



CMOS, 2.5 Ω Low Voltage, Triple/Quad SPDT Switches

ADG733/ADG734

FEATURES

1.8 V to 5.5 V Single Supply
 ± 3 V Dual Supply
2.5 Ω On Resistance
0.5 Ω On Resistance Flatness
100 pA Leakage Currents
19 ns Switching Times
Triple SPDT: ADG733
Quad SPDT: ADG734
Small TSSOP and QSOP Packages
Low Power Consumption
TTL/CMOS-Compatible Inputs

APPLICATIONS

Data Acquisition Systems
Communication Systems
Relay Replacement
Audio and Video Switching
Battery-Powered Systems

GENERAL DESCRIPTION

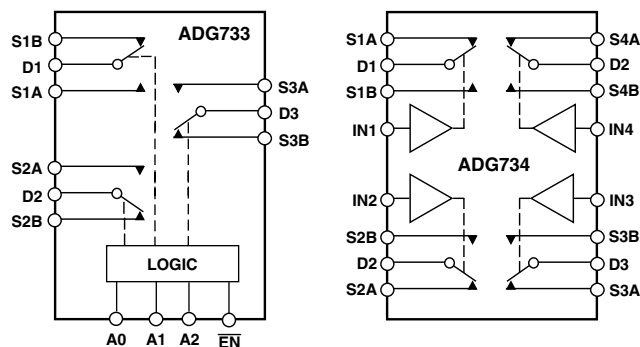
The ADG733 and ADG734 are low voltage, CMOS devices comprising three independently selectable SPDT (single pole, double throw) switches and four independently selectable SPDT switches respectively.

Low power consumption and operating supply range of 1.8 V to 5.5 V and dual ± 3 V make the ADG733 and ADG734 ideal for battery powered, portable instruments. All channels exhibit break-before-make switching action preventing momentary shorting when switching channels. An $\overline{\text{EN}}$ input on the ADG733 is used to enable or disable the device. When disabled, all channels are switched OFF.

These 2–1 multiplexers/SPDT switches are designed on an enhanced submicron process that provides low power dissipation yet gives high switching speed, very low on resistance, high signal bandwidths and low leakage currents. On resistance is in the region of a few ohms, is closely matched between switches and very flat over the full signal range. These parts can operate equally well in either direction and have an input signal range which extends to the supplies.

The ADG733 is available in small TSSOP and QSOP packages, while the ADG734 is available in a small TSSOP package.

FUNCTIONAL BLOCK DIAGRAMS



SWITCHES SHOWN FOR A "1" INPUT LOGIC

PRODUCT HIGHLIGHTS

1. Single/Dual Supply Operation. The ADG733 and ADG734 are fully specified and guaranteed with 3 V and 5 V single supply rails and ± 3 V dual supply rails.
2. Low On Resistance (2.5 Ω typical).
3. Low Power Consumption ($<0.01 \mu\text{W}$).
4. Guaranteed Break-Before-Make Switching Action.

REV. 0

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ADG733/ADG734—SPECIFICATIONS¹ ($V_{DD} = 5\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $GND = 0\text{ V}$, unless otherwise noted.)

Parameter	B Version		Unit	Test Conditions/Comments
	25°C	–40°C to +85°C		
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; Test Circuit 1
	4.5	5.0	Ω max	
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)})	0.5		Ω typ	V _S = 0 V to V _{DD} , I _{DS} = 10 mA
		1.2	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I _S (OFF)	±0.01		nA typ	V _{DD} = 5.5 V
	±0.1	±0.3	nA max	V _D = 4.5 V/1 V, V _S = 1 V/4.5 V; Test Circuit 2
Channel ON Leakage I _D , I _S (ON)	±0.01		nA typ	V _D = V _S = 1 V, or 4.5 V;
	±0.1	±0.5	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	
C _{IN} , Digital Input Capacitance	4		pF typ	
DYNAMIC CHARACTERISTICS ²				
t _{ON}	19		ns typ	R _L = 300 Ω, C _L = 35 pF;
		34	ns max	V _S = 3 V, Test Circuit 4
t _{OFF}	7		ns typ	R _L = 300 Ω, C _L = 35 pF;
		12	ns max	V _S = 3 V, Test Circuit 4
ADG733 t _{ON} ($\overline{\text{EN}}$)	20		ns typ	R _L = 300 Ω, C _L = 35 pF;
		40	ns max	V _S = 3 V, Test Circuit 5
t _{OFF} ($\overline{\text{EN}}$)	7		ns typ	R _L = 300 Ω, C _L = 35 pF;
		12	ns max	V _S = 3 V, Test Circuit 5
Break-Before-Make Time Delay, t _D	13		ns typ	R _L = 300 Ω, C _L = 35 pF;
		1	ns min	V _S = 3 V, Test Circuit 6
Charge Injection	±3		pC typ	V _S = 2 V, R _S = 0 Ω, C _L = 1 nF; Test Circuit 7
Off Isolation	–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
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 9
–3 dB Bandwidth	200		MHz typ	R _L = 50 Ω, C _L = 5 pF, Test Circuit 8
C _S (OFF)	11		pF typ	
C _D , C _S (ON)	34		pF typ	
POWER REQUIREMENTS				
I _{DD}	0.001		μA typ	V _{DD} = 5.5 V
		1.0	μA max	Digital Inputs = 0 V or 5.5 V

NOTES

¹Temperature range is as follows: B Version: –40°C to +85°C.

