

# 32-Tap MiniPot™ Digitally Programmable Potentiometers with 2-Wire Interface



## FEATURES

- 0.3µA Ultra-low standby current
- Single-supply operation: 2.7V to 5.5V
- Glitchless switching between resistor taps
- Power-on reset to midscale
- 2-Wire up/down serial interface
- Resistance values: 10kΩ, 50kΩ and 100kΩ
- All devices available in SOT-23 package
- CAT5110, CAT5118, CAT5119 also available in SC70

## APPLICATIONS

- LCD screen adjustment
- Volume control
- Mechanical potentiometer replacement
- Gain adjustment
- Line impedance matching

For Ordering Information details, see page 11.

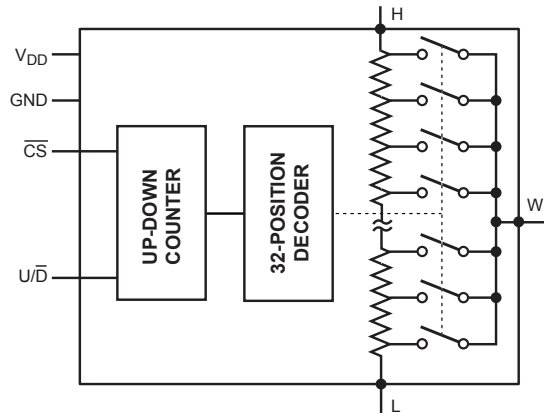
## DESCRIPTION

CAT5110/5118/5119/5123/5124/5125 linear-taper digitally programmable potentiometers perform the same function as a mechanical potentiometer or a variable resistor. These devices consist of a fixed resistor and a wiper contact with 32-tap points that are digitally controlled through a 2-wire up/down serial interface.

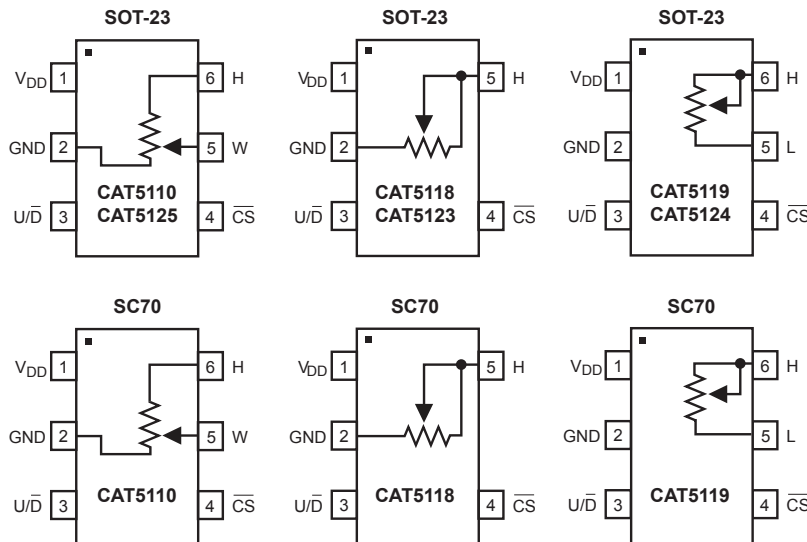
The CAT5110 and CAT5125 are configured as potentiometers. The CAT5118/19/23/24 are configured as variable resistors.

Three resistance values are available: 10kΩ, 50kΩ and 100kΩ. All devices are available in space-saving 5-pin and 6-pin SOT-23 packages. The CAT5110/5118/5119 are also available in the SC70 package.

## FUNCTIONAL DIAGRAM



## PIN CONFIGURATION



**PIN DESCRIPTIONS**

Pin Number			Pin Name	Description
CAT5110/ CAT5125	CAT5118/ CAT5123	CAT5119/ CAT5124		
1	1	1	V <sub>DD</sub>	Power Supply
2	2	2	GND	Ground
3	3	3	U/ $\overline{D}$	Up/ $\overline{\text{Down}}$ Control Input. With $\overline{\text{CS}}$ low, a low-to-high transition increments or decrements the wiper position.
4	4	4	$\overline{\text{CS}}$	Chip Select Input. A high-to-low $\overline{\text{CS}}$ transition determines the mode: increment if U/ $\overline{D}$ is high, or decrement if U/ $\overline{D}$ is low.
-	-	5	L	Low Terminal of Resistor
5	-	-	W	Wiper Terminal of Resistor
6	6	6	H	High Terminal of Resistor

**ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>**

V <sub>DD</sub> to GND	-0.3V to +6V
All Other Pins to GND	-0.3V to (V <sub>DD</sub> + 0.3)V
Input and Output Latch-Up Immunity	±200mA
Maximum Continuous Current into H, L and W	
100k $\Omega$	±0.6mA
50k $\Omega$	±1.3mA
10k $\Omega$	±1.3mA
Continuous Power Dissipation (T <sub>A</sub> = +70°C)	
5-pin SC70*	247mW
6-pin SC70*	245mW
Operating Temperature Range	-40°C to +85°C
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Soldering Temperature (soldering, 10s)	+300°C

**Notes:**

(1) 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 outside of those listed in the operational sections of this specification is not implied. Exposure to any absolute maximum rating for extended periods may affect device performance and reliability.

