

CAT5128

32-tap Digital Up/Down Control Potentiometer (POT)

Description

The CAT5128 is a single digital POT designed as an electronic replacement for mechanical potentiometers and trim pots. 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 CAT5128 contains a 32-tap series resistor array connected between two terminals A and B. An up/down counter and decoder that are controlled by two input pins, determines which tap is connected to the wiper, W. Wiper-control of the CAT5128 is accomplished with two input control pins, \overline{UP} and \overline{DOWN} . A high-to-low transition on the \overline{UP} input increments the wiper position and a high-to-low transition on the \overline{DOWN} input decrements the wiper position. The tap position is not stored in memory. The wiper is always set to the mid point, tap 15 at power up.

The digital POT can be used as a three-terminal resistive divider or as a two-terminal variable resistor. Digital potentiometers bring variability and programmability to a wide variety of applications including control, parameter adjustments, and signal processing.

Features

- 32-position Linear Taper Potentiometer
- Low Power CMOS Technology
- Single Supply Operation: 2.5 V – 5.5 V
- Discrete Step-up/Step-down Digital Control
- Resistance Values: 10 k Ω , 50 k Ω and 100 k Ω
- Available in SOT-23 8-lead Package
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

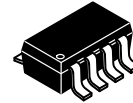
Applications

- 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



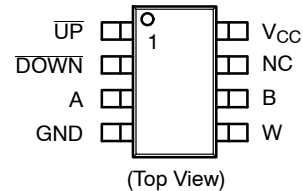
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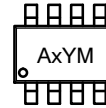


SOT-23
TB SUFFIX
CASE 527AK

PIN CONFIGURATION



MARKING DIAGRAM



- x = H, B or C
- AH = CAT5128TBI-00GT3
- AB = CAT5128TBI-10GT3
- AC = CAT5128TBI-50GT3
- Y = Production Year (Last Digit)
- M = Production Month (1-9, O, N, D)

PIN DESCRIPTIONS

| Pin Name | Function |
|-------------------|-----------------------------|
| \overline{UP} | Step-Up Control |
| \overline{DOWN} | Step-Down Control |
| A | Potentiometer High Terminal |
| GND | Ground |
| W | Wiper Terminal |
| B | Potentiometer Low Terminal |
| NC | Not Connected |
| V _{CC} | Supply Voltage |

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

Functional Diagrams

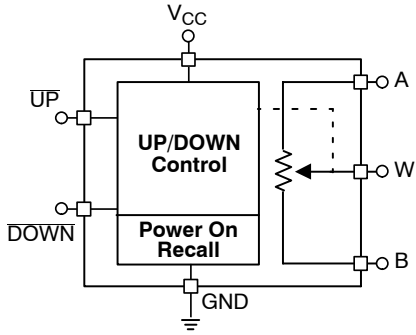


Figure 1. General

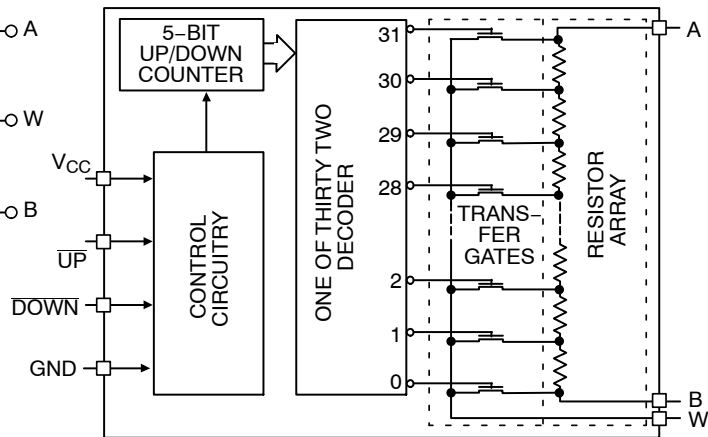


Figure 2. Detailed

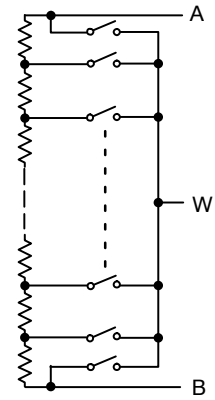


Figure 3. Electronic Potentiometer Implementation

Pin Description

\overline{UP} : Step-Up Control Input

When \overline{DOWN} input is high, a high-to-low transition on \overline{UP} input will cause the wiper to move one increment toward the A terminal.

\overline{DOWN} : Step-Down Control Input

A high-to-low transition on \overline{DOWN} input will cause the wiper to move one increment towards the B terminal.

