19-2580; Rev 2; 5/04

EVALUATION KIT AVAILABLE

# +3.3V, 622Mbps SDH/SONET Laser Driver with Current Monitors and APC

MAX3663

## General Description

The MAX3663 is a complete, +3.3V laser driver with automatic power-control (APC) circuitry for SDH/SONET applications up to 622Mbps. It accepts differential PECL inputs, provides bias and modulation currents, and operates over a -40°C to +85°C temperature range.

An APC feedback loop is incorporated to maintain a constant average optical power over temperature and lifetime. The wide modulation current range from 5mA to 75mA and bias current of 1mA to 80mA are easy to program, making this product ideal for use in various SDH/SONET applications. Two pins are provided to monitor the current levels in the laser: BIASMON with current proportional to laser bias current, and MODMON with current proportional to laser modulation.

The MAX3663 also provides enable control and a failure-monitor output to indicate when the APC loop is unable to maintain the average optical power. The MAX3663 is available in a compact 4mm x 4mm 24-pin thin QFN package.

## Applications

- 622Mbps SDH/SONET Access Nodes
- Laser Driver Transmitters
- Section Regenerators
- FTTH/FTTC Applications

## Features

- ♦ **+3.3V or +5.0V Single-Supply Operation**
- ♦ **40mA Supply Current at +3.3V**
- ♦ **Programmable Bias Current from 1mA to 80mA**
- ♦ **Programmable Modulation Current from 5mA to 75mA**
- ♦ **Bias Current and Modulation Current Monitors**
- ♦ **200ps Rise/Fall Time**
- ♦ **Automatic Average Power Control with Failure Monitor**
- ♦ **Complies with ANSI, ITU, and Bellcore SONET/SDH Specifications**
- ♦ **Enable Control**

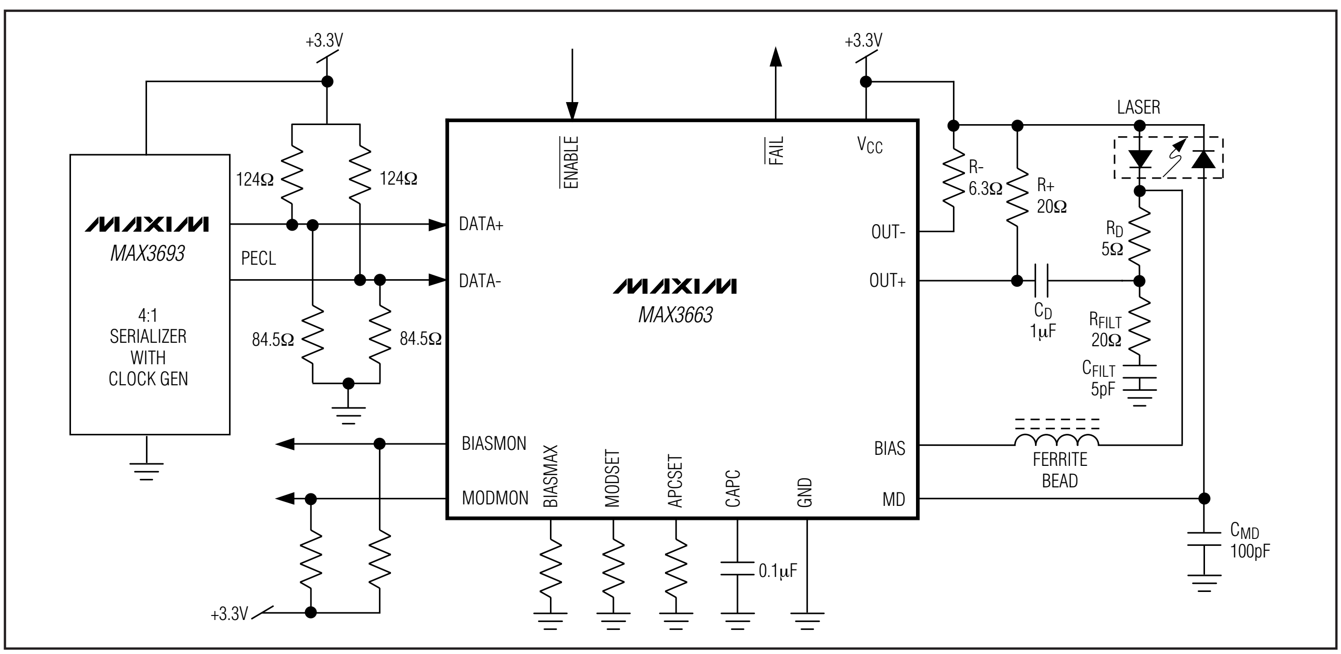
## Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|---|---|---|
| MAX3663ETG | -40°C to +85°C | 24 Thin QFN (4mm x 4mm) |
| MAX3663ETG+ | -40°C to +85°C | 24 Thin QFN (4mm x 4mm) |

*+Denotes lead-free package.*

***Pin Configuration appears at end of data sheet.***

## Typical Application Circuit



# +3.3V, 622Mbps SDH/SONET Laser Driver with Current Monitors and APC

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage, $V_{CC}$ ...........................................-0.5V to +7.0V
Current into BIAS ...........................................-20mA to +150mA
Current into OUT+, OUT- .............................. -20mA to +100mA
Current into MD...................................................-5mA to +5mA
Voltage at DATA+, DATA-, $\overline{ENABLE}$,
$\overline{FAIL}$, BIASMON, MODMON .................-0.5V to ($V_{CC}$ + 0.5V)
Voltage at OUT+, OUT-............................+1.5V to ($V_{CC}$ + 1.5V)
Voltage at MODSET, APCSET, BIASMAX,
CAPC.............................................................. -0.5V to +3.0V

Voltage at BIAS .......................................+1.0V to ($V_{CC}$ + 0.5V)
Continuous Power Dissipation ($T_A$ = +85°C)
24-Lead Thin QFN
(derate 20.8mW/°C above +85°C)........................1354mW
Operating Junction Temperature Range...........-55°C to +150°C
Processing Temperature (Die)........................................+400°C
Storage Temperature Range ........................... -65°C to +165°C
Lead Temperature (soldering, 10s) ................................+300°C

*Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## DC ELECTRICAL CHARACTERISTICS

