Low Charge Injection 8-Channel High Voltage Analog Switch

Ordering Information

$V_{PP} - V_{NN}$	Package Options				
	28-pin plastic DIP	28-lead plastic chip carrier	48-lead TQFP	μ-BGA	Die
200V	HV20220P	HV20220PJ	HV20220FG	HV20220GA	HV20220X
200V	—	HV20320PJ	—	—	—

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
- Surface mount package available

General Description

This device is a low charge injection 8-channel high-voltage analog switch integrated circuit (IC) 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, this switch combines high voltage bilateral DMOS switches and low power CMOS logic to provide efficient control of high voltage analog signals. The HV203 has the same electrical specifications as the HV202, but it is packaged in the 28 lead plastic chip carrier with the pin configuration of the Supertex HV2216PJ.

This IC is suitable for various combinations of high voltage supplies, e.g., V_{PP}/V_{NN} : +50V/–150V, or +100V/–100V.

Absolute Maximum Ratings*

V_{DD} Logic power supply voltage		-0.5V to +15V
V_{PP} - V_{NN} Supply voltage		220V
V_{PP} Positive high voltage supply		-0.5V to V_{NN} +200V
V_{NN} Negative high voltage supply		+0.5V to -200V
Logic input voltages		-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	28-pin PLCC and DIP	1.2W
	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.

Electrical Characteristics

DC Characteristics (over recommended operating conditions unless otherwise noted)

Characteristics	Sym	0°C		+25°C			+70°C		Units	Test Conditions	
		min	max	min	typ	max	min	max			
Small Signal Switch (ON) Resistance	R_{ONS}		30		26	38		48	ohms	I_{SIG} = 5mA	V_{PP} = 40V,
			25		22	27		32		I_{SIG} = 200mA	V_{NN} = -160V
			25		22	27		30		I_{SIG} = 5mA	V_{PP} = 100V,
			18		18	24		27		I_{SIG} = 200mA	V_{NN} = -100V
			23		20	25		30		I_{SIG} = 5mA	V_{PP} = 160V,
			22		16	25		27		I_{SIG} = 200mA	V_{NN} = -40V
Small Signal Switch (ON) Resistance Matching	ΔR_{ONS}		20		5.0	20		20	%	I_{SW} = 5mA, V_{PP} = 100V, V_{NN} = -100V	
Large Signal Switch (ON) Resistance	R_{ONL}				15				ohms	$V_{SIG} = V_{PP}$ - 10V, I_{SIG} = 1A	
Switch Off Leakage Per Switch	I_{SOL}		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	R_L = 100KΩ	
DC Offset Switch On			500		100	500		500	mV	R_L = 100KΩ	
Pos. HV Supply Current	I_{PPQ}				10	50			µA	ALL SWs OFF	
Neg. HV Supply Current	I_{NNQ}				-10	-50			µA	ALL SWs OFF	
Pos. HV Supply Current	I_{PPQ}				10	50			µA	ALL SWs ON I_{SW} = 5mA	
Neg. HV Supply Current	I_{NNQ}				-10	-50			µA	ALL SWs ON I_{SW} = 5mA	
Switch Output Peak Current			3.0		3.0	2.0		2.0	A	V_{SIG} duty cycle ≤ 0.1%	
Output Switch Frequency	f_{SW}					50			KHz	Duty Cycle = 50%	
I_{PP} Supply Current	I_{PP}		6.5			7.0		8.0	mA	V_{PP} = 40V, V_{NN} = -160V	50KHz Output Switching Frequency with no load
			4.0			5.0		5.5		V_{PP} = 100V, V_{NN} = -100V	
			4.0			5.0		5.5		V_{PP} = 160V, V_{NN} = -40V	
I_{NN} Supply Current	I_{NN}		6.5			7.0		8.0	mA	V_{PP} = 40V, V_{NN} = -160V	
			4.0			5.0		5.5		V_{PP} = 100V, V_{NN} = -100V	
			4.0			5.0		5.5		V_{PP} = 160V, V_{NN} = -40V	
Logic Supply Average Current	I_{DD}		4.0			4.0		4.0	mA	f_{CLK} = 5MHz, V_{DD} = 5.0V	
Logic Supply Quiescent Current	I_{DDQ}		10			10		10	µA		
Data Out Source Current	I_{SOR}	0.45		0.45	0.70		0.40		mA	$V_{OUT} = V_{DD}$ - 0.7V	
Data Out Sink Current	I_{SINK}	0.45		0.45	0.70		0.40		mA	V_{OUT} = 0.7V	
Logic Input Capacitance	C_{IN}		10			10		10	pF		

