Crystal Oscillator / Clock Generator with optional SSC

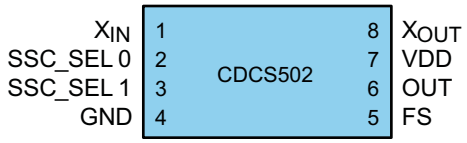
FEATURES

- Part of a Family of Easy to use Clock Generator Devices With Optional SSC
- Crystal Oscillator With Integrated Crystal Capacitors, Selectable Output Frequency and Selectable SSC
- SSC Controllable via 2 External Pins
  - ±0%, ±0.5%, ±1%, ±2% Center Spread
- Frequency Multiplication Selectable Between x1 or x4 With one External Control Pin
- Single 3.3V Device Power Supply
- Wide Temperature Range –40°C to 85°C
- Low space Consumption by 8 pin TSSOP Package

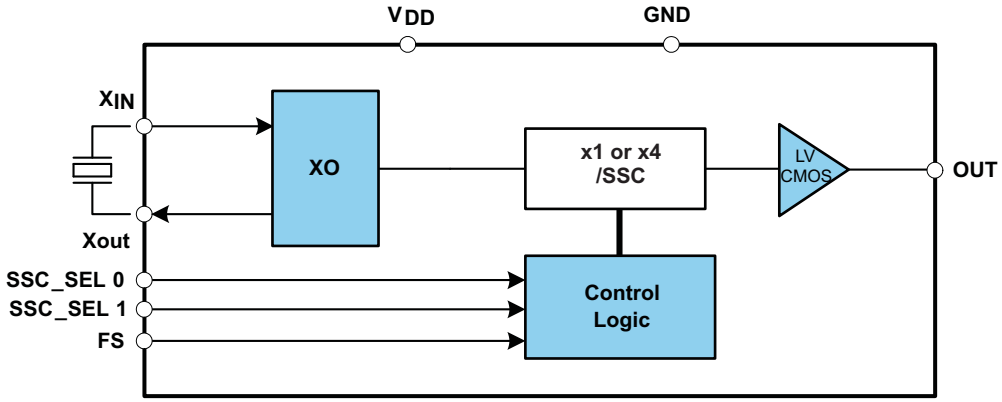
APPLICATIONS

- Consumer and Industrial Applications requiring Crystal Oscillator with the possibility of EMI reduction through Spread Spectrum Clocking

PACKAGE



BLOCK DIAGRAM



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

DESCRIPTION

The CDCS502 is a spread spectrum capable, fundamental mode crystal oscillator with selectable frequency multiplication.

It features an advanced gain controlled fundamental mode crystal oscillator stage with a built-in load capacitance of 10pF. This oscillator stage accepts crystals from 8MHz to 32MHz with an ESR of up to 180Ω. The stage can be used with crystals with power dissipation of 50µW and up.

The input signal is processed by a PLL, whose output frequency is either equal to the input frequency or multiplied by the factor of 4.

The PLL is also able to spread the clock signal by ±0%, ±0.5%, ±1% or ±2% centered around the output clock frequency with an triangular modulation.

By this, the device can generate output frequencies between 8MHz and 108MHz with or without SSC from a fundamental mode crystal.

In x1 Mode with an SSC amount of 0%, the device works as a standard crystal oscillator and does not make use of the built in PLL.

The CDCS502 operates in 3.3V environment.

It is characterized for operation from –40°C to 85°C. It is offered in an 8 Pin TSSOP package.

FUNCTION TABLE

FS	SSC_SEL 0	SSC_SEL 1	SSC Amount	f_{OUT}/f_{IN}	f_{OUT} at f_{in} = 27 MHz
0	0	0	±0.00%	1	27 MHz(1)
0	0	1	±0.50%	1	27 MHz
0	1	0	±1.00%	1	27 MHz
0	1	1	±2.00%	1	27 MHz
1	0	0	±0.00%	4	108 MHz
1	0	1	±0.50%	4	108 MHz
1	1	0	±1.00%	4	108 MHz
1	1	1	±2.00%	4	108 MHz

(1) In this mode the signal from the crystal bypasses the internal PLL for maximum performance.

