

ADJUSTABLE BATTERY-BACKUP SUPERVISOR FOR RAM RETENTION

FEATURES

- Supply Current of 40 μA (Max)
- Battery Supply Current of 100 nA (Max)
- Supply Voltage Supervision Range:
 - Adjustable
 - Other Versions Available on Request
- Backup-Battery Voltage Can Exceed V_{DD}
- Power-On Reset Generator With Fixed 100-ms Reset Delay Time
- Active-High and Active-Low Reset Output
- Chip-Enable Gating: 3 ns (at $V_{DD} = 5\text{ V}$) Max Propagation Delay
- 10-Pin MSOP Package
- Temperature Range: -40°C to 85°C

APPLICATIONS

- Fax Machines
- Set-Top Boxes
- Advanced Voice Mail Systems
- Portable Battery-Powered Equipment
- Computer Equipment
- Advanced Modems
- Automotive Systems
- Portable Long-Time Monitoring Equipment
- Point-of-Sale Equipment

DESCRIPTION

The TPS3613-01 supervisory circuit monitors and controls processor activity by providing backup-battery switchover for data retention of CMOS RAM.

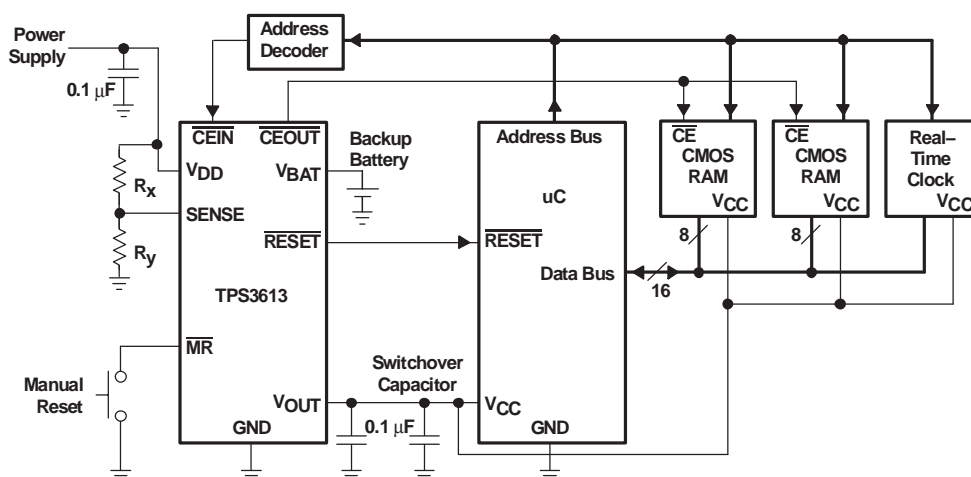
During power-on, reset ($\overline{\text{RESET}}$ and $\overline{\text{RESET}}$) is asserted when the supply voltage (V_{DD} or V_{BAT}) becomes higher than 1.1 V.

Thereafter, the supply voltage supervisor monitors V_{DD} at the SENSE pin through external feedback resistors and keeps reset active as long as SENSE remains below the threshold voltage, V_{IT} .

An internal timer delays the release of the reset state to ensure proper system reset. The delay time starts after SENSE rises above the threshold voltage, V_{IT} .

When SENSE drops below V_{IT} , reset becomes active again.

The TPS3613-01 is available in a 10-pin MSOP package and is characterized for operation over a temperature range of -40°C to $+85^{\circ}\text{C}$.



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.

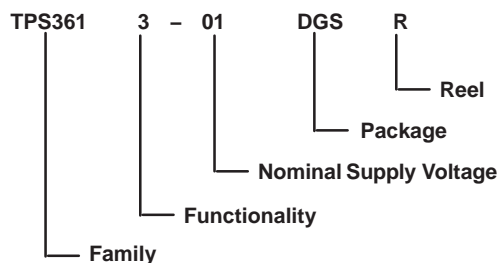
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PACKAGE INFORMATION

T _A	DEVICE NAME	MARKING
–40°C to +85°C	TPS3613–01DGSR†	AFK

† The DGSR passive indicates tape and reel of 2500 parts.

ordering information application specific versions



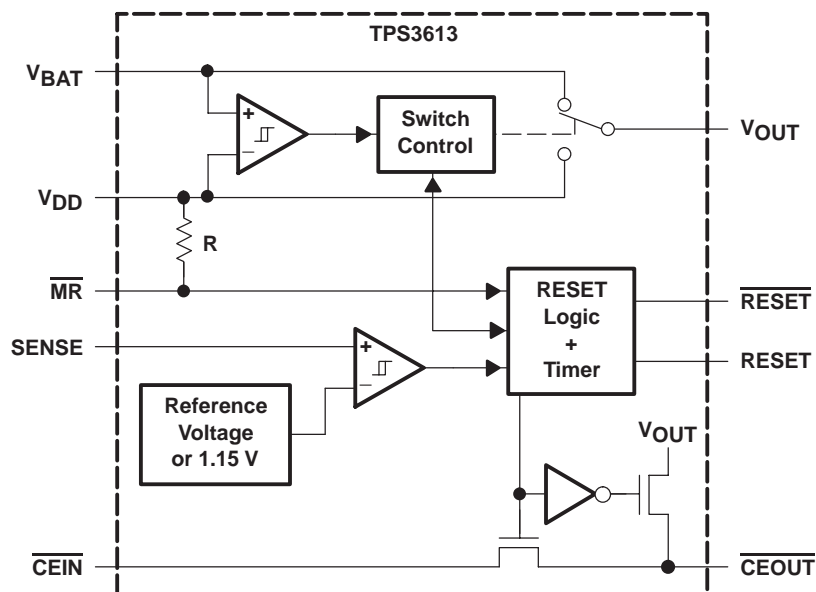
DEVICE NAME	NOMINAL VOLTAGE‡, V _{NOM}
TPS3613–01 DGS	Adjustable

‡ For other threshold voltages, contact the local TI sales office for availability and lead-time.

