MODULAR ONE TECHNOLOGY

MOT6550GC, MOT6550CC, MOT6550GA, & MOT6550CA Series

Dual-Mode Laser Driver Modules with Temperature and VREF Outputs

FEATURES

- **Available configurations are Grounded Cathode (GC), Grounded Anode (GA), Common Cathode (CC), & Common Anode (CA)**
- **3.3 to 5-Volt Operation**
- **250mA, 500mA & 1A maximum current versions**
- **Dual mode; constant current or constant power mode**
- **Programmable current or power set through simple potentiometer or high precision external DAC**
- **Slow Start circuit for laser protection**
- **Wide-band Modulation through current set input**
- **Factory calibrated for zero current**
- **Over temperature and over current monitor with auto shutdown**
- **Module Temperature Monitor Output**
- **Precision Reference Voltage output for control and/or external DAC or ADC**
- **Configurations for Grounded case laser assemblies**
- **Low power consumption**
- **-40 to +85˚C Operation**
- **Small footprint**

APPLICATIONS

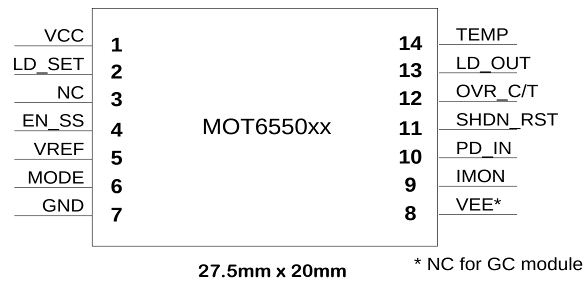
- **Instrumentation**
- **EDFA**
- **Fiber Laser**
- **Direct drive laser diode**

OVERVIEW

The MOT6550xx Series is a family of high-precision, low-noise laser driver modules. The modules are available in current ranges extending up to 1A.

These modules are dual mode devices, offering either programmable Constant Current (CC) or Constant Power (CP) control, selected by a mode control pin. The laser current or power is set by an analog voltage applied to module LD_SET pin, which can be derived from an external high-resolution DAC, or with a simple potentiometer.

PIN CONFIGURATIONS



Laser current is continuously monitored and represented by a voltage at the monitor pin. This voltage can be measured using an external ADC and a microcontroller.
The laser output current can be modulated, if desired, through the input set pin, with a modulation small signal bandwidth in excess of 1MHz. The monitor output is also wide bandwidth allowing the modulated current to be monitored.

An on-board temperature sensor offers a proportional voltage output for temperature monitoring, and the output from the internal Precision Reference is also available for use with the current setting potentiometer or with external DACs and/or ADCs.

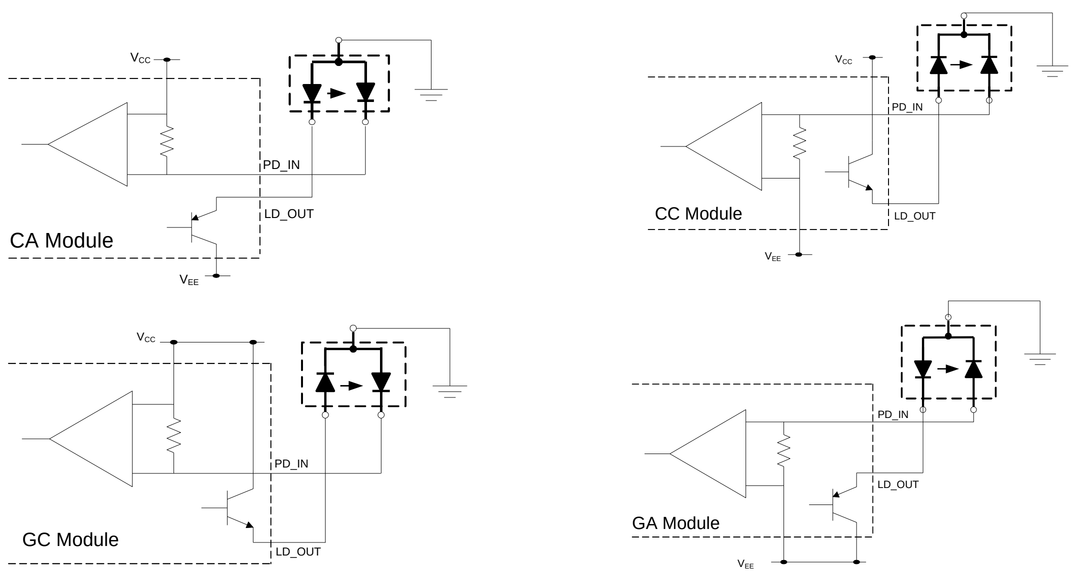
Both laser current and temperature are monitored and excessive values of either will cause the module to shut down, and generate a logic-level output flag, which can be monitored by the system.

