20 GHz Transmitter/Receiver RF over Fiber Low Noise High SFDR

DC-20 GHz Analog

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The LRFF series is a family of low-noise analog RF-over-Fiber (RFoF) transmit/receive links designed for long-distance transport of wideband RF signals with minimal degradation. These links offer a high spurious-free dynamic range (SFDR), enabling simultaneous transmission of multiple signals with widely varying power levels while maintaining excellent noise figure (NF) performance. High-SFDR operation reduces the need for heavy front-end signal conditioning, avoiding gain compression issues and simplifying separation of true signals from spurious artifacts. The transmitter uses a narrow-linewidth, high-side-mode-suppression laser coupled with an external $LiNbO_3$ modulator biased for high linearity, with a built-in RF pre-amplifier to improve NF and link gain. External modulation also supports WDM operation with up to 98 channels. The receiver includes a post-amplifier to boost RF output levels. The Tx and Rx are connected via customer fiber, with a circulator-based cable option enabling bidirectional operation. These high-performance links excel in applications requiring high SFDR — such as antenna testing, radar and communication test ranges, DF/ELINT systems, civil communications, antenna remoting, telemetry, and satellite communications — where strong jammers or large main-to-sidelobe power ratios coexist with weak signals of interest. For maximum SFDR performance, the L-series (Low Noise) products are preferred over the Q-series (standard).

Features

- Up to 20GHz
- SM28 Fiber
- Low Loss
- Low Cost
- Stable

Applications

- GSM Repeater
- CDMA Repeater
- WCDMA Repeater
- PHS Repeater
- Digital TV Repeater
- Broadcast Repeater

Note: The specifications provided are for general applications with a cost-effective approach. If you need to narrow or expand the tolerance, coverage, limit, or qualifications, please [click this link]:

RoHS COMPLIANT

Specifications (with 17dBm RF Amplifier)

Parameter	Min	Typical	Max	Unit
Frequency Range [1]	DC		20	GHz
RF Gain [2,3]		-18		dB
Gain Flatness for the entire frequency range [4]		±1.6		dB
1dB Input gain compression point [3]		11		dBm
Noise Figure [2,3]		24		dB
SFDR (calculated) [3,5]		114		$dBm/H^{2/3}$
Maximum RF input level (No damage)		16		dB
RF Transmitter Input Power	-10		+10	dBm
VSWR Input		2:1		-
VSWR Output		2:1		-
Spurious [4]		≤ -90		dBc
Phase Noise at 10KHz Offset		≤ -130		dBc/Hz
Input / Output impedance		50		Ω
Laser Diode Optical Wavelength		1.55		µm
Receiver Photodiode Optical Wavelength	1.5		1.58	µm
Laser Output Power	3			mW
Optical Output Power		3		mW
Optical Input Power	-16		-6	dBm
Operating temperature range	0		+70	°C
Storage temperature	-40		+85	°C
LED status indicators (Tx/Rx)		Blue/Green/Red		-
Input voltage [7]		5		VDC
Power consumption Tx module [8]		2		W
Power consumption Rx module [8]		0.25		W
RF Input / Output connectors		SMA		-
Optical Connector		FC/APC		-
Power connector and Data/monitor connector [9]		DB15		-

Notes:

[1]. Extended low frequency 0.01-20.0 GHz is optional.
[2]. Excluding customer fiber loss.
[3]. Measured at 10GHz. Typical values of Gain, P1dB and NF with Pre/Post Amps are indicated in the table below.
[4]. Each of the pre/post amplifiers (optional) add about ±1.2dB to the gain flatness.
[5]. Excluding in-band harmonics. SFDR (calculated) ≈ $2/3x[(IP1dB+10)+174-NF]$ $dB/Hz^{2/3}$.
[6]. Measured with input signal at Ip1dBc - 3dB at 1GHz. Ultra with 30dB post amplifier spurious level is about -85dBc
[7]. Recommended Power Supplies: Meanwell P/N GSM25U05-P1J (USA); GSM25E05-P1J (Europe); GE40I05-P1J (all purpose).
[8]. Each of the pre/post amplifiers (optional) add about 1.8W to the module power consumption.
[9]. For USB monitor software please contact us.