PACKAGE

PIN FUNCTIONS

SIGNAL	PIN	TYPE	DESCRIPTION
X_{IN}	1	I	Crystal Input
X_{OUT}	8	O	Crystal Output
OUT	6	O	LVCMOS Clock Output
SSC_SEL 0, 1	2, 3	I	Spread Selection Pins, internal pull-up
FS	5	I	Frequency Multiplication Selection, internal pull-up
V_{DD}	7	Power	3.3V Power Supply
GND	4	Ground	Ground

PACKAGE THERMAL RESISTANCE FOR TSSOP (PW) PACKAGE(1)

CDCV304PW 8-PIN TSSOP			THERMAL AIR FLOW (CFM)				UNIT
			0	150	250	500	
$R_{\theta JA}$	High K		149	142	138	132	°C/W
$R_{\theta JA}$	Low K		230	185	170	150	°C/W
$R_{\theta JC}$	High K	65					°C/W
$R_{\theta JC}$	High K	69					°C/W

(1) The package thermal impedance is calculated in accordance with JESD 51 and JEDEC2S2P (high-k board).

ABSOLUTE MAXIMUM RATINGS(1)

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

		VALUE	UNIT
V_{DD}	Supply voltage range	–0.5 to 4.6	V
V_{IN}	Input voltage range	–0.5 to 4.6	V
V_{out}	Output voltage range	–0.5 to 4.6	V
I_{IN}	Input current (V_I < 0, V_I > VDD)	±20	mA
I_{out}	Continuous output current	±50	mA
T_{ST}	Storage temperature range	–65 to 150	°C
T_J	Maximum junction temperature	125	°C

(1) 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.

RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
V_{DD}	Supply voltage	3.0		3.6	V
f_{IN}	Input Frequency	8		32	MHz
V_{IL}	Low level input voltage LVCMOS			0.3 VDD	V
V_{IH}	High level input voltage LVCMOS	0.7 VDD			V
V_I	Input Voltage threshold LVCMOS		0.5 VDD		V
C_L	Output Test Load LVCMOS			10	pF
I_{OH}/I_{OL}	Output Current			12	mA
T_A	Operating free-air temperature	–40		85	°C

RECOMMENDED CRYSTAL SPECIFICATIONS(1)

PARAMETER		CONDITIONS	MIN	NOM	MAX	UNIT
$f_{X\text{-}tal}$	Crystal input frequency range	FS = 0	8		32	MHz
		FS = 1	8		27	
ESR	Effective series resistance(2)				180	Ω
C_L	On-chip load capacitance at Xin and Xout			10		pF
$T_{X\text{-}tal}$	Crystal power dissipation		50			µW

(1) For further details on the crystal, see the crystal part in the Applications section
(2) With 5 pF crystal package parallel capacitance

DEVICE CHARACTERISTICS

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

PARAMETER		CONDITIONS	MIN	TYP	MAX	UNIT
IDD	Device supply current	f_{out} = 20 MHz; FS = 0, no SSC		8		mA
		f_{out} = 20 MHz; FS = 0, SSC = 2%		18		
		f_{out} = 70 MHz; FS = 1, SSC = 2%		22		
f_{OUT}	Output frequency	FS = 0	8		32	MHz
		FS = 1	32		108	MHz
I_{IH}	LVCMOS input current	V_I = VDD; VDD = 3.6 V			10	µA
I_{IL}	LVCMOS input current	V_I = 0 V; VDD = 3.6 V			–10	µA
V_{OH}	LVCMOS high-level output voltage	I_{OH} = –0.1 mA	2.9			V
		I_{OH} = - 8 mA	2.4			
		I_{OH} = –12 mA	2.2			
V_{OL}	LVCMOS low-level output voltage	I_{OL} = 0.1 mA			0.1	V
		I_{OL} = 8 mA			0.5	
		I_{OL} = 12 mA			0.8	
$t_{jit(CC)}$	Cycle to cycle jitter	f_{out} = 108 MHz; FS = 1, SSC = 1%, 10000 Cycles		100		ps
t_r/t_f	Rise and fall time	20%–80%		0.75		ns
O_{dc}	Output duty cycle	PLL active	45%		55%	
f_{MOD}	Modulation frequency			30		kHz

