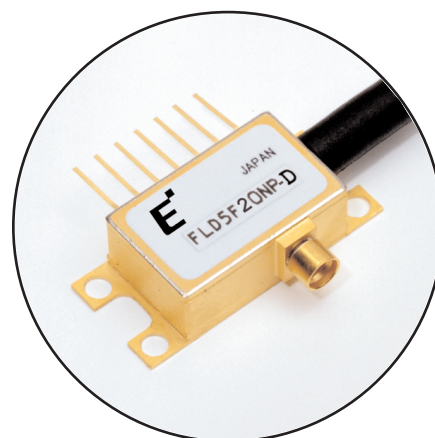


# 1,550nm Modulator Integrated DFB Laser

FLD5F20NP-D

## FEATURES

- Modulator Integrated DFB Laser Diode Module
- CW operation of DFB laser section
- Available at C Band ITU-T grid wavelengths between 1529.55 - 1563.05nm
- 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



## APPLICATION

This MI laser is intended for intermediate reach applications ( $\leq 40\text{km}$ ) 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 ( $T_{\text{op}}=25^{\circ}\text{C}$ , unless otherwise specified)

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

OPTICAL & ELECTRICAL CHARACTERISTICS ( $T_L = T_{set}$ ,  $T_C = 25^\circ\text{C}$ , BOL, unless otherwise specified)

| Parameter                                  | Symbol      | Test Condition                                                                  | Limits       |       |           | Unit                 |
|--------------------------------------------|-------------|---------------------------------------------------------------------------------|--------------|-------|-----------|----------------------|
|                                            |             |                                                                                 | Min.         | Type  | Max.      |                      |
| Peak Wavelength                            | $\lambda_p$ | Note (2)                                                                        | Note (4)     |       |           |                      |
| Threshold Current                          | $I_{th}$    | CW, $V_m=V_o$                                                                   | -            | -     | 30        | mA                   |
| Operating Current                          | $I_{op}$    | -                                                                               | 40           | -     | 100       | mA                   |
| Forward Voltage                            | $V_F$       | CW, $I_F=I_{op}$ , $V_m=V_o$                                                    | -            | 1.4   | 2.0       | V                    |
| Optical Output Power (Avg. Power)          | $P_f$       | Note (2)                                                                        | -2.0         | -     | -         | dBm                  |
| Dispersion Penalty                         | dP          | Note (1)                                                                        | -            | -     | 2         | dB                   |
| Sidemode Suppression Ratio                 | SSR         | Note (2)                                                                        | 35           | -     | -         | dB                   |
| Laser Set Temperature (BOL)                | $T_{set}$   |                                                                                 | 15           | -     | 35        | $^\circ\text{C}$     |
| Wavelength Drift (after 20 years)          | -           |                                                                                 | -0.1         | -     | 0.1       | nm                   |
| Wavelength Stability with Case Temperature | -           |                                                                                 | -            | -     | $\pm 0.5$ | pm/ $^\circ\text{C}$ |
| Optical Isolation                          | $I_s$       | $T_c=-20$ to $+70^\circ\text{C}$                                                | 25           | 35    | -         | dB                   |
| On Level Modulation                        | $V_o$       | -                                                                               | -0.7         | -     | 0         | V                    |
| Modulator Drive Voltage                    | $V_{mod}$   | $(V_o-V_{mod}) \geq -3.3\text{V}$ , $R_{ext}=10\text{dB}$                       | -            | -     | 2.6       | V                    |
| Extinction Ratio                           | $R_{ext}$   | $f=10\text{Gb/s}$ , $I_F=I_{op}$ , $V_m=V_o/(V_o-V_{mod})$                      | 10           | -     | -         | dB                   |
| Rise Time                                  | $T_r$       | Note (2), 20 to 80%                                                             | -            | 20    | 25        | ps                   |
| Fall Time                                  | $T_f$       |                                                                                 | -            | 20    | 25        | ps                   |
| Cut-off Frequency                          | $S_{21}$    | -3dB bandwidth, $V_m=V_o-0.5V_{mod}$ , $I_F=I_{op}$                             | 10           | -     | -         | GHz                  |
| RF Return Loss                             | $S_{11}$    | $f=\text{DC}-5\text{GHz}$ , $50\Omega$ Test Set, $V_m=V_o$ , $I_F=I_{op}$       | 8            | -     | -         | dB                   |
| RF Return Loss                             | $S_{11}$    | $f=5-10\text{GHz}$ , $50\Omega$ Test Set, $V_m=V_o$ , $I_F=I_{op}$              | 5            | -     | -         | dB                   |
| Monitor Current                            | $I_m$       | Note (2), $V_{DR}=5\text{V}$                                                    | 0.04         | -     | 1.5       | mA                   |
| In-Band Ripple                             | $\Delta G$  | $I_F=I_{op}$ , $f=0.1-10\text{GHz}$ , $V_m=V_o-0.5V_{mod}$                      | -            | -     | $\pm 1.0$ | dB                   |
| Relative Intensity Noise                   | RIN         | $f=10\text{ MHz to } 8.5\text{ GHz}$ , $V_m=V_o$ , $I_F=I_{op}$ , 8% Reflection | -            | -     | -120      | dB/Hz                |
| TEC Capacity                               | $\Delta T$  | $P_{TEC}=3.3\text{W}$ , $I_F=I_{op}$                                            | $70-T_{set}$ | -     | -         | $^\circ\text{C}$     |
| TEC Current                                | $I_c$       | $I_F=I_{op}$ , $\Delta T=(70-T_{set})[^\circ\text{C}]$                          | -            | -     | 1.3       | A                    |
| TEC Voltage                                | $V_c$       | $I_F=I_{op}$ , $\Delta T=(70-T_{set})[^\circ\text{C}]$                          | -            | -     | 2.5       | V                    |
| TEC Power Dissipation                      | $P_c$       | $I_F=I_{op}$                                                                    | -            | -     | 3.3       | W                    |
| Thermistor B Constant (Note 3)             | B           | $T_L=25^\circ\text{C}$ , $T_c=+25^\circ\text{C}$                                | 3,270        | 3,450 | 3,630     | K                    |
| Thermal Resistance                         | $R_{th}$    |                                                                                 | 9.5          | 10.0  | 10.5      | k $\Omega$           |

