# SY88303BL

## 3.3V, 3.2 Gbps CML Limiting Post Amplifier with Wide Loss-of-Signal Detection Range

### Features

- Loss-of-Signal Detection Circuit Optimized to Detect a Wide Input Range
- Chatter-Free Open-Collector TTL Loss-of-Signal (LOS) Output
- Single 3.3V Power Supply
- 155 Mbps to 3.2 Gbps Operation
- Low-Noise CML Data Outputs
- Programmable LOS Level Set ($LOS_{LVL}$)
- Available in a 16-Lead VQFN Package

### Applications

- PON
- Gigabit Ethernet
- 1X and 2X Fibre Channel
- SONET/SDH: OC 3/12/24/48 – STM 1/4/8/16
- High-Gain Line Driver and Line Receiver

### Markets

- FTTX
- Optical Transceivers
- Datacom/Telecom
- Low-Gain TIA Interface
- Long-Reach FOM

### General Description

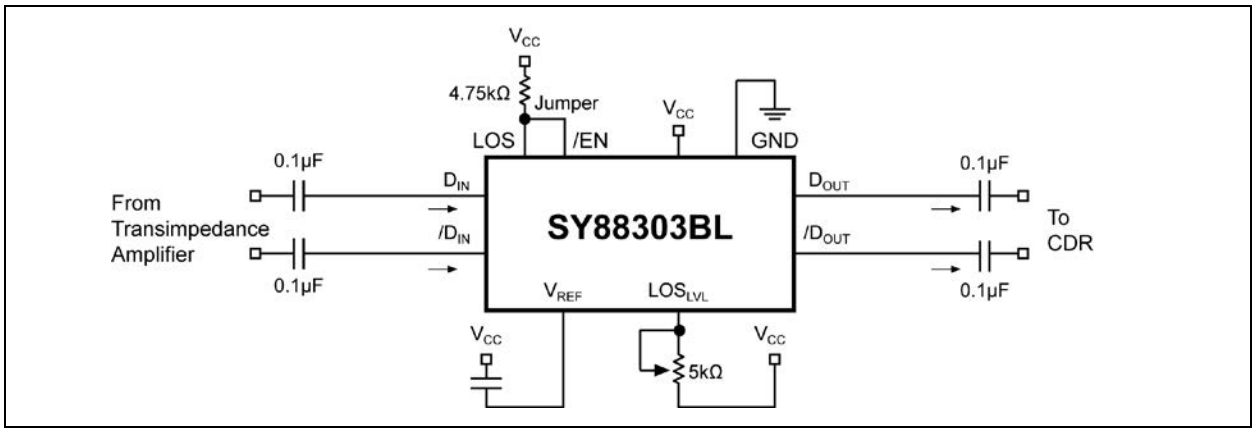
The SY88303BL low-power limiting post amplifier is designed for use in fiber-optic receivers. This device connects to typical transimpedance amplifiers (TIAs). The linear signal output from TIAs can contain significant amounts of noise and may vary in amplitude over time. The SY88303BL quantizes these signals and output CML-level waveforms.

The SY88303BL 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 with data rates up to 3.2 Gbps, and as small as 10 $mV_{PP}$, can be amplified to drive devices with CML/PECL inputs.

The device generates a loss-of-signal (LOS) open-collector TTL output. The LOS function is optimized to detect a wide input range, as shown in the typical operating characteristic graphs. 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 set 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, 3.5 dB LOS hysteresis is provided to prevent chattering.

### Typical Application Circuit




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## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

Supply Voltage ($V_{CC}$) ..... 0V to +4.0V
input Voltage (DIN, /DIN)..... 0V to $V_{CC}$
Output Current ($I_{OUT}$)
Continuous .....±50 mA
Surge.....±100 mA
/EN Voltage ..... 0V to $V_{CC}$
$V_{REF}$ Current ..... –800 µA to +500 µA
$LOL_{LVL}$ Voltage..... $V_{REF}$ to $V_{CC}$

