# SGM824
# Microprocessor Supervisory Circuit with Watchdog Timer

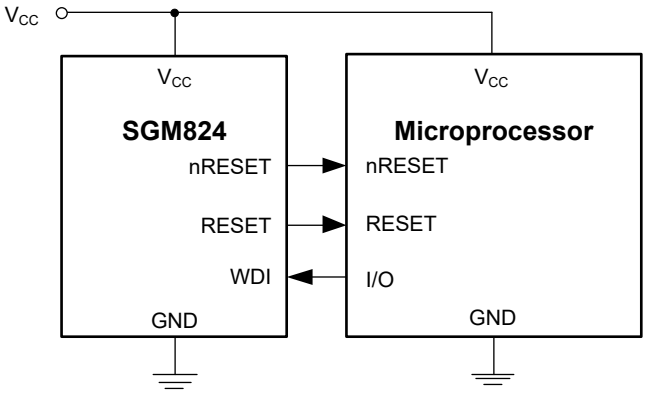
## GENERAL DESCRIPTION

The SGM824 is a complete microprocessor supervisory device which combines reset and watchdog functions in a SOT-23-5 package. System reliability is significantly improved by such integration compared to the designs with individual ICs or discrete components. The SGM824 also features an excellent transient immunity to ignore fast $V_{CC}$ transients.

This device has an active-low push-pull reset output (nRESET) that is activated by a watchdog expiry event or due to a low $V_{CC}$ voltage. The nRESET output can still be in the correct logic state even if $V_{CC}$ is lower than 1V. The SGM824 is offered in four fixed $V_{CC}$ reset threshold voltages.

The SGM824 is available in a Green SOT-23-5 package. It operates over an ambient temperature range of -40℃ to +125℃.

## TYPICAL APPLICATION




## FEATURES

- **Ultra-Low Supply Current: < 1μA (TYP)**
- **Precision Supply-Voltage Monitor**
  - **4.63V for SGM824-L**
  - **3.08V for SGM824-T**
  - **2.93V for SGM824-S**
  - **2.63V for SGM824-R**
- **Guaranteed Reset Valid at $V_{CC}$ = 1V**
- **Two Reset Output Options**
  - **Push-Pull nRESET**
  - **Push-Pull RESET**
- **Reset Pulse Width: 200ms (TYP)**
- **Debounced TTL/CMOS-Compatible**
- **Watchdog Timer with 1.6s (TYP) Timeout**
- **Fully Specified over Temperature**
- **Power-Supply Transient Immunity**
- **Without External Components**
- **-40℃ to +125℃ Operating Temperature Range**
- **Available in a Green SOT-23-5 Package**

## APPLICATIONS

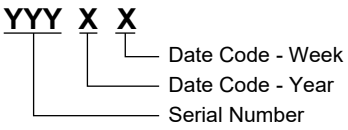
Computers
Portable Equipment
Automotive Equipment
Intelligent Instruments
Critical μP Power Monitoring

# PACKAGE/ORDERING INFORMATION

| MODEL | RESET THRESHOLD (V) | PACKAGE DESCRIPTION | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|---|---|---|---|---|---|
| SGM824 | 4.63 | SOT-23-5 | SGM824-LXN5G/TR | MZ1XX | Tape and Reel, 3000 |
| | 3.08 | SOT-23-5 | SGM824-TXN5G/TR | MG9XX | Tape and Reel, 3000 |
| | 2.93 | SOT-23-5 | SGM824-SXN5G/TR | MGAXX | Tape and Reel, 3000 |
| | 2.63 | SOT-23-5 | SGM824-RXN5G/TR | MGBXX | Tape and Reel, 3000 |

## MARKING INFORMATION

NOTE: XX = Date Code.




Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

## ABSOLUTE MAXIMUM RATINGS

Terminal Voltage (with Respect to GND)
- $V_{CC}$ ..... -0.3V to 6.0V
- All Other Inputs ..... -0.3V to ($V_{CC}$ + 0.3V)

Input Current
- $V_{CC}$ ..... 20mA
- GND ..... 20mA

Output Current
- All Outputs ..... 20mA

Package Thermal Resistance
SOT-23-5, $\theta_{JA}$ ..... 234℃/W
Junction Temperature ..... +150℃
Storage Temperature Range ..... -65℃ to +150℃
Lead Temperature (Soldering, 10s) ..... +260℃
ESD Susceptibility
HBM ..... 4000V
MM ..... 400V
CDM ..... 1000V

## RECOMMENDED OPERATING CONDITIONS

Ambient Temperature Range ..... -40℃ to +125℃

## OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

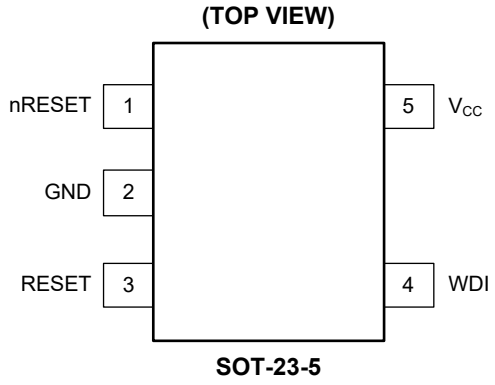
## ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

## DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

## PIN CONFIGURATION




## PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|---|---|---|
| 1 | nRESET | Active-Low Reset Output Pin. It delivers a 200ms (TYP) low pulse when activated. nRESET remains low if $V_{CC}$ is below the reset threshold. It goes (or remains) low for 200ms after either of the following events: $V_{CC}$ rises above the reset threshold or a watchdog expiry triggers a reset. |
| 2 | GND | Ground. |
| 3 | RESET | Active-High Reset Output Pin. It is the inverse of nRESET. |
| 4 | WDI | Watchdog Input Pin. If the high or low state of WDI exceeds the watchdog timeout period, the internal watchdog timer is expired and a reset is triggered. The internal watchdog timer is clear while a reset is asserted. The timer is also cleared if the WDI input is changed (on rising or falling edges). The watchdog feature is disabled if the WDI is left open or if it is connected to a three-stated buffer output. |
| 5 | $V_{CC}$ | Supply Voltage Pin. |

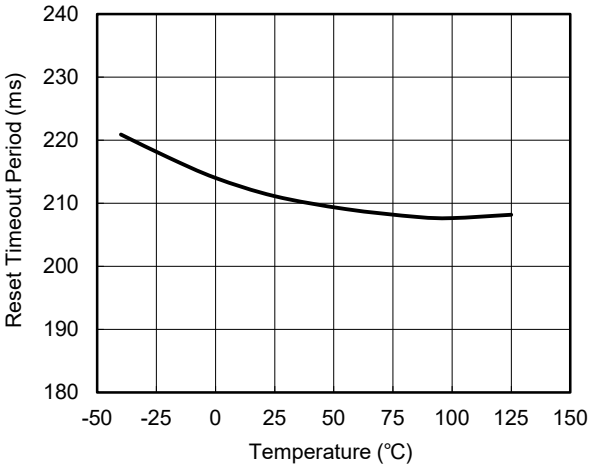
## ELECTRICAL CHARACTERISTICS

($T_A$ = +25℃, $V_{CC}$ = 4.73V to 5.5V for SGM824-L, $V_{CC}$ = 3.14V to 5.5V for SGM824-T, $V_{CC}$ = 2.99V to 5.5V for SGM824-S, $V_{CC}$ = 2.68V to 5.5V for SGM824-R, Full = -40℃ to +125℃, unless otherwise noted.)

