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## Low Charge Injection 8-Channel High Voltage Analog Switch

### Ordering Information

Operating $V_{PP}$	$V_{PP} - V_{NN}$	Package Options	
		28-lead plastic chip carrier	Die
40V to 80V	160V	HV21716PJ	HV21716X
80V to 150V	160V	HV21816PJ	HV21816X

### Features

- HVCMOS<sup>®</sup> technology for high performance
- Low charge injection
- Very low quiescent power dissipation – 10 $\mu$ A
- Output On-resistance typically 22 ohms
- Low parasitic capacitances
- DC to 10MHz analog signal frequency
- 50dB typical output off isolation at 5MHz
- CMOS logic circuitry for low power
- Excellent noise immunity
- On-chip shift register and latch logic circuitry
- Flexible high voltage supplies
- Surface mount package available

### General Description

**Not recommended for new designs. Please use HV20220 for all new designs.**

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 feedthrough noise, Latch Enable (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.

### Absolute Maximum Ratings\*

$V_{DD}$ logic power supply voltage	-0.5V to +18V
$V_{PP} - V_{NN}$ supply voltage	174V
$V_{PP}$ positive high voltage supply	-0.5V to +160V
$V_{NN}$ negative high voltage supply	+0.5V to -160V
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	1.2W

\* 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

(over operating conditions,  $V_{PP} = +80V$ ,  $V_{NN} = -80V$ , and  $V_{DD} = 15V$  unless otherwise noted)

### DC Characteristics

Characteristics	Sym	0°C		+25°C			+70°C		Units	Test Conditions
		min	max	min	typ	max	min	max		
Small Signal Switch (ON) Resistance	$R_{ONS}$		24		22	25		28	ohms	$I_{SIG} = 5mA$
	$R_{ONS}$		18		18	20		23	ohms	$I_{SIG} = 200mA$
Small Signal Switch (ON) Resistance Matching	$\Delta R_{ONS}$		20		5.0	20		20	%	$I_{SW} = 5mA$
Large Signal Switch (ON) Resistance	$R_{ONL}$				13	22			ohms	$V_{SIG} = V_{PP} - 10V$ , $I_{SIG} = 1.0A$
Switch Off Leakage Per Switch	$I_{SOL}$		5.0		1.0	10		15	$\mu A$	$V_{SIG} = V_{PP} - 10V$ and $V_{NN} + 10V$
DC Offset Switch Off			300		100	300		300	mV	$R_L = 100K\Omega$
DC Offset Switch On			500		100	500		500	mV	$R_L = 100K\Omega$
Pos. HV Supply Current	$I_{PPQ}$				10	50			$\mu A$	ALL SWS OFF
Neg. HV Supply Current	$I_{NNQ}$				-10	-50			$\mu A$	
Pos. HV Supply Current	$I_{PPQ}$				10	50			$\mu A$	ALL SWS ON $I_{SW} = 5mA$
Neg. HV Supply Current	$I_{NNQ}$				-10	-50			$\mu A$	
Switch Output Peak Current			3.0		3.0	2.0		2.0	A	$V_{SIG} \leq 0.1\%$ Duty Cycle
Output Switch Frequency	$f_{SW}$					50			KHz	Duty Cycle = 50%
$I_{PP}$ Supply Current	$I_{PP}$		4.0		3.5	5.0		5.5	mA	HV output switching frequency = 50KHz
$I_{NN}$ Supply Current	$I_{NN}$		4.0		3.5	5.0		5.5	mA	
Logic Supply Average Current	$I_{DD}$		6.0		4.0	6.0		6.0	mA	$f_{CLK} = 3MHz$
Logic Supply Quiescent Current	$I_{DDQ}$		10			10		10	$\mu A$	
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	$V_{OUT} = 0.7V$

