

# Low Charge Injection 8-Channel High Voltage Analog Switches

## Features

- ❑ HVCMOS® technology for high performance
- ❑ Very low quiescent power dissipation – 10µA
- ❑ Output on-resistance typically 22 ohms
- ❑ Low parasitic capacitances
- ❑ DC to 10MHz analog signal frequency
- ❑ -60dB typical output off isolation at 5MHz
- ❑ CMOS logic circuitry for low power
- ❑ Excellent noise immunity
- ❑ On-chip shift register, latch and clear logic circuitry
- ❑ Flexible high voltage supplies

## Applications

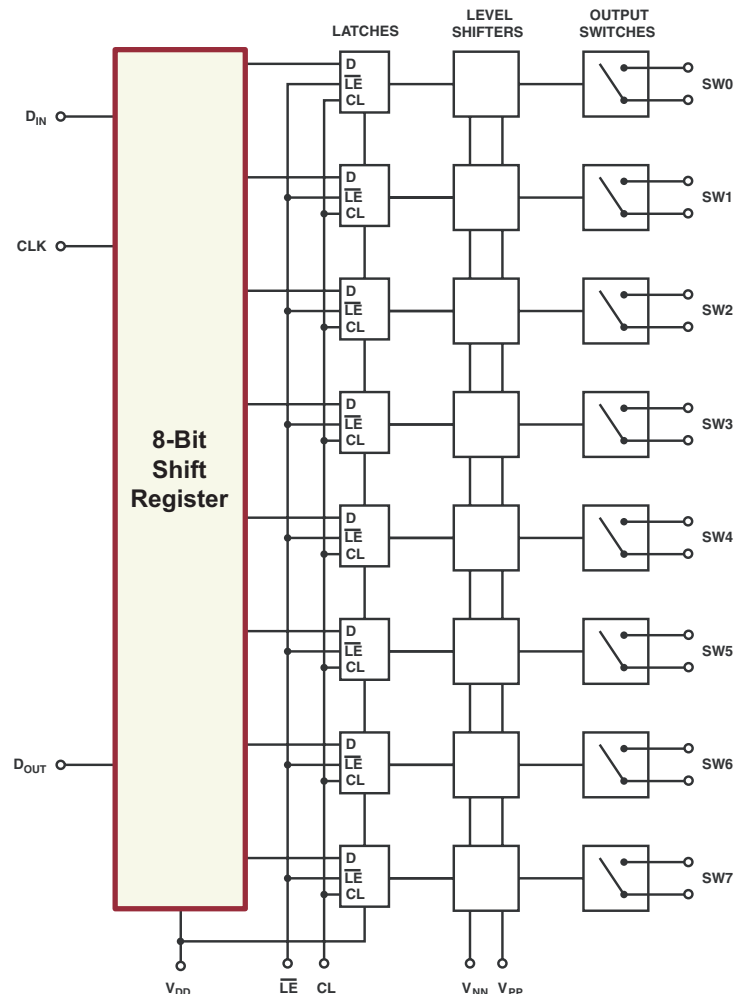
- ❑ Medical ultrasound imaging
- ❑ Piezoelectric transducer drivers

## General Description

These devices are low charge injection 8-channel high-voltage analog switch integrated circuits (ICs) intended for use in applications requiring high voltage switching controlled by low voltage control signals, such as ultrasound imaging and printers. 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 Bar ( $\overline{LE}$ ) should be left high until all bits are clocked in. Using HVCMOS technology, these switches combine high voltage bilateral DMOS switches and low power CMOS logic to provide efficient control of high voltage analog signals.

These ICs are suitable for various combinations of high voltage supplies, e.g.,  $V_{PP}/V_{NN}$  : +50V/-150V, or +100V/-100V.B

## Block Diagram



## Ordering Information

Device	Package Options		
	28-Lead PLCC	48-Lead LQFP/TQFP (1.4mm)	25-Ball fpBGA
HV220	-	-	HV220GA
			HV220GA-G
HV20220	HV20220PJ	HV20220FG	-
	HV20220PJ-G	HV20220FG-G	
HV20320	HV20320PJ	-	-
	HV20320PJ-G		



-G indicates the part is RoHS compliant ('Green')

