Low Charge Injection 8-Channel High Voltage Analog Switch

Features

- HVCMOS® technology for high performance
- Very low quiescent power dissipation (-10µA)
- Output on-resistance typically 22Ω
- Low parasitic capacitances
- DC to 50MHz small signal frequency response
- -60dB typical output off isolation at 5.0MHz
- 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

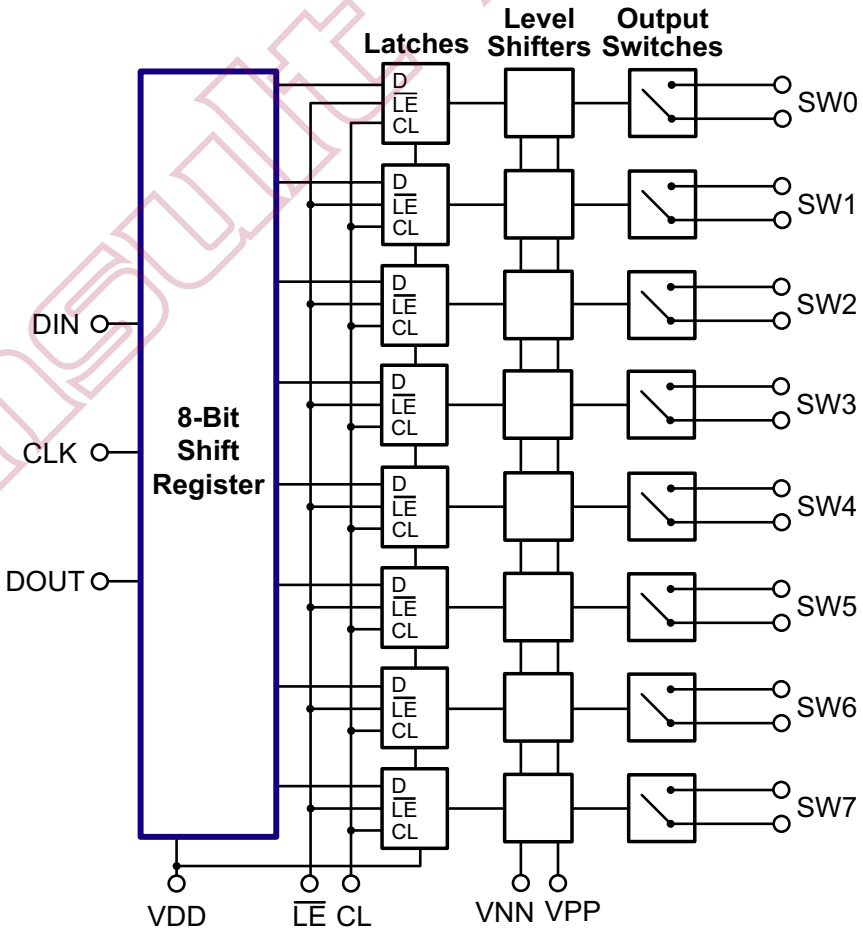
General Description

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.

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

Block Diagram



Ordering Information

Device	Package Option
	25-Ball fpBGA *5.70x5.00mm body* *1.20mm height (max)* *0.75mm pitch*
HV220	HV220GA-G

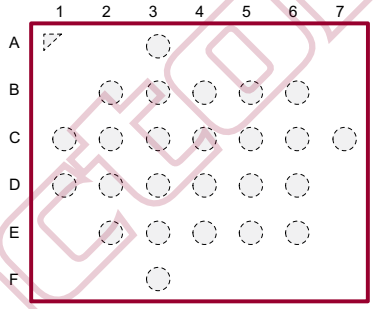
-G indicates the part is RoHS compliant ('Green')

Absolute Maximum Ratings

Parameter	Value
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	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



25-Ball fpBGA (GA)
(top view)

Product Marking

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

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

25-Ball fpBGA (GA)

Operating Conditions

Sym	Parameter	Value
V_{DD}	Logic power supply voltage [1,3]	4.5 to 13.2V
V_{PP}	Positive high voltage supply [1,3]	40 to V_{NN} +200V
V_{NN}	Negative high voltage supply [1,3]	-40 to -160V
V_{IH}	High level input voltage	V_{DD} -1.5V to V_{DD}
V_{IL}	Low-level input voltage	0 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 arbtrary except GND must be powered -up first and powered down last.*
2. *V_{SIG} must be $V_{NN} \le V_{SIG} \le V_{PP}$ 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 operating conditions unless otherwise specified)

