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HV2802/HV2902

Low Harmonic Distortion, 32-Channel SPST, High-Voltage Analog Switch

Features

- 32-Channel SPST (Single-Pole, Single-Throw) High-Voltage Analog Switch
- 3.3V or 5.0V CMOS Input Logic Level
- 20 MHz Data Shift Clock Frequency
- High-Voltage CMOS (HVCMOS) Technology for High Performance
- Very Low Quiescent Power Dissipation (10 µA)
- Low Parasitic Capacitance
- DC to 50 MHz Analog Signal Frequency
- -60 dB Typical OFF-Isolation at 5.0 MHz
- CMOS Logic Circuitry for Low Power
- Excellent Noise Immunity
- Cascadable Serial Data Register with Latches
- Flexible Operating Supply Voltages
- Integrated Bleed Resistors on the Outputs (HV2902 only)

Applications

- Medical Ultrasound Imaging
- Non-Destructive Testing (NDT) Metal Flaw Detection
- Piezoelectric Transducer Drivers
- Inkjet Printer Heads
- Optical MEMS Modules

General Description

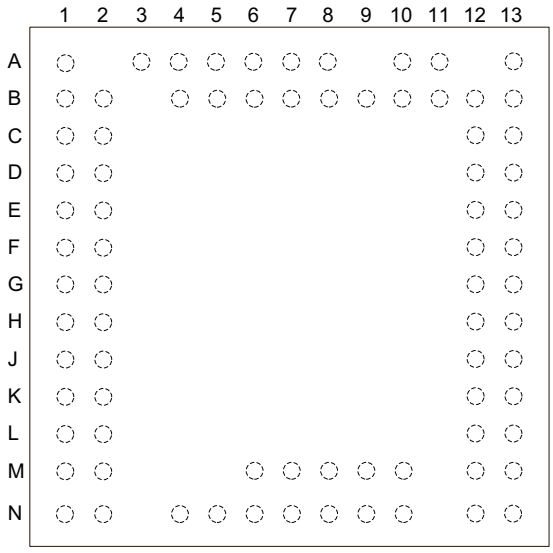
The HV2802 and HV2902 are low-charge injection, 32-channel, high-voltage analog switches intended for use in applications requiring high-voltage switching controlled by low-voltage control signals, such as medical ultrasound imaging, driving piezoelectric transducers and printers. The HV2902 has integrated bleed resistors which eliminate voltage build-up on capacitive loads such as piezoelectric transducers.

Input data are shifted into a 32-bit shift register that can then be retained in a 32-bit latch. To reduce any possible clock feedthrough 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 the 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.

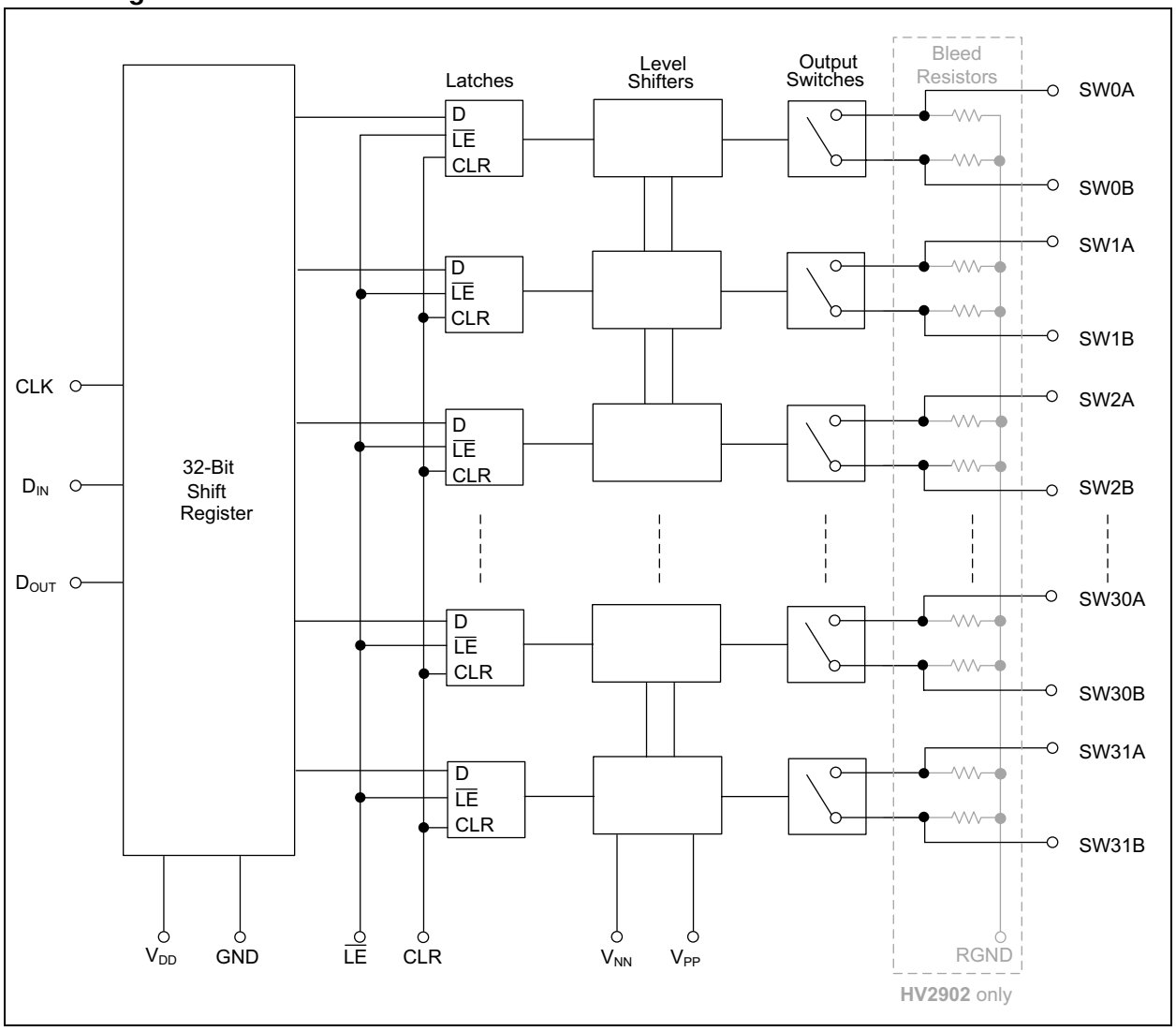
Package Type

HV2802/HV2902
9x9x1.0 mm VFBGA*
Top View



*See **Section 2.0 "Package Pin Configurations and Functions Description"**

Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

V_{DD} Logic Supply Voltage ..... -0.5V to +6.5V
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
Power Dissipation 1.5W

† Notice: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING CONDITIONS (Note 1 — 3)

Parameter	Symbol	Value
Logic Power Supply Voltage	V_{DD}	+3.0V to +5.5V
Positive Voltage Supply	V_{PP}	+40V to V_{NN}+200V
Negative Voltage Supply	V_{NN}	-40V to -160V
High-Level Input Voltage	V_{IH}	$0.9V_{DD}$ to V_{DD}
Low-Level Input Voltage	V_{IL}	0V to $0.1V_{DD}$
Analog Signal Voltage Peak-to-Peak	V_{SIG}	V_{NN} +10V to V_{PP} -10V

Note 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 1.0 ms.

