

**FEATURES**

**1.8 V to 5.5 V single supply**  
**Tiny 1.65 mm  $\times$  1.65 mm package**  
**Low on resistance: 1.3  $\Omega$  at 5 V supply**  
**High current-carrying capability**  
**300 mA continuous current**  
**500 mA peak current at 5 V**  
**Rail-to-rail operation**  
**Typical power consumption: <0.01  $\mu$ W**  
**TTL/CMOS-compatible inputs**

**APPLICATIONS**

**Cellular phones**  
**PDA's**  
**MP3 players**  
**Battery-powered systems**  
**Audio and video signal routing**  
**Modems**  
**PCMCIA cards**  
**Hard drives**  
**Relay replacement**

**GENERAL DESCRIPTION**

The ADG859 is a monolithic, CMOS SPDT (single pole, double throw) switch that operates with a supply range of 1.8 V to 5.5 V. It is designed to offer low on resistance of 2.3  $\Omega$  maximum over the entire temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ . The ADG859 also has the capability of carrying large amounts of current, typically 300 mA at 5 V operation. These features make the ADG859 an ideal solution for applications that are space-constrained, such as handsets, PDA's, and MP3 players.

Each switch conducts equally well in both directions when on. The device exhibits break-before-make switching action, thereby preventing momentary shorting when switching channels.

The ADG859 is available in a tiny 6-lead SOT-66 package.

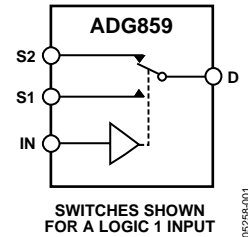
**FUNCTIONAL BLOCK DIAGRAM**

Figure 1.

**PRODUCT HIGHLIGHTS**

1. Low on resistance: 2.3  $\Omega$  maximum over the full temperature range of  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ .
2. High current-carrying capability.
3. Tiny 6-lead, 1.65 mm  $\times$  1.65 mm SOT-66 package.

**Rev. 0**

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**REVISION HISTORY**

6/05—Revision 0: Initial Version

## SPECIFICATIONS

$V_{DD} = 5\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ , unless otherwise noted.<sup>1</sup>

**Table 1.**

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			0 V to $V_{DD}$	V	
On Resistance, $R_{ON}$	1.3			$\Omega$ typ	$V_{DD} = 4.5\text{ V}$ , $V_S = 0\text{ V to }V_{DD}$ , $I_S = -100\text{ mA}$ ; Figure 16
	2.1	2.2	2.3	$\Omega$ max	
On Resistance Match Between Channels, $\Delta R_{ON}$	0.01			$\Omega$ typ	$V_{DD} = 4.5\text{ V}$ , $V_S = 4.5\text{ V}$ , $I_S = -100\text{ mA}$ ; Figure 16
	0.093	0.163	0.163	$\Omega$ max	
On Resistance Flatness, $R_{FLAT(ON)}$	0.32			$\Omega$ typ	$V_{DD} = 4.5\text{ V}$ , $V_S = 0\text{ V to }V_{DD}$ , $I_S = -100\text{ mA}$ ; Figure 16
	0.45	0.6	0.65	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.02$			nA typ	$V_{DD} = 5.5\text{ V}$ $V_S = 4.5\text{ V/1 V}$ , $V_D = 1\text{ V/4.5 V}$ ; Figure 17
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.02$			nA typ	$V_S = V_D = 1\text{ V or }4.5\text{ V}$ ; Figure 18
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2	V min	
Input Low Voltage, $V_{INL}$			0.8	V max	
Input Current, $I_{INL}$ or $I_{INH}$	0.005		$\pm 0.1$	$\mu\text{A}$ typ $\mu\text{A}$ max	$V_{IN} = V_{INL}$ or $V_{INH}$
Digital Input Capacitance, $C_{IN}$	4			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>					
$t_{ON}$	8			ns typ	$R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$
	10	11	12	ns max	$V_S = 3\text{ V}$ ; Figure 19
$t_{OFF}$	4.5			ns typ	$R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$
	6	6.5	7	ns max	$V_S = 3\text{ V}$ ; Figure 19
Break-Before-Make Time Delay, $t_{BBM}$	4			ns typ	$R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$
			1	ns min	$V_{S1} = V_{S2} = 1.5\text{ V}$ ; Figure 20
Charge Injection	$\pm 13$			pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; Figure 21
Off Isolation	-78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; Figure 22
Channel-to-Channel Crosstalk	-78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; Figure 23
-3 dB Bandwidth	125			MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; Figure 24
Insertion Loss	-0.11			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; Figure 24
Total Harmonic Distortion (THD + N)	0.062			%	$R_L = 32\ \Omega$ , $f = 20\text{ Hz to }20\text{ kHz}$ , $V_S = 3\text{ V p-p}$ ; Figure 14
$C_S$ (Off)	18			pF typ	$f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)	45			pF typ	$f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>					
$I_{DD}$	0.001		1	$\mu\text{A}$ typ $\mu\text{A}$ max	$V_{DD} = 5.5\text{ V}$ Digital inputs = 0 V or 5.5 V

