



Fault-Protected, Low-Voltage, Quad SPST Analog Switches

MAX4711/MAX4712/MAX4713

General Description

The MAX4711/MAX4712/MAX4713 are fault-protected, Rail-to-Rail®, low-voltage analog switches featuring low on-resistance and guaranteed on-resistance flatness over the specified signal range. Due to the fault protection feature the analog switch input (NO_ or NC_) and output (COM_) pins are not symmetrical. The fault protection feature allows for the analog input to go beyond the plus or minus supplies without the device drawing excessive amounts of current from the analog inputs. When the analog inputs are driven beyond the supply rails when the switch is on, it will sense a fault and turn itself off and the analog switch output will be clamped to the same polarity supply as the input signal and will not go beyond the supply rails. This feature protects any electronic circuitry connected to the output from excessive voltages present on the analog inputs.

The MAX4711/MAX4712/MAX4713 are quad, single-pole/single-throw (SPST) analog switches. The MAX4711 has four normally closed switches (NC), the MAX4712 has four normally open switches (NO), and the MAX4713 has two NO and two NC switches. Switching times are less than 125ns for t_{ON}, and less than 80ns for t_{OFF}. These switches operate from a single +2.7V to +11V supply or from dual ±2.7V to ±5.5V supplies. All digital inputs have +0.8V to +2.4V logic thresholds, ensuring both TTL and CMOS logic compatibility when using ±4.5V to ±5.5V or single +4.5V to +11V supplies.

Applications

- Communication Systems
- Battery-Operated Systems
- Signal Routing
- Test Equipment
- Data-Acquisition
- Industrial and Process Control Systems
- Avionics
- Redundant/Backup Systems

Pin Configurations/Functional Diagrams/Truth Tables
continued at end of data sheet.

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

Features

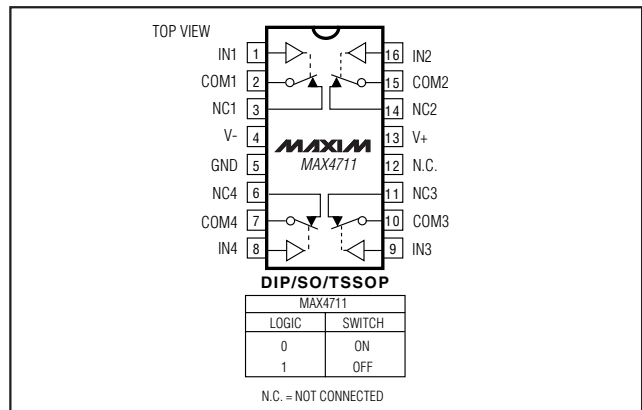
- ◆ Fault-Protected Analog Inputs
- ◆ ±12V Fault Protection with Power Off
- ◆ ±7V Fault Protection with ±5V Supplies
- ◆ +12V and -7V Fault Protection with +5V Supply
- ◆ +12V and -9V Fault Protection with +3V Supply
- ◆ Fault-Protected Digital Inputs May Exceed V₊ Supply Rail
- ◆ All Switches Off with Power Off
- ◆ Rail-to-Rail Signal Handling
- ◆ Output Clamped to Appropriate Supply Voltages During Fault Condition
- ◆ 25Ω (max) R_{ON} at +25°C
- ◆ 1Ω (max) On-Resistance Match Between Channels
- ◆ Single- and Dual-Supply Operation
- ◆ Pin-Compatible with Industry-Standard MAX391/MAX392/MAX393
- ◆ TTL- and CMOS-Compatible Logic Inputs

Ordering Information

| PART | TEMP RANGE | PIN-PACKAGE |
|------------|----------------|----------------|
| MAX4711CUE | 0°C to +70°C | 16 TSSOP |
| MAX4711CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4711CPE | 0°C to +70°C | 16 Plastic Dip |
| MAX4711EUE | -40°C to +85°C | 16 TSSOP |
| MAX4711ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4711EPE | -40°C to +85°C | 16 Plastic Dip |

Ordering Information continued at end of data sheet.

Pin Configurations/Functional Diagrams/Truth Tables



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ABSOLUTE MAXIMUM RATINGS

| | |
|--|----------------------------|
| V+ | -0.3V to +13V |
| V- | -13V to +0.3V |
| V+ to V- | -0.3V to +13V |
| IN | (V- + 12V) to (V- - 0.3V) |
| COM ₋ (Note 1) | (V- - 0.3V) to (V+ + 0.3V) |
| NO ₋ , NC ₋ (Note 2) | (V+ - 12V) to (V- + 12V) |
| Continuous Current into Any Terminal | ±40mA |
| Peak Current, into Any Terminal (pulsed at 1ms, 10% duty cycle) | ±70mA |

| | |
|---|-----------------|
| Continuous Power Dissipation (T _A = +70°C) | |
| 16-Pin TSSOP (derate 5.70mW/°C above +70°C) | 457mW |
| 16-Pin Narrow SO (derate 8.70mW/°C above +70°C) | 696mW |
| 16-Pin Plastic Dip (derate 10.53mW/°C above +70°C) | 842mW |
| Operating Temperature Ranges | |
| MAX471_C_E | 0°C to +70°C |
| MAX471_E_E | -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: COM₋ pin is not fault-protected. Signals on COM₋ exceeding V+ or V- are clamped by internal diodes. Limit forward diode current to maximum current rating.

Note 2: NO₋ and NC₋ pins are fault-protected. Signals on NO₋ or NC₋ exceeding -12V to +12V may damage device. These limits apply with V+ = V- = 0.

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 Supplies

(V+ = +4.5V to +5.5V, V- = -4.5V to -5.5V, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|--|--|--|----------------|-------------|----------|-------------|-------|
| ANALOG SWITCH | | | | | | | |
| Fault-Free Analog Signal Range | V _{COM-} , V _{NO-} , V _{NC-} | Applies with power on | C, E | V- | | V+ | V |
| On-Resistance | R _{ON} | V+ = +4.5V, V- = -4.5V, V _{NO-} , V _{NC-} = ±3.5V, I _{OUT} = 10mA | +25°C C, E | | 16 25 | 30 | Ω |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +4.5V, V- = -4.5V, V _{NO-} , V _{NC-} = ±3.5V, I _{OUT} = 10mA | +25°C C, E | | 0.2 1 | 2 | Ω |
| On-Resistance Flatness | R _{FLAT} | V+ = +4.5V, V- = -4.5V, V _{NO-} , V _{NC-} = ±3.5V, I _{OUT} = 10mA | +25°C C, E | | 1.3 4 | 5 | Ω |
| NO ₋ , NC ₋ Off-Leakage Current (Note 5) | I _{NO-(OFF)} , I _{NC-(OFF)} | V+ = +5.5V, V- = -5.5V, V _{COM-} = ±4.5V, V _{NO-} , V _{NC-} = 4.5V | +25°C C, E | -0.5 -10 | | +0.5 +10 | nA |
| COM ₋ Off-Leakage Current (Note 5) | I _{COM-(OFF)} | V+ = +5.5V, V- = -5.5V, V _{COM-} = ±4.5V, V _{NO-} , V _{NC-} = 4.5V | +25°C C, E | -0.5 -10 | | +0.5 +10 | nA |
| COM ₋ On-Leakage Current (Note 5) | I _{COM-(ON)} | V+ = +5.5V, V- = -5.5V, V _{COM-} = ±4.5V, V _{NO-} , V _{NC-} = ±4.5V or floating | +25°C C, E | -0.5 -20 | | +0.5 +20 | nA |
| FAULT | | | | | | | |
| Fault-Protected Analog Signal Range | V _{NO-} , V _{NC-} | Applies with power on | C, E | -12 + V+ | | +12 + V- | V |
| Fault-Protected Analog Signal Range | V _{NO-} , V _{NC-} | Applies with power off | C, E | -12 | | +12 | V |
| COM ₋ Output-Leakage Current, Supplies ON (Note 5) | I _{COM} | All channels off, V+ = +5V, V- = -5V, V _{NO-} , V _{NC-} = ±7V | +25°C C, E | -50 -500 | | +50 +500 | nA |