### Operating Ratings ‡

Supply Voltage ($V_{CC}$) ..... +3.0V to +3.6V

**† Notice:** Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

**‡ Notice:** The device is not guaranteed to function outside its operating ratings.

**Note 1:** Devices are ESD sensitive. Handling precautions recommended.

## DC ELECTRICAL CHARACTERISTICS

**Electrical Characteristics:** $V_{CC}$ = 3.0V to 3.6V; $R_L$ = 50Ω to $V_{CC}$; $T_A$ = –40°C to +85°C; typical values at $V_{CC}$ = 3.3V, $T_A$ = +25°C.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Power Supply Current | $I_{CC}$ | — | 38 | 60 | mA | No output load |
| $LOS_{LVL}$ Voltage | $V_{LOSLVL}$ | $V_{REF}$ | — | $V_{CC}$ | V | — |
| CML Output HIGH Voltage | $V_{OH}$ | $V_{CC}$ – 0.020 | $V_{CC}$ – 0.005 | $V_{CC}$ | V | — |
| CML Output LOW Voltage | $V_{OL}$ | $V_{CC}$ – 0.475 | $V_{CC}$ – 0.4 | $V_{CC}$ – 0.350 | V | — |
| Differential Output Offset | $V_{OFFSET}$ | — | — | ±80 | mV | — |
| Reference Voltage | $V_{REF}$ | $V_{CC}$ – 1.48 | $V_{CC}$ – 1.32 | $V_{CC}$ – 1.16 | V | — |
| Single-Ended Input Impedance | $Z_I$ | 40 | 50 | 60 | Ω | — |

## TTL DC ELECTRICAL CHARACTERISTICS

**Electrical Characteristics:** $V_{CC}$ = 3.0V to 3.6V; $T_A$ = –40°C to +85°C.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| /EN Input HIGH Voltage | $V_{IH}$ | 2.0 | — | — | V | — |
| /EN Input LOW Voltage | $V_{IL}$ | — | — | 0.8 | V | — |
| /EN Input HIGH Current | $I_{IH}$ | — | — | 20 | µA | $V_{IN}$ = 2.7V |
| | | — | — | 100 | µA | $V_{IN}$ = $V_{CC}$ |
| /EN Input LOW Current | $I_{IL}$ | –300 | — | — | µA | $V_{IN}$ = 0.5V |
| LOS Output Leakage | $I_{OH}$ | — | — | 100 | µA | $V_{OH}$ = 3.6V |
| LOS Output LOW Level | $V_{OL}$ | — | — | 0.5 | V | $I_{OL}$ = +4 mA |


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## AC ELECTRICAL CHARACTERISTICS

**Electrical Characteristics:** $V_{CC}$ = 3.0V to 3.6V; $T_A$ = –40°C to +85°C.

| Parameter | Symbol | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| Output Rise/Fall Time (20% to 80%) | $t_r/t_f$ | — | 60 | 120 | ps | Note 1 |
| Deterministic Jitter | $t_{JITTER}$ | — | 15 | — | $ps_{PP}$ | Note 2 |
| Random Jitter | | — | 5 | — | $ps_{RMS}$ | Note 3 |
| Differential Input Voltage Swing | $V_{ID}$ | 10 | — | 1800 | $mV_{PP}$ | Figure 4-2 |
| Differential Output Voltage Swing | $V_{OD}$ | 700 | 800 | 950 | $mV_{PP}$ | $V_{ID} \geq 12\ mV_{PP}$, Figure 4-2 |
| LOS De-assert Time | $t_{OFF}$ | — | 2 | 10 | µs | — |
| LOS Assert Time | $t_{ON}$ | — | 2 | 10 | µs | — |
| Low LOS De-assert Level | $LOS_{DL}$ | — | 27 | — | $mV_{PP}$ | R = 15 kΩ, Note 5 |
| Low LOS Assert Level | $LOS_{AL}$ | — | 18 | — | $mV_{PP}$ | R = 15 kΩ, Note 5 |
| Low LOS Hysteresis | $HYS_L$ | — | 3.4 | — | dB | R = 15 kΩ, Note 4 |
| Medium LOS De-assert Level | $LOS_{DM}$ | — | 53 | 80 | $mV_{PP}$ | R = 5 kΩ, Note 5 |
| Medium LOS Assert Level | $LOS_{AM}$ | 21 | 36 | — | $mV_{PP}$ | R = 5 kΩ, Note 5 |
| LOS Hysteresis | $HYS_M$ | 2 | 3.5 | 6 | dB | R = 5 kΩ, Note 4 |
| High LOS De-assert Level | $LOS_{DH}$ | — | 137 | 200 | $mV_{PP}$ | R = 100Ω, Note 5 |
| High LOS Assert Level | $LOS_{AH}$ | 70 | 94 | — | $mV_{PP}$ | R = 100Ω, Note 5 |
| High LOS Hysteresis | $HYS_H$ | 2 | 3.5 | 6 | dB | R = 100Ω, Note 4 |
| 3 dB Bandwidth | $B_{-3dB}$ | — | 2 | — | GHz | — |
| Differential Voltage Gain | $A_{V(DIFF)}$ | — | 39 | — | dB | — |
| Single-Ended Small-Signal Gain | $S_{21}$ | 26 | 33 | — | dB | — |

**Note 1:** Amplifier in limiting mode. Input is a 200 MHz, 100 $mV_{PP}$ square wave.

**2:** Deterministic jitter measured using 3.2 Gbps K28.5 pattern, $V_{ID}$ = 10 $mV_{PP}$.

**3:** Random jitter measured using 3.2 Gbps K28.7 pattern, $V_{ID}$ = 10 $mV_{PP}$.

**4:** 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 2 dB to 6 dB, shown in the AC characteristics table, will be 1 dB to 3 dB Optical Hysteresis.

