



**THE DATASHEET OF  
MAX4648EUT+T**





# 25Ω SPST Analog Switches in SOT23-6

MAX4647/MAX4648

## General Description

The MAX4647/MAX4648 are dual-supply single-pole/single-throw (SPST) switches. On-resistance is 25Ω max and flat (2Ω max) over the specified signal range. Each switch can handle rail-to-rail analog signals. Off-leakage current is only 1nA max at +25°C. They conduct analog or digital signals equally well in either direction. The primary application areas are in the switching and routing of signals in telecommunications and test equipment.

The MAX4647/MAX4648 are single SPST analog switches. The MAX4647 has one normally closed (NC) switch, and the MAX4648 has one normally open (NO) switch. These devices operate from a single +9V to +36V supply or from dual ±4.5V to ±20V supplies. The MAX4647/MAX4648 are available in tiny 6-pin SOT23 packages.

## Applications

- PBX, PABX Systems
- Communication Systems
- DSL
- Test Equipment
- Avionics
- Audio Systems
- Redundant Systems
- Relay Replacement
- PC Multimedia Boards

## Features

- ◆ Low On-Resistance 25Ω max (±15V Supplies)
- ◆ Guaranteed R<sub>ON</sub> Flatness Over Specified Signal Range (2Ω max)
- ◆ V<sub>L</sub> Logic Supply Not Required
- ◆ Rail-to-Rail Signal Handling
- ◆ ±15V and Single 12V Supply Operation
- ◆ Low Leakage (1nA max)
- ◆ Fast Switching Speeds
  - t<sub>ON</sub> = 100ns
  - t<sub>OFF</sub> = 100ns

## Ordering Information

| PART          | TEMP RANGE     | PIN-PACKAGE | TOP MARK | PKG CODE |
|---------------|----------------|-------------|----------|----------|
| MAX4647EUT-T+ | -40°C to +85°C | 6 SOT23     | AARV     | U6SN-1   |
| MAX4648EUT-T+ | -40°C to +85°C | 6 SOT23     | AARW     | U6SN-1   |

+Denotes a lead-free package.

## Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

**MAX4647**

SOT23-6

| LOGIC | SWITCH |
|-------|--------|
| 0     | ON     |
| 1     | OFF    |

**MAX4648**

SOT23-6

| LOGIC | SWITCH |
|-------|--------|
| 0     | OFF    |
| 1     | ON     |

# 25Ω SPST Analog Switches in SOT23-6

## ABSOLUTE MAXIMUM RATINGS

(Voltages referenced to GND)

|   |                        |
|---|------------------------|
| V+ .....  | -0.3V, +44.0V          |
| V- .....  | -44.0V, +0.3V          |
| V+ to V- .....  | -0.3V to +44.0V        |
| All Other Pins (Note 1) .....   | V- - 0.3V to V+ + 0.3V |
| Continuous Current into Any Terminal .....                              | ±60mA                  |
| Peak Current into Any Terminal<br>(pulsed at 1ms, 10% duty cycle) ..... | ±100mA                 |

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

|   |                 |
|---|-----------------|
| 6-Pin SOT23 (derate 8.7mW/°C above +70°C) ..... | 696mW           |
| Operating Temperature Ranges                    |                 |
| MAX464_EUT .....                                | -40°C to +85°C  |
| Storage Temperature Range .....                 | -65°C to +150°C |
| Junction Temperature .....                      | +150°C          |
| Lead Temperature (soldering, 10s) .....         | +300°C          |

**Note 1:** Signals on NO, NC, COM, or IN exceeding V+ or V- 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 – Dual ±15V Supplies

(V+ = +15V, V- = -15V, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C.) (Notes 2, 3)

