CY23S05
CY23S09

Low-Cost 3.3V Spread Aware™ Zero Delay Buffer

Features

- **10-MHz to 100-/133-MHz operating range, compatible with CPU and PCI bus frequencies**
- **Zero input-output propagation delay**
- **Multiple low-skew outputs**
  - **— Output-output skew less than 250 ps**
  - **— Device-device skew less than 700 ps**
  - **— One input drives five outputs (CY23S05)**
  - **— One input drives nine outputs, grouped as 4 + 4 + 1 (CY23S09)**
- **Less than 200 ps cycle-cycle jitter is compatible with Pentium®-based systems**
- **Test Mode to bypass PLL (CY23S09 only, see *Table 1* on page 2)**
- **Available in space-saving 16-pin, 150-mil SOIC and 4.4-mm TSSOP (CY23S09) or 8-pin, 150-mil SOIC package (CY23S05)**
- **3.3V operation, advanced 0.65µ CMOS technology**
- **Spread Aware™**

Functional Description

The CY23S09 is a low-cost 3.3V zero delay buffer designed to distribute high-speed clocks and is available in a 16-pin SOIC package. The CY23S05 is an 8-pin version of the CY23S09. It accepts one reference input and drives out five low-skew clocks. The -1H versions of each device operate at up to 100-/133-MHz frequencies, and have higher drive than the -1 devices. All parts have on-chip PLLs that lock to an input clock on the REF pin. The PLL feedback is on-chip and is obtained from the CLKOUT pad.

The CY23S09 has two banks of four outputs each, which can be controlled by the Select inputs as shown in the *Table 1* on page 2. If all output clocks are not required, Bank B can be three-stated. The select inputs also allow the input clock to be directly applied to the outputs for chip and system testing purposes.

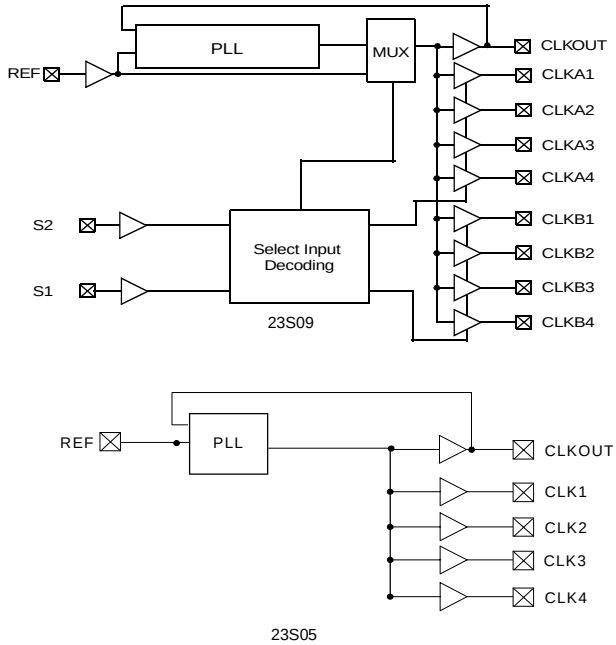
The CY23S05 and CY23S09 PLLs enter a Power-Down mode when there are no rising edges on the REF input. In this state, the outputs are three-stated and the PLL is turned off, resulting in less than 12.0 µA of current draw for commercial temperature devices and 25.0 µA for industrial temperature parts. The CY23S09 PLL shuts down in one additional case, as shown in *Table 1*.

Multiple CY23S05 and CY23S09 devices can accept the same input clock and distribute it. In this case, the skew between the outputs of two devices is guaranteed to be less than 700 ps.

All outputs have less than 200 ps of cycle-cycle jitter. The input to output propagation delay on both devices is guaranteed to be less than 350 ps, and the output-to-output skew is guaranteed to be less than 250 ps.

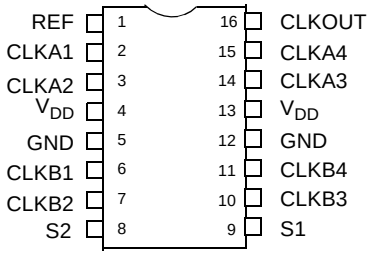
The CY23S05/CY23S09 is available in two/three different configurations, as shown in the ordering information (see page 7). The CY23S05-1/CY23S09-1 is the base part. The CY23S05-1H/ CY23S09-1H is the high-drive version of the -1, and its rise and fall times are much faster than the -1s.