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ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +4.5V to +5.5V, V- = -4.5V to -5.5V, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS | |
|---|--|---|----------------|--------------|-----|--------------|-------|----|
| NO ₋ or NC ₋ Off-Leakage Current, Supplies ON (Note 5) | I _{NO-} , I _{NC-} | V+ = +5V, V- = -5V, V _{NO-} , V _{NC-} = ±7V | +25°C | -50 | | +50 | nA | |
| | | | C, E | -500 | | +500 | | |
| NO ₋ or NC ₋ Input-Leakage Current, Supplies OFF (Note 5) | I _{NO-} , I _{NC-} | V _{NO-} , V _{NC-} = ±12V, V± = 0 | +25°C | -0.5 | | +0.5 | μA | |
| | | | C, E | -5 | | +5 | | |
| Output Clamp Current | I _{COM-} | V _{NO-} , V _{NC-} = +7V, V+ = +5V, V- = -5V | C, E | | 9 | 20 | 33 | mA |
| | | | | | -33 | -16 | -9 | |
| Output Clamp Resistance | R _{CLAMP-} | V _{NO-} , V _{NC-} = ±7V | +25°C | | 200 | | Ω | |
| Fault Trip Threshold | | | +25°C | V- - 0.4V | | V+ + 0.4V | V | |
| ±Fault Output Turn-On Delay Time | | V _{NO-} , V _{NC-} = ±7V, R _{COM} = 1kΩ | +25°C | | 200 | | ns | |
| ±Fault Recovery Time | | V _{NO-} , V _{NC-} = ±7V, R _{COM} = 1kΩ | +25°C | | 700 | | ns | |
| LOGIC INPUT | | | | | | | | |
| Input Logic High | V _{IH} | | C, E | 2.4 | | | V | |
| Input Logic Low | V _{IL} | | C, E | | | 0.8 | V | |
| Input-Leakage Current (Note 5) | I _{IN} | V _{IN-} = 0 or V+ | +25°C | -1 | | +1 | μA | |
| | | | C, E | -5 | | +5 | | |
| SWITCH DYNAMICS | | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO-} or V _{NC-} = ±3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | | 80 | 125 | ns | |
| | | | C, E | | | 150 | | |
| Turn-Off Time | t _{OFF} | V _{NO-} or V _{NC-} = ±3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | | 50 | 80 | ns | |
| | | | C, E | | | 100 | | |
| Break-Before-Make Time Delay (MAX4713 only) | t _{BBM} | V _{NO-} or V _{NC-} = ±3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | 15 | 30 | | ns | |
| | | | C, E | 5 | | | | |
| Charge Injection | Q | V _{GEN} = 0, R _{GEN} = 0, C _L = 1nF, Figure 4 | +25°C | | 25 | | pC | |
| NO ₋ or NC ₋ Off-Capacitance | C _{N(OFF)} | f = 1MHz, Figure 5 | +25°C | | 8 | | pF | |
| COM ₋ Off-Capacitance | C _{COM(OFF)} | f = 1MHz, Figure 5 | +25°C | | 8 | | pF | |
| COM ₋ On-Capacitance | C _{COM(ON)} | f = 1MHz, Figure 5 | +25°C | | 30 | | pF | |
| Off-Isolation (Note 6) | V _{ISO} | R _L = 50Ω, C _L = 15pF, P _{IN} = 0, f = 1MHz, Figure 6 | +25°C | | -59 | | dB | |
| Channel-to-Channel Crosstalk (Note 7) | V _{CT} | R _L = 50Ω, C _L = 15pF, P _{IN} = 0, f = 1MHz, Figure 6 | +25°C | | -87 | | dB | |

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ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +4.5V to +5.5V, V- = -4.5V to -5.5V, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---------------------|------------------|-------------------------------|----------------|------|-----|------|-------|
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | V+, V- | | C, E | ±2.7 | | ±5.5 | V |
| V+ Supply Current | I+ | All V _{IN} = 0 or V+ | +25°C | | 38 | 75 | μA |
| | | | C, E | | | 100 | |
| V- Supply Current | I- | All V _{IN} = 0 or V+ | +25°C | | 38 | 75 | μA |
| | | | C, E | | | 100 | |
| GND Supply Current | I _{GND} | All V _{IN} = 0 or V+ | +25°C | | 0 | 1 | μA |
| | | | C, E | | | 10 | |

ELECTRICAL CHARACTERISTICS—+5V Single Supply

(V+ = +4.5V to +5.5V, V- = 0, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|--|---|---|----------------|----------|------|------|-------|
| ANALOG SWITCH | | | | | | | |
| Fault-Free Analog Signal Range | V _{COM} , V _{NO} , V _{NC} | Power on | C, E | V- | | V+ | V |
| On-Resistance | R _{ON} | V+ = +4.5V, V _{NO} , V _{NC} = +3.5V, I _{OUT} = 10mA | +25°C | | 30 | 40 | Ω |
| | | | C, E | | | 50 | |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +4.5V, V _{NO} , V _{NC} = +3.5V, I _{OUT} = 10mA | +25°C | | 0.3 | 2 | Ω |
| | | | C, E | | | 3 | |
| On-Resistance Flatness | R _{FLAT} | V+ = +4.5V, V _{NO} , V _{NC} = +1.5V, +2.25V, +3.5V, I _{OUT} = 10mA | +25°C | | 2 | 5 | Ω |
| | | | C, E | | | 6 | |
| NO ₋ , NC ₋ Off-Leakage Current (Note 5) | I _{NO(OFF)} , I _{NC(OFF)} | V+ = +5.5V, V _{COM} = +1V, +4.5V; V _{NO} , V _{NC} = +4.5V, +1V | +25°C | | -0.5 | +0.5 | nA |
| | | | C, E | | | -10 | |
| COM ₋ Off-Leakage Current (Note 5) | I _{COM(OFF)} | V+ = +5.5V, V _{COM} = +1V, +4.5V; V _{NO} , V _{NC} = +4.5V, +1V | +25°C | | -0.5 | +0.5 | nA |
| | | | C, E | | | -10 | |
| COM ₋ On-Leakage Current (Note 5) | I _{COM(ON)} | V+ = +5.5V, V _{COM} = +1V, +4.5V; V _{NO} , V _{NC} = +1V, +4.5V, or floating | +25°C | | -0.5 | +0.5 | nA |
| | | | C, E | | | -20 | |
| FAULT | | | | | | | |
| Fault-Protected Analog Signal Range | V _{NO} , V _{NC} | Power on | C, E | -12 + V+ | | +12 | V |

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ELECTRICAL CHARACTERISTICS—+5V Single Supply (continued)

(V+ = +4.5V to +5.5V, V- = 0, V_{IH} = +2.4V, V_{IL} = +0.8V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|--------------------------------------|---|----------------|-------------|-----|-------------|-------|
| Fault-Protected Analog Signal Range | V _{NO-} , V _{VNC-} | Power off | C, E | -12 | | +12 | V |
| COM_ Output-Leakage Current, Supplies ON (Note 5) | I _{COM-} | All channels off; V _{NO-} , V _{VNC-} = +12V or -7V, V+ = +5V | +25°C C, E | -50 -500 | | +50 +500 | nA |
| NO_ or NC_ Off-Leakage Current, Supplies ON (Note 5) | I _{NO-} , I _{VNC-} | V _{NO-} , V _{VNC-} = +12V or -7V, V+ = +5V | +25°C C, E | -50 -500 | | +50 +500 | nA |
| NO_ or NC_ Input-Leakage Current, Supplies OFF (Note 5) | I _{NO-} , I _{VNC-} | V _{NO-} , V _{VNC-} = ±12V, V± = 0 | +25°C C, E | -0.5 -5 | | +0.5 +5 | μA |
| Output Clamp Current | I _{COM-} | V _{NO-} , V _{VNC-} = +12V, V+ = 5V | C, E | 2 | 6 | 11 | mA |
| Output Clamp Resistance | R _{CLAMP-} | Clamp on | +25°C | | 500 | | Ω |
| +Fault Output Turn-On Delay Time | | V _{NO-} , V _{VNC-} = +12V, R _L = 300Ω, V+ = +5V | +25°C | | 200 | | ns |
| +Fault Recovery Time | | V _{NO-} , V _{VNC-} = +12V, R _L = 300Ω, V+ = +5V | +25°C | | 500 | | μs |
| LOGIC INPUT | | | | | | | |
| Input Logic High | V _{IH} | | C, E | 2.4 | | | V |
| Input Logic Low | V _{IL} | | C, E | | | 0.8 | V |
| Input-Leakage Current (Note 5) | I _{IN} | V _{IN-} = 0 or V+ | C, E | -1 | | +1 | μA |
| SWITCH DYNAMICS | | | | | | | |
| Turn-On Time | t _{ON} | V _{NO-} or V _{VNC-} = +3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C C, E | | 170 | 230 275 | ns |
| Turn-Off Time | t _{OFF} | V _{NO-} or V _{VNC-} = +3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C C, E | | 55 | 100 125 | ns |
| Break-Before-Make Time Delay (MAX4713 only) | t _{BBM} | V _{NO-} or V _{VNC-} = +3V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C C, E | 30 | 115 | | ns |
| Charge Injection | Q | V _{GEN} = 0, R _{GEN} = 0, C _L = 1nF, Figure 4 | +25°C | | -1 | | pC |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | C, E | 2.7 | | 11 | V |
| V+ Supply Current | I+ | All V _{IN-} = 0 or V+ | +25°C C, E | | 34 | 65 75 | μA |

