

## Ultra Low ON-Resistance, +1.1V to +4.5V Single Supply, SPDT Analog Switch

The Intersil ISL43L210 device is a low ON-resistance, low voltage, bidirectional, single pole/double throw (SPDT) analog switch designed to operate from a single +1.1V to +4.5V supply. Targeted applications include battery powered equipment that benefit from low on-resistance and fast switching speeds ( $t_{ON} = 7\text{ns}$ ,  $t_{OFF} = 3\text{ns}$ ). The digital logic input is 1.8V CMOS compatible when using a single +3V supply.

Cell phones, for example, often face ASIC functionality limitations. The number of analog input or GPIO pins may be limited and digital geometries are not well suited to analog switch performance. This part may be used to “mux-in” additional functionality while reducing ASIC design risk. The ISL43L210 is offered in a 6 lead SC70 package, alleviating board space limitations.

The ISL43L210 is a committed SPDT that consist of one normally open (NO) and one normally closed (NC) switch. This configuration can also be used as a 2-to-1 multiplexer.

**TABLE 1. FEATURES AT A GLANCE**

|                                         |                 |
|-----------------------------------------|-----------------|
| <b>Number of Switches</b>               | 1               |
| <b>SW</b>                               | SPDT or 2-1 MUX |
| <b>1.8V <math>R_{ON}</math></b>         | 0.75 $\Omega$   |
| <b>1.8V <math>t_{ON}/t_{OFF}</math></b> | 16ns/5ns        |
| <b>3V <math>R_{ON}</math></b>           | 0.38 $\Omega$   |
| <b>3V <math>t_{ON}/t_{OFF}</math></b>   | 8ns/4ns         |
| <b>4.3V <math>R_{ON}</math></b>         | 0.34 $\Omega$   |
| <b>4.3V <math>t_{ON}/t_{OFF}</math></b> | 7ns/3ns         |
| <b>Package</b>                          | 6 Ld SC70       |

## Features

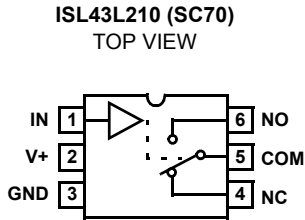
- Pb-free available (RoHS compliant)
- Drop In replacement for the MAX4714
- ON resistance ( $R_{ON}$ )
  - $V_{CC} = +4.3\text{V}$  ..... 0.34 $\Omega$
  - $V_{CC} = +3.0\text{V}$  ..... 0.38 $\Omega$
  - $V_{CC} = +1.8\text{V}$  ..... 0.75 $\Omega$
- $R_{ON}$  matching between channels ..... 0.002 $\Omega$
- $R_{ON}$  flatness ..... 0.06 $\Omega$
- Single supply operation ..... +1.1V to +4.5V
- Fast switching action (+3.9V Supply)
  - $t_{ON}$  ..... 7ns
  - $t_{OFF}$  ..... 3ns
- Guaranteed break-before-make
- ESD HBM rating ..... >6kV
- 1.8V CMOS logic compatible (+3V supply)
- 6 lead SC70 package

## Applications

- Battery powered, handheld, and portable equipment
  - Cellular/mobile phones
  - Pagers
  - Laptops, notebooks, palmtops
- Portable test and measurement
- Medical equipment
- Audio and video switching

## Related Literature

- Technical Brief TB363 “Guidelines for Handling and Processing Moisture Sensitive Surface Mount Devices (SMDs)”

**Pinout** (Note 1)**NOTE:**

1. Switches Shown for Logic "0" Input.

**Truth Table**

| LOGIC | PIN NC | PIN NO |
|-------|--------|--------|
| 0     | On     | Off    |
| 1     | Off    | On     |

NOTE: Logic "0"  $\leq 0.5V$ . Logic "1"  $\geq 1.4V$  with a 3V supply.

**Pin Descriptions**

| PIN | FUNCTION                                   |
|-----|--------------------------------------------|
| V+  | System Power Supply Input (+1.1V to +4.5V) |
| GND | Ground Connection                          |
| IN  | Digital Control Input                      |
| COM | Analog Switch Common Pin                   |
| NO  | Analog Switch Normally Open Pin            |
| NC  | Analog Switch Normally Closed Pin          |

**Ordering Information**

| PART NO.<br>(BRAND)                   | TEMP.<br>RANGE (°C) | PACKAGE                              | PKG.<br>DWG. # |
|---------------------------------------|---------------------|--------------------------------------|----------------|
| ISL43L210IH-T<br>(CMA)                | -40 to 85           | 6 Ld SC70<br>Tape and Reel           | P6.049         |
| ISL43L210IHZ-T<br>(CMA)<br>(See Note) | -40 to 85           | 6 Ld SC70<br>Tape and Reel (Pb-free) | P6.049         |

NOTE: Intersil Pb-free products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.

**Absolute Maximum Ratings**

|                                                                  |                       |
|------------------------------------------------------------------|-----------------------|
| V+ to GND                                                        | -0.3 to 4.7V          |
| Input Voltages                                                   |                       |
| NO, NC, IN (Note 2)                                              | -0.3 to ((V+) + 0.3V) |
| Output Voltages                                                  |                       |
| COM (Note 2)                                                     | -0.3 to ((V+) + 0.3V) |
| Continuous Current NO, NC, or COM                                | ±150mA                |
| Peak Current NO, NC, or COM<br>(Pulsed 1ms, 10% Duty Cycle, Max) | ±300mA                |
| ESD Rating:                                                      |                       |
| HBM                                                              | >6kV                  |
| MM                                                               | >300V                 |
| CDM                                                              | >1000V                |

**Thermal Information**

|                                                              |                      |
|--------------------------------------------------------------|----------------------|
| Thermal Resistance (Typical, Note 3)                         | $\theta_{JA}$ (°C/W) |
| 6 Ld SC70 Package                                            | 590                  |
| Maximum Junction Temperature (Plastic Package)               | 150°C                |
| Maximum Storage Temperature Range                            | -65°C to 150°C       |
| Maximum Lead Temperature (Soldering 10s)<br>(Lead Tips Only) | 300°C                |

**Operating Conditions**

|                   |               |
|-------------------|---------------|
| Temperature Range | -40°C to 85°C |
|-------------------|---------------|

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

**NOTES:**

2. Signals on NC, NO, IN, or COM exceeding V+ or GND are clamped by internal diodes. Limit forward diode current to maximum current ratings.
3.  $\theta_{JA}$  is measured with the component mounted on a high effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

