



3 Ω , 4-/8-Channel Multiplexers in Chip Scale Package

ADG758/ADG759

FEATURES

1.8 V to 5.5 V Single Supply
 ± 2.5 V Dual Supply
3 Ω ON Resistance
0.75 Ω ON Resistance Flatness
100 pA Leakage Currents
14 ns Switching Times
Single 8-to-1 Multiplexer ADG758
Differential 4-to-1 Multiplexer ADG759
20-Lead 4 mm $\times$ 4 mm Chip Scale Package
Low Power Consumption
TTL-/CMOS-Compatible Inputs
For Functionally Equivalent Devices in 16-Lead TSSOP
Package, See ADG708/ADG709

APPLICATIONS

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

GENERAL DESCRIPTION

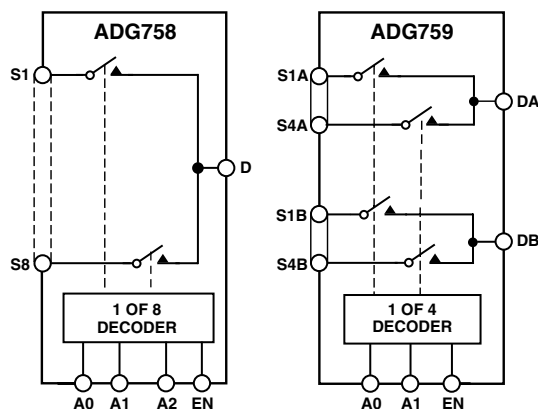
The ADG758 and ADG759 are low voltage, CMOS analog multiplexers comprising eight single channels and four differential channels, respectively. The ADG758 switches one of eight inputs (S1–S8) to a common output, D, as determined by the 3-bit binary address lines A0, A1, and A2. The ADG759 switches one of four differential inputs to a common differential output as determined by the 2-bit binary address lines A0 and A1. An EN input on both devices is used to enable or disable the device. When disabled, all channels are switched OFF.

Low power consumption and an operating supply range of 1.8 V to 5.5 V make the ADG758 and ADG759 ideal for battery-powered, portable instruments. All channels exhibit break-before-make switching action preventing momentary shorting when switching channels.

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

The ADG758 and ADG759 are available in 20-lead chip scale packages.

FUNCTIONAL BLOCK DIAGRAMS



PRODUCT HIGHLIGHTS

1. Small 20-Lead 4 mm $\times$ 4 mm Chip Scale Packages (CSP).
2. Single/Dual Supply Operation. The ADG758 and ADG759 are fully specified and guaranteed with 3 V and 5 V single-supply and ± 2.5 V dual-supply rails.
3. Low R_{ON} (3 Ω Typical).
4. Low Power Consumption (<0.01 μ W).
5. Guaranteed Break-Before-Make Switching Action.

REV. A

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ADG758/ADG759—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	V _S = 0 V to V _{DD} ; I _{DS} = 10 mA; Test Circuit 1
ON Resistance (R _{ON})	3		Ω typ	
	4.5	5	Ω max	
ON Resistance Match Between Channels (ΔR _{ON})		0.4	Ω typ	V _S = 0 V to V _{DD} ; I _{DS} = 10 mA V _S = 0 V to V _{DD} ; I _{DS} = 10 mA
		0.8	Ω max	
ON Resistance Flatness (R _{FLAT(ON)})	0.75		Ω typ	
		1.2	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I _S (OFF)	±0.01		nA typ	V _{DD} = 5.5 V V _D = 4.5 V/1 V, V _S = 1 V/4.5 V; Test Circuit 2
	±0.1	±0.3	nA max	
Drain OFF Leakage I _D (OFF)	±0.01		nA typ	
	±0.1	±0.75	nA max	V _D = 4.5 V/1 V, V _S = 1 V/4.5 V; Test Circuit 3
Channel ON Leakage I _D , I _S (ON)	±0.01		nA typ	
	±0.1	±0.75	nA max	
DIGITAL INPUTS				
Input High Voltage, V _{INH}		2.4	V min	V _{IN} = V _{INL} or V _{INH}
Input Low Voltage, V _{INL}		0.8	V max	
Input Current I _{INL} or I _{INH}	0.005		μA typ	
		±0.1	μA max	
C _{IN} , Digital Input Capacitance	2		pF typ	
DYNAMIC CHARACTERISTICS ²				
t _{TRANSITION}	14		ns typ	R _L = 300 Ω, C _L = 35 pF; Test Circuit 5 V _{S1} = 3 V/0 V, V _{S8} = 0 V/3 V
		25	ns max	
Break-Before-Make Time Delay, t _D	8		ns typ	
		1	ns min	R _L = 300 Ω, C _L = 35 pF V _S = 3 V; Test Circuit 6
t _{ON} (EN)	14		ns typ	
		25	ns max	
t _{OFF} (EN)	7		ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 3 V; Test Circuit 7
		12	ns max	
Charge Injection	±3		pC typ	
Off Isolation	−60		dB typ	V _S = 2.5 V, R _S = 0 Ω, C _L = 1 nF; Test Circuit 8
	−80		dB typ	
Channel-to-Channel Crosstalk	−60		dB typ	
	−80		dB typ	R _L = 50 Ω, C _L = 5 pF, f = 10 MHz R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Test Circuit 9
−3 dB Bandwidth	55		MHz typ	
C _S (OFF)	13		pF typ	
C _D (OFF)				R _L = 50 Ω, C _L = 5 pF; Test Circuit 11 f = 1 MHz
ADG758	85		pF typ	
ADG759	42		pF typ	
C _D , C _S (ON)				f = 1 MHz f = 1 MHz
ADG758	96		pF typ	
ADG759	48		pF typ	
POWER REQUIREMENTS				
I _{DD}	0.001		μA typ	V _{DD} = 5.5 V Digital Inputs = 0 V or 5.5 V
		1.0	μA max	

