

Low Charge Injection 8-Channel High Voltage Analog Switches with Bleed Resistors

Features

- ▶ HVCMOS® technology for high performance
- ▶ Very low quiescent power dissipation (10µA max.)
- ▶ Output on-resistance (22Ω typ.)
- ▶ Integrated bleed resistors on the outputs
- ▶ Low parasitic capacitances
- ▶ DC to 50MHz small signal frequency response
- ▶ -60dB typical output off isolation at 5.0MHz
- ▶ CMOS logic circuitry for low power
- ▶ Excellent noise immunity
- ▶ On-chip shift register, latch and clear logic circuitry
- ▶ Flexible high voltage supplies

Applications

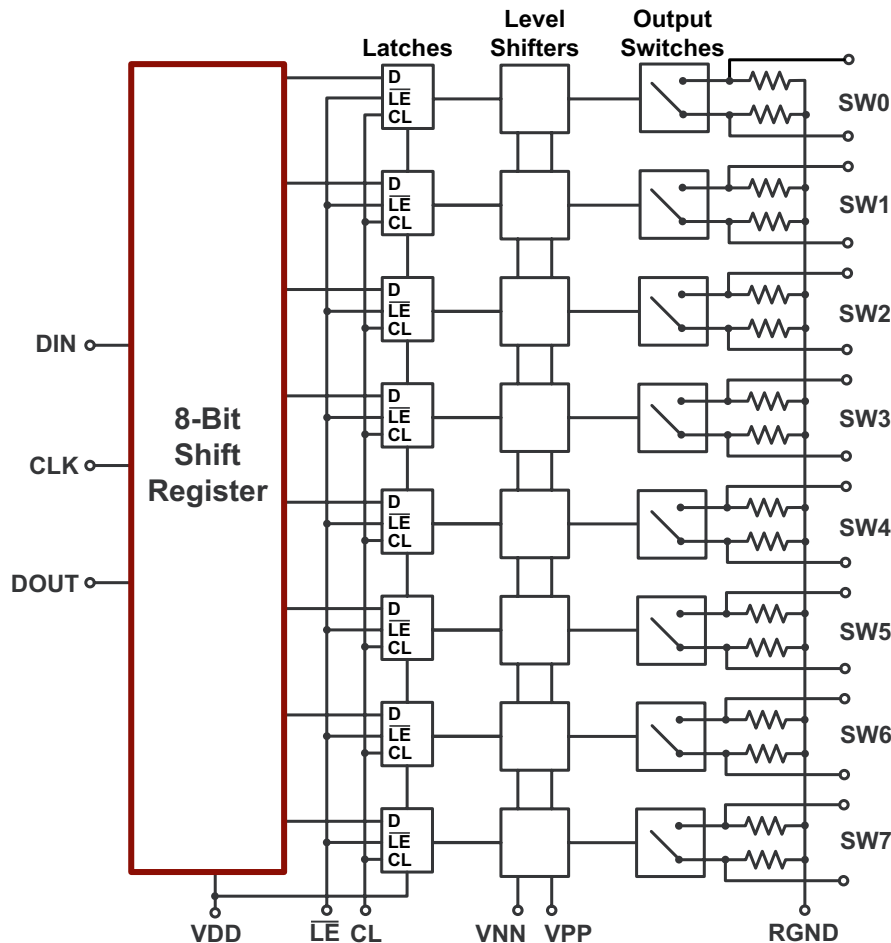
- ▶ Medical ultrasound imaging
- ▶ Piezoelectric transducer drivers

General Description

The Supertex HV232 is a low charge injection 8-channel, high-voltage, analog switch integrated circuit (IC) with bleed resistors. This device can be used in applications requiring high voltage switching controlled by low voltage control signals, such as ultrasound imaging and printers. The bleed resistors eliminate voltage built up on capacitive loads such as piezoelectric transducers. Input data is shifted into an 8-bit shift register which can then be retained in an 8-bit latch. To reduce any possible clock feed-through noise, Latch Enable (\overline{LE}) should be left high until all bits are clocked in. Using HVCMOS® technology, this switch combines high voltage bilateral DMOS switches and low power CMOS logic to provide efficient control of high voltage analog signals.

This IC is suitable for various combinations of high voltage supplies, e.g., V_{PP}/V_{NN} : +50V/-150V, or +100V/-100V.

