



# SY89200U

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

### General Description

The SY89200U is a 2.5V precision, high-speed, integrated clock divider and LVDS 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  $\div 4$  divider ratios.

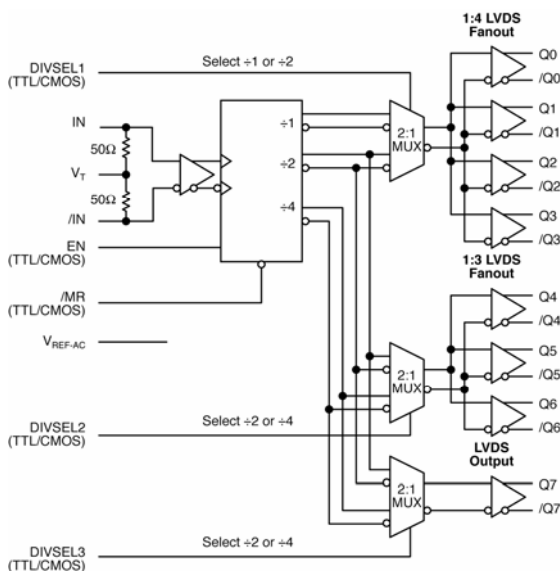
The differential input includes Micrel's unique, 3-pin input termination architecture that allows the user to interface to any differential signal path. The low-skew, low-jitter outputs are LVDS-compatible with extremely fast rise/fall times guaranteed to be less than 150ps.

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 master rest (MR) is asserted. This is accomplished by enabling the outputs after a four-clock delay to allow the counters to synchronize.

The SY89200U 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).

### Functional Block Diagram



Precision Edge is a registered trademark of Micrel, Inc  
MLF and MicroLeadFrame are registered trademark of Amkor Technology.



Precision Edge<sup>®</sup>

### Features

- Three low-skew LVDS output banks with programmable  $\div 1$ ,  $\div 2$  and  $\div 4$  divider options
- Three independently programmable output banks
- Guaranteed AC performance over temperature and voltage:
  - Accepts a clock frequency up to 1.5GHz
  - <900ps IN-to-OUT propagation delay
  - <150ps rise/fall time
  - <50ps bank-to-bank phase offset
- Ultra-low jitter design:
  - <1ps<sub>RMS</sub> random jitter
  - <10ps<sub>PP</sub> total jitter (clock)
- Patent-pending input termination and VT pin accepts DC- and AC-coupled inputs (CML, PECL, LVDS)
- LVDS-compatible outputs
- CMOS/TTL-compatible output enable (EN) and divider select control
- 2.5V  $\pm 5\%$  power supply
- $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range
- Available in 32-pin (5mm x 5mm) MLF<sup>®</sup> package

### Applications

- All SONET/SD applications
- All Fibre Channel applications
- All Gigabit Ethernet applications

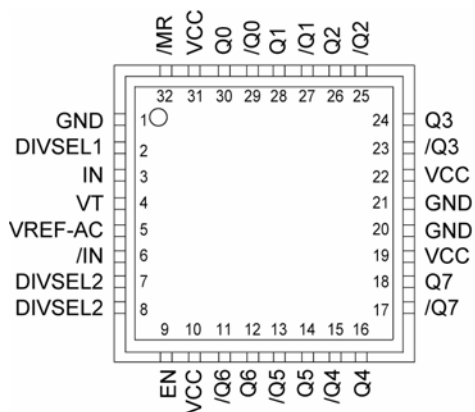
## Ordering Information<sup>(1)</sup>

Part Number	Package Type	Temperature Range	Package Marking	Lead Finish
SY89200UMI	MLF-32	Industrial	SY89200U	Sn-Pb
SY89200UMITR <sup>(2)</sup>	MLF-32	Industrial	SY89200U	Sn-Pb
SY89200UMG	MLF-32	Industrial	SY89200U with Pb-Free bar-line indicator	Pb-Free NiPdAu
SY89200UMGTR <sup>(2)</sup>	MLF-32	Industrial	SY89200U with Pb-Free bar-line indicator	Pb-Free NiPdAu

