

CDC5801

LOW JITTER CLOCK MULTIPLIER AND DIVIDER WITH PROGRAMMABLE DELAY AND PHASE ALIGNMENT

SCAS682A – OCTOBER 2002

Depending on the selection of the mode terminals (P0:2), the device behaves as a multiplier (by 4, 6, or 8) with the phase aligner bypassed or as a multiplier or divider with programmable delay and phase aligner functionality. Through the select terminals (P0:2) user can also bypass the phase aligner and the PLL (test mode) and output the REFCLK directly on the CLKOUT/CLKOUTB terminals. Through P0:2 terminals the outputs could be in a high impedance state. This device has another unique capability to be able to function with a wide band of voltages on the REFCLK terminal by varying the voltage on the V_{DDREF} terminal.

The CDC5801 device is characterized for operation over free-air temperatures of -40°C to 85°C .

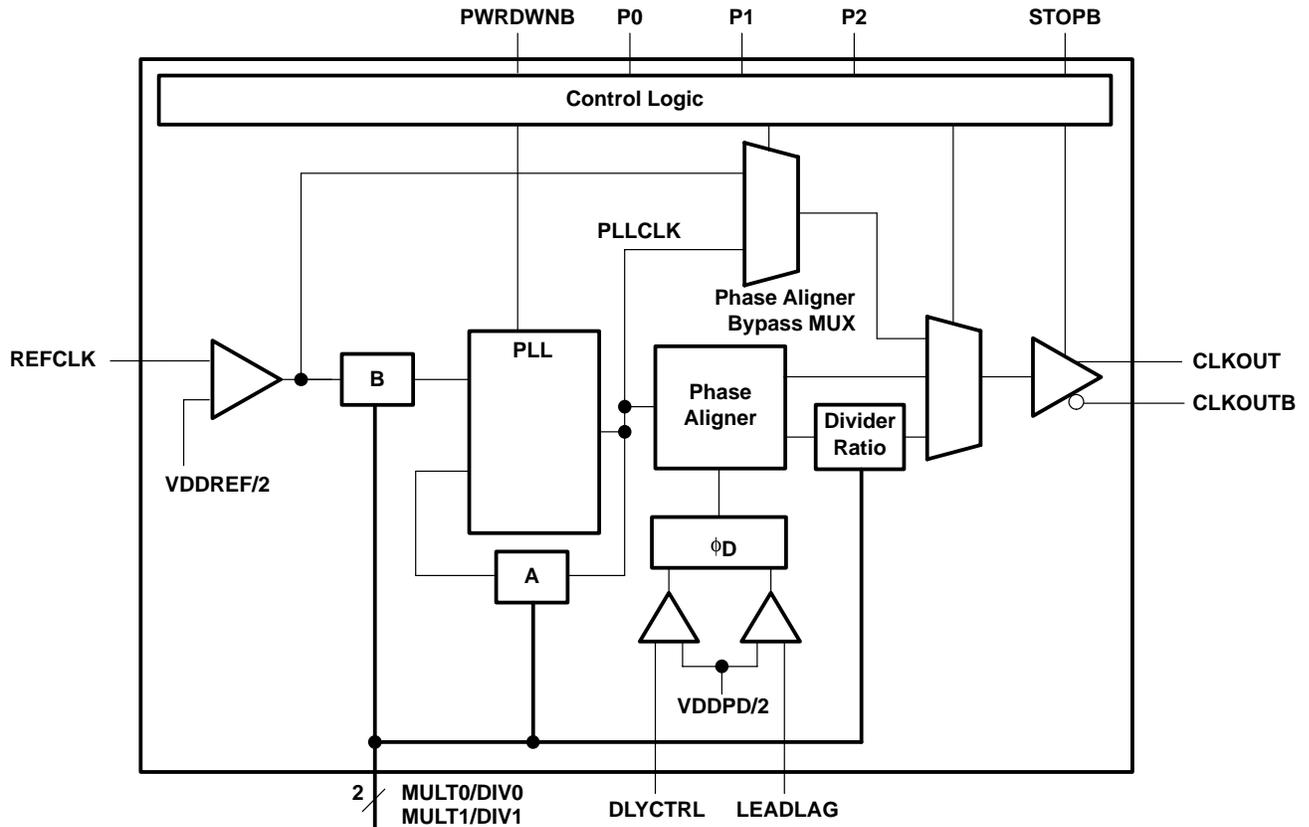


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functional block diagram



FUNCTION TABLE†

MODE	P0	P1	P2	CLKOUT/CLKOUTB
Multiplication with programmable delay and phase alignment active‡	0	0	0	REFCLK multiplied by ratio per Table 1 selected by MULT/DIV terminals. Outputs are delayed or advanced based on DLYCTRL and LEADLAG terminal configuration.
Division with programmable delay and phase alignment active ‡	0	0	1	REFCLK divided by ratio per Table 2 selected by MULT/DIV terminals. Outputs are delayed or advanced based on DLYCTRL and LEADLAG terminal configuration.
Multiplication only mode (phase aligner bypassed) §	1	0	0	In this mode one can only multiply as per Table 1. Programmable delay capability and divider capability is deactivated. PLL is running.
Test mode	1	1	0	PLL and phase aligner both bypassed. REFCLK is directly channeled to output.
Hi-Z mode	0	1	X	Hi-Z

† X = don't care, Hi-Z = high impedance

‡ Please see Table 4 and Table 5 for explanation for the programmability and phase alignment functions.

