MODULAR ONE TECHNOLOGY

MOT5550GC & MOT5550GA Series

Constant-Current Laser Driver Module with Temperature Monitor and VREF

FEATURES

- **Configured for Grounded Cathode (GC) or Grounded Anode (GA) laser assemblies**
- **3.3 to 5 Volt Single Supply Operations for GC modules.**
- **250mA, 500mA & 1A maximum current versions**
- **Constant current Operation**
- **Programmable current set through simple potentiometer or high precision external DAC**
- **Slow Start circuit for laser protection**
- **Wide-band Modulation through current set input**
- **Factory calibrated.**
- **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**
- **Low power consumption**
- **-40 to +85˚C Operation**
- **Small footprint**

APPLICATIONS

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

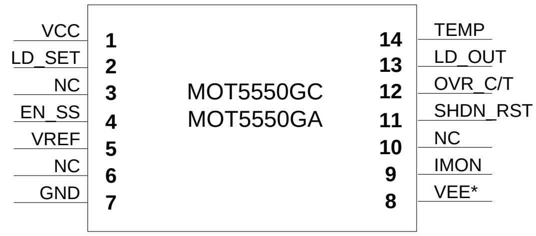
OVERVIEW

The MOT5550xx Series are a family of high-precision, low-noise laser driver modules. The modules are available in current ranges extending up to 1A.

The laser current is set by an analog voltage applied to the laser diode set pin, which can be derived from an external high-resolution DAC, or with a simple potentiometer.

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.

PIN CONFIGURATIONS



27.5mm x 20mm

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.

The MOT5550GC modules are characterized for single supply operation, with 3.3V to 5V supplies.

The MOT5550GA modules uses +/-3.3V or +/-5V power supplies.

These modules consume very little power. They also offer a very small footprint, and are characterized over the Industrial Temperature Range (-40 to +85˚C).

SUPPORTED LASER CONFIGURATIONS

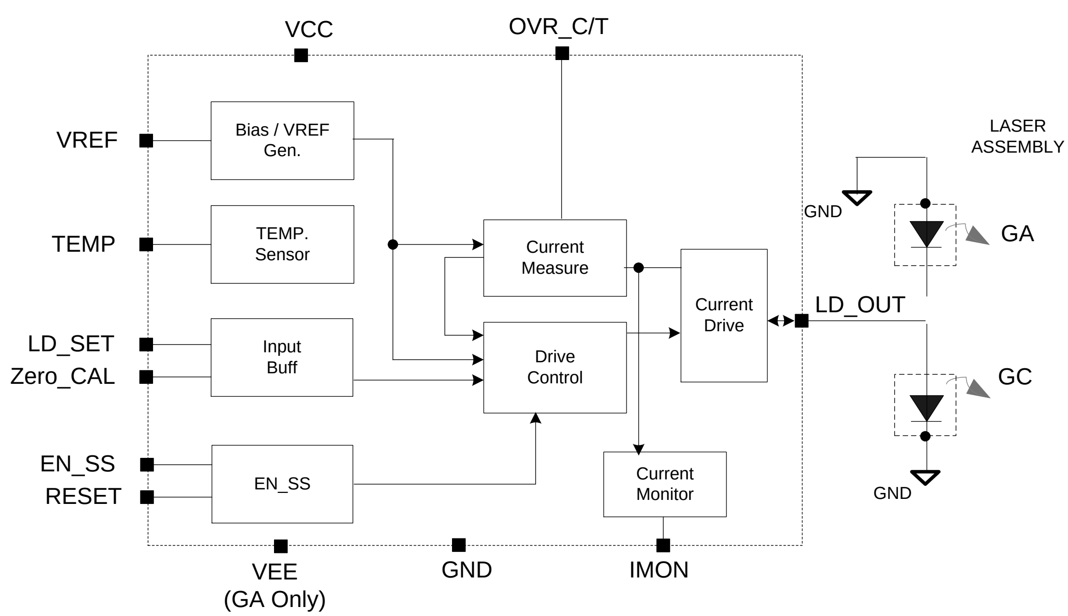
The MOT5550GC is configured for lasers where the cathode is connected to the case, allowing the case of the laser to be grounded. A companion product, the MOT5550GA is available for grounded anode operation.

