Initial Release

# Low Charge Injection, 8-Channel, High Voltage, Enhanced Analog Switch with Bleed Resistors

## Features

- HVCMOS technology for high performance
- Integrated bleed resistors on the outputs
- 8 Channels of high voltage analog switch
- 3.3V or 5V CMOS input logic level
- 20MHz data shift clock frequency
- Very low quiescent power dissipation-10µA
- Low parasitic capacitance
- DC to 10MHz analog signal frequency
- -60dB typical off-isolation at 5MHz
- CMOS logic circuitry for low power
- Excellent noise immunity
- Cascadable serial data register with latches
- Flexible operating supply voltages

## Applications

- Medical ultrasound imaging
- NDT metal flaw detection
- Piezoelectric transducer drivers
- Inkjet printer heads
- Optical MEMS modules

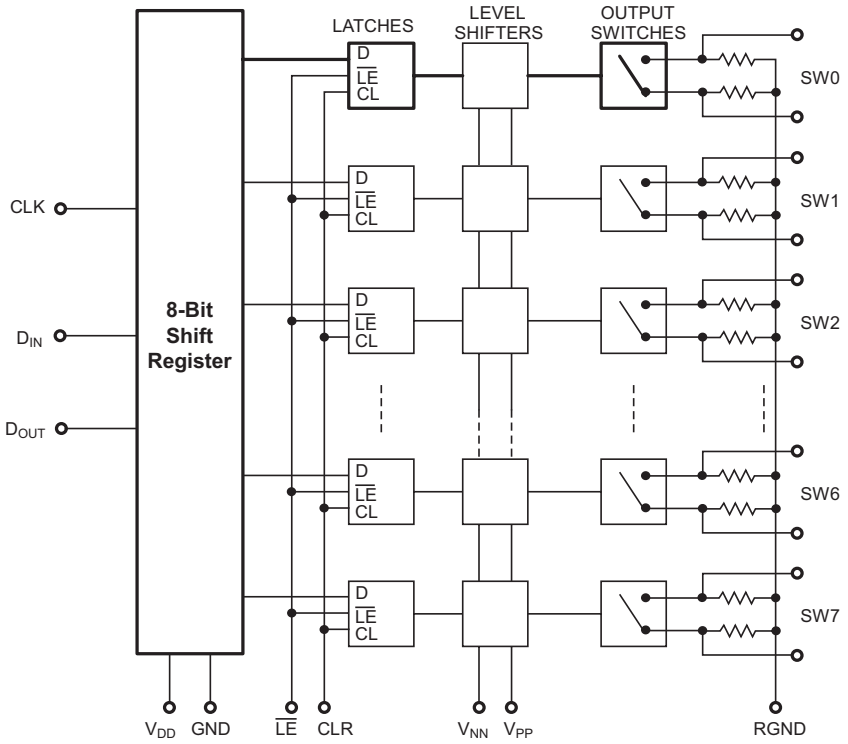
## General Description

The Supertex HV2301 is a low charge injection, 8-channel, high voltage analog switch integrated circuit (IC) with bleed resistors. The device can be used in applications requiring high voltage switching, controlled by low voltage control signals, such as medical ultrasound imaging, piezoelectric transducer driver, and printers. The built-in bleed resistors eliminate voltage built up on capacitive loads such as piezoelectric transducers. The HV2301 is an enhanced version of the HV232.

Input data is shifted into an 8-bit shift register that can then be retained in an 8-bit latch. To reduce any possible clock feed- through noise, the latch enable bar should be left high until all bits are clocked in. Data is clocked in during the rising edge of the clock. Using HVCMOS technology, this device combines high voltage bilateral DMOS switches and low power CMOS logic to provide efficient control of high voltage analog signals.

The device is suitable for various combinations of high voltage supplies, e.g., $V_{PP}/V_{NN}$: +40V/-160V, +100V/-100V, and +160V/-40V.

