



Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

General Description

The MAX4539/MAX4540 low-voltage, CMOS 8-channel (MAX4539) and dual 4-channel (MAX4540) multiplexers are ideal for precision ADC calibration and system self-monitoring applications. These calibration multiplexers (cal-muxes) have precision resistor-dividers to generate accurate voltage ratios from an input reference voltage. The reference ratios include 15/4096 and 4081/4096 of the external reference voltage, accurate to 15 bits, and 1/2V₊ and 5/8(V₊ - V₋), accurate to 8 bits. The external reference voltage as well as ground can also be switched to the output. The MAX4539/MAX4540 have enable inputs and address latching. All digital inputs have 0.8V and 2.4V logic thresholds, ensuring both TTL- and CMOS-logic compatibility when using a $\pm 5V$ or a single +5V supply. Protection diodes at all inputs provide an ESD rating $>2kV$.

The MAX4539/MAX4540 operate from a single +2.7V to +12V supply, or from dual supplies of $\pm 2.7V$ to $\pm 6V$. On-resistance (100 Ω max) is matched between switches to 6 Ω max. Each switch can handle Rail-to-Rail[®] analog signals. The off leakage current is 0.1nA at T_A = +25°C and 2nA at T_A = +85°C.

The MAX4539/MAX4540 are available in small 20-pin DIP, SO, and SSOP packages.

Applications

| | |
|----------------------------|----------------------|
| Battery-Operated Equipment | Avionics |
| Data-Acquisition Systems | Audio-Signal Routing |
| Test Equipment | Networking |

Ordering Information

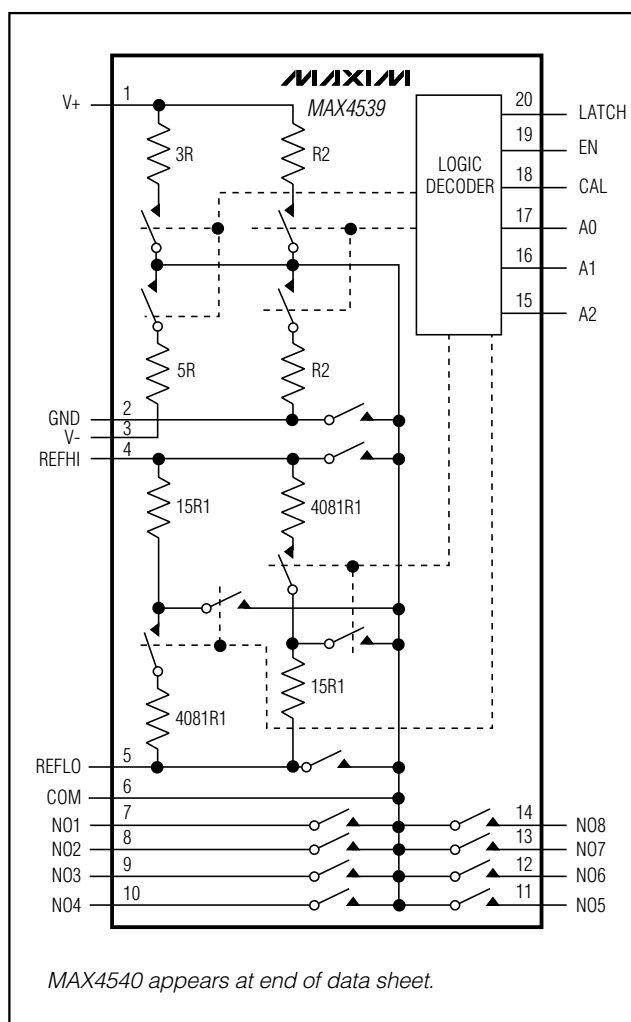
| PART | TEMP. RANGE | PIN-PACKAGE |
|--------------------|----------------|----------------|
| MAX4539 CAP | 0°C to +70°C | 20 SSOP |
| MAX4539CWP | 0°C to +70°C | 20 Wide SO |
| MAX4539CPP | 0°C to +70°C | 20 Plastic DIP |
| MAX4539EAP | -40°C to +85°C | 20 SSOP |
| MAX4539EWP | -40°C to +85°C | 20 Wide SO |
| MAX4539EPP | -40°C to +85°C | 20 Plastic DIP |
| MAX4540 CAP | 0°C to +70°C | 20 SSOP |
| MAX4540CWP | 0°C to +70°C | 20 Wide SO |
| MAX4540CPP | 0°C to +70°C | 20 Plastic DIP |
| MAX4540EAP | -40°C to +85°C | 20 SSOP |
| MAX4540EWP | -40°C to +85°C | 20 Wide SO |
| MAX4540EPP | -40°C to +85°C | 20 Plastic DIP |

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

Features

- ♦ On-Chip Gain and Offset Divider Networks Provide 15-Bit Accurate Output Ratios
- ♦ On-Chip V₊ to GND and V₊ to V₋ Divider Networks Provide 8-Bit Accurate Output Ratios
- ♦ R_{ON}: 100 Ω max
- ♦ R_{ON} Matching Between Channels: 6 Ω max
- ♦ Charge Injection: 5pC max
- ♦ Low 0.1nA Off Leakage Current
- ♦ Small 20-Pin SSOP/SO/DIP Packages

Pin Configurations/Functional Diagrams



MAX4539/MAX4540



Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

ABSOLUTE MAXIMUM RATINGS

V+ to GND-0.3V to +13V
 V- to GND-13V to +0.3V
 V+ to V--0.3V to +13V
 CAL, LATCH, A₋, EN, NO₋, COM₋,
 REFHI, REFLO (Note 1)(V₋ - 0.3V) to (V₊ + 0.3V)
 Continuous Current (any terminal)±20mA
 Peak Current, NO₋ or COM₋
 (pulsed at 1ms, 10% duty cycle max)±40mA

Continuous Power Dissipation (T_A = +70°C)
 SSOP (derate 8mW/°C above +70°C)640mW
 Wide SO (derate 8mW/°C above +70°C)800mW
 Plastic DIP (derate 10.53mW/°C above +70°C)842mW
 Operating Temperature Ranges
 MAX4539C_P/MAX4540C_P0°C to +70°C
 MAX4539E_P/MAX4540E_P-40°C to +85°C
 Storage Temperature Range-65°C to +160°C
 Lead Temperature (soldering, 10sec)+300°C

Note 1: Signals on NO₋, COM₋, EN, LATCH, CAL, A₋ exceeding V₊ or V₋ are clamped by internal diodes. Limit forward current to maximum current ratings.

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₊ = +5V ±10%, V₋ = -5V ±10%, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS | |
|--|---|---|---|---|------|------|-------|----|
| SWITCH | | | | | | | | |
| Analog-Signal Range | V _{COM_} , V _{NO_} | (Note 3) | | V- | | V+ | V | |
| On-Resistance | R _{ON} | I _{COM_} = 1mA, V _{NO_} = ±3.0V, V+ = 4.5V, V- = -4.5V | T _A = +25°C | 45 | 75 | Ω | | |
| | | | T _A = T _{MIN} to T _{MAX} | 100 | | | | |
| On-Resistance Matching Between Channels (Note 4) | ΔR _{ON} | I _{COM_} = 1mA, V _{NO_} = ±3.0V, V+ = 4.5V, V- = -4.5V | T _A = +25°C | 1 | 4 | Ω | | |
| | | | T _A = T _{MIN} to T _{MAX} | 6 | | | | |
| On-Resistance Flatness (Note 5) | R _{FLAT} | I _{COM_} = 1mA; V _{NO_} = -3V, 0, +3V; V+ = 4.5V; V- = -4.5V | T _A = +25°C | 7 | 10 | Ω | | |
| | | | T _A = T _{MIN} to T _{MAX} | 13 | | | | |
| NO-Off Leakage Current (Note 6) | I _{NO(OFF)} | V _{COM_} = ±4.5V, V _{NO_} = ∓4.5V, V+ = 5.5V, V- = -5.5V | T _A = +25°C | -0.1 | 0.01 | 0.1 | nA | |
| | | | T _A = T _{MIN} to T _{MAX} | -2 | 2 | | | |
| COM-Off Leakage Current (Note 6) | I _{COM_(OFF)} | V _{COM_} = ±4.5V, V _{NO_} = ∓4.5V, V+ = 5.5V, V- = -5.5V | MAX4539 | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | MAX4540 | T _A = T _{MIN} to T _{MAX} | -10 | 10 | | |
| | | | | T _A = +25°C | -0.1 | 0.01 | 0.1 | |
| | | | | T _A = T _{MIN} to T _{MAX} | -5 | 5 | | |
| COM-On Leakage Current (Note 6) | I _{COM_(ON)} | V _{COM_} = ±4.5V, V _{NO_} = ±4.5V, V+ = 5.5V, V- = -5.5V | MAX4539 | T _A = +25°C | -0.2 | 0.01 | 0.2 | nA |
| | | | MAX4540 | T _A = T _{MIN} to T _{MAX} | -10 | 10 | | |
| | | | | T _A = +25°C | -0.1 | 0.01 | 0.1 | |
| | | | | T _A = T _{MIN} to T _{MAX} | -5 | 5 | | |