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 V ± 10%, V_{SS} = 0 V, GND = 0 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	V _S = 0 V to V _{DD} , I _{DS} = 10 mA; Test Circuit 1 V _S = 0 V to V _{DD} , I _{DS} = 10 mA
ON Resistance (R _{ON})	8		Ω typ	
	11	12	Ω max	
ON Resistance Match Between Channels (ΔR _{ON})		0.4	Ω typ	
		1.2	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I _S (OFF)	±0.01		nA typ	V _{DD} = 3.3 V V _S = 3 V/1 V, V _D = 1 V/3 V; Test Circuit 2 V _S = 3 V/1 V, V _D = 1 V/3 V; Test Circuit 3 V _S = V _D = 1 V or 3 V; Test Circuit 4
	±0.1	±0.3	nA max	
Drain OFF Leakage I _D (OFF)	±0.01		nA typ	
	±0.1	±0.75	nA max	
Channel ON Leakage I _D , I _S (ON)	±0.01		nA typ	
	±0.1	±0.75	nA max	
DIGITAL INPUTS				
Input High Voltage, V _{INH}		2.0	V min	V _{IN} = V _{INL} or V _{INH}
Input Low Voltage, V _{INL}		0.8	V max	
Input Current				
I _{INL} or I _{INH}	0.005	±0.1	μA typ μA max	
C _{IN} , Digital Input Capacitance	2		pF typ	
DYNAMIC CHARACTERISTICS ²				
t _{TRANSITION}	18		ns typ	R _L = 300 Ω, C _L = 35 pF; Test Circuit 5 V _{S1} = 2 V/0 V, V _{S2} = 0 V/2 V
		30	ns max	
Break-Before-Make Time Delay, t _D	8		ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 2 V; Test Circuit 6
		1	ns min	
t _{ON} (EN)	18		ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 2 V; Test Circuit 7
		30	ns max	
t _{OFF} (EN)	8		ns typ	R _L = 300 Ω, C _L = 35 pF V _S = 2 V; Test Circuit 7
		15	ns max	
Charge Injection	±3		pC typ	V _S = 1.5 V, R _S = 0 Ω, C _L = 1 nF; Test Circuit 8
Off Isolation	–60		dB typ	R _L = 50 Ω, C _L = 5 pF, f = 10 MHz R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Test Circuit 9
	–80		dB typ	
Channel-to-Channel Crosstalk	–60		dB typ	R _L = 50 Ω, C _L = 5 pF, f = 10 MHz R _L = 50 Ω, C _L = 5 pF, f = 1 MHz; Test Circuit 10
	–80		dB typ	
–3 dB Bandwidth	55		MHz typ	R _L = 50 Ω, C _L = 5 pF; Test Circuit 11 f = 1 MHz
C _S (OFF)	13		pF typ	
C _D (OFF)				
ADG758	85		pF typ	f = 1 MHz
ADG759	42		pF typ	f = 1 MHz
C _D , C _S (ON)				
ADG758	96		pF typ	f = 1 MHz
ADG759	48		pF typ	f = 1 MHz
POWER REQUIREMENTS				
I _{DD}	0.001		μA typ	V _{DD} = 3.3 V Digital Inputs = 0 V or 3.3 V
		1.0	μA max	

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.

