IPS DIGITAL U-TYPE MODULE USER GUIDE APC CONTROL

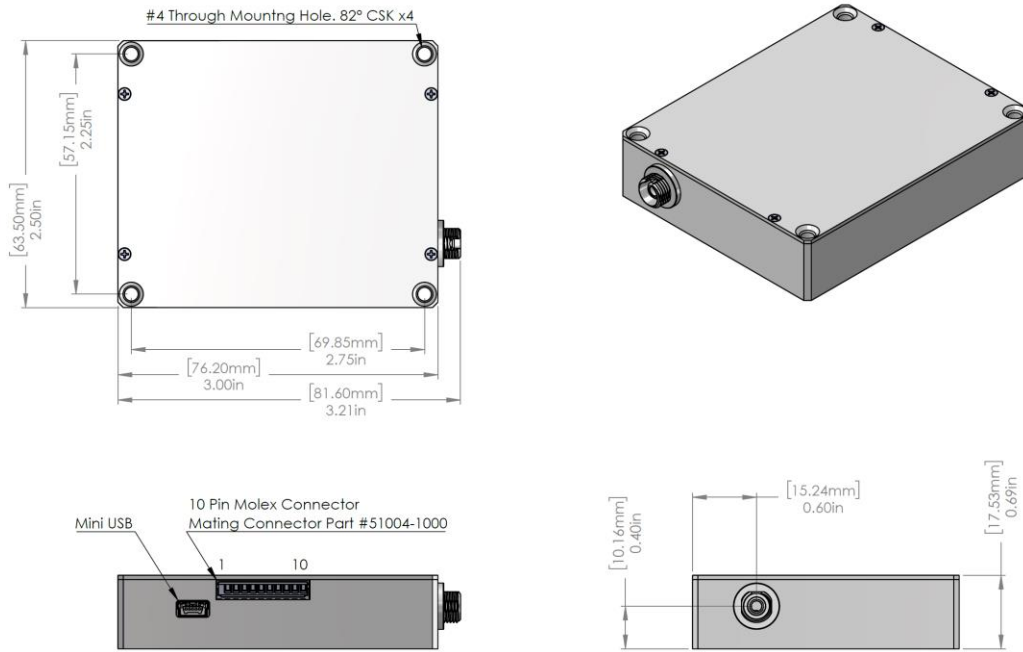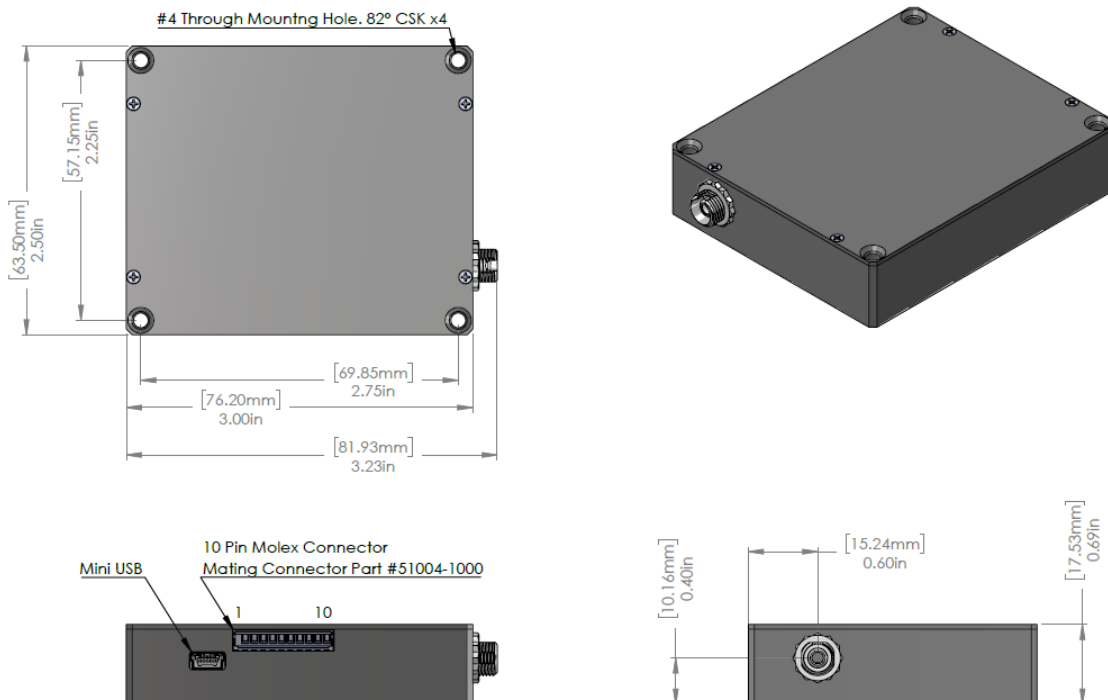# Contents

