SY88353BL

3.3V, 3.2 Gbps Limiting Post Amplifier with Programmable Decision Threshold

General Description

The SY88353BL limiting post amplifier is designed for use in fiber-optic receivers, and is specially optimized for WDM applications where optical amplifiers such as EDFAs and Raman amplifier are used. The device connects to typical transimpedance amplifiers (TIAs). The linear signal from TIAs can contain significant amounts of noise that is unevenly distributed between top and bottom rails due to the ASE noise generated by the optical amplifiers, crosstalk, or non-linear effect in the fiber. In order to optimize the BER in such noisy conditions, the decision threshold between bit 1 and bit 0, needs to be moved to the rail that contains less noise. The SY88353BL features a pin at which an external voltage can be applied to move the crossing point up and down, from 20% to 80%, for BER optimization purposes.

The SY88353BL operates from a single +3.3V power supply, over temperatures ranging from –40°C to +85°C. Signals with data rates from 155Mbps up to 3.2Gbps, and as small as10mV$_{pp}$, can be amplified to drive devices with CML or PECL inputs.

The SY88353L features a Loss-of-Signal (LOS) open-collector TTL output. A programmable Loss-of-Signal level set pin (LOS$_{LVL}$) sets the sensitivity of the input amplitude detection. LOS asserts high if the input amplitude falls below the threshold sets by LOS$_{LVL}$ and de-asserts low otherwise. The enable bar input (/EN) de-asserts the true output signal without removing the input signal. The LOS output can be fed back to the /EN input to maintain output stability under a loss-of-signal condition. Typically, 3.3dB LOS hysteresis is provided to prevent chattering.

All support documentation can be found on Micrel's web site at: www.micrel.com.

Features

- Single 3.3V power supply
- Fast LOS release/assert
- 155Mbps to 3.2Gbps operation
- Low-noise CML data outputs
- Chatter-free Open-Collector TTL loss-of-signal (LOS) output
- TTL /EN input
- Programmable LOS level set (LOS$_{LVL}$)
- Programmable Decision Threshold
- Available in a tiny 3mm x 3mm MLF® package

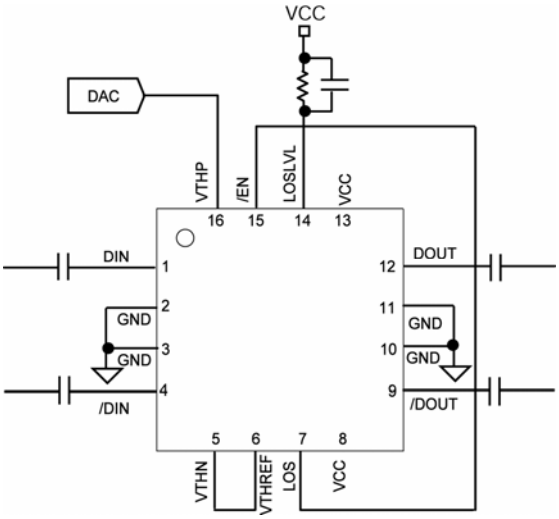
Applications

- WDM Systems
- Gigabit Ethernet, 1X and 2X Fibre Channel
- SONET/SDH: OC-3/12/24/48 – STM1/4/8/16
- Low-gain TIA interface

