

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 × 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 × 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.B

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$\label{eq:added_states} ADG758/ADG759 \\ -SPECIFICATIONS^1 (v_{DD} = 5 \ v \ \pm \ 10\%, \ v_{ss} = 0 \ v, \ \text{GND} = 0 \ v, \ \text{unless otherwise noted.})$

	B Vers	ion		
		-40°C		
Parameter	+25°C	to +85°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 V to V_{DD}	V	
ON Resistance (R _{ON})	3		Ω typ	$V_{S} = 0 V$ to V_{DD} , $I_{DS} = 10 mA$;
	4.5	5	Ω max	Test Circuit 1
ON Resistance Match Between		0.4	Ω typ	
Channels (ΔR_{ON})		0.8	Ω max	$V_{S} = 0 V$ to V_{DD} , $I_{DS} = 10 mA$
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	$V_D = 4.5 \text{ V/1 V}, V_S = 1 \text{ V/4.5 V};$
	±0.1	±0.3	nA max	Test Circuit 2
Drain OFF Leakage I _D (OFF)	± 0.01		nA typ	$V_{\rm D} = 4.5 \text{ V}/1 \text{ V}, V_{\rm S} = 1 \text{ V}/4.5 \text{ V};$
	± 0.1	±0.75	nA max	Test Circuit 3
Channel ON Leakage I _D , I _S (ON)	± 0.01		nA typ	$V_D = V_S = 1$ V, or 4.5 V, Test Circuit 4
	±0.1	± 0.75	nA max	
DIGITAL INPUTS				
Input High Voltage, V _{INH}		2.4	V min	
Input Low Voltage, V _{INL}		0.8	V max	
Input Current		010	,	
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 CHARACTERISTICS ²				
t _{TRANSITION}	14		ns typ	$R_L = 300 \Omega$, $C_L = 35 pF$; Test Circuit 5
		25	ns max	$V_{S1} = 3 V/0 V, V_{S8} = 0 V/3 V$
Break-Before-Make Time Delay, t _D	8		ns typ	$R_L = 300 \Omega, C_L = 35 pF$
		1	ns min	$V_s = 3 V$; Test Circuit 6
t _{on} (EN)	14		ns typ	$R_{\rm L} = 300 \ \Omega, C_{\rm L} = 35 \ \rm pF$
		25	ns max	$V_s = 3 V$; Test Circuit 7
t _{off} (EN)	7		ns typ	$R_{L} = 300 \Omega, C_{L} = 35 pF$
		12	ns max	$V_s = 3 V$; Test Circuit 7
Charge Injection	±3		pC typ	$V_{s} = 2.5 V, R_{s} = 0 \Omega, C_{L} = 1 nF;$
<i>c</i> ,			1 51	Test Circuit 8
Off Isolation	-60		dB typ	$R_{L} = 50 \Omega, C_{L} = 5 pF, f = 10 MHz$
	-80		dB typ	$R_{L} = 50 \Omega, C_{L} = 5 pF, f = 1 MHz;$
				Test Circuit 9
Channel-to-Channel Crosstalk	-60		dB typ	$R_{L} = 50 \Omega, C_{L} = 5 pF, f = 10 MHz$
	-80		dB typ	$R_{L} = 50 \Omega, C_{L} = 5 pF, f = 1 MHz;$
			·· · · 5 F	Test Circuit 10
-3 dB Bandwidth	55		MHz typ	$R_L = 50 \Omega$, $C_L = 5 pF$; Test Circuit 11
C _S (OFF)	13		pF typ	f = 1 MHz
$C_{\rm D}$ (OFF)				
ADG758	85		pF typ	f = 1 MHz
ADG759	42		pF typ	f = 1 MHz
$C_D, C_S(ON)$			1 ⁻ 71	
ADG758	96		pF typ	f = 1 MHz
ADG759	48		pF typ	f = 1 MHz
DOWED DEOLUDEMENTS				V _{DD} = 5.5 V
PUWER REQUIREMENTS				
POWER REQUIREMENTS I _{DD}	0.001		μA typ	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.

