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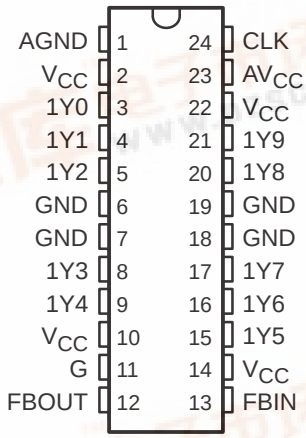
CDC2510C
3.3-V PHASE-LOCK LOOP CLOCK DRIVER

SCAS621 – DECEMBER 1998

- Designed to Meet PC SDRAM Registered DIMM Design Support Document Rev. 1.2
- Spread Spectrum Clock Compatible
- Operating Frequency 25 MHz to 125 MHz
- Static tPhase Error Distribution at 66 MHz to 100 MHz is ±150 ps
- Drop-In Replacement for TI CDC2510A With Enhanced Performance
- Jitter (cyc – cyc) at 66 MHz to 100 MHz is |100 ps|
- Available in Plastic 24-Pin TSSOP
- Phase-Lock Loop Clock Distribution for Synchronous DRAM Applications
- Distributes One Clock Input to One Bank of Ten Outputs
- External Feedback (FBIN) Terminal Is Used to Synchronize the Outputs to the Clock Input
- On-Chip Series Damping Resistors
- No External RC Network Required
- Operates at 3.3 V

PW PACKAGE
(TOP VIEW)



description

The CDC2510C is a high-performance, low-skew, low-jitter, phase-lock loop (PLL) clock driver. It uses a PLL to precisely align, in both frequency and phase, the feedback (FBOUT) output to the clock (CLK) input signal. It is specifically designed for use with synchronous DRAMs. The CDC2510C operates at V_{CC} = 3.3 V . It also provides integrated series-damping resistors that make it ideal for driving point-to-point loads.

One bank of ten outputs provides ten low-skew, low-jitter copies of CLK. Output signal duty cycles are adjusted to 50 percent, independent of the duty cycle at CLK. All outputs can be enabled or disabled via a single output enable input. When the G input is high, the outputs switch in phase and frequency with CLK; when the G input is low, the outputs are disabled to the logic-low state.

Unlike many products containing PLLs, the CDC2510C does not require external RC networks. The loop filter for the PLL is included on-chip, minimizing component count, board space, and cost.

Because it is based on PLL circuitry, the CDC2510C requires a stabilization time to achieve phase lock of the feedback signal to the reference signal. This stabilization time is required, following power up and application of a fixed-frequency, fixed-phase signal at CLK, and following any changes to the PLL reference or feedback signals. The PLL can be bypassed for test purposes by strapping AV_{CC} to ground.

The CDC2510C is characterized for operation from 0°C to 85°C.

For application information refer to application reports *High Speed Distribution Design Techniques for CDC509/516/2509/2510/2516* (literature number SLMA003) and *Using CDC2509A/2510A PLL with Spread Spectrum Clocking (SSC)* (literature number SCAA039).

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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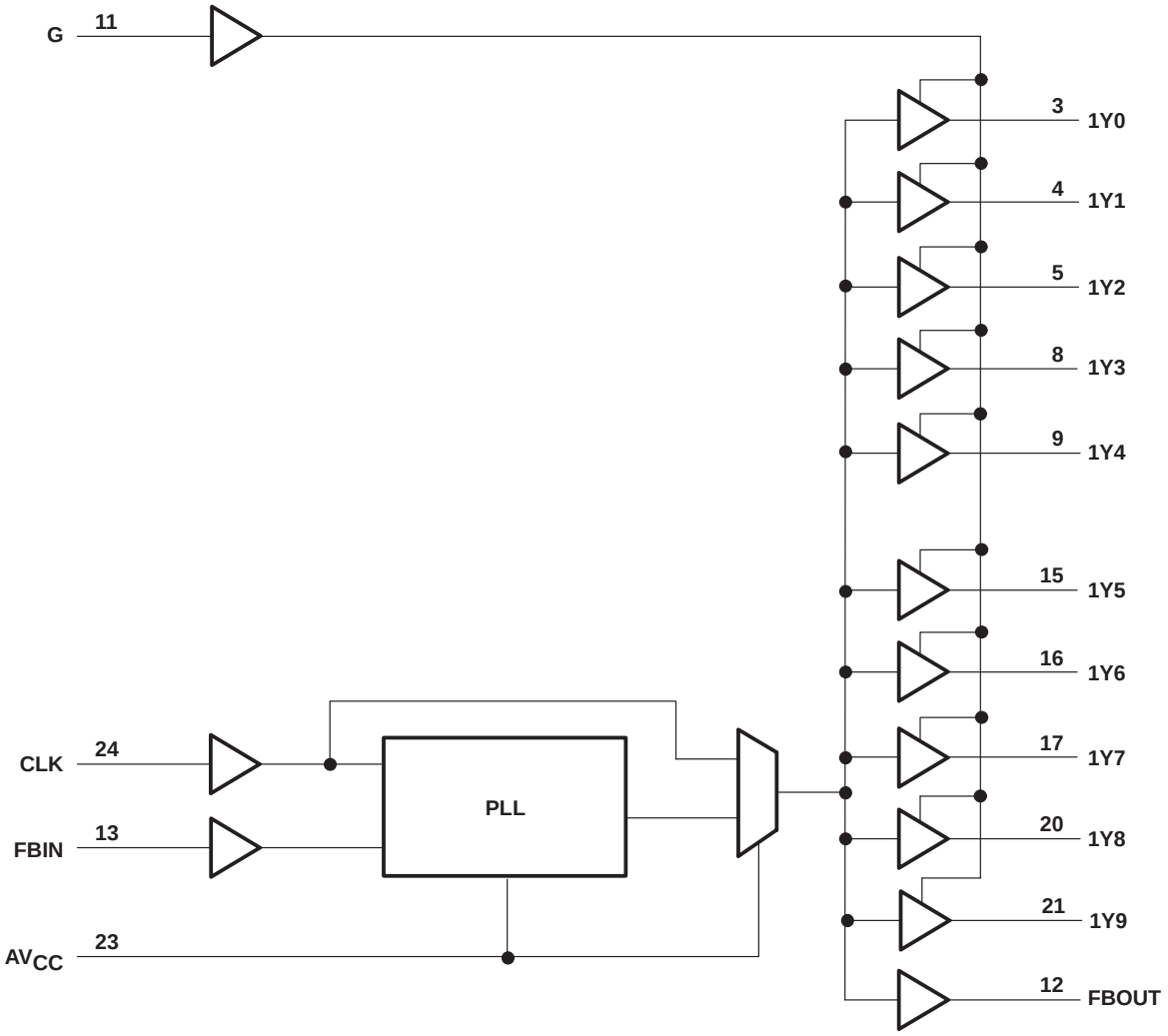
FUNCTION TABLE

