

June 2009

# NC7SBU3157, FSAU3157 Low-Voltage SPDT Analog Switch or 2:1 Multiplexer / De-multiplexer Bus Switch

## **Features**

- Analog and digital applications
- Space-saving, SC70 6-lead, surface-mount package
- Low on resistance: <10Ω on typical at 3.3V V<sub>CC</sub>
- Broad V<sub>CC</sub> 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
- 250 MHz, 3dB bandwidth

## **General Description**

The NC7SBU3157 / FSAU3157 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  $\rm V_{CC}$  operating range. The control input tolerates voltages up to 5.5V, independent of the  $\rm V_{CC}$  operating range.

Fairchild's integrated Undershoot Hardened Circuit (UHC®) senses undershoot at the I/Os, and responds by preventing voltage differentials from developing and turning the switch on.

# **Ordering Information**

| Part Number   | Top<br>Mark | Operating<br>Temperature Range | Eco<br>Status                        | Package Description                             | Packing<br>Method           |
|---------------|-------------|--------------------------------|--------------------------------------|---|-----------------------------|
| NC7SBU3157P6X | U7A         | -40 to +85°C                   | RoHS                                 | 6-Lead, SC70, EIAJ SC88,<br>1.25mm Wide Package | 3000 Units<br>Tape and Reel |
| FSAU3157P6X   | U7A         | -40 to +85°C                   | +85°C RoHS 6-Lead, SC7<br>1.25mm Wid |   | 3000 Units<br>Tape and Reel |



For Fairchild's definition of Eco Status, please visit: http://www.fairchildsemi.com/company/green/rohs\_green.html.

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# **Logic Symbol**

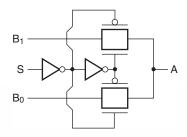


Figure 1. Logic Symbol

# **Analog Symbol**

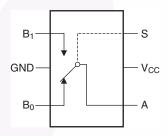
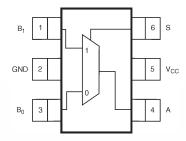


Figure 3. Analog Symbol

## **Function Table**

| Input (S)        | Function                      |
|------------------|-------------------------------|
| Logic Level Low  | B <sub>0</sub> Connected to A |
| Logic Level High | B <sub>1</sub> Connected to A |

# **Connection Diagrams**



2. Pin Assignments SC70

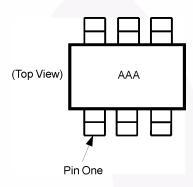


Figure 4. Pin One Orientation

### Note:

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

# **Pin Descriptions**

| Pin Names                          | Description   |
|------------------------------------|---------------|
| A, B <sub>0</sub> , B <sub>1</sub> | Data Ports    |
| S                                  | Control Input |

## **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.                 | Units |
|-----------------------------------|---|------|----------------------|-------|
| V <sub>CC</sub>                   | Supply Voltage                                    | -0.5 | +7.0                 | V     |
| V <sub>S</sub>                    | DC Switch Voltage <sup>(1)</sup>                  | -0.5 | V <sub>CC</sub> +0.5 | V     |
| V <sub>IN</sub>                   | DC Input Voltage <sup>(1)</sup>                   | -0.5 | +7.0                 | V     |
| I <sub>IK</sub>                   | DC Input Diode Current at V <sub>IN</sub> < 0V    |      | -50                  | mA    |
| I <sub>OUT</sub>                  | DC Output Current                                 |      | 128                  | mA    |
| I <sub>CC</sub> /I <sub>GND</sub> | DC V <sub>CC</sub> or Ground Current              |      | ±100                 | mA    |
| T <sub>STG</sub>                  | Storage Temperature Range                         | -65  | +150                 | °C    |
| T <sub>J</sub>                    | Junction Temperature Under Bias                   |      | +150                 | °C    |
| TL                                | Junction Lead Temperature (Soldering, 10 seconds) |      | +260                 | °C    |
| P <sub>D</sub>                    | Power Dissipation at +85°C                        |      | 180                  | mW    |