Block Diagram



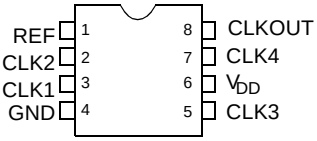
Pin Configuration

SOIC/TSSOP
Top View



23S09

SOIC
Top View



23S05

Table 1. Select Input Decoding for CY23S09

S2	S1	CLOCK A1–A4	CLOCK B1–B4	CLKOUT[1]	Output Source	PLL Shutdown
0	0	Three-State	Three-State	Driven	PLL	N
0	1	Driven	Three-State	Driven	PLL	N
1	0	Driven	Driven	Driven	Reference	Y
1	1	Driven	Driven	Driven	PLL	N

Zero Delay and Skew Control

All outputs should be uniformly loaded to achieve zero delay between the input and output. Since the CLKOUT pin is the internal feedback to the PLL, its relative loading can adjust the input-output delay. This is shown in the above graph.

For applications requiring zero input-output delay, all outputs, including CLKOUT, must be equally loaded. Even if CLKOUT is not used, it must have a capacitive load equal to that on other outputs, in order to obtain zero input-output delay. If input to output delay adjustments are required, use the above graph to calculate loading differences between the CLKOUT pin and other outputs.

For zero output-output skew, be sure to load all outputs equally. For further information please refer to the application note “CY23S05 and CY23S09 as PCI and SDRAM Buffers.”

Spread Aware

Many systems being designed now utilize a technology called Spread Spectrum Frequency Timing Generation. Cypress is one of the pioneers of SSFTG development, and we designed this product so as not to filter off the Spread Spectrum feature of the Reference input, assuming it exists. When a zero delay buffer is not designed to pass the spread spectrum feature through, the result is a significant amount of tracking skew which may cause problems in systems requiring synchronization.

For more details on Spread Spectrum timing technology, please see the application note, “EMI Suppression Techniques with Spread Spectrum Frequency Timing Generator (SSFTG) ICs.”

Note:

1. This output is driven and has an internal feedback for the PLL. The load on this output can be adjusted to change the skew between the reference and output.

Pin Description for CY23S09

Pin	Signal	Description
1	REF[2]	Input reference frequency, 5V-tolerant input
2	CLKA1[3]	Buffered clock output, Bank A
3	CLKA2[3]	Buffered clock output, Bank A
4	V_{DD}	3.3V supply
5	GND	Ground
6	CLKB1[3]	Buffered clock output, Bank B
7	CLKB2[3]	Buffered clock output, Bank B
8	S2[4]	Select input, bit 2
9	S1[4]	Select input, bit 1
10	CLKB3[3]	Buffered clock output, Bank B
11	CLKB4[3]	Buffered clock output, Bank B
12	GND	Ground
13	V_{DD}	3.3V supply
14	CLKA3[3]	Buffered clock output, Bank A
15	CLKA4[3]	Buffered clock output, Bank A
16	CLKOUT[3]	Buffered output, internal feedback on this pin

Pin Description for CY23S05

Pin	Signal	Description
1	REF[2]	Input reference frequency, 5V-tolerant input
2	CLK2[3]	Buffered clock output
3	CLK1[3]	Buffered clock output
4	GND	Ground
5	CLK3[3]	Buffered clock output
6	V_{DD}	3.3V supply
7	CLK4[3]	Buffered clock output
8	CLKOUT[3]	Buffered clock output, internal feedback on this pin

Notes:
2. Weak pull-down.
3. Weak pull-down on all outputs.
4. Weak pull-up on these inputs.

