description: Returns the optical power setting, in dBm.
Controller Types: OM5110
Example: `GetOpticalPower(obj);`
Returns: `ans = 12.4`
- **double GetOpticalPowerAdjustment(classname);**
Description: Returns the optical power adjustment setting, in dBm.
Controller Types: OM5110
Example: `GetOpticalPowerAdjustment(obj);`
Returns: `ans = 10.4`
- **float GetPhotoCurrent(classname);**
Description: Returns the photocurrent (in mA) of the receiver in the active controller.
Controller Types: 4006, 4106
Example: `GetPhotoCurrent(Obj);`
Returns: `ans = 11.034`
- **string GetPolarization(classname);**
Description: Returns the polarization state.
Valid Polarization states: filter1, filter2, unknown, hardwarefailed.
Controller Types: 2210
Example: `GetPolarization(Obj);`
Returns: `ans = filter2`

■ **bool InitializePolarization(classname);**

Description: Sets the initial polarization state. Returning True = Successful.

Controller Types: 2210

Example: `InitializePolarization(Obj);`

Returns: `ans = true`

■ **bool IsActiveControllerChosen5110Y(classname);**

Description: Returns true if the active controller is an OM5110; returns false if it is not an OM5110.

Controller Types: OM5110

Example: `IsActiveControllerChosen5110Y(obj);`

Returns: `ans = true/false`

The ATE methods for the modulator use the following enumerations:

modulatorenenum (YQ, YI, YP, XQ, XI, XP)

modulatormode (noset, dpqpsk, qam, arbitrary)

slope (notset, negative, positive)

controlmode (notset, automatic, manual)

■ **bool Reset(classname);**

Description: Resets the modulator.

Controller Types: OM5110

Example: `Reset(obj);`

Returns: `ans = true/false`

■ **bool SetActiveControllerByIPAddress(classname, string_ipAddress);**

Description: Sets the active controller by IP Address. True = Successful.

Controller Types: All

Example: `SetActiveControllerByIPAddress(Obj, '172.17.200.112');`

Returns: `ans = true`

Returns (after GetIP(Obj)): `ans = '172.17.200.112'`

■ **bool SetActiveControllerByName(classname, string_activeController);**

Description: Sets the active controller by name. True = Successful.

Controller Types: All

Example: `SetActiveControllerByName(Obj, 'OM4106:6300121');`

Returns: `ans = true`

■ **bool SetActiveLaser(classname, byte_activeLaser);**

Description: Sets the active laser. Returning True = Successful.

Controller Types: All

Example: `SetActiveLaser(Obj, 2);`

Returns: `ans = true`

- **bool SetDesiredCavityLock(classname, bool_desiredCavityLock);**
Description: Sets the desired cavity lock state for the active laser. 1 (True) = Locked. Returning True = Successful.
Controller Types: All
Example: `SetDesiredCavityLock(Obj, 1);`
Returns: `ans = true`
- **bool SetDesiredChannel(classname, int_desiredChannel);**
Description: Sets the channel number for the active laser. Returning True = Successful.
Controller Types: All
Example: `SetDesiredChannel(Obj, 45);`
Returns: `ans = true`
- **bool SetDesiredChannel1(classname, double_desiredChannel1);**
Description: Sets the channel 1 frequency (in THz) for the active laser. Can only be set if the active laser is NOT emitting. Returning True = Successful.
Controller Types: All
Example: `SetDesiredChannel1(Obj, 192.5);`
Returns: `ans = true`
- **bool SetDesiredControlMode(classname, modulatorenum, controlmode);**
Description: Sets the control mode of the specified modulator. Returns true if control mode was set, or false if mode was not set.
Controller Types: OM5110
Example: `SetDesiredControlMode(obj, modulatorenum.XI, controlmode.automatic);`
Returns: `ans = true/false`
- **bool SetDesiredEmittingOff(classname);**
Description: Sets the Active Laser to Off (not emitting). Returning True = Successful.
Controller Types: All
Example: `SetDesiredEmittingOff(Obj);`
Returns: `ans = true`
- **bool SetDesiredEmittingOn(classname);**
Description: Sets the Active Laser to emitting. Returning True = Successful.
Controller Types: All
Example: `SetDesiredEmittingOn(Obj);`
Returns: `ans = true`
- **bool SetDesiredFineTuneFrequency(classname, short_desiredFineTuneFrequency);**
Description: Sets the desired fine tune frequency (in MHz) of the active laser.
Controller Types: All
Example: `SetDesiredFineTuneFrequency(Obj, 300);`
Returns: `ans = true`

