# SY88149HL

## 3.3V 1.25Gbps Burst-Mode Limiting Amplifier with Ultra-Fast Signal Assert Timing

## General Description

The SY88149HL is a high-sensitivity, burst-mode capable limiting post amplifier designed for Optical Line Terminal (OLT) receiver applications. The SY88149HL satisfies the strict timing restrictions of the GPON standards by providing ultra-fast Loss-of-Signal (LOS) or Signal-Detect (SD) output. Auto Reset and Manual Reset options are provided to control LOS/SD output timing. For increased flexibility, this device also includes an option to select between LOS or SD output. The device can be connected to burst-mode capable transimpedance amplifiers (TIAs) using AC or DC coupling.

The SY88149HL generates a high-gain LOS or SD LVTTL output. A programmable LOS/SD level pin ($LOS/SD_{LVL}$) sets the sensitivity of the input amplitude detection. This device also offers the option to choose between a Loss-of-Signal (LOS) and a Signal-Detect (SD) output from the LOS/SD pin based the LOS/SDSEL pin setting. To select SD output, leave LOS/SDSEL pin open or connect to Vcc; to select LOS output, tie LOS/SDSEL-to-ground. If the input signal amplitude falls below the threshold set by $LOS/SD_{LVL}$, LOS will assert high (or SD will de-assert low). Once the input signal rises above the threshold set by $LOS/SD_{LVL}$, LOS will de-assert low (or SD output will assert high). The SY88149HL also features a JAM function which, when active, disables the LVPECL outputs. JAM is active LOW when SD is selected and active HIGH when LOS is selected. The LOS/SD output should be fed back to the JAM input to maintain output stability under an invalid signal condition. Typically, 3dB SD hysteresis is provided to prevent chattering.

The SY88149HL operates from a single +3.3V power supply over temperatures ranging from –40°C to +85°C. With its wide bandwidth and high gain, signals up to 1.25Gbps and as small as 4mVpp can be amplified to drive devices with LVPECL inputs.

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

## Features

- Single 3.3V power supply
- <5ns SD assert (LOS de-assert) time
- Option to AUTORESET or Manual RESET LOS output to HIGH and SD output to LOW
- Option to select LOS or SD output
- Up to 1.25Gbps operation
- Low-noise differential LVPECL data outputs
- 4mVpp input sensitivity
- High sensitivity LOS/SD detect
- Ultra fast LVTTL LOS/SD output
- Squelching function to disable output
- Programmable LOS/SD level set ($LOS/SD_{LVL}$)
- Available in a 16-pin (3mmx 3mm) MLF® package

## Applications

- GE-PON/GPON/EPON OLT
- Gigabit Ethernet
- Fibre Channel
- OC-3/12/24 SONET/SDH
- High-gain line driver and line receiver
- Low-gain TIA interface

## Markets

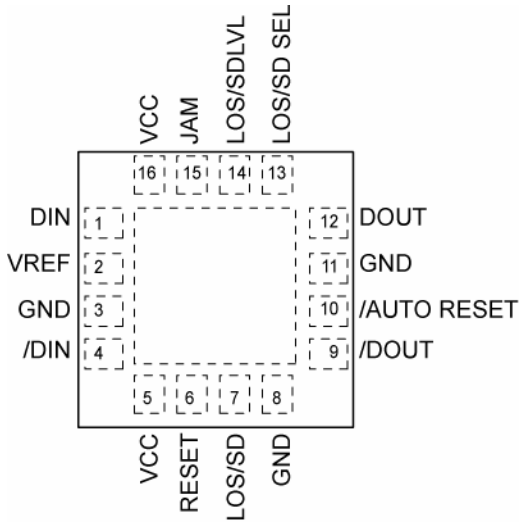
- FTTH/FTTP
- Datacom/Telecom
- Optical transceiver

MLF is a registered trademark of Amkor Technology, Inc.