($V_{CC}$ = +3.14V to +5.5V, $T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $V_{CC}$ = +3.3V, $T_A$ = +25°C.)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Supply Current | | (Note 1) | | | 40 | 60 | mA |
| Bias Current Range | $I_{BIAS}$ | $V_{BIAS}$ = $V_{CC}$ - 1.6V | | 1 | | 80 | mA |
| Bias Off Current | | $\overline{ENABLE}$ = high (Note 2) | | | | 100 | µA |
| Bias Current Stability | | APC open loop | $I_{BIAS}$ = 80mA | | 255 | | ppm/°C |
| | | | $I_{BIAS}$ = 1mA | | 815 | | |
| Bias Current Absolute Accuracy | | APC open loop, 3mA ≤ $I_{BIAS}$ ≤ 80mA | | -15 | | +15 | % |
| Differential Input Voltage | $V_{ID}$ | Figure 1 | | 200 | | 1600 | $mV_{P-P}$ |
| Common-Mode Input Voltage | $V_{ICM}$ | PECL compatible (Table 2) | | $V_{CC}$ - 1.49 | $V_{CC}$ - 1.32 | $V_{CC}$ - $V_{ID}$/4 | V |
| DATA+, DATA- Input Current | $I_{IN}$ | | | -1 | | +10 | µA |
| Monitor Diode Current Stability | | (Note 3) | $I_{MD}$ = 1mA | -480 | -50 | +480 | ppm/°C |
| | | | $I_{MD}$ = 18µA (Note 4) | | 35 | | |
| Monitor Diode Current Absolute Accuracy | | | | -15 | | +15 | % |
| DC Monitor Diode Current | $I_{MD}$ | | | 18 | | 1000 | µA |
| BIASMON to $I_{BIAS}$ Gain | $A_{BIAS}$ | $I_{BIAS}/I_{BIASMON}$ | | | 38 | | mA/mA |
| MODMON to $I_{MOD}$ Gain | $A_{MOD}$ | $I_{MOD}/I_{MODMON}$ | | | 29 | | mA/mA |
| Monitor Diode Input Voltage (MD Pin) | $V_{MD}$ | | | | 0.8 | | V |
| TTL Input High Voltage | $V_{IH}$ | | | 2 | | | V |
| TTL Input Low Voltage | $V_{IL}$ | | | | | 0.8 | V |
| TTL Output High Voltage ($\overline{FAIL}$) | $V_{OH}$ | Sourcing 50µA | | 2.4 | $V_{CC}$ - 0.3 | $V_{CC}$ | V |
| TTL Output Low Voltage ($\overline{FAIL}$) | $V_{OL}$ | Sinking 100µA | | 0.1 | | 0.44 | V |

### AC ELECTRICAL CHARACTERISTICS

($V_{CC}$ = +3.14V to +5.5V, load as shown in Figure 2, $T_A$ = -40°C to +85°C, unless otherwise noted. Typical values are at $V_{CC}$ = +3.3V, $T_A$ = +25°C.) (Note 6)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Modulation Current Range | $I_{MOD}$ | (Note 6) | | 5 | | 75 | mA |
| Modulation Off-Current | | $\overline{ENABLE}$ = high (Note 2) | | | | 200 | µA |
| Modulation Current Stability | | $I_{MOD}$ = 75mA | | -620 | -165 | +620 | ppm/°C |
| | | $I_{MOD}$ = 5mA (Note 4) | | | 205 | | |
| Modulation Current Absolute Accuracy | | | | -15 | | +15 | % |
| Output Rise/Fall Time | $t_R$, $t_F$ | 20% to 80%, $R_L$ = 10Ω \|\| 20Ω load | $I_{MOD}$ = 5mA | | 100 | 200 | ps |
| | | | $I_{MOD}$ = 75mA | | 230 | 375 | |
| Jitter Generation (Peak-to-Peak) | | (Note 7) | | | | 100 | ps |
| Pulse-Width Distortion (Peak-to-Peak) | | (Notes 8, 9) | $I_{MOD}$ = 5mA | | 70 | 155 | ps |
| | | | $I_{MOD}$ = 75mA | | 10 | 135 | |
| Enable/Startup Delay | | Open loop | | | 250 | | ns |
| Maximum Consecutive Identical Digits at 622Mbps | CID | | | 80 | | | Bits |

**Note 1:** Tested with $R_{MODSET}$ = 5.11kΩ ($I_{MOD}$ ≈ 38mA), $R_{BIASMAX}$ = 4.56kΩ ($I_{BIAS}$ ≈ 52mA), excluding $I_{BIAS}$ and $I_{MOD}$.
**Note 2:** Both the bias and modulation currents are disabled if any of the current set pins are shorted to ground.
**Note 3:** Guaranteed by design and characterization. This assumes that the laser to monitor diode transfer function does not change with temperature.
**Note 4:** See the *Typical Operating Characteristics* for worst-case distributions.
**Note 5:** AC characteristics are guaranteed by design and characterization.
**Note 6:** Total $I_{MOD}$ out of OUT+. See the *Design Procedure* section for information regarding current delivered to the laser.
**Note 7:** Input signal is a 622Mbps, $2^{13}$ - 1 PRBS with eighty inserted 0s.
**Note 8:** Input signal is a 622Mbps, 11110000 pattern.
**Note 9:** PWD = (wider pulse - narrower pulse) / 2.

