

# 1,550nm Modulator Integrated DFB Laser

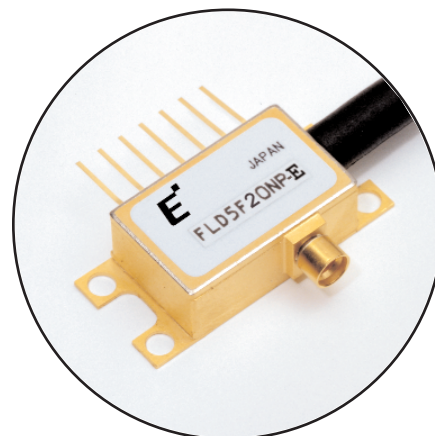
## FLD5F20NP-E

### FEATURES

- Modulator Integrated DFB Laser Diode Module
- CW operation of DFB laser section
- Modulation voltage applied only to modulator section
- High speed butterfly package with GPO connection
- Built-in optical isolator, monitor photodiode, thermistor, and thermo-electric cooler
- Available at C-Band ITU-T grid wavelengths between 1529.55nm thru 1563.05nm

### APPLICATION

This MI DFB laser is intended for long reach applications ( $\leq 80\text{km}$ ) at 10Gb/s.



### DESCRIPTION

The Modulator Integrated DFB Laser (MI DFB Laser) has an electro-absorption modulator monolithically integrated with a conventional Distributed Feed-Back (DFB) laser. The modulation voltage is applied to the modulator section while the laser section operates CW allowing extremely low wavelength chirping. Extinction ratios of more than 10 dB can be achieved with 2.6 Vp-p modulation. The MI laser is installed in a butterfly type package. The module incorporates a highly stable optical coupling system. The module includes an optical isolator, monitor photodiode, thermistor and a thermo-electric cooler.

### ABSOLUTE MAXIMUM RATINGS ( $T_{op}=25^{\circ}\text{C}$ , unless otherwise specified)

| Parameter                  | Symbol    | Condition              | Rating |      | Unit               |
|----------------------------|-----------|------------------------|--------|------|--------------------|
|                            |           |                        | Min.   | Max. |                    |
| Storage Temperature        | $T_{stg}$ | -                      | -40    | +85  | $^{\circ}\text{C}$ |
| Operating Case Temperature | $T_{op}$  | -                      | -20    | +70  | $^{\circ}\text{C}$ |
| Optical Output Power       | $P_f$     | CW                     | -      | 5    | mW                 |
| Laser Forward Current      | $I_F$     | CW                     | -      | 150  | mA                 |
| Laser Reverse Voltage      | $V_R$     | CW                     | -      | 2    | V                  |
| Modulator Forward Voltage  | $V_m$     | CW                     | -5     | +1   | V                  |
| Photodiode Forward Current | -         | -                      | -      | 1    | mA                 |
| Photodiode Reverse Voltage | $V_{DR}$  | -                      | -      | 10   | V                  |
| TEC Voltage                | $V_c$     | Cooling                | -      | +2.5 | V                  |
|                            |           | Heating                | -2.5   | -    |                    |
| TEC Current                | $I_c$     | Cooling                | -      | +1.4 | A                  |
|                            |           | Heating                | -0.9   | -    |                    |
| Thermistor Temperature     | $T_{th}$  | ATC Operation          | -20    | +70  | $^{\circ}\text{C}$ |
| Lead Soldering Time        | -         | 260 $^{\circ}\text{C}$ | -      | 10   | sec                |