SUPPORTED LASER CONFIGURATIONS

Four different module configurations are offered allowing grounded-case operation for all common laser diode/photodiode assemblies:

MOT6550CA	Common Anode
MOT6550CC	Common Cathode
MOT6550GA	Grounded Anode*
MOT6550GC	Grounded Cathode*

* refers to laser diode connection



The MOT6550CA, CC and GA modules are characterized for dual supply operation, while the MOT6550GCmodules are characterized for single supply operation, with supply range from 3.3V to 5V.

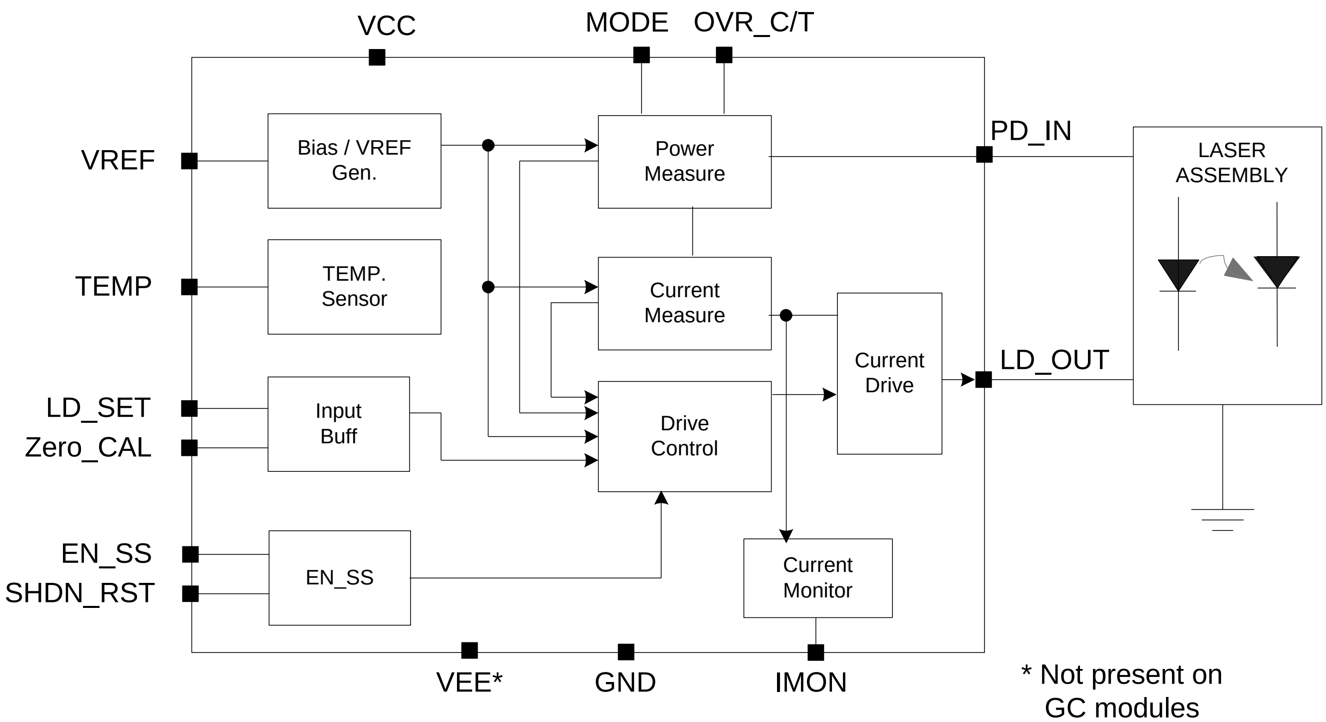
These modules consume very little power and do not require a heat sink. They also offer a very small footprint, and are characterized over the Industrial Temperature Range (-40 to +85˚C).