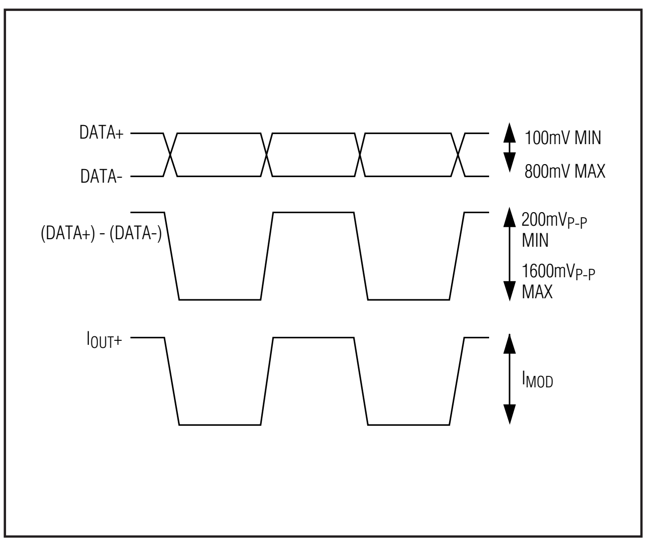



*Figure 1. Required Input Signal and Output Polarity*

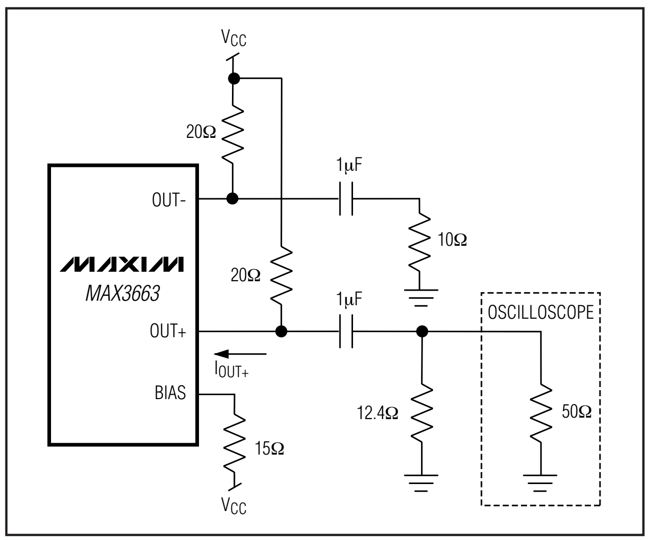


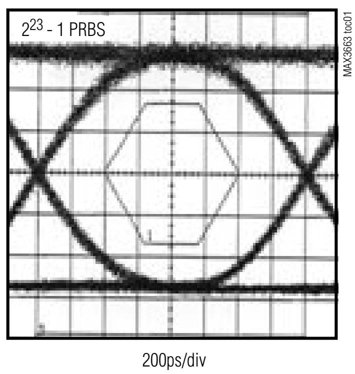

*Figure 2. Output Termination for Characterization*

# +3.3V, 622Mbps SDH/SONET Laser Driver with Current Monitors and APC

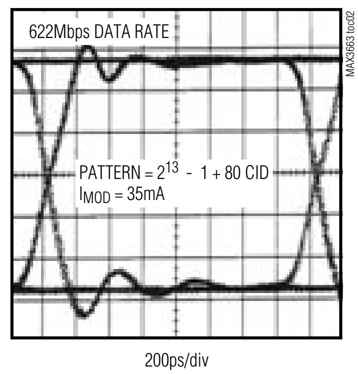
## Typical Operating Characteristics

($V_{CC}$ = +3.3V, $T_A$ = +25°C, unless otherwise noted.)

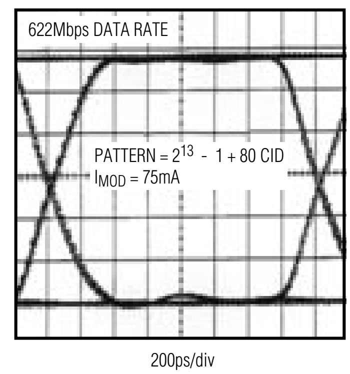
**EYE DIAGRAM (622Mbps, 1300nm LASER WITH 467MHz FILTER)**