## Absolute Maximum Ratings

Parameter	Value
V <sub>DD</sub> logic power supply voltage	-0.5V to +15V
V <sub>PP</sub> - V <sub>NN</sub> supply voltage	220V
V <sub>PP</sub> positive high voltage supply	-0.5V to V <sub>NN</sub> +200V
V <sub>NN</sub> negative high voltage supply	+0.5V to -200V
Logic input voltages	-0.5V to V <sub>DD</sub> +0.3V
Analog signal range	V <sub>NN</sub> to V <sub>PP</sub>
Peak analog signal current/channel	3.0A
Storage temperature	-65°C to +150°C
Power dissipation:	
28-Lead PLCC	1.2W
48-Lead LQFP/ TQFP(1.4mm)	1.0W
25-Ball fpBGA	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

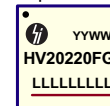
Symbol	Parameter	Value
V <sub>DD</sub>	Logic power supply voltage <sup>1,3</sup>	4.5V to 13.2V
V <sub>PP</sub>	positive high voltage supply <sup>1,3</sup>	40V to V <sub>NN</sub> +200V
V <sub>NN</sub>	negative high voltage supply <sup>1,3</sup>	-40V to -160V
V <sub>IH</sub>	High level input voltage	V <sub>DD</sub> -1.5V to V <sub>DD</sub>
V <sub>IL</sub>	Low-level input voltage	0V to 1.5V
V <sub>SIG</sub>	Analog signal voltage peak-to-peak	V <sub>NN</sub> +10V to V <sub>PP</sub> -10V <sup>2</sup>
T <sub>A</sub>	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<sub>SIG</sub> must be V<sub>NN</sub> ≤ V<sub>SIG</sub> ≤ V<sub>PP</sub> or floating during power up/down transition.
- Rise and fall times of power supplies V<sub>DD</sub>, V<sub>PP</sub> and V<sub>NN</sub> should not be less than 1.0msec.

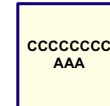
## Product Marking

### Top Marking



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

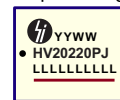
### Bottom Marking



\*May be part of top marking

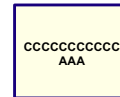
### HV220 FG

### Top Marking



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

### Bottom Marking



\*May be part of top marking

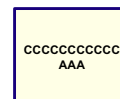
### HV20220 PJ

### Top Marking



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 L = Lot Number  
 C = Country of Origin\*  
 A = Assembler ID\*  
 — = "Green" Packaging

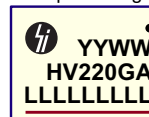
### Bottom Marking



\*May be part of top marking

### HV20320 PJ

### Top Marking



YY = Year Sealed  
 WW = Week Sealed  
 L = Lot Number  
 — = "Green" Packaging

### HV220 GA

**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 <sub>ONS</sub>	Small signal switch on-resistance	-	30	-	26	38	-	48	Ω	I <sub>SIG</sub> = 5mA	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> = 5mA	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> = 5mA	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	
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</sub>	DC offset switch off	-	300	-	100	300	-	300	mV	R <sub>L</sub> = 100Ω	
	DC offset switch on	-	500	-	100	500	-	500	mV	R <sub>L</sub> = 100kΩ	
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 cyclcy < 0.1%	
f <sub>SW</sub>	Output switching frequency	-	-	-	-	50	-	-	kHz	Duty cycle = 50%	
I <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	-	-	5.0	-	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>NN</sub>	Supply curent	-	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>	Logic supply average current	-	4.0	-	-	4.0	-	4.0	mA	f <sub>CLK</sub> = 5.0MHz, V <sub>DD</sub> = 5.0V	
I <sub>DDQ</sub>	Logic supply Quiescent current	-	10	-	-	10	-	10	μA	---	
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	---	

