

MAXIM

Dual, 5Ω Analog Switches

MAX4621/MAX4622/MAX4623

General Description

The MAX4621/MAX4622/MAX4623 are precision, dual, high-speed analog switches. The single-pole/single-throw (SPST) MAX4621 and double-pole/single-throw (DPST) MAX4623 dual switches are normally open (NO). The single-pole/double-throw (SPDT) MAX4622 has two normally closed (NC) and two NO poles. All three parts offer low 5Ω on-resistance guaranteed to match to within 0.5Ω between channels and to remain flat over the full analog signal range (Δ0.5Ω max). They also offer low leakage (<500pA at +25°C, <5nA at +85°C) and fast switching times (turn-on time <250ns, turn-off time <200ns).

These analog switches are ideal in low-distortion applications and are the preferred solution over mechanical relays in automatic test equipment or applications where current switching is required. They have low power requirements, use less board space, and are more reliable than mechanical relays.

The MAX4621/MAX4622/MAX4623 are pin-compatible replacements for the DG401/DG403/DG405, respectively, offering improved overall performance. These monolithic switches operate from a single positive supply (+4.5V to +36V) or with bipolar supplies (±4.5V to ±18V) while retaining CMOS-logic input compatibility.

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

Features

- ◆ Low On-Resistance: 3Ω (typ), 5Ω (max)
- ◆ Guaranteed RON Match Between Channels (0.5Ω max)
- ◆ Guaranteed Break-Before-Make Operation (MAX4622)
- ◆ Guaranteed Off-Channel Leakage <5nA at +85°C
- ◆ Single-Supply Operation (+4.5V to +36V)
Bipolar-Supply Operation (±4.5V to ±18V)
- ◆ TTL/CMOS-Logic Compatible
- ◆ Rail-to-Rail® Analog Signal Handling Capability
- ◆ Pin Compatible with DG401/DG403/DG405

Applications

| | |
|--------------------------|----------------------|
| Reed Relay Replacement | Military Radios |
| Test Equipment | PBX, PABX Systems |
| Communication Systems | Audio-Signal Routing |
| Data-Acquisition Systems | Avionics |

Ordering Information

| PART | TEMP. RANGE | PIN-PACKAGE |
|------------|--------------|----------------|
| MAX4621CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4621CPE | 0°C to +70°C | 16 Plastic DIP |

Ordering Information continued at end of data sheet.

Pin Configurations/Functional Diagrams/Truth Tables

TOP VIEW

SO/DIP

| MAX4621 | |
|---------|--------|
| LOGIC | SWITCH |
| 0 | OFF |
| 1 | ON |

SO/DIP

| MAX4622 | | |
|---------|---------------|---------------|
| LOGIC | SWITCHES 1, 2 | SWITCHES 3, 4 |
| 0 | OFF | ON |
| 1 | ON | OFF |

SO/DIP

| MAX4623 | |
|---------|--------|
| LOGIC | SWITCH |
| 0 | OFF |
| 1 | ON |

SWITCHES SHOWN FOR LOGIC "0" INPUT

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ABSOLUTE MAXIMUM RATINGS

(Voltages Referenced to GND)

| | |
|---|----------------------------|
| V+ to GND | -0.3V to +44V |
| V- to GND | +0.3V to -44V |
| V+ to V- | -0.3V to +44V |
| V _L to GND | -0.3V to (V+ + 0.3V) |
| All Other Pins to GND (Note 1) | (V- - 0.3V) to (V+ + 0.3V) |
| Continuous Current (COM ₋ , NO ₋ , NC ₋) | ±100mA |
| Peak Current (COM ₋ , NO ₋ , NC ₋) (pulsed at 1ms, 10% duty cycle) | ±300mA |

Continuous Power Dissipation (T_A = +70°C)

| | |
|--|-----------------|
| Narrow SO (derate 8.70mW/°C above +70°C) | 696mW |
| Narrow DIP (derate 10.53mW/°C above +70°C) | 842mW |
| Operating Temperature Ranges | |
| MAX462_C_ | 0°C to +70°C |
| MAX462_E_ | -40°C to +85°C |
| Storage Temperature Range | |
| | -65°C to +150°C |
| Lead Temperature (soldering, 10sec) | |
| | +300°C |

Note 1: Signals on NO₋, NC₋, or COM₋ 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 Supplies