## OPTICAL & ELECTRICAL CHARACTERISTICS (T<sub>L</sub> = T<sub>set</sub>, T<sub>c</sub> = 25°C, BOL, unless otherwise specified)

| Parameter                                  | Symbol           | Test Condition                                                                                                                                    | Limits              |       |       | Unit  |
|--------------------------------------------|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|-------|-------|-------|
|                                            |                  |                                                                                                                                                   | Min.                | Type  | Max.  |       |
| Peak Wavelength                            | $\lambda_p$      |                                                                                                                                                   | Note (4)            |       |       | nm    |
| Threshold Current                          | I <sub>th</sub>  | CW, V <sub>m</sub> =V <sub>o</sub>                                                                                                                | -                   | -     | 30    | mA    |
| Operating Current                          | I <sub>op</sub>  |                                                                                                                                                   | 40                  | -     | 100   | mA    |
| Forward Voltage                            | V <sub>F</sub>   | CW, I <sub>F</sub> =I <sub>op</sub>                                                                                                               | -                   | 1.4   | 2.0   | V     |
| Optical Output Power (Avg. Power)          | P <sub>f</sub>   | Note (1)                                                                                                                                          | -2.0                | -     | -     | dBm   |
| Dispersion Penalty                         | dP               |                                                                                                                                                   | -                   | -     | 2     | dB    |
| Sidemode Suppression Ratio                 | SSR              | Note (2)                                                                                                                                          | 35                  | -     | -     | dB    |
| Wavelength Drift                           | -                | after 20 years                                                                                                                                    | -0.1                | -     | 0.1   | nm    |
| Wavelength Stability with Case Temperature | -                | -                                                                                                                                                 | -                   | -     | ±1.0  | pm/°C |
| Optical Isolation                          | I <sub>s</sub>   | T <sub>c</sub> =-20 to +70°C                                                                                                                      | 25                  | 35    | -     | dB    |
| On Level Modulation                        | V <sub>o</sub>   | -                                                                                                                                                 | -0.7                | -     | 0     | V     |
| Modulator Drive Voltage                    | V <sub>mod</sub> | (V <sub>o</sub> -V <sub>mod</sub> )≥-3.3V, R <sub>ext</sub> =10dB                                                                                 | -                   | -     | 2.6   | V     |
| Extinction Ratio                           | R <sub>ext</sub> | I <sub>F</sub> =I <sub>op</sub> , V <sub>m</sub> =V <sub>o</sub> (at On Level)<br>V <sub>m</sub> =V <sub>o</sub> -V <sub>mod</sub> (at Off Level) | 10                  | -     | -     | dB    |
| Rise Time                                  | T <sub>r</sub>   | I <sub>F</sub> =I <sub>op</sub> , V <sub>m</sub> =V <sub>o</sub> , 20 to 80%                                                                      | -                   | 20    | 25    | ps    |
| Fall Time                                  | T <sub>f</sub>   |                                                                                                                                                   | -                   | 20    | 25    | ps    |
| Cut-off Frequency                          | S <sub>21</sub>  | -3dB bandwidth,<br>V <sub>m</sub> =V <sub>o</sub> -0.5IV <sub>mod</sub> I, I <sub>F</sub> =I <sub>op</sub>                                        | 10                  | -     | -     | GHz   |
| In-Band Ripple                             | ΔG               | I <sub>F</sub> =I <sub>op</sub> , f=0.1-10GHz,<br>V <sub>m</sub> =V <sub>o</sub> -0.5IV <sub>mod</sub> I                                          | -                   | -     | ±1.0  | dB    |
| RF Return Loss                             | S <sub>11</sub>  | f=DC-5GHz, 50Ω Test Set,<br>V <sub>m</sub> =V <sub>o</sub> , I <sub>F</sub> =I <sub>op</sub>                                                      | 8                   | -     | -     | dB    |
| RF Return Loss                             | S <sub>11</sub>  | f=5-10GHz, 50Ω Test Set,<br>V <sub>m</sub> =V <sub>o</sub> , I <sub>F</sub> =I <sub>op</sub>                                                      | 5                   | -     | -     | dB    |
| Relative Intensity Noise                   | RIN              | f=10 MHz to 8.5 GHz,<br>V <sub>m</sub> =V <sub>o</sub> , I <sub>F</sub> =I <sub>op</sub> , 8% Reflection                                          | -                   | -     | -120  | dB/Hz |
| TEC Capacity                               | ΔT               | P <sub>TEC</sub> =3.3W, I <sub>F</sub> =I <sub>op</sub>                                                                                           | 70-T <sub>set</sub> | -     | -     | °C    |
| TEC Current                                | I <sub>TEC</sub> | I <sub>F</sub> =I <sub>op</sub> , ΔT=(70-T <sub>set</sub> )[°C]                                                                                   | -                   | -     | 1.3   | A     |
| TEC Voltage                                | V <sub>TEC</sub> | I <sub>F</sub> =I <sub>op</sub> , ΔT=(70-T <sub>set</sub> )[°C]                                                                                   | -                   | -     | 2.5   | V     |
| TEC Power Dissipation                      | P <sub>TEC</sub> | I <sub>F</sub> =I <sub>op</sub>                                                                                                                   | -                   | -     | 3.3   | W     |
| Thermal Resistance                         | R <sub>th</sub>  | T <sub>L</sub> =25°C, T <sub>c</sub> =+25°C                                                                                                       | 9.5                 | 10.0  | 10.5  | kΩ    |
| Thermistor B Constant (Note 3)             | B                |                                                                                                                                                   | 3,270               | 3,450 | 3,630 | K     |