## Block Diagram




NR032106

## Ordering Information

| Device | Package Options | | |
|---|---|---|---|
| | 48-Lead TQFP | 28-Lead PLCC | 32-Lead BCC |
| HV2301 | HV2301FG-G | HV2301PJ-G | HV2301B1-G |

*-G indicates package is RoHS compliant ('Green')*

## Absolute Maximum Ratings

| Parameter | Value |
|---|---|
| $V_{DD}$ logic supply | -0.5V to +7V |
| $V_{PP}$-$V_{NN}$ differential supply | 220V |
| $V_{PP}$ positive supply | -0.5V to $V_{NN}$+200V |
| $V_{NN}$ negative supply | +0.5V to -200V |
| Logic input voltage | -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:<br>48-Lead TQFP<br>28-Lead PLCC<br>32-Lead BCC | <br>1.0W<br>1.2W<br>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.*

## Operating Conditions

| Symbol | Parameter | Value |
|---|---|---|
| $V_{DD}$ | Logic power supply voltage | 3.0V to 5.5V |
| $V_{PP}$ | positive high voltage supply | 40V to $V_{NN}$ +200V |
| $V_{NN}$ | negative high voltage supply | -40V to -160V |
| $V_{IH}$ | High level input voltage | 0.9V to $V_{DD}$ |
| $V_{IL}$ | Low-level input voltage | 0V to 0.1V |
| $V_{SIG}$ | 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:*

1. *Power up/down sequence is arbtrary except GND must be powered -up first and powered down last.*
2. *$V_{SIG}$ must be $V_{NN} \le V_{SIG} \le V_{PP}$ or floating during power up/down transition.*
3. *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 | 38 | - | 48 | Ω | $I_{SIG}$ = 5mA | $V_{PP}$ = +40V, $V_{NN}$ = -160V |
| | | - | 25 | - | 22 | 27 | - | 32 | | $I_{SIG}$ = 200mA | |
| | | - | 25 | - | 22 | 27 | - | 30 | | $I_{SIG}$ = 5mA | $V_{PP}$ = +100V, $V_{NN}$ = -100V |
| | | - | 18 | - | 18 | 24 | - | 27 | | $I_{SIG}$ = 200mA | |
| | | - | 23 | - | 20 | 25 | - | 30 | | $I_{SIG}$ = 5mA | $V_{PP}$ = +160V, $V_{NN}$ = -40V |
| | | - | 22 | - | 16 | 25 | - | 27 | | $I_{SIG}$ = 200mA | |
| $\Delta R_{ONS}$ | Small signal switch on-resistance matching | - | 20 | - | 5.0 | 20 | - | 20 | % | $I_{SIG}$ = 5mA, $V_{PP}$ = +100V, $V_{NN}$ = - 100V | |
| $R_{ONL}$ | Large signal switch on-resistance | - | - | - | 15 | - | - | - | Ω | $V_{SIG}$ = $V_{PP}$ -10V, $I_{SIG}$ = 1A | |
| $R_{INT}$ | Value of output bleed resistance | - | - | 20 | 35 | 50 | - | - | KΩ | Output switch to RGND $I_{RINT}$ = 0.5mA | |
| $I_{SOL}$ | Switch off leakage per switch | - | 5.0 | - | 1.0 | 10 | - | 15 | µA | $V_{SIG}$ = $V_{PP}$ -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 | mV | | |
| $I_{PPQ}$ | 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, $I_{SW}$ = 5mA | |
| $I_{NNQ}$ | Quiescent $V_{NN}$ supply current | - | - | - | -10 | -50 | - | - | µA | All switches on, $I_{SW}$ = 5mA | |
| $I_{SW}$ | Switch output peak current | - | 3.0 | - | 3.0 | 2.0 | - | 2.0 | A | $V_{SIG}$ duty cycly < 0.1% | |
| $f_{SW}$ | Output switching frequency | - | - | - | - | 50 | - | - | kHz | Duty cycle = 50% | |
| $I_{PP}$ | Average $V_{PP}$ supply current | - | 4.0 | - | - | 5.0 | - | 5.5 | mA | $V_{PP}$ = +40V, $V_{NN}$ = -160V | All output switches are turning On and Off at 50kHz with no load |
| | | - | 3.5 | - | - | 3.5 | - | 3.5 | | $V_{PP}$ = +100V, $V_{NN}$ = -100V | |
| | | - | 3.5 | - | - | 3.5 | - | 4.0 | | $V_{PP}$ = +160V, $V_{NN}$ = -40V | |
| $I_{NN}$ | Average $V_{NN}$ supply curent | - | 4.5 | - | - | 5.0 | - | 5.5 | mA | $V_{PP}$ = +40V, $V_{NN}$ = -160V | |
| | | - | 3.5 | - | - | 3.5 | - | 3.5 | | $V_{PP}$ = +100V, $V_{NN}$ = -100V | |
| | | - | 3.5 | - | - | 3.5 | - | 4.0 | | $V_{PP}$ = +160V, $V_{NN}$ = -40V | |
| $I_{DD}$ | Average $V_{DD}$ supply current | - | 4.0 | - | - | 4.0 | - | 4.0 | mA | $f_{CLK}$ = 5MHz, $V_{DD}$ = 5.0V | |
| $I_{DDQ}$ | Quiescent $V_{DD}$ supply current | - | 10 | - | - | 10 | - | 10 | µA | All logic inputs are static | |
| $I_{SOR}$ | 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, $t_R = t_F \leq 5$ns, 50% duty cycle, $C_{LOAD}$ = 20pF unless otherwise specified)*

