

# 16-Channel High Voltage Analog Switch With Bleed Resistors

## Features

- ▶ HVCMOS® technology for high performance
- ▶ 220V operating conditions
- ▶ Output on-resistance typically 22Ω
- ▶ Integrated bleed resistors on the outputs
- ▶ 5.0 and 12.0V CMOS logic compatibility
- ▶ Very low quiescent power dissipation (~10μA)
- ▶ -45dB min off isolation at 7.5MHz
- ▶ Low parasitic capacitance
- ▶ Excellent noise immunity
- ▶ Flexible operating supply voltages

## Applications

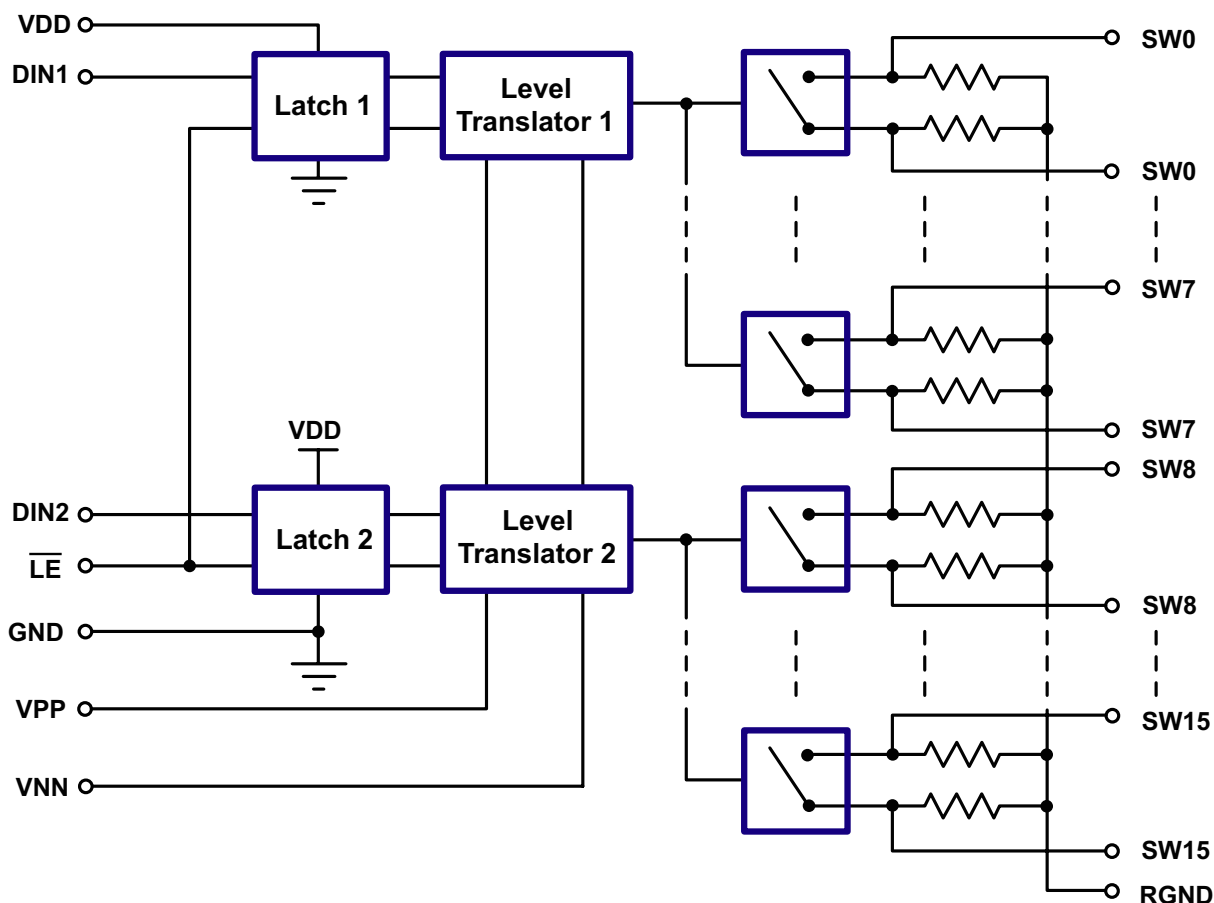
- ▶ Medical ultrasound imaging
- ▶ Non-destructive evaluation

