



## Low Harmonic Distortion, 16-Channel, High Voltage, Analog Switches with Bleed Resistors

### Features

- ▶ HVCMOS technology for high performance
- ▶ Integrated bleed resistors on the outputs
- ▶ 16-channel high voltage analog switch
- ▶ 3.3V input logic level compatible
- ▶ 20MHz data shift clock frequency
- ▶ Very low quiescent power dissipation ( $\sim 10\mu\text{A}$ )
- ▶ Low parasitic capacitance
- ▶ DC to 50MHz small signal frequency response
- ▶ -60dB typical off-isolation at 5.0MHz
- ▶ CMOS logic circuitry for low power
- ▶ Low harmonic distortion
- ▶ Cascadable serial data register with latches
- ▶ Flexible operating supply voltages

### Applications

- ▶ Medical ultrasound imaging
- ▶ NDT metal flaw detection
- ▶ Piezoelectric transducer drivers
- ▶ Optical MEMS modules

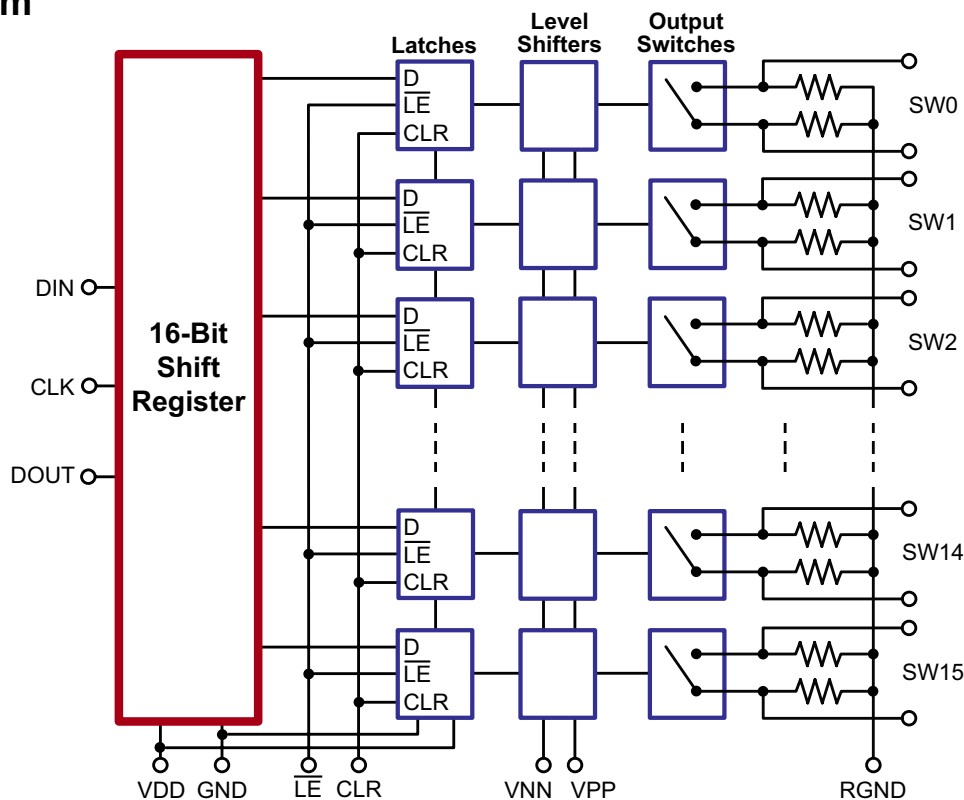
### General Description

The Supertex HV2705 and HV2706 are low charge injection, 16-channel, high voltage analog switch integrated circuits (ICs) with bleed resistors. The devices can be used in applications requiring high voltage switching controlled by low voltage control signals, such as medical ultrasound imaging and piezoelectric transducer drivers. The bleed resistors eliminate voltage build-up on capacitive loads such as piezoelectric transducers. The HV2706 has a different pin configuration than the HV2705.