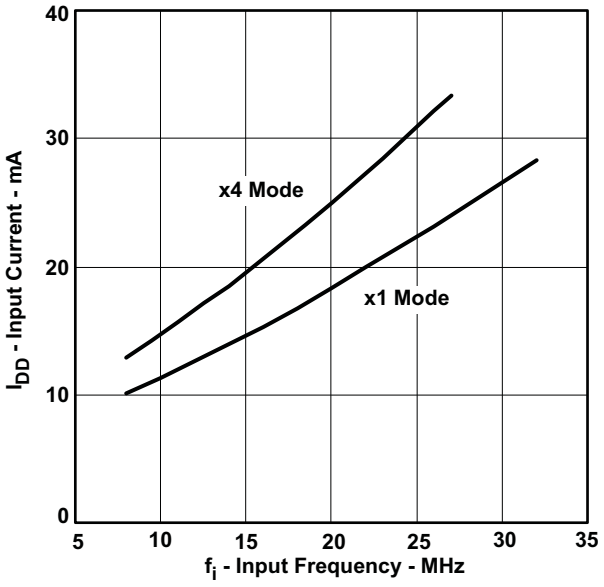


Figure 1. IDD vs Input Frequency, VCC = 3.3V, SSC = 2%

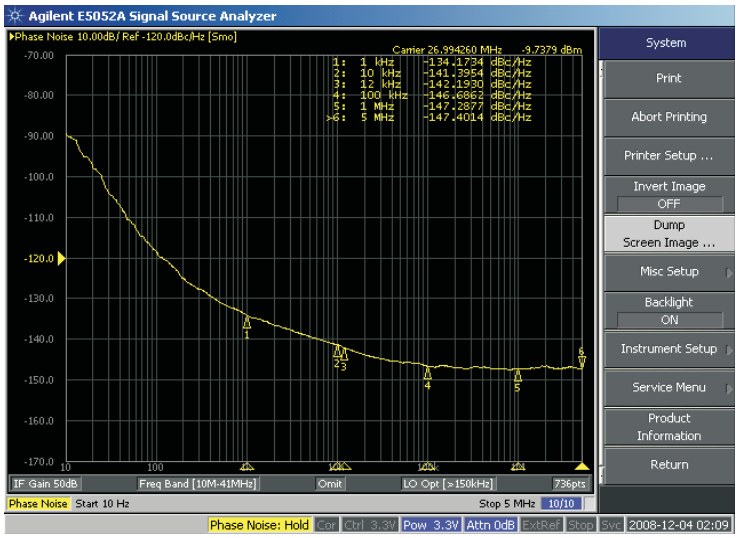


Figure 2. Phase Noise Plot, x1 Mode, 0% SSC, 27 MHz Crystal

APPLICATION INFORMATION

SELECTION OF A CRYSTAL

The CDCS502 requires a crystal with a frequency between 8 and 32 MHz (27MHz in x4 Mode). The crystal stage is designed with an internal load capacitance of 10pF for crystals with this shunt load capacitance. If a slightly bigger capacity then 10pF is needed, small external capacitors can be used to get to this value. This solution however might influence the power-up behavior of the crystal stage, so using a 10pF load capacitance crystal is highly recommended.

For further details on capacitive load calculation, see application report (SCAA085).

NOTE:

Even though the CDCS502 is characterized down to –40°C, a standard crystal is usually not rated for operation at this low temperature.

SSC MODULATION

The exact implementation of the SSC modulation plays a vital role for the EMI reduction. The CDCS502 uses a triangular modulation scheme implemented in a way that the modulation frequency depends on the VCO frequency of the internal PLL and the spread amount is independent from the VCO frequency.

The modulation frequency can be calculated by using one of the below formulas chosen by frequency multiplication mode.

