

## 16-Channel (2 Banks of 8-Channels), High Voltage, Analog Switch With Bleed Resistors

### Features

- ▶ HVCMOS® technology for high performance
- ▶ 220V operating conditions
- ▶ 22Ω typical output on-resistance
- ▶ Integrated bleed resistors on the outputs
- ▶ 3.3V and 5.0V 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
- ▶ 48-lead LQFP package

### Applications

- ▶ Medical ultrasound imaging
- ▶ Non-destructive evaluation

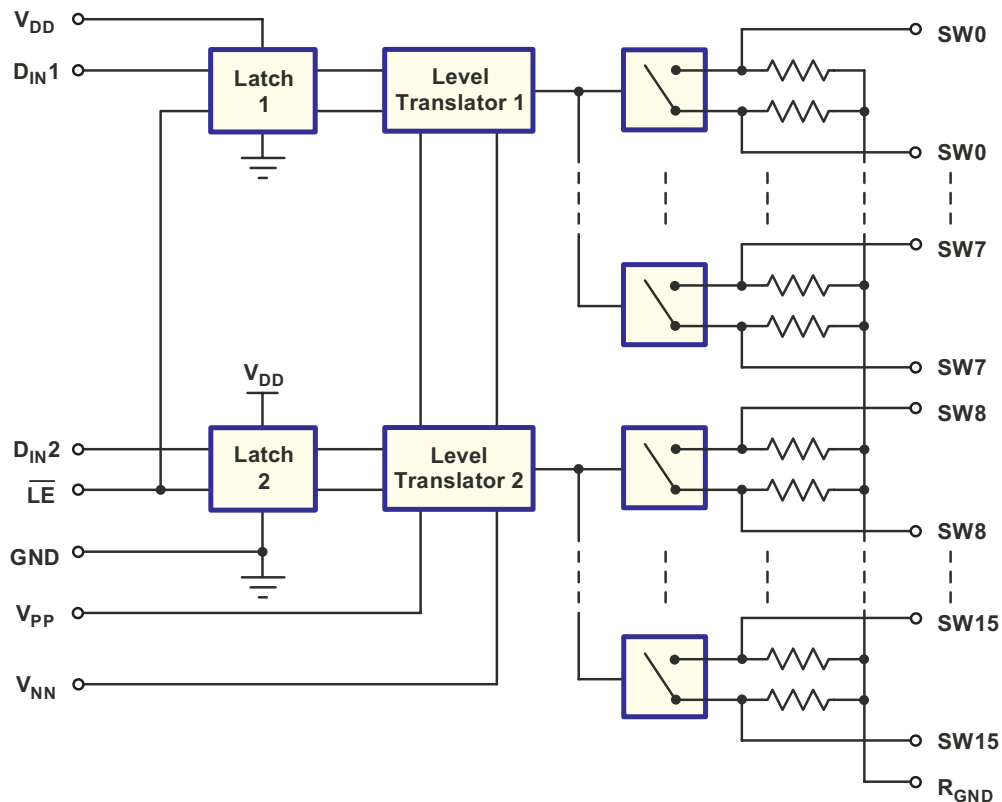
### General Description

The Supertex HV2731 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. The IC 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.

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.

### Block Diagram



## Ordering Information

Device	48-Lead LQFP 7x7mm body, 1.4mm height (min), 0.50mm pitch
HV2731	HV2731FG-G

-G indicates package is RoHS compliant ("Green")

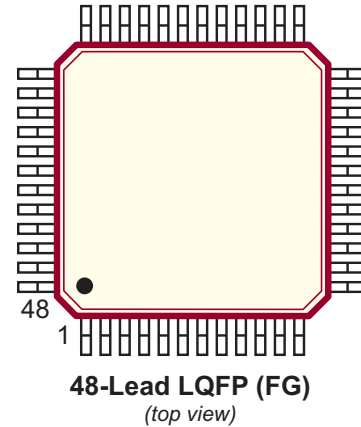


## Absolute Maximum Ratings

Parameter	Value
$V_{DD}$ logic supply	-0.5V to +7.0V
$V_{PP}$ - $V_{NN}$ 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	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



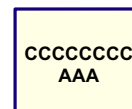
## Product Marking

Top Marking



YY = Year Sealed  
 WW = Week Sealed  
 L = Lot Number  
 C = Country of Origin\*  
 A = Assembler ID\*

Bottom Marking



— = "Green" Packaging  
 \*May be part of top marking

48-Lead LQFP (FG)

