Data Sheet

CX60087

10.7 Gbps EML and $LiNO_3$ Modulator Driver

Key Features

-
- High Voltage Swing: up to 6 V_{P-P} for Single-Ended and 12 V_{P-P} for Differential Output
- High-Speed Operation (Up to 10.7 Gbps NRZ Data)
- On-Chip Data Retiming Option
- Single-Ended Data and Clock Input with 50 Ω Termination
- Output Current of 0-100 mA into 50 Ω
- Optimized to supply an output current of 80 to 100 mA into 50 Ω
- Laser Diode Bias Current of 0 - 120 mA
- Duty Control, Polarity Control and Loss of Signal Indication

Applications

- Fiber Optic Transceiver/Transponder Modules
- Fiber Optic Communication Systems (OC-192/STM-64)
- SONET/SDH Test Equipment
- Data Communications
- Voltage Driver

Product Description

The CX60087 is a high-speed laser modulator driver designed for long haul applications. This driver is typically used in transmitter modules for fiber-optic communications, such as Synchronous Optical Network (SONET), Synchronous Digital Hierarchy (SDH), and Dense Wavelength Division Multiplexed (DWDM).

The device can be used as a Lithium Niobate ($LiNO_3$) modulator driver or EA modulator driver When an output Bias-Tee is tied to +1.0 V, the CX60087 provides a 6 V_{P-P} output swing single-ended and 12 V_{P-P} swing differential into a 50 Ω load for data rates of 10.7 Gbps. When the output Bias-Tee is tied to ground the output swing is 3.5 V_{P-P} single-ended at 10.7 Gbps.

The CX60087 can deliver a maximum output drive current of 100 mA and provide bias currents up to 120 mA. Figure 1 is the functional block diagram, Table 1 lists functional block descriptions, and Table 2 lists terminal name descriptions. The CX60087 is available in a 30-terminal ceramic quad flat pack as shown in Figure 13.

Figure 1. CX60087 Laser Modulator Driver Functional Block Diagram

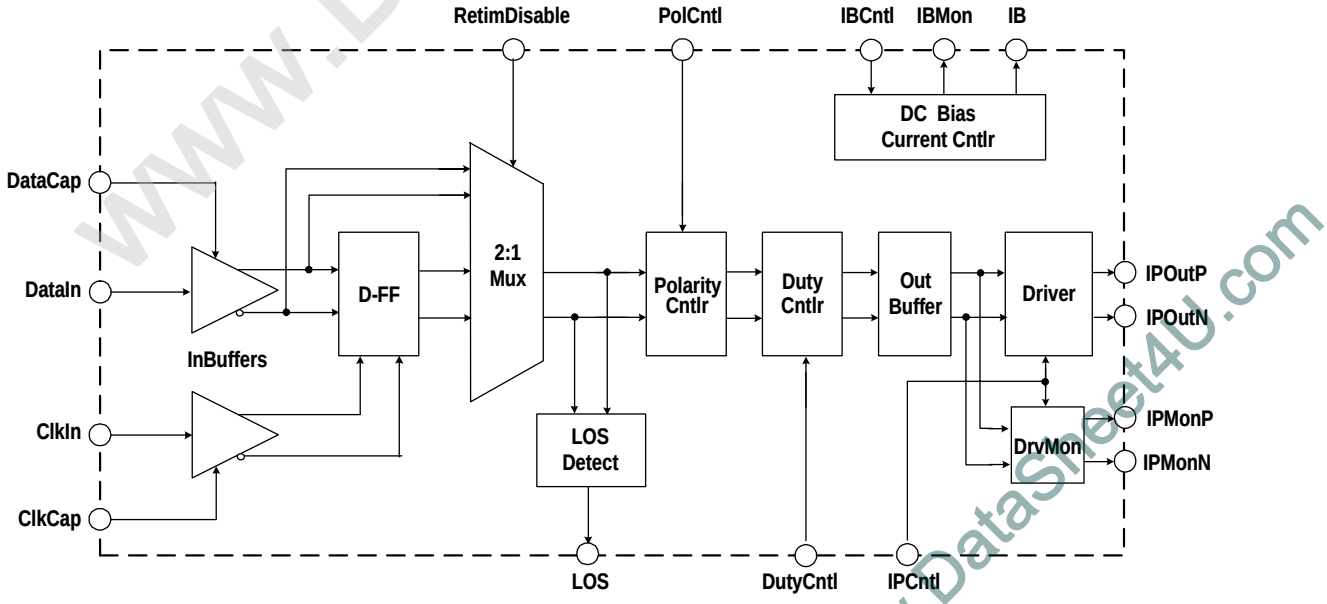


Table 1. Functional Block Descriptions

Block	Function
2:1 Mux	Data or retimed data select
DC Bias Current Cntlr	Laser diode DC bias current controller
D-FF	D-type flip flop for retiming input signal
Driver	Output driver stage with 200 Ω on-chip back termination (variable output current)
DrvMon	Output current and duty cycle monitor circuit (sinks 1/20 the value of driver current)
DutyCntlr	Duty cycle control of output current (external control)
InBuffers	Single-ended data and clock input/differential output buffer amplifiers
LOS Detect	Loss of input signal detector
OutBuffer	Buffer amplifier
PolarityCntlr	Polarity control circuit

Table 2. Terminal Name Descriptions

Number	Terminal Name	Description	Type	I/O	Rate/DC
13	ClkIn	Clock input	CML	I	10 Ghz
16	ClkCap	ClkIn reference terminal		I	DC
11	DataIn	Data input	CML	I	10 Gbps
8	DataCap	DataIn reference terminal		I	DC
17	DutyCntl	Output current, duty cycle control signal input	Analog	I	DC
1	IB	Laser diode, DC bias current output	Current Sink	O	DC
2	IBCntl	DC bias current, control signal input	Analog	I	DC
3	IBMon	DC bias current monitor		O	DC
19	IPCntl	Output current, control signal input	Analog	I	DC
20	IPMonN	Output current monitor, inverted output	Current Sink	O	DC
21	IPMonP	Output current monitor, non-inverted output	Current Sink	O	DC
25	IPOutN	Inverted output	Current Output	O	10 Gbps
27	IPOutP	Non-inverted output	Current Output	O	10 Gbps
6	LOS	Loss of input or clock signal indicator output	Current Sink (1)	O	DC
5	PolCntl	Input signal polarity control signal input	ECL	I	DC
7	RetimDisable	Input for disabling data and clock retiming	(2)	I	DC

Note 1. See description of current sinking in LOS section, Figure 6.

