

## FEATURES

- > 3.2Gbps operation
- 3.3V or 5V power supply option
- Low noise CML data outputs
- Chatter-Free LOS generation
- Open Collector TTL LOS output
- TTL /EN Input
- Differential PECL inputs for data
- Single power supply
- Available in a tiny 10-pin (3mm) MSOP

## APPLICATIONS

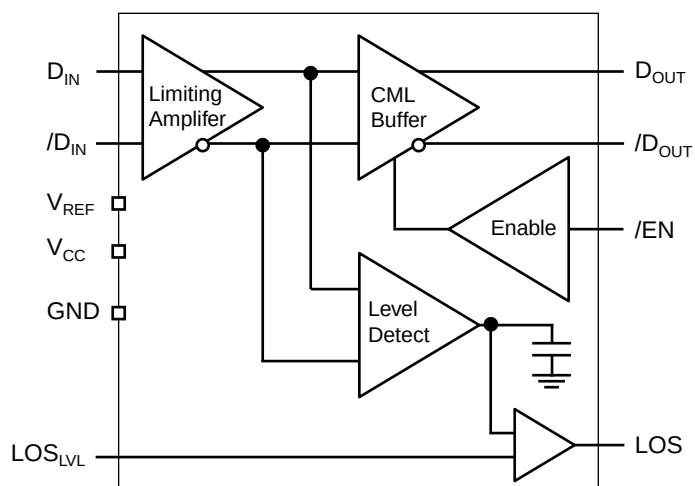
- 1.25Gbps Gigabit Ethernet
- 531Mbps and 1062Mbps Fibre Channel
- 622Mbps SONET
- Gigabit interface converter
- 2.5Gbps SDH/SONET

## DESCRIPTION

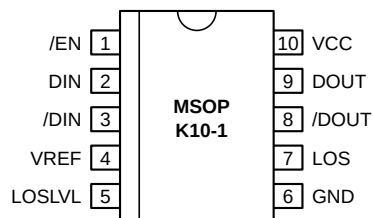
The SY88993V limiting post amplifier with its high and wide bandwidth is ideal for use as a post amplifier in fiber-optic receivers with data rates up to 3.2Gbps. Signals as small as  $4\text{mV}_{\text{PP}}$  can be amplified to drive devices with CML inputs. The SY88993V generates a chatter-free Loss of Signal (LOS) open collector TTL output.

The SY88993V 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  $\text{LOS}_{\text{LVL}}$  pin the sensitivity of the level detect can be adjusted. The  $\text{LOS}_{\text{LVL}}$  voltage can be set by connecting a resistor divider between  $V_{\text{CC}}$  and  $V_{\text{REF}}$ , Figure 2.

## BLOCK DIAGRAM



## PACKAGE/ORDERING INFORMATION



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

## Ordering Information

| Part Number                 | Package Type | Operating Range | Package Marking                      | Lead Finish    |
|-----------------------------|--------------|-----------------|--------------------------------------|----------------|
| SY88993VKC                  | K10-1        | Commercial      | 993V                                 | Sn-Pb          |
| SY88993VKCTR <sup>(1)</sup> | K10-1        | Commercial      | 993V                                 | Sn-Pb          |
| SY88993VKG                  | K10-1        | Commercial      | 993V with Pb-Free bar-line indicator | Pb-Free NiPdAu |
| SY88993VKGTR <sup>(1)</sup> | K10-1        | Commercial      | 993V with Pb-Free bar-line indicator | Pb-Free NiPdAu |

**Note:**

1. Tape and Reel.

## PIN NAMES

| Pin                | Type                        | Function                                                |
|--------------------|-----------------------------|---------------------------------------------------------|
| D <sub>IN</sub>    | Data Input                  | Data Input                                              |
| /D <sub>IN</sub>   | Data Input                  | Inverting Data Input                                    |
| LOS <sub>LVL</sub> | Input                       | Loss of Signal Level Set                                |
| /EN                | TTL Input                   | Output Enable (Active Low)                              |
| LOS                | TTL Output (Open Collector) | Loss of Signal Indicator (Active High)                  |
| GND                | Ground                      | Ground                                                  |
| D <sub>OUT</sub>   | CML Output                  | Data Output                                             |
| /D <sub>OUT</sub>  | CML Output                  | Inverting Data Output                                   |
| V <sub>CC</sub>    | Power Supply                | Positive Power Supply                                   |
| V <sub>REF</sub>   | Output                      | Reference Voltage Output for LOS Level Set (see Fig. 3) |

## GENERAL DESCRIPTION

### General

The SY88993V is an integrated limiting amplifier intended for high-frequency fiber-optic applications. The circuit connects to typical transimpedance amplifiers found within a fiber-optics link. The linear signal output from a transimpedance amplifier can contain significant amounts of noise, and may vary in amplitude over time. The SY88993V limiting amplifier quantizes the signal and outputs a voltage-limited waveform.

