# SY88993AL

## 3.3V 3.2Gbps High-Speed Limiting Post Amplifier with High Input Sensitivity

## General Description

The SY88993AL limiting post amplifier, with its wide bandwidth, is ideal for use as a post amplifier in fiber-optic receivers with data rates up to 3.2Gbps. Signals as small as $4mV_{PP}$ can be amplified to drive devices with CML inputs or AC-coupled PECL inputs. The SY88993AL generates a chatter-free Loss-of-Signal (LOS) open collector TTL output using an external resistor, as shown Figure 1.

The SY88993AL incorporates a programmable level detect function to identify when the input signal has been lost. This information can be fed back to the /EN input of the device to maintain stability under loss of signal conditions. Using $LOS_{LVL}$ pin the sensitivity of the level detect can be adjusted. The $LOS_{LVL}$ voltage can be set by connecting a resistor divider between $V_{CC}$ and $V_{REF}$, Figure 5.

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

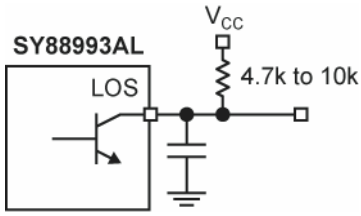



**Figure 1. $LOS_{LVL}$ resistor configuration**

## Features

- Up to 3.2Gbps operation
- Low noise CML data outputs
- Chatter-Free LOS generation
- Open Collector TTL LOS output
- TTL /EN Input
- Differential PECL inputs for data
- Single 3.3V power supply
- Available in a tiny 10-pin (3mm x 3mm) MSOP

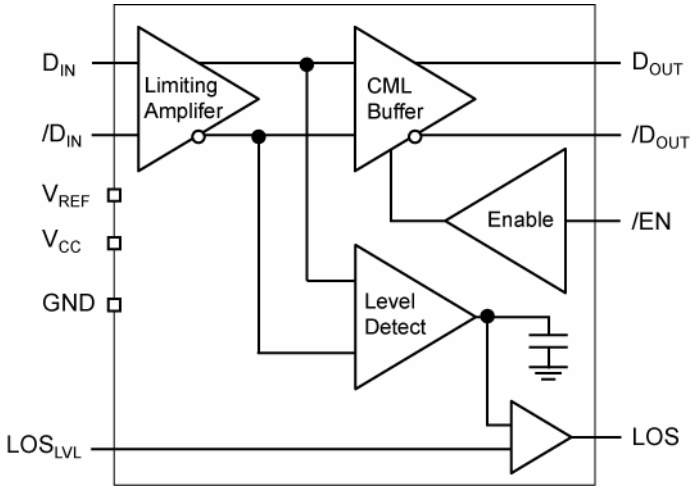
## Applications

- PON
- SFP/SFF/GBIC optical transceivers
- Gigabit Ethernet
- 1X and 2X Fibre Channel
- SONET/SDH: OC 3/12/24/48 – STM 1/4/8/16
- Line driver and line receiver

## Markets

- FTTX
- Datacom/Telecom

## Block Diagram




## Detailed Description

The SY88993AL is a high-sensitivity limiting post amplifier that operates from a single +3.3V power supply, over temperatures from –40°C to +85°C. Signals with data rates up to 3.2Gbps and as small as 4mV$_{PP}$ can be amplified. Figure 2 shows the allowed input voltage swing. The SY88993AL generates a LOS output. $LOS_{LVL}$ sets the sensitivity of the input amplitude detection.

### Input Amplifier/Buffer

Figure 3 shows a simplified schematic of the SY88993AL's input stage. The high-sensitivity of the input amplifier allows signals as small as 4mV$_{PP}$ to be detected and amplified. The input amplifier also allows input signals as large as 1800mV$_{PP}$. Input signals below 6mVpp are linearly amplified with a typical 38dB differential voltage gain. Since it is a limiting amplifier, the SY88993AL outputs typically 800mV$_{PP}$ voltage-limited waveforms for input signals that are greater than 10mV$_{PP}$. Applications requiring the SY88993AL to operate with high-gain should have the upstream TIA placed as close as possible to the SY88993AL's input pins to ensure the best performance of the device.