| PARAMETER                          | SYMBOL  | CONDITIONS   | T <sub>A</sub>                       | MIN | TYP  | MAX | UNITS |
|------------------------------------|---|--|--------------------------------------|-----|------|-----|-------|
| <b>ANALOG SWITCH</b>               |   |  |                                      |     |      |     |       |
| Analog Signal Range                | V <sub>NO</sub> , V <sub>NC</sub> ,<br>V <sub>COM</sub> |  |                                      | V-  |      | V+  | V     |
| On-Resistance                      | R <sub>ON</sub>   | I <sub>COM</sub> = 10mA; V <sub>NO</sub><br>or V <sub>NC</sub> = ±10V                                | +25°C                                |     | 18   | 25  | Ω     |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | 30  |       |
| On-Resistance<br>Flatness (Note 4) | R <sub>FLAT(ON)</sub>                                   | I <sub>COM</sub> = 10mA; V <sub>NO</sub><br>or V <sub>NC</sub> = +5V, 0, -5V                         | +25°C                                |     | 0.8  | 2   | Ω     |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | 3   |       |
| NO or NC Off-Leakage<br>Current    | I <sub>NO(OFF)</sub> or<br>I <sub>NC(OFF)</sub>         | V <sub>NO</sub> or V <sub>NC</sub> = +14V, -14V;<br>V <sub>COM</sub> = -14V, +14V                    | +25°C                                | -1  | 0.01 | 1   | nA    |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> | -10 |      | 10  |       |
| COM Off-Leakage<br>Current         | I <sub>COM(OFF)</sub>                                   | V <sub>COM</sub> = -14V, +14V;<br>V <sub>NO</sub> or V <sub>NC</sub> = +14V, -14V                    | +25°C                                | -1  | 0.01 | 1   | nA    |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> | -10 |      | 10  |       |
| COM On-Leakage<br>Current          | I <sub>COM(ON)</sub>                                    | V <sub>COM</sub> = +14V, -14V;<br>V <sub>NO</sub> or V <sub>NC</sub> = +14V, -14V or<br>floating     | +25°C                                | -2  |      | 2   | nA    |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> | -20 |      | 20  |       |
| <b>LOGIC INPUT</b>                 |   |  |                                      |     |      |     |       |
| Input Logic High                   | V <sub>IH</sub>   |  | T <sub>MIN</sub> to T <sub>MAX</sub> | 2.4 |      |     | V     |
| Input Logic Low                    | V <sub>IL</sub>   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | 0.8 | V     |
| Input Leakage Current              | I <sub>IN</sub>   | V <sub>IN</sub> = 0 or +5V   | T <sub>MIN</sub> to T <sub>MAX</sub> | -1  |      | 1   | μA    |
| <b>DYNAMIC CHARACTERISTICS</b>     |   |  |                                      |     |      |     |       |
| Turn-On Time                       | t <sub>ON</sub>   | V <sub>NO</sub> or V <sub>NC</sub> = ±10V; R <sub>L</sub> = 300Ω;<br>C <sub>L</sub> = 35pF; Figure 2 | +25°C                                |     | 68   | 100 | ns    |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | 125 |       |
| Turn-Off Time                      | t <sub>OFF</sub>  | V <sub>NO</sub> or V <sub>NC</sub> = ±10V; R <sub>L</sub> = 300Ω;<br>C <sub>L</sub> = 35pF; Figure 2 | +25°C                                |     | 62   | 100 | ns    |
|                                    |   |  | T <sub>MIN</sub> to T <sub>MAX</sub> |     |      | 125 |       |
| Charge Injection                   | Q   | COM = 0; R <sub>S</sub> = 0; C <sub>L</sub> = 1nF;<br>Figure 3                                       | +25°C                                |     | 4    |     | pC    |

# 25Ω SPST Analog Switches in SOT23-6

MAX4647/MAX4648

## ELECTRICAL CHARACTERISTICS—Dual ±15V Supplies (continued)

(V+ = +15V, V- = -15V, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C. (Notes 2, 3))

| PARAMETER  | SYMBOL                                      | CONDITIONS  | T <sub>A</sub>                       | MIN  | TYP   | MAX | UNITS |
|--|---|---|--------------------------------------|------|-------|-----|-------|
| Off-Isolation                                      | V <sub>ISO</sub>                            | C <sub>L</sub> = 5pF; R <sub>L</sub> = 50Ω; f = 1MHz; V <sub>COM</sub> = 1V <sub>RMS</sub> ; Figure 4 | +25°C                                |      | -92   |     | dB    |
| Total Harmonic Distortion                          | THD   | R <sub>L</sub> = 600Ω, 5Vp-p, f = 20Hz to 20kHz   | +25°C                                |      | 0.006 |     | %     |
| V <sub>NO</sub> or V <sub>NC</sub> Off-Capacitance | C <sub>NO(OFF)</sub> , C <sub>NC(OFF)</sub> | f = 1MHz; Figure 5  | +25°C                                |      | 6     |     | pF    |
| COM Off-Capacitance                                | C <sub>COM(OFF)</sub>                       | f = 1MHz; Figure 5  | +25°C                                |      | 6     |     | pF    |
| COM On-Capacitance                                 | C <sub>COM(ON)</sub>                        | f = 1MHz; Figure 6  | +25°C                                |      | 19    |     | pF    |
| <b>POWER SUPPLY</b>                                |   |   |                                      |      |       |     |       |
| Power Supply Range                                 |   |   | T <sub>MIN</sub> to T <sub>MAX</sub> | ±4.5 |       | ±20 | V     |
| Positive Supply Current                            | I <sub>+</sub>                              | V <sub>IN</sub> = 5V  | +25°C                                |      | 45    | 100 | μA    |
|  |   |   | T <sub>MIN</sub> to T <sub>MAX</sub> |      |       | 150 |       |
|  |   | V <sub>IN</sub> = 0 or V <sub>+</sub>   | +25°C                                |      | 0.001 | 1   |       |
|  |   |   | T <sub>MIN</sub> to T <sub>MAX</sub> |      |       | 10  |       |
| Negative Supply Current                            | I <sub>-</sub>                              | V <sub>IN</sub> = 0 or 5V   | +25°C                                |      | 0.001 | 1   | μA    |
|  |   |   | T <sub>MIN</sub> to T <sub>MAX</sub> |      |       | 10  |       |

