

# DATA SHEET

## **MAX708R/S/T**

3 V microprocessor supervisor circuit with  
power fail comparator and manual reset

Product data  
Supersedes data of 20 Jun 2002

2003 Feb 13

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

## MAX708R/S/T

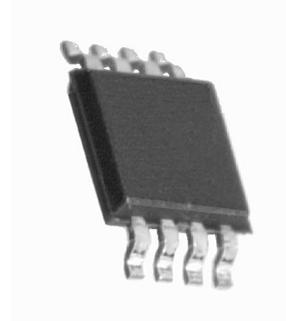
### DESCRIPTION

The MAX708R/S/T are microprocessor supervisory circuits used to monitor +3 V power supply levels in +3 V to +5 V microprocessor and other logic systems. The R, S, T suffixes have reset thresholds of 2.63 V, 2.93 V and 3.08 V, respectively. They reduce the number of circuit components, and improve reliability and accuracy compared to using separate ICs or discrete components.

The MAX708R/S/T features make the MAX708R/S/T ideal for use in portable, battery operated equipment. The low supply current, typically 50  $\mu$ A, minimizes battery load. Both  $\overline{\text{RESET}}$  and RESET are active during power-up, power-down and brownout conditions. An active-LOW manual reset input is also available.

A 1.25 V threshold detector provides power-fail warning. This independent comparator can be used to monitor a second voltage supply and provide an early warning to the microprocessor that voltage is falling. This allows for an orderly shutdown, transmitting an alert to an operator, or activation of an alternate power source before the device asserts the reset signals.

The device is available in the 8-pin SO package.



### FEATURES

- RESET and  $\overline{\text{RESET}}$  signals
- Independent comparator with 1.25 V threshold for power failure or low battery warning
- Manual reset input
- 50  $\mu$ A quiescent current
- Reset thresholds of 2.63, 2.93, and 3.08 V
- Guaranteed RESET assertion to  $V_{\text{CC}} = 1$  V

### APPLICATIONS

- Battery powered devices
- Critical microprocessor monitoring
- Controllers
- Portable instruments

### SIMPLIFIED SYSTEM DIAGRAM

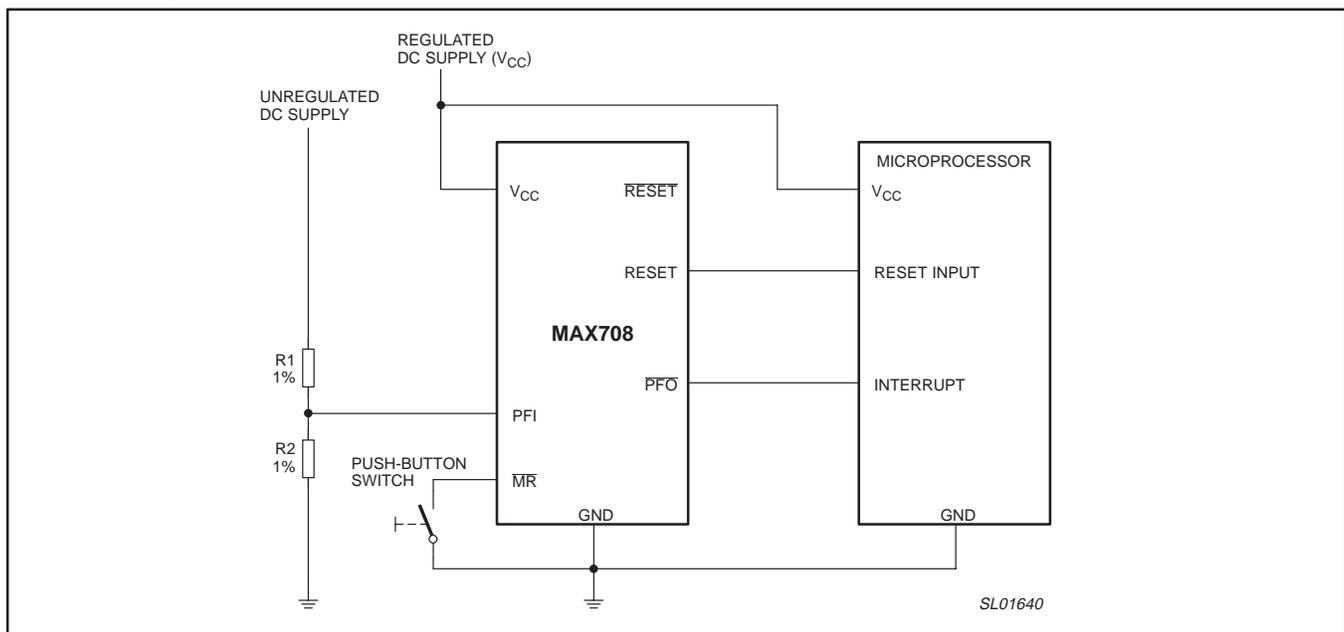


Figure 1. Simplified system diagram.