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise specified, V_{DD} = 5.0V, V_{PP} = +100V, V_{NN} = -100V, Specification at 0°C and 70°C based on characterization and not 100% tested.

Parameters	Symbol	0°C		+25°C			+70°C		Units	Conditions
		Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
Small Signal Switch ON-Resistance	R_{ONS}	—	30	—	26	38	—	48	Ω	I_{SIG} = 5.0 mA, V_{PP} = +40V, V_{NN} = -160V
		—	25	—	22	27	—	32		I_{SIG} = 200 mA, V_{PP} = +40V, V_{NN} = -160V
		—	25	—	22	27	—	30		I_{SIG} = 5.0 mA, V_{PP} = +100V, V_{NN} = -100V
		—	18	—	18	24	—	27		I_{SIG} = 200 mA, V_{PP} = +100V, V_{NN} = -100V
		—	23	—	20	25	—	30		I_{SIG} = 5.0 mA, V_{PP} = +160V, V_{NN} = -40V
		—	22	—	16	25	—	27		I_{SIG} = 200 mA, V_{PP} = +160V, V_{NN} = -40V
Small Signal Switch ON-Resistance Matching	ΔR_{ONS}	—	20	—	5	20	—	20	%	I_{SIG} = 5.0 mA, V_{PP} = +100V, V_{NN} = -100V
Large Signal Switch ON-Resistance (**Note 1**)	R_{ONL}	—	—	—	15	—	—	—	Ω	V_{SIG} = V_{PP} -10V, I_{SIG} = 1A
Value of Output Bleed Resistor	R_{INT}	—	—	20	35	50	—	—	kΩ	Output switch to RGND I_{RINT} = 0.5 mA
Switch off Leakage per Switch	I_{SOL}	—	5	—	1	10	—	15	µA	V_{SIG} = V_{PP} -10V, V_{NN} +10V
Switch DC Offset	V_{OS}	—	300	—	100	300	—	300	mV	Switch OFF, R_{LOAD} = 100 kΩ for HV2802 No load for HV2902
		—	500	—	100	500	—	500		Switch ON R_{LOAD} = 100 kΩ for HV2802 No load for HV2902
Quiescent V_{PP} Supply Current	I_{PPQ}	—	—	—	10	50	—	—	µA	All switches off
Quiescent V_{NN} Supply Current	I_{NNQ}	—	—	—	10	50	—	—		
Quiescent V_{PP} Supply Current	I_{PPQ}	—	—	—	10	50	—	—	µA	All switches on, I_{SW} = 5.0 mA
Quiescent V_{NN} Supply Current	I_{NNQ}	—	—	—	10	50	—	—		
Switch Output Peak Current (**Note 1**)	I_{SW}	—	—	2	3	—	—	—	A	V_{SIG} duty cycle < 0.1%
Output Switching Frequency (**Note 1**)	f_{SW}	—	—	—	—	50	—	—	kHz	Duty cycle = 50%

Note 1: Specification is obtained by characterization and is not 100% tested.

2: Design guidance only.

DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise specified, V_{DD} = 5.0V, V_{PP} = +100V, V_{NN} = -100V, Specification at 0°C and 70°C based on characterization and not 100% tested.

Parameters	Symbol	0°C		+25°C			+70°C		Units	Conditions
		Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
Average V_{PP} Supply Current	I_{PP}	—	14	—	—	14	—	14	mA	V_{PP} = +40V, V_{NN} = -160V All output switches are turning on and off at 50 kHz with no load
		—	14	—	—	14	—	14		V_{PP} = +100V, V_{NN} = -100V All output switches are turning on and off at 50 kHz with no load
		—	14	—	—	14	—	14		V_{PP} = +160V, V_{NN} = -40V All output switches are turning on and off at 50 kHz with no load
Average V_{NN} Supply Current	I_{NN}	—	14	—	—	14	—	14	mA	V_{PP} = +40V, V_{NN} = -160V All output switches are turning on and off at 50 kHz with no load
		—	14	—	—	14	—	14		V_{PP} = +100V, V_{NN} = -100V All output switches are turning on and off at 50 kHz with no load
		—	14	—	—	14	—	14		V_{PP} = +160V, V_{NN} = -40V All output switches are turning on and off at 50 kHz with no load
Average V_{DD} Supply Current	I_{DD}	—	8	—	—	8	—	8	mA	f_{CLK} = 5.0 MHz, V_{DD} = 5.0V
Quiescent V_{DD} Supply Current	I_{DDQ}	—	10	—	—	10	—	10	µA	All logic inputs are static
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 (**Note 2**)	C_{IN}	—	10	—	—	10	—	10	pF	

Note 1: Specification is obtained by characterization and is not 100% tested.

2: Design guidance only.

AC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise specified, V_{DD} = 5.0V, V_{PP} = +100V, V_{NN} = -100V, Specification at 0°C and 70°C based on characterization and not 100% tested.

Parameters	Symbol	0°C		+25°C			+70°C		Units	Conditions
		Min.	Max.	Min.	Typ.	Max.	Min.	Max.		
Set Up Time Before $\overline{LE}$ Rises (**Note 1**)	t_{SD}	25	—	25	—	—	25	—	ns	
Time Width of $\overline{LE}$ (**Note 1**)	t_{WLE}	56	—	56	—	—	56	—	ns	V_{DD} = 3.0V
		12	—	12	—	—	12	—		V_{DD} = 5.0V
Clock Delay Time to Data Out (**Note 1**)	t_{DO}	8	40	8	19	40	8	40	ns	V_{DD} = 3.0V
		8	30	8	15	30	8	30		V_{DD} = 5.0V
Time Width of CLR (**Note 1**)	t_{WCLR}	55	—	55	—	—	55	—	ns	
Set Up Time Data to Clock (**Note 1**)	t_{SU}	21	—	21	—	—	21	—	ns	V_{DD} = 3.0V
		7	—	7	—	—	7	—		V_{DD} = 5.0V
Hold Time Data from Clock (**Note 1**)	t_H	5	—	5	—	—	5	—	ns	V_{DD} = 3.0V
		7	—	7	—	—	7	—		V_{DD} = 5.0V
Clock Frequency	f_{CLK}	—	8	—	—	8	—	8	MHz	V_{DD} = 3.0V
		—	20	—	—	20	—	20		V_{DD} = 5.0V
Clock Rise and Fall Times	t_R, t_F	—	50	—	—	50	—	50	ns	
Turn ON Time	t_{ON}	—	5	—	—	5	—	5	µs	V_{SIG} = V_{PP} -10V, R_{LOAD} = 10 kΩ
Turn OFF Time	t_{OFF}	—	5	—	—	5	—	5		
Maximum V_{SIG} Slew Rate (**Note 1**)	dv/dt	—	—	—	—	20	—	—	V/ns	V_{PP} = +40V, V_{NN} = -160V
		—	—	—	—	20	—	—		V_{PP} = +100V, V_{NN} = -100V
		—	—	—	—	20	—	—		V_{PP} = +160V, V_{NN} = -40V
OFF Isolation (**Note 1**)	K_O	—	—	—	-33	-30	—	—	dB	f = 5.0 MHz, 1.0 kΩ ‖ 15 pF load
		—	—	—	-60	-58	—	—		f = 5.0 MHz, 50Ω load
Switch Crosstalk (**Note 1**)	K_{CR}	—	—	—	-70	-60	—	—	dB	f = 5.0 MHz, 50Ω load
Output Switch Isolation Diode Current (**Note 1**)	I_{ID}	—	—	—	—	300	—	—	mA	300 ns pulse width, 2.0% duty cycle
Off Capacitance SW to GND (**Note 1**)	$C_{SG(OFF)}$	—	—	—	10	15	—	—	pF	0V, f = 1.0 MHz
On Capacitance SW to GND (**Note 1**)	$C_{SG(ON)}$	—	—	—	13	18	—	—		
Output Voltage Spike SWA, SWB (**Note 1**)	$+V_{SPK}$	—	—	—	—	+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	—	—	—	—		
Charge Injection (per switch) (**Note 1**)	QC	—	—	—	820	—	—	—	pC	V_{PP} = +40V, V_{NN} = -160V
		—	—	—	600	—	—	—		V_{PP} = +100V, V_{NN} = -100V
		—	—	—	350	—	—	—		V_{PP} = +160V, V_{NN} = -40V