Input data are shifted into a 16-bit shift register that can then be retained in a 16-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 are 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



## Ordering Information / Availability

Part Number	Package Option	Packing
HV2705FG-G	48-Lead LQFP	250/Tray
HV2705FG-G M931	48-Lead LQFP	1000/Reel
HV2706FG-G	48-Lead LQFP	250/Tray
HV2706FG-G M931	48-Lead LQFP	1000/Reel

-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	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: 48-Lead LQFP (FG)	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.

## Typical Thermal Resistance

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

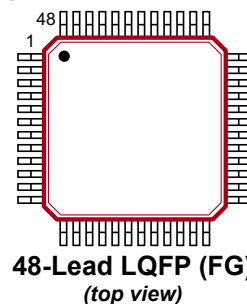
## Recommended Operating Conditions

Sym	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	0.9 $V_{DD}$ to $V_{DD}$
$V_{IL}$	Low level input voltage	0V to 0.1 $V_{DD}$
$V_{SIG}$	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.

## Pin Configuration



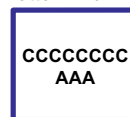
## Product Marking

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

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

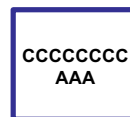
### 48-Lead LQFP (FG)

Top Marking



YY = Year Sealed  
WW = Week Sealed  
L = Lot Number  
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A = Assembler ID\*

Bottom Marking



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

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

### 48-Lead LQFP (FG)

## DC Electrical 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 <sub>ONS</sub>	Small signal switch on-resistance	-	30	-	26	38	-	48	Ω	I <sub>SIG</sub> = 5.0mA	V <sub>PP</sub> = +40V V <sub>NN</sub> = -160V
		-	25	-	22	27	-	32		I <sub>SIG</sub> = 200mA	V <sub>NN</sub> = -160V
		-	25	-	22	27	-	30		I <sub>SIG</sub> = 5.0mA	V <sub>PP</sub> = +100V V <sub>NN</sub> = -100V
		-	18	-	18	24	-	27		I <sub>SIG</sub> = 200mA	V <sub>NN</sub> = -100V
		-	23	-	20	25	-	30		I <sub>SIG</sub> = 5.0mA	V <sub>PP</sub> = +160V V <sub>NN</sub> = -40V
		-	22	-	16	25	-	27		I <sub>SIG</sub> = 200mA	V <sub>NN</sub> = -40V
ΔR <sub>ONS</sub>	Small signal switch on-resistance matching	-	20	-	5.0	20	-	20	%	I <sub>SIG</sub> = 5.0mA, V <sub>PP</sub> = +100V, V <sub>NN</sub> = -100V	
R <sub>ONL</sub>	Large signal switch on-resistance	-	-	-	15	-	-	-	Ω	V <sub>SIG</sub> = V <sub>PP</sub> -10V, I <sub>SIG</sub> = 1.0A	
R <sub>INT</sub>	Value of output bleed resistor	-	-	20	35	50	-	-	kΩ	Output Switch to RGND 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 and V <sub>NN</sub> +10V	
V <sub>OS</sub>	DC offset switch off*	-	300	-	100	300	-	300	mV	No Load	
	DC offset switch on*	-	500	-	100	500	-	500	mV		
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	-	-	μA	All switches off	
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	-	-	μA	All switches on, I <sub>SW</sub> = 5.0mA	
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	-	6.5	-	-	7.0	-	8.0	mA	V <sub>PP</sub> = +40V V <sub>NN</sub> = -160V	All output switches are turning ON and OFF at 50kHz with no load.
		-	4.0	-	-	5.5	-	5.5		V <sub>PP</sub> = +100V V <sub>NN</sub> = -100V	
		-	4.0	-	-	5.0	-	5.5		V <sub>PP</sub> = +160V V <sub>NN</sub> = -40V	
I <sub>NN</sub>	Average V <sub>NN</sub> supply current	-	6.5	-	-	7.0	-	8.0	mA	V <sub>PP</sub> = +40V V <sub>NN</sub> = -160V	
		-	4.0	-	-	5.0	-	5.5		V <sub>PP</sub> = +100V V <sub>NN</sub> = -100V	
		-	4.0	-	-	5.0	-	5.5		V <sub>PP</sub> = +160V V <sub>NN</sub> = -40V	
I <sub>DD</sub>	Average V <sub>DD</sub> supply current	-	4.0	-	-	4.0	-	4.0	mA	f <sub>CLK</sub> = 5.0MHz, V <sub>DD</sub> = 5.0V	
I <sub>DDQ</sub>	Quiescent V <sub>DD</sub> supply current	-	10	-	-	10	-	10	μA	All logic inputs are static	
I <sub>SOR</sub>	Data out source current	0.45	-	0.45	0.70	-	0.40	-	mA	V <sub>OUT</sub> = V <sub>DD</sub> -0.7V	
I <sub>SINK</sub>	Data out sink current	0.45	-	0.45	0.70	-	0.40	-	mA	V <sub>OUT</sub> = 0.7V	
C <sub>IN</sub>	Logic input capacitance	-	10	-	-	10	-	10	pF	---	

