



## SY89202U

### Precision 1:8 LVPECL Fanout Buffer with Three $\div 1/\div 2/\div 4$ Clock Divider Output Banks

## General Description

The SY89202U is a precision, high-speed, integrated clock divider LVPECL fanout buffer capable of handling clocks up to 1.5GHz. Optimized for communications applications, the three independently controlled output banks are phase matched and can be configured for pass-through ( $\div 1$ ),  $\div 2$  or  $\div 4$  divide ratios.

The differential input includes Micrel's unique, 3-pin input termination architecture that allows the user to interface to any AC- or DC-coupled signal as small as 100mV (200mV<sub>pp</sub>) without any level shifting or termination resistor networks in the signal path. The low skew, low jitter outputs are 800mV, 100k compatible LVPECL, with extremely fast rise/fall times guaranteed to be less than 220ps.

The EN (enable) input guarantees that the  $\div 1$ ,  $\div 2$  and  $\div 4$  outputs will start from the same state without any runt pulse after an asynchronous MR (master reset) is asserted. This is accomplished by enabling the outputs after a four-clock delay to allow the counters to synchronize.

The SY89202U is part of Micrel's Precision Edge<sup>®</sup> product family.

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



Precision Edge<sup>®</sup>

## Features

- Three low-skew LVPECL output banks with programmable  $\div 1$ ,  $\div 2$  and  $\div 4$  divider options
- Three independently programmable output banks
- Guaranteed AC performance over temp and voltage:
  - >1.5GHz clock frequency ( $f_{MAX}$ )
  - <930ps In-to-Out  $t_{pd}$
  - <220ps  $t_r/t_f$
- Ultra-low jitter design:
  - <1ps<sub>RMS</sub> random jitter (RJ)
  - <10ps<sub>pp</sub> total jitter (clock)
- Internal input termination
- Patent-pending input termination and VT pin accepts AC- and DC-coupled inputs (CML, PECL, LVDS)
- 800mV LVPECL output swing
- CMOS/TTL-compatible output enable (EN) and divider select control
- Power supply 2.5V  $\pm 5\%$  or 3.3V  $\pm 10\%$
- 40°C to +85°C industrial temperature range
- Available in 32-pin QFN package

## Applications

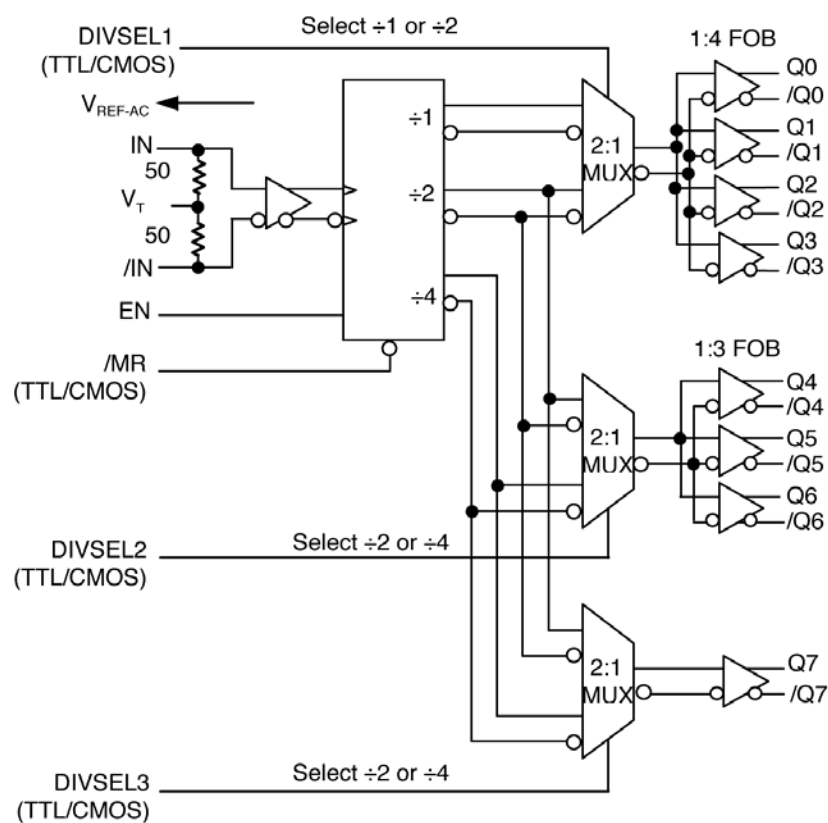
- All SONET/SDH channel select applications
- All Fibre Channel multi-channel select applications
- All Gigabit Ethernet multi-channel select applications