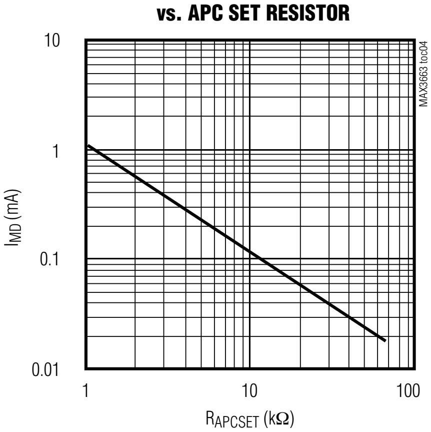

**ELECTRICAL EYE DIAGRAM ($I_{MOD}$ = 35mA)**



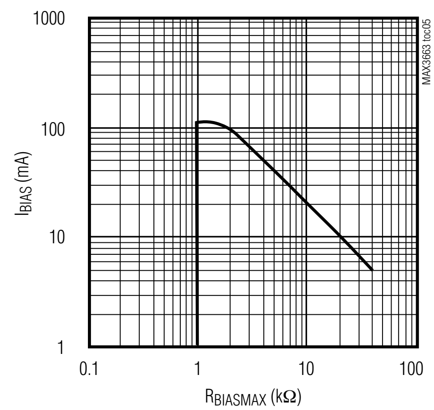

**ELECTRICAL EYE DIAGRAM ($I_{MOD}$ = 75mA)**



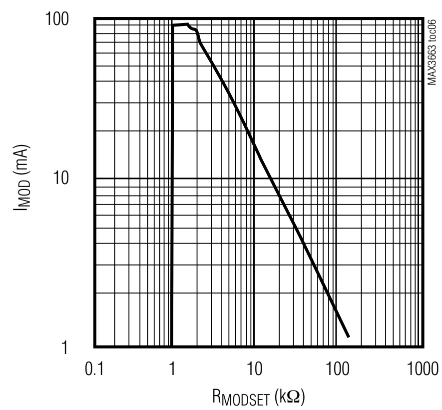

**MONITOR DIODE CURRENT vs. APC SET RESISTOR**



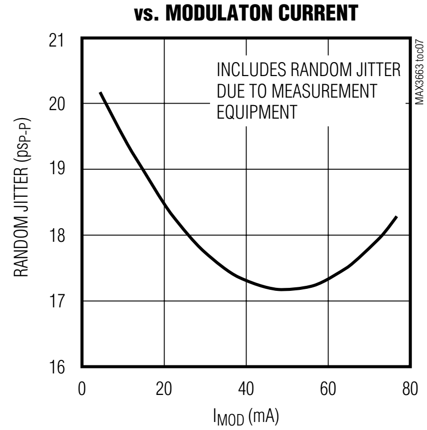

**BIAS CURRENT vs. MAXIMUM BIAS SET RESISTOR**



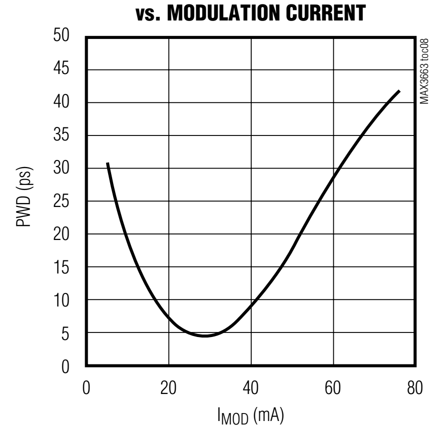

**MODULATION CURRENT vs. MODULATION SET RESISTOR**



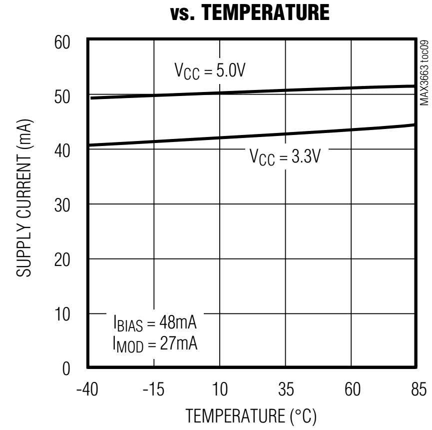

**RANDOM JITTER vs. MODULATON CURRENT**




**PULSE-WIDTH DISTORTION vs. MODULATION CURRENT**

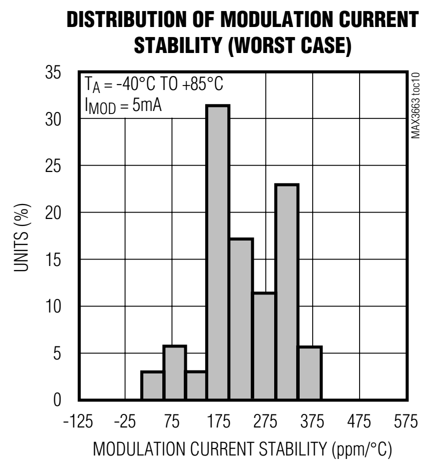


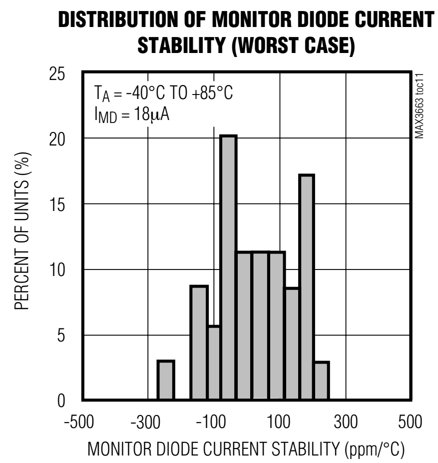

**SUPPLY CURRENT vs. TEMPERATURE**

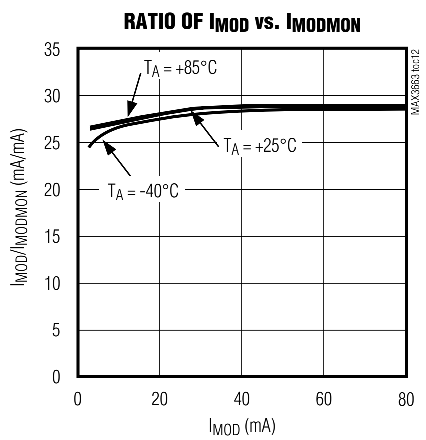


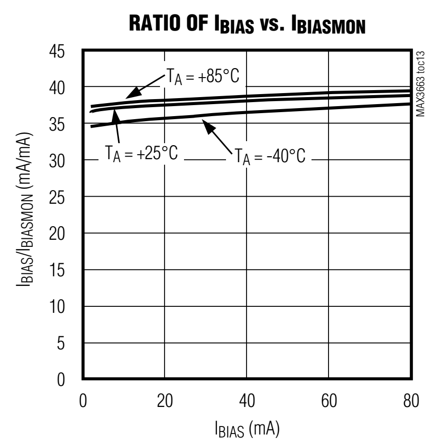
## Typical Operating Characteristics (continued)

($V_{CC}$ = +3.3V, $T_A$ = +25°C, unless otherwise noted.)



# +3.3V, 622Mbps SDH/SONET Laser Driver with Current Monitors and APC

## Pin Description

| PIN | NAME | FUNCTION |
|---|---|---|
| 1, 13, 16, 19 | $V_{CC}$ | Positive Supply Voltage |
| 2 | DATA+ | Positive PECL Data Input |
| 3 | DATA- | Negative PECL Data Input |
| 4, 8, 11, 17, 22 | GND | Ground |
| 5 | BIASMON | Sink Current Source. Proportional to the laser bias current. |
| 6 | MODMON | Sink Current Source. Proportional to the laser modulation current. |
| 7 | $\overline{\text{ENABLE}}$ | TTL/CMOS Enable Input. Low for normal operation, high to disable laser bias and modulation currents. Internally pulled low. |
| 9 | $\overline{\text{FAIL}}$ | TTL Output. Indicates APC failure when low. Internally pulled high through a 6kΩ resistor. |
| 10 | N.C. | No Connection. Leave unconnected. |
| 12 | BIAS | Laser Bias Current Output. Isolate from laser with a ferrite bead. |
| 14 | OUT+ | Positive Modulation Current Output. $I_{MOD}$ flows into this pad when the input signal is high. Connect this pad to AC-coupling network. |
| 15 | OUT- | Negative Modulation Current Output. $I_{MOD}$ flows into this pad when the input signal is low. Connect this pad to $V_{CC}$ through a 6.3Ω resistor. |
| 18 | MD | Monitor Photodiode Connection. Connect this pad to the monitor photodiode anode. A capacitor to ground is required to filter high-speed AC monitor photocurrent. |
| 20 | CAPC | APC Compensation Capacitor. A 0.1µF capacitor connected from this pad to ground controls the dominant pole of the APC feedback loop. |
| 21 | APCSET | APC Set Resistor. A resistor connected from this pad to ground sets the desired average optical power. The resulting current is equal to the desired DC monitor diode current. Connect a 100kΩ resistor from this pad to ground if APC is not used. |
| 23 | MODSET | Modulation Set Resistor. A resistor from this pad to ground sets the laser modulation current. |
| 24 | BIASMAX | Maximum Bias Set Resistor. A resistor from this pad to ground sets the maximum laser bias current. The APC function can subtract from this maximum value but cannot add to it. This resistor controls the bias-current level when the APC loop is not used. |
| EP | Exposed Paddle | The exposed paddle must be soldered to ground. |

