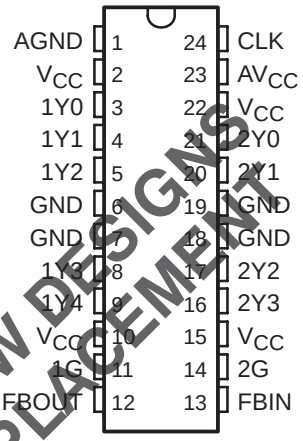
- **Use *CDCVF2509A* as a Replacement for this Device**
- **Designed to Meet PC133 SDRAM Registered DIMM Specification Rev. 0.9**
- **Spread Spectrum Clock Compatible**
- **Operating Frequency 25 MHz to 140 MHz**
- **Static Phase Error Distribution at 66 MHz to 133 MHz is ±125 ps**
- **Jitter (cyc−cyc) at 66 MHz to 133 MHz Is |70| ps**
- **Available in Plastic 24-Pin TSSOP**
- **Phase-Lock Loop Clock Distribution for Synchronous DRAM Applications**
- **Distributes One Clock Input to One Bank of Five and One Bank of Four Outputs**
- **Separate Output Enable for Each Output Bank**
- **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)



NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

description

The CDCF2509 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 CDCF2509 operates at 3.3 V V_{CC}. It also provides integrated series-damping resistors that make it ideal for driving point-to-point loads.

One bank of five outputs and one bank of four outputs provide nine low-skew, low-jitter copies of CLK. Output signal duty cycles are adjusted to 50%, independent of the duty cycle at CLK. Each bank of outputs is enabled or disabled separately via the control (1G and 2G) inputs. When the G inputs are high, the outputs switch in phase and frequency with CLK; when the G inputs are low, the outputs are disabled to the logic-low state.

Unlike many products containing PLLs, the CDCF2509 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 CDCF2509 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 CDCF2509 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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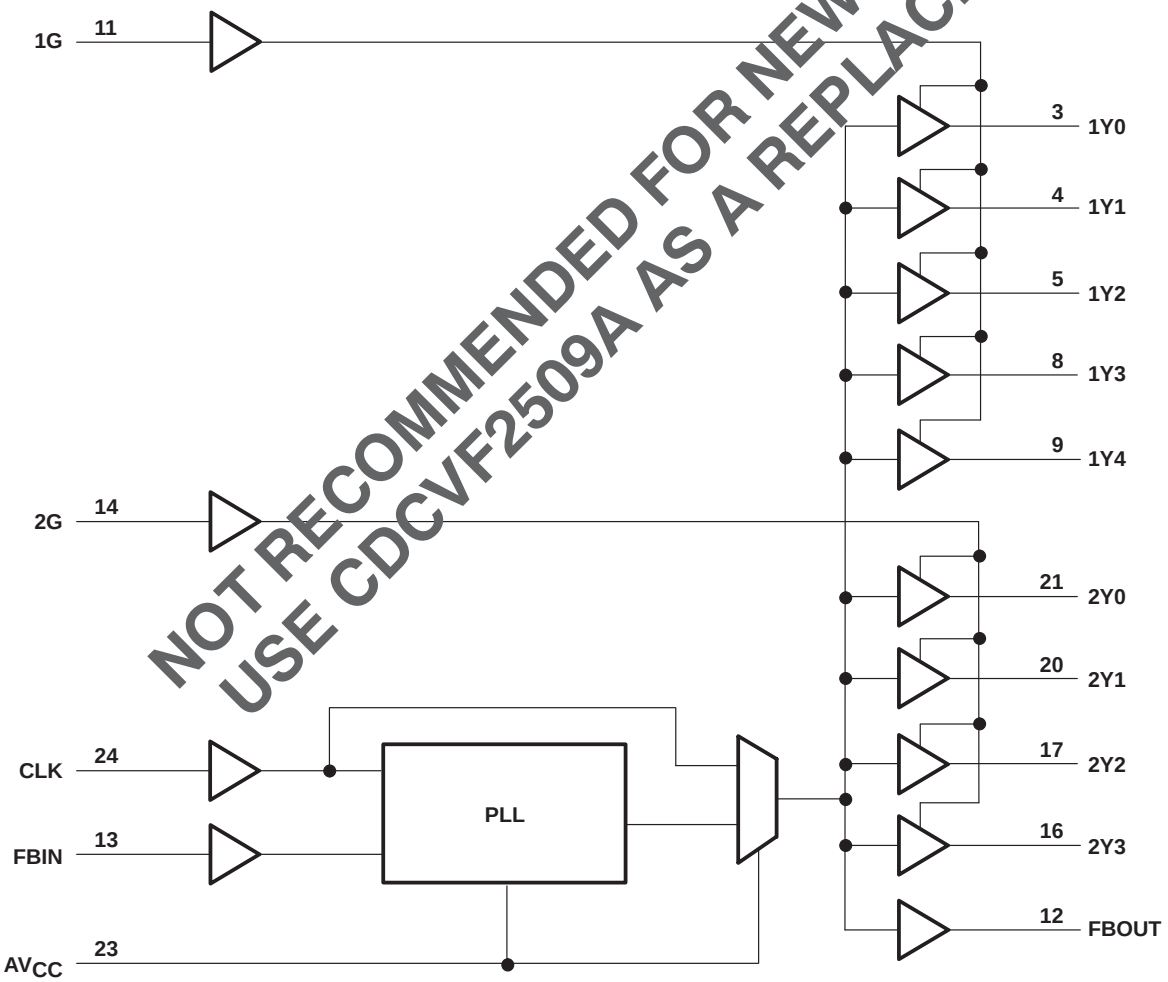
FUNCTION TABLE

