

# CMOS Two 4-Channel Analog Multiplexer/Demultiplexer

## FEATURES

- -3dB Bandwidth: 180MHz
- Single Supply Operation +2.5V to +5.5V
- Low ON Resistance, 48Ω(TYP) With 5V Supply
- High Off-Isolation: -83dB (RL = 50Ω, f = 1MHz)
- Break-Before-Make Switching
- Binary Address Decoding on Chip
- Operating Temperature Range: -40°C to +125°C
- PACKAGES: SOIC-16(SOP16), SSOP-16, TSSOP-16 and QFN-3×3-16L

## APPLICATIONS

- Sensors
- Analog and Digital Multiplexing and Demultiplexing
- A/D and D/A Conversion
- Signal Gating
- Battery-Operated Equipment
- Factory Automation
- Appliances
- Communications Circuits

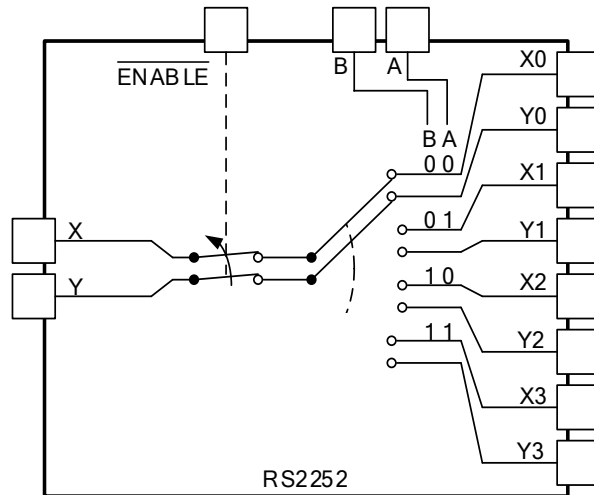
## DESCRIPTION

The RS2252 is a CMOS analog IC configured as two 4-channel multiplexers. This CMOS device can operate from 2.5 V to 5.5 V.

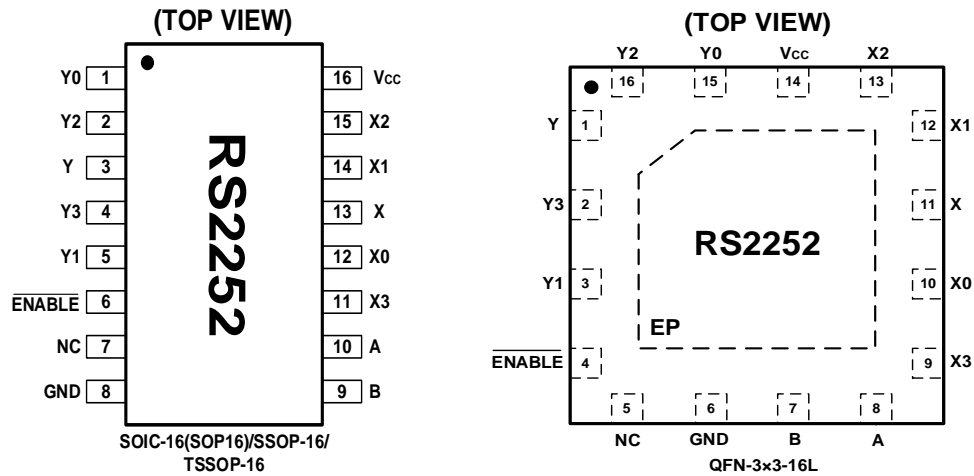
The RS2252 device are digitally-controlled analog switches. It has low on-resistance (48Ω TYP) and very low off-leakage current (1nA TYP).

The RS2252 is available in Green SOIC-16, SSOP-16, TSSOP-16 and QFN-3×3-16L packages. It operates over an ambient temperature range of -40°C to +125°C.

## Functional Diagrams of RS2252



## PIN CONFIGURATIONS



## PIN DESCRIPTION

| NAME                       | PIN<br>(SOIC-16/SSOP-16/TSSOP-16) | PIN<br>(QFN-3×3-16L) | FUNCTION  |
|----------------------------|-----------------------------------|----------------------|---|
| X0-X3                      | 12,14,15,11                       | 10,12,13,9           | Analog Switch Inputs X0-X3.                       |
| Y0-Y3                      | 1,5,2,4                           | 15,3,16,2            | Analog Switch Inputs Y0-Y3.                       |
| X                          | 13                                | 11                   | Analog Switch “X” Output.                         |
| Y                          | 3                                 | 1                    | Analog Switch “Y” Output.                         |
| V <sub>cc</sub>            | 16                                | 14                   | Positive Analog and Digital Supply Voltage Input. |
| A                          | 10                                | 8                    | Digital Address “A” Input.                        |
| B                          | 9                                 | 7                    | Digital Address “B” Input.                        |
| GND                        | 8                                 | 6                    | Ground. Connect to digital ground.                |
| NC                         | 7                                 | 5                    | No Connect.                                       |
| $\overline{\text{ENABLE}}$ | 6                                 | 4                    | Digital Enable Input. Normally connected to GND.  |
| EP                         | —                                 | Exposed Pad          | Exposed Pad. Connect EP to GND.                   |

## FUNCTION TABLE

| $\overline{\text{ENABLE}}$<br>INPUT | INPUT STATES |   | ON CHANNEL(S) |
|-------------------------------------|--------------|---|---------------|
|                                     | B            | A |               |
| 1                                   | X            | X | NONE          |
| 0                                   | 0            | 0 | X0, Y0        |
| 0                                   | 0            | 1 | X1, Y1        |
| 0                                   | 1            | 0 | X2, Y2        |
| 0                                   | 1            | 1 | X3, Y3        |

X=Don't care

NOTE: Input and output pins are identical and interchangeable. Either may be considered an input or output; signals pass equally well in either direction.

