

## 1 $\mu$ A Voltage Detector with Output Delay

### Features

- Precise Detection Thresholds:  $\pm 2.0\%$
- Small Package: 3-Pin SOT-23A
- Low Supply Current: Typ. 1 $\mu$ A
- Wide Detection Range: 1.6V to 6.0V
- Wide Operating Voltage Range: 0.7V to 10V
- Built-in Delay Circuit: 50msec to 200 msec
- Open-Drain Output

### Applications

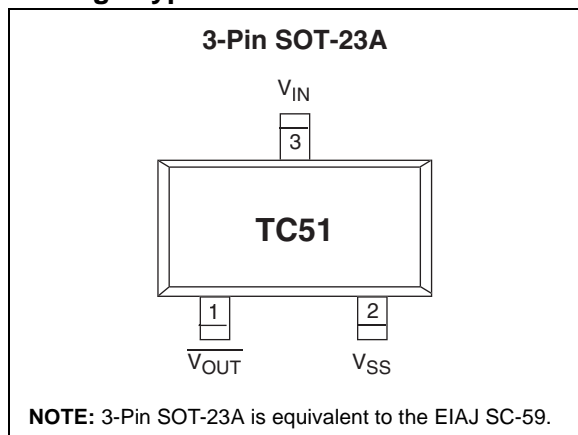
- Battery Voltage Monitoring
- Microprocessor Reset
- System Brown-out Protection

### Device Selection Table

Part Number	Package	Temp. Range
TC51-xxxxxxxxx	3-Pin SOT-23A	-40°C to +85°C

Other output voltages are available. Please contact Microchip Technology Inc. for details.

### Package Type



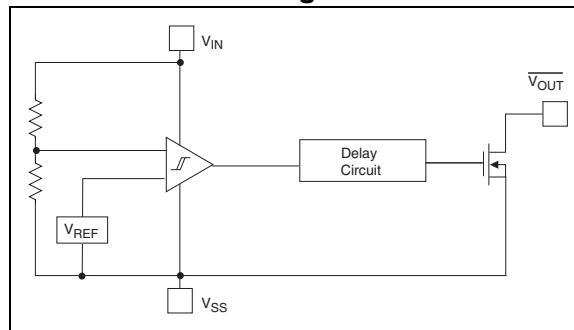
### General Description

The TC51 is a very low power, open drain output, CMOS voltage detector with built-in delay. It is particularly well-suited for battery powered applications because of its extremely low 1 $\mu$ A operating current and small surface-mount packaging. Each part is laser-trimmed to the desired threshold voltage, which can be specified from 1.6V to 6.0V. The standard built-in output delay is 50msec-200msec.

The device includes a comparator, low-current high-precision reference, laser-programmed voltage divider, hysteresis circuit and output driver with digital delay timer.

In operation, the TC51's output ( $\overline{V_{OUT}}$ ) remains in the logic HIGH state as long as  $V_{IN}$  is greater than the specified threshold voltage ( $V_{DET-}$ ). When  $V_{IN}$  falls below  $V_{DET-}$ , the output is immediately driven to a logic LOW.  $\overline{V_{OUT}}$  remains LOW until  $V_{IN}$  rises above  $V_{DET-}$  by an amount  $V_{HYST}$ , whereupon it returns to a logic HIGH after expiration of the built-in delay time.

### Functional Block Diagram



# TC51

## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings\*

Input Voltage .....+12V  
 Output Current .....50mA  
 Output Voltage: Open Drain .....( $V_{SS} - 0.3V$ ) to 12V  
 Power Dissipation ( $T_A \leq 70^\circ C$ ):  
   3-Pin SOT-23A .....240mW  
 Operating Temperature Range.....-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.

