1310/1550 nm CWDM Integrated RF Transmitter

General Description

The EM655 RF Transmitter integrates a high-bandwidth fiber-coupled DFB laser with both an ultra-low noise laser current source *and* temperature controller. The module also contains an optical isolator and back facet monitor detector readout amplifier. The entire module operates from a single +5 V supply and offers a bi-directional bias adjust input that may used to control the laser output power or finely adjust the laser oscillation frequency via chirp. The unit also incorporates a bi-directional temperature adjust input for coarse tuning of the laser oscillation frequency. The module is designed and built using our high-reliability platform for defense components and incorporates an advanced ultra-low noise laser current source. The EM655 drives the internal TEC with a class AB linear H-bridge and incorporates multiple layers of EMI protection. The device accepts a standard female DB9 connector for the application of power and low-frequency tuning signals while the RF input accepts a standard male 2.92 mm "K" connector. The output optical fiber is available with or without PVDF furcation tubing terminated with a variety of standard optical connectors.

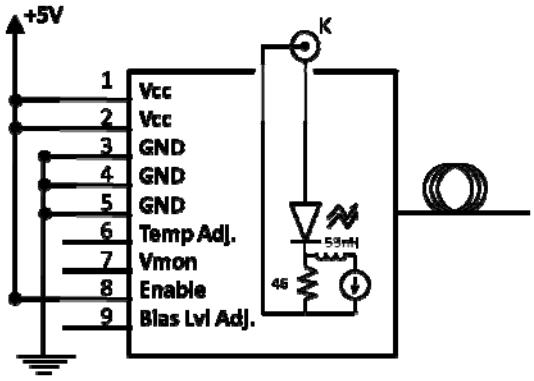
Applications

- RF Links
- CATV
- Seeding
- Sensing

Features

- Integrated current source
- Integrated temperature controller
- Integrated monitor detector amplifier
- PM/SM fiber with or without furcation tubing
- Simple interface
- Small form factor
- Operates from single +5V supply

Basic Operating Circuit



Ordering Information

The EM655 part number has the following structure:

EM655-FREQUE-POW-FIBuM-CON-50

OR without an optical isolator:

EM656-FREQUE-POW-FIBuM-CON-50

Valid values for each field are included at the end of this document.

Absolute Maximum Ratings

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and operation of the device at these or conditions beyond these is not implied. Exposure to absolute maximum ratings for extended periods of time may affect device reliability.

Parameter	Sym.	Condition	Min	Max	Unit
Storage Temperature	T_{STG}	non-condensing atmosphere	-40	+85	°C
Operating Temperature	T_{OP}	temp. at base of module, non-condensing atmosphere	-10	60	°C
Voltage Supply	V_{CC}		4.6	5.5	V
Current Supply	I_{CC}			3500	mA
Laser Enable Input Voltage	LE		GND-0.3	V_{CC} +0.3	V
Laser Enable Input Current	I_{LE}			2	mA
Bias Adjust Input Voltage	Vpa	**Warning:** see notes	0	2.6	V
Bias Adjust Input Current Source or Sink		**Warning:** see notes	-3.5	3.5	mA
Temperature Adjust Input Voltage	Vta	**Warning:** see notes	0	5	V
Temperature Adjust Input Current Source or Sink		**Warning:** see notes	-3.5	3.5	mA
Monitor Detector Output Voltage	V_{MON}			V_{CC}	V
Monitor Detector Output Current Source or Sink	I_{MON}		-15	15	mA
Optical Output Power	Pop			20	mW

Optical Characteristics

T_{OP}=25°C unless otherwise noted, All parameters measured after an initial 60s settling time. V_{CC} = LE = 5.0V with PA and TA open.