**5:** See Figure 2-1 for a graph showing how to choose a particular $R_{LOSLVL}$ for a particular LOS assert and its associated de-assert amplitude.

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## TEMPERATURE SPECIFICATIONS (Note 1)

| Parameters | Sym. | Min. | Typ. | Max. | Units | Conditions |
|---|---|---|---|---|---|---|
| **Temperature Ranges** | | | | | | |
| Ambient Temperature | $T_A$ | –40 | — | +85 | °C | — |
| Lead Temperature | — | — | — | +260 | °C | Soldering, 10 sec. |
| Storage Temperature | $T_S$ | –65 | — | +150 | °C | — |
| **Package Thermal Resistance** | | | | | | |
| Thermal Resistance, VQFN 16-Ld, Note 2 | $\theta_{JA}$ | — | 61 | — | °C/W | — |
| | $\Psi_{JB}$ | — | 38 | — | °C/W | — |

**Note 1:** The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., $T_A$, $T_J$, $\theta_{JA}$). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +85°C rating. Sustained junction temperatures above +85°C can impact the device reliability.

**2:** 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.


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## 2.0 TYPICAL PERFORMANCE CURVES

**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

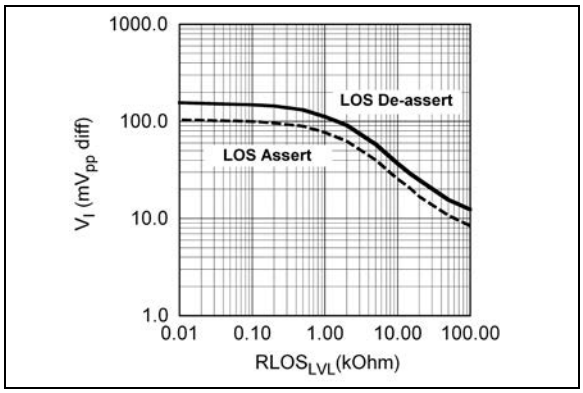



***FIGURE 2-1:*** *$V_{ID}$ to Assert/De-Assert LOS vs. $R_{LOSLVL}$.*

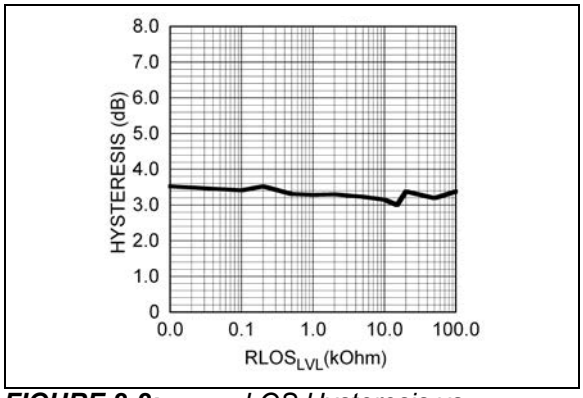



***FIGURE 2-2:*** *LOS Hysteresis vs. $R_{LOSLVL}$.*

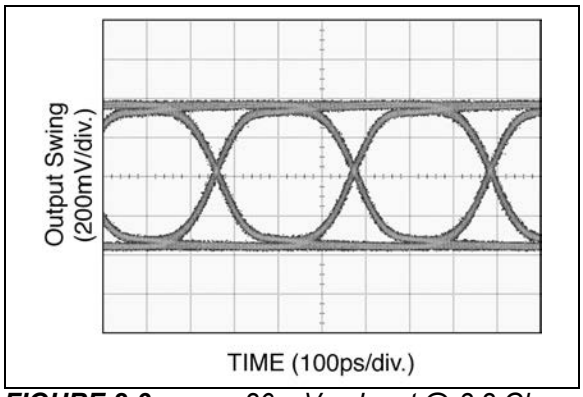



***FIGURE 2-3:*** *20 $mV_{PP}$ Input @ 3.2 Gbps $2^{23}–1$ PRBS.*

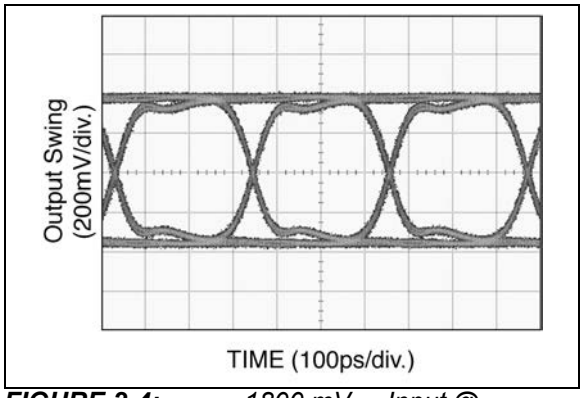
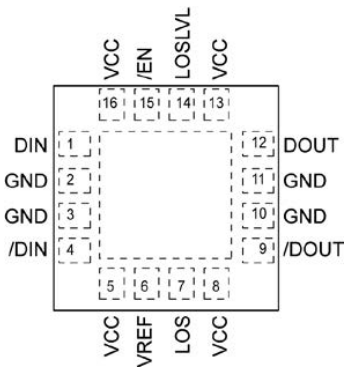



