

## FEATURES

44 V supply maximum ratings

$V_{SS}$  to  $V_{DD}$  analog signal range

Low on resistance (45  $\Omega$  max)

Low  $\Delta R_{ON}$  (5  $\Omega$  max)

Low  $R_{ON}$  match (4  $\Omega$  max)

Low power dissipation

Fast switching times

$t_{ON} < 175$  ns

$t_{OFF} < 145$  ns

Low leakage currents (5 nA max)

Low charge injection (10 pC max)

Break-before-make switching action

## APPLICATIONS

Audio and video switching

Battery-powered systems

Test equipment

Communication systems

## GENERAL DESCRIPTION

The **ADG333A** is a monolithic complementary metal-oxide semiconductor (CMOS) device comprising four independently selectable single-pole, double-throw (SPDT) switches. It is designed on a linear compatible CMOS (LC<sup>2</sup>MOS) process, which provides low power dissipation yet achieves a high switching speed and a low on resistance.

The on-resistance profile is very flat over the full analog input range, ensuring good linearity and low distortion when switching audio signals. High switching speed also makes the device suitable for video signal switching. CMOS construction ensures ultralow power dissipation, making the device ideally suited for portable, battery-powered instruments.

When they are on, each switch conducts equally well in both directions and has an input signal range that extends to the power supplies. In the off condition, signal levels up to the supplies are blocked. All switches exhibit break-before-make switching action for use in multiplexer applications. Low charge injection is inherent in the design.

## FUNCTIONAL BLOCK DIAGRAM

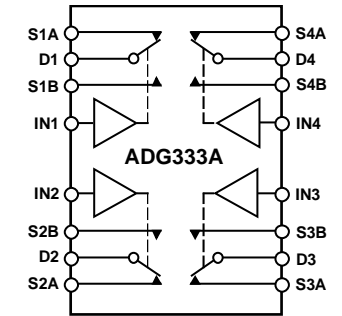


Figure 1.

## PRODUCT HIGHLIGHTS

1. Extended signal range. The **ADG333A** is fabricated on an enhanced LC<sup>2</sup>MOS process, giving an increased signal range which extends to the supply rails.
2. Low power dissipation.
3. Low  $R_{ON}$ .
4. Single-supply operation. For applications in which the analog signal is unipolar, the **ADG333A** can be operated from a single rail power supply. The device is fully specified with a single 12 V supply.

Rev. B

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## REVISION HISTORY

### 6/2016—Rev. A to Rev. B

Changes to $V_{DD}$ Parameter, Table 2 .....	4
Updated Outline Dimensions .....	12
Changes to Ordering Guide .....	13

### 3/2005—Rev. 0 to Rev. A

Updated Format .....	Universal
Changes to Specifications Section .....	3
Updated Outline Dimensions .....	12
Changes to Ordering Guide .....	12

### 10/1995—Revision 0: Initial Version

## SPECIFICATIONS

### DUAL SUPPLY

$V_{DD} = +15\text{ V}$ ,  $V_{SS} = -15\text{ V}$ ,  $GND = 0\text{ V}$ , unless otherwise noted.<sup>1</sup>

Table 1.