(V+ = +15V, V- = -15V, V_L = +5V, GND = 0, V_{INH} = +2.4V, V_{INL} = +0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values are at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|--|---|---|---|-------|------|-------|----|
| ANALOG SWITCH | | | | | | | |
| Input Voltage Range (Note 3) | V _{COM-} , V _{NO-} , V _{NC-} | | V- | | V+ | V | |
| On-Resistance | R _{ON} | I _{COM-} = 10mA, V _{NO-} or V _{NC-} = ±10V | | 3 | 5 | Ω | |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | 7 | | |
| On-Resistance Match Between Channels (Notes 3, 4) | ΔR _{ON} | I _{COM-} = 10mA, V _{NO-} or V _{NC-} = ±10V | | 0.25 | 0.5 | Ω | |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.7 | | |
| On-Resistance Flatness (Notes 3, 5) | R _{FLAT(ON)} | I _{COM-} = 10mA; V _{NO-} or V _{NC-} = -5V, 0, 5V | | 0.2 | 0.5 | Ω | |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | | 0.7 | | |
| Off-Leakage Current (NO ₋ or NC ₋) (Note 6) | I _{NO-} , I _{NC-} | V _{NO-} or V _{NC-} = ±10V, V _{COM-} = ∓10V | | -0.5 | 0.01 | 0.5 | nA |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| COM ₋ Off-Leakage Current (Note 6) | I _{COM-(OFF)} | V _{COM-} = ±10V, V _{NO-} or V _{NC-} = ∓10V | | -0.5 | 0.01 | 0.5 | nA |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| COM ₋ On-Leakage Current (Note 6) | I _{COM-(ON)} | V _{COM-} = ±10V, V _{NO-} or V _{NC-} = ∓10V or floating | | -1 | 0.02 | 1 | nA |
| | | | T _A = +25°C | | | | |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| LOGIC INPUT | | | | | | | |
| Input Current with Input Voltage High | I _{INH} | V _{IN-} = 2.4V | -0.5 | 0.001 | 0.5 | μA | |
| Input Current with Input Voltage Low | I _{INL} | V _{IN-} = 0.8V | -0.5 | 0.001 | 0.5 | μA | |
| Logic Input Voltage High | V _{INH} | | 2.4 | | | V | |
| Logic Input Voltage Low | V _{INL} | | | | 0.8 | V | |

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MAX4621/MAX4622/MAX4623

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +15V, V- = -15V, VL = +5V, GND = 0, VINH = +2.4V, VINL = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|--------|--|-------------------|------|-------|-------|-------|
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | | | | ±4.5 | | ±20.0 | V |
| Positive Supply Current | I+ | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| Negative Supply Current | I- | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| Logic Supply Current | IL | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| Ground Current | IGND | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | | |
| Turn-On Time | tON | VCOM_ = ±10V, Figure 2 | TA = +25°C | | 120 | 250 | ns |
| | | | TA = TMIN to TMAX | | | 325 | |
| Turn-Off Time | tOFF | VCOM_ = ±10V, Figure 2 | TA = +25°C | | 90 | 200 | ns |
| | | | TA = TMIN to TMAX | | | 275 | |
| Break-Before-Make Time Delay (MAX4622 only) | tD | VCOM_ = ±10V, Figure 3, TA = +25°C | | 5 | 25 | | ns |
| Charge Injection | Q | CL = 1.0nF, VGEN = 0, RGEN = 0, Figure 4, TA = +25°C | | | 480 | | pC |
| Off-Isolation (Note 7) | VISO | RL = 50Ω, f = 1MHz, Figure 5, TA = +25°C | | | -62 | | dB |
| Crosstalk (Note 8) | VCT | RL = 50Ω, f = 1MHz, Figure 6, TA = +25°C | | | -60 | | dB |
| NC_ or NO_ Capacitance | COFF | f = 1MHz, Figure 7, TA = +25°C | | | 34 | | pF |
| COM_ Off-Capacitance | CCOM | f = 1MHz, Figure 7, TA = +25°C | | | 34 | | pF |
| On-Capacitance | CCOM | f = 1MHz, Figure 8, TA = +25°C | | | 150 | | pF |

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ELECTRICAL CHARACTERISTICS—Single Supply

(V+ = +12V, V- = 0, VL = +5V, GND = 0, VINH = +2.4V, VINL = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS | |
|---|-------------------------|--|-------------------|-------|-------|-------|----|
| ANALOG SWITCH | | | | | | | |
| Input Voltage Range (Note 3) | VCOM_, VNO_, VNC_ | | GND | | V+ | V | |
| On-Resistance | RON | ICOM_ = 10mA, VNO_ or VNC_ = 10V | TA = +25°C | 5.5 | 8 | Ω | |
| | | | TA = TMIN to TMAX | | 10 | | |
| On-Resistance Match Between Channels (Notes 3, 4) | ΔRON | ICOM_ = 10mA, VNO_ or VNC_ = 10V, TA = +25°C | | 0.2 | 0.5 | Ω | |
| On-Resistance Flatness (Notes 3, 5) | RFLAT(ON) | ICOM_ = 10mA; VNO_ or VNC_ = 3V, 6V, 9V; TA = +25°C | | 0.9 | 1.3 | Ω | |
| NO_ or NC_ Off-Leakage Current (Notes 6, 9) | INO_(OFF), INC_(OFF) | VCOM_ = 1V, 10V; VNO_ or VNC_ = 10V, 1V | TA = +25°C | -0.5 | 0.01 | 0.5 | nA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| COM_ Off-Leakage Current (Notes 6, 9) | ICOM_(OFF) | VCOM_ = 10V, 1V; VNO_ or VNC_ = 1V, 10V | TA = +25°C | -0.5 | 0.01 | 0.5 | nA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| COM_ On-Leakage Current (Notes 6, 9) | ICOM_(ON) | VCOM_ = 10V, 1V; VNO_ or VNC_ = 10V, 1V, or floating | TA = +25°C | -1 | 0.02 | 1 | nA |
| | | | TA = TMIN to TMAX | -10 | | 10 | |
| LOGIC INPUT | | | | | | | |
| Input Current with Input Voltage High | IINH | VIN_ = 2.4V | -0.5 | 0.001 | 0.5 | μA | |
| Input Current with Input Voltage Low | IINL | VIN_ = 0.8V | -0.5 | 0.001 | 0.5 | μA | |
| Logic Input Voltage High | VINH | | 2.4 | | | V | |
| Logic Input Voltage Low | VINL | | | | 0.8 | V | |
| POWER SUPPLY | | | | | | | |
| Power-Supply Range | | | 4.5 | | 36.0 | V | |
| Positive Supply Current | I+ | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| Logic Supply Current | IL | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |
| Ground Current | IGND | VIN_ = 0 or 5V | TA = +25°C | -0.5 | 0.001 | 0.5 | μA |
| | | | TA = TMIN to TMAX | -5 | | 5 | |