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## AC Characteristics

Characteristics	Sym	0°C		+25°C			+70°C		Units	Test Conditions
		min	max	min	typ	max	min	max		
Time to Turn Off $V_{SIG}^*$	$t_{SIG(OFF)}$			0					ns	
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	$t_{DO}$		175			175		190	ns	
Turn On Time	$t_{ON}$		3.0			3.0		3.0	$\mu s$	$R_L = 10K\Omega$
Turn Off Time	$t_{OFF}$		5.0			5.0		5.0	$\mu s$	$R_L = 10K\Omega$
Off Isolation	KO	-30		-30	-33		-30		dB	$f = 5MHz$ , 1K $\Omega$ // 15pF load
		-45		-45	-50		-45		dB	$f = 5MHz$ , 50 $\Omega$ load
Clock Freq	$f_{CLK}$		5.0			5.0		5.0	MHz	50% duty cycle $f_{DATA} = f_{CLK}/2$
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	
Switch Crosstalk	$K_{CR}$	-60		-60	-70		-60		dB	$f = 5MHz$ , 50 $\Omega$ load
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
Output Voltage Spike	$+V_{SPK}$				150				mV	$V_{PP} = +80V$ , $V_{NN} = -80V$ , $R_L = 50\Omega$
	$-V_{SPK}$				150					

\* Time required for analog signal to turn off before output switch turns off (critical timing).

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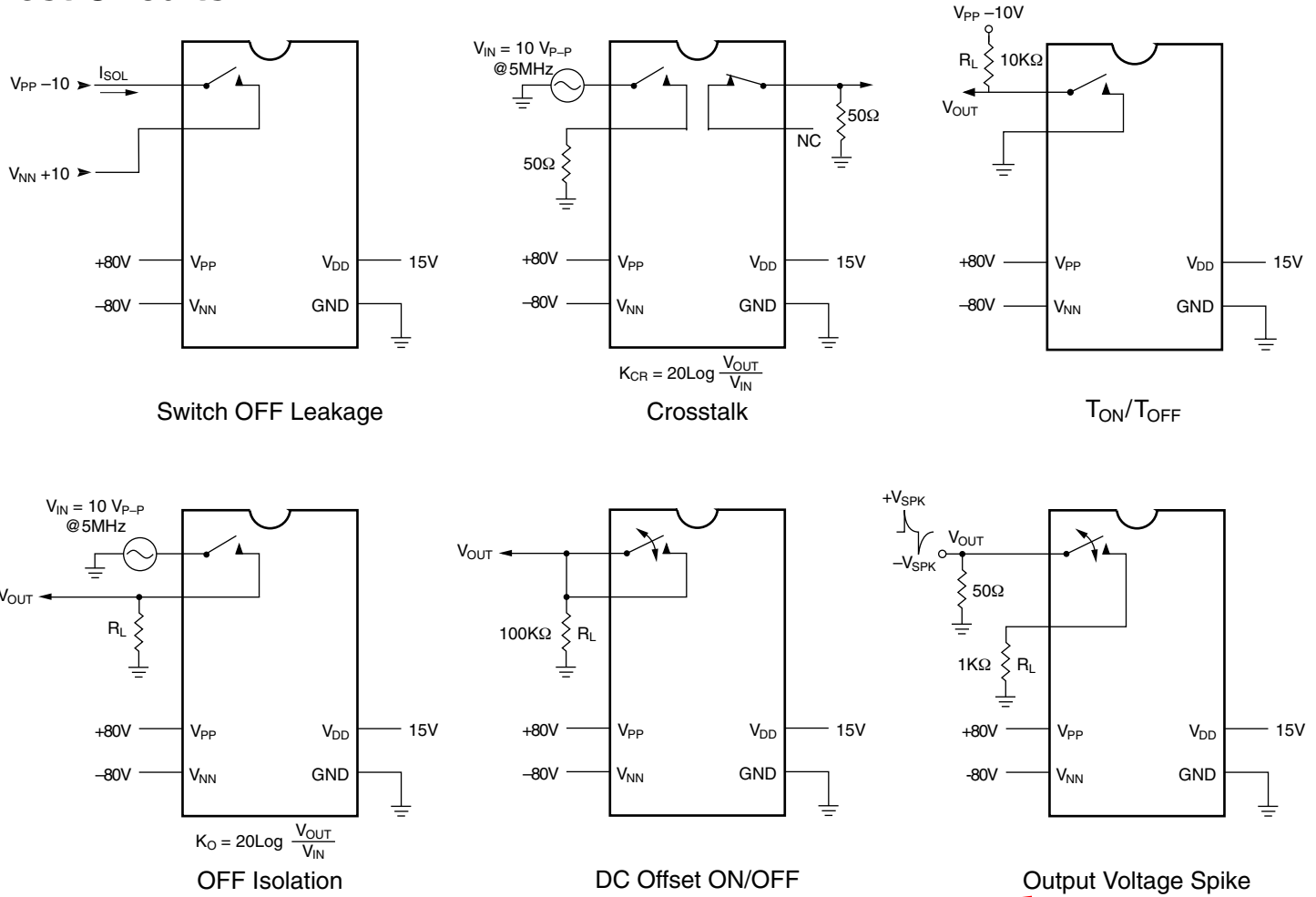
## Operating Conditions\*