### Output Buffer

The SY88993AL's CML output buffer is designed to drive 50Ω lines. The output buffer requires appropriate termination for proper operation. An external 50Ω resistor to $V_{CC}$ for each output pin provides this. Figure 4 shows a simplified schematic of the output stage.

### Loss-of-Signal

The SY88993AL generates a chatter-free LOS open-collector TTL output which requires an external pull-up resistor, as shown in Figure 1. LOS is used to determine that the input amplitude is large enough to be considered a valid input. LOS asserts high if the input amplitude falls below the threshold sets by $LOS_{LVL}$ and de-asserts low otherwise. LOS can be fed back to the enable bar (/EN) input to maintain output stability under a loss of signal condition. /EN de-asserts the true output signal without removing the input signals. Typically, 5.6dB LOS hysteresis is provided to prevent chattering.

### Loss-of-Signal Level Set

The SY88993AL incorporates a programmable level detect function to identify when the input signal has been lost. This information can be fed back to the /EN input of the device to maintain stability under loss of signal conditions. Using $LOS_{LVL}$ pin the sensitivity of the level detect can be adjusted. The $LOS_{LVL}$ voltage can be set by connection a resistor divider between $V_{CC}$ and $V_{REF}$, Figure 5.

### Hysteresis

The SY88993AL typically provides 5.6dB LOS electrical hysteresis. By definition, a power ratio measured in dB is 10log (power ratio). Power is calculated as $V^2_{IN}/R$ for an electrical signal. Hence, the same ratio can be stated as 20log (voltage ratio). While in linear mode, the electrical voltage input changes linearly with the optical power and therefore, the ratios change linearly. Thus, the optical hysteresis in dB is half the electrical hysteresis in dB given in the data sheet. Since the SY88993AL is an electrical device, this data sheet refers to hysteresis in electrical terms. With 5.6dB LOS hysteresis, a voltage factor of about 2 is required to assert or de-assert LOS.

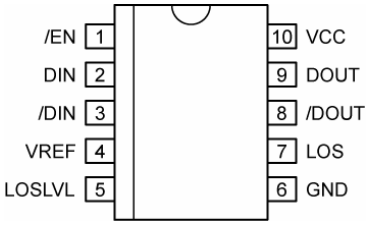
## Ordering Information

| Part Number | Package Type | Operating Range | Package Marking | Lead Finish |
|---|---|---|---|---|
| SY88993ALKG | K10-1 | Industrial | 993L with Pb-Free bar-line indicator | Pb-Free NiPdAu |
| SY88993ALKGTR[1] | K10-1 | Industrial | 993L with Pb-Free bar-line indicator | Pb-Free NiPdAu |

**Note:**

1. Tape and reel.

## Pin Configuration




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

## Pin Description

| Pin Number | Pin Name | Pin Function |
|---|---|---|
| 1 | /EN | TTL (Input): Output enable (Active Low). |
| 2 | DIN | Data (Input): Data input. |
| 3 | /DIN | Data (Input): Complementary data input. |
| 4 | VREF | Output: Reference voltage output for LOS Level Set (See Figure 3). |
| 5 | LOSLVL | Input: Loss-of-Signal Level Set |
| 6 | GND | Ground. |
| 7 | LOS | TTL Output (Open Collector): Loss-of-Signal indicator (Active High). |
| 8 | /DOUT | CML (Output): Inverting data output. |
| 9 | DOUT | CML (Output): Data output. |
| 10 | VCC | Power Supply: Positive power supply. |

## Absolute Maximum Ratings[1]

Supply Voltage ($V_{CC}$) ..... 0V to +4.0V
Input Voltage (DIN, /DIN) ..... 0V to $V_{CC}$
Lead Temperature (soldering, #sec.) ..... 260°C
Storage Temperature ($T_s$) ..... –55°C to +85°C

## Operating Ratings[2]

Supply Voltage ($V_{IN}$) ..... +3.0V to +3.6V
Ambient Temperature ($T_A$) ..... –40°C to +85°C
Junction Thermal Resistance
MSOP ($\theta_{JA}$) ..... 113°C/W
MSOP ($\psi_{JB}$) ..... 96°C/W