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MAX4621/MAX4622/MAX4623

ELECTRICAL CHARACTERISTICS—Single Supply (continued)

(V+ = +12V, V- = 0, VL = +5V, GND = 0, VINH = +2.4V, VINL = +0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values are TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--|--------|--|-------------------|-----|-----|-------|
| SWITCH DYNAMIC CHARACTERISTICS | | | | | | |
| Turn-On Time (Note 3) | tON | VCOM_ = 10V, Figure 2 | TA = +25°C | 200 | 350 | ns |
| | | | TA = TMIN to TMAX | | 475 | |
| Turn-Off Time (Note 3) | tOFF | VCOM_ = 10V, Figure 2 | TA = +25°C | 100 | 200 | ns |
| | | | TA = TMIN to TMAX | | 300 | |
| Break-Before-Make Time Delay (MAX4622 only) (Note 3) | tD | RL = 100Ω, CL = 35pF, Figure 3, TA = +25°C | 10 | 75 | | ns |
| Charge Injection | Q | CL = 1.0nF, VGEN = 0, RGEN = 0, Figure 4 | | 45 | | pC |
| Off-Isolation (Note 7) | VISO | RL = 50Ω, f = 1MHz, Figure 5 | | -62 | | dB |
| Crosstalk (Note 8) | VCT | RL = 50Ω, f = 1MHz, Figure 6 | | -60 | | dB |

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: Guaranteed by design.

Note 4: $\Delta R_{ON} = R_{ON_MAX} - R_{ON_MIN}$.

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

Note 6: Leakage currents are 100% tested at the maximum-rated hot temperature and guaranteed by correlation at +25°C.

Note 7: Off-isolation = $20\log_{10} [V_{COM_} / (V_{NC_} \text{ or } V_{NO_})]$. VCOM_ = output, VNC_ or VNO_ = input to off switch.

