

# MAX16072/MAX16073/MAX16074

## μP Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### General Description

The MAX16072/MAX16073/MAX16074 ultra-small, ultra-low-power, microprocessor (μP) supervisory circuits feature a precision band-gap reference, comparator, and internally trimmed resistors that set the threshold voltage. Designed to monitor the system supply voltage and assert an output during power-up, power-down, and brownout conditions, these devices provide excellent circuit reliability and low cost by eliminating external components and adjustments when monitoring nominal system voltage from 1.8V to 3.6V.

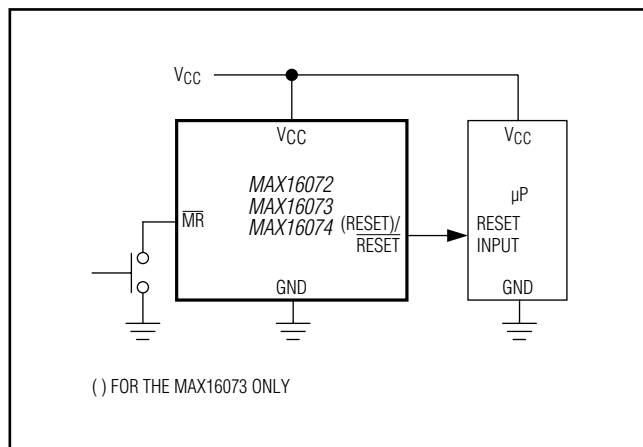
The MAX16072 has a push-pull, active-low reset output, the MAX16073 has a push-pull, active-high reset output, and the MAX16074 has an open-drain active-low reset output. The devices are designed to ignore fast transients on V<sub>CC</sub>. The devices also include a manual reset input (MR).

The MAX16072/MAX16073/MAX16074 are available in a 1mm x 1mm, space-saving, 4-bump, chip-scale package (UCSP™).

### Applications

Portable/Battery-Powered Equipment  
Cell Phones  
PDAs  
MP3 Players  
Digital Cameras

### Typical Operating Circuit



### Features

- ♦ Ultra-Low, 0.7μA Supply Current
- ♦ Ultra-Small (1mm x 1mm), 4-Bump UCSP
- ♦ 20μs, 8ms, 34ms, and 140ms Reset Timeout Options Available
- ♦ Factory-Trimmed Reset Thresholds Available from 1.58V to 3.08V in Approximately 100mV Increments
- ♦ ±2.5% Threshold Accuracy Over Temperature
- ♦ Manual Reset Input
- ♦ Guaranteed Reset Valid to V<sub>CC</sub> = 1.0V
- ♦ Immune to Short V<sub>CC</sub> Transient

### Ordering Information

| PART             | RESET OUTPUT TYPE      | PIN-PACKAGE |
|------------------|------------------------|-------------|
| MAX16072RS_ _D_+ | Push-Pull, Active-Low  | 4 UCSP      |
| MAX16073RS_ _D_+ | Push-Pull, Active-High | 4 UCSP      |
| MAX16074RS_ _D_+ | Open-Drain, Active-Low | 4 UCSP      |

+Denotes a lead(Pb)-free/RoHS-compliant package.

**Note:** All devices are specified over the -40°C to +85°C operating temperature range.

Insert the desired suffix numbers (from Table 1) into the blanks "RS\_ \_D" to indicate the reset trip threshold. Insert the desired suffix number (from Table 2) into the blank "D\_+" to indicate the reset timeout. Minimum order quantity may apply.

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# MAX16072/MAX16073/MAX16074

## μP Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND.)

VCC,  $\overline{\text{MR}}$  ..... -0.3V to +6V  
 RESET,  $\overline{\text{RESET}}$  Push-Pull ..... -0.3V to (VCC + 0.3V)  
 RESET Open-Drain ..... -0.3V to +6V  
 Output Current (all pins) .....  $\pm 20\text{mA}$   
 Continuous Power Dissipation (TA = +70°C)  
   4-Bump UCSP (derate 3mW/°C above +70°C) ..... 239mW

