

# FSTUD16211

## 24-Bit Bus Switch with -2V Undershoot Protection and Level Shifting

### General Description

The Fairchild Switch FSTUD16211 provides 24-bits of high-speed CMOS TTL-compatible bus switching. The low on resistance of the switch allows inputs to be connected to outputs without adding propagation delay or generating additional ground bounce noise. A diode to  $V_{CC}$  has been integrated into the circuit to allow for level shifting between 5V inputs and 3.3V outputs.

The device is organized as a 12-bit or 24-bit bus switch. When  $\overline{OE}_1$  is LOW, the switch is ON and Port 1A is connected to Port 1B. When  $\overline{OE}_2$  is LOW, Port 2A is connected to Port 2B. When  $\overline{OE}_{1/2}$  is HIGH, a high impedance state exists between the A and B Ports. The A and B Ports have "undershoot hardened" circuit protection to support an extended range to 2.0V below ground. Fairchild's integrated Undershoot Hardened Circuit (UHC®) senses undershoot at the I/O's, and responds by preventing voltage differentials from developing and turning on the switch.

### Features

- Undershoot hardened to -2V (A and B Ports)
- Voltage level shifting
- 4Ω switch connection between two ports
- Minimal propagation delay through the switch
- Low  $I_{CC}$
- Zero bounce in flow-through mode
- Control inputs compatible with TTL level
- See Applications Note AN-5008 for details
- Also packaged in plastic Fine-Pitch Ball Grid Array (FBGA) (Preliminary)

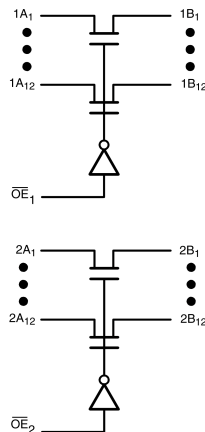
### Ordering Code:

Order Number	Package Number	Package Description
FSTUD16211GX (Note 1)	BGA54A (Preliminary)	54-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide [TAPE and REEL]
FSTUD16211MTD	MTD56	56-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 6.1mm Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

**Note 1:** BGA package available in Tape and Reel only.

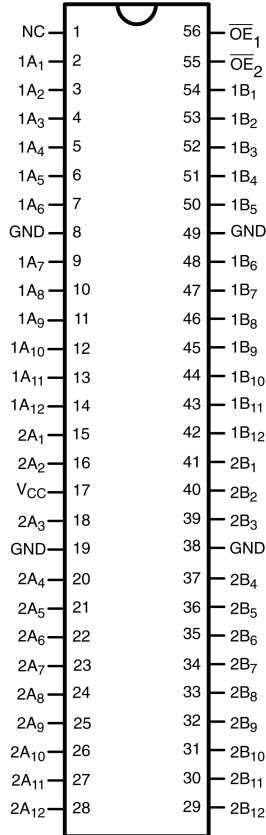
### Logic Diagram



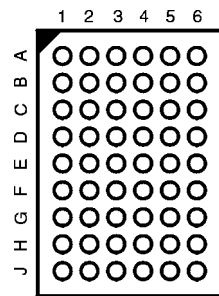
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### Connection Diagrams

Pin Assignment for TSSOP



Pin Assignment for FBGA



(Top Thru View)

### Pin Descriptions

Pin Name	Description
$\overline{OE}_1, \overline{OE}_2$	Bus Switch Enables
1A, 2A	Bus A
1B, 2B	Bus B
NC	No Connect