Parameter	+25°C	-40°C to +85°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>				
Analog Signal Range		$V_{SS}$ to $V_{DD}$	V	
$R_{ON}$	20 45	45	$\Omega$ typ $\Omega$ max	$V_D = \pm 10\text{ V}$ , $I_S = -1\text{ mA}$
$\Delta R_{ON}$		5	$\Omega$ max	$V_D = \pm 5\text{ V}$ , $I_S = -10\text{ mA}$
$R_{ON}$ Match		4	$\Omega$ max	$V_D = \pm 10\text{ V}$ , $I_S = -10\text{ mA}$
<b>LEAKAGE CURRENTS</b>				
Source Off Leakage $I_S$ (OFF)	$\pm 0.1$ $\pm 0.25$	$\pm 3$	nA typ nA max	$V_{DD} = +16.5\text{ V}$ , $V_{SS} = -16.5\text{ V}$ $V_D = \pm 15.5\text{ V}$ , $V_S = +15.5\text{ V}$ Figure 15
Channel On Leakage $I_D$ , $I_S$ (ON)	$\pm 0.1$ $\pm 0.4$	$\pm 5$	nA typ nA max	$V_S = V_D = \pm 15.5\text{ V}$ Figure 16
<b>DIGITAL INPUTS</b>				
Input High Voltage, $V_{INH}$		2.4	V min	
Input Low Voltage, $V_{INL}$		0.8	V max	
Input Current $I_{INL}$ or $I_{INH}$		$\pm 0.005$ $\pm 0.5$	$\mu\text{A}$ typ $\mu\text{A}$ max	$V_{IN} = 0\text{ V}$ or $V_{DD}$
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>				
$t_{ON}$	90	175	ns typ ns max	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ ; $V_S = \pm 10\text{ V}$ ; Figure 17
$t_{OFF}$	80	145	ns typ ns max	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ ; $V_S = \pm 10\text{ V}$ ; Figure 17
Break-Before-Make Delay, $t_{OPEN}$	10		ns min	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ ; $V_S = +5\text{ V}$ ; Figure 18
Charge Injection	2		pC typ	$V_D = 0\text{ V}$ , $R_D = 0\ \Omega$ , $C_L = 10\text{ nF}$ ; $V_{DD} = +15\text{ V}$ , $V_{SS} = -15\text{ V}$ ; Figure 19
Off Isolation	10		pC max	
Channel-to-Channel Crosstalk	72		dB typ	$R_L = 75\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; $V_S = 2.3\text{ V rms}$ ; Figure 20
$C_S$ (OFF)	85		dB typ	$R_L = 75\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; $V_S = 2.3\text{ V rms}$ ; Figure 21
$C_D$ , $C_S$ (ON)	7 26		pF typ pF typ	
<b>POWER REQUIREMENTS</b>				
$I_{DD}$	0.05 0.25	0.35	mA typ mA max	Digital inputs = 0 V or 5 V
$I_{SS}$	0.01 1	5	$\mu\text{A}$ typ $\mu\text{A}$ max	
$V_{DD}/V_{SS}$		$\pm 3/\pm 20$	V min/V max	$ V_{DD}  =  V_{SS} $

<sup>1</sup> Temperature range is as follows: B version:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

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

**SINGLE SUPPLY**

$V_{DD} = +12\text{ V}$ ,  $V_{SS} = 0\text{ V} \pm 10\%$ ,  $GND = 0\text{ V}$ , unless otherwise noted.<sup>1</sup>

**Table 2.**

Parameter	+25°C	-40°C to +85°C	Unit	Test Conditions/Comments
<b>ANALOG SWITCH</b>				
Analog Signal Range		0 V to $V_{DD}$	V	
$R_{ON}$	35	75	$\Omega$ typ $\Omega$ max	$V_D = 1\text{ V}$ , $10\text{ V}$ , $I_S = -1\text{ mA}$
<b>LEAKAGE CURRENTS</b>				
Source Off Leakage $I_S$ (OFF)	$\pm 0.1$ $\pm 0.25$	$\pm 3$	nA typ nA max	$V_{DD} = 13.2\text{ V}$ $V_D = 12.2\text{ V}/1\text{ V}$ , $V_S = 1\text{ V}/12.2\text{ V}$ Figure 15
Channel On Leakage $I_D$ , $I_S$ (ON)	$\pm 0.1$ $\pm 0.4$	$\pm 5$	nA typ nA max	$V_S = V_D = 12.2\text{ V}/1\text{ V}$ Figure 16
<b>DIGITAL INPUTS</b>				
Input High Voltage, $V_{INH}$		2.4	V min	
Input Low Voltage, $V_{INL}$		0.8	V max	
Input Current $I_{INL}$ or $I_{INH}$		$\pm 0.005$ $\pm 0.5$	$\mu\text{A}$ typ $\mu\text{A}$ max	$V_{IN} = 0\text{ V}$ or $V_{DD}$
<b>DYNAMIC CHARACTERISTICS<sup>2</sup></b>				
$t_{ON}$	110	200	ns typ ns max	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ ; $V_S = 8\text{ V}$ ; Figure 17
$t_{OFF}$	100	180	ns typ ns max	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ ; $V_S = 8\text{ V}$ ; Figure 17
Break-Before-Make Delay, $t_{OPEN}$	10		ns min	$R_L = 300\ \Omega$ , $C_L = 35\text{ pF}$ ; $V_S = 5\text{ V}$ ; Figure 18
Charge Injection	5		pC typ	$V_D = 6\text{ V}$ , $R_D = 0\text{ W}$ , $C_L = 10\text{ nF}$ ; $V_{DD} = 12\text{ V}$ , $V_{SS} = 0\text{ V}$ ; Figure 19
Off Isolation	72		dB typ	$R_L = 75\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; $V_S = 1.15\text{ V rms}$ ; Figure 20
Channel-to-Channel Crosstalk	85		dB typ	$R_L = 75\ \Omega$ , $C_L = 5\text{ pF}$ , $f = 1\text{ MHz}$ ; $V_S = 1.15\text{ V rms}$ ; Figure 21
$C_S$ (OFF)	12		pF typ	
$C_D$ , $C_S$ (ON)	25		pF typ	
<b>POWER REQUIREMENTS</b>				
$I_{DD}$	0.05 0.25	0.35	mA typ mA max	$V_{DD} = 13.5\text{ V}$ Digital inputs = 0 V or 5 V
$V_{DD}$		3/30	V min/V max	