| Sym | Parameter | 0°C | | +25°C | | | +70°C | | Units | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Typ | Max | Min | Max | | |
| $t_{SD}$ | Set up time before $\overline{LE}$ rises | 25 | - | 25 | - | - | 25 | - | ns | --- |
| $t_{WLE}$ | Time width of $\overline{LE}$ | 56 | - | - | 56 | - | 56 | - | ns | $V_{DD}$ = 3.0V |
| | | 12 | - | - | 12 | - | 12 | - | | $V_{DD}$ = 5.0V |
| $t_{DO}$ | Clock delay time to data out | - | 120 | - | 95 | 140 | - | 167 | ns | $V_{DD}$ = 3.0V |
| | | - | 58 | - | 40 | 69 | - | 85 | | $V_{DD}$ = 5.0V |
| $t_{WCL}$ | Time width of CL | 55 | - | 55 | 30 | - | 55 | - | ns | --- |
| $t_{SU}$ | Set up time data to clock | 39 | - | 47 | 30 | - | 58 | - | ns | $V_{DD}$ = 3.0V |
| | | 16 | - | 21 | 10 | - | 26 | - | | $V_{DD}$ = 5.0V |
| $t_H$ | Hold time data from clock | 2 | - | 2 | - | - | 2 | - | ns | $V_{DD}$ = 3.0 or 5.0V |
| $f_{CLK}$ | Clock frequency | - | TBD | - | - | 7.5 | - | TBD | MHz | $V_{DD}$ = 3.0V |
| | | - | 20 | - | - | 20 | - | 20 | | $V_{DD}$ = 5.0V |
| $t_R$, $t_F$ | Clock rise and fall times | - | 50 | | - | 50 | - | 50 | ns | --- |
| $t_{ON}$ | Turn on time | - | 5.0 | - | - | 5.0 | - | 5.0 | µs | $V_{SIG} = V_{PP}$ -10V, $R_{LOAD}$ = 10kΩ |
| $t_{OFF}$ | Turn off time | - | 5.0 | - | - | 5.0 | - | 5.0 | µs | $V_{SIG} = V_{PP}$ -10V, $R_{LOAD}$ = 10kΩ |
| dv/dt | Maximun $V_{SIG}$ slew rate | - | 20 | - | - | 20 | - | 20 | V/ns | $V_{PP}$ = +40V, $V_{NN}$ = -160V |
| | | - | 20 | - | - | 20 | - | 20 | | $V_{PP}$ = +100V, $V_{NN}$ = -100V |
| | | - | 20 | - | - | 20 | - | 20 | | $V_{PP}$ = +160V, $V_{NN}$ = -40V |
| $K_O$ | Off isolation | -30 | - | -30 | -33 | - | -30 | - | dB | f = 5.0MHz, 1kΩ/15pF load |
| | | -58 | - | -58 | - | - | -58 | - | | f = 5.0MHz, 50Ω load |
| $K_{CR}$ | Switch crosstalk | -60 | - | -60 | -70 | - | -60 | - | dB | f = 5.0MHz, 50Ω 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, $R_{LOAD}$ = 50Ω |
| $-V_{SPK}$ | | - | - | - | - | 150 | - | - | | |
| $+V_{SPK}$ | | - | - | - | - | 150 | - | - | | $V_{PP}$ = +100V, $V_{NN}$ = -100V, $R_{LOAD}$ = 50Ω |
| $-V_{SPK}$ | | - | - | - | - | 150 | - | - | | |
| $+V_{SPK}$ | | - | - | - | - | 150 | - | - | | $V_{PP}$ = +160V, $V_{NN}$ = -40V, $R_{LOAD}$ = 50Ω |
| $-V_{SPK}$ | | - | - | - | - | 150 | - | - | | |
| QC | Charge injection | - | - | - | 820 | - | - | - | pC | $V_{PP}$ = +40V, $V_{NN}$ = -160V, $V_{SIG}$ = 0V |
| | | - | - | - | 600 | - | - | - | | $V_{PP}$ = +100V, $V_{NN}$ = -100V, $V_{SIG}$ = 0V |
| | | - | - | - | 350 | - | - | - | | $V_{PP}$ = +160V, $V_{NN}$ = -40V, $V_{SIG}$ = 0V |