²Guaranteed by design, not subject to production test.

Specifications subject to change without notice.

SPECIFICATIONS¹ ($V_{DD} = 3\text{ V} \pm 10\%$, $V_{SS} = 0\text{ V}$, $GND = 0\text{ V}$, unless otherwise noted.)

Parameter	B Version		Unit	Test Conditions/Comments
	25°C	−40°C to +85°C		
ANALOG SWITCH				
Analog Signal Range		0 V to V _{DD}	V	
On Resistance (R _{ON})	6		Ω typ	V _S = 0 V to V _{DD} , I _{DS} = 10 mA; Test Circuit 1
	11	12	Ω max	
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)})		3	Ω typ	V _S = 0 V to V _{DD} , I _{DS} = 10 mA
LEAKAGE CURRENTS				
Source OFF Leakage I _S (OFF)	±0.01		nA typ	V _{DD} = 3.3 V
	±0.1	±0.3	nA max	V _S = 3 V/1 V, V _D = 1 V/3 V; Test Circuit 2
Channel ON Leakage I _D , I _S (ON)	±0.01		nA typ	V _S = V _D = 1 V or 3 V; Test Circuit 3
	±0.1	±0.5	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}	0.005		μA typ	V _{IN} = V _{INL} or V _{INH}
		±0.1	μA max	
C _{IN} , Digital Input Capacitance	4		pF typ	
DYNAMIC CHARACTERISTICS ²				
t _{ON}	28		ns typ	R _L = 300 Ω, C _L = 35 pF;
		55	ns max	V _S = 2 V, Test Circuit 4
t _{OFF}	9		ns typ	R _L = 300 Ω, C _L = 35 pF;
		16	ns max	V _S = 2 V, Test Circuit 4
ADG733 t _{ON} ($\overline{\text{EN}}$)	29		ns typ	R _L = 300 Ω, C _L = 35 pF;
		60	ns max	V _S = 2 V, Test Circuit 5
t _{OFF} ($\overline{\text{EN}}$)	9		ns typ	R _L = 300 Ω, C _L = 35 pF;
		16	ns max	V _S = 2 V, Test Circuit 5
Break-Before-Make Time Delay, t _D	22		ns typ	R _L = 300 Ω, C _L = 35 pF;
		1	ns min	V _S = 2 V, Test Circuit 6
Charge Injection	±3		pC typ	V _S = 1 V, R _S = 0 Ω, C _L = 1 nF; Test Circuit 7
Off Isolation	−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
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 9
−3 dB Bandwidth	200		MHz typ	R _L = 50 Ω, C _L = 5 pF, Test Circuit 8
C _S (OFF)	11		pF typ	
C _D , C _S (ON)	34		pF typ	
POWER REQUIREMENTS				
I _{DD}	0.001		μA typ	V _{DD} = 3.3 V
		1.0	μA max	Digital Inputs = 0 V or 3.3 V

NOTES

¹Temperature ranges are as follows: B Version: -40°C to +85°C.²Guaranteed by design, not subject to production test.

Specifications subject to change without notice.

ADG733/ADG734—SPECIFICATIONS¹

DUAL SUPPLY ($V_{DD} = +3\text{ V} \pm 10\%$, $V_{SS} = -3\text{ V} \pm 10\%$, $GND = 0\text{ V}$, unless otherwise noted.)