***FIGURE 2-4:*** *1800 $mV_{PP}$ Input @ 3.2 Gbps $2^{23}–1$ PRBS.*

## 3.0 PIN DESCRIPTIONS

### Package Type

**SY88303BL**
16-Lead VQFN (M)
(Top View)




The descriptions of the pins are listed in Table 3-1.

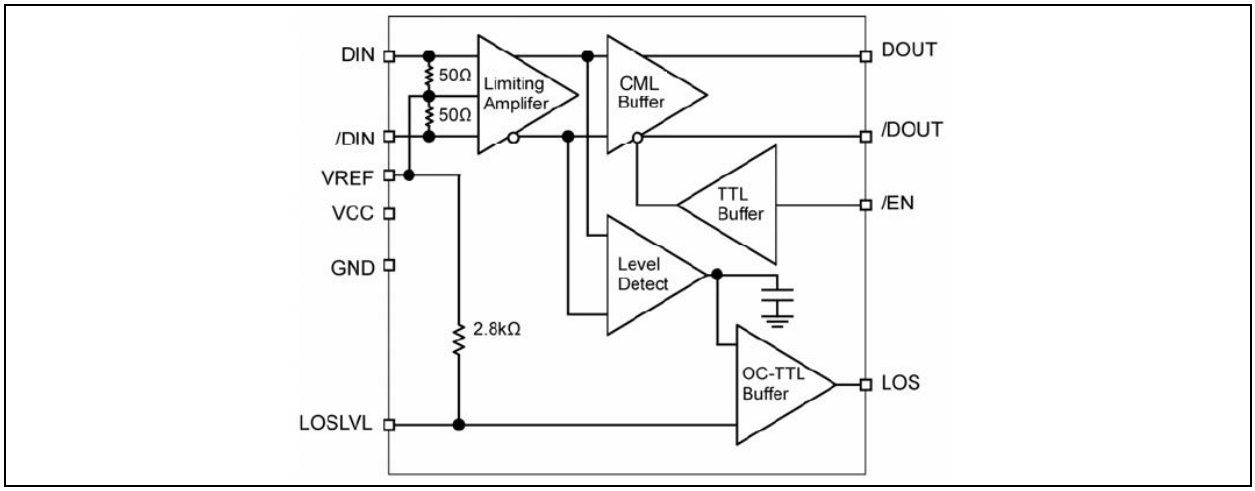
**TABLE 3-1: PIN FUNCTION TABLE**

| Pin Number | Pin Name | Type | Description |
|---|---|---|---|
| 15 | /EN | TTL Input: Default is low | Enable bar: De-asserts true data output when High. |
| 1 | DIN | Data Input | True data input with 50Ω termination to $V_{REF}$. |
| 4 | /DIN | Data Input | Complementary data input with 50Ω termination to $V_{REF}$. |
| 6 | VREF | — | Reference Voltage: Placing a capacitor here to $V_{CC}$ helps stabilize. |
| 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 the LOS output will be asserted. |
| 2, 3, 10, 11, ePAD | GND | Ground | Device ground. Exposed pad must be connected to PCB ground plane. |
| 7 | LOS | Open Collector TTL Output | Loss-of-Signal: Asserts high when the data input amplitude falls below the threshold sets by $LOS_{LVL}$.<br>For proper operation, install an external 4.75 kΩ pull-up resistor at this output. |
| 9 | /DOUT | CML Output | Complementary data output. |
| 12 | DOUT | CML Output | True data output. |
| 5, 8, 13, 16 | VCC | Power Supply | Positive power supply. |


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# 4.0 FUNCTIONAL DESCRIPTION

## Functional Block Diagram




The SY88303BL low-power limiting post amplifier operates from a single +3.3V power supply, over temperatures from –40°C to +85°C. Signals with data rates up to 3.2 Gbps and as small as 10 $mV_{PP}$ can be amplified. Figure 4-1 shows the allowed input voltage swing. The SY88303BL generates a LOS output allowing feedback to /EN for output stability. $LOS_{LVL}$ sets the sensitivity of the input amplitude detection.