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Rev 10/08/26

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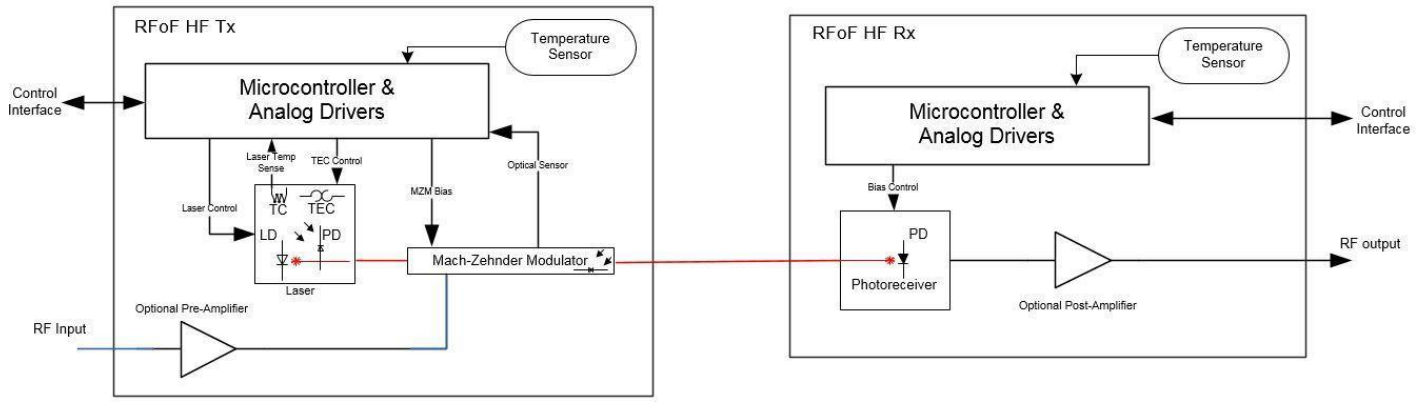
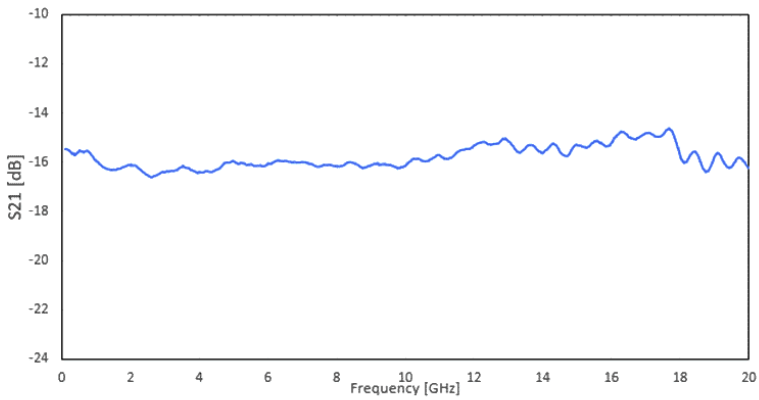
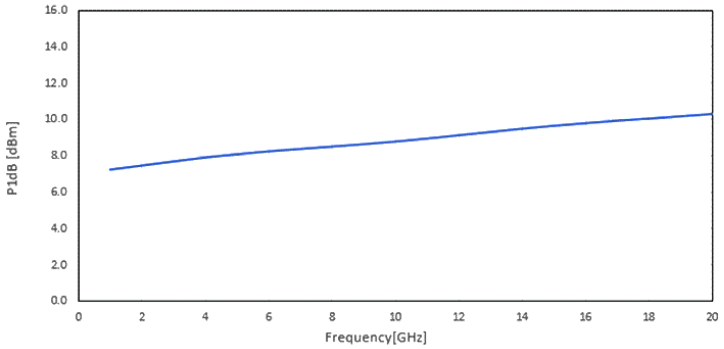
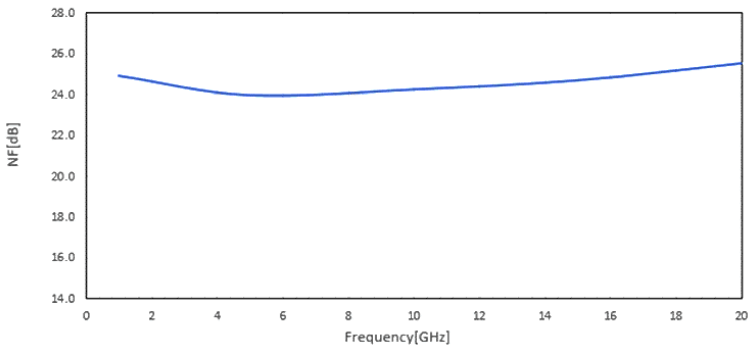
Simplified Block Diagram