Product View and Connector Pinout

This chapter consists of the product view mechanical drawings, connector pin out, and standard product configurations.

Image 1.0: Mechanical Drawing – Single-Mode Digital U-Type

Image 2.0: Mechanical Drawing – Multi-Mode Digital U-Type

v1.0

Table 1.0: Digital U-Type Molex 53014-1010 Connector Pinout
(Mating connector part number: Molex 51004-1000)

Pin Number	Pin Label	Function
1*	V+	**Power Supply: 5V - 12 V.** For lasers operating <600mW, a 5V minimum is required. For lasers operating ≥600mW, a minimum of 9V is required, 12V recommended.

2	VBIAS ENABLE (Set Enable)	For analog control
		Enable external laser power control through pin 8 (LD VBIAS):
		    Low (GND) = Enable
		    Not Connected OR High (>3.6V up to V+ supply voltage) = Disable
		The same functionality is emulated via software as a replacement for this analog control.

3	SCL/TX	I2C: SCL standard (RS232: TX; board by request)
4	SDA/RX	I2C: SDA standard (RS232: RX; board by request)
5**	GND	Ground
6*	V+	**Power Supply: 5V - 12 V.** For lasers operating <600mW, a 5V minimum is required. For lasers operating ≥600mW, a minimum of 9V is required, 12V recommended.

7	ENABLE	**Laser enable:**
		    TTL High (>3.6V up to V+ supply voltage) = Enable
		    TTL Low (GND) = Disable
		Pin may also be used for PW modulation at a rate of 1kHz

8	LD VBIAS (LD Set)	Laser power setpoint – Enables analog external control of laser drive current. **Drive VBIAS ENABLE (pin 2) LOW to enable this option.** Drive a voltage between 0V and 1V. The voltage bias will be a 1:1 ratio to the laser drive current. Be aware that this approach may cause laser mode hopping behavior in single-mode lasers. Do not exceed maximum recommended drive current for given laser model. The same functionality is emulated via software as a replacement for this analog control.
9^	PD+	For analog readout Connect voltmeter to PD+ (pin 9) and GND for photo diode V output (0V – 3.3V) The same functionality is emulated via software as a replacement for this analog control.
10**	GND	Ground

Pins 1, 5, 6, 7, and 10 are required for laser operation

Notes:
*Power must be supplied to both V+ pins (pin 1 and pin 6)
**GND must be supplied to both GND pins (pin 5 and pin 10)
^ Pins 2, 8, and 9 are optional for analog control/readout

Product Specifications and Standard Configurations

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

Single-Mode Fiber Coupled Digital U-Type Module

GENERAL OPTICAL SPECIFICATIONS:

Standard Wavelengths*	633nm, 638nm, 780nm, 783nm, 785nm, 808nm, 830nm, 976nm, 1030nm, 1053nm, 1064nm
Wavelength Tolerance	+/- 0.5nm
Narrowed Linewidth Spectral Linewidth	< 100MHz
Wavelength Stability Temperature Range	15°C – 45°C
SMSR	45dB – 55dB
Output Power Stability	<1% at constant case temperature
Polarization Orientation	Standard is PM slow. Optional PM fast.
Polarization Extinction Ratio (PER)	>17dB, 20dB typical
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	Polarization maintaining Panda type
Connector	FC/APC
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 www.ipslasers.com

WARNING
VISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT
633 nm, 638 nm, 50 mW CW
EN/IEC 60825-1:2014-5

WARNING
INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT
976 nm, 1030 nm, 1053 nm
1064 nm, 400 mW CW
EN/IEC 60825-1:2014-5

WARNING
INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT
780 nm, 785 nm, 808 nm, 830 nm,
1030 nm, 1053 nm, 200 mW CW
EN/IEC 60825-1:2014-5

Multi-Mode Fiber Coupled Digital U-Type Module

GENERAL OPTICAL SPECIFICATIONS

Standard Wavelengths*	638nm, 680nm, 785nm, 808nm, 830nm, 1064nm
Wavelength Tolerance	+/- 0.5nm
Narrowed Linewidth Spectral Linewidth	<0.1nm (0.08nm typical)
SMSR	35dB – 45dB
Wavelength Stability Temperature Range	15ºC – 45ºC
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	-10ºC - 45ºC
Internal Cooling Air Flow	100 LFM with attached heatsink
Environment	0% - 80% humidity, non-condensing
Storage Temperature	-50ºC – 90ºC
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

WARNING
VISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
CLASS 3B LASER PRODUCT
680 nm 499 mW CW
EN/IEC 60825-1:2014-5

WARNING
INVISIBLE LASER RADIATION
AVOID EXPOSURE TO BEAM
785 nm, 808 nm, 830 nm
CLASS 3B LASER PRODUCT
499 mW CW
EN/IEC 60825-1:2014-5

WARNING
INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION
CLASS IV LASER PRODUCT
785 nm, 808 nm, 830 nm 1W CW
EN/IEC 60825-1:2014-5

WARNING
INVISIBLE LASER RADIATION
AVOID EYE OR SKIN EXPOSURE TO
DIRECT OR SCATTERED RADIATION
CLASS IV LASER PRODUCT
1064 nm 800 mW CW
EN/IEC 60825-1:2014-5

Laser Set-Up and Operation

This chapter is an overview of the digital U-type laser operation. It includes laser set-up, digital interface instructions, command syntax, and a list of software commands.

Initial Set-Up and Power On

1.   Connect power supply to the U-type module via the Molex connector

To properly power the unit, connect the voltage source to pins 1 and 6. Connect GND to pins 5 and 10. Pins 1 and 6 must be tied together. Pins 5 and 10 must also be tied together. Two pins are used for each signal to ensure that sufficient current can be handled.

For lasers operating at less than 600mW, a minimum of 5V is required.

For lasers operating at or greater than 600mW, a minimum of 9V is required with 12V recommended. Do not exceed 14V on V+.

At full power, the device can consume up to 15W; an appropriate heatsink is required.

*Please note, a USB connection alone is not enough to power the laser. The laser must be powered via the Molex connector in the above listed manner to ensure adequate power.

2.   Connect TTL signal source to the U-type module via the Molex connector

Connect pin 7 (ENABLE) to a TTL signal source. In order to operate the unit, pin 7 (ENABLE) must be connected and must driven high (>3.6V).

Pin 7 (ENABLE) can be used to turn the laser off in case of emergencies by driving low (GND).

3.   Connect the U-type module to the host system

If using USB, connect the USB cable provided from the U-type module mini USB connector to the host system.

If communicating to the device via I2C or RS232, pins 3 (SCL/TX) and 4 (SDA/TX), need to be connected to the controller.

