# 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
- 5.0V 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

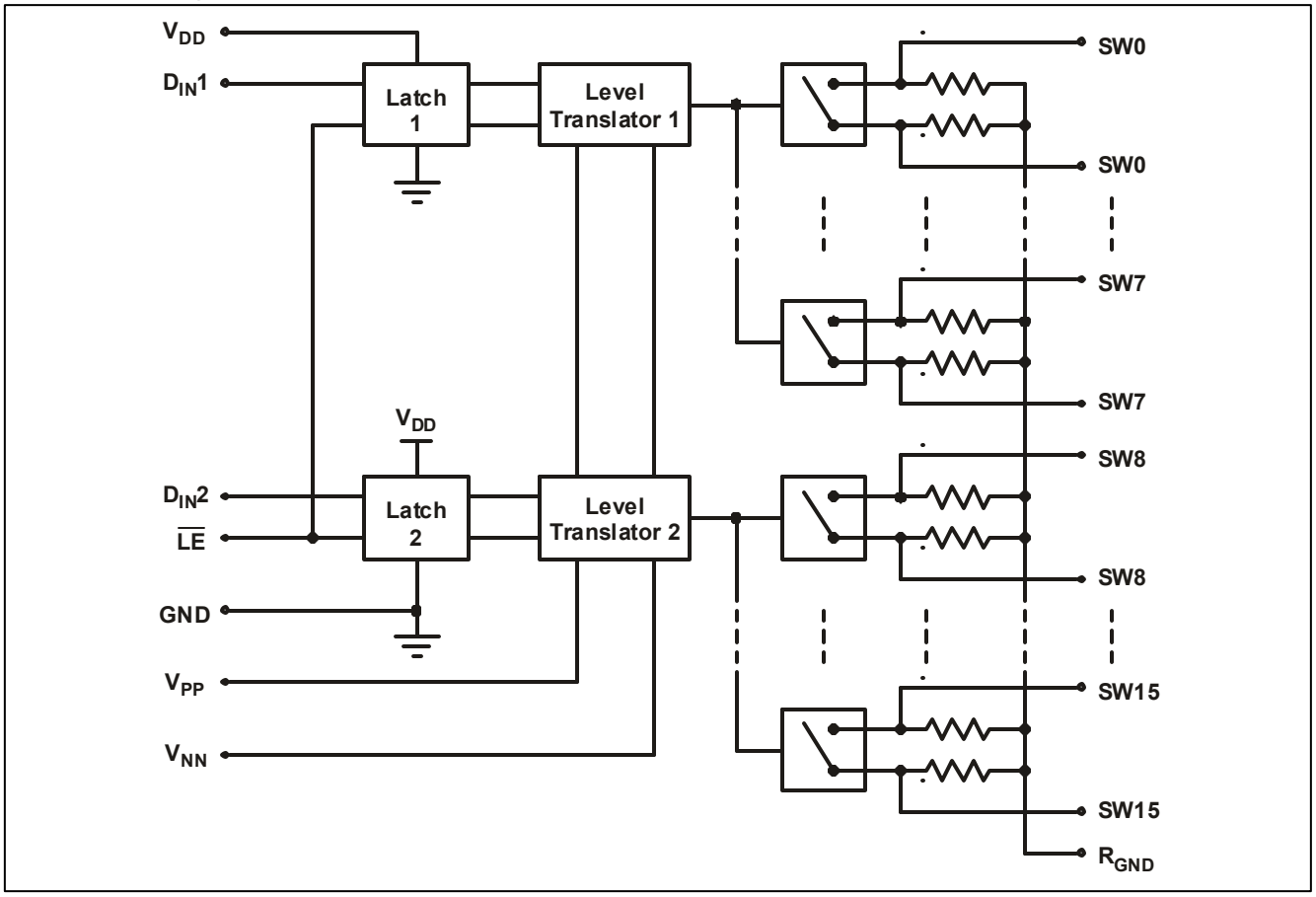
- Medical ultrasound imaging
- Piezoelectric transducer drivers

## 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, $D_{IN}1$ and $D_{IN}2$. A logic high on $D_{IN}1$ will turn ON switches 0 to 7 and a logic high on $D_{IN}2$ will turn ON switches 8 to 15. The bleed resistors help significantly reduce voltage built up on capacitive loads such as piezoelectric transducers connected to the outputs.

