



32-Tap Digitally Programmable Potentiometer (DPP™) with Buffered Wiper



FEATURES

- 32-position linear taper potentiometer
- Non-volatile EEPROM wiper storage; buffered wiper
- Low power CMOS technology
- Single supply operation: 2.5 V - 6.0 V
- Increment up/down serial interface
- Resistance values: 10 kΩ, 50 kΩ and 100 kΩ
- Available in PDIP, SOIC, TSSOP and MSOP packages

APPLICATIONS

- Automated product calibration
- Remote control adjustments
- Offset, gain and zero control
- Tamper-proof calibrations
- Contrast, brightness and volume controls
- Motor controls and feedback systems
- Programmable analog functions

For Ordering Information details, see page 10.

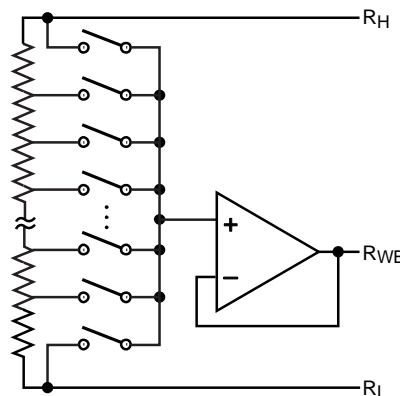
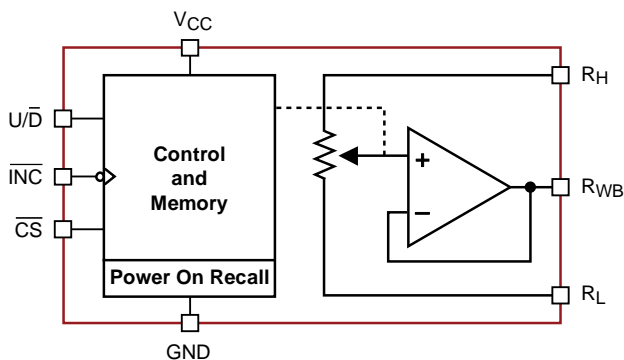
DESCRIPTION

The CAT5112 is a single digitally programmable potentiometer (DPP™) designed as a electronic replacement for mechanical potentiometers. Ideal for automated adjustments on high volume production lines, they are also well suited for applications where equipment requiring periodic adjustment is either difficult to access or located in a hazardous or remote environment.

The CAT5112 contains a 32-tap series resistor array connected between two terminals R_H and R_L . An up/down counter and decoder that are controlled by three input pins, determines which tap is connected to the wiper, R_{WB} . The CAT5112 wiper is buffered by an op amp that operates rail to rail. The wiper setting, stored in non-volatile memory, is not lost when the device is powered down and is automatically recalled when power is returned. The wiper can be adjusted to test new system values without effecting the stored setting. Wiper-control of the CAT5112 is accomplished with three input control pins, \overline{CS} , U/\overline{D} , and \overline{INC} . The \overline{INC} input increments the wiper in the direction which is determined by the logic state of the U/\overline{D} input. The \overline{CS} input is used to select the device and also store the wiper position prior to power down.

The digitally programmable potentiometer can be used as a buffered voltage divider. For applications where the potentiometer is used as a 2-terminal variable resistor, please refer to the CAT5114. The buffered wiper of the CAT5112 is not compatible with that application.

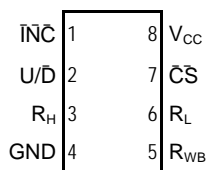
FUNCTIONAL DIAGRAM



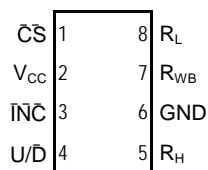
Electronic Potentiometer Implementation

PIN CONFIGURATION

PDIP 8-Lead (L)
SOIC 8 Lead (V)
MSOP 8 Lead (Z)



TSSOP 8 Lead (Y)



PIN DESCRIPTION

IINC: Increment Control Input

The IINC input (on the falling edge) moves the wiper in the up or down direction determined by the condition of the U/D input.

