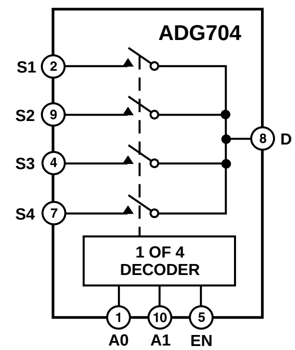
CMOS Low Voltage 4 Ω, 4-Channel Multiplexer

ADG704

FEATURES
- +1.8 V to +5.5 V Single Supply
- 2.5 Ω (Typ) On Resistance
- Low On-Resistance Flatness
- –3 dB Bandwidth >200 MHz
- Rail-to-Rail Operation
- 10-Lead μSOIC Package
- Fast Switching Times
  - t_{ON} 20 ns
  - t_{OFF} 13 ns
- Typical Power Consumption (<0.01 μW)
- TTL/CMOS Compatible

APPLICATIONS
- Battery Powered Systems
- Communication Systems
- Sample-and-Hold Systems
- Audio Signal Routing
- Data Acquisition System
- Video Switching

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The ADG704 is a CMOS analog multiplexer, comprising four single channels. This multiplexer is designed on an advanced submicron process that provides low power dissipation yet gives high switching speed, low on resistance, low leakage currents and high bandwidths.

The on resistance profile is very flat over the full analog signal range. This ensures excellent linearity and low distortion when switching audio signals. Fast switching speed also makes the part suitable for video signal switching.

The ADG704 can operate from a single supply range of +1.8 V to +5.5 V, making it ideal for use in battery powered instruments and with the new generation of DACs and ADCs from Analog Devices.

The ADG704 switches one of four inputs to a common output, D, as determined by the 3-bit binary address lines, A0, A1 and EN. A Logic "0" on the EN pin disables the device.

Each switch of the ADG704 conducts equally well in both directions when ON. The ADG704 exhibits break-before-make switching action.

The ADG704 is available in 10-lead μSOIC package.

PRODUCT HIGHLIGHTS

1. +1.8 V to +5.5 V Single Supply Operation.
   The ADG704 offers high performance and is fully specified and guaranteed with +3 V and +5 V supply rails.
2. Very Low R_{ON} (4.5 Ω Max at 5 V, 8 Ω Max at 3 V).
   At supply voltage of +1.8 V, R_{ON} is typically 35 Ω over the temperature range.
3. Low On-Resistance Flatness.
4. –3 dB Bandwidth Greater than 200 MHz.
5. Low Power Dissipation.
   CMOS construction ensures low power dissipation.
6. Fast t_{ON}/t_{OFF}.
7. Break-Before-Make Switching Action.
8. 10-Lead μSOIC Package.

REV. A

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ADG704–SPECIFICATIONS[1] (V_{DD} = +5 V ± 10%, GND = 0 V. All Specifications –40°C to +85°C, unless otherwise noted.)