### TC51 ELECTRICAL SPECIFICATIONS

Electrical Characteristics: $T_A = 25^\circ C$ , unless otherwise specified.						
Symbol	Parameter	Min	Typ	Max	Units	Test Conditions
$V_{IN}$	Operating Voltage	0.7	—	10.0	V	( $V_{DET-}$ ) = 1.6 to 6.0V
$I_{SS}$	Quiescent Current	—	0.9	2.6	$\mu A$	$V_{IN} = 1.5V$ $V_{IN} = 2.0V$ $V_{IN} = 3.0V$ $V_{IN} = 4.0V$ $V_{IN} = 5.0V$
		—	1.0	3.0		
		—	1.3	3.4		
		—	1.6	3.8		
		—	2.0	4.2		
$V_{DET-}$	Threshold Voltage	$V_T \times 0.98$	$V_T \pm 0.5\%$	$V_T \times 1.02$	V	Note 1
$V_{HYST}$	Hysteresis Voltage	$V_{DET-} \times 0.02$	$V_{DET-} \times 0.05$	$V_{DET-} \times 0.08$	V	
$I_{OUT}$	Output Current	—	2.2	—	mA	$V_{OL} = 0.5V, V_{IN} = 1.0V$ $V_{IN} = 2.0V$ $V_{IN} = 3.0V$ $V_{IN} = 4.0V$ $V_{IN} = 5.0V$
		—	7.7	—		
		—	10.1	—		
		—	11.5	—		
		—	13.0	—		
$T_{DLY}$	Delay Time	50	—	200	msec	Standard
$T_C (V_{DET-})$	Tempco of ( $V_{DET-}$ )	—	$\pm 100$	—	ppm/ $^\circ C$	$-40^\circ C \leq T_A \leq 85^\circ C$

**Note 1:**  $V_T$  is the factory programmed threshold voltage setting.

## 2.0 PIN DESCRIPTIONS

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

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

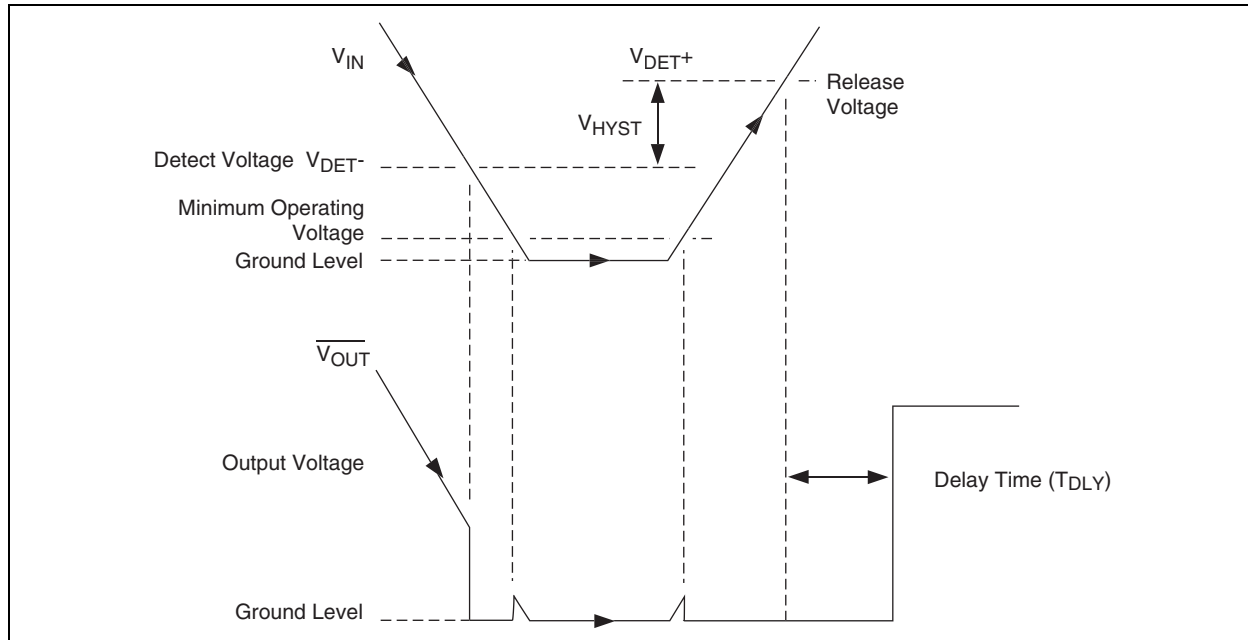
Pin No. (3-Pin SOT-23A)	Symbol	Description
1	$\overline{V_{OUT}}$	Digital output. This output goes low when $V_{IN}$ drops below $V_{DET-}$ and returns high when $V_{IN}$ rises above $V_{DET-} + V_{HYST}$ . (See Figure 3-1, Timing Diagram).
2	$V_{SS}$	Ground terminal.
3	$V_{IN}$	Analog input. This pin is both the power supply input and the voltage to be monitored.