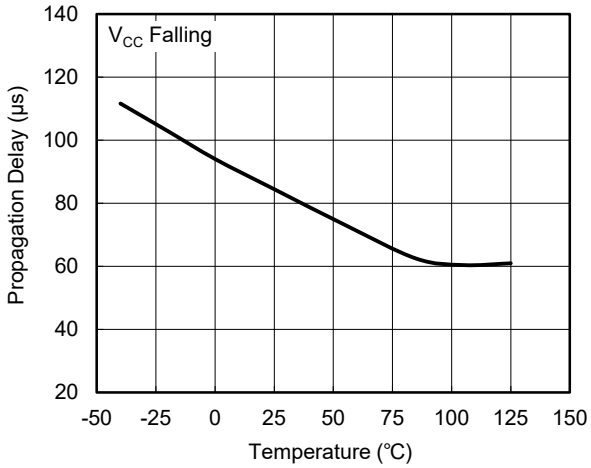
| PARAMETER | | CONDITIONS | TEMP | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|---|
| Operating Voltage Range ($V_{CC}$) | | | Full | 1 | | 5.5 | V |
| Supply Current ($I_{SUPPLY}$) | | $V_{CC}$ = 3.6V | Full | | 0.5 | 1.2 | μA |
| | | $V_{CC}$ = 5.5V | Full | | 0.7 | 1.4 | |
| Reset Threshold ($V_{RST}$) | | SGM824-L | +25℃ | 4.55 | 4.63 | 4.70 | V |
| | | | Full | 4.54 | 4.63 | 4.73 | |
| | | SGM824-T | +25℃ | 3.03 | 3.08 | 3.13 | |
| | | | Full | 3.02 | 3.08 | 3.14 | |
| | | SGM824-S | +25℃ | 2.88 | 2.93 | 2.98 | |
| | | | Full | 2.87 | 2.93 | 2.99 | |
| | | SGM824-R | +25℃ | 2.59 | 2.63 | 2.67 | |
| | | | Full | 2.58 | 2.63 | 2.68 | |
| Reset Threshold Hysteresis ($V_{HYS}$) | | SGM824-L | +25℃ | | 20 | | mV |
| | | SGM824-T | +25℃ | | 14 | | |
| | | SGM824-S | +25℃ | | 13 | | |
| | | SGM824-R | +25℃ | | 12 | | |
| Reset Threshold Temperature Coefficient | | | Full | | 20 | | ppm/℃ |
| Reset Pulse Width ($t_{RP}$) | | | Full | 140 | 200 | 290 | ms |
| nRESET Output Voltage | $V_{OH}$ | SGM824-L, $V_{CC}$ = $V_{RST(MAX)}$, $I_{SOURCE}$ = 120μA | Full | $V_{CC}$ - 1.5 | | | V |
| | | SGM824-T/S/R, $V_{CC}$ = $V_{RST(MAX)}$, $I_{SOURCE}$ = 30μA | Full | 0.8 × $V_{CC}$ | | | |
| | $V_{OL}$ | SGM824-L, $V_{CC}$ = $V_{RST(MIN)}$, $I_{SINK}$ = 3.2mA | Full | | | 0.4 | |
| | | SGM824-T/S/R, $V_{CC}$ = $V_{RST(MIN)}$, $I_{SINK}$ = 1.2mA | Full | | | 0.3 | |
| | | $V_{CC}$ = 1V, $V_{CC}$ falling, $I_{SINK}$ = 50μA | Full | | | 0.3 | |
| nRESET Output Short-Circuit Current ($I_{SOURCE}$) | | SGM824-L, nRESET = 0V, $V_{CC}$ = 5.5V | Full | | | 460 | μA |
| | | SGM824-T/S/R, nRESET = 0V, $V_{CC}$ = 3.6V | Full | | | 430 | |
| RESET Output Voltage | $V_{OH}$ | $V_{CC}$ > 1.8V, $I_{SOURCE}$ = 150μA | Full | 0.8 × $V_{CC}$ | | | V |
| | $V_{OL}$ | SGM824-L, $V_{CC}$ = $V_{RST(MAX)}$, $I_{SINK}$ = 3.2mA | Full | | | 0.4 | |
| | | SGM824-T/S/R, $V_{CC}$ = $V_{RST(MAX)}$, $I_{SINK}$ = 1.2mA | Full | | | 0.3 | |
| $V_{CC}$ to Reset Delay ($t_{RD}$) | | $V_{RST}$ - $V_{CC}$ = 100mV | +25℃ | | 84 | | μs |
| Watchdog Timeout Period ($t_{WD}$) | | | Full | 1.1 | 1.6 | 2.4 | sec |
| WDI Pulse Width ($t_{WP}$) | | $V_{IL}$ = 0V, $V_{IH}$ = $V_{CC}$ | Full | 90 | | | ns |
| WDI Input Threshold | Low | $V_{CC}$ = 5V | Full | | | 0.8 | V |
| | High | $V_{CC}$ = 5V | Full | 3.5 | | | |
| | Low | $V_{RST(MAX)}$ < $V_{CC}$ < 3.6V | Full | | | 0.8 | |
| | High | $V_{RST(MAX)}$ < $V_{CC}$ < 3.6V | Full | 0.7 × $V_{CC}$ | | | |
| WDI Input Current | | WDI = $V_{CC}$, time average | Full | | 0.02 | 0.5 | μA |
| | | WDI = 0V, time average | Full | -0.5 | -0.01 | | |