## General Description

The Supertex HV238 is a 220V, 16-channel, high voltage analog switch integrated circuit (IC) with output bleed resistors ( $R_{INT}$ ). The output switches are configured as 2 sets of 8 single pole single throw analog switches. It is intended to be used in applications requiring high voltage switching controlled by low voltage control signals such as ultrasound imaging.

The 2 sets of 8 analog switches are controlled by 2 input logic controls,  $D_{IN1}$  and  $D_{IN2}$ . A logic high on  $D_{IN1}$  will turn on switches 0 to 7 and a logic high on  $D_{IN2}$  will turn on switches 8 to 15. The bleed resistors help to significantly reduce voltage built up on capacitive loads such as piezoelectric transducers connected to the outputs.

## Block Diagram



## Ordering Information

| Part Number    | Package Option | Packing   |
|----------------|----------------|-----------|
| HV238FG-G      | 48-Lead LQFP   | 250/Tray  |
| HV238FG-G M931 |                | 1000/Reel |

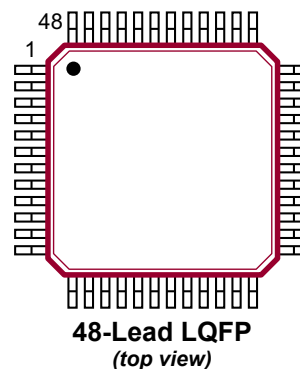
-G denotes a lead (Pb)-free / RoHS compliant package

## Absolute Maximum Ratings

| Parameter                             | Value                    |
|---------------------------------------|--------------------------|
| $V_{DD}$ logic power supply voltage   | -0.5V to +15V            |
| $V_{PP} - V_{NN}$ supply voltage      | 225V                     |
| $V_{PP}$ positive high voltage supply | -0.5V to $V_{NN} + 225V$ |
| $V_{NN}$ negative high voltage supply | +0.5V to -225V           |
| Logic input voltages                  | -0.5V to $V_{DD} + 0.3V$ |
| Analog signal range                   | $V_{NN}$ to $V_{PP}$     |
| Peak analog signal current/channel    | 3.0A                     |
| Storage temperature                   | -65°C to +150°C          |
| Power dissipation                     | 1.0W                     |

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. Continuous operation of the device at the absolute rating level may affect device reliability. All voltages are referenced to device ground.

## Pin Configuration



## Product Marking

Top Marking



YY = Year Sealed  
WW = Week Sealed  
L = Lot Number  
C = Country of Origin\*  
A = Assembler ID\*  
— = “Green” Packaging

Bottom Marking



\*May be part of top marking

Package may or may not include the following marks: Si or

48-Lead LQFP

## Typical Thermal Resistance

| Package      | $\theta_{ja}$ |
|--------------|---------------|
| 48-Lead LQFP | 52°C/W        |

## Operating Conditions

| Sym       | Parameter                          | Value                            |
|-----------|------------------------------------|----------------------------------|
| $V_{DD}$  | Logic power supply voltage         | 4.75V to 12.6V                   |
| $V_{PP}$  | Positive high voltage supply       | 50V to 110V                      |
| $V_{NN}$  | Negative high voltage supply       | -10V to $V_{PP} - 220V$          |
| $V_{IH}$  | High level input voltage           | $V_{DD} - 1.0V$ to $V_{DD}$      |
| $V_{IL}$  | Low-level input voltage            | 0V to 1.0V                       |
| $V_{SIG}$ | Analog signal voltage peak-to-peak | $V_{NN} + 10V$ to $V_{PP} - 10V$ |
| $T_A$     | Operating free air temperature     | 0°C to 70°C                      |

### Notes:

- Power up/down sequence is arbitrary except GND must be powered -up first and powered-down last.
- $V_{SIG}$  must be  $V_{NN} \leq V_{SIG} \leq V_{PP}$  or floating during power up/down transition.
- Rise and fall times of power supplies  $V_{DD}$ ,  $V_{PP}$  and  $V_{NN}$  should not be less than 1.0msec.

