CATALYST
SEMICONDUCTOR, INC.
BEYOND MEMORY™

CAT5110, CAT5118, CAT5119
CAT5123, CAT5124, CAT5125

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

HALOGEN FREE
LEAD FREE™
RoHS Compliance

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

Doc. No. 2120, Rev. E
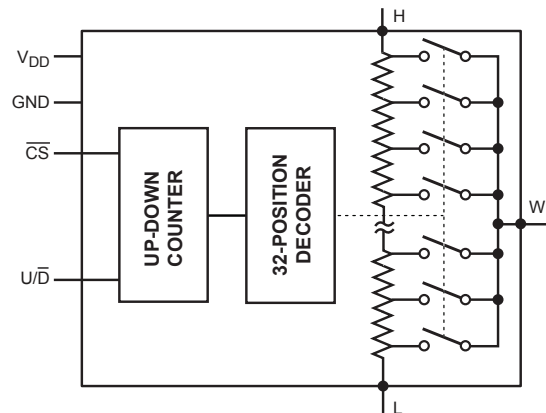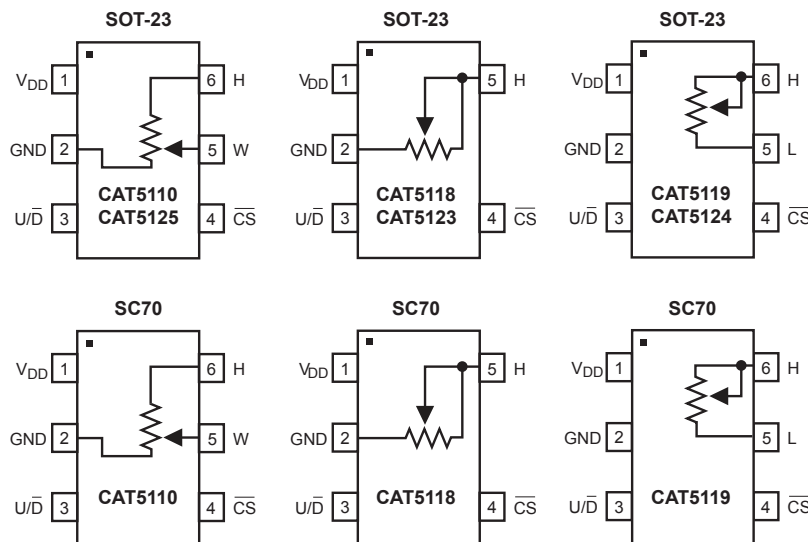
CAT5110, CAT5118, CAT5119, CAT5123, CAT5124, CAT5125

PIN DESCRIPTIONS

Pin Number				
CAT5110/ CAT5125	CAT5118/ CAT5123	CAT5119/ CAT5124	Pin Name	Description
1	1	1	V_{DD}	Power Supply
2	2	2	GND	Ground
3	3	3	U/$\overline{D}$	Up/Down Control Input. With $\overline{CS}$ low, a low-to-high transition increments or decrements the wiper position.
4	4	4	$\overline{CS}$	Chip Select Input. A high-to-low $\overline{CS}$ 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[1]

V_{DD} to GND	-0.3V to +6V
All Other Pins to GND	-0.3V to (V_{DD} + 0.3)V
Input and Output Latch-Up Immunity	±200mA

Maximum Continuous Current into H, L and W
    100kΩ
     50kΩ
     10kΩ
	
	±0.6mA
	±1.3mA
	±1.3mA

Continuous Power Dissipation (T_A = +70ºC)
    5-pin SC70*
    6-pin SC70*
	
	247mW
	245mW

Operating Temperature Range	-40°C to +85ºC
Junction Temperature	+150ºC
Storage Temperature Range	-65ºC to +150ºC
Soldering Temperature (soldering, 10s)	+300ºC

