ON Semiconductor®

# NC7SB3157, FSA3157
# Low-Voltage SPDT Analog Switch or 2:1Multiplexer / De-multiplexer Bus Switch

## Features

- Useful in Both Analog and Digital Applications
- Space-Saving, SC70 6-Lead Surface Mount Package
- Ultra-Small, MicroPak™ Leadless Package
- Low On Resistance: <10Ω on Typical at 3.3V $V_{CC}$
- Broad $V_{CC}$ Operating Range: 1.65V to 5.5V
- Rail-to-Rail Signal Handling
- Power-Down, High-Impedance Control Input
- Over-Voltage Tolerance of Control Input to 7.0V
- Break-Before-Make Enable Circuitry
- 250MHz, 3dB Bandwidth

## Description

The NC7SB3157 / FSA3157 is a high-performance, single-pole / double-throw (SPDT) analog switch or 2:1 multiplexer / de-multiplexer bus switch.

The device is fabricated with advanced sub-micron CMOS technology to achieve high-speed enable and disable times and low on resistance. The break-before-make select circuitry prevents disruption of signals on the B Port due to both switches temporarily being enabled during select pin switching. The device is specified to operate over the 1.65 to 5.5V $V_{CC}$ operating range. The control input tolerates voltages up to 5.5V, independent of the $V_{CC}$ operating range.

## Ordering Information

| Part Number | Top Mark | Eco Status | Package Description | Packing Method |
|---|---|---|---|---|
| NC7SB3157P6X | B7A | RoHS | 6-Lead, SC70, EIAJ SC88, 1.25mm Wide Package | 3000 Units on Tape and Reel |
| NC7SB3157L6X | BB | RoHS | 6-Lead, MicroPak 1.0mm Wide Package | 5000 Units on Tape and Reel |
| FSA3157P6X | B7A | RoHS | 6-Lead, SC70, EIAJ SC88, 1.25mm Wide Package | 3000 Units on Tape and Reel |
| FSA3157L6X | BB | RoHS | 6-Lead, MicroPak 1.0mm Wide Package | 5000 Units on Tape and Reel |


October-2017, Rev. 2

Publication Order Number:
NC7SB3157/D

## Logic Symbol

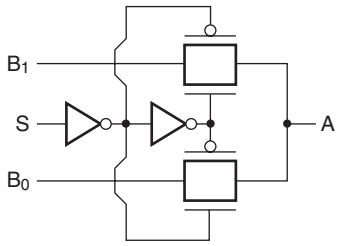



**Figure 1. Logic Symbol**

## Analog Symbol

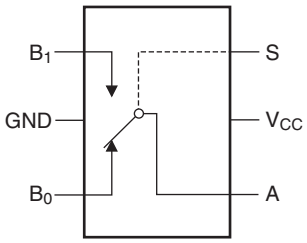



**Figure 3. Analog Symbol**

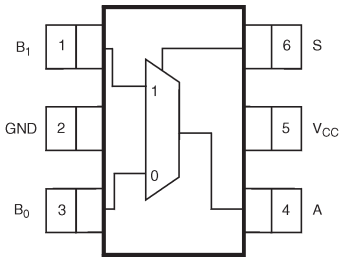
## Function Table

| Input (S) | Function |
|---|---|
| Logic Level Low | $B_0$ Connected to A |
| Logic Level High | $B_1$ Connected to A |

## Pin Descriptions

| Pin Names | Description |
|---|---|
| A, $B_0$, $B_1$ | Data Ports |
| S | Control Input |

## Connection Diagrams




**2. Pin Assignments SC70**

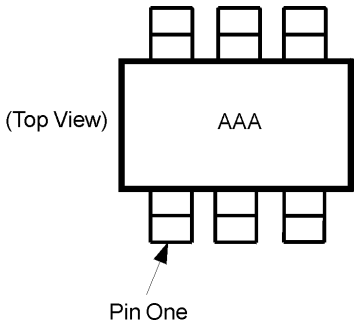



**Figure 4. Pin One Orientation**

*Note:*

Orientation of top mark determines pin one location. Read the top product code mark left to right and pin one is the lower left pin *(see Figure 4)*.