U/D: Up/Down Control Input

The U/D input controls the direction of the wiper movement. When in a high state and CS is low, any high-to-low transition on IINC will cause the wiper to move one increment toward the RH terminal. When in a low state and CS is low, any high-to-low transition on IINC will cause the wiper to move one increment towards the RL terminal.

RH: High End Potentiometer Terminal

RH is the high end terminal of the potentiometer. It is not required that this terminal be connected to a potential greater than the RL terminal. Voltage applied to the RH terminal cannot exceed the supply voltage, VCC or go below ground, GND.

RWB: Wiper Potentiometer Terminal (Buffered)

RWB is the buffered wiper terminal of the potentiometer. Its position on the resistor array is controlled by the control inputs, IINC, U/D and CS.

RL: Low End Potentiometer Terminal

RL is the low end terminal of the potentiometer. It is not required that this terminal be connected to a potential less than the RH terminal. Voltage applied to the RL terminal cannot exceed the supply voltage, VCC or go below ground, GND. RL and RH are electrically interchangeable.

CS: Chip Select

The chip select input is used to activate the control input of the CAT5112 and is active low. When in a

PIN DESCRIPTIONS

| Name | Function |
|------|-----------------------------|
| IINC | Increment Control |
| U/D | Up/Down Control |
| RH | Potentiometer High Terminal |
| GND | Ground |
| RWB | Buffered Wiper Terminal |
| RL | Potentiometer Low Terminal |
| CS | Chip Select |
| VCC | Supply Voltage |

high state, activity on the IINC and U/D inputs will not affect or change the position of the wiper.

DEVICE OPERATION

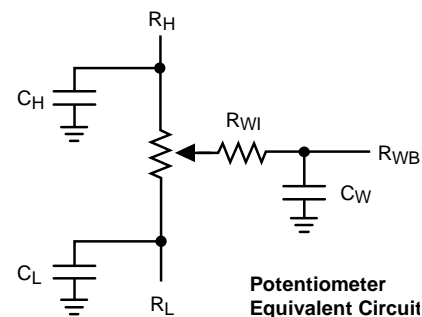
The CAT5112 operates like a digitally controlled potentiometer with RH and RL equivalent to the high and low terminals and RWB equivalent to the mechanical potentiometer's wiper. There are 32 available tap positions including the resistor end points, RH and RL. There are 31 resistor elements connected in series between the RH and RL terminals. The wiper terminal is connected to one of the 32 taps and controlled by three inputs, IINC, U/D and CS. These inputs control a five-bit up/down counter whose output is decoded to select the wiper position. The selected wiper position can be stored in nonvolatile memory using the IINC and CS inputs.

With CS set LOW the CAT5112 is selected and will respond to the U/D and IINC inputs. HIGH to LOW transitions on IINC will increment or decrement the wiper (depending on the state of the U/D input and five-bit counter). The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. The value of the counter is stored in nonvolatile memory whenever CS transitions HIGH while the IINC input is also HIGH. When the CAT5112 is powered-down, the last stored wiper counter position is maintained in the nonvolatile memory. When power is restored, the contents of the memory are recalled and the counter is set to the value stored.

With IINC set low, the CAT5112 may be deselected and powered down without storing the current wiper position in nonvolatile memory. This allows the system to always power up to a preset value stored in nonvolatile memory.

OPERATION MODES

| INC | CS | U/D | Operation |
|-------------|-------------|------|-----------------------------|
| High to Low | Low | High | Wiper toward R _H |
| High to Low | Low | Low | Wiper toward R _L |
| High | Low to High | X | Store Wiper Position |
| Low | Low to High | X | No Store, Return to Standby |
| X | High | X | Standby |

ABSOLUTE MAXIMUM RATINGS⁽¹⁾

| Parameters | Ratings | Units |
|--|------------------------------|-------|
| Supply Voltage V _{CC} to GND | -0.5 to +7 | V |
| Inputs | | |
| CS to GND | -0.5 to V _{CC} +0.5 | V |
| INC to GND | -0.5 to V _{CC} +0.5 | V |
| U/D to GND | -0.5 to V _{CC} +0.5 | V |
| R _H to GND | -0.5 to V _{CC} +0.5 | V |
| R _L to GND | -0.5 to V _{CC} +0.5 | V |
| R _{WB} to GND | -0.5 to V _{CC} +0.5 | V |

| Parameters | Ratings | Units |
|---|------------|-------|
| Operating Ambient Temperature Commercial ('C' or Blank suffix) | 0 to 70 | °C |
| Industrial ('I' suffix) | -40 to +85 | °C |
| Junction Temperature | +150 | °C |
| Storage Temperature | -65 to 150 | °C |
| Lead Soldering (10s max) | +300 | °C |