## Markets

- LAN/WAN
- Enterprise servers
- ATE
- Test and measurement

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## Functional Block Diagram



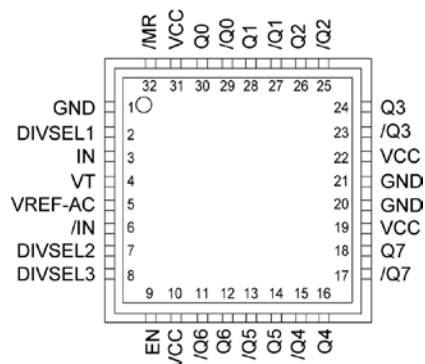
## Ordering Information

Part Number	Package Type	Operating Range	Package Marking	Lead Finish
SY89202UMG	QFN-32	Industrial	SY89202U with Pb-Free bar-line indicator	NiPdAu Pb-Free
SY89202UMGTR <sup>(2)</sup>	QFN-32	Industrial	SY89202U with Pb-Free bar-line indicator	NiPdAu Pb-Free

**Notes:**

1. Contact factory for die availability. Dice are guaranteed at  $T_A = 25_{-}^{\circ}\text{C}$ , DC Electricals Only.
2. Tape and Reel.

## Pin Configuration



32-Pin QFN

## Pin Description

Pin Number	Pin Name	Pin Function
2, 7, 8	DIVSEL1 DIVSEL2 DIVSEL3	Single-Ended Inputs: These TTL/CMOS inputs select the divide ratio for each of the three banks of outputs. Note that each of these inputs is internally connected to a 25k $\Omega$ pull-up resistor and will default to logic HIGH state if left open. The input-switching threshold is $V_{CC}/2$ .
3, 6	IN, /IN	Differential Input: This input pair is the differential signal input to the device. This input accepts AC- or DC-coupled signals as small as 100mV. The input pair internally terminates to a VT pin through 50 $\Omega$ . Note that these inputs will default to an indeterminate state if left open. Please refer to the "Input Interface Applications" section for more details.
4	VT	Input Termination Center-Tap: Each side of the differential input pair terminates to the VT pin. The VT pin provides a center-tap to a termination network for maximum interface flexibility. See "Input Interface Applications" section for more details.
5	VREF-AC	Reference Voltage: This output biases to $V_{CC}-1.2V$ . It is used for AC-coupling inputs IN and /IN. For AC-coupled applications, connect $V_{REF-AC}$ directly to the VT pin. Bypass with 0.01 $\mu F$ low ESR capacitor to $V_{CC}$ .
9	EN	Single-Ended Input: This TTL/CMOS input disables and enables the Q0 – Q7 outputs. This input is internally connected to a 25k $\Omega$ pull-up resistor and will default to logic HIGH state if left open. The input-switching threshold is $V_{CC}/2$ . For the input enable and disable functional description, refer to "Timing Diagram" section.
10, 19, 22, 31	VCC	Positive power supply. Bypass with 0.1 $\mu F$   0.01 $\mu F$ low ESR capacitors as close to VCC pins as possible.
16, 15, 14, 13, 12, 11	Q4, /Q4, Q5, /Q5, Q6, /Q6	Bank 2 LVPECL differential output pairs controlled by DIVSEL2: LOW, Q4 – Q6 = $\div 2$ , HIGH, Q4 – Q6 = $\div 4$ . Unused output pairs may be left open. Each output is designed to drive 800mV into 50 $\Omega$ terminated at $V_{CC}-2V$ .
30, 29, 28, 27, 26, 25, 24, 23	Q0, /Q0, Q1, /Q1, Q2, /Q2, Q3, /Q3	Bank 1 LVPECL differential output pairs controlled by DIVSEL1: LOW, Q0 – Q3 = $\div 1$ , HIGH, Q0 – Q3 = $\div 2$ . Unused output pairs may be left open. Each output is designed to drive 800mV into 50 $\Omega$ terminated at $V_{CC}-2V$ .
18, 17	Q7, /Q7	Bank 3 LVPECL differential output pair controlled by DIVSEL3: LOW, Q7 = $\div 2$ , HIGH, Q7 = $\div 4$ . Unused output pairs may be left open. Each output is designed to drive 800mV into 50 $\Omega$ terminated at $V_{CC}-2V$ .
32	/MR	Single-Ended Input: This TTL/CMOS-compatible master reset function asynchronously sets Q0 – Q7 outputs LOW and /Q0 – /Q7 outputs HIGH, and holds them in that state as long as the /MR input remains LOW. This input is internally connected to a 25k $\Omega$ pull-up resistor and will default to a logic HIGH state if left open. The input-switching threshold is $V_{CC}/2$ .
1, 20, 21	GND, Exposed Pad	Ground: Ground pin and exposed pad must be connected to the same ground plane.