Electrical Characteristics

AC Characteristics (over operating conditions V_{DD} = 5V, unless otherwise noted)

Characteristics	Sym	0°C		+25°C			+70°C		Units	Test Conditions
		min	max	min	typ	max	min	max		
Set Up Time Before $\overline{LE}$ Rises	t_{SD}	150		150			150		ns	
Time Width of $\overline{LE}$	t_{WLE}	150		150			150		ns	
Clock Delay Time to Data Out	t_{DO}		150			150		150	ns	
Time Width of CL	t_{WCL}	150		150			150		ns	
Set Up Time Data to Clock	t_{SU}	15		15	8.0		20		ns	
Hold Time Data from Clock	t_h	35		35			35		ns	
Clock Freq	f_{CLK}		5.0			5.0		5.0	MHz	50% duty cycle $f_{DATA} = f_{CLK}/2$
Clock Rise and Fall Times	t_r, t_f		50			50		50	ns	
Turn On Time	t_{ON}		5.0			5.0		5.0	µs	$V_{SIG} = V_{PP}$ -10V, R_L = 10KΩ
Turn Off Time	t_{OFF}		5.0			5.0		5.0	µs	$V_{SIG} = V_{PP}$ -10V, R_L = 10KΩ
Maximum V_{SIG} Slew Rate	dv/dt		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
Off Isolation	KO	-30		-30	-33		-30		dB	f = 5MHz, 1KΩ//15pF load
		-58		-58			-58		dB	f = 5MHz, 50Ω load
Switch Crosstalk	K_{CR}	-60		-60	-70		-60		dB	f = 5MHz, 50Ω load
Output Switch Isolation Diode Current	I_{ID}		300			300		300	mA	300ns pulse width, 2.0% duty cycle
Off Capacitance SW to GND	$C_{SG(OFF)}$	5.0	17	5.0	12	17	5.0	17	pF	0V, 1MHz
On Capacitance SW to GND	$C_{SG(ON)}$	25	50	25	38	50	25	50	pF	0V, 1MHz

Electrical Characteristics

AC Characteristics (over operating conditions V_{DD} = 5V, unless otherwise noted)

Characteristics	Sym	+25°C			Units	Test Conditions
		min	typ	max		
Output Voltage Spike	$+V_{SPK}$			150	mV	V_{PP} = 40V, V_{NN} = -160V, R_L = 50Ω
	$-V_{SPK}$					
	$+V_{SPK}$					V_{PP} = 100V, V_{NN} = -100V, R_L = 50Ω
	$-V_{SPK}$					
	$+V_{SPK}$					V_{PP} = 160V, V_{NN} = -40V, R_L = 50Ω
	$-V_{SPK}$					
Charge Injection	Q		820		pC	V_{PP} = 40V, V_{NN} = -160V, V_{SIG} = 0V
			600			V_{PP} = 40V, V_{NN} = -160V, V_{SIG} = 0V
			350			V_{PP} = 40V, V_{NN} = -160V, V_{SIG} = 0V

Operating Conditions*

Symbol	Parameter	Value
V_{DD}	Logic power supply voltage[1, 3]	4.5V to 13.2V
V_{PP}	Positive high voltage supply[1, 3]	40V to V_{NN}+ 200V
V_{NN}	Negative high voltage supply[1, 3]	-40V to -160V
V_{IH}	High-level input voltage	V_{DD} -1.5V to V_{DD}
V_{IL}	Low-level input voltage	0V to 1.5V
V_{SIG}	Analog signal voltage peak to peak	V_{NN} +10V to V_{PP} -10V[2]
T_A	Operating free air-temperature	0°C to 70°C