INPUTS		OUTPUTS	
G	CLK	1Y (0:9)	FBOUT
X	L	L	L
L	H	L	H
H	H	H	H

functional block diagram



AVAILABLE OPTIONS

T_A	PACKAGE
	SMALL OUTLINE (PW)
0°C to 85°C	CDC2510CPWR

Terminal Functions

TERMINAL		TYPE	DESCRIPTION
NAME	NO.		
CLK	24	I	Clock input. CLK provides the clock signal to be distributed by the CDC2510C clock driver. CLK is used to provide the reference signal to the integrated PLL that generates the clock output signals. CLK must have a fixed frequency and fixed phase for the PLL to obtain phase lock. Once the circuit is powered up and a valid CLK signal is applied, a stabilization time is required for the PLL to phase lock the feedback signal to its reference signal.
FBIN	13	I	Feedback input. FBIN provides the feedback signal to the internal PLL. FBIN must be hardwired to FBOUT to complete the PLL. The integrated PLL synchronizes CLK and FBIN so that there is nominally zero phase error between CLK and FBIN.
G	11	I	Output bank enable. G is the output enable for outputs 1Y(0:9). When G is low, outputs 1Y(0:9) are disabled to a logic-low state. When G is high, all outputs 1Y(0:9) are enabled and switch at the same frequency as CLK.
FBOUT	12	O	Feedback output. FBOUT is dedicated for external feedback. It switches at the same frequency as CLK. When externally wired to FBIN, FBOUT completes the feedback loop of the PLL. FBOUT has an integrated 25-Ω series-damping resistor.
1Y (0:9)	3, 4, 5, 8, 9 15, 16, 17, 20, 21	O	Clock outputs. These outputs provide low-skew copies of CLK. Output bank 1Y(0:9) is enabled via the G input. These outputs can be disabled to a logic-low state by deasserting the G control input. Each output has an integrated 25-Ω series-damping resistor.
AV_{CC}	23	Power	Analog power supply. AV_{CC} provides the power reference for the analog circuitry. In addition, AV_{CC} can be used to bypass the PLL for test purposes. When AV_{CC} is strapped to ground, PLL is bypassed and CLK is buffered directly to the device outputs.
AGND	1	Ground	Analog ground. AGND provides the ground reference for the analog circuitry.
V_{CC}	2, 10, 14, 22	Power	Power supply
GND	6, 7, 18, 19	Ground	Ground

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

Supply voltage, AV_{CC} (see Note 1) . . . . . $AV_{CC} < V_{CC}$ +0.7 V
Supply voltage range, V_{CC}, AV_{CC} . . . . . –0.5 V to 4.6 V
Input voltage range, V_I (see Note 2) . . . . . –0.5 V to 6.5 V
Voltage range applied to any output in the high
or low state, V_O (see Notes 2 and 3) . . . . . –0.5 V to V_{CC} + 0.5 V
Input clamp current, I_{IK} ($V_I < 0$) . . . . . –50 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$) . . . . . ±50 mA
Continuous output current, I_O (V_O = 0 to V_{CC}) . . . . . ±50 mA
Continuous current through each V_{CC} or GND . . . . . ±100 mA
Maximum power dissipation at T_A = 55°C (in still air) (see Note 4) . . . . . 0.7 W
Storage temperature range, T_{stg} . . . . . –65°C to 150°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.