Operating Temperature Range ..... -40°C to +85°C  
 Storage Temperature Range ..... -65°C to +150°C  
 Junction Temperature ..... +150°C  
 Soldering Temperature (reflow) ..... +260°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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

### ELECTRICAL CHARACTERISTICS

(VCC = 1.5V to 5.5V, TA = -40°C to +85°C, unless otherwise noted. Typical values are at TA = +25°C and VCC = 3.6V.) (Note 1)

| PARAMETER                                                   | SYMBOL  | CONDITIONS                                      | MIN        | TYP       | MAX        | UNITS  |
|-------------------------------------------------------------|---------|-------------------------------------------------|------------|-----------|------------|--------|
| Operating Voltage Range                                     | VCC     | TA = 0°C to +85°C                               | 1.0        |           | 5.5        | V      |
|                                                             |         | TA = -40°C to +85°C                             | 1.2        |           | 5.5        |        |
| Supply Current                                              | ICC     | VCC = 1.8V for VTH ≤ 1.66V                      |            | 0.7       | 1.2        | μA     |
|                                                             |         | VCC = 3.6V, no load                             |            | 1.0       | 1.5        |        |
| Detector Threshold                                          | VTH     | See Table 1                                     | VTH - 1.5% | VTH       | VTH + 1.5% | V      |
|                                                             |         | VCC falling, TA = +25°C                         | VTH - 2.5% | VTH       | VTH + 2.5% |        |
| Detector Threshold Hysteresis                               | VHYS    | VCC rising, VTH ≤ 1.66V (Note 2)                |            | 6.3       |            | mV     |
| Detector Threshold Tempco                                   | ΔVTH/°C | (Note 2)                                        |            | 40        |            | ppm/°C |
| <b><math>\overline{\text{MR}}</math> INPUT</b>              |         |                                                 |            |           |            |        |
| $\overline{\text{MR}}$ Input High Voltage                   | VIH     |                                                 | 0.7 x VCC  |           |            | V      |
|                                                             | VIL     |                                                 |            | 0.7 x VCC |            |        |
| $\overline{\text{MR}}$ Pullup Resistance                    |         |                                                 | 25         | 50        | 75         | kΩ     |
| <b>RESET/RESET OUTPUT (Note 3)</b>                          |         |                                                 |            |           |            |        |
| Output-Voltage Low                                          | VOL     | VCC ≥ 1.2V, ISINK = 100μA                       |            |           | 0.4        | V      |
|                                                             |         | VCC ≥ 1.65V, ISINK = 1mA                        |            |           | 0.3        |        |
| Output-Voltage High                                         | VOH     | VCC ≥ 1.65V, ISOURCE = 500μA                    | 0.8 x VCC  |           |            | V      |
|                                                             |         | VCC ≥ 1.2V, ISOURCE = 50μA                      | 0.8 x VCC  |           |            |        |
| Open-Drain $\overline{\text{RESET}}$ Output Leakage Current |         | $\overline{\text{RESET}}$ not asserted (Note 2) |            |           | 0.1        | μA     |
| <b>TIMING</b>                                               |         |                                                 |            |           |            |        |
| $\overline{\text{MR}}$ Minimum Pulse Width                  | tMPW    | (Note 2)                                        | 0.8        |           |            | μs     |
| $\overline{\text{MR}}$ Glitch Rejection                     | tEGR    | (Note 2)                                        |            | 100       |            | ns     |
| $\overline{\text{MR}}$ to RESET/RESET Propagation Delay     | tOFF    | $\overline{\text{MR}}$ falling                  |            | 1         | 2          | μs     |
|                                                             | tON     | $\overline{\text{MR}}$ rising                   |            | 200       | 400        | ns     |
| VCC to Reset Delay                                          | tDL     | VCC = (VTH + 100mV) to (VTH - 100mV)            |            | 20        | 90         | μs     |