## Truth Table

/MR <sup>(1)</sup>	EN <sup>(2, 3)</sup>	DIVSEL1	DIVSEL2	DIVSEL3	Q0 – Q3	Q4 – Q6	Q7
0	X	X	X	X	0	0	0
1	0	X	X	X	0	0	0
1	1	0	0	0	$\sim 1$	$\sim 2$	$\sim 2$
1	1	1	1	1	$\sim 2$	$\sim 4$	$\sim 4$

### Notes:

1. /MR asynchronously forces Q0 – Q7 LOW (/Q0 - /Q7 HIGH).
2. EN forces Q0 – Q7 LOW between 2 and 6 input clock cycles after the falling edge of EN. Refer to "Timing Diagram" section.
3. EN synchronously enables the outputs between 2 and 6 input clock cycles after the rising edge of EN. Refer to "Timing Diagram" section.

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

Supply Voltage ( $V_{CC}$ ) ..... -0.5V to +4.0V  
 Input Voltage ( $V_{IN}$ ) ..... -0.5V to  $V_{CC}$   
 Termination Current  
     Source or sink current on  $V_T$  .....  $\pm 100$ mA  
 Output Current  
     Source or sink current on IN, /IN .....  $\pm 50$ mA  
 $V_{REF-AC}$  Current  
     Source or sink current on  $V_{REF-AC}$  .....  $\pm 1.5$ mA  
 Lead Temperature (soldering, 20 sec.) ..... +260°C  
 Storage Temperature ( $T_s$ ) ..... -65°C to 150°C

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

Supply Voltage ( $V_{CC}$ ) ..... +2.375V to +2.625V  
     ..... +3.0V to +3.6V  
 Ambient Temperature ( $T_A$ ) ..... -40°C to +85°C  
 Package Thermal Resistance<sup>(3)</sup>  
     QFN ( $\theta_{JA}$ )  
         Still-Air ..... 35°C/W  
     QFN ( $\psi_{JB}$ )  
         Junction-to-Board ..... 20°C/W

**DC Electrical Characteristics<sup>(4)</sup>**

$T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , unless noted.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply		2.375 3.0		2.625 3.6	V V
$I_{CC}$	Power Supply Current	No load, max. $V_{CC}$		125	180	mA
$R_{DIFF\_IN}$	Differential Input Resistance (IN-to-/IN)		90	100	110	$\Omega$
$R_{IN}$	Input Resistance (IN-to- $V_T$ )		45	50	55	$\Omega$
$V_{IH}$	Input High Voltage (IN, /IN)		1.2		$V_{CC}$	V
$V_{IL}$	Input Low Voltage (IN, /IN)		0		$V_{IH}-0.1$	V
$V_{IN}$	Input Voltage Swing (IN, /IN)	See Figure 1a.	0.1		$V_{CC}$	V
$V_{DIFF\_IN}$	Differential Input Voltage Swing  IN-/IN	See Figure 1b.	0.2			V
$V_{REF-AC}$	Output Reference Voltage ( $V_{REF-AC}$ )		$V_{CC}-1.3$	$V_{CC}-1.2$	$V_{CC}-1.1$	V
IN-to- $V_T$	Voltage from Input to $V_T$				1.8	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 ratings 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. Package Thermal Resistance assumes exposed pad is soldered (or equivalent) to the devices most negative potential on the PCB.  $\theta_{JA}$  and  $\psi_{JB}$  values are determined for a 4-layer board in still air, unless otherwise stated.
4. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.

## LVPECL Outputs DC Electrical Characteristics<sup>(5)</sup>

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 50\Omega$  to  $V_{CC}-2V$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage Q, /Q		$V_{CC}-1.145$		$V_{CC}-0.895$	V
$V_{OL}$	Output LOW Voltage Q, /Q		$V_{CC}-1.945$		$V_{CC}-1.695$	V
$V_{OUT}$	Output Voltage Swing Q, /Q	See Figure 1a.	550	800		mV
$V_{DIFF-OUT}$	Differential Output Voltage Swing  Q - /Q	See Figure 1b.	1100	1600		mV

## LVTTTL/CMOS DC Electrical Characteristics<sup>(5)</sup>

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{IH}$	Input HIGH Voltage		2.0			V
$V_{IL}$	Input LOW Voltage				0.8	V
$I_{IH}$	Input HIGH Current		-125		30	$\mu A$
$I_{IL}$	Input LOW Current		-300			$\mu A$

