Fysik
KTH
February 2003

Semiconductor Lasers

In this laboration you will become familiar with the properties of semiconductor lasers and their use in absorption spectroscopy.

1. Introduction

Semiconductor diodes and lasers are nowadays widely used in communication, electronic equipment, e.g. in CD-players, in traffic lights, in spectroscopy research and so on.

2. General principles

Lasers in general can be classified in several categories:

- Gas lasers
- Dye lasers
- Solid state lasers
- Chemical lasers
- Free-electron lasers

Semiconductor lasers fall in the category of solid state lasers. They are most notably characterized by their small size (linear dimensions of less than 1 mm), high efficiency (often in the order of 90 %) and low price (often less than 10 % of the price of other laser types). Some semiconductor lasers can be run in single mode with small linewidths and they can be modulated easily. Semiconductor lasers also have some drawbacks, for instance they are found most often in the near infrared and infrared spectral regions, their tunability is limited and they cannot be easily run in pulsed mode. These drawbacks can be addressed in different ways, however.

The semiconductor lasers get their input power from an electrical current passed through the device. Semiconductor lasers are normally constructed from several different semiconductor materials, such as gallium arsenide (GaAs), indium phosphide (InP), gallium phosphide (GaP), gallium aluminium arsenide (GaAlAs) or lead salts. The emission wavelength of the laser depends on the particular semiconductor used, as well as on the doping characteristics and design. In general, lasers with GaAs and GaAlAs will work in the near infrared region, InGaAsP in the 1300 nm - 1500 nm range and AlGaInP in the red between 630 nm and 800 nm. Other visible wavelengths can be obtained using GaN, GaP or SiC-based semiconductors. Lead salts work between 3 μm and 25 μm, but they have a drawback of mostly having to be cooled to very low temperatures for operation.

The first semiconductor lasers were made from chips of gallium arsenide (Fig. 1). The gallium arsenide material was grown so that a *p*-*n* junction (a diode) was formed inside the crystal. The injection current was supplied through a metallic contact on the top of the crystal, with the base in contact with metal. Smooth end faces acted as mirrors to provide enough optical feedback for laser action. In these early lasers very high injection currents had to be used, and the beam and spectral characteristics of the laser radiation were poor. Also, the lasers had to be operated at very low temperatures. With the advent of modern processing technology, these drawbacks have been greatly reduced. Today's semiconductor lasers can be run at room temperature, they can be made spectrally pure, and their beam characteristics have been greatly improved.

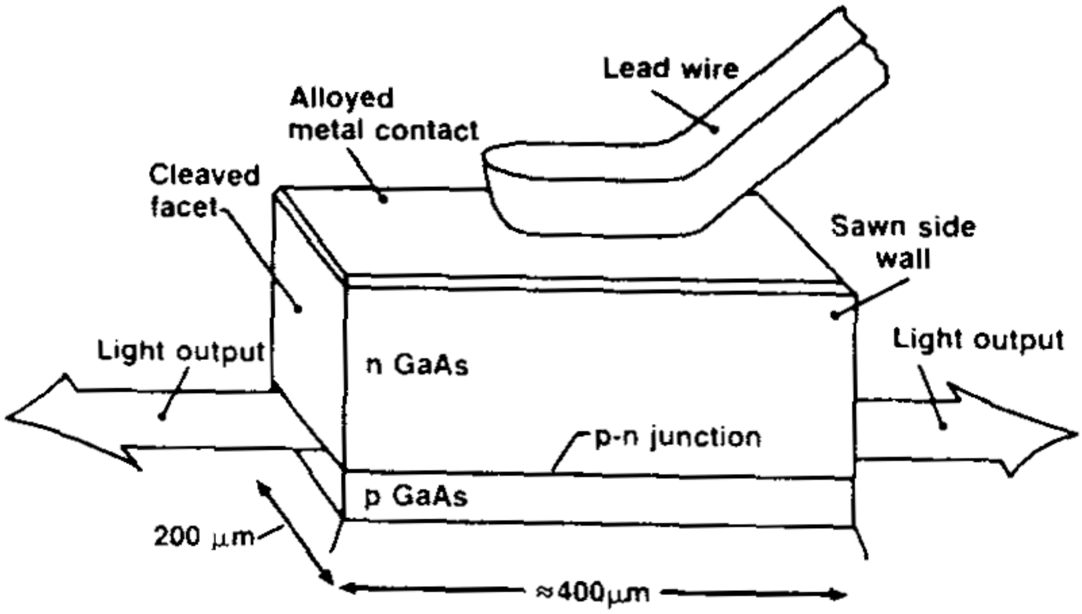


FIG. 1. Broad contact semiconductor injection laser mounted on a heat sink, with a wire contact. [From Thompson, G. H. B. (1980). "Physics of Semiconductor Laser Devices." Wiley, New York.]

The light generation in semiconductor lasers can be understood by examining the energy level diagram of a *p-n* junction (Fig. 2). Two semiconductor layers with opposite doping are grown in contact with each other. The *n*-doped side has an excess number of holes. The doping levels are typically $10^{18}/cm^3$ and assure that the Fermi level, shown as the dotted line in Fig. 2a, lies within the upper level or conduction band on the *n*-doped side and the lower level or valence band lies on the *p*-doped side. In thermal equilibrium, the electrons and holes cannot recombine, due to the potential barrier. However, if a forward potential V_{fb} is applied, the potential barrier is lowered. If the forward potential is increased to a level where the product $e \cdot V_{fb}$ approaches the band gap energy E_{bg}, then both electrons and holes are injected in the active region, whereby a population inversion is created. This is a necessary condition for lasing. The gain inside a semiconductor laser can approach 100, which means that lasing can easily occur even with low reflectivities of the end facets.

