

## Micropower Voltage Detector

### Features

- Ultra-low supply current: 1.75  $\mu\text{A}$  (max.)
- Precision monitoring options of:
  - 1.90V, 2.32V, 2.63V, 2.90V, 2.93V, 3.08V, 4.38V and 4.63V
- Resets microcontroller in a power-loss event
- Active-low  $V_{\text{OUT}}$  pin:
  - **MCP111** active-low, open-drain
  - **MCP112** active-low, push-pull
- Available in SOT23-3, TO-92, SC-70 and SOT-89-3 packages
- Temperature Range:
  - Extended:  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  (except MCP1XX-195)
  - Industrial:  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  (MCP1XX-195 only)
- Pb-free devices

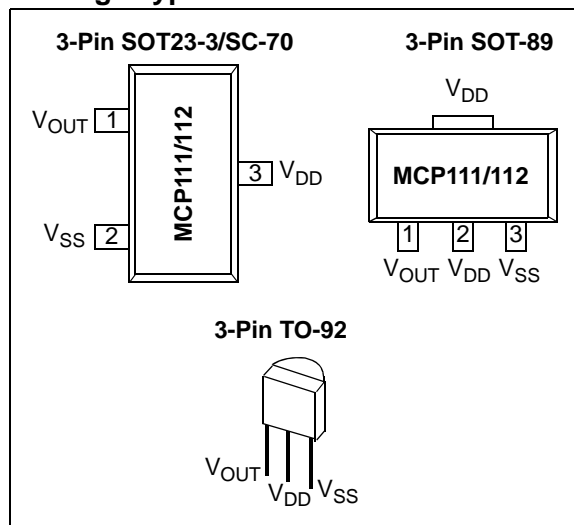
### Applications

- Critical Microcontroller and Microprocessor Power-Monitoring Applications
- Computers
- Intelligent Instruments
- Portable Battery-Powered Equipment

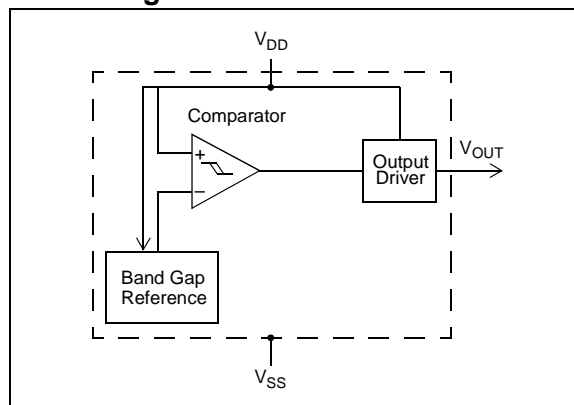
### Description

The MCP111/112 are voltage-detecting devices designed to keep a microcontroller in reset until the system voltage has stabilized at the appropriate level for reliable system operation. These devices also operate as protection from brown-out conditions when the system supply voltage drops below the specified threshold voltage level. Eight different trip voltages are available.

### Package Types



### Block Diagram



**TABLE 1: DEVICE FEATURES**

| Device        | Output     |                            | Reset Delay (typ) | Package Pin Out (Pin # 1, 2, 3)                       | Comment                                            |
|---------------|------------|----------------------------|-------------------|-------------------------------------------------------|----------------------------------------------------|
|               | Type       | Pull-up Resistor           |                   |                                                       |                                                    |
| <b>MCP111</b> | Open-drain | External                   | No                | $V_{\text{OUT}}, V_{\text{SS}}, V_{\text{DD}}$        |                                                    |
| <b>MCP112</b> | Push-pull  | No                         | No                | $V_{\text{OUT}}, V_{\text{SS}}, V_{\text{DD}}$        |                                                    |
| <b>MCP102</b> | Push-pull  | No                         | 120 ms            | $\overline{\text{RST}}, V_{\text{DD}}, V_{\text{SS}}$ | See <b>MCP102/103/121/131</b> Data Sheet (DS21906) |
| <b>MCP103</b> | Push-pull  | No                         | 120 ms            | $V_{\text{SS}}, \overline{\text{RST}}, V_{\text{DD}}$ | See <b>MCP102/103/121/131</b> Data Sheet (DS21906) |
| <b>MCP121</b> | Open-drain | External                   | 120 ms            | $\overline{\text{RST}}, V_{\text{DD}}, V_{\text{SS}}$ | See <b>MCP102/103/121/131</b> Data Sheet (DS21906) |
| <b>MCP131</b> | Open-Drain | Internal (~95 k $\Omega$ ) | 120 ms            | $\overline{\text{RST}}, V_{\text{DD}}, V_{\text{SS}}$ | See <b>MCP102/103/121/131</b> Data Sheet (DS21906) |

