

## ECONOMONITOR™ – 3-Pin System Supervisor with Power Supply Monitor and Watchdog

### 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

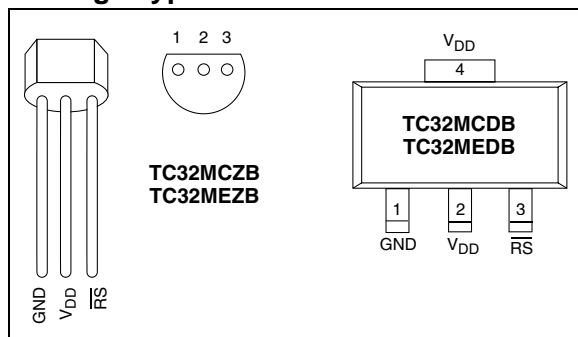
### Applications

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

### Device Selection Table

Part Number	Package	Temp. Range
TC32MCDB	SOT-223	0°C to +70°C
TC32MCZB	TO-92	0°C to +70°C
TC32MEDB	SOT-223	-40°C to +85°C
TC32MEZB	TO-92	-40°C to +85°C

### Package Type



### 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.

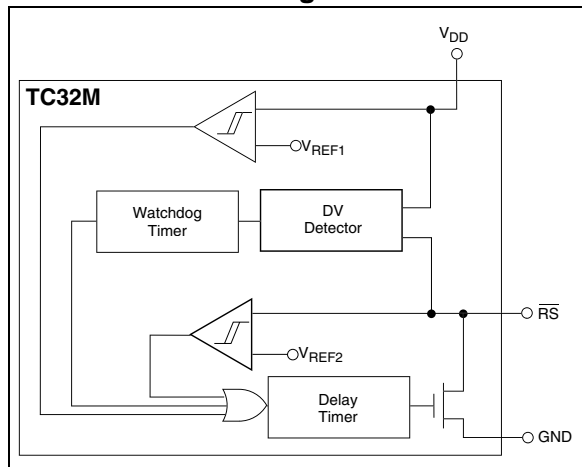
On power-up, the TC32M holds the processor in the reset state for a minimum of 500msec after V<sub>DD</sub> is within tolerance to ensure a stable system start-up. Microprocessor sanity is monitored by the on-board watchdog circuit. The microprocessor must provide a high-to-low level shift (through an external resistor divider) on the RS pin of the TC32M. Should the processor fail to supply this signal within the specified timeout period (typically 700msec), 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.

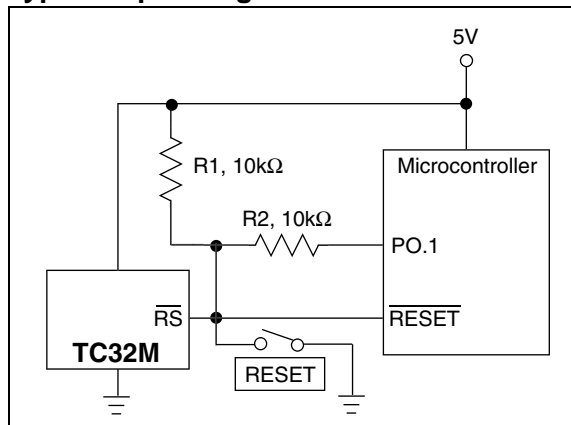
The TC32M is packaged in a space-saving TO-92 or SOT-223 package. It provides all of the functionality of the industry standard TC1232 in a smaller, lower cost configuration.

