Operating Instructions for CK Laser Diode Module

INTRODUCTION

The CK is Power Technology's latest generation microprocessor controlled laser diode drive system designed with an industry standard footprint in mind. The CK provides precision beam pointing stability, stable wavelength & output powers, and CW, TTL digital or analog modulation at speeds up to 150MHz. This module needs no external control box to operate, and with a small optional heat sink, it can drive high current lasers in multiple modes. The CK delivers 1mW to 130mW of power with wavelengths of 375nm, 405nm, 445nm, 488nm, 635nm, 640nm, 660nm, 685nm, 730nm, and 785nm. As an industry standard drop-in, the CK can replace more expensive lasers without sacrificing power, wavelength, or application success. A typical configuration is shown in Figure 3.

PRODUCT OVERVIEW

The CK is interfaced through a 15 pin high density DB connector. Steel and aluminum in construction, the module is durable and reliable. Available Features (depending on module configuration):

- 500mA high speed (up to 200MHz TTL / 3MHz analog) modulator.
- 2A high current (up to 10MHz TTL or analog) modulator.
- Constant current or constant power with provision for user analog feedback.
- Software monitors for LD current, LD temp, LD power, PCB temp, TEC current and many more.
- TTL Fault and Emission indication, Enable and Interlock controls.
- Fixed or adjustable PID controlled 3A TEC driver.
- Full function digital controls with high resolution settings and measurements.
- Circularized beam, fiber coupling, and other custom configurations.
- 5 volt dc operation (up to 8Vdc limited by heat dissipation).
- Up to 7.5 volt LD compliance voltage.

COMPONENTS

Module, lens assembly, adjustment tools, covers, cable assembly and optional items.

INSTALLATION

Do not mount the laser in a thermal insulating material, such as foam plastic. Heat can have adverse effects on laser diodes. Such effects include decreased output power and large shifts in wavelengths. Lasers below 5mW may not need a heat sink. A heat sink is always recommended for operating temperatures 25°C and above.

If the label attached to the laser module reads, "Complies with 21CFR 1040.10 and 1040.11," a permanently installed switch at the power source will be required to retain the modules certification as a laser system. This certification is void if the unit is enclosed or otherwise inaccessible, if the labels are modified or removed, or if the system is permanently connected (i.e. soldered, etc.) directly to the power source without the required switch. Modifying the laser will void the CDRH certification. If the distance between the laser head and the power source switch exceeds two meters, an emissions indicator must be mounted near the switch.

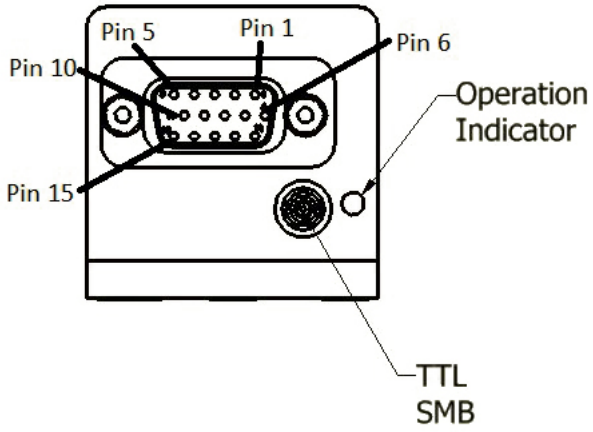
This laser module is connectorized for easy integration into your application. The unit may feature as many as two connectors on the rear panel. The SMC connector is present only for those units featuring analog or

TTL beam modulation. The 16-pin header connector is present on all units and accommodates the DC supply voltage and monitoring connections. Connections are listed below:

CONNECTOR PINOUT

Pin	Name	I/O	Function
1	Interlock	I	Safety, internal 10k pull-down, must be pulled high to enable laser
2	Enable	I	LD emission enable, internal 10k pull-up, pull low to disable laser
3	Power In	I	External power monitor feedback, 0 to 2 Vdc max
4	RS232RX	I	Serial communication receive
5	RS232TX	O	Serial communication transmit
6	GROUND	I	Ground
7	Fault	O	Active high (TTL 5V) fault indication
8	ANAMOD	I	Analog modulation input, 0 to 5V = 0 to full power (390 termination)
9	5Vout	O	5 Vdc source (200mA max) (source for Interlock signal)
10	GROUND	I	Ground
11	VIN	I	Module supply voltage, 5 to 8.5 Vdc @ 5A max
12	0-2Vmon	I	Analog level control, 0 to 2 Vdc max
13	GROUND	I	Module supply ground
14	PWROUT	O	Analog power monitor, 0-2 Vdc = 0 to full power
15	EMISSION	O	Emission TTL output, high = emission active or imminent
Shell	Shell	I	Not connected – could be grounded through chassis
SMB	TTLMOD	I	Separate (TTL 5V) modulation input RF connector