\* See Test Circuits on page 5

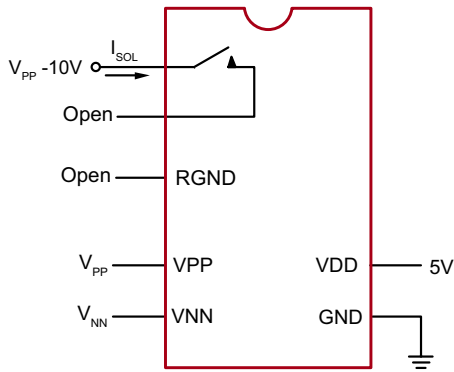
## AC Electrical Characteristics

(over recommended operating conditions,  $V_{DD} = 5.0V$ ,  $t_R = t_F \leq 5.0ns$ , 50% duty cycle,  $C_{LOAD} = 20pF$ , unless otherwise noted)

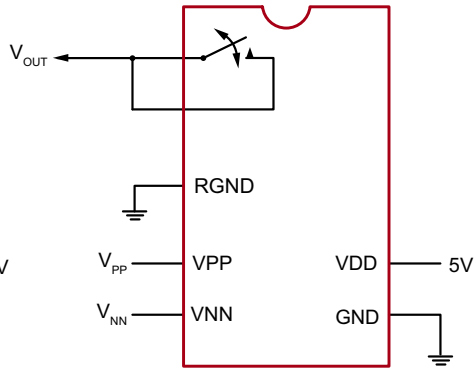
Sym	Parameter	0°C		+25°C			+70°C		Units	Conditions
		Min	Max	Min	Typ	Max	Min	Max		
$t_{SD}$	Set up time before $\overline{LE}$ rises	25	-	25	-	-	25	-	ns	---
$t_{WLE}$	Time width of $\overline{LE}$	56	-	-	56	-	56	-	ns	$V_{DD} = 3.0V$
		12	-	-	12	-	12	-		$V_{DD} = 5.0V$
$t_{DO}$	Clock delay time to data out	50	100	50	78	100	50	100	ns	$V_{DD} = 3.0V$
		15	40	15	30	40	15	40		$V_{DD} = 5.0V$
$t_{WCLR}$	Time width of CLR	55	-	55	-	-	55	-	ns	---
$t_{SU}$	Set up time data to clock	21	-	-	21	-	21	-	ns	$V_{DD} = 3.0V$
		7.0	-	-	7.0	-	7.0	-		$V_{DD} = 5.0V$
$t_H$	Hold time data from clock	2.0	-	2.0	-	-	2.0	-	ns	$V_{DD} = 3.0$ or $5.0V$
$f_{CLK}$	Clock frequency	-	8.0	-	-	8.0	-	8.0	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	$\mu s$	$V_{SIG} = V_{PP} - 10V$ , $R_{LOAD} = 10k\Omega$
$T_{OFF}$	Turn OFF time*	-	5.0	-	-	5.0	-	5.0	$\mu s$	$V_{SIG} = V_{PP} - 10V$ , $R_{LOAD} = 10k\Omega$