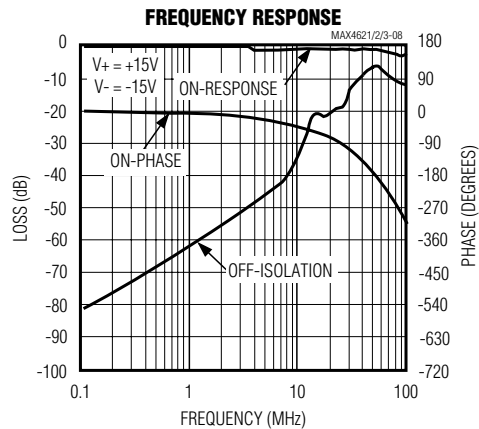
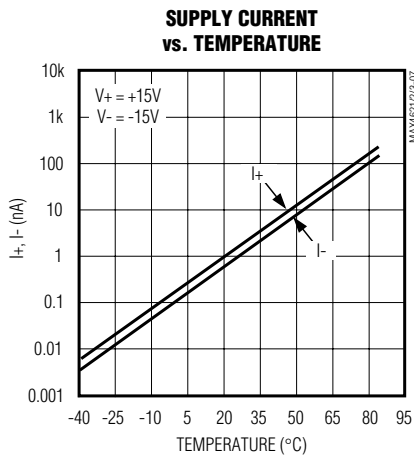
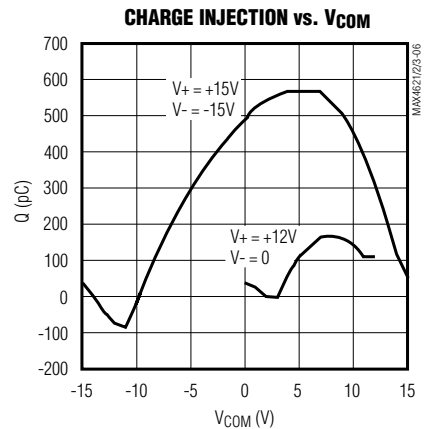
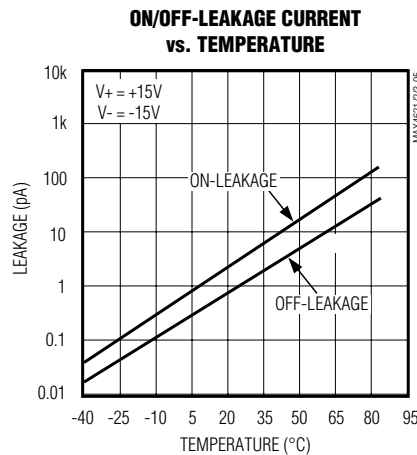
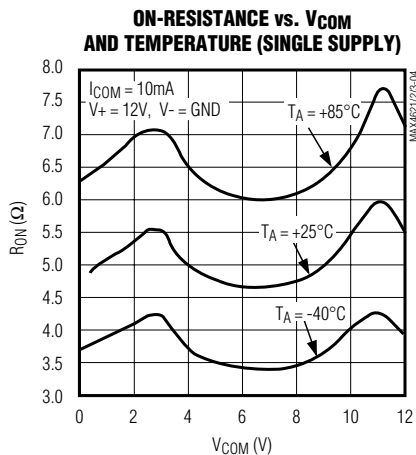
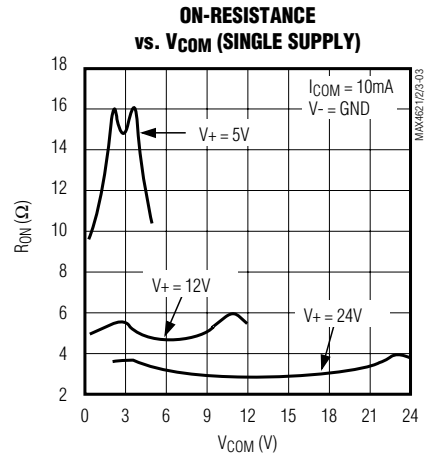
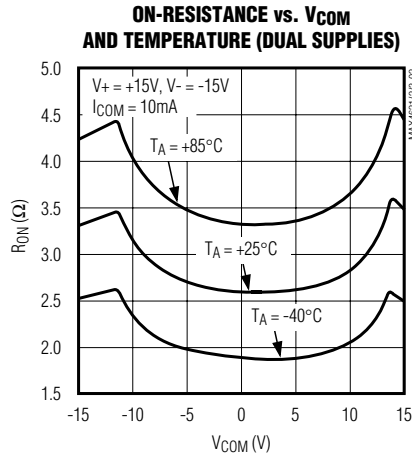
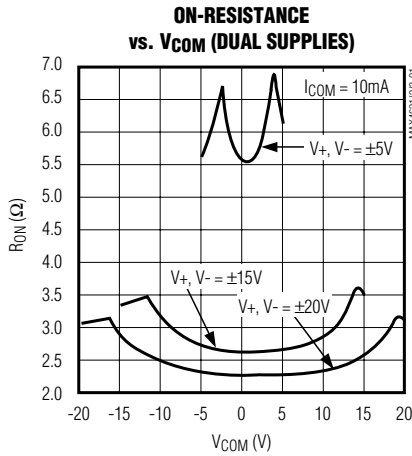
Note 8: Between any two switches.

Note 9: Leakage testing for single-supply operation is guaranteed by testing with dual supplies.

Dual, 5Ω Analog Switches

Typical Operating Characteristics

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



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MAX4621/MAX4622/MAX4623

Pin Description

| PIN | NAME | FUNCTION |
|----------------|-----------------------------------|--------------------------------------|
| MAX4621 | | |
| 1, 8 | COM1, COM2 | Switch Common Terminal |
| 2–7 | N.C. | Not internally connected |
| 9, 16 | NO2, NO1 | Switch Normally Open Terminal |
| 10, 15 | IN2, IN1 | Digital Logic Inputs |
| 11 | V+ | Positive Supply-Voltage Input |
| 12 | V _L | Logic Supply-Voltage Input |
| 13 | GND | Ground |
| 14 | V- | Negative Supply Voltage Input |
| MAX4622 | | |
| 1, 3, 6, 8 | COM ₋ | Switch Common Terminal |
| 2, 7 | N.C. | Not internally connected |
| 4, 5, 9, 16 | NC ₋ , NO ₋ | Switch Normally Closed/Open Terminal |
| 10, 15 | IN2, IN1 | Digital Logic Inputs |
| 11 | V+ | Positive Supply-Voltage Input |
| 12 | V _L | Logic Supply-Voltage Input |
| 13 | GND | Ground |
| 14 | V- | Negative Supply Voltage Input |
| MAX4623 | | |
| 1, 3, 6, 8 | COM ₋ | Switch Common Terminal |
| 2, 7 | N.C. | Not internally connected |
| 4, 5, 9, 16 | NO ₋ | Switch Normally Open Terminal |
| 10, 15 | IN2, IN1 | Digital Logic Inputs |
| 11 | V+ | Positive Supply-Voltage Input |
| 12 | V _L | Logic Supply-Voltage Input |
| 13 | GND | Ground |
| 14 | V- | Negative Supply Voltage |

Applications Information

Operation with Supply Voltages Other than ±15V

The MAX4621/MAX4622/MAX4623 switches operate with ±4.5V to ±18V bipolar supplies and a +4.5V to +36V single supply. In either case, analog signals ranging from V₊ to V₋ can be switched. The *Typical Operating Characteristics* graphs show the typical on-resistance variation with analog signal and supply voltage.

