19-2597; Rev 2; 8/06

3.2Gbps Compact SFP VCSEL Driver

General Description

The MAX3741 is a high-speed VCSEL driver for small-form-factor (SFF) and small-form-factor pluggable (SFP) fiber-optic LAN transmitters. It contains a bias generator, laser modulator, and peaking current option to improve VCSEL edge speed. The driver accommodates common cathode and differential configurations.

The MAX3741 operates up to 3.2Gbps. It can switch up to 15mA of laser modulation current and source up to 15mA of bias current. The MAX3741 is designed to interface with a digital potentiometer and control circuitry. The MAX3741 accommodates various VCSEL packages, including low-cost TO-46 headers.

The MAX3741 is available in a compact 3mm x 3mm 16-pin thin QFN package and operates over a temperature range of -40°C to +85°C.

Applications

Multirate (1Gbps to 3.2Gbps) SFP/SFF Modules

Gigabit Ethernet Optical Transmitters

Fibre Channel Optical Transmitters

Features

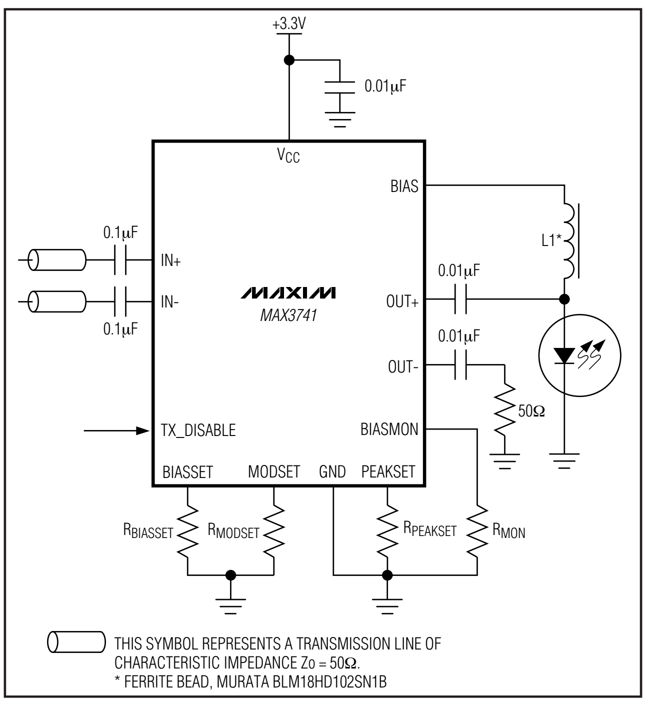
- **2mA to 15mA Modulation Current**
- **1mA to 15mA Bias Current**
- **Optional Peaking Current to Improve VCSEL Edge Speed**
- **Supports Common Cathode and Differential Configuration**
- **3mm × 3mm 16-Pin Thin QFN Package**

Ordering Information

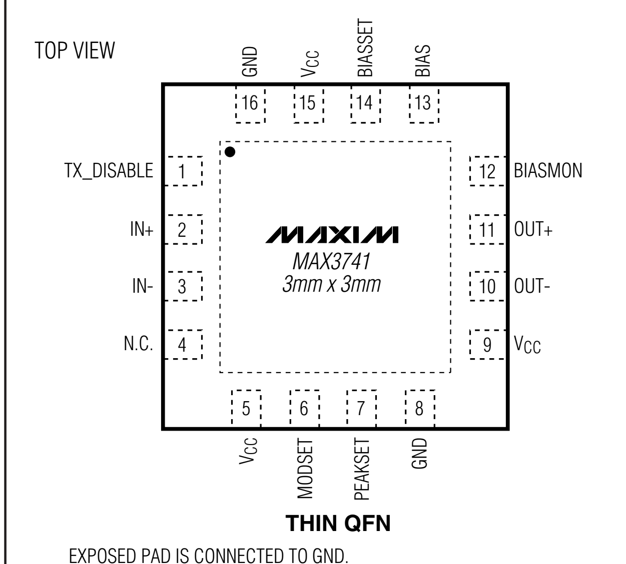
PART	TEMP RANGE	PIN-PACKAGE	PKG. CODE
MAX3741ETE	-40°C to +85°C	16 Thin QFN	T1633F-3
MAX3741HETE*	-40°C to +85°C	16 Thin QFN	T1633F-3

**Hybrid lead-free package. See the* Hybrid Lead-Free Package *section.*

Typical Application Circuit



Pin Configuration



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.

3.2Gbps Compact SFP VCSEL Driver

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (V_{CC}) ....-0.5V to +5.0V
Voltage at TX_DISABLE, IN+, IN-, MODSET,
PEAKSET, BIASSET, BIAS, BIASMON ....-0.5V to (V_{CC} + 0.5V)
Voltage at OUT+, OUT- ....(V_{CC} - 2V) to (V_{CC} + 2V)
Current into OUT+, OUT- 60mA
Continuous Power Dissipation (T_A = +85°C)
16-Lead Thin QFN (derate 25mW/°C above +85°C) 2W
Operating Temperature Range .... -40°C to +85°C
Storage Temperature Range ....-55°C to +150°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.