CONNECTOR PINOUT DIAGRAM (Figure 1)



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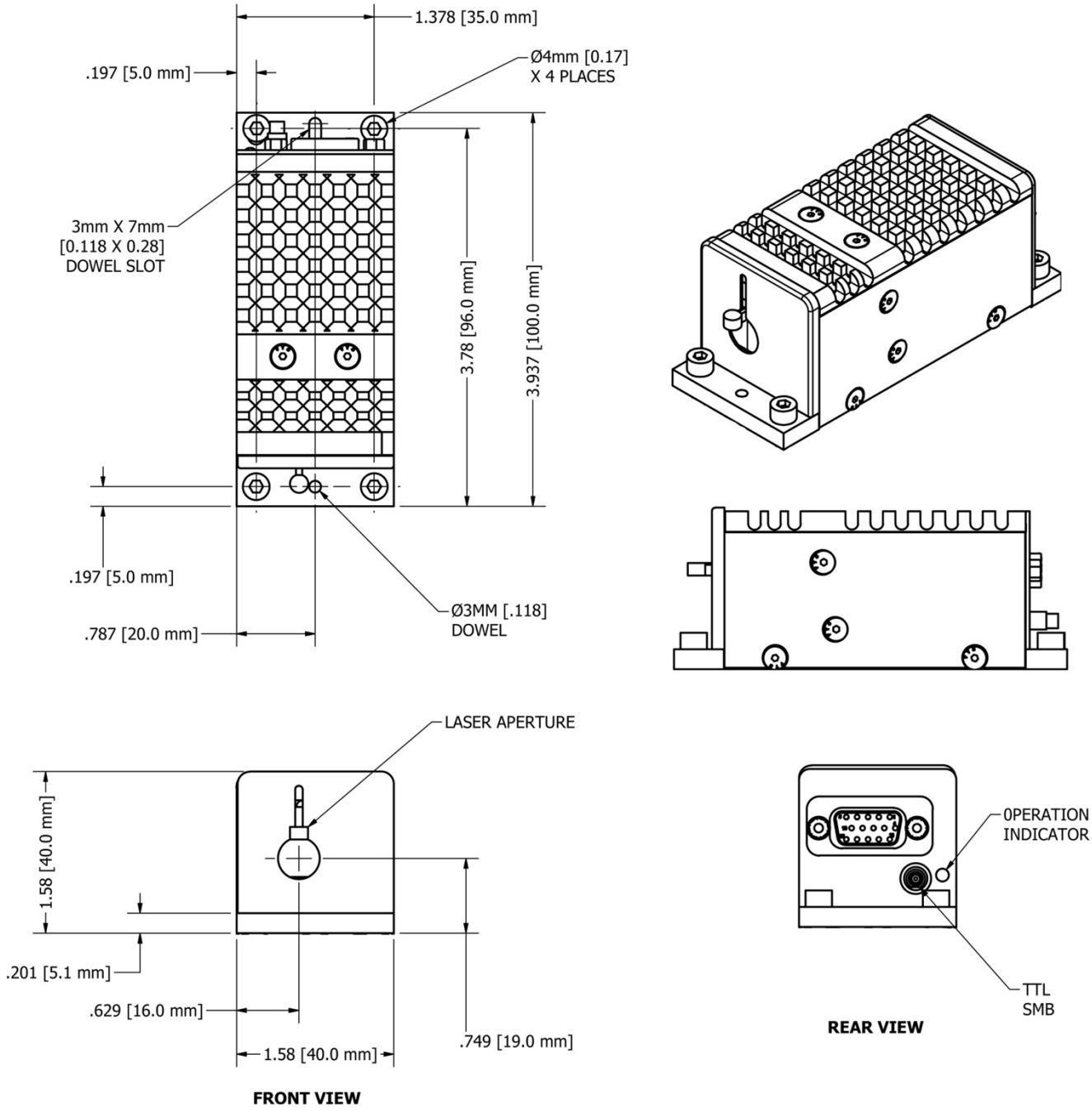
OUTLINE DRAWING (Figure 2)



