

## Low-Voltage, Single Supply, Dual SPST, SPDT Analog Switches

The Intersil ISL5120–ISL5123 devices are precision, bidirectional, dual analog switches designed to operate from a single +2.7V to +12V supply. Targeted applications include battery powered equipment that benefit from the devices' low power consumption (5μW), low leakage currents (100pA max), and fast switching speeds ( $t_{ON} = 28ns$ ,  $t_{OFF} = 20ns$ ). 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 family of parts may be used to “mux-in” additional functionality while reducing ASIC design risk. Some of the smallest packages are available, alleviating board space limitations, and making Intersil's newest line of low-voltage switches an ideal solution.

The ISL5120/ISL5121/ISL5122 are dual single-pole/single-throw (SPST) devices. The ISL5120 has two normally open (NO) switches; the ISL5121 has two normally closed (NC) switches; the ISL5122 has one NO and one NC switch and can be used as an SPDT. The ISL5123 is a committed SPDT, which is perfect for use in 2-to-1 multiplexer applications.

**TABLE 1. FEATURES AT A GLANCE**

|   | ISL5120                   | ISL5121     | ISL5122     | ISL5123                   |
|---|---------------------------|-------------|-------------|---------------------------|
| <b>Number of Switches</b>                 | 2                         | 2           | 2           | 1                         |
| <b>SW 1 / SW 2</b>                        | NO / NO                   | NC / NC     | NO / NC     | SPDT                      |
| <b>3.3V <math>R_{ON}</math></b>           | 32Ω                       | 32Ω         | 32Ω         | 32Ω                       |
| <b>3.3V <math>t_{ON} / t_{OFF}</math></b> | 40ns / 20ns               | 40ns / 20ns | 40ns / 20ns | 40ns / 20ns               |
| <b>5V <math>R_{ON}</math></b>             | 19Ω                       | 19Ω         | 19Ω         | 19Ω                       |
| <b>5V <math>t_{ON} / t_{OFF}</math></b>   | 28ns / 20ns               | 28ns / 20ns | 28ns / 20ns | 28ns / 20ns               |
| <b>12V <math>R_{ON}</math></b>            | 11Ω                       | 11Ω         | 11Ω         | 11Ω                       |
| <b>12V <math>t_{ON} / t_{OFF}</math></b>  | 25ns / 17ns               | 25ns / 17ns | 25ns / 17ns | 25ns / 17ns               |
| <b>Packages</b>                           | 8 Ld SOIC,<br>8 Ld SOT-23 |             |             | 8 Ld SOIC,<br>6 Ld SOT-23 |

## Related Literature

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

## Features

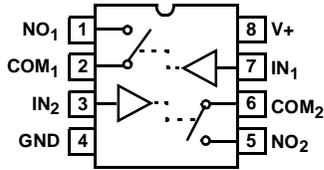
- Improved (lower  $R_{ON}$ , faster switching), pin compatible replacements for ISL84541–44
- Fully specified at 3.3V, 5V, and 12V supplies
- ON resistance ( $R_{ON}$ ) . . . . . 19Ω
- $R_{ON}$  matching between channels . . . . . <1Ω
- Low charge injection . . . . . 5pC (Max)
- Single supply operation . . . . . +2.7V to +12V
- Low power consumption ( $P_D$ ) . . . . . <5μW
- Low leakage current. . . . . 10nA
- Fast switching action
  - $t_{ON}$  . . . . . 28ns
  - $t_{OFF}$  . . . . . 20ns
- Guaranteed break-before-make (ISL5122/ISL5123 only)
- Minimum 2000V ESD protection per method 3015.7
- TTL, CMOS compatible
- Available in SOT-23 packaging

## Applications

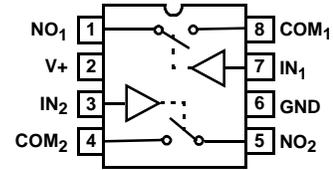
- Battery powered, handheld, and portable equipment
  - Cellular/mobile phones
  - Pagers
  - Laptops, notebooks, palmtops
- Communications systems
  - Military radios
  - PBX, PABX
- Test equipment
  - Ultrasound
  - Electrocardiograph
- Heads-up displays
- Audio and video switching
- Various circuits
  - +3V/+5V DACs and ADCs
  - Sample and hold circuits
  - Digital filters
  - Operational amplifier gain switching networks
  - High frequency analog switching
  - High speed multiplexing
  - Integrator reset circuits

**Pinouts** (Note 1)

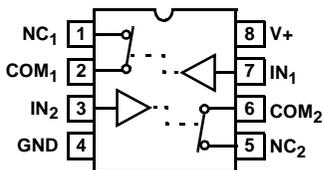
**ISL5120 (SOIC)**  
TOP VIEW



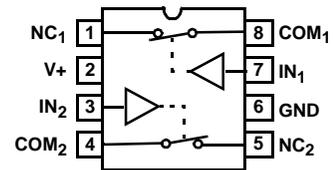
**ISL5120 (SOT-23)**  
TOP VIEW



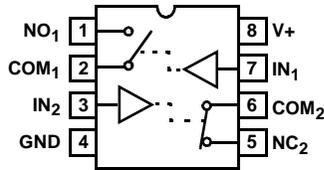
**ISL5121 (SOIC)**  
TOP VIEW



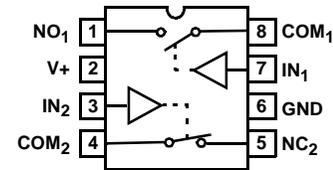
**ISL5121 (SOT-23)**  
TOP VIEW



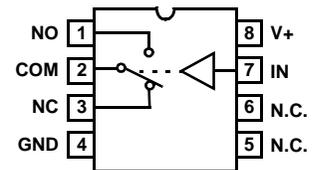
**ISL5122 (SOIC)**  
TOP VIEW



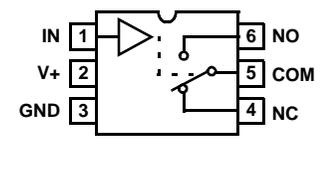
**ISL5122 (SOT-23)**  
TOP VIEW



**ISL5123 (SOIC)**  
TOP VIEW



**ISL5123 (SOT-23)**  
TOP VIEW



NOTE:

1. Switches Shown for Logic "0" Input.

**Truth Table**

| LOGIC | ISL5120 | ISL5121 | ISL5122 |      | ISL5123 |        |
|-------|---------|---------|---------|------|---------|--------|
|       | SW 1,2  | SW 1,2  | SW 1    | SW 2 | PIN NC  | PIN NO |
| 0     | OFF     | ON      | OFF     | ON   | ON      | OFF    |
| 1     | ON      | OFF     | ON      | OFF  | OFF     | ON     |

NOTE: Logic "0" ≤0.8V. Logic "1" ≥2.4V.

**Pin Descriptions**

| PIN  | FUNCTION                                  |
|------|---|
| V+   | System Power Supply Input (+2.7V to +12V) |
| GND  | Ground Connection                         |
| IN   | Digital Control Input                     |
| COM  | Analog Switch Common Pin                  |
| NO   | Analog Switch Normally Open Pin           |
| NC   | Analog Switch Normally Closed Pin         |
| N.C. | No Internal Connection                    |

**Ordering Information**

| <b>PART NO.<br/>(BRAND)<br/>(NOTE 2)</b> | <b>TEMP.<br/>RANGE (°C)</b> | <b>PACKAGE</b> | <b>PKG. NO.</b> |
|--|-----------------------------|----------------|-----------------|
| ISL5120CB                                | 0 to 70                     | 8 Ld SOIC      | M8.15           |
| ISL5120IB                                | -40 to 85                   | 8 Ld SOIC      | M8.15           |
| ISL5120IH-T *<br>(120I)                  | -40 to 85                   | 8 Ld SOT-23    | P8.064          |
| ISL5121CB                                | 0 to 70                     | 8 Ld SOIC      | M8.15           |
| ISL5121IB                                | -40 to 85                   | 8 Ld SOIC      | M8.15           |
| ISL5121IH-T *<br>(121I)                  | -40 to 85                   | 8 Ld SOT-23    | P8.064          |
| ISL5122CB                                | 0 to 70                     | 8 Ld SOIC      | M8.15           |
| ISL5122IB                                | -40 to 85                   | 8 Ld SOIC      | M8.15           |
| ISL5122IH-T *<br>(122I)                  | -40 to 85                   | 8 Ld SOT-23    | P8.064          |
| ISL5123CB                                | 0 to 70                     | 8 Ld SOIC      | M8.15           |
| ISL5123IB                                | -40 to 85                   | 8 Ld SOIC      | M8.15           |
| ISL5123IH-T<br>(123I)                    | -40 to 85                   | 6 Ld SOT-23    | P6.064          |

NOTES:

- 2. Most surface mount devices are available on tape and reel; add "-T" to suffix.