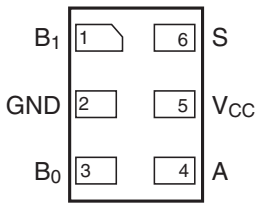



**Figure 5. Pad Assignments for MicroPak™**

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol | Parameter | Min. | Max. | Unit |
|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage | –0.5 | +7.0 | V |
| $V_S$ | DC Switch Voltage[1] | –0.5 | $V_{CC}$ +0.5 | V |
| $V_{IN}$ | DC Input Voltage[1] | –0.5 | +7.0 | V |
| $I_{IK}$ | DC Input Diode Current at $V_{IN}$ < 0V | | –50 | mA |
| $I_{OUT}$ | DC Output Current | | 128 | mA |
| $I_{CC}/I_{GND}$ | DC $V_{CC}$ or Ground Current | | ±100 | mA |
| $T_{STG}$ | Storage Temperature Range | –65 | +150 | °C |
| $T_J$ | Junction Temperature Under Bias | | +150 | °C |
| $T_L$ | Junction Lead Temperature (Soldering, 10 seconds) | | +260 | °C |
| MSL | Moisture Sensitivity Level (JEDEC J-STD-020A) | | 1 | Level |
| $P_D$ | Power Dissipation at +85°C | | 180 | mW |
| ESD | Human Body Model, JESD22-A114 | | 4000 | V |

**Note**:

1. The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. ON Semiconductor does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol | Parameter | | Min. | Max. | Unit |
|---|---|---|---|---|---|
| $V_{CC}$ | Supply Voltage Operating | | 1.65 | 5.50 | V |
| $V_{IN}$ | Control Input Voltage[2] | | 0 | $V_{CC}$ | V |
| $V_{IN}$ | Switch Input Voltage[2] | | 0 | $V_{CC}$ | V |
| $V_{OUT}$ | Output Voltage[2] | | 0 | $V_{CC}$ | V |
| $T_A$ | Operating Temperature | | –40 | +85 | °C |
| $t_r$, $t_f$ | Input Rise and Fall Time | Control Input $V_{CC}$ = 2.3V–3.6V | 0 | 10 | ns/V |
| | | Control Input $V_{CC}$ = 4.5V–5.5V | 0 | 5 | ns/V |
| $\theta_{JA}$ | Thermal Resistance, SC70 | | | 270 | °C/W |

**Note:**

2. Control input must be held HIGH or LOW; it must not float.

## DC Electrical Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A$ = +25°C | | | $T_A$ = –40°C to +85°C | | Units |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | |
| $V_{IH}$ | High Level Input Voltage | | 1.65 – 1.95 | 0.75 $V_{CC}$ | | | 0.75 $V_{CC}$ | | V |
| | | | 2.3 – 5.5 | 0.7 $V_{CC}$ | | | 0.7 $V_{CC}$ | | |
| $V_{IL}$ | Low Level Input Voltage | | 1.65 – 1.95 | | | 0.25 $V_{CC}$ | | 0.25 $V_{CC}$ | V |
| | | | 2.3 – 5.5 | | | 0.3 $V_{CC}$ | | 0.3 $V_{CC}$ | |
| $I_{IN}$ | Input Leakage Current | $0 \le V_{IN} \le 5.5V$ | 0 – 5.5 | | ±0.05 | ±0.1 | | ±1 | µA |
| $I_{OFF}$ | Off State Leakage Current | $0 \le A, B \le V_{CC}$ | 1.65 – 5.5 | | ±0.05 | ±0.1 | | ±1 | µA |
| $R_{ON}$ | Switch On Resistance(3) | $V_{IN}$ = 0V, $I_O$ = 30mA | 4.5 | | 3.0 | 7.0 | | 7.0 | Ω |
| | | $V_{IN}$ = 2.4V, $I_O$ = –30mA | | | 5.0 | 12.0 | | 12.0 | |
| | | $V_{IN}$ = 4.5V, $I_O$ = –30mA | | | 7.0 | 15.0 | | 15.0 | |
| | | $V_{IN}$ = 0V, $I_O$ = 24mA | 3.0 | | 4.0 | 9.0 | | 9.0 | |
| | | $V_{IN}$ = 3V, $I_O$ = –24mA | | | 10.0 | 20.0 | | 20.0 | |
| | | $V_{IN}$ = 0V, $I_O$ = 8mA | 2.3 | | 5.0 | 12.0 | | 12.0 | |
| | | $V_{IN}$ = 2.3V, $I_O$ = –8mA | | | 13.0 | 30.0 | | 30.0 | |
| | | $V_{IN}$ = 0V, $I_O$ = 4mA | 1.65 | | 6.5 | 20.0 | | 20.0 | |
| | | $V_{IN}$ = 1.65V, $I_O$ = –4mA | | | 17.0 | 50.0 | | 50.0 | |
| $I_{CC}$ | Quiescent Supply Current; All Channels On or Off | $V_{IN}$ = $V_{CC}$ or GND $I_{OUT}$ = 0 | 5.5 | | | 1 | | 10 | µA |
| | Analog Signal Range | | $V_{CC}$ | 0 | | $V_{CC}$ | 0 | $V_{CC}$ | V |
| $R_{RANGE}$ | On Resistance Over Signal Range (3, 7) | $I_A$ = –30mA, $0 \le V_{Bn} \le V_{CC}$ | 4.5 | | | | | 25.0 | Ω |
| | | $I_A$ = –24mA, $0 \le V_{Bn} \le V_{CC}$ | 3.0 | | | | | 50.0 | |
| | | $I_A$ = –8mA, $0 \le V_{Bn} \le V_{CC}$ | 2.3 | | | | | 100 | |
| | | $I_A$ = –4mA, $0 \le V_{Bn} \le V_{CC}$ | 1.65 | | | | | 300 | |
| $\Delta R_{ON}$ | On Resistance Match Between-Channels(3, 4, 5) | $I_A$ = –30mA, $V_{Bn}$ = 3.15 | 4.5 | | 0.15 | | | | Ω |
| | | $I_A$ = –24mA, $V_{Bn}$ 2.1 | 3.0 | | 0.2 | | | | |
| | | $I_A$ = –8mA, $V_{Bn}$ = 1.6 | 2.3 | | 0.5 | | | | |
| | | $I_A$ = –4mA, $V_{Bn}$ = 1.15 | 1.65 | | 0.50 | | | | |
| $R_{flat}$ | On Resistance Flatness(3, 4, 6) | $I_A$ = –30mA, $0 \le V_{Bn} \le V_{CC}$ | 5.0 | | 6.0 | | | | Ω |
| | | $I_A$ = –24mA, $0 \le V_{Bn} \le V_{CC}$ | 3.3 | | 12.0 | | | | |
| | | $I_A$ = –8mA, $0 \le V_{Bn} \le V_{CC}$ | 2.5 | | 28.0 | | | | |
| | | $I_A$ = –4mA, $0 \le V_{Bn} \le V_{CC}$ | 1.8 | | 125 | | | | |