## DC Electrical Characteristics

$V_{CC}$ = +3.3V ±10%; $R_{LOAD}$ = 50Ω to $V_{CC}$; $T_A$ = -40°C to +85°C, unless noted. Typical values at Vcc = 3.3V, $T_A$ = 25°C

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $I_{CC}$ | Power Supply Current | No output load. | | 40 | 55 | mA |
| $I_{OH}$ | LOS Output Leakage | $V_{cc}$ = 3.6V | | | 100 | µA |
| $LOS_{LVL}$ | LOSLVL Level | | $V_{REF}$ | | $V_{CC}$ | V |
| $V_{OH}$ | Output HIGH Voltage | | $V_{CC}$–20 | $V_{CC}$–5 | $V_{CC}$ | mV |
| $V_{OL}$ | Output LOW Voltage | Note 9 | Vcc-350 | $V_{CC}$–400 | Vcc-475 | mV |
| $Z_O$ | Single-Ended Output Impedance | Note 10 | 40 | 50 | 60 | Ω |
| $V_{REF}$ | Reference Voltage | | $V_{CC}$–1.38 | $V_{CC}$–1.32 | $V_{CC}$–1.26 | V |
| $V_{OFFSEST}$ | Differential Output Offset | | | | ±80 | mV |
| $V_{CMR}$ | Common Mode Range | | GND ±2 | | $V_{CC}$–0.2 | V |

## TTL DC Electrical Characteristics

$V_{CC}$ = +3.3V ±10%; $R_{LOAD}$ = 50Ω to $V_{CC}$; $T_A$ = -40°C to +85°C, unless noted.

| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{IH}$ | /EN Input HIGH Voltage | | 2.0 | | | |
| $V_{IL}$ | /EN Input LOW Voltage | | | | 0.8 | V |
| $I_{IH}$ | /EN Input HIGH Current | $V_{IN}$ = 2.7V<br>$V_{IN}$ = $V_{CC}$ | | | 20<br>100 | µA<br>µA |
| $I_{IL}$ | /EN Input LOW Current | $V_{IN}$ = 0.5V | -300 | | | µA |

**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.

## AC Electrical Characteristics

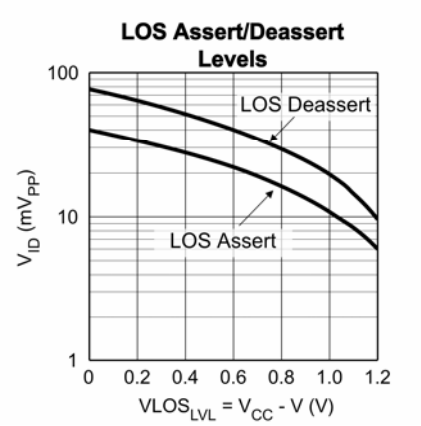
$V_{CC}$ = +3.3V ±10%; $R_{LOAD}$ = 50Ω to $V_{CC}$; $T_A$ = -40°C to +85°C, unless noted.