NOTES:
1. AV_{CC} **must not** exceed V_{CC}.
2. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
3. This value is limited to 4.6 V maximum.
4. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils. For more information, refer to the *Package Thermal Considerations* application note in the *ABT Advanced BiCMOS Technology Data Book*, literature number SCBD002.

recommended operating conditions (see Note 5)

		MIN	MAX	UNIT
V_{CC}, AV_{CC}	Supply voltage	3	3.6	V
V_{IH}	High-level input voltage	2		V
V_{IL}	Low-level input voltage		0.8	V
V_I	Input voltage	0	V_{CC}	V
I_{OH}	High-level output current		–12	mA
I_{OL}	Low-level output current		12	mA
T_A	Operating free-air temperature	0	85	°C

NOTE 5: Unused inputs must be held high or low to prevent them from floating.

timing requirements over recommended ranges of supply voltage and operating free-air temperature

		MIN	MAX	UNIT
f_{clk}	Clock frequency	25	125	MHz
	Input clock duty cycle	40%	60%	
	Stabilization time†		1	ms

† Time required for the integrated PLL circuit to obtain phase lock of its feedback signal to its reference signal. For phase lock to be obtained, a fixed-frequency, fixed-phase reference signal must be present at CLK. Until phase lock is obtained, the specifications for propagation delay, skew, and jitter parameters given in the switching characteristics table are not applicable. This parameter does not apply for input modulation under SSC application.

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

PARAMETER		TEST CONDITIONS	AV_{CC}, V_{CC}	MIN	TYP‡	MAX	UNIT
V_{IK}	Input clamp voltage	I_I = –18 mA	3 V			–1.2	V
V_{OH}	High-level output voltage	I_{OH} = –100 µA	MIN to MAX	V_{CC} – 0.2			V
		I_{OH} = –12 mA	3 V	2.1			
		I_{OH} = –6 mA	3 V	2.4			
V_{OL}	Low-level output voltage	I_{OL} = 100 µA	MIN to MAX			0.2	V
		I_{OL} = 12 mA	3 V			0.8	
		I_{OL} = 6 mA	3 V			0.55	
I_{OH}	High-level output current	V_O = 1 V	3.135 V	–32			mA
		V_O = 1.65 V	3.3 V		–36		
		V_O = 3.135 V	3.465 V			–12	
I_{OL}	Low-level output current	V_O = 1.95 V	3.135 V	34			mA
		V_O = 1.65 V	3.3 V		40		
		V_O = 0.4 V	3.465 V			14	
I_I	Input current	V_I = V_{CC} or GND	3.6 V			±5	µA
I_{CC}§	Supply current	V_I = V_{CC} or GND, I_O = 0, Outputs: low or high	3.6 V			10	µA
ΔI_{CC}	Change in supply current	One input at V_{CC} – 0.6 V, Other inputs at V_{CC} or GND	3.3 V to 3.6 V			500	µA
C_i	Input capacitance	V_I = V_{CC} or GND	3.3 V		4		pF
C_o	Output capacitance	V_O = V_{CC} or GND	3.3 V		6		pF

‡ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
§ For I_{CC} of AV_{CC} and I_{CC} vs Frequency (see Figures 11 and 12).

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 30 pF (see Note 6 and Figures 1 and 2)‡

PARAMETER		FROM (INPUT)/CONDITION	TO (OUTPUT)	V_{CC}, AV_{CC} = 3.3 V ± 0.165 V			UNIT
				MIN	TYP	MAX	
	Phase error time – static (normalized) (See Figures 3 – 8)	CLKIN↑ = 66 MHz to 100 MHz	FBIN↑	–150		150	ps
$t_{sk(o)}$	Output skew time§	Any Y or FBOUT	Any Y or FBOUT			200	ps
	Phase error time – jitter (see Note 7)	Clkin = 66 MHz to 100 MHz	Any Y or FBOUT	–50		50	ps
	$Jitter_{(cycle-cycle)}$ (See Figures 9 and 10)	Clkin = 66 MHz to 100 MHz	Any Y or FBOUT			|100|	ps
	Duty cycle	F(clkin > 60 MHz)	Any Y or FBOUT	45%		55%	
t_r	Rise time (See Notes 8 and 9)	V_O = 1.2 V to 1.8 V, IBIS simulation	Any Y or FBOUT	2.5		1	V/ns
t_f	Fall time (See Notes 8 and 9)	V_O = 1.2 V to 1.8 V, IBIS simulation	Any Y or FBOUT	2.5		1	V/ns

‡ These parameters are not production tested.
§ The $t_{sk(o)}$ specification is only valid for equal loading of all outputs.

NOTES:
6. The specifications for parameters in this table are applicable only after any appropriate stabilization time has elapsed.
7. Calculated per PC DRAM SPEC ($t_{phase\ error}$, static – $jitter_{(cycle-to-cycle)}$).
8. This is equivalent to 0.8 ns/2.5 ns and 0.8 ns/2.7 ns into standard 500 Ω/ 30 pf load for output swing of 04. V to 2 V.
9. 64 MB DIMM configuration according to PC SDRAM Registered DIMM Design Support Document, Figure 20 and Table 13.