INPUTS			OUTPUTS		
1G	2G	CLK	1Y (0:4)	2Y (0:3)	FBOUT
X	X	L	L	L	L
L	L	H	L	L	H
L	H	H	L	H	H
H	L	H	H	L	H
H	H	H	H	H	H

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

functional block diagram



AVAILABLE OPTIONS

T_A	PACKAGE
	SMALL OUTLINE (PW)
0°C to 85°C	CDCF2509PWR

Terminal Functions

TERMINAL NAME	TERMINAL NO.	TYPE	DESCRIPTION
CLK	24	I	Clock input. CLK provides the clock signal to be distributed by the CDCF2509 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 hard-wired 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.
1G	11	I	Output bank enable. 1G is the output enable for outputs 1Y(0:4). When 1G is low, outputs 1Y(0:4) are disabled to a logic-low state. When 1G is high, all outputs 1Y(0:4) are enabled and switched at the same frequency as CLK.
2G	14	I	Output bank enable. 2G is the output enable for outputs 2Y(0:3). When 2G is low, outputs 2Y(0:3) are disabled to a logic low state. When 2G is high, all outputs 2Y(0:3) 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 (0:4)	3, 4, 5, 8, 9	O	Clock outputs. These outputs provide low-skew copies of CLK. Output bank 1Y(0:4) is enabled via the 1G input. These outputs can be disabled to a logic-low state by deasserting the 1G control input. Each output has an integrated 25-Ω series-damping resistor.
2Y (0:3)	21, 20, 17, 16	O	Clock outputs. These outputs provide low-skew copies of CLK. Output bank 2Y(0:3) is enabled via the 2G input. These outputs can be disabled to a logic-low state by deasserting the 2G 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, 15, 22	Power	Power supply
GND	6, 7, 18, 19	Ground	Ground

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

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

Supply voltage range, AV_{CC} (see Note 1) . . . . . $AV_{CC} < V_{CC}$ +0.7 V
Supply voltage range, V_{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.

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

recommended operating conditions (see Note 5)

	MIN	MAX	UNIT
Supply voltage, V_{CC}, AV_{CC}	3	3.6	V
High-level input voltage, V_{IH}	2		V
Low-level input voltage, V_{IL}		0.8	V
Input voltage, V_I	0	V_{CC}	V
High-level output current, I_{OH}		−12	mA
Low-level output current, I_{OL}		12	mA
Operating free-air temperature, T_A	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	140	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	V_{CC}, AV_{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	−32			
		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			
		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 8 and 9).

