



# 7Ω Quad SPST Switches with Over-Rail Signal Handling

**MAX4854**

## General Description

The MAX4854 quad single-pole/single-throw (SPST) switch operates from a single +2V to +5.5V supply and can handle signals greater than the supply rail. This switch features low 7Ω on-resistance with 30pF on-capacitance, making it ideal for switching data signals.

For over-rail applications, this device passes signals greater than the positive supply (up to +5.5V) through the switch without distortion.

The MAX4854 is available in the space-saving, 16-pin, 3mm x 3mm thin QFN package and operates over the -40°C to +85°C extended temperature range.

## Features

- ◆ USB 2.0 Full Speed (12Mbps) and USB 1.1 Signal Switching
- ◆ Switches Signals Greater than V<sub>CC</sub>
- ◆ 7Ω On-Resistance
- ◆ 30pF On-Capacitance
- ◆ 150MHz, -3dB Bandwidth
- ◆ 1.8V Logic Compatibility
- ◆ +2V to +5.5V Supply Range
- ◆ Low 0.01μA Supply Current
- ◆ Available in a Space-Saving, 3mm x 3mm, 16-Pin TQFN Package

## Applications

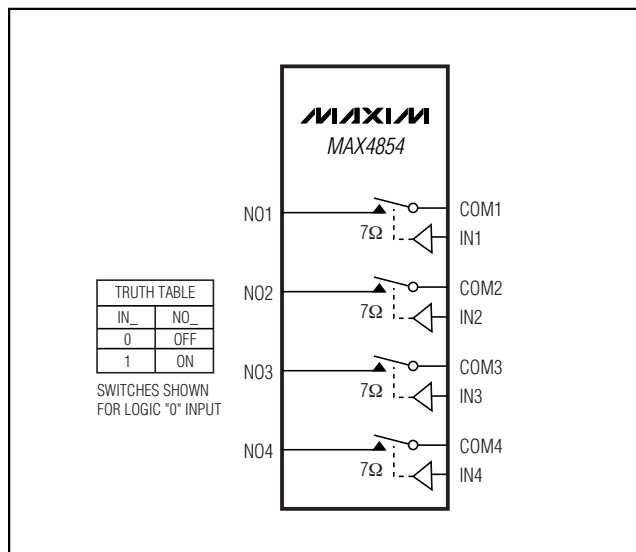
USB Switching  
Cellular Phones  
Notebook Computers  
PDAs and Other Handheld Devices

## Ordering Information

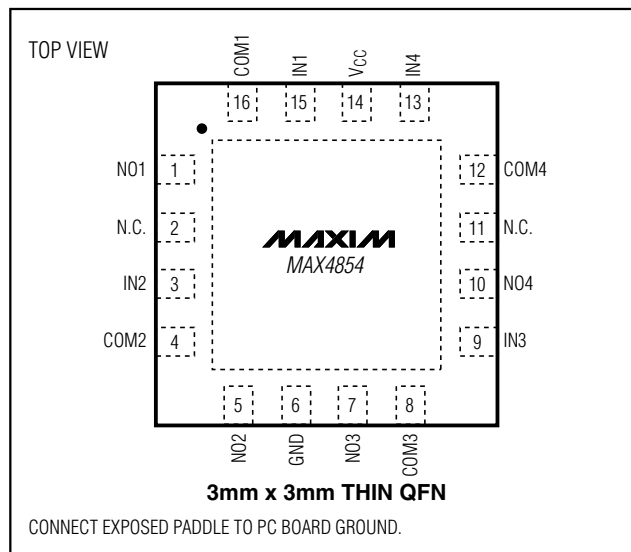
| PART       | TEMP RANGE     | PIN-PACKAGE | TOP MARK |
|------------|----------------|-------------|----------|
| MAX4854ETE | -40°C to +85°C | 16 TQFN-EP* | ACE      |

\*EP = Exposed paddle.

## Block Diagram/Truth Table



## Pin Configuration



# 7 $\Omega$ Quad SPST Switches with Over-Rail Signal Handling

## ABSOLUTE MAXIMUM RATINGS

V<sub>CC</sub>, IN<sub>-</sub>, COM<sub>-</sub>, NO<sub>-</sub> to GND (Note 1) .....-0.3V to +6.0V  
 Closed-Switch Continuous Current COM<sub>-</sub>, NO<sub>-</sub>, NC<sub>-</sub> .....±50mA  
 Peak Current COM<sub>-</sub>, NO<sub>-</sub>  
 (pulsed at 1ms, 50% duty cycle).....±100mA  
 Peak Current COM<sub>-</sub>, NO<sub>-</sub>  
 (pulsed at 1ms, 10% duty cycle).....±120mA

Continuous Power Dissipation (T<sub>A</sub> = +70°C)

16-Pin Thin QFN (derate 20.8mW/°C above +70°C) ....1667mW

Operating Temperature Range .....-40°C to +85°C

Junction Temperature .....+150°C

Storage Temperature Range .....-65°C to +150°C

Lead Temperature (soldering, 10s) .....+300°C

**Note 1:** Signals on IN<sub>-</sub>, NO<sub>-</sub>, or COM<sub>-</sub> below GND are clamped by internal diodes. Limit forward-diode current to maximum current rating.

