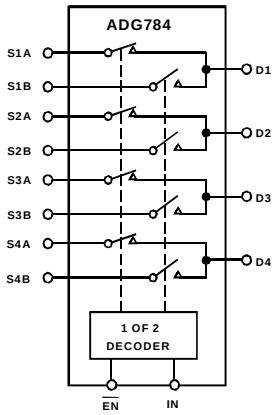
CMOS 3 V/5 V, Wide Bandwidth Quad 2:1 Mux in Chip Scale

Preliminary Technical Data — ADG784

FEATURES
Low Insertion Loss and On Resistance: 4 Ω Typical
On-Resistance Flatness <2 Ω
Bandwidth >200 MHz
Single 3 V/5 V Supply Operation
Rail-to-Rail Operation
Very Low Distortion: <1%
Low Quiescent Supply Current (100 nA Typical)
Fast Switching Times
t_{ON} 10 ns
t_{OFF} 4 ns
TTL/CMOS Compatible

APPLICATIONS
10/100 Base-TX/T4
100VG-AnyLAN
Token Ring 4 Mbps/16 Mbps
ATM25/155
NIC Adapter and Hubs
Audio and Video Switching
Relay Replacement

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The ADG784 is a monolithic CMOS device comprising four 2:1 multiplexer/demultiplexers with high impedance outputs. The CMOS process provides low power dissipation yet gives high switching speed and low on resistance. The on-resistance variation is typically less than 0.5 Ω with an input signal ranging from 0 V to 5 V.

The bandwidth of the ADG784 is greater than 200 MHz and this, coupled with low distortion (typically 0.5%), makes the part suitable for switching fast ethernet signals.

The on-resistance profile is very flat over the full analog input range ensuring excellent linearity and low distortion when switching audio signals. Fast switching speed, coupled with high signal bandwidth, also makes the parts suitable for video signal switching. CMOS construction ensures ultralow power dissipation making the parts ideally suited for portable and battery powered instruments.

The ADG784 operates from a single 3.3 V/5 V supply and is TTL logic compatible. The control logic for each switch is shown in the Truth Table.

These switches conduct equally well in both directions when ON, and have an input signal range that extends to the supplies. In the OFF condition, signal levels up to the supplies are blocked. The ADG784 switches exhibit break-before-make switching action.

PRODUCT HIGHLIGHTS

1. Wide bandwidth data rates >200 MHz.
2. Ultralow Power Dissipation.
3. Extended Signal Range.
   The ADG784 is fabricated on a CMOS process giving an increased signal range that fully extends to the supply rails.
4. Low leakage over temperature.
5. Break-Before-Make Switching.
   This prevents channel shorting when the switches are configured as a multiplexer.
6. Crosstalk is typically –70 dB @ 30 MHz.
7. Off isolation is typically –60 dB @ 10 MHz.
8. Available in Chip Sclae Package.

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ADG784–SPECIFICATIONS

SINGLE SUPPLY (V_{DD} = +5 V ± 10%, GND = 0 V. All specifications T_{MIN} to T_{MAX} unless otherwise noted.)

