



3.0V/3.3V Adjustable Microprocessor Supervisory Circuits

General Description

The MAX793/MAX794/MAX795 microprocessor (μ P) supervisory circuits monitor and control the activities of +3.0V/+3.3V μ Ps by providing backup-battery switchover, among other features such as low-line indication, μ P reset, write protection for CMOS RAM, and a watchdog (see the *Selector Guide* below). The backup-battery voltage can exceed V_{CC} , permitting the use of 3.6V lithium batteries in systems using 3.0V to 3.3V for V_{CC} .

The MAX793/MAX795 offer a choice of reset threshold voltage range (denoted by suffix letter): 3.00V to 3.15V (T), 2.85V to 3.00V (S), and 2.55V to 2.70V (R). The MAX794's reset threshold is set externally with a resistor divider. The MAX793/MAX794 are available in 16-pin DIP and narrow SO packages, and the MAX795 comes in 8-pin DIP and SO packages.

Selector Guide

FEATURE	MAX793	MAX794	MAX795
Active-Low Reset	✓	✓	✓
Active-High Reset	✓	✓	
Programmable Reset Threshold		✓	
Low-Line Early Warning Output	✓	✓	
Backup-Battery Switchover	✓	✓	✓
External Switch Driver	✓	✓	✓
Power-Fail Comparator	✓	✓	
Battery OK Output	✓		
Watchdog Input	✓	✓	
Battery Freshness Seal	✓	✓	
Manual Reset Input	✓	✓	
Chip-Enable Gating	✓	✓	✓
Pin-Package	16-DIP/SO	16-DIP/SO	8-DIP/SO

Applications

Battery-Powered Computers and Controllers
 Embedded Controllers
 Intelligent Controllers
 Critical μ P Power Monitoring
 Portable Equipment

Pin Configurations appear at end of data sheet.

Features

MAX793/MAX794/MAX795

- ◆ Precision Supply-Voltage Monitor:
Fixed Reset Trip Voltage (MAX793/MAX795)
Adjustable Reset Trip Voltage (MAX794)
- ◆ Guaranteed Reset Assertion to $V_{CC} = 1V$
- ◆ Backup-Battery Power Switching—Battery Voltage Can Exceed V_{CC}
- ◆ On-Board Gating of Chip-Enable Signals—7ns Max Propagation Delay

MAX793/MAX794 Only

- ◆ Battery Freshness Seal
- ◆ Battery OK Output (MAX793)
- ◆ Uncommitted Voltage Monitor for Power-Fail or Low-Battery Warning
- ◆ Independent Watchdog Timer (1.6s timeout)
- ◆ Manual Reset Input

Ordering Information

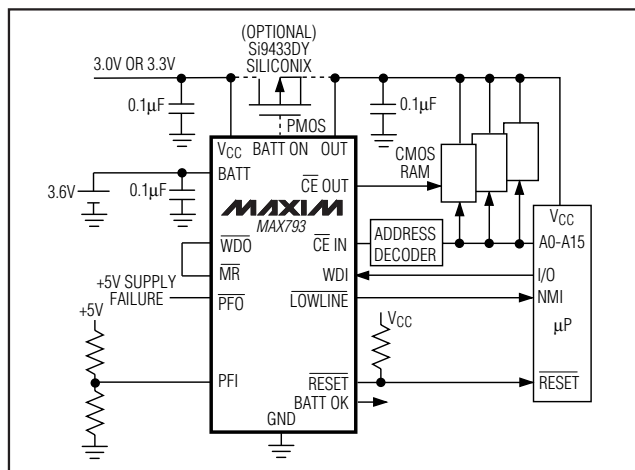
PART*	TEMP RANGE	PIN-PACKAGE
MAX793_CPE	0°C to +70°C	16 Plastic DIP
MAX793_CSE	0°C to +70°C	16 Narrow SO

Ordering Information continued at end of data sheet.

*The MAX793/MAX795 offer a choice of reset threshold voltage. Select the letter corresponding to the desired reset threshold voltage range (T = 3.00V to 3.15V, S = 2.85V to 3.00V, R = 2.55V to 2.70V) and insert it into the blank to complete the part number. The MAX794's reset threshold is adjustable.

Devices are available in both leaded and lead-free packaging. Specify lead free by adding the + symbol at the end of the part number when ordering.

Typical Operating Circuit



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ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (with respect to GND)

VCC-0.3V to +6.0V

VBATT-0.3V to +6.0V

All Other Inputs-0.3V to the higher of VCC or VBATT

Continuous Input Current

VCC200mA

VBATT50mA

GND20mA

Output Current

VOU200mA

All Other Outputs20mA

Continuous Power Dissipation (T_A = +70°C)

8-Pin Plastic DIP (derate 9.09mW/°C above +70°C)727mW

8-Pin SO (derate 5.88mW/°C above +70°C)471mW

16-Pin Plastic DIP (derate 10.53mW/°C above +70°C)842mW

16-Pin Narrow SO (derate 9.52mW/°C above +70°C)696mW

Operating Temperature Ranges

MAX793_C_/MAX794C_/MAX795_C_ 0°C to +70°C

MAX793_E_/MAX794E_/MAX795_E_-40°C to +85°C

Storage Temperature Range-65°C to +160°C

Lead Temperature (soldering, 10s)+300°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 = 3.17V to 5.5V for the MAX793T/MAX795T, VCC = 3.02V to 5.5V for the MAX793S/MAX795S, VCC = 2.72V to 5.5V for the MAX793R/MAX794/MAX795R, VBATT = 3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Operating Voltage Range, VCC, VBATT (Note 1)		MAX79_C		1.0		5.5	V
		MAX79_E		1.1		5.5	
VCC Supply Current (excluding I _{OUT} , I _{CE} OUT)	ISUPPLY	MAX793/MAX794, MR = VCC	VCC < 3.6V		46	60	μA
			VCC < 5.5V		62	80	
		MAX795	VCC < 3.6V		35	50	
			VCC < 5.5V		49	70	
VCC Supply Current in Battery-Backup Mode (excluding I _{OUT})	ISUPPLY	VCC = 2.1V, VBATT = 2.3V	MAX793/MAX794		32	45	μA
			MAX795		24	35	
BATT Supply Current (excluding I _{OUT}) (Note 2)						1	μA
BATT Leakage Current, Freshness Seal Enabled		VCC = 0V, V _{OUT} = 0V				1	μA
Battery Leakage Current (Note 3)						0.5	μA
OUT Output Voltage in Normal Mode	VOUT	I _{OUT} = 75mA		VCC - 0.3	VCC - 0.125		V
		I _{OUT} = 30mA (Note 4)		VCC - 0.12	VCC - 0.050		
		I _{OUT} = 250μA (Note 4)		VCC - 0.001	VCC - 0.5mV		
OUT Output Voltage in Battery-Backup Mode	VOUT	VBATT = 2.3V	I _{OUT} = 250μA	VBATT - 0.1	VBATT - 0.034		V
			I _{OUT} = 1mA		VBATT - 0.14		
Battery Switch Threshold (VCC falling)	VCC - VBATT	V _{SW} > VCC > 1.75V (Note 5)			20	65	mV
	VSW	VBATT > VCC (Note 6)	MAX793T/MAX795T	2.69	2.82	2.95	
			MAX793S/MAX795S	2.55	2.68	2.80	
			MAX793R/MAX795R/MAX794	2.30	2.41	2.52	
Battery Switch Threshold (VCC rising) (Note 7)	VCC - VBATT	This value is identical to the reset threshold, VCC rising for VBATT > V _{RST}					
		VBATT < V _{RST}			25	65	