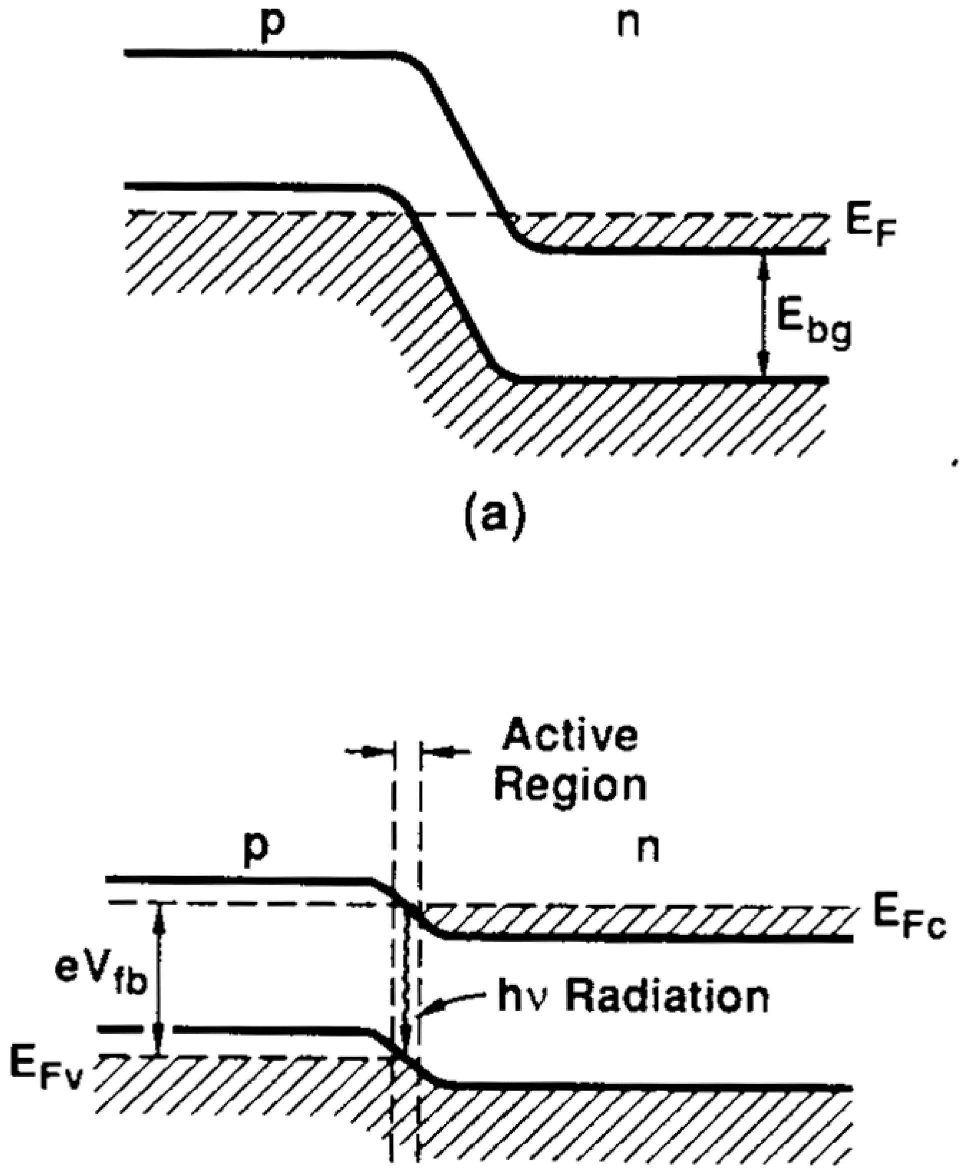


FIG. 2. (a) Degenerate *p*–*n* junction at zero bias. (b) Junction with a forward bias voltage comparable to the band gap energy. [From Yariv, A. (1975). "Quantum Electronics," 2nd ed. Wiley, New York.]

The semiconductor laser described above is a so-called homostructure laser. With the use of heterostructure design, for instance gallium arsenide combined with aluminum gallium arsenide, better beam confinement (and thus beam quality) is obtained through a combination of different refractive indices. Heterostructure lasers can be constructed as sandwiches (double heterostructure laser) by inserting a low band gap *p*-type semiconductor between two high band gap semiconductors of *p*- and *n*-types, respectively (Fig. 3).

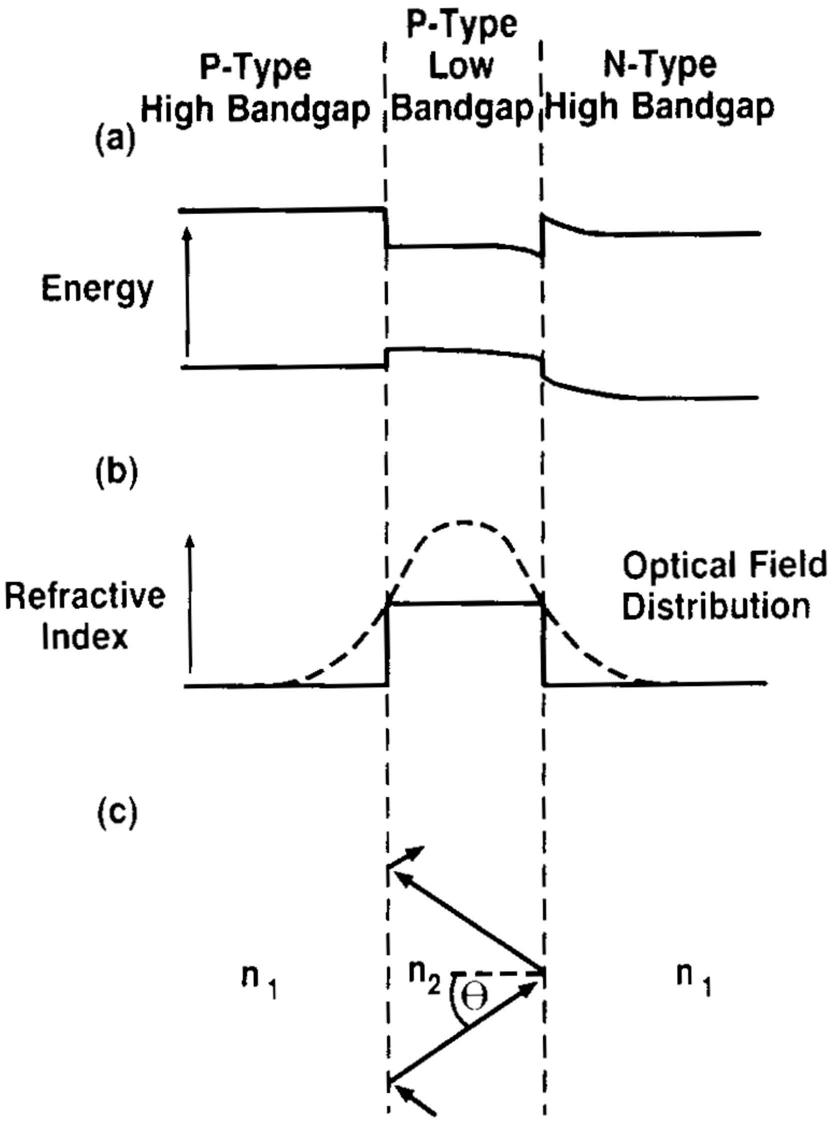


FIG. 3. Schematic of a double heterostructure laser. (a) Band diagram under forward bias. (b) Refractive index profile and optical field distribution. (c) Waveguiding effect produced by total internal reflection and the index profile shown in (b). [From Kapon, E. (1989). *In* "Handbook of Solid State Lasers" (P. K. Cheo, ed.), Marcel Dekker, New York.]

The laser user in the laboration (RLT7605MG) is a GaAlAs laser of index guided type (Fig 4). The data sheet can be found in the Appendix. The laser system consists of a laser controller (LDC 500), a temperature controller (TEC 2000) and a laser mount (TCLDM9). The data sheets of the system are found in the Appendix. The RLT7605MG is a single mode laser, operating near 760 nm in the red spectral region. It has a line width in the MHz region, which means that it can be used in spectroscopic applications. Although it is only a 5 mW laser, and although the beam does not look very bright, the intensity is approximately fivefold, as compared to an ordinary He-Ne laser. This is due to the low response of human eye at 760 nm, which is near the seeing limit (intense light at up to 830 nm is still visible and has a deep red color). The laser should be used with care, and exposure to the human eye should be avoided.