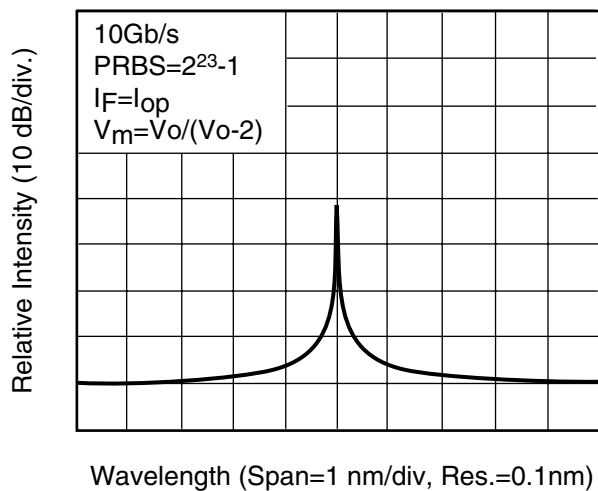
Note (1) Eudyna Test System  
9.95328Gb/s, PRBS=2<sup>23</sup>-1, I<sub>F</sub>=I<sub>op</sub>, V<sub>m</sub>=V<sub>o</sub> and (V<sub>o</sub>-V<sub>mod</sub>)  
Dispersion=1600ps/nm, Dispersion penalty at  
Bit Error Rate = 1.0E-10

Note (2) Eudyna Test System  
9.95328Gb/s, PRBS=2<sup>23</sup>-1, I<sub>F</sub>=I<sub>op</sub>, V<sub>m</sub>=V<sub>o</sub> and (V<sub>o</sub>-V<sub>mod</sub>)

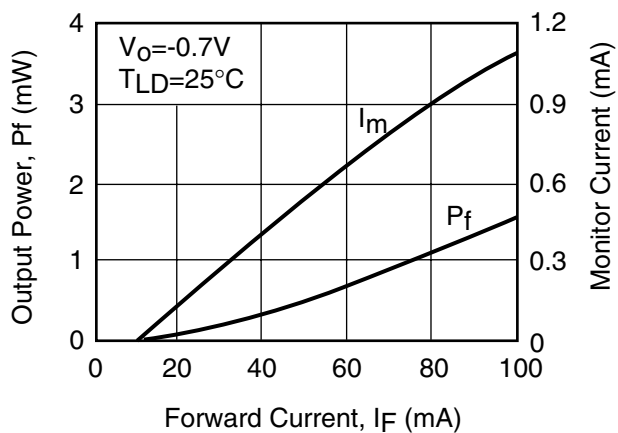
Note (3) Relation between resistance and temperature (°K) is: R<sub>th</sub> (T) = R<sub>th</sub> (25°C) \* exp[B(1/T-1/298)]

