DATA SHEET

NEC

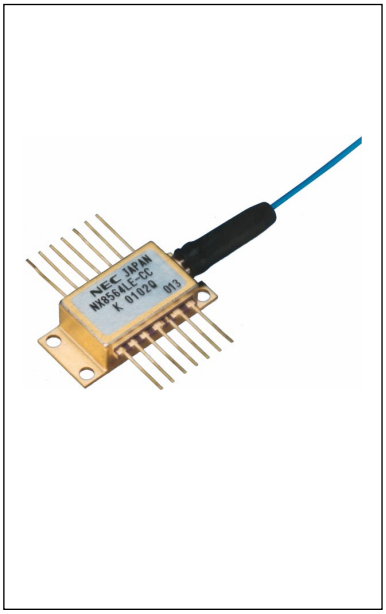
LASER DIODE

# NX8564/8565/8566LE Series

## EA MODULATOR INTEGRATED 1 550 nm MQW-DFB LASER DIODE MODULE FOR 2.5 Gb/s DWDM ULTRALONG-REACH 360 km, 600 km, 240 km APPLICATIONS

### DESCRIPTION

The NX8564/8565/8566LE Series is an Electro-Absorption (EA) modulator integrated, 1 550 nm Multiple Quantum Well (MQW) structured Distributed Feed-Back (DFB) laser diode. The module is capable of 2.5 Gb/s applications of over 360 km, 600 km, 240 km ultralong-reach and available for Dense Wavelength Division Multiplexing (DWDM) wavelengths based on ITU-T recommendations, enabling a wide range of applications.




### FEATURES

- Integrated electroabsorption modulator
- Very low dispersion penalty (over 360 km (6480 ps/nm), NX8564LE-BC/CC)
  (over 600 km (10800 ps/nm), NX8565LE-BC/CC)
  (over 240 km (4320 ps/nm), NX8566LE-BC/CC)
- Low modulation voltage
- Available for DWDM wavelengths based on ITU-T recommendations
  (100 GHz grid, refer to **ORDERING INFORMATION**)



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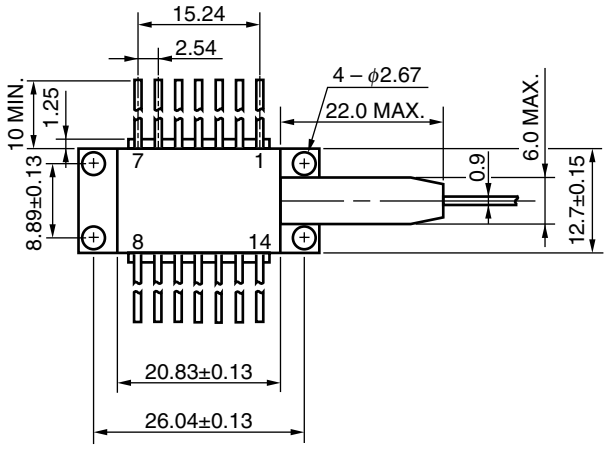
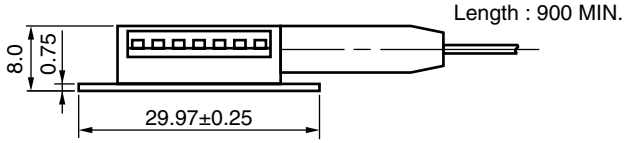
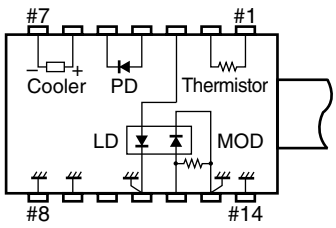
**The mark ★ shows major revised points.**