Note 1: Specification is obtained by characterization and is not 100% tested.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Operating Temperature	T_A	0	—	+70	°C	
Storage Temperature	T_A	-65	—	+150	°C	
Package Thermal Resistance						
Thermal Resistance, 78-Ball VFBGA	θ_{JA}	—	32.2	—	°C/W	

1.1 Logic Timing and Truth Table

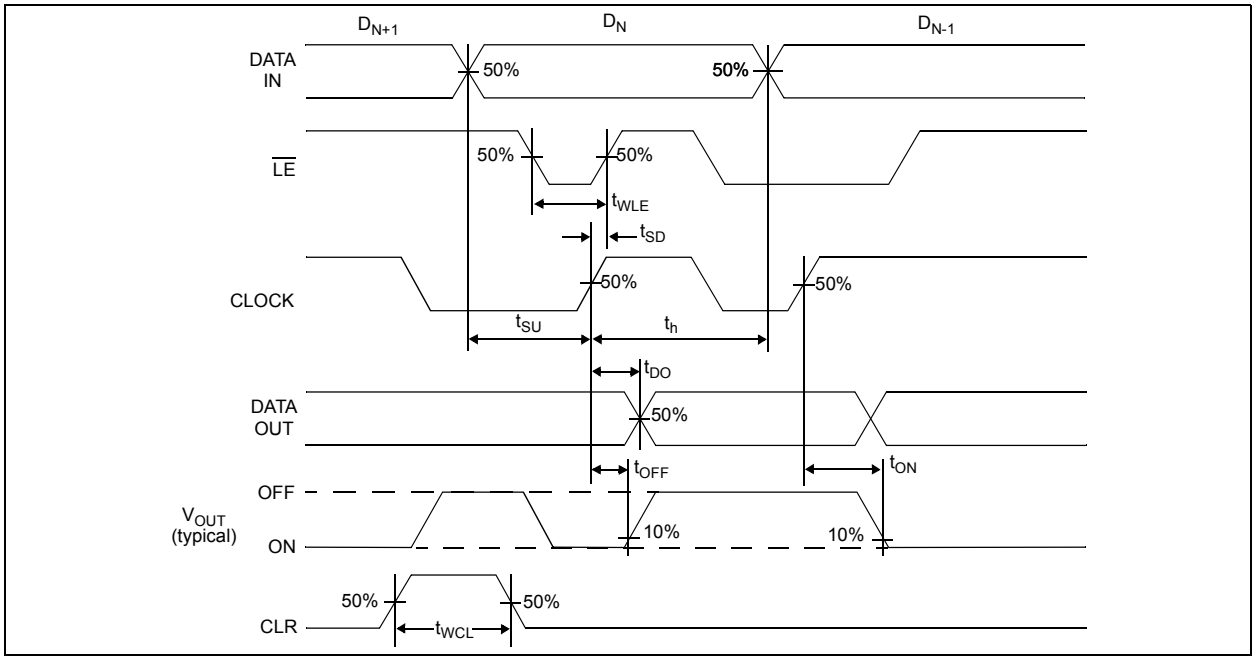


FIGURE 1-1: *Logic Timing Waveforms.*

TABLE 1-1: TRUTH TABLE (Notes 1 — 6)

D0	D1	•••	D15	D16	•••	D31	$\overline{LE}$	CLR	SW0	SW1	•••	SW15	SW16	•••	SW31
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						

Legend: X = Do not care; L = Low; H = High.

Note 1: The 32 switches operate independently.

2: Serial data is clocked in on the L to H transition of the CLK.

3: All 32 switches go to a state retaining their latched condition at the rising edge of $\overline{LE}$. When $\overline{LE}$ is low, the shift register's data flow through the latch.

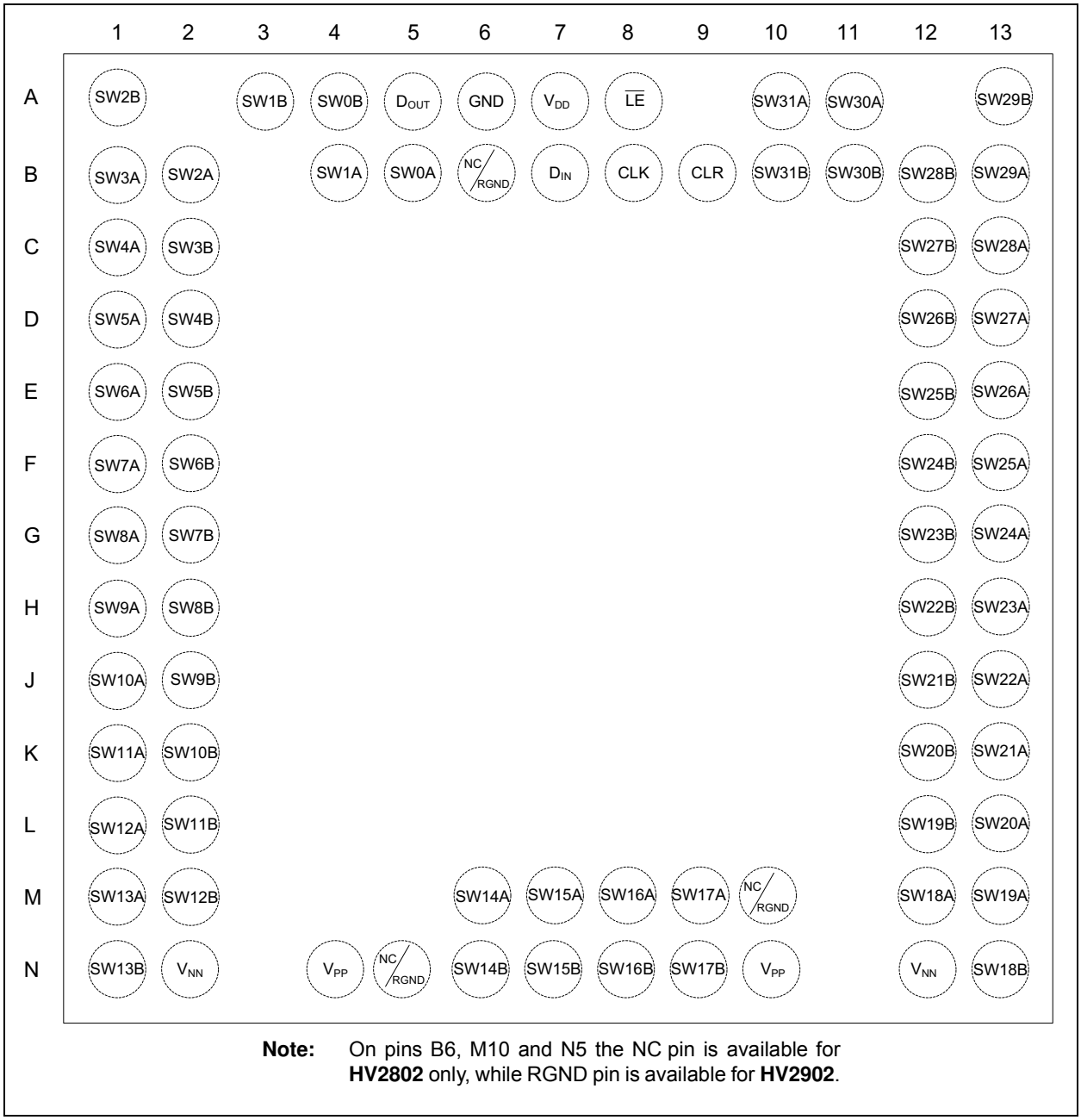
4: D_{OUT} is high when data in register 31 is high.