## Ordering Information

| Part Number | Package Type | Operating Range | Package Marking | Lead Finish |
|---|---|---|---|---|
| SY88149HLMG | MLF-16 | Industrial | 149H with Pb-Free bar-line indicator | NiPdAu Pb-Free |
| SY88149HLMGTR[1] | MLF-16 | Industrial | 149H with Pb-Free bar-line indicator | NiPdAu Pb-Free |

## Pin Configuration




**16-Pin MLF® (MLF-16)**

## Truth Tables

| LOS/SDSEL | Function | LOS/SD Output (JAM Input) | OUTPUTS |
|---|---|---|---|
| High | SD | High | Enabled |
| High | SD | Low | Disabled |
| Low | LOS | Low | Enabled |
| Low | LOS | High | Disabled |

## Pin Description

| Pin Number | Pin Name | Pin Function |
|---|---|---|
| 1, 4 | DIN, /DIN | Data Inputs. If AC-Coupled, terminate each pin to Vref with 50Ω. |
| 2 | VREF | Reference Voltage Output. Typically Vcc – 1.3V. |
| 3,11,8 | GND | Device Ground. Exposed pad must be soldered (or equivalent) to the same potential as ground pins. |
| 10 | /AUTORESET | LVTTL Input. This pin is internally connected to a 25kΩ pull-up resistor and defaults to HIGH. When this pin is LOW or tied to ground, the /AUTORESET function is enabled and SD de-asserts or LOS asserts within 100ns (typical) after the last high to low transition of the burst input. When this pin is left floating or not connected, the AUTORESET function is disabled and the SD de-assert or LOS assert must be forced by using the manual RESET function. |
| 5,16 | VCC | Positive power supply. Bypass with 0.1uF \| \| 0.01uF low ESR capacitors. 0.01uF capacitors should be as close as possible to VCC pins. |
| 6 | RESET | LVTTL Input. Apply a high-level signal (>2V) to this pin to discharge the time constant and reset the signal de-assert time or LOS assert time within 5ns. RESET defaults to Low if left floating. If the /AUTORESET function is not used, this RESET function needs to be used to quickly de-assert the SD or assert LOS. Note that this input is internally connected to a 25kΩ pull-up resistor. |
| 7 | LOS/SD | LVTTL Output. Signal-Detect (SD) asserts high when the data input amplitude rises above the threshold set by $SD_{LVL}$. Conversely, Loss-of-Signal (LOS) de-asserts low when the data input amplitude rises above the threshold set by $LOS_{LVL}$. |
| 12, 9 | DOUT, /DOUT | LVPECL Outputs. When JAM disables the device, output DOUT is forced to logic LOW and output /DOUT is forced to logic HIGH. |
| 13 | LOS/SDSEL | LVTTL Input. Connect to $V_{CC}$ or leave open to select SD; set low or connect-to-GND to select LOS. This pin also controls the LOS/SD output and polarity of the JAM function. When SD is selected, JAM is active LOW and LOS/SD (pin 7) operates as signal detect. Conversely, when LOS is selected, JAM is active HIGH and LOS/SD operates as loss-of-signal. Note that this input is internally connected to a 25Ω pull-down resistor |
| 14 | LOS/SDLVL | Voltage Input. Sets the Loss of Signal/Signal Detect Level. A resistor from this pin to $V_{CC}$ sets the threshold for the data input amplitude at which LOS/SD will be asserted. |
| 15 | JAM | LVTTL Input. JAM acts as a squelch function which can disable the LVPECL outputs. The polarity of the input that triggers an active JAM depends upon LOS/SDSEL status. When LOS is selected, this pin is active HIGH. When SD is selected, this pin is active LOW. To create a squelch function, connect JAM to LOS/SD output. When JAM disables the device, output Q is forced to logic LOW and output /Q is forced to logic HIGH. Note that this input is internally connected to a 25kΩ pull-up resistor. |

## 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 ..... ±50mA
  Surge ..... ±100mA
TTL Inputs Voltage ..... 0 to $V_{CC}$
$V_{REF}$ Current ..... -800µA to +500µA
$LOS/SD_{LVL}$ 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 +125°C
Junction Thermal Resistance[3]
  MLF® ($\theta_{JA}$) Still-air ..... 60°C/W
  MLF® ($\Psi_{JB}$) Junction-to-board ..... 38°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 | | 57 | 78 | mA |
| $LOS/SD_{LVL}$ | $LOS/SD_{LVL}$ Voltage | | $V_{REF}$ | | $V_{CC}$ | V |
| $V_{OH}$ | LVPECL Output HIGH Voltage | 50Ω to $V_{CC}$-2V | $V_{CC}$-1.085 | $V_{CC}$-0.955 | $V_{CC}$-0.880 | V |
| $V_{OL}$ | LVPECL Output LOW Voltage | 50Ω to $V_{CC}$-2V | $V_{CC}$-1.830 | $V_{CC}$-1.705 | $V_{CC}$-1.555 | V |
| $I_{OFFSET}$ | Input Offset Voltage | | | | 1 | mV |
| $V_{IHCMR}$ | Common Mode Range | | GND+2.0 | | $V_{CC}$ | V |
| $V_{REF}$ | Reference Voltage | | $V_{CC}$-1.48 | $V_{CC}$-1.32 | $V_{CC}$-1.16 | V |