<sup>1</sup> Temperature range is  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

<sup>2</sup> Guaranteed by design; not subject to production test.

# ADG859

$V_{DD} = 2.7\text{ V}$  to  $3.6\text{ V}$ ,  $GND = 0\text{ V}$ , unless otherwise noted.<sup>1</sup>

**Table 2.**

Parameter	25°C	-40°C to +85°C	-40°C to +125°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>					
Analog Signal Range			0 V to $V_{DD}$	V	
On Resistance, $R_{ON}$	3			$\Omega$ typ	$V_{DD} = 2.7\text{ V}$ , $V_S = 0\text{ V}$ to $V_{DD}$ , $I_S = -100\text{ mA}$ ; Figure 16
	4.3	4.5	4.7	$\Omega$ max	
On Resistance Match Between Channels, $\Delta R_{ON}$	0.03			$\Omega$ typ	$V_{DD} = 2.7\text{ V}$ , $V_S = 1.2\text{ V}$ , $I_S = -100\text{ mA}$ ; Figure 16
	0.11	0.15	0.15	$\Omega$ max	
<b>LEAKAGE CURRENTS</b>					
Source Off Leakage, $I_S$ (Off)	$\pm 0.02$			nA typ	$V_{DD} = 3.6\text{ V}$ $V_S = 3\text{ V}/1\text{ V}$ , $V_D = 1\text{ V}/3\text{ V}$ ; Figure 17
Channel On Leakage, $I_D$ , $I_S$ (On)	$\pm 0.05$			nA typ	$V_S = V_D = 1\text{ V}$ or $3\text{ V}$ ; Figure 18
<b>DIGITAL INPUTS</b>					
Input High Voltage, $V_{INH}$			2.0	V min	
Input Low Voltage, $V_{INL}$			0.8	V max	$V_{DD} = 3\text{ V}$ to $3.6\text{ V}$
			0.7	V max	$V_{DD} = 2.7\text{ V}$
Input Current, $I_{INL}$ or $I_{IN}$	0.005	$\pm 0.1$	$\pm 0.1$	$\mu\text{A}$ typ	$V_{IN} = V_{INL}$ or $V_{INH}$
				$\mu\text{A}$ max	
Digital Input Capacitance, $C_{IN}$	4			pF typ	
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>					
$t_{ON}$	11			ns typ	$R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$
	15	16	17	ns max	$V_S = 1.5\text{ V}$ ; Figure 19
$t_{OFF}$	6			ns typ	$R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$
	9.5	10	11	ns max	$V_S = 1.5\text{ V}$ ; Figure 19
Break-Before-Make Time Delay, $t_{BBM}$	5			ns typ	$R_L = 50\ \Omega$ , $C_L = 35\text{ pF}$
			1	ns min	$V_{S1} = V_{S2} = 1.5\text{ V}$ ; Figure 20
Charge Injection	$\pm 7$			pC typ	$V_S = 0\text{ V}$ , $R_S = 0\ \Omega$ , $C_L = 1\text{ nF}$ ; Figure 21
Off Isolation	-78			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; Figure 22
Channel-to-Channel Crosstalk	-78			dB typ	S1 to S2; $R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 100\text{ kHz}$ ; Figure 23
-3 dB Bandwidth	125			MHz typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; Figure 24
Insertion Loss	-0.11			dB typ	$R_L = 50\ \Omega$ , $C_L = 5\text{ pF}$ ; Figure 24
Total Harmonic Distortion (THD + N)	0.1			%	$R_L = 32\ \Omega$ , $f = 20\text{ Hz}$ to $20\text{ kHz}$ , $V_S = 2\text{ V p-p}$ ; Figure 14
$C_S$ (Off)	18			pF typ	$f = 1\text{ MHz}$
$C_D$ , $C_S$ (On)	46			pF typ	$f = 1\text{ MHz}$
<b>POWER REQUIREMENTS</b>					
$I_{DD}$	0.001		1	$\mu\text{A}$ typ $\mu\text{A}$ max	$V_{DD} = 3.6\text{ V}$ Digital inputs = $0\text{ V}$ or $3.6\text{ V}$