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/ºC above T_A = +70ºC

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ELECTRICAL CHARACTERISTICS

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

Parameter	Symbol	Conditions	Min	Typ	Max	Units
DC Performance						
Resolution			32			Taps
End-to-End Resistance (-00)			80	100	120	
End-to-End Resistance (-50)			40	50	60	kΩ
End-to-End Resistance (-10)			8	10	12	
End-to-End Resistance Tempco	TC_R			200		ppm/ºC
Ratiometric Resistance Tempco				5		ppm/ºC
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	
Digital Inputs						
Input High Voltage	V_{IH}		0.7 x V_{DD}			V
Input Low Voltage	V_{IL}				0.3 x V_{DD}	V
Timing Characteristics (Figures 1, 2)						
U/$\overline{D}$ Mode to CS Setup	t_{CU}		25			ns
CS to U/$\overline{D}$ Step Setup	t_{CI}		50			ns
CS to U/$\overline{D}$ Step Hold	t_{IC}		25			ns
U/$\overline{D}$ Step Low Period	t_{IL}		25			ns
U/$\overline{D}$ Step High Period	t_{IH}		25			ns
Up/$\overline{Down}$ Toggle Rate [1]	f_{TOGGLE}			1		MHz
Output Settling Time [2]	t_{SETTLE}	100kΩ variable resistor configuration, C_L = 10pF		1		µs
		100kΩ potentiometer configuration, C_L = 10pF		0.25		
Power Supply						
Supply Voltage	V_{DD}		2.7		5.5	V
Active Supply Current [3]	I_{DD}				25	µA
Standby Supply Current [4]	I_{SB}	V_{DD} = +5V		0.3	1	µA

Notes:

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

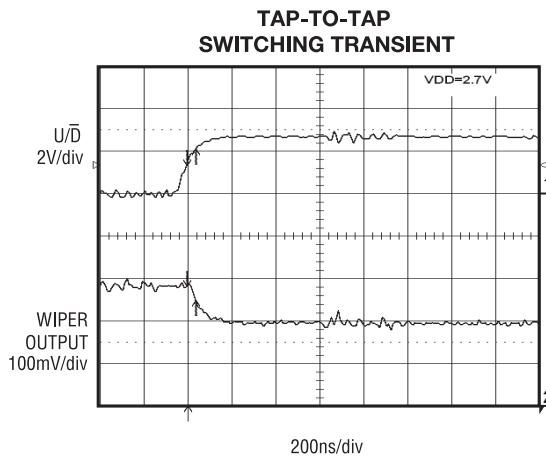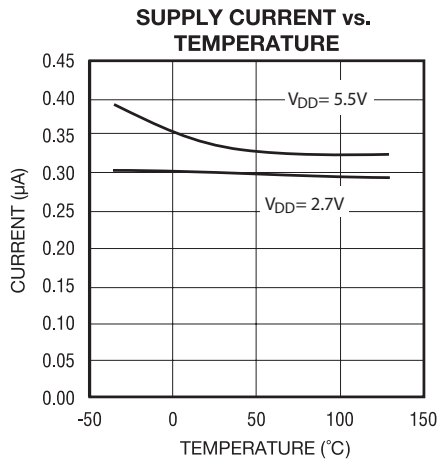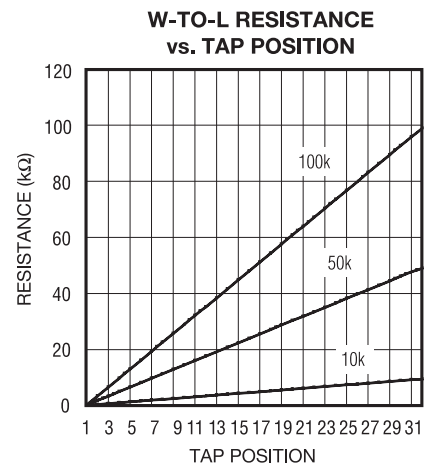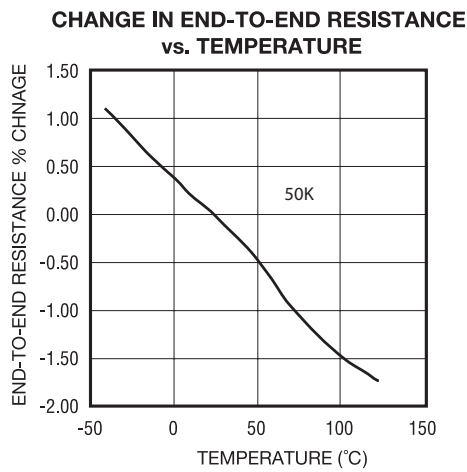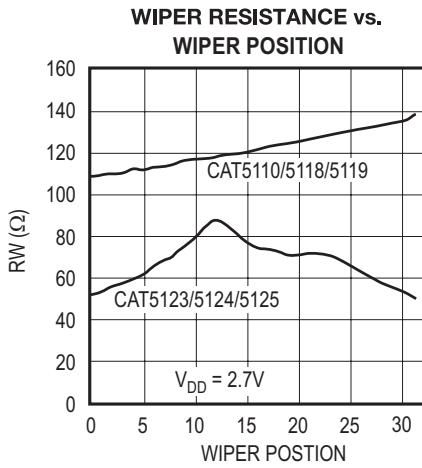(2) Typical settling times are dependent on end-to-end resistance.
(3) Supply current measured while changing wiper tap, f_{TOGGLE} = 1MHz.
(4) Supply current measured while wiper position is fixed.