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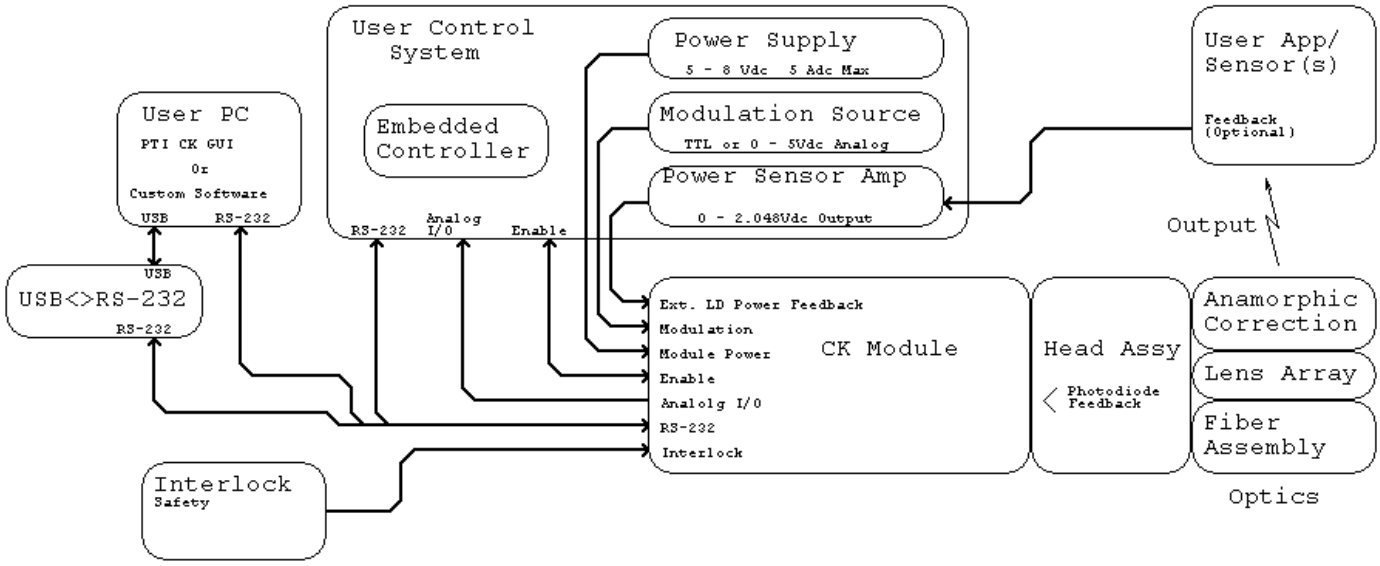
SYSTEM BLOCK DIAGRAM (Figure 3)



FUNCTIONAL SPECIFICATIONS

General Description - The CK was designed to give the user complete access to the controls of a precision laser system. There are no local controls on the module and all interface is through two connectors on the back panel. The module can operate completely autonomously after configuration at PTI or by an OEM. It can also be utilized as a smart subassembly, communicating with a larger control system to set power levels, monitor laser status and many other functions.

Connections - Power – Input - The module requires a minimum of 4.9Vdc *at the module power input pins* to operate normally and possibly more if a high voltage laser diode is installed. Wire length should be as short as possible and wire gauge must be as heavy (16ga to 20ga) as possible to maintain supply voltage if current consumption is high. You must also ensure that no other connection to the module will supply voltage to a pin until the module supply voltage is on.

Interlock – Input - The safety interlock is designed to disable laser emission any time a door or access panel is opened that might expose personnel to dangerous (and possibly invisible) laser radiation. The Interlock pin is internally pulled to ground through a 10K resistor which disables laser emission. A source of 5 volts on the module connector loops through the safety switch and back to the Interlock input. When the door is closed (safe), the switch is closed and the Interlock pin is pulled high, enabling the laser. If unused, the Interlock pin must be connected to the 5 volt pin when configuring the cable harness.

Enable – Input - The Enable input is a remote TTL ON/OFF signal. A TTL high means laser is enabled and free to emit. A TTL low will disable emission. The turn-on time is slow at 100 to 300 mS.