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

## MAX708R/S/T

### ORDERING INFORMATION

TYPE NUMBER	PACKAGE		TEMPERATURE RANGE
	NAME	DESCRIPTION	
MAX708xD	SO8	plastic small outline package; 8 leads (see dimensional drawing)	-45 °C to +85 °C

**NOTE:**

The device has 3 voltage output options, indicated by the 'x' on the 'Type number'.

Part number	Threshold Voltage (Typical)
MAX708RD	2.63 V
MAX708SD	2.93 V
MAX708TD	3.08 V

### PIN CONFIGURATION

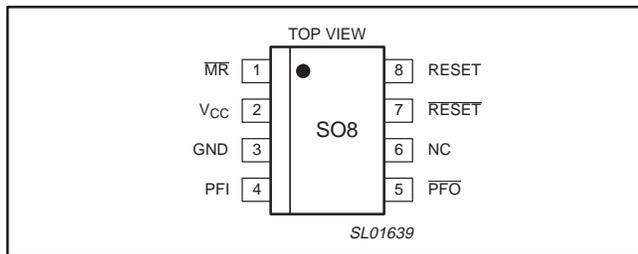


Figure 2. Pin configuration.

### PIN DESCRIPTION

PIN	SYMBOL	DESCRIPTION
1	$\overline{MR}$	Manual reset input (Active-LOW). Triggers a reset pulse when pulled below 0.6 V. Connect to $V_{CC}$ or leave floating if not used.
2	$V_{CC}$	Supply voltage input.
3	GND	Ground.
4	PFI	Power fail comparator input. When PFI is less than 1.25 V, PFO goes LOW, otherwise PFO remains HIGH. Connect to ground if not used.
5	PFO	Power fail comparator output (Active-LOW). When voltage at PFI is less than 1.25 V, PFO goes LOW and sinks current. Do not connect if not used.
6	NC	No connection.
7	RESET	Active-LOW reset output. RESET is LOW if $V_{CC}$ is below the threshold voltage or if $\overline{MR}$ is held LOW. RESET is maintained for 200 ms after the reset conditions are terminated.
8	RESET	Active-HIGH reset output. RESET is HIGH if $V_{CC}$ is below the threshold voltage or if $\overline{MR}$ is held LOW. RESET is maintained for 200 ms after the reset conditions are terminated.

### MAXIMUM RATINGS

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CC}$	Supply voltage		-0.3	6.0	V
$V_n$	Other input pin voltage	Note 1	-0.3	$V_{CC} + 0.3$	V
	Input current at $V_{CC}$ or GND		-	20	mA
	Output current, all outputs		-	20	mA
	Rate of rise at $V_{CC}$		-	100	V/ $\mu$ s
$T_{amb}$	Ambient temperature		-40	+85	°C
$T_{stg}$	Storage temperature		-65	+160	°C
P	Power dissipation, SO8 package	$T_{amb} = 70$ °C; Note 2	-	470	mW

**NOTES:**

- Input voltage limits on PFI and  $\overline{MR}$  can be exceeded provided the input current is less than 10 mA.
- Derate the dissipation 5.88 mW/°C above 70 °C.

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## ELECTRICAL CHARACTERISTICS