FUNCTION TABLE

SENSE > V _{IT}	V _{DD} > V _{BAT}	$\overline{\text{MR}}$	$\overline{\text{CEIN}}$	V _{OUT}	$\overline{\text{RESET}}$	RESET	$\overline{\text{CEOUT}}$
0	0	0	0	V _{BAT}	0	1	DIS
0	0	0	1	V _{BAT}	0	1	DIS
0	0	1	0	V _{BAT}	0	1	DIS
0	0	1	1	V _{BAT}	0	1	DIS
0	1	0	0	V _{DD}	0	1	DIS
0	1	0	1	V _{DD}	0	1	DIS
0	1	1	0	V _{DD}	0	1	DIS
0	1	1	1	V _{DD}	0	1	DIS
1	0	0	0	V _{DD}	0	1	DIS
1	0	0	1	V _{DD}	0	1	DIS
1	0	1	0	V _{DD}	1	0	0
1	0	1	1	V _{DD}	1	0	1
1	1	0	0	V _{DD}	0	1	DIS
1	1	0	1	V _{DD}	0	1	DIS
1	1	1	0	V _{DD}	1	0	0
1	1	1	1	V _{DD}	1	0	1

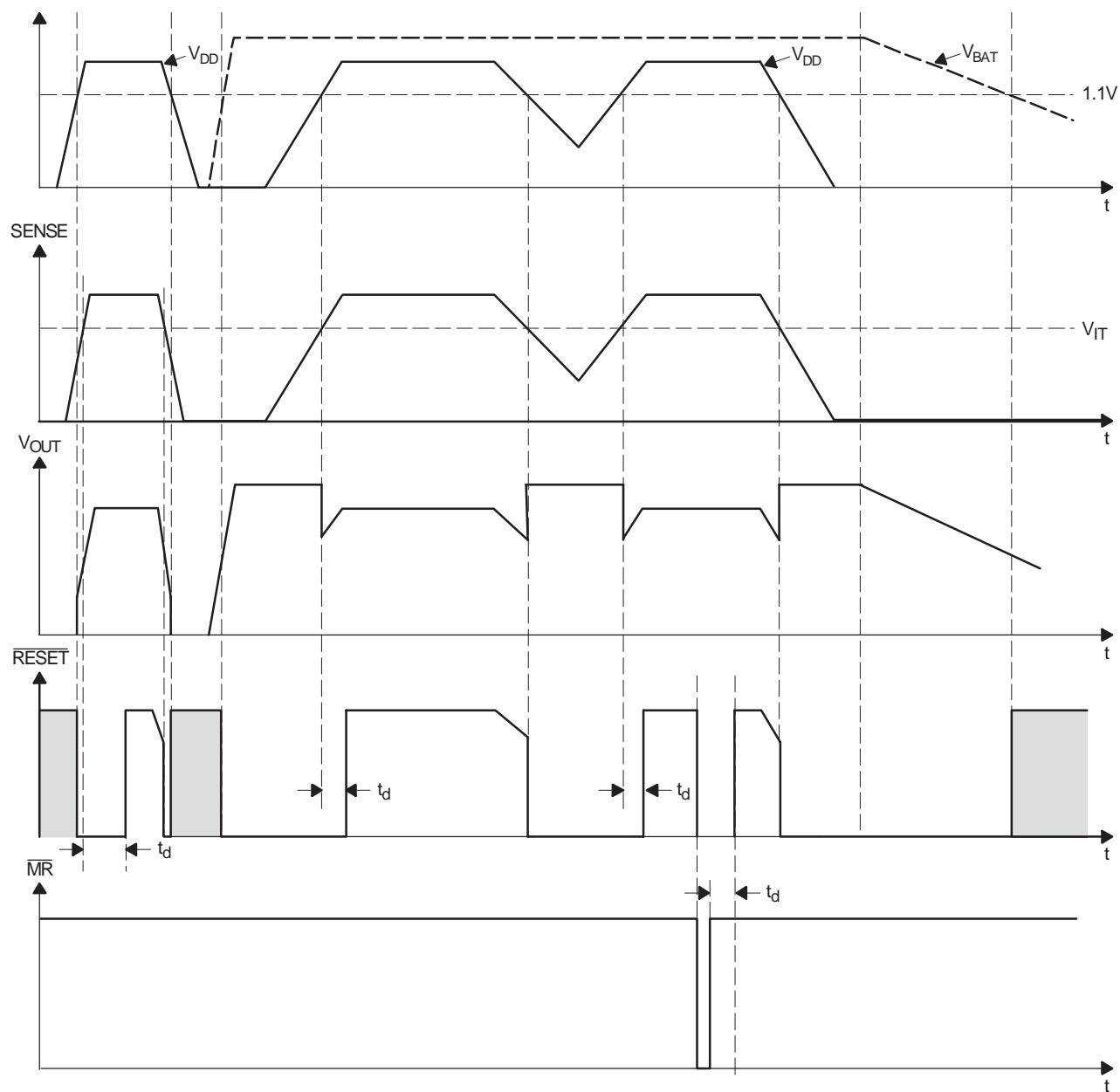
FUNCTIONAL SCHEMATIC



Terminal Functions

TERMINAL NAME	NO.	I/O	DESCRIPTION
CEIN	5	I	Chip-enable input
CEOUT	6	O	Chip-enable output
GND	3	I	Ground
MR	4	I	Manual reset input
RESET	7	O	Active-high reset output
RESET	9	O	Active-low reset output
SENSE	8	I	Adjustable sense input, assumed to be connect to V _{DD} through feedback resistences. Call your local contacts for other application connections.
VBAT	10	I	Backup-battery input
VDD	2	I	Input supply voltage
VOUT	1	O	Supply output

TIMING DIAGRAM



NOTE: Shaded area in $\overline{\text{RESET}}$ is *undefined*.

detailed description

backup-battery switchover

In case of a brownout or power failure, it may be necessary to preserve the contents of RAM. If a backup battery is installed at V_{BAT} , the device automatically switches the connected RAM to backup power when V_{DD} fails. In order to allow the backup battery (for example, 3.6-V lithium cells) to have a higher voltage than V_{DD} , these

supervisors do not connect V_{BAT} to V_{OUT} when V_{BAT} is greater than V_{DD} . V_{BAT} only connects to V_{OUT} (through a 15- Ω switch) when V_{DD} falls below V_{IT} and V_{BAT} is greater than V_{DD} . When V_{DD} recovers, switchover is deferred either until V_{DD} crosses V_{BAT} , or when V_{DD} rises above the reset threshold V_{IT} . V_{OUT} connects to V_{DD} through a 1- Ω (max) PMOS switch when V_{DD} crosses the reset threshold.