ADG758/ADG759—SPECIFICATIONS¹

DUAL SUPPLY ($V_{DD} = +2.5\text{ V} \pm 10\%$, $V_{SS} = -2.5\text{ V} \pm 10\%$, $GND = 0\text{ V}$, 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} , $I_{DS} = 10\text{ mA}$; Test Circuit 1
	4.5	5	Ω max	
ON Resistance Match Between Channels (ΔR_{ON})		0.4	Ω typ	$V_S = V_{SS}$ to V_{DD} , $I_{DS} = 10\text{ mA}$
		0.8	Ω max	$V_S = V_{SS}$ to V_{DD} , $I_{DS} = 10\text{ mA}$
ON Resistance Flatness ($R_{FLAT(ON)}$)	0.6		Ω typ	$V_S = V_{SS}$ to V_{DD} , $I_{DS} = 10\text{ mA}$
		1.0	Ω max	
LEAKAGE CURRENTS				
Source OFF Leakage I_S (OFF)	± 0.01		nA typ	$V_{DD} = +2.75\text{ V}$, $V_{SS} = -2.75\text{ V}$
	± 0.1	± 0.3	nA max	$V_S = +2.25\text{ V}/-1.25\text{ V}$, $V_D = -1.25\text{ V}/+2.25\text{ V}$; Test Circuit 2
Drain OFF Leakage I_D (OFF)	± 0.01		nA typ	$V_S = +2.25\text{ V}/-1.25\text{ V}$, $V_D = -1.25\text{ V}/+2.25\text{ V}$; Test Circuit 3
	± 0.1	± 0.75	nA max	
Channel ON Leakage I_D , I_S (ON)	± 0.01		nA typ	$V_S = V_D = +2.25\text{ V}/-1.25\text{ V}$; Test Circuit 4
	± 0.1	± 0.75	nA max	
DIGITAL INPUTS				
Input High Voltage, V_{INH}		1.7	V min	
Input Low Voltage, V_{INL}		0.7	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	2		pF typ	
DYNAMIC CHARACTERISTICS²				
$t_{TRANSITION}$	14		ns typ	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$; Test Circuit 5
		25	ns max	$V_S = 1.5\text{ V}/0\text{ V}$; Test Circuit 5
Break-Before-Make Time Delay, t_D	8		ns typ	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$
		1	ns min	$V_S = 1.5\text{ V}$; Test Circuit 6
t_{ON} (EN)	14		ns typ	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$
		25	ns max	$V_S = 1.5\text{ V}$; Test Circuit 7
t_{OFF} (EN)	8		ns typ	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$
		15	ns max	$V_S = 1.5\text{ V}$; Test Circuit 7
Charge Injection	± 3		pC typ	$V_S = 0\text{ V}$, $R_S = 0\ \Omega$, $C_L = 1\text{ nF}$; Test Circuit 8
Off Isolation	–60		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 10\text{ MHz}$
	–80		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 1\text{ MHz}$; Test Circuit 9
Channel-to-Channel Crosstalk	–60		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 10\text{ MHz}$
	–80		dB typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$, $f = 1\text{ MHz}$; Test Circuit 10
–3 dB Bandwidth	55		MHz typ	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$; Test Circuit 11
C_S (OFF)	13		pF typ	$f = 1\text{ MHz}$
C_D (OFF)				
ADG758	85		pF typ	$f = 1\text{ MHz}$
ADG759	42		pF typ	$f = 1\text{ MHz}$
C_D , C_S (ON)				
ADG758	96		pF typ	$f = 1\text{ MHz}$
ADG759	48		pF typ	$f = 1\text{ MHz}$
POWER REQUIREMENTS				
I_{DD}	0.001		μA typ	$V_{DD} = +2.75\text{ V}$
		1.0	μA max	Digital Inputs = 0 V or 2.75 V
I_{SS}	0.001		μA typ	$V_{SS} = -2.75\text{ V}$
		1.0	μA max	Digital Inputs = 0 V or 2.75 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 (B Version)	–40°C to +85°C
Storage Temperature Range	–65°C to +150°C
Junction Temperature	150°C

Chip Scale Package,

θ_{JA} Thermal Impedance 32°C/W

Lead Temperature, Soldering

Vapor Phase (60 sec) 215°C

Infrared (15 sec) 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 EN, A, 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 ADG758/ADG759 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.



Table I. ADG758 Truth Table

A2	A1	A0	EN	Switch Condition
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

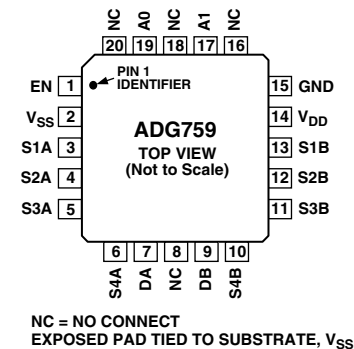
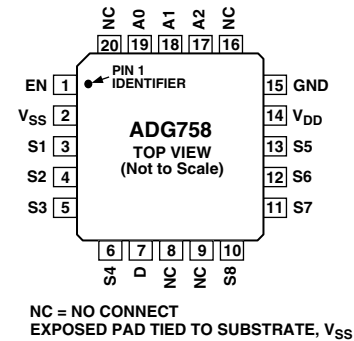
X = Don't Care