$T_{amb} = -40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ ;  $V_{CC} = (V_{RST(max)} + 0.7\text{ V})$  to 5.5 V, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT		
$V_{CC}$	Operating voltage range		1.2	–	5.5	V		
$I_{SUP}$	Supply current	$V_{CC} < 3.6\text{ V}$	–	50	300	$\mu\text{A}$		
		$V_{CC} < 5.5\text{ V}$	–	65	500	$\mu\text{A}$		
$V_{RST}$	Reset threshold (Note 1)	MAX708R	2.55	2.63	2.70	V		
		MAX708S	2.85	2.93	3.00	V		
		MAX708T	3.00	3.08	3.15	V		
	Reset threshold hysteresis		–	20	–	mV		
$t_{RST}$	Reset delay time (Note 1)	MAX708R; $V_{CC} = 3.0\text{ V}$	140	200	280	ms		
		MAX708S, MAX708T; $V_{CC} = 3.3\text{ V}$	140	200	280	ms		
		MAX708R, MAX708S, MAX708T; $V_{CC} = 5.0\text{ V}$	–	200	–	ms		
$V_{OH}$	HIGH-level output voltage	RESET	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $I_{SOURCE} = 500\text{ }\mu\text{A}$	$V_{CC} \times 0.8$	–	–	V	
			$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $I_{SOURCE} = 800\text{ }\mu\text{A}$	$V_{CC} - 1.5$	–	–	V	
		RESET	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $I_{SOURCE} = 500\text{ }\mu\text{A}$	$V_{CC} \times 0.8$	–	–	V	
			$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $I_{SOURCE} = 800\text{ }\mu\text{A}$	$V_{CC} - 1.5$	–	–	V	
		PFO	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $I_{SOURCE} = 500\text{ }\mu\text{A}$	$V_{CC} \times 0.8$	–	–	V	
			$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $I_{SOURCE} = 800\text{ }\mu\text{A}$	$V_{CC} - 1.5$	–	–	V	
$V_{OL}$	LOW-level output voltage	RESET	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $I_{SINK} = 1.2\text{ mA}$	–	–	0.3	V	
			$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $I_{SINK} = 3.2\text{ mA}$	–	–	0.4	V	
			$V_{CC} = 1.2\text{ V}$ ; $I_{SINK} = 100\text{ }\mu\text{A}$	–	–	0.3	V	
		RESET	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $I_{SINK} = 500\text{ }\mu\text{A}$	–	–	0.3	V	
			$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $I_{SINK} = 1.2\text{ mA}$	–	–	0.4	V	
		PFO	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $I_{SINK} = 1.2\text{ mA}$	–	–	0.3	V	
			$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $I_{SINK} = 3.2\text{ mA}$	–	–	0.4	V	
			$\overline{MR}$ pull-up current	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$ ; $\overline{MR} = 0\text{ V}$	25	70	250	$\mu\text{A}$
				$4.5\text{ V} < V_{CC} < 5.5\text{ V}$ ; $\overline{MR} = 0\text{ V}$	100	250	600	$\mu\text{A}$
$t_{MR}$	$\overline{MR}$ pulse width	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$	500	–	–	ns		
		$4.5\text{ V} < V_{CC} < 5.5\text{ V}$	150	–	–	ns		
$V_{IL}$	$\overline{MR}$ LOW-level input threshold	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$	–	–	0.6	V		
		$4.5\text{ V} < V_{CC} < 5.5\text{ V}$	–	–	0.8	V		
$V_{IH}$	$\overline{MR}$ HIGH-level input threshold	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$	$V_{CC} \times 0.7$	–	–	V		
		$4.5\text{ V} < V_{CC} < 5.5\text{ V}$	2.0	–	–	V		
$t_{MD}$	MR to reset out delay (Note 1)	$V_{RST(max)} < V_{CC} < 3.6\text{ V}$	–	–	750	ns		
		$4.5\text{ V} < V_{CC} < 5.5\text{ V}$	–	–	250	ns		
	PFI input threshold	PFI falling; MAX708R: $V_{CC} = 3.0\text{ V}$ ; MAX708S/T: $V_{CC} = 3.3\text{ V}$	1.2	1.25	1.3	V		
	PFI input current		–25	0.01	+25	nA		

### NOTE:

1. Applies to RESET and RESET.

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

## MAX708R/S/T

### TIMING DIAGRAM

On power-up, when  $V_{CC}$  reaches 1 V,  $\overline{RESET}$  is guaranteed to be a logic LOW and RESET is guaranteed to be a logic HIGH.

**Event A:**  $V_{CC}$  rises to the reset threshold voltage,  $V_{RST}$ . At this time, the internal reset delay timer is initiated.  $\overline{RESET}$  and RESET will remain asserted for the reset delay time,  $t_{RST}$  of typically 200 ms after the supply voltage rises above the reset threshold,  $V_{RST}$ .

**Event B:** At this time, the resets are released.  $\overline{RESET}$  goes HIGH; while RESET goes LOW. The reset delay time helps to ensure valid reset signals despite erratic changes in supply voltage.

**Events C–E:** At Event C, under brown-out conditions,  $V_{CC}$  falls below the reset threshold minus the hysteresis voltage (typically 20 mV), and the reset signal is asserted. As power recovers and  $V_{CC}$  rises above the reset threshold (Event D), it once again initiates the reset delay time. At Event E,  $V_{CC}$  falls below the reset threshold before the reset delay time has elapsed and reset remains asserted.

**Event F:** The  $V_{CC}$  rises above the reset threshold again and remains above the reset threshold for typically 200 ms. At G, the reset is once again released.

**Event H:** The  $\overline{MR}$  is externally pulled LOW for longer than 150 ns (minimum  $\overline{MR}$  pulse width,  $t_{MR}$  for  $V_{CC} = +5V$ ).

**Event I:** The manual reset is asserted within 250 ns (maximum  $\overline{MR}$  to reset out delay time,  $t_{MD}$  for  $V_{CC} = +5V$ ).

**Event J:** the  $\overline{MR}$  pin returns HIGH. At this point, reset delay timer is initiated and in typically 200 ms, (at Event K), the reset condition is released.

**Event L:** On power-down, when  $V_{CC}$  falls below  $V_{RST} - 20\text{ mV}$ ,  $\overline{RESET}$  and RESET are guaranteed to be asserted until  $V_{CC}$  falls below 1 V.