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

MAX4539/MAX4540

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +5V ±10%, V- = -5V ±10%, VIH = 2.4V, VIL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---------------------------------------|------------------------|---|---|------|------|-----|-------|
| LOGIC INPUTS | | | | | | | |
| Input High Voltage | V _{IH} | | | 2.4 | 1.7 | | V |
| Input Low Voltage | V _{IL} | | | | 1.4 | 0.8 | V |
| Input Current with Input Voltage High | I _{IH} | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = V+ | | -0.1 | 0.01 | 0.1 | μA |
| Input Current with Input Voltage Low | I _{IL} | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 | | -0.1 | 0.01 | 0.1 | μA |
| SUPPLY | | | | | | | |
| Power-Supply Range | | | | ±2.7 | | ±6 | V |
| Positive Supply Current | I+ | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 or V+, V+ = 5.5V, V- = -5.5V (Note 7) | T _A = +25°C | -1 | 0.01 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| Negative Supply Current | I- | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 or V+, V+ = 5.5V, V- = -5.5V (Note 7) | T _A = +25°C | -1 | 0.01 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| GND Supply Current | I _{GND} | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 or V+, V+ = 5.5V, V- = -5.5V (Note 7) | T _A = +25°C | -1 | 0.01 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| DYNAMIC CHARACTERISTICS | | | | | | | |
| Transition Time | t _{TRANS} | Figure 1 | T _A = +25°C | | 100 | 150 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 200 | |
| Break-Before-Make Interval (Note 3) | t _{OPEN} | Figure 2 | T _A = +25°C | 4 | 10 | | ns |
| | | | T _A = T _{MIN} to T _{MAX} | 1 | | | |
| Enable Turn-On Time | t _{ON} | Figure 3 | T _A = +25°C | | 75 | 115 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 175 | |
| Enable Turn-Off Time | t _{OFF} | Figure 3 | T _A = +25°C | | 50 | 100 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 120 | |
| Charge Injection (Note 3) | V _{CTE} | C _L = 1nF, V _{NO_} = 0, Figure 4 | T _A = +25°C | | 1 | 5 | pC |
| Off-Isolation (Note 8) | V _{ISO} | V _{EN} = 0, f = 1MHz, Figure 5 | T _A = +25°C | | -75 | | dB |
| Crosstalk Between Channels (Note 9) | V _{CT} | V _{EN} = 2.4V, f = 1MHz, V _{GEN} = 1Vp-p, Figure 5 | T _A = +25°C | | -75 | | dB |
| Logic Input Capacitance | C _{IN} | f = 1MHz | T _A = +25°C | | 15 | | pF |
| NO-Off Capacitance | C _{OFF} | f = 1MHz, V _{EN} = V _{COM_} = 0, Figure 6 | T _A = +25°C | | 3 | | pF |
| COM-Off Capacitance | C _{COM_(OFF)} | f = 1MHz, V _{EN} = V _{COM_} = 0, Figure 6 | T _A = +25°C | | 15 | | pF |
| COM-On Capacitance | C _{COM_(ON)} | f = 1MHz, V _{EN} = 2.4V, V _{COM_} = 0, Figure 6 | T _A = +25°C | | 26 | | pF |

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

($V_+ = +5V \pm 10\%$, $V_- = -5V \pm 10\%$, $V_{IH} = 2.4V$, $V_{IL} = 0.8V$, $T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values at $T_A = +25^\circ C$.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---------------------------------------|--------|--|-------------------|-----------------|---------------|-----------------|-------|
| LATCH TIMING (Note 3) | | | | | | | |
| Setup Time | ts | Figure 7 | TA = +25°C | 45 | 70 | ns | |
| | | | TA = TMIN to TMAX | 80 | | | |
| Hold Time | tH | Figure 7 | TA = +25°C | -10 | 0 | ns | |
| | | | TA = TMIN to TMAX | -10 | | | |
| Pulse Width, Latch Enable | tMPW | Figure 7 | TA = +25°C | 30 | 15 | ns | |
| | | | TA = TMIN to TMAX | 40 | | | |
| Enable Setup Time | tES | Figure 8 | TA = +25°C | 15 | 30 | ns | |
| | | | TA = TMIN to TMAX | 40 | | | |
| INTERNAL DIVIDERS | | | | | | | |
| Offset Divider Output | | VREF = 4.096V, REFHI = 4.096V, REFLO = GND | TA = +25°C | 14.9/ 4096 | 15/ 4096 | 15.1/ 4096 | LSB |
| | | | TA = TMIN to TMAX | 14.9/ 4096 | 15/ 4096 | 15.1/ 4096 | |
| Gain Divider Output | | VREF = 4.096V, REFHI = 4.096V, REFLO = GND | TA = +25°C | 4080.9/ 4096 | 4081/ 4096 | 4081.1/ 4096 | LSB |
| | | | TA = TMIN to TMAX | 4080.9/ 4096 | 4081/ 4096 | 4081.1/ 4096 | |
| (V+ / 2) Divider Output | | Referenced to GND | TA = +25°C | 2032/ 4096 | 2048/ 4096 | 2064/ 4096 | LSB |
| | | | TA = TMIN to TMAX | 2032/ 4096 | 2048/ 4096 | 2064/ 4096 | |
| (V+ - V-) Divider Output | | Referenced to V- | TA = +25°C | 2544/ 4096 | 2560/ 4096 | 2576/ 4096 | LSB |
| | | | TA = TMIN to TMAX | 2544/ 4096 | 2560/ 4096 | 2576/ 4096 | |
| Output Resistance Offset Divider | | (Note 3) | TA = +25°C | 400 | 800 | Ω | |
| Output Resistance Gain Divider | | (Note 3) | TA = +25°C | 400 | 800 | Ω | |
| Output Resistance (V+ / 2) Divider | | (Note 3) | TA = +25°C | 6 | 9 | kΩ | |
| Output Resistance (V+ - V-) Divider | | (Note 3) | TA = +25°C | 6 | 9 | kΩ | |
| Output Resistance (REFHI, REFLO, GND) | | (Note 3) | TA = +25°C | 400 | 800 | Ω | |
| Additional Positive Supply Current | | (V+ / 2) divider active, VIH = V+, VIL = 0 (Note 3) | TA = +25°C | V+ / 24k | V+ / 13k | mA | |

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

MAX4539/MAX4540

ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)

(V+ = +5V ±10%, V- = -5V ±10%, VIH = 2.4V, VIL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---|--------|--|------------------------|---------------|-----|---------------|-------|
| Additional Positive Supply Current (Note 3) | | (V+ - V-) divider active, V _{IH} = V+, V _{IL} = 0 | T _A = +25°C | (V+ - V-)/24k | | (V+ - V-)/13k | mA |
| Additional Negative Supply Current | | (V+ - V-) divider active, V _{IH} = V+, V _{IL} = 0 (Note 3) | T _A = +25°C | (V+ - V-)/24k | | (V+ - V-)/13k | mA |
| REFHI, REFLO Input Range (Note 3) | | | | V- - 0.3 | | V+ + 0.3 | V |
| Input Resistance (REFHI, REFLO) (Note 3) | | Offset divider active, gain divider active | T _A = +25°C | 25 | 40 | | kΩ |

ELECTRICAL CHARACTERISTICS—Single +5V Supply

(V+ = +5V ±10%, V- = 0, VIH = 2.4V, VIL = 0.8V, TA = TMIN to TMAX, unless otherwise noted. Typical values at TA = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS | |
|--|---|--|---|---|------|-----|-------|----|
| SWITCH | | | | | | | | |
| Analog-Signal Range | V _{NO_} , V _{COM_} | (Note 3) | | 0 | | V+ | V | |
| On-Resistance | R _{ON} | I _{COM_} = 1mA, V _{NO_} = 3.0V, V+ = 4.5V | T _A = +25°C | 80 | | 150 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 200 | | |
| On-Resistance Matching Between Channels (Notes 3, 4) | ΔR _{ON} | I _{COM_} = 1mA, V _{NO_} = 3.0V, V+ = 4.5V | T _A = +25°C | 2 | | 8 | Ω | |
| | | | T _A = T _{MIN} to T _{MAX} | | | 12 | | |
| On-Resistance Flatness (Note 5) | R _{FLAT} | I _{COM_} = 1mA; V _{NO_} = 3V, 2V, 1V; V+ = 4.5V | T _A = +25°C | 8 | | | Ω | |
| NO-Off Leakage Current (Notes 6, 10) | I _{NO(OFF)} | V _{COM_} = 1V, 4.5V; V _{NO_} = 4.5V, 1V; V+ = 5.5V | T _A = +25°C | -0.1 | | 0.1 | nA | |
| | | | T _A = T _{MIN} to T _{MAX} | -2 | | 2 | | |
| COM-Off Leakage Current (Notes 6, 10) | I _{COM_(OFF)} | V _{COM_} = 4.5V, 1V; V _{NO_} = 1V, 4.5V; V+ = 5.5V | MAX4539 | T _A = +25°C | -0.2 | | 0.2 | nA |
| | | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| | | | MAX4540 | T _A = +25°C | -0.1 | | 0.1 | |
| | | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| COM-On Leakage Current (Notes 6, 10) | I _{COM_(ON)} | V _{COM_} = 4.5V, V _{NO_} = 4.5V, V+ = 5.5V | MAX4539 | T _A = +25°C | -0.2 | | 0.2 | nA |
| | | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| | | | MAX4540 | T _A = +25°C | -0.1 | | 0.1 | |
| | | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

ELECTRICAL CHARACTERISTICS—Single +5V Supply (continued)