Parameter	B Version +25°C	B Version –40°C to +85°C	Units	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On-Resistance (R_{ON})	2.5		Ω typ	V_S = 0 V to V_{DD}, I_{DS} = –10 mA;
	4	4.5	Ω max	Test Circuit 1
On-Resistance Match Between Channels (ΔR_{ON})		0.1	Ω typ	V_S = 0 V to V_{DD}, I_{DS} = –10 mA
		0.4	Ω max	
On-Resistance Flatness ($R_{FLAT(ON)}$)	0.75		Ω typ	V_S = 0 V to V_{DD}, I_{DS} = –10 mA
		1.2	Ω max	
LEAKAGE CURRENTS				V_{DD} = +5.5 V
Source OFF Leakage I_S (OFF)	±0.01		nA typ	V_S = 4.5 V/1 V, V_D = 1 V/4.5 V;
	±0.1	±0.3	nA max	Test Circuit 2
Drain OFF Leakage I_D (OFF)	±0.01		nA typ	V_S = 4.5 V/1 V, V_D = 1 V/4.5 V;
	±0.1	±0.3	nA max	Test Circuit 2
Channel ON Leakage I_D, I_S (ON)	±0.01		nA typ	V_S = V_D = 4.5 V or 1 V;
	±0.1	±0.3	nA max	Test Circuit 3
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}	0.005		µA typ	V_{IN} = V_{INL} or V_{INH}
		±0.1	µA max	
DYNAMIC CHARACTERISTICS[2]				
t_{ON}	14		ns typ	R_L = 300 Ω, C_L = 35 pF
		20	ns max	V_S = 3 V, Test Circuit 4
t_{OFF}	6		ns typ	R_L = 300 Ω, C_L = 35 pF
		13	ns max	V_S = 3 V, Test Circuit 4
Break-Before-Make Time Delay, t_D	8		ns typ	R_L = 300 Ω, C_L = 35 pF
		1	ns min	V_{S1} = V_{S2} = 3 V, Test Circuit 5
Charge Injection	3		pC typ	V_S = 2 V, R_S = 0 Ω, C_L = 1 nF; Test Circuit 6
Off Isolation	–60		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz
	–80		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz; Test Circuit 7
Channel-to-Channel Crosstalk	–62		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz
	–82		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz; Test Circuit 8
Bandwidth –3 dB	200		MHz typ	R_L = 50 Ω, C_L = 5 pF; Test Circuit 9
C_S (OFF)	9		pF typ	
C_D (OFF)	37		pF typ	
C_D, C_S (ON)	54		pF typ	
POWER REQUIREMENTS				V_{DD} = +5.5 V Digital Inputs = 0 V or 5 V
I_{DD}	0.001		µA typ	
		1.0	µA max	

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.

SPECIFICATIONS[1] (V_{DD} = +3 V ± 10%, GND = 0 V. All Specifications –40°C to +85°C, unless otherwise noted.)

Parameter	B Version +25°C	B Version –40°C to +85°C	Units	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
On-Resistance (R_{ON})	4.5	5	Ω typ	V_S = 0 V to V_{DD}, I_{DS} = –10 mA;
		8	Ω max	Test Circuit 1
On-Resistance Match Between Channels (ΔR_{ON})	0.1		Ω typ	V_S = 0 V to V_{DD}, I_{DS} = –10 mA
		0.4	Ω max	
On-Resistance Flatness ($R_{FLAT(ON)}$)		2.5	Ω typ	V_S = 0 V to V_{DD}, I_{DS} = –10 mA
LEAKAGE CURRENTS				V_{DD} = +3.3 V
Source OFF Leakage I_S (OFF)	±0.01		nA typ	V_S = 3 V/1 V, V_D = 1 V/3 V;
	±0.1	±0.3	nA max	Test Circuit 2
Drain OFF Leakage I_D (OFF)	±0.01		nA typ	V_S = 3 V/1 V, V_D = 1 V/3 V;
	±0.1	±0.3	nA max	Test Circuit 2
Channel ON Leakage I_D, I_S (ON)	±0.01		nA typ	V_S = V_D = 3 V or 1 V;
	±0.1	±0.3	nA max	Test Circuit 3
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}	0.005		µA typ	V_{IN} = V_{INL} or V_{INH}
		±0.1	µA max	
DYNAMIC CHARACTERISTICS[2]				
t_{ON}	16		ns typ	R_L = 300 Ω, C_L = 35 pF
		24	ns max	V_S = 2 V, Test Circuit 4
t_{OFF}	8		ns typ	R_L = 300 Ω, C_L = 35 pF
		16	ns max	V_S = 2 V, Test Circuit 4
Break-Before-Make Time Delay, t_D	9		ns typ	R_L = 300 Ω, C_L = 35 pF
		1	ns min	V_{S1} = V_{S2} = 2 V, Test Circuit 5
Charge Injection	3		pC typ	V_S = 1.5 V, R_S = 0 Ω, C_L = 1 nF; Test Circuit 6
Off Isolation	–60		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz
	–80		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz; Test Circuit 7
Channel-to-Channel Crosstalk	–62		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz
	–82		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz; Test Circuit 8
Bandwidth –3 dB	200		MHz typ	R_L = 50 Ω, C_L = 5 pF; Test Circuit 9
C_S (OFF)	9		pF typ	
C_D (OFF)	37		pF typ	
C_D, C_S (ON)	54		pF typ	
POWER REQUIREMENTS				V_{DD} = +3.3 V; Digital Inputs = 0 V or 3 V
I_{DD}	0.001		µA typ	
		1.0	µA max	

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.