Maximum Ratings

Supply Voltage to Ground Potential ..... –0.5V to +7.0V

DC Input Voltage (Except REF) .....–0.5V to V_{DD} + 0.5V

DC Input Voltage REF ..... –0.5V to 7V

Storage Temperature .....–65°C to +150°C

Max. Soldering Temperature (10 sec.) ..... 260°C

Junction Temperature ..... 150°C

Static Discharge Voltage
(per MIL-STD-883, Method 3015) ..... >2,000V

Operating Conditions for CY23S05SC-XX and CY23S09SC-XX Commercial Temperature Devices

Parameter	Description	Min.	Max.	Unit
V_{DD}	Supply Voltage	3.0	3.6	V
T_A	Operating Temperature (Ambient Temperature)	0	70	°C
C_L	Load Capacitance, below 100 MHz		30	pF
C_L	Load Capacitance, from 100 MHz to 133 MHz		10	pF
C_{IN}	Input Capacitance		7	pF

Electrical Characteristics for CY23S05SC-XX and CY23S09SC-XX Commercial Temperature Devices

Parameter	Description	Test Conditions	Min.	Max.	Unit
V_{IL}	Input LOW Voltage[5]			0.8	V
V_{IH}	Input HIGH Voltage[5]		2.0		V
I_{IL}	Input LOW Current	V_{IN} = 0V		50.0	µA
I_{IH}	Input HIGH Current	V_{IN} = V_{DD}		100.0	µA
V_{OL}	Output LOW Voltage[6]	I_{OL} = 8 mA (-1) I_{OH} = 12 mA (-1H)		0.4	V
V_{OH}	Output HIGH Voltage[6]	I_{OH} = –8 mA (-1) I_{OL} = –12 mA (-1H)	2.4		V
I_{DD} (PD mode)	Power Down Supply Current	REF = 0 MHz		12.0	µA
I_{DD}	Supply Current	Unloaded outputs at 66.67 MHz, SEL inputs at V_{DD}		32.0	mA

Switching Characteristics for CY23S05SC-1 and CY23S09SC-1 Commercial Temperature Devices[7]

Parameter	Name	Test Conditions	Min.	Typ.	Max.	Unit
t_1	Output Frequency	30-pF load 10-pF load	10 10		100 133.33	MHz MHz
	Duty Cycle[6] = $t_2 \div t_1$	Measured at 1.4V, F_{out} = 66.67 MHz	40.0	50.0	60.0	%
t_3	Rise Time[6]	Measured between 0.8V and 2.0V			2.50	ns
t_4	Fall Time[6]	Measured between 0.8V and 2.0V			2.50	ns
t_5	Output to Output Skew[6]	All outputs equally loaded			250	ps
t_6	Delay, REF Rising Edge to CLKOUT Rising Edge[6]	Measured at V_{DD}/2		0	±350	ps
t_7	Device-to-Device Skew[6]	Measured at V_{DD}/2 on the CLKOUT pins of devices		0	700	ps
t_J	Cycle to Cycle Jitter[6]	Measured at 66.67 MHz, loaded outputs			200	ps
t_{LOCK}	PLL Lock Time[6]	Stable power supply, valid clock presented on REF pin			1.0	ms

Notes:

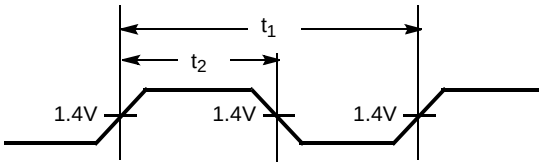
5. REF input has a threshold voltage of V_{DD}/2.
6. Parameter is guaranteed by design and characterization. Not 100% tested in production.
7. All parameters specified with loaded outputs.

Switching Characteristics for CY23S05SC-1H and CY23S09SC-1H Commercial Temperature Devices[7]