Table II. ADG759 Truth Table

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

X = Don't Care

PIN CONFIGURATIONS



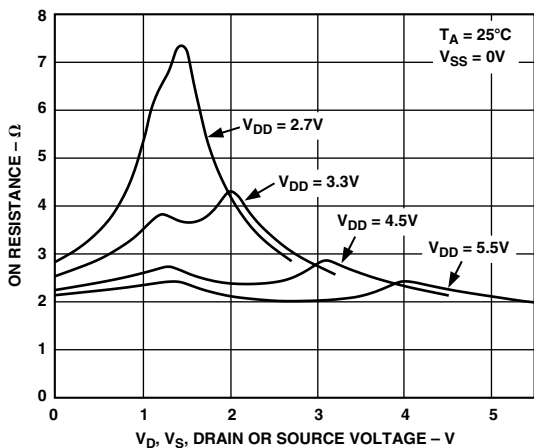
ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option
ADG758BCP	–40°C to +85°C	20-Lead Chip Scale Package (CSP)	CP-20
ADG759BCP	–40°C to +85°C	20-Lead Chip Scale Package (CSP)	CP-20

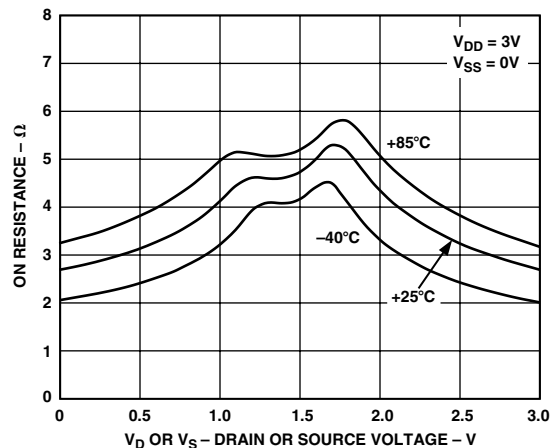
TERMINOLOGY

V_{DD}	Most Positive Power Supply Potential
V_{SS}	Most Negative Power Supply in a dual-supply application. In single-supply applications, this should be tied to ground at the device.
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
R_{ON}	Ohmic Resistance between D and S
$R_{FLAT(ON)}$	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. Measured with reference to ground.
C_D (OFF)	OFF Switch Drain Capacitance. Measured with reference to ground.
C_D, C_S (ON)	ON Switch Capacitance. Measured with reference to ground.
C_{IN}	Digital Input Capacitance
$t_{TRANSITION}$	Delay Time measured between the 50% and 90% points of the digital inputs and the switch ON condition when switching from one address state to another.
t_{ON} (EN)	Delay Time between the 50% and 90% points of the EN digital input and the switch ON condition.
t_{OFF} (EN)	Delay Time between the 50% and 90% points of the EN digital input and the switch OFF condition.
t_{OPEN}	OFF Time measured between the 80% points of both switches when switching from one address state to another.
Off Isolation	A measure of unwanted signal coupling through an OFF switch.
Crosstalk	A measure of unwanted signal which is coupled through from one channel to another as a result of parasitic capacitance.
Charge Injection	A measure of the glitch impulse transferred from the digital input to the analog output during switching.
On Response	The Frequency Response of the ON Switch.
On Loss	The Loss Due to the ON Resistance of the Switch
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
I_{DD}	Positive Supply Current
I_{SS}	Negative Supply Current

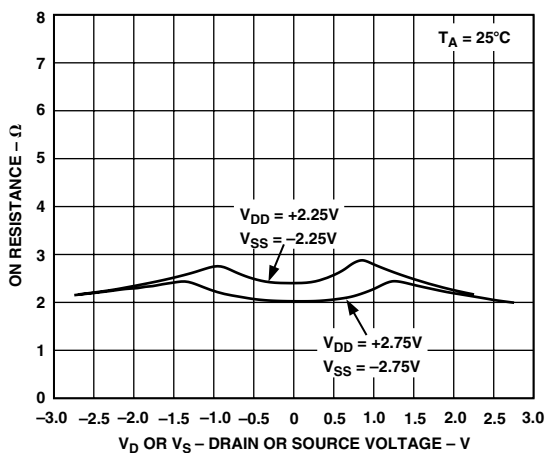
Typical Performance Characteristics—ADG758/ADG759



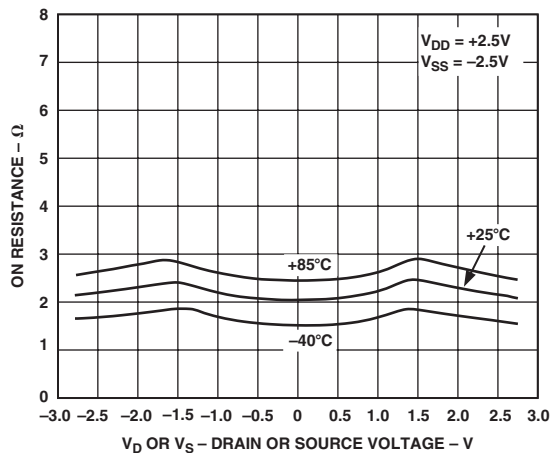
TPC 1. ON Resistance as a Function of V_D (V_S) for Single Supply