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

(V<sub>CC</sub> = +2.7V to +5.5V, T<sub>A</sub> = -40°C to +85°C, unless otherwise noted. Typical values are at V<sub>CC</sub> = +3.0V, T<sub>A</sub> = +25°C, unless otherwise noted.) (Note 2)

| PARAMETER                                               | SYMBOL                                  | CONDITIONS                                                                                                          |                                 | MIN    | TYP   | MAX | UNITS |
|---------------------------------------------------------|-----------------------------------------|---------------------------------------------------------------------------------------------------------------------|---------------------------------|--------|-------|-----|-------|
| Supply Voltage                                          | V <sub>CC</sub>                         |                                                                                                                     |                                 | 2.0    |       | 5.5 | V     |
| Supply Current                                          | I <sub>CC</sub>                         | V <sub>CC</sub> = +5.5V, V <sub>IN_</sub> = 0 or V <sub>CC</sub>                                                    |                                 |        | 0.01  | 1   | μA    |
| ANALOG SWITCH                                           |                                         |                                                                                                                     |                                 |        |       |     |       |
| Analog Signal Range                                     | V <sub>NO_</sub> ,<br>V <sub>COM_</sub> |                                                                                                                     |                                 | 0      |       | 5.5 | V     |
| On-Resistance                                           | R <sub>ON</sub>                         | V <sub>CC</sub> = +3V, I <sub>COM_</sub> = 10mA,<br>V <sub>NO_</sub> = 0 to +5.5V                                   | T <sub>A</sub> = +25°C          | 7      | 9     | Ω   |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C |        | 10    |     |       |
| On-Resistance Match<br>Between Channels<br>(Notes 3, 4) | ΔR <sub>ON</sub>                        | V <sub>CC</sub> = +3V, I <sub>COM</sub> = 10mA,<br>V <sub>NO_</sub> = +1.5V                                         | T <sub>A</sub> = +25°C          | 0.2    | 0.4   | Ω   |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C |        | 0.5   |     |       |
| On-Resistance<br>Flatness (Note 5)                      | R <sub>FLAT</sub>                       | V <sub>CC</sub> = +3V; I <sub>COM_</sub> = 10mA;<br>V <sub>NO_</sub> = +1V, +2V, +3V                                | T <sub>A</sub> = +25°C          | 2.5    | 3.75  | Ω   |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C |        | 4.0   |     |       |
| NO_ Off-Leakage<br>Current                              | I <sub>OFF</sub>                        | V <sub>CC</sub> = +5.5V, V <sub>NO_</sub> = +1V or +4.5V,<br>V <sub>COM_</sub> = +4.5V or +1V                       | T <sub>A</sub> = +25°C          | - 2    | +2    | nA  |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C | -10    | +10   |     |       |
| COM_ On-Leakage<br>Current                              | I <sub>ON</sub>                         | V <sub>CC</sub> = +5.5V; V <sub>NO_</sub> = +1V, +4.5V, or<br>floating; V <sub>COM_</sub> = +1V, +4.5V, or floating | T <sub>A</sub> = +25°C          | - 2    | +2    | nA  |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C | - 12.5 | +12.5 |     |       |
| DYNAMIC CHARACTERISTICS                                 |                                         |                                                                                                                     |                                 |        |       |     |       |
| Skew (Note 3)                                           | t <sub>SKEW</sub>                       | R <sub>S</sub> = 39Ω, C <sub>L</sub> = 50pF, Figure 2                                                               |                                 | 0.1    | 1     | ns  |       |
| Propagation Delay<br>(Note 3)                           | t <sub>PD</sub>                         | R <sub>S</sub> = 39Ω, C <sub>L</sub> = 50pF, Figure 2                                                               |                                 | 0.9    | 2     | ns  |       |
| Turn-On Time                                            | t <sub>ON</sub>                         | V <sub>CC</sub> = +3V, V <sub>NO_</sub> = +1.5V,<br>R <sub>L</sub> = 300Ω, C <sub>L</sub> = 50pF, Figure 1          | T <sub>A</sub> = +25°C          | 40     | 60    | ns  |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C |        | 100   |     |       |
| Turn-Off Time                                           | t <sub>OFF</sub>                        | V <sub>CC</sub> = +3V, V <sub>NO_</sub> = +1.5V,<br>R <sub>L</sub> = 300Ω, C <sub>L</sub> = 50pF, Figure 1          | T <sub>A</sub> = +25°C          | 30     | 40    | ns  |       |
|                                                         |                                         |                                                                                                                     | T <sub>A</sub> = -40°C to +85°C |        | 60    |     |       |
| Charge Injection                                        | Q                                       | V <sub>COM_</sub> = +1.5V, R <sub>S</sub> = 0Ω, C <sub>L</sub> = 1nF, Figure 3                                      |                                 | 8      |       | pC  |       |
| Off-Isolation (Note 6)                                  |                                         | f = 100kHz, V <sub>COM_</sub> = 1V <sub>RMS</sub> , R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 4            |                                 | -80    |       | dB  |       |
| Crosstalk                                               |                                         | f = 1MHz, V <sub>COM_</sub> = 1V <sub>RMS</sub> , R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 4              |                                 | -95    |       | dB  |       |
| -3dB Bandwidth                                          | BW                                      | Signal = 0dBm, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, Figure 4                                                 |                                 | 150    |       | MHz |       |

# 7Ω Quad SPST Switches with Over-Rail Signal Handling

## ELECTRICAL CHARACTERISTICS (continued)

( $V_{CC} = +2.7V$  to  $+5.5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $V_{CC} = +3.0V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.) (Note 2)