§ In this mode the DLYCTRL and LEADLAG terminals must be strapped high or low. Lowest possible jitter is achieved in this mode, but a delay of 200 ps to 2 ns expected typically from REFCLK to CLKOUT depending on the output frequency.

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Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
CLKOUT	20	O	Output clock
CLKOUTB	18	O	Output clock (complement)
DLYCTRL	7	I	Every rising edge on this terminal delays/advances the CLKOUT/CLKOUTB signal by 1/384th of the CLKOUT/CLKOUTB period. (e.g., for a 90 degree delay or advancement one needs to provide 96 rising edges). See Table 4.
GND	5		GND for V _{DDREF} and V _{DDPD}
GND0	17, 21		GND for clock output terminals (CLKOUT, CLKOUTB)
GNDP	4		GND for PLL
GNDPA	8		GND for phase aligner
LEADLAG	6	I	Decides if the output clock is delayed or advanced with respect to REFCLK. See Table 4.
MULT0/DIV0	15	I	PLL multiplier and divider select
MULT1/DIV1	14	I	PLL multiplier and divider select
NC	19		Not used
PWRDNB	12	I	Active low power down state, CLKOUT/CLKOUTB goes low
P0	24	I	Mode control, see Function Table
P1	23	I	Mode control, see Function Table
P2	13	I	Mode control, see Function Table
REFCLK	2	I	Reference input clock
STOPB	11	I	Active low output disabler, PLL and PA still running, CLKOUT and CLKOUTB goes to a dc value as per Table 3
V _{DDPA}	9	I	Supply voltage for phase aligner
V _{DDPD}	10	I	Reference voltage for the DLYCTRL, LEADLAG terminals and STOPB function
V _{DDREF}	1	I	Reference voltage for REFCLK
V _{DDO}	16, 22	I	Supply voltage for the output terminals (CLKOUT, CLKOUTB)
V _{DDP}	3	I	Supply voltage for PLL



PLL divider/multiplier selection

Table 1 and Table 2 list the supported REFCLK and BUSCLK (CLKOUT/CLKOUTB) frequencies.

Table 1. Multiplication Ratios (P0:2 = 000 or 100)

MULT0	MULT1	REFCLK (MHZ)	MULTIPLICATION RATIO	BUSCLK (MHZ)
0	0	38–125	4	152–500
0	1	25–83.3	6	150–500
1	1	19–62.5	8	152–500

Table 2. Divider Ratio (P0:2 = 001)

MULT0	MULT1	REFCLK (MHZ)	DIVISION RATIO	BUSCLK (MHZ)
0	0	100–125	2	50–62.5
1	0	75–93	3	25–31
1	1	50–62	4	12.5–15.5

Table 3. Clock Output Driver States

STATE	PWRDNB	STOPB	CLKOUT	CLKOUTB
Powerdown	0	X	GND	GND
CLK stop	1	0	V _O , STOP	V _O , STOP
Normal	1	1	As per Function Table	As per Function Table

Table 4. Programmable Delay and Phase Alignment

DLYCTRL	LEADLAG	CLKOUT AND CLKOUTB
Each rising edge [†]	1	Will be advanced by one step size (see Table 5)
Each rising edge [†]	0	Will be delayed by one step size (see Table 5)

[†] For every 32nd edge, there are one or two edges the phase aligner does not update. Therefore, CLKOUT phase is not updated on every 32nd edge.

Table 5. Clock Output Driver States

FUNCTIONALITY	STEP SIZE
Multiply by 4, 6, 8	CLKOUT period/384 (for example, 6.5 ps @ 400 MHz)
Divide by 2	CLKOUT period/3072 (for example, 6.5 ps @ 50 MHz)
Divide by 3	CLKOUT period/6144 (for example, 6.5 ps @ 25 MHz)
Divide by 4	CLKOUT period/12288 (for example, 6.5 ps @ 12.5 MHz)

NOTE: The frequency of the DLYCTRL terminal must always be equal or less than the frequency of the LEADLAG terminal.