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MAX793/MAX794/MAX795

ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 3.17V to 5.5V for the MAX793T/MAX795T, V_{CC} = 3.02V to 5.5V for the MAX793S/MAX795S, V_{CC} = 2.72V to 5.5V for the MAX793R/MAX794/MAX795R, V_{BATT} = 3.6V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Reset Threshold (Note 8)	VRST	VCC falling	MAX793T/MAX795T	3.00	3.075	3.15	V
			MAX793S/MAX795S	2.85	2.925	3.00	
			MAX793R/MAX795R	2.55	2.625	2.70	
		VCC rising	MAX793T/MAX795T	3.00	3.085	3.17	
			MAX793S/MAX795S	2.85	2.935	3.02	
			MAX793R/MAX795R	2.55	2.635	2.72	
RESET IN Threshold (MAX794 only)	VRST IN	VCC falling		1.212	1.240	1.262	V
VCC rising		1.212	1.250	1.282			
RESET IN Leakage Current (MAX794 only)				-25	2	25	nA
Reset Timeout Period	tRP	VCC < 3.6V		140	200	280	ms
LOWLINE-to-Reset Threshold, (VLOWLINE - VRST), VCC Falling	VLR	MAX793		30	45	60	mV
		MAX794		5	15	25	
Low-Line Comparator Hysteresis		MAX793			10		mV
		MAX794			10		mV
LOWLINE Threshold, VCC Rising	VLL	MAX793T/MAX795T				3.23	V
		MAX793S/MAX795S				3.08	
		MAX793R/MAX795R				2.78	
		MAX794				1.317	
PFI Input Threshold	VTH	VPFI falling		1.212	1.240	1.262	V
		VPFI rising		1.212	1.250	1.287	
PFI Input Current				-25	2	25	nA
PFI Hysteresis, PFI Rising					10	20	mV
BATT OK Threshold (MAX793)	VBOK			2.00	2.25	2.50	V
INPUT AND OUTPUT LEVELS							
RESET Output-Voltage High	VOH	ISOURCE = 300µA, VCC = VRST min		0.8VCC	0.86VCC		V
BATT OK, BATT ON, WDO, LOWLINE Output-Voltage High	VOH	ISOURCE = 300µA, VCC = VRST max		0.8VCC	0.86VCC		V
PFO Output-Voltage High	VOH	ISOURCE = 65µA, VCC = VRST max		0.8VCC			V
BATT ON Output-Voltage High	VOH	ISOURCE = 100µA, VCC = 2.3V, VBATT = 3V		0.8VBATT			V
RESET Output Leakage Current (Note 9)	ILEAK	VCC = VRST max		-1		-1	µA
PFO Output Short to GND Current	ISC	VCC = 3.3V, V PFO = 0V		180		500	µA
PFO, RESET, RESET, WDO, LOWLINE Output-Voltage Low	VOL	ISINK = 1.2mA; RESET, LOWLINE tested with VCC = VRST min; RESET, BATTOK, WDO tested with VCC = VRST max		0.08		0.2VCC	V

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ELECTRICAL CHARACTERISTICS (continued)

(V_{CC} = 3.17V to 5.5V for the MAX793T/MAX795T, V_{CC} = 3.02V to 5.5V for the MAX793S/MAX795S, V_{CC} = 2.72V to 5.5V for the MAX793R/MAX794/MAX795R, V_{BATT} = 3.6V, T_A = T_{MIN} to T_{MAX} , unless otherwise noted. Typical values are at T_A = +25°C.)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
RESET Output-Voltage Low	VOL	MAX79_C, VBATT = VCC = 1.0V, ISINK = 40μA		0.13	0.3	V
		MAX79_E, VBATT = VCC = 1.2V, ISINK = 200μA		0.17	0.3	
BATT ON Output-Voltage Low	VOL	ISINK = 3.2mA, VCC = VRST max			0.2VCC	V
All Inputs Including PFO (Note 10)	VIH	VRST max < VCC < 5.5V			0.7VCC	V
	VIL		0.3VCC			
MANUAL RESET INPUT						
MR Pulse Width	tMR	MAX793/MAX794 only	100			ns
MR-to-Reset Delay	tMD	MAX793/MAX794 only		75	250	ns
MR Pullup Current		MAX793/MAX794 only, MR = 0V	25	70	250	μA
CHIP-ENABLE GATING						
CE IN Leakage Current	I _{LEAK}	Disable mode		±10		nA
CE IN-to-CE OUT Resistance		Enable mode, VCC = VRST max		46		Ω
CE IN-to-CE OUT Propagation Delay		VCC = VRST max, Figure 9		2	7	ns
CE OUT Drive from CE IN	VOH	VCC = VRST max, IOUT = -1mA, VCE IN = VCC	0.8VCC			V
	VOL	VCC = VRST max, IOUT = 1.6mA, VCE IN = 0V			0.2VCC	
Reset to CE OUT High Delay				10		μs
CE OUT Output-Voltage High (reset active)	VOH	IOH = 500μA, VCC < 2.3V	0.8VBATT			V
WATCHDOG (MAX793/MAX794 only)						
WDI Input Current		0V < VCC < 5.5V	-1	0.01	1	μA
Watchdog Timeout Period	tWD		1.00	1.60	2.25	s
WDI Pulse Width			100			ns

Note 1: V_{CC} supply current, logic-input leakage, watchdog functionality (MAX793/MAX794), $\overline{MR}$ functionality (MAX793/MAX794), $\overline{PFI}$ functionality (MAX793/MAX794), and state of $\overline{RESET}$ and RESET (MAX793/MAX794) tested at $V_{BATT} = 3.6V$ and $V_{CC} = 5.5V$. The state of RESET is tested at $V_{CC} = V_{CC}$ min.

Note 2: Tested at $V_{BATT} = 3.6V$, $V_{CC} = 3.5V$ and $0V$. The battery current rises to $10\mu A$ over a narrow transition window around $V_{CC} = 1.9V$.

Note 3: Leakage current into the battery is tested under the worst-case conditions at $V_{CC} = 5.5V$, $V_{BATT} = 1.8V$ and $V_{CC} = 1.5V$, $V_{BATT} = 1.0V$.

Note 4: Guaranteed by design.

Note 5: When $V_{SW} > V_{CC} > V_{BATT}$, OUT remains connected to V_{CC} until V_{CC} drops below V_{BATT} . The V_{CC} -to- V_{BATT} comparator has a small 15mV typical hysteresis to prevent oscillation. For $V_{CC} < 1.75V$ (typical), OUT switches to BATT regardless of V_{BATT} .

Note 6: When $V_{BATT} > V_{CC} > V_{SW}$, OUT remains connected to V_{CC} until V_{CC} drops below the battery switch threshold (V_{SW}).

Note 7: OUT switches from BATT to V_{CC} when V_{CC} rises above the reset threshold, if $V_{BATT} > V_{RST}$. In this case, switchover back to V_{CC} occurs at the exact voltage that causes reset to be asserted, however, switchover occurs 200ms prior to reset. If $V_{BATT} < V_{RST}$, OUT switches from BATT to V_{CC} when V_{CC} exceeds V_{BATT} .

Note 8: The reset threshold tolerance is wider for V_{CC} rising than for V_{CC} falling to accommodate the 10mV typical hysteresis, which prevents internal oscillation.

Note 9: The leakage current into or out of the RESET pin is tested with RESET not asserted (RESET output high impedance).