## SPECIFICATIONS

### Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

| SYMBOL            | PARAMETER                  |   | MIN  | MAX                  | UNIT |
|-------------------|----------------------------|---|------|----------------------|------|
| V <sub>CC</sub>   | Supply Voltage             |   | -0.3 | 6                    | V    |
| V <sub>IN</sub>   | Input Voltage (All inputs) |   | -0.3 | V <sub>CC</sub> +0.3 |      |
| I <sub>IN</sub>   | Switch Input Current       | Any one input                           | -20  | +20                  | mA   |
| I <sub>PEAK</sub> | Peak Switch Current        | Pulsed at 1ms Duration, <10% Duty Cycle | -40  | +40                  |      |
| T <sub>J</sub>    | Junction Temperature       |   |      | 150                  | °C   |
| T <sub>stg</sub>  | Storage temperature        |   | -65  | +150                 |      |

(1) Stresses above these ratings may cause permanent damage. Exposure to absolute maximum conditions for extended periods may degrade device reliability. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those specified is not implied.

### ESD Ratings

|                    |                         |                            | VALUE | UNIT |
|--------------------|-------------------------|----------------------------|-------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human-body model (HBM)     | ±4000 | V    |
|                    |                         | Charged-device Model (CDM) | ±1000 | V    |

### Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted) <sup>(3)</sup>

| SYMBOL          | PARAMETER             | MIN | MAX  | UNIT |
|-----------------|-----------------------|-----|------|------|
| V <sub>CC</sub> | Supply Voltage        | 2.5 | 5.5  | V    |
| T <sub>A</sub>  | Operating temperature | -40 | +125 | °C   |

### Thermal Information

| THERMAL METRIC        |  | RS2252              |         |          |            | UNIT |
|-----------------------|--|---------------------|---------|----------|------------|------|
|                       |  | 16 PINS             |         |          |            |      |
|                       |  | SOIC-16<br>(SOP-16) | SSOP-16 | TSSOP-16 | QFN3X3-16L |      |
| R <sub>θJA</sub>      | Junction-to-ambient thermal resistance       | 76                  | 118.7   | 111.3    | 51.9       | °C/W |
| R <sub>θJC(top)</sub> | Junction-to-case(top) thermal resistance     | 42.1                | 66.4    | 45.3     | 53.3       | °C/W |
| R <sub>θJB</sub>      | Junction-to-board thermal resistance         | 34.8                | 62.2    | 56.9     | 26.6       | °C/W |
| Ψ <sub>JT</sub>       | Junction-to-top characterization parameter   | 26.9                | 20.9    | 5.4      | 1.7        | °C/W |
| Ψ <sub>JB</sub>       | Junction-to-board characterization parameter | 34.7                | 61.7    | 56.3     | 26.6       | °C/W |
| R <sub>θJC(bot)</sub> | Junction-to-case(bottom) thermal resistance  | N/A                 | N/A     | N/A      | 11.6       | °C/W |

**PACKAGE/ORDERING INFORMATION**

| PRODUCT | ORDERING NUMBER | TEMPERATURE RANGE | PACKAGE LEAD   | PACKAGE MARKING <sup>(1)</sup> | PACKAGE OPTION     |
|---------|-----------------|-------------------|----------------|--------------------------------|--------------------|
| RS2252  | RS2252XS16      | -40°C ~+125°C     | SOIC-16(SOP16) | RS2252                         | Tape and Reel,4000 |
|         | RS2252XSS16     | -40°C ~+125°C     | SSOP-16        | RS2252                         | Tape and Reel,4000 |
|         | RS2252XTSS16    | -40°C ~+125°C     | TSSOP-16       | RS2252                         | Tape and Reel,4000 |
|         | RS2252XTQC16    | -40°C ~+125°C     | QFN-3x3 -16L   | RS2252                         | Tape and Reel,5000 |

**NOTE:**

- (1) There may be additional marking, which relates to the lot trace code information(data code and vendor code), the logo or the environmental category on the device.

## ELECTRICAL CHARACTERISTICS

$V_{CC} = 5.0\text{ V}$  or  $3.3\text{ V}$ , FULL =  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , Typical values are at  $T_A = +25^{\circ}\text{C}$ . (unless otherwise noted)

| PARAMETER   | SYMBOL   | CONDITIONS   | $V_{CC}$   | $T_A$ | MIN | TYP | MAX      | UNITS    |
|---|--|--|------------|-------|-----|-----|----------|----------|
| <b>ANALOG SWITCH</b>  |  |  |            |       |     |     |          |          |
| Analog Signal Range   | $V_{X\_}, V_X$<br>$V_{Y\_}, V_Y$                   |  |            | FULL  | 0   |     | $V_{CC}$ | V        |
| On-Resistance   | $R_{ON}$   | $V_{CC}=5\text{V}, I_X, I_Y=1\text{mA}$  | 5V         | +25°C |     | 48  | 65       | $\Omega$ |
|   |  |  |            | FULL  |     |     | 70       | $\Omega$ |
|   |  | $V_{CC}=3.3\text{V}, I_X, I_Y=1\text{mA}$  | 3.3V       | +25°C |     | 100 | 130      | $\Omega$ |
|   |  |  |            | FULL  |     |     | 140      | $\Omega$ |
| On-Resistance Match Between Channels  | $\Delta R_{ON}$                                    | $V_{CC}=5\text{V}, I_X, I_Y=1\text{mA}$ Switch ON  | 5V         | +25°C |     | 1.5 | 5        | $\Omega$ |
|   |  |  |            | FULL  |     |     | 5.3      | $\Omega$ |
| On-Resistance Flatness  | $R_{FLAT(ON)}$                                     | $V_{CC}=5\text{V}, I_X, I_Y=1\text{mA}$ Switch ON  | 5V         | +25°C |     | 17  | 25       | $\Omega$ |
|   |  |  |            | FULL  |     |     | 28       | $\Omega$ |
| X <sub>Off</sub> , Y <sub>Off</sub> , X <sub>On</sub> , Y <sub>On</sub> Leakage Current | $I_{X(OFF)}, I_{Y(OFF)}$<br>$I_{X(ON)}, I_{Y(ON)}$ | $V_{CC}=5\text{V}, V_{X\_}, V_{Y\_}=1\text{V}, 4.5\text{V}$<br>$V_X, V_Y=4.5\text{V}, 1\text{V}$ | 5V         | +25°C |     | 1   | 100      | nA       |
|   |  | $V_{CC}=3.3\text{V}, V_{X\_}, V_{Y\_}=1\text{V}, 3\text{V}$<br>$V_X, V_Y=3\text{V}, 1\text{V}$   | 3.3V       | +25°C |     | 1   | 100      | nA       |
| <b>DIGITAL CONTROL INPUTS<sup>(1)</sup></b>   |  |  |            |       |     |     |          |          |
| Logic Input Logic Threshold High  | $V_{AH}, V_{BH}, V_{ENABLE}$                       |  | 5V         | +25°C | 1.7 |     |          | V        |
|   |  |  | 3.3V       | +25°C | 1.7 |     |          | V        |
| Logic Input Logic Threshold Low   | $V_{AL}, V_{BL}, V_{ENABLE}$                       |  | 5V         | +25°C |     |     | 0.5      | V        |
|   |  |  | 3.3V       | +25°C |     |     | 0.5      | V        |
| Input-Current High  | $I_{AH}, I_{BH}, I_{ENABLE}$                       | $V_A, V_B, V_{ENABLE} = V_{CC}$  | 3.3V to 5V | +25°C |     | 1   | 100      | nA       |
| Input-Current Low   | $I_{AL}, I_{BL}, I_{ENABLE}$                       | $V_A, V_B, V_{ENABLE} = 0\text{V}$   | 3.3V to 5V | +25°C |     | 1   | 100      | nA       |