## ELECTRICAL CHARACTERISTICS—Single +12V Supply

(V+ = +12V, V- = 0, V<sub>IH</sub> = 2.4V, V<sub>IL</sub> = 0.8V, T<sub>A</sub> = T<sub>MIN</sub> to T<sub>MAX</sub>, unless otherwise noted. Typical values are at T<sub>A</sub> = +25°C. (Notes 2, 3))

| PARAMETER                       | SYMBOL   | CONDITIONS  | T <sub>A</sub>                       | MIN | TYP | MAX | UNITS |
|---------------------------------|--|---|--------------------------------------|-----|-----|-----|-------|
| <b>ANALOG SWITCH</b>            |  |   |                                      |     |     |     |       |
| Analog Signal Range             | V <sub>NO</sub> , V <sub>NC</sub> , V <sub>COM</sub> |   |                                      | 0   |     | V+  | V     |
| On-Resistance                   | R <sub>ON</sub>                                      | I <sub>COM</sub> = 10mA; V <sub>NO</sub> or V <sub>NC</sub> = +10V                                | +25°C                                |     | 36  | 45  | Ω     |
|                                 |  |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 60  |       |
| On-Resistance Flatness (Note 4) | R <sub>FLAT(ON)</sub>                                | I <sub>COM</sub> = 10mA; V <sub>NO</sub> or V <sub>NC</sub> = +2V, +6V, +10V                      | +25°C                                |     | 4   | 6   | Ω     |
|                                 |  |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 8   |       |
| <b>DYNAMIC</b>                  |  |   |                                      |     |     |     |       |
| Turn-On Time                    | t <sub>ON</sub>                                      | V <sub>NO</sub> or V <sub>NC</sub> = +10V; R <sub>L</sub> = 300Ω; C <sub>L</sub> = 35pF; Figure 2 | +25°C                                |     | 100 | 175 | ns    |
|                                 |  |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 225 |       |
| Turn-Off Time                   | t <sub>OFF</sub>                                     | V <sub>NO</sub> or V <sub>NC</sub> = +10V; R <sub>L</sub> = 300Ω; C <sub>L</sub> = 35pF; Figure 2 | +25°C                                |     | 68  | 150 | ns    |
|                                 |  |   | T <sub>MIN</sub> to T <sub>MAX</sub> |     |     | 200 |       |
| Charge Injection                | Q  | COM = 0; R <sub>S</sub> = 0; C <sub>L</sub> = 1nF; Figure 3                                       | +25°C                                |     | -5  |     | pC    |

# 25Ω SPST Analog Switches in SOT23-6

## ELECTRICAL CHARACTERISTICS—Single +12V Supply (continued)

( $V_+ = +12V$ ,  $V_- = 0$ ,  $V_{IH} = 2.4V$ ,  $V_{IL} = 0.8V$ ,  $T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted. Typical values are at  $T_A = +25^\circ C$ .)  
(Notes 2, 3)

| PARAMETER               | SYMBOL | CONDITIONS            | $T_A$                  | MIN | TYP   | MAX | UNITS   |
|-------------------------|--------|-----------------------|------------------------|-----|-------|-----|---------|
| Power Supply Range      |        |                       | $T_{MIN}$ to $T_{MAX}$ | +9  |       | +36 | V       |
| Positive Supply Current | I+     | $V_{IN} = 5V$         | +25°C                  |     | 20    | 50  | $\mu A$ |
|                         |        |                       | $T_{MIN}$ to $T_{MAX}$ |     |       | 75  |         |
|                         |        | $V_{IN} = 0$ or $V_+$ | +25°C                  |     | 0.001 | 1   |         |
|                         |        |                       | $T_{MIN}$ to $T_{MAX}$ |     |       | 10  |         |

