THORLABS MX40G Fiber Optic Calibrated Electrical to Optical Converters User Guide

Contents

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THORLABS MX40G Fiber Optic Calibrated Electrical to Optical Converters

Product Information

The Remote Control User Guide is a comprehensive manual for the MX / MBX / TLX1 / TLX2 Series remote control. It provides detailed instructions on interfacing the instrument with a computer, defines the supported serial commands, and includes information about the remote control software tool.

Introduction

Chapter 1 gives an overview of the user guide and provides a description of its contents. It explains the process of interfacing the instrument with a computer and mentions the availability of remote control software and supporting files for download.

Description

The description section explains that the user guide covers the process of interfacing the instrument with a controlling computer. It also defines the serial commands used and provides information about the remote control software tool, which can be downloaded from a specific webpage.

Interfacing the Computer and the MX / MBX / TLX1 / TLX2 Instrument

This section explains that the following instructions apply to all instruments in the MX / MBX / TLX1 / TLX2 series, using the MX40G Electrical-to-Optical Converter as an example. It states that these instruments can be connected to a computer via USB or RS-232 ports located on the back panel, as shown in Figure 1.

Product Usage Instructions

1. Connect the MX / MBX / TLX1 / TLX2 instrument to a computer using either the USB or RS-232 ports located on the backpanel.
2. Download the remote control software tool and supporting files from the specified webpage.

3. Install the remote control software on the computer.
4. Open the remote control software and establish a connection with the instrument.
5. Refer to the supported commands listed in Chapter 2 of the user guide for controlling specific features of the instrument.
6. Use the remote control application to send commands and control the instrument.
7. If desired, develop custom applications for remote control using the provided guidelines in Chapter 3.

Supported Commands

Chapter 2 provides information about the supported commands for remote control of the MX / MBX / TLX1 / TLX2 series. It includes command return codes and lists specific commands for RF amplifiers, laser control, Mach-Zehnder EO intensity modulators, system commands, and variable optical attenuators (VOA).

Command Return Codes

- This section explains the return codes that can be expected when sending commands to the instrument.

RF Amplifier Commands

- Here, specific commands related to RF amplifiers are listed.

Laser Control Commands

- This section provides a list of commands for controlling lasers.

Introduction

Description

The MX / MBX / TLX1 / TLX2 series of instruments may be remotely controlled via SCPI-type serial commands. This requires connecting a computer running the Microsoft® Windows® 7 operating system, or later versions, to the instrument using a USB cable, or connecting a computer running any operating system to the RS-232 port on the instrument. Serial commands are sent to the USB or RS-232 ports located on the back panel of the instrument. The touchscreen interface remains active while the instrument is controlled remotely, and instrument functionality remains accessible through the touchscreen interface. This document describes the process of interfacing the instrument with the controlling computer, defines the serial commands, and includes information about the remote control software tool that serves as an example and a tutorial for sending the serial commands. To download the remote control software tool and supporting files for your MX / MBX / TLX1 / TLX2 instrument, visit the following page and type in the instrument's Item #: **https://www.thorlabs.com/manuals.cfm**

Interfacing the Computer and the MX / MBX / TLX1 / TLX2 Instrument

The following sections use the MX40G Electrical-to-Optical Converter as an example, but the procedure and guidelines apply to all of the MX / MBX / TLX1 / TLX2 series of instruments. These instruments may be connected with a computer via USB or RS-232 ports located on the back panel, as shown in Figure 1. Please note that using both USB and RS-232 connections at the same time is not supported. If it is necessary to change from a USB to a RS-232 connection, or vice versa, first power off the instrument, change the connection, and then power on the instrument. This will ensure that the instrument recognizes the new connection.

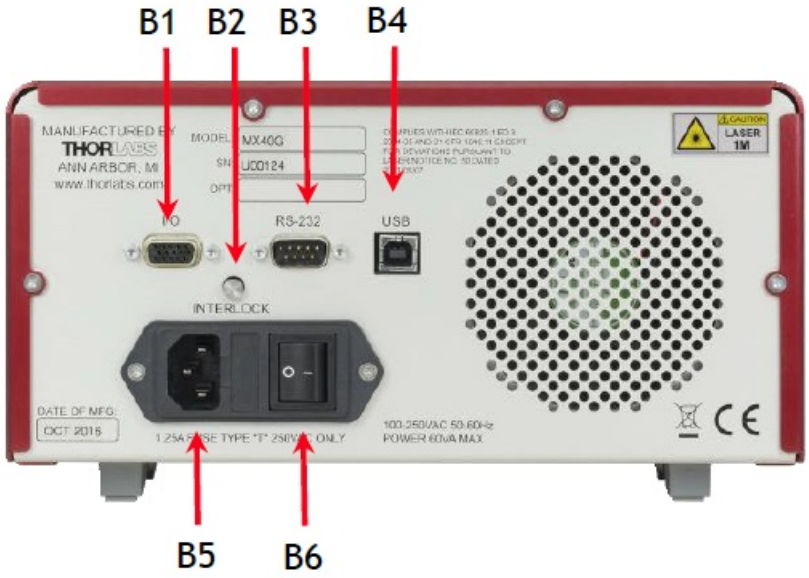

Figure 1 Back Panel of the MX40G

Label	Description
B1	I/O Port (HDDB15 Connector)
B2	Laser Interlock (2.5 mm Connector)
B3	RS-232 Port (DB9 Connector)
B4	USB Port (USB Type B Connector)
B5	Power Connector
B6	Power Switch Supply On; Supply Off

Connecting to the USB Port on the Back Panel of the MX / MBX / TLX1 / TLX2 Instrument

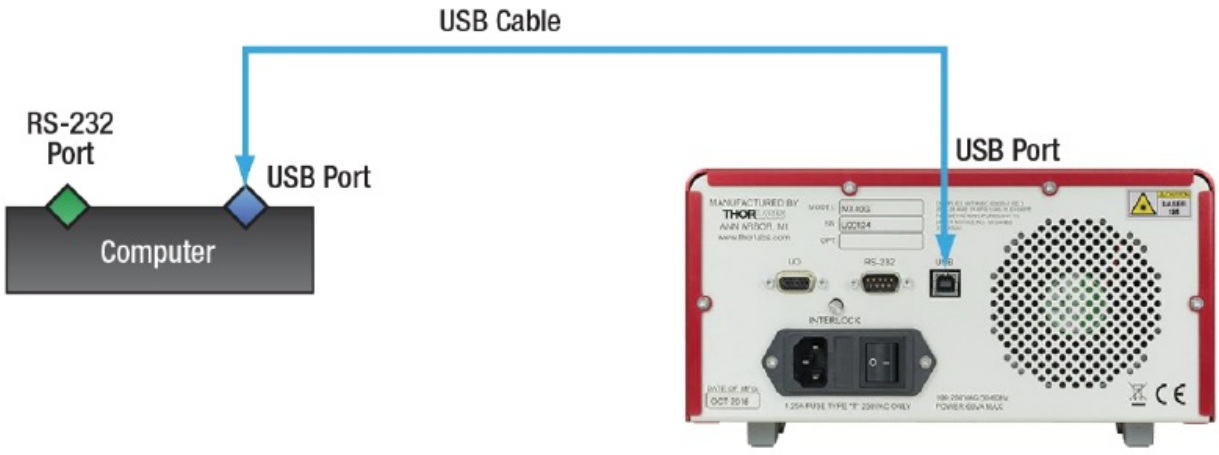

Figure 2 Connecting the Computer and MX / MBX / TLX1 / TLX2 Instrument via the USB Ports

A USB cable can be used to connect a computer running Windows 7, or later, with the port on the back panel of the instrument as shown in Figure 2. The USB port is type-B. A USB cable with a type-B connector on one end and a type-A connector on the other would allow connection with most computers.

When discovered by the Windows PC, the MX / MBX / TLX1 / TLX2 instrument will appear as a human interface device (HID), rather than as a virtual serial port. The HID class includes the computer mouse and keyboard. Please note that PC terminal software, such as Tera Term, cannot be used to communicate with the MX / MBX / TLX1 / TLX2 instrument via USB cable. This is due to PC terminal software requiring the connected instrument to be recognized by the PC as a virtual serial port. The Thorlabs remote control application discussed in Chapter 3 can scan for, discover, and open a connection with the connected MX / MBX / TLX1 / TLX2 instrument.