Note 2. To select retimed data this terminal can be connected to V_{EE} or it can float. Connecting the RetimDisable terminal to ground selects non-retimed data.

Functional Description

The CX60087 translates the single ended input data on DataIn from a digital voltage signal to current signals on the complementary IPOutP, IPOutN terminals for driving a ($LiNO_3$) or an EML modulator.

Data is retimed with ClkIn in the D-type flip-flop (D-FF) and output to the 2:1 Mux. The 2:1 Mux under control of the RetimDisable terminal selects retimed data from the D-FF.

The duty cycle and polarity of the output signal are controlled using the DutyCntl and PolCntl pins respectively.

The data output pulse current on IPOutP/N is adjusted using the IPCntl terminal and monitored using the IPMonP and IPMonN terminals.

The DC Bias Current Controller provides current (IB) for an external diode laser. Current is adjusted using the IBCntl terminal and monitored on the IBMon terminal.

The LOS Detect circuit detects loss of input signal and indicates that condition on the LOS terminal.

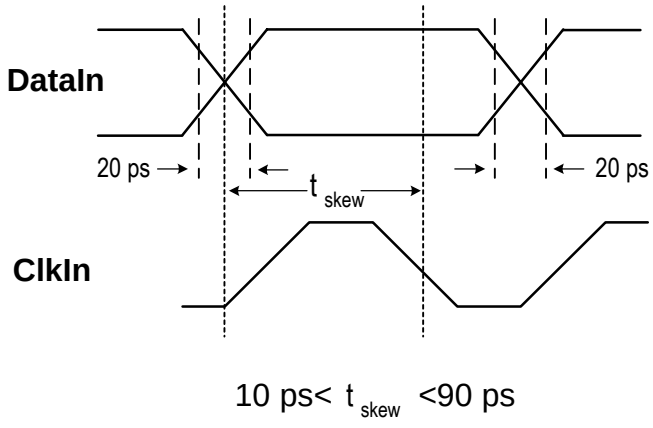
High Speed Data and Clock Inputs

The DataIn and ClkIn terminals are high-speed inputs that each include a 50 Ω on-chip termination resistor to ground. These terminals are CML interface compatible.

DataIn Retiming

The DataIn signal is retimed by the D-FF with ClkIn. See Figure 2 for the DataIn and ClkIn timing relationship. Note: During retiming mode tests, with scope synchronized to the system strobe, a shift in crossover point timing of 1.0 picosecond per degree C in relation to the strobe can occur.

Figure 2. Falling Edge of ClkIn Synchronized to DataIn Signal Transition



Retiming Terminal

The RetimDisable terminal controls the 2:1 Mux output. When RetimDisable is open (floats) or is connected to VEE, retimed data is selected for output. When this terminal is grounded, the non-retimed data is selected for output.

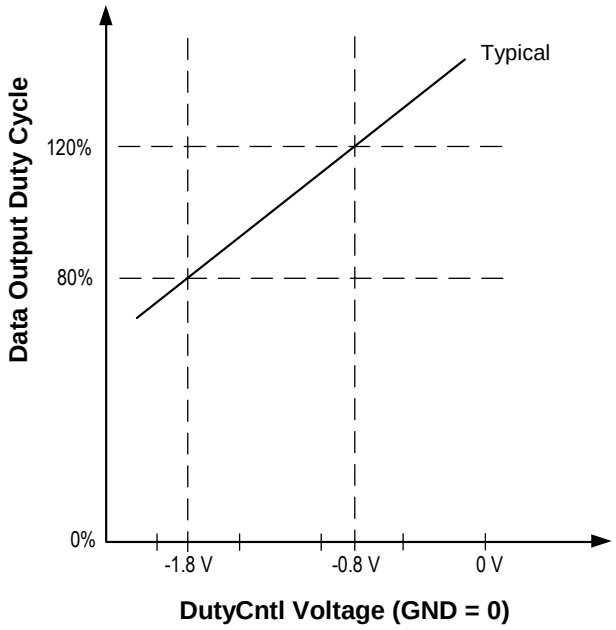
Polarity Control

Polarity of the differential signal IPOutP/IPOutN pulse can be inverted by an external control voltage on the PolCntl terminal. With PolCntl open or connected to an ECL low, the output is inverted; with PolCntl at ground or an ECL high, the output is non-inverted.

Duty Cycle Control

DutyCntl is an analog voltage input terminal, which controls the duty cycle of the data output on IPOutP/IPOutN. Figure 3 illustrates the duty cycle as controlled by the DutyCntl voltage value.

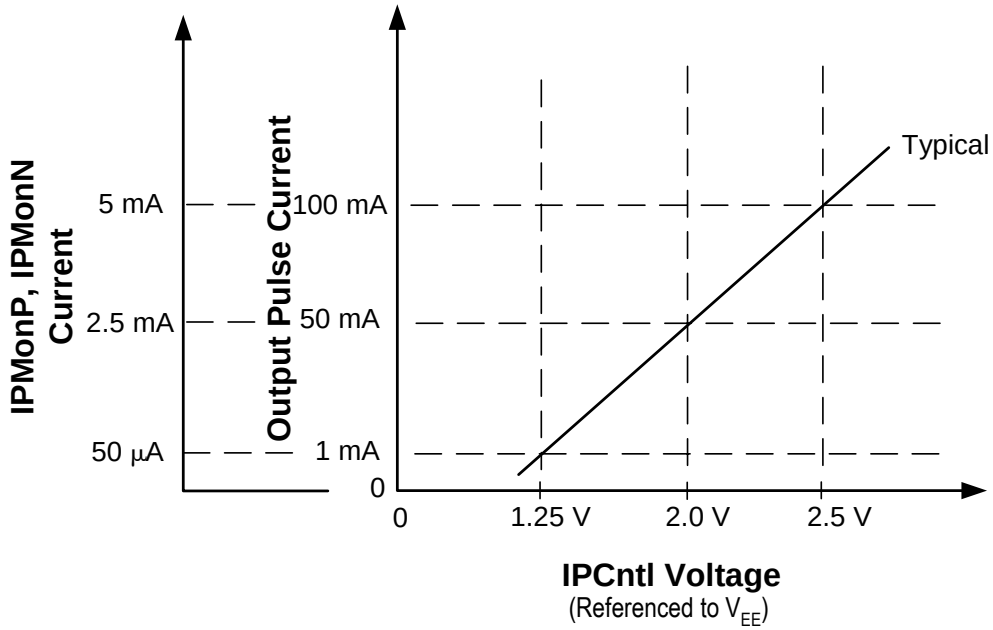
Figure 3. Typical Data Output Duty Cycle vs. DutyCntl Voltage



Pulse Current Driver

An external signal supplied to the IpCntl terminal controls the amplitude of the pulse modulation current. Differential signals on the IPMonP/N terminals monitor the IPOutP/N modulation current. Figure 4 illustrates the output pulse current and IPMonP/N current versus the IPCntl voltage.