<sup>1</sup> Temperature range is  $-40^\circ\text{C}$  to  $+125^\circ\text{C}$ .

<sup>2</sup> Guaranteed by design; not subject to production test.

## ABSOLUTE MAXIMUM RATINGS

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

**Table 3.**

Parameter	Rating
$V_{DD}$ to GND	-0.3 V to +7.0 V
Analog Inputs <sup>1</sup>	-0.3 V to $V_{DD} + 0.3$ V or 30 mA, whichever occurs first
Digital Inputs <sup>1</sup>	-0.3 V to $V_{DD} + 0.3$ V or 30 mA, whichever occurs first
Peak Current, S or D	
5 V Operation	500 mA
3 V Operation	460 mA
Continuous Current, S or D	
5 V Operation	300 mA
3 V Operation	275 mA
Operating Temperature Range	
Automotive	-40°C to +85°C
Storage Temperature Range	-65°C to +150°C
Junction Temperature	150°C
SOT-66 Package (4-Layer Board)	
$\theta_{JA}$ Thermal Impedance	191°C/W
Lead-Free Reflow	
Peak Temperature	260(+0/-5)°C
Time at Peak Temperature	10 sec to 40 sec

<sup>1</sup> Overvoltages at S or D are 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.



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. Only one absolute maximum rating may be applied at any one time.

**Table 4. Truth Table**

Logic (IN)	Switch 2 (S2)	Switch 1 (S1)
0	Off	On
1	On	Off

# ADG859

## PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

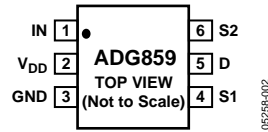


Figure 2. 6-Lead SOT-66 Pin Configuration

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	IN	Logic Control Input.
2	V <sub>DD</sub>	Most Positive Power Supply Potential.
3	GND	Ground (0 V) Reference.
4	S1	Source Terminal. Can be an input or an output.
5	D	Drain Terminal. Can be an input or an output.
6	S2	Source Terminal. Can be an input or an output.

# TYPICAL PERFORMANCE CHARACTERISTICS

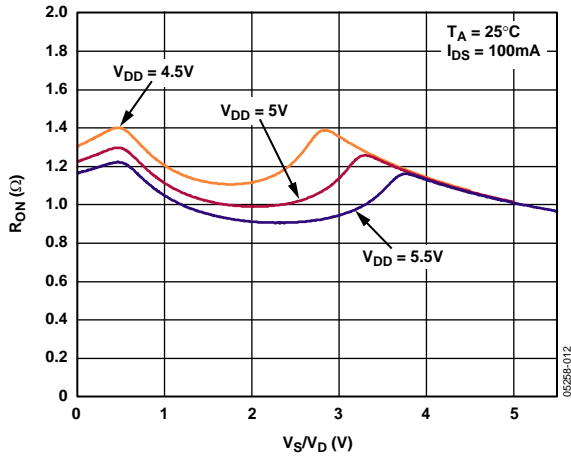


Figure 3. On Resistance vs.  $V_S (V_D)$ ;  $V_{DD} = 5 V \pm 10\%$

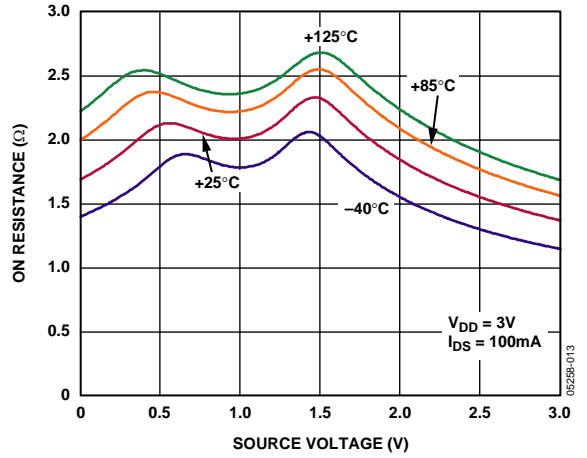


Figure 6. On Resistance vs. Source Voltage for Different Temperatures,  $V_{DD} = 3 V$