Note (4) Reference Table 1 for Wavelength Table

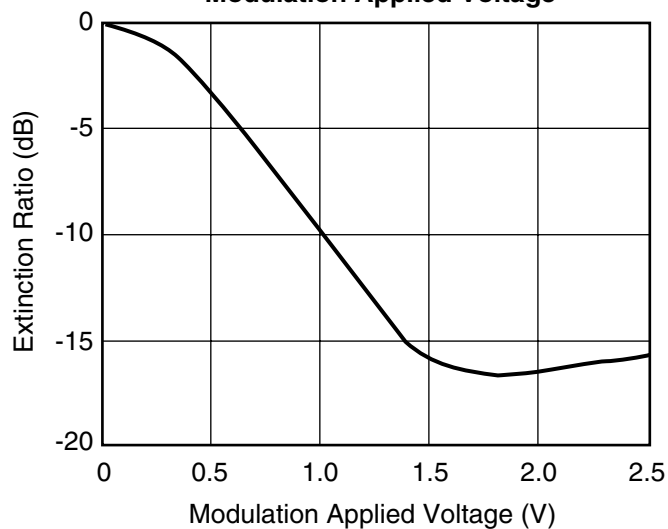
**Fig. 1 Lasing Spectrum**



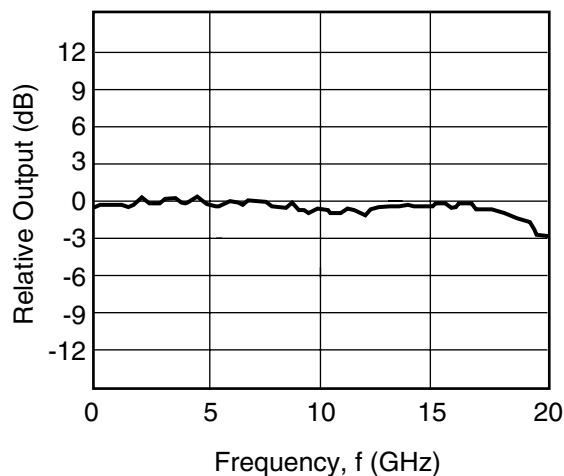
**Fig. 2 Output Power & Monitor Current  
vs. Forward Current**



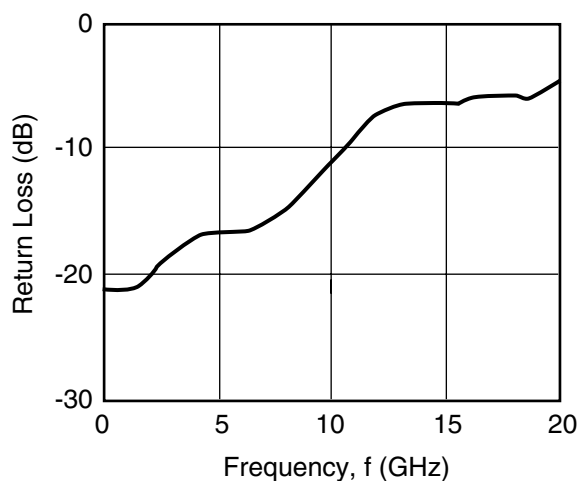
**Fig. 3 Extinction Ratio vs. Modulation Applied Voltage**