FS =0: $f_{mod} = f_{IN} / 708$
FS =1: $f_{mod} = f_{IN} / 620$

PARAMETER MEASUREMENT INFORMATION

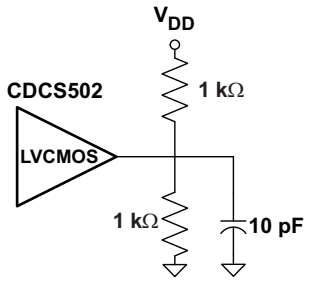


Figure 3. Test Load

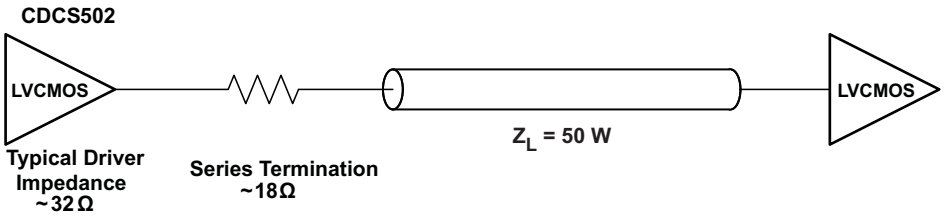


Figure 4. Test Load for 50-Ω Board Environment

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
CDCS502PW	ACTIVE	TSSOP	PW	8	150	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CDCS502PWR	ACTIVE	TSSOP	PW	8	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

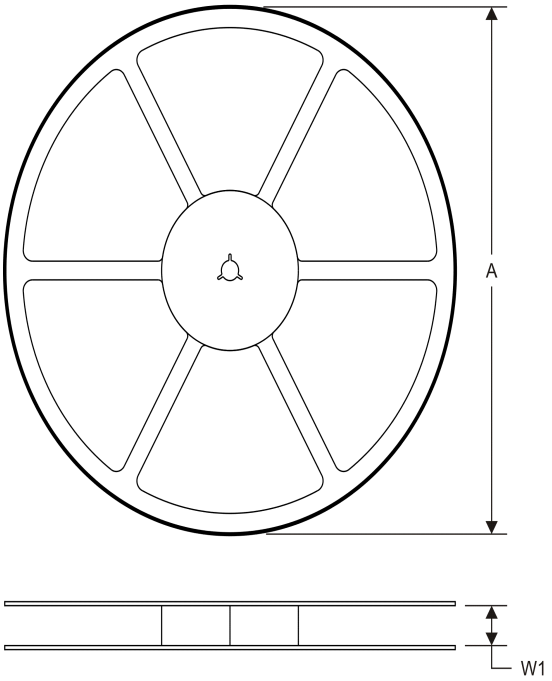
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

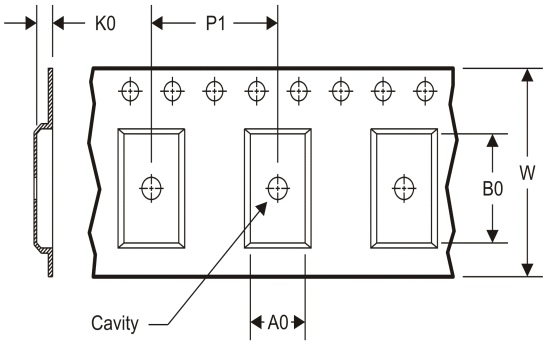
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



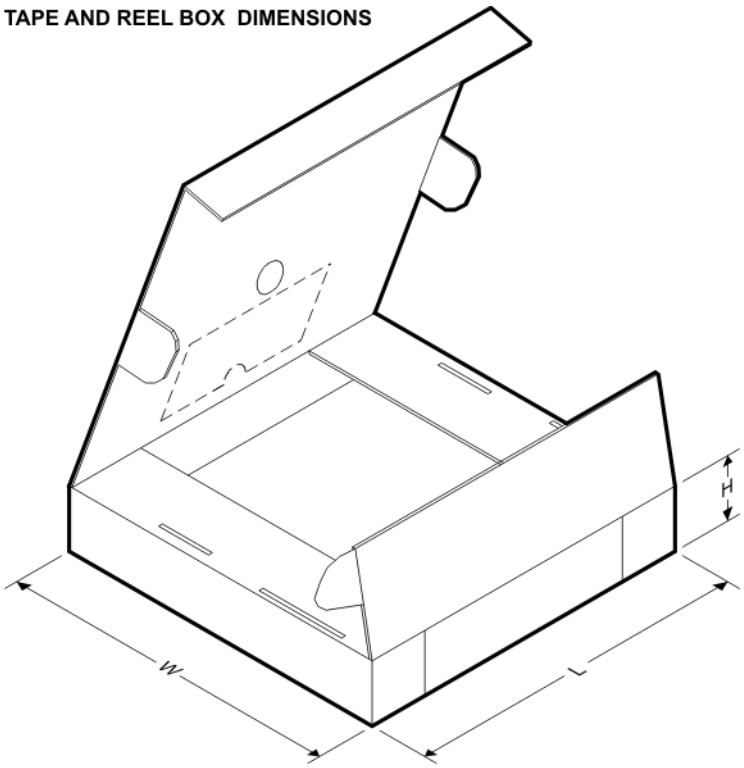
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
CDCS502PWR	TSSOP	PW	8	2000	330.0	12.4	7.0	3.6	1.6	8.0	12.0	Q1

