



THE DATASHEET OF MAX4653ESE





Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

MAX4651/MAX4652/MAX4653

General Description

The MAX4651/MAX4652/MAX4653 quad analog switches feature 4Ω max on-resistance (RON) when operating from a single +5V supply. RON is matched between switches to 0.2Ω (max) and is flat (0.8Ω max) over the specified signal range. Each switch can handle Rail-to-Rail® analog signals. Off-leakage current is 0.1nA at +25°C. These switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automated test equipment or applications where current switching is required. They have low power requirements, require less board space, and are more reliable than mechanical relays.

The MAX4651/MAX4652/MAX4653 operate from a single +1.8V to +5.5V supply, making them ideal for use in battery-powered applications.

The MAX4651 has four normally closed (NC) switches, the MAX4652 has four normally open (NO) switches, and the MAX4653 has two NO and two NC switches. These devices are available in 16-pin QFN, TSSOP and SO packages, as well as 20-pin QFN package.

Applications

- Battery-Powered Systems
- Audio and Video Signal Routing
- Low-Voltage Data-Acquisition Systems
- Sample-and-Hold Circuits
- Communications Circuits
- Relay Replacement

Rail-to-Rail is a registered trademark of Nippon Motorola, Ltd.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

TSSOP/SO

| MAX4651 | |
|---------|--------|
| LOGIC | SWITCH |
| 0 | ON |
| 1 | OFF |

TSSOP/SO

| MAX4652 | |
|---------|--------|
| LOGIC | SWITCH |
| 0 | OFF |
| 1 | ON |

SWITCHES SHOWN FOR LOGIC "0" INPUT

TSSOP/SO

| MAX4653 | | |
|---------|---------------|---------------|
| LOGIC | SWITCHES 1, 4 | SWITCHES 2, 3 |
| 0 | OFF | ON |
| 1 | ON | OFF |

Pin Configurations continued at end of data sheet.

Features

- ◆ On-Resistance
 - 4Ω max at 5V
 - 7Ω max at 3V
- ◆ On-Resistance Flatness
 - 0.8Ω max at 5V
 - 2.5Ω max at 3V
- ◆ On-Resistance Matching
 - 0.2Ω max (+2.7V to +5.5V)
- ◆ +1.8V to +5.5V Single-Supply Voltage
- ◆ +1.8V Operation
 - On-Resistance 30Ω (typ) Over Temperature
 - tON 20ns typ, tOFF 12ns (typ)
- ◆ TTL/CMOS-Logic Compatible
- ◆ Crosstalk
 - 100dB at 1MHz
- ◆ Off-Isolation
 - 75dB at 1MHz
- ◆ Rail-to-Rail Signal Range

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|------------|----------------|----------------|
| MAX4651EGE | -40°C to +85°C | 16 QFN (4 × 4) |
| MAX4651EUE | -40°C to +85°C | 16 TSSOP |
| MAX4651ESE | -40°C to +85°C | 16 SO |
| MAX4651EGP | -40°C to +85°C | 20 QFN (4 × 4) |

Ordering Information continued at end of data sheet.



For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

V+ to GND-0.3 to +6V
 IN_, COM_, NO_, NC_ to GND (Note 1).....-0.3V to (V+ + 0.3V)
 Continuous Current (NO_, NC_, COM_).....±50mA
 Peak Current (NO_, NC_, COM_, pulsed at 1ms
 10% duty cycle).....±100mA

Continuous Power Dissipation (T_A = +70°C)
 16-Pin QFN (derate 18.5mW/°C above +70°C)1481mW
 16-Pin TSSOP (derate 5.7mW/°C above +70°C)457mW
 16-Pin SO (derate 8mW/°C above +70°C).....640mW
 20-Pin QFN (derate 20mW/°C above +70°C)1600mW
 Operating Temperature Range-40°C to +85°C
 Storage Temperature Range-65°C to +150°C
 Lead Temperature (soldering, 10s)+300°C

Note 1: Signals on NO_, NC_, COM_, or IN_ exceeding V+ or GND are clamped by internal diodes. Limit forward 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—Single +5V Supply

(V+ = 4.5V to 5.5V, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V+ = 5V, T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--|---|--|------|------|------|-------|----|
| ANALOG SWITCH | | | | | | | |
| Input Voltage Range | V _{COM_} , V _{NO_} , V _{NC_} | | 0 | | V+ | V | |
| COM_ to NO_ or NC_ On-Resistance | R _{ON} | I _{COM} = 10mA, V _{NO_} or V _{NC_} = 0 to V+, V+ = 4.5V | | 2.5 | 4 | Ω | |
| | | T _A = T _{MIN} to T _{MAX} | | | 4.5 | | |
| COM_ to NO_ or NC_ On-Resistance Match Between Channels (Notes 3, 8) | ΔR _{ON} | I _{COM} = 10mA, V _{NO_} or V _{NC_} = 0 to V+, V+ = 4.5V | | 0.05 | 0.2 | Ω | |
| | | T _A = T _{MIN} to T _{MAX} | | | 0.3 | | |
| On-Resistance Flatness (Note 4) | R _{FLAT(ON)} | I _{COM} = 10mA, V _{NO_} or V _{NC_} = 0 to V+, V+ = 4.5V | | 0.5 | 0.8 | Ω | |
| | | T _A = T _{MIN} to T _{MAX} | | | 1 | | |
| Off-Leakage Current (NO_ or NC_) (Note 5) | I _{NO_} , I _{NC_} | V _{COM} = 1V, 4.5V; V _{NO_} or V _{NC_} = 4.5V, 1V; V+ = 5.5V | | -0.1 | 0.01 | 0.1 | nA |
| | | T _A = T _{MIN} to T _{MAX} | | -0.2 | | 0.2 | |
| COM_ Off-Leakage Current (Note 5) | I _{COM(OFF)} | V _{COM} = 1V, 4.5V; V _{NO_} or V _{NC_} = 4.5V, 1V; V+ = 5.5V | | -0.1 | 0.01 | 0.1 | nA |
| | | T _A = T _{MIN} to T _{MAX} | | -0.2 | | 0.2 | |
| COM_ On-Leakage Current (Note 5) | I _{COM(ON)} | V+ = 5.5V, V _{COM} = 1V, 4.5V; V _{NO_} or V _{NC_} = 1V, 4.5V or floating | | -0.1 | 0.01 | 0.1 | nA |
| | | T _A = T _{MIN} to T _{MAX} | | -0.2 | | 0.2 | |
| LOGIC INPUT (IN_) | | | | | | | |
| Input High | V _{IH} | | 2.4 | | | V | |
| Input Low | V _{IL} | | | | 0.8 | V | |
| Logic Input Current | I _{IN} | | -100 | 5 | 100 | nA | |