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C_L = 25 pF (see Note 6 and Figures 1 and 2)§

PARAMETER		FROM (INPUT)	TO (OUTPUT)	V_{CC}, AV_{CC} = 3.3 V ± 0.3 V			UNIT
				MIN	TYP	MAX	
	Phase error time − static (normalized) (See Figures 3−6)	CLKIN↑ = 66 MHz to133 MHz	FBIN↑	−125		125	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 Figure 7)		Any Y or FBOUT		|70|		
		Clkin = 100 MHz to 133 MHz	Any Y or FBOUT		|65|		
	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 0.4 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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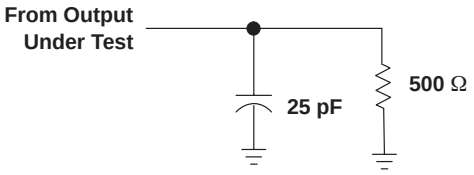
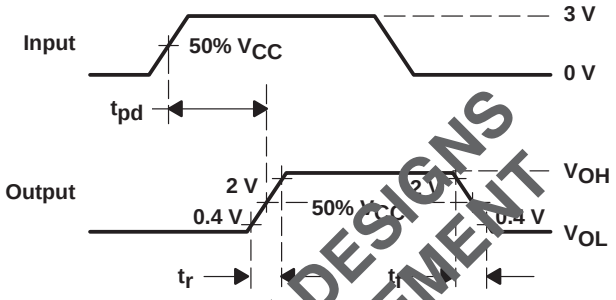
PC SDRAM Register DIMM Design Support Document is published by Intel Corporation.

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT FOR OUTPUTS



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

NOTES: A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 133 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