★ **PACKAGE DIMENSIONS (UNIT: mm, unless otherwise specified ±0.2 mm)**




**TOP VIEW**

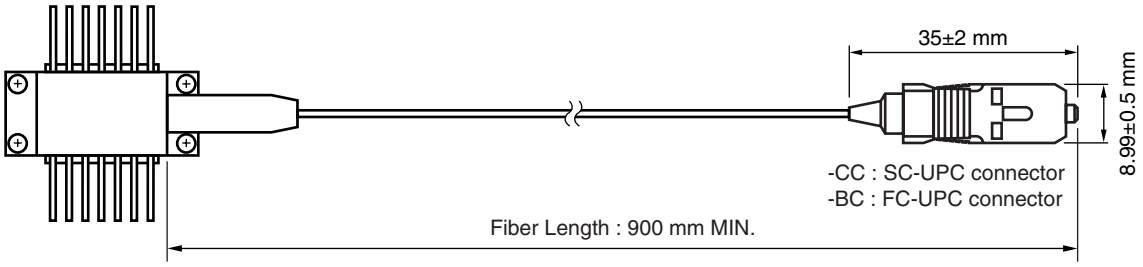



**PIN CONNECTIONS**

| Pin No. | Function | Pin No. | Function |
|---|---|---|---|
| 1 | Thermistor | 8 | GND |
| 2 | Thermistor | 9 | GND |
| 3 | LD DC Bias | 10 | NC |
| 4 | PD Anode | 11 | GND |
| 5 | PD Cathode | 12 | Signal Input (MOD), 50 Ω RF Input |
| 6 | Cooler Anode | | |
| 7 | Cooler Cathode | 13 | GND |
| | | 14 | GND |

## OPTICAL FIBER CHARACTERISTICS

| Parameter | Specification | Unit |
|---|---|---|
| Mode Field Diameter | 9.3±0.5 | μm |
| Cladding Diameter | 125±1 | μm |
| Tight Buffer Diameter | 900±100 | μm |
| Cut-off Wavelength | < 1 270 | nm |
| Attenuation 1 525 to 1 575 nm | < 0.3 | dB/km |
| Minimum Fiber Bending Radius | 30 | mm |
| ★ Fiber Length | 900 MIN. | mm |
| Flammability | UL1581 VW-1 | |



## ORDERING INFORMATION

NX856□LE□□□-□□

- CC : SC-UPC connector
  BC : FC-UPC connector (option)
- Without wavelength code : Wavelength is a certain point between 1528 to 1565 nm, 1579 to 1609 nm
  With wavelength code : Refer to **Table A**
- 4 : 360 km (6480 ps/nm)
  5 : 600 km (10800 ps/nm)
  6 : 240 km (4320 ps/nm)

**Table A: DWDM wavelengths based on ITU-T recommendations (@$T_{LD}$ = $T_{set}$) (1/2)**

| Wavelength Code | ITU-T Wavelength *1 (nm) | Frequency (THz) | Wavelength Code | ITU-T Wavelength *1 (nm) | Frequency (THz) |
|---|---|---|---|---|---|
| 287 | 1528.77 | 196.10 | 485 | 1548.51 | 193.60 |
| 295 | 1529.55 | 196.00 | 493 | 1549.31 | 193.50 |
| 303 | 1530.33 | 195.90 | 501 | 1550.11 | 193.40 |
| 311 | 1531.11 | 195.80 | 509 | 1550.91 | 193.30 |
| 318 | 1531.89 | 195.70 | 517 | 1551.72 | 193.20 |
| 326 | 1532.68 | 195.60 | 525 | 1552.52 | 193.10 |
| 334 | 1533.46 | 195.50 | 533 | 1553.32 | 193.00 |
| 342 | 1534.25 | 195.40 | 541 | 1554.13 | 192.90 |
| 350 | 1535.03 | 195.30 | 549 | 1554.94 | 192.80 |
| 358 | 1535.82 | 195.20 | 557 | 1555.74 | 192.70 |
| 366 | 1536.60 | 195.10 | 565 | 1556.55 | 192.60 |
| 373 | 1537.39 | 195.00 | 573 | 1557.36 | 192.50 |
| 381 | 1538.18 | 194.90 | 581 | 1558.17 | 192.40 |
| 389 | 1538.97 | 194.80 | 589 | 1558.98 | 192.30 |
| 397 | 1539.76 | 194.70 | 597 | 1559.79 | 192.20 |
| 405 | 1540.55 | 194.60 | 606 | 1560.60 | 192.10 |
| 413 | 1541.34 | 194.50 | 614 | 1561.41 | 192.00 |
| 421 | 1542.14 | 194.40 | 622 | 1562.23 | 191.90 |
| 429 | 1542.93 | 194.30 | 630 | 1563.04 | 191.80 |
| 437 | 1543.73 | 194.20 | 745 | 1574.54 | 190.40 |
| 445 | 1544.52 | 194.10 | 753 | 1575.36 | 190.30 |
| 453 | 1545.32 | 194.00 | 761 | 1576.19 | 190.20 |
| 461 | 1546.11 | 193.90 | 770 | 1577.02 | 190.10 |
| 469 | 1546.91 | 193.80 | 778 | 1577.85 | 190.00 |
| 477 | 1547.71 | 193.70 | 786 | 1578.68 | 189.90 |