### Pin Assignment for FBGA

	1	2	3	4	5	6
<b>A</b>	1A <sub>2</sub>	1A <sub>1</sub>	NC	OE <sub>2</sub>	1B <sub>1</sub>	1B <sub>2</sub>
<b>B</b>	1A <sub>4</sub>	1A <sub>3</sub>	1A <sub>7</sub>	OE <sub>1</sub>	1B <sub>3</sub>	1B <sub>4</sub>
<b>C</b>	1A <sub>6</sub>	1A <sub>5</sub>	GND	1B <sub>7</sub>	1B <sub>5</sub>	1B <sub>6</sub>
<b>D</b>	1A <sub>10</sub>	1A <sub>9</sub>	1A <sub>8</sub>	1B <sub>8</sub>	1B <sub>9</sub>	1B <sub>10</sub>
<b>E</b>	1A <sub>12</sub>	1A <sub>11</sub>	2A <sub>1</sub>	2B <sub>1</sub>	1B <sub>11</sub>	1B <sub>12</sub>
<b>F</b>	2A <sub>4</sub>	2A <sub>3</sub>	2A <sub>2</sub>	2B <sub>2</sub>	2B <sub>3</sub>	2B <sub>4</sub>
<b>G</b>	2A <sub>6</sub>	2A <sub>5</sub>	V <sub>CC</sub>	GND	2B <sub>5</sub>	2B <sub>6</sub>
<b>H</b>	2A <sub>8</sub>	2A <sub>7</sub>	2A <sub>9</sub>	2B <sub>9</sub>	2B <sub>7</sub>	2B <sub>8</sub>
<b>J</b>	2A <sub>12</sub>	2A <sub>11</sub>	2A <sub>10</sub>	2B <sub>10</sub>	2B <sub>11</sub>	2B <sub>12</sub>

### Truth Table

Inputs		Inputs/Outputs	
$\overline{OE}_1$	$\overline{OE}_2$	1A, 1B	2A, 2B
L	L	1A = 1B	2A = 2B
L	H	1A = 1B	Z
H	L	Z	2A = 2B
H	H	Z	Z

Absolute Maximum Ratings (Note 2)		Recommended Operating Conditions (Note 5)	
Supply Voltage ( $V_{CC}$ )	-0.5V to +7.0V	Power Supply Operating ( $V_{CC}$ )	4.5V to 5.5V
DC Switch Voltage ( $V_S$ ) (Note 3)	-2.0V to +7.0V	Input Voltage ( $V_{IN}$ )	0V to 5.5V
DC Input Control Pin Voltage ( $V_{IN}$ ) (Note 4)	-0.5V to +7.0V	Output Voltage ( $V_{OUT}$ )	0V to 5.5V
DC Input Diode Current ( $I_{IK}$ ) $V_{IN} < 0V$	-50 mA	Input Rise and Fall Time ( $t_r, t_f$ )	
DC Output ( $I_{OUT}$ )	128 mA	Switch Control Input	0 ns/V to 5 ns/V
DC $V_{CC}/GND$ Current ( $I_{CC}/I_{GND}$ )	+/- 100 mA	Switch I/O	0 ns/V to DC
Storage Temperature Range ( $T_{STG}$ )	-65°C to +150 °C	Free Air Operating Temperature ( $T_A$ )	-40 °C to +85 °C

**Note 2:** The "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. The device should not be operated at these limits. The parametric values defined in the Electrical Characteristics tables are not guaranteed at the absolute maximum rating. The "Recommended Operating Conditions" table will define the conditions for actual device operation.