$\label{eq:specifications} SPECIFICATIONS^1 \ (v_{\text{DD}} = 3 \ \text{V} \pm 10\%, \ v_{\text{SS}} = 0 \ \text{V}, \ \text{GND} = 0 \ \text{V}, \ \text{unless otherwise noted.})$

	B Vers			
Parameter	+25°C	-40°C to +85°C	Unit	Test Conditions/Comments
ANALOG SWITCH Analog Signal Range ON Resistance (R _{ON}) ON Resistance Match Between Channels (ΔR _{ON})	8 11	0 V to V _{DD} 12 0.4 1.2	V Ω typ Ω max Ω typ Ω max	$V_{S} = 0 V \text{ to } V_{DD}, I_{DS} = 10 \text{ mA};$ Test Circuit 1 $V_{S} = 0 V \text{ to } V_{DD}, I_{DS} = 10 \text{ mA}$
LEAKAGE CURRENTS Source OFF Leakage I _S (OFF) Drain OFF Leakage I _D (OFF) Channel ON Leakage I _D , I _S (ON)	$\begin{array}{c} \pm 0.01 \\ \pm 0.1 \\ \pm 0.01 \\ \pm 0.1 \\ \pm 0.01 \\ \pm 0.01 \\ \pm 0.1 \end{array}$	±0.3 ±0.75 ±0.75	nA typ nA max nA typ nA max nA typ nA max	$V_{DD} = 3.3 V$ $V_{S} = 3 V/1 V, V_{D} = 1 V/3 V;$ Test Circuit 2 $V_{S} = 3 V/1 V, V_{D} = 1 V/3 V;$ Test Circuit 3 $V_{S} = V_{D} = 1 V \text{ or } 3 V;$ Test Circuit 4
DIGITAL INPUTS Input High Voltage, V _{INH} Input Low Voltage, V _{INL} Input Current I _{INL} or I _{INH} C _{IN} , Digital Input Capacitance	0.005	2.0 0.8 ±0.1	V min V max μA typ μA max pF typ	$V_{IN} = V_{INL}$ or V_{INH}
DYNAMIC CHARACTERISTICS ² t _{TRANSITION} Break-Before-Make Time Delay, t _D t _{ON} (EN) t _{OFF} (EN) Charge Injection Off Isolation Channel-to-Channel Crosstalk	$ 18 8 18 8 \pm 3 -60 -80 -60 -80 $	30 1 30 15	ns typ ns max ns typ ns min ns typ ns max ns typ ns max pC typ dB typ dB typ dB typ dB typ	$ \begin{array}{l} R_L = 300 \ \Omega, \ C_L = 35 \ pF; \ Test \ Circuit \ 4\\ V_{S1} = 2 \ V/0 \ V, \ V_{S2} = 0 \ V/2 \ V\\ R_L = 300 \ \Omega, \ C_L = 35 \ pF\\ V_S = 2 \ V; \ Test \ Circuit \ 6\\ R_L = 300 \ \Omega, \ C_L = 35 \ pF\\ V_S = 2 \ V; \ Test \ Circuit \ 7\\ R_L = 300 \ \Omega, \ C_L = 35 \ pF\\ V_S = 2 \ V; \ Test \ Circuit \ 7\\ V_S = 1.5 \ V, \ R_S = 0 \ \Omega, \ C_L = 1 \ nF;\\ Test \ Circuit \ 8\\ R_L = 50 \ \Omega, \ C_L = 5 \ pF, \ f = 10 \ MHz \ R_L = 50 \ \Omega, \ C_L = 5 \ PF, \ f = 10 \ MHz \ R_L = 50 \ \Omega, \ C_L = 5 \ PF, \ f = 10 \ MHz \ R_L = 50 \ \Omega, \ C_L = 5 \ PF, \ f = 10 \ MHz \ R_L = 50 \ \Omega, \ C_L = 5 \ PF, \ f = 10 \ MHz \ R_L = 50 \ \Omega, \ C_L = 5 \ PF, \ f = 10 \ MHz \ R_L = 50 \ \Omega, \ R_L = 50 \ \Omega, \ R_L = 50 \ R$
$-3 dB Bandwidth C_{S} (OFF) C_{D} (OFF) ADG758 ADG759 C_{D}, C_{S} (ON) ADG758 ADG759 POWER REQUIREMENTS$	55 13 85 42 96 48		MHz typ pF typ pF typ pF typ pF typ pF typ	Test Circuit 10 $R_L = 50 \Omega$, $C_L = 5 pF$; Test Circuit 11 f = 1 MHz f = 1 MHz $V_{DD} = 3.3 V$
I _{DD}	0.001	1.0	μA typ μA max	$V_{DD} = 3.3 V$ Digital Inputs = 0 V or 3.3 V

NOTES

¹Temperature ranges are as follows: B Version: -40°C to +85°C.