Block Diagram



Ordering Information

| Part Number | Package Option | Packing |
|----------------|----------------|-----------|
| HV232FG-G | 48-Lead LQFP | 250/Tray |
| HV232FG-G M931 | 48-Lead LQFP | 1000/Reel |
| HV232PJ-G | 28-Lead PLCC | 38/Tube |
| HV232PJ-G M904 | 28-Lead PLCC | 500/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 | 220V |
| V_{PP} positive high voltage supply | -0.5V to $V_{NN} + 200V$ |
| V_{NN} negative high voltage supply | +0.5V to -200V |
| 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: | |
| 48-Lead LQFP | 1.0W |
| 28-Lead PLCC | 1.2W |

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.

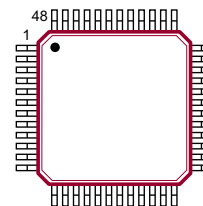
Operating Conditions

| Sym | Parameter | Value |
|-----------|---|----------------------------------|
| V_{DD} | Logic power supply voltage ^{1,3} | 4.5V to 13.2V |
| V_{PP} | Positive high voltage supply ^{1,3} | 40V to $V_{NN} + 200V$ |
| V_{NN} | Negative high voltage supply ^{1,3} | -40V to -160V |
| V_{IH} | High level input voltage | $V_{DD} - 1.5V$ to V_{DD} |
| V_{IL} | Low-level input voltage | 0V to 1.5V |
| V_{SIG} | Analog signal voltage peak-to-peak ² | $V_{NN} + 10V$ to $V_{PP} - 10V$ |
| T_A | Operating free air temperature | 0°C to 70°C |

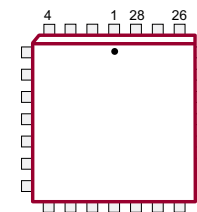
Notes:

- 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.

Pin Configuration



48-Lead LQFP
(top view)



28-Lead PLCC
(top view)

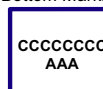
Product Marking

Top Marking



YY = Year Sealed
WW = Week Sealed
L = Lot Number
C = Country of Origin*
A = Assembler ID*
— = "Green" Packaging
*May be part of top marking

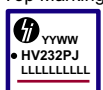
Bottom Marking



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

48-Lead LQFP

Top Marking



YY = Year Sealed
WW = Week Sealed
L = Lot Number
C = Country of Origin*
A = Assembler ID*
— = "Green" Packaging
*May be part of top marking

Bottom Marking



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

28-Lead PLCC

Typical Thermal Resistance

| Package | θ_{ja} |
|--------------|---------------|
| 48-Lead LQFP | 52°C/W |
| 28-Lead PLCC | 48°C/W |

DC Electrical Characteristics (Over operating conditions unless otherwise specified)