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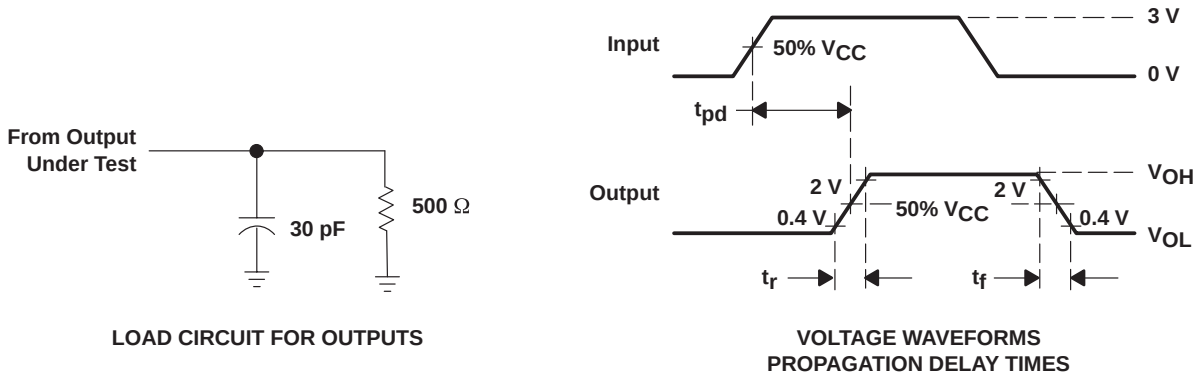
PARAMETER MEASUREMENT INFORMATION



NOTES: A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 100 MHz, Z_O = 50 Ω, t_r ≤ 1.2 ns, t_f ≤ 1.2 ns.
C. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