Please note, for boards with RS232 enabled, the USB and I2C busses will be disabled.

4. Ensure the digital U-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 U-type module uses a serial interface, with COM port settings of 115200 baud and 8N1 configuration.

Image 2.0: Digital U-type module recognized by Microsoft® Device Manager
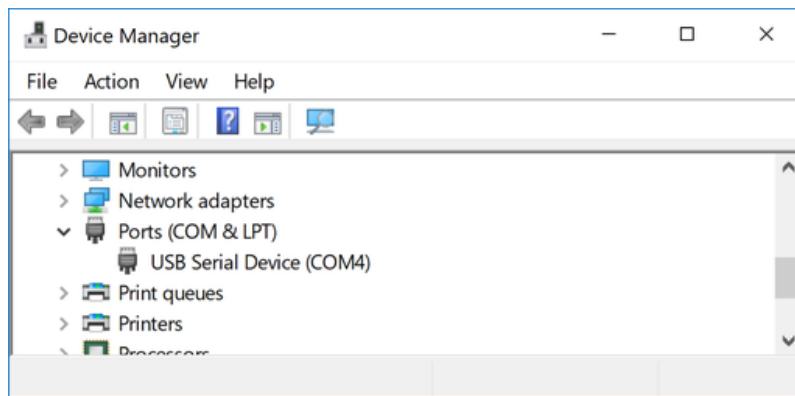

5. Test the U-type module functionality

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.

