CY7B9910
CY7B9920

Low Skew Clock Buffer

Features

- All outputs skew <100 ps typical (250 max.)
- 15 to 80 MHz output operation
- Zero input to output delay
- 50% duty cycle outputs
- Outputs drive 50Ω terminated lines
- Low operating current
- 24-pin SOIC package
- Jitter:<200 ps peak to peak, <25 ps RMS

Functional Description

The CY7B9910 and CY7B9920 Low Skew Clock Buffers offer low skew system clock distribution. These multiple output clock drivers optimize the timing of high performance computer systems. Each of the eight individual drivers can drive terminated transmission lines with impedances as low as 50Ω. They deliver minimal and specified output skews and full swing logic levels (CY7B9910 TTL or CY7B9920 CMOS).

The completely integrated PLL enables “zero delay” capability. External divide capability, combined with the internal PLL, allows distribution of a low frequency clock that is multiplied by virtually any factor at the clock destination. This facility minimizes clock distribution difficulty while allowing maximum system clock speed and flexibility.

Block Diagram Description

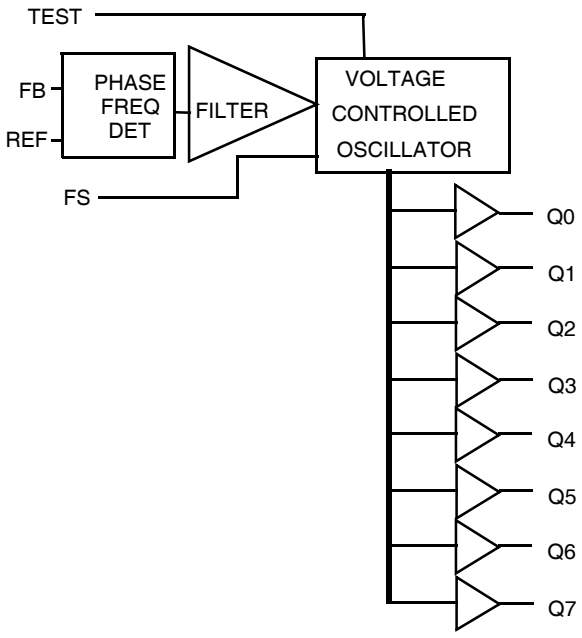
Phase Frequency Detector and Filter

The Phase Frequency Detector and Filter blocks accept inputs from the reference frequency (REF) input and the feedback (FB) input and generate correction information to control the frequency of the Voltage Controlled Oscillator (VCO). These blocks, along with the VCO, form a Phase Locked Loop (PLL) that tracks the incoming REF signal.

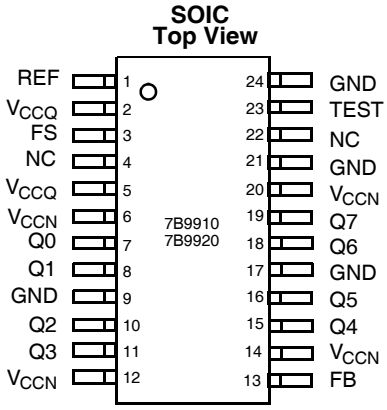
VCO

The VCO accepts analog control inputs from the PLL filter block and generates a frequency. The operational range of the VCO is determined by the FS control pin.

Logic Block Diagram



Pin Configuration



Pin Definitions

Signal Name	IO	Description
REF	I	Reference frequency input.This input supplies the frequency and timing against which all functional variations are measured.
FB	I	PLL feedback input (typically connected to one of the eight outputs).
FS[1,2,3]	I	Three level frequency range select.
TEST	I	Three level select. See TEST MODE.
Q[0..7]	O	Clock outputs.
V_{CCN}	PWR	Power supply for output drivers.
V_{CCQ}	PWR	Power supply for internal circuitry.
GND	PWR	Ground.

Test Mode

The TEST input is a three level input. In normal system operation, this pin is connected to ground, allowing the CY7B9910 and CY7B9920 to operate as described in Block Diagram Description. For testing purposes, any of the three level inputs can have a removable jumper to ground or be tied LOW through a 100W resistor. This enables an external tester to change the state of these pins.

If the TEST input is forced to its MID or HIGH state, the device operates with its internal phase locked loop disconnected and input levels supplied to REF directly control all outputs. Relative output-to-output functions are the same as in normal mode.

