

## 3.3V Low-Noise, Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination

### Features

- Ultra-Low Jitter Design:
  - 80 fs<sub>RMS</sub> Additive Phase Jitter (typical)
- Guaranteed AC Performance Over Temperature and Voltage:
  - DC-to > 2 GHz throughput
  - <470 ps Propagation Delay (IN-to-Q)
  - <20 ps Within-Device Skew
  - <190 ps Rise/Fall Times
- Unique Input Termination and V<sub>T</sub> Pin Accepts DC- and AC-Coupled Inputs
- High-Speed LVDS Outputs
- 3.3V Power Supply Operation
- Industrial Temperature Range: -40°C to +85°C
- Available in 16-Pin (3 mm × 3 mm) QFN Package

### Applications

- Processor Clock Distribution
- SONET Clock Distribution
- Fibre Channel Clock Distribution
- Gigabit Ethernet Clock Distribution

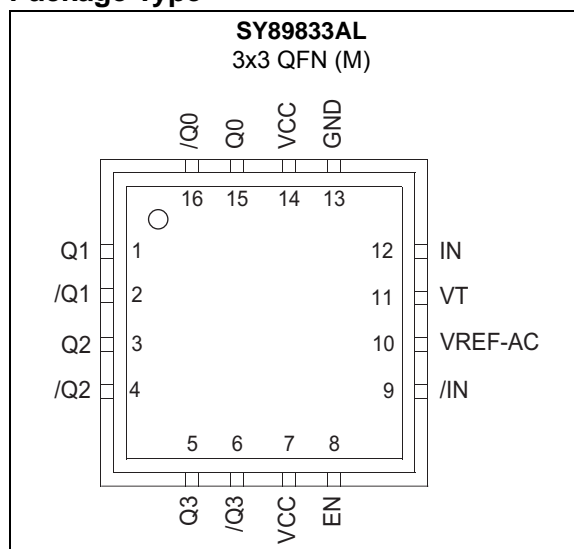
### General Description

The SY89833AL is a lower noise version of the SY89833L 3.3V, high-speed 2 GHz differential, low voltage differential swing (LVDS) 1:4 fanout buffer optimized for ultra-low skew applications. Within device skew is guaranteed to be less than 20 ps over supply voltage and temperature.

The differential input buffer has a unique internal termination design that allows access to the termination network through a V<sub>T</sub> pin. This feature allows the device to easily interface to different logic standards. A V<sub>REF-AC</sub> reference is included for AC-coupled applications.

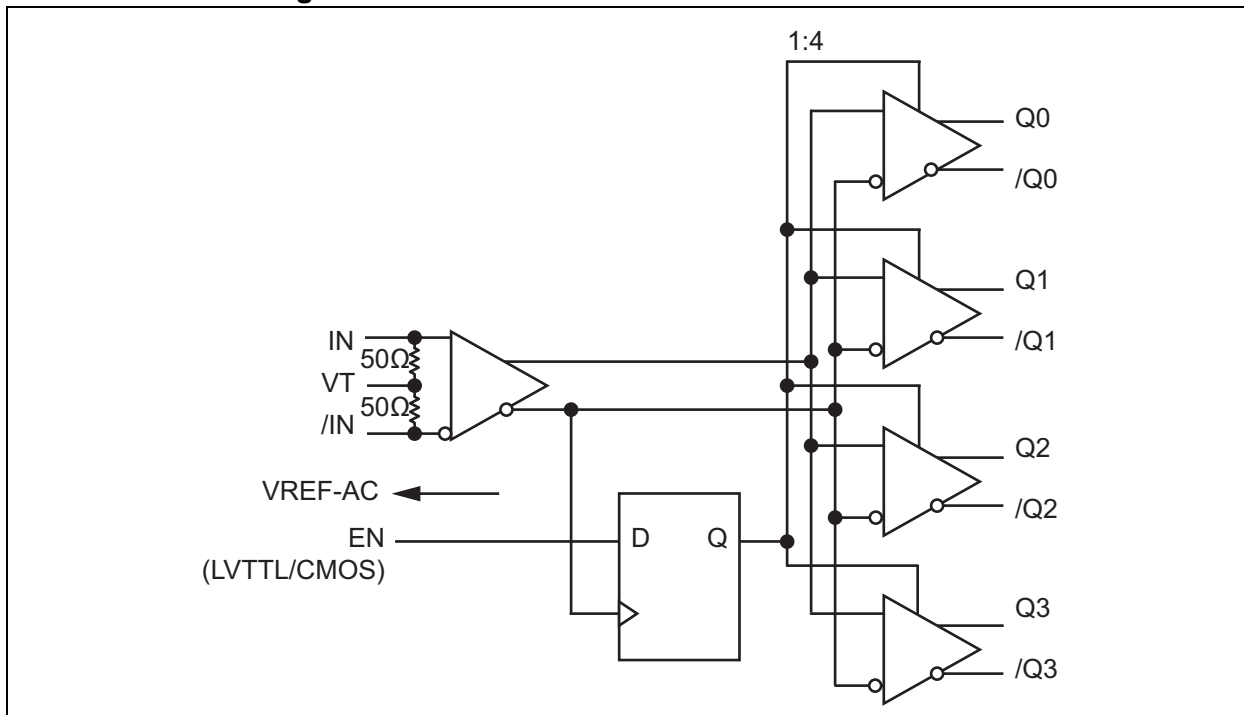
The SY89833AL is part of Microchip's high-speed clock synchronization family. For 2.5V applications, the SY89832U provides similar functionality while operating from a 2.5V ±5% supply. For applications that require a different I/O combination, consult the Microchip website and choose from a comprehensive product line of high-speed, low-skew fanout buffers, translators, and clock generators.