**Note:**

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

## AC Electrical Characteristics<sup>(6)</sup>

$V_{CC} = 2.5V \pm 5\%$  or  $3.3V \pm 10\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ,  $R_L = 50\Omega$  to  $V_{CC} - 2V$ , unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Output Toggle Frequency	Output swing $\geq 400mV$	1.5			GHz
	Maximum Input Frequency		3.0			GHz
$t_{PD}$	Differential Propagation Delay	IN-to-Q	530	700	930	ps
	/MR – Q Propagation Delay				900	ps
$t_{PD}$ Tempco	Differential Propagation Delay Temperature Coefficient			115		fs/ $^\circ C$
$t_{SKEW}$	Within-bank Skew	Within same fanout bank, Note 7		10	25	ps
	Bank-to-Bank Skew	Same divide setting, Note 8		15	35	ps
	Bank-to-Bank Skew	Different divide setting, Note 8		25	50	ps
	Part-to-Part Skew	Note 9			200	ps
$t_{JITTER}$	Deterministic Jitter (DJ)	Note 10			10	pS <sub>PP</sub>
	Random Jitter (RJ)	Note 11			1	pS <sub>RMS</sub>
	Total Jitter	Note 12			10	pS <sub>PP</sub>
	Cycle-to-Cycle Jitter	Note 13			1	pS <sub>RMS</sub>
$t_r, t_f$	Output Rise/Fall Time	20% to 80%, At full output swing.	70	130	220	ps

### Notes:

6. Measured with 100mV input swing. See "Timing Diagrams" section for definition of parameters. High-frequency AC-parameters are guaranteed by design and characterization.
7. Within-bank skew is the difference in propagation delays among the outputs within the same bank.
8. Bank-to-bank skew is the difference in propagation delays between outputs from different banks. Bank-to-bank skew is also the phase offset between each bank, after MR is applied.
9. Part-to-part skew is defined for two parts with identical power supply voltages at the same temperature and with no skew of the edges at the respective inputs.
10. Deterministic jitter is measured with a K28.7 101010 pattern, measured at  $<f_{MAX}$ .
11. Random jitter is measured with a K28.7 101010 pattern, measured at  $<f_{MAX}$ .
12. Total jitter definition: with an ideal clock input of frequency  $<f_{MAX}$ , no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.
13. Cycle-to-cycle jitter definition: the variation of periods between adjacent cycles,  $T_n - T_{n-1}$  where T is the time between rising edges of the output signal.

## Single-Ended and Differential Swings



Figure 1a. Single-Ended Voltage Swing

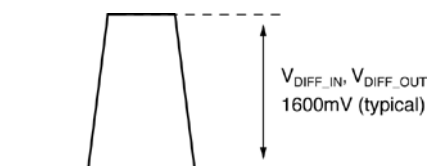
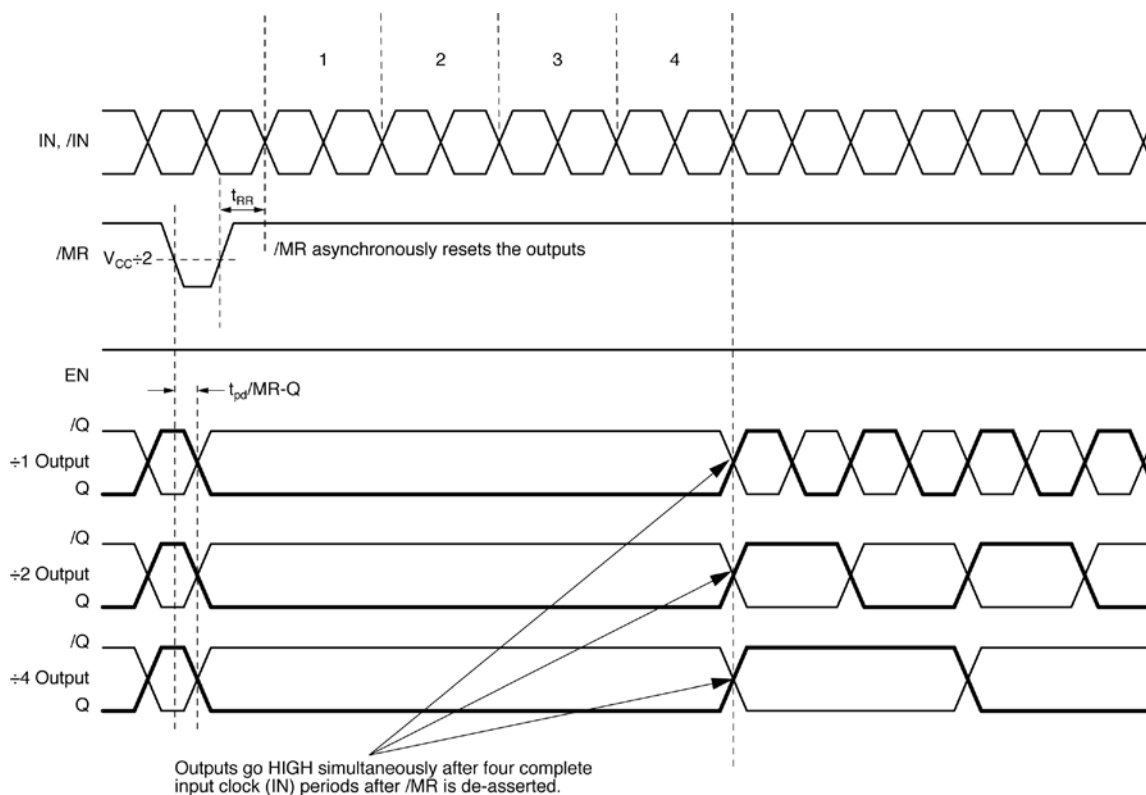