Parameter	B Version +25°C	B Version T_{MIN} to T_{MAX}	Units	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On Resistance (R_{ON})	2.2		Ω typ	V_D = 0 V to V_{DD}, I_S = –10 mA
		5	Ω max	
On Resistance Match Between Channels (ΔR_{ON})	0.15		Ω typ	V_D = 0 V to V_{DD}, I_S = –10 mA
		0.5	Ω max	
On Resistance Flatness ($R_{FLAT(ON)}$)	0.5		Ω typ	V_D = 0 V to V_{DD}; I_S = –1 mA
		1	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I_S (OFF)	±0.01	±0.05	nA typ	V_D = 4.5 V, V_S = 1 V; V_D = 1 V, V_S = 4.5 V;
	±10	±20	nA max	Test Circuit 2
Drain OFF Leakage I_D (OFF)	±0.01	±0.05	nA typ	V_D = 4.5 V, V_S = 1 V; V_D = 1 V, V_S = 4.5 V;
	±10	±20	nA max	Test Circuit 2
Channel ON Leakage I_D, I_S (ON)	±0.01	±0.05	nA typ	V_D = V_S = 4.5 V; V_D = V_S = 1 V; Test Circuit 3
	±10	±20	nA max	
DIGITAL INPUTS				
Input High Voltage, V_{INH}		2.4	V min	
Input Low Voltage, V_{INL}		0.8	V max	
Input Current				
I_{INL} or I_{INH}	0.001		µA typ	V_{IN} = V_{INL} or V_{INH}
		±0.5	µA max	
DYNAMIC CHARACTERISTICS[2]				
t_{ON}		10	ns typ	R_L = 100 Ω, C_L = 35 pF,
		20	ns max	V_S = +3 V; Test Circuit 4
t_{OFF}		4	ns typ	R_L = 100 Ω, C_L = 35 pF,
		8	ns max	V_S = +3 V; Test Circuit 4
Break-Before-Make Time Delay, t_D		5	ns typ	R_L = 100 Ω, C_L = 35 pF,
		1	ns min	V_{S1} = V_{S2} = +5 V; Test Circuit 5
Off Isolation		–65	dB typ	R_L = 100 Ω, f = 10 MHz; Test Circuit 7
Channel-to-Channel Crosstalk		–75	dB typ	R_L = 100 Ω, f = 10 MHz; Test Circuit 8
Bandwidth –3 dB		240	MHz typ	R_L = 100 Ω; Test Circuit 6
Distortion		0.5	% typ	R_L = 100 ý
Charge Injection		10	pC typ	C_L = 1 nF; Test Circuit 9
C_S (OFF)		10	pF typ	f = 1 kHz
C_D (OFF)		20	pF typ	f = 1 kHz
C_D, C_S (ON)		30	pF typ	f = 1 MHz
POWER REQUIREMENTS				V_{DD} = +5.5 V Digital Inputs = 0 V or V_{DD}
I_{DD}		1	µA max	
	0.001		µA typ	
I_{IN}		1	µA typ	V_{IN} = +5 V
I_O		100	mA max	V_S/V_D = 0 V

NOTES

[1]Temperature ranges are as follows: B Version, –40°C to +85°C.

[2]Guaranteed by design, not subject to production test.

Specifications subject to change without notice.

SINGLE SUPPLY (V_{DD} = +3 V 6 10%, GND = 0 V. All specifications T_{MIN} to T_{MAX} unless otherwise noted.)