Parameter	B Version		Unit	Test Conditions/Comments
	25°C	–40°C to +85°C		
ANALOG SWITCH				
Analog Signal Range		V _{SS} to V _{DD}	V	
On Resistance (R _{ON})	2.5		Ω typ	V _S = V _{SS} to V _{DD} , I _{DS} = 10 mA; Test Circuit 1
	4.5	5.0	Ω max	
On-Resistance Match between Channels (ΔR _{ON})		0.1	Ω typ	V _S = V _{SS} to V _{DD} , I _{DS} = 10 mA
		0.4	Ω max	
On-Resistance Flatness (R _{FLAT(ON)})	0.5		Ω typ	V _S = V _{SS} to V _{DD} , I _{DS} = 10 mA
		1.2	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I _S (OFF)	±0.01		nA typ	V _{DD} = +3.3 V, V _{SS} = –3.3 V
	±0.1	±0.3	nA max	V _S = +2.25 V/–1.25 V, V _D = –1.25 V/+2.25 V; Test Circuit 2
Channel ON Leakage I _D , I _S (ON)	±0.01		nA typ	V _S = V _D = +2.25 V/–1.25 V, Test Circuit 3
	±0.1	±0.5	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}	0.005		μA typ	V _{IN} = V _{INL} or V _{INH}
		±0.1	μA max	
C _{IN} , Digital Input Capacitance	4		pF typ	
DYNAMIC CHARACTERISTICS ²				
t _{ON}	21		ns typ	R _L = 300 Ω, C _L = 35 pF; V _S = 1.5 V, Test Circuit 4
		35	ns max	
t _{OFF}	10		ns typ	R _L = 300 Ω, C _L = 35 pF; V _S = 1.5 V, Test Circuit 4
		16	ns max	
ADG733 t _{ON} ($\overline{\text{EN}}$)	21		ns typ	R _L = 300 Ω, C _L = 35 pF; V _S = 1.5 V, Test Circuit 5
		40	ns max	
t _{OFF} ($\overline{\text{EN}}$)	10		ns typ	R _L = 300 Ω, C _L = 35 pF; V _S = 1.5 V, Test Circuit 5
		16	ns max	
Break-Before-Make Time Delay, t _D	13		ns typ	R _L = 300 Ω, C _L = 35 pF; V _S = 1.5 V, Test Circuit 6
		1	ns min	
Charge Injection	±5		pC typ	V _S = 0 V, R _S = 0 Ω, C _L = 1 nF; Test Circuit 7
Off Isolation	–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
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 9
–3 dB Bandwidth	200		MHz typ	R _L = 50 Ω, C _L = 5 pF, Test Circuit 8
C _S (OFF)	11		pF typ	
C _D , C _S (ON)	34		pF typ	
POWER REQUIREMENTS				
I _{DD}	0.001		μA typ	V _{DD} = 3.3 V
		1.0	μA max	Digital Inputs = 0 V or 3.3 V
I _{SS}	0.001		μA typ	V _{SS} = –3.3 V
		1.0	μA max	Digital Inputs = 0 V or 3.3 V

NOTES

¹Temperature range is as follows: B Version: –40°C to +85°C.

²Guaranteed by design, not subject to production test.

Specifications subject to change without notice.

ABSOLUTE MAXIMUM RATINGS¹

(T_A = 25°C unless otherwise noted)

V _{DD} to V _{SS}	7 V
V _{DD} to GND	–0.3 V to +7 V
V _{SS} to GND	+0.3 V to –3.5 V
Analog Inputs ²	V _{SS} – 0.3 V to V _{DD} + 0.3 V or 30 mA, Whichever Occurs First
Digital Inputs ²	–0.3 V to V _{DD} + 0.3 V or 30 mA, Whichever Occurs First
Peak Current, S or D	100 mA (Pulsed at 1 ms, 10% Duty Cycle max)
Continuous Current, S or D	30 mA
Operating Temperature Range	
Industrial (A, B Versions)	–40°C to +85°C
Storage Temperature Range	–65°C to +150°C

Junction Temperature	150°C
16-Lead TSSOP, θ _{JA} Thermal Impedance	150.4°C/W
20-Lead TSSOP, θ _{JA} Thermal Impedance	143°C/W
16-Lead QSOP, θ _{JA} Thermal Impedance	149.97°C/W
Lead Temperature, Soldering (10 sec)	300°C
IR Reflow, Peak Temperature	220°C

NOTES

¹Stresses 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.

²Overvoltages at IN, S or D will be clamped by internal diodes. Current should be limited to the maximum ratings given.

CAUTION

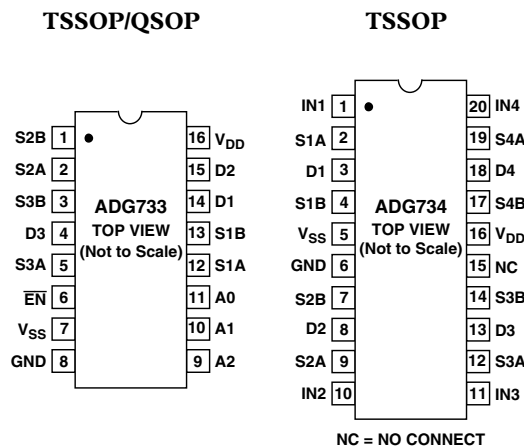
ESD (electrostatic discharge) sensitive device. Electrostatic charges as high as 4000 V readily accumulate on the human body and test equipment and can discharge without detection. Although the ADG733/ADG734 features proprietary ESD protection circuitry, permanent damage may occur on devices subjected to high-energy electrostatic discharges. Therefore, proper ESD precautions are recommended to avoid performance degradation or loss of functionality.



ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADG733BRU	–40°C to +85°C	Thin Shrink Small Outline Package (TSSOP)	RU-16
ADG733BRQ	–40°C to +85°C	Quarter Size Outline Package (QSOP)	RQ-16
ADG734BRU	–40°C to +85°C	Thin Shrink Small Outline Package (TSSOP)	RU-20

PIN CONFIGURATIONS



ADG733/ADG734

Table I. ADG733 Truth Table

A2	A1	A0	$\overline{\text{EN}}$	ON Switch
X	X	X	1	None
0	0	0	0	D1-S1A, D2-S2A, D3-S3A
0	0	1	0	D1-S1B, D2-S2A, D3-S3A
0	1	0	0	D1-S1A, D2-S2B, D3-S3A
0	1	1	0	D1-S1B, D2-S2B, D3-S3A
1	0	0	0	D1-S1A, D2-S2A, D3-S3B
1	0	1	0	D1-S1B, D2-S2A, D3-S3B
1	1	0	0	D1-S1A, D2-S2B, D3-S3B
1	1	1	0	D1-S1B, D2-S2B, D3-S3B

X = Don't Care.

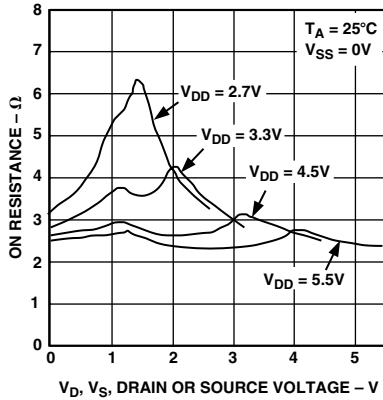
Table II. ADG734 Truth Table

Logic	Switch A	Switch B
0	OFF	ON
1	ON	OFF

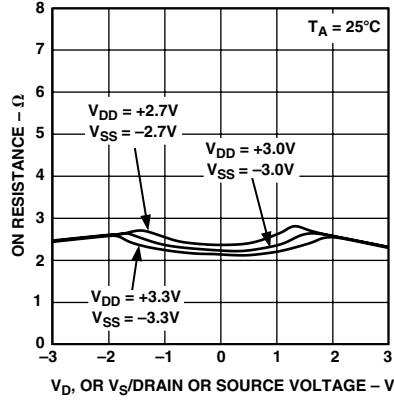
TERMINOLOGY

V_{DD}	Most Positive Power Supply Potential.	C_{IN}	Digital Input Capacitance.
V_{SS}	Most Negative Power Supply in a Dual Supply Application. In single supply applications, this should be tied to ground close to the device.	t_{ON}	Delay time measured between the 50% and 90% points of the digital inputs and the switch "ON" condition.
I_{DD}	Positive Supply Current.	t_{OFF}	Delay time measured between the 50% and 90% points of the digital input and the switch "OFF" condition.
I_{SS}	Negative Supply Current.	$t_{ON}(\overline{\text{EN}})$	Delay time between the 50% and 90% points of the $\overline{\text{EN}}$ digital input and the switch "ON" condition.
GND	Ground (0 V) Reference.	$t_{OFF}(\overline{\text{EN}})$	Delay time between the 50% and 90% points of the $\overline{\text{EN}}$ digital input and the switch "OFF" condition.
S	Source Terminal. May be an input or output.	t_{OPEN}	"OFF" time measured between the 80% points of both switches when switching from one address state to another.
D	Drain Terminal. May be an input or output.	Charge Injection	A measure of the glitch impulse transferred from the digital input to the analog output during switching.
IN	Logic Control Input.	Off Isolation	A measure of unwanted signal coupling through an "OFF" switch.
$V_D (V_S)$	Analog Voltage on Terminals D, S	Crosstalk	A measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.
R_{ON}	Ohmic Resistance between D and S.	Bandwidth	The frequency at which the output is attenuated by 3 dBs.
ΔR_{ON}	On Resistance Match between Any Two Channels, i.e., $R_{ON,max} - R_{ON,min}$	On Response	The Frequency Response of the "ON" Switch.
$R_{FLAT(ON)}$	Flatness is defined as the difference between the maximum and minimum value of on-resistance as measured over the specified analog signal range.	Insertion Loss	The loss due to the ON resistance of the switch.
$I_S (OFF)$	Source Leakage Current with the Switch "OFF."		
$I_D, I_S (ON)$	Channel Leakage Current with the Switch "ON."		
V_{INL}	Maximum Input Voltage for Logic "0."		
V_{INH}	Minimum Input Voltage for Logic "1."		
$I_{INL}(I_{INH})$	Input Current of the Digital Input.		
$C_S (OFF)$	"OFF" Switch Source Capacitance. Measured with reference to ground.		
$C_D, C_S(ON)$	"ON" Switch Capacitance. Measured with reference to ground.		