| PARAMETER                 | SYMBOL    | CONDITIONS                                                         | MIN  | TYP  | MAX  | UNITS   |
|---------------------------|-----------|--------------------------------------------------------------------|------|------|------|---------|
| NO_ Off-Capacitance       | $C_{OFF}$ | $f = 1MHz$ , Figure 5                                              |      | 13   |      | pF      |
| COM On-Capacitance        | $C_{ON}$  | $f = 1MHz$ , Figure 5                                              |      | 30   |      | pF      |
| Total Harmonic Distortion | THD       | $f = 20Hz$ to $20kHz$ , $V_{COM\_} = 1V$ +2VP-P, $R_L = 600\Omega$ |      | 0.04 |      | %       |
| <b>DIGITAL I/O (IN_)</b>  |           |                                                                    |      |      |      |         |
| Input Logic High Voltage  | $V_{IH}$  | $V_{CC} = +2V$ to $+3.6V$                                          | 1.4  |      |      | V       |
|                           |           | $V_{CC} = +3.6V$ to $+5.5V$                                        | 1.8  |      |      |         |
| Input Logic Low Voltage   | $V_{IL}$  | $V_{CC} = +2V$ to $+3.6V$                                          |      |      | 0.5  | V       |
|                           |           | $V_{CC} = +3.6V$ to $+5.5V$                                        |      |      | 0.8  |         |
| Input Leakage             | $I_{IN}$  | $V_{IN\_} = 0$ or $+5.5V$                                          | -0.5 |      | +0.5 | $\mu A$ |

**Note 2:** Specifications are 100% tested at  $T_A = +85^{\circ}C$  only, and guaranteed by design and characterization over the specified temperature range.

**Note 3:** Guaranteed by design and characterization; not production tested.

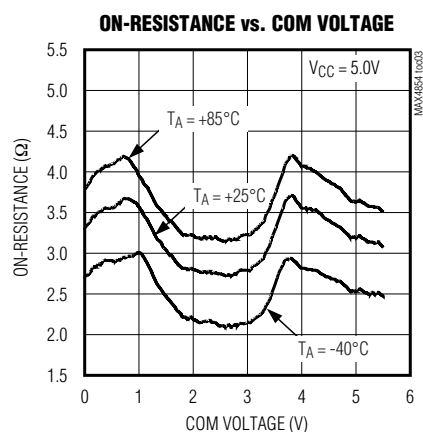
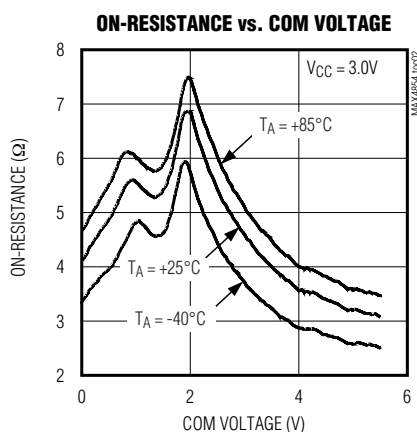
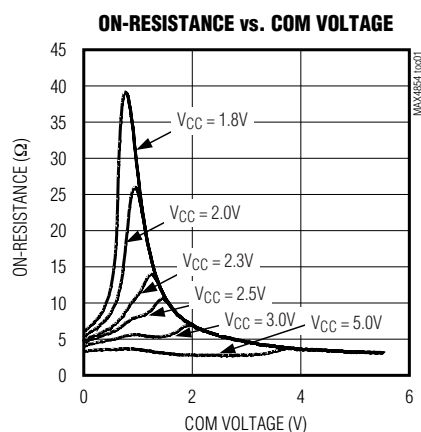
**Note 4:**  $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$ .

**Note 5:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal ranges.

**Note 6:** Off-isolation =  $20\log_{10}(V_{COM\_} / V_{NO\_})$ ,  $V_{COM\_}$  = output,  $V_{NO\_}$  = input to off switch.

