**Features:**

- Incorporates the Functionality of the Industry Standard TC1232 (Processor Monitor, Watchdog and Manual Override Reset Controller) into a Small, Lower Cost Package
- Guards Against Unstable Processor Operation Resulting from Power “Brown-Out”
- Automatically Halts and Restarts an Out-of-Control Microprocessor
- Output can be Wire-ORed, or Hooked to Manual Reset Push-button Switch
- Space-Saving 3-Pin TO-92 or SOT-223 Package

**Applications:**

- All Microprocessor-Based Systems
- Battery Powered Computers and Controllers
- Automotive Systems
- Intelligent Instruments
- Critical Processor Monitoring
- Embedded Controllers

**Device Selection Table**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>Temp. Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>TC32MCDB</td>
<td>SOT-223</td>
<td>0°C to +70°C</td>
</tr>
<tr>
<td>TC32MCZB</td>
<td>TO-92</td>
<td>0°C to +70°C</td>
</tr>
<tr>
<td>TC32MEDB</td>
<td>SOT-223</td>
<td>-40°C to +85°C</td>
</tr>
<tr>
<td>TC32MEZB</td>
<td>TO-92</td>
<td>-40°C to +85°C</td>
</tr>
</tbody>
</table>

**General Description:**

The TC32M is a fully-integrated processor supervisor in a 3-pin package. It provides three important functions to safeguard processor sanity: precision power on/off Reset control, Watchdog Timer and external Reset override.

On power-up, the TC32M holds the processor in the Reset state for a minimum of 500 msec after $V_{DD}$ is within tolerance to ensure a stable system start-up. Microprocessor sanity is monitored by the on-board Watchdog circuit. The microprocessor must provide a high-to-low level shift (through an external resistor divider) on the RS pin of the TC32M. Should the processor fail to supply this signal within the specified time-out period (typically 700 msec), an out-of-control processor is indicated and the TC32M issues a processor Reset as a result.

The output of the TC32M can be wire-ORed with a push-button switch (or electronic signal) to override the TC32M and unconditionally reset the processor. When connected to a push-button switch, the TC32M provides contact debounce.

The TC32M is packaged in a space-saving TO-92 or SOT-223 package. It provides all of the functionality of the industry standard TC1232 in a smaller, lower cost configuration.
Functional Block Diagram

Typical Operating Circuit

TC32M

Watchdog Timer

DV Detector

Delay Timer

GND

VDD

VREF1

VREF2

R1, 10 kΩ

R2, 10 kΩ

Reset

PO.1

Microcontroller

R5

5V

TC32M

Reset
1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings*

Supply Voltage (VDD to GND) ..................................+6.0V
Input Voltage Any Pin.... (GND – 0.3V) to (VDD +0.3V)
Operating Temperature Range
   TC32MC Package........................... 0°C to +70°C
   TC32ME Package........................ -40°C to +85°C
Storage Temperature Range ..........-65°C to +150°C

*Stresses above 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 above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

TC32M ELECTRICAL SPECIFICATIONS

Recommended DC Operating Conditions: TA = -40°C to +85°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDD</td>
<td>Supply Voltage</td>
<td>4.5</td>
<td>—</td>
<td>5.5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VIH</td>
<td>RS Input HIGH Level for PB</td>
<td>2.0</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VIL</td>
<td>RS Input LOW Level for PB</td>
<td>—</td>
<td>—</td>
<td>0.3</td>
<td>V</td>
<td></td>
</tr>
</tbody>
</table>