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ADG758/ADG759-SPECIFICATIONS¹

DUAL SUPPLY (V_{DD} = +2.5 V ± 10%, V_{SS} = -2.5 V ± 10%, GND = 0 V, unless otherwise noted.)

	B Vers			
Parameter	+25°C	-40°C to +85°C	Unit	Test Conditions/Comments
	+23 C	10 +85 C	Um	Test Conditions/Comments
ANALOG SWITCH Analog Signal Range ON Resistance (R _{ON})	2.5 4.5	V_{SS} to V_{DD}	V Ω typ Ω max	$V_{S} = V_{SS}$ to V_{DD} , $I_{DS} = 10$ mA; Test Circuit 1
$\begin{array}{l} ON \ Resistance \ Match \ Between \\ Channels \ (\Delta R_{ON}) \\ ON \ Resistance \ Flatness \ (R_{FLAT(ON)}) \end{array}$	0.6	0.4 0.8 1.0	Ω typ Ω max Ω typ Ω max	$V_{S} = V_{SS}$ to V_{DD} , $I_{DS} = 10$ mA $V_{S} = V_{SS}$ to V_{DD} , $I_{DS} = 10$ mA
LEAKAGE CURRENTS				V_{DD} = +2.75 V, V_{SS} = -2.75 V
Source OFF Leakage I _S (OFF)	$\pm 0.01 \\ \pm 0.1$	±0.3	nA typ nA max	$V_{\rm S}$ = +2.25 V/-1.25 V, $V_{\rm D}$ = -1.25 V/+2.25 V; Test Circuit 2
Drain OFF Leakage I_D (OFF)	$\pm 0.01 \\ \pm 0.1$	±0.75	nA typ nA max	V_{S} = +2.25 V/-1.25 V, V_{D} = -1.25 V/+2.25 V; Test Circuit 3
Channel ON Leakage I_D , I_S (ON)	$\pm 0.01 \\ \pm 0.1$	±0.75	nA typ nA max	$V_{\rm S} = V_{\rm D} = +2.25 \text{ V/}-1.25 \text{ V}; \text{ Test Circuit 4}$
DIGITAL INPUTS Input High Voltage, V _{INH} Input Low Voltage, V _{INL} Input Current		1.7 0.7	V min V max	
I _{INL} or I _{INH}	0.005	± 0.1	μA typ μA max	$V_{IN} = V_{INL}$ or V_{INH}
C _{IN} , Digital Input Capacitance	2		pF typ	
DYNAMIC CHARACTERISTICS ²	14		ns typ	R_L = 300 Ω, C_L = 35 pF; Test Circuit 5
t _{TRANSITION} Break-Before-Make Time Delay, t _D	8	25	ns typ	$V_{\rm S} = 1.5 \text{ V/O V}; \text{ Test Circuit 5}$ $R_{\rm L} = 300 \Omega, C_{\rm L} = 35 \text{ pF}$
t _{on} (EN)	14	1	ns min ns typ	$V_s = 1.5 V$; Test Circuit 6 $R_L = 300 \Omega$, $C_L = 35 pF$
t _{off} (EN)	8	25 15	ns max ns typ ns max	$V_{S} = 1.5 \text{ V}; \text{ Test Circuit 7}$ $R_{L} = 300 \Omega, C_{L} = 35 \text{ pF}$ $V_{S} = 1.5 \text{ V}; \text{ Test Circuit 7}$
Charge Injection	±3	15	pC typ	$V_S = 0$ V, $R_S = 0$ Ω , $C_L = 1$ nF; Test Circuit 8
Off Isolation	-60 -80		dB typ dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, $f = 10 MHz$ $R_L = 50 \Omega$, $C_L = 5 pF$, $f = 1 MHz$; Test Circuit 9
Channel-to-Channel Crosstalk	-60 -80		dB typ dB typ	$R_L = 50 \Omega$, $C_L = 5 pF$, f = 10 MHz $R_L = 50 \Omega$, $C_L = 5 pF$, f = 1 MHz; Test Circuit 10
–3 dB Bandwidth C _S (OFF) C _D (OFF)	55 13		MHz typ pF typ	$R_L = 50 \Omega$, $C_L = 5 pF$; Test Circuit 11 f = 1 MHz
ADG758 ADG759 C _D , C _S (ON)	85 42		pF typ pF typ	f = 1 MHz f = 1 MHz
ADG758 ADG759	96 48		pF typ pF typ	f = 1 MHz f = 1 MHz
POWER REQUIREMENTS				V _{DD} = +2.75 V
I _{DD}	0.001	1.0	μA typ μA max	Digital Inputs = 0 V or 2.75 V
I _{SS}	0.001	1.0	μA typ μA max	$V_{SS} = -2.75 V$ Digital Inputs = 0 V or 2.75 V

