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### General Description

The SY88149CL is a high-sensitivity limiting post amplifier designed for use in fiber-optic receivers. These devices connect to typical transimpedance amplifiers (TIAs). The linear signal output from TIAs can contain significant amounts of noise and may vary in amplitude over time. The SY88149CL quantizes these signals and outputs PECL level waveforms.

The SY88149CL operates from a single +3.3V power supply, over temperatures ranging from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . With its wide bandwidth and high gain, signals with data rates up to 1.25Gbps, and as small as  $5\text{mV}_{\text{pp}}$ , can be amplified to drive devices with PECL inputs.

The SY88149CL generates a high-gain signal-detect (SD) open-collector TTL output. The SD function has a high gain input stage for increased sensitivity. A programmable Signal Detect level set pin ( $\text{SD}_{\text{LVL}}$ ) sets the sensitivity of the input amplitude detection. SD asserts high if the input amplitude rises above the threshold set by  $\text{SD}_{\text{LVL}}$  and de-asserts low otherwise. The enable input (EN) de-asserts the true output signal without removing the input signal. The SD output can be fed back to the EN input to maintain output stability under a loss-of-signal condition. Typically, 3.4dB SD hysteresis is provided to prevent chattering.

All support documentation can be found on Micrel's web site at: [www.micrel.com](http://www.micrel.com).

### Features

- Single 3.3V power supply
- Fast SD enable/disable time
- 622Mbps to 1.25Gbps operation
- Low-noise PECL data outputs
- High-gain SD
- Chatter-free Open-Collector TTL signal detect (SD) output with internal 4.75k $\Omega$  pull-up resistor
- TTL EN input
- Programmable SD level set ( $\text{SD}_{\text{LVL}}$ )
- Available in a tiny 10-pin MSOP package

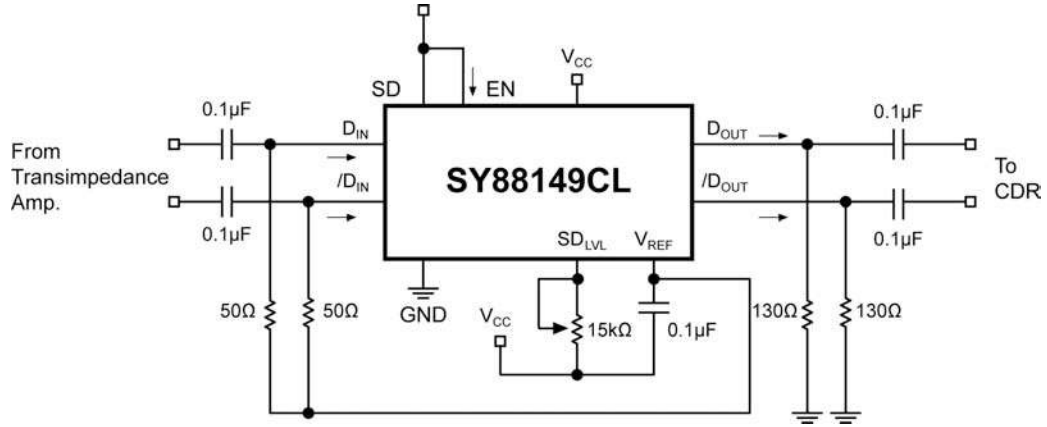
### Applications

- GE-PON/GPON/EPON
- Gigabit Ethernet
- 1062Mbps Fibre Channel
- OC-12/24 SONET/SDH
- High-gain line driver and line receiver
- Low-gain TIA interface

### Markets

- FTTH/FTTP
- Datacom/Telecom
- Optical transceiver

### Typical Application Circuit



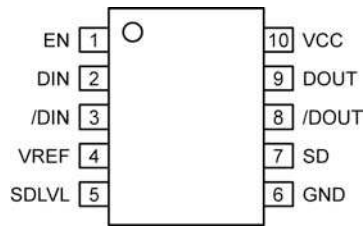
## Ordering Information<sup>(1)</sup>

| Part Number                  | Package Type | Operating Range | Package Marking                      | Lead Finish    |
|------------------------------|--------------|-----------------|--------------------------------------|----------------|
| SY88149CLKG                  | K10-1        | Industrial      | 149C with Pb-Free bar line indicator | NiPdAu Pb-Free |
| SY88149CLKGTR <sup>(1)</sup> | K10-1        | Industrial      | 149C with Pb-Free bar line indicator | NiPdAu Pb-Free |