\* In Development.

# ISL5120, ISL5121, ISL5122, ISL5123

## Absolute Maximum Ratings

|  |                       |
|--|-----------------------|
| V+ to GND  | -0.3 to 15V           |
| Input Voltages   |                       |
| IN (Note 3)  | -0.3 to ((V+) + 0.3V) |
| NO, NC (Note 3)  | -0.3 to ((V+) + 0.3V) |
| Output Voltages  |                       |
| COM (Note 3)   | -0.3 to ((V+) + 0.3V) |
| Continuous Current (Any Terminal)                                | 30mA                  |
| Peak Current NO, NC, or COM<br>(Pulsed 1ms, 10% Duty Cycle, Max) | 40mA                  |
| ESD Rating (Per MIL-STD-883 Method 3015)                         | >2kV                  |

## Operating Conditions

|                   |               |
|-------------------|---------------|
| Temperature Range |               |
| ISL512XCX         | 0°C to 70°C   |
| ISL512XIX         | -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:

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

## Electrical Specifications - 5V Supply

Test Conditions: V+ = +4.5V to +5.5V, GND = 0V, V<sub>INH</sub> = 2.4V, V<sub>INL</sub> = 0.8V (Note 5), Unless Otherwise Specified

| PARAMETER  | TEST CONDITIONS   | TEMP (°C) | (NOTE 6) MIN | TYP  | (NOTE 6) MAX | UNITS |
|--|---|-----------|--------------|------|--------------|-------|
| <b>ANALOG SWITCH CHARACTERISTICS</b>                                       |   |           |              |      |              |       |
| Analog Signal Range, V <sub>ANALOG</sub>                                   |   | Full      | 0            | -    | V+           | V     |
| ON Resistance, R <sub>ON</sub>   | V+ = 4.5V, I <sub>COM</sub> = 1.0mA, V <sub>NO</sub> or V <sub>NC</sub> = 3.5V, See Figure 5                                  | 25        | -            | 19   | 30           | Ω     |
|  |   | Full      | -            | 23   | 40           | Ω     |
| R <sub>ON</sub> Matching Between Channels, ΔR <sub>ON</sub>                | V+ = 5V, I <sub>COM</sub> = 1.0mA, V <sub>NO</sub> or V <sub>NC</sub> = 3.5V  | 25        | -            | 0.8  | 2            | Ω     |
|  |   | Full      | -            | 1    | 4            | Ω     |
| R <sub>ON</sub> Flatness, R <sub>FLAT(ON)</sub>                            | V+ = 5V, I <sub>COM</sub> = 1.0mA, V <sub>NO</sub> or V <sub>NC</sub> = 1V, 2V, 3V  | Full      | -            | 7    | 8            | Ω     |
| NO or NC OFF Leakage Current, I <sub>NO(OFF)</sub> or I <sub>NC(OFF)</sub> | V+ = 5.5V, V <sub>COM</sub> = 1V, 4.5V, V <sub>NO</sub> or V <sub>NC</sub> = 4.5V, 1V, Note 7                                 | 25        | -0.1         | 0.01 | 0.1          | nA    |
|  |   | Full      | -5           | -    | 5            | nA    |
| COM OFF Leakage Current, I <sub>COM(OFF)</sub>                             | V+ = 5.5V, V <sub>COM</sub> = 4.5V, 1V, V <sub>NO</sub> or V <sub>NC</sub> = 1V, 4.5V, Note 7                                 | 25        | -0.1         | -    | 0.1          | nA    |
|  |   | Full      | -5           | -    | 5            | nA    |
| COM ON Leakage Current, I <sub>COM(ON)</sub>                               | V+ = 5.5V, V <sub>COM</sub> = 1V, 4.5V, or V <sub>NO</sub> or V <sub>NC</sub> = 1V, 4.5V, or Floating, Note 7                 | 25        | -0.2         | -    | 0.2          | nA    |
|  |   | Full      | -10          | -    | 10           | nA    |
| <b>DYNAMIC CHARACTERISTICS</b>   |   |           |              |      |              |       |
| Turn-ON Time, t <sub>ON</sub>  | V <sub>NO</sub> or V <sub>NC</sub> = 3V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF, V <sub>IN</sub> = 0 to 3V, See Figure 1 | 25        | -            | 28   | 75           | ns    |
|  |   | Full      | -            | 40   | 150          | ns    |
| Turn-OFF Time, t <sub>OFF</sub>  | V <sub>NO</sub> or V <sub>NC</sub> = 3V, R <sub>L</sub> = 1kΩ, C <sub>L</sub> = 35pF, V <sub>IN</sub> = 0 to 3V, See Figure 1 | 25        | -            | 20   | 50           | ns    |
|  |   | Full      | -            | 30   | 100          | ns    |
| Break-Before-Make Time Delay (ISL5122, ISL5123), t <sub>D</sub>            | R <sub>L</sub> = 300Ω, C <sub>L</sub> = 35pF, V <sub>NO</sub> = V <sub>NC</sub> = 3V, V <sub>IN</sub> = 0 to 3V, See Figure 3 | Full      | 3            | 10   | -            | ns    |
| Charge Injection, Q  | C <sub>L</sub> = 1.0nF, V <sub>G</sub> = 0V, R <sub>G</sub> = 0Ω, See Figure 2  | 25        | -            | 3    | 5            | pC    |
| OFF Isolation  | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, See Figure 4  | 25        | -            | 76   | -            | dB    |
| Crosstalk (Channel-to-Channel)   | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz, See Figure 6  | 25        | -            | -105 | -            | dB    |
| Power Supply Rejection Ratio   | R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF, f = 1MHz  | 25        | -            | 60   | -            | dB    |
| 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        | -            | 8    | -            | pF    |
| COM OFF Capacitance, C <sub>COM(OFF)</sub>                                 | f = 1MHz, V <sub>NO</sub> or V <sub>NC</sub> = V <sub>COM</sub> = 0V, See Figure 7  | 25        | -            | 8    | -            | pF    |

## ISL5120, ISL5121, ISL5122, ISL5123

### Electrical Specifications - 5V Supply

Test Conditions:  $V_+ = +4.5V$  to  $+5.5V$ ,  $GND = 0V$ ,  $V_{INH} = 2.4V$ ,  $V_{INL} = 0.8V$  (Note 5), Unless Otherwise Specified (Continued)

| PARAMETER                            | TEST CONDITIONS  | TEMP (°C) | (NOTE 6) MIN | TYP    | (NOTE 6) MAX | UNITS   |
|--------------------------------------|--|-----------|--------------|--------|--------------|---------|
| COM ON Capacitance, $C_{COM(ON)}$    | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$ , See Figure 7, ISL5120/1/2 | 25        | -            | 21     | -            | pF      |
|                                      | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$ , See Figure 7, ISL5123     | 25        | -            | 28     | -            | pF      |
| <b>POWER SUPPLY CHARACTERISTICS</b>  |  |           |              |        |              |         |
| Power Supply Range                   |  | Full      | 2.7          |        | 12           | V       |
| Positive Supply Current, $I_+$       | $V_+ = 5.5V$ , $V_{IN} = 0V$ or $V_+$ , all channels on or off               | Full      | -1           | 0.0001 | 1            | $\mu A$ |
| <b>DIGITAL INPUT CHARACTERISTICS</b> |  |           |              |        |              |         |
| Input Voltage Low, $V_{INL}$         |  | Full      | -            | -      | 0.8          | V       |
| Input Voltage High, $V_{INH}$        |  | Full      | 2.4          | -      | -            | V       |
| Input Current, $I_{INH}$ , $I_{INL}$ | $V_+ = 5.5V$ , $V_{IN} = 0V$ or $V_+$  | Full      | -1           | -      | 1            | $\mu A$ |

**NOTES:**

5.  $V_{IN}$  = input voltage to perform proper function.
6. The algebraic convention, whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
7. Leakage parameter is 100% tested at high temp, and guaranteed by correlation at 25°C.