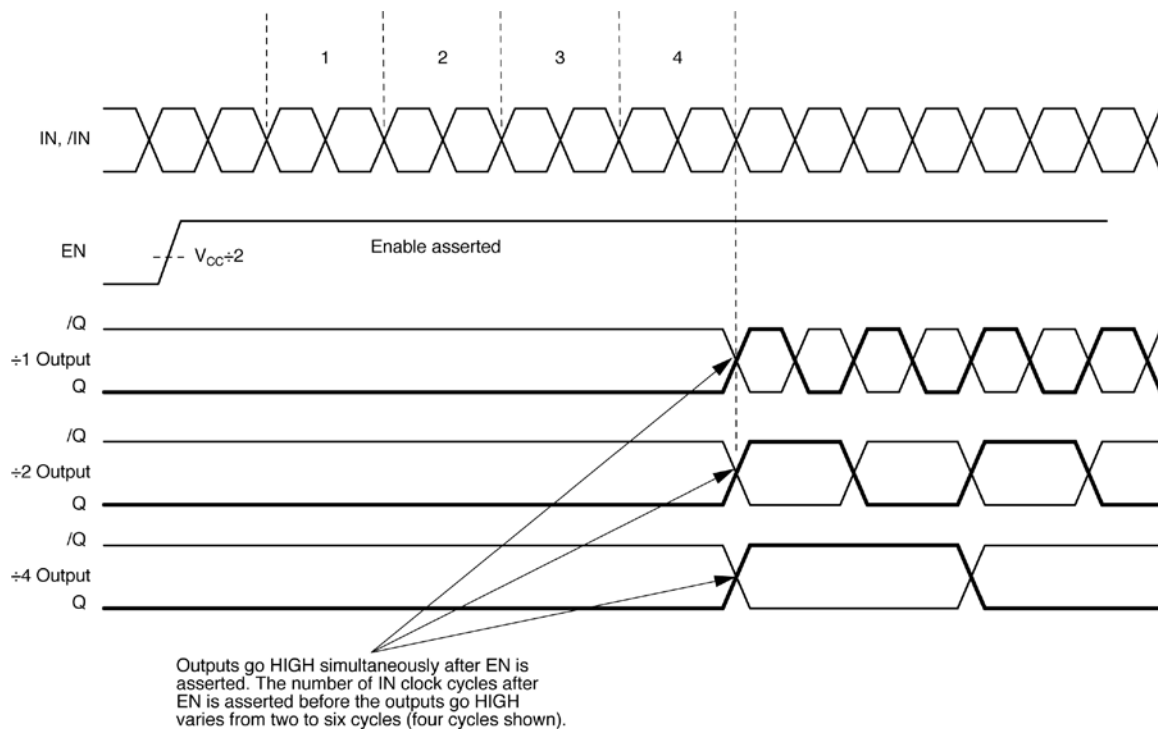
Figure 1b. Differential Voltage Swing

## Timing Diagrams

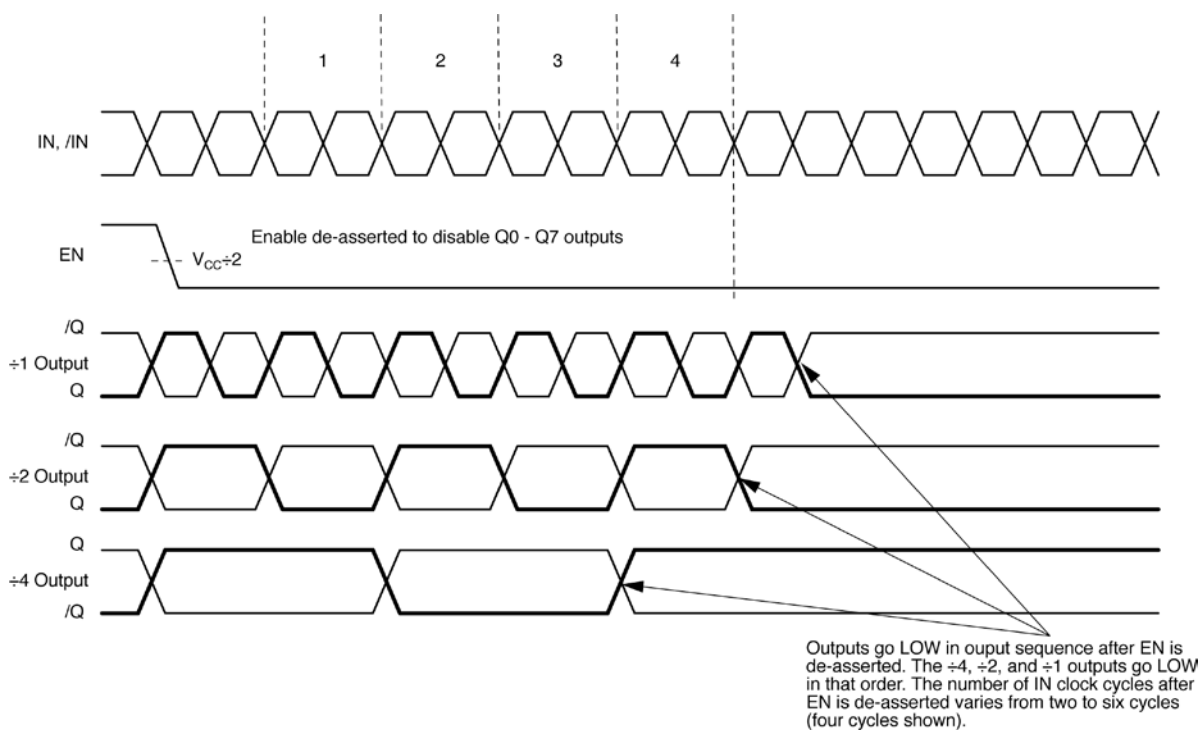


Timing Diagram Showing Reset with Output Enabled



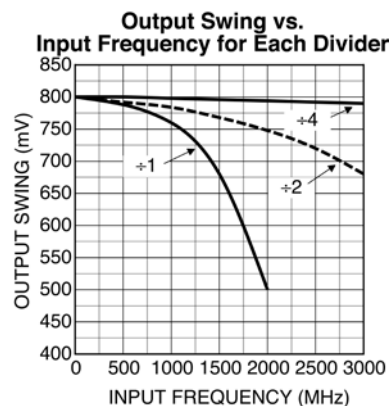