## Typical Operating Characteristics

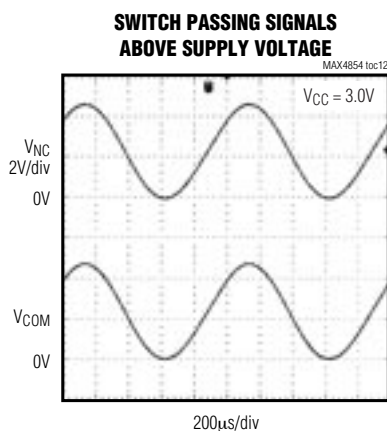
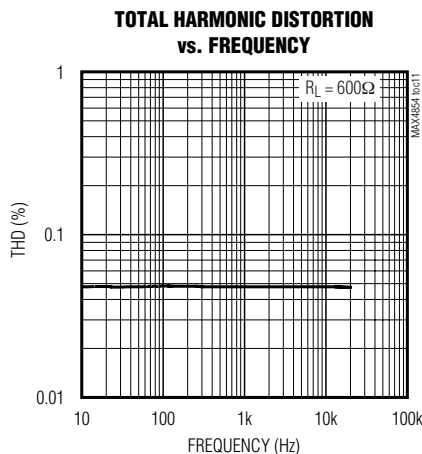
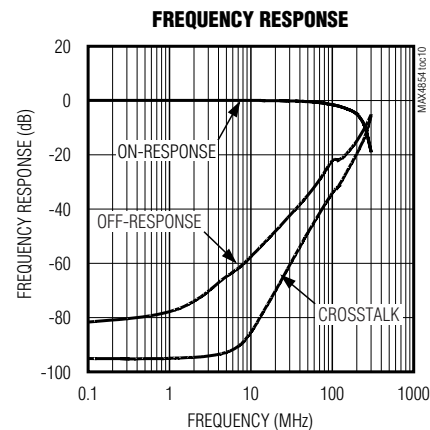
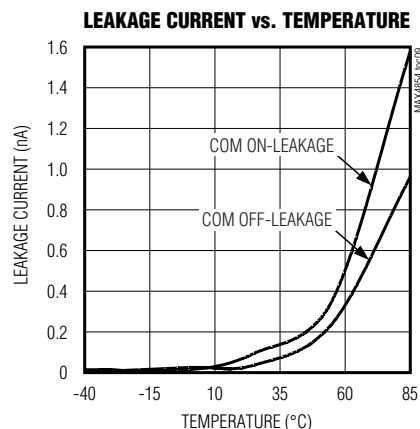
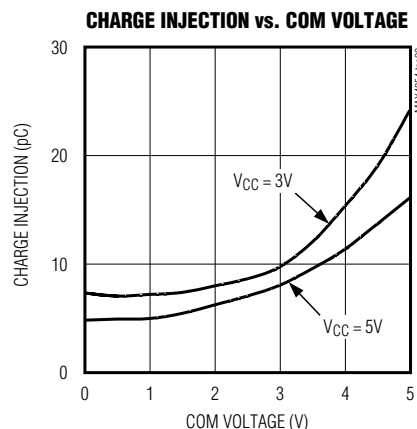
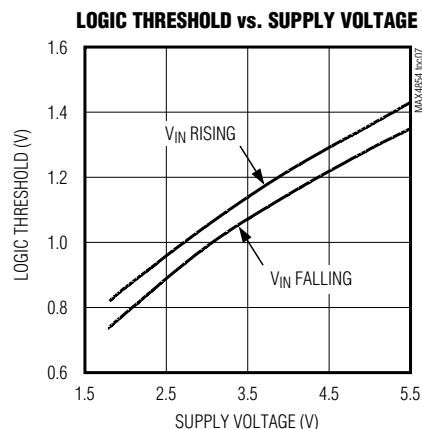
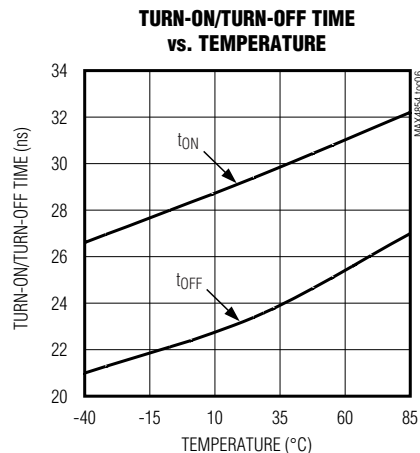
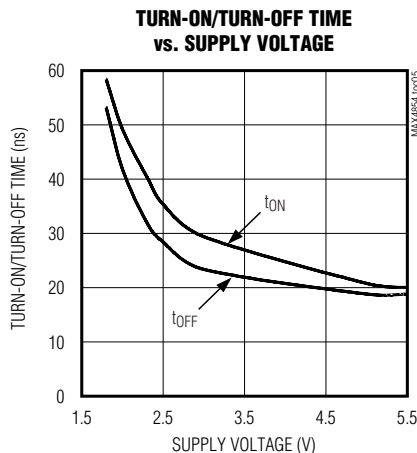
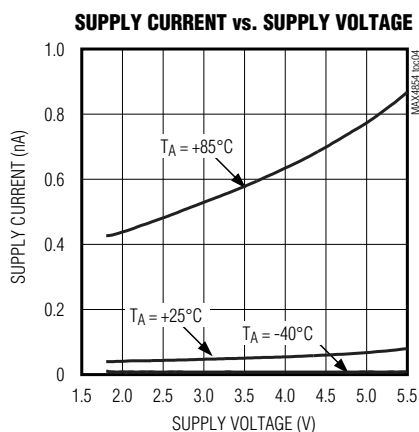
( $V_{CC} = 3.0V$ ,  $T_A = +25^{\circ}C$ , unless otherwise noted.)



# 7 $\Omega$ Quad SPST Switches with Over-Rail Signal Handling

## Typical Operating Characteristics (continued)

( $V_{CC} = 3.0V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)



# 7Ω Quad SPST Switches with Over-Rail Signal Handling

## Pin Description

**MAX4854**

| PIN   | NAME | FUNCTION                                                                                                                       |
|-------|------|--------------------------------------------------------------------------------------------------------------------------------|
| 1     | NO1  | Normally Open Terminal for Analog Switch 1                                                                                     |
| 2, 11 | N.C. | No Connection. Not internally connected.                                                                                       |
| 3     | IN2  | Digital Control Input for Analog Switch 2. A logic-low on IN2 disconnects COM2 from NO2 and a logic-high connects COM2 to NO2. |
| 4     | COM2 | Common Terminal for Analog Switch 2                                                                                            |
| 5     | NO2  | Normally Open Terminal for Analog Switch 2                                                                                     |
| 6     | GND  | Ground                                                                                                                         |
| 7     | NO3  | Normally Open Terminal for Analog Switch 3                                                                                     |
| 8     | COM3 | Common Terminal for Analog Switch 3                                                                                            |
| 9     | IN3  | Digital Control Input for Analog Switch 3. A logic-low on IN3 disconnects COM3 from NO3 and a logic-high connects COM3 to NO3. |
| 10    | NO4  | Normally Open Terminal for Analog Switch 4                                                                                     |
| 12    | COM4 | Common Terminal for Analog Switch 4                                                                                            |
| 13    | IN4  | Digital Control Input for Analog Switch 4. A logic-low on IN4 disconnects COM4 from NO4 and a logic-high connects COM4 to NO4. |
| 14    | VCC  | Supply Voltage. Bypass to GND with a 0.01μF capacitor as close to the pin as possible.                                         |
| 15    | IN1  | Digital Control Input for Analog Switch 1. A logic-low on IN1 disconnects COM1 from NO1 and a logic-high connects COM1 to NO1. |
| 16    | COM1 | Common Terminal for Analog Switch 1                                                                                            |
| EP    | GND  | Exposed Pad. Connect to ground.                                                                                                |

# 7Ω Quad SPST Switches with Over-Rail Signal Handling

## Detailed Description

The MAX4854 low on-resistance, low-voltage, analog switch is designed to operate from a +2V to +5.5V single supply and is fully specified for nominal +3.0V applications. The device features over-rail signal capability that allows signals up to +5.5V with supply voltages down to +2.0V to pass through without distortion.