Symbol	Device		Value
	HV21716	HV21816	
$V_{PP}^{1,3}$	X		40V to 80V
		X	80V to 150V
$V_{NN}^{1,3}$	X	X	-10V to $V_{PP}$ -160V
$V_{DD}^{1,3}$	X	X	10V to 15.5V
$V_{IH}$	X	X	$V_{DD}$ -2.0V to $V_{DD}$
$V_{IL}$	X	X	0V to 2.0V
$V_{SIG}^2$	X	X	$V_{NN} +10V$ to $V_{PP} -10$
$T_A$	X	X	0°C to 70°C

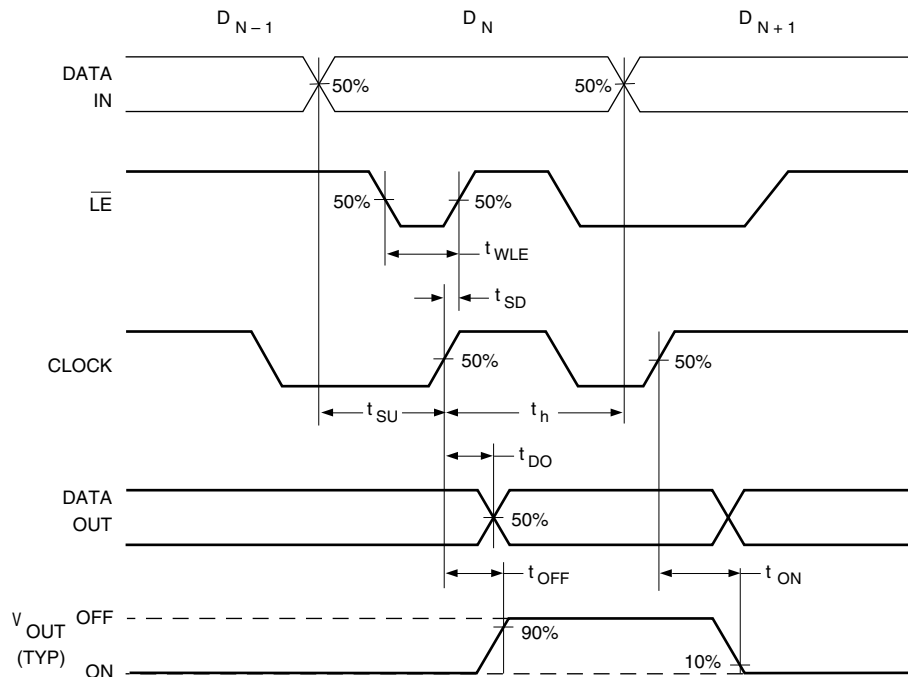
## Notes:

- Power up/down sequence is arbitrary except GND must be powered-up first and powered-down last.
- $V_{SIG}$  must be  $V_{NN} \leq V_{SIG} \leq V_{PP}$  or floating during power up/down transition.
- Rise and fall times of power supplies,  $V_{DD}$ ,  $V_{PP}$ , and  $V_{NN}$  should not be less than 1.0msec.