Notes

1. For all three state inputs, HIGH indicates a connection to VCC, LOW indicates a connection to GND, and MID indicates an open connection. Internal termination circuitry holds an unconnected input to VCC/2.
2. The level to be set on FS is determined by the “normal” operating frequency (fNOM) of the VCO (see Logic Block Diagram). The frequency appearing at the REF and FB inputs are fNOM when the output connected to FB is undivided. The frequency of the REF and FB inputs are fNOM/X when the device is configured for a frequency multiplication by using external division in the feedback path of value X.
3. When the FS pin is selected HIGH, the REF input must not transition upon power up until VCC reached 4.3V.

Maximum Ratings

Operating outside these boundaries may affect the performance and life of the device. These user guidelines are not tested.

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

Ambient Temperature with Power Applied .....–55°C to +125°C

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

DC Input Voltage .....–0.5V to +7.0V

Output Current into Outputs (LOW)..... 64 mA

Static Discharge Voltage.....>2001V (MIL-STD-883, Method 3015)

Latch Up Current .....>200 mA

Operating Range

Range	Ambient Temperature	V_{CC}
Commercial	0°C to +70°C	5V ± 10%
Industrial	–40°C to +85°C	5V ± 10%

Electrical Characteristics Over the Operating Range

Parameter	Description	Test Conditions		CY7B9910 Min	CY7B9910 Max	CY7B9920 Min	CY7B9920 Max	Unit
V_{OH}	Output HIGH Voltage	V_{CC} = Min, I_{OH} = –16 mA		2.4				V
		V_{CC} = Min, I_{OH} =–40 mA				V_{CC}–0.75		
V_{OL}	Output LOW Voltage	V_{CC} = Min, I_{OL} = 46 mA			0.45			V
		V_{CC} = Min, I_{OL} = 46 mA					0.45	
V_{IH}	Input HIGH Voltage (REF and FB inputs only)			2.0	V_{CC}	V_{CC} – 1.35	V_{CC}	V
V_{IL}	Input LOW Voltage (REF and FB inputs only)			–0.5	0.8	–0.5	1.35	V
V_{IHH}	Three Level Input HIGH Voltage (Test, FS)[4]	Min ≤ V_{CC} ≤ Max		V_{CC} – 1V	V_{CC}	V_{CC} – 1V	V_{CC}	V
V_{IMM}	Three Level Input MID Voltage (Test, FS)[4]	Min ≤ V_{CC} ≤ Max		V_{CC}/2 – 500 mV	V_{CC}/2 + 500 mV	V_{CC}/2 – 500 mV	V_{CC}/2 + 500 mV	V
V_{ILL}	Three Level Input LOW Voltage (Test, FS)[4]	Min ≤ V_{CC} ≤ Max		0.0	1.0	0.0	1.0	V
I_{IH}	Input HIGH Leakage Current (REF and FB inputs only)	V_{CC} = Max, V_{IN} = Max			10		10	µA
I_{IL}	Input LOW Leakage Current (REF and FB inputs only)	V_{CC} = Max, V_{IN} = 0.4V		–500		–500		µA
I_{IHH}	Input HIGH Current (Test, FS)	V_{IN} = V_{CC}			200		200	µA
I_{IMM}	Input MID Current (Test, FS)	V_{IN} = V_{CC}/2		–50	50	–50	50	µA
I_{ILL}	Input LOW Current (Test, FS)	V_{IN} = GND			–200		–200	µA
I_{OS}	Output Short Circuit Current[5]	V_{CC} = Max, V_{OUT} = GND (25°C only)			–250		N/A	mA
I_{CCQ}	Operating Current Used by Internal Circuitry	V_{CCN} = V_{CCQ} = Max All Input Selects Open	Com'l		85		85	mA
			Mil/Ind		90		90	
I_{CCN}	Output Buffer Current per Output Pair[6]	V_{CCN} = V_{CCQ} = Max I_{OUT} = 0 mA Input Selects Open, f_{MAX}			14		19	mA
PD	Power Dissipation per Output Pair[7]	V_{CCN} = V_{CCQ} = Max I_{OUT} = 0 mA Input Selects Open, f_{MAX}			78		104[5]	mW

Notes

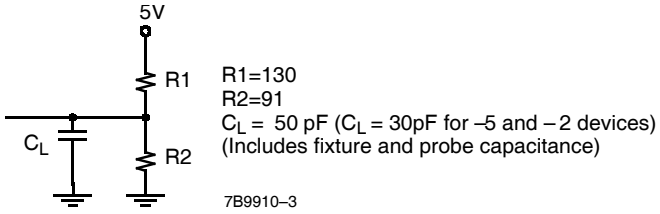
4. These inputs are normally wired to VCC, GND, or left unconnected (actual threshold voltages vary as a percentage of VCC). Internal termination resistors hold unconnected inputs at VCC/2. If these inputs are switched, the function and timing of the outputs may glitch and the PLL may require an additional tLOCK time before all data sheet limits are achieved.
5. Tested one output at a time, output shorted for less than one second, less than 10% duty cycle. Room temperature only. CY7B9920 outputs are not short circuit protected.
6. Total output current per output pair is approximated by the following expression that includes device current plus load current:
   CY7B9910:
   ICCN = [(4 + 0.11F) + [((835 – 3F)/Z) + (.0022FC)]N] x 1.1
   CY7B9920:
   ICCN = [(3.5+.17F) + [((1160 – 2.8F)/Z) + (.0025FC)]N] x 1.1
   Where
   F = frequency in MHz
   C = capacitive load in pF
   Z = line impedance in ohms
   N = number of loaded outputs; 0, 1, or 2
   FC = F < C.
7. Total power dissipation per output pair is approximated by the following expression that includes device power dissipation plus power dissipation due to the load circuit:
   CY7B9910:
   PD = [(22 + 0.61F) + [((1550 – 2.7F)/Z) + (.0125FC)]N] x 1.1
   CY7B9920:
   PD = [(19.25+ 0.94F) + [((700 + 6F)/Z) + (.017FC)]N] x 1.1.See note 3 for variable definition.

Capacitance

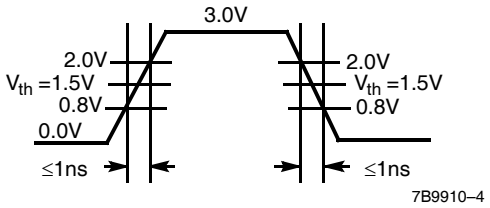
Tested initially and after any design or process changes that may affect these parameters.

Parameter	Description	Test Conditions	Max	Unit
C_{IN}	Input Capacitance	T_A = 25°C, f = 1 MHz, V_{CC} = 5.0V	10	pF

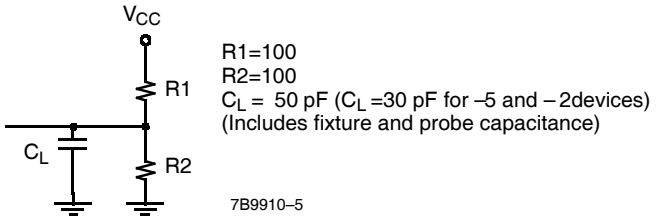
AC Test Loads and Waveforms



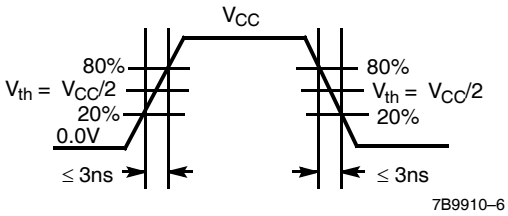
TTL AC Test Load (CY7B9910)



TTL Input Test Waveform (Cy7B9910)



CMOS AC Test Load (CY7B9920)



CMOS Input Test Waveform (CY7B9920)

Switching Characteristics

Over the Operating Range [11]

Parameter	Description		CY7B9910–2[8]			CY7B9920–2[8]			Unit
			Min	Typ	Max	Min	Typ	Max	
f_{NOM}	Operating Clock Frequency in MHz	FS = LOW[1, 2]	15		30	15		30	MHz
		FS = MID[1, 2]	25		50	25		50	
		FS = HIGH[1, 2, 3]	40		80	40		80[12]	
t_{RPWH}	REF Pulse Width HIGH		5.0			5.0			ns
t_{RPWL}	REF Pulse Width LOW		5.0			5.0			ns
t_{SKEW}	Zero Output Skew (All Outputs)[13, 14]			0.1	0.25		0.1	0.25	ns
t_{DEV}	Device-to-Device Skew[14, 15]				0.75			0.75	ns
t_{PD}	Propagation Delay, REF Rise to FB Rise		–0.25	0.0	+0.25	–0.25	0.0	+0.25	ns
t_{ODCV}	Output Duty Cycle Variation[16]		–0.65	0.0	+0.65	–0.65	0.0	+0.65	ns
t_{ORISE}	Output Rise Time[17, 18]		0.15	1.0	1.2	0.5	2.0	2.5	ns
t_{OFALL}	Output Fall Time[17, 18]		0.15	1.0	1.2	0.5	2.0	2.5	ns
t_{LOCK}	PLL Lock Time[19]				0.5			0.5	ms
t_{JR}	Cycle-to-Cycle Output Jitter	Peak to Peak			200			200	ps
		RMS			25			25	ps

Parameter	Description		CY7B9910–5			CY7B9920–5			Unit
			Min	Typ	Max	Min	Typ	Max	
f_{NOM}	Operating Clock Frequency in MHz	FS = LOW[1, 2]	15		30	15		30	MHz
		FS = MID[1, 2]	25		50	25		50	
		FS = HIGH[1, 2, 3]	40		80	40		80[12]	
t_{RPWH}	REF Pulse Width HIGH		5.0			5.0			ns
t_{RPWL}	REF Pulse Width LOW		5.0			5.0			ns
t_{SKEW}	Zero Output Skew (All Outputs)[13, 14]			0.25	0.5		0.25	0.5	ns
t_{DEV}	Device-to-Device Skew[8, 15]				1.0			1.0	ns
t_{PD}	Propagation Delay, REF Rise to FB Rise		–0.5	0.0	+0.5	–0.5	0.0	+0.5	ns
t_{ODCV}	Output Duty Cycle Variation[16]		–1.0	0.0	+1.0	–1.0	0.0	+1.0	ns
t_{ORISE}	Output Rise Time[17, 18		0.15	1.0	1.5	0.5	2.0	3.0	ns
t_{OFALL}	Output Fall Time[17, 18]		0.15	1.0	1.5	0.5	2.0	3.0	ns
t_{LOCK}	PLL Lock Time[19]				0.5			0.5	ms
t_{JR}	Cycle-to-Cycle Output Jitter	Peak to Peak[8]			200			200	ps
		RMS[8]			25			25	ps

Notes

8. Guaranteed by statistical correlation. Tested initially and after any design or process changes that may affect these parameters.
9. CMOS output buffer current and power dissipation specified at 50 MHz reference frequency.
10. Applies to REF and FB inputs only.
11. Test measurement levels for the CY7B9910 are TTL levels (1.5V to 1.5V). Test measurement levels for the CY7B9920 are CMOS levels (VCC/2 to VCC/2). Test conditions assume signal transition times of 2ns or less and output loading as shown in the AC Test Loads and Waveforms unless otherwise specified.
12. Except as noted, all CY7B9920–2 and –5 timing parameters are specified to 80 MHz with a 30 pF load.
13. tSKEW is defined as the time between the earliest and the latest output transition among all outputs when all are loaded with 50 pF and terminated with 50Ω to 2.06V (CY7B9910) or VCC/2 (CY7B9920).
14. tSKEW is defined as the skew between outputs.
15. tDEV is the output-to-output skew between any two outputs on separate devices operating under the same conditions (VCC, ambient temperature, air flow, and so on).
16. tODCV is the deviation of the output from a 50% duty cycle.
17. Specified with outputs loaded with 30 pF for the CY7B99X0–2 and –5 devices and 50 pF for the CY7B99X0–7 devices. Devices are terminated through 50Ω to 2.06V (CY7B9910) or VCC/2 (CY7B9920).
18. tORISE and tOFALL measured between 0.8V and 2.0V for the CY7B9910 or 0.8VCC and 0.2VCC for the CY7B9920.
19. tLOCK is the time that is required before synchronization is achieved. This specification is valid only after VCC is stable and within normal operating limits. This parameter is measured from the application of a new signal or frequency at REF or FB until tPD is within specified limits.

Switching Characteristics

Over the Operating Range[11] (continued)

Parameter	Description		CY7B9910–7			CY7B9920–7			Unit
			Min	Typ	Max	Min	Typ	Max	
f_{NOM}	Operating Clock Frequency in MHz	FS = LOW[1, 2]	15		30	15		30	MHz
		FS = MID[1, 2]	25		50	25		50	
		FS = HIGH[1, 2, 3]	40		80	40		80[12]	
t_{RPWH}	REF Pulse Width HIGH		5.0			5.0			ns
t_{RPWL}	REF Pulse Width LOW		5.0			5.0			ns
t_{SKEW}	Zero Output Skew (All Outputs)[13, 14]			0.3	0.75		0.3	0.75	ns
t_{DEV}	Device-to-Device Skew[8, 15]				1.5			1.5	ns
t_{PD}	Propagation Delay, REF Rise to FB Rise		–0.7	0.0	+0.7	–0.7	0.0	+0.7	ns
t_{ODCV}	Output Duty Cycle Variation[16]		–1.2	0.0	+1.2	–1.2	0.0	+1.2	ns
t_{ORISE}	Output Rise Time[17, 18]		0.15	1.5	2.5	0.5	3.0	5.0	ns
t_{OFALL}	Output Fall Time[17, 18]		0.15	1.5	2.5	0.5	3.0	5.0	ns
t_{LOCK}	PLL Lock Time[19]				0.5			0.5	ms
t_{JR}	Cycle-to-Cycle Output Jitter	Peak to Peak[8]			200			200	ps
t_{JR}		RMS[8]			25			25	ps

AC Timing Diagrams

Figure 1. AC Timing Diagrams

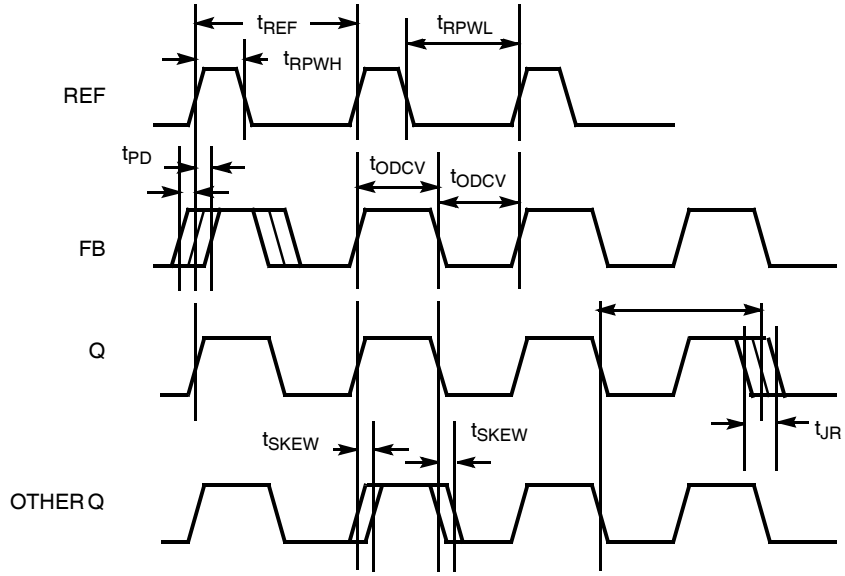
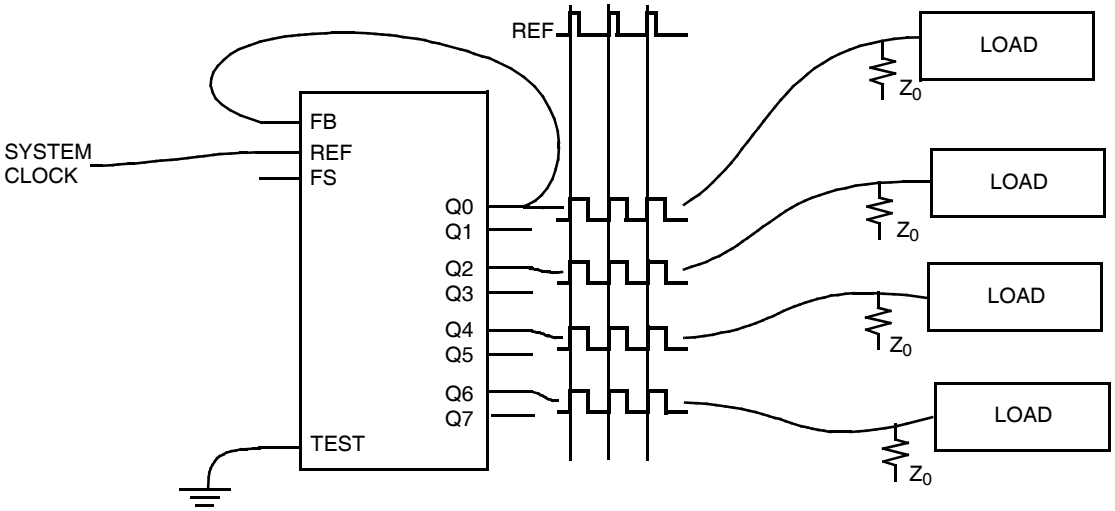


Figure 2. Zero Skew and Zero Delay Clock Driver

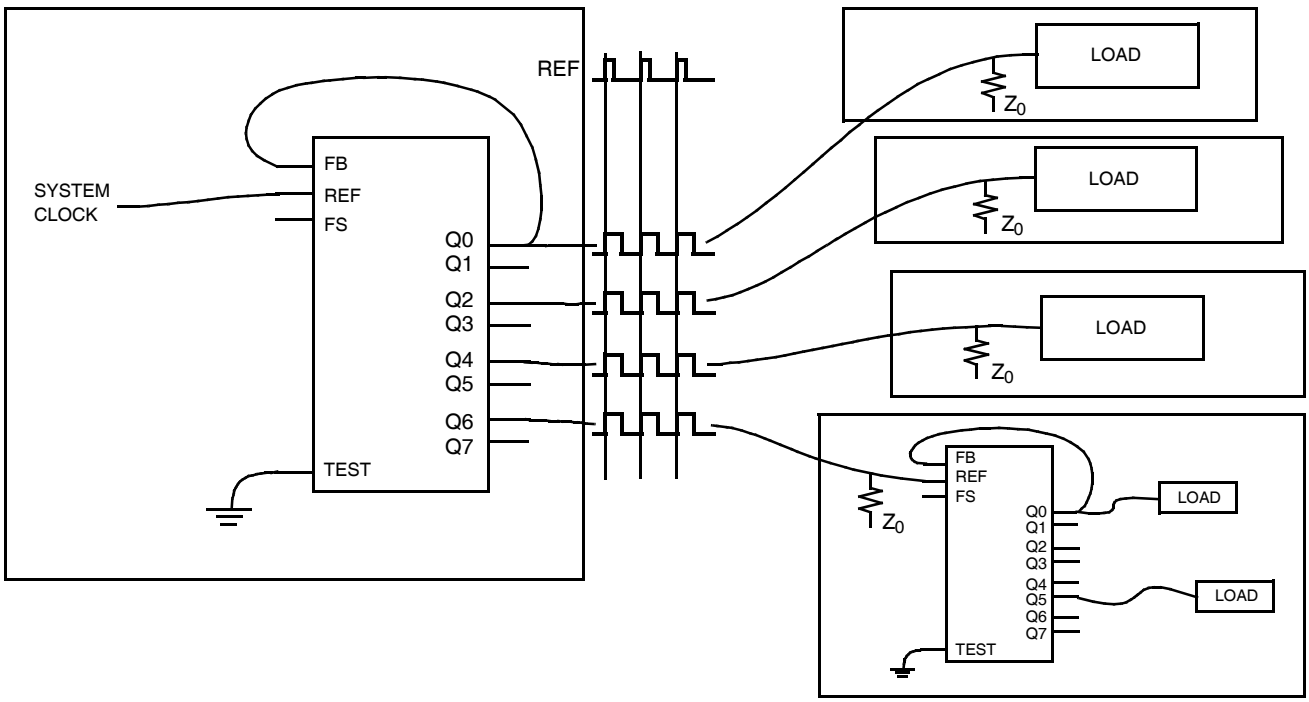


Operational Mode Descriptions

Figure 2 shows the device configured as a zero skew clock buffer. In this mode the 7B9910/9920 is used as the basis for a low skew clock distribution tree. The outputs are aligned and may each drive a terminated transmission line to an independent load. The FB input is tied to any output and the operating frequency range is selected with the FS pin. The low skew specification, coupled with the ability to drive terminated transmission lines (with impedances as low as 50 ohms), enables efficient printed circuit board design.

Figure 1 shows the CY7B9910/9920 connected in series to construct a zero skew clock distribution tree between boards. Cascaded clock buffers accumulates low frequency jitter because of the non-ideal filtering characteristics of the PLL filter. Do not connect more than two clock buffers in series.

Figure 3. Board-to-Board Clock Distribution

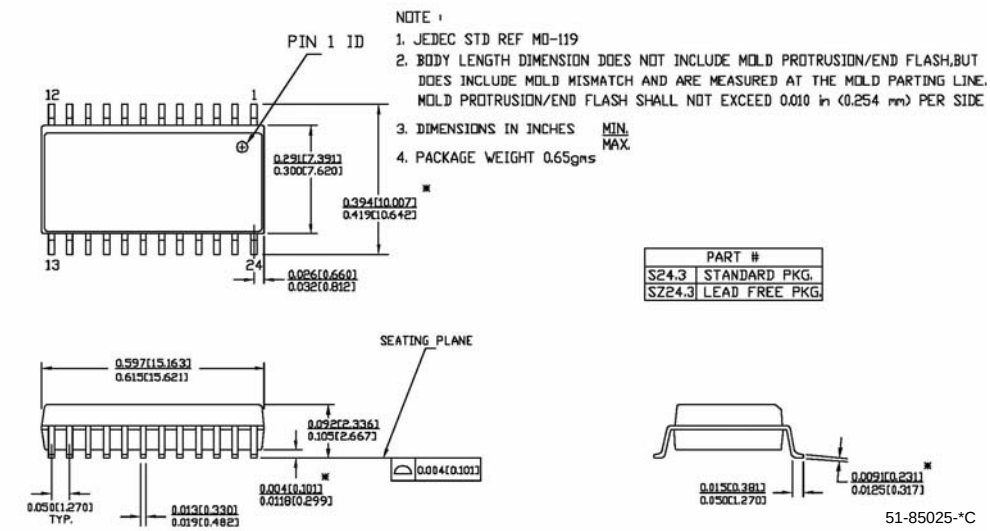


Ordering Information

Accuracy (ps)	Ordering Code	Package Type	Operating Range
250	CY7B9910–2SC	24-Pb Small Outline IC	Commercial
	CY7B9910–2SCT	24-Pb Small Outline IC - Tape and Reel	Commercial
	CY7B9920–2SC[20]	24-Pb Small Outline IC	Commercial
500	CY7B9910–5SC	24-Pb Small Outline IC	Commercial
	CY7B9910–5SCT	24-Pb Small Outline IC - Tape and Reel	Commercial
	CY7B9910–5SI	24-Pb Small Outline IC	Industrial
	CY7B9910–5SIT	24-Pb Small Outline IC - Tape and Reel	Industrial
	CY7B9920–5SC	24-Pb Small Outline IC	Commercial
	CY7B9920–5SCT	24-Pb Small Outline IC - Tape and Reel	Commercial
	CY7B9920–5SI	24-Pb Small Outline IC	Industrial
750	CY7B9910–7SC	24-Pb Small Outline IC	Commercial
	CY7B9910–7SI[20]	24-Pb Small Outline IC	Industrial
	CY7B9920–7SC[20]	24-Pb Small Outline IC	Commercial
	CY7B9920–7SI[20]	24-Pb Small Outline IC	Industrial
Pb-Free			
250	CY7B9910–2SXC	24-Pb Small Outline IC	Commercial
	CY7B9910–2SXCT	24-Pb Small Outline IC - Tape and Reel	Commercial
500	CY7B9910–5SXC	24-Pb Small Outline IC	Commercial
	CY7B9910–5SXCT	24-Pb Small Outline IC - Tape and Reel	Commercial
	CY7B9910–5SXI	24-Pb Small Outline IC	Industrial
	CY7B9910–5SXIT	24-Pb Small Outline IC - Tape and Reel	Industrial
750	CY7B9910–7SXC	24-Pb Small Outline IC	Commercial
	CY7B9910–7SXCT	24-Pb Small Outline IC - Tape and Reel	Commercial

Package Diagram

Figure 4. 24-Pin (300 Mil) Molded SOIC S13



Note
20. Not recommended for new design.

Document History

Document Title: CY7B9910/CY7B9920 Low Skew Clock Buffer Document Number: 38-07135				
REV.	**ECN NO.**	**Issue Date**	**Orig. of Change**	**Description of Change**
**	110244	10/28/01	SZV	Change from Specification number: 38-00437 to 38-07135
*A	1199925	See ECN	DPF/AESA	Added Pb-free parts in Ordering Information Added Note 20: Not recommended for the new design
*B	1353343	See ECN	AESA	Change status to final