MOT5550GA Grounded Anode
MOT5550GC Grounded Cathode

MODULE SELECTION TABLE

Part Number	Max Output Current	Part Number	Max Output Current
MOT5550GC-25	250mA Output Current	MOT5550GA-25	250mA Output Current
MOT5550GC-50	500mA Output Current	MOT5550GA-50	500mA Output Current
MOT5550GC-100	1A Output Current	MOT5550GA-100	1A Output Current

MODULE BLOCK DIAGRAM



PIN DESCRIPTIONS

Pin #	Pin Name	Description
1	VCC	Positive supply voltage.
2	LD_SET	Laser diode current set. A voltage from 0V to 2.0V 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 pull-down), Enabled*
5	VREF	2.5V Reference voltage output.
6	NC	No Connect
7	GND	Ground.
8	VEE, NC	It is NC for GC modules. VEE for GA modules.
9	IMON	Monitor output. A voltage from 0V to 2.5V corresponds to laser current from 0mA to the specified maximum.
10	NC	No Connect
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 pull-up)*
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 GC modules.
14	TEMP	Temperature output. An analog voltage indicates the internal temperature of the module.

FUNCTIONAL DESCRIPTION

Setting Laser Current

The LD_SET Pin is used to set the required laser current. Once set the controller maintains this current.

A voltage from 0V to ~2V at the LD_SET pin results in a laser current from approximately 0mA to the specified maximum. (The upper limit is somewhat higher than the nominal maximum, as it is designed to have additional margin).

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 MOT5550 & MOT6550 series are capable of precise laser current adjustments using a 12-bit or higher resolution DAC.

Zero calibration

All laser driver modules are factory calibrated for approximately ~0mA when 0V is applied to the LD_SET pin.

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.

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 pull-down 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 120°C approximately.

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 approximately 130°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 forexternal DACs or ADCs.

ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Positive Supply Voltage, V_{CC}	-0.3 to 6 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.

Recommended Operating Conditions

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

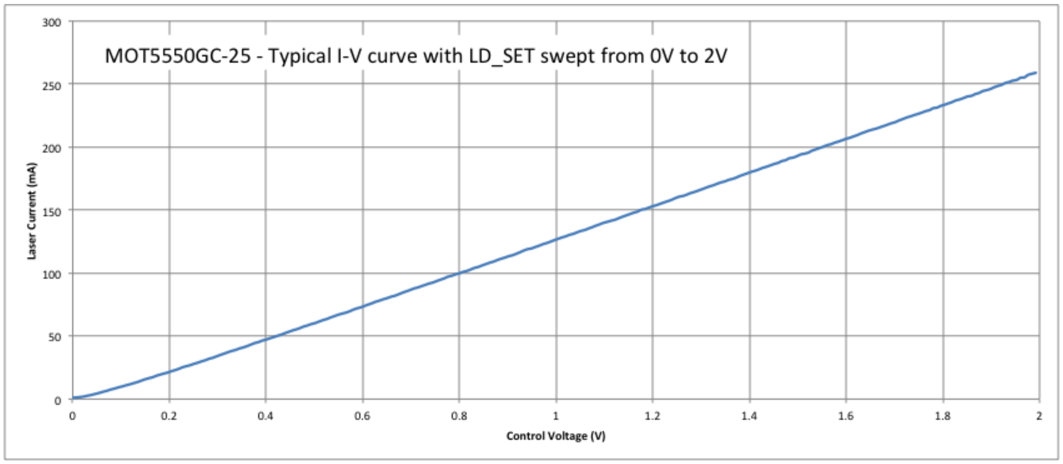
Electrical Specifications

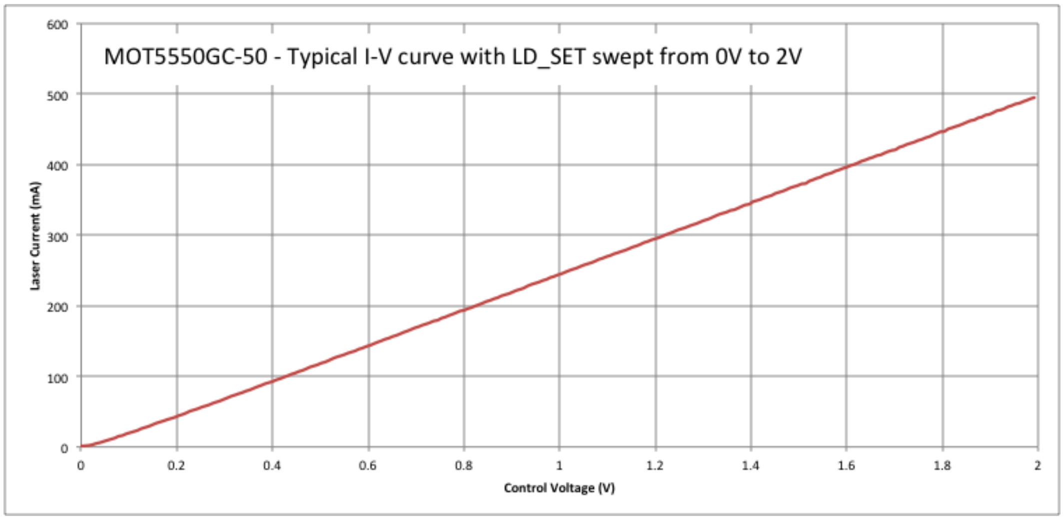
(Over recommended operating conditions unless otherwise noted. Typical values at T_A= +25°C.All voltage values are with respect to ground)

