

# CAT5132

## 16 Volt Digitally Programmable Potentiometer (DPP) with 128 Taps and I<sup>2</sup>C Interface

### Description

The CAT5132 is a high voltage Digitally Programmable Potentiometer (DPP) with non-volatile wiper setting memory, operating like a mechanical potentiometer. The tap points between the 127 equal resistive elements are connected to the wiper output via CMOS switches. The switches are controlled by a 7-bit Wiper Control Register (WCR). The wiper setting can be stored in a 7-bit non-volatile Data Register (DR). The WCR is accessed via the I<sup>2</sup>C serial bus.

Upon power-up, the WCR is set to mid-scale (1000000). After the power supply is stable, the contents of the DR are transferred to the WCR and the wiper is returned to the memorized setting.

The CAT5132 has two voltage supplies: V<sub>CC</sub>, the digital supply and V<sub>+</sub>, the analog supply. V<sub>+</sub> can be much higher than V<sub>CC</sub>, allowing for 16 V analog operations.

The CAT5132 can be used as a potentiometer or as a two-terminal variable resistor.

### Features

- Single Linear DPP with 128 Taps
- End-to-end Resistance of 10 k $\Omega$ , 50 k $\Omega$  or 100 k $\Omega$
- I<sup>2</sup>C Interface
- Fast Up/Down Wiper Control Mode
- Non-volatile Wiper Setting Storage
- Automatic Wiper Setting Recall at Power-up
- Digital Supply Range (V<sub>CC</sub>): 2.7 V to 5.5 V
- Analog Supply Range (V<sub>+</sub>): +8 V to +16 V
- Low Standby Current: 15  $\mu$ A
- 100 Year Wiper Setting Memory
- Industrial Temperature Range: -40°C to +85°C
- 10-pin MSOP Package
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

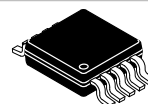
### Applications

- LCD Screen Adjustment
- Volume Control
- Mechanical Potentiometer Replacement
- Gain Adjustment
- Line Impedance Matching
- VCOM Setting Adjustments



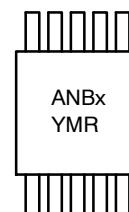
ON Semiconductor®

<http://onsemi.com>



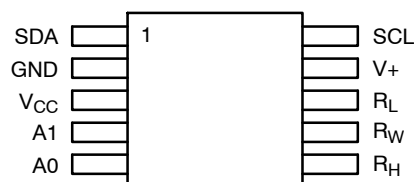
MSOP-10  
Z SUFFIX  
CASE 846AE

### MARKING DIAGRAM



ANBU = CAT5132ZI-10-GT3  
ANBK = CAT5132ZI-50-GT3  
ANBP = CAT5132ZI-00-GT3  
Y = Production Year (Last Digit)  
M = Production Month (1-9, A, B, C)  
R = Production Revision

### PIN CONFIGURATION



(Top View)

### ORDERING INFORMATION

| Device           | Package           | Shipping†              |
|------------------|-------------------|------------------------|
| CAT5132ZI-10-GT3 | MSOP<br>(Pb-Free) | 3,000 /<br>Tape & Reel |
| CAT5132ZI-50-GT3 |                   |                        |
| CAT5132ZI-00-GT3 |                   |                        |

†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.

1. 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](http://www.onsemi.com).
2. The standard lead finish is NiPdAu.
3. For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.

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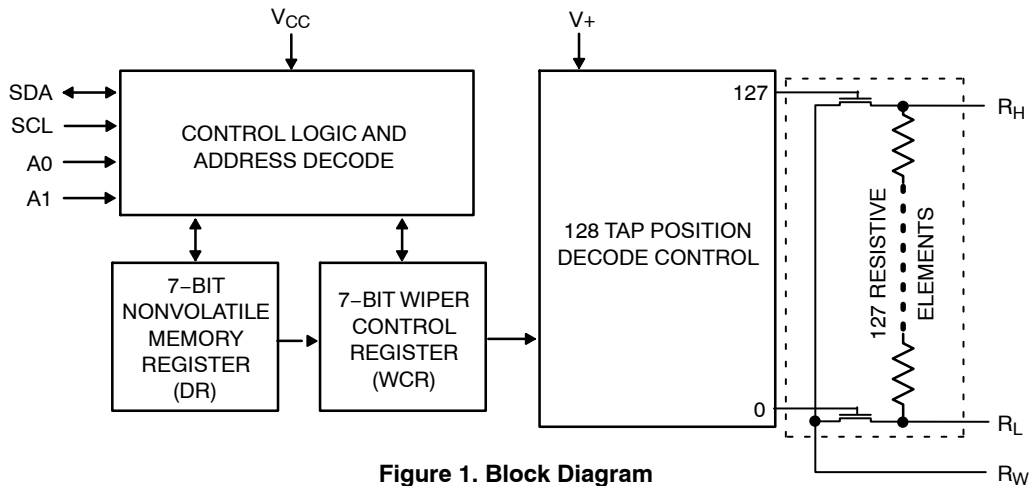


Figure 1. Block Diagram

Table 1. PIN FUNCTION DESCRIPTION

| Pin No. | Pin Name        | Description  |
|---------|-----------------|--|
| 1       | SDA             | Serial Data Input/Output – Bidirectional Serial Data pin used to transfer data into and out of the CAT5132. This is an Open-Drain I/O and can be wire OR'd with other Open-Drain (or Open Collector) I/Os. |
| 2       | GND             | Ground   |
| 3       | V <sub>CC</sub> | Digital Supply Voltage (2.7 V to 5.5 V)  |
| 4       | A1              | Address Select Input to select slave address for I <sup>2</sup> C bus.   |
| 5       | A0              | Address Select Input to select slave address for I <sup>2</sup> C bus.   |
| 6       | R <sub>H</sub>  | High Reference Terminal for the potentiometer  |
| 7       | R <sub>W</sub>  | Wiper Terminal for the potentiometer   |
| 8       | R <sub>L</sub>  | Low Reference Terminal for the potentiometer   |
| 9       | V+              | Analog Supply Voltage for the potentiometer (+8.0 V to 16.0 V)   |
| 10      | SCL             | Serial Bus Clock input for the I <sup>2</sup> C Serial Bus. This clock is used to clock all data transfers into and out of the CAT5132   |

Table 2. ABSOLUTE MAXIMUM RATINGS

| Rating  | Value                         | Unit |
|---|-------------------------------|------|
| Temperature Under Bias  | -55 to +125                   | °C   |
| Storage Temperature   | -65 to +150                   | °C   |
| Voltage on any SDA, SCL, A0 & A1 pins with respect to Ground (Note 4)                   | -0.3 to V <sub>CC</sub> + 0.3 | V    |
| Voltage on R <sub>H</sub> , R <sub>L</sub> & R <sub>W</sub> pins with respect to Ground | V+                            |      |
| V <sub>CC</sub> with respect to Ground  | -0.3 to +6                    | V    |
| V+ with respect to Ground   | -0.3 to +16.5                 | V    |
| Wiper Current (10 sec)  | ±6                            | mA   |
| Lead Soldering temperature (10 sec)   | +300                          | °C   |

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.