dv/dt	Maximum $V_{SIG}$ 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	$f = 5.0MHz$ , $1k\Omega//15pF$ load
		-58	-	-58	-	-	-58	-		$f = 5.0MHz$ , $50\Omega$ load
$K_{CR}$	Switch crosstalk*	-60	-	-60	-70	-	-60	-	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	-	15	-	10	15	-	15	pF	0V, $f = 1.0MHz$
$C_{SG(ON)}$	On capacitance SW to GND	-	18	-	13	18	-	18	pF	0V, $f = 1.0MHz$
$+V_{SPK}$	Output voltage spike*	-	-	-	-	150	-	-	mV	$V_{PP} = +40V$ , $V_{NN} = -160V$ , $R_{LOAD} = 50\Omega$
$-V_{SPK}$		-	-	-	-	150	-	-		$V_{PP} = +100V$ , $V_{NN} = -100V$ , $R_{LOAD} = 50\Omega$
$+V_{SPK}$		-	-	-	-	150	-	-		$V_{PP} = +160V$ , $V_{NN} = -40V$ , $R_{LOAD} = 50\Omega$
$-V_{SPK}$		-	-	-	-	150	-	-		$V_{PP} = +160V$ , $V_{NN} = -40V$ , $R_{LOAD} = 50\Omega$
$+V_{SPK}$		-	-	-	-	150	-	-		$V_{PP} = +160V$ , $V_{NN} = -40V$ , $R_{LOAD} = 50\Omega$
$-V_{SPK}$		-	-	-	-	150	-	-		$V_{PP} = +160V$ , $V_{NN} = -40V$ , $R_{LOAD} = 50\Omega$
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	-	-	-		$V_{PP} = +160V$ , $V_{NN} = -40V$ , $V_{SIG} = 0V$

\* See Test Circuits on page 5

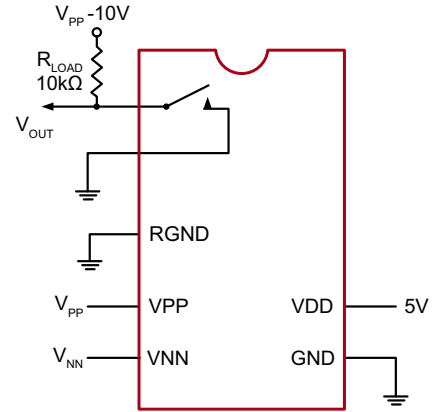
**HV2705/HV2706 Test Circuits**



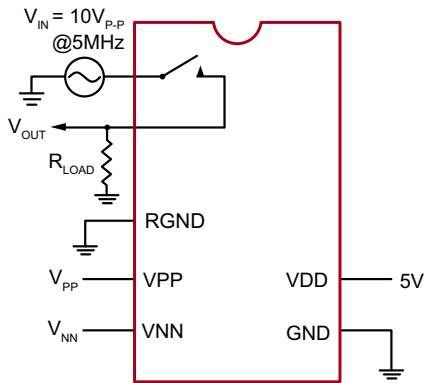
**Switch Off Leakage  
per Switch  
(for HV2705 only)**