***1** The value which omitted and computed the 3rd place below the decimal point

**Table A: DWDM wavelengths based on ITU-T recommendations (@$T_{LD}$ = $T_{set}$) (2/2)**

| Wavelength Code | ITU-T Wavelength *1 (nm) | Frequency (THz) | Wavelength Code | ITU-T Wavelength *1 (nm) | Frequency (THz) |
|---|---|---|---|---|---|
| 795 | 1579.51 | 189.80 | 946 | 1594.64 | 188.00 |
| 803 | 1580.35 | 189.70 | 954 | 1595.48 | 187.90 |
| 811 | 1581.18 | 189.60 | 963 | 1596.33 | 187.80 |
| 820 | 1582.01 | 189.50 | 971 | 1597.18 | 187.70 |
| 828 | 1582.85 | 189.40 | 980 | 1598.04 | 187.60 |
| 836 | 1583.69 | 189.30 | 988 | 1598.89 | 187.50 |
| 845 | 1584.52 | 189.20 | 997 | 1599.74 | 187.40 |
| 853 | 1585.36 | 189.10 | 6006 | 1600.60 | 187.30 |
| 862 | 1586.20 | 189.00 | 6014 | 1601.45 | 187.20 |
| 870 | 1587.04 | 188.90 | 6023 | 1602.31 | 187.10 |
| 878 | 1587.88 | 188.80 | 6031 | 1603.16 | 187.00 |
| 887 | 1588.72 | 188.70 | 6040 | 1604.02 | 186.90 |
| 895 | 1589.56 | 188.60 | 6048 | 1604.88 | 186.80 |
| 904 | 1590.41 | 188.50 | 6057 | 1605.74 | 186.70 |
| 912 | 1591.25 | 188.40 | 6066 | 1606.60 | 186.60 |
| 921 | 1592.10 | 188.30 | 6074 | 1607.46 | 186.50 |
| 929 | 1592.94 | 188.20 | 6083 | 1608.32 | 186.40 |
| 937 | 1593.79 | 188.10 | | | |

***1** The value which omitted and computed the 3rd place below the decimal point

## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Ratings | Unit |
|---|---|---|---|
| Optical Output Power from Fiber | $P_f$ | 10 | mW |
| Forward Current of LD | $I_{FLD}$ | 150 | mA |
| Reverse Voltage of LD | $V_{RLD}$ | 2.0 | V |
| Forward Voltage of Modulator | $V_{FEA}$ | 1 | V |
| Reverse Voltage of Modulator | $V_{REA}$ | 5 | V |
| Forward Current of PD | $I_{FPD}$ | 1 | mA |
| Reverse Voltage of PD | $V_{RPD}$ | 10 | V |
| Cooler Current | $I_C$ | 1.5 | A |
| Cooler Voltage | $V_C$ | 2.5 | V |
| Operating Case Temperature | $T_C$ | –20 to +70 | °C |
| Storage Temperature | $T_{stg}$ | –40 to +85 | °C |
| Lead Soldering Temperature | $T_{sld}$ | 260 (10 sec.) | °C |

