## 3.3V ZERO DELAY CLOCK BUFFER, SPREAD SPECTRUM COMPATIBLE

### IDT23S09E

### **FEATURES:**

- · Phase-Lock Loop Clock Distribution
- · 10MHz to 200MHz operating frequency
- Distributes one clock input to one bank of five and one bank of four outputs
- · Separate output enable for each output bank
- Output Skew < 250ps</li>
- Low jitter <200 ps cycle-to-cycle
- IDT23S09E-1 for Standard Drive
- · IDT23S09E-1H for High Drive
- · No external RC network required
- Operates at 3.3V VDD
- · Spread spectrum compatible
- · Available in SOIC and TSSOP packages

# NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01

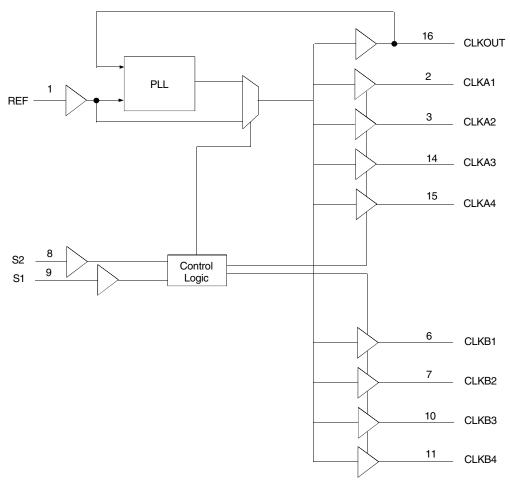
### **DESCRIPTION:**

The IDT23S09E is a high-speed phase-lock loop (PLL) clock buffer, designed to address high-speed clock distribution applications. The zero delay is achieved by aligning the phase between the incoming clock and the output clock, operable within the range of 10 to 200 MHz.

The IDT23S09E is a 16-pin version of the IDT23S05E. The IDT23S09E accepts one reference input, and drives two banks of four low skew clocks. The -1H version of this device operates up to 200MHz frequency and has higher drive than the -1 device. All parts have on-chip PLLs which lock to an input clock on the REF pin. The PLL feedback is on-chip and is obtained from the CLKOUT pad. In the absence of an input clock, the IDT23S09E enters power down. In this mode, the device will draw less than  $12\mu\,A$  for Commercial Temperature range and less than  $25\mu\,A$  for Industrial temperature range, and the outputs are tri-stated.

The IDT23S09E is characterized for both Industrial and Commercial operation.

## FUNCTIONAL BLOCK DIAGRAM

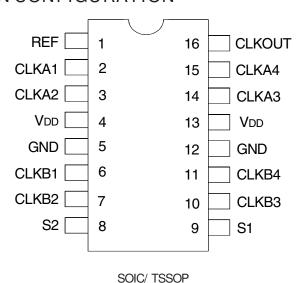


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COMMERCIAL AND INDUSTRIAL TEMPERATURE RANGES

AUGUST 2009

## **PIN CONFIGURATION**



**TOP VIEW** 

## **APPLICATIONS:**

- SDRAM
- Telecom
- Datacom
- PC Motherboards/Workstations
- Critical Path Delay Designs

## ABSOLUTE MAXIMUM RATINGS(1)

Symbol	Rating	Max.	Unit
VDD	Supply Voltage Range	-0.5 to +4.6	٧
VI <sup>(2)</sup>	Input Voltage Range (REF)	-0.5 to +5.5	V
Vı	Input Voltage Range	–0.5 to	٧
	(except REF)	VDD+0.5	
IIK (VI < 0)	Input Clamp Current	-50	mA
Io (Vo = 0 to VDD)	Continuous Output Current	±50	mA
VDD or GND	Continuous Current	±100	mA
TA = 55°C	Maximum Power Dissipation	0.7	W
(in still air) <sup>(3)</sup>			
Tstg	Storage Temperature Range	-65 to +150	°C
Operating	Commercial Temperature	0 to +70	°C
Temperature	Range		
Operating	Industrial Temperature	-40 to +85	°C
Temperature	Range		

#### NOTES:

- 1. Stresses greater than those listed under ABSOLUTE MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.
- The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
- The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils.