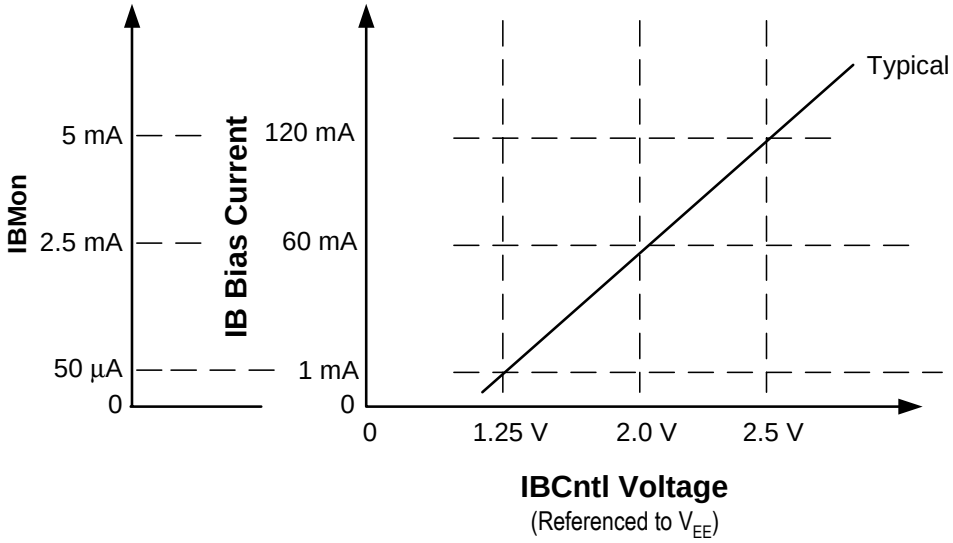
Figure 4. Typical Output Control Characteristics



DC Bias Current Driver

The IB terminal provides an adjustable DC bias current for a laser modulator or laser diode. An external voltage on the IBCntl terminal controls the DC bias current on IB. The IBMon terminal monitors the IB current. Figure 5 illustrates the IB bias current and IB monitor currents versus the IBCntl control voltage.

Figure 5. Typical IB Control Characteristics



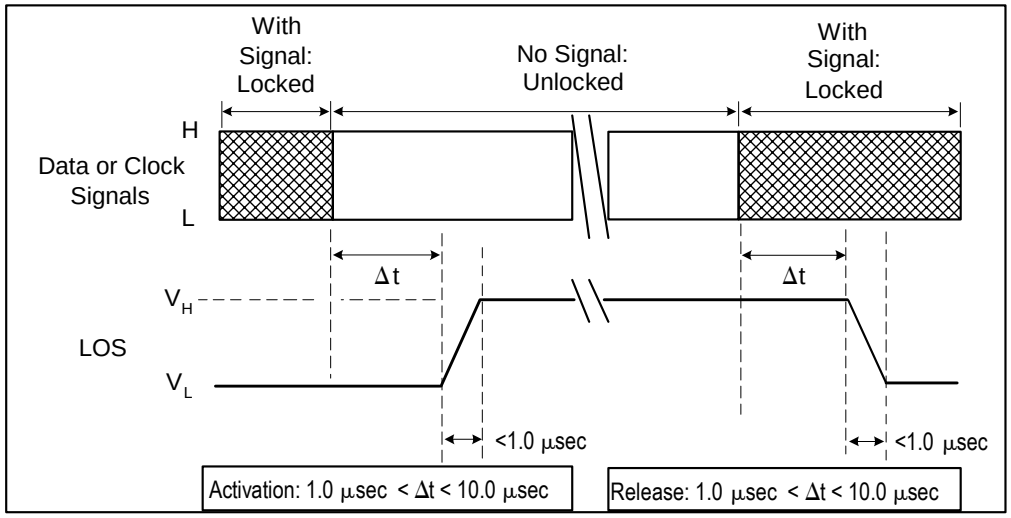
Loss of Signal Detection

The Loss of Signal Detection circuit (LOS Detect) indicates a loss of a valid signal in the data path (DataIn) and/or clock signal (ClkIn). If no voltage transitions occur during a specified time period, the LOS output terminal goes to a high level (ground). Figure 6 illustrates the LOS detect circuit timing waveforms.

LOS can be used by an external control circuit to shut down both the output pulse current and DC bias current drivers.

Under normal operating conditions, when data is transitioning, LOS will remain low. For an interface other than CML, the LOS output can be made ECL logic compatible with the circuits shown in Figures 10 and 11.

Figure 6. LOS Detect Circuit Timing Waveforms



Electrical Specifications

Table 3 lists the CX60087 electrical specifications. Absolute maximum ratings and recommended operating conditions are listed in Table 4 and Table 5 respectively.

Table 3. CX60087 Electrical Specifications

Tcase = 0° C to +85° C, V_{EE} = –5.2 V ±5%, R_L = 50 Ω

Parameter	Symbol	Min.	Typical	Max.	Unit
Input Data amplitude (DataIn)	VDAT	300	500	1000	mV P-P
Input Data, VIH level	DataIn	-0.2	0.0	+0.5	V
Input Data, VIL level	DataIn	-1.2	-0.9	-0.5	V
Input Clock amplitude (ClkIn)	VCLK	300	500	1000	mV P-P
Input Data duty cycle	tDATоc	80	100	120	%
Input CLK duty cycle	tCLKoc	40	50	60	%
Input Data rise/fall	tDATr, tDATf	–	–	50	ps
Input CLK rise/fall	tCLKr, tCLKf	–	–	40	ps
DataIn return loss (DC-3GHz)	S11data	–	-20	–	dB
DataIn return loss (3-10GHz)	S11data	–	–	-10	dB
ClkIn return loss (1-12GHz)	S11Clk	–	-10	–	dB
Bias current output	IB	1	-	120	mA
Peak output current	IPOut	40 (1)	100	110	mA
Ratio of IPOutP/N to IPMonP/N ((IPOutP/N) ÷ (IPMonP/N))	IPOut/IPMon	–	20.00	–	–
Maximum output swing (peak-to-peak with Bias-Tee to + 1.0 V)	Vout	4.5	5.0	6.0	V P-P
Maximum output swing (peak-to-peak without Bias-Tee)	Vout	–	3.0	–	V P-P
Output duty cycle range (retimed)		–	±20	–	%
Output rise/fall time	tIPr, tIPf	–	35	40	ps
Jitter added (2) (retimed)	Jrms	–	2	3	ps RMS
Change in delay over temperature			1		ps/deg. C
LOS V_L (no transitions on DataIn/ClkIn)		-0.2	0.0	–	V
LOS V_H (DataIn/ClkIn transitioning)		-1.5	-0.9	-0.5	V
$T_{Activation}$ (no transitions on DataIn/ClkIn)		1.0	–	10	µs
$T_{Release}$ (DataIn / ClkIn transitioning)		1.0	–	10	µs
Power consumption (V_{out} s-e equals 5.0 V P-P, no Ibias)	P_{max}		1.8	–	W
Power consumption (quiescent)	P_q	-	1.2	1.3	W