| Sym | Parameter | 0°C | | +25°C | | | +70°C | | Unit | Conditions | |
|------------------|--|------|-----|-------|------|-----|-------|-----|------------|--|--|
| | | Min | Max | Min | Typ | Max | Min | Max | | | |
| R_{ONS} | Small signal switch on-resistance | - | 30 | - | 26 | 38 | - | 48 | Ω | $I_{SIG} = 5.0mA$ | $V_{PP} = +40V$ $V_{NN} = -160V$ |
| | | - | 25 | - | 22 | 27 | - | 32 | | $I_{SIG} = 200mA$ | $V_{PP} = +100V$ $V_{NN} = -100V$ |
| | | - | 25 | - | 22 | 27 | - | 30 | | $I_{SIG} = 5.0mA$ | $V_{PP} = +160V$ $V_{NN} = -40V$ |
| | | - | 18 | - | 18 | 24 | - | 27 | | $I_{SIG} = 200mA$ | $V_{PP} = +100V$ $V_{NN} = -100V$ |
| | | - | 23 | - | 20 | 25 | - | 30 | | $I_{SIG} = 5.0mA$ | $V_{PP} = +160V$ $V_{NN} = -40V$ |
| | | - | 22 | - | 16 | 25 | - | 27 | | $I_{SIG} = 200mA$ | $V_{PP} = +100V$ $V_{NN} = -100V$ |
| ΔR_{ONS} | Small signal switch on-resistance matching | - | 20 | - | 5.0 | 20 | - | 20 | % | $I_{SIG} = 5.0mA, V_{PP} = +100V,$ $V_{NN} = -100V$ | |
| R_{ONL} | Large signal switch on-resistance | - | - | - | 15 | - | - | - | Ω | $V_{SIG} = V_{PP} -10V, I_{SIG} = 1.0A$ | |
| R_{INT} | Output switch shunt resistance | - | - | 20 | 35 | 50 | - | - | K Ω | Output switch to R_{GND} $I_{RINT} = 0.5mA$ | |
| I_{SOL} | Switch off leakage per switch | - | 5.0 | - | 1.0 | 10 | - | 15 | μA | $V_{SIG} = V_{PP} -10V$ | |
| V_{OS} | DC offset switch off | - | 300 | - | 100 | 300 | - | 300 | mV | No load | |
| | DC offset switch on | - | 500 | - | 100 | 500 | - | 500 | mV | No load | |
| I_{PPQ} | Quiescent V_{PP} supply current | - | - | - | 10 | 50 | - | - | μA | All switches off | |
| I_{NNQ} | Quiescent V_{NN} supply current | - | - | - | -10 | -50 | - | - | μA | All switches off | |
| I_{PPQ} | Quiescent V_{PP} supply current | - | - | - | 10 | 50 | - | - | μA | All switches on, $I_{SW} = 5.0mA$ | |
| I_{NNQ} | Quiescent V_{NN} supply current | - | - | - | -10 | -50 | - | - | μA | All switches on, $I_{SW} = 5.0mA$ | |
| I_{SW} | Switch output peak current | - | 3.0 | - | 3.0 | 2.0 | - | 2.0 | A | V_{SIG} duty cycle - 0.1% | |
| f_{SW} | Output switching frequency | - | - | - | - | 50 | - | - | kHz | Duty cycle = 50% | |
| I_{PP} | Supply current | - | 6.5 | - | - | 7.0 | - | 8.0 | mA | $V_{PP} = +40V$ $V_{NN} = -160V$ | All output switches are turning On and Off at 50kHz with no load |
| | | - | 4.0 | - | - | 5.0 | - | 5.5 | | $V_{PP} = +100V$ $V_{NN} = -100V$ | |
| | | - | 4.0 | - | - | 5.0 | - | 5.5 | | $V_{PP} = +160V$ $V_{NN} = -40V$ | |
| I_{NN} | Supply current | - | 6.5 | - | - | 7.0 | - | 8.0 | mA | $V_{PP} = +40V$ $V_{NN} = -160V$ | All output switches are turning On and Off at 50kHz with no load |
| | | - | 4.0 | - | - | 5.0 | - | 5.5 | | $V_{PP} = +100V$ $V_{NN} = -100V$ | |
| | | - | 4.0 | - | - | 5.0 | - | 5.5 | | $V_{PP} = +160V$ $V_{NN} = -40V$ | |
| I_{DD} | Logic supply average current | - | 4.0 | - | - | 4.0 | - | 4.0 | mA | $f_{CLK} = 5.0MHz, V_{DD} = 5.0V$ | |
| I_{DDQ} | Logic supply quiescent current | - | 10 | - | - | 10 | - | 10 | μA | --- | |
| I_{SOR} | Data out source current | 0.45 | - | 0.45 | 0.70 | - | 0.40 | - | mA | $V_{OUT} = V_{DD} -0.7V$ | |
| I_{SINK} | Data out sink current | 0.45 | - | 0.45 | 0.70 | - | 0.40 | - | mA | $V_{OUT} = 0.7V$ | |
| C_{IN} | Logic input capacitance | - | 10 | - | - | 10 | - | 10 | pF | --- | |