Fault-Protected, Low-Voltage, Quad SPST Analog Switches

ELECTRICAL CHARACTERISTICS—+3V Single Supply

(V+ = +2.7V to +3.6V, V- = 0, V_{IH} = +2.0V, V_{IL} = +0.6V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|--|--|----------------|-------------|----------|-------------|-------|
| ANALOG SWITCH | | | | | | | |
| Fault-Free Analog Signal Range | V _{COML} , V _{NO-} , V _{NC-} | Power-on | C, E | V- | | V+ | V |
| On-Resistance | R _{ON} | V+ = +2.7V, V _{NO-} , V _{NC-} = +1V, I _{OUT} = 1mA | +25°C C, E | | 54 75 | 75 100 | Ω |
| On-Resistance Match Between Channels (Note 4) | ΔR _{ON} | V+ = +2.7V, V _{NO-} , V _{NC-} = +1V, I _{OUT} = 1mA | +25°C C, E | | 1 7 | 7 9 | Ω |
| NO-, NC_ Off-Leakage Current (Note 5) | I _{NO-(OFF)} , I _{NC-(OFF)} | V+ = +3.6V, V _{COML} = +0.7V, +3V; V _{NO-} , V _{NC-} = +3V, +0.7V | +25°C C, E | -0.5 -10 | | +0.5 +10 | nA |
| COM_ Off-Leakage Current (Note 5) | I _{COML(OFF)} | V+ = +3.6V, V _{COML} = +0.7V, +3V; V _{NO-} , V _{NC-} = +3V, +0.7V | +25°C C, E | -0.5 -10 | | +0.5 +10 | nA |
| COM_ On-Leakage Current (Note 5) | I _{COML(ON)} | V+ = +3.6V, V _{COML} = +0.7, +3V; V _{NO-} , V _{NC-} = +0.7V, +3V, or floating | +25°C C, E | -0.5 -20 | | +0.5 +20 | nA |
| FAULT | | | | | | | |
| Fault-Protected Analog Signal Range | V _{NO-} , V _{NC-} | Power-on | C, E | -12 + V+ | | +12 | V |
| Fault-Protected Analog Signal Range | V _{NO-} , V _{NC-} | Power-off | C, E | -12 | | +12 | V |
| COM_ Output-Leakage Current, Supplies ON (Note 5) | I _{COM} | All channels off; V _{NO-} , V _{NC-} = +12V or -9V, V+ = +3V | +25°C C, E | -50 -500 | | +50 +500 | nA |
| NO_ or NC_ Off-Leakage Current, Supplies ON (Note 5) | I _{NO-} , I _{NC-} | V _{NO-} , V _{NC-} = +12V or -9V, V+ = +3V | +25°C C, E | -50 -500 | | +50 +500 | nA |
| NO_ or NC_ Input-Leakage Current, Supplies OFF (Note 5) | I _{NO-} , I _{NC-} | V _{NO-} , V _{NC-} = ±12V, V± = 0 | +25°C C, E | -0.5 -5 | | +0.5 +5 | μA |
| Output Clamp Current | I _{COML} | V _{NO-} , V _{NC-} = +12V, V+ = +3V | C, E | 0.5 | | 3.0 | mA |
| Output Clamp Resistance | R _{CLAMP-} | V+ = +3V, V _{NO-} , V _{NC-} = +12V; clamp on | +25°C | | 600 | | kΩ |
| +Fault Output Turn-On Delay Time | | V _{NO-} , V _{NC-} = +12V, R _L = 300Ω, V+ = +3V | +25°C | | 200 | | ns |
| +Fault Recovery Time | | V _{NO-} , V _{NC-} = +12V, R _L = 300Ω, V+ = +3V | +25°C | | 2.2 | | μs |

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MAX4711/MAX4712/MAX4713

ELECTRICAL CHARACTERISTICS—+3V Single Supply (continued)

(V+ = +2.7V to +3.6V, V- = 0, V_{IH} = +2.0V, V_{IL} = +0.6V, GND = 0, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 3)

| PARAMETER | SYMBOL | CONDITIONS | T _A | MIN | TYP | MAX | UNITS |
|---|------------------|--|----------------|-----|-----|-----|-------|
| LOGIC INPUT | | | | | | | |
| Input Logic High | V _{IH} | | C, E | 2 | | | V |
| Input Logic Low | V _{IL} | | C, E | | | 0.6 | V |
| Input-Leakage Current (Note 5) | I _{INL} | V _{INL} = 0 or V+ | C, E | -5 | | +5 | μA |
| SWITCH DYNAMICS | | | | | | | |
| Turn-On Time | t _{ON} | V+ = +2.7V, V _{NO-} or V _{NC-} = +1.5V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | 340 | 500 | | ns |
| | | | C, E | | 600 | | |
| Turn-Off Time | t _{OFF} | V+ = +2.7V, V _{NO-} or V _{NC-} = +1.5V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | 100 | 175 | | ns |
| | | | C, E | | 225 | | |
| Break-Before-Make Time Delay (MAX4713 only) | t _{BBM} | V+ = +2.7V, V _{NO-} or V _{NC-} = +1.5V, R _L = 300Ω, C _L = 35pF, Figure 2 | +25°C | 60 | 240 | | ns |
| | | | C, E | 50 | | | |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | V+ | | C, E | 2.7 | | 11 | V |
| V+ Supply Current | I+ | All V _{INL} = 0 or V+ | +25°C | 8 | | 15 | μA |
| | | | C, E | | | 20 | |

Note 3: Algebraic convention is used in this data sheet; the most negative value is shown in the minimum column.

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

Note 5: Leakage parameters are 100% tested at maximum-rated temperature and with dual supplies. Leakage parameters are guaranteed by correlation at +25°C.