# MAX16072/MAX16073/MAX16074

## $\mu$ P Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = 1.5V$  to  $5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = +25^{\circ}C$  and  $V_{CC} = 3.6V$ .) (Note 1)

| PARAMETER                   | SYMBOL   | CONDITIONS                                                         | MIN | TYP | MAX | UNITS   |
|-----------------------------|----------|--------------------------------------------------------------------|-----|-----|-----|---------|
| Reset Active Timeout Period | $t_{RP}$ | $V_{CC}$ rising, $V_{CC} = (V_{TH} - 100mV)$ to $(V_{TH} + 100mV)$ |     |     |     |         |
|                             |          | MAX1607_RSD0+                                                      | 20  | 80  | 120 | $\mu s$ |
|                             |          | MAX1607_RSD1+                                                      | 8   | 13  | 17  | ms      |
|                             |          | MAX1607_RSD2+                                                      | 34  | 52  | 69  | ms      |
|                             |          | MAX1607_RSD3+                                                      | 140 | 210 | 280 | ms      |

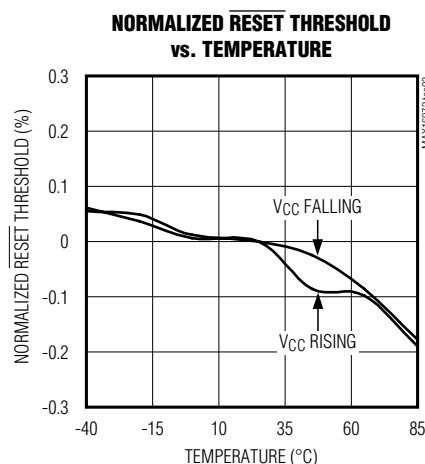
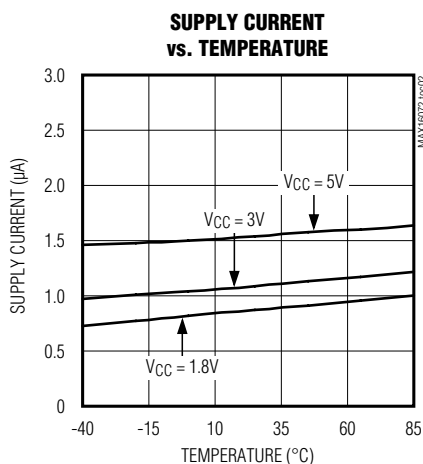
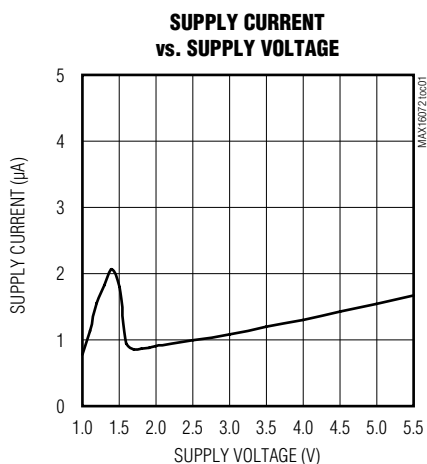
**Note 1:** Production testing done at  $T_A = +25^{\circ}C$  only. Overtemperature limits are guaranteed by design and are not production tested.

**Note 2:** Guaranteed by design.

**Note 3:** Reset is guaranteed down to  $V_{CC} = 1.0V$ .

### Typical Operating Characteristics

( $T_A = +25^{\circ}C$ , unless otherwise noted.)

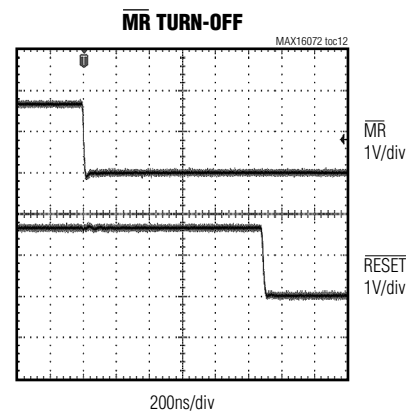
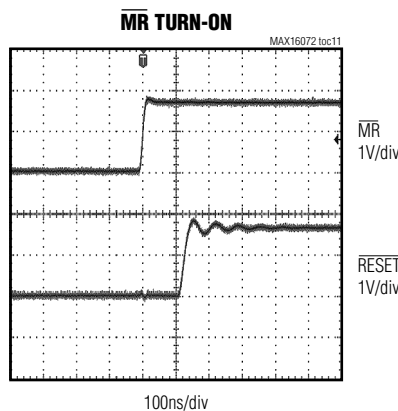
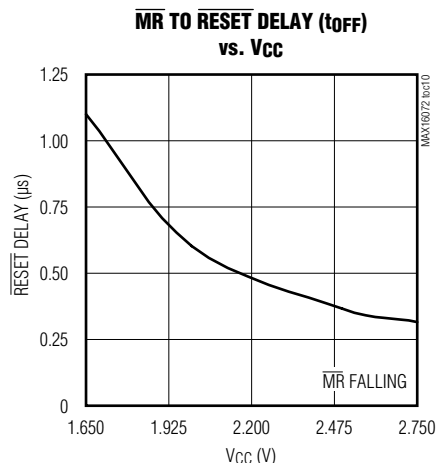
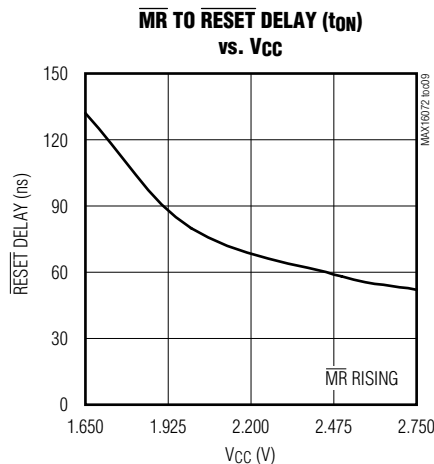
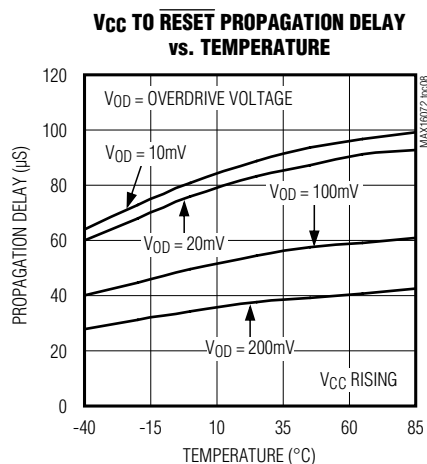
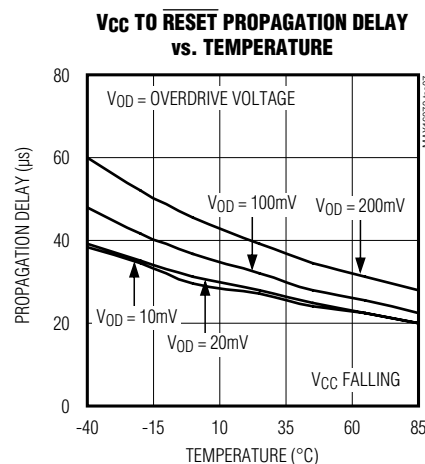
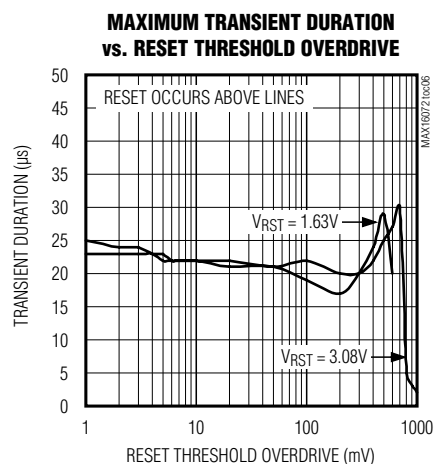
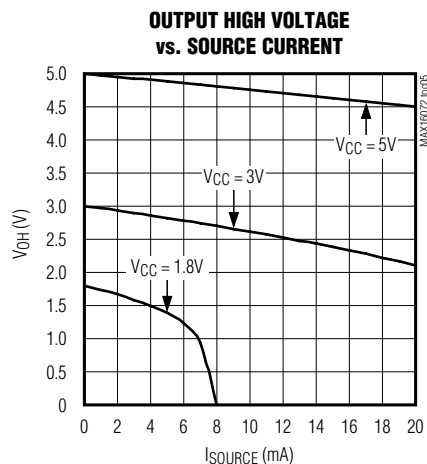
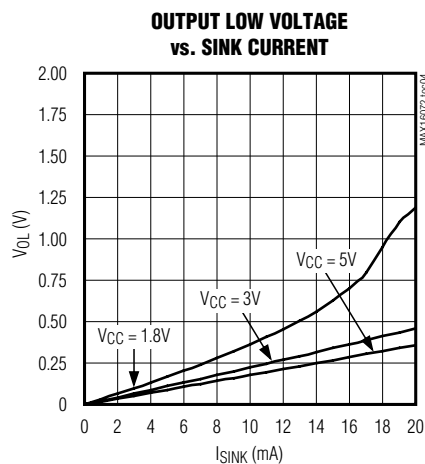


# MAX16072/MAX16073/MAX16074

## $\mu$ P Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### Typical Operating Characteristics (continued)

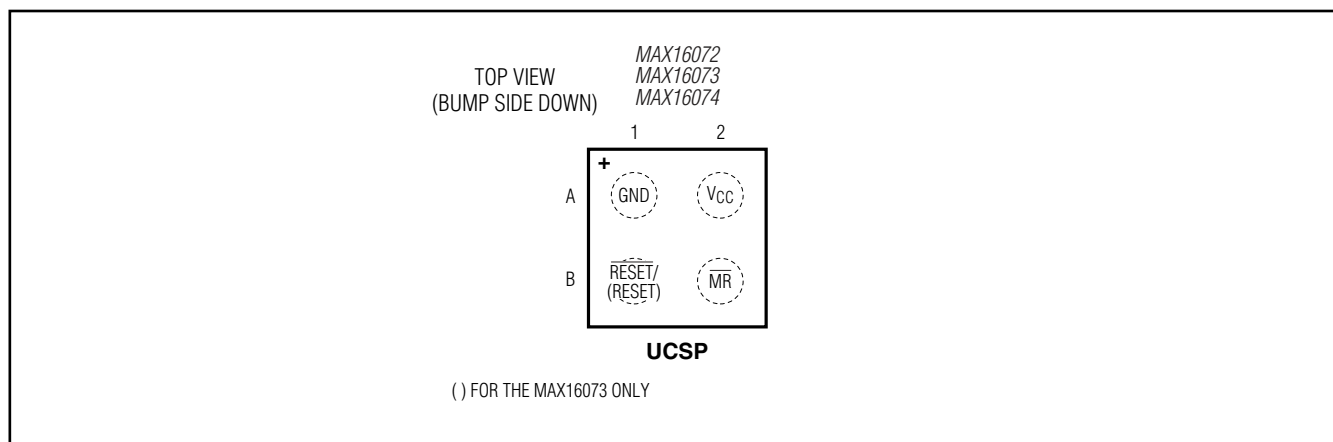
( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



# MAX16072/MAX16073/MAX16074

## $\mu$ P Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### Bump Configuration



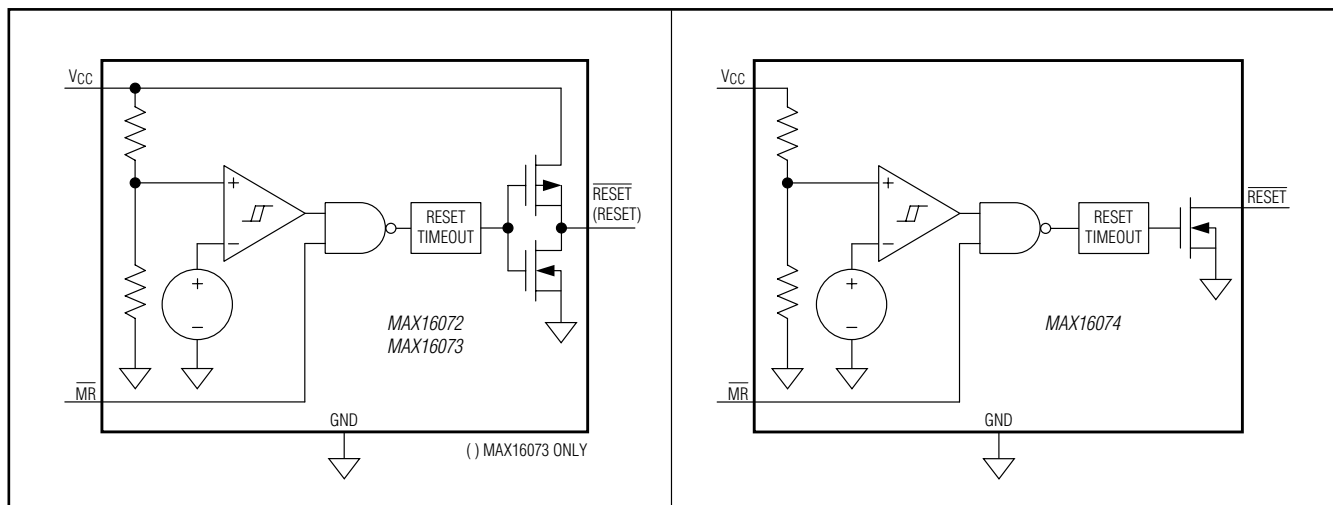
### Bump Description

| BUMP     |          |          | NAME                      | FUNCTION                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------|----------|----------|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| MAX16072 | MAX16073 | MAX16074 |                           |                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| A1       | A1       | A1       | GND                       | Ground                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| B1       | —        | —        | $\overline{\text{RESET}}$ | Active-Low Push-Pull Reset Output. $\overline{\text{RESET}}$ changes from high to low when $V_{CC}$ drops below the detector threshold ( $V_{TH}$ ) or $\overline{\text{MR}}$ is pulled low. $\overline{\text{RESET}}$ remains low for the reset timeout period after $V_{CC}$ exceeds $V_{TH}$ and $\overline{\text{MR}}$ is high. When $\overline{\text{MR}}$ is low, $\overline{\text{RESET}}$ is low.                              |
| —        | B1       | —        | RESET                     | Active-High Push-Pull Reset Output. $\overline{\text{RESET}}$ changes from low to high when $V_{CC}$ drops below the detector threshold ( $V_{TH}$ ) or $\overline{\text{MR}}$ is pulled low. $\overline{\text{RESET}}$ remains high for the reset timeout period after $V_{CC}$ exceeds $V_{TH}$ and $\overline{\text{MR}}$ is high. When $\overline{\text{MR}}$ is low, $\overline{\text{RESET}}$ is high.                           |
| —        | —        | B1       | $\overline{\text{RESET}}$ | Active-Low Open-Drain Reset Output. $\overline{\text{RESET}}$ changes from high-impedance to active-low when $V_{CC}$ drops below the detector threshold ( $V_{TH}$ ) or $\overline{\text{MR}}$ is pulled low. $\overline{\text{RESET}}$ remains low for the reset timeout period after $V_{CC}$ exceeds the reset threshold and $\overline{\text{MR}}$ is high. When $\overline{\text{MR}}$ is low, $\overline{\text{RESET}}$ is low. |
| A2       | A2       | A2       | $V_{CC}$                  | Supply Voltage and Input for the Reset Threshold Monitor                                                                                                                                                                                                                                                                                                                                                                               |
| B2       | B2       | B2       | $\overline{\text{MR}}$    | Active-Low Manual-Reset Input. Drive low to force a reset. Reset remains active as long as $\overline{\text{MR}}$ is low and for the reset timeout period (if applicable) after $\overline{\text{MR}}$ is driven high. $\overline{\text{MR}}$ has an internal pullup resistor connected to $V_{CC}$ , and may be left unconnected if not used.                                                                                         |

# MAX16072/MAX16073/MAX16074

## μP Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### Functional Diagrams



### Detailed Description

The MAX16072/MAX16073/MAX16074 ultra-small, ultra-low-power, μP supervisory circuits feature a precision band-gap reference, comparator, and internally trimmed resistors that set specified trip threshold voltages. Designed to monitor the system supply voltage and an output during power-up, power-down, and brownout conditions, these devices provide excellent circuit reliability and low cost by eliminating external components and adjustments when monitoring nominal system voltage from 1.8V to 3.6V.

The MAX16072 has a push-pull active-low reset output, the MAX16073 has a push-pull active-high reset output, and the MAX16074 has an open-drain active-low reset

output. The devices are designed to ignore fast transients on VCC. The devices also include a manual reset input (MR). When MR is low, reset is asserted. When MR is high and VCC is above the detector threshold (VTH), reset is not asserted.

### Supply and Monitored Input (VCC)

The MAX16072/MAX16073/MAX16074 operate with a VCC supply voltage from 1.2V to 5.5V. VCC has a rising threshold of VTH + VHYS and a falling threshold of VTH. When VCC rises above VTH + VHYS and MR is high, RESET goes high (RESET goes low) after the reset timeout period (tRP). See Figure 1.

When VCC falls below VTH, RESET goes low (RESET goes high) after a fixed delay (tRD).

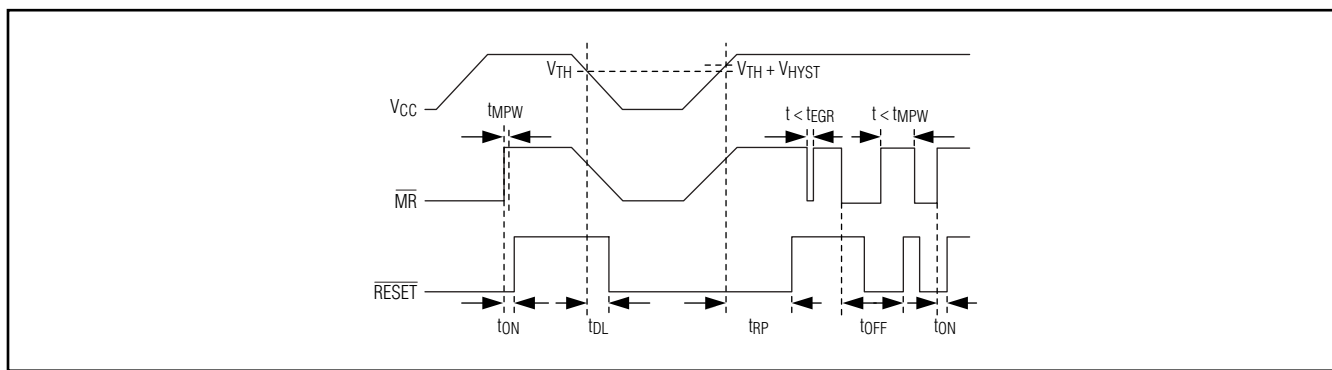


Figure 1. MAX16072/MAX16073/MAX16074 Timing Diagram

# MAX16072/MAX16073/MAX16074

## μP Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package

### Manual Reset Input ( $\overline{MR}$ )

Many μP-based products require manual-reset capability, allowing the operator, a test technician, or external logic circuit to initiate a reset. A logic-low on  $\overline{MR}$  asserts reset. Reset remains asserted while  $\overline{MR}$  is low, and for the reset active timeout period (tRP) or delay (tON) after  $\overline{MR}$  returns high. This input has an internal 50kΩ pullup resistor, so it can be left unconnected if it is not used.  $\overline{MR}$  can be driven with TTL or CMOS logic levels, or with open-drain/collector outputs. For manual operation, connect a normally open momentary switch from  $\overline{MR}$  to GND; external debouncing circuitry is not required. If  $\overline{MR}$  is driven from long cables or if the device is used in a noisy environment, connect a 0.1μF capacitor from  $\overline{MR}$  to ground to provide additional noise immunity.

### Applications Information

#### Interfacing to μP with Bidirectional Reset Pins

Since  $\overline{RESET}$  on the MAX16074 is open-drain, this device interfaces easily with μPs that have bidirectional reset pins. Connecting the μP supervisor's  $\overline{RESET}$  output directly to the μP's  $\overline{RESET}$  pin with a single pullup resistor allows either device to assert reset (Figure 2).

#### Negative-Going VCC Transients

The MAX16072/MAX16073/MAX16074 family of devices is relatively immune to short-duration, negative-going VCC transients (glitches). The *Typical Operating Characteristics* show the Maximum Transient Duration vs. Reset Threshold Overdrive graph, for which reset pulses are not generated. The graph shows the maximum pulse width that a negative-going VCC transient may typically have when issuing a reset signal. As the amplitude of the transient increases, the maximum allowable pulse width decreases.

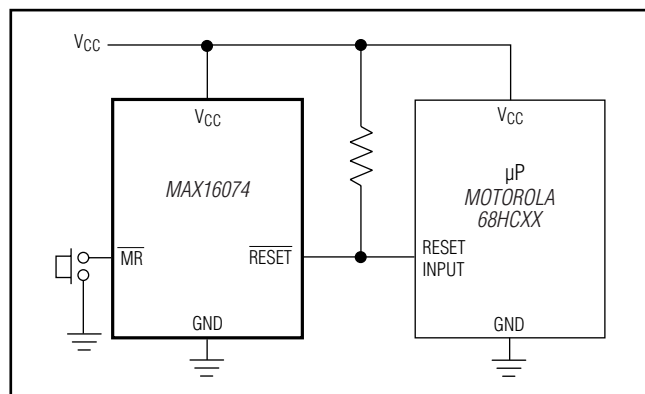


Figure 2. Interfacing to μP with Bidirectional Reset Pins

Table 1. Factory Trimmed Reset Thresholds

| THRESHOLD SUFFIX | RESET TRIP THRESHOLD (V) |                     |       |
|------------------|--------------------------|---------------------|-------|
|                  | TA = +25°C               | TA = -40°C to +85°C |       |
|                  | TYP                      | MIN                 | MAX   |
| 15               | 1.58                     | 1.54                | 1.61  |
| 16               | 1.63                     | 1.60                | 1.66  |
| 17               | 1.67                     | 1.62                | 1.71  |
| 18               | 1.80                     | 1.76                | 1.85  |
| 19               | 1.90                     | 1.85                | 1.95  |
| 20               | 2.00                     | 1.95                | 2.05  |
| 21               | 2.10                     | 2.05                | 2.15  |
| 22               | 2.20                     | 2.145               | 2.25  |
| 23               | 2.32                     | 2.262               | 2.375 |
| 24               | 2.40                     | 2.34                | 2.46  |
| 25               | 2.50                     | 2.437               | 2.562 |
| 26               | 2.63                     | 2.564               | 2.69  |
| 27               | 2.70                     | 2.633               | 2.768 |
| 28               | 2.80                     | 2.63                | 2.87  |
| 29               | 2.93                     | 2.857               | 3.0   |
| 30               | 3.00                     | 2.925               | 3.075 |
| 31               | 3.08                     | 3.003               | 3.15  |

Table 2. Reset Timeout Periods

| RESET TIMEOUT PERIODS |     |     |     |       |
|-----------------------|-----|-----|-----|-------|
| SUFFIX                | MIN | TYP | MAX | UNITS |
| 0                     | 20  | 80  | 120 | μs    |
| 1                     | 8   | 13  | 17  | ms    |
| 2                     | 34  | 52  | 69  | ms    |
| 3                     | 140 | 210 | 280 | ms    |

# **MAX16072/MAX16073/MAX16074**

## **μP Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package**

### **Chip Information**

PROCESS: BiCMOS

### **Package Information**

For the latest package outline information and land patterns, go to [www.maximintegrated.com/packages](http://www.maximintegrated.com/packages). Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

| PACKAGE TYPE | PACKAGE CODE | DOCUMENT NO.            |
|--------------|--------------|-------------------------|
| 4 UCSP       | R41C1-1      | <a href="#">21-0242</a> |

# **MAX16072/MAX16073/MAX16074**

## **μP Supervisory Circuits in 4-Bump (1mm x 1mm) Chip-Scale Package**

### **Revision History**

| REVISION<br>NUMBER | REVISION<br>DATE | DESCRIPTION                                            | PAGES<br>CHANGED |
|--------------------|------------------|--------------------------------------------------------|------------------|
| 0                  | 1/10             | Initial release                                        | —                |
| 1                  | 3/15             | Changed upper $V_{CC}$ supply range from 2.75V to 5.5V | 2, 3, 6          |



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