(V+ = +5V ±10%, V- = 0, V_{IH} = 2.4V, V_{IL} = 0.8V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---------------------------------------|--------------------|--|---|------|------|-----|-------|
| LOGIC INPUTS (Note 3) | | | | | | | |
| Input High Voltage | V _{IH} | | | 2.4 | 1.6 | | V |
| Input Low Voltage | V _{IL} | | | | 1.4 | 0.8 | V |
| Input Current with Input Voltage High | I _{IH} | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = V+ | | -0.1 | | 0.1 | μA |
| Input Current with Input Voltage Low | I _{IL} | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 | | -0.1 | | 0.1 | μA |
| SUPPLY | | | | | | | |
| Power-Supply Range | | | | 2.7 | | 12 | V |
| Positive Supply Current (Note 3) | I ₊ | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 or V+, V+ = 5.5V | T _A = +25°C | -1 | 0.01 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -5 | | 5 | |
| GND Supply Current (Note 3) | I _{GND} | V _{EN} = V _{A_} = V _{LATCH} = V _{CAL} = 0 or V+, V+ = 5.5V | T _A = +25°C | -1 | 0.01 | 1 | μA |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | 10 | |
| DYNAMIC CHARACTERISTICS (Note 3) | | | | | | | |
| Transition Time | t _{TRANS} | Figure 1 | T _A = +25°C | | 150 | 200 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 250 | |
| Break-Before-Make Interval | t _{OPEN} | Figure 2 | T _A = +25°C | 4 | 10 | | ns |
| | | | T _A = T _{MIN} to T _{MAX} | 1 | | | |
| Enable Turn-On Time | t _{ON} | Figure 3 | T _A = +25°C | | 115 | 150 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 200 | |
| Enable Turn-Off Time | t _{OFF} | Figure 3 | T _A = +25°C | | 60 | 100 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 130 | |
| Charge Injection | V _{CTE} | C _L = 1nF, V _{NO_} = 0, Figure 4 | T _A = +25°C | | 1 | 5 | pC |
| LATCH TIMING (Note 3) | | | | | | | |
| Setup Time | t _S | Figure 7 | T _A = +25°C | | | 70 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 80 | |
| Hold Time | t _H | Figure 7 | T _A = +25°C | -10 | 0 | | ns |
| | | | T _A = T _{MIN} to T _{MAX} | -10 | | | |
| Pulse Width, Latch Enable | t _{MPW} | Figure 7 | T _A = +25°C | 30 | 15 | | ns |
| | | | T _A = T _{MIN} to T _{MAX} | 40 | | | |
| Enable Setup Time | t _{ES} | Figure 8 | T _A = +25°C | | 15 | 30 | ns |
| | | | T _A = T _{MIN} to T _{MAX} | | | 40 | |

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

MAX4539/MAX4540

ELECTRICAL CHARACTERISTICS—Single +3V Supply

(V+ = +2.7V to +3.6V, V- = 0, V_{IH} = 2.4V, V_{IL} = 0.5V, T_A = T_{MIN} to T_{MAX}, unless otherwise noted. Typical values at T_A = +25°C.) (Note 2)

| PARAMETER | SYMBOL | CONDITIONS | | MIN | TYP | MAX | UNITS |
|---------------------------|--------|---------------------------------------|-------------------|-----|-----|-----|-------|
| SWITCH | | | | | | | |
| Analog-Signal Range | VCOM_ | (Note 3) | | 0 | | V+ | V |
| On-Resistance | RON | ICOM_ = 0.2mA, VNO_ = 1.5V, V+ = 2.7V | TA = +25°C | 220 | 500 | | Ω |
| | | | TA = TMIN to TMAX | 600 | | | |
| LOGIC INPUTS (Note 3) | | | | | | | |
| Input High Voltage | VIH | | | 2.4 | 1.1 | | V |
| Input Low Voltage | VIL | | | | 1.1 | 0.5 | V |
| DYNAMIC (Note 3) | | | | | | | |
| Transition Time | tTRANS | VNO1 = 1.5V, VNO8 = 0, Figure 1 | TA = +25°C | | 260 | 400 | ns |
| Enable Turn-On Time | ton | VNO1 = 1.5V, Figure 3 | TA = +25°C | | 220 | 350 | ns |
| Enable Turn-Off Time | toff | VNO = 1.5V, Figure 3 | TA = +25°C | | 100 | 150 | ns |
| LATCH TIMING (Note 3) | | | | | | | |
| Setup Time | ts | Figure 7 | TA = +25°C | | | 100 | ns |
| Hold Time | tH | Figure 7 | TA = +25°C | -10 | 0 | | ns |
| Pulse Width, Latch Enable | tMPW | Figure 7 | TA = +25°C | 40 | | | ns |
| Enable Setup Time | tES | Figure 8 | TA = +25°C | | | 50 | ns |

Note 2: The algebraic convention, where the most negative value is a minimum and the most positive value 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 value of on-resistance as measured over the specified analog signal range.

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

Note 7: If the logic inputs can float during power-on, connect a 1MΩ pull-up from LATCH to V+; see *Applications Information* section.

Note 8: Off Isolation = 20log₁₀ (V_{COM}/V_{NO}), V_{COM} = output, V_{NO} = input to off switch.

Note 9: Between any two switches.

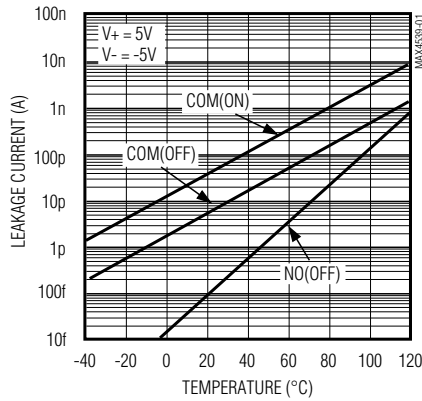
Note 10: Leakage testing with a single supply is guaranteed by testing with dual supplies.

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

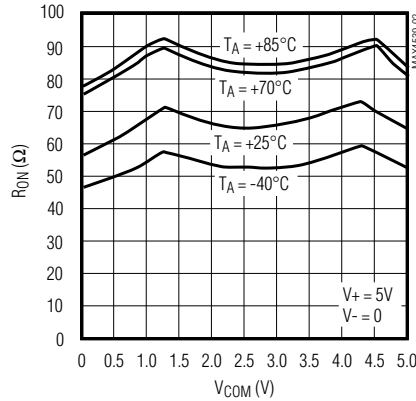
Typical Operating Characteristics

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

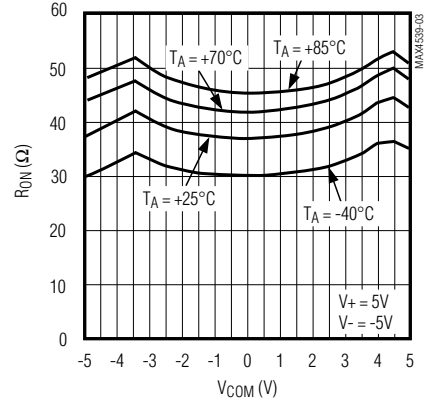
LEAKAGE CURRENT vs. TEMPERATURE



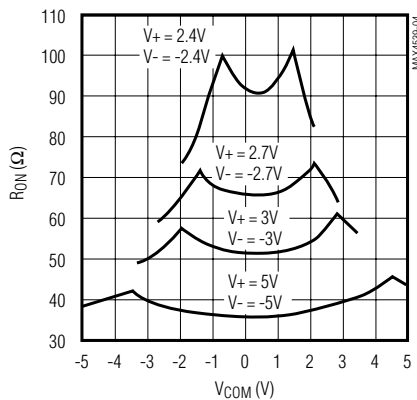
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (SINGLE SUPPLY)



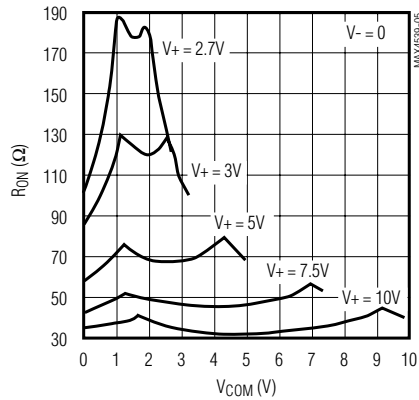
ON-RESISTANCE vs. V_{COM} AND TEMPERATURE (DUAL SUPPLIES)



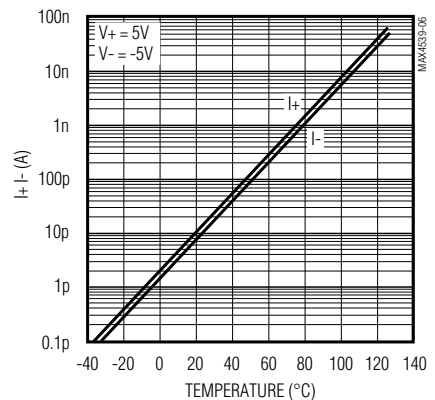
ON-RESISTANCE vs. V_{COM} (DUAL SUPPLIES)



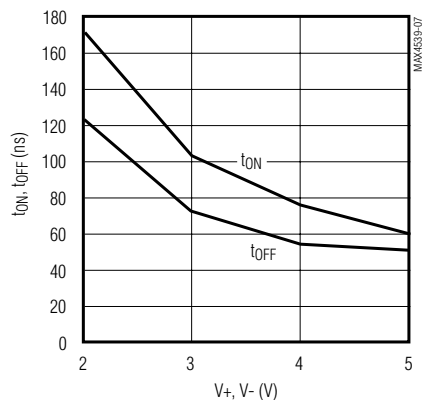
ON-RESISTANCE vs. V_{COM} (SINGLE SUPPLY)