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

| Sym | Parameter | 0°C | | +25°C | | | +70°C | | Unit | Conditions |
|---------------|--|-----|-----|-------|-----|-----|-------|-----|---------|--|
| | | Min | Max | Min | Typ | Max | Min | Max | | |
| t_{SD} | Set up time before \overline{LE} rises | 150 | - | 150 | - | - | 150 | - | ns | --- |
| t_{WLE} | Time width of \overline{LE} | 150 | - | 150 | - | - | 150 | - | ns | --- |
| t_{DO} | Clock delay time to data out | 55 | 150 | 60 | - | 150 | 70 | 150 | ns | --- |
| t_{WCL} | Time width of CL | 150 | - | 150 | - | - | 150 | - | ns | --- |
| t_{SU} | Set up time data to clock | 15 | - | 15 | 8.0 | - | 20 | - | ns | --- |
| t_H | Hold time data from clock | 35 | - | 35 | - | - | 35 | - | ns | --- |
| f_{CLK} | Clock frequency | - | 5.0 | - | - | 5.0 | - | 5.0 | MHz | 50% Duty cycle, $f_{DATA} = f_{CLK}/2$ |
| t_R, t_F | Clock rise and fall times | - | 1.0 | - | - | 1.0 | - | 1.0 | μs | --- |
| t_{ON} | Turn on time | - | 5.0 | - | - | 5.0 | - | 5.0 | μs | $V_{SIG} = V_{PP} - 10V, R_L = 10k\Omega$ |
| t_{OFF} | Turn off time | - | 5.0 | - | - | 5.0 | - | 5.0 | μs | $V_{SIG} = V_{PP} - 10V, R_L = 10k\Omega$ |
| dv/dt | Maximun V_{SIG} slew rate | - | 20 | - | - | 20 | - | 20 | V/ns | $V_{PP} = +160V, V_{NN} = -40V$ |
| | | - | 20 | - | - | 20 | - | 20 | | $V_{PP} = +100V, V_{NN} = -100V$ |
| | | - | 20 | - | - | 20 | - | 20 | | $V_{PP} = +40V, V_{NN} = -160V$ |
| K_O | Off isolation | -30 | - | -30 | -33 | - | -30 | - | dB | f = 5.0MHz, 1.0k Ω /15pF load |
| | | -58 | - | -58 | - | - | -58 | - | | f = 5.0MHz, 50 Ω load |
| K_{CR} | Switch crosstalk | -60 | - | -60 | -70 | - | -60 | - | dB | f = 5.0MHz, 50 Ω 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 | 0V, f = 1.0MHz |
| $C_{SG(ON)}$ | On capacitance SW to GND | 25 | 50 | 25 | 38 | 50 | 25 | 50 | pF | 0V, f = 1.0MHz |
| $+V_{SPK}$ | Output voltage spike | - | - | - | - | 150 | - | - | mV | $V_{PP} = +40V, V_{NN} = -160V, R_L = 50\Omega$ |
| $-V_{SPK}$ | | - | - | - | - | 150 | - | - | | |
| $+V_{SPK}$ | | - | - | - | - | 150 | - | - | | $V_{PP} = +100V, V_{NN} = -100V, R_L = 50\Omega$ |
| $-V_{SPK}$ | | - | - | - | - | 150 | - | - | | |
| $+V_{SPK}$ | | - | - | - | - | 150 | - | - | | $V_{PP} = +160V, V_{NN} = -40V, R_L = 50\Omega$ |
| $-V_{SPK}$ | | - | - | - | - | 150 | - | - | | |