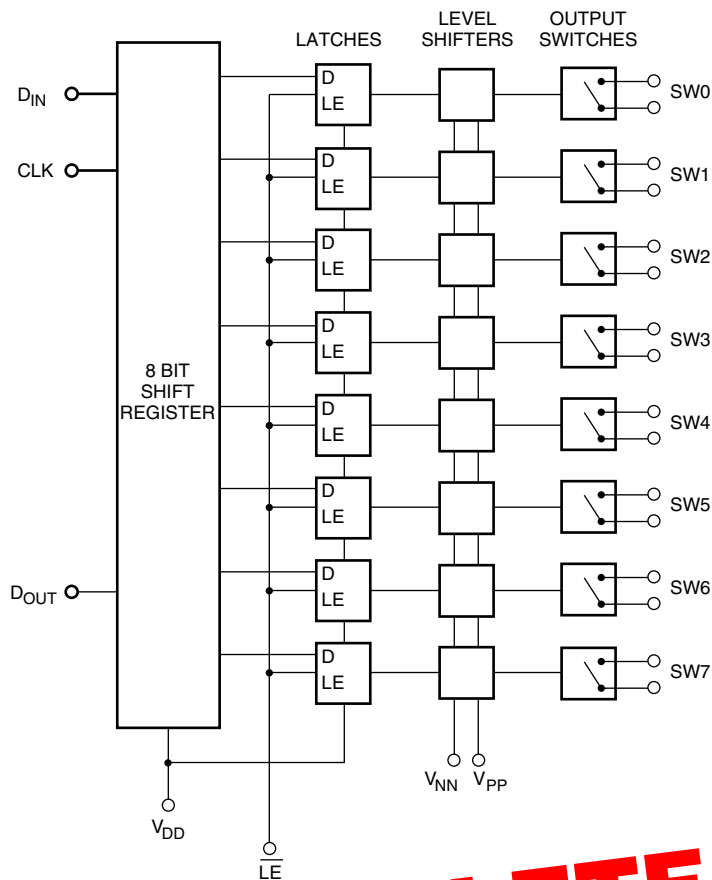
# Test Circuits



# Logic Timing Waveforms - OBSOLETE -



# Logic Diagram



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## Truth Table

D0	D1	D2	D3	D4	D5	D6	D7	$\overline{LE}$	SW0	SW1	SW2	SW3	SW4	SW5	SW6	SW7	
L								L	OFF								
H								L	ON								
	L							L		OFF							
	H							L		ON							
		L						L			OFF						
		H						L			ON						
			L					L				OFF					
			H					L				ON					
				L				L					OFF				
				H				L					ON				
					L			L						OFF			
					H			L						ON			
						L		L							OFF		
						H		L							ON		
X	X	X	X	X	X	X	X	H	HOLD PREVIOUS STATE								

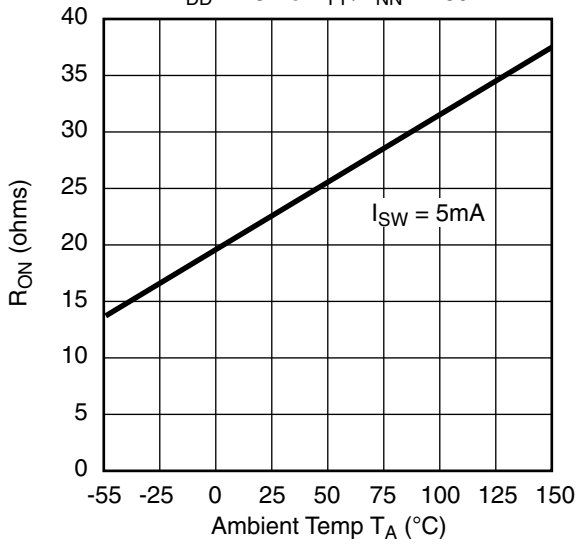
### Notes:

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.