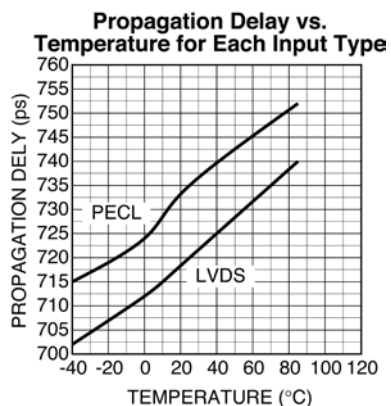


Timing Diagram Showing Enable Timing

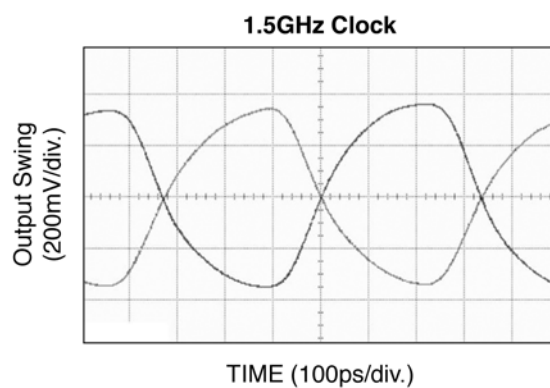
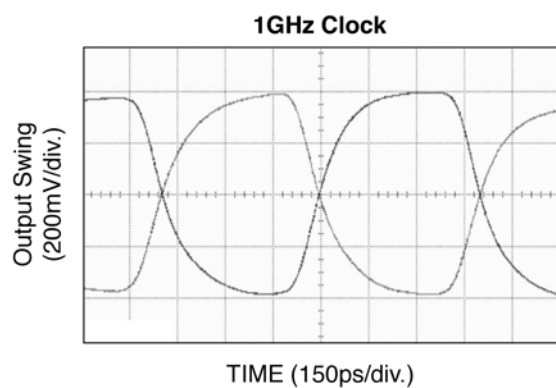
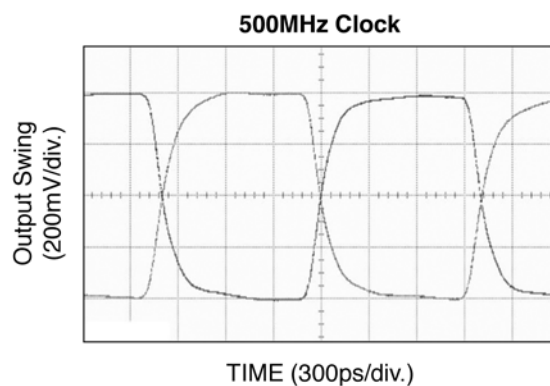
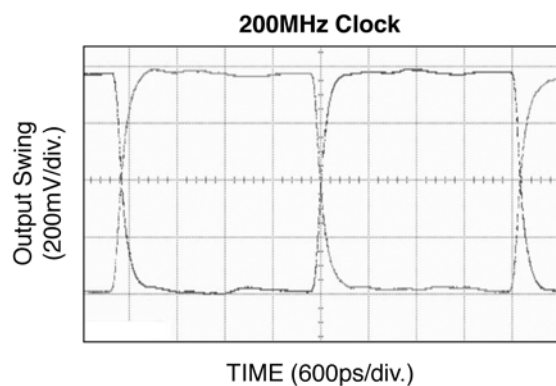


