



IPS DIGITAL DUAL WAVELENGTH M-TYPE USER GUIDE

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I. Product Summary







The Innovative Photonic Solutions (IPS) Digital Dual Wavelength M-Type Spectrum Stabilized Laser Module provides the user with a powerful and extremely stable laser source that is ideal for scientific applications including Raman Spectroscopy and Illumination.

The Digital Dual Wavelength M-Type is a Class 3B or Class IV laser product depending on output power. Your product will be labeled with the proper labels according to the power level. Extreme care should be taken when operating this unit to avoid potentially hazardous exposure to both eyes and skin. Users should wear eye protection when operating this unit and should avoid exposure to the output beam.

Class 3B Lasers	<499mW
Class IV Lasers	>500mW

II. Explanation of Symbols Used in This Manual & On Module

The following table details the symbols placed on the module and in this manual, and their meanings:

Symbol	Description
	Identifies important information that should be read and thoroughly understood before operating the equipment.
	Laser Warning Label
	Explanatory label – Documents important information about equipment specifications and features.
	General Information Label – Provides information that may be helpful and documents IEC 60825-1 & FDA Compliance information
O	Symbol indicating “Off” position on a switch
I	Symbol indicating “On” position on a switch
	Protective Ground Symbol
	USB I/O Port Symbol

III. Laser Safety

- ⚠ Caution – use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.
- ⚠ Do not point laser or allow laser light to be directed or reflected toward other people or reflective objects.
- ⚠ Do not modify unit or remove protective covers or housings
- ⚠ Laser light emitted from this equipment may be sufficient to ignite some materials and initiate fire
- ⚠ Never operate laser if unit is defective or if safety covers, interlocks, and labels are damaged or missing.

The use of laser safety goggles is required when operating this product.

Laser Safety Eyewear specifications:

- Optical density: ND5 or higher at laser excitation wavelength
- ND 1 or lower at 600 nm
- Top and side shield protection
- CE certified



Failure to wear appropriate eye protection may result in permanent eye damage

INVISIBLE LASER RADIATION

Avoid Eye or Skin Exposure to Direct or Scattered Radiation

Additional helpful information may be found in ANSI Z136.1 “Standard for Safe Use of Lasers”. This document can be obtained at www.rli.com or www.laserinstitute.org

IV. Product View

Figure 1: Mechanical Schematics

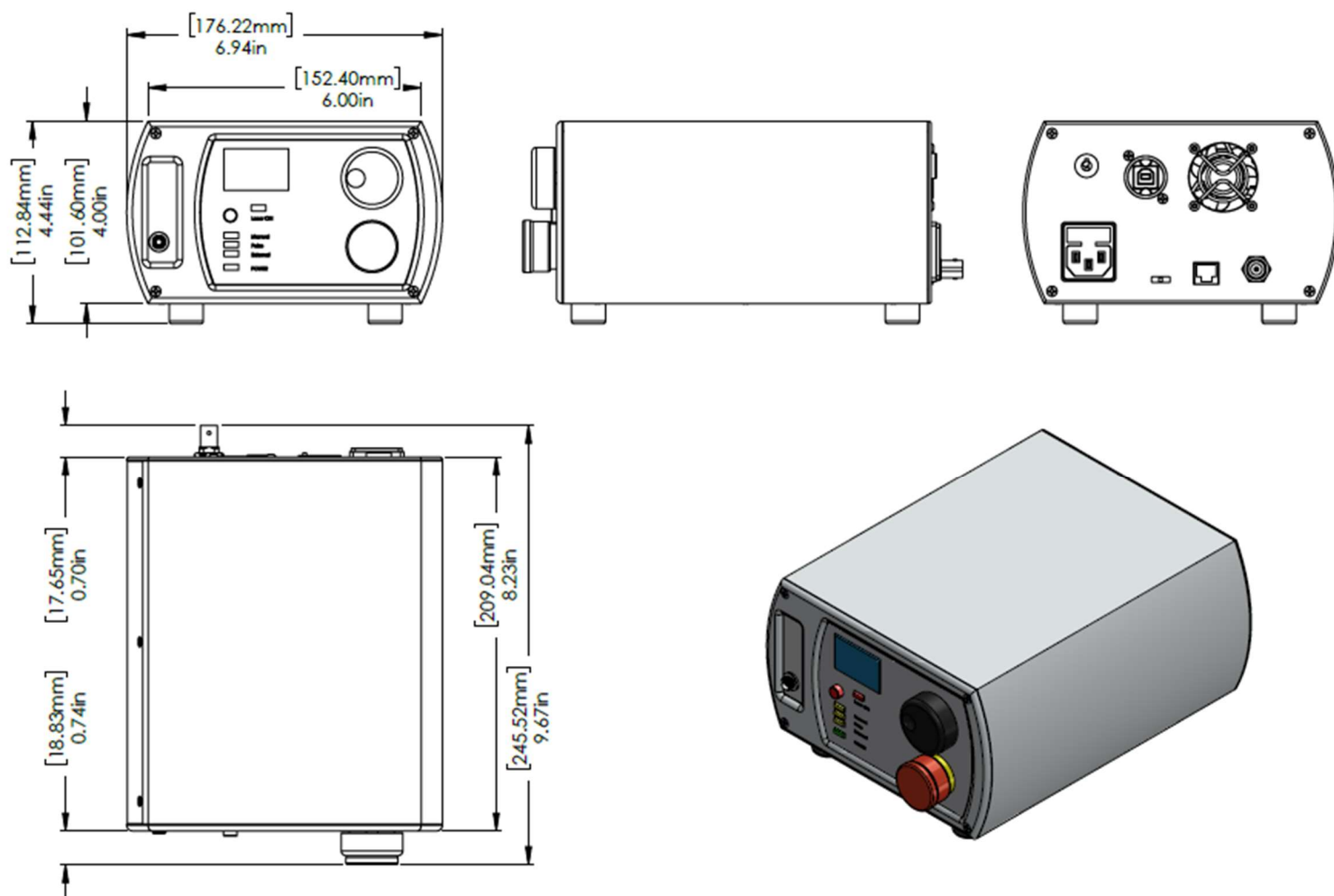


Figure 2: Front Panel



- 1 Power LED
- 2 FC/PC Bulkhead Connector
- 3 "Laser ON" Button and LED
- 4 Drive Current Display Window (mA)
- 5 Operating Mode LED
- 6 Emergency Shut-off Switch (EMO)
- 7 Wavelength Selection Switch
- 8 Drive Current Adjustment Dials