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 . . . . 30 mA
Peak Current, S or D . . . . 100 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
µSOIC Package, Power Dissipation . . . . 315 mW
θ_{JA} Thermal Impedance . . . . 206°C/W
Lead Temperature, Soldering
Vapor Phase (60 sec) . . . . +215°C
Infrared (15 sec) . . . . +220°C
ESD . . . . 2 kV

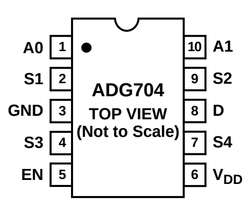
NOTES
[1]Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied. Exposure 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.

ORDERING GUIDE

Model	Temperature Range	Brand[1]	Package Option[2]
ADG704BRM	–40°C to +85°C	S9B	RM-10

NOTES
[1]Brand = Due to small package size, these three characters represent the part number.
[2]RM = µSOIC.

PIN CONFIGURATION (10-Lead µSOIC)



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.
A0, A1	Logic control inputs.
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_D (OFF)	Drain leakage current with the switch "OFF."
I_S (OFF)	Source 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.
Charge Injection	A measure of the glitch impulse transferred from the digital input to the analog output during switching.
Bandwidth	The frequency at which the output is attenuated by –3 dBs.
On Response	The frequency response of the "ON" switch.
On Loss	The voltage drop across the "ON" switch, seen on the On Response vs. Frequency plot as how many dBs the signal is away from 0 dB at very low frequencies.

Table I. Truth Table

A1	A0	EN	ON Switch
X	X	0	NONE
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

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 ADG704 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.

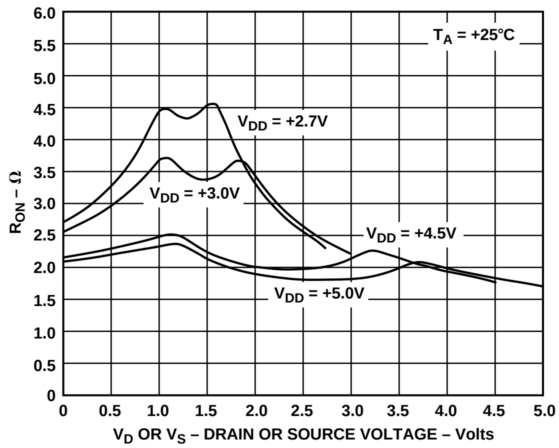


Figure 1. On Resistance as a Function of V_D (V_S) Single Supplies

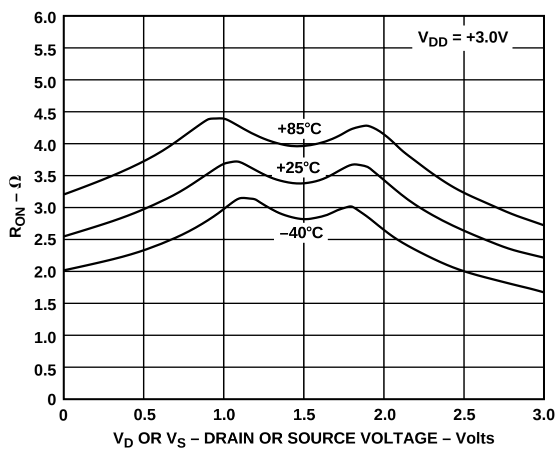


Figure 2. On Resistance as a Function of V_D (V_S) for Different Temperatures; V_{DD} = 3 V