4. Latch-up protection is provided for stresses up to 100 mA on address and data pins from -0.3 V to V<sub>CC</sub> + 0.3 V.

Table 3. RECOMMENDED OPERATING CONDITIONS

| Rating                      | Value        | Unit |
|-----------------------------|--------------|------|
| V <sub>CC</sub>             | +2.7 to +5.5 | V    |
| V+                          | +8.0 to +16  | V    |
| Operating Temperature Range | -40 to +85   | °C   |

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**Table 4. POTENTIOMETER CHARACTERISTICS** (Over recommended operating conditions unless otherwise stated.)

| Symbol   | Parameter  | Test Conditions   | Limits |          |                | Units        |
|--|--|---|--------|----------|----------------|--------------|
|  |  |   | Min    | Typ      | Max            |              |
| R <sub>POT</sub>                               | Potentiometer Resistance (100 kΩ)                            |   |        | 100      |                | kΩ           |
| R <sub>POT</sub>                               | Potentiometer Resistance (50 kΩ)                             |   |        | 50       |                | kΩ           |
| R <sub>POT</sub>                               | Potentiometer Resistance (10 kΩ)                             |   |        | 10       |                | kΩ           |
| R <sub>TOL</sub>                               | Potentiometer Resistance Tolerance                           |   |        |          | ±20            | %            |
|  | Power Rating   | 25°C  |        |          | 50             | mW           |
| I <sub>W</sub>                                 | Wiper Current  |   |        |          | ±3             | mA           |
| R <sub>W</sub>                                 | Wiper Resistance   | I <sub>W</sub> = ±1 mA @ V <sub>+</sub> = 12 V                        |        | 70       | 150            | Ω            |
|  |  | I <sub>W</sub> = ±1 mA @ V <sub>+</sub> = 8 V                         |        | 110      | 200            | Ω            |
| V <sub>TERM</sub>                              | Voltage on R <sub>W</sub> , R <sub>H</sub> or R <sub>L</sub> | GND = 0 V; V <sub>+</sub> = 8 V to 16 V                               | GND    |          | V <sub>+</sub> | V            |
| RES  | Resolution   |   |        | 0.78     |                | %            |
| A <sub>LIN</sub>                               | Absolute Linearity (Note 6)                                  | V <sub>W(n)(actual)</sub> - V <sub>W(n)(expected)</sub> (Notes 9, 10) |        |          | ±1             | LSB (Note 8) |
| R <sub>LIN</sub>                               | Relative Linearity (Note 7)                                  | V <sub>W(n+1)</sub> - [V <sub>W(n)</sub> + LSB] (Notes 9, 10)         |        |          | ±0.5           | LSB (Note 8) |
| TC <sub>R<sub>POT</sub></sub>                  | Temperature Coefficient of R <sub>POT</sub>                  | (Note 5)  |        | ±300     |                | ppm/°C       |
| TC <sub>Ratio</sub>                            | Ratiometric Temperature Coefficient                          | (Note 5)  |        |          | 30             | ppm/°C       |
| C <sub>H</sub> /C <sub>L</sub> /C <sub>W</sub> | Potentiometer Capacitances                                   | (Note 5)  |        | 10/10/25 |                | pF           |
| fc   | Frequency Response   | R <sub>POT</sub> = 50 kΩ  |        | 0.4      |                | MHz          |

5. This parameter is tested initially and after a design or process change that affects the parameter.

6. Absolute linearity is utilized to determine actual wiper voltage versus expected voltage as determined by wiper position when used as a potentiometer.

7. Relative linearity is utilized to determine the actual change in voltage between two successive tap positions when used as a potentiometer.

8. LSB = (R<sub>HM</sub> - R<sub>LM</sub>)/127; where R<sub>HM</sub> and R<sub>LM</sub> are the highest and lowest measured values on the wiper terminal.

9. n = 1, 2, ..., 127

10. V<sub>+</sub> @ R<sub>H</sub>; 0 V @ R<sub>L</sub>; V<sub>W</sub> measured @ R<sub>W</sub> with no load.

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**Table 5. D.C. ELECTRICAL CHARACTERISTICS** (Over recommended operating conditions unless otherwise stated.)

| Symbol        | Parameter                                  | Test Conditions  | Min                 | Max                 | Units         |
|---------------|--|--|---------------------|---------------------|---------------|
| $I_{CC1}$     | Power Supply Current (Volatile Write/Read) | $F_{SCL} = 400 \text{ kHz}$ , SDA Open, $V_{CC} = 5.5 \text{ V}$ , Input = GND |                     | 1                   | mA            |
| $I_{CC2}$     | Power Supply Current (Nonvolatile WRITE)   | $F_{SCL} = 400 \text{ kHz}$ , SDA Open, $V_{CC} = 5.5 \text{ V}$ , Input = GND |                     | 3.0                 | mA            |
| $I_{SB(VCC)}$ | Standby Current ( $V_{CC} = 5 \text{ V}$ ) | $V_{IN} = \text{GND}$ or $V_{CC}$ , SDA = $V_{CC}$                             |                     | 5                   | $\mu\text{A}$ |
| $I_{SB(V+)}$  | V+ Standby Current                         | $V_{CC} = 5 \text{ V}$ , $V+ = 16 \text{ V}$                                   |                     | 10                  | $\mu\text{A}$ |
| $I_{LI}$      | Input Leakage Current                      | $V_{IN} = \text{GND}$ to $V_{CC}$  |                     | 10                  | $\mu\text{A}$ |
| $I_{LO}$      | Output Leakage Current                     | $V_{OUT} = \text{GND}$ to $V_{CC}$   |                     | 10                  | $\mu\text{A}$ |
| $V_{IL}$      | Input Low Voltage                          |  | -1                  | $V_{CC} \times 0.3$ | V             |
| $V_{IH}$      | Input High Voltage                         |  | $V_{CC} \times 0.7$ | $V_{CC} + 1.0$      | V             |
| $V_{OL1}$     | Output Low Voltage ( $V_{CC} = 3.0$ )      | $I_{OL} = 3 \text{ mA}$  |                     | 0.4                 | V             |