## LVTTL 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 |
|---|---|---|---|---|---|---|
| $V_{IH}$ | TTL Input HIGH Voltage | | 2.0 | | | V |
| $V_{IL}$ | TTL Input LOW Voltage | | | | 0.8 | V |
| $I_{IH}$ | TTL Input HIGH Current (/AUTORESET, JAM, LOS/SDSEL) | $V_{IN}$ = 2.7V<br>$V_{IN}$ = $V_{CC}$ | | | 20<br>100 | µA<br>µA |
| $I_{IL}$ | TTL Input LOW Current (/AUTORESET, JAM, LOS/SDSEL) | $V_{IN}$ = 0.5V | -0.3 | | | mA |
| $I_{IH}$ | TTL Input HIGH Current (RESET) | $V_{IN}$ = 2.7V<br>$V_{IN}$ = $V_{CC}$ | | | 200<br>300 | µA<br>µA |
| $I_{IL}$ | TTL Input LOW Current (RESET) | $V_{IN}$ = 0.5V | -0.05 | | | mA |
| $V_{OL}$ | TTL Output LOW Level | $I_{OL}$ = +20mA | | | 0.5 | V |

**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 rating 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. Thermal performance assumes the use of a 4-layer PCB. Exposed pad must be soldered (or equivalent) to the device's most negative potential on the PCB.

## AC Electrical Characteristics

$V_{CC}$ = 3.0V to 3.6V; $R_{LOAD}$ = 50Ω to $V_{CC}$–2V; $T_A$ = –40°C to +85°C.

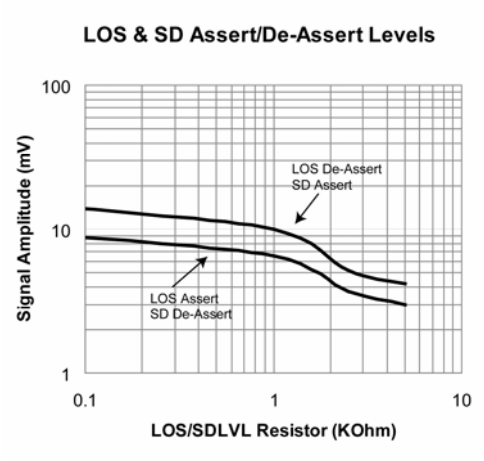
| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $t_r$, $t_f$ | Output Rise/Fall Time (20% to 80%) | Note 4 | | | 260 | ps |
| $t_{JAM_LH}$ | JAM Low to High Propagation Time | Note 12 | | | 5 | ns |
| $t_{JAM_HL}$ | JAM High to Low Propagation Time | Note 13 | | | 2 | ns |
| $t_{AUTORESET}$ | SD de-assert or LOS assert with Auto Reset enabled. | | 75 | 100 | 150 | ns |
| $t_{RESET}$ | RESET time constant | Note 5 | | | 5 | ns |
| $t_{ON}$ | SD Assert Time/LOS De-assert time | Note 9 | | | 5 | ns |
| $t_{JITTER}$ | Deterministic<br>Random | Note 6<br>Note 7 | | 15<br>5 | | $ps_{PP}$<br>$ps_{RMS}$ |
| $V_{ID}$ | Differential Input Voltage Swing | Figure 1 | 4 | | 1800 | $mV_{PP}$ |
| $V_{OD}$ | Differential Output Voltage Swing | $V_{ID} \geq 18mV_{PP}$ | | 1500 | | $mV_{PP}$ |
| $SD_{AL}$ /$LOS_{DL}$ | Low SD Assert/LOS De-assert Level | $R_{LOS/SDLVL}$ = 5kΩ, Note 8, 10 | | 4.2 | | $mV_{PP}$ |
| $SD_{DL}$/ $LOS_{AL}$ | Low SD De-assert/LOS Assert Level | $R_{LOS/SDLVL}$ = 5kΩ, Note 10 | | 3 | | $mV_{PP}$ |
| $HYS_L$ | Low SD/LOS Hysteresis | $R_{LOS/SDLVL}$ = 5kΩ, Note 11 | | 2.9 | | dB |
| $SD_{AM}$/ $LOS_{DM}$ | Medium SD Assert/LOS De-assert Level | $R_{LOS/SDLVL}$ = 2.5kΩ, Note 10 | | 5.2 | 12 | $mV_{PP}$ |
| $SD_{DM}$/ $LOS_{AM}$ | Medium SD De-assert/LOS Assert Level | $R_{LOS/SDLVL}$ = 2.5kΩ, Note 10 | 2.5 | 3.7 | | $mV_{PP}$ |
| $HYS_M$ | Medium SD/LOS Hysteresis | $R_{LOS/SDLVL}$ = 2.5kΩ, Note 11 | | 3 | | dB |
| $SD_{AH}$/ $LOS_{DH}$ | High SD Assert/LOS De-assert Level | $R_{LOS/SDLVL}$ = 50Ω, Note 10 | | 15 | 24 | $mV_{PP}$ |
| $SD_{DH}$/ $LOS_{AH}$ | High SD De-assert/ LOS Assert Level | $R_{LOS/SDLVL}$ = 50Ω, Note 10 | 6 | 9.5 | | $mV_{PP}$ |
| $HYS_H$ | High SD/LOS Hysteresis | $R_{LOS/SDLVL}$ = 50Ω, Note 11 | | 4 | | dB |
| $B_{-3dB}$ | 3dB Bandwidth | | | 1 | | GHz |
| $A_{V(Diff)}$ | Differential Voltage Gain | | | 48 | | dB |
| $S_{21}$ | Single-ended Small-Signal Gain | | | 42 | | dB |