### Electrical Specifications - 3.3V Supply

Test Conditions:  $V_+ = +3.0V$  to  $+3.6V$ ,  $GND = 0V$ ,  $V_{INH} = 2.4V$ ,  $V_{INL} = 0.8V$  (Note 5), Unless Otherwise Specified

| PARAMETER  | TEST CONDITIONS  | TEMP (°C) | (NOTE 6) MIN | TYP  | (NOTE 6) MAX | UNITS    |
|--|--|-----------|--------------|------|--------------|----------|
| <b>ANALOG SWITCH CHARACTERISTICS</b>                         |  |           |              |      |              |          |
| Analog Signal Range, $V_{ANALOG}$                            |  | Full      | 0            | -    | $V_+$        | V        |
| ON Resistance, $R_{ON}$                                      | $V_+ = 3V$ , $I_{COM} = 1.0mA$ , $V_{NO}$ or $V_{NC} = 1.5V$                                     | 25        | -            | 32   | 50           | $\Omega$ |
|  |  | Full      | -            | 40   | 60           | $\Omega$ |
| $R_{ON}$ Matching Between Channels, $\Delta R_{ON}$          | $V_+ = 3.3V$ , $I_{COM} = 1.0mA$ , $V_{NO}$ or $V_{NC} = 1.5V$                                   | 25        | -            | 0.8  | 2            | $\Omega$ |
|  |  | Full      | -            | 1    | 4            | $\Omega$ |
| $R_{ON}$ Flatness, $R_{FLAT(ON)}$                            | $V_+ = 3.3V$ , $I_{COM} = 1.0mA$ , $V_{NO}$ or $V_{NC} = 0.5V$ , $1V$ , $1.5V$                   | 25        | -            | 6    | 8            | $\Omega$ |
|  |  | Full      | -            | 7    | 12           | $\Omega$ |
| NO or NC OFF Leakage Current, $I_{NO(OFF)}$ or $I_{NC(OFF)}$ | $V_+ = 3.6V$ , $V_{COM} = 1V$ , $3V$ , $V_{NO}$ or $V_{NC} = 3V$ , $1V$ , Note 7                 | 25        | -0.1         | 0.01 | 0.1          | nA       |
|  |  | Full      | -5           | -    | 5            | nA       |
| COM OFF Leakage Current, $I_{COM(OFF)}$                      | $V_+ = 3.6V$ , $V_{COM} = 3V$ , $1V$ , $V_{NO}$ or $V_{NC} = 1V$ , $3V$ , Note 7                 | 25        | -0.1         | 0.01 | 0.1          | nA       |
|  |  | Full      | -5           | -    | 5            | nA       |
| COM ON Leakage Current, $I_{COM(ON)}$                        | $V_+ = 3.6V$ , $V_{COM} = 1V$ , $3V$ , or $V_{NO}$ or $V_{NC} = 1V$ , $3V$ , or floating, Note 7 | 25        | -0.2         | -    | 0.2          | nA       |
|  |  | Full      | -10          | -    | 10           | nA       |
| <b>DYNAMIC CHARACTERISTICS</b>                               |  |           |              |      |              |          |
| Turn-ON Time, $t_{ON}$                                       | $V_{NO}$ or $V_{NC} = 1.5V$ , $R_L = 1k\Omega$ , $C_L = 35pF$ , $V_{IN} = 0$ to $3V$             | 25        | -            | 40   | 120          | ns       |
|  |  | Full      | -            | 60   | 200          | ns       |
| Turn-OFF Time, $t_{OFF}$                                     | $V_{NO}$ or $V_{NC} = 1.5V$ , $R_L = 1k\Omega$ , $C_L = 35pF$ , $V_{IN} = 0$ to $3V$             | 25        | -            | 20   | 50           | ns       |
|  |  | Full      | -            | 30   | 120          | ns       |
| Break-Before-Make Time Delay (ISL5122, ISL5123), $t_D$       | $R_L = 300\Omega$ , $C_L = 35pF$ , $V_{NO}$ or $V_{NC} = 1.5V$ , $V_{IN} = 0$ to $3V$            | Full      | 3            | 20   | -            | ns       |
| Charge Injection, Q  | $C_L = 1.0nF$ , $V_G = 0V$ , $R_G = 0\Omega$   | 25        | -            | 1    | 5            | pC       |
| OFF Isolation  | $R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$  | 25        | -            | 76   | -            | dB       |
| Crosstalk (Channel-to-Channel)                               |  | 25        | -            | -105 | -            | dB       |
| Power Supply Rejection Ratio                                 | $R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$  | 25        | -            | 56   | -            | dB       |
| NO or NC OFF Capacitance, $C_{OFF}$                          | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$   | 25        | -            | 8    | -            | pF       |
| COM OFF Capacitance, $C_{COM(OFF)}$                          | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$   | 25        | -            | 8    | -            | pF       |

## ISL5120, ISL5121, ISL5122, ISL5123

### Electrical Specifications - 3.3V Supply

Test Conditions:  $V_+ = +3.0V$  to  $+3.6V$ ,  $GND = 0V$ ,  $V_{INH} = 2.4V$ ,  $V_{INL} = 0.8V$  (Note 5), Unless Otherwise Specified **(Continued)**

| PARAMETER                            | TEST CONDITIONS  | TEMP (°C) | (NOTE 6) MIN | TYP | (NOTE 6) MAX | UNITS   |
|--------------------------------------|--|-----------|--------------|-----|--------------|---------|
| COM ON Capacitance, $C_{COM(ON)}$    | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$ , ISL5120/1/2 | 25        | -            | 21  | -            | pF      |
|                                      | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$ , ISL5123     | 25        | -            | 28  | -            | pF      |
| <b>POWER SUPPLY CHARACTERISTICS</b>  |  |           |              |     |              |         |
| Positive Supply Current, $I_+$       | $V_+ = 3.6V$ , $V_{IN} = 0V$ or $V_+$ , all channels on or off | Full      | -1           | -   | 1            | $\mu A$ |
| <b>DIGITAL INPUT CHARACTERISTICS</b> |  |           |              |     |              |         |
| Input Voltage Low, $V_{INL}$         |  | Full      | -            | -   | 0.8          | V       |
| Input Voltage High, $V_{INH}$        |  | Full      | 2.4          | -   | -            | V       |
| Input Current, $I_{INH}$ , $I_{INL}$ | $V_+ = 3.6V$ , $V_{IN} = 0V$ or $V_+$                          | Full      | -1           | -   | 1            | $\mu A$ |

### Electrical Specifications - 12V Supply

Test Conditions:  $V_+ = +10.8V$  to  $+13V$ ,  $GND = 0V$ ,  $V_{INH} = 4V$ ,  $V_{INL} = 0.8V$  (Note 5), Unless Otherwise Specified