Parameter	Sym.	Condition	Min	Typ	Max	Unit
Optical Output Power Setpoint	P_{OP}	See ordering information	Pop			mW
Center Wavelength	λ_{OP}	P=P_{OP}	λ_{OP}-10	λ_{OP}	λ_{OP}+10	nm
Optical Output Power Fluctuation[1]	ΔP_{OP}	1σ, t_m=400s, 0.1s avg&period		20	50	PPM
Long-Term Power Fluctuation	ΔP_{OP}	1σ, t_m=20hr, 0.1s avg, 18s period		200	500	PPM
Temperature Dependent Power Drift	ΔP_T	$-10 \leq T_{OP} \leq 60°$			500	PPM/°C
Temperature Dependent Frequency Drift	ΔF_T	$-10 \leq T_{OP} \leq 60°$			±500	MHz/°C
Side Mode Suppression Ratio	SMSR		30			dB
Polarization Extinction Ratio		w/ PM fiber only	17	20		dB
Optical Isolation			30	35		dB
Relative Intensity Noise[2]	RIN			-150		dBc/Hz
Cold Start Settling Time		V_{CC}=V_{EN} 0→5V			30	s
Rise Time (Hot Start)	t_R	V_{EN}=0→5V		30		ms
Fall Time (Hot Standby)	t_F	V_{EN}=5→0V		5		µs
Back Facet Tracking Over Temp			-10		+10	%
Modulation Bandwidth			10	12		GHz

Electrical Characteristics

Parameter	Sym.	Condition	Min	Typ	Max	Unit
Voltage Supply	Vcc	across inputs		5		V
Current Supply	Icc				3	A
Laser Enable High	LE_H		3.5			V
Laser Enable Low	LE_L				1.5	V
Laser Enable Input Impedance	Z_{LE}			5		kΩ
Bias Level Adjust[3]	Vpa	**Warning:** see notes	0		2.2	V
Bias Level Adjust Input Impedance	Z_{PA}	to 2V Vref		1		kΩ
Bias Level Adjust Bandwidth		-3dB		8		kHz
Temperature Adjust	Vta	**Warning:** see notes	1.5		3.5	V
Temp Adjust Input Impedance	Z_{ta}	to 2.5V Vref		1		kΩ
Monitor Detector Output	V_{MON}	at Pop	1		3	V
Bias Tee Inductance				53		nH

Environmental Characteristics

Parameter	Sym.	Condition	Min	Typ	Max	Unit
Storage Temperature	Tstg	non-condensing	-40		+85	°C
Operational Temperature	Top	temp. at base of module, non-condensing	-10		+60	°C