Figure 3: Rear Panel



- 9 Power Connector Port
- 10 Removable Fast Blow Fuse Access Panel
- 11 Master Power Key Switch ("0" = Off, "1" = On)
- 12 USB Type A Hub
- 13 BNC Modulation Input Connector/Control Port
- 14 SMA Wavelength/Channel Select
- 15 Remote Interlock (RJ-11 Port)
- 16 Mode Selection

V. Product Specifications and Standard Configurations

This chapter consists of the product specifications, standard wavelength configurations, and product options.

Multi-Mode Fiber Coupled Digital Dual Wavelength M-Type Module

GENERAL OPTICAL SPECIFICATIONS

Standard Wavelengths*	680nm/785nm, 730nm/830nm, 860nm/1064nm	
Wavelength Tolerance	+/- 0.5nm	
Narrowed Linewidth Spectral Linewidth	<0.1nm (0.08nm typical)	
Standard Output Power Levels	680/785nm, 730/830nm, 860/1064nm	
	350mW	500mW
SMSR	35dB – 45dB	
Wavelength Stability Temperature Range	15°C – 45°C	
Output Power Stability	<1% at constant case temperature	
Modulation Rate	Digital Modulation: 25KHz External Modulation: CW to 10kHz at 50% duty cycle or CW to 1kHz at 10% - 100% duty cycle	
Warm-Up Time	Cold Start: 10 seconds	
	Warm Start: 1.5 second	

PHYSICAL SPECIFICATIONS

Optical Fiber	105/125 micron multimode fiber, 0.22 NA
Connector	FC/PC or SMA905
Electrical Connector	10-pin Molex #53014-1010 (mating connector 51004-1000) USB mini B
Module Dimensions	3.0in. (76.2mm) x 2.5in. (63.5mm) x 0.69in. (17.53mm)
Module Weight	3.5oz. (100g)
Case Material	Anodized Aluminum
Case Temperature Range	-10°C - 45°C
Internal Cooling Air Flow	100 LFM with attached heatsink
Environment	0% - 80% humidity, non-condensing
Storage Temperature	-50°C – 90°C
Regulatory	RoHS 2.0 Certified Exempt from CFR Title 21 1040.10 and 1040.11 (component/replacement part)

ELECTRICAL SPECIFICATIONS

Supply Voltage	5Vmin – 14Vmax (see specific product information)
Power Consumption	3W – 5W typical 15W maximum

* Additional wavelengths may be available, contact IPS at ipslasers.com



Included Components

The Innovative Photonic Solutions Digital Dual Wavelength M-Type Module comes complete with an internal 350mW (or 500 mW) dual wavelength spectrum stabilized laser module that contains an integral Thermo-Electric Cooler (TEC) and thermistor for monitoring the internal temperature of the laser platform. The unit comes complete with a laser enable switch for safety, an LED readout, an output power control dial, a safety key lockout, a USB connection port, a remote interlock, and an emergency shut-off switch.

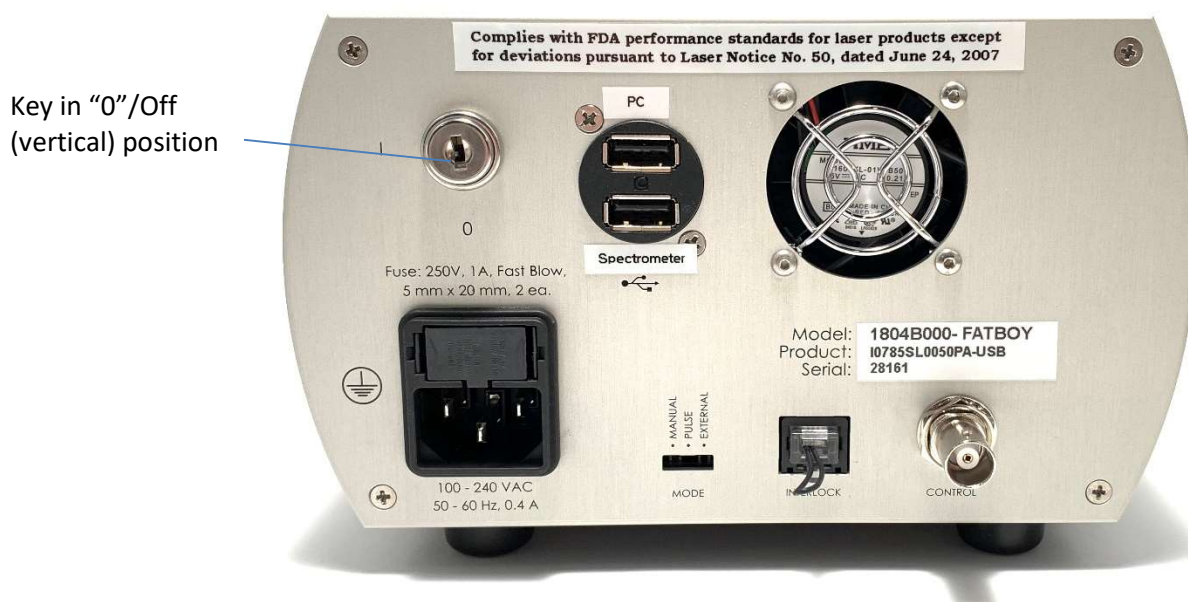
VI. Laser Start-Up (Control of Output Power Via Front Panel)

The following steps and illustrations should be followed when starting the Dual Wavelength Digital M-Type Module.

Caution—use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1. Ensure the Master Power Key Switch is set to the “0”/Off (vertical) position. See Figure 4.
2. Connect the supplied power cable to the power connector port on the M-Type unit and plug into a 100V – 240V AC electrical outlet.