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

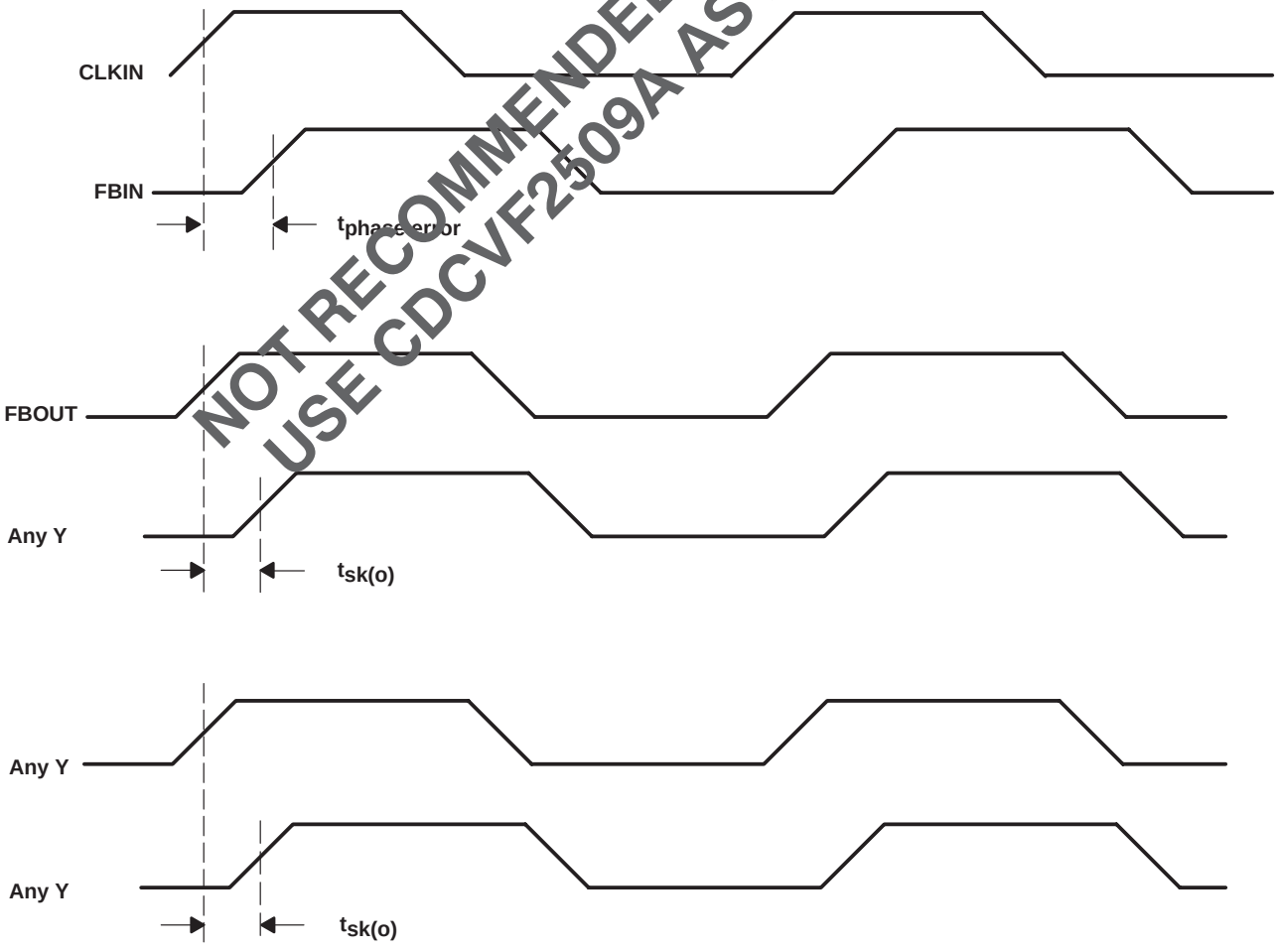


Figure 2. Phase Error and Skew Calculations

TYPICAL CHARACTERISTICS

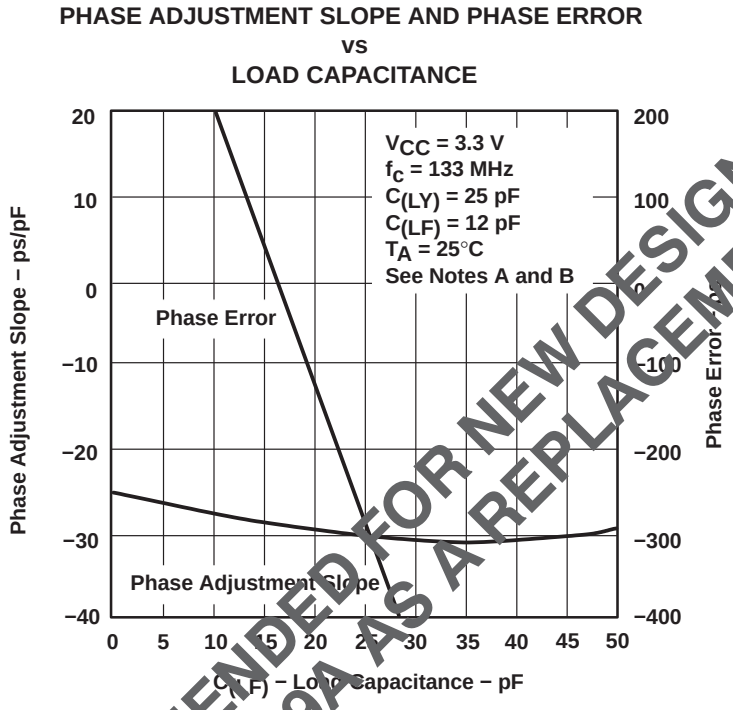


Figure 3

NOTES: A. Trace feedback length FBOUT to FBIN = 5 mm, Z_O = 50 Ω, phase error measured from CLK to Y_n
B. $C_{(LF)}$ = Lumped feedback capacitance at FBIN