Parameter	B Version +25°C	B Version T_{MIN} to T_{MAX}	Units	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On Resistance (R_{ON})	4		Ω typ	V_D = 0 V to V_{DD}, I_S = –10 mA
		8	Ω max	
On Resistance Match Between Channels (ΔR_{ON})	0.15		Ω typ	V_D = 0 V to V_{DD}, I_S = –10 mA
		0.5	Ω max	
On Resistance Flatness ($R_{FLAT(ON)}$)	2		Ω typ	V_D = 0 V to V_{DD}, I_S = –10 mA
		4	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I_S (OFF)	±0.01	±0.05	nA typ	V_D = 3 V, V_S = 1 V; V_D = 1 V, V_S = 3 V;
	±10	±20	nA max	Test Circuit 2
Drain OFF Leakage I_D (OFF)	±0.01	±0.05	nA typ	V_D = 3 V, V_S = 1 V; V_D = 1 V, V_S = 3 V;
	±10	±20	nA max	Test Circuit 2
Channel ON Leakage I_D, I_S (ON)	±0.01	±0.05	nA typ	V_D = V_S = 3 V; V_D = V_S = 1 V; Test Circuit 3
	±10	±20	nA max	
DIGITAL INPUTS				
Input High Voltage, V_{INH}		2.0	V min	
Input Low Voltage, V_{INL}		0.4	V max	
Input Current				
I_{INL} or I_{INH}	0.001		µA typ	V_{IN} = V_{INL} or V_{INH}
		±0.5	µA max	
DYNAMIC CHARACTERISTICS[2]				
t_{ON}		12	ns typ	R_L = 100 Ω, C_L = 35 pF,
		25	ns max	V_S = +1.5 V; Test Circuit 4
t_{OFF}		5	ns typ	R_L = 100 Ω, C_L = 35 pF,
		10	ns max	V_S = +1.5 V; Test Circuit 4
Break-Before-Make Time Delay, t_D		5	ns typ	R_L = 100 Ω, C_L = 35 pF,
		1	ns min	V_{S1} = V_{S2} = 3 V; Test Circuit 5
Off Isolation		–65	dB typ	R_L = 50 Ω, f = 10 MHz; Test Circuit 7
Channel-to-Channel Crosstalk		–75	dB typ	R_L = 50 Ω, f = 10 MHz; Test Circuit 8
Bandwidth –3 dB		240	MHz typ	R_L = 50 Ω; Test Circuit 6
Distortion		2	% typ	R_L = 50 ý
Charge Injection		3	pC typ	C_L = 1 nF; Test Circuit 9
C_S (OFF)		10	pF typ	f = 1 kHz
C_D (OFF)		20	pF typ	f = 1 kHz
C_D, C_S (ON)		30	pF typ	f = 1 MHz
POWER REQUIREMENTS				V_{DD} = +3.3 V Digital Inputs = 0 V or V_{DD}
I_{DD}		1	µA max	
	0.001		µA typ	
I_{IN}		1	µA typ	V_{IN} = +3 V
I_O		100	mA max	V_S/V_D = 0 V

NOTES
[1]Temperature ranges are as follows: B Version, –40°C to +85°C.
[2]Guaranteed by design, not subject to production test.
Specifications subject to change without notice.

Table I. Truth Table

EN	IN	D1	D2	D3	D4	Function
1	X	Hi-Z	Hi-Z	Hi-Z	Hi-Z	DISABLE
0	0	S1A	S2A	S3A	S4A	IN = 0
0	1	S1B	S2B	S3B	S4B	IN = 1

ABSOLUTE MAXIMUM RATINGS[1]

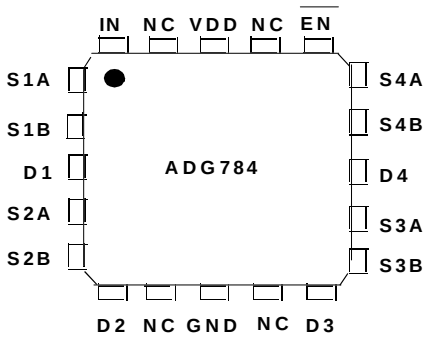
(T_A = +25°C unless otherwise noted)

V_{DD} to GND ..... –0.3 V to +6 V
Analog, Digital Inputs[2] ..... –0.3 V to V_{DD} + 0.3 V or 30 mA, Whichever Occurs First
Continuous Current, S or D ..... 100 mA
Peak Current, S or D ..... 300 mA
(Pulsed at 1 ms, 10% Duty Cycle max)
Operating Temperature Range
Industrial (B Version) ..... –40°C to +85°C
Storage Temperature Range ..... –65°C to +150°C
Junction Temperature ..... +150°C
Chip Scale Package, Power Dissipation ..... TBD mW
θ_{JA} Thermal Impedance ..... TBD°C/W
Lead Temperature, Soldering
Vapor Phase (60 sec) ..... +215°C
Infrared (15 sec) ..... +220°C

ESD ..... 2 kV

NOTES
[1]Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Only one absolute maximum rating may be applied at any one time.
[2]Overvoltages at IN, S or D will be clamped by internal diodes. Current should be limited to the maximum ratings given.