**Table 6. CAPACITANCE** ( $T_A = 25^\circ\text{C}$ ,  $f = 1.0 \text{ MHz}$ ,  $V_{CC} = 5.0 \text{ V}$ )

| Symbol    | Parameter                       | Test Conditions                   | Min | Max | Units |
|-----------|---------------------------------|-----------------------------------|-----|-----|-------|
| $C_{I/O}$ | Input/Output Capacitance (SDA)  | $V_{I/O} = 0 \text{ V}$ (Note 11) |     | 8   | pF    |
| $C_{IN}$  | Input Capacitance (A0, A1, SCL) | $V_{IN} = 0 \text{ V}$ (Note 11)  |     | 6   | pF    |

**Table 7. A.C. CHARACTERISTICS**

| Symbol              | Parameter (see Figure 6)                                      | $V_{CC} = 2.7 - 5.5 \text{ V}$ |     | Units         |
|---------------------|---|--------------------------------|-----|---------------|
|                     |   | Min                            | Max |               |
| $F_{SCL}$           | Clock Frequency   |                                | 400 | kHz           |
| $T_I$ (Note 11)     | Noise Suppression Time Constant at SCL & SDA Inputs           |                                | 50  | ns            |
| $t_{AA}$            | SLC Low to SDA Data Out and ACK Out                           |                                | 1   | $\mu\text{s}$ |
| $t_{BUF}$ (Note 11) | Time the bus must be free before a new transmission can start | 1.2                            |     | $\mu\text{s}$ |
| $t_{HD:STA}$        | Start Condition Hold Time                                     | 0.6                            |     | $\mu\text{s}$ |
| $t_{LOW}$           | Clock Low Period  | 1.2                            |     | $\mu\text{s}$ |
| $t_{HIGH}$          | Clock High Period   | 0.6                            |     | $\mu\text{s}$ |
| $t_{SU:STA}$        | Start Condition Setup Time (for a Repeated Start Condition)   | 0.6                            |     | $\mu\text{s}$ |
| $t_{HD:DAT}$        | Data in Hold Time   | 0                              |     | ns            |
| $t_R$ (Note 11)     | SDA and SCL Rise Time   |                                | 0.3 | $\mu\text{s}$ |
| $t_F$ (Note 11)     | SDA and SCL Fall Time   |                                | 300 | ns            |
| $t_{SU:STO}$        | Stop Conditions Setup Time                                    | 0.6                            |     | $\mu\text{s}$ |
| $t_{DH}$            | Data Out Hold Time  | 100                            |     | ns            |

11. This parameter is tested initially and after a design or process change that affects the parameter.

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**Table 8. POWER UP TIMING** (Notes 12, 13)

| Symbol    | Parameter                   | Min | Max | Units |
|-----------|-----------------------------|-----|-----|-------|
| $t_{PUR}$ | Power-up to Read Operation  |     | 1   | ms    |
| $t_{PUW}$ | Power-up to Write Operation |     | 1   | ms    |

**Table 9. WIPER TIMING**

| Symbol     | Parameter                                     | Min | Max | Units   |
|------------|---|-----|-----|---------|
| $t_{WRPO}$ | Wiper Response Time After Power Supply Stable | 5   | 10  | $\mu$ s |
| $t_{WRL}$  | Wiper Response Time After Instruction Issued  | 5   | 10  | $\mu$ s |

**Table 10. WRITE CYCLE LIMITS**

| Symbol   | Parameter                       | Min | Max | Units |
|----------|---------------------------------|-----|-----|-------|
| $t_{WR}$ | Write Cycle Time (see Figure 7) |     | 5   | ms    |

The write cycle is the time from a valid stop condition of a write sequence to the end of the internal program/erase cycle. During the write cycle, the bus interface circuits are disabled, SDA is allowed to remain high and the device does not respond to its slave address.

**Table 11. RELIABILITY CHARACTERISTICS**

| Symbol              | Parameter      | Reference Test Method         | Min     | Max | Units  |
|---------------------|----------------|-------------------------------|---------|-----|--------|
| $N_{END}$ (Note 12) | Endurance      | MIL-STD-883, Test Method 1033 | 100,000 |     | Cycles |
| $T_{DR}$ (Note 12)  | Data Retention | MIL-STD-883, Test Method 1008 | 100     |     | Years  |

12. This parameter is tested initially and after a design or process change that affects the parameter.

13.  $t_{PUR}$  and  $t_{PUW}$  are the delays required from the time VCC is stable until the specified operation can be initiated.