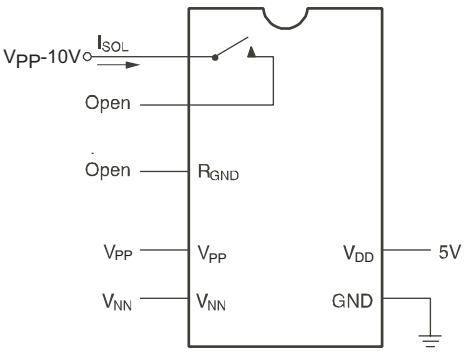
## Truth Table

| D0 | D1 | D2 | D3 | D4 | D5 | D6 | D7 | LE | CLR | 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 | | | | | | | |

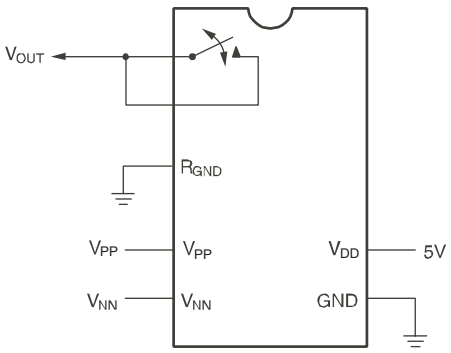
*Notes:*

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 LE. When LE is low the shift register data flow through the latch.*
4. *$D_{OUT}$ is high when data in the register 7 is high.*
5. *Shift register clocking has no effect on the switch states if LE is high.*
6. *The CLR clear input overrides all other inputs.*