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absolute maximum ratings over operating free-air temperature (unless otherwise noted)†

Supply voltage range, V_{DD} (see Note 1)	-0.5 V to 4 V
Output voltage range, V_O , at any output terminal	-0.5 V to $V_{DD} + 0.5$ V
Input voltage range, V_I , at any input terminal	-0.5 V to $V_{DD} + 0.5$ V
Continuous total power dissipation	see Dissipation Rating Table
Operating free-air temperature range, T_A	-40°C to 85°C
Storage temperature range, T_{stg}	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to the GND terminals.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$ ‡	$T_A = 85^\circ\text{C}$ POWER RATING
DBQ	1400 mW	11 mW/°C	740 mW

‡ This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.

recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, V_{DD} (V_{DDP} , V_{DDPA} , V_{DDO})	3.0	3.3	3.6	V
High-level input voltage, V_{IH} (CMOS)	$0.7 \times V_{DD}$			V
Low-level input voltage, V_{IL} (CMOS)	$0.3 \times V_{DD}$			V
REFCLK low-level input voltage, V_{IL}	$0.3 \times V_{DDREF}$			V
REFCLK high-level input voltage, V_{IH}	$0.7 \times V_{DDREF}$			V
Input signal low voltage, V_{IL} (STOPB, DLYCTRL, LEADLAG)	$0.3 \times V_{DDPD}$			V
Input signal high voltage, V_{IH} (STOPB, DLYCTRL, LEADLAG)	$0.7 \times V_{DDPD}$			V
Input reference voltage for (REFCLK) (V_{DDREF})	1.235		V_{DD}	V
Input reference voltage for (DLYCTRL and LEADLAG) (V_{DDPD})	1.235		V_{DD}	V
High-level output current, I_{OH}			-16	mA
Low-level output current, I_{OL}			16	mA
Operating free-air temperature, T_A	-40		85	°C

timing requirements

	MIN	MAX	UNIT
Input frequency of modulation, f_{mod} (if driven by SSC CLKIN)		33	kHz
Modulation index (nonlinear maximum 0.5%)		0.6%	
Input slew rate, SR	1	4	V/ns
Input duty cycle on REFCLK	40%	60%	
Input frequency on REFCLK	19	125	MHz
Allowable frequency on DLYCTRL		200	MHz
Allowable frequency on LEADLAG		400	MHz
Allowable duty cycle on DLYCTRL and LEADLAG	25%	75%	



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electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
$V_{O(STOP)}$	Output voltage during CLK stop mode	See Figure 1	1.1		2	V
V_{OX}	Output crossing-point voltage	See Figure 1 and Figure 4	$0.5V_{DDO}-0.2$		$0.5V_{DDO}+0.2$	V
V_O	Output voltage swing ($V_{OH} - V_{OL}$)	See Figure 1	1.7		2.9	V
V_{IK}	Input clamp voltage	$V_{DD} = 3.0\text{ V}$, $I_I = -18\text{ mA}$			-1.2	V
V_{OH}	High-level output voltage	See Figure 1, $V_{DD} = 3\text{ to }3.6\text{ V}$	2.0	2.6		V
		$V_{DD} = 3.0\text{ V}$, $I_{OH} = -16\text{ mA}$	2.2			
V_{OL}	Low-level output voltage	See Figure 1, $V_{DD} = 3\text{ to }3.6\text{ V}$		0.3	0.6	V
		$V_{DD} = 3.0\text{ V}$, $I_{OH} = -16\text{ mA}$			0.5	
I_{OH}	High-level output current	$V_{DD} = 3.135\text{ V}$, $V_O = 1\text{ V}$	-32	-52		mA
		$V_{DD} = 3.3\text{ V}$, $V_O = 1.65\text{ V}$		-51		
		$V_{DD} = 3.465\text{ V}$, $V_O = 3.135\text{ V}$		-14.5	-21	
I_{OL}	Low-level output current	$V_{DD} = 3.135\text{ V}$, $V_O = 1.95\text{ V}$	43	61.5		mA
		$V_{DD} = 3.3\text{ V}$, $V_O = 1.65\text{ V}$		65		
		$V_{DD} = 3.465\text{ V}$, $V_O = 0.4\text{ V}$		25.5	36	
I_{OZ}	High-impedance-state output current	$P0 = 0$, $P1 = 1$			± 10	μA
$I_{OZ(STOP)}$	High-impedance-state output current during CLK stop	Stop = 0, $V_O = \text{GND}$ or V_{DD}			± 100	μA
$I_{OZ(PD)}$	High-impedance-state output current in power-down state	$\text{PWRDNB} = 0$, $V_O = \text{GND}$ or V_{DD}	-10		100	μA
I_{IH}	High-level input current	REFCLK, STOPB $V_{DD} = 3.6\text{ V}$, $V_I = V_{DD}$			10	μA
		PWRDNB, P0:2, MULT/DIV0:1 $V_{DD} = 3.6\text{ V}$, $V_I = V_{DD}$			10	
I_{IL}	Low-level input current	REFCLK, STOPB $V_{DD} = 3.6\text{ V}$, $V_I = 0$			-10	μA
		PWRDNB, P0:2, MULT/DIV0:1 $V_{DD} = 3.6\text{ V}$, $V_I = 0$			-10	
Z_O	Output impedance (single ended)	High state R_I at $I_O -14.5\text{ mA}$ to -16.5 mA	15	35	50	Ω
		Low state R_I at $I_O 14.5\text{ mA}$ to 16.5 mA	11	17	35	
	Reference current	V_{DDREF} , V_{DDPD} $V_{DD} = 3.6\text{ V}$	PWRDNB = 0		50	μA
			PWRDNB = 1		0.5	mA
C_I	Input capacitance	$V_I = V_{DD}$ or GND		2		pF
C_O	Output capacitance	$V_O = V_{DD}$ or GND		3		pF
$I_{DD(PD)}$	Supply current in power-down state	REFCLK = 0 MHz to 100 MHz, PWDNB = 0, STOPB = 1			100	μA
$I_{DD(CLKSTOP)}$	Supply current in CLK stop state	BUSCLK configured for 500 MHz			40	mA
$I_{DD(NORMAL)}$	Supply current in normal state	BUSCLK = 500 MHz P0:2 = 000; load see Figure 1			70	mA