(\*) Derate 3.1mW/°C above T<sub>A</sub> = +70°C

**ELECTRICAL CHARACTERISTICS**

$V_{DD} = 2.7V$  to  $5.5V$ ,  $V_H = V_{DD}$ ,  $V_L = 0$ ,  $T_A = -40^{\circ}C$  to  $85^{\circ}C$ . Typical values are at  $V_{DD} = 2.7V$ ,  $T_A = 25^{\circ}C$ , unless otherwise noted.

Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>DC Performance</b>						
Resolution			32			Taps
End-to-End Resistance (-00)			80	100	120	kΩ
End-to-End Resistance (-50)			40	50	60	
End-to-End Resistance (-10)			8	10	12	
End-to-End Resistance Tempco	$TC_R$			200		ppm/°C
Ratiometric Resistance Tempco				5		ppm/°C
Integral Nonlinearity	INL			±0.5	±1	LSB
Differential Nonlinearity	DNL				±1	LSB
Full-Scale Error				±0.1		LSB
Zero-Scale Error					1	LSB
Wiper Resistance	$R_W$	CAT5110/18/19		200	600	Ω
		CAT5123/24/25		80	200	
<b>Digital Inputs</b>						
Input High Voltage	$V_{IH}$		$0.7 \times V_{DD}$			V
Input Low Voltage	$V_{IL}$				$0.3 \times V_{DD}$	V
<b>Timing Characteristics (Figures 1, 2)</b>						
$U/\bar{D}$ Mode to CS Setup	$t_{CU}$		25			ns
CS to $U/\bar{D}$ Step Setup	$t_{CI}$		50			ns
CS to $U/\bar{D}$ Step Hold	$t_{CH}$		25			ns
$U/\bar{D}$ Step Low Period	$t_{LL}$		25			ns
$U/\bar{D}$ Step High Period	$t_{HL}$		25			ns
Up/Down Toggle Rate <sup>(1)</sup>	$f_{TOGGLE}$			1		MHz
Output Settling Time <sup>(2)</sup>	$t_{SETTLE}$	100kΩ variable resistor configuration, $C_L = 10pF$		1		μs
		100kΩ potentiometer configuration, $C_L = 10pF$		0.25		
<b>Power Supply</b>						
Supply Voltage	$V_{DD}$		2.7		5.5	V
Active Supply Current <sup>(3)</sup>	$I_{DD}$				25	μA
Standby Supply Current <sup>(4)</sup>	$I_{SB}$	$V_{DD} = +5V$		0.3	1	μA

**Notes:**

(1) Up/Down Toggle Rate:  $f_{TOGGLE} = \frac{1}{t_{SETTLE}}$

(2) Typical settling times are dependent on end-to-end resistance.

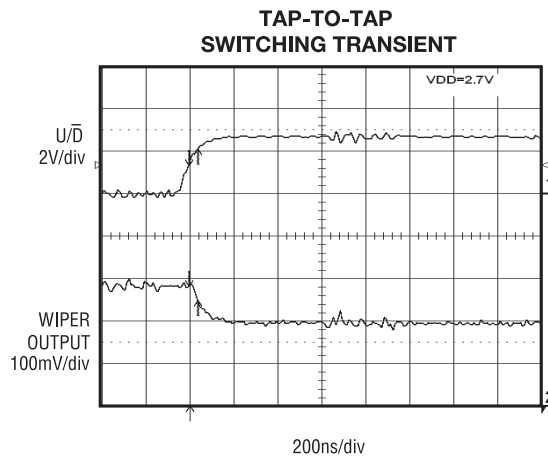
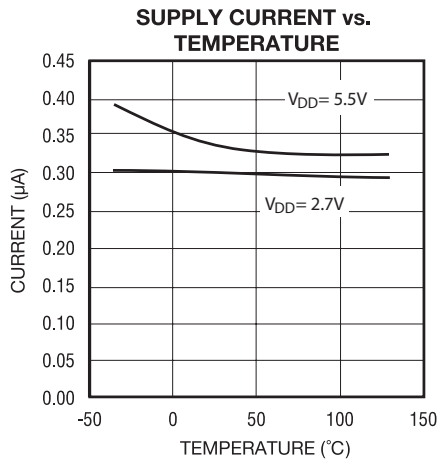
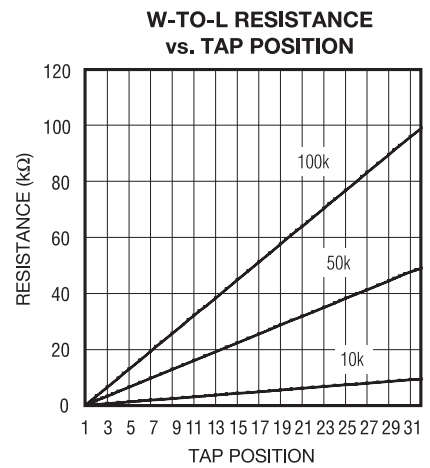
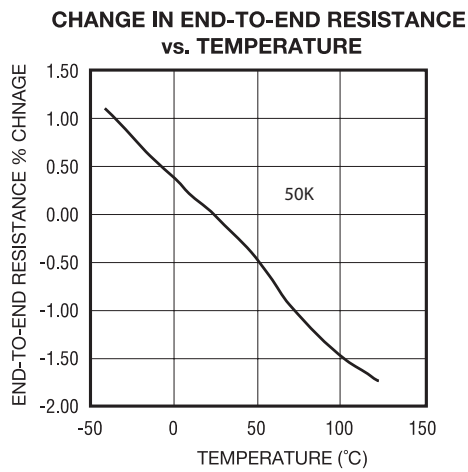
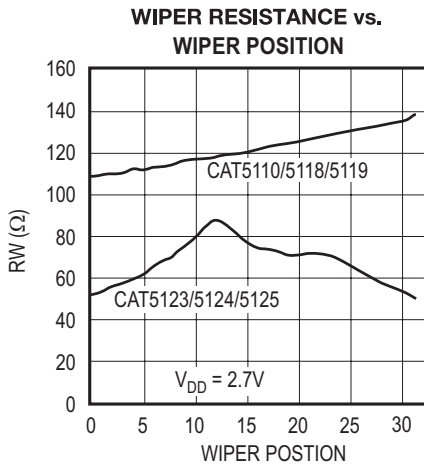
(3) Supply current measured while changing wiper tap,  $f_{TOGGLE} = 1MHz$ .