## DC Electrical Characteristics (Over operating conditions unless otherwise specified)

| Sym              | Parameter                                  | 0°C |      | +25°C |     |      | +70°C |      | Units      | Conditions                                                                                 |
|------------------|--------------------------------------------|-----|------|-------|-----|------|-------|------|------------|--------------------------------------------------------------------------------------------|
|                  |                                            | Min | Max  | Min   | Typ | Max  | Min   | Max  |            |                                                                                            |
| $R_{ONS}$        | Small signal switch on-resistance          | -   | 30   | -     | 26  | 32   | -     | 40   | $\Omega$   | $V_{SIG} = 0V$ ,<br>$I_{SIG} = 5.0mA$<br>$V_{PP} = +50V$<br>$V_{NN} = -170V$               |
|                  |                                            | -   | 25   | -     | 22  | 27   | -     | 35   |            | $V_{SIG} = 0V$ ,<br>$I_{SIG} = 200mA$                                                      |
|                  |                                            | -   | 25   | -     | 22  | 27   | -     | 30   |            | $V_{SIG} = 0V$ ,<br>$I_{SIG} = 5.0mA$<br>$V_{PP} = +110V$<br>$V_{NN} = -110V$              |
|                  |                                            | -   | 20   | -     | 18  | 22   | -     | 25   |            | $V_{SIG} = 0V$ ,<br>$I_{SIG} = 200mA$                                                      |
| $\Delta R_{ONS}$ | Small signal switch on-resistance matching | -   | 20   | -     | 5.0 | 20   | -     | 20   | %          | $V_{SIG} = 0V$ , $I_{SIG} = 5.0mA$ ,<br>$V_{PP} = +110V$ , $V_{NN} = -110V$                |
| $R_{ONL}$        | Large signal switch on-resistance          | -   | -    | -     | 15  | -    | -     | -    | $\Omega$   | $V_{SIG} = 0V$ , $I_{SIG} = 1.0A$                                                          |
| $R_{INT}$        | Output switch shunt resistance             | -   | -    | 20    | 35  | 50   | -     | -    | K $\Omega$ | Output switch to $R_{GND}$ , $I_{RINT} = 0.5mA$                                            |
| $I_{SOL}$        | Switch off leakage per switch              | -   | 5.0  | -     | 1.0 | 10   | -     | 15   | $\mu A$    | $V_{SIG} = V_{PP} - 10V$ , $V_{NN} = +10V$                                                 |
| $V_{OS}$         | DC offset switch off                       | -   | 300  | -     | 100 | 300  | -     | 300  | mV         | No Load                                                                                    |
|                  | DC offset switch on                        | -   | 500  | -     | 100 | 500  | -     | 500  |            |                                                                                            |
| $I_{PPQ}$        | Quiescent $V_{PP}$ supply current          | -   | -    | -     | 10  | 50   | -     | -    | $\mu A$    | All switches off                                                                           |
| $I_{NNQ}$        | Quiescent $V_{NN}$ supply current          | -   | -    | -     | -10 | -50  | -     | -    |            |                                                                                            |
| $I_{PPQ}$        | Quiescent $V_{PP}$ supply current          | -   | -    | -     | 10  | 50   | -     | -    | $\mu A$    | All switches on, $I_{SW} = 5.0mA$                                                          |
| $I_{NNQ}$        | Quiescent $V_{NN}$ supply current          | -   | -    | -     | -10 | -50  | -     | -    |            |                                                                                            |
| $I_{SW}$         | Switch output peak current                 | -   | 3.0  | -     | 3.0 | 2.0  | -     | 2.0  | A          | $V_{SIG}$ duty cyclcy < 0.1%                                                               |
| $f_{SW}$         | Output switching frequency                 | -   | -    | -     | -   | 50   | -     | -    | kHz        | Duty cycle = 50%                                                                           |
| $I_{PP}$         | Average $V_{PP}$ supply current            | -   | 6.5  | -     | -   | 8.8  | -     | 10   | mA         | $V_{PP} = +50V$ , $V_{NN} = -170V$<br>All output switches are turning on and off at 50kHz  |
| $I_{NN}$         | Average $V_{NN}$ supply current            | -   | 8.1  | -     | -   | -8.8 | -     | -10  |            |                                                                                            |
| $I_{PP}$         | Average $V_{PP}$ supply current            | -   | -8.1 | -     | -   | 6.3  | -     | 6.9  | mA         | $V_{PP} = +110V$ , $V_{NN} = -110V$<br>All output switches are turning on and off at 50kHz |
| $I_{NN}$         | Average $V_{NN}$ supply current            | -   | 5.0  | -     | -   | -6.3 | -     | -6.9 |            |                                                                                            |
| $I_{DDQ}$        | Logic supply quiescent current             | -   | 10   | -     | -   | 10   | -     | 10   | $\mu A$    | All logic inputs are static.                                                               |
| $I_{DD}$         | Logic supply average current               | -   | 2.0  | -     | -   | 2.0  | -     | 2.0  | mA         | $D_{IN1} = D_{IN2} = 3.0MHz$ , $\overline{LE}$ is high                                     |
| $C_{IN}$         | Logic input capacitance                    | -   | 10   | -     | -   | 10   | -     | 10   | pF         | ---                                                                                        |