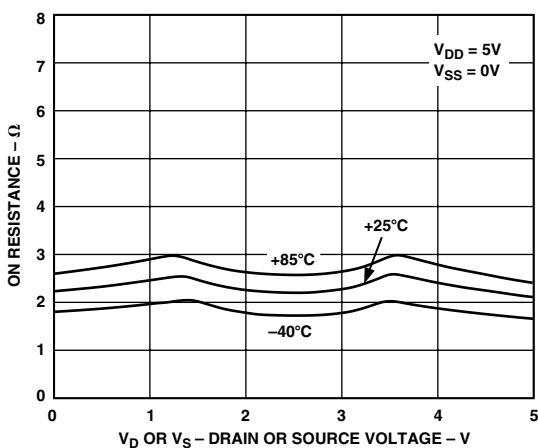
TPC 4. ON Resistance as a Function of V_D (V_S) for Different Temperatures, Single Supply



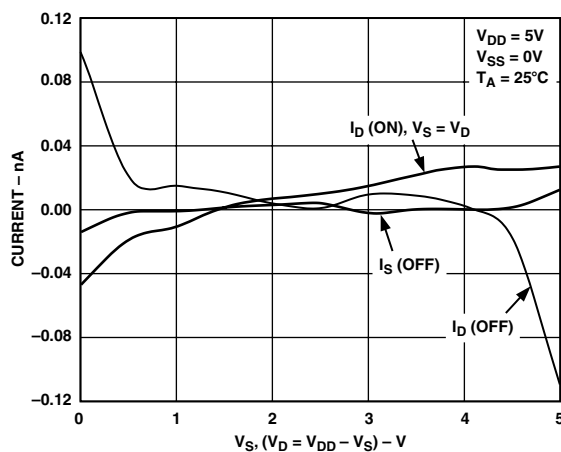
TPC 2. ON Resistance as a Function of V_D (V_S) for Dual Supply



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

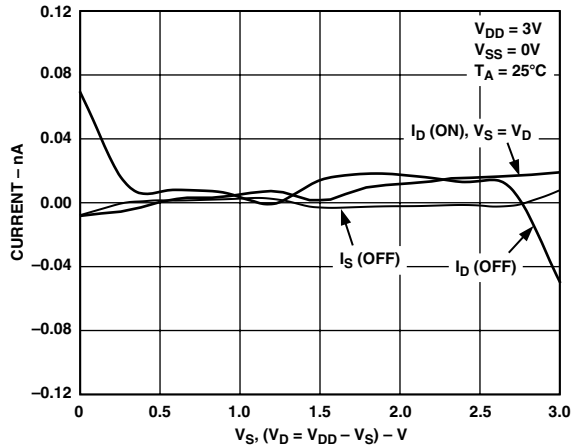


TPC 3. ON Resistance as a Function of V_D (V_S) for Different Temperatures, Single Supply

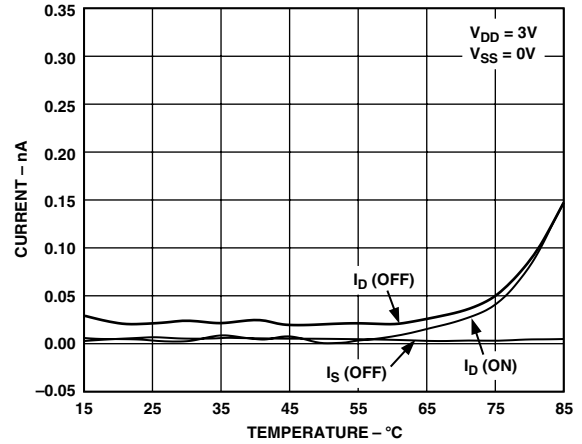


TPC 6. Leakage Currents as a Function of V_D (V_S)

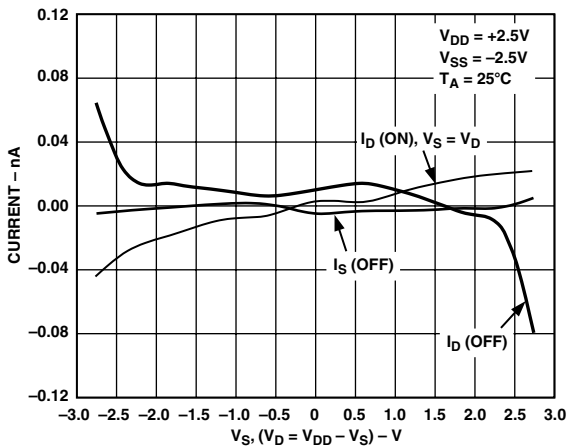
ADG758/ADG759



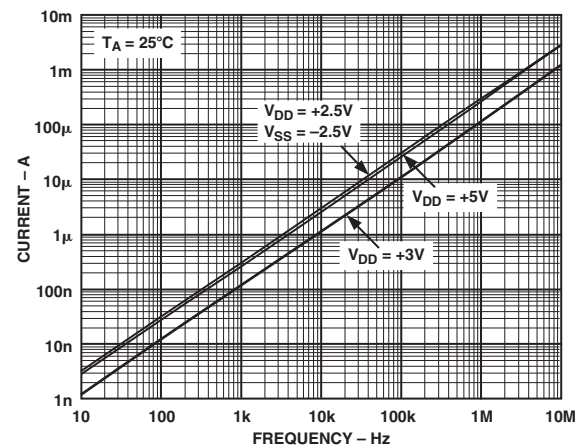
TPC 7. Leakage Currents as a Function of V_D (V_S)



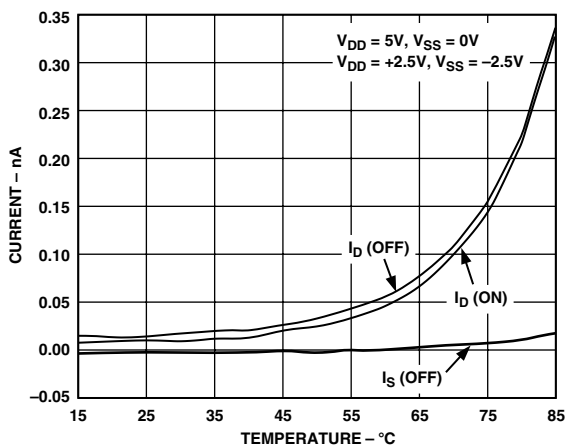
TPC 10. Leakage Currents as a Function of Temperature



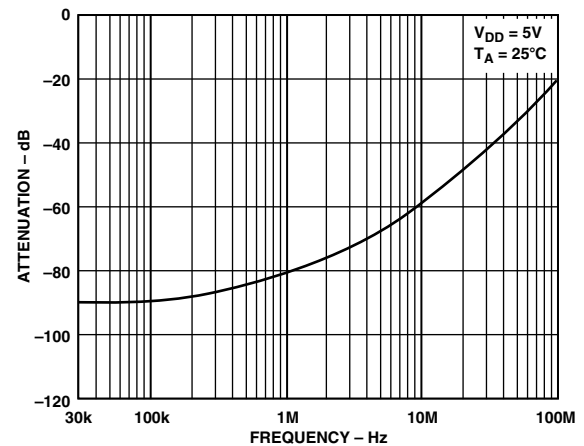
TPC 8. Leakage Currents as a Function of V_D (V_S)



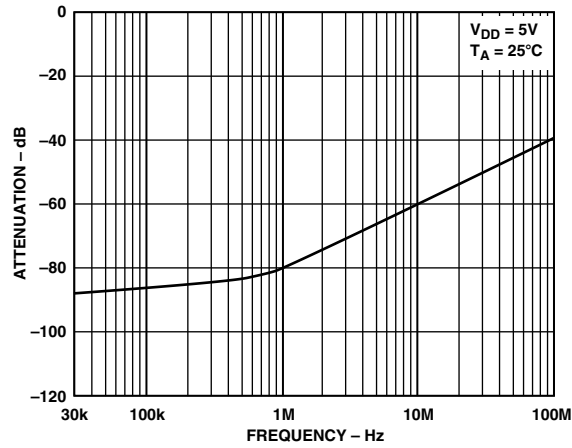
TPC 11. Supply Current vs. Input Switching Frequency



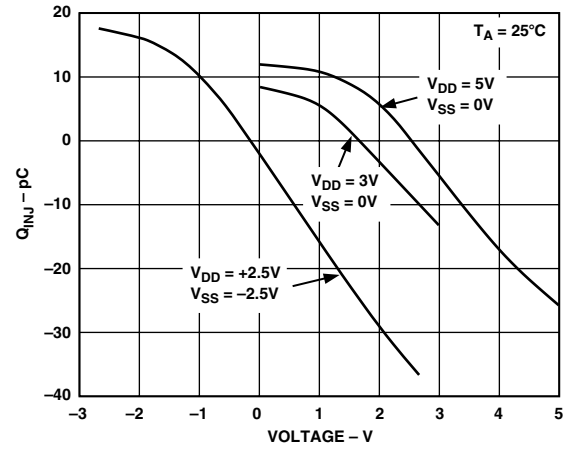
TPC 9. Leakage Currents as a Function of Temperature



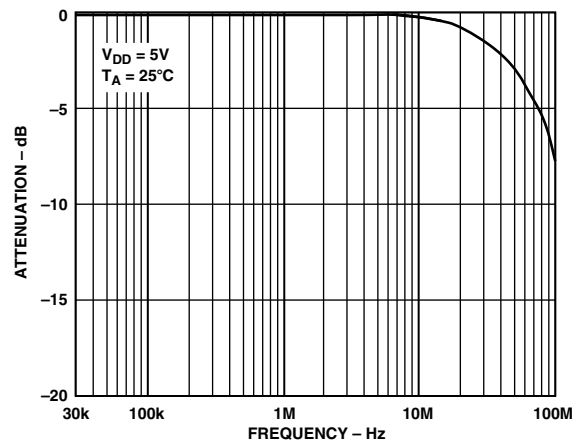
TPC 12. OFF Isolation vs. Frequency



TPC 13. Crosstalk vs. Frequency



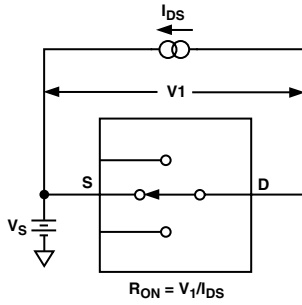
TPC 15. Charge Injection vs. Source Voltage