Connecting to the RS-232 Port on the Back Panel of the MX / MBX / TLX1 / TLX2 Instrument

If the controlling computer has an RS-232 port, or if a USB to RS-232 adapter is connected to the computer's USB port, an RS-232 cable can be used to make the physical connection between the computer and the RS-232 port on the back panel of the MX / MBX / TLX1 / TLX2 instrument. Any software capable of sending and receiving data using serial ports can then be used to control the MX / MBX / TLX1 / TLX2 instrument. Configure the serial port of the controlling computer for 115200 baud, 8 bits, no parity, 1 stop bit, and no flow control. The Thorlabs remote control application discussed in Chapter 3 can also control the MX / MBX / TLX1 / TLX2 instrument via an RS-232 connection. The pin assignments for the DB9 connector on the back panel of the MX / MBX / TLX1 / TLX2 instrument are described by Figure 3 and the table below.

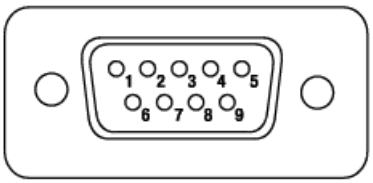

Figure 3 RS-232 DB9 Connector on the Back Panel of the MX / MBX / TLX1 / TLX2 Instrument

RS-232 Connector	
Pin #	**Description**
1	Not Connected
2	RS-232 Input
3	RS-232 Output
4	Not Connected
5	Digital Ground
6	Not Connected
7	Not Connected
8	Not Connected
9	Not Connected

Connecting to the MX /MBX / TLX1 / TLX2 Instrument Using the RS-232 Port on the Controlling Computer

Figure 4 illustrates the physical connection when the RS-232 ports on the MX / MBX / TLX1 / TLX2 instrument and the controlling computer are used. The details of the connection depend on the controlling computer's RS-232 port. When it is a:

Figure 4 Connecting the Computer and MX / MBX / TLX1 / TLX2 Series Instrument via the RS-232 Ports

- 9-pin DB9 male connector, an option is to use a female-to-female 9-pin "null modem" cable. National Instruments® explains the difference between a standard and a null modem cable here: http://digital.ni.com/public.nsf/allkb/1EE0DD8AF67922FA86256F720071DECF
- 25-pin DB25 male connector, a null modem cable that converts between 25 and 9 pins can be used.

In either case, if a null modem cable is not available, a null modem adapter could be used with a standard cable.

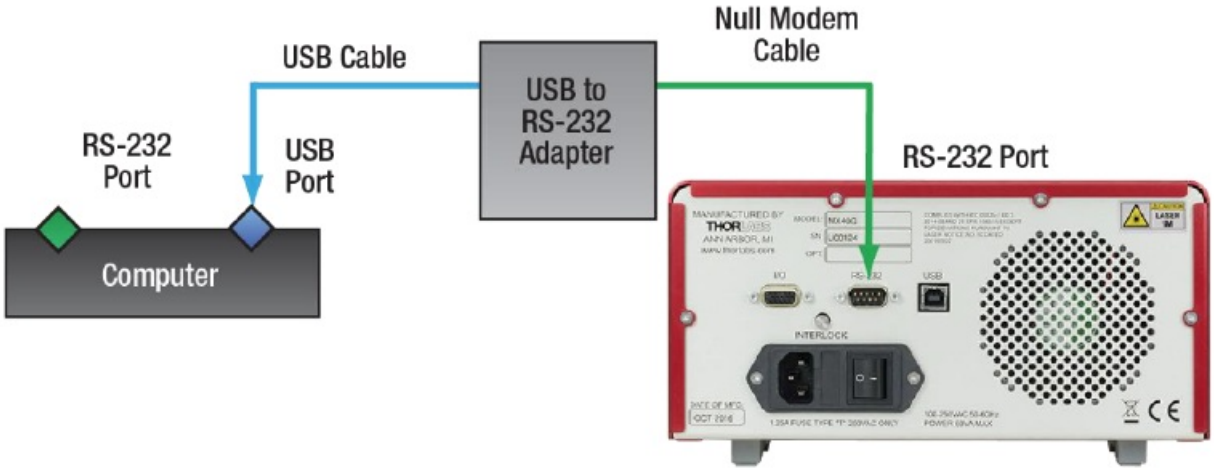

Figure 5 Connecting the USB Port on the Computer to the RS-232 Port on the Instrument

If the USB port on the controlling computer is used, a USB cable terminating in a USB to RS-232 adapter can be used to allow connection to a null modem cable. When the connector on the adapter is a 9-pin DB9 male, and the null model cable has two 9-pin female DB9 connectors, it is possible to use the adapter and null modem cable to make a connection between the computer's USB and the MX / MBX / TLX1 / TLX2 instrument's RS-232 ports. This is illustrated in Figure 5.

Please note that the USB port on the MX / MBX / TLX1 / TLX2 instrument should not be connected to the RS-232 port on the controlling computer; this configuration is not supported.

Supported Commands

This section describes the commands supported by firmware version V1.9.4 and later. The commands are modeled on the IEEE 488.2 standard commands for programmable instruments (SCPI) specification. Following this convention, many commands in the “Syntax” columns of the following tables include both uppercase and lowercase letters. Uppercase letters identify the shortest acceptable form of the commands. If including additional characters, all command characters must be included. (For example, VOA:SET? and VOA:SETPOINT? are the only acceptable variations of the VOA:SETpoint? command.)

Each SCPI command string sent to the instrument must be terminated with either <new line> (<NL>) character (ASCII decimal 10), <CR><NL> (ASCII decimal 13 10), <CR> (ASCII decimal 13), or <NL><CR> (ASCII decimal 10 13). IEEE 488 specifies that the standard termination is the <NL> character. For every SCPI message that is sent to the instrument that warrants a response, the instrument terminates the returned response with a <NL> character. The commands described below have been developed as a custom set, as no device in the SCPI standard is an exact analogue. Please note that not every command described in the following sections applies to every MX / MBX / TLX1 / TLX2 Item #. In order for a command to apply to a specific instrument, the instrument must have the related built-in component. For example, the Laser Control Commands do not apply to instruments that do not include an internal tunable laser. The following table lists the commands supported by each instrument.

Item #	Section 2.2 RF Amplifier Commands	Section 2.3 Laser Control Commands	Section 2.4 Mach-Zehnder Modular Bias Control Commands	Section 2.5 System Commands	Section 2.6 Variable Optical Attenuator Commands
MBX	–	–	✓	✓	✓
MXxxA	✓	–	✓	✓	✓
MXxxB	✓	✓	✓	✓	✓
MXxxC	✓	✓	–	✓	✓
MXxxD, MXxxE	✓	✓	✓	✓	✓
MXxxG	–	✓	✓	✓	✓
TLX1, TLX2	–	✓	–	✓	✓

Figure 6: The Available Command Set for Each Instrument Corresponds to its Built-In Functionality

Valid commands will return a value of 1 on receipt. Valid queries return a value/string as noted in the query descriptions in Sections 0 through 2.6. The following table lists possible return values for exception handling.

Command Return Codes

Return Value	Return Explanation
1	Response to a valid command
Values without “Err:” indicator string	Response to a valid query
Err: Feature not present	Issued a command to an instrument that does not have the built-in hardware. See Figure 6 for command compatibility. System application firmware < V1.9.5 reports as Err: Hardware missing
Err: Parameter error	Issued a command with a parameter value that is outside of the acceptable range. Refer to the command description for acceptable value ranges.
Err: Illegal parameter value	Issued a command with a parameter value that is outside of the range supported by this device.
Err: Data out of range	Issued a command with a data value that is outside of the acceptable range. Refer to the command description for acceptable value ranges.
Err: Numeric data error	Issued a command with a numeric data value that is outside of the acceptable range. Refer to the command description for acceptable value ranges.
Err: Data type error	Issued a command with the incorrect data type. Refer to the command description for acceptable data types.
Err: Storage fault	An error occurred accessing the internal EEprom. Could not continue to execute the command.
Err: System error	The system encountered an internal error while processing the command. Could not continue to execute the command.
Err: Execution error	An error occurred attempting to execute the given command. Check that unit is powered on and in run mode.
Err: Undefined header	Issued an invalid command or a command with invalid formatting or a command not recognized by the current system application firmware.
Err: Tunable laser not selected	Issued a command pertaining to a tunable laser while the fixed wavelength laser is active. Applies to dual-band instruments only.
Err: Laser is locked	Issued a command to access the laser and the laser is locked by the Interlock mechanism.
Err: This command requires bootloader >= 1.7.4	Issued a command that is only supported in bootloader code ≥ version 1.7.4.

Figure 7: Return Values and Explanations

RF Amplifier Commands

The MX series of instruments include several that have a built-in RF amplifier, and the following commands apply only to these instruments. The amplifier type is digital (limiting) in some of these products, such as the MXxxA, MXxxB, MXxxC. In other products, such as the MXxxD and MXxxE, the amplifier type is linear (analog). Only digital RF amplifiers have crossing point and swing settings, and only these RF amplifiers can operate in either analog or digital modes. In contrast, the gain may be set only for linear RF amplifiers. Unless otherwise noted, the following RF Amplifier commands apply to both amplifier types.