**Electrical Specifications - 4.3V Supply**

Test Conditions: V+ = +3.9V to +4.5V, GND = 0V,  $V_{INH}$  = 1.6V,  $V_{INL}$  = 0.5V (Notes 4, 6), Unless Otherwise Specified

| PARAMETER                                                                     | TEST CONDITIONS                                                                                                             | TEMP<br>(°C) | (NOTE 5)<br>MIN | TYP   | (NOTE 5)<br>MAX | UNITS |
|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------|-----------------|-------|-----------------|-------|
| ANALOG SWITCH CHARACTERISTICS                                                 |                                                                                                                             |              |                 |       |                 |       |
| Analog Signal Range, V <sub>ANALOG</sub>                                      |                                                                                                                             | Full         | 0               | -     | V+              | V     |
| ON Resistance, R <sub>ON</sub>                                                | V+ = 3.9V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 2.2V<br>(See Figure 5)                            | 25           | -               | 0.36  | -               | Ω     |
|                                                                               |                                                                                                                             | Full         | -               | 0.4   | -               | Ω     |
| R <sub>ON</sub> Matching Between Channels,<br>ΔR <sub>ON</sub>                | V+ = 3.9V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 2.2V                                              | 25           | -               | 0.002 | -               | Ω     |
|                                                                               |                                                                                                                             | Full         | -               | 0.003 | -               | Ω     |
| R <sub>ON</sub> Flatness, R <sub>FLAT(ON)</sub>                               | V+ = 3.9V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 0.8V, 2.2V, 3.5V, (Note 7)                        | 25           | -               | 0.06  | -               | Ω     |
|                                                                               |                                                                                                                             | Full         | -               | 0.08  | -               | Ω     |
| NO or NC OFF Leakage Current,<br>I <sub>NO(OFF)</sub> or I <sub>NC(OFF)</sub> | V+ = 4.5V, V <sub>COM</sub> = 0.3V, 3V, V <sub>NO</sub> or V <sub>NC</sub> = 3V, 0.3V                                       | 25           | -30             | -     | 30              | nA    |
|                                                                               |                                                                                                                             | Full         | -100            | -     | 100             | nA    |
| COM ON Leakage Current,<br>I <sub>COM(ON)</sub>                               | V+ = 4.5V, V <sub>COM</sub> = 0.3V, 3V, or V <sub>NO</sub> or V <sub>NC</sub> = 0.3V, 3V, or Floating                       | 25           | -30             | -     | 30              | nA    |
|                                                                               |                                                                                                                             | Full         | -100            | -     | -100            | nA    |
| DYNAMIC CHARACTERISTICS                                                       |                                                                                                                             |              |                 |       |                 |       |
| Turn-ON Time, t <sub>ON</sub>                                                 | V+ = 3.9V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1, Note 8) | 25           | -               | 7     | 15              | ns    |
|                                                                               |                                                                                                                             | Full         | -               | -     | 20              | ns    |
| Turn-OFF Time, t <sub>OFF</sub>                                               | V+ = 3.9V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1, Note 8) | 25           | -               | 3     | 10              | ns    |
|                                                                               |                                                                                                                             | Full         | -               | -     | 15              | ns    |
| Break-Before-Make Time Delay, t <sub>D</sub>                                  | V+ = 4.5V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 3, Note 8) | Full         | 1               | 3     | -               | ns    |
| Charge Injection, Q                                                           | V <sub>G</sub> = V+/2, R <sub>G</sub> = 0Ω, C <sub>L</sub> = 1.0nF (See Figure 2)                                           | 25           | -               | 25    | -               | pC    |
| OFF Isolation                                                                 | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 100kHz, V <sub>COM</sub> = 1V <sub>RMS</sub><br>(See Figure 4)              | 25           | -               | -70   | -               | dB    |
| Crosstalk (Channel-to-Channel)                                                | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 100kHz, V <sub>COM</sub> = 1V <sub>RMS</sub><br>(See Figure 6)              | 25           | -               | -70   | -               | dB    |

**Electrical Specifications - 4.3V Supply**

Test Conditions:  $V_+ = +3.9V$  to  $+4.5V$ ,  $GND = 0V$ ,  $V_{INH} = 1.6V$ ,  $V_{INL} = 0.5V$  (Notes 4, 6),  
Unless Otherwise Specified **(Continued)**

| PARAMETER                                          | TEST CONDITIONS                                                                      | TEMP<br>(°C) | (NOTE 5)<br>MIN | TYP   | (NOTE 5)<br>MAX | UNITS |
|----------------------------------------------------|--------------------------------------------------------------------------------------|--------------|-----------------|-------|-----------------|-------|
| Total Harmonic Distortion                          | f = 20Hz to 20kHz, V <sub>COM</sub> = 2V <sub>P-P</sub> , R <sub>L</sub> = 32Ω       | 25           | -               | 0.006 | -               | %     |
| NO or NC OFF Capacitance, C <sub>OFF</sub>         | f = 1MHz, V <sub>NO</sub> or V <sub>NC</sub> = V <sub>COM</sub> = 0V, (See Figure 7) | 25           | -               | 40    | -               | pF    |
| COM ON Capacitance, C <sub>COM(ON)</sub>           | f = 1MHz, V <sub>NO</sub> or V <sub>NC</sub> = V <sub>COM</sub> = 0V, (See Figure 7) | 25           | -               | 100   | -               | pF    |
| POWER SUPPLY CHARACTERISTICS                       |                                                                                      |              |                 |       |                 |       |
| Power Supply Range                                 |                                                                                      | Full         | 1.1             | -     | 4.5             | V     |
| Positive Supply Current, I+                        | V+ = +4.5V, V <sub>IN</sub> = 0V or V+                                               | 25           | -               | -     | 0.05            | μA    |
|                                                    |                                                                                      | Full         | -               | -     | 0.4             | μA    |
| DIGITAL INPUT CHARACTERISTICS                      |                                                                                      |              |                 |       |                 |       |
| Input Voltage Low, V <sub>INL</sub>                |                                                                                      | Full         | -               | -     | 0.5             | V     |
| Input Voltage High, V <sub>INH</sub>               |                                                                                      | Full         | 1.6             | -     | -               | V     |
| Input Current, I <sub>INH</sub> , I <sub>INL</sub> | V+ = 4.5V, V <sub>IN</sub> = 0V or V+ (Note 8)                                       | Full         | -0.5            | -     | 0.5             | μA    |

## NOTES:

- $V_{IN}$  = input voltage to perform proper function.
- The algebraic convention, whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Parts are 100% tested at  $+25^\circ C$ . Limits across the full temperature range are guaranteed by design and correlation.
- Flatness is defined as the difference between maximum and minimum value of on-resistance over the specified analog signal range.
- Guaranteed but not tested.

**Electrical Specifications - 3V Supply**

Test Conditions:  $V_+ = +2.7V$  to  $+3.6V$ ,  $GND = 0V$ ,  $V_{INH} = 1.4V$ ,  $V_{INL} = 0.5V$  (Notes 4, 6),  
Unless Otherwise Specified