Overvoltage Protection

Proper power-supply sequencing is recommended for all CMOS devices. It is important not to exceed the absolute maximum ratings because stresses beyond the listed ratings may cause permanent damage to the devices. Always sequence V₊ on first, followed by V_L, V₋, and logic inputs. If power-supply sequencing is not possible, add two small signal diodes in series with the supply pins and a Schottky diode between V₊ and V_L (Figure 1). Adding diodes reduces the analog signal range to 1V below V₊ and 1V above V₋, but low switch resistance and low leakage characteristics are unaffected. The difference between V₊ and V₋ should not exceed +44V.

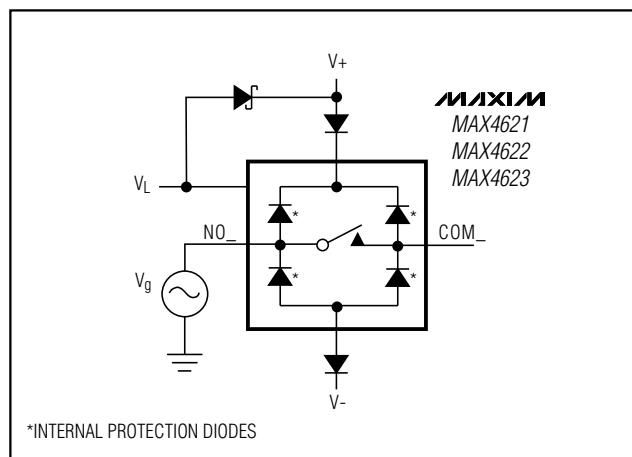


Figure 1. Overvoltage Protection Using Blocking Diodes

Dual, 5Ω Analog Switches

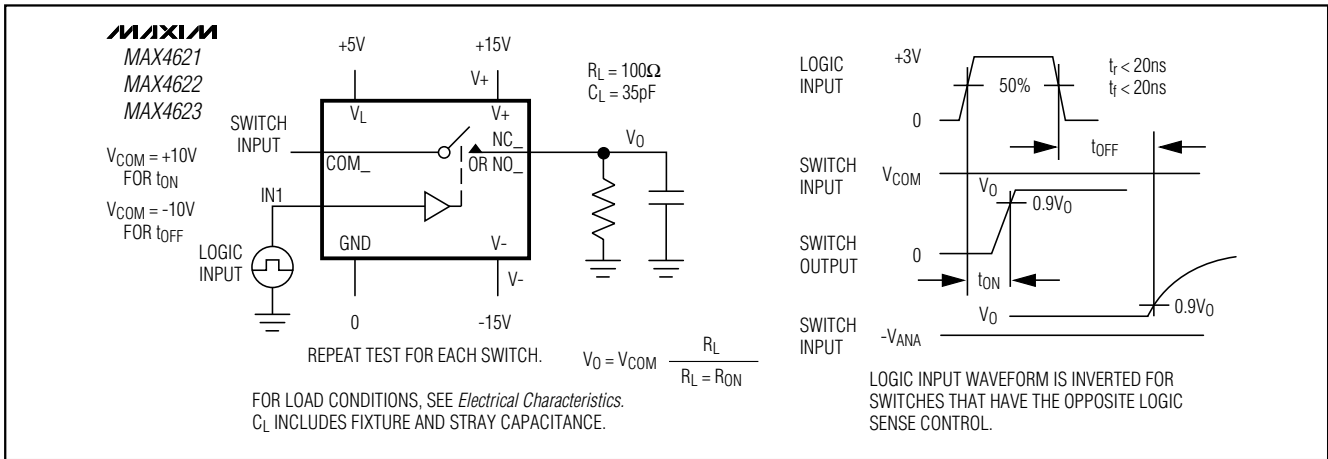


Figure 2. Switching-Time Test Circuit

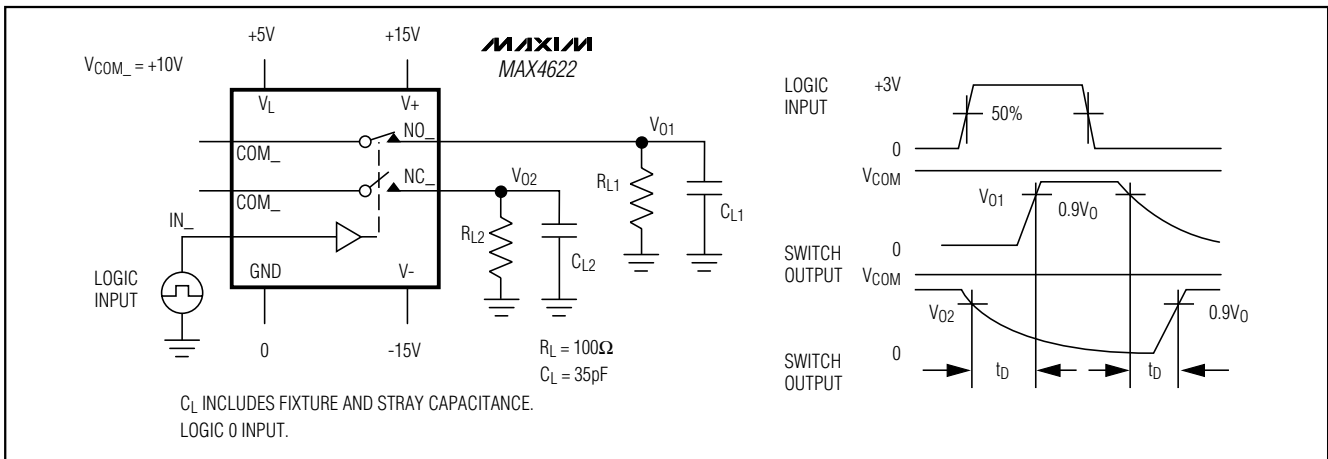


Figure 3. MAX4622 Break-Before-Make Test Circuit

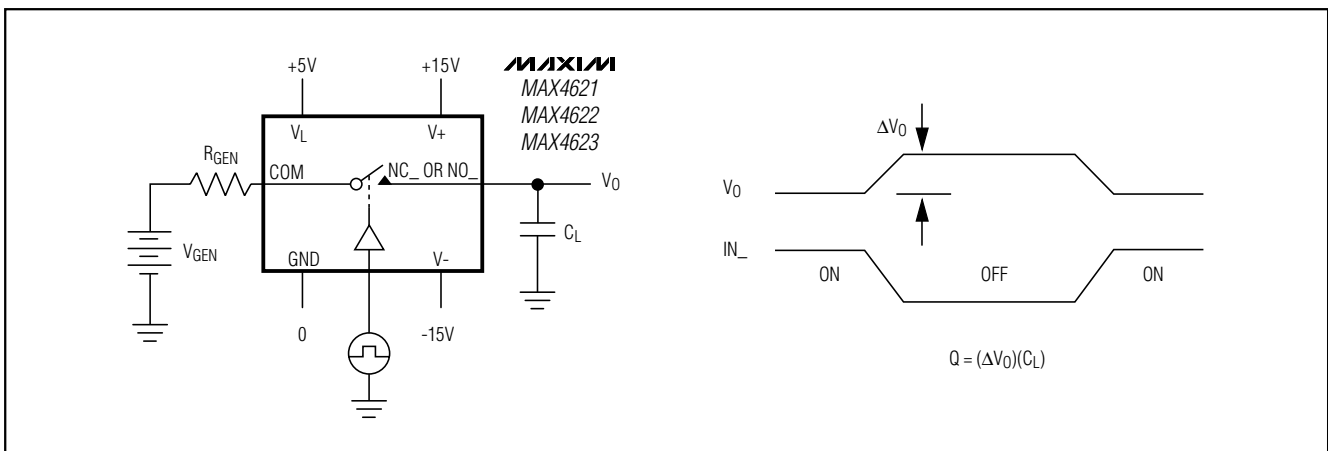