# MCP111/112

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings†

|                                                              |                              |
|--------------------------------------------------------------|------------------------------|
| $V_{DD}$ .....                                               | 7.0V                         |
| Input current ( $V_{DD}$ ) .....                             | 10 mA                        |
| Output current ( $RST$ ) .....                               | 10 mA                        |
| Rated Rise Time of $V_{DD}$ .....                            | 100V/ $\mu$ s                |
| All inputs and outputs (except $RST$ ) w.r.t. $V_{SS}$ ..... | -0.6V to ( $V_{DD} + 1.0V$ ) |
| $RST$ output w.r.t. $V_{SS}$ .....                           | -0.6V to 13.5V               |
| Storage temperature .....                                    | -65°C to +150°C              |
| Ambient temp. with power applied .....                       | -40°C to +125°C              |
| Maximum Junction temp. with power applied .....              | 150°C                        |
| ESD protection on all pins .....                             | $\geq 2$ kV                  |

† **Notice:** Stresses above those listed under “Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

### DC CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated, all limits are specified for  $V_{DD} = 1V$  to 5.5V,  $R_{PU} = 100$  k $\Omega$  (only **MCP111**),  $T_A = -40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

| Parameters                                |                   | Sym        | Min   | Typ       | Max                                         | Units                 | Conditions                                                         |
|-------------------------------------------|-------------------|------------|-------|-----------|---------------------------------------------|-----------------------|--------------------------------------------------------------------|
| Operating Voltage Range                   |                   | $V_{DD}$   | 1.0   | —         | 5.5                                         | V                     |                                                                    |
| Specified $V_{DD}$ Value to $V_{OUT}$ low |                   | $V_{DD}$   | 1.0   | —         |                                             | V                     | $I_{RST} = 10 \mu\text{A}$ , $V_{RST} < 0.2V$                      |
| Operating Current                         |                   | $I_{DD}$   | —     | < 1       | 1.75                                        | $\mu\text{A}$         |                                                                    |
| $V_{DD}$ Trip Point                       | <b>MCP1XX-195</b> | $V_{TRIP}$ | 1.872 | 1.900     | 1.929                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
|                                           |                   |            | 1.853 | 1.900     | 1.948                                       | V                     | $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$ ( <b>Note 2</b> ) |
|                                           | <b>MCP1XX-240</b> |            | 2.285 | 2.320     | 2.355                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
|                                           |                   |            | 2.262 | 2.320     | 2.378                                       | V                     | <b>Note 2</b>                                                      |
|                                           | <b>MCP1XX-270</b> |            | 2.591 | 2.630     | 2.670                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
|                                           |                   |            | 2.564 | 2.630     | 2.696                                       | V                     | <b>Note 2</b>                                                      |
|                                           | <b>MCP1XX-290</b> |            | 2.857 | 2.900     | 2.944                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
|                                           |                   |            | 2.828 | 2.900     | 2.973                                       | V                     | <b>Note 2</b>                                                      |
|                                           | <b>MCP1XX-300</b> |            | 2.886 | 2.930     | 2.974                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
|                                           |                   |            | 2.857 | 2.930     | 3.003                                       | V                     | <b>Note 2</b>                                                      |
|                                           | <b>MCP1XX-315</b> |            | 3.034 | 3.080     | 3.126                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
|                                           |                   |            | 3.003 | 3.080     | 3.157                                       | V                     | <b>Note 2</b>                                                      |
|                                           | <b>MCP1XX-450</b> |            | 4.314 | 4.380     | 4.446                                       | V                     | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> )                        |
| 4.271                                     |                   | 4.380      | 4.490 | V         | <b>Note 2</b>                               |                       |                                                                    |
| <b>MCP1XX-475</b>                         | 4.561             | 4.630      | 4.700 | V         | $T_A = +25^\circ\text{C}$ ( <b>Note 1</b> ) |                       |                                                                    |
|                                           | 4.514             | 4.630      | 4.746 | V         | <b>Note 2</b>                               |                       |                                                                    |
| $V_{DD}$ Trip Point Tempco                |                   | $T_{TPCO}$ | —     | $\pm 100$ | —                                           | ppm/ $^\circ\text{C}$ |                                                                    |