| PARAMETER                                                                  | TEST CONDITIONS                                                                                                             | TEMP<br>(°C) | (NOTE 5)<br>MIN | TYP   | (NOTE 5)<br>MAX | UNITS |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------|-----------------|-------|-----------------|-------|
| ANALOG SWITCH CHARACTERISTICS                                              |                                                                                                                             |              |                 |       |                 |       |
| Analog Signal Range, V <sub>ANALOG</sub>                                   |                                                                                                                             | Full         | 0               | -     | V+              | V     |
| ON Resistance, R <sub>ON</sub>                                             | V+ = 2.7V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V<br>(See Figure 5)                            | 25           | -               | 0.44  | 0.6             | Ω     |
|                                                                            |                                                                                                                             | Full         | -               | -     | 0.7             | Ω     |
| R <sub>ON</sub> Matching Between Channels, ΔR <sub>ON</sub>                | V+ = 2.7V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V                                              | 25           | -               | 0.005 | 0.03            | Ω     |
|                                                                            |                                                                                                                             | Full         | -               | -     | 0.05            | Ω     |
| R <sub>ON</sub> Flatness, R <sub>FLAT(ON)</sub>                            | V+ = 2.7V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 0.6V, 1.5V, 2.1V (Note 7)                         | 25           | -               | 0.06  | 0.1             | Ω     |
|                                                                            |                                                                                                                             | Full         | -               | -     | 0.12            | Ω     |
| NO or NC OFF Leakage Current, I <sub>NO(OFF)</sub> or I <sub>NC(OFF)</sub> | V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V, V <sub>NO</sub> or V <sub>NC</sub> = 3V, 0.3V                                       | 25           | -               | 0.9   | -               | nA    |
|                                                                            |                                                                                                                             | Full         | -               | 8     | -               | nA    |
| COM ON Leakage Current, I <sub>COM(ON)</sub>                               | V+ = 3.3V, V <sub>COM</sub> = 0.3V, 3V, or V <sub>NO</sub> or V <sub>NC</sub> = 0.3V, 3V, or Floating                       | 25           | -               | 0.9   | -               | nA    |
|                                                                            |                                                                                                                             | Full         | -               | 17    | -               | nA    |
| DYNAMIC CHARACTERISTICS                                                    |                                                                                                                             |              |                 |       |                 |       |
| Turn-ON Time, t <sub>ON</sub>                                              | V+ = 2.7V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1, Note 8) | 25           | -               | 8     | 15              | ns    |
|                                                                            |                                                                                                                             | Full         | -               | -     | 20              | ns    |
| Turn-OFF Time, t <sub>OFF</sub>                                            | V+ = 2.7V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1, Note 8) | 25           | -               | 4     | 10              | ns    |
|                                                                            |                                                                                                                             | Full         | -               | -     | 15              | ns    |
| Break-Before-Make Time Delay, t <sub>D</sub>                               | V+ = 3.0V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 3, Note 8) | Full         | 1               | 4     | -               | ns    |

**Electrical Specifications - 3V Supply**

Test Conditions:  $V_+ = +2.7V$  to  $+3.6V$ ,  $GND = 0V$ ,  $V_{INH} = 1.4V$ ,  $V_{INL} = 0.5V$  (Notes 4, 6),  
Unless Otherwise Specified **(Continued)**

| PARAMETER                                          | TEST CONDITIONS                                                                                                | TEMP<br>(°C) | (NOTE 5)<br>MIN | TYP   | (NOTE 5)<br>MAX | UNITS |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------|--------------|-----------------|-------|-----------------|-------|
| Charge Injection, Q                                | V <sub>G</sub> = V+/2, R <sub>G</sub> = 0Ω, C <sub>L</sub> = 1.0nF (See Figure 2)                              | 25           | -               | 22    | -               | pC    |
| OFF Isolation                                      | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 100kHz, V <sub>COM</sub> = 1V <sub>RMS</sub><br>(See Figure 4) | 25           | -               | -70   | -               | dB    |
| Crosstalk (Channel-to-Channel)                     | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 100kHz, V <sub>COM</sub> = 1V <sub>RMS</sub><br>(See Figure 6) | 25           | -               | -70   | -               | dB    |
| Total Harmonic Distortion                          | f = 20Hz to 20kHz, V <sub>COM</sub> = 2V <sub>P-P</sub> , R <sub>L</sub> = 32Ω                                 | 25           | -               | 0.006 | -               | %     |
| NO or NC OFF Capacitance, C <sub>OFF</sub>         | f = 1MHz, V <sub>NO</sub> or V <sub>NC</sub> = V <sub>COM</sub> = 0V (See Figure 7)                            | 25           | -               | 40    | -               | pF    |
| COM ON Capacitance, C <sub>COM(ON)</sub>           | f = 1MHz, V <sub>NO</sub> or V <sub>NC</sub> = V <sub>COM</sub> = 0V (See Figure 7)                            | 25           | -               | 100   | -               | pF    |
| POWER SUPPLY CHARACTERISTICS                       |                                                                                                                |              |                 |       |                 |       |
| Positive Supply Current, I+                        | V+ = 3.6V, V <sub>IN</sub> = 0V or V+                                                                          | 25           | -               | 0.018 | -               | μA    |
|                                                    |                                                                                                                | Full         | -               | 0.13  | -               | μA    |
| DIGITAL INPUT CHARACTERISTICS                      |                                                                                                                |              |                 |       |                 |       |
| Input Voltage Low, V <sub>INL</sub>                |                                                                                                                | Full         | -               | -     | 0.5             | V     |
| Input Voltage High, V <sub>INH</sub>               |                                                                                                                | Full         | 1.4             | -     | -               | V     |
| Input Current, I <sub>INH</sub> , I <sub>INL</sub> | V+ = 3.6V, V <sub>IN</sub> = 0V or V+ (Note 8)                                                                 | Full         | -0.5            | -     | 0.5             | μA    |

**Electrical Specifications - 1.8V Supply**

Test Conditions:  $V_+ = +1.8V$ ,  $GND = 0V$ ,  $V_{INH} = 1V$ ,  $V_{INL} = 0.4V$  (Notes 4, 6),  
Unless Otherwise Specified

| PARAMETER                                                                  | TEST CONDITIONS                                                                                                             | TEMP<br>(°C) | (NOTE 5)<br>MIN | TYP   | (NOTE 5)<br>MAX | UNITS |
|----------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|--------------|-----------------|-------|-----------------|-------|
| ANALOG SWITCH CHARACTERISTICS                                              |                                                                                                                             |              |                 |       |                 |       |
| Analog Signal Range, V <sub>ANALOG</sub>                                   |                                                                                                                             | Full         | 0               | -     | V+              | V     |
| ON Resistance, R <sub>ON</sub>                                             | V+ = 1.8V, I <sub>COM</sub> = 10mA, V <sub>NO</sub> or V <sub>NC</sub> = 0.9V<br>(See Figure 5)                             | 25           | -               | 0.75  | 0.9             | Ω     |
|                                                                            |                                                                                                                             | Full         | -               | -     | 1               | Ω     |
| NO or NC OFF Leakage Current, I <sub>NO(OFF)</sub> or I <sub>NC(OFF)</sub> | V+ = 1.8V, V <sub>COM</sub> = 0.3V, 1.5V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, 0.3V                                   | 25           | -               | 0.3   | -               | nA    |
|                                                                            |                                                                                                                             | Full         | -               | 7     | -               | nA    |
| COM ON Leakage Current, I <sub>COM(ON)</sub>                               | V+ = 1.8V, V <sub>COM</sub> = 0.3V, 1.5V, or V <sub>NO</sub> or V <sub>NC</sub> = 0.3V, 1.5V, or Floating                   | 25           | -               | 0.9   | -               | nA    |
|                                                                            |                                                                                                                             | Full         | -               | 18    | -               | nA    |
| DYNAMIC CHARACTERISTICS                                                    |                                                                                                                             |              |                 |       |                 |       |
| Turn-ON Time, t <sub>ON</sub>                                              | V+ = 1.8V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1, Note 8) | 25           | -               | 16    | 22              | ns    |
|                                                                            |                                                                                                                             | Full         | -               | -     | 25              | ns    |
| Turn-OFF Time, t <sub>OFF</sub>                                            | V+ = 1.8V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1, Note 8) | 25           | -               | 5     | 12              | ns    |
|                                                                            |                                                                                                                             | Full         | -               | -     | 15              | ns    |
| Break-Before-Make Time Delay, t <sub>D</sub>                               | V+ = 1.8V, V <sub>NO</sub> or V <sub>NC</sub> = 1.5V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 3, Note 8) | Full         | 2               | 5     | -               | ns    |
| Charge Injection, Q                                                        | V <sub>G</sub> = V+/2, R <sub>G</sub> = 0Ω, C <sub>L</sub> = 1.0nF (See Figure 2)                                           | 25           | -               | 15    | -               | pC    |
| POWER SUPPLY CHARACTERISTICS                                               |                                                                                                                             |              |                 |       |                 |       |
| Positive Supply Current, I+                                                | V+ = 1.8V, V <sub>IN</sub> = 0V or V+                                                                                       | 25           | -               | 0.018 | -               | μA    |
|                                                                            |                                                                                                                             | Full         | -               | 0.13  | -               | μA    |