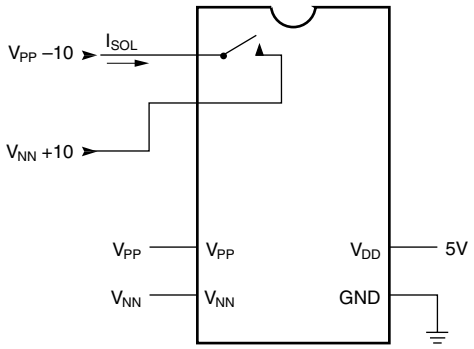
Notes:

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

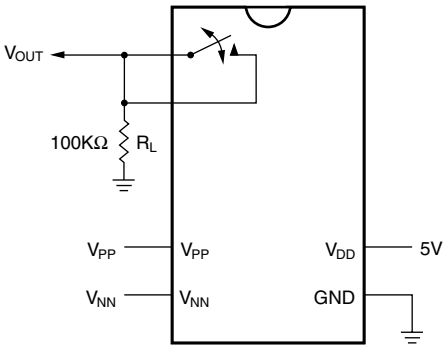
2 V_{SIG} must be $V_{NN} \leq V_{SIG} \leq V_{PP}$ or floating during power up/down transistion.

3 Rise and fall times of power supplies V_{DD}, V_{PP}, and V_{NN} should not be less than 1.0msec.

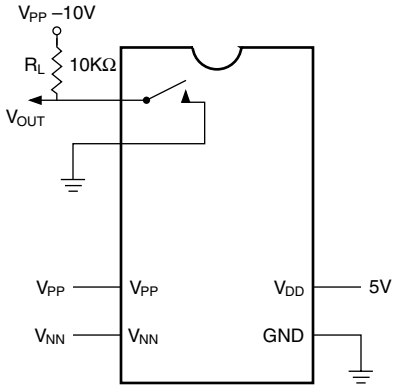
Test Circuits



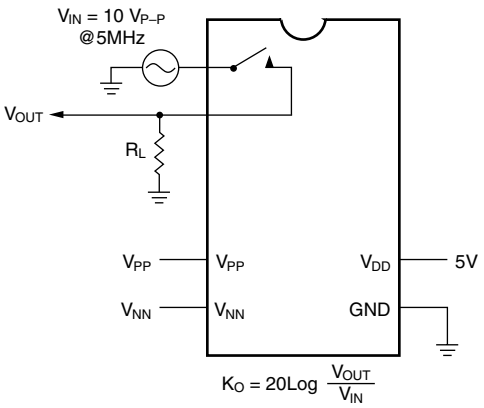
Switch OFF Leakage



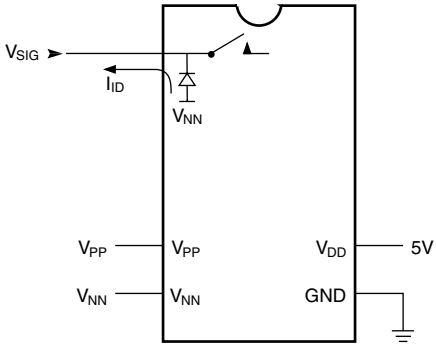