5: Shift register's clocking has no effect on the switch states if $\overline{LE}$ is high.

6: The CLR clear input overrides all other inputs.

2.0 PACKAGE PIN CONFIGURATIONS AND FUNCTIONS DESCRIPTION

This section details the pin designation for the 78-Ball VFBGA package (Figure 2-1). The descriptions of the pins are listed in Table 2-1.



Note: On pins B6, M10 and N5 the NC pin is available for **HV2802** only, while RGND pin is available for **HV2902**.

FIGURE 2-1: *78-Ball VFBGA Package - Top View.*

TABLE 2-1: PIN FUNCTION TABLE

Pin Number	Symbol		Description
	9x9x1.0 VFBGA		
	HV2802	HV2902	
A1	SW2B	SW2B	Analog switch 2 terminal B
A3	SW1B	SW1B	Analog switch 1 terminal B
A4	SW0B	SW0B	Analog switch 0 terminal B
A5	D_{OUT}	D_{OUT}	Data out logic output
A6	GND	GND	Ground
A7	V_{DD}	V_{DD}	Logic supply voltage
A8	$\overline{LE}$	$\overline{LE}$	Latch enable logic input, low active
A10	SW31A	SW31A	Analog switch 31 terminal A
A11	SW30A	SW30A	Analog switch 30 terminal A
A13	SW29B	SW29B	Analog switch 29 terminal B
B1	SW3A	SW3A	Analog switch 3 terminal A
B2	SW2A	SW2A	Analog switch 2 terminal A
B4	SW1A	SW1A	Analog switch 1 terminal A
B5	SW0A	SW0A	Analog switch 0 terminal A
B6	NC	RGND	No connect / Ground for bleed resistor
B7	D_{IN}	D_{IN}	Data in logic input
B8	CLK	CLK	Clock logic input for shift register
B9	CLR	CLR	Latch clear logic input
B10	SW31B	SW31B	Analog switch 31 terminal B
B11	SW30B	SW30B	Analog switch 30 terminal B
B12	SW28B	SW28B	Analog switch 28 terminal B
B13	SW29A	SW29A	Analog switch 29 terminal A
C1	SW4A	SW4A	Analog switch 4 terminal A
C2	SW3B	SW3B	Analog switch 3 terminal B
C12	SW27B	SW27B	Analog switch 27 terminal B
C13	SW28A	SW28A	Analog switch 28 terminal A
D1	SW5A	SW5A	Analog switch 5 terminal A
D2	SW4B	SW4B	Analog switch 4 terminal B
D12	SW26B	SW26B	Analog switch 26 terminal B
D13	SW27A	SW27A	Analog switch 27 terminal A
E1	SW6A	SW6A	Analog switch 6 terminal A
E2	SW5B	SW5B	Analog switch 5 terminal B
E12	SW25B	SW25B	Analog switch 25 terminal B
E13	SW26A	SW26A	Analog switch 26 terminal A
F1	SW7A	SW7A	Analog switch 7 terminal A
F2	SW6B	SW6B	Analog switch 6 terminal B
F12	SW24B	SW24B	Analog switch 24 terminal B
F13	SW25A	SW25A	Analog switch 25 terminal A
G1	SW8A	SW8A	Analog switch 8 terminal A
G2	SW7B	SW7B	Analog switch 7 terminal B
G12	SW23B	SW23B	Analog switch 23 terminal B
G13	SW24A	SW24A	Analog switch 24 terminal A

TABLE 2-1: PIN FUNCTION TABLE (CONTINUED)

Pin Number	Symbol		Description
	9x9x1.0 VFBGA		
	HV2802	HV2902	
H1	SW9A	SW9A	Analog switch 9 terminal A
H2	SW8B	SW8B	Analog switch 8 terminal B
H12	SW22B	SW22B	Analog switch 22 terminal B
H13	SW23A	SW23A	Analog switch 23 terminal A
J1	SW10A	SW10A	Analog switch 10 terminal A
J2	SW9B	SW9B	Analog switch 9 terminal B
J12	SW21B	SW21B	Analog switch 21 terminal B
J13	SW22A	SW22A	Analog switch 22 terminal A
K1	SW11A	SW11A	Analog switch 11 terminal A
K2	SW10B	SW10B	Analog switch 10 terminal B
K12	SW20B	SW20B	Analog switch 20 terminal B
K13	SW21A	SW21A	Analog switch 21 terminal A
L1	SW12A	SW12A	Analog switch 12 terminal A
L2	SW11B	SW11B	Analog switch 11 terminal B
L12	SW19B	SW19B	Analog switch 19 terminal B
L13	SW20A	SW20A	Analog switch 20 terminal A
M1	SW13A	SW13A	Analog switch 13 terminal A
M2	SW12B	SW12B	Analog switch 12 terminal B
M6	SW14A	SW14A	Analog switch 14 terminal A
M7	SW15A	SW15A	Analog switch 15 terminal A
M8	SW16A	SW16A	Analog switch 16 terminal A
M9	SW17A	SW17A	Analog switch 17 terminal A
M10	NC	RGND	No connect/Ground for bleed resistor
M12	SW18A	SW18A	Analog switch 18 terminal A
M13	SW19A	SW19A	Analog switch 19 terminal A
N1	SW13B	SW13B	Analog switch 13 terminal B
N2	V_{NN}	V_{NN}	Negative supply voltage
N4	V_{PP}	V_{PP}	Positive supply voltage
N5	NC	RGND	No connect/Ground for bleed resistor
N6	SW14B	SW14B	Analog switch 14 terminal B
N7	SW15B	SW15B	Analog switch 15 terminal B
N8	SW16B	SW16B	Analog switch 16 terminal B
N9	SW17B	SW17B	Analog switch 17 terminal B
N10	V_{PP}	V_{PP}	Positive supply voltage
N12	V_{NN}	V_{NN}	Negative supply voltage
N13	SW18B	SW18B	Analog switch 18 terminal B

3.0 TEST CIRCUIT EXAMPLES

This section details test circuit examples for a few electrical characteristics. The RGND pins are found only on the HV2902 device. The Switch DC Offset of HV2802 needs 100 kΩ external load.

