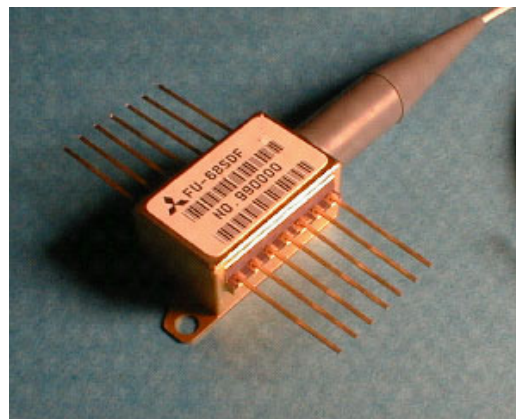


FU-68SDF-x9yyMzzF**1.55 μ m DFB-LD MODULE WITH SINGLEMODE FIBER PIGTAIL****DESCRIPTION**

Module type FU-68SDF-x902MzzF/-x910MzzF is a 1.55 μ m DFB-LD module with single mode optical fiber. This module is suitable to a directly modulated light source for use in 2.5Gb/s digital optical communication systems.

This module is prepared in accordance with ITU-T recommendation wavelength channel plan for Dense-WDM transmission.

**FEATURES**

- Input impedance is 25 Ω
- Multi quantum wells (MQW) DFB Laser Diode module
- Emission wavelength is in full C band
- Single mode optical fiber pig-tail
- Built-in optical isolator
- Built-in thermal electric cooler
- Butterfly package
- With photodiode for optical output monitor
- RoHS (2002/95/EC) compliant

APPLICATION

High speed transmission systems (~2.5Gb/s)
Dense-WDM systems

ABSOLUTE MAXIMUM RATINGS (T_{id}=T_{set})

Parameter		Symbol	Conditions	Rating	Unit	
Laser diode	Optical output power	Pf	CW	-x902MzzF	6	mW
				-x910MzzF	15	
	Forward current	I _f	CW	150	mA	
	Reverse voltage	V _{rl}	-	2	V	
Photodiode	Reverse voltage	V _{rd}	-	20	V	
	Forward current	I _{fd}	-	2	mA	
Thermo-electric cooler (Note 1)	Cooler current	I _{pe}	-	1.3	A	
	Cooler voltage	V _{pe}	-	3.1	V	
Operating case temperature		T _c	-	-20 ~ 70	°C	
Storage temperature		T _{stg}	-	-40 ~ 85	°C	

Note 1) Even if the thermo-electric cooler (TEC) is operated within the rated conditions, uncontrolled current loading or operation without heatsink may easily damage the module by exceeding the storage temperature range.

Thermistor resistance should be properly monitored by the feedback circuit during TEC operation to avoid the catastrophic damage.

FU-68SDF-x9yyMzzF1.55 μm DFB-LD MODULE WITH SINGLEMODE FIBER PIGTAIL**ELECTRICAL/OPTICAL CHARACTERISTICS** ($T_{\text{ld}}=T_{\text{set}}$, $T_{\text{c}}=25^{\circ}\text{C}$ unless otherwise noted)

