# Ultralow Power Voltage Detector

Data Sheet

# ADM8641/ADM8642

## FEATURES

**Ultralow power consumption with $I_{CC}$ = 92 nA (typical)**
**Precision, low voltage monitoring**
**Pretrimmed voltage monitoring threshold options**
   **10 options from 2 V to 4.63 V for the ADM8641**
   **20 options from 0.5 V to 1.9 V for the ADM8642**
**±1.3% threshold accuracy over full temperature range**
**Output disable input**
**23 μs to 26 μs typical propagation delay**
**Open-drain type output**
**Power supply glitch immunity**
**Available in a 1.46 mm × 0.96 mm WLCSP**
**Operational temperature range: −40°C to +85°C**

## APPLICATIONS

**Portable/battery-operated equipment**
**Microprocessor systems**
**Energy metering**
**Energy harvesting**

## FUNCTIONAL BLOCK DIAGRAMS



*Figure 1. ADM8641 Functional Block Diagram*
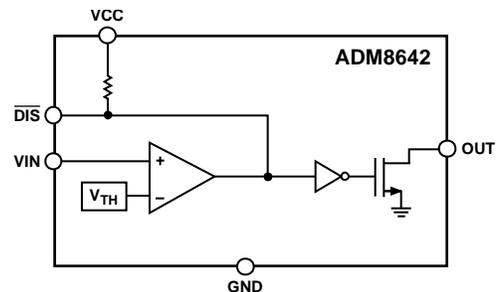


*Figure 2. ADM8642 Functional Block Diagram*

## GENERAL DESCRIPTION

The ADM8641 and ADM8642 are simple voltage detectors suitable for use in general-purpose applications. The ultralow power consumption of these devices makes them suitable for power efficiency sensitive systems, such as battery-powered portable devices and energy meters.

The factory preset detection thresholds from 0.5 V to 4.63 V with ±1.2% accuracy over the full temperature range enable the devices to monitor the node of interest accurately with direct contact. The DIS input lets the user hold the output low regardless of the state of the input.
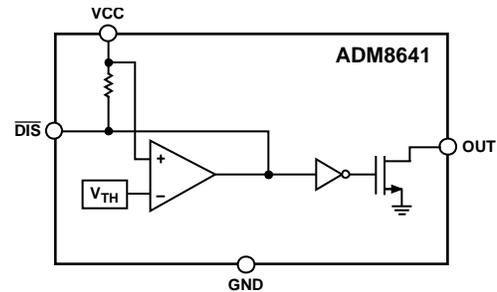
The ADM8641 monitors the voltage using the VCC pin. The separate supply pin on the ADM8642 allows it to have a lower detection threshold down to 0.5 V.

The ADM8641 and ADM8642 are available in a 6-ball, 1.46 mm × 0.96 mm WLCSP. These devices are specified over the temperature range of −40°C to +85°C.

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## REVISION HISTORY

**1/15—Revision 0: Initial Version**

## SPECIFICATIONS

$V_{CC}$ = 2 V to 5.5 V, $V_{IN}$ < $V_{CC}$ + 0.3 V, $T_A$ = −40°C to +85°C, unless otherwise noted. Typical values are at $T_A$ = 25°C.