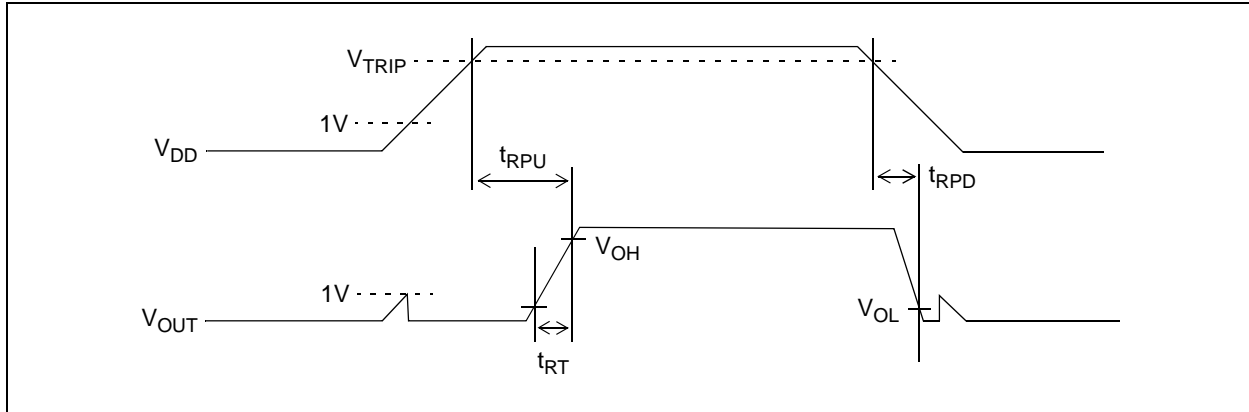
- Note 1:** Trip point is  $\pm 1.5\%$  from typical value.  
**Note 2:** Trip point is  $\pm 2.5\%$  from typical value.  
**3:** This specification allows this device to be used in PICmicro<sup>®</sup> microcontroller applications that require the In-Circuit Serial Programming<sup>™</sup> (ICSP<sup>™</sup>) feature (see device-specific programming specifications for voltage requirements). This specification DOES NOT allow a continuous high voltage to be present on the open-drain output pin ( $V_{OUT}$ ). The total time that the  $V_{OUT}$  pin can be above the maximum device operational voltage (5.5V) is 100 sec. Current into the  $V_{OUT}$  pin should be limited to 2 mA. It is recommended that the device operational temperature be maintained between 0°C to 70°C (+25°C preferred). For additional information, please refer to Figure 2-28.  
**4:** This parameter is established by characterization and is not 100% tested.