A: High End Potentiometer Terminal

A is the high end terminal of the potentiometer. It is not required that this terminal be connected to a potential greater than the B terminal. Voltage applied to the A terminal cannot exceed the supply voltage, V_{CC} or go below ground, GND.

W: Wiper Potentiometer Terminal

W is the wiper terminal of the potentiometer. Its position on the resistor array is controlled by the control inputs, \overline{UP} and \overline{DOWN} . Voltage applied to the W terminal cannot exceed the supply voltage, V_{CC} or go below ground, GND.

B: Low End Potentiometer Terminal

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

Device Operation

The CAT5128 operates like a digitally controlled potentiometer with A and B equivalent to the high and low terminals and W equivalent to the mechanical potentiometer's wiper. There are 32 available tap positions including the resistor end points, A and B. There are 31 resistor elements connected in series between the A and B terminals. The wiper terminal is connected to one of the 32 taps and controlled by two inputs, \overline{UP} and \overline{DOWN} . These inputs control a five-bit up/down counter whose output is decoded to select the wiper position.

A high-to-low transition on \overline{DOWN} input will decrement one step the wiper position (R_{WB} will decrease with 1LSB and R_{WA} will increase with 1LSB). If and only if \overline{DOWN} input is high, a high-to-low transition on \overline{UP} input will increment one step the wiper position (R_{WB} will increase with 1LSB and R_{WA} will decrease with 1LSB).

The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. When the CAT5128 is powered-down, the wiper position is reset. When power is restored, the counter is set to the mid point, tap 15.

Table 1. OPERATION MODES

| UP | DOWN | Operation |
|-------------|-------------|----------------------------------|
| High to Low | High | Wiper toward A – R_W Increment |
| X | Low | Wiper does not change |
| High | High to Low | Wiper toward B – R_W Decrement |
| High to Low | High to Low | Wiper toward B – R_W Decrement |
| Low | X | Wiper does not change |
| High | High | Wiper does not change |

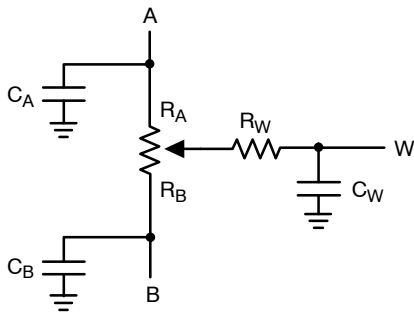


Figure 4. Potentiometer Equivalent Circuit

Table 2. ABSOLUTE MAXIMUM RATINGS

| Parameters | Ratings | Units |
|--|--|-------|
| Supply Voltage V_{CC} to GND | -0.5 to +7 V | V |
| Inputs UP to GND DOWN to GND A, B, W to GND | -0.5 to $V_{CC} + 0.5$ -0.5 to $V_{CC} + 0.5$ -0.5 to $V_{CC} + 0.5$ | V |
| Operating Ambient Temperature Industrial ('I' suffix) | -40 to +85 | °C |
| Junction Temperature | +150 | °C |
| Storage Temperature | -65 to 150 | °C |
| Lead Soldering (10 seconds max) | +300 | °C |
| Thermal Resistance θ_{JA} | 230 | °C/W |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Table 3. DC ELECTRICAL CHARACTERISTICS ($V_{CC} = +2.5$ V to +5.5 V unless otherwise specified)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---------------------|----------------------------|--|-----|------|-----|---------|
| POWER SUPPLY | | | | | | |
| V_{CC} | Operating Voltage Range | | 2.5 | – | 5.5 | V |
| I_{CC1} | Supply Current (Increment) | $V_{CC} = 5.5$ V, $f = 1$ MHz, $I_W = 0$ | – | – | 100 | μ A |
| | | $V_{CC} = 5.5$ V, $f = 250$ kHz, $I_W = 0$ | – | – | 50 | μ A |
| I_{SB1} (Note 1) | Supply Current (Standby) | UP, DOWN = V_{CC} or GND | – | 0.01 | 1 | μ A |

1. These parameters are periodically sampled and are not production tested.

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Table 4. LOGIC INPUTS ($V_{CC} = +2.5\text{ V}$ to $+5.5\text{ V}$ unless otherwise specified)