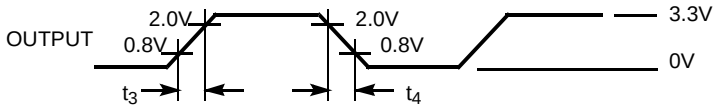
Parameter	Name	Description	Min.	Typ.	Max.	Unit
t_1	Output Frequency	30-pF load 10-pF load	10 10		100 133.33	MHz MHz
	Duty Cycle[6] = $t_2 \div t_1$	Measured at 1.4V, F_{out} = 66.67 MHz	40.0	50.0	60.0	%
	Duty Cycle[6] = $t_2 \div t_1$	Measured at 1.4V, F_{out} < 50.0 MHz	45.0	50.0	55.0	%
t_3	Rise Time[6]	Measured between 0.8V and 2.0V			1.50	ns
t_4	Fall Time[6]	Measured between 0.8V and 2.0V			1.50	ns
t_5	Output to Output Skew[6]	All outputs equally loaded			250	ps
t_6	Delay, REF Rising Edge to CLKOUT Rising Edge[6]	Measured at $V_{DD}/2$		0	±350	ps
t_7	Device to Device Skew[6]	Measured at $V_{DD}/2$ on the CLKOUT pins of devices		0	700	ps
t_8	Output Slew Rate[6]	Measured between 0.8V and 2.0V using Test Circuit #2	1			V/ns
t_J	Cycle to Cycle Jitter[6]	Measured at 66.67 MHz, loaded outputs			200	ps
t_{LOCK}	PLL Lock Time[6]	Stable power supply, valid clock presented on REF pin			1.0	ms