Figure 4. Charge-Injection Test Circuit

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MAX4621/MAX4622/MAX4623

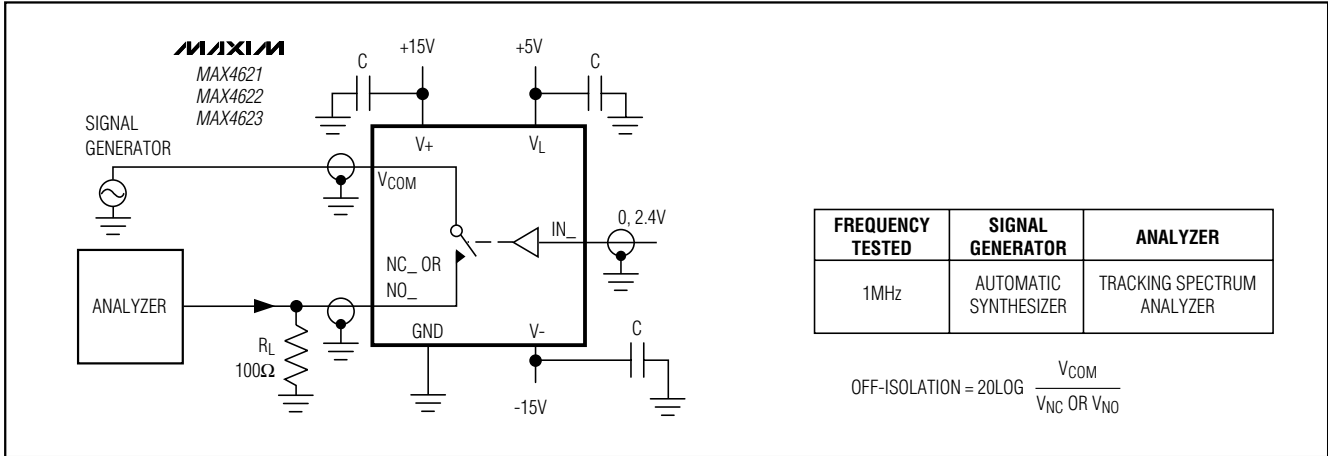


Figure 5. Off-Isolation

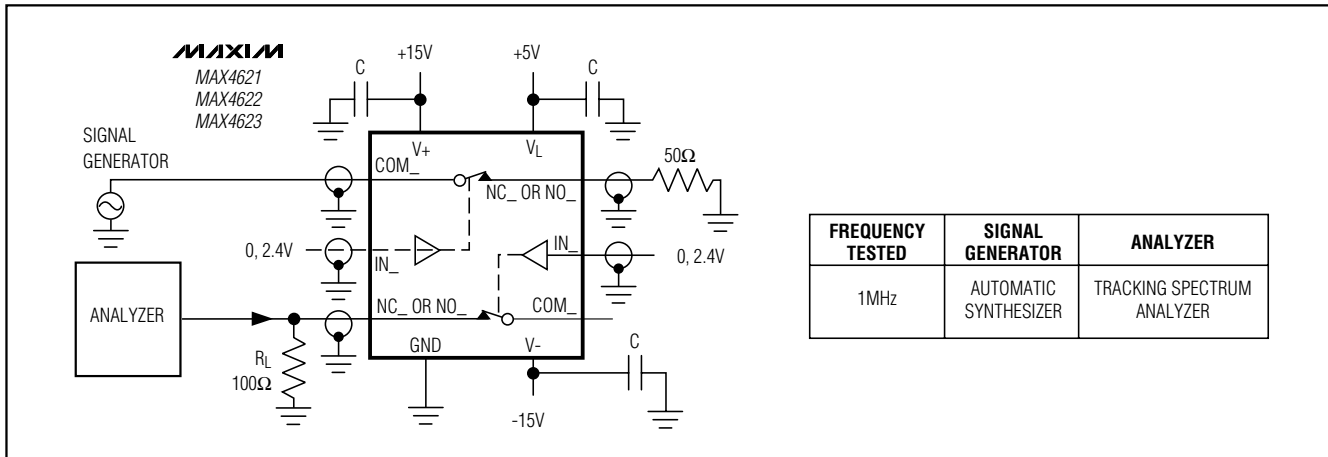


Figure 6. Crosstalk Test Circuit

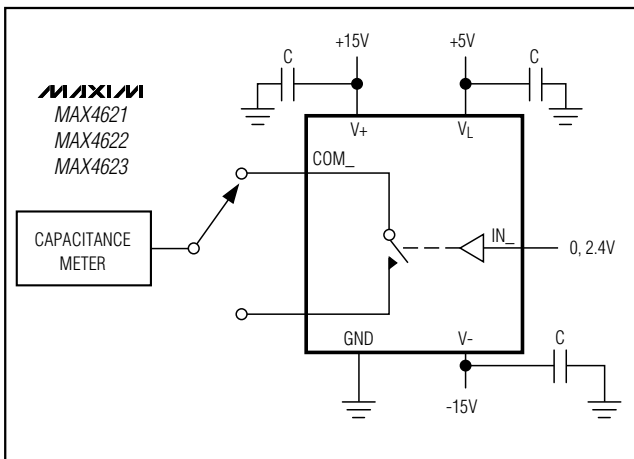


Figure 7. Channel-On Capacitance

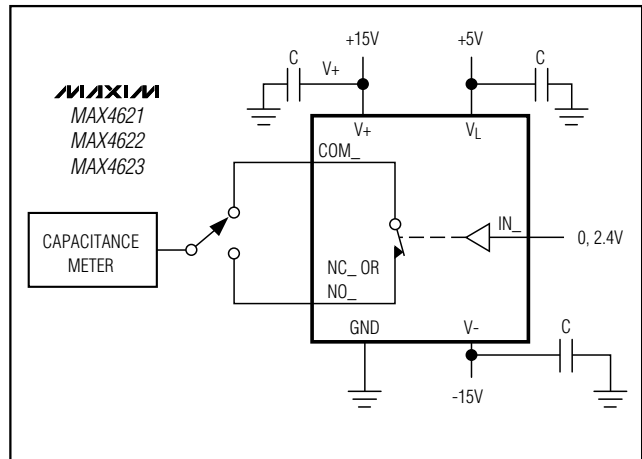


Figure 8. Channel-Off Capacitance

Dual, 5Ω Analog Switches

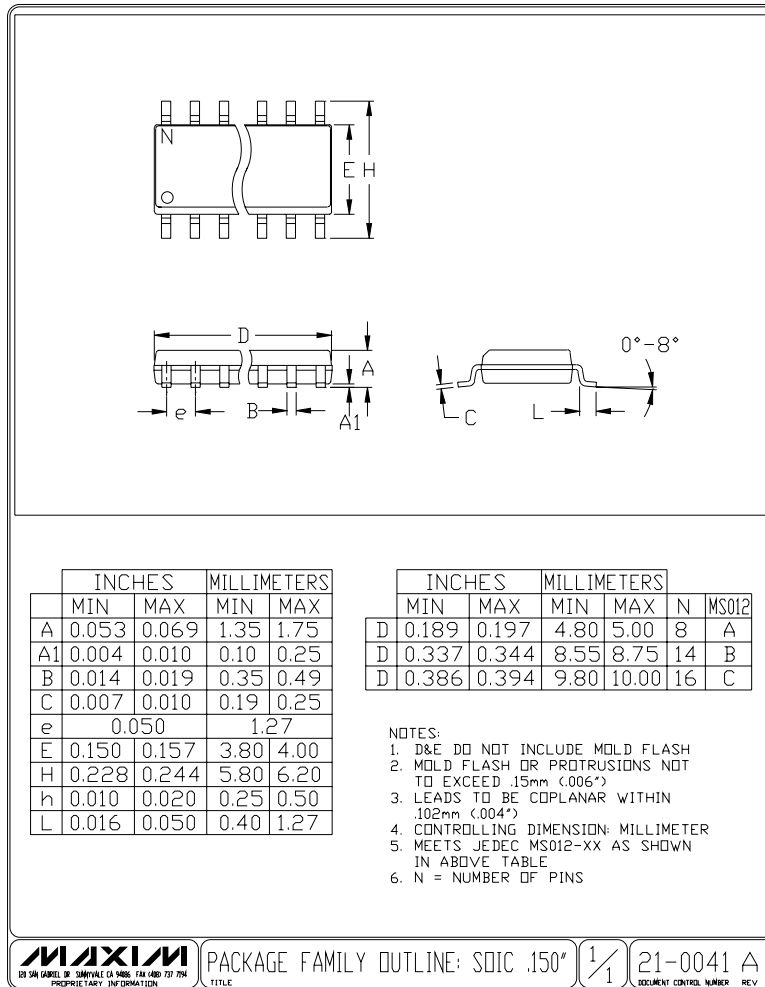
Ordering Information (continued)