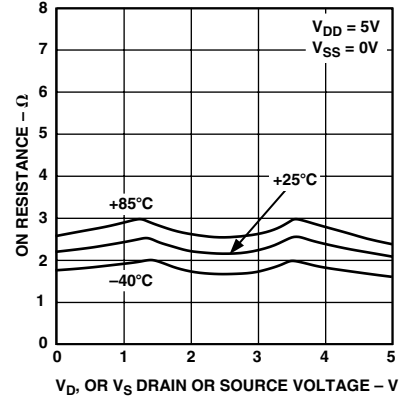
Typical Performance Characteristics—ADG733/ADG734



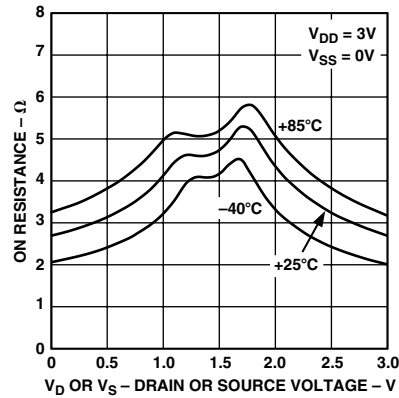
TPC 1. On Resistance as a Function of V_D (V_S) for Single Supply



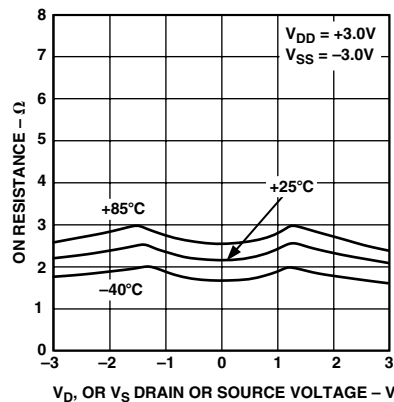
TPC 2. On Resistance as a Function of V_D (V_S) for Dual Supply



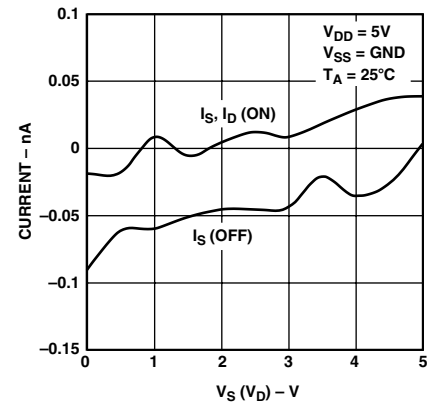
TPC 3. On Resistance as a Function of V_D (V_S) for Different Temperatures, Single Supply



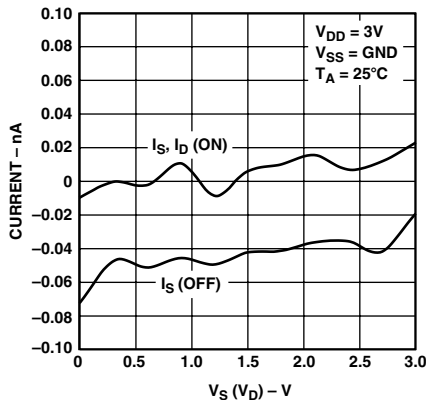
TPC 4. On Resistance as a Function of V_D (V_S) for Different Temperatures, Single Supply



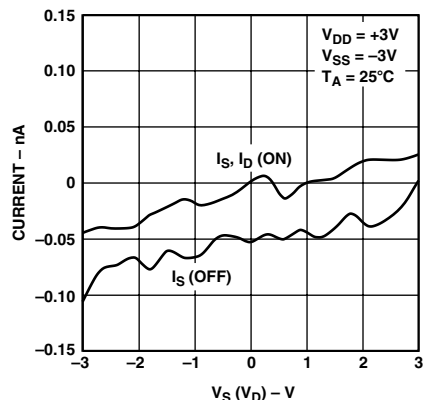
TPC 5. On Resistance as a Function of V_D (V_S) for Different Temperatures, Dual Supply



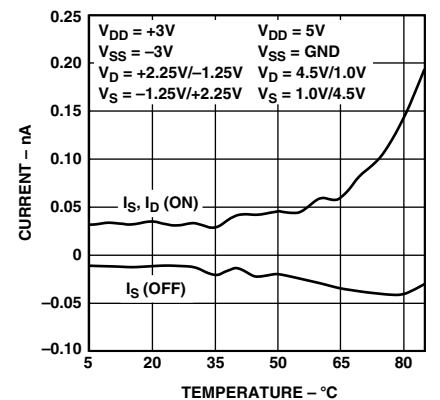
TPC 6. Leakage Currents as a Function of V_D (V_S)