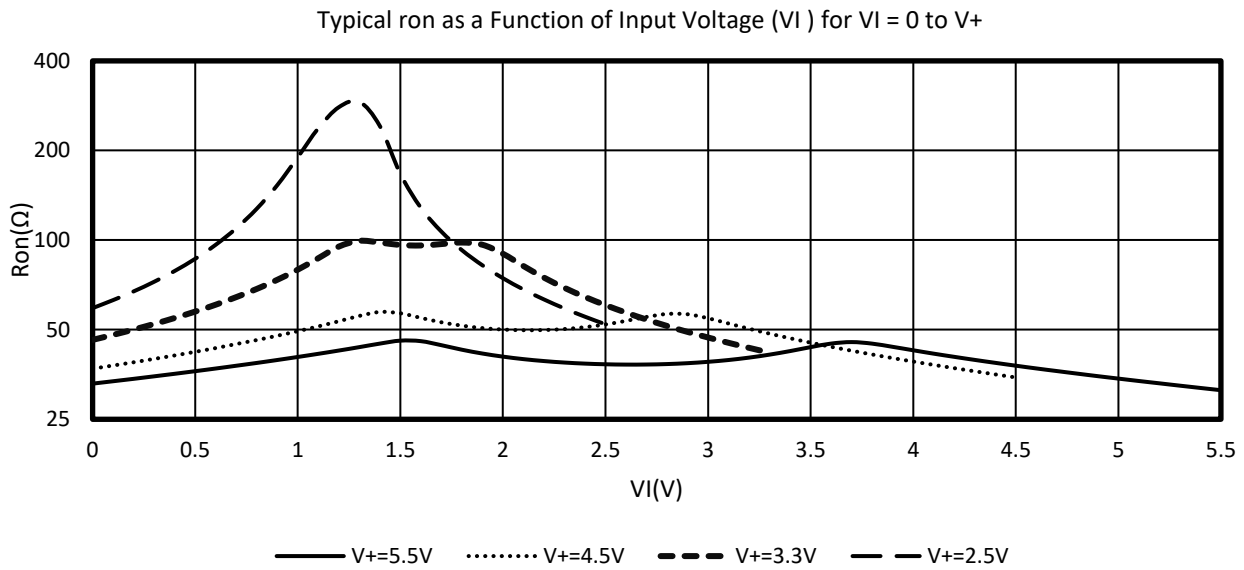
(1) All unused digital inputs of the device must be held at  $V_{IO}$  or GND to ensure proper device operation.

## ELECTRICAL CHARACTERISTICS (continued)

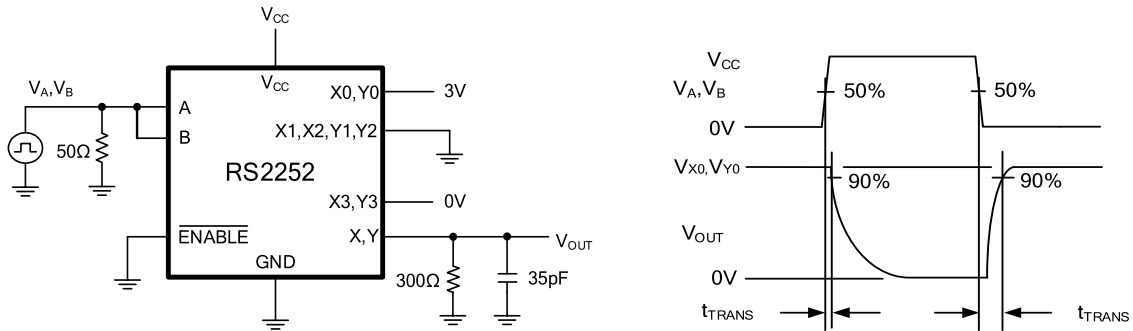
V<sub>CC</sub> = 5.0 V or 3.3V, FULL = -40°C to +125°C Typical values are at TA = +25°C (unless otherwise noted)