## PIN DESCRIPTION

Pin Name	Pin Number	Туре	Functional Description
REF <sup>(1)</sup>	1	IN	Input reference clock, 5 Volt tolerant input
CLKA1 <sup>(2)</sup>	2	Out	Output clock for bank A
CLKA2 <sup>(2)</sup>	3	Out	Output clock for bank A
V <sub>DD</sub>	4, 13	PWR	3.3V Supply
GND	5, 12	GND	Ground
CLKB1 <sup>(2)</sup>	6	Out	Output clock for bank B
CLKB2 <sup>(2)</sup>	7	Out	Output clock for bank B
S2 <sup>(3)</sup>	8	IN	Select input Bit 2
S1 <sup>(3)</sup>	9	IN	Select input Bit 1
CLKB3 <sup>(2)</sup>	10	Out	Output clock for bank B
CLKB4 <sup>(2)</sup>	11	Out	Output clock for bank B
CLKA3 <sup>(2)</sup>	14	Out	Output clock for bank A
CLKA4 <sup>(2)</sup>	15	Out	Output clock for bank A
CLKOUT <sup>(2)</sup>	16	Out	Output clock, internal feedback on this pin

#### NOTES:

- 1. Weak pull down.
- 2. Weak pull down on all outputs.
- 3. Weak pull ups on these inputs.

## FUNCTION TABLE(1)

S2	S1	CLKA	CLKB	CLKOUT <sup>(2)</sup>	Output Source	PLL Shut Down
L	L	Tri-State	Tri-State	Driven	PLL	N
L	Н	Driven	Tri-State	Driven	PLL	N
Н	L	Driven	Driven	Driven	REF	Υ
Н	Н	Driven	Driven	Driven	PLL	N

#### NOTES:

- 1. H = HIGH Voltage Level.
  - L = LOW Voltage Level
- 2. This output is driven and has an internal feedback for the PLL. The load on this ouput can be adjusted to change the skew between the REF and the output.

## DC ELECTRICAL CHARACTERISTICS - COMMERCIAL

Symbol	Parameter	Condition	ons	Min.	Max.	Unit	
VIL	Input LOW Voltage Level			_	0.8	٧	
VIH	Input HIGH Voltage Level			2	_	٧	
lıL	Input LOW Current	VIN = 0V		_	50	μΑ	
Іін	Input HIGH Current	VIN = VDD	VIN = VDD		100	μΑ	
Vol	Output LOW Voltage	Standard Drive	IOL = 8mA	_	0.4	0.4	٧
		High Drive	IoL = 12mA (-1H)				
Vон	Output HIGH Voltage	Standard Drive	IOH = -8mA	2.4	_	V	
		High Drive	IOH = -12mA (-1H)				
IDD_PD	Power Down Current	REF = 0MHz (S2 = S1 = H)		_	12	μΑ	
IDD	Supply Current	Unloaded Outputs at 66.66MH:	z, SEL inputs at VDD or GND	_	32	mA	

## OPERATING CONDITIONS - COMMERCIAL

Symbol	Parameter	Min.	Max.	Unit
VDD	Supply Voltage	3	3.6	V
TA	Operating Temperature (Ambient Temperature)	0	70	°c
CL	Load Capacitance < 100MHz	_	30	pF
	Load Capacitance 100MHz - 200MHz	_	10	
CIN	Input Capacitance	_	7	рF

