# *Low-Voltage SPDT Analog Switch*

## UM3156 *SC70-6/SC88/SOT363*

### General Description

The UM3156 is an advanced CMOS analog switch fabricated with silicon gate CMOS technology. It achieves very low propagation delay and $R_{DS(ON)}$ resistances while maintaining CMOS low power dissipation. These make it ideal for portable and battery power applications.
The switch conducts signals within power rails equally well in both directions when on, and blocks up to the power supply level when off. Break-before-make is guaranteed.
The select pin has over-voltage protection that allows voltages above $V_{CC}$, up to 6.5V to be present on the pin without damage or disruption of operation of the part, regardless of the operating voltage.
The UM3156 can maintain low power consumption for rail-to-rail signaling as long as the control signal input is held at a level that is greater than $V_{IH}$ minimum and less than $V_{IL}$ maximum by improving the control circuitry input buffer. so the part can be used in mixed voltage rail environments, especially services the mobile handset applications very well allowing for the direct interface with baseband processor general purpose I/Os, and it is no longer necessary to have the control input equal to $V_{CC}$ to maintain low power consumption

### Applications

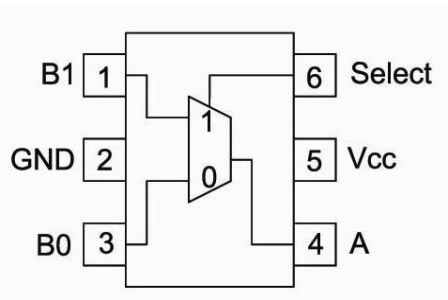
- Sample-and-Hold Circuits
- Battery-Powered Equipment
- Audio and Video Signal Routing
- Communication Circuits

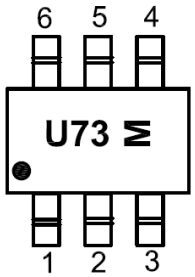
### Features

- Control Inputs Are 5V Tolerant
- Low Charge Injection
- Excellent ON-State Resistance Matching
- Low Total Harmonic Distortion (THD)
- 1.65V to 5.5V Single-Supply Operation
- ESD Performance:
  Human Body Model＞2kV
  Machine Model＞200V
- SC70-6/SC88/SOT363 Package
- Pb-Free Package

### Pin Configurations

### Top View




**M: Month Code**
**UM3156**
**SC70-6/SC88/SOT363**

## Ordering Information

| Part Number | Packaging Type | Marking Code | Shipping Qty |
|---|---|---|---|
| UM3156 | SC70-6/SC88/SOT363 | U73 | 3000pcs/7 Inch Tape & Reel |

## Function Table

| Select Input | Function |
|---|---|
| L | B0 Connected to A |
| H | B1 Connected to A |

## Absolute Maximum Ratings

| Symbol | Parameter | Limit | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | - 0.5 to + 6.5 | V |
| $V_S$ | DC Switch Voltage (Note 1) | - 0.5 to ($V_{CC}$ + 0.5) | |
| $V_{IN}$ | DC IN Voltage (Note 1) | - 0.5 to + 6.5 | |
| $I_{IK}$ | DC Input Diode Current@ $V_{IN}$＜0V | -50 | mA |
| $I_{OUT}$ | DC Output Current | 128 | |
| $I_{CC}$/ $I_{GND}$ | DC $V_{CC}$ or Ground Current | +100 | |
| $T_J$ | Junction Temperature Under Bias | +150 | ℃ |
| $T_{STG}$ | Storage Temperature | - 65 to +150 | |
| $T_L$ | Junction Lead Temperature (Soldering, 10seconds) | 260 | |
| $\theta_{JA}$ | Thermal Resistance | 350 | ℃/W |
| $P_D$ | Power Dissipation @ +85℃ | 180 | mW |

Note 1: The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

## Recommended Ratings (Note2)

| Symbol | Parameter | Limit | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage Operating | 1.65 to 5.5 | V |
| $V_{IN}$ | Switch Input Voltage | 0 to $V_{CC}$ | |
| $V_{IN}$ | Select Input Voltage | 0 to $V_{CC}$ | |
| $V_{OUT}$ | Output Voltage | 0 to $V_{CC}$ | |
| $T_A$ | Operating Temperature | -55 to +125 | ℃ |
| $t_r$, $t_f$ | Input Rise and Fall Time<br>Control Input Vcc=2.3V to 3.6V<br>Control Input Vcc=4.5V to 5.5V | <br>0 to 10<br>0 to 5.0 | ns/V |

Note 2: Select input must be held HIGH or LOW, it must not float.