The /EN pin allows the user to disable the output signal without removing the input signal.

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

| Symbol            | Rating                      | Value         | Unit |
|-------------------|-----------------------------|---------------|------|
| $V_{CC}$          | Power Supply Voltage        | 0 to +7.0     | V    |
| $D_{IN}, /D_{IN}$ | Input Voltage               | 0 to $V_{CC}$ | V    |
| $T_A$             | Operating Temperature Range | -40 to +85    | °C   |
| $T_{store}$       | Storage Temperature Range   | -55 to +125   | °C   |

**Note:**

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.

**DC ELECTRICAL CHARACTERISTICS**

$V_{CC} = +3.3V \pm 10\%$  or  $+5V \pm 10\%$ ,  $R_{LOAD} = 50\Omega$  to  $V_{CC}$

| Symbol       | Parameter                                         | $T_A = -40^\circ C$ |                                         | $T_A = 0^\circ C$   |                                         | $T_A = +25^\circ C$ |                 |                                         | $T_A = +85^\circ C$ |                                         | Unit    |
|--------------|---------------------------------------------------|---------------------|-----------------------------------------|---------------------|-----------------------------------------|---------------------|-----------------|-----------------------------------------|---------------------|-----------------------------------------|---------|
|              |                                                   | Min.                | Max.                                    | Min.                | Max.                                    | Min.                | Typ.            | Max.                                    | Min.                | Max.                                    |         |
| $I_{CC}$     | Power Supply Current <sup>(1)</sup><br>5V<br>3.3V | —                   | 40<br>35                                | —                   | 40<br>35                                | —                   | 34<br>30        | 40<br>35                                | —                   | 45<br>40                                | mA      |
| $I_{IL}$     | /EN Input LOW Current                             | -0.3 <sup>(6)</sup> | —                                       | -0.3 <sup>(6)</sup> | —                                       | -0.3 <sup>(6)</sup> | —               | —                                       | -0.3 <sup>(6)</sup> | —                                       | mA      |
| $I_{IH}$     | /EN Input HIGH Current                            | —                   | 20 <sup>(4)</sup><br>100 <sup>(5)</sup> | —                   | 20 <sup>(4)</sup><br>100 <sup>(5)</sup> | —                   | —               | 20 <sup>(4)</sup><br>100 <sup>(5)</sup> | —                   | 20 <sup>(4)</sup><br>100 <sup>(5)</sup> | $\mu A$ |
| $I_{OH}$     | LOS Output Leakage <sup>(2)</sup>                 | —                   | 100                                     | —                   | 100                                     | —                   | —               | 100                                     | —                   | 100                                     | $\mu A$ |
| $LOS_{LVL}$  | $LOS_{LVL}$ Level                                 | $V_{REF}$           | $V_{CC}$                                | $V_{REF}$           | $V_{CC}$                                | $V_{REF}$           | —               | $V_{CC}$                                | $V_{REF}$           | $V_{CC}$                                | V       |
| $V_{OL}$     | LOS Output Low Level <sup>(3)</sup>               | —                   | 0.5                                     | —                   | 0.5                                     | —                   | —               | 0.5                                     | —                   | 0.5                                     | V       |
| $V_{REF}$    | Reference Voltage                                 | $V_{CC} - 1.38$     | $V_{CC} - 1.26$                         | $V_{CC} - 1.38$     | $V_{CC} - 1.26$                         | $V_{CC} - 1.38$     | $V_{CC} - 1.32$ | $V_{CC} - 1.26$                         | $V_{CC} - 1.38$     | $V_{CC} - 1.26$                         | V       |
| $V_{IH}$     | /EN Input HIGH Voltage                            | 2.0                 | —                                       | 2.0                 | —                                       | 2.0                 | —               | —                                       | 2.0                 | —                                       | V       |
| $V_{IL}$     | /EN Input LOW Voltage                             | —                   | —                                       | 0.8                 | —                                       | 0.8                 | —               | —                                       | 0.8                 | —                                       | V       |
| $V_{OFFSET}$ | Differential Output Offset                        | —                   | $\pm 80$                                | —                   | $\pm 80$                                | —                   | $\pm 10$        | $\pm 80$                                | —                   | $\pm 80$                                | mV      |
| $V_{CMR}$    | Common Mode Range                                 | $GND \pm 2$         | $V_{CC} - 0.2$                          | $GND \pm 2$         | $V_{CC} - 0.2$                          | $GND \pm 2$         | —               | $V_{CC} - 0.2$                          | $GND \pm 2$         | $V_{CC} - 0.2$                          | V       |