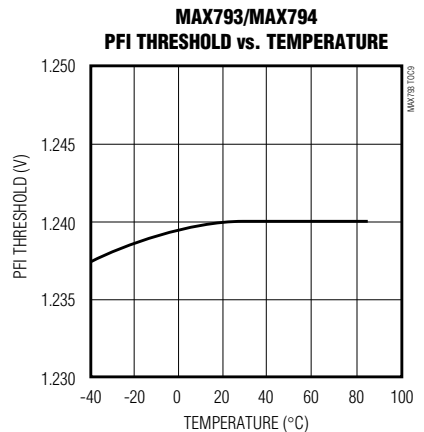
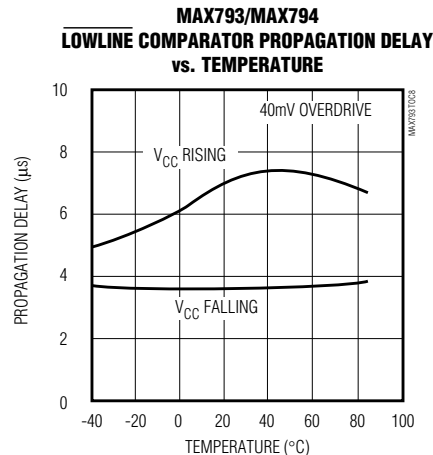
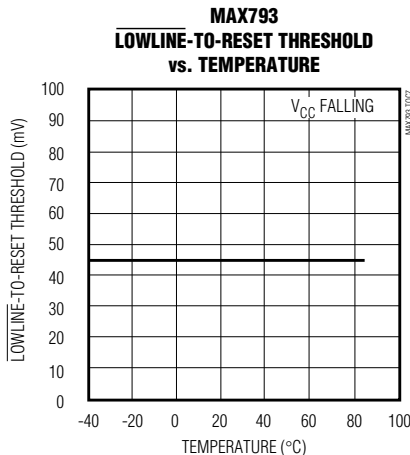
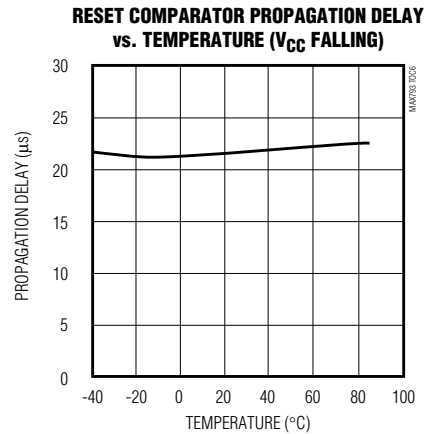
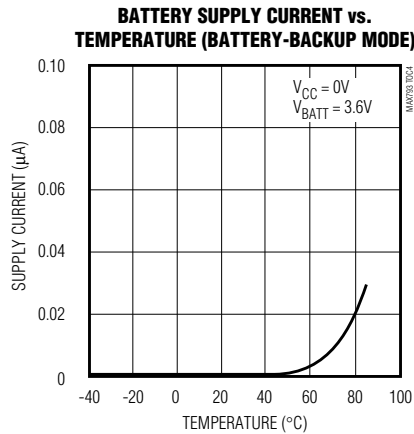
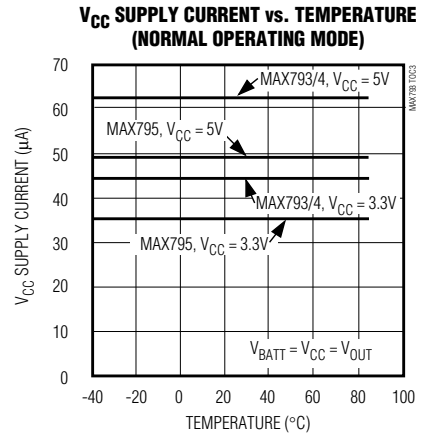
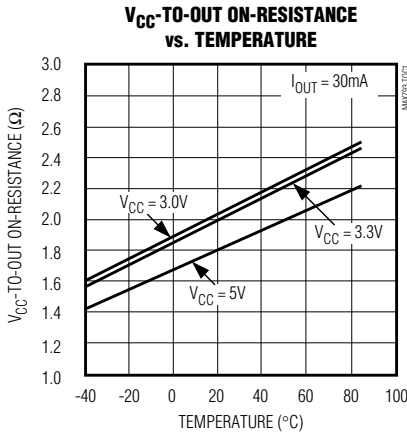
Note 10: $\overline{PFO}$ is normally an output, but is used as an input when activating the battery freshness seal.

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Typical Operating Characteristics

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

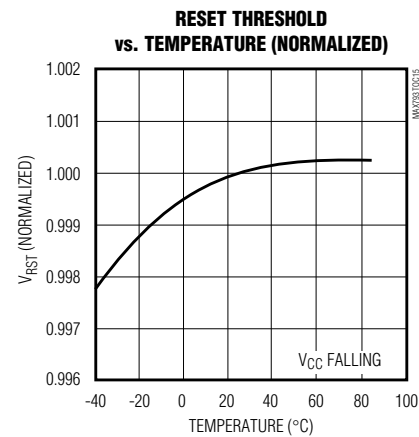
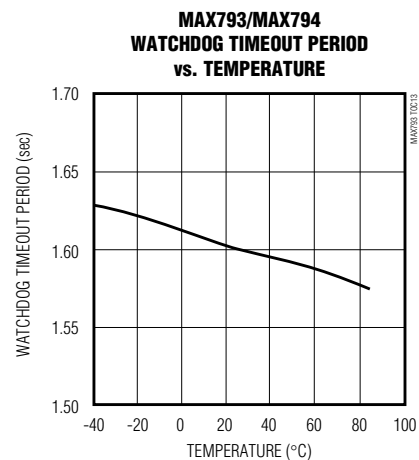
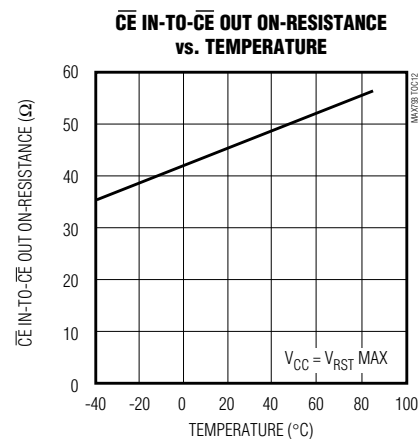
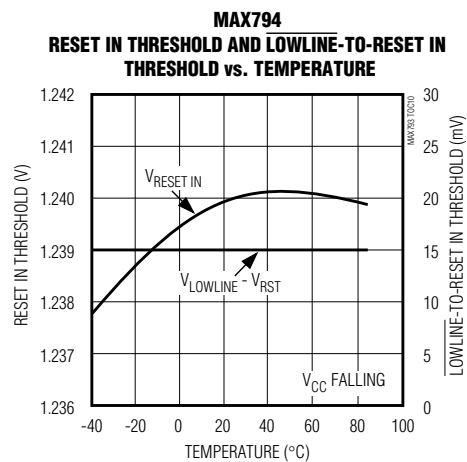
MAX793/MAX794/MAX795



3.0V/3.3V Adjustable Microprocessor Supervisory Circuits

Typical Operating Characteristics (continued)

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



3.0V/3.3V Adjustable Microprocessor Supervisory Circuits

Pin Description

PIN		NAME	FUNCTION
MAX793/ MAX794	MAX795		
1	1	OUT	Supply Output for CMOS RAM. When V_{CC} rises above the reset threshold or above V_{BATT} , OUT is connected to V_{CC} through an internal p-channel MOSFET switch. When V_{CC} falls below V_{SW} and V_{BATT} , BATT connects to OUT.
2	2	V_{CC}	Main Supply Input
3	—	BATT OK (MAX793)	Battery Status Output. High in normal operating mode when V_{BATT} exceeds V_{BOK} , otherwise low. V_{BATT} is checked continuously. Disabled and logic low while V_{CC} is below V_{SW} .
		RESET IN (MAX794)	Reset Input. Connect to an external resistor-divider to select the reset threshold. The reset threshold can be programmed anywhere in the V_{SW} to 5.5V range.
4	—	PFI	Power-Fail Comparator Input. When PFI is less than V_{PFT} or when V_{CC} falls below V_{SW} , $\overline{PFO}$ goes low; otherwise, $\overline{PFO}$ remains high (see <i>Power-Fail Comparator</i> section). Connect to V_{CC} if unused.
5	3	BATT ON	Logic Output/External Bypass Switch-Driver Output. High when OUT switches to BATT. Low when OUT switches to V_{CC} . Connect the base/gate of PNP/PMOS transistor to BATT ON for I_{OUT} requirements exceeding 75mA.
6	4	GND	Ground
7	—	$\overline{PFO}$	Power-Fail Comparator Output. When PFI is less than V_{PFT} or when V_{CC} falls below V_{SW} , $\overline{PFO}$ goes low; otherwise, $\overline{PFO}$ remains high. $\overline{PFO}$ is also used to enable the battery freshness seal (see <i>Battery Freshness Seal</i> and <i>Power-Fail Comparator</i> sections).
8	—	$\overline{MR}$	Manual Reset Input. A logic low on $\overline{MR}$ asserts reset. Reset remains asserted as long as $\overline{MR}$ is low and for 200ms after $\overline{MR}$ returns high. The active-low input has an internal 70 μ A pullup current. It can be driven from a TTL- or CMOS-logic line or shorted to ground with a switch. Leave open if unused.
9	—	$\overline{WDO}$	Watchdog Output. $\overline{WDO}$ goes low if WDI remains either high or low for longer than the watchdog timeout period. $\overline{WDO}$ returns high on the next transition of WDI. $\overline{WDO}$ is a logic high for $V_{SW} < V_{CC} < V_{RST}$, and low when V_{CC} is below V_{SW} .
10	—	WDI	Watchdog Input. If WDI remains either high or low for longer than the watchdog timeout period, the internal watchdog timer runs out and $\overline{WDO}$ goes low. $\overline{WDO}$ returns high on the next transition of WDI. Connect $\overline{WDO}$ to $\overline{MR}$ to generate a reset due to a watchdog fault.
11	5	$\overline{CE}$ IN	Chip-Enable Input. The input to the chip-enable gating circuit. Connect to GND if unused.
12	6	$\overline{CE}$ OUT	Chip-Enable Output. $\overline{CE}$ OUT goes low only when $\overline{CE}$ IN is low and reset is not asserted. If $\overline{CE}$ IN is low when reset is asserted, $\overline{CE}$ OUT remains low for 10 μ s or until $\overline{CE}$ IN goes high, whichever occurs first. $\overline{CE}$ OUT is pulled up to OUT.
13	—	RESET	Active-High Reset Output. Sources and sinks current. RESET is the inverse of $\overline{RESET}$.
14	—	$\overline{LOWLINE}$	Early Power-Fail Warning Output. Low when V_{CC} falls to V_{LR} . This output can be used to generate an NMI to provide early warning of imminent power failure.
15	7	$\overline{RESET}$	Open-Drain, Active-Low Reset Output. Pulses low for 200ms when triggered, and stays low whenever V_{CC} is below the reset threshold or when $\overline{MR}$ is a logic low. It remains low for 200ms after either V_{CC} rises above the reset threshold, the watchdog triggers a reset ($\overline{WDO}$ connected to $\overline{MR}$), or $\overline{MR}$ goes low to high.
16	8	BATT	Backup-Battery Input. When V_{CC} falls below V_{SW} and V_{BATT} , OUT switches from V_{CC} to BATT. When V_{CC} rises above the reset threshold or above V_{BATT} , OUT reconnects to V_{CC} . V_{BATT} can exceed V_{CC} . Connect V_{CC} , OUT, and BATT together if no battery is used.