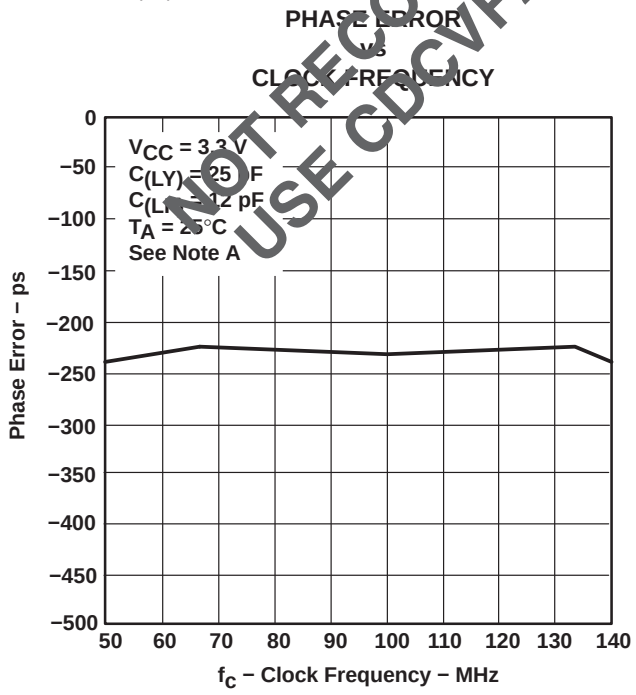


Figure 4

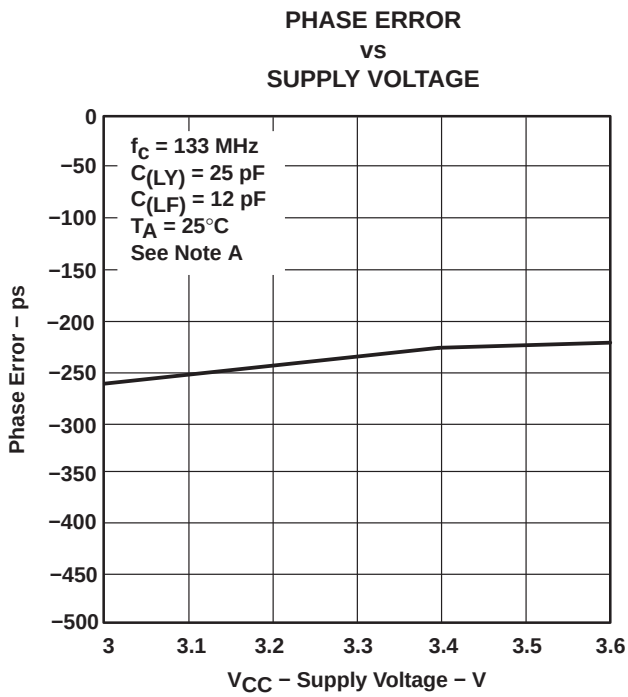


Figure 5

NOTE A: Trace feedback length FBOUT to FBIN = 5 mm, Z_O = 50 Ω

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

TYPICAL CHARACTERISTICS

STATIC PHASE ERROR vs CLOCK FREQUENCY

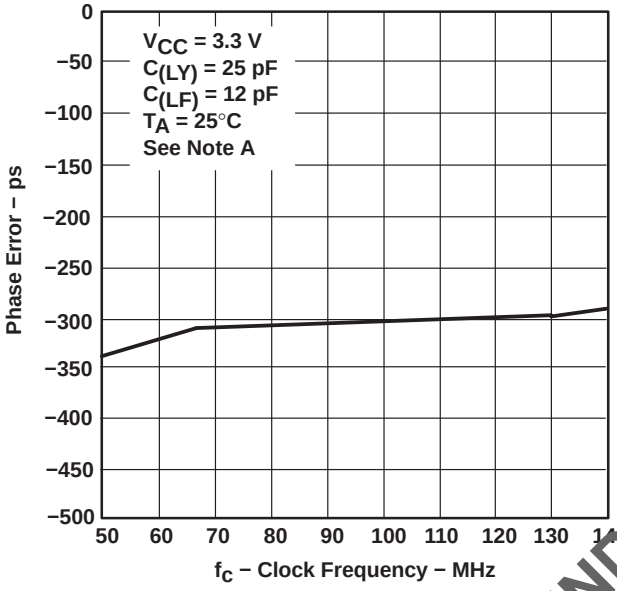


Figure 6

JITTER vs CLOCK FREQUENCY

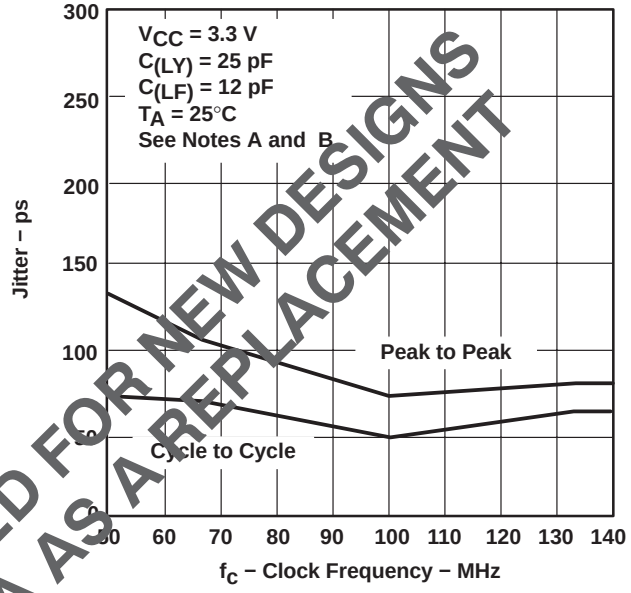


Figure 7

NOTES: A. Trace feedback length FBOUT to FBIN = 5 mm, Z_O = 50 Ω
B. Phase error measured from CLK to FBIN
C. $C_{(LY)}$ = Lumped capacitive load at Y
D. $C_{(LF)}$ = Lumped feedback capacitance at FBIN

