CY28351

Differential Clock Buffer/Driver DDR400- and DDR333-Compliant

Features

- **Supports 333-MHz and 400-MHz DDR SDRAM**
- **60- – 200-MHz operating frequency**
- **Phase-locked loop (PLL) clock distribution for double data rate synchronous DRAM applications**
- **Distributes one clock input to ten differential outputs**
- **External feedback pin (FBIN) is used to synchronize the outputs to the clock input**
- **Conforms to the DDRI specification**
- **Spread Aware for electromagnetic interference (EMI) reduction**
- **48-pin SSOP package**

Description

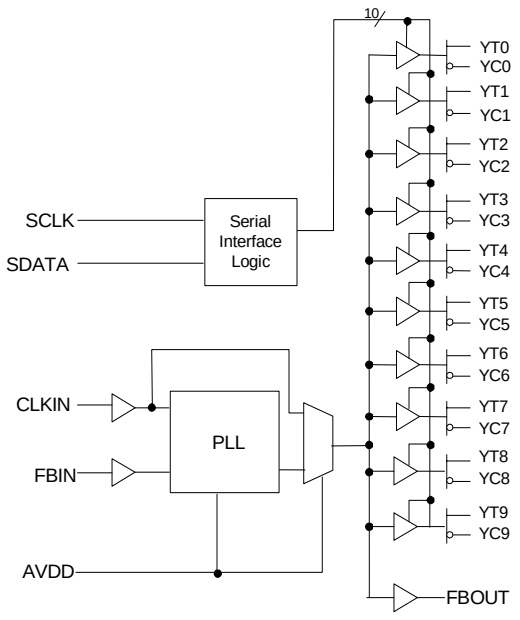
This PLL clock buffer is designed for 2.5-V_{DD} and 2.5-AV_{DD} operation and differential outputs levels.

This device is a zero delay buffer that distributes a clock input (CLKIN) to ten differential pairs of clock outputs (YT[0:9], YC[0:9]) and one feedback clock output (FBOUT). The clock outputs are individually controlled by the serial inputs SCLK and SDATA.

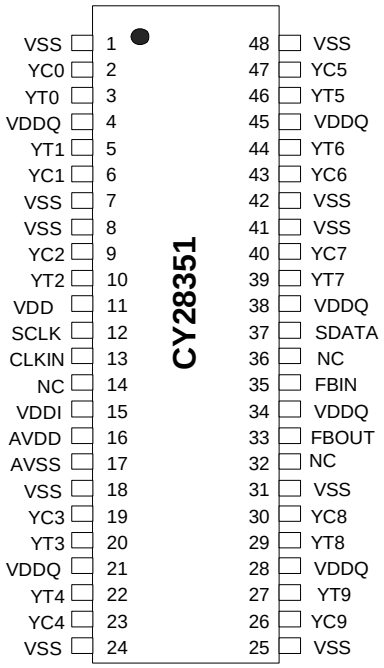
The two-line serial bus can set each output clock pair (YT[0:9], YC[0:9]) to the Hi-Z state. When AV_{DD} is grounded, the PLL is turned off and bypassed for the test purposes.

The PLL in this device uses the input clock (CLKIN) and the feedback clock (FBIN) to provide high-performance, low-skew, low-jitter output differential clocks.

Block Diagram



Pin Configuration



Pin Description[1]