**DC Offset Switch  
ON/OFF**

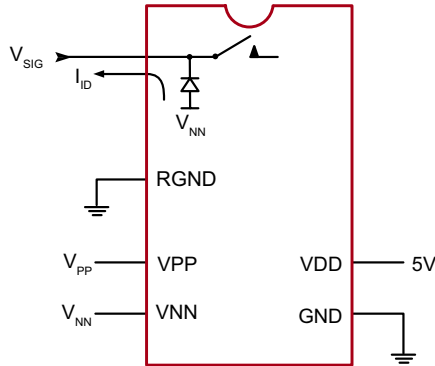


**T<sub>ON</sub>/T<sub>OFF</sub> Test Circuit**

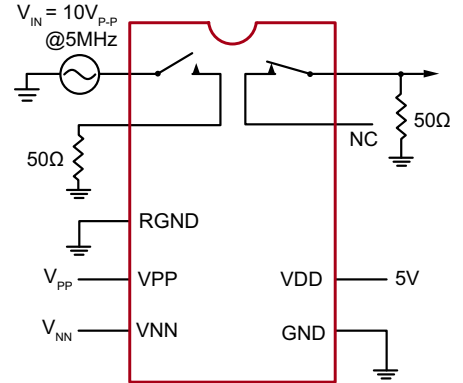


$$K_o = 20 \log \frac{V_{OUT}}{V_{IN}}$$

**OFF Isolation**

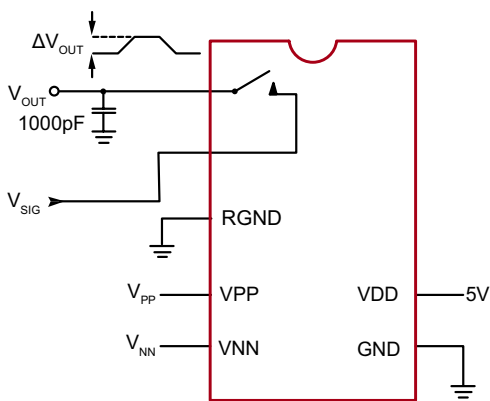


**Output Switch  
Isolation Diode Current**



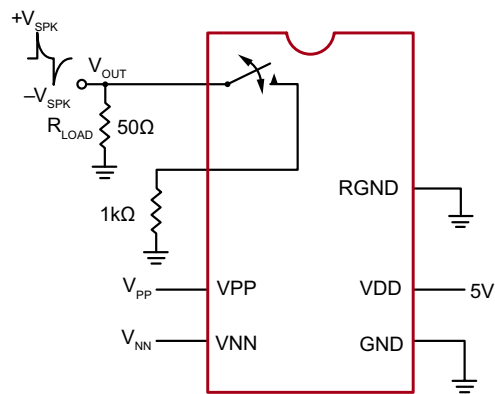
$$K_{CR} = 20 \log \frac{V_{OUT}}{V_{IN}}$$