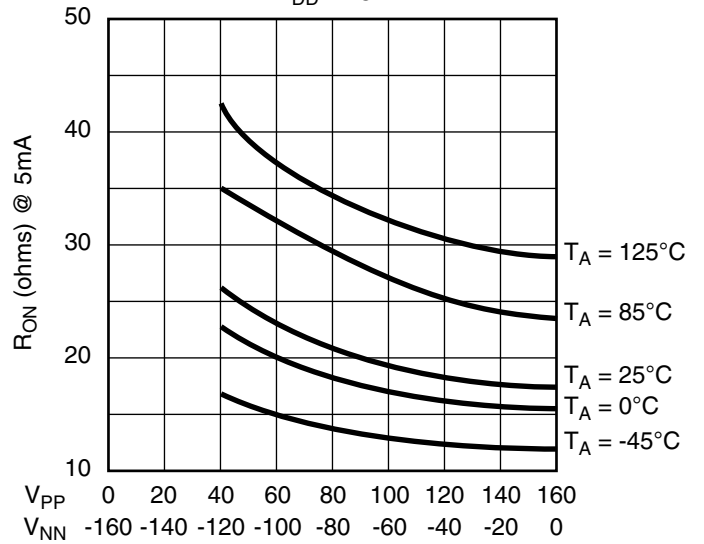
# Typical Performance Curves

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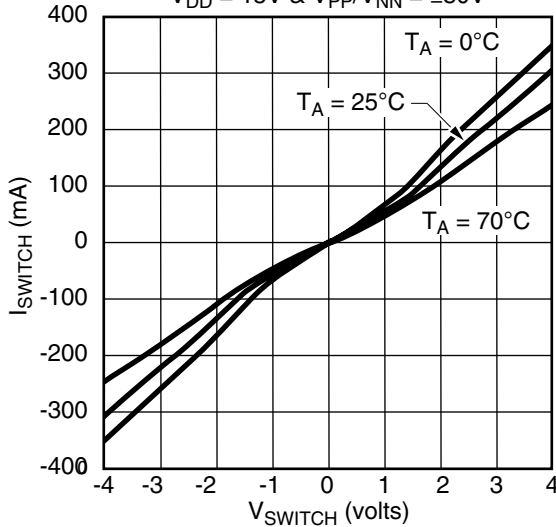
$R_{ON}$  vs. Ambient Temp  $T_A$   
 $V_{DD} = 15V$  &  $V_{PP}/V_{NN} = \pm 80V$



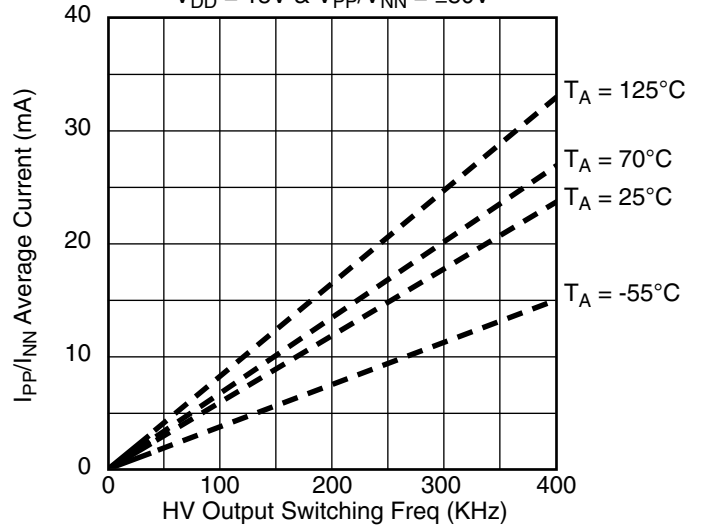
$R_{ON}$  vs.  $V_{PP}/V_{NN}$   
 $V_{DD} = 15V$



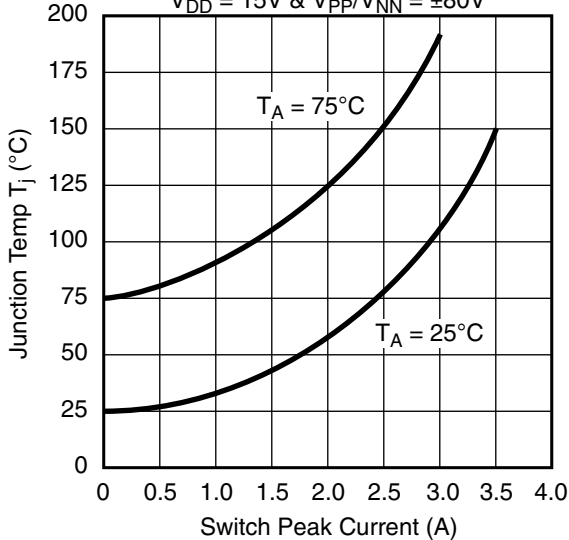
Switch Current vs. Switch Voltage Drop  
 $V_{DD} = 15V$  &  $V_{PP}/V_{NN} = \pm 80V$



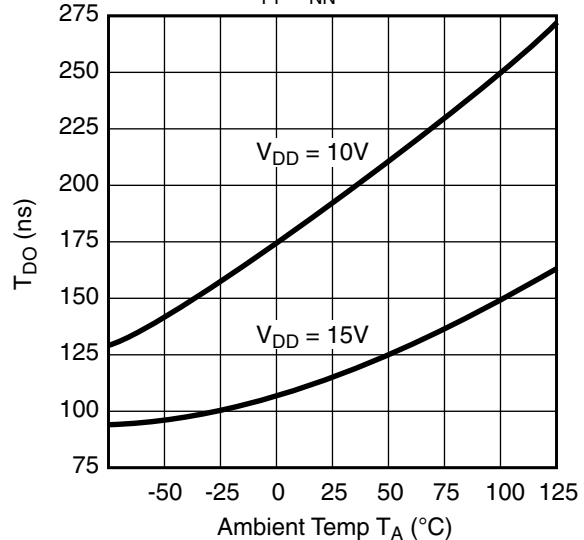
$I_{PP}/I_{NN}$  vs. Output Switching Frequency  
 $V_{DD} = 15V$  &  $V_{PP}/V_{NN} = \pm 80V$