## 3.0 DETAILED DESCRIPTION

In normal steady-state operation, when  $V_{IN} > V_{DET-}$ , the output is high, see Figure 3-1. If and when the input falls below  $V_{DET-}$ , the output pulls down (Logic 0) to  $V_{SS}$ . Generally,  $V_{OUT}$  can pull down to within 0.5V of  $V_{SS}$  at rated output current and input voltage. (Also see Section 1.0, Electrical Characteristics).

The output,  $\overline{V_{OUT}}$ , stays valid until the input voltage falls below the minimum operating voltage,  $V_{INMIN}$ , of 0.7V. Below this minimum operating voltage, the output is undefined. During power-up or anytime  $V_{IN}$  has fallen below  $V_{INMIN}$ ,  $\overline{V_{OUT}}$  will remain undefined until  $V_{IN}$  rises above  $V_{INMIN}$ , at which time the output becomes valid.  $\overline{V_{OUT}}$  is maintained in its active low state while  $V_{INMIN} < V_{IN} < V_{DET+}$ . ( $V_{DET+} = V_{DET-} + V_{HYST}$ ). If and when the input rises above  $V_{DET+}$ , the output will assume its inactive state after Delay Time ( $T_{DLY}$ ).

**FIGURE 3-1: TIMING DIAGRAM**



## 4.0 APPLICATIONS INFORMATION

### 4.1 Processor $\overline{\text{RESET}}$ Supervisor

Figure 4-1 shows the TC51 used as a processor reset supervisor. Because the TC51 is available in threshold settings of 1.6V to 6.0V, the user can choose the reset single threshold setting best suited to the system power supply voltage at hand. Also, the 1 $\mu$ A supply current is significantly lower than its nearest competitor.

As shown in the timing diagram (Figure 3-1),  $\overline{V_{\text{OUT}}}$  is low for voltages between 0.7V and  $V_{\text{DET+}}$ . The TC51 activates its on-board delay timer once the power supply voltage is within tolerance (i.e., greater than  $V_{\text{DET+}}$ ).  $\overline{V_{\text{OUT}}}$  is released after delay time ( $T_{\text{DLY}}$ ).

Should the power supply voltage momentarily dip (“brown-out” condition), the TC51 immediately drives and holds the processor  $\overline{\text{RESET}}$  input low.  $\overline{\text{RESET}}$  is released after the power supply voltage is again within tolerance, and after the delay timer expires.  $\overline{\text{RESET}}$  is driven and held low when power fails (power-off or “blackout”), and is maintained down low to a supply voltage of 0.7V.

FIGURE 4-1: PROCESSOR  $\overline{\text{RESET}}$  SUPERVISOR

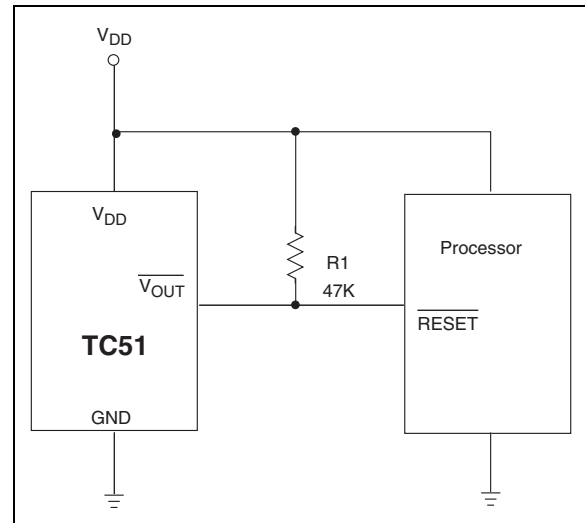
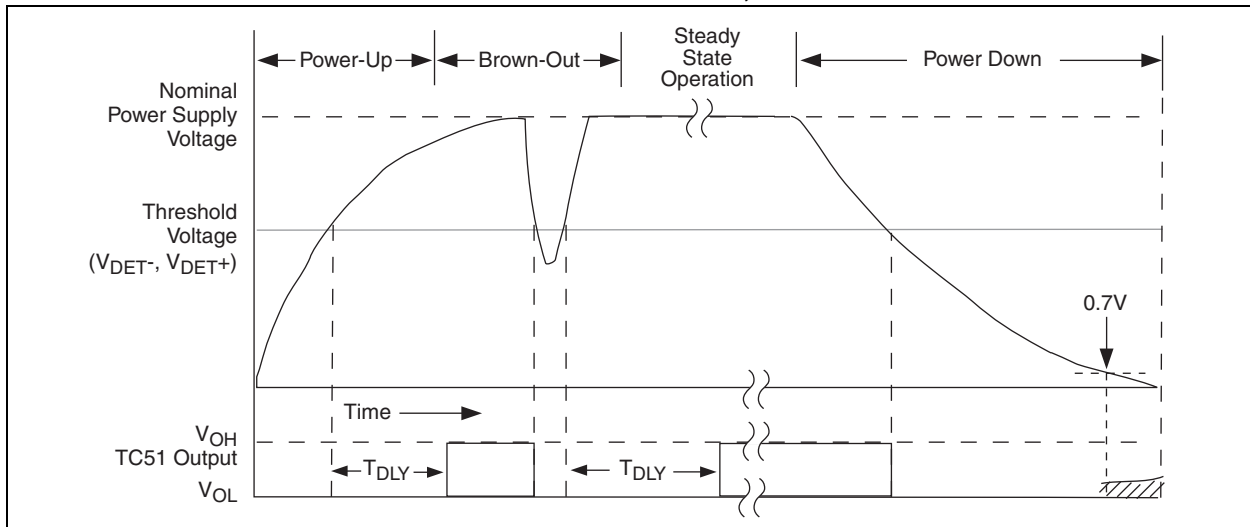