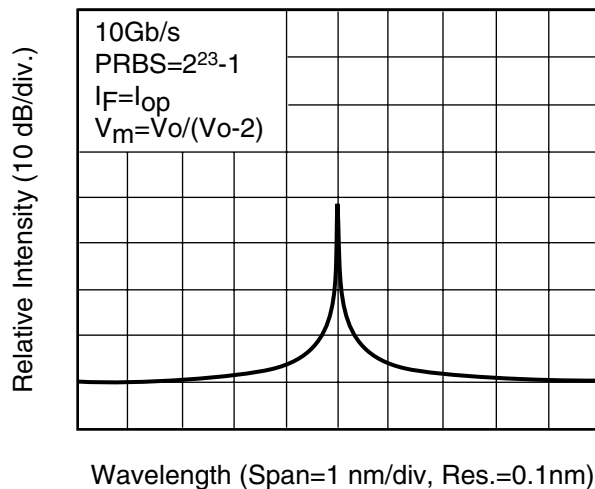
Note (1) Eudyna Test System  
9.95328Gb/s, PRBS=2<sup>23</sup>-1,  $I_F=I_{op}$ ,  $V_m=V_o$  and  $(V_o-V_{mod})$   
Dispersion=800ps/nm, Dispersion penalty at  
Bit Error Rate = 1.0E-10

Note (3) Relation between resistance and temperature ( $^\circ\text{K}$ ) is:  
 $R_{th}(T) = R_{th}(25^\circ\text{C}) \cdot \exp[B(1/T - 1/298)]$

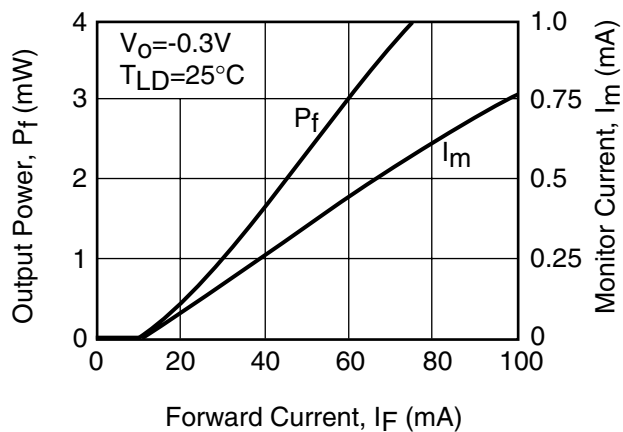
Note (4) Reference Figure 7 for Wavelength Table