## TYPICAL PERFORMANCE CHARACTERISTICS

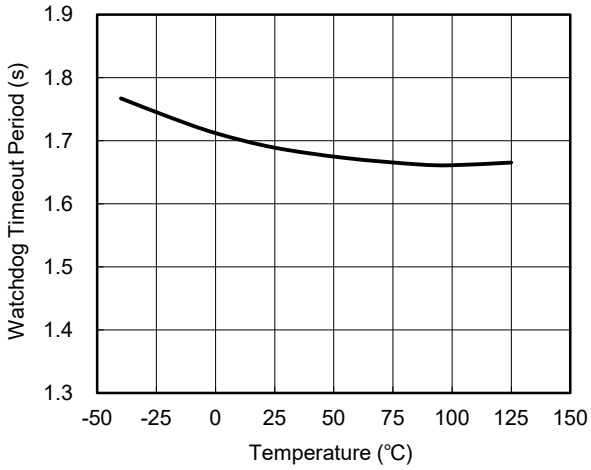
Reset Timeout Period vs. Temperature



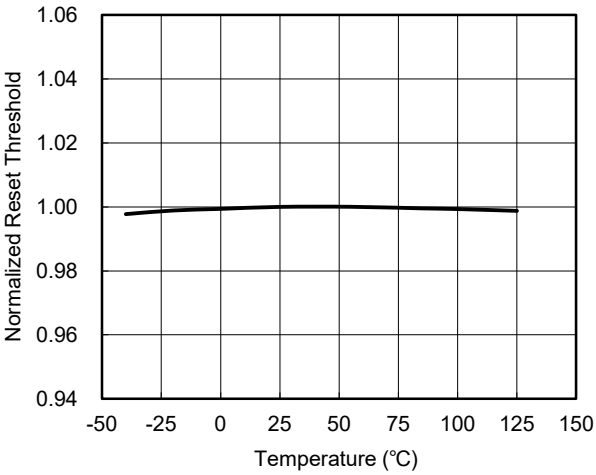

Reset Comparator Propagation Delay vs. Temperature



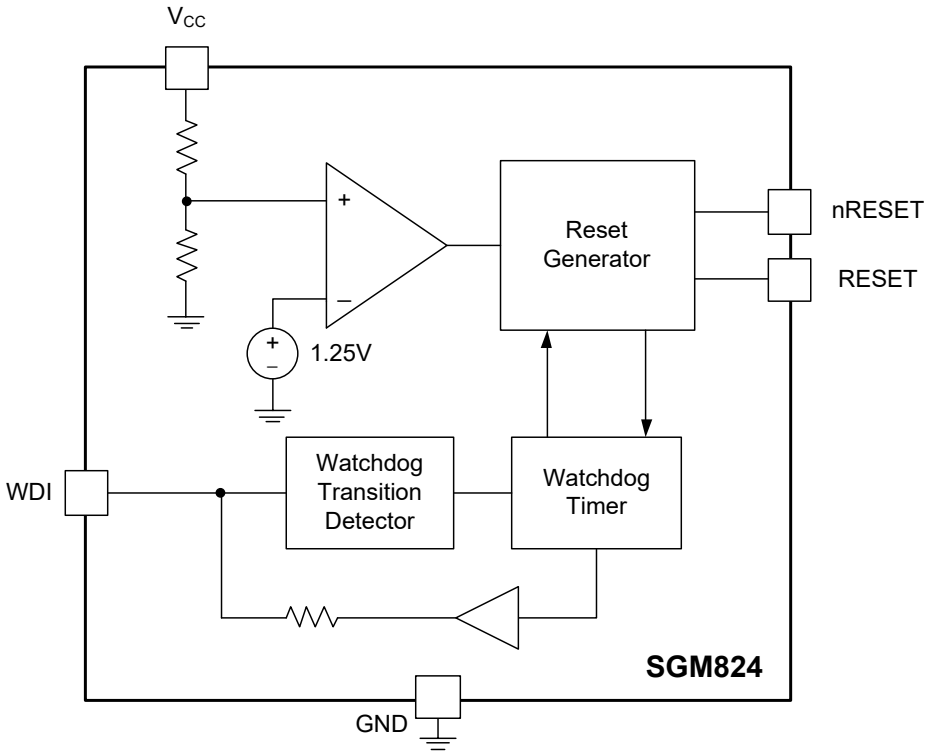

Watchdog Timeout Period vs. Temperature




Normalized Reset Threshold Voltage vs. Temperature



## FUNCTIONAL BLOCK DIAGRAM



# DETAILED DESCRIPTION

## Reset Output

The reset input of a microprocessor (μP) initiates it to a known state. The SGM824 supervisory circuit asserts a reset to the supervised μP to prevent the code-execution errors that may occur due to power-up, power-down, brownout conditions or other transients. The nRESET output is still in the correct logic state even if $V_{CC}$ is lower than 1V. During power-up, when $V_{CC}$ exceeds the rising threshold voltage ($V_{RST}$ + $V_{HYS}$), an internal timer keeps nRESET in low state for the reset timeout period ($t_{RP}$) before nRESET returns to the high state (Figure 1).

If $V_{CC}$ drops below the falling threshold voltage ($V_{RST}$) (a brownout condition occurs), a reset is asserted and nRESET goes low. In general, nRESET remains low for the $t_{RP}$ (200ms, TYP) period every time after the last event. So, if during the low period of nRESET, $V_{CC}$ goes up and dips below $V_{RST}$ again, the internal timer will restart for a new $t_{RP}$ period. The nRESET output can source and sink current. The RESET function is the inverse of nRESET.