**Notes:**

3. Measured by the voltage drop between A and B pins at the indicated current through the switch. On resistance is determined by the lower of the voltages on the two (A or B Ports).
4. Parameter is characterized, but not tested in production.
5. $\Delta R_{ON}$ = $R_{ON}$ max – $R_{ON}$ minimum measured at identical $V_{CC}$, temperature, and voltage levels.
6. Flatness is defined as the difference between the maximum and minimum value of on resistance over the specified range of conditions.
7. Guaranteed by design.

## AC Electrical Characteristics

| Symbol | Parameter | Conditions | $V_{CC}$ (V) | $T_A$ = +25°C | | | $T_A$ = –40°C to +85°C | | Units | Figure Number |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Typ. | Max. | Min. | Max. | | |
| $t_{PHL}$, $t_{PLH}$ | Propagation Delay Bus-to-Bus[8] | $V_I$ = OPEN | 1.65 – 1.95 | | | 3.5 | | 3.5 | ns | Figure 12 Figure 13 |
| | | | 2.3 – 2.7 | | | 1.2 | | 1.2 | | |
| | | | 3.0 – 3.6 | | | 0.8 | | 0.8 | | |
| | | | 4.5 – 5.5 | | | 0.3 | | 0.3 | | |
| $t_{PZL}$, $t_{PZH}$ | Output Enable Time Turn-On Time (A to $B_n$) | $V_I$ = 2 x $V_{CC}$ for $t_{PZL}$ $V_I$ = 0V for $t_{PZH}$ | 1.65 – 1.95 | 7.0 | | 23.0 | 7.0 | 24.0 | ns | Figure 12 Figure 13 |
| | | | 2.3 – 2.7 | 3.5 | | 13.0 | 3.5 | 14.0 | | |
| | | | 3.0 – 3.6 | 2.5 | | 6.9 | 2.5 | 7.6 | | |
| | | | 4.5 – 5.5 | 1.7 | | 5.2 | 1.7 | 5.7 | | |
| $t_{PLZ}$, $t_{PHZ}$ | Output Disable Time Turn-Off Time (A Port to B Port) | $V_I$ = 2 x $V_{CC}$ for $t_{PLZ}$ $V_I$ = 0V for $t_{PHZ}$ | 1.65 – 1.95 | 3.0 | | 12.5 | 3.0 | 13.0 | ns | Figure 12 Figure 13 |
| | | | 2.3 – 2.7 | 2.0 | | 7.0 | 2.0 | 7.5 | | |
| | | | 3.0 – 3.6 | 1.5 | | 5.0 | 1.5 | 5.3 | | |
| | | | 4.5 – 5.5 | 0.8 | | 3.5 | 0.8 | 3.8 | | |
| $t_{B-M}$ | Break-Before-Make Time[9] | | 1.65 –1.95 | 0.5 | | | 0.5 | | ns | Figure 14 |
| | | | 2.3 – 2.7 | 0.5 | | | 0.5 | | | |
| | | | 3.0 – 3.6 | 0.5 | | | 0.5 | | | |
| | | | 4.5 – 5.5 | 0.5 | | | 0.5 | | | |
| Q | Charge Injection[9] | $C_L$ = 0.1nF, $V_{GEN}$ = 0V, | 5.0 | | 7.0 | | | | pC | Figure 15 |
| | | $R_{GEN}$ = 0Ω | 3.3 | | 3.0 | | | | | |
| OIRR | Off Isolation[10] | $R_L$ = 50Ω, f = 10MHz | 1.65 – 5.5 | | –57.0 | | | | dB | Figure 16 |
| Xtalk | Crosstalk | $R_L$ = 50Ω, f = 10MHz | 1.65 – 5.5 | | –54.0 | | | | dB | Figure 17 |
| BW | –3dB Bandwidth | $R_L$ = 50Ω | 1.65 – 5.5 | | 250 | | | | MHz | Figure 20 |
| THD | Total Harmonic Distortion[9] | $R_L$ = 600Ω, 0.5 $V_{PP}$, f = 600 Hz to 20 KHz | 5.0 | | .011 | | | | % | |