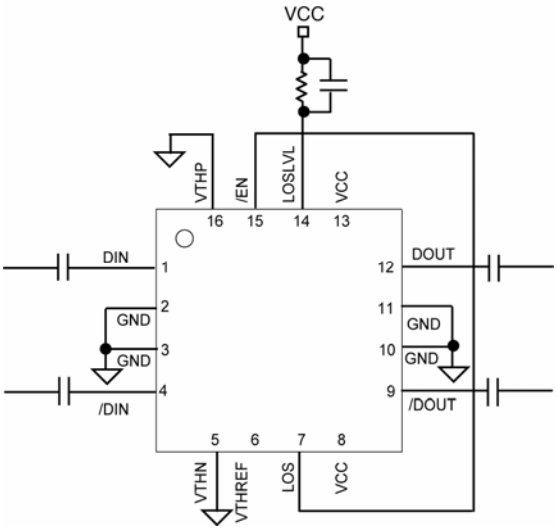
Markets

- Datacom/telecom
- Optical transceiver

Typical Application Circuit



Programmable Decision Threshold



Fixed Decision Threshold

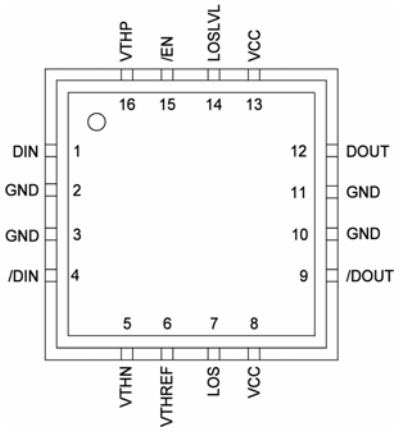
Ordering Information

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY88353BLMG	MLF-16	Industrial	353B with Pb-Free bar line indicator	NiPdAu Pb-Free
SY88353BLMGTR[(1)]	MLF16	Industrial	353B with Pb-Free bar line indicator	NiPdAu Pb-Free

Note:

1. Tape and Reel.

Pin Configuration



16-Pin MLF® (MLF-16)

Pin Description

Pin Number	Pin Name	Type	Pin Function
1	DIN	Data Input	True data input.
4	/DIN	Data Input	Complementary data input.
5	VTHN	DC Input	Tie this pin to pin 6 (VTHREF) and apply a DC voltage on pin 16 (VTHP) for signal crossing adjustment. Connect to ground if no crossing adjustment is needed.
6	VTHREF		1.25V Reference voltage (referenced to ground) for decision threshold adjustment.
7	LOS	Open-collector TTL output	Loss-of-Signal: asserts high when the data input amplitude falls below the threshold set by LOS_{LVL}.
9	/DOUT	CML Output	Complementary data output.
12	DOUT	CML Output	True data output.
14	LOSLVL	Input	Loss-of-Signal Level Set. A resistor from this pin to V_{CC} sets the threshold for the data input amplitude at which LOS will be asserted.
15	/EN	TTL Input: Default is HIGH.	/Enable: This input enables the outputs when it is LOW. Note that this input is internally connected to a 25kΩ pull-up resistor and will default to a logic HIGH state if left open.
16	VTHP	DC Input	Apply a DC voltage from 0 to 2.4V to adjust the signal crossing level when pin 5 (VTHN) is tied to pin 6 (VTHREF). 1.25V sets the crossing close to 50%. Connect to ground if no crossing adjustment is needed.
2, 3, 10, 11	GND	Ground	Device ground.
8, 13	VCC	Power Supply	Positive power supply.

Absolute Maximum Ratings[1]

Supply Voltage (V_{CC}) ..... 0V to +4.0V
Input Voltage (DIN, /DIN) ..... 0 to V_{CC}
Output Current (I_{OUT})
  Continuous ..... ±25mA
/EN Voltage ..... 0 to V_{CC}
V_{REF} Current ..... -800µA to +500µA
LOS_{LVL} Voltage ..... V_{REF} to V_{CC}
Lead Temperature (soldering, 20sec.) ..... +260°C
Storage Temperature (T_s) ..... –65°C to +150°C

Operating Ratings[2]

Supply Voltage (V_{CC}) ..... +3.0V to +3.6V
Ambient Temperature (T_A) ..... –40°C to +85°C
Junction Temperature (T_J) ..... –40°C to +120°C
Supply Voltage (V_{CC}) ..... +3.0V to +3.6V
Ambient Temperature (T_A) ..... –40°C to +85°C
Package Thermal Resistance[3]
  MLF®
  (θ_{JA}) Still-air ..... 60°C/W
  (ψ_{JB}) ..... 33°C/W

DC Electrical Characteristics

V_{CC} = 3.0 to 3.6V; T_A = –40°C to +85°C, typical values at V_{CC} = 3.3V, T_A = 25°C.

Symbol	Parameter	Condition	Min	Typ	Max	Units
I_{CC}	Power Supply Current	No output load		45	62	mA
LOS_{LVL}	LOS_{LVL} Voltage		V_{CC} -1.3		V_{CC}	V
V_{OH}	DOUT, /DOUT HIGH Voltage		V_{CC}-0.020	V_{CC}-0.005	V_{CC}	V
V_{OL}	DOUT, /DOUT LOW Voltage		V_{CC}-0.475	V_{CC}-0.400	V_{CC}-0.350	V
V_{OFFSET}	Differential Output Offset				±80	mV
V_{THREF}	Decision Threshold Reference Voltage			1.25		V
Z_0	Single-Ended Output Impedance		40	50	60	Ω
Z_I	Single-Ended Input Impedance		40	50	60	Ω

TTL DC Electrical Characteristics

V_{CC} = 3.0 to 3.6V; T_A = –40°C to +85°C, typical values at V_{CC} = 3.3V, T_A = 25°C.