**Note:**

1. Contact factory for die availability. Dice are guaranteed at TA = 25°C, DC Electricals only.
2. Tape and Reel.

## Pin Configuration



**32-Pin MLF<sup>®</sup> (MLF-32)**

## Pin Description

Pin Number	Pin Name	Pin Function
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 50Ω. Note that these inputs will default to an indeterminate state if left open. Please refer to the “Input Interface Applications” section for more details.
2 7 8	DIVSEL1 DIVSEL2 DIVSEL3	Single-Ended Inputs: These TTL/CMOS inputs select the device ratio for each of the three banks of outputs. Note that each of these inputs is internally connected to a 25kΩ pull-up resistor and will default to logic HIGH state if left open. The input-switching threshold is $V_{CC}/2$ .
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 VREF-AC directly to the VT pin. Bypass with 0.01μF low ESR capacitor to $V_{CC}$ . Maximum sink/source capability is 0.5mA.
9	EN	Single-Ended Input: This TTL/CMOS input disable and enable the Q0 – Q7 outputs. This input is internally connected to a 25kΩ 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 Figures 2a through 2c.
30, 29, 28, 27, 26, 25, 24, 23	Q0, /Q0, /Q1, /Q1, Q2, /Q2 Q3, /Q3	Bank 1 LVDS differential output pairs controlled by DIVSEL1: LOW Q0 – Q3 = ÷1 HIGH, Q0 – Q3 = ÷2. Unused output pairs should be terminated with 100Ω across the differential pair.
16, 15, 14, 13, 12, 11	Q4, /Q4, Q5, /Q5, Q6, /Q6	Bank 2 LVDS differential output pairs controlled by DIVSEL2: LOW Q4 – Q6 = ÷2 HIGH, Q4 – Q6 = ÷2. Unused output pairs should be terminated with 100Ω across the differential pair.
18, 17	Q7, /Q7	Bank 3 LVDS differential output pairs controlled by DIVSEL3: LOW Q7 = ÷2 HIGH, Q7 = ÷2. Unused output pairs should be terminated with 100Ω across the differential pair.
32	/MR	Single-Ended Input: This TTL/CMOS-compatible master reset function asynchronously sets Q0 – Q7 outputs LOW, /Q0 – /Q7 outputs HIGH, and holds them in that state as long as /MR remains LOW. This input is internally connected to a 25kΩ pull-up resistor and will default to a logic HIGH state if left open. The input-switching threshold is $V_{CC}/2$ .
10, 19, 22, 31	VCC	Positive power supply. Bypass with 0.1μF  0.01μF low ESR capacitors.
1, 20, 21	GND Exposed	Ground and exposed pad must be connected to the same GND plane on the board.

## 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	÷1	÷2	÷2
1	1	1	1	1	÷2	÷4	÷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 two and six 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 <sup>(3)</sup>	
Source or sink current on $V_T$	±100mA
Output Current <sup>(3)</sup>	
Source or sink current on IN, /IN	±50mA
$V_{REF-AC}$ Current <sup>(3)</sup>	
Source or sink current on $V_{REF-AC}$	±2mA
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
Ambient Temperature ( $T_A$ )	-40°C to +85°C
Package Thermal Resistance <sup>(4)</sup>	
MLF <sup>®</sup> ( $\theta_{JA}$ )	
Still-Air	35°C/W
MLF <sup>®</sup> ( $\Psi_{JB}$ )	
Junction -to-Board	20°C/W

### DC Electrical Characteristics

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

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{CC}$	Power Supply		2.375	2.5	2.625	V
$I_{CC}$	Power Supply Current	No load, max. $V_{CC}$ , Note 6			350	mA
$R_{DIFF\_IN}$	Differential Input Resistance (IN-to-/IN)		80	100	120	$\Omega$
$R_{IN}$	Input Resistance (IN-to- $V_T$ , /IN-to- $V_T$ )		40	50	60	$\Omega$
$V_{IH}$	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
$V_{REF-AC}$	Reference Voltage		$V_{CC}-1.3$	$V_{CC}-1.2$	$V_{CC}-1.1$	V
IN-to- $V_T$	Voltage from Input to $V_T$				1.8	V