TYPICAL PERFORMANCE CHARACTERISTICS

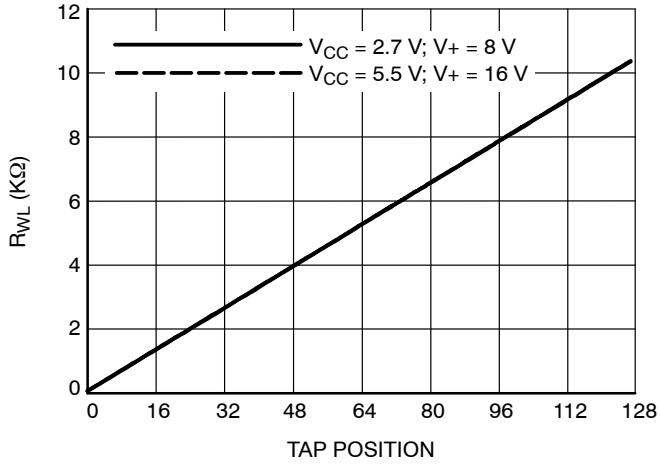


Figure 2. Resistance between  $R_W$  and  $R_L$

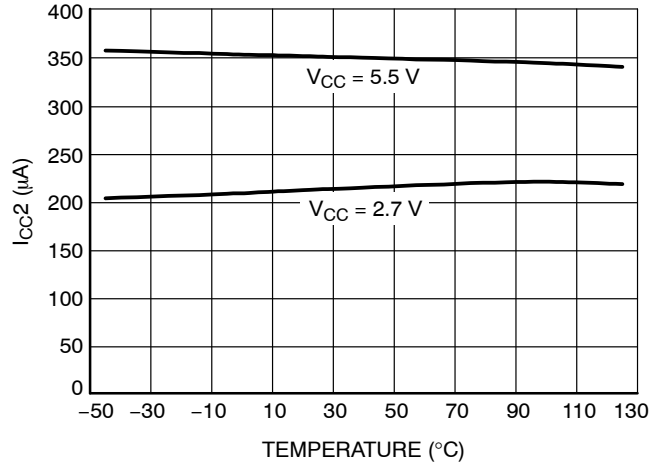


Figure 3.  $I_{CC2}$  (NV Write) vs. Temperature

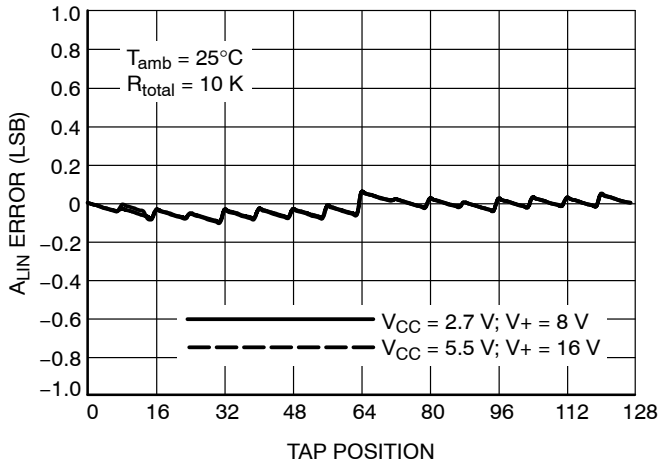


Figure 4. Absolute Linearity Error per Tap Position

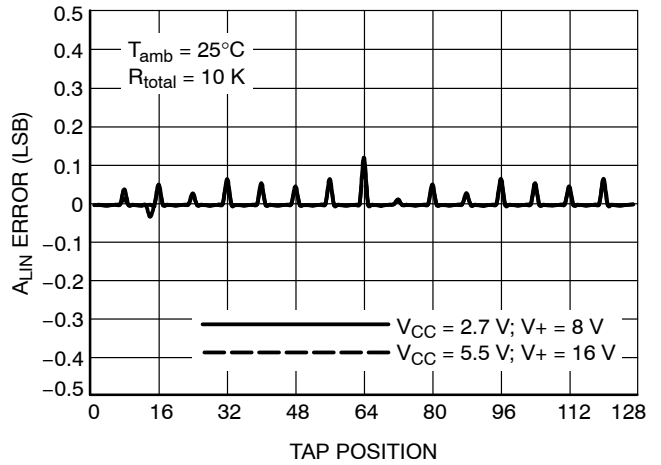


Figure 5. Relative Linearity Error

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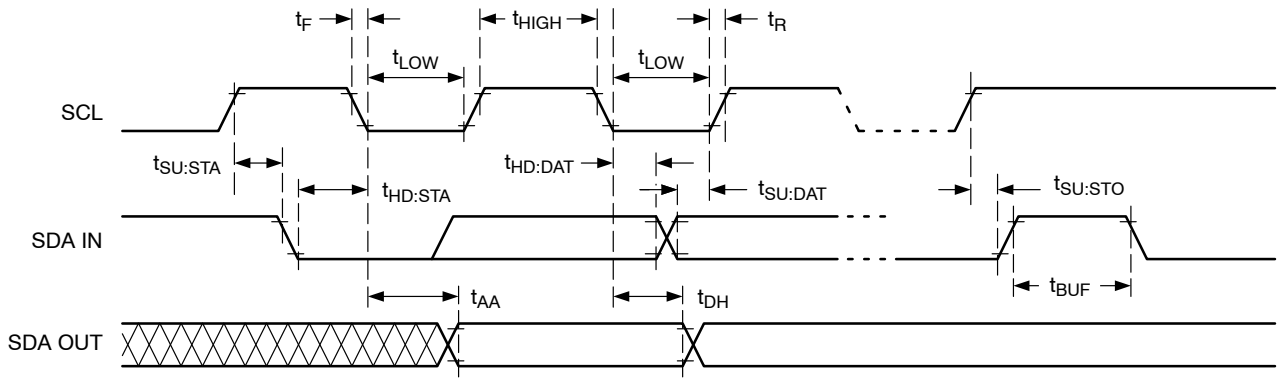


Figure 6. Bus Timing

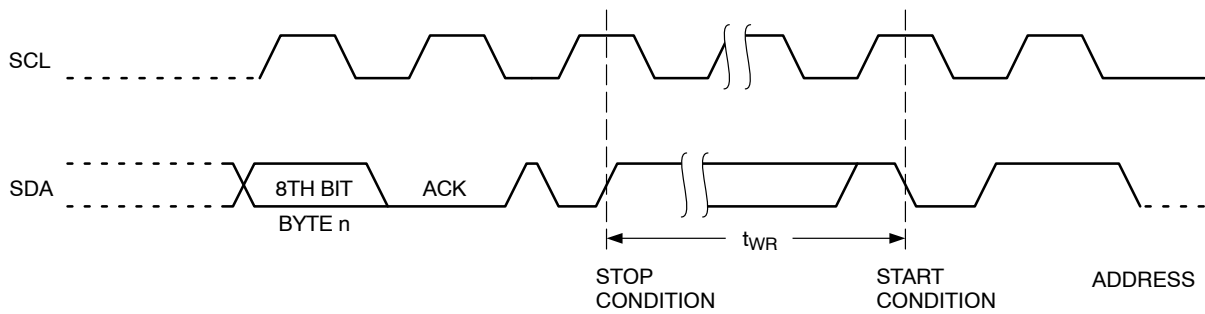


Figure 7. Write Cycle Timing

**Serial Bus Protocol**

The following defines the features of the I<sup>2</sup>C bus protocol:

1. Data transfer may be initiated only when the bus is not busy.
2. During a data transfer, the data line must remain stable whenever the clock line is high. Any changes in the data line while the clock is high will be interpreted as a START or STOP condition.

The device controlling the transfer is a master, typically a processor or controller, and the device being controlled is the slave. The master will always initiate data transfers and provide the clock for both transmit and receive operations. Therefore, the CAT5132 will be considered a slave device in all applications.