Parameter	Symbol	Test Conditions	Limits			Unit	
			Min.	Typ.	Max.		
Optical output	P_0	CW, $I_f=I_{\text{op}}$	-x902MzzF	2		mW	
			-x910MzzF	10			
Threshold current	I_{th}	CW	-	10	25	mA	
Optical output power at threshold current	P_{th}	CW, $I_f=I_{\text{th}}$	-x902MzzF	-	100	μW	
			-x910MzzF	-	150		
Operating current	I_{op}	CW, $P_f=P_0$	-x902MzzF	-	40	mA	
			-x910MzzF	-	50		
Operating voltage	V_{op}	CW, $P_f=P_0$	-	1.3	1.8	V	
Input impedance	Z_{in}	$P_f=P_0$	-	25	-	Ω	
Light-emission central wavelength	λ_{c}	(Note 2)	See Ordering Information and Table 1			nm	
Central wavelength drift with case temp.	$\Delta\lambda_{\text{c}}/\Delta T_{\text{c}}$	$T_{\text{c}}=-20\sim 70^{\circ}\text{C}$	-1	-	0	$\text{pm}/^{\circ}\text{C}$	
Laser operating temperature	T_{set}	-	20	-	35	$^{\circ}\text{C}$	
Spectral width	$\Delta\lambda$	(Note 2), -20dB	-	0.2	0.4	nm	
Side mode suppression ratio	S_{r}	(Note 2)	33	40	-	dB	
Dispersion penalty	P_{p}	(Note 2), at 10^{-10} BER, +3000ps/nm	-	-	2	dB	
Cutoff frequency (-1.5dB optical)	f_{c}	$P_f=P_0$	3.5	-	-	GHz	
Rise and fall time (10~90%)	$t_{\text{r}}, t_{\text{f}}$	(Note 2)	-	-	150	psec	
Relative intensity noise	N_{r}	CW, $P_f=P_0$, $f=0.5\sim 3\text{GHz}$	-	-155	-145	dB/Hz	
Tracking error	E_{r}	$T_{\text{c}}=-20\sim 70^{\circ}\text{C}$, APC, ATC (Note 3)	-	-	0.5	dB	
Differential efficiency	η	CW $P_f=P_0$	-x902MzzF	0.057	0.07	0.15	mW/mA
			-x910MzzF	0.15	0.25	0.35	
Linearity	$\Delta\eta$	CW, $P_f=P_0 \times 0.1 \sim P_0 \times 1.2$ (Note 4)	-20	-	20	%	
Monitor current	I_{mon}	CW, $P_f=P_0$ $V_{\text{rd}}=5\text{V}$	-x902MzzF	0.1	-	2	mA
			-x910MzzF	0.2	-	3	
Optical isolation	I_{so}	$T_{\text{c}}=25^{\circ}\text{C}$	35	-	-	dB	
		$T_{\text{c}}=-20\sim 70^{\circ}\text{C}$	23	-	-		
Dark current (PD)	I_{d}	$V_{\text{rd}}=5\text{V}$, $T_{\text{c}}=-20\sim 70^{\circ}\text{C}$	-	-	0.1	μA	
Capacitance (PD)	C_{t}	$V_{\text{rd}}=5\text{V}$, $f=1\text{MHz}$	-	-	10	pF	

Note 2) 2.48832Gb/s NRZ, $2^{23}-1$, $P_{f_ave}=P_0 \times 0.5$, Extinction ratio 10dB, optical return loss of the connectors should be greater than 40dB in order to ensure the specified performance.

Note 3) $E_{\text{r}}=\max\{10 \times \log(P_f / P_f@25^{\circ}\text{C})\}$

Note 4) Variation of the differential efficiency from the straight line between $P_0 \times 0.1 \sim P_0 \times 1.2$

THERMAL CHARACTERISTICS ($T_{\text{ld}}=T_{\text{set}}$, $T_{\text{c}}=-20\sim 70^{\circ}\text{C}$)

Parameter	Symbol	Test Conditions	Limits			Unit
			Min.	Typ.	Max.	
Thermistor resistance	R_{th}	$T_{\text{ld}}=25^{\circ}\text{C}$	9.5	10	10.5	$\text{k}\Omega$
B constant of R_{th}	B	-	-	3950	-	K
Cooling capacity	ΔT	$P_f=P_0$, $T_{\text{c}}=70^{\circ}\text{C}$	50	-	-	$^{\circ}\text{C}$
Cooler current	I_{pe}	$P_f=P_0$, $T_{\text{c}}=70^{\circ}\text{C}$, $T_{\text{ld}}=T_{\text{set}}$	-	0.6	1	A
Cooler voltage	V_{pe}	$P_f=P_0$, $T_{\text{c}}=70^{\circ}\text{C}$, $T_{\text{ld}}=T_{\text{set}}$	-	1.2	2	V

FU-68SDF-x9yyMzzF**1.55 μm DFB-LD MODULE WITH SINGLEMODE FIBER PIGTAIL****FIBER PIGTAIL SPECIFICATIONS**

Parameter	Limits	Unit
Type	SM	-
Mode field diameter	9.5+/-1	μm
Cladding diameter	125+/-2	μm
Secondary coating outer diameter	0.9+/-0.1	mm
Connector	(Note 5)	-
Optical return loss of connector	40 (min)	dB

Note 5) SC/PC and FC/PC are available. Other connectors are also available for large quantities.