MAX793/MAX794/MAX795

3.0V/3.3V Adjustable Microprocessor Supervisory Circuits

Detailed Description

General Timing Characteristics

The MAX793/MAX794/MAX795 are designed for 3.3V and 3V systems, and provide a number of supervisory functions (see the *Selector Guide* on the front page). Figures 1 and 2 show the typical timing relationships of the various outputs during power-up and power-down with typical V_{CC} rise and fall times.

Manual Reset Input (MAX793/MAX794)

Many microprocessor-based products require manual-reset capability, allowing the operator, a test technician, or external logic circuitry to initiate a reset. On the MAX793/MAX794, a logic low on $\overline{MR}$ asserts reset. Reset remains asserted while $\overline{MR}$ is low, and for t_{RP} (200ms) after it returns high. During the first half of the reset time-

out period (t_{RP}), the state of $\overline{MR}$ is ignored if $\overline{PFO}$ is externally forced low to facilitate enabling the battery freshness seal. $\overline{MR}$ has an internal 70 μ A pullup current, so it can be left open if it is not used. This input can be driven with TTL- or CMOS-logic levels, or with open-drain/collector outputs. Connect a normally open momentary switch from $\overline{MR}$ to GND to create a manual-reset function; external debounce circuitry is not required. If $\overline{MR}$ is driven from long cables or the device is used in a noisy environment, connect a 0.1 μ F capacitor from $\overline{MR}$ to ground to provide additional noise immunity.

Reset Outputs

A microprocessor's (μ P's) reset input starts the μ P in a known state. These MAX793/MAX794/MAX795 μ P supervisory circuits assert a reset to prevent code execution errors during power-up, power-down, and



Figure 1. Timing Diagram, V_{CC} Rising

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brownout conditions. RESET is guaranteed to be a logic low for $0V < V_{CC} < V_{RST}$, provided V_{BATT} is greater than 1V. Without a backup battery ($V_{BATT} = V_{CC} = V_{OUT}$), RESET is guaranteed valid for $V_{CC} \geq 1V$. Once V_{CC} exceeds the reset threshold, an internal timer keeps RESET low for the reset timeout period (t_{RP}); after this interval, RESET becomes high impedance (Figure 2). RESET is an open-drain output, and requires a pullup resistor to V_{CC} (Figure 3). Use a $4.7k\Omega$ to $1M\Omega$ pullup resistor that provides sufficient current to assure the proper logic levels to the μP .

If a brownout condition occurs (V_{CC} dips below the reset threshold), RESET goes low. Each time RESET is asserted, it stays low for the reset timeout period. Any time V_{CC} goes below the reset threshold, the internal timer restarts.

The watchdog output ($\overline{WDO}$) can also be used to initiate a reset. See the *Watchdog Output* section.

The RESET output is the inverse of the $\overline{RESET}$ output, and it can both source and sink current.



Figure 2. Timing Diagram, V_{CC} Falling

3.0V/3.3V Adjustable Microprocessor Supervisory Circuits

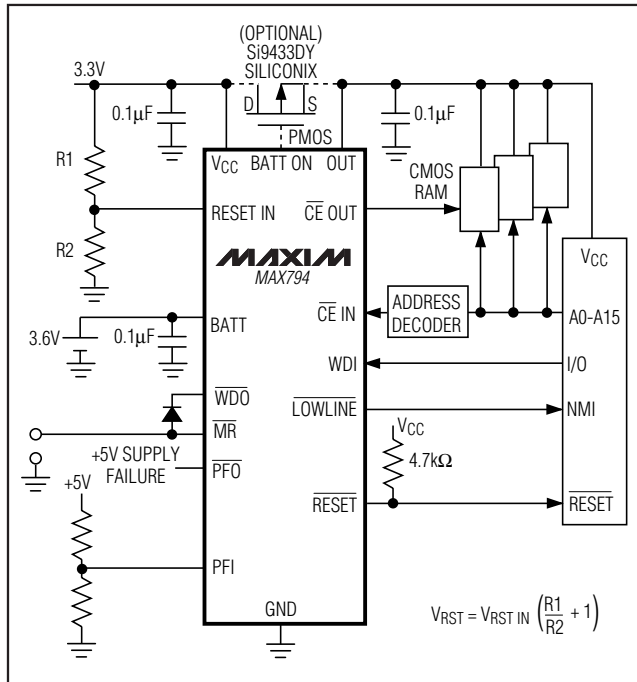


Figure 3. MAX794 Standard Application Circuit

Reset Threshold

The MAX793T/MAX795T are intended for 3.3V systems with a $\pm 5\%$ power-supply tolerance and a 10% systems tolerance. Except when MR is asserted, reset does not assert as long as the power supply remains above 3.15V (3.3V - 5%). Reset is guaranteed to assert before the power supply falls below 3.0V (3.3V - 10%).

The MAX793S/MAX795S are designed for 3.3V $\pm 10\%$ power supplies. Except when MR is asserted, they are guaranteed not to assert reset as long as the supply remains above 3.0V (3.0V is just above 3.3V - 10%). Reset is guaranteed to assert before the power supply falls below 2.85V (3.3V - 14%).

The MAX793R/MAX795R are optimized to monitor 3.0V $\pm 10\%$ power supplies. Reset does not occur until VCC falls below 2.7V (3.0V - 10%), but is guaranteed to occur before the supply falls below 2.55V (3.0V - 15%).

Program the MAX794's reset threshold with an external voltage divider to RESET IN. The reset-threshold tolerance is a combination of the RESET IN tolerance and the tolerance of the resistors used to make the external voltage divider. Calculate the reset threshold as follows:

$$V_{RST} = V_{RST\ IN} (R1 / R2 + 1)$$

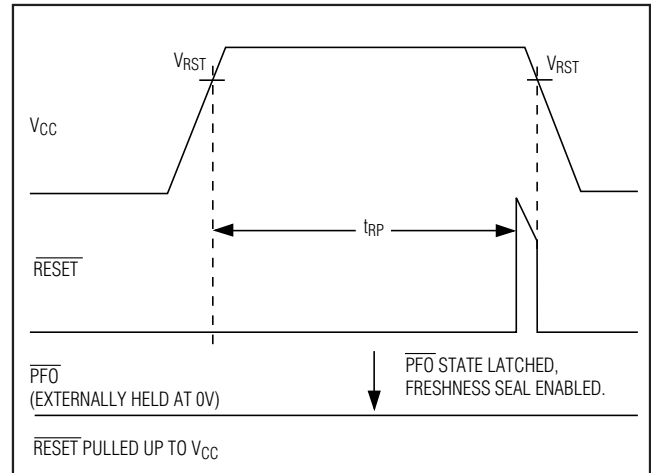


Figure 4. Battery Freshness Seal Enable Timing

Using the standard application circuit (Figure 3), the reset threshold can be programmed anywhere in the range of VSW (the battery switch threshold) to 5.5V. Reset is asserted when VCC falls below VSW.