**AC Electrical Characteristics**

(Over recommended operating conditions:  $V_{DD} = 5.0V$ , 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	150		150				150		ns	---
$t_{WLE}$	Time width of LE	150		150				150		ns	---
$t_{DO}$	Clock delay time to data out		150					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		50			50		50		ns	---
$t_{ON}$	Turn on time		5.0			5.0		5.0		μs	$V_{SIG} = V_{PP} - 10V, R_{LOAD} = 10k\Omega$
$t_{OFF}$	Turn off time		5.0			5.0		5.0		μs	$V_{SIG} = V_{PP} - 10V, R_{LOAD} = 10k\Omega$
dv/dt	Maximum $V_{SIG}$ 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	$f = 5.0MHz, 1k\Omega/15pF$ 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		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	$V_{PP} = +40V, V_{NN} = -160V, R_{LOAD} = 50\Omega$
$-V_{SPK}$		-	-	-	-	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			-	-		$V_{PP} = +160V, V_{NN} = -40V, V_{SIG} = 0V$

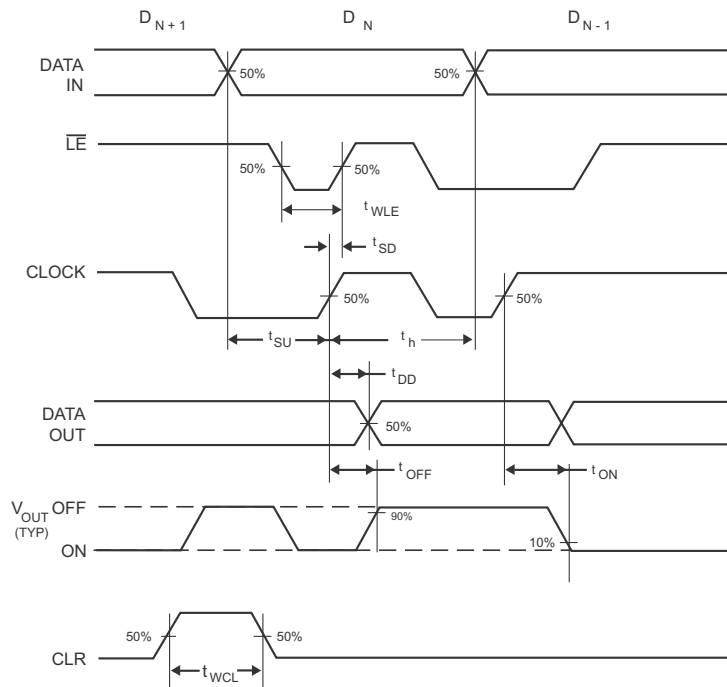
Truth Table

D0	D1	D2	D3	D4	D5	D6	D7	$\overline{LE}$	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								
							H	L	L								
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							

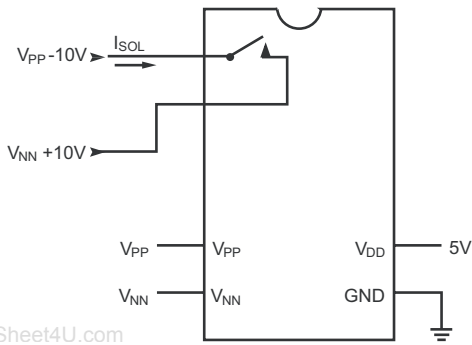
Notes:

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.