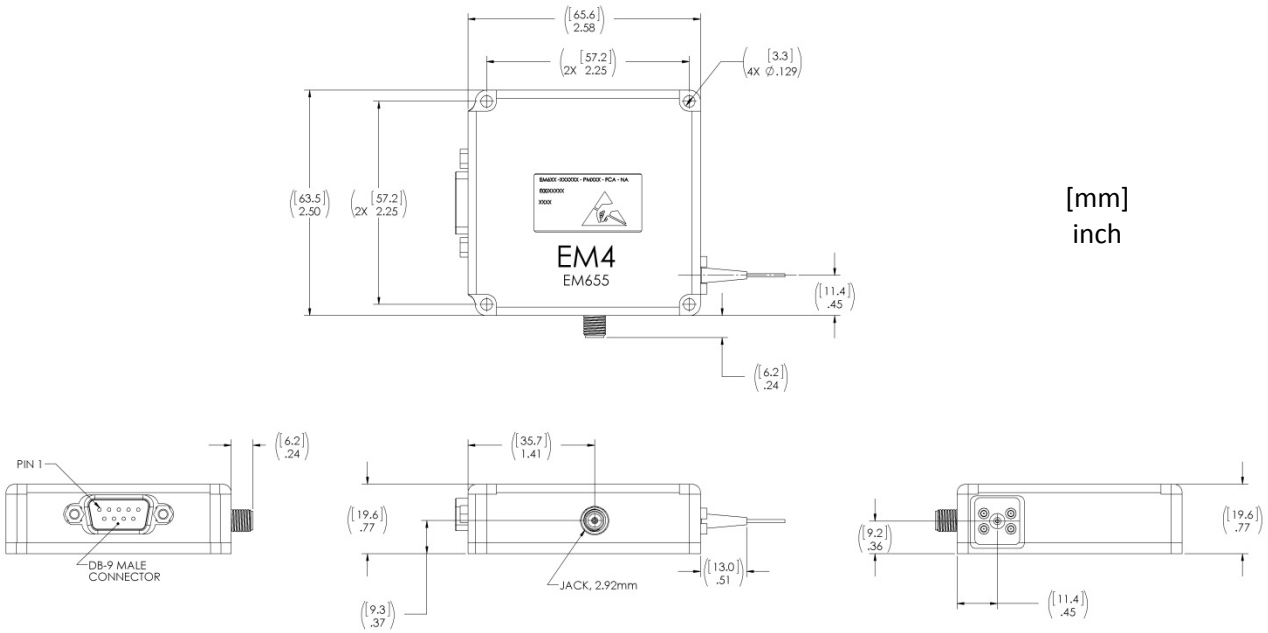
Electrical Connectors

Pin	Name	Description
1	V_{CC}	Voltage supply
2	V_{CC}	Voltage supply
3	GND	Ground connection
4	GND	Ground connection
5	GND	Ground connection
6	TA	Temperature Adjust Input
7	Vmon	Monitor Voltage Output
8	LE	Laser Enable
9	PA	Bias Level Adjust Input
DB-9 Shield		Connected to connector shield only
Mating Connector		DB-09F, Standard DB-09 Female/Receptacle/Socket Connector
RF (center pin)		Connected to laser cathode via 46Ω resistor
RF (shield)		DC coupled to laser anode (~1.3VDC potential typ. to DC GND, must be isolated from DC supply ground)
Mating Connector		2.92 mm Male/Plug

Optical Fiber Specification

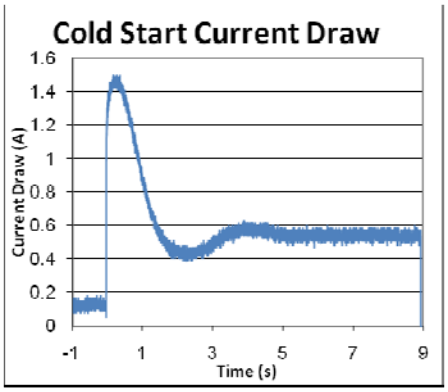
Parameter	Type	Unit
Fiber Type	Single-mode PM or non-PM	-
Core Diameter	8	µm
Outer Diameter	125	µm
Buffer Diameter[4]	250 (optional 900 µm loose buffer avail.)	µm
Buffer Material	Acrylate (optional loose-buffer is PVDF)	-
Minimum Length	1	M
Minimum Bend Radius	35	mm
Connector Type (see ordering information)	FC, SC, or LC/APC, key parallel to slow axis; key type is tight-fit/narrow	-
Output Polarization	Parallel to slow axis	-