Typical Response – RFoF Low NF 20GHz







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Electrical Pin Layout

Pinout D-Sub 9 Pin Male		
Pin	**Function**	**Description**
1, 3	NC	No Connection
2	Power Supply Input	Power Supply Input, +5 V
4	Alarm Out	TTL Low Output if Unit is in Alarm
5	Ground	Power Supply Ground
6	Optical Power Monitor	Analog Output, 0.125V/mW
7	Laser Enable (Active Low)	Must ground this pin to enable laser output
8	Laser Current Monitor	Analog Output, 50 mA/V
9	Temperature Out	Analog Temperature Output, VO = (10 mV/°C x T°C) + 500 mV

* Interface includes laser status, alarm status, and laser enable

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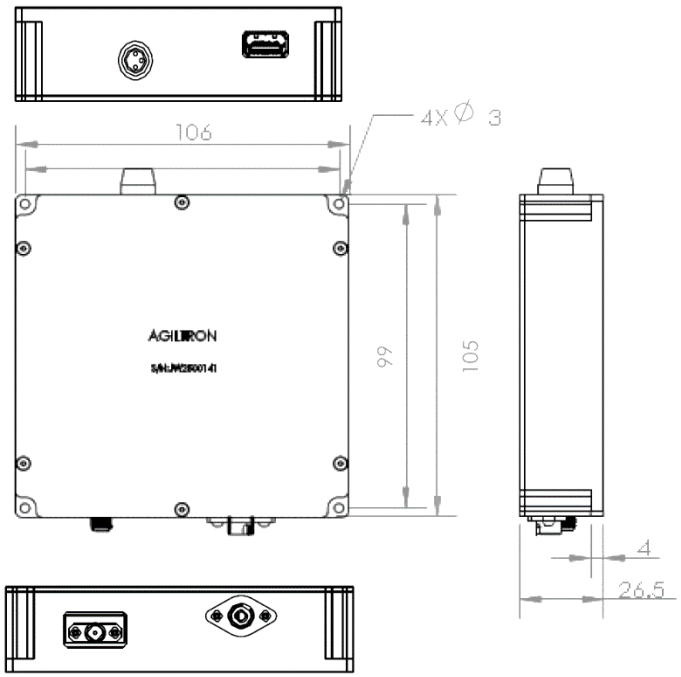
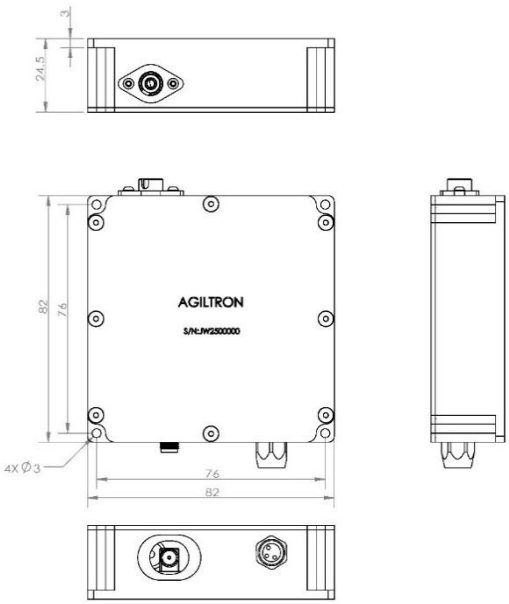
Dimensions Module (Unit: mm)

Transmitter



Receiver



*Product dimensions may change without notice. This is sometimes required for non-standard specifications.