### Package Type



# SY89833AL

## Functional Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings †

|  |                          |
|--|--------------------------|
| Supply Voltage ( $V_{CC}$ ) .....                                    | –0.5V to +4.0V           |
| Input Voltage ( $V_{IN}$ ) .....                                     | –0.5V to $V_{CC} + 0.3V$ |
| LVDS Output Current ( $I_{OUT}$ ).....                               | +10 mA                   |
| Input Current Source or Sink Current on ( $I_N$ , $/I_N$ ).....      | ±50 mA                   |
| $V_T$ Current Source or Sink Current on ( $V_T$ ).....               | ±100 mA                  |
| $V_{REF-AC}$ Current Source or Sink Current on ( $V_{REF-AC}$ )..... | ±2 mA                    |

### Operating Ratings ‡

|                            |                |
|----------------------------|----------------|
| Supply Voltage Range ..... | +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.

**TABLE 1-1: ELECTRICAL CHARACTERISTICS**

| Electrical Characteristics: $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ , unless otherwise stated. (Note 1). |   |                  |                  |                  |          |                        |
|---|---|------------------|------------------|------------------|----------|------------------------|
| Symbol  | Parameters                                | Min.             | Typ.             | Max.             | Units    | Conditions             |
| $V_{CC}$  | Power Supply Voltage Range                | 3.0              | 3.3              | 3.6              | V        | —                      |
| $I_{CC}$  | Power Supply Current                      | —                | 75               | 100              | mA       | No load; max. $V_{CC}$ |
| $R_{IN}$  | Input Resistance (IN-to- $V_T$ )          | 45               | 50               | 55               | $\Omega$ | —                      |
| $R_{DIFF-IN}$   | Differential Input Resistance (IN-to-/IN) | 90               | 100              | 110              | $\Omega$ | —                      |
| $V_{IH}$  | Input High Voltage (IN-to-/IN)            | 1.2              | —                | $V_{CC}$         | V        | —                      |
| $V_{IL}$  | Input Low Voltage (IN-to-/IN)             | 0                | —                | $V_{IH} - 0.1$   | V        | —                      |
| $V_{IN}$  | Input Voltage Swing (IN-to-/IN)           | 0.1              | —                | 1.7              | V        | See Figure 5-3         |
| $V_{DIFF\_IN}$  | Differential Input Voltage                | 0.2              | —                | —                | V        | See Figure 5-4         |
| $ I_{IN} $  | Input Current (IN, /IN)                   | —                | —                | 45               | mA       | Note 2                 |
| $V_{REF-AC}$  | Reference Voltage                         | $V_{CC} - 1.525$ | $V_{CC} - 1.425$ | $V_{CC} - 1.325$ | V        | —                      |

**Note 1:** The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

**2:** Due to the internal termination (see "Input Buffer Structure" section) the input current depends on the applied voltages at IN, /IN, and  $V_T$  inputs. Do not apply a combination of voltages that causes the input current to exceed the maximum limit.

**TABLE 1-2: LVDS OUTPUTS DC ELECTRICAL CHARACTERISTICS**

| Electrical Characteristics: $V_{CC} = 3.3\text{V} \pm 10\%$ , $R_L = 100\Omega$ across the outputs; $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ . (Note 1) |                                   |       |      |       |       |                |
|---|-----------------------------------|-------|------|-------|-------|----------------|
| Symbol  | Parameters                        | Min.  | Typ. | Max.  | Units | Conditions     |
| $V_{OUT}$   | Output Voltage Swing              | 250   | 325  | —     | mV    | see Figure 5-3 |
| $V_{DIFF\_OUT}$   | Differential Output Voltage Swing | 500   | 650  | —     | mV    | see Figure 5-4 |
| $V_{OCM}$   | Output Common-Mode Voltage        | 1.125 | —    | 1.275 | V     | —              |
| $\Delta V_{OCM}$  | Change in Common-Mode Voltage     | —50   | —    | 50    | mV    | —              |