Fault – Output - Fault is a TTL output that, when high, indicates one or more fault conditions is active. The CK firmware constantly monitors internal status and will set a distinct fault code for a number of possible warnings or errors. The Status LED located on the back panel of the module will change to Yellow if any fault codes are set while the laser is active. In the PC GUI fault codes are displayed in the Fault text box any time one or more of the signal monitors are checked.

Fault Codes:
A: Unused
B: PCB Overheat
C: TEC Current Warning
D: LD Temperature out of window
E: ENABLE input low
F: Vin out of range
G: Internal PD error
H: External PD error
I: Interlock input open (low)
J: Back facet PD error
K: LD at current limit
L: User GUI LD inhibit

Power – Output - The power output pin will output 0 to 2 Vdc for 0 to 100% of the module's rated power. This follows the module power measurement as selected under APC Feedback drop-down menu.

Power – Input - An optional input that the module can use to regulate output power. This signal must be calibrated by the user prior to use. If the signal moves too far from the module's internal power calculation while driving the laser, control of feedback will revert back to the internal signal.

Emission – Output - TTL. When high, the laser output is active. Although the laser actually may not be emitting, it could at any moment as other conditions are met internally or externally.

Analog Adjust – Input - This will adjust the output power level setting when in APC mode or modulation current setting in CC mode by applying a 0 to 1 Vdc signal to pin 12 of the connector. This control is filtered and reacts slowly to voltage changes. If the module receives a serial power or current command, this mode will be disabled.

Analog Modulation – Input - This is the high speed analog signal. See further description in "Laser diode operating modes" below.

TTL Modulation – Input - The SMC jack on the module back panel is the TTL modulation input which is AC terminated with 50 ohms through a 1000pF capacitor to ground. This input also has an internal 10k ohm pull-up to 4.7 volts (the internal supply voltage) so that when unused, the TTL input will be high, enabling laser modulation current. The laser bias current is not affected by TTL modulation. Rise and fall times are reduced by high forward voltage (on laser diodes less than 630nm) and by high current laser diodes.

Communication – Input / Output - The communications port on the CK is a 3-wire (RX,TX and GND) asynchronous RS-232 with 19200,N,8,1 port settings.USB ports can be used with a simple USB to RS-232

adapter. Once connected, commands are sent to the module as ASCII text followed by a CR/LF (carriage return / line-feed). If the command sent is a query, the module will respond within 20mS. To set LD temp to 20.765 degrees C, transmit "#LDTS20.765" + CHR(13). To read it, transmit “LDTS?”+CHR(13).

Laser diode operating modes - There are three possible modes of operation for the laser. TTL modulation is available in each of these modes by simply applying a 5V TTL signal to the SMC jack on the back panel. This input is pulled high internally so that modulation current will be enabled if no signal is applied. The bias current setting is not affected by the TTL signal and laser current / power measurements are only valid when the TTL signal is high or low (not switching). The operating modes are as follows:

Constant Current - The laser diode is driven with a steady (CW) current that is the sum of the bias and modulation current settings. The bias setting is only modified (clipped) by the module firmware if the laser diode's maximum current is surpassed (either by increasing modulation current or by reducing laser diode operating temperature). The modulation current setting may be adjusted by the firmware as it maintains the laser diode's measured current inside of the constant current tolerance window. This window can be adjusted to limit laser diode current movement as the module is exposed to the full operating temperature range.

Automatic Power Control - This mode of operation is identical to constant current with one exception. Instead of maintaining a current setting, the firmware monitors and maintains the laser's measured output power inside of the APC tolerance window by adjusting modulation current. If TTL modulation is applied, APC adjustment only occurs when the TTL signal has been high for longer than 200mS. The power measurement source is selectable in the supplied software under the APC Feedback drop-down menu.

Analog modulation - A 0 to 5 volt modulation signal applied to pin 8 of the connector is followed by the laser driver's modulation current source as quickly as possible with 0 volts being 0% of modulation current applied and 5 volts being 100% of modulation current applied. Current and power measurements are not considered in this control. Once again however, a TTL low applied will disable modulation current. This mode was designed for high speed analog modulation of the laser emission. If the application simply requires the analog control of output power level without the need for speed (< 1kHz), a better option exists with Analog Voltage Control under the Controls drop-down menu.