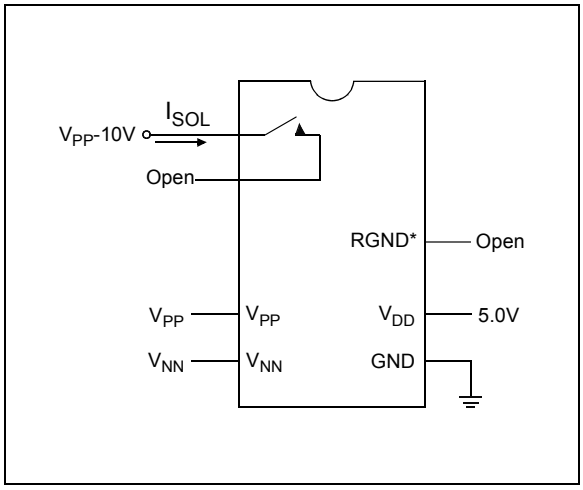


FIGURE 3-1: *Switch Off Leakage per Switch.*

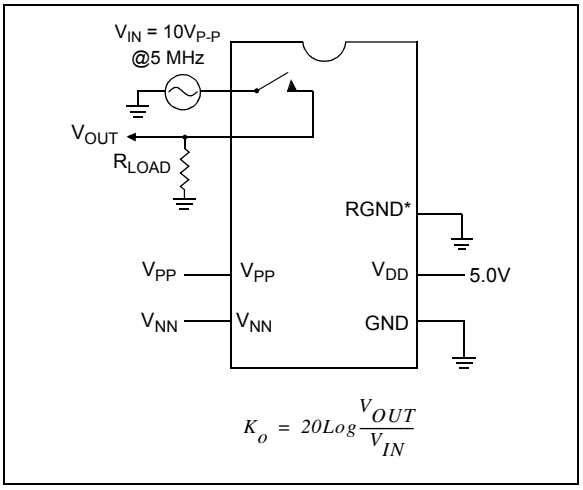


FIGURE 3-4: *Off Isolation.*

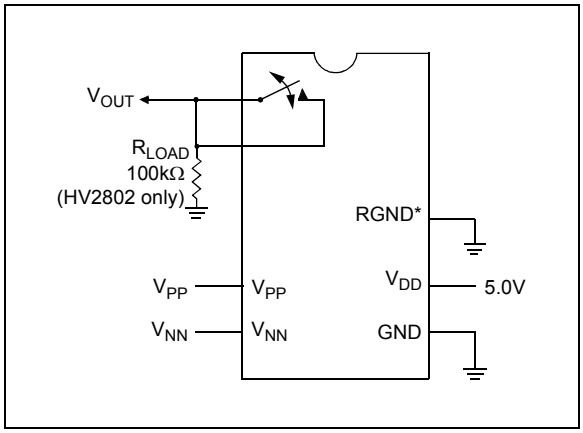


FIGURE 3-2: *Switch DC Offset.*

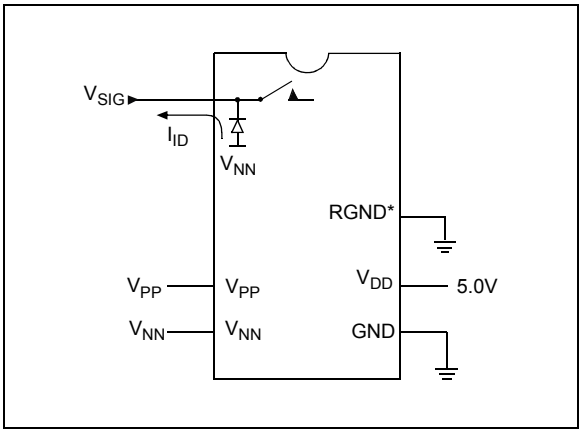


FIGURE 3-5: *Output Switch Isolation Diode Current.*

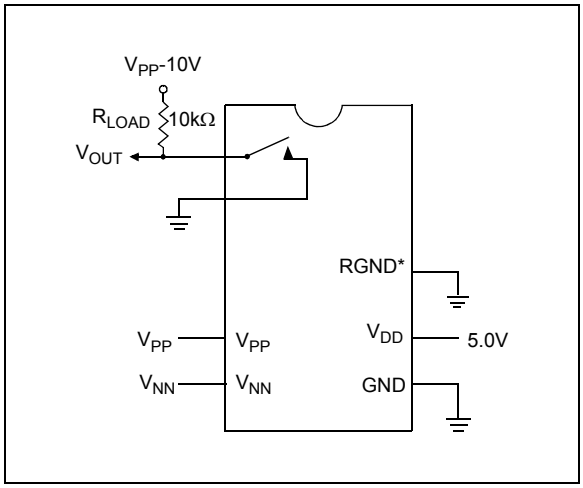


FIGURE 3-3: *T_{ON}/T_{OFF} Test Circuit.*

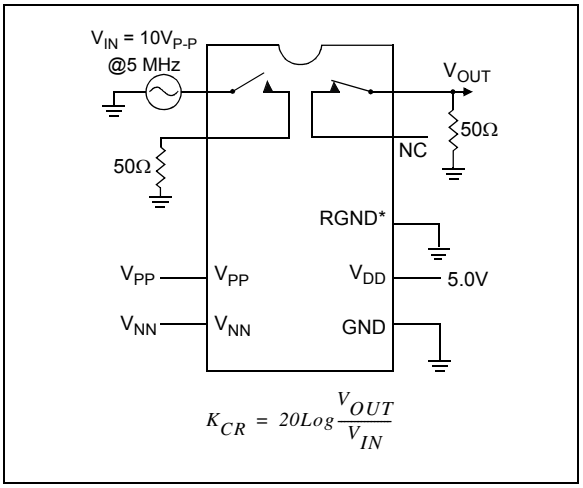


FIGURE 3-6: *Switch Crosstalk.*

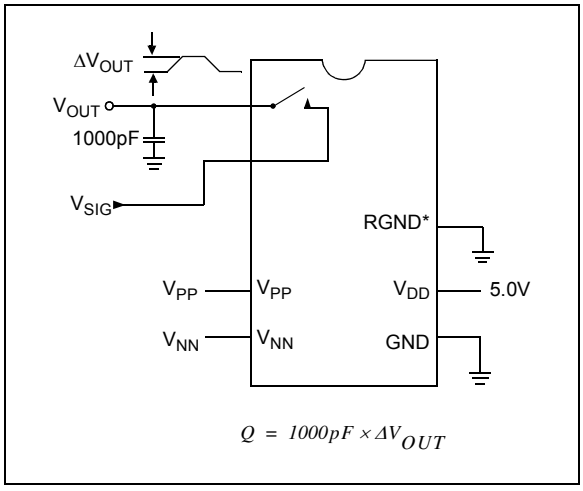


FIGURE 3-7: *Charge Injection.*

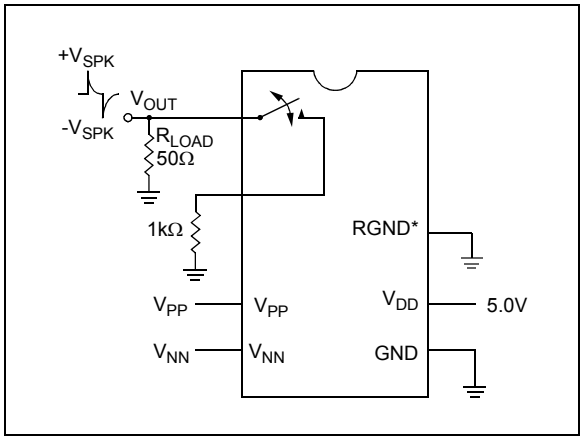


FIGURE 3-8: *Output Voltage Spike.*

4.0 DETAILED DESCRIPTION AND APPLICATION INFORMATION

The high-voltage analog switches are used for multiplexing a piezoelectric transducer array in a probe to multiple channel transmitters (Tx) arrays in a medical ultrasound system.

Figure 4-1 shows a typical medical ultrasound image system comprising 64-channels of transmit pulsers, 64-channels of receivers (LNA and ADC) and 64-channels of T/R switches connecting to 192 elements of an ultrasound transducer probe via a high-voltage analog switch array.

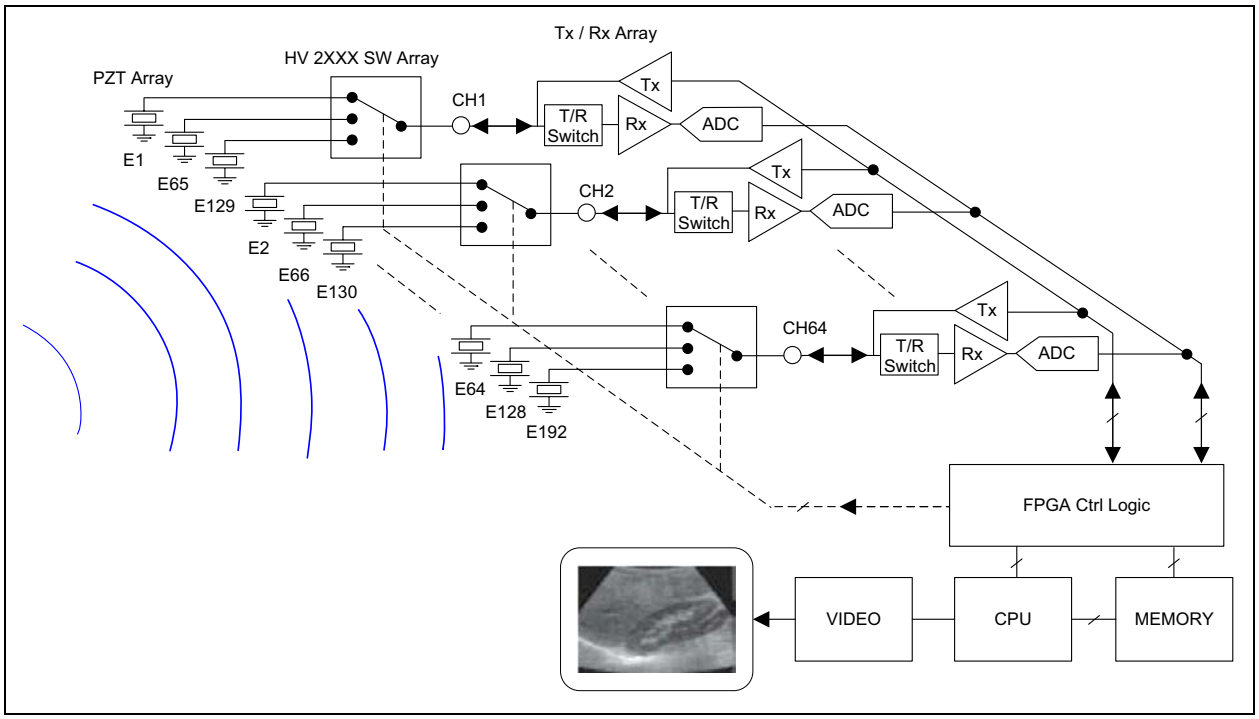


FIGURE 4-1: *Typical Medical Ultrasound Imaging System.*

The HV2802/HV2902 devices are comprised of two main circuitries:

- A low-power CMOS digital serial interface powered by V_{DD} to control the high-voltage analog switches
- High-voltage bilateral analog switch.