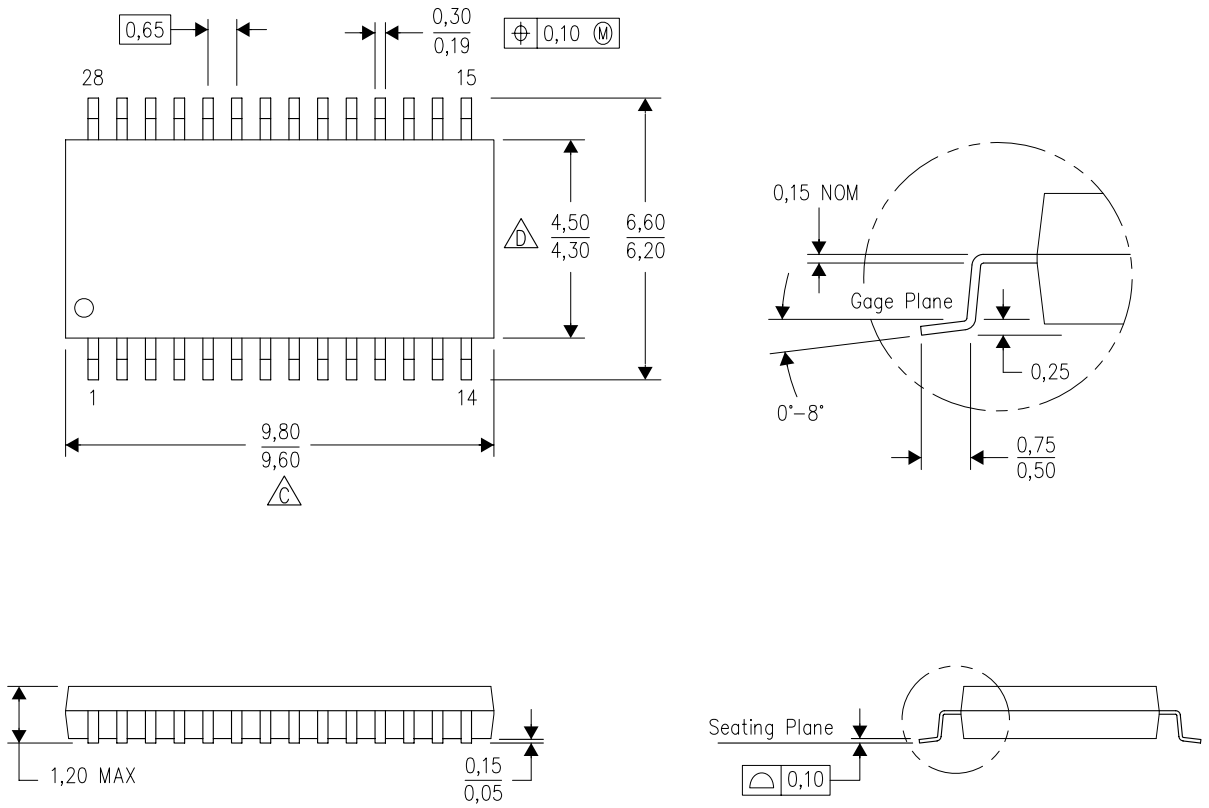
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CDCS502PWR	TSSOP	PW	8	2000	367.0	367.0	35.0