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TYPICAL OPERATING CHARACTERISTICS

T_A = 25ºC, unless otherwise noted.

WIPER RESISTANCE vs. WIPER POSITION

CAT5110/5118/5119

CAT5123/5124/5125

V_{DD} = 2.7V

RW (Ω)

WIPER POSTION

CHANGE IN END-TO-END RESISTANCE vs. TEMPERATURE

END-TO-END RESISTANCE % CHNAGE

50K

TEMPERATURE (°C)

W-TO-L RESISTANCE vs. TAP POSITION

RESISTANCE (kΩ)

100k

50k

10k

TAP POSITION

SUPPLY CURRENT vs. TEMPERATURE

V_{DD}= 5.5V

V_{DD}= 2.7V

CURRENT (μA)

TEMPERATURE (°C)

TAP-TO-TAP SWITCHING TRANSIENT

VDD=2.7V

U/$\overline{D}$
2V/div

1

WIPER
OUTPUT
100mV/div

2

200ns/div

4

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.

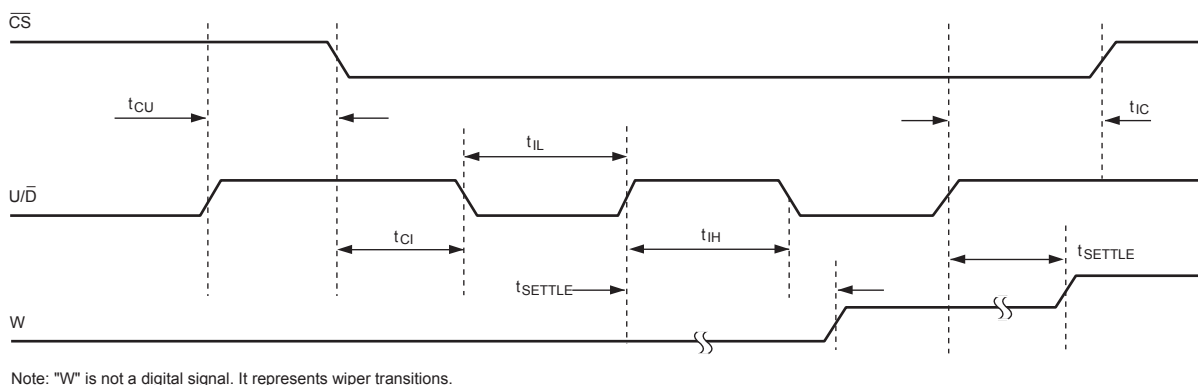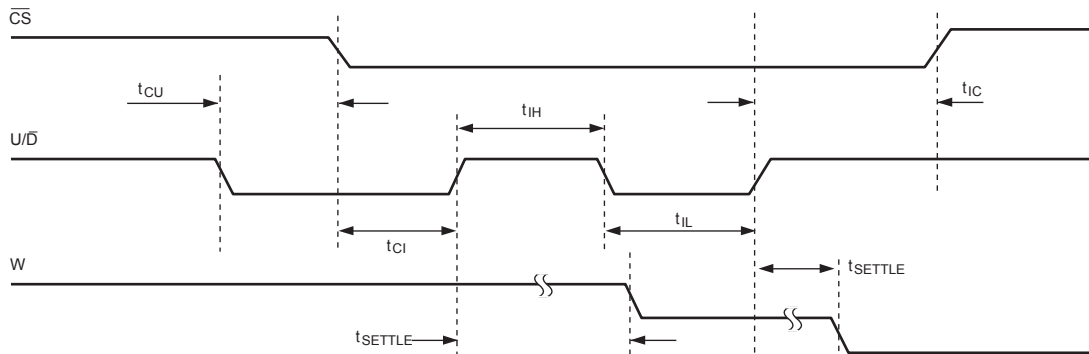**Figure 1. Serial Interface Timing Diagram, Increment Mode**

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.