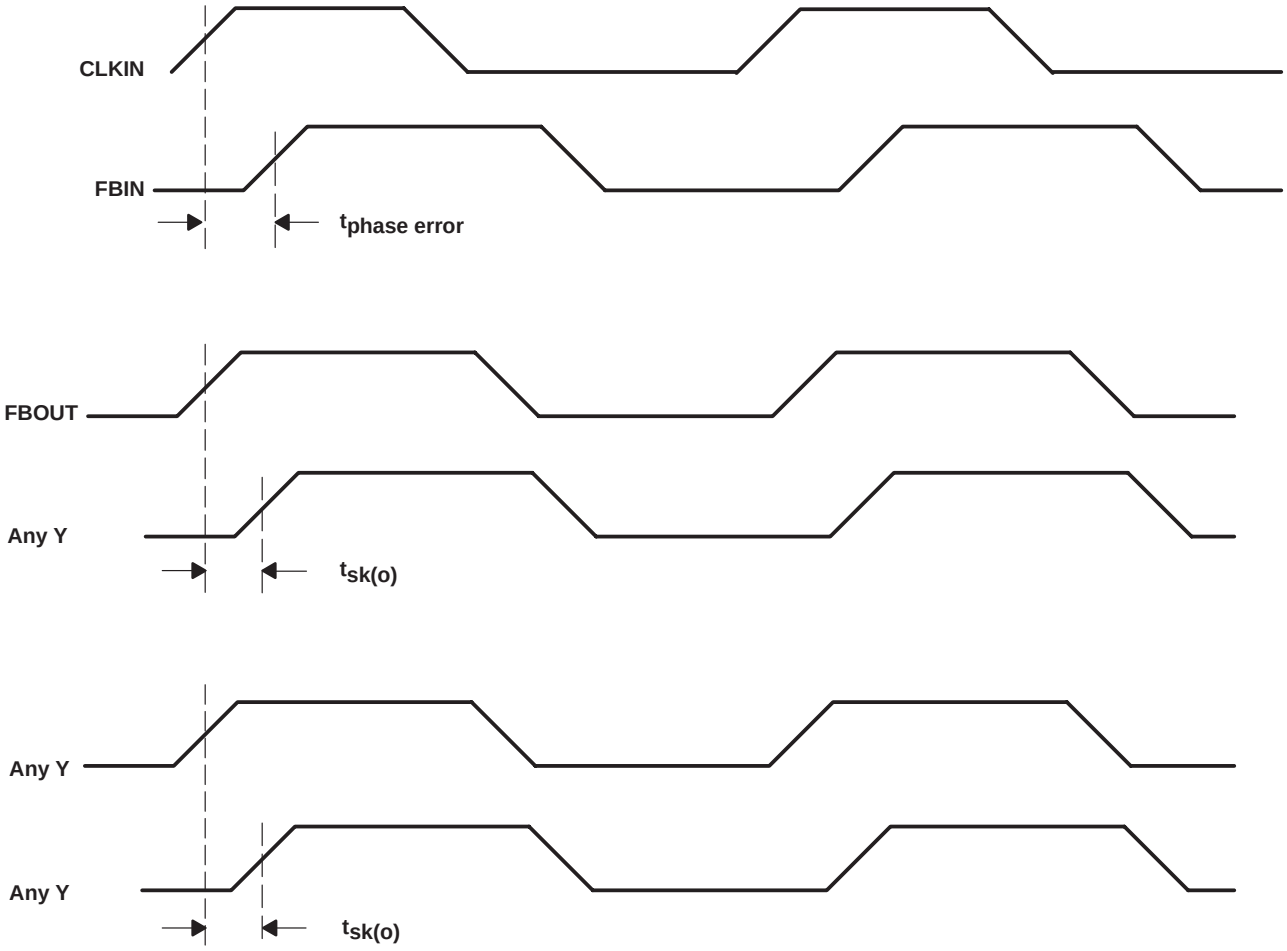


Figure 2. Phase Error and Skew Calculations

TYPICAL CHARACTERISTICS

CDC2510C
PHASE ADJUSTMENT SLOPE AND PHASE ERROR
vs
LOAD CAPACITANCE

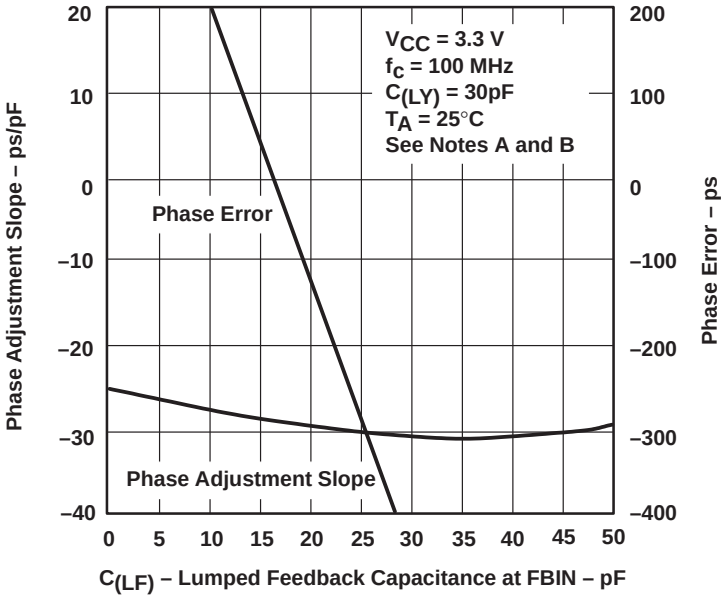


Figure 3

CDC2510A
PHASE ADJUSTMENT SLOPE AND PHASE ERROR
vs
LOAD CAPACITANCE

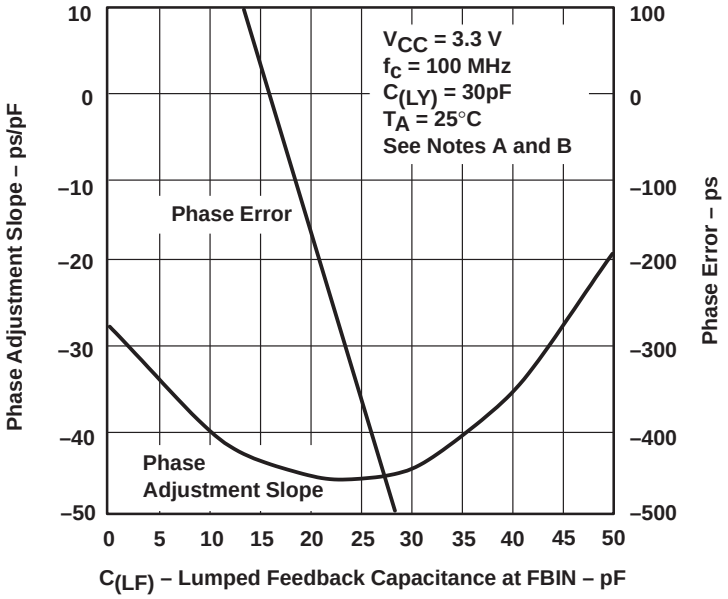


Figure 4

NOTES: A. Trace feedback length FBOUT to FBIN = 5 mm, Z_O = 50 Ω Phase error measured from CLK to Y
B. CLF = Lumped feedback capacitance at FBIN