Switching Waveforms

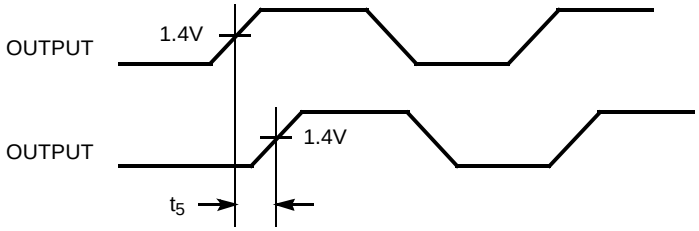
Duty Cycle Timing



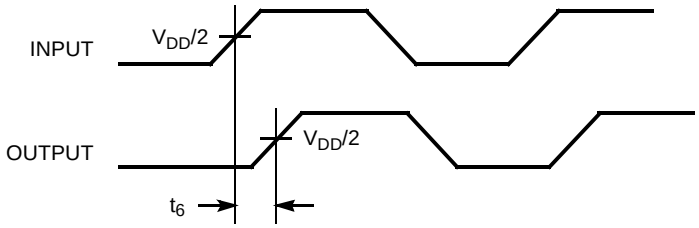
All Outputs Rise/Fall Time



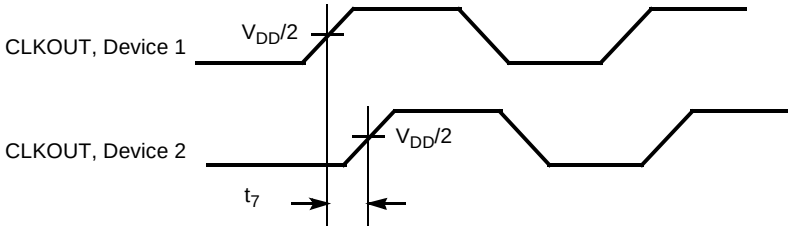
Output-Output Skew



Input-Output Propagation Delay

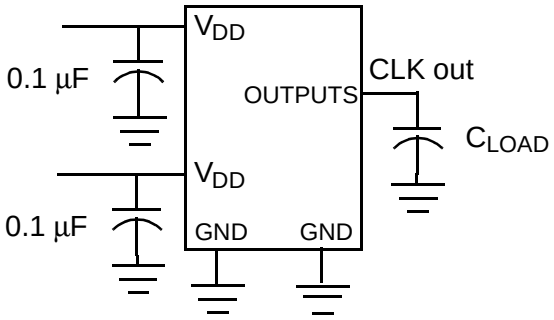


Device-Device Skew

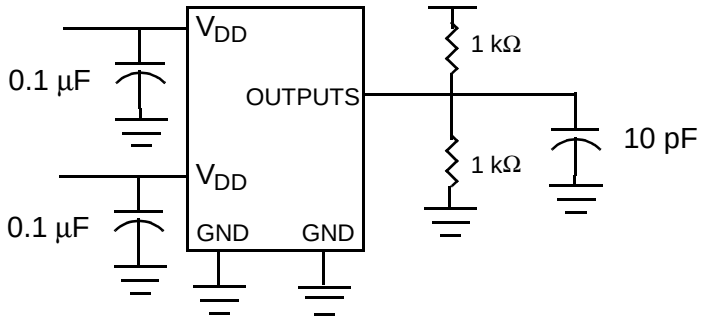


Test Circuits

Test Circuit #1



Test Circuit #2



For parameter t_8 (output slew rate) on -1H devices

Ordering Information

Ordering Code	Package Name	Package Type	Operating Range
CY23S09SC-1	S8	8-pin 150-mil SOIC	Commercial
CY23S09SC-1H	S8	8-pin 150-mil SOIC	Commercial
CY23S05SC-1	S16	16-pin 150-mil SOIC	Commercial
CY23S05SC-1H	S16	16-pin 150-mil SOIC	Commercial
CY23S05ZC-1	Z16	16-pin 4.4-mm TSSOP	Commercial
CY23S05ZC-1H	Z16	16-pin 4.4-mm TSSOP	Commercial

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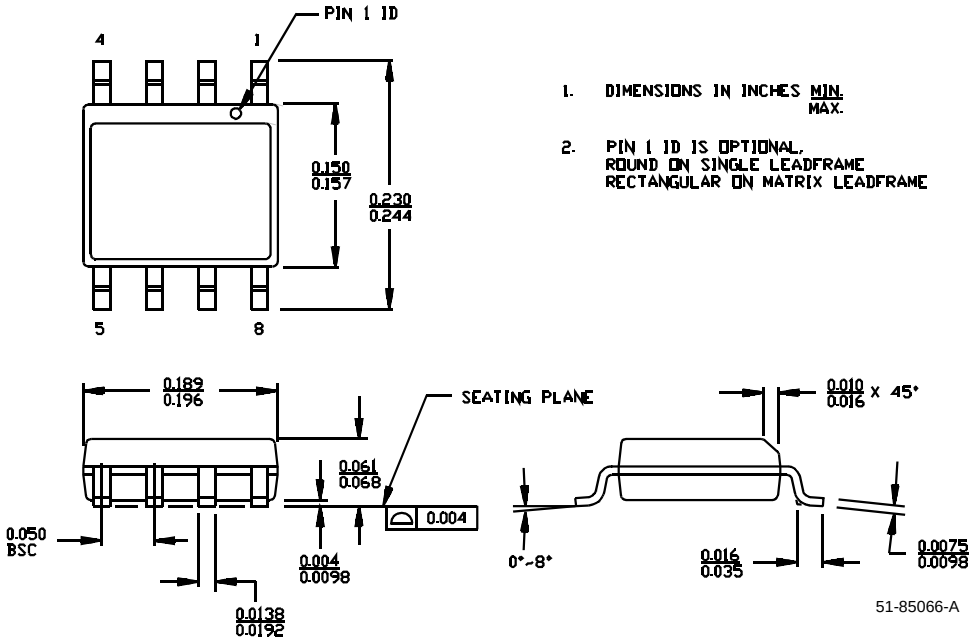
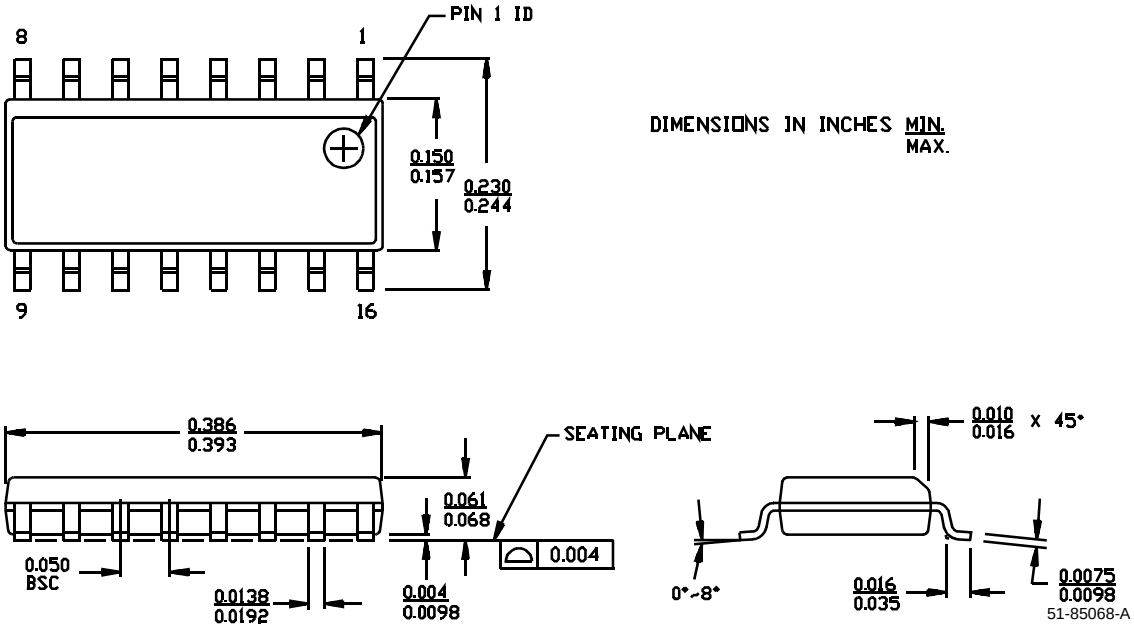
Package Diagrams

