



ADM8690/ADM8691/ADM8695

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REVISION HISTORY

12/11—Rev. B to Rev. C

| | |
|---|------------|
| Deleted ADM8692 and ADM8693 | Throughout |
| Changes to Table 4..... | 7 |
| Change to Power-Fail RESET Output Section..... | 11 |
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6/11—Rev. A to Rev. B

| | |
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| Updated Figure 11, Figure 12, and Figure 13..... | 9 |
| Updated Outline Dimensions | 18 |

9/06—Rev. 0 to Rev. A

| | |
|--|-----------|
| Updated Format..... | Universal |
| Changes to Absolute Maximum Ratings..... | 6 |
| Updated Ordering Guide | 20 |

2/97—Revision 0: Initial Version

GENERAL DESCRIPTION

The [ADM8690/ADM8691/ADM8695](#) supervisory circuits offer complete single-chip solutions for power supply monitoring and battery control functions in microprocessor systems. These functions include microprocessor reset, backup battery switchover, watchdog timer, CMOS RAM write protection, and power failure warning. The complete family provides a variety of configurations to satisfy most microprocessor system requirements.

The [ADM8690/ADM8691/ADM8695](#) are fabricated using an advanced epitaxial CMOS process that combines low power consumption (0.7 mW), extremely fast chip enable gating (3 ns), and high reliability. RESET assertion is guaranteed with V_{CC} as low as 1 V. In addition, the power switching circuitry is designed for minimal voltage drop, thereby permitting increased output current drive of up to 100 mA without the need for an external pass transistor.

See Table 1 for a product selection guide listing the characteristics of each device. To place an order, see the Ordering Guide.

Table 1. Product Selection Guide

| Part No. | Nominal Reset Time | Nominal V_{CC} Reset Threshold | Nominal Watchdog Timeout Period | Battery Backup Switching | Base Drive, Ext PNP | Chip Enable Signals |
|-------------------------|--------------------|----------------------------------|---------------------------------|--------------------------|---------------------|---------------------|
| ADM8690 | 50 ms | 4.65 V | 1.6 sec | Yes | No | No |
| ADM8691 | 50 ms or ADJ | 4.65 V | 100 ms, 1.6 sec, ADJ | Yes | Yes | Yes |
| ADM8695 | 200 ms or ADJ | 4.65 V | 100 ms, 1.6 sec, ADJ | Yes | Yes | Yes |

SPECIFICATIONS

V_{CC} = full operating range, $V_{BATT} = 2.8\text{ V}$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted.

Table 2.

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|---|--------------------|--------------------|-------|---------------|---|
| BATTERY BACKUP SWITCHING | | | | | |
| V_{CC} Operating Voltage Range | 4.75 | | 5.5 | V | |
| V_{BATT} Operating Voltage Range | 2.0 | | 4.25 | V | |
| V_{OUT} Output Voltage | $V_{CC} - 0.005$ | $V_{CC} - 0.0025$ | | V | $I_{OUT} = 1\text{ mA}$ |
| | $V_{CC} - 0.2$ | $V_{CC} - 0.125$ | | V | $I_{OUT} \leq 100\text{ mA}$ |
| V_{OUT} in Battery Backup Mode | $V_{BATT} - 0.005$ | $V_{BATT} - 0.002$ | | V | $I_{OUT} = 250\text{ }\mu\text{A}$, $V_{CC} < V_{BATT} - 0.2\text{ V}$ |
| Supply Current (Excludes I_{OUT}) | | 140 | 200 | μA | $I_{OUT} = 100\text{ }\mu\text{A}$ |
| Supply Current in Battery Backup Mode | | 0.4 | 1 | μA | $V_{CC} = 0\text{ V}$, $V_{BATT} = 2.8\text{ V}$ |
| Battery Standby Current | | | | | $5.5\text{ V} > V_{CC} > V_{BATT} + 0.2\text{ V}$ |
| + = Discharge, - = Charge | -0.1 | | +0.02 | μA | $T_A = 25^\circ\text{C}$ |
| Battery Switchover Threshold | | 70 | | mV | Power-up |
| $V_{CC} - V_{BATT}$ | | 50 | | mV | Power-down |
| Battery Switchover Hysteresis | | 20 | | mV | |
| BATT ON Output Voltage | | | 0.3 | V | $I_{SINK} = 3.2\text{ mA}$ |
| BATT ON Output Short-Circuit Current | | 55 | | mA | BATT ON = $V_{OUT} = 4.5\text{ V}$, sink current |
| | 0.5 | 2.5 | 25 | μA | BATT ON = 0 V , source current |
| RESET AND WATCHDOG TIMER | | | | | |
| Reset Voltage Threshold | 4.5 | 4.65 | 4.73 | V | |
| Reset Threshold Hysteresis | | 40 | | mV | |
| Reset Timeout Delay | | | | | |
| ADM8690 and ADM8691 | 35 | 50 | 70 | ms | OSC SEL = high |
| ADM8695 | 140 | 200 | 280 | ms | OSC SEL = high |
| Watchdog Timeout Period, Internal Oscillator | 1.0 | 1.6 | 2.25 | Seconds | Long period |
| | 70 | 100 | 140 | ms | Short period |
| Watchdog Timeout Period, External Clock | 3840 | 4064 | 4097 | Cycles | Long period |
| | 768 | 1011 | 1025 | Cycles | Short period |
| Minimum WDI Input Pulse Width | 50 | | | ns | $V_{IL} = 0.4\text{ V}$, $V_{IH} = 3.5\text{ V}$ |
| $\overline{\text{RESET}}$ Output Voltage at $V_{CC} = 1\text{ V}$ | | 4 | 20 | mV | $I_{SINK} = 10\text{ }\mu\text{A}$, $V_{CC} = 1\text{ V}$ |
| $\overline{\text{RESET}}$, LOW LINE Output Voltage | | 0.05 | 0.4 | V | $I_{SINK} = 1.6\text{ mA}$, $V_{CC} = 4.25\text{ V}$ |
| | 3.5 | | | V | $I_{SOURCE} = 1\text{ }\mu\text{A}$ |
| $\overline{\text{RESET}}$, WDO Output Voltage | | | 0.4 | V | $I_{SINK} = 1.6\text{ mA}$ |
| | 3.5 | | | V | $I_{SOURCE} = 1\text{ }\mu\text{A}$ |
| Output Short-Circuit Source Current | 1 | 10 | 25 | μA | |
| Output Short-Circuit Sink Current | | 25 | | mA | |
| WDI Input Threshold ¹ | | | | | |
| Logic Low | | | 0.8 | V | |
| Logic High | 3.5 | | | V | |
| WDI Input Current | | 1 | 10 | μA | $\text{WDI} = V_{OUT}$ |
| | -10 | -1 | | μA | $\text{WDI} = 0\text{ V}$ |
| POWER-FAIL DETECTOR | | | | | |
| PFI Input Threshold | 1.25 | 1.3 | 1.35 | V | $V_{CC} = 5\text{ V}$ |
| PFI Input Current | -25 | ± 0.01 | +25 | nA | |
| $\overline{\text{PFO}}$ Output Voltage | | | 0.4 | V | $I_{SINK} = 3.2\text{ mA}$ |
| | 3.5 | | | V | $I_{SOURCE} = 1\text{ }\mu\text{A}$ |
| $\overline{\text{PFO}}$ Short-Circuit Source Current | 1 | 3 | 25 | μA | $\text{PFI} = \text{low}$, $\overline{\text{PFO}} = 0\text{ V}$ |
| $\overline{\text{PFO}}$ Short-Circuit Sink Current | | 25 | | mA | $\text{PFI} = \text{high}$, $\overline{\text{PFO}} = V_{OUT}$ |

