

## Low-Cost Monolithic Quad SPST CMOS Analog Switches

### Features

- $\pm 15\text{-V}$  Analog Signal Range
- TTL Compatibility
- Logic Inputs Accept Negative Voltages
- On-Resistance— $r_{DS(on)}$ :  $115\ \Omega$

### Benefits

- Wide Signal Range
- Simple Logic Interface
- Reduced Power Consumption

### Applications

- Disk Drives
- Test Equipment
- Communication Systems
- Sample-and-Holds

### Description

The DG211 and DG212 are low cost quad single-pole single-throw analog switches for use in general purpose switching applications in communication, instrumentation and process control. These devices differ only in that the digital control logic is inverted (see Truth Table). The use of both p- and n-channel devices minimizes on-resistance variation over the analog signal range.

Designed with the Siliconix PLUS-40 CMOS process to combine low power dissipation with a high

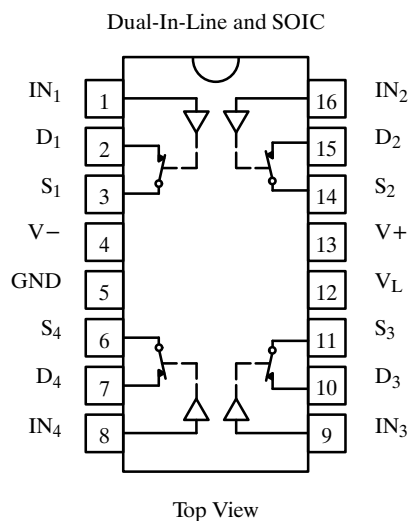
breakdown voltage rating of 40 V, both switches will handle  $\pm 15\text{-V}$  input signals with ease, and have a continuous current rating of 20 mA. An epitaxial layer prevents latchup.

Both devices feature true bi-directional performance (with no offset voltage) in the on condition, and will block signals to 30 V peak-to-peak in the off condition.

For new designs we recommend the silicon-gate DG211B/212B upgrades.

### Functional Block Diagram and Pin Configuration

#### DG211



#### Truth Table

Logic	DG211	DG212
0	ON	OFF
1	OFF	ON

Logic "0"  $\leq 0.8\text{ V}$   
 Logic "1"  $\geq 2.4\text{ V}$

Switches Shown for DG211 Logic "0" Input

#### Ordering Information – DG211/212

Temp Range	Package	Part Number
0°C to 70°C	16-Pin Plastic DIP	DG211CJ
		DG212CJ
-40°C to 85°C	16-Pin Narrow SOIC	DG211DY
		DG212DY

# DG211/212

## Absolute Maximum Ratings

V+ to V- .....	44 V	(Pulsed at 1 ms, 10% duty cycle max) .....	70 mA
V <sub>IN</sub> to GND <sup>a</sup> .....	V-, V+	Storage Temperature .....	-65 to 125°C
V <sub>L</sub> to GND .....	-0.3 V, 25 V	Power Dissipation (Package) <sup>b</sup>	
V <sub>S</sub> or V <sub>D</sub> to V+ <sup>a</sup> .....	0, -40 V	16-Pin Plastic DIP <sup>c</sup> .....	470 mW
V <sub>S</sub> or V <sub>D</sub> to V- <sup>a</sup> .....	0, 40 V	16-Pin Narrow SOIC <sup>d</sup> .....	600 mW
V+ to GND .....	25 V	Notes	
V- to GND .....	-25 V	a. Signals on S <sub>X</sub> , D <sub>X</sub> , or IN <sub>X</sub> exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.	
Current, Any Terminal Except S or D .....	30 mA	b. All leads welded or soldered to PC Board.	
Continuous Current, S or D .....	20 mA	c. Derate 6.5 mW/°C above 25°C	
Peak Current, S or D		d. Derate 7.6 mW/°C above 75°C	

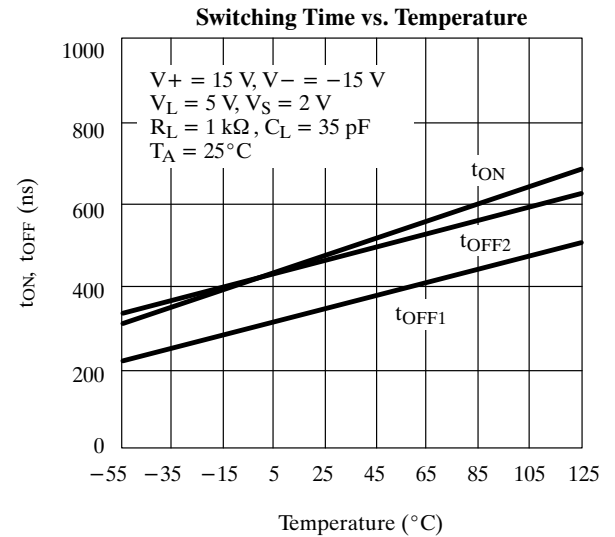
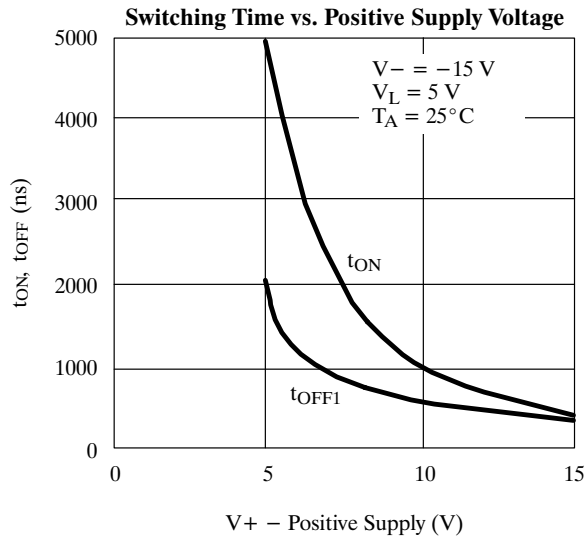
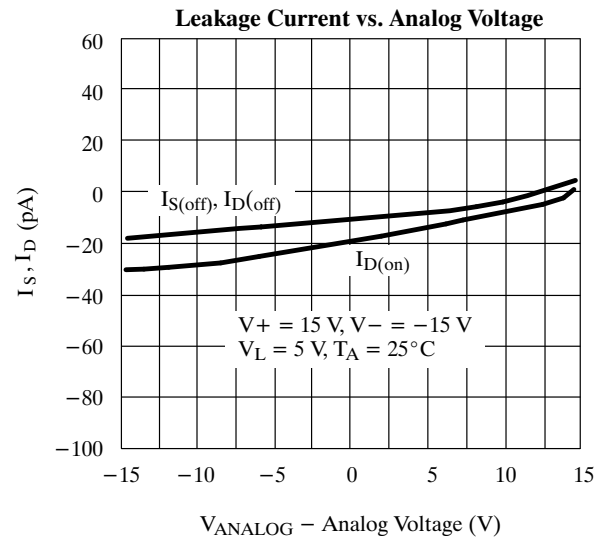
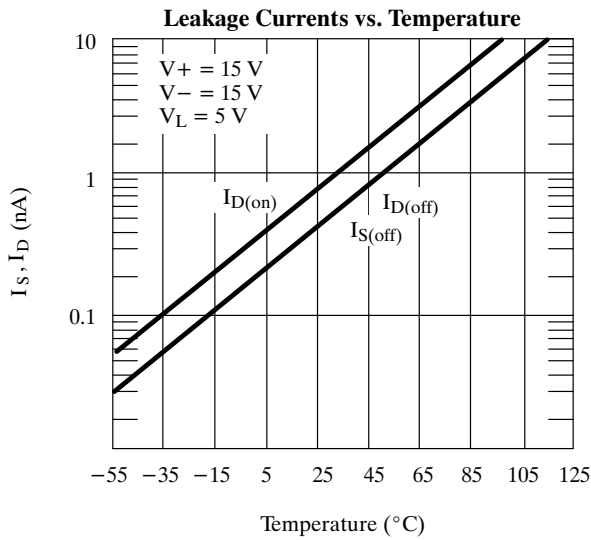
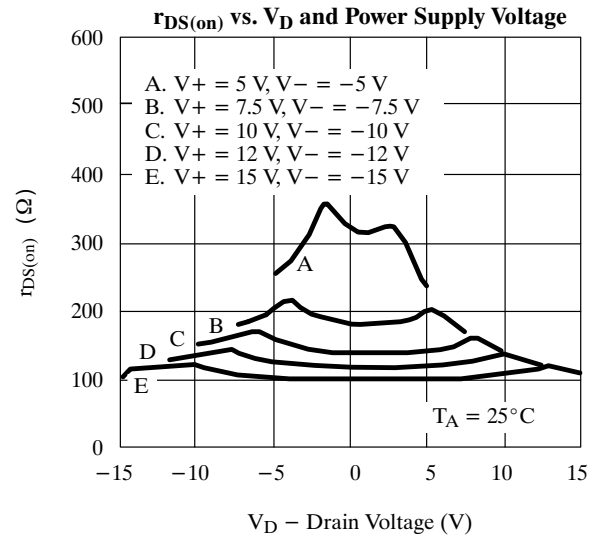
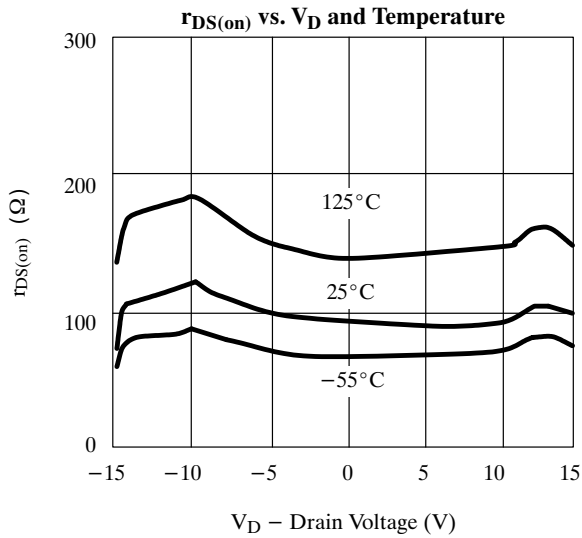
## Specifications

Parameter	Symbol	Conditions Unless Otherwise Specified V+ = 15 V, V- = -15 V V <sub>IN</sub> = 2.4 V, 0.8 V <sup>e</sup>	Temp <sup>a</sup>	Limits			Unit
				Min <sup>c</sup>	Typ <sup>b</sup>	Max <sup>c</sup>	
<b>Analog Switch</b>							
Analog Signal Range <sup>d</sup>	V <sub>ANALOG</sub>		Full	-15		15	V
Drain-Source On-Resistance	r <sub>DS(on)</sub>	I <sub>S</sub> = 1 mA, V <sub>D</sub> = ±10 V	Room		115	175	Ω
Source Off Leakage Current	I <sub>S(off)</sub>	V <sub>S</sub> = ±14 V, V <sub>D</sub> = ∓14 V	Room	-5	±0.02	5	nA
Drain Off Leakage Current	I <sub>D(off)</sub>		Room	-5	±0.02	5	
Drain On Leakage Current	I <sub>D(on)</sub>	V <sub>S</sub> = V <sub>D</sub> = ±14 V	Room	-5	±0.15	5	
<b>Digital Control</b>							
Input Current, Input Voltage High	I <sub>INH</sub>	V <sub>IN</sub> = 2.4 V	Room	-1	-0.0004		μA
		V <sub>IN</sub> = 15 V	Room		0.003	1	
Input Current, Input Voltage Low	I <sub>INL</sub>	V <sub>IN</sub> = 0 V	Room	-1	-0.0004		
<b>Dynamic Characteristics</b>							
Turn-On Time	t <sub>ON</sub>	See Switching Time Test Circuit, V <sub>S</sub> = 2 V	Room		460	1000	ns
Turn-Off Time	t <sub>OFF1</sub>		Room		360	500	
	t <sub>OFF2</sub>		Room		450	450	
Source-Off Capacitance	C <sub>S(off)</sub>	V <sub>S</sub> = 0 V, V <sub>IN</sub> = 5 V, f = 1 MHz	Room		5		pF
Drain-Off Capacitance	C <sub>D(off)</sub>		Room		5		
Channel On Capacitance	C <sub>ON</sub>	V <sub>D</sub> = V <sub>S</sub> = 0 V, V <sub>IN</sub> = 0 V, f = 1 MHz	Room		16		
Off Isolation	OIRR	V <sub>IN</sub> = 5 V, R <sub>L</sub> = 1 kΩ C <sub>L</sub> = 15 pF, V <sub>S</sub> = 1 V <sub>RMS</sub> , f = 100 kHz	Room		70		dB
Channel-to-Channel Crosstalk	X <sub>TALK</sub>		Room		90		
<b>Power Supplies</b>							
Positive Supply Current	I+	V <sub>IN</sub> = 0 or 5 V	Room		0.35	0.48	mA
Negative Supply Current	I-		Room		0.3	0.48	
Logic Supply Current	I <sub>L</sub>		Room		0.5	1.2	

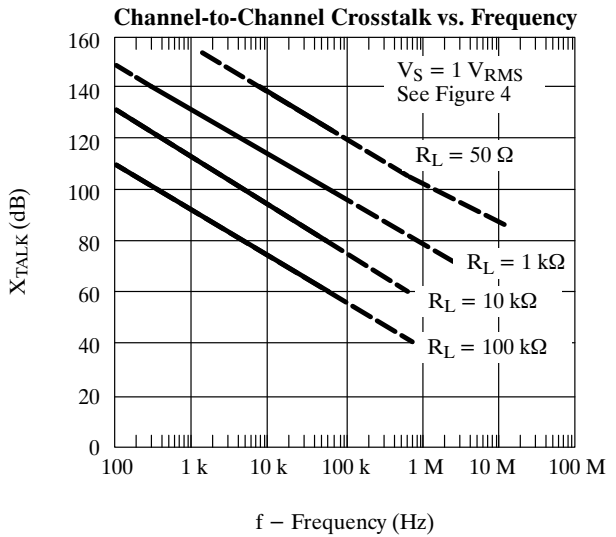
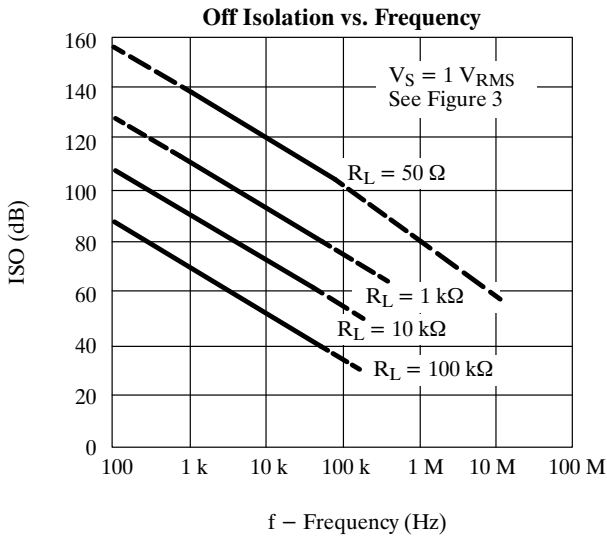
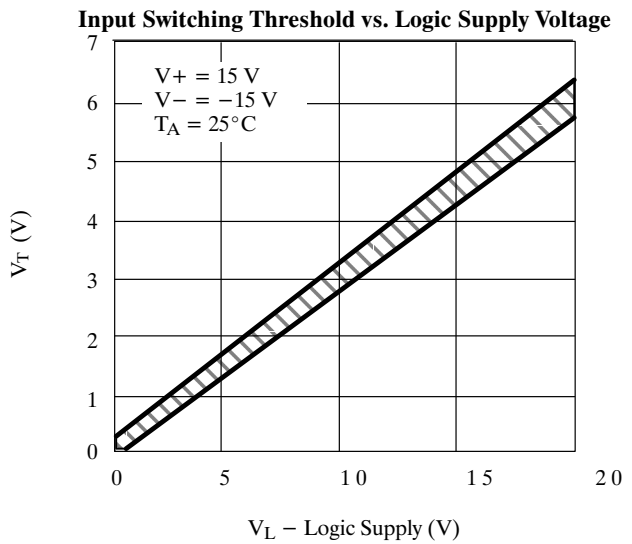
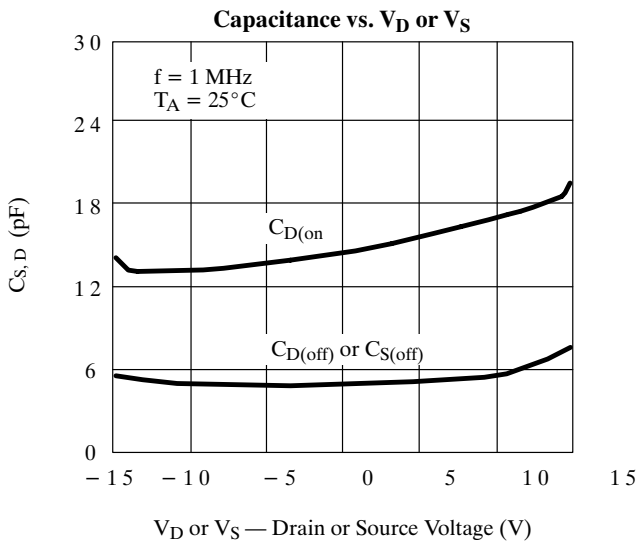
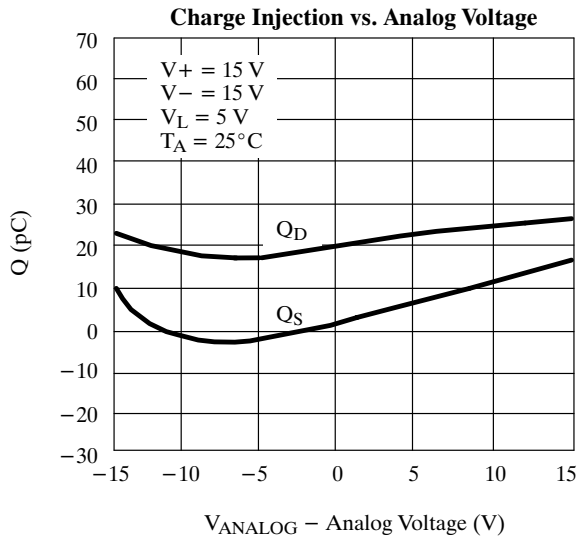
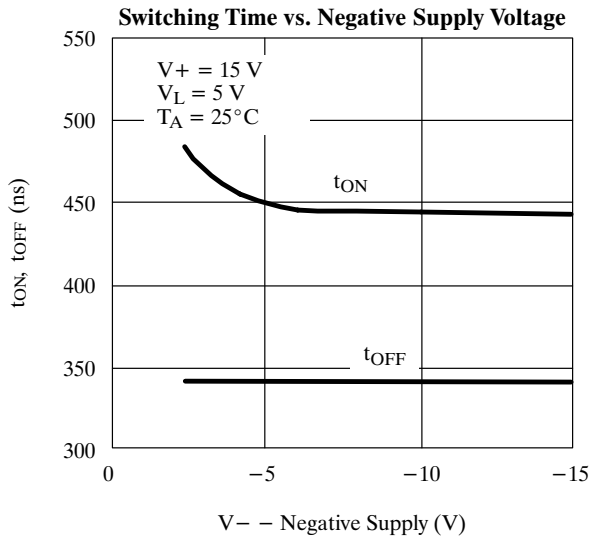
### Notes

- Room = 25°C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- V<sub>IN</sub> = input voltage to perform proper function.

## Typical Characteristics



### Typical Characteristics (Cont'd)



## Schematic Diagram (Typical Channel)

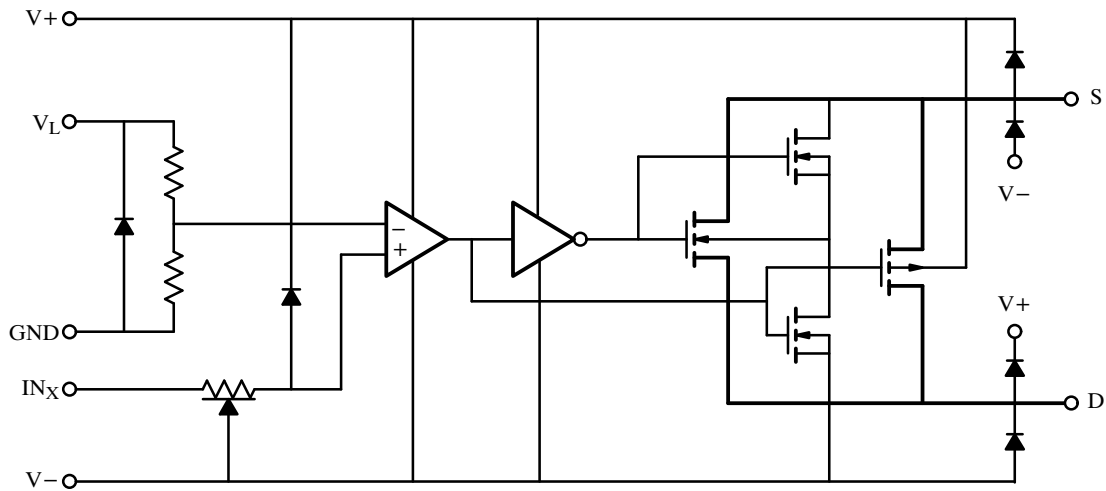
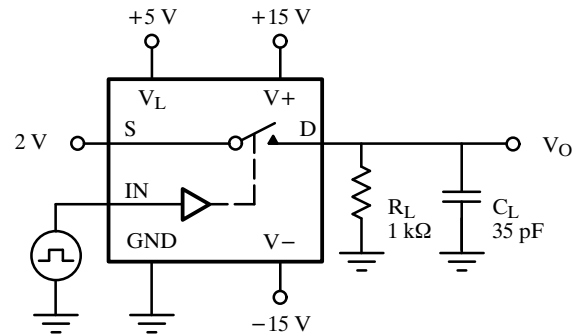
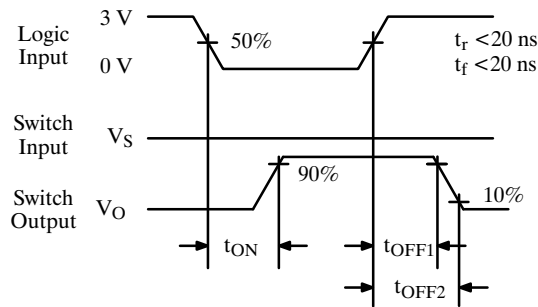


Figure 1.

## Test Circuits

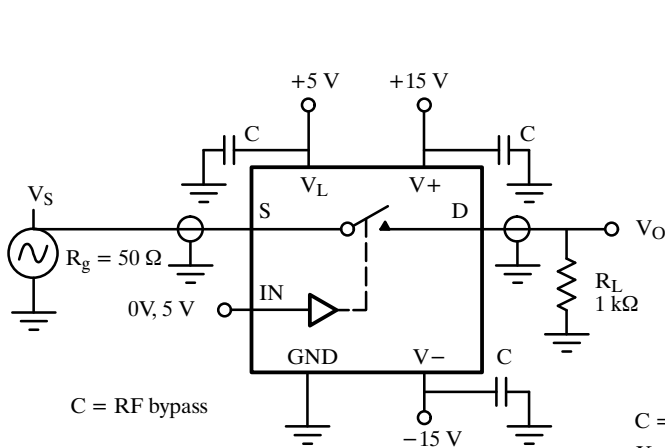
$V_O$  is the steady state output with the switch on. Feedthrough via switch capacitance may result in spikes at the leading and trailing edge of the output waveform.



$C_L$  (includes fixture and stray capacitance)

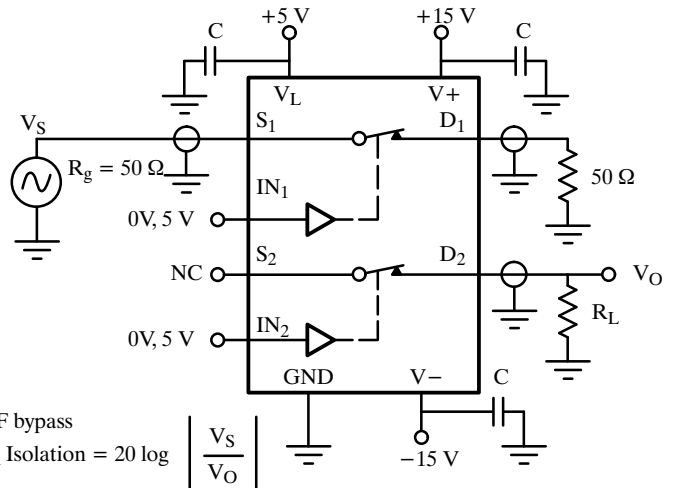
$$V_O = V_S \frac{R_L}{R_L + r_{DS(on)}}$$

Figure 2. Switching Time



$C$  = RF bypass

Figure 3. Off Isolation vs. Frequency



$C$  = RF bypass

$$X_{TALK} \text{ Isolation} = 20 \log \left| \frac{V_S}{V_O} \right|$$

Figure 4. Crosstalk vs. Frequency

## DG211/212

### Applications Hints<sup>a</sup>

Some applications of the DG211 or DG212 will find the logic control inputs  $IN_X$  driven from the output of comparators or op-amps with nearly plus to minus 15-V transitions. In these applications the user can shift the input logic transition voltage from the normal

1.6 V of TTL to zero volts by connecting the  $V_L$  pin to the GND pin. In this mode of operation the input offset voltage between  $IN_X$  and  $V_L (= GND)$  measures less than  $\pm 500$  mV.

V+ Positive Supply Voltage (V)	V- Negative Supply Voltage (V)	V <sub>L</sub> Logic Supply Voltage (V)	V <sub>IN</sub> Logic Input Voltage V <sub>INH(min)</sub> /V <sub>INL(max)</sub> (V)	V <sub>S</sub> or V <sub>D</sub> Analog Voltage Range (V)
20	-20	5	2.4/0.8	-20 to 20
15	-15	5	2.4/0.8	-15 to 15
12	-12	5	2.4/0.8	-12 to 12
10	-10	5	2.4/0.8	-10 to 10
8 <sup>b</sup>	-8	5	2.4/0.8	-8 to 8
10	-10	10	5/2	-10 to 10

Notes

- a. Application Hints are for DESIGN AID ONLY, not guaranteed and not subject to production testing.
- b. Operation below  $\pm 8$  V is not recommended.

### Applications

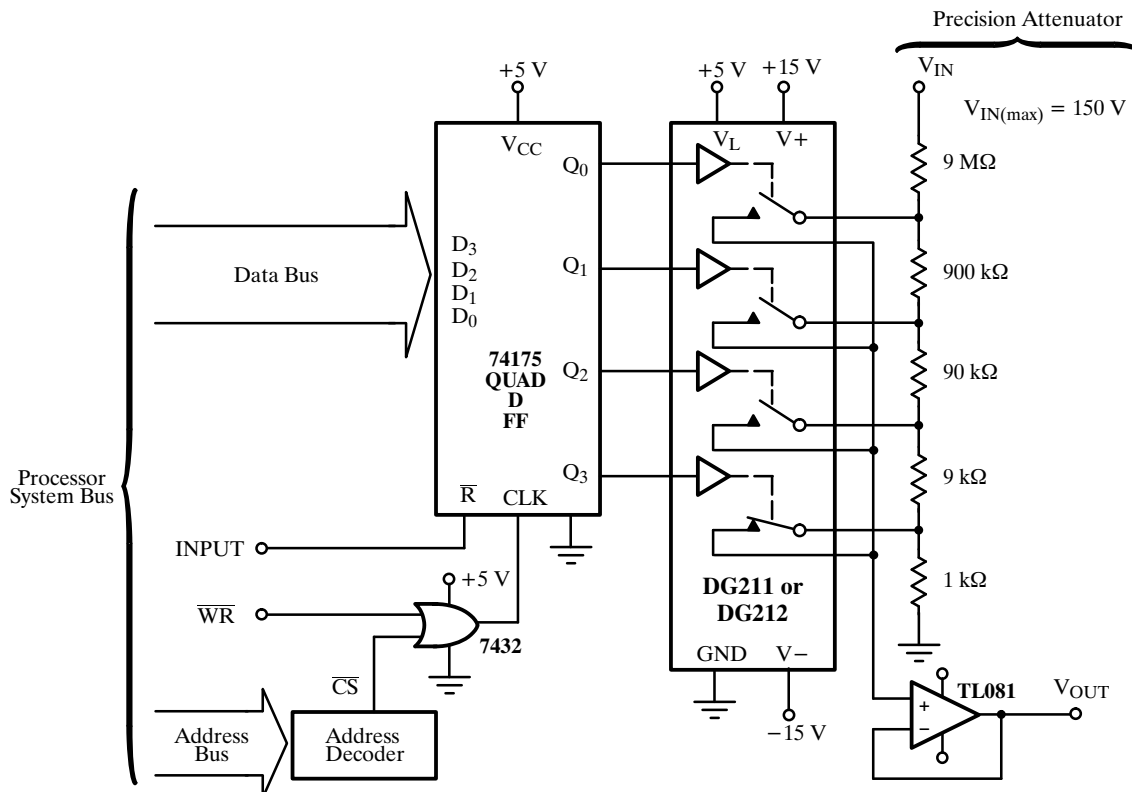


Figure 5. Microprocessor Controlled Analog Signal Attenuator

## Applications (Cont'd)

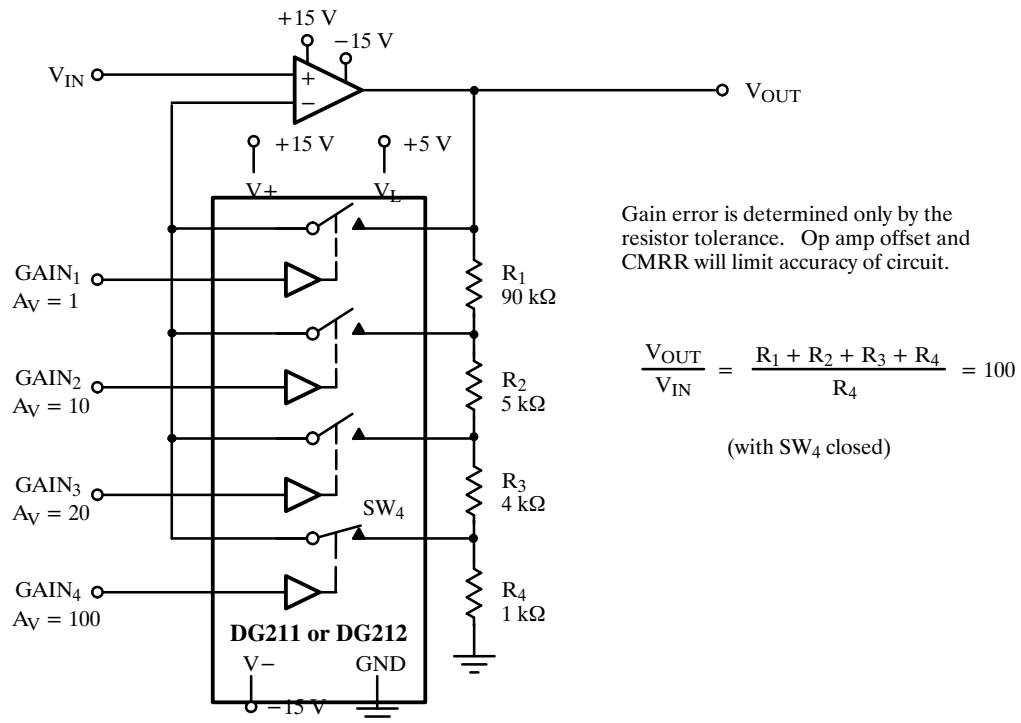
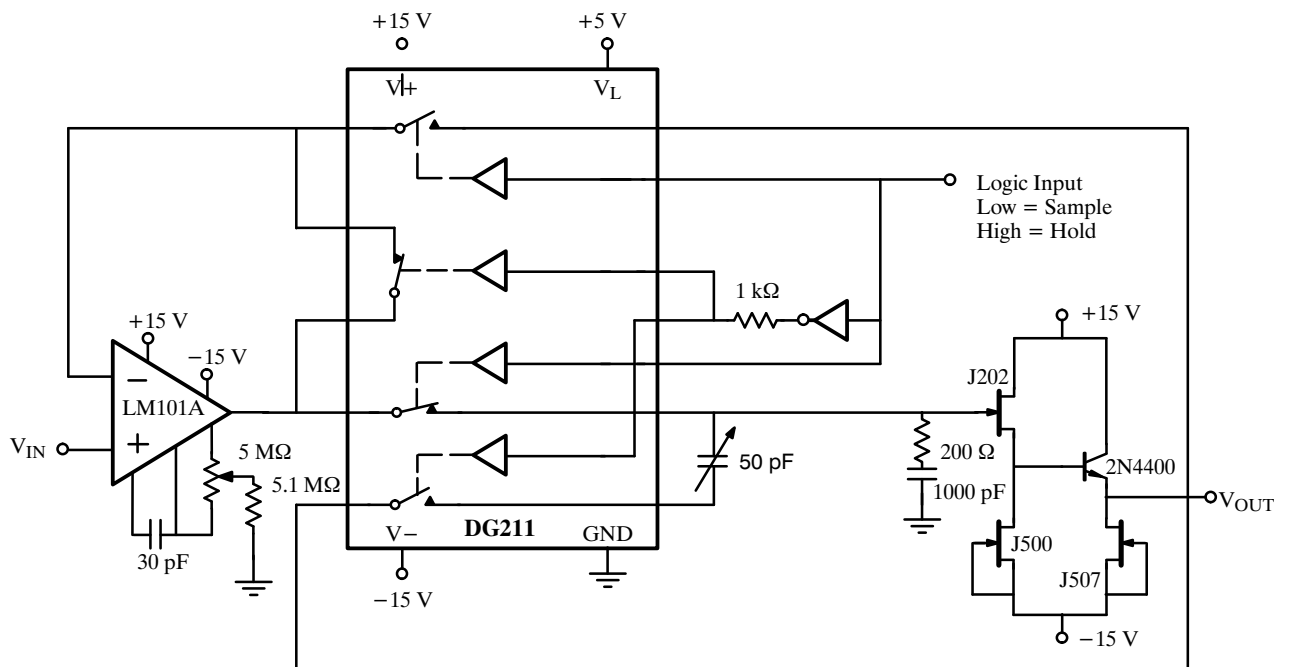


Figure 6. Precision-Weighted Resistor Programmable-Gain Amplifier

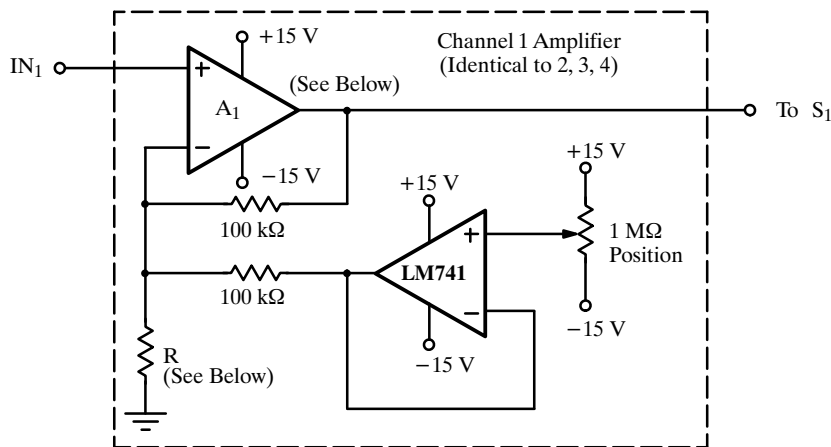
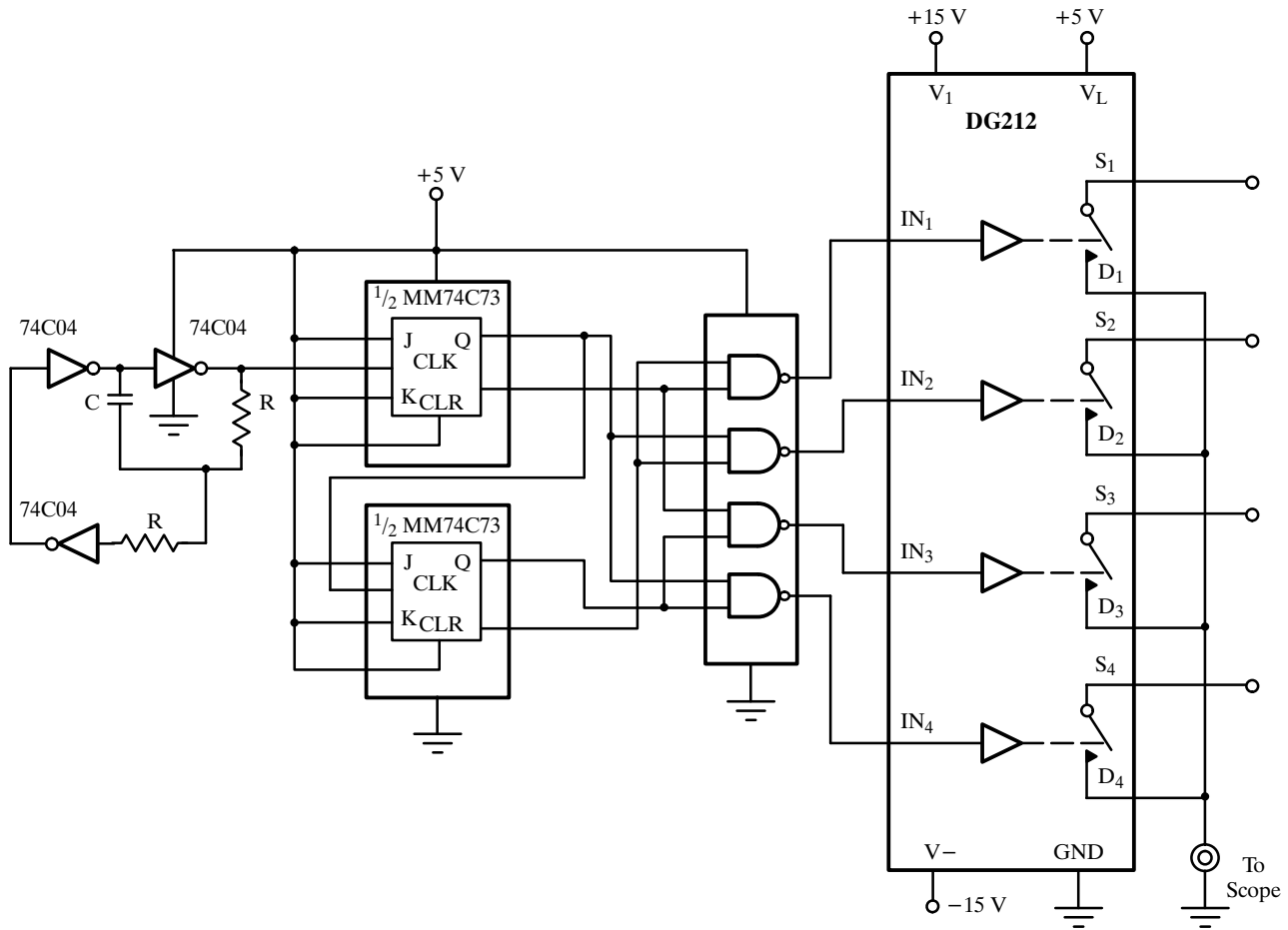


- Acquisition Time = 25 μs
- Aperature Time = 1 μs
- Sample to Hold Offset = 5 mV
- Droop Rate = 5 mV/s

Figure 7. DG211 Sample-and-Hold

### DG211/212

### Applications (Cont'd)



A<sub>1</sub> is op amp with suitable bandwidth, slew rate, etc., for desired signals.

R is added for extra gain according to formula: Voltage Gain =  $1 + \frac{100 \text{ k}\Omega}{R}$

**Figure 8.** The “Scope Extender” Which Displays 4-Channels Simultaneously on a Single Trace Scope