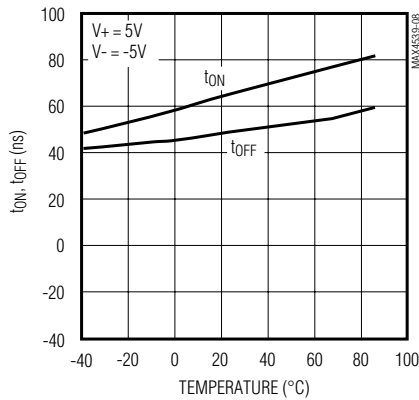
SUPPLY CURRENT vs. TEMPERATURE



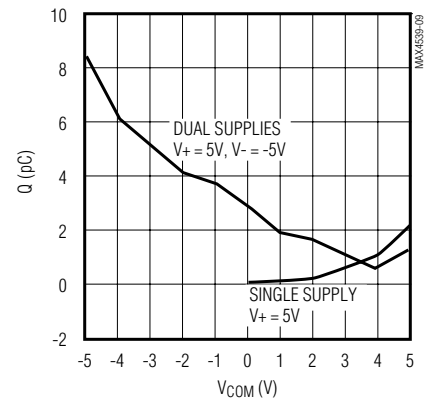
ON/OFF TIME vs. SUPPLY VOLTAGE



ON/OFF TIME vs. TEMPERATURE



CHARGE INJECTION vs. V_{COM}

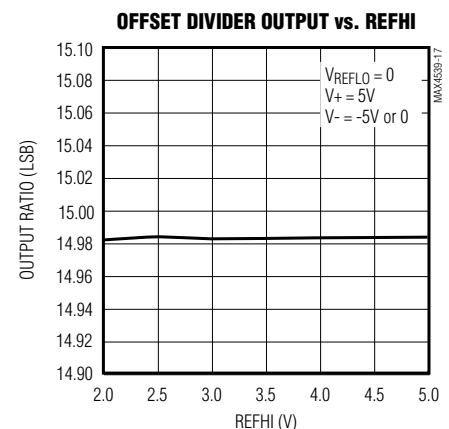
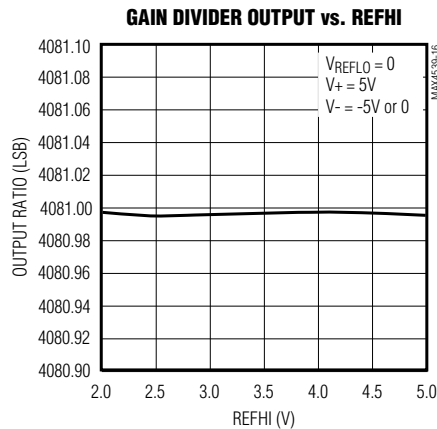
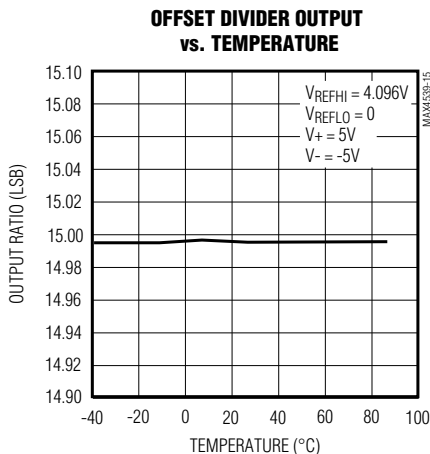
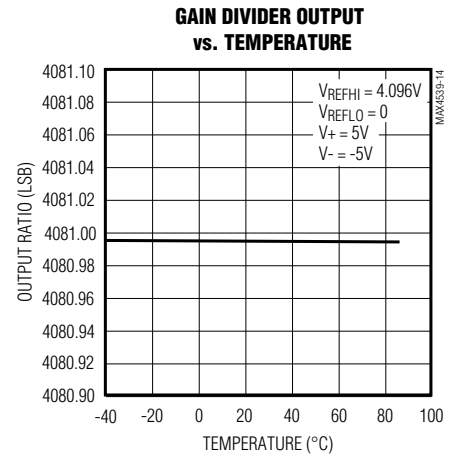
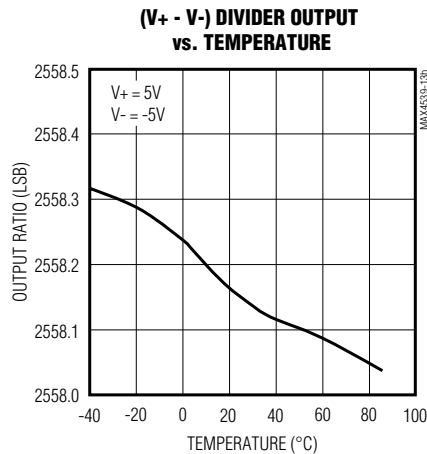
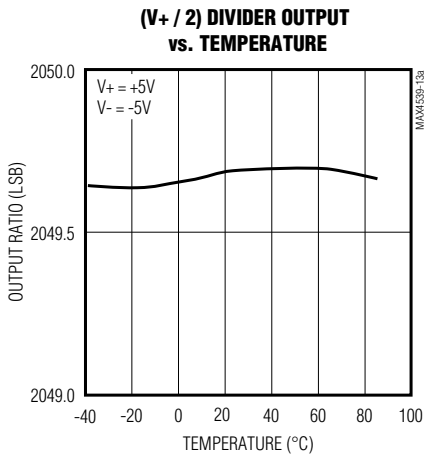
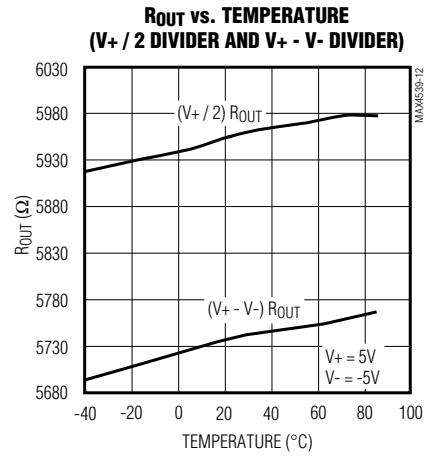
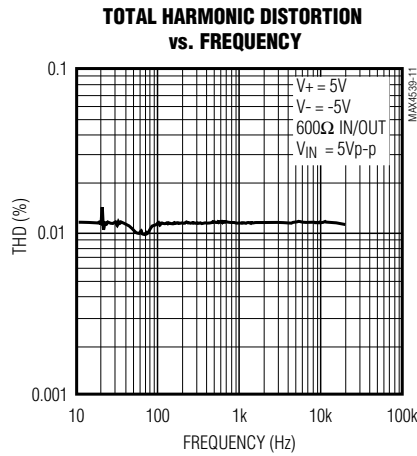
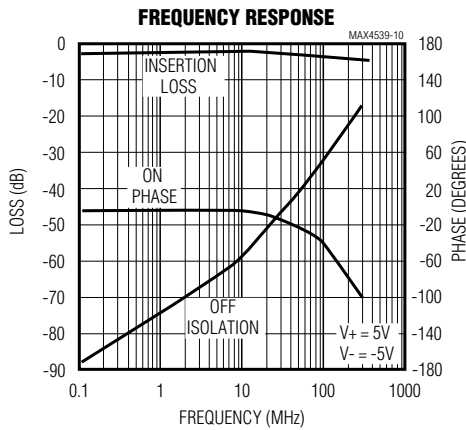


Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Typical Operating Characteristics (continued)

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

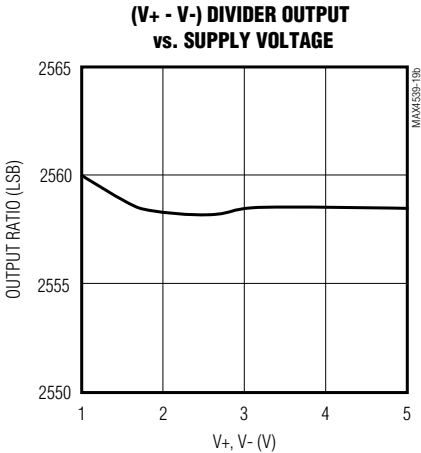
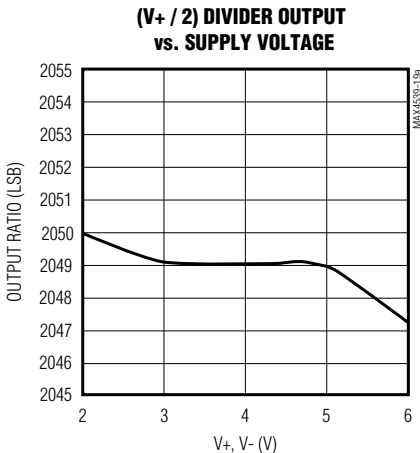
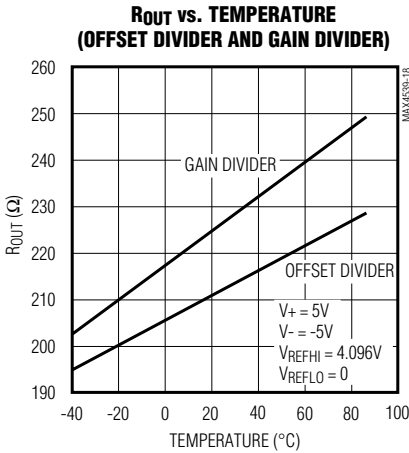
MAX4539/MAX4540



Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Typical Operating Characteristics (continued)

(T_A = +25°C, unless otherwise noted.)