Doc No.: 2126, Rev. E

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/ºC ratiometric tempco that allows for a very stable adjustable gain configuration over temperature.
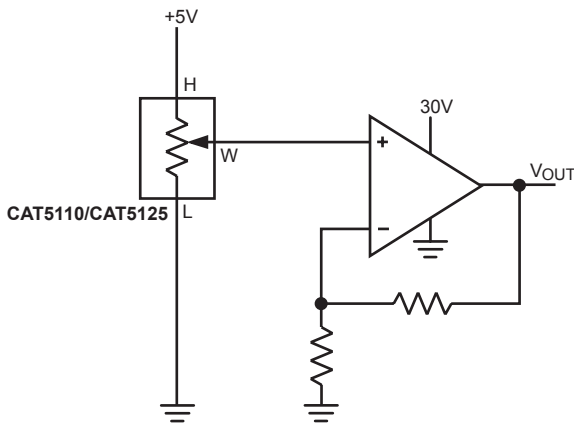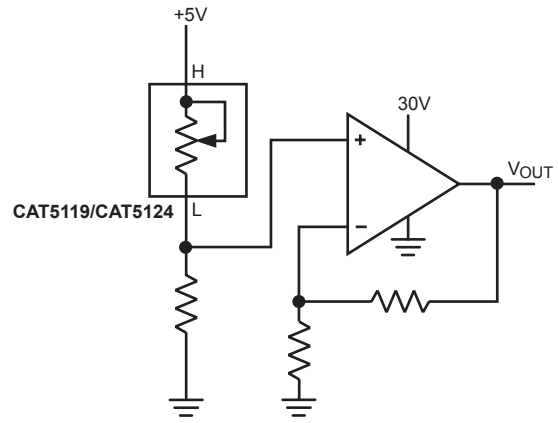
Figure 3. Positive LCD Bias Control

Figure 4. Positive LCD Bias Control
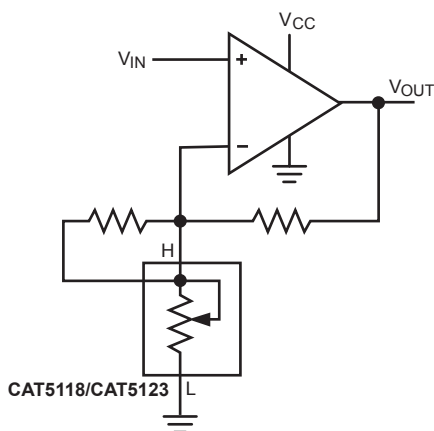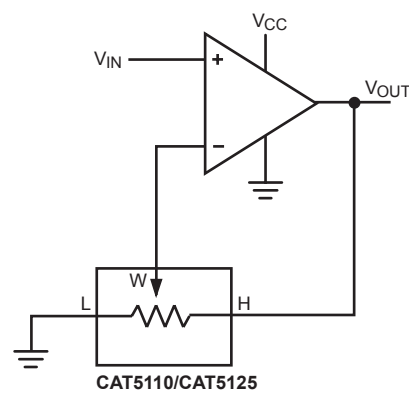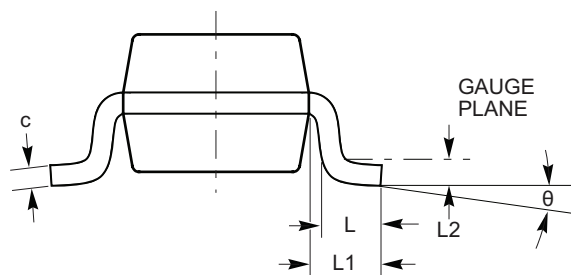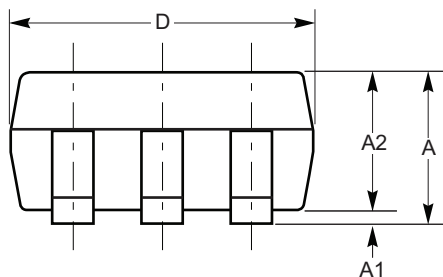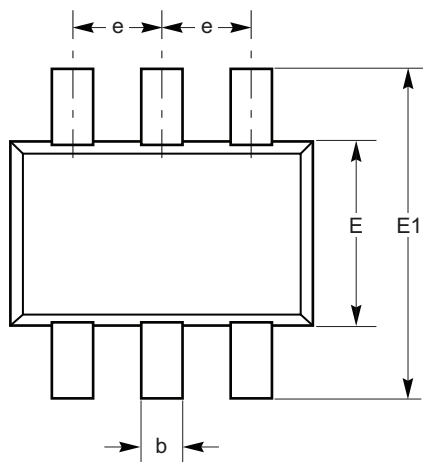