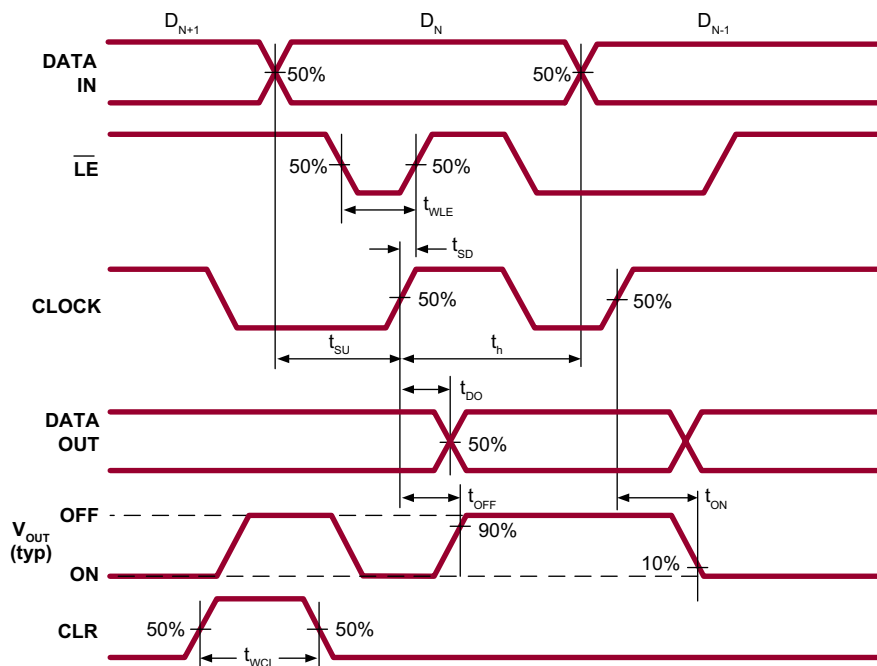
Truth Table

| D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | \overline{LE} | CLK | SW0 | SW1 | SW2 | SW3 | SW4 | SW5 | SW6 | SW7 |
|----|----|----|----|----|----|----|----|-----------------|-----|---------------------|-----|-----|-----|-----|-----|-----|-----|
| L | | | | | | | | L | L | Off | | | | | | | |
| H | | | | | | | | L | L | On | | | | | | | |
| | L | | | | | | | L | L | | Off | | | | | | |
| | H | | | | | | | L | L | | On | | | | | | |
| | | L | | | | | | L | L | | | Off | | | | | |
| | | H | | | | | | L | L | | | On | | | | | |
| | | | L | | | | | L | L | | | | Off | | | | |
| | | | H | | | | | L | L | | | | On | | | | |
| | | | | L | | | | L | L | | | | | Off | | | |
| | | | | H | | | | L | L | | | | | On | | | |
| | | | | | L | | | L | L | | | | | | Off | | |
| | | | | | H | | | L | L | | | | | | On | | |
| | | | | | | L | | L | L | | | | | | | Off | |
| | | | | | | H | | L | L | | | | | | | On | |
| | | | | | | | L | L | L | | | | | | | | Off |
| | | | | | | | H | L | L | | | | | | | | On |
| X | X | X | X | X | X | X | X | H | L | Hold Previous State | | | | | | | |
| X | X | X | X | X | X | X | X | X | H | All Switches Off | | | | | | | |

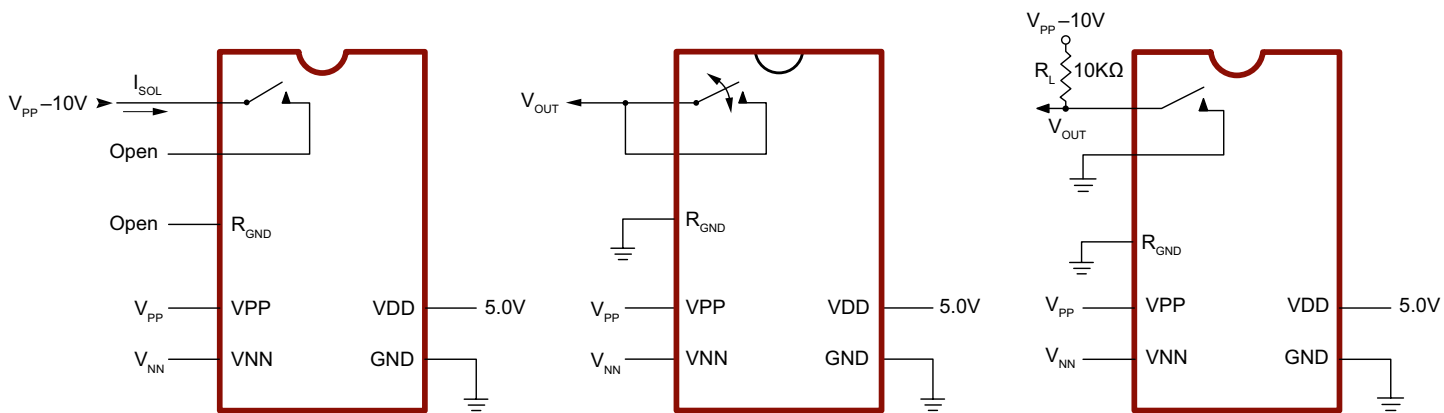
Notes:

1. The eight switches operate independently.
2. Serial data is clocked in on the L to H transition of the CLK.
3. The switches go to a state retaining their present condition at the rising edge of \overline{LE} . When \overline{LE} is low the shift register data flow through the latch.
4. D_{OUT} is high when data in the shift register 7 is high.
5. Shift register clocking has no effect on the switch states if \overline{LE} is high.
6. The CLR clear input overrides all other inputs.