ELECTRICAL CHARACTERISTICS

(V_{CC} = +2.97V to +3.63V, T_A = -40°C to +85°C. Typical values are at V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Current	I_{CC}	TX_DISABLE set low, peaking is not used (Note 1)	I_{MOD} = 2mA$_{P-P}$		41		mA
			I_{MOD} = 15mA$_{P-P}$		51	65	
		Additional current when peaking is used (Note 2)			14	20	
	$I_{CC-SHDW}$	Total current when TX_DISABLE is high			0.15	1	
TX_DISABLE INPUT							
Input Impedance				80	105		kΩ
Input High Voltage	V_{IH}			2			V
Input Low Voltage	V_{IL}					0.8	V
TX_DISABLE Time	t_off	Time from rising edge of TX_DISABLE to I_{BIAS} = I_{BIAS_OFF} and I_{MOD} = I_{MOD_OFF} (Note 3)			0.2	3	µs
	t_on	Time from falling edge of TX_DISABLE to I_{BIAS} = 15mA and I_{MOD} = 15mA$_{P-P}$			111		
Input Leakage		V_{CC} = 0V and $V_{TX\_DISABLE}$ = 3.3V			25	40	µA
BIAS GENERATOR (Note 4)							
Bias Current	I_{BIAS}	Min				1	mA
		Max		15			
Accuracy of Programmed Bias Current	ΔI_{BIAS}			-8		+8	%
Bias Current During Disable	I_{BIAS_OFF}	TX_DISABLE high				10	µA
BIASMON Gain				0.095	0.115	0.135	mA/mA
LASER MODULATOR (Note 5)							
Data Input Voltage Swing	V_{ID}	Total differential signal		250		2200	mV$_{P-P}$
Output Resistance	R_{OUT}	Single-ended resistance at OUT+, OUT-			63	80	Ω
Modulation Current	I_{MOD}	Min				2	mA$_{P-P}$
		Max		15			

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = +2.97V to +3.63V, T_A = -40°C to +85°C. Typical values are at V_{CC} = +3.3V, T_A = +25°C, unless otherwise noted.)

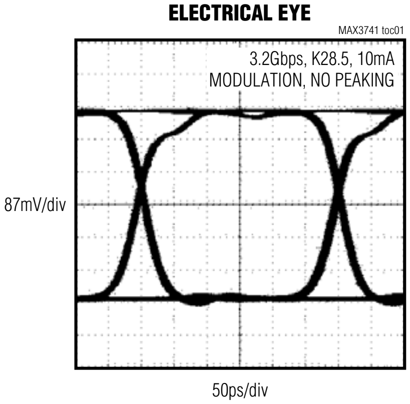
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Programmable Peaking Current	I_{PEAK}	Min		0.2		mA
		Max		2		
Peaking Current Duration				80		ps
Tolerance of Programmed Modulation Current			-10		+10	%
Modulation Transition Time	t_R, t_F	$5mA_{P-P} \le I_{MOD} \le 15mA_{P-P}$ (Note 3)		65	95	ps
Deterministic Jitter	DJ	$5mA_{P-P} \le I_{MOD} \le 15mA_{P-P}$ (Notes 3, 6)		13	25	ps_{P-P}
Random Jitter	RJ	(Note 3)		1	4	ps_{RMS}
Laser Modulation During Disable	I_{MOD_OFF}	Differential input voltage at $2200mV_{P-P}$		15	50	μA_{P-P}
Differential Input Resistance			85	100	115	Ω
Input Bias Voltage	V_{IN}			V_{CC} - 0.3		V

Note 1: Measured with $R_{BIASSET}$ = 1.87kΩ ($I_{BIAS} \approx$ 15mA). Supply current excludes I_{BIAS}.
Note 2: Tested with R_{PEAK} = 1.18kΩ.
Note 3: Guaranteed by design and characterization.
Note 4: V_{BIAS} is less than V_{CC} - 0.7V.
Note 5: Measured electrically with a 50Ω load AC-coupled to OUT+.
Note 6: Deterministic jitter is the peak-to-peak deviation from the ideal time crossings measured with a K28.5 bit pattern at 3.2Gbps (00111110101100000101).

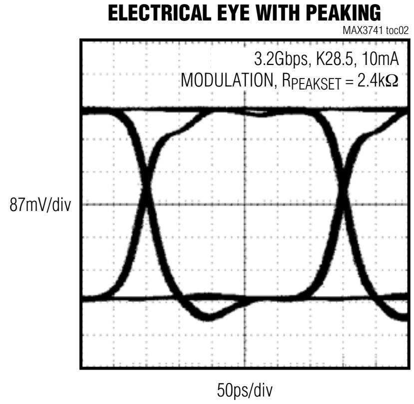
Typical Operating Characteristics

(V_{CC} = +3.3V, T_A = 25°C, measured electrically with a 50Ω load AC-coupled to OUT+, unless otherwise noted.)

