Low-Cost Monolithic Quad SPST CMOS Analog Switches

Features

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

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 ± 15-V input signals with ease, and have a continuous current rating of 20 mA. An epitaxial layer prevents latchup.

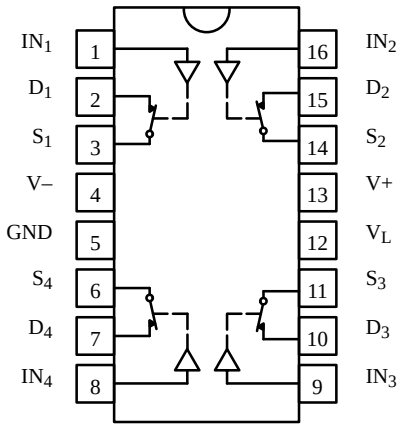
Both devices feature true bi-directional performance (with no offset voltage) in the on condition, and will block signals to 30 V peak-to-peak in the off condition.

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

Functional Block Diagram and Pin Configuration

DG211

Dual-In-Line and SOIC



Top View

Truth Table

Logic	DG211	DG212
0	ON	OFF
1	OFF	ON

Logic "0" ≤ 0.8 V
Logic "1" ≥ 2.4 V

Ordering Information

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

Updates to this data sheet may be obtained via facsimile by calling Siliconix FaxBack, 1-408-970-5600. Please request FaxBack document #70039.

Absolute Maximum Ratings

V+ to V– . . . . . 44 V
V_{IN} to GND[a] . . . . . V–, V+
V_L to GND . . . . . –0.3 V, 25 V
V_S or V_D to V+[a] . . . . . 0, –40 V
V_S or V_D to V–[a] . . . . . 0, 40 V
V+ to GND . . . . . 25 V
V– to GND . . . . . –25 V
Current, Any Terminal Except S or D . . . . . 30 mA
Continuous Current, S or D . . . . . 20 mA
Peak Current, S or D
(Pulsed at 1 ms, 10% duty cycle max) . . . . . 70 mA

Storage Temperature . . . . . –65 to 125°C
Power Dissipation (Package)[b]
16-Pin Plastic DIP[c] . . . . . 470 mW
16-Pin Narrow SOIC[d] . . . . . 600 mW

Notes:
a. Signals on S_X, D_X, or IN_X exceeding V+ or V– will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
b. All leads welded or soldered to PC Board.
c. Derate 6.5 mW/°C above 25°C
d. Derate 7.6 mW/°C above 75°C

Specifications

Parameter	Symbol	Conditions Unless Otherwise Specified V+ = 15 V, V– = –15 V V_{IN} = 2.4 V, 0.8 V[e]	Temp[a]	Limits Min[c]	Limits Typ[b]	Limits Max[c]	Unit
Analog Switch							
Analog Signal Range[d]	V_{ANALOG}		Full	–15		15	V
Drain-Source On-Resistance	$r_{DS(on)}$	I_S = 1 mA, V_D = ± 10 V	Room Full		115	175 250	Ω
Source Off Leakage Current	$I_{S(off)}$	V_S = ± 14 V, V_D = ∓ 14 V	Room Full	–5 –100	± 0.02	5 100	nA
Drain Off Leakage Current	$I_{D(off)}$		Room Full	–5 –100	± 0.02	5 100	
Drain On Leakage Current	$I_{D(on)}$	V_S = V_D = ± 14 V	Room Full	–5 –200	± 0.15	5 200	
Digital Control							
Input Current Input Voltage High	I_{INH}	V_{IN} = 2.4 V	Room Full	–1 –10	–0.0004		µA
		V_{IN} = 15 V	Room Full		0.003	1 10	
Input Current Input Voltage Low	I_{INL}	V_{IN} = 0 V	Room Full	–1 –10	–0.0004		
Dynamic Characteristics							
Turn-On Time	t_{ON}	See Switching Time Test Circuit, V_S = 2 V	Room		460	1000	ns
Turn-Off Time	t_{OFF1}		Room		360	500	
	t_{OFF2}		Room		450	450	
Source-Off Capacitance	$C_{S(off)}$	V_S = 0 V, V_{IN} = 5 V, f = 1 MHz	Room		5		pF
Drain-Off Capacitance	$C_{D(off)}$		Room		5		
Channel On Capacitance	C_{ON}	V_D = V_S = 0 V, V_{IN} = 0 V, f = 1 MHz	Room		16		
Off Isolation	OIRR	V_{IN} = 5 V, R_L = 1 kΩ C_L = 15 pF, V_S = 1 V_{RMS}, f = 100 kHz	Room		70		dB
Channel-to-Channel Crosstalk	X_{TALK}		Room		90		