Logic Timing Waveforms



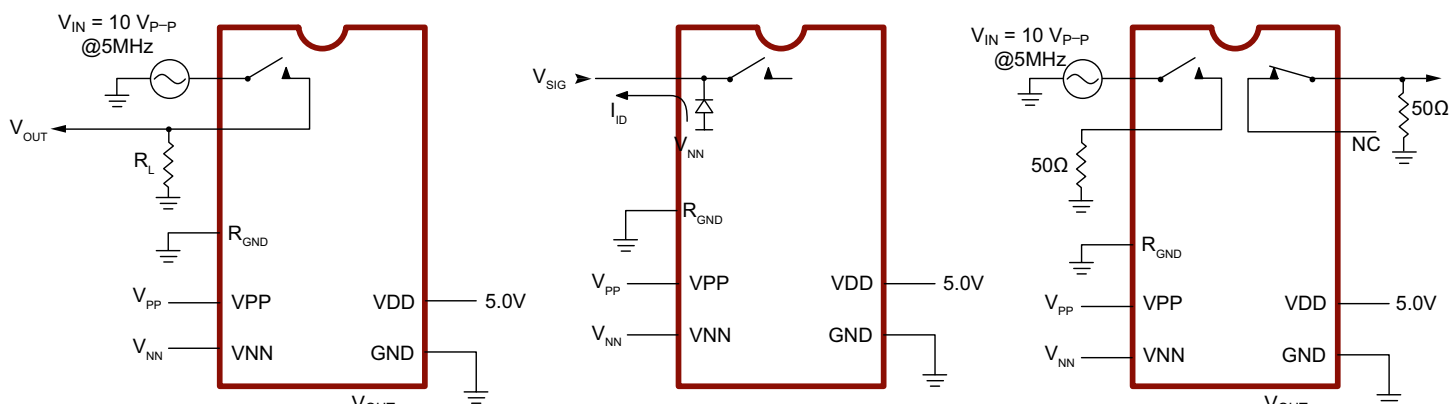
Test Circuits



Switch OFF Leakage

DC Offset ON/OFF

T_{ON}/T_{OFF} Test Circuit



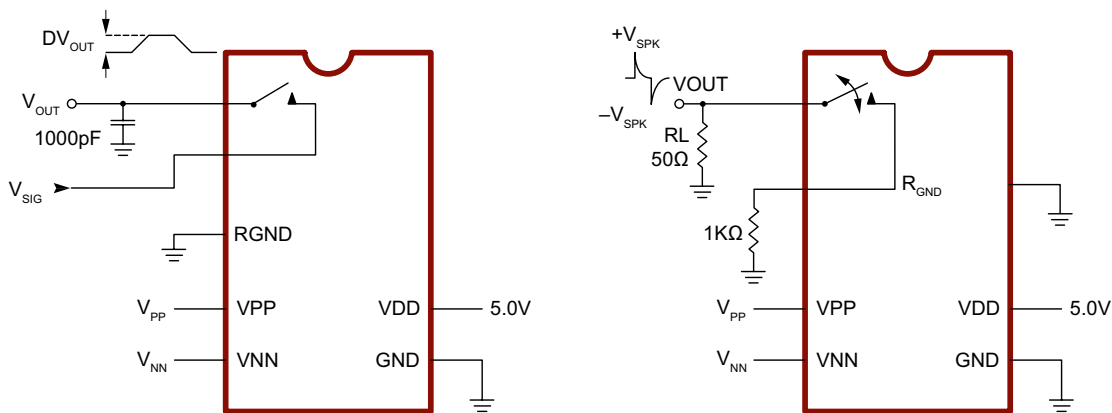
$$K_O = 20 \text{Log} \frac{V_{OUT}}{V_{IN}}$$

OFF Isolation

Isolation Diode Current

$$K_{CR} = 20 \text{Log} \frac{V_{OUT}}{V_{IN}}$$

Crosstalk



$$Q = 1000pF \times DV_{OUT}$$

Charge Injection

Output Voltage Spike

Pin Description (48-Lead LQFP)