Command	**Syntax**	**Description**
Set Crossing Point **(Analog Mode)**	AMP:CROSSing:ANAlog: N	N is a floating point value between -1.0 and 1.0, inclusive. This parameter applies to the digital amplifier operating in analog mode and determines the location of the crossing point. N has no units; -1.0 corresponds to the maximum possible negative offset, and 1.0 corresponds to the maximum possible positive offset. The available range, which depends on the amplifier's voltage limits and the current AMP:SWING setting, may be smaller than this full – 1.0 to 1.0 range. When this is the case, N values within ±1.0 but exceeding the currently available range will set the crossing point to the closest permitted value. This command is not available for instruments with linear (analog) amplifier types.
Get Crossing Point **(Analog Mode)**	AMP:CROSSing:ANAlog?	Returns a floating point value between -1.0 and 1.0, inclusive. This value has no units and corresponds to the current crossing point for the digital amplifier when it operates in analog mode. This command is not available for instruments with linear (analog) amplifier types.
Set Crossing Point **(Digital Mode)**	AMP:CROSSing:DIGital: N	N is a floating point value between -1.0 and 1.0, inclusive. This parameter applies to the digital amplifier operating in digital mode and determines the location of the crossing point. Please see AMP:CROSS:ANA for additional information. This command is not available for instruments with linear (analog) amplifier types.
Get Crossing Point **(Digital Mode)**	AMP:CROSSing: DIGital?	Returns a floating point value between -1.0 and 1.0, inclusive. This value has no units and corresponds to the current crossing point for the digital amplifier when it operates in analog mode. This command is not available for instruments with linear (analog) amplifier types.

Set Gain	AMP:GAIN: N	N is a floating point value between 10.0 and 23.0 in decibels. This value sets the gain of linear (analog) type amplifiers. This command is not available for instruments with digital (limiting) or fixed gain amplifier types.
Get Gain	AMP:GAIN?	Returns a floating point value between 10.0 and 23.0 in decibels, which corresponds to the current gain of the linear (analog) type amplifier. This command is not available for instruments with digital (limiting) or fixed gain amplifier types.
Set Amplifier Mode to Analog	AMP:MODE: 1	Sets the operation of the digital amplifier to analog mode. This includes setting the crossing point to that currently specified for analog mode operation (AMP:CROSS:ANA) and applying the maximum possible swing. This command is not available for instruments with linear (analog) amplifier types.

Set Amplifier Mode to Digital	AMP:MODE: 0	Sets the operation of the digital amplifier to digital mode. This includes setting the crossing point to that currently specified for digital mode operation (AMP:CROSS:DIG) and applying the current value of swing (AMP:SWING). The default value of swing is the amplifier's value for Vp at 1 GHz, which is determined at the factory and place in instrument memory. This command is not available for instruments with linear (analog) amplifier types.
Get Amplifier Mode	AMP:MODE?	Returns 0 if the amplifier mode is set to analog and 1 if the amplifier mode is set to digital. This command is not available for instruments with linear (analog) amplifier types.
Set Amplifier Power On	AMP:POWer: 1	Sets amplifier power to "on" and returns 1 on receipt of command.
Set Amplifier Power Off	AMP:POWer: 0	Sets amplifier power to "off" and returns 1 on receipt of command.
Get Amplifier Power Status	AMP:POWer?	Returns 0 if the amplifier power is set to "off" and 1 if the amplifier power is set to "on." This command returns the most recent ***requested*** power state, which may differ from the amplifier's currently active power state. AMP:SET? can be used to verify the last requested power state is active.

Get Amplifier Status	AMP:SETpoint?	A 1 is returned and a steady green dot shows in the AMP field of the instrument's touchscreen when the amplifier is fully ready and has reached the requested settings. Otherwise, a 0 is returned and the green dot blinks. Amplifier settings are updated quickly, typically within a second. However, it is possible that an immediate query after sending a command to adjust amplifier voltage will find the amplifier in a transient state and return a zero.
Set the Amplifier Swing (Digital Mode)	AMP:SWING: N	N is a floating point value with a standard range of 3.0 to 7.0 Vpp. This command sets the swing of the digital amplifier when it operates in digital mode, and this value can be set while operating in analog mode. Some factory- customized units have an extended swing range. Use the touchscreen GUI on the instrument to view the available range. This command is not available for instruments with linear(analog) amplifier types.
Get the Amplifier Swing (Digital Mode)	AMP:SWING?	Returns a floating point value with units of Vpp. This is the swing setting applied when the digital amplifier operates in digital mode. This value can be retrieved while operating in analog mode. This command is not available for instruments with linear (analog) amplifier types.
Set the Amplifier Swing to Vp **(Digital Mode)**	AMP:SWING:VPI	Sets the swing to the amplifier's Vp at 1 GHz and returns 1 on receipt of command. This Vp value is found for each instrument at the factory and saved to memory. It is the "optimal swing" setting applied when the Vp button on the touchscreen interface is pressed. This command is not available for instruments with linear (analog) amplifier types.

Laser Control Commands

These commands are available for the TLX1 / TLX2 series of instruments and those MX series products with a built-in tunable laser, which include the MXxxB, MXxxE, and MXxxG. In the following, "Laser" refers to the built-in tunable laser, unless otherwise specified. Please note that the ITU channels are defined using a 50 MHz grid.

Be advised that there will be a delay between when requested laser state is specified in a "set" command and when the requested state becomes the active laser state, as the instrument requires a finite period of time to execute commands. Typical execution times are given in the following table for each relevant command. After setting laser parameter(s), the LASer:SETpoint? command can be used to determine the laser's active status.

Command	Syntax	Description
Set the ITU Channel Number	LASer:CHANnel: N	N is an integer from 1 and 96, inclusive, for the C-Band laser or from 1 and 93, inclusive, for the L-Band laser. This command sets the ITU channel of the laser and returns 1 on receipt of command. While tuning to the desired channel, the laser's optical output may be temporarily reduced or turned off and then on.
Get the ITU Channel Number	LASer:CHANnel?	Returns an integer value from 1 and 96, inclusive, for a C- Band laser or from 1 and 93, inclusive, for an L-Band laser. This command returns the most recent ***requested*** ITU channel, which may differ from the currently active ITU channel due to a typical channel set time duration of <10 s. The LAS:SET? command can be used to verify the last requested ITU channel is active.
Set Dither On	LASer:Dither: 1	Sets the laser dither to "on" and returns 1 on receipt of command.
Set Dither Off	LASer:Dither: 0	Sets the laser dither to "off" and returns 1 on receipt of command.
Get Dither Status	LASer:Dither?	Returns 0 if dither is set to "off" and 1 if dither is set to "on." This command returns the most recent ***requested*** dither state, which may differ from the currently active dither state due to a typical dither set time duration of <10 s. The LAS:SET? command can be used to verify the last requested dither state is active.
Set Fine Tuning Frequency Offset	LASer:FINE: N	N is an integer between -30,000 and 30,000, inclusive. The entered value is the frequency offset in MHz, and 1 is returned on receipt of command. Sending this command causes the laser frequency to be tuned to the sum of the current ITU channel frequency and this specified fine tuning frequency offset. The range of fine tuning frequency offsets spans the full frequency range between ITU channels.
Get Fine Tuning Frequency Offset	LASer:FINE?	Returns an integer between -30,000 and 30,000, inclusive, corresponding to the requested frequency offset in MHz. This value may differ from the current frequency offset due to a typical laser tuning time duration of <30 s. There is currently no accurate way to determine, via remote control, whether a fine-tuning operation has finished. However, other laser status information can be obtained using: · **LAS:FREQ?** · **LAS:SET?** · **LAS:OOP?**

