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## Triple 10-Bit, 50 MSPS, 3-Channel D/A Converter

### Features

- Resolution .....Triple 10-Bit
- Maximum Conversion Speed ..... 50MHz
- RGB 3-Channel Input/Output
- Differential Linearity Error .....  $\pm 0.5$  LSB
- Low Power Consumption .....200mW  
(200 $\Omega$  Load for 2V<sub>p-p</sub> Output)
- Power Supply .....+5V Single
- Low Glitch
- Direct Replacement for Sony CXD2309

### Applications

- Digital TV
- Graphics Display
- High Resolution Color Graphics
- Video Reconstruction
- Instrumentation
- Image Processing
- I/Q Modulation

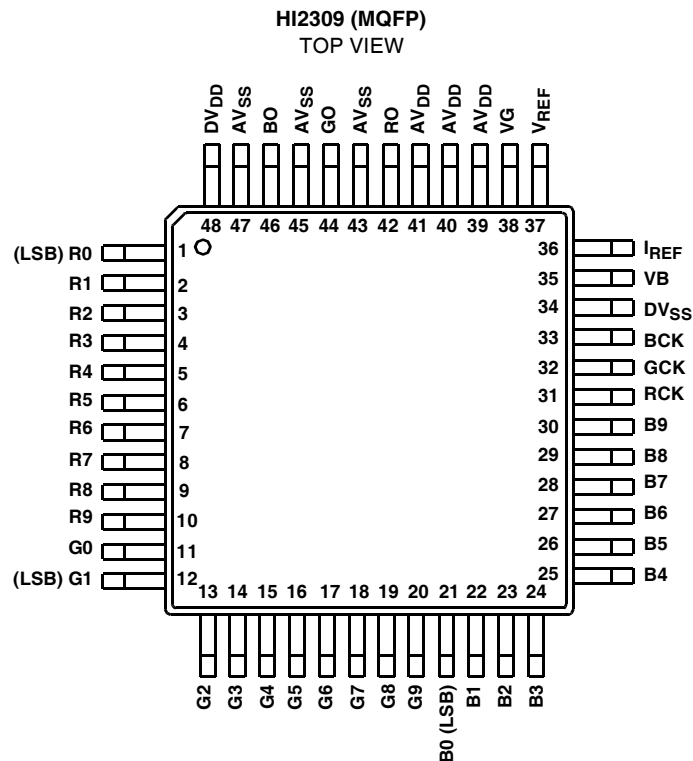
### Description

The HI2309 is a triple 10-bit, high-speed, CMOS D/A converter designed for video band use. It has three separate, 10-bit, pixel inputs, one each for red, green, and blue video data. A single 5.0V power supply and pixel clock input is all that is required to make the device operational. A bias voltage generator is internal. Each channel clock input can be controlled individually, or connected together as one. The HI2309 also has BLANK video control signal.