## SWITCHING CHARACTERISTICS (23S09E-1) - COMMERCIAL (1,2)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
tı	Output Frequency	10pFLoad	10	_	200	MHz
		30pFLoad	10	_	100	
	Duty Cycle = t2 t1	Measured at 1.4V, FOUT = 66.66MHz	40	50	60	%
t3	Rise Time	Measured between 0.8V and 2V		_	2.5	ns
t4	FallTime	Measured between 0.8V and 2V		_	2.5	ns
t5	Output to Output Skew	All outputs equally loaded		_	250	ps
t6A	Delay, REF Rising Edge to CLKOUT Rising Edge <sup>(2)</sup>	Measured at VDD/2		0	±350	ps
t6B	Delay, REF Rising Edge to CLKOUT Rising Edge <sup>(2)</sup>	Measured at VDD/2 in PLL bypass mode (IDT23S09E only)	1	5	8.7	ns
t7	Device-to-Device Skew	Measured at VDD/2 on the CLKOUT pins of devices		0	700	ps
tu	Cycle-to-Cycle Jitter	Measured at 66.66MHz, loaded outputs	_	_	200	ps
tLOCK	PLLLockTime	Stable power supply, valid clock presented on REF pin	_	_	1	ms

#### NOTES:

- 1. REF Input has a threshold voltage of VDD/2.
- 2. All parameters specified with loaded outputs.

## SWITCHING CHARACTERISTICS (23S09E-1H) - COMMERCIAL (1,2)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
tı	Output Frequency	10pFLoad	10	_	200	MHz
		30pFLoad	10	_	100	
	Duty Cycle = t2 t1	Measured at 1.4V, Fout = 66.66MHz	40	50	60	%
	Duty Cycle = t2 t1	Measured at 1.4V, FOUT <50MHz	45	50	55	%
t3	Rise Time	Measured between 0.8V and 2V	1	_	1.5	ns
t4	Fall Time	Measured between 0.8V and 2V	1	_	1.5	ns
t5	Output to Output Skew	All outputs equally loaded	-	_	250	ps
t6A	Delay, REF Rising Edge to CLKOUT Rising Edge	Measured at VDD/2		0	±350	ps
t6B	Delay, REF Rising Edge to CLKOUT Rising Edge	Measured at VDD/2 in PLL bypass mode (IDT23S09E only)	1	5	8.7	ns
t	Device-to-Device Skew	Measured at VDD/2 on the CLKOUT pins of devices	_	0	700	ps
t8	Output Slew Rate	Measured between 0.8V and 2V using Test Circuit 2	1	_	_	V/ns
tı	Cycle-to-Cycle Jitter	Measured at 66.66MHz, loaded outputs	_	_	200	ps
tlock	PLLLockTime	Stable power supply, valid clock presented on REF pin	_	_	1	ms

#### NOTES:

- 1. REF Input has a threshold voltage of VDD/2.
- 2. All parameters specified with loaded outputs.

## DC ELECTRICAL CHARACTERISTICS - INDUSTRIAL

Symbol	Parameter	Condition	ons	Min.	Max.	Unit
VIL	Input LOW Voltage Level			_	0.8	V
VIH	Input HIGH Voltage Level			2	_	V
lıL	Input LOW Current	VIN = 0V		_	50	μΑ
Іін	Input HIGH Current	VIN = VDD		_	100	μΑ
Vol	Output LOW Voltage	Standard Drive	IOL = 8mA	_	0.4	V
		High Drive	IoL = 12mA (-1H)			
Vон	Output HIGH Voltage	Standard Drive	IOH = -8mA	2.4	_	V
		High Drive	Iон = -12mA (-1H)			
IDD_PD	Power Down Current	REF = 0MHz (S2 = S1 = H)		_	25	μΑ
IDD	Supply Current	Unloaded Outputs at 66.66MH:	z, SEL inputs at VDD or GND	_	35	mA

## OPERATING CONDITIONS - INDUSTRIAL

Symbol	Parameter	Min.	Max.	Unit
VDD	Supply Voltage	3	3.6	V
TA	Operating Temperature (Ambient Temperature)	-40	+85	°c
CL	Load Capacitance < 100MHz	_	30	pF
	Load Capacitance 100MHz - 200MHz	_	10	
CIN	Input Capacitance	-	7	pF