Get Optical Laser Frequency	LASer:FREQuency?	Returns a floating point value with unit of GHz. The reported optical laser frequency, which is determined by the ITU channel (LAS:CHAN:N) and fine offset (LAS:FINE:N). As the resolution of the returned value is limited to 0.1 GHz (100 MHz), the values of the intermediate frequencies set using the fine-tuning feature are reported rounded to the nearest 0.1 GHz.
Get Nominal Laser Frequency	LASer:FREQ_NOMinal?	Returns a positive integer for the calculated frequency, generated from the nominal frequency of the ITU channel, with the current fine-tuning frequency offset added or subtracted. This value is in units of MHz. This is the same value that is displayed on the LCD GUI laser settings page. Note that it is derived from the requested frequency and does not represent a live measurement.
Get Reported Optical Output Power (OOP)	LASer:OOP?	Returns a floating point value with units of dBm. This value corresponds to the optical output power from the laser module measured by an integrated photodiode. A typical operating value is 13.5 dBm. This is a different measurement than the one reported in response to the LAS:TAP:DBM? command, which measures the downstream optical power via optical tap. The two measurements may differ slightly. Optical output power will be unstable during laser warm-up and frequency tuning.
Set Laser Power On	LASer:POWer: 1	Sets the laser power to “on” and returns 1 on receipt of command. To ensure optimal stability and full optical output power, allow the laser to warm up for 15 minutes after powering on.
Set Laser Power Off	LASer:POWer: 0	Sets the laser power to “off” and returns 1 on receipt of command.
Get Laser Power Status	LASer:POWer?	Returns 0 if the laser power is set to “off” and 1 if the laser power is set to “on.” This command returns the most recent requested power state, which may differ from the laser’s currently active power state. The LAS:SET? command can be used to verify the last requested power state is active. Additional laser status and setpoint information can be obtained using: · LAS:SET? · LAS:OOP? · LAS:TAP:DBM? · LAS:TAP:MW?
Select C-band Laser	LASer:SELect: Cband	Selects the C-Band laser and returns 1 on receipt of command. This command is not available for instruments with a single laser.

Select L-band Laser	LASer:SELect: Lband	Selects the L-Band laser and returns 1 on receipt of command. This command is not available for instruments with a single laser.
Select 1310nm Laser	LASer:SELect: 1310	Selects the fixed 1310nm laser and returns 1 on receipt of command. This command is not available for instruments with a single laser.
Get Selected Laser	LASer:SELect?	Returns a string corresponding to the currently selected laser.

Get Laser Status	LASer:SETpoint?	When the following conditions are all true, a 1 is returned and a steady green dot shows in the laser field of the instrument's touchscreen. Otherwise, a 0 is returned. · The hardware key switch interlock on the front panel is in the "on" position. · The instrument's microcontroller, in response to remote or touchscreen control, has commanded the laser to power on. · The laser's currently active dither state (on or off) matches the last requested dither state. · The laser's currently active ITU channel matches the last requested ITU channel. · The laser currently reports it is in the "ready" state. · The laser currently reports it is in the "enabled" state. · The laser currently reports its optical output power is greater than 12.0 dBm.
Get Measured Optical Output Power in dBm	LASer:TAP:DBM?	Returns a floating point value with units of dBm. This is a measurement of the optical output power measured downstream from the laser module using an optical tap. The value returned by LAS:OOP? is a measurement made by a photodiode integrated into the laser module. The two measurements may differ slightly. Optical output power will be unstable during laser warm-up and frequency tuning.
Get Measured Optical Output Power in mW	LASer:TAP:MW?	Returns a floating point value with units of mW, with the measurement details identical to those described for LAS:TAP:DBM?.
Get Nominal Laser Wavelength	LASer:WAVE_NOMinal?	Returns a positive integer for the calculated wavelength, generated from the nominal frequency of the ITU channel, with the current fine-tuning frequency offset added or subtracted. The value is in units of 10 fm (femtometers). This is the same value that is displayed on the LCD GUI laser settings page. Note that it is derived from the requested frequency and does not represent a live measurement.

Mach-Zehnder EO Intensity Modulator Commands

Several of the MX Series of instruments have built-in controllers for lithium-niobate-based, Mach-Zehnder EO intensity modulators (MZMs). The following commands apply only to these instruments, which include the MBX, MXxxA, MXxxB, MXxxD, MXxxE, and MXxxG.

Command	**Syntax**	**Description**

Get Calibration Status	MZM:CALibrating?	Returns a 0 if the MZM bias is not currently being calibrated and a 1 calibration is currently in progress. The MZM bias is calibrated automatically when the MZM Bias controller is turned on for the first time or when recalibration is triggered manually (MZM:RESET or using the RESET AUTO BIAS button on the touch screen GUI). Calibration data is maintained when the bias controller is turned off and on without powering down the MX instrument, but MZM calibration data is not stored upon instrument shut-down.
Set Dither Amplitude	MZM:Dither:AMPLitude: N	N is a positive integer between 20 and 2,000, inclusive, with units of mVpp. It sets the dither amplitude for those MZM bias modes that reference this value. Not all MZM bias modes use dither.
Get Dither Amplitude	MZM:Dither:AMPLitude?	Returns the current dither amplitude setting in mVpp as a positive integer between 20 and 2,000. This will return the stored dither setting. It is not a measurement of the dither in the output from the MZM. Not all MZM bias modes use dither.
Set Dither Frequency	MZM:Dither:FREQuency: N	N is a positive integer between 1,000 and 10,000, inclusive, with units of Hz. Not all MZM bias modes use dither.
Get Dither Frequency	MZM:Dither:FREQuency?	Returns the current dither amplitude setting in Hz as a positive integer between 1,000 and 10,000, inclusive. This will return the stored dither setting. It is not a measurement of the dither in the output from the MZM. Not all MZM bias modes use dither.
Set Hold Ratio	MZM:HOLD:Ratio: N	N is a positive integer between 250 and 10,000, inclusive. It has no units and represents the input power required to achieve the desired input to output power ratio. Determine N by first choosing the desired ratio of input to output powers, then multiply that ratio by 100. (e.g. If desired input and output power values are the same, their ratio is 1.0 and N = 100. If the input is 100.00 times greater than the output power, N = 10,000.) This setting is used only in *Auto Power Ratio Positive* and *Auto Power Ratio Negative* MZM bias modes.
Get Hold Ratio	MZM:HOLD:Ratio?	Returns a positive integer between 250 and 10,000, inclusive. It has no units and represents the input power required to achieve the desired input to output power ratio, as described in the entry for MZM:HOLD:R:N. This will return the stored ratio setting. It is not a measurement of the MZM bias output. It is only used in *Auto Power Ratio Positive* and *Auto Power* *Ratio Negative* MZM bias modes.
Set Hold Voltage	MZM:HOLD:Voltage: N	N is an integer between -10,000 and 10,000, inclusive, and has units of mV. This setting is used only in *Manual Voltage* MZM bias mode.

Get Hold Voltage	MZM:HOLD:Voltage?	Returns an integer between -10,000 and 10,000, inclusive, and has units of mV. This will return the stored ratio setting. It is not a measurement of the MZM bias output. It is only used in *Manual Voltage* MZM bias mode.

Set MZM Bias Mode	MZM:MODE: N	N is a positive integer between 0 and 9, inclusive. Set this value to select the MZM bias mode. The mode associated with each value is: · 0: Bias control is off. 0 V is applied to the MZM bias. · 1: Auto Peak bias mode, which uses dither to maintain operation at the peak of the modulation function. · 2: Auto Null bias mode, which uses dither to maintain operation at the lowest point (null) of the modulation function. · 3: Auto Quad Pos bias mode, which maintains operation at the positive quadrature position on the modulation function. This is equivalent to using the touchscreen GUI to select Quad Mode and positive slope, with dither on. Not available on MX110G models. · 4: Auto Quad Neg bias mode, which maintains operation at the negative quadrature position on the modulation function. This is equivalent to using the touchscreen GUI to select Quad Mode and negative slope, with dither on. Not available on MX110G models. · 5: Hold Quad Pos bias mode: o All models except MX110G: holds the bias at the last voltage found in Quad mode. It is equivalent to using the touchscreen GUI to select Quad Mode and positive slope, with dither off. o MX110G: maintains operation at the positive quadrature position by holding the option input/output ratio 3dB down from peak. This is equivalent to using the touchscreen GUI to select Quad Mode and positive slope. Note: dither is off in this mode. · 6: Hold Quad Neg bias mode: o All models except MX110G: holds the bias at the last voltage found in Quad mode. It is equivalent to using the touchscreen GUI to select Quad Mode and negative slope, with dither off. o MX110G: maintains operation at the positive quadrature position by holding the option input/output ratio 3dB down from peak. This is equivalent to using the touchscreen GUI to select Quad Mode and negative slope. Note: dither is off in this mode. · 7: Manual Voltage bias mode, which is equivalent to using the touchscreen GUI to select Manual Mode while the “bias” setting is selected. · 8: Auto Power Ratio Pos, which is equivalent to using the touchscreen GUI to select Manual Mode while the “ratio” setting and positive slope are selected. · 9: Auto Power Ratio Neg, which is equivalent to using the touchscreen GUI to select Manual Mode while the “ratio” setting and negative slope are selected.