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	38	-	48	Ω	I_{SIG} = 5.0mA	V_{PP} = +40V, V_{NN} = -160V
		-	25	-	22	27	-	32		I_{SIG} = 200mA	
		-	25	-	22	27	-	30		I_{SIG} = 5.0mA	V_{PP} = +100V, V_{NN} = -100V
		-	18	-	18	24	-	27		I_{SIG} = 200mA	
		-	23	-	20	25	-	30		I_{SIG} = 5.0mA	V_{PP} = +160V, V_{NN} = -40V
		-	22	-	16	25	-	27		I_{SIG} = 200mA	
ΔR_{ONS}	Small signal switch on-resistance matching	-	20	-	5.0	20	-	20	%	I_{SIG} = 5.0mA, V_{PP} = +100V, V_{NN} = -100V	
R_{ONL}	Large signal switch on-resistance	-	-	-	15	-	-	-	Ω	V_{SIG} = V_{PP} -10V, I_{SIG} = 1.0A	
I_{SOL}	Switch off leakage per switch	-	5.0	-	1.0	10	-	15	µA	V_{SIG} = V_{PP} -10V, V_{NN} +10V	
V_{OS}	DC offset switch off	-	300	-	100	300	-	300	mV	R_L = 100kΩ	
	DC offset switch on	-	500	-	100	500	-	500	mV	R_L = 100kΩ	
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} = 5.0mA	
I_{NNQ}	Quiescent V_{NN} supply current	-	-	-	-10	-50	-	-	µA	All switches on, I_{SW} = 5.0mA	
I_{SW}	Switch output peak current	-	3.0	-	3.0	2.0	-	2.0	A	V_{SIG} duty cycly < 0.1%	
f_{SW}	Output switching frequency	-	-	-	-	50	-	-	kHz	Duty cycle = 50%	
I_{PP}	Supply current	-	6.5	-	-	7.0	-	8.0	mA	V_{PP} = +40V, V_{NN} = -160V	All output switches are turning On and Off at 50kHz 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 curent	-	6.5	-	-	7.0	-	8.0	mA	V_{PP} = +40V, V_{NN} = -160V	All output switches are turning On and Off at 50kHz 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_{DD}	Logic supply average current	-	4.0	-	-	4.0	-	4.0	mA	f_{CLK} = 5.0MHz, V_{DD} = 5.0V	
I_{DDQ}	Logic supply quiescent current	-	10	-	-	10	-	10	µA	---	
I_{SOR}	Data out source current	0.45	-	0.45	0.70	-	0.40	-	mA	V_{OUT} = V_{DD} -0.7V	
I_{SINK}	Data out sink current	0.45	-	0.45	0.70	-	0.40	-	mA	V_{OUT} = 0.7V	
C_{IN}	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 $\overline{LE}$	150	-	150	-	-	150	-	ns	---
t_{DO}	Clock delay time to data out	-	150	-	-	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} = 10kΩ
t_{OFF}	Turn off time	-	5.0	-	-	5.0	-	5.0	µs	V_{SIG} = V_{PP} -10V, R_{LOAD} = 10kΩ
dv/dt	Maximun 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, 1.0kΩ/15pF load
		-58	-	-58	-	-	-58	-		f = 5.0MHz, 50Ω load
K_{CR}	Switch crosstalk	-60	-	-60	-70	-	-60	-	dB	f = 5.0MHz, 50Ω 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	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} = 50Ω
$-V_{SPK}$		-	-	-	-	150	-	-		
$+V_{SPK}$		-	-	-	-	150	-	-		V_{PP} = +100V, V_{NN} = -100V, R_{LOAD} = 50Ω
$-V_{SPK}$		-	-	-	-	150	-	-		
$+V_{SPK}$		-	-	-	-	150	-	-		V_{PP} = +160V, V_{NN} = -40V, R_{LOAD} = 50Ω
$-V_{SPK}$		-	-	-	-	150	-	-		
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