Timing Diagram Showing Disable Timing

## Typical Operating Characteristics



## Functional Characteristics



## Input and Output Stages

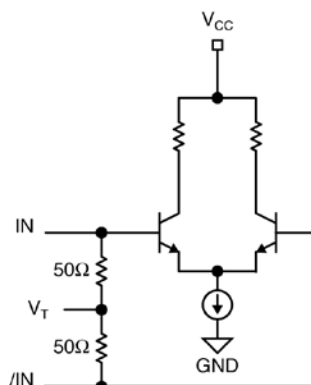


Figure 2a. Simplified Differential Input Stage

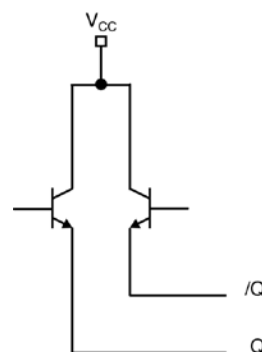


Figure 2b. Simplified LVPECL Output Stage

## Input Interface Applications

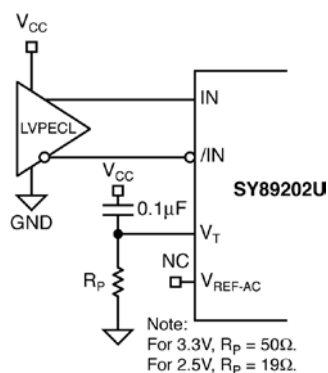


Figure 3a. LVPECL Interface (DC-Coupled)

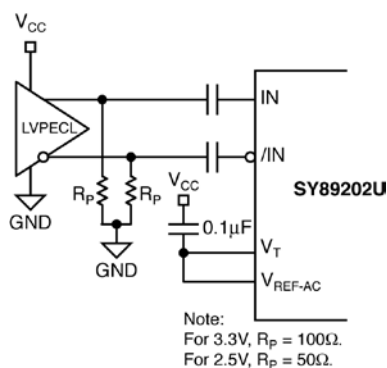


Figure 3b. LVPECL Interface (AC-Coupled)

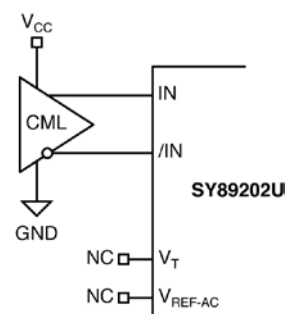


Figure 3c. CML Interface (DC-Coupled)

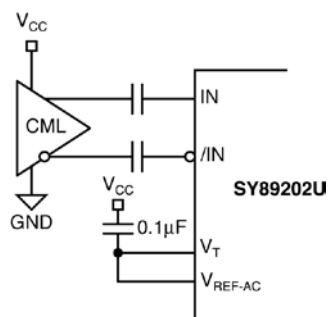


Figure 3d. CML Interface (AC-Coupled)

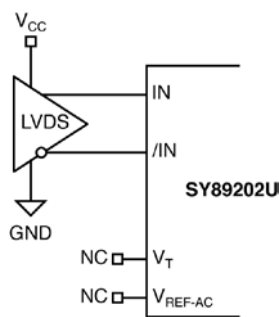


Figure 3e. LVDS Interface (DC-Coupled)

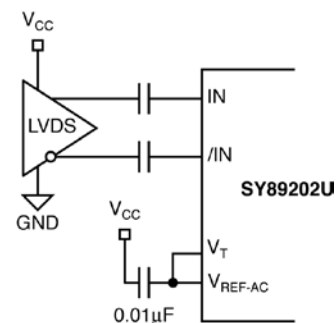


Figure 3f. LVDS Interface (AC-Coupled)

## LVPECL Output Interface Applications

LVPECL has high input impedance, and very low output impedance (open emitter), and small signal swing which results in low EMI. LVPECL is ideal for driving 50Ω- and 100Ω-controlled impedance transmission lines. There are several techniques for terminating the LVPECL

output: Parallel Termination-Thevenin Equivalent, Parallel Termination (3-resistor), and AC-Coupled Termination. Unused output pairs may be left floating. However, single-ended outputs must be terminated, or balanced.