**ELECTRO-OPTICAL CHARACTERISTICS ($T_{LD}$ = $T_{set}$, $T_C$ = –20 to +70°C, unless otherwise specified)**

| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Laser Set Temperature | $T_{set}$ | ***1** | 20 | | 35 | °C |
| Operating Current | $I_{op}$ | | 50 | 60 | 80 | mA |
| Modulation Center Voltage | $V_{center}$ | Under modulation [*2] | –1.5 | –1.2 | –0.5 | V |
| Modulation Voltage | $V_{mod}$ | Under modulation [*2] | | 2 | 3 | V |
| Forward Voltage of LD | $V_{FLD}$ | $I_{FLD}$ = $I_{op}$ | | 1.6 | 2.0 | V |
| Threshold Current | $I_{th}$ | | | 7 | 20 | mA |
| Optical Output Power from Fiber | $P_f$ | $I_{FLD}$ = $I_{op}$, Under modulation [*2] (NX8564/65LE Series) | –5 | –2 | | dBm |
| | | $I_{FLD}$ = $I_{op}$, Under modulation [*2] (NX8566LE Series) | 0 | 1 | | |
| Peak Emission Wavelength | $\lambda_p$ | $I_{FLD}$ = $I_{op}$, $V_{EA}$ = 0 V | 1 528 | ITU-T [*3] | 1 565 | nm |
| | | | 1 574 | | 1 609 | |
| Side Mode Suppression Ratio | SMSR | $I_{FLD}$ = $I_{op}$, $V_{EA}$ = 0 V | 30 | > 37 | | dB |
| Extinction Ratio | ER | $I_{FLD}$ = $I_{op}$, Under modulation [*2] | 10 | > 11 | | dB |
| Rise Time | $t_r$ | $I_{FLD}$ = $I_{op}$, 20-80%, Under modulation [*2] | | 70 | 125 | ps |
| Fall Time | $t_f$ | $I_{FLD}$ = $I_{op}$, 80-20%, Under modulation [*2] | | 70 | 125 | ps |
| Dispersion Penalty | DP | $I_{FLD}$ = $I_{op}$, Under modulation [*2, 4] | | < 1.5 | 2.0 | dB |
| Isolation | $I_s$ | | 23 | | | dB |
| Relative Intensity Noise | RIN | 10 MHz to 10 GHz, $V_{EA}$ = 0 V, $I_{FLD}$ = $I_{op}$ | | < –135 | –130 | dB/Hz |
| Input Return Loss | $S_{11}$ | $I_{FLD}$ = $I_{op}$, $V_{EA}$ = –1 V, 50 Ω, f = 130 MHz to 2 GHz | | | –8 | dB |
| | | $I_{FLD}$ = $I_{op}$, $V_{EA}$ = –1 V, 50 Ω, f = 2 to 2.5 GHz | | | –5 | |

***1** NX8564/65/66LE Series : $T_{set}$ is a certain point between 20 and 35°C
NX8564/65/66LE××× Series : $T_{set}$ is set at a certain point between 20 and 35°C for ITU-T grid wavelength

***2** NX8564LE : C-band 360 km, L-band 288 km (6480 ps/nm) SMF under modulation
NX8565LE : C-band 600 km, L-band 480 km (10800 ps/nm) SMF under modulation
NX8566LE : C-band 240 km, L-band 192 km (4320 ps/nm) SMF under modulation
2.48832 Gb/s, PRBS $2^{23}$–1, $V_{EA}$ = $V_{center}$ ± 1/2$V_{mod}$, $I_{FLD}$ = $I_{op}$, $T_{LD}$ = $T_{set}$, NEC Test System
$V_{center}$ : a certain point between –1.5 and –0.5 V
$V_{mod}$ : a certain point 3 V or below
$I_{op}$ : a certain point between 50 and 80 mA