DOCUMENTATION (T_{ld}=T_{set})

- Fiber output power vs. Laser forward current at T_{ld}=T_{set} and T_c=25°C
- Threshold current (I_{th})
- Laser forward current (I_{op}) at P_f=P₀
- Laser forward voltage (V_{op}) at P_f=P₀
- Laser operating temperature (T_{set}) at λ_c (Note 6)
- Monitor current (I_{mon}) at P_f=P₀
- Thermistor resistance (R_{th})
- Cooler current (I_{pe}) at P_f=P₀ and T_c=70°C
- Cooler voltage (V_{pe}) at P_f=P₀ and T_c=70°C

Note 6) T_{set} is attached as a reference data. R_{th} should be used in order to tune the wavelength to the specified value accurately.

FU-68SDF-x9yyMzzF1.55 μm DFB-LD MODULE WITH SINGLEMODE FIBER PIGTAIL

ORDERING INFORMATION

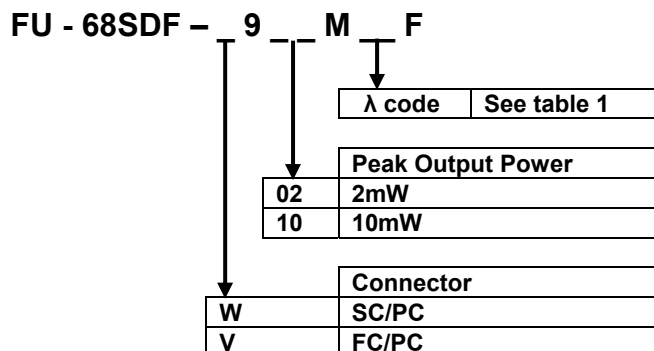


Table 1.

f [THz]	λ_c [nm]	λ code	f [THz]	λ_c [nm]	λ code
196.30	1527.22	3	192.80	1554.94	73
196.20	1527.99	5	192.70	1555.75	75
196.10	1528.77	7	192.60	1556.55	77
196.00	1529.55	9	192.50	1557.36	79
195.90	1530.33	11	192.40	1558.17	81
195.80	1531.12	13	192.30	1558.98	83
195.70	1531.90	15	192.20	1559.79	85
195.60	1532.68	17	192.10	1560.61	87
195.50	1533.47	19	192.00	1561.42	89
195.40	1534.25	21	191.90	1562.23	91
195.30	1535.04	23	191.80	1563.05	93
195.20	1535.82	25	191.70	1563.86	95
195.10	1536.61	27			
195.00	1537.40	29			
194.90	1538.19	31			
194.80	1538.98	33			
194.70	1539.77	35			
194.60	1540.56	37			
194.50	1541.35	39			
194.40	1542.14	41			
194.30	1542.94	43			
194.20	1543.73	45			
194.10	1544.53	47			
194.00	1545.32	49			
193.90	1546.12	51			
193.80	1546.92	53			
193.70	1547.72	55			
193.60	1548.51	57			
193.50	1549.32	59			
193.40	1550.12	61			
193.30	1550.92	63			
193.20	1551.72	65			
193.10	1552.52	67			
193.00	1553.33	69			
192.90	1554.13	71			