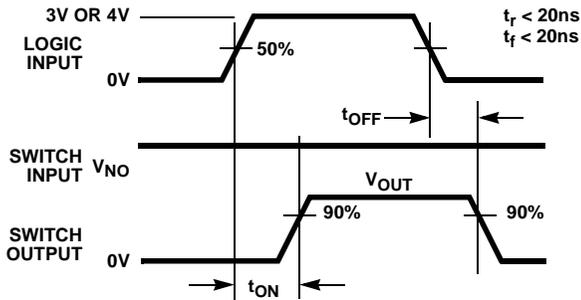
| PARAMETER  | TEST CONDITIONS   | TEMP (°C) | (NOTE 6) MIN | TYP  | (NOTE 6) MAX | UNITS    |
|--|---|-----------|--------------|------|--------------|----------|
| <b>ANALOG SWITCH CHARACTERISTICS</b>                         |   |           |              |      |              |          |
| Analog Signal Range, $V_{ANALOG}$                            |   | Full      | 0            | -    | $V_+$        | V        |
| ON Resistance, $R_{ON}$                                      | $V_+ = 10.8V$ , $I_{COM} = 1.0mA$ , $V_{NO}$ or $V_{NC} = 10V$                              | 25        | -            | 11   | 20           | $\Omega$ |
|  |   | Full      | -            | 15   | 25           | $\Omega$ |
| $R_{ON}$ Matching Between Channels, $\Delta R_{ON}$          | $V_+ = 12V$ , $I_{COM} = 1.0mA$ , $V_{NO}$ or $V_{NC} = 10V$                                | 25        | -            | 0.8  | 2            | $\Omega$ |
|  |   | Full      | -            | 1    | 4            | $\Omega$ |
| $R_{ON}$ Flatness, $R_{FLAT(ON)}$                            | $V_+ = 12V$ , $I_{COM} = 1.0mA$ , $V_{NO}$ or $V_{NC} = 3V, 6V, 9V$                         | 25        | -            | 1    | 4            | $\Omega$ |
|  |   | Full      | -            | -    | 6            | $\Omega$ |
| NO or NC OFF Leakage Current, $I_{NO(OFF)}$ or $I_{NC(OFF)}$ | $V_+ = 13V$ , $V_{COM} = 1V, 12V$ , $V_{NO}$ or $V_{NC} = 12V, 1V$ , Note 7                 | 25        | -0.1         | 0.01 | 0.1          | nA       |
|  |   | Full      | -5           | -    | 5            | nA       |
| COM OFF Leakage Current, $I_{COM(OFF)}$                      | $V_+ = 13V$ , $V_{COM} = 12V, 1V$ , $V_{NO}$ or $V_{NC} = 1V, 12V$ , Note 7                 | 25        | -0.1         | 0.01 | 0.1          | nA       |
|  |   | Full      | -5           | -    | 5            | nA       |
| COM ON Leakage Current, $I_{COM(ON)}$                        | $V_+ = 13V$ , $V_{COM} = 1V, 12V$ , or $V_{NO}$ or $V_{NC} = 1V, 12V$ , or floating, Note 7 | 25        | -0.2         | -    | 0.2          | nA       |
|  |   | Full      | -10          | -    | 10           | nA       |
| <b>DYNAMIC CHARACTERISTICS</b>                               |   |           |              |      |              |          |
| Turn-ON Time, $t_{ON}$                                       | $V_{NO}$ or $V_{NC} = 10V$ , $R_L = 1k\Omega$ , $C_L = 35pF$ , $V_{IN} = 0$ to $4V$         | 25        | -            | 25   | 35           | ns       |
|  |   | Full      | -            | 35   | 55           | ns       |
| Turn-OFF Time, $t_{OFF}$                                     | $V_{NO}$ or $V_{NC} = 10V$ , $R_L = 1k\Omega$ , $C_L = 35pF$ , $V_{IN} = 0$ to $4V$         | 25        | -            | 17   | 30           | ns       |
|  |   | Full      | -            | 26   | 50           | ns       |
| Break-Before-Make Time Delay (ISL5122, ISL5123), $t_D$       | $R_L = 300\Omega$ , $C_L = 35pF$ , $V_{NO}$ or $V_{NC} = 10V$ , $V_{IN} = 0$ to $4V$        | Full      | 0            | 2    | -            | ns       |
| Charge Injection, Q  | $C_L = 1.0nF$ , $V_G = 0V$ , $R_G = 0\Omega$  | 25        | -            | 5    | 15           | pC       |
| OFF Isolation  | $R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$   | 25        | -            | 76   | -            | dB       |
| Crosstalk (Channel-to-Channel)                               |   | 25        | -            | -105 | -            | dB       |
| Power Supply Rejection Ratio                                 | $R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$   | 25        | -            | 63   | -            | dB       |
| NO or NC OFF Capacitance, $C_{OFF}$                          | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$  | 25        | -            | 8    | -            | pF       |
| COM OFF Capacitance, $C_{COM(OFF)}$                          | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$  | 25        | -            | 8    | -            | pF       |
| COM ON Capacitance, $C_{COM(ON)}$                            | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$ , ISL5120/1/2                              | 25        | -            | 21   | -            | pF       |
|  | $f = 1MHz$ , $V_{NO}$ or $V_{NC} = V_{COM} = 0V$ , ISL5123                                  | 25        | -            | 28   | -            | pF       |
| <b>POWER SUPPLY CHARACTERISTICS</b>                          |   |           |              |      |              |          |
| Positive Supply Current, $I_+$                               | $V_+ = 13V$ , $V_{IN} = 0V$ or $V_+$ , all channels on or off                               | Full      | -1           | -    | 1            | $\mu A$  |

**Electrical Specifications - 12V Supply**

Test Conditions:  $V_+ = +10.8V$  to  $+13V$ ,  $GND = 0V$ ,  $V_{INH} = 4V$ ,  $V_{INL} = 0.8V$  (Note 5), Unless Otherwise Specified (Continued)

| PARAMETER                            | TEST CONDITIONS                      | TEMP (°C) | (NOTE 6) MIN | TYP | (NOTE 6) MAX | UNITS   |
|--------------------------------------|--------------------------------------|-----------|--------------|-----|--------------|---------|
| <b>DIGITAL INPUT CHARACTERISTICS</b> |                                      |           |              |     |              |         |
| Input Voltage Low, $V_{INL}$         |                                      | Full      | -            | -   | 0.8          | V       |
| Input Voltage High, $V_{INH}$        |                                      | Full      | 4            | 3   | -            | V       |
| Input Current, $I_{INH}$ , $I_{INL}$ | $V_+ = 13V$ , $V_{IN} = 0V$ or $V_+$ | Full      | -1           | -   | 1            | $\mu A$ |

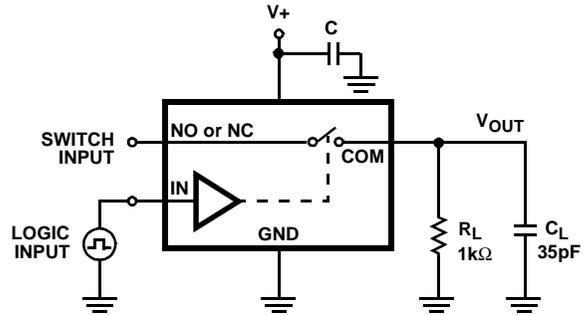
**Test Circuits and Waveforms**



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

FIGURE 1A. MEASUREMENT POINTS

FIGURE 1. SWITCHING TIMES



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

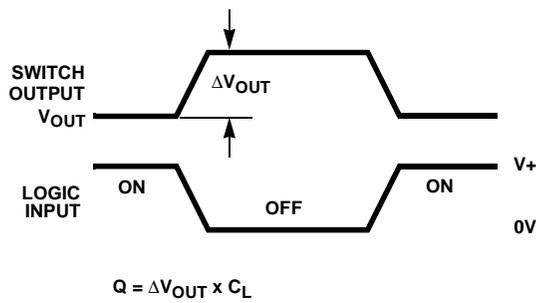


FIGURE 2A. MEASUREMENT POINTS

FIGURE 2. CHARGE INJECTION

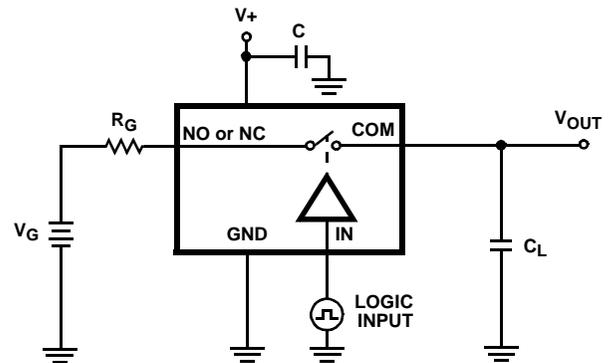


FIGURE 2B. TEST CIRCUIT

Test Circuits and Waveforms (Continued)