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

Table 5. POTENTIOMETER CHARACTERISTICS ($V_{CC} = +2.5\text{ V}$ to $+5.5\text{ V}$ unless otherwise specified)

| Symbol | Parameter | Conditions | Min | Typ (Note 2) | Max | Units |
|----------------|------------------------------|--|------|-----------------|----------|-------------------------|
| R_{POT} | Potentiometer Resistance | –10 Device | | 10 | | $\text{k}\Omega$ |
| | | –50 Device | | 50 | | |
| | | –00 Device | | 100 | | |
| | Pot. Resistance Tolerance | | | | ± 20 | % |
| V_A | Voltage on A pin | | 0 | | V_{CC} | V |
| V_B | Voltage on B pin | | 0 | | V_{CC} | V |
| | Resolution | | | 3.2 | | % |
| INL | Integral Linearity Error | $I_W \leq 2\ \mu\text{A}$ | –0.5 | 0.1 | 0.5 | LSB |
| DNL | Differential Linearity Error | $I_W \leq 2\ \mu\text{A}$ | –0.5 | 0.05 | 0.5 | LSB |
| R_{WI} | Wiper Resistance | $V_{CC} = 5\text{ V}, I_W = 1\text{ mA}$ | | 70 | | Ω |
| | | $V_{CC} = 2.5\text{ V}, I_W = 1\text{ mA}$ | | 150 | 300 | Ω |
| I_W | Wiper Current | (Note 3) | | | 1 | mA |
| TC_{RPOT} | TC of Pot Resistance | (Note 4) | | 50 | | ppm/ $^{\circ}\text{C}$ |
| TC_{RATIO} | Ratiometric TC | (Note 4) | | 5 | 20 | ppm/ $^{\circ}\text{C}$ |
| V_N (Note 4) | Noise | 100 kHz / 1 kHz | | 8/24 | | nV/ $\sqrt{\text{Hz}}$ |
| $C_A/C_B/C_W$ | Potentiometer Capacitances | (Note 4) | | 8/8/25 | | pF |
| f_c (Note 4) | Frequency Response | Passive Attenuator, 10 k Ω | | 1.7 | | MHz |

2. Typical values are for $T_A = 25^{\circ}\text{C}$ and nominal supply voltage.

3. I_W = source or sink.

4. These parameters are periodically sampled and are not production tested.

Table 6. AC CONDITIONS OF TEST

| | |
|---------------------------|--|
| V_{CC} Range | $2.5\text{ V} \leq V_{CC} \leq 5.5\text{ V}$ |
| Input Pulse Levels | $0.2 V_{CC}$ to $0.7 V_{CC}$ |
| Input Rise and Fall Times | 10 ns |
| Input Reference Levels | $0.5 V_{CC}$ |

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Table 7. AC OPERATING CHARACTERISTICS ($V_{CC} = +2.5\text{ V to }+5.5\text{ V}$, $V_H = V_{CC}$, $V_L = 0\text{ V}$, unless otherwise specified)

| Symbol | Parameter | Min | Typ (Note 5) | Max | Units |
|-------------------------------------|--------------------------|-----|--------------|-----|---------------|
| t_{UP} | UP LOW Period | 500 | – | – | ns |
| t_{DOWN} | DOWN LOW Period | 500 | – | – | ns |
| t_{UP_CYC} | UP Cycle Time | 1 | – | – | μs |
| t_{DOWN_CYC} | DOWN Cycle Time | 1 | – | – | μs |
| t_{UP_R}, t_{UP_F} (Note 6) | UP Rise and Fall Time | – | – | 500 | ns |
| t_{DOWN_R}, t_{DOWN_F} (Note 6) | DOWN Rise and Fall Time | – | – | 500 | ns |
| t_{UP_SET} | UP Settling Time | 200 | – | – | ns |
| t_{DOWN_SET} | DOWN Settling Time | 200 | – | – | ns |
| t_{PU} (Note 6) | Power-up to Wiper Stable | – | – | 1 | ms |