DC Offset ON/OFF



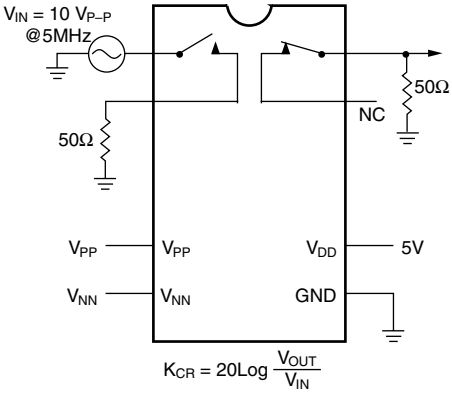
T_{ON}/T_{OFF} Test Circuit



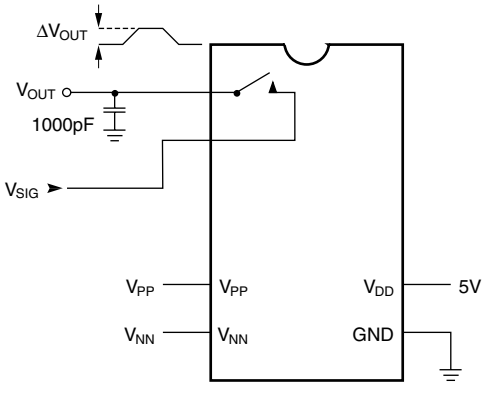
OFF Isolation



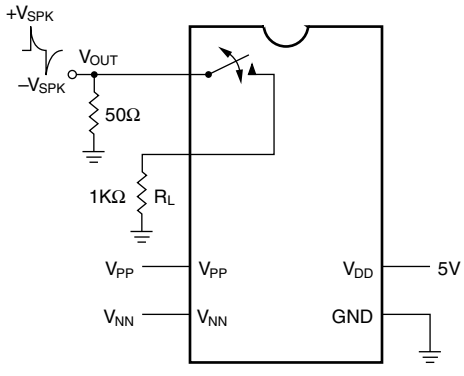
Isolation Diode Current



Crosstalk

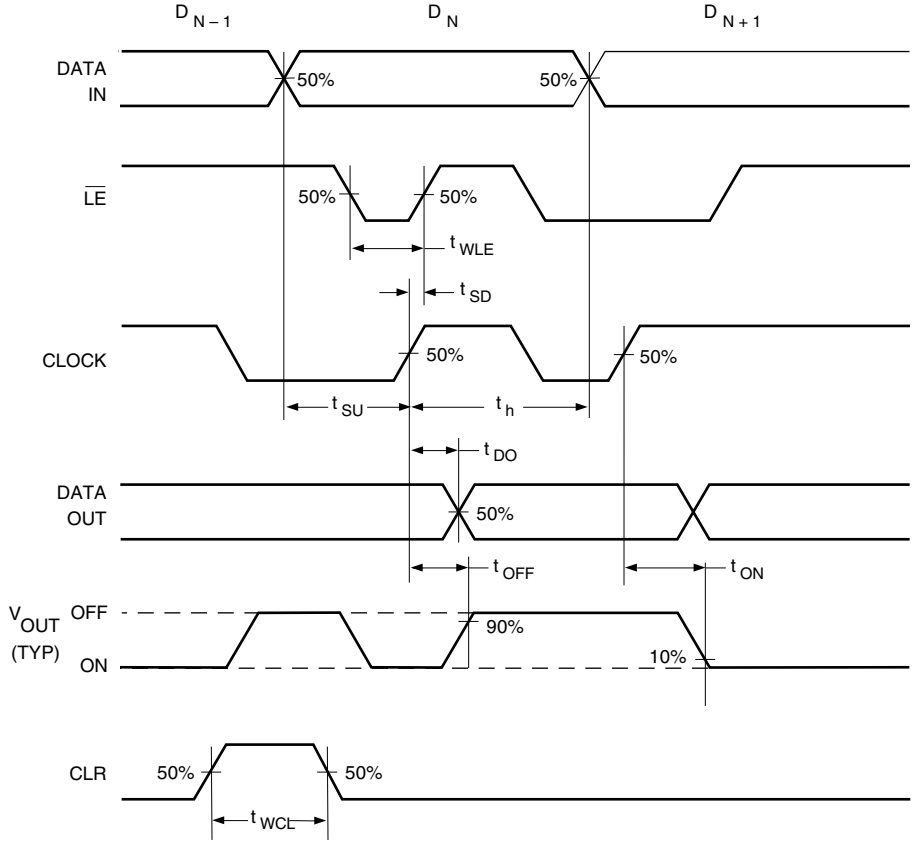


Charge Injection

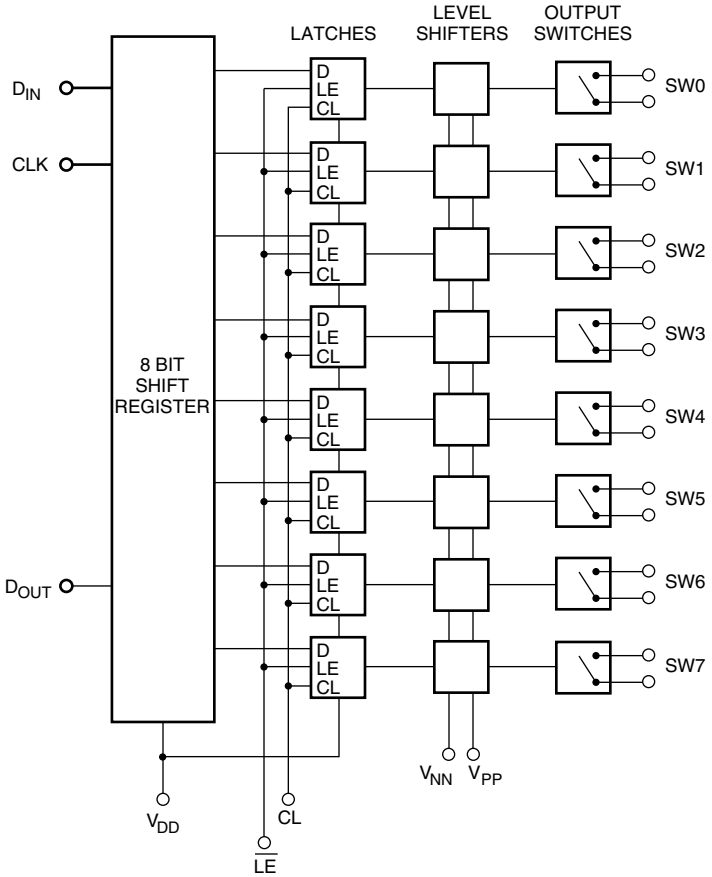


Output Voltage Spike

Logic Timing Waveforms



Logic Diagram



Truth Table