Pin Descriptions

MAX4539 (Single 8-to-1 Cal-Mux)

| PIN | NAME | FUNCTION |
|-----|-------|------------------------------|
| 1 | V+ | Positive Supply Voltage |
| 2 | GND | Ground |
| 3 | V- | Negative Supply Voltage |
| 4 | REFHI | Reference High Voltage Input |
| 5 | REFLO | Reference Low Voltage Input |
| 6 | COM | Multiplexer Output |
| 7 | NO1 | Channel Input 1 |
| 8 | NO2 | Channel Input 2 |
| 9 | NO3 | Channel Input 3 |
| 10 | NO4 | Channel Input 4 |
| 11 | NO5 | Channel Input 5 |
| 12 | NO6 | Channel Input 6 |
| 13 | NO7 | Channel Input 7 |
| 14 | NO8 | Channel Input 8 |
| 15 | A2 | Address Bit 2 |
| 16 | A1 | Address Bit 1 |
| 17 | A0 | Address Bit 0 |
| 18 | CAL | Calibration Control Input |
| 19 | EN | Multiplexer Enable |
| 20 | LATCH | Address Latch Control Input |

MAX4540 (Dual 4-to-1 Cal-Mux)

| PIN | NAME | FUNCTION |
|-----|-------|------------------------------|
| 1 | V+ | Positive Supply Voltage |
| 2 | GND | Ground |
| 3 | V- | Negative Supply Voltage |
| 4 | REFHI | Reference High Voltage Input |
| 5 | REFLO | Reference Low Voltage Input |
| 6 | COMA | Multiplexer Output A |
| 7 | NO1A | Channel Input 1A |
| 8 | NO2A | Channel Input 2A |
| 9 | NO3A | Channel Input 3A |
| 10 | NO4A | Channel Input 4A |
| 11 | NO1B | Channel Input 1B |
| 12 | NO2B | Channel Input 2B |
| 13 | NO3B | Channel Input 3B |
| 14 | NO4B | Channel Input 4B |
| 15 | COMB | Multiplexer Output B |
| 16 | A1 | Address Bit 1 |
| 17 | A0 | Address Bit 0 |
| 18 | CAL | Calibration Control Input |
| 19 | EN | Multiplexer Enable |
| 20 | LATCH | Address Latch Control Input |

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Truth Tables

MAX4539/MAX4540

MAX4539 (Single 8-to-1 Cal-Mux)

| CAL | A2 | A1 | A0 | EN | LATCH | COM |
|-----|----|----|----|----|-------|--|
| X | X | X | X | 0 | X | All switches and dividers open. COM is high-Z. Latch contents set to all 1's. |
| X | X | X | X | 1 | 1 | State is latched when LATCH is high. |
| 0 | 0 | 0 | 0 | 1 | 0 | NO1 |
| 0 | 0 | 0 | 1 | 1 | 0 | NO2 |
| 0 | 0 | 1 | 0 | 1 | 0 | NO3 |
| 0 | 0 | 1 | 1 | 1 | 0 | NO4 |
| 0 | 1 | 0 | 0 | 1 | 0 | NO5 |
| 0 | 1 | 0 | 1 | 1 | 0 | NO6 |
| 0 | 1 | 1 | 0 | 1 | 0 | NO7 |
| 0 | 1 | 1 | 1 | 1 | 0 | NO8 |
| 1 | 0 | 0 | 0 | 1 | 0 | (V+ / 2) Divider Mode, V _{COM} = 2048/4096 V+ |
| 1 | 0 | 0 | 1 | 1 | 0 | REFHI |
| 1 | 0 | 1 | 0 | 1 | 0 | REFLO |
| 1 | 0 | 1 | 1 | 1 | 0 | (V+ - V-) Divider Mode , V _{COM} = 2560/4096 (V+ - V-) |
| 1 | 1 | 0 | 0 | 1 | 0 | GND |
| 1 | 1 | 0 | 1 | 1 | 0 | Gain Divider Mode, V _{COM} = 4081/4096 (V _{REFHI} - V _{REFLO}) |
| 1 | 1 | 1 | 0 | 1 | 0 | Offset Divider Mode, V _{COM} = 15/4096 (V _{REFHI} - V _{REFLO}) |
| 1 | 1 | 1 | 1 | 1 | 0 | All switches and dividers open. COM is high-Z. |

X = Don't care

MAX4540 (Dual 4-to-1 Cal-Mux)

| CAL | A1 | A0 | EN | LATCH | COMA | COMB |
|-----|----|----|----|-------|---|---|
| X | X | X | 0 | X | All switches and dividers open. COMA is high-Z. | All switches and dividers open. COMB is high-Z. |
| X | X | X | 1 | 1 | State is latched | State is latched |
| 0 | 0 | 0 | 1 | 0 | NO1A | NO1B |
| 0 | 0 | 1 | 1 | 0 | NO2A | NO2B |
| 0 | 1 | 0 | 1 | 0 | NO3A | NO3B |
| 0 | 1 | 1 | 1 | 0 | NO4A | NO4B |
| 1 | 0 | 0 | 1 | 0 | GND | GND |
| 1 | 0 | 1 | 1 | 0 | Gain Divider Mode | REFLO |
| 1 | 1 | 0 | 1 | 0 | Offset Divider Mode | REFLO |
| 1 | 1 | 1 | 1 | 0 | All switches and dividers open. COMA is high-Z. | All switches and dividers open. COMB is high-Z. |

X = Don't care

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Detailed Description

The MAX4539/MAX4540 are multiplexers with additional calibration features. Internal resistor-dividers generate accurate voltage ratios from an external voltage reference, allowing zero- and full-scale calibration of ADC systems as well as facilitation of system self-monitoring. To access the resistor-dividers, assert the CAL pin. When CAL and ENABLE are asserted, the three address pins select one of the various resistor-divider or external reference outputs. The MAX4539/MAX4540 also contain a LATCH input that allows the state of the CAL and address signals to be captured.

Calibration Functions

The Gain Divider, Offset Divider, REFHI and REFLO modes allow calibration of offset and gain errors in ADC systems. The Gain Divider mode outputs a voltage ratio that is 4081/4096 of $V_{REFHI} - V_{REFLO}$, accurate to 0.1/4096, or better than 15 bits. The Offset Divider mode outputs a voltage ratio that is 15/4096 of $V_{REFHI} - V_{REFLO}$, also accurate to 0.1/4096. The REFHI mode allows the voltage on the REFHI pin to be switched to the output. The REFLO mode allows the voltage on the REFLO pin to be switched to the output.

Self-Monitoring Functions

The self-monitoring functions are intended to allow an ADC to measure its own supply voltage. The MAX4539 has an internal divide-by-two resistor string between $V+$ and GND that is accurate to 8 bits (16/4096). It also has a 5/8 resistor string between $V+$ and $V-$ that is also accurate to 8 bits. This divider string allows measurement of the negative supply with a unipolar ADC. GND can also be switched to the output, eliminating the need for an additional multiplexer channel.

Applications Information

The MAX4539/MAX4540's construction is typical of most CMOS analog switches. There are three supply pins: $V+$, $V-$, and GND. The positive and negative power supplies provide drive to the internal CMOS switches and set the limits of the analog voltage on any switch. Reverse-biased ESD protection diodes are internally connected between each analog signal pin and both $V+$ and $V-$. If the voltage on any pin exceeds $V+$ or $V-$, one of these diodes will conduct. During normal operation, these reverse-biased ESD diodes leak, forming the only current drawn from $V-$.

Virtually all the analog-leakage current is through the ESD diodes. Although the ESD diodes on a given signal pin are identical, and therefore fairly well balanced, they are reverse-biased differently. Each is

biased by either $V+$ or $V-$ and the analog signal. This means their leakage varies as the signal varies. The difference in the two-diode leakage from the signal path to the $V+$ and $V-$ pins constitutes the analog-signal path leakage current. All analog-leakage current flows to the supply terminals, not to the other switch terminal, which explains how both sides of a given switch can show leakage currents of either the same or opposite polarity.

There is no connection between the analog-signal paths and GND. The analog-signal paths consist of an N-channel and P-channel MOSFET with their sources and drains paralleled and their gates driven out of phase with $V+$ and $V-$ by the logic-level translators.

$V+$ and GND power the internal logic and logic-level translators and set the input-logic thresholds. The logic-level translators convert the logic levels to switched $V+$ and $V-$ signals to drive the gates of the analog switches. This drive signal is the only connection between the logic supplies and the analog supplies. All pins have ESD protection to $V+$ and to $V-$.

Increasing $V-$ has no effect on the logic-level thresholds, but it does increase the drive to the P-channel switches, which reduces their on-resistance. $V-$ also sets the negative limit of the analog-signal voltage.

The logic-level thresholds are CMOS- and TTL- compatible when $V+$ is +5V. As $V+$ is raised, the threshold increases slightly; when $V+$ reaches +12V, the level threshold is about 3.2V. Although that is above the TTL output high-level minimum of 2.4V, it is still compatible with CMOS outputs.

Bipolar-Supply Operation

The MAX4539/MAX4540 operate with bipolar supplies between $\pm 2.7V$ and $\pm 6V$. The $V+$ and $V-$ supplies need not be symmetrical, but their sum cannot exceed the absolute maximum rating of 13V.

Note: Do not connect the MAX4539/MAX4540 $V+$ pin to +3V AND connect the logic-level input pins to TTL logic-level signals. TTL logic-level outputs can exceed the absolute maximum ratings, which will cause damage to the part and/or external circuits.

Caution: The absolute maximum $V+$ to $V-$ differential voltage is 13V. Typical "±6-Volt" or "12-Volt" supplies with ±10% tolerances can be as high as 13.2V. This voltage can damage the MAX4539/MAX4540. Even ±5% tolerance supplies may have overshoot or noise spikes that exceed 13V.

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Single-Supply Operation

The MAX4539/MAX4540 operate from a single supply between +2.7V and +12V when V- is connected to GND. All of the bipolar precautions must be observed. However, these parts are optimized for $\pm 5V$ operation, and most AC and DC characteristics are degraded significantly when departing from $\pm 5V$. As the overall supply voltage (V+ to V-) is lowered, switching speed, on-resistance, off isolation, and distortion will degrade. (see the *Typical Operating Characteristics* section).

Single-supply operation also limits signal levels and interferes with ground referenced signals. When V- = 0, AC signals are limited to -0.3V. Voltages below -0.3V can be clipped by the internal ESD-protection diodes, and the parts can be damaged if excessive current flows.

Power Up

During power up, on-chip latches will strobe whatever addresses are present if EN goes high before LATCH reaches a logic high. When this condition occurs, one of

the internal dividers connected between the supplies may inadvertently turn on, causing higher supply current ($\sim 200\mu A$ supply current) when the enable input is toggled. Avoid this condition by ensuring that EN pin stays low until the remaining logic inputs are valid. To accomplish this, connect a resistor from EN to ground or apply a low voltage to EN before the other logic inputs go high.