Battery Freshness Seal

The MAX793/MAX794's battery freshness seal disconnects the backup battery from internal circuitry until it is needed. This allows an OEM to ensure that the backup battery connected to BATT is fresh when the final product is put to use. To enable the freshness seal, connect a battery to BATT, ground PFO, bring VCC above the reset threshold, and hold it there until reset is deasserted following the reset timeout period, then bring VCC back down again (Figure 4). Once the battery freshness seal is enabled (disconnecting the backup battery from the internal circuitry and anything connected to OUT), it remains enabled until VCC is brought above V_RST. Note that connecting PFO to MR does not interfere with battery freshness seal operation.

BATT OK Output (MAX793)

BATT OK indicates the status of the backup battery. When reset is not asserted, the MAX793 checks the battery voltage continuously. If VBATT is below VBOK (2.0V min), BATT OK goes low; otherwise, it remains pulled up to VCC. BATT OK also goes low when VCC goes below VSW.

Watchdog Input (MAX793/MAX794)

In the MAX793/MAX794, the watchdog circuit monitors the μP 's activity. If the μP does not toggle the watchdog input (WDI) within 1.6s, WDO goes low. The internal 1.6s timer is cleared and WDO returns high either when

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Figure 5. Watchdog Timing Relationship

a reset occurs or when a transition (low-to-high or high-to-low) takes place at WDI. As long as reset is asserted, the timer remains cleared and does not count. As soon as reset is released or WDI changes state, the timer starts counting (Figure 5). WDI can detect pulses as short as 100ns. Unlike the 5V MAX690 family, the watchdog function **cannot** be disabled.

Watchdog Output (MAX793/MAX794)

In the MAX793/MAX794, WDO remains high (WDO is pulled up to V_{CC}) if there is a transition or pulse at WDI during the watchdog timeout period. WDO goes low if no transition occurs at WDI during the watchdog timeout period. The watchdog function is disabled and WDO is a logic high when reset is asserted if V_{CC} is above V_{SW} . WDO is a logic low when V_{CC} is below V_{SW} .

If a system reset is desired on every watchdog fault, simply diode-OR connect WDO to MR (Figure 6). When a watchdog fault occurs in this mode, WDO goes low, pulling MR low, which causes a reset pulse to be issued. Ten microseconds after reset is asserted, the watchdog timer clears and WDO returns high. This delay results in a 10 μ s pulse at WDO, allowing external circuitry to capture a watchdog fault indication. A continuous high or low on WDI causes 200ms reset pulses to be issued every 1.6s.



Figure 6. Generating a Reset on Each Watchdog Fault

Chip-Enable Signal Gating

Internal gating of chip-enable (CE) signals prevents erroneous data from corrupting CMOS RAM in the event of an undervoltage condition. The MAX793/MAX794/MAX795 use a series transmission gate from $\overline{CE}$ IN to $\overline{CE}$ OUT. 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 $\overline{CE}$ IN to $\overline{CE}$ OUT enables these μ P supervisors to be used with most μ Ps. If $\overline{CE}$ IN is low when reset asserts, $\overline{CE}$ OUT remains low for typically 10 μ s to permit completion of the current write cycle.

Chip-Enable Input

The CE transmission gate is disabled and $\overline{CE}$ IN is high impedance (disabled mode) while reset is asserted. During a power-down sequence when V_{CC} passes the reset threshold, the CE transmission gate disables and $\overline{CE}$ IN immediately becomes high impedance if the voltage at $\overline{CE}$ IN is high. If $\overline{CE}$ IN is low when reset asserts, the CE transmission gate disables at the moment $\overline{CE}$ IN goes high, or 10 μ s after reset asserts, whichever occurs first (Figure 8). This permits the current write cycle to complete during power-down.

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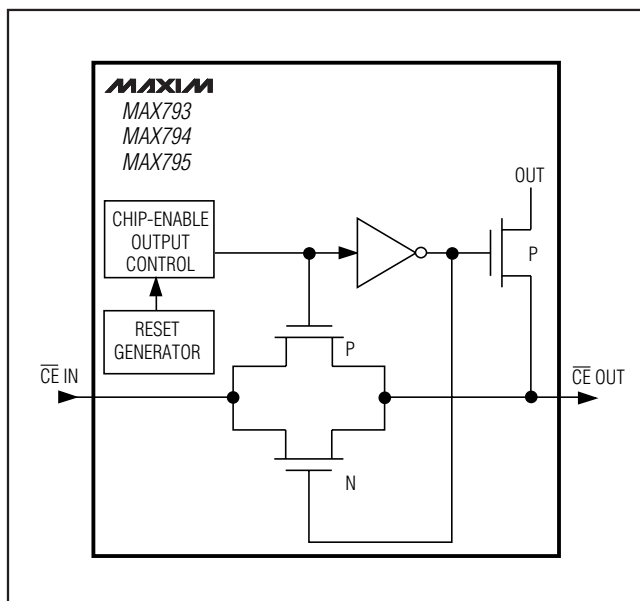


Figure 7. Chip-Enable Transmission Gate

The CE transmission gate remains disabled and $\overline{\text{CE IN}}$ remains high impedance (regardless of $\overline{\text{CE IN}}$ activity) for the first half of the reset timeout period ($\text{TRP} / 2$), any time a reset is generated. While disabled, $\overline{\text{CE IN}}$ is high impedance. When the CE transmission gate is enabled, the impedance of $\overline{\text{CE IN}}$ appears as a 46Ω resistor in series with the load at $\overline{\text{CE OUT}}$.

The propagation delay through the CE transmission gate depends on V_{CC} , the source impedance of the drive connected to $\overline{CE}$ IN, and the loading on $\overline{CE}$ OUT. The CE propagation delay is production tested from the 50% point on $\overline{CE}$ IN to the 50% point on $\overline{CE}$ OUT using a 50Ω driver and 50pF of load capacitance (Figure 9). For minimum propagation delay, minimize the capacitive load at $\overline{CE}$ OUT and use a low-output-impedance driver.

Chip-Enable Output

When the CE transmission gate is enabled, the impedance of $\overline{\text{CE}}_{\text{OUT}}$ is equivalent to a 46Ω resistor in series with the source driving $\overline{\text{CE}}_{\text{IN}}$. In the disabled mode, the transmission gate is off and an active pullup connects $\overline{\text{CE}}_{\text{OUT}}$ to OUT (Figure 8). This pullup turns off when the transmission gate is enabled.

Early Power-Fail Warning (MAX793/MAX794)

Critical systems often require an early warning indicating that power is failing. This warning provides time for the μ P to store vital data and take care of any additional “housekeeping” functions, before the power supply gets too far out of tolerance for the μ P to operate reliably. The MAX793/MAX794 offer two methods of achieving this early warning. If access to the unregulated supply is feasible, the power-fail comparator input (PFI) can be connected to the unregulated supply through a voltage divider, with the power-fail comparator output ($\overline{\text{PFO}}$) providing the NMI to the μ P (Figure