| PARAMETER                      | SYMBOL                                     | CONDITIONS  | V <sub>CC</sub> | TEMP  | MIN | TYP       | MAX | UNITS |
|--------------------------------|--|---|-----------------|-------|-----|-----------|-----|-------|
| <b>DYNAMIC CHARACTERISTICS</b> |  |   |                 |       |     |           |     |       |
| Address Transition Time        | t <sub>TRANS</sub>                         | V <sub>X_</sub> , V <sub>Y_</sub> = 3V/0V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Test Circuit 1 | 5V              | +25°C |     | 120       |     | ns    |
|                                |  | V <sub>X_</sub> , V <sub>Y_</sub> = 3V/0V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Test Circuit 1 | 3.3V            | +25°C |     | 210       |     | ns    |
| ENABLE Turn-On Time            | t <sub>ON</sub>                            | V <sub>X_</sub> , V <sub>Y_</sub> = 3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Test Circuit 2    | 5V<br>3.3V      | +25°C |     | 70<br>130 |     | ns    |
| ENABLE Turn-Off Time           | t <sub>OFF</sub>                           | V <sub>X_</sub> , V <sub>Y_</sub> = 3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Test Circuit 2    | 5V<br>3.3V      | +25°C |     | 80<br>120 |     | ns    |
| Internal A, B, C Rise Time     | t <sub>R</sub>                             |   | 5V              | +25°C |     | 50        |     | ns    |
|                                |  |   | 3.3V            |       |     | 80        |     |       |
| Internal A, B, C Fall Time     | t <sub>F</sub>                             |   | 5V              | +25°C |     | 60        |     | ns    |
|                                |  |   | 3.3V            |       |     | 85        |     | ns    |
| Break-Before-Make Time Delay   | t <sub>D</sub>                             | V <sub>X_</sub> , V <sub>Y_</sub> = 3V, R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, Test Circuit 3    | 5V              | +25°C |     | 50        |     | ns    |
|                                |  |   | 3.3V            |       |     | 80        |     | ns    |
| Charge Injection               | Q  | R <sub>S</sub> = 0Ω, C <sub>L</sub> = 1nF, Test Circuit 4   | 5V              | +25°C |     | 6         |     | pC    |
|                                |  |   | 3.3V            |       |     | 4         |     | pC    |
| Crosstalk                      | X <sub>TALK</sub>                          | f = 1MHz, Test Circuit 5  | 5V              | +25°C |     | -110      |     | dB    |
| Off Isolation                  | O <sub>ISO</sub>                           | R <sub>L</sub> = 50Ω, f = 1MHz, Test Circuit 5  | 5V              | +25°C |     | -83       |     | dB    |
| -3dB Bandwidth                 | BW   | R <sub>L</sub> = 50Ω  | 5V              | +25°C |     | 180       |     | MHz   |
|                                |  |   | 3.3V            |       |     | 180       |     | MHz   |
| Input Off-Capacitance          | C <sub>X(OFF)</sub><br>C <sub>X(OFF)</sub> | f = 1MHz, Test Circuit 6  | 5V              | +25°C |     | 4.7       |     | pF    |
| Output Off-Capacitance         | C <sub>X(OFF)</sub><br>C <sub>Y(OFF)</sub> | f = 1MHz, Test Circuit 6  | 5V              | +25°C |     | 12.7      |     | pF    |
| Output On- Capacitance         | C <sub>X(ON)</sub><br>C <sub>Y(ON)</sub>   | f = 1MHz, Test Circuit 6  | 5V              | +25°C |     | 16        |     | pF    |
| Total Harmonic Distortion      | THD  | R <sub>L</sub> = 600Ω, 5V <sub>P-P</sub> , f = 20Hz to 20kHz  | 5V              | +25°C |     | 0.7       |     | %     |
| <b>POWER REQUIREMENTS</b>      |  |   |                 |       |     |           |     |       |
| Power Supply Range             | V <sub>CC</sub>                            |   |                 | FULL  | 2.5 |           | 5.5 | V     |
| Power Supply Current           | I <sub>CC</sub>                            | V <sub>CC</sub> = 5.0V, V <sub>A</sub> , V <sub>B</sub> , V <sub>ENABLE</sub> = V <sub>CC</sub> or 0    | 5V              | +25°C |     | 0.001     | 2   | μA    |
|                                |  | V <sub>CC</sub> = 3.3V, V <sub>A</sub> , V <sub>B</sub> , V <sub>ENABLE</sub> = V <sub>CC</sub> or 0    | 3.3V            | +25°C |     | 0.001     | 1   | μA    |