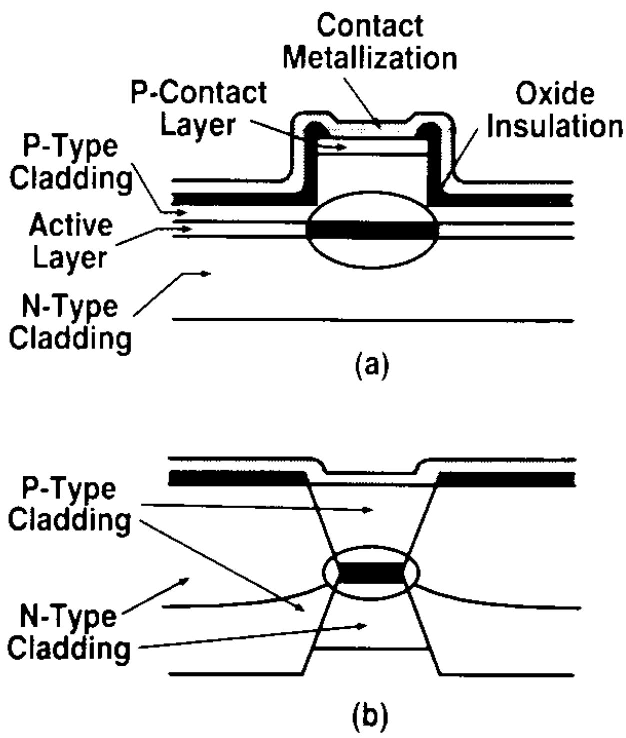


FIG. 4. Schematic cross sections of two types of index-guided lasers. (a) The ridge waveguide laser. (b) The buried heterostructure laser. [From Kapon, E. (1989). *In* "Handbook of Solid State Lasers" (P. K. Cheo, ed.), Marcel Dekker, New York.]

In this laboration several tasks will be performed, for instance:

Recording of the tuning curve of the laser (temperature - wavelength dependence). Using either a Mechelle 900, Mechelle 7500 spectrometer, or a BOMEM DA3.002 Fourier transform interferometer, depending on the availability of these instruments. The tuning curve will tell us where the mode hops are located, which will allow us to use the laser for the recording of some individual lines in the oxygen absorption spectrum. A complete spectrum, recorded with a BOMEM DA3.002 instrument is shown in the Appendix, together with a corresponding line list.

In the optical setup, the ellipticity of the diode laser beam sometimes poses problems. Ideally, one would like to have a gaussian beam, to be focused on small detector areas. A compromise consists of the use of an anamorphic prism pair (Fig. 5), which will expand the beam laterally in one direction, but will leave the direction perpendicular to it unaffected. This will ideally give a circular beam, provided that the excentricity of the ellipse is not too great at the input. In the case of RLT7605MG, the anamorhic prism pair gives a noticeable improvement in the beam quality, although the end result is not entirely circular.

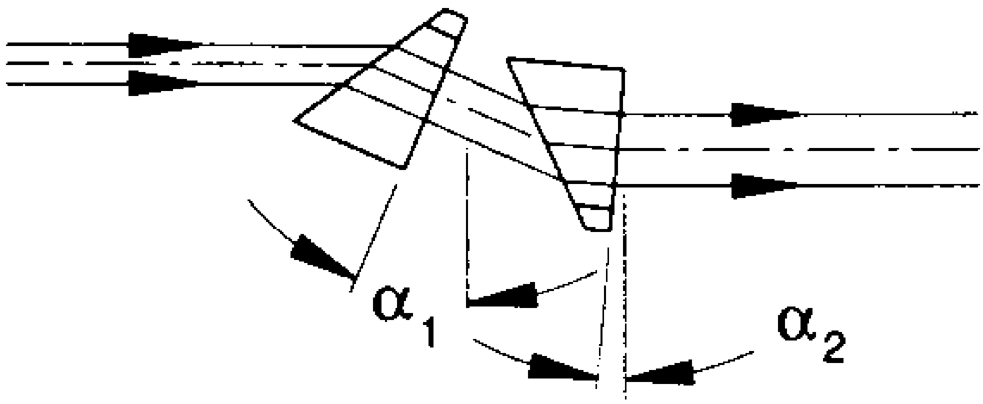


Fig. 5. An anamorphic prism pair, used in order to convert elliptic beams to circular ones.

As is known from elementary laser optics, an expanded beam has a substantially smaller divergence than an unexpanded one, which means that it can be arranged for longer path lengths, which is substantial for the detection of low concentration impurities. In our case, the molecule to be studied is oxygen, which means that long path lengths are not necessarily needed. Expanding a beam also decreases the local intensity, which means that saturation problems can be avoided more easily.

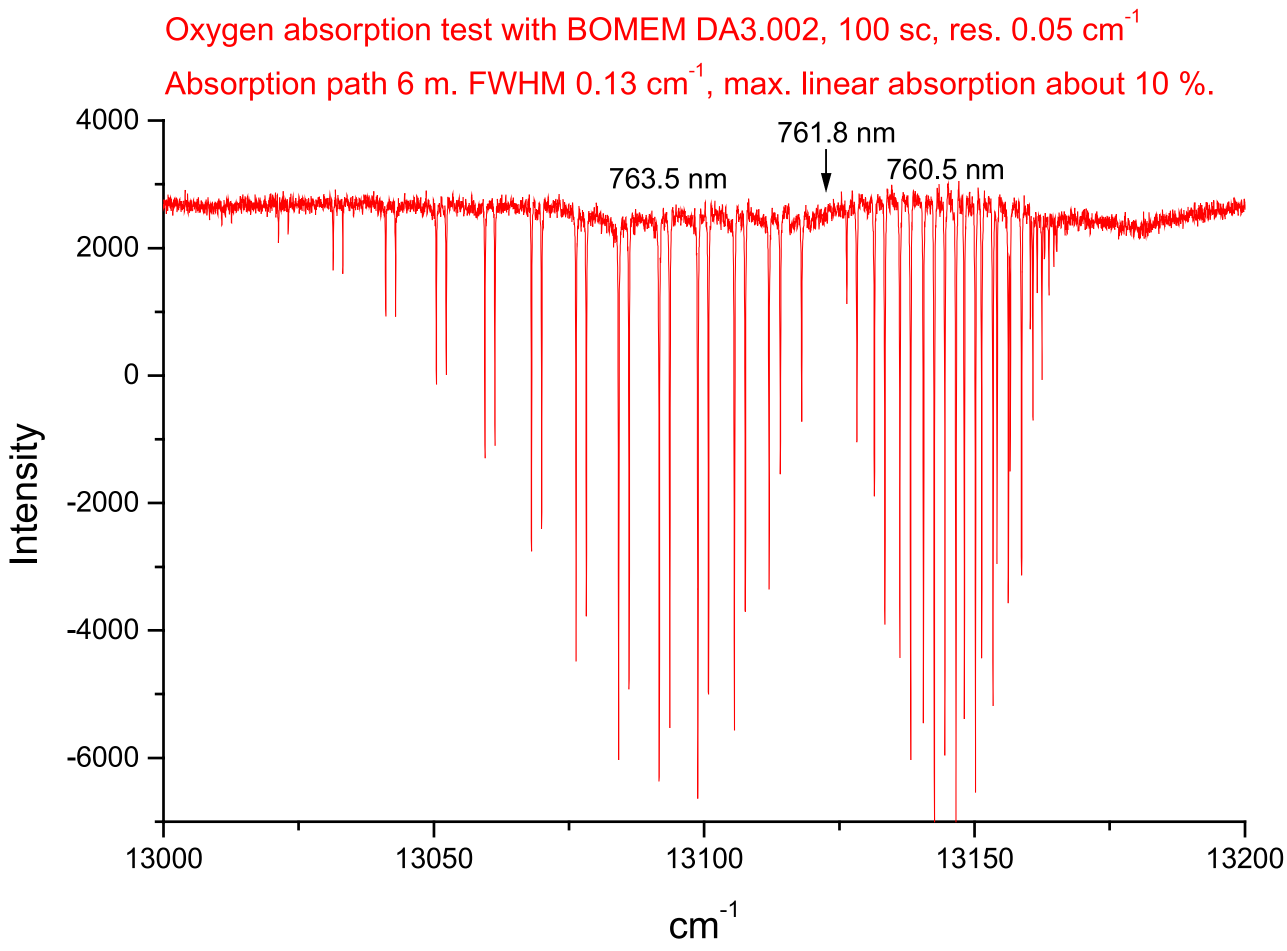
The optical setup is simple. The laser beam is passed through the anamorphic prism pair, sent to a mirror and reflected back to a photodiode (FDS100). The active area of the photodiode is rather large (13 mm^2). It is nevertheless necessary to use a lens in front of the photodiode in order to get an adequate signal. The data sheet of FDS100 is found in the Appendix. The photodiode is connected to an oscilloscope for direct monitoring of the signal, and the laser diode controller is modulated with a triangular signal (input on the back side of LDC 500).