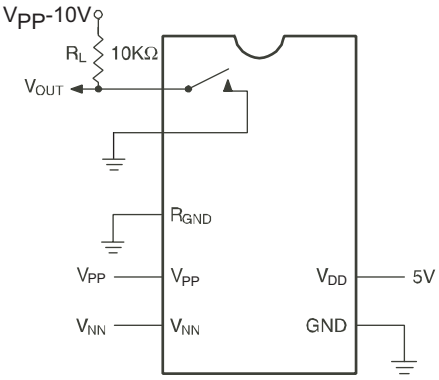
## Test Circuits



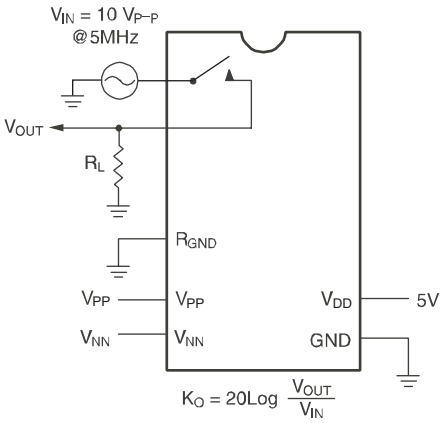

Switch OFF Leakage



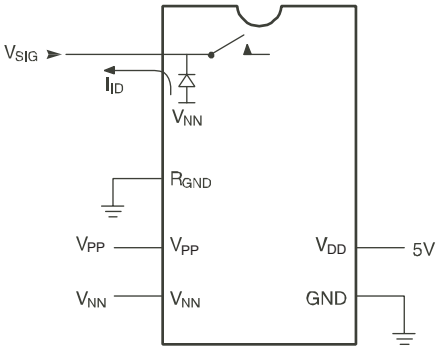

DC Offset ON/OFF



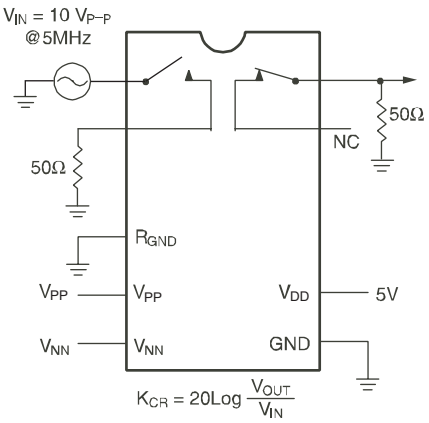

$T_{ON}/T_{OFF}$ Test Circuit



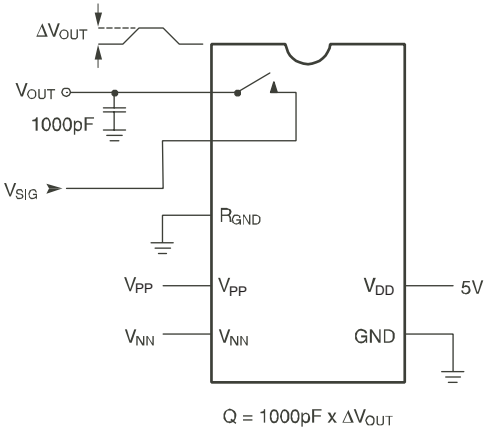

OFF Isolation



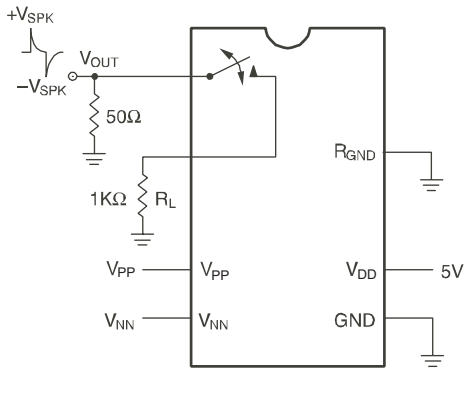

Isolation Diode Current




Crosstalk

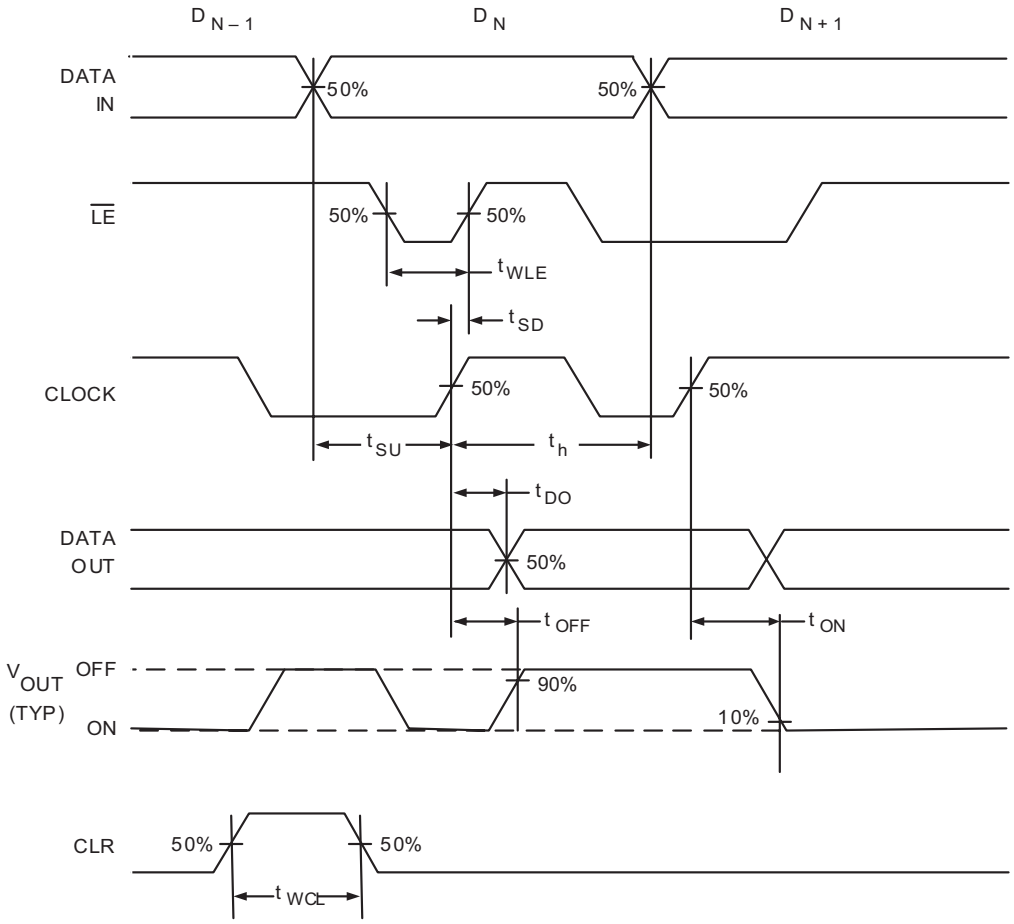



Charge Injection