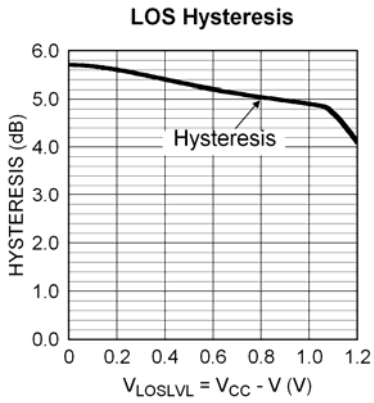
| Symbol | Parameter | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $LOS_{AH}$ | High LOS Assert Level | $V_{LOSLVL} = V_{CC}$ | 30 | 43 | | $mV_{PP}$ |
| $LOS_{DH}$ | High LOS De-assert Level | $V_{LOSLVL} = V_{CC}$ | | 83 | 95 | $mV_{PP}$ |
| $HYS_H$ | High LOS Hysteresis | | 2 | 5.6 | 8 | dB |
| $LOS_{AM}$ | Medium LOS Assert Level | $V_{LOSLVL} = V_{CC} - 400mV$ | 20 | 31 | | $mV_{PP}$ |
| $LOS_{DM}$ | Medium LOS De-assert Level | $V_{LOSLVL} = V_{CC} - 400mV$ | | 55 | 65 | $mV_{PP}$ |
| $HYS_M$ | Medium LOS Hysteresis | | 2 | 5.6 | 8 | dB |
| $LOS_{AL}$ | Low LOS Assert Level | $V_{LOSLVL} = V_{CC} - 800mV$ | 10 | 19 | | $mV_{PP}$ |
| $LOS_{DL}$ | Low LOS De-assert Level | $V_{LOSLVL} = V_{CC} - 800mV$ | | 31 | 45 | $mV_{PP}$ |
| $HYS_L$ | Low LOS Hysteresis | | 2 | 5.6 | 8 | dB |
| PSRR | Power Supply Rejection Ratio | Note 4 | | 35 | | dB |
| $t_{OFFL}$ | LOS Release Time Minimum Input | Note 5 | | 0.1 | 0.5 | µs |
| $t_{OFFH}$ | LOS Release Time Maximum Input | Note 5 | | 0.1 | 0.5 | µs |
| $t_{ONL}$ | LOS Assert Time | Note 5 | | 0.2 | 0.5 | µs |
| $t_r$, $t_f$ | Differential Output Rise/Fall Time (20% to 80%) | Note 6 | | 60 | 120 | Ps |
| $V_{ID}$ | Input Voltage Range | | 4 | | 1800 | $mV_{PP}$ |
| $V_{OD}$ | Differential Output Voltage Swing | Note 7, 8, 9, 10 | 700 | 800 | 950 | $mV_{PP}$ |
| $V_{SR}$ | LOS Sensitivity Range | | 4 | | 50 | $mV_{PP}$ |
| $A_{V(Diff)}$ | Differential Voltage Gain | | | 38 | | DB |
| $B_{-3dB}$ | 3dB Bandwidth | | | 2.5 | | GHz |
| $S_{21}$ | Single-Ended Small Signal-Gain | | 26 | 32 | | dB |

**Notes:**

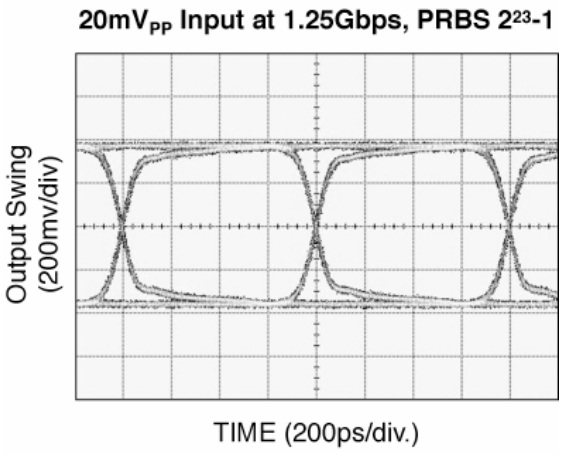
4. Input referred noise = RMS output noise/low frequency gain. Input referred, 55MHz.
5. Input is a 200MHz square wave, tr < 300ps.
6. With input signal $V_{ID}$ > $50mV_{PP}$ with 50Ω load.
7. Input is a 200MHz square wave, tr < 300ps, 50Ω load.
8. VID > 10mVPP.
9. Output levels are based on 50Ω impedance. If the load impedance is different, the output level will be changed.
10. See output structure.