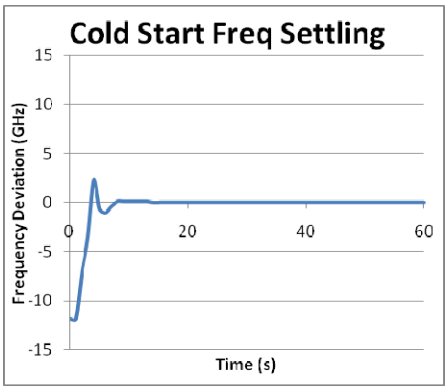
Mechanical Drawing

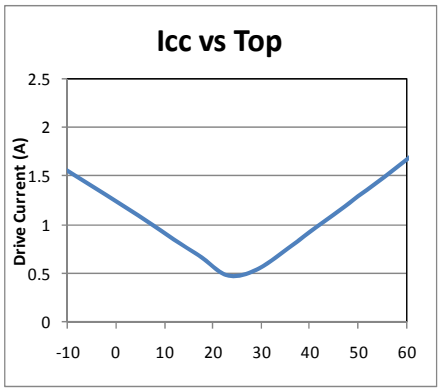


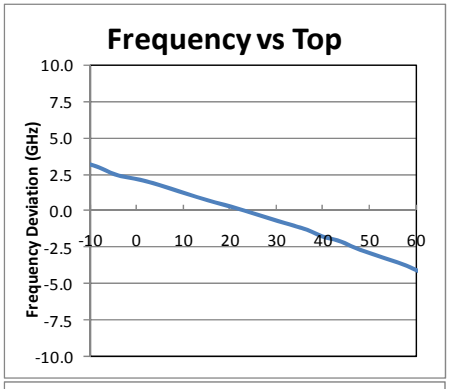
[mm]
inch

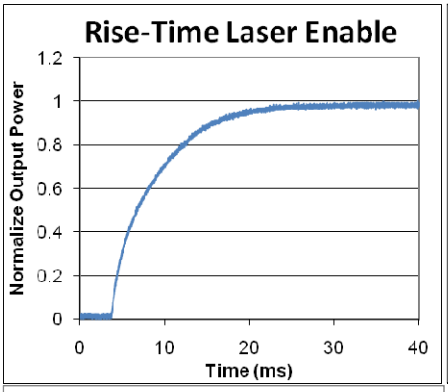
Typical Operating Characteristics

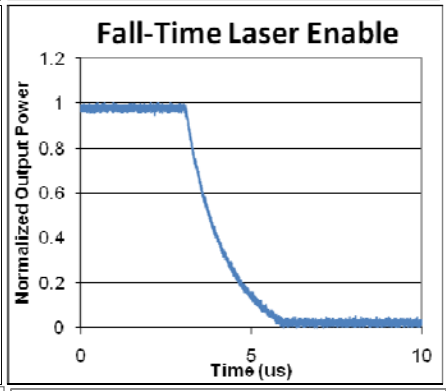


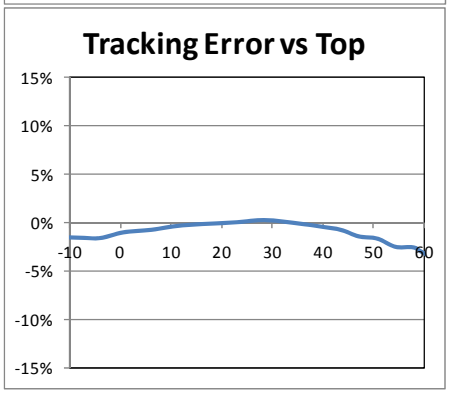


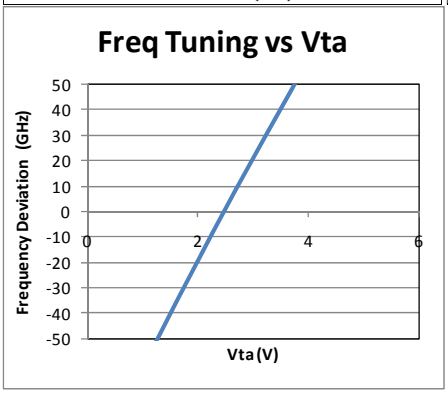


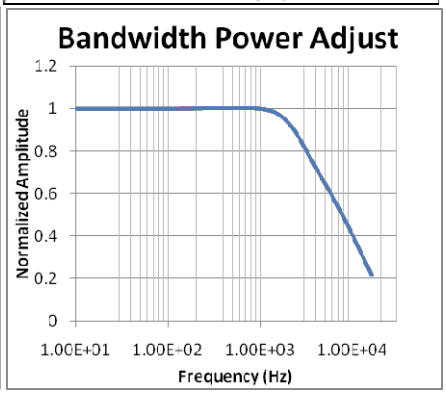




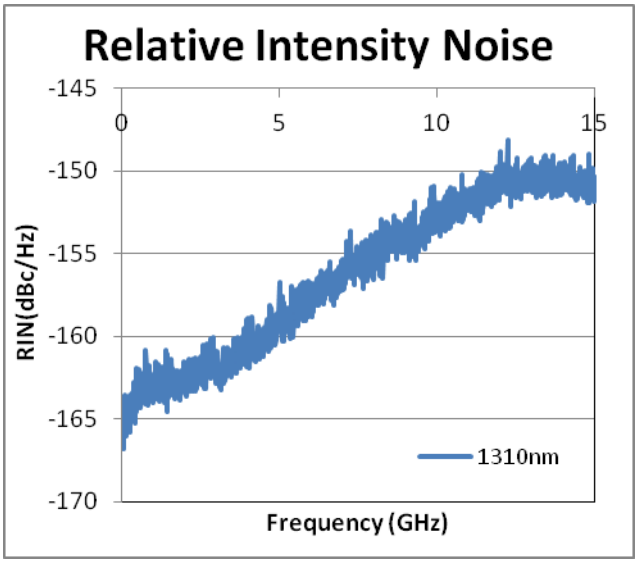


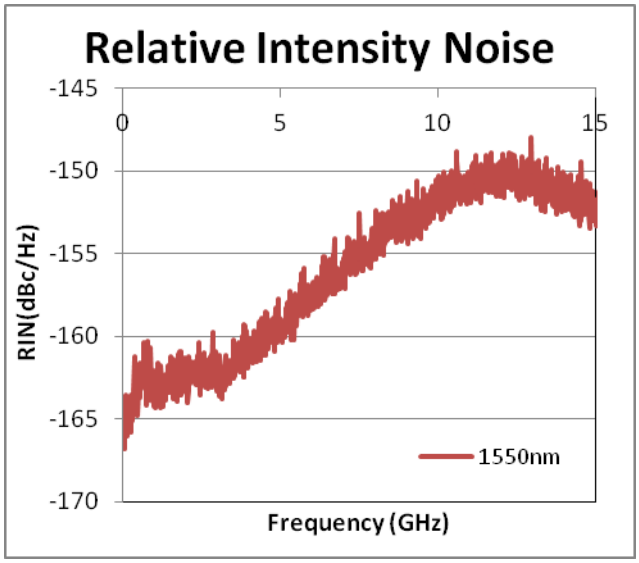


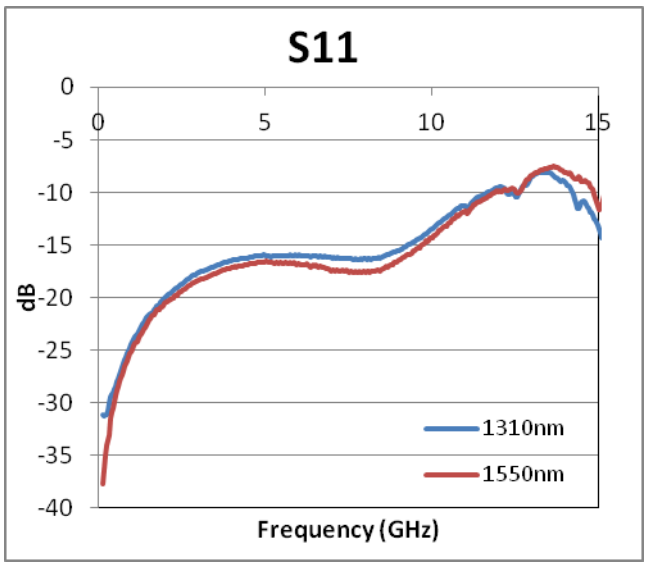


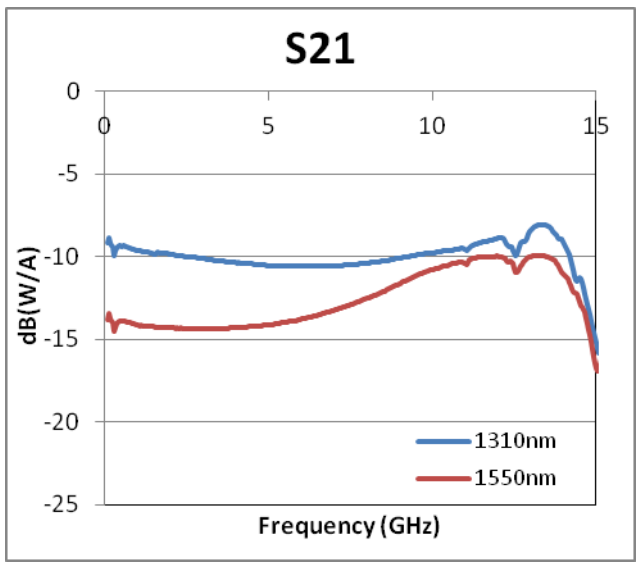


Typical Operating Characteristics (continued)









[1]Power stability of this magnitude is strongly influenced by any movement of the fiber. To duplicate this stability measurement the fiber must be secured and motionless.
[2]At rated operating power and over the range 0.2 – 3 GHz
[3]The peak of the RIN curve corresponds to the relaxation oscillation frequency of the laser which varies in proportion to the drive current above threshold by f_{relax} α $((I_{ld}/I_{threshold}) - 1)^{1/2}$. Customers employing this device in RIN sensitive applications should therefore be aware that reducing the bias level using the PA input will reduce performance. Reducing the bias level reduces the device modulation bandwidth by the same relationship.