**Notes:**

1. No output load.
2.  $V_{OH} = 5.5V$ .
3.  $I_{OL} = +2mA$ .
4.  $V_{IN} = 2.7V$
5.  $V_{IN} = V_{CC}$
6.  $V_{IN} = 0.5V$

## AC ELECTRICAL CHARACTERISTICS

$V_{CC} = +3.3V \pm 10\%$  or  $+5V \pm 10\%$ ,  $R_{LOAD} = 50\Omega$  to  $V_{CC}$

| Symbol         | Parameter                                            | $T_A = -40^\circ C$ |      | $T_A = 0^\circ C$ |      | $T_A = +25^\circ C$ |                    |      | $T_A = +85^\circ C$ |      | Unit             |
|----------------|------------------------------------------------------|---------------------|------|-------------------|------|---------------------|--------------------|------|---------------------|------|------------------|
|                |                                                      | Min.                | Max. | Min.              | Max. | Min.                | Typ.               | Max. | Min.                | Max. |                  |
| HYS            | LOS Hysteresis                                       | 2                   | 8    | 2                 | 8    | 2                   | 5.6                | 8    | 2                   | 8    | dB               |
| PSRR           | Power Supply <sup>(1)</sup><br>Rejection Ratio       | —                   | —    | —                 | —    | —                   | 35                 | —    | —                   | —    | dB               |
| $t_{OFFL}$     | LOS Release Time <sup>(2)</sup><br>Minimum Input     | —                   | 0.5  | —                 | 0.5  | —                   | 0.1                | 0.5  | —                   | 0.5  | $\mu s$          |
| $t_{OFFH}$     | LOS Release Time <sup>(3)</sup><br>Maximum Input     | —                   | 0.5  | —                 | 0.5  | —                   | 0.1                | 0.5  | —                   | 0.5  | $\mu s$          |
| $t_{ONL}$      | LOS Assert Time <sup>(2)</sup>                       | —                   | 0.5  | —                 | 0.5  | —                   | 0.2                | 0.5  | —                   | 0.5  | $\mu s$          |
| $t_r$<br>$t_f$ | Differential Output <sup>(3)</sup><br>Rise/Fall Time | —                   | 120  | —                 | 120  | —                   | 70                 | 120  | —                   | 120  | ps               |
| $V_{ID}$       | Input Voltage Range                                  | 4                   | 1800 | 4                 | 1800 | 4                   | —                  | 1800 | 4                   | 1800 | mV <sub>PP</sub> |
| $V_{OD}$       | Differential Output<br>Voltage Swing <sup>(4)</sup>  | —                   | —    | —                 | —    | —                   | 400 <sup>(5)</sup> | —    | —                   | —    | mV <sub>PP</sub> |
| $V_{SR}$       | LOS Sensitivity Range                                | 4                   | 50   | 4                 | 50   | 4                   | —                  | 50   | 4                   | 50   | mV <sub>PP</sub> |

### Output Spec ( $D_{OUT}$ and $I_{DOUT}$ )

|          |                                                 |              |              |              |              |              |              |              |              |              |          |
|----------|-------------------------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|----------|
| $V_{OH}$ | Output HIGH Voltage                             | $V_{CC}-20$  | $V_{CC}$     | $V_{CC}-20$  | $V_{CC}$     | $V_{CC}-20$  | $V_{CC}-5$   | $V_{CC}$     | $V_{CC}-20$  | $V_{CC}$     | mV       |
| $V_{OL}$ | Output LOW Voltage <sup>(6)</sup>               | $V_{CC}-280$ | $V_{CC}-140$ | $V_{CC}-280$ | $V_{CC}-140$ | $V_{CC}-280$ | $V_{CC}-200$ | $V_{CC}-140$ | $V_{CC}-280$ | $V_{CC}-140$ | mV       |
| $Z_O$    | Single-Ended Output <sup>(7)</sup><br>Impedance | 40           | 60           | 40           | 60           | 40           | 50           | 60           | 40           | 60           | $\Omega$ |