## SWITCHING CHARACTERISTICS (23S09E-1) - INDUSTRIAL (1,2)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
tı	Output Frequency	10pFLoad	10	_	200	MHz
		30pFLoad	10	_	100	
	Duty Cycle = t2 t1	Measured at 1.4V, FOUT = 66.66MHz	40	50	60	%
t3	Rise Time	Measured between 0.8V and 2V	_	_	2.5	ns
t4	Fall Time	Measured between 0.8V and 2V	_	_	2.5	ns
t5	Output to Output Skew	All outputs equally loaded		_	250	ps
t6A	Delay, REF Rising Edge to CLKOUT Rising Edge	Measured at VDD/2	_	0	±350	ps
t6B	Delay, REF Rising Edge to CLKOUT Rising Edge	Measured at VDD/2 in PLL bypass mode (IDT23S09E only)	1	5	8.7	ns
t	Device-to-Device Skew	Measured at VDD/2 on the CLKOUT pins of devices		0	700	ps
tJ	Cycle-to-Cycle Jitter	Measured at 66.66MHz, loaded outputs	_	_	200	ps
tLOCK	PLLLockTime	Stable power supply, valid clock presented on REF pin		_	1	ms

#### NOTES:

- 1. REF Input has a threshold voltage of  $V\mbox{DD}/2$ .
- 2. All parameters specified with loaded outputs.

## SWITCHING CHARACTERISTICS (23S09E-1H) - INDUSTRIAL (1,2)

Symbol	Parameter	Conditions	Min.	Тур.	Max.	Unit
tı	Output Frequency	10pFLoad	10	_	200	MHz
		30pFLoad	10	_	100	
	Duty Cycle = t2 t1	Measured at 1.4V, FOUT = 66.66MHz	40	50	60	%
	Duty Cycle = t2 t1	Measured at 1.4V, FOUT <50MHz	45	50	55	%
t3	RiseTime	Measured between 0.8V and 2V	-	_	1.5	ns
t4	FallTime	Measured between 0.8V and 2V	1	_	1.5	ns
ts	Output to Output Skew	All outputs equally loaded	1	_	250	ps
t6A	Delay, REF Rising Edge to CLKOUT Rising Edge	Measured at VDD/2		0	±350	ps
t6B	Delay, REF Rising Edge to CLKOUT Rising Edge	Measured at VDD/2 in PLL bypass mode (IDT23S09E only)	1	5	8.7	ns
t7	Device-to-Device Skew	Measured at VDD/2 on the CLKOUT pins of devices	1	0	700	ps
t8	Output Slew Rate	Measured between 0.8V and 2V using Test Circuit 2	1	_	_	V/ns
tu	Cycle-to-Cycle Jitter	Measured at 66.66MHz, loaded outputs			200	ps
tLOCK	PLLLockTime	Stable power supply, valid clock presented on REF pin	_	_	1	ms

#### NOTES:

- 1. REF Input has a threshold voltage of VDD/2.
- 2. All parameters specified with loaded outputs.

### ZERO DELAY AND SKEW CONTROL

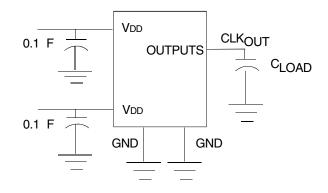
All outputs should be uniformly loaded in order to achieve Zero I/O Delay. Since the CLKOUT pin is the internal feedback for the PLL, its relative loading can affect and adjust the input/output delay.

For designs utilizing zero I/O Delay, all outputs including CLKOUT must be equally loaded. Even if the output is not used, it must have a capacitive load equal to that on the other outputs in order to obtain true zero I/O Delay. For zero output-to-output skew, all outputs must be loaded equally.

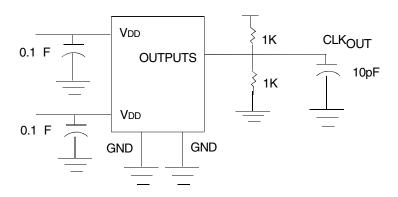
## SPREAD SPECTRUM COMPATIBLE

Many systems being designed now use a technology called Spread Spectrum Frequency Timing Generation. This product is designed 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.