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

$V_{CC} = 2.5V \pm 5\%$ ;  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ , 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	$\mu\text{A}$
$I_{IL}$	Input Low Current				-300	$\mu\text{A}$

**Notes:**

1. Permanent device damage may occur if ratings in the "Absolute Maximum Ratings" section are exceeded. This is a stress rating only and functional operation is not implied for conditions other than those detailed in the operational sections of this datasheet. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.
2. The datasheet limits are not guaranteed if the device is operated beyond the operating ratings.
3. Due to the limited drive capability use for input of the same package only.
4. Package thermal resistance assumes exposed pad is soldered (or equivalent) to the device's most negative potential on the PCB.  $\Psi_{JB}$  uses 4-layer  $\theta_{JA}$  in still-air, unless otherwise stated.
5. The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
6. Includes current through internal 50 $\Omega$  pull-up.

## LVDS OUTPUT DC Electrical Characteristics<sup>(7)</sup>

$V_{CC} = 2.5V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 100\Omega$  across Q and /Q, unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$V_{OH}$	Output HIGH Voltage; (Q, /Q)				1.475	V
$V_{OL}$	Output LOW Voltage; (Q, /Q)		0.925			V
$V_{OUT}$	Output Voltage Swing; (Q, /Q)		250	350		mV
$V_{DIFF\_OUT}$	Differential Output Voltage Swing  Q - /Q		500	700		mV
$V_{OCM}$	Output Common Mode Voltage (Q, /Q)		1.125		1.275	V
$\Delta V_{OCM}$	Change in Common Mode Voltage (Q, /Q)		-50		+50	mV

## AC Electrical Characteristics<sup>(8)</sup>

$V_{CC} = 2.5V \pm 5\%$ ;  $T_A = -40^\circ C$  to  $+85^\circ C$ ;  $R_L = 100\Omega$  across all outputs (Q and /Q), unless otherwise stated.

Symbol	Parameter	Condition	Min	Typ	Max	Units
$f_{MAX}$	Maximum Operating Frequency	$V_{OUT} > 200mV$ Clock	1.5			GHz
$t_{PD}$	Differential Propagation Delay	IN-to-Q	500	700	900	ps
		/MR-to-Q			900	ps
$t_{RR}$	Reset Recovery Time	/MR(L-H)-to-(L-H)			900	ps
$t_{PD}$ Tempco	Differential Propagation Delay Temperature Coefficient			115		fs/ $^\circ C$
$t_{SKEW}$	Within-Bank Skew	Within same fanout bank, Note 9		10	25	ps
	Bank-to-Bank Skew	Same divide setting, Note 10		15	35	ps
	Bank-to-Bank Skew	Differential divide setting, Note 10		25	50	ps
	Part-to-Part Skew	Note 11			200	ps
$t_{JITTER}$	Random Jitter (RJ)	Note 12			1	ps <sub>RMS</sub>
	Total Jitter (TJ)	Note 13			10	ps <sub>PP</sub>
	Cycle-to-Cycle Jitter	Note 14			1	ps <sub>RMS</sub>
$t_r, t_f$	Rise/Fall Time	20% to 80% at full output swing	40	80	150	ps

### Notes:

- The circuit is designed to meet the DC specifications shown in the above table after thermal equilibrium has been established.
- Measured with 100mV input swing. See "Timing Diagram" section for definition of parameters. High-frequency AC-parameters are guaranteed by design and characterization.
- Within-bank is the difference in propagation delays among the outputs within the same bank.
- 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.
- 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.
- RJ is measured with a K28.7 comma detect character pattern.
- Total jitter definition: with an ideal clock input of frequency  $\leq f_{MAX}$ , no more than one output edge in  $10^{12}$  output edges will deviate by more than the specified peak-to-peak jitter value.
- 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 Differential Swings