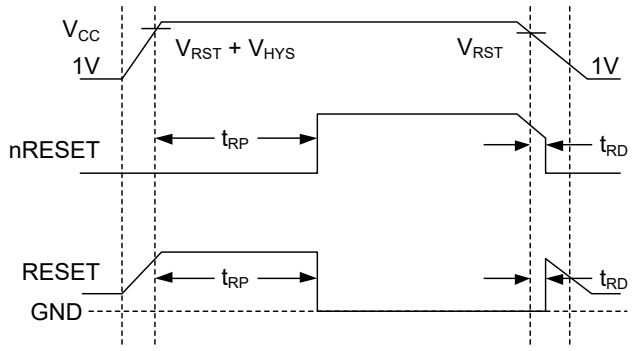



**Figure 1. Reset Timing Diagram**

## Watchdog Input

The internal watchdog circuit monitors the μP's activity by checking the WDI input. If the μP does not toggle the WDI within the watchdog $t_{WD}$ (1.6s, TYP) period, the reset output will send a low pulse to reset the μP. So, the code should be written such that successive toggles on WDI occur in periods not longer than the lowest $t_{WD}$ time to reset the internal watchdog timer and prevent μP reset when the code is running normally. The watchdog timer is cleared by either toggling WDI or by a pulse with a duration as short as 90ns. While the reset is asserted, the watchdog timer is cleared and timer does not count. It starts counting when the reset is released (Figure 2).

To disable the watchdog function, leave the WDI pin open. If WDI is driven by a 3-state buffer, set it to the Hi-Z state. In this case the buffer leakage current should not exceed 10μA. The maximum capacitance seen on the WDI pin should be less than 200pF to assure that watchdog remains disabled. The watchdog input is internally oscillating when it is left open to clear the watchdog timer and prevent it from generating a reset. It is driven low during the first 7/8 of the watchdog timeout period and driven high in the last 1/8 of that. For example if WDI input is open and the watchdog timeout is 1.6s, the watchdog timer will automatically clear every 1.4s and reset will not occur.