RELIABILITY CHARACTERISTICS

| Symbol | Parameter | Test Method | Min | Typ | Max | Units |
|-------------------------------------|--------------------|-------------------------------|-----------|-----|-----|--------|
| V _{ZAP} ⁽²⁾ | ESD Susceptibility | MIL-STD-883, Test Method 3015 | 2000 | | | V |
| I _{LTH} ^{(2) (3)} | Latch-Up | JEDEC Standard 17 | 100 | | | mA |
| T _{DR} | Data Retention | MIL-STD-883, Test Method 1008 | 100 | | | Years |
| N _{END} | Endurance | MIL-STD-883, Test Method 1003 | 1,000,000 | | | Stores |

DC ELECTRICAL CHARACTERISTICS

V_{CC} = +2.5 V to +6 V unless otherwise specified

Power Supply

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---------------------------------|----------------------------|---|-----|-----|------|-------|
| V _{CC} | Operating Voltage Range | | 2.5 | – | 6 | V |
| I _{CC1} | Supply Current (Increment) | V _{CC} = 6 V, f = 1 MHz, I _w = 0 | – | – | 200 | μA |
| | | V _{CC} = 6 V, f = 250 kHz, I _w = 0 | – | – | 100 | μA |
| I _{CC2} | Supply Current (Write) | Programming, V _{CC} = 6 V | – | – | 1000 | μA |
| | | V _{CC} = 3 V | – | – | 500 | μA |
| I _{SB1} ⁽³⁾ | Supply Current (Standby) | CS = V _{CC} - 0.3 V U/D, INC = V _{CC} - 0.3 V or GND | – | 75 | 150 | μA |

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.
- (2) This parameter is tested initially and after a design or process change that affects the parameter.
- (3) Latch-up protection is provided for stresses up to 100mA on address and data pins from -1 V to V_{CC} + 1 V
- (4) I_w = source or sink
- (5) These parameters are periodically sampled and are not 100% tested.

Logic Inputs

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|-----------|-------------------------------|--------------------------------|---------------------|-----|---------------------|---------|
| I_{IH} | Input Leakage Current | $V_{IN} = V_{CC}$ | - | - | 10 | μA |
| I_{IL} | Input Leakage Current | $V_{IN} = 0 V$ | - | - | -10 | μA |
| V_{IH1} | TTL High Level Input Voltage | $4.5 V \leq V_{CC} \leq 5.5 V$ | 2 | - | V_{CC} | V |
| V_{IL1} | TTL Low Level Input Voltage | | 0 | - | 0.8 | V |
| V_{IH2} | CMOS High Level Input Voltage | $2.5 V \leq V_{CC} \leq 6 V$ | $V_{CC} \times 0.7$ | - | $V_{CC} + 0.3$ | V |
| V_{IL2} | CMOS Low Level Input Voltage | | -0.3 | - | $V_{CC} \times 0.2$ | V |