# TC32M

## Functional Block Diagram



## Typical Operating Circuit



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

Supply Voltage ( $V_{DD}$ to GND) .....	+6.0V
Input Voltage Any Pin..... (GND – 0.3V) to ( $V_{DD}$ +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: $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$V_{DD}$	Supply Voltage	4.5	—	5.5	V	
$V_{IH}$	$\overline{RS}$ Input HIGH Level for PB	2.0	—	—	V	
$V_{IL}$	$\overline{RS}$ Input LOW Level for PB	—	—	0.3	V	
DC Electrical Characteristics: $V_{DD} = 4.5\text{V}$ to $5.5\text{V}$ , $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$I_{IL}$	$\overline{RS}$ Input Leakage	-1	—	+1	$\mu\text{A}$	
$I_{OL}$	$\overline{RS}$ Output Current	2.0	10	—	mA	$V_{OL} = 0.4\text{V}$
$I_{CC}$	Operating Current	—	50	200	$\mu\text{A}$	Note 1
$V_{STH}$	$\overline{RS}$ Strobe HIGH Level	$(V_{DD} - 0.5\text{V})$	—	—	V	Figure 3-1
$V_{STL}$	$\overline{RS}$ Strobe LOW Level	2.00	—	$(V_{DD} - 1.5\text{V})$	V	Figure 3-1
$V_{RST}$	RESET Threshold	4.25	—	4.50	V	$V_{DD}$ Falling (Note 2, Figure 3-3)
Capacitance Electrical Characteristics: $T_A = 25^\circ\text{C}$ unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$C_{IN}$	Input Capacitance	—	—	5	pF	
$C_{OUT}$	Output Capacitance	—	—	7	pF	
AC Electrical Characteristics: $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ , $V_{DD} = 5\text{V} \pm 10\%$ , unless otherwise noted.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$t_{RST}$	RESET Active Time	500	700	900	msec	Figure 3-2
$t_{ST}$	$\overline{RS}$ Strobe Pulse Width	500	—	—	nsec	Figure 3-1
$t_{TD}$	Watchdog Timeout Period	500	700	900	msec	Figure 3-1
$t_{RPD}$	$V_{DD}$ Detect to $\overline{RS}$ LOW	—	—	—	nsec	Figure 3-3

- Note** 1: No output load.  
 2: All voltages referenced to ground.

# TC32M

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## 2.0 PIN DESCRIPTIONS

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

**TABLE 2-1: PIN FUNCTION TABLE**

Pin No. (SOT-223, TO-92)	Symbol	Description
1	GND	Ground.
2	$V_{DD}$	The +5V power supply input.
3	$\overline{RS}$	$\overline{RESET}/\overline{STROBE}$ (Bidirectional). The open drain goes active if: 1. $V_{DD}$ falls below 4.5V nominal. 2. If pulled low by an external electronic signal or switch closure. 3. If the watchdog is not strobed within the minimum watchdog timeout period. 4. During power-up and power-down. In the input mode, $\overline{RS}$ 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 $\leq V_{STL}$ to be applied to $\overline{RS}$ .
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.

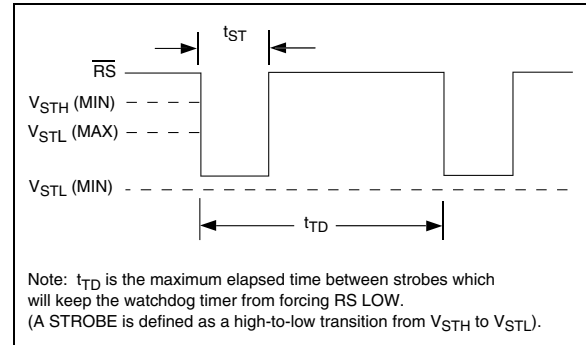
### 3.1 Processor Monitor

The  $\overline{RS}$  pin is immediately driven low any time  $V_{DD}$  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.  $\overline{RS}$  remains low for a minimum of 500msec after  $V_{DD}$  is within tolerance to allow the power supply and processor to stabilize.

### 3.2 Watchdog Timer

The processor drives the  $\overline{RS}$  pin with an input/output (I/O) line in series with an resistor voltage divider to  $V_{DD}$ . Pulling the bottom resistor of this divider low results in an internal voltage change (*strobe*) sufficient to reset the watchdog timer, but above the  $V_{IL}$  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 (500msec minimum) is generated by the TC32M if a hardware or software failure keeps  $\overline{RS}$  from being strobed within the watchdog timeout period. This action typically initiates the processor's power-up routine. If the interruption persists, new reset pulses are generated each timeout period until  $\overline{RS}$  is strobed. This timeout period is typically 700msec.

**FIGURE 3-1: WATCHDOG STROBE**



The software routine that drives the  $\overline{RS}$  strobe must be in a section of the program that executes frequently enough so the time between toggles is less than one watchdog timeout period. The strobe signal can be derived from microprocessor address, data and/or control signals. Typical circuit examples are shown in Figure 3-4.

### 3.3 Resistor Value Selection

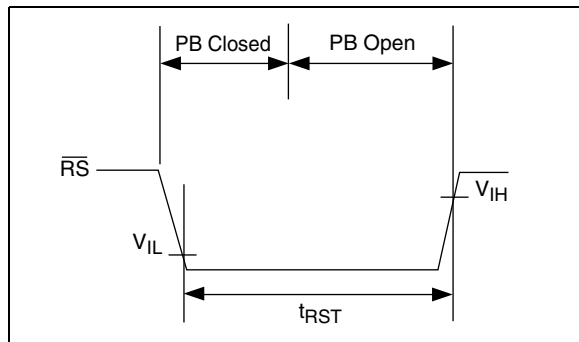
The values of R1 and R2 must be chosen to ensure a valid low strobe level ( $V_{STL}$ ) on  $\overline{RS}$  when the processor I/O line is low. The use of 10k $\Omega$ ,  $\pm 5\%$  tolerance resistors are recommended. These values result in a nominal strobe level of 2.5 on  $\overline{RS}$  (min/max of 2.13V/3.08V, assuming  $V_{DD} = 5.0V \pm 10\%$ ). 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  $V_{STH}$  and  $V_{STL}$  under all additive tolerance conditions.

# TC32M

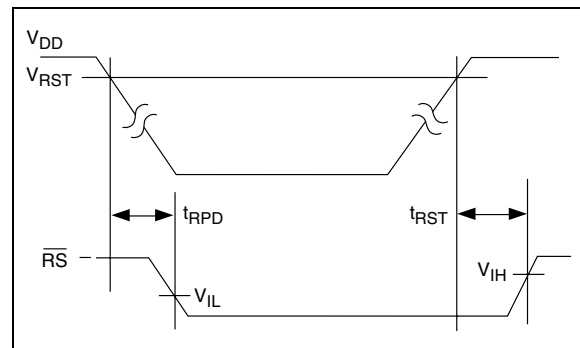
## 3.4 External Override Reset Control

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  $\overline{\text{RESET}}$  override control. The external  $\overline{\text{RESET}}$  is required to be an active low signal. Internally, this input is timed to provide a minimum  $\overline{\text{RESET}}$  pulse width of 500msec. Reference Figure 3-2.

**FIGURE 3-2:  $\overline{\text{RS}}$  PULLED LOW BY PUSH-BUTTON RESET**



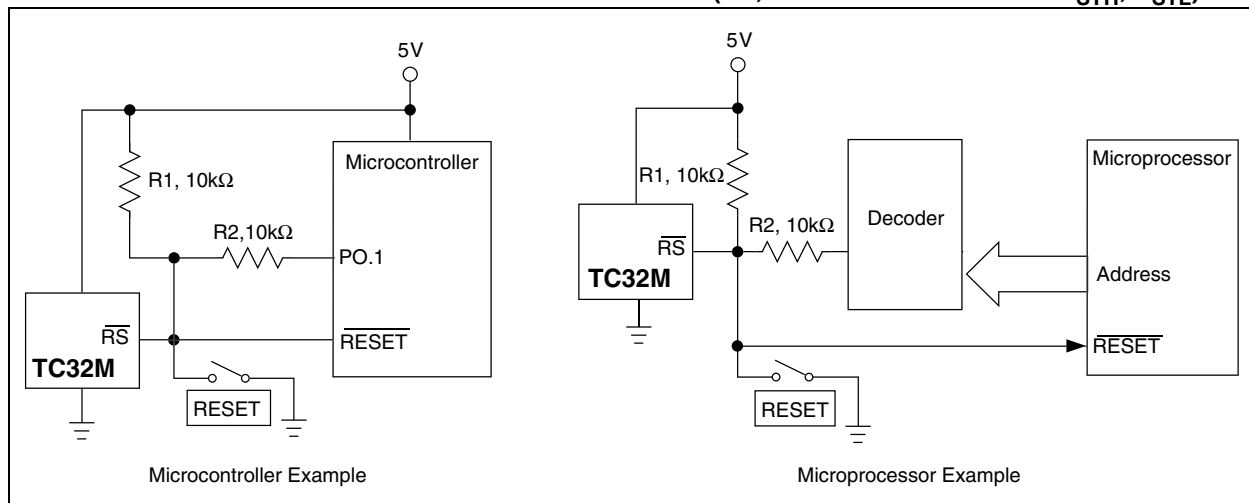
**FIGURE 3-3: POWER UP/DOWN RESET TIMING**



## 3.5 Supply Monitor Noise Sensitivity

The TC32M is optimized for fast response to negative-going changes in  $V_{DD}$ . Systems with an inordinate amount of electrical noise on  $V_{DD}$  (such as systems using relays), may require a  $0.01\mu\text{F}$  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 3-4: TC32M HARDWARE CONNECTIONS (R1, R2 CHOSEN TO MEET  $V_{STH}$ ,  $V_{STL}$ )**

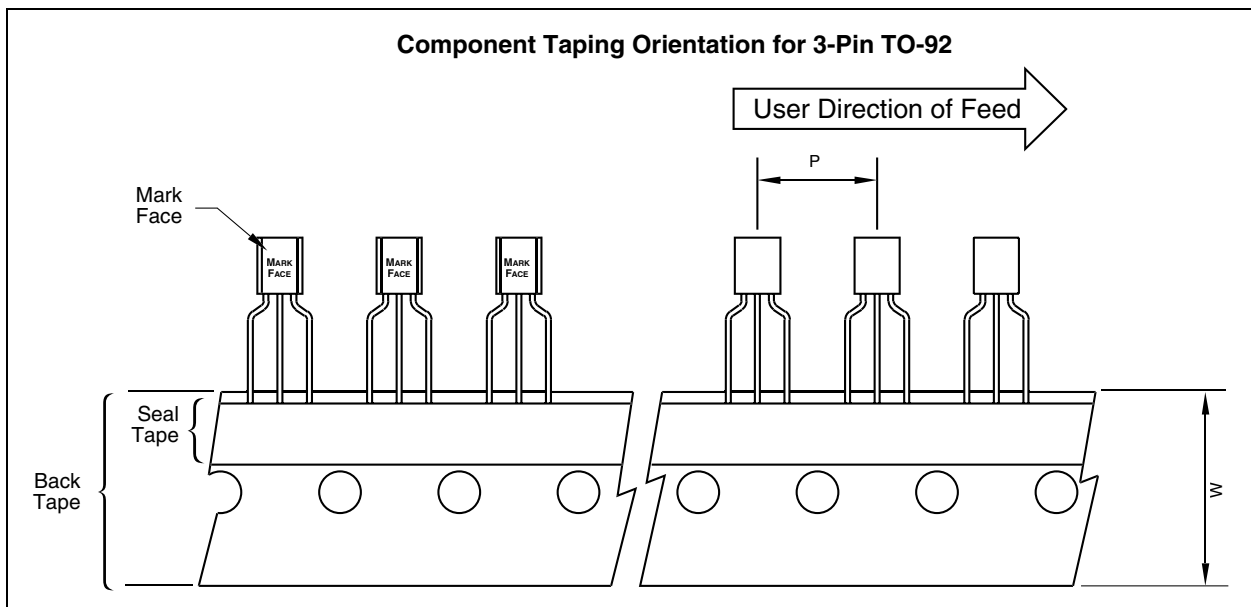
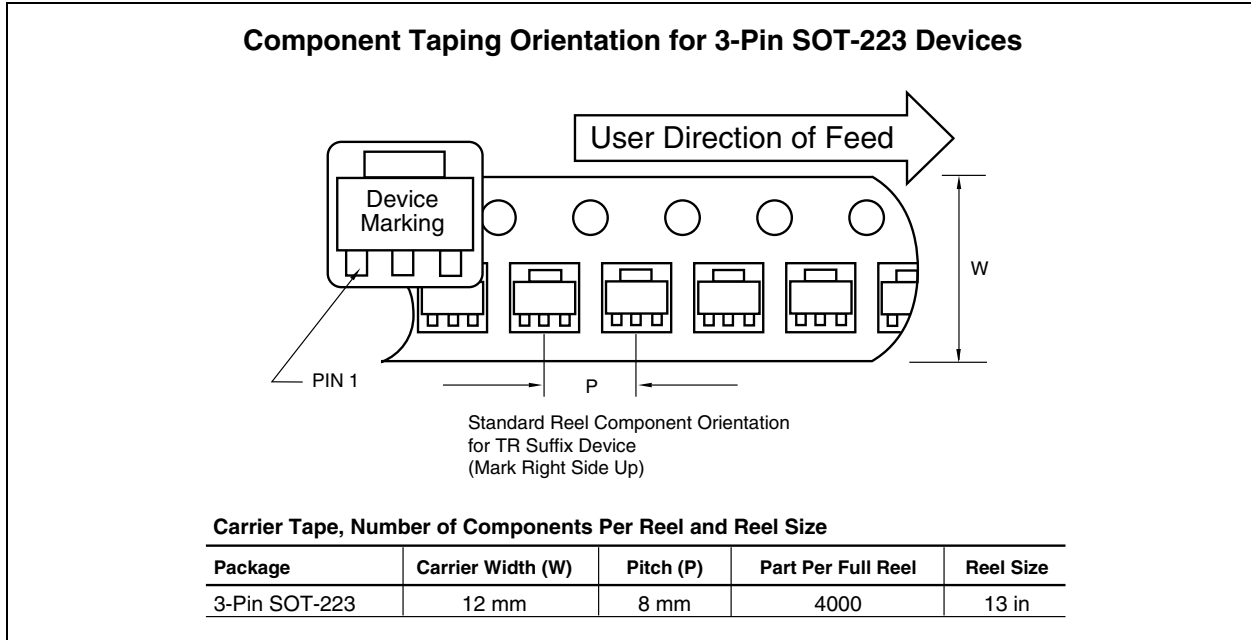


## 4.0 PACKAGING INFORMATION

### 4.1 Package Marking Information

Package marking data not available at this time.