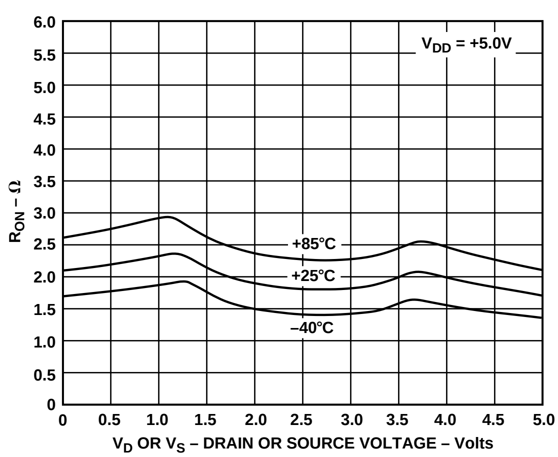


Figure 3. On Resistance as a Function of V_D (V_S) for Different Temperatures; V_{DD} = 5 V

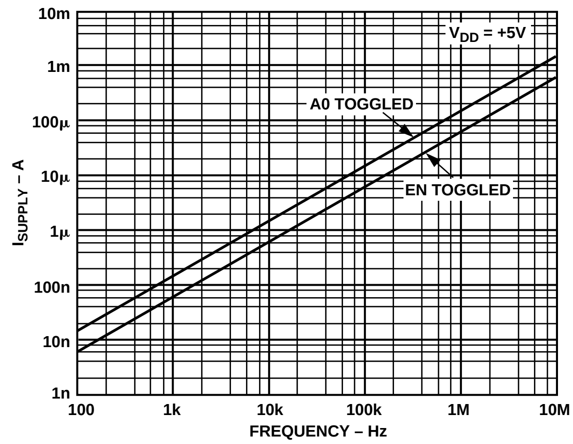


Figure 4. Supply Current vs. Input Switching Frequency

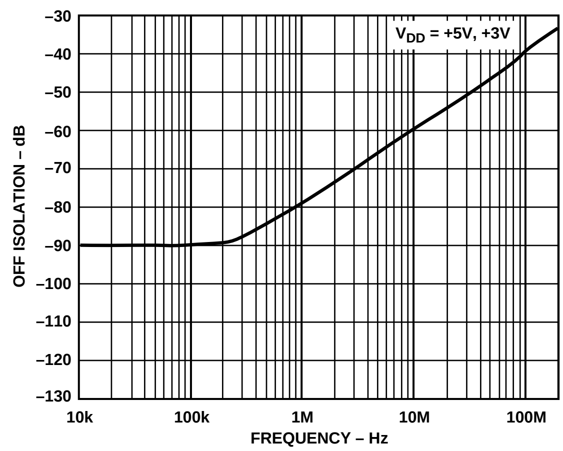


Figure 5. Off Isolation vs. Frequency

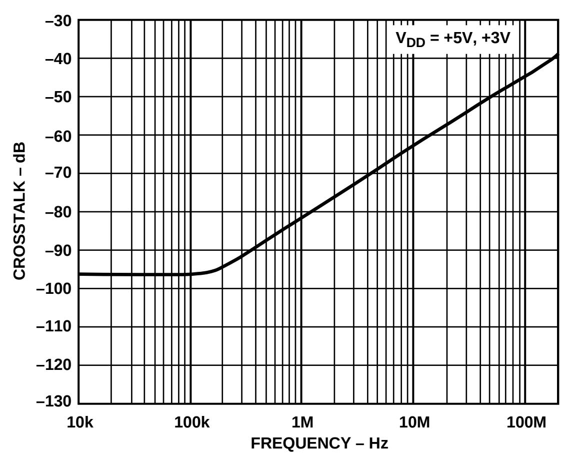