Symbol	Parameter	Condition	Min	Typ	Max	Units
	Output signal Crossing Range Lower Limit	VTHN connected to VTHREF and 0-2.4V applied to VTHP.			20	%
	Output signal Crossing Range Upper Limit	20 ≤ DIN ≤ 100(mVpp), see Figure on page 6.	80			%
V_{IH}	/EN Input HIGH Voltage		2.0			V
V_{IL}	/EN Input LOW Voltage				0.8	V
I_{IH}	/EN Input HIGH Current	V_{IN} = 2.7V V_{IN} = V_{CC}			20 100	µA µA
I_{IL}	/EN Input LOW Current	V_{IN} = 0.5V	-0.3			mA
I_{CEX}	LOS Output Leakage Current	V_{OUT} = V_{CC}			100	µA
V_{OL}	LOS Output LOW Level	Sinking 2mA			0.5	V

AC Electrical Characteristics

V_{CC} = 3.0 to 3.6V; R_{Load} = 50Ω to V_{CC}; T_A = –40°C to +85°C, typical values at V_{CC} = 3.3V, T_A = 25°C.

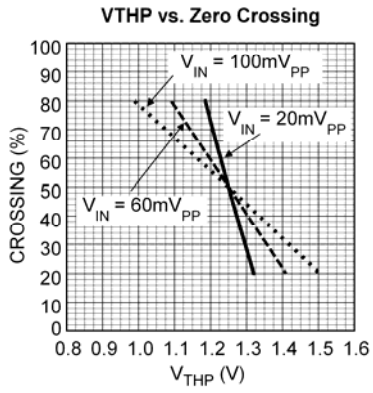
Symbol	Parameter	Condition	Min	Typ	Max	Units
t_r, t_f	Output Rise/Fall Time (20% to 80%)	Note 4		60	100	ps
t_{JITTER}	Deterministic Random	Note 5 Note 6		15 5		ps_{PP} ps_{RMS}
V_{ID}	Differential Input Voltage Swing		20		1800	mV_{PP}
V_{OD}	Differential Output Voltage Swing	Note 4	700	800	950	mV_{PP}
T_{OFF}	LOS Release Time	Note 9		2	10	µs
T_{ON}	LOS Assert Time	Note 9		2	10	µs
LOS_{AL}	Low LOS Assert Level	R_{LOSLVL} = 15kΩ, Note 7		9		mV_{PP}
LOS_{DL}	Low LOS De-assert Level	R_{LOSLVL} = 15kΩ, Note 7		13		mV_{PP}
HYS_L	Low LOS Hysteresis	R_{LOSLVL} = 15kΩ, Note 8		3.2		dB
LOS_{AM}	Medium LOS Assert Level	R_{LOSLVL} = 5kΩ, Note 7		17		mV_{PP}
LOS_{DM}	Medium LOS De-assert Level	R_{LOSLVL} = 5kΩ, Note 7		25		mV_{PP}
HYS_M	Medium LOS Hysteresis	R_{LOSLVL} = 5kΩ, Note 8		3.3		dB
LOS_{AH}	High LOS Assert Level	R_{LOSLVL} = 100Ω, Note 7		47		mV_{PP}
LOS_{DH}	High LOS De-assert Level	R_{LOSLVL} = 100Ω, Note 7		70		mV_{PP}
HSY_H	High LOS Hysteresis	R_{LOSLVL} = 100Ω, Note 8		3.4		dB
B_{-3dB}	3dB Bandwidth			2.0		GHz
$A_{V(Diff)}$	Differential Voltage Gain			38		dB
S_{21}	Single-Ended Small-Signal Gain		26	32		dB

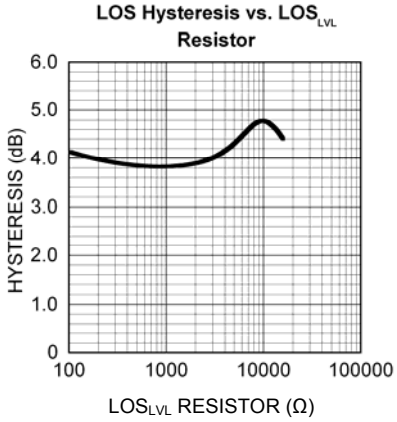
Notes:

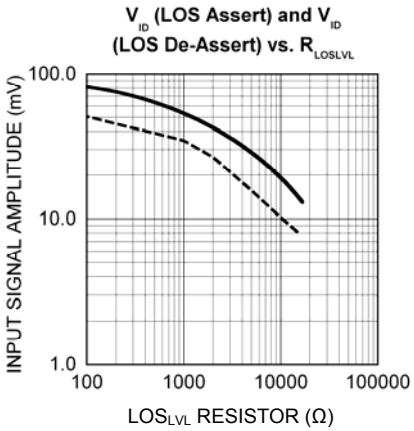
1. Permanent device damage may occur if absolute maximum ratings are exceeded. This is a stress rating only and functional operation is not implied at conditions other than those detailed in the operational sections of this data sheet. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.
2. The data sheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Package Thermal Resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB. ψ_{JB} uses a 4-layer and θ_{JA} in still-air number, unless otherwise stated.
4. Amplifier in limiting mode. Input is a 200MHz square wave.
5. Deterministic jitter measured using 2.5Gbps K28.5 pattern, V_{ID} = $10mV_{PP}$.
6. Random jitter measured using 2.5Gbps K28.7 pattern, V_{ID} = $10mV_{PP}$.
7. See “Typical Operating Characteristics” for a graph showing how to choose a particular R_{LOSLVL} for a particular LOS assert and its associated de-assert amplitude.
8. This specification defines electrical hysteresis as 20log (LOS De-Assert/LOS Assert). The ratio between optical hysteresis and electrical hysteresis is found to vary between 1.5 and 2, depending upon the level of received optical power and ROSA characteristics. Based upon that ratio, the optical hysteresis corresponding to the electrical hysteresis range 1dB-4.5 dB, shown in the AC characteristics table, will be 0.5dB-3dB Optical Hysteresis.
9. In real world applications, the LOS Release/Assert time can be strongly influenced by the RC time constant of the AC-coupling cap and the 50Ω input termination. To keep this time low, use a decoupling cap with the lowest value that is allowed by the data rate and the number of consecutive identical bits in the application. Typical values are in the range of 0.001µF to 1.0µF.

Typical Operating Characteristics

V_{CC} = 3.3V, T_A = 25°C, R_L = 50Ω to V_{CC}-2V, unless otherwise stated.



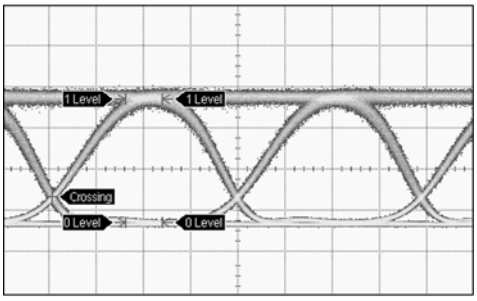




Functional Characteristics

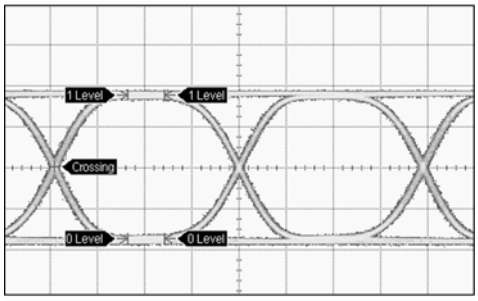
V_{CC} = 3.3V, T_A = 25°C, R_L = 50Ω to V_{CC}-2V, unless otherwise stated.

20% Crossing Point
VTHP = 1.32V, VTHN = VTHREF



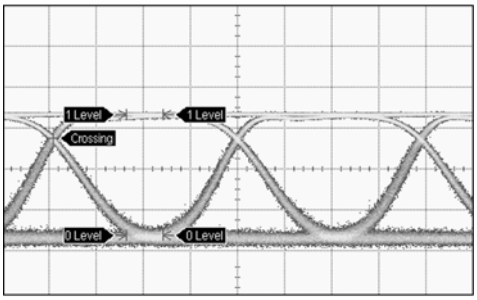
TIME (80ps/div.)