### Electrical Specifications - 1.8V Supply

Test Conditions:  $V_+ = +1.8V$ ,  $GND = 0V$ ,  $V_{INH} = 1V$ ,  $V_{INL} = 0.4V$  (Notes 4, 6), Unless Otherwise Specified **(Continued)**

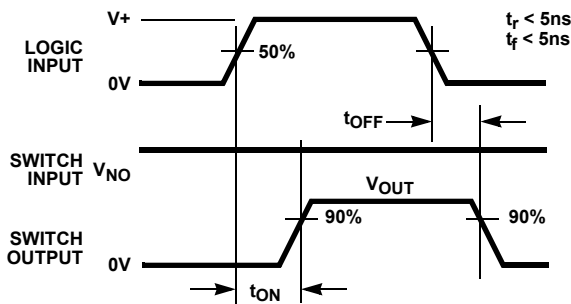
| PARAMETER                            | TEST CONDITIONS                                | TEMP (°C) | (NOTE 5) MIN | TYP | (NOTE 5) MAX | UNITS   |
|--------------------------------------|------------------------------------------------|-----------|--------------|-----|--------------|---------|
| <b>DIGITAL INPUT CHARACTERISTICS</b> |                                                |           |              |     |              |         |
| Input Voltage Low, $V_{INL}$         |                                                | Full      | -            | -   | 0.4          | V       |
| Input Voltage High, $V_{INH}$        |                                                | Full      | 1            | -   | -            | V       |
| Input Current, $I_{INH}$ , $I_{INL}$ | $V_+ = 1.1V$ , $V_{IN} = 0V$ or $V_+$ (Note 8) | Full      | -0.5         | -   | 0.5          | $\mu A$ |

### Electrical Specifications - 1.1V Supply

Test Conditions:  $V_+ = +1.1V$ ,  $GND = 0V$ ,  $V_{INH} = 1.0V$ ,  $V_{INL} = 0.3V$  (Note 4, 6), Unless Otherwise Specified

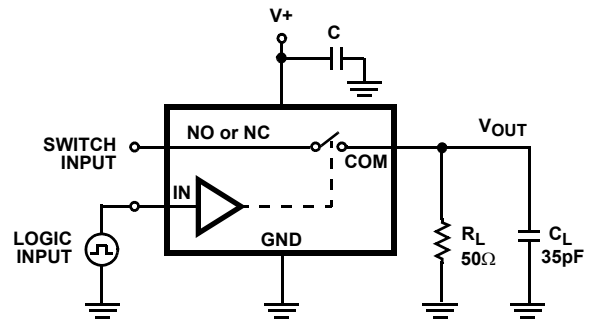
| PARAMETER                                    | TEST CONDITIONS                                                                                                      | TEMP<br>(°C) | (NOTE 5)<br>MIN | TYP  | (NOTE 5)<br>MAX | UNITS |
|----------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------------|-----------------|------|-----------------|-------|
| ANALOG SWITCH CHARACTERISTICS                |                                                                                                                      |              |                 |      |                 |       |
| Analog Signal Range, V <sub>ANALOG</sub>     |                                                                                                                      | Full         | 0               | -    | V+              | V     |
| ON Resistance, R <sub>ON</sub>               | V+ = 1.1V, I <sub>COM</sub> = 100mA, V <sub>NO</sub> or V <sub>NC</sub> = 0.6<br>(See Figure 5)                      | 25           | -               | 2.8  | -               | Ω     |
|                                              |                                                                                                                      | Full         | -               | 3.5  | -               | Ω     |
| DYNAMIC CHARACTERISTICS                      |                                                                                                                      |              |                 |      |                 |       |
| Turn-ON Time, t <sub>ON</sub>                | V+ = 1.1V, V <sub>NO</sub> or V <sub>NC</sub> = 1.0V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF<br>(See Figure 1)  | 25           | -               | 25   | -               | ns    |
|                                              |                                                                                                                      | Full         | -               | 28   | -               | ns    |
| Turn-OFF Time, t <sub>OFF</sub>              | V+ = 1.1V, V <sub>NO</sub> or V <sub>NC</sub> = 1.0V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>(See Figure 1) | 25           | -               | 7    | -               | ns    |
|                                              |                                                                                                                      | Full         | -               | 10   | -               | ns    |
| Break-Before-Make Time Delay, t <sub>D</sub> | V+ = 1.1V, V <sub>NO</sub> or V <sub>NC</sub> = 1.0V, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 35pF,<br>(See Figure 3) | Full         | -               | 9    | -               | ns    |
| DIGITAL INPUT CHARACTERISTICS                |                                                                                                                      |              |                 |      |                 |       |
| Input Voltage Low, V <sub>INL</sub>          |                                                                                                                      | Full         | -               | 0.4  | -               | V     |
| Input Voltage High, V <sub>INH</sub>         |                                                                                                                      | Full         | -               | 0.58 | -               | V     |

### Test Circuits and Waveforms



Logic input waveform is inverted for switches that have the opposite logic sense.

FIGURE 1A. MEASUREMENT POINTS



Repeat test for all switches.  $C_L$  includes fixture and stray capacitance.