**Notes:**

8. This parameter is guaranteed by design but not tested. The bus switch contributes no propagation delay other than the RC delay of the on resistance of the switch and the 50pF load capacitance, when driven by an ideal voltage source (zero output impedance).
9. Guaranteed by design.
10. Off Isolation = 20 $\log_{10}$ [$V_A$ / $V_{Bn}$].

## Capacitance

$T_A$ = +25°C, f = 1MHz. Capacitance is characterized, but not tested in production.

| Symbol | Parameter | Conditions | Typ. | Max. | Units | Figure Number |
|---|---|---|---|---|---|---|
| $C_{IN}$ | Control Pin Input Capacitance | $V_{CC}$ = 0V | 2.3 | | pF | |
| $C_{IO-B}$ | B Port Off Capacitance | $V_{CC}$ = 5.0V | 6.5 | | pF | Figure 18 |
| $C_{IOA-ON}$ | A Port Capacitance When Switch Is Enabled | $V_{CC}$ = 5.0V | 18.5 | | pF | Figure 19 |

## Typical Characteristics

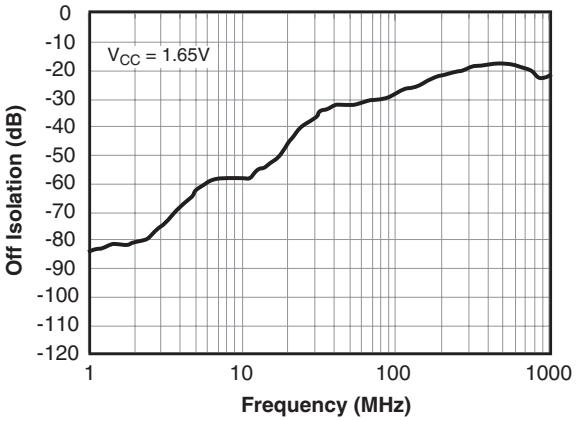



**Figure 6. Off Isolation, $V_{CC}$ = 1.65V**

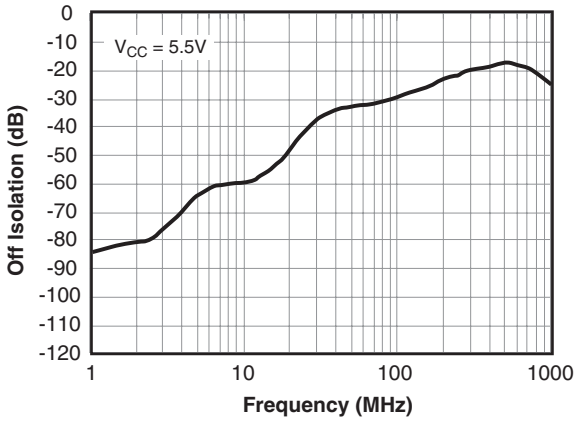



**Figure 7. Off Isolation, $V_{CC}$ = 5.5V**

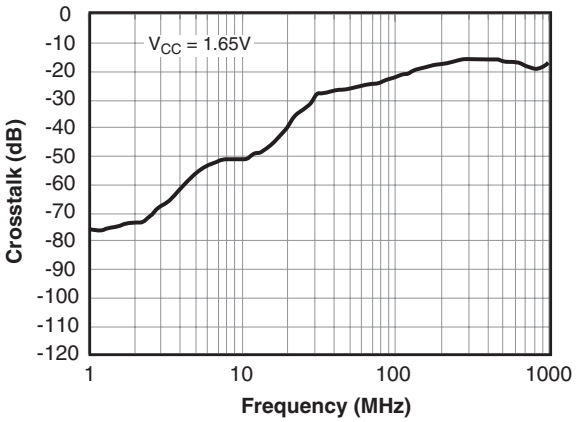



**Figure 8. Crosstalk, $V_{CC}$ = 1.65V**

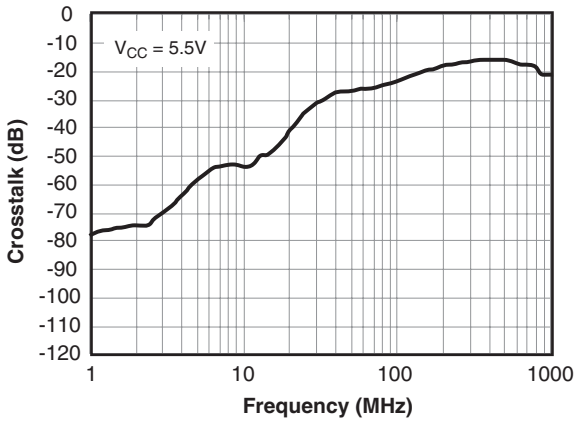



**Figure 9. Crosstalk, $V_{CC}$ = 5.5V**

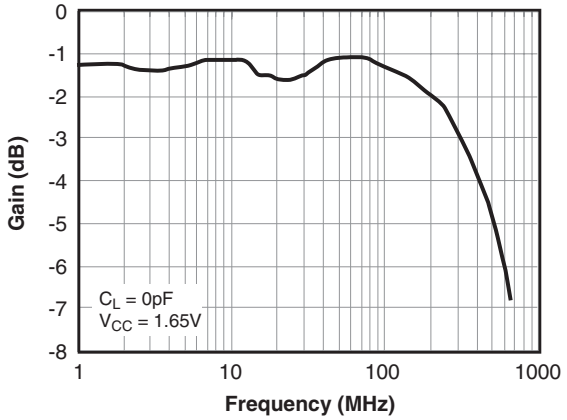



**Figure 10. Bandwidth, $V_{CC}$ = 1.65V**

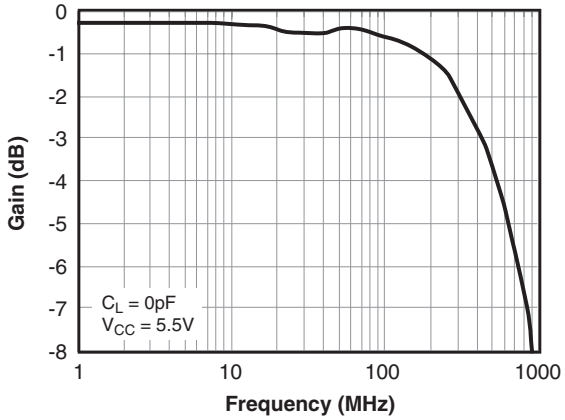
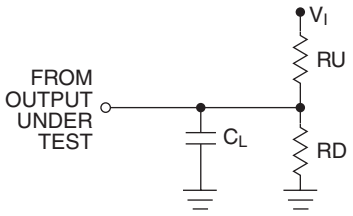



**Figure 11. Bandwidth, $V_{CC}$ = 5.5V**

## AC Loading and Waveforms




**Notes:**
Input driven by 50Ω source terminated in 50Ω
$C_L$ includes load and stray capacitance
Input PRR = 1.0 MHz; $t_W$ = 500 ns