FIGURE 4-2: TC51 OPERATION DURING POWER-UP, BROWN-OUT AND POWER DOWN

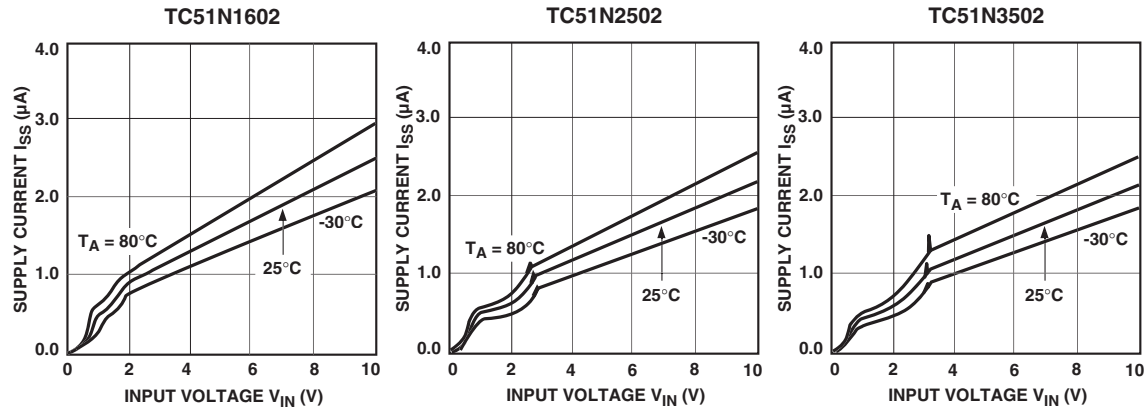


# TC51

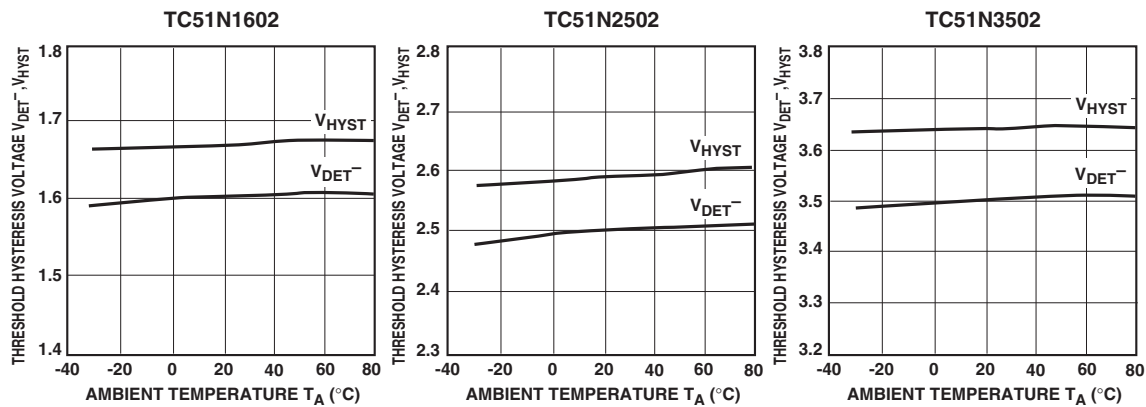
## 5.0 TYPICAL CHARACTERISTICS

**Note:** The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

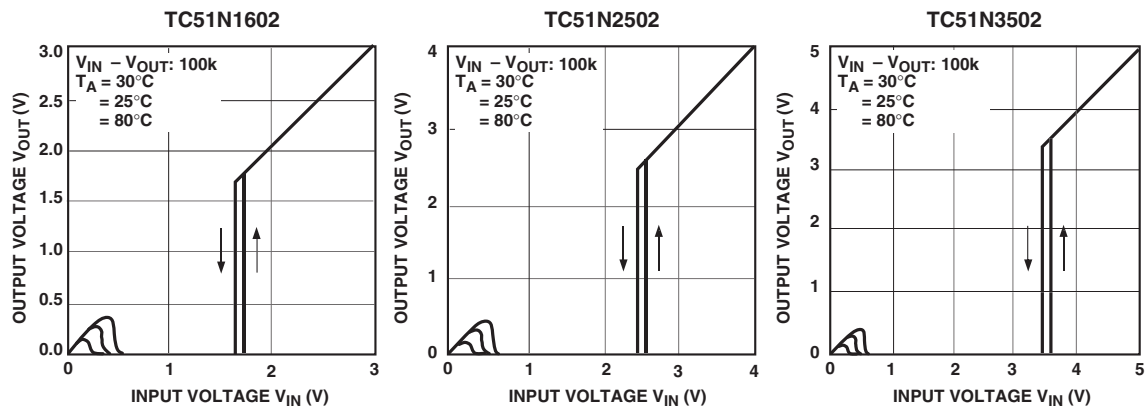