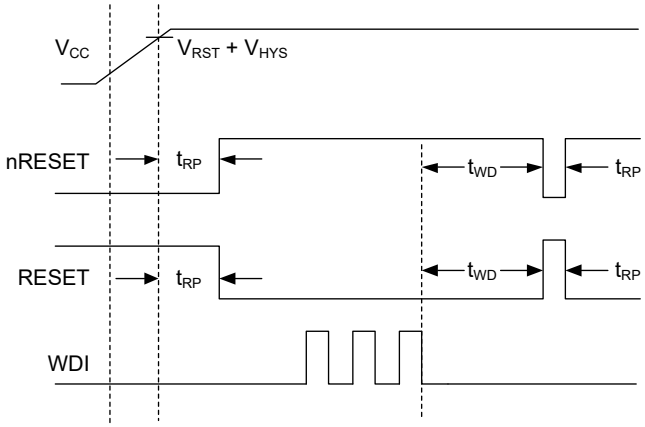



**Figure 2. Watchdog Timing Relationship**

# APPLICATION INFORMATION

## Using SGM824 with Microprocessors with Bidirectional Reset Pins

Some microprocessors can internally force their reset pins low to assert a reset (bidirectional reset pins). The low pull-up current of the SGM824 allows using of them along with the microprocessors with bidirectional resets like the 68HC11. The microprocessor can force nRESET low when nRESET is pulled high by the SGM824 with no issues (Figure 3).

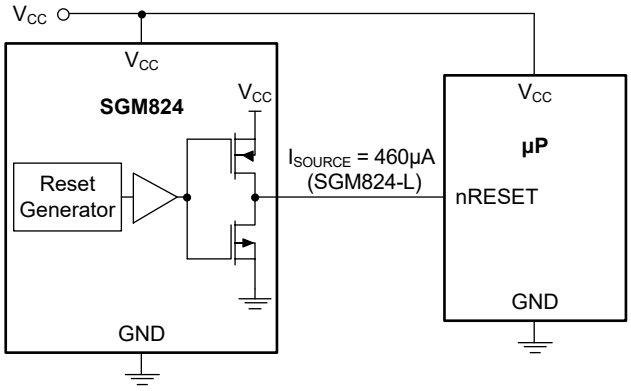



**Figure 3. Interfacing to μP with Bidirectional Resets**

## Negative-Going $V_{CC}$ Transient Immunity

The SGM824 has the ability to immune short time and negative $V_{CC}$ transients or even glitches. It does not need to shut down the entire system. Resets are applied to the microprocessor during power-up, power-down and brownout conditions and not when an insignificant $V_{CC}$ transient occurs.

A 0.1μF ceramic capacitor is recommended between the $V_{CC}$ and GND pin to reduce the input supply noise.

## Watchdog Input Current

The WDI input is internally driven by a buffer and series resistor from an internal counter chain stage of the watchdog. Therefore, when WDI is open, the watchdog timer is automatically cleared before timeout (by an internal low-high-low pulse).

To get the minimum WDI input current (minimum power loss), keep WDI low for the majority of the timeout period and send a high pulse at the first 7/8 of the timeout period for clearing the watchdog timer.

## Watchdog Software Considerations

To have a more effective watchdog in software monitoring, rather than generating pulses by a code segment, set and reset the WDI input at different points of the program code. For example, set it in the main program and reset it in a periodic timing interrupt. For example if WDI is toggled within an unwanted infinite loop, it will continuously reset watchdog as a normal condition and the processor is not reset.

An example of a watchdog flow is shown in Figure 4. The WDI is set high at the start of the program, and is set low at the start of every subroutine or loop, then is set high again when the program returns to the start. If the processor hangs in any subroutine, the WDI toggling will not occur and the watchdog will reset the processor and correct the situation.

The reset output may also be connected to an interrupt input of the μP for a corrective action if preferred.

Note that such watchdog control schemes may not be optimal if the total power consumption is critical as discussed in the watchdog input current section.