High-voltage supplies V_{PP} and V_{NN} are needed by the high-voltage level translation circuitry to control the states of the output high-voltage analog switches. In addition, each high-voltage analog switch can be independently controlled because each switch is controlled via a corresponding latch. A 32-bit shift register and 32 latches allow the user to serially load data into the registers, and after completion, to load the data onto the latches that control the states of the high-voltage analog switches.

The HV2802/HV2902 have a digital serial interface consisting of logic signals, Data In (D_{IN}), Clock (CLK), Data Out (D_{OUT}), Latch Enable ($\overline{LE}$) and Clear (CLR). The digital circuits are supplied by V_{DD} and either a 3.3V or a 5V logic can be used. With a V_{DD} = 5V supply, the serial clock frequency can operate up to 20 MHz.

The data is shifted into the shift registers on the rising edge (low-to-high transition) of the clock. The switch configuration bit of SW31 is shifted in first and the switch configuration bit of SW0 is shifted in last. To avoid clock feedthrough, the latch enable input ($\overline{LE}$) should remain high while the 32-bit data-in signal is shifted into the 32-bit register. After the valid 32-bit data complete shifting into the shift registers, the high-to-low transition of the $\overline{LE}$ signal transfers the contents of the shift register into the latches. Finally, setting the $\overline{LE}$ high again allows all the latches to keep the current state, while new data can now be shifted into the shift registers without upsetting the latches.

It is recommended to change all the latch states at the same time through this method to avoid possible clock feedthrough noise. See Figure 4-2 for details.