(4) Supply current measured while wiper position is fixed.

**CAT5110, CAT5118, CAT5119, CAT5123, CAT5124, CAT5125**

**TYPICAL OPERATING CHARACTERISTICS**

$T_A = 25^\circ\text{C}$ , unless otherwise noted.



## FUNCTIONAL DESCRIPTION

The CAT5110/5118/5119/5123/5124/5125 consist of a fixed resistor and a wiper contact with 32-tap points that are digitally controlled through a 2-wire up/down serial interface. Three end-to-end resistance values are available: 10kΩ, 50kΩ and 100kΩ.

The CAT5110/5125 is designed to operate as a potentiometer. In this configuration, the low terminal of the resistor array is connected to ground (pin 2).

The CAT5118/5123 performs as a variable resistor. In this device, the wiper terminal and high terminal of the resistor array are connected at pin 5. The CAT5119/5124 is a similar variable resistor, except the low terminal is connected to pin 5.

## DIGITAL INTERFACE OPERATION

The MiniPots have two modes of operation when the serial interface is active: increment and decrement mode. The serial interface is only active when  $\overline{CS}$  is low.

The  $\overline{CS}$  and  $U/\overline{D}$  inputs control the position of the wiper along the resistor array. When  $\overline{CS}$  transitions from high to low, the part will go into increment mode if  $U/\overline{D}$  input is high, and into decrement mode when  $U/\overline{D}$  input is low. Once the mode is set, the device will remain in that mode until  $\overline{CS}$  goes high again. A low-to-high transition at the  $U/\overline{D}$  pin will increment or decrement the wiper position depending on the current mode (Figures 1 and 2).

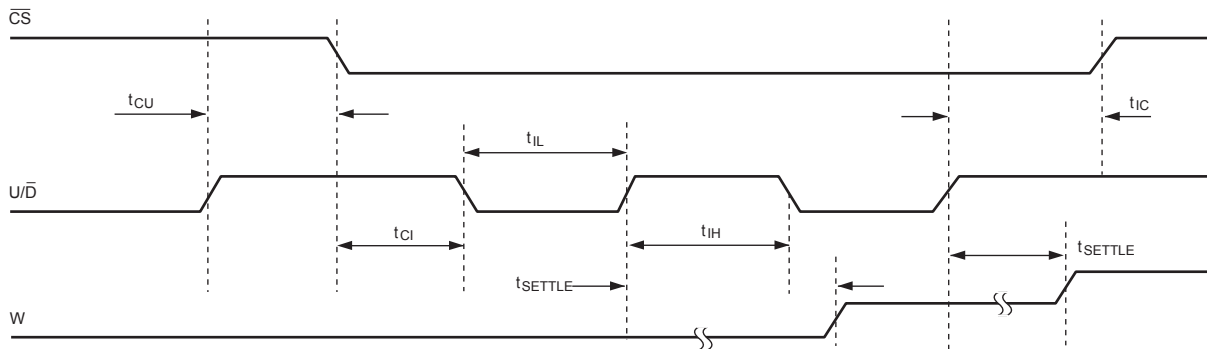
When the  $\overline{CS}$  input transitions to high (serial interface inactive), the value of the counter is stored and the wiper position is maintained.

Note that when the wiper reaches the maximum (or minimum) tap position, the wiper will not wrap around to the minimum (or maximum) position.