Figure 6. Crosstalk vs. Frequency

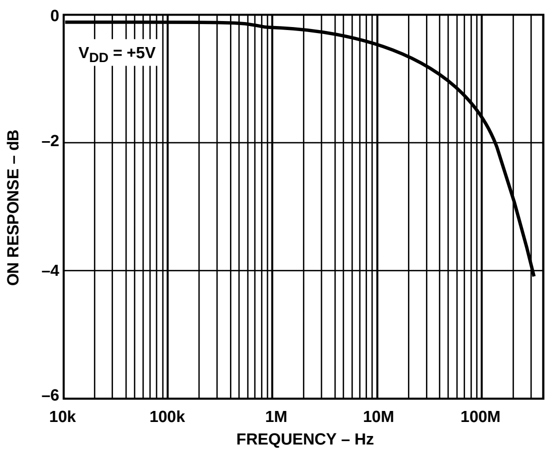


Figure 7. On Response vs. Frequency

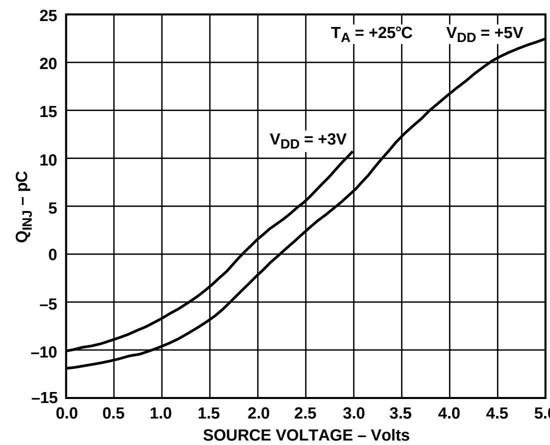


Figure 8. Charge Injection vs. Source Voltage

APPLICATIONS

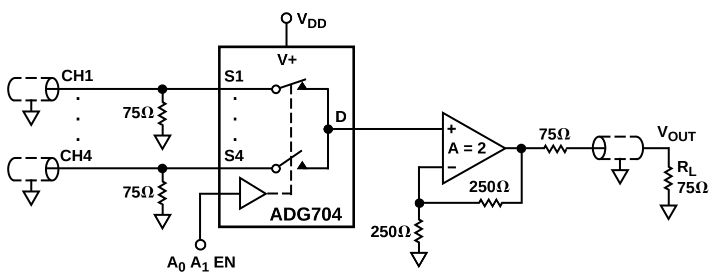
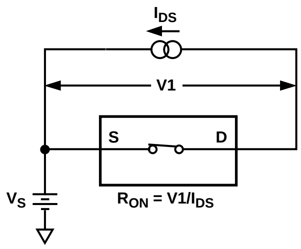
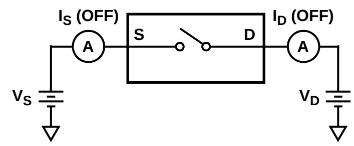