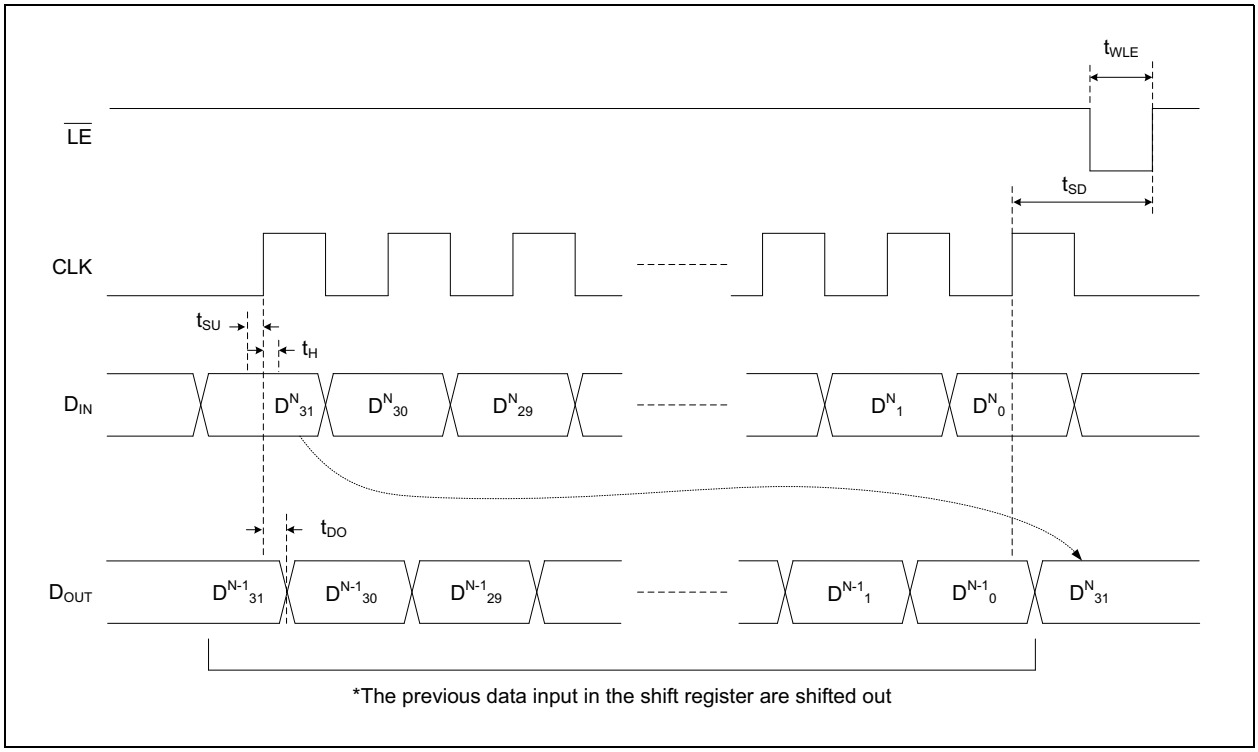


FIGURE 4-2: *Latch Enable Timing Waveforms.*

When the CLR input is set high, all 32 latches are cleared of the data. Consequently, all the high-voltage switches are set to off state. However, the CLR signal does not affect the contents of the shift register, so the shift register can operate independently of the CLR signal. Hence, after the CLR input is set low, the shift register would still retain the previous data.

The serial input interface of the HV2802/HV2902 allows multiple devices to daisy-chain together. In this configuration, D_{OUT} of a HV2802/HV2902 device is connected to the D_{IN} of the subsequent device, and so forth. The last D_{OUT} of the daisy-chained HV2802/HV2902 can either be floating or fed back to an FPGA to check the previously stored shift register data. To control all the high-voltage analog switch states in daisy-chained N devices, N times 32 clocks and N times 32 bits of data are shifted into shift registers, while $\overline{LE}$ remains high and CLR remains low. After all N times 32 bits of data finish shifting in, the high-to-low transition of the $\overline{LE}$ transfers the data from all N times 32-bit shift registers to N times 32 latches simultaneously. Consequently, all N times 32 high-voltage analog switches change states simultaneously.

It is recommended that 0.1 uF ceramic decoupling capacitors, with the appropriate voltage ratings, be connected between GND and the other supplies (V_{DD}, V_{PP} and V_{NN}). These decoupling capacitors should be placed as close as possible to the device.

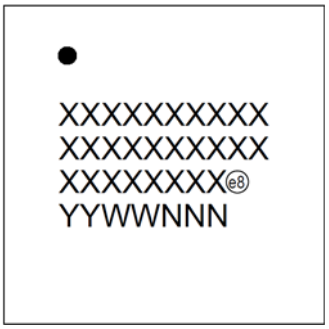
The HV2802/HV2902 devices do not have a specific power up/down sequence. During the power up/down period, all the analog switch inputs should be within the V_{PP} and V_{NN} range or floating. The rise time and fall time of the power supplies, V_{DD}, V_{PP} and V_{NN}, should be greater than 1 ms. Violating the rise time or fall time requirement on the power supplies may cause malfunction such as latch-up or even permanent damage of the device.

The HV2902 device has 35 kΩ integrated bleed resisters connected from all the analog switch terminals A and B to RGND. These bleed resisters eliminate voltage build-up on capacitive loads such as piezoelectric transducers. The HV2802 device does not have integrated bleed resistors.

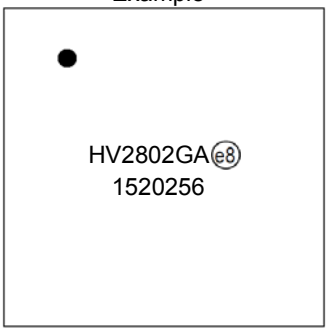
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

78-Ball VFBGA (9x9x1.0)