50% Crossing Point
VTHP = 1.25V, VTHN = VTHREF



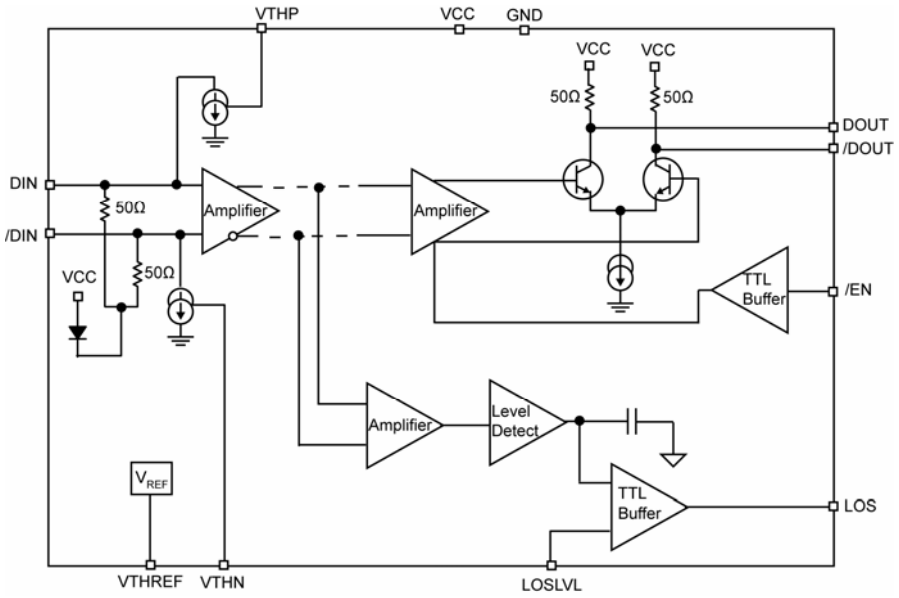
TIME (80ps/div.)

80% Crossing Point
VTHP = 1.185V, VTHN = VTHREF



TIME (80ps/div.)

Functional Block Diagram



Detailed Description

The SY88353L limiting post amplifier operates from a single +3.3V power supply, over temperatures from –40°C to +85°C. Signals with data rates from 155Mbps up to 3.2Gbps, and as small as 10mV$_{pp}$, can be amplified. Figure 1 shows the allowed input voltage swing. The SY88353L generates a LOS output that can be feedback to /EN for output stability in the absence of a signal at the input. LOS$_{LVL}$ sets the sensitivity of the input amplitude detection. The amplifier features a signal crossing adjustment for BER optimization in optical links using optical amplifiers such in WDM applications.

Input Amplifier/Buffer

Figure 2 shows a simplified schematic of the input stage. The input amplifier allows signals as small as 10mV$_{pp}$ to be detected and amplified. The input amplifier allows input signals as large as 1800mV$_{pp}$. Input signals are linearly amplified with a typical 38dB differential voltage gain. Since it is a limiting amplifier, the SY88353BL outputs typically 800mV$_{pp}$ voltage-limited waveforms for input signals that are greater than 12mV$_{pp}$. Applications requiring the SY88353L to operate with high gain should have the upstream TIA placed as close as possible to the SY88353BL's input pins to ensure the best performance of the device.

Output Buffer

The SY88353BL's CML output buffer is designed to drive 50Ω lines and is internally terminated with 50Ω to V_{CC}. Figure 3 shows a simplified schematic of the output stage.

Loss-of-Signal

The SY88353L generates a chatter-free loss-of-signal (LOS) open-collector, TTL output, as shown in Figure 4. LOS is used to determine if the input amplitude is too small to be considered a valid input. LOS asserts high if the input amplitude falls below the threshold set by LOSLVL and de-asserts low otherwise. LOS can be fed back to the enable (/EN) input to maintain output stability under a loss of signal condition. /EN de-asserts low the true output signal without removing the input signals. Typically, 3.3dB LOS hysteresis is provided to prevent chattering.

Loss-of-Signal-Level Set

A programmable LOS level set pin (LOS$_{LVL}$) sets the threshold of the input amplitude detection. Connecting an external resistor between V_{CC} and LOS$_{LVL}$ sets the voltage at LOS$_{LVL}$. This voltage ranges from V_{CC} to V_{CC}-1.3V. The external resistor creates a voltage divider between V_{CC} and V_{CC}-1.3V, as shown in Figure 5.