## POWER-ON RESET

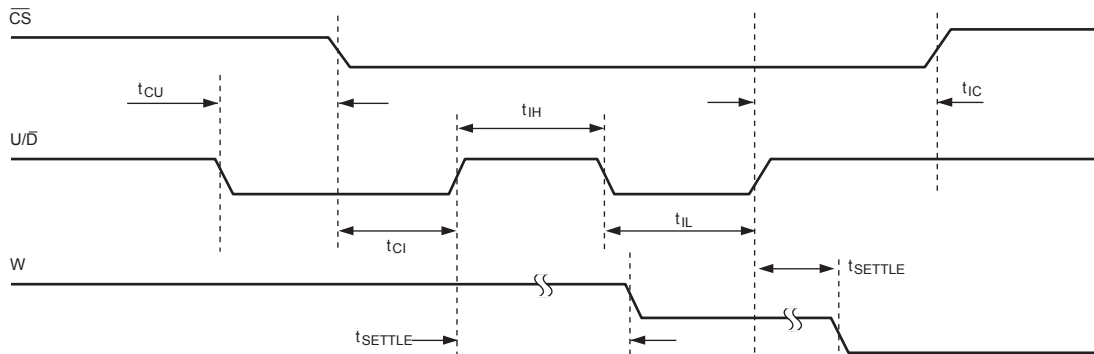
All parts in this family feature power-on reset (POR) circuitry that sets the wiper position to midscale at power-up. By default, the chip is in the increment mode.

**Figure 1. Serial Interface Timing Diagram, Increment Mode**



Note: "W" is not a digital signal. It represents wiper transitions.

**Figure 2. Serial Interface Timing Diagram, Decrement Mode**



Note: "W" is not a digital signal. It represents wiper transitions.

**APPLICATIONS INFORMATION**

The MiniPots are intended for circuits requiring digitally controlled adjustable resistance, such as LCD contrast control, where voltage biasing adjusts the display contrast.

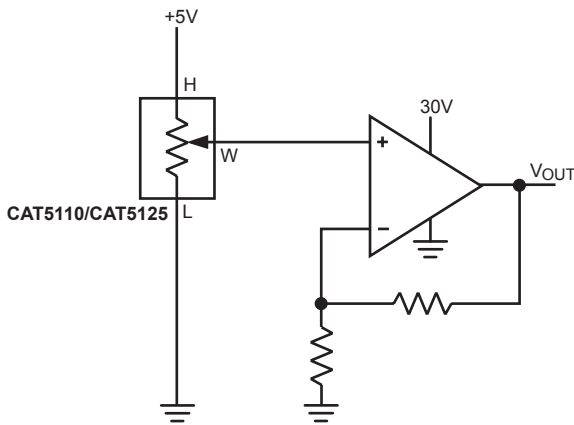
**ALTERNATIVE POSITIVE LCD BIAS CONTROL**

An op amp can be used to provide buffering and gain on the output of the CAT5110/CAT5125. This can be done by connecting the wiper output to the positive input of a noninverting op amp as shown in Figure 3. Figure 4 shows a similar circuit for the CAT5119/CAT5124.

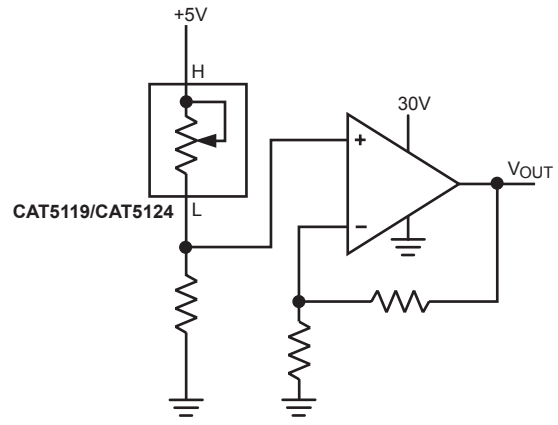
**ADJUSTABLE GAIN**

Figure 5 shows how to use either a variable resistor or a potentiometer to digitally adjust the gain of a noninverting op amp configuration, by connecting the Minipot in series with a resistor to ground. The MiniPots have a low 5ppm/°C ratiometric tempco that allows for a very stable adjustable gain configuration over temperature.