| Parameter | Min | Typ | Max | Unit | Test Conditions/Comments |
|--|-------------------------|---------|-----|---------------|--|
| CHIP ENABLE GATING | | | | | |
| $\overline{\text{CE}}_{\text{IN}}$ Threshold | 3.0 | | 0.8 | V | V_{IL} |
| $\overline{\text{CE}}_{\text{IN}}$ Pull-Up Current | | 3 | | μA | V_{IH} |
| $\overline{\text{CE}}_{\text{OUT}}$ Output Voltage | | | 0.4 | V | $I_{\text{SINK}} = 3.2 \text{ mA}$ |
| | $V_{\text{OUT}} - 1.5$ | | | V | $I_{\text{SOURCE}} = 3.0 \text{ mA}$ |
| | $V_{\text{OUT}} - 0.05$ | | | V | $I_{\text{SOURCE}} = 1 \mu\text{A}, V_{\text{CC}} = 0 \text{ V}$ |
| $\overline{\text{CE}}$ Propagation Delay | | 3 | 7 | ns | |
| OSCILLATOR | | | | | |
| OSC IN Input Current | | ± 2 | | μA | |
| OSC SEL Input Pull-Up Current | | 5 | | μA | |
| OSC IN Frequency Range | 0 | | 500 | kHz | OSC SEL = 0 V |
| OSC IN Frequency with External Capacitor | | 4 | | kHz | OSC SEL = 0 V, $C_{\text{OSC}} = 47 \text{ pF}$ |

¹ WDI is a three-level input that is internally biased to 38% of V_{CC} and has an input impedance of approximately 5 M Ω .

ABSOLUTE MAXIMUM RATINGS

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

Table 3.

| Parameter | Rating |
|--------------------------------------|---|
| V_{CC} | $-0.3\text{ V to }+6\text{ V}$ |
| V_{BATT} | $-0.3\text{ V to }+6\text{ V}$ |
| All Other Inputs | $-0.3\text{ V to }V_{OUT} + 0.5\text{ V}$ |
| Input Current | |
| V_{CC} | 200 mA |
| V_{BATT} | 50 mA |
| GND | 20 mA |
| Digital Output Current | 20 mA |
| Power Dissipation, 8-Lead PDIP | 400 mW |
| θ_{JA} Thermal Impedance | 120°C/W |
| Power Dissipation, 8-Lead SOIC | 400 mW |
| θ_{JA} Thermal Impedance | 120°C/W |
| Power Dissipation, 16-Lead PDIP | 600 mW |
| θ_{JA} Thermal Impedance | 135°C/W |
| Power Dissipation, 16-Lead TSSOP | 600 mW |
| θ_{JA} Thermal Impedance | 158°C/W |
| Power Dissipation, 16-Lead SOIC_N | 600 mW |
| θ_{JA} Thermal Impedance | 110°C/W |
| Power Dissipation, 16-Lead SOIC_W | 600 mW |
| θ_{JA} Thermal Impedance | 73°C/W |
| Operating Temperature Range | |
| Industrial (A Version) | $-40^\circ\text{C to }+85^\circ\text{C}$ |
| Lead Temperature (Soldering, 10 sec) | 300°C |
| Storage Temperature Range | $-65^\circ\text{C to }+150^\circ\text{C}$ |

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

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

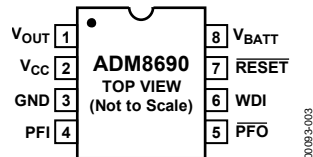


Figure 3. ADM8690 Pin Configuration, 8-Lead PDIP and 8-Lead SOIC_N

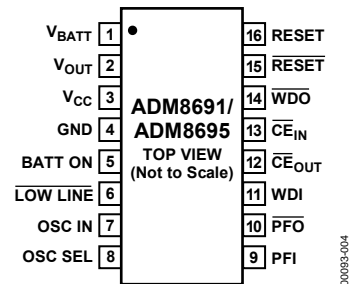


Figure 4. ADM8691/ADM8695 Pin Configuration, 16-Lead PDIP, 16-Lead SOIC_N, 16-Lead SOIC_W, and 16-Lead TSSOP

Table 4. Pin Function Descriptions

| Pin No. | | Mnemonic | Description |
|---------|---------|----------|---|
| 8-Lead | 16-Lead | | |
| 8 | 1 | VBATT | Backup Battery Input. VBATT or VCC is internally switched to VOUT, depending on which is at the highest potential. |
| 1 | 2 | VOUT | Output Voltage. VCC or VBATT is internally switched to VOUT, depending on which is at the highest potential. VOUT can supply up to 100 mA to power CMOS RAM. Connect VOUT to VCC if VOUT and VBATT are not used. |
| 2 | 3 | VCC | Power Supply Input. 5 V nominal. VCC or VBATT is internally switched to VOUT, depending on which is at the highest potential. |
| 3 | 4 | GND | Ground. This is the 0 V ground reference for all signals. |
| N/A | 5 | BATT ON | Logic Output. BATT ON goes high when VOUT is internally switched to the VBATT input. It goes low when VOUT is internally switched to VCC. The output typically sinks 35 mA and can directly drive the base of an external PNP transistor to increase the output current above the 100 mA rating of VOUT. |
| N/A | 6 | LOW LINE | Logic Output. LOW LINE goes low when VCC falls below the reset threshold. It returns high as soon as VCC rises above the reset threshold. |
| N/A | 7 | OSC IN | Oscillator Logic Input. When OSC SEL is low, OSC IN can be driven by an external clock signal, or an external capacitor can be connected between OSC IN and GND. This sets both the reset active pulse timing and the watchdog timeout period (see Table 5 and Figure 17 through Figure 20). When OSC SEL is high or floating, the internal oscillator is enabled and the reset active time is fixed at 50 ms typical (ADM8691) or 200 ms typical (ADM8695). In this mode, the OSC IN pin selects either the fast (100 ms) or slow (1.6 sec) watchdog timeout period. In both modes, the timeout period immediately after a reset is 1.6 sec typical. |
| N/A | 8 | OSC SEL | Logic Oscillator Select Input. When OSC SEL is unconnected (floating) or driven high, the internal oscillator sets the reset active time and watchdog timeout period. When OSC SEL is low, the external oscillator input, OSC IN, is enabled (see Table 5). OSC SEL has a 5 μ A internal pull-up. |
| 4 | 9 | PFI | Power-Fail Input. PFI is the noninverting input to the power-fail comparator. When PFI is less than 1.3 V, PFO goes low. Connect PFI to GND or VOUT when not used. |
| 5 | 10 | PFO | Power-Fail Output. PFO is the output of the power-fail comparator. It goes low when PFI is less than 1.3 V. The comparator is turned off and PFO goes low when VCC is below VBATT. |
| 6 | 11 | WDI | Watchdog Input. WDI is a three-level input. If WDI remains either high or low for longer than the watchdog timeout period, RESET pulses low and WDO goes low. The timer is reset with each transition on the WDI line. The watchdog timer can be disabled if WDI is left floating or is driven to midsupply. |
| N/A | 12 | CEOUT | Logic Output. CEOUT is a gated version of the CEIN signal. CEOUT tracks CEIN when VCC is above the reset threshold. If VCC is below the reset threshold, CEOUT is forced high. See Figure 21 and Figure 22. |
| N/A | 13 | CEIN | Logic Input. Input to the CE gating circuit. When not in use, connect this pin to GND or VOUT. |
| N/A | 14 | WDO | Logic Output. The watchdog output, WDO, goes low if WDI remains either high or low for longer than the watchdog timeout period. WDO is set high by the next transition at WDI. If WDI is unconnected or at midsupply, the watchdog timer is disabled and WDO remains high. WDO also goes high when LOW LINE goes low. |

| Pin No. | | Mnemonic | Description |
|---------|---------|---------------------------|--|
| 8-Lead | 16-Lead | | |
| 7 | 15 | $\overline{\text{RESET}}$ | Logic Output. $\overline{\text{RESET}}$ goes low if V_{CC} falls below the reset threshold or if the watchdog timer is not serviced within its timeout period. The reset threshold is typically 4.65 V. $\overline{\text{RESET}}$ remains low for 50 ms (ADM8690/ADM8691) or 200 ms (ADM8695) after V_{CC} returns above the threshold. $\overline{\text{RESET}}$ also goes low for 50 ms (ADM8690/ADM8691) or 200 ms (ADM8695) if the watchdog timer is enabled but not serviced within its timeout period. The $\overline{\text{RESET}}$ pulse width can be adjusted on the ADM8691/ADM8695, as shown in Table 5. The $\overline{\text{RESET}}$ output has an internal 3 μA pull-up and can either connect to an open-collector reset bus or directly drive a CMOS gate without an external pull-up resistor. |
| N/A | 16 | RESET | Logic Output. RESET is an active high output. It is the inverse of $\overline{\text{RESET}}$. |