Hysteresis

The SY88353L typically provides 3.3dB LOS electrical hysteresis, which is defined as 20log (VIN$_{LOS\text{-}De\text{-}assert}$/ VIN$_{LOS\text{-}Assert}$). Since the relationship between the voltage out of the ROSA and optical power at its input is linear, the optical hysteresis will be typically half of the electrical hysteresis reported in the datasheet. In practice, the ratio between electrical and optical hysteresis is found to be within the range 1.5 to 1.8dB. Thus, 3.3dB electrical hysteresis will correspond to an optical hysteresis within the range 1.8 to 2.2dB.

Signal Crossing Adjustment

In order to optimize the decision threshold level and hence, the BER of the optical link, the SY88353L provides two pins for output signal crossing control. The signal crossing can be adjusted by connecting VTHN (pin 5) to VTHREF (pin 6), and applying a DC signal at VTHP (pin 16). By varying the DC signal at VTHP from – 0V to 2.5V – while the input signal to the post amplifier is less than 100mVpp, the crossing of the output signal will change from 20% to 80% reaching 50% when VTHP = VTHREF = 1.25V. If the crossing control function is not needed, VTHN and VTHP must be connected to ground.

The zero crossing vs. VTHP plot, shown on page 6, shows how the crossing of the output signal changes with the voltage applied at VTHP (pin 16) while VTHN (pin 5) is tied to VTHREF (pin 6) for different input signal levels.