**Note 1:** The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

**TABLE 1-3: LVTTTL/CMOS DC ELECTRICAL CHARACTERISTICS**

| Electrical Characteristics: $V_{CC} = 3.3\text{V} \pm 10\%$ , $T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$ . (Note 1) |                    |      |      |          |               |            |
|---|--------------------|------|------|----------|---------------|------------|
| Symbol  | Parameters         | Min. | Typ. | Max.     | Units         | Conditions |
| $V_{IH}$  | Input High Voltage | 2.0  | —    | $V_{CC}$ | V             | —          |
| $V_{IL}$  | Input Low Voltage  | 0    | —    | 0.8      | V             | —          |
| $I_{IH}$  | Input High Current | —125 | —    | 30       | $\mu\text{A}$ | —          |
| $I_{IL}$  | Input Low Current  | —300 | —    | —        | $\mu\text{A}$ | —          |

**Note 1:** The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

**TABLE 1-4: AC ELECTRICAL CHARACTERISTICS**

| <b>Electrical Characteristics:</b> $V_{CC} = 3.3V \pm 10\%$ , $R_L = 100\Omega$ across the outputs; $T_A = -40^\circ C$ to $+85^\circ C$ unless otherwise stated. (Note 1) |  |      |      |      |       |  |
|--|--|------|------|------|-------|--|
| Symbol   | Parameters                             | Min. | Typ. | Max. | Units | Conditions   |
| $f_{MAX}$  | Maximum Frequency                      | 2.0  | —    | —    | GHz   | $V_{OUT} \geq 200$ mV  |
| $t_{pd}$   | Propagation Delay                      | 250  | —    | 470  | ps    | —  |
| $t_{SKEW}$   | Within-Device Skew                     | —    | 5    | 20   | ps    | Note 2   |
|  | Part-to-Part Skew                      | —    | —    | 200  | ps    | Note 3   |
| $t_S$  | Set-Up Time                            | 400  | —    | —    | ps    | Note 4   |
| $t_H$  | Hold Time                              | 400  | —    | —    | ps    | Note 4   |
| $t_{JITTER}$   | Additive Phase Jitter, RMS             | —    | 80   | —    | fs    | 622.08 MHz @ 3.3V,<br>Integration range: 12 kHz to<br>20 MHz |
| $t_r/t_f$  | Output Rise/Fall Times (20% to<br>80%) | 60   | 110  | 190  | ps    | At Full Output Swing   |
| —  | Duty Cycle                             | 47   | —    | 53   | %     | Differential I/O   |

**Note 1:** High-frequency AC parameters are guaranteed by design and characterization.

**2:** Within device skew is measured between two different outputs under identical input transitions.

**3:** Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and no skew at the edges at the respective inputs.

**4:** Set-up and hold times apply to synchronous applications that intend to enable/disable before the next clock cycle. For asynchronous applications, set-up and hold times do not apply.

## TEMPERATURE SPECIFICATIONS

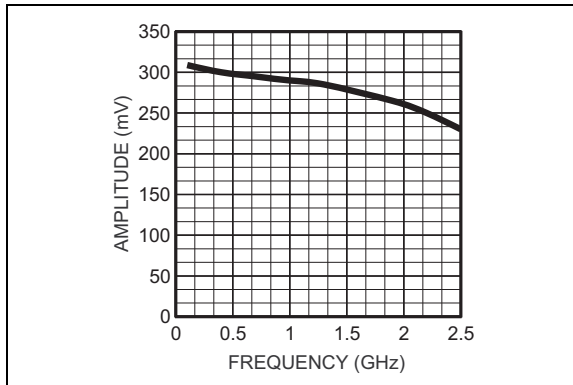
| Parameters                                  | Sym.          | Min. | Typ. | Max. | Units | Conditions     |
|---|---------------|------|------|------|-------|----------------|
| <b>Temperature Ranges</b>                   |               |      |      |      |       |                |
| Junction Operating Temperature              | $T_J$         | —    | —    | +125 | °C    | Note 1         |
| Storage Temperature Range                   | $T_S$         | −65  | —    | +150 | °C    | —              |
| Lead Temperature                            | —             | —    | —    | +260 | °C    | Soldering, 20s |
| Ambient Temperature                         | $T_A$         | −40  | —    | +85  | °C    | —              |
| <b>Package Thermal Resistances (Note 2)</b> |               |      |      |      |       |                |
| 16-pin 3 mm x 3 mm QFN (Still-Air)          | $\theta_{JA}$ | —    | 60   | —    | °C/W  | —              |
| 16-pin 3 mm x 3 mm QFN                      | $\Psi_{JB}$   | —    | 33   | —    | °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 +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.
- 2:** Package thermal resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.  $\Psi_{JB}$  and  $\theta_{JA}$  values are determined for a 4-layer board in still-air number, unless otherwise stated.