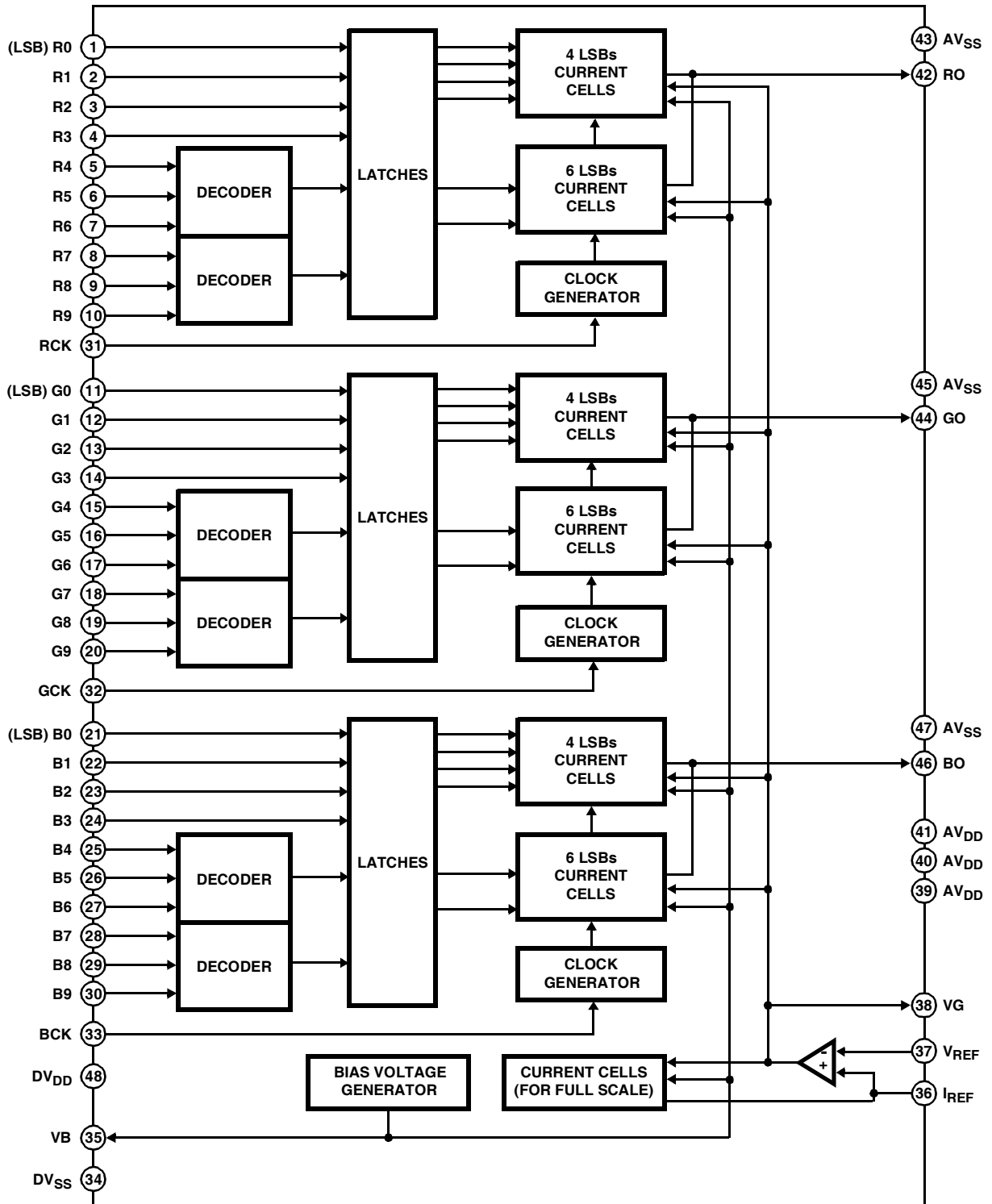
### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HI2309JCQ	-20 to 75	48 Ld MQFP	Q48.12x12-S

### Pinout



**Functional Block Diagram**



**Pin Descriptions**

PIN NO.	SYMBOL	EQUIVALENT CIRCUIT	DESCRIPTION
1 to 10	R0 to R9		Digital Input.
11 to 20	G0 to G9		
21 to 30	B0 to B9		
31	RCLK		Clock pin.
32	GCLK		
33	BCLK		
34	DVSS		Digital GND.
35	VB		Connect an approximately 0.1μF capacitor.
36	IREF		Connect a "16R" resistor which is 16 times the output resistance "R".
37	VREF		Sets an output full scale value.
38	VG		Connect an approximately 0.1μF capacitor.
39 to 41	AVDD		Analog V <sub>DD</sub> .
42	RO		Current Output. Output can be obtained by connecting a resistor (200Ω typical).
44	GO		
46	BO		
43, 45, 47	AVDD		Analog GND.
47, 48	DVDD		Digital V <sub>DD</sub> .