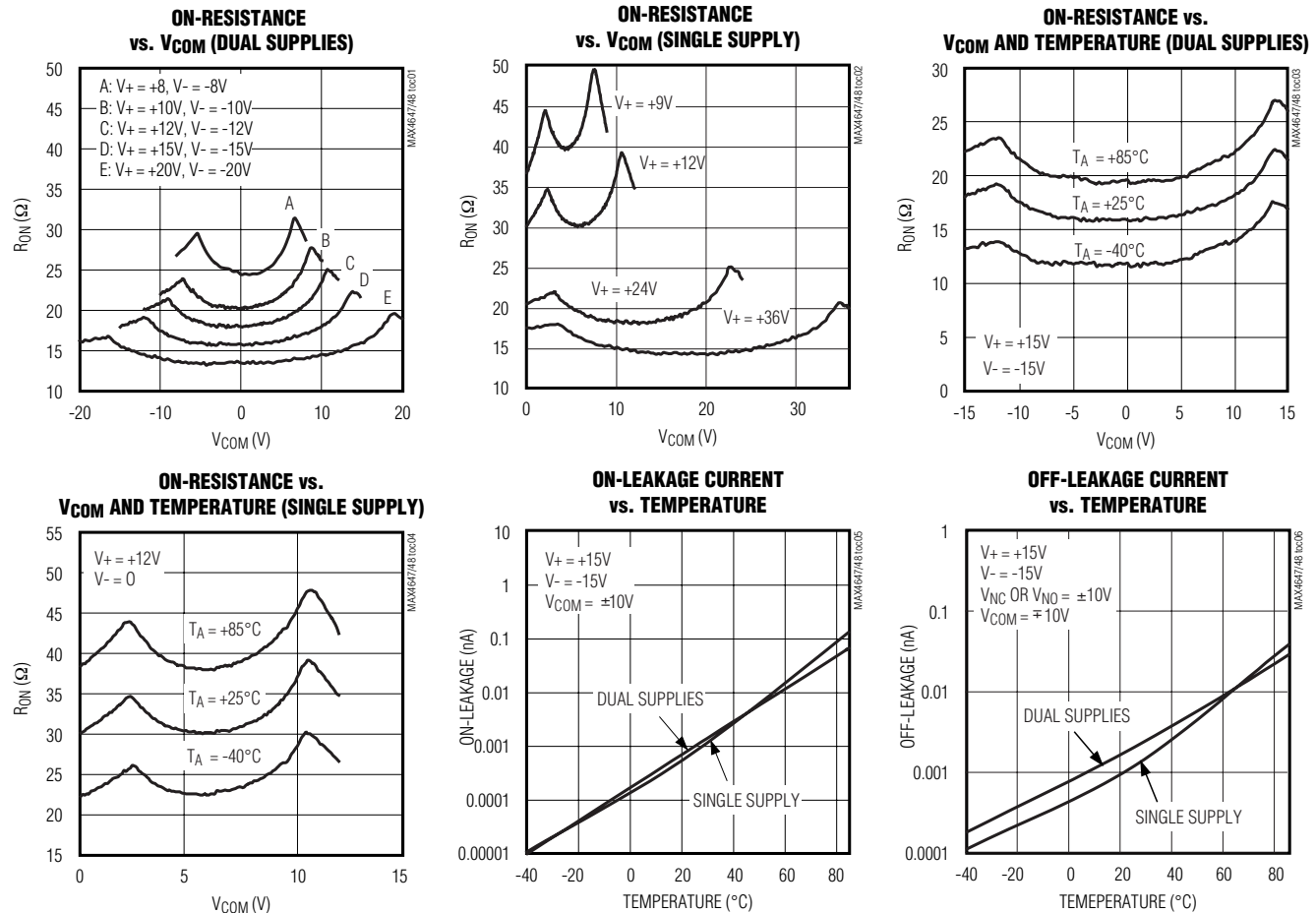
**Note 2:** The algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.

**Note 3:** SOT packaged parts are 100% tested at +25°C. Limits across the full temperature range are guaranteed by design and correlation.

**Note 4:** Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.

## Typical Operating Characteristics

( $T_A = +25^\circ C$ , unless otherwise noted.)