Get MZM Bias Mode	MZM:MODE?	Returns a positive integer between 0 and 9, inclusive, corresponding to the current MZM bias mode. The mode associated with each value is d efined in the Set MZM Bias Mode description.
Trigger MZM Ca libration	MZM:RESET	Triggers a MZM bias calibration and returns a 1. While the calibration is running, the MZM:CAL? command returns a 1.
Get MZM Status	MZM:SETpoint?	A 1 is returned and a steady green dot shows in the Bias field of the inst rument's touchscreen when the MZM bias is stable and at setpoint. A 0 is returned and the green dot in the Bias field blinks while the MZM is n ot at setpoint.

Get Post-MZM P ower in dBm	MZM:TAP:DBM?	Returns the optical power, as a floating point value in dB, output by the MZM. This value is the scaled optical power measurement made at a ta p located at the output of the MZM.
Get Post-MZM P ower in mW	MZM:TAP:MW?	Returns the optical power, as a floating point value in mW, output by the MZM. This value is the scaled optical power measurement made at a ta p located at the output of the MZM.
Get MZM Bias V oltage	MZM:Voltage?	Returns the current MZM bias voltage as a floating point value in Volts.

System Commands

The system commands described in this section apply to all MX / MBX / TLX1 / TLX2 instrument Item #s. The LED brightness commands given below allow the user to either individually set the brightness of the red, green, and blue LEDs or to set the brightness of the White LED which is a combination of the red, green and blue LEDs being controlled at the same level automatically, that contribute to the under-chassis lighting integrated into the housings of these instruments. The brightness can be set using a scale from 0.0 to 1.0, and the default combination is a value of 0.0 for the red LEDs, 0.0 for the green, 0.75 for the blue, and 0.75 for white. These LEDs can be used to provide a visual indicator of a change in instrument status. For example, the lighting could be changed to green to indicate the conclusion of a test driven by remote-control commands.

Command	Syntax	Description
Get System Bootloader Version	SYStem:BOOTloader?	Returns the bootloader version as a string.
Get System Firmware Version	SYStem:FIRMware?	Returns the firmware version as a string.
Get System Hardware Version	SYStem:HARDware?	Returns the hardware version as a string.
Get System Model Number	SYStem:MODEL?	Returns the module number as a string.
Trigger Restart	SYStem:RESTART	Triggers a safe shutdown and reboots the system as a quick way to restore all settings to default. Returns a 1 on receipt of command. This will also power down the LCD GUI. After restart, the screen will be off and the system will come up to standby mode (with the standby button LED amber), the same state that it normally goes into after powering on.
Get System Serial Number	SYStem:SERial?	Returns the serial number as a string.
Trigger Sleep	SYStem:SLEEP	Puts the system in standby and returns a 1 on receipt of command.
Trigger Wake	SYStem:WAKE	Brings the system out of standby and returns a 1 on receipt of command.

Set System Wavelength	SYStem:WAVElength: N	N is the positive integer value 1310, 1550, or 1590 with units of nm. This command sets the system wavelength, which is used to selected which calibration values to use when configuring the VOA and when evaluating the power measurements made at the taps. Setting the system wavelength optimizes the instrument for use at that wavelength. Setting this value is equivalent to using the touchscreen GUI to set the system wavelength.
Get System Wavelength	SYStem:WAVElength?	Returns a positive integer value of 1310, 1550, or 1590 with units of nm that correspond to the current system wavelength setting.
Set Red LED Brightness	RGB:RED: N	N is an integer value between 0 and 100, which is used to set the brightness of the red LEDs that contribute to the under-chassis accent lighting.

Get Red LED Brightness	RGB:RED?	Returns an integer value between 0 and 100, indicating the brightness of the red LEDs that contribute to the under-chassis accent lighting.
Set Green LED Brightness	RGB:GREEN: N	N is an integer value between 0 and 100, which is used to set the brightness of the green LEDs that contribute to the under-chassis accent lighting.
Get Green LED Brightness	RGB:GREEN?	Returns an integer value between 0 and 100, indicating the brightness of the green LEDs that contribute to the under-chassis accent lighting.
Set Blue LED Brightness	RGB:BLUE: N	N is an integer value between 0 and 100, which is used to set the brightness of the blue LEDs that contribute to the under-chassis accent lighting.
Get Blue LED Brightness	RGB:BLUE?	Returns an integer value between 0 and 100, indicating the brightness of the red LEDs that contribute to the under-chassis accent lighting.
Set White LED Brightness	RGB:WHITE: N	N is an integer value between 0 and 100, which is used to set the brightness of the White accent lighting.
Get White LED Brightness	RGB:WHITE?	Returns an integer value between 0 and 100, indicating the brightness of the White accent lighting.
Set LEDs Power Mode	RGB:POWer: N	N is a positive integer between 0 and 2, inclusive. Set this value to select the Accent lighting mode. The mode associated with each value is: · 0: Accent lighting OFF. · 1.Accent lighting is ON and the Red, Green and Blue can be changed independently to control the hue and the brightness. · 2:Accent lighting is ON and the Red, Green and Blue are controlled simultaneously to create the White accent lighting. The White can be changed to control the brightness.
Get LED Power Status	RGB:POWer?	Returns a positive integer between 0 and 2, inclusive, corresponding to the current Accent lighting mode. The mode associated with each value is defined in the Set LEDs Power Mode description.

Variable Optical Attenuator (VOA) Commands

The VOA commands described in this section apply to all MX / MBX / TLX1 / TLX2 instrument Item #s. These commands are provided for controlling the VOA and determining its status are described in the following tables.

Command	Syntax	Description
Set the Optical Attenuation Value	VOA:ATTen: N	N is a floating point value between 1.0 and 20.0, inclusive, with units of dB. This command sets optical attenuation of the VOA and returns 1 on receipt of command. If set while operating in constant power mode, the operation of the VOA will not be affected. Instead, the value will be cached and applied when constant attenuation mode is activated.
Get the Optical Attenuation Value	VOA:ATTen?	Returns the attenuation setting of the VOA as a floating point value between 1.0 and 20.0, inclusive, with units of dB.
Get Difference between Actual and Setpoint Attenuation	VOA:ERRor?	Returns the difference between the attenuation provided by the VOA and the attenuation setpoint value as a floating point value with units of dB.
Get Measured Attenuation Provided by VOA	VOA:MEASured?	Returns the value of attenuation provided by the VOA as a floating point value with units of dB. The value of attenuation is the calculated ratio of the optical power measured before and after the VOA.
Set VOA Mode to Constant Optical Output	VOA:MODE: 1	Sets the VOA mode to constant optical output power and returns 1 on receipt of command. While operating in this mode, the optical power measured after the VOA is monitored and the VOA bias voltage is adjusted to maintain the requested optical output power. Holding the optical output power constant requires adequate optical power input.
Set VOA Mode to Constant Attenuation	VOA:MODE: 0	Sets the VOA mode to constant optical attenuation and returns 1 on receipt of command. While operating in this mode, optical power levels measured before and after the VOA are monitored. The VOA bias voltage is adjusted to maintain the specified ratio between the two.
Get VOA Mode	VOA:MODE?	Returns 0 if the VOA mode is set to constant optical attenuation and 1 if the VOA mode is set to constant optical output power.
Set the Optical Output Power Value in dBm	VOA:OUTput:DBM: N	N is interpreted as a floating point value between -20.0 and 20.0, inclusive, and the units are dBm. This command sets optical output power of the VOA and returns 1 on receipt of command. While this range exceeds the maximum power output of the built-in laser, the entire range is supported to accommodate the use of higher-power external laser sources. If this value is set while operating in constant attenuation mode, it will not affect the operation of the VOA. In this case, the value will be cached and applied when constant power mode is activated.

Get the Optical Output Power Value in dBm	VOA:OUTput:DBM?	Returns the power setting of the VOA as floating point value between -20.0 and 20.0, inclusive, with units of dBm.

Set the Optical Output Power Value in mW	VOA:OUTput:MW: N	N is a floating point value between 0.01 and 100.0, inclusive, and the units are mW. This command sets optical output power of the VOA and returns 1 on receipt of command. While this range exceeds the maximum power output of the built-in laser, the entire range is supported to accommodate the use of higher-power external laser sources. If this value is set while operating in constant attenuation mode, it will not affect the operation of the VOA. In this case, the value will be cached and applied when constant power mode is activated.
Get the Optical Output Power Value in mW	VOA:OUTput:MW?	Returns the power setting of the VOA as a floating point value between 0.01 and 100.0, inclusive, with units of mW.
Set VOA Power On	VOA:POWer: 1	Sets the VOA power to “on” and returns 1 on receipt of command. When the VOA is powered on, an active and automatic software control loop is engaged to vary the VOA bias voltage. This maintains the requested attenuation level, or optical output power, depending on the VOA operating mode.
Set VOA Power Off	VOA:POWer: 0	Sets the VOA power to “off” and returns 1 on receipt of command. As VOA is in-line with the optical path, there is an insertion loss associated with it. When the VOA is powered off, the VOA bias voltage is set to 0.0 V, which minimizes the optical attenuation through the VOA.
Get VOA Power Status	VOA:POWer?	Returns 0 if the VOA power is set to “off” and 1 if the VOA power is set to “on.”