PIN CONFIGURATION
Exposed Pad tied to Substrate, GND



TERMINOLOGY

V_{DD}	Most Positive Power Supply Potential.
GND	Ground (0 V) Reference.
S	Source Terminal. May be an input or output.
D	Drain Terminal. May be an input or output.
IN	Logic Control Input.
EN	Logic Control Input.
R_{ON}	Ohmic resistance between D and S.
ΔR_{ON}	On Resistance match between any two channels i.e., R_{ON} max – R_{ON} min.
$R_{FLAT(ON)}$	Flatness is defined as the difference between the maximum and minimum value of on resistance as measured over the specified analog signal range.
I_S (OFF)	Source Leakage Current with the switch "OFF."
I_D (OFF)	Drain Leakage Current with the switch "OFF."
I_D, I_S (ON)	Channel Leakage Current with the switch "ON."
V_D (V_S)	Analog Voltage on Terminals D, S.
C_S (OFF)	"OFF" Switch Source Capacitance.
C_D (OFF)	"OFF" Switch Drain Capacitance.
C_D, C_S (ON)	"ON" Switch Capacitance.
t_{ON}	Delay between applying the digital control input and the output switching on. See Test Circuit 4.
t_{OFF}	Delay between applying the digital control input and the output switching Off.
t_D	"OFF" time or "ON" time measured between the 90% points of both switches, when switching from one address state to another. See Test Circuit 5.
Crosstalk	A measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.
Off Isolation	A measure of unwanted signal coupling through an "OFF" switch.
Bandwidth	Frequency response of the switch in the ON state measured at 3 dB down.
Distortion	$R_{FLAT(ON)}/R_L$

ORDERING GUIDE

Model	Temperature Range	Package Descriptions	Package Options
ADG784BCP	–40°C to +85°C	Chip Scale Package	CP-20

CAUTION
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the ADG784 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.

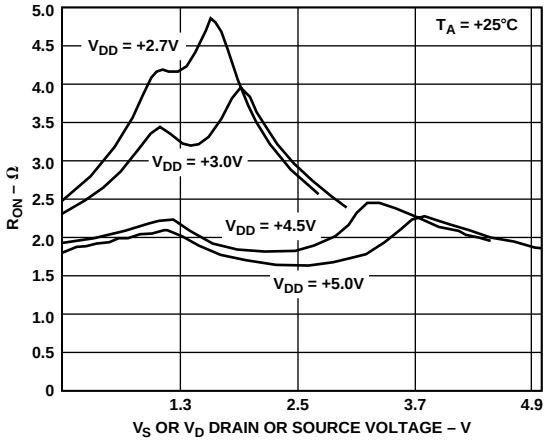


Figure 1. On Resistance as a Function of V_D (V_S) for Various Single Supplies

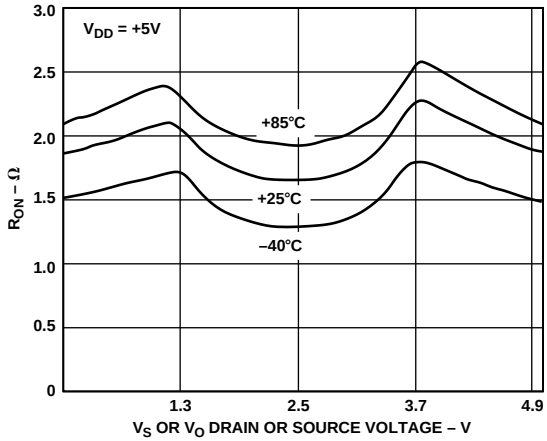


Figure 2. On Resistance as a Function of V_D (V_S) for Different Temperatures with 5 V Single Supplies

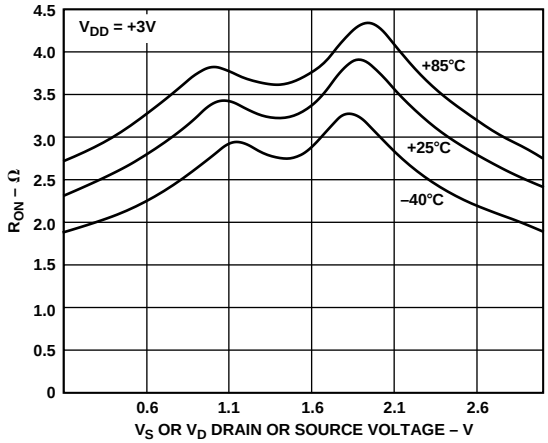


Figure 3. On Resistance as a Function of V_D (V_S) for Different Temperatures with 3 V Single Supplies