**Figure 12. AC Test Circuit**

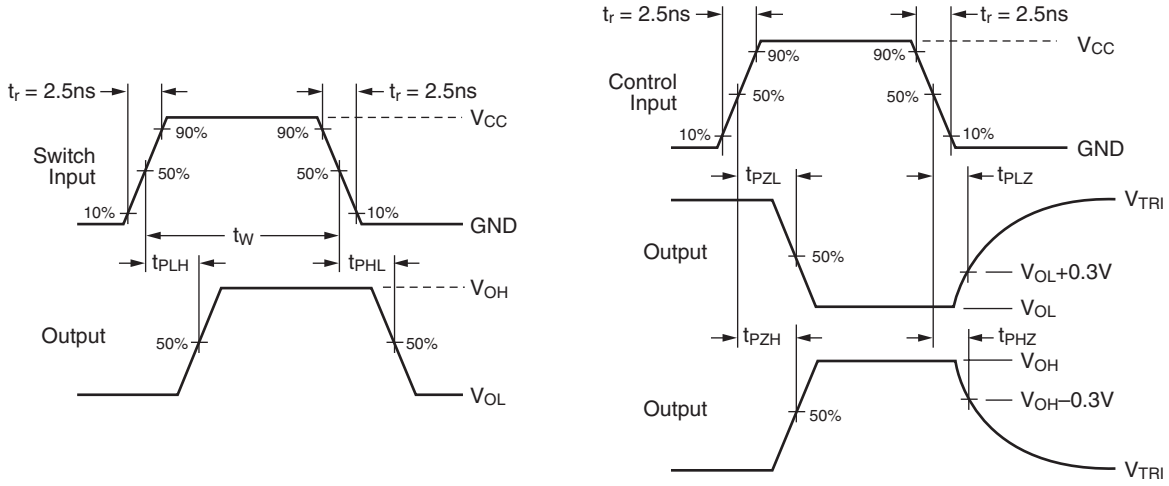



**Figure 13. AC Waveforms**

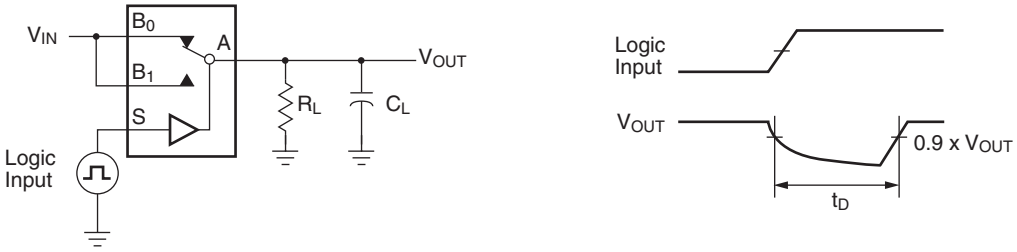



**Figure 14. Break-Before-Make Interval Timing**

## AC Loading and Waveforms (continued)

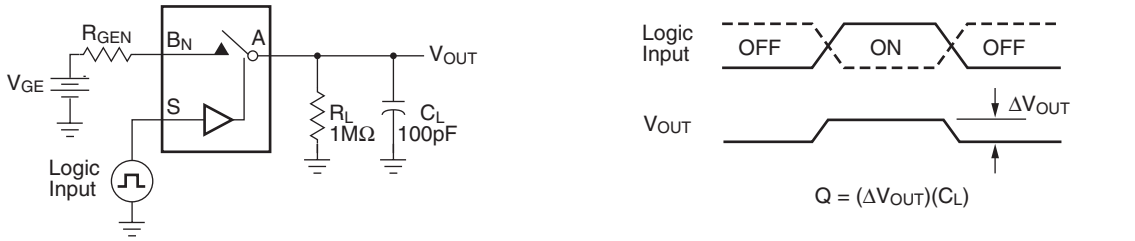