## Recommended Operating Conditions

Sym	Parameter	Value
$V_{DD}$	Logic power supply voltage	3.0V to 5.5V
$V_{PP}$	Positive driver 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:

1. Power up/down sequence is arbitrary except GND must be powered-up first and powered-down last.
2.  $V_{SIG}$  must be  $V_{NN} \leq V_{SIG} \leq V_{PP}$  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 recommended operating conditions unless otherwise specified)

Sym	Parameter	0°C		+25°C			+70°C		Units	Conditions
		Min	Max	Min	Typ	Max	Min	Max		
R <sub>ONS</sub>	Small signal switch on-resistance	-	30	-	26	32	-	40	Ω	V <sub>SIG</sub> = 0V, I <sub>SIG</sub> = 5.0mA, V <sub>PP</sub> = +50V, V <sub>NN</sub> = -170V
		-	25	-	22	27	-	35		V <sub>SIG</sub> = 0V, I <sub>SIG</sub> = 200mA, V <sub>PP</sub> = +50V, V <sub>NN</sub> = -170V
		-	15	-	22	27	-	30		V <sub>SIG</sub> = 0V, I <sub>SIG</sub> = 5.0mA, V <sub>PP</sub> = +110V, V <sub>NN</sub> = -110V
		-	20	-	18	22	-	25		V <sub>SIG</sub> = 0V, I <sub>SIG</sub> = 200mA, V <sub>PP</sub> = +110V, V <sub>NN</sub> = -110V
ΔR <sub>ONS</sub>	Small signal switch on-resistance matching	-	20	-	5.0	20	-	20	%	V <sub>SIG</sub> = 0V, I <sub>SIG</sub> = 5.0mA, V <sub>PP</sub> = +110V, V <sub>NN</sub> = -110V
R <sub>ONL</sub>	Large signal switch on-resistance	-	-	-	15	-	-	-	Ω	V <sub>SIG</sub> = 0V, I <sub>SIG</sub> = 1.0A
R <sub>INT</sub>	Output switch shunt resistance	-	-	20	35	50	-	-	KΩ	Output switch to R <sub>GND</sub> I <sub>RINT</sub> = 0.5mA
I <sub>SOL</sub>	Switch off-leakage per switch	-	5.0	-	1.0	10	-	15	μA	V <sub>SIG</sub> = V <sub>PP</sub> -10V, V <sub>NN</sub> = +10V
V <sub>OS(OFF)</sub>	DC offset switch off	-	300	-	100	300	-	300	mV	No load
V <sub>OS(ON)</sub>	DC offset switch on	-	500	-	100	500	-	500		
I <sub>PPQ</sub>	Quiescent V <sub>PP</sub> supply current	-	-	-	10	50	-	-	μA	All switches off
I <sub>NNQ</sub>	Quiescent V <sub>NN</sub> supply current	-	-	-	-10	-50	-	-		
I <sub>PPQ</sub>	Quiescent V <sub>PP</sub> supply current	-	-	-	10	50	-	-	μA	All switches on, I <sub>SW</sub> = 5.0mA
I <sub>NNQ</sub>	Quiescent V <sub>NN</sub> supply current	-	-	-	-10	-50	-	-		
I <sub>SW</sub>	Switch output peak current	-	3.0	-	3.0	2.0	-	2.0	A	V <sub>SIG</sub> duty cycle < 0.1%
f <sub>SW</sub>	Output switching frequency	-	-	-	-	50	-	-	kHz	Duty cycle = 50%
I <sub>PP</sub>	Average V <sub>PP</sub> supply current	-	8.1	-	-	8.8	-	10	mA	V <sub>PP</sub> = 50V, V <sub>NN</sub> = -170V, All switches turning on and off at 50kHz
I <sub>NN</sub>	Average V <sub>NN</sub> supply current	-	-8.1	-	-	-8.8	-	-10		
I <sub>PP</sub>	Average V <sub>PP</sub> supply current	-	8.1	-	-	6.3	-	6.9	mA	V <sub>PP</sub> = 110V, V <sub>NN</sub> = -110V, All switches turning on and off at 50kHz
I <sub>NN</sub>	Average V <sub>NN</sub> supply current	-	-8.1	-	-	-6.3	-	-6.9		
I <sub>DDQ</sub>	Quiescent V <sub>DD</sub> supply current	-	10	-	-	10	-	10	μA	All logic inputs are static
I <sub>DD</sub>	Average V <sub>DD</sub> supply current	-	2.0	-	-	2.0	-	2.0	mA	D <sub>IN1</sub> = D <sub>IN2</sub> = 3.0MHz, LE = high
C <sub>IN</sub>	Logic input capacitance	-	10	-	-	10	-	10	pF	---