MODULE SELECTION TABLE:

Part Number	Description
MOT6550xx-25	250mA Output Current
MOT6550xx-50	500mA Output Current
MOT6550xx-100	1A Output Current

“xx” - indicates module configuration: CA, CC, GA or GC

MODULE BLOCK DIAGRAM



PIN DESCRIPTIONS

Pin #	Pin Name	Description
1	V_{CC}	Positive supply voltage.
2	LD_SET	Laser diode current set. A voltage from 0V to ~ 2V sets the required laser current or power.
3	NC	No Connect
4	EN_SS	Enable & Slow Start. To disable the module this pin must be tied to a high logic level. *Default = low (internal pulldown), Enabled*
5	VREF	2.5V Reference voltage output.
6	MODE	Mode select. A low logic level at this pin configures the module for Constant Current (CC) control. A high logic level configures the module for Constant Power (CP) control. *Default = low (internal pulldown)*
7	GND	Ground.
8	V_{EE}	CA, CC, GA Modules. Negative supply voltage.
	NC	GC modules only
9	IMON	Monitor output. A voltage from 0V to ~2.5V corresponds to laser current from 0mA to the specified maximum.
10	PD_IN	Photodiode Input. Connects to the photodiode anode for CC and GA modules and the photodiode cathode for CA and GC modules. See application diagrams for various laser and photodiode configurations. *Note: This pin has no function in CC mode and must be left open.*
11	SHDN_RST	Following an over current or over temperature shutdown, a negative-going pulse at this pin restores normal operation, assuming the fault condition has been cleared. *Default = high (internal pullup)*
12	OVR_C/T	Over Current & Over Temperature. In case of over temperature or over current this pin will be pulled low by the module.
13	LD_OUT	Laser diode driver connection. This pin sources current and connects to the laser anode for CC and GC modules. For CA and GA modules, this pin sinks current and connects to the laser diode cathode.
14	TEMP	Temperature output. An analog voltage indicates the internal temperature of the module.

FUNCTIONAL DESCRIPTION

Mode Selection

The MOT6550xx series can be programmed to be either a Constant Current or a Constant Power controller.

In Constant Current mode the device will maintain the output current at the programmed value. In Constant Power mode, feedback from a photodiode in close proximity to the laser diode is monitored and the output current is varied as needed to keep the feedback current constant, and hence a constant laser power output.

The MODE pin should be set to a stable value before enabling the device for normal operations.

MODE = 0, Constant Current control. This is the default mode.
MODE= 1, Constant Power control.

Setting Laser Current

The LD_SET Pin is used to set the required laser current (or power). Once set the controller maintains this current.
A voltage from 0V to ~2V at the LD_SET pin results in a laser current from 0mA to the specified maximum. The upper limit is somewhat higher than the nominal maximum for additional margin.

The specified maximum current for each member of the MOT6550xx family is shown in the Module Selection Table.

It is possible to reduce the upper limit below the nominal maximum by simply adding a resistor in series with the control potentiometer. This could be desirable in some applications where the laser current has to be limited to a certain value.
The LD_SET pin can be driven by a precision DAC or by a simple potentiometer. All devices in the MOT6550xx series are capable of precise laser current adjustments using a 12-bit or higher resolution DAC.

Constant Power Mode:

In Constant Power mode a real laser should be attached to the MOT600-EVM using CN6 connector.
Power supply to the MOT600-EVM must be turned off at this time.

Important note:
Before connecting a laser to MOT600_OEM make sure that the laser maximum current rating is compatible with the laser driver module you are using. Always use a laser with current rating greater than the laser driver module. Applying current greater than the laser maximum rating shall destroy the laser permanently.

Before attaching the laser, set VR5 to its maximum (fully anti-clockwise), and set LK5 to external. Place LK3 for using on-board pot (VR5). LK4 has been replaced with a resistor appropriately for using GC and CC modules.