### 1. SUPPLY CURRENT VS. INPUT VOLTAGE



### 2. THRESHOLD VOLTAGE, HYSTERESIS VOLTAGE VS. AMBIENT TEMPERATURE

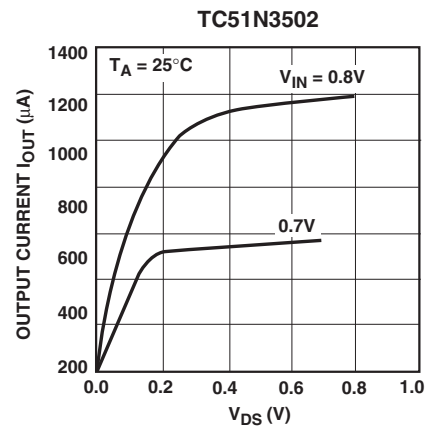
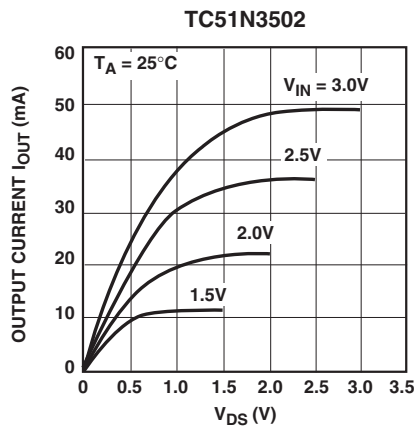
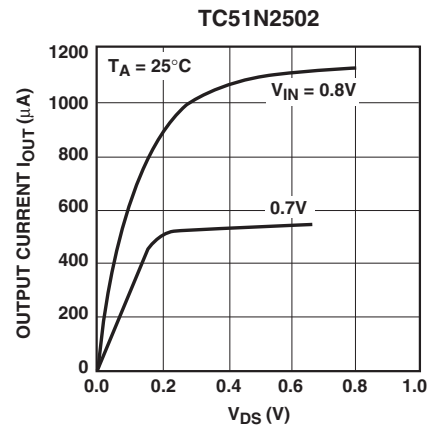
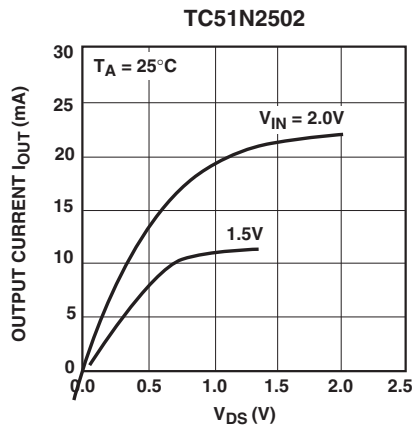
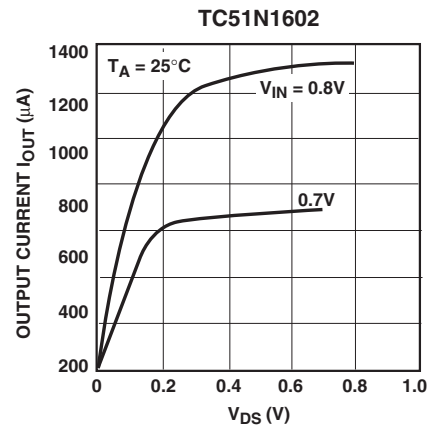
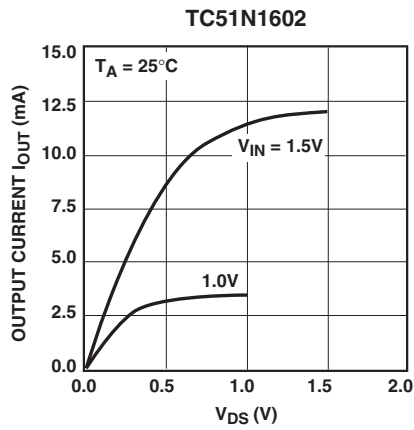