Example

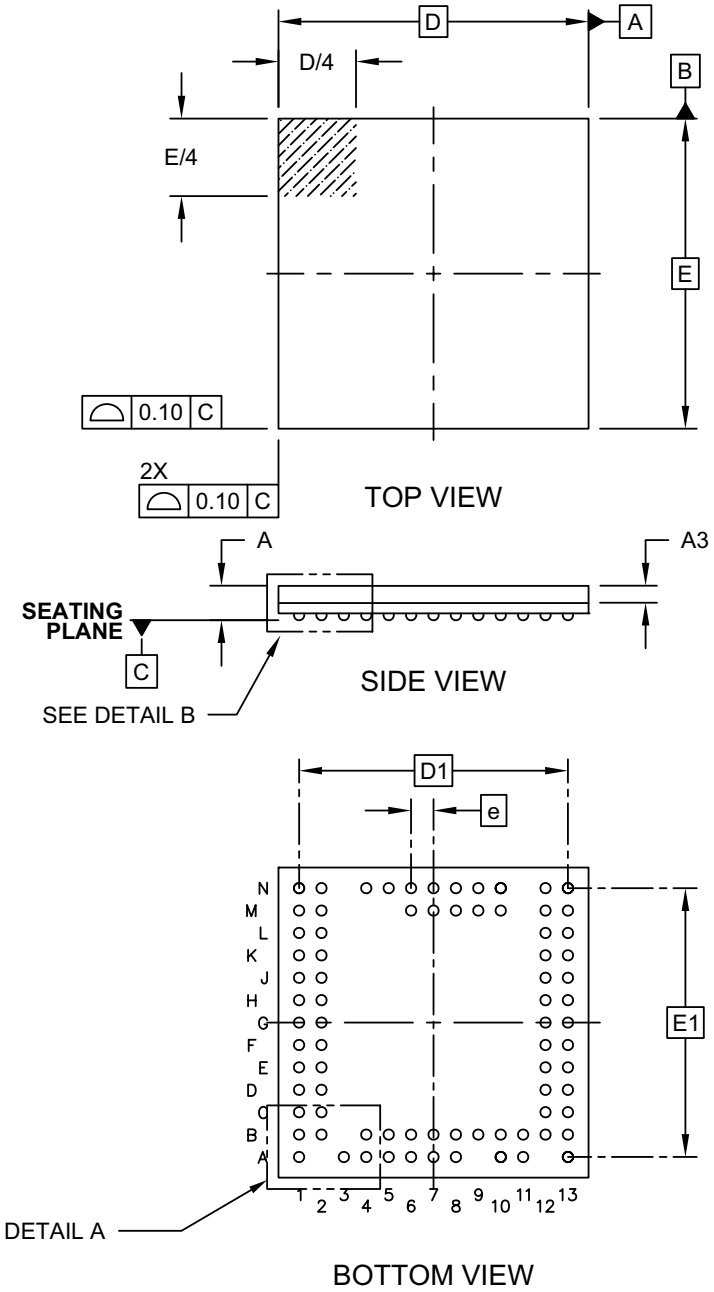


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e8)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e8)) can be found on the outer packaging for this package.

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

78-Ball Very Thin Fine Pitch Ball Grid Array (5G) - 9x9x1.0 mm Body [VFBGA]

Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

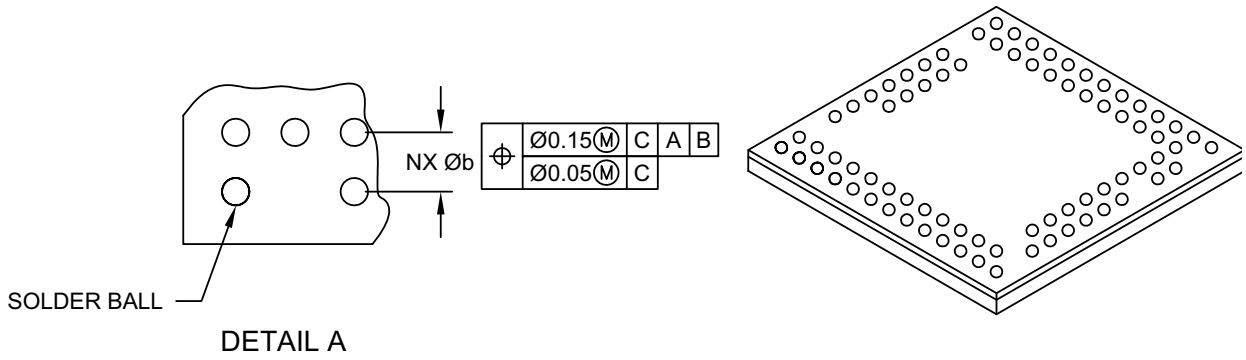


Microchip Technology Drawing C04-371A Sheet 1 of 2

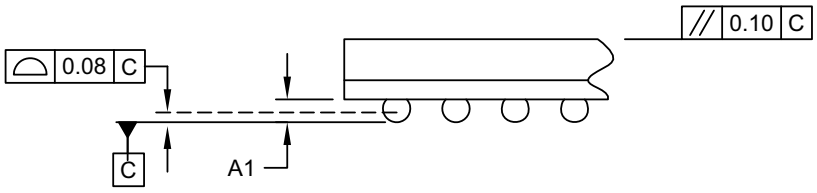
78-Ball Very Thin Fine Pitch Ball Grid Array (5G) - 9x9x1.0 mm Body [VFBGA]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at

http://www.microchip.com/packaging



DETAIL A



DETAIL A

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		78	
Pitch	e		0.65 BSC	
Overall Height	A	-	-	1.00
Standoff	A1	0.15	0.20	0.25
Molded Cap Thickness	A3	0.45	0.50	0.55
Overall Width	E		9.00 BSC	
Overall Ball Pitch	E1		7.80 BSC	
Overall Length	D		9.00 BSC	
Overall Ball Pitch	D1		7.80 BSC	
Ball Diameter	Øb	0.25	0.30	0.35

Notes:

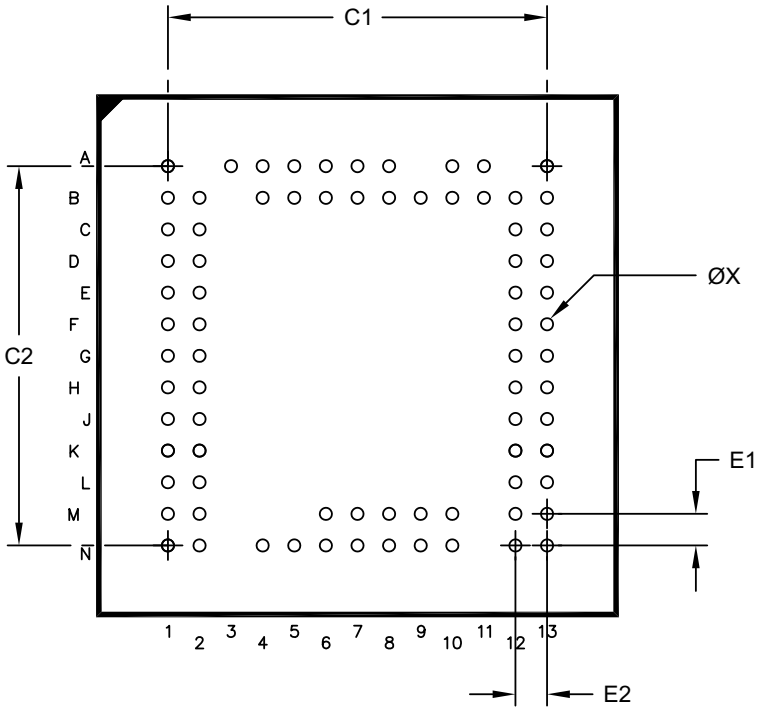
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensioning and tolerancing per ASME Y14.5M

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-371A Sheet 2 of 2

78-Ball Very Thin Fine Pitch Ball Grid Array (5G) - 9x9x1.0 mm Body [VFBGA]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E1		0.65 BSC	
Contact Pitch	E2		0.65 BSC	
Contact Pad Spacing	C1		780	
Contact Pad Spacing	C2		7.80	
Contact Pad Diameter (X78)	X		0.25	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-2371A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (October 2015)

- Original release of this document.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

PART NO. XX-X Device Package	Examples:
Device: HV2802: 32-Channel SPST, High-Voltage Analog Switch HV2902: 32-Channel SPST, High-Voltage Analog Switch with Bleed Resistors Package: GA-G = Very Thin Fine Pitch Ball Grid Array (5G) - 9x9x1.0 mm (VFBGA), 78-Ball	a) HV2802GA-G: 78-Ball VFBGA package b) HV2902GA-G: 78-Ball VFBGA package

NOTES:

Note the following details of the code protection feature on Microchip devices:

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
- Microchip is willing to work with the customer who is concerned about the integrity of their code.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

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