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

MAX4651/MAX4652/MAX4653

ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = 4.5V to 5.5V, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V+ = 5V, T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|-----------------------|--|---|-------|-----|-------|
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | |
| Turn-On Time (Note 5) | t _{ON} | V _{NO_} = V _{NC_} = 3V, R _L = 300Ω, C _L = 35pF, Figure 2 | T _A = +25°C | 11 | 14 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | 16 | |
| Turn-Off Time (Note 5) | t _{OFF} | V _{NO_} = V _{NC_} = 3V, R _L = 300Ω, C _L = 35pF, Figure 2 | T _A = +25°C | 6 | 8 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | 10 | |
| Break-Before-Make (MAX4653 only) (Note 5) | | V _{NO_} = V _{NC_} = 3V, R _L = 300Ω, C _L = 35pF | T _A = +25°C | 1 | 6 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | 1 | | |
| Charge Injection | Q | V _{GEN} = 2V, C _L = 1.0nF, R _{GEN} = 0, Figure 3 | | 2 | | pC |
| NO_ or NC_ Off-Capacitance | C _{OFF} | V _{NO_} = V _{NC_} = GND, f = 1MHz, Figure 6 | | 16 | | pF |
| COM_ Off-Capacitance | C _{COM(OFF)} | V _{COM_} = GND, f = 1MHz, Figure 6 | | 16 | | pF |
| COM_ On-Capacitance | C _{COM(ON)} | V _{COM_} = V _{NO_} , V _{NC_} = GND, f = 1MHz, Figure 7 | | 32 | | pF |
| Off-Isolation (Note 6) | V _{ISO} | R _L = 50Ω, C _L = 5pF, f = 10MHz, Figure 4 | | -50 | | dB |
| | | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 4 | | -75 | | |
| Crosstalk (Note 7) | V _{CT} | R _L = 50Ω, C _L = 5pF, f = 10MHz, Figure 5 | | -80 | | dB |
| | | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 5 | | -100 | | |
| Total Harmonic Distortion | THD | R _L = 600Ω, f = 20Hz to 20kHz | | 0.02 | | % |
| POWER SUPPLY | | | | | | |
| Positive Supply Current | I ₊ | V+ = 5.5V, V _{IN} = 0 or V+ | | 0.001 | 1.0 | μA |

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = 2.7V to 3.3V, V_{IH} = 2.0V, V_{IL} = 0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V+ = 3V, T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|---|--|---|-----|-----|-------|
| ANALOG SWITCH | | | | | | |
| Input Voltage Range | V _{COM_} , V _{NO_} , V _{NC_} | | 0 | | V+ | V |
| COM_ to NO_ or NC_ On-Resistance | R _{ON} | V+ = 2.7V, I _{COM} = 10mA, V _{NO_} or V _{NC_} = 0 to V+ | T _A = +25°C | 5 | 7 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | 8 | |
| COM_ to NO_ or NC_ On-Resistance Match Between Channels (Notes 3, 8) | ΔR _{ON} | V+ = 2.7V, I _{COM} = 10mA, V _{NO_} or V _{NC_} = 0 to V+ | T _A = +25°C | 0.1 | 0.2 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.3 | |
| On-Resistance Flatness (Note 4) | R _{FLAT(ON)} | V+ = 2.7V, I _{COM} = 10mA, V _{NO_} or V _{NC_} = 0 to V+ | T _A = +25°C | 1.2 | 2.5 | Ω |
| | | | T _A = T _{MIN} to T _{MAX} | | 3 | |

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

ELECTRICAL CHARACTERISTICS—Single +3V Supply (continued)

(V+ = 2.7V to 3.3V, V_{IH} = 2.0V, V_{IL} = 0.4V, T_A = T_{MIN} to T_{MAX}, unless otherwise specified. Typical values are at V+ = 3V, T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|-----------------------|--|---|-------|-----|-------|
| LOGIC INPUT (IN₋) | | | | | | |
| Input High | V _{IH} | | 2.0 | | | V |
| Input Low | V _{IL} | | | | 0.4 | V |
| Logic Input Current | I _{IN} | | -100 | 5 | 100 | nA |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | |
| Turn-On Time (Note 5) | t _{ON} | V _{NO₋} = V _{NC₋} = 2V, R _L = 300Ω, C _L = 35pF, Figure 2 | T _A = +25°C | 13 | 16 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | 20 | |
| Turn-Off Time (Note 5) | t _{OFF} | V _{NO₋} = V _{NC₋} = 2V, R _L = 300Ω, C _L = 35pF, Figure 2 | T _A = +25°C | 7 | 10 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | 12 | |
| Break-Before-Make (MAX4653 only) (Note 5) | | V _{NO₋} = V _{NC₋} = 2V, R _L = 300Ω, C _L = 35pF | T _A = +25°C | 1 | 7 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | 1 | | |
| Charge Injection | Q | V _{GEN} = 1.5V, C _L = 1.0nF, R _{GEN} = 0, Figure 3 | | 2 | | pC |
| NO ₋ or NC ₋ Off-Capacitance | C _{OFF} | V _{NO₋} = V _{NC₋} = GND, f = 1MHz, Figure 6 | | 16 | | pF |
| COM ₋ Off-Capacitance | C _{COM(OFF)} | V _{COM₋} = GND, f = 1MHz, Figure 6 | | 16 | | pF |
| COM ₋ On-Capacitance | C _{COM(ON)} | V _{COM₋} = V _{NO₋} , V _{NC₋} = GND, f = 1MHz, Figure 7 | | 32 | | pF |
| Off-Isolation (Note 6) | V _{ISO} | R _L = 50Ω, C _L = 5pF, f = 10MHz, Figure 4 | | -50 | | dB |
| | | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 4 | | -75 | | |
| Crosstalk (Note 7) | V _{CT} | R _L = 50Ω, C _L = 5pF, f = 10MHz, Figure 5 | | -80 | | dB |
| | | R _L = 50Ω, C _L = 5pF, f = 1MHz, Figure 5 | | -100 | | |
| Total Harmonic Distortion | THD | R _L = 600Ω, f = 20Hz to 20kHz | | 0.02 | | % |
| POWER SUPPLY | | | | | | |
| Positive Supply Current | I+ | V+ = 3.3V, V _{IN} = 0 or V+ | | 0.001 | 1.0 | μA |

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value is a maximum, is used in this data sheet.