# HI2309

## Absolute Maximum Ratings $T_A = 25^\circ\text{C}$

Supply Voltage ( $V_{DD}$ ) ..... 7V  
 Input Voltage ( $V_{IN}$ ) .....  $V_{DD}$  to  $V_{SS}$   
 Output Current ( $I_{OUT}$ ) ..... 0mA to 15mA  
 Storage Temperature .....  $-55^\circ\text{C}$  to  $150^\circ\text{C}$

## Operating Conditions

Supply Voltage  
 $AV_{DD}, AV_{SS}$  ..... 4.75V to 5.25V  
 $DV_{DD}, DV_{SS}$  ..... 4.75V to 5.25V  
 Reference Input Voltage ( $V_{REF}$ ) ..... 0.5V to 2.0V  
 Clock Pulse Width  
 $t_{PW1}$  ..... 10ns (Min)  
 $t_{PW0}$  ..... 10ns (Min)  
 Temperature Range ( $T_{OPR}$ ) .....  $-20^\circ\text{C}$  to  $75^\circ\text{C}$

## Thermal Information

Thermal Resistance (Typical, Note 1)  $\theta_{JA}$  ( $^\circ\text{C}/\text{W}$ )  
 MQFP Package ..... 94  
 Maximum Junction Temperature (Plastic Package) .....  $150^\circ\text{C}$   
 Maximum Storage Temperature Range .....  $-65^\circ\text{C}$  to  $150^\circ\text{C}$   
 Maximum Lead Temperature (Soldering 10s) .....  $300^\circ\text{C}$   
 (Lead Tips Only)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

## NOTE:

- $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

## Electrical Specifications $f_{CLK} = 50\text{MHz}$ , $V_{DD} = 5\text{V}$ , $R = 200\Omega$ , $V_{REF} = 2.0\text{V}$ , $T_A = 25^\circ\text{C}$

PARAMETER		SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Resolution		n		-	10	-	Bit
Maximum Conversion Speed		$f_{MAX}$		50	-	-	MHz
Linearity Error		$E_L$		-2.0	-	2.0	LSB
Differential Linearity Error		$E_D$		-0.5	-	0.5	LSB
Output Full Scale Voltage		$V_{FS}$		1.8	1.92	2.0	V
Output Full Scale Current		$I_{FS}$		9.0	9.6	10	mA
Output Offset Voltage		$V_{OS}$		-	-	1	mV
Supply Current		$I_{DD}$		-	40	50	mA
Digital Input Current	High Level	$I_{IH}$		-	-	5	$\mu\text{A}$
	Low Level	$I_{IL}$		-5	-	-	$\mu\text{A}$
Digital Input Voltage	High Level	$V_{IH}$	$DV_{DD} = 4.75$ to $5.25\text{V}$	2.15	-	-	V
	Low Level	$V_{IL}$	$DV_{DD} - 4.75$ to $5.25\text{V}$	-	-	0.85	V
Precision Guaranteed Output Voltage Range		$V_{OC}$		1.8	1.92	2.0	V
Setup Time		$t_S$		6	-	-	ns
Hold Time		$t_H$		3	-	-	ns
Propagation Delay Time		$t_{PD}$		-	14	-	ns
Glitch Energy		GE	For $R_{OUT} = 100\Omega$ , 1V <sub>P-P</sub> Output	-	50	-	pV/s
Cross Talk		CT	For 10MHz Sine Wave Output	40	42	-	dB
SNR		SNR	For 1MHz Sine Wave Output	50	55	-	dB

## NOTE:

- Output full scale ratio =  $\left| \frac{\text{Full scale voltage for each channel}}{\text{Average of full scale voltage for each channel}} - 1 \right| \times 100\%$ .