**Note 3:**  $V_S$  is the voltage observed/applied at either A or B Ports across the switch.

**Note 4:** The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

**Note 5:** Unused control inputs must be held HIGH or LOW. They may not float.

### DC Electrical Characteristics

Symbol	Parameter	$V_{CC}$ (V)	$T_A = -40\text{ }^\circ\text{C to }+85\text{ }^\circ\text{C}$			Units	Conditions
			Min	Typ (Note 6)	Max		
$V_{IK}$	Clamp Diode Voltage	4.5			-1.2	V	$I_{IN} = -18\text{ mA}$
$V_{IH}$	HIGH Level Input Voltage	4.5-5.5	2.0			V	
$V_{IL}$	LOW Level Input Voltage	4.5-5.5			0.8	V	
$V_{OH}$	HIGH Level	4.5-5.5	See Figure 4			V	
$I_I$	Input Leakage Current	5.5			$\pm 1.0$	$\mu\text{A}$	$0 \leq V_{IN} \leq 5.5V$
		0			10	$\mu\text{A}$	$V_{IN} = 5.5V$
$I_{OZ}$	OFF-STATE Leakage Current	5.5			$\pm 1.0$	$\mu\text{A}$	$0 \leq A, B \leq V_{CC}$
$R_{ON}$	Switch On Resistance (Note 7)	4.5		4	7	$\Omega$	$V_{IN} = 0V, I_{IN} = 64\text{ mA}$
		4.5		4	7	$\Omega$	$V_{IN} = 0V, I_{IN} = 30\text{ mA}$
		4.5		35	50	$\Omega$	$V_{IN} = 2.4V, I_{IN} = 15\text{ mA}$
$I_{CC}$	Quiescent Supply Current	5.5			1.5	mA	$OE_1 = OE_2 = GND$ $V_{IN} = V_{CC}$ or $GND, I_{OUT} = 0$
					10	$\mu\text{A}$	$OE_1 = OE_2 = V_{CC}$ $V_{IN} = V_{CC}$ or $GND, I_{OUT} = 0$
$\Delta I_{CC}$	Increase in $I_{CC}$ per Input	5.5			2.5	mA	One Input at 3.4V Other Inputs at $V_{CC}$ or $GND$
$V_{IKU}$	Voltage Undershoot	5.5			-2.0	V	$0.0\text{ mA} \geq I_{IN} \geq -50\text{ mA}$ $\overline{OE}_{1,2} = 5.5V$

**Note 6:** Typical values are at  $V_{CC} = 5.0V$  and  $T_A = +25^\circ\text{C}$

**Note 7:** 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) pins.

## AC Electrical Characteristics

Symbol	Parameter	$T_A = -40\text{ }^\circ\text{C to } +85\text{ }^\circ\text{C}$ , $C_L = 50\text{pF}$ , $R_U = R_D = 500\Omega$		Units	Conditions	Figure No.
		$V_{CC} = 4.5 - 5.5\text{V}$				
		Min	Max			
$t_{PHL}$ , $t_{PLH}$	Propagation Delay Bus to Bus (Note 8)		0.25	ns	$V_I = \text{OPEN}$	Figures 2, 3
$t_{PZH}$ , $t_{PZL}$	Output Enable Time	1.5	5.5	ns	$V_I = 7\text{V}$ for $t_{PZL}$ $V_I = \text{OPEN}$ for $t_{PZH}$	Figures 2, 3
$t_{PHZ}$ , $t_{PLZ}$	Output Disable Time	1.5	6.5	ns	$V_I = 7\text{V}$ for $t_{PLZ}$ $V_I = \text{OPEN}$ for $t_{PHZ}$	Figures 2, 3

**Note 8:** This parameter is guaranteed by design but is not tested. The bus switch contributes no propagation delay other than the RC delay of the typical On Resistance of the switch and the 50pF load capacitance, when driven by an ideal voltage source (zero output impedance).

### Capacitance (Note 9)

Symbol	Parameter	Typ	Max	Units	Conditions
$C_{IN}$	Control pin Input Capacitance	3.5		pF	$V_{CC} = 5.0\text{V}$
$C_{I/O\ OFF}$	Input/Output Capacitance "OFF State"	5.5		pF	$V_{CC} = 5.0\text{V}$ , Switch OFF

**Note 9:**  $T_A = +25\text{ }^\circ\text{C}$ ,  $f = 1\text{ MHz}$ , Capacitance is characterized but not tested.

### Undershoot Characteristic (Note 10)

Symbol	Parameter	Min	Typ	Max	Units	Conditions
$V_{OUTU}$	Output Voltage During Undershoot	2.5	$V_{OH} - 0.3$		V	Figure 1

**Note 10:** This test is intended to characterize the device's protective capabilities by maintaining output signal integrity during an input transient voltage undershoot event.

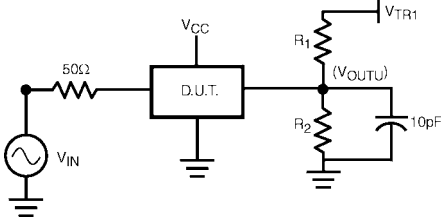
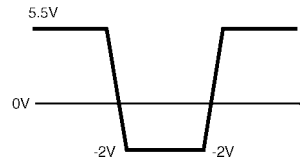


FIGURE 1.