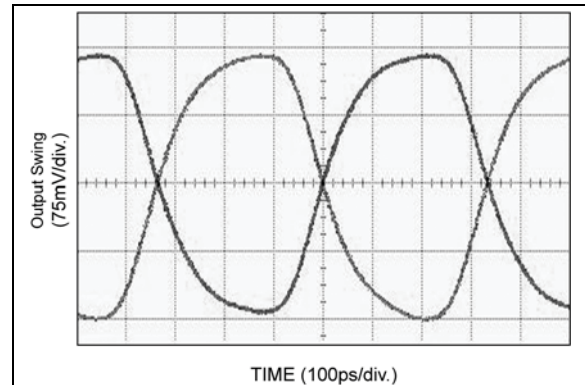
## 2.0 TYPICAL PERFORMANCE CURVES

**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.

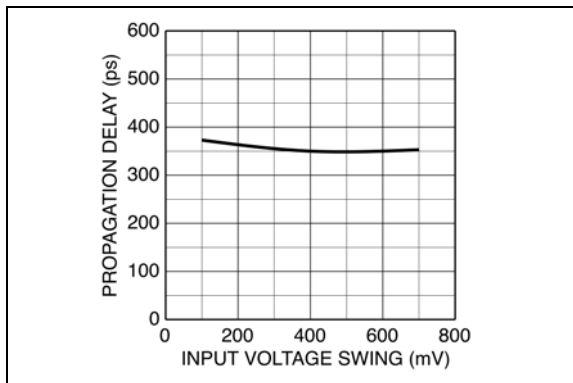
$V_{CC} = 3.3V$ ,  $GND = 0V$ ,  $V_{IN} = 400\text{ mV}$ ,  $R_L = 100\Omega$  across the outputs;  $T_A = +25^\circ C$  unless otherwise stated.



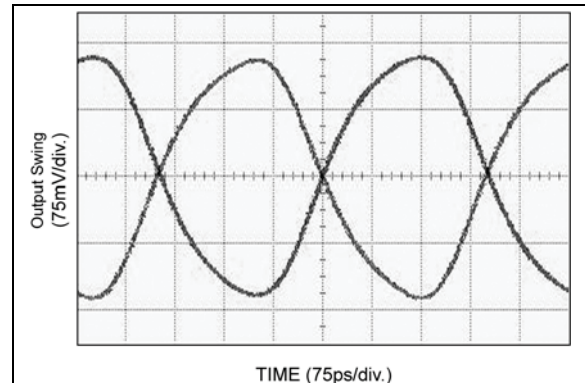
**FIGURE 2-1:** Output Swing vs. Frequency.



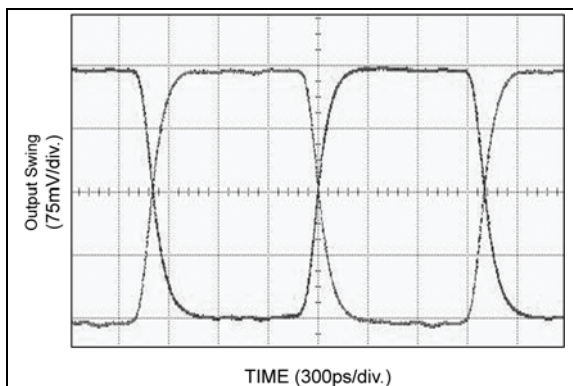
**FIGURE 2-4:** 1.5 GHz Output.