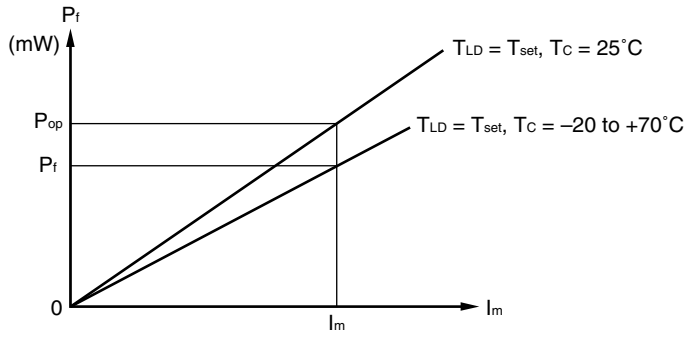
***3** Available for DWDM wavelengths based on ITU-T recommendations (100 GHz grid).
Please refer to **ORDERING INFORMATION**.

***4** BER = $10^{-10}$

### ELECTRO-OPTICAL CHARACTERISTICS (Applicable to Monitor PD: $T_{LD} = T_{set}$, $T_C$ = –20 to +70°C)

| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Monitor Current | $I_m$ | $V_{RPD}$ = 5 V, $I_{FLD} = I_{op}$, $V_{EA}$ = 0 V | 20 | 100 | 1 000 | $\mu$A |
| Dark Current | $I_D$ | $V_{RPD}$ = 5 V, $V_{EA}$ = 0 V | | | 10 | nA |
| Terminal Capacitance | $C_t$ | $V_{RPD}$ = 5 V, f = 1 MHz | | | 15 | pF |
| Tracking Error | $\gamma$ *1 | $I_m$ = const. | | | 0.5 | dB |

***1** Tracking Error: $\gamma$



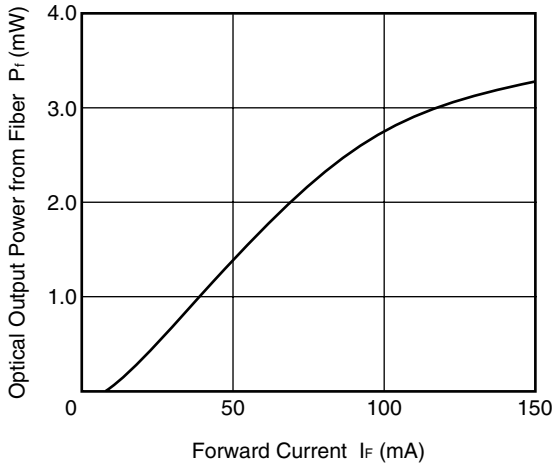

$$\gamma = \left| 10 \log \frac{P_f}{P_{op}} \right| \text{ [dB]}$$

### ★ ELECTRO-OPTICAL CHARACTERISTICS (Applicable to Thermistor and TEC: $T_C$ = –20 to +70°C)

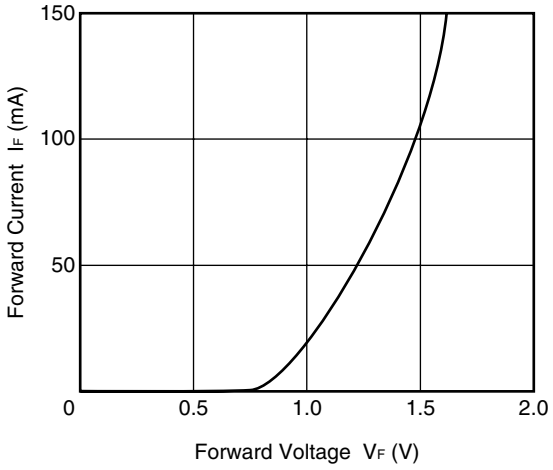
| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Thermistor Resistance | R | $T_{LD}$ = 25°C | 9.5 | 10.0 | 10.5 | kΩ |
| B Constant | B | | 3 350 | 3 450 | 3 550 | K |
| TEC Current | $I_C$ | $T_{LD} = T_{set}$ | | | 1.2 | A |
| TEC Voltage | $V_C$ | $T_{LD} = T_{set}$ | | | 2.4 | V |