Module Cooling - The CK module can generate as much as 40 watts of heat. High current or high voltage laser diodes, high ambient temperatures or inadequate cooling methods all result in elevated thermoelectric cooler current and potential for overheating. With a maximum core temperature of 55C it is important to keep the base of the module at 50C or less to avoid laser diode shut-down. If core temperature does reach 55C and the laser is disabled, the module core will have to cool to 50C (around 45C at the base) before the laser is again enabled. Conductive cooling through the base plate can be adequate if ambient temperatures are kept below 30C and there is a large metal mounting surface for cooling. A small flow of air across the module will also help lower core temperature. With high temperatures or high power laser diodes, an optional heat sink / fan assembly may be required. The software supplied with the module has a core temperature monitor to assist with module cooling choices as well as optimizing TEC settings if required.

Setting the laser diode operating temperature significantly lower than module core temperature can also add to more heat so extra module cooling should be planned for if colder laser temperatures (< 20C) will be required.

Laser Diode Temperature Control - Precision LD temperature control and stabilization is one of the primary functions of the CK. Offering simultaneously adjustable LD current and temperature has been a risky proposition due to the hypersensitivity of laser diodes to overcurrent. Many laser diodes set for their maximum power at 25C will produce too much power with the same current applied if adjusted to 20C, damaging or destroying the LD. The CK works to avoid this problem by allowing adjustment of each parameter while actively limiting available current based on the laser diode's measured temperature. Every CK produced goes through a series of calibration procedures to configure the module for the specific laser diode installed. Max overtemp of the LD is limited in software at anywhere up to 10C. Surpassing the overtemp point will disable the LD, placing less load on the TEC circuit. The control uses a temperature tolerance window that will disable laser emission is the temperature exceeds this window.

CK MODULE CONTROLS

Analog Adjust - This will adjust the output power level setting when in APC mode or modulation current setting in CC or AM modes by applying a 0 to 1 Vdc signal to pin 12 of the connector. This control is filtered and reacts slowly to voltage changes. If the module receives a serial power or current command, this will be disabled.

Manual reset after LD shutdown - If active, errors that cause the Laser Diode to be disabled will keep the laser disabled until the laser is manually reset (LD OFF/ON). If not active, laser output will resume normally after the error that caused the shut-down is cleared.

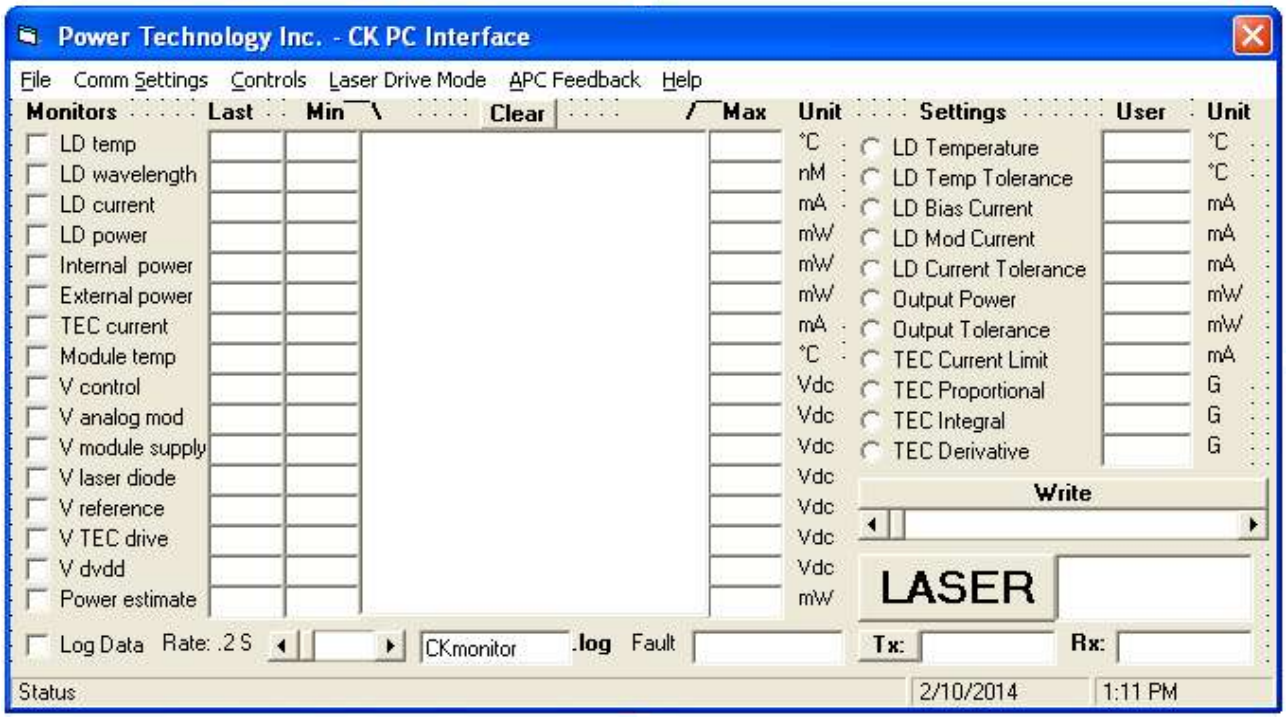
CDRH 5 second turn-on delay - If not active, the module will immediately enter into it's control loop after power-up, allowing laser output any time thereafter as conditions dictate.