<sup>1</sup> Temperature range is as follows: B Version:  $-40^\circ\text{C}$  to  $+85^\circ\text{C}$ .

<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	Min
$V_{DD}$ to $V_{SS}$	+44 V
$V_{DD}$ to GND	-0.3 V to +30 V
$V_{SS}$ to GND	+0.3 V to -30 V
Analog, Digital Inputs <sup>1</sup>	$V_{SS} - 2\text{ V}$ to $V_{DD} + 2\text{ V}$ or 20 mA, whichever occurs first
Continuous Current, S or D	20 mA
Peak Current, S or D (Pulsed at 1 ms, 10% Duty Cycle Max)	40 mA
Operating Temperature Range	
Industrial (B Version)	-40°C to +85°C
Storage Temperature Range	-65°C to +125°C
Junction Temperature	150°C
$\theta_{JA}$ , Thermal Impedance	
PDIP Package	103°C/W
SOIC Package	74°C/W
SSOP Package	130°C/W
Lead Temperature, Soldering	
10 sec	260°C
Vapor Phase (60 sec)	215°C
Infrared (15 sec)	220°C

<sup>1</sup> Overvoltage at IN, S, or D is clamped by internal diodes. Current should be limited to the maximum ratings given.

Stresses at or above those listed under Absolute Maximum Ratings may cause permanent damage to the product. This is a stress rating only; functional operation of the product at these or any other conditions above those indicated in the operational section of this specification is not implied. Operation beyond the maximum operating conditions for extended periods may affect product reliability.

**Table 4. Truth Table**

Logic	Switch A	Switch B
0	Off	On
1	On	Off

### ESD CAUTION



**ESD (electrostatic discharge) sensitive device.** Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

## TERMINOLOGY

**R<sub>ON</sub>**

Ohmic resistance between D and S.

**ΔR<sub>ON</sub>**

R<sub>ON</sub> variation due to a change in the analog input voltage with a constant load current.

**R<sub>ON</sub> Match**

Difference between the R<sub>ON</sub> of any two channels.

**I<sub>S</sub> (OFF)**

Source leakage current with the switch off.

**I<sub>D</sub> (OFF)**

Drain leakage current with the switch off.

**I<sub>D</sub>, I<sub>S</sub> (ON)**

Channel leakage current with the switch on.

**V<sub>D</sub> (V<sub>S</sub>)**

Analog voltage on Terminal D and Terminal S.

**C<sub>S</sub> (OFF)**

Off switch source capacitance.

**C<sub>D</sub> (OFF)**

Off switch drain capacitance.

**C<sub>D</sub>, C<sub>S</sub> (ON)**

On switch capacitance.

**t<sub>ON</sub>**

Delay between applying the digital control input and the output switching on.

**t<sub>OFF</sub>**

Delay between applying the digital control input and the output switching off.