## 4.1 Input Amplifier Buffer

Figure 4-2 shows a simplified schematic of the input stage. The high-sensitivity of the input amplifier allows signals as small as 10 $mV_{PP}$ to be amplified. The input amplifier also allows input signals as large as 1800 $mV_{PP}$. Input signals below 12 $mV_{PP}$ are linearly amplified with a typical 42 dB differential voltage gain. Because it is a limiting amplifier, this device outputs typically 800 $mV_{PP}$ voltage-limited waveforms for input signals greater than 12 $mV_{PP}$. Applications that require the SY88303BL to operate with strong signals should have the upstream TIA placed as close as possible to the device's input pins. This ensures the best performance of the device.

## 4.2 Output Buffer

The SY88303BL CML output buffers are 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 4-4 shows a simplified schematic of the output stage.

## 4.3 Loss-of-Signal

The SY88303BL generates a chatter-free LOS open-collector TTL output, as shown in Figure 4-3. 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.

## 4.4 Loss-of-Signal Level Set

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 $V_{REF}$. The external resistor creates a voltage divider between $V_{CC}$ and $V_{REF}$, as shown in Figure 4-5.

## 4.5 Hysteresis

The SY88303BL typically provides 3.5 dB LOS electrical hysteresis. By definition, a power ratio measured in dB is 10log (power ratio). Power is calculated as $V_{IN}^2/R$ 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. Because the SY88303BL is an electrical device, this data sheet refers to hysteresis in electrical terms. With 3.5 dB LOS hysteresis, a voltage factor of 1.5 is required to assert or de-assert LOS.

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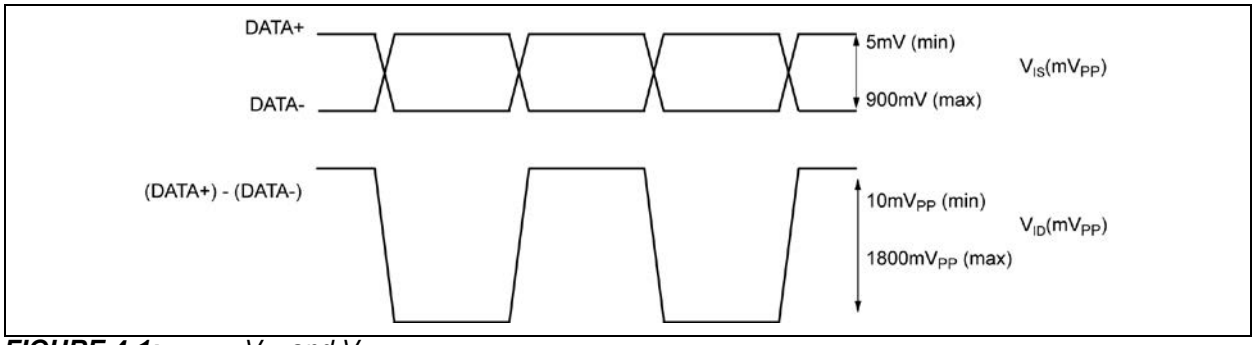