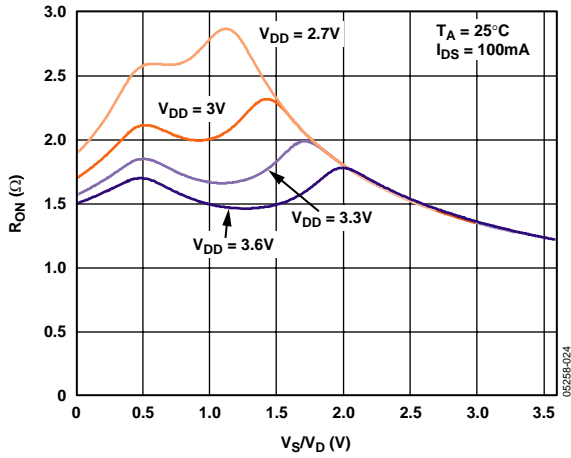


Figure 4. On Resistance vs.  $V_S (V_D)$ ;  $V_{DD} = 2.7 V$  to  $3.6 V$

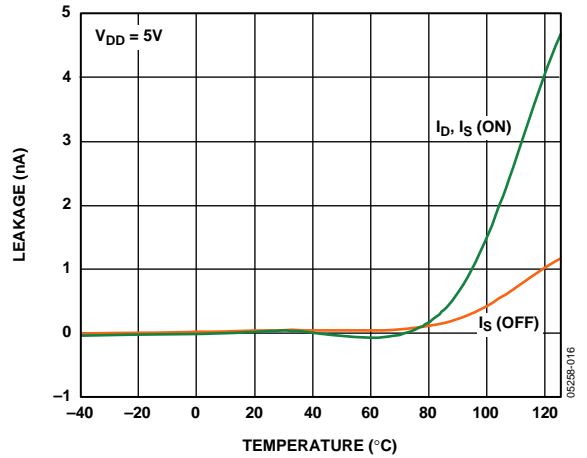


Figure 7. Leakage vs. Temperature,  $V_{DD} = 5 V$

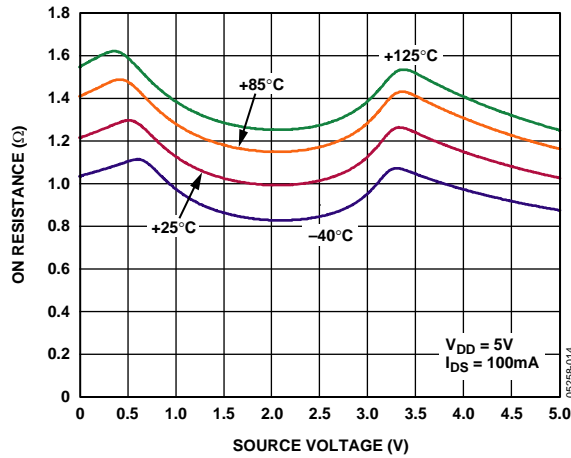


Figure 5. On Resistance vs. Source Voltage for Different Temperatures,  $V_{DD} = 5 V$