**START Condition**

The START Condition precedes all commands to the device, and is defined as a HIGH to LOW transition of SDA when SCL is HIGH. The CAT5132 monitors the SDA and SCL lines and will not respond until this condition is met (see Figure 8).

**STOP Condition**

A LOW to HIGH transition of SDA when SCL is HIGH determines the STOP condition. All operations must end with a STOP condition (see Figure 8).

**Acknowledge**

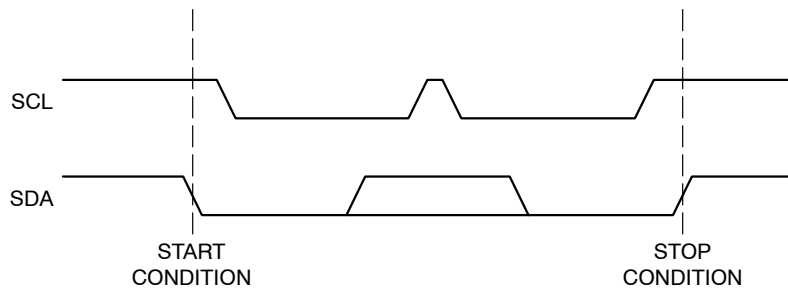
After a successful data transfer, each receiving device is required to generate an acknowledge. The acknowledging device pulls down the SDA line during the ninth clock cycle, signaling that it received the 8 bits of data (see Figure 9).

The CAT5132 responds with an acknowledge after receiving a START condition and its slave address. If the device has been selected along with a write operation, it responds with an acknowledge after receiving each 8-bit byte.

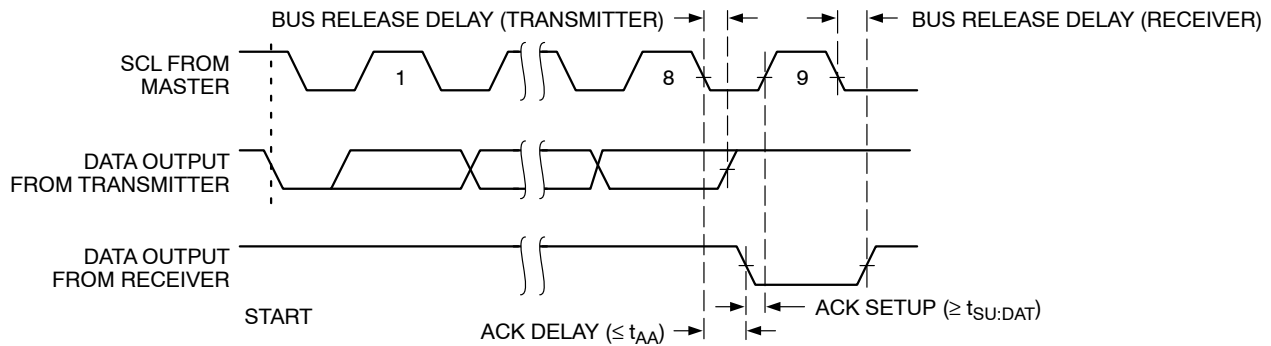
When the CAT5132 is in a READ mode it transmits 8 bits of data, releases the SDA line, and monitors the line for an acknowledge. Once it receives this acknowledge, the CAT5132 will continue to transmit data. If no acknowledge is sent by the Master, the device terminates data transmission and waits for a STOP condition.

**Acknowledge Polling**

The disabling of the inputs can be used to take advantage of the typical write cycle time. Once the STOP condition is issued to indicate the end of the write operation, the CAT5132 initiates the internal write cycle. ACK polling can be initiated immediately. This involves issuing the START condition followed by the slave address. If the CAT5132 is still busy with the write operation, no ACK will be returned. If the CAT5132 has completed the write operation, an ACK will be returned and the host can then proceed with the next instruction operation.



**Figure 8. Start/Stop Condition**



**Figure 9. Acknowledge Condition**



**Device Description**

**Access Control Register**

The volatile register WCR and the non-volatile register DR are accessed only by addressing the volatile Access Register AR first, using the 3 byte I<sup>2</sup>C protocol for all read and write operations (see Table 12). The first byte is the slave address/instruction byte (see details below). The second byte contains the address (02h) of the AR register. The data in the third byte controls which register WCR (80h) or DR (00h) is being addressed (see Figure 10).

**Slave Address Instruction Byte Description**

The first byte sent to the CAT5132 from the master processor is called the Slave/DPP Address Byte. The most significant five bits of the slave address are a device type identifier. For the CAT5132 these bits are fixed at 01010 (refer to Table 13).

The next two bits, A1 and A0, are the internal slave address and must match the physical device address which is defined by the state of the A1 and A0 input pins. Only the device with slave address matching the input byte will be accessed by the master. This allows up to 4 devices to reside on the same bus. The A1 and A0 inputs can be actively driven by CMOS input signals or tied to V<sub>CC</sub> or Ground.

The last bit is the READ/WRITE bit and determines the function to be performed. If it is a “1” a read command is initiated and if it is a “0” a write is initiated. For the AR register only write is allowed.

After the Master sends a START condition and the slave address byte, the CAT5132 monitors the bus and responds with an acknowledge when its address matches the transmitted slave address.

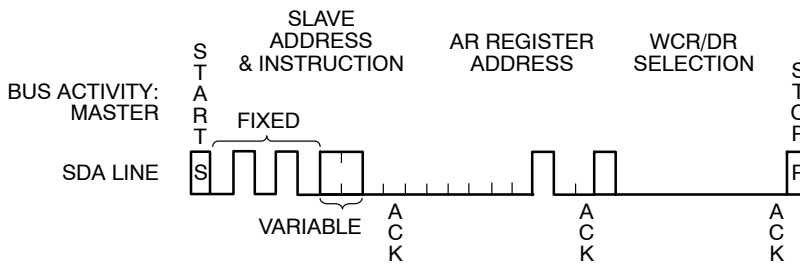
**Table 12. ACCESS CONTROL REGISTER**

| START | 1st byte |     |     |     |     |    |    |    | ACK | 2nd byte         |   |   |   |   |   | ACK | 3rd byte                     |   |   |   |   |   |   |   | ACK | STOP |   |   |    |    |
|-------|----------|-----|-----|-----|-----|----|----|----|-----|------------------|---|---|---|---|---|-----|------------------------------|---|---|---|---|---|---|---|-----|------|---|---|----|----|
|       | ID4      | ID3 | ID2 | ID1 | ID0 | A1 | A0 | Wb |     | AR address – 02h |   |   |   |   |   |     | WCR(80h) / DR(00h) selection |   |   |   |   |   |   |   |     |      |   |   |    |    |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | A   | 0                | 0 | 0 | 0 | 0 | 0 | 1   | 0                            | A | 1 | 0 | 0 | 0 | 0 | 0 | 0   | 0    | 0 | 0 | A  | SP |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | A   | 0                | 0 | 0 | 0 | 0 | 0 | 1   | 0                            | A | 0 | 0 | 0 | 0 | 0 | 0 | 0   | 0    | 0 | A | SP |    |