Test Circuits

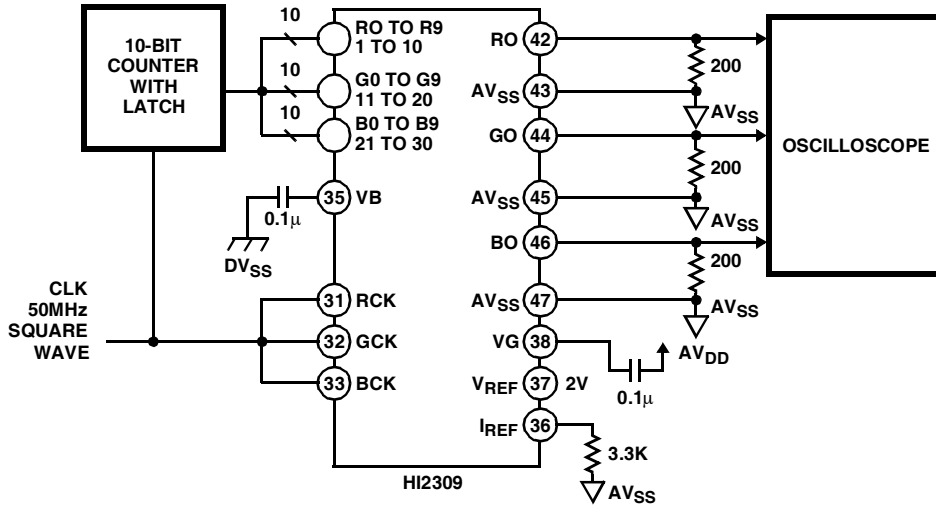


FIGURE 1. MAXIMUM CONVERSION RATE TEST CIRCUIT

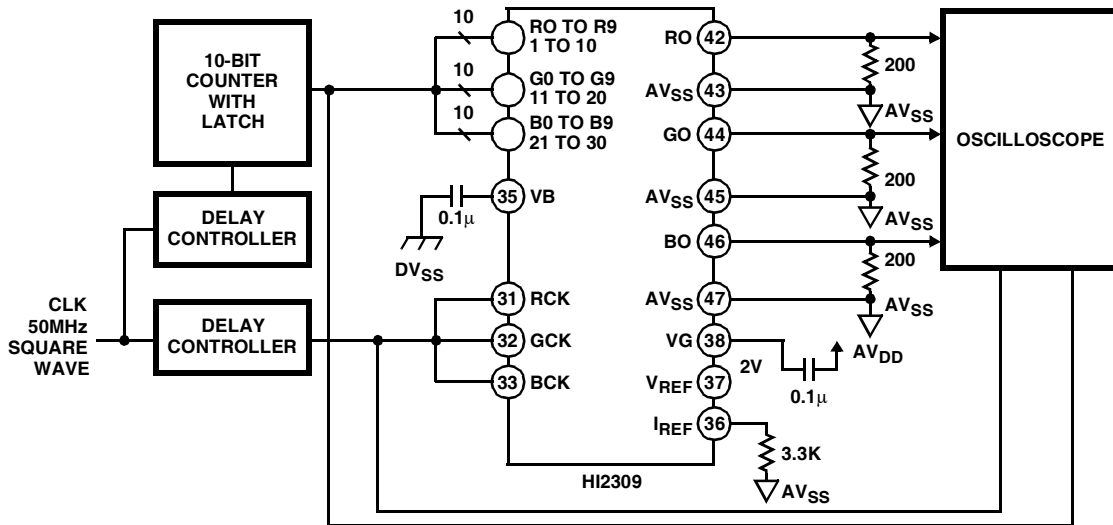


FIGURE 2. SETUP HOLD TIME GLITCH ENERGY TEST CIRCUIT

Test Circuits (Continued)