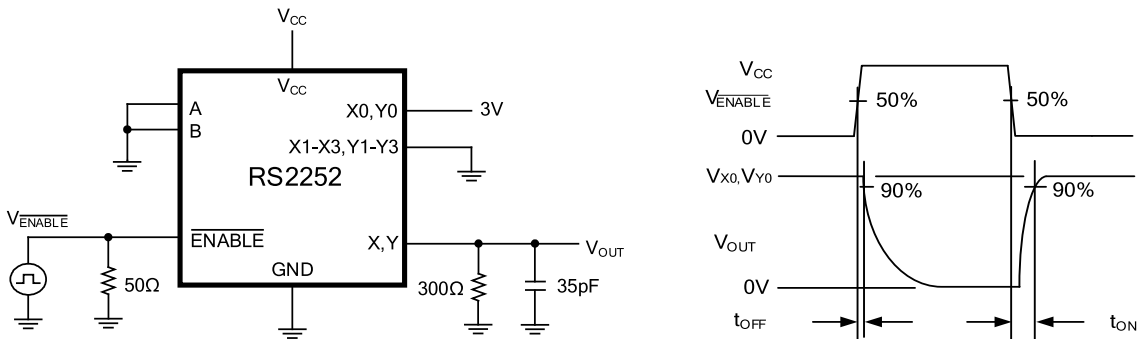
## TYPICAL CHARACTERISTICS



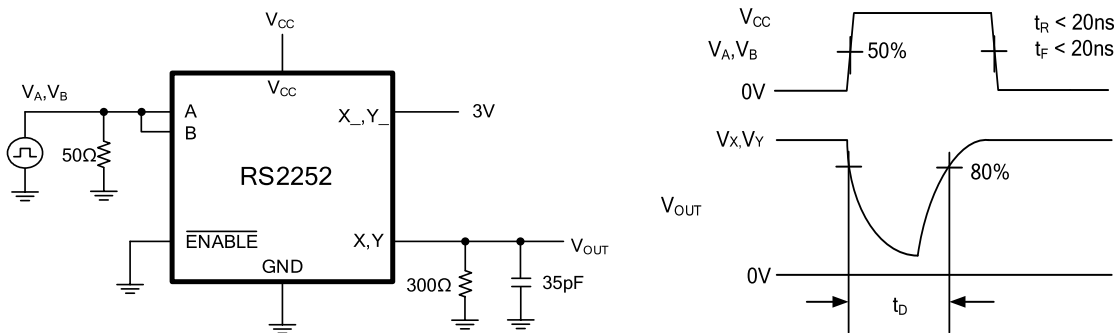
## Parameter Measurement Information



**Test Circuit 1. Address Transition Times ( $t_{TRANS}$ )**



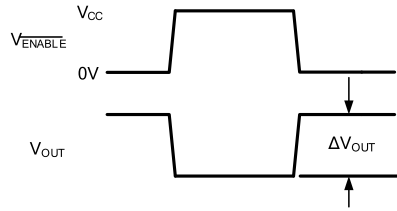
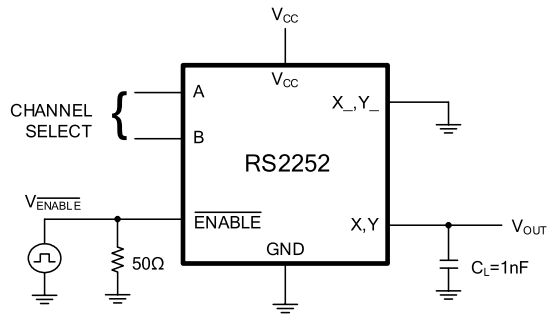
**Test Circuit 2. Switching Times ( $t_{ON}$ ,  $t_{OFF}$ )**



**Test Circuit 3. Break-Before-Make Time Delay ( $t_d$ )**

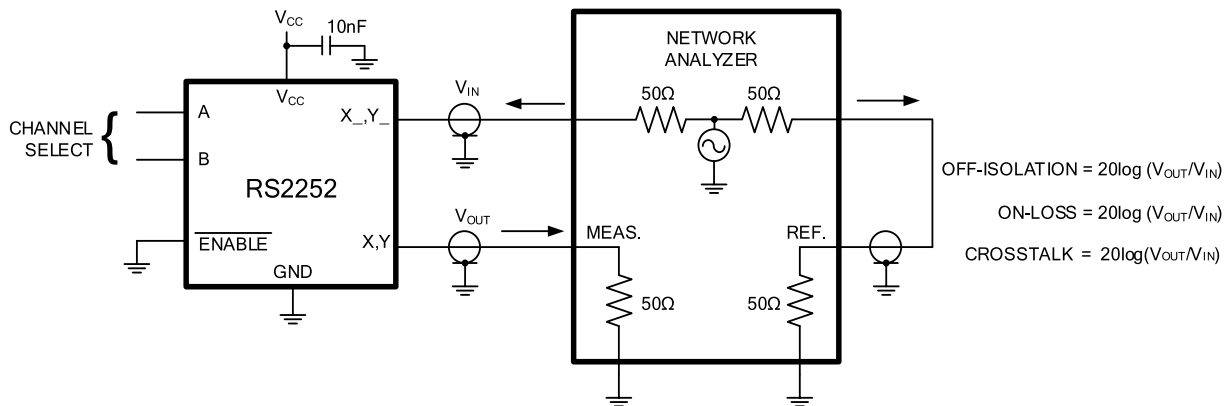


### Parameter Measurement Information (continued)



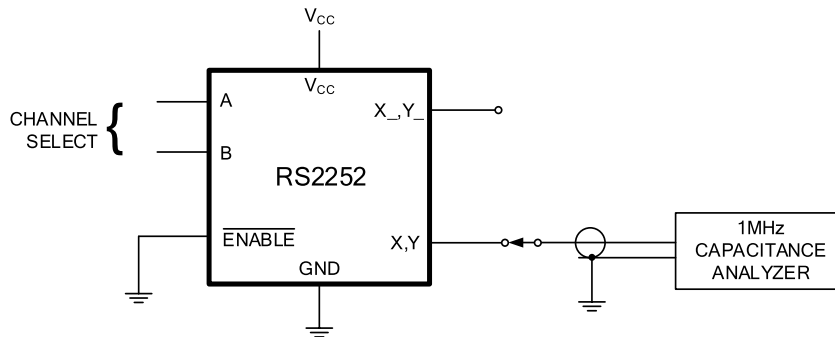
$\Delta V_{OUT}$  IS THE MEASURED VOLTAGE DUE TO CHARGE TRANSFER ERROR Q WHEN THE CHANNEL TURNS OFF  
 $Q = \Delta V_{OUT} \times C_L$

### Test Circuit 4. Charge Injection (Q)



MEASUREMENTS ARE STANDARDIZED AGAINST SHORT AT SOCKET TERMINALS.  
 OFF-ISOLATION IS MEASURED BETWEEN COM AND "OFF" NO TERMINAL ON EACH SWITCH.  
 ON-LOSS IS MEASURED BETWEEN COM AND "ON" NO TERMINAL ON EACH SWITCH.  
 SIGNAL DIRECTION THROUGH SWITCH IS REVERSED; WORST VALUES ARE RECORDED.

### Test Circuit 5. Off Isolation, On Loss



### Test Circuit 6. Capacitance

### APPLICATION NOTES

The RS2252 device is a differential 4-channel multiplexer having two binary control inputs, A and B, and an inhibit input. The two binary input signals select 1 of 4 pairs of channels to be turned on and connect the analog inputs to the outputs.