Pin Number	Pin Name	I/O	Pin Description	Electrical Characteristics
13	CLKIN	I	**Clock Input**.	Input
35	FBIN	I	**Feedback Clock Input**. Connect to FBOUT for accessing the PLL.	Input
3, 5, 10, 20, 22 46, 44, 39, 29, 27	YT(0:9)	O	**Clock Outputs**.	Differential Outputs
2, 6, 9, 19, 23 47, 43, 40, 30, 26	YC(0:9)	O	**Clock Outputs**.	
33	FBOUT	O	**Feedback Clock Output**. Connect to FBIN for normal operation. A bypass delay capacitor at this output will control Input Reference/Output Clocks phase relationships.	Output
12	SCLK	I	**Serial Clock Input**. Clocks data at SDATA into the internal register.	Data Input for the two-line serial bus
37	SDATA	I/O	**Serial Data Input**. Input data is clocked to the internal register to enable/disable individual outputs. This provides flexibility in power management.	Data Input and Output for the two-line serial bus
11	VDD		**2.5V Power Supply for Logic**.	2.5V Nominal
4, 21, 28, 34, 38, 45	VDDQ		**2.5V Power Supply for Output Clock Buffers**.	2.5V Nominal
16	AVDD		**2.5V Power Supply for PLL**.	2.5V Nominal
15	VDDI		**2.5V Power Supply for Two-line Serial Interface**.	2.5V Nominal
1, 7, 8, 18, 24, 25, 31, 41, 42, 48	VSS		**Common Ground**.	0.0V Ground
17	AVSS	–	**Analog Ground**.	0.0V Analog Ground
14, 32,36	NC		**Not Connected**.	

Zero Delay Buffer

When used as a zero delay buffer, the CY28351 will likely be in a nested clock tree application. For these applications the CY28351 offers a clock input as a PLL reference. The CY28351 then can lock onto the reference and translate with near zero delay to low skew outputs. For normal operation, the external feedback input, FBIN, is connected to the feedback output, FBOUT. By connecting the feedback output to the feedback input the propagation delay through the device is eliminated. The PLL works to align the output edge with the input reference edge thus producing a near zero delay. The reference frequency affects the static phase offset of the PLL and thus the relative delay between the inputs and outputs.

When V_{DDA} is strapped LOW, the PLL is turned off and bypassed for test purposes.

Function Table

Input		Outputs			PLL
V_{DDA}	CLKIN	YT(0:9)[2]	YC(0:9)[2]	FBOUT	
GND	L	L	H	L	BYPASSED/OFF
GND	H	H	L	H	BYPASSED/OFF
2.5V	L	L	H	L	On
2.5V	H	H	L	H	On
2.5V	< 20 MHz	Hi-Z	Hi-Z	Hi-Z	Off

Notes:

1. A bypass capacitor (0.1µF) should be placed as close as possible to each positive power pin (< 0.2”). If these bypass capacitors are not close to the pins their high-frequency filtering characteristic will be cancelled by the lead inductance of the traces.
2. Each output pair can be three-stated via the two-line serial interface.

Power Management

The individual output enable/disable control of the CY28351 allows the user to implement unique power management schemes into the design. Outputs are three-stated when disabled through the two-line interface as individual bits are set LOW in Byte0 and Byte1 registers. The feedback output (FBOUT) cannot be disabled via two line serial bus. The enabling and disabling of individual outputs is done in such a manner as to eliminate the possibility of partial “runt” clocks.

Serial Control Registers

Following the acknowledge of the Address Byte, two additional bytes must be sent:

- Command Code byte
- Byte Count byte.

Byte0: Output Register 1 (1 = Enable, 0 = Disable)

Bit	@Pup	Pin#	Description
7	1	3, 2	YT0, YC0
6	1	5, 6	YT1, YC1
5	1	10, 9	YT2, YC2
4	1	20, 19	YT3, YC3
3	1	22, 23	YT4, YC4
2	1	46, 47	YT5, YC5
1	1	44, 43	YT6, YC6
0	1	39, 40	YT7, YC7

Byte1: Output Register 2 (1 = Enable, 0 = Disable)

Bit	@Pup	Pin#	Description
7	1	29, 30	YT8, YC8
6	1	27, 26	YT9, YC9
5	0	–	Reserved
4	0	–	Reserved
3	0	–	Reserved
2	0	–	Reserved
1	0	–	Reserved
0	0	–	Reserved

Byte2: Test Register 3

Bit	@Pup	Pin#	Description
7	1	–	0 = PLL leakage test, 1 = disable test
6	1	–	Reserved
5	1	–	Reserved
4	1	–	Reserved
3	1	–	Reserved
2	1	–	Reserved
1	1	–	Reserved
0	1	–	Reserved

Maximum Ratings[3]

Input Voltage Relative to V_{SS}: ..... V_{SS} – 0.3V

Input Voltage Relative to V_{DDQ} or AV_{DD}: ..... V_{DD} + 0.3V

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

Operating Temperature: .....0°C to +70°C

Maximum Power Supply: 3.5V

This device contains circuitry to protect the inputs against damage due to high static voltages or electric field; however, precautions should be taken to avoid application of any voltage higher than the maximum rated voltages to this circuit. For proper operation, V_{IN} and V_{OUT} should be constrained to the range:

$V_{SS} < (V_{IN}$ or $V_{OUT}) < V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (either V_{SS} or V_{DD}).