Note (2) Eudyna Test System  
9.95328Gb/s, PRBS=2<sup>23</sup>-1,  $I_F=I_{op}$ ,  $V_m=V_o$  and  $(V_o-V_{mod})$

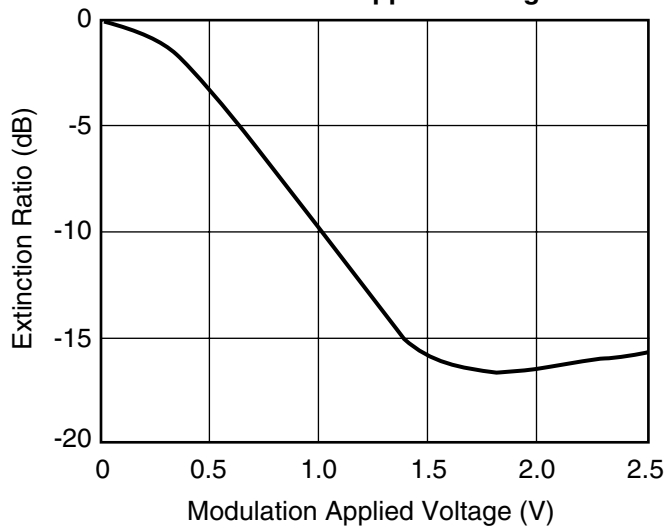
**Fig. 1 Lasing Spectrum**



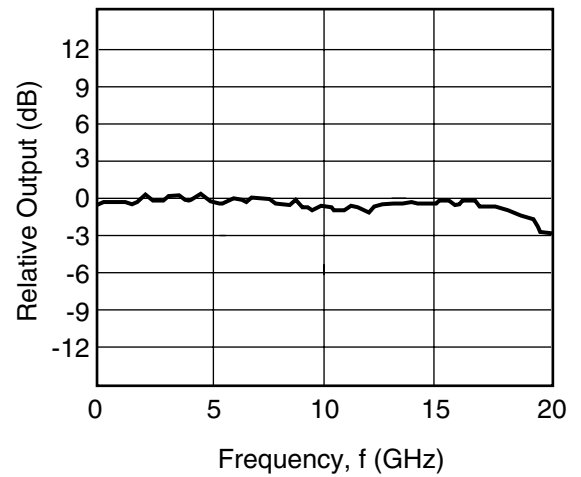
**Fig. 2 Output Power & Monitor Current  
vs. Forward Current**



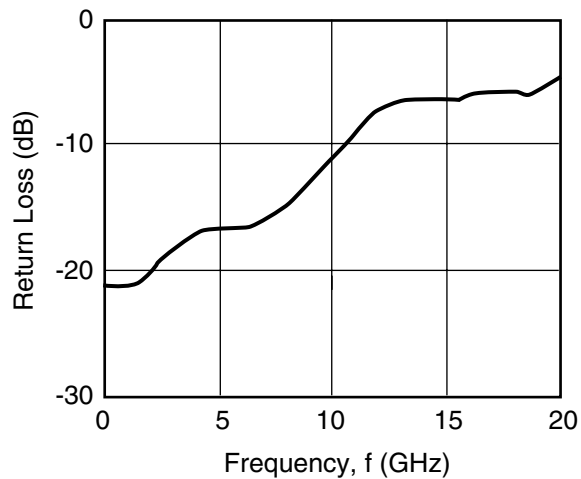
**Fig. 3 Extinction Ratio vs. Modulation Applied Voltage**