$V_{DD} > V_{BAT}$	$V_{DD} > V_{IT}$	V_{OUT}
1	1	V_{DD}
1	0	V_{DD}
0	1	V_{DD}
0	0	V_{BAT}

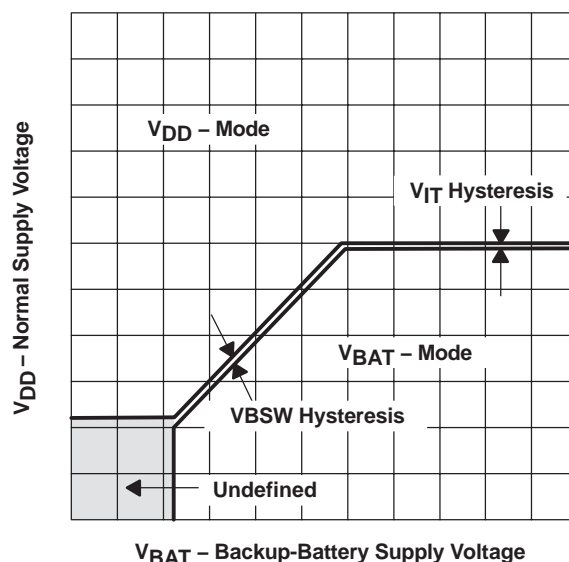


Figure 1. V_{DD} - V_{BAT} Switchover

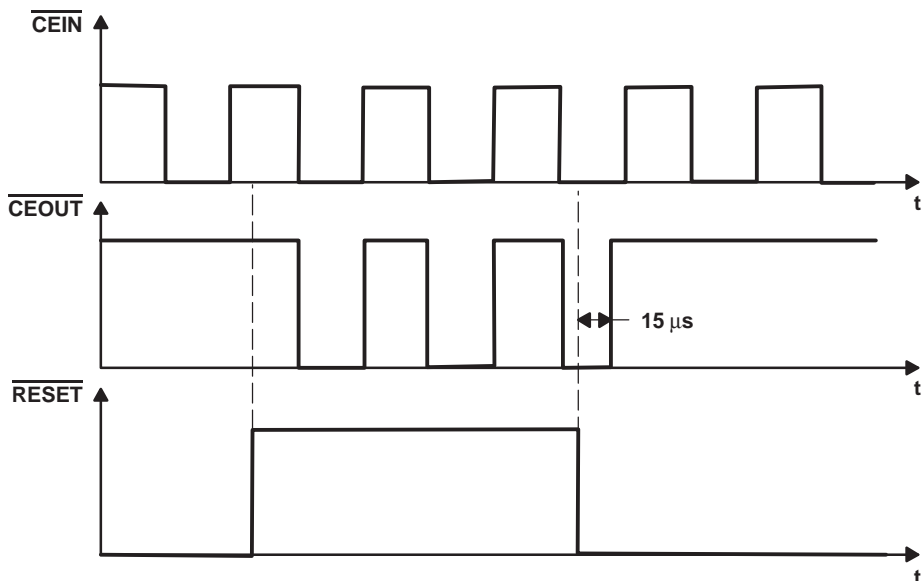
detailed description (continued)**chip-enable signal gating**

The internal gating of chip-enable (\overline{CE}) signals prevents erroneous data from corrupting CMOS RAM during an under-voltage condition. The TPS3613 uses a series transmission gate from \overline{CEIN} to \overline{CEOUT} . During normal operation (reset not asserted), the CE transmission gate is enabled and passes all CE transitions. When reset is asserted, this path becomes disabled, preventing erroneous data from corrupting the CMOS RAM. The short CE propagation delay from \overline{CEIN} to \overline{CEOUT} enables the TPS3613 device to be used with most processors.

The CE transmission gate is disabled and \overline{CEIN} is in high impedance (disable mode) while reset is asserted. During a power-down sequence when V_{DD} crosses the reset threshold, the CE transmission gate is disabled and \overline{CEIN} immediately becomes high impedance if the voltage at \overline{CEIN} is high. If \overline{CEIN} is low when reset

is asserted, the CE transmission gate is disabled when \overline{CEIN} goes high, or 15 μs after reset asserts, whichever occurs first. This allows the current write cycle to complete during power down. When the CE transmission gate is enabled, the impedance of \overline{CEIN} appears as a resistor in series with the load at \overline{CEOUT} . The overall device propagation delay through the CE transmission gate depends on V_{OUT} , the source impedance of the drive connected to \overline{CEIN} , and the load at \overline{CEOUT} . To achieve minimum propagation delay, the capacitive load at \overline{CEOUT} should be minimized, and a low-output-impedance driver is used.

In the disabled mode, the transmission gate is off and an active pullup connects \overline{CEOUT} to V_{OUT} . This pullup turns off when the transmission gate is enabled.

**Figure 2. Chip-Enable Timing**

ABSOLUTE MAXIMUM RATINGS

OVER OPERATING FREE-AIR TEMPERATURE (unless otherwise noted)⁽¹⁾

Supply voltage: V_{DD} ⁽²⁾	7 V
MR and SENSE pins ⁽²⁾	–0.3 V to ($V_{DD} + 0.3$ V)
Continuous output current at V_{OUT} : I_O	400 mA
All other pins, I_O	±10 mA
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 soldering 1,6 mm (1/16 inch) from case for 10 seconds	+260°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.