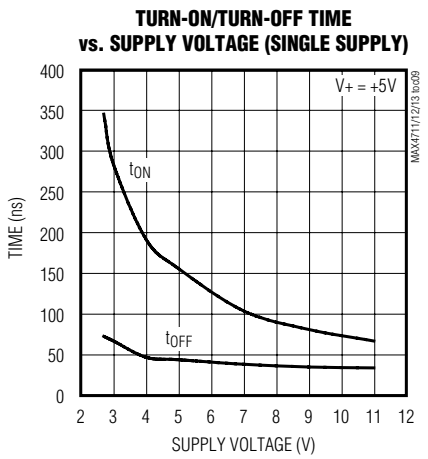
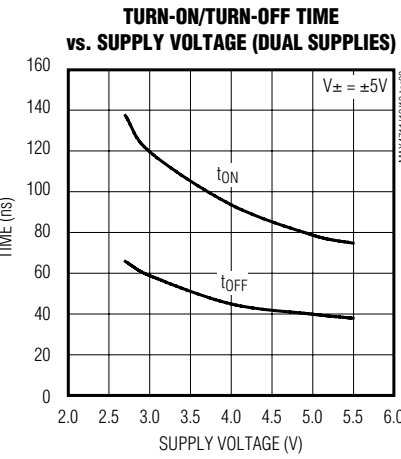
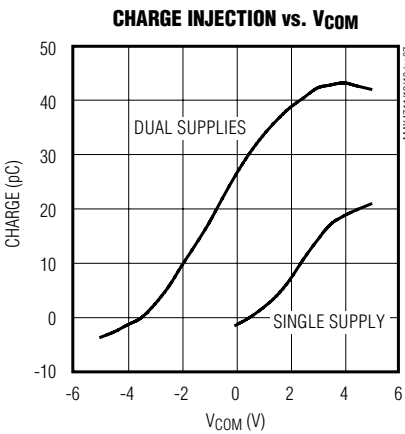
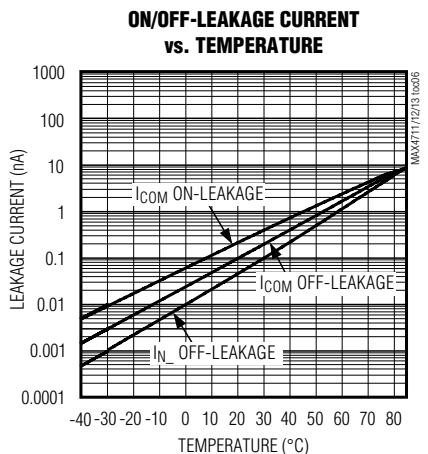
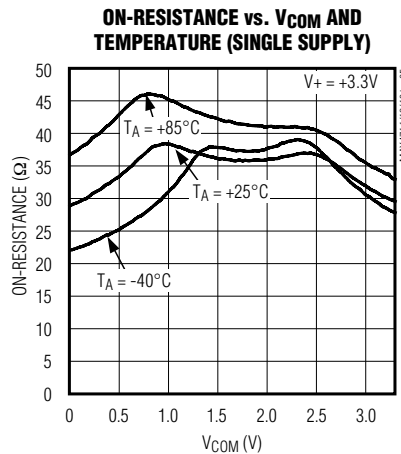
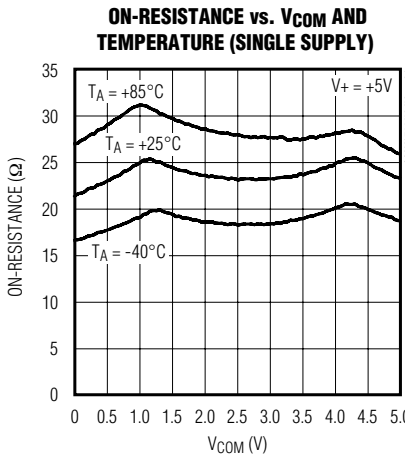
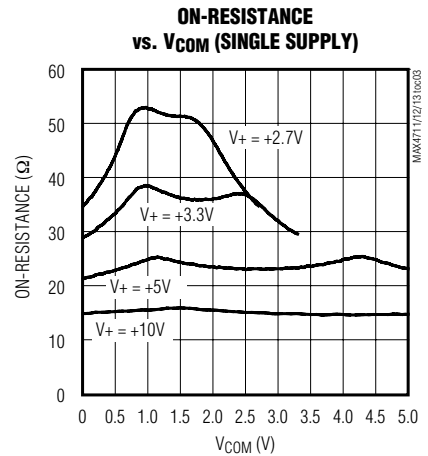
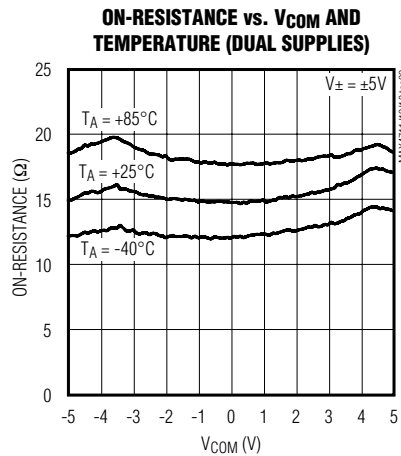
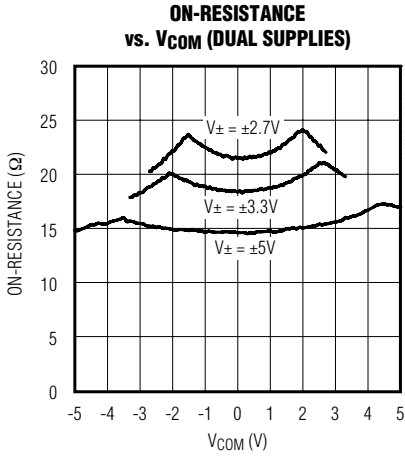
Note 6: Off-isolation = $20 \log_{10} [V_{COM-}/(V_{NO-} \text{ or } V_{NC-})]$, V_{COM-} = output, V_{NO-} or V_{NC-} = input to off switch.

Note 7: Between any two switches.

Fault-Protected, Low-Voltage, Quad SPST Analog Switches

Typical Operating Characteristics

($V_+ = +5V$, $V_- = -5V$, $T_A = +25^\circ C$, unless otherwise noted.)

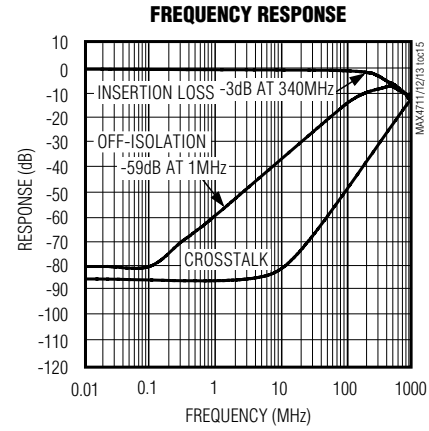
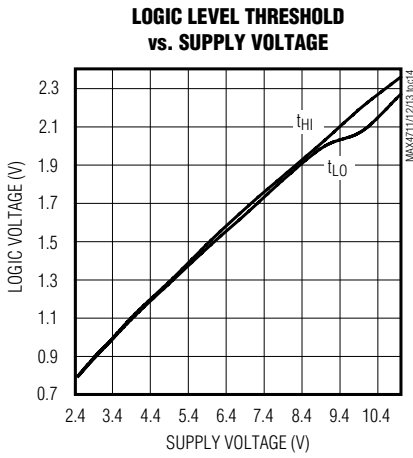
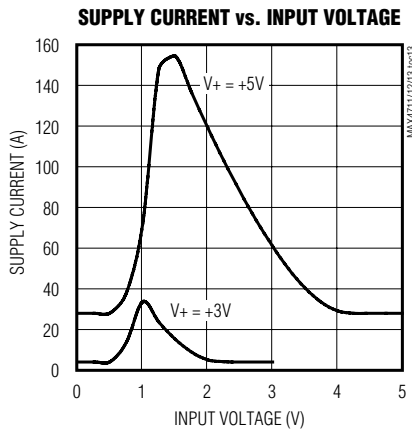
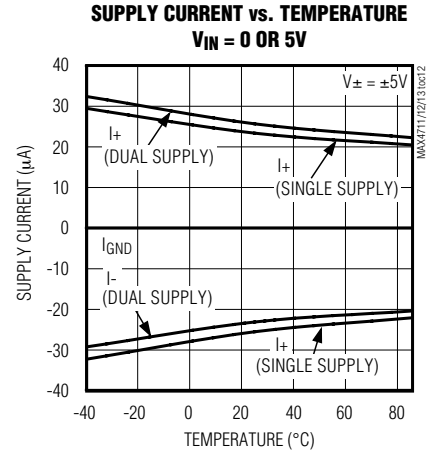
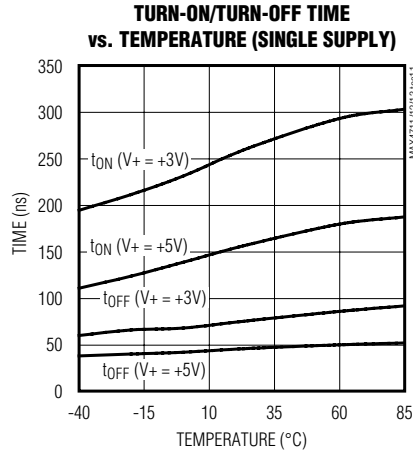
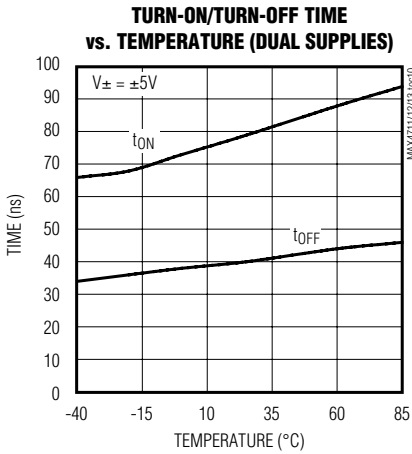


Fault-Protected, Low-Voltage, Quad SPST Analog Switches

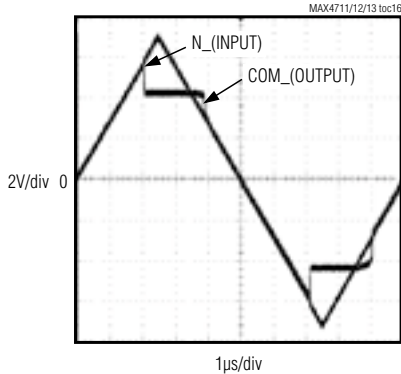
Typical Operating Characteristics (continued)

($V_+ = +5V$, $V_- = -5V$, $T_A = +25^\circ C$, unless otherwise noted.)

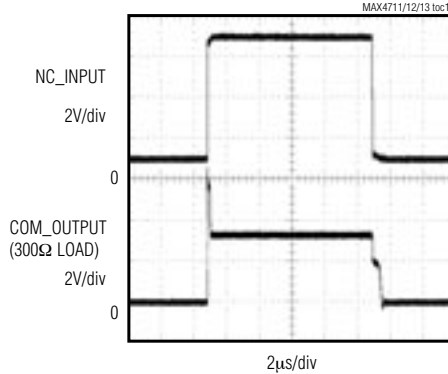
MAX4711/MAX4712/MAX4713



FAULT TURN-ON DELAY AND RECOVERY TIME



FAULT TURN-ON DELAY AND RECOVERY TIME



Fault-Protected, Low-Voltage, Quad SPST Analog Switches

Pin Description

| PIN | | | NAME | FUNCTION |
|--------------|--------------|--------------|------------------------|--|
| MAX4711 | MAX4712 | MAX4713 | | |
| 1, 16, 9, 8 | 1, 16, 9, 8 | 1, 16, 9, 8 | IN1, IN2, IN3, IN4 | Logic Inputs. Fault-protected to (V- + 12V). |
| 2, 15, 10, 7 | 2, 15, 10, 7 | 2, 15, 10, 7 | COM1, COM2, COM3, COM4 | Analog Switch Common Terminals |
| 3, 14, 11, 6 | — | — | NC1, NC2, NC3, NC4 | Fault-Protected Analog Switch Normally Closed Terminals |
| — | 3, 14, 11, 6 | — | NO1, NO2, NO3, NO4 | Fault-Protected Analog Switch Normally Open Terminals |
| — | — | 3, 6 | NO1, NO4 | Fault-Protected Analog Switch Normally Open Terminals |
| — | — | 14, 11 | NC2, NC3 | Fault-Protected Analog Switch Normally Closed Terminals |
| 4 | 4 | 4 | V- | Negative Supply Voltage Input. Connect to GND for single-supply operation. |
| 5 | 5 | 5 | GND | Ground |
| 12 | 12 | 12 | N.C. | No Connection. Not internally connected. |
| 13 | 13 | 13 | V+ | Positive Supply Input |

Detailed Description

The MAX4711/MAX4712/MAX4713 differ considerably from traditional fault-protection switches, with several advantages. First, they are constructed with two parallel FET's allowing very low on-resistance. Second, they allow signals on the NC_ or NO_ pins that are within or slightly beyond the supply rails to be passed through the switch to the COM terminal, allowing rail-to-rail signal operation. Third, when a signal on NC_ or NO_ exceeds the supply rails by about 150mV (a fault condition) the voltage on COM_ is limited to the same polarity supply voltage. Operation is identical for both fault polarities.

During a fault condition, the NO_ or NC_ input becomes high impedance regardless of the switch state or load resistance. If the switch is on, the COM_ output current is supplied from V+ or V- by the clamp FET's that are connected from COM to each supply. These FET's can typically source or sink up to 15mA. When power is removed, the fault protection is still in effect. In this case, the NO_ or NC_ terminals are a virtual open circuit. The fault can be up to $\pm 12V$.

The COM_ pins are not fault-protected, they act as normal CMOS switch terminals. If a voltage source is connected to any COM_ pin, it should be limited to the supply voltages. Exceeding the supply voltage will

cause high currents to flow through the ESD-protected diodes, possibly damaging the device (see *Absolute Maximum Ratings*).

Pin Compatibility

These switches have identical pinouts to common non-fault-protected CMOS switches. Care should be exercised while considering them for direct replacements in existing printed circuit boards since only the NO_ and NC_ pins of each switch are fault-protected.

Internal Construction

Internal construction is shown in Figure 1, with the analog signal paths shown in bold. A single NO switch is shown; the NC configuration is identical except the logic-level translator is inverting. The analog switch is formed by the parallel combination of N-channel FET (N1) and P-channel FET (P1), which are driven on and off simultaneously according to the input fault condition and the logic-level state.

Normal Operation

Two comparators continuously compare the voltage on the NO_ (or NC_) pin with V+ and V-. When the signal on NO_ or NC_ is between V+ and V- the switch acts normally, with FETs N1 and P1 turning on and off in response to IN_ signals. The parallel combination of N1 and P1 forms a low-value resistor between NO_ (or

Fault-Protected, Low-Voltage, Quad SPST Analog Switches

MAX4711/MAX4712/MAX4713

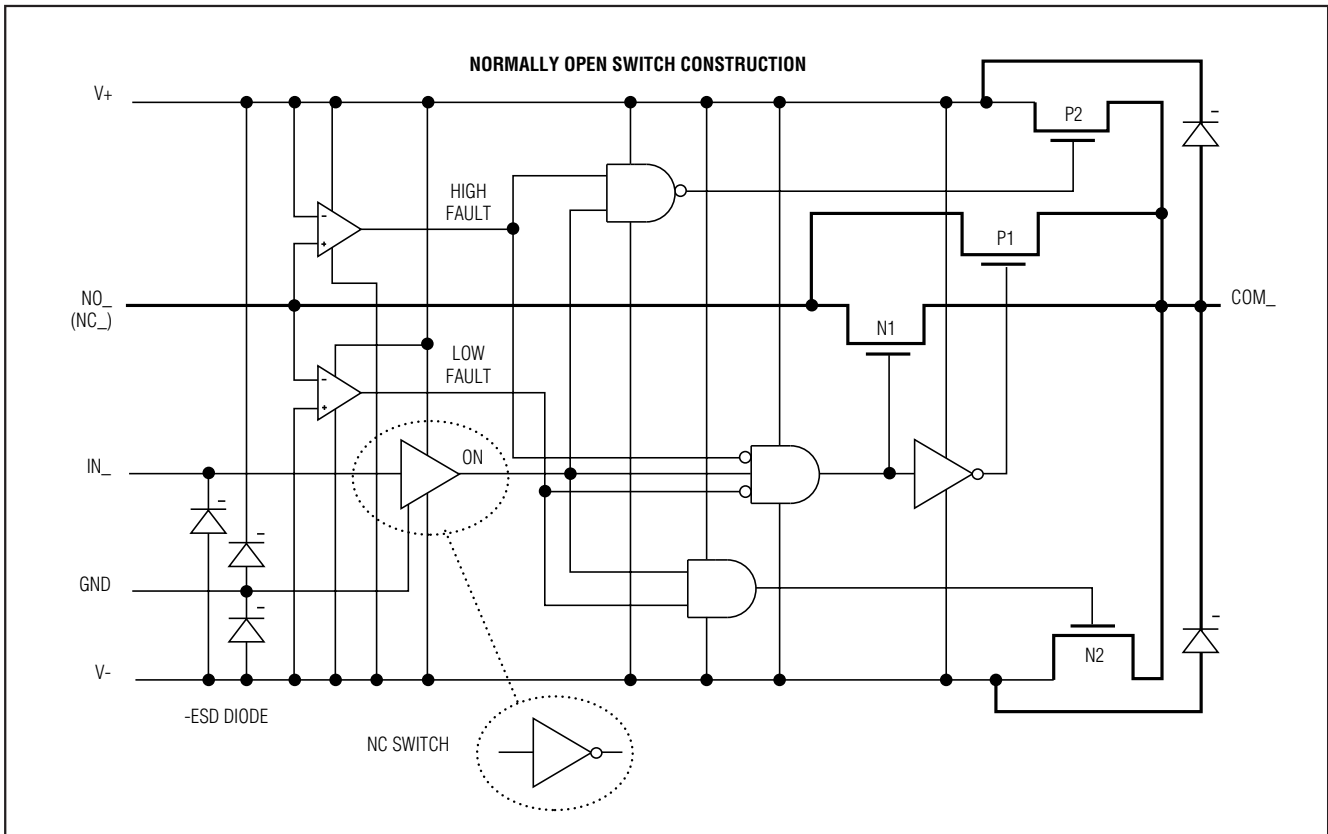


Figure 1. Block Diagram

NC_) and COM_ so that signals pass equally well in either direction.

Positive Fault Condition

When the signal on NO_ (or NC_) exceeds V+ by about 150mV, the high-fault comparator output is high, turning off FETs N1 and P1. This makes the NO_ (or NC_) input high impedance regardless of the switch state. If the switch state is "off", all FETs are turned off and both NO_ (or NC_) and COM_ are high impedance. If the switch state is "on", clamp FET P2 is turned on, sourcing current from V+ to COM_.

Negative Fault Condition

When the signal on NO_ (or NC_) exceeds V- by about 150mV, the low-fault comparator output is high, turning off FETs N1 and P1. This makes the NO_ (or NC_) input high impedance regardless of the switch state. If the switch state is "off", all FETs are turned off and both NO_ (or NC_) and COM_ are high impedance. If the switch state is "on", clamp FET N2 is turned on, sinking current from COM_ to V-.

Transient Fault Response and Recovery

When a fast rise-time or fall-time transient on NC_ or NO_ exceeds V+ or V-, the output (COM_) follows the input to the supply rail with only a few nanoseconds delay. This delay is due to the switch on-resistance and circuit capacitance to ground. When the input transient returns to within the supply rails, however, there is a 700ns output recovery delay time. These values depend on the COM_ output resistance and capacitance, and are not production tested or guaranteed. The delays are not dependent on the fault amplitude. Higher COM_ output resistance and capacitance increase recovery times.

COM_ and IN_ Pins

FETs N2 and P2 can source about $\pm 15\text{mA}$ from V+ or V- to COM_ in the fault condition. Ensure that if the COM_ pin is connected to a low-resistance load, the absolute maximum current rating of 40mA is never exceeded both in normal and fault conditions.

Fault-Protected, Low-Voltage, Quad SPST Analog Switches

The COM_ pins do not have fault protection. Reverse ESD-protection diodes are internally connected between COM_ and V+ and V-. If a signal on COM_ exceeds V+ or V- by more than a diode drop, one of these diodes will conduct. The IN_ pin can exceed the positive supply voltage, but they can go below the negative supply by only a diode drop. The maximum voltage on these pins is 12V if operating from a single supply, regardless of the supply voltage (including 0 volts), and if operating from dual supplies, the maximum voltage is (V- + 12V).

Fault-Protection Voltage and Power Off

The maximum fault voltage on the NC_ or NO_ pins is ±12V with power off.

IN_ Logic-Level Thresholds

The logic-level thresholds are CMOS and TTL compatible when using ±4.5V to ±5.5V or single +4.5V to +11V supplies. When using a +2.7V supply, the logic thresholds are $V_{IH} = 2.0V$ and $V_{IL} = 0.6V$.

Dual Supplies

The MAX4711/MAX4712/MAX4713 operate with bipolar supplies between ±2.7V and ±5.5V. The V+ and V- supplies need not be symmetrical, but their difference should not exceed 11V.

Single Supply

The MAX4711/MAX4712/MAX4713 operate from a single supply between +2.7V and +11V when V- is connected to GND.

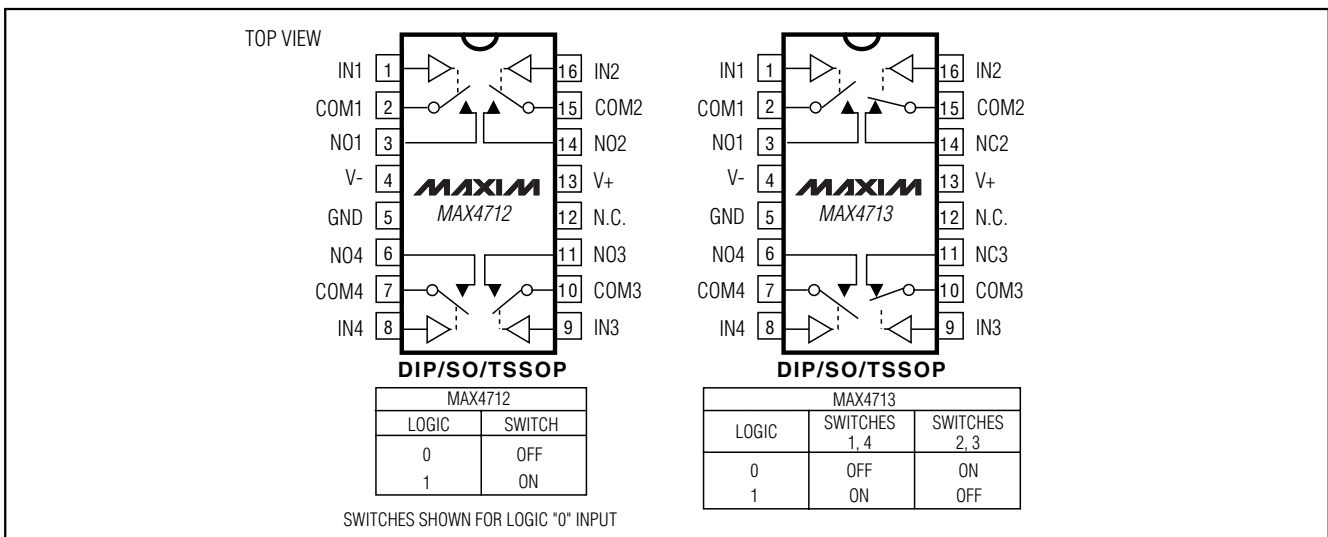
Chip Information

TRANSISTOR COUNT: 463

Ordering Information (continued)

| PART | TEMP RANGE | PIN-PACKAGE |
|------------|----------------|----------------|
| MAX4712CUE | 0°C to +70°C | 16 TSSOP |
| MAX4712CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4712CPE | 0°C to +70°C | 16 Plastic Dip |
| MAX4712EUE | -40°C to +85°C | 16 TSSOP |
| MAX4712ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4712EPE | -40°C to +85°C | 16 Plastic Dip |
| MAX4713CUE | 0°C to +70°C | 16 TSSOP |
| MAX4713CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4713CPE | 0°C to +70°C | 16 Plastic Dip |
| MAX4713EUE | -40°C to +85°C | 16 TSSOP |
| MAX4713ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4713EPE | -40°C to +85°C | 16 Plastic Dip |

Pin Configurations/Functional Diagrams/Truth Tables (continued)



Fault-Protected, Low-Voltage, Quad SPST Analog Switches

Test Circuits/Timing Diagrams

MAX4711/MAX4712/MAX4713

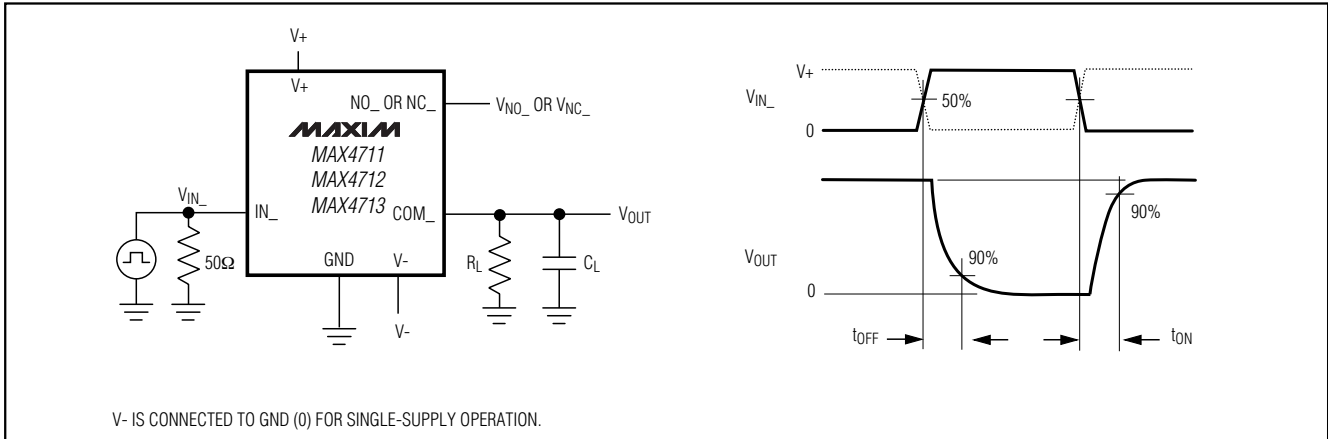


Figure 2. Switch Turn-On/Turn-Off Times

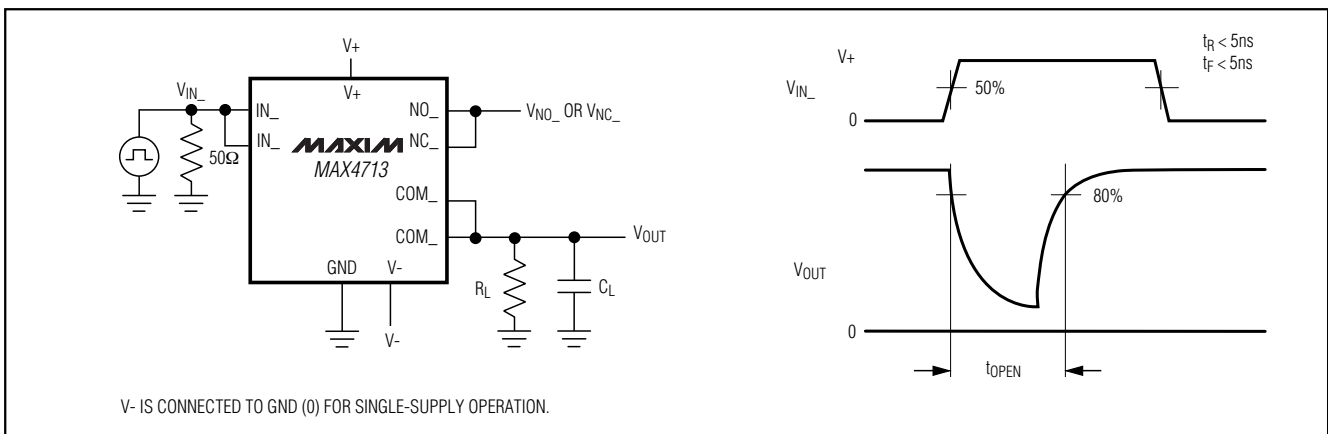


Figure 3. MAX4713 Break-Before-Make Interval

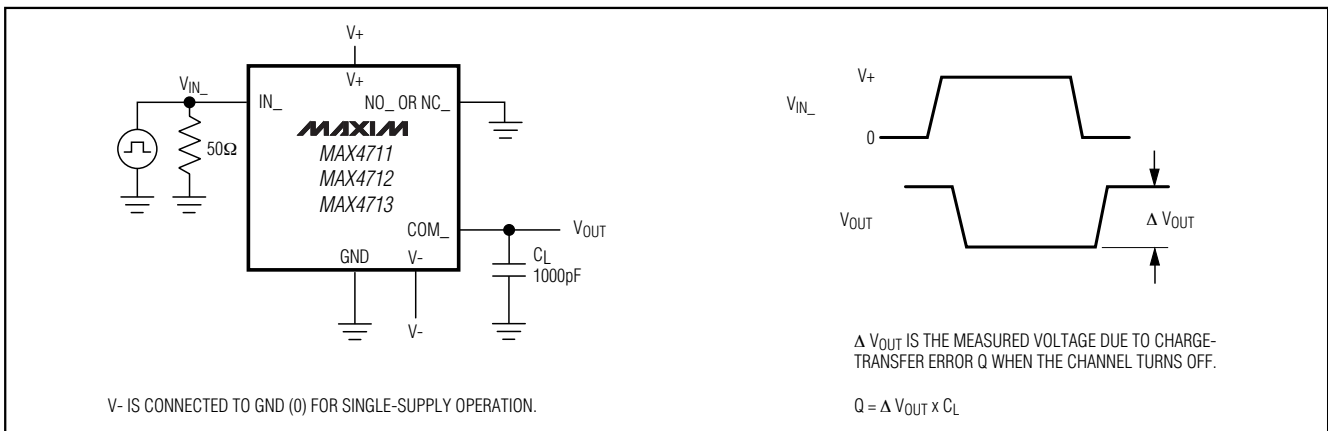


Figure 4. Charge Injection

Fault-Protected, Low-Voltage, Quad SPST Analog Switches

Test Circuits/Timing Diagrams (continued)