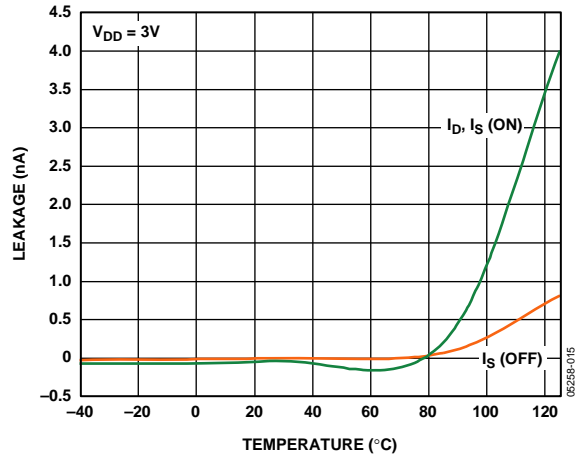


Figure 8. Leakage vs. Temperature,  $V_{DD} = 3 V$

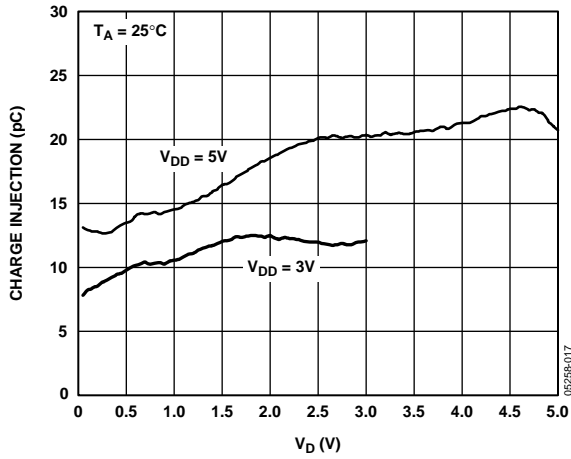


Figure 9. Charge Injection vs. Source Voltage

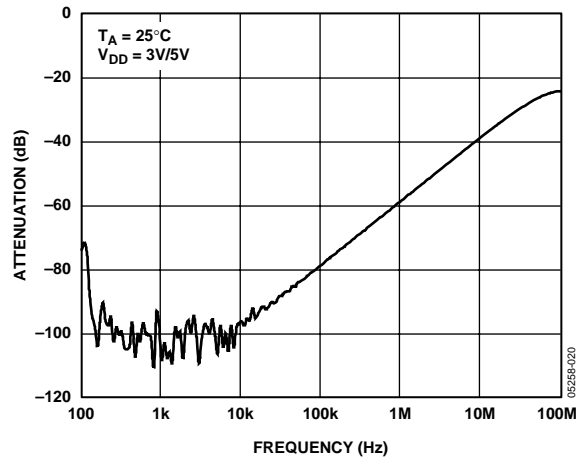


Figure 12. Off Isolation vs. Frequency

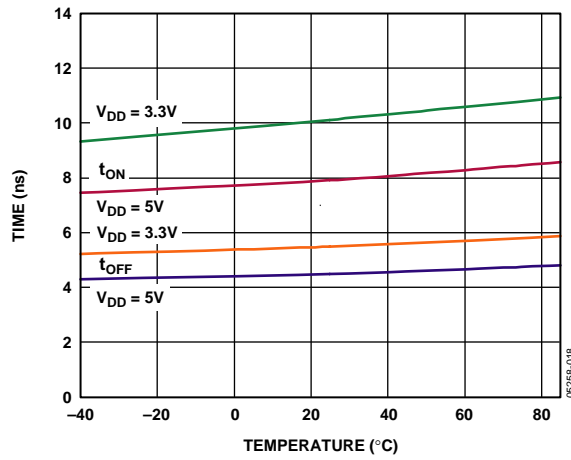


Figure 10.  $t_{ON}/t_{OFF}$  Times vs. Temperature

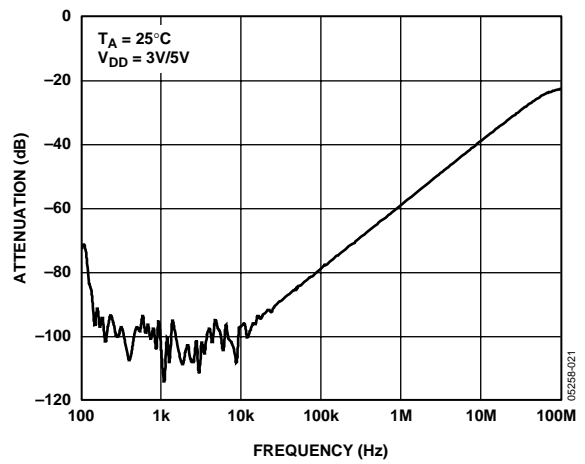


Figure 13. Crosstalk vs. Frequency

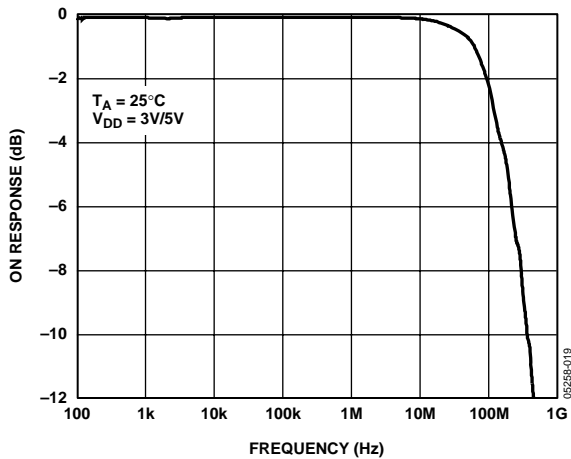


Figure 11. Bandwidth

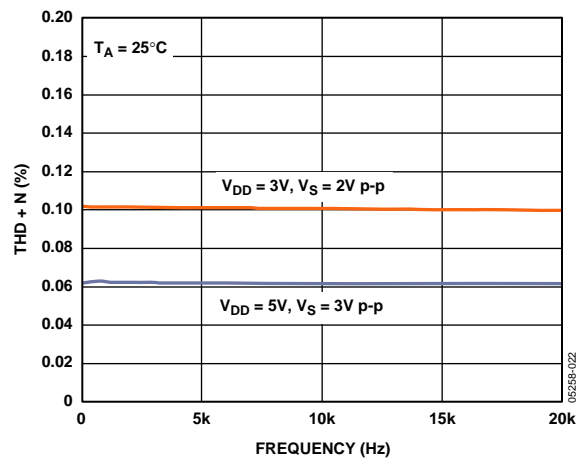


Figure 14. Total Harmonic Distortion + Noise



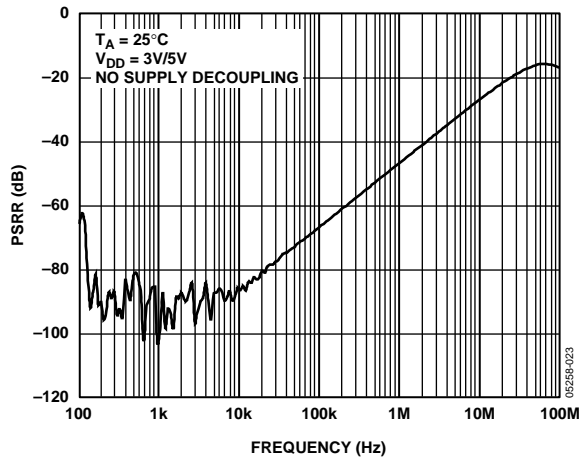


Figure 15. PSRR

## TEST CIRCUITS

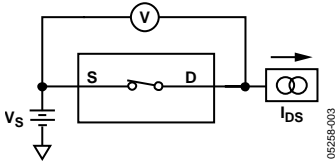


Figure 16. On Resistance

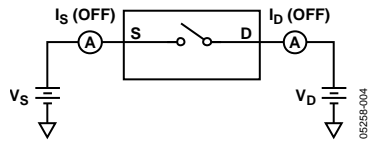


Figure 17. Off Leakage

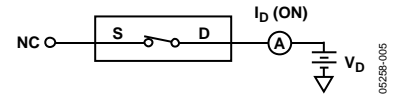


Figure 18. On Leakage

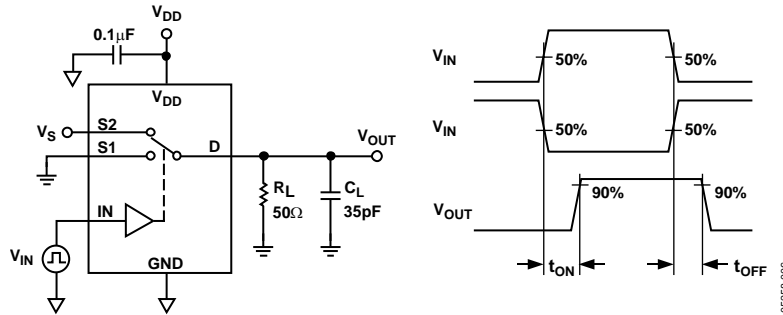


Figure 19. Switching Times,  $t_{ON}$ ,  $t_{OFF}$

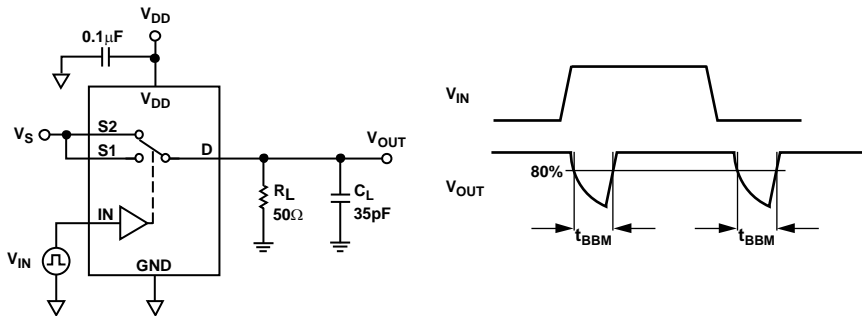


Figure 20. Break-Before-Make Time Delay,  $t_{BBM}$

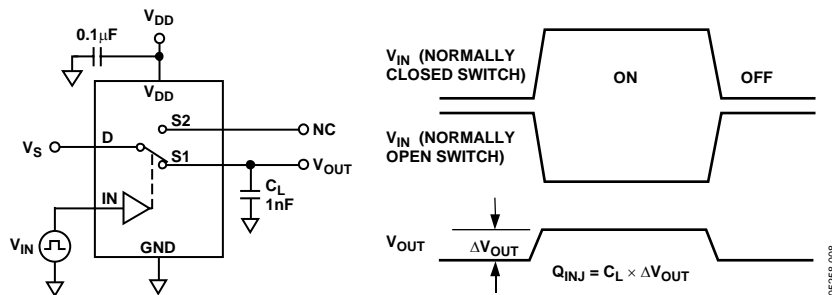


Figure 21. Charge Injection