Note 3: $\Delta R_{ON} = R_{ON(MAX)} - R_{ON(MIN)}$.

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

Note 5: Guaranteed by design.

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

Note 7: Between any two switches.

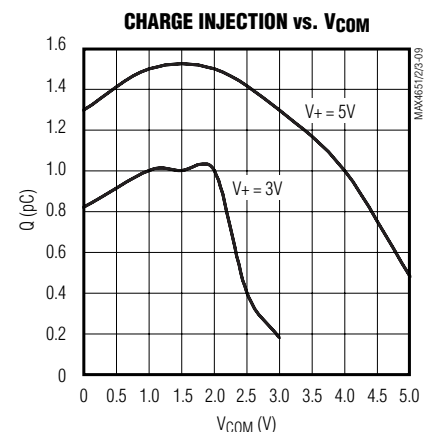
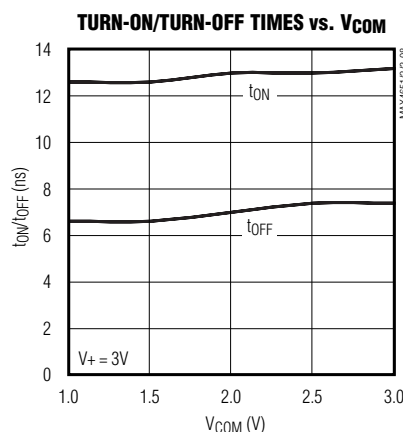
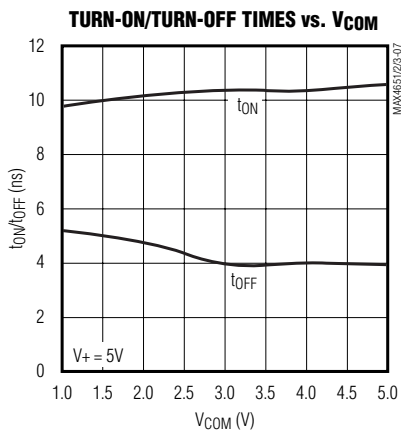
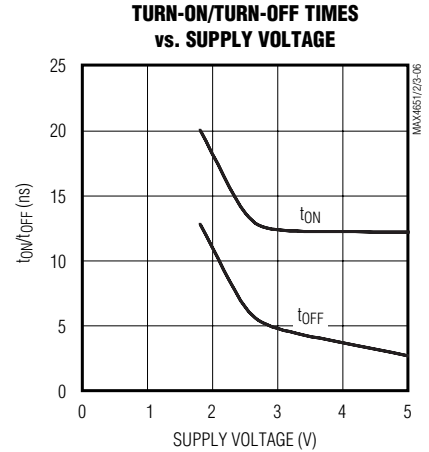
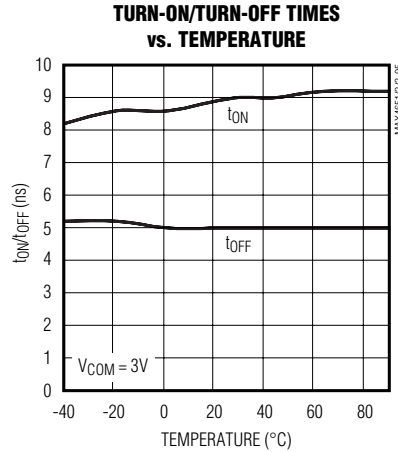
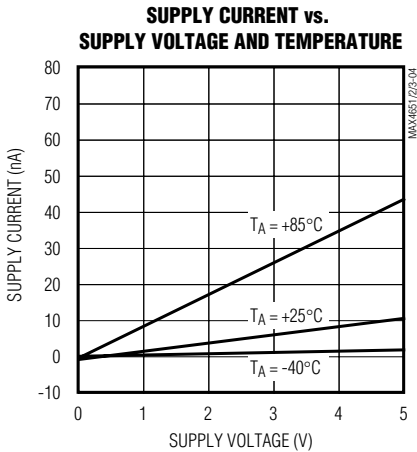
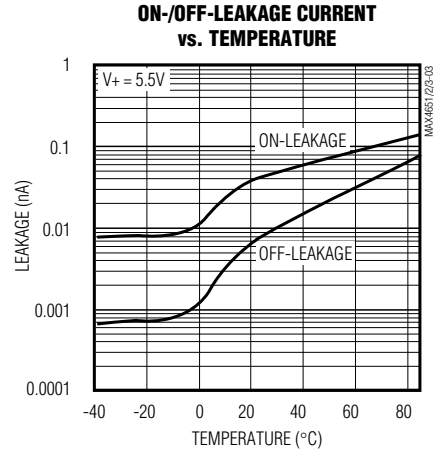
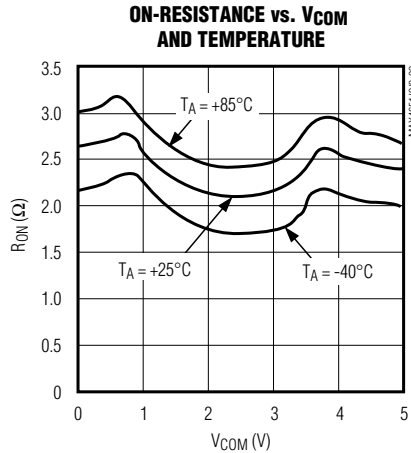
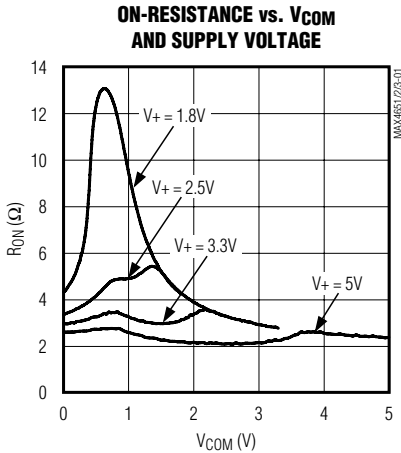
Note 8: ΔR_{ON} matching specifications for QFN-packages parts are guaranteed by design.