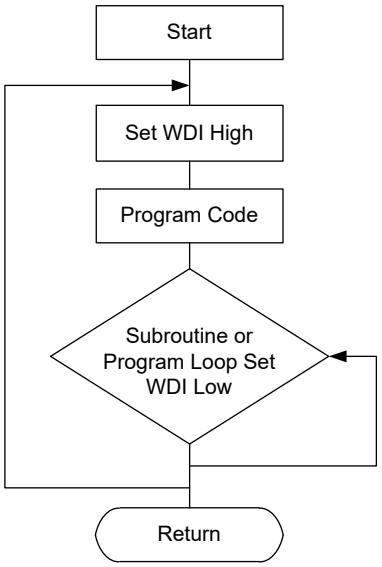



**Figure 4. Watchdog Flow Diagram**

# REVISION HISTORY

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| JULY 2022 – REV.A.2 to REV.A.3 | Page |
|---|---|
| Updated General Description section | 1 |
| Updated Detailed Description section | 7 |
| Updated Application Information section | 8 |

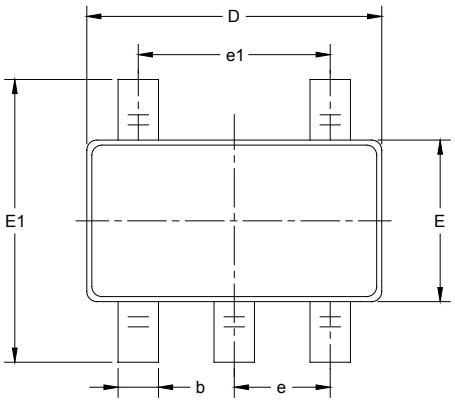
| JULY 2020 – REV.A.1 to REV.A.2 | Page |
|---|---|
| Updated Features section | 1 |
| Changed Detailed Description section | 7 |

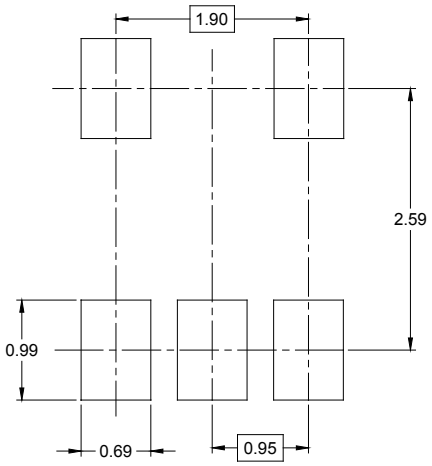
| JANUARY 2020 – REV.A to REV.A.1 | Page |
|---|---|
| Changed Electrical Characteristics section | 4 |
| Changed Typical Performance Characteristics section | 5 |
| Changed Figure 1 | 7 |

| Changes from Original (DECEMBER 2018) to REV.A | Page |
|---|---|
| Changed from product preview to production data | All |