Figure 4: Master Power Key set to “0”/Off (vertical) position



3. Connect a suitable FC/PC connectorized fiber patch cord to the FC/PC bulkhead connector located on front panel.
4. The laser is configured with a remote interlock. IPS has provided an RJ-11 port that is pre-wired to provide a closed loop connection for the interlock. Removal of the RJ-11 connector, or break in the closed loop circuit provided, will result in a laser interrupt and the system will be reset to standby mode. See *section XIa. Performance Features, Item 1: Remote Interlock* for more details.
5. Ensure that the Emergency Shut-off Switch (EMO) is in the “ready” position by turning the button clockwise until it pops out slightly.
6. You are now ready to turn on the laser module. Start by turning the master power key switch 90 degrees clockwise from the “0”/Off (vertical) position to the “I”/On (horizontal). The “Power” LED on the front panel will turn green indicating that system power is on.

*****A 5 SECOND WAIT TIME IS REQUIRED BEFORE THE LASER CAN BE TURNED ON. THIS IS FOR THE CONTROL BOARD INITIALIZATION*****

7. Press the “Laser ON” button on the front panel. The “Laser ON” LED will turn red LED indicating that the laser is operational, and the laser will turn on ~2 seconds after the button is pressed.

Note: The “Laser ON” button is a momentary contact. Users should allow the button to return to its natural center position after pressing. This button will also function as a manual reset. In the event of a power interruption, failure, or interlock break, the laser will be automatically disabled. To re-enable, simply toggle the laser enable to the on position once again.

8. Turn the Drive Current Adjustment Dial to adjust to the desired drive current setting as read out on the front panel display window.

Vla. Laser Start-Up (External Control via USB)

The Dual Wavelength Digital M-Type can be controlled by interfacing with a computer via the included USB cable and USB I/O port located on the rear panel of the module. For information on laser control via USB, please see Appendix A located at the end of this document.

The following steps should be taken if the user wishes to control the laser output power via the integrated USB I/O:

Caution—use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

1. Ensure that the laser is not operating by assuring that the red “Laser ON” LED on the front panel is not illuminated. If it is, press the “Laser ON” button to turn off.

2. Connect the provided USB cable to both the laser and a computer.
3. Turn on the laser by momentarily pressing the “Laser ON” button on the front panel, and ensuring the “Laser ON” LED is now illuminated red. The laser will now accept control input from either the front panel interface or the USB computer control interface.

Vlb. Laser Start-Up (External Power Control via Analog BNC)

The Dual Wavelength Digital M-Type is designed for operation by interfacing with front panel controls and/or the USB connection, however users may wish to manually modulate, switch wavelengths, or adjust the output power of the laser via analog controls in some circumstances. The following steps should be taken to control the laser output power via a signal generator or computer:

Caution—use of controls or adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Option 1 – Setting laser power via front panel input, but switching wavelengths remotely (Pulse Mode)

1. Ensure that the laser is not operating by assuring that the red “Laser ON” LED on the front panel is not illuminated. If it is, press the “Laser ON” button to turn off.
2. Put the Mode Selection switch located on the back panel to the “Pulse” (Center) position. The amber “Operating Mode” LED on the front panel should illuminate next to “Pulse”.
3. Connect a BNC cable to the port labeled “Control” on the back panel. The user may apply a TTL signal (0 V DC – representing TTL LO, or > 3.6 V DC – representing TTL HI) to modulate the laser or to adjust the laser’s output power. TTL LO corresponds to Laser OFF, TTL HI corresponds to Laser ON. See section IX. *Product Specifications* for modulation rate information.
4. Connect an SMA cable to the port labeled “Channel Select” on the back panel. The user may apply a TTL signal (0 V DC – representing TTL LO, or > 3.6 V DC – representing TTL HI) on the coaxial SMA connection labelled "Channel Select" to toggle between the two laser wavelengths contained with the Dual Wavelength Laser Source (DWLS) Module. TTL – LO enables the shorter wavelength and TTL HI enables the longer wavelength.
5. Turn on the laser by momentarily pressing the “Laser ON” button on the front panel. The laser will now output a variable amount of output power that is dependent upon the DC bias voltage that has been applied to the Control port on the back panel.

Option 2 – Setting both laser wavelength and power remotely (External Mode)

1. Ensure that the laser is not operating by assuring that the red “Laser ON” LED on the front panel is not illuminated. If it is, press the “Laser ON” button to turn off.
2. Put the Mode Selection switch located on the back panel to the “External” (right-most) position. The amber “Operating Mode” LED on the front panel should illuminate next to “External”.
3. Connect a BNC cable to the port labeled “Control” on the back panel. The user may apply a DC bias between 0 and 1.0 V to modulate the laser or to adjust the laser’s output power. Zero (0) V corresponds to 0 power, 1.0 V corresponds to full power. See section IX. *Product Specifications* for modulation rate information.

4. Connect an SMA cable to the port labeled “Channel Select” on the back panel. The user may apply a TTL signal (0 V DC – representing TTL LO, or > 3.6 V DC – representing TTL HI) on the coaxial SMA connection labelled "Channel Select" to toggle between the two laser wavelengths contained with the Dual Wavelength Laser Source (DWLS) Module. TTL – LO enables the shorter wavelength and TTL HI enables the longer wavelength.
5. Turn on the laser by momentarily pressing the “Laser ON” button on the front panel. The laser will now output a variable amount of output power that is dependent upon the DC bias voltage that has been applied to the Control port on the back panel.

VII. Laser Shut Down

The following steps should be followed when shutting down the Dual Wavelength Digital M-Type.

1. Press the “Laser ON” button on the front panel and ensure that the red “Laser ON” LED is not illuminated.
2. Turn the Master Power Key Switch on the back panel counter clockwise from “I”/On (horizontal) position to the “O”/Off (vertical) position.
3. Disconnect the fiber patch cord, USB, and power cables as needed.