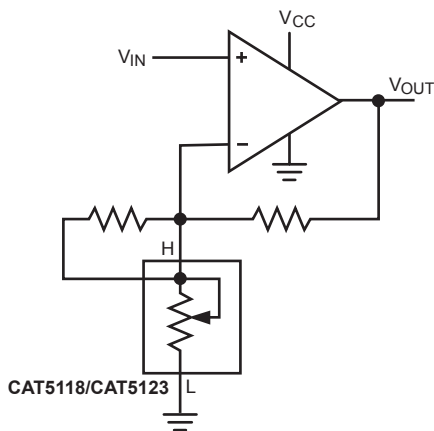
**Figure 3. Positive LCD Bias Control**



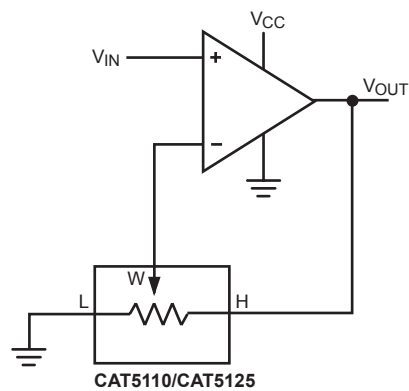
**Figure 4. Positive LCD Bias Control**



**Figure 5a. Adjustable Gain Circuit**

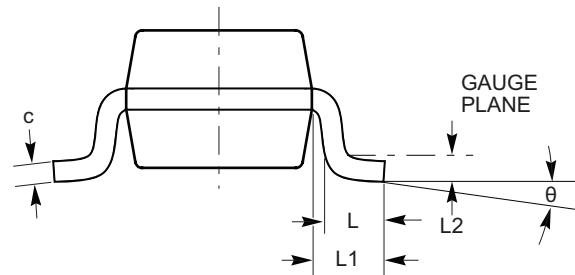
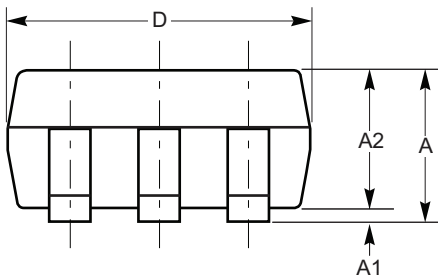
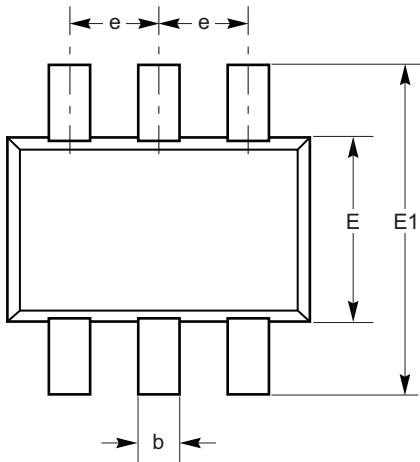


**Figure 5b. Adjustable Gain Circuit**



**PACKAGE INFORMATION**

**SC-70 6 LEAD**



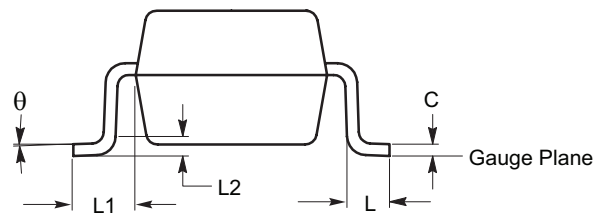
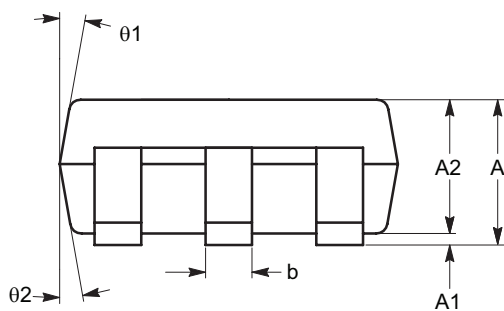
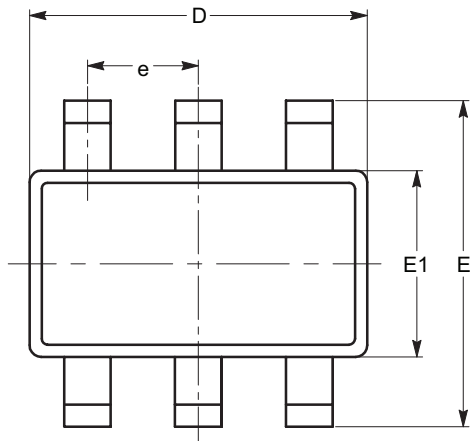
SYMBOL	MIN	NOM	MAX
A	0.80		1.10
A1	0.00		0.10
A2	0.70	0.90	1.00
b	0.15		0.30
c	0.08	0.20	0.22
D	1.80	2.00	2.20
E	1.15	1.25	1.38
E1	1.80	2.10	2.40
e	—	0.65 BSC	—
L	0.26	0.36	0.46
L1	0.425 REF		
L2	0.15 BSC		
θ	0°		8°

For current Tape and Reel information,  
download the PDF file from:  
[www.catsemi.com/documents/tapeandreeel.pdf](http://www.catsemi.com/documents/tapeandreeel.pdf)

**Notes:**

- (1) All dimensions are in millimeters.
- (2) All specifications comply to JEDEC standard M0-203.

**SOT-23 6 LEAD**



SYMBOL	MIN	NOM	MAX
A			1.45
A1	0.00		0.15
A2	0.90	1.15	1.30
c	0.08		0.22
b	0.30		0.50
e	0.95 BSC		
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
L	0.30	0.45	0.60
L1	0.60 REF		
L2	0.25 BSC		
θ	0°		8°
θ1	0°		10°
θ2	0°		10°

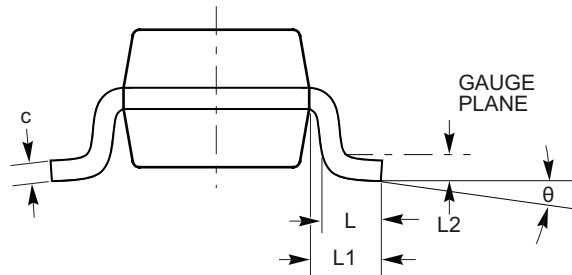
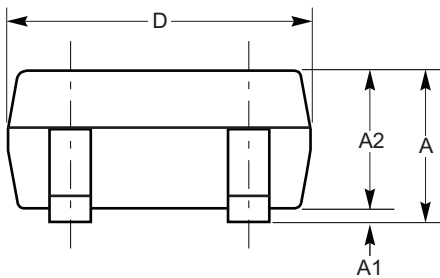
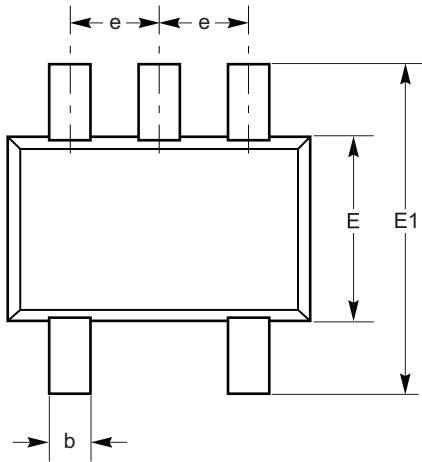
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**Notes:**

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) All specifications comply to JEDEC standard MO-178.