### 3. OUTPUT VOLTAGE VS. INPUT VOLTAGE



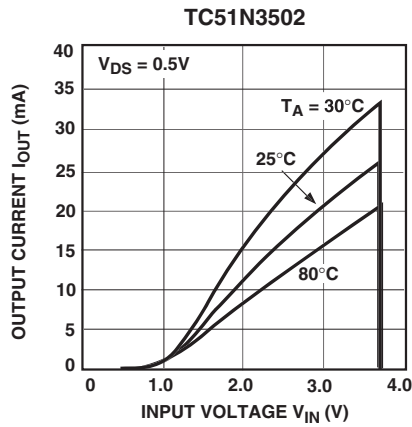
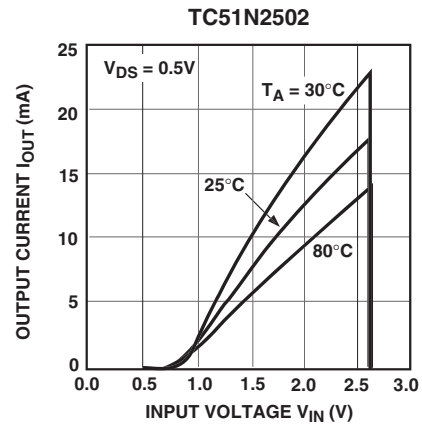
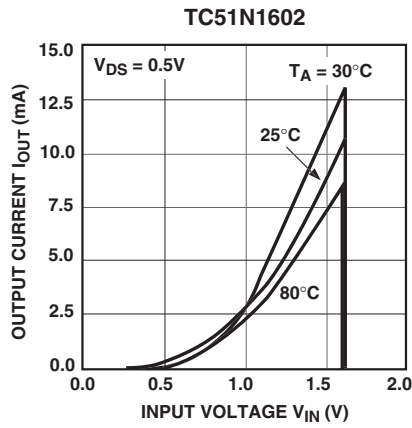
## 5.0 TYPICAL CHARACTERISTICS (CONTINUED)

### 4. OUTPUT CURRENT VS. $V_{DS}$



## 5.0 TYPICAL CHARACTERISTICS (CONTINUED)

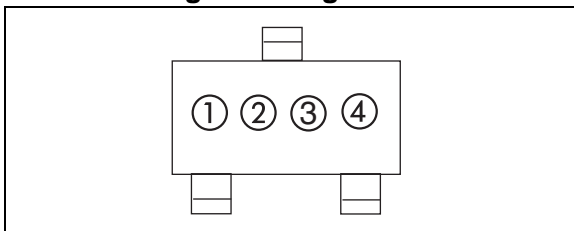
### 5. OUTPUT CURRENT VS. INPUT VOLTAGE





## 6.0 PACKAGING INFORMATION

### 6.1 Package Marking Information



① represents N-channel indication and integer part of output voltage

Symbol	Output	Voltage
K	Nch	0.
L	Nch	1.
M	Nch	2.
N	Nch	3.
P	Nch	4.
R	Nch	5.
S	Nch	6.