NOTE 1. Output current can be lower, however eye quality degrades at low current values.
NOTE 2. Valid only at V_{EE} = –5.2 V with Clock and Data = 500 mV P–P (± 150 mV.)

Table 4. CX60087 Absolute Maximum Ratings

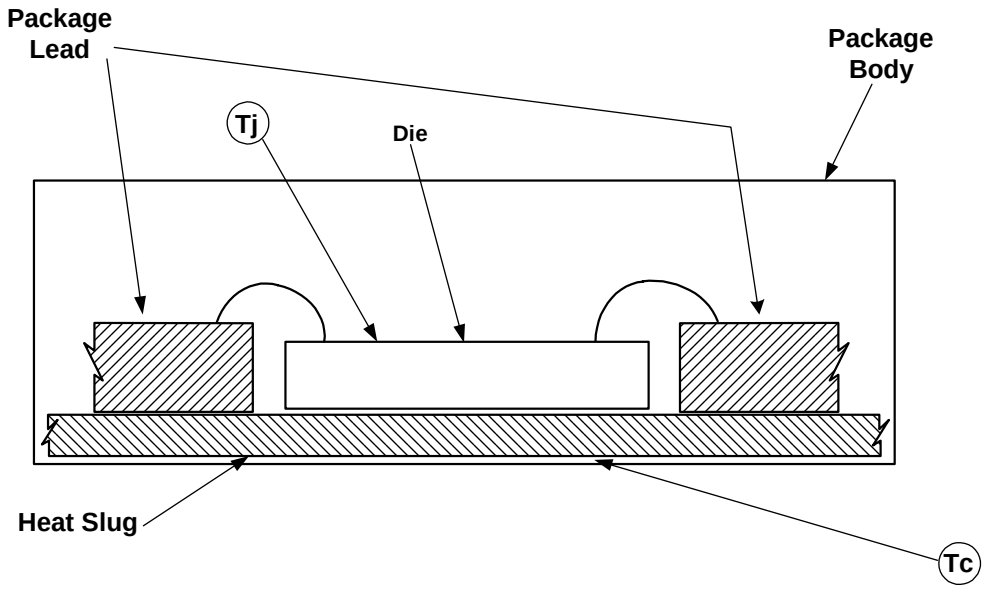
Exceeding the CX60087 absolute maximum ratings listed in Table 4 will damage the unit.

Parameter	Symbol	Min.	Max.	Unit
Supply Voltage	V_{EE}	-7.0	+0.5	V
Input Voltage	Vin	Vee -0.5	+0.5	V
IP Maximum Current	Ipmax	–	180	mA
IB Maximum Current	Ibmax	–	200	
Storage Temperature	Tst	-65	+150	°C
Electrostatic Discharge (Human Body Model)	ESD	–	>2000	V
High-speed Terminals			≥100	

Table 5. CX60087 Recommended Operating Conditions

Parameter	Symbol	Min.	Typical	Max.	Unit
Vee Supply Voltage	V_{EE}	–4.68	–5.20	–5.72	V
Operating Case Temperature	Tc(1)	0.0	–	+85	°C
Junction Temperature	Tj(1)	0.0	–	+125	°C
Relative Humidity		5	–	95	%
Note 1: See Figure 7 for temperature measurement locations.					

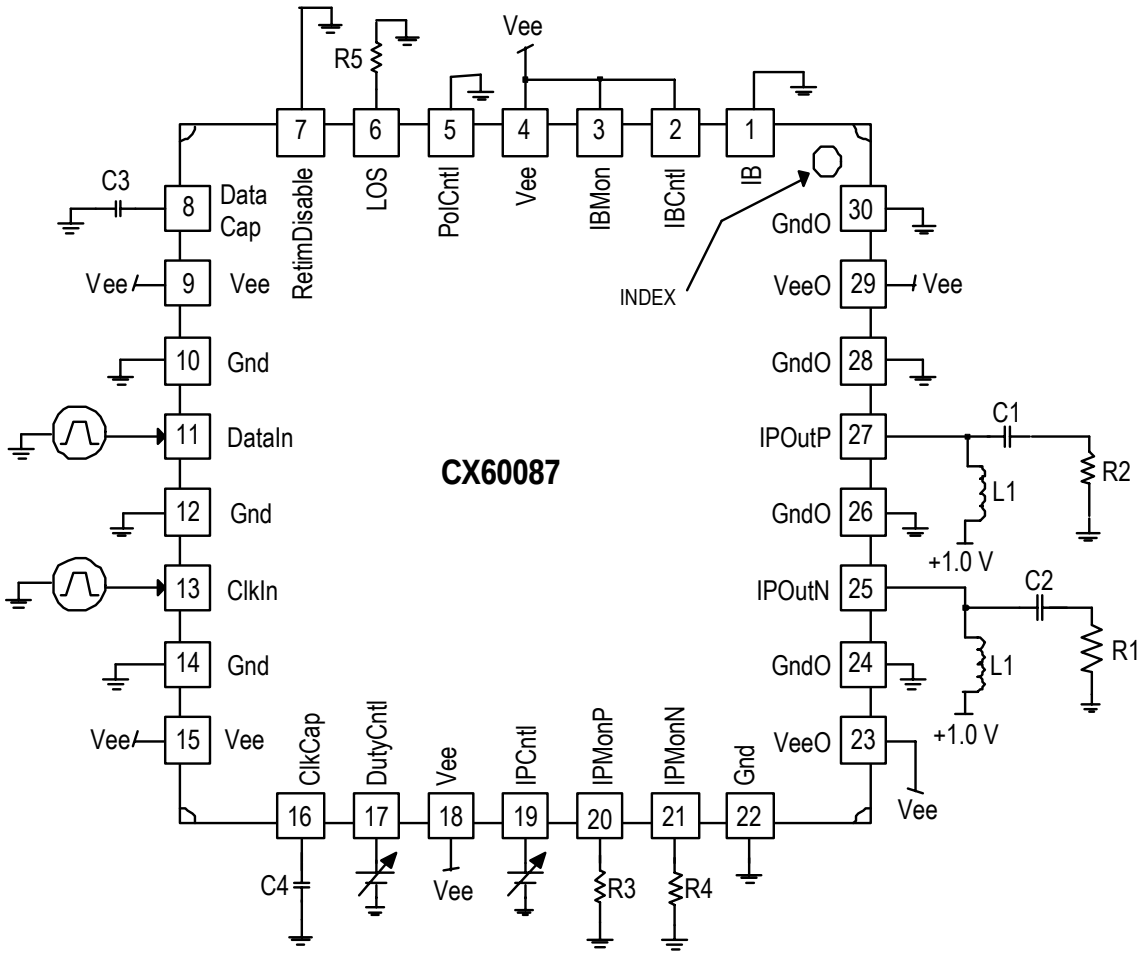
Figure 7. Temperature Measurement Locations