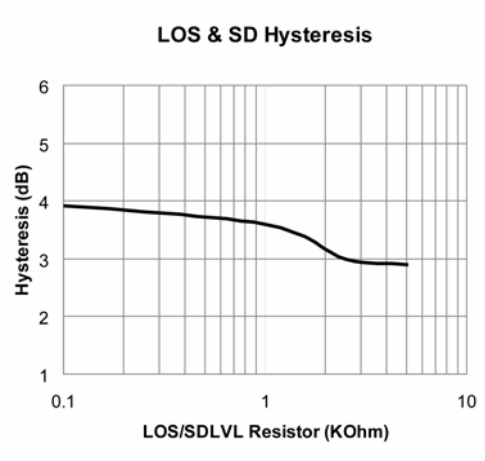
**Notes:**

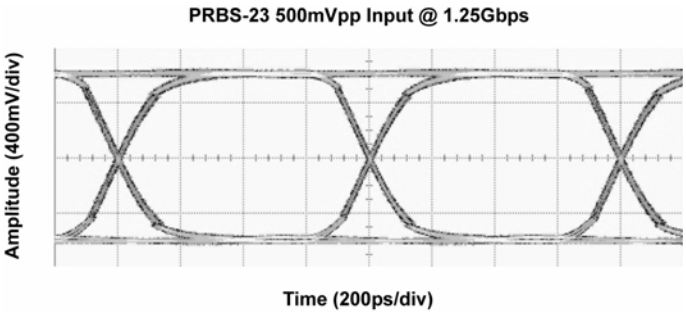
4. Amplifier in limiting mode. Input is a 200MHz square wave.
5. The time between applying RESET and outputs being disabled.
6. Deterministic jitter measured using 1.25Gbps K28.5 pattern, $V_{ID}$ = $10mV_{PP}$.
7. Random jitter measured using 1.25Gbps K28.7 pattern, $V_{ID}$ = $10mV_{PP}$.
8. SD is the opposite polarity of LOS. Therefore, an SD Assert parameter is equivalent to a LOS De-assert parameter and vice versa.
9. See “Typical Operating Characteristics” for graphs showing input signal vs. SD Assert/LOS De-assert time at various $R_{LOS/SDLVL}$ settings.
10. See “Typical Operating Characteristics” for a graph showing how to choose a particular $R_{LOS/SDLVL}$ for a particular assert and its associated de-assert amplitude.
11. This specification defines electrical hysteresis as 20log (SD Assert/SD De-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 2dB-5dB, shown in the AC characteristics table, will be: 1dB-4dB optical Hysteresis.
12. JAM Low to High transition propagation delay refers to the time it takes from a LOW to HIGH transition at JAM input to turning on (if SD is selected) or turning off (if LOS is selected) the LVPECL outputs.
13. JAM High to Low transition propagation delay refers to the time it takes from a HIGH to LOW transition at JAM input to turning off (if SD is selected) or turning on (if LOS is selected) the LVPECL outputs.