**Table 1.**

| Parameter | Symbol | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|---|
| OPERATING VOLTAGE RANGE | $V_{CC}$ | | | | | |
| ADM8641 | | 0.9 | | 5.5 | V | Guarantees valid OUT output |
| ADM8642 | | 2 | | 5.5 | V | Guarantees valid OUT output |
| | | 0.9 | | | V | Guarantees OUT low |
| UNDERVOLTAGE LOCKOUT | | | | | | ADM8642 only |
| Input Voltage Rising | $UVLO_{RISE}$ | | | 1.95 | V | |
| Input Voltage Falling | $UVLO_{FALL}$ | 1.6 | | | V | |
| Hysteresis | $UVLO_{HYS}$ | | 90 | | mV | |
| INPUT CURRENT | | | | | | |
| VCC Quiescent Current | $I_{CC}$ | | 92 | 190 | nA | $V_{CC}$ = 2 V to 5.5 V, OUT pulled high |
| | | | | 110 | nA | $T_A$ = 25°C, OUT pulled high |
| VIN Average Input Current | $I_{VIN}$ | | 4 | 32 | nA | $V_{IN}$ = 2 V, $V_{CC}$ = 2 V |
| | | | 4 | 8.5 | nA | $V_{IN}$ = 2 V, $V_{CC}$ = 5.5 V |
| THRESHOLD VOLTAGE | $V_{TH}$ | | | | | Input falling |
| ADM8641 | | $V_{TH}$ − 1.3% | $V_{TH}$ | $V_{TH}$ + 1.3% | V | See Table 6 |
| ADM8642 | | $V_{TH}$ − 1.3% | $V_{TH}$ | $V_{TH}$ + 1.3% | V | See Table 7, $V_{TH}$ ≥ 1.2 V |
| | | $V_{TH}$ − 1.4% | 1.1 | $V_{TH}$ + 1.4% | V | 1.1 V threshold option |
| | | $V_{TH}$ − 1.6% | 1 | $V_{TH}$ + 1.6% | V | 1 V threshold option |
| | | $V_{TH}$ − 1.6% | 0.95 | $V_{TH}$ + 1.6% | V | 0.95 V threshold option |
| | | $V_{TH}$ − 1.7% | 0.9 | $V_{TH}$ + 1.7% | V | 0.9 V threshold option |
| | | $V_{TH}$ − 1.8% | 0.85 | $V_{TH}$ + 1.8% | V | 0.85 V threshold option |
| | | $V_{TH}$ − 1.8% | 0.8 | $V_{TH}$ + 1.8% | V | 0.8 V threshold option |
| | | $V_{TH}$ − 1.9% | 0.75 | $V_{TH}$ + 1.9% | V | 0.75 V threshold option |
| | | $V_{TH}$ − 1.9% | 0.7 | $V_{TH}$ + 1.9% | V | 0.7 V threshold option |
| | | $V_{TH}$ − 2.0% | 0.65 | $V_{TH}$ + 2.0% | V | 0.65 V threshold option |
| | | $V_{TH}$ − 2.1% | 0.6 | $V_{TH}$ + 2.1% | V | 0.6 V threshold option |
| | | $V_{TH}$ − 2.1% | 0.55 | $V_{TH}$ + 2.1% | V | 0.55 V threshold option |
| | | $V_{TH}$ − 2.2% | 0.5 | $V_{TH}$ + 2.2% | V | 0.5 V threshold option |
| THRESHOLD HYSTERESIS | $V_{HYST}$ | | | | | |
| ADM8641 | | | 0.5% × $V_{TH}$ | | V | |
| ADM8642 | | | 0.5% × $V_{TH}$ | | V | $V_{TH}$ ≥ 1 V |
| | | | 5 | | mV | $V_{TH}$ < 1 V |
| PROPAGATION DELAY | | | | | | |
| ADM8641 VCC to OUT | $t_{PD\_VCC}$ | 18 | 26 | 37 | µs | $V_{CC}$ falling with $V_{TH}$ × 10% overdrive |
| | | 20.5 | 36 | 57 | µs | $V_{CC}$ rising with $V_{TH}$ × 10% overdrive |
| ADM8642 VIN to OUT | $t_{PD\_VIN}$ | 13.5 | 23 | 35 | µs | $V_{IN}$ falling with $V_{TH}$ × 10% overdrive |
| | | 22 | 39.5 | 61 | µs | $V_{IN}$ rising with $V_{TH}$ × 10% overdrive |
| INPUT GLITCH REJECTION | | | | | | |
| ADM8641 VCC Glitch Rejection | $t_{GR\_VCC}$ | | 23 | | µs | $V_{CC}$ falling with $V_{TH}$ × 10% overdrive |
| | | | 35 | | µs | $V_{CC}$ rising with $V_{TH}$ × 10% overdrive |
| ADM8642 VIN Glitch Rejection | $t_{GR\_VIN}$ | | 21 | | µs | $V_{IN}$ falling with $V_{TH}$ × 10% overdrive |
| | | | 38 | | µs | $V_{IN}$ rising with $V_{TH}$ × 10% overdrive |