Junction Temp  $T_j$  vs. Switch Peak Current  
 $V_{SIG}$  Freq = 10KHz & Duty Cycle = 0.1%  
 $V_{DD} = 15V$  &  $V_{PP}/V_{NN} = \pm 80V$

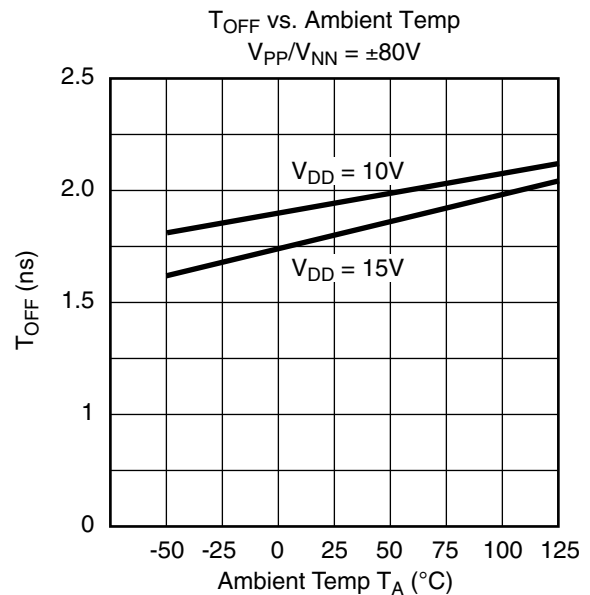
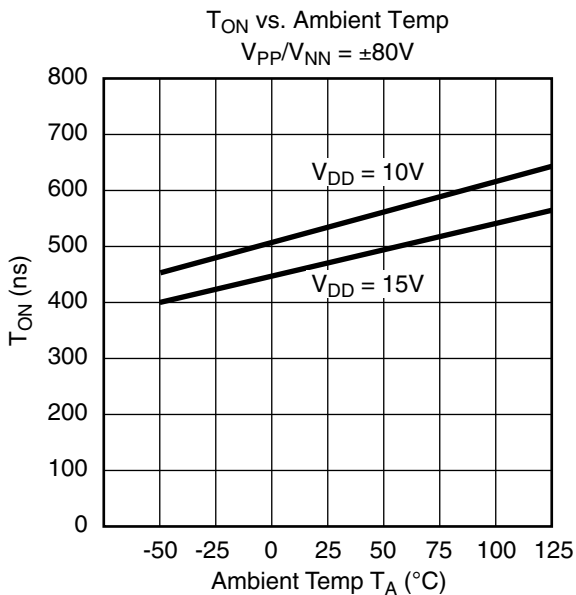
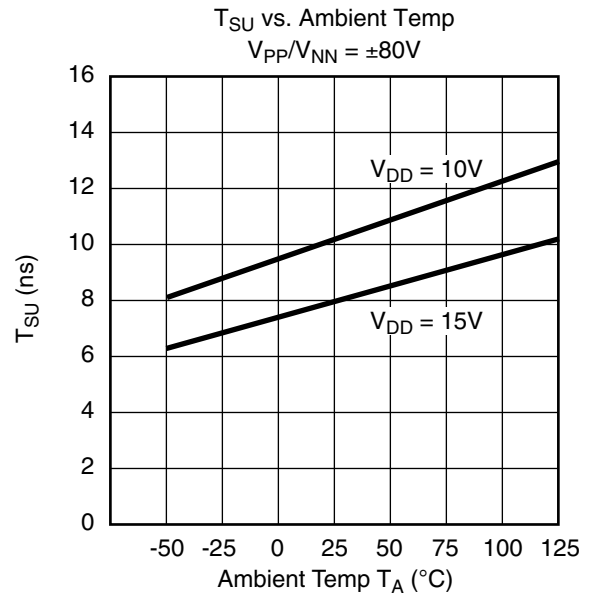
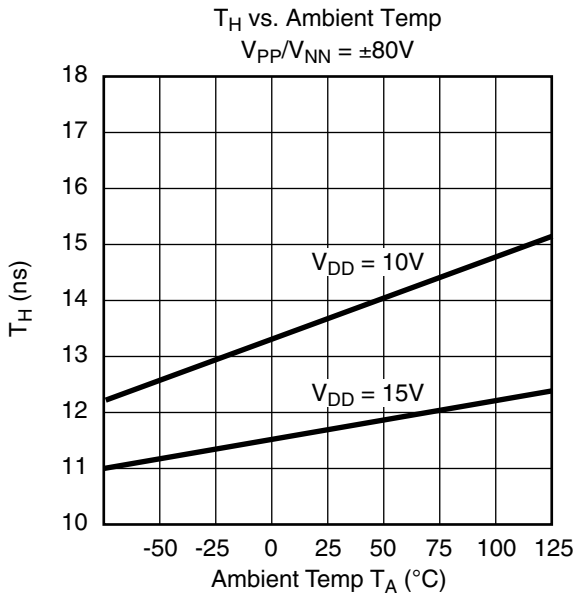
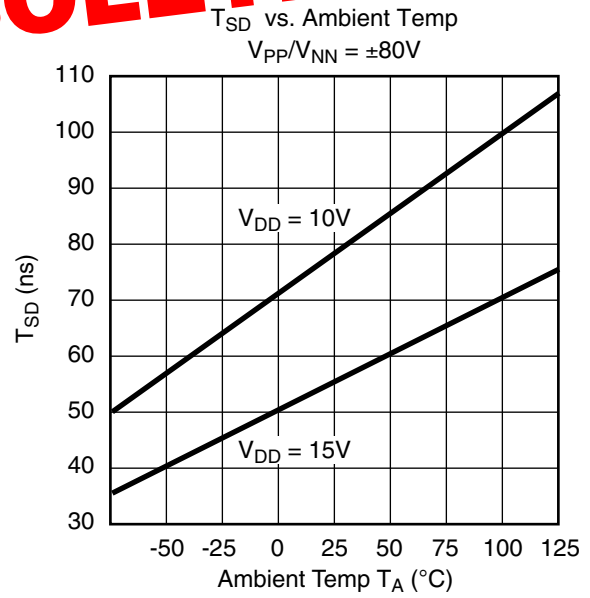
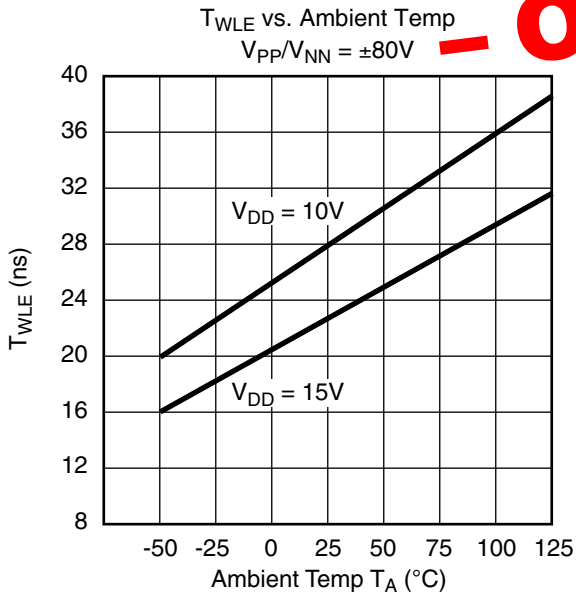