TPC 7. Leakage Currents as a Function of V_D (V_S)

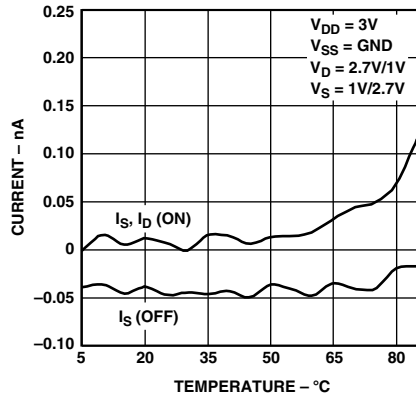


TPC 8. Leakage Currents as a Function of V_D (V_S)

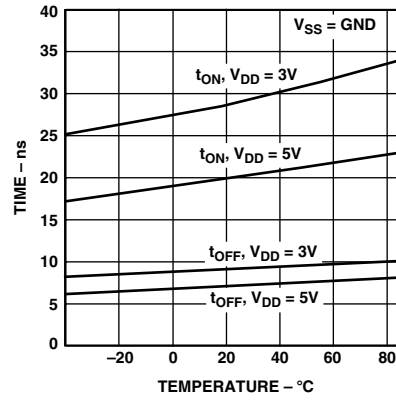


TPC 9. Leakage Currents as a Function of Temperature

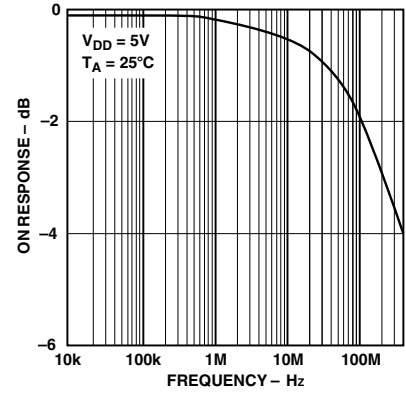
ADG733/ADG734



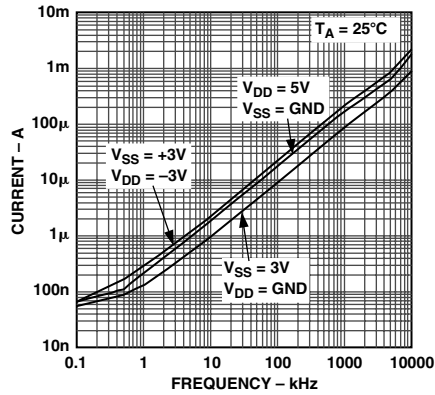
TPC 10. Leakage Currents as a Function of Temperature



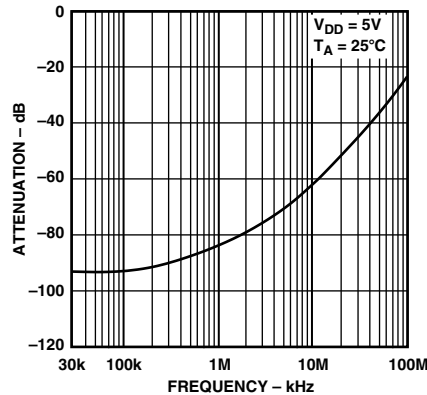
TPC 11. t_{ON}/t_{OFF} Times vs. Temperature



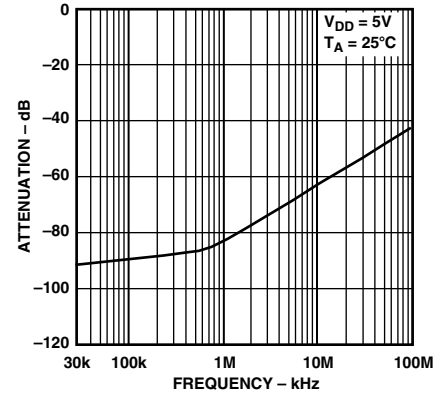
TPC 12. On Response vs. Frequency



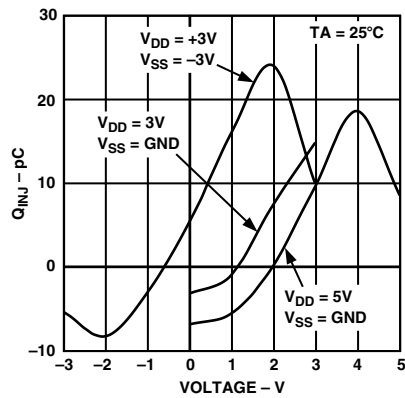
TPC 13. Input Current, I_{DD} vs. Switching Frequency