### Input Spec ( $D_{IN}$ and $I_{DIN}$ )

|               |                                   |    |   |    |   |    |     |   |    |   |     |
|---------------|-----------------------------------|----|---|----|---|----|-----|---|----|---|-----|
| $A_{V(Diff)}$ | Differential Voltage<br>Gain      | —  | — | —  | — | —  | 38  | — | —  | — | dB  |
| $B_{-3dB}$    | 3dB Bandwidth                     | —  | — | —  | — | —  | 2.5 | — | —  | — | GHz |
| $S_{21}$      | Single-Ended Small<br>Signal-Gain | 26 | — | 26 | — | 26 | 32  | — | 26 | — | dB  |

#### Notes:

1. Input referred noise = RMS output noise/low frequency gain. Input referred, 55MHz.
2. Input is a 200MHz square wave,  $t_r < 300ps$ ,  $1.8V_{PP}$ .
3. With input signal  $V_{ID} > 5mV_{PP}$ .
4. Input is a 200MHz square wave,  $t_r < 300ps$ ,  $50\Omega$  load.
5.  $V_{ID} > 5mV_{PP}$ .
6. Output levels are based on  $50\Omega$  impedance. If the load impedance is different, the output level will be changed.
7. See output structure.

## APPLICATION NOTE

### Output Termination

The SY88993V outputs must be terminated with a  $50\Omega$  load to  $V_{CC}$ .

### Layout and PCB Design

Since the SY88993V is a high-frequency component, performance can largely be determined by board layout and design. A common problem with high-gain amplifiers is feedback from the large swing outputs to the input via power supply.

The SY88993V ground pin should be connected to the circuit board ground. Use multiple PCB vias close to the part to connect to ground. Avoid long, inductive runs which can degrade performance.

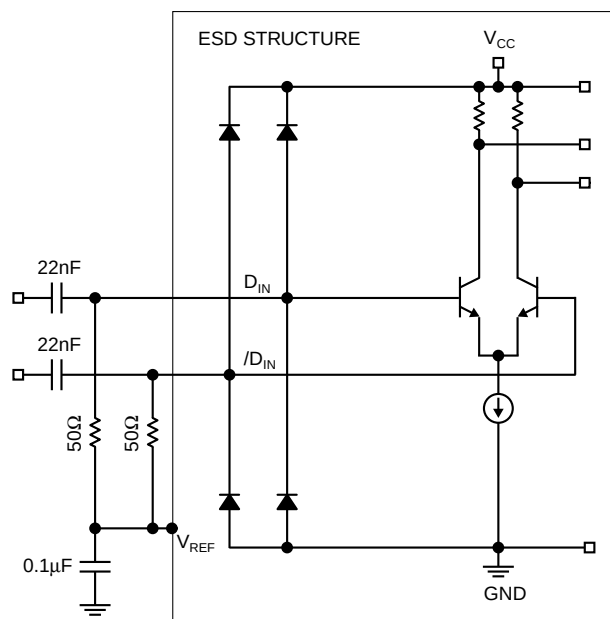


Figure 1. Differential Input Configuration

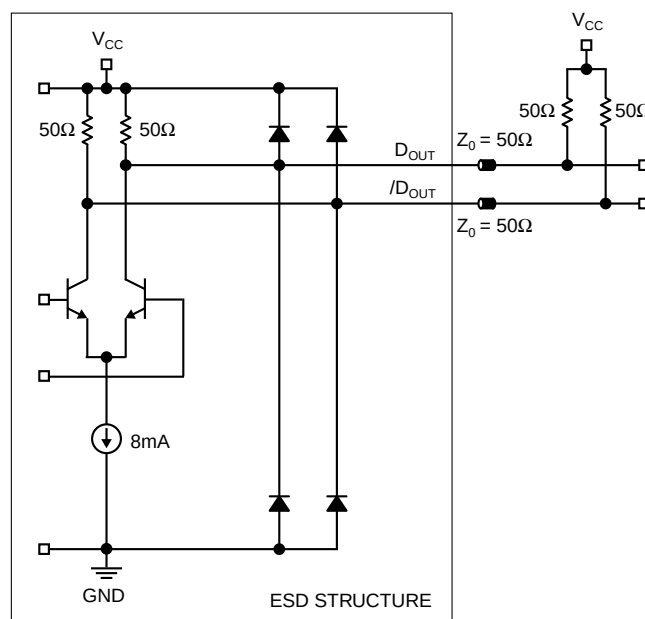
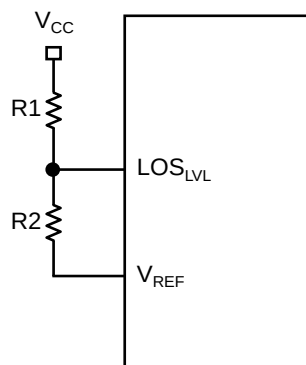