#### Note

 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. Fairchild does not recommend exceeding them or designing to absolute maximum ratings.

| Symbol                          | Parameter                            |  | Min. | Max             | Units |
|---------------------------------|--------------------------------------|--|------|-----------------|-------|
| V <sub>CC</sub>                 | Supply Voltage Operating             |  | 1.65 | 5.50            | V     |
| V <sub>IN</sub>                 | Control Input Voltage <sup>(2)</sup> |  | 0    | V <sub>CC</sub> | V     |
| V <sub>IN</sub>                 | Switch Input Voltage <sup>(2)</sup>  |  | 0    | V <sub>CC</sub> | V     |
| V <sub>OUT</sub>                | Output Voltage <sup>(2)</sup>        |  | 0    | V <sub>CC</sub> | V     |
| T <sub>A</sub>                  | Operating Temperature                |  | -40  | +85             | °C    |
| + +.                            | Input Rise and Fall Time             | Control Input V <sub>CC</sub> =2.3V-3.6V | 0    | 10              | ns/V  |
| t <sub>r</sub> , t <sub>f</sub> | input rase and rail rime             | Control Input V <sub>CC</sub> =4.5V-5.5V | 0    | 5               | ns/V  |
| $\theta_{JA}$                   | Thermal Resistance                   |  |      | 350             | °C/W  |