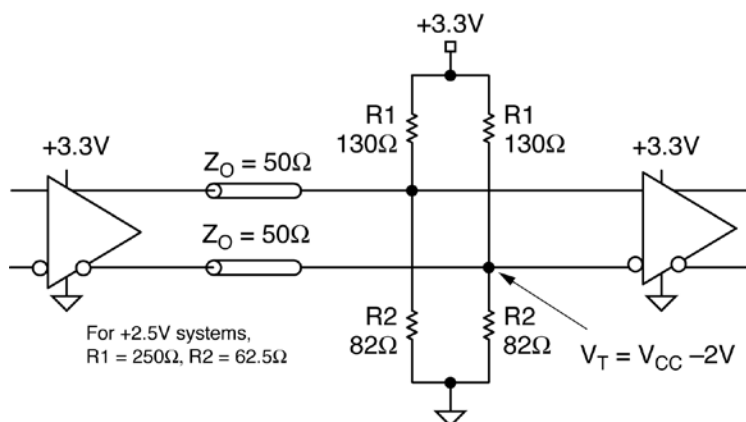


Figure 4. Parallel Termination-Thevenin Equivalent

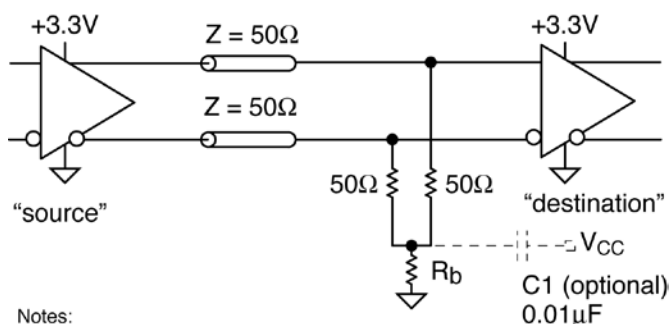
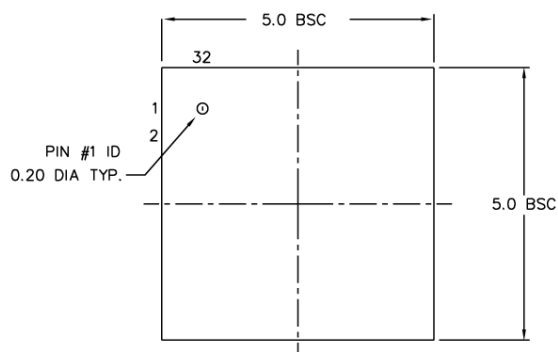


Figure 5. Parallel Termination (3-Resistor)

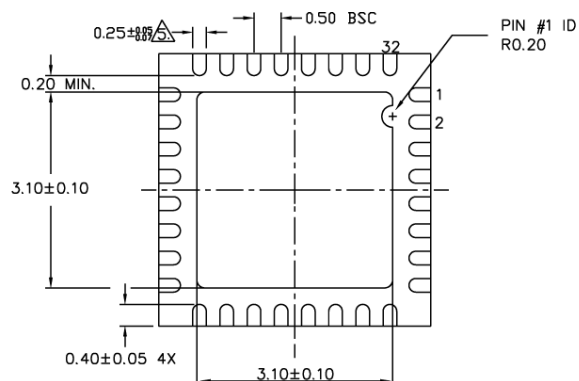
## Related Product and Support Documentation

Part Number	Function	Datasheet Link
SY89200U	Ultra-Precision 1:8 LVDS Fanout with Three $\div 1/\div 2/\div 4$ Clock Divider Output Banks	<a href="http://www.micrel.com/_PDF/HBW/sy89200u.pdf#page=1">http://www.micrel.com/_PDF/HBW/sy89200u.pdf#page=1</a>
HBW Solutions	New Products and Applications	<a href="http://www.micrel.com/page.do?page=/product-info/as/HBWsolutions.shtml">http://www.micrel.com/page.do?page=/product-info/as/HBWsolutions.shtml</a>

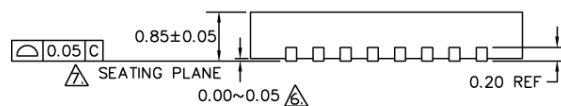
## Package Information



TOP VIEW



BOTTOM VIEW



SIDE VIEW

### NOTE:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
  2. MAX. PACKAGE WARPAGE IS 0.05 mm.
  3. MAXIMUM ALLOWABLE BURRS IS 0.076 mm IN ALL DIRECTIONS.
  4. PIN #1 ID ON TOP WILL BE LASER/INK MARKED.
- △ DIMENSION APPLIES TO METALIZED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25 mm FROM TERMINAL TIP.
- △ APPLIED ONLY FOR TERMINALS.
- △ APPLIED FOR EXPOSED PAD AND TERMINALS.

### 32-Pin QFN

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