Figure 2. Differential Output Configuration



#### NOTES:

1. Resistor Divider =  $R2 / (R1 + R2)$
2.  $R1 + R2 \geq 5k\Omega$

Figure 3.  $LOS_{LVL}$  Circuit

PERFORMANCE CURVE

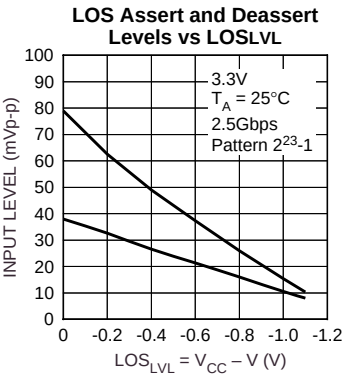


Figure 4.

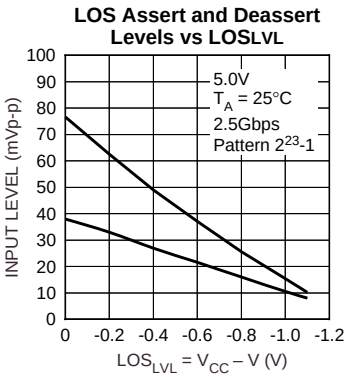


Figure 5.

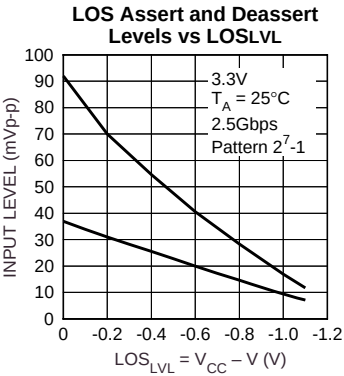


Figure 6.