[4]Optional 900 µm loose-tube PVDF buffer recommend for laboratory use. Adds approximately one week to device lead time.

NOTES

WARNINGS: several of the parameters listed in the specifications above are denoted with a warning. These warnings are covered by the following notes which should be understood before operating the device.

Mounting

The EM655 is conductively cooled through its base and needs to be mounted using a thermal interface material to a customer supplied heatsink. EM4 recommends Panasonic PGS series pyrolitic graphite sheets, available in the US from Digi-Key Corporation. Care should be taken to keep the base temperature of the module between -10 and 60°C at all times during operation.

Noise suppression

The EM655 is a no-compromises low-noise integrated laser solution; the temperature controller output is class AB linear, there are no DC/DC converters in the module, the lowest noise components and architectures available are used along with heavy filtering and EMI shielding. Nevertheless, power supply ripple and noise should be minimized and the cable shield should be connected to the EM655 connector shield and tied to the appropriate signal at the power supply end of the cable.

Bias Level Adjust (PA)

The EM655 is designed to run in constant current mode with the drive current set for the as-ordered output power to achieve the highest possible performance. However, some applications require fine tuning of the laser bias current. The PA input provides this functionality, but its use carries an amount of risk. If bias adjustment is not required this input should be left open. Use of this input carries the potential to overdrive the laser and/or circuitry with the ability to destroy or drastically reduce the device lifetime. No internal protections on this input are provided, but the user is encouraged to clamp or otherwise limit the voltage and current that may be applied to this input. The default operating power corresponds to an input of 2.05V. For maximum reliability it is recommended that power only be reduced, although if required it can be driven as high as 2.2V (corresponding to a 10% boast in output power). The safest method of using this input is to pull the voltage down using an external resistor or potentiometer to ground. Applying a resistance to ground will create a voltage divide circuit between the external resistance and an internal resistance of 1K to the 2.05V reference. Damage due to overdrive will not be covered under warranty. Use of this input will likely decrease the performance of the EM655 by bypassing its internal ultra-low noise voltage reference.

The PA input must never be shorted directly to Vcc which would cause circuit malfunction or rapidly destroy the DFB laser.