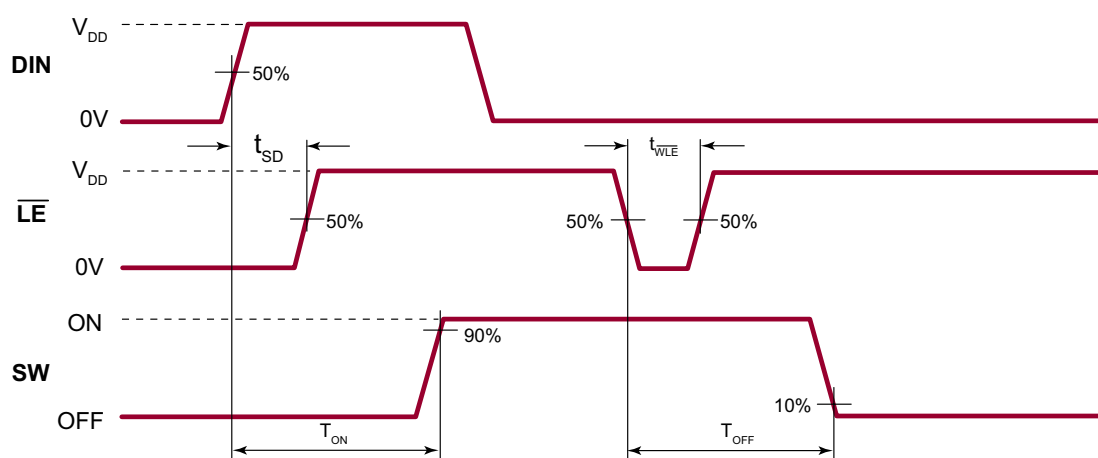
## AC Electrical Characteristics (Over recommended operating conditions, $V_{DD} = 5.0V$ , unless otherwise specified)