## Block Diagram



# Ordering Information

| Device | Package Options |
|---|---|
| | 48 Lead TQFP |
| HV238 | HV238FG |

# Absolute Maximum Ratings*

| | |
|---|---|
| $V_{DD}$ Logic supply | -0.5V to +15V |
| $V_{PP}$-$V_{NN}$ differential supply | 225V |
| $V_{PP}$ Positive supply | -0.5V to $V_{NN}$+225V |
| $V_{NN}$ Negative supply | +0.5V to –225V |
| 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 48 lead TQFP | 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.*

# Operating Conditions*

| Symbol | Parameter | Value |
|---|---|---|
| $V_{PP}$ | Positive high voltage supply | 50V to 110V |
| $V_{NN}$ | Negative high voltage supply | -10V to $V_{PP}$ –220V |
| $V_{DD}$ | Logic power supply voltage | 4.75V to 12.6V |
| $V_{IH}$ | 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:**

1 Power up/down sequence is arbitrary except GND must be powered-up first and powered-down last.

2 $V_{SIG}$ must be within $V_{NN}$ and $V_{PP}$ 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.

# Truth Table

| $D_{IN}2$ | $D_{IN}1$ | LE bar | 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 | |

# Electrical Characteristics

## DC Characteristics *(over recommended operating conditions unless otherwise noted)*

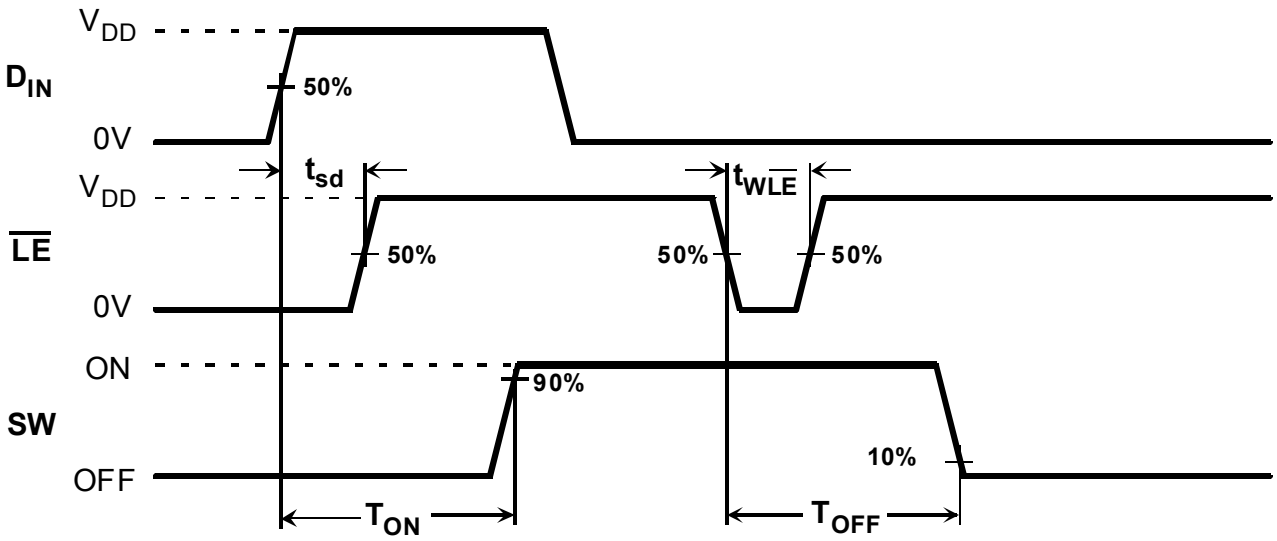
| Sym | Parameter | 0°C | | +25°C | | | +70°C | | Units | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Typ | Max | Min | Max | | |
| $R_{ONS}$ | Small Signal Switch On-Resistance | | 30 | | 26 | 32 | | 40 | Ω | $V_{SIG}$=0V, $I_{SIG}$=5mA, $V_{PP}$=50V, $V_{NN}$=-170V |
| | | | 25 | | 22 | 27 | | 35 | | $V_{SIG}$=0V, $I_{SIG}$=200mA, $V_{PP}$=50V, $V_{NN}$=-170V |
| | | | 15 | | 22 | 27 | | 30 | | $V_{SIG}$=0V, $I_{SIG}$=5mA, $V_{PP}$=110V, $V_{NN}$=-110V |
| | | | 20 | | 18 | 22 | | 25 | | $V_{SIG}$=0V, $I_{SIG}$=200mA, $V_{PP}$=110V, $V_{NN}$=-110V |
| $\Delta R_{ONS}$ | Small Signal Switch On-Resistance Matching | | 20 | | 5.0 | 20 | | 20 | % | $V_{SIG}$=0V, $I_{SIG}$=5mA, $V_{PP}$=110V, $V_{NN}$=-110V |
| $R_{ONL}$ | Large Signal Switch On-Resistance | | | | 15 | | | | Ω | $V_{SIG}$=0V, $I_{SIG}$=1.0A |
| $R_{INT}$ | Output Switch Shunt Resistance | | | 20 | 35 | 50 | | | KΩ | 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 and $V_{NN}$=+10V |
| | 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, $I_{SW}$=5mA |
| $I_{NNQ}$ | Quiescent $V_{NN}$ supply current | | | | -10 | -50 | | | µA | All switches on, $I_{SW}$=5mA |
| | Switch output peak current | | 3.0 | | 3.0 | 2.0 | | 2.0 | A | $V_{SIG}$ duty cycle < 0.1% |
| $f_{SW}$ | Output switch 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, All Switches 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, All Switches turning ON and OFF at 50kHz |
| $I_{NN}$ | Average $V_{NN}$ supply current | | 5.0 | | | -6.3 | | -6.9 | | |
| $I_{DDQ}$ | Quiescent $V_{DD}$ supply current | | 10 | | | 10 | | 10 | µA | All logic inputs are static |
| $I_{DD}$ | Average $V_{DD}$ supply current | | 2.0 | | | 2.0 | | 2.0 | mA | $D_{IN}$1= $D_{IN}$2=3MHz, LE bar =high |
| $C_{IN}$ | Logic input capacitance | | 10 | | | 10 | | 10 | pF | |