The molecular transition to be studied is the forbidden $X^3\Sigma_g^- \rightarrow b^1\Sigma_g^+$ transition of O_2 near 762 nm. It is a so-called magnetic dipole transition, much weaker than electric dipole transitions. Furthermore, it is an intercombination (triplet-singlet) transition, which makes it even weaker. The 20 per cent concentration of oxygen in air only gives rise to a linear absorption of about 10 per cent for an absorption path of 5 m.

Tasks during the laboration:

1. Recording of the temperature-wavelength curve, using thermistor data in the Appendix together with BOMEM DA3.002, Mechelle 900 or Mechelle 7500.
2. Recording and identification of oxygen absorption lines, including determination of linear absorption as well as linewidth (in wavenumbers). For the determination of the linewidth, the injection current-wavelength dependence has to be measured for the relevant region between two mode hops.
3. Comparison with the measured linewidth with the expected doppler width, calculated using the expression $\delta\nu_0 = 7.16 \cdot 10^{-7} \cdot \nu_0 \cdot \mathrm{sqrt}(T/M)$, where T is the temperature in Kelvin, M is the molecular mass in a.m.u. units, and ν_0 is the transition wavenumber. Are there other broadening mechanisms?

APPENDIX


Oxygen absorption test with BOMEM DA3.002, 100 sc, res. 0.05 cm-1
Absorption path 6 m. FWHM 0.13 cm-1, max. linear absorption about 10 %.
763.5 nm
761.8 nm
760.5 nm
Intensity
4000
2000
0
-2000
-4000
-6000
13000
13050
13100
13150
13200
cm-1

Line list of the $X^3\Sigma_g^- \rightarrow b^1\Sigma_g^+$ transition of O_2

Wavelength/nm	Wavenumber/cm^{-1}	Intensity
759.3670	13165.239	1098
759.3988	13164.686	1289
759.4508	13163.786	1609
759.4983	13162.963	1206
759.5255	13162.492	2731
759.5765	13161.607	1608
759.6221	13160.817	3482
759.6494	13160.344	2220
759.7431	13158.721	6096
759.8645	13156.619	4377
759.8840	13156.281	6228
760.0055	13154.179	5592
760.0489	13153.428	7208
760.1692	13151.346	6561
760.2357	13150.195	8404
760.3548	13148.135	7566
760.4447	13146.581	9758
760.5627	13144.541	7859
760.6760	13142.583	9110
760.7928	13140.566	7822
760.9294	13138.206	8594
761.0445	13136.219	7218
761.2055	13133.442	6298
761.3183	13131.496	4715
761.5053	13128.272	3842
761.6138	13126.401	1850
762.0989	13118.046	3406
762.3281	13114.101	4140
762.4493	13112.017	5742
762.7045	13107.629	6290
762.8216	13105.617	8050
763.1009	13100.821	7468
763.2158	13098.848	8504
763.5185	13093.655	7512
763.6319	13091.710	8775
763.9578	13086.126	7422
764.0701	13084.202	7952
764.4192	13078.227	5985
764.5303	13076.327	7065
764.9026	13069.961	5105
765.0126	13068.082	5257
765.4083	13061.327	3666
765.5174	13059.466	3900
765.9362	13052.324	2925
766.0446	13050.477	2841
766.4869	13042.947	2036
766.5941	13041.123	1916
767.0602	13033.200	1429
767.1662	13031.397	1325
767.6562	13023.080	811
767.7616	13021.293	876
768.3798	13010.817	712

THORLABS INC

LDC 500 Laser Diode Controller

Instruction Manual

Doc. Number 2136-D01
Rev D 7-9-2000

435 Route 206N
Newton, NJ 07860 USA
Phone (973) 579-7227 FAX (973) 300-3600 www.thorlabs.com

Doc 2136-D01 Rev E 1/24/02

2 Operation

2.1 Operating elements

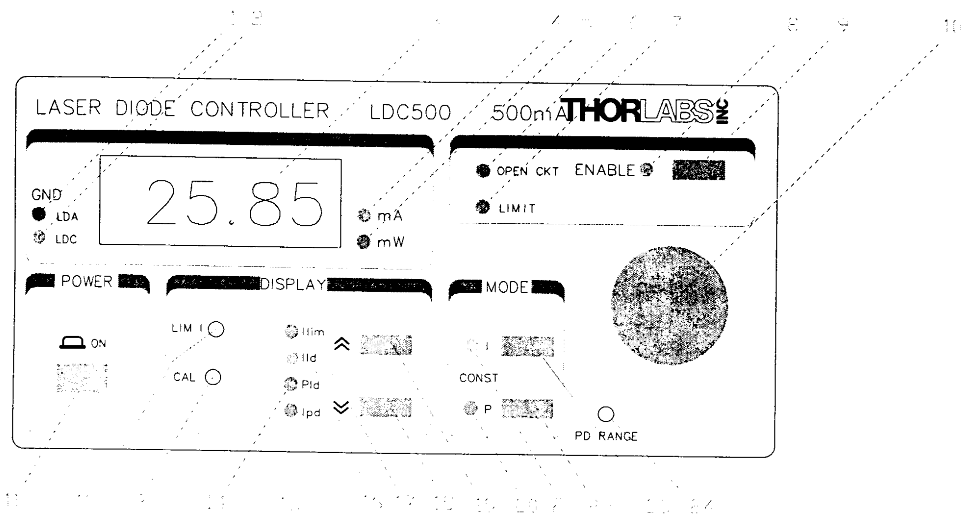


Fig. 2.1 Displaying- and operating elements at the front panel

1	LED "LDA"	Selected polarity of the laser: anode grounded
2	LED "LDC"	Selected polarity of the laser: cathode grounded
3		4½-digit LCD display
4	LED "mA"	Display is laser current (mA)
5	LED "mW"	Display is laser power (mW)
6	LED "OPEN CKT"	Indicates no laser diode connected
7	LED "LIMIT"	Adjusted current limit reached
8	LED "ENABLE"	Laser current is switched on
9	"ENABLE" Button	Enables the laser current on or off
10		Knob for adjusting the set value
11		Line switch
12	LIM I	Potentiometer for setting the current limit
13	CAL	Potentiometer for calibrating the power display
14	LED "PLD"	Displaying the optical output power
15	LED "IPD"	Displaying the photodiode current
16	LED "ILD"	Displaying the laser current
17	LED "ILIM"	Displaying current limit
18	DOWN Button	Used for selecting the display parameter

19	UP Button	Used for selecting the display parameter
20	LED "P"	Constant power mode
21	LED "I"	Constant current mode
22	"P" Button	Selecting constant power mode
23	"I" Button	Selecting constant current mode
24	PD RANGE	Potentiometer for setting the photodiode current range