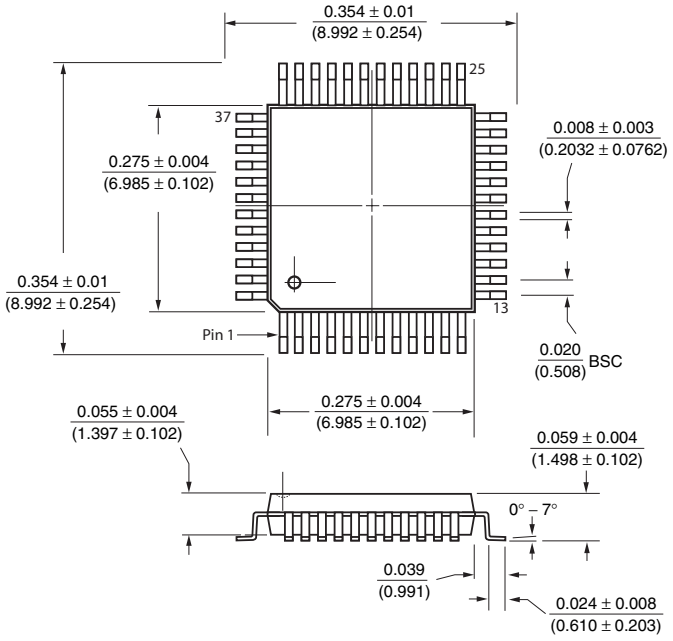



Output Voltage Spike

## Typical Waveforms



## 48-Lead TQFP (1.4mm) Package Outline (FG)

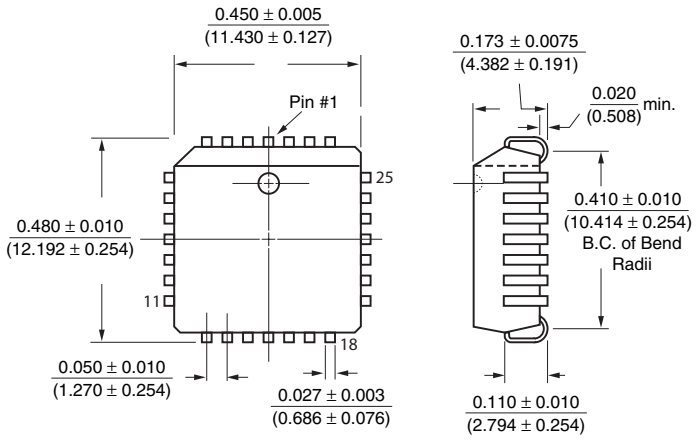



Measurement Legend = Dimensions in Inches / (Dimensions in Millimeters)

## Pin Configuration

| Pin # | Pin Name | Pin # | Pin Name |
|---|---|---|---|
| 1 | SW5 | 25 | $V_{NN}$ |
| 2 | NC | 26 | NC |
| 3 | SW4 | 27 | RGND |
| 4 | NC | 28 | GND |
| 5 | SW4 | 29 | $V_{DD}$ |
| 6 | NC | 30 | NC |
| 7 | NC | 31 | NC |
| 8 | SW3 | 32 | NC |
| 9 | NC | 33 | $D_{IN}$ |
| 10 | SW3 | 34 | CLK |
| 11 | NC | 35 | $\overline{LE}$ |
| 12 | SW2 | 36 | CLR |
| 13 | NC | 37 | $D_{OUT}$ |
| 14 | SW2 | 38 | NC |
| 15 | NC | 39 | SW7 |
| 16 | SW1 | 40 | NC |
| 17 | NC | 41 | SW7 |
| 18 | SW1 | 42 | NC |
| 19 | NC | 43 | SW6 |
| 20 | SW0 | 44 | NC |
| 21 | NC | 45 | SW6 |
| 22 | SW0 | 46 | NC |
| 23 | NC | 47 | SW5 |
| 24 | $V_{PP}$ | 48 | NC |