## Note:

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

## **DC Electrical Characteristics**

| Symbol Parameter   |   | Conditions  | V <sub>CC</sub> (V) | TA                   | = +25 | °C                   | • •                  | 40°C to<br>5°C       | Units |
|--------------------|---|---|---------------------|----------------------|-------|----------------------|----------------------|----------------------|-------|
|                    |   |   | Min. Typ.           |                      | Max.  | Min.                 | Max.                 |                      |       |
| V                  | High Level  |   | 1.65 to 1.95        | 0.75 V <sub>CC</sub> |       |                      | 0.75 V <sub>CC</sub> |                      | V     |
| $V_{IH}$           | Input Voltage   |   | 2.3 to 5.5          | 0.7 V <sub>CC</sub>  |       |                      | 0.7 V <sub>CC</sub>  |                      | \ \   |
| \/                 | Low Level   |   | 1.65 to 1.95        |                      |       | 0.25 V <sub>CC</sub> |                      | 0.25 V <sub>CC</sub> | V     |
| $V_{IL}$           | Input Voltage   |   | 2.3 to 5.5          |                      |       | 0.3 V <sub>CC</sub>  |                      | 0.3 V <sub>CC</sub>  | \ \ \ |
| I <sub>IN</sub>    | Input Leakage<br>Current                                  | $0 \le V_{IN} \le 5.5V$                                     | 0 to 5.5            |                      | ±0.05 | ±0.1                 |                      | ±1                   | μA    |
| I <sub>OFF</sub>   | Off State Leakage<br>Current                              | $0 \le A, B \le V_{CC}$                                     | 1.65 to 5.5         |                      | ±0.05 | ±0.1                 |                      | ±1                   | μA    |
|                    |   | V <sub>IN</sub> =0V, I <sub>O</sub> =30mA                   | 4.5                 |                      | 3.0   | 15.0                 |                      | 15.0                 |       |
|                    |   | V <sub>IN</sub> =2.4V, I <sub>O</sub> =-30mA                |                     |                      | 5.0   | 15.0                 |                      | 15.0                 |       |
|                    |   | V <sub>IN</sub> =4.5V, I <sub>O</sub> =–30mA                |                     |                      | 7.0   | 15.0                 |                      | 15.0                 |       |
|                    | 0 11 0  | V <sub>IN</sub> =0V, I <sub>O</sub> =24mA                   | 3.0                 |                      | 4.0   | 20.0                 |                      | 20.0                 |       |
| $R_{ON}$           | Switch On<br>Resistance <sup>(3)</sup>                    | V <sub>IN</sub> =3V, I <sub>O</sub> =-24mA                  |                     |                      | 10.0  | 20.0                 |                      | 20.0                 | Ω     |
|                    | . rooiotaires   | V <sub>IN</sub> =0V, I <sub>O</sub> =8mA                    | 2.3                 |                      | 5.0   | 30.0                 |                      | 30.0                 |       |
|                    |   | V <sub>IN</sub> =2.3V, I <sub>O</sub> =-8mA                 |                     |                      | 13.0  | 30.0                 |                      | 30.0                 |       |
|                    |   | V <sub>IN</sub> =0V, I <sub>O</sub> =4mA                    | 1.65                |                      | 6.5   | 50.0                 |                      | 50.0                 |       |
|                    |   | V <sub>IN</sub> =1.65V, I <sub>O</sub> =-4mA                |                     |                      | 17.0  | 50.0                 |                      | 50.0                 |       |
| I <sub>cc</sub>    | Quiescent Supply<br>Current;<br>All Channels On or<br>Off | V <sub>IN</sub> =V <sub>CC</sub> or GND I <sub>OUT</sub> =0 | 5.5                 |                      |       | 1                    |                      | 10                   | μA    |
|                    | Analog Signal<br>Range                                    |   | V <sub>CC</sub>     | 0                    |       | V <sub>CC</sub>      | 0                    | V <sub>CC</sub>      | ٧     |
|                    |   | $I_A$ =-30mA, $0 \le V_{Bn} \le V_{CC}$                     | 4.5                 |                      |       |                      |                      | 25.0                 |       |
| Б                  | On Resistance   | $I_A$ =-24mA, $0 \le V_{Bn} \le V_{CC}$                     | 3.0                 |                      |       |                      |                      | 50.0                 | 1     |
| R <sub>RANGE</sub> | Over Signal Range (3, 7)                                  | $I_A$ =-8mA, $0 \le V_{Bn} \le V_{CC}$                      | 2.3                 |                      |       |                      |                      | 100                  | Ω     |
|                    |   | $I_A$ =-4mA, $0 \le V_{Bn} \le V_{CC}$                      | 1.65                |                      |       |                      |                      | 300                  |       |
|                    |   | I <sub>A</sub> =-30mA, V <sub>Bn</sub> =3.15                | 4.5                 |                      | 0.15  |                      |                      |                      |       |
| . 5                | On Resistance   | I <sub>A</sub> =–24mA, V <sub>Bn</sub> 2.1                  | 3.0                 |                      | 0.2   |                      |                      |                      |       |
| $\Delta R_{ON}$    | Match Between-<br>Channels <sup>(3, 4, 5)</sup>           | I <sub>A</sub> =-8mA, V <sub>Bn</sub> =1.6                  | 2.3                 |                      | 0.5   |                      |                      |                      | Ω     |
|                    |   | I <sub>A</sub> =-4mA, V <sub>Bn</sub> =1.15                 | 1.65                |                      | 0.5   |                      |                      |                      |       |
| V <sub>IKU</sub>   | Voltage Under-<br>shoot                                   | $0.0\text{mA} \le I_{1N} \le -50, \overline{OE} 5.5v$       | 5.5                 |                      |       |                      |                      | -2                   | V     |
|                    |   | $I_A$ =-30mA, $0 \le V_{Bn} \le V_{CC}$                     | 5.0                 |                      | 6.0   |                      |                      |                      |       |
| В                  | On Resistance   | $I_A$ =-24mA, $0 \le V_{Bn} \le V_{CC}$                     | 3.3                 |                      | 12.0  |                      |                      |                      |       |
| R <sub>flat</sub>  | Flatness <sup>(3, 4, 6)</sup>                             | $I_A=-8mA$ , $0 \le V_{Bn} \le V_{CC}$                      | 2.5                 |                      | 28.0  |                      |                      |                      | Ω     |
|                    |   | $I_A=-4mA$ , $0 \le V_{Bn} \le V_{CC}$                      | 1.8                 |                      | 125   |                      |                      |                      | 1     |