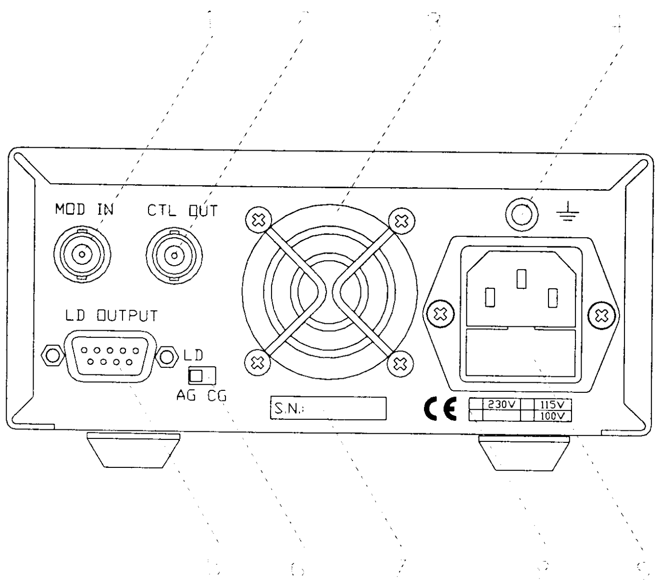


Fig. 2.2 **Operating elements on the rear panel**

1	Modulation input/ analog control input "MOD IN"
2	Control Out (Laser Current Monitor)
3	Ventilation Fan
4	Connector for chassis ground
5	Connector "LD OUT" for laser diode, photodiode, interlock, status-LED (DB9F)
6	Switch "LD POL" for selecting the laser diode polarity
7	Serial number of the unit
8	Letterplate displaying the allowed line voltage
9	IEC 320 AC power receptacle and fuse holder

THORLABS INC

TEC 2000

Thermoelectric

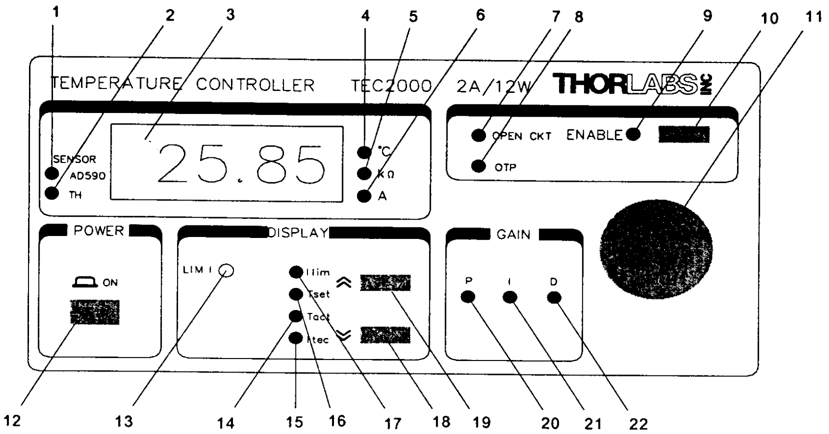
Temperature Controller

Instruction Manual

Doc. Number 2135-D01
Rev E 7-20-2001

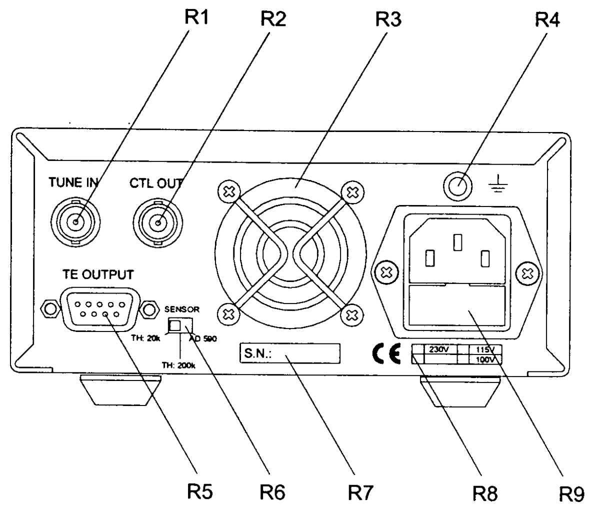
435 Rt. 206
Newton, NJ 07860
Tel.(973) 579-7227 FAX (973) 300-3600

2.2 Operating elements of the TEC 2000



1	Indicates that the selected temperature sensor is an AD 590
2	Indicates that the selected temperature sensor is a thermistor
3	4½-digit LCD display
4	Temperature display in °C
5	Resistance display in kΩ
6	Current display in A
7	LED display "maximum TEC current "ILIM" cannot be delivered, i.e. temperature sensor or TEC element missing or incorrectly connected"
8	LED display "over-temperature-protection"
9	LED display "TEC output switched on"
10	On/off switch for temperature control loop
11	Set temperature "TSET"
12	Power switch
13	Sets current limit "ILIM" for the TEC element
14	Displays the actual temperature "TACT'"
15	Displays the TEC current "ITEC"
16	Displays the set temperature "TSET"
17	Displays the current limit "ILIM"
18	Selects the measurement value for the display (toggle switch)
19	Selects the measurement value for the display (toggle switch)
20	Sets the proportional gain of the control loop (P)
21	Sets the integral gain (I) of the control loop
22	Sets the derivative gain (D) of the control loop

Fig. 2.1 Display and operating elements on front panel



R1 Analog control input "TUNE IN"
R2 Analog control output "CTL OUT"
R3 Fan
R4 DB9 jack chassis ground
R5 DB9 plug for the TEC element (TEC) and the temperature sensor
R6 Selects the temperature sensor and the thermistor resistance range
R7 Serial number of the unit
R8 States the admissible power voltage
R9 IEC320 AC power receptacle and main fuse holder

Fig. 2.2 Operating elements on rear

THORLABS inc PO Box 366, 435 Route 206N, Newton, NJ 07860
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Operating Manual

Model TCLDM9
Temperature-Controlled Laser Diode Mount for 5.6mm and 9mm Lasers

Description:

The TCLDM9 is a temperature-controlled laser diode mount. When used with Thorlabs LDC500 Laser Controller and TEC2000 TEC Controller, a laser diode can be operated with precise temperature control for wavelength stability and temperature tuning. A four pin socket accepts all 9mm and 5.6mm laser diodes. Easy to use internal switches allow the laser mount to be configured for all possible laser pin assignments.

The TCLDM9 was designed with features that allow it to be easily incorporated into complex systems. The front of the TCLDM9 has a 1.035"-40 thread to accept a wide variety of Thorlabs SM1 1" optics mounts and accessories. Also standard with the mount are 4-40 tapped holes on 30mm centers for mounting any number of Thorlabs cage assembly products. Thorlabs has successfully demonstrated external cavity grating tunable lasers using the TCLDM9 and off-the-shelf Thorlabs accessories.

An 50Ω Rf input using a bias-tee allows the laser to be directly modulated up to 1GHz.

The TCLDM9 uses two thermo-electric coolers (TEC) to precisely regulate the operating temperature of a laser diode. Each TEC element is capable of up 13W of cooling at a maximum operating current of 5.6 amps. The two TECs are connected in series so that a single connection provides up to 26W of cooling. Temperature sensing is done by one of two ways. An AD590 Temperature Transducer provides a linear temperature monitor proportional to the laser temperature in degrees Celsius. A 10kΩ NTC thermistor is also provided for controllers that only work with thermistor feedback. The Thorlabs TEC2000 supports both sensors.