This quad SPST switch has low on-channel capacitance, which allows switching of the data signals for USB 2.0/1.1 applications (12Mbps). It is designed to switch D+ and D- USB signals with a guaranteed skew of less than 1ns (see Figure 2) as measured from 50% of the input signal to 50% of the output signal.

## Applications Information

### Digital Control Inputs

The logic inputs (IN<sub>n</sub>) accept up to +5.5V even if the supply voltages are below this level. For example, with a +3.3V V<sub>CC</sub> supply, IN<sub>n</sub> can be driven low to GND and high to +5.5V, allowing for mixing of logic levels in a system. Driving IN<sub>n</sub> rail-to-rail minimizes power consumption. For a +2V supply voltage, the logic thresholds are +0.5V (low) and +1.4V (high); for a +5V supply voltage, the logic thresholds are +0.8V (low) and +1.8V (high).

### Analog Signal Levels

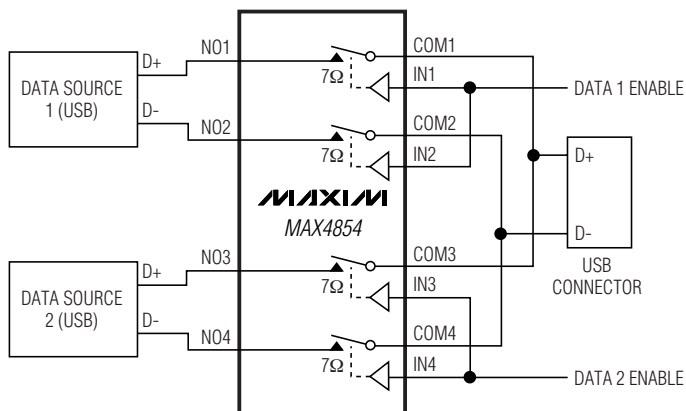
The on-resistance of these switches changes very little for analog input signals across the entire supply voltage range (see the *Typical Operating Characteristics*). The switches are bidirectional; therefore, NO<sub>n</sub> and COM<sub>n</sub> can be either inputs or outputs.

### Power-Supply Sequencing

**Caution: Do not exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the device.**

Proper power-supply sequencing is recommended for all CMOS devices. Always apply V<sub>CC</sub> before applying analog signals, especially if the analog signal is not current limited.