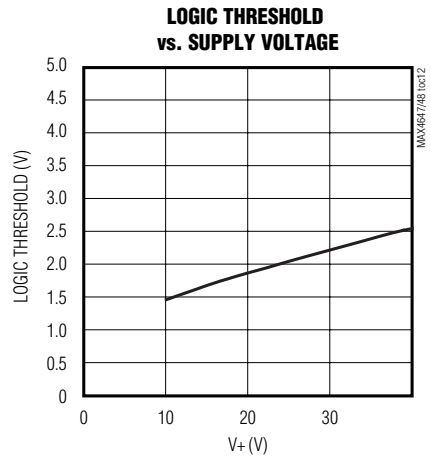
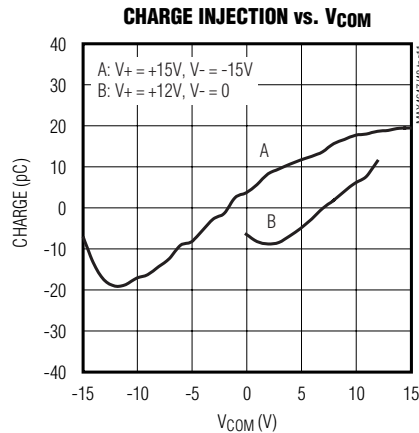
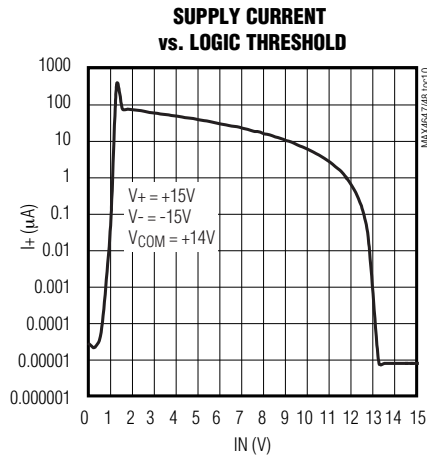
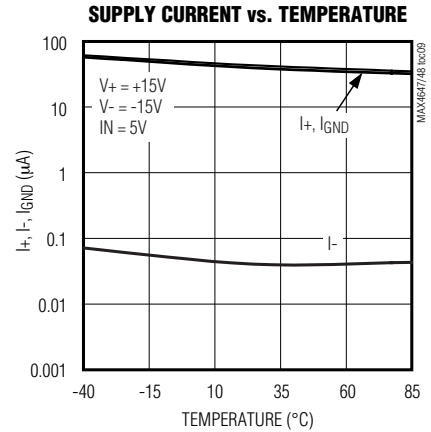
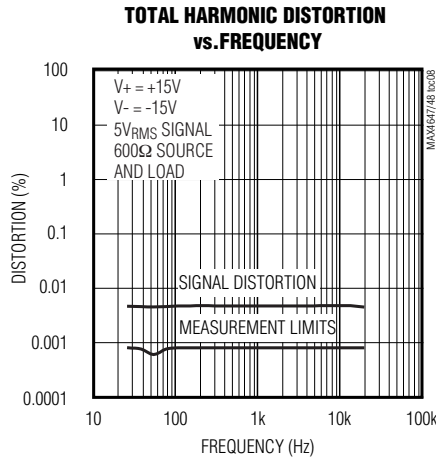
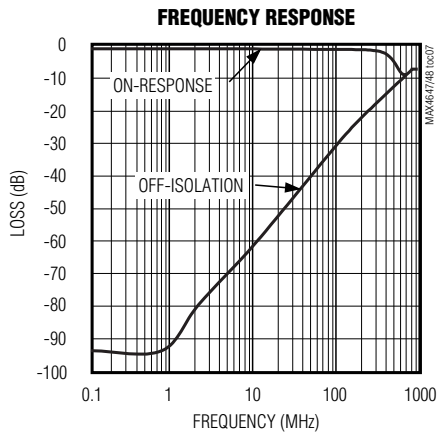


# 25Ω SPST Analog Switches in SOT23-6

MAX4647/MAX4648

## Typical Operating Characteristics (continued)

( $T_A = +25^\circ\text{C}$ , unless otherwise noted.)



## Pin Description

| MAX4647 | MAX4648 | PIN NAME | FUNCTION                        |
|---------|---------|----------|---------------------------------|
| 1       | —       | NC       | Normally Closed Switch Terminal |
| —       | 1       | NO       | Normally Open Switch Terminal   |
| 2       | 2       | $V_-$    | Negative Supply Voltage Input   |
| 3       | 3       | IN       | Digital Control Input           |
| 4       | 4       | GND      | Ground                          |
| 5       | 5       | $V_+$    | Positive Supply Voltage Input   |
| 6       | 6       | COM      | Analog Switch Common            |

# 25Ω SPST Analog Switches in SOT23-6

## Applications Information

### Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, then V-, followed by the logic inputs, NO, NC, or COM. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with supply pins (Figure 1). Adding diodes reduces the analog signal range to one diode drop below V+ and one diode drop above V-, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and V- should not exceed 44V. These protection diodes are not recommended when using a single supply.

### Off-Isolation at High Frequencies

In 50Ω systems, the high-frequency on-response of these parts extends from DC to above 300MHz, with a typical loss of -2dB. When the switch is turned off, however, it behaves like a capacitor, and off-isolation decreases with increasing frequency. This effect is

more pronounced with higher source and load impedances. Above 5MHz, circuit board layout becomes critical. The graphs shown in the *Typical Operating Characteristics* were taken using a 50Ω source and load connected with BNC connectors.