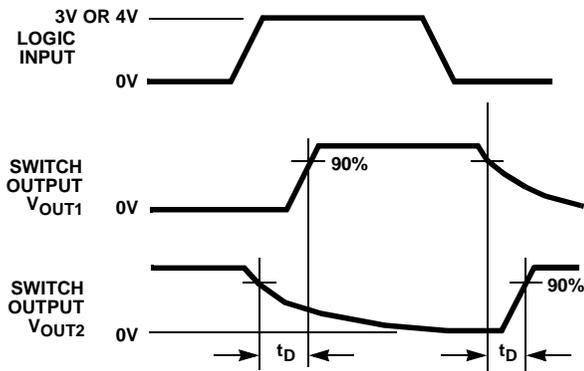
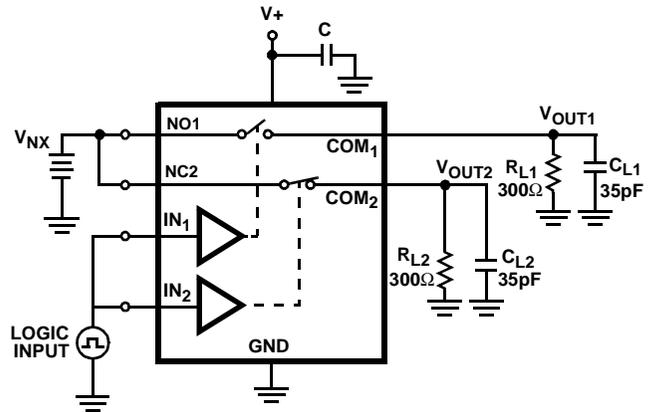


FIGURE 3A. MEASUREMENT POINTS (ISL5122 ONLY)



$C_L$  includes fixture and stray capacitance.

FIGURE 3B. TEST CIRCUIT (ISL5122 ONLY)

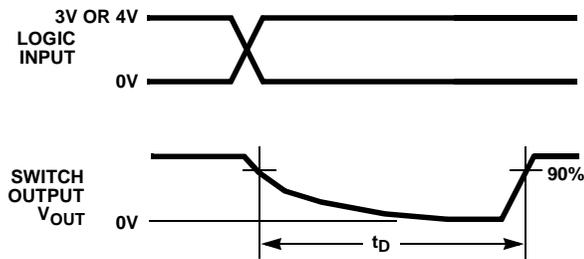
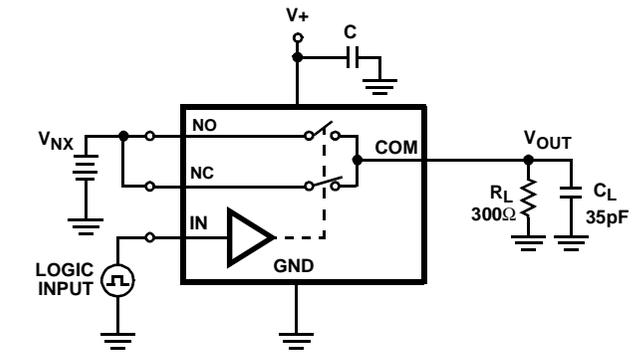


FIGURE 3C. MEASUREMENT POINTS (ISL5123 ONLY)



$C_L$  includes fixture and stray capacitance.

FIGURE 3D. TEST CIRCUIT (ISL5123 ONLY)

FIGURE 3. BREAK-BEFORE-MAKE TIME

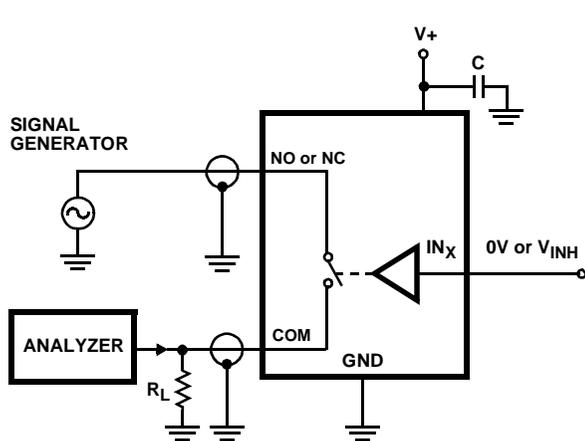


FIGURE 4. OFF ISOLATION TEST CIRCUIT

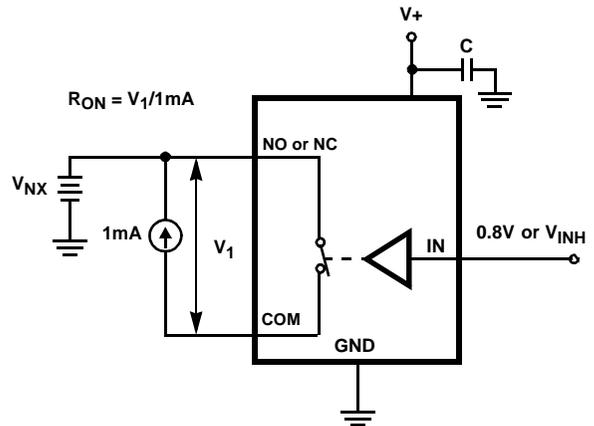


FIGURE 5.  $R_{ON}$  TEST CIRCUIT

Test Circuits and Waveforms (Continued)

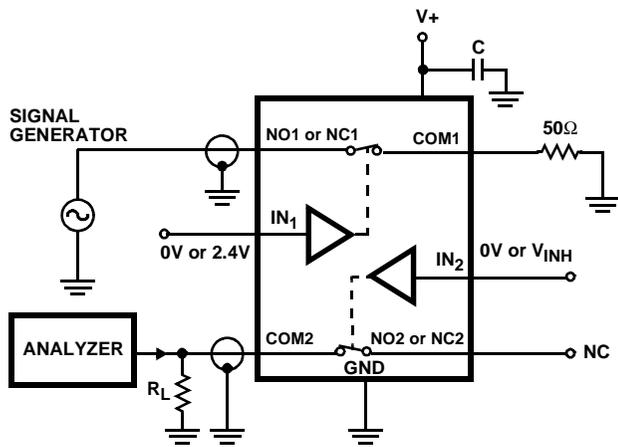


FIGURE 6. CROSSTALK TEST CIRCUIT

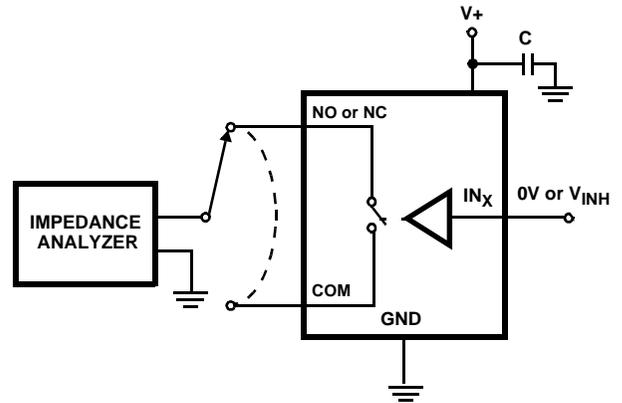


FIGURE 7. CAPACITANCE TEST CIRCUIT

## Detailed Description

The ISL5120–ISL5123 bidirectional, dual analog switches offer precise switching capability from a single 2.7V to 12V supply with low on-resistance ( $19\Omega$ ) and high speed operation ( $t_{ON} = 28\text{ns}$ ,  $t_{OFF} = 20\text{ns}$ ). The devices are especially well suited to portable battery powered equipment thanks to the low operating supply voltage (2.7V), low power consumption ( $5\mu\text{W}$ ), low leakage currents (100pA max), and the tiny SOT-23 packaging. High frequency applications also benefit from the wide bandwidth, and the very high off isolation and crosstalk rejection.