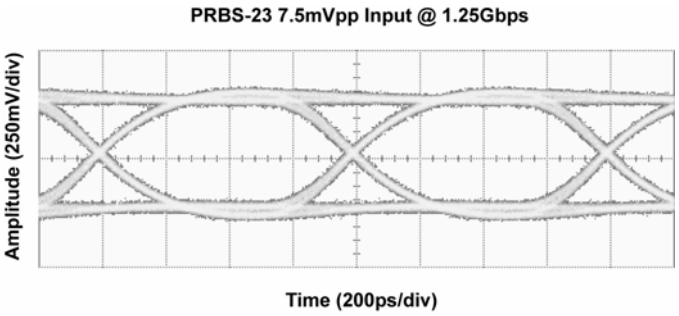
## Typical Operating Characteristics

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

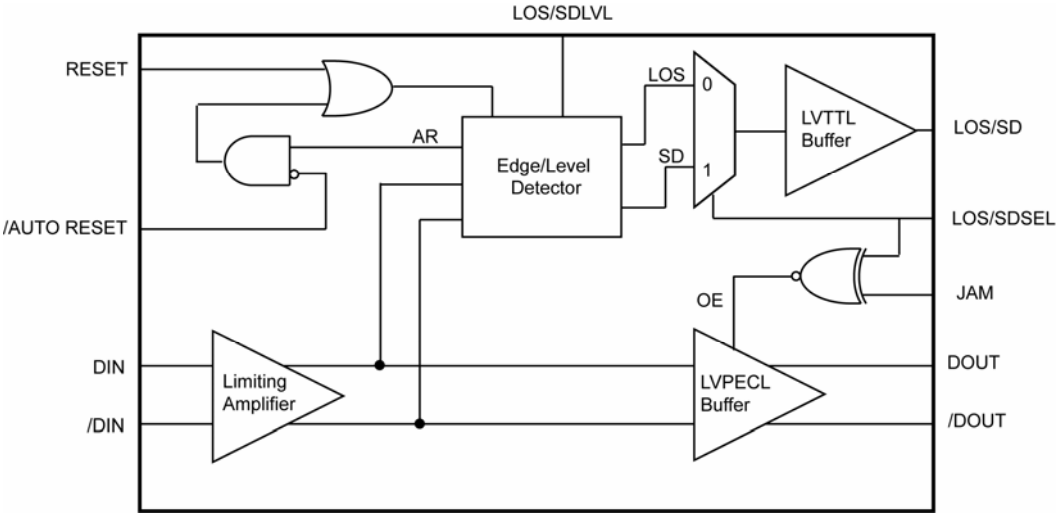


## Functional Block Diagram




## Detailed Description

The SY88149HL is a high-sensitivity limiting post amplifier which operates on a +3.3V power supply over the industrial temperature range. Signals with data rates up to 1.25Gbps and as small as 4mVpp can be amplified. Figure 1 shows the allowed input voltage swing. Depending upon the LOS/SDSEL option, the SY88149HL can generate an SD or LOS output, and allow feedback to the JAM input for output stability. LOS/$SD_{LVL}$ sets the sensitivity of the input amplitude detection.

To satisfy the stringent timing requirements of the GPON specifications, the signal detect circuit offers 5ns SD assert (LOS de-assert) time and the option to de-assert SD (assert LOS) using the /AUTORESET or manual RESET function. When /AUTORESET is enabled, SD de-asserts/LOS asserts automatically within 100ns after the last high-to-low transition of the input burst. When the /AUTORESET function is disabled, the SD De-assert/LOS Assert time can be reset by using the provided RESET pin.