## Typical Operating Circuit



# 7Ω Quad SPST Switches with Over-Rail Signal Handling

## Test Circuits/Timing Diagrams

MAX4854

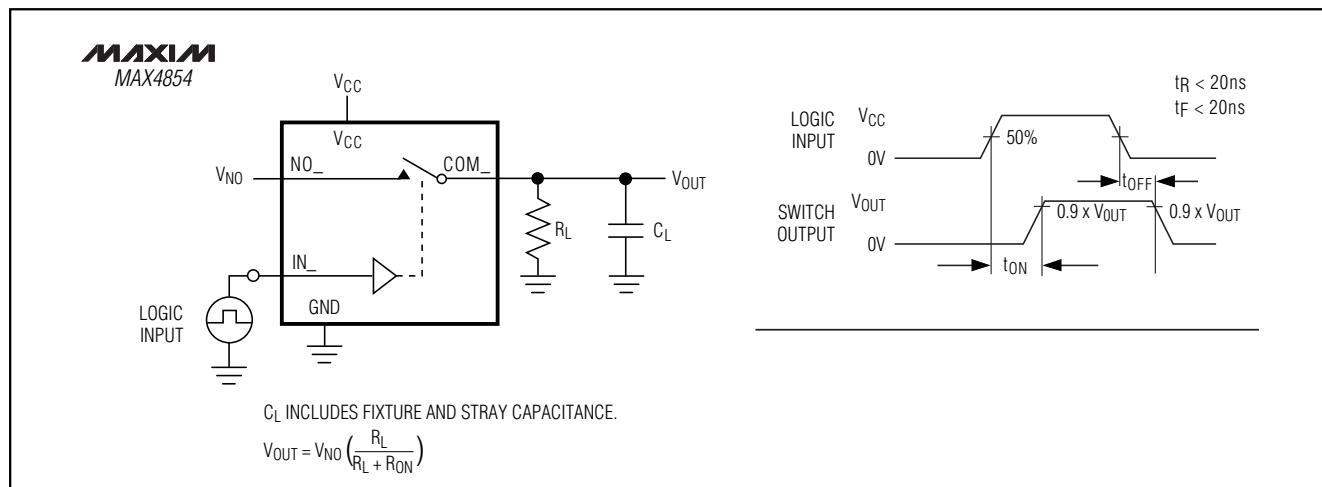


Figure 1. Switching Time

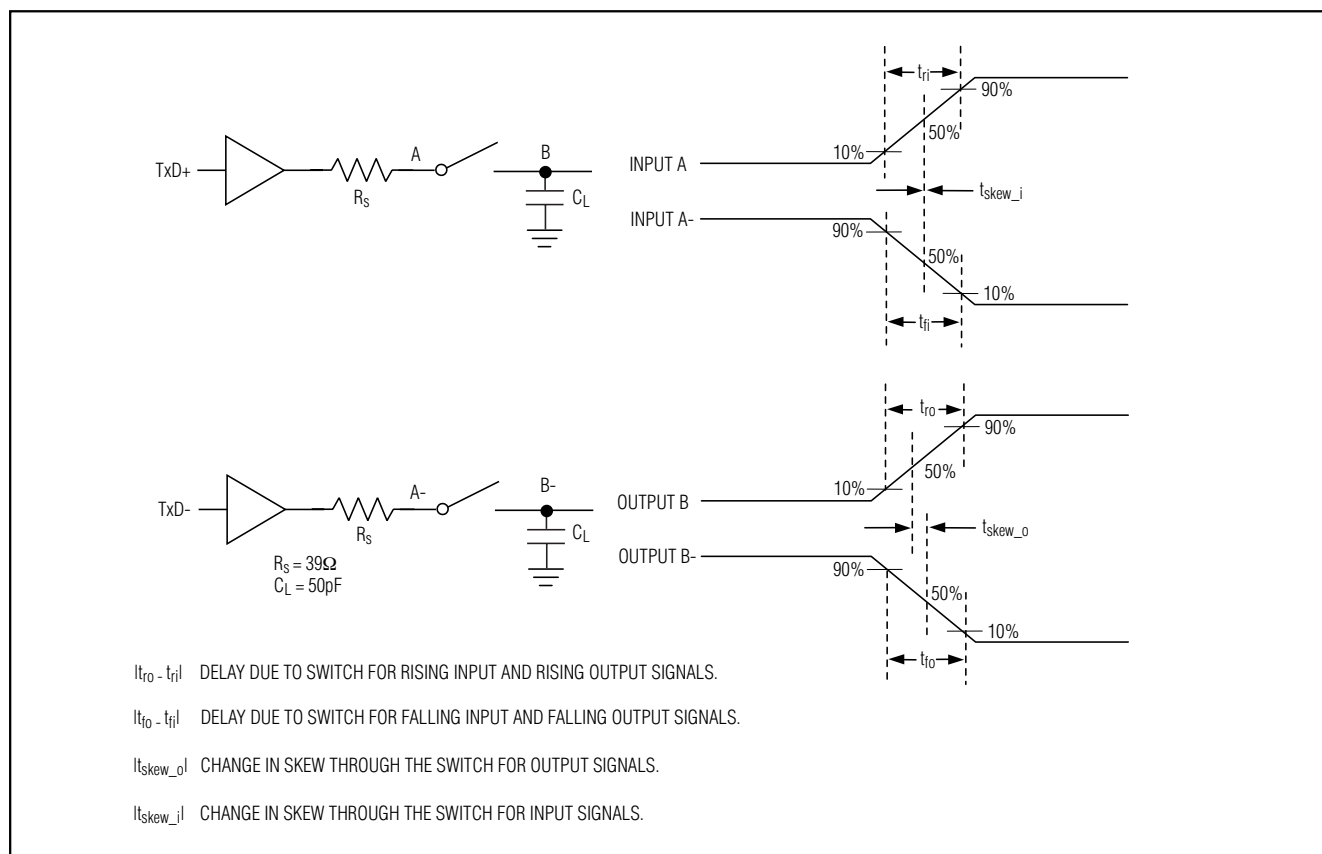


Figure 2. Input/Output Skew Timing Diagram

# 7Ω Quad SPST Switches with Over-Rail Signal Handling

## Test Circuits/Timing Diagrams (continued)

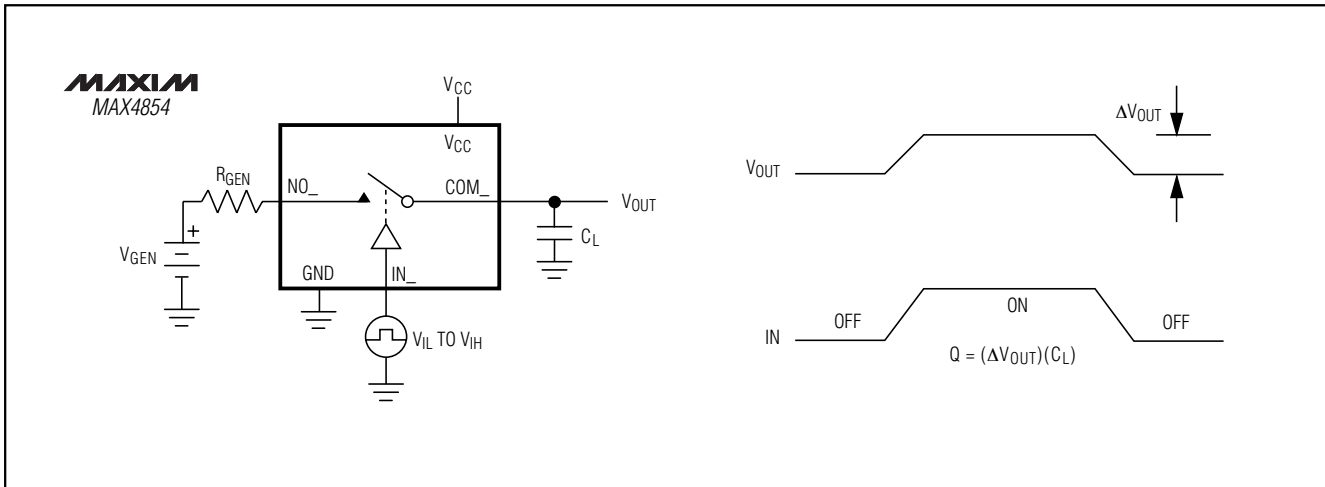