***FIGURE 4-1:*** *$V_{IS}$ and $V_{ID}$.*

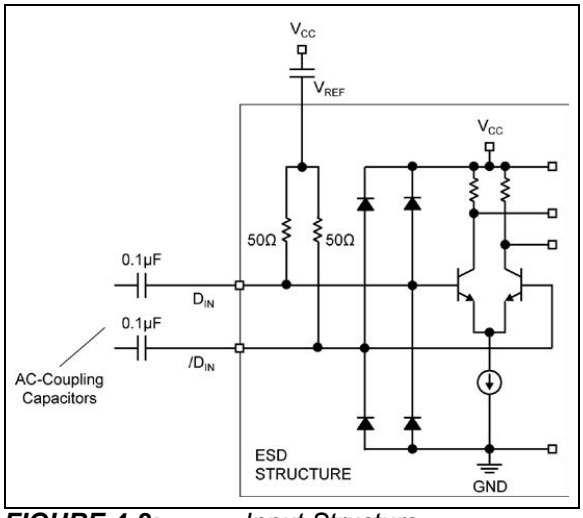



***FIGURE 4-2:*** *Input Structure.*

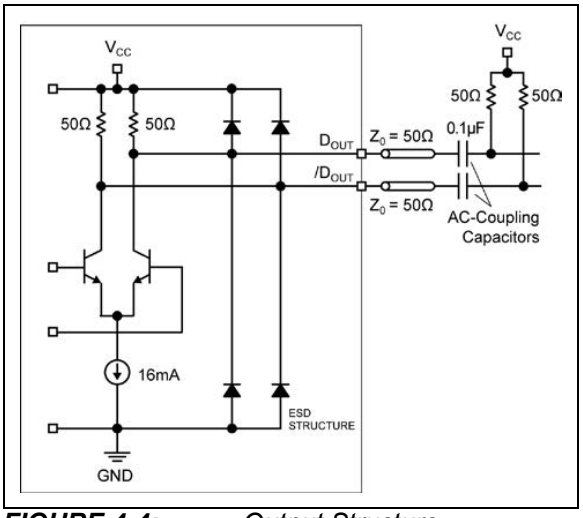



***FIGURE 4-4:*** *Output Structure.*

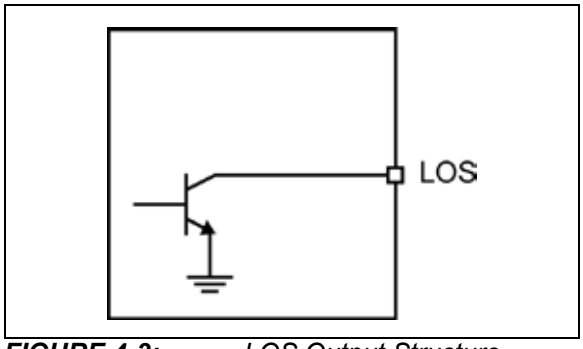



***FIGURE 4-3:*** *LOS Output Structure.*

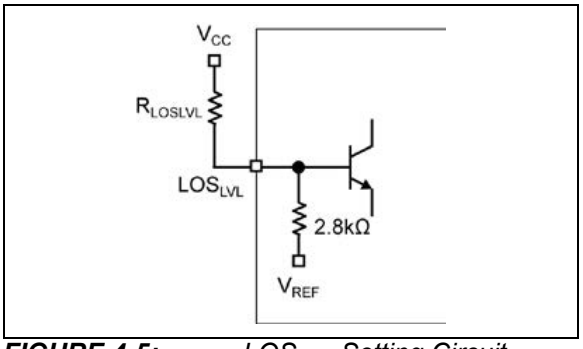


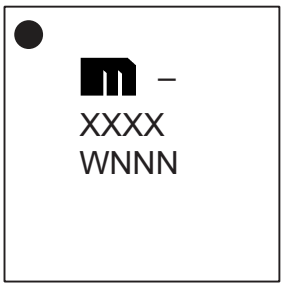

***FIGURE 4-5:*** *$LOS_{LVL}$ Setting Circuit.*


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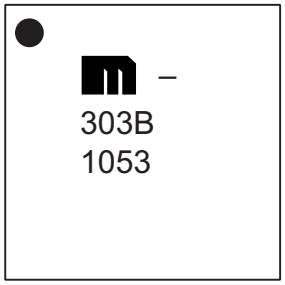
## 5.0 PACKAGING INFORMATION

### 5.1 Package Marking Information

16-Lead VQFN*




Example




| | | |
|---|---|---|
| **Legend:** | XX...X | Product code or customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week ‘01’) |
| | NNN | Alphanumeric traceability code |
| | (e3) | Pb-free JEDEC® designator for Matte Tin (Sn) |
| | * | This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package. |
| | ●, ▲, ▼ | Pin one index is identified by a dot, delta up, or delta down (triangle mark). |