NOT RECOMMENDED FOR NEW DESIGNS
USE CDCVF2509A AS A REPLACEMENT

ANALOG SUPPLY CURRENT vs CLOCK FREQUENCY

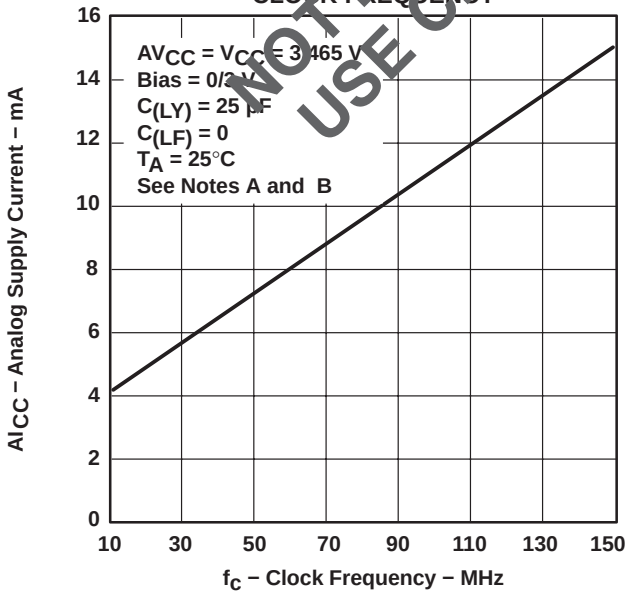


Figure 8

SUPPLY CURRENT vs CLOCK FREQUENCY

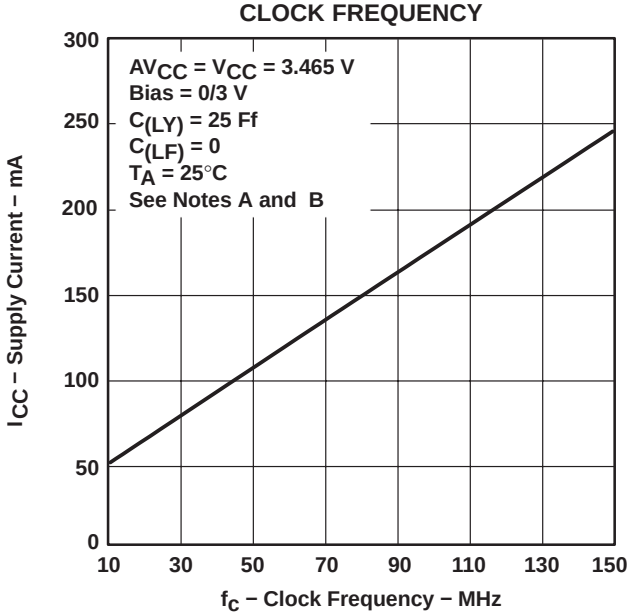


Figure 9

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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
CDCF2509PWR	NRND	Production	TSSOP (PW) | 24	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	CDCF2509
CDCF2509PWR.B	NRND	Production	TSSOP (PW) | 24	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	CDCF2509