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Typical Operating Characteristics

(V+ = 5V, TA = +25°C, unless otherwise noted.)

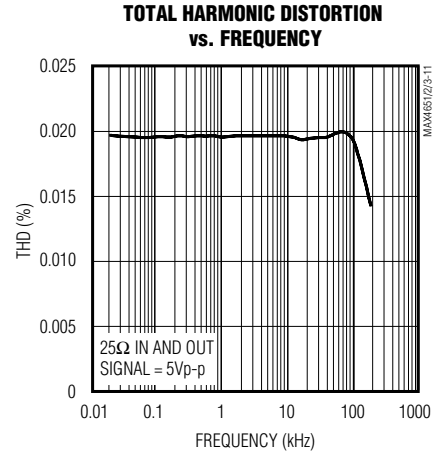
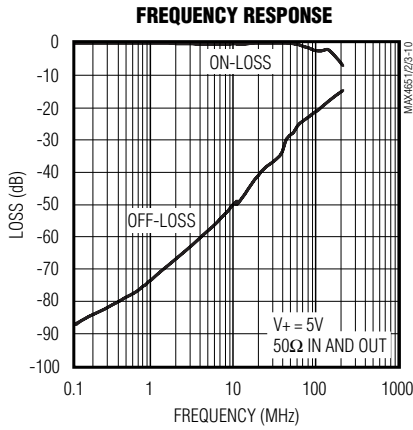
MAX4651/MAX4652/MAX4653



Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Typical Operating Characteristics (continued)

(V+ = 5V, TA = +25°C, unless otherwise noted.)



Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Pin Description

MAX4651/MAX4652/MAX4653

| PIN | | | | | | | | | NAME | FUNCTION |
|--------------|---------------|----------------------------|--------------|---------------|----------------------------|--------------|---------------|----------------------------|------|--|
| MAX4651 | | | MAX4652 | | | MAX4653 | | | | |
| TSSOP/ SO | 16-PIN QFN | 20-PIN QFN | TSSOP/ SO | 16-PIN QFN | 20-PIN QFN | TSSOP/ SO | 16-PIN QFN | 20-PIN QFN | | |
| 1 | 15 | 19 | 1 | 15 | 19 | 1 | 15 | 19 | IN1 | Digital Control Input 1 |
| 2 | 16 | 1 | 2 | 16 | 1 | 2 | 16 | 1 | COM1 | Analog Switch 1 Common Terminal |
| 3 | 1 | 2 | — | — | — | — | — | — | NC1 | Analog Switch 1 Normally Closed Terminal |
| — | — | — | 3 | 1 | 2 | 3 | 1 | 2 | NO1 | Analog Switch 1 Normally Open Terminal |
| 4, 12 | 2, 10 | 6, 8, 10, 16, 18, 20 | 4, 12 | 2, 10 | 6, 8, 10, 16, 18, 20 | 4, 12 | 2, 10 | 6, 8, 10, 16, 18, 20 | N.C. | No Connection. Not internally connected. |
| 5 | 3 | 3 | 5 | 3 | 3 | 5 | 3 | 3 | GND | Ground |
| 6 | 4 | 4 | — | — | — | — | — | — | NC4 | Analog Switch 4 Normally Closed Terminal |
| — | — | — | 6 | 4 | 4 | 6 | 4 | 4 | NO4 | Analog Switch 4 Normally Open Terminal |
| 7 | 5 | 5 | 7 | 5 | 5 | 7 | 5 | 5 | COM4 | Analog Switch 4 Common Terminal |
| 8 | 6 | 7 | 8 | 6 | 7 | 8 | 6 | 7 | IN4 | Digital Control Input 4 |
| 9 | 7 | 9 | 9 | 7 | 9 | 9 | 7 | 9 | IN3 | Digital Control Input 3 |
| 10 | 8 | 11 | 10 | 8 | 11 | 10 | 8 | 11 | COM3 | Analog Switch 3 Common Terminal |
| 11 | 9 | 12 | — | — | — | 11 | 9 | 12 | NC3 | Analog Switch 3 Normally Closed Terminal |
| — | — | — | 11 | 9 | 12 | — | — | — | NO3 | Analog Switch 3 Normally Open Terminal |
| 13 | 11 | 13 | 13 | 11 | 13 | 13 | 11 | 13 | V+ | Positive-Supply Voltage Input |
| 14 | 12 | 14 | — | — | — | 14 | 12 | 14 | NC2 | Analog Switch 2 Normally Closed Terminal |
| — | — | — | 14 | 12 | 14 | — | — | — | NO2 | Analog Switch 2 Normally Open Terminal |
| 15 | 13 | 15 | 15 | 13 | 15 | 15 | 13 | 15 | COM2 | Analog Switch 2 Common Terminal |
| 16 | 14 | 17 | 16 | 14 | 17 | 16 | 14 | 17 | IN2 | Digital Control Input 2 |

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Detailed Description

The MAX4651/MAX4652/MAX4653 are low on-resistance, low-voltage analog switches that operate from a single +1.8V to +5.5V supply. CMOS switch construction allows processing analog signals that are within the supply voltage range (GND to V+).

Applications Information

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, followed by the logic inputs, NO or COM. If power-supply sequencing is not possible, add two small signal diodes (D1, D2) in series with the supply pins for overvoltage protection (Figure 1). Adding these diodes reduces the analog signal by one diode drop below V+ and one diode drop above GND, but does not affect the devices' low switch resistance and low leakage characteristics. Device operation is unchanged, and the difference between V+ and GND should not exceed 6V.

Although it is not required, power-supply bypassing improves noise margin and prevents switching noise from propagating from the V+ supply to other components. A 0.1μF capacitor connected from V+ to GND is adequate for most applications.