Ordering Information (Part Number)

	□□	□	□□□	□	□	□	□	□
Prefix	**Max RF Frequency**	**Min RF Frequency**	**Wavelength**	**TX/RX**	**RF Amplifier**	**Bidirectional [1]**	**Fiber Type**	**Fiber Connector [2]**
LRFF-	20GHz = 20	0.1GHz = 1 0.01GHz = 2	1550 nm = 111 ITU Tunable = 222 1310 nm = 333 Special = 0	Receiver = 1 Transmitter = 2 Pair = 3	Non = 1 Yes = 2	None = 1 Yes = 2 Special = 0	SM28 = 1 PM1550 = 2	FC/APC = 2 FC/UPC = 3 SC/APC = 4 SC/UPC = 5 LC/APC = A LC/UPC = U Special = 0

Note:

[1]. Bidirectional means two-way communications via a single fiber link. The price is double since it comprises two pairs of transceivers and receivers with WDM (different wavelength) or circulator (same wavelength) cable jumpers.

[2]. The default connector configuration uses fiber with 0.9 mm buffer protection. The connector cannot be installed directly onto bare fiber because the bare fiber is prone to damage during shipping. However, the connector can be assembled on bare fiber if a 3 cm protective loose tube is added for reinforcement. The customer may remove this protective tube after testing. The optical power handling of a standard connector is less than 0.5 W for SMF-28 fiber and decreases further for smaller-core fibers.

Red marked -- Special order

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ITU Grid Table

Channel	f (GHz)	λ (nm)	Channel	f (GHz)	λ (nm)	Channel	f (GHz)	λ (nm)
L48	184800	1622.25	L67	186700	1605.74	L86	188600	1589.57
Q48	184850	1621.81	Q67	186750	1605.31	Q86	188650	1589.15
L49	184900	1621.38	L68	186800	1604.88	L87	188700	1588.73
Q49	184950	1620.94	Q68	186850	1604.45	Q87	188750	1588.30
L50	185000	1620.50	L69	186900	1604.03	L88	188800	1587.88
Q50	185050	1620.06	Q69	186950	1603.60	Q88	188850	1587.46
L51	185100	1619.62	L70	187000	1603.17	L89	188900	1587.04
Q51	185150	1619.19	Q70	187050	1602.74	Q89	188950	1586.62
L52	185200	1618.75	L71	187100	1602.31	L90	189000	1586.20
Q52	185250	1618.31	Q71	187150	1601.88	Q90	189050	1585.78
L53	185300	1617.88	L72	187200	1601.46	L91	189100	1585.36
Q53	185350	1617.44	Q72	187250	1601.03	Q91	189150	1584.95
L54	185400	1617.00	L73	187300	1600.60	L92	189200	1584.53
Q54	185450	1616.57	Q73	187350	1600.17	Q92	189250	1584.11
L55	185500	1616.13	L74	187400	1599.75	L93	189300	1583.69
Q55	185550	1615.70	Q74	187450	1599.32	Q93	189350	1583.27
L56	185600	1615.26	L75	187500	1598.89	L94	189400	1582.85
Q56	185650	1614.83	Q75	187550	1598.47	Q94	189450	1582.44
L57	185700	1614.39	L76	187600	1598.04	L95	189500	1582.02
Q57	185750	1613.96	Q76	187650	1597.62	Q95	189550	1581.60
L58	185800	1613.52	L77	187700	1597.19	L96	189600	1581.18
Q58	185850	1613.09	Q77	187750	1596.76	Q96	189650	1580.77
L59	185900	1612.65	L78	187800	1596.34	L97	189700	1580.35
Q59	185950	1612.22	Q78	187850	1595.91	Q97	189750	1579.93
L60	186000	1611.79	L79	187900	1595.49	L98	189800	1579.52
Q60	186050	1611.35	Q79	187950	1595.06	Q98	189850	1579.10
L61	186100	1610.92	L80	188000	1594.64	L99	189900	1578.69
Q61	186150	1610.49	Q80	188050	1594.22	Q99	189950	1578.27
L62	186200	1610.06	L81	188100	1593.79	L00	190000	1577.86
Q62	186250	1609.62	Q81	188150	1593.37	Q00	190050	1577.44
L63	186300	1609.19	L82	188200	1592.95	C01	190100	1577.03
Q63	186350	1608.76	Q82	188250	1592.52	H01	190150	1576.61
L64	186400	1608.33	L83	188300	1592.10	C02	190200	1576.20
Q64	186450	1607.90	Q83	188350	1591.68	H02	190250	1575.78
L65	186500	1607.47	L84	188400	1591.26	C03	190300	1575.37
Q65	186550	1607.04	Q84	188450	1590.83	H03	190350	1574.95
L66	186600	1606.60	L85	188500	1590.41	C04	190400	1574.54
Q66	186650	1606.17	Q85	188550	1589.99	H04	190450	1574.13