TYPICAL PERFORMANCE CHARACTERISTICS

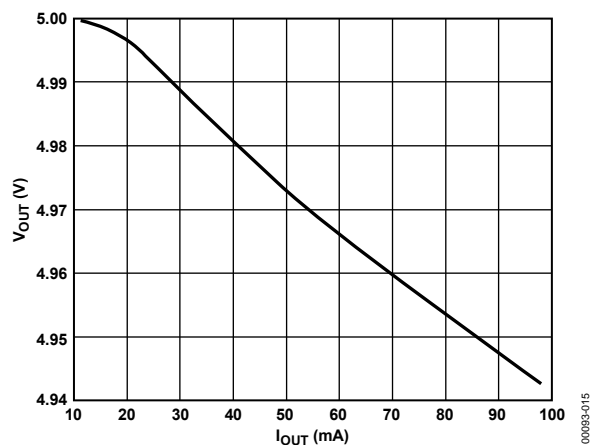
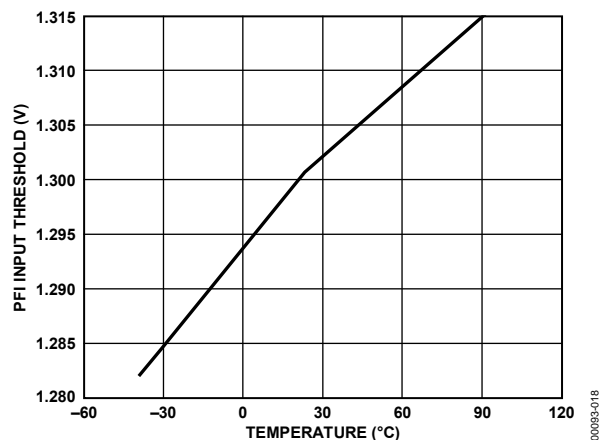
Figure 5. V_{OUT} vs. I_{OUT} , Normal Operation

Figure 8. PFI Input Threshold vs. Temperature

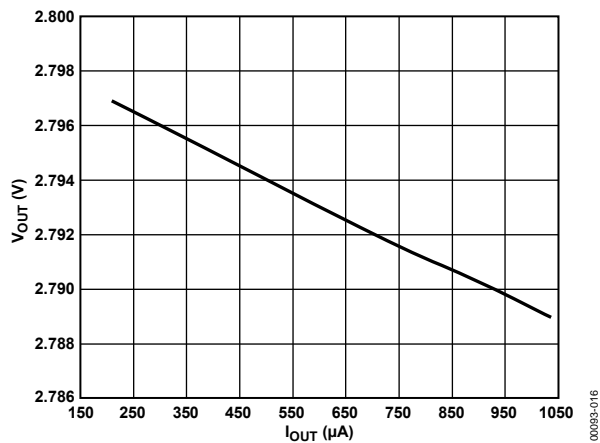
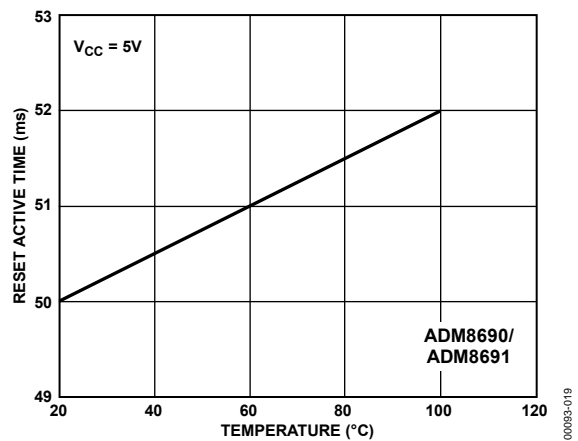
Figure 6. V_{OUT} vs. I_{OUT} , Battery Backup