#### 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.  $\Delta R_{ON} = R_{ON} \text{ max} R_{ON} \text{ minimum measured at identical } V_{CC}$ , 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 <sub>CC</sub> | T <sub>A</sub> = +25°C Min. Typ. Max. |       | T <sub>A</sub> = -4 | 10°C to<br>5°C | Units | Figure   |           |
|--------------------|---|--|-----------------|---------------------------------------|-------|---------------------|----------------|-------|----------|-----------|
|                    |   |  | (V)             |                                       |       | Min.                | Max.           |       |          |           |
|                    |   |  | 1.65 to 1.95    |                                       |       |                     |                |       |          |           |
| t <sub>PHL</sub> , | Propagation Delay V <sub>I</sub> = OPEN     | 2.3 to 2.7   |                 |                                       | 1.2   |                     | 1.2            | ns    | Figure 7 |           |
| t <sub>PLH</sub>   | Bus-to-Bus <sup>(8)</sup>                   | VI = OPEN  | 3.0 to 3.6      |                                       |       | 0.8                 |                | 0.8   | 115      | Figure 8  |
|                    |   |  | 4.5 to 5.5      |                                       |       | 0.3                 |                | 0.3   |          |           |
|                    |   |  | 1.65 to 1.95    | 7.0                                   |       | 23.0                | 7.0            | 24.0  |          |           |
| $t_{PZL}$ ,        | Output Enable Time<br>Turn-On Time          | $V_I = 2 \times V_{CC}$ for $t_{PZL}$                  | 2.3 to 2.7      | 3.5                                   |       | 13.0                | 3.5            | 14.0  | ns       | Figure 7  |
| $t_{PZH}$          | (A to B <sub>n</sub> )                      | $V_I = 0V$ for $t_{PZH}$                               | 3.0 to 3.6      | 2.5                                   |       | 6.9                 | 2.5            | 7.6   | 1115     | Figure 8  |
|                    |   |  | 4.5 to 5.5      | 1.7                                   |       | 5.2                 | 1.7            | 5.7   | Ī        |           |
|                    |   |  | 1.65 to 1.95    | 3.0                                   |       | 12.5                | 3.0            | 13.0  |          |           |
| t <sub>PLZ</sub> , | Output Disable Time Turn-Off Time           | $V_I = 2 \times V_{CC}$ for $t_{PLZ}$                  | 2.3 to 2.7      | 2.0                                   |       | 7.0                 | 2.0            | 7.5   | ns       | Figure 7  |
| $t_{PHZ}$          | (A Port to B Port)                          | $V_I = 0V$ for $t_{PHZ}$                               | 3.0 to 3.6      | 1.5                                   |       | 5.0                 | 1.5            | 5.3   | 115      | Figure 8  |
|                    |   |  | 4.5 to 5.5      | 0.8                                   |       | 3.5                 | 0.8            | 3.8   |          |           |
|                    |   |  | 1.65 to 1.95    | 0.5                                   |       |                     | 0.5            |       |          |           |
| <b>4</b>           | Break-Before-Make                           |  | 2.3 to 2.7      | 0.5                                   |       |                     | 0.5            |       | ns       | Figure 9  |
| t <sub>BBM</sub>   | Time <sup>(9)</sup>                         |  | 3.0 to 3.6      | 0.5                                   |       |                     | 0.5            |       | 115      | Figure 9  |
|                    |   |  | 4.5 to 5.5      | 0.5                                   |       |                     | 0.5            |       | Ī        |           |
| Q                  | Charge Injection <sup>(9)</sup>             | $C_L = 0.1 nF, V_{GEN} = 0 V,$                         | 5.0             |                                       | 7.0   |                     |                |       | рС       | Figure 10 |
| Q                  | Charge injection.                           | $R_{GEN} = 0\Omega$                                    | 3.3             |                                       | 3.0   |                     |                |       | рС       | rigule 10 |
| OIRR               | Off Isolation <sup>(10)</sup>               | $R_L = 50\Omega$ , $f = 10MHz$                         | 1.65 to 5.5     |                                       | -57.0 |                     |                |       | dB       | Figure 11 |
| Xtalk              | Crosstalk                                   | $R_L = 50\Omega$ , $f = 10MHz$                         | 1.65 to 5.5     |                                       | -54.0 |                     | _              |       | dB       | Figure 12 |
| BW                 | -3dB Bandwidth                              | $R_L = 50\Omega$                                       | 1.65 to 5.5     |                                       | 250   |                     |                |       | MHz      | Figure 15 |
| THD                | Total Harmonic<br>Distortion <sup>(9)</sup> | $R_L = 600\Omega$ , 0.5 $V_{PP}$ , $f = 20Hz$ to 20KHz | 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             | Тур. | Max. | Units | Figure    |
|---------------------|---|------------------------|------|------|-------|-----------|
| C <sub>IN</sub>     | Control Pin Input Capacitance             | V <sub>CC</sub> = 0V   | 2.3  |      | pF    |           |
| C <sub>IO-B</sub>   | B Port Off Capacitance                    | V <sub>CC</sub> = 5.0V | 6.5  |      | pF    | Figure 13 |
| C <sub>IOA-ON</sub> | A Port Capacitance When Switch Is Enabled | V <sub>CC</sub> = 5.0V | 18.5 |      | pF    | Figure 14 |