Connect the laser to CN6 making sure correct terminals have been identified and connected according to the module being used. Following is an example for GC modules:

LD_C (laser cathode) = GND (CN6 PIN 2)
LD_A (laser anode) = LD_C/A (CN6 pin 1)
PD_A (photodiode anode) = GND (CN6 PIN 2)
PD_C (photodiode cathode) = PD_A/C (CN6 pin3)

Important note:

Lasers must be handled by qualified personnel having full understanding of laser safety principles and procedures.

Connect the laser pigtail optical connector to a suitable optical power meter. The power meter must be capable of handling high power if you are using high power lasers.

1. Set the mode to constant current (CC) using LK9 and set VR4 for minimum current (fully clockwise).
Turn on the power supply to the MOT600_OEM. Increase 5the laser current using VR4 (turning anti-clockwise) - by

increasing the voltage at the LD_SET pin. The optical power meter should now be reading corresponding power and increasing as the LD_SET voltage is being increased. Set LD_SET to approximately 1.75V and note optical power as well as the laser current for this LD_SET value.

2. Change the mode to constant power mode using LK9. You will notice that the laser current as well as the laser power decreases. Increase the laser current (power) using VR5 (turn clockwise) until laser power reaches approximately 1dB less than the power you noted in step 1.

3. If you wish to keep this module together with this OEM board and laser / photodiode setup: The ohmic value of VR5 can optionally be measured and a resistor having the closest value to VR5 can now be placed for R16. (This is more stable than the VR5 pot). When using R16, LK3 should be placed accordingly.

The laser power can now be changed using VR4 (LD_SET). It is now possible to change mode from CC to CP and vice versa with only minimal transients.

Modulation

The output current can be modulated by varying the voltage applied to the LD_SET input. The modulation bandwidth extends to beyond 1MHz. The modulation waveform could be a sine wave, square wave, or any other arbitrary waveform.

Monitor Output

The laser current is continuously monitored. The resulting value is presented as a voltage at the IMON pin. This output voltage has a linear relationship with the laser current. The voltage to current ratio (transimpedance) or V_{mon} / I_{las} can be found in the specification tables, where V_{mon} is the output voltage at the IMON pin, and I_{las} is the output current.

Enable & Slow Start

These modules feature a slow start and enable circuit in order to protect the laser. The laser current will be enabled if EN_SS is held low, which is the default condition at power up, ensured by an onboard pulldown resistor. The output current will then ramp to the programmed value over several microseconds. To disable the module EN_SS should be pulled high. In an application this pin may be left to enable the slow start immediately on power up, or could be driven to the desired level by an external controller.

Temperature Sensor

An on-board temperature sensor monitors the module temperature continuously. The output of the sensor is presented as a voltage at the TEMP pin. The output voltage varies with a slope of 11.9mV/°C, the temperature is given by:

$$T = [(V_{TEMP} - 0.744) / 11.9] \times 1000.$$

The modules are designed to shutdown, and set the OVER_C/T output, when the module temperature exceeds 135°C.

Over Current & Over Temperature

Both output current and temperature are monitored continuously. When either of these parameters exceeds a certain threshold the module will shutdown automatically, and the OVER_C/T output will be pulled low. Following a shutdown the module has to be reset in order to resume normal operation. A negative-going pulse at the RESET pin will restart the module.

The over temperature threshold is set to 135°C, and the over current sensor threshold is set to activate 5-10% above the nominal maximum output current.

Precision Voltage Reference

The output of the internal reference voltage generator is available at the VREF pin. This is a 2.5V precision reference voltage which remains stable over supply voltage and temperature variations. It can be used for the current setting potentiometer and/or for external DACs or ADCs.

ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Positive Supply Voltage, V_{CC}	-0.3 to 6 V
Negative Supply Voltage*, V_{EE}	-6 to 0.3 V
Peak Output Current	2 A
Storage Temperature	-55°Cto 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the module. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "Electrical Specifications" are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

* Except GC modules, which do not have a negative supply

Recommended Operating Conditions

Positive Supply Voltage, V_{CC}	3.3 to 5.5 V
Negative Supply Voltage*, V_{EE}	-5.5 to -3 V
Operating Free-air Temperature Range	-40°C to +85°C

* Except GC modules, which do not have a negative supply

Electrical Specifications

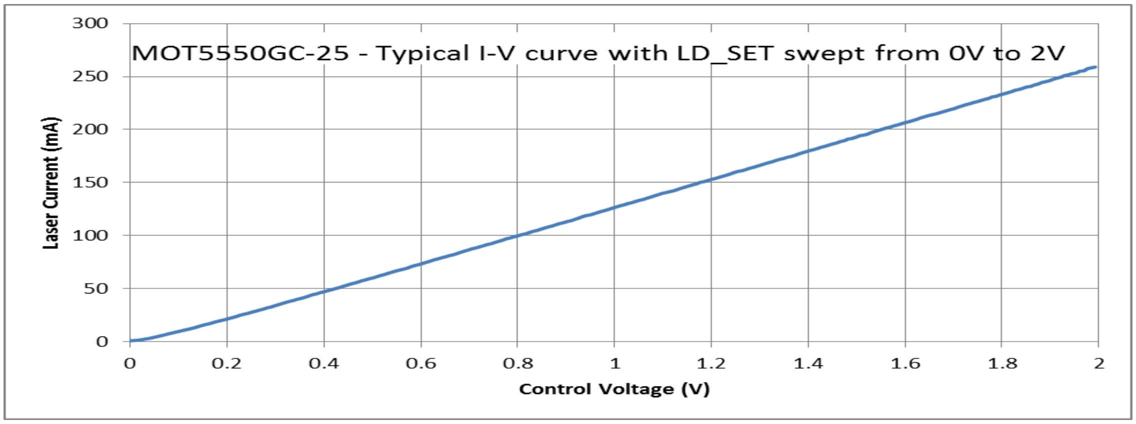
(Over recommended operating conditions unless otherwise noted. Typical values at T_A= +25°C.All voltage values are with respect to ground)

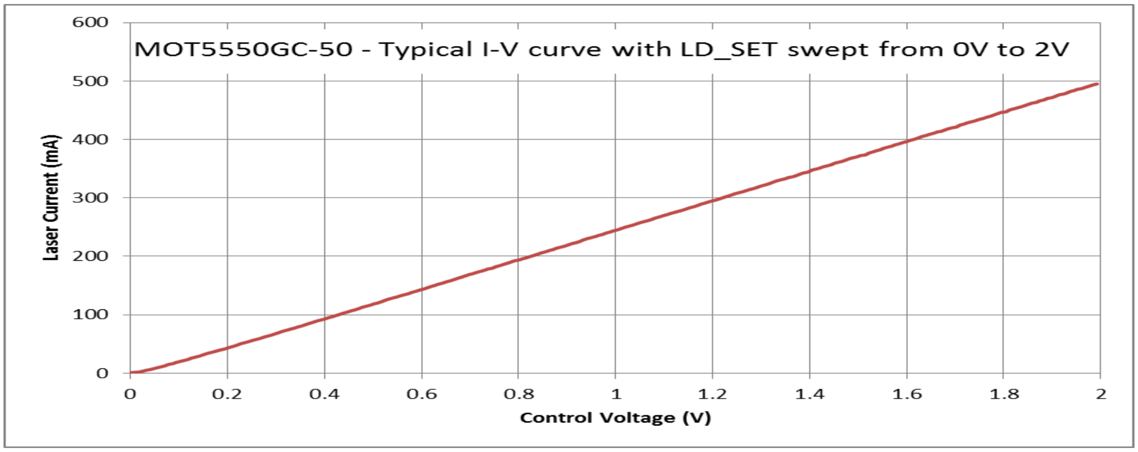
Parameter	Symbol	Conditions	Min[1]	Typ	Max	UNITS
Maximum Supply Current	I_{CCMAX}	CA, GA modules. V_{CC} = 5V, I_L = Max			35	mA
		CA, GA modules. V_{CC} = 3.3V, I_L = Max			20	
		CC, GC modules. V_{CC} = 5V, I_L = Max			I_{LMAX} +35	mA
		CC, GC modules. V_{CC} = 3.3V, I_L = Max			I_{LMAX} +20	
	I_{EEMAX}	CA, GA modules. V_{EE}= -5V, I_L = Max	I_{LMAX} - 10			mA
		CA, GA modules. V_{EE}= -3.3V, I_L = Max	I_{LMAX} - 5			
		CC modules. V_{EE}= -5V, I_L = Max	-10			mA
		CC modules. V_{EE}= -3.3V, I_L = Max	-5			
Shutdown Supply Current	I_{CCQ}	V_{CC} = 5V, EN_SS = V_{CC}		30	35	mA
		V_{CC} = 3.3V, EN_SS = V_{CC}		20	25	
	I_{EEQ}*	V_{EE}= -5V, EN_SS = V_{CC}	-2	-1		mA
		V_{EE}= -3.3V, EN_SS = V_{CC}	-1	-0.5		
Laser Drive Output	I_L	MOT6550xx-25	0	250	260	mA
		MOT6550xx-50	0	500	515	mA
		MOT6550xx-100	0	1	1.05	A