$$V_{OUT} = V_{(NO \text{ or } NC)} \frac{R_L}{R_L + R_{(ON)}}$$

FIGURE 1B. TEST CIRCUIT

FIGURE 1. SWITCHING TIMES

# Test Circuits and Waveforms (Continued)

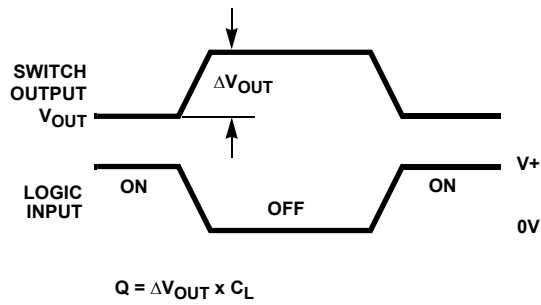


FIGURE 2A. MEASUREMENT POINTS

FIGURE 2. CHARGE INJECTION

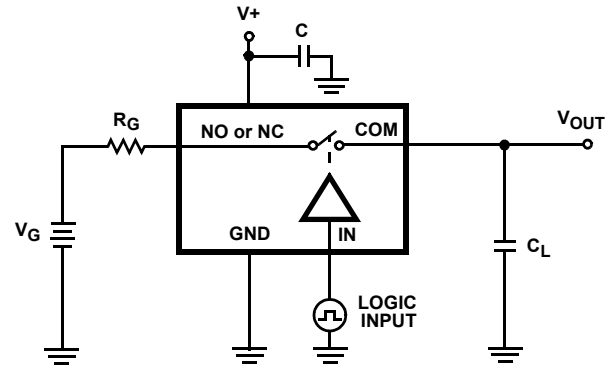


FIGURE 2B. TEST CIRCUIT

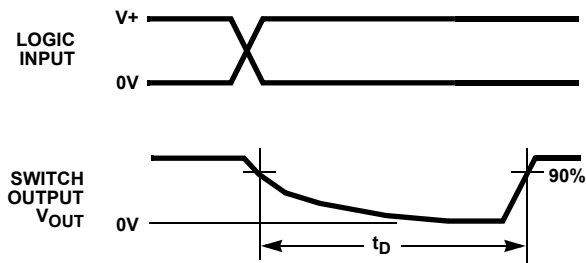


FIGURE 3A. MEASUREMENT POINTS

FIGURE 3. BREAK-BEFORE-MAKE TIME

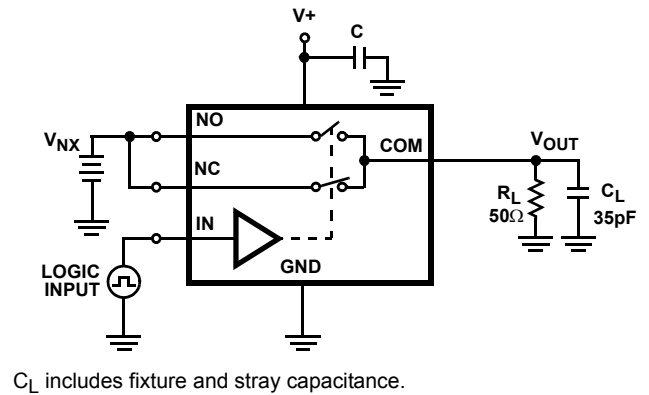


FIGURE 3B. TEST CIRCUIT

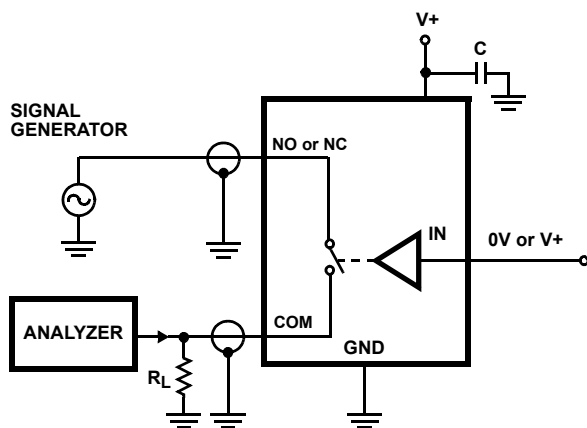
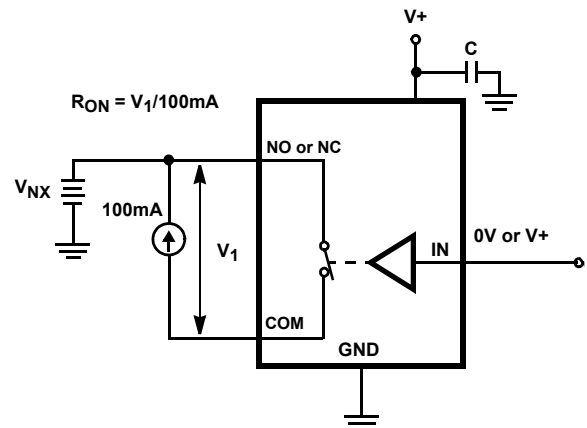


FIGURE 4. OFF ISOLATION TEST CIRCUIT

FIGURE 5.  $R_{ON}$  TEST CIRCUIT

## Test Circuits and Waveforms (Continued)

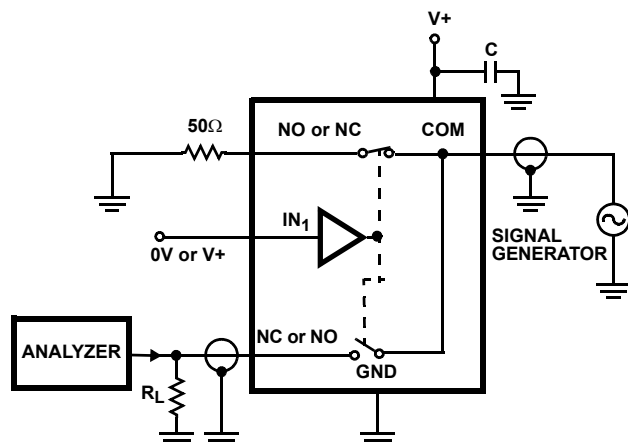


FIGURE 6. CROSSTALK TEST CIRCUIT

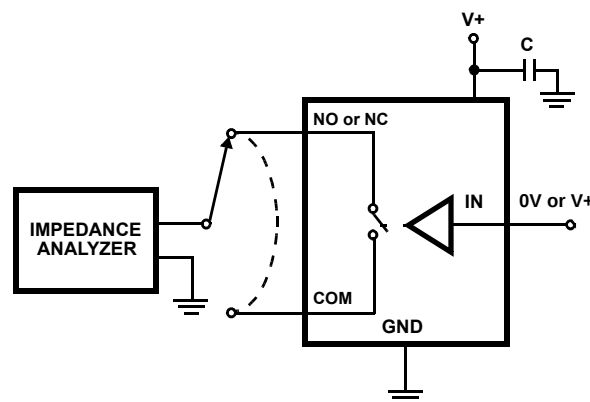


FIGURE 7. CAPACITANCE TEST CIRCUIT

### Detailed Description

The ISL43L210 is a bidirectional, single pole/double throw (SPDT) analog switch that offers precise switching capability from a single +1.1V to +4.5V supply with low on-resistance ( $0.34\Omega$ ) and high speed operation ( $t_{ON} = 7\text{ns}$ ,  $t_{OFF} = 3\text{ns}$ ). The device is especially well suited for portable battery powered equipment due to its low operating supply voltage (1.1V), low power consumption ( $1.8\mu\text{W}$  max), low leakage currents ( $100\text{nA}$  max), and the tiny SC70 packaging. The ultra low on-resistance and Ron flatness provide very low insertion loss and distortion to application that require signal reproduction.

### Supply Sequencing and Overvoltage Protection

With any CMOS device, proper power supply sequencing is required to protect the device from excessive input currents which might permanently damage the IC. All I/O pins contain ESD protection diodes from the pin to V+ and to GND (see Figure 8). To prevent forward biasing these diodes, V+ must be applied before any input signals, and the input signal voltages must remain between V+ and GND.

If these conditions cannot be guaranteed, then precautions must be implemented to prohibit the current and voltage at the logic pin and signal pins from exceeding the maximum ratings of the switch. The following two methods can be used to provided additional protection to limit the current in the event that the voltage at a signal pin or logic pin goes below ground or above the V+ rail.

Logic inputs can be protected by adding a  $1\text{k}\Omega$  resistor in series with the input (see Figure 8). The resistor limits the input current below the threshold that produces permanent damage, and the sub-microamp input current produces an insignificant voltage drop during normal operation.

This method is not acceptable for the signal path inputs. Adding a series resistor to the switch input defeats the

purpose of using a low  $R_{ON}$  switch. Connecting schottky diodes to the signal pins as shown in Figure 8 will shunt the fault current to the supply or to ground thereby protecting the switch. These schottky diodes must be sized to handle the expected fault current.