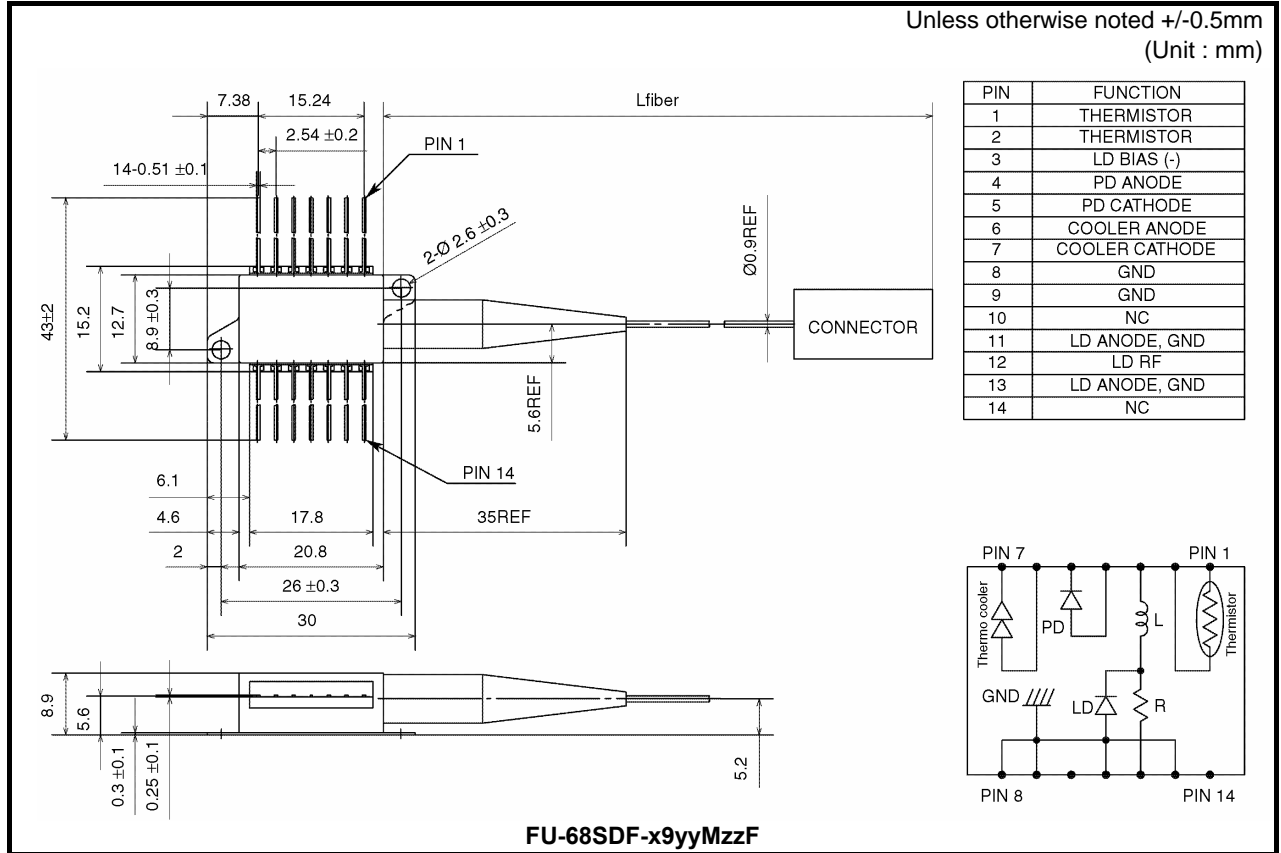
All wavelengths are referred to vacuum. Tolerance is $\lambda_c \pm 0.05\text{nm}$.

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1.55 μm DFB-LD MODULE WITH SINGLEMODE FIBER PIGTAIL

OUTLINE DIAGRAM

Unless otherwise noted +/-0.5mm
(Unit : mm)



FU-68SDF-x9yyMzzF**1.55 μm DFB-LD MODULE WITH SINGLEMODE FIBER PIGTAIL****Safety Cautions for Use of Optoelectronic Devices****General:**

Although the manufacturer is always striving to improve the reliability of its product, problems and errors may occur with semiconductor products. Therefore, the user's products are required to be designed with full safety regard to prevent any accidents that results in injury, death, fire or environmental damage even when semiconductor products happen to error. Especially it is recommended to take in consideration about redundancy, fire prevention, error prevention safeguards. And the following requirements must be strictly observed.

Warning!

1. Eye safety : Semiconductor laser radiates laser light during operation. Laser light is very dangerous when shot directly into human eyes. Don't look at laser light directly, or through optics such as a lens. The laser light should be observed using the ITV camera, IR-viewer, or other appropriate instruments.