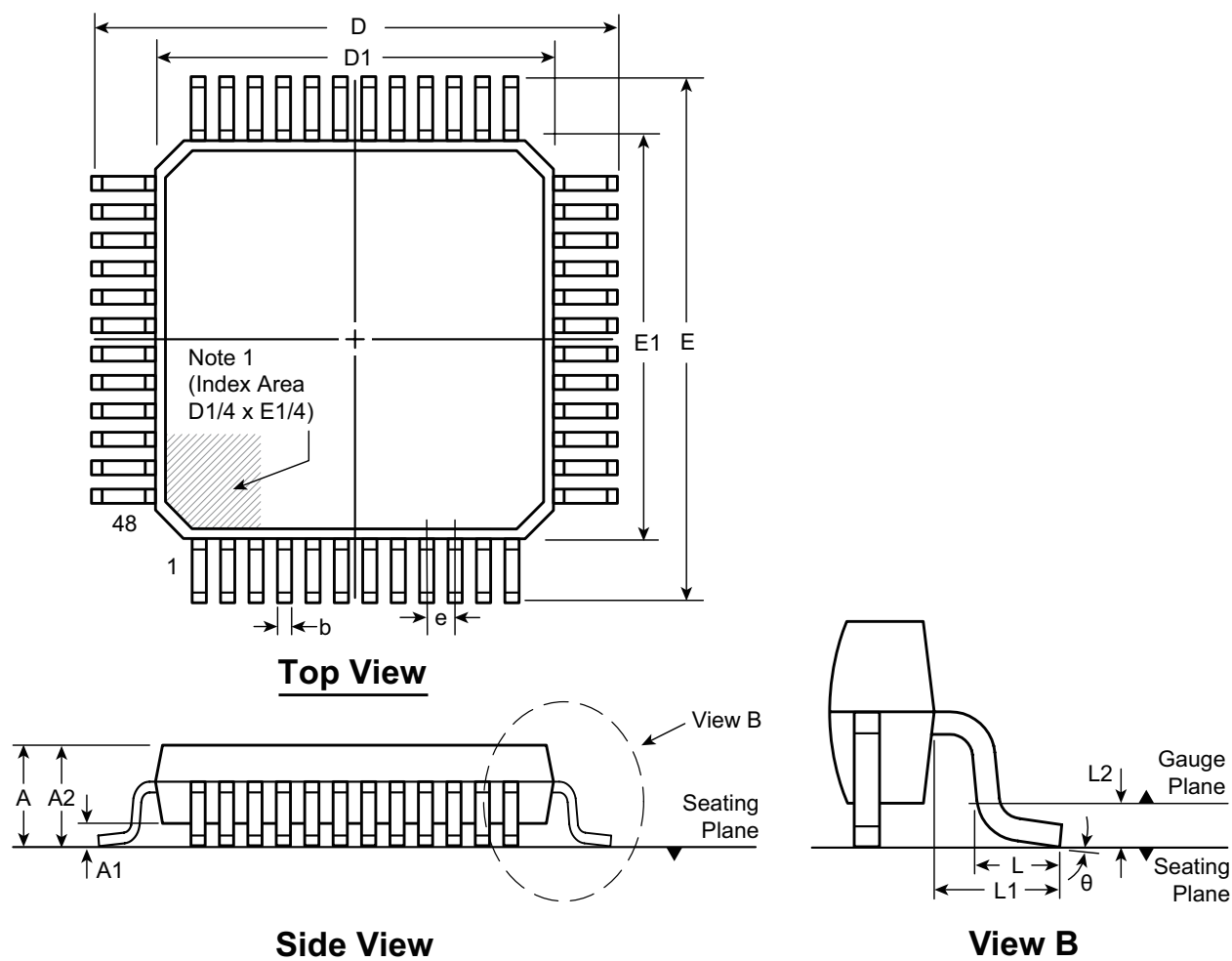
| Pin | Function | Pin | Function |
|-----|----------|-----|------------------------|
| 1 | SW5 | 25 | VNN |
| 2 | N/C | 26 | N/C |
| 3 | SW4 | 27 | RGND |
| 4 | N/C | 28 | GND |
| 5 | SW4 | 29 | VDD |
| 6 | N/C | 30 | N/C |
| 7 | N/C | 31 | N/C |
| 8 | SW3 | 32 | N/C |
| 9 | N/C | 33 | DIN |
| 10 |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

Pin Description (28-Lead PLCC)

| Pin | Function | Pin | Function |
|-----|----------|-----|------------------------|
| 1 | SW3 | 15 | N/C |
| 2 | SW3 | 16 | DIN |
| 3 | SW2 | 17 | CLK |
| 4 | SW2 | 18 | $\overline{\text{LE}}$ |
| 5 | SW1 | 19 | CL |
| 6 | SW1 | 20 | DOUT |
| 7 | SW0 | 21 | SW7 |
| 8 | SW0 | 22 | SW7 |
| 9 | N/C | 23 | SW6 |
| 10 | VPP | 24 | SW6 |
| 11 | RGND | 25 | SW5 |
| 12 | VNN | 26 | SW5 |
| 13 | GND | 27 | SW4 |
| 14 | VDD | 28 | SW4 |

48-Lead LQFP Package Outline (FG)

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



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.