**Switch Crosstalk**



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

**Charge Injection**



**Output Voltage Spike**

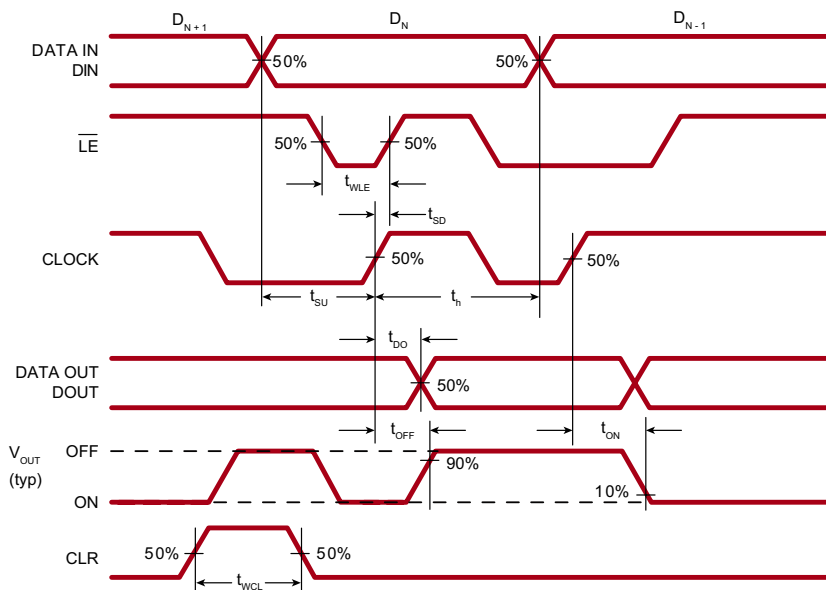
Logic Function Table

D0	D1	...	D7	D8	...	D15	$\overline{LE}$	CLR	SW0	SW1	...	SW7	SW8	...	SW15
L	-		-	-		-	L	L	OFF	-		-	-		-
H	-		-	-		-	L	L	ON	-		-	-		-
-	L		-	-		-	L	L	-	OFF		-	-		-
-	H		-	-		-	L	L	-	ON		-	-		-
-	-		-	-		-	L	L	-	-		-	-		-
-	-		-	-		-	L	L	-	-		-	-		-
-	-		L	-		-	L	L	-	-		OFF	-		-
-	-		H	-		-	L	L	-	-		ON	-		-
-	-	...	-	L	...	-	L	L	-	-	...	-	OFF	...	-
-	-		-	H		-	L	L	-	-		-	ON		-
-	-		-	-		-	L	L	-	-		-	-		-
-	-		-	-		-	L	L	-	-		-	-		-
-	-		-	-		-	L	L	-	-		-	-		-
-	-		-	-		-	L	L	-	-		-	-		-
-	-		-	-		L	L	L	-	-		-	-		OFF
-	-		-	-		H	L	L	-	-		-	-		ON
X	X	X	X	X	X	X	H	L	HOLD PREVIOUS STATE						
X	X	X	X	X	X	X	X	H	ALL SWITCHES OFF						

Notes:

1. The 16 switches operate independently.
2. Serial data is clocked in on the L to H transition of the CLK.
3. All 16 switches go to a state retaining their latched condition at the rising edge of  $\overline{LE}$ . When  $\overline{LE}$  is low the shift registers data flow through the latch.
4.  $D_{OUT}$  is high when data in the shift register 15 is high.
5. Shift registers 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