**Note:**

1. Tape and Reel.

## Pin Configuration



10-Pin MSOP (K10-1)

## Pin Description

| Pin Number | Pin Name | Type   | Pin Function   |
|------------|----------|--|--|
| 1          | EN       | TTL Input: Default is HIGH.                                  | Enable: This input enables the outputs when it is HIGH. Note that this input is internally connected to a 25kΩ pull-up resistor and will default to a logic HIGH state if left open. |
| 2          | DIN      | Data Input   | True data input.   |
| 3          | /DIN     | Data Input   | Complementary data input.  |
| 4          | VREF     |  | Reference voltage: Placing a capacitor here to V <sub>CC</sub> helps stabilize SD <sub>LVL</sub> .   |
| 5          | SDLVL    | Input  | Signal Detect Level Set: a resistor from this pin to V <sub>CC</sub> sets the threshold for the data input amplitude at which SD will be asserted.                                   |
| 6          | GND      | Ground   | Device ground.   |
| 7          | SD       | Open-collector TTL output w/internal 4.75kΩ pull-up resistor | Signal-Detect asserts high when the data input amplitude rises above the threshold set by SD <sub>LVL</sub> .  |
| 8          | /DOUT    | PECL Output  | Complementary data output.   |
| 9          | DOUT     | PECL Output  | True data output.  |
| 10         | VCC      | Power Supply   | Positive power supply.   |

### Absolute Maximum Ratings<sup>(1)</sup>

Supply Voltage ( $V_{CC}$ ) ..... 0V to +7.0V  
 Input Voltage (DIN, /DIN) ..... 0 to  $V_{CC}$   
 Output Current ( $I_{OUT}$ )  
     Continuous .....  $\pm 50$ mA  
     Surge .....  $\pm 100$ mA  
 EN Voltage ..... 0 to  $V_{CC}$   
 $V_{REF}$  Current ..... -800 $\mu$ A to +500 $\mu$ A  
 $SD_{LVL}$  Voltage .....  $V_{REF}$  to  $V_{CC}$   
 Lead Temperature (soldering, 20sec.) ..... 260°C  
 Storage Temperature ( $T_s$ ) ..... -65°C to +150°C

### Operating Ratings<sup>(2)</sup>

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  
     MSOP ( $\theta_{JA}$ ) Still-air ..... 113°C/W

### DC Electrical Characteristics

$V_{CC} = 3.0$  to  $3.6$ V;  $R_L = 50\Omega$  to  $V_{CC}-2$ V;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , typical values at  $V_{CC} = 3.3$ V,  $T_A = 25^\circ\text{C}$ .

| Symbol      | Parameter                | Condition      | Min            | Typ            | Max            | Units |
|-------------|--------------------------|----------------|----------------|----------------|----------------|-------|
| $I_{CC}$    | Power Supply Current     | No output load |                | 26             | 39             | mA    |
| $SD_{LVL}$  | $SD_{LVL}$ Voltage       |                | $V_{REF}$      |                | $V_{CC}$       | V     |
| $V_{OH}$    | PECL Output HIGH Voltage |                | $V_{CC}-1.085$ | $V_{CC}-0.955$ | $V_{CC}-0.880$ | V     |
| $V_{OL}$    | PECL Output LOW Voltage  |                | $V_{CC}-1.830$ | $V_{CC}-1.705$ | $V_{CC}-1.555$ | V     |
| $V_{IHCMR}$ | 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     |

### TTL DC Electrical Characteristics

$V_{CC} = 3.0$  to  $3.6$ V;  $R_L = 50\Omega$  to  $V_{CC}-2$ V;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , typical values at  $V_{CC} = 3.3$ V,  $T_A = 25^\circ\text{C}$ .