TYPICAL CHARACTERISTICS

PHASE ERROR vs CLOCK FREQUENCY

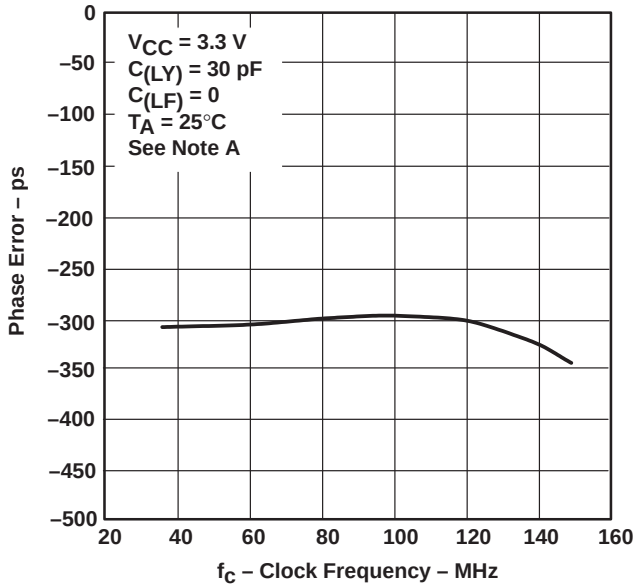


Figure 5

PHASE ERROR vs SUPPLY VOLTAGE

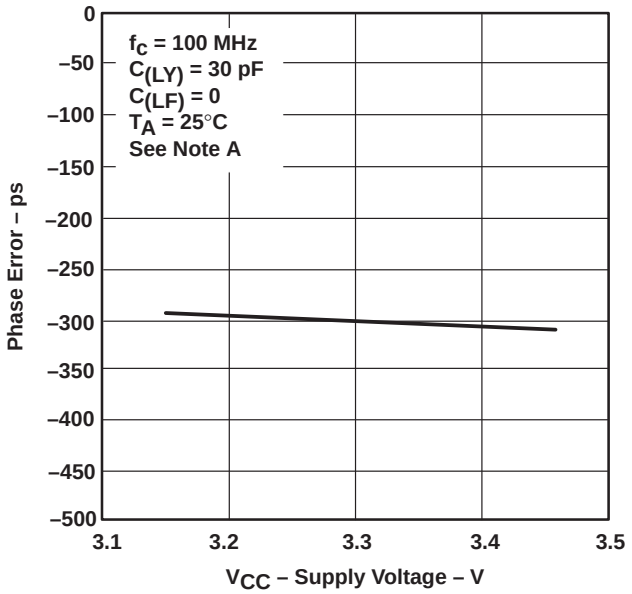


Figure 6

CDC2510C STATIC PHASE ERROR vs CLOCK FREQUENCY

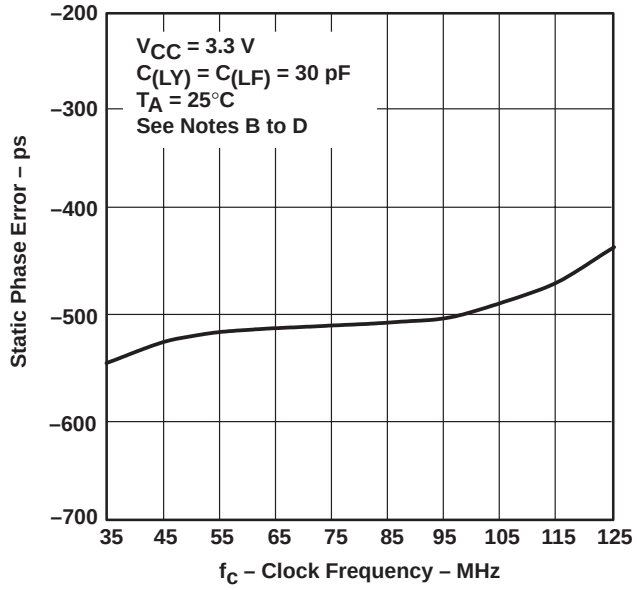


Figure 7

CDC2510A STATIC PHASE ERROR vs CLOCK FREQUENCY

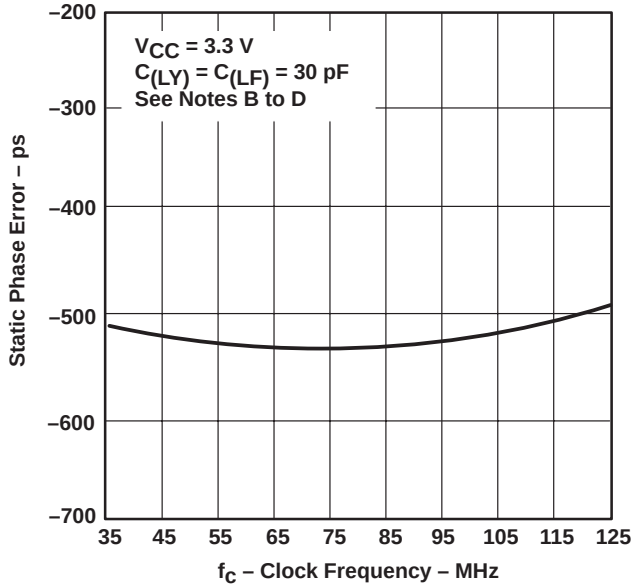


Figure 8

NOTES: A. Trace feedback length FBOUT to FBIN = 5 mm, Z_O = 50 Ω
B. Phase error measured from CLK to FBIN
C. CLY = Lumped capacitive load at Y
D. CLF = Lumped feedback capacitance at FBIN