Potentiometer Characteristics

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|------------------------|------------------------------|--|--------------|--------|--------------|------------------|
| R_{POT} | Potentiometer Resistance | -10 Device | | 10 | | k Ω |
| | | -50 Device | | 50 | | |
| | | -00 Device | | 100 | | |
| | Pot. Resistance Tolerance | | | | ± 20 | % |
| V_{RH} | Voltage on R_H pin | | 0 | | V_{CC} | V |
| V_{RL} | Voltage on R_L pin | | 0 | | V_{CC} | V |
| | Resolution | | | 1 | | % |
| INL | Integral Linearity Error | $I_W \leq 2 \mu A$ | | 0.5 | 1 | LSB |
| DNL | Differential Linearity Error | $I_W \leq 2 \mu A$ | | 0.25 | 0.5 | LSB |
| R_{OUT} | Buffer Output Resistance | $0.05V_{CC} \leq V_{WB} \leq 0.95V_{CC}$, $V_{CC} = 5 V$ | | | 1 | Ω |
| I_{OUT} | Buffer Output Current | $0.05V_{CC} \leq V_{WB} \leq 0.95V_{CC}$, $V_{CC} = 5 V$ | | | 3 | mA |
| TC_{RPOT} | TC of Pot Resistance | | | 300 | | ppm/ $^{\circ}C$ |
| TC_{RATIO} | Ratiometric TC | | | 20 | | ppm/ $^{\circ}C$ |
| $C_{RH}/C_{RL}/C_{RW}$ | Potentiometer Capacitances | | | 8/8/25 | | pF |
| fc | Frequency Response | Passive Attenuator, 10k Ω | | 1.7 | | MHz |
| $V_{WB(SWING)}$ | Output Voltage Range | $I_{OUT} \leq 100 \mu A$, $V_{CC} = 5 V$ | $0.01V_{CC}$ | | $0.99V_{CC}$ | |

AC CONDITIONS OF TEST

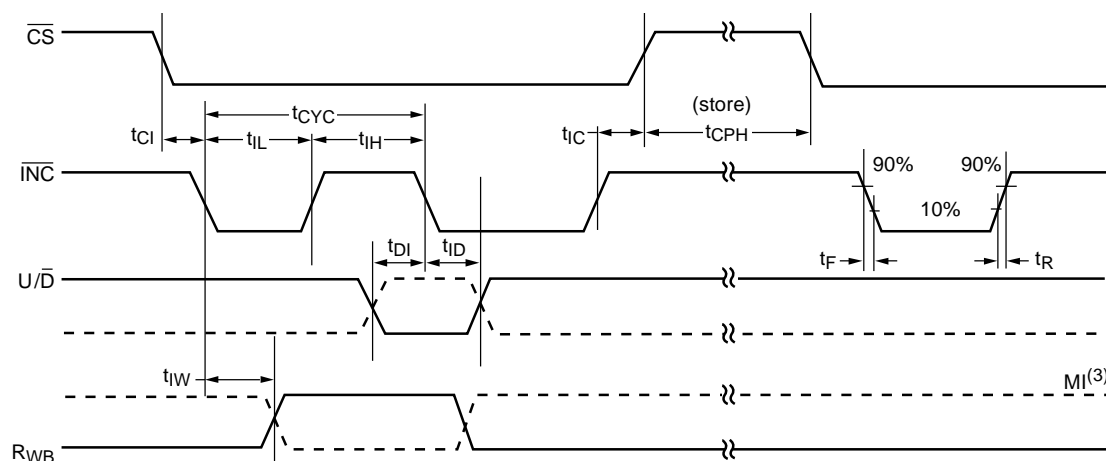
| | |
|---------------------------|----------------------------|
| V_{CC} Range | $2.5V \leq V_{CC} \leq 6V$ |
| Input Pulse Levels | $0.2V_{CC}$ to $0.7V_{CC}$ |
| Input Rise and Fall Times | 10 ns |
| Input Reference Levels | $0.5V_{CC}$ |

AC OPERATING CHARACTERISTICS

$V_{CC} = +2.5 V$ to $+6.0 V$, $V_H = V_{CC}$, $V_L = 0 V$, unless otherwise specified

| Symbol | Parameter | Min | Typ ⁽¹⁾ | Max | Units |
|------------------|------------------------------|-----|--------------------|-----|---------|
| t_{CI} | CS to INC Setup | 100 | – | – | ns |
| t_{DI} | U/D to INC Setup | 50 | – | – | ns |
| t_{ID} | U/D to INC Hold | 100 | – | – | ns |
| t_{IL} | INC LOW Period | 250 | – | – | ns |
| t_{IH} | INC HIGH Period | 250 | – | – | ns |
| t_{IC} | INC Inactive to CS Inactive | 1 | – | – | μs |
| t_{CPH} | CS Deselect Time (NO STORE) | 100 | – | – | ns |
| t_{CPH} | CS Deselect Time (STORE) | 10 | – | – | ms |
| t_{IW} | INC to V_{OUT} Change | – | 1 | 5 | μs |
| t_{CYC} | INC Cycle Time | 1 | – | – | μs |
| $t_R, t_F^{(2)}$ | INC Input Rise and Fall Time | – | – | 500 | μs |
| $t_{PU}^{(2)}$ | Power-up to Wiper Stable | – | – | 1 | ms |
| t_{WR} | Store Cycle | – | 5 | 10 | ms |