6.   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

v1.0
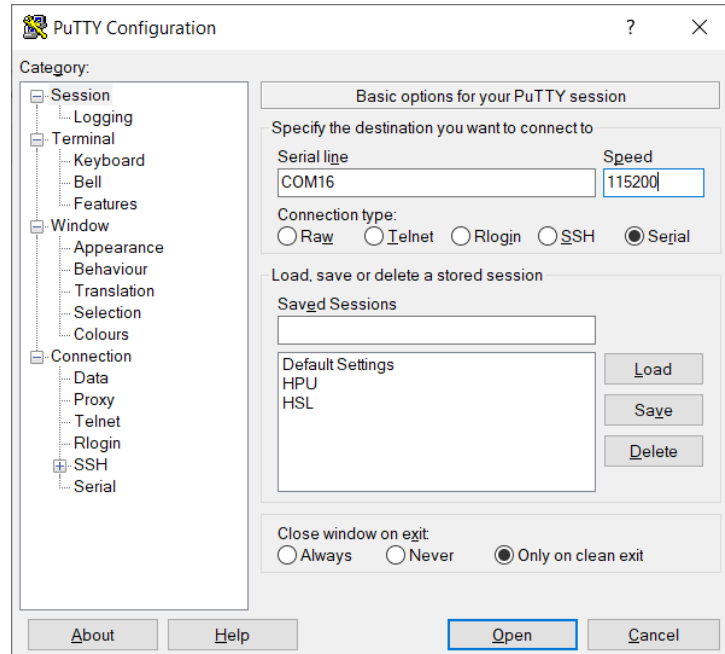
7. Configure the "Terminal" by accessing the "Terminal" menu and enabling:
   i. "Implicit CR in every LF"
   ii. "Implicit LF in every CR"
   iii. "Local echo:" Force On
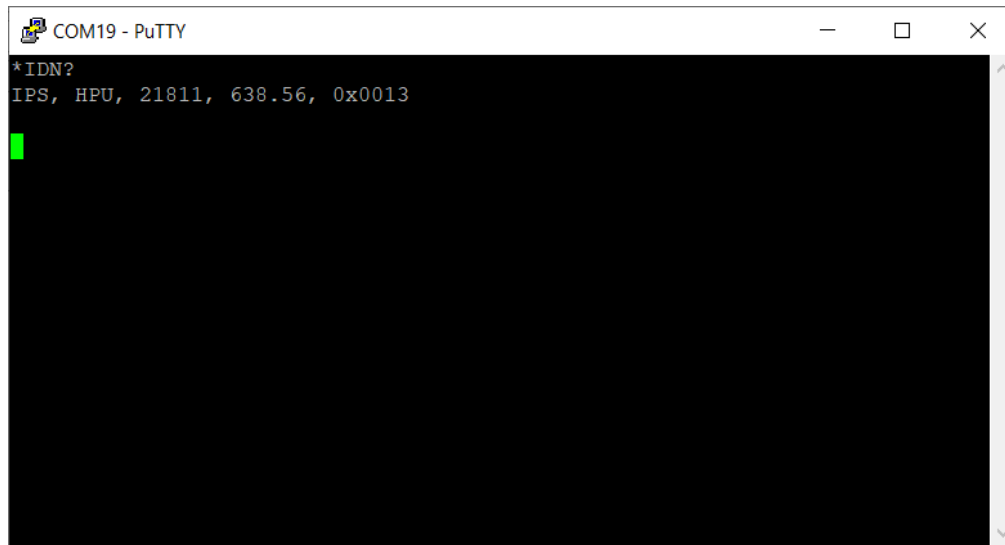
Image 2.2: "PuTTY" Terminal Configuration
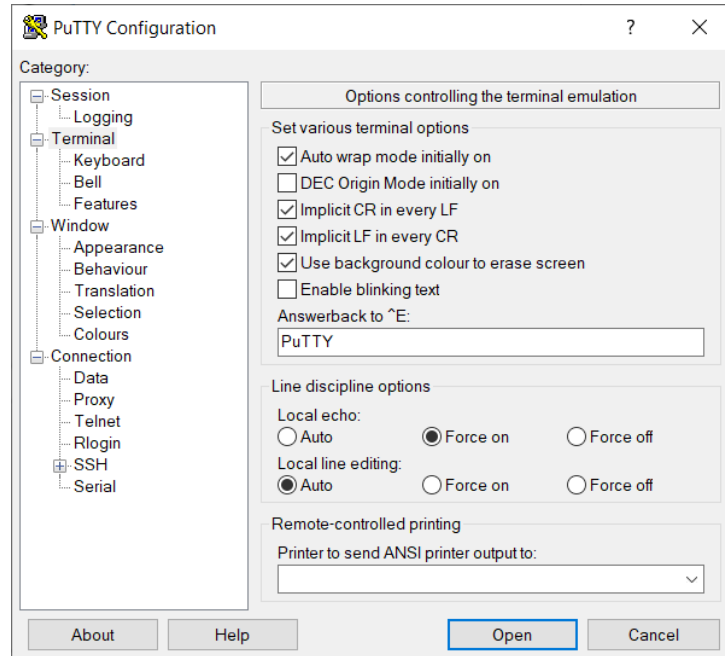
8. Ensure the device is correctly connected to the host system

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 U-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 U-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). *Save state permanently (1) or until power cycle (0)*
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 *Save state permanently "1" or until power cycle "0"*
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 *Save state permanently "1" or until power cycle "0"*
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 *Laser can be turned on with "1" or "ON"; laser can be turned off with "0" or "OFF"*
Laser:Enable?	LASER:EN?	Reports laser enable state
Laser:Hours?	LASER:HOUR?	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 *Laser default is "0", off state. Input "1" to enable*
Laser:Mode:Analog?	LASER:MOD:AN?	Reports the external VBIAS enable state *Return value = 0,1*
Laser:Mode:Digital <value>	LASER:MOD:DIG <value>	Enables/Disables digital (PWM) mode *Laser default is "0", off state. Input "1" to enable*
Laser:Mode:Digital?	LASER:MOD:DIG?	Reports digital mode (PWM) enable status *Return value = 0,1*
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)
APC:ENable?	APC:EN?	Query if APC mode is on . 1- ON 0- OFF
APC:ENable <0/1>	APC:EN <ON/OFF>	Enable/Disable APC Ex-**APC:EN 1**
APC:PWRSETPoint?	APC:PWRSETP?	Queries the set power(mW) for APC. Out will be in mW
APC:PWRSETPoint <power(mW)>	APC:PWRSETP? <power>	Sets the required power level to be maintained in APC mode. For changes to take effect, either Laser EN or APC EN must be toggled
APC:DELAY?	APC:DELAY?	Queies the APC set delay time . output will be in ms
APC:DELAY <ms>	APC:DELAY <ms>	Sets the delay time for APC algorithm closed loop
APC:SPEC?	APC:SPEC?	Queries APC spec. (ie., if power has to be maintained within setpoint +/- APCspec%)
APC:SPEC <spec in %>	APC:SPEC <spec in %>	Sets APC spec . if power has to be maintained within +/-0.1 % of set point , give command as APC:SPEC 0.1