VIII. Maintenance & Cleaning

Fuse replacement:

The Dual Wavelength Digital M-Type has two (2) 250V, 1A fast blow fuses located in a removable panel immediately above the AC power socket. Replacement fuses must be rated at 250V, 1A, fast blow and must be 5mm x 20mm. To remove the fuse panel, pinch panel retention clips on each side and gently pull. The fuses will be seated in sockets within the removed panel and can be gently lifted out. Once fuses have been checked or replaced, slide the fuse panel back in place until the panel is firmly seated; An audible click will indicate when the fuse panel is properly seated.

Cleaning:

Clean the Dual Wavelength Digital M-Type module with a soft cloth dampened with water as needed. Abrasives, chemical solvents, and cleaning agents should not be used to clean laser module.

Other than the two (2) electrical fuses detailed above, the IPS Dual Wavelength Digital M-Type does not have any user serviceable components and does not require any periodic maintenance.

IX. Warranty

The IPS Dual Wavelength Digital M-Type is warranted against defects in materials and workmanship for a period of one (1) year from date of shipment. During the warranty period, IPS will, at its option, either repair or replace products which prove to be defective.

The unit does not contain any user serviceable components and does not require any preventative maintenance operations during the device lifetime. Opening, modifying, or servicing of this unit is expressly prohibited and will result in nullification of product warranty. All necessary service and repair will be made at the IPS facility upon request of a Return Material Authorization (RMA) and return of the unit.

This warranty is in lieu of all other guarantees expressed or implied and does not cover incidental or consequential loss or improper operation/handling by operator.

X. Performance Features & Laser Safety and Compliance Labels

The IPS Dual Wavelength Digital M-Type conforms to all FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

X1a. Performance Features:

1. **Remote Interlock:** The Dual Wavelength Digital M-Type is equipped with a remote interlock feature that may be utilized by the operator to shut down the laser in the event that a door or enclosure is opened. The interlock is located on the back panel and utilizes an RJ-11 plug. The remote interlock is normally open circuit, so the RJ-11 connector provided by IPS or a user configured closed loop interconnect is **REQUIRED** to be in place for proper function of the laser module. Users may decide to enable a remote interlock mechanism when integrating into a laboratory or system. To enable the remote interlock, the user must obtain an RJ-11 plug (or modify the plug provided) and create a closed circuit between the 2 signal terminals of the plug. Then insert the closed-circuit RJ-11 plug into the interlock port. The laser will function normally when it senses a closed circuit, however it will disable laser output when an open circuit is detected. To re-enable laser function after a shutdown event, the user must ensure that the interlock is closed circuit and manually reset the unit by pressing the “Laser ON” button on the front panel, at which point the LED should turn red, indicating the laser is on.
2. **Manual laser reset mechanism:** The Dual Wavelength Digital M-Type is equipped with a manual laser reset. In the event of a power interruption, power failure, or interlock breach, the laser will default to a laser off position. To re-enable the laser, the user must toggle the “Laser ON” button on the front panel, at which point the LED should turn red, indicating the laser is on.

X1b. Laser Safety and Compliance Labels:

1. Laser Warning and aperture label is located on the front panel of the module, immediately adjacent to the FC/PC bulkhead connector.
 - Identifies location of output beam



2. Class IIIB laser or Class IV explanatory label is located on the top of the module in the front left-hand corner. The label details:
 - Laser exposure warnings
 - Laser wavelength and maximum output power levels
 - Laser classification



3. Manufacturers ID label is located on the left-hand panel (when viewing from the front of the laser module) of the module. The label details:
 - Manufacturer’s address & the date of manufacture of item

INNOVATIVE PHOTONIC SOLUTIONS
4250 U.S. HIGHWAY 1, SUITE 1
Monmouth Junction, NJ 08852, USA

Manufactured: September 2010

4. Certification statement label is located on the top center of the rear panel rear panel on the laser module, above the master power key switch. The label details:
 - Compliance with FDA performance standards

Complies with FDA performance standards for laser products except
For deviations pursuant to Laser Notice No. 50, dated June 24, 2007

5. Labeling indicating model #, and Serial # of the unit is located on the back panel above the BNC modulation input connector.



- 1 Laser Warning and Aperture Label
- 2 Laser Explanatory Label



- 3 Manufacturers ID Label
- 4 Laser FDA Compliance Label
- 5 Module Model # and S/N

XI. Technical Support Contact Information

Questions regarding the use or operation of this product may be directed to:

Innovative Photonic Solutions

Attn: Sales

4250 U.S. Highway 1, Suite 1

Monmouth Junction, NJ 08852

Phone: (732) 355-9300

Fax: (732) 355-9302

sales@IPSLasers.com

Appendix A

Connect the USB cable provided from the Dual Wavelength Digital M-Type Module USB A connector to the host system.

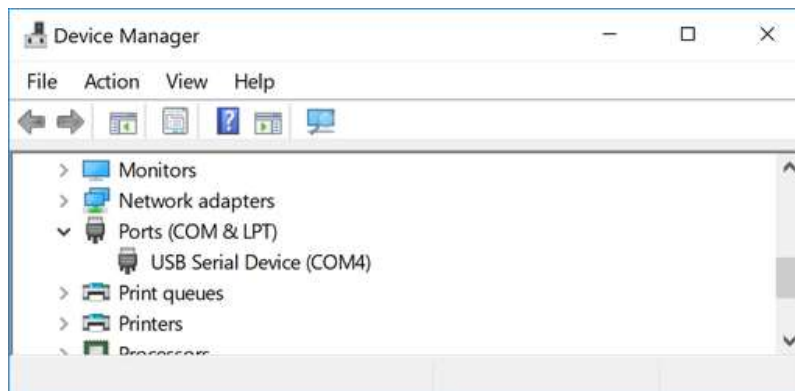
1. Ensure the Dual Wavelength Digital M-Type Module is recognized by the host system by opening the Windows® Device Manager. If using an alternate Operating System, please contact IPS for additional details on verifying device recognition.

Locate “Ports (COM & LPT)” in the Device Manager. Ensure “USB Serial Device (COMX)” is present.