**FIGURE 2-2:** Propagation Delay vs. Input Voltage Swing.



**FIGURE 2-5:** 2 GHz Output.



**FIGURE 2-3:** 500 MHz Output.

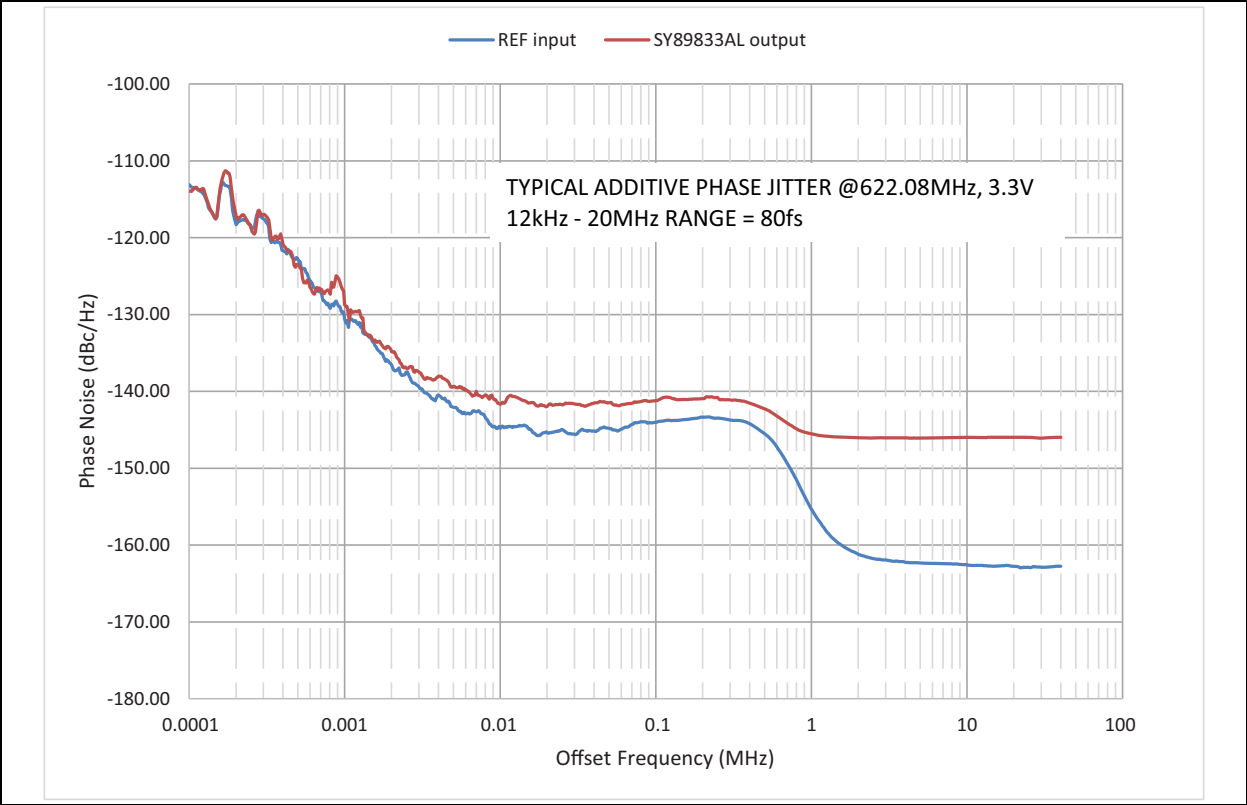


FIGURE 2-6: Typical Additive Phase Jitter.

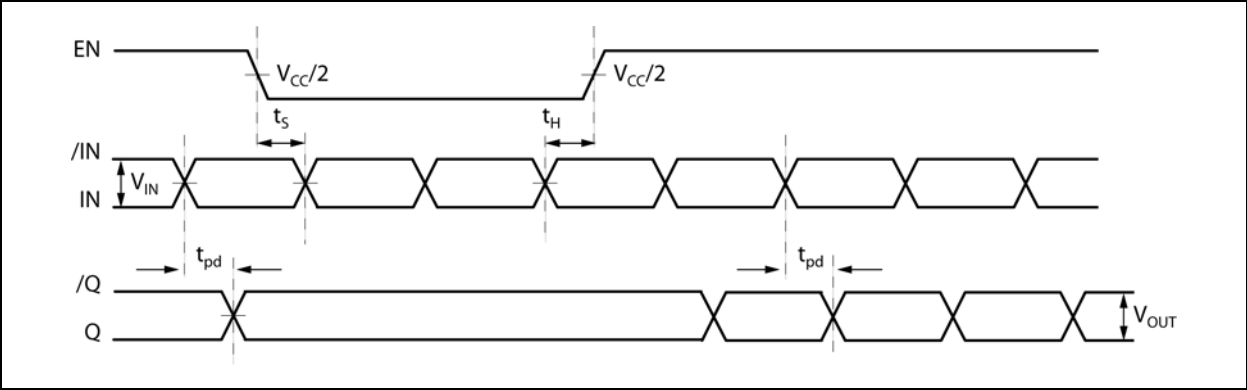


FIGURE 2-7: Timing Diagram.



### 3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

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

| Pin Number                     | Pin Name                                 | Description   |
|--------------------------------|--|---|
| 15, 16<br>1, 2<br>3, 4<br>5, 6 | Q0, /Q0<br>Q1, /Q1<br>Q2, /Q2<br>Q3, /Q3 | LVDS Differential Outputs: Normally terminated with 100Ω across the pair (Q, /Q). See the <a href="#">LVDS Outputs</a> section, <a href="#">Figure 5-1</a> . Unused outputs should be terminated with a 100Ω resistor across each pair.   |
| 8                              | EN                                       | This single-ended TTL/CMOS-compatible input functions as a synchronous output enable. The synchronous enable ensures that enable/disable will only occur when the outputs are in a logic low state. Note that this input is internally connected to a 25 kΩ pull-up resistor and will default to logic high state (enabled) if left open.   |
| 9, 12                          | /IN, IN                                  | Differential Input: This input pair is the differential signal input to the device. Input accepts AC- or DC-Coupled differential signals as small as 100 mV. Each pin of the pair internally terminates to a $V_T$ pin through 50Ω. Note that this input will default to an intermediate state if left open. Please refer to the <a href="#">Input Interface Applications</a> section for more details. |
| 10                             | $V_{REF-AC}$                             | Reference Voltage: These outputs bias to $V_{CC} - 1.425V$ . They are used when AC coupling the inputs (IN, /IN). For AC-coupled applications, connect $V_{REF-AC}$ to $V_T$ pin and bypass with 0.01 μF low-ESR capacitor to $V_{CC}$ . See the <a href="#">Input Interface Applications</a> section for more details. Maximum sink/source current is ±1.5 mA.   |
| 11                             | $V_T$                                    | Input Termination Center-Tap: Each side of the differential input pair terminates to a $V_T$ pin. The $V_T$ pin provides a center-tap to a termination network for maximum interface flexibility. See the <a href="#">Input Interface Applications</a> section for more details.  |
| 13                             | GND                                      | Ground. GND pin and exposed pad must be connected to the most negative potential of the device ground.  |
| 7, 14                          | $V_{CC}$                                 | Positive Power Supply: Bypass with 0.1 μF//0.01 μF low-ESR capacitors and place as close as possible to each $V_{CC}$ pin.  |