(2) All voltage values are with respect to GND. For reliable operation the device must not operate at 7 V for more than $t = 1000$ h continuously.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq +25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = +25^\circ\text{C}$	$T_A = +70^\circ\text{C}$ POWER RATING	$T_A = +85^\circ\text{C}$ POWER RATING
DGS	424 mW	3.4 mW/°C	271 mW	220 mW

RECOMMENDED OPERATING CONDITIONS

	MIN	MAX	UNIT
Supply voltage, V_{DD}	1.65	5.5	V
Battery supply voltage, V_{BAT}	1.5	5.5	V
Input voltage, V_I	0	$V_{DD} + 0.3$	V
High-level input voltage, V_{IH}	0.7 x V_{DD}		V
Low-level input voltage, V_{IL}		0.3 x V_{DD}	V
Continuous output current at V_{OUT} , I_O		300	mA
Input transition rise and fall rate at MR, $\Delta t/\Delta V$		100	ns/V
Slew rate at V_{DD} or V_{bat}		1	V/ μ s
Operating free-air temperature range, T_A	–40	+85	°C

ELECTRICAL CHARACTERISTICS**OVER RECOMMENDED OPERATING CONDITIONS (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{OH}	High-level output voltage	RESET	V _{DD} = 1.8 V, I _{OH} = -400 µA	V _{DD} - 0.2 V		V
			V _{DD} = 3.3 V, I _{OH} = -2 mA	V _{DD} - 0.4 V		
			V _{DD} = 5 V, I _{OH} = -3 mA	V _{DD} - 0.4 V		
	RESET		V _{DD} = 1.8 V, I _{OH} = -20 µA	V _{DD} - 0.3 V		
			V _{DD} = 3.3 V, I _{OH} = -80 µA	V _{DD} - 0.4 V		
			V _{DD} = 5 V, I _{OH} = -120 µA	V _{DD} - 0.4 V		
	CEOUT	V _{OUT} = 1.8 V, I _{OH} = -1 mA	V _{OUT} - 0.2 V			
	Enable mode CEIN = V _{OUT}	V _{OUT} = 3.3 V, I _{OH} = -2 mA V _{OUT} = 5 V, I _{OH} = -5 mA	V _{OUT} - 0.3 V			
	CEOUT Disable mode	V _{OUT} = 3.3 V, I _{OH} = -0.5 mA	V _{OUT} - 0.4 V			
V _{OL}	Low-level output voltage	RESET	V _{DD} = 1.8 V, I _{OL} = 400 µA		0.2	V
		RESET	V _{DD} = 3.3 V, I _{OL} = 2 mA V _{DD} = 5 V, I _{OL} = 3 mA		0.4	
		CEOUT	V _{OUT} = 1.8 V, I _{OL} = 1.0 mA		0.2	
		Enable mode CEIN = 0 V	V _{OUT} = 3.3 V, I _{OL} = 2 mA V _{OUT} = 5 V, I _{OL} = 5 mA		0.3	
		Power-up reset voltage (see Note 1)	V _{DD} > 1.1 V or V _{BAT} > 1.1 V, I _{OL} = 20 µA		0.4	V
V _{OUT}	Normal mode	I _O = 8.5 mA, V _{DD} = 1.8 V, V _{BAT} = 0 V	V _{DD} - 50 mV			V
		I _O = 125 mA, V _{DD} = 3.3 V, V _{BAT} = 0 V	V _{DD} - 150 mV			
		I _O = 200 mA, V _{DD} = 5 V, V _{BAT} = 0 V	V _{DD} - 200 mV			
	Battery-backup mode	I _O = 0.5 mA, V _{BAT} = 1.5 V, V _{DD} = 0 V	V _{BAT} - 20 mV			
		I _O = 7.5 mA, V _{BAT} = 3.3 V, V _{DD} = 0 V	V _{BAT} - 113 mV			
R _{DS(on)}	V _{DD} to V _{OUT} on-resistance		V _{DD} = 5 V	0.6	1	Ω
	V _{BAT} to V _{OUT} on-resistance		V _{BAT} = 3.3 V	8	15	
V _{IT}	Negative-going input threshold voltage (see Note 2)			1.13	1.15 1.17	V
V _{hys}	Hysteresis	Sense	1.1 V < V _{IT} < 1.65 V	12		mV
		V _{BSW} (see Note 3)	V _{DD} = 1.8 V	55		
I _{IH}	High-level input current	MR	MR = 0.7 × V _{DD} , V _{DD} = 5 V	-33	-76	µA
I _{IL}	Low-level input current		MR = 0 V, V _{DD} = 5 V	-110	-255	
I _I	Input current	SENSE	V _{DD} = 1.15 V	-25	25	nA
I _{DD}	V _{DD} supply current		V _{OUT} = V _{DD}		40	µA
			V _{OUT} = V _{BAT}		40	
I _{BAT}	V _{BAT} supply current		V _{OUT} = V _{DD}	-0.1	0.1	µA
			V _{OUT} = V _{BAT}		0.5	
I _{lkg}	CEIN leakage current		Disable mode, V _I < V _{DD}		±1	µA
C _i	Input capacitance		V _I = 0 V to 5 V	5		pF

(1) The lowest voltage at which RESET becomes active. $t_r(V_{DD}) \geq 15 \mu s/V$.

(2) To ensure best stability of the threshold voltage, a bypass capacitor (ceramic, 0.1 µF) should be placed near to the supply terminals.

(3) For V_{DD} < 1.6 V, V_{OUT} switches to V_{BAT} regardless of V_{BAT}

TIMING REQUIREMENTS AT $R_L = 1\text{ M}\Omega$, $C_L = 50\text{ pF}$, $T_A = -40^\circ\text{C TO } +85^\circ\text{C}$

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_w	Pulse width	SENSE	$V_{IH} = V_{IT} + 0.2\text{ V}$, $V_{IL} = V_{IT} - 0.2\text{ V}$	6			μs

SWITCHING CHARACTERISTICS AT $R_L = 1\text{ M}\Omega$, $C_L = 50\text{ pF}$, $T_A = -40^\circ\text{C TO } +85^\circ\text{C}$