## Electrical Characteristics

| Symbol | Parameter | Test Conditions | Vcc(V) | Temp | Limits (–40 to 85 ℃) | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | |
| **DC Electrical Characteristics** | | | | | | | | |
| | Analog Signal Range | | Vcc | Full | 0 | | $V_{cc}$ | V |
| $I_{IN}$ | Input Leakage Current | $0 \le V_{IN} \le 5.5V$ | 0 to 5.5 | Room<br>Full | | ±0.05 | ±0.1<br>±1 | μA |
| $I_{OFF}$ | OFF State Leakage Current | 0≤A, B≤Vcc | 1.65 to 5.5 | Room<br>Full | | ±0.05 | ±0.1<br>±1 | μA |
| $V_{IH}$ | Input High Voltage | | 1.65 to 2.3 | Full | 1.1 | | | V |
| | | | 2.3 to 2.7 | | 1.4 | | | |
| | | | 2.7 to 3.6 | | 1.8 | | | |
| | | | 3.6 to 4.3 | | 2.1 | | | |
| | | | 4.3 to 5.5 | | 2.6 | | | |
| $V_{IL}$ | Input Low Voltage | | 1.65 to 2.3 | Full | | | 0.4 | V |
| | | | 2.3 to 2.7 | | | | 0.7 | |
| | | | 2.7 to 3.6 | | | | 1.0 | |
| | | | 3.6 to 4.3 | | | | 1.3 | |
| | | | 4.3 to 5.5 | | | | 1.5 | |
| $I_{CC}$ | Quiescent Supply Current | $V_{IN}$ =Vcc or GND<br>$I_O$=0 | 5.5 | Room<br>Full | | | 1.0<br>10 | μA |
| $R_{ON}$ | On-Resistance (Note3) | $V_{IN}$ = 0V, $I_O$=30mA<br>$V_{IN}$ = 2.4V, $I_O$=-30mA<br>$V_{IN}$ = 4.5V, $I_O$=-30mA | 4.5 | Full | | 3.0<br>4.0<br>4.5 | 7.0<br>12<br>15 | Ω |
| | | $V_{IN}$ = 0V, $I_O$=24mA<br>$V_{IN}$ = 3V, $I_O$=-24mA | 3.0 | Full | | 4.0<br>6.0 | 9.0<br>20 | |
| | | $V_{IN}$ = 0V, $I_O$=8mA<br>$V_{IN}$ = 2.3V, $I_O$=-8mA | 2.3 | Full | | 5.0<br>8.0 | 12<br>30 | |
| | | $V_{IN}$ = 0V, $I_O$=4mA<br>$V_{IN}$ = 1.65V, $I_O$=-4mA | 1.65 | Full | | 6.5<br>15 | 20<br>50 | |
| $R_{RANGE}$ | On Resistance Over Signal Range (Note3,7) | $I_A$=-30mA<br>$0 \le V_{Bn} \le Vcc$ | 4.5 | Full | | | 25 | Ω |
| | | $I_A$=-24mA<br>$0 \le V_{Bn} \le Vcc$ | 3.0 | Full | | | 50 | |
| | | $I_A$=-8mA, $0 \le V_{Bn} \le Vcc$ | 2.3 | Full | | | 100 | |
| | | $I_A$=-4mA, $0 \le V_{Bn} \le Vcc$ | 1.65 | Full | | | 300 | |
| $\Delta R_{ON}$ | On Resistance Match Between Channels (Note3,4,5) | $I_A$=-30mA, $V_{Bn}$ = 3.15V | 4.5 | Room | | 0.15 | | Ω |
| | | $I_A$=-24mA, $V_{Bn}$ = 2.1V | 3.0 | Room | | 0.2 | | |
| | | $I_A$=-8mA, $V_{Bn}$ = 1.6V | 2.3 | Room | | 0.5 | | |
| | | $I_A$=-4mA, $V_{Bn}$ = 1.15V | 1.65 | Room | | 0.5 | | |
| $R_{FLAT}$ | On Resistance Flatness (Note3,4,6) | $I_A$=-30mA<br>$0 \le V_{Bn} \le Vcc$ | 5.0 | Room | | 6.0 | | Ω |
| | | $I_A$=-24mA<br>$0 \le V_{Bn} \le Vcc$ | 3.3 | Room | | 12 | | |
| | | $I_A$=-8mA, $0 \le V_{Bn} \le Vcc$ | 2.5 | Room | | 28 | | |
| | | $I_A$=-4mA, $0 \le V_{Bn} \le Vcc$ | 1.8 | Room | | 125 | | |