2. Product handling : The product contains GaAs (gallium arsenide). It is safe for regular use, but harmful to the human body if made into powder or steam. Be sure to avoid dangerous process like smashing, burning, chemical etching. Never put this product in one's mouth or swallow it.

3. Product disposal : This product must be disposed of as special industrial waste. It is necessary to separate it from general industrial waste and general garbage.

Handling Cautions for Optoelectronic Devices**1. General:**

(1) The products described in this specification are designed and manufactured for use in general communication systems or electronic devices, unless their applications or reliability are otherwise specified. Therefore, they are not designed or manufactured for installation in devices or systems that may affect human life or that are used in social infrastructure requiring high reliability.

(2) When the customer is considering to use the products in special applications, such as transportation systems (automobiles, trains, vessels), medical equipments, aerospace, nuclear power control, and submarine repeaters or systems, please contact Mitsubishi Electric or an authorized distributor.

2. Shipping Conditions:

(1) During shipment, place the packing boxes in the correct direction, and fix them firmly to keep them immovable. Placing the boxes upside down, tilting, or applying abnormal pressure onto them may cause deformation in the electrode terminals, breaking of optical fiber, or other problems.

(2) Never throw or drop the packing boxes. Hard impact on the boxes may cause break of the devices.

(3) Take strict precautions to keep the devices dry when shipping under rain or snow.

3. Storage Conditions:

When storing the products, it is recommended to store them following the conditions described below without opening the packing. Not taking enough care in storing may result in defects in electrical characteristics, soldering quality, visual appearance, and so on. The main points are described below (if special storage conditions are given to the product in the specification sheet, they have priority over the following general cautions):

(1) Appropriate temperature and humidity conditions, i.e., temperature range between 5~30°C, and humidity between 40~60 percent RH, should be maintained in storage locations. Controlling the temperature and humidity within this range is particularly important in case of long-term storage for six months or more.

(2) The atmosphere should be particularly free from toxic gases and dust.

(3) Do not apply any load on the product.

(4) Do not cut or bend the leads of the devices which are to be stored. This is to prevent corrosion in the cut or bent part of the lead causing soldering problems in the customer's assembling process.

(5) Sudden change in temperature may cause condensation in the product or packing, therefore, such locations should be avoided for storing. Temperature in storage locations should be stable.

(6) When storing ceramic package products for extended periods of time, the leads may turn reddish due to reaction with sulfur in the atmosphere.

(7) Storage conditions for bare chip and unsealed products shall be stated separately because bare chip and unsealed products require stricter controls than package sealed products.

4. Design Conditions and Environment under Use:

(1) Avoid use in locations where water or organic solvents adhere directly to the product, or where there is any possibility of the generation of corrosive gas, explosive gas, dust, salinity, or other troublesome conditions. Such environments will not only significantly lower the reliability, but also may lead to serious accidents.

(2) Operation in excess of the absolute maximum ratings can cause permanent damage to the device. The customers are requested to design not to exceed those ratings even for a short time.

5. ESD Safety Cautions:

The optoelectronic devices are sensitive to static electricity (ESD, electro-static discharge). The product can be broken by ESD. When handling this product, please observe the following countermeasures:

<Countermeasures against Static Electricity and Surge>

To prevent break of devices by static electricity or surge, please adopt the following countermeasures in the assembly line:

(1) Ground all equipments, machinery jigs, and tools in the process line with earth wires installed in them. Take particular care with hot plates, solder irons and other items for which the commercial power supplies are prone to leakage.

(2) Workers should always use earth bands. Use of antistatic clothing, electric conductive shoes, and other safety equipment while at work is highly recommended.

(3) Use conductive materials for this product's container, etc.

(4) It is recommended that grounding mats be placed on the surfaces of assembly line workbench and the surrounding floor in work area, etc.

(5) When mounting this product in parts or materials which can be electrically charged (printed wiring boards, plastic products, etc.), pay close attention to the static electricity in those parts. ESD may damage the product.

(6) Humidity in working environment should be controlled to be 40 percent RH or higher.

These countermeasures are most general, and there is a need to carefully confirm the line before starting mass production using this product (in the trial production, etc.). It is extremely important to prevent surge, eliminate it rapidly, and prevent it from spreading.