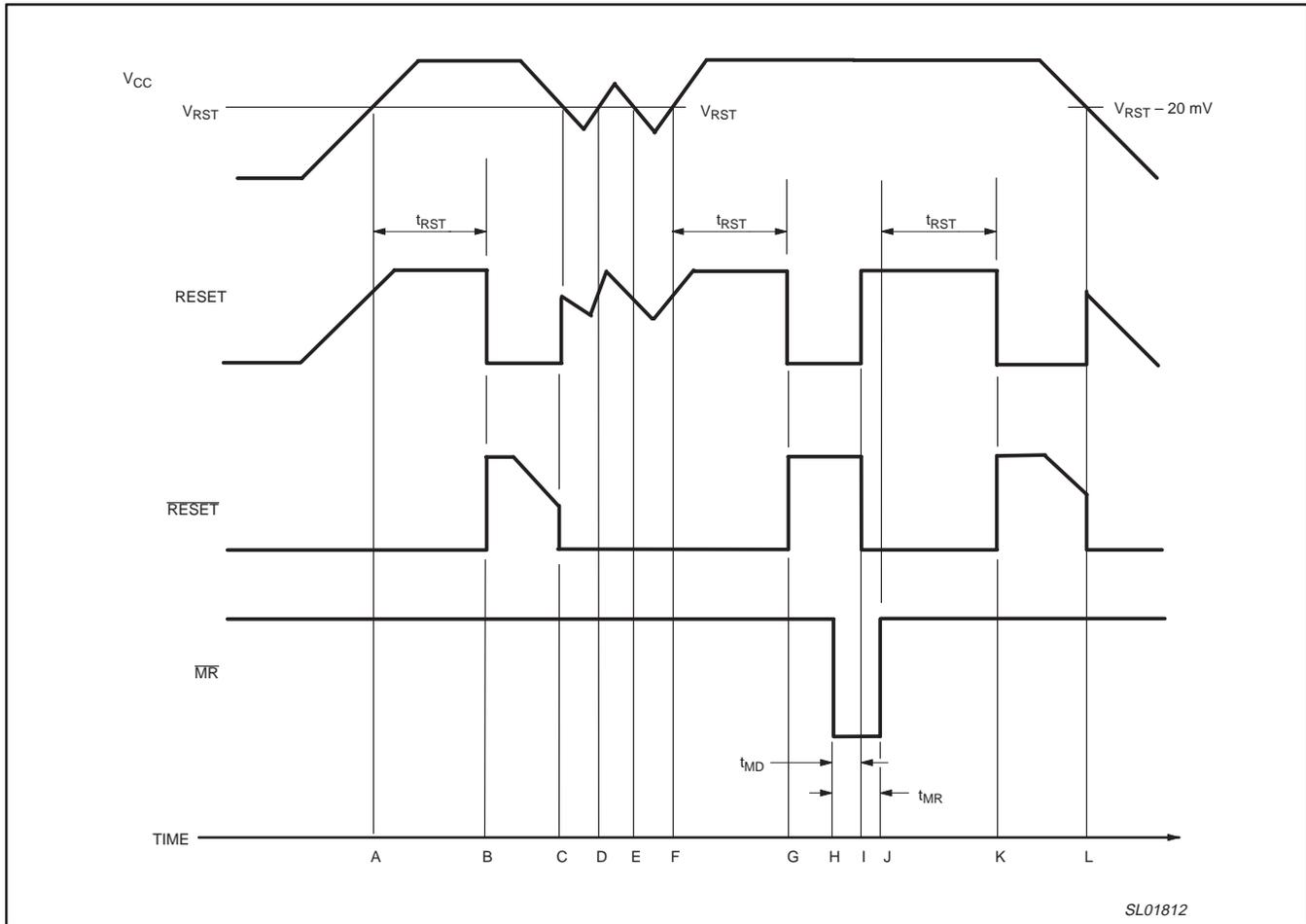


Figure 3. Timing diagram.

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

## MAX708R/S/T

### TECHNICAL DISCUSSION

#### General discussion

The MAX708R/S/T microprocessor supervisor circuits are comprised of both  $\overline{\text{RESET}}$  and RESET outputs, a  $\overline{\text{MR}}$  manual reset input, and a comparator which may be used for power-failure detection (see Figure 4).

The reset threshold voltages are guaranteed within  $\pm 3\%$  of the nominal reset threshold. The MAX708R/S/T are designed to monitor +3 V to +3.3 V power supplies in +3 V to +5 V microprocessor and other logic systems. With a threshold voltage range between 5% to 10% of the nominal supply voltage, the MAX708R/S/T will assert an output within predictable range of power supply voltage.