Figure 9. Reset Active Time vs. Temperature

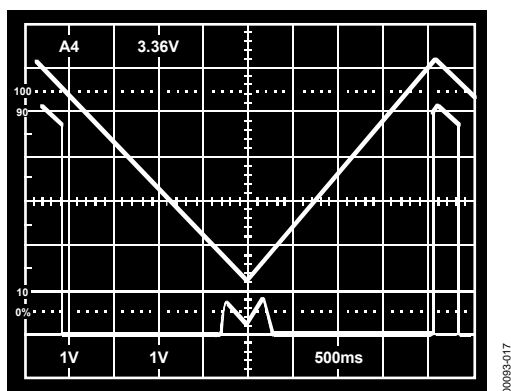


Figure 7. Reset Output Voltage vs. Supply Voltage

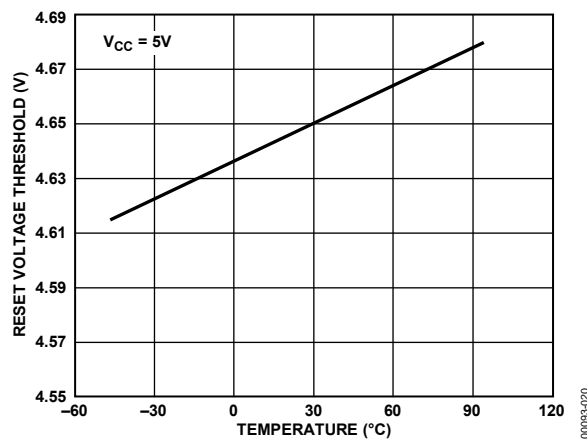


Figure 10. Reset Voltage Threshold vs. Temperature

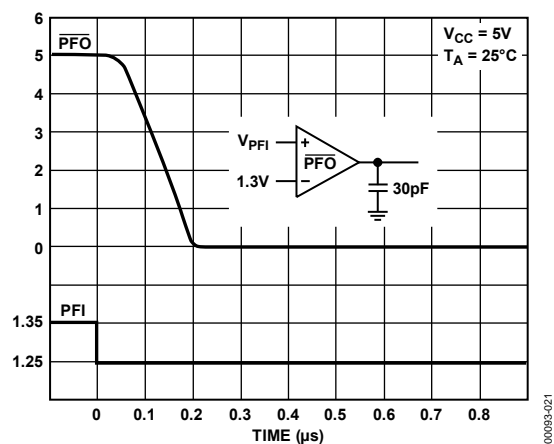


Figure 11. Power-Fail Comparator Response Time, Falling

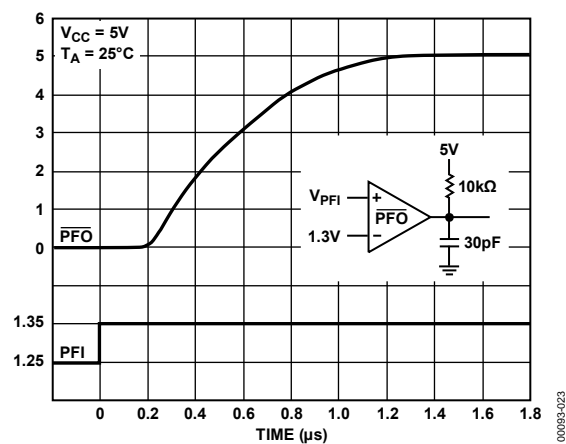


Figure 13. Power-Fail Comparator Response Time with Pull-Up Resistor

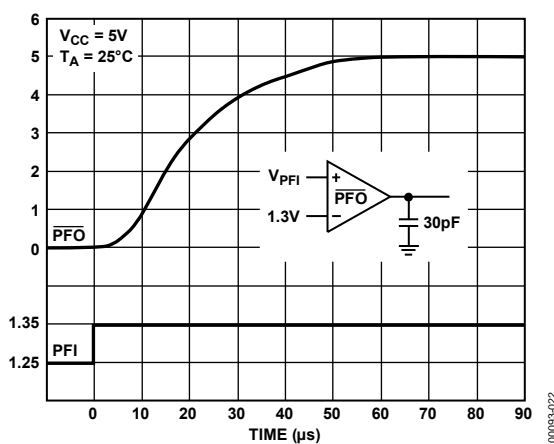


Figure 12. Power-Fail Comparator Response Time, Rising

CIRCUIT INFORMATION

BATTERY SWITCHOVER SECTION

The battery switchover circuit compares V_{CC} to the V_{BATT} input and connects V_{OUT} to whichever is higher. Switchover occurs when V_{CC} is 50 mV higher than V_{BATT} as V_{CC} falls, and when V_{CC} is 70 mV greater than V_{BATT} as V_{CC} rises. This 20 mV hysteresis prevents repeated rapid switching if V_{CC} falls very slowly or remains nearly equal to the battery voltage.

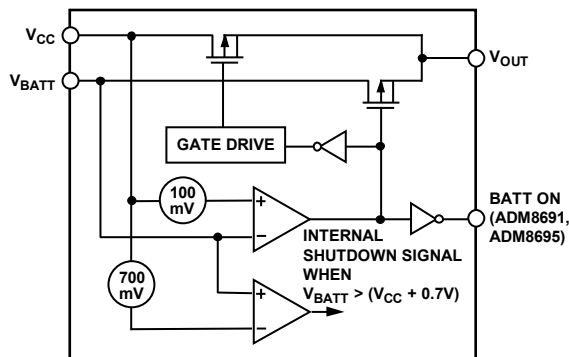


Figure 14. Battery Switchover Schematic

During normal operation, with V_{CC} higher than V_{BATT} , V_{CC} is internally switched to V_{OUT} through an internal PMOS transistor switch. This switch has a typical on resistance of $0.7\ \Omega$ and can supply up to 100 mA at the V_{OUT} terminal. V_{OUT} is normally used to drive a RAM memory bank, requiring instantaneous currents of greater than 100 mA. If this is the case, a bypass capacitor should be connected to V_{OUT} . The capacitor provides the peak current transients to the RAM. A capacitance value of $0.1\ \mu\text{F}$ or greater can be used.

If the continuous output current requirements at V_{OUT} exceed 100 mA or if a lower $V_{CC} - V_{OUT}$ voltage differential is desired, an external PNP pass transistor can be connected in parallel with the internal transistor. The BATT ON output (ADM8691/ADM8695) can directly drive the base of the external transistor (see Figure 24).

A $7\ \Omega$ MOSFET switch connects the V_{BATT} input to V_{OUT} during battery backup. This MOSFET has very low input-to-output differential (dropout voltage) at the low current levels required for battery backup of CMOS RAM or other low power CMOS circuitry. The supply current in battery backup is typically $0.4\ \mu\text{A}$.

The ADM8690/ADM8691/ADM8695 operate with battery voltages from 2.0 V to 4.25 V. High value capacitors, either standard electrolytic or the farad-size, double-layer capacitors, can also be used for short-term memory backup. A small charging current of typically 10 nA ($0.1\ \mu\text{A}$ maximum) flows out of the V_{BATT} terminal. This current is useful for maintaining rechargeable batteries in a fully charged condition. This extends the life of the backup battery by compensating for its self-discharge current. Also note that this current poses no problem when lithium batteries are used for backup because the maximum charging current ($0.1\ \mu\text{A}$) is safe for even the smallest lithium cells.

If the battery switchover section is not used, V_{BATT} should be connected to GND and V_{OUT} should be connected to V_{CC} .

POWER-FAIL RESET OUTPUT

RESET is an active low output that provides a RESET signal to the microprocessor whenever V_{CC} is at an invalid level. When V_{CC} falls below the reset threshold, the RESET output is forced low. The nominal reset voltage threshold is 4.65 V.

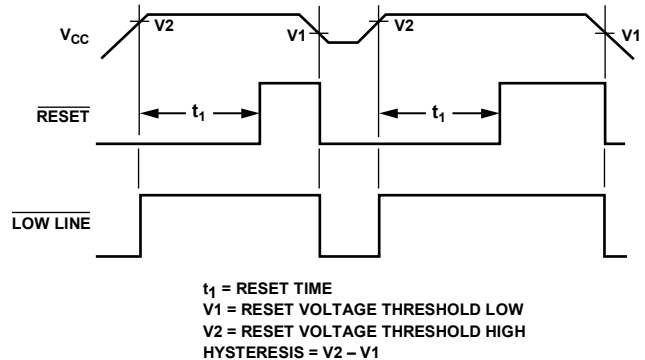


Figure 15. Power-Fail Reset Timing

On power-up, RESET remains low for 50 ms (200 ms for the ADM8695) after V_{CC} rises above the appropriate reset threshold. This allows time for the power supply and microprocessor to stabilize. On power-down, the RESET output remains low with V_{CC} as low as 1 V. This ensures that the microprocessor is held in a stable shutdown condition.

The RESET active time is adjustable on the ADM8691/ADM8695 by using an external oscillator or by connecting an external capacitor to the OSC IN pin. See Table 5 and Figure 17 through Figure 20.

The guaranteed minimum and maximum reset thresholds for the ADM8690/ADM8691/ADM8695 are 4.5 V and 4.73 V. The ADM8690/ADM8691/ADM8695 are, therefore, compatible with 5 V supplies with a +10%, -5% tolerance. The reset threshold comparator typically has 40 mV of hysteresis. The response time of the reset voltage comparator is less than $1\ \mu\text{s}$. If glitches are present on the V_{CC} line that could cause spurious reset pulses, V_{CC} should be decoupled close to the device.

In addition to RESET, the ADM8691/ADM8695 provide an active high RESET output. This output is the complement of RESET and is intended for processors that require an active high reset signal.

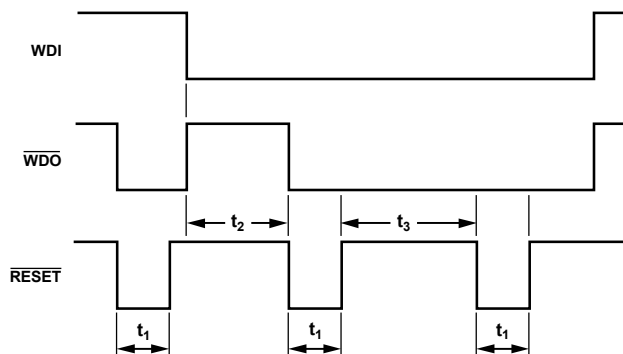
WATCHDOG TIMER RESET

The watchdog timer circuit monitors the activity of the microprocessor to check that it is not stalled in an indefinite loop. An output line on the processor is used to toggle the watchdog input (WDI) line. If this line is not toggled within the selected timeout period, a $\overline{\text{RESET}}$ pulse is generated.

The nominal watchdog timeout period is preset at 1.6 sec on the ADM8690. The ADM8691/ADM8695 can be configured for a fixed timeout period—short (100 ms) or long (1.6 sec)—or for an adjustable timeout period. Some systems are unable to service the watchdog timer immediately after a reset; in this case, if the short period is selected for the ADM8691/ADM8695, the device automatically selects the long timeout period directly after a reset is issued. The watchdog timer is restarted at the end of a reset, regardless of whether the reset was caused by lack of activity on WDI or by V_{CC} falling below the reset threshold.