**TYPICAL CHARACTERISTICS ($T_{LD}$ = $T_{set}$, $T_C$ = 25°C, unless otherwise specified)**

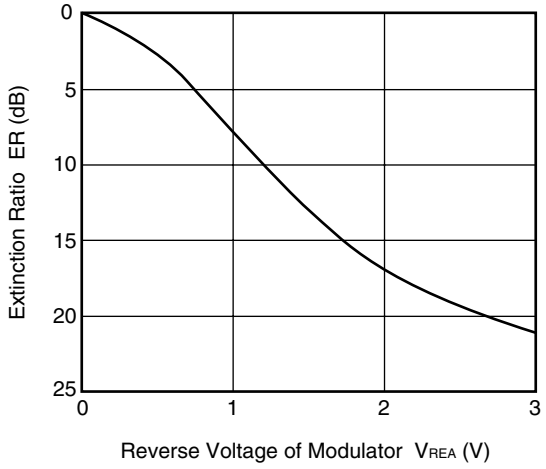
OPTICAL OUTPUT POWER FROM FIBER (CW) vs. FORWARD CURRENT



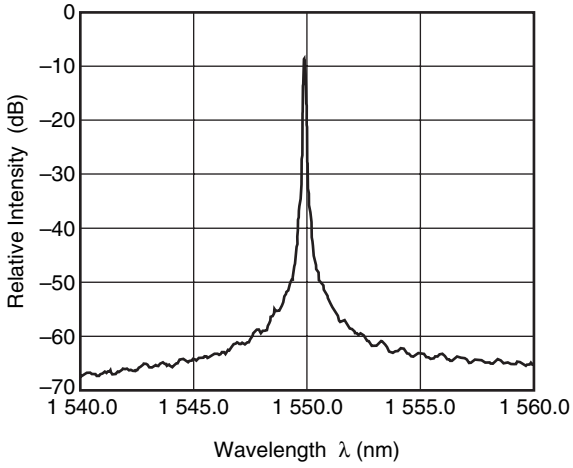

FORWARD CURRENT vs. FORWARD VOLTAGE



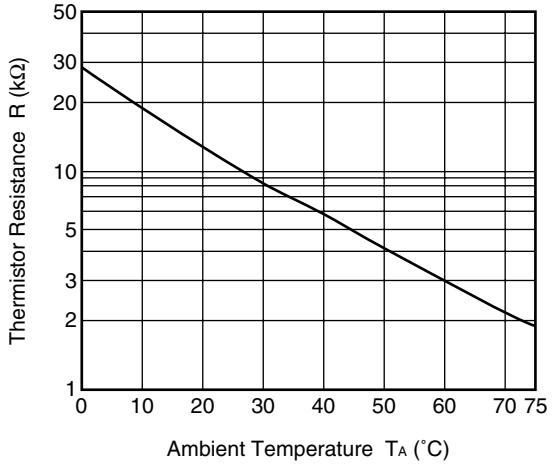

EXTINCTION RATIO vs. MODULATOR VOLTAGE




SPECTRUM



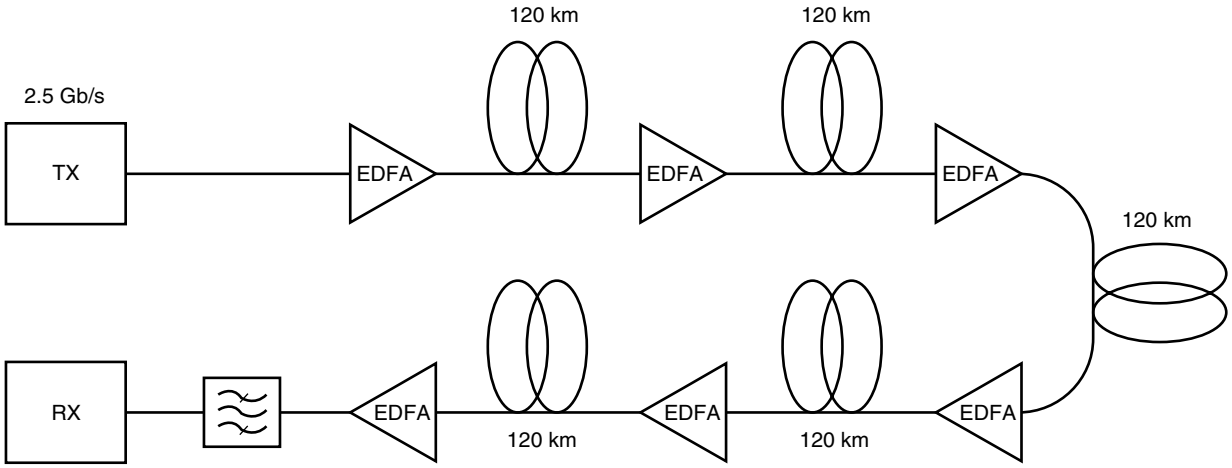