**Table 13. BYTE 1 SLAVE ADDRESS AND INSTRUCTION BYTE**

| Device Type Identifier |     |     |     |     | Slave Address |    | Read/Write |
|------------------------|-----|-----|-----|-----|---------------|----|------------|
| ID4                    | ID3 | ID2 | ID1 | ID0 | A1            | A0 | R/W        |
| 0                      | 1   | 0   | 1   | 0   | X             | X  | X          |

(MSB) (LSB)



**Figure 10. Access Register Addressing Using 3 Bytes**

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## Wiper Control Register (WCR) Description

The CAT5132 contains a 7-bit Wiper Control Register which is decoded to select one of the 128 switches along its resistor array. The WCR is a volatile register and is written with the contents of the nonvolatile Data Register (DR) on power-up. The Wiper Control Register loses its contents when the CAT5132 is powered-down. The contents of the WCR may be read or changed directly by the host using a READ/WRITE command after addressing the WCR (see Table 12 to access WCR). Since the CAT5132 will only

make use of the 7 LSB bits (The first data bit, or MSB, is ignored) on write instructions and will always come back as a “0” on read commands.

A write operation (see Table 14) requires a Start condition, followed by a valid slave address byte, a valid address byte 00h, a data byte and a STOP condition. After each of the three bytes the CAT5132 responds with an acknowledge. At this time the data is written only to volatile registers, then the device enters its standby state.

**Table 14. WCR WRITE OPERATION**

| START | 1st byte |     |     |     |     |    |    |    |                  | ACK | 2nd byte |   |   |   |   |                    |   | ACK | 3rd byte |   |   |   |   |   |   | ACK | STOP |   |   |    |
|-------|----------|-----|-----|-----|-----|----|----|----|------------------|-----|----------|---|---|---|---|--------------------|---|-----|----------|---|---|---|---|---|---|-----|------|---|---|----|
|       | ID4      | ID3 | ID2 | ID1 | ID0 | A1 | A0 | Wb | AR address – 02h |     |          |   |   |   |   | WCR(80h) selection |   |     |          |   |   |   |   |   |   |     |      |   |   |    |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | 0                | A   | 0        | 0 | 0 | 0 | 0 | 0                  | 1 | 0   | A        | 1 | 0 | 0 | 0 | 0 | 0 | 0   | 0    | 0 | A | SP |

| START | slave address byte |   |   |   |   |   |   |   |   | ACK | WCR address – 00h |   |   |   |   |   |   | ACK | data byte |   |   |   |   |   |   | ACK | STOP |   |   |    |
|-------|--------------------|---|---|---|---|---|---|---|---|-----|-------------------|---|---|---|---|---|---|-----|-----------|---|---|---|---|---|---|-----|------|---|---|----|
| ST    | 0                  | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | A   | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0   | A         | x | x | x | x | x | x | x   | x    | x | A | SP |

An increment operation (see Table 15) requires a Start condition, followed by a valid increment address byte (01011), a valid address byte 00h. After each of the two bytes, the CAT5132 responds with an acknowledge. At this time if the data is high then the wiper is incremented or if the

data is low the wiper is decremented at each clock. Once the stop is issued then the device enters its standby state with the WCR data as being the last inc/dec position. Also, the wiper position does not roll over but is limited to min and max positions.

**Table 15. WCR INCREMENT/DECREMENT OPERATION**

| START | 1st byte |     |     |     |     |    |    |    |                  | ACK | 2nd byte |   |   |   |   |                    |   | ACK | 3rd byte |   |   |   |   |   |   | ACK | STOP |   |   |    |
|-------|----------|-----|-----|-----|-----|----|----|----|------------------|-----|----------|---|---|---|---|--------------------|---|-----|----------|---|---|---|---|---|---|-----|------|---|---|----|
|       | ID4      | ID3 | ID2 | ID1 | ID0 | A1 | A0 | Wb | AR address – 02h |     |          |   |   |   |   | WCR(80h) selection |   |     |          |   |   |   |   |   |   |     |      |   |   |    |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | 0                | A   | 0        | 0 | 0 | 0 | 0 | 0                  | 1 | 0   | A        | 1 | 0 | 0 | 0 | 0 | 0 | 0   | 0    | 0 | A | SP |

| START | slave address byte |   |   |   |   |   |   |   |   | ACK | WCR address – 00h |   |   |   |   |   |   | ACK | increment (1) / decrement (0) bits |   |   |   |   |   |   | ACK | STOP |  |    |
|-------|--------------------|---|---|---|---|---|---|---|---|-----|-------------------|---|---|---|---|---|---|-----|------------------------------------|---|---|---|---|---|---|-----|------|--|----|
| ST    | 0                  | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | A   | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0   | A                                  | 1 | 1 | 1 | 1 | 0 | 0 | 0   | 0    |  | SP |

A read operation (see Table 16) requires a Start condition, followed by a valid slave address byte for write, a valid address byte 00h, a second START and a second slave address byte for read. After each of the three bytes, the

CAT5132 responds with an acknowledge and then the device transmits the data byte. The master terminates the read operation by issuing a STOP condition following the last bit of Data byte.