# Electrical Characteristics

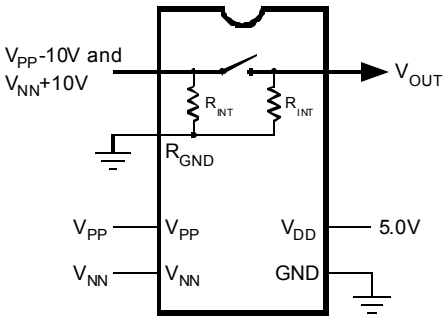
## AC Characteristics *(over recommended operating conditions unless otherwise noted)*

| Sym | Parameter | 0°C | | +25°C | | | +70°C | | Units | Conditions |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Min | Max | Min | Typ | Max | Min | Max | | |
| $t_{WLE}$ | Time Width of LE bar | 150 | | 150 | | | 150 | | ns | |
| $t_{WDIN}$ | Time Width of $D_{IN}$ | 150 | | 150 | | | 150 | | ns | |
| $t_{SD}$ | Set Up Time Before LE bar Rises | 150 | | 150 | | | 150 | | ns | |
| $T_{ON}$ | Turn On Time | | 2.0 | | | 2.0 | | 2.0 | µs | $V_{SIG}=V_{PP}$-10V, $R_{LOAD}$=10KΩ |
| $T_{OFF}$ | Turn Off Time | | 2.0 | | | 2.0 | | 2.0 | µs | $V_{SIG}=V_{PP}$-10V, $R_{LOAD}$=10KΩ |
| dv/dt | Maximum Vsig Slew Rate | | 20 | | | 20 | | 20 | V/ns | |
| KO | Off Isolation | -30 | | -30 | -33 | | -30 | | dB | f=5MHz, Load=1KΩ//15pF |
| | | -45 | | -45 | -50 | | -45 | | | f=7.5MHz, $R_{LOAD}$=50Ω |
| $K_{CR}$ | Switch Crosstalk | -45 | | -45 | | | -45 | | dB | f=5.0MHz, $R_{LOAD}$=50Ω |
| $I_{ID}$ | Output Switch Isolation Diode Current | | 300 | | | 300 | | 300 | mA | 300ns pulse width, 2.0% duty cycle |
| $C_{SG(OFF)}$ | Off Capacitance Switch to Gnd | 5.0 | 17 | 5.0 | 12 | 17 | 5.0 | 17 | pF | $V_{SIG}$=0V, f=1.0MHz |
| $C_{SG(ON)}$ | On Capacitance Swithc to Gnd | 25 | 50 | 25 | 38 | 50 | 25 | 50 | pF | $V_{SIG}$=0V, f=1.0MHz |
| $+V_{SPK}$ | Output Voltage Spike | | | | 4.0 | | | | V | $R_{LOAD}$=50Ω |
| $-V_{SPK}$ | | | | | -4.0 | | | | | |