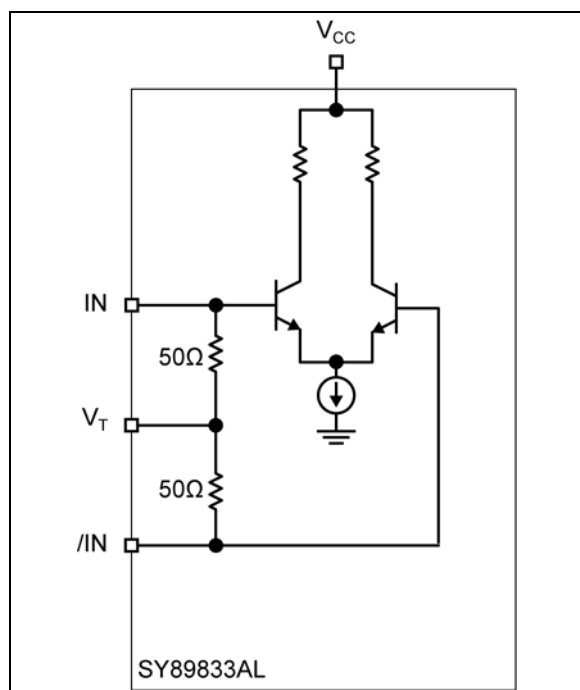
**TABLE 3-2: TRUTH TABLE**

| IN | /IN | EN | Q                            | /Q                           |
|----|-----|----|------------------------------|------------------------------|
| 0  | 1   | 1  | 0                            | 1                            |
| 1  | 0   | 1  | 1                            | 0                            |
| X  | X   | 0  | 0 ( <a href="#">Note 1</a> ) | 1 ( <a href="#">Note 1</a> ) |