TYPICAL CHARACTERISTICS

CDC2510C
JITTER
vs
CLOCK FREQUENCY

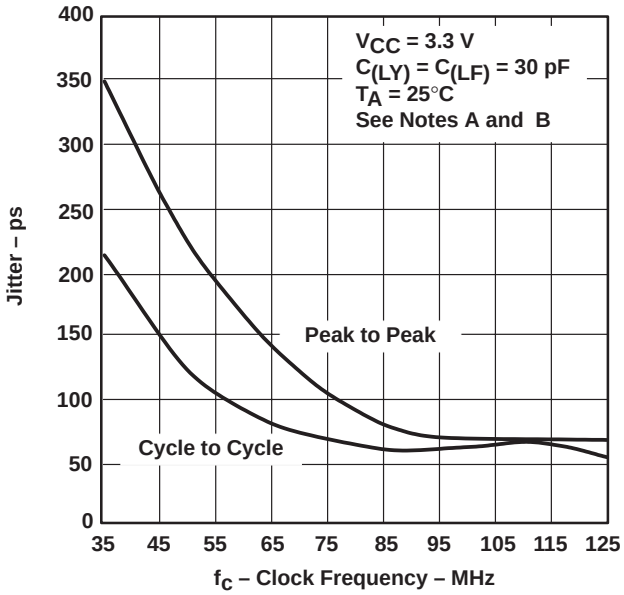


Figure 9

CDC2510A
JITTER
vs
CLOCK FREQUENCY

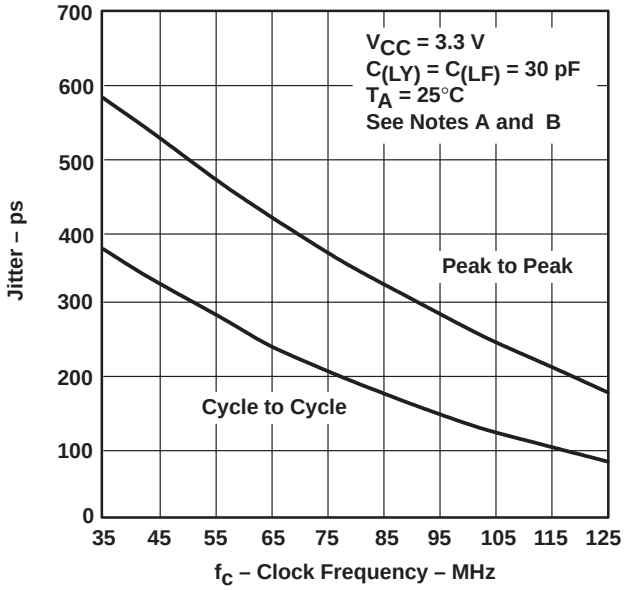


Figure 10

ANALOG SUPPLY CURRENT
vs
CLOCK FREQUENCY

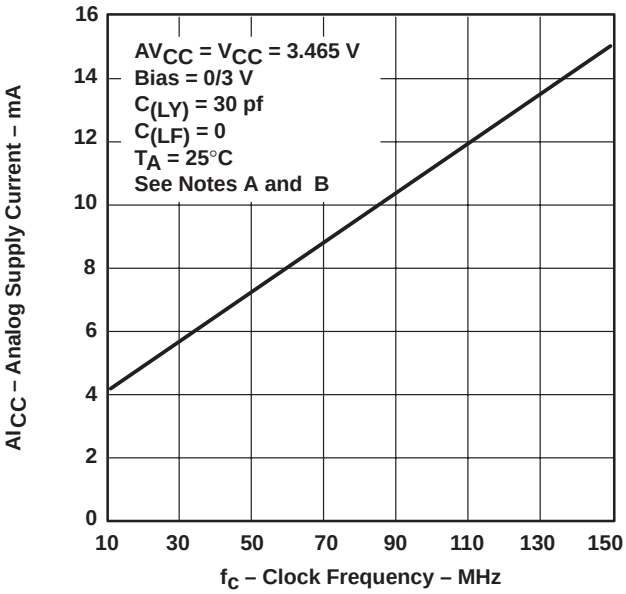


Figure 11

SUPPLY CURRENT
vs
CLOCK FREQUENCY

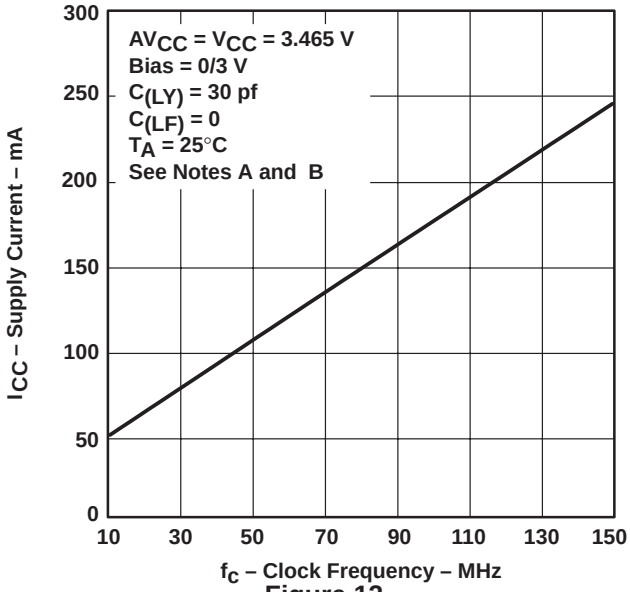


Figure 12

NOTES: A. $C_{(LY)}$ = Lumped capacitive load at Y
B. $C_{(LF)}$ = Lumped feedback capacitance at FBIN