|            |                                          |     |     |     |   |     |     |     |         |                                                   |
|------------|------------------------------------------|-----|-----|-----|---|-----|-----|-----|---------|---------------------------------------------------|
| $t_{WLE}$  | Time width of $\overline{LE}$            | 150 | -   | 150 | - | -   | 150 | -   | ns      | ---                                               |
| $t_{WDIN}$ | Time width of $D_{IN}$                   | 150 | -   | 150 | - | -   | 150 | -   | ns      | ---                                               |
| $t_{SD}$   | Set up time before $\overline{LE}$ rises | 150 | -   | 150 | - | -   | 150 | -   | ns      | ---                                               |
| $t_{ON}$   | Turn on time                             | -   | 5.0 | -   | - | 5.0 | -   | 5.0 | $\mu s$ | $V_{SIG} = V_{PP} - 10V$ , $R_{LOAD} = 10k\Omega$ |
| $t_{OFF}$  | Turn off time                            | -   | 5.0 | -   | - | 5.0 | -   | 5.0 | $\mu s$ | $V_{SIG} = V_{PP} - 10V$ , $R_{LOAD} = 10k\Omega$ |
| dv/dt      | Maximun $V_{SIG}$ slew rate              | -   | 20  | -   | - | 20  | -   | 20  | V/ns    | ---                                               |

## AC Electrical Characteristics (Over recommended operating conditions, $V_{DD} = 5.0V$ , unless otherwise specified)

| Sym           | Parameter                             | 0°C |     | +25°C |      |     | +70°C |     | Units | Conditions                                |
|---------------|---------------------------------------|-----|-----|-------|------|-----|-------|-----|-------|-------------------------------------------|
|               |                                       | Min | Max | Min   | Typ  | Max | Min   | Max |       |                                           |
| $K_O$         | Off isolation                         | -30 | -   | -30   | -33  | -   | -30   | -   | dB    | $f = 5.0MHz$ , $1.0k\Omega/15pF$ load     |
|               |                                       | -45 | -   | -45   | -50  | -   | -45   | -   |       | $f = 7.5MHz$ , $R_{LOAD} = 50\Omega$ load |
| $K_{CR}$      | Switch crosstalk                      | -45 | -   | -45   | -    | -   | -45   | -   | dB    | $f = 5.0MHz$ , $50\Omega$ load            |
| $I_{ID}$      | Output switch isolation diode current | -   | 300 | -     | -    | 300 | -     | 300 | mA    | 300ns pulse width, 2.0% duty cycle        |
| $C_{SG(OFF)}$ | Off capacitance SW to GND             | 5.0 | 17  | 5.0   | 12   | 17  | 5.0   | 17  | pF    | $V_{SIG} = 0V$ , $f = 1.0MHz$             |
| $C_{SG(ON)}$  | On capacitance SW to GND              | 25  | 50  | 25    | 38   | 50  | 25    | 50  | pF    | $V_{SIG} = 0V$ , $f = 1.0MHz$             |
| $+V_{SPK}$    | Output voltage spike                  | -   | -   | -     | 4.0  | -   | -     | -   | V     | $R_{LOAD} = 50\Omega$                     |
| $-V_{SPK}$    |                                       | -   | -   | -     | -4.0 | -   | -     | -   |       |                                           |