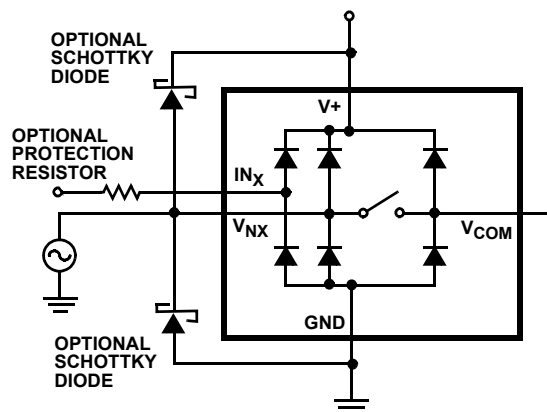


FIGURE 8. OVERVOLTAGE PROTECTION

### Power-Supply Considerations

The ISL43L210 construction is typical of most single supply CMOS analog switches, in that they have two supply pins: V+ and GND. V+ and GND drive the internal CMOS switches and set their analog voltage limits. Unlike switches with a 4V maximum supply voltage, the ISL43L210 4.7V maximum supply voltage provides plenty of room for the 10% tolerance of 4.2V supplies, as well as room for overshoot and noise spikes.

The minimum recommended supply voltage is 1.1V. It is important to note that the input signal range, switching times, and on-resistance degrade at lower supply voltages. Refer to the electrical specification tables and *Typical Performance* curves for details.

V+ and GND also power the internal logic and level shifters. The level shifters convert the input logic levels to switched V+ and GND signals to drive the analog switch gate terminals.

This family of switches cannot be operated with bipolar supplies, because the input switching point becomes negative in this configuration.

### **Logic-Level Thresholds**

This switch family is 1.8V CMOS compatible (0.5V and 1.4V) over a supply range of 2V to 3.6V (See Figure 17). At 3.6V the  $V_{IH}$  level is about 1.1V. This is still below the 1.8V CMOS guaranteed high output minimum level of 1.4V, but noise margin is reduced.

The digital input stages draw supply current whenever the digital input voltage is not at one of the supply rails. Driving the digital input signals from GND to V+ with a fast transition time minimizes power dissipation.

### **High-Frequency Performance**

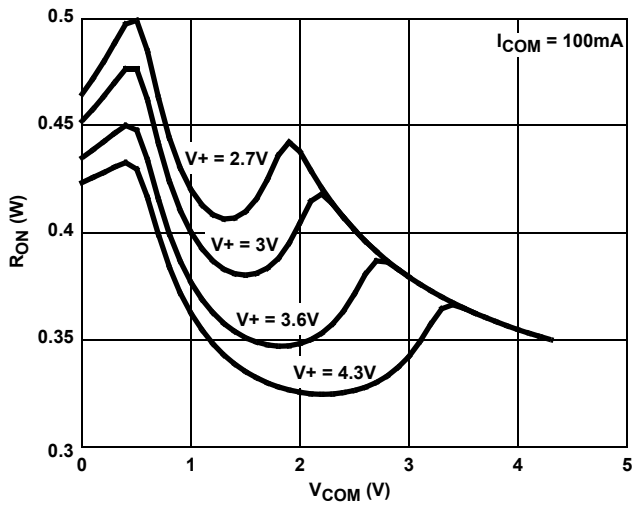
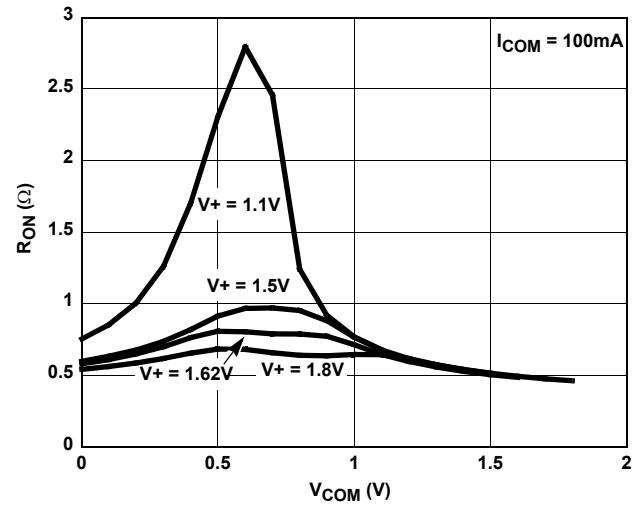
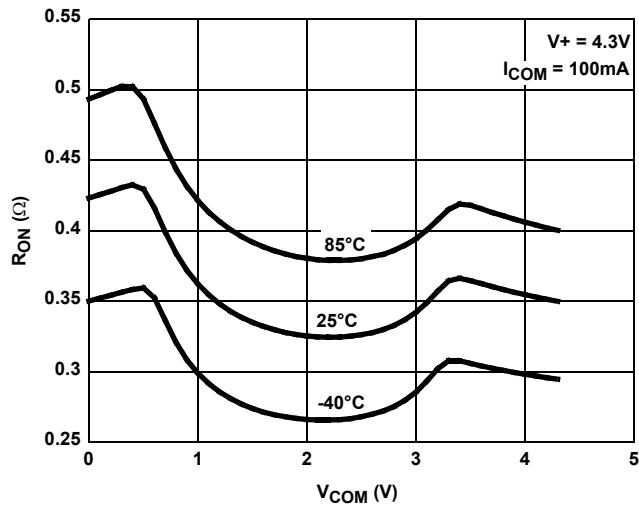
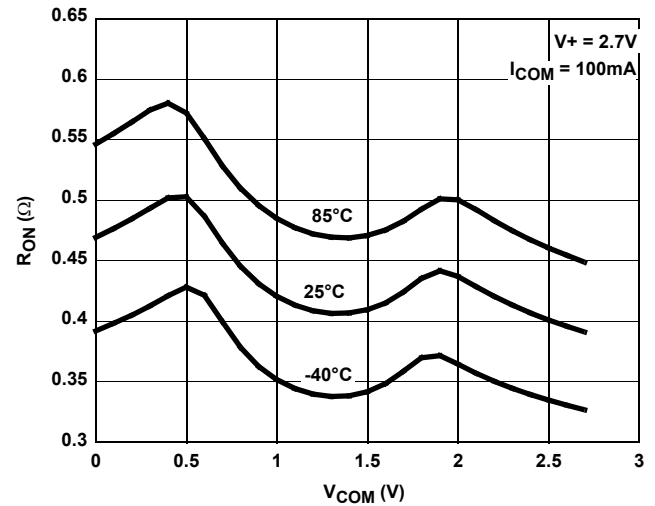
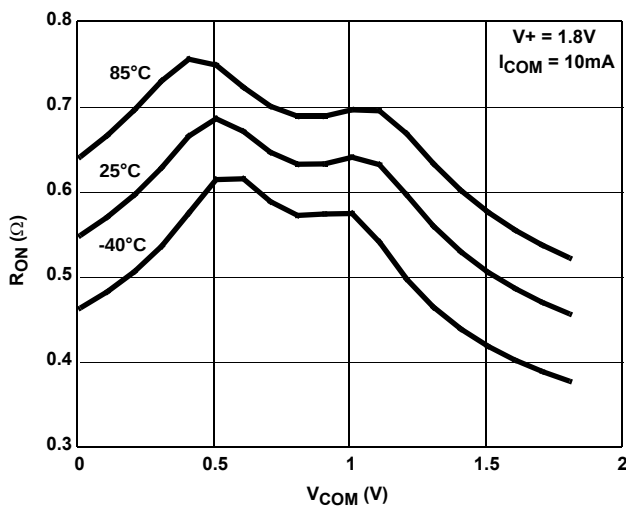
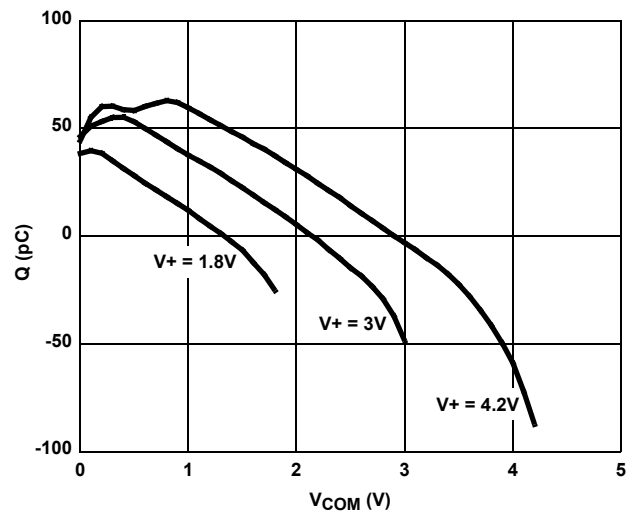
In 50 $\Omega$  systems, signal response is reasonably flat even past 90MHz (See Figure 18). The frequency response is very consistent over a wide V+ range, and for varying analog signal levels.