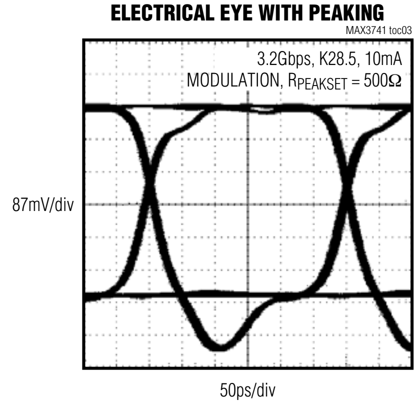
ELECTRICAL EYE



ELECTRICAL EYE WITH PEAKING



ELECTRICAL EYE WITH PEAKING

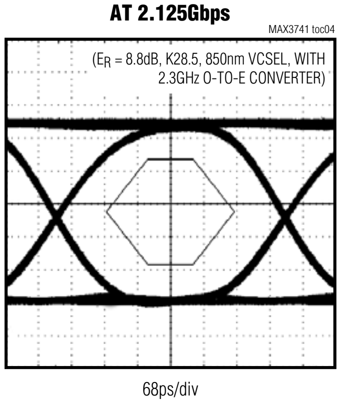


3.2Gbps Compact SFP VCSEL Driver

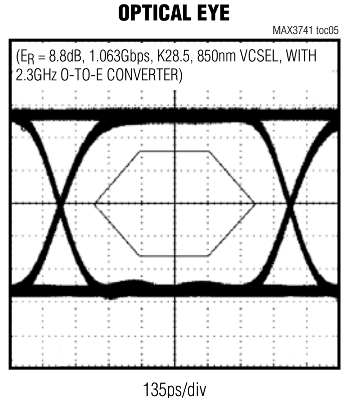
Typical Operating Characteristics (continued)

(V_{CC} = +3.3V, T_A = 25°C, measured electrically with a 50Ω load AC-coupled to OUT+, unless otherwise noted.)