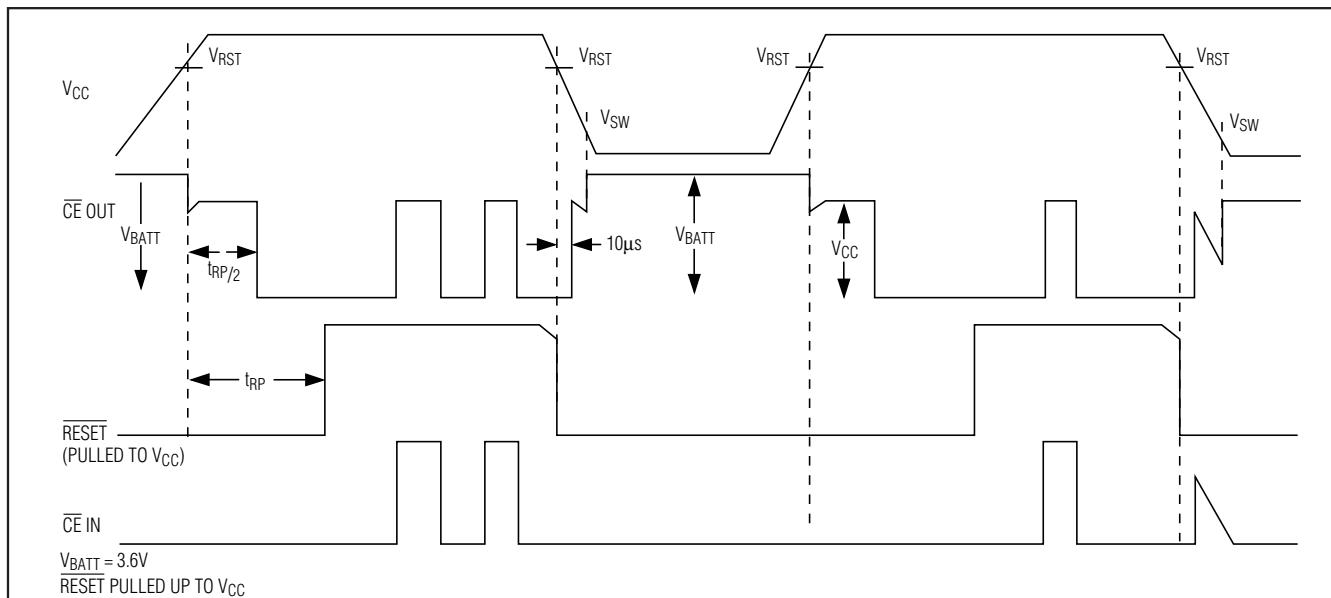


Figure 8. Chip-Enable Timing

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Figure 9. CE Propagation Delay Test Circuit

10). If there is no easy access to the unregulated supply, the LOWLINE output can be used to generate an NMI to the μ P (see *LOWLINE Output* section).

LOWLINE Output (MAX793/MAX794)

The low-line comparator monitors VCC with a threshold voltage typically 45mV above the reset threshold (10mV of hysteresis) for the MAX793, and 15mV above RESET IN (4mV of hysteresis) for the MAX794. For normal operation (VCC above the reset threshold), LOWLINE is pulled to VCC. Use LOWLINE to provide an NMI to the μ P when power begins to fall.

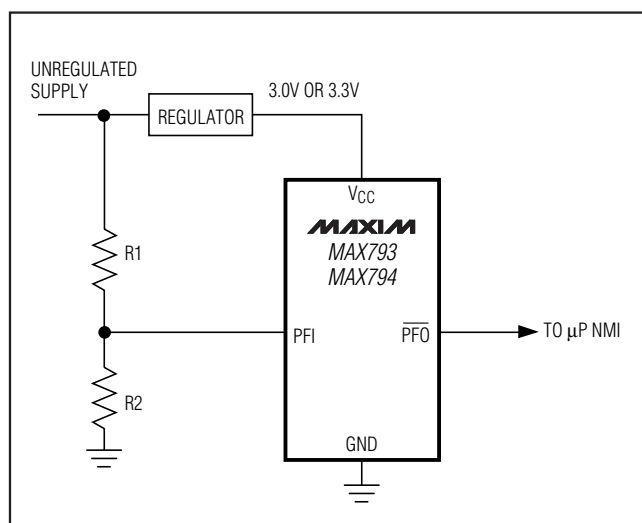


Figure 10. Using the Power-Fail Comparator to Generate Power-Fail Warning

In most battery-operated portable systems, reserve energy in the battery provides ample time to complete the shutdown routine once the low-line warning is encountered and before reset asserts. If the system must also contend with a more rapid VCC fall time, such as when the main battery is disconnected or a high-side switch is opened during normal operation, use capacitance on the VCC line to provide time to execute the shutdown routine (Figure 11).

First, calculate the worst-case time required for the system to perform its shutdown routine. Then, with the worst-case shutdown time, the worst-case load current, and the minimum low-line to reset threshold (V_{LR} min), calculate the amount of capacitance required to allow the shutdown routine to complete before reset is asserted:

$$C_{HOLD} > I_{LOAD} \times t_{SHDN} / V_{LR}$$

where I_{LOAD} is the current being drained from the capacitor, V_{LR} is the low-line to reset threshold difference (V_{LL} - V_{RST}), and t_{SHDN} is the time required for the system to complete an orderly shutdown routine.

Power-Fail Comparator (MAX793/MAX794)

The MAX793/MAX794's PFI input is compared to an internal reference. If PFI is less than the power-fail threshold (V_{PFT}), PFO goes low. The power-fail comparator is intended for use as an undervoltage detector to signal a failing power supply (Figure 12). However, the comparator does not need to be dedicated to this function because it is completely separate from the rest of the circuitry.

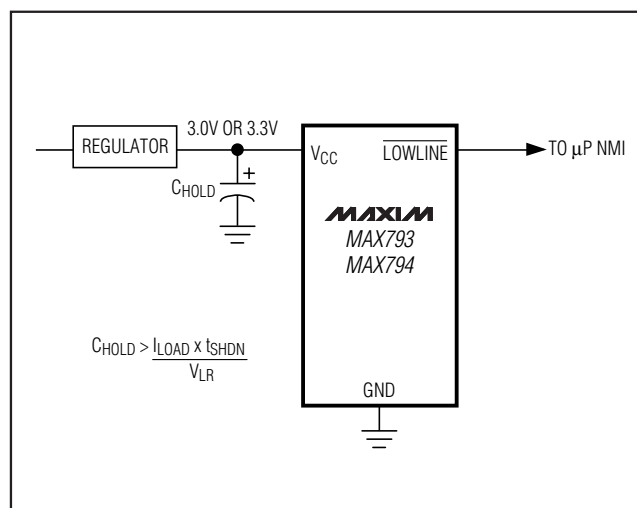


Figure 11. Using LOWLINE to Provide Power-Fail Warning to the μ P

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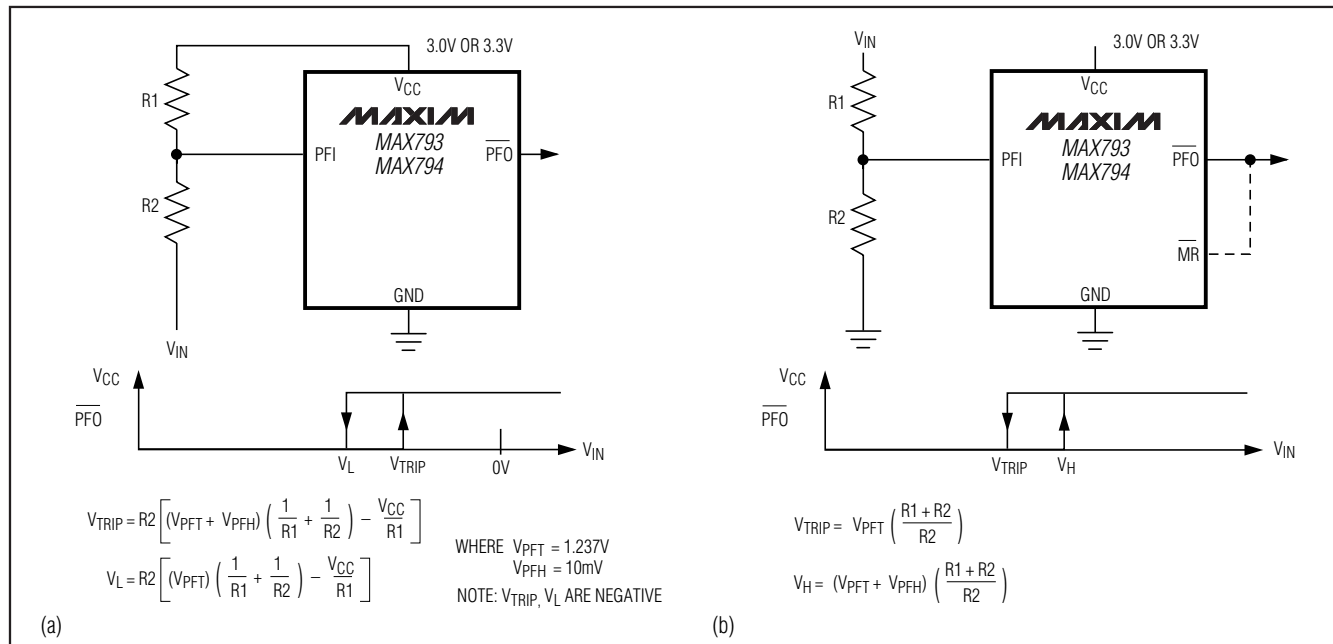