Figure 1a. Single-Ended Voltage Swing

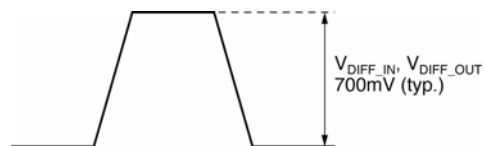


Figure 1b. Differential Voltage Swing

### Timing Diagram

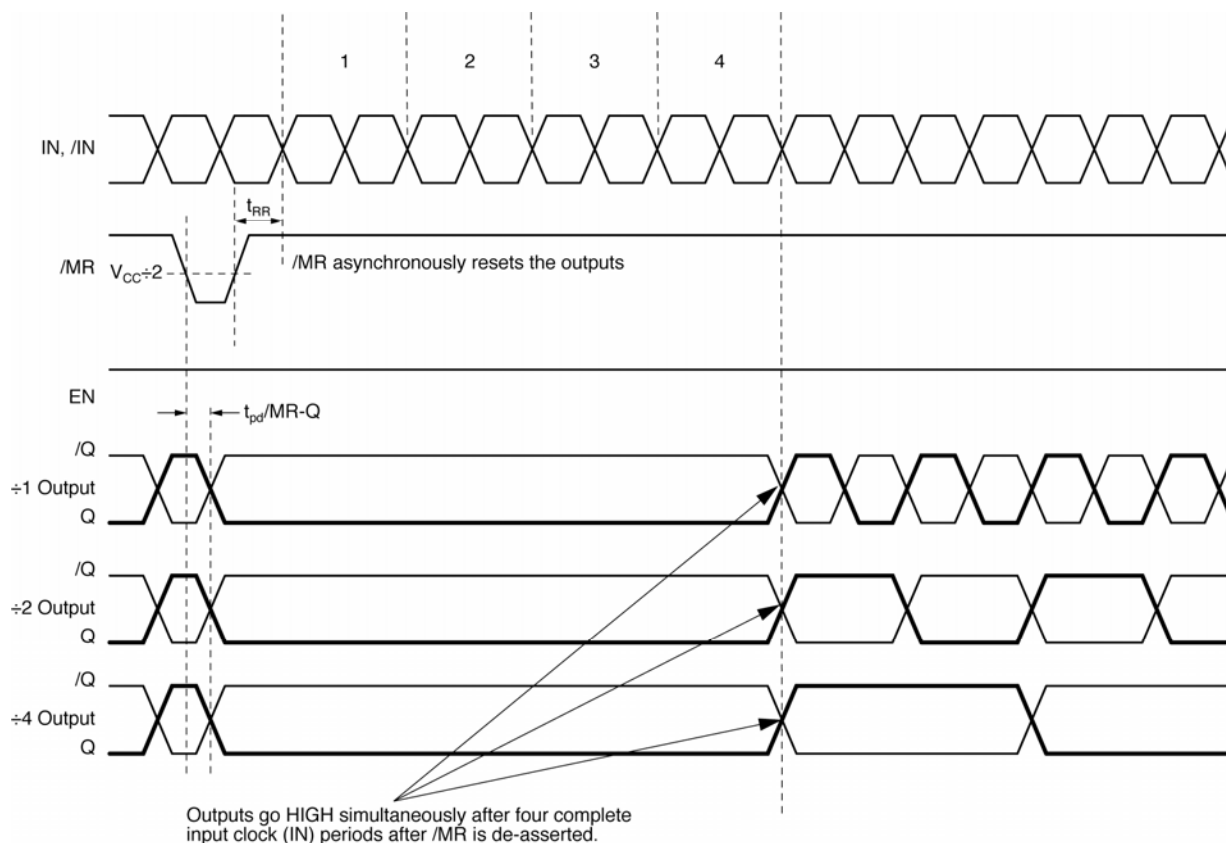