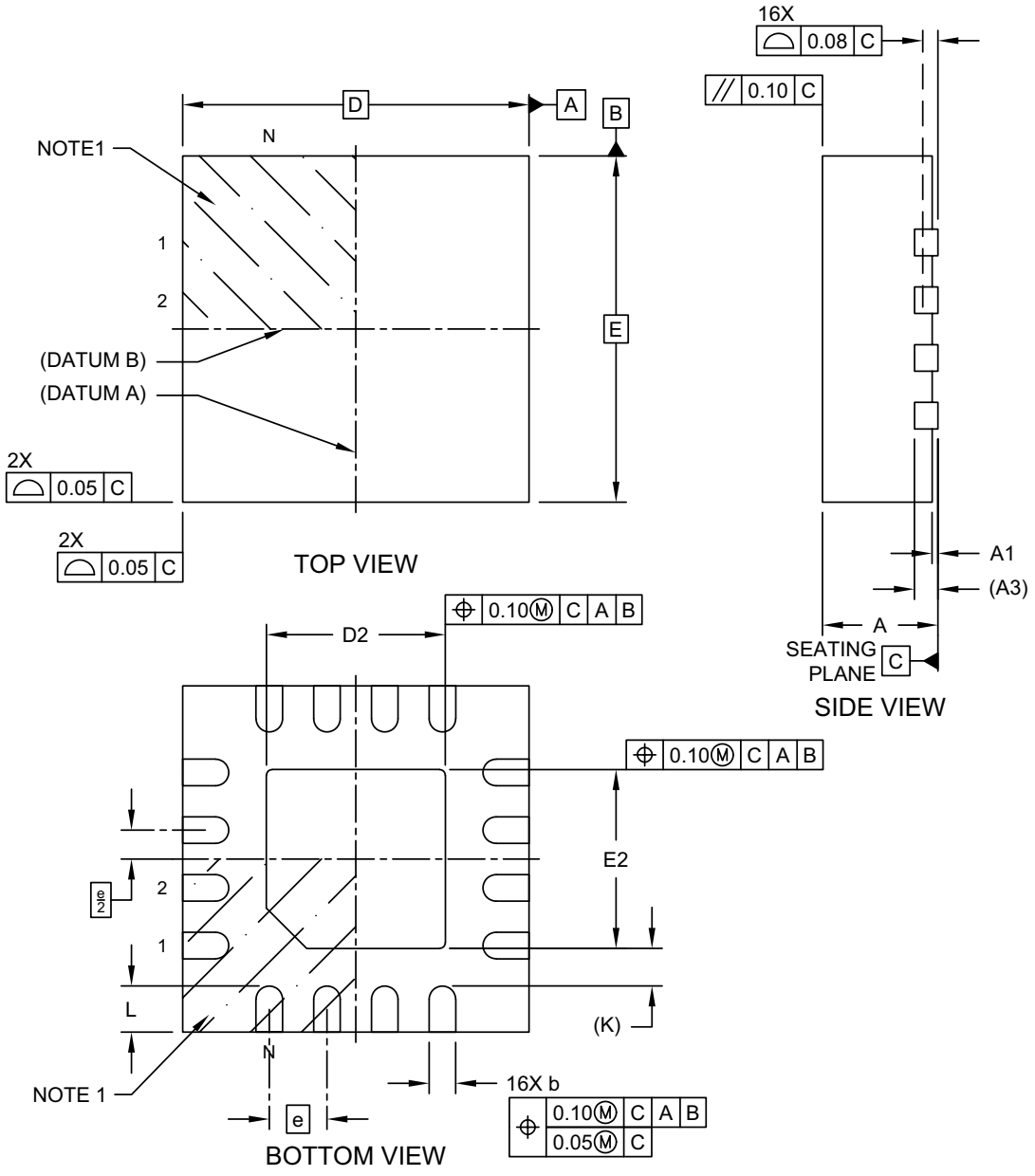
**Note**: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (¯) symbol may not be to scale.

## 16-Lead VQFN Package Outline and Recommended Land Pattern

**16-Lead Very Thin Plastic Quad Flat, No Lead Package (NCA) - 3x3x1.0 mm Body [VQFN] With 1.55 mm Exposed Pad**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

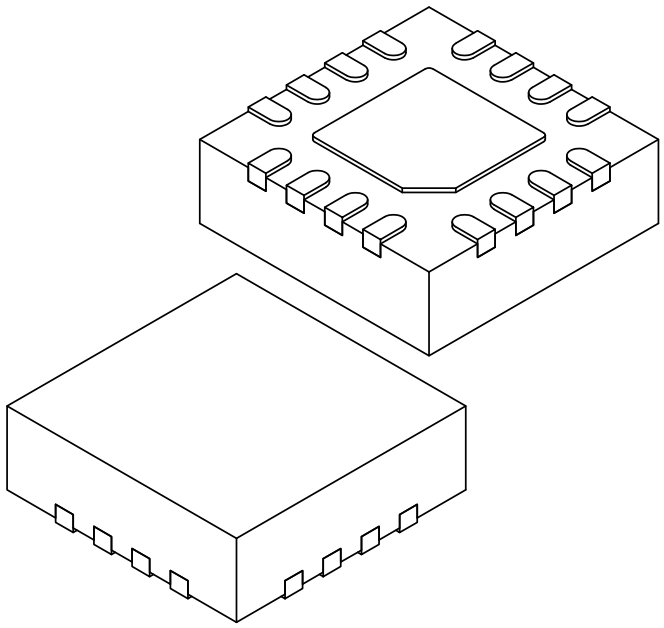



Microchip Technology Drawing C04-1103-NCA Rev B Sheet 1 of 2


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**16-Lead Very Thin Plastic Quad Flat, No Lead Package (NCA) - 3x3x1.0 mm Body [VQFN] With 1.55 mm Exposed Pad**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Number of Terminals | N | | 16 | |
| Pitch | e | | 0.50 BSC | |
| Overall Height | A | 0.80 | 0.90 | 1.00 |
| Standoff | A1 | 0.00 | 0.02 | 0.05 |
| Terminal Thickness | A3 | | 0.203 REF | |
| Overall Length | D | | 3.00 BSC | |
| Exposed Pad Length | D2 | 1.50 | 1.55 | 1.60 |
| Overall Width | E | | 3.00 BSC | |
| Exposed Pad Width | E2 | 1.50 | 1.55 | 1.60 |
| Terminal Width | b | 0.18 | 0.23 | 0.28 |
| Terminal Length | L | 0.35 | 0.40 | 0.45 |
| Terminal-to-Exposed-Pad | K | | 0.33 REF | |