DC Parameters $V_{DD} = V_{DDA} = V_{DDQ} = V_{DDI}$ = 2.5V + 5%, T_A = 0°C to +70°C[4]

Parameter	Description	Condition	Min.	Typ.	Max.	Unit
V_{IL}	Input Low Voltage	SDATA , SCLK			1.0	V
V_{IH}	Input High Voltage	SDATA , SCLK	2.2			V
V_{IL}	Input Voltage Low	CLKIN, FBIN			0.4	V
V_{IH}	Input Voltage High	CLKIN, FBIN	2.1			V
I_{IN}	Input Current	V_{IN} = 0V or $V_{IN} = V_{DDQ}$, CLKT, FBIN	–10		10	µA
I_{OL}	Output Low Current	V_{DDQ} = 2.375V, V_{OUT} = 1.2V	26	35		mA
I_{OH}	Output High Current	V_{DDQ} = 2.375V, V_{OUT}= 1V	–18	–32		mA
V_{OL}	Output Low Voltage	V_{DDQ} = 2.375V, I_{OL} = 12 mA			0.6	V
V_{OH}	Output High Voltage	V_{DDQ} = 2.375V, I_{OH} = –12 mA	1.7			V
V_{OUT}	Output Voltage Swing[5]		1.1		V_{DDQ} – 0.4	V
V_{OC}	Output Crossing Voltage[6]		(V_{DDQ}/2) – 0.2	V_{DDQ}/2	(V_{DDQ}/2) + 0.2	V
I_{OZ}	High-Impedance Output Current	V_O = GND or $V_O = V_{DDQ}$	–10		10	µA
I_{DDQ}	Dynamic Supply Current[7]	All V_{DDQ} and V_{DDI}, F_O = 170 MHz		235	300	mA
ID_{STAT}	Static Supply Current				1	mA
I_{DD}	PLL Supply Current	$V_{DDA\ only}$		9	12	mA
C_{IN}	Input Pin Capacitance			4	6	pF

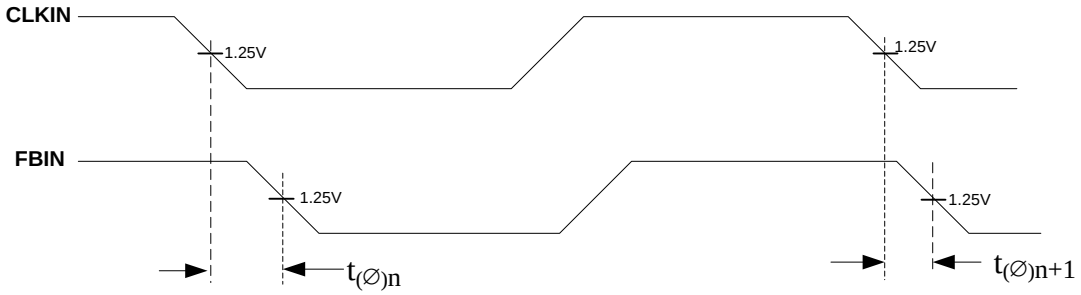
AC Parameters $V_{DD} = V_{DDQ}$ = 2.5V ± 5%, T_A = 0°C to + 70°C[8,9]

Parameter	Description	Condition	Min.	Typ.	Max.	Unit
fCLK	Operating Clock Frequency		60		200	MHz
tDC	Input Clock Duty Cycle		40		60	%
tLOCK	Maximum PLL lock Time				100	µs
Tr/Tf	Output Clocks Slew Rate	20% to 80% of VOD	1		2.5	V/ns
tpZL, tpZH	Output Enable Time (all outputs)[10]			3		ns
tpLZ, tpHZ	Output Disable Time (all outputs)[10]			3		ns
tCCJ	Cycle to Cycle Jitter[12]	f > 66 MHz	–100		100	ps
tjit(h-per)	Half-period jitter[12]	f > 66 MHz	–100		100	ps
tPLH	LOW-to-HIGH Propagation Delay, CLKIN to YT		1.5	3.5	6	ns
tPHL	HIGH-to-LOW Propagation Delay, CLKIN to YT		1.5	3.5	6	ns
tSKEW	Any Output to Any Output Skew[11]				100	ps
tPHASE	Phase Error[11]		–150		150	ps
tPHASEJ	Phase Error Jitter	f > 66 MHz	–50		50	ps

Notes:

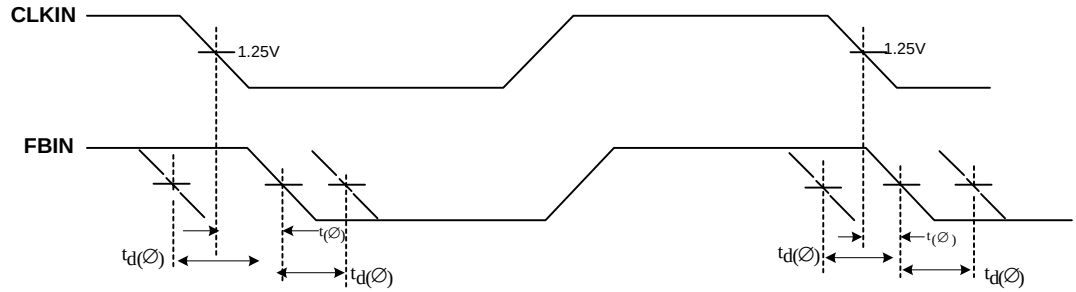
3. Multiple Supplies: The voltage on any input or I/O pin cannot exceed the power pin during power-up. Power supply sequencing is NOT required.
4. unused inputs must be held HIGH or LOW to prevent them from floating.
5. For load conditions, see *Figure 7*.
6. The value of VOC is expected to be |VTR + VCP|/2. In case of each clock directly terminated by a 120Ω resistor. See *Figure 7*.
7. All outputs switching loaded with 16 pF in 60Ω environment. See *Figure 7*.
8. Parameters are guaranteed by design and characterization. Not 100% tested in production
9. PLL is capable of meeting the specified parameters while supporting SSC synthesizers with modulation frequency between 30 kHz and 33.3 kHz with a down spread of –0.5%.
10. Refers to transition of non-inverting output.
11. All differential input and output terminals are terminated with 120Ω/16 pF, as shown in *Figure 7*.
12. Period Jitter and Half-Period Jitter specifications are separate specifications that must be met independently of each other.

Parameter Measurement Information



$$t_{(\varnothing)n} = \frac{\sum_{1}^{n=N} t_{(\varnothing)n}}{} \quad \text{(N is large number of samples)}$$

Figure 1. Static Phase Offset



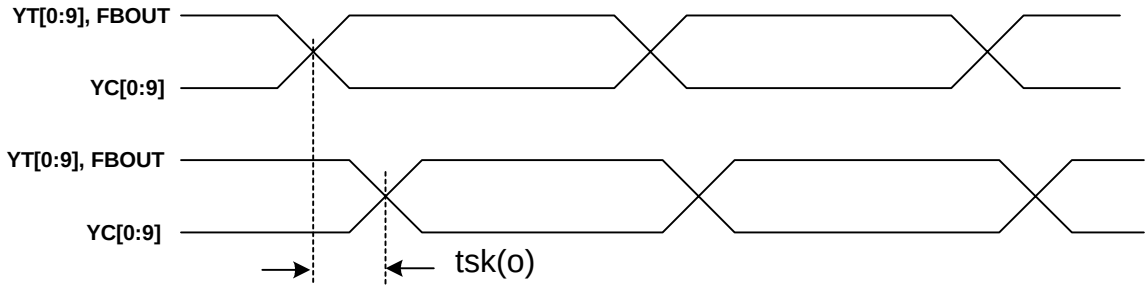
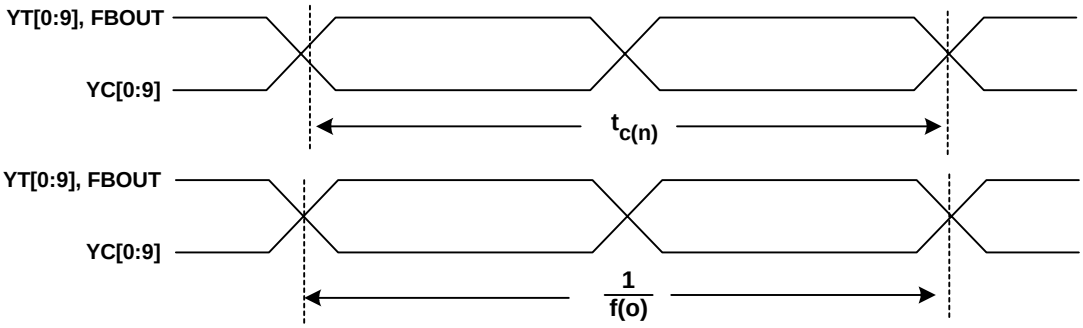
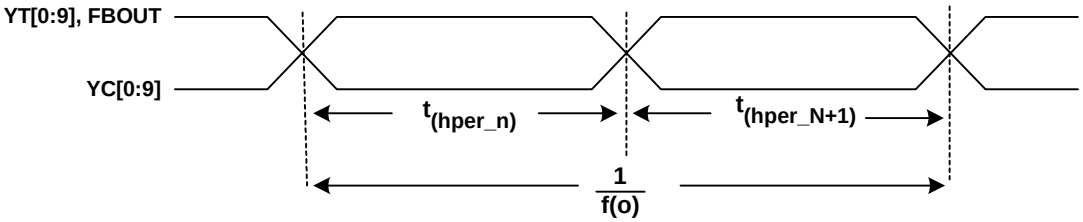


Figure 3. Output Skew



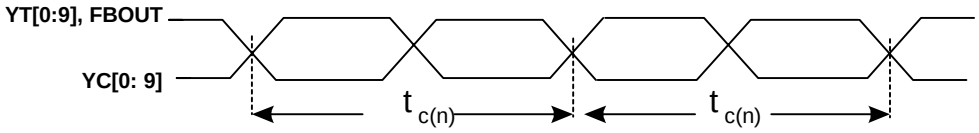
$$t_{jit(hper)} = t_{c(n)} - \frac{1}{fo}$$

Figure 4. Period Jitter



$$t_{jit(hper)} = t_{hper(n)} - \frac{1}{2x\ fo}$$

Figure 5. Half-Period Jitter



$$t_{jit(cc)} = t_{c(n)} - t_{c(n+1)}$$

Figure 6. Cycle-to-Cycle Jitter

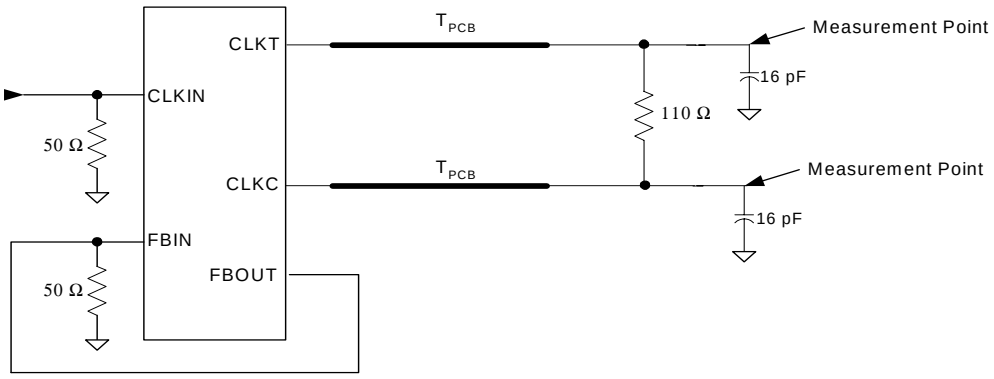


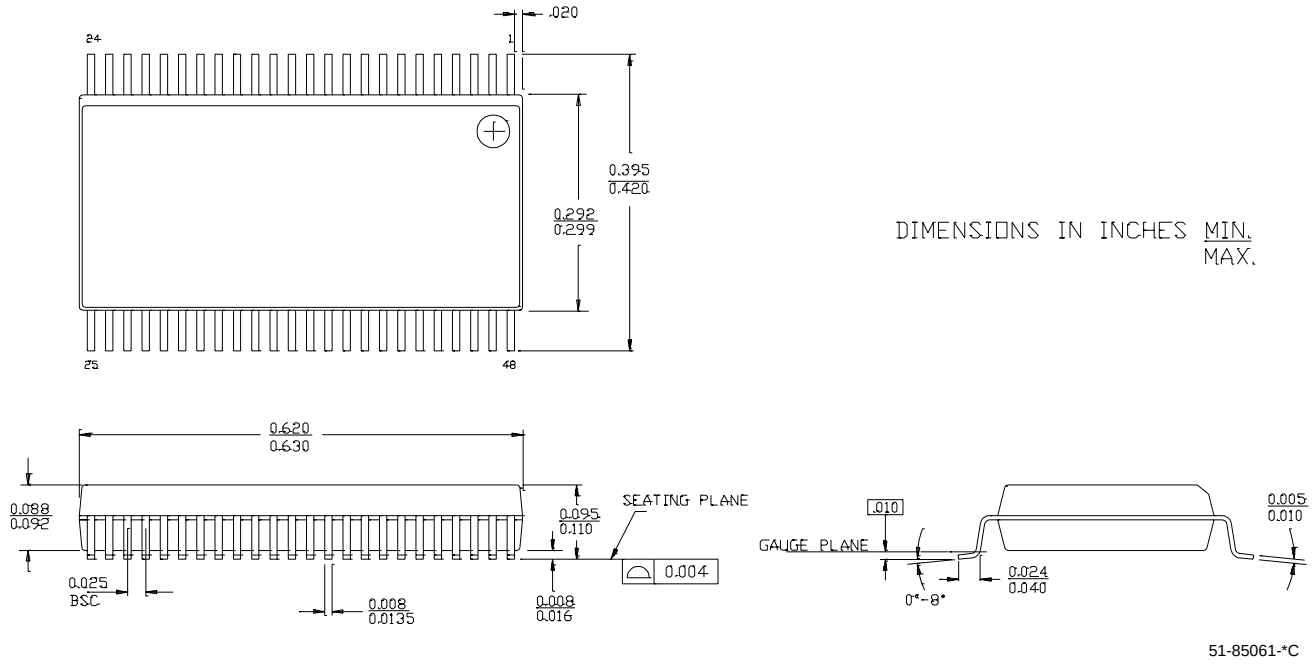
Figure 7. Differential Signal Using Direct Termination Resistor

Ordering Information

Part Number	Package Type	Product Flow
CY28351OC	48-pin SSOP	Commercial, 0° to 70°C
CY28351OCT	48-pin SSOP–Tape and Reel	Commercial, 0° to 70°C

Package Drawing and Dimensions

48-lead Shrunk Small Outline Package O48



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Document History Page

Document Title: CY28351 Differential Clock Buffer/Driver, DDR400- and DDR333-Compliant Document Number: 38-07370				
REV.	**ECN NO.**	**Issue Date**	**Orig. of Change**	**Description of Change**
**	112786	05/08/02	DMG	New Data Sheet
*A	122910	12/26/02	RBI	Add power up requirements to maximum ratings information
*B	127011	05/28/03	RGL	Change the maximum operating clock frequency from 170 MHz to 200 MHz Added DDR400- and DDR333-Compliant in the title.