TPC 14. Off Isolation vs. Frequency

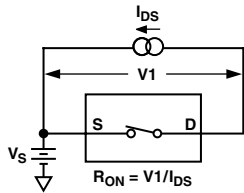


TPC 15. Crosstalk vs. Frequency

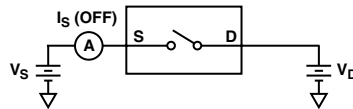


TPC 16. Charge Injection vs. Source Voltage

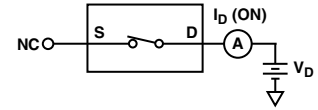
Test Circuits



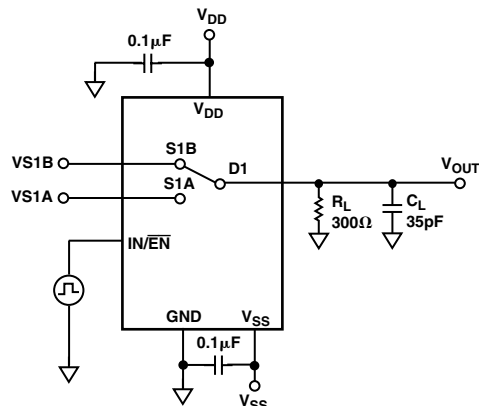
Test Circuit 1. On Resistance



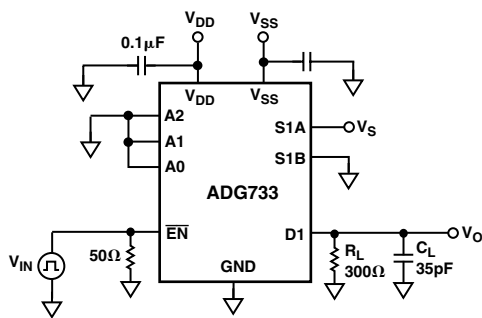
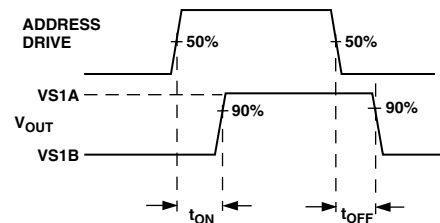
Test Circuit 2. I_S (OFF)



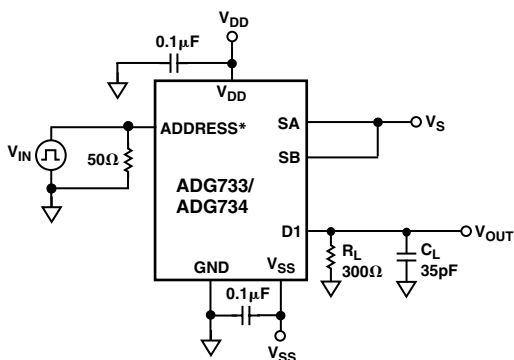
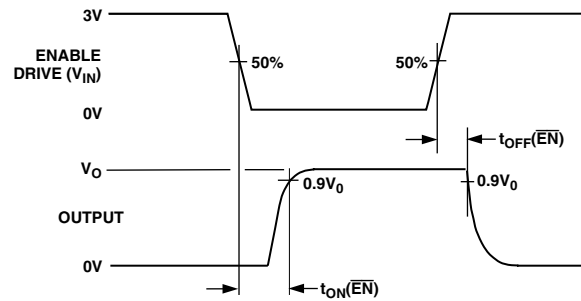
Test Circuit 3. I_D (ON)