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_d	Delay time		$V_{SENSE} \geq V_{IT} + 0.2\text{ V}$, $MR \geq 0.7 \times V_{DD}$, See timing diagram	60	100	140	ms
t_{PLH}	Propagation (delay) time, low-to-high-level output	50% $\overline{\text{RESET}}$ to 50% $\overline{\text{CEOUT}}$	$V_{OUT} = V_{IT}$		15		μs
t_{PHL}	Propagation (delay) time, high-to-low-level output	50% $\overline{\text{CEIN}}$ to 50% $\overline{\text{CEOUT}}$, $C_L = 50\text{ pF}$ only (see Note 5)	$V_{DD} = 1.8\text{ V}$		5	15	ns
			$V_{DD} = 3.3\text{ V}$		1.6	5	
			$V_{DD} = 5\text{ V}$		1	3	
		SENSE to $\overline{\text{RESET}}$	$V_{IL} = V_{IT} - 0.2\text{ V}$, $V_{IH} = V_{IT} + 0.2\text{ V}$		2	5	μs
		$\overline{\text{MR}}$ to $\overline{\text{RESET}}$	$V_{SENSE} \geq V_{IT} + 0.2\text{ V}$, $V_{IL} = 0.3 \times V_{DD}$, $V_{IH} = 0.7 \times V_{DD}$		0.1	1	μs
	Transition time	V_{DD} to V_{BAT}	$V_{IH} = V_{BAT} + 0.2\text{ V}$, $V_{IL} = V_{BAT} - 0.2\text{ V}$, $V_{BAT} < V_{IT}$			3	μs

(1) Assured by design

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
$r_{DS(on)}$	Static drain-source on-state resistance (V_{DD} to V_{OUT})	vs Output current	3
	Static drain-source on-state resistance (V_{BAT} to V_{OUT})	vs Output current	4
	Static drain-source on-state resistance ($CEIN$ to $CEOUT$)	vs Input voltage at $CEIN$	5
I_{DD}	Supply current	vs Supply voltage	6
V_{IT}	Input threshold voltage at \overline{RESET}	vs Free-air temperature	7
V_{OH}	High-level output voltage at \overline{RESET}	vs High-level output current	8, 9
	High-level output voltage at \overline{CEOUT}		10, 11, 12, 13
V_{OL}	Low-level output voltage at \overline{RESET}	vs Low-level output current	14, 15
	Low-level output voltage at \overline{CEOUT}	vs Low-level output current	16, 17