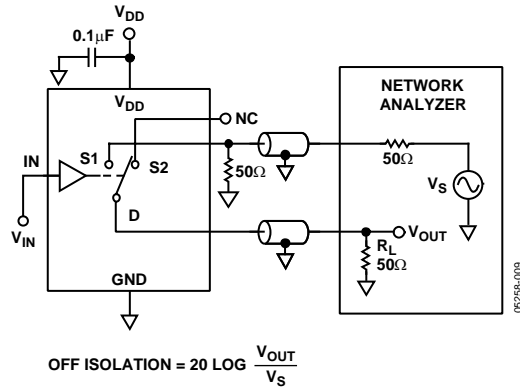


Figure 22. Off Isolation

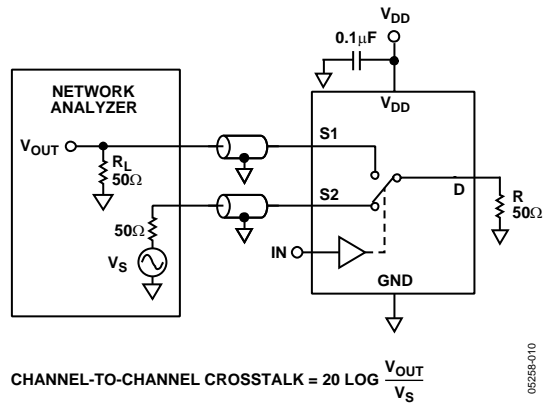


Figure 23. Channel-to-Channel Crosstalk

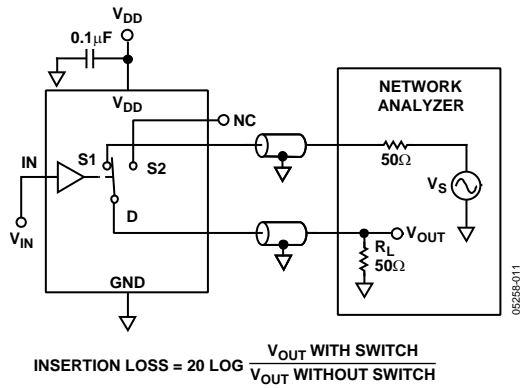


Figure 24. Bandwidth

## TERMINOLOGY

<b>V<sub>DD</sub></b> Most positive power supply potential.	<b>C<sub>S</sub> (Off)</b> Off switch source capacitance. Measured with reference to ground.
<b>I<sub>DD</sub></b> Positive supply current.	<b>C<sub>D</sub> (Off)</b> Off switch drain capacitance. Measured with reference to ground.
<b>GND</b> Ground (0 V) reference.	<b>C<sub>D</sub>, C<sub>S</sub> (On)</b> On switch capacitance. Measured with reference to ground.
<b>S</b> Source terminal. Can be an input or an output.	<b>C<sub>IN</sub></b> Digital input capacitance.
<b>D</b> Drain terminal. Can be an input or an output.	<b>t<sub>ON</sub></b> Delay time between the 50% and 90% points of the digital input and switch on condition.
<b>IN</b> Logic control input.	<b>t<sub>OFF</sub></b> Delay time between the 50% and 90% points of the digital input and switch off condition.