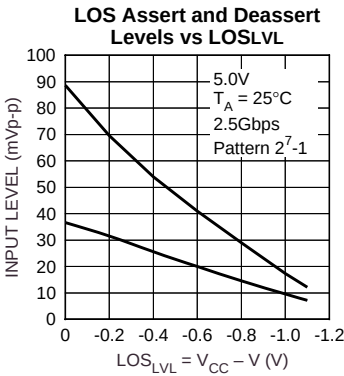
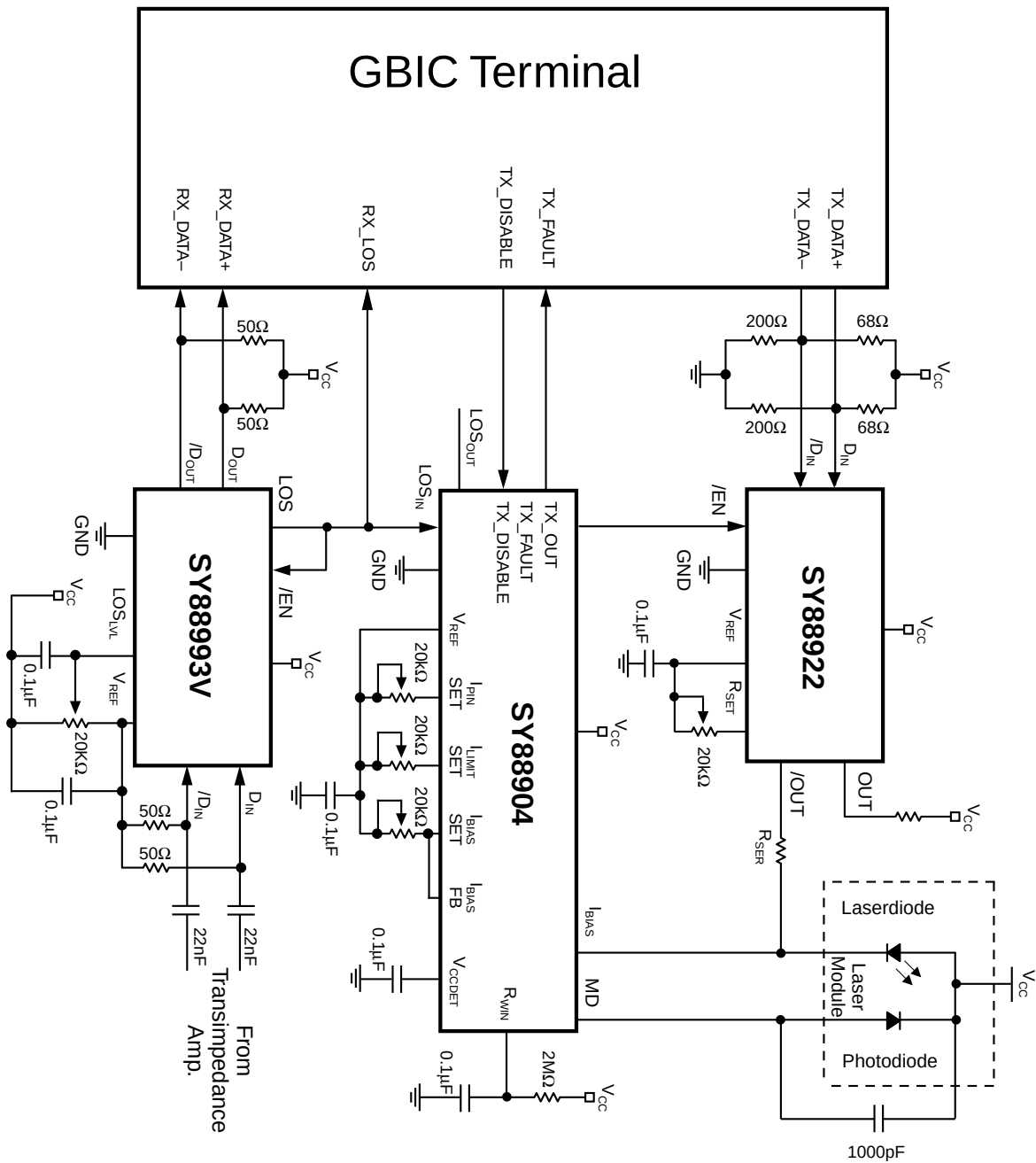
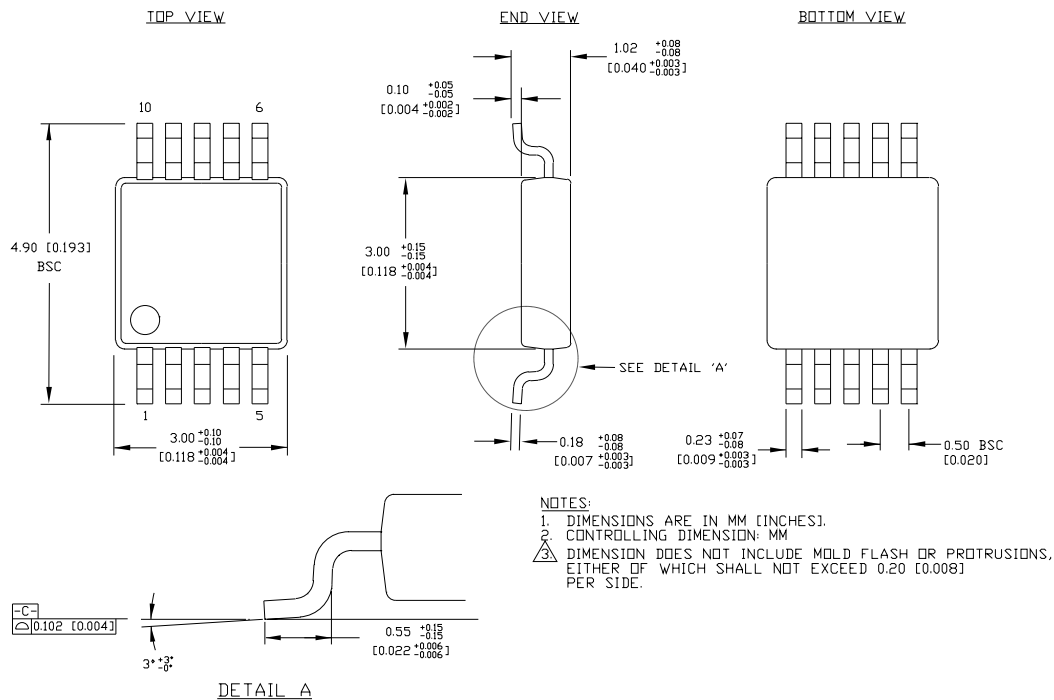


Figure 7.

## APPLICATION EXAMPLE FOR 3-CHIP SET SOLUTION



# 10 LEAD MSOP (K10-1)



Rev. 00

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