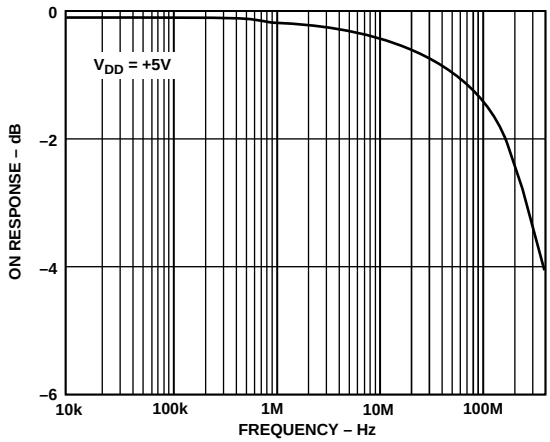


Figure 4. On Response vs. Frequency

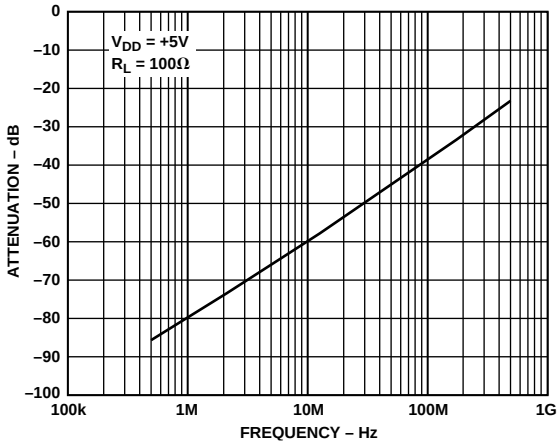


Figure 5. Off Isolation vs. Frequency

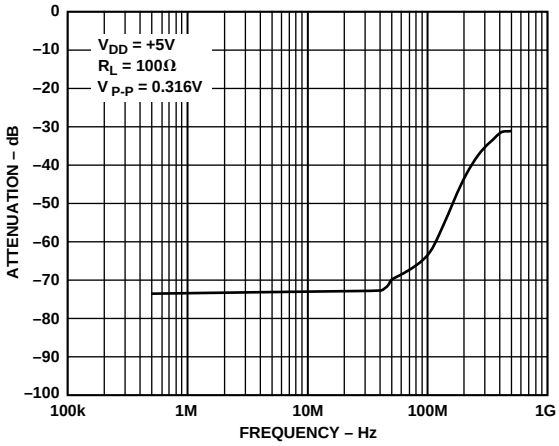


Figure 6. Crosstalk vs. Frequency

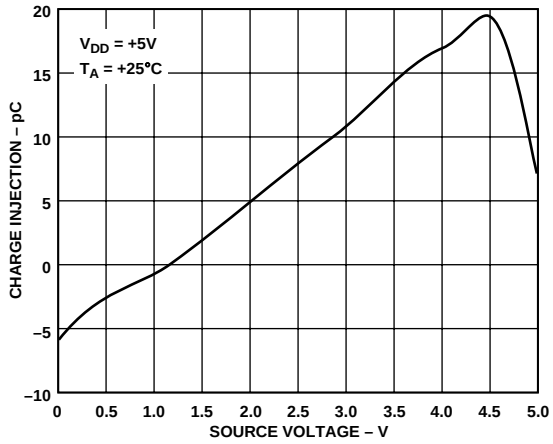


Figure 7. Charge Injection vs. Source Voltage

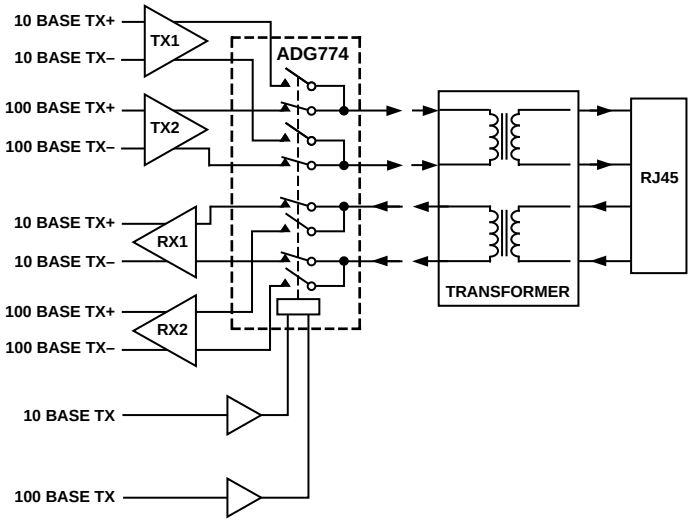


Figure 8. Full Duplex Transceiver

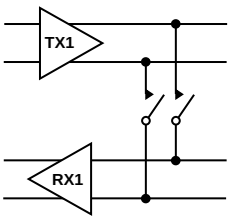


Figure 9. Loop Back

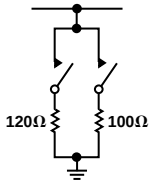


Figure 10. Line Termination

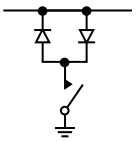
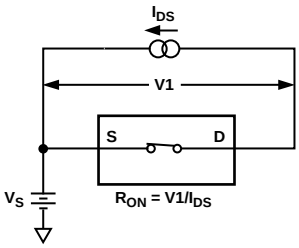
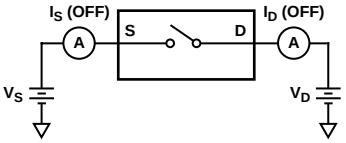