The normal (short) timeout period becomes effective following the first transition of WDI after $\overline{\text{RESET}}$ has gone inactive. The watchdog timeout period restarts with each transition on the WDI pin. To ensure that the watchdog timer does not time out, either a high-to-low or low-to-high transition on the WDI pin must occur by the end of the minimum timeout period. If WDI remains permanently high or low, reset pulses are issued after each long (1.6 sec) timeout period. The watchdog monitor can be deactivated by allowing the watchdog input (WDI) to float or by connecting it to midsupply.

On the ADM8690 the watchdog timeout period is fixed at 1.6 sec, and the reset pulse width is fixed at 50 ms. The ADM8691/ADM8695 allow these times to be adjusted, as shown in Table 5. Figure 17, Figure 18, Figure 19, and Figure 20 show the various oscillator configurations that can be used to adjust the reset pulse width and watchdog timeout period.



t_1 = RESET TIME
 t_2 = NORMAL (SHORT) WATCHDOG TIMEOUT PERIOD
 t_3 = WATCHDOG TIMEOUT PERIOD IMMEDIATELY FOLLOWING A RESET

Figure 16. Watchdog Timeout Period and Reset Active Time

The internal oscillator is enabled when OSC SEL is high or floating. In this mode, OSC IN selects either the 1.6 sec watchdog timeout period or the 100 ms watchdog timeout period. When OSC IN is connected high or left floating, the 1.6 sec timeout period is selected; when OSC IN is connected low, the 100 ms timeout period is selected. In either case, the timeout period is 1.6 sec immediately after a reset. This gives the microprocessor time to reinitialize the system. If OSC IN is low, the 100 ms watchdog timeout period becomes effective after the first transition of WDI. The software should be written such that the input/output port driving WDI is left in its power-up reset state until the initialization routines are completed and the microprocessor is able to toggle WDI at the minimum watchdog timeout period of 70 ms.

Table 5. ADM8691 and ADM8695 Reset Pulse Width and Watchdog Timeout Selections

| OSC SEL | OSC IN | Watchdog Timeout Period | | Reset Active Period | |
|------------------|----------------------|---|--|---|---|
| | | Normal | Immediately After Reset | ADM8691 | ADM8695 |
| Low ¹ | External clock input | 1024 CLKs | 4096 CLKs | 512 CLKs | 2048 CLKs |
| Low ¹ | External capacitor | $400 \text{ ms} \times C/47 \text{ pF}$ | $1.6 \text{ sec} \times C/47 \text{ pF}$ | $200 \text{ ms} \times C/47 \text{ pF}$ | $520 \text{ ms} \times C/47 \text{ pF}$ |
| Floating or high | Low | 100 ms | 1.6 sec | 50 ms | 200 ms |
| Floating or high | Floating or high | 1.6 sec | 1.6 sec | 50 ms | 200 ms |

¹ When the OSC SEL pin is low, OSC IN can be driven by an external clock signal, or an external capacitor (C) can be connected between OSC IN and GND. The nominal internal oscillator frequency is 10.24 kHz. The nominal oscillator frequency with an external capacitor is $f_{osc} \text{ (Hz)} = 184,000/C \text{ (pF)}$.

WATCHDOG OUTPUT ($\overline{\text{WDO}}$) (ADM8691/ADM8695)

The watchdog output ($\overline{\text{WDO}}$ pin on the ADM8691/ADM8695) provides a status output that goes low if the watchdog timer times out and remains low until set high by the next transition on the watchdog input. $\overline{\text{WDO}}$ is also set high when V_{CC} goes below the reset threshold.

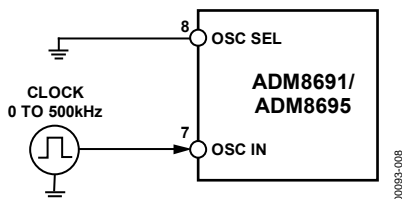


Figure 17. External Clock Source

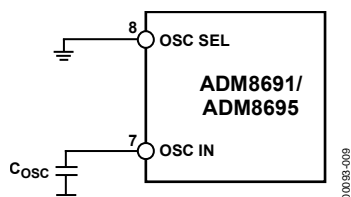


Figure 18. External Capacitor

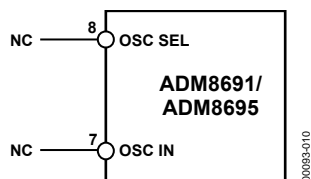


Figure 19. Internal Oscillator (1.6 Second Watchdog)

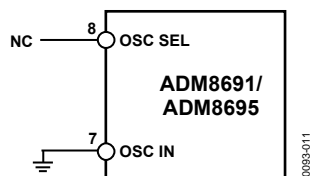


Figure 20. Internal Oscillator (100 ms Watchdog)

 $\overline{\text{CE}}$ GATING AND RAM WRITE PROTECTION (ADM8691/ADM8695)

The ADM8691/ADM8695 include memory protection circuitry that ensures the integrity of data in memory by preventing write operations when V_{CC} is at an invalid level. Two additional pins ($\overline{\text{CE}}_{IN}$ and $\overline{\text{CE}}_{OUT}$) can be used to control the chip enable or write inputs of CMOS RAM. When V_{CC} is present, $\overline{\text{CE}}_{OUT}$ is a buffered replica of $\overline{\text{CE}}_{IN}$, with a 3 ns propagation delay. When V_{CC} falls below the reset voltage threshold or V_{BATT} , an internal gate forces $\overline{\text{CE}}_{OUT}$ high, independent of $\overline{\text{CE}}_{IN}$.

$\overline{\text{CE}}_{OUT}$ typically drives the $\overline{\text{CE}}$, $\overline{\text{CS}}$, or write input of battery backed-up CMOS RAM. This ensures the integrity of the data in memory by preventing write operations when V_{CC} is at an invalid level. Similar protection of EEPROMs can be achieved using the $\overline{\text{CE}}_{OUT}$ pin to drive the store or write inputs.

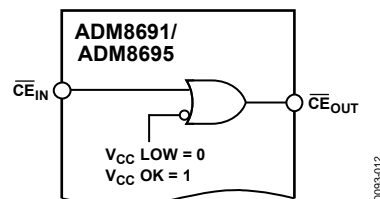
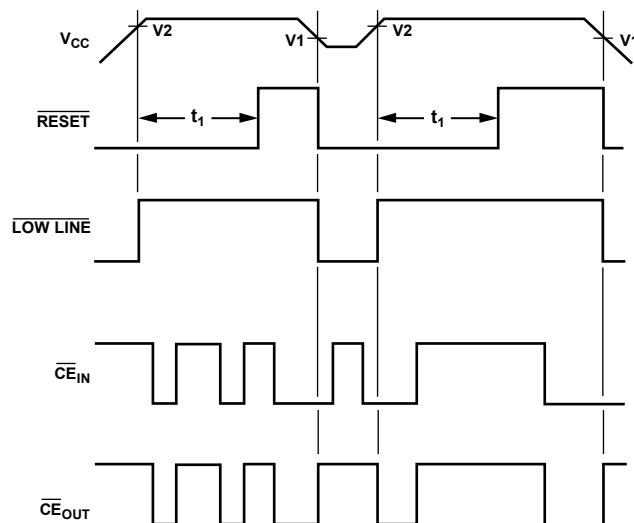


Figure 21. Chip Enable Gating



t_1 = RESET TIME
 V_1 = RESET VOLTAGE THRESHOLD LOW
 V_2 = RESET VOLTAGE THRESHOLD HIGH
 HYSTERESIS = $V_2 - V_1$

Figure 22. Chip Enable Timing

POWER-FAIL WARNING COMPARATOR

An additional comparator is provided for early warning of failure in the microprocessor power supply. The power-fail input (PFI) is compared to an internal 1.3 V reference. The power-fail output (PFO) goes low when the voltage at PFI is less than 1.3 V.