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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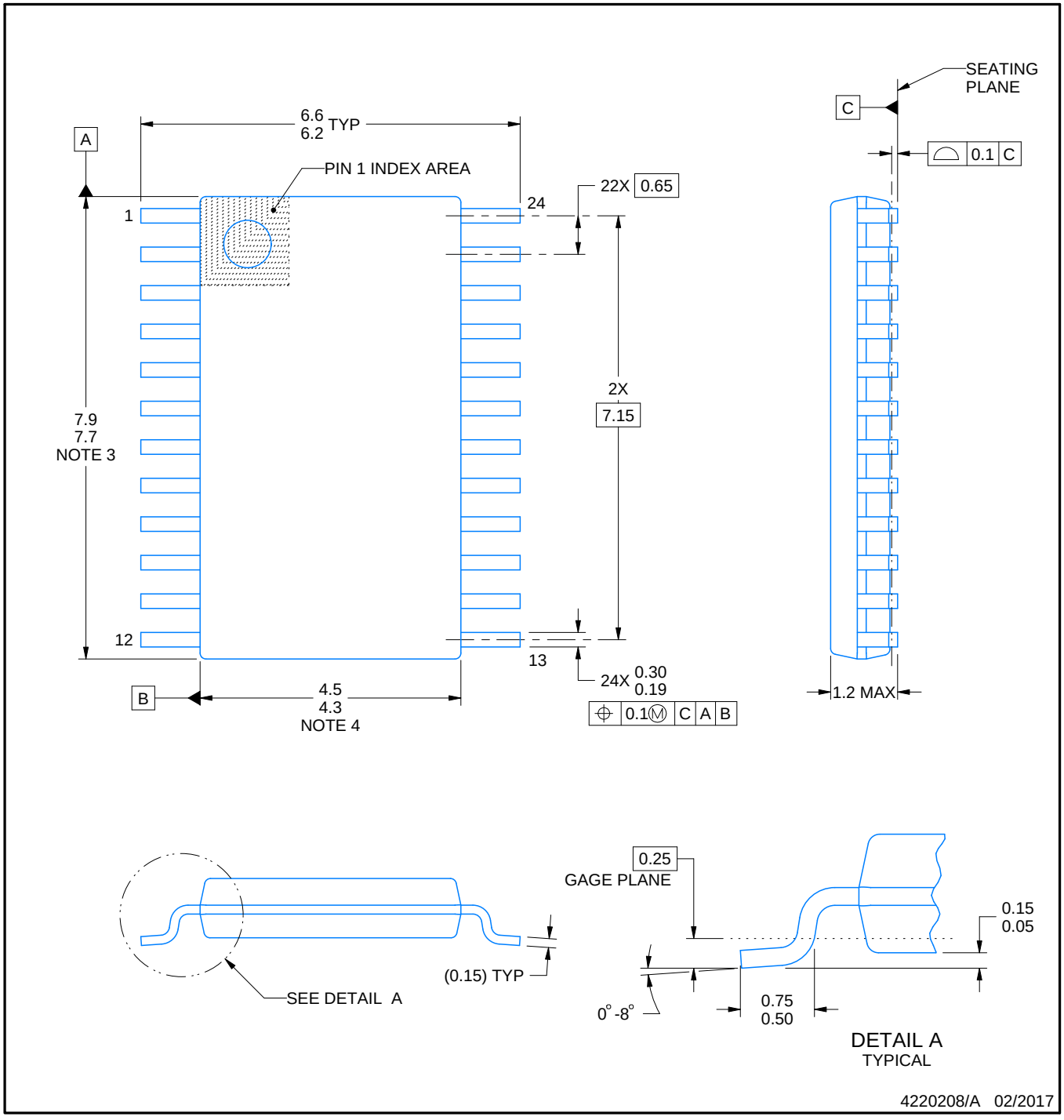
PACKAGE OUTLINE

PW0024A

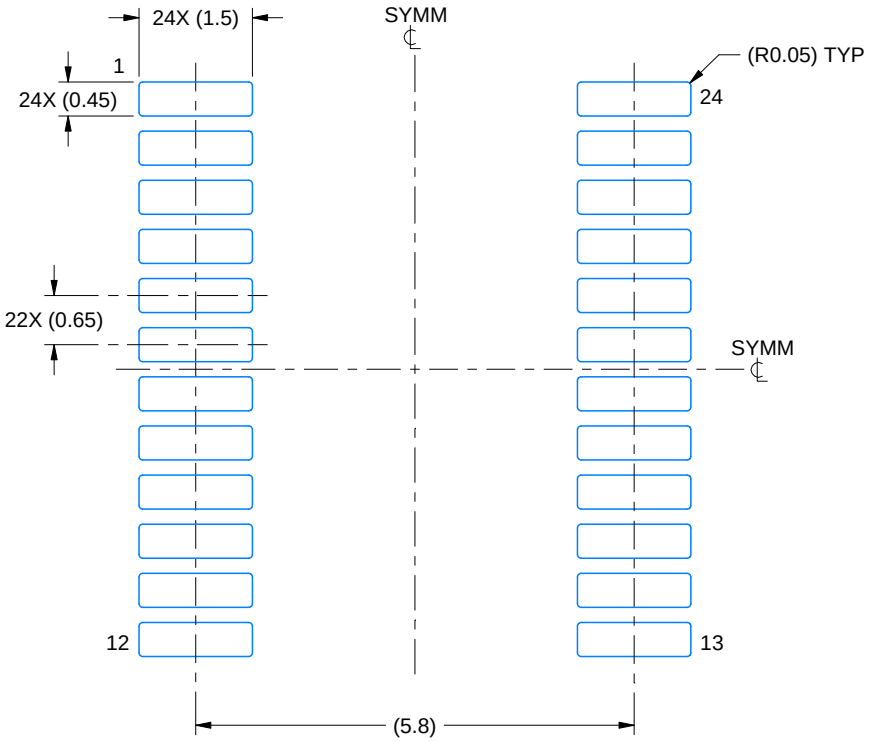
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