† V_{DD} refers to any of the following: V_{DDPA} , V_{DDPD} , V_{DDREF} , V_{DDO} , and V_{DDP}

‡ All typical values are at $V_{DD} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.



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jitter specification over recommended operating free-air temperature range and V_{CC} (unless otherwise noted)

PARAMETER	CLKOUT	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{(jitter)}$ (Multiplication only mode. Phase alignment and programmable delay features are not selected (PA bypass). See Figure 2.)	155 MHz	Period RMS (1 Σ jitter, full frequency band)		6.0		ps
		Period p-p		40		
		Phase jitter (accumulated, 12 kHz to 20 MHz)		50		
		Cycle-to-cycle (+)		27		
		Cycle-to-cycle (-)		27		
200 MHz	Period RMS (1 Σ jitter, full frequency band)		5.5		ps	
	Period p-p		36			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		36			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		36			
	Cycle-to-cycle (+)		23			
312 MHz	Period RMS (1 Σ jitter, full frequency band)		3.0		ps	
	Period p-p		20			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		18			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		18			
	Cycle-to-cycle (+)		17			
400 MHz	Period RMS (1 Σ jitter, full frequency band)		2.3		ps	
	Period p-p		17			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		12			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		12			
	Cycle-to-cycle (+)		15			
500 MHz	Period RMS (1 Σ jitter, full frequency band)		2.1		ps	
	Period p-p		16			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		8			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		8			
	Cycle-to-cycle (+)		14			
$t_{(jitter)}$ (Multiplication with phase alignment and programmable delay features selected. See Figure 2.)	155 MHz	Period RMS (1 Σ jitter, full frequency band)		9.0		ps
		Period p-p		70		
		Phase jitter (accumulated, 12 kHz to 20 MHz)		50		
		Cycle-to-cycle (+)		50		
		Cycle-to-cycle (-)		50		
200 MHz	Period RMS (1 Σ jitter, full frequency band)		7.0		ps	
	Period p-p		55			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		36			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		36			
	Cycle-to-cycle (+)		40			
312 MHz	Period RMS (1 Σ jitter, full frequency band)		4.0		ps	
	Period p-p		35			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		18			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		18			
	Cycle-to-cycle (+)		30			
400 MHz	Period RMS (1 Σ jitter, full frequency band)		3.1		ps	
	Period p-p		27			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		13			
	Phase jitter (accumulated, 50 kHz to 80 MHz)		13			
	Cycle-to-cycle (+)		25			
		Cycle-to-cycle (-)		25		

† All typical values are at $V_{DD} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.



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jitter specification over recommended operating free-air temperature range and V_{CC} (unless otherwise noted) (continued)