**Figure 15. Charge Injection Test**

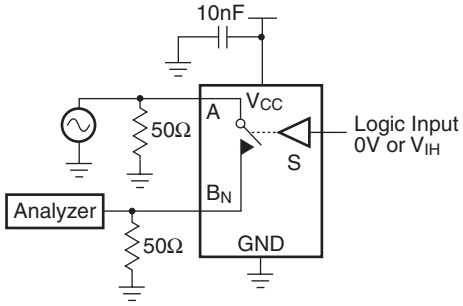



**Figure 16. Off Isolation**

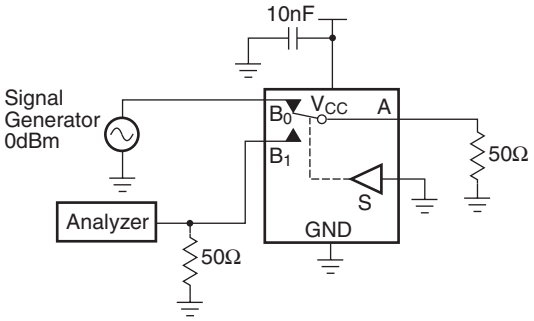



**Figure 17. Crosstalk**

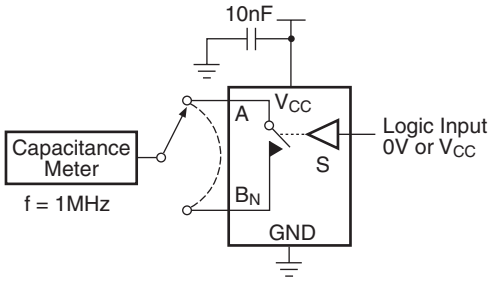