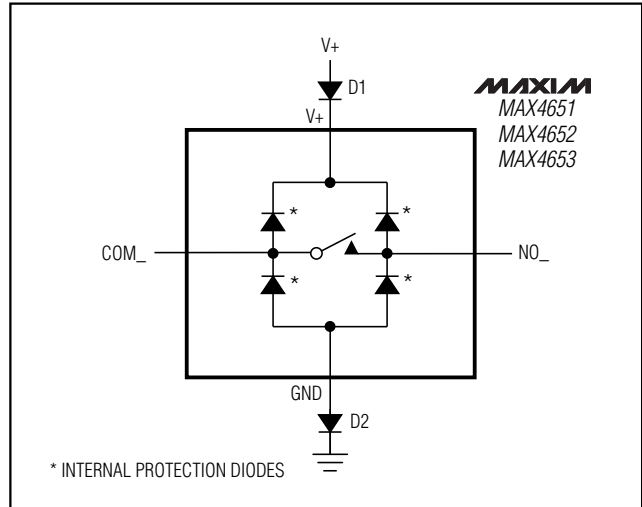


Figure 1. Overvoltage Protection Using External Blocking Diodes

Chip Information

TRANSISTOR COUNT: 205

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Timing Diagrams/Test Circuits

MAX4651/MAX4652/MAX4653

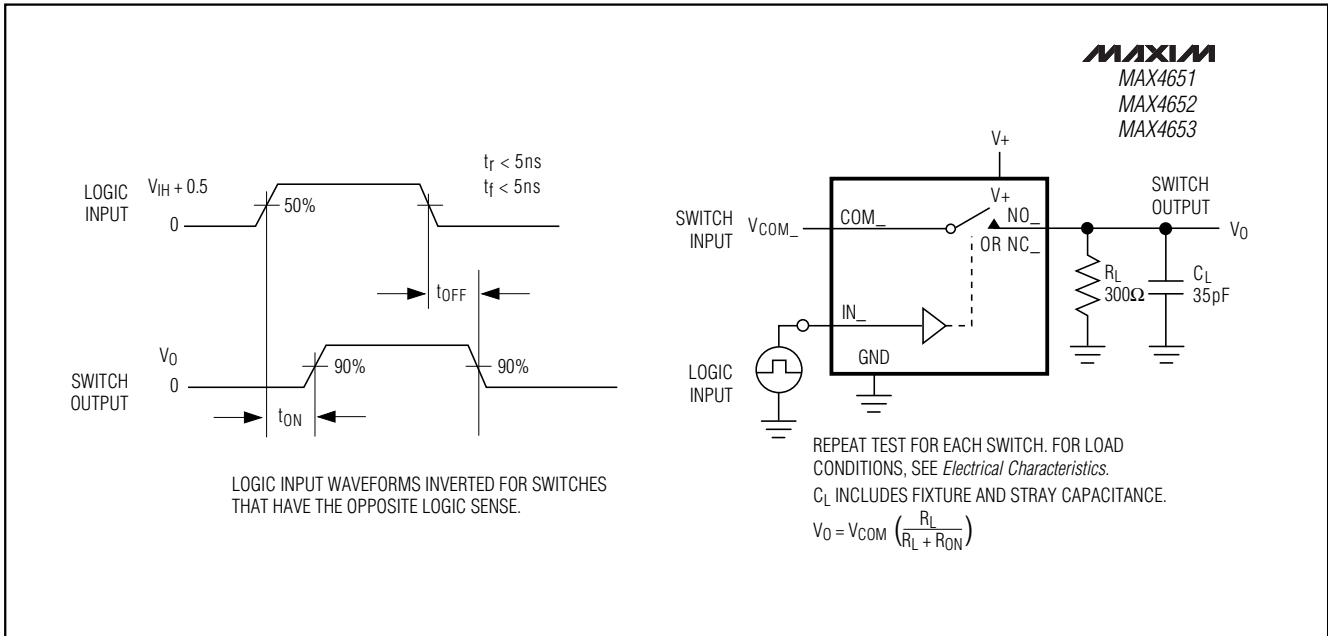


Figure 2. Switching-Time Test Circuit

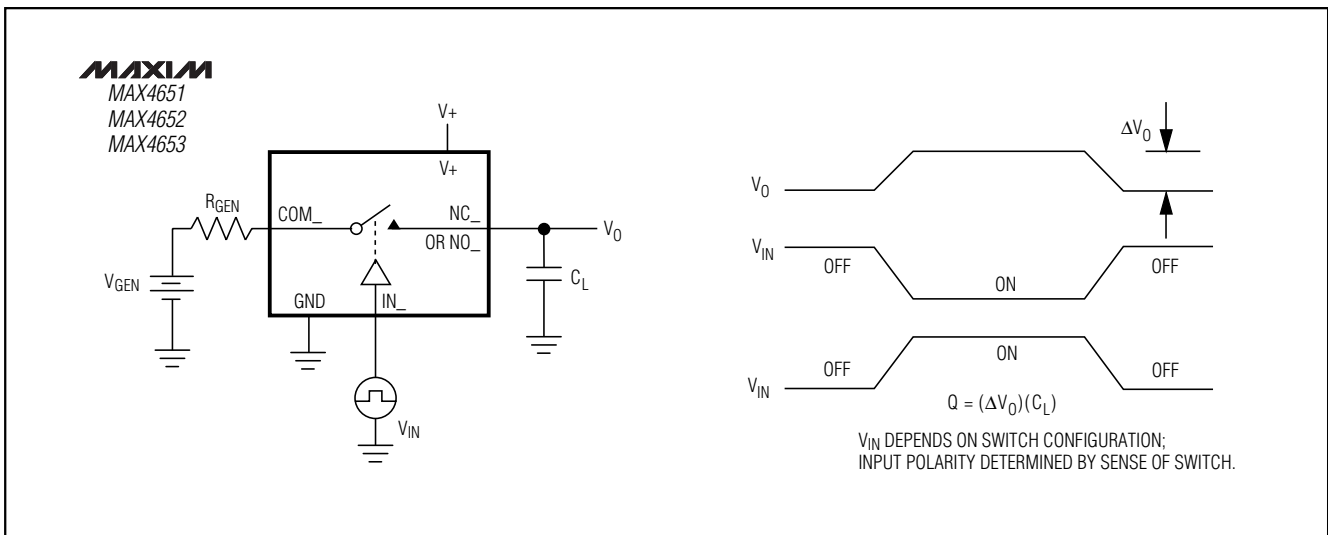


Figure 3. Charge-Injection Test Circuit

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Timing Diagrams/Test Circuits (continued)