One application of the RS2252 is to use it in conjunction with a microcontroller to poll a keypad. Figure 1 shows the basic schematic for such a polling system. The microcontroller uses the channel select pins to cycle through the different channels while reading the input to see if a user is pressing any of the keys. This is a very robust setup, allowing for multiple simultaneous key-presses with very little power consumption. It also utilizes very few pins on the microcontroller. The down side of polling is that the microcontroller must continually scan the keys for a press and can do little else during this process.

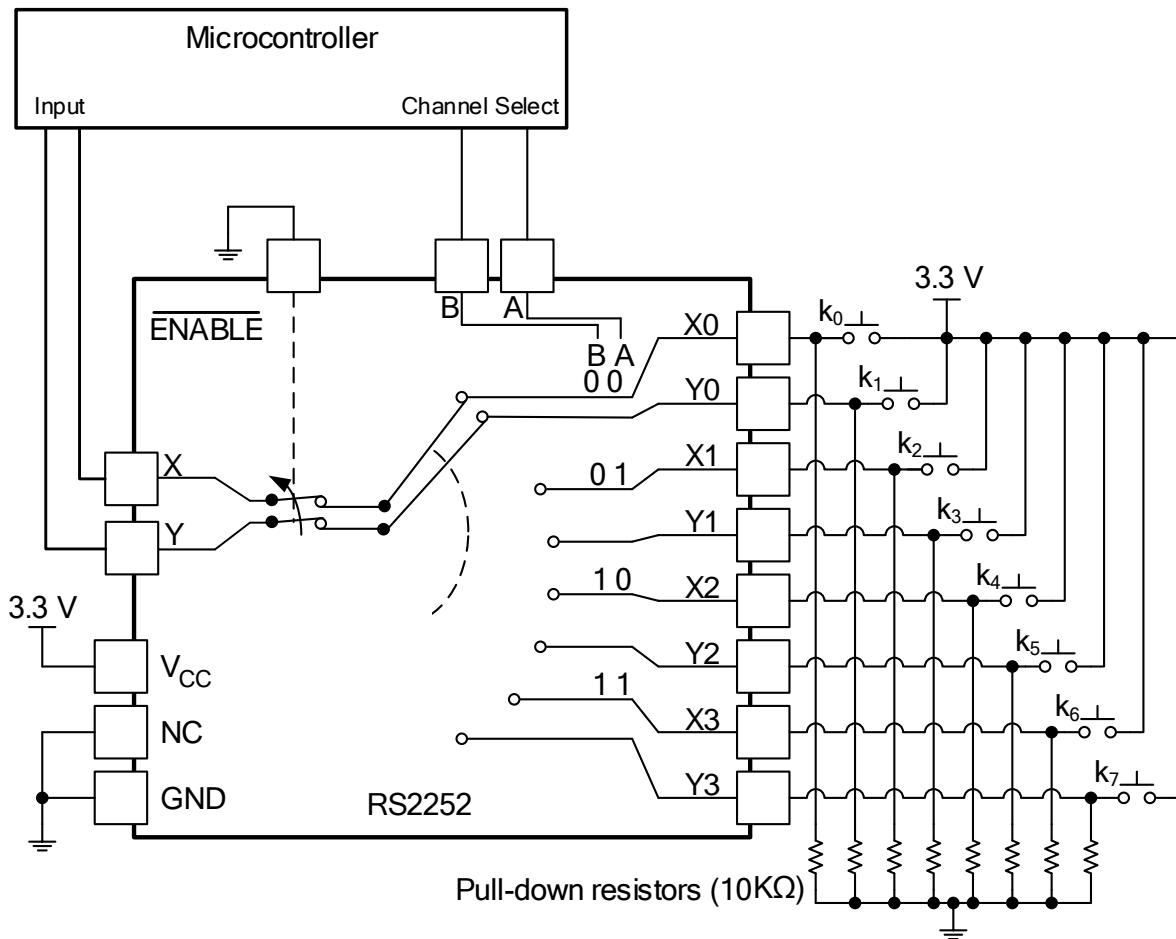
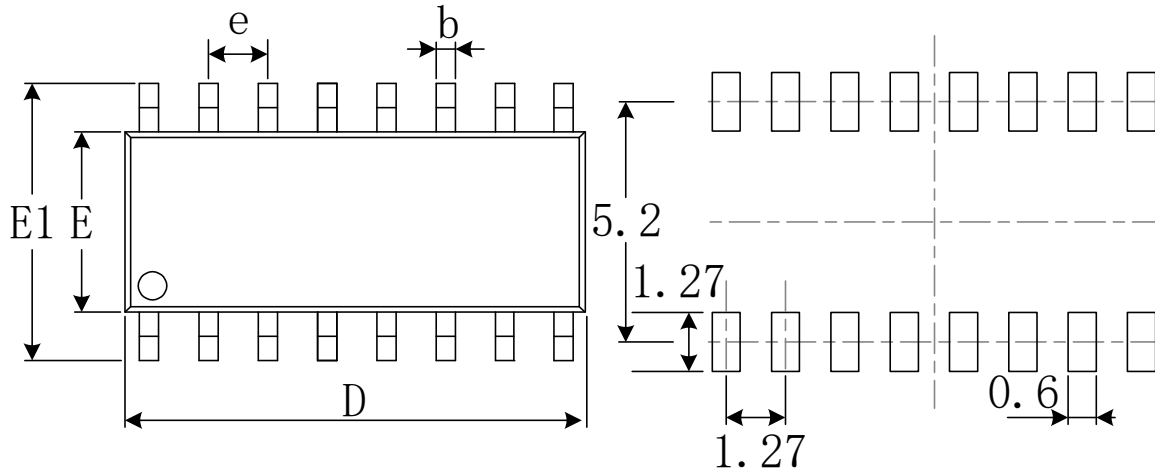


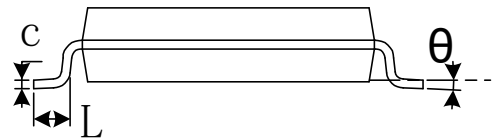
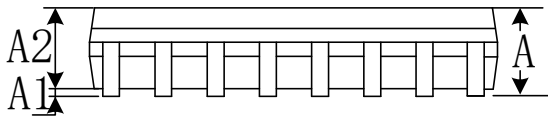
Figure 1. The RS2252 Being Used to Help Read Button Presses on a Keypad.