Get VOA Status	VOA:SETpoint?	A 1 is returned, and a steady green dot shows in the VOA field of the instrument's touchscreen, if the attenuation provided by the VOA is within 0.1 dB of the attenuation setpoint. The attenuation provided by the VOA is the calculated ratio of the optical power measured before and after the VOA. The attenuation setpoint references the last requested power setting if operating in constant power mode, and it references the last requested attenuation setting if operating in constant attenuation mode. If the difference between the attenuation provided by the VOA and the attenuation setpoint is >0.1 dB, a 0 is returned. This command returns a valid value whether or not the VOA is powered on.
Get Optical Power Output by the VOA in dBm	VOA:TAP:DBM?	Returns the measured optical output of the VOA as a floating point value with units of dBm.
Get Optical Power Output by the VOA in mW	VOA:TAP:MW?	Returns the measured optical output of the VOA as a floating point value with units of mW.

Remote Control Software

Thorlabs provides a software tool for computers running Windows operating systems (Windows 7 and later). The Remote Control application is primarily intended to be used as a reference example as well as a tool for exploring the behavior of and interactions between the various remote control commands. Use it to experiment with all of the currently supported laser and VOA commands, as well as to see examples of the outgoing commands and replies from the MX / MBX / TLX1 / TLX2 instrument. This tool sends serial commands to the instrument, but this application software is not intended for system integration, as it does not support running scripts or processes.

Installing the Software and Opening a Connection with the Instrument

Begin by downloading the application software by visiting the following link, typing in the Item # of the MX / MBX / TLX1 / TLX2 instrument, and clicking on the Software Download Icon shown in the list of files available for download.
https://www.thorlabs.com/manuals.cfm

Unzip the file whose name begins with "RCUP." Keep the "Remote Control Utility Program.exe" file in the same directory with the "platforms" folder and other supporting files, as the application will not run if these are separated.
Before running the application, connect the MX / MBX / TLX1 / TLX2 instrument and the controlling computer using the appropriate cabling as described in Section 1.2. Power on the instrument and ensure the power button on the front panel is glowing green and the touchscreen is active. Wait until the computer discovers the instrument, and then launch the application. The application window is shown in Figure 7. The actual application window does not include the red, green, blue, violet and orange outlines shown in Figure 7, these outlines were drawn on an image of the window for illustrative purposes.

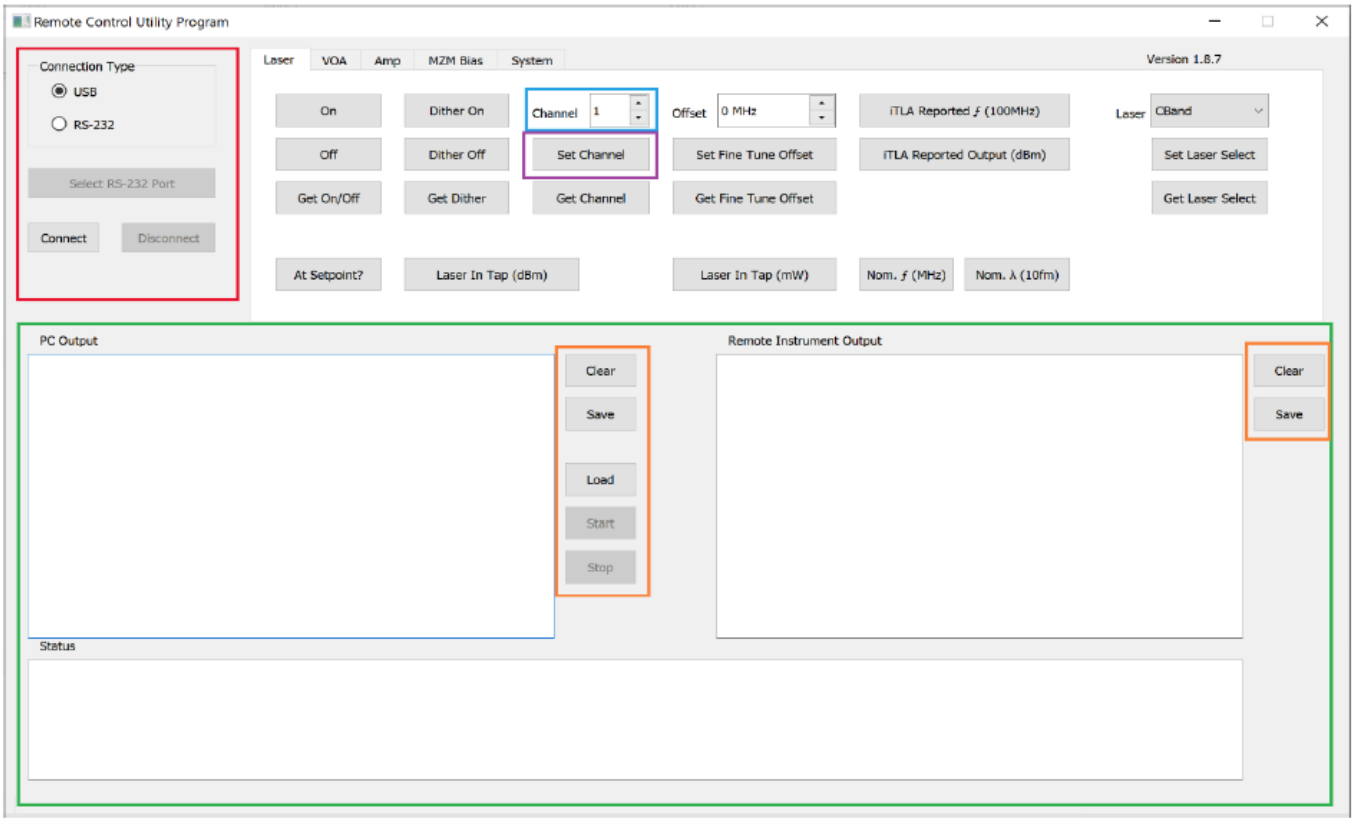

Figure 7 Laser Tab of the Remote Control Tool's Application Window

Select the "Connection Type" radio button corresponding to the utilized connector on the instrument. (The locations of the radio buttons are indicated by the red outline in Figure 7.) Then click the "Connect" button to open a connection to the instrument.
After clicking the "Connect" button, the "Status" field, which is located at the bottom of the region enclosed by the green outline, should show a number of lines of text. If the application established a connection with the instrument, the text shown in the status field will conclude with "Device Opened Successfully."

If a connection was not established between the computer and instrument, the text in the "Status" field will note the failure. A common reason for a failure to connect is that the instrument has not been recognized by the computer; the software cannot find the instrument unless it has been discovered by the computer. It may take up to 30 seconds for the computer to recognize the instrument. If the device fails to open successfully, we recommend closing the Remote Control application, waiting a few seconds, re- opening the application, and attempting again to connect to the instrument. Other reasons the application may fail to successfully open a connection to the instrument include the connection already being open or another copy of the application running. If none of these are the source of the problem, and the problem persists when a different USB cable is used, please contact Thorlabs' Technical Support for assistance.

Using the Remote Control Application

When using the application, clicking the buttons located at the top of the application window sends serial commands to the MX / MBX / TLX1 / TLX2 instrument. The results of clicking the buttons are logged in the three rectangular text fields, which are bordered by the green outline in Figure 7. The commands sent by the computer are written to the PC Output field, the data sent back from the instrument in response to the commands are written to the Remote Instrument Output field, and the status of the software is written to the Status field.
Command responses can be saved or cleared from the Remote Instrument Output field by using the Save and Clear buttons to the right of the Remote Instrument Output field and bordered in an orange outline in Figure 7.

Commands sent by the computer and written to the PC Output field can be saved or cleared by using the Save and Clear buttons to the right of the PC Output field and bordered in the orange outline in Figure 7. Properly formatted text files, either by using the save of the PC Output field or by user entry, which contain SCPI commands

can be loaded to the application using the Load button. Once loaded, the user can select the Start button to begin to send, in sequence, the loaded text file SCPI commands to the MX/MBX/TLX1/TLX2 instrument. Once started, the user may select the Stop button to stop sending commands to the MX/MBX/TLX1/TLX2 instrument. Hitting the Start button again will begin the sequence at the start of the loaded file.