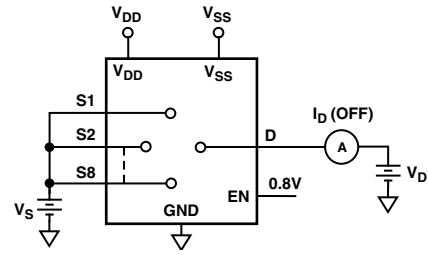
TPC 14. ON Response vs. Frequency

ADG758/ADG759

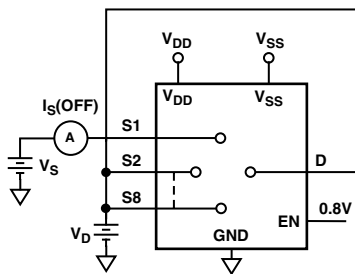
Test Circuits



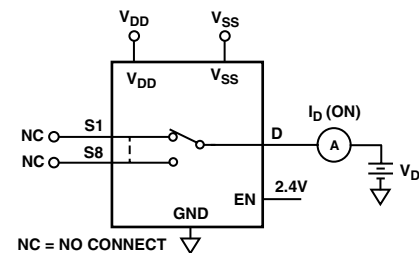
Test Circuit 1. ON Resistance



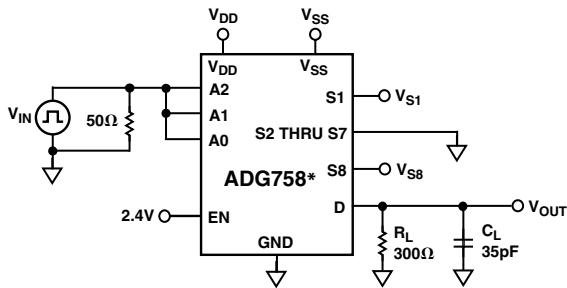
Test Circuit 3. I_D (OFF)



Test Circuit 2. I_S (OFF)

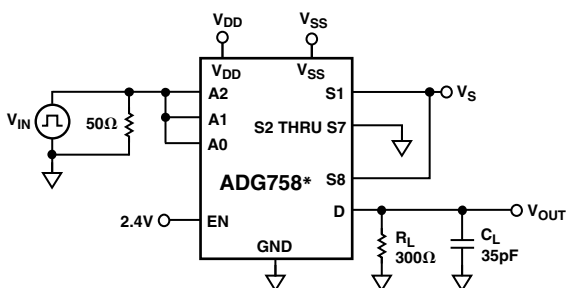
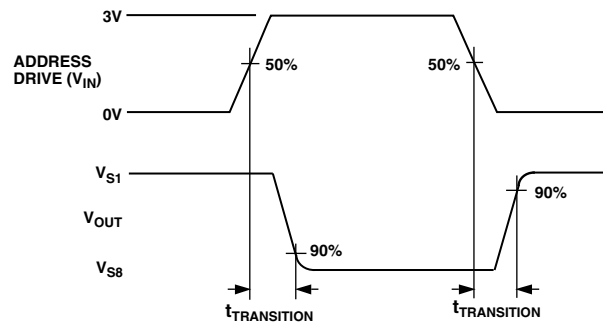


Test Circuit 4. I_D (ON)



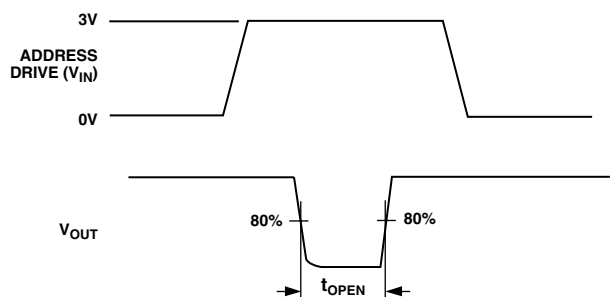
*SIMILAR CONNECTION FOR ADG759

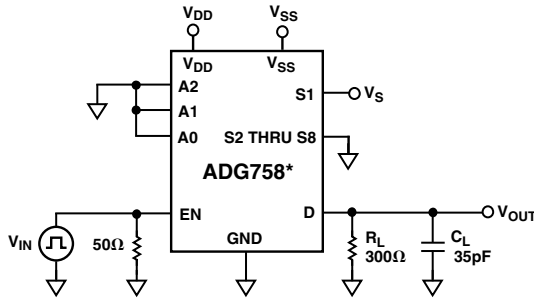
Test Circuit 5. Switching Time of Multiplexer, $t_{TRANSITION}$