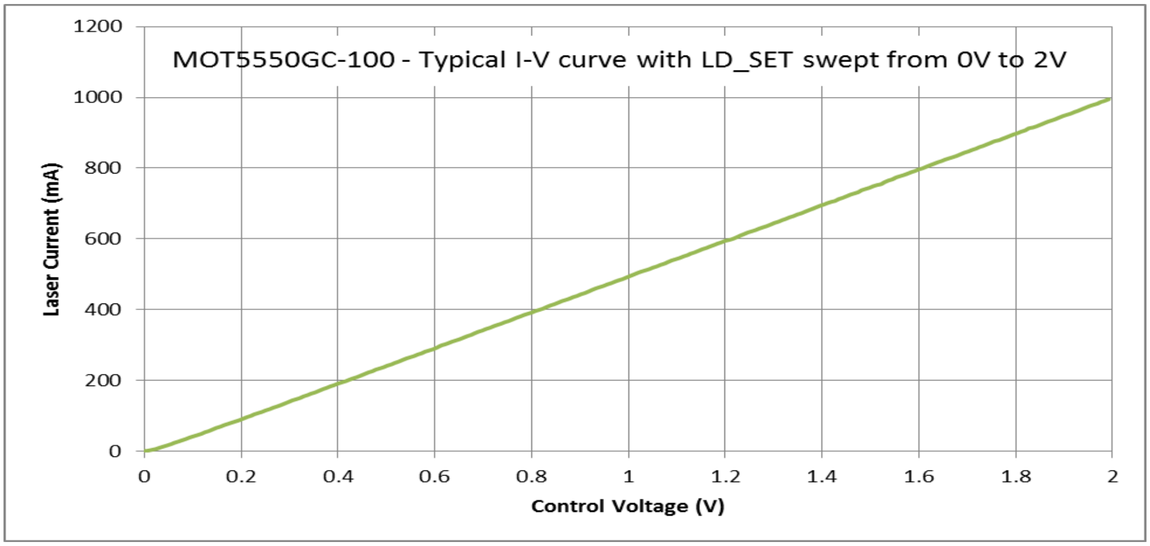
Parameter	Symbol	Conditions	Min[1]	Typ	Max	UNITS
Output Compliance Voltage[4]	V_L	I_L = Max, V_{CC}= 3.3 to 5V, V_{EE}= -3.3 to -5V*			1.35	V
Output Current Stability				tbd		ppm/°C
Over Temperature Shutdown	T_{SH}			140		°C
Over Current Shutdown Threshold		MOT6550xx-25		260		mA
		MOT6550xx-50		515		mA
Control Inputs						
Current Set Voltage	V_{LDSET}		0	0 - 2.0	2.2	V
Current Set Resolution			12			bits
Zero cal range		V_{LDSET} = 0V		2		mA
High Level Input Voltage	V_{IH}	EN_SS, MODE Inputs	0.7V_{CC}			V
Low Level Input Voltage	V_{IL}	SHDN_RST Input			0.4V_{CC}	V
Monitor Outputs						
Reference Voltage Output	V_{REF}			2.5		V
Reference Voltage Output Regulation		I_{REF} = 1 – 15mA		2.5	10	mV
Reference Voltage Temperature Stability				+/-15	+/-150	ppm/°C
Output Current Monitor Voltage (IMON)		IMON Output	0		2.6	V
OVER_C/T Output Current	V_{OL}	V_{OL} = 0.5V			15	mA
Monitor Output Transfer Characteristic		MOT6550xx-25		10.4		mV/mA
		MOT6550xx-50		5.2		
		MOT6550xx-100		2.6		
Temperature Output Voltage (TEMP)	V_{TEMP}		0		2.5	V
		T_A= 25 °C		1.04		V
Temperature Output Voltage Coefficient				11.9		mV/°C