PARAMETER		CLKOUT	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t(jitter) (Multiplication with phase alignment and programmable delay features selected. See Figure 2.)		500 MHz	Period RMS (1Σ jitter, full frequency band)		2.9		ps
			Period p-p		24		
			Phase jitter (accumulated, 12 kHz to 20 MHz)		9		
			Phase jitter (accumulated, 50 kHz to 80 MHz)		9		
			Cycle-to-cycle (+)		20		
			Cycle-to-cycle (-)		20		
t(jitter) (Divider mode with phase aligner not active: DLYCTRL = LEADLAG = 0 or 1. See Figure 2.)	MULT0:1 = 11 (Divider ratio = 4)	12.5 MHz	Period RMS (1Σ jitter, full frequency band)		12.0		ps
			Period p-p		75		
		Cycle-to-cycle (+)		55			
		Cycle-to-cycle (-)		55			
		15.5 MHz	Period RMS (1Σ jitter, full frequency band)		8.0		ps
			Period p-p		50		
			Cycle-to-cycle (+)		38		
			Cycle-to-cycle (-)		38		
	MULT0:1 = 10 (Divider ratio = 3)	25.0 MHz	Period RMS (1Σ jitter, full frequency band)		7.5		ps
			Period p-p		50		
		Cycle-to-cycle (+)		35			
		Cycle-to-cycle (-)		35			
	31.0 MHz	Period RMS (1Σ jitter, full frequency band)		5.5		ps	
		Period p-p		30			
		Cycle-to-cycle (+)		23			
		Cycle-to-cycle (-)		23			
MULT0:1 = 00 (Divider ratio = 2)	50.0 MHz	Period RMS (1Σ jitter, full frequency band)		8.0		ps	
		Period p-p		40			
	Phase jitter (accumulated, 12 kHz to 20 MHz)		12				
	Cycle-to-cycle (+)		30				
		Cycle-to-cycle (-)		30			
62.5 MHz	Period RMS (1Σ jitter, full frequency band)		5.5		ps		
	Period p-p		28				
	Phase jitter (accumulated, 12 kHz to 20 MHz)		9				
	Cycle-to-cycle (+)		24				
		Cycle-to-cycle (-)		24			
t(jitter) (Divider mode with phase alignment and programmable delay features selected. See Figure 2.)	MULT0:1 = 11 (Divider ratio = 4)	12.5 MHz	Period RMS (1Σ jitter, full frequency band)		12.5		ps
			Period p-p		80		
		Cycle-to-cycle (+)		55			
		Cycle-to-cycle (-)		55			
		15.5 MHz	Period RMS (1Σ jitter, full frequency band)		8.5		ps
			Period p-p		55		
			Cycle-to-cycle (+)		38		
			Cycle-to-cycle (-)		38		
MULT0:1 = 10 (Divider ratio = 3)	25.0 MHz	Period RMS (1Σ jitter, full frequency band)		10.0		ps	
		Period p-p		60			
	Cycle-to-cycle (+)		35				
	Cycle-to-cycle (-)		35				
31.0 MHz	Period RMS (1Σ jitter, full frequency band)		7.0		ps		
	Period p-p		40				
	Cycle-to-cycle (+)		23				
	Cycle-to-cycle (-)		23				



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jitter specification over recommended operating free-air temperature range and V_{CC} (unless otherwise noted) (continued)

PARAMETER		CLKOUT	TEST CONDITIONS	MIN	TYP†	MAX	UNIT	
t(jitter) (Divider mode with phase alignment and programmable delay features selected. See Figure 2.)	MULT0:1 = 00 (Divider ratio = 2)	50.0 MHz	Period RMS (1 Σ jitter, full frequency band)		9.0		ps	
			Period p-p		50			
			Phase jitter (accumulated, 12 kHz to 20 MHz)		13			
			Cycle-to-cycle (+)		35			
				Cycle-to-cycle (-)		35		
		62.5 MHz	Period RMS (1 Σ jitter, full frequency band)		6.5		ps	
	Period p-p			30				
	Phase jitter (accumulated, 12 kHz to 20 MHz)			10				
Cycle-to-cycle (+)			26					
			Cycle-to-cycle (-)		26			

† All typical values are at $V_{DD} = 3.3$ V, $T_A = 25^\circ\text{C}$.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t(DC)	Output duty cycle	See Figure 3	45%		55%	
t _r , t _f	Output rise and fall times (measured at 20%–80% of output voltage)	See Figure 5 and Figure 1	150		350	ps

† All typical values are at $V_{DD} = 3.3$ V, $T_A = 25^\circ\text{C}$.



state transition latency specifications

PARAMETER		FROM	TO	TEST CONDITIONS	MIN	TYP†	MAX	UNIT
t(powerup)	Delay time, PWRDNB↑ to CLKOUT/CLKOUTB output settled (excluding t(DISTLOCK))	Powerdown	Normal	See Figure 6			3	ms
	Delay time, PWRDNB↑ to internal PLL and clock are on and settled						3	
t(VDDpowerup)	Delay time, power up to CLKOUT/CLKOUTB output settled	V _{DD}	Normal	See Figure 6			3	ms
	Delay time, power up to internal PLL and clock are on and settled						3	
t(MULT)	MULT0 and MULT1 change to CLKOUT/CLKOUTB output resettled (excluding t(DISTLOCK))	Normal	Normal	See Figure 7			1	ms
t(CLKON)	STOPB↑ to CLKOUT/CLKOUTB glitch-free clock edges	CLK Stop	Normal	See Figure 8			10	ns
t(CLKSETL)	STOPB↑ to CLKOUT/CLKOUTB output settled to within 50 ps of the phase before STOPB was disabled	CLK Stop	Normal	See Figure 8			20	cycles
t(CLKOFF)	STOPB↓ to CLKOUT/CLKOUTB output disabled	Normal	CLK Stop	See Figure 8			5	ns
t(powerdown)	Delay time, PWRDNB↓ to the device in the power-down mode	Normal	Power-down	See Figure 6			1	ms
t(STOP)	Maximum time in CLKSTOP (STOPB = 0) before reentering normal mode (STOPB = 1)	STOPB	Normal	See Figure 8			100	μs
t(ON)	Minimum time in normal mode (STOPB = 1) before reentering CLKSTOP (STOPB = 0)	Normal	CLK stop	See Figure 8	100			ms