THERMISTOR RESISTANCE vs. AMBIENT TEMPERATURE



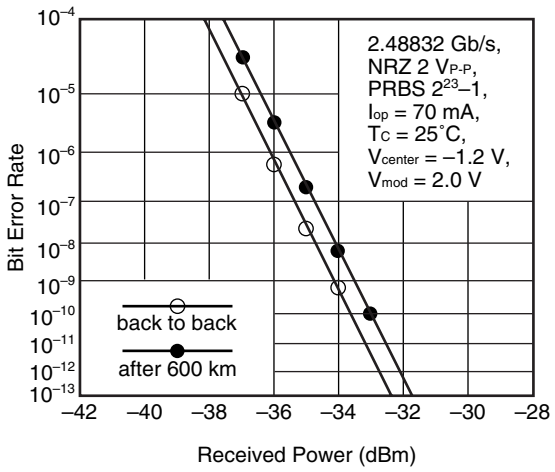

**Remark** The graphs indicate nominal characteristics.

## 600 km STANDARD FIBER TRANSMISSION EXAMPLE (NX8565LE Series)

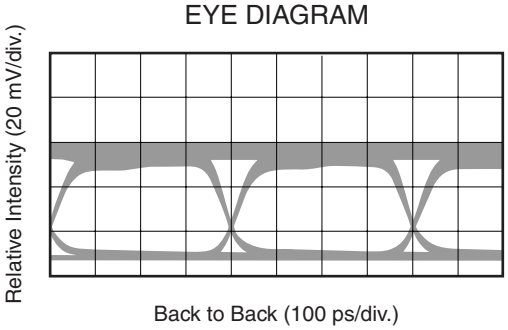
### Test Setup



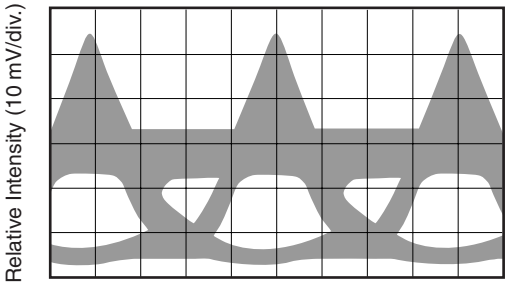

ERROR RATE CHARACTERISTICS




EYE DIAGRAM




Back to Back (100 ps/div.)




After 600 km (100 ps/div.)