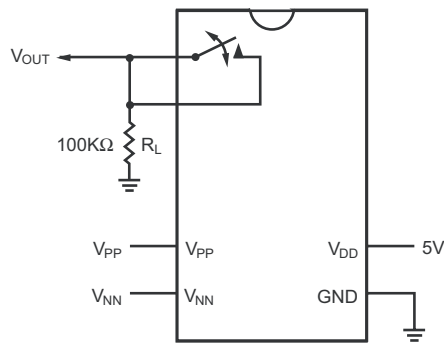
Logic Timing Waveforms



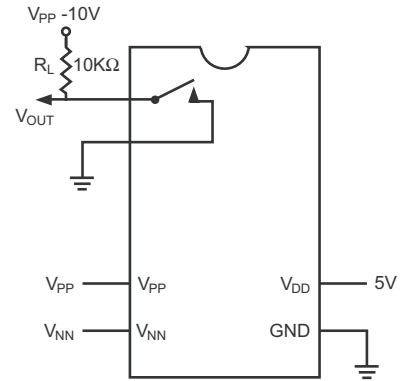
Test Circuits



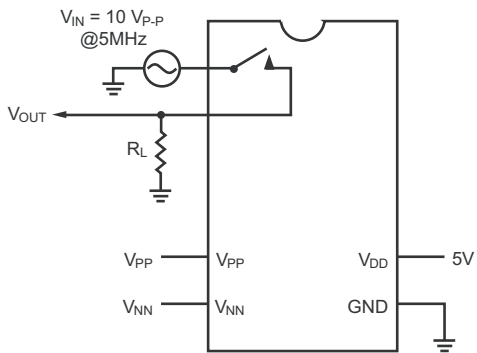
Switch OFF Leakage



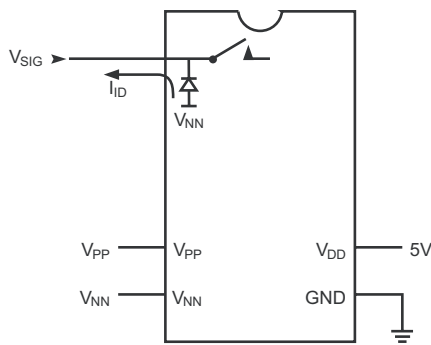
DC Offset ON/OFF



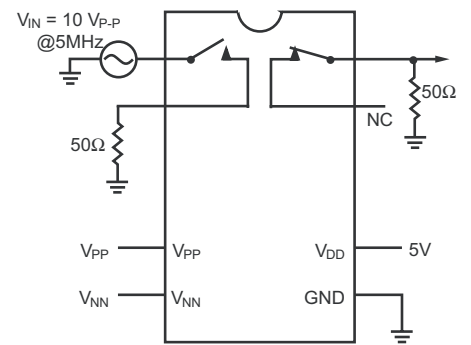
T<sub>ON</sub>/T<sub>OFF</sub> Test Circuit



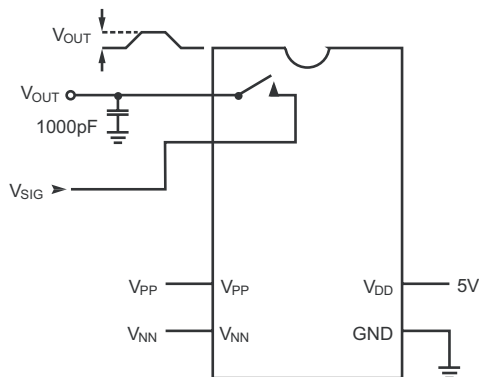
$K_O = 20 \text{Log} \frac{V_{OUT}}{V_{IN}}$   
OFF Isolation