If “Ports (COM & LPT)” does not appear, it’s possible it is hidden (select the “View” drop down and “Show hidden devices”). If “Ports (COM & LPT)” still does not appear, please visit the Microsoft® answers page to view steps to enable legacy hardware.

The M-type module uses a serial interface, with COM port settings of 115200 baud and 8N1 configuration.

Image 1.0: Digital M-type module recognized by Microsoft® Device Manager



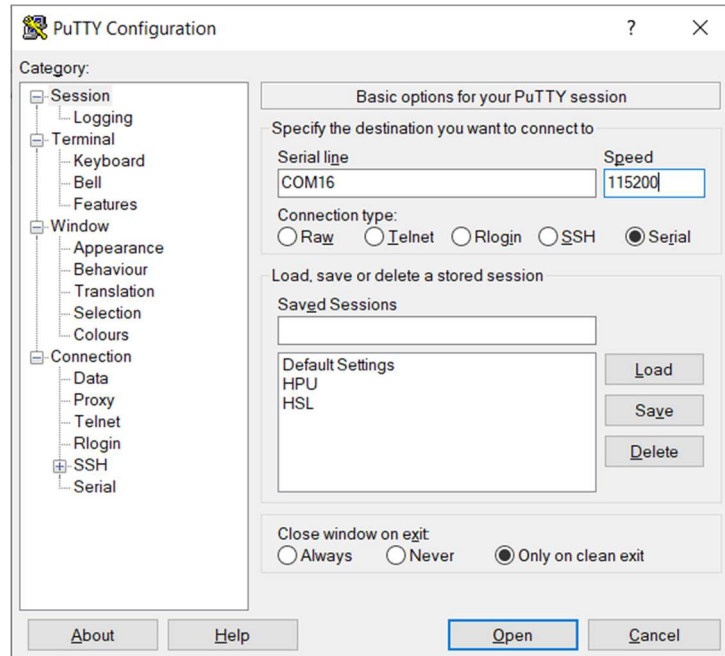
2. Test the M-type module functionality

Use a serial port monitor program to test the device functionality.

The open source program "PuTTY" (<https://www.putty.org/>) can be used to test the device manually.

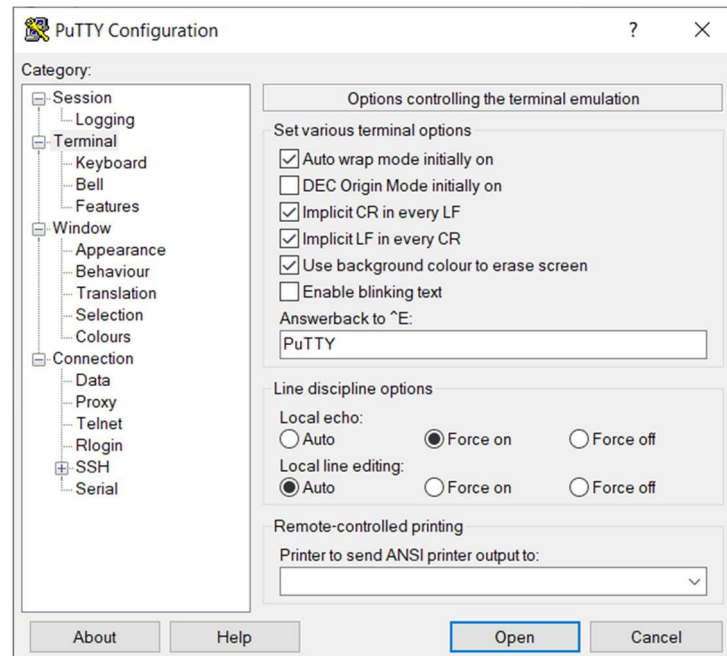
3. Before starting the session, configure the “Session” via the “Session” menu and setting the following:
 - i. Verify the correct COM port is populated in the “Serial line” input box
 - ii. Manually set “Speed” to 115200
 - iii. “Connection type” should be set to “Serial”

Image 2.1: “PuTTY” Session Configuration



4. Configure the "Terminal" by accessing the "Terminal" menu and enabling:
 - i. "Implicit CR in every LF"
 - ii. "Implicit LF in every CR"
 - iii. "Local echo:" Force On

Image 2.2: "PuTTY" Terminal Configuration



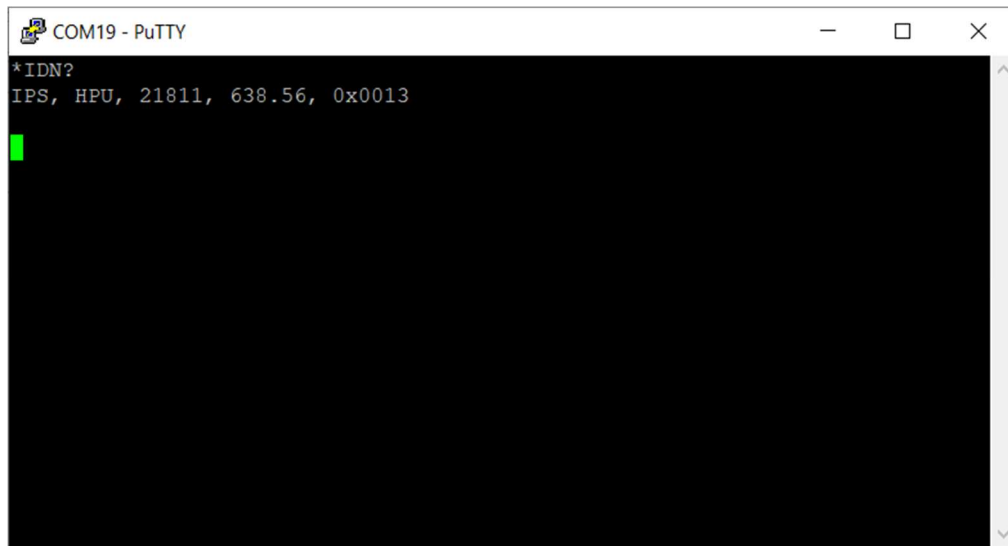
5. Ensure the device is correctly connected to the host system

***Any text command needs to be entered within 10 seconds or the device will time out. This is a function of IPS' firmware and is independent of terminal.**

Send the command `"*IDN?"`

The device should respond with "IPS, HPU, laser serial number, laser wavelength, firmware version". This confirms the device is correctly connected to the host system.