DC Electrical Characteristics: VDD = 4.5V to 5.5V, TA = -40°C to +85°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIL</td>
<td>Input Leakage</td>
<td>-1</td>
<td>—</td>
<td>+1</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>IOL</td>
<td>Output Current</td>
<td>2.0</td>
<td>10</td>
<td>—</td>
<td>mA</td>
<td>VDD = 0.4V</td>
</tr>
<tr>
<td>ICC</td>
<td>Operating Current</td>
<td>—</td>
<td>50</td>
<td>200</td>
<td>μA</td>
<td>Note 1</td>
</tr>
<tr>
<td>VSTH</td>
<td>RS Strobe HIGH Level (VDD – 0.5V)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>V</td>
<td>Figure 3-1</td>
</tr>
<tr>
<td>VSTL</td>
<td>RS Strobe LOW Level</td>
<td>2.00</td>
<td>—</td>
<td>(VDD – 1.5V)</td>
<td>V</td>
<td>Figure 3-1</td>
</tr>
<tr>
<td>V_RST</td>
<td>Reset Threshold</td>
<td>4.25</td>
<td>—</td>
<td>4.50</td>
<td>V</td>
<td>VDD Falling (Note 2, Figure 3-3)</td>
</tr>
</tbody>
</table>

Capacitance Electrical Characteristics: TA = 25°C unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIN</td>
<td>Input Capacitance</td>
<td>—</td>
<td>—</td>
<td>5</td>
<td>pF</td>
<td></td>
</tr>
<tr>
<td>COUT</td>
<td>Output Capacitance</td>
<td>—</td>
<td>—</td>
<td>7</td>
<td>pF</td>
<td></td>
</tr>
</tbody>
</table>

AC Electrical Characteristics: TA = -40°C to +85°C, VDD = 5V ±10%, unless otherwise noted.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
<th>Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>t_RST</td>
<td>Reset Active Time</td>
<td>500</td>
<td>700</td>
<td>900</td>
<td>msec</td>
<td>Figure</td>
</tr>
<tr>
<td>t_ST</td>
<td>RS Strobe Pulse Width</td>
<td>500</td>
<td>—</td>
<td>—</td>
<td>nsec</td>
<td>Figure 3-1</td>
</tr>
<tr>
<td>t_TD</td>
<td>Watchdog Time-out Period</td>
<td>500</td>
<td>700</td>
<td>900</td>
<td>msec</td>
<td>Figure 3-1</td>
</tr>
<tr>
<td>t_RPD</td>
<td>VDD Detect to RS LOW</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>nsec</td>
<td>Figure 3-1</td>
</tr>
</tbody>
</table>

Note 1: No output load.
Note 2: All voltages referenced to ground.
# 2.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 2-1.

## TABLE 2-1: PIN FUNCTION TABLE

<table>
<thead>
<tr>
<th>Pin No. (SOT-223, TO-92)</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GND</td>
<td>Ground.</td>
</tr>
<tr>
<td>2</td>
<td>V_DD</td>
<td>The +5V power supply input.</td>
</tr>
</tbody>
</table>
| 3                        | RS     | Reset/Strobe (Bidirectional). The open drain goes active if:
  |                  |        | V_DD falls below 4.5V nominal. |
  |                  |        | If pulled low by an external electronic signal or switch closure. |
  |                  |        | If the Watchdog is not strobed within the minimum Watchdog Time-out period. |
  |                  |        | During power-up and power-down. |
  |                  |        | In the Input mode, RS connects to a voltage level shift network (typically a resistor divider to V_DD.) The Watchdog Timer is reset when processor causes a voltage level ≤ V_STL to be applied to RS. |
| 4                        | V_DD   | The +5V power supply input (SOT-223 only). |
3.0 DETAILED DESCRIPTION

The TC32M provides three important functions to safeguard stable processor operation: precision processor monitor, Watchdog sanity timer and external override Reset control.

3.1 Processor Monitor

The RS pin is immediately driven low any time VDD is below the nominal threshold voltage. As a result, this pin is LOW when power is initially applied, holding the processor in its Reset state. RS remains low for a minimum of 500 msec after VDD is within tolerance to allow the power supply and processor to stabilize.

3.2 Watchdog Timer

The processor drives the RS pin with an input/output (I/O) line in series with an resistor voltage divider to VDD. Pulling the bottom resistor of this divider low results in an internal voltage change (strobe) sufficient to reset the Watchdog Timer, but above the VIL input threshold of the processor Reset pin. The processor must continuously apply strobes in this manner within a set period to verify proper software execution. A momentary Reset (500 msec minimum) is generated by the TC32M if a hardware or software failure keeps RS from being strobed within the Watchdog Time-out period. This action typically initiates the processor’s power-up routine. If the interruption persists, new Reset pulses are generated each time-out period until RS is strobed. This time-out period is typically 700 msec.