Test Circuit 4. Switching Times, t_{ON} , t_{OFF}

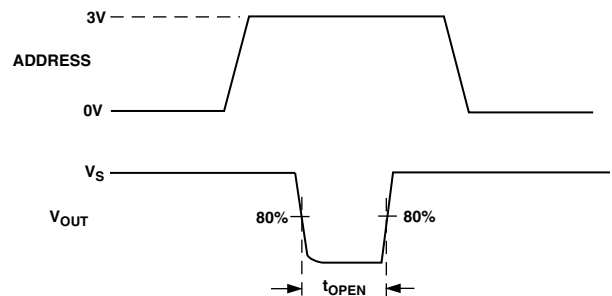


Test Circuit 5. Enable Delay, $t_{ON}(\overline{EN})$, $t_{OFF}(\overline{EN})$

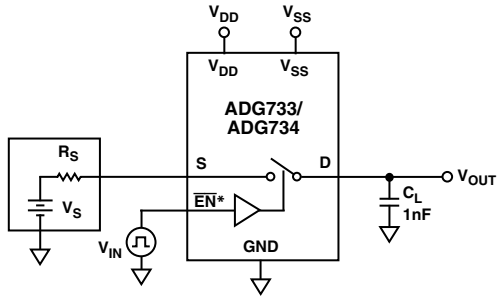


*A0, A1, A2 FOR ADG733, IN1-4 FOR ADG734

Test Circuit 6. Break-Before-Make Delay, t_{OPEN}

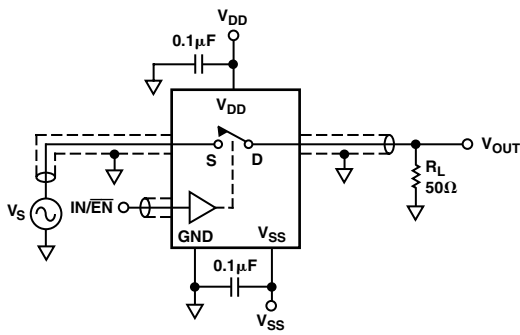
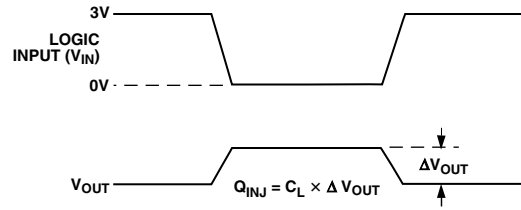


ADG733/ADG734



* IN1-4 FOR ADG734

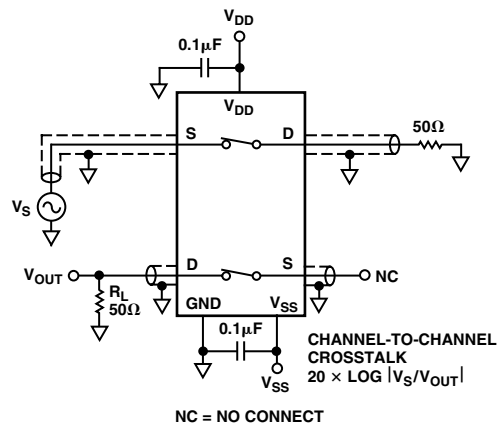
Test Circuit 7. Charge Injection



SWITCH OPEN FOR OFF ISOLATION MEASUREMENTS
SWITCH CLOSED FOR BANDWIDTH MEASUREMENTS
OFF ISOLATION = $20 \log_{10}(V_{OUT}/V_S)$

$$\text{INSERTION LOSS} = 20 \log_{10} \left(\frac{V_{OUT} \text{ WITH SWITCH}}{V_{OUT} \text{ WITHOUT SWITCH}} \right)$$

Test Circuit 8. OFF Isolation and Bandwidth



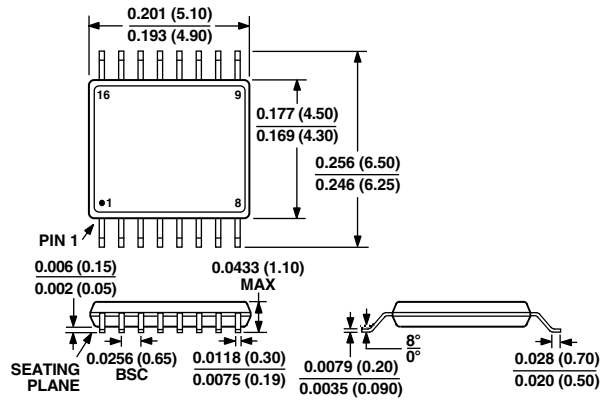
NC = NO CONNECT

Test Circuit 9. Channel-to-Channel Crosstalk

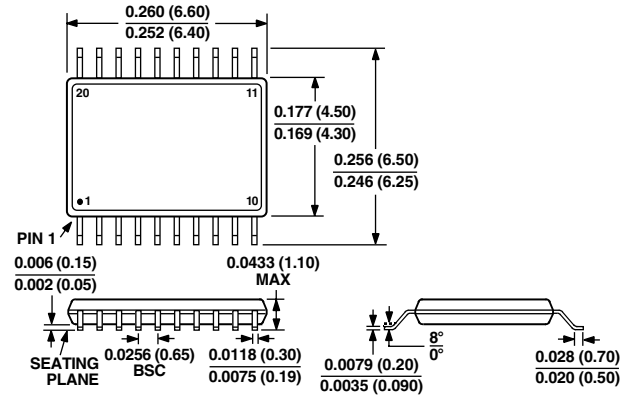
OUTLINE DIMENSIONS

Dimensions shown in inches and (mm).

**16-Lead TSSOP
(RU-16)**



**20-Lead TSSOP
(RU-20)**



**16-Lead QSOP
(RQ-16)**