## 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 GND (see Figure 8). To prevent forward biasing these diodes, V+ must be applied before any input signals, and input signal voltages must remain between V+ and GND. If these conditions cannot be guaranteed, then one of the following two protection methods should be employed.

Logic inputs can easily 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.

Adding a series resistor to the switch input defeats the purpose of using a low  $R_{ON}$  switch, so two small signal diodes can be added in series with the supply pins to provide overvoltage protection for all pins (see Figure 8). These additional diodes limit the analog signal from 1V below V+ to 1V above GND. The low leakage current performance is unaffected by this approach, but the switch resistance may increase, especially at low supply voltages.

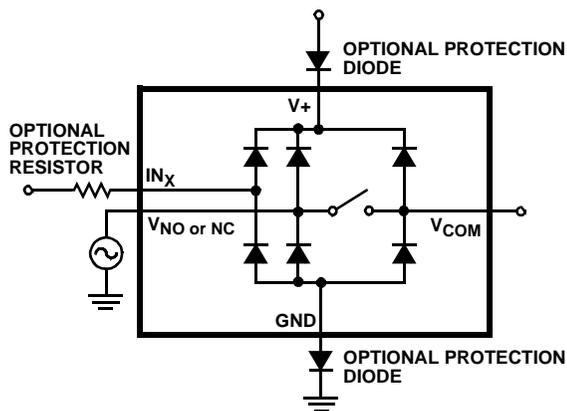


FIGURE 8. OVERVOLTAGE PROTECTION

## Power-Supply Considerations

The ISL512X construction is typical of most CMOS analog switches, except that they have only two supply pins: V+ and GND. V+ and GND drive the internal CMOS switches and set their analog voltage limits. Unlike switches with a 13V maximum supply voltage, the ISL512X 15V maximum supply voltage provides plenty of room for the 10% tolerance of 12V supplies, as well as room for overshoot and noise spikes.

The minimum recommended supply voltage is 2.7V. 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 TTL compatible (0.8V and 2.4V) over a supply range of 3V to 11V (see Figure 15). At 12V the  $V_{IH}$  level is about 2.5V. This is still below the TTL guaranteed high output minimum level of 2.8V, but noise margin is reduced. For best results with a 12V supply, use a logic family that provides a  $V_{OH}$  greater than 3V.

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 300MHz (see Figure 16). Figure 16 also illustrates that 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 17 details the high Off Isolation and Crosstalk rejection provided by this family. At 10MHz, Off Isolation is about 50dB 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