**Remark** The graphs indicate nominal characteristics.

## EA MODULATOR INTEGRATED DFB-LD FAMILY

| Part Number | Absolute Maximum Ratings | | Electro-Optical Characteristics | | Application | Package |
|---|---|---|---|---|---|---|
| | $T_C$ (°C) | $T_{stg}$ (°C) | $P_f$ [*1] (mW) | $\lambda_p$ (nm) | | |
| | | | MIN. | TYP. | | |
| NX8560LJ Series | −20 to +70 | −40 to +85 | −3 dBm | 1 550 [*2] | 10 Gb/s: STM-64 | BFY with GPO™ |
| ★ | | | −1 dBm | 1 550 | | |
| NX8560MC Series | 0 to +75 | −40 to +85 | −1 dBm | 1 550 | 10 Gb/s: STM-64 | 19-pin mini BFY |
| NX8560MCS Series | 0 to +75 | −40 to +85 | −5 dBm | 1 550 | 10 Gb/s: STM-64 | 19-pin mini BFY |
| NX8560SJ Series | −5 to +70 | −40 to +85 | −3 dBm | 1 550 [*2] | 10 Gb/s: STM-64 with λ monitoring PD | BFY with GPO |
| NX8564LE Series | −20 to +70 | −40 to +85 | −5 dBm | 1 550 [*2] | 2.5 Gb/s: STM-16, 360 km | BFY |
| NX8565LE Series | −20 to +70 | −40 to +85 | −5 dBm | 1 550 [*2] | 2.5 Gb/s: STM-16, 600 km | BFY |
| NX8566LE Series | −20 to +70 | −40 to +85 | 0 dBm | 1 550 [*2] | 2.5 Gb/s: STM-16, 240 km | BFY |
| NX8567SA Series | −5 to +70 | −40 to +85 | −5 dBm | 1 550 [*2] | 2.5 Gb/s: STM-16, 600 km with λ monitoring PD | BFY |
| NX8567SAM Series | −5 to +70 | −40 to +85 | −5 dBm | 1 550 [*2] | 2.5 Gb/s: STM-16, 360 km with λ monitoring PD | BFY |
| NX8567SAS Series | −5 to +70 | −40 to +85 | 0 dBm | 1 550 [*2] | 2.5 Gb/s: STM-16, 240 km with λ monitoring PD | BFY |

***1** Under modulation

***2** Available for DWDM Wavelengths based on ITU-T recommendations

**REFERENCE**

| Document Name | Document No. |
|---|---|
| OPTICAL SEMICONDUCTOR DEVICES FOR FIBEROPTIC COMMUNICATIONS SELECTION GUIDE | PL10161E |
| Opto-Electronics Devices Pamphlet | PX10160E |

- **PATENT**

  **USP 4,826,295**

  **CA 1,286,848**

  **EP 143 000**

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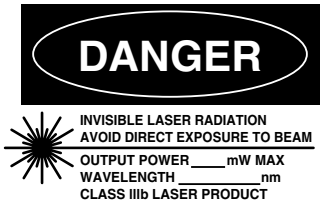
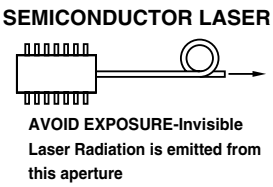
M8E 00.4-0110

## SAFETY INFORMATION ON THIS PRODUCT




| | |
|---|---|
| **Warning** Laser Beam | A laser beam is emitted from this diode during operation.<br>The laser beam, visible or invisible, directly or indirectly, may cause injury to the eye or loss of eyesight.<br>• Do not look directly into the laser beam.<br>• Avoid exposure to the laser beam, any reflected or collimated beam. |
| **Caution** GaAs Products | This product uses gallium arsenide (GaAs).<br>GaAs vapor and powder are hazardous to human health if inhaled or ingested, so please observe the following points.<br>• Follow related laws and ordinances when disposing of the product. If there are no applicable laws and/or ordinances, dispose of the product as recommended below.<br>1. Commission a disposal company able to (with a license to) collect, transport and dispose of materials that contain arsenic and other such industrial waste materials.<br>2. Exclude the product from general industrial waste and household garbage, and ensure that the product is controlled (as industrial waste subject to special control) up until final disposal.<br>• Do not burn, destroy, cut, crush, or chemically dissolve the product.<br>• Do not lick the product or in any way allow it to enter the mouth. |
| **Caution** Optical Fiber | A glass-fiber is attached on the product. Handle with care.<br>• When the fiber is broken or damaged, handle carefully to avoid injury from the damaged part or fragments. |

▶**For further information, please contact**

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