**Figure 18. Channel Off Capacitance**

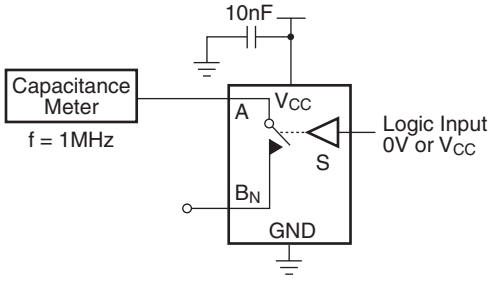



**Figure 19. Channel On Capacitance**

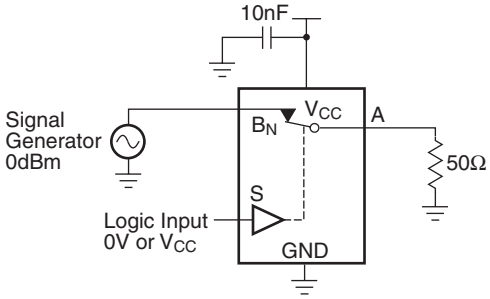



**Figure 20. Bandwidth**

## Physical Dimensions

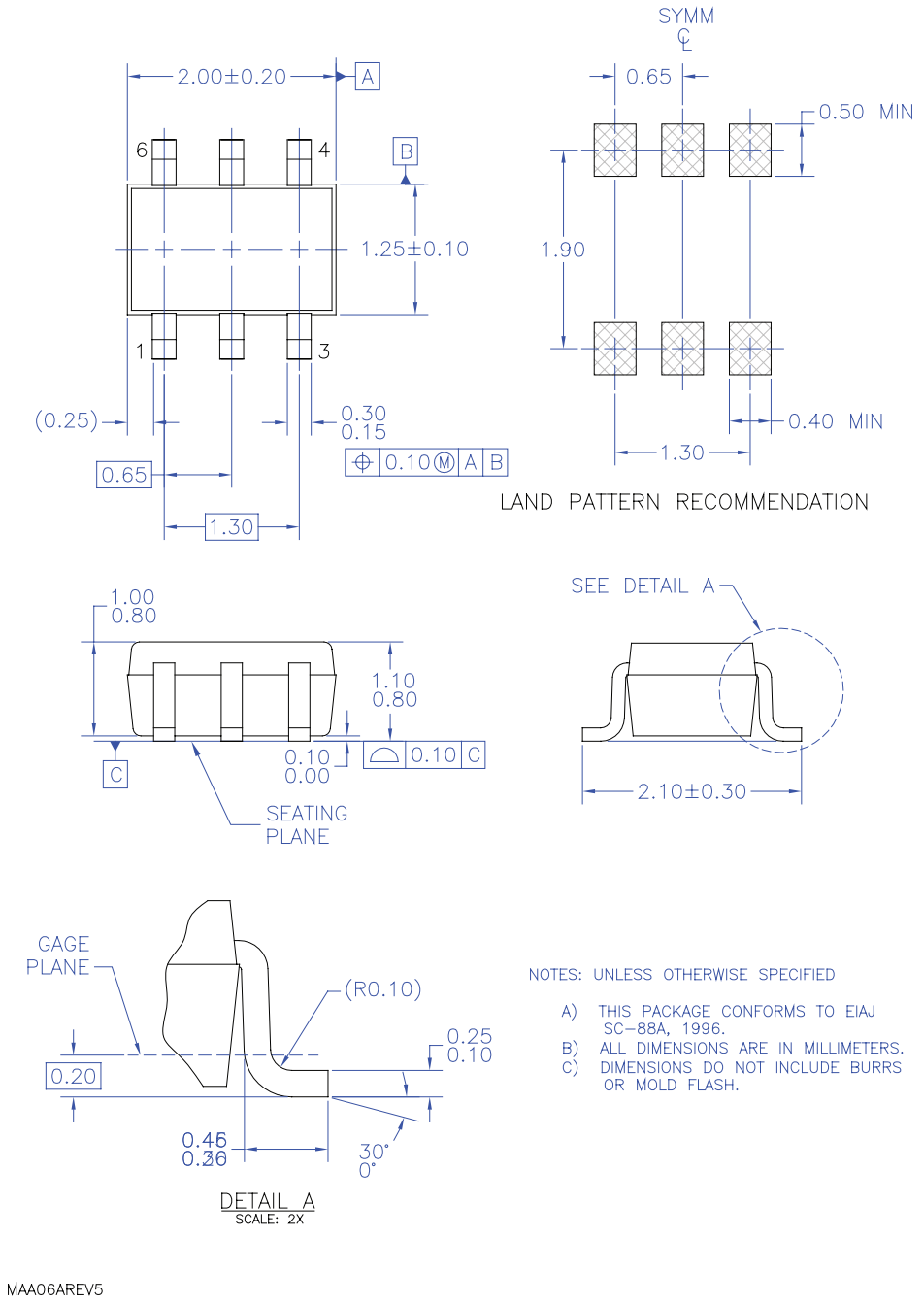
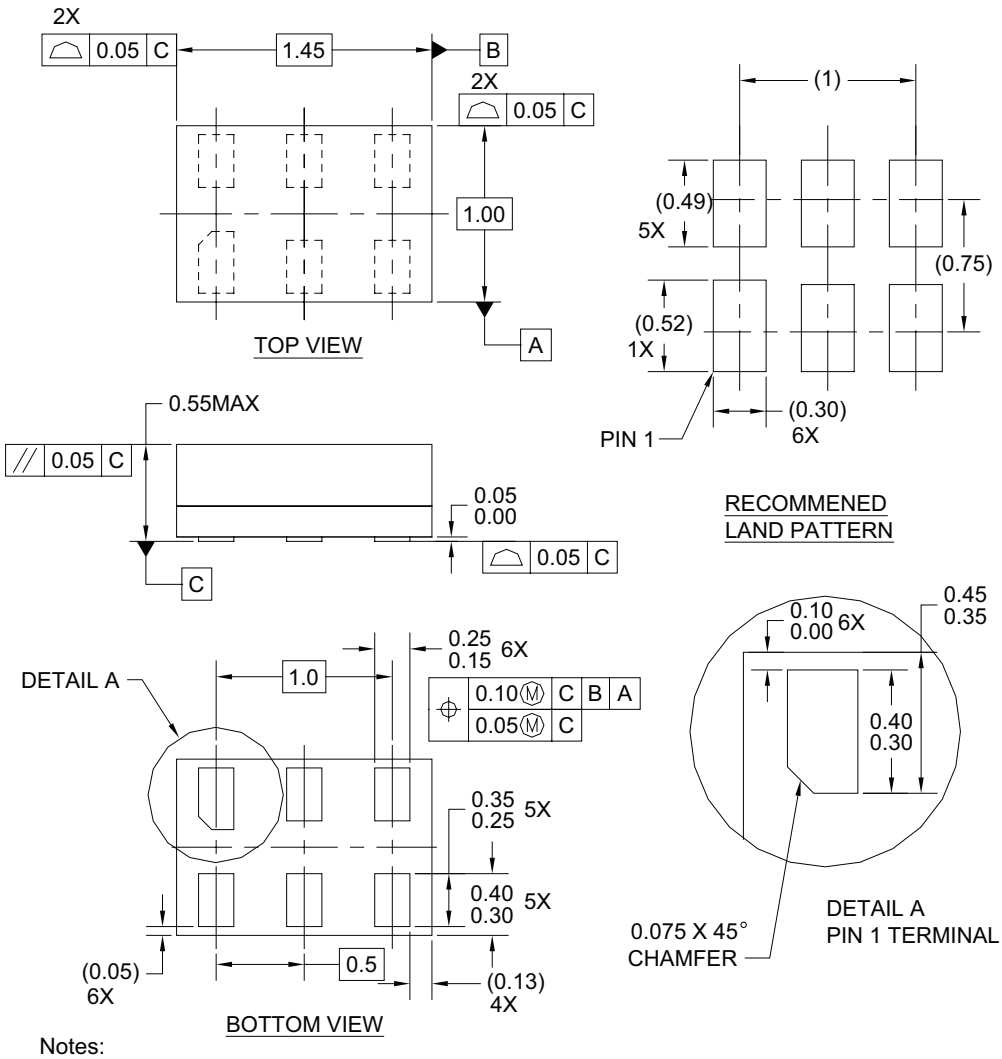