## **Undershoot Characteristic**

| Symbol            | Parameter                        | Min. | Тур.                  | Units | Figure   |
|-------------------|----------------------------------|------|-----------------------|-------|----------|
| V <sub>OUTU</sub> | Output Voltage During Undershoot | 2.5  | V <sub>OH</sub> - 0.3 | V     | Figure 5 |

### Note:

11. This test is intended to characterize the device's protective capabilities by maintaining output signal integrity during an input transient voltage undershoot event.

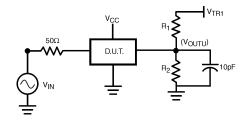


Figure 5. Output Voltage During Undershoot

## **Device Test Conditions**

| Parameter       | Value        | Units |
|-----------------|--------------|-------|
| V <sub>IN</sub> | see Figure 6 | V     |
| $R_1 = R_2$     | 100          | ΚΩ    |
| $V_{TRI}$       | 7.0          | V     |
| V <sub>CC</sub> | 5.5          | V     |

# Transient Input Voltage (V<sub>IN</sub>) Waveform

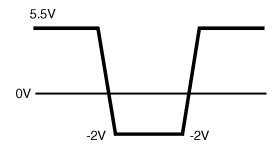
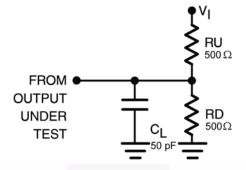


Figure 6. Transient Input Voltage Waveform

# **AC Loading and Waveforms**



#### Notes:

Input driven by  $50\Omega$  source terminated in  $50\Omega.$   $C_L$  includes load and stray capacitance. Input PRR=1.0MHz; tw = 500ns.

Figure 7. AC Test Circuit

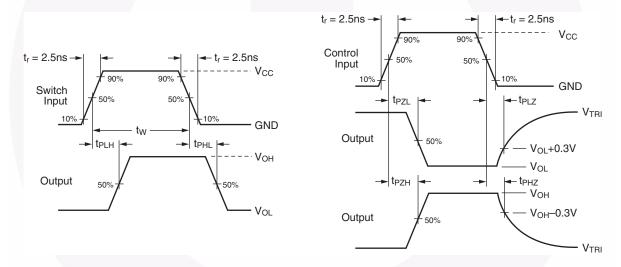


Figure 8. AC Waveforms

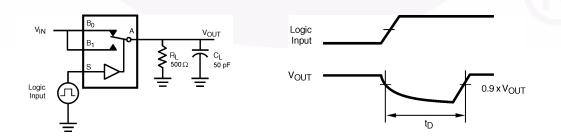


Figure 9. Break-Before-Make Interval Timing

# AC Loading and Waveforms (continued)



Figure 10. Charge Injection Test

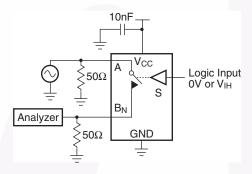
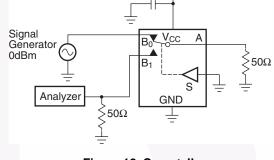