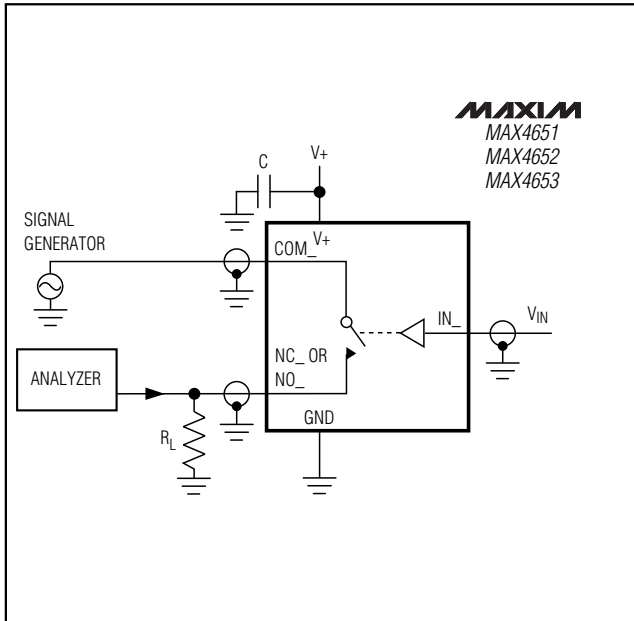


Figure 4. Off-Isolation Test Circuit/On-Channel Bandwidth

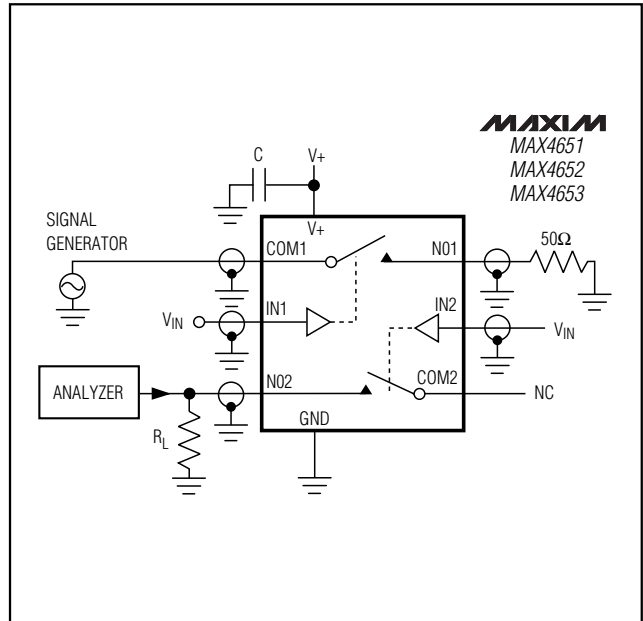


Figure 5. Crosstalk Test Circuit

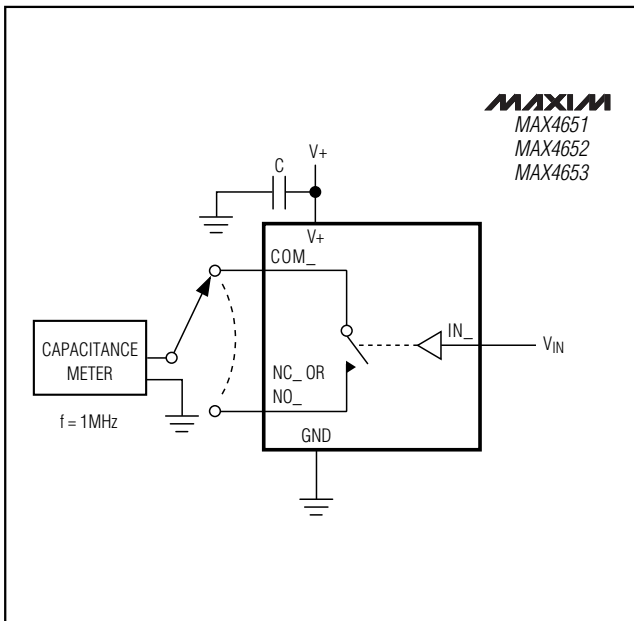


Figure 6. Switch Off-Capacitance Test Circuit

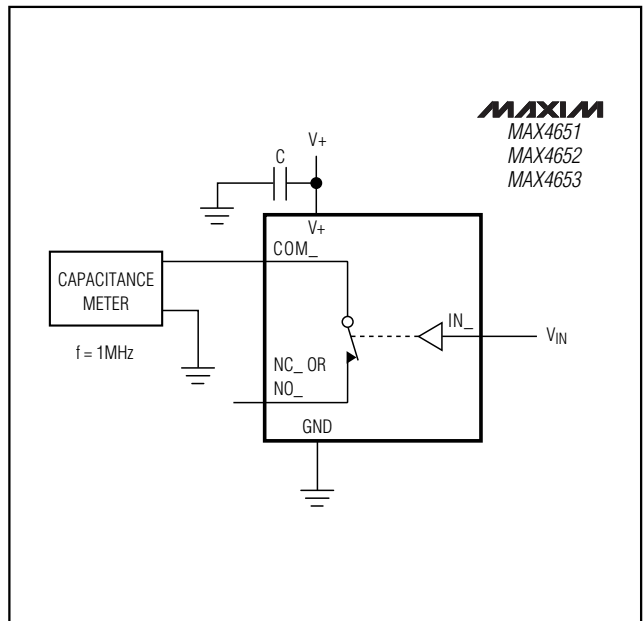
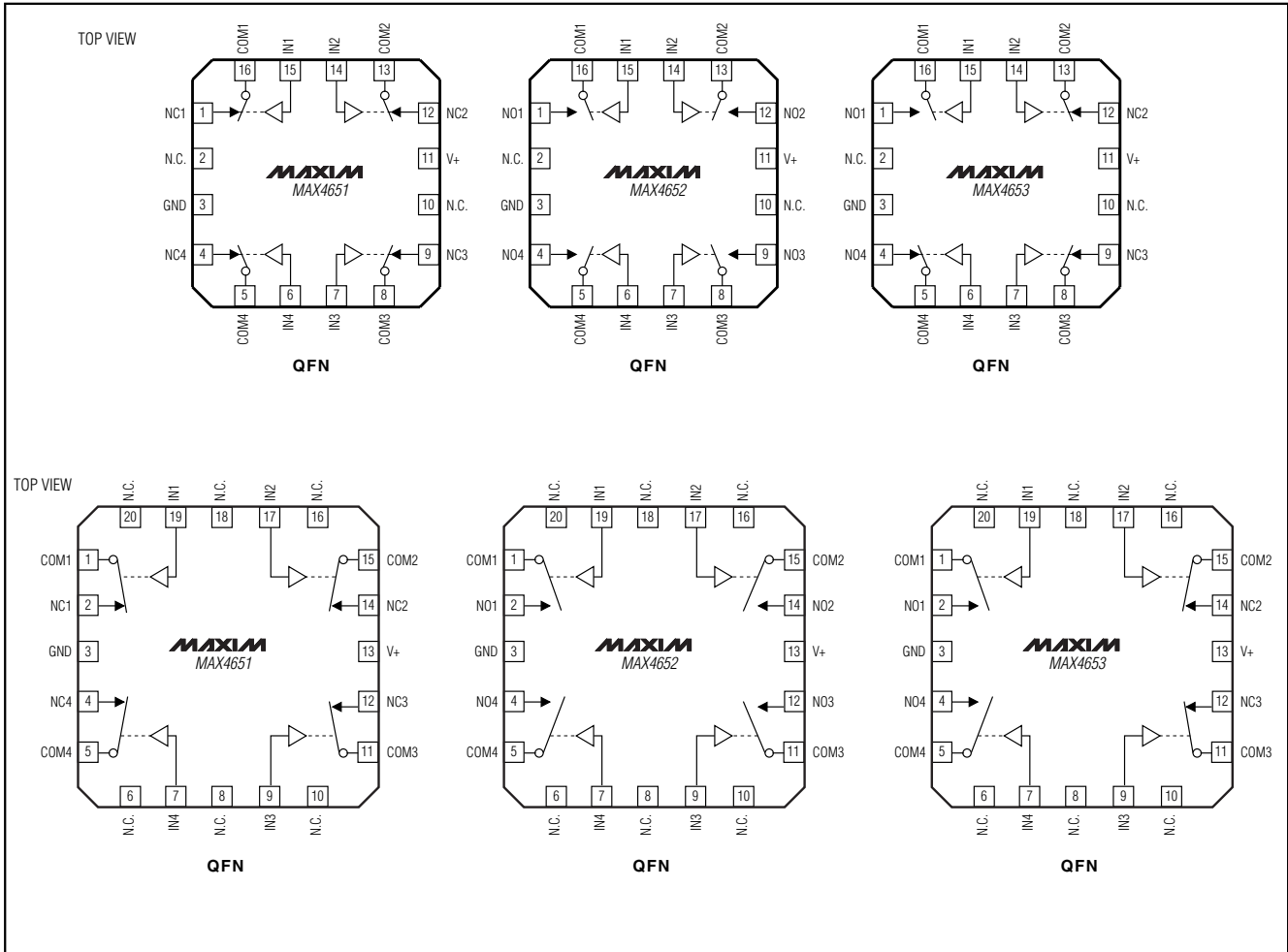


Figure 7. Switch On-Capacitance Test Circuit

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Pin Configurations (continued)

MAX4651/MAX4652/MAX4653



Ordering Information (continued)

| PART | TEMP RANGE | PIN-PACKAGE |
|--------------------|----------------|----------------|
| MAX4652 EGE | -40°C to +85°C | 16 QFN (4 × 4) |
| MAX4652EUE | -40°C to +85°C | 16 TSSOP |
| MAX4652ESE | -40°C to +85°C | 16 SO |
| MAX4652EGP | -40°C to +85°C | 20 QFN (4 × 4) |
| MAX4653 EGE | -40°C to +85°C | 16 QFN (4 × 4) |
| MAX4653EUE | -40°C to +85°C | 16 TSSOP |
| MAX4653ESE | -40°C to +85°C | 16 SO |
| MAX4653EGP | -40°C to +85°C | 20 QFN (4 × 4) |

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

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.)

| SYMBOL | COMMON DIMENSIONS | | | |
|----------------|-------------------|-------|----------------|-------|
| | MILLIMETERS | | INCHES | |
| | MIN. | MAX. | MIN. | MAX. |
| A | 0.05 | 0.15 | .002 | .006 |
| A ₁ | 0.85 | 0.95 | .033 | .037 |
| A ₂ | 0.19 | 0.30 | .007 | .012 |