## 28-Lead PLCC Package Outline (PJ)

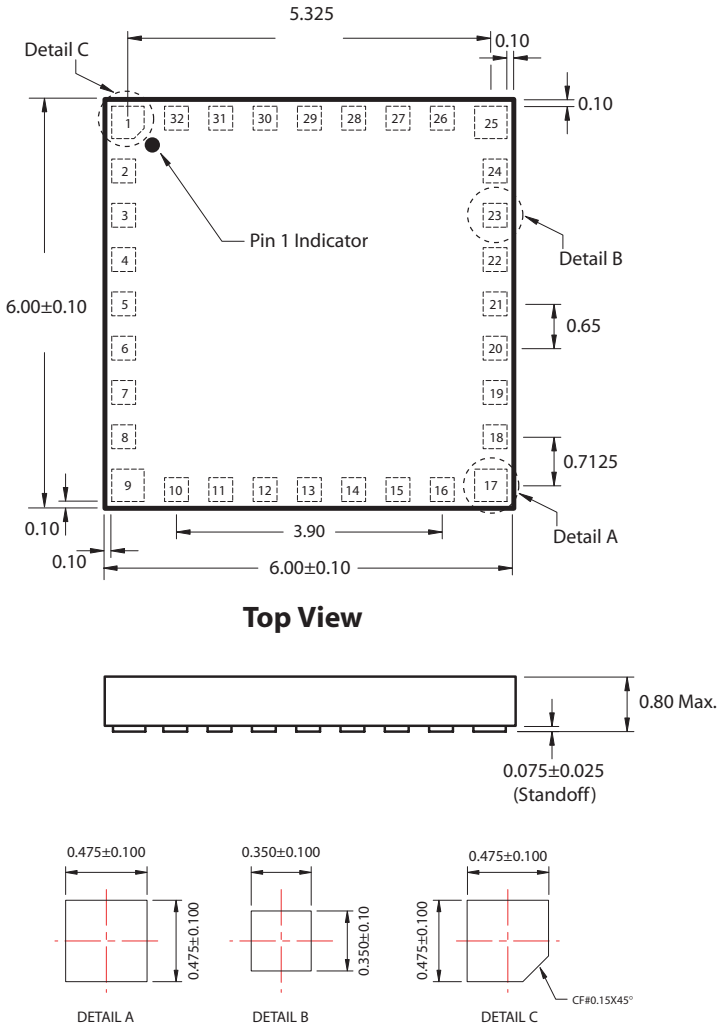



Measurement Legend = Dimensions in Inches / (Dimensions in Millimeters)

## Pin Configuration

| Pin # | Pin Name | Pin # | Pin Name |
|---|---|---|---|
| 1 | SW3 | 15 | NC |
| 2 | SW3 | 16 | $D_{IN}$ |
| 3 | SW2 | 17 | CLK |
| 4 | SW2 | 18 | $\overline{LE}$ |
| 5 | SW1 | 19 | CLR |
| 6 | SW1 | 20 | $D_{OUT}$ |
| 7 | SW0 | 21 | SW7 |
| 8 | SW0 | 22 | SW7 |
| 9 | NC | 23 | SW6 |
| 10 | $V_{PP}$ | 24 | SW6 |
| 11 | RGND | 25 | SW5 |
| 12 | $V_{NN}$ | 26 | SW5 |
| 13 | GND | 27 | SW4 |
| 14 | $V_{DD}$ | 28 | SW4 |

## 32-Lead BCC
## Package Outline (B1)




Note: All dimensions are in mm and angles are in degrees

## Pin Configuration

| Pin # | Pin Name | Pin # | Pin Name |
|---|---|---|---|
| 1 | NC | 17 | NC |
| 2 | SW5 | 18 | $V_{NN}$ |
| 3 | SW5 | 19 | RGND |
| 4 | SW4 | 20 | GND |
| 5 | SW4 | 21 | $V_{DD}$ |
| 6 | SW3 | 22 | $D_{IN}$ |
| 7 | SW3 | 23 | CLK |
| 8 | SW2 | 24 | $\overline{LE}$ |
| 9 | SW2 | 25 | CLR |
| 10 | NC | 26 | $D_{OUT}$ |
| 11 | SW1 | 27 | NC |
| 12 | SW1 | 28 | SW7 |
| 13 | SW0 | 29 | SW7 |
| 14 | SW0 | 30 | SW6 |
| 15 | NC | 31 | SW6 |
| 16 | $V_{PP}$ | 32 | NC |

*(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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*ИНН 7805602321 КПП 780501001 Р/С 40702810122510004610 ФАКБ "АБСОЛЮТ БАНК" (ЗАО) в г.Санкт-Петербурге К/С 30101810900000000703 БИК 044030703*

*Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.*

*С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров*

*Мы предлагаем:*

- *Конкурентоспособные цены и скидки постоянным клиентам.*
- *Специальные условия для постоянных клиентов.*
- *Подбор аналогов.*
- *Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.*

- *Приемлемые сроки поставки, возможна ускоренная поставка.*
- *Доставку товара в любую точку России и стран СНГ.*
- *Комплексную поставку.*
- *Работу по проектам и поставку образцов.*
- *Формирование склада под заказчика.*

- *Сертификаты соответствия на поставляемую продукцию (по желанию клиента).*
- *Тестирование поставляемой продукции.*
- *Поставку компонентов, требующих военную и космическую приемку.*
- *Входной контроль качества.*
- *Наличие сертификата ISO.*

*В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.*

*Конструкторский отдел помогает осуществить:*

- *Регистрацию проекта у производителя компонентов.*
- *Техническую поддержку проекта.*
- *Защиту от снятия компонента с производства.*
- *Оценку стоимости проекта по компонентам.*
- *Изготовление тестовой платы монтаж и пусконаладочные работы.*

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