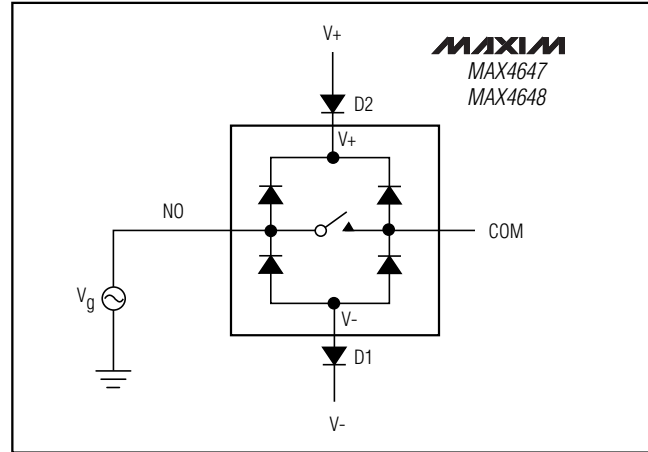


Figure 1. Overvoltage Protection Using External Blocking Diodes

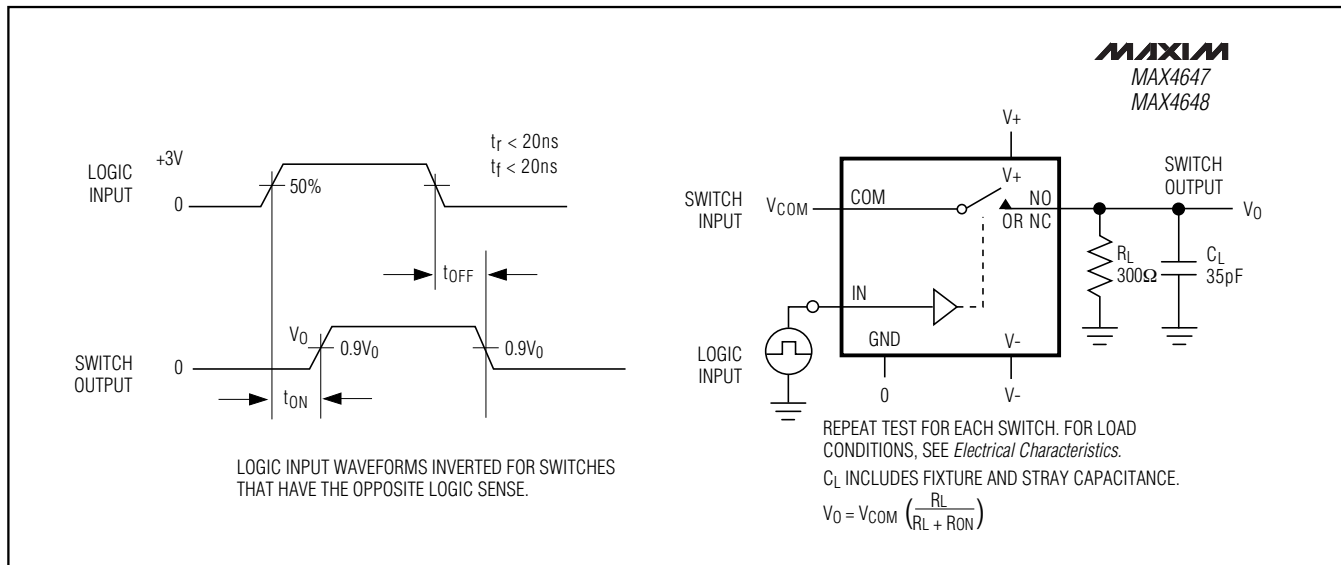


Figure 2. Switching-Time Test Circuit

# 25Ω SPST Analog Switches in SOT23-6

**MAX4647/MAX4648**

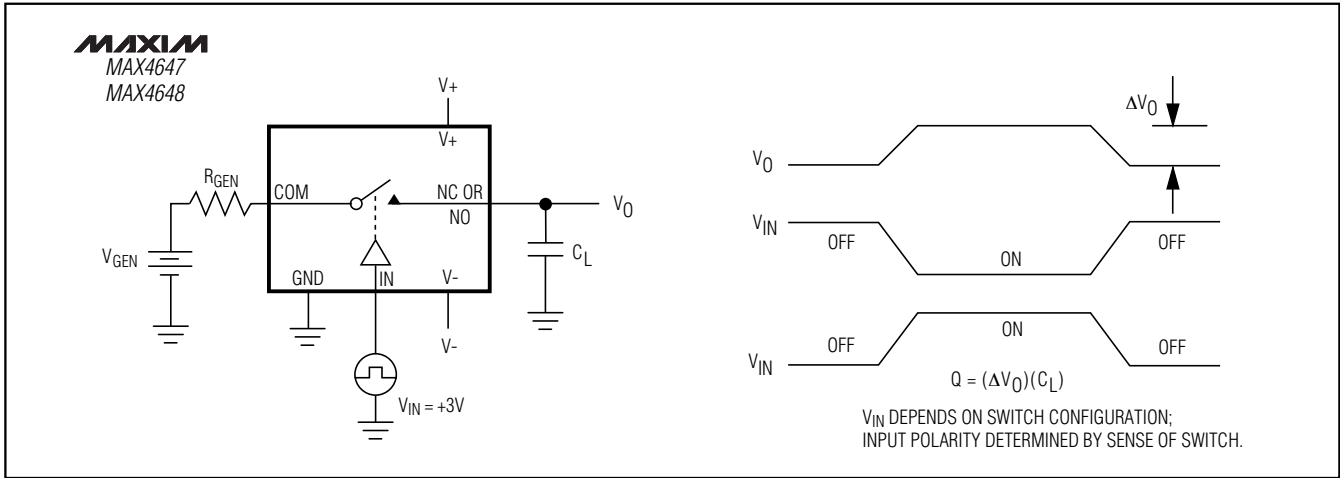


Figure 3. Charge Injection Test Circuit