Power-up with Laser Diode On - If active, the module will power-up with the LD enabled.
Enable 250 MHz Oscillator (Only on High-Speed modulator modules)
If active, a 250MHz carrier will be modulated on top of the laser diode output any time the modulation input is low (output on).

Power-up / Reset to User Saved Settings - If active, a reset will load all settings from the module's user memory. The user settings start out the same as the PTI settings. If not active, the module loads the PTI defaults - which can't be altered by the user.

TEC integral temperature compensation - If enabled, the integral setting will be increased as required when the module experiences large differences in LD temperature vs module temperature.

CK Module Graphical User Interface:



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CK COMMAND SET

Function / Description	Read	Write	Range of x	Units
LD Temp Set (range set by PTI)	LDTS?	#LDTSx	0.000-70.000	degC
LD Modulation Current Set (range limited by LD installed)	LDMS?	#LDMSx	0.0-2000.0	DC mA
LD Bias Current Set (range limited by LD installed)	LDBS?	#LDBSx	0.0-2000.0	DC mA
LD Power Set (range set by PTI)	LDPS?	#LDPSx	0.0-2000.0	mW
LD Current Inhibit (1=LD disabled, 0=LD enabled)	LDII?	#LDIIx	0-1	
LD Current Tolerance Set (CC mode)	LDCT?	#LDCTx	0.1-100.0	DC mA
TEC Current Limit (can be limited for low current supplies - risk loss of temp regulation)	TECL?	#TECIx	Oct-00	DC mA
LD Temp Error (LD temp tolerance - exceeding will pull error! low and disable LD	LDSD?	#LDSDx	0.01-10.00	degC
CDRH 5 second turn-on delay (0=off, 1=on)	CDRH?	#CDRHx	0-1	
TEC Integral Temp Compensation (0=off, 1=on) (boosts integral as load increases)	TITC?	#TITCx	0-1	
Internal oscillator on/off (0=off, 1=on, Only used on high speed modulator)	ATRO?	#ATROx	0-1	
Analog Adjust Enable (0=off, 1=on) (control modulation current or power with 0-1V in)	AAEN?	#AAENx	0-1	
APC mode power feedback source (0=est. power, 1=LDBF, 2=CKint, 3=user)	PDFB?	#PDFBx	0-3	
Power-up laser output status (0=off, 1 = on)	PUPL?	#PUPLx	0-1	
Power-up to PTI default or user default settings (0=PTI, 1=User)	PUPS?	#PUPSx	0-1	
Errors that disable the LD have to be manually reset (0=off, 1=on)	LDLT?	#LDLTx	0-1	
Active LD drive mode (0=Constant Current, 1=Automatic Power Control, 2=Analog Mod)	DRVM?	#DRVMx	0-2	
Proportional gain / TEC driver control - LD temp stability adjustment	PGAN?	#PGANx	typ .3-.6	level
Integral gain / TEC driver control - LD temp stability adjustment	IGAN?	#IGANx	typ .003-.007	level
Derivative gain / TEC driver control - LD temp stability adjustment	DGAN?	#DGANx	typ .15-.25	level
Automatic Power Control output power tolerance	APCT?	#APCTx	Min .01	mW
Calibrate external power signal against internal sensor (or read setting)	EXPC?	#EXPC	0-10	Cal
Reset module to PTI default settings		#RSTA		
Save User Settings to Module Memory		#WUSR		
Module model number	MDL?		12char	text
Module Serial number	SER?		12char	text
Firmware version number	VER?		12char	text
LD operating current @ 25C	LIOP?		0.0-2000.0	DC mA
LD active max current (calculated in firmware)	LDIT?		0.0-2000.0	DC mA
LD constant power max overdrive % (overdrive used as LD degrades)	LDMO?		0-50	%
Max module output power	MPWR?		0.0-2000.0	mW
LD threshold current @ 25C	LDTH?		0.0-2000.0	DC mA
LD PTI part number	LDPT?		12char	Text
Max allowed module core temp	PCMT?		0-99	degC
Analog input voltage monitor	MODV?		0.000-2.048	DC V
LD max operating temp	LTMX?		0.0-70.0	degC
LD min operating temp	LTMN?		0.0-70.0	degC
ERROR! Status read (0=problem= LD disabled, 1=normal)	ERR?		0-1	
VREG internal (TEC) supply voltage measurement	VREG?		4.5-7.5	DC V
Restart temp (after module overheat)	OHRT?		0-99	degC
LD back facet monitor available (0=no, 1=yes)	PDIN?		0-1	
LD nominal power @ Iop (LIOP?) @ 25C	LDNP?		0.0-2000.0	mW
LD Wavelength (calculated in firmware)	LDWA?		0.0-2000.0	Nm
LD Wavelength @ 25C	LDWL?		0.0-2000.0	Nm
LD calculated threshold current	LDT?		0.0-2000.0	DC mA
Maximum LD current at minimum LD temp	LD15?		0.0-2000.0	DC mA
LD operating time (# of hours laser diode has been run since new)	HOUR?		0-50,000	Hours
Wavelength drift per degC (nm/degC)	WLDR?		.001-10	nM
LD current measurement (only accurate when laser is CW)	LDIM?		0.0-2000.0	DC mA
External power measurement (analog in 0-2.048V) (has to be calibrated with #EXPC)	EPM?		0.0-2000.0	DC mW
LD Back Facet Photodiode power measurement (if available)	PDM?		0.0-2000.0	mW
Module output power measurement from selected (#PDFBx) source	PWR?		0.0-2000.0	mW
Module (PCB) temp measurement	PCTM?		0.0-99.9	degC
DVDD internal (circuit) supply voltage measurement	DVDD?		4.6-4.8	DC V
LD temp monitor measurement	LDTM?		0.0-99.9	degC
VLD voltage measurement	VLDM?		0.0-99.9	DC V
TEC current measurement	TECI?		0-3000	DC mA
Module supply voltage measurement	VIN?		0.0-99.999	DC V
Laser diode serial number	LSER?		12char	Text
LD driver type (0=high speed, 1=high current)	DRVT?		0-1	Type