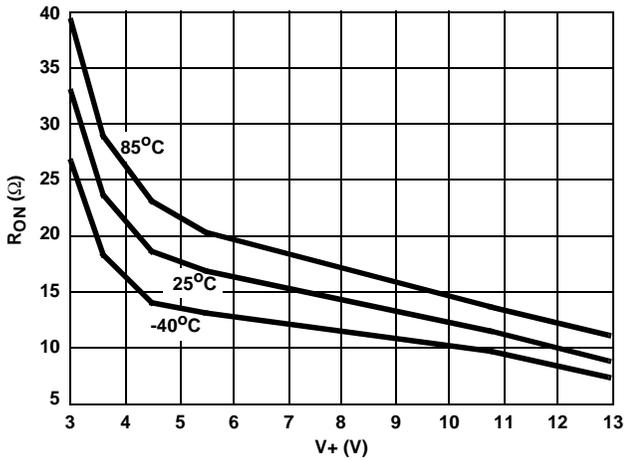


FIGURE 9. ON RESISTANCE vs SUPPLY VOLTAGE

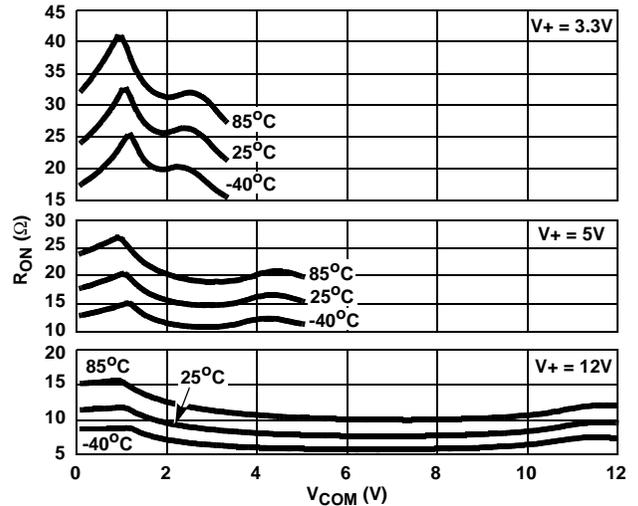


FIGURE 10. ON RESISTANCE vs SWITCH VOLTAGE

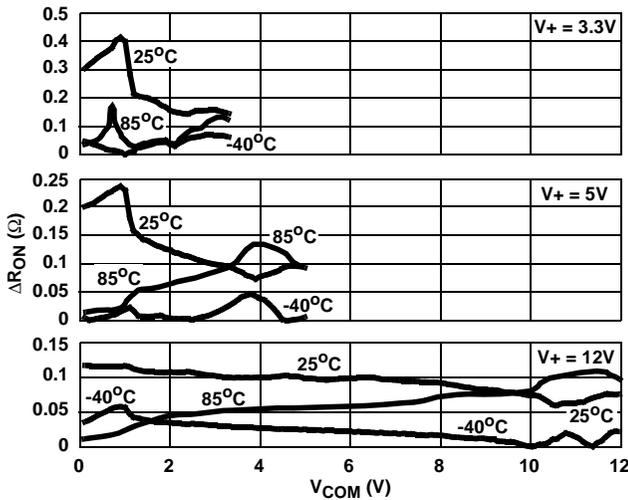


FIGURE 11.  $R_{ON}$  MATCH vs SWITCH VOLTAGE

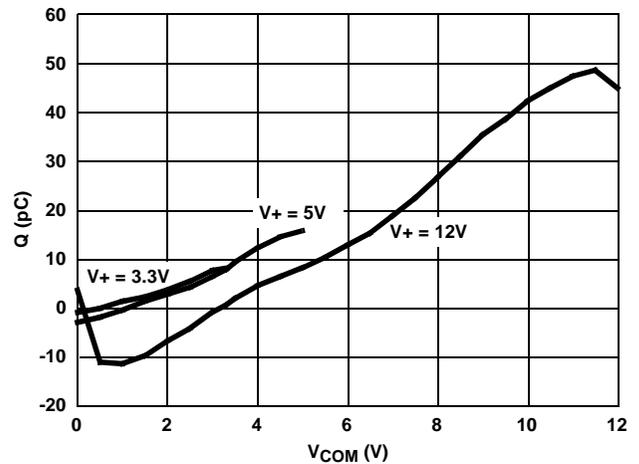


FIGURE 12. CHARGE INJECTION vs SWITCH VOLTAGE

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

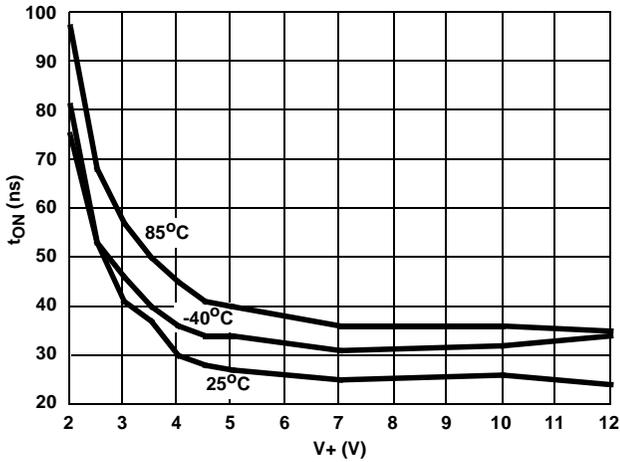


FIGURE 13. TURN - ON TIME vs SUPPLY VOLTAGE

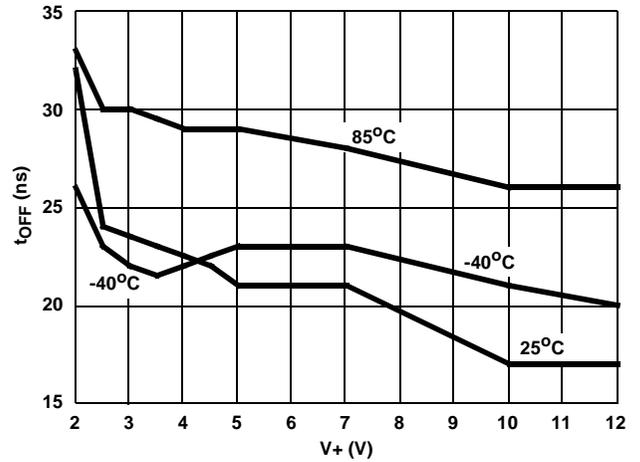


FIGURE 14. TURN - OFF TIME vs SUPPLY VOLTAGE

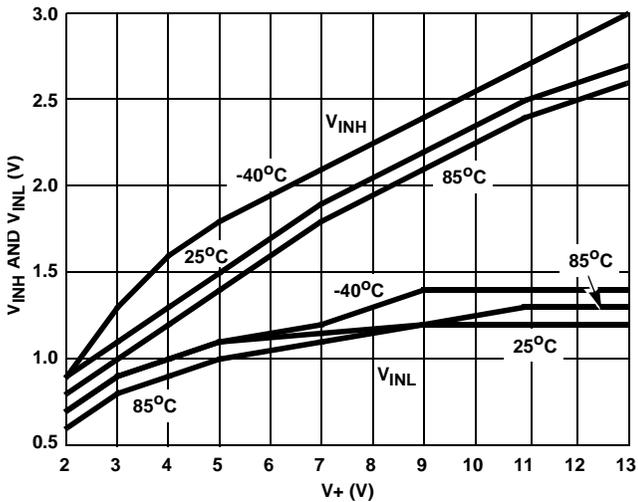


FIGURE 15. DIGITAL SWITCHING POINT vs SUPPLY VOLTAGE

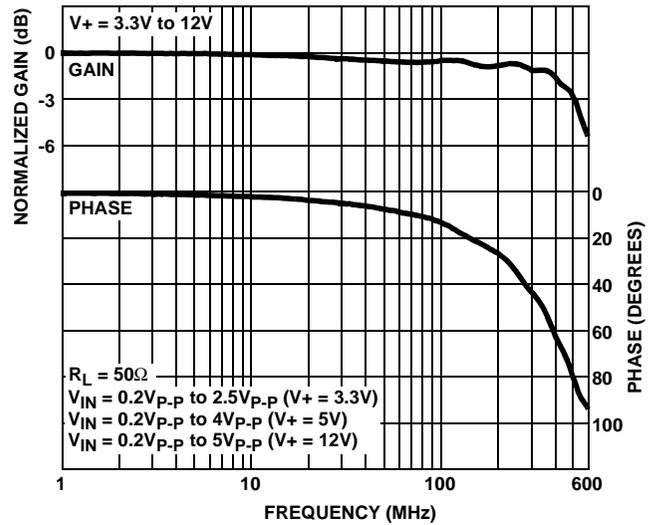


FIGURE 16. FREQUENCY RESPONSE

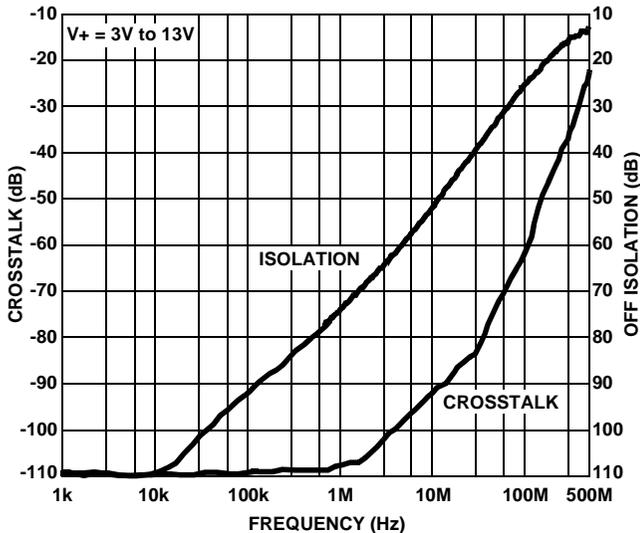


FIGURE 17. CROSSTALK AND OFF ISOLATION

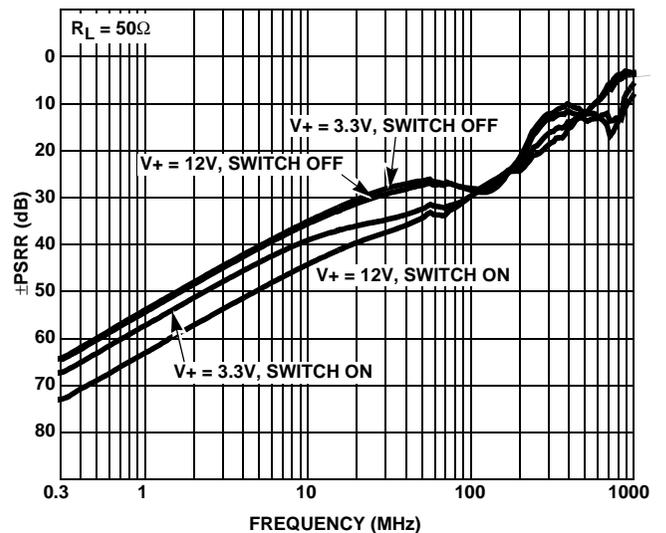


FIGURE 18.  $\pm$ PSRR vs FREQUENCY

***Die Characteristics***

**SUBSTRATE POTENTIAL (POWERED UP):**

GND

**TRANSISTOR COUNT:**

ISL5120: 66

ISL5121: 66

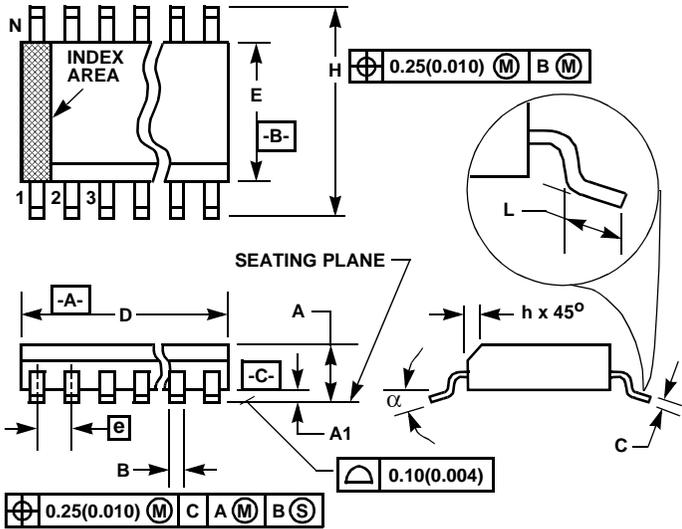
ISL5122: 66

ISL5123: 58

**PROCESS:**

Si Gate CMOS

**Small Outline Plastic Packages (SOIC)**



**M8.15 (JEDEC MS-012-AA ISSUE C)**  
**8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE**

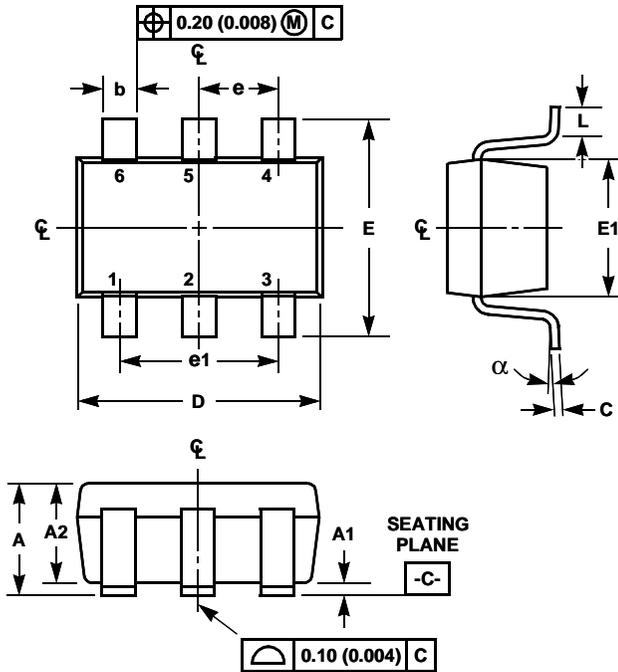
| SYMBOL | INCHES    |        | MILLIMETERS |      | NOTES |
|--------|-----------|--------|-------------|------|-------|
|        | MIN       | MAX    | MIN         | MAX  |       |
| A      | 0.0532    | 0.0688 | 1.35        | 1.75 | -     |
| A1     | 0.0040    | 0.0098 | 0.10        | 0.25 | -     |
| B      | 0.013     | 0.020  | 0.33        | 0.51 | 9     |
| C      | 0.0075    | 0.0098 | 0.19        | 0.25 | -     |
| D      | 0.1890    | 0.1968 | 4.80        | 5.00 | 3     |
| E      | 0.1497    | 0.1574 | 3.80        | 4.00 | 4     |
| e      | 0.050 BSC |        | 1.27 BSC    |      | -     |
| H      | 0.2284    | 0.2440 | 5.80        | 6.20 | -     |
| h      | 0.0099    | 0.0196 | 0.25        | 0.50 | 5     |
| L      | 0.016     | 0.050  | 0.40        | 1.27 | 6     |
| N      | 8         |        | 8           |      | 7     |
| α      | 0°        | 8°     | 0°          | 8°   | -     |

**NOTES:**

1. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension "E" does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. "L" is the length of terminal for soldering to a substrate.
7. "N" is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width "B", as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Rev. 0 12/93

Small Outline Transistor Plastic Packages (SOT23-6)



P6.064

6 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE

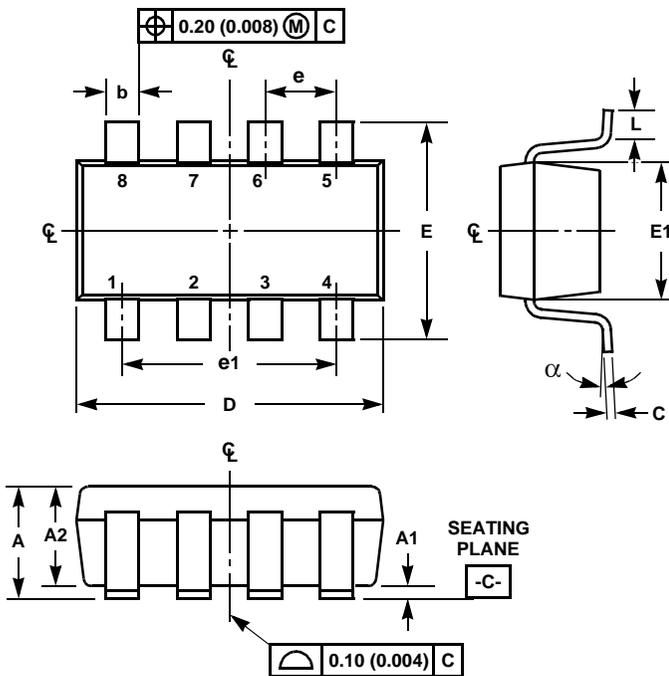
| SYMBOL   | INCHES     |        | MILLIMETERS |      | NOTES |
|----------|------------|--------|-------------|------|-------|
|          | MIN        | MAX    | MIN         | MAX  |       |