Notes:

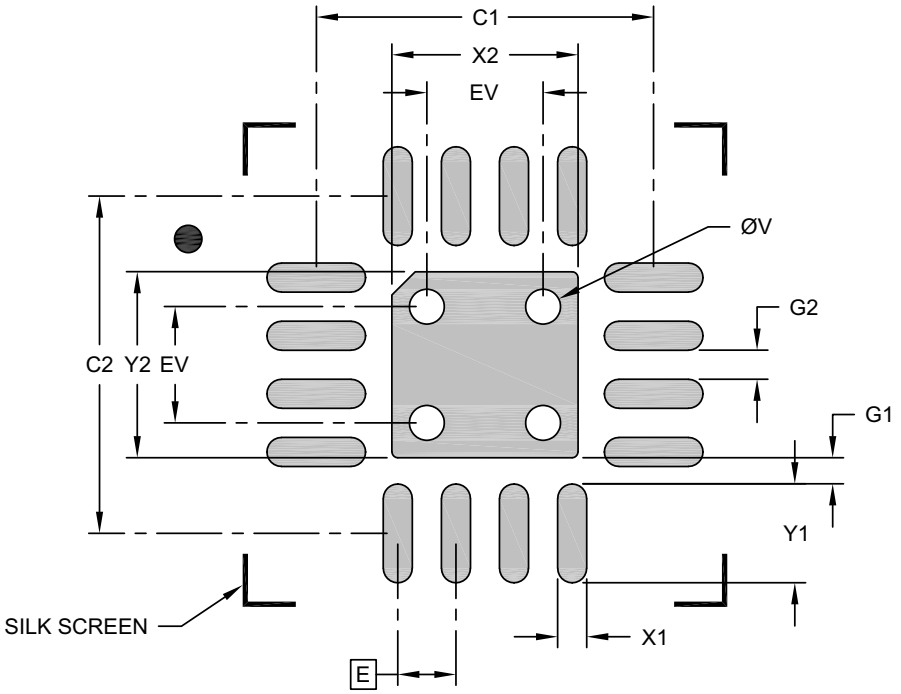
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1103-NCA Rev B Sheet 2 of 2

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**16-Lead Very Thin Plastic Quad Flat, No Lead Package (NCA) - 3x3x1.0 mm Body [VQFN] With 1.55 mm Exposed Pad**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging




RECOMMENDED LAND PATTERN

| Units | | MILLIMETERS | | |
|---|---|---|---|---|
| Dimension Limits | | MIN | NOM | MAX |
| Contact Pitch | E | | 0.50 BSC | |
| Center Pad Width | X2 | | | 1.60 |
| Center Pad Length | Y2 | | | 1.60 |
| Contact Pad Spacing | C1 | | 2.90 | |
| Contact Pad Spacing | C2 | | 2.90 | |
| Contact Pad Width (Xnn) | X1 | | | 0.25 |
| Contact Pad Length (Xnn) | Y1 | | | 0.85 |
| Contact Pad to Center Pad (Xnn) | G1 | 0.23 | | |
| Contact Pad to Contact Pad (Xnn) | G2 | 0.25 | | |
| Thermal Via Diameter | V | | 0.30 | |
| Thermal Via Pitch | EV | | 1.00 | |

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-3103-NCA Rev B


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## APPENDIX A: REVISION HISTORY

### Revision A (November 2021)

- Converted Micrel document SY88303BL to Microchip data sheet DS20006621A.
- Minor text changes throughout.

**NOTES:**


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## PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

| PART No. | X | X | X | -XX |
|---|---|---|---|---|
| Device | Supply Voltage | Package | Temperature Range | Media Type |

| | | |
|---|---|---|
| **Device:** | SY88303B: | 3.2 Gbps CML Limiting Post Amplifier with Wide Loss-of-Signal Detection Range |
| **Supply Voltage:** | L = | 3.3V |
| **Package:** | M = | 16-Lead 3 mm x 3 mm VQFN |
| **Temperature Range:** | G = | –40°C to +85°C |
| **Media Type:** | (blank)= | 100/Tube |
| | TR = | 1,000/Reel |

**Examples:**

a) SY88303BLMG: SY88303B, 3.3V Supply Voltage, 16-Lead 3x3 VQFN, –40°C to +85°C Temp. Range, 100/Tube

b) SY88303BLMG-TR: SY88303B, 3.3V Supply Voltage, 16-Lead 3x3 VQFN, –40°C to +85°C Temp. Range, 1,000/Reel

**Note 1:** Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

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ISBN: 978-1-5224-9301-3

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