† All typical values are at V_{DD} = 3.3 V, T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION

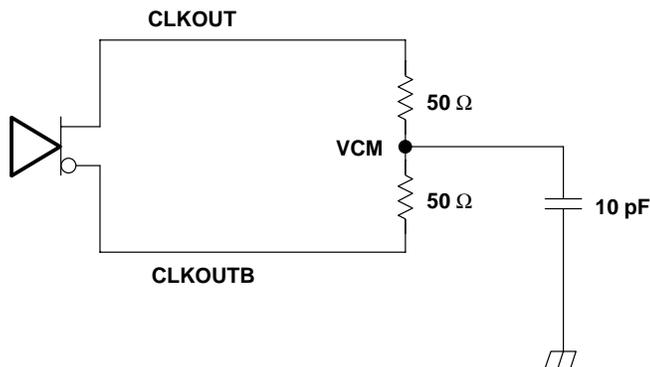


Figure 1. Test Load and Voltage Definitions (V_{O(STOP)}, V_{Ox}, V_{OH}, V_{OL})

PARAMETER MEASUREMENT INFORMATION

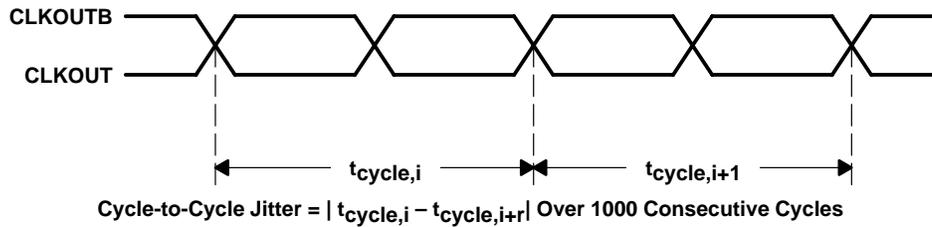


Figure 2. Cycle-to-Cycle Jitter

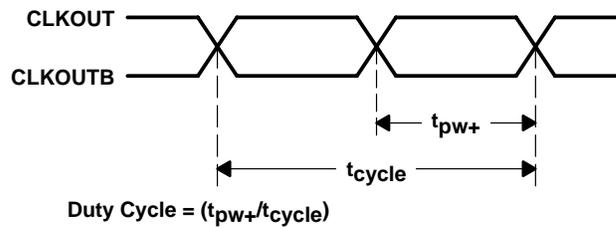


Figure 3. Output Duty Cycle

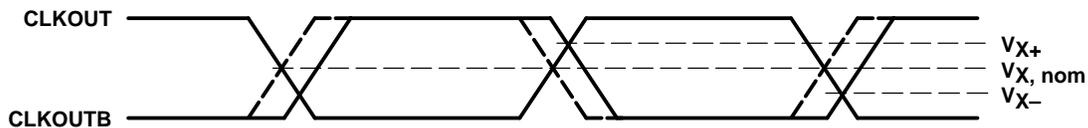