D0	D1	D2	D3	D4	D5	D6	D7	$\overline{LE}$	CL	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	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

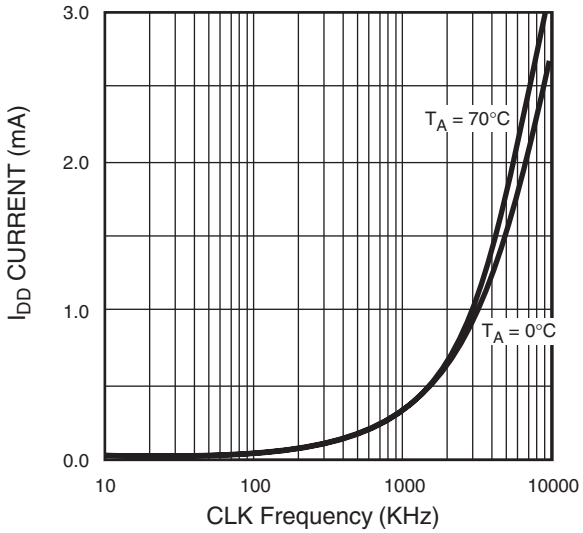
Notes:

1. The eight switches operate independently.
2. Serial data is clocked in on the L→ H transition 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 flows through the latch.
4. D_{OUT} is high when switch 7 is on.
5. Shift register clocking has no effect on the switch states if $\overline{LE}$ is H.
6. The clear input overrides all other inputs.