Figure 2a. Reset with Output Enabled

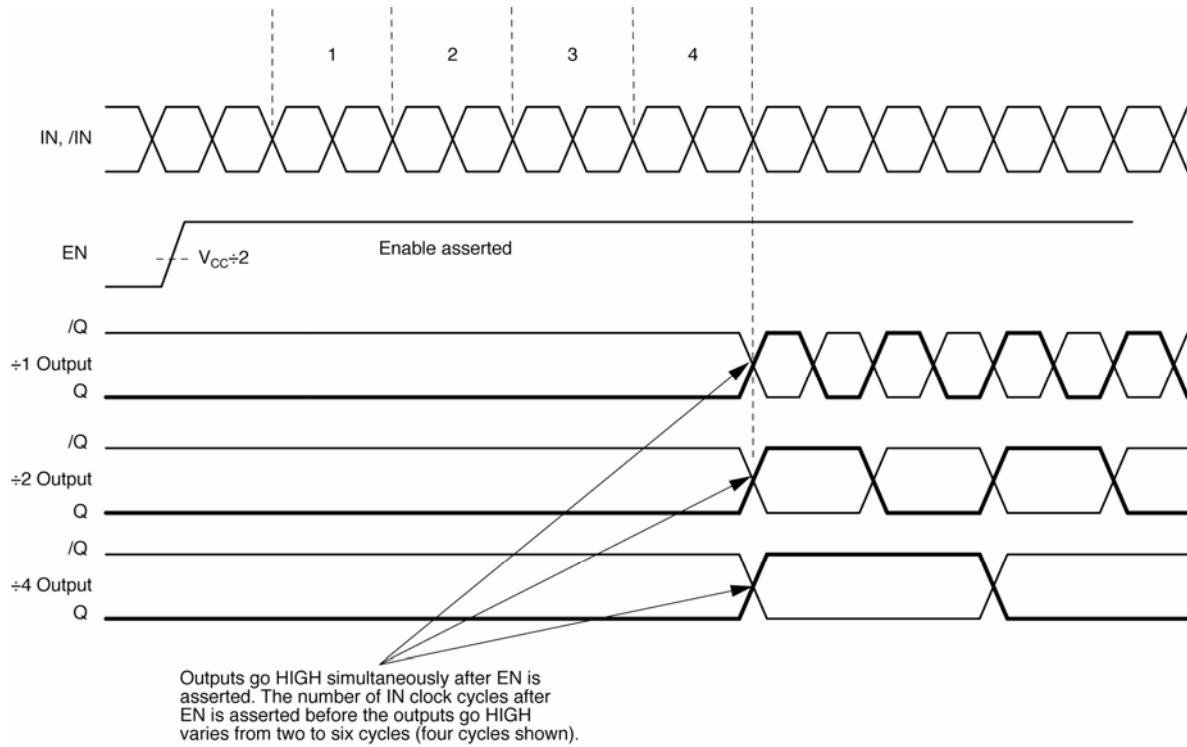


Figure 2b. Enable Timing

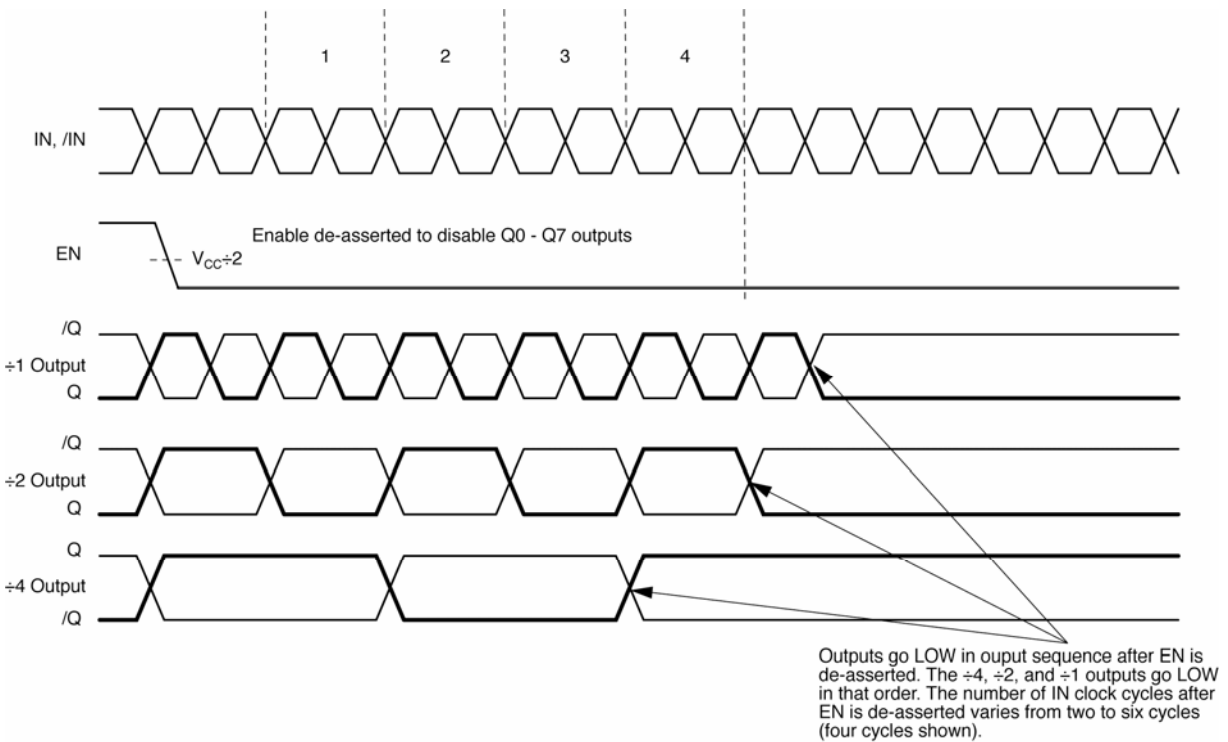