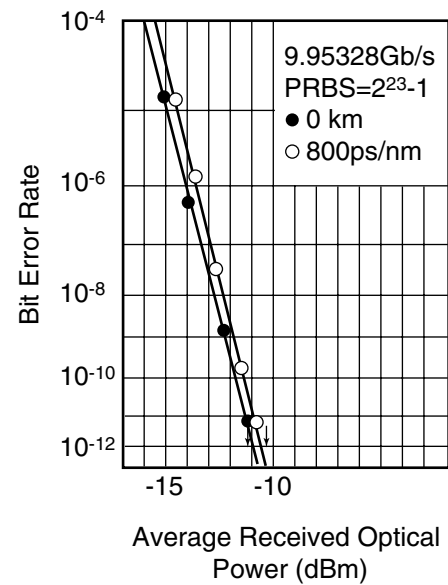
**Fig. 4 Cut-off Frequency (S21)**



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

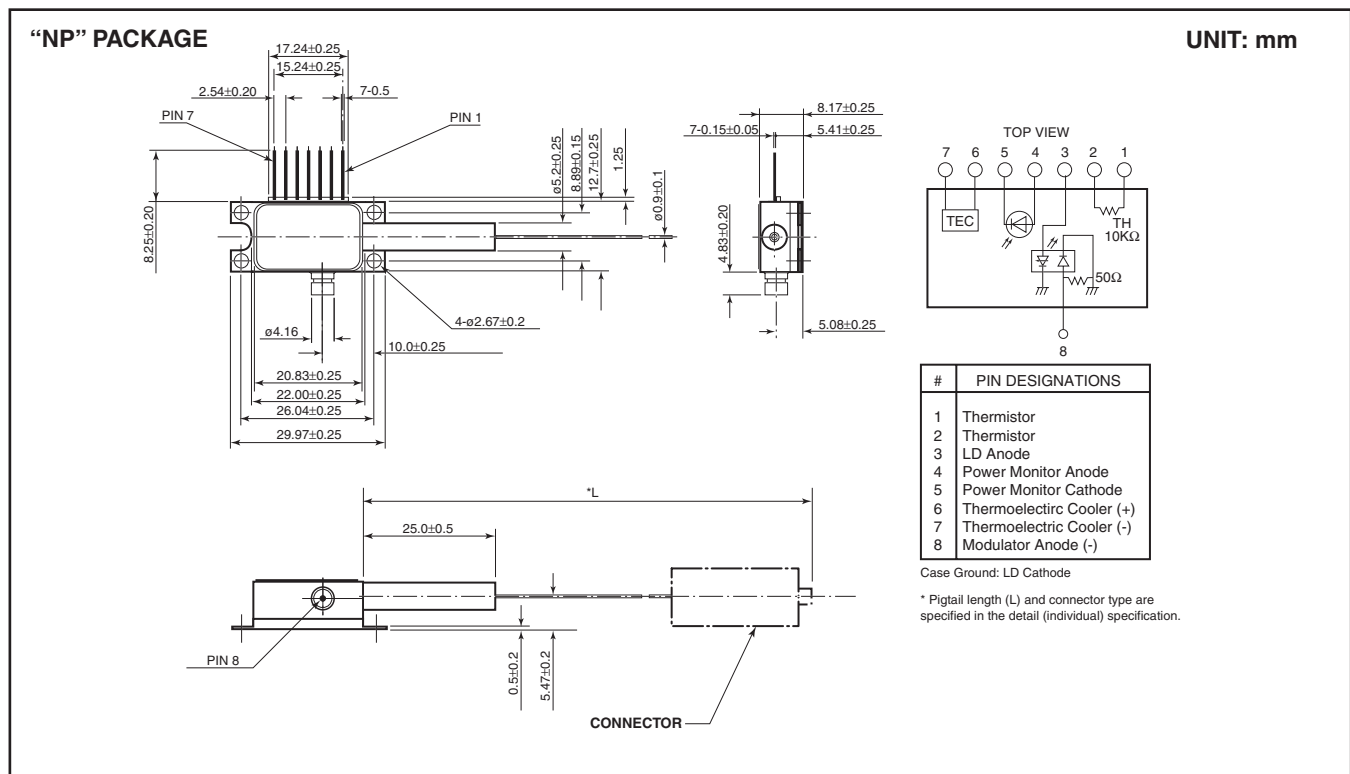


**Fig. 6 Transmission Characteristics**



**Figure 7 Wavelength Table**

| Part Number   | Wavelength (nm)<br>(TL=Tset)<br>(in vacuum) | Frequency<br>(THz) | Tolerance (nm) |
|---------------|---------------------------------------------|--------------------|----------------|
| FLD5F20NP-D60 | 1529.55                                     | 196.00             | ±0.1           |
| FLD5F20NP-D59 | 1530.33                                     | 195.90             | ±0.1           |
| FLD5F20NP-D58 | 1531.12                                     | 195.80             | ±0.1           |
| FLD5F20NP-D57 | 1531.90                                     | 195.70             | ±0.1           |
| FLD5F20NP-D56 | 1532.68                                     | 195.60             | ±0.1           |
| FLD5F20NP-D55 | 1533.47                                     | 195.50             | ±0.1           |
| FLD5F20NP-D54 | 1534.25                                     | 195.40             | ±0.1           |
| FLD5F20NP-D53 | 1535.04                                     | 195.30             | ±0.1           |
| FLD5F20NP-D52 | 1535.82                                     | 195.20             | ±0.1           |
| FLD5F20NP-D51 | 1536.61                                     | 195.10             | ±0.1           |
| FLD5F20NP-D50 | 1537.40                                     | 195.00             | ±0.1           |
| FLD5F20NP-D49 | 1538.19                                     | 194.90             | ±0.1           |
| FLD5F20NP-D48 | 1538.98                                     | 194.80             | ±0.1           |
| FLD5F20NP-D47 | 1539.77                                     | 194.70             | ±0.1           |
| FLD5F20NP-D46 | 1540.56                                     | 194.60             | ±0.1           |
| FLD5F20NP-D45 | 1541.35                                     | 194.50             | ±0.1           |
| FLD5F20NP-D44 | 1542.14                                     | 194.40             | ±0.1           |
| FLD5F20NP-D43 | 1542.94                                     | 194.30             | ±0.1           |
| FLD5F20NP-D42 | 1543.73                                     | 194.20             | ±0.1           |
| FLD5F20NP-D41 | 1544.53                                     | 194.10             | ±0.1           |