Specifications:

Laser Specs	
Lasers Supported:	5.6mm & 9mm
Max. Laser Current:	2amps
Laser Pin Configurations:	All LD packages, switch selectable
Rf Modulation Frequency:	100kHz to 1GHz
Rf Input Impedance:	50Ω
Max. Rf Power:	200mW
Laser Polarity Select:	Internal Slide SW
Laser Interface:	DB9 Female

General	
Size:	3.5" x 3.5" x 2"
Weight:	1.3 lb.
Accessory Mounting:	1.035-40 Thread for SM1 series optics mounts 4-40 x 30mm tapped holes for Cage Assembly products

TEC Specs	
Max TEC Current:	5.6A
Max TEC Voltage :	4V
TEC Heating / Cooling Capacity:	26W
Typical Temperature Range (LD dependent)	0 to 70°C
Temp Sensors	AD590 (1μA / K) Thermistor (10KΩ @ 25°C, NTC)
TEC Interface:	DB9 Male

Setup

Laser Installation

- Unpack the laser mount and remove the four 2-56 socket head screws from the front cover using a 5/64" hex driver.
- Remove the three Philips head 2-56 screws from the laser-mounting flange and remove the flange.
- Determine the laser pin configuration from the laser diode manufacturer's data sheets and set switches SW1 and SW2 according to drawing 1981-E01.
- Most laser diodes are three pins with the case tied to one of the laser pins and also to one of the photodiode pins. The other laser and photodiode pin will be isolated from the case. The TCLDM9 was designed to operate the laser case at ground potential therefore this common pin will be inserted into either the 3 o'clock or the 9 o'clock position of the laser pin socket. Locate the isolated laser pin and insert it in the 12 o'clock position. The isolated photodiode should now be in the 6 o'clock position.
- Replace the laser mounting flange and the cover.

Special note for 4-pin laser diodes:

The TCLDM9 also supports 4-pin laser diodes. Insert the laser into the 4-pin socket and note which laser pin is in the 12 o'clock position (laser anode or cathode) . Also note which photodiode pin is in the 6 o'clock position (anode or cathode). The mount will tie the laser and photodiode pins located at 3 o'clock and 9 o'clock together and also to ground. By noting which polarity pins are inserted in the socket, you can convert the 4-pin layout to one of the 3-pin layouts in drawing 1981-E01. Set switches SW1 and SW2 accordingly.

Laser Controller Connection

Using the Thorlabs LDC500 laser Controller:

- The TCLDM9 is best used with Thorlabs LDC500 Laser Controller. The LDC500 is shipped with a mating DB9 cable that plugs directly into the controller and laser head. Using the cable supplied with the LDC500, the controller cannot be connected incorrectly. Also, the LDC500 has built-in protection circuitry the protects the laser when not in use. Simply connect the LDC500-CAB DB9 cable included with the LDC500 to the Laser Mount and to the controller.

Using a third-party laser controller:

- When using a third-party controller, a custom cable will have to be made to properly interface to the laser mount. Please refer to the table below for laser connections:

LD Interface Pin	Signal	Description
1	Interlock and Status Pin (LDC500 only)	This pin is connected to pin 5 and can be used as an interlock input.
5	Digital Ground	Shorted to pin 1
7	Laser Diode Cathode	This is connected to the 12 o'clock pin on the laser socket when SW1 is in the right position. It is floating when SW1 is to the left.
8	Laser Diode Anode	This is connected to the 12 o'clock pin on the laser socket when SW1 is in the left position. It is floating when SW1 is to the right.
3	Laser Ground (Case)	This pin is connected to the 3 o'clock and 9 o'clock pins on the laser socket.
2	Photodiode Cathode	This pin is connected to the 6 o'clock pin on the laser socket when SW2 is in the right position. It is attached to ground and the 3 o'clock and 9 o'clock pins on the laser socket when SW2 is to the left.
4	Photodiode Anode	This pin is connected to the 6 o'clock pin on the laser socket when SW2 is in the left position. It is attached to ground and the 3 o'clock and 9 o'clock pins on the laser socket when SW2 is to the right.

TEC Controller Connection

Using the Thorlabs TEC2000 TEC Controller:

- The TCLDM9 is best used with Thorlabs TEC2000 TEC Controller. The TEC2000 is shipped with a mating DB9 cable that plugs directly into the controller and laser head. Using the cable supplied with the TEC2000, the controller cannot be connected incorrectly. Simply connect the TEC2000-CAB DB9 cable included with the TEC2000 to the Laser Mount and to the controller.

Using a third-party TEC controller:

- When using a third-party controller, a custom cable will have to be made to properly interface to the laser mount. Please refer to the table below for laser connections:

TEC Interface Pin	Signal	Description
4	+TEC	Connect the positive TEC output terminal to this pin.
5	-TEC	Connect the negative TEC output terminal to this pin.
1	n.c.	
2	+Thermistor	A 10KΩ @ 25°C NTC thermistor (provided for temperature feedback).
3	-Thermistor	The other thermistor pin.
7	-AD590	The negative terminal of a AD590 temperature transducer which has a coefficient of 1μA per degree K (provided for temperature feedback).
9	+AD590	the positive terminal of the AD590
6	n.c.	
8	n.c.	

Mounting other Accessories

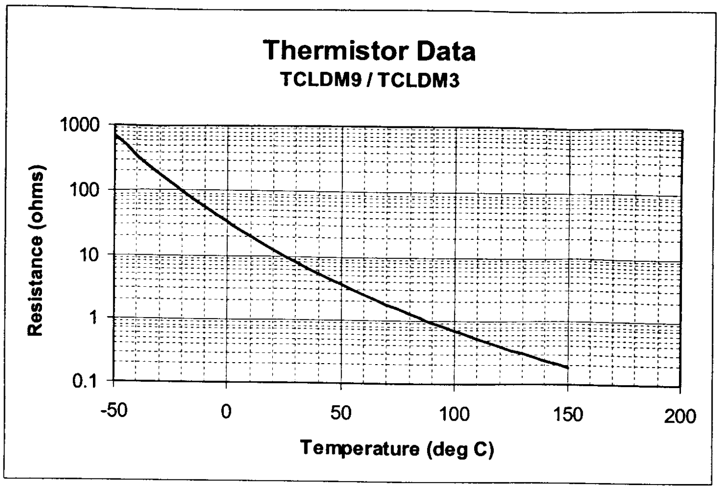
The TCLDM9 includes a 1.035-40 threaded hole centered on the laser for mounting Thorlabs SM1-series optics mounts. This is most often used for mounting aspheric collimating optics available separately from Thorlabs.

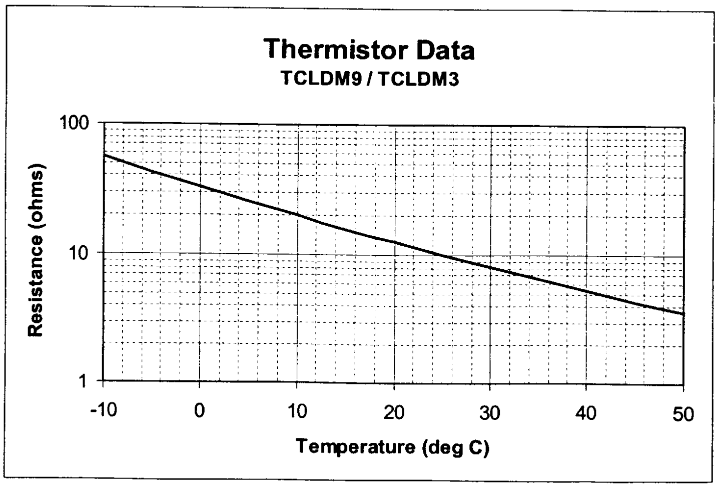
Also included are four 4-40 tapped holes mounted on 30mm centers for attaching Thorlabs cage assembly products. Using the combination of the SM1 threaded mount and the cage assemblies' products, a wide variety of optical systems can be easily assembled form off-the-shelf products. In one such example, Thorlabs successfully built an external cavity grating tunable laser used for atomic spectroscopy experiments. For more information and other examples please call Thorlabs and an engineer will be happy to assist you.