Typically, PFI is driven by an external voltage divider that senses either the unregulated dc input to the system 5 V regulator or the regulated 5 V output. The voltage divider ratio can be chosen such that the voltage at PFI falls below 1.3 V several milliseconds before the 5 V power supply falls below the reset threshold.

$\overline{\text{PFO}}$ is normally used to interrupt the microprocessor so that data can be stored in RAM and the shutdown procedure executed before power is lost.

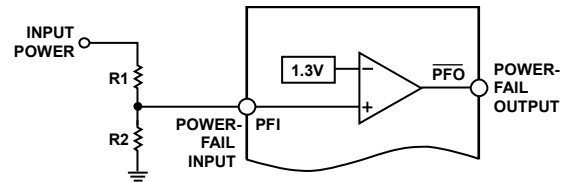


Figure 23. Power-Fail Comparator

Table 6. Input and Output Status in Battery Backup Mode

| Signal | Status |
|-------------------------------------|--|
| V_{OUT} | V_{OUT} is connected to V_{BATT} via an internal PMOS switch. |
| $\overline{\text{RESET}}$ | Logic low. |
| RESET | Logic high. The open circuit output voltage is equal to V_{OUT} . |
| $\overline{\text{LOW LINE}}$ | Logic low. |
| BATT ON | Logic high. The open circuit voltage is equal to V_{OUT} . |
| WDI | WDI is ignored. It is internally disconnected from its internal pull-up resistor and does not source or sink current as long as its input voltage is between GND and V_{OUT} . The input voltage does not affect supply current. |
| $\overline{\text{WDO}}$ | Logic high. The open circuit voltage is equal to V_{OUT} . |
| PFI | The power-fail comparator is turned off and has no effect on the power-fail output. |
| $\overline{\text{PFO}}$ | Logic low. |
| $\overline{\text{CE}}_{\text{IN}}$ | $\overline{\text{CE}}_{\text{IN}}$ is ignored. It is internally disconnected from its internal pull-up resistor and does not source or sink current as long as its input voltage is between GND and V_{OUT} . The input voltage does not affect supply current. |
| $\overline{\text{CE}}_{\text{OUT}}$ | Logic high. The open circuit voltage is equal to V_{OUT} . |
| OSC IN | OSC IN is ignored. |
| OSC SEL | OSC SEL is ignored. |

APPLICATIONS INFORMATION

INCREASING THE DRIVE CURRENT

If the continuous output current requirements at V_{OUT} exceed 100 mA, or if a lower $V_{CC} - V_{OUT}$ voltage differential is desired, an external PNP pass transistor can be connected in parallel with the internal transistor. The BATT ON output (ADM8691/ADM8695) can directly drive the base of the external transistor.

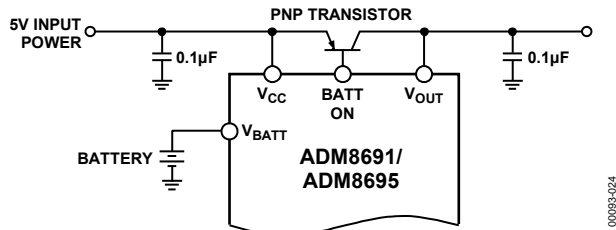


Figure 24. Increasing the Drive Current

USING A RECHARGEABLE BATTERY FOR BACKUP

If a capacitor or a rechargeable battery is used for backup, the charging resistor should be connected to V_{OUT} to eliminate the discharge path that would exist during power-down if the resistor were connected to V_{CC} .

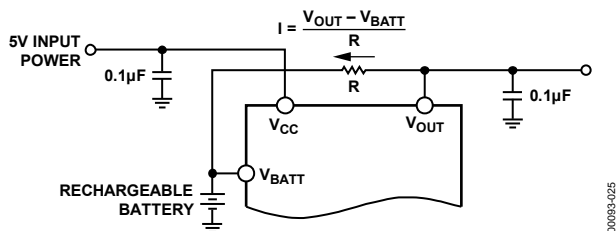


Figure 25. Rechargeable Battery

ADDING HYSTERESIS TO THE POWER-FAIL COMPARATOR

For increased noise immunity, hysteresis can be added to the power-fail comparator. Because the comparator circuit is noninverting, hysteresis can be added simply by connecting a resistor between the \overline{PFO} output and the PFI input, as shown in Figure 26. When \overline{PFO} is low, Resistor R_3 sinks current from the summing junction at the PFI pin. When \overline{PFO} is high, the series combination of R_3 and R_4 sources current into the PFI summing junction. This results in differing trip levels for the comparator.

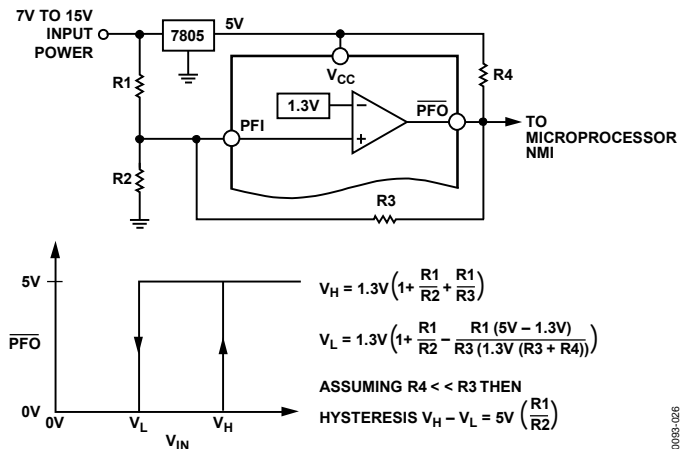


Figure 26. Adding Hysteresis to the Power-Fail Comparator

MONITORING THE STATUS OF THE BATTERY

The power-fail comparator can be used to monitor the status of the backup battery instead of the power supply, if desired (see Figure 27). The PFI input samples the battery voltage and generates an active low \overline{PFO} signal when the battery voltage drops below a selected threshold. It may be necessary to apply a test load to determine the loaded battery voltage. This is done under processor control using \overline{CE}_{OUT} . Because \overline{CE}_{OUT} is forced high during the battery backup mode, the test load is not applied to the battery while it is in use, even if the microprocessor is not powered.

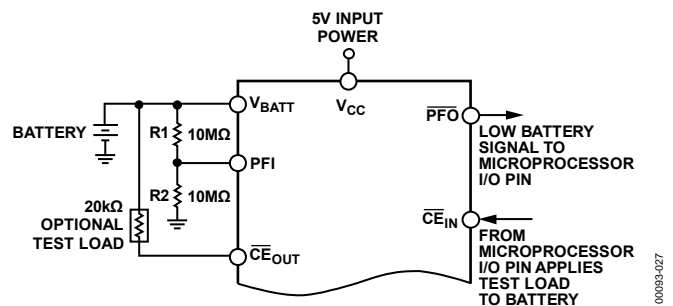


Figure 27. Monitoring the Battery Status

ALTERNATE WATCHDOG INPUT DRIVE CIRCUITS

The watchdog feature can be enabled and disabled under program control by driving WDI with a three-state buffer (see Figure 28). When three-stated, the WDI input floats, thereby disabling the watchdog timer.

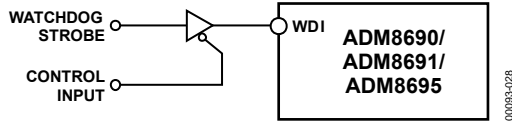


Figure 28. Enabling and Disabling the Watchdog Input

This circuit is not entirely foolproof, and it is possible for a software fault to erroneously three-state the buffer, preventing the ADM8690/ADM8691/ADM8695 from detecting that the microprocessor is no longer operating correctly. In most cases, a better method is to extend the watchdog period rather than disable the watchdog.