Power Off

When power to the MAX4539/MAX4540 is off (i.e., V+ = V- = 0), the Absolute Maximum Ratings still apply. This means that neither logic-level inputs on NO_ nor signals on COM_ can exceed $\pm 0.3V$. Voltages beyond $\pm 0.3V$ cause the internal ESD-protection diodes to conduct, and the parts can be damaged if excessive current flows.

Chip Information

TRANSISTOR COUNT: 561

Test Circuits/Timing Diagrams

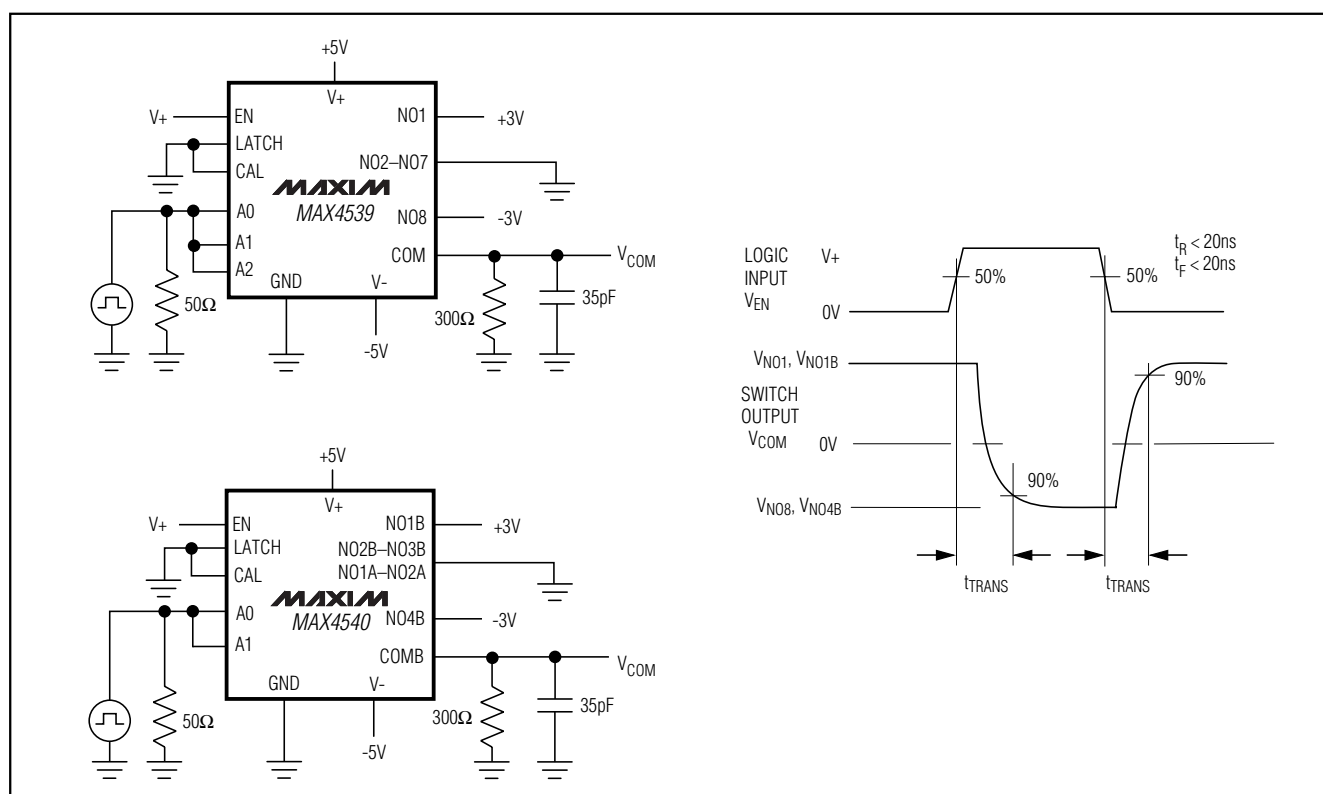


Figure 1. Transition Time

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Test Circuits/Timing Diagrams (continued)

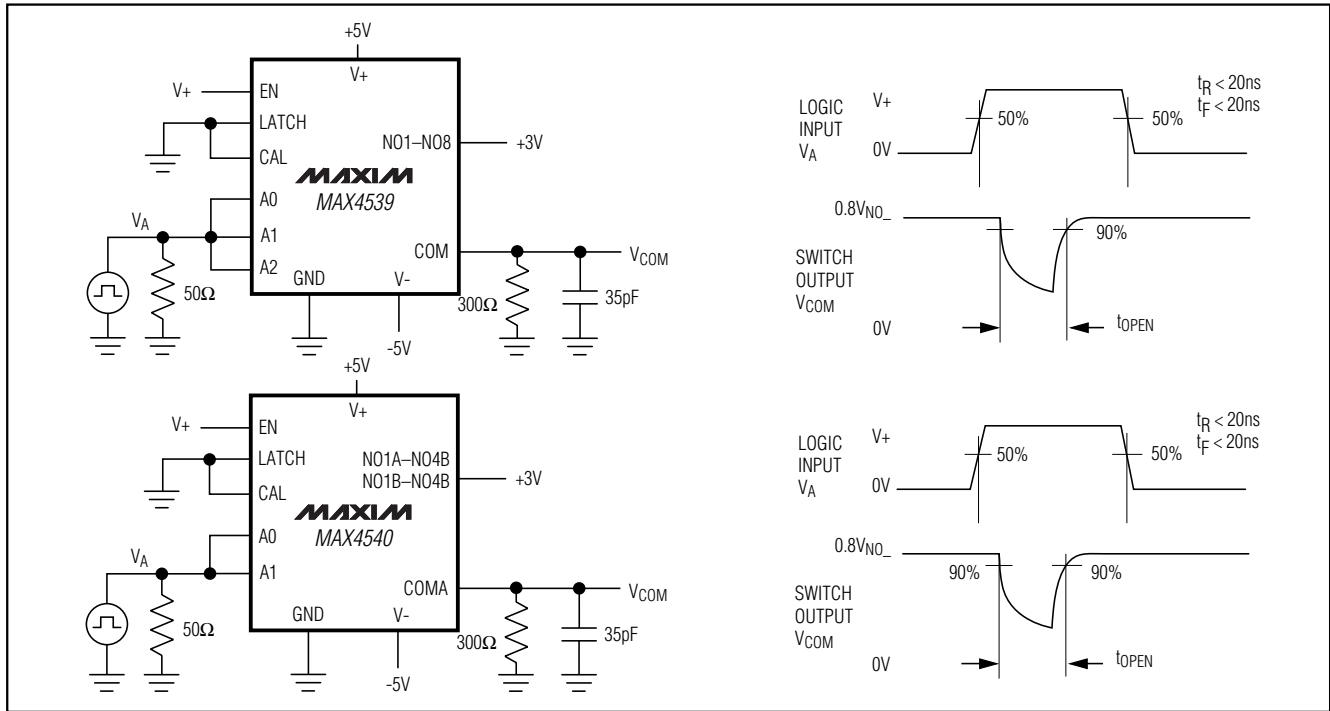


Figure 2. Break-Before-Make Interval

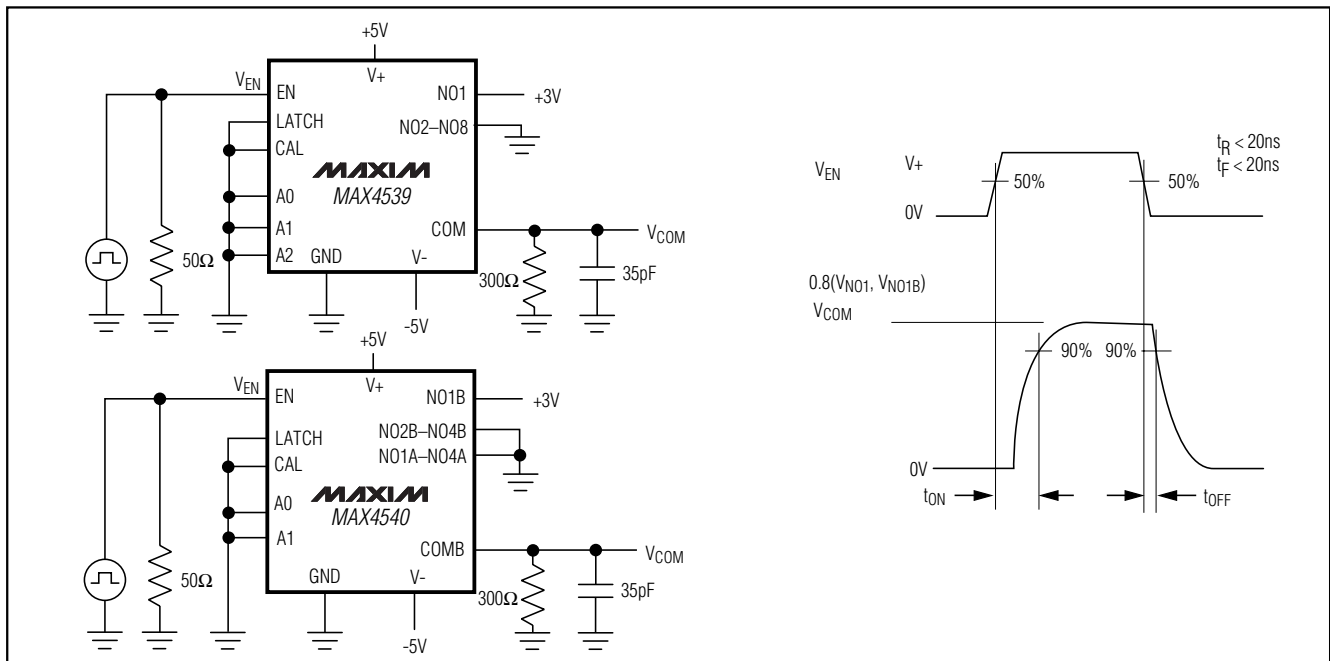


Figure 3. Enable Switching Time

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Test Circuits/Timing Diagrams (continued)