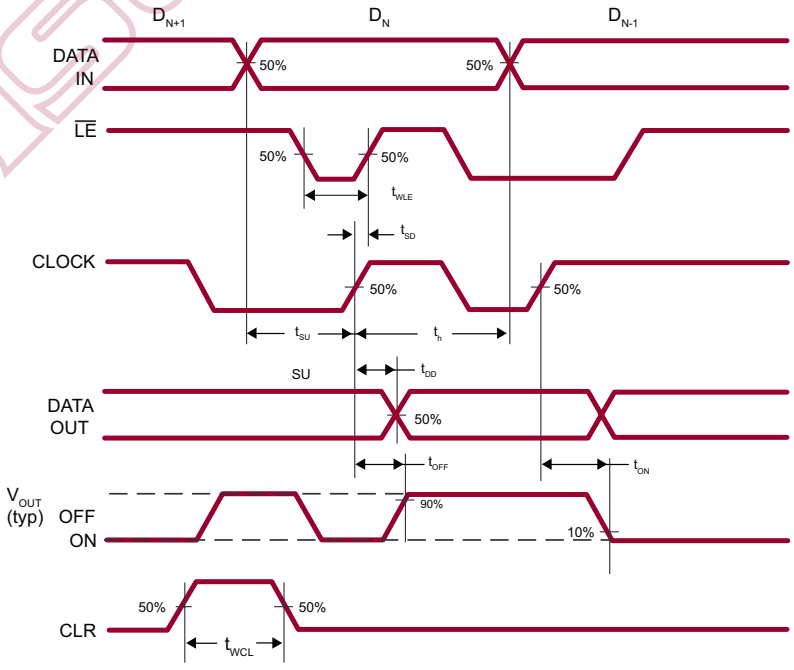
Truth Table

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								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	All Switches Off							

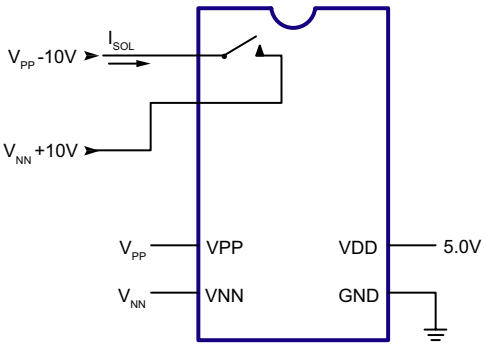
Notes:

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.*

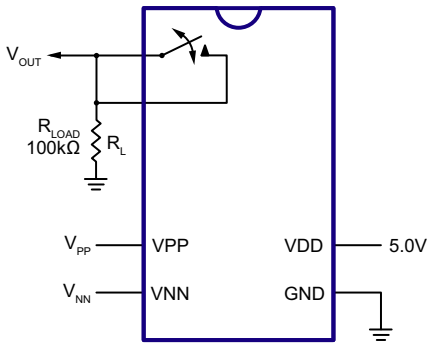
Logic Timing Waveforms



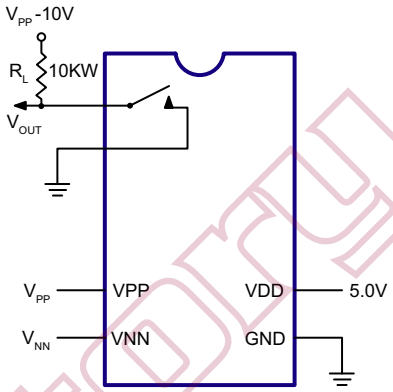
Test Circuits



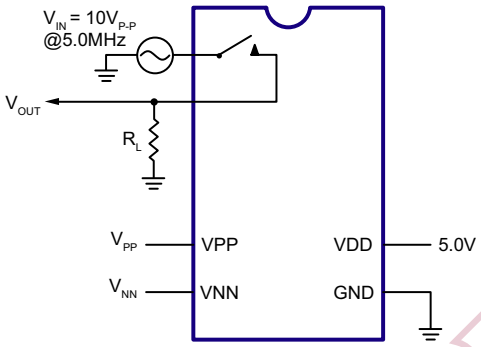
Switch OFF Leakage



DC Offset ON/OFF

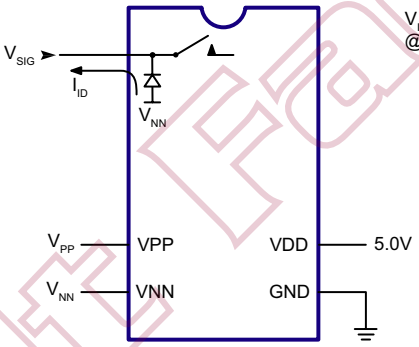


T_{ON}/T_{OFF} Test Circuit

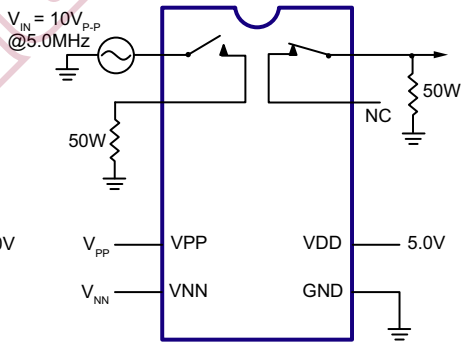


$K_O = 20Log \frac{V_{OUT}}{V_{IN}}$

OFF Isolation

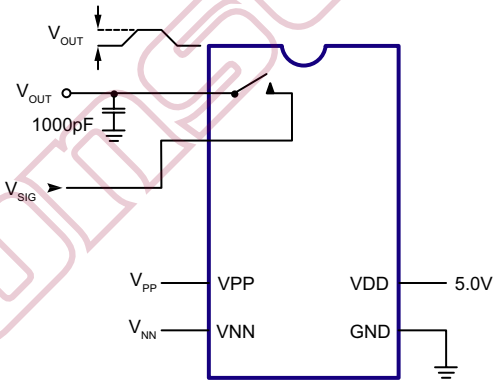


Isolation Diode Current



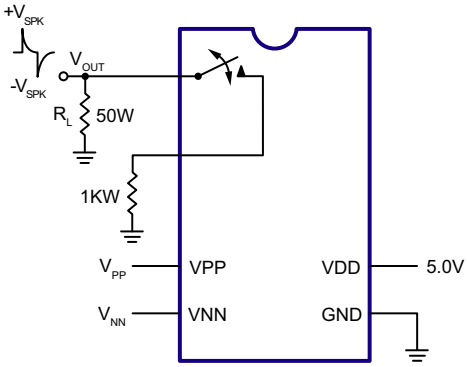
$K_{CR} = 20Log \frac{V_{OUT}}{V_{IN}}$

Crosstalk



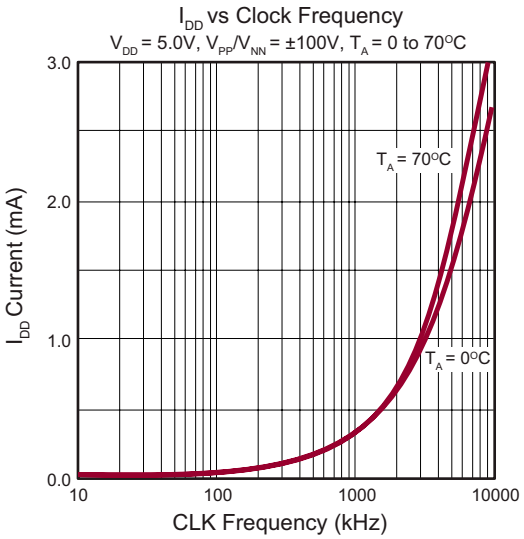
Q = 1000pF x V_{OUT}

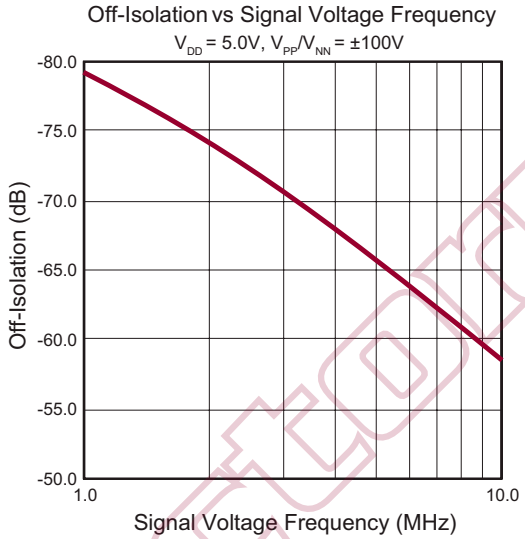