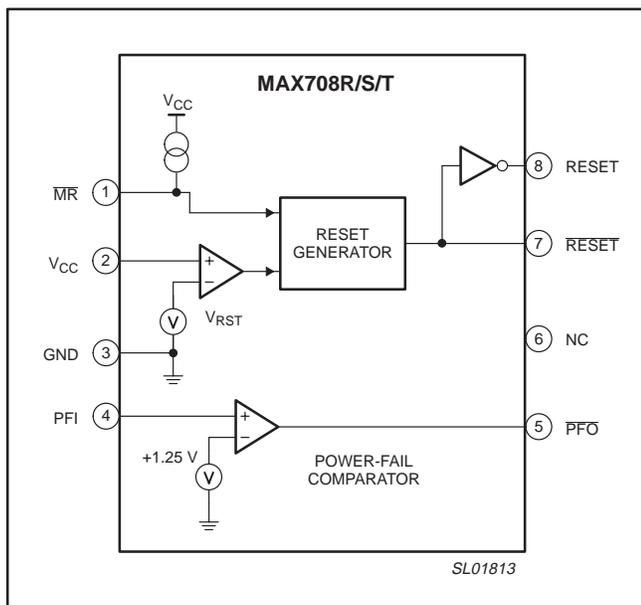


Figure 4. MAX708R/S/T internal block diagram.

#### $\overline{\text{RESET}}$ and RESET outputs

The MAX708R/S/T  $\overline{\text{RESET}}$  and RESET outputs are push-pull outputs and do not require an external pull-up resistor. The  $\overline{\text{RESET}}$  output is active-LOW logic, while the RESET output is active-HIGH logic.

#### Manual Reset

The manual reset input,  $\overline{\text{MR}}$  is active-LOW logic. It allows the  $\overline{\text{RESET}}$  and RESET to be asserted by a pushbutton switch. A mechanical pushbutton switch is effectively debounced by the 140 ms minimum reset time delay.  $\overline{\text{MR}}$  may be driven from an external logic circuit because it is TTL/CMOS compatible. The minimum  $\overline{\text{MR}}$  input pulse is 500 ns for  $V_{CC} = +3$  V and 150 ns for  $V_{CC} = +5$  V. If manual reset will not be used, leave the pin left floating or tie it to  $V_{CC}$ .

#### Power-fail comparator

The power-fail comparator has many useful purposes, such as monitoring upstream or secondary power supplies. The Power-Fail Output (PFO) and the non-inverting Power-Fail Input (PFI) are pinned out. The inverting input of the power-fail comparator is internally connected to a 1.25 V reference. The comparator has 10 mV of hysteresis which prevents repeated triggering of the output (PFO).

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## MAX708R/S/T

### APPLICATION INFORMATION

#### Operating with a +3 V or +5 V supply

When powered from either +3.0 V or +5.0 V, the MAX708R/S/T provides voltage monitoring at the reset threshold. The MAX708R/S/T are ideal for portable applications that are powered from a +3 V battery or an AC-DC wall adapter that generates +5 V.

#### Power-fail comparator

An early warning power-fail circuit uses the power-fail input to monitor the upstream, unregulated DC supply that powers the +3 V/+3.3 V regulator powering the MAX708R/S/T.

Figure 1, "Simplified system diagram", shows the resistor divider network that is connected to PFI. The network resistors R1 and R2 are chosen so that the voltage at PFI will fall below 1.25 V before the regulator voltage drops out. The PFO signal may be used to interrupt the microprocessor so it can perform an orderly shutdown.

Any unregulated or regulated supply can be monitored by adjusting the resistive divider for the desired power supply trip voltage. Table 1 shows examples for nominal trip voltages of 3.7 V and 10.9 V. The desired trip voltage,  $V_T$  is calculated by the following equation:

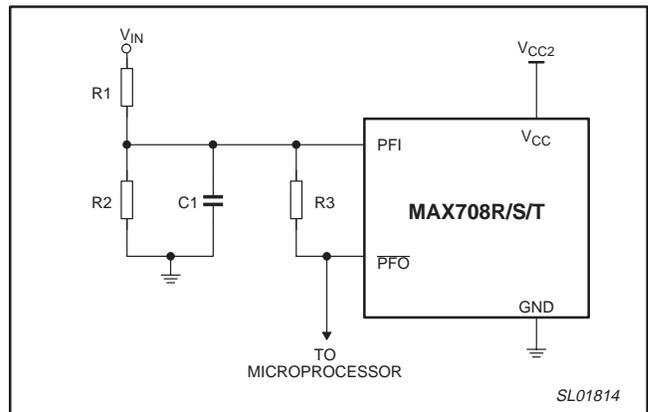
$$V_T = 1.25 \text{ V} \left[ \frac{R1 + R2}{R2} \right]$$