| Parameter | Symbol | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|---|---|---|---|---|---|
| OUT OUTPUT | | | | | | |
| Output Voltage Low | $V_{OUT\_OL}$ | | | 0.4 | V | $V_{CC}$ > 4.25 V, $I_{SINK}$ = 6.5 mA |
| | | | | 0.4 | V | $V_{CC}$ > 2.5 V, $I_{SINK}$ = 6 mA |
| | | | | 0.4 | V | $V_{CC}$ > 1.2 V, $I_{SINK}$ = 4.6 mA |
| | | | | 0.4 | V | $V_{CC}$ > 0.9 V, $I_{SINK}$ = 0.9 mA |
| Leakage Current | | | | 5 | nA | $V_{OUT} = V_{CC}$ = 5.5 V |
| $\overline{DIS}$ INPUT | | | | | | |
| $V_{IL}$ | | | | 0.4 | V | |
| $V_{IH}$ | | 0.9 | | | V | |
| $\overline{DIS}$ Glitch Rejection | | | 0.4 | | μs | |
| $\overline{DIS}$ to OUT Delay | $t_{D\_DIS1}$ | | 0.65 | | μs | $\overline{DIS}$ falling |
| $\overline{DIS}$ Pull-Up Resistance | | 0.5 | 0.6 | 0.82 | MΩ | |

# ABSOLUTE MAXIMUM RATINGS

**Table 2.**

| Parameter | Rating |
|---|---|
| VCC | −0.3 V to +6 V |
| OUT | −0.3 V to +6 V |
| VIN | −0.3 V to +6 V |
| $\overline{\text{DIS}}$ | −0.3 V to $V_{CC}$ + 0.3 V |
| Input/Output Current | 10 mA |
| Storage Temperature Range | −40°C to +150°C |
| Operating Temperature Range | −40°C to +85°C |

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

## THERMAL RESISTANCE

$\theta_{JA}$ is specified for a device soldered on an FR4 board with a minimum footprint.

**Table 3.**

| Package Type | $\theta_{JA}$ | Unit |
|---|---|---|
| 6-Ball WLCSP | 105.6 | °C/W |

## ESD CAUTION

**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

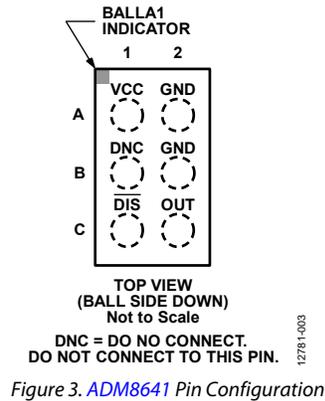# PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS



Figure 3. *ADM8641 Pin Configuration*

**Table 4. ADM8641 Pin Function Descriptions**

| Pin No. | Mnemonic | Description |
|---------|----------|-------------|
| A1 | VCC | Power Supply Input. The voltage on the VCC pin is monitored on the ADM8641. It is recommended to place a 0.1 µF decoupling capacitor between the VCC pin and the GND pin. |
| A2 | GND | Ground. Both GND pins on the ADM8641 must be grounded. |
| B1 | DNC | Do Not Connect. Do not connect to this pin. |
| B2 | GND | Ground. Both GND pins on the ADM8641 must be grounded. |
| C1 | $\overline{\text{DIS}}$ | Active Low Output Disable Input. |
| C2 | OUT | Open-Drain Detector Output. |
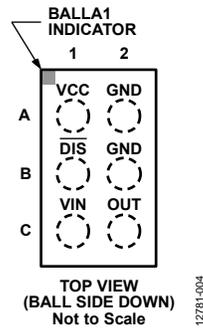