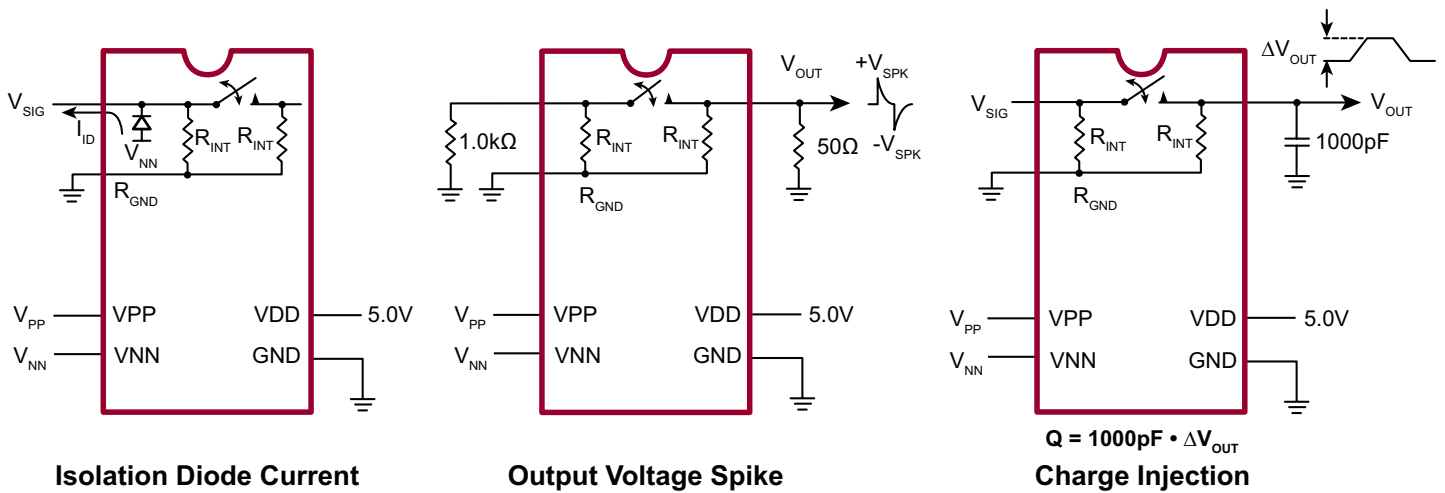
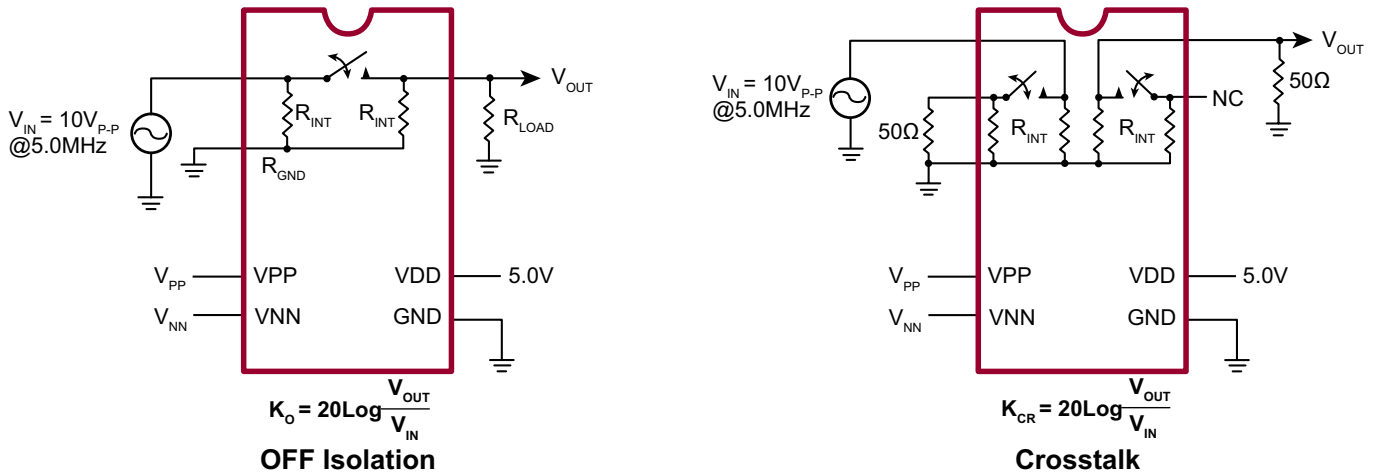