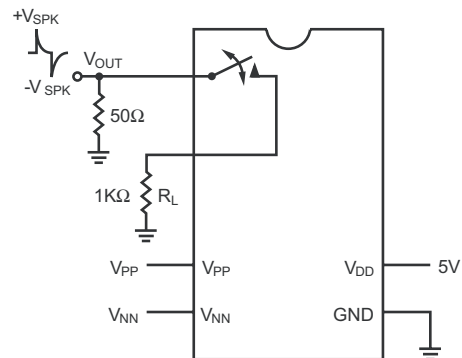
Isolation Diode Current



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

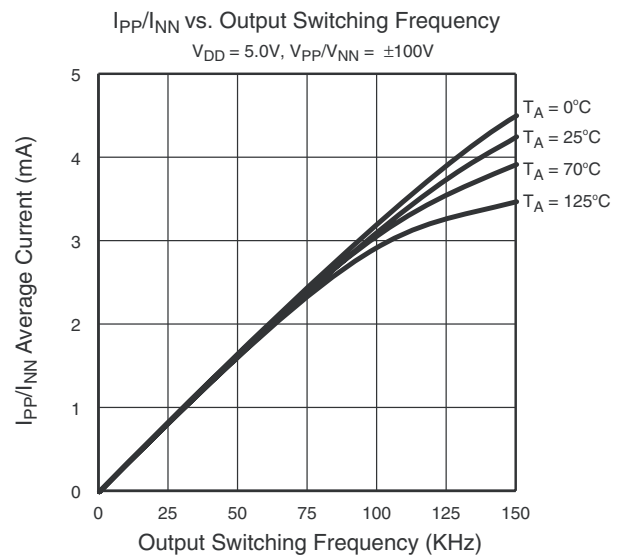
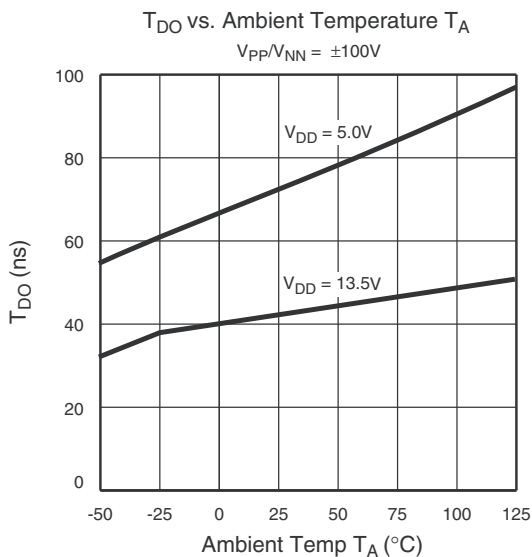
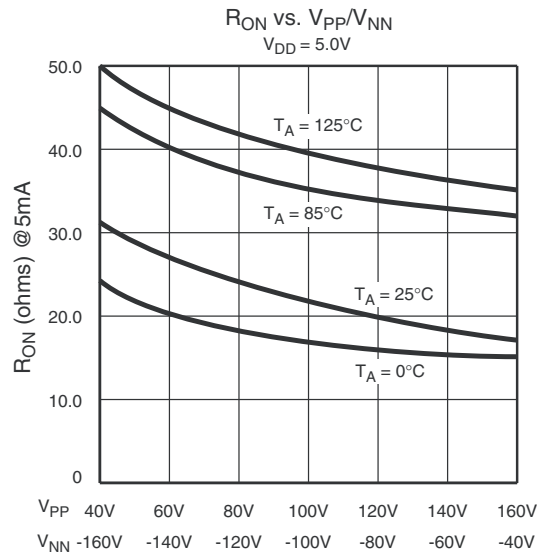
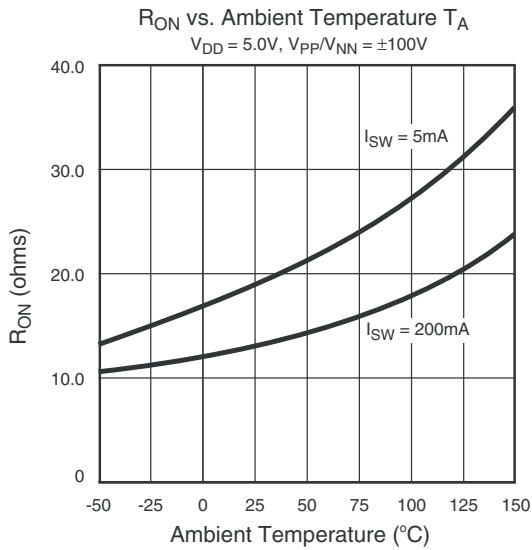
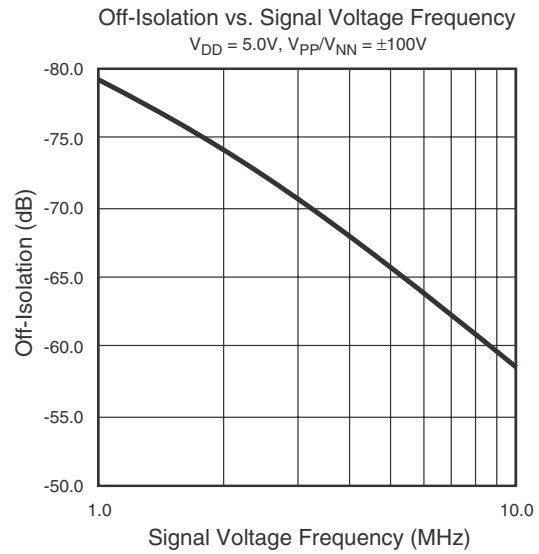
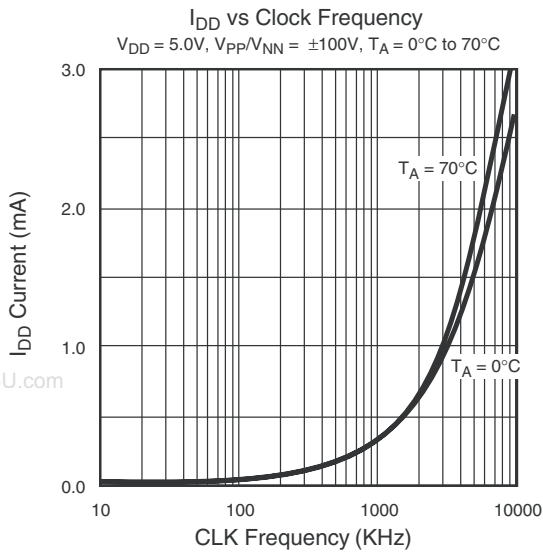