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Channel	ƒ (GHz)	λ (nm)	Channel	ƒ (GHz)	λ (nm)	Channel	ƒ (GHz)	λ (nm)
C05	190500	1573.71	C24	192400	1558.17	C43	194300	1542.94
H05	190550	1573.30	H24	192450	1557.77	H43	194350	1542.54
C06	190600	1572.89	C25	192500	1557.36	C44	194400	1542.14
H06	190650	1572.48	H25	192550	1556.96	H44	194450	1541.75
C07	190700	1572.06	C26	192600	1556.55	C45	194500	1541.35
H07	190750	1571.65	H26	192650	1556.15	H45	194550	1540.95
C08	190800	1571.24	C27	192700	1555.75	C46	194600	1540.56
H08	190850	1570.83	H27	192750	1555.34	H46	194650	1540.16
C09	190900	1570.42	C28	192800	1554.94	C47	194700	1539.77
H09	190950	1570.01	H28	192850	1554.54	H47	194750	1539.37
C10	191000	1569.59	C29	192900	1554.13	C48	194800	1538.98
H10	191050	1569.18	H29	192950	1553.73	H48	194850	1538.58
C11	191100	1568.77	C30	193000	1553.33	C49	194900	1538.19
H11	191150	1568.36	H30	193050	1552.93	H49	194950	1537.79
C12	191200	1567.95	C31	193100	1552.52	C50	195000	1537.40
H12	191250	1567.54	H31	193150	1552.12	H50	195050	1537.00
C13	191300	1567.13	C32	193200	1551.72	C51	195100	1536.61
H13	191350	1566.72	H32	193250	1551.32	H51	195150	1536.22
C14	191400	1566.31	C33	193300	1550.92	C52	195200	1535.82
H14	191450	1565.90	H33	193350	1550.52	H52	195250	1535.43
C15	191500	1565.50	C34	193400	1550.12	C53	195300	1535.04
H15	191550	1565.09	H34	193450	1549.72	H53	195350	1534.64
C16	191600	1564.68	C35	193500	1549.32	C54	195400	1534.25
H16	191650	1564.27	H35	193550	1548.91	H54	195450	1533.86
C17	191700	1563.86	C36	193600	1548.51	C55	195500	1533.47
H17	191750	1563.45	H36	193650	1548.11	H55	195550	1533.07
C18	191800	1563.05	C37	193700	1547.72	C56	195600	1532.68
H18	191850	1562.64	H37	193750	1547.32	H56	195650	1532.29
C19	191900	1562.23	C38	193800	1546.92	C57	195700	1531.90
H19	191950	1561.83	H38	193850	1546.52	H57	195750	1531.51
C20	192000	1561.42	C39	193900	1546.12	C58	195800	1531.12
H20	192050	1561.01	H39	193950	1545.72	H58	195850	1530.72
C21	192100	1560.61	C40	194000	1545.32	C59	195900	1530.33
H21	192150	1560.20	H40	194050	1544.92	H59	195950	1529.94
C22	192200	1559.79	C41	194100	1544.53	C60	196000	1529.55
H22	192250	1559.39	H41	194150	1544.13	H60	196050	1529.16
C23	192300	1558.98	C42	194200	1543.73	C61	196100	1528.77
H23	192350	1558.58	H42	194250	1543.33	H61	196150	1528.38