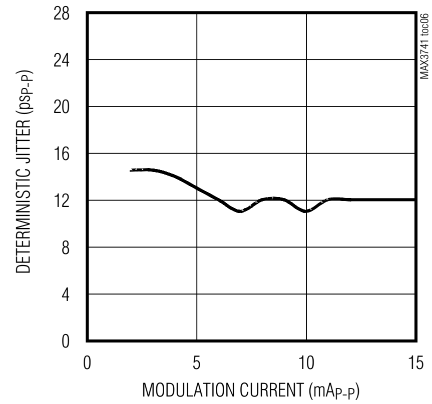
OPTICAL EYE AT 2.125Gbps



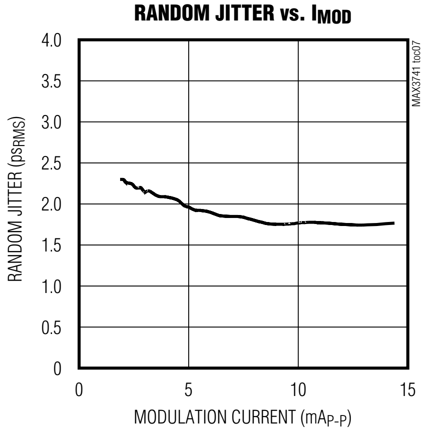
OPTICAL EYE



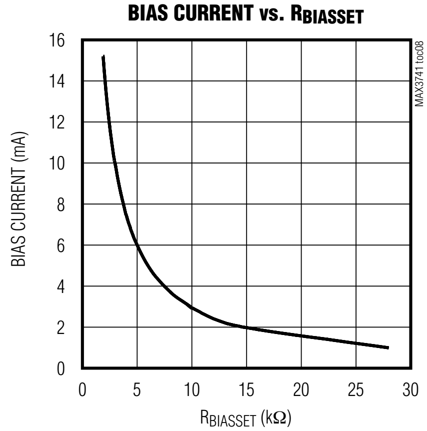
DETERMINISTIC JITTER vs. I_{MOD}



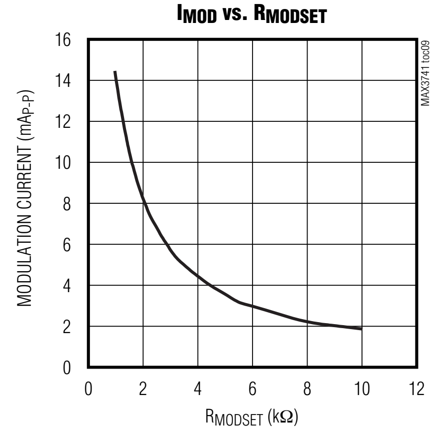
RANDOM JITTER vs. I_{MOD}



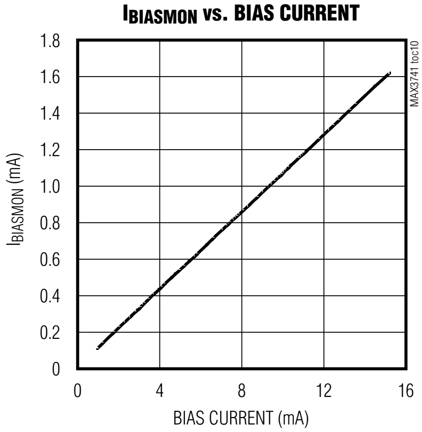
BIAS CURRENT vs. $R_{BIASSET}$



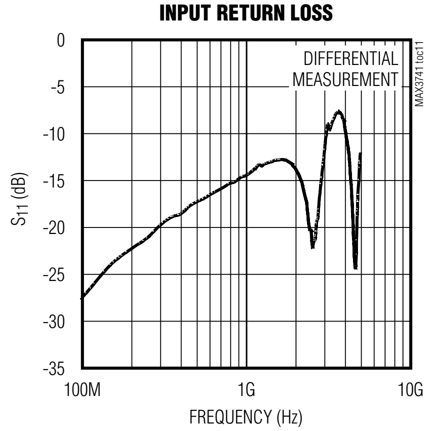
I_{MOD} vs. R_{MODSET}



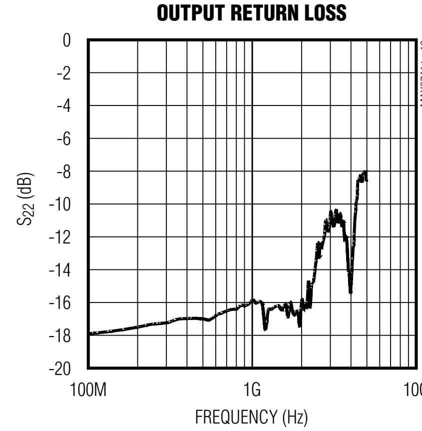
$I_{BIASMON}$ vs. BIAS CURRENT



INPUT RETURN LOSS

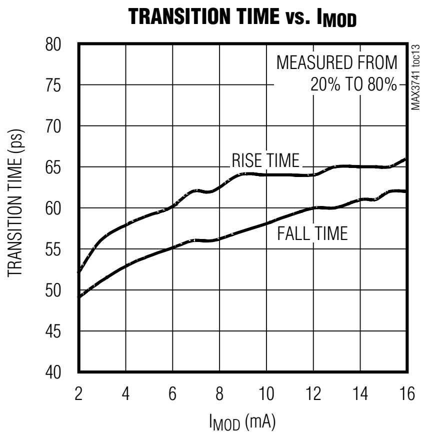


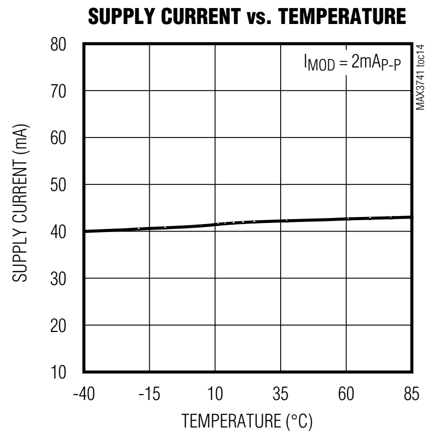
OUTPUT RETURN LOSS

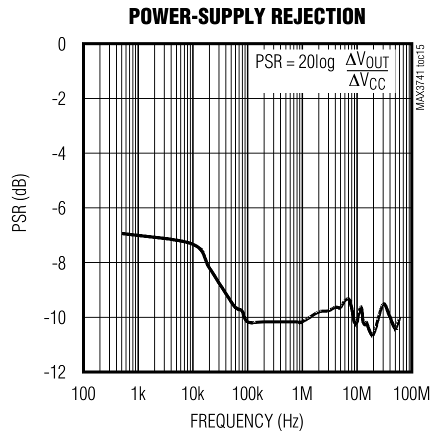


Typical Operating Characteristics (continued)

(V_{CC} = +3.3V, T_A = 25°C, measured electrically with a 50Ω load AC-coupled to OUT+, unless otherwise noted.)