$Q = 1000\text{pF} \times V_{OUT}$   
Charge Injection



Output Voltage Spike

## Typical Performance Curves



## Pin Description (HV220GA)

Ball Location	Function
A3	SW1
B2	SW2
B3	SW1
B4	SW0
B5	SW0
B6	V <sub>NN</sub>
C1	SW3
C2	SW3
C3	SW2
C4	V <sub>PP</sub>
C5	GND
C6	D <sub>IN</sub>
C7	V <sub>DD</sub>
D1	SW4
D2	SW4
D3	SW5
D4	SW7
D5	$\overline{\text{LE}}$
D6	CLK
E2	SW5
E3	SW6
E4	SW7
E5	D <sub>OUT</sub>
E6	CLR
F3	SW6

## Pin Description (48-Lead FG)

Pin	Function	Pin	Function
1	SW5	25	V <sub>NN</sub>
2	N/C	26	N/C
3	SW4	27	N/C
4	N/C	28	GND
5	SW4	29	V <sub>DD</sub>
6	N/C	30	N/C
7	N/C	31	N/C
8	SW3	32	N/C
9	N/C	33	D <sub>IN</sub>
10	SW3	34	CLK
11	N/C	35	$\overline{\text{LE}}$
12	SW2	36	CLR
13	N/C	37	D <sub>OUT</sub>
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	V <sub>PP</sub>	48	N/C

## Pin Description (HV20220PJ)

Pin	Function	Pin	Function
1	SW3	15	N/C
2	SW3	16	D <sub>IN</sub>
3	SW2	17	CLK
4	SW2	18	$\overline{\text{LE}}$
5	SW1	19	CL
6	SW1	20	D <sub>OUT</sub>
7	SW0	21	SW7
8	SW0	22	SW7
9	N/C	23	SW6
10	V <sub>PP</sub>	24	SW6
11	N/C	25	SW5
12	V <sub>NN</sub>	26	SW5
13	GND	27	SW4
14	V <sub>DD</sub>	28	SW4

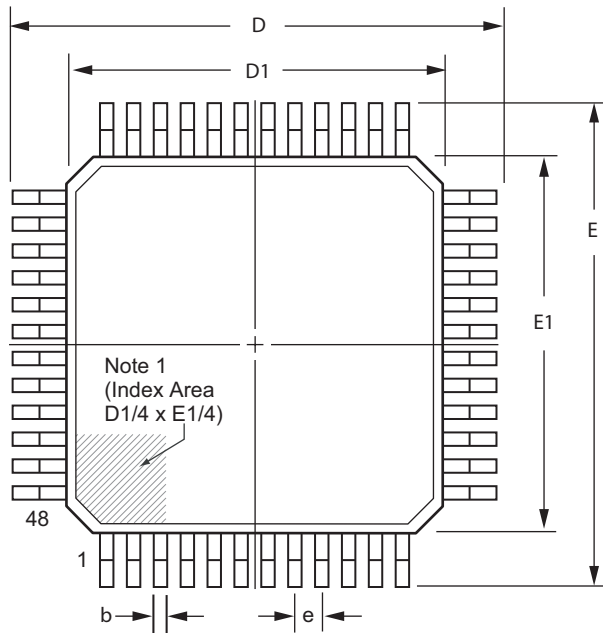
## Pin Description (HV20320PJ)