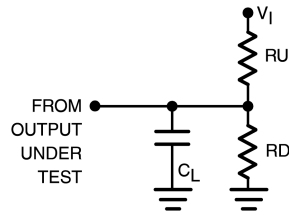
### Device Test Conditions

Parameter	Value	Units
$V_{IN}$	see Waveform	V
$R_1 = R_2$	100K	$\Omega$
$V_{TRI}$	11.0	V
$V_{CC}$	5.5	V

### Transient Input Voltage ( $V_{IN}$ ) Waveform



## AC Loading and Waveforms

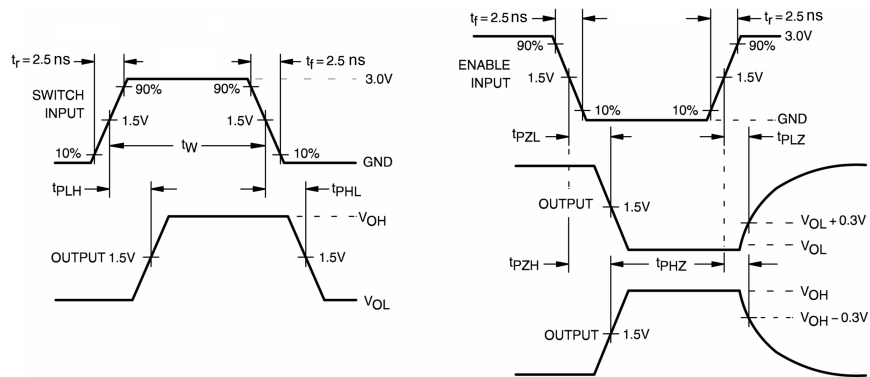


**Note:** Input driven by  $50\Omega$  source terminated in  $50\Omega$

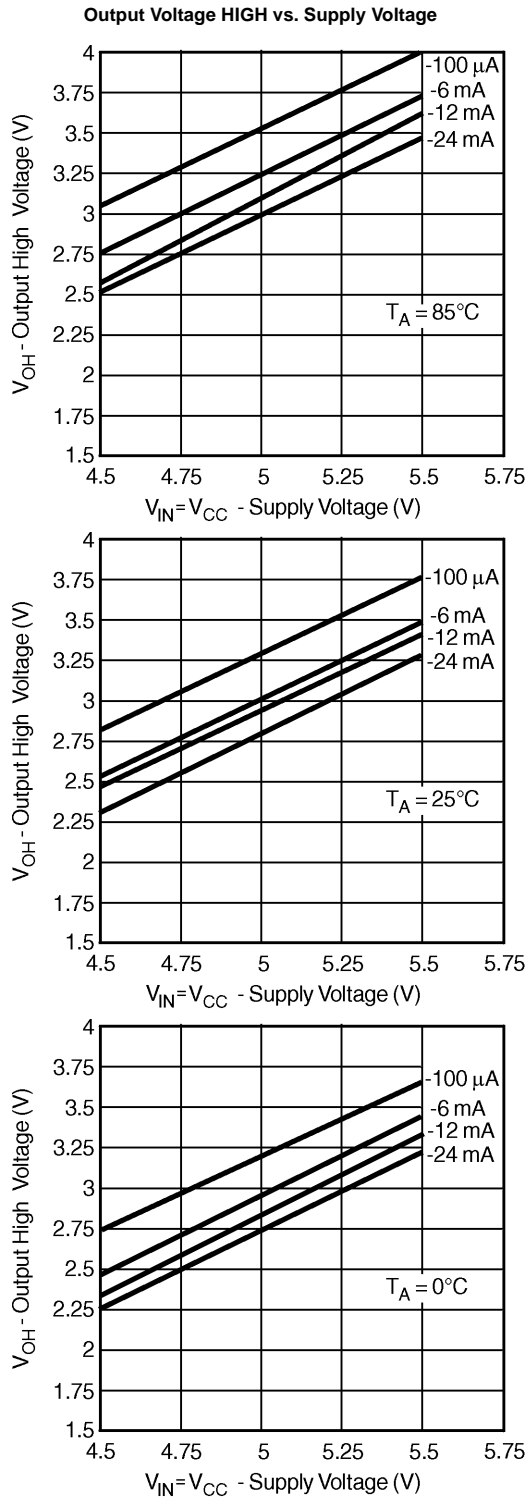
**Note:**  $C_L$  includes load and stray capacitance