**AC Electrical Characteristics**

(Over recommended operating conditions unless otherwise specified)

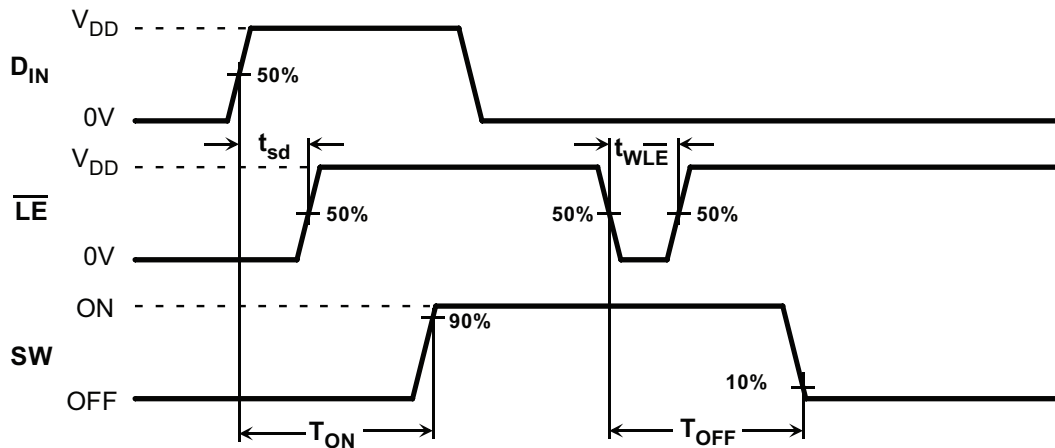
Sym	Parameter	0°C		+25°C			+70°C		Units	Conditions
		Min	Max	Min	Typ	Max	Min	Max		
t <sub>WLE</sub>	Time width of $\overline{LE}$	150	-	150	-	-	150	-	ns	---
t <sub>WDIN</sub>	Time width of D <sub>IN</sub>	150	-	150	-	-	150	-	ns	---
t <sub>SD</sub>	Set up time before $\overline{LE}$ rises	150	-	150	-	-	150	-	ns	---

**AC Electrical Characteristics** (cont.)

(Over recommended operating conditions unless otherwise specified)

Sym	Parameter	0°C		+25°C			+70°C		Units	Conditions
		Min	Max	Min	Typ	Max	Min	Max		
t <sub>ON</sub>	Turn on time	-	5.0	-	-	5.0	-	5.0	μs	V <sub>SIG</sub> = V <sub>PP</sub> -10V, R <sub>LOAD</sub> = 10KΩ
t <sub>OFF</sub>	Turn off time	-	5.0	-	-	5.0	-	5.0		
dv/dt	Maximum V <sub>SIG</sub> slew rate	-	20	-	-	20	-	20	V/ns	---
K <sub>O</sub>	Off isolation	-30	-	-30	-33	-	-30	-	dB	f = 5.0MHz, load = 1.0KΩ/15pF
		-45	-	-45	-50	-	-45	-		f = 7.5MHz, R <sub>LOAD</sub> = 50KΩ
K <sub>CR</sub>	Switch crosstalk	-45	-	-45	-	-	-45	-	dB	f = 5.0MHz, R <sub>LOAD</sub> = 50KΩ
I <sub>ID</sub>	Output switch isolation diode current	-	300	-	-	300	-	300	mA	300ns pulse width, 2.0% duty cycle
C <sub>SG(OFF)</sub>	Off capacitance SW to GND	5.0	17	5.0	12	17	5.0	17	pF	V <sub>SIG</sub> = 0V, f = 1.0MHz
C <sub>SG(ON)</sub>	On capacitance SW to GND	25	50	25	38	50	25	50	pF	V <sub>SIG</sub> = 0V, f = 1.0MHz
+V <sub>SPK</sub>	Output voltage spike	-	-	-	250	-	-	-	mV	R <sub>LOAD</sub> = 50Ω
-V <sub>SPK</sub>		-	-	-	500	-	-	-		
QC	Charge injection	-	-	-	770	-	-	-	PC	V <sub>PP</sub> = +50V, V <sub>NN</sub> = -170V
		-	-	-	620	-	-	-		V <sub>PP</sub> = +110V, V <sub>NN</sub> = -110V