- **void SetDesiredFrequency(double desiredFrequency);**
 Description: Sets the channel and fine tune frequency of the selected laser to the specified frequency.
 Controller Types: 2210, 2012
- **bool SetDesiredGridSpacing(classname, double_desiredGridSpacing);**
 Description: Sets the desired grid spacing (in THz) of the active laser. Can only be set if the active laser is NOT emitting. Returning true = Successful.
 Controller Types: All
 Example: `SetDesiredGridSpacing(Obj, 0.05,0);`
 Returns: `ans = true`
- **bool SetDesiredModulatorMode(classname, modulatormode);**
 Description: Sets the specified modulator mode. Returns true if mode was set, or false if mode was not set.
 Controller Types: OM5110
 Example: `SetDesiredModulatorMode (obj, modulatormode.qam)`
 Returns: `ans = true/false`
- **bool SetDesiredOffset(classname, modulatorenum, double);**
 Description: Sets the offset for the specified modulator. Returns true if offset was set, or false if offset was not set.

 Valid offset value range depends on the modulator that is being set:
 Q and I modulators range from -2000 to 2000.
 P modulators range from -6000 to 6000.
 Controller Types: OM5110
 Example: `SetDesiredOffset(obj, modulatorenum.XI, 2000);`
 Returns: `ans = true/false`
- **bool SetDesiredPower(classname, double_desiredPower, bool_waitUntilFinished);**
 Description: Sets the desired power (in dBm) of the active laser. For WaitUntilFinished, 0 (False) = don't wait. Returning True = Successful.
 Controller Types: All
 Example: `SetDesiredPower(Obj, 13, 0);`
 Returns: `ans = true`
- **bool SetDesiredPowerOnDefault(classname, string, byte);**
 Description: Sets the default power-on value for the specified voltage. Returns true if value was set, or false if value was not set.
 Controller Types: OM5110
 Example: `SetDesiredPowerOnDefault(obj, "YI G1", 125);`
 Returns: `ans = true/false`

The following are valid string values:

"YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"

- **bool SetDesiredSlope(classname, modulatorenum, slope);**
 Description: Sets the slope for the specified modulator to positive or negative. Returns true if slope was set, or false if slope was not set.
 Controller Types: OM5110
 Example: `SetDesiredSlope(obj, modulatorenum.XI, slope.positive);`
 Returns: ans = true/false
- **bool SetDesiredVoltage(classname, modulatorenum, double);**
 Description: Sets the voltage of the specified modulator. Returns true if voltage was set, or false if voltage was not set.
 Controller Types: OM5110
 Example: `SetDesiredVoltage(obj, modulatorenum.XI, 10.2);`
 Returns: ans = true/false
- **bool SetDesireStep(classname, string, byte);**
 Description: Sets the step for the specified voltage. Returns true if value was set, or false if value was not set.
 Controller Types: OM5110
 Example: `SetDesireStep(obj, "YQ G1", 135);`
 Returns: ans = true/false

 The following are valid string values:

 "YQ G1", "YI G1", "YQ G2", "YI G2", "YQ D2", "YI D2", "XI D2", "XQ D2", "XI G2", "XQ G2", "XI G1", "XQ G1"
- **bool SetManualCalibration();**
 Description: This is the same as the SetParams button in the user interface. It sends a new set of null voltages and Vpi voltages to the OM5110 for use by the optical bias controller. Returns true if the calibration was successfully started, and false if the calibration was not started.
 Controller Types: OM5110
 Example: `Calibrate(obj, float, float, float, float, float, float, float, float, float, float, float, float);`
 Returns: ans = true/false
- **bool SetOpticalPowerAdjustment(classname, double);**
 Description: Sets the optical power adjustment, in dBm. Returns true if power adjustment value was set, false if the value was not set.
 Controller Types: OM5110
 Example: `SetOpticalPowerAdjustment(obj, 10.1);`
 Returns: ans = true/false
- **bool SetPolarizationIn(classname);**
 Description: Puts both polarization filters in. Returning True = Successful.
 Controller Types: 2210
 Example: `SetPolarizationIn(Obj);`
 Returns: ans = true