Figure 9. 4-Channel Video Multiplexing

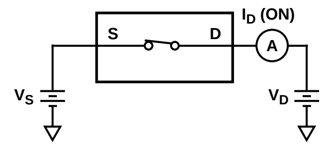
Test Circuits



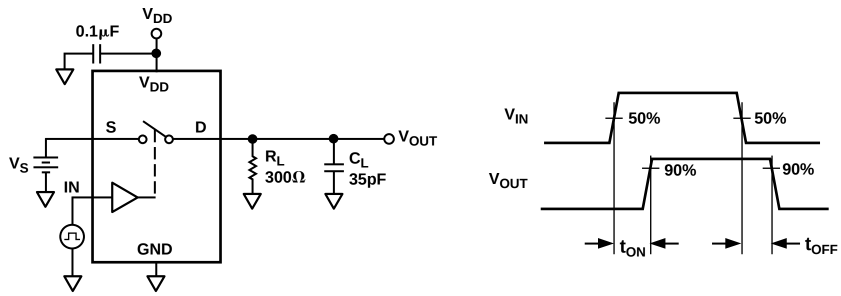
Test Circuit 1. On Resistance



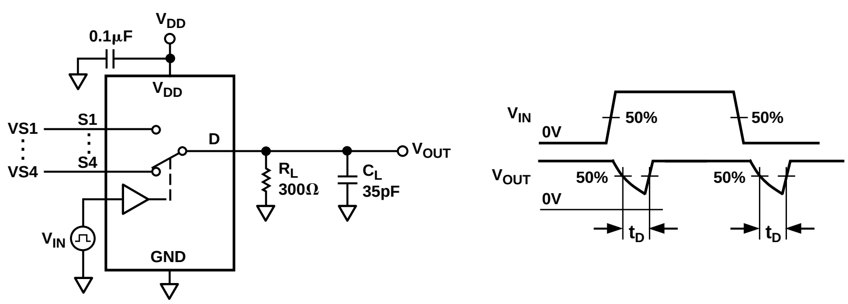
Test Circuit 2. Off Leakage



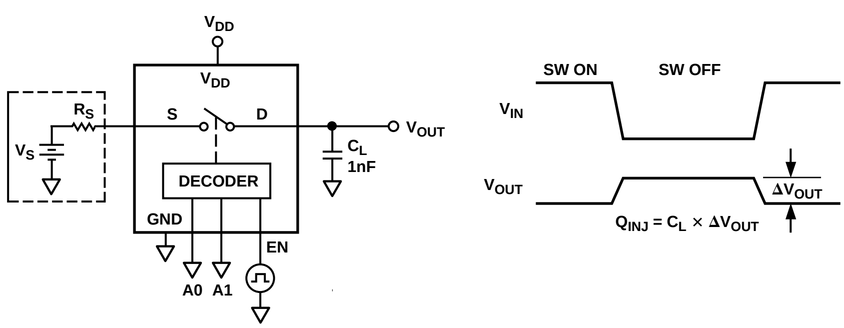
Test Circuit 3. On Leakage



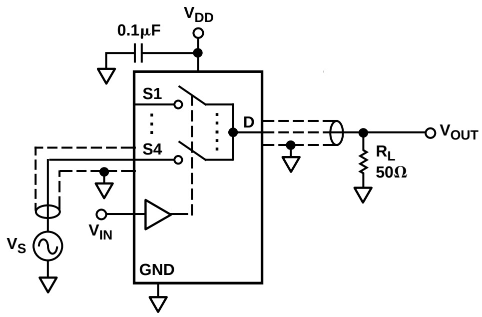
Test Circuit 4. Switching Times



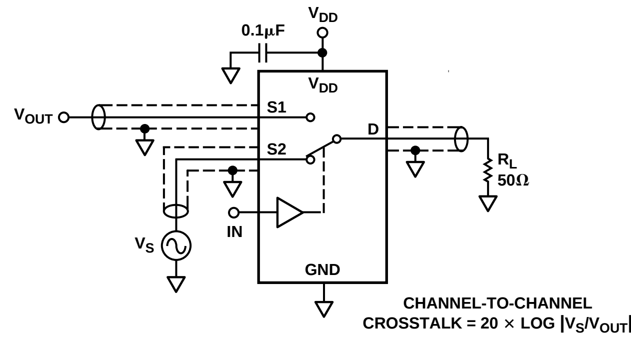
Test Circuit 5. Break-Before-Make Time Delay, t_D



Test Circuit 6. Charge Injection

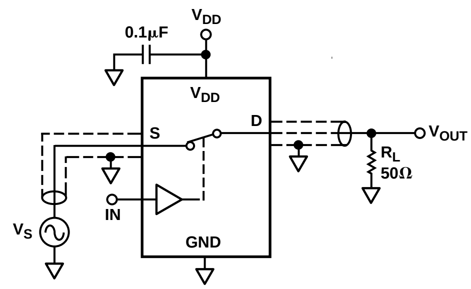


Test Circuit 7. Off Isolation



Test Circuit 8. Channel-to-Channel Crosstalk

C3383a–0–6/99

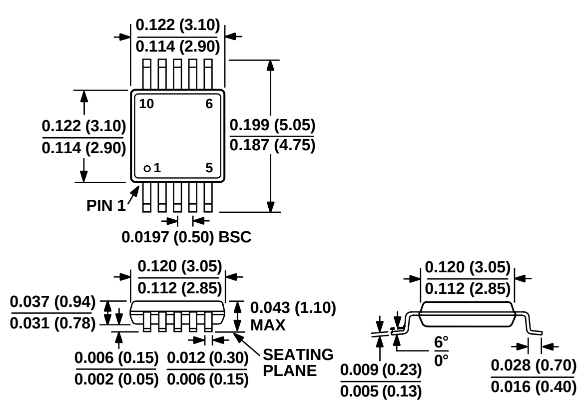


Test Circuit 9. Bandwidth

OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

10-Lead µSOIC (RM-10)



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