Waveform Evaluation

Figure 8 illustrates the CX60087 in an equivalent load circuit for waveform evaluation.

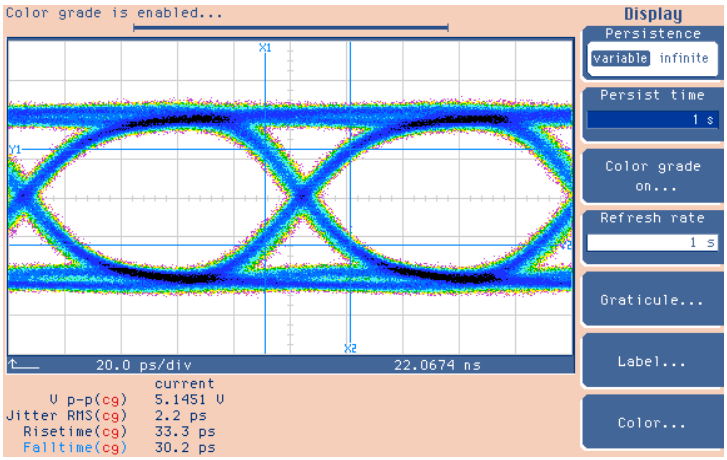
Figure 8. CX60087 Equivalent Load Circuit for Waveform Evaluation



Component List
R1 = 50Ω
R2 = 50Ω
R3 = 180Ω
R4 = 180Ω
R5 = 2kΩ
C1 = 0.12μF
C2 = 0.12μF
C3 = 15 nF
C4 = 10 nF
L1 = 330μH
L2 = 330μH

Figures 9. CX60087 Eye Diagrams (Directly Measured No Sonet Filters with Bias-Tee connected to +1 Volt)

With Re-timing.



CX60087 Eye Diagrams (Unfiltered, without Bias-Tee)

The three following eye diagram show CX60087operation under unfiltered test conditions while directly driving a 50 Ω Load.

Figure 10a. Output eye for CX60087 Maximum Signal Swing with 10Gbps Ethernet Eye Mask, without a Bias-Tee.

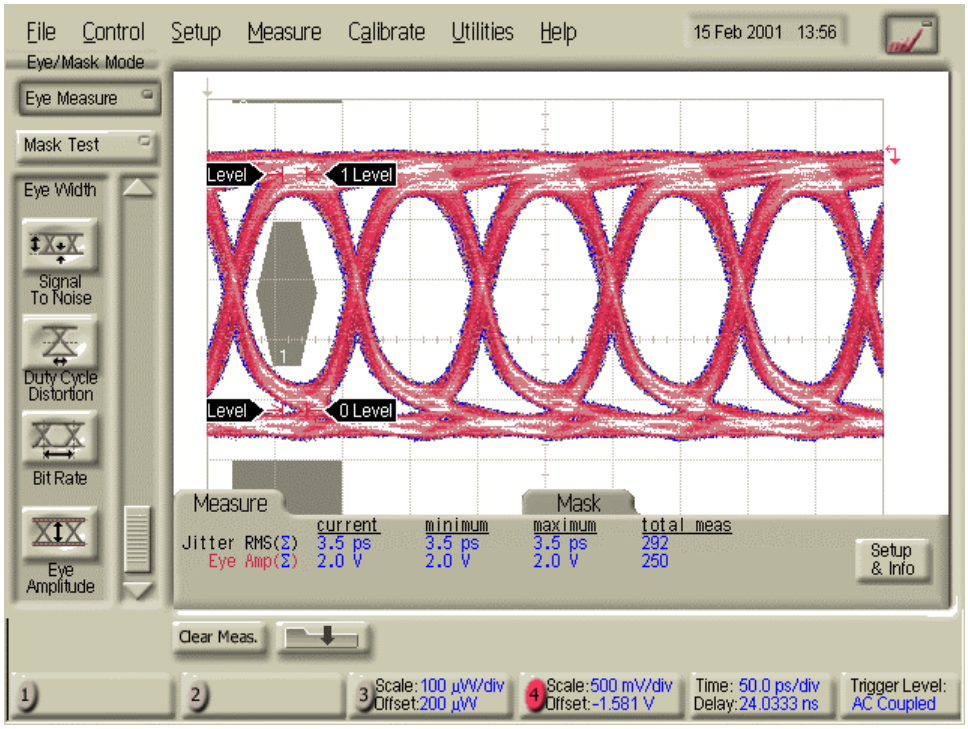


Figure 10b. CX60087 Output eye for Minimum Signal Swing with 10 Gbps Ethernet Eye Mask, without a Bias-Tee