Figure 5a. Adjustable Gain Circuit

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/tapeandreel.pdf

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

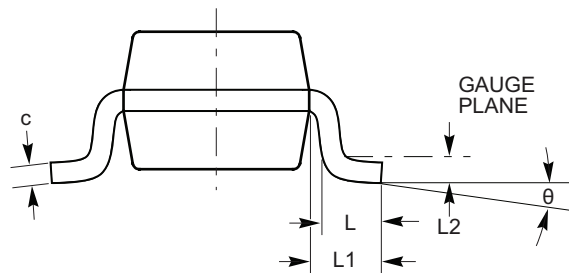## CAT5110, CAT5118, CAT5119, CAT5123, CAT5124, CAT5125

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°

For current Tape and Reel information, download the PDF file from: www.catsemi.com/documents/tapeandreel.pdf

Notes:

(1) All dimensions are in millimeters. Angles in degrees.

(2) All specifications comply to JEDEC standard MO-178.

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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	
θ	0°		8°

For current Tape and Reel information, download the PDF file from: www.catsemi.com/documents/tapeandreel.pdf

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

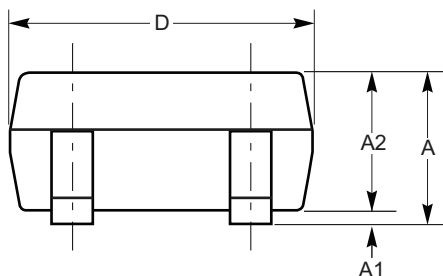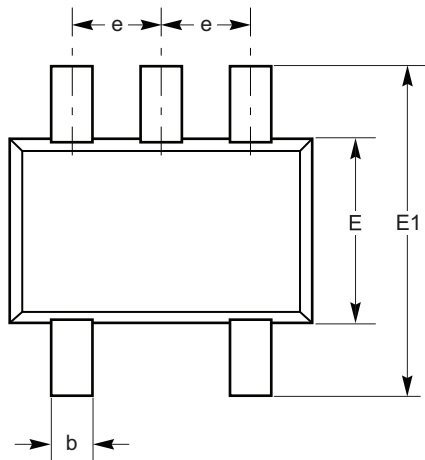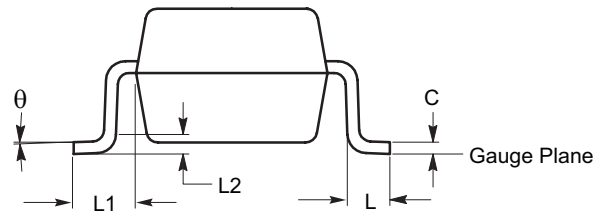# CAT5110, CAT5118, CAT5119, CAT5123, CAT5124, CAT5125

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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°

**For current Tape and Reel information,
download the PDF file from:
www.catsemi.com/documents/tapeandreel.pdf**

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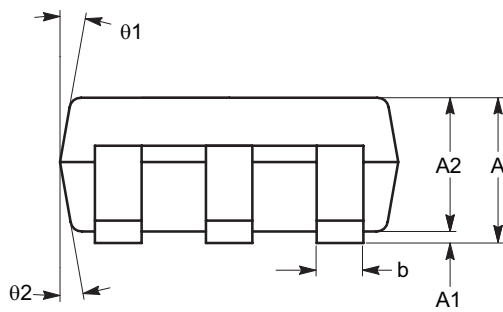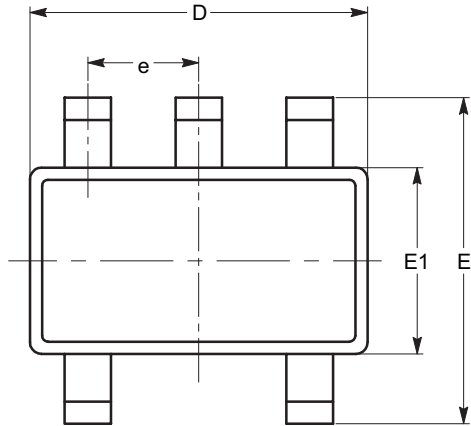(2) All specifications comply to JEDEC standard MO-178.