NOTES

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

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ABSOLUTE MAXIMUM RATINGS

 $T_A = 25^{\circ}C$, unless otherwise noted.

Parameter	Rating
V _{DD} to V _{SS}	7 V
V _{DD} to GND	–0.3 V to +7 V
Vss to GND	+0.3 V to -3.5 V
Analog Inputs ¹	V _{ss} – 0.3 V to V _{DD} +0.3 V or 30 mA, Whichever Occurs First
Digital Inputs ¹	–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℃
Infrared (15 sec)	220°C

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 indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

¹ Overvoltages at EN, A, S, or D will be clamped by internal diodes. Current should be limited to the maximum ratings given.

ESD 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 this product 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

Table	I. ADU/	50 11uu	1 1 auto		
A2	A1	A0	EN	Switch Condition	
Х	Х	Х	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	
	1. 6				

X = Don't Care

Table II. ADG759 Truth Table

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

X = Don't Care

PIN CONFIGURATIONS



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"
$I_{INL} \left(I_{INH} \right)$	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_{\text{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



TPC 10. Leakage Currents as a Function of Temperature



TPC 11. Supply Current vs. Input Switching Frequency



TPC 12. OFF Isolation vs. Frequency



TPC 13. Crosstalk vs. Frequency



TPC 15. Charge Injection vs. Source Voltage



TPC 14. ON Response vs. Frequency

Test Circuits



Test Circuit 1. ON Resistance



Test Circuit 2. I_S (OFF)



Test Circuit 3. I_D (OFF)



Test Circuit 4. I_D (ON)



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 8. Charge Injection



Test Circuit 9. OFF Isolation



Test Circuit 10. Channel-to-Channel Crosstalk



Test Circuit 11. Bandwidth

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.

OUTLINE DIMENSIONS



20-Lead Lead Frame Chip Scale Package [LFCSP_WQ] 4 mm × 4 mm Body, Very Very Thin Quad (CP-20-6) Dimensions shown in millimeters

ORDERING GUIDE

Model ¹	Temperature Range	Package Description	Package Option
ADG758BCPZ	-40°C to +85°C	20-Lead Lead Frame Chip Scale Package (LFCSP_WQ)	CP-20-6
ADG758BCPZ-REEL7	-40°C to +85°C	20-Lead Lead Frame Chip Scale Package (LFCSP_WQ)	CP-20-6
ADG759BCPZ	-40°C to +85°C	20-Lead Lead Frame Chip Scale Package (LFCSP_WQ)	CP-20-6
ADG759BCPZ-REEL	-40°C to +85°C	20-Lead Lead Frame Chip Scale Package (LFCSP_WQ)	CP-20-6
ADG759BCPZ-REEL7	–40°C to +85°C	20-Lead Lead Frame Chip Scale Package (LFCSP_WQ)	CP-20-6

¹ Z = RoHS Compliant Part.

REVISION HISTORY

3/13—Rev. A to Rev. B
Updated Outline Dimensions
5/02—Rev. 0 to Rev. A
Edits to General Description section

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