Figure 3. Charge Injection

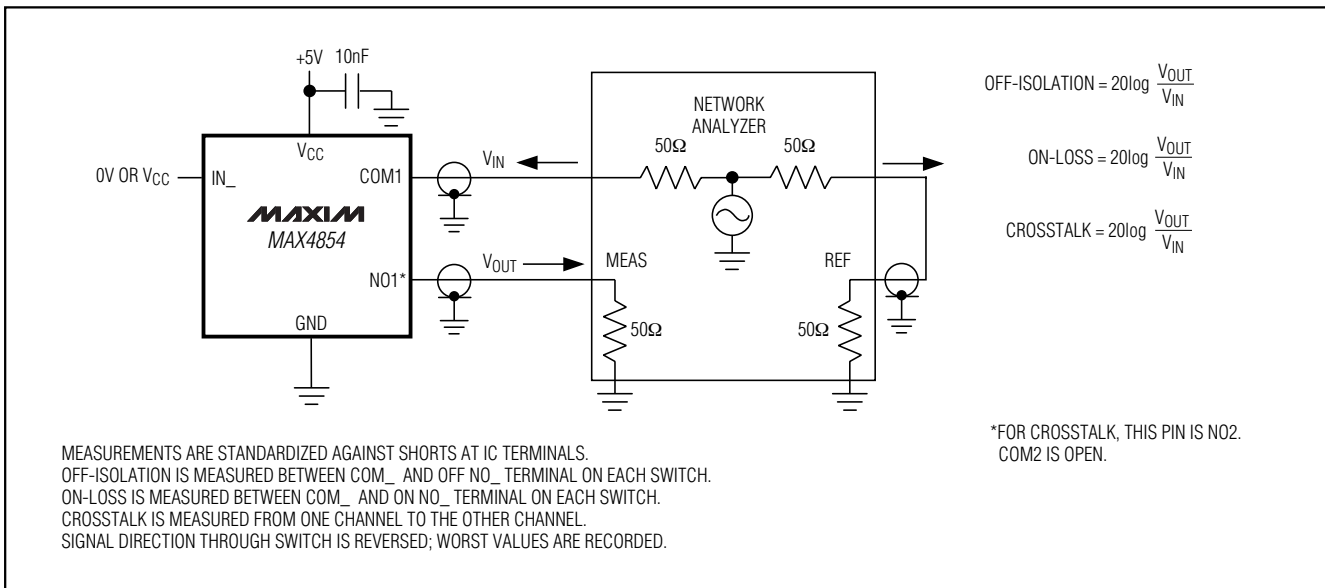


Figure 4. On-Loss, Off-Isolation, and Crosstalk

# 7 $\Omega$ Quad SPST Switches with Over-Rail Signal Handling

## Test Circuits/ Timing Diagrams (continued)

## Chip Information

TRANSISTOR COUNT: 735  
PROCESS: CMOS

**MAX4854**

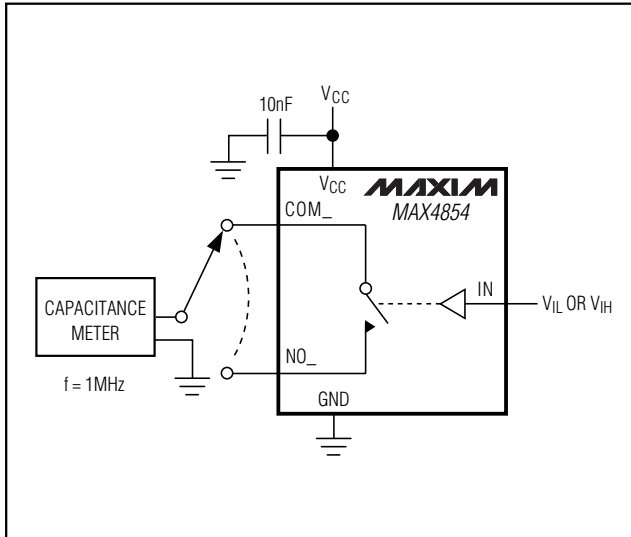
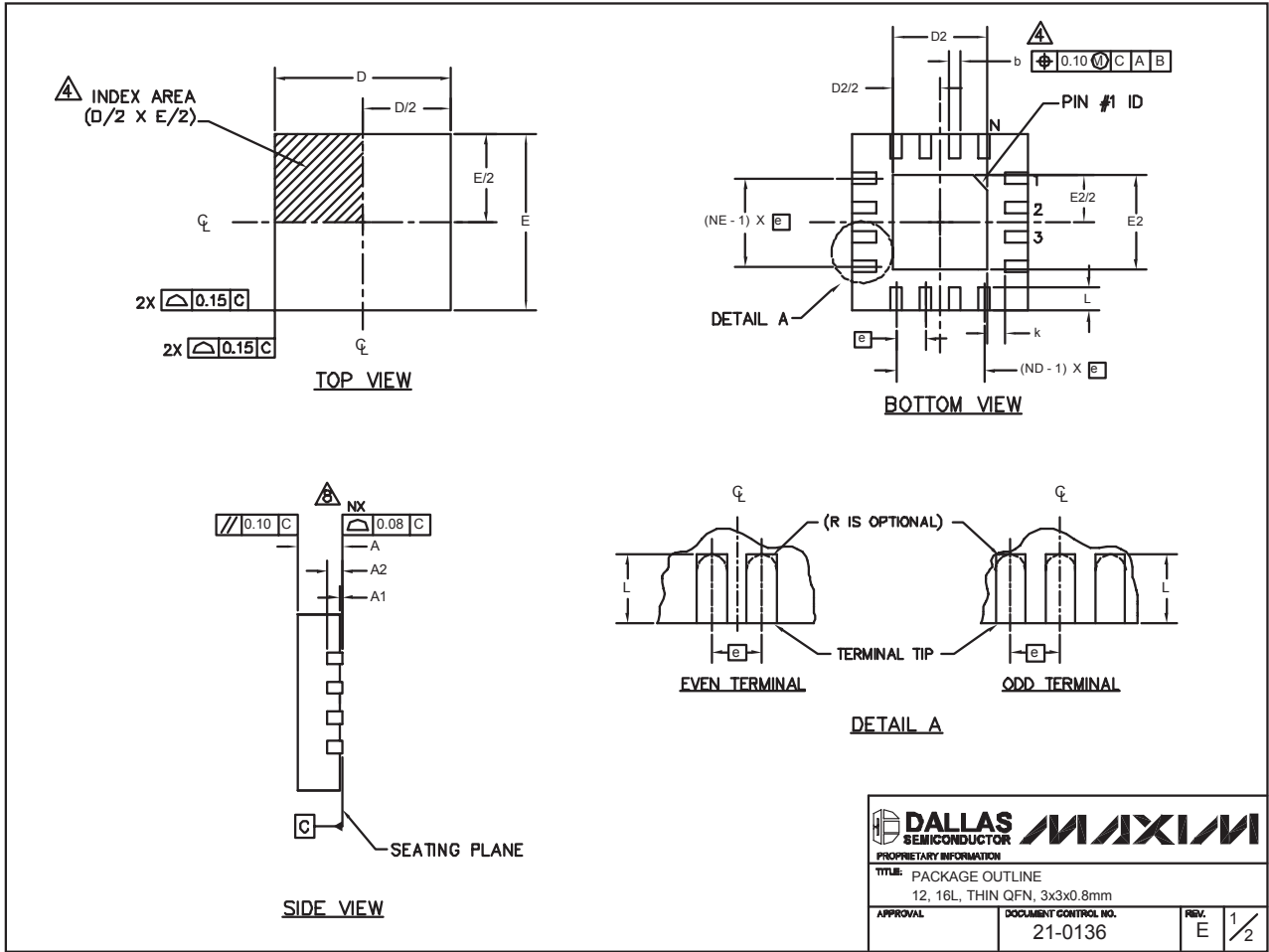