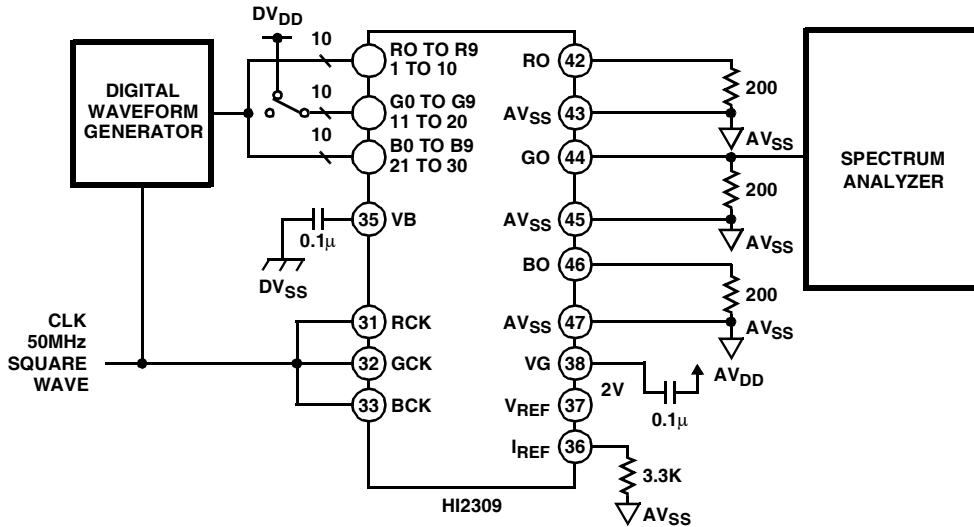


FIGURE 3. CROSS TALK TEST CIRCUIT

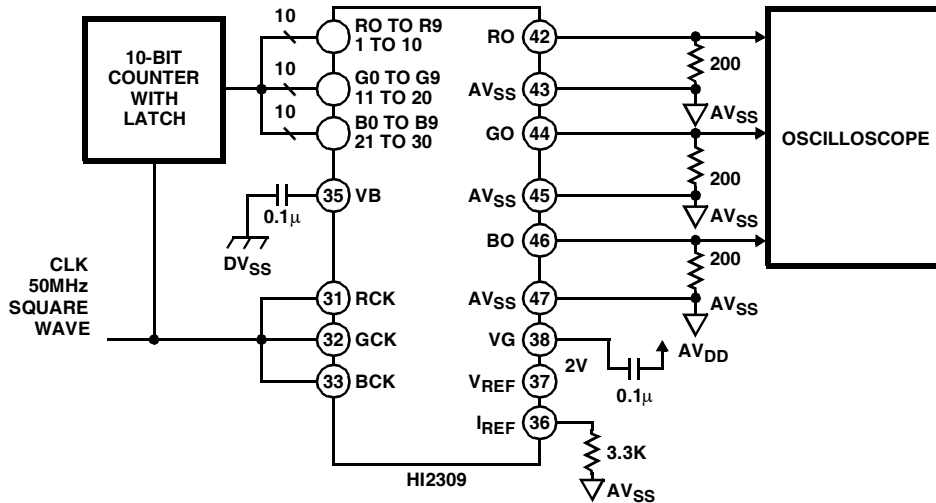


FIGURE 4. DC CHARACTERISTICS TEST CIRCUIT

Test Circuits (Continued)