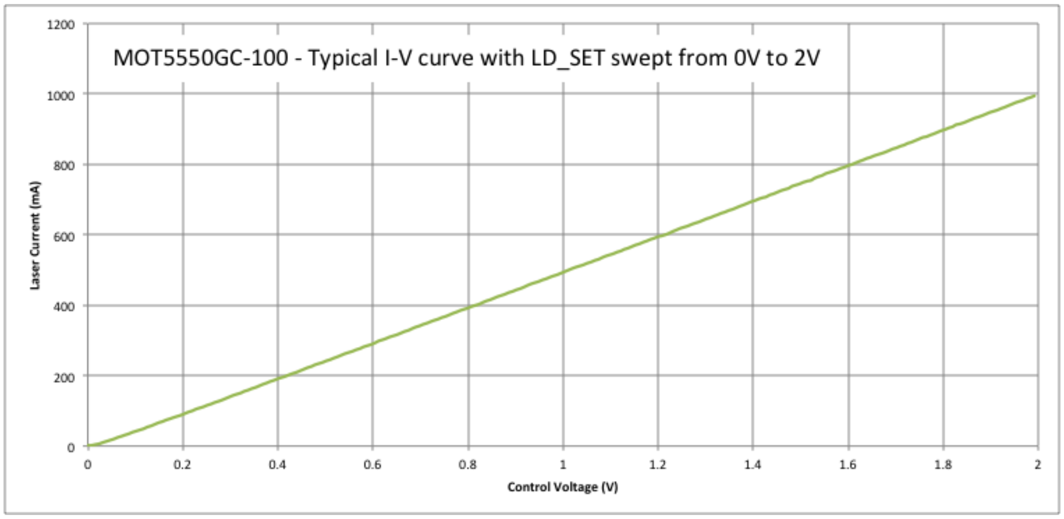
Parameter	Symbol	Conditions	Min[1]	Typ	Max	UNITS
Maximum Supply Current	I_{CCMAX}	V_{CC} = 5V, I_L = Max		I_{LMAX} +35		mA
		V_{CC} = 3.3V, I_L = Max		I_{LMAX} +25		
Shutdown Supply Current	I_{CCQ}	V_{CC} = 5V, EN_SS = V_{CC}		35		mA
		V_{CC} = 3.3V, EN_SS = V_{CC}		25		
Laser Output						
Laser Drive Current[2]	I_L	MOT5550xx-25[3]	0	250	260	mA
		MOT5550xx-50	0	500	515	mA
		MOT5550xx-100	0	1	1.04	A
Laser Current Transfer Characteristic[4]		MOT5550xx-25		130		mA/V
		MOT5550xx-50		250		
		MOT5550xx-100		500		
Output Compliance Voltage[5]	V_L	I_L = Max, V_{CC}= 3.3 to 5V,	1.4			V
Output Current Stability				tbd		ppm/°C
Over Temperature Shutdown	T_{SH}			125		°C
Over Current Shutdown Threshold		MOT5550xx-25[3]		260		mA
		MOT5550xx-50		515		mA
		MOT5550xx-100		1.05		A

Parameter	Symbol	Conditions	Min[1]	Typ	Max	UNITS
Control Inputs						
Current Set Voltage	V_{LDSET}		0	0 – 2	2.2	V
Current Set Resolution			12			bits
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 – 10mA		2.5	10	mV
Reference Voltage Temperature Stability				+/-15	+/-150	ppm/°C
Output Current Monitor Voltage (IMON)		IMON Output	0		2.65	V
OVER_C/T Output Current	V_{OL}	V_{OL} = 0.5V			15	mA
Monitor Output Transfer Characteristic		MOT5550xx-25[3]		10.4		mV/mA
		MOT5550xx-50		5.2		
		MOT5550xx-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

Notes:
1. The minimum value is the most negative value.
2. For GC modules this is a source current, for GA modules this is a sink current
3. xx refers to GC or GA modules.
4. Variation in IL with change to LD_SET. See the following page for transfer characteristic graphs.
5. Minimum voltage required across the output driver at maximum load to ensure linear operation of the output driver. The voltage drop across the laser diode (VF added to this value will equate to the supply voltage.