*SIMILAR CONNECTION FOR ADG759

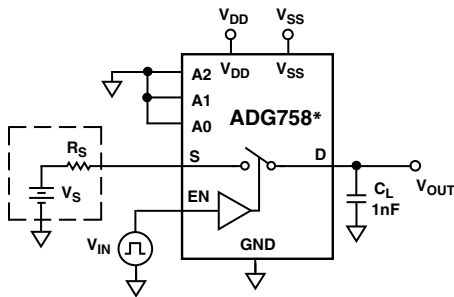
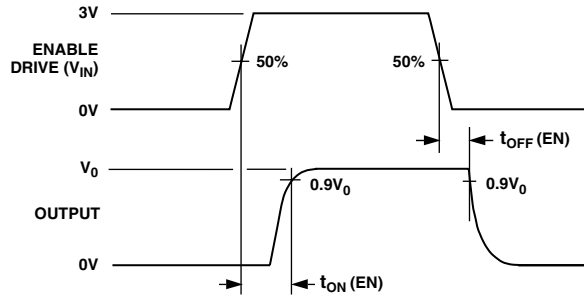
Test Circuit 6. Break-Before-Make Delay, t_{OPEN}





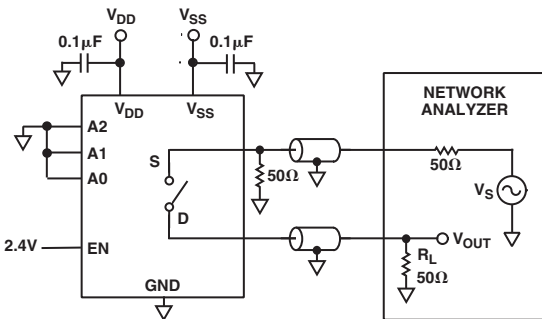
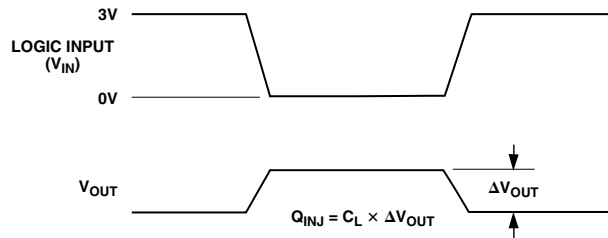
*SIMILAR CONNECTION FOR ADG759

Test Circuit 7. Enable Delay, $t_{ON}(EN)$, $t_{OFF}(EN)$



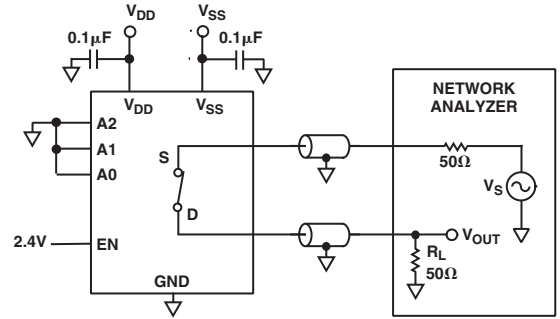
*SIMILAR CONNECTION FOR ADG759

Test Circuit 8. Charge Injection



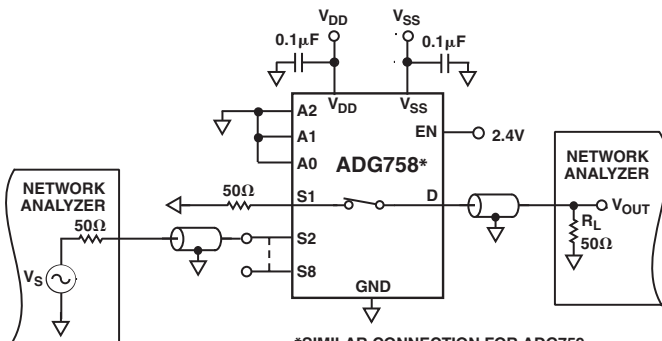
$$\text{OFF ISOLATION} = 20 \log \frac{V_{OUT}}{V_S}$$

Test Circuit 9. OFF Isolation



$$\text{INSERTION LOSS} = 20 \log \frac{V_{OUT \text{ WITH SWITCH}}}{V_{OUT \text{ WITHOUT SWITCH}}}$$

Test Circuit 11. Bandwidth



*SIMILAR CONNECTION FOR ADG759

CHANNEL-TO-CHANNEL

$$\text{CROSSTALK} = 20 \log \frac{V_{OUT}}{V_S}$$

Test Circuit 10. Channel-to-Channel Crosstalk

Power-Supply Sequencing

When using CMOS devices, care must be taken to ensure correct power-supply sequencing. Incorrect power-supply sequencing can result in the device being subjected to stresses beyond the maximum ratings listed in the data sheet. Digital and analog inputs should always be applied after power supplies and ground. For single-supply operation, V_{SS} should be tied to GND as close to the device as possible.

Revision History

Location

Data Sheet changed from REV. 0 to REV. A.

Edits to General Description section	1
Update Outline Drawings	12