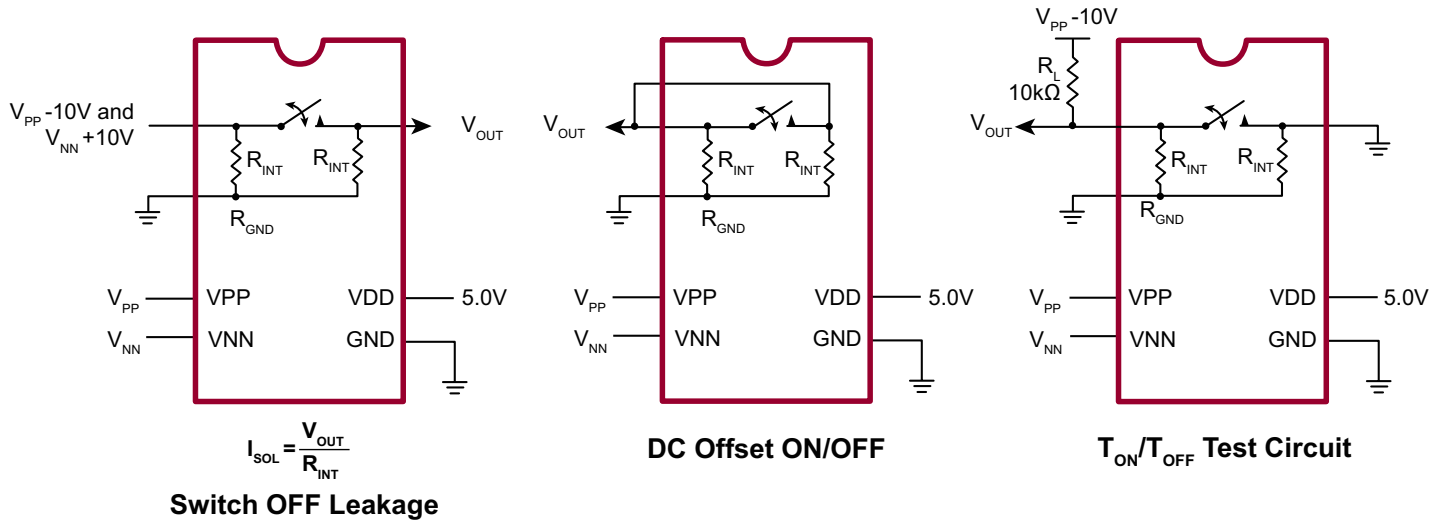
## Logic Timing Diagram