**t<sub>OPEN</sub>**

Break-before-make delay when switches are configured as a multiplexer.

**V<sub>INL</sub>**

Maximum input voltage for Logic 0.

**V<sub>INH</sub>**

Minimum input voltage for Logic 1.

**I<sub>INL</sub> (I<sub>INH</sub>)**

Input current of the digital input.

**Crosstalk**

A measure of unwanted signal which 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.

### PIN CONFIGURATIONS AND FUNCTION DESCRIPTIONS

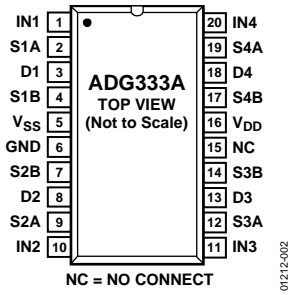


Figure 2. PDIP Pin Configuration

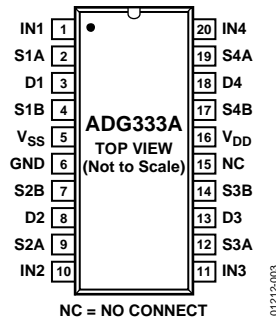


Figure 3. SOIC Pin Configuration

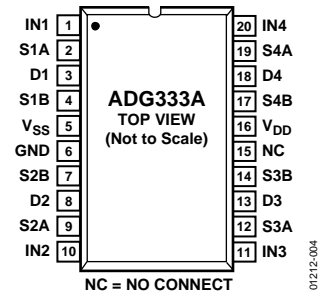


Figure 4. SSOP Pin Configuration

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1, 10, 11, 20	IN1, IN2, IN3, IN4	Logic Control Input.
2, 4, 7, 9, 12, 14, 17, 19	S1A, S1B, S2B, S2A, S3A, S3B, S4B, S4A	Source Terminal. Can be an input or an output.
3, 8, 13, 18	D1, D2, D3, D4	Drain Terminal. Can be an input or an output.
5	V <sub>SS</sub>	Most Negative Power Supply Potential in Dual Supplies. In single-supply applications, it can be connected to ground.
6	GND	Ground (0 V) Reference.
15	NC	No Connect.
16	V <sub>DD</sub>	Most Positive Power Supply Potential.

TYPICAL PERFORMANCE CHARACTERISTICS

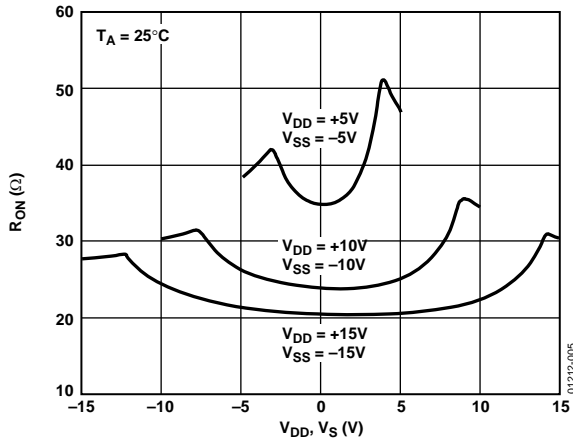


Figure 5.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ), Dual Supply

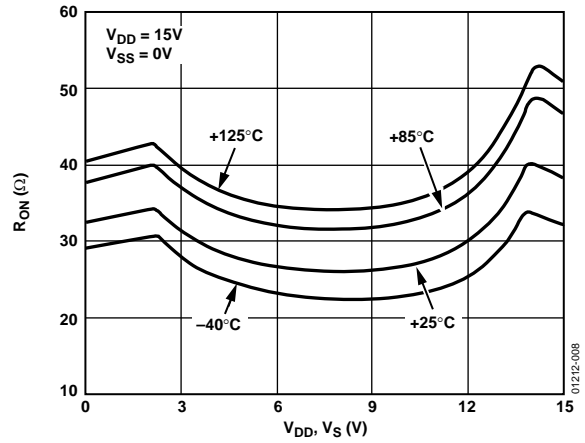


Figure 8.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures, Single Supply