Command Reference (Detailed)

The following pages contain a reference for commands for the digital U-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 $^{\circ}$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:HOUR? – 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

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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

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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 $^{\circ}$C
Parameters	None
Examples	LASER:TEMP? Response: "30.00" indicating a 30.00 $^{\circ}$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

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Status?

Description   Requests the status of the digital U-type

Response   2 decimal numbers; the first number represents the board state:

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

The second number is the number of errors in the hardware error queue.

Use the "ERRor?" command to read the error code and information

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

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TEC:SETpoint <temperature>

TEC:SETpoint? [0|1]

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

APC:Enable <enable>
APC:Enable?

Description	Controls whether the APC is enabled or disabled

Reports APC enable state

Parameters	Valid values for \<enable\> are:
	1/ON = Enables the Laser
	0/OFF = Disables the laser
Examples	APC:EN 0 – Disables the APC mode
	APC:ENable? - Response "1", APC is enabled

APC:PWRSETPoint \<Power(mW)\>

Description	Sets the required power for APC control
Parameters	Power in mW from 10 – max Power(~3000 mW)
Examples	**APC:PWRSETPoint** 50– Set APC power set point of the laser to 50 mW

APC:PWRSETPoint?

Description	Reports Power set point for APC control
Parameters	None
Examples	**APC:PWRSETPoint**? – Response "100", Reports the current APC set point as 100 mW

APC:SPEC \<control %)\>

Description	Sets the APC control Percentage
Parameters	Control % ranging from 0.1 to 1 %
Notes	For changes to take effect, either Laser EN or APC EN must be toggled
Examples	**APC:SPEC** 0.2– set the APC spec to 0.2% so APC algorithm will maintain power within
setpoint +/- 0.2%	

APC:SPEC?

Description	Reports the APC control Percentage
Parameters	None
Examples	**APC:SPEC**? – Response "0.1", Reports control percentage of APC algorithm as 0.1

APC:DELAY <ms)>

Description	Sets the APC Delay time
Parameters	time in ms . delay in between each control loop of APC algorithm. Range – 100 to 5000 ms
Examples	**APC:DELAY** 100 – set the APC delay to 100 so APC algorithm will make adjustment every 100 msec to maintain setpower +/ spec %

APC:SPEC?

Description	Reports the APC Delay time
Parameters	None
Examples	**APC:DELAY**? – Response "500", Reports the delay time of algorithm as 500 ms

Error Codes

<u>**HARDWARE ERROR CODES**</u>

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

<u>**COMMUNICATION ERROR CODES**</u>

-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

Part Numbering Schema

Spatial Mode
S = Single Mode
M = Multi Mode

Minimum Ouput Power (mW)

Fiber Termination
F – FC/PC
A – FC/APC
S – SMA905

Options
IS – Built in dual stage isolator
ISTH – Built in dual stage isolator in a D-type tethered head module
ISTHL - Built in dual stage isolator in a D-type tethered head module with L-Type Controller
ET – External TEC
TH – Tethered Head
THL – Tethered Head with L-Type Controller
NBE – No Beam Expander
HD – Digital D-Type
USB – USB output for Digital U-Type
I2C – I2C enabled for Digital U-Type
RS – RS232 enabled for Digital U-Type