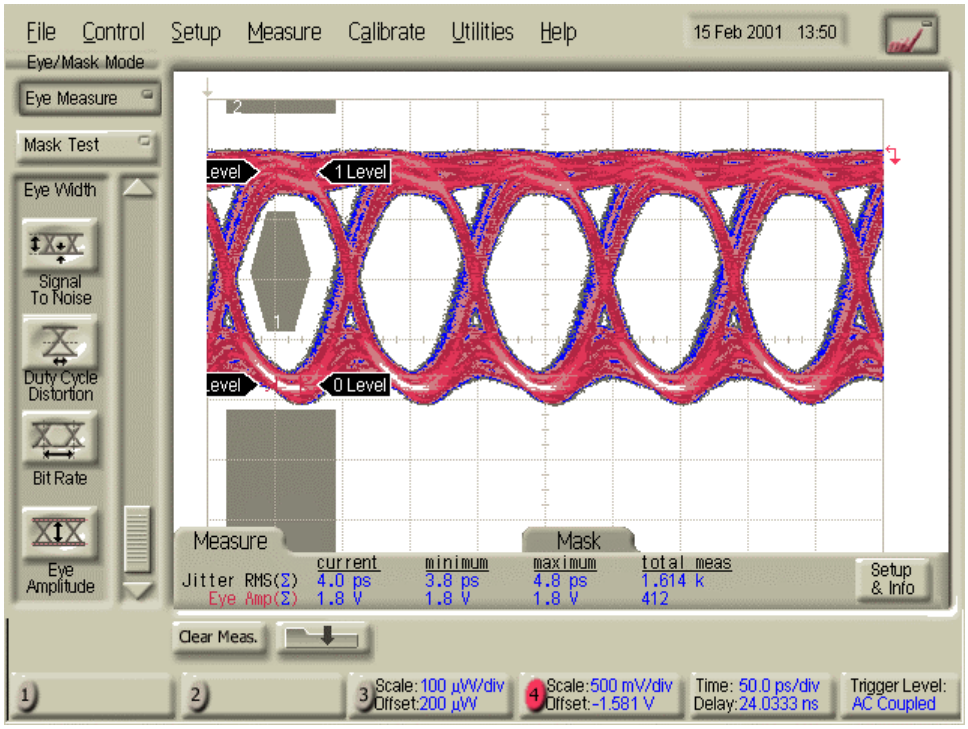
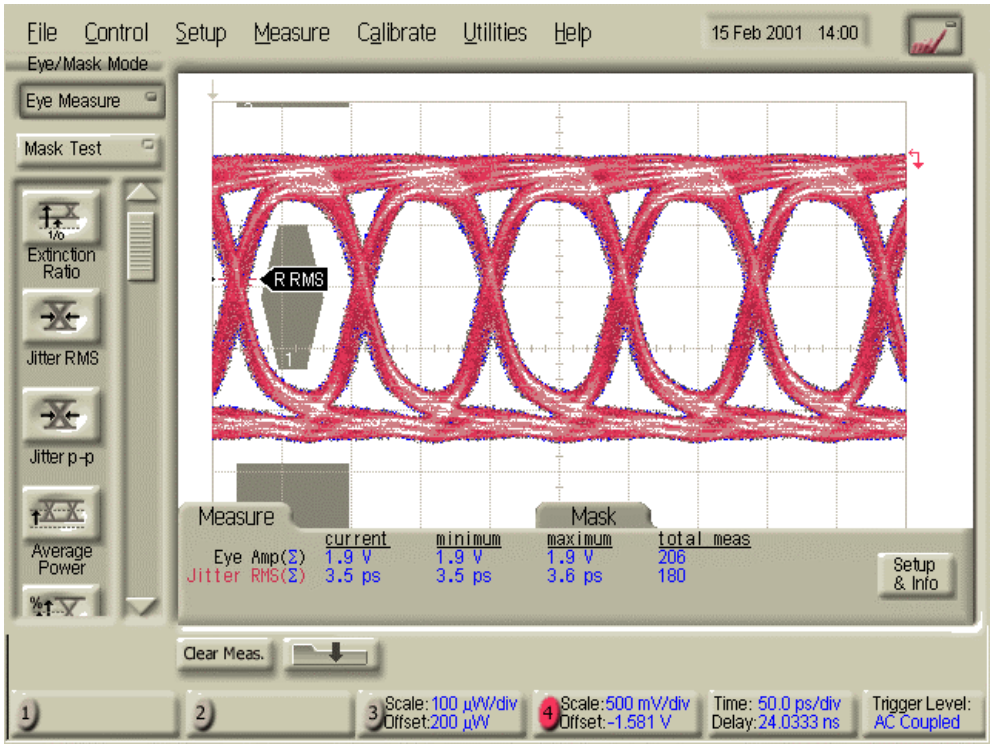


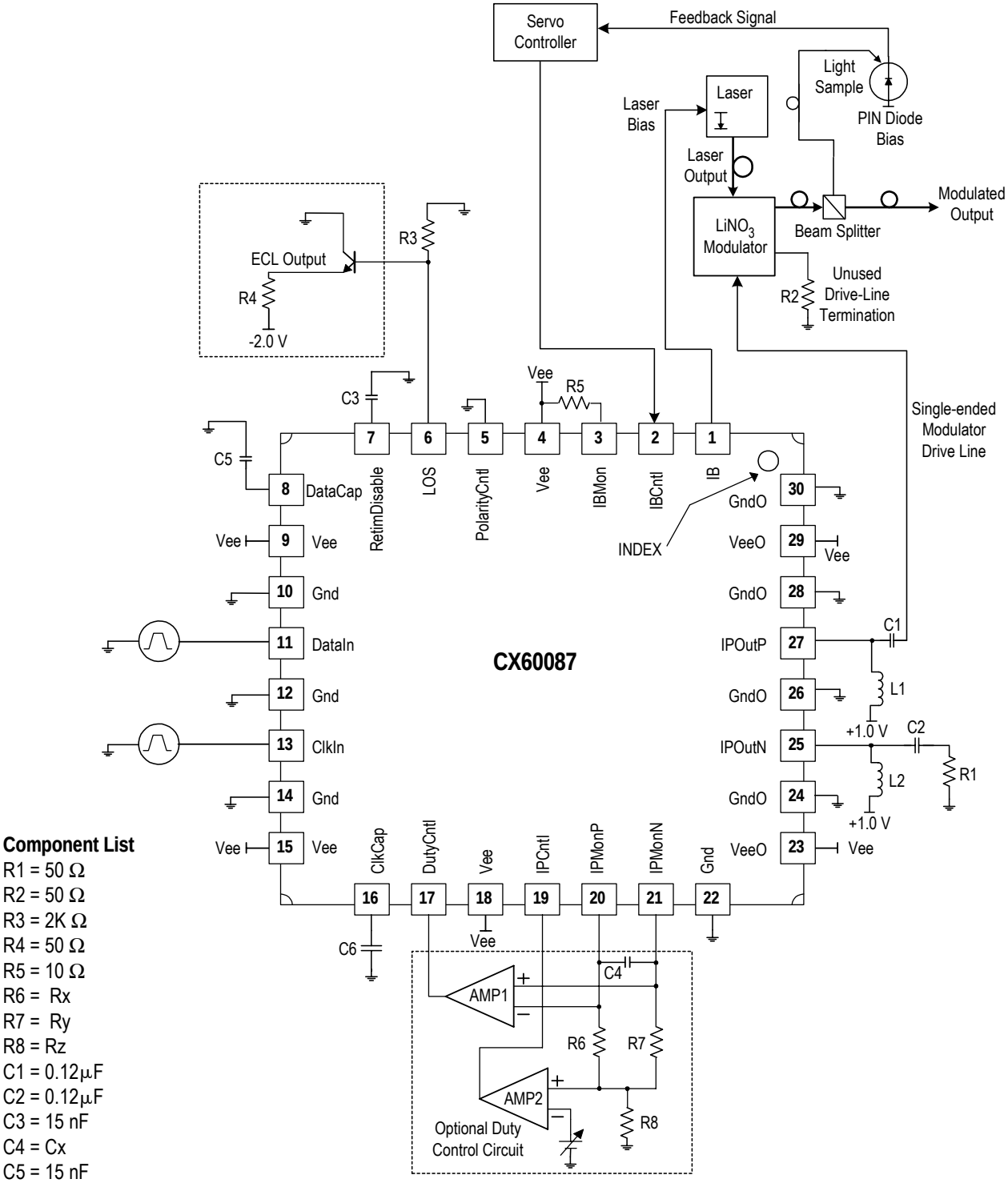
Figure 10c. CX60087 Output eye for Optimum Signal Swing with 10 Gbps Ethernet Eye Mask, without a Bias-Tee