# Logic Timing Diagram

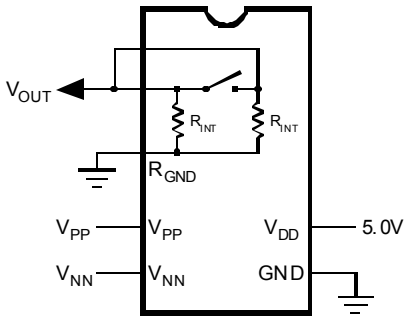


# Test Circuits

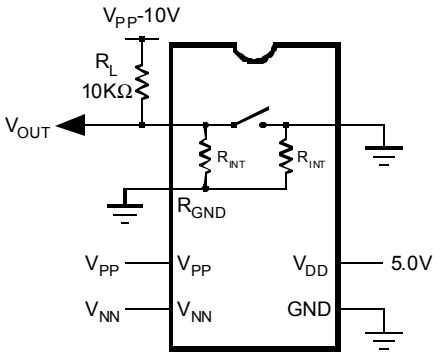



$$I_{SOL} = \frac{V_{OUT}}{R_{INT}}$$

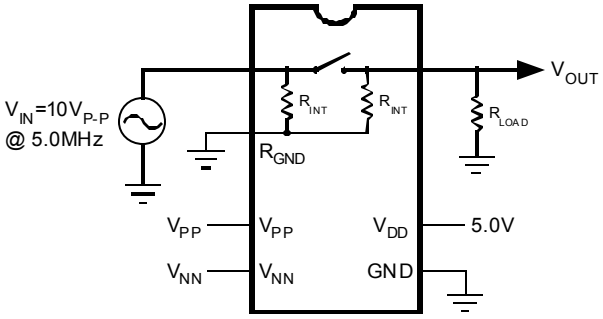
Switch OFF Leakage




DC Offset ON/OFF

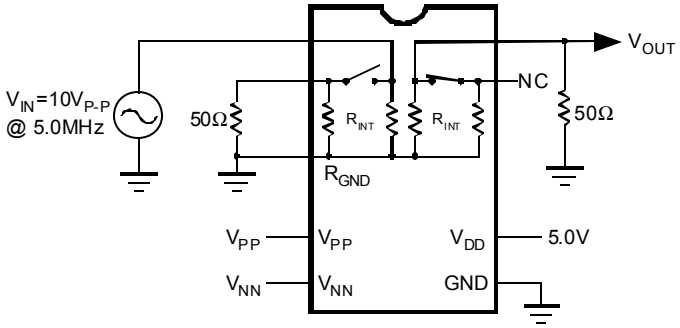



$T_{ON}/T_{OFF}$



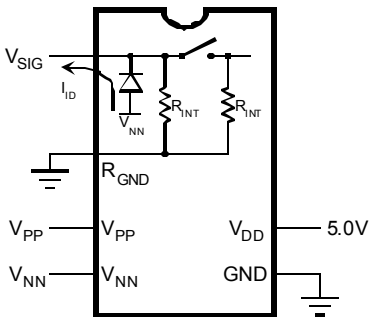

$$KO = 20Log\frac{V_{OUT}}{V_{IN}}$$

Off Isolation

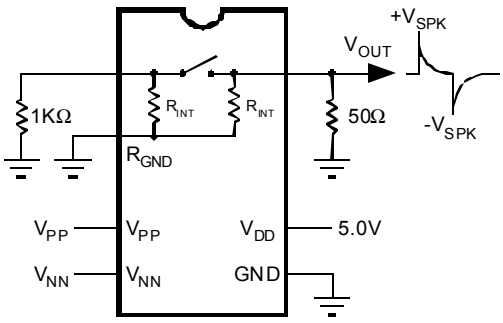



$$K_{CR} = 20Log\frac{V_{OUT}}{V_{IN}}$$

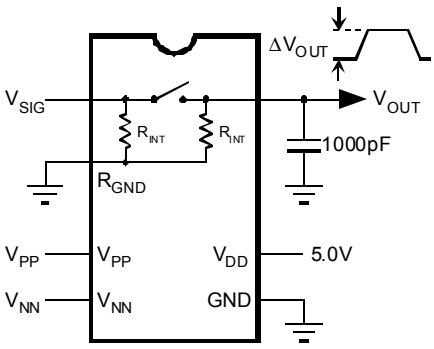
Crosstalk




Isolation Diode Current




Output Voltage Spike



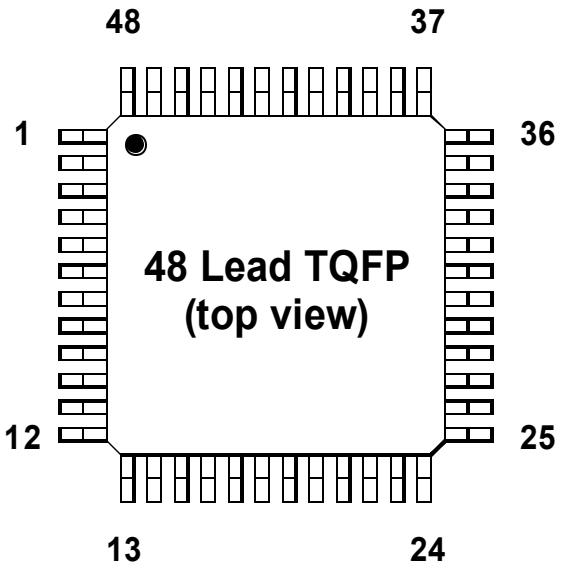

Q = 1000pF x $\Delta V_{OUT}$

Charge Injection