* Except GC modules, which do not have a negative supply

Notes:
1. The minimum value is the most negative value.
2. For CC and GC modules this is a source current, for CA and GA modules this is a sink current
3. Unadjusted: no external resistor connected to the Zero_CAL pin.
4. Maximum voltage drop across the output driver at maximum load. To ensure maximum laser output power, the voltage drop across the laser diode added to this value must not exceed the supply voltage.


MOT5550GC-25 - Typical I-V curve with LD_SET swept from 0V to 2V
Laser Current (mA)
300
250
200
150
100
50
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Control Voltage (V)


MOT5550GC-50 - Typical I-V curve with LD_SET swept from 0V to 2V
Laser Current (mA)
600
500
400
300
200
100
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Control Voltage (V)


MOT5550GC-100 - Typical I-V curve with LD_SET swept from 0V to 2V
Laser Current (mA)
1200
1000
800
600
400
200
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Control Voltage (V)

THERMAL DERATING

Although the module is capable of operating at temperatures in excess of 85˚C, in certain applications (high ambient temperature and high output current) the internal module temperature may rise to such an extent that thermal shutdown occurs. For operation at higher ambient temperatures either the output current must be reduced or additional thermal dissipation must be provided for the module (thermal putty and large copper areas beneath the module or "stick-on" heatsinks are standard procedures). The efficiency of such measures can be easily evaluated by use of the Temperature Output Voltage (TEMP) pin of the device.

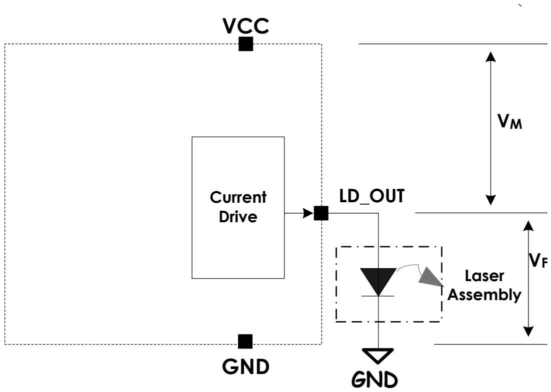
While there is no risk of damage to the module the net effect of these considerations is that it may not be possible to achieve maximum rated output currents at high ambient temperatures. To estimate if additional considerations are required you may calculate the module power dissipation as described below.

THERMAL CALCULATIONS

The bulk of the module's power dissipation is dissipated in the output driver stage for the laser (plus small additional dissipations incurs by the module's internal circuitry). This dissipation can be calculated by multiplying the voltage across the module's output stage (V_M) by the current through the laser.

V_F = forward voltage drop across the laser. This depends on the type of laser used and the current being driven. It can range from approximately 1.2V to greater than 2.5V.

V_M = voltage across the module



Example

Assuming V_{CC} = 5V, I_L = 500mA, V_F = 1.8V:
$V_M = V_{CC} - V_F = 5 – 1.8 = 3.2V$
Therefore PD = $V_M \times I_L$ = 3.2 x 500 = 1.6W

***Note: By using V_{CC} < 5V we can reduce the module power dissipation*. Ensure V_M is greater or equal to 1.4V.**
By knowing the thermal coefficient of the module in use we can now calculate the maximum ambient temperature for a given power dissipation:

Thermal coefficient of module inserted in socket for 250mA modules (θ_{MA1}): 134 ˚C / Watt
(This number is measured with a module dissipating 500mW)

θ_{MA1}: Thermal coefficient of the module inserted in the socket.
θ_{MA2}: Thermal coefficient of the module soldered on the board.
For the thermally enhanced package used for the 500mA and 1000mA modules:

Thermal Coefficient	Module dissipating (750mW)	Module dissipating (1.5W)
θ_{MA1}	85˚C/W	65˚C/W
θ_{MA2}	81˚C/W	58˚C/W

The Thermal coefficients are calculated by measuring the module temperature (using TEMP pin) while dissipating a known power in the module for long enough time so that the temperature has been stabilized.