Temperature Adjust (TA)

The EM655 is designed to operate the laser chip at a constant temperature of 25C holding the output frequency within a window of 5 GHz. However, some applications require coarse tuning of the output frequency via temperature. In these cases, the laser may be tuned using the TA input. Temperature deviations of more than a few degrees (50 GHz in laser frequency)

may result in decreased stability and increases the likelihood of the laser experiencing a longitudinal mode-hop. Use of this input carries the inherent potential of overdriving the TEC. The TA input is clamped to Vcc through integrated protection diodes. If Vta is established before Vcc these clamp diodes will conduct. The input current should always be limited to ≤3.5mA to prevent destruction of the clamp diodes. The safest method of driving this input is with a tri-state output whose output is current limited when active, maintained at high-impedance until Vcc is established, and whose output returns to high-impedance before Vcc is removed. The device warranty will not be honored for lasers with overdriven TECs. Use of this input also carries the likelihood of decreased frequency stability as it bypasses the internal ultra-low noise voltage reference.

The TA input must never be shorted directly to Vcc or ground which would cause circuit malfunction or rapidly destroy the DFB laser.

Grounding (DC and RF)

Care must be taken with grounding, cabling, and connections due to the amount of current the module consumes. Make sure that the voltage on pins PA/TA reference ground as close to the EM655 as possible if either input is connected. **DO NOT** connect the cable shield to ground at both ends of the cable to avoid producing a ground loop. **DO NOT** connect the EM655 housing to ground to avoid producing a ground loop.

The shield of the RF input 2.92 mm connector is connected to the laser anode and the center conductor to the laser cathode via the RF matching resistor. Care should be taken that the connection of an RF source does not result in a DC leakage path. The ground of the RF source must be isolated from the ground of the DC power supply, as 1.3V typical bias voltage difference will exist between the RF ground and DC ground due to the laser diode bias voltage. In addition, shorting of the RF connector places an electrical short in parallel with the laser which will prevent the laser from operating.

Startup Considerations

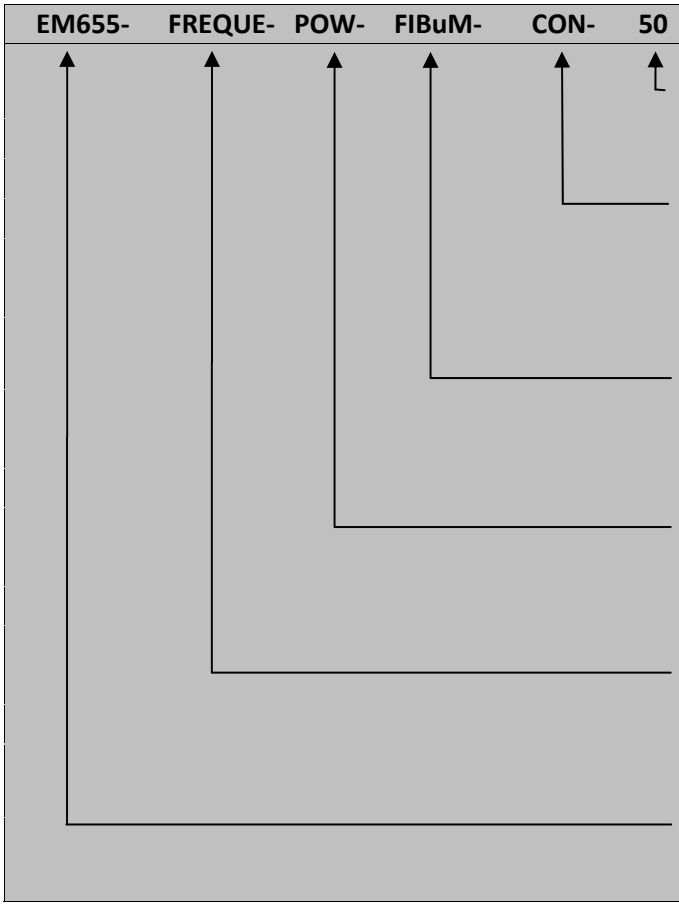
The EM655 consumes a considerable amount of current in the startup phase and when operating at temperature extremes. A voltage source plus cabling able to deliver the maximum specified current at no less than the minimum voltage is therefore needed. Current limiting below the specified maximum during the startup phase will result in an internally measured drive voltage lower than specified. This condition can result in permanent, non-warrantable damage to the device.