**STATIC DRAIN-SOURCE ON-STATE RESISTANCE
(V_{DD} to V_{OUT})
vs
OUTPUT CURRENT**

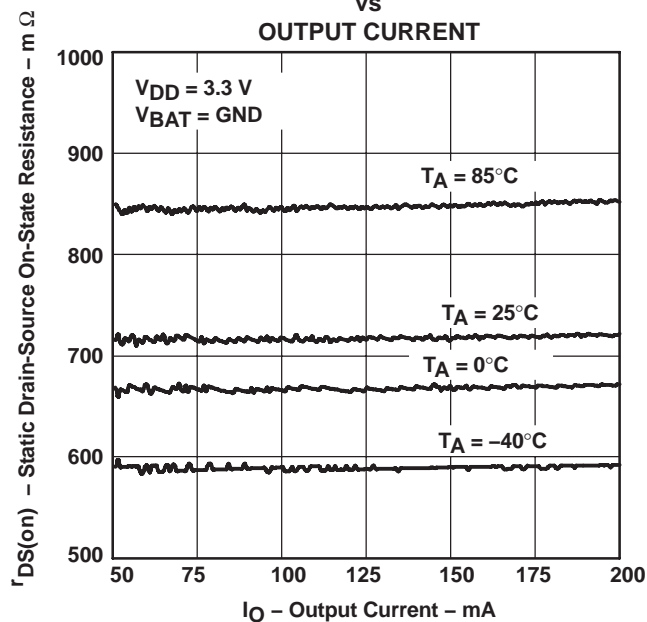


Figure 3

**STATIC DRAIN-SOURCE ON-STATE RESISTANCE
(V_{BAT} to V_{OUT})
vs
OUTPUT CURRENT**

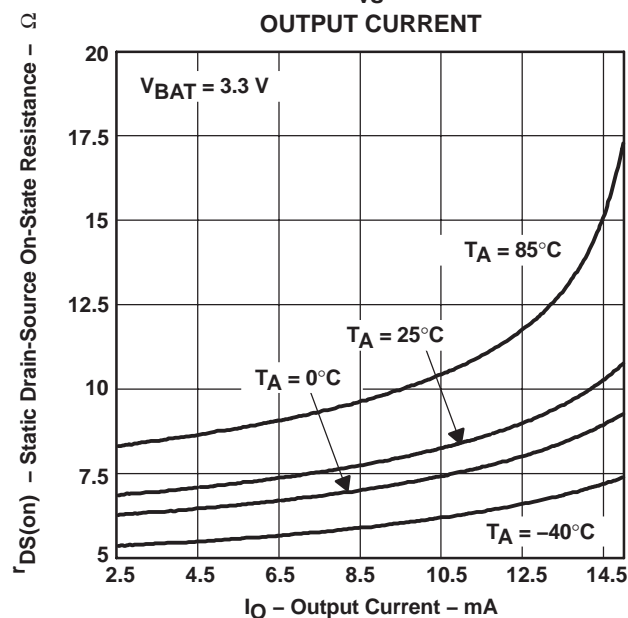


Figure 4

TYPICAL CHARACTERISTICS

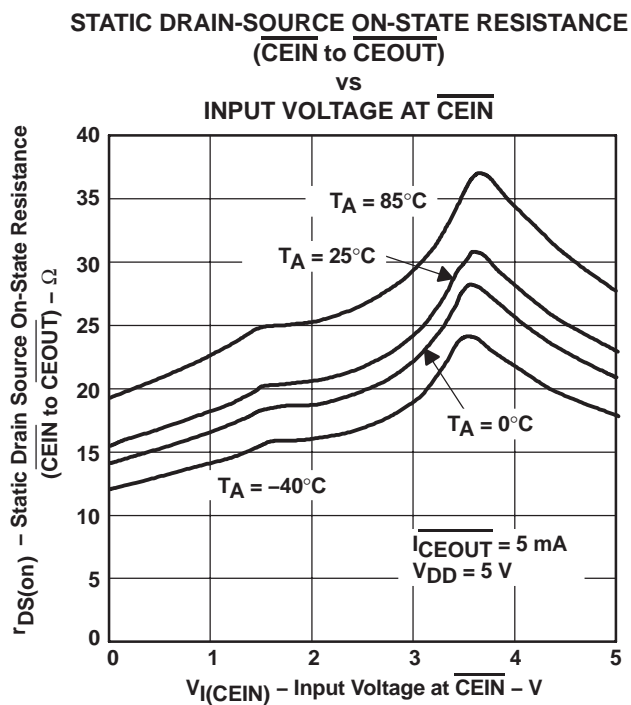


Figure 5

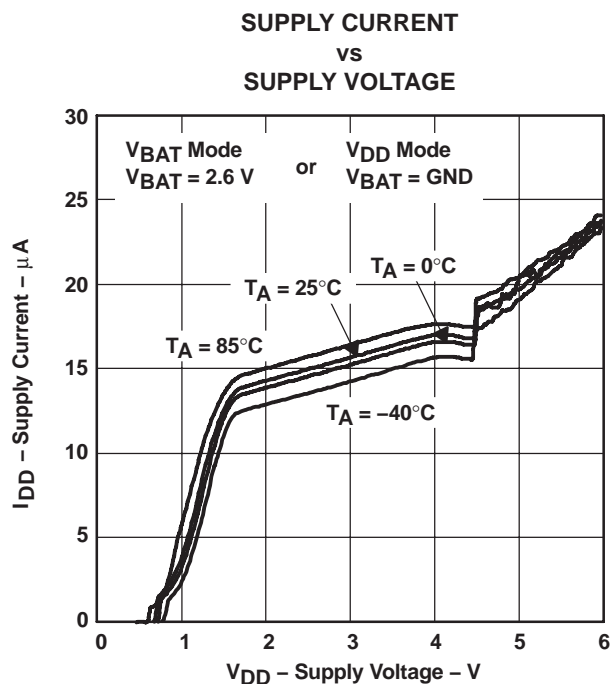


Figure 6