Typical Performance Curves

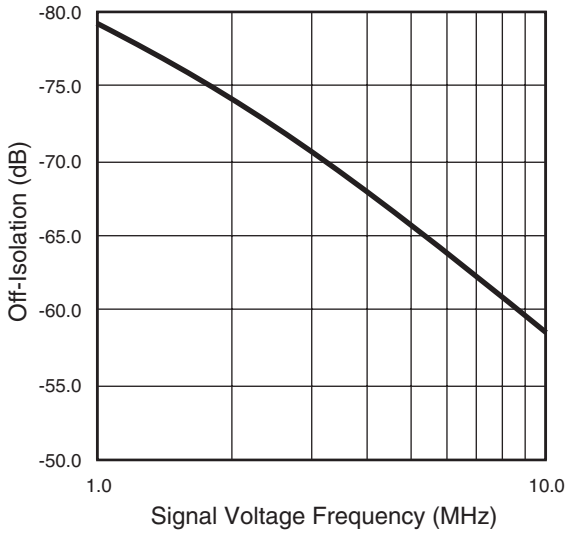
I_{DD} vs Clock Frequency

V_{DD} = 5.0V, V_{PP}/V_{NN} = ±100V, T_A = 0°C to 70°C



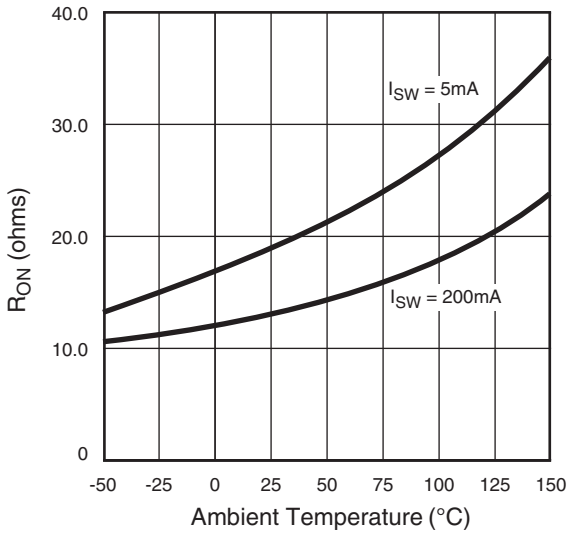
Off-Isolation vs. Signal Voltage Frequency