Figure 4. Crossing-Point Voltage



Figure 5. Voltage Waveforms

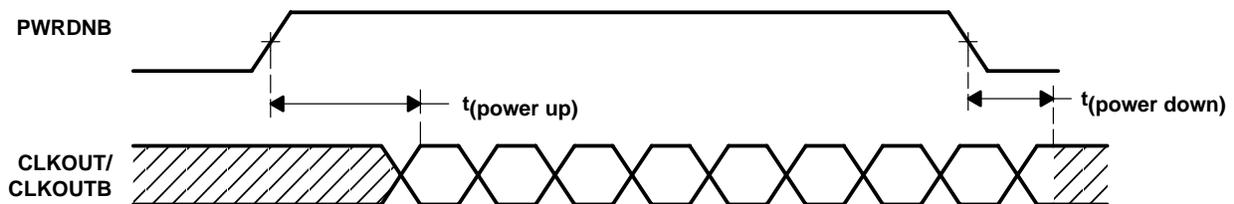


Figure 6. PWRDNB Transition Timings

PARAMETER MEASUREMENT INFORMATION

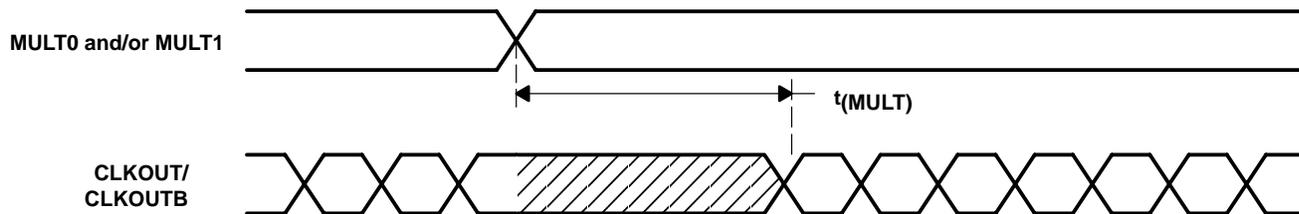
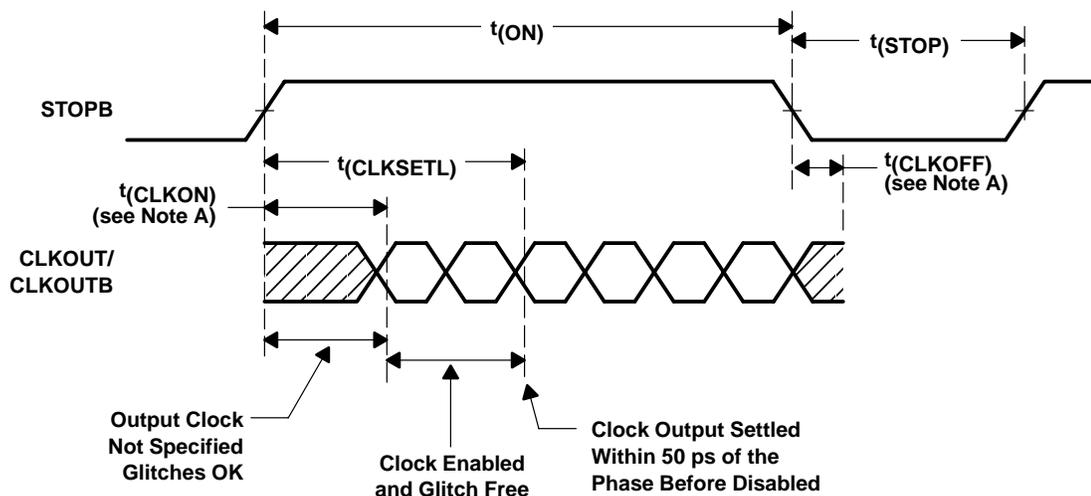


Figure 7. MULT Transition Timings



NOTE A: $V_{ref} = V_O \pm 200 \text{ mV}$

Figure 8. STOPB Transition Timings

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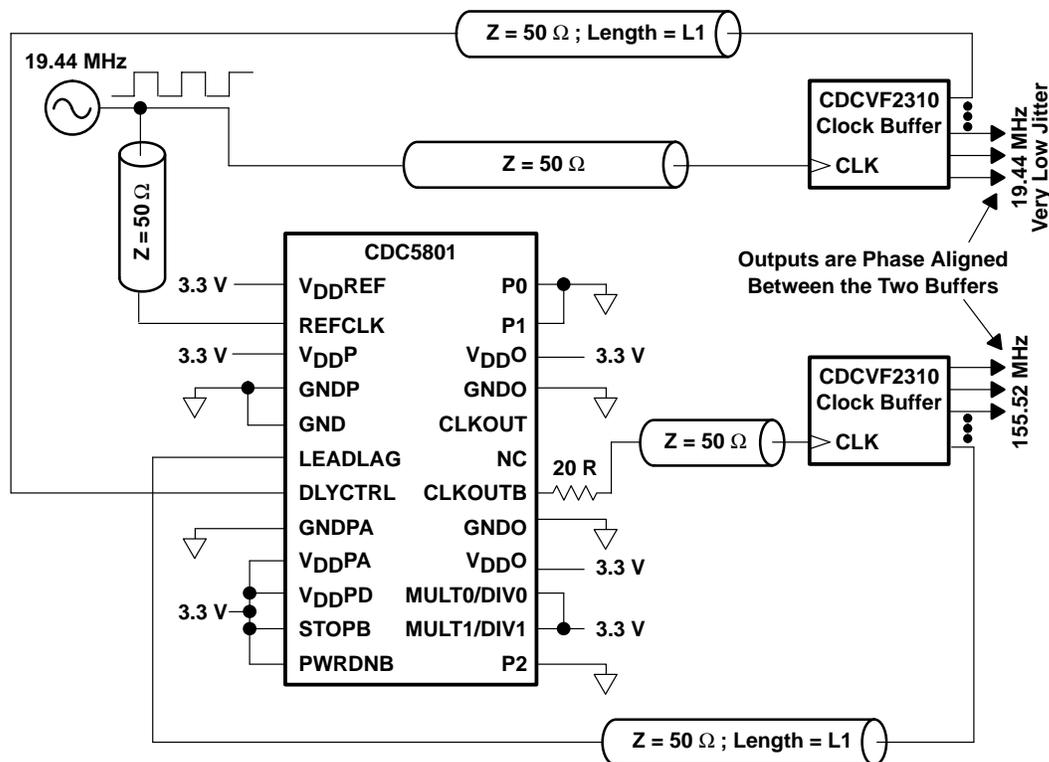