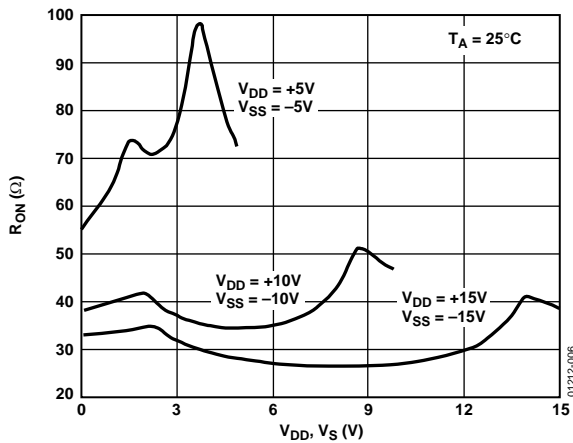


Figure 6.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ), Single Supply

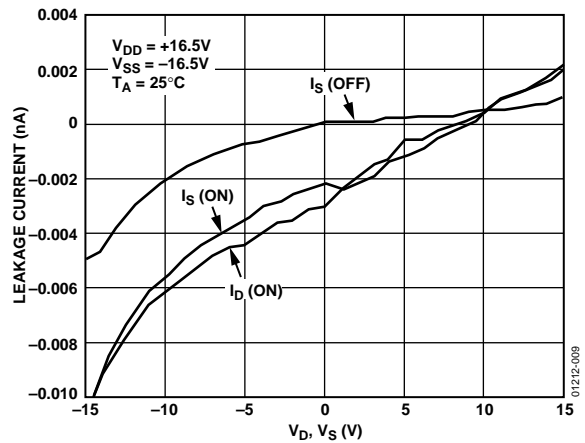


Figure 9. Leakage Currents as a Function of  $V_D$  ( $V_S$ ), Dual Supply

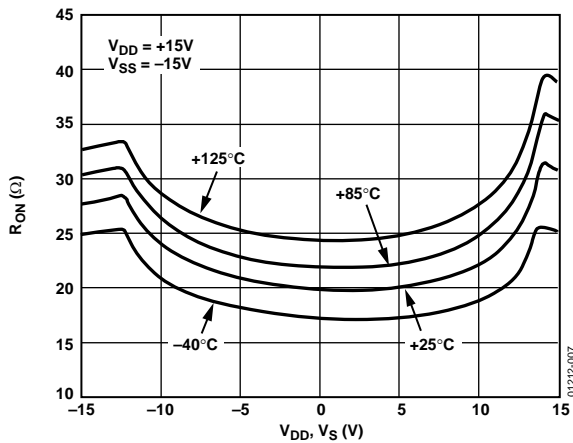


Figure 7.  $R_{ON}$  as a Function of  $V_D$  ( $V_S$ ) for Different Temperatures, Dual Supply