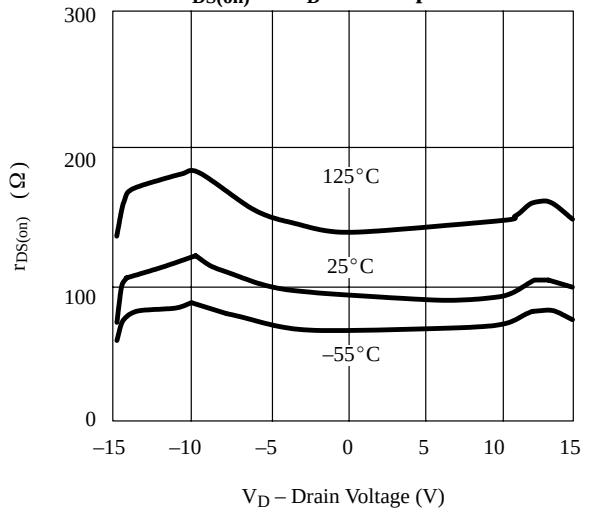
Specifications

Parameter	Symbol	Conditions Unless Otherwise Specified V+ = 15 V, V– = –15 V V_{IN} = 2.4 V, 0.8 V[e]	Temp[a]	Limits			Unit
				Min[c]	Typ[b]	Max[c]	
Power Supplies							
Positive Supply Current	I+	V_{IN} = 0 or 5 V	Room		0.35	0.48	mA
Negative Supply Current	I–		Room		0.3	0.48	
Logic Supply Current	I_L		Room		0.5	1.2	

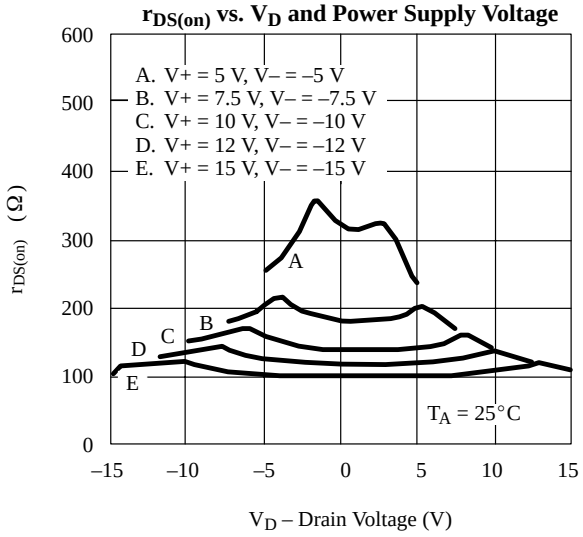
Notes:
a. Room = 25°C, Full = as determined by the operating temperature suffix.
b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
d. Guaranteed by design, not subject to production test.
e. V_{IN} = input voltage to perform proper function.

Typical Characteristics

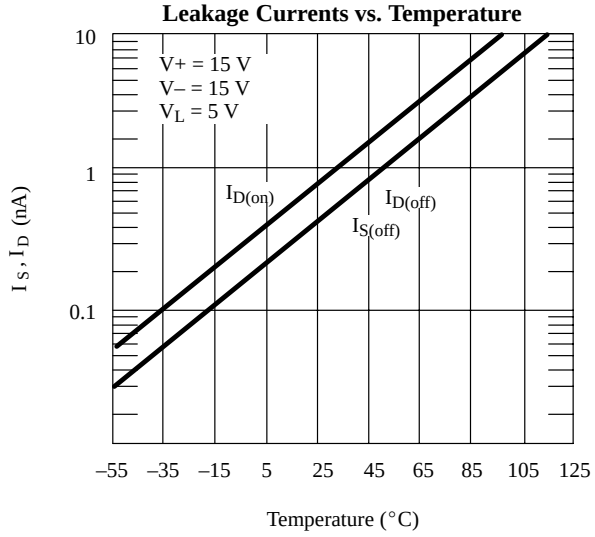
$r_{DS(on)}$ vs. V_D and Temperature



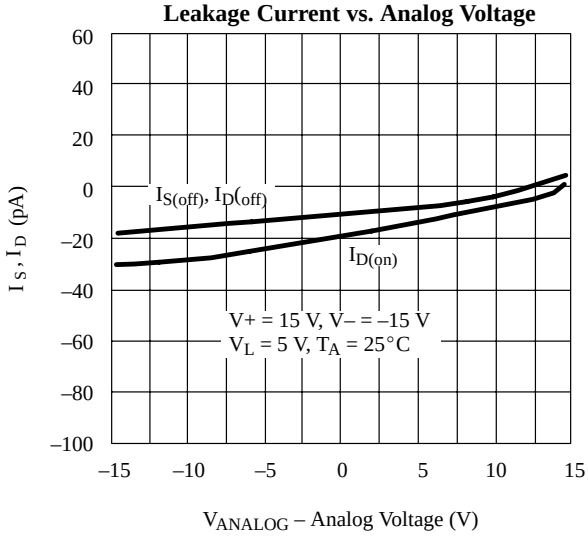
$r_{DS(on)}$ vs. V_D and Power Supply Voltage