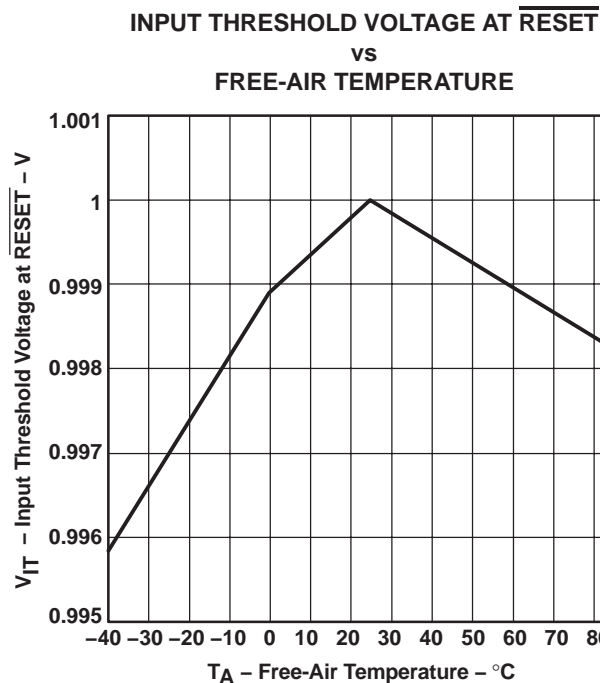


Figure 7

TYPICAL CHARACTERISTICS

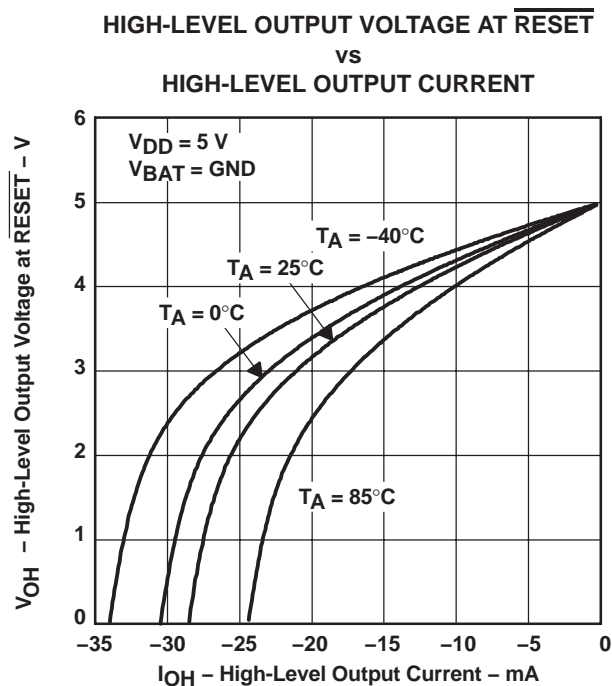


Figure 8

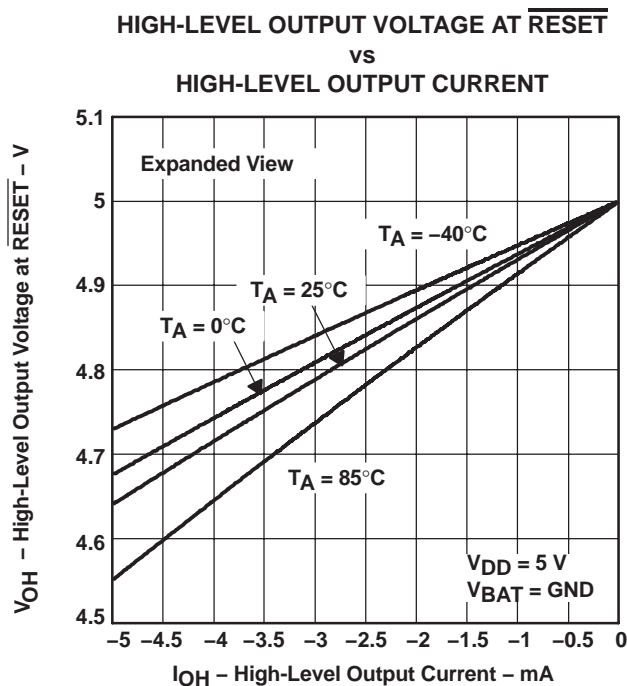


Figure 9

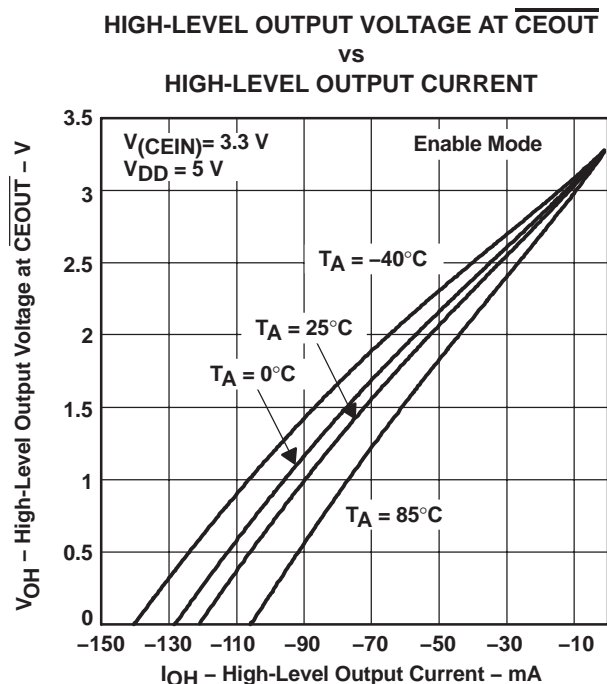


Figure 10

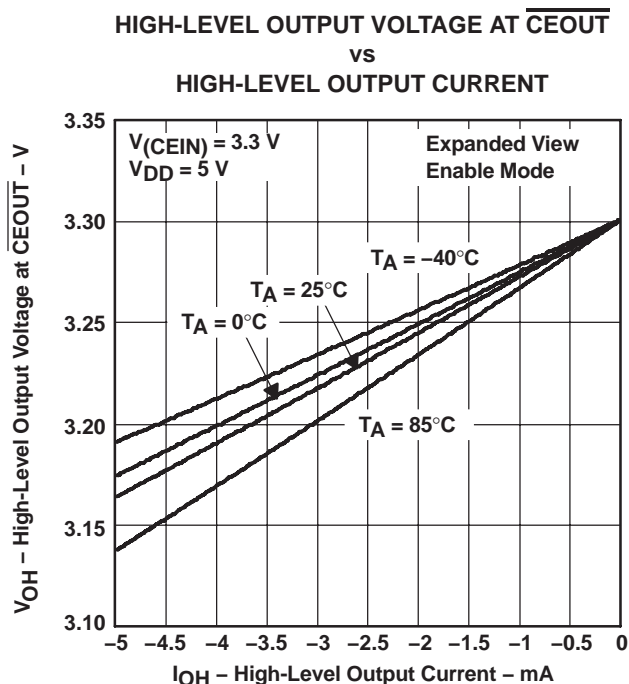
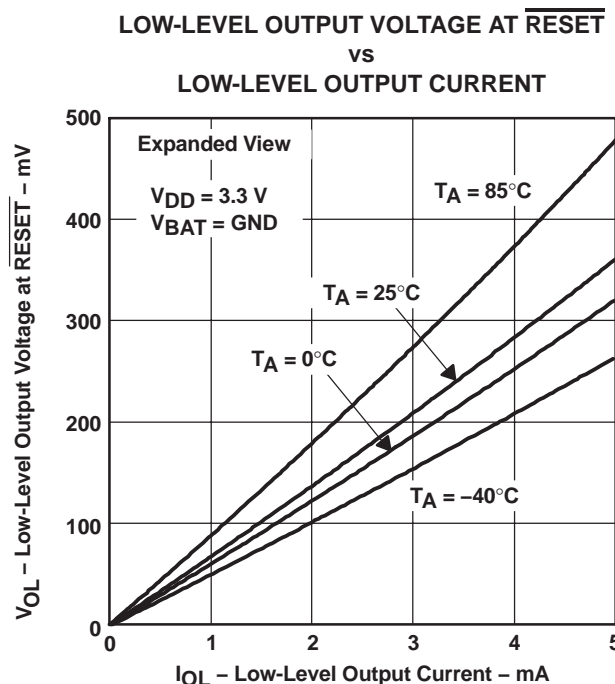
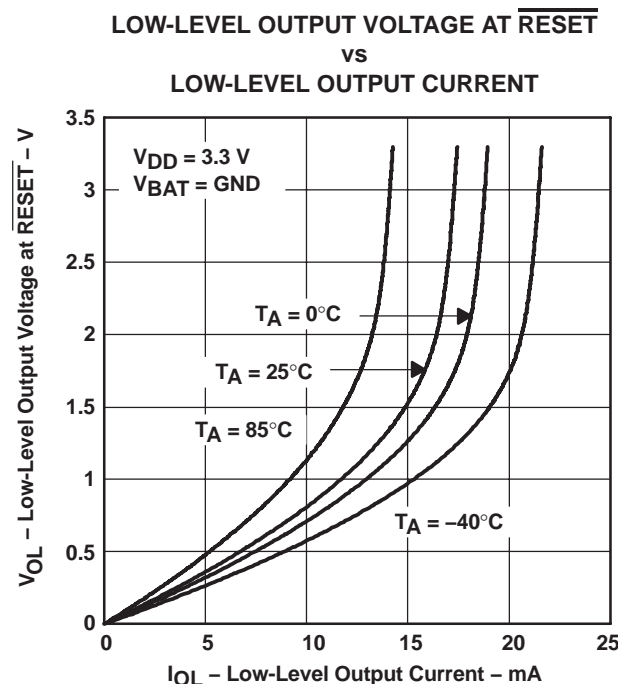
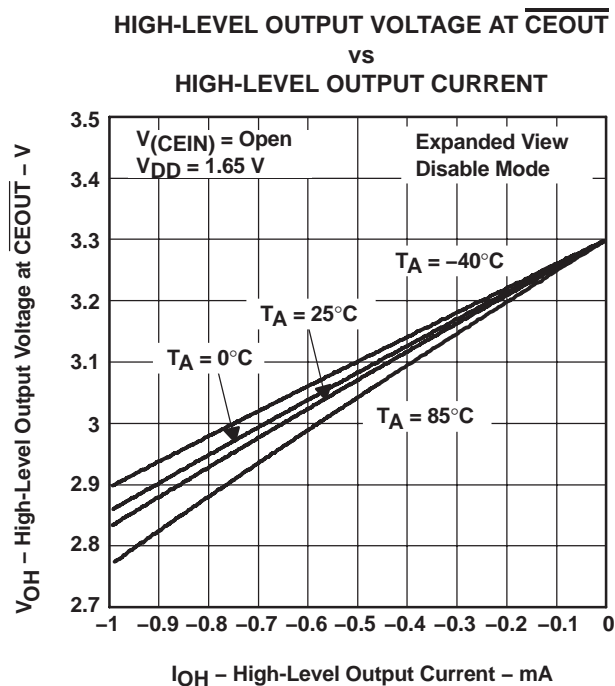
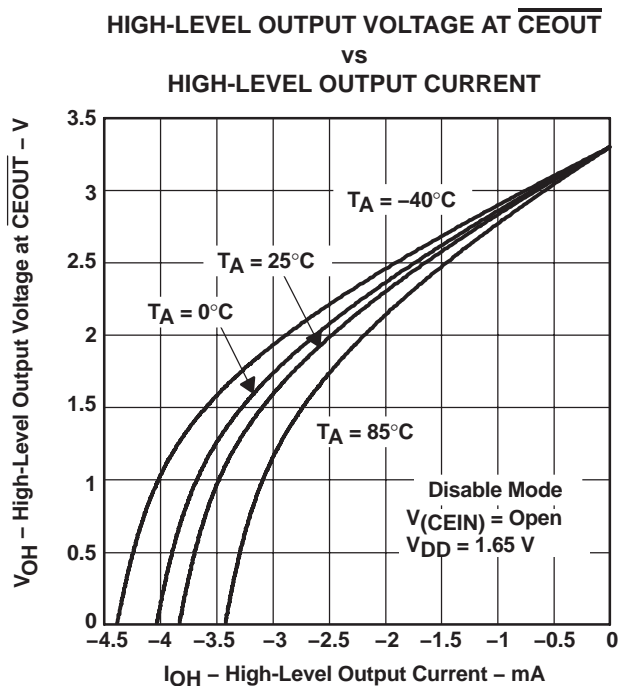