Figure 12. Using the Power-Fail Comparator to Monitor an Additional Power Supply: (a) V_{IN} Is Negative, (b) V_{IN} Is Positive

The power-fail comparator turns off and $\overline{PFO}$ goes low when V_{CC} falls below V_{SW} on power-down. During the first half of the reset timeout period (t_{RP}), $\overline{PFO}$ is forced high, irrespective of V_{PFI} . At the beginning of the second half of t_{RP} , the power-fail comparator is enabled and $\overline{PFO}$ follows PFI . If the comparator is unused, connect PFI to V_{CC} and leave $\overline{PFO}$ unconnected. $\overline{PFO}$ can be connected to $\overline{MR}$ so that a low voltage on PFI generates a reset (Figure 12b). In this configuration, when the monitored voltage causes PFI to fall below V_{PFT} , $\overline{PFO}$ pulls $\overline{MR}$ low, causing a reset to be asserted. Reset remains asserted as long as $\overline{PFO}$ holds $\overline{MR}$ low, and for 200ms after $\overline{PFO}$ pulls $\overline{MR}$ high when the monitored supply is above the programmed threshold.

Backup-Battery Switchover

In the event of a brownout or power failure, it may be necessary to preserve the contents of RAM. With a backup battery installed at $BATT$, the devices automatically switch RAM to backup power when V_{CC} falls. In order to allow the backup battery (e.g., a 3.6V lithium cell) to have a higher voltage than V_{CC} , this family of μP supervisors (designed for 3.3V and 3V systems) does not always connect $BATT$ to OUT when V_{BATT} is greater than V_{CC} . $BATT$ connects to OUT (through a 140 Ω switch) either when V_{CC} falls below V_{SW} and

V_{BATT} is greater than V_{CC} , or when V_{CC} falls below 1.75V (typ) regardless of the $BATT$ voltage.

Switchover at V_{SW} ensures that battery-backup mode is entered before V_{OUT} gets too close to the 2.0V minimum required to reliably retain data in most CMOS RAM, (switchover at higher V_{CC} voltages would decrease backup-battery life). When V_{CC} recovers, switchover is deferred either until V_{CC} crosses V_{BATT} if V_{BATT} is below V_{RST} , or when V_{CC} rises above the reset threshold (V_{RST}) if V_{BATT} is above V_{RST} . This power-up switchover technique prevents V_{CC} from charging the backup battery through OUT when using an external transistor driven by $BATT$ ON. OUT connects to V_{CC} through a 4 Ω (max) PMOS power switch when V_{CC} crosses the reset threshold (Figure 13).

BATT ON (MAX793/MAX794)

$BATT$ ON is high when OUT is connected to $BATT$. Although $BATT$ ON can be used as a logic output to indicate the battery switchover status, it is most often used as a gate or base drive for an external pass transistor for high-current applications (see *Driving an External Switch with BATT ON* in the *Applications Information* section). When V_{CC} exceeds V_{RST} on power-up, $BATT$ ON sinks 3.2mA at 0.4V. In battery-backup mode, this terminal sources 100 μA from $BATT$.

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Figure 13. Battery Switchover Timing

Table 1. Input and Output Status in Battery-Backup Mode

PIN NAME	STATUS
OUT	Connected to BATT through an internal 140Ω switch
V _{CC}	Disconnected from OUT
BATT ON	Pulled up to BATT
BATT OK	Logic low
PFI	Disabled
PFO	Logic low
MR	Disabled, but still pulled up to V _{CC}
WDO	Logic low
WDI	Disabled
RESET	Logic low
RESET	Pulled up to V _{CC}
BATT	Connected to OUT
LOWLINE	Logic low
CE IN	High impedance
CE OUT	Pulled to BATT

Applications Information

These μP supervisory circuits are not short-circuit protected. Shorting V_{OUT} to ground, excluding power-up transients such as charging a decoupling capacitor, destroys the device. Decouple both V_{CC} and BATT pins to ground by placing 0.1μF ceramic capacitors as close to the device as possible.

Driving an External Switch with BATT ON

BATT ON can be directly connected to the base of a PNP transistor or the gate of a PMOS transistor. The PNP connection is straightforward: connect the emitter

to V_{CC}, the collector to OUT, and the base to BATT ON (Figure 14a). No current-limiting resistor is required, but a resistor connecting the base of the PNP to BATT ON can be used to limit the current drawn from V_{CC}, prolonging battery life in portable equipment.

If you are using a PMOS transistor, however, it must be connected backwards from the traditional method. Connect the gate to BATT ON, the drain to V_{CC}, and the source to OUT (Figure 14b). This method orients the body diode from V_{CC} to OUT and prevents the backup battery from discharging through the FET when its gate is high. Two PMOS transistors in the Siliconix LITTLE FOOT® series are specified with V_{GS} down to -2.7V. The Si9433DY has a maximum 100mΩ drain-source on-resistance with 2.7V of gate drive and a 2A drain-source current. The Si9434DY specifies a 60mΩ drain-source on-resistance with 2.7V of gate drive and a 5.1A drain-source current.

Using a Super Cap as a Backup Power Source

Super caps are capacitors with extremely high capacitance values (e.g., order of 0.47F) for their size. Figure 15 shows two ways to use a super cap as a backup power source. The super cap can be connected through a diode to the 3V input (Figure 15a); or, if a 5V supply is also available, the super cap can be charged up to the 5V supply (Figure 15b), allowing a longer backup period. Since V_{BATT} can exceed V_{CC} while V_{CC} is above the reset threshold, there are no special precautions when using these μP supervisors with a super cap.

Operation without a Backup Power Source

These μP supervisors were designed for battery-backed applications. If a backup battery is not used, connect BATT, OUT, and V_{CC} together, or use a different μP supervisor.

Replacing the Backup Battery

The backup power source can be removed while V_{CC} remains valid, without danger of triggering a reset pulse, provided that BATT is decoupled with a 0.1μF capacitor to ground. As long as V_{CC} stays above the reset threshold, battery-backup mode cannot be entered.

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Figure 14. Driving an External Transistor with BATT ON



Figure 15. Using a Super Cap as a Backup Source

Adding Hysteresis to the Power-Fail Comparator (MAX793/MAX794)

The power-fail comparator has a typical input hysteresis of 10mV. This is sufficient for most applications where a power-supply line is being monitored through an external voltage divider (see the section *Monitoring an Additional Power Supply*).

If additional noise margin is desired, connect a resistor between PFO and PFI as shown in Figure 16a. Select the ratio of R1 and R2 such that PFI sees V_{PFT} when V_{IN} falls to its trip point (V_{TRIP}). R3 adds the additional hysteresis and should typically be more than 10 times the value of R1 or R2. The hysteresis window extends

both above (V_H) and below (V_L) the original trip point (V_{TRIP}).

Connecting an ordinary signal diode in series with R3, as shown in Figure 16b, causes the lower trip point (V_L) to coincide with the trip point without hysteresis (V_{TRIP}), so the entire hysteresis window occurs above V_{TRIP} . This method provides additional noise margin without compromising the accuracy of the power-fail threshold when the monitored voltage is falling. It is useful for accurately detecting when a voltage falls past a threshold. The current through R1 and R2 should be at least 1μA to ensure that the 25nA (max over temperature) PFI input current does not shift the trip point. R3 should be larger than 82kΩ so it does not load down the PFO pin. Capacitor C1 is optional, and adds noise rejection.

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Figure 16. Adding Hysteresis to the Power-Fail Comparator: (a) Symmetrical Hysteresis, (b) Hysteresis Only on Rising V_{IN}

Monitoring an Additional Power Supply

These μP supervisors can monitor either positive or negative supplies using a resistor voltage divider to PFI. PFO can be used to generate an interrupt to the μP or to cause reset to assert (Figure 12).