TYPICAL CHARACTERISTICS

TI SILICON-BASED PLL PULLDOWN IBIS I/V

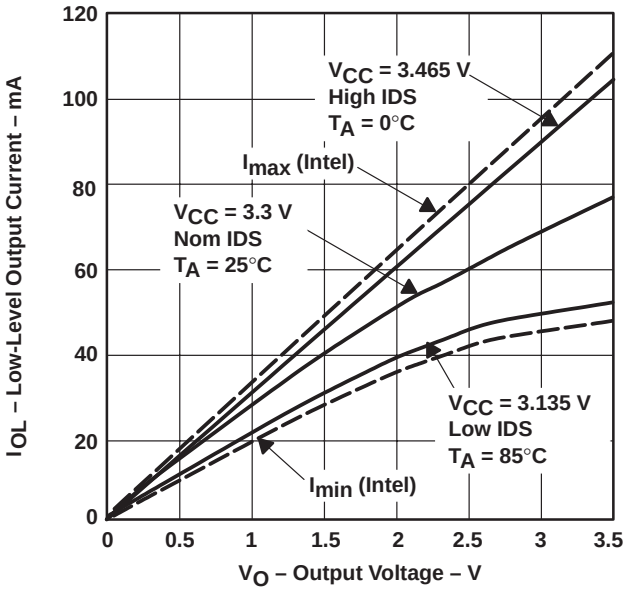


Figure 13

TI SILICON-BASED PLL PULLUP IBIS I/V

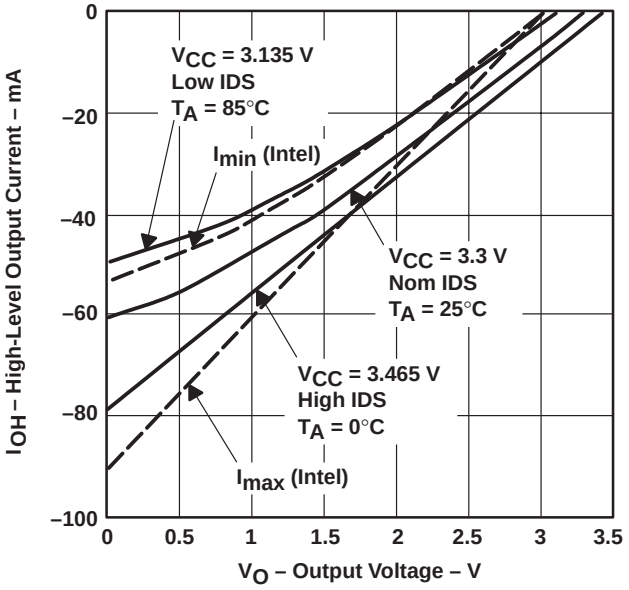
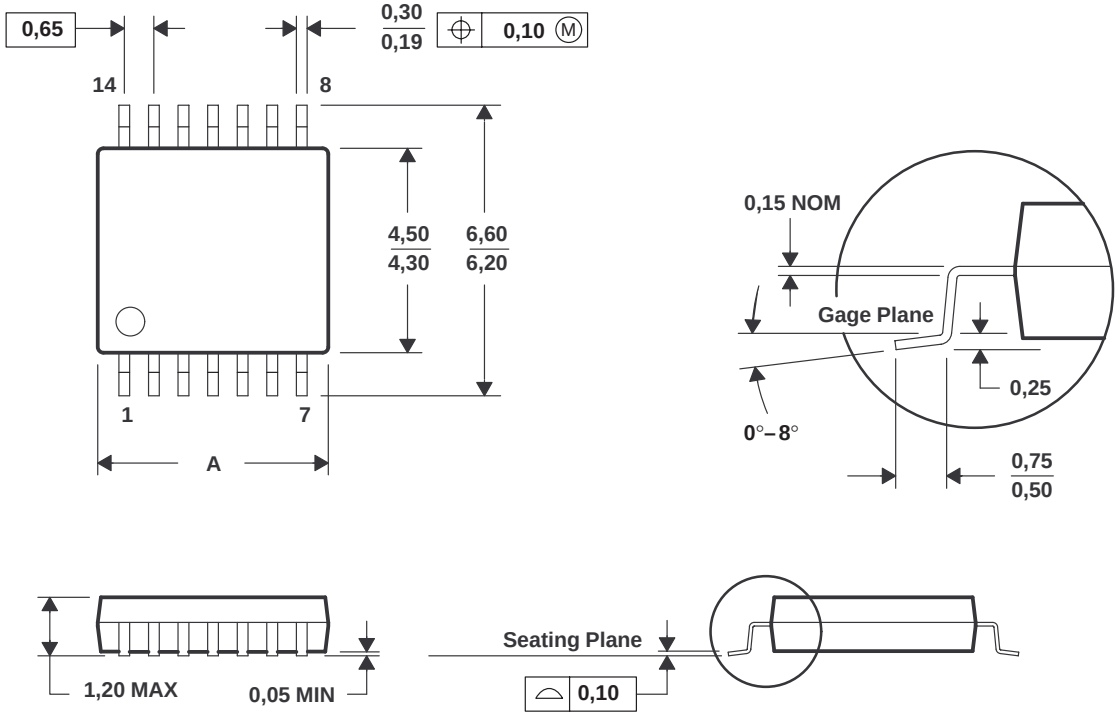


Figure 14

MECHANICAL INFORMATION

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



DIM \ PINS **	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064/E 08/96

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 0,15.
D. Falls within JEDEC MO-153

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