### Input Buffer

Figure 2 shows a simplified schematic of the input stage. The high sensitivity of the input amplifier allows signals as small as 4mVpp to be detected and amplified. The input buffer can allow input signals as large as 1800$mV_{PP}$. Input signals are linearly amplified with a typically 48dB differential voltage gain until the outputs reach 1500$mV_{PP}$ (typ). Applications requiring the SY88149HL to operate with high-gain should have the upstream TIA placed as close as possible to the SY88149HL's input pins. This ensures the best performance of the device.

### Output Buffer

The SY88149HL's LVPECL output buffer is designed to drive 50Ω lines. The output buffer requires appropriate termination for proper operation. An external 50Ω resistor to $V_{CC}$–2V for each output pin provides this. Figure 3 shows a simplified schematic of the output stage.

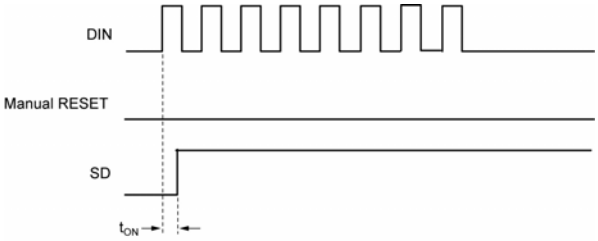
### Loss of Signal/Signal Detect

The SY88149HL generates a chatter-free Signal-Detect (SD) or LOS LVTTL output, as shown in Figure 4. A highly sensitive signal detect circuit is used to determine that 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 LOS/SDLVL and de-asserts low otherwise. SD asserts high if the input amplitude rises above the threshold set by LOS/SDLVL and de-asserts low otherwise. LOS/SD can be fed back to the JAM input to maintain output stability under the absence of an invalid signal condition. Typically, a 3 dB hysteresis is provided to prevent chattering.

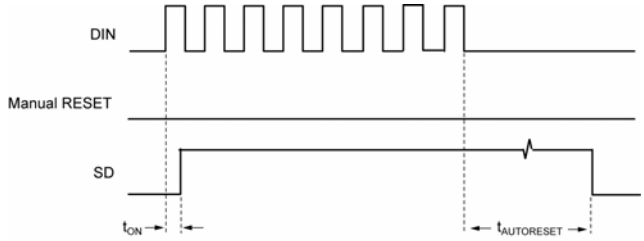
### LOS/SD Level Set

A programmable LOS/SD level set pin (LOS/$SD_{LVL}$) sets the threshold of the input amplitude detection. Connecting an external resistor between $V_{CC}$ and LOS/$SD_{LVL}$ sets the voltage at LOS/$SD_{LVL}$. This voltage ranges from $V_{CC}$ to $V_{REF}$. The external resistor creates a voltage divider between $V_{CC}$ and $V_{REF}$, as shown in Figure 5. Set the LOS/$SD_{LVL}$ voltage closer to $V_{REF}$ or more sensitive LOS/SD detection or closer to $V_{CC}$ for higher amplitude inputs.