V_{DD} = 5.0V, V_{PP}/V_{NN} = ±100V



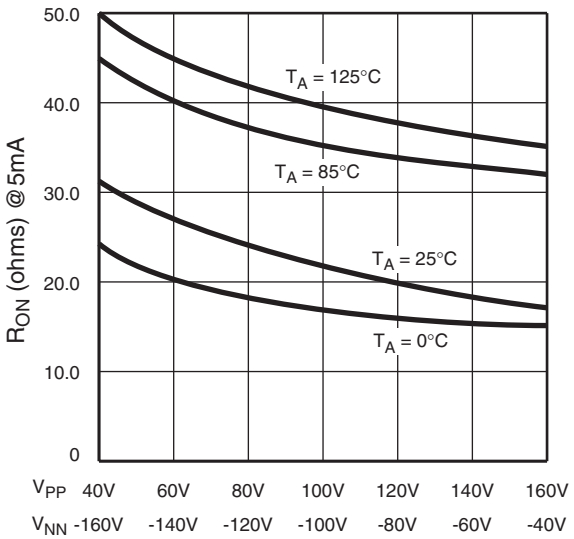
R_{ON} vs. Ambient Temperature T_A

V_{DD} = 5.0V, V_{PP}/V_{NN} = ±100V



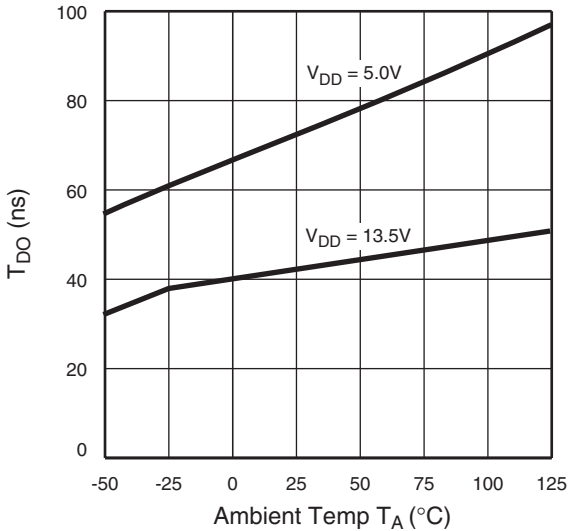
R_{ON} vs. V_{PP}/V_{NN}

V_{DD} = 5.0V



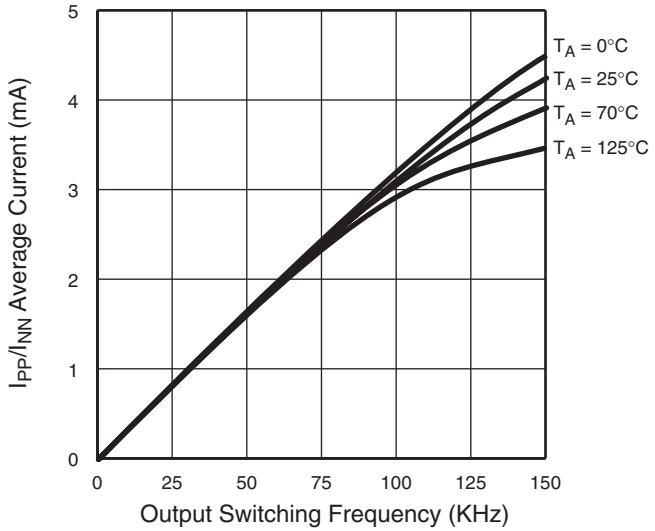
T_{DO} vs. Ambient Temperature T_A

V_{PP}/V_{NN} = ±100V



I_{PP}/I_{NN} vs. Output Switching Frequency

V_{DD} = 5.0V, V_{PP}/V_{NN} = ±100V



Pin Configurations

HV202 28-Pin DIP

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

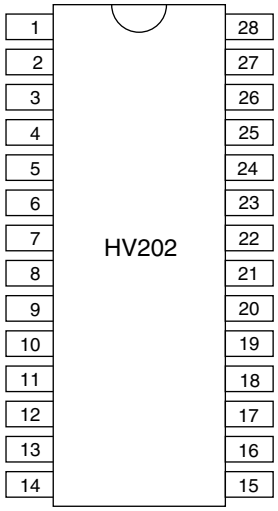
HV202 28 Pin J-Lead

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

HV203 28 Pin J-Lead

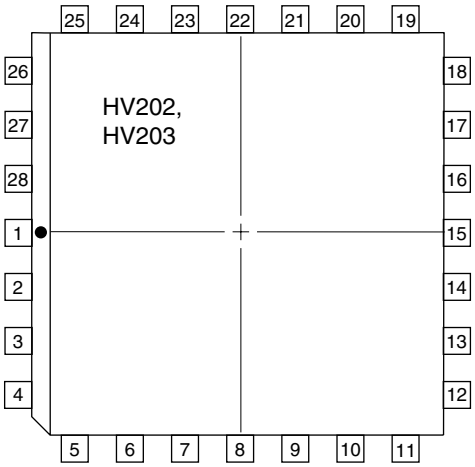
Pin	Function	Pin	Function
1	SW3	15	N/C
2	SW3	16	D_{IN}
3	SW2	17	CLK
4	SW2	18	$\overline{LE}$
5	SW1	19	CL
6	SW1	20	D_{OUT}
7	SW0	21	SW7
8	SW0	22	SW7
9	V_{PP}	23	SW6
10	V_{NN}	24	SW6
11	N/C	25	SW5
12	GND	26	SW5
13	V_{DD}	27	SW4
14	N/C	28	SW4