**SC-70 5 LEAD**



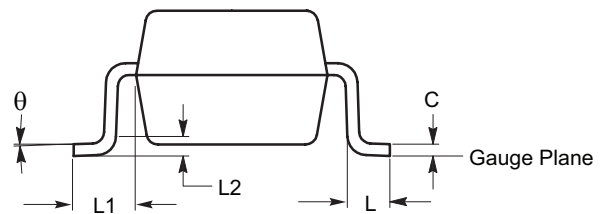
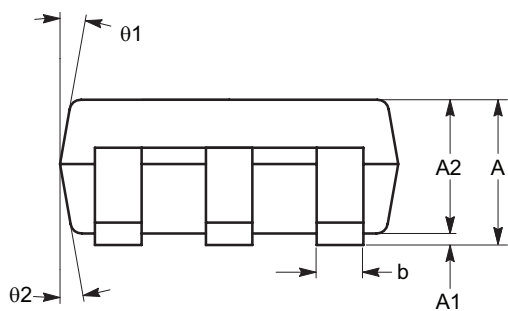
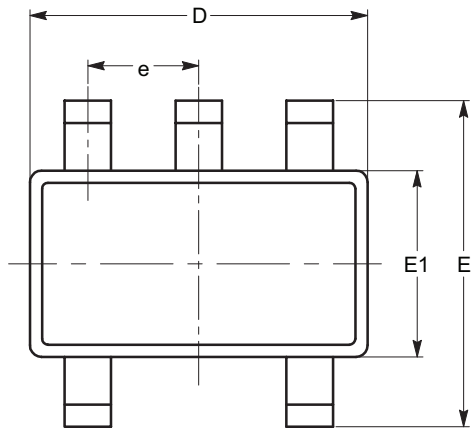
SYMBOL	MIN	NOM	MAX
A	0.80		1.10
A1	0.00		0.10
A2	0.80		1.00
b	0.15		0.30
c	0.10		0.18
D	1.80	2.00	2.20
E	1.15	1.25	1.35
E1	1.80	2.10	2.40
e		0.65 BSC	
L	0.26	0.36	0.46
L1		0.42 REF	
L2		0.15 BSC	
$\theta$	0°		8°

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[www.catsemi.com/documents/tapeandreeel.pdf](http://www.catsemi.com/documents/tapeandreeel.pdf)

**Notes:**

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) All specifications comply to JEDEC standard M0-203.

**SOT-23 5 LEAD**



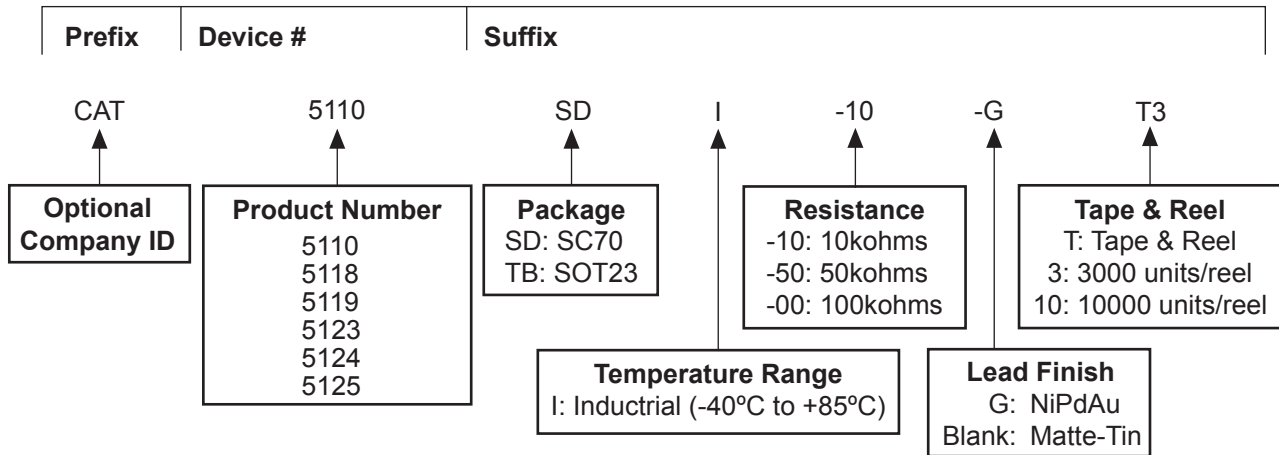
SYMBOL	MIN	NOM	MAX
A			1.45
A1	0.00		0.15
A2	0.90	1.15	1.30
c	0.08		0.22
b	0.30		0.50
e	0.95 BSC		
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
L	0.30	0.45	0.60
L1	0.60 REF		
L2	0.25 BSC		
θ	0°		8°
θ1	0°		10°
θ2	0°		10°

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**Notes:**

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) All specifications comply to JEDEC standard MO-178.