MAX4539/MAX4540

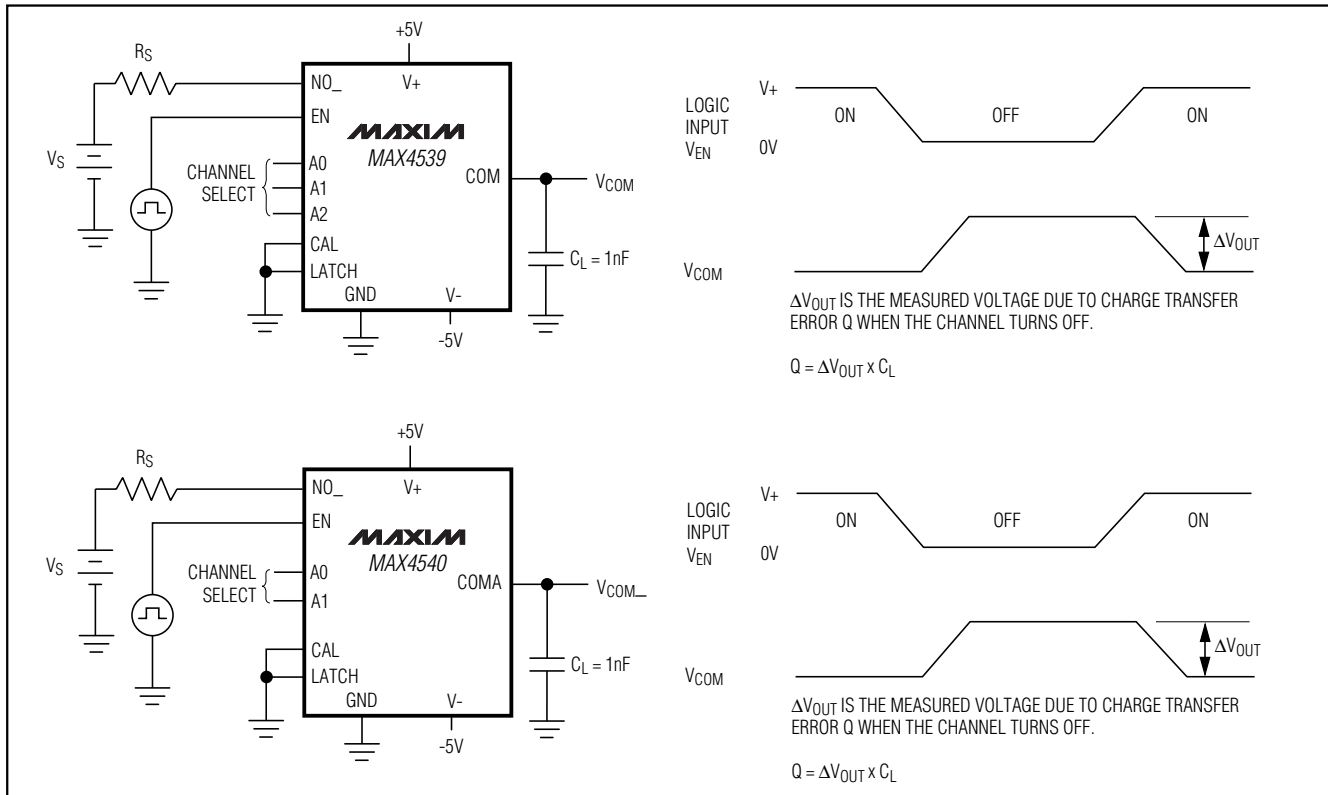


Figure 4. Charge Injection

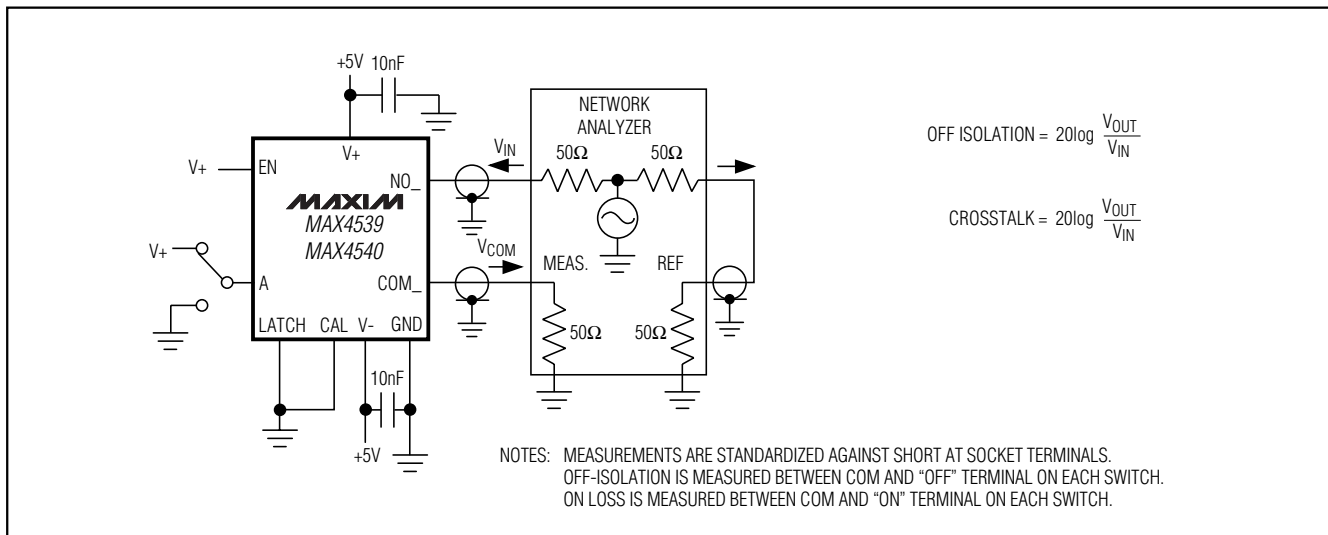


Figure 5. Off-Isolation/Crosstalk

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Test Circuits/Timing Diagrams (continued)