# PACKAGE OUTLINE DIMENSIONS

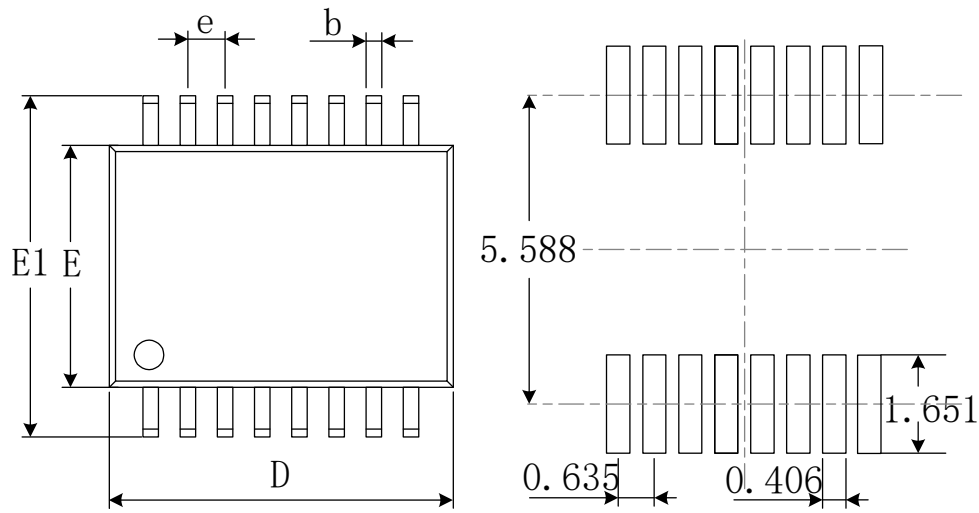
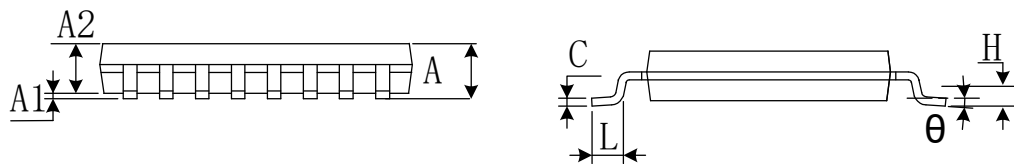
## SOIC-16



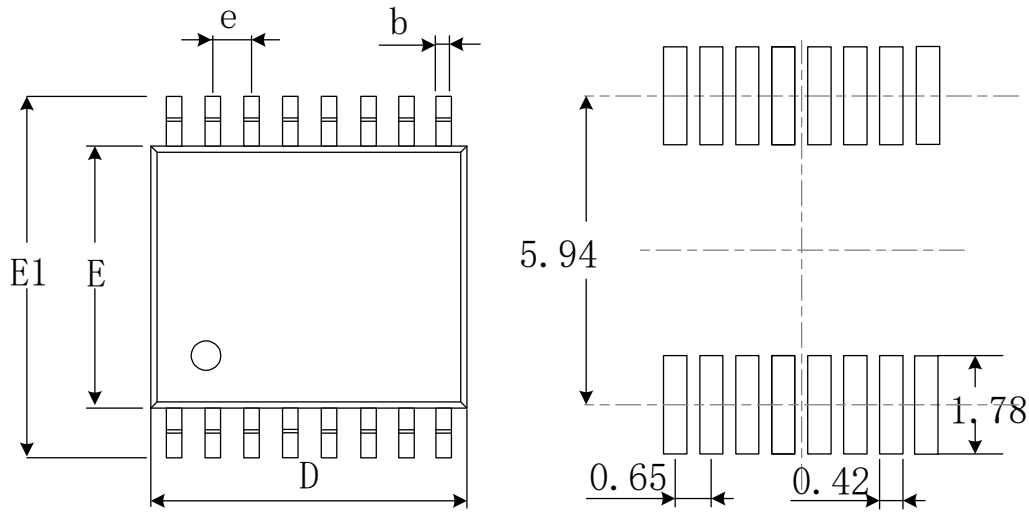
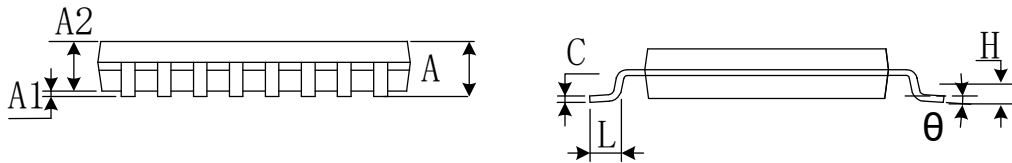
RECOMMENDED LAND PATTERN (Unit: mm)