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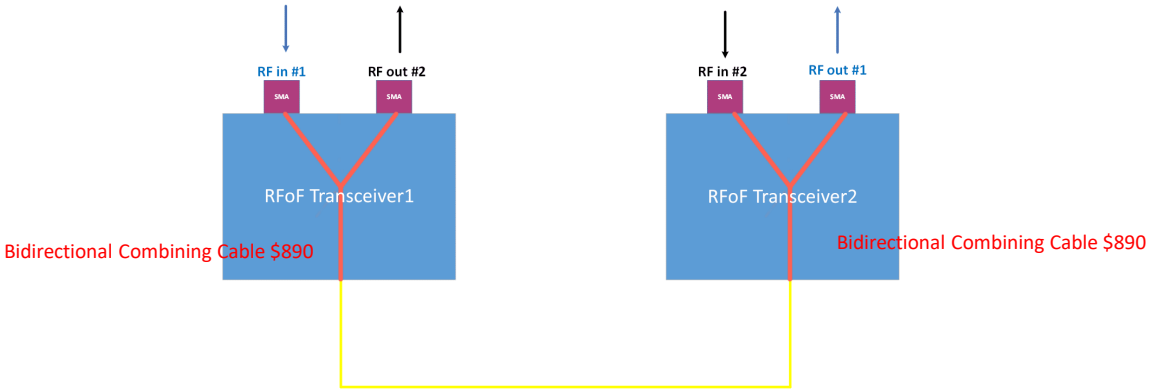
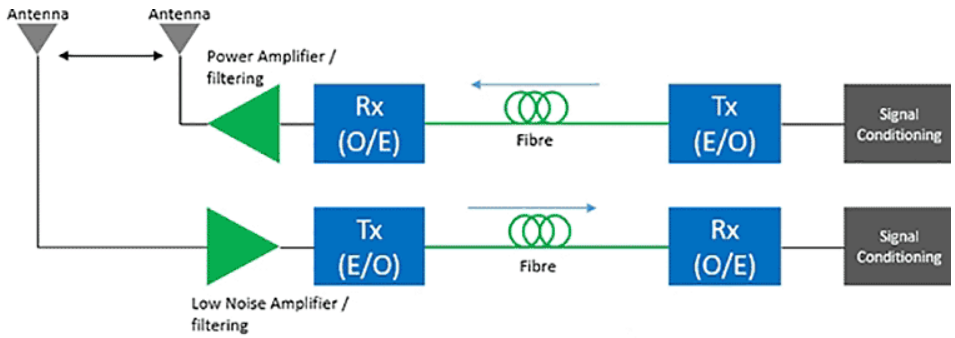
Application Example 1 – Bidirectional RF Link via a Single Fiber



Application Example 2 – WDM Multichannel Transmission

Application Example – Satellite RF over Fiber Link



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Operation Instructions

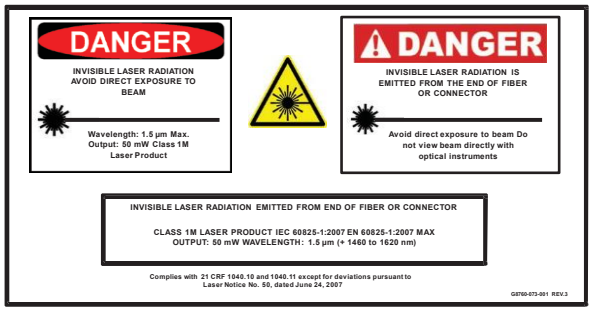
1. Connect the optical fiber input port on the receiver to the signal source.
2. Connect the RF output port on the receiver to the RF input port of the transmitter.
3. Connect the RF output port of the transmitter to the readout instrument.
4. Plug in the provided power supply to power the device. The LED will turn on (CW for the receiver, blinking for the transmitter).
5. The unit will operate with the performance specified in the test report.
6. If the device does not function as expected, contact us via the sales email. **Do not open the enclosure — doing so will invalidate the one-year warranty.**