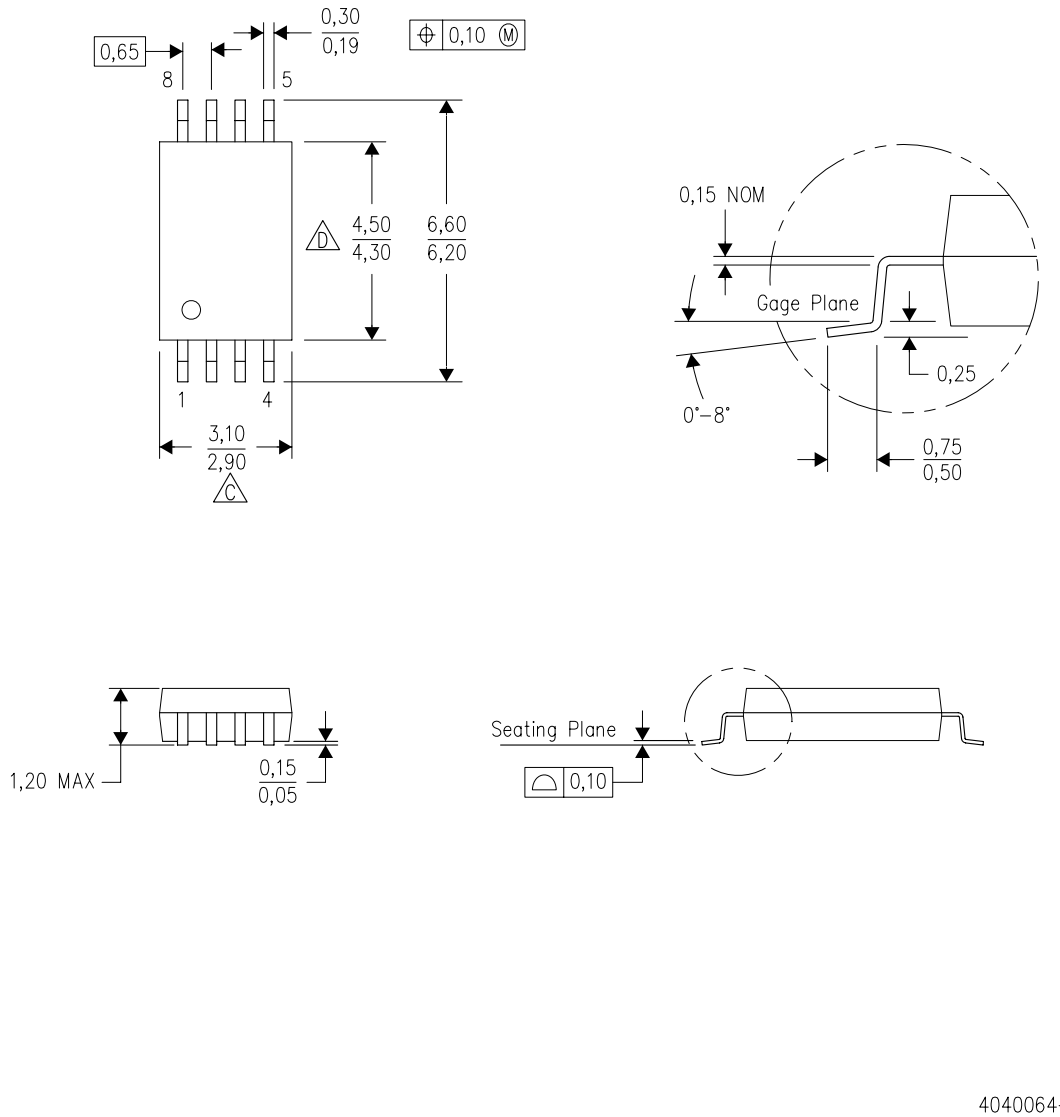
PW (R–PDSO–G28) PLASTIC SMALL OUTLINE



4040064–7/G 02/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (R–PDSO–G8) PLASTIC SMALL OUTLINE



4040064–2/G 02/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46C and to discontinue any product or service per JESD48B. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as “components”) are sold subject to TI’s terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI’s terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers’ products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers’ products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI’s goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components which meet ISO/TS16949 requirements, mainly for automotive use. Components which have not been so designated are neither designed nor intended for automotive use; and TI will not be responsible for any failure of such components to meet such requirements.

Products		**Applications**	
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy
Clocks and Timers	www.ti.com/clocks	Industrial	www.ti.com/industrial
Interface	interface.ti.com	Medical	www.ti.com/medical
Logic	logic.ti.com	Security	www.ti.com/security
Power Mgmt	power.ti.com	Space, Avionics and Defense	www.ti.com/space-avionics-defense
Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
RFID	www.ti-rfid.com		
OMAP Mobile Processors	www.ti.com/omap	**TI E2E Community**	e2e.ti.com
Wireless Connectivity	www.ti.com/wirelessconnectivity		

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265