| A        | 0.036      | 0.057  | 0.90        | 1.45 | -     |
| A1       | 0.000      | 0.0059 | 0.00        | 0.15 | -     |
| A2       | 0.036      | 0.051  | 0.90        | 1.30 | -     |
| b        | 0.0138     | 0.0196 | 0.35        | 0.50 | -     |
| C        | 0.0036     | 0.0078 | 0.09        | 0.20 | -     |
| D        | 0.111      | 0.118  | 2.80        | 3.00 | 3     |
| E        | 0.103      | 0.118  | 2.60        | 3.00 | -     |
| E1       | 0.060      | 0.068  | 1.50        | 1.75 | 3     |
| e        | 0.0374 Ref |        | 0.95 Ref    |      | -     |
| e1       | 0.0748 Ref |        | 1.90 Ref    |      | -     |
| L        | 0.004      | 0.023  | 0.10        | 0.60 | 4, 5  |
| N        | 6          |        | 6           |      | 6     |
| $\alpha$ | 0°         | 10°    | 0°          | 10°  | -     |

Rev. 1 2/98

NOTES:

1. Dimensioning and tolerances per ANSI 14.5M-1982.
2. Package conforms to EIAJ SC-74 (1992).
3. Dimensions D and E1 are exclusive of mold flash, protrusions, or gate burrs.
4. Footlength L measured at reference to seating plane.
5. "L" is the length of flat foot surface for soldering to substrate.
6. "N" is the number of terminal positions.
7. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

Small Outline Transistor Plastic Packages (SOT23-8)



P8.064

8 LEAD SMALL OUTLINE TRANSISTOR PLASTIC PACKAGE

| SYMBOL   | INCHES     |        | MILLIMETERS |      | NOTES |
|----------|------------|--------|-------------|------|-------|
|          | MIN        | MAX    | MIN         | MAX  |       |
| A        | 0.036      | 0.057  | 0.90        | 1.45 | -     |
| A1       | 0.000      | 0.0059 | 0.00        | 0.15 | -     |
| A2       | 0.036      | 0.051  | 0.90        | 1.30 | -     |
| b        | 0.011      | 0.018  | 0.28        | 0.45 | -     |
| C        | 0.0036     | 0.0078 | 0.09        | 0.20 | -     |
| D        | 0.111      | 0.118  | 2.80        | 3.00 | 3     |
| E        | 0.103      | 0.118  | 2.60        | 3.00 | -     |
| E1       | 0.060      | 0.068  | 1.50        | 1.75 | 3     |
| e        | 0.0256 Ref |        | 0.65 Ref    |      | -     |
| e1       | 0.0768 Ref |        | 1.95 Ref    |      | -     |
| L        | 0.012      | 0.020  | 0.30        | 0.50 | 4, 5  |
| N        | 8          |        | 8           |      | 6     |
| $\alpha$ | 0°         | 10°    | 0°          | 10°  | -     |

Rev. 1 10/01

NOTES:

1. Dimensioning and tolerances per ANSI 14.5M-1982.
2. Package patterned after EIAJ SC-74 (1992).
3. Dimensions D and E1 are exclusive of mold flash, protrusions, or gate burrs.
4. Footlength L measured at reference to seating plane.
5. "L" is the length of flat foot surface for soldering to substrate.
6. "N" is the number of terminal positions.
7. Controlling dimension: MILLIMETER. Converted inch dimensions are for reference only.

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