| FLD5F20NP-D40 | 1545.32                                     | 194.00             | ±0.1           |
| FLD5F20NP-D39 | 1546.12                                     | 193.90             | ±0.1           |
| FLD5F20NP-D38 | 1546.92                                     | 193.80             | ±0.1           |
| FLD5F20NP-D37 | 1547.72                                     | 193.70             | ±0.1           |
| FLD5F20NP-D36 | 1548.51                                     | 193.60             | ±0.1           |
| FLD5F20NP-D35 | 1549.32                                     | 193.50             | ±0.1           |
| FLD5F20NP-D34 | 1550.12                                     | 193.40             | ±0.1           |
| FLD5F20NP-D33 | 1550.92                                     | 193.30             | ±0.1           |
| FLD5F20NP-D32 | 1551.72                                     | 193.20             | ±0.1           |
| FLD5F20NP-D31 | 1552.52                                     | 193.10             | ±0.1           |
| FLD5F20NP-D30 | 1553.33                                     | 193.00             | ±0.1           |
| FLD5F20NP-D29 | 1554.13                                     | 192.90             | ±0.1           |
| FLD5F20NP-D28 | 1554.94                                     | 192.80             | ±0.1           |
| FLD5F20NP-D27 | 1555.75                                     | 192.70             | ±0.1           |
| FLD5F20NP-D26 | 1556.56                                     | 192.60             | ±0.1           |
| FLD5F20NP-D25 | 1557.36                                     | 192.50             | ±0.1           |
| FLD5F20NP-D24 | 1558.17                                     | 192.40             | ±0.1           |
| FLD5F20NP-D23 | 1558.98                                     | 192.30             | ±0.1           |
| FLD5F20NP-D22 | 1559.79                                     | 192.20             | ±0.1           |
| FLD5F20NP-D21 | 1560.61                                     | 192.10             | ±0.1           |
| FLD5F20NP-D20 | 1561.42                                     | 192.00             | ±0.1           |
| FLD5F20NP-D19 | 1562.23                                     | 191.90             | ±0.1           |
| FLD5F20NP-D18 | 1563.05                                     | 191.80             | ±0.1           |



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