5. Typical values are for $T_A = 25^\circ\text{C}$ and nominal supply voltage.

6. This parameter is periodically sampled and not 100% tested.

Interface Timing Diagrams

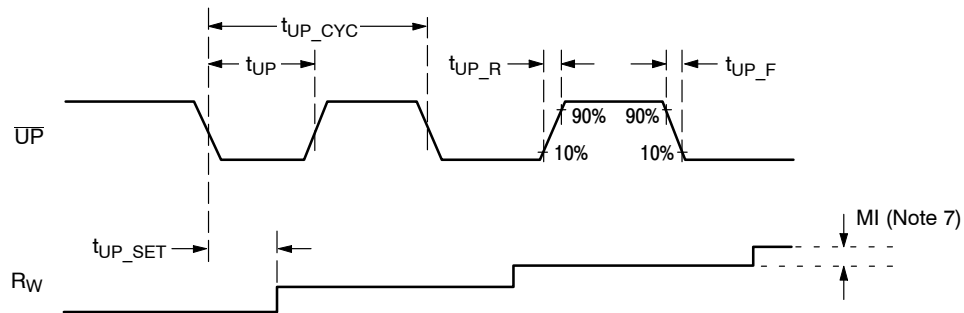


Figure 5. Increment R_W in Discrete Steps

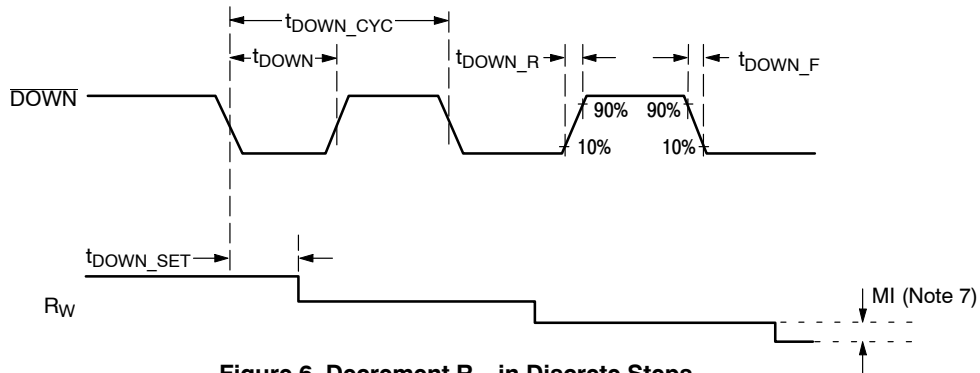


Figure 6. Decrement R_W in Discrete Steps

7. 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.

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Table 8. ORDERING INFORMATION

| Orderable Part Number | Resistance (k Ω) | Lead Finish | Package | Shipping [†] |
|----------------------------|--------------------------|-------------|-----------------------|-----------------------|
| CAT5128TBI-10GT3 | 10 | NiPdAu | SOT-23-8 (Pb-Free) | 3000 / Tape & Reel |
| CAT5128TBI-50GT3 | 50 | | | |
| CAT5128TBI-00GT3 (Note 12) | 100 | | | |

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

8. For detailed information and a breakdown of device nomenclature and numbering systems, please see the ON Semiconductor Device Nomenclature document, TND310/D, available at www.onsemi.com.

9. All packages are RoHS-compliant (Pb-Free, Halogen-Free).

10. The standard lead finish is NiPdAu.

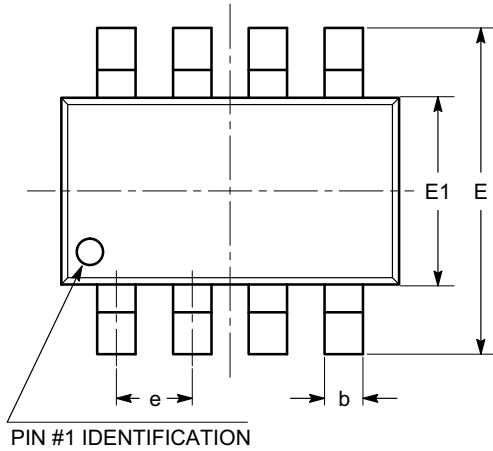
11. For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.

12. Contact factory for availability.

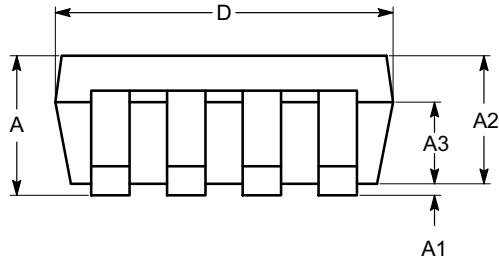
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PACKAGE DIMENSIONS

SOT-23, 8 Lead
CASE 527AK
ISSUE A

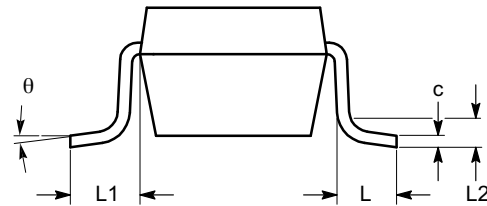


TOP VIEW



SIDE VIEW


| SYMBOL | MIN | NOM | MAX |
|----------|----------|------|------|
| A | 0.90 | | 1.45 |
| A1 | 0.00 | | 0.15 |
| A2 | 0.90 | 1.10 | 1.30 |
| A3 | 0.60 | | 0.80 |
| b | 0.28 | | 0.38 |
| c | 0.08 | | 0.22 |
| D | 2.90 BSC | | |
| E | 2.80 BSC | | |
| E1 | 1.60 BSC | | |
| e | 0.65 BSC | | |
| L | 0.30 | 0.45 | 0.60 |
| L1 | 0.60 REF | | |
| L2 | 0.25 REF | | |
| θ | 0° | | 8° |



END VIEW

Notes:

- (1) All dimensions in millimeters. Angles in degrees.
- (2) Complies with JEDEC standard MO-178.

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