Figure 11. Line Clamp

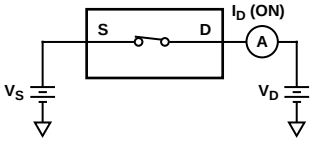
Test Circuits



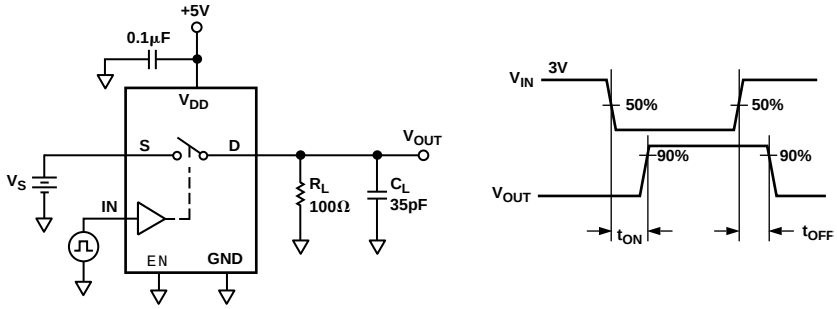
Test Circuit 1. On Resistance



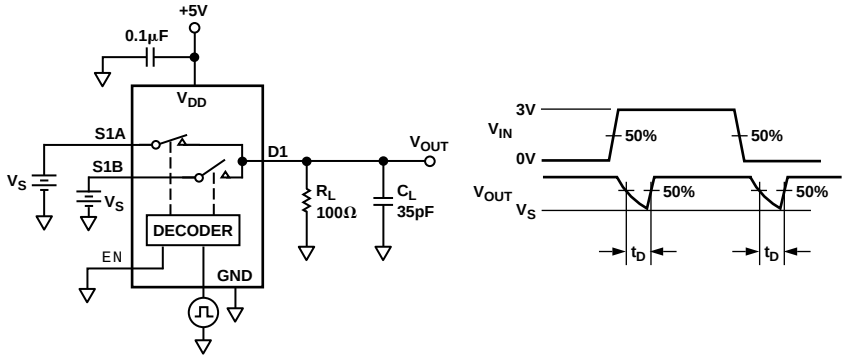
Test Circuit 2. Off Leakage



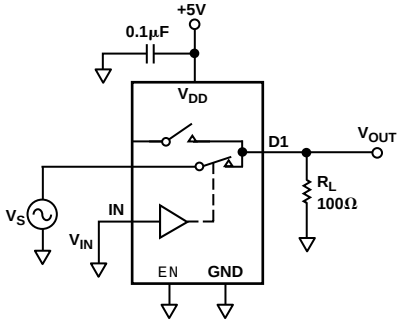
Test Circuit 3. On Leakage



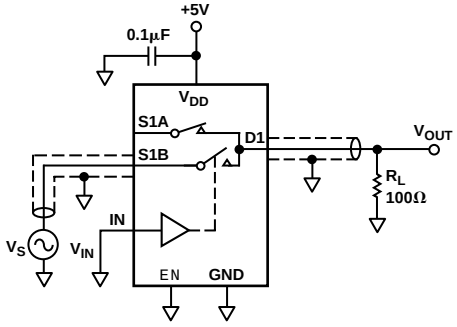
Test Circuit 4. Switching Times