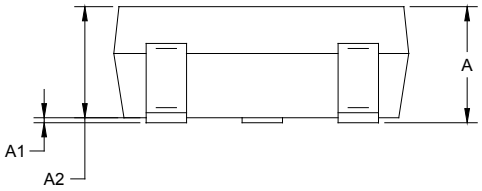
# PACKAGE OUTLINE DIMENSIONS

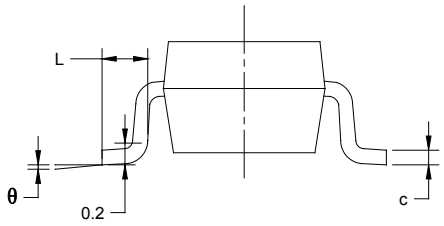
## SOT-23-5




**RECOMMENDED LAND PATTERN** (Unit: mm)

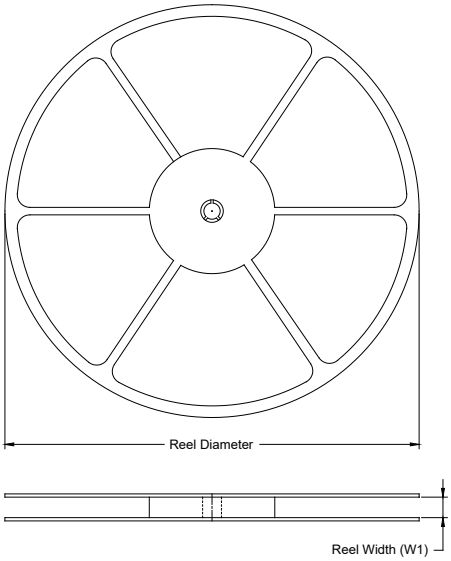


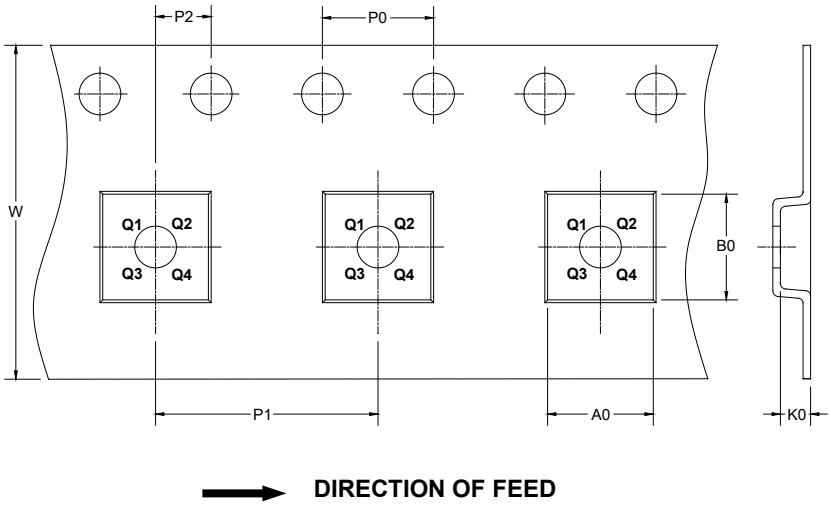

| Symbol | Dimensions In Millimeters | | Dimensions In Inches | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 1.050 | 1.250 | 0.041 | 0.049 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 1.050 | 1.150 | 0.041 | 0.045 |
| b | 0.300 | 0.500 | 0.012 | 0.020 |
| c | 0.100 | 0.200 | 0.004 | 0.008 |
| D | 2.820 | 3.020 | 0.111 | 0.119 |
| E | 1.500 | 1.700 | 0.059 | 0.067 |
| E1 | 2.650 | 2.950 | 0.104 | 0.116 |
| e | 0.950 BSC | | 0.037 BSC | |
| e1 | 1.900 BSC | | 0.075 BSC | |
| L | 0.300 | 0.600 | 0.012 | 0.024 |
| θ | 0° | 8° | 0° | 8° |

# TAPE AND REEL INFORMATION

### REEL DIMENSIONS




### TAPE DIMENSIONS



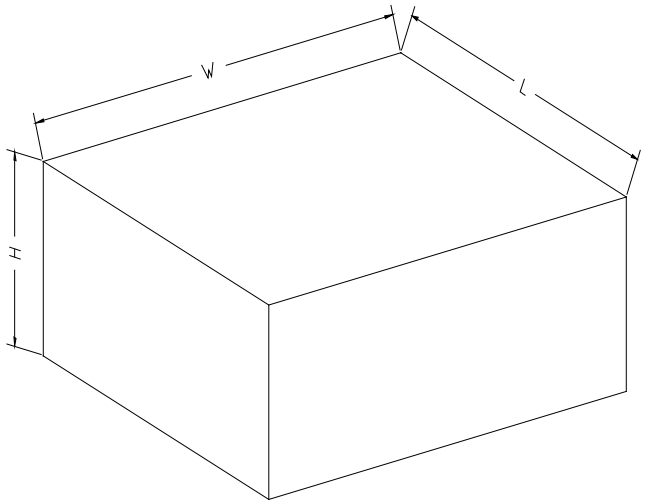

NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---|---|---|---|---|---|---|---|---|---|---|
| SOT-23-5 | 7″ | 9.5 | 3.20 | 3.20 | 1.40 | 4.0 | 4.0 | 2.0 | 8.0 | Q3 |

DD0001

## CARTON BOX DIMENSIONS




NOTE: The picture is only for reference. Please make the object as the standard.

## KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|---|---|---|---|---|
| 7″ (Option) | 368 | 227 | 224 | 8 |
| 7″ | 442 | 410 | 224 | 18 |

DD0002