Charge Injection

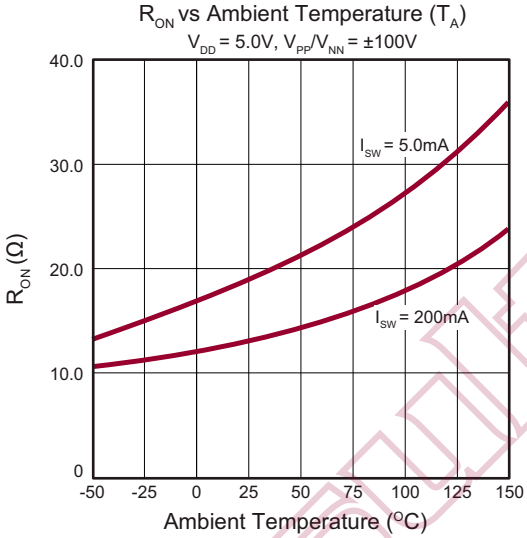


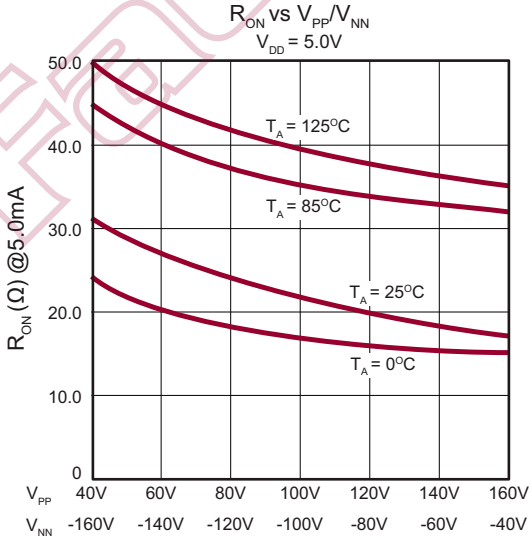
Output Voltage Spike

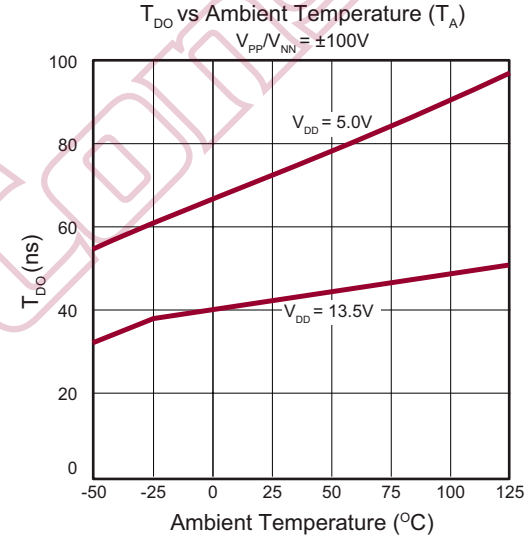
Typical Performance Curves

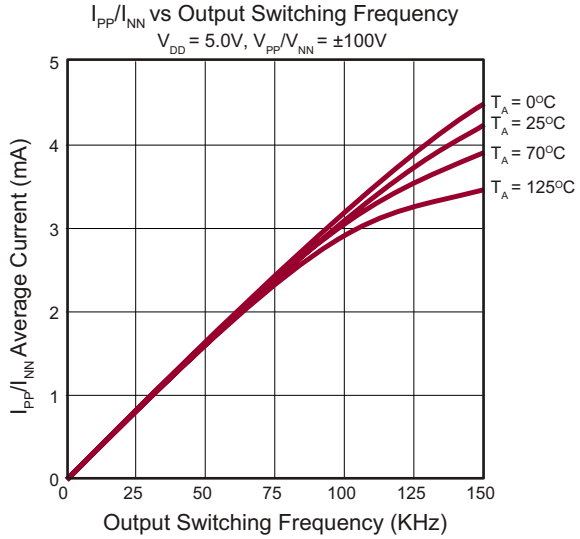












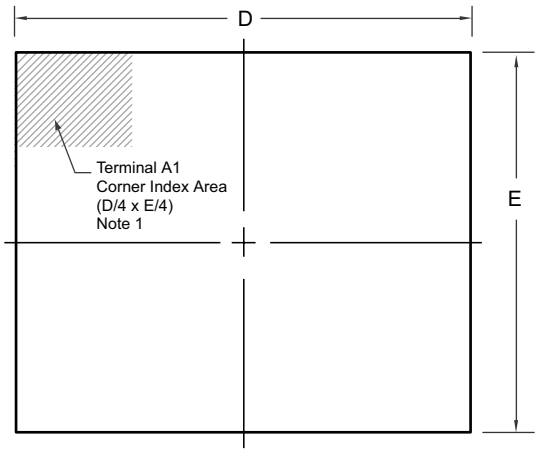
Pin Description

Ball Location	Function
A3	SW1
B2	SW2
B3	SW1
B4	SW0
B5	SW0
B6	VNN
C1	SW3
C2	SW3
C3	SW2
C4	VPP
C5	GND
C6	DIN
C7	VDD

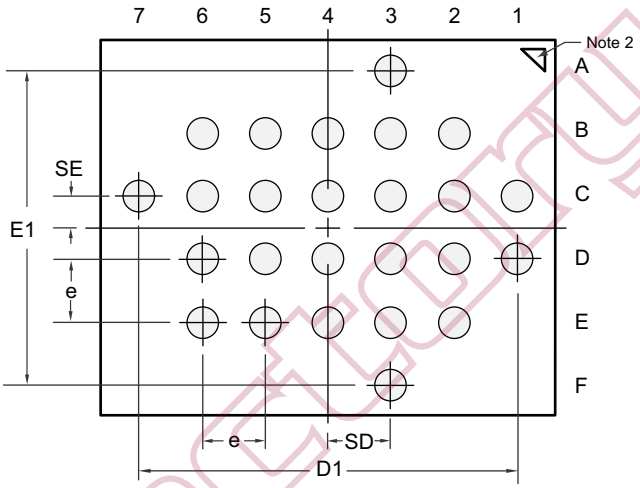
Ball Location	Function
D1	SW4
D2	SW4
D3	SW5
D4	SW7
D5	$\overline{\text{LE}}$
D6	CLK
E2	SW5
E3	SW6
E4	SW7
E5	DOUT
E6	CLR
F3	SW6

25-Ball fpBGA Package Outline (GA)

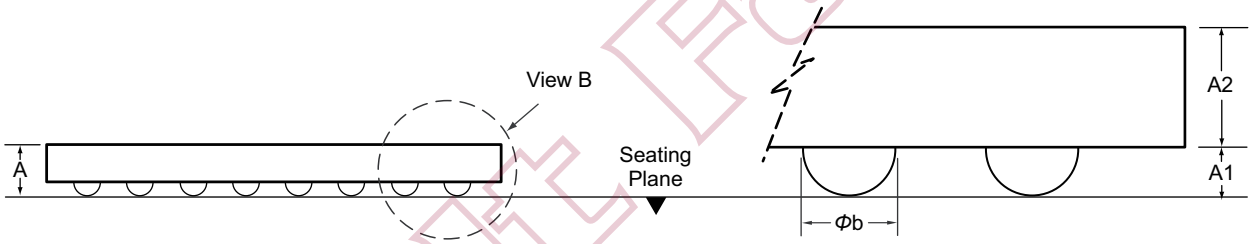
5.70x5.00mm body, 1.20mm height (max), 0.75mm pitch



Top View



Bottom View



Side View **View B**

Notes:

1. *A ball A1 identifier must be located in the index area indicated. The ball A1 identifier can be: a molded mark/identifier; an embedded metal marker; or a printed indicator.*
2. *Corner A1 identifier (actual shape may vary).*

Symbol		A	A1	A2	Φb	D	D1	E	E1	e	SD	SE
Dimension (mm)	MIN	0.844	0.18	0.664	0.25	5.60	4.50 BSC	4.90	3.75 BSC	0.75 BSC	0.75 BSC	0.375 BSC
	NOM	0.994	0.23	0.764	0.30	5.70		5.00				
	MAX	1.200	0.28	0.864	0.35	5.80		5.10				

Drawings not to scale.
***Supertex** Doc. #: DSPD-25fpBGAGA, Version B092208.*

(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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