Laser Safety

This product meets the appropriate standard in Title 21 of the Code of Federal Regulations (CFR). FDA/CDRH Class 1M laser product. This device has been classified with the FDA/CDRH under accession number 0220191. All versions of this laser are Class 1M laser products, tested according to IEC 60825-1:2007 / EN 60825-1:2007. An additional warning for Class 1M laser products. For diverging beams, this warning shall state that viewing the laser output with certain optical instruments (for example eye loupes, magnifiers, and microscopes) within a distance of 100 mm may pose an eye hazard. For collimated beams, this warning shall state that viewing the laser output with certain instruments designed for use at a distance (for example telescopes and binoculars) may pose an eye hazard.

Wavelength = 1.3/1.5 µm.

Maximum power = 30 mW.



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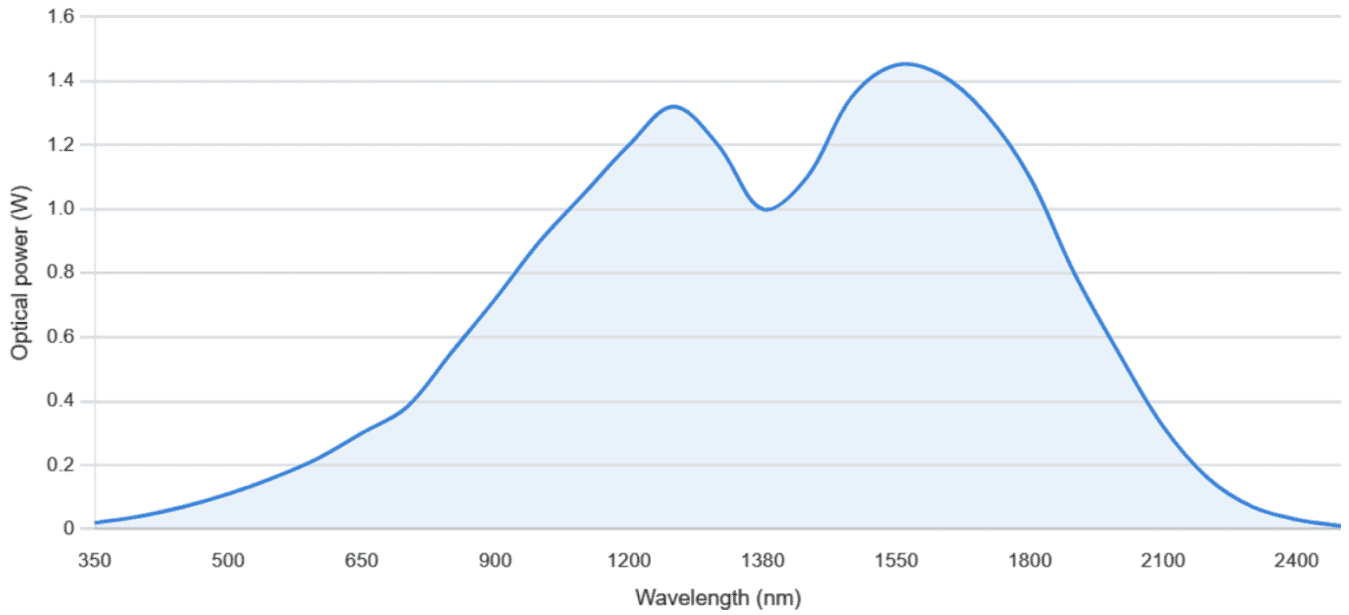
Regular Single Mode / Polarization Maintaining Fiber Optical Power Handing vs Wavelength



Single mode fiber optical power is limited by nonlinear effects in addition to absorption that increase loss and generate heat. The curve shows the approximate safe CW power envelope for standard single-mode fiber. Actual limits depend on fiber design, core size, length, and laser characteristics. Specialty fibers can significantly increase the power limit.

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