| Symbol   | Parameter             | Condition   | Min        | Typ | Max       | Units              |
|----------|-----------------------|---|------------|-----|-----------|--------------------|
| $V_{IH}$ | EN Input HIGH Voltage |   | 2.0        |     |           | V                  |
| $V_{IL}$ | EN Input LOW Voltage  |   |            |     | 0.8       | V                  |
| $I_{IH}$ | EN Input HIGH Current | $V_{IN} = 2.7$ V<br>$V_{IN} = V_{CC}$   |            |     | 20<br>100 | $\mu$ A<br>$\mu$ A |
| $I_{IL}$ | EN Input LOW Current  | $V_{IN} = 0.5$ V  | -0.3       |     |           | mA                 |
| $V_{OH}$ | SD Output HIGH Level  | $V_{CC} \geq 3.3$ V, $I_{OH-MAX} < 160\mu$ A<br>$V_{CC} < 3.3$ V, $I_{OH-MAX} < 160\mu$ A | 2.4<br>2.0 |     |           | V<br>V             |
| $V_{OL}$ | SD Output LOW Level   | $I_{OL} = +2$ mA  |            |     | 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  $3.6V$ ;  $R_{LOAD} = 50\Omega$  to  $V_{CC}-2V$ ;  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ .

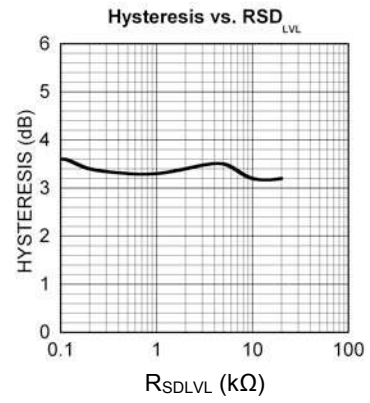
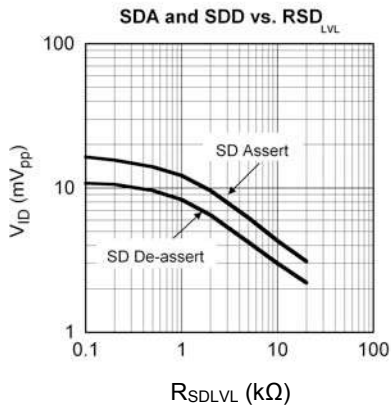
| Symbol        | Parameter                             | Condition                        | Min | Typ     | Max  | Units                                 |
|---------------|---------------------------------------|----------------------------------|-----|---------|------|---------------------------------------|
| $t_r, t_f$    | Output Rise/Fall Time<br>(20% to 80%) | Note 4                           |     |         | 260  | ps                                    |
| $t_{JITTER}$  | Deterministic<br>Random               | Note 5<br>Note 6                 |     | 15<br>5 |      | ps <sub>PP</sub><br>ps <sub>RMS</sub> |
| $V_{ID}$      | Differential Input Voltage Swing      | Figure 1                         | 5   |         | 1800 | mV <sub>PP</sub>                      |
| $V_{OD}$      | Differential Output Voltage Swing     | $V_{ID} \geq 18mV_{PP}$ Figure 1 |     | 1500    |      | mV <sub>PP</sub>                      |
| $T_{OFF}$     | SD Release Time                       |                                  |     | 100     | 500  | ns                                    |
| $T_{ON}$      | SD Assert Time                        |                                  |     | 100     | 500  | ns                                    |
| $SD_{AL}$     | Low SD Assert Level                   | $R_{SDLVL} = 15k\Omega$ , Note 8 |     | 3.4     |      | mV <sub>PP</sub>                      |
| $SD_{DL}$     | Low SD De-assert Level                | $R_{SDLVL} = 15k\Omega$ , Note 8 |     | 2.3     |      | mV <sub>PP</sub>                      |
| $HYS_L$       | Low SD Hysteresis                     | $R_{SDLVL} = 15k\Omega$ , Note 7 |     | 3.4     |      | dB                                    |
| $SD_{AM}$     | Medium SD Assert Level                | $R_{SDLVL} = 5k\Omega$ , Note 8  |     | 6.2     | 8    | mV <sub>PP</sub>                      |
| $SD_{DM}$     | Medium SD De-assert Level             | $R_{SDLVL} = 5k\Omega$ , Note 8  | 3   | 4.2     |      | mV <sub>PP</sub>                      |
| $HYS_M$       | Medium SD Hysteresis                  | $R_{SDLVL} = 5k\Omega$ , Note 7  | 2   | 3.4     | 5    | dB                                    |
| $SD_{AH}$     | High SD Assert Level                  | $R_{SDLVL} = 100\Omega$ , Note 8 |     | 16.4    | 20   | mV <sub>PP</sub>                      |
| $SD_{DH}$     | High SD De-assert Level               | $R_{SDLVL} = 100\Omega$ , Note 8 | 8   | 10.8    |      | mV <sub>PP</sub>                      |
| $HYS_H$       | High SD Hysteresis                    | $R_{SDLVL} = 100\Omega$ , Note 7 | 2   | 3.4     | 5    | dB                                    |
| $B_{-3dB}$    | 3dB Bandwidth                         |                                  |     | 1       |      | GHz                                   |
| $A_{V(Diff)}$ | Differential Voltage Gain             |                                  |     | 42      |      | dB                                    |
| $S_{21}$      | Single-ended Small-Signal Gain        |                                  |     | 36      |      | dB                                    |