For the ADM8691/ADM8695, the watchdog period can be extended under program control using the circuit shown in Figure 29. When the control input is high, the OSC SEL pin is low and the watchdog timeout is set by the external capacitor. A 0.01 μ F capacitor sets a watchdog timeout delay of 100 sec. When the control input is low, the OSC SEL pin is driven high, selecting the internal oscillator. The 100 ms or the 1.6 sec period is chosen, depending on which diode is used, as shown in Figure 29. With D1 inserted, the internal timeout is set to 100 ms; with D2 inserted, the timeout is set to 1.6 sec.

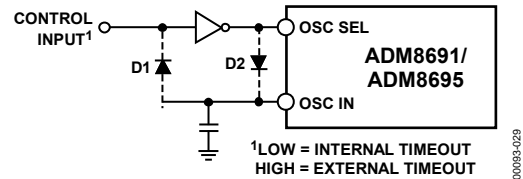


Figure 29. Extending the Watchdog Period

TYPICAL APPLICATIONS

ADM8690 APPLICATIONS

Figure 30 shows the ADM8690 in a typical power monitoring, battery backup application. V_{OUT} powers the CMOS RAM. Under normal operating conditions with V_{CC} present, V_{OUT} is internally connected to V_{CC} . If a power failure occurs, V_{CC} decays and V_{OUT} is switched to V_{BATT} , thereby maintaining power for the CMOS RAM. A RESET pulse is also generated when V_{CC} falls below 4.65 V for the ADM8690. RESET remains low for 50 ms after V_{CC} returns to 5 V.

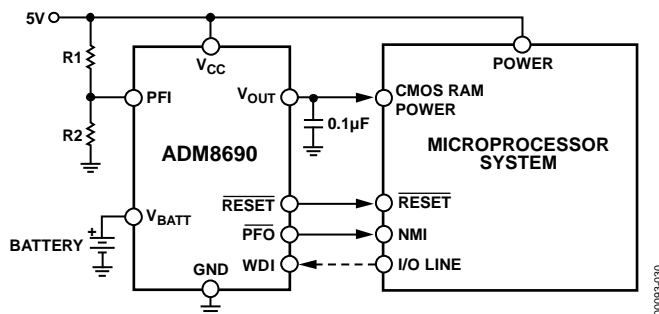


Figure 30. ADM8690 Typical Application, Circuit A

The watchdog timer input (WDI) monitors an input/output line from the microprocessor system. This line must be toggled once every 1.6 sec to verify correct software execution. Failure to toggle the line indicates that the microprocessor system is not correctly executing its program and may be tied up in an endless loop. If this happens, a reset pulse is generated to initialize the microprocessor.

If the watchdog timer is not needed, the WDI input should be left floating.

The power-fail input, PFI, monitors the input power supply via a resistive divider network. The voltage on the PFI input is compared with a precision 1.3 V internal reference. If the input voltage drops below 1.3 V, a power-fail output (PFO) signal is generated. This signal warns of an impending power failure and can be used to interrupt the processor so that the system can be shut down in an orderly fashion. The resistors in the sensing network are ratioed to give the desired power-fail threshold voltage (V_T).

$$V_T = (1.3 R1/R2) + 1.3 V$$

$$R1/R2 = (V_T/1.3) - 1$$

Figure 31 shows a similar application, but in this case the PFI input monitors the unregulated input to the 7805 voltage regulator. This circuit provides an earlier warning of an impending power failure. It is useful with processors that operate at low speeds or where there are a significant number of housekeeping tasks to be completed before the power is lost.

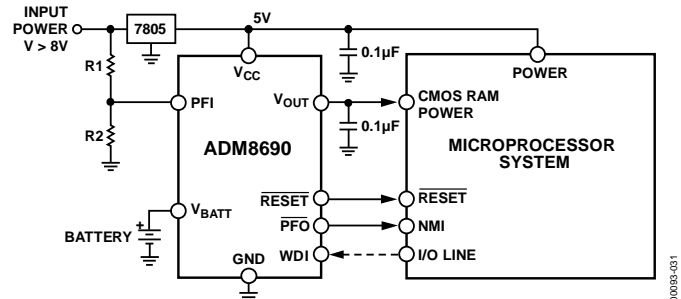


Figure 31. ADM8690 Typical Application, Circuit B

ADM8691/ADM8695 APPLICATIONS

Figure 32 shows a typical connection for the ADM8691/ADM8695. CMOS RAM is powered from V_{OUT} . When 5 V power is present, this voltage is routed to V_{OUT} . If V_{CC} fails, V_{BATT} is routed to V_{OUT} . V_{OUT} can supply up to 100 mA from V_{CC} , but if more current is required, an external PNP transistor can be added. When V_{CC} is higher than V_{BATT} , the BATT ON output goes low, providing up to 35 mA of base drive for the external transistor. A 0.1 µF capacitor is connected to V_{OUT} to supply the transient currents for CMOS RAM. When V_{CC} is lower than V_{BATT} , an internal 20 Ω MOSFET connects the backup battery to V_{OUT} .

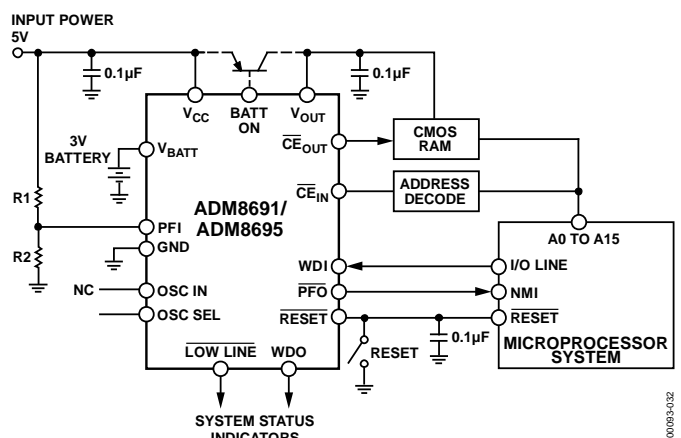


Figure 32. ADM8691/ADM8695 Typical Application

RESET OUTPUT

The internal voltage detector monitors V_{CC} and generates a $\overline{\text{RESET}}$ output to hold the microprocessor reset line low when V_{CC} is below 4.65 V. An internal timer holds $\overline{\text{RESET}}$ low for 50 ms (200 ms for the ADM8695) after V_{CC} rises above 4.65 V. This prevents repeated toggling of $\overline{\text{RESET}}$, even if the 5 V power drops out and recovers with each power line cycle.

The crystal oscillator normally used to generate the clock for microprocessors can take several milliseconds to stabilize. Because most microprocessors need several clock cycles to reset, $\overline{\text{RESET}}$ must be held low until the microprocessor clock oscillator has started. The power-up $\overline{\text{RESET}}$ pulse lasts 50 ms (200 ms for the ADM8695) to allow for this oscillator start-up time. If a different reset pulse width is required, a capacitor should be connected to OSC IN, or an external clock can be used (see Table 5 and Figure 17 through Figure 20). The manual reset switch and the 0.1 μF capacitor connected to the reset line can be omitted if a manual reset is not needed. An inverted, active high $\overline{\text{RESET}}$ output is also available on the ADM8691/ADM8695.

POWER-FAIL DETECTOR

The 5 V V_{CC} power line is monitored via a resistive potential divider connected to the power-fail input (PFI). When the voltage at PFI falls below 1.3 V, the power-fail output (PFO) drives the processor's NMI input low. For example, if a power-fail threshold of 4.8 V is set with Resistor R1 and Resistor R2 and V_{CC} falls from 4.8 V to 4.65 V, the microprocessor has time to save data into RAM. An earlier power-fail warning can be generated if the unregulated dc input to the 5 V regulator is available for monitoring. This allows more time for microprocessor housekeeping tasks to be completed before power is lost.

RAM WRITE PROTECTION

The ADM8691/ADM8695 $\overline{\text{CE}}_{\text{OUT}}$ line drives the chip select inputs of the CMOS RAM. $\overline{\text{CE}}_{\text{OUT}}$ follows $\overline{\text{CE}}_{\text{IN}}$ as long as V_{CC} is above the 4.65 V reset threshold.