**EXAMPLE OF ORDERING INFORMATION**



**Notes:**

- (1) All packages are RoHS-compliant (Lead-free, Halogen-free).
- (2) The device used in the example above is a CAT5110SDI-10 -GT3 (NiPdAu, Tape and Reel).
- (3) The standard finish for SOT23 package is Matte-Tin.
- (4) The standard finish for SC70 package is NiPdAu.
- (5) For additional package and temperature options, please contact your nearest Catalyst Semiconductor Sales office.

**ORDERING INFORMATION**

Device	Ordering part number	Resistor [kΩ]	Top Marking	Pin package	Parts per reel
<b>CAT5110</b>	CAT5110SDI-10-GT3	10	JU_	SC70-6	3,000
	CAT5110SDI-10-GT10	10	JU_	SC70-6	10,000
	CAT5110TBI-10-T3	10	JUYM	SOT23-6	3,000
	CAT5110TBI-10-T10	10	JUYM	SOT23-6	10,000
	CAT5110TBI-10-GT3	10	JUYM	SOT23-6	3,000
	CAT5110TBI-10-GT10	10	JUYM	SOT23-6	10,000
	CAT5110SDI-50-GT3	50	JV_	SC70-6	3,000
	CAT5110SDI-50-GT10	50	JV_	SC70-6	10,000
	CAT5110TBI-50-T3	50	JVYM	SOT23-6	3,000
	CAT5110TBI-50-T10	50	JVYM	SOT23-6	10,000
	CAT5110TBI-50-GT3	50	JVYM	SOT23-6	3,000
	CAT5110TBI-50-GT10	50	JVYM	SOT23-6	10,000
	CAT5110SDI-00-GT3	100	JW_	SC70-6	3,000
	CAT5110SDI-00-GT10	100	JW_	SC70-6	10,000
	CAT5110TBI-00-T3	100	JWYM	SOT23-6	3,000
	CAT5110TBI-00-T10	100	JWYM	SOT23-6	10,000
CAT5110TBI-00-GT3	100	JWYM	SOT23-6	3,000	
CAT5110TBI-00-GT10	100	JWYM	SOT23-6	10,000	
<b>CAT5118</b>	CAT5118SDI-10-GT3	10	JL_	SC70-5	3,000
	CAT5118SDI-10-GT10	10	JL_	SC70-5	10,000
	CAT5118TBI-10-T3	10	JLYM	SOT23-5	3,000
	CAT5118TBI-10-T10	10	JLYM	SOT23-5	10,000
	CAT5118TBI-10-GT3	10	JLYM	SOT23-5	3,000
	CAT5118TBI-10-GT10	10	JLYM	SOT23-5	10,000
	CAT5118SDI-50-GT3	50	JM_	SC70-5	3,000
	CAT5118SDI-50-GT10	50	JM_	SC70-5	10,000
	CAT5118TBI-50-T3	50	JMYM	SOT23-5	3,000
	CAT5118TBI-50-T10	50	JMYM	SOT23-5	10,000
	CAT5118TBI-50-GT3	50	JMYM	SOT23-5	3,000
	CAT5118TBI-50-GT10	50	JMYM	SOT23-5	10,000
	CAT5118SDI-00-GT3	100	JN_	SC70-5	3,000
	CAT5118SDI-00-GT10	100	JN_	SC70-5	10,000
	CAT5118TBI-00-T3	100	JNYM	SOT23-5	3,000
	CAT5118TBI-00-T10	100	JNYM	SOT23-5	10,000
CAT5118TBI-00-GT3	100	JNYM	SOT23-5	3,000	
CAT5118TBI-00-GT10	100	JNYM	SOT23-5	10,000	