3.3 Resistor Value Selection

The values of R1 and R2 must be chosen to ensure a valid low strobe level (VSTL) on RS when the processor I/O line is low. The use of 10 kΩ, ±5% tolerance resistors are recommended. These values result in a nominal strobe level of 2.5 on RS (min/max of 2.13V/3.08V, assuming VDD = 5.0V ±10%). Other resistor values can be used, so long as the additive tolerances of the power supply and resistor values result in a strobe that falls within VSTH and VSTL under all additive tolerance conditions.
3.4 External Override Reset Control

A built-in debounce circuit allows a push-button switch (PB) or other electronic signal to be wire-ORed to this pin as an external Reset override control. The external Reset is required to be an active low signal. Internally, this input is timed to provide a minimum Reset pulse width of 500 msec. Reference Figure 3-2.

![FIGURE 3-2: RS Pulled Low By Push-Button Reset](image1)

3.5 Supply Monitor Noise Sensitivity

The TC32M is optimized for fast response to negative-going changes in VDD. Systems with an inordinate amount of electrical noise on VDD (such as systems using relays), may require a 0.01 μF bypass capacitor to reduce detection sensitivity. This capacitor should be installed as close to the TC32M as possible to keep the capacitor lead length short.

![FIGURE 3-3: Power-Up/Down Reset Timing](image2)

![FIGURE 3-4: TC32M Hardware Connections (R1, R2 Chosen To Meet VSTH, VSTL)](image3)
4.0 PACKAGING INFORMATION

4.1 Package Marking Information

Package marking data not available at this time.

4.2 Taping Form

Component Taping Orientation for 3-Pin SOT-223 Devices

User Direction of Feed

Standard Reel Component Orientation for 713 Suffix Device (Mark Right Side Up)

Carrier Tape, Number of Components Per Reel and Reel Size

<table>
<thead>
<tr>
<th>Package</th>
<th>Carrier Width (W)</th>
<th>Pitch (P)</th>
<th>Part Per Full Reel</th>
<th>Reel Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-Pin SOT-223</td>
<td>12 mm</td>
<td>8 mm</td>
<td>4000</td>
<td>13 in</td>
</tr>
</tbody>
</table>

Component Taping Orientation for 3-Pin TO-92

User Direction of Feed

Mark Face

Seal Tape
4.3 Package Dimensions

3-Pin SOT-223

Dimensions: inches (mm)

TO-92-3

Dimensions: inches (mm)
PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

<table>
<thead>
<tr>
<th>PART CODE</th>
<th>TC32M</th>
<th>X</th>
<th>XX</th>
</tr>
</thead>
</table>

**Temperature:**
- C: Commercial (0°C to +70°C)
- E: Extended (-40°C to +85°C)

**Package Type:**
- ZB: 3-Pin TO-92
- DB: 3-Pin SOT223
- DB713: 3-Pin Tape & Reel SOT223

Sales and Support

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Fax:  86-532-8502-7205

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Fax:  86-21-5407-5066

China - Shenyang
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Fax:  86-24-2334-2393

China - Shenzhen
Tel:  86-755-8203-2660
Fax:  86-755-8203-1760

China - Shunde
Tel:  86-757-2839-5507
Fax:  86-757-2839-5571

China - Wuhan
Tel:  86-27-5980-5300
Fax:  86-27-5980-5118

China - Xian
Tel:  86-29-8833-7250
Fax:  86-29-8833-7256

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Fax:  91-80-2229-0062

India - New Delhi
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Fax:  91-11-5160-8632

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Fax:  91-20-2566-1513

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Fax:  82-54-473-4302

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82-2-558-5934

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Fax:  45-4485-2829

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Fax:  33-1-69-30-90-79

Germany - Munich
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Fax:  49-89-627-144-44

Italy - Milan
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Fax:  39-0331-466781

Netherlands - Drunen
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Fax:  31-416-690340

Spain - Madrid
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Fax:  34-91-708-08-91

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