**Table 16. WCR READ OPERATION**

| START | 1st byte |     |     |     |     |    |    |    |                  | ACK | 2nd byte |   |   |   |   |                    |   | ACK | 3rd byte |   |   |   |   |   |   | ACK | STOP |   |   |    |
|-------|----------|-----|-----|-----|-----|----|----|----|------------------|-----|----------|---|---|---|---|--------------------|---|-----|----------|---|---|---|---|---|---|-----|------|---|---|----|
|       | ID4      | ID3 | ID2 | ID1 | ID0 | A1 | A0 | Wb | AR address – 02h |     |          |   |   |   |   | WCR(80h) selection |   |     |          |   |   |   |   |   |   |     |      |   |   |    |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | 0                | A   | 0        | 0 | 0 | 0 | 0 | 0                  | 1 | 0   | A        | 1 | 0 | 0 | 0 | 0 | 0 | 0   | 0    | 0 | A | SP |

| START | slave address byte |   |   |   |   |   |   |   |   | ACK | WCR address – 00h |   |   |   |   |   |   |   |      |  |  |  |  |  | STOP |  |  |  |  |    |
|-------|--------------------|---|---|---|---|---|---|---|---|-----|-------------------|---|---|---|---|---|---|---|------|--|--|--|--|--|------|--|--|--|--|----|
| ST    | 0                  | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | A   | 0                 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |      |  |  |  |  |  |      |  |  |  |  |    |
| START | slave address byte |   |   |   |   |   |   |   |   |     | data byte         |   |   |   |   |   |   |   | STOP |  |  |  |  |  |      |  |  |  |  |    |
| ST    | 0                  | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | A   | 0                 | X | X | X | X | X | X | X |      |  |  |  |  |  |      |  |  |  |  | SP |

## CAT5132

### Data Register (DR)

The Data Register (DR) is a nonvolatile register and its contents are automatically written to the Wiper Control Register (WCR) on power-up. It can be read at any time without effecting the value of the WCR. The DR, like the WCR, only stores the 7 LSB bits and will report the MSB bit as a “0”. Writing to the DR is performed in the same fashion as the WCR except that a time delay of up to 5 ms is experienced while the nonvolatile store operation is being performed. During the internal non-volatile write cycle, the device ignores transitions at the SDA and SCL pins, and the SDA output is at a high impedance state. The WCR is also

written during a write to DR. After a DR WRITE is complete the DR and WCR will contain the same wiper position.

To write or read to the DR, first the access to DR is selected, see table 1 then the data is written or read using the following sequences.

A write operation (see Table 17) requires a Start condition, followed by a valid slave address byte, a valid address byte 00h, a data byte and a STOP condition. After each of the three bytes the CAT5132 responds with an acknowledge. At this time the data is written both to volatile and non-volatile registers, then the device enters its standby state.

**Table 17. DR WRITE OPERATION**

| START | 1st byte |     |     |     |     |    |    |    | ACK | 2nd byte         |   |   |   |   |   | ACK | 3rd byte          |   |   |   |   |   | ACK | STOP |   |   |   |    |
|-------|----------|-----|-----|-----|-----|----|----|----|-----|------------------|---|---|---|---|---|-----|-------------------|---|---|---|---|---|-----|------|---|---|---|----|
|       | ID4      | ID3 | ID2 | ID1 | ID0 | A1 | A0 | Wb |     | AR address – 02h |   |   |   |   |   |     | DR(00h) selection |   |   |   |   |   |     |      |   |   |   |    |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | A   | 0                | 0 | 0 | 0 | 0 | 0 | 1   | 0                 | A | 0 | 0 | 0 | 0 | 0   | 0    | 0 | 0 | A | SP |

| START | slave address byte |   |   |   |   |   |   |   | ACK | DR address – 00h |   |   |   |   |   | ACK | data byte |   |   |   |   |   | ACK | STOP |   |   |   |   |    |
|-------|--------------------|---|---|---|---|---|---|---|-----|------------------|---|---|---|---|---|-----|-----------|---|---|---|---|---|-----|------|---|---|---|---|----|
| ST    | 0                  | 1 | 0 | 1 | 0 | 0 | 0 | 0 | A   | 0                | 0 | 0 | 0 | 0 | 0 | 0   | 0         | A | X | X | X | X | X   | X    | X | X | X | A | SP |

A read operation (see Table 18) requires a Start condition, followed by a valid slave address byte, a valid address byte 00h, a second Start and a second slave address byte for read. After each of the three bytes the CAT5132 responds with an

acknowledge and then the device transmits the data byte. The master terminates the read operation by issuing a STOP condition following the last bit of Data byte.

**Table 18. DR READ OPERATION**

| START | 1st byte |     |     |     |     |    |    |    | ACK | 2nd byte         |   |   |   |   |   | ACK | 3rd byte          |   |   |   |   |   | ACK | STOP |   |   |   |    |
|-------|----------|-----|-----|-----|-----|----|----|----|-----|------------------|---|---|---|---|---|-----|-------------------|---|---|---|---|---|-----|------|---|---|---|----|
|       | ID4      | ID3 | ID2 | ID1 | ID0 | A1 | A0 | Wb |     | AR address – 02h |   |   |   |   |   |     | DR(00h) selection |   |   |   |   |   |     |      |   |   |   |    |
| ST    | 0        | 1   | 0   | 1   | 0   | 0  | 0  | 0  | A   | 0                | 0 | 0 | 0 | 0 | 0 | 1   | 0                 | A | 0 | 0 | 0 | 0 | 0   | 0    | 0 | 0 | A | SP |

| START | slave address byte |   |   |   |   |   |   |   | ACK | DR address – 00h |   |   |   |   |   | ACK | data byte |  |  |  |  |  | ACK | STOP |  |  |  |    |  |      |
|-------|--------------------|---|---|---|---|---|---|---|-----|------------------|---|---|---|---|---|-----|-----------|--|--|--|--|--|-----|------|--|--|--|----|--|------|
| ST    | 0                  | 1 | 0 | 1 | 0 | 0 | 0 | 0 | A   | 0                | 0 | 0 | 0 | 0 | 0 | 0   | 0         |  |  |  |  |  |     |      |  |  |  |    |  |      |
| START | slave address byte |   |   |   |   |   |   |   |     | data byte        |   |   |   |   |   |     |           |  |  |  |  |  |     |      |  |  |  |    |  | STOP |
| ST    | 0                  | 1 | 0 | 1 | 0 | 0 | 0 | 1 | A   | 0                | X | X | X | X | X | X   | X         |  |  |  |  |  |     |      |  |  |  | SP |  |      |

**Potentiometer Operation**

**Power-On**

The CAT5132 is a 128-position, digital controlled potentiometer. When applying power to the CAT5132,  $V_{CC}$  must be supplied prior to or simultaneously with  $V+$ . At the same time, the signals on  $R_H$ ,  $R_W$  and  $R_L$  terminals should not exceed  $V+$ . If  $V+$  is applied before  $V_{CC}$ , the electronic switches of the DPP are powered in the absence of the switch control signals, that could result in multiple switches being turned on. This causes unexpected wiper settings and possible current overload of the potentiometer. When  $V_{CC}$  is applied the device turns on at the mid-point wiper location (64) until the wiper register can be loaded with the nonvolatile memory location previously stored in the device. After the nonvolatile memory data is loaded into the wiper register the wiper location will change to the previously stored wiper position.