**Table 1. Power-fail detection circuit of 3.7 V and 10.9 V**

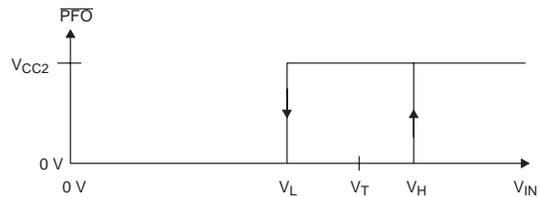
	R1 1%	R2 1%	$V_T$
5 V unregulated power supply	1 M $\Omega$	510 k $\Omega$	3.7 V
12 V unregulated power supply	1 M $\Omega$	130 k $\Omega$	10.9 V

#### Adding hysteresis to the power-fail comparator

Hysteresis adds noise margin to the power-fail comparator and prevents repeated triggering of PFO when  $V_{IN}$  is varying around the comparator trip point. In Figure 5, "Adding hysteresis to the power-fail comparator", R1 and R2 are the divider resistors that set the desired trip point. R3 is added from the comparator input to the output to increase hysteresis; it is typically an order of magnitude greater than R1 and R2. The current through R1 and R2 should be at least 1 mA to ensure that the 25 nA max PFI input current does not significantly shift the trip point. Capacitor C1 provides noise rejection.



**Figure 5. Adding hysteresis to the power-fail comparator.**



$$V_T = 1.25 \text{ V} \left[ \frac{R1 + R2}{R2} \right]$$

The hysteresis of  $V_H$  and  $V_L$  voltages are calculated by:

$$V_H = 1.25 \text{ V} \left\{ 1 + \left[ \frac{R3 + R2}{R2 \times R3} \right] R1 \right\}$$

$$V_L = 1.25 \text{ V} + R1 \left\{ \left( \frac{1.25}{R2} \right) + \left( \frac{1.25 - V_{CC}}{R3} \right) \right\}$$

Thus,

$$V_{HYS} = V_H - V_L = \frac{R1 \times V_{CC}}{R3}$$

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## MAX708R/S/T

### Monitoring a negative voltage

The power-fail comparator can be used to monitor a negative voltage using the circuit shown in Figure 6.

When the negative supply is operating in tolerance,  $\overline{PFO}$  is LOW. However, when the negative supply drops (goes positive)  $\overline{PFO}$  goes HIGH.

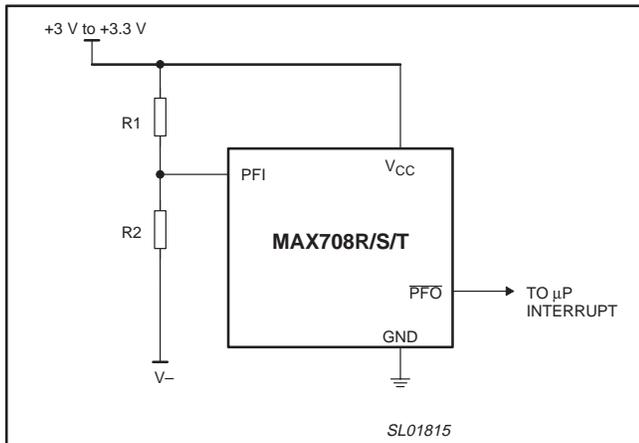


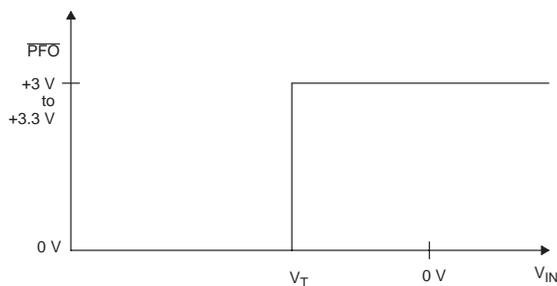
Figure 6. Circuit for monitoring a negative voltage.

When monitoring a negative supply, the trip voltage,  $V_T$  is a negative voltage. Use the following ratio to determine the divider resistors:

$$\frac{(V_{CC} - 1.25)}{R1} = \frac{(1.25 - V_T)}{R2}$$

Solving for  $V_T$ :

$$V_T = 1.25 - \left(\frac{R2}{R1}\right) (V_{CC} - 1.25)$$



### Ensuring a valid reset down to $V_{CC} = 0 V$

When  $V_{CC}$  falls below 1 V, the MAX708R/S/T  $\overline{RESET}$  no longer sinks current (i.e., it becomes open circuit). A high impedance CMOS logic input connected to  $\overline{RESET}$  can drift to undetermined voltages. In most applications in which the microprocessor circuitry is inoperative below 1 V this will not present a problem. However, in applications in which  $\overline{RESET}$  must be valid down to 0 V, use a relatively large pull-down resistor from  $\overline{RESET}$  to ground (Figure 7). 100 k $\Omega$  is small enough to provide a path for any stray leakage currents to flow to ground (holding  $\overline{RESET}$  LOW), while it is large enough not to load  $\overline{RESET}$ .