## Electrical Characteristics (Continued)

| Symbol | Parameter | Test Conditions | Vcc(V) | Temp | Limits (–40 to 85 ℃) | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | Min | Typ | Max | |
| **AC Electrical Characteristics** | | | | | | | | |
| $t_{PHL}$<br>$t_{PLH}$ | Propagation Delay<br>Bus to Bus (Note 9) | $V_I$ = OPEN | 1.65 to1.95<br>2.3 to 2.7<br>3.0 to 3.6<br>4.5 to 5.5 | Full | | | 1.5<br>1.0<br>0.8 | ns |
| $t_{PZL}$<br>$t_{PZH}$ | Output Enable Time<br>Turn On Time<br>(A to Bn) | $V_I = 2 \times V_{CC}$ for $t_{PZL}$<br>$V_I$ = 0 V for $t_{PZH}$ | 1.65 to1.95<br>2.3 to 2.7<br>3.0 to 3.6<br>4.5 to 5.5 | Full | 7.0<br>3.5<br>2.5<br>1.5 | | 26<br>15<br>8.6<br>6.2 | ns |
| $t_{PLZ}$<br>$t_{PHZ}$ | Output Disable Time<br>Turn Off Time<br>(A Port to B Port) | $V_I = 2 \times V_{CC}$ for $t_{PLZ}$<br>$V_I$ = 0 V for $t_{PHZ}$ | 1.65 to1.95<br>2.3 to 2.7<br>3.0 to 3.6<br>4.5 to 5.5 | Full | 3.0<br>2.0<br>1.7<br>0.8 | | 13<br>7.5<br>5.3<br>3.8 | ns |
| $t_D$ | Break Before Make Time<br>(Note 8) | | 1.65 to1.95<br>2.3 to 2.7<br>3.0 to 3.6<br>4.5 to 5.5 | Full | 0.5<br>0.5<br>0.5<br>0.5 | | | ns |
| $Q_{INJ}$ | Charge Injection<br>(Note 8) | $C_L$ = 0.1 nF,<br>$V_{GEN}$ = 0 V $R_{GEN}$ = 0Ω | 5.0<br>3.3 | Room | | 9.0<br>4.0 | | pC |
| $O_{IRR}$ | Off Isolation (Note 10) | $R_L$=50Ω, f = 10 MHz | 1.65 to 5.5 | Room | | -60 | | dB |
| Xtalk | Crosstalk | $R_L$=50Ω, f = 10 MHz | 1.65 to 5.5 | Room | | -54 | | dB |
| BW | -3 dB Bandwidth | $R_L$=50Ω | 1.65 to 5.5 | Room | | 230 | | MHz |
| THD | Total Harmonic Distortion<br>(Note8) | $R_L$=600Ω<br>$0.5V_{P-P}$<br>f=600Hz to 20kHz | 5.0 | Room | | 0.011 | | % |
| **Capacitance** | | | | | | | | |
| $C_{IN}$ | IN Pin Input Capacitance<br>(Note11) | $V_{CC}$ = 0V | | | | 2.5 | | pF |
| $C_{IO-B}$ | B Port Off Capacitance<br>(Note11) | $V_{CC}$ =5.0V | | | | 7.5 | | pF |
| $C_{IOA-ON}$ | A Port Capacitance when<br>Switch is Enabled (Note11) | $V_{CC}$ =5.0V | | | | 20.1 | | pF |

Note 3: Measured by the voltage drop between A and B pins at the indicated current through the switch. On Resistance is determined by the lower of the voltages on the two (A or B Ports).

Note 4: Parameter is characterized but not tested in production.

Note 5: $\Delta R_{ON} = \left| R_{ON\,(B0)} - R_{ON(B1)} \right|$ measured at identical $V_{CC}$, temperature and voltage levels.