A.C. TIMING

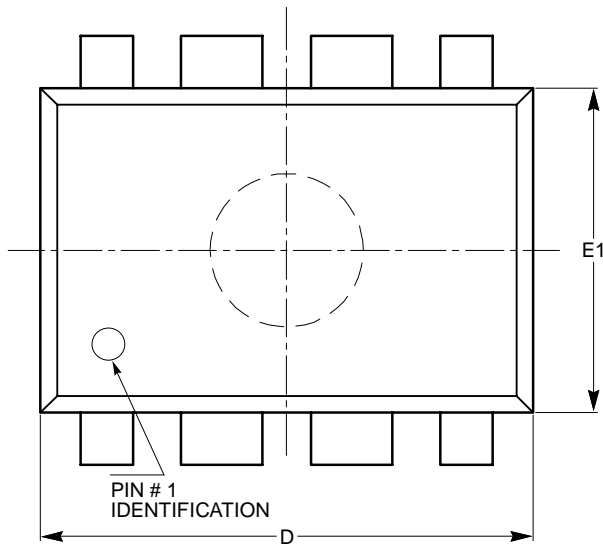


Notes:

- (1) Typical values are for $T_A = 25^\circ C$ and nominal supply voltage.
- (2) This parameter is periodically sampled and not 100% tested.
- (3) MI in the A.C. Timing diagram refers to the minimum incremental change in the W output due to a change in the wiper position.

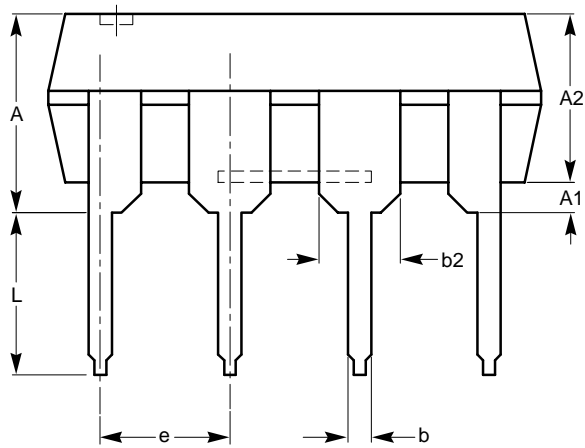
PACKAGE OUTLINE DRAWINGS

PDIP 8-Lead 300 mil (L) ⁽¹⁾⁽²⁾

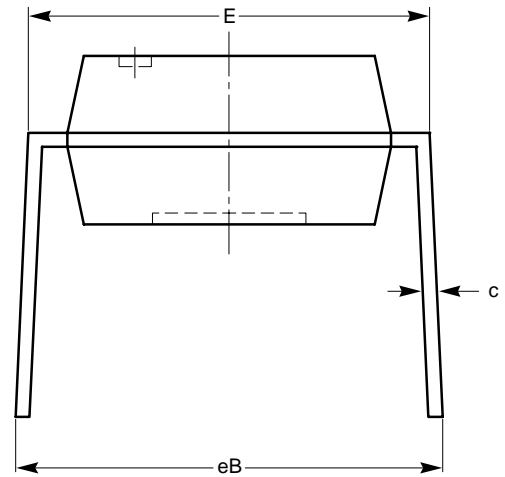


TOP VIEW

| SYMBOL | MIN | NOM | MAX |
|--------|----------|------|-------|
| A | | | 5.33 |
| A1 | 0.38 | | |
| A2 | 2.92 | 3.30 | 4.95 |
| b | 0.36 | 0.46 | 0.56 |
| b2 | 1.14 | 1.52 | 1.78 |
| c | 0.20 | 0.25 | 0.36 |
| D | 9.02 | 9.27 | 10.16 |
| E | 7.62 | 7.87 | 8.25 |
| e | 2.54 BSC | | |
| E1 | 6.10 | 6.35 | 7.11 |
| eB | 7.87 | | 10.92 |
| L | 2.92 | 3.30 | 3.80 |