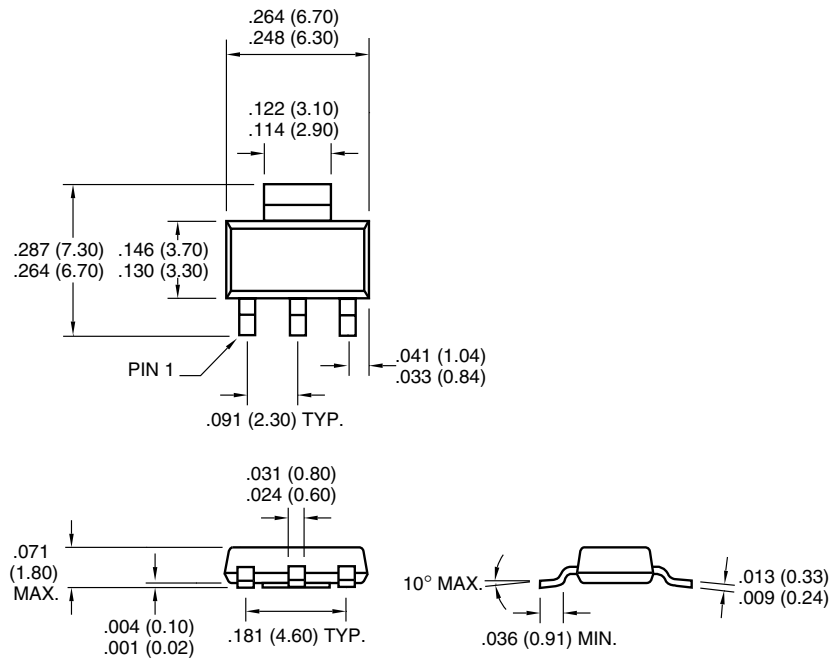
### 4.2 Taping Form



# TC32M

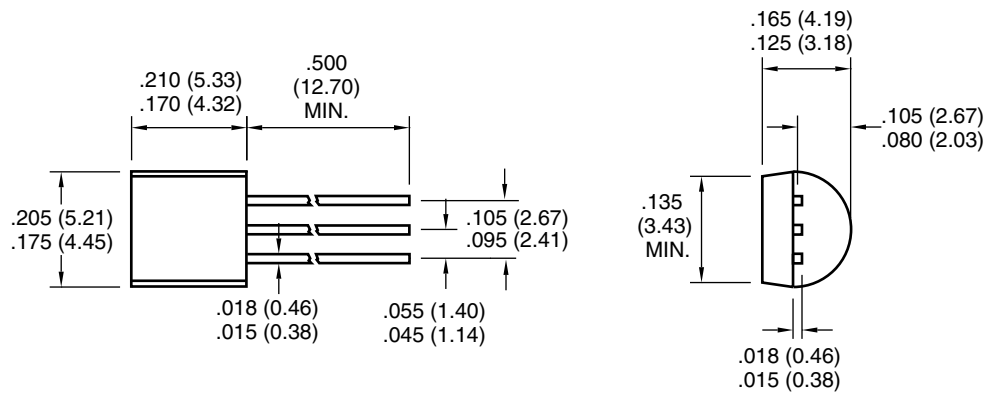
## 4.3 Package Dimensions

### 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.

<b>PART CODE</b>	<b>TC32M</b>	<b>X</b>	<b>XX</b>
<b>Temperature:</b>	_____		
C: Commercial (0°C to +70°C)			
E: Extended (-40°C to +85°C)			
<b>Package Type:</b>	_____		
ZB: 3-Pin TO-92			
DB: 3-Pin SOT223			
DB713: 3-Pin Tape & Reel SOT223			

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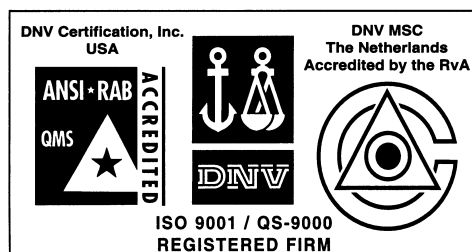
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