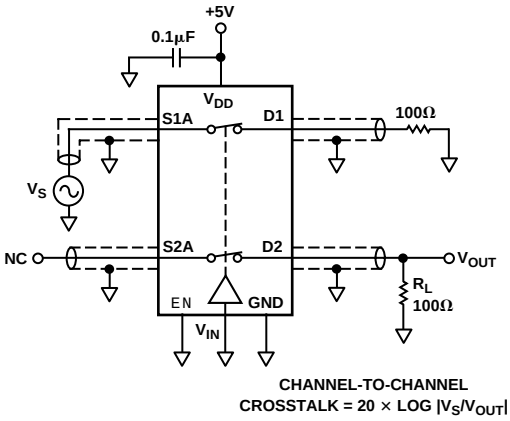
Test Circuit 5. Break-Before-Make Time Delay



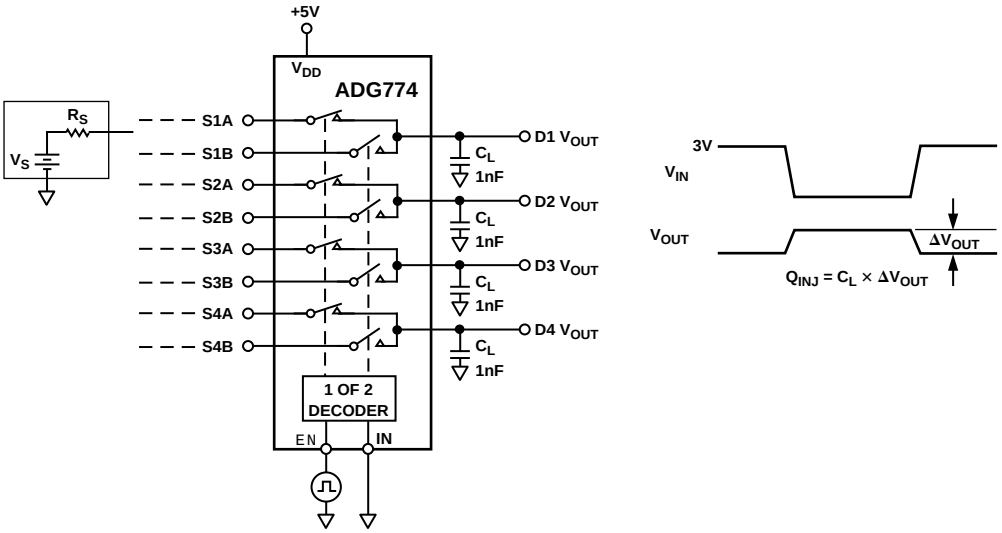
Test Circuit 6. Bandwidth



Test Circuit 7. Off Isolation



Test Circuit 8. Channel-to-Channel Crosstalk



Test Circuit 9. Charge Injection

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

20-Lead CSP
(CP-20)