Note 6: Flatness is defined as the difference between the maximum and minimum value of On Resistance over the specified range of conditions.

Note 7: Guaranteed by design.

Note 8: Guaranteed by design.

Note 9: This parameter is guaranteed by design but not tested. The bus switch contributes no propagation delay other than the RC delay of the On Resistance of the switch and the 50 pF load capacitance, when driven by an ideal voltage source (zero output impedance).

Note 10: Off Isolation = 20 log10 [$V_A/V_{Bn}$].

Note 11: $T_A$ = +25, f = 1 MHz, Capacitance is characterized but not tested in production.

## Test Circuits/Timing Diagrams

NOTE: Input driven by 50 Ω source terminated in 50 Ω
NOTE: $C_L$ includes load and stray capacitance
NOTE: Input PRR = 1.0 MHz; $t_W$ = 500 ns

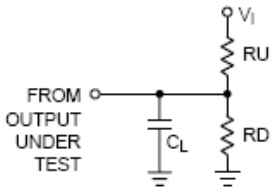



Figure 1 . AC Test Circuit

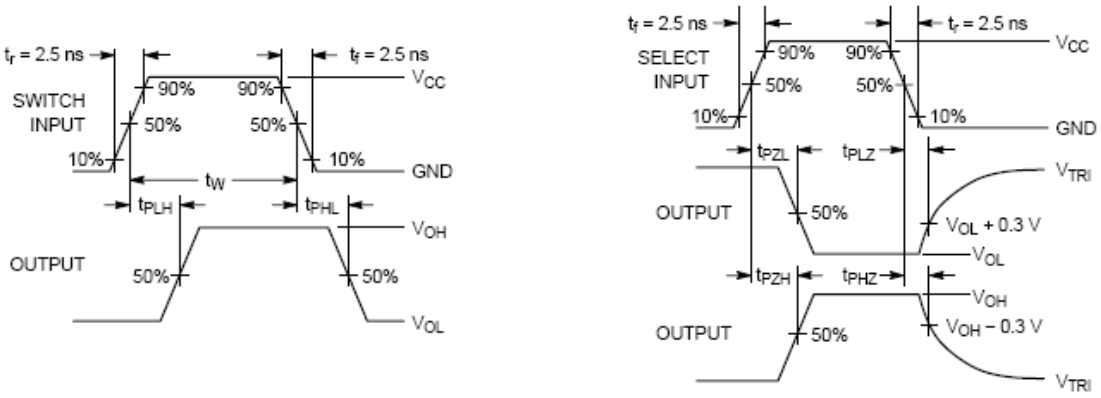
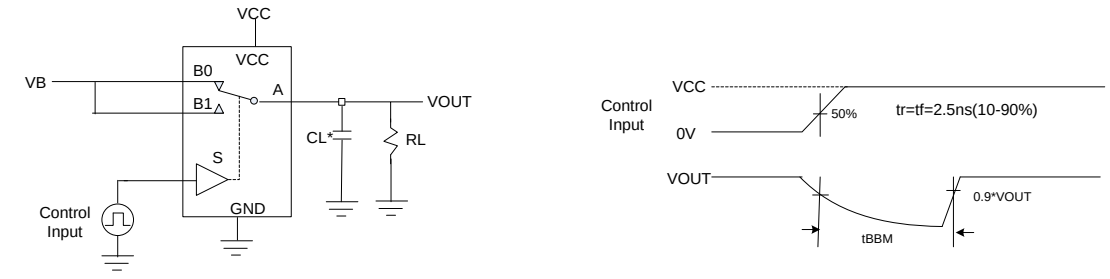