The following examples illustrate the operation of the software and the interaction between the software and the touchscreen interface on the front panel of the MX / MBX / TLX1 / TLX2 series instrument that includes a built-in laser, such as the MX40G.

Example: Using the Application to Change the Laser's ITU Channel

- Adjust the "Channel" control (within the blue outline) to 5.
- Click the "Set Channel" button (within the violet outline).
- The text "LAS:CHAN 5", which is the command sent to the instrument, is printed to the "PC Output" field (within green outline).
- After a short delay, the text "1" is printed to the "Remote Instrument Output" field (within green outline). This indicates the command was received by the instrument.
- The text printed to the "Status" field indicates the response was received.
- Click the "Get Channel" button (below the violet outline).
- The text "LAS:CHAN?" , which is the command sent to the instrument, is printed to the "PC Output" field (within green outline).
- After a short delay, the text "5", which is the most recent ITU channel requested, is printed to the "Remote Instrument Output" field (within green outline).

Example: Using the Software Application with the MX40G's Front Panel Touchscreen

Figure 8 Laser Settings Page of the MX40G

- Navigate to the Laser Settings Page, which is shown in Figure 8, from the Home Screen
- Use the Laser Settings Page to change the ITU Chanel to 6.
- Click the "Get Channel" button (within the violet outline) in the Remote Control Application.
- The text "LAS:CHAN?" , which is the command sent to the MX40G, is printed to the "PC Output" field (within green outline).
- After a short delay, the text "6", which is the ITU channel entered using the touchscreen, is printed to the "Remote Instrument Output" field (within green outline).

Software Application Screenshots

- The functions in the Laser tab (Figure 9) correspond to the commands described in Section 2.3: Laser Control Commands

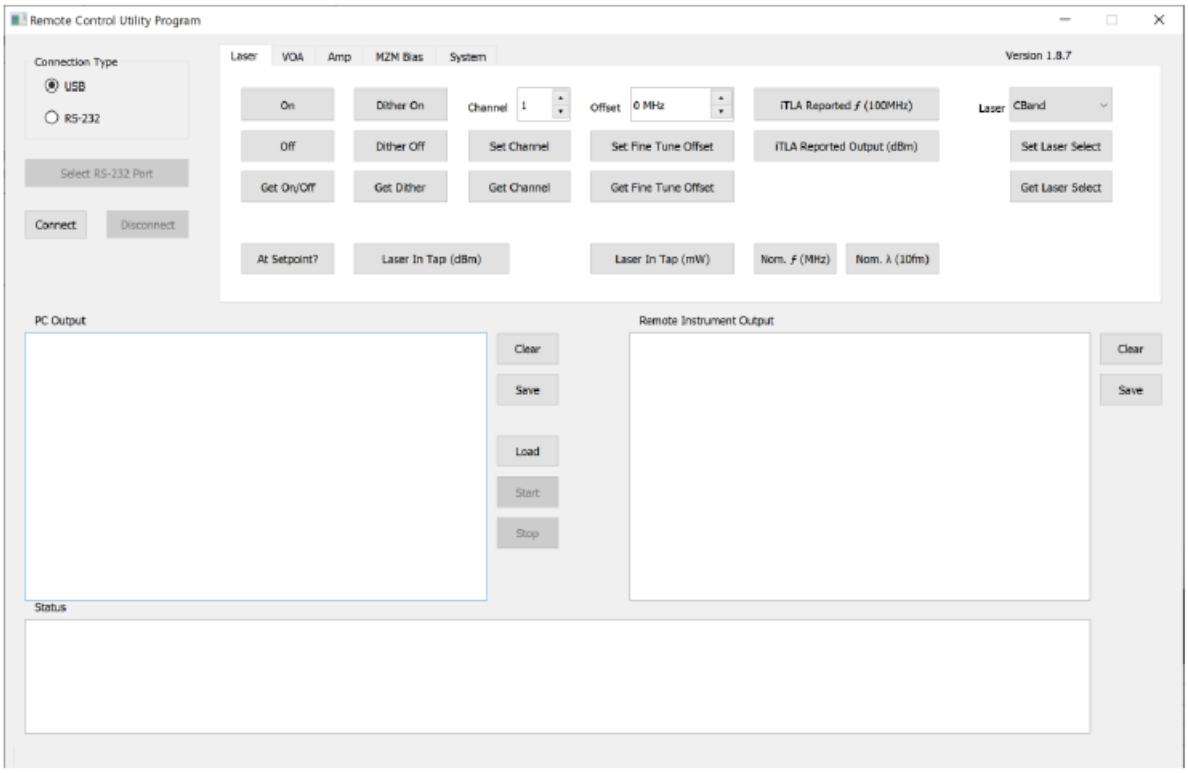

Figure 9 Laser Tab

- The functions in the VOA tab (Figure 10) correspond to the commands described in Section 2.6: Variable Optical Attenuator (VOA) Commands.

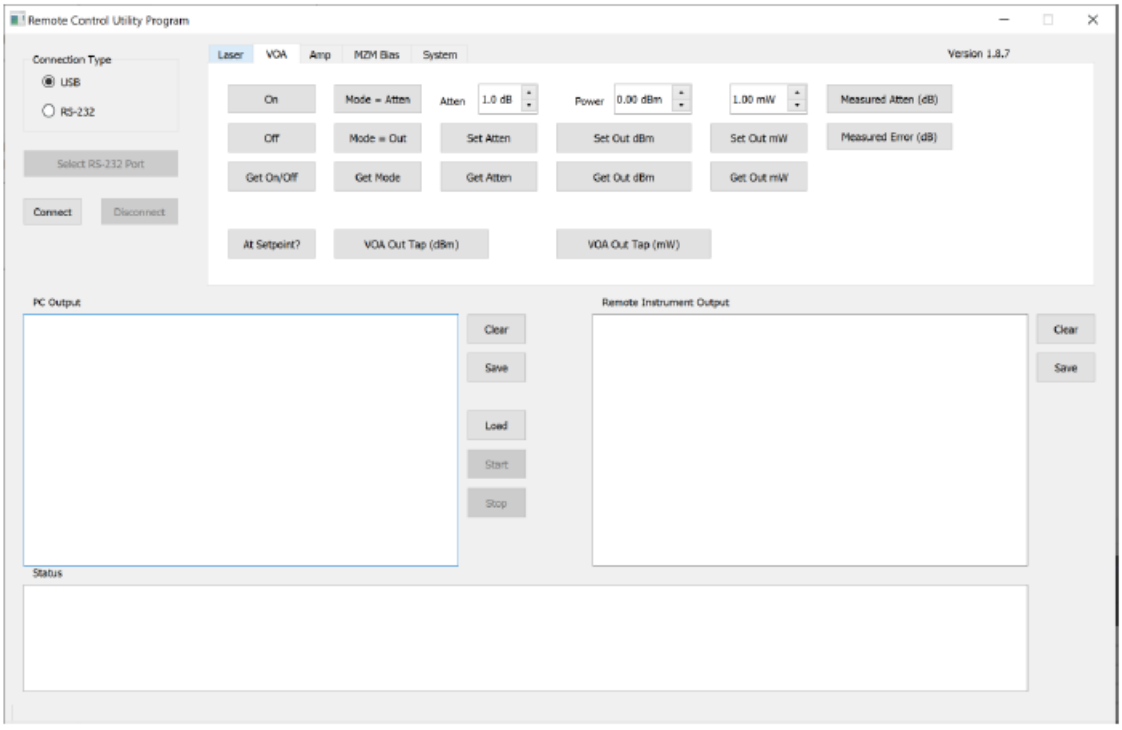

Figure 10 VOA Tab

- The functions in the Amp tab (Figure 11) correspond to the commands described in Section 2.2: RF Amplifier Commands.