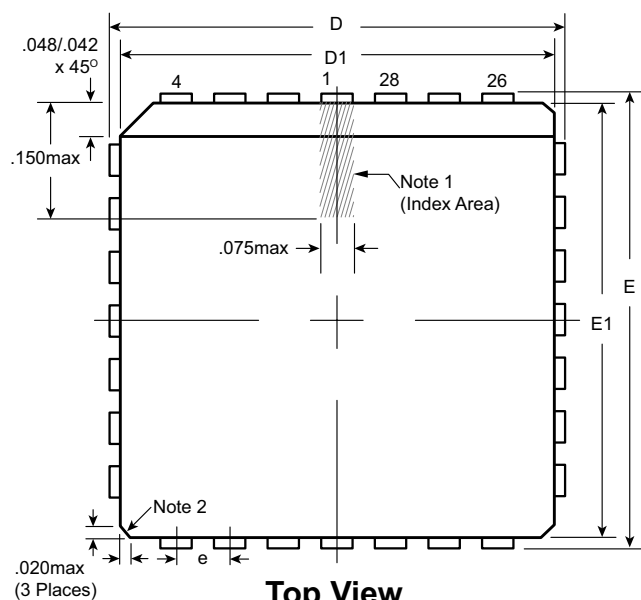
| Symbol | A | A1 | A2 | b | D | D1 | E | E1 | e | L | L1 | L2 | □ | |
|----------------|-----|-------|------|------|------|-------|-------|-------|-------|----------|------|----------|----------|------|
| Dimension (mm) | MIN | 1.40* | 0.05 | 1.35 | 0.17 | 8.80* | 6.80* | 8.80* | 6.80* | 0.50 BSC | 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.

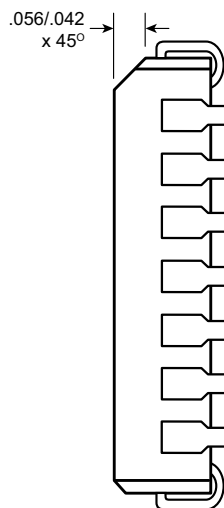
Drawings are not to scale.
 Supertex Doc. #: DSPD-48LQFPFG Version, D041309.

28-Lead PLCC Package Outline (PJ)

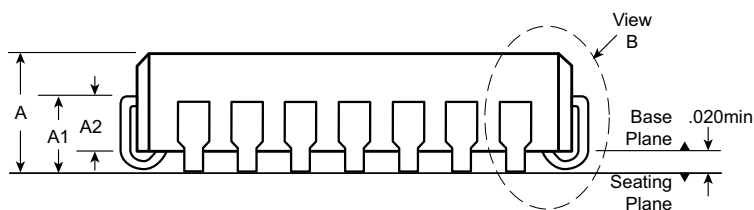
.453x.453in. body, .180in. height (max), .050in. pitch



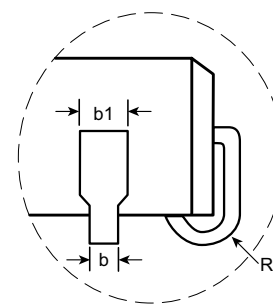
Top View



Vertical Side View



Horizontal Side View



View B

Notes:

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.
2. Actual shape of this feature may vary.

| Symbol | | A | A1 | A2 | b | b1 | D | D1 | E | E1 | e | R |
|--------------------|-----|------|------|------|------|------|------|------|------|------|----------|------|
| Dimension (inches) | MIN | .165 | .090 | .062 | .013 | .026 | .485 | .450 | .485 | .450 | .050 BSC | .025 |
| | NOM | .172 | .105 | - | - | - | .490 | .453 | .490 | .453 | | .035 |
| | MAX | .180 | .120 | .083 | .021 | .032 | .495 | .456 | .495 | .456 | | .045 |

JEDEC Registration MS-018, Variation AB, Issue A, June, 1993.

Drawings not to scale.

Supertex Doc. #: DSPD-28PLCCPJ, Version B031111.

(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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