An OFF switch acts like a capacitor and passes higher frequencies with less attenuation, resulting in signal feedthrough from a switch's input to its output. Off Isolation is the resistance to this feedthrough, while Crosstalk indicates the amount of feedthrough from one switch to another. Figure 19 details the high Off Isolation and Crosstalk rejection provided by this family. At 100kHz, Off Isolation is about 70dB in 50 $\Omega$  systems, decreasing approximately 20dB per decade as frequency increases. Higher load impedances decrease Off Isolation and Crosstalk rejection due to the voltage divider action of the switch OFF impedance and the load impedance.

### **Leakage Considerations**

Reverse ESD protection diodes are internally connected between each analog-signal pin and both V+ and GND. One of these diodes conducts if any analog signal exceeds V+ or GND.

Virtually all the analog leakage current comes from the ESD diodes to V+ or GND. 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 GND and the analog signal. This means their leakages will vary as the signal varies. The difference in the two diode leakages to the V+ and GND pins constitutes the analog-signal-path leakage current. All analog leakage current flows between each pin and one of the supply terminals, not to the other switch terminal. This is why both sides of a given switch can show leakage currents of the same or opposite polarity. There is no connection between the analog signal paths and V+ or GND.

**Typical Performance Curves**  $T_A = 25^\circ\text{C}$ , Unless Otherwise Specified

**FIGURE 9. ON RESISTANCE vs SUPPLY VOLTAGE vs SWITCH VOLTAGE**

**FIGURE 10. ON RESISTANCE vs SUPPLY VOLTAGE vs SWITCH VOLTAGE**

**FIGURE 11. ON RESISTANCE vs SWITCH VOLTAGE**

**FIGURE 12. ON RESISTANCE vs SWITCH VOLTAGE**

**FIGURE 13. ON RESISTANCE vs SWITCH VOLTAGE**

**FIGURE 14. CHARGE INJECTION vs SWITCH VOLTAGE**

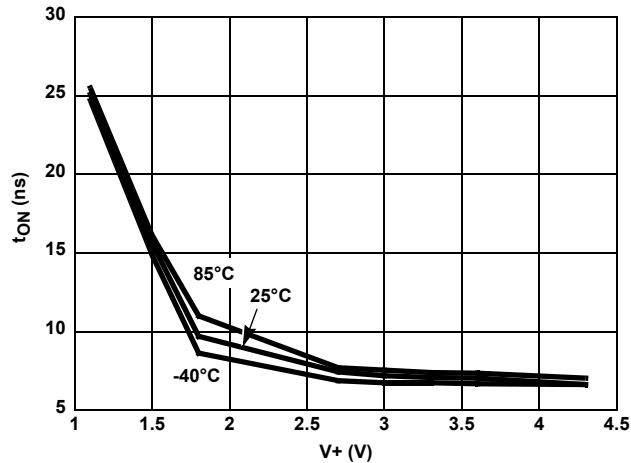
**Typical Performance Curves**  $T_A = 25^\circ\text{C}$ , Unless Otherwise Specified (Continued)