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Function / Description	Read	Write	Range of x	Units
Active faults inquiry (see fault code list)	FLT?		A-L	Fault
Voltage reference (2.028V) measurement	VREF?		2.0-2.048	DC V
External control voltage measurement	VCTL?		0.0-2.048	DC V
Estimated output power	PEST?		0.0-2000.0	mW
Laser Diode forward voltage	LDVF?		1.3-7.5	DC V
Minimum module supply voltage	VINL?		4.9-8.0	DC V
Laser Diode supply voltage	VLDD?		2.1-7.5	DC V
Module internal (not LD back facet) power measurement (if available)	IPWR?		0.0-2000.0	mW

MAINTENANCE & SERVICE

This laser module contains no user serviceable parts. Depending on environmental conditions, the optics may require occasional cleaning. Clean, compressed air is recommended to blow the optics clean. If compressed air fails, clean lens carefully with alcohol and a lint-free rag or cotton swab.

WARRANTY & RETURN REPAIR POLICY

Opening the CK laser will void the warranty.

No return of merchandise will be accepted by PTI without an RMA (Return Material Authorization) number, issued by the factory and prominently displayed on the return package. No return shipments will be accepted "Collect" or "COD". On warranty returns, PTI will pay for shipping charges on the return of merchandise to the customer.

When contacting the factory for an RMA number, please have the following information available: model number, serial number(s), and a description of the problem.

LASER SAFETY

Class 3b and 4 lasers are not intended for use in surveying, leveling, alignment, or medical applications.

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Caution: The use of optical instruments with this product will increase eye hazard.

Do not shine laser in the direction of other people or at reflective surfaces that might cause exposure to the human eye. Do not mount the laser at eye level.