### Notes:

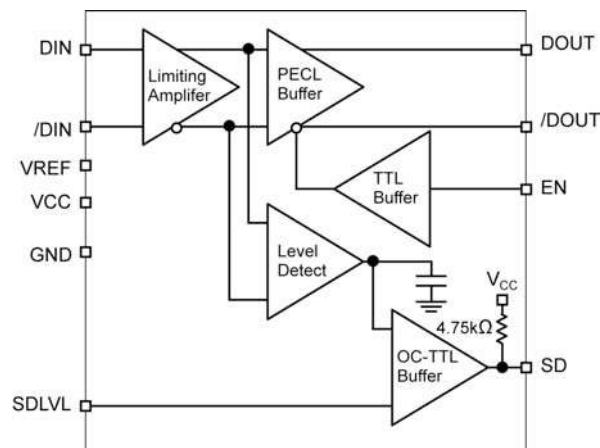
- Amplifier in limiting mode. Input is a 200MHz square wave.
- Deterministic jitter measured using 1.25Gbps K28.5 pattern,  $V_{ID} = 10mV_{PP}$ .
- Random jitter measured using 1.25Gbps K28.7 pattern,  $V_{ID} = 10mV_{PP}$ .
- This specification defines electrical hysteresis as  $20\log(SD \text{ Assert}/SD \text{ De-assert})$ . 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.
- See "Typical Operating Characteristics" for a graph showing how to choose a particular  $R_{SDLVL}$  for a particular SD assert and its associated de-assert amplitude.

### Typical Operating Characteristics

$V_{CC} = 3.3V$ ,  $T_A = 25^\circ C$ ,  $R_L = 50\Omega$  to  $V_{CC}-2V$ , unless otherwise stated.



## Functional Block Diagram



### Detailed Description

The SY88149CL high-sensitivity limiting post amplifier operates from a single +3.3V power supply, over temperatures from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ . Signals with data rates up to 1.25Gbps and as small as  $5\text{mV}_{\text{PP}}$  can be amplified. Figure 1 shows the allowed input voltage swing. The SY88149CL generates an SD output, allowing feedback to EN for output stability.  $\text{SD}_{\text{LVL}}$  sets the sensitivity of the input amplitude detection.

### Input Amplifier/Buffer

Figure 2 shows a simplified schematic of the input stage. The high-sensitivity of the input amplifier allows signals as small as  $5\text{mV}_{\text{PP}}$  to be detected and amplified. The input amplifier allows input signals as large as  $1800\text{mV}_{\text{PP}}$ . Input signals are linearly amplified with a typically 42dB differential voltage gain. Since it is a limiting amplifier, the SY88149CL outputs typically  $1500\text{mV}_{\text{PP}}$  voltage-limited waveforms for input signals that are greater than  $12\text{mV}_{\text{PP}}$ . Applications requiring the SY88149CL to operate with high-gain should have the upstream TIA placed as close as possible to the SY88149CL's input pins. This ensures the best performance of the device.

### Output Buffer

The SY88149CL's PECL output buffer is designed to drive  $50\Omega$  lines. The output buffer requires appropriate termination for proper operation. An external  $50\Omega$  resistor to  $V_{\text{CC}}-2\text{V}$  for each output pin provides this. Figure 3 shows a simplified schematic of the output stage.