**Note 1:** On next negative transition of the input signal (IN).

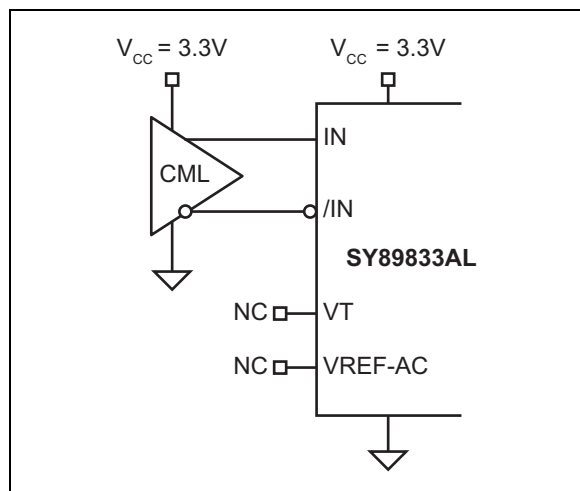
## 4.0 INPUT INFORMATION

### 4.1 Input Stage

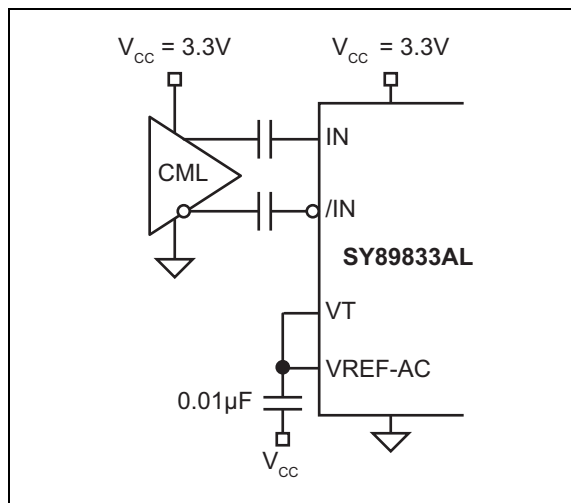


**FIGURE 4-1:** Simplified Differential Input Buffer.

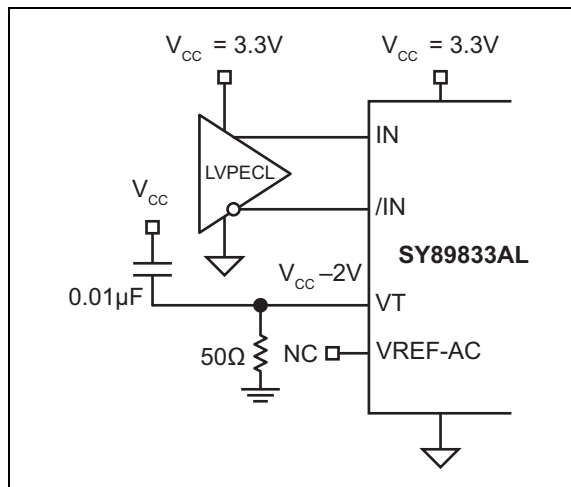
### 4.2 Input Interface Applications



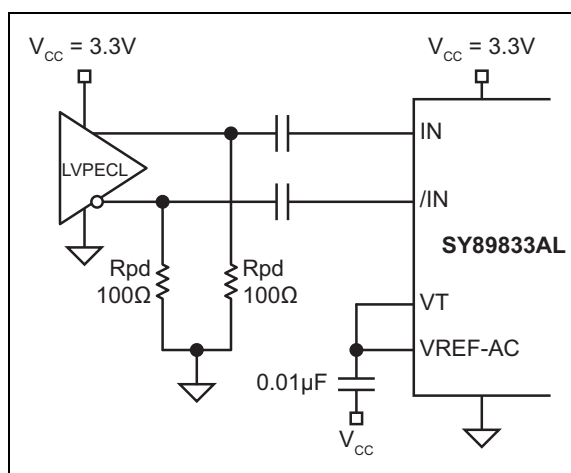
**FIGURE 4-2:** DC-Coupled CML Input Interface (Option: May Connect  $V_T$  to  $V_{CC}$ ).



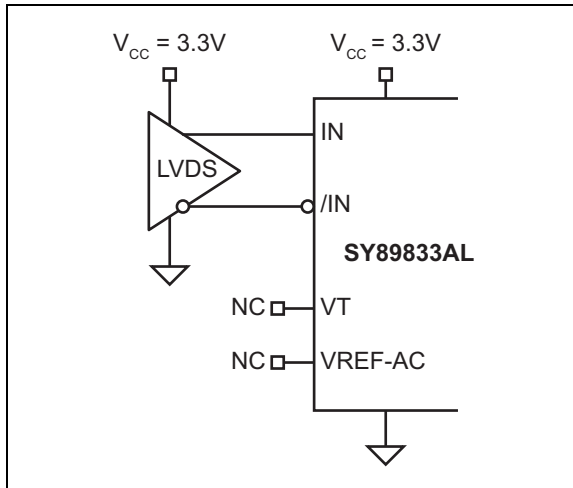
**FIGURE 4-3:** AC-Coupled CML Input Interface.



**FIGURE 4-4:** DC-Coupled LVPECL Input Interface.



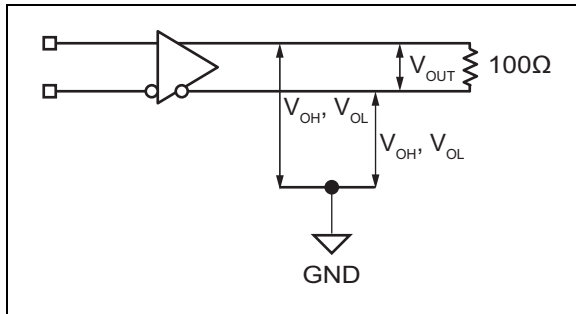
**FIGURE 4-5:** AC-Coupled LVPECL Input Interface.



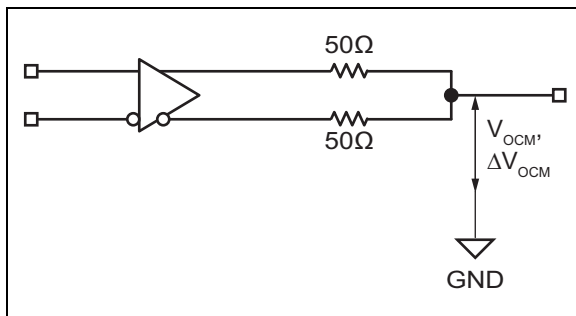
**FIGURE 4-6:** *LVDS Input Interface.*

## 5.0 LVDS OUTPUTS

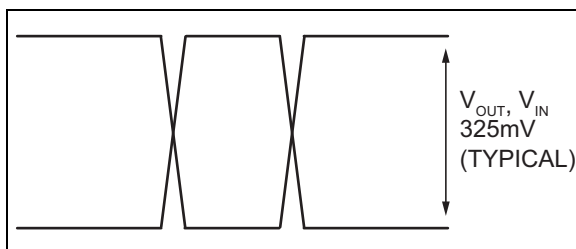
LVDS specifies a small swing of 325 mV typical, on a nominal 1.20V common-mode above ground. The common-mode voltage has tight limits to permit large variations in ground noise between a LVDS driver and receiver.



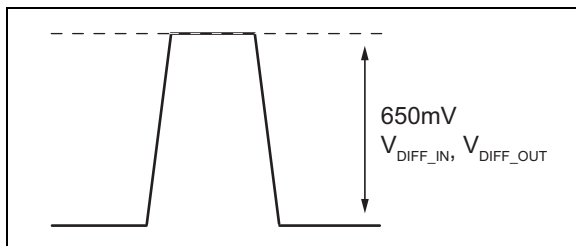
**FIGURE 5-1:** LVDS Differential Measurement.