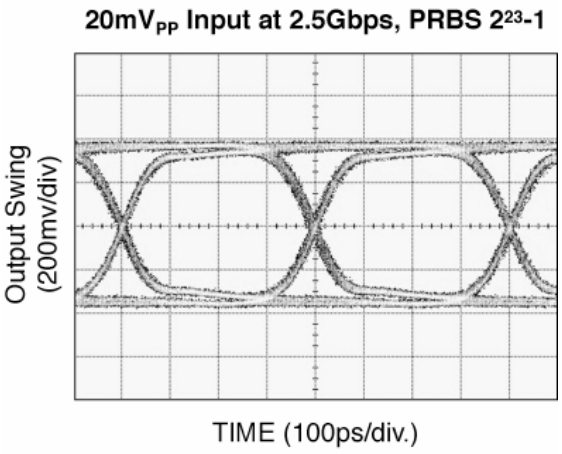
## Typical Characteristics

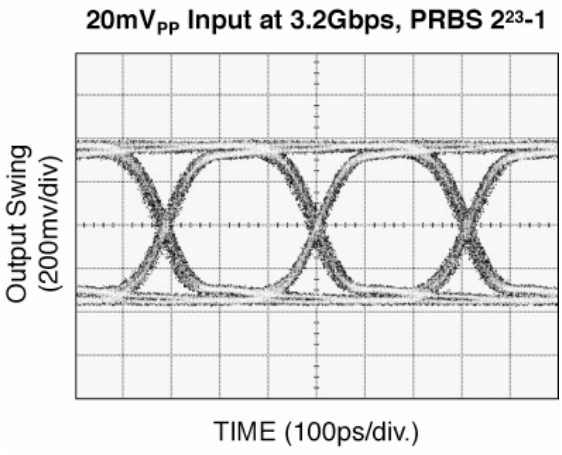


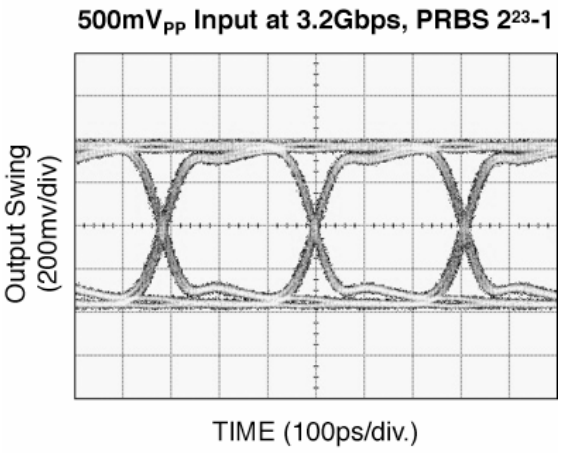




## Functional Characteristics



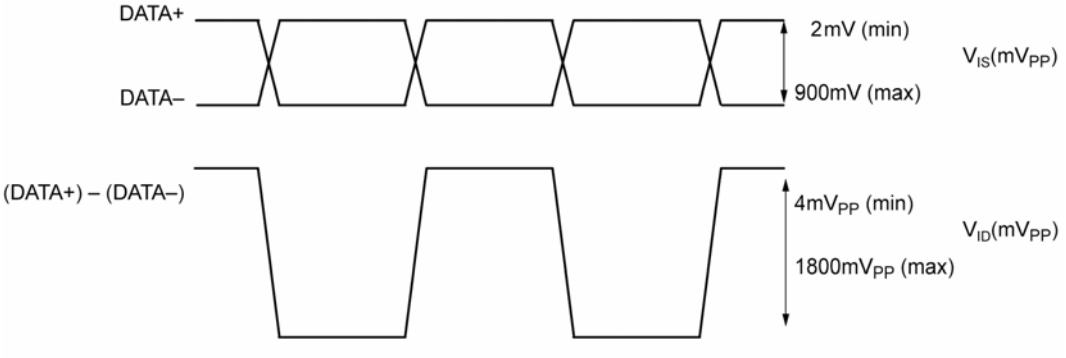