**ORDERING INFORMATION (Continued)**

Device	Ordering part number	Resistor [kΩ]	Top Marking	Pin package	Parts per reel	
<b>CAT5119</b>	CAT5119SDI-10-GT3	10	JP_	SC70-6	3,000	
	CAT5119SDI-10-GT10	10	JP_	SC70-6	10,000	
	CAT5119TBI-10-T3	10	JPYM	SOT23-6	3,000	
	CAT5119TBI-10-T10	10	JPYM	SOT23-6	10,000	
	CAT5119TBI-10-GT3	10	JPYM	SOT23-6	3,000	
	CAT5119TBI-10-GT10	10	JPYM	SOT23-6	10,000	
	CAT5119SDI-50-GT3	50	JR_	SC70-6	3,000	
	CAT5119SDI-50-GT10	50	JR_	SC70-6	10,000	
	CAT5119TBI-50-T3	50	JRYM	SOT23-6	3,000	
	CAT5119TBI-50-T10	50	JRYM	SOT23-6	10,000	
	CAT5119TBI-50-GT3	50	JRYM	SOT23-6	3,000	
	CAT5119TBI-50-GT10	50	JRYM	SOT23-6	10,000	
	CAT5119SDI-00-GT3	100	JT_	SC70-6	3,000	
	CAT5119SDI-00-GT10	100	JT_	SC70-6	10,000	
	CAT5119TBI-00-T3	100	JTYM	SOT23-6	3,000	
	CAT5119TBI-00-T10	100	JTYM	SOT23-6	10,000	
	CAT5119TBI-00-GT3	100	JTYM	SOT23-6	3,000	
	CAT5119TBI-00-GT10	100	JTYM	SOT23-6	10,000	
	<b>CAT5123</b>	CAT5123TBI-10-T3	10	JLYM	SOT23-5	3,000
		CAT5123TBI-10-T10	10	JLYM	SOT23-5	10,000
CAT5123TBI-10-GT3		10	JLYM	SOT23-5	3,000	
CAT5123TBI-10-GT10		10	JLYM	SOT23-5	10,000	
CAT5123TBI-50-T3 <sup>(1)</sup>		50	JMYM	SOT23-5	3,000	
CAT5123TBI-50-T10 <sup>(1)</sup>		50	JMYM	SOT23-5	10,000	
CAT5123TBI-50-GT3 <sup>(1)</sup>		50	JMYM	SOT23-5	3,000	
CAT5123TBI-50-GT10 <sup>(1)</sup>		50	JMYM	SOT23-5	10,000	
CAT5123TBI-00-T3 <sup>(1)</sup>		100	JNYM	SOT23-5	3,000	
CAT5123TBI-00-T10 <sup>(1)</sup>		100	JNYM	SOT23-5	10,000	
CAT5123TBI-00-GT3 <sup>(1)</sup>		100	JNYM	SOT23-5	3,000	
CAT5123TBI-00-GT10 <sup>(1)</sup>		100	JNYM	SOT23-5	10,000	

**Notes:**

(1) Contact factory for availability.

**CAT5110, CAT5118, CAT5119, CAT5123, CAT5124, CAT5125**
**ORDERING INFORMATION (Continued)**

Device	Ordering part number	Resistor [kΩ]	Top Marking	Pin package	Parts per reel
<b>CAT5124</b>	CAT5124TBI-10-T3 <sup>(1)</sup>	10	JLYM	SOT23-5	3,000
	CAT5124TBI-10-T10 <sup>(1)</sup>	10	JLYM	SOT23-5	10,000
	CAT5124TBI-10-GT3 <sup>(1)</sup>	10	JLYM	SOT23-5	3,000
	CAT5124TBI-10-GT10 <sup>(1)</sup>	10	JLYM	SOT23-5	10,000
	CAT5124TBI-50-T3	50	JMYM	SOT23-5	3,000
	CAT5124TBI-50-T10	50	JMYM	SOT23-5	10,000
	CAT5124TBI-50-GT3	50	JMYM	SOT23-5	3,000
	CAT5124TBI-50-GT10	50	JMYM	SOT23-5	10,000
	CAT5124TBI-00-T3 <sup>(1)</sup>	100	JNYM	SOT23-5	3,000
	CAT5124TBI-00-T10 <sup>(1)</sup>	100	JNYM	SOT23-5	10,000
	CAT5124TBI-00-GT3 <sup>(1)</sup>	100	JNYM	SOT23-5	3,000
	CAT5124TBI-00-GT10 <sup>(1)</sup>	100	JNYM	SOT23-5	10,000
	<b>CAT5125</b>	CAT5125TBI-10-T3	10	JUYM	SOT23-6
CAT5125TBI-10-T10		10	JUYM	SOT23-6	10,000
CAT5125TBI-10-GT3		10	JUYM	SOT23-6	3,000
CAT5125TBI-10-GT10		10	JUYM	SOT23-6	10,000
CAT5125TBI-50-T3 <sup>(1)</sup>		50	JVYM	SOT23-6	3,000
CAT5125TBI-50-T10 <sup>(1)</sup>		50	JVYM	SOT23-6	10,000
CAT5125TBI-50-GT3 <sup>(1)</sup>		50	JVYM	SOT23-6	3,000
CAT5125TBI-50-GT10 <sup>(1)</sup>		50	JVYM	SOT23-6	10,000
CAT5125TBI-00-T3 <sup>(1)</sup>		100	JWYM	SOT23-6	3,000
CAT5125TBI-00-T10 <sup>(1)</sup>		100	JWYM	SOT23-6	10,000
CAT5125TBI-00-GT3 <sup>(1)</sup>		100	JWYM	SOT23-6	3,000
CAT5125TBI-00-GT10 <sup>(1)</sup>		100	JWYM	SOT23-6	10,000

**Notes:**

(1) Contact factory for availability.

**REVISION HISTORY**

<b>Date</b>	<b>Rev.</b>	<b>Reason</b>
03/10/2004	A	Initial Issue
03/18/2004	B	Update Typical Operating Characteristics Update SC70 package outline
07/19/2004	C	Added SOT-23 package in all areas Update Description Update Electrical Characteristics Update Typical Operating Characteristics Update Functional Description
12/15/2006	D	Added CAT5123, CAT5124, CAT5125 Update Features Update Description Update Pin Configuration Update Pin Description Update Electrical Characteristics Update Typical Operating Characteristics Update Functional Description Update Figures 3, 4, 5 and 6 Update Package Information Update Example of Ordering Information Update Ordering information
01/29/07	E	Update Electrical Characteristics

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Document No: 2120  
Revision: E  
Issue date: 01/29/07