I | XXXX | X | X | XXXX | X | X | - | XXX

Center Wavelength

Packaging Form Factor
5 – TO-56
B – 14-Pin Butterfly
D – D-Type OEM Open Beam
U – U-Type OEM Fiber Coupled
R – Turn-Key R-Type
M – Turn-Key M-Type
L – Turn-Key L-Type

Output Type
M – Multi-Mode
S – Single mode
P – Slow axis coupled PM
F – Fast axis coupled PM
B – Open Beam

Standard Part Numbers

Single-Mode Fiber Coupled Digital U-Type

Wavelength (nm)	Power (mW)	Part Number	Polarization/Connector
633	20	I0633SU0020PA-USB	PM Slow FC/APC
638	25	I0638SU0025PA-USB	PM Slow FC/APC
780	50	I0780SU0050PA-USB	PM Slow FC/APC
785	50	I0783SU0050PA-USB	PM Slow FC/APC
808	50	I07808U0050PA-USB	PM Slow FC/APC
830	50	I0830SU0050PA-USB	PM Slow FC/APC
976	220	I0976SU0220PA-USB	PM Slow FC/APC
976	500	I0976SU0500PA-USB	PM Slow FC/APC
1030	100	I1030SU0100PA-USB	PM Slow FC/APC
1030	250	I1030SU0250PA-USB	PM Slow FC/APC
1053	50	I1053SU0050PA-IS-USB	PM Slow FC/APC With Optical Isolator
1053	120	I1053SU0120PA-USB	PM Slow FC/APC
1053	300	I1053SU0300PA-USB	PM Slow FC/APC
1064	50	I1064SU0050PA-IS-USB	PM Slow FC/APC With Optical Isolator
1064	120	I1064SU0120PA-USB	PM Slow FC/APC
1064	300	I1064SU0300PA-USB	PM Slow FC/APC

For I2C enabled board, input "-I2C" in place of "-USB". For RS232 enabled board, input "-RS" in place of "-USB". Please note RS232 board will disable USB and I2C busses.

Multi-Mode Fiber Coupled Digital U-Type

Wavelength (nm)	Power (mW)	Part Number	Connector
638	300	I0638MU0300MF-USB	FC/PC
		I0638MU0300MS-USB	SMA
647	150	I0647MU0150MF-USB	FC/PC
		I0647MU0150MS-USB	SMA
680	300	I0680MU0300MF-USB	FC/PC
		I0680MU0300MS-USB	SMA
785	350	I0785MU0350MF-USB	FC/PC
		I0785MU0350MS-USB	SMA
	500	I0785MU0500MF-USB	FC/PC
		I0785MU0500MS-USB	SMA
	1200	I0785MU1200MF-USB	FC/PC
		I0785MU1200MS-USB	SMA
808	350	I0808MU0350MF-USB	FC/PC
		I0808MU0350MS-USB	SMA
	500	I0808MU0500MF-USB	FC/PC
		I0808MU0500MS-USB	SMA
	1200	I0808MU1200MF-USB	FC/PC
		I0808MU1200MS-USB	SMA
830	350	I0830MU0350MF-USB	FC/PC
		I0830MU0350MS-USB	SMA
	500	I0830MU0500MF-USB	FC/PC
		I0830MU0500MS-USB	SMA
	1400	I0830MU1400MF-USB	FC/PC
		I0830MU1400MS-USB	SMA
1064	500	I1064MU0500MF-USB	FC/PC
		I1064MU0500MS-USB	SMA

For I2C enabled board, input "-I2C" in place of "-USB". For RS232 enabled board, input "-RS" in place of "-USB". Please note RS232 board will disable USB and I2C busses.

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