- **bool SetPolarizationOut(classname);**

Description: Puts both polarization filters out. Returning True = Successful.

Controller Types: 2210

Example: `SetPolarizationOut(Obj);`

Returns: `ans = true`

- **bool SetReceiverOff(classname);**

Description: Turns the receiver off in the active controller. Returning True = Successful.



CAUTION. *Make sure that laser power is off before running this command, otherwise the photoreceiver could be damaged.*

NOTE. *To turn off lasers, click the LRCP software Laser Emission button to **Off**, or push the front-panel **Power** button to power off the instrument.*

Controller Types: 4006, 4106

Example: `SetReceiverOff(Obj);`

Returns: `ans = true`

- **bool SetReceiverOn(classname);**

Description: Turns the receiver on in the active controller. Returning True = Successful.

Controller Types: 4006, 4106

Example: `SetReceiverOn(Obj);`

Returns: `ans = true`

- **void TogglePolarization(classname);**

Description: Toggles the polarization state by moving both filters to the opposite position.

Controller Types: 2210

Example: `TogglePolarization(Obj);`

ATE functionality in MATLAB

MATLAB supports a limited subset of services, namely the Basic service. This section describes how to create and address the functions from MATLAB.

LRCP control

The Laser/Receiver Control Panel communicates with other programs using port 9000 on the computer running the Control Panel software. MATLAB 2009a has a built-in capability that makes control from MATLAB easy if you are running the February 2010 or later release of the Laser/Receiver Control Panel.

NOTE. *Make sure that the LRCP is running before using this interface.*

Initialize the interface in the MATLAB desktop command window with the following commands:

```
url = 'http://localhost:9000/LaserReceiverControlPanel/  
Laser_ReceiverServiceBasic/?wsdl';  
  
createClassFromWsd1(url);  
  
obj = Laser_ReceiverServiceBasic;
```

Where:

The first specifies the URL or path to a WSDL application programming interface (API) that defines the web service methods, arguments, and transactions for the LRCP.

The second creates the new class based upon that API and builds a series of M-Files for accessing the Laser/Receiver Control Panel service.

The third instantiates the object class name and opens a connection to the service.

These commands only need to be run anytime the service interface (available methods) changes.

To get an up-to-date listing of methods for the service, type the following:

```
methods(obj)
```

Matlab should return the same functions and any new functions that have been added. These functions are self-documented when they are generated. By enabling the MATLAB help window, you can find out the function's parameters by typing the function name followed by a "(" and waiting for the help to display.

Appendix B: Cleaning and maintenance

Cleaning

- Use a dry, soft cotton cloth to clean the external OM5110 case. Do not use any liquid cleaning agents or chemicals that could possibly infiltrate the enclosure, or that could damage markings or labels.
- If the dust filter on the underside of the unit becomes clogged, use a small vacuum or brush to clean the filter.
- From time to time it is necessary to clean the optical input and output connectors on the front of the unit. Use square-ended optical connector cleaning swabs made for this purpose to clean each connector.
- Do not attempt to clean inside the instrument; cleaning of internal parts is not necessary.

Maintenance

- There are no user-serviceable components or subsystems within the OM5110. Attempting any internal repairs will void your warranty. Never remove the external lid on the unit.
- If it becomes necessary to replace the fuse in the power input module in the rear of the unit, use a 5X20mm “slo-blo” fuse rated at 3.15 A, 250 V_{AC}. Use a small screwdriver to gently pry open the fuse drawer.



WARNING. *Disconnect the unit from the power source when changing the fuse to be sure that line voltage is not present during the replacement.*

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