Pin	Function	Pin	Function
1	SW3	15	N/C
2	SW3	16	D <sub>IN</sub>
3	SW2	17	CLK
4	SW2	18	$\overline{\text{LE}}$
5	SW1	19	CL
6	SW1	20	D <sub>OUT</sub>
7	SW0	21	SW7
8	SW0	22	SW7
9	V <sub>PP</sub>	23	SW6
10	V <sub>NN</sub>	24	SW6
11	N/C	25	SW5
12	GND	26	SW5
13	V <sub>DD</sub>	27	SW4
14	N/C	28	SW4

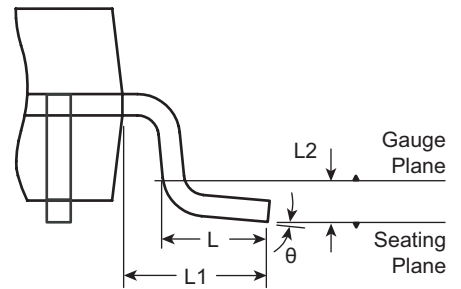


# 48-Lead LQFP Package Outline (FG)

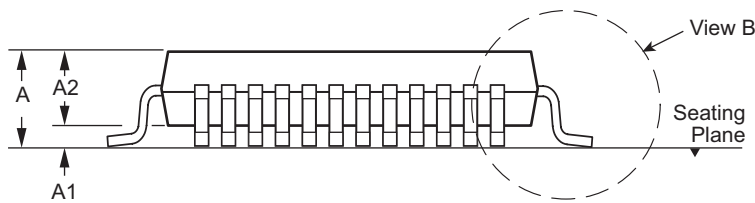
7x7mm body, 1.4mm height (min), 0.50mm pitch



**Top View**



**View B**



**Side View**

**Note 1:**

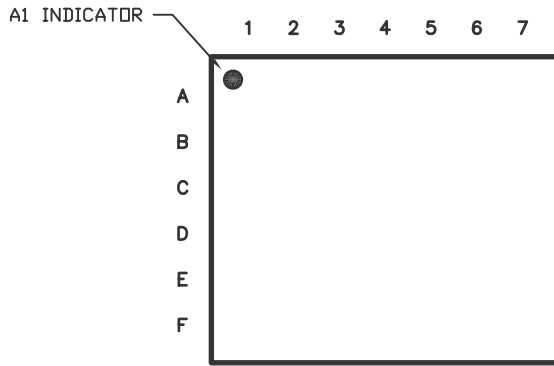
A Pin 1 identifier must be located in the index area indicated. The Pin 1 identifier may be either a mold, or an embedded metal or marked feature.

Symbol	A	A1	A2	b	D	D1	E	E1	e	L	L1	L2	$\theta$	
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°

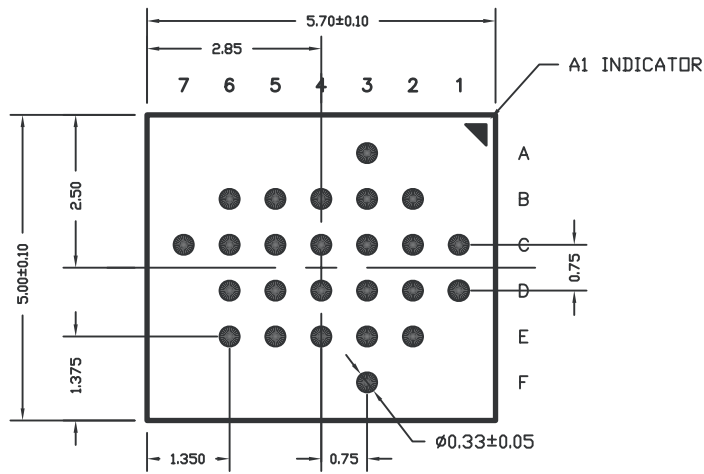
JEDEC Registration MS-026, Variation BBC, Issue D, Jan. 2001.

Drawings not to scale.