**FIGURE 5-2:** LVDS Common-Mode Measurement.



**FIGURE 5-3:** Single-Ended Swing.



**FIGURE 5-4:** Differential Swing.



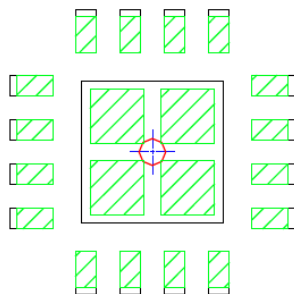
## 16-Lead QFN 3 mm x 3 mm Recommended Land Pattern

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

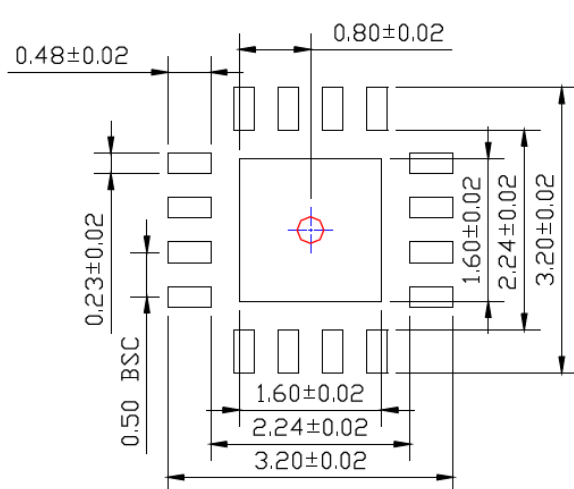
POD-Land Pattern drawing # QFN33-16LD-PL-1

### RECOMMENDED LAND PATTERN

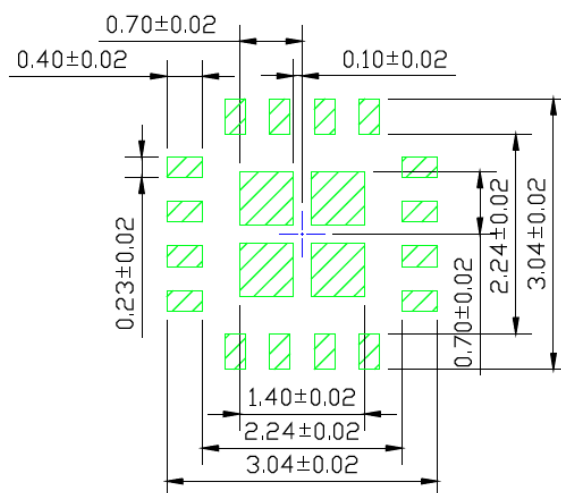
NOTE: 4, 5



STACKED-UP



EXPOSED METAL TRACE



SOLDER STENCIL OPENING

## APPENDIX A: REVISION HISTORY

### Revision A (January 2018)

- Converted Micrel document SY89833AL to Microchip data sheet DS20005608A.
- Minor text changes throughout.
- Updated [Figure 2-6](#).

# SY89833AL

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NOTES:



## PRODUCT IDENTIFICATION SYSTEM

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

| <u>PART NO.</u>     |           | X   | X       | X           | — | XX                 |
|---------------------|-----------|---|---------|-------------|---|--------------------|
| Device              |           | Voltage Option  | Package | Temperature |   | Special Processing |
| Device:             | SY89833A: | 3.3V Low-Noise, Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination |         |             |   |                    |
| Voltage Option:     | L =       | 3.3V Only   |         |             |   |                    |
| Package:            | M =       | 16-Pin 3 mm x 3 mm QFN  |         |             |   |                    |
| Temperature:        | G =       | −40°C to +85°C  |         |             |   |                    |
| Special Processing: | Blank =   | Bulk, 100 pcs.  |         |             |   |                    |
|                     | TR =      | Tape and Reel, 1000/Reel  |         |             |   |                    |

**Note 1:** Contact factory for die availability. Dice are guaranteed at T<sub>A</sub> = 25°C, DC Electricals only.

**Examples:**

a) SY89833ALMG: 3.3V Low-Noise, Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination, 3.3V Voltage Option, −40°C to +85°C Temp. Range, 16-Pin QFN, 100 pcs.

b) SY89833ALMG-TR: 3.3V Low-Noise, Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination, 3.3V Voltage Option, −40°C to +85°C Temp. Range, 16-Pin QFN, 1000/Reel

### Examples:

- a) SY89833ALMG: 3.3V Low-Noise, Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination, 3.3V Voltage Option, –40°C to +85°C Temp. Range, 16-Pin QFN, 100 pcs.
- b) SY89833ALMG-TR: 3.3V Low-Noise, Ultra-Precision 1:4 LVDS Fanout Buffer/Translator with Internal Termination, 3.3V Voltage Option, –40°C to +85°C Temp. Range, 16-Pin QFN, 1000/Reel

# SY89833AL

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NOTES:

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**Note the following details of the code protection feature on Microchip devices:**

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