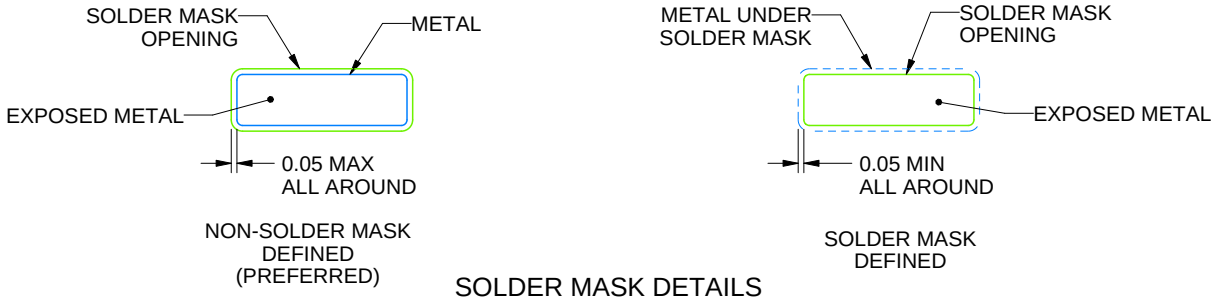


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

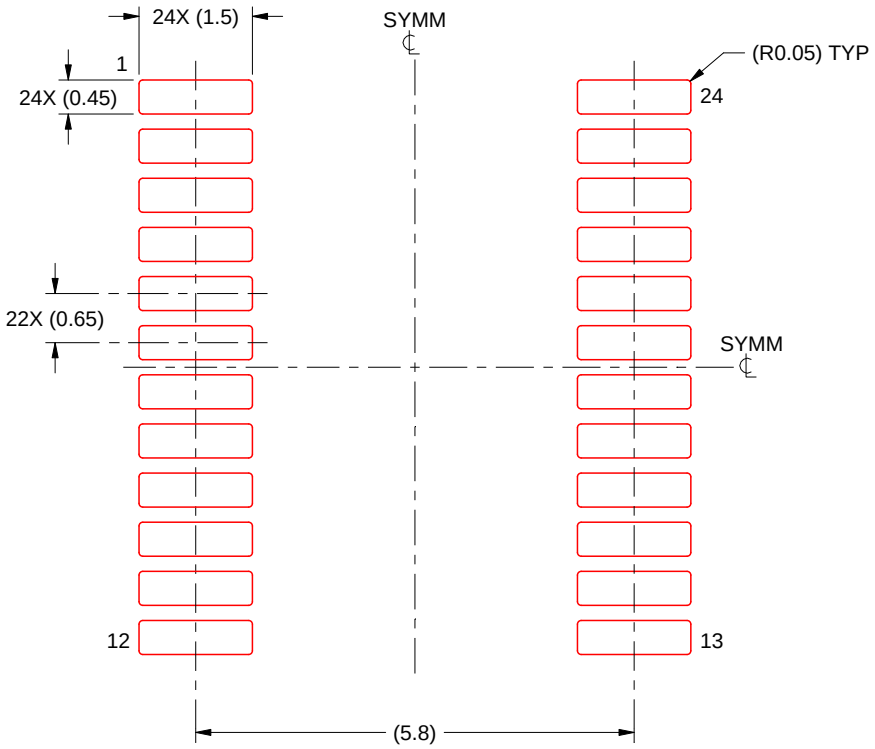


SOLDER MASK DETAILS

4220208/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220208/A 02/2017

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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