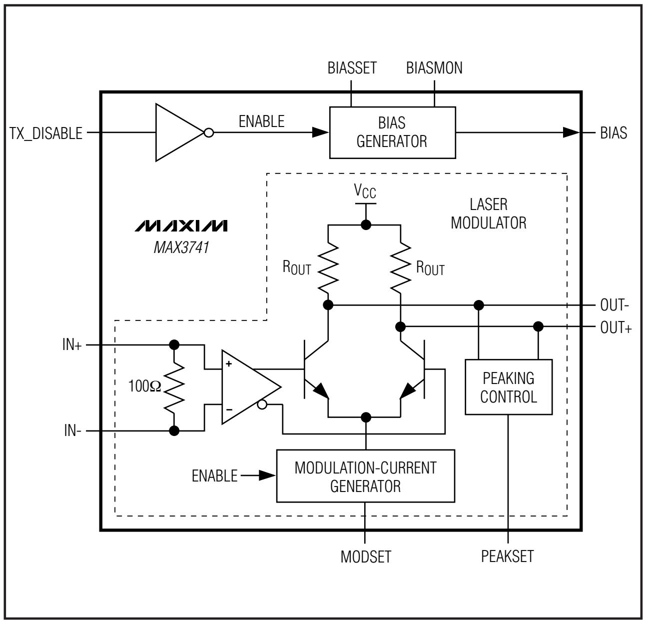


Pin Description

PIN	NAME	FUNCTION
1	TX_DISABLE	Transmit Disable. Driver output is disabled when TX_DISABLE is high or left unconnected. The driver output is enabled when the pin is asserted low.
2	IN+	Noninverted Data Input
3	IN-	Inverted Data Input
4	N.C.	No Connection
5, 9, 15	V_{CC}	+3.3V Supply Voltage
6	MODSET	Modulation Set. A resistor connected from MODSET to ground (R_{MODSET}) programs the desired modulation current amplitude.
7	PEAKSET	Peaking Current Set. A resistor connected between PEAKSET and ground ($R_{PEAKSET}$) programs the peaking current amplitude. To disable peaking, leave PEAKSET open.
8, 16	GND	Ground
10	OUT-	Inverted Modulation-Current Output
11	OUT+	Noninverted Modulation-Current Output
12	BIASMON	Bias Current Monitor. The output of BIASMON is a sourced current proportional to the bias current. A resistor connected between BIASMON and ground ($R_{BIASMON}$) can be used to form a ground referenced bias monitor.
13	BIAS	Bias Current Output
14	BIASSET	Bias Current Set. A resistor connected between BIASSET and ground ($R_{BIASSET}$) programs the VCSEL bias current.
EP	Exposed Pad	Ground. This must be soldered to the circuit board ground for proper thermal and electrical performance. See the *Layout Considerations* section.

3.2Gbps Compact SFP VCSEL Driver

Functional Diagram



Detailed Description

The MAX3741 contains a bias generator and a laser modulator with optional peaking compensation.

Bias Generator

Figure 1 shows the bias generator circuitry that contains a bandgap voltage reference, current mirror, and bias monitor. The bias current output to the laser is controlled with the $R_{BIASSET}$ resistor. For appropriate $R_{BIASSET}$ values, see the Bias Current vs. $R_{BIASSET}$ graph in the *Typical Operating Characteristics*.

The BIASMON output provides a current proportional to the laser bias current given by:

$$I_{BIASMON} = I_{BIAS} / 9$$

Modulation Circuit

The modulation circuitry consists of an input buffer, a current mirror, and a high-speed current switch (Figure 2). The modulators drive up to 15mA of modulation into a 50Ω VCSEL load.

The amplitude of the modulation current is set with resistor at MODSET (R_{MODSET}). For appropriate R_{MODSET} values, see the I_{MOD} vs. R_{MODSET} graph in the *Typical Operating Characteristics*. Figure 3 shows a simplified diagram of the MAX3741 output stage.

Input Termination

The MAX3741 data inputs are SFP MSA compatible. On-chip 100Ω differential input impedance is provided for optimal termination (Figure 4). The MAX3741 inputs self-bias to the proper operating point to accommodate AC-coupling.

Applications Information

VCSEL Selection

Select a communications-grade VCSEL with a rise time of 260ps or better for 1.25Gbps or 130ps or better for 2.5Gbps applications.

Use a high-efficiency VCSEL that requires low modulation current and generates a low voltage swing. Trim the leads to reduce VCSEL package inductance. The typical package leads have inductance of 25nH per inch (1nH/mm). This inductance causes a large voltage swing across the VCSEL. A compensation filter network can be used to reduce ringing, edge speed, and voltage swing. See the *Designing the Laser-Compensation Filter Network* section for more information.

Layout Considerations

To minimize inductance, keep the connections between the MAX3741 output pins and VCSEL as close as possible. Use good high-frequency layout techniques and multiple-layer boards with uninterrupted ground planes to minimize EMI and crosstalk.