**Note:** Input PRR = 1.0 MHz,  $t_W = 500$  ns

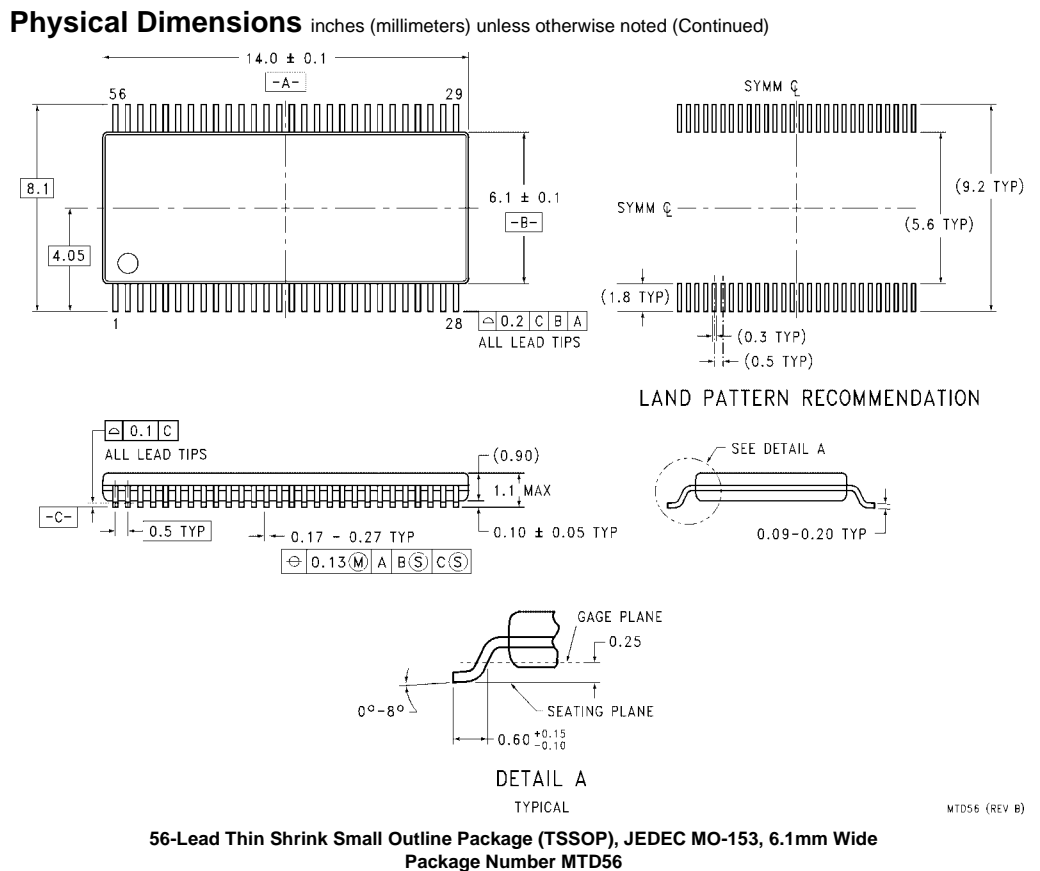
**FIGURE 2. AC Test Circuit**



**FIGURE 3. AC Waveforms**







## Technology Description

The Fairchild Switch family derives from and embodies Fairchild's proven switch technology used for several years in its 74LVX3L384 (FST3384) bus switch product.

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