If V_{CC} falls below the reset threshold, $\overline{\text{CE}}_{\text{OUT}}$ goes high, independent of the logic level at $\overline{\text{CE}}_{\text{IN}}$. This prevents the microprocessor from writing erroneous data into RAM during power-up, power-down, brownouts, and momentary power interruptions.

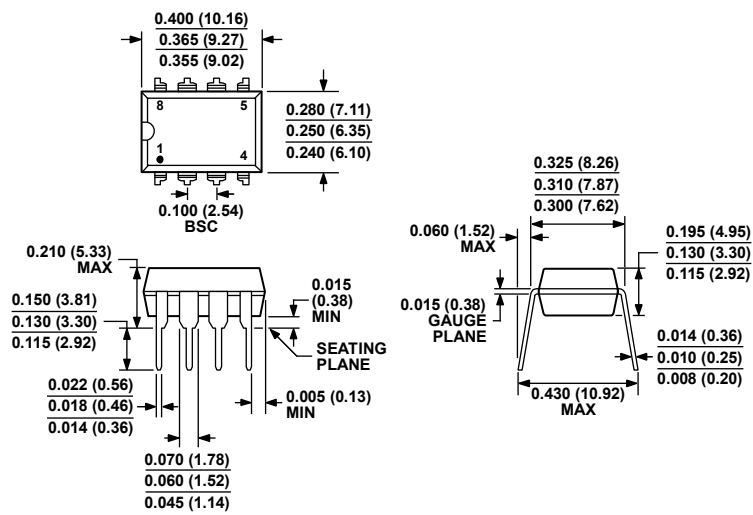
WATCHDOG TIMER

The microprocessor drives the watchdog input (WDI) with an input/output line. When OSC IN and OSC SEL are unconnected, the microprocessor must toggle the WDI pin once every 1.6 sec to verify proper software execution. If a hardware or software failure occurs such that WDI is not toggled, the ADM8691 issues a 50 ms (200 ms for the ADM8695) $\overline{\text{RESET}}$ pulse after 1.6 sec. This typically restarts the microprocessor power-up routine. A new $\overline{\text{RESET}}$ pulse is issued every 1.6 sec until WDI is again strobed. If a different watchdog timeout period is required, a capacitor should be connected to OSC IN or an external clock can be used (see Table 5 and Figure 17 through Figure 20).

The watchdog output ($\overline{\text{WDO}}$) goes low if the watchdog timer is not serviced within its timeout period. After $\overline{\text{WDO}}$ goes low, it remains low until a transition occurs at WDI. The watchdog timer feature can be disabled by leaving WDI unconnected.

The $\overline{\text{RESET}}$ output has an internal 3 μA pull-up and can either connect to an open-collector reset bus or directly drive a CMOS gate without an external pull-up resistor.

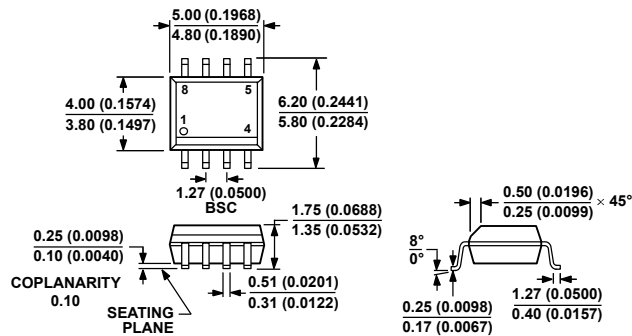
OUTLINE DIMENSIONS



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Figure 33. 8-Lead Plastic Dual In-Line Package [PDIP]
Narrow Body
(N-8)

Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MS-012-AA
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Figure 34. 8-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-8)

Dimensions shown in millimeters and (inches)



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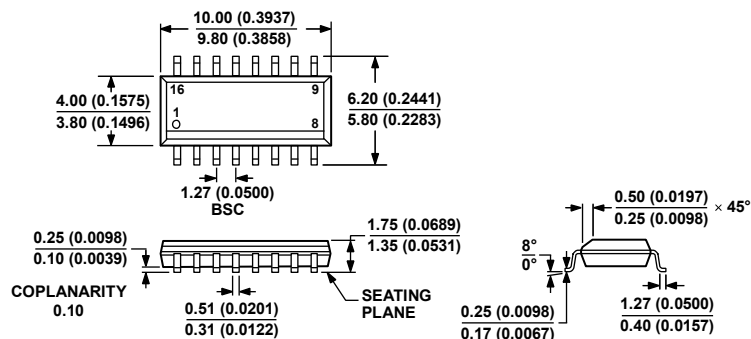
(N-16)

Dimensions shown in inches and (millimeters)



(RW-16)

Dimensions shown in millimeters and (inches)

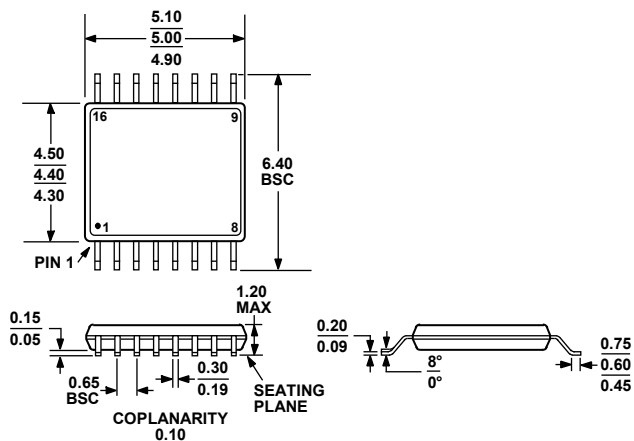


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Figure 37. 16-Lead Standard Small Outline Package [SOIC_N]
Narrow Body
(R-16)

Dimensions shown in millimeters and (inches)

069606-A



COMPLIANT TO JEDEC STANDARDS MO-153-AB

Figure 38. 16-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-16)

Dimensions shown in millimeters

ORDERING GUIDE

| Model ¹ | Temperature Range | Package Description | Package Option |
|--------------------|-------------------|---|----------------|
| ADM8690AN | –40°C to +85°C | 8-Lead Plastic Dual In-Line Package [PDIP] | N-8 |
| ADM8690ANZ | –40°C to +85°C | 8-Lead Plastic Dual In-Line Package [PDIP] | N-8 |
| ADM8690ARN | –40°C to +85°C | 8-Lead Standard Small Outline Package [SOIC_N] | R-8 |
| ADM8690ARN-REEL | –40°C to +85°C | 8-Lead Standard Small Outline Package [SOIC_N] | R-8 |
| ADM8690ARNZ | –40°C to +85°C | 8-Lead Standard Small Outline Package [SOIC_N] | R-8 |
| ADM8691ANZ | –40°C to +85°C | 16-Lead Plastic Dual In-Line Package [PDIP] | N-16 |
| ADM8691ARN | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_N] | R-16 |
| ADM8691ARN-REEL | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_N] | R-16 |
| ADM8691ARNZ | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_N] | R-16 |
| ADM8691ARW | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_W] | RW-16 |
| ADM8691ARW-REEL | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_W] | RW-16 |
| ADM8691ARWZ | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_W] | RW-16 |
| ADM8691ARU | –40°C to +85°C | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16 |
| ADM8691ARU-REEL | –40°C to +85°C | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16 |
| ADM8691ARUZ | –40°C to +85°C | 16-Lead Thin Shrink Small Outline Package [TSSOP] | RU-16 |
| ADM8695ARW | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_W] | RW-16 |
| ADM8695ARW-REEL | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_W] | RW-16 |
| ADM8695ARWZ | –40°C to +85°C | 16-Lead Standard Small Outline Package [SOIC_W] | RW-16 |

¹ Z = RoHS Compliant Part.

NOTES

NOTES

Mouser Electronics

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