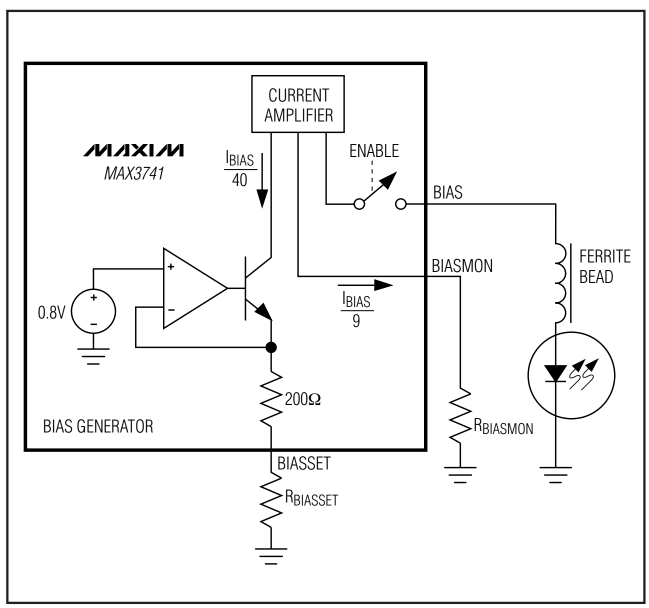


Figure 1. Bias Generator

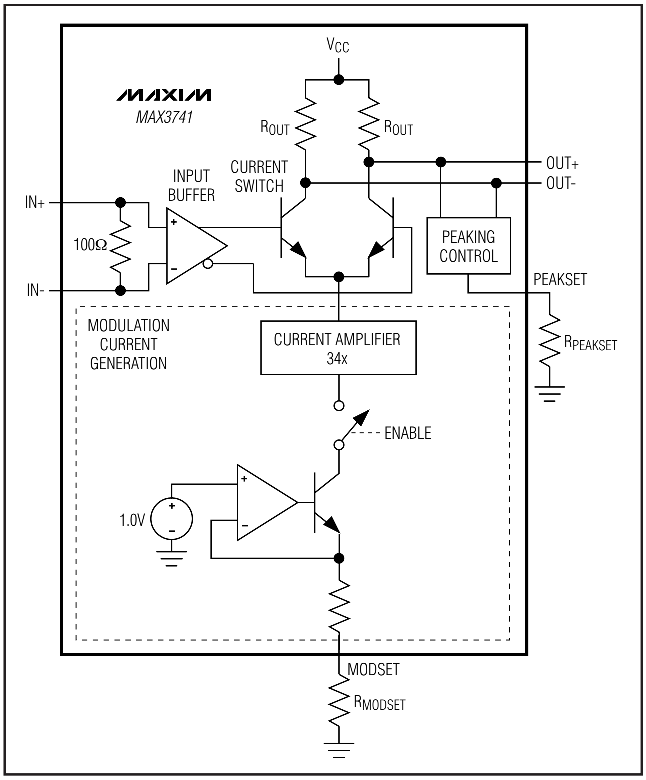


Figure 2. Modulation Circuit

Designing the Compensation Filter Network

VCSEL package inductance causes the VCSEL impedance to increase at high frequencies, leading to ringing, overshoot, and degradation of the VCSEL output. A VCSEL compensation filter network can be used to reduce the VCSEL impedance at high frequencies, thereby reducing output ringing and overshoot.

The compensation components (R_F and C_F) are most easily determined by experimentation. Begin with R_F = 50Ω and C_F = 1pF. Increase C_F until the desired transmitter response is obtained (Figure 5). Refer to Application Note HFAN-2.0: *Interfacing Maxim Laser Drivers with Laser Diodes* for more information.

Exposed-Pad (EP) Package

The exposed pad on the 16-pin thin QFN provides a very low thermal resistance path for heat removal from the IC. The pad is electrical ground on the MAX3741 and must be soldered to the circuit board ground for proper thermal and electrical performance. Refer to Maxim Application Note HFAN-08.1: *Thermal Considerations for QFN and Other Exposed Pad Packages*, for additional information.

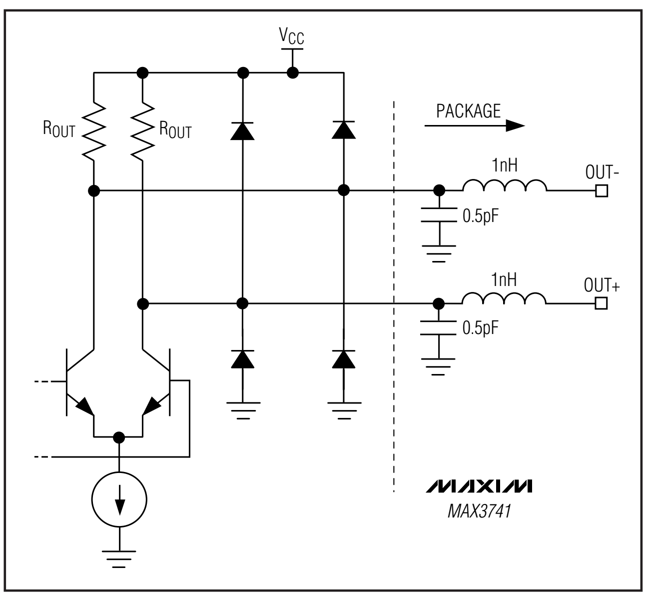


Figure 3. Simplified Output Structure

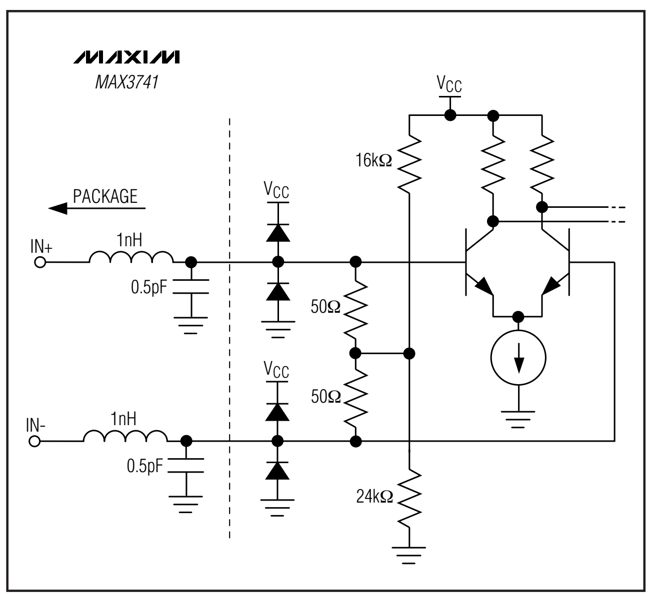


Figure 4. Simplified Input Structure

Laser Safety and IEC 825

The International Electrotechnical Commission (IEC) determines standards for hazardous light emissions from fiber-optic transmitters. IEC 825 defines the maximum light output for various hazard levels. Using this 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 applications, 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.