Figure 4. *ADM8642 Pin Configuration*

**Table 5. ADM8642 Pin Function Descriptions**

| Pin No. | Mnemonic | Description |
|---------|----------|-------------|
| A1 | VCC | Power Supply Input. The voltage on the VCC pin is not monitored on the ADM8642. It is recommended to place a 0.1 µF decoupling capacitor between the VCC pin and the GND pin. |
| A2 | GND | Ground. Both GND pins on the ADM8642 must be grounded. |
| B1 | $\overline{\text{DIS}}$ | Active Low Output Disable Input. |
| B2 | GND | Ground. Both GND pins on the ADM8642 must be grounded. |
| C1 | VIN | Low Voltage Monitoring Input. This separate supply input allows the ADM8642 to monitor low voltages of 0.8 V on the VIN pin. |
| C2 | OUT | Open-Drain Detector Output. |

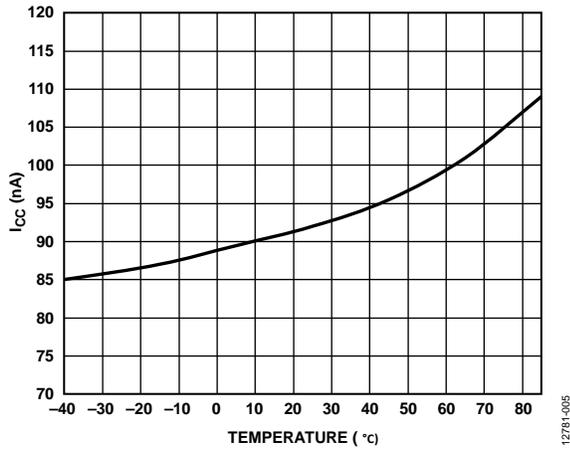# TYPICAL PERFORMANCE CHARACTERISTICS



Figure 5. Supply Current ($I_{CC}$) vs. Temperature
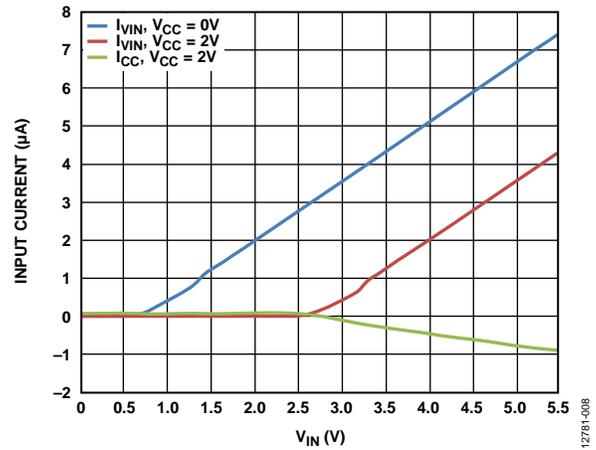


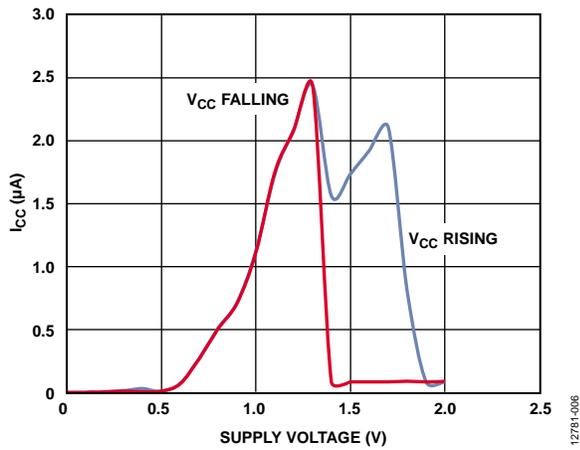Figure 8. VIN Pin and VCC Pin Input Current vs. $V_{IN}$



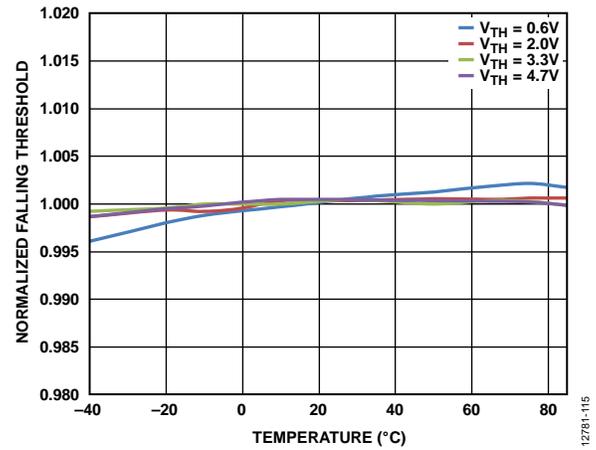Figure 6. Supply Current ($I_{CC}$) vs. Supply Voltage, $V_{CC} < 2\ V$