**Figure 2. $V_{IS}$ and $V_{ID}$**

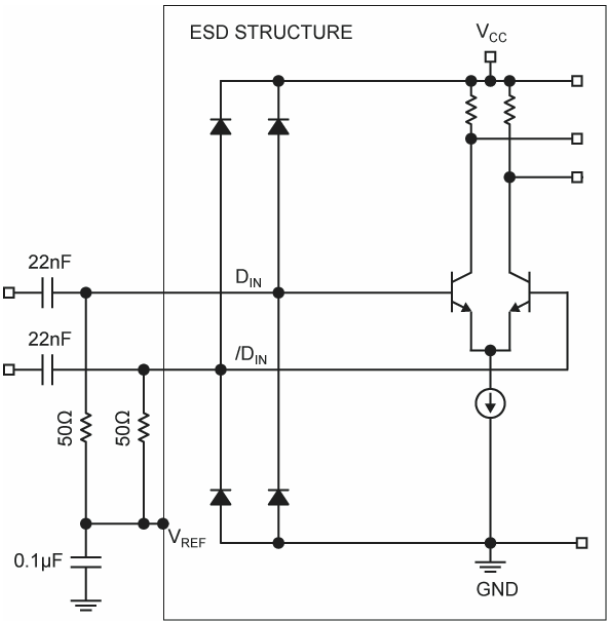



**Figure 3. Differential Input Configuration**

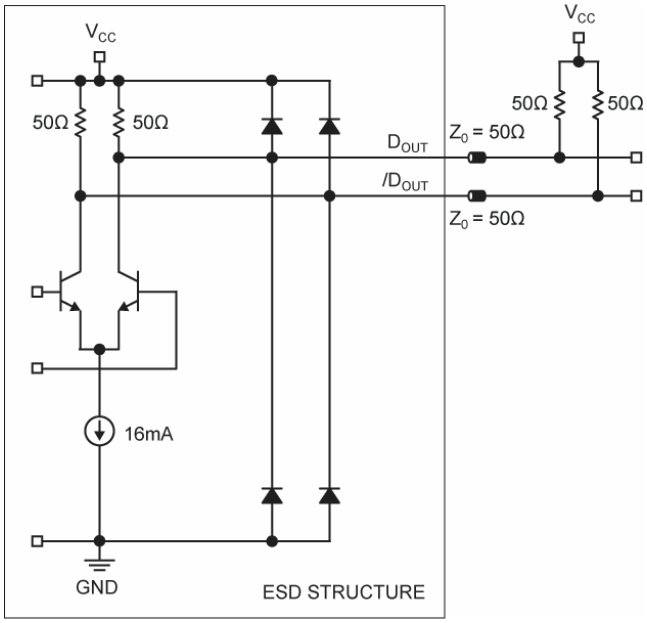



**Figure 4. Differential Output Configuration**

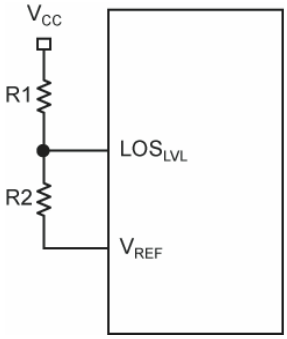
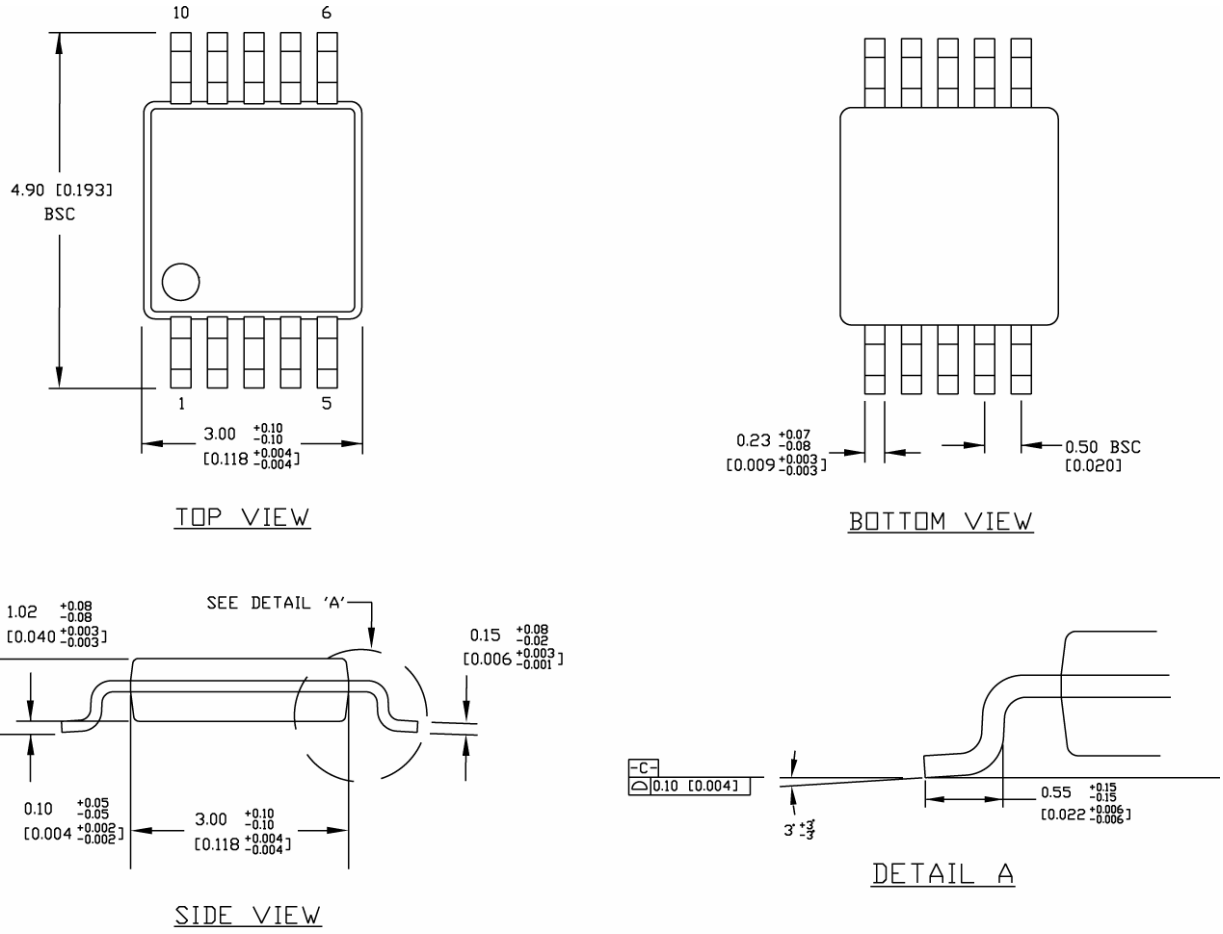