**HV2705 Pin Description**  
**48-Lead LQFP (FG)**

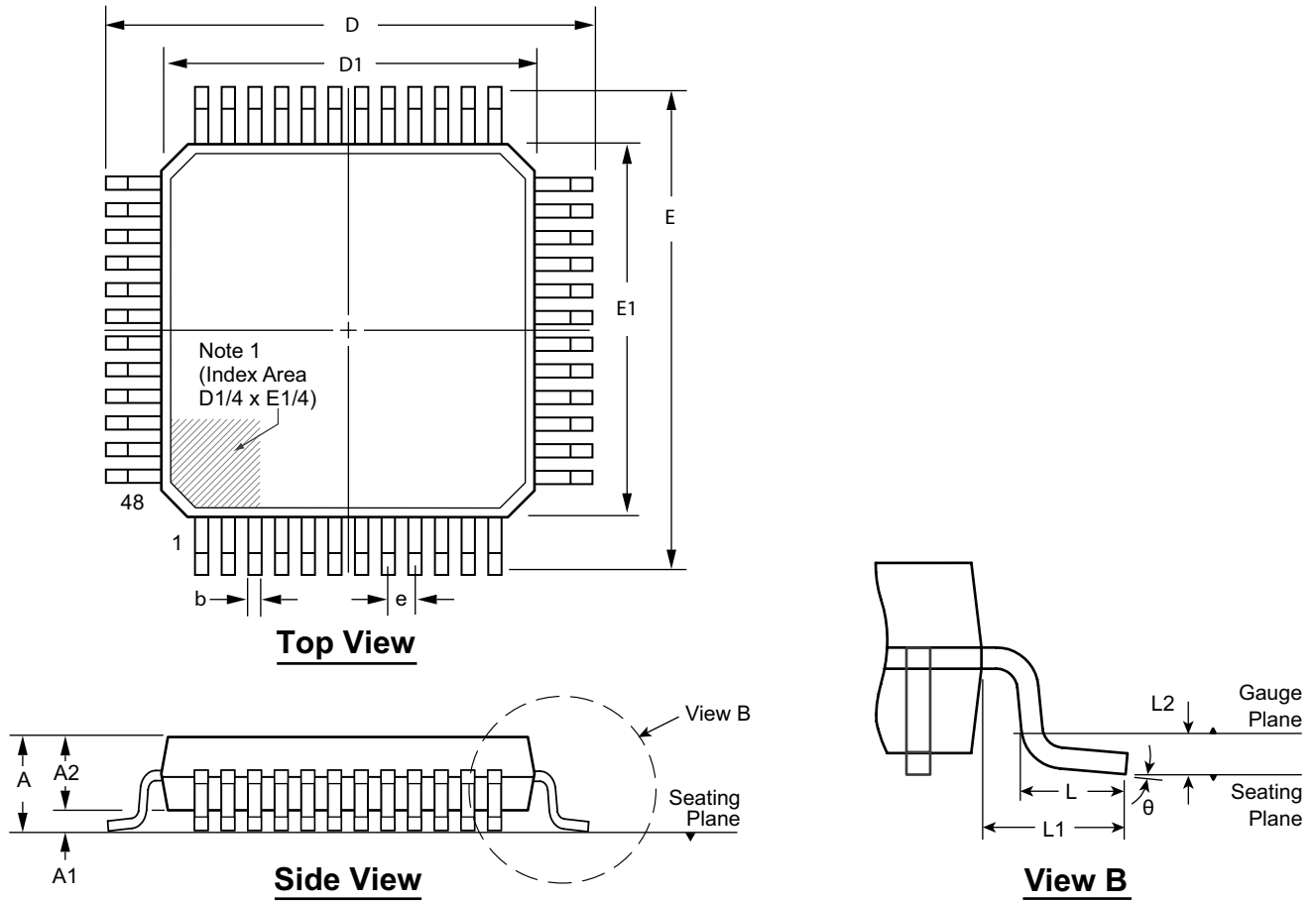
Pin #	Function	Pin #	Function	Pin #	Function	Pin #	Function
1	NC	13	VNN	25	SW15B	37	SW10B
2	NC	14	NC	26	SW15A	38	SW10A
3	SW4B	15	VPP	27	SW14B	39	SW9B
4	SW4A	16	NC	28	SW14A	40	SW9A
5	SW3B	17	GND	29	SW13B	41	SW8B
6	SW3A	18	VDD	30	SW13A	42	SW8A
7	SW2B	19	DIN	31	SW12B	43	SW7B
8	SW2A	20	CLK	32	SW12A	44	SW7A
9	SW1B	21	$\overline{LE}$	33	SW11B	45	SW6B
10	SW1A	22	CLR	34	SW11A	46	SW6A
11	SW0B	23	DOUT	35	NC	47	SW5B
12	SW0A	24	RGND	36	NC	48	SW5A

**HV2706 Pin Description**  
**48-Lead LQFP (FG)**

Pin #	Function	Pin #	Function	Pin #	Function	Pin #	Function
1	NC	13	VNN	25	SW15B	37	SW10B
2	NC	14	NC	26	SW15A	38	SW10A
3	SW4B	15	VPP	27	SW14B	39	SW9B
4	SW4A	16	NC	28	SW14A	40	SW9A
5	SW3B	17	GND, RGND	29	SW13B	41	SW8B
6	SW3A	18	VDD	30	SW13A	42	SW8A
7	SW2B	19	DIN	31	SW12B	43	SW7B
8	SW2A	20	CLK	32	SW12A	44	SW7A
9	SW1B	21	$\overline{LE}$	33	SW11B	45	SW6B
10	SW1A	22	CLR	34	SW11A	46	SW6A
11	SW0B	23	DOUT	35	NC	47	SW5B
12	SW0A	24	NC	36	NC	48	SW5A

# 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	$\theta$	
Dimension (mm)	MIN	1.40*	0.05	1.35	0.17	8.80*	6.80*	8.80*	6.80*	0.50 BSC	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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