Modifications, that affect any aspect of the product's performance or intended functions will require re-certification and re-identification of the product in accordance with the provisions of 21CFR 1040.10 and 1040.11. A copy of 21CFR 1040.10 and 1040.11 can be downloaded from www.powertechnology.com.

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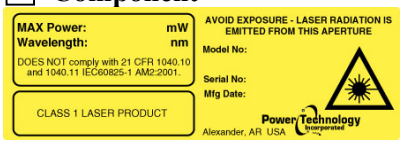
PRODUCT LABELS

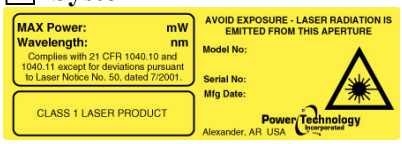
The product labels shown below can typically be found near the output optics.

Class 1 Laser:
Class 1 Laser Product

☐ **Component**



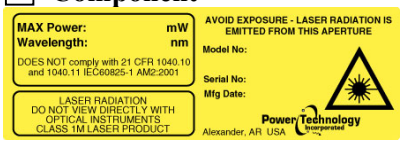
☐ **System**



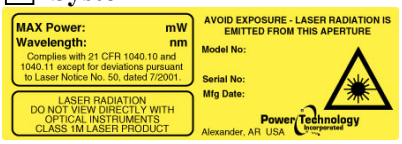
One of the above labels is attached to the laser head.

Class 1M Laser:
Laser Radiation, Do not view directly with optical instruments

☐ **Component**



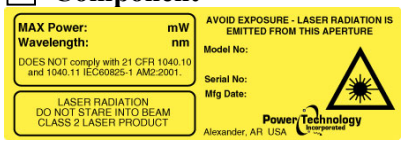
☐ **System**



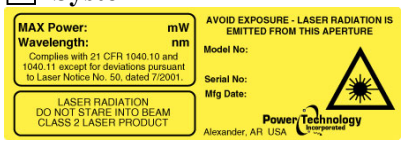
One of the above labels is attached to the laser head.

Class 2 Laser:
Laser Radiation,
Do not stare into beam

☐ **Component**



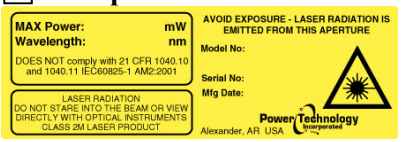
☐ **System**



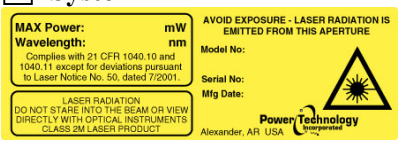
One of the above labels is attached to the laser head.

Class 2M Laser:
Laser Radiation, Do not stare into the beam or view directly with optical instruments

☐ **Component**



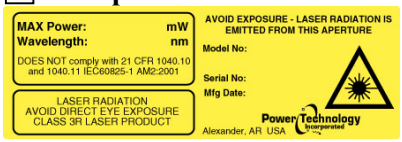
☐ **System**



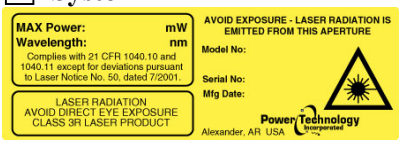
One of the above labels is attached to the laser head.

Class 3R Laser:
Laser Radiation,
Avoid direct eye exposure

☐ **Component**



☐ **System**

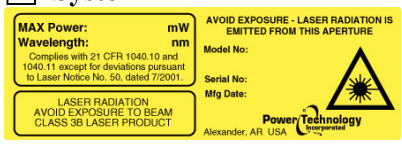


One of the above labels is attached to the laser head.

Class 3B Laser:
Laser Radiation,
Avoid exposure to beam

☐ **Component**

☐ **System**



One of the above labels is attached to the laser head.

Power Technology Incorporated
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Note: These specifications are subject to change without prior notice. Should the customer require modifications to these specifications, changes will be made based on meetings and the mutual consent of both companies. NRE charges may apply at the discretion of Power Technology Inc. for any customization of hardware configurations, firmware or software.

This product is not intended for use as a medical appliance, nuclear power equipment, aerospace apparatus or any application related to human life and requiring a high level of reliability. Power Technology Inc. assumes no responsibility for personal injury, fire, social harm or other damage resulting from use of this product as all safety precautions, redundant systems and planning are the responsibility of the user.

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