| b | 0.19 | 0.25 | .007 | .010 |
| c | 0.090 | 0.20 | .0035 | .008 |
| cl | 0.090 | 0.135 | .0035 | .0053 |
| D | SEE VARIATIONS | | SEE VARIATIONS | |
| E | 4.30 | 4.50 | .169 | .177 |
| e | 0.65 BSC | | .026 BSC | |
| H | 6.25 | 6.50 | .246 | .256 |
| L | 0.50 | 0.70 | .020 | .028 |
| N | SEE VARIATIONS | | SEE VARIATIONS | |
| Y | 2.85 | 3.15 | .112 | .124 |
| α | 0° | 8° | 0° | 8° |

| JEDEC | N | VARIATIONS | | | | |
|-------|----|-------------|------|--------|------|------|
| | | MILLIMETERS | | INCHES | | |
| | | MIN. | MAX. | MIN. | MAX. | |
| AB | 14 | D | 4.90 | 5.10 | .193 | .201 |
| AC | 16 | D | 4.90 | 5.10 | .193 | .201 |
| AC-EP | 16 | D | 4.90 | 5.10 | .193 | .201 |
| | | X | 2.85 | 3.15 | .112 | .124 |
| AD | 20 | D | 6.40 | 6.60 | .252 | .260 |
| AD-EP | 20 | D | 6.40 | 6.60 | .252 | .260 |
| | | X | 4.00 | 4.34 | .157 | .171 |
| AE | 24 | D | 7.70 | 7.90 | .303 | .311 |
| AF | 28 | D | 9.60 | 9.80 | .378 | .386 |
| AF-EP | | D | 9.60 | 9.80 | .378 | .386 |
| | | X | 5.35 | 5.65 | .211 | .222 |

NOTES:
 1. DIMENSIONS D AND E DO NOT INCLUDE FLASH.
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15 mm PER SIDE.
 3. CONTROLLING DIMENSION: MILLIMETER.
 4. MEETS JEDEC OUTLINE MO-153 VARIATIONS AB, AC, AD, AE, AF.
 5. DIMENSIONS X AND Y APPLY TO EXPOSED PAD (EP) VERSIONS ONLY.
 6. EXPOSED PAD FLUSH WITH BOTTOM OF PACKAGE WITHIN .002".