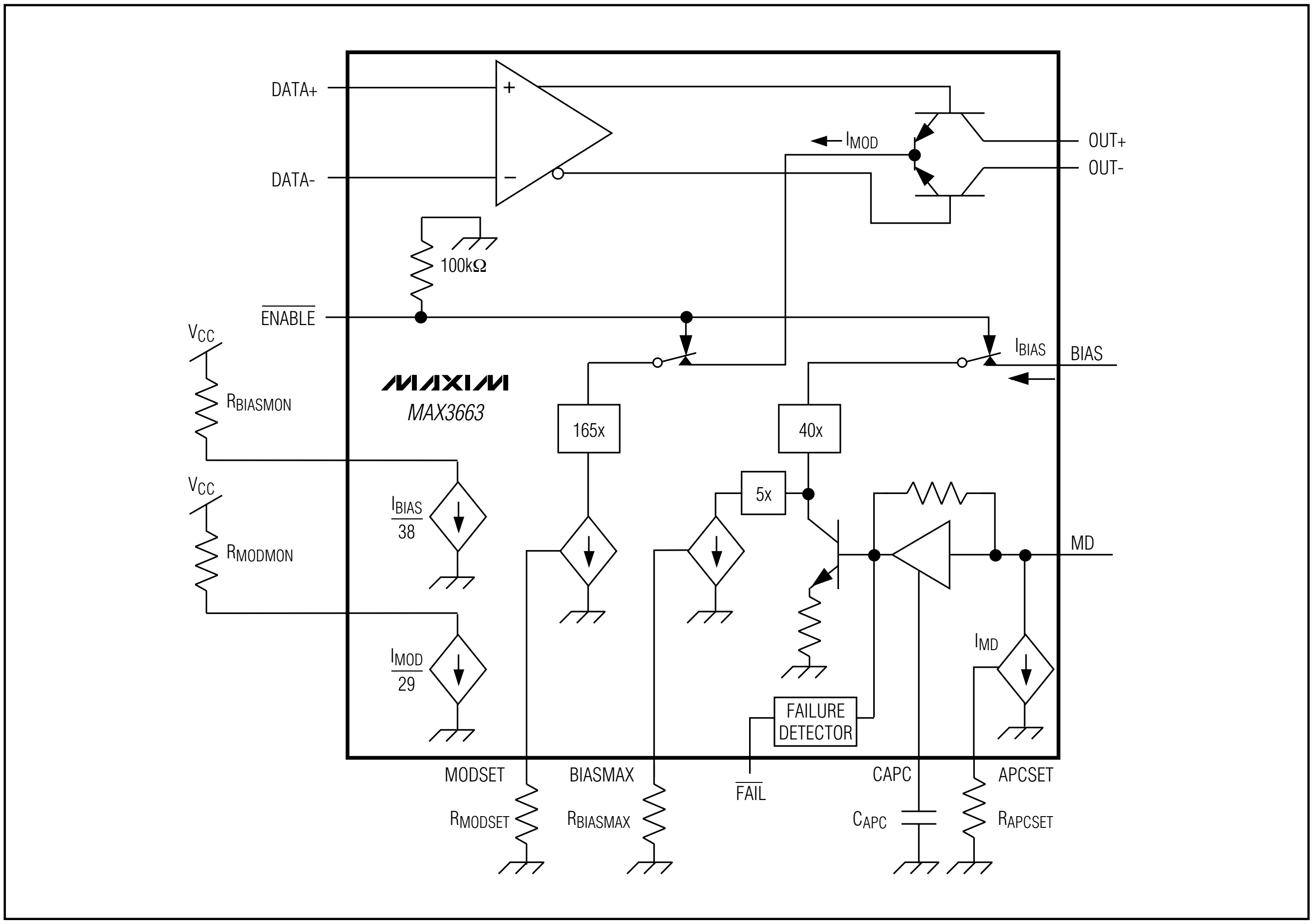



*Figure 3. Functional Diagram*

## Detailed Description

The MAX3663 laser driver consists of three main parts: a high-speed modulation driver, a laser-biasing block with automatic power control (APC), and bias current and modulation current monitors. The circuit is optimized for low-voltage (+3.3V) operation.

The output stage is composed of a high-speed differential pair and a programmable modulation current source. Since the modulation output drives a maximum current of 75mA into the laser with a 230ps edge speed, large transient voltage spikes can be generated due to the parasitic inductance. These transients and the laser forward voltage leave insufficient headroom for the proper operation of the laser driver if the modulation output is DC-coupled to the laser diode. To solve this problem, the MAX3663's modulation output is designed to be AC-coupled to the cathode of a laser diode. A simplified functional diagram is shown in Figure 3.

The MAX3663's modulation output is optimized for driving a 20Ω || 10Ω load; the minimum required voltage at OUT+ is 2.0V. Modulation current swings of 75mA are possible. To interface with the laser diode, a damping resistor ($R_D$) is required for impedance matching. An RC shunt network can be used to compensate for the laser-diode parasitic inductance, thereby improving the optical output aberrations and duty-cycle distortion.

At a 622Mbps data rate, any capacitive load at the cathode of a laser diode degrades the optical output performance. Since the BIAS output is directly connected to the laser cathode, minimize the parasitic capacitance associated with this pin by using an inductor to isolate the BIAS pin from the laser diode.

### Automatic Power Control

To maintain constant average optical power, the MAX3663 incorporates an APC loop to compensate for the changes in laser threshold current over temperature and lifetime. A back-facet photodiode mounted in the laser package is used to convert the optical power into a photocurrent. The APC loop adjusts the laser bias current so the monitor current is matched to a reference current set by $R_{APCSET}$. The time constant of the APC loop is determined by an external capacitor ($C_{APC}$). To eliminate the pattern-dependent jitter associated with the APC loop-time constant and to guarantee loop stability, the recommended value for $C_{APC}$ is 0.1µF.

When the APC loop is functioning, the maximum allowable bias current is set by an external resistor, $R_{BIASMAX}$. An APC failure flag ($\overline{FAIL}$) is set low when the bias current can no longer be adjusted to achieve the desired average optical power.

APC closed-loop operation requires the user to set three currents with external resistors connected between ground and BIASMAX, MODSET, and APCSET. Detailed guidelines for these resistor settings are described in the *Design Procedure* section.

### Bias and Modulation Monitors

The MAX3663 includes pins to monitor the output levels of bias and modulation current. BIASMON and MODMON sink current proportional to laser bias current and modulation current, respectively. By monitoring the current through $R_{MODMON}$ and $R_{BIASMON}$, it is possible to monitor the levels of bias and modulation current in the laser (Figure 3).

### Open-Loop Operation

If necessary, the MAX3663 is fully operational without APC. In this case, the laser current is directly set by two external resistors connected from ground to BIASMAX and MODSET. Connect a 100kΩ resistor from APCSET to ground and leave MD open for open-loop operation.

## Table 1. Optical Power Definition

| PARAMETER | SYMBOL | RELATION |
|---|---|---|
| Average Power | $P_{AVG}$ | $P_{AVG} = (P_0 + P_1) / 2$ |
| Extinction Ratio | $r_e$ | $r_e = P_1 / P_0$ |
| Optical Power High | $P_1$ | $P_1 = 2P_{AVG} \times r_e / (r_e + 1)$ |
| Optical Power Low | $P_0$ | $P_0 = 2P_{AVG} / (r_e + 1)$ |
| Optical Amplitude | $P_{P-P}$ | $P_{P-P} = 2P_{AVG} (r_e - 1) / (r_e + 1)$ |
| Laser Slope Efficiency | $\eta$ | $\eta = P_{P-P} / I_{MODL}$ |
| Laser Modulation Current | $I_{MOD}$ | $I_{MODL} = P_{P-P} / \eta$ |

### Enable Control

The MAX3663 incorporates a laser driver enable function. When $\overline{ENABLE}$ is high, both the bias and modulation currents are off. The typical laser enable time is 250ns.

### APC Failure Monitor

The MAX3663 provides an APC failure monitor (TTL/CMOS) to indicate an APC loop tracking failure. $\overline{FAIL}$ is set low when the APC loop can no longer adjust the bias current to maintain the desired monitor current. This output is internally pulled up to $V_{CC}$ through a 6kΩ resistor.

### Short-Circuit Protection

The MAX3663 provides short-circuit protection for the modulation, bias, and monitor current sources. If either BIASMAX, MODSET, or APCSET is shorted to ground, the bias and modulation outputs turn off.

## Design Procedure

When designing a laser transmitter, the optical output is usually expressed in terms of average power and extinction ratio. Table 1 gives the relationships that are helpful in converting between the optical average power and the modulation current. These relationships are valid if the average duty cycle of the optical waveform is 50%.

### Programming the Modulation Current

In addition to being a function of $R_{MODSET}$, the modulation current delivered to the laser ($I_{MODL}$) also depends on the values of the series damping resistor ($R_D$), the shunt compensation resistance ($R_{FILT}$), and the laser diode's resistance (see the *Typical Operating Circuit*).

The modulation current (assuming $C_{FILT} << C_D$) into the laser diode can be represented by the following:

$$I_{MODL} = I_{MOD}\left[\frac{20\Omega}{20\Omega + \left(R_D + r_{LASER}\right)}\right]$$

Assuming $R_D$ = 5Ω and $r_{LASER}$ = 5Ω, this equation is simplified to:

$$I_{MODL} = I_{MOD}(0.67)$$

For $R_D$ = 5.0Ω and a laser resistance of approximately 5Ω, see the Modulation Current vs. Modulation Set Resistor graph in the *Typical Operating Characteristics* and select the value of $R_{MODSET}$ that corresponds to the required current at +25°C.

### Programming the Bias Current

When using the MAX3663 in open-loop operation, the bias current is determined by the $R_{BIASMAX}$ resistor. To select this resistor, determine the required bias current at +25°C. See the Bias Current vs. Maximum Bias Set

Resistor graph in the *Typical Operating Characteristics* and select the value of $R_{BIASMAX}$ that corresponds to the required current at +25°C.

When using the MAX3663 in closed-loop operation, the $R_{BIASMAX}$ resistor sets the maximum bias current available to the laser diode over temperature and life. The APC loop can subtract from this maximum value but cannot add to it. See the Bias Current vs. Maximum Bias Set Resistor graph in the *Typical Operating Characteristics* and select the value of $R_{BIASMAX}$ that corresponds to the end-of-life bias current at +85°C.

### Programming the APC Loop

When the MAX3663's APC feature is used, program the average optical power by adjusting the APCSET resistor. To select this resistor, determine the desired monitor current to be maintained over temperature and life. See the Monitor Diode Current vs. APC Set Resistor graph in the *Typical Operating Characteristics* and select the value of $R_{APCSET}$ that corresponds to the required current.

### Interfacing with the Laser Diode

To minimize optical output aberrations due to the laser parasitic inductance, an RC shunt network can be used (see the *Typical Operating Circuit*). If $R_L$ represents the laser diode resistance, the recommended total resistance for $R_D + R_L$ is 10Ω. Starting values for coaxial lasers are $R_{FILT}$ = 20Ω and $C_{FILT}$ = 5pF. $R_{FILT}$ and $C_{FILT}$ should be experimentally adjusted to optimize the output waveform. A bypass capacitor should also be placed as close to the laser anode as possible for best performance.

### Pattern-Dependent Jitter (PDJ)

When transmitting NRZ data with long strings of consecutive identical digits (CIDs), LF droop can contribute to PDJ. To minimize this PDJ, two external components must be properly chosen: capacitor $C_{APC}$, which dominates the APC loop time constant, and AC-coupling capacitor $C_D$.

To filter out noise effects and guarantee loop stability, the recommended value for $C_{APC}$ is 0.1µF. This results in an APC loop bandwidth of 20kHz. Consequently, the PDJ associated with an APC loop time constant can be ignored.

The time constant associated with the DC-blocking capacitor on $I_{MOD}$ effects PDJ. It is important that this time constant produce minimum droop for long consecutive bit streams.

Referring to Figure 4, the droop resulting from long time periods without transitions can be represented by the following equation:

$$(100\% - \text{DROOP}) = e^{\frac{-t}{\tau}}$$

AC-coupling of $I_{MOD}$ results in a discharge level for $\tau$ that is equal to $P_{AVG}$. An overall droop of 6% relative to $P_{P-P}$ equates to a 12% droop relative to $P_{AVG}$. To ensure a droop of less than 12% (6% relative to $P_{P-P}$), this equation can be solved for $\tau$ as follows:

$$\tau = \frac{-t}{\ln(1 - 0.12)} = 7.8t$$

If $t_1$ equals 80 consecutive unit intervals without a transition, the time constant associated with the DC blocking capacitor needs to be longer than:

$$\tau_{AC} \ge R_{AC}C_D = 7.8\ (80\ \text{bits})\ (1.6\text{ns/bit}) = 1.0\mu s$$

$R_{FILT}$ can be ignored for $C_{FILT} << C_D$; therefore, the estimated value of $R_{AC}$ is:

$$R_{AC} = 20\Omega\ ||\ (R_D + r_{LASER})$$

Assuming $R_D$ = 5Ω, and $r_{LASER}$ = 5Ω:

$$R_{AC} = 6.7\Omega$$

with $C_D$ = 1µF, $\tau_{AC}$ = 6.7µs.

### Input Termination Requirement

The MAX3663 data inputs are PECL compatible (Table 2). However, it is not necessary to drive the MAX3663 with a standard PECL signal. As long as the specified common-mode voltage and differential voltage swings are met, the MAX3663 will operate properly.

## Table 2. PECL-Compatible Input Voltage Range

| PECL-COMPATIBLE INPUTS (DATA+, DATA-) | SYMBOL | VICM = $V_{CC}$ - 1.0 | | VICM = $V_{CC}$ - 1.32V | | VICM = $V_{CC}$ - 1.4 | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX | MIN | MAX | |
| Input High Voltage | VH | $V_{CC}$ - 0.95 | $V_{CC}$ - 0.60 | $V_{CC}$ - 1.27 | $V_{CC}$ - 0.92 | $V_{CC}$ - 1.35 | $V_{CC}$ - 1.00 | V |
| Input Low Voltage | VL | $V_{CC}$ - 1.40 | $V_{CC}$ - 1.05 | $V_{CC}$ - 1.72 | $V_{CC}$ - 1.37 | $V_{CC}$ - 1.80 | $V_{CC}$ - 1.45 | V |

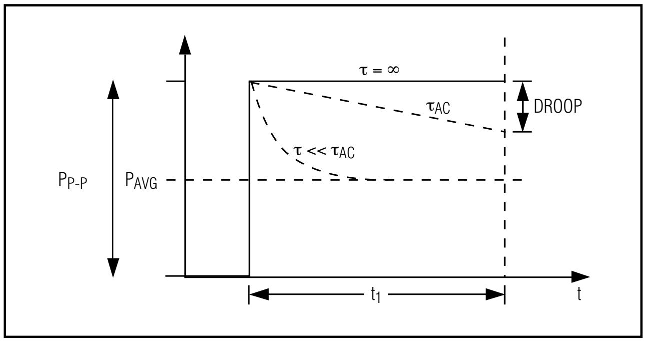



*Figure 4. Droop*

### Calculate Power Consumption

The total power dissipation of the MAX3663 can be estimated by the following:

$$P = V_{CC} \times I_{CC} + (V_{CC} - V_f) \times I_{BIAS} + I_{MOD} (V_{CC} - 20\Omega \times I_{MOD} / 2)$$

where $I_{BIAS}$ is the maximum bias current set by $R_{BIASMAX}$, $I_{MOD}$ is the modulation current, and $V_f$ is the typical laser forward voltage.

## Applications Information

The following is an example of how to set up the MAX3663.

### Select Laser

A communication-grade laser should be selected for 622Mbps applications. Assume the laser output average power is $P_{AVG}$ = 0dBm, the minimum extinction ratio is $r_e$ = 6.6 (8.2dB), the operating temperature is -40°C to +85°C, and the laser diode has the following characteristics:

| | |
|---|---|
| Wavelength: | $\lambda$ = 1.3µm |
| Threshold Current: | $I_{TH}$ = 22mA at +25°C |
| Threshold Temperature Coefficient: | $\beta_{TH}$ = 1.3%/°C |
| Laser to Monitor Transfer: | $\rho_{MON}$ = 0.2A/W |
| Laser Slope Efficiency: | $\eta$ = 0.05mW/mA at +25°C |

### Determine $R_{APCSET}$

The desired monitor diode current is estimated by $I_{MD} = P_{AVG} \times \rho_{MON}$ = 200µA. The Monitor Diode Current vs. APC Set Resistor graph in the *Typical Operating Characteristics* shows that $R_{APCSET}$ should be 6kΩ.

### Determine $R_{MODSET}$

To achieve a minimum extinction ratio ($r_e$) of 6.6dB over temperature and lifetime, calculate the required extinction ratio at +25°C. Assuming $r_e$ = 20, the peak-to-peak optical power $P_{P-P}$ = 1.81mW, according to Table 1. The required modulation current is 1.81(mW) / 0.05(mW/mA) = 36.2mA. The Modulation Current vs. Modulation Set Resistor graph (see *Typical Operating Characteristics*) shows that $R_{MODSET}$ should be 5kΩ.

### Determine $R_{BIASMAX}$

Calculate the maximum threshold current ($I_{TH(MAX)}$) at $T_A$ = +85°C and end of life. Assuming $I_{TH(MAX)}$ = 50mA, the maximum bias current should be:

$$I_{BIAS} = I_{TH(MAX)} + I_{MOD} / 2$$

In this example, $I_{BIAS}$ = 68.1mA. The Bias Current vs. Maximum Bias Set Resistor graph in the *Typical Operating Characteristics* shows that $R_{BIASMAX}$ should be 3kΩ.

### Determine $R_{BIASMON}$

To avoid saturating the current mirror of BIASMON, the voltage at this pin should not drop below ($V_{CC}$ - 1.6V). The resulting condition is:

$$R_{BIASMON} \le 1.6V\left(\frac{A_{BIAS}}{I_{BIASMAX}}\right)$$

where $I_{BIASMAX}$ is the maximum current expected for the application.

### Determine $R_{MODMON}$

To avoid saturating the current mirror of MODMON, the voltage at this pin should not drop below ($V_{CC}$ - 1V). The resulting condition is:

$$R_{MODMON} \le 1V\left(\frac{A_{MOD}}{I_{MOD}}\right)$$

### Modulation Currents Exceeding 50mA

To drive modulation currents greater than 50mA at 3.3V, external pullup inductors (Figure 5) should be used to DC-bias the modulation output at $V_{CC}$. Such a configuration isolates the laser forward voltage from the output circuitry and allows the output at OUT+ to swing above and below the supply voltage $V_{CC}$.

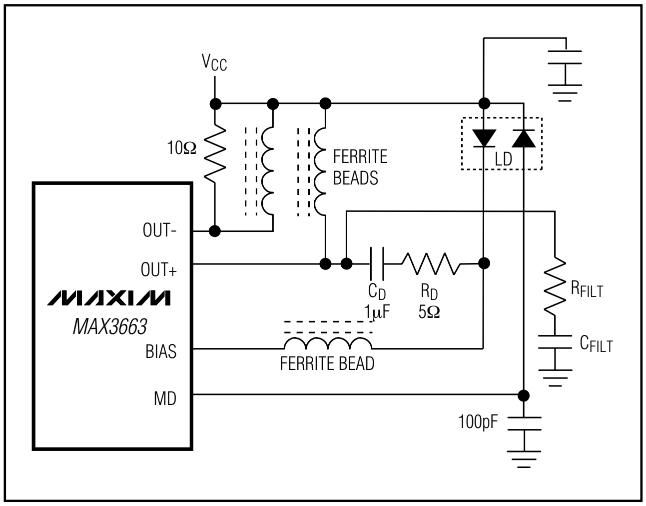



*Figure 5. Output Termination for Maximum Modulation Current*

At +5V power supply, the headroom voltage for the MAX3663 is significantly improved. In this case, it is possible to achieve a modulation current of more than 50mA (using resistor pullups as shown in the *Typical Operating Circuit*). The MAX3663 can also be DC-coupled to a laser diode when operating at +5V supply; the voltage at OUT+ should be ≥2.0V for proper operation.

### Wire Bonding Die

For high-current density and reliable operation, the MAX3663 uses gold metalization. Make connections to the die with gold wire only, using ball-bonding techniques. Wedge bonding is not recommended. Die-pad size is 4 mils (100µm) square, and die thickness is 12 mils (300µm).

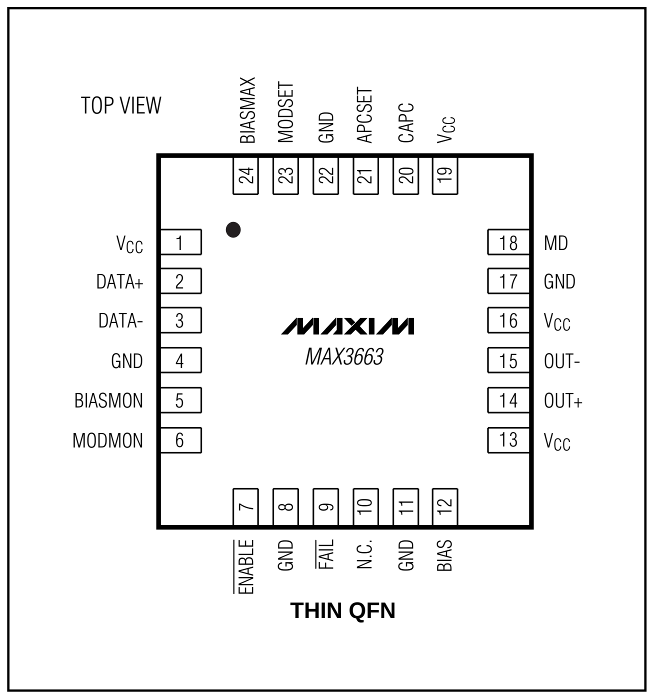
### Layout Considerations

To minimize inductance, keep the connections between the MAX3663 output pins and LD as close as possible. Optimize the laser diode performance by placing a bypass capacitor as close as possible to the laser anode. Use good high-frequency layout techniques and multilayer boards with uninterrupted ground planes to minimize EMI and crosstalk.

### Laser Safety and IEC 825

Using the MAX3663 laser driver alone does not ensure that a transmitter design is compliant with IEC 825. The entire transmitter circuit and component selections must be considered. Customers must determine the level of fault tolerance required by their application, recognizing that Maxim products are not designed or authorized for use as components in systems intended for surgical implant into the body, for applications intended to support or sustain life, or for any other application where the failure of a Maxim product could create a situation where personal injury or death may occur.

## Pin Configuration




## Chip Information

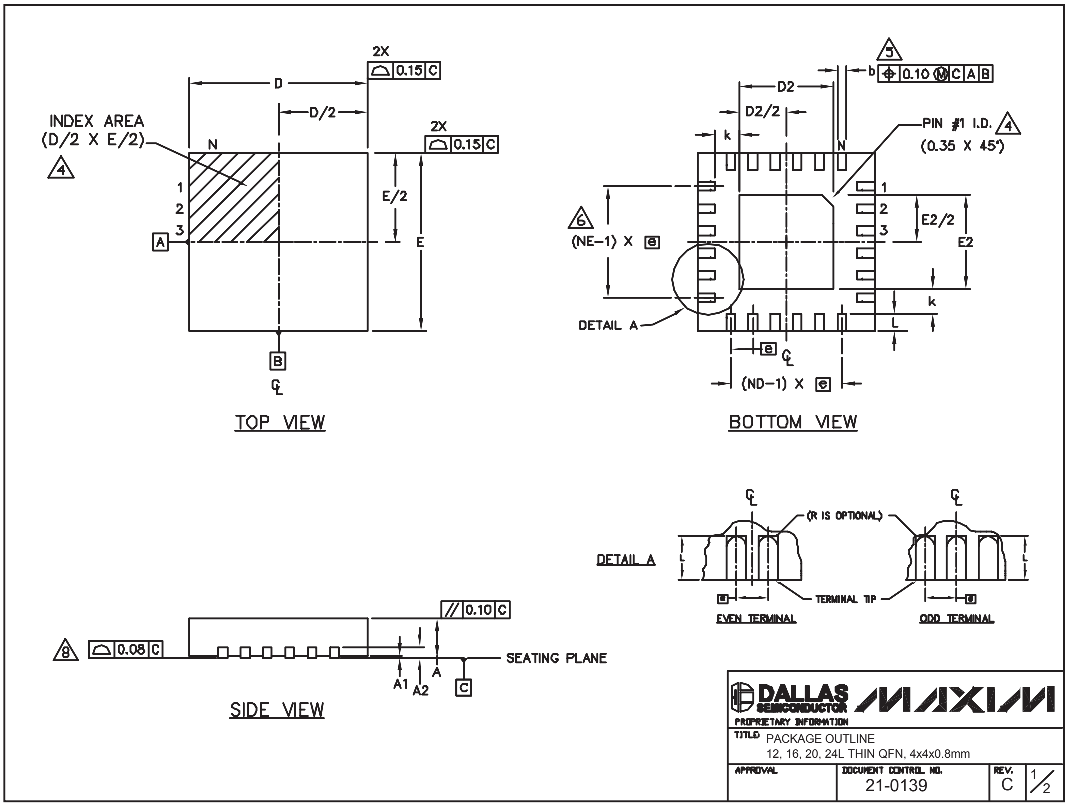
TRANSISTOR COUNT: 1525

SUBSTRATE CONNECTED TO GND

# +3.3V, 622Mbps SDH/SONET Laser Driver with Current Monitors and APC

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)




24L QFN THIN.EPS

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to **www.maxim-ic.com/packages**.)

COMMON DIMENSIONS

| PKG | 12L 4x4 | | | 16L 4x4 | | | 20L 4x4 | | | 24L 4x4 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| REF. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |
| A | 0.70 | 0.75 | 0.80 | 0.70 | 0.75 | 0.80 | 0.70 | 0.75 | 0.80 | 0.70 | 0.75 | 0.80 |
| A1 | 0.0 | 0.02 | 0.05 | 0.0 | 0.02 | 0.05 | 0.0 | 0.02 | 0.05 | 0.0 | 0.02 | 0.05 |
| A2 | 0.20 REF | | | 0.20 REF | | | 0.20 REF | | | 0.20 REF | | |
| b | 0.25 | 0.30 | 0.35 | 0.25 | 0.30 | 0.35 | 0.20 | 0.25 | 0.30 | 0.18 | 0.23 | 0.30 |
| D | 3.90 | 4.00 | 4.10 | 3.90 | 4.00 | 4.10 | 3.90 | 4.00 | 4.10 | 3.90 | 4.00 | 4.10 |
| E | 3.90 | 4.00 | 4.10 | 3.90 | 4.00 | 4.10 | 3.90 | 4.00 | 4.10 | 3.90 | 4.00 | 4.10 |
| e | 0.80 BSC. | | | 0.65 BSC. | | | 0.50 BSC. | | | 0.50 BSC. | | |
| k | 0.25 | - | - | 0.25 | - | - | 0.25 | - | - | 0.25 | - | - |
| L | 0.45 | 0.55 | 0.65 | 0.45 | 0.55 | 0.65 | 0.45 | 0.55 | 0.65 | 0.30 | 0.40 | 0.50 |
| N | 12 | | | 16 | | | 20 | | | 24 | | |
| ND | 3 | | | 4 | | | 5 | | | 6 | | |
| NE | 3 | | | 4 | | | 5 | | | 6 | | |
| Jedec Var. | WGGB | | | WGGC | | | WGGD-1 | | | WGGD-2 | | |

EXPOSED PAD VARIATIONS

| PKG. CODES | D2 | | | E2 | | | DOWN BONDS ALLOWED |
|---|---|---|---|---|---|---|---|
| | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. | |
| T1244-2 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | NO |
| T1244-3 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | YES |
| T1244-4 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | NO |
| T1644-2 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | NO |
| T1644-3 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | YES |
| T1644-4 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | NO |
| T2044-1 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | NO |
| T2044-2 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | YES |
| T2044-3 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | NO |
| T2444-1 | 2.45 | 2.60 | 2.63 | 2.45 | 2.60 | 2.63 | NO |
| T2444-2 | 1.95 | 2.10 | 2.25 | 1.95 | 2.10 | 2.25 | YES |
| T2444-3 | 2.45 | 2.60 | 2.63 | 2.45 | 2.60 | 2.63 | YES |
| T2444-4 | 2.45 | 2.60 | 2.63 | 2.45 | 2.60 | 2.63 | NO |

NOTES:

1. DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
2. ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
3. N IS THE TOTAL NUMBER OF TERMINALS.
4. THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
5. DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.25 mm AND 0.30 mm FROM TERMINAL TIP.
6. ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
7. DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
8. COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
9. DRAWING CONFORMS TO JEDEC MO220, EXCEPT FOR T2444-1, T2444-3 AND T2444-4.

DALLAS SEMICONDUCTOR MAXIM

PROPRIETARY INFORMATION

TITLE: PACKAGE OUTLINE
12, 16, 20, 24L THIN QFN, 4x4x0.8mm

| APPROVAL | DOCUMENT CONTROL NO. | REV. | |
|---|---|---|---|
| | 21-0139 | C | 2/2 |