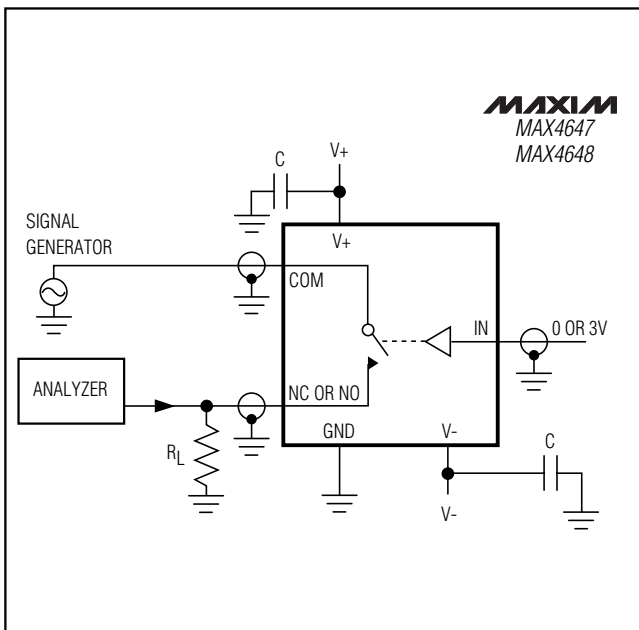


Figure 4. Off-Isolation Test Circuit

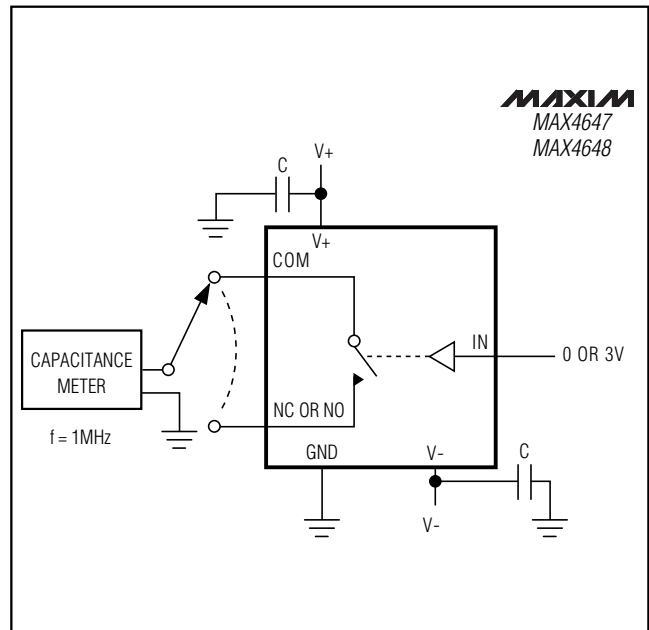


Figure 5. Channel-Off Capacitance Test Circuit

# 25Ω SPST Analog Switches in SOT23-6

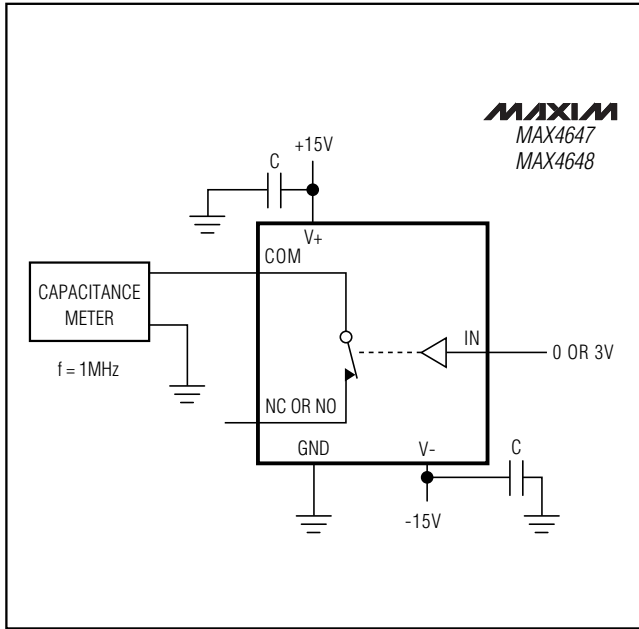


Figure 6. Channel-On Capacitance Test Circuit

## Chip Information

TRANSISTOR COUNT: 24

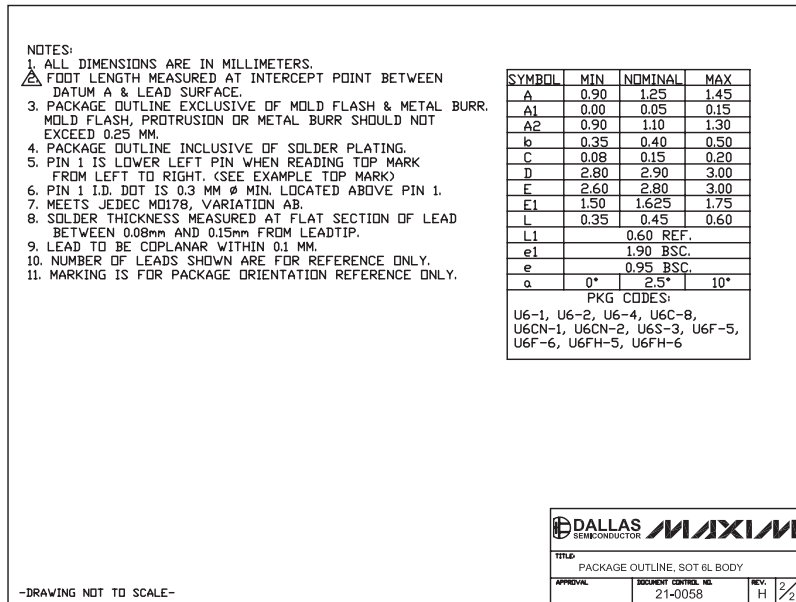