Figure 9. Using the CDC5801 Device as a Multiplier by 8 and Aligning Two Different Clocks

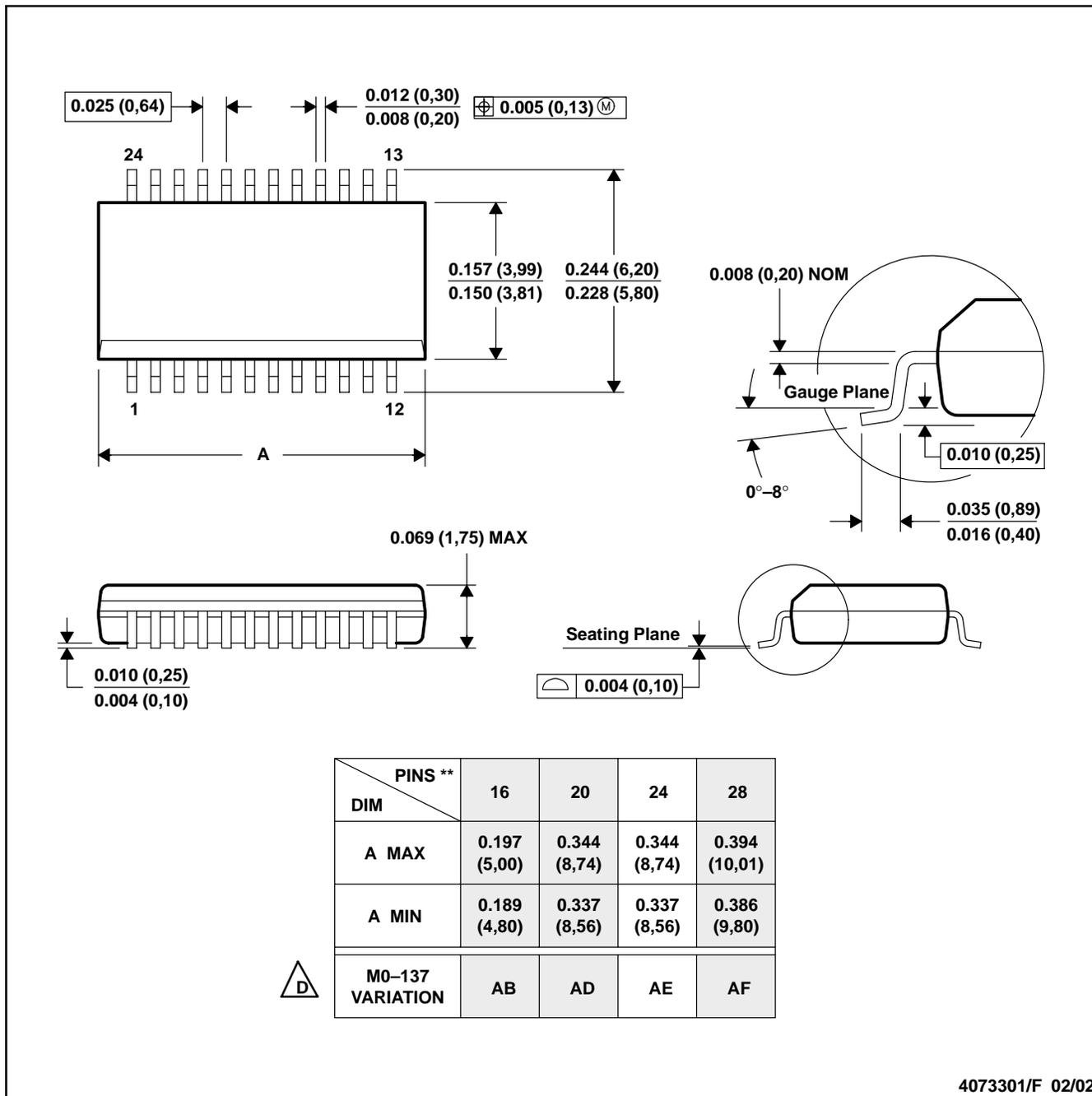
CDC5801
LOW JITTER CLOCK MULTIPLIER AND DIVIDER WITH
PROGRAMMABLE DELAY AND PHASE ALIGNMENT

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MECHANICAL DATA

DBQ (R-PDSO-G)**

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 D. Falls within JEDEC MO-137.

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