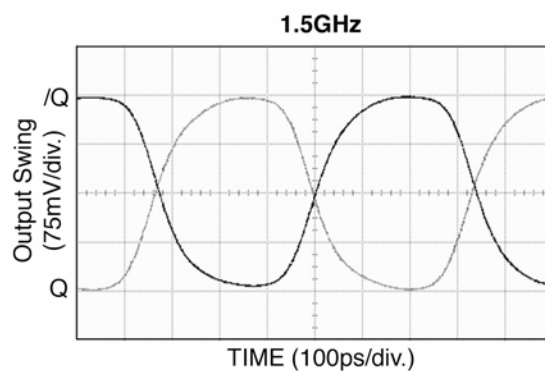
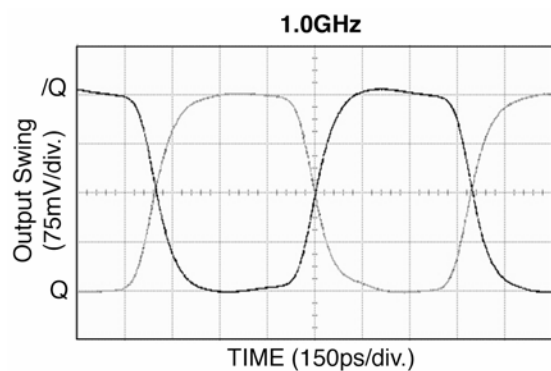
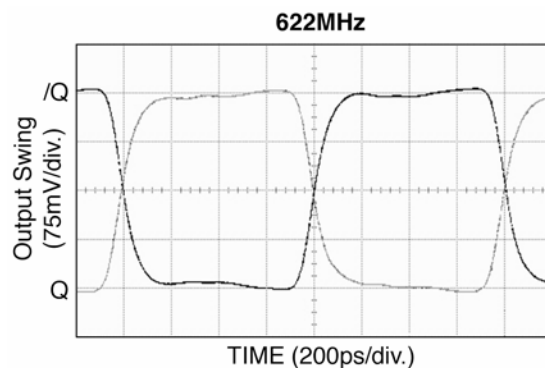
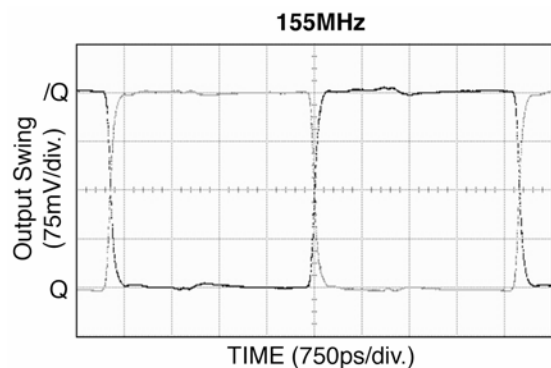