## **TEST CIRCUITS**

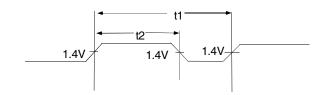


Test Circuit 1 (all Parameters Except t8)

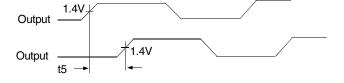


Test Circuit 2 (t8, Output Slew Rate On -1H Devices)

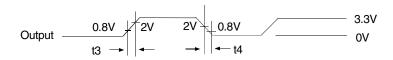
## **SWITCHING WAVEFORMS**



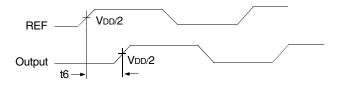
Duty Cycle Timing



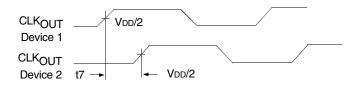
Output to Output Skew



All Outputs Rise/Fall Time

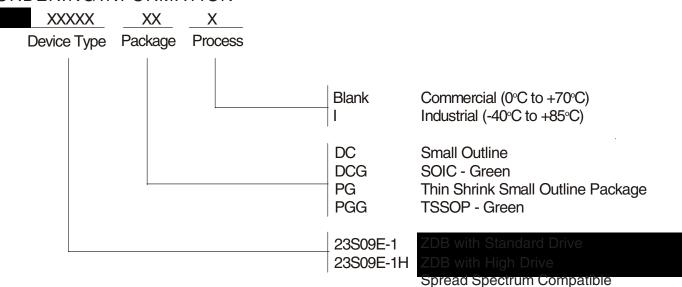


Input to Output Propagation Delay



Device to Device Skew

## ORDERING INFORMATION



\*NOTE: EOL for non-green parts to occur on 5/13/10 per PDN U-09-01

Part / Order Number	Shipping Packaging	Package	Temperature
23S09E-1DC*	Tubes	16-pin SOIC	0° to +70° C
23S09E-1DC8*	Tape and Reel	16-pin SOIC	0° to +70° C
23S09E-1DCI*	Tubes	16-pin SOIC	-40° to +85°C
23S09E-1DCI8*	Tape and Reel	16-pin SOIC	-40° to +85°C
23S09E-1HDC*	Tubes	16-pin SOIC	0° to +70° C
23S09E-1HDC8*	Tape and Reel	16-pin SOIC	0° to +70° C
23S09E-1HDCI*	Tubes	16-pin SOIC	-40° to +85°C
23S09E-1HDCI8*	Tape and Reel	16-pin SOIC	-40° to +85°C
23S09E-1HPG*	Tubes	16-pin TSSOP	0° to +70° C
23S09E-1HPG8*	Tape and Reel	16-pin TSSOP	0° to +70° C
23S09E-1HPGI*	Tubes	16-pin TSSOP	-40° to +85°C
23S09E-1HPGI8*	Tape and Reel	16-pin TSSOP	-40° to +85°C
23S09E-1DCG	Tubes	16-pin SOIC	0° to +70° C
23S09E-1DCG8	Tape and Reel	16-pin SOIC	0° to +70° C
23S09E-1DCGI	Tubes	16-pin SOIC	-40° to +85°C
23S09E-1DCGI8	Tape and Reel	16-pin SOIC	-40° to +85°C
23S09E-1HDCG	Tubes	16-pin SOIC	0° to +70° C
23S09E-1HDCG8	Tape and Reel	16-pin SOIC	0° to +70° C
23S09E-1HDCGI	Tubes	16-pin SOIC	-40° to +85°C
23S09E-1HDCGI8	Tape and Reel	16-pin SOIC	-40° to +85°C
23S09E-1HPGG	Tubes	16-pin TSSOP	0° to +70° C
23S09E-1HPGG8	Tape and Reel	16-pin TSSOP	0° to +70° C
23S09E-1HPGGI	Tubes	16-pin TSSOP	-40° to +85°C
23S09E-1HPGGI8	Tape and Reel	16-pin TSSOP	-40° to +85°C



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