### Signal Detect

The SY88149CL generates a chatter-free Signal-Detect (SD) open-collector TTL output with internal  $4.75\text{k}\Omega$  pull-up resistor, as shown in Figure 4. SD is used to determine that the input amplitude is too small to be considered a valid input. SD asserts high if the input amplitude rises above threshold set by  $\text{SD}_{\text{LVL}}$  and de-asserts low otherwise. SD can be fed back to the enable (EN) input to maintain output stability under a SDs of signal condition. EN de-asserts low the true output signal without removing the input signals. Typically, 3.4dB SD hysteresis is provided to prevent chattering.

### Signal Detect Level Set

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

### Hysteresis

The SY88149CL provides typically 3.4dB SD electrical hysteresis. By definition, a power ratio measured in dB is  $10\log(\text{power ratio})$ . Power is calculated as  $V_{\text{IN}}^2/R$  for an electrical signal. Hence the same ratio can be stated as  $20\log(\text{voltage ratio})$ . While in linear mode, the electrical voltage input changes linearly with the optical power and hence the ratios change linearly. Therefore, the optical hysteresis in dB is half the electrical hysteresis in dB given in the data sheet. The SY88149CL is an electrical device; this data sheet refers to hysteresis in electrical terms. With 3.4dB SD hysteresis, a voltage factor of 1.5 is required to assert or de-assert SD.