At power-down, it is recommended to turn-off first the signals on  $R_H$ ,  $R_W$  and  $R_L$ , followed by  $V+$  and, after that,  $V_{CC}$ , in order to avoid unexpected transmissions of the wiper and uncontrolled current overload of the potentiometer.

The end-to-end nominal resistance of the potentiometer has 128 contact points linearly distributed across the total resistor. Each of these contact points is addressed by the 7 bit wiper register which is decoded to select one of these 128 contact points.

Each contact point generates a linear resistive value between the 0 position and the 127 position. These values can be determined by dividing the end-to-end value of the

potentiometer by 127. In the case of the 10 k $\Omega$  potentiometer  $\sim 79 \Omega$  is the resistance between each wiper position. However in addition to the  $\sim 79 \Omega$  for each resistive segment of the potentiometer, a wiper resistance offset must be considered. Table 19 shows the effect of this value and how it would appear on the wiper terminal.

This offset will appear in each of the CAT5132 end-to-end resistance values in the same way as the 10 k $\Omega$  example. However resistance between each wiper position for the 50 k $\Omega$  version will be  $\sim 395 \Omega$  and for the 100 k $\Omega$  version will be  $\sim 790 \Omega$ .

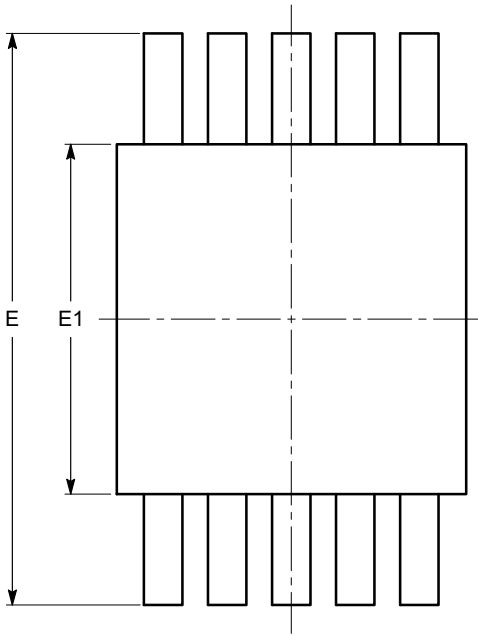
**Table 19. POTENTIOMETER RESISTANCE AND WIPER RESISTANCE OFFSET EFFECTS**

| Position | Typical $R_W$ to $R_L$ Resistance for 10 k $\Omega$ DPP |                               |
|----------|---|-------------------------------|
| 00       | 70 $\Omega$ or  | 0 $\Omega$ + 70 $\Omega$      |
| 01       | 149 $\Omega$ or   | 79 $\Omega$ + 70 $\Omega$     |
| 63       | 5,047 $\Omega$ or                                       | 4,977 $\Omega$ + 70 $\Omega$  |
| 127      | 10,070 $\Omega$ or                                      | 10,000 $\Omega$ + 70 $\Omega$ |
|          |   |                               |
| Position | Typical $R_W$ to $R_H$ Resistance for 10 k $\Omega$ DPP |                               |
| 00       | 10,070 $\Omega$ or                                      | 10,000 $\Omega$ + 70 $\Omega$ |
| 64       | 5,047 $\Omega$ or                                       | 4,977 $\Omega$ + 70 $\Omega$  |
| 126      | 149 $\Omega$ or   | 79 $\Omega$ + 70 $\Omega$     |
| 127      | 70 $\Omega$ or  | 0 $\Omega$ + 70 $\Omega$      |

# CAT5132

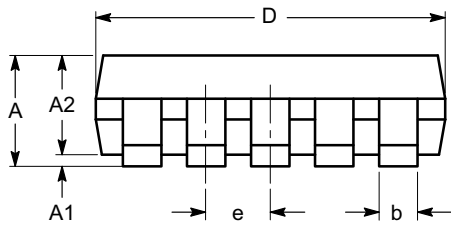
## PACKAGE DIMENSIONS

MSOP 10, 3x3  
CASE 846AE-01  
ISSUE O

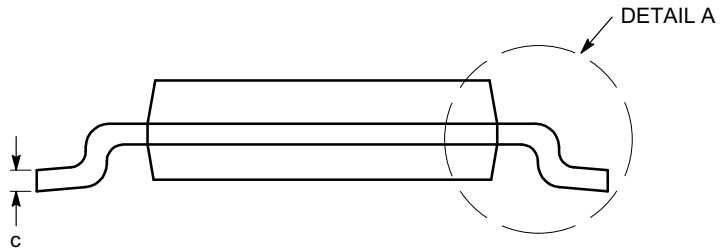


TOP VIEW

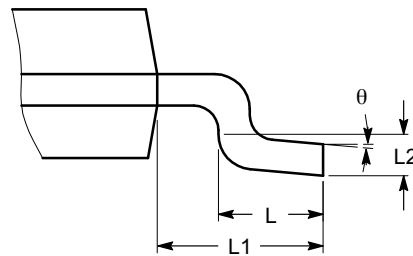
| SYMBOL   | MIN      | NOM  | MAX  |
|----------|----------|------|------|
| A        |          |      | 1.10 |
| A1       | 0.00     | 0.05 | 0.15 |
| A2       | 0.75     | 0.85 | 0.95 |
| b        | 0.17     |      | 0.27 |
| c        | 0.13     |      | 0.23 |
| D        | 2.90     | 3.00 | 3.10 |
| E        | 4.75     | 4.90 | 5.05 |
| E1       | 2.90     | 3.00 | 3.10 |
| e        | 0.50 BSC |      |      |
| L        | 0.40     | 0.60 | 0.80 |
| L1       | 0.95 REF |      |      |
| L2       | 0.25 BSC |      |      |
| $\theta$ | 0°       |      | 8°   |



SIDE VIEW



END VIEW



DETAIL A

**Notes:**

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

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