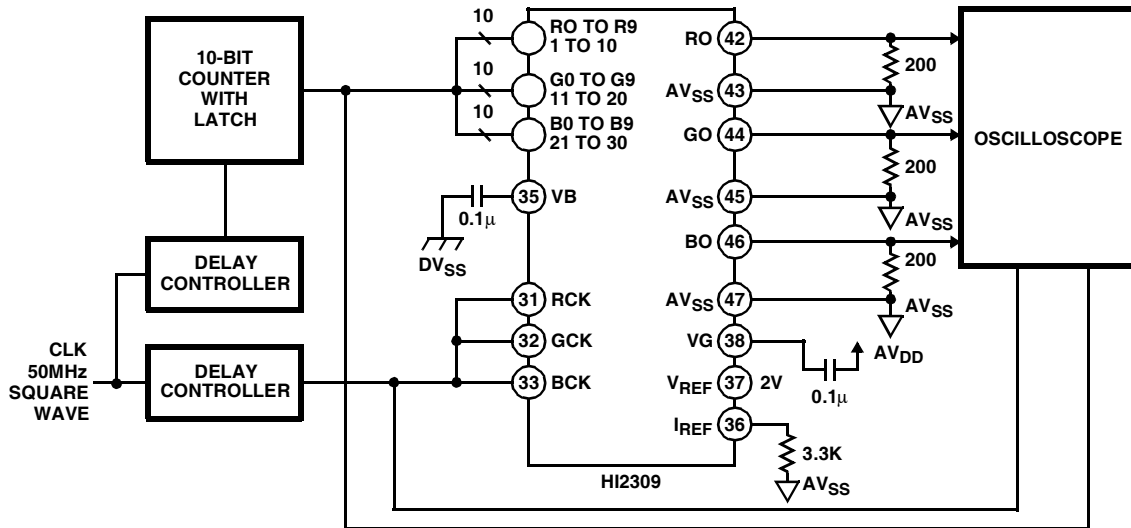


FIGURE 5. PROPAGATION DELAY TIME TEST CIRCUIT

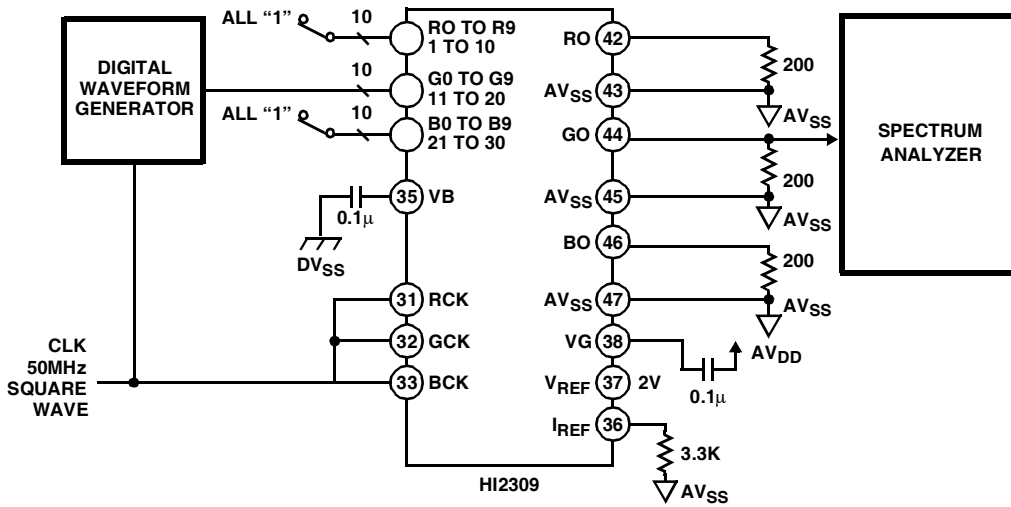
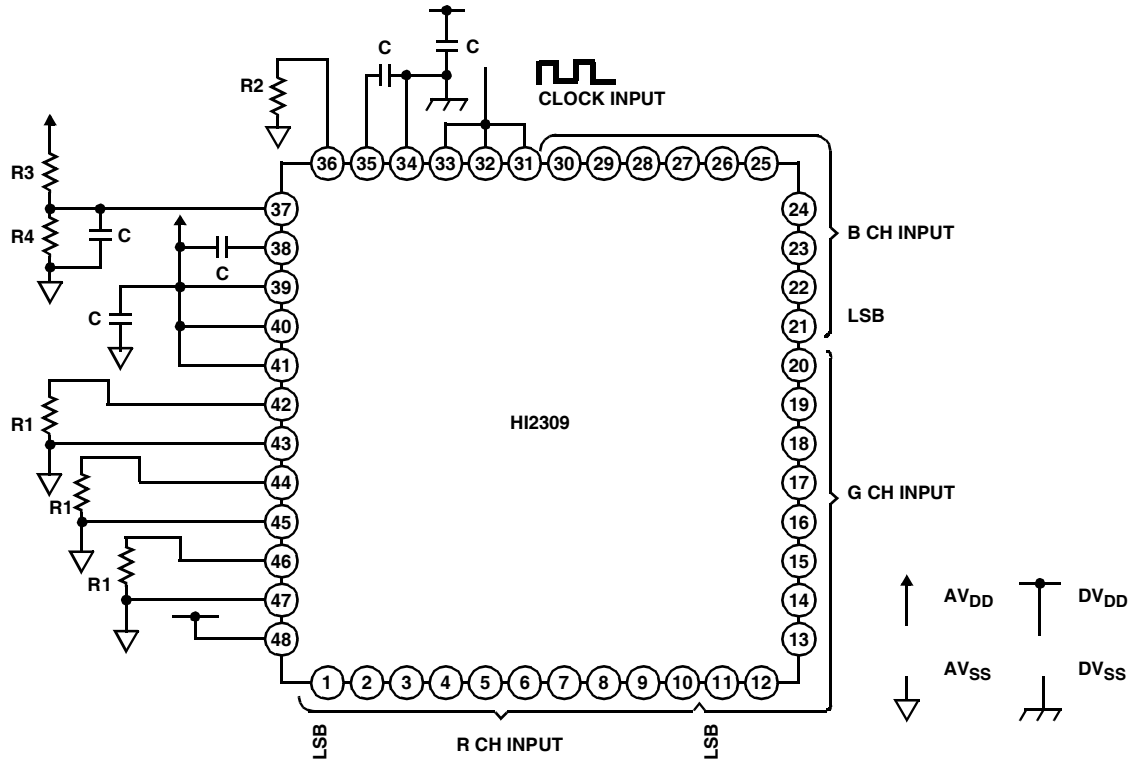