If the user fails to sequence the supplies as described in the Power and Temperature adjust sections of this document and Applications Note DS-7047, the device will immediately suffer non-warrantable damage or destruction.

Applications Information

Be sure to check the website for the latest applications information for this device. Application note DS-7047 covers general usage of the EM655 along with information particular to tuning via temperature or chirp. If you plan to tune this device, it is highly recommended that you read this app note.

Ordering Information

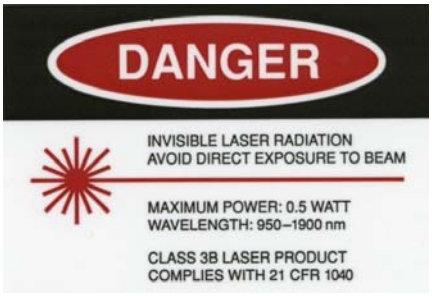


Parameter	Option	Description
Bias-T	50	50Ω Matched Bias-T
Connector	NOC	No Connector
	FCA	FC/APC
	SCA	SC/APC
	LCA	See Note 1 below
Fiber & Buffer	SM250	Single Mode Fiber, 250um Buffer
	SM900	Single Mode Fiber, 900um Loose Buffer
	PM250	PM Fiber, 250um Buffer
	PM900	PM Fiber, 900um Loose Buffer
Related Output Power	10	1310nm w/ PM Fiber
		1530-1570nm w/ any fiber
	18	1310nm w/ SM Fiber
Wavelength	FREQUE	For λ_{op} = 1310nm: 228849
		For λ_{op} = 1530nm: 195943
		For λ_{op} = 1550nm: 193414
		For λ_{op} = 1570nm: 190951
Product Family	EM655	7-pin DFB w/ Integrated Electronics
	EM656[3]	7-pin DFB w/ Integrated Electronics, WITH NO ISOLATOR[3]

1. LCA connector only offered with SM900 fiber. Fiber length 530 +/- 20mm as measured from outside wall of package (snout end) to tip of ferrule on LCA connector.
2. Optional 900 µm loose-tube PVDF buffer recommend for laboratory use. Adds approximately one week to device lead time.
3. The stability of the ordered wavelength for devices with no optical isolator cannot be guaranteed. Devices without optical isolators are also subject to mode-hops and will be susceptible to back reflections.

The component complies with all applicable portions of 21 CFR 1040.10, 21 CFR 1010.2 and 21 CFR 1010.3. Since this is a component, it does not comply with all of the requirements contained in 21 CFR 1040.10 and 21 CFR 1040.11 for complete laser products.

The information published in this datasheet is believed to be accurate and reliable. G & H reserves the right to change without notice including but not limited to the design, specification, form, fit or function relating to the product herein.



DO NOT connect the DB-9 connector on the EM655 to any commercial laser controller.

Warning:

This device requires between 4.6V and 5.5V as measured from the Vcc to GND terminals. These voltages must be maintained for currents ranging from 0-3A necessitating the use of short wires and/or large AWG wire.

Failure to supply sufficient voltage at the device terminals may result in excess current draw and permanent, non-warrantable damage. If the device draws 3A for more than 3 seconds, turn off power and check for excessive wiring resistance or a baseplate temperature outside the operational range.

Warning:

The TA and PA inputs should be driven with a current limited source with sequencing of the signal and power supply as described in the datasheet. Failure to follow these guidelines has the potential to cause non-warrantable damage to the drive electronics and/or laser module. If the device is to be tuned using either the PA or TA input, it is highly recommended that the user read and understand the application note “DS-7047 Frequency Tuning a DFB Laser,” available on the website.

Warning:

A thermal interface material is required between the EM655 and a customer supplied heatsink. G & H’s recommends the use of Panasonic PGS Series flexible graphite sheets available in the US from Digi-Key Corporation.