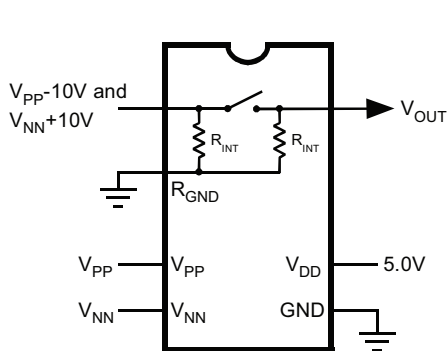
**Logic Timing Waveforms**



**Truth Table**

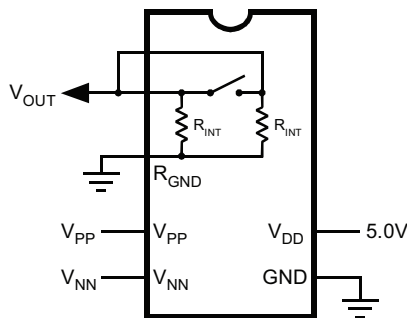
DIN2	DIN1	LE	SW0 to SW7	SW8 to SW15
L	L	L	OFF	OFF
L	H	L	ON	OFF
H	L	L	OFF	ON
H	H	L	ON	ON
X	X	H	Hold Previous State	

Test Circuits

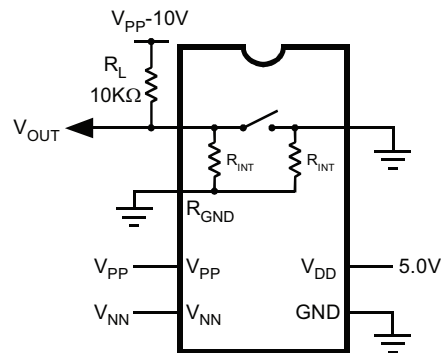


$$I_{SOL} = \frac{V_{OUT}}{R_{INT}}$$

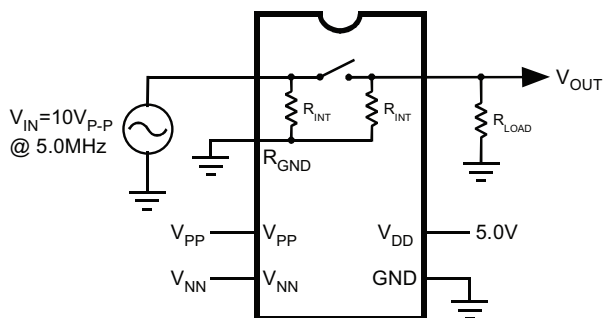
Switch OFF Leakage



DC Offset ON/OFF

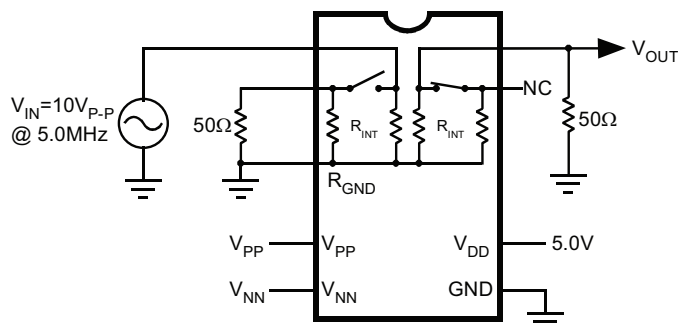


T<sub>ON</sub>/T<sub>OFF</sub>



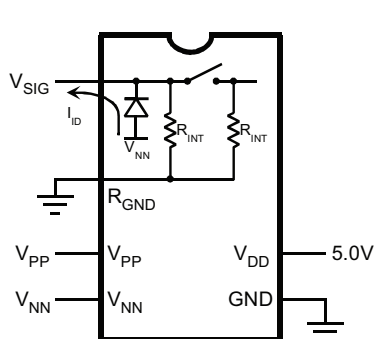
$$KO = 20 \text{Log} \frac{V_{OUT}}{V_{IN}}$$