Figure 11

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS

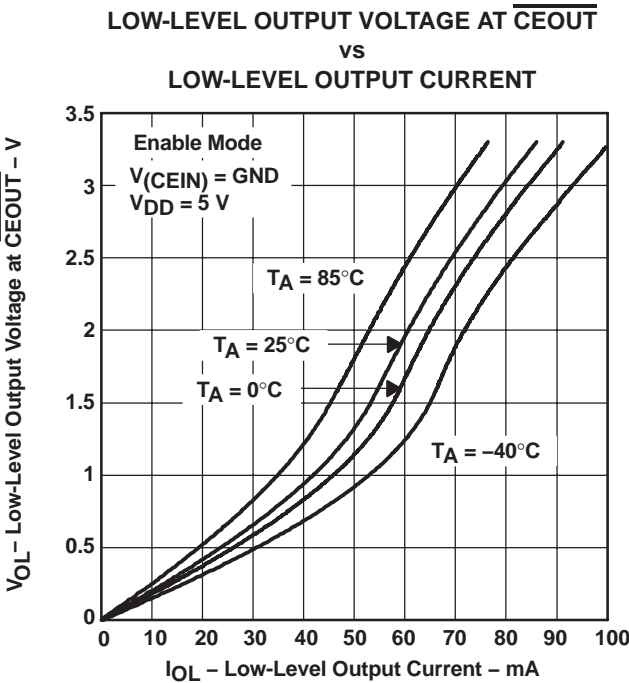


Figure 16

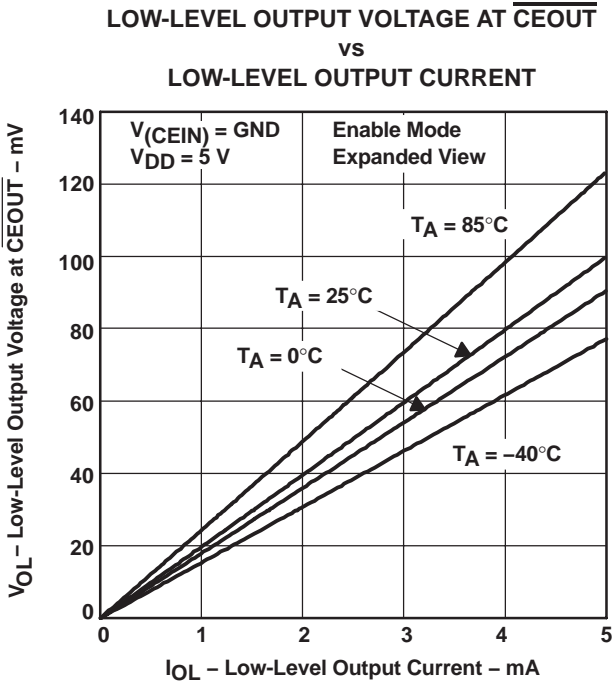


Figure 17

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)
TPS3613-01DGS	Active	Production	VSSOP (DGS) 10	80 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AFK
TPS3613-01DGS.A	Active	Production	VSSOP (DGS) 10	80 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AFK
TPS3613-01DGSR	Active	Production	VSSOP (DGS) 10	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AFK
TPS3613-01DGSR.A	Active	Production	VSSOP (DGS) 10	2500 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AFK

⁽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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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
TPS3613-01DGSR	VSSOP	DGS	10	2500	330.0	12.4	5.3	3.4	1.4	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)
TPS3613-01DGSR	VSSOP	DGS	10	2500	358.0	335.0	35.0



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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-187, variation BA.

EXAMPLE BOARD LAYOUT

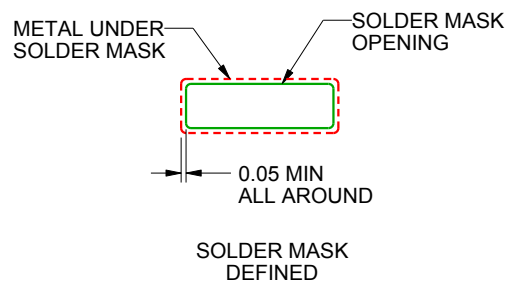
DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:10X



SOLDER MASK DETAILS
NOT TO SCALE

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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.

EXAMPLE STENCIL DESIGN

DGS0010A

VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



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

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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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