## DC CHARACTERISTICS (CONTINUED)

| Electrical Specifications: Unless otherwise indicated, all limits are specified for $V_{DD} = 1V$ to $5.5V$ , $R_{PU} = 100\text{ k}\Omega$ (only <b>MCP111</b> ), $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$ . |                   |                |       |                     |               |                                                                                                                                                                                                     |                           |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|----------------|-------|---------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|
| Parameters                                                                                                                                                                                                             | Sym               | Min            | Typ   | Max                 | Units         | Conditions                                                                                                                                                                                          |                           |
| Threshold Hysteresis<br>(min. = 1%, max = 6%)                                                                                                                                                                          | <b>MCP1XX-195</b> | $V_{HYS}$      | 0.019 | —                   | 0.114         | V                                                                                                                                                                                                   | $T_A = +25^\circ\text{C}$ |
|                                                                                                                                                                                                                        | <b>MCP1XX-240</b> |                | 0.023 | —                   | 0.139         | V                                                                                                                                                                                                   |                           |
|                                                                                                                                                                                                                        | <b>MCP1XX-270</b> |                | 0.026 | —                   | 0.158         | V                                                                                                                                                                                                   |                           |
|                                                                                                                                                                                                                        | <b>MCP1XX-290</b> |                | 0.029 | —                   | 0.174         | V                                                                                                                                                                                                   |                           |
|                                                                                                                                                                                                                        | <b>MCP1XX-300</b> |                | 0.029 | —                   | 0.176         | V                                                                                                                                                                                                   |                           |
|                                                                                                                                                                                                                        | <b>MCP1XX-315</b> |                | 0.031 | —                   | 0.185         | V                                                                                                                                                                                                   |                           |
|                                                                                                                                                                                                                        | <b>MCP1XX-450</b> |                | 0.044 | —                   | 0.263         | V                                                                                                                                                                                                   |                           |
|                                                                                                                                                                                                                        | <b>MCP1XX-475</b> |                | 0.046 | —                   | 0.278         | V                                                                                                                                                                                                   |                           |
| $V_{OUT}$ Low-level Output Voltage                                                                                                                                                                                     | $V_{OL}$          | —              | —     | 0.4                 | V             | $I_{OL} = 500\text{ }\mu\text{A}$ , $V_{DD} = V_{TRIP(MIN)}$                                                                                                                                        |                           |
| $V_{OUT}$ High-level Output Voltage                                                                                                                                                                                    | $V_{OH}$          | $V_{DD} - 0.6$ | —     | —                   | V             | $I_{OH} = 1\text{ mA}$ , For only <b>MCP112</b> (push-pull output)                                                                                                                                  |                           |
| Open-drain High Voltage on Output                                                                                                                                                                                      | $V_{ODH}$         | —              | —     | 13.5 <sup>(3)</sup> | V             | <b>MCP111</b> only,<br>$V_{DD} = 3.0V$ , Time voltage ><br>5.5V applied $\leq 100s$ ,<br>current into pin limited to<br>2 mA, $+25^\circ\text{C}$ operation<br>recommended<br><b>Note 3, Note 4</b> |                           |
| Open-drain Output Leakage Current<br>( <b>MCP111</b> only)                                                                                                                                                             | $I_{OD}$          | —              | 0.1   | —                   | $\mu\text{A}$ |                                                                                                                                                                                                     |                           |

- Note 1:** Trip point is  $\pm 1.5\%$  from typical value.
- Note 2:** Trip point is  $\pm 2.5\%$  from typical value.
- Note 3:** This specification allows this device to be used in PICmicro<sup>®</sup> microcontroller applications that require the In-Circuit Serial Programming<sup>™</sup> (ICSP<sup>™</sup>) feature (see device-specific programming specifications for voltage requirements). This specification DOES NOT allow a continuous high voltage to be present on the open-drain output pin ( $V_{OUT}$ ). The total time that the  $V_{OUT}$  pin can be above the maximum device operational voltage (5.5V) is 100 sec. Current into the  $V_{OUT}$  pin should be limited to 2 mA. It is recommended that the device operational temperature be maintained between  $0^\circ\text{C}$  to  $70^\circ\text{C}$  ( $+25^\circ\text{C}$  preferred). For additional information, please refer to Figure 2-28.
- Note 4:** This parameter is established by characterization and is not 100% tested.

# MCP111/112



**FIGURE 1-1:** Timing Diagram.

## AC CHARACTERISTICS

**Electrical Specifications:** Unless otherwise indicated, all limits are specified for V<sub>DD</sub> = 1V to 5.5V, R<sub>PU</sub> = 100 kΩ (only **MCP111**), T<sub>A</sub> = -40°C to +125°C.

| Parameters                                               | Sym              | Min | Typ | Max | Units | Conditions                                                                                                                                           |
|----------------------------------------------------------|------------------|-----|-----|-----|-------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| V <sub>DD</sub> Detect to V <sub>OUT</sub> Inactive      | t <sub>RPU</sub> | —   | 90  | —   | μs    | Figure 1-1 and C <sub>L</sub> = 50 pF (Note 1)                                                                                                       |
| V <sub>DD</sub> Detect to V <sub>OUT</sub> Active        | t <sub>RPD</sub> | —   | 130 | —   | μs    | V <sub>DD</sub> ramped from V <sub>TRIP(MAX)</sub> + 250 mV down to V <sub>TRIP(MIN)</sub> - 250 mV, per Figure 1-1, C <sub>L</sub> = 50 pF (Note 1) |
| V <sub>OUT</sub> Rise Time After V <sub>OUT</sub> Active | t <sub>RT</sub>  | —   | 5   | —   | μs    | For V <sub>OUT</sub> 10% to 90% of final value per Figure 1-1, C <sub>L</sub> = 50 pF (Note 1)                                                       |