Figure 2. AC Waveforms


Figure 3. Break Before Make Interval Timing




CL* includes fixture and stray capacitance

**Figure 4. Break-Before-Make Timing**

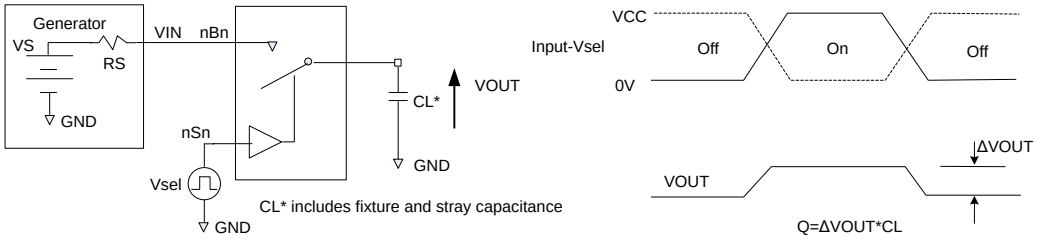



**Figure 5. Charge Injection Test**

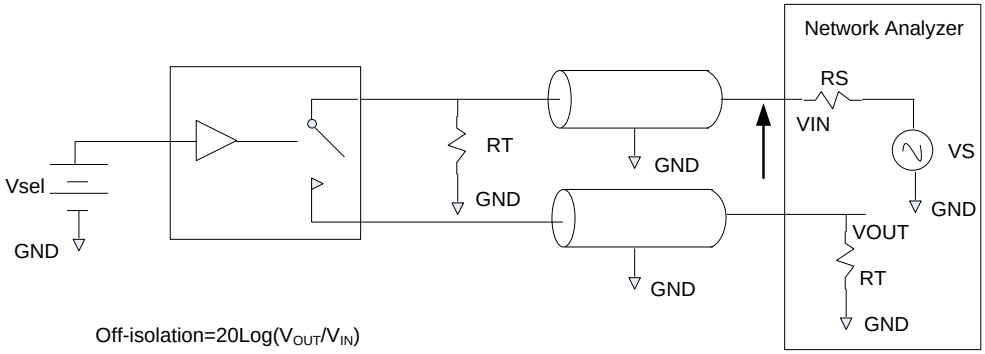



**Figure 6. Off-Isolation**

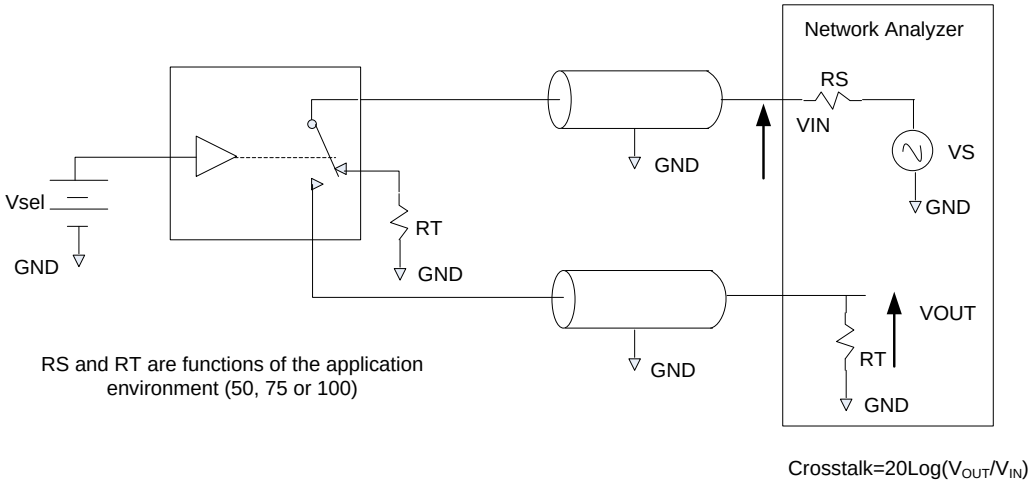



**Figure 7. Non-Adjacent Channel-to-Channel Crosstalk**

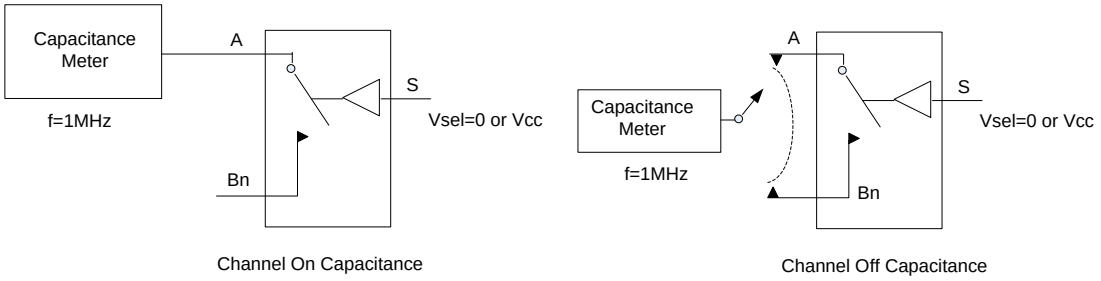



**Figure 8. On/Off Capacitance Measurement Setup**

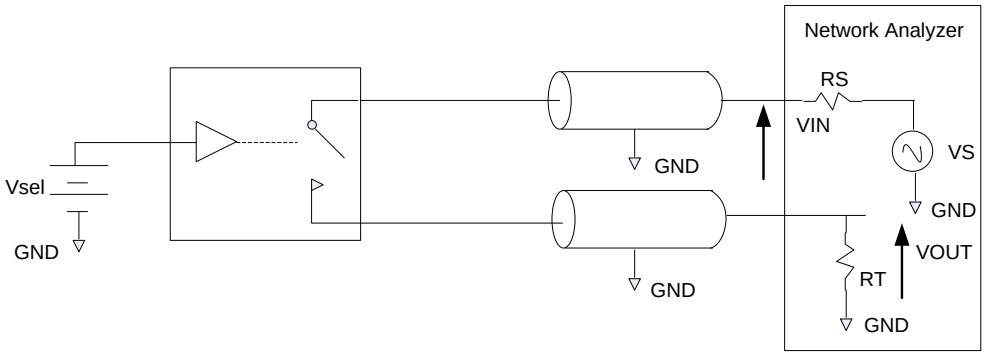
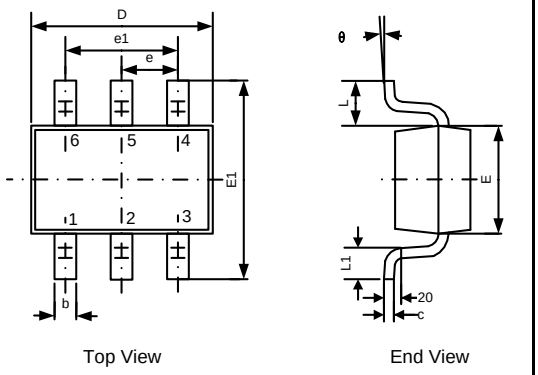



**Figure 9. Bandwidth**

## Package Information

**UM3156 SC70-6/SC88/SOT363**

### Outline Drawing



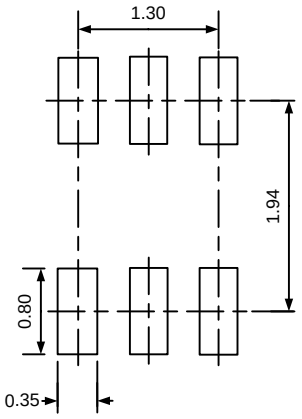

Top View

End View

Side View

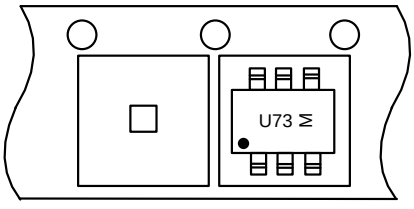
| Symbol | DIMENSIONS | | | |
|---|---|---|---|---|
| | MILLIMETERS | | INCHES | |
| | Min | Max | Min | Max |
| A | 0.900 | 1.100 | 0.035 | 0.043 |
| A1 | 0.000 | 0.100 | 0.000 | 0.004 |
| A2 | 0.900 | 1.000 | 0.035 | 0.039 |
| b | 0.150 | 0.350 | 0.006 | 0.014 |
| c | 0.080 | 0.150 | 0.003 | 0.006 |
| D | 2.000 | 2.200 | 0.079 | 0.087 |
| E | 1.150 | 1.350 | 0.045 | 0.053 |
| E1 | 2.150 | 2.450 | 0.085 | 0.096 |
| e | 0.650REF | | 0.026REF | |
| e1 | 1.200 | 1.400 | 0.047 | 0.055 |
| L | 0.525REF | | 0.021REF | |
| L1 | 0.260 | 0.460 | 0.010 | 0.018 |
| θ | 0° | 8° | 0° | 8° |

### Land Pattern




NOTES:
1. Compound dimension: 2.10×1.25;
2. Unit: mm;
3.General tolerance ±0.05mm unless otherwise specified;
4. The layout is just for reference.

### Tape and Reel Orientation



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