Figure 2c. Disable Timing

## Typical Operating Characteristics





## Input Stage Internal Termination

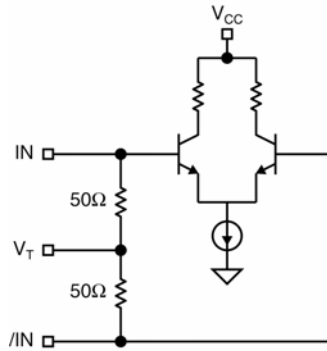


Figure 3. Simplified Differential Input Stage

## Input Interface Applications

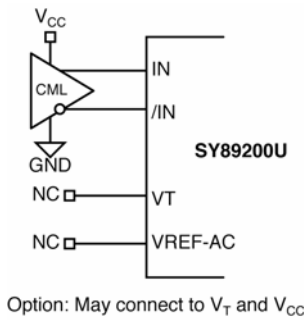


Figure 4a. CML Interface (DC-Coupled)

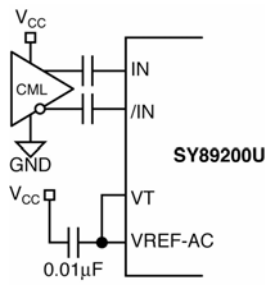


Figure 4b. CML Interface (AC-Coupled)

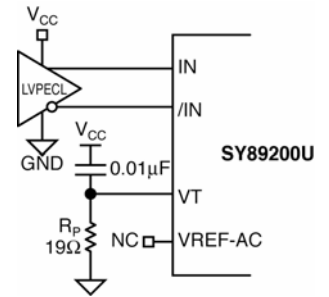


Figure 4c. LVPECL Interface (DC-Coupled)

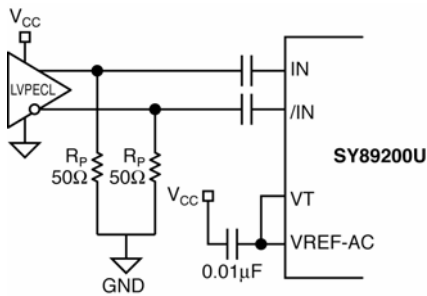


Figure 4d. LVPECL Interface (AC-Coupled)

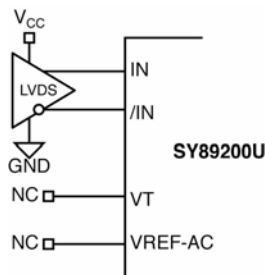


Figure 4e. LVDS Interface

## Output Interface Applications

LVDS specifies a small swing of 350mV typical, on a nominal 1.25V common mode above ground. The common mode voltage has tight limits to permit large variations in ground between an LVDS driver and receiver. Also, change in common mode voltage, as a function of data input, is kept to a minimum to keep EMI low.

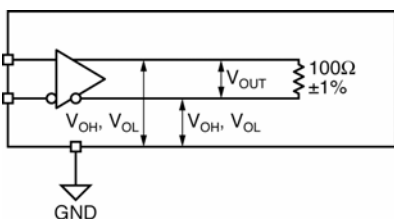


Figure 5a. LVDS Differential Measurement

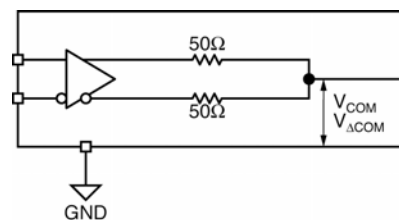


Figure 5b. LVDS Common Mode Measurement

## Related Product and Support Documentation

Part Number	Function	Datasheet Link
	MLF® Application Note	<a href="http://www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf">www.amkor.com/products/notes_papers/MLF_AppNote_0902.pdf</a>
HBW Solutions	New Products and Applications	<a href="http://www.micrel.com/product-info/products/solutions.shtml">www.micrel.com/product-info/products/solutions.shtml</a>