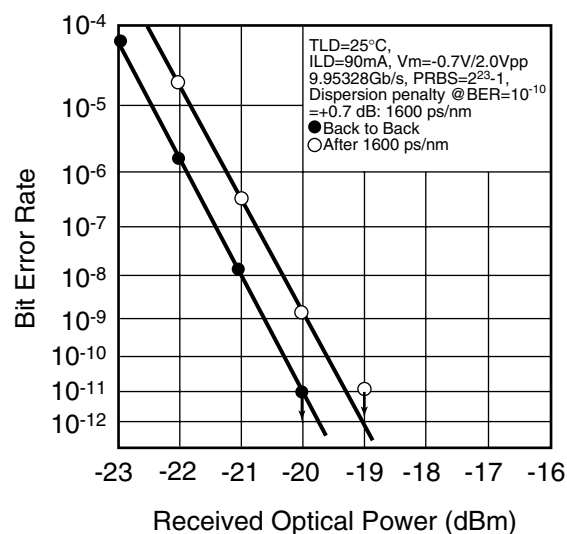
**Fig. 4 Cut-off Frequency (S21)**



**Fig. 5 RF Return Loss (S11)**

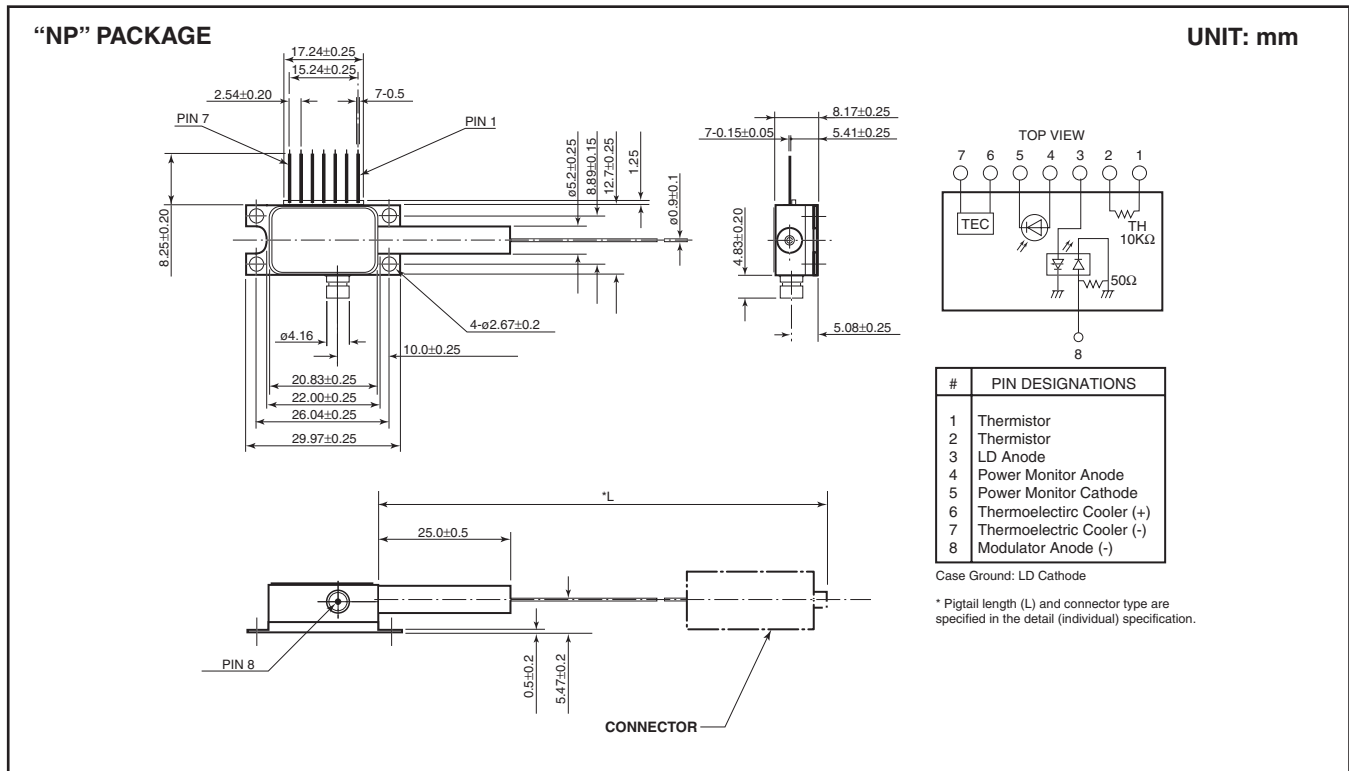


**Fig. 6 Transmission Characteristics**



**Table 1 Wavelength Table**

| Part Number   | Wavelength (nm)<br>(TL=Tset)<br>(in vacuum) | Frequency (THz) | Tolerance (nm) |
|---------------|---------------------------------------------|-----------------|----------------|
| FLD5F20NP-E60 | 1529.55                                     | 196.00          | ±0.1           |
| FLD5F20NP-E59 | 1530.33                                     | 195.90          | ±0.1           |
| FLD5F20NP-E58 | 1531.12                                     | 195.80          | ±0.1           |
| FLD5F20NP-E57 | 1531.90                                     | 195.70          | ±0.1           |
| FLD5F20NP-E56 | 1532.68                                     | 195.60          | ±0.1           |
| FLD5F20NP-E55 | 1533.47                                     | 195.50          | ±0.1           |
| FLD5F20NP-E54 | 1534.25                                     | 195.40          | ±0.1           |
| FLD5F20NP-E53 | 1535.04                                     | 195.30          | ±0.1           |
| FLD5F20NP-E52 | 1535.82                                     | 195.20          | ±0.1           |
| FLD5F20NP-E51 | 1536.61                                     | 195.10          | ±0.1           |
| FLD5F20NP-E50 | 1537.40                                     | 195.00          | ±0.1           |
| FLD5F20NP-E49 | 1538.19                                     | 194.90          | ±0.1           |
| FLD5F20NP-E48 | 1538.98                                     | 194.80          | ±0.1           |
| FLD5F20NP-E47 | 1539.77                                     | 194.70          | ±0.1           |
| FLD5F20NP-E46 | 1540.56                                     | 194.60          | ±0.1           |
| FLD5F20NP-E45 | 1541.35                                     | 194.50          | ±0.1           |
| FLD5F20NP-E44 | 1542.14                                     | 194.40          | ±0.1           |
| FLD5F20NP-E43 | 1542.94                                     | 194.30          | ±0.1           |
| FLD5F20NP-E42 | 1543.73                                     | 194.20          | ±0.1           |
| FLD5F20NP-E41 | 1544.53                                     | 194.10          | ±0.1           |