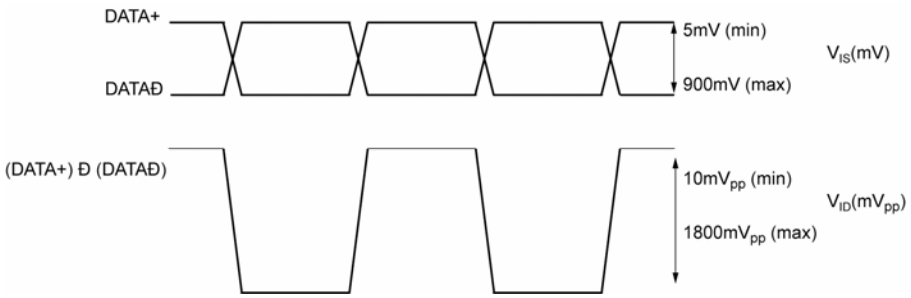


Figure 1. V_{IS} and V_{ID} Definition

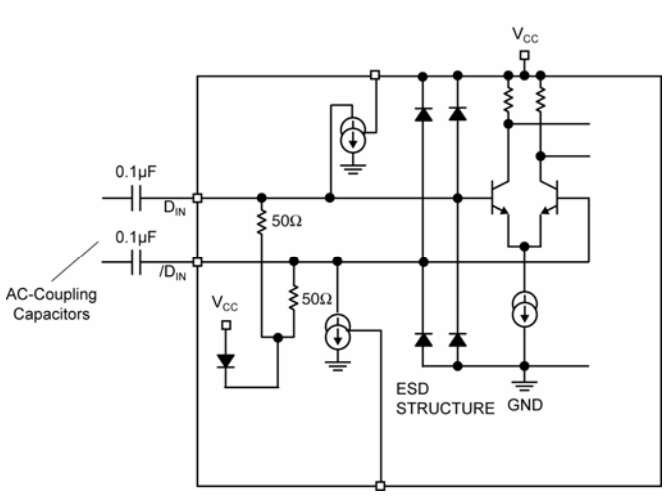


Figure 2. Input Structure

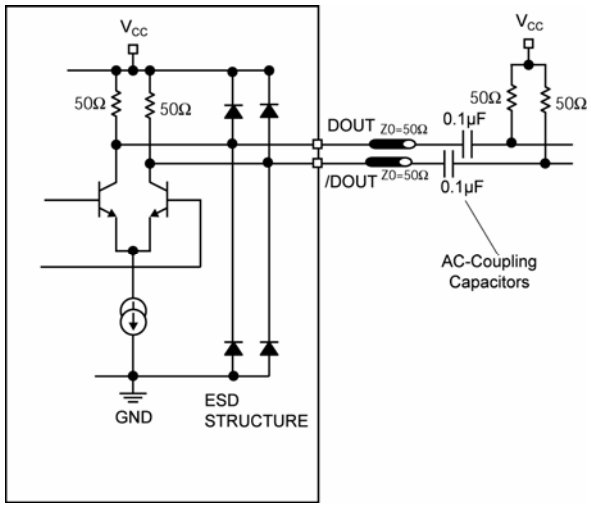


Figure 3. Output Structure

hbwhelp@micrel.com or (408) 955-1690

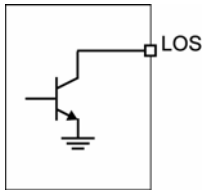


Figure 4. LOS Output Structure

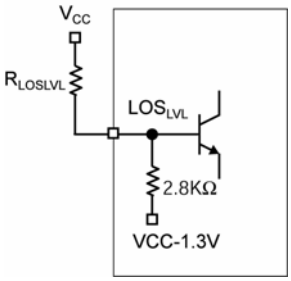


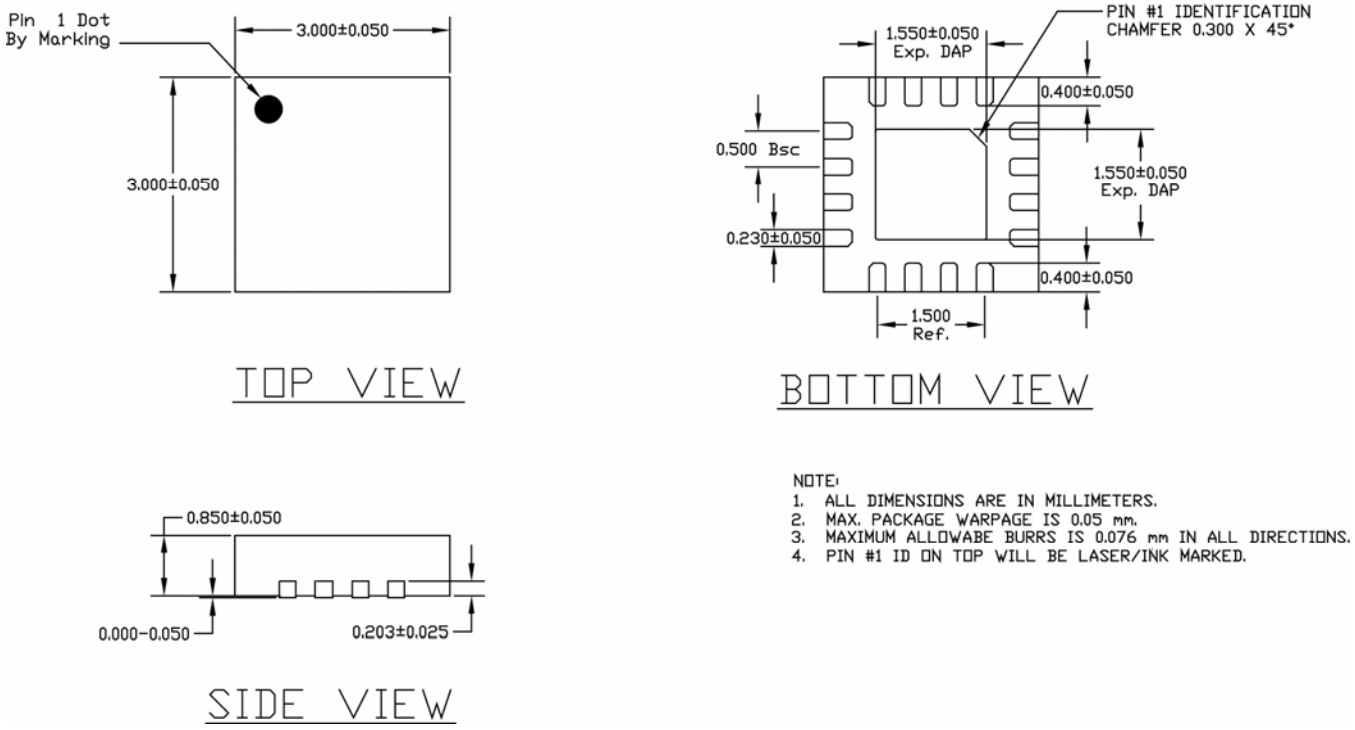
Figure 5. LOS_{LVL} Setting Circuit

Note: Recommended value for R_{LOSLVL} is 15kΩ or less.

Related Product and Support Documentation

Part Number	Function	Data Sheet Link
AN-45	Notes on Sensitivity and Hysteresis in Micrel Post Amplifiers	http://www.micrel.com/product-info/app_hints+notes.shtml

Package Information



16-Pin (3mm x 3mm) MLF® (MLF-16)

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