Note: The MAX4651/MAX4652/MAX4653 do not come in an exposed-pad package.

| | | | |
|---|----------------------|-----|-----|
| MAXIM | | | |
| PROPRIETARY INFORMATION | | | |
| TITLE: PACKAGE OUTLINE, TSSOP, 4.40mm BODY, 0.65mm PITCH | | | |
| APPROVAL | DOCUMENT CONTROL NO. | REV | 1/1 |
| | 21-0066 | C | |

TSSOPERS

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Package Information (continued)

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NOTES:

1. DIE THICKNESS ALLOWABLE IS 0.305mm MAXIMUM (.012 INCHES MAXIMUM)
2. DIMENSIONING & TOLERANCES CONFORM TO ASME Y14.5M. - 1994.
3. N IS THE NUMBER OF TERMINALS.
Nd IS THE NUMBER OF TERMINALS IN X-DIRECTION &
Ne IS THE NUMBER OF TERMINALS IN Y-DIRECTION.
4. DIMENSION b APPLIES TO PLATED TERMINAL AND IS MEASURED BETWEEN 0.20 AND 0.25mm FROM TERMINAL TIP.
5. THE PIN #1 IDENTIFIER MUST BE EXISTED ON THE TOP SURFACE OF THE PACKAGE BY USING INDENTATION MARK OR INK/ LASER MARKED.
6. EXACT SHAPE AND SIZE OF THIS FEATURE IS OPTIONAL.
7. ALL DIMENSIONS ARE IN MILLIMETERS.
8. PACKAGE WARPAGE MAX 0.05mm.
9. APPLIED FOR EXPOSED PAD AND TERMINALS.
EXCLUDE EMBEDDED PART OF EXPOSED PAD FROM MEASURING.
10. MEETS JEDEC MO220.
11. THIS PACKAGE OUTLINE APPLIES TO ANVIL SINGULATION (STEPPED SIDES) AND TO SAW SINGULATION (STRAIGHT SIDES) QFN STYLES.

| SYMBOL | COMMON DIMENSIONS | | | NOTE |
|--------|-------------------|------|------|------|
| | MIN. | NOM. | MAX. | |
| A | 0.80 | 0.90 | 1.00 | |
| A1 | 0.00 | 0.01 | 0.05 | |
| A2 | 0.00 | 0.65 | 1.00 | |
| A3 | 0.20 REF. | | | |
| D | 5.00 BSC | | | |
| D1 | 4.75 BSC | | | |
| E | 5.00 BSC | | | |
| E1 | 4.75 BSC | | | |
| θ | 0° | - | 12° | |
| P | 0 | - | 0.60 | |
| D2 | 1.25 | - | 3.25 | |
| E2 | 1.25 | - | 3.25 | |

| SYMBOL | PITCH VARIATION B | | | NOTE | SYMBOL | PITCH VARIATION B | | | NOTE | SYMBOL | PITCH VARIATION C | | | NOTE | SYMBOL | PITCH VARIATION D | | | NOTE |
|--------|-------------------|------|------|------|----------|-------------------|------|------|----------|--------|-------------------|------|----------|------|--------|-------------------|------|------|------|
| | MIN. | NOM. | MAX. | | | MIN. | NOM. | MAX. | | | MIN. | NOM. | MAX. | | | MIN. | NOM. | MAX. | |
| Ⓢ | 0.80 BSC | | | Ⓢ | 0.65 BSC | | | Ⓢ | 0.50 BSC | | | Ⓢ | 0.50 BSC | | | | | | |
| N | 16 | | | N | 20 | | | N | 28 | | | N | 32 | | | | | | |
| Nd | 4 | | | Nd | 5 | | | Nd | 7 | | | Nd | 8 | | | | | | |
| Ne | 4 | | | Ne | 5 | | | Ne | 7 | | | Ne | 8 | | | | | | |
| L | 0.35 | 0.55 | 0.75 | L | 0.35 | 0.55 | 0.75 | L | 0.35 | 0.55 | 0.75 | L | 0.30 | 0.40 | 0.50 | | | | |
| b | 0.28 | 0.33 | 0.40 | b | 0.23 | 0.28 | 0.35 | b | 0.18 | 0.23 | 0.30 | b | 0.18 | 0.23 | 0.30 | | | | |



PROPRIETARY INFORMATION

TITLE:
PACKAGE OUTLINE, 16,20,28,32L QFN, 5x5x0.90 MM

| | | | |
|----------|----------------------|-----|-----|
| APPROVAL | DOCUMENT CONTROL NO. | REV | 2/2 |
| | 21-0091 | G | |

Low-Voltage, 4Ω, Quad, SPST, CMOS Analog Switches

Package Information (continued)

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MAX4651/MAX4652/MAX4653

| | INCHES | | MILLIMETERS | |
|----|--------|-------|-------------|------|
| | MIN | MAX | MIN | MAX |
| A | 0.053 | 0.069 | 1.35 | 1.75 |
| A1 | 0.004 | 0.010 | 0.10 | 0.25 |
| B | 0.014 | 0.019 | 0.35 | 0.49 |
| C | 0.007 | 0.010 | 0.19 | 0.25 |
| e | 0.050 | | 1.27 | |
| E | 0.150 | 0.157 | 3.80 | 4.00 |
| H | 0.228 | 0.244 | 5.80 | 6.20 |
| h | 0.010 | 0.020 | 0.25 | 0.50 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

| | INCHES | | MILLIMETERS | | N | MS012 |
|---|--------|-------|-------------|-------|----|-------|
| | MIN | MAX | MIN | MAX | | |
| D | 0.189 | 0.197 | 4.80 | 5.00 | 8 | A |
| D | 0.337 | 0.344 | 8.55 | 8.75 | 14 | B |
| D | 0.386 | 0.394 | 9.80 | 10.00 | 16 | C |

NOTES:
 1. D&E DO NOT INCLUDE MOLD FLASH
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
 3. LEADS TO BE COPLANAR WITHIN .102mm (.004")
 4. CONTROLLING DIMENSION: MILLIMETER
 5. MEETS JEDEC MS012-XX AS SHOWN IN ABOVE TABLE
 6. N = NUMBER OF PINS

MAXIM PACKAGE FAMILY OUTLINE: SOIC .150" 1/1 21-0041 A
120 SAN GABRIEL DR. SUNNYVALE, CA 94086 FAX (408) 737-7204 PROPRIETARY INFORMATION TITLE DOCUMENT CONTROL NUMBER REV

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