8-Lead (150-Mil) SOIC S8

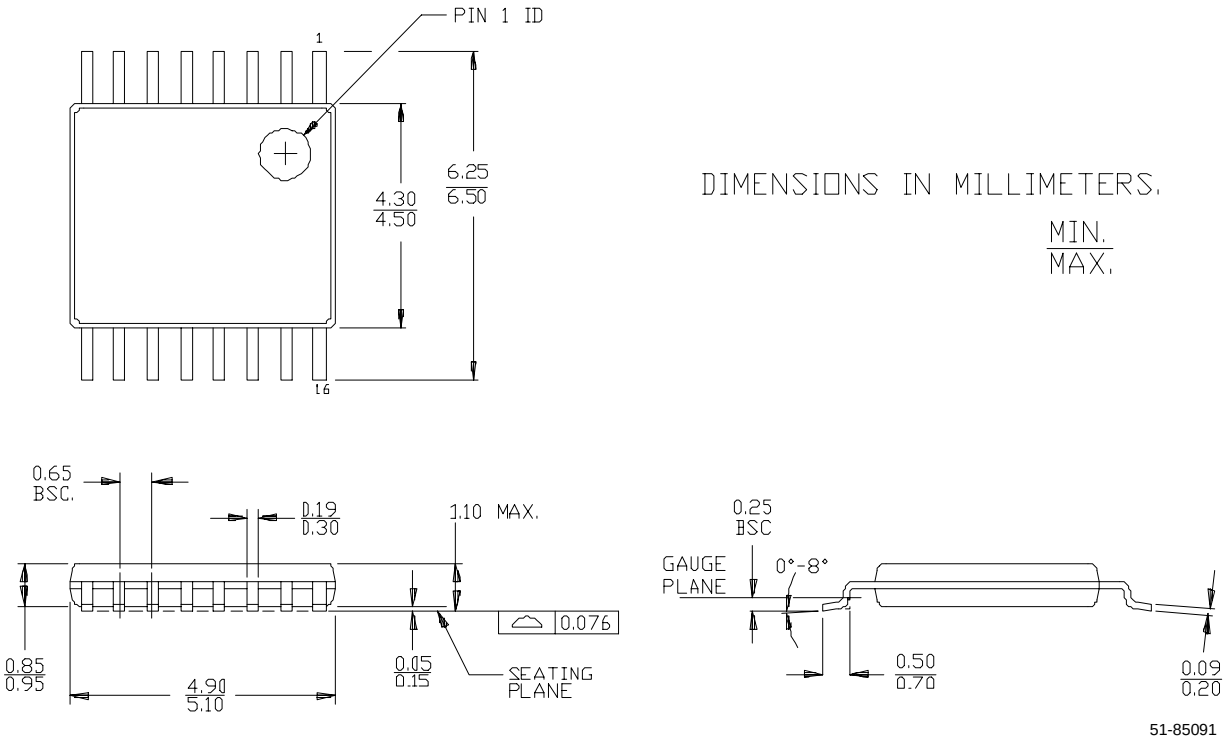


16-Lead (150-Mil) Molded SOIC S16



Package Diagrams (continued)

16-Lead Thin Shrunk Small Outline Package (4.40-mm Body) Z16



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