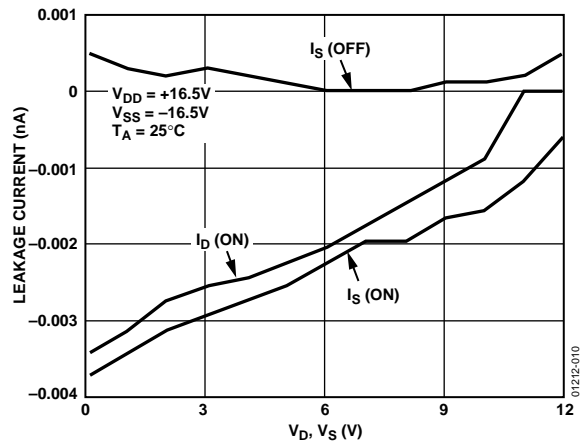


Figure 10. Leakage Currents as a Function of  $V_D$  ( $V_S$ ), Single Supply



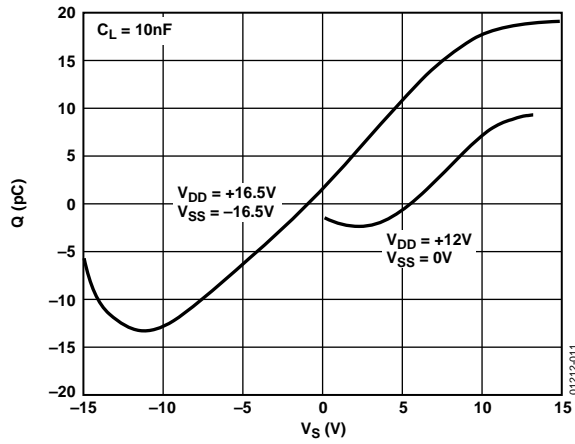


Figure 11. Charge Injection as a Function of  $V_S$

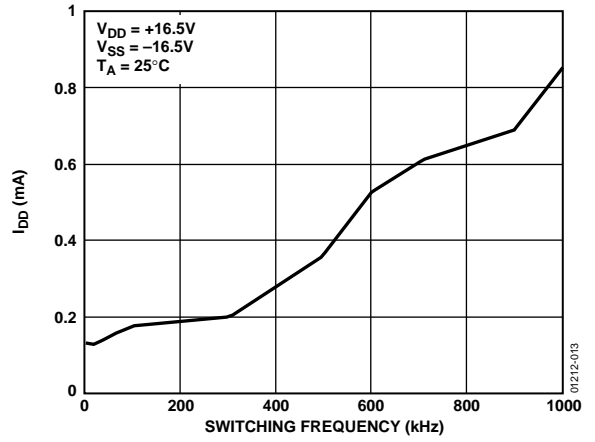


Figure 13.  $I_{DD}$  as a Function of Switching Frequency

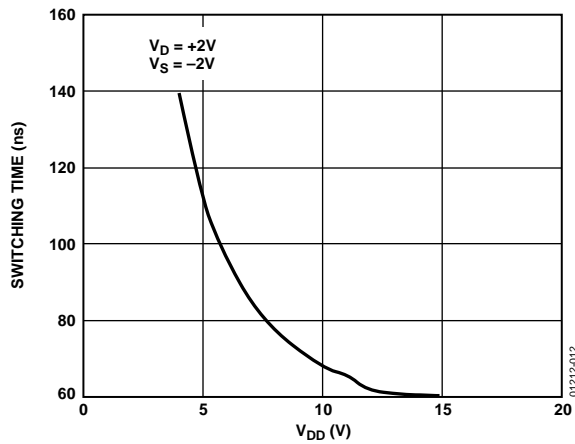


Figure 12. Switching Time as a Function of  $V_D$

TEST CIRCUITS

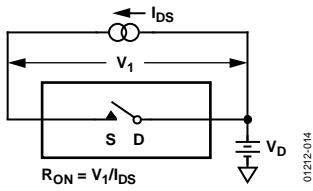


Figure 14. On Resistance

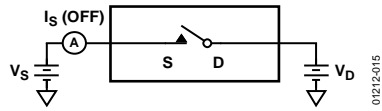


Figure 15. Off Leakage

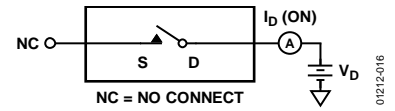


Figure 16. On Leakage

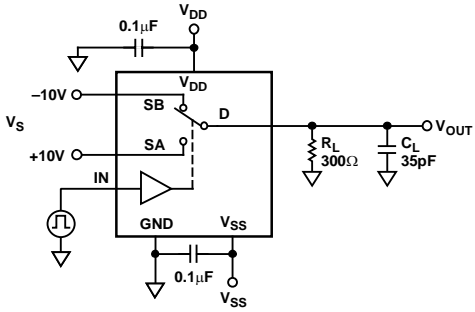


Figure 17. Switching Times

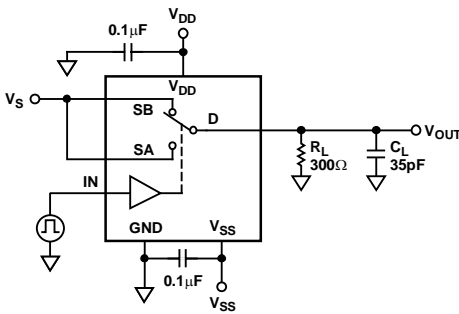


Figure 18. Break-Before-Make Delay,  $t_{OPEN}$