| FLD5F20NP-E40 | 1545.32                                     | 194.00          | ±0.1           |
| FLD5F20NP-E39 | 1546.12                                     | 193.90          | ±0.1           |
| FLD5F20NP-E38 | 1546.92                                     | 193.80          | ±0.1           |
| FLD5F20NP-E37 | 1547.72                                     | 193.70          | ±0.1           |
| FLD5F20NP-E36 | 1548.51                                     | 193.60          | ±0.1           |
| FLD5F20NP-E35 | 1549.32                                     | 193.50          | ±0.1           |
| FLD5F20NP-E34 | 1550.12                                     | 193.40          | ±0.1           |
| FLD5F20NP-E33 | 1550.92                                     | 193.30          | ±0.1           |
| FLD5F20NP-E32 | 1551.72                                     | 193.20          | ±0.1           |
| FLD5F20NP-E31 | 1552.52                                     | 193.10          | ±0.1           |
| FLD5F20NP-E30 | 1553.33                                     | 193.00          | ±0.1           |
| FLD5F20NP-E29 | 1554.13                                     | 192.90          | ±0.1           |
| FLD5F20NP-E28 | 1554.94                                     | 192.80          | ±0.1           |
| FLD5F20NP-E27 | 1555.75                                     | 192.70          | ±0.1           |
| FLD5F20NP-E26 | 1556.56                                     | 192.60          | ±0.1           |
| FLD5F20NP-E25 | 1557.36                                     | 192.50          | ±0.1           |
| FLD5F20NP-E24 | 1558.17                                     | 192.40          | ±0.1           |
| FLD5F20NP-E23 | 1558.98                                     | 192.30          | ±0.1           |
| FLD5F20NP-E22 | 1559.79                                     | 192.20          | ±0.1           |
| FLD5F20NP-E21 | 1560.61                                     | 192.10          | ±0.1           |
| FLD5F20NP-E20 | 1561.42                                     | 192.00          | ±0.1           |
| FLD5F20NP-E19 | 1562.23                                     | 191.90          | ±0.1           |
| FLD5F20NP-E18 | 1563.05                                     | 191.80          | ±0.1           |



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