SIDE VIEW

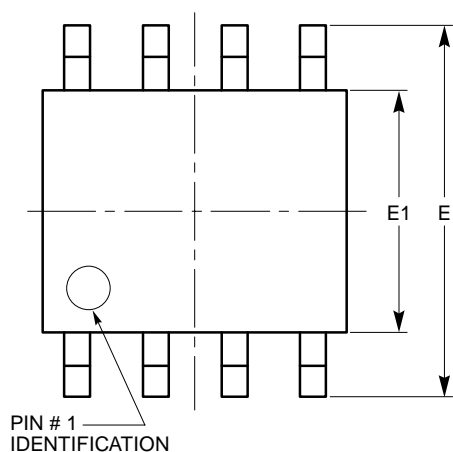


END VIEW

Notes:

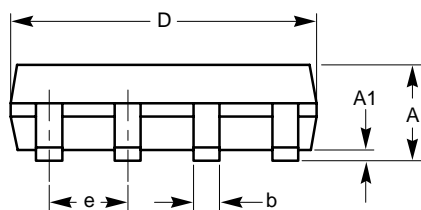
- (1) All dimensions are in millimeters.
- (2) Complies with JEDEC Specification MS-001.

SOIC 8-LEAD Narrow Body (150 mil) (V) ⁽¹⁾⁽²⁾

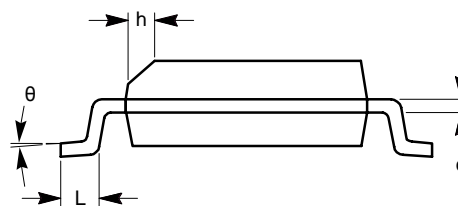


TOP VIEW

| SYMBOL | MIN | NOM | MAX |
|----------|----------|-----|------|
| A | 1.35 | | 1.75 |
| A1 | 0.10 | | 0.25 |
| b | 0.33 | | 0.51 |
| c | 0.19 | | 0.25 |
| D | 4.80 | | 5.00 |
| E | 5.80 | | 6.20 |
| E1 | 3.80 | | 4.00 |
| e | 1.27 BSC | | |
| h | 0.25 | | 0.50 |
| L | 0.40 | | 1.27 |
| θ | 0° | | 8° |



SIDE VIEW

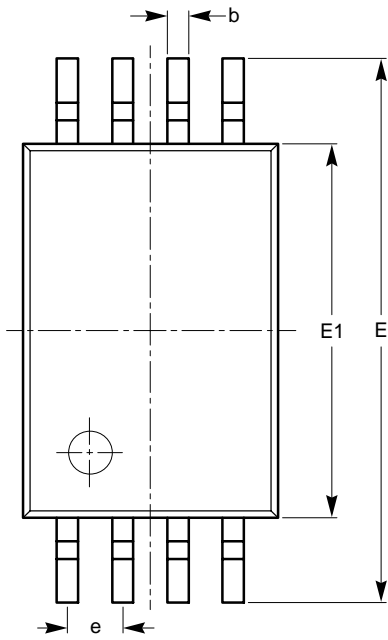


END VIEW

Notes:

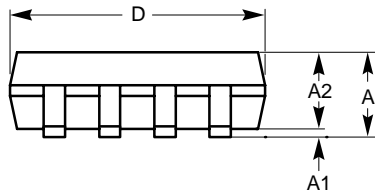
- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC Specification MS-012.

TSSOP 8-Lead (Y) ⁽¹⁾⁽²⁾

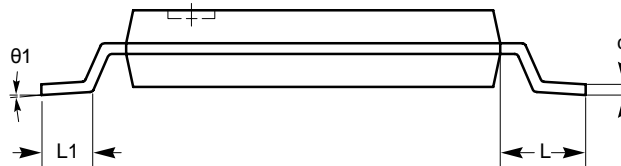


TOP VIEW

| SYMBOL | MIN | NOM | MAX |
|------------|----------|------|------|
| A | | | 1.20 |
| A1 | 0.05 | | 0.15 |
| A2 | 0.80 | 0.90 | 1.05 |
| b | 0.19 | | 0.30 |
| c | 0.09 | | 0.20 |
| D | 2.90 | 3.00 | 3.10 |
| E | 6.30 | 6.40 | 6.50 |
| E1 | 4.30 | 4.40 | 4.50 |
| e | 0.65 BSC | | |
| L | 1.00 REF | | |
| L1 | 0.50 | 0.60 | 0.75 |
| $\theta 1$ | 0° | | 8° |



SIDE VIEW

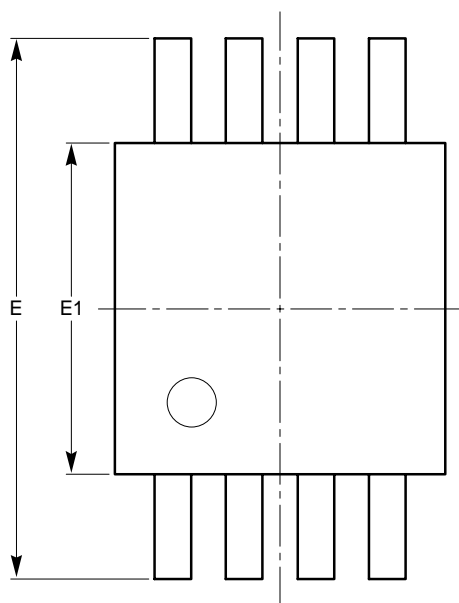


END VIEW

Notes:

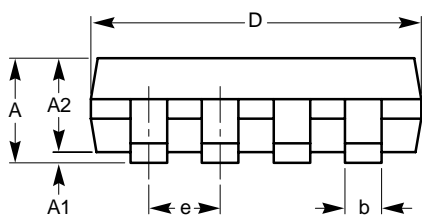
- (1) All dimensions are in millimeters.
- (2) Complies with JEDEC Standard MO-153

MSOP 8-Lead (Z) ⁽¹⁾⁽²⁾

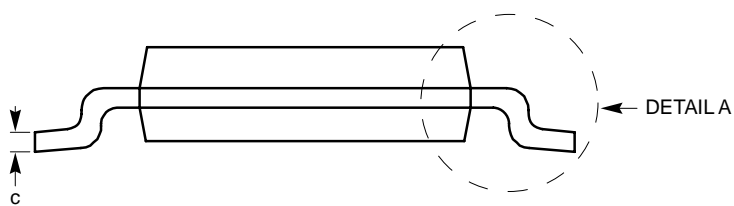


TOP VIEW

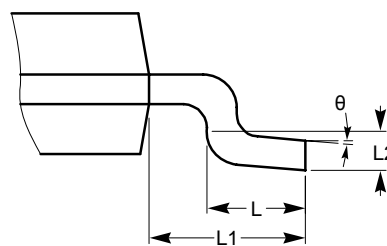
| SYMBOL | MIN | NOM | MAX |
|----------|----------|------|------|
| A | | | 1.10 |
| A1 | 0.05 | 0.10 | 0.15 |
| A2 | 0.75 | 0.85 | 0.95 |
| b | 0.22 | | 0.38 |
| c | 0.13 | | 0.23 |
| D | 2.90 | 3.00 | 3.10 |
| E | 4.80 | 4.90 | 5.00 |
| E1 | 2.90 | 3.00 | 3.10 |
| e | 0.65 BSC | | |
| L | 0.40 | 0.60 | 0.80 |
| L1 | 0.95 REF | | |
| L2 | 0.25 BSC | | |
| θ | 0° | | 6° |