Figure 11. Off Isolation



10nF

Figure 12. Crosstalk

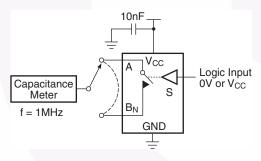


Figure 13. Channel Off Capacitance

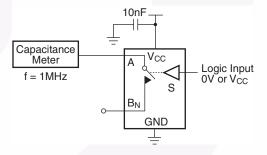


Figure 14. Channel On Capacitance

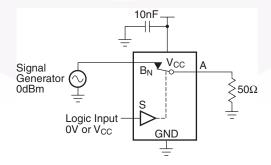
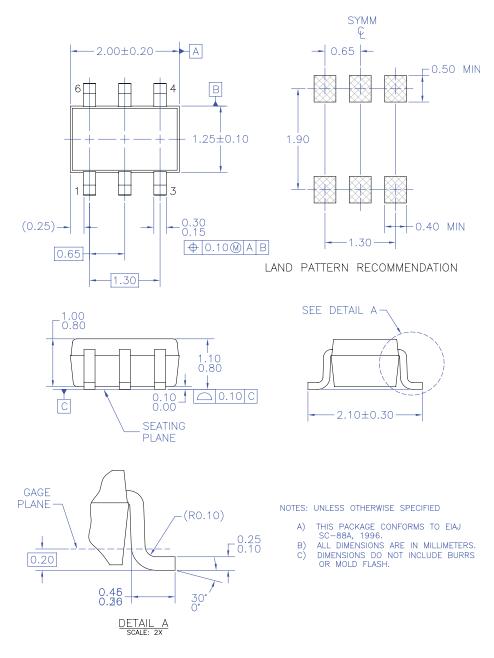


Figure 15. Bandwidth

# **Physical Dimensions**



MAA06ARFV5

Figure 16. 6-Lead, SC70, EIAJ SC88, 1.25mm Wide Package

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#### LIFE SUPPORT POLICY

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- 1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
- 2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

#### ANTI-COUNTERFEITING POLICY

Fairchild Semiconductor Corporation's Anti-Counterfeiting Policy. Fairchild's Anti-Counterfeiting Policy is also stated on our external website, www.fairchildsemi.com, under Sales Support.

Counterfeiting of semiconductor parts is a growing problem in the industry. All manufacturers of semiconductor products are experiencing counterfeiting of their parts. Customers who inadvertently purchase counterfeit parts experience many problems such as loss of brand reputation, substandard performance, failed applications, and increased cost of production and manufacturing delays. Fairchild is taking strong measures to protect ourselves and our customers from the proliferation of counterfeit parts. Fairchild strongly encourages customers to purchase Fairchild parts either directly from Fairchild or from Authorized Fairchild Distributors who are listed by country on our web page cited above. Products customers buy either from Fairchild directly or from Authorized Fairchild Distributors are genuine parts, have full traceability, meet Fairchild's quality standards for handling and storage and provide access to Fairchild's full range of up-to-date technical and product information. Fairchild and our Authorized Distributors will stand behind all warranties and will appropriately address any warranty issues that may arise. Fairchild will not provide any warranty coverage or other assistance for parts bought from Unauthorized Sources. Fairchild is committed to combat this global problem and encourage our customers to do their part in stopping this practice by buying direct or from authorized distributors

#### PRODUCT STATUS DEFINITIONS

### Definition of Terms

| Datasheet Identification   | Product Status        | Definition  |  |  |  |
|----------------------------|-----------------------|---|--|--|--|
| Advance Information        | Formative / In Design | Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.   |  |  |  |
| Preliminary                | First Production      | Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design. |  |  |  |
| No Identification Needed   | Full Production       | Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.   |  |  |  |
| Obsolete Not In Production |                       | Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.  |  |  |  |

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