| PART | TEMP. RANGE | PIN-PACKAGE |
|-------------------|----------------|----------------|
| MAX4621ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4621EPE | -40°C to +85°C | 16 Plastic DIP |
| MAX4622CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4622CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4622ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4622EPE | -40°C to +85°C | 16 Plastic DIP |
| MAX4623CSE | 0°C to +70°C | 16 Narrow SO |
| MAX4623CPE | 0°C to +70°C | 16 Plastic DIP |
| MAX4623ESE | -40°C to +85°C | 16 Narrow SO |
| MAX4623EPE | -40°C to +85°C | 16 Plastic DIP |

Chip Information

TRANSISTOR COUNT: 82

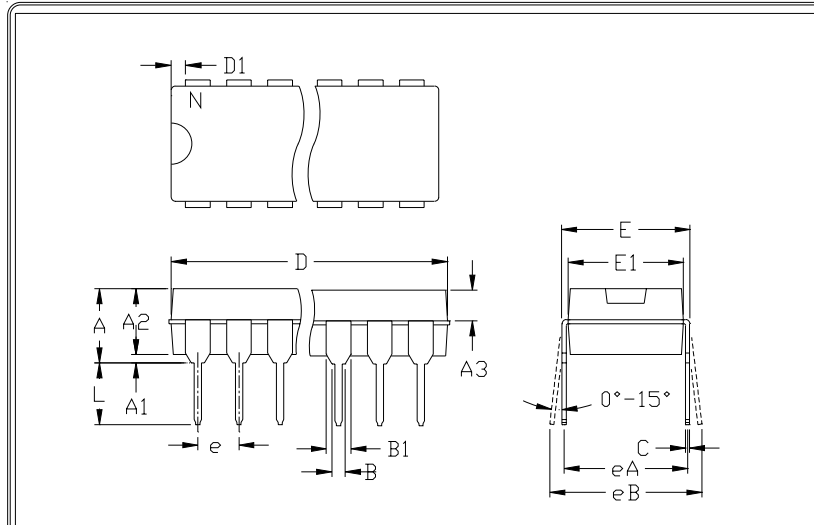
Package Information



Dual, 5Ω Analog Switches

Package Information (continued)

MAX4621/MAX4622/MAX4623



| | INCHES | | MILLIMETERS | |
|----|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | --- | 0.200 | --- | 5.08 |
| A1 | 0.015 | --- | 0.38 | --- |
| A2 | 0.125 | 0.175 | 3.18 | 4.45 |
| A3 | 0.055 | 0.080 | 1.40 | 2.03 |
| B | 0.016 | 0.022 | 0.41 | 0.56 |
| B1 | 0.045 | 0.065 | 1.14 | 1.65 |
| C | 0.008 | 0.012 | 0.20 | 0.30 |
| D1 | 0.005 | 0.080 | 0.13 | 2.03 |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.310 | 6.10 | 7.87 |
| e | 0.100 | --- | 2.54 | --- |
| eA | 0.300 | --- | 7.62 | --- |
| eB | --- | 0.400 | --- | 10.16 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |

| | INCHES | | MILLIMETERS | | N | MS001 |
|---|--------|-------|-------------|-------|----|-------|
| | MIN | MAX | MIN | MAX | | |
| D | 0.348 | 0.390 | 8.84 | 9.91 | 8 | AB |
| D | 0.735 | 0.765 | 18.67 | 19.43 | 14 | AC |
| D | 0.745 | 0.765 | 18.92 | 19.43 | 16 | AA |
| D | 0.885 | 0.915 | 22.48 | 23.24 | 18 | AD |
| D | 1.015 | 1.045 | 25.78 | 26.54 | 20 | AE |
| D | 1.14 | 1.265 | 28.96 | 32.13 | 24 | AF |
| D | 1.360 | 1.380 | 34.54 | 35.05 | 28 | *5 |

- NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH
 2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
 3. CONTROLLING DIMENSION: MILLIMETER
 4. MEETS JEDEC MS001-XX AS SHOWN IN ABOVE TABLE
 5. SIMILAR TO JEDEC MO-058AB
 6. N = NUMBER OF PINS



PACKAGE FAMILY OUTLINE: PDIP .300"

1/1

21-0043 A
DOCUMENT CONTROL NUMBER REV