Hybrid Lead-Free Package

The MAX3741HETE is a MAX3741 in a hybrid lead-free package. It is a hybrid part that contains high-lead bumps inside a lead-free thin QFN package. The part is not 100% lead free; however, the high-lead solder in the internal portion of the part does meet the RoHS exemption for high-lead solders. For more information, visit www.maxim-ic.com/emmi.

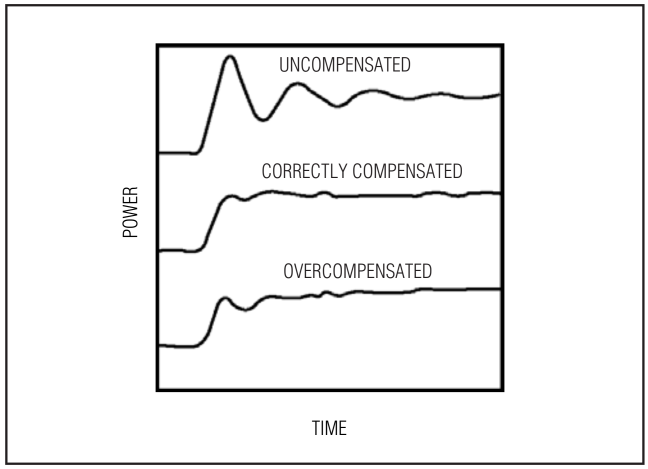


Figure 5. Laser Compensation

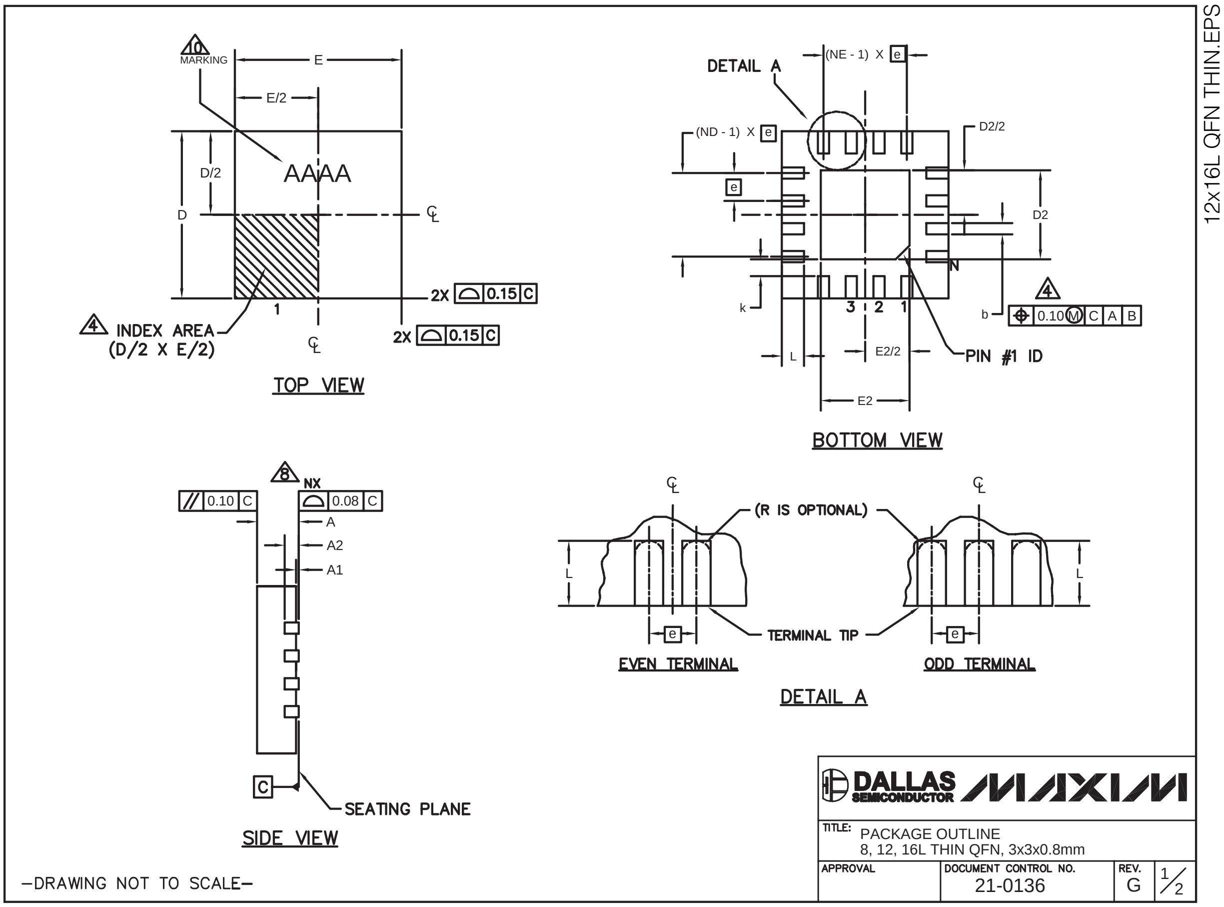
Chip Information

TRANSISTOR COUNT: 1597

PROCESS: SiGe bipolar

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**.)



3.2Gbps Compact SFP VCSEL Driver

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**.)

PKG	8L 3x3			12L 3x3			16L 3x3		
REF.	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
b	0.25	0.30	0.35	0.20	0.25	0.30	0.20	0.25	0.30
D	2.90	3.00	3.10	2.90	3.00	3.10	2.90	3.00	3.10
E	2.90	3.00	3.10	2.90	3.00	3.10	2.90	3.00	3.10
e	0.65 BSC.			0.50 BSC.			0.50 BSC.		
L	0.35	0.55	0.75	0.45	0.55	0.65	0.30	0.40	0.50
N	8			12			16		
ND	2			3			4		
NE	2			3			4		
A1	0	0.02	0.05	0	0.02	0.05	0	0.02	0.05
A2	0.20 REF			0.20 REF			0.20 REF		
k	0.25	-	-	0.25	-	-	0.25	-	-

EXPOSED PAD VARIATIONS

PKG. CODES	D2			E2			PIN ID	JEDEC	DOWN BONDS ALLOWED
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.			
TQ833-1	0.25	0.70	1.25	0.25	0.70	1.25	0.35 x 45°	WEEC	NO
T1233-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1	NO
T1233-3	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1	YES
T1233-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-1	YES
T1633-1	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2	NO
T1633-2	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2	YES
T1633F-3	0.65	0.80	0.95	0.65	0.80	0.95	0.225 x 45°	WEED-2	N/A
T1633FH-3	0.65	0.80	0.95	0.65	0.80	0.95	0.225 x 45°	WEED-2	N/A
T1633-4	0.95	1.10	1.25	0.95	1.10	1.25	0.35 x 45°	WEED-2	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 0.20 mm AND 0.25 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 REVISION C.