SIDE VIEW



END VIEW

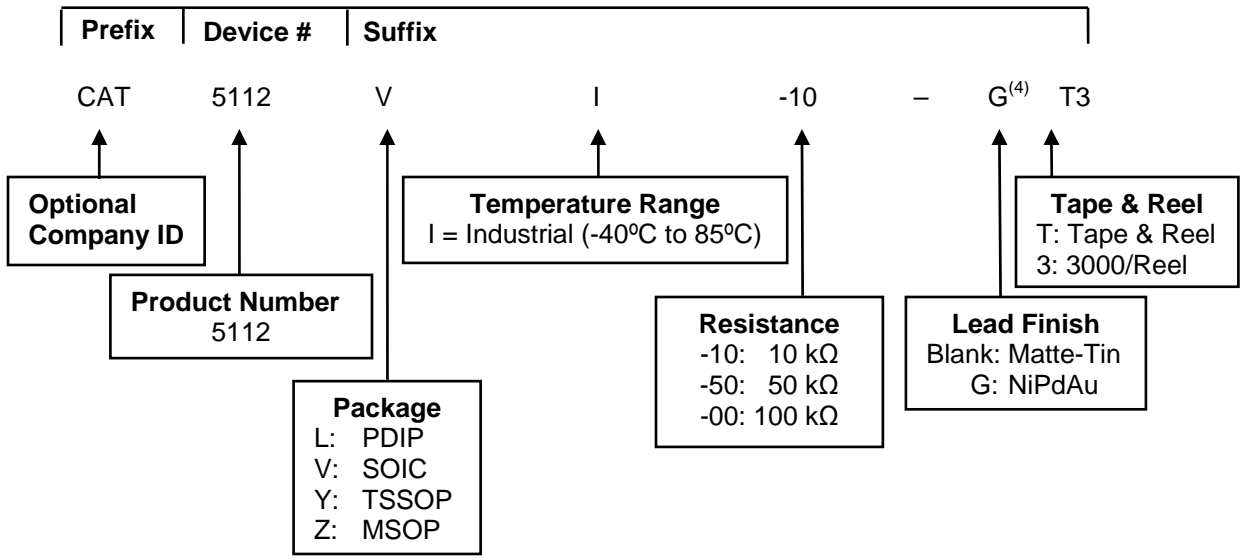


DETAIL A

Notes:

- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC Specification MS-187.

EXAMPLE OF ORDERING INFORMATION



ORDERING INFORMATION


| Orderable Part Number | Resistance (kΩ) | Package-Pins | Lead Finish ⁽⁴⁾ |
|-----------------------|-----------------|--------------|----------------------------|
| CAT5112LI-10-G | 10 | PDIP-8 | NiPdAu |
| CAT5112LI-50-G | 50 | | |
| CAT5112LI-00-G | 100 | | |
| CAT5112VI-10-GT3 | 10 | SOIC-8 | |
| CAT5112VI-50-GT3 | 50 | | |
| CAT5112VI-00-GT3 | 100 | | |
| CAT5112YI-10-GT3 | 10 | TSSOP-8 | |
| CAT5112YI-50-GT3 | 50 | | |
| CAT5112YI-00-GT3 | 100 | | |
| CAT5112ZI-10-GT3 | 10 | MSOP-8 | |
| CAT5112ZI-50-GT3 | 50 | | |
| CAT5112ZI-00-GT3 | 100 | | |

Notes:

- (1) All packages are RoHS-compliant (Lead-free, Halogen-free).
- (2) The standard lead finish is NiPdAu.
- (3) This device used in the above example is a CAT5112VI-10-GT3 (SOIC, Industrial Temperature, 10 kΩ, NiPdAu, Tape & Reel).
- (4) For Matte-Tin finish, contact factory.

REVISION HISTORY

| Date | Rev. | Description |
|-----------|------|--|
| 10-Mar-07 | J | Updated Potentiometer Parameters |
| 29-Mar-04 | K | Change Green Package marking for SOIC from W to V |
| 12-Apr-04 | L | Update Reel Ordering Information |
| 04-Jun-07 | M | Add Package Outline Drawings Update Example of Ordering Information Add MD- to the Document Number |
| 20-Nov-08 | N | Update Package Outline Drawings Change logo and fine print to ON Semiconductor |
| 10-Jul-09 | O | Update Ordering Information table |

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