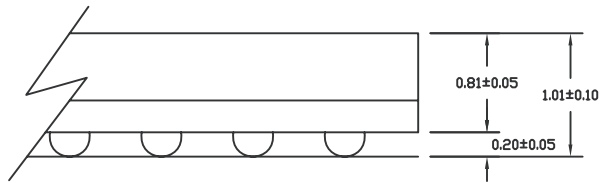
# HV220GA 25-Ball fpBGA (GA)



Top View



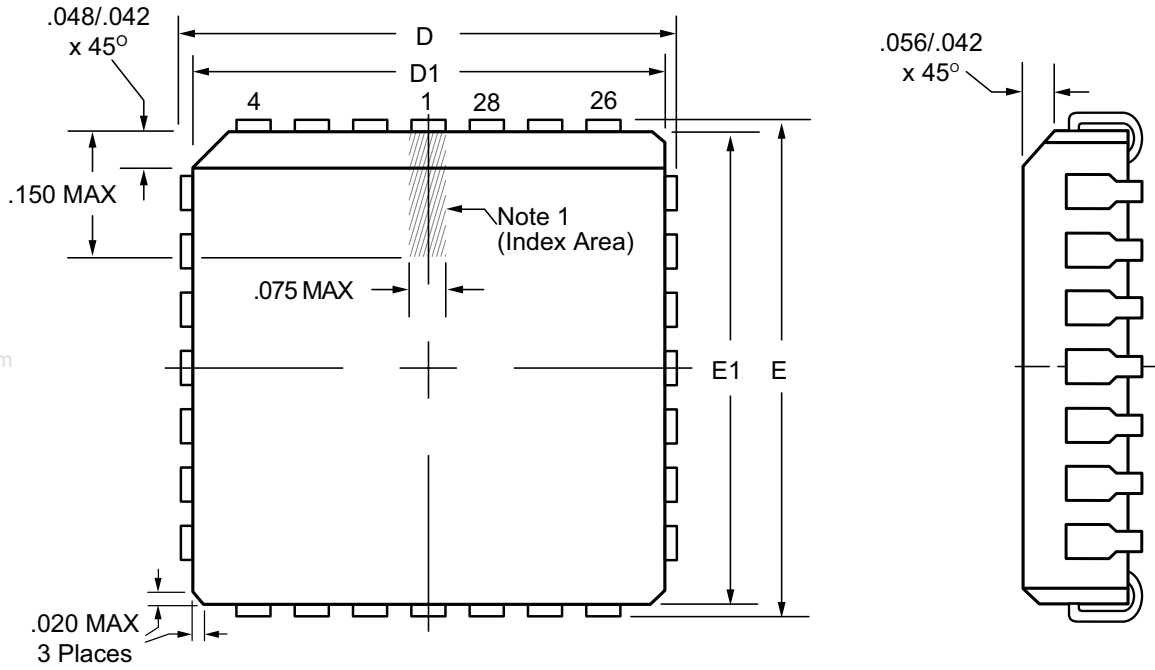
Bottom View



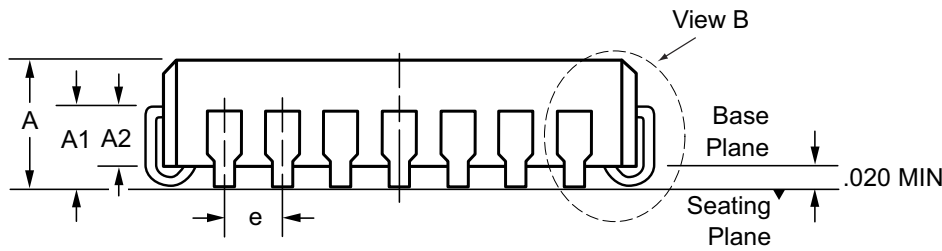
Enlarged Side View

Note:  
All dimensions are in millimeters

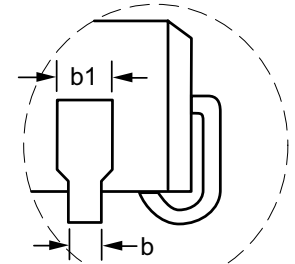
# 28-Lead PLCC Package Outline (PJ)



**Top View**



**Side View**



**View B**

**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	
Dimension (inches)	MIN	.165	.090	.062	.013	.485	.450	.485	.450	.050 BSC
	NOM	.172	.105	-	-	.490	.453	.490	.453	
	MAX	.180	.120	.083	.021	.495	.456	.495	.456	

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

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>.)

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