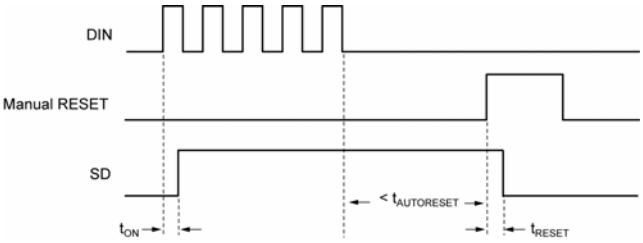
## Timing Diagrams



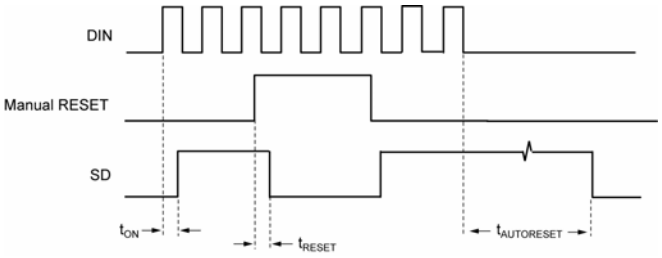

**a) No manual RESET & /AutoReset tied HIGH**




**b) No manual RESET & /AutoReset tied LOW**




**c) Manual RESET pulse & /AutoReset tied LOW**




**d) Manual RESET Pulse & /AutoReset tied LOW**

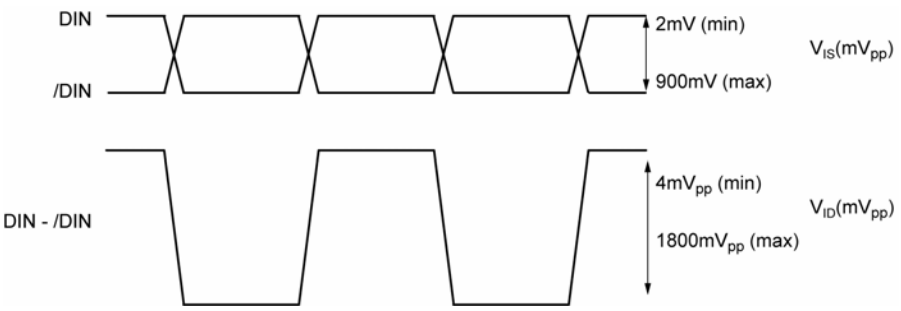



**Figure 1. VIS and VID Definition**

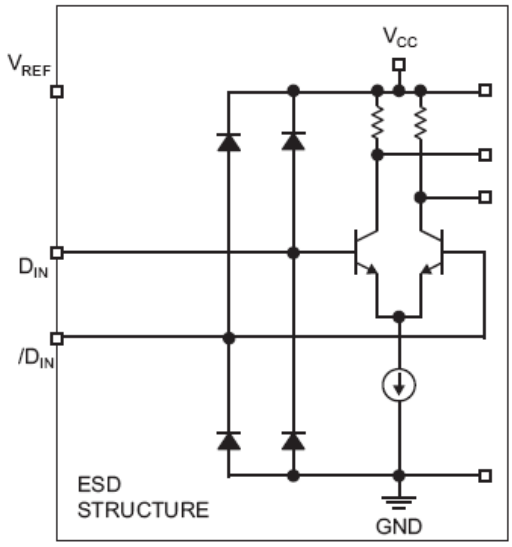



**Figure 2. Input Structure**

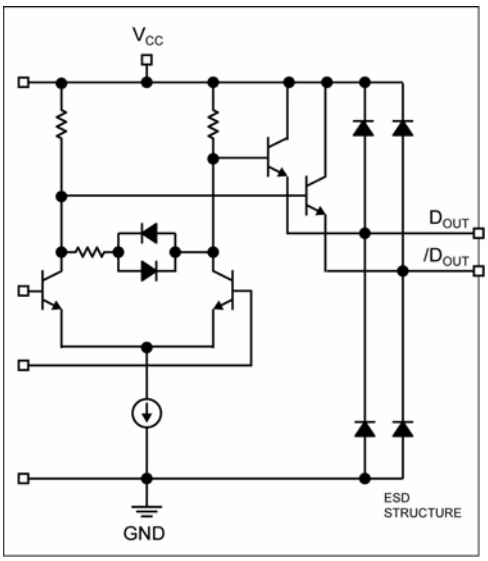



**Figure 3. Output Structure**

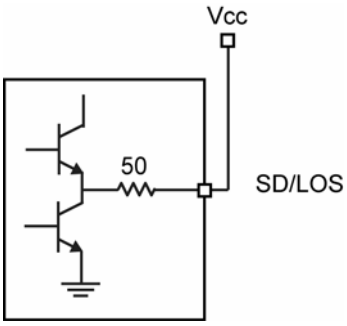



**Figure 4. SD Output Structure**

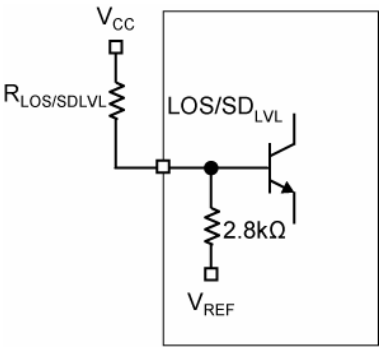
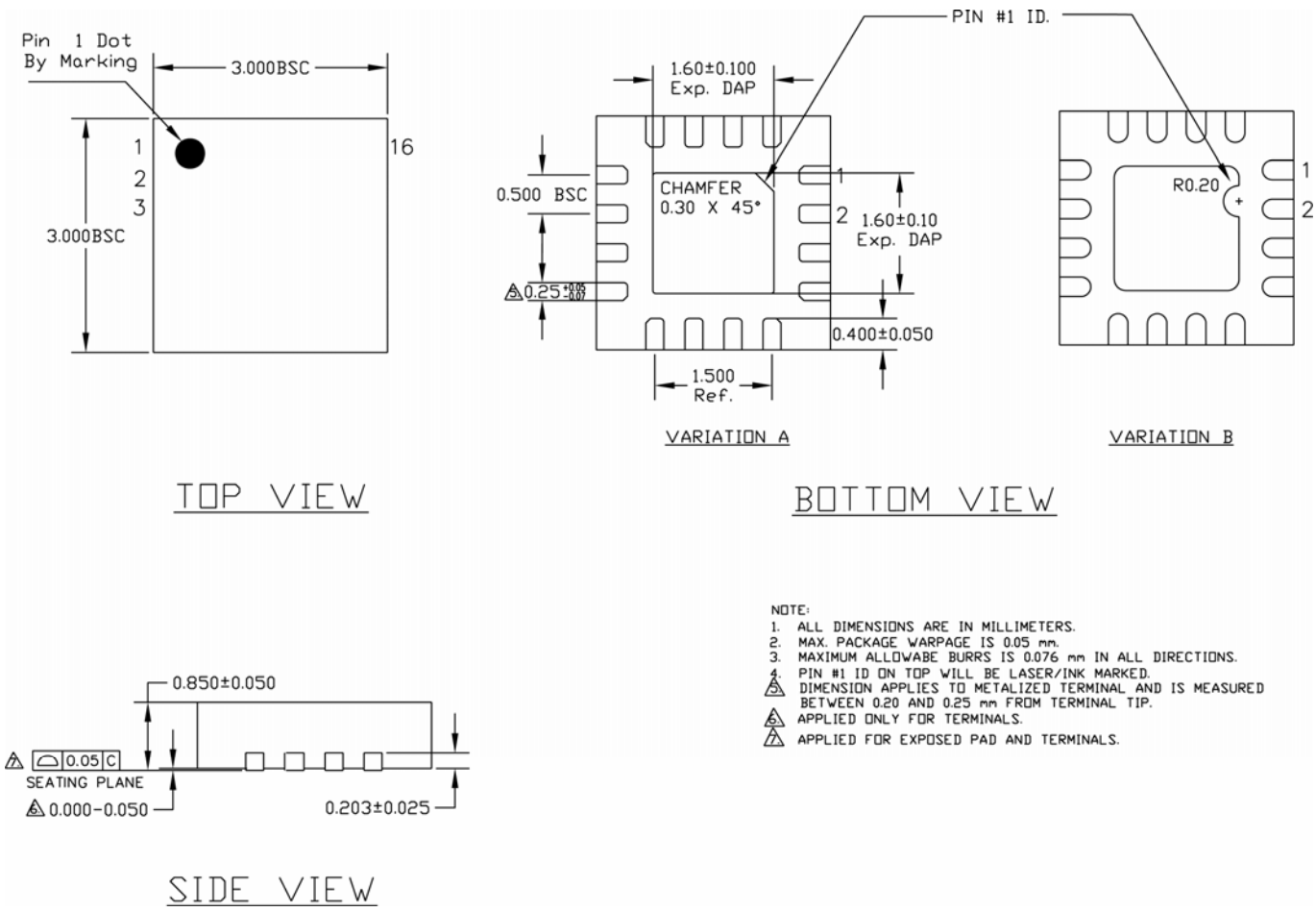



**Figure 5. LOS/SDLVL Setting Circuit**

## Related Product and Support Documentation

| Part Number | Function | Datasheet Link |
|---|---|---|
| SY88903AL | 3.3V, Burst Mode 1.25Gbps PECL High-Sensitivity Limiting Post Amplifier with TTL Loss-of-Signal | http://www.micrel.com/product-info/sy88903al.shtml |
| SY88149CL | 3.3V, 1.25Gbps PECL Limiting Post Amplifier w/High Gain TTL Signal Detect | http://www.micrel.com/product-info/sy88149cl.shtml |
| Application Notes | Notes on Sensitivity and Hysteresis in Micrel Post Amplifiers | http://www.micrel.com/product-info/app_hints+notes.shtml |

## Package Information




**16-Pin MLF® (MLF-16)**

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