Operation

- With the laser mounted and the laser controller and temperature controller connected, the TCLDM9 is ready to operate. Please refer to the operating instructions for the laser and temperature controller for specific operating instructions.
- When operating at low temperatures in high humidity climates the laser mount may develop internal condensation. If this occurs, turn the laser off, open the case and allow the mount to dry off completely before re-using.
- When using a collimating optic in the 1" threaded mount, the lens may be positioned laterally by loosening the four 2-56 screws on the cover and shifting the cover plate manually.

Thermistor Data





T (deg C)	R (kohm)
-50	692.7
-45	485.5
-40	344.7
-35	247.8
-30	180.1
-25	132.4
-20	98.32
-15	73.72
-10	55.79
-5	42.58
0	32.77
5	25.46
10	19.93
15	15.73
20	12.5
25	10
30	8.055
35	6.528
40	5.323
45	4.365
50	3.599
55	2.983
60	2.486
65	2.082
70	1.753
75	1.482
80	1.258
85	1.073
90	0.9189
95	0.7899
100	0.6816
105	0.5906
110	0.5134
115	0.4479
120	0.392
125	0.3441
130	0.303
135	0.2676
140	0.2369
145	0.2104
150	0.1873

7

RF Modulation

The TCLDM9 has RF input for modulating the laser with an external RF source up to 1 GHz. This is a 50Ω input that is AC-coupled directly to the laser through a Bias-Tee network. To calculate the desired RF power to modulate the laser determine the amount of modulating current needed from the laser manufacturer's data sheets and use the following calculations:

RF Voltage = (Laser Diode Modulating Current) * 50Ω

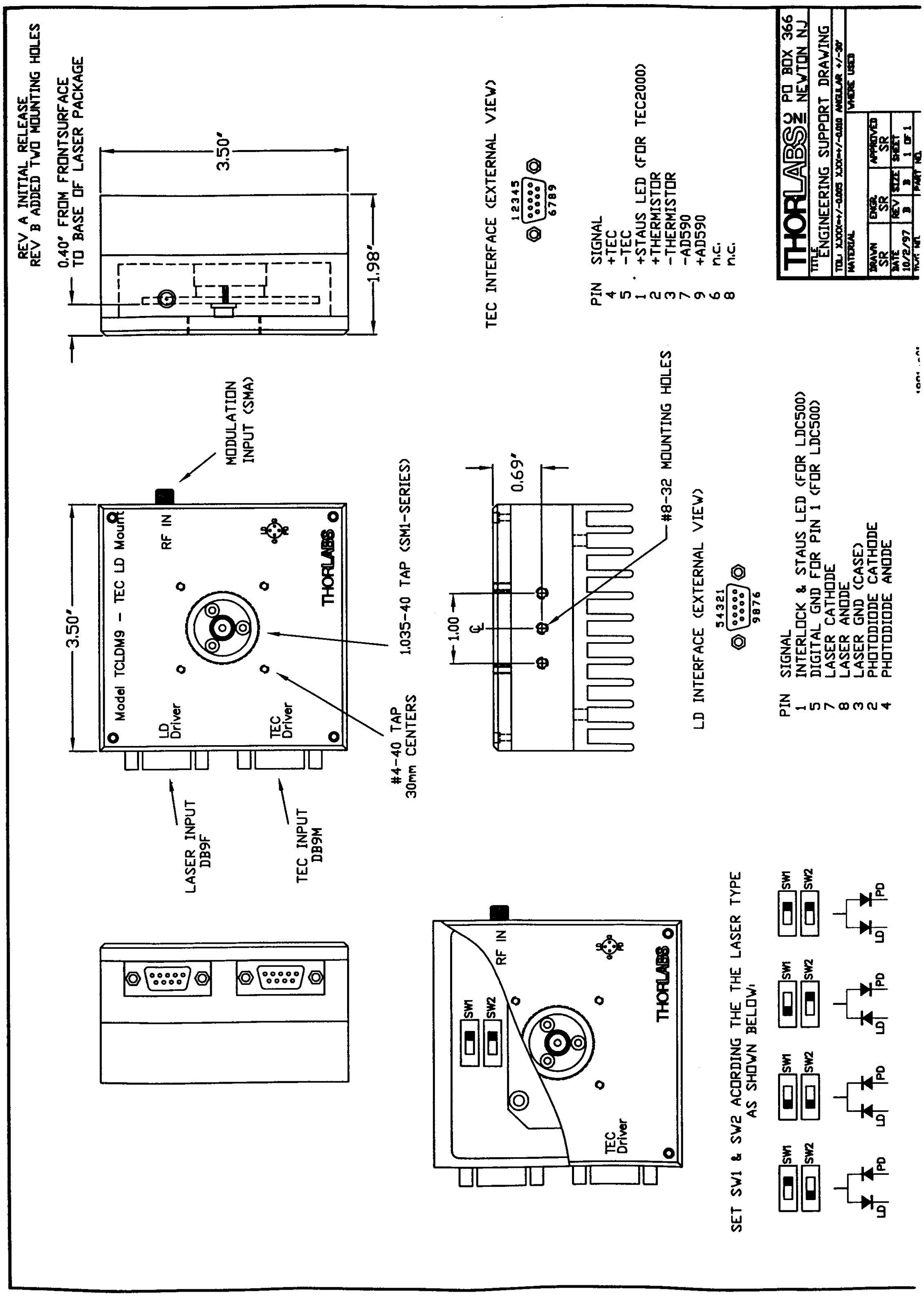
It is strongly recommended that you start of conservatively by, say a factor of 10 below the calculated modulating voltage and slowly bring the RF power up until the desired depth of modulation is reached.

Use the laser controller to establish the DC operating point of the laser.

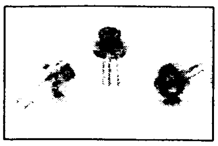
WARNING: The RF input is directly coupled to the laser. Any excessive transients or noise will be coupled into the laser and may cause the laser to be overdriven. Also, the laser can be easily overdriven if excessive RF power is applied to this input. Use the RF modulation input with care to avoid damaging your laser.

Maintaining the TCLDM9

There are no serviceable parts in the TCLDM9. The housing may be cleaned by wiping with a soft damp cloth. If you suspect a problem with your TCLDM9 please call Thorlabs and an engineer will be happy to assist you.


REV A INITIAL RELEASE
REV B ADDED TWO MOUNTING HOLES
0.40" FROM FRONTSURFACE TO BASE OF LASER PACKAGE
3.50"
1.98"
MODULATION INPUT (SMA)
3.50"
Model TCLDM9 - TEC LD Mount
RF IN
LD Driver
TEC Driver
THORLABS
1.035-40 TAP (SM1-SERIES)
#4-40 TAP 30mm CENTERS
LASER INPUT DB9F
TEC INPUT DB9M
0.69"
1.00
#8-32 MOUNTING HOLES
TEC INTERFACE (EXTERNAL VIEW)
12345
6789
PIN SIGNAL
4 +TEC
5 -TEC
1 +STAUS LED (FOR TEC2000)
2 +THERMISTOR
3 -THERMISTOR
7 -AD590
9 +AD590
6 n.c.
8 n.c.
LD INTERFACE (EXTERNAL VIEW)
54321
9876
PIN SIGNAL
1 INTERLOCK & STAUS LED (FOR LDC500)
5 DIGITAL GND FOR PIN 1 (FOR LDC500)
7 LASER CATHODE
8 LASER ANODE
3 LASER GND (CASE)
2 PHOTODIODE CATHODE
4 PHOTODIODE ANODE
SET SW1 & SW2 ACORDING THE THE LASER TYPE AS SHOWN BELOW:
SW1
SW2
LD
PD
THORLABS PO BOX 366 NEWTON NJ
TITLE ENGINEERING SUPPORT DRAWING
MATERIAL
WHERE USED
DRAWN SR
ENGR SR
APPROVED SR
DATE 10/2/97
REV B
SIZE B
SHEET 1 OF 1
PART NO.