## Truth Table

| $D_{IN2}$ | $D_{IN1}$ | $\overline{LE}$ | SW0 to SW7          | SW8 to SW15 |
|-----------|-----------|-----------------|---------------------|-------------|
| L         | L         | L               | OFF                 | OFF         |
| L         | H         | L               | ON                  | OFF         |
| H         | L         | L               | OFF                 | ON          |
| H         | H         | L               | ON                  | ON          |
| X         | X         | H               | Hold Previous State |             |

# Test Circuits

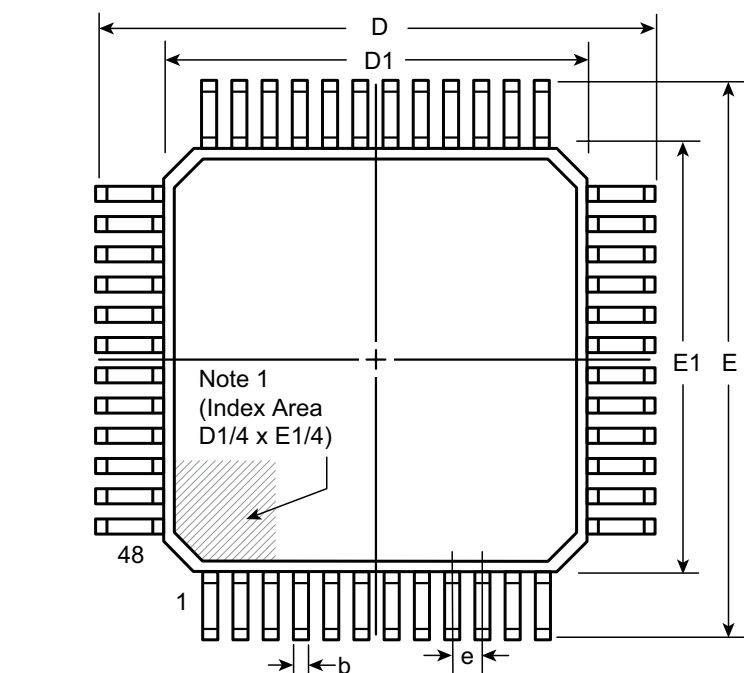


## Pin Description

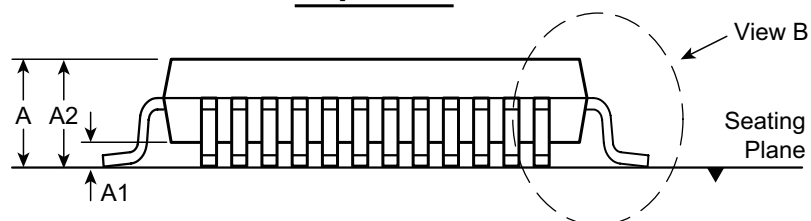
| Pin | Function               | Pin | Function |
|-----|------------------------|-----|----------|
| 1   | VNN                    | 25  | SW10     |
| 2   | N/C                    | 26  | SW10     |
| 3   | VPP                    | 27  | SW9      |
| 4   | N/C                    | 28  | SW9      |
| 5   | DIN1                   | 29  | SW8      |
| 6   | $\overline{\text{LE}}$ | 30  | SW8      |
| 7   | DIN2                   | 31  | SW7      |
| 8   | N/C                    | 32  | SW7      |
| 9   | N/C                    | 33  | SW6      |
| 10  | VDD                    | 34  | SW6      |
| 11  | GND                    | 35  | SW5      |
| 12  | N/C                    | 36  | SW5      |
| 13  | RGND                   | 37  | SW4      |
| 14  | SW15                   | 38  | N/C      |
| 15  | SW15                   | 39  | SW4      |
| 16  | SW14                   | 40  | N/C      |
| 17  | SW14                   | 41  | SW3      |
| 18  | SW13                   | 42  | SW3      |
| 19  | SW13                   | 43  | SW2      |
| 20  | SW12                   | 44  | SW2      |
| 21  | SW12                   | 45  | SW1      |
| 22  | SW11                   | 46  | SW1      |
| 23  | SW11                   | 47  | SW0      |
| 24  | N/C                    | 48  | SW0      |

# 48-Lead LQFP Package Outline (FG)

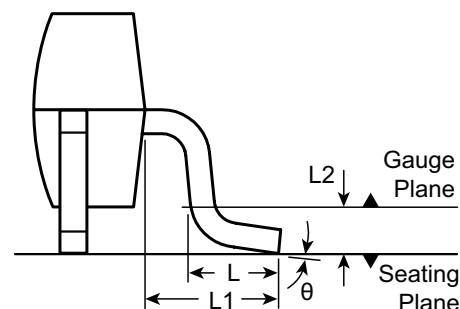
7.00x7.00mm body, 1.60mm height (max), 0.50mm pitch



**Top View**



**Side View**



**View B**

**Note:**

1. A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.

| Symbol         |     | A     | A1   | A2   | b    | D     | D1    | E     | E1    | e        | L    | L1       | L2       | θ    |
|----------------|-----|-------|------|------|------|-------|-------|-------|-------|----------|------|----------|----------|------|
| Dimension (mm) | MIN | 1.40* | 0.05 | 1.35 | 0.17 | 8.80* | 6.80* | 8.80* | 6.80* | 0.50 BSC | 0.45 | 1.00 REF | 0.25 BSC | 0°   |
|                | NOM | -     | -    | 1.40 | 0.22 | 9.00  | 7.00  | 9.00  | 7.00  |          | 0.60 |          |          | 3.5° |
|                | MAX | 1.60  | 0.15 | 1.45 | 0.27 | 9.20* | 7.20* | 9.20* | 7.20* |          | 0.75 |          |          | 7°   |

JEDEC Registration MS-026, Variation BBC, Issue D, Jan. 2001.

\* This dimension is not specified in the JEDEC drawing.

**Drawings are not to scale.**

**Supertex Doc. #: DSPD-48LQFPFG Version, D041309.**

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to <http://www.supertex.com/packaging.html>.)

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