Package Outlines



top view

28-pin DIP



top view

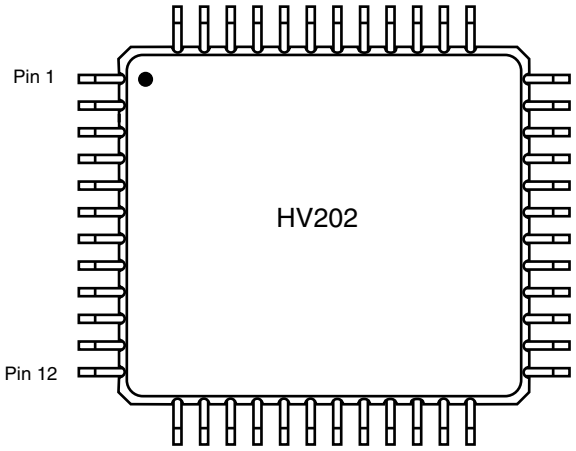
28-pin J-Lead Package

Pin Configurations

HV202 48-Pin TQFP

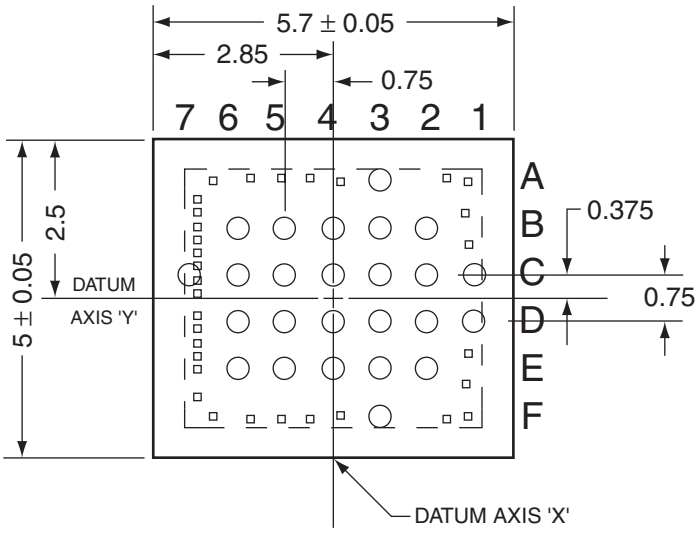
Pin	Function	Pin	Function
1	SW5	25	V_{NN}
2	N/C	26	N/C
3	SW4	27	N/C
4	N/C	28	GND
5	SW4	29	V_{DD}
6	N/C	30	N/C
7	N/C	31	N/C
8	SW3	32	N/C
9	N/C	33	D_{IN}
10	SW3	34	CLK
11	N/C	35	$\overline{LE}$
12	SW2	36	CLR
13	N/C	37	D_{OUT}
14	SW2	38	N/C
15	N/C	39	SW7
16	SW1	40	N/C
17	N/C	41	SW7
18	SW1	42	N/C
19	N/C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

Package Outlines

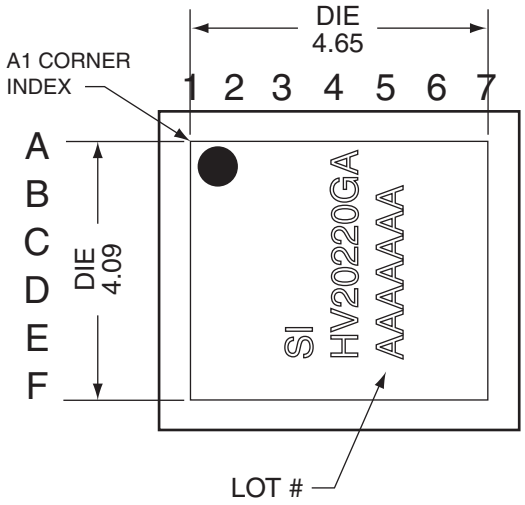


top view
48-pin TQFP

HV20220GA Package Outline (μ-BGA)

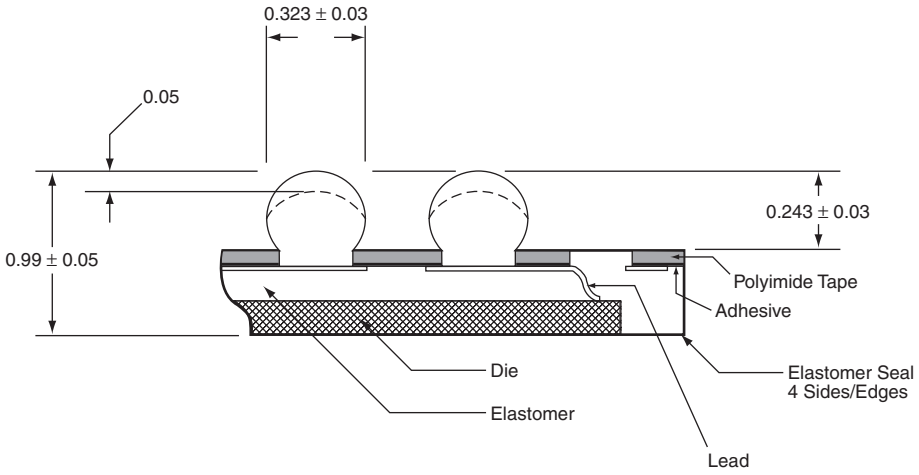


BUMP VIEW



BACK VIEW

NOTES:
1. Dimensioning and tolerance per ASME Y14.5M-1994.
2. Do not subject part to ultrasonic cleaning or intense UV.
3. Contact ball position per JESD 95-1, SPP-010.
4. Units are in millimeters.



ENLARGED VIEW

μ-BGA Function Table

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

Supertex inc
1235 Bordeaux Drive, Sunnyvale, CA 94089