$T_{DO}$  vs. Ambient Temp  $T_A$   
 $V_{PP}/V_{NN} = \pm 80V$

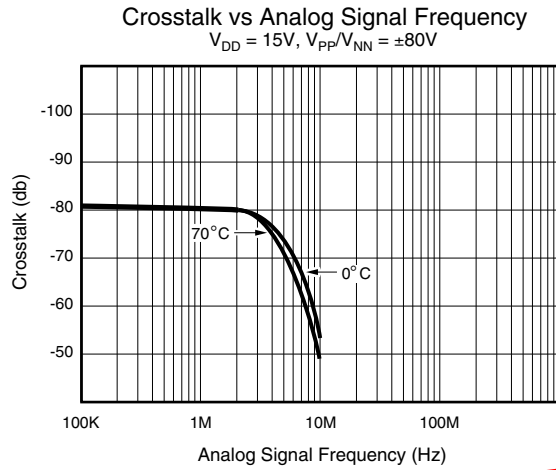
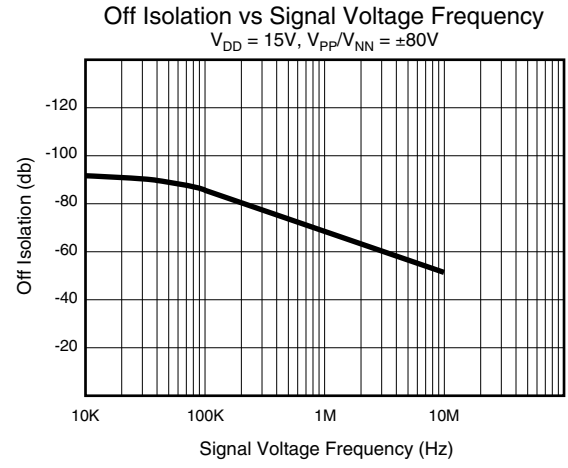
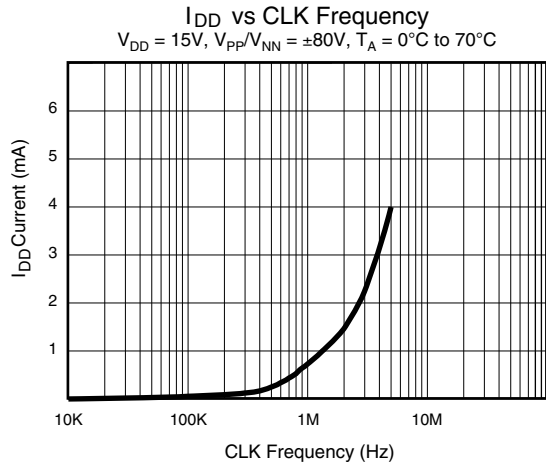


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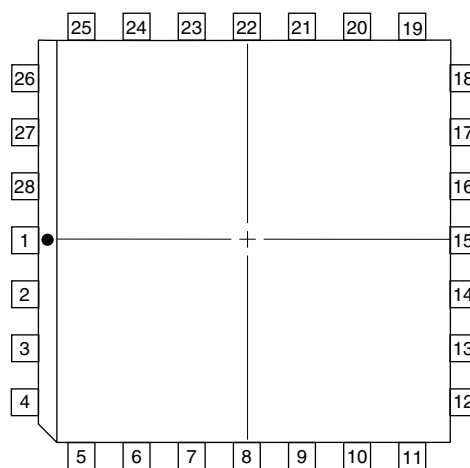


# Pin Configurations

# Package Outlines

## 28-Pin J-Lead

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	N/C	19	D <sub>OUT</sub>
6	N/C	20	SW7
7	SW1	21	SW7
8	SW1	22	SW6
9	SW0	23	SW6
10	SW0	24	N/C
11	V <sub>PP</sub>	25	SW5
12	V <sub>NN</sub>	26	SW5
13	GND	27	SW4
14	V <sub>DD</sub>	28	SW4



top view

28-pin J-Lead Package

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## 8-Channel High Voltage Analog Switch

### Ordering Information

$V_{PP} - V_{NN}$	Package Options		
	28-pin plastic DIP	28-lead plastic chip carrier	Die
160V	HV2216P	HV2216PJ	HV2216X

### Features

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- Very low quiescent power dissipation – 10µA
- Output On-resistance typically 22 ohms
- Low parasitic capacitances
- DC to 10MHz analog signal frequency
- 50dB typical output off isolation at 5MHz
- CMOS logic circuitry for low power
- Excellent noise immunity
- On-chip shift register, latch and clear logic circuitry
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### General Description

**Not recommended for new designs. Please use HV20220 for all new designs.**

This device is an 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 feedthrough noise, Latch Enable ( $\overline{LE}$ ) 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.

This IC is suitable for various combinations of high voltage supplies, e.g., for HV2216 +40V/-120V, or +80V/-80V or +150V/-10V.

### Absolute Maximum Ratings\*

$V_{DD}$ Logic power supply voltage	-0.5V to +18V
$V_{PP} - V_{NN}$ Supply voltage	174V
$V_{PP}$ Positive high voltage supply	-0.5V to +160V
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