<b>V<sub>D</sub> (V<sub>S</sub>)</b> Analog voltage on the D and S terminals.	<b>t<sub>BBM</sub></b> On or off time measured between the 80% points of both switches when switching from one to another.
<b>R<sub>ON</sub></b> Ohmic resistance between the D and S terminals.	<b>Charge Injection</b> A measure of the glitch impulse transferred from the digital input to the analog output during on/off switching.
<b>R<sub>FLAT (ON)</sub></b> Flatness is defined as the difference between the maximum and minimum value of on resistance as measured.	<b>Off Isolation</b> A measure of unwanted signal coupling through an off switch.
<b>ΔR<sub>ON</sub></b> On resistance mismatch between any two channels.	<b>Crosstalk</b> A measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.
<b>I<sub>S</sub> (Off)</b> Source leakage current with the switch off.	<b>-3 dB Bandwidth</b> The frequency at which the output is attenuated by 3 dB.
<b>I<sub>D</sub> (Off)</b> Drain leakage current with the switch off.	<b>On Response</b> The frequency response of the on switch.
<b>I<sub>D</sub>, I<sub>S</sub> (On)</b> Channel leakage current with the switch on.	<b>Insertion Loss</b> The loss due to the on resistance of the switch.
<b>V<sub>INL</sub></b> Maximum input voltage for Logic 0.	<b>THD + N</b> The ratio of harmonic amplitudes plus noise of a signal to the fundamental.
<b>V<sub>INH</sub></b> Minimum input voltage for Logic 1.	
<b>I<sub>INL</sub> (I<sub>INH</sub>)</b> Input current of the digital input.	

# OUTLINE DIMENSIONS

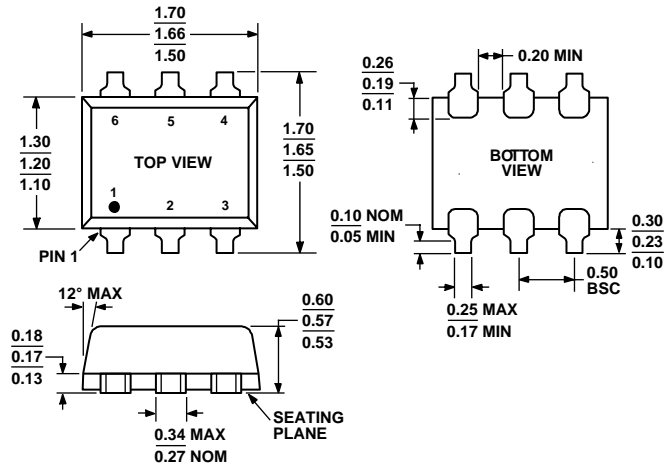


Figure 25. 6-Lead Small Outline Transistor Package [SOT-66] (RY-6-1)  
 Dimensions shown in millimeters

## ORDERING GUIDE

Model	Temperature Range	Package Description	Package Option	Branding <sup>1</sup>
ADG859YRYZ-REEL <sup>2</sup>	-40°C to +125°C	6-Lead Small Outline Transistor Package (SOT-66)	RY-6-1	02
ADG859YRYZ-REEL7 <sup>2</sup>	-40°C to +125°C	6-Lead Small Outline Transistor Package (SOT-66)	RY-6-1	02
ADG859BRYZ-REEL <sup>2</sup>	-40°C to +85°C	6-Lead Small Outline Transistor Package (SOT-66)	RY-6-1	04
ADG859BRYZ-REEL7 <sup>2</sup>	-40°C to +85°C	6-Lead Small Outline Transistor Package (SOT-66)	RY-6-1	04

<sup>1</sup> Branding on this package is limited to two characters due to space constraints.

<sup>2</sup> Z = Pb-free part.

**ADG859**

**NOTES**

**NOTES**

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**NOTES**