EXAMPLE OF ORDERING INFORMATION

Prefix	Device #	Suffix

CAT   5110   SD   I   -10   -G   T3

Optional Company ID

Product Number
5110
5118
5119
5123
5124
5125

Package
SD: SC70
TB: SOT23

Temperature Range
I: Inductrial (-40ºC to +85ºC)

Resistance
-10: 10kohms
-50: 50kohms
-00: 100kohms

Lead Finish
G: NiPdAu
Blank: Matte-Tin

Tape & Reel
T: Tape & Reel
3: 3000 units/reel
10: 10000 units/reel
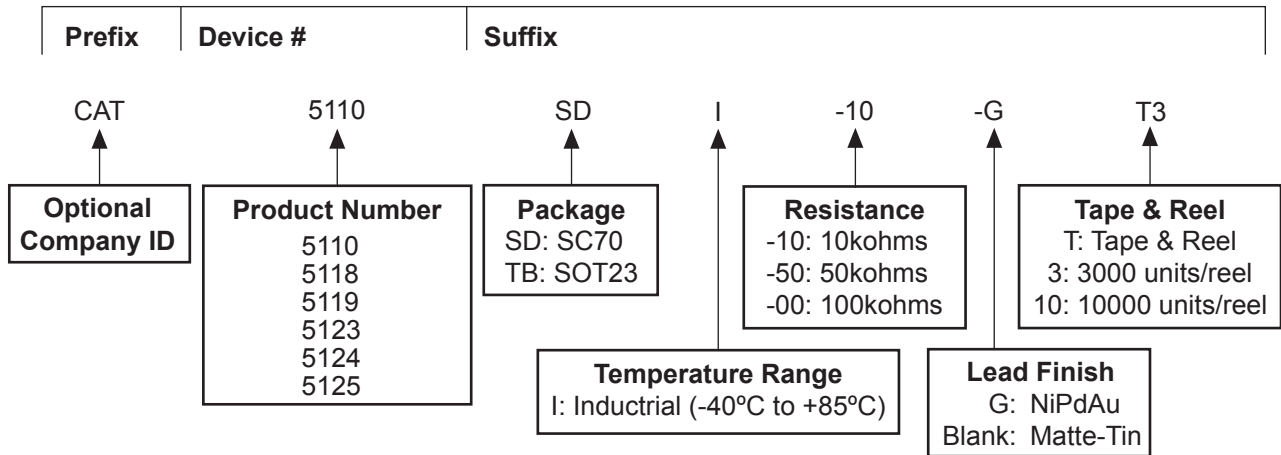
Notes:

(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.

CAT5110, CAT5118, CAT5119, CAT5123, CAT5124, CAT5125

ORDERING INFORMATION

Device	Ordering part number	Resistor [kΩ]	Top Marking	Pin package	Parts per reel
CAT5110	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
CAT5118	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
CAT5119	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
CAT5123	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 [1]	50	JMYM	SOT23-5	3,000
	CAT5123TBI-50-T10 [1]	50	JMYM	SOT23-5	10,000
	CAT5123TBI-50-GT3 [1]	50	JMYM	SOT23-5	3,000
	CAT5123TBI-50-GT10 [1]	50	JMYM	SOT23-5	10,000
	CAT5123TBI-00-T3 [1]	100	JNYM	SOT23-5	3,000
	CAT5123TBI-00-T10 [1]	100	JNYM	SOT23-5	10,000
	CAT5123TBI-00-GT3 [1]	100	JNYM	SOT23-5	3,000
	CAT5123TBI-00-GT10 [1]	100	JNYM	SOT23-5	10,000

Notes:

(1) Contact factory for availability.

ORDERING INFORMATION (Continued)

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

Notes:

(1) Contact factory for availability.

REVISION HISTORY

Date	Rev.	Reason
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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