Image 2.3: "*IDN?" Command Line Example



Command Reference

Command Syntax

This section describes command syntax and structure. This information must be understood in order to effectively write a control program. The syntax of commands follows the rules defined in the Standard Commands for Programmable Instruments (SCPI v1999.0). This standard is based on the IEEE 488.2 standard.

Letters

Commands are not case sensitive

Acceptable Command Spelling

Full Name	Abbreviated
TEC:Setpoint	TEC:SET
Laser:Enable	LASER:EN

White Space

“White space” can be any number of space characters (space bar). A white space **must** separate a command from its input parameters or data. For example:

Acceptable	Acceptable	Not Acceptable
Laser:Enable 1	LASER:EN 1	LASER:EN1

A query has no space between the mnemonic and the question mark. For example:

Acceptable	Not Acceptable
*IDN?	*IDN ?

Terminators

A program message terminator identifies the end of a command string. Valid terminator sequences are <LF> (linefeed), <CR> (carriage return) and <CR><LF> (carriage return / line feed). The digital M-type terminates its responses with <CR><LF>.

Command Separators

More than one command may be placed in the same command string if each command is separated by a semicolon (;). The semicolon can be preceded by one or more spaces. For example:

```
OUTPUT ON;*IDN?;SYSTEM:ERROR? OUTPUT ON ; *IDN?;
```

```
SYST:ERROR?
```

The digital M-type will respond to multiple queries within the same command string by separating each response with a command separator.

Parameters

Some commands require an input parameter. The parameter must be separated from the command by white space.

The syntax symbol <numeric_value> refers to the flexible numeric representation described by section 7.7.2.1 of IEEE 488.2. Some numbers may be represented with or without a decimal point and with or without exponent. White space is not accepted on either side of the decimal or after the sign character, but is acceptable on either side of the “e/E” exponent character. For example, the number “twenty” may be represented by any of the following ASCII strings:

NR1	Integer	20	+20
NR2	Floating Point	20.0	+20.0
NR3	Scientific Notation	2 E 1	+2.0E+1
		2.0e+1	+2.0 e1

Refer to the command reference section to determine what forms of parameters a command accepts.

Command Reference Summary

*Any text command needs to be entered within 10 seconds or the device will time out. This is a function of IPS' firmware and is independent of terminal.

Table 2.0 Command Reference Summary

Command	Command Abbreviation	Function
*IDN?		Reports the device identification string. Will read back: IPS, HPU, laser serial number, factory measured wavelength, FW revision
Board:Current?	BOARD:CUR?	Reports the measured current draw in mA
Board:Temperature?	BOARD:TEMP?	Reports the module case temperature in °C
Calibrate:Number <num_entries> <save state>	CAL:NUM <num entries><save state>	Sets number of desired entries in the calibration Look Up Table (LUT). <i>Save state permanently (1) or until power cycle (0)</i>
Calibrate:Number?	CAL:NUM?	Reports number of entries in the LUT
Calibrate:Monitor <num> <value> <save state>	CAL:MON <num><value><save state>	Sets PD monitor value in LUT <i>Save state permanently "1" or until power cycle "0"</i>
Calibrate:Monitor? <num>	CAL:MON? <num>	Reports the PD monitor value in the requested <num> LUT entry
Calibrate:Power <num> <value> <save state>	CAL:POW <num><value><save state>	Sets LUT power value in mW <i>Save state permanently "1" or until power cycle "0"</i>
Calibrate:Power? <num>	CAL:POW? <num>	Reports the laser power value in the requested <num> LUT entry
ERRor?	ERR?	Queries the errors in the hardware error queue. This differs from Communication Error Codes
Laser:Current <current>	LASER:CUR <current>	Sets laser operating current setpoint in mA

Command	Command Abbreviation	Function
Laser:Current?	LASER:CUR?	Reports measured laser operating current in mA
Laser:Setpoint?	LASER:SET?	Reports the laser operating current setpoint in mA
Laser:Enable <enable state>	LASER:EN <enable state>	Enables/Disables laser operation <i>Laser can be turned on with "1" or "ON"; laser can be turned off with "0" or "OFF"</i>
Laser:Enable?	LASER:EN?	Reports laser enable state
Laser:Hours?	LASER:HOURL?	Reports the number of hours of ON time of the laser
Laser:Mode:Analog <enable state>	LASER:MOD:AN <enable state>	Enables/Disables external (hardware) VBIAS input <i>Laser default is "0", off state. Input "1" to enable</i>
Laser:Mode:Analog?	LASER:MOD:AN?	Reports the external VBIAS enable state <i>Return value = 0,1</i>
Laser:Mode:Digital <value>	LASER:MOD:DIG <value>	Enables/Disables digital (PWM) mode <i>Laser default is "0", off state. Input "1" to enable</i>
Laser:Mode:Digital?	LASER:MOD:DIG?	Reports digital mode (PWM) enable status <i>Return value = 0,1</i>
Laser:Mode:PWM <duty cycle>	LASER:MOD:PWM <duty cycle>	Sets PWM percent (0 – 100) for digital mode
Laser:Mode:PWM?	LASER:MOD:PWM?	Reports PWM duty cycle setting in percent
Laser:Monitor?	LASER:MON?	Reports the measured photodiode signal in mV

Command	Command Abbreviation	Function
Laser:Power?	LASER:POW?	Reports the laser power (based on calibration table data/LUT) in mW
Laser:Temperature?	LASER:TEMP?	Reports the measured laser/TEC temperature (°C)
Parameters:Restore	PARAM:RESTORE	Restores factory default power-up settings
Parameters:Save	PARAM:SAVE	Saves the current settings as power-up defaults
Status?	STAT?	Reports the Board State and number of errors in the hardware error queue
System:Error:Count?	SYST:ERR:COUN?	Reports the number of errors in the communication error queue
SYSTem:ERRor[:NEXT]?	SYSTem:ERRor[:NEXT]?	Queries the errors in the communication error queue.
TEC:Setpoint <temperature>	TEC:SET <temperature>	Sets the TEC temperature setpoint (°C). It is recommended NOT to set above 35°C.
TEC:Setpoint?	TEC:SET?	Reports TEC temperature setpoint (°C)

Command Reference (Detailed)

The following pages contain a reference for commands for the digital M-type laser controller. See Table 2.0 above for command abbreviations.