**Figure 5. LOSLVL Circuit**

**Notes:**

1. Resistor Divider = R2/ (R1 + R2)
2. R1 + R2 ≥ 5kΩ

## Package Information




NOTES:
1. DIMENSIONS ARE IN MM [INCHES].
2. CONTROLLING DIMENSION: MM
3. DIMENSION DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS, EITHER OF WHICH SHALL NOT EXCEED 0.20 [0.008] PER SIDE.

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

**MICREL, INC. 2180 FORTUNE DRIVE SAN JOSE, CA 95131 USA**
TEL +1 (408) 944-0800 FAX +1 (408) 474-1000 WEB http://www.micrel.com

Общество с ограниченной ответственностью «МосЧип» ИНН 7719860671 / КПП 771901001
Адрес: 105318, г.Москва, ул.Щербаковская д.3, офис 1107

**Данный компонент на территории Российской Федерации**

**Вы можете приобрести в компании MosChip.**

Для оперативного оформления запроса Вам необходимо перейти по данной ссылке:

http://moschip.ru/get-element

Вы можете разместить у нас заказ для любого Вашего проекта, будь то серийное производство или разработка единичного прибора.

В нашем ассортименте представлены ведущие мировые производители активных и пассивных электронных компонентов.

Нашей специализацией является поставка электронной компонентной базы двойного назначения, продукции таких производителей как XILINX, Intel (ex.ALTERA), Vicor, Microchip, Texas Instruments, Analog Devices, Mini-Circuits, Amphenol, Glenair.

Сотрудничество с глобальными дистрибьюторами электронных компонентов, предоставляет возможность заказывать и получать с международных складов практически любой перечень компонентов в оптимальные для Вас сроки.

На всех этапах разработки и производства наши партнеры могут получить квалифицированную поддержку опытных инженеров.

Система менеджмента качества компании отвечает требованиям в соответствии с ГОСТ Р ИСО 9001, ГОСТ РВ 0015-002 и ЭС РД 009

**Офис по работе с юридическими лицами:**

105318, г.Москва, ул.Щербаковская д.3, офис 1107, 1118, ДЦ «Щербаковский»

Телефон: +7 495 668-12-70 (многоканальный)

Факс: +7 495 668-12-70 (доб.304)

E-mail: info@moschip.ru

Skype отдела продаж:
moschip.ru
moschip.ru_4
moschip.ru_6
moschip.ru_9