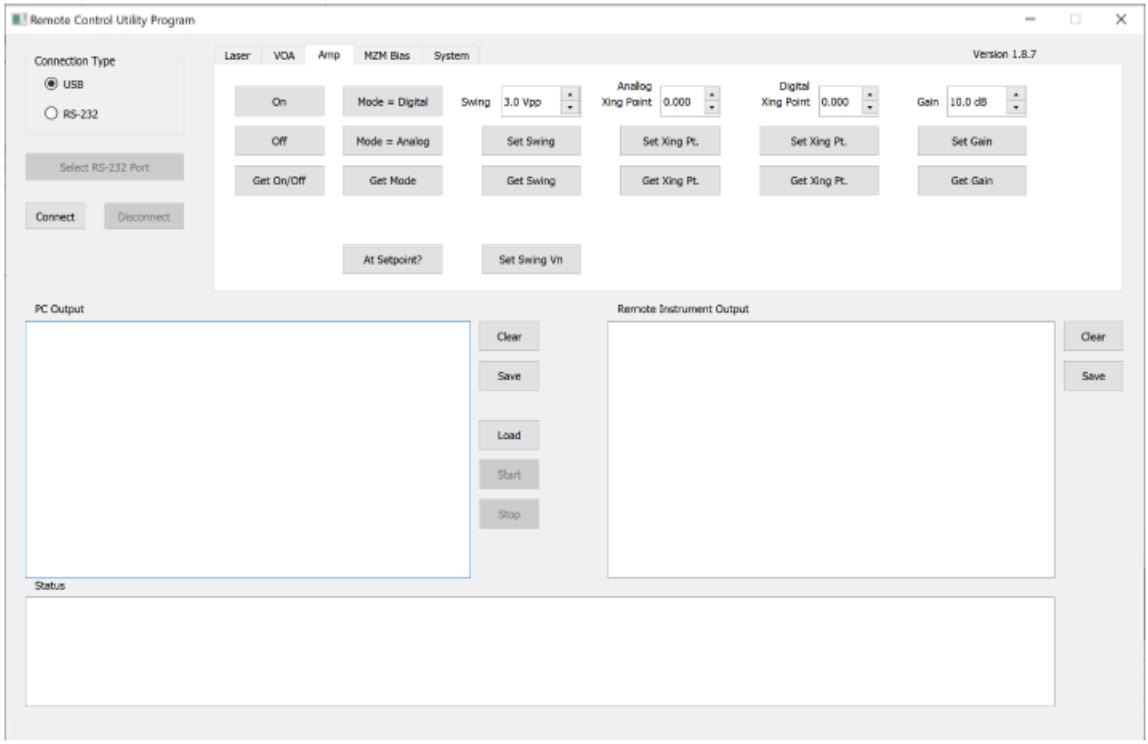

Figure 11 Amp Tab

- The functions in the MZM Bias tab (Figure 12) correspond to the commands described in Section 2.4: Mach-Zehnder EO Intensity Modulator Commands.

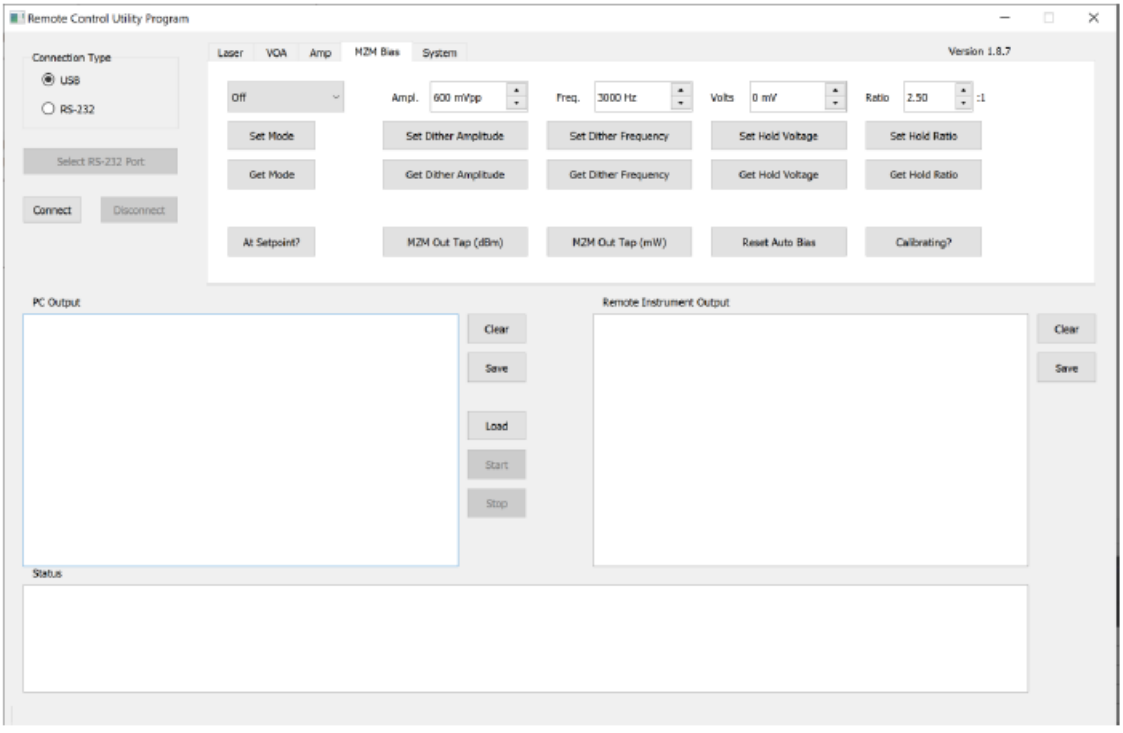

Figure 12 MZM Bias Tab

- The functions in the System tab (Figure 13) correspond to the commands described in Section 2.5: System

Commands.

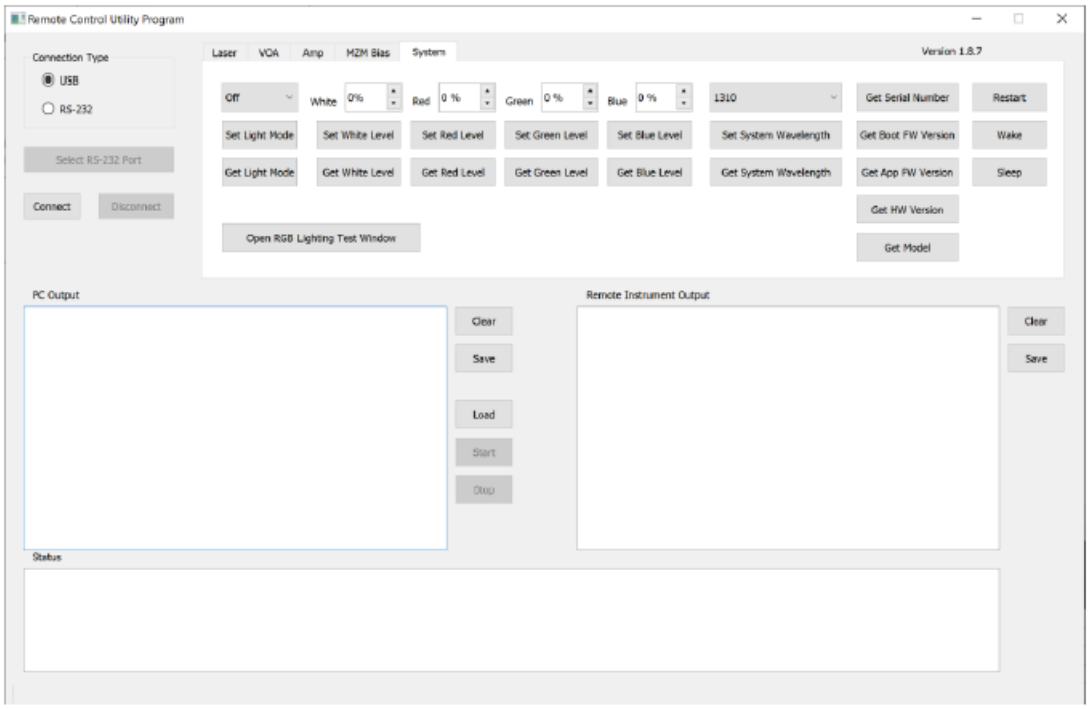

Figure 13 System Tab

Custom Application Development

One option for users interested in developing custom software is to use our Remote Control application as a reference and starting point. Please contact us to request the source code. Using this source code and a development platform such as free version of the Qt® software, our example application can be modified and expanded.

When the computer is connected to the RS-232 port on the MX / MBX / TLX1/ TLX2 series instrument, commands are sent directly to the instrument's universal asynchronous receiver/transmitter (UART). This is not the case for applications communicating with the instrument over USB. In this case, commands sent by the computer address a Silicon Labs® USB to UART bridge chip built into the instrument. The UART is interfaced to the bridge chip. A dynamic-link library (DLL) available from Silicon Labs' website can be used to communicate with the bridge chip. If you have questions or would like guidance as you develop a custom test configuration, please contact us. We are happy to assist you.

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Documents / Resources

	**THORLABS MX40G Fiber Optic Calibrated Electrical to Optical Converters** [pdf] User Guide MX40G Fiber Optic Calibrated Electrical to Optical Converters, MX40G, Fiber Optic Calibrated Electrical to Optical Converters, Electrical to Optical Converters, Optical Converters