$\theta_{MA} = (T_M - T_A)/P_D$; P_D is power dissipated in the module.

The internal temperature shutdown point of the module is ~135˚C, therefore the maximum ambient temperature is:
$135 - (P_D \times \theta_{MA})$˚C

Example

Assuming V_{CC} = 3.3V, I_L = 500mA, V_F = 1.8V, module soldered to board:

$V_M = V_{CC} - V_F = 3.3 - 1.8 = 1.5V$

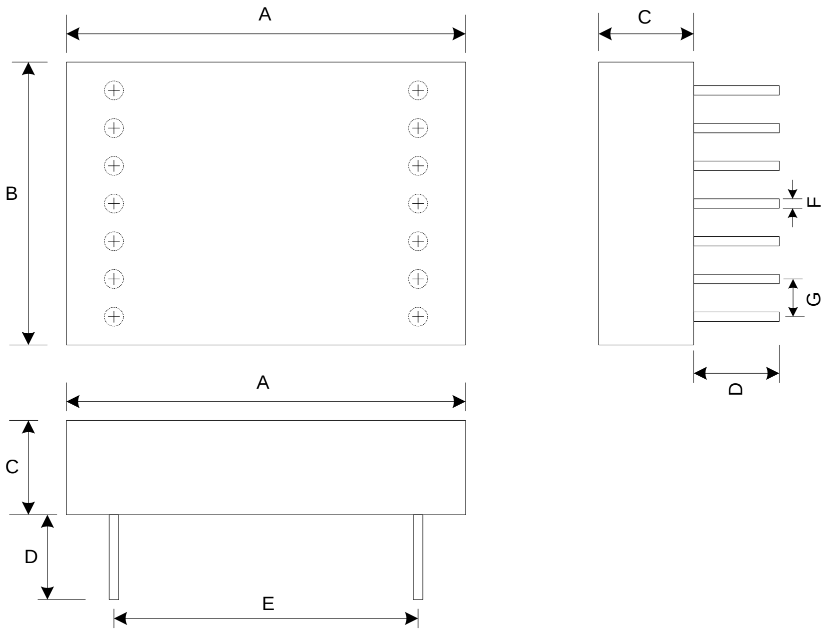
Therefore:

$P_D = V_M \times I_L = 1.5 \times 500 = 0.75W$

Maximum Ambient Temperature = 135 – (0.75 x 81) = 74.25˚C

In this case the module should be kept to ambient temperatures of about 70 or less. If operation at higher ambient temperatures is required additional measures for heat sinking should be provided.

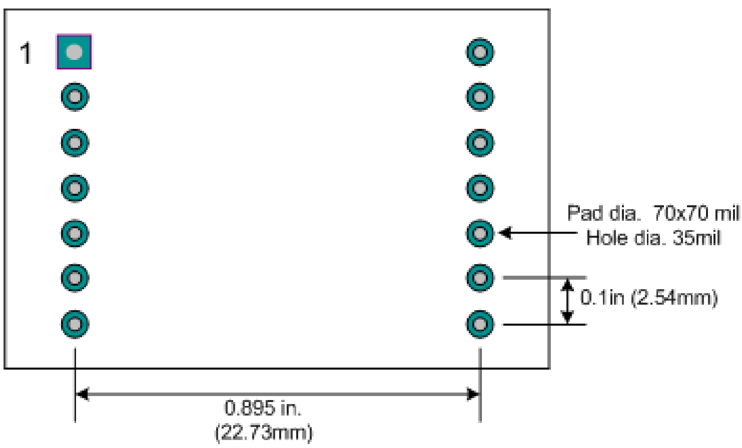
MECHANICAL OUTLINE:



Module Dimensions (typical values)

Dimension	Value	
	in	mm
A	1.18	30
B	0.79	20
C	0.315	8
D	0.144	3.6
E	0.895	22.73
F	0.025	0.64
G	0.1	2.54

PCB FOOTPRINT



IMPORTANT NOTICE

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