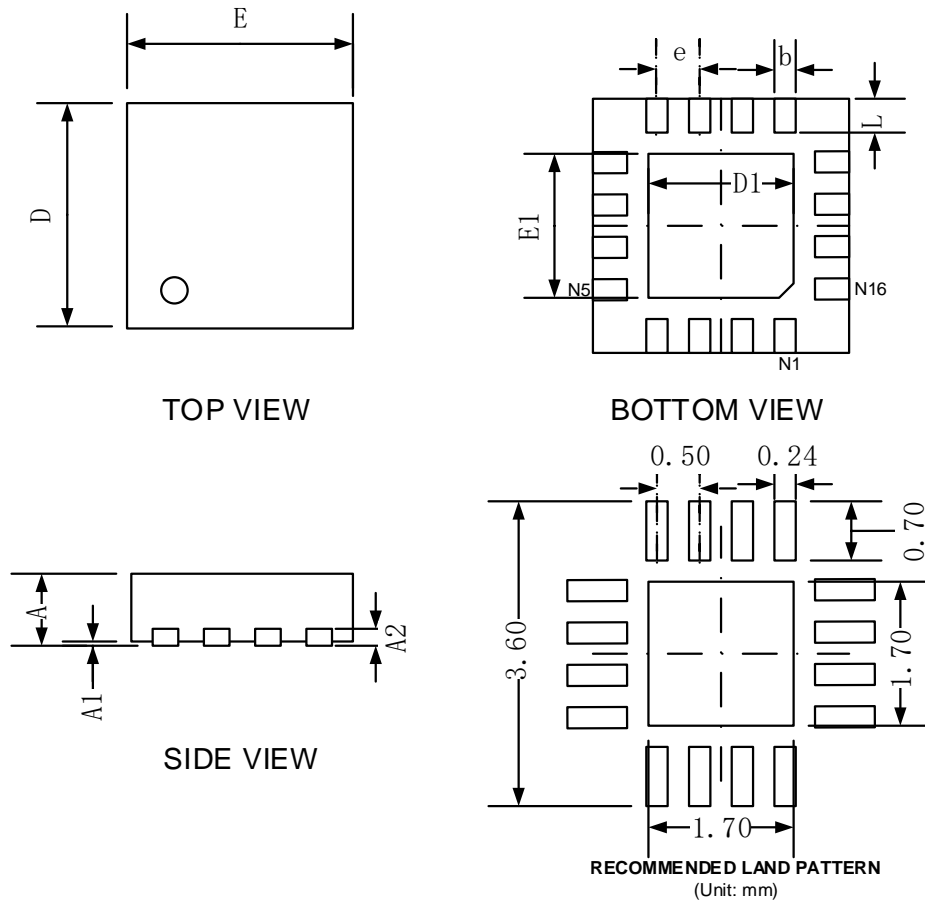
| Symbol | Dimensions In Millimeters |        | Dimensions In Inches |       |
|--------|---------------------------|--------|----------------------|-------|
|        | Min                       | Max    | Min                  | Max   |
| A      | 1.350                     | 1.750  | 0.053                | 0.069 |
| A1     | 0.100                     | 0.250  | 0.004                | 0.010 |
| A2     | 1.350                     | 1.550  | 0.053                | 0.061 |
| b      | 0.330                     | 0.510  | 0.013                | 0.020 |
| c      | 0.170                     | 0.250  | 0.006                | 0.010 |
| D      | 9.800                     | 10.200 | 0.386                | 0.402 |
| E      | 3.800                     | 4.000  | 0.150                | 0.157 |
| E1     | 5.800                     | 6.200  | 0.228                | 0.244 |
| e      | 1.27(BSC)                 |        | 0.050(BSC)           |       |
| L      | 0.400                     | 1.270  | 0.016                | 0.050 |
| θ      | 0°                        | 8°     | 0°                   | 8°    |

**SSOP-16**

**RECOMMENDED LAND PATTERN** (Unit: mm)


| Symbol   | Dimensions In Millimeters |       | Dimensions In Inches |       |
|----------|---------------------------|-------|----------------------|-------|
|          | Min                       | Max   | Min                  | Max   |
| A        | 1.350                     | 1.750 | 0.053                | 0.069 |
| A1       | 0.100                     | 0.250 | 0.004                | 0.010 |
| A2       | 1.350                     | 1.550 | 0.053                | 0.061 |
| b        | 0.200                     | 0.300 | 0.008                | 0.012 |
| c        | 0.170                     | 0.250 | 0.007                | 0.010 |
| D        | 4.700                     | 5.100 | 0.185                | 0.200 |
| E        | 3.800                     | 4.000 | 0.150                | 0.157 |
| E1       | 5.800                     | 6.200 | 0.228                | 0.244 |
| e        | 0.635(BSC)                |       | 0.025(BSC)           |       |
| L        | 0.400                     | 1.270 | 0.016                | 0.050 |
| $\theta$ | 0°                        | 8°    | 0°                   | 8°    |

**TSSOP-16**

**RECOMMENDED LAND PATTERN** (Unit: mm)


| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      |                           | 1.200 |                      | 0.047 |
| A1     | 0.050                     | 0.150 | 0.002                | 0.006 |
| A2     | 0.800                     | 1.050 | 0.031                | 0.041 |
| b      | 0.190                     | 0.300 | 0.007                | 0.012 |
| c      | 0.090                     | 0.200 | 0.004                | 0.008 |
| D      | 4.860                     | 5.100 | 0.191                | 0.201 |
| E      | 4.300                     | 4.500 | 0.169                | 0.177 |
| E1     | 6.200                     | 6.600 | 0.244                | 0.260 |
| e      | 0.650(BSC)                |       | 0.026(BSC)           |       |
| L      | 0.500                     | 0.700 | 0.02                 | 0.028 |
| H      | 0.25TYP                   |       | 0.01TYP              |       |
| θ      | 1°                        | 7°    | 1°                   | 7°    |

**QFN-3x3-16L**


| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 0.700                     | 0.800 | 0.028                | 0.031 |
| A1     | 0.000                     | 0.050 | 0.000                | 0.002 |
| A2     | 0.203                     |       | 0.008                |       |
| b      | 0.180                     | 0.300 | 0.007                | 0.012 |
| D      | 2.900                     | 3.100 | 0.114                | 0.122 |
| D1     | 1.600                     | 1.800 | 0.063                | 0.071 |
| E      | 2.900                     | 3.100 | 0.114                | 0.122 |
| E1     | 1.600                     | 1.800 | 0.063                | 0.071 |
| e      | 0.500 TYP                 |       | 0.020 TYP            |       |
| L      | 0.300                     | 0.500 | 0.012                | 0.020 |

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