**Note 1:** These parameters are for design guidance only and are not 100% tested.

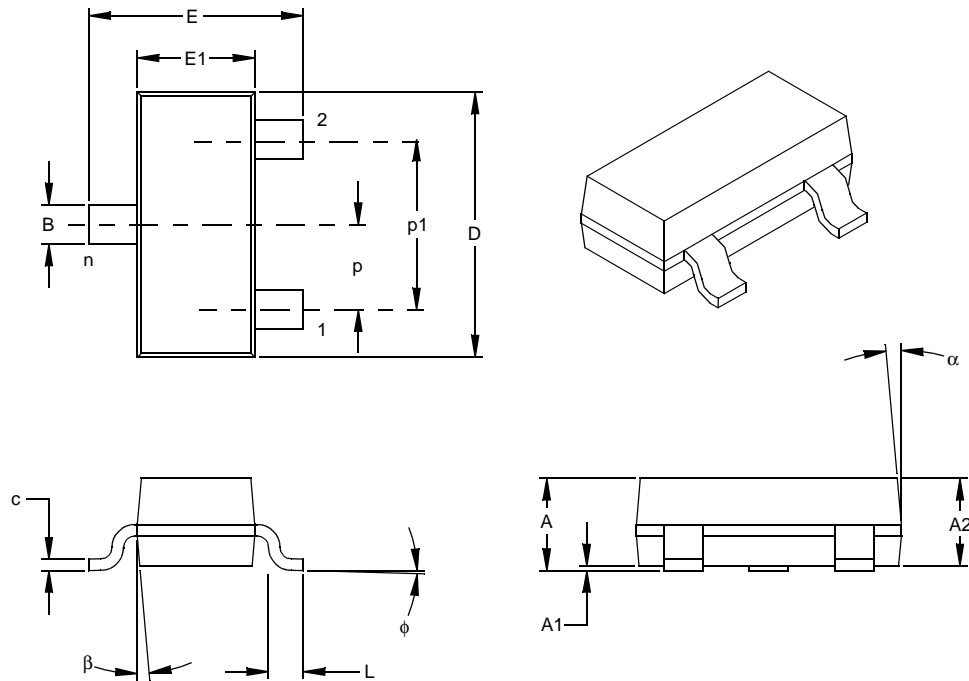
## TEMPERATURE CHARACTERISTICS

**Electrical Specifications:** Unless otherwise noted, all limits are specified for V<sub>DD</sub> = 1V to 5.5V, R<sub>PU</sub> = 100 kΩ (only **MCP111**), T<sub>A</sub> = -40°C to +125°C.

| Parameters                         | Sym             | Min | Typ   | Max  | Units | Conditions               |
|------------------------------------|-----------------|-----|-------|------|-------|--------------------------|
| <b>Temperature Ranges</b>          |                 |     |       |      |       |                          |
| Specified Temperature Range        | T <sub>A</sub>  | -40 | —     | +85  | °C    | <b>MCP1XX-195</b>        |
| Specified Temperature Range        | T <sub>A</sub>  | -40 | —     | +125 | °C    | Except <b>MCP1XX-195</b> |
| Maximum Junction Temperature       | T <sub>J</sub>  | —   | —     | +150 | °C    |                          |
| Storage Temperature Range          | T <sub>A</sub>  | -65 | —     | +150 | °C    |                          |
| <b>Package Thermal Resistances</b> |                 |     |       |      |       |                          |
| Thermal Resistance, 3L-SOT23       | θ <sub>JA</sub> | —   | 336   | —    | °C/W  |                          |
| Thermal Resistance, 3L-SC-70       | θ <sub>JA</sub> | —   | 340   | —    | °C/W  |                          |
| Thermal Resistance, 3L-TO-92       | θ <sub>JA</sub> | —   | 131.9 | —    | °C/W  |                          |
| Thermal Resistance, 3L-SOT-89      | θ <sub>JA</sub> | —   | 110   | —    | °C/W  |                          |

# MCP111/112

## 3-Lead Plastic Small Outline Transistor (TT) (SOT-23)



| Units                      |    | INCHES* |      |      | MILLIMETERS |      |      |
|----------------------------|----|---------|------|------|-------------|------|------|
| Dimension Limits           |    | MIN     | NOM  | MAX  | MIN         | NOM  | MAX  |
| Number of Pins             | n  |         | 3    |      |             | 3    |      |
| Pitch                      | p  |         | .038 |      |             | 0.96 |      |
| Outside lead pitch (basic) | p1 |         | .076 |      |             | 1.92 |      |
| Overall Height             | A  | .035    | .040 | .044 | 0.89        | 1.01 | 1.12 |
| Molded Package Thickness   | A2 | .035    | .037 | .040 | 0.88        | 0.95 | 1.02 |
| Standoff §                 | A1 | .000    | .002 | .004 | 0.01        | 0.06 | 0.10 |
| Overall Width              | E  | .083    | .093 | .104 | 2.10        | 2.37 | 2.64 |
| Molded Package Width       | E1 | .047    | .051 | .055 | 1.20        | 1.30 | 1.40 |
| Overall Length             | D  | .110    | .115 | .120 | 2.80        | 2.92 | 3.04 |
| Foot Length                | L  | .014    | .018 | .022 | 0.35        | 0.45 | 0.55 |
| Foot Angle                 | φ  | 0       | 5    | 10   | 0           | 5    | 10   |
| Lead Thickness             | c  | .004    | .006 | .007 | 0.09        | 0.14 | 0.18 |
| Lead Width                 | B  | .015    | .017 | .020 | 0.37        | 0.44 | 0.51 |
| Mold Draft Angle Top       | α  | 0       | 5    | 10   | 0           | 5    | 10   |
| Mold Draft Angle Bottom    | β  | 0       | 5    | 10   | 0           | 5    | 10   |

\* Controlling Parameter  
§ Significant Characteristic

Notes:

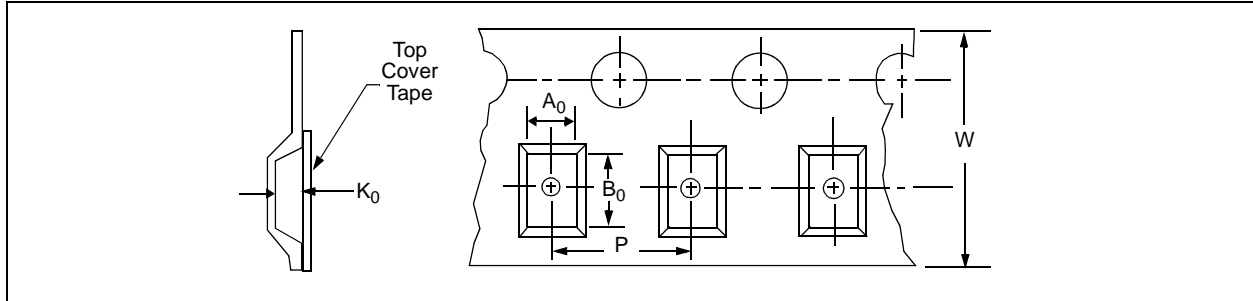
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: TO-236

Drawing No. C04-104

## 5.2 Product Tape and Reel Specifications

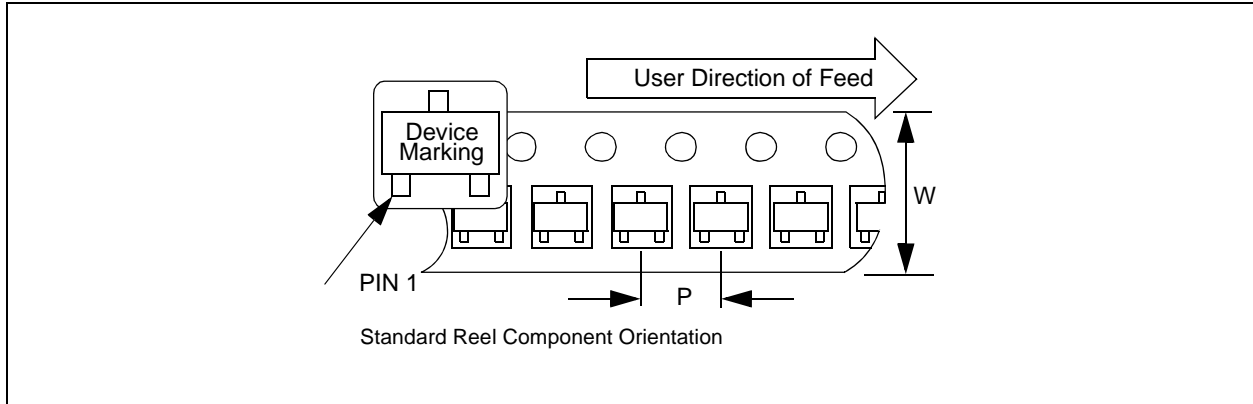
**FIGURE 5-1: EMBOSSED CARRIER DIMENSIONS (8, 12, 16 AND 24 MM TAPE ONLY)**



**TABLE 1: CARRIER TAPE/CAVITY DIMENSIONS**

| Case Outline | Package Type |    | Carrier Dimensions |      | Cavity Dimensions |       |       | Output Quantity Units | Reel Diameter in mm |
|--------------|--------------|----|--------------------|------|-------------------|-------|-------|-----------------------|---------------------|
|              |              |    | W mm               | P mm | A0 mm             | B0 mm | K0 mm |                       |                     |
| TT           | SOT-23B      | 3L | 8                  | 4    | 3.15              | 2.77  | 1.22  | 3000                  | 180                 |
| LB           | SC-70        | 3L | 8                  | 4    | 2.4               | 2.4   | 1.19  | 3000                  | 180                 |

**FIGURE 5-2: 3-LEAD SOT-23/SC70 DEVICE TAPE AND REEL SPECIFICATIONS**



## PRODUCT IDENTIFICATION SYSTEM

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

| <u>PART NO.</u>     | <u>X</u>         | <u>XXX</u>                                                                  | <u>X</u>                                     | <u>XX</u>            |
|---------------------|------------------|-----------------------------------------------------------------------------|----------------------------------------------|----------------------|
| Device              | Tape/Reel Option | Monitoring Options                                                          | Temperature Range                            | Package              |
| Device:             |                  |                                                                             |                                              |                      |
|                     |                  | MCP111: MicroPower Voltage Detector, open-drain                             |                                              |                      |
|                     |                  | MCP111T: MicroPower Voltage Detector, open-drain (Tape and Reel)            |                                              |                      |
|                     |                  | MCP112: MicroPower Voltage Detector, push-pull                              |                                              |                      |
|                     |                  | MCP112T: MicroPower Voltage Detector, push-pull (Tape and Reel)             |                                              |                      |
| Monitoring Options: |                  | 195 = 1.90V                                                                 |                                              |                      |
|                     |                  | 240 = 2.32V                                                                 |                                              |                      |
|                     |                  | 270 = 2.63V                                                                 |                                              |                      |
|                     |                  | 290 = 2.90V                                                                 |                                              |                      |
|                     |                  | 300 = 2.93V                                                                 |                                              |                      |
|                     |                  | 315 = 3.08V                                                                 |                                              |                      |
|                     |                  | 450 = 4.38V                                                                 |                                              |                      |
|                     |                  | 475 = 4.63V                                                                 |                                              |                      |
| Temperature Range:  |                  |                                                                             | I = -40°C to +85°C (MCP11X-195 only)         |                      |
|                     |                  |                                                                             | E = -40°C to +125°C (Except MCP11X-195 only) |                      |
| Package:            |                  |                                                                             |                                              | LB = SC-70, 3-lead   |
|                     |                  |                                                                             |                                              | MB = SOT-89, 3-lead  |
|                     |                  |                                                                             |                                              | TO = TO-92, 3-lead   |
|                     |                  |                                                                             |                                              | TT = SOT-23B, 3-lead |
| <b>Examples:</b>    |                  |                                                                             |                                              |                      |
| a)                  | MCP111T-195I/TT: | Tape and Reel, 1.95V option, open-drain, -40°C to +85°C, SOT-23B package.   |                                              |                      |
| b)                  | MCP111T-315E/LB: | Tape and Reel, 3.15V option, open-drain, -40°C to +125°C, SC-70-3 package.  |                                              |                      |
| c)                  | MCP111-300E/TO:  | 3.00V option, open-drain, -40°C to +125°C, TO-92-3 package.                 |                                              |                      |
| d)                  | MCP111-315E/MB:  | 3.15V option, open-drain, -40°C to +125°C, SOT-89-3 package.                |                                              |                      |
| a)                  | MCP112T-290E/TT: | Tape and Reel, 2.90V option, push-pull, -40°C to +125°C, SOT-23B-3 package. |                                              |                      |
| b)                  | MCP112T-475E/LB: | Tape and Reel, 4.75V option, push-pull, -40°C to +125°C, SC-70-3 package.   |                                              |                      |
| c)                  | MCP112-450E/TO:  | 4.5V option, push-pull, -40°C to +125°C, TO-92-3 package.                   |                                              |                      |
| d)                  | MCP112-315E/MB:  | 3.15V option, push-pull, -40°C to +125°C, SOT-89-3 package.                 |                                              |                      |