Driver Configuration

Figure 11 illustrates the CX60087 configured as single-ended $LiNO_3$ driver.

Figure 11. CX60087 Single-Ended Mode $LiNO_3$ Modulator Driver Application

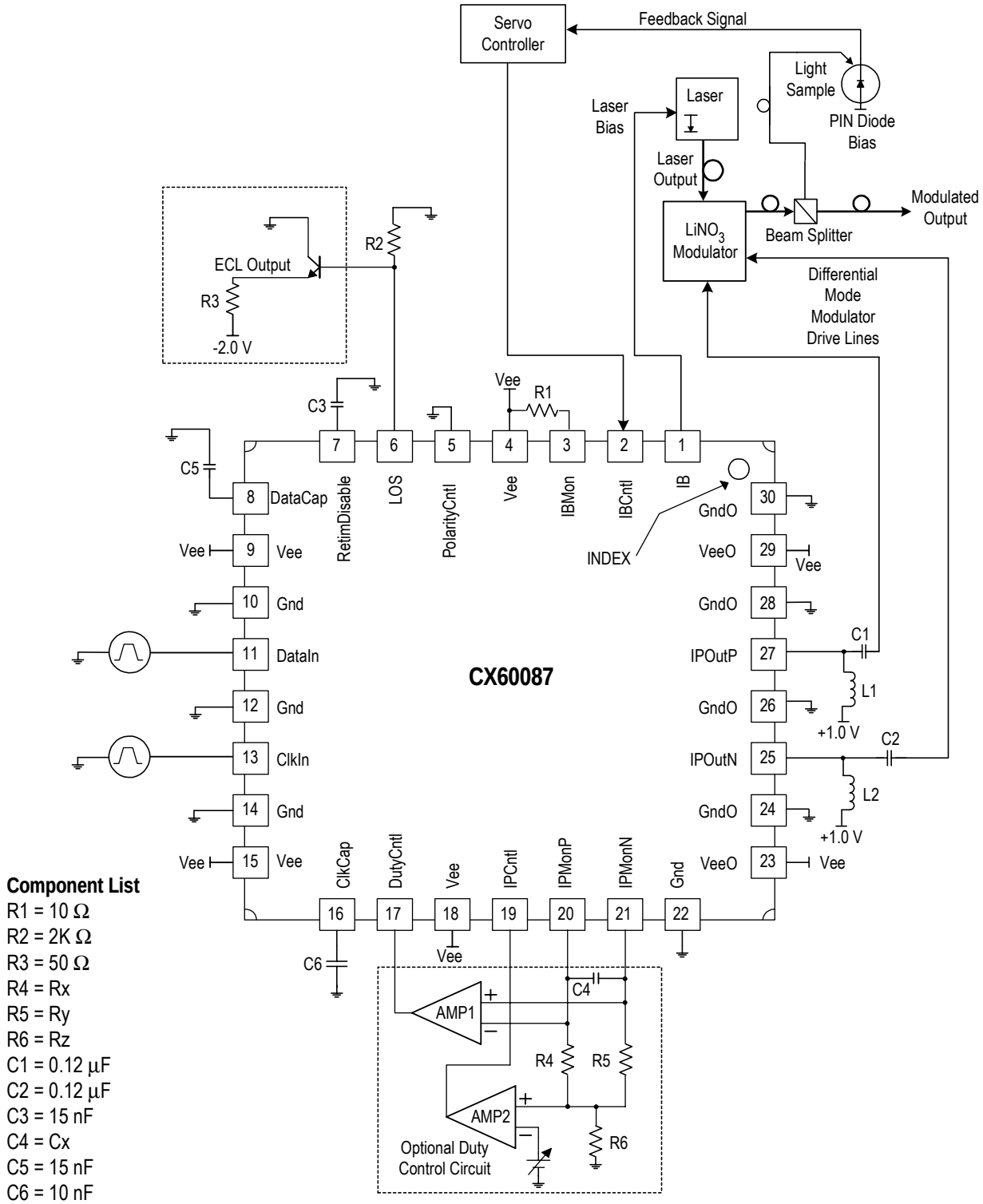


Component List

R1 = 50 Ω
R2 = 50 Ω
R3 = 2K Ω
R4 = 50 Ω
R5 = 10 Ω
R6 = Rx
R7 = Ry
R8 = Rz
C1 = 0.12µF
C2 = 0.12µF
C3 = 15 nF
C4 = Cx
C5 = 15 nF
C6 = 10 nF
L1 = 330µH
L2 = 330µH

Figure 12 illustrates the CX60087 configured as differential-mode $LiNO_3$ driver.

Figure 12. CX60087 Differential-Mode $LiNO_3$ Modulator Driver Application



Component List

R1 = 10 Ω
R2 = 2K Ω
R3 = 50 Ω
R4 = Rx
R5 = Ry
R6 = Rz
C1 = 0.12 µF
C2 = 0.12 µF
C3 = 15 nF
C4 = Cx
C5 = 15 nF
C6 = 10 nF
L1 = 330 µH
L2 = 330 µH

Application Notes for EML and DML applications.