Leakage Currents vs. Temperature

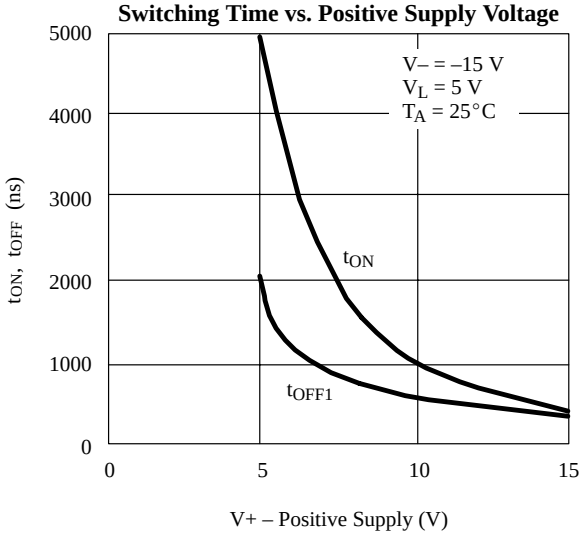


Leakage Current vs. Analog Voltage

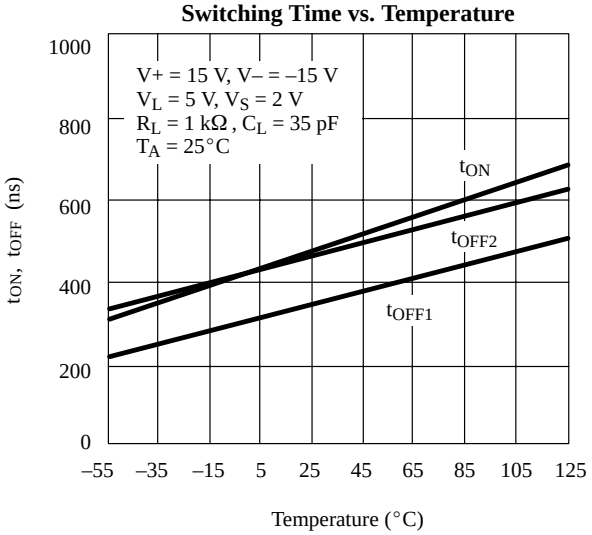


Typical Characteristics

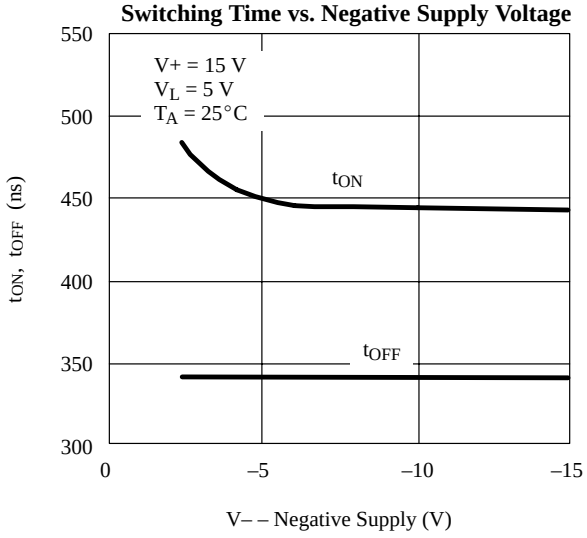
Switching Time vs. Positive Supply Voltage