**Figure 21. 6-Lead, SC70, EIAJ SC88, 1.25mm Wide Package**

*Package drawings are provided as a service to customers considering ON Semiconductor components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a ON Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of ON Semiconductor's worldwide terms and conditions, specifically the warranty therein, which covers ON Semiconductor products.*

## Physical Dimensions




Notes:

1. CONFORMS TO JEDEC STANDARD M0-252 VARIATION UAAD
2. DIMENSIONS ARE IN MILLIMETERS
3. DRAWING CONFORMS TO ASME Y14.5M-1994

MAC06AREVC

**6-Lead, MicroPak™ 1.0mm Wide Package**

*Package drawings are provided as a service to customers considering ON Semiconductor components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a ON Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of ON Semiconductor's worldwide terms and conditions, specifically the warranty therein, which covers ON Semiconductor products.*

## PUBLICATION ORDERING INFORMATION

**LITERATURE FULFILLMENT**:
Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
**Phone**: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
**Fax**: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
**Email**: orderlit@onsemi.com

**N. American Technical Support**: 800−282−9855 Toll Free USA/Canada
**Europe, Middle East and Africa Technical Support:**
Phone: 421 33 790 2910
**Japan Customer Focus Center**
Phone: 81−3−5817−1050

**ON Semiconductor Website**: **www.onsemi.com**

**Order Literature**: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative