MAXIM

2.7Gbps, +3.3V DC-Coupled Laser Driver

MAX3850

EVALUATION KIT AVAILABLE

General Description

The MAX3850 is a +3.3V DC-coupled laser driver for SDH/SONET applications up to 2.7Gbps. The device accepts differential data and clock inputs and provides bias and modulation currents for driving a laser. If a clock signal is available, a synchronizing input latch can be used to reduce jitter. An automatic power-control (APC) feedback loop is incorporated to maintain a constant average optical power over temperature and lifetime. The wide modulation current range of 5mA to 60mA (up to 80mA AC-coupled) and bias current of 1mA to 100mA are easy to program, making this product ideal for SDH/SONET applications. The MAX3850 also provides laser current-enable control, two current monitors that are directly proportional to the laser bias and modulation currents, and a failure-monitor output to indicate when the APC loop is unable to maintain the average optical power. Designed to be DC-coupled to the laser with a supply voltage of only 3.3V, the MAX3850 greatly simplifies interface requirements. The MAX3850 is available in a small 32-pin QFN package as well as dice.

Applications

SDH/SONET Transmission Systems

MPLS Transmitter Systems

Add/Drop Multiplexers

Digital Cross-Connects

Section Regenerators

Features

♦ **Single +3.3V Power Supply**

♦ **35mA Supply Current**

♦ **Programmable Bias Current from 1mA to 100mA**

♦ **Programmable Modulation Current from 5mA to 60mA (Up to 80mA AC-Coupled)**

♦ **Bias Current and Modulation Current Monitors**

♦ **70ps Rise/Fall Time**

♦ **Automatic Average Power Control with Failure Monitor**

♦ **Complies with ANSI, ITU, and Bellcore SDH/SONET Specifications**

♦ **Laser Current-Enable Control**

Ordering Information

PART	TEMP RANGE	PIN-PACKAGE	PACKAGE CODE
MAX3850EGJ	-40°C to +85°C	32 QFN	G3255-1
MAX3850E/D	-40°C to +85°C	Dice*	—

*Dice are designed to operate over this range, but are tested and guaranteed at T_A = +25°C only. Contact factory for availability.

Typical Application Circuits are continued at the end of the data sheet.

Pin Configuration appears at the end of the data sheet.

Typical Application Circuits

TYPICAL APPLICATION CIRCUIT WITH DC-COUPLED INPUTS
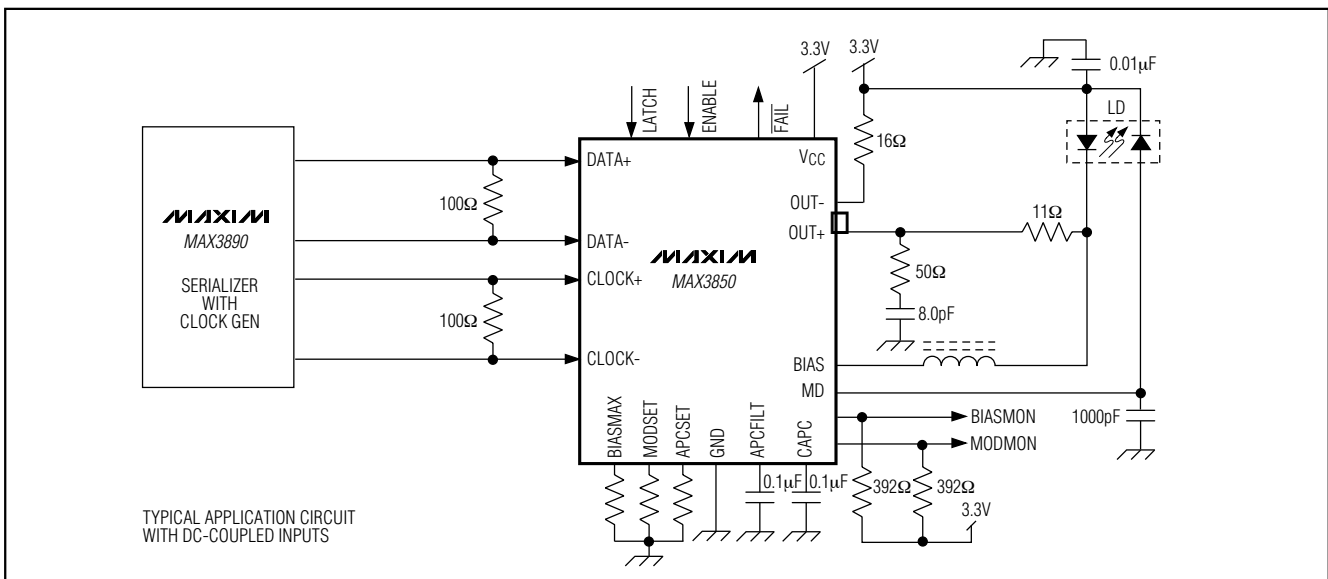
Covered by U.S. Patent numbers 5,802,089 and 5,883,910

MAXIM _____ **Maxim Integrated Products** 1

For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

2.7Gbps, +3.3V DC-Coupled Laser Driver

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V_{CC}...-0.5V to +4.0V
Current into BIAS ....-20mA to +150mA
Current into OUT+, OUT- ....-20mA to +100mA
Current into MD...-5mA to +5mA
Voltage at DATA+, DATA-, CLK+, CLK-, ENABLE, LATCH,
$\overline{FAIL}$, BIASMON, MODMON, CAPC,
MODSET, BIASMAX, APCSET................-0.5V to (V_{CC} + 0.5V)
Voltage at APCFILT ....-0.5V to +3.0V
Voltage at OUT+, OUT-..0.4V to 4.8V

Voltage at BIAS...1.0V to (V_{CC} + 0.5V)
Continuous Power Dissipation (T_A = +85°C)
    32-Pin QFN (derate 21.2mW/°C above +85°C) 13.84mW
Storage Temperature Range ....-65°C to +165°C
Operating Junction Temperature Range............-55°C to +150°C
Processing Temperature (die) ....+400°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} = +3.0V to +3.6V, T_A = -40°C to +85°C. Typical values are at V_{CC} = +3.3V, I_{MOD} = 30mA, I_{BIAS} = 60mA, T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage	V_{CC}			3.0	3.3	3.6	V
Supply Current	I_{CC}	(Note 2)			35	65	mA
Bias-Current Range	I_{BIAS}	(Note 3)		1		100	mA
Bias Off-Current	$I_{BIAS-OFF}$	ENABLE = low (Note 4)				100	µA
Bias-Current Stability		APC open loop	I_{BIAS} = 100mA	-480	12	480	ppm/°C
			I_{BIAS} = 1mA	-1000	456	1000	
Differential Input Voltage Range	V_{ID}	(Figure 1)		200		1600	mV_{P-P}
Common-Mode Input Voltage	V_{ICM}	LVPECL compatible		V_{CC} - 1.49	V_{CC} - 1.32	V_{CC} - V_{ID}/4	V
TTL Input High Voltage		ENABLE, LATCH		2.0			V
TTL Input Low Voltage		ENABLE, LATCH				0.8	V
TTL Output High Voltage		$\overline{FAIL}$ sourcing 50µA		2.4	V_{CC} - 0.3	V_{CC}	V
TTL Output Low Voltage		Sinking 100µA		0	0.025	0.4	V
Monitor-Diode Reverse Bias Voltage				1.5			V
Monitor-Diode DC Current Range	I_{MD}			18		1000	µA
Monitor-Diode Set-Point Stability		(Note 6)	I_{MD} = 1mA	-480	95	480	ppm/°C
			I_{MD} = 18µA	-1000	295	1000	
Monitor-Diode Bias Absolute Accuracy		(Note 5)		-15		+15	%
BIASMON to I_{BIAS} Gain	A_{BIAS}	I_{BIAS}/$I_{BIASMON}$		36	41	46	A/A
MODMON to I_{MOD} Gain	A_{MOD}	I_{MOD}/I_{MODMON}		25	30	35	A/A
Modulation-Current Range	I_{MOD}	V_{OUT+}, V_{OUT-} = 0.6V (DC-coupled)		5		60	mA
		V_{OUT+}, V_{OUT-} = 2.0V (AC-coupled)		5		80	

MAXIM

2.7Gbps, +3.3V DC-Coupled Laser Driver

DC ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +3.0V to +3.6V, T_A = -40°C to +85°C. Typical values are at V_{CC} = +3.3V, I_{MOD} = 30mA, I_{BIAS} = 60mA, T_A = +25°C, unless otherwise noted.) (Note 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Modulation Off-Current	$I_{MOD-OFF}$	ENABLE = low (Note 4)			100	µA
Modulation-Current Stability		I_{MOD} = 60mA	-480	66	480	ppm/°C
		I_{MOD} = 5mA	-1000	110	1000	

AC ELECTRICAL CHARACTERISTICS

(V_{CC} = +3.0V to +3.6V, I_{MOD} = 5mA to 60mA, T_A = -40°C to +85°C. Typical values are at V_{CC} = +3.3V, I_{MOD} = 30mA, T_A = +25°C.) (Note 7)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Maximum Data Rate					2.7	Gbps
Input Latch Setup Time	t_{SU}	LATCH = high (Figure 3)	90			ps
Input Latch Hold Time	t_H	LATCH = high (Figure 3)	60			ps
Output Rise Time	t_R	20% to 80% edge speeds (Note 8)		66	110	ps
Output Fall Time	t_F	20% to 80% edge speeds (Note 8)		70	100	ps
Output Overshoot		30mA ≤ I_{MOD} ≤ 60 (Note 8)		±2		%
		I_{MOD} = 5mA (Note 8)		±12		
I_{MOD} Enable/Startup Delay				270		ns
I_{BIAS} Typical Startup Delay		APC open loop, C_{APC} and $C_{APCFILT}$ = 0		370		ns
Output Random Jitter	RJ_{OUT}	(Note 8)		0.66	1.4	ps_{RMS}
Output Deterministic Jitter	TJ_{OUT}	LATCH = high, 2^7- 1 PRBS with 80 inserted 0s and 80 inserted 1s		8.6	50	ps_{P-P}

Note 1: Dice are tested at T_A = +25°C only. Specifications at -40°C are guaranteed by design and characterization.
Note 2: Tested at R_{MODSET} = 2.61kΩ, $R_{BIASMAX}$ = 1.96kΩ, excluding I_{BIAS} and I_{MOD}.
Note 3: Voltage on BIAS pin is (V_{CC} - 1.5V).
Note 4: The bias and modulation currents will be switched off if any of the current set pins are grounded.
Note 5: Accuracy refers to part-to-part variation.
Note 6: Assuming the laser-to-monitor diode transfer function does not change with temperature. Guaranteed by design and characterization.
Note 7: AC characteristics are guaranteed by design and characterization using the characterization circuit of Figure 2.
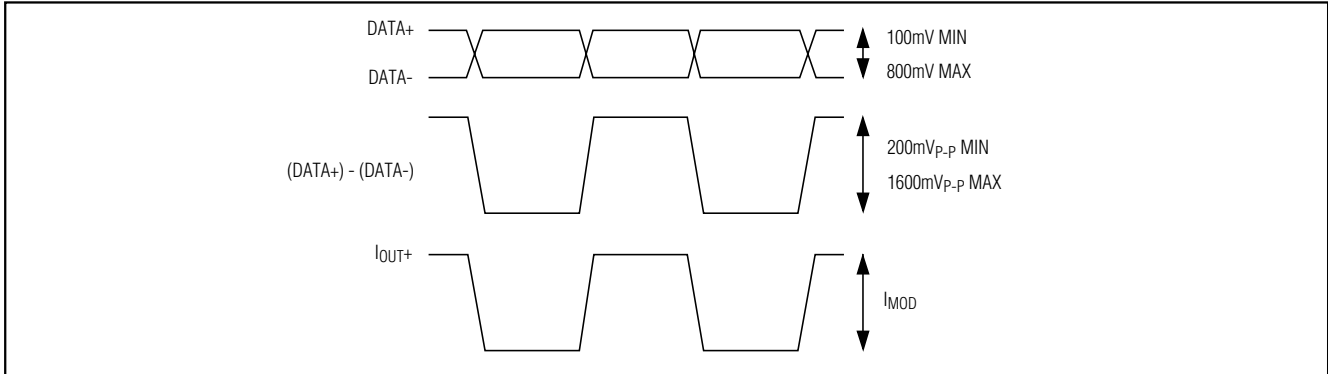**Note 8:** Measured with repeating 0000 1111 pattern, LATCH = high.

MAX3850
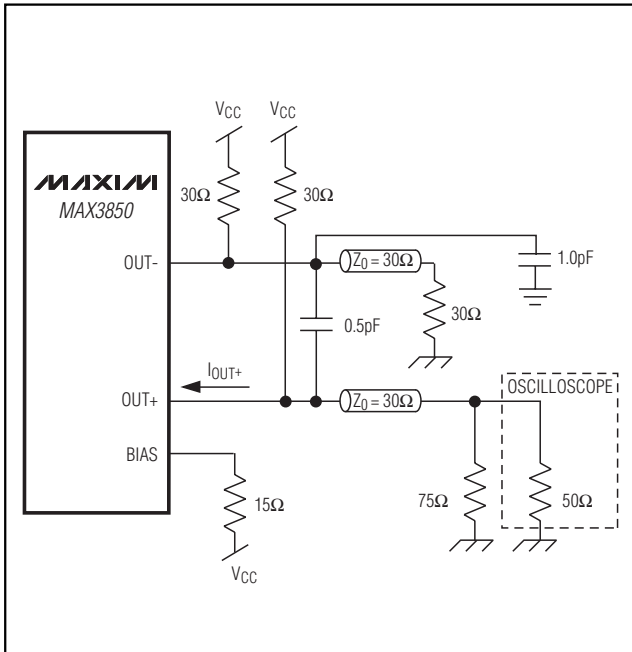

Figure 1. Required Input Signal and Output Polarity

Figure 2. Output Termination for Characterization
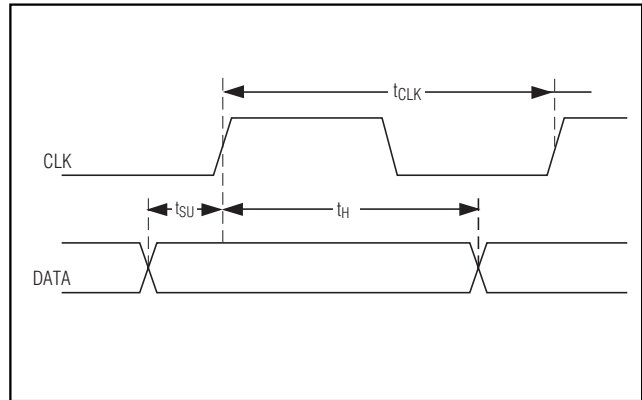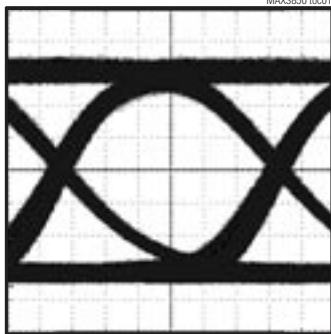

Figure 3. Setup/Hold Time Definition

MAXIM

2.7Gbps, +3.3V DC-Coupled Laser Driver

(DC-coupled output, T_A = +25°C, unless otherwise noted.)

OPTICAL EYE DIAGRAM
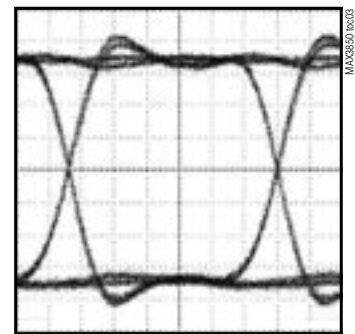**(2.7Gbps, 130mm FP LASER**
1.87Gbps FILTER, 32-QFN)

MAX3850 toc01

MITSUBISHI ML725C8F LASER DIODE

BIAS CURRENT ENABLE
STARTUP DELAY vs. C$_{APC}$

MAX3850 toc02

STARTUP DELAY (ms)

CAPC (F)
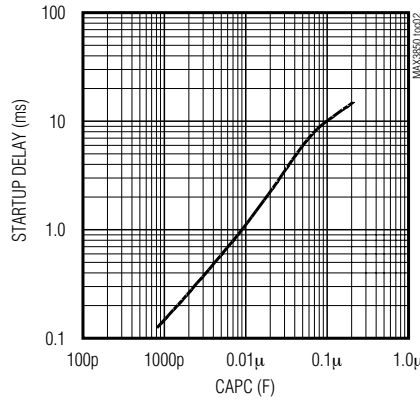
ELECTRICAL EYE DIAGRAM
(I_{MOD} = 25mA, 2^{13} - 1 + 80 CID, 32 QFN)

MAX3850 toc03

58ps/div

ELECTRICAL EYE DIAGRAM
(I_{MOD} = 60mA, 2^{13} - 1 + 80 CID, 32 QFN)

MAX3850 toc04
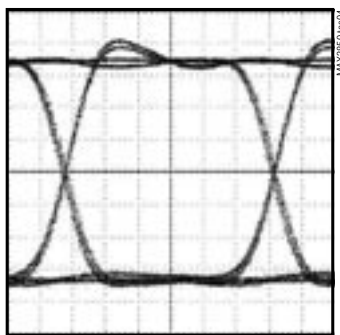
58ps/div

ELECTRICAL EYE DIAGRAM
AC-COUPLED
(I_{MOD} = 80mA, 2^{13} - 1 + 80 CID, 32 QFN)

MAX3850 toc05
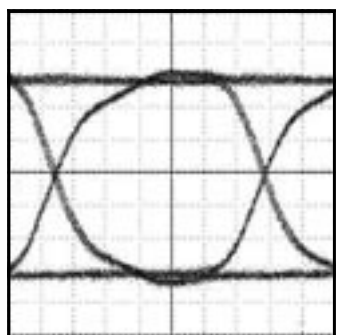
58ps/div

RANDOM JITTER vs. I$_{MOD}$

MAX3850 toc06

RANDOM JITTER (psms)

I_{MOD} (mA)

DETERMINISTIC JITTER vs. I$_{MOD}$
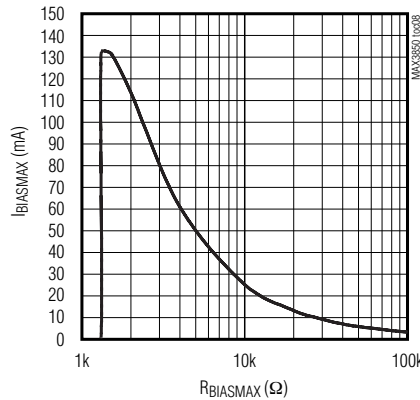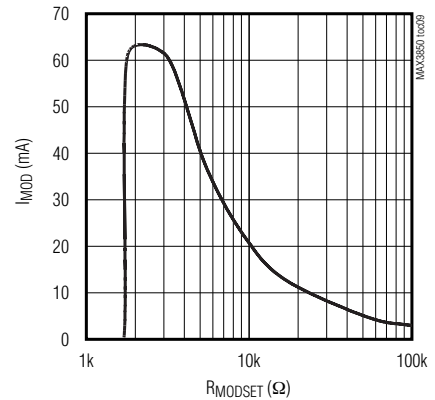
MAX3850 toc07

TOTAL JITTER (psP-P)

I_{MOD} (mA)

I$_{BIASMAX}$ vs. R$_{BIASMAX}$

MAX3850 toc08

$I_{BIASMAX}$ (mA)

$R_{BIASMAX}$ (Ω)

I$_{MOD}$ vs. R$_{MODSET}$

MAX3850 toc09

I_{MOD} (mA)

R_{MODSET} (Ω)

MAX3850

MAX3850

(DC-coupled output, T_A = +25°C, unless otherwise noted.)

I_{MD} vs. R_{APCSET}

**SUPPLY CURRENT vs. TEMPERATURE
(EXCLUDES I_{BIAS}, I_{MOD}, 15Ω LOAD)**

**BIAS-CURRENT MONITOR GAIN
vs. TEMPERATURE**

**MODULATION-CURRENT MONITOR GAIN
vs. TEMPERATURE**

PULSE-WIDTH DISTORTION vs. I_{MOD}

MAXIM
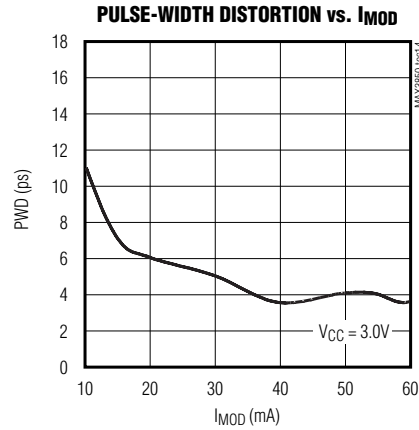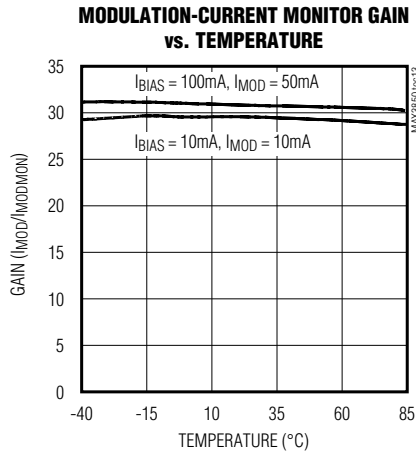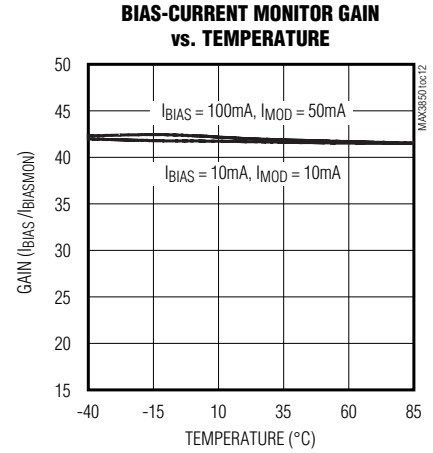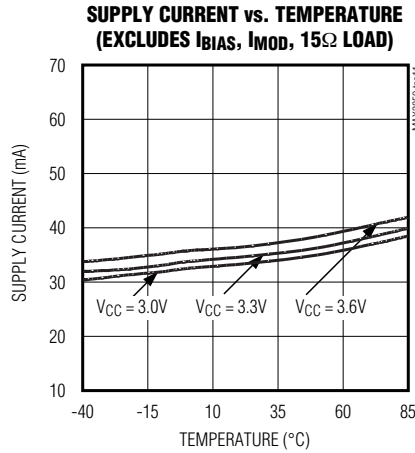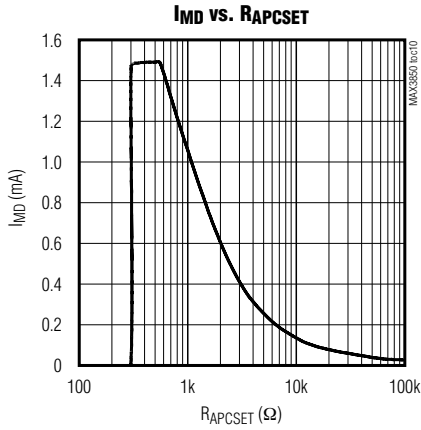
2.7Gbps, +3.3V DC-Coupled Laser Driver

| PIN	NAME	FUNCTION
1, 4, 7	V_{CC1}	Power Supply for Digital Circuits
2	DATA+	Positive Data Input
3	DATA-	Negative Data Input
5	CLK+	Positive Clock Input. Connect to V_{CC} or leave unconnected if latch function is not used.
6	CLK-	Negative Clock Input. Connect to V_{CC} or leave unconnected if latch function is not used.
8	LATCH	TTL/CMOS Latch Input. High for latched data, low for direct data. Internal 100kΩ pullup resistor to V_{CC}.
9	ENABLE	TTL/CMOS Enable Input. High for normal operation, low to disable laser bias and modulation current. Internal 100kΩ pullup resistor to V_{CC}.
10	GND1	Ground for Digital Curcuits
11	BIASMON	Bias Current Monitor. Current into this pin is proportional to the laser bias current.
12	MODMON	Modulation Current Monitor. Current into this pin is proportional to the laser modulation current.
13	$\overline{FAIL}$	TTL/CMOS Failure Output. Indicates APC failure when low.
14	APCFILT	Connect a capacitor ($C_{APCFILT}$ = 0.1µF) from this pad to ground to filter the APC noise.
15	GND4	Ground for Output Curcuitry
16, 18, 21	V_{CC4}	Power Supply for Output Circuitry
17	BIAS	Laser Bias Current Output
19	OUT+	Positive Modulation Current Output. I_{MOD} flows into this pad when input data is high.
20	OUT-	Negative Modulation Current Output. I_{MOD} flows into this pad when input data is low.
22	GND4	Ground for Modulation Current Source
23	GND3	Ground for APC Circuitry
24	MD	Monitor Diode Input. Connect this pin to a monitor photodiode anode. A capacitor to ground is required to filter high-speed AC monitor photocurrent.
25	V_{CC3}	Power Supply for APC
26	CAPC	A capacitor connected from this pad to ground controls the dominant pole for the APC feedback loop (C_{APC} = 0.1µF).
27	GND2	Ground for Internal Reference
28	N.C.	No Connection. Leave unconnected.
29	APCSET	A resistor connected from this pad to ground sets the desired average optical power. Connect a 100kΩ resistor from this pad to ground if APC is not used.
30	MODSET	A resistor connected from this pad to ground sets the desired modulation current.
31	BIASMAX	A resistor connected from this pad to ground sets the maximum bias current. The APC function can subtract from this maximum value but cannot add to it.
32	VCC2	Power Supply for Internal Reference
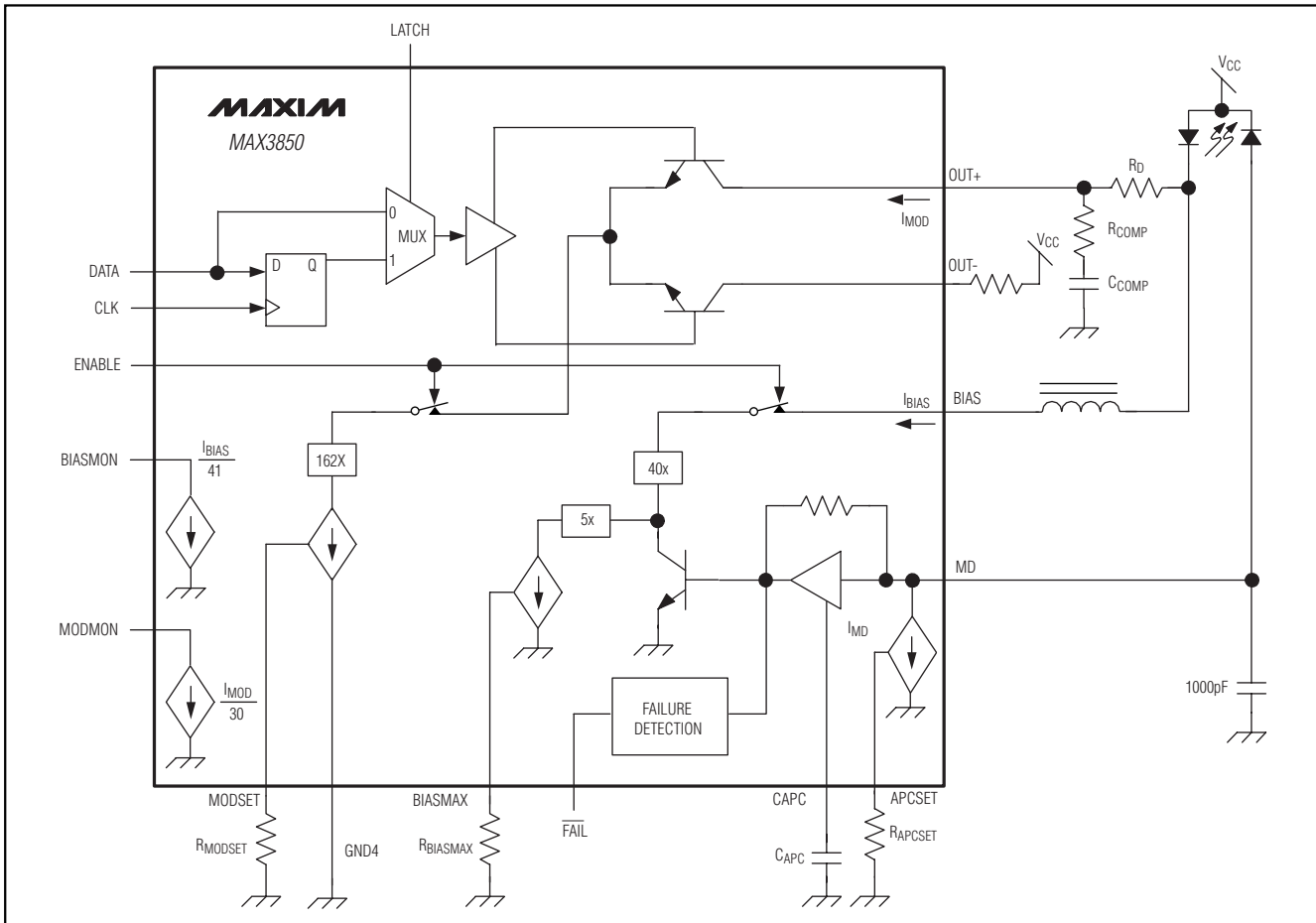
MAX3850

Figure 4. Functional Diagram

Detailed Description

The MAX3850 laser driver has two main parts: a high-speed modulation driver and a laser-biasing block with automatic power control (APC). The circuit design is optimized for high-speed, low-voltage (3.3V), direct-coupled operation. To reject pattern-dependent jitter of the input signal at speeds as high as 2.7Gbps, the device accepts a differential clock signal for data retiming. When LATCH is high, the input data is synchronized by the clock signal. When LATCH is low, the input data is directly applied to the output stage. The output stage has a high-speed differential pair and a programmable modulation current source.

The MAX3850 modulation output is optimized for driving a 15Ω load; the minimum required voltage at OUT+ is 0.6V. Modulation current swings up to 80mA are possible when the laser diode is AC-coupled to the driver (refer to Maxim Application Note HFAN 2.0). To

interface with the laser diode, a damping resistor (RD) is required for impedance matching. The combined resistance due to the series damping resistor and the equivalent series resistance of the laser diode should equal 15Ω. To reduce optical output aberrations and duty-cycle distortion caused by laser diode parasitic inductance, an RC shunt network might be necessary. At data rates of 2.7Gbps, any capacitive load at the cathode of a laser diode degrades optical output performance. Because the BIAS output is directly connected to the laser cathode, minimize the parasitic capacitance associated with the pin by using an inductor to isolate the BIAS pin from the laser cathode.

Automatic Power Control

To maintain constant average optical power, the MAX3850 incorporates an APC loop to compensate for the changes in laser threshold current over temperature and lifetime. A back-facet photodiode mounted in the

MAXIM

laser package converts the optical power into a photocurrent. The APC loop adjusts the laser bias current so that 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, an external resistor ($R_{BIASMAX}$) sets the maximum allowable bias current. An APC failure flag ($\overline{FAIL}$) is set low when the bias current cannot be adjusted to achieve the desired average optical power. To filter APC loop noise, use an external capacitor at APCFILT with a recommended value of 0.1µF.

APC closed-loop operation requires that the user 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.

Open-Loop Operation
If necessary, the MAX3850 is fully operational without APC. To operate the MAX3850 open loop, connect a 100kΩ resistor from R_{APCSET} to GND and leave MD unconnected. In this case, the laser current is directly set by two external resistors connected from ground to BIASMAX and MODSET.

Optional Data Input Latch
If LATCH is high, the input data is retimed by the rising edge of CLK+. If LATCH is low, the input data is directly connected to the output stage. When not using the LATCH function, connect CLK+ and CLK- to V_{CC} or leave unconnected.

Enable Control
The MAX3850 incorporates a laser-driver enable function. When ENABLE is low, the bias and modulation currents are off. For open-loop operation, the typical enable time is 370ns, and the typical disable time is 20ns. For closed-loop operation, the bias current is controlled by the APC loop, and the enable time will be affected by the APC loop time constant. With C_{APC} = 0.1µF, typical closed-loop enable time is 10ms, and typical closed-loop disable time is 40ns. For more information, see the Bias Current Enable Time *Typical Operating Characteristics*.

Current Monitors
The MAX3850 features bias and modulation-current monitor outputs. The BIASMON output sinks a current equal to 1/41 of the laser bias current, I_{BIAS}/41. The MODMON output sinks a current equal to 1/30 of the

laser modulation current, I_{MOD}/30. BIASMON and MODMON should be connected through a pullup resistor to V_{CC}. Choose a pullup resistor value that ensures a voltage at BIASMON greater than V_{CC} - 1.5V and a voltage at MODMON greater than V_{CC} - 2.0V. These pins should be connected V_{CC} if not used.

Slow-Start
For laser safety reasons, the MAX3850 incorporates a slow-start circuit that provides a delay of 370ns for enabling a laser diode.

APC Failure Monitor
The MAX3850 provides an APC failure monitor (TTL/CMOS) to indicate an APC loop-tracking failure. $\overline{FAIL}$ is set low when the APC cannot adjust the bias current to maintain the desired monitor current. For example, the laser diode requires more bias current (to maintain a constant optical output) than maximum bias current set by $R_{BIASMAX}$. The bias current is limited and $\overline{FAIL}$ will be asserted. In an alternate example, assume that a circuit failure causes the cathode of the laser diode to be shorted to GND, thereby causing an uncontrolled high optical output. In this case, the APC loop cannot decrease the user current, and $\overline{FAIL}$ will be asserted.

Short-Circuit Protection
The MAX3850 provides short-circuit protection for the modulation, bias, and monitor current sources. If BIASMAX, MODSET, or APCSET is shorted to ground, bias and modulation output will be turned off.

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

Programming the Modulation Current
For a given laser power (P_{AVG}), slope efficiency (η), and extinction ratio (r_e), the modulation current can be calculated using Table 1. See the I_{MOD} vs. R_{MODSET} 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 the MAX3850 is used in open-loop operation, the $R_{BIASMAX}$ resistor determines the bias current. To select this resistor, determine the required bias current at +25°C. See the $I_{BIASMAX}$ vs. $R_{BIASMAX}$ graph in the *Typical*

MAX3850

Operating Characteristics, and select the value of $R_{BIASMAX}$ that corresponds to the required current at +25°C.

When using the MAX3850 in closed-loop operation, the $R_{BIASMAX}$ resistor sets the maximum bias current available to the laser diode over temperature and lifetime. The APC loop can subtract from this maximum value but cannot add to it. See the $I_{BIASMAX}$ vs. $R_{BIASMAX}$ 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 using the MAX3850's APC feature, 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 lifetime. See the I_{MD} vs. R_{APCSET} graph in the *Typical Operating Characteristics* and select the value of R_{APCSET} that corresponds to the required current.

Interfacing with Laser Diodes
To minimize optical output aberrations caused by signal reflections at the electrical interface to the laser diode, a series damping resistor (R_D) is required (Figure 4). Additionally, the MAX3850 outputs are optimized for a 15Ω load. Therefore, the series combination of R_D and R_L (where R_L represents the laser-diode resistance) should equal 15Ω. Typical values for R_D are 8Ω to 13Ω. For best performance, place a bypass capacitor (0.01µF typ) as close as possible to the anode of the laser diode. An RC shunt network between the laser cathode and ground minimizes optical output aberrations. Starting values for most coaxial lasers are R_{COMP} = 50Ω in series with C_{COMP} = 8.0pF. Adjust these values experimentally until the optical output waveform is optimized. (Refer to Maxim Application Note HFAN 3.0, *Interfacing Maxim's Laser Drivers with Laser Diodes*.)

Pattern-Dependent Jitter
When transmitting NRZ data with long strings of consecutive identical digits (CIDs), low-frequency droop can occur and contribute to pattern-dependent jitter (PDJ). To minimize PDJ, carefully select the APC loop capacitor (C_{APC}), which dominates the APC loop time constant. To filter out noise effects and guarantee loop stability, the recommended value for C_{APC} is 0.1µF. Refer to Maxim Application Note HFAN11, *Choosing AC-Coupling Capacitors,* for more information.

Input Termination Requirement
The MAX3850 data and clock inputs are internally biased. Although the data and clock inputs are com-

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}	$P_{P-P} = P_1 - P_0$
Laser Slope Efficiency	η	$\eta = P_{P-P} / I_{MOD}$
Modulation Current	I_{MOD}	$I_{MOD} = P_{P-P} / \eta$

patible with LVPECL signals, it is not necessary to drive the MAX3850 with a standard LVPECL signal. While DC-coupled, as long as the specified common-mode voltage and differential voltage swings are met, the MAX3850 will operate properly. Because of the on-chip biasing network, the MAX3850 data and clock inputs also will self-bias to the proper operating point to accommodate AC-coupling.

Calculating Power Consumption
The junction temperature of the MAX3850 dice must be kept below +150°C at all times. Approximate the total power dissipation of the MAX3850 using the following equation:

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

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. Junction Temperature = $P(W) \times 47(°C/W)$.

Applications Information
An example of how to set up the MAX3850:

Select Laser
Select a communication-grade laser for 2.488Gbps or higher data-rate applications. Assume the laser output average power is P_{AVG} = 0dBm, the operating temperature is -40°C to +85°C, and the laser diode has the following characteristics: Wavelength: λ = 1.3µm, Threshold Current: I_{TH} = 22mA at +25°C, Threshold Temperature Coefficient: β_{TH} = 1.3%/°C, Laser-to-Monitor Transfer: ρ_{MON} = 0.2A/W, Laser Slope Efficiency: η = 0.05mW/mA at +25°C.

Determine R_{APCSET}
The desired monitor diode current is estimated by I_{MD} = P_{AVG} x ρ_{MON} = 200µA. The I_{MD} vs. R_{APCSET} graph in the *Typical Operating Characteristics* shows R_{APCSET} at 6.2kΩ.

MAXIM

Table 2. Bondpad Locations

PAD	NAME	COORDINATES	
		X	Y
1	GND2	46	1523
2	GND1	46	1334
3	V_{CC1}	46	1213
4	DATA+	46	1091
5	DATA-	46	970
6	V_{CC1}	46	848
7	GND1	46	727
8	V_{CC1}	46	605
9	CLK+	46	484
10	CLK-	46	362
11	V_{CC1}	46	241
*12	GND1	46	46
13	LATCH	205	46
14	ENABLE	351	46
15	GND1	484	46
16	GND1	605	46
17	BIASMON	727	46
18	MODMON	848	46
19	$\overline{FAIL}$	970	46
20	GND4	1091	46
21	N.C.	1213	46
22	APCFILT	1334	46
23	GND4	1456	46
24	V_{CC4}	1577	46

PAD	NAME	COORDINATES	
		X	Y
25	BIAS	1709	46
26	N.C.	1861	241
27	V_{CC4}	1861	373
28	N.C.	1861	494
29	OUT+	1861	616
30	OUT-	1861	737
31	N.C.	1861	859
32	V_{CC4}	1861	980
33	GND4	1861	1102
34	GND3	1861	1223
35	MD	1861	1356
36	GND3	1709	1523
37	V_{CC3}	1577	1523
38	CAPC	1456	1523
39	N.C.	1334	1523
40	GND3	1213	1523
41	N.C.	1091	1523
42	GND3	970	1523
43	N.C.	848	1523
44	APCSET	727	1523
45	GND2	605	1523
46	MODSET	484	1523
47	BIASMAX	351	1523
48	V_{CC2}	205	1523

*Index pad. Orient the die with this pad in the lower-left corner.

Determine R_{MODSET}

Assuming r_e = 20, and average power of 0dBm (1mW), then according to Table 1, the peak-to-peak optical power P_{P-P} = 1.81mW. The required modulation current is 1.81(mW) / 0.05(mW/mA) = 36.2mA. The I_{MOD} vs. R_{MODSET} graph in the *Typical Operating Characteristic*s shows R_{MODSET} at 5.5kΩ.

Determine $R_{BIASMAX}$

Determine 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:

$$I_{BIASMAX} = I_{TH(MAX)}$$

In this example, $I_{BIASMAX}$ = 50mA. The $I_{BIASMAX}$ vs. $R_{BIASMAX}$ graph in the *Typical Operating Characteristics* shows $R_{BIASMAX}$ at 5kΩ.

Modulation Currents Exceeding 60mA

For applications requiring modulation current greater than 60mA, headroom is insufficient for proper operation of the laser driver if the laser is DC-coupled.

To avoid this problem, the MAX3850's modulation output can be AC-coupled to the cathode of a laser diode. An external pullup inductor is necessary to DC-bias the modulation output at V_{CC}. Such a configuration isolates laser forward voltage from the output circuitry and allows the output at OUT+ to swing above and below the supply voltage (V_{CC}). Refer to Maxim Application Note HFAN 2.0 *Interfacing Maxim's Laser Drivers to Laser Diodes* for more information on AC-coupling laser drivers to laser diodes.

MAXIM _____

2.7Gbps, +3.3V DC-Coupled Laser Driver

Wirebonding Die

For high-current density and reliable operation, the MAX3850 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 4mils (100µm) square, and die thickness is 12mils (300µm) square.

Layout Considerations

To minimize inductance, keep the connections between the MAX3850 output pins and laser diode 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 IEC825

Using the MAX3850 laser driver alone does not ensure that a transmitter design is compliant with IEC825. The entire transmitter circuit and component selections must be considered. Each user must determine the level of fault tolerance required by the application, recognizing that Maxim products are neither designed nor 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 in which the failure of a Maxim product could create a situation where personal injury or death may occur.
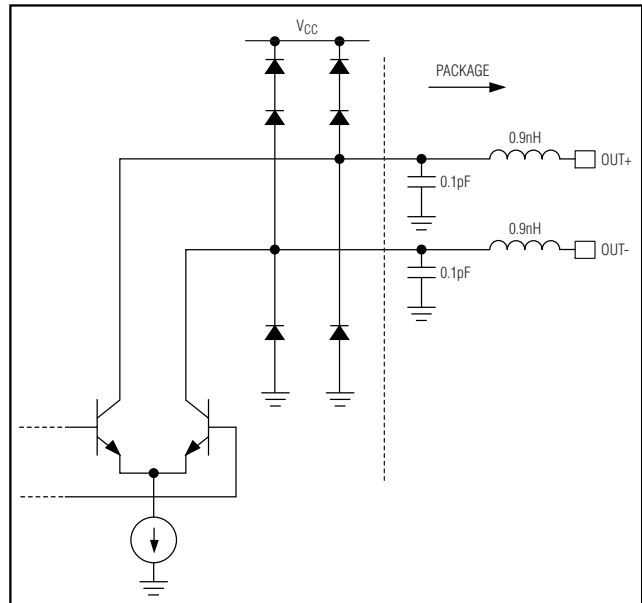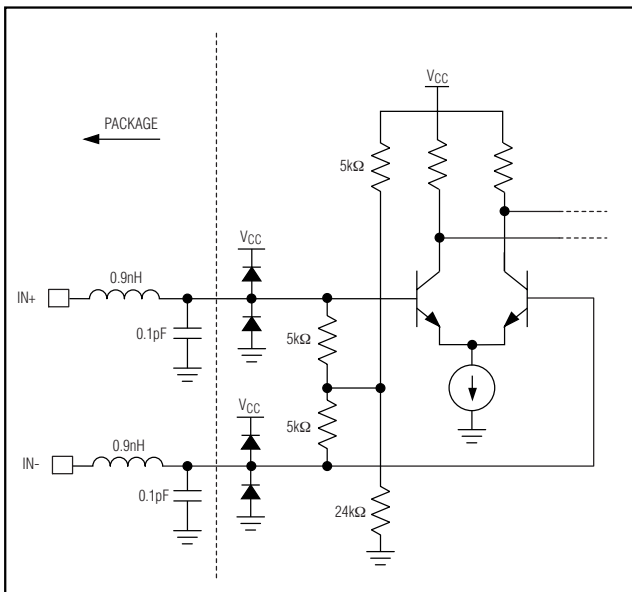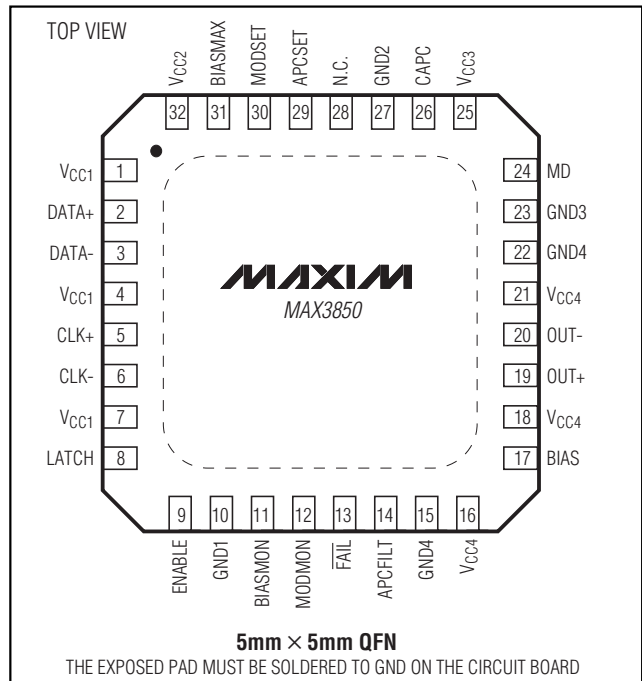

Figure 6. Simplified Output Circuit

Pin Configuration

Figure 5. Simplified Input Circuit

2.7Gbps, +3.3V DC-Coupled Laser Driver

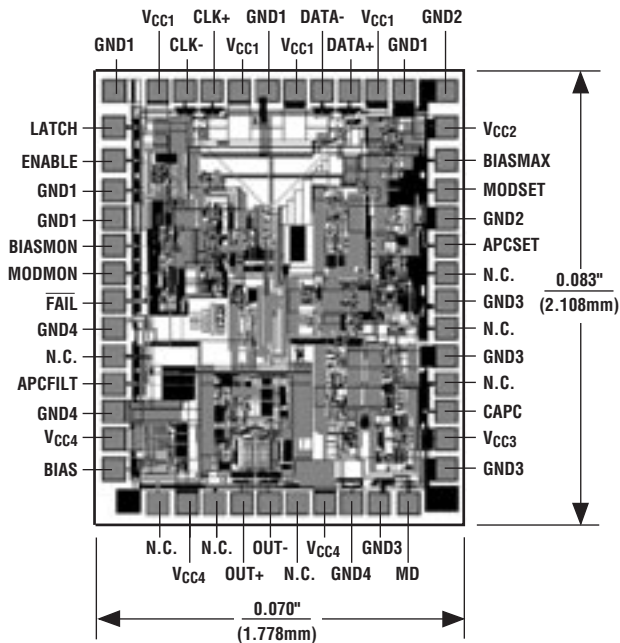## Typical Application Circuits (continued)

TYPICAL APPLICATION CIRCUIT
WITH AC-COUPLED INPUTS
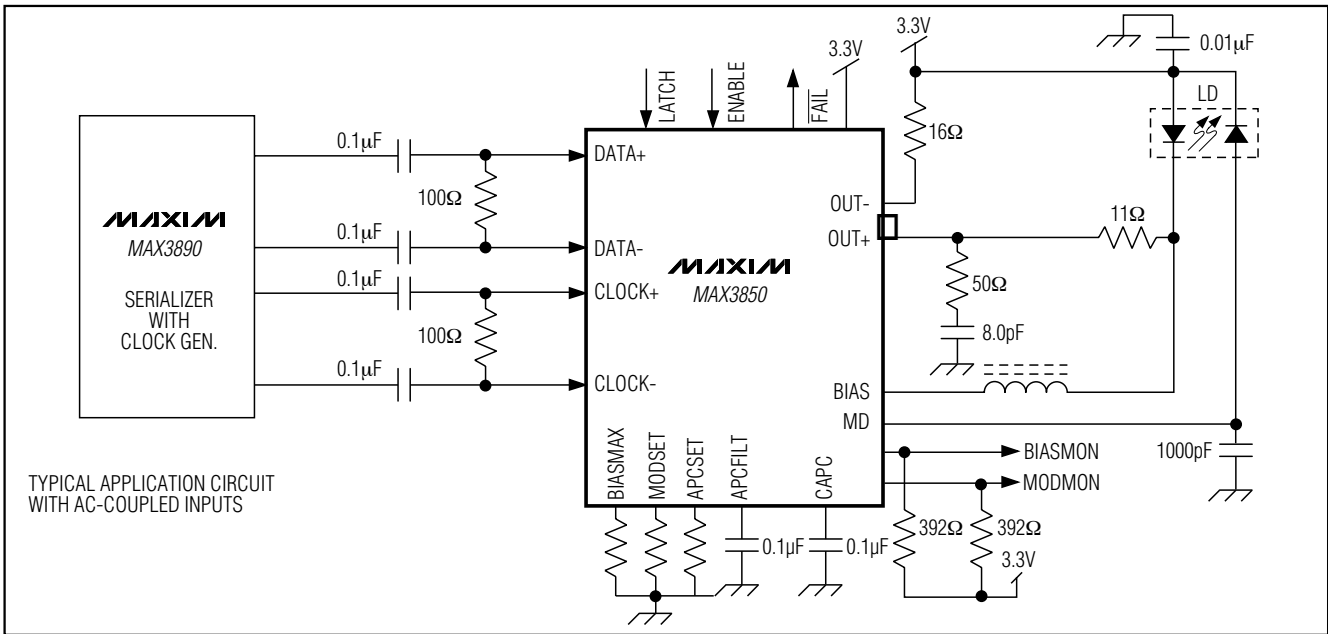
## Chip Topography

Chip Information

TRANSISTOR COUNT: 1749

SUBSTRATE CONNECTED TO GND

DIE SIZE: 70mils × 83mils

DIE THICKNESS: 12mils

PROCESS: SIGe Bipolar

2.7Gbps, +3.3V DC-Coupled Laser Driver

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**.)

32L QFN.EPS
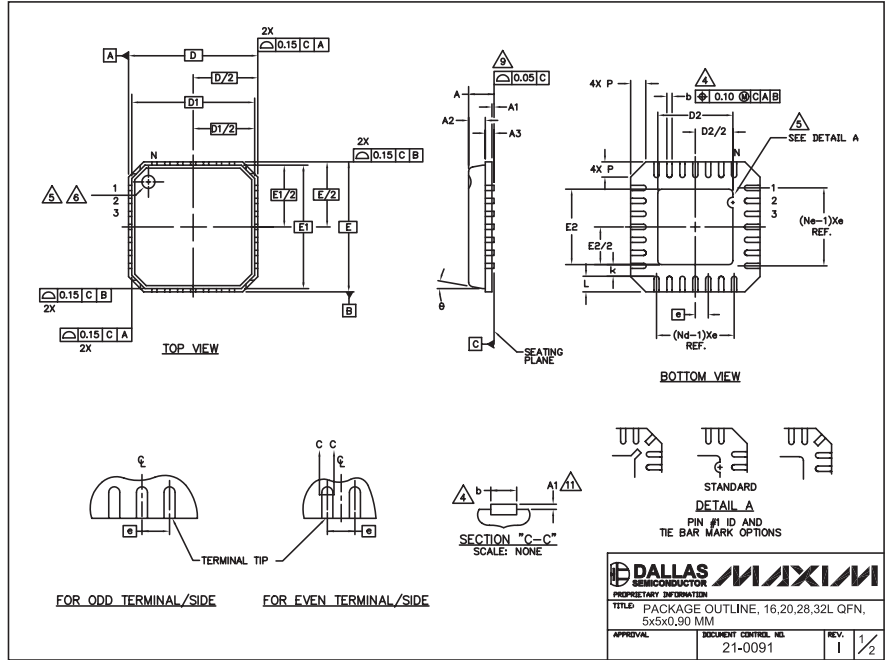
COMMON DIMENSIONS

PKG	16L 5x5			20L 5x5			28L 5x5			32L 5x5		
SYMBOL	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.80	0.90	1.00	0.80	0.90	1.00	0.80	0.90	1.00	0.80	0.90	1.00
A1	0.00	0.01	0.05	0.00	0.01	0.05	0.00	0.01	0.05	0.00	0.01	0.05
A2	0.00	0.65	1.00	0.00	0.65	1.00	0.00	0.65	1.00	0.00	0.65	1.00
A3	0.20 REF			0.20 REF			0.20 REF			0.20 REF		
b	0.28	0.33	0.40	0.23	0.28	0.35	0.18	0.23	0.30	0.18	0.23	0.30
D	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
D1	4.75 BSC			4.75 BSC			4.75 BSC			4.75 BSC		
E	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10	4.90	5.00	5.10
E1	4.75 BSC			4.75 BSC			4.75 BSC			4.75 BSC		
e	0.80 BSC			0.65 BSC			0.50 BSC			0.50 BSC		
k	0.25	–	–	0.25	–	–	0.25	–	–	0.25	–	–
L	0.35	0.55	0.75	0.35	0.55	0.75	0.35	0.55	0.75	0.30	0.40	0.50
N	16			20			28			32		
ND	4			5			7			8		
NE	4			5			7			8		
P	0.00	0.42	0.60	0.00	0.42	0.60	0.00	0.42	0.60	0.00	0.42	0.60
θ	0°		12°	0°		12°	0°		12°	0°		12°

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
G1655-3	2.95	3.10	3.25	2.95	3.10	3.25
G2055-1	2.55	2.70	2.85	2.55	2.70	2.85
G2055-2	2.95	3.10	3.25	2.95	3.10	3.25
G2855-1	2.55	2.70	2.85	2.55	2.70	2.85
G2855-2	2.95	3.10	3.25	2.95	3.10	3.25
G3255-1	2.95	3.10	3.25	2.95	3.10	3.25

NOTES:
1. DIE THICKNESS ALLOWABLE IS 0.305mm MAXIMUM (.012 INCHES MAXIMUM)
2. DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M. – 1994.
3. N IS THE NUMBER OF TERMINALS.
   Nd IS THE NUMBER OF TERMINALS IN X–DIRECTION & Ne IS THE NUMBER OF TERMINALS IN Y–DIRECTION.
4. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.
5. THE PIN #1 IDENTIFIER MUST BE EXISTED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR INK/LASER MARKED.
   DETAILS OF PIN #1 IDENTIFIER IS OPTIONAL, BUT MUST BE LOCATED WITHIN ZONE INDICATED.
6. EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
7. ALL DIMENSIONS ARE IN MILLIMETERS.
8. PACKAGE WARPAGE MAX 0.05mm.
9. APPLIED FOR EXPOSED PAD AND TERMINALS.
   EXCLUDE EMBEDDED PART OF EXPOSED PAD FROM MEASURING.
10. MEETS JEDEC MO220; EXCEPT DIMENSION "b".
11. APPLIED FOR EXPOSED PAD AND TERMINALS. EXCLUDE EMBEDDING PART OF EXPOSED PAD
    FROM MEASURING.
12. THIS PACKAGE OUTLINE APPLIES TO ANVIL SINGULATION (STEPPED SIDES).

DALLAS SEMICONDUCTOR /VI/IXI/VI
PROPRIETARY INFORMATION
TITLE: PACKAGE OUTLINE, 16,20,28,32L QFN, 5x5x0.90 MM
APPROVAL | DOCUMENT CONTROL NO. 21-0091 | REV. I | 2/2