The CX60087 can also be used for EML or DML applications, however it is important to note that for optimum eye opening and performance the following limitations exist:
When driving a 50 ohm load directly, as in the case of EML (Externally modulated laser) or DML (direct modulated laser) the CX60087 exhibits a range of linear operation spanning 80% to 100% of the maximum voltage swing realized. In order to optimize performace for lower signal swings, it is necessary to use an external 50 ohm attenuator network, in order to drop the signal swing to match the application. When used with a Bias-Tee, the linear range of adjustability spans approximatly 60% to 100% of the maximum. This level of adjustment is generally sufficient for EA modulators and cooled DML applications.

Package Pins Assignments

The CX60087 package terminal assignments are listed in Table 6 and illustrated in Figure 13.

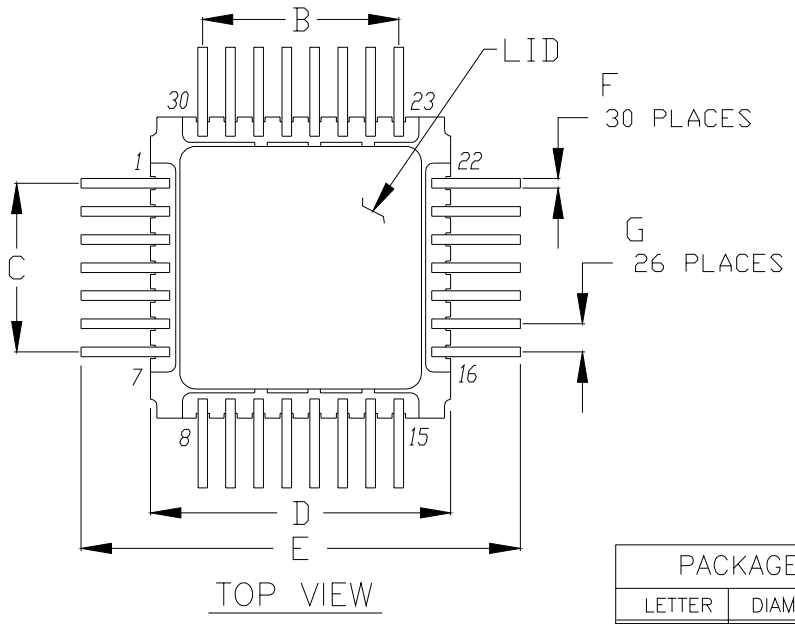
Table 6. CX60087 Package Terminal Assignments

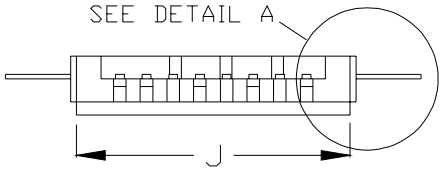
Package Terminal Number	Signal Name	Package Terminal Number	Signal Name
1	IB	16	ClkCap
2	IBCntl	17	DutyCntl
3	IBMon	18	Vee
4	Vee	19	IPCntl
5	PolCntl	20	IPMonP
6	LOS	21	IPMonN
7	RetimDisable	22	Gnd
8	DataCap	23	VeeO
9	Vee	24	GndO
10	Gnd	25	IPOutN
11	DataIn	26	GndO
12	Gnd	27	IPOutP
13	ClkIn	28	GndO
14	Gnd	29	VeeO
15	Vee	30	GndO

Package Dimensions

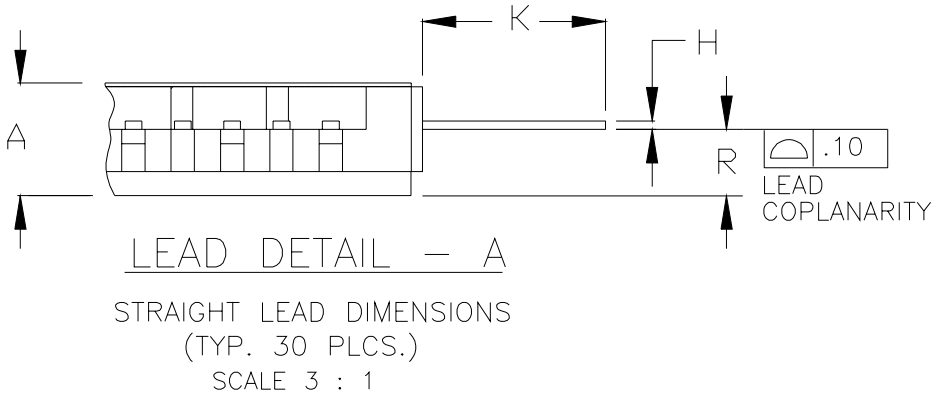
Figure 13 illustrates CX60087 package dimensions in millimeters.

Figure 13 CX60087 Package Dimensions





PACKAGE DIMENSIONS		
LETTER	DIAMENSION	TOLERANCE
A	2.44	MAX.
B	6.22	±.20
C	5.33	±.20
D	9.50 SQ.	±.20
E	13.90 SQ.	±.20
F	0.30	±.20
G	0.89	±.20
H	0.10	±.20
J	9.12	±.025
K	2.20	±.20
R	1.19	±.20



Ordering Information

Name	Number	Package Data
10 Gbs Lithium Niobate Modulator Driver	CX60087- (TBD)	30 Pin flat pack.

Revision History

Revision	Date	Comments
CX60087	4/19/00	Original issue.
CX60087v1a	5/8/00	Internal review copy, not for release. Requires update to CX60087 design specifications.
CX60087v1b	6/21/00	Internal review copy, not for release. Added review comments.
CX60087v1c	7/26/00	Internal review copy, not for release. Added review comments. Added illustration of output response eye displays. Removed laser modulator references and EML driver system block diagrams. Added single-ended mode and differential mode Lithium Niobate modulator driver SBD illustrations.
CX60087v1d	7/28/00	Internal review copy, not for release. Reviewed specifications, text, and figures.
CX60087v1e	8/2/00	Added review corrections and additions.
CX60087v1f	8/10/00	Internal review copy, not for release. Added new data to features and applications.
CX60087v1g	9/22/00	Internal review copy, not for release. Added review data
CX60087v1h	9/28/00	Internal review copy, not for release. Added review data
CX60087v2	3/8/01	Front page features and application data edits
CX60087v2a	5/8/01	Added note on jitter specification, and temperature dependent crossover shift in during retiming tests
CX60087v3	5/18/01	Modified Figure 3, Figure 4, and Figure 5. Table 3 values modified, added note on delay increase over temperature.

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Fax: (61-3) 9583 9453
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Fax: 86-21-6361-2516
China – South
Phone: (852) 2 827-0181
Fax: (852) 2 827-6488
China – South (Satellite)
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Fax: (86) 755-5183024
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