10. MARKING IS FOR PACKAGE ORIENTATION REFERENCE ONLY.
11. NUMBER OF LEADS SHOWN ARE FOR REFERENCE ONLY.

DALLAS SEMICONDUCTOR MAXIM

TITLE: PACKAGE OUTLINE
8, 12, 16L THIN QFN, 3x3x0.8mm

APPROVAL	DOCUMENT CONTROL NO.	REV.	
	21-0136	G	2/2

–DRAWING NOT TO SCALE–

Revision History

Rev 0; 10/02: Initial data sheet release.

Rev 1; 5/04: Added package code (page 1); added package drawing (page 9).

Rev 2; 8/06: Added hybrid package ordering information (pages 1 and 8).

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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MAX3741

Part Number Table

Notes:

1. See the MAX3741 QuickView Data Sheet for further information on this product family or download the MAX3741 full data sheet (PDF, 292kB).
2. Other options and links for purchasing parts are listed at: http://www.maxim-ic.com/sales.
3. Didn't Find What You Need? Ask our applications engineers. Expert assistance in finding parts, usually within one business day.
4. Part number suffixes: T or T&R = tape and reel; + = RoHS/lead-free; # = RoHS/lead-exempt. More: See full data sheet or Part Naming Conventions.
5. * Some packages have variations, listed on the drawing. "PkgCode/Variation" tells which variation the product uses.

Part Number	Free Sample	Buy Direct	Package: TYPE PINS SIZE DRAWING CODE/VAR *	Temp	RoHS/Lead-Free? Materials Analysis
MAX3741HETE#TG16			THIN QFN;16 pin;3X3X0.8mm Dwg: 21-0136I (PDF) Use pkgcode/variation: T1633FH-3*	-40C to +85C	RoHS/Lead-Free: Yes Materials Analysis
MAX3741ETE			Thin QFN;16 pin;3X3X0.8mm Dwg: 21-0136I (PDF) Use pkgcode/variation: T1633F-3*	-40C to +85C	RoHS/Lead-Free: No Materials Analysis
MAX3741ETE-T			Thin QFN;16 pin;3X3X0.8mm Dwg: 21-0136I (PDF) Use pkgcode/variation: T1633F-3*	-40C to +85C	RoHS/Lead-Free: No Materials Analysis
MAX3741HETE#G16			THIN QFN;16 pin;3X3X0.8mm Dwg: 21-0136I (PDF) Use pkgcode/variation: T1633FH-3*	-40C to +85C	RoHS/Lead-Free: Yes Materials Analysis

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