FIGURE 15. TURN-ON TIME vs SUPPLY VOLTAGE

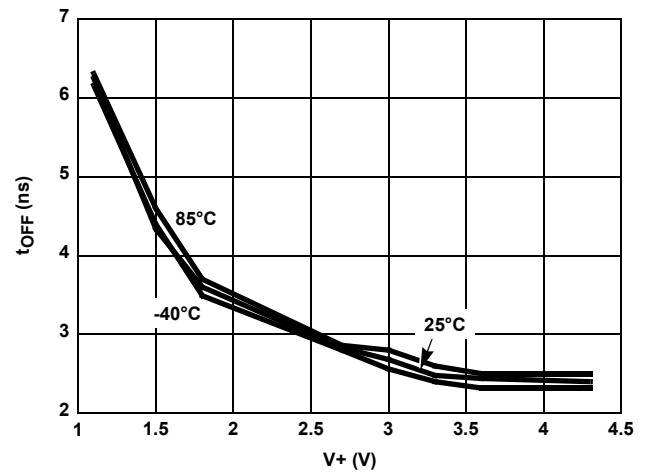


FIGURE 16. TURN-OFF TIME vs SUPPLY VOLTAGE

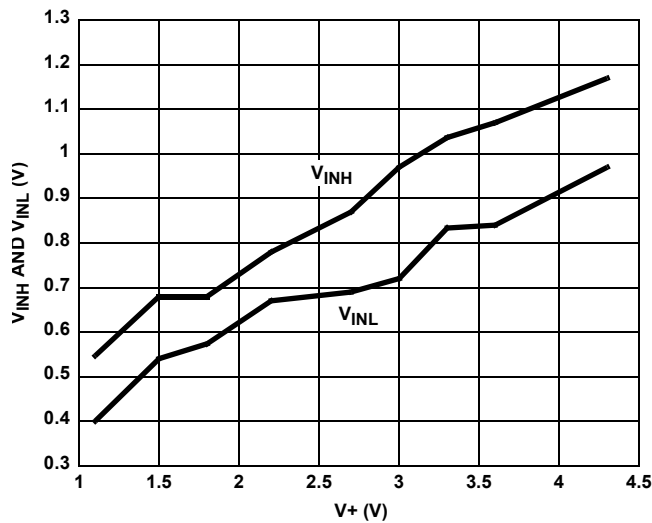


FIGURE 17. DIGITAL SWITCHING POINT vs SUPPLY VOLTAGE

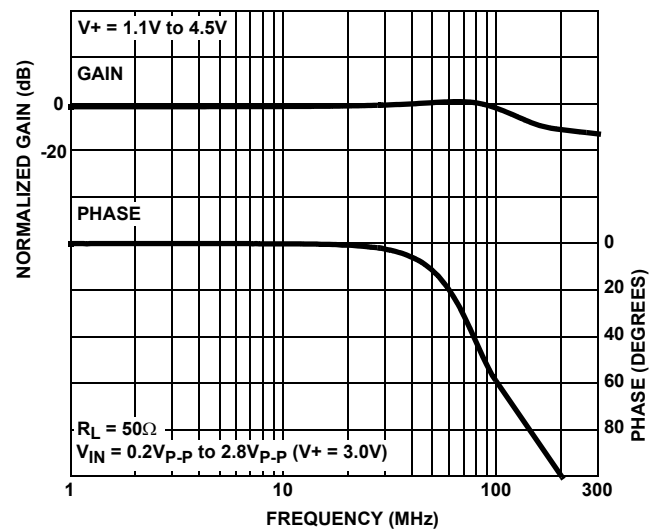


FIGURE 18. FREQUENCY RESPONSE

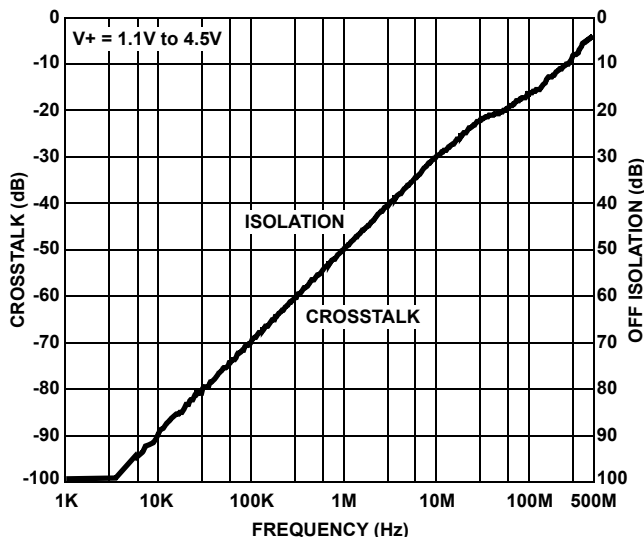


FIGURE 19. CROSSTALK AND OFF ISOLATION

**Die Characteristics**
**SUBSTRATE POTENTIAL (POWERED UP):**

GND

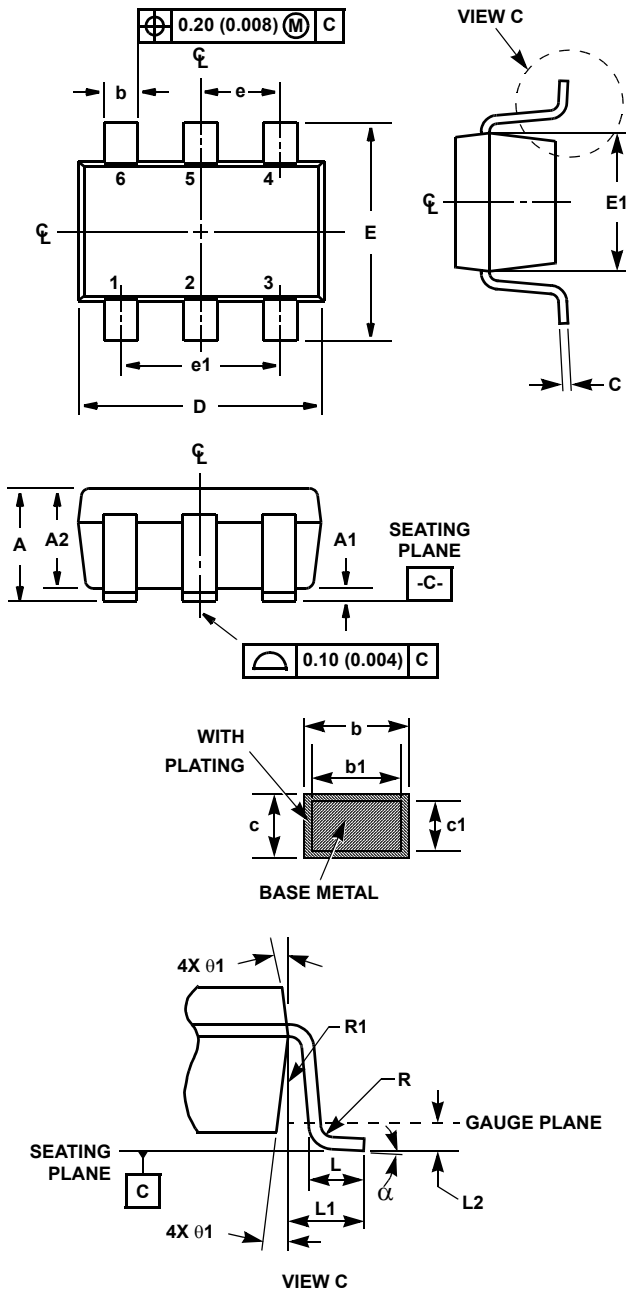
**TRANSISTOR COUNT:**

57

**PROCESS:**

Submicron CMOS

## Small Outline Transistor Plastic Packages (SC70-6)



## P6.049

## 6 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE

| SYMBOL   | INCHES     |       | MILLIMETERS |      | NOTES |
|----------|------------|-------|-------------|------|-------|
|          | MIN        | MAX   | MIN         | MAX  |       |
| A        | 0.031      | 0.043 | 0.80        | 1.10 | -     |
| A1       | 0.000      | 0.004 | 0.00        | 0.10 | -     |
| A2       | 0.031      | 0.039 | 0.00        | 1.00 | -     |
| b        | 0.006      | 0.012 | 0.15        | 0.30 | -     |
| b1       | 0.006      | 0.010 | 0.15        | 0.25 |       |
| c        | 0.003      | 0.009 | 0.08        | 0.22 | 6     |
| c1       | 0.003      | 0.009 | 0.08        | 0.20 | 6     |
| D        | 0.073      | 0.085 | 1.85        | 2.15 | 3     |
| E        | 0.071      | 0.094 | 1.80        | 2.40 | -     |
| E1       | 0.045      | 0.053 | 1.15        | 1.35 | 3     |
| e        | 0.0256 Ref |       | 0.65 Ref    |      | -     |
| e1       | 0.0512 Ref |       | 1.30 Ref    |      | -     |
| L        | 0.010      | 0.018 | 0.26        | 0.46 | 4     |
| L1       | 0.017 Ref. |       | 0.420 Ref.  |      |       |
| L2       | 0.006 BSC  |       | 0.15 BSC    |      |       |
| N        | 6          |       | 6           |      | 5     |
| R        | 0.004      | -     | 0.10        | -    |       |
| R1       | 0.004      | 0.010 | 0.15        | 0.25 |       |
| $\alpha$ | 0°         | 8°    | 0°          | 8°   | -     |

Rev. 2 9/03

## NOTES:

1. Dimensioning and tolerance per ASME Y14.5M-1994.
2. Package conforms to EIAJ SC70 and JEDEC MO203AB.
3. Dimensions D and E1 are exclusive of mold flash, protrusions, or gate burrs.
4. Footlength L measured at reference to gauge plane.
5. "N" is the number of terminal positions.
6. These Dimensions apply to the flat section of the lead between 0.08mm and 0.15mm from the lead tip.
7. Controlling dimension: MILLIMETER. Converted inch dimensions are for reference only

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