Interfacing to μP s with Bidirectional Reset Pins

Since the $\overline{\text{RESET}}$ output is open drain, the MAX793/MAX794/MAX795 interface easily with μP s that have bidirectional reset pins, such as the Motorola 68HC11. Connecting the $\overline{\text{RESET}}$ output of the μP supervisor directly to the $\overline{\text{RESET}}$ input of the microcontroller with a single pullup resistor allows either device to assert reset (Figure 17).

Negative-Going V_{CC} Transients

These supervisors are relatively immune to short-duration negative-going V_{CC} transients (glitches) while issuing resets to the μP during power-up, power-down, and brownout conditions. Therefore, resetting the μP when V_{CC} experiences only small glitches is usually not recommended.



Figure 17. Interfacing to μP s with Bidirectional Reset I/O

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Figure 18 shows maximum transient duration vs. reset-comparator overdrive, for which reset pulses are **not** generated. The graph was produced using negative-going V_{CC} pulses, starting at 3.3V and ending below the reset threshold by the magnitude indicated (reset comparator overdrive). The graph shows the maximum pulse width a negative-going V_{CC} transient can typically have without causing a reset pulse to be issued. As the amplitude of the transient increases (i.e., goes farther below the reset threshold), the maximum allowable pulse width decreases. Typically, a V_{CC} transient that goes 40mV below the reset threshold and lasts for 10 μ s or less does not cause a reset pulse to be issued.

A 0.1 μ F bypass capacitor mounted close to the V_{CC} pin provides additional transient immunity.

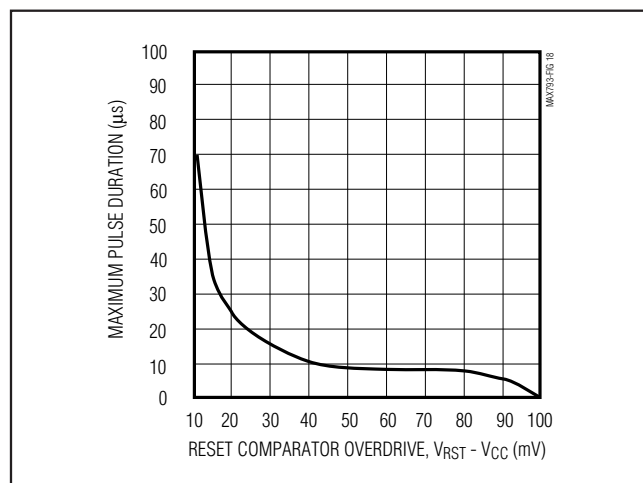


Figure 18. Maximum Transient Duration without Causing a Reset Pulse vs. Reset Comparator Overdrive

Watchdog Software Considerations

There is a way to help the watchdog timer monitor software execution more closely, which involves setting and resetting the watchdog input at different points in the program rather than pulsing the watchdog input high-low-high or low-high-low. This technique avoids a stuck loop, in which the watchdog timer would continue to be reset within the loop, keeping the watchdog from timing out. Figure 19 shows an example of a flow diagram where the I/O driving the watchdog input is set high at the beginning of the program, set low at the beginning of every subroutine or loop, then set high again when the program returns to the beginning. If the program should hang in any subroutine, the problem would quickly be corrected, since the I/O is continually set low and the watchdog timer is allowed to time out, causing a reset or interrupt to be issued.

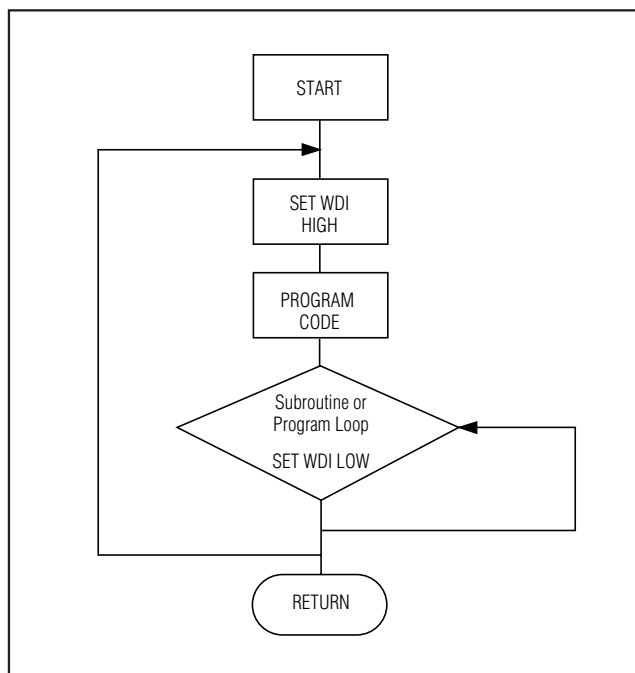


Figure 19. Watchdog Flow Diagram

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MAX793/MAX794/MAX795

Ordering Information (continued)

PART*	TEMP RANGE	PIN-PACKAGE
MAX793_EPE	-40°C to +85°C	16 Plastic DIP
MAX793_ESE	-40°C to +85°C	16 Narrow SO
MAX794 CPE	0°C to +70°C	16 Plastic DIP
MAX794CSE	0°C to +70°C	16 Narrow SO
MAX794EPE	-40°C to +85°C	16 Plastic DIP
MAX794ESE	-40°C to +85°C	16 Narrow SO
MAX795 _CPA	0°C to +70°C	8 Plastic DIP
MAX795_CSA	0°C to +70°C	8 SO
MAX795_EPA	-40°C to +85°C	8 Plastic DIP
MAX795_ESA	-40°C to +85°C	8 SO

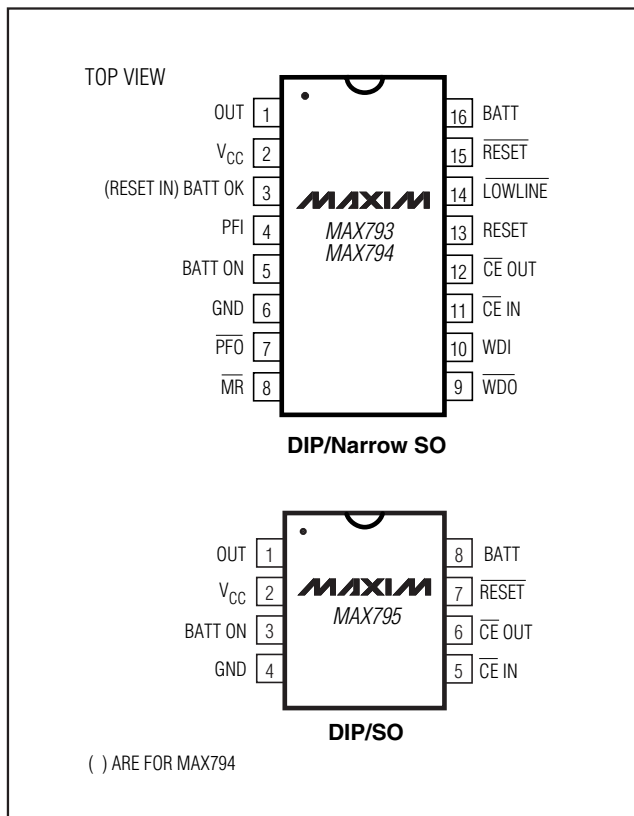
*The MAX793/MAX795 offer a choice of reset threshold voltage. Select the letter corresponding to the desired reset threshold voltage range (T = 3.00V to 3.15V, S = 2.85V to 3.00V, R = 2.55V to 2.70V) and insert it into the blank to complete the part number. The MAX794's reset threshold is adjustable.

Devices are available in both leaded and lead-free packaging. Specify lead free by adding the + symbol at the end of the part number when ordering.

Chip Information

TRANSISTOR COUNT: 1271

Pin Configurations



Package Information

For the latest package outline information and land patterns, go to www.maxim-ic.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.
8 SO	S8-2	21-0041
8 Plastic Dip	R8-1	21-0043
16 Plastic Dip	P16-1	21-0043
16 Narrow SO	S16-1	21-0041

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Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/95	Initial release	—
5	2/07	Revised <i>Electrical Characteristics</i> .	4
6	3/10	Revised <i>Absolute Maximum Ratings</i> and <i>Chip-Enable Input</i> section.	1, 2

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