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


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


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

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.

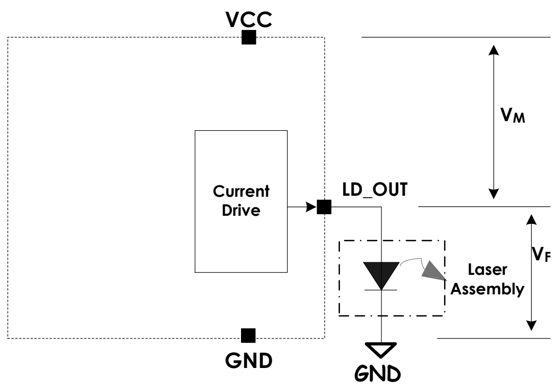
While there is no risk of damage to the module the net effect of these considerations is that it may not be possible to achieve maximum rated output currents at high ambient temperatures. To estimate if additional considerations are required you may calculate the module power dissipation as described 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 ~125˚C, therefore the maximum ambient temperature is:
$125 – (P_D \times \theta_{MA})$˚C

Example

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

$V_M = V_{CC} - V_F = 5 – 1.8 = 3.2V$

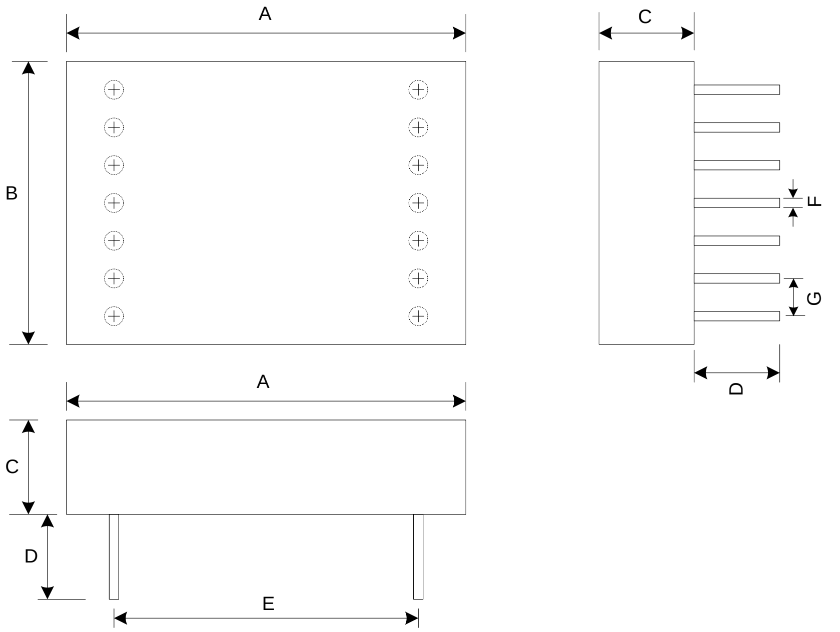
Therefore:

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

Maximum Ambient Temperature = 125 – (0.75 x 81) = 64.25˚C

In this case the module should be kept to ambient temperatures of about 60 or less. If operation at higher ambient temperatures is required additional measures for heat sinking should be provided.

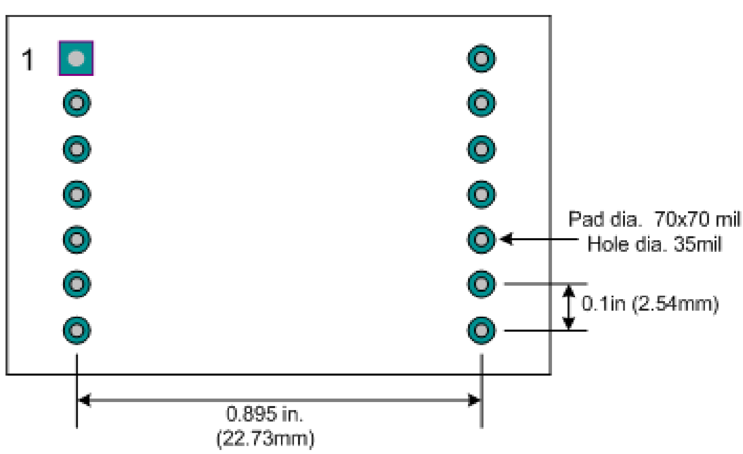
MECHANICAL OUTLINE



Module Dimensions (typical values)

Dimension	Value	
	in	mm
A	1.08	27.5
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



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