FIGURE 6. SNR TEST CIRCUIT

**Application Circuit**



- When the power supply ( $AV_{DD}$  and  $DV_{DD}$ ) is 5.0.
- $R1 = 200\Omega$ .
- $R2 = 3.3k\Omega$ .
- $R3 = 3.0k\Omega$ .
- $R4 = 2.0k\Omega$ .
- $C = 0.1\mu F$ .

Application circuits shown are typical examples illustrating the operation of the devices. Intersil cannot assume responsibility for any problems arising out of the use of these circuits or for any infringement of third party patent and other right due to same.

**Typical Performance Curves**

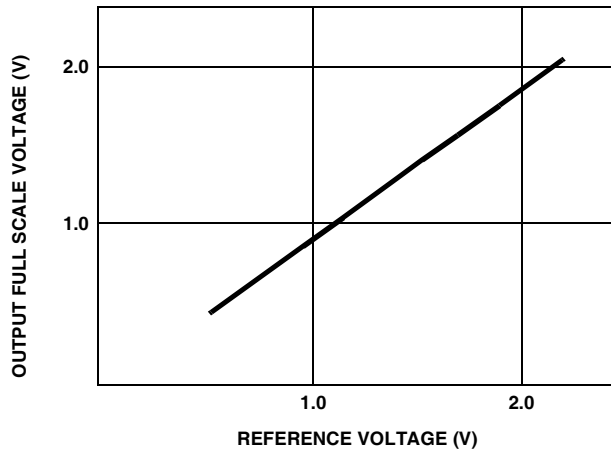


FIGURE 7. OUTPUT FULL SCALE VOLTAGE vs REFERENCE VOLTAGE

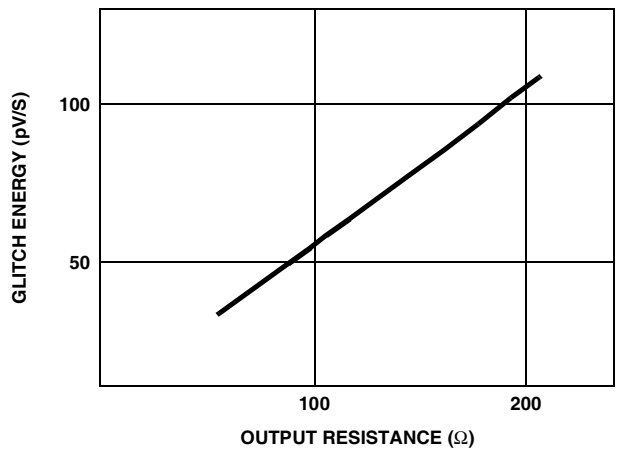


FIGURE 8. OUTPUT RESISTANCE vs GLITCH ENERGY



## Typical Performance Curves (Continued)

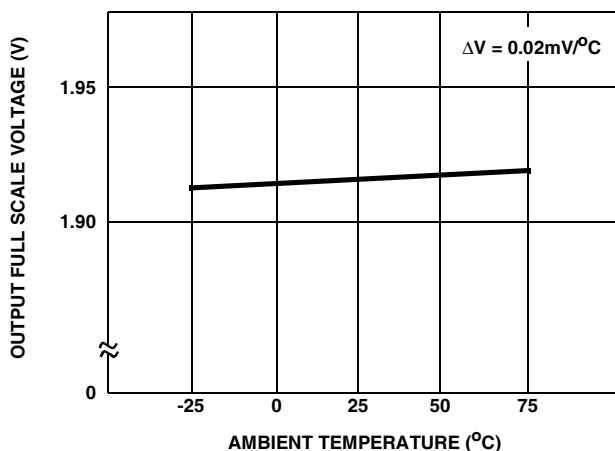


FIGURE 9. OUTPUT FULL SCALE VOLTAGE vs AMBIENT TEMPERATURE

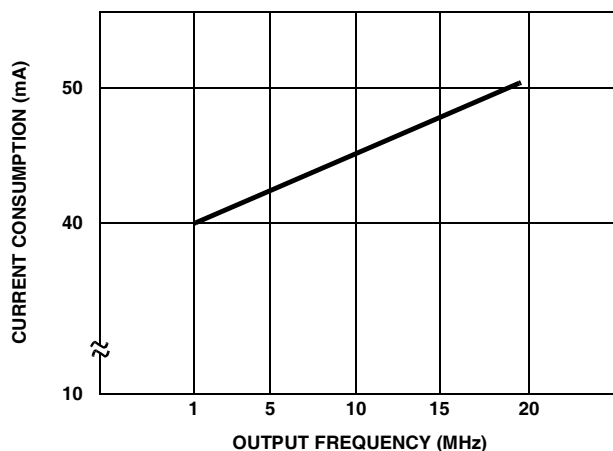


FIGURE 10. OUTPUT FREQUENCY vs CURRENT CONSUMPTION

## Standard Measurement Conditions and Description

$V_{DD} = 5.0V$ .

$V_{REF} = 2.0V$ .

$R = 200\Omega$ .

$16R = 3.3k\Omega$ .

$T_A = 25^\circ C$ .

$V_{REF}$  in Figure 9 is fixed to  $2V_{DC}$  without resistor dividing.

Input data in Figure 10 is all "0" and "1" of rectangular wave, clock frequency = 50MHz for a total value of three channels.

## Notes On Operation

Selecting the Output Resistance:

HI2309 is a current output type D/A converter. To create the output voltage, connect the resistor to the current output pin.

Specifications:

Output full scale voltage  $V_{FS} \text{ Max} = 2.0 [V]$ .

Output full scale current  $I_{FS} \text{ Max} = 10 [mA]$ .