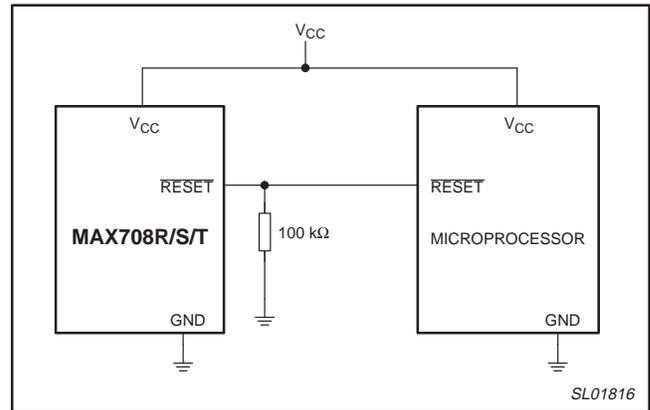


Figure 7.  $\overline{RESET}$  valid to  $V_{CC} = \text{Ground}$  circuit.

### Interfacing to a microprocessor with bi-directional reset pins

Microprocessors with bi-directional reset pins, such as the Motorola 68HC11 series, can be connected to the MAX708R/S/T  $\overline{RESET}$  output. The bi-directional reset of the microprocessor functions both as a driven reset input and as an active reset driver.

To ensure a correct output on the MAX708R/S/T even when the microprocessor reset pin is in the opposite state, connect a 4.7 k $\Omega$  resistor between the reset pins as shown in Figure 8. This allows the microprocessor to issue commands to the system regardless of the state of the  $\overline{RESET}$  pin.

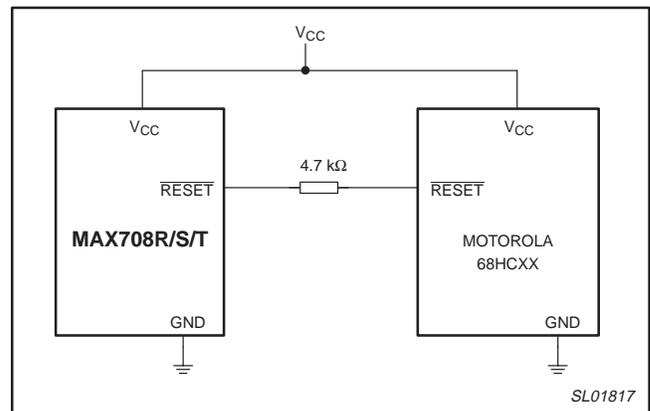


Figure 8. Interfacing to a microprocessor with bi-directional Reset I/O

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

## MAX708R/S/T

### PACKING METHOD

The MAX708R/S/T are packed in reels, as shown in Figure 9.