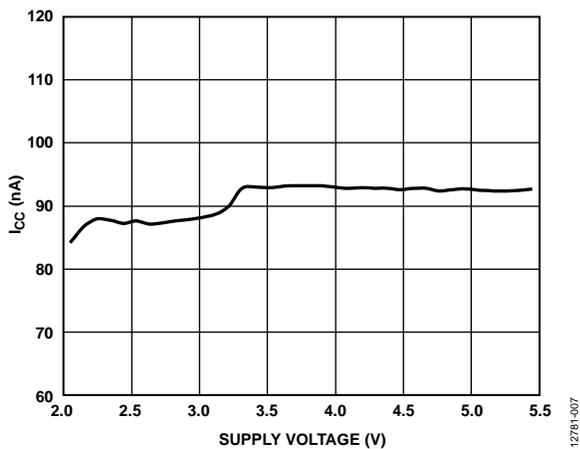Figure 9. Normalized Falling Threshold vs. Temperature
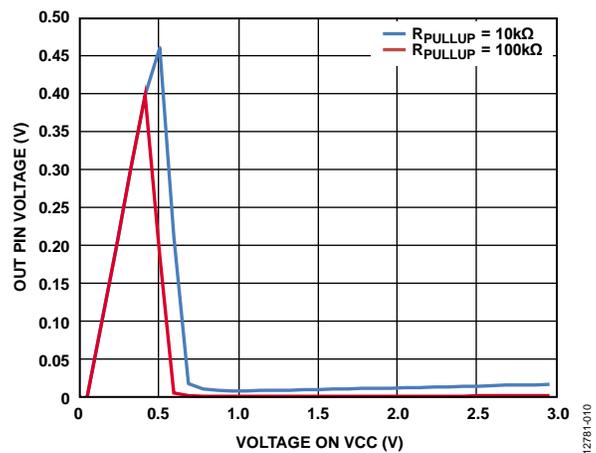


Figure 7. Supply Current ($I_{CC}$) vs. Supply Voltage



Figure 10. OUT Pin Voltage vs. Voltage on VCC
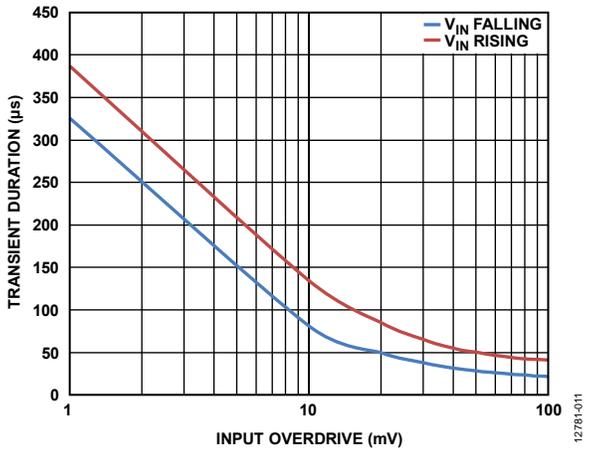(with the OUT Pin Pulled up to the VCC Pin Through $R_{PULLUP}$)

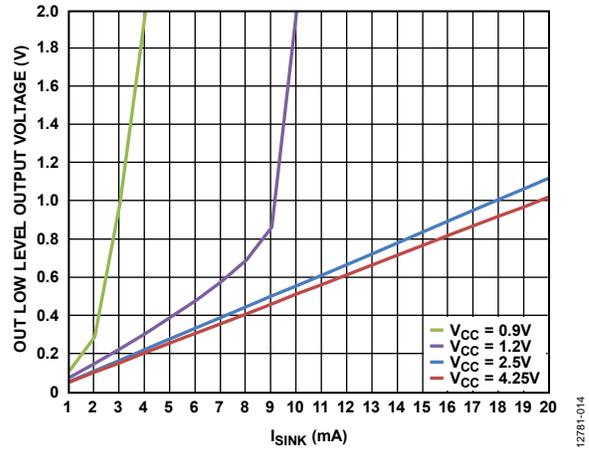Figure 11. Maximum Transient Duration vs. Input Overdrive



Figure 12. VIN Pin Leakage Current vs. Temperature



Figure 13. Output Leakage Current vs. Output Voltage



Figure 14. OUT Low Level Output Voltage vs. Sink Current ($I_{SINK}$)



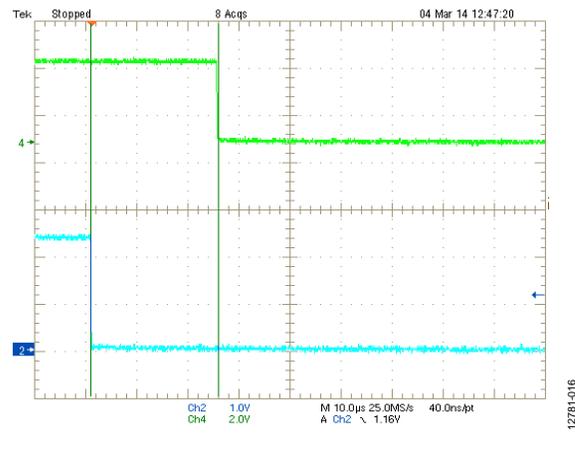Figure 15. OUT Propagation Delay With VCC/VIN Rising



Figure 16. OUT Propagation Delay With VCC/VIN Falling

# THEORY OF OPERATION

The [ADM8641](#) and [ADM8642](#) ultralow power voltage detectors are especially suited for battery-powered applications due to the 190 nA quiescent current (maximum). The internal precision reference allows the user to monitor specific voltage levels accurately from 0.5 V to 4.63 V. These devices feature internal input hysteresis and an open-drain output. The output remains logic high after the monitored input is above the preset threshold. The output changes to logic low after the input voltage falls below the threshold. The devices keep the output in a logic low state whenever the supply voltage on the VCC pin is below the UVLO threshold. The output disable input can also keep the output low regardless of the status on the input.
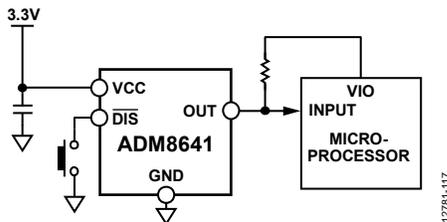


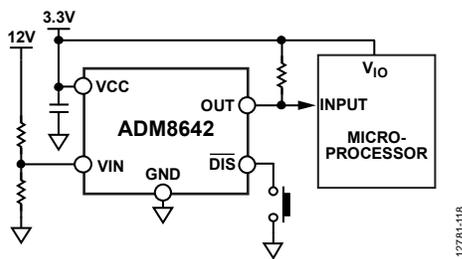*Figure 17. [ADM8641](#) Typical Application Circuit*



*Figure 18. [ADM8642](#) Typical Application Circuit*

## VOLTAGE MONITORING INPUT

The VCC pin on the [ADM8641](#) acts as both a device power input node and a voltage monitoring input node. The [ADM8642](#) uses separate pins for supply and voltage monitoring to achieve a low voltage monitoring threshold to 0.5 V. It is recommended to place a 0.1 µF decoupling capacitor between the VCC pin and the GND pin.

## VIN AS AN ADJUSTABLE INPUT

Due to the low leakage nature of the VIN pin, the [ADM8642](#) can be used as a device with an adjustable threshold. Use an external resistor divider circuit to program the desired voltage monitoring threshold based on the VIN threshold, as shown in Figure 19.
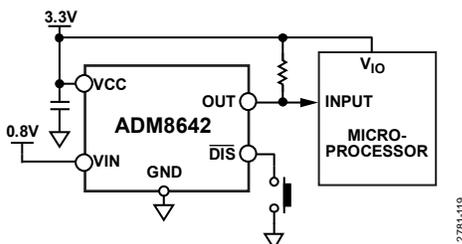


*Figure 19. [ADM8642](#) as an Adjustable Threshold Device*

## TRANSIENT IMMUNITY

To avoid unnecessary output state changes caused by fast power supply transients, an input glitch filter is added to the VCC pin of the [ADM8641](#) and the VIN pin of the [ADM8642](#) to filter out the transient glitches on these pins.

Figure 11 shows the comparator overdrive (that is, the maximum magnitude of positive and negative going pulses with respect to the typical threshold) vs. the pulse duration without changing the state of the output.

## OUTPUT

Both the [ADM8641](#) and [ADM8642](#) voltage detectors have an open-drain output. For the [ADM8641](#), the state of the output is guaranteed to be valid as soon as $V_{CC}$ rises above 0.9 V. For the [ADM8642](#), the output is guaranteed to be logic low from when $V_{CC}$ = 0.9 V to when the device exits ULVO.

When the monitored voltage falls below its associated threshold, the OUT pin asserts low after 23 µs to 26 µs (typical). When the monitored voltage rises above the threshold plus hysteresis, the OUT pin asserts high after 36 µs to 39.5 µs (typical).

## DISABLE INPUT

The [ADM8641](#)/[ADM8642](#) feature a disable input ($\overline{DIS}$). Drive the $\overline{DIS}$ pin low to assert the output low. The $\overline{DIS}$ input has a 0.6 MΩ internal pull-up resistor so that the input is always high when unconnected. To drive the $\overline{DIS}$ input, use an external signal or a push-button switch to ground; debounce circuitry is integrated on-chip for this purpose. Noise immunity is provided on the $\overline{DIS}$ input, and fast, negative going transients of up to 0.4 µs (typical) are ignored. If required, a 0.1 µF capacitor between the $\overline{DIS}$ pin and ground provides additional noise immunity.
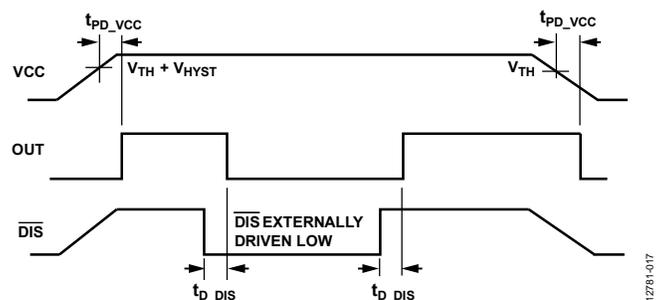


*Figure 20. $\overline{DIS}$ Input Timing*

## DEVICE OPTIONS

Table 6. ADM8641 $V_{CC}$ Threshold ($V_{TH}$) Options ($T_A$ = −40°C to +85°C)

| Threshold Number | Min | Typ | Max | Unit |
|---|---|---|---|---|
| 200 | 1.974 | 2 | 2.026 | V |
| 220 | 2.171 | 2.2 | 2.229 | V |
| 232 | 2.290 | 2.32 | 2.350 | V |
| 263 | 2.596 | 2.63 | 2.664 | V |
| 280 | 2.764 | 2.8 | 2.836 | V |
| 293 | 2.892 | 2.93 | 2.968 | V |
| 300 | 2.961 | 3 | 3.039 | V |
| 308 | 3.040 | 3.08 | 3.120 | V |
| 440 | 4.343 | 4.4 | 4.457 | V |
| 463 | 4.570 | 4.63 | 4.690 | V |

Table 7. ADM8642 $V_{IN}$ Threshold ($V_{TH}$) Options ($T_A$ = −40°C to +85°C)

| Threshold Number | Min | Typ | Max | Unit |
|---|---|---|---|---|
| 050 | 0.489 | 0.5 | 0.511 | V |
| 055 | 0.538 | 0.55 | 0.562 | V |
| 060 | 0.588 | 0.6 | 0.612 | V |
| 065 | 0.637 | 0.65 | 0.663 | V |
| 070 | 0.686 | 0.7 | 0.714 | V |
| 075 | 0.736 | 0.75 | 0.764 | V |
| 080 | 0.785 | 0.8 | 0.815 | V |
| 085 | 0.835 | 0.85 | 0.865 | V |
| 090 | 0.885 | 0.9 | 0.915 | V |
| 095 | 0.935 | 0.95 | 0.965 | V |
| 100 | 0.984 | 1 | 1.016 | V |
| 110 | 1.084 | 1.1 | 1.116 | V |
| 120 | 1.184 | 1.2 | 1.216 | V |
| 130 | 1.283 | 1.3 | 1.317 | V |
| 140 | 1.382 | 1.4 | 1.418 | V |
| 150 | 1.481 | 1.5 | 1.520 | V |
| 160 | 1.579 | 1.6 | 1.621 | V |
| 170 | 1.678 | 1.7 | 1.722 | V |
| 180 | 1.777 | 1.8 | 1.823 | V |
| 190 | 1.875 | 1.9 | 1.925 | V |

ADM864_ T_ _ _ACBZ-R7

GENERIC NUMBER
(1 OR 2)

THRESHOLD NUMBER
(050 TO 463)

TEMPERATURE RANGE
A: −40°C TO +85°C

PACKING MATERIAL
R7 = 7" TAPE AND REEL
(3000 PIECE QUANTITY)

Z = LEAD-FREE

PACKAGE DESIGNATON
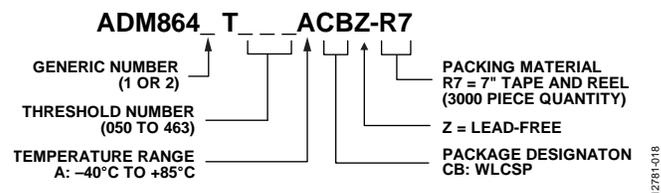CB: WLCSP

12781-018

Figure 21. Ordering Code Structure
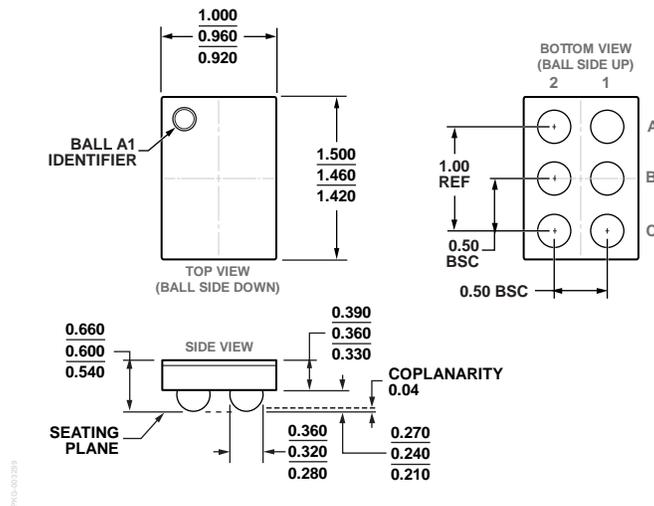
# OUTLINE DIMENSIONS



*Figure 22. 6-Ball Wafer Level Chip Scale Package [WLCSP]*
*(CB-6-17)*
*Dimensions shown in millimeters*

## ORDERING GUIDE

| Model[1, 2, 3] | Temperature Range | Package Description | Package Option | Branding |
|---|---|---|---|---|
| ADM8641T263ACBZ-R7 | −40°C to +85°C | 6-Ball Wafer Level Chip Scale Package [WLCSP] | CB-6-17 | DT |
| ADM8642T100ACBZ-R7 | −40°C to +85°C | 6-Ball Wafer Level Chip Scale Package [WLCSP] | CB-6-17 | DU |

[1] Z = RoHS Compliant Part.
[2] If ordering nonstandard models, complete the ordering code shown in Figure 21 by inserting the model number and threshold number. Contact Analog Devices, Inc., sales for availability of nonstandard models, quoting ADM864x-NTSD first, and then the complete ordering code.
[3] A minimum of 10,000 must be ordered for nonstandard models.

**ANALOG DEVICES**

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