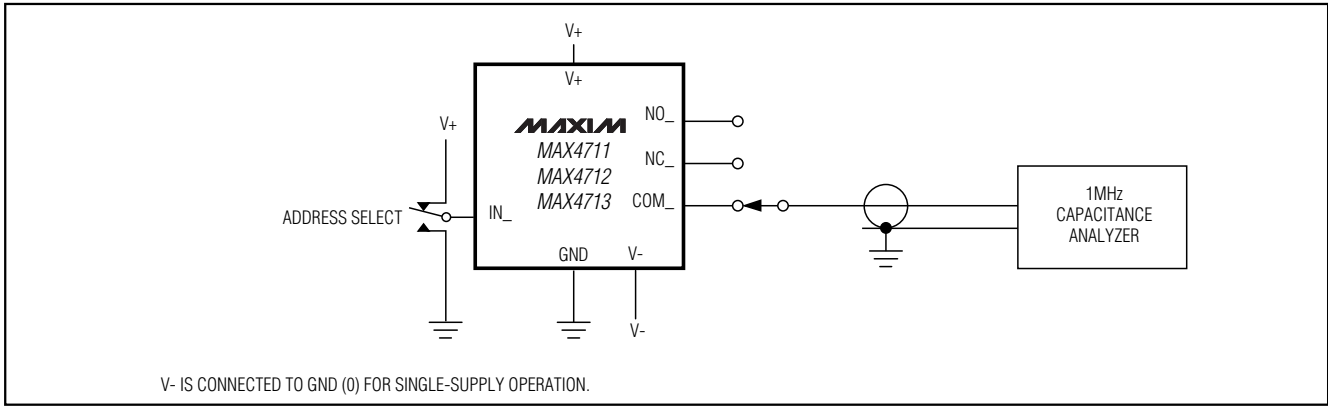


Figure 5. COM_, NO_, NC_ Capacitance

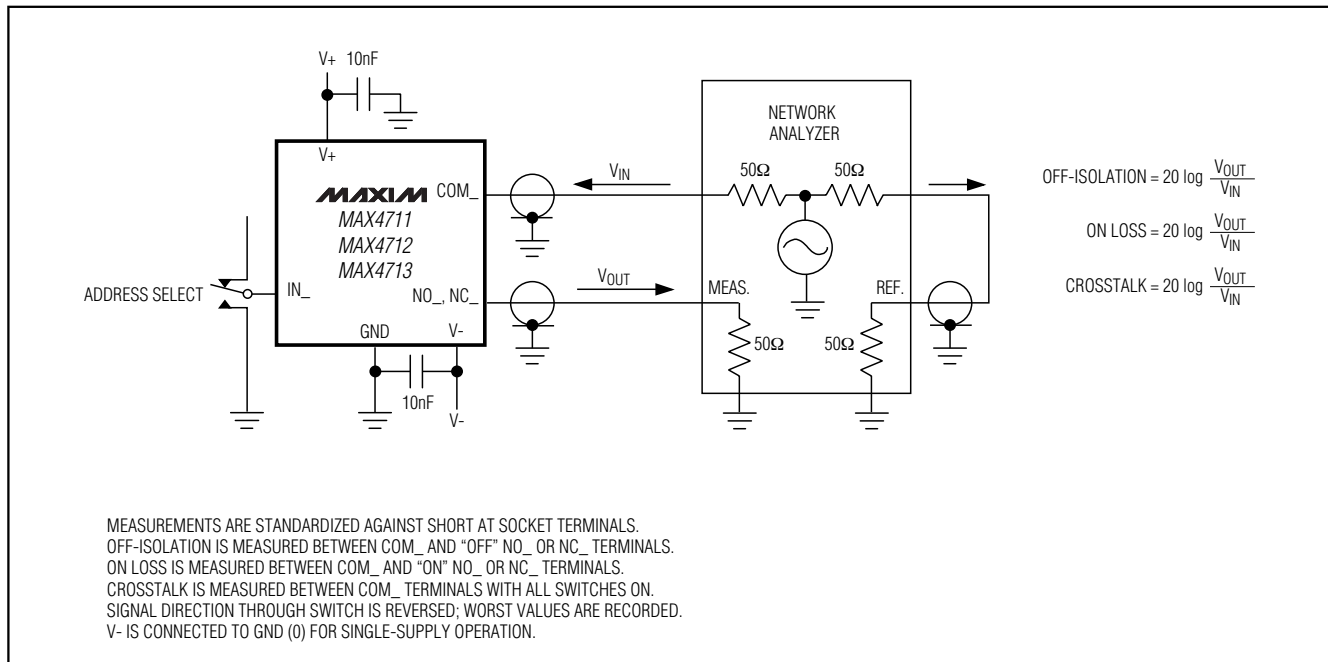


Figure 6. Frequency Response, Off-Isolation, and Crosstalk

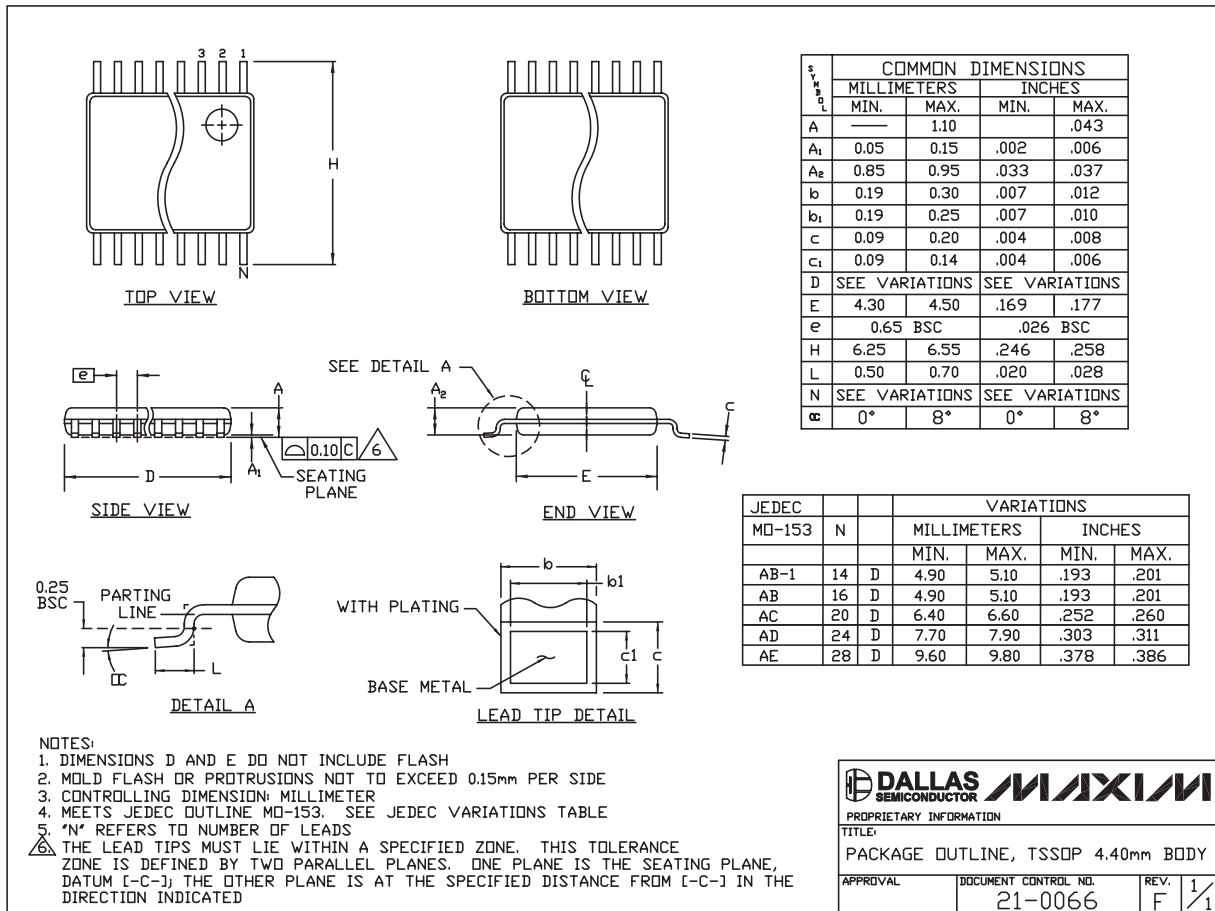
Fault-Protected, Low-Voltage, Quad SPST Analog Switches

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.)

MAX4711/MAX4712/MAX4713

TSSOP4, 4.40mm BOD



DALLAS SEMICONDUCTOR **MAXIM**

PROPRIETARY INFORMATION

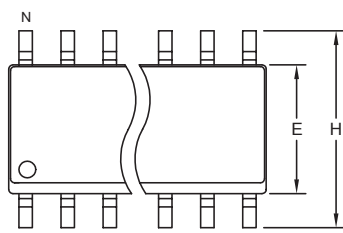
TITLE:
PACKAGE OUTLINE, TSSOP 4.40mm BODY

| | | | |
|----------|---------------------------------|-----------|-----|
| APPROVAL | DOCUMENT CONTROL NO. 21-0066 | REV. F | 1/1 |
|----------|---------------------------------|-----------|-----|

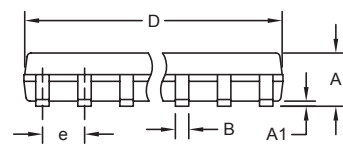
Fault-Protected, Low-Voltage, Quad SPST Analog Switches

Package Information (continued)

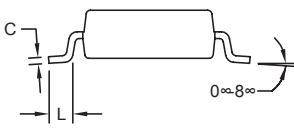
(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to www.maxim-ic.com/packages.)



TOP VIEW



FRONT VIEW



SIDE VIEW


| DIM | 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 BSC | | 1.27 BSC | |
| E | 0.150 | 0.157 | 3.80 | 4.00 |
| H | 0.228 | 0.244 | 5.80 | 6.20 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

VARIATIONS:

| DIM | INCHES | | MILLIMETERS | | N | MS012 |
|-----|--------|-------|-------------|-------|----|-------|
| | MIN | MAX | MIN | MAX | | |
| D | 0.189 | 0.197 | 4.80 | 5.00 | 8 | AA |
| D | 0.337 | 0.344 | 8.55 | 8.75 | 14 | AB |
| D | 0.386 | 0.394 | 9.80 | 10.00 | 16 | AC |

NOTES:

1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. LEADS TO BE COPLANAR WITHIN 0.10mm (.004").
4. CONTROLLING DIMENSION: MILLIMETERS.
5. MEETS JEDEC MS012.
6. N = NUMBER OF PINS.

| | | |
|---|----------------------|-------|
|  | DALLAS SEMICONDUCTOR | MAXIM |
| PROPRIETARY INFORMATION | | |
| TITLE: | | |
| PACKAGE OUTLINE, .150" SOIC | | |
| APPROVAL | DOCUMENT CONTROL NO. | REV. |
| | 21-0041 | B 1/1 |

SOICN EPS