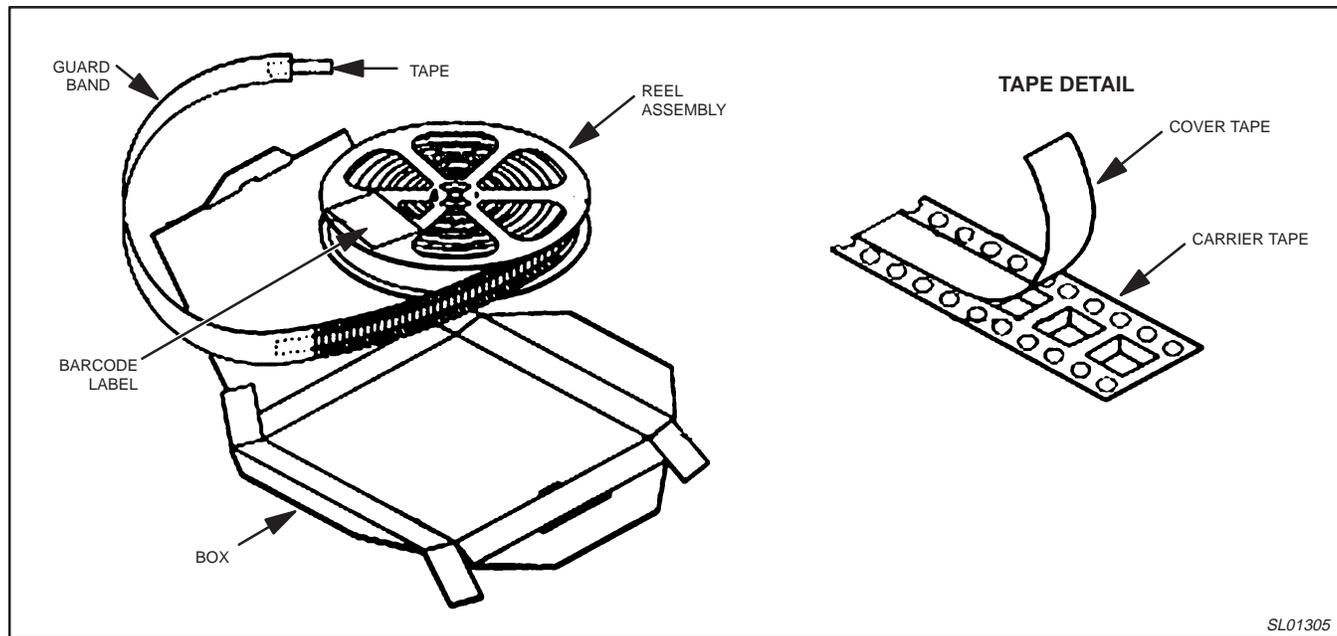
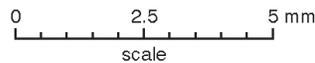
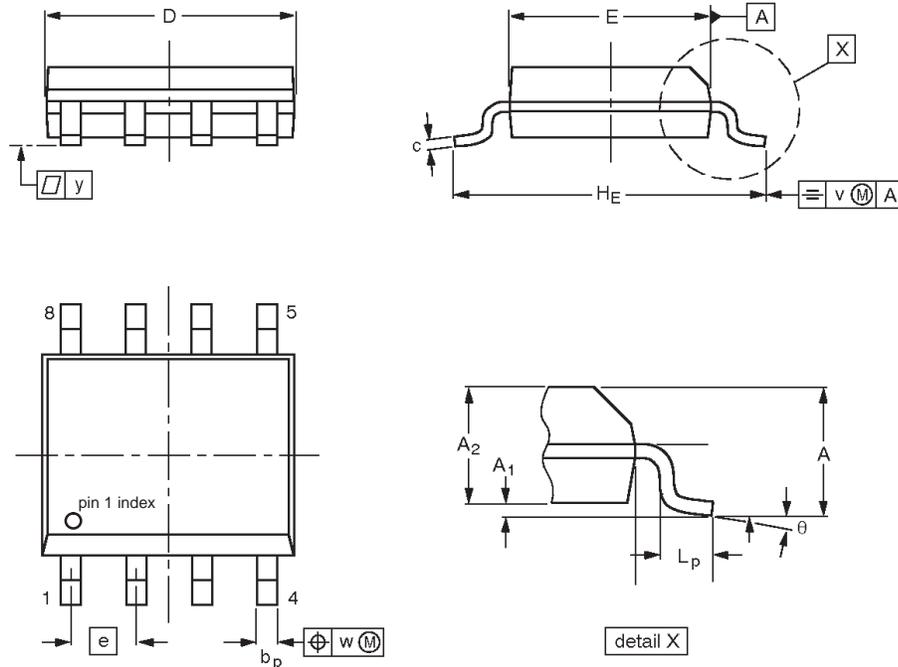


Figure 9. Tape and reel packing method.

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

## MAX708R/S/T

**SO8: plastic small outline package; 8 leads; body width 3.9 mm**



**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	B <sub>2</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L <sub>p</sub>	y	θ
mm	1.73	0.25 0.10	1.45 1.25	4.95 4.80	0.51 0.33	0.25 0.19	4.95 4.80	4.0 3.8	1.27	6.2 5.8	1.27 0.38	0.076	8° 0°
inches	0.068	0.010 0.004	0.057 0.049	0.189 0.195	0.013 0.020	0.0100 0.0075	0.20 0.19	0.16 0.15	0.050	0.244 0.228	0.050 0.015	0.003	

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES		
	IEC	JEDEC	EIAJ
SO8	076E03	MS-012	

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**MAX708R/S/T****REVISION HISTORY**

Rev	Date	Description
_2	20030213	<b>Product data (9397 750 10514); ECN 853–2354 29010 of 02 October 2002; supersedes data of 20 Jun 2002 (9397 750 10023).</b> <b>Modifications:</b> <ul style="list-style-type: none"><li>● Ordering information: change temperature range from: (0 °C to +70 °C) to: (–45 °C to +85 °C).</li><li>● Maximum ratings: change (<math>T_{opr}</math>, operating temperature) to (<math>T_{amb}</math>, ambient temperature).</li></ul>
_1	20020620	<b>Product data (9397 750 10023).</b> Engineering Change Notice 853–2354 28505 (date: 20020620).

# 3 V microprocessor supervisor circuit with power fail comparator and manual reset

MAX708R/S/T

## Data sheet status

Level	Data sheet status <sup>[1]</sup>	Product status <sup>[2] [3]</sup>	Definitions
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

## Definitions

**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

**Application information** — Applications that are described herein for any of these products are for illustrative purposes only. Philips Semiconductors make no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

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