*IDN?

Instrument Identification

Description	Requests the instrument to identify itself	
Parameters	None	
Notes	Returns a string of instrument identification information. The string contains a comma separated list of manufacturer, "HPU" designator, serial number, laser wavelength, and firmware revision	
Examples	"*IDN?"	Responds with "IPS, HPU, 1234, 785.8, 0x8100"

Board:Current?

Description	Reports the measured current draw in mA	
Parameters	None	
Examples	BOARD:CUR? Response: 300, indicating a 300mA input supply current	

Board:Temperature?

Description	Reports the module case temperature in °C	
Parameters	None	
Examples	BOARD:TEMP? Response: "30.00" indicating a 30.00°C temperature	

Calibrate:Number <num_entries><save state>

Calibrate:Number?

Description	Sets number of desired entries in the calibration Look Up Table (LUT) Reports number of entries in the LUT
Parameters	Valid values for <num_entries> are integers from 2 to 9 Valid values for <save state> are: 1 = store permanently, and 0 = use until next power cycle If no value entered for <save state> default is to 0
Examples	CAL:NUM 3 0 – Sets the Number of LUT entries to 3, use until next power cycle CAL:NUM 3 1 - Sets the Number of LUT entries to 3, Permanently stores Look-Up-Table Entries CALIBRATE:NUMBER? - Response “2”, indicating 2 LUT entries currently

Calibrate:Monitor<num><value><savestate>

Calibrate:Monitor? <num>

Description	Sets photodiode (PD) monitor value in LUT in mV Reports the PD monitor value in the requested <num> LUT entry in mV
Parameters	<num> - the entry number in the LUT. Valid values for <num> are integers from 1 to 9 <value> – the value in the LUT. Valid values for <value> are integers from 0 to 3000 Valid values for <save state> are: 1 = store permanently, and 0 = use until next power cycle If no value entered for <save state> default is to 0
Examples	CAL:MON 1 100 1 – Sets PD LUT entry 1 permanently to 100mV CAL:MON? 2 - Response “300”, indicating Photodiode LUT entry 2 is currently 300mV

Calibrate:Power<num><value><savestate>

Calibrate:Power? <num>

Description	Sets LUT power value in mW Reports the laser power value in the requested <num> LUT entry in mW
Parameters	Valid values for <num> – the entry number in the LUT - are: integers from 1 to 9 Valid values <value> – the value into the LUT – are numbers from: 0 to 6553.5 Valid values for <save state> are: 1 = store permanently, and 0 = use until next power cycle
Examples	CAL:POW 1,100,1 – Set Laser Power LUT entry 1 permanently to 100mW CAL:POW? 2 - Response “300.4”, indicating Laser Power LUT entry 2 is currently 300.4mW

Error?

Description	Returns the hardware error number, a sub-code, and a brief description
Parameters	None
Response	ASCII character string containing an error number and a brief description
Notes	If more than one error has occurred, repeated error queries are required until the response is “0, No error”. See below for a list of error numbers.
Examples	ERR?- Response “0, 0, No error” means no errors to report. Error? - Response “3097, 0, Failed initial POST” means the initial power-on self-test failed at location “0”.

Laser:Current <current>

Laser:Current?

Description	Sets laser operating current setpoint in mA Reports measured laser operating current in mA
Notes	The laser current for each laser module is internally limited for safety of the laser. Inputting values above the internal limit will result in a failed response and will not change the laser current setpoint. It is recommended to validate that the value entered is saved by following the input with a LASER:SET? Query.
Parameters	<current> is the laser operating current in mA
Examples	LASER:CUR 200.0 – Sets the operating current for the laser to 200mA.

LASER:CURrent? - Response “250.0”, indicating a 250mA current flowing through the laser

Laser:Setpoint?

Description	Reports the laser operating current setpoint in mA
Parameters	None
Examples	LASER:SET? - Response “250.0”, indicating a 250mA is the laser operating current setpoint

Laser:Enable <enable>

Laser:Enable?

Description	Controls whether the laser is enabled or disabled Reports laser enable state
Parameters	Valid values for <enable> are: 1/ON = Enables the Laser 0/OFF = Disables the laser
Notes	The actual ON/OFF state of the laser is determined by a combination of hardware and software. If the Laser is disabled through this command it will be OFF. When it is enabled its ON/OFF state will depend on the hardware enable state (If hardware enable is ON, then laser is ON. If hardware enable is OFF then laser is OFF).
Examples	LASER:EN 0 – Disables the laser LASER:ENable? - Response “1”, Laser is enabled

Laser:Hours?

Description	Reports the number of hours of ON time of the laser
Parameters	None
Return	A floating point number in hours
Examples	LASER:HOURL? – Response “100.34”, meaning laser has been on 100.34 hours LASER:ENable? - Response “1”, Laser is enabled

Laser:Mode:Analog <enable>

Description Enable/Disable VBIAS input from external hardware connection on pin 8 of module. This function allows the user to adjust the output power of the laser via an external voltage bias.

Parameters Valid values for <enable> are:

1/ON = Enables VBIAS input to control the laser current

0/OFF = Disables external VBIAS input

Examples LASER:MOD:AN 1 – enables external VBIAS input

Laser:Mode:Analog?