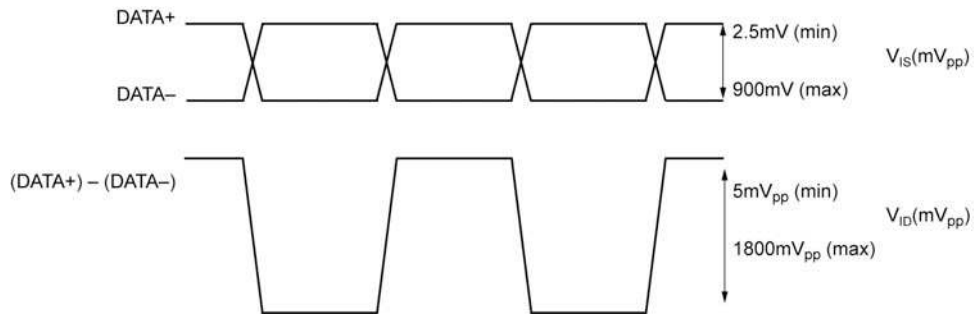


Figure 1. VIS and VID Definition

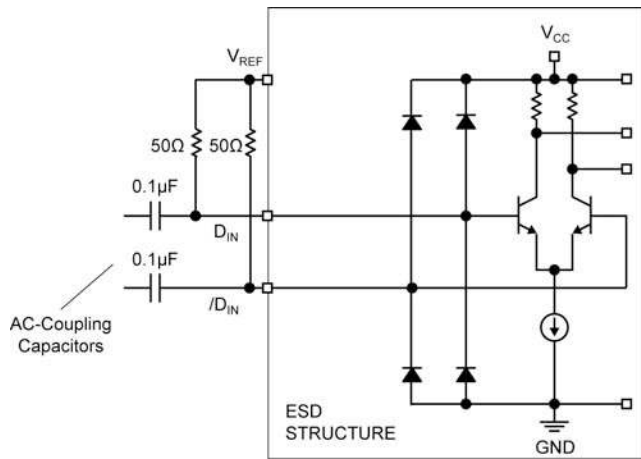


Figure 2. Input Structure

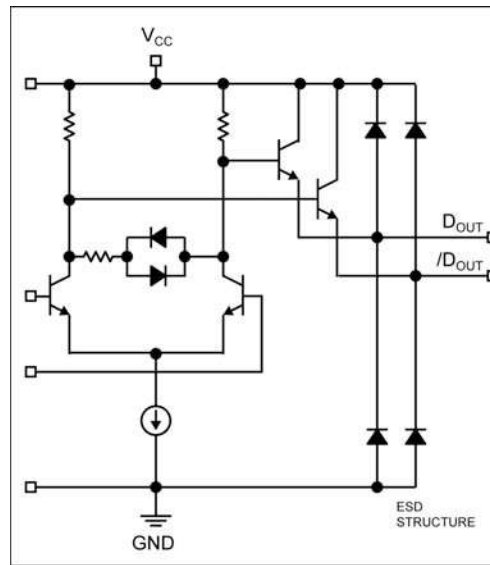


Figure 3. Output Structure

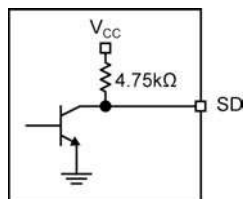


Figure 4. SD Output Structure

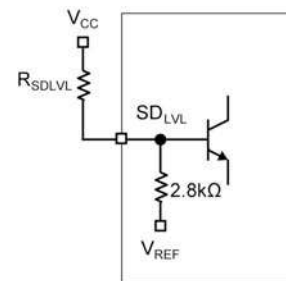


Figure 5. SD<sub>LVL</sub> Setting Circuit

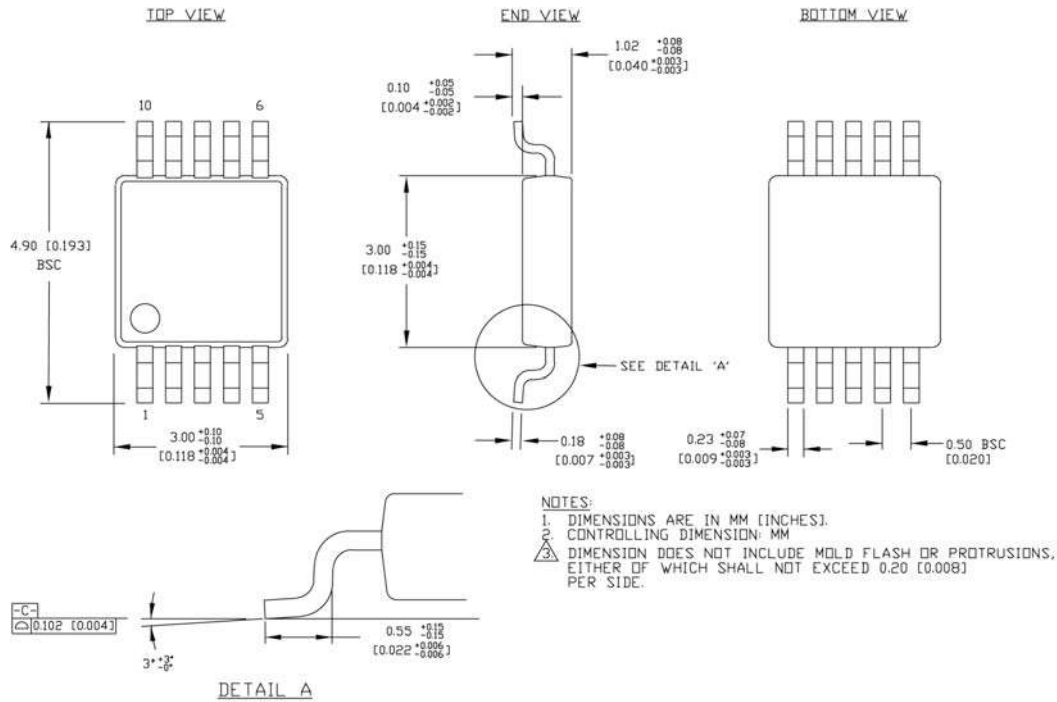
Note: Recommended value for  $R_{SDLVL}$  is 15kΩ or less.



**Related Product and Support Documentation**

| <b>Part Number</b> | <b>Function</b>  | <b>Data Sheet Link</b>  |
|--------------------|--|---|
| SY88933AL          | 3.3V/5V 1.25Gbps PECL High-Sensitivity Limiting Post Amplifier with TTL SD | <a href="http://www.micrel.com/product-info/sy88933al.shtml">http://www.micrel.com/product-info/sy88933al.shtml</a>             |
| Application Notes  | Notes on Sensitivity and Hysteresis in Micrel Post Amplifiers              | <a href="http://www.micrel.com/product-info/app_hints+notes.shtml">http://www.micrel.com/product-info/app_hints+notes.shtml</a> |

**Package Information**



Rev. 00

**10-Pin MSOP (K10-1)**

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