② represents first decimal of output voltage

Symbol	Voltage
0	.0
1	.1
2	.2
3	.3
4	.4
5	.5
6	.6
7	.7
8	.8
9	.9

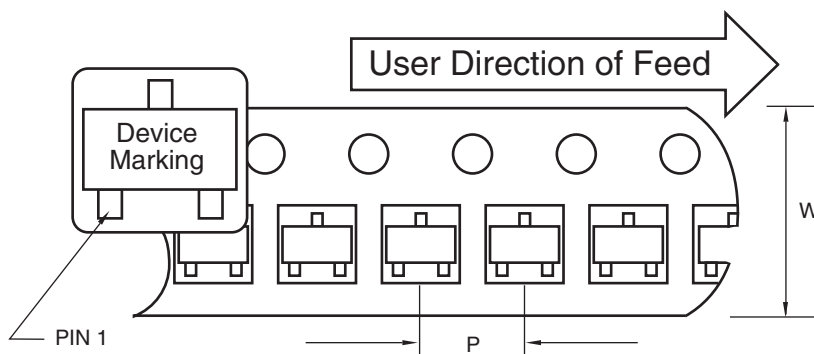
③ represents delay time

Symbol	Delay Time
5	50ms-200ms

④ represents assembly lot code

### 6.2 Taping Form

#### Component Taping Orientation for 3-Pin SOT-23A (EIAJ SC-59) Devices



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

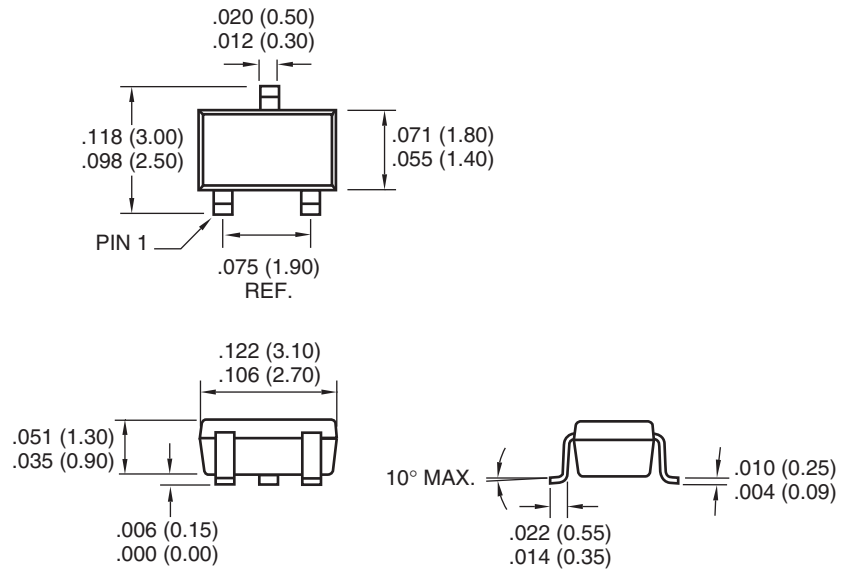
#### Carrier Tape, Number of Components Per Reel and Reel Size

Package	Carrier Width (W)	Pitch (P)	Part Per Full Reel	Reel Size
3-Pin SOT-23A	8 mm	4 mm	3000	7 in

## 6.3 Package Dimensions

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>

### SOT-23A-3



Dimensions: inches (mm)

## 7.0 REVISION HISTORY

### Revision C (December 2012)

Added a note to the package outline drawing.

# TC51

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NOTES:

## 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>TC51</b>	<b>N</b>	<b>18</b>	<b>0</b>	<b>2</b>	<b>E</b>	<b>CB</b>	<b>XX</b>
<b>Output Configuration:</b>								
N = Open Drain								
<b>Detected Voltage:</b>								
Ex: 18 = 1.8V								
<b>Output Delay:</b>								
0 = 50msec-200msec (standard)								
<b>Tolerance:</b>								
2 = $\pm 2\%$								
<b>Temperature:</b>								
E: -40°C to +85°C								
<b>Package Type and Pin Count:</b>								
CB: 3-Pin SOT-23A (equivalent to EIAJ SC-59)								
<b>Taping Direction:</b>								
TR: Standard Taping								

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NOTES:

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