Off Isolation

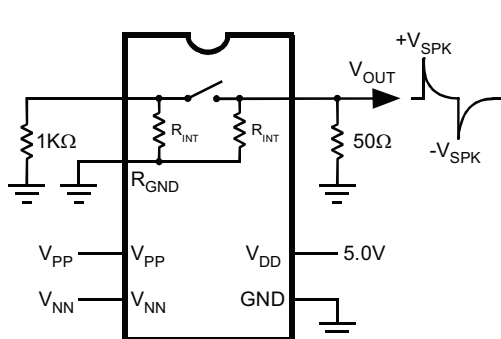


$$K_{CR} = 20 \text{Log} \frac{V_{OUT}}{V_{IN}}$$

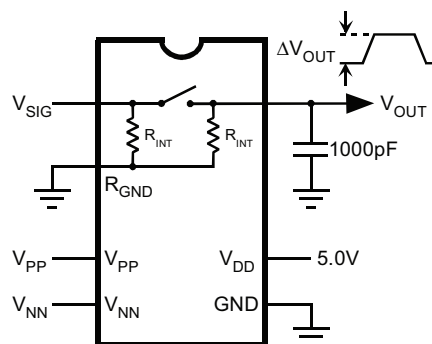
Crosstalk



Isolation Diode Current



Output Voltage Spike



$$Q = 1000\text{pF} \times \Delta V_{OUT}$$

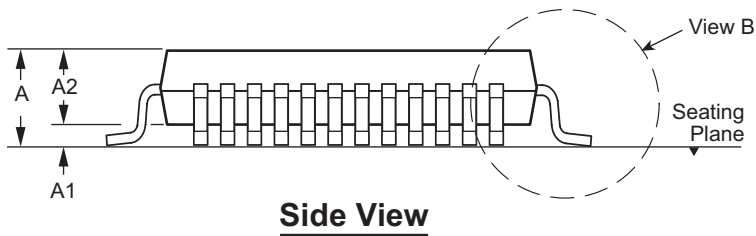
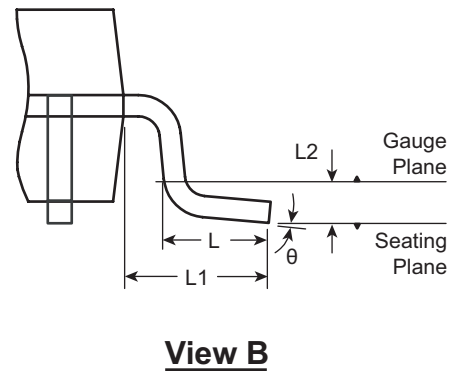
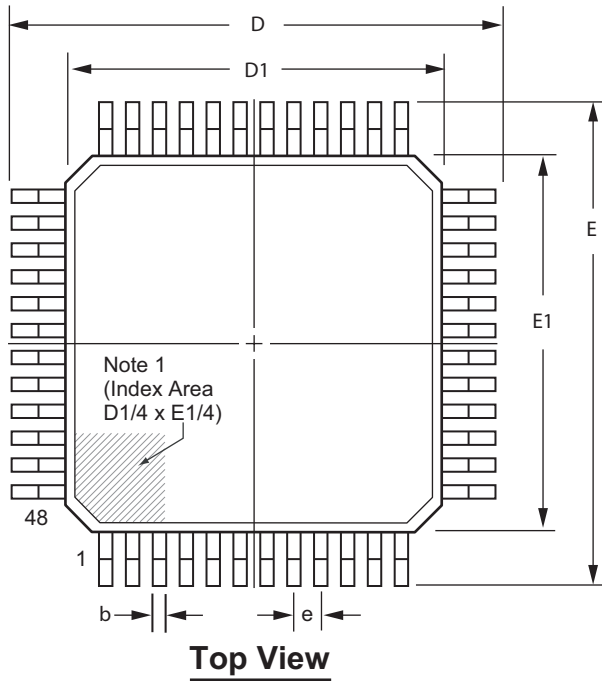
Charge Injection

## Pin Configuration

Pin	Function	Pin	Function
1	VNN	25	SW10
2	N/C	26	SW10
3	VPP	27	SW9
4	N/C	28	SW9
5	D <sub>IN</sub> 1	29	SW8
6	$\overline{LE}$	30	SW8
7	D <sub>IN</sub> 2	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)

7x7mm body, 1.4mm height (min), 0.50mm pitch



**Note 1:**

A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier may be either a mold, or an embedded metal or marked feature.

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.

Drawings not to scale.

(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>.)

**Supertex inc.** does not recommend the use of its products in life support applications, and will not knowingly sell its products for use in such applications, unless it receives an adequate "product liability indemnification insurance agreement". **Supertex** does not assume responsibility for use of devices described and limits its liability to the replacement of the devices determined defective due to workmanship. No responsibility is assumed for possible omissions or inaccuracies. Circuitry and specifications are subject to change without notice. For the latest product specifications, refer to the **Supertex** website: <http://www.supertex.com>.