Calculate the output resistance from  $V_{FS} = I_{FS} \times R$ . Connect a resistance sixteen times the output resistance to the reference current pin  $I_{REF}$ . In some cases, this value may not exist, a similar value can be used instead.

Note that the  $V_{FS}$  will be the following:

$$V_{FS} = V_{REF} \times 16 R/R'$$

$R$  is the resistor to be connected to the IO and  $R'$  is the resistor to be connected to the  $I_{REF}$ . Power consumption can be reduced by increasing the resistance, but this will on the contrary, increase the glitch energy and data setting

time. Set the best values according to the purpose of use.

Correlation Between Data and Clock:

For HI2309 to display the desired performance as a D/A converter, the data transmitted from outside and the clock must be synchronized properly. Adjust the setup time ( $t_S$ ) and hold time ( $t_H$ ) as specified in "Electrical Characteristics."

$V_{DD}$ ,  $V_{SS}$ :

Separate the analog and digital signals around the device to reduce noise effects. Bypass the  $V_{DD}$  pin to each GND with a  $0.1\mu F$  ceramic capacitor as near as possible to the pin for both digital and analog signals.

Latch Up:

The  $AV_{DD}$  and  $DV_{DD}$  pins must be able to share the same power supply of the board. This is to prevent latch up caused by potential difference between the two pins when the power is turned on.

$I_{REF}$  Pin:

The  $I_{REF}$  pin is very sensitive to improve the AC Characteristics. Pay attention for capacitance component not to attach to this pin because its output may become unstable.

VG Pin:

It is recommended to use a  $1\mu F$  capacitor to improve the AC Characteristics, though the typical capacitance value externally connected to the  $V_G$  Pin is  $0.1\mu F$ .