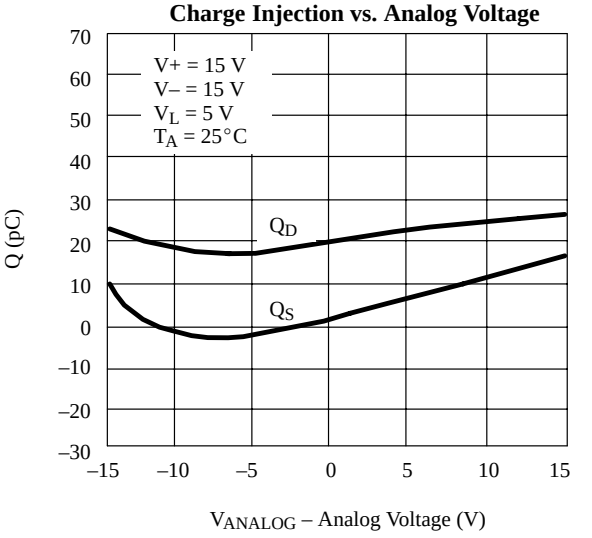
Switching Time vs. Temperature



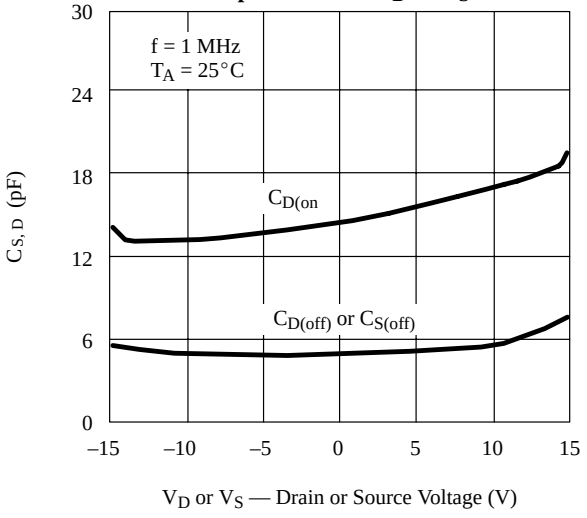
Switching Time vs. Negative Supply Voltage



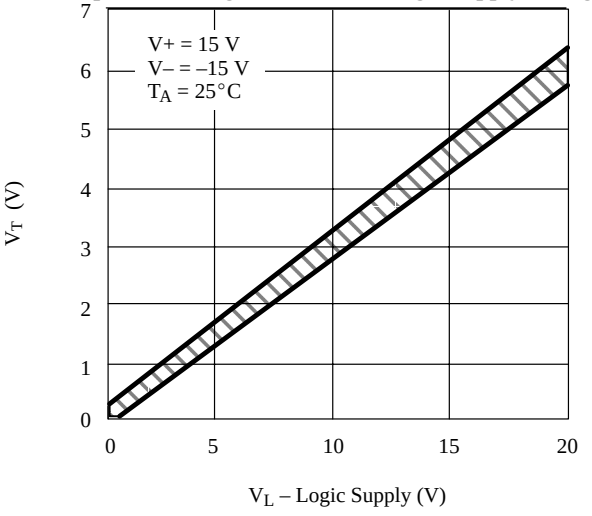
Charge Injection vs. Analog Voltage



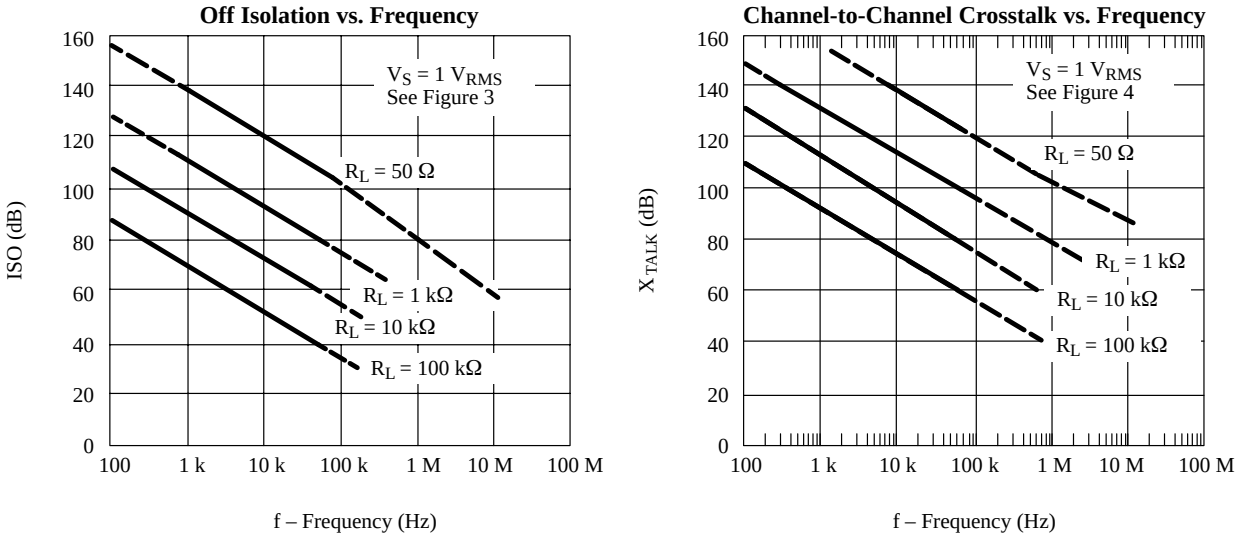
Capacitance vs. V_D or V_S



Input Switching Threshold vs. Logic Supply Voltage



Typical Characteristics



Schematic Diagram (Typical Channel)

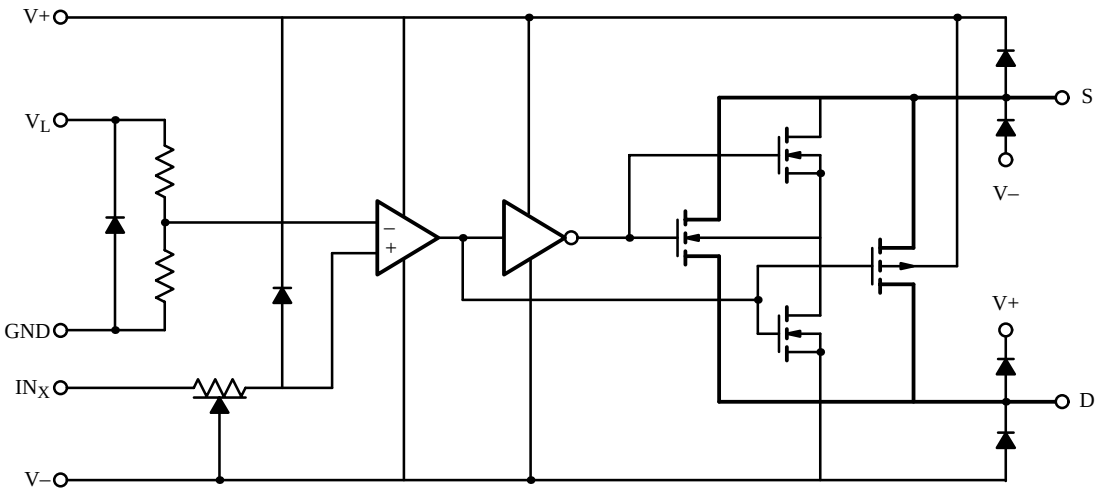


Figure 1.

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.

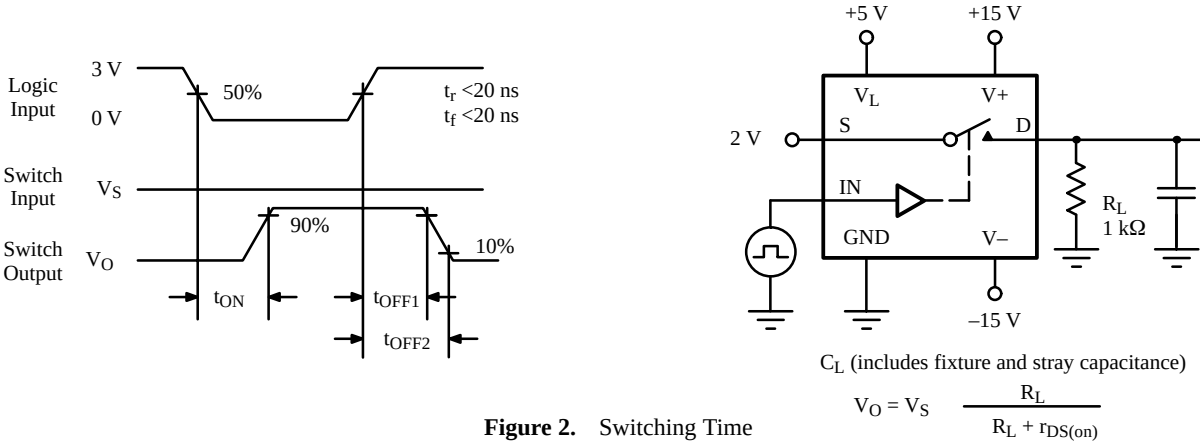


Figure 2. Switching Time

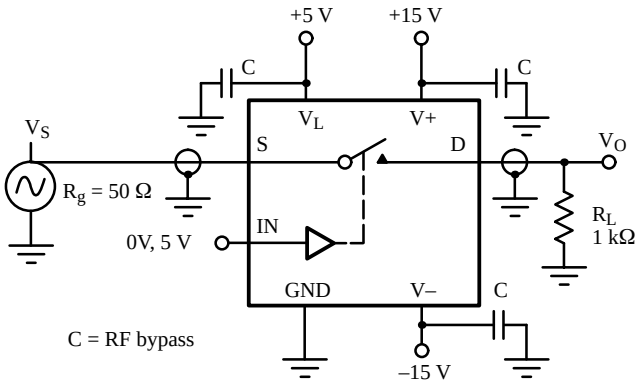


Figure 3. Off Isolation vs. Frequency

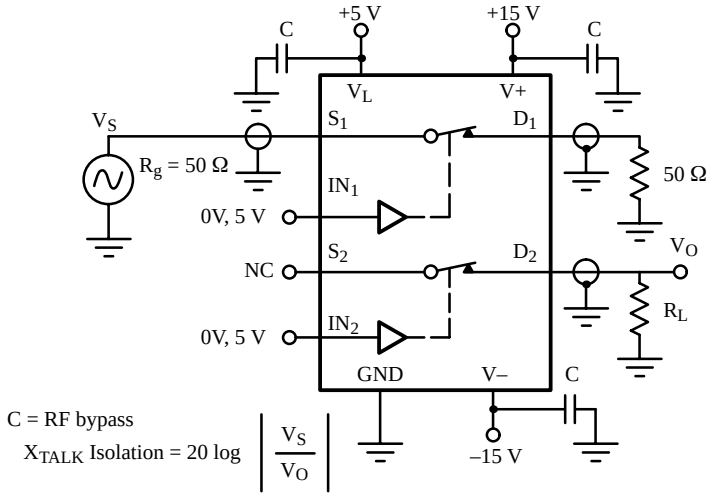


Figure 4. Crosstalk vs. Frequency

Applications Hints[a]

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 ±500 mV.

V+ Positive Supply Voltage (V)	V– Negative Supply Voltage (V)	V_L Logic Supply Voltage (V)	V_{IN} Logic Input Voltage $V_{INH(min)}/V_{INL(max)}$ (V)	V_S or V_D 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[b]	–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 ±8 V is not recommended.

Applications

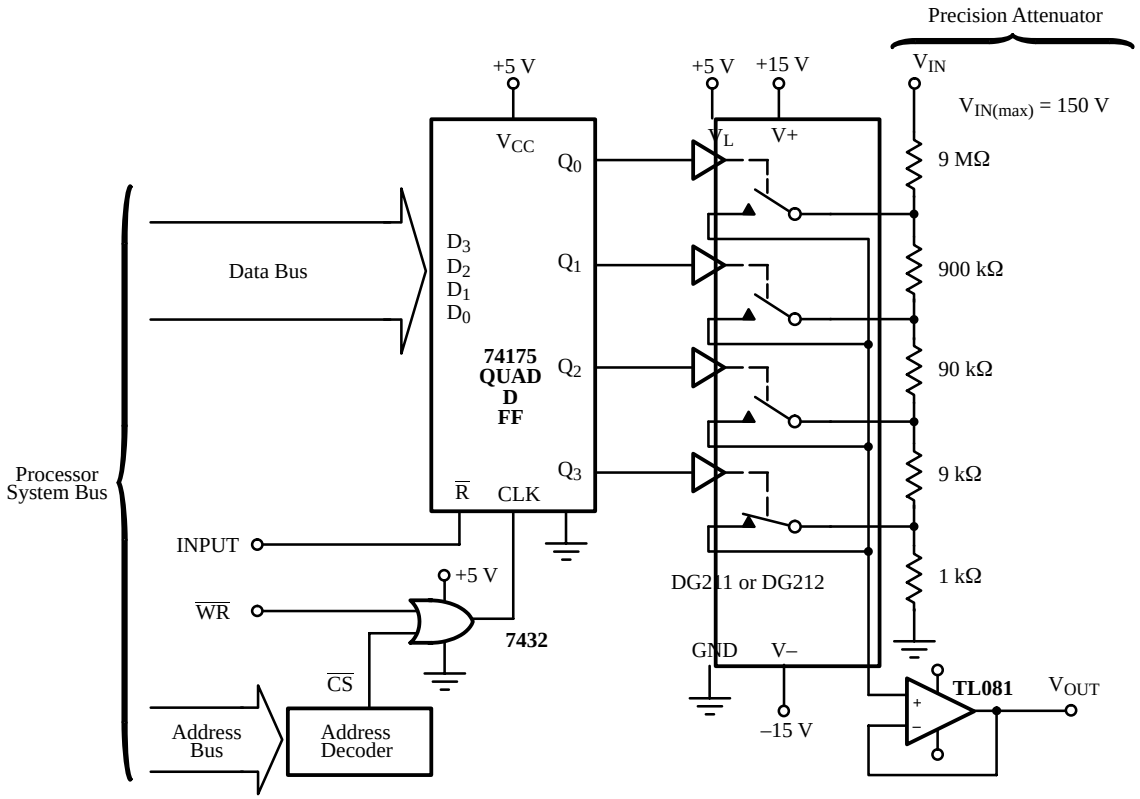


Figure 5. Microprocessor Controlled Analog Signal Attenuator

Applications (Cont'd)

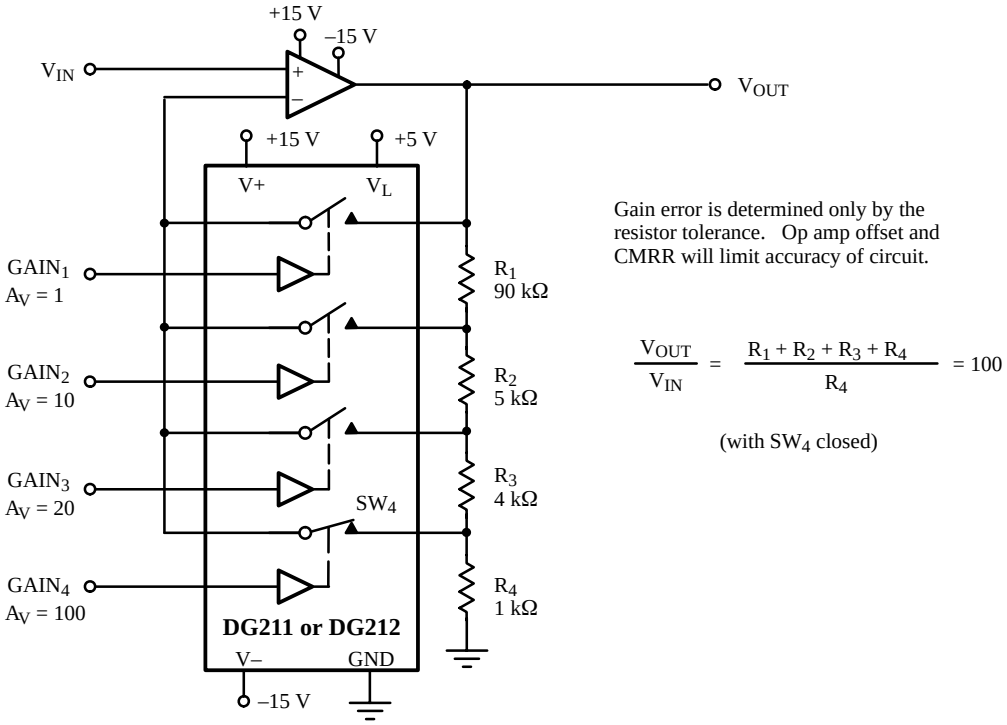
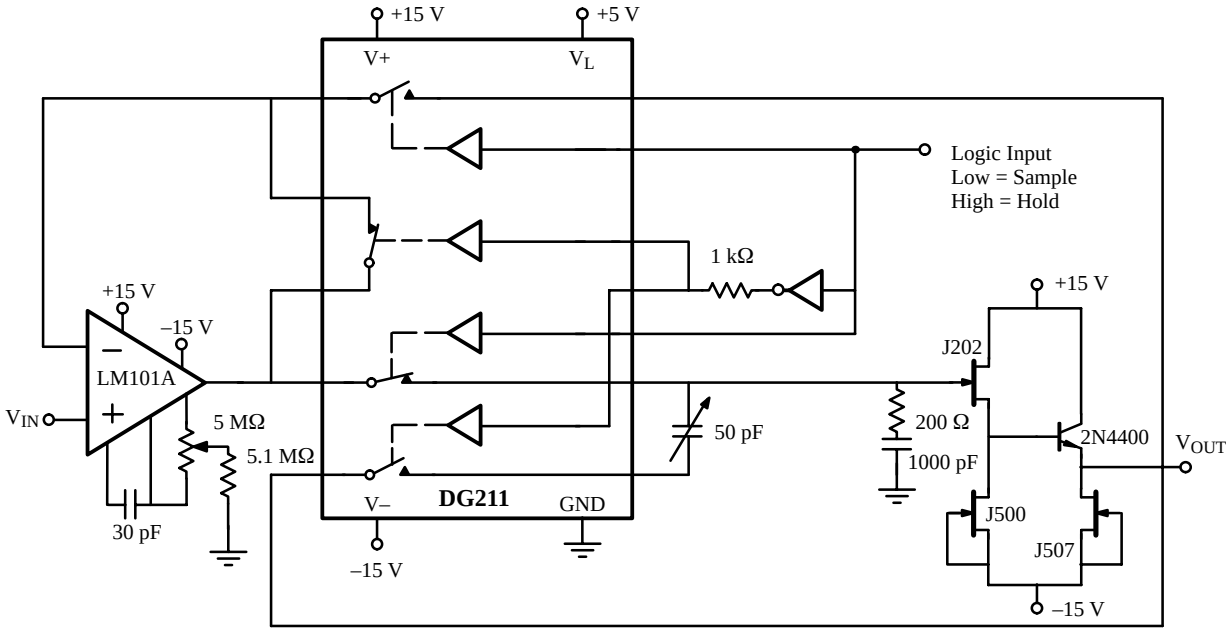


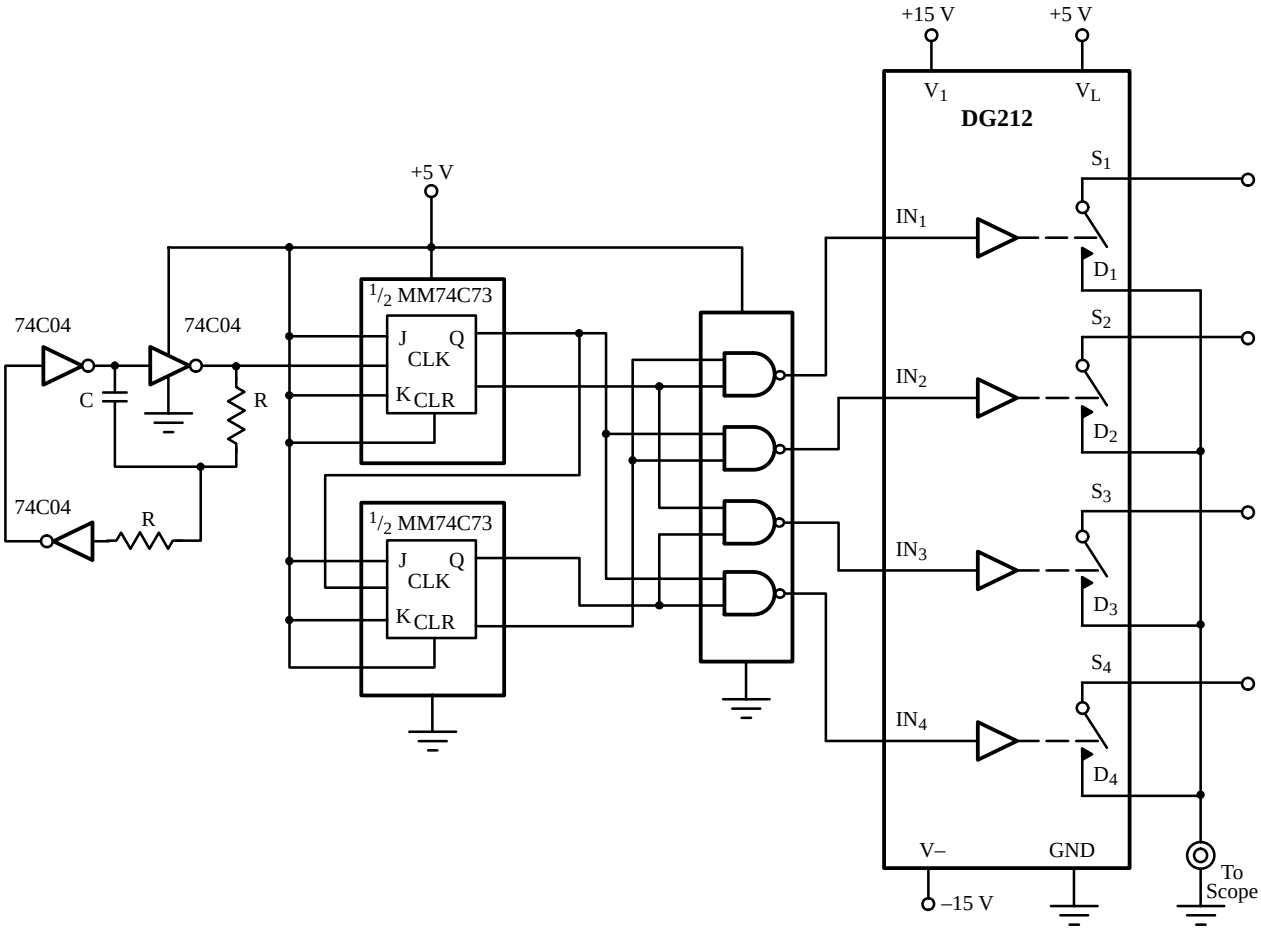
Figure 6. Precision-Weighted Resistor Programmable-Gain Amplifier

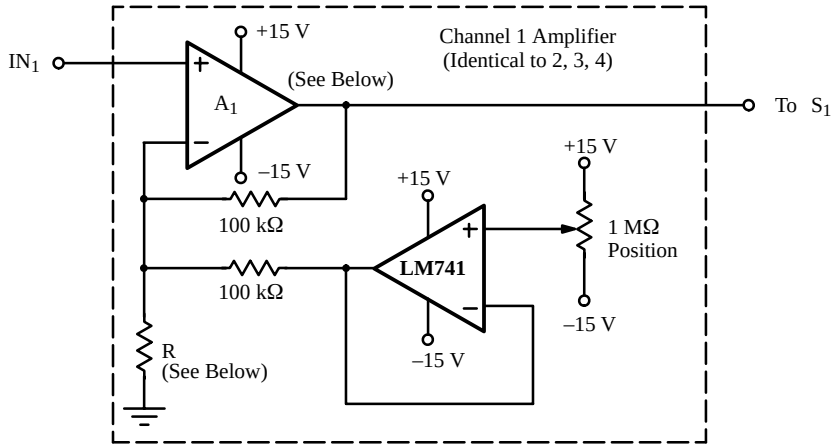


Aquisition Time = 25 µs
Aperature Time = 1 µs
Sample to Hold Offset = 5 mV
Droop Rate = 5 mV/s

Figure 7. DG211 Sample-and-Hold

Applications (Cont'd)





A_1 is op amp with suitable bandwidth, slew rate, etc., for desired signals.
R is added for extra gain according to formula: Voltage Gain = $1 + \frac{100\ k\Omega}{R}$

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