RLT7605MG TECHNICAL DATA



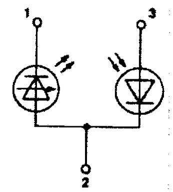
Infrared Laserdiode

Structure: **index guided single transverse mode**
Lasing wavelength: **760 nm typ.**
Output power: **5 mW cw**
Package: **5.6 mm, TO-18**

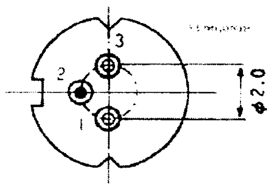
ATTENTION
OBSERVE PRECAUTIONS FOR HANDLING
ELECTROSTATIC SENSITIVE DEVICE

NOTE!
LASERDIODE MUST BE COOLED!

PIN CONNECTION:



1) Laser diode cathode
2) Laser diode anode and photodiode cathode
3) Photodiode anode



Maximum Ratings (Tc = 25°C)

CHARACTERISTIC	SYMBOL	RATING	UNIT
Optical Output Power	P_o	5	mW
LD Reverse Voltage	$V_{R(LD)}$	2	V
PD Reverse Voltage	$V_{R(PD)}$	30	V
Operation Case Temperature	T_C	-10 .. +50	°C
Storage Temperature	T_{STG}	-40 .. +85	°C

Optical-Electrical Characteristics (Tc = 25°C)

CHARACTERISTIC	SYMBOL	TEST CONDITION	MIN	TYP	MAX	UNIT
Threshold Current	I_{th}	cw		15	20	mA
Operation Current	I_{op}	P_o = 5 mW		25	40	mA
Operating Voltage	V_{op}	P_o = 5 mW	1.8	1.9	2.0	V
Lasing Wavelength	λ_p	P_o = 5 mW	750	760	766	nm
Spectral Width	$\Delta\lambda$	P_o = 5 mW	0.2	0.4	1.1	nm
Beam Divergence	$\theta_{//}$	P_o = 5 mW	7	10	12	°
Beam Divergence	$\theta_{\perp}$	P_o = 5 mW	30	33	38	°
Slope Efficiency	η	cw	0.5	0.65	1	mW/mA
Monitor Current	I_m	P_o = 5 mW	250	400	800	µA

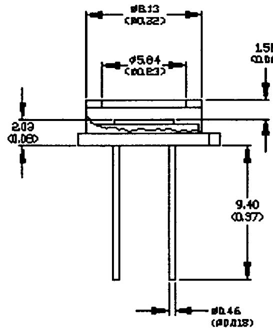
THORLABS INC
435 Route 206 • P.O. Box 366
Newton, NJ 07860-0366
Ph. 973-579-7227
FAX 973-300-3600

FDS100 Si Photodiode

High Speed
Large Active Area

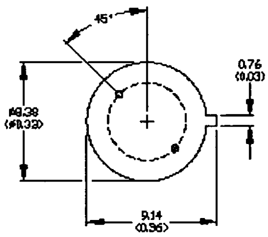
The FDS100 is a high-speed silicon photodiode with a spectral response from 350nm to over 1100nm. This photodiode has a PIN structure that provides fast rise and fall times with a bias of 20V.

Electrical Characteristics



Spectral Response:	350-1100nm
Active Area:	13.0mm²
Rise Time (RL=50Ω):	10ns (20V bias)
Fall Time (RL=50Ω):	10ns (20V bias)
NEP@900nm:	1.2×10^{-14} W/√Hz (@20V bias)
Dark Current:	20nA max (20V)
Package:	T05, 0.36" can

Maximum Ratings



Damage Threshold CW:	100 mW/cm²
Damage 10ns Pulse:	500mJ/cm²
Max Bias Voltage:	25V

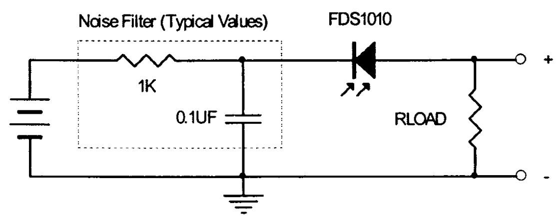
The Thorlabs FDS100 photodiode is ideal for measuring both pulsed and CW light sources, by converting the optical power to an electrical current. The Si detector is housed in a T05 can, with an anode, cathode and case connection. The photodiode anode produces a current, which is a function of the incident light power and the wavelength. The responsivity $\Re(\lambda)$, can be read from **Figure 1** to estimate the amount of photocurrent to expect. This can be converted to a voltage by placing a load resistor (R_{LOAD}) from the photodiode anode to the circuit ground. The output voltage is derived as:

$$Vo = P * \Re(\lambda) * R_{LOAD}$$

The bandwidth, f_{BW}, and the rise time response, t_R, are determined from the diode capacitance, C_J, and the load resistance, R_{LOAD}, as shown below. Placing a bias voltage from the photo diode cathode to the circuit ground can lower the photo diode capacitance.

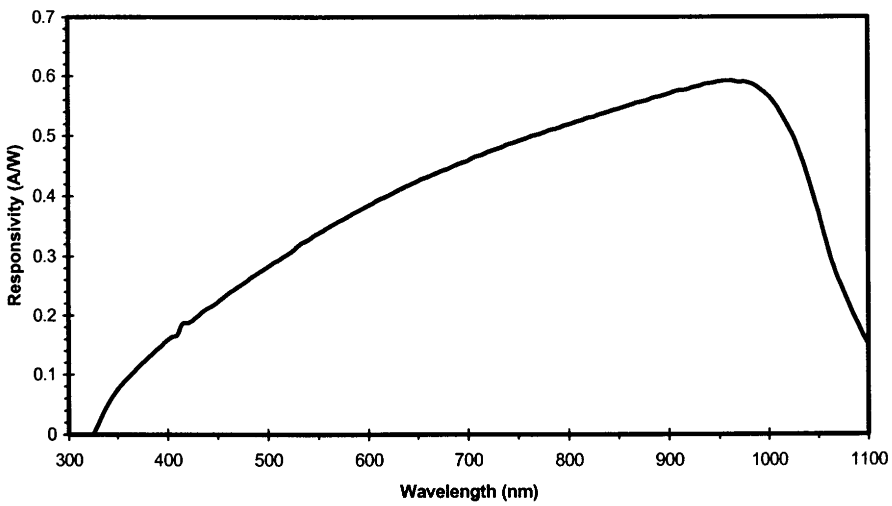
$$f_{BW} = 1/(2\pi * R_{LOAD} * CJ),\ t_R = 0.35/f_{BW}$$

Typical Circuit Diagram



Typical Plots

Figure 1 - FDS100 Spectral Responsivity Curve



Typical Responsivity Curve using Thorlabs calibration services.