Description Reports the external VBIAS enable state

Parameters A return of 0 = Factory Default setting (VBIAS is disabled)

A return of 1 = External VBIAS is enabled

Examples LASER:MOD:AN? – Response “1” reports the VBIAS control setting of the laser is enabled

Laser:Mode:Digital <enable>

Description Enable/Disable digital Pulse Width Modulation (PWM) of the laser

Parameters <enable> values: 1 = Allows digital modulation of the laser current, ON = Allows digital modulation of the laser current

<enable> values: 0 = Do not allow digital modulation of the laser, OFF = Do not allow digital modulation of the laser

Examples LASER:MOD:DIG 1 – Enable digital modulation of the laser

Laser:Mode:Digital?

Description	Reports digital mode (PWM) enable status
Parameters	None or 0 to report current laser mode digital (PWM) enable status 1 to report laser mode digital (PWM) factory default setting
Examples	LASER:MOD:DIG? – Response “0”, Laser PWM is not enabled LASER:MOD:DIG? 0 – Response “0”, Laser PWM is not enabled LASER:MOD:DIG? 1 – Report the factory default digital modulation setting of the laser

Laser:Mode:PWM <Duty Cycle>

Description	Sets the PWM duty cycle for digital modulation
Parameters	Duty Cycle in Percent is this from 10.0% to 100%
Examples	LASER:MOD:PWM 30.3 – Set PWM duty cycle of the laser to 30.3%

Laser:Mode:PWM?

Description	Reports the PWM duty cycle of laser current
Parameters	None or 0: Report current laser PWM setting 1: Report factory default PWM setting
Examples	LASER:MOD:PWM? – Response “45.3”, Reports the current digital modulation duty cycle setting of the laser as 45.3% LASER:MOD:PWM? 0 – Response “45.3”, Reports the current digital modulation duty cycle setting of the laser as 45.3% LASER:MOD:PWM? 1 – Reports the factory default digital modulation duty cycle setting of the laser

Laser:Monitor?

Description	Reports the monitor photodiode (PD) signal level
Parameters	None
Examples	LASER:MON? – Response “3.13”, Reports the Monitor Photodiode Signal level is 3.13 mV

Laser:Power?

Description	Reports the Laser Power in mW as derived from the calibration Look Up Table (LUT)
Parameters	None
Examples	LASER:POW? – Response “200.3”, Reports the laser power as 200.3 mW

Laser:Temperature?

Description	Reports the Laser/TEC Temperature in °C
Parameters	None
Examples	LASER:TEMP? Response: “30.00” indicating a 30.00 °C operating temperature of the laser

Parameters:Restore

Description	Restores the default power-up configuration to the IPS factory default. To save the default parameters, you must add a Parameters:Save command following the Parameters: Restore command
Parameters	None
Notes	The parameters restored are: TEC_Setpoint, Laser_Drive, Laser Enable Mode, Analog Mode Enable, Digital Mode Enable, and PWM Duty Cycle

Parameters:Save

Description	Saves current parameter settings to FLASH for use as default power-up configuration (Note: At present, there is no IPS factory “as shipped” setting, so it is recommended that users document parameters before changing them so that they can be returned to the IPS default set state if desired.
Parameters	None
Notes	The parameters stored to FLASH are: TEC_Setpoint, Laser_Drive, Laser Enable Mode, Analog Mode Enable, Digital Mode Enable and PWM Duty Cycle

Status?

Description	Requests the status of the digital M-type
Response	<p>2 decimal numbers; the first number represents the board state:</p> <ul style="list-style-type: none"> 0 = unknown state 1 = board passed POST 2 = board failed POST 3 = board in normal state 4 = board in fault state 5 = board in boot load state 6 = board not attached <p>The second number is the number of errors in the hardware error queue.</p> <p>Use the “ERRor?” command to read the error code and information</p>

System:Error[:NEXT]?

Description	Requests communication errors that may have occurred
Parameters	None
Response	ASCII character string containing an error number and a brief description
Notes	If more than one error has occurred, repeated error queries are required until the response is "0, No error".

See below for a list of communication error numbers

Examples	<p>SYST:ERR?- Response "0, No error" means no errors to report.</p> <p>System:Error? - Response "-109, Missing parameter": a parameter was missing from a command. See list of error numbers below</p>
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TEC:SETpoint <temperature>

TEC:SETpoint? [0|1]

Description	Sets or reports the setpoint target for the TEC temperature
Parameters	<p>Temperature – The set point temperature in °C degrees for the laser TEC. Acceptable values range from 10.0 to 45.0. Optimal setting is between 30 °C - 35°C for most system configurations.</p> <p>None or 0: Report current laser TEC temperature setting</p> <p>1: Report factory default TEC temperature setting</p>
Examples	<p>TEC:SET 30.0 – Set TEC setpoint temperature to 30°C</p> <p>TEC:SET? - Response "40", Current TEC setpoint is 40°C</p> <p>TEC:SET? 0 - Response "40", Current TEC setpoint is 40°C</p> <p>TEC:SET? 1 - Response "35.5", factory default temperature setpoint is 35.5C</p>

Error Codes

HARDWARE ERROR CODES

0 - NO_ERROR
3011 - HOUSEKEEPING
3012 - FLASH_INITIALIZATION_FAILED
3013 - FLASH_HOUSEKEEPING_FAILED
3014 - LOW_VOLTAGE_EVENT
3015 - BAD_VOLTAGE_3V3
3016 - BAD_VOLTAGE_VIN
3017 - BAD_VOLTAGE_VTEC
3018 - HIGH_INPUT_CURRENT

3019 - TEC_UPDT_ON_BRD_STATE_BAD
3020 - TEC_UPDT_ON_TEMP_LONG_BAD
3021 - TEC_UPDT_ON_TEMP_OUT_SETPT
3022 - TEC_UPDT_ON_TEMP_OUT_RANGE
3097 - FAILED_INITIAL_POST
3098 - FLASH_PARAMS_REINITIALIZED
3099 - UNIDENTIFIED_ERROR

COMMUNICATION ERROR CODES

-102 - Syntax error
-103 - Invalid separator
-108 - Parameter not allowed
-109 - Missing parameter
-113 - Undefined header
-131 - Invalid suffix
-138 - Suffix not allowed
-200 - Execution error
-224 - Illegal parameter value

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