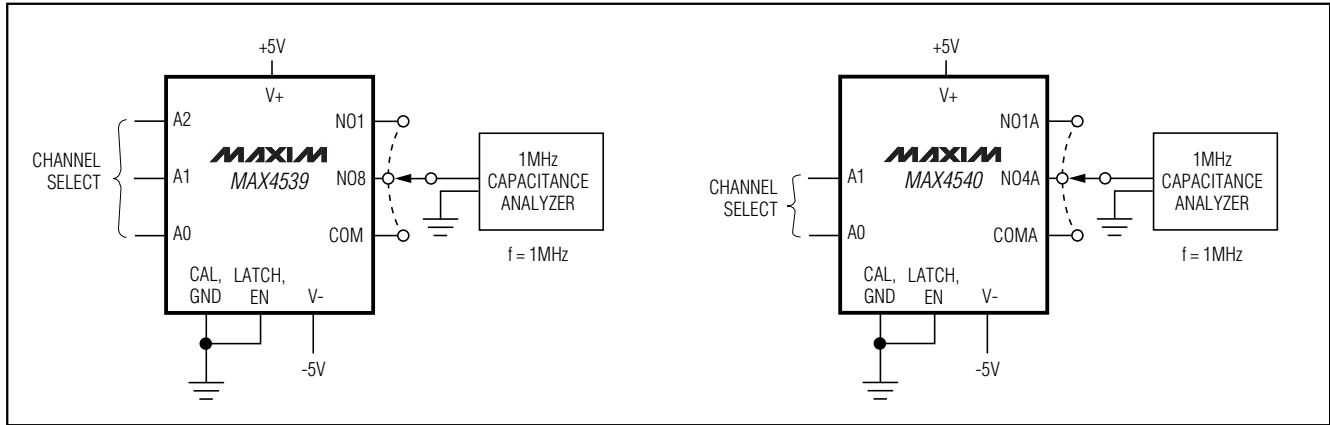


Figure 6. NO_/COM_ Capacitance

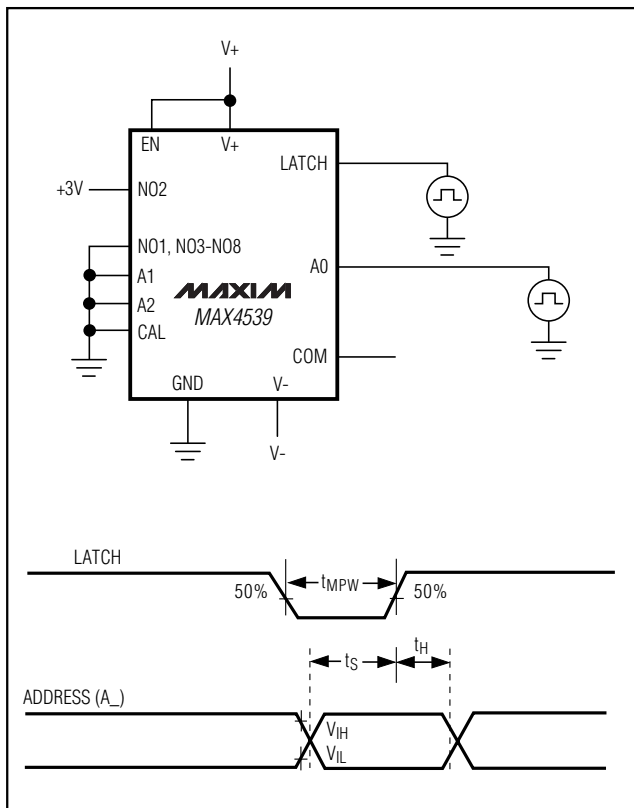


Figure 7. Setup Time, Hold Time, Latch Pulse Width

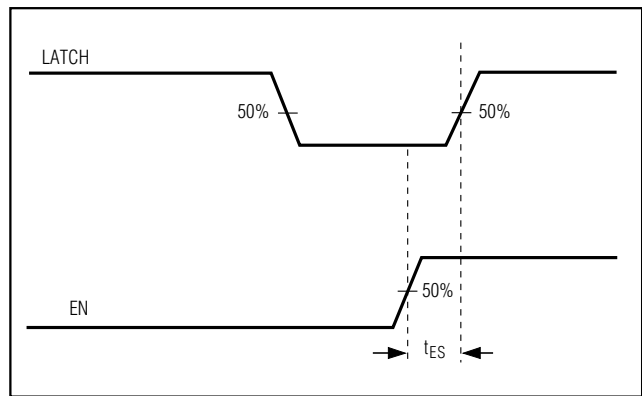
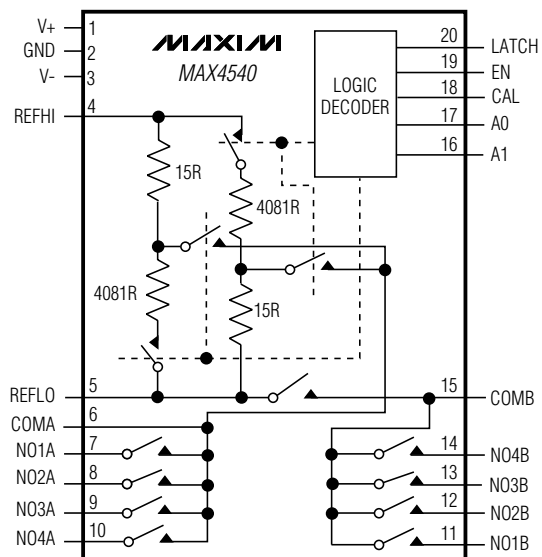


Figure 8. Enable Setup Time

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

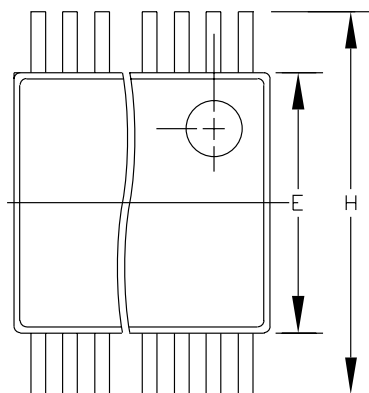
Pin Configurations/Functional Diagrams (continued)

MAX4539/MAX4540



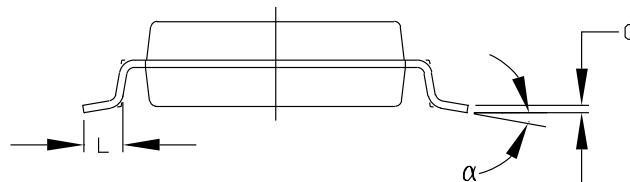
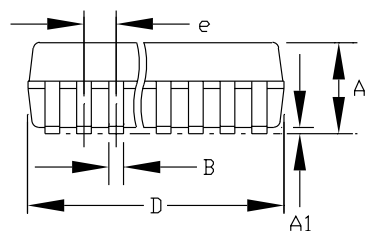
Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Package Information



| DIM | INCHES | | MILLIMETERS | |
|----------|----------------|-------|-------------|------|
| | MIN | MAX | MIN | MAX |
| A | 0.068 | 0.078 | 1.73 | 1.99 |
| A1 | 0.002 | 0.008 | 0.05 | 0.21 |
| B | 0.010 | 0.015 | 0.25 | 0.38 |
| C | 0.004 | 0.008 | 0.09 | 0.20 |
| D | SEE VARIATIONS | | | |
| E | 0.205 | 0.209 | 5.20 | 5.38 |
| e | 0.0256 | BSC | 0.65 | BSC |
| H | 0.301 | 0.311 | 7.65 | 7.90 |
| L | 0.025 | 0.037 | 0.63 | 0.95 |
| α | 0° | 8° | 0° | 8° |

| | INCHES | | MILLIMETERS | |
|---|--------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| D | 0.239 | 0.249 | 6.07 | 6.33 |
| D | 0.239 | 0.249 | 6.07 | 6.33 |
| D | 0.278 | 0.289 | 7.07 | 7.33 |
| D | 0.317 | 0.328 | 8.07 | 8.33 |
| D | 0.397 | 0.407 | 10.07 | 10.33 |



NOTES:

1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED .15mm (.006")
3. CONTROLLING DIMENSION: MILLIMETER

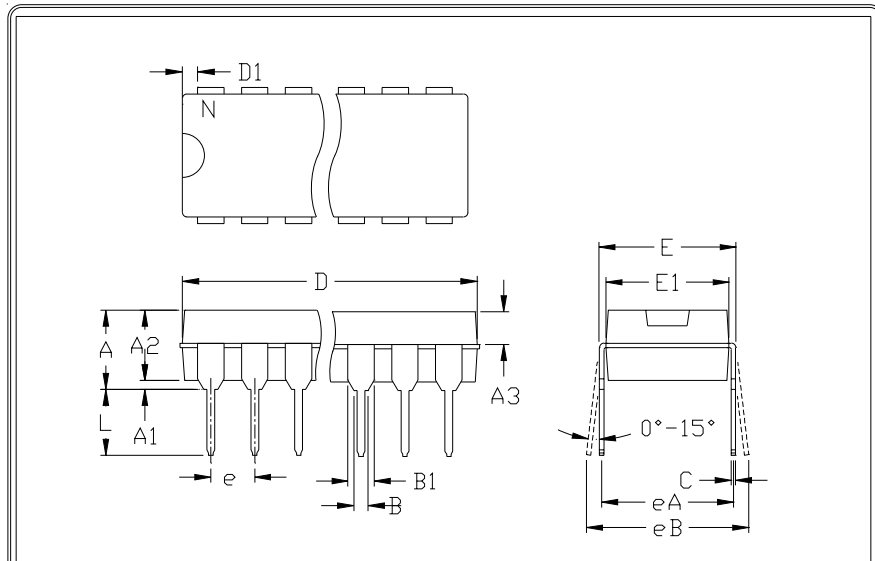
| | | | |
|----------------------------------|----------------------|-----|-----|
| MAXIM | | | |
| PROPRIETARY INFORMATION | | | |
| TITLE: | | | |
| PACKAGE OUTLINE, SSOP, 5.3X.65mm | | | |
| APPROVAL | DOCUMENT CONTROL NO. | REV | 1/1 |
| | 21-0056 | A | |

SSOP/PS

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Package Information (continued)

MAX4539/MAX4540



| | 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 | | | |
|---|--------|-------|-------------|-------|----|-------|
| | MIN | MAX | MIN | MAX | N | MS001 |
| 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



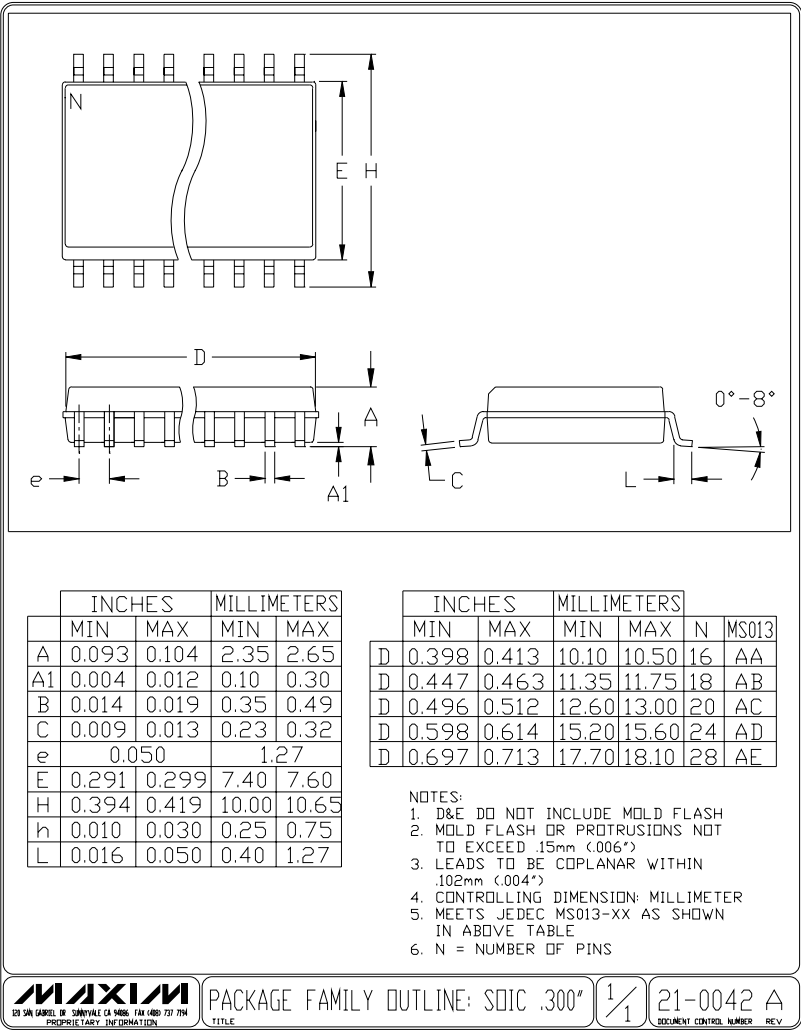
PACKAGE FAMILY OUTLINE: PDIP .300"



21-0043 A
DOCUMENT CONTROL NUMBER REV

Low-Voltage, Single 8-to-1 and Dual 4-to-1 Cal-Multiplexers

Package Information (continued)



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.

20 Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 408-737-7600