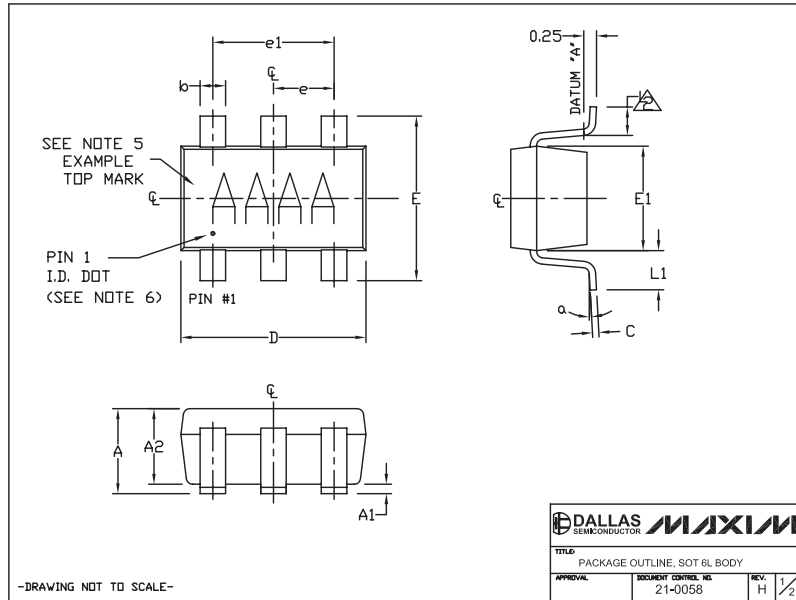
PROCESS TECHNOLOGY: CMOS

# 25Ω SPST Analog Switches in SOT23-6

## 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).)

MAX4647/MAX4648



## Revision History



Pages changed at Rev 1: 1, 9

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

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