Figure 5. Channel Off-/On-Capacitance

# **7Ω Quad SPST Switches with Over-Rail Signal Handling**

## **Package Information**

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)



# 7Ω Quad SPST Switches with Over-Rail Signal Handling

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information, go to [www.maxim-ic.com/packages](http://www.maxim-ic.com/packages).)

MAX4854

| PKG  | 12L 3x3   |      |      | 16L 3x3   |      |      |
|------|-----------|------|------|-----------|------|------|
| REF. | MIN.      | NOM. | MAX. | MIN.      | NOM. | MAX. |
| A    | 0.70      | 0.75 | 0.80 | 0.70      | 0.75 | 0.80 |
| b    | 0.20      | 0.25 | 0.30 | 0.20      | 0.25 | 0.30 |
| D    | 2.90      | 3.00 | 3.10 | 2.90      | 3.00 | 3.10 |
| E    | 2.90      | 3.00 | 3.10 | 2.90      | 3.00 | 3.10 |
| e    | 0.50 BSC. |      |      | 0.50 BSC. |      |      |
| L    | 0.45      | 0.55 | 0.65 | 0.30      | 0.40 | 0.50 |
| N    | 12        |      |      | 16        |      |      |
| ND   | 3         |      |      | 4         |      |      |
| NE   | 3         |      |      | 4         |      |      |
| A1   | 0         | 0.02 | 0.05 | 0         | 0.02 | 0.05 |
| A2   | 0.20 REF  |      |      | 0.20 REF  |      |      |
| k    | 0.25      | -    | -    | 0.25      | -    | -    |

| EXPOSED PAD VARIATIONS |      |      |      |      |      |      |             |        |
|------------------------|------|------|------|------|------|------|-------------|--------|
| PKG. CODES             | D2   |      |      | E2   |      |      | PIN ID      | JEDEC  |
|                        | MIN. | NOM. | MAX. | MIN. | NOM. | MAX. |             |        |
| T1233-1                | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45°  | WEED-1 |
| T1233-3                | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45°  | WEED-1 |
| T1633-1                | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45°  | WEED-2 |
| T1633-2                | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45°  | WEED-2 |
| T1633F-3               | 0.85 | 0.80 | 0.85 | 0.85 | 0.80 | 0.85 | 0.225 x 45° | WEED-2 |
| T1633-4                | 0.95 | 1.10 | 1.25 | 0.95 | 1.10 | 1.25 | 0.35 x 45°  | WEED-2 |

### NOTES:

- DIMENSIONING & TOLERANCING CONFORM TO ASME Y14.5M-1994.
- ALL DIMENSIONS ARE IN MILLIMETERS. ANGLES ARE IN DEGREES.
- N IS THE TOTAL NUMBER OF TERMINALS.
- △ THE TERMINAL #1 IDENTIFIER AND TERMINAL NUMBERING CONVENTION SHALL CONFORM TO JESD 95-1 SPP-012. DETAILS OF TERMINAL #1 IDENTIFIER ARE OPTIONAL, BUT MUST BE LOCATED WITHIN THE ZONE INDICATED. THE TERMINAL #1 IDENTIFIER MAY BE EITHER A MOLD OR MARKED FEATURE.
- △ DIMENSION b APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.20 mm AND 0.25 mm FROM TERMINAL TIP.
- △ ND AND NE REFER TO THE NUMBER OF TERMINALS ON EACH D AND E SIDE RESPECTIVELY.
- DEPOPULATION IS POSSIBLE IN A SYMMETRICAL FASHION.
- △ COPLANARITY APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
- DRAWING CONFORMS TO JEDEC MO220 REVISION C.

|                                                                                       |                                        |
|---------------------------------------------------------------------------------------|----------------------------------------|
|  |                                        |
| <b>PROPRIETARY INFORMATION</b>                                                        |                                        |
| <b>TITLE:</b> PACKAGE OUTLINE<br>12, 16L, THIN QFN, 3x3x0.8mm                         |                                        |
| <b>APPROVAL</b>                                                                       | <b>DOCUMENT CONTROL NO.</b><br>21-0136 |
| <b>REV.</b><br>E                                                                      | <b>2/2</b>                             |

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