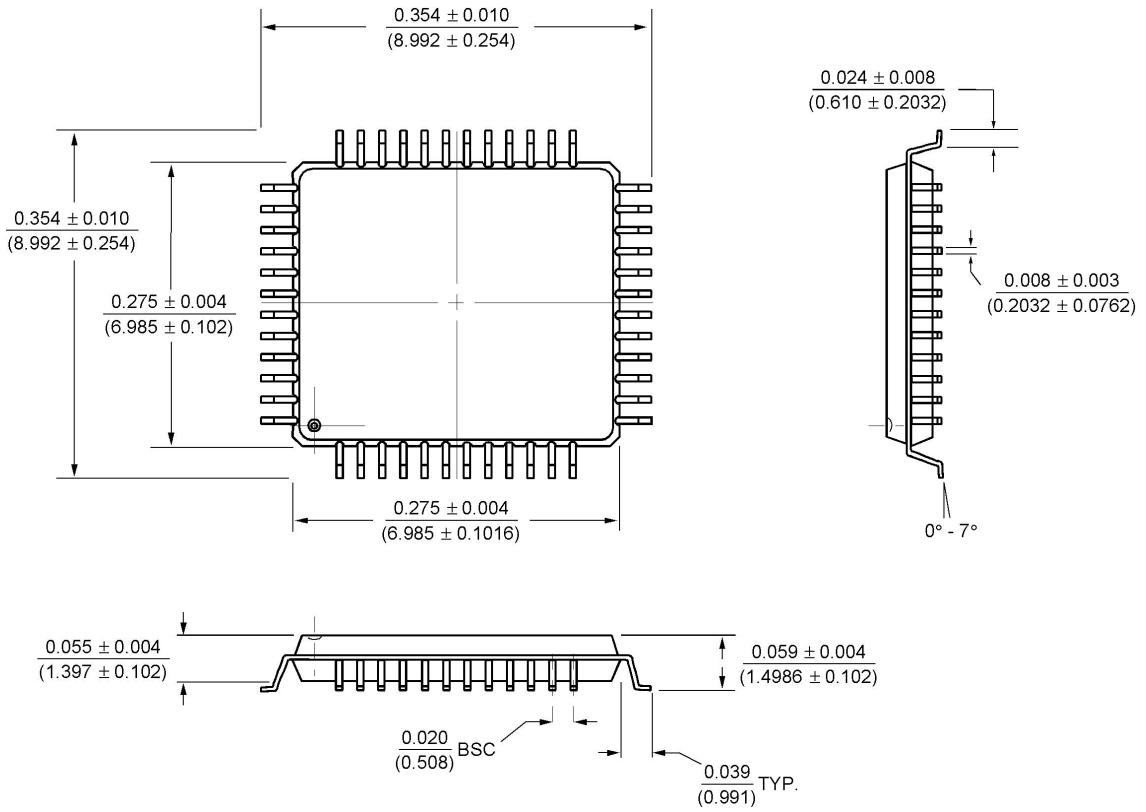
# Pin Configurations

### 48 Lead TQFP

| Pin | Function | Pin | Function |
|---|---|---|---|
| 1 | $V_{NN}$ | 25 | SW10 |
| 2 | N/C | 26 | SW10 |
| 3 | $V_{PP}$ | 27 | SW9 |
| 4 | N/C | 28 | SW9 |
| 5 | $D_{IN}1$ | 29 | SW8 |
| 6 | LE bar | 30 | SW8 |
| 7 | $D_{IN}2$ | 31 | SW7 |
| 8 | N/C | 32 | SW7 |
| 9 | N/C | 33 | SW6 |
| 10 | $V_{DD}$ | 34 | SW6 |
| 11 | GND | 35 | SW5 |
| 12 | N/C | 36 | SW5 |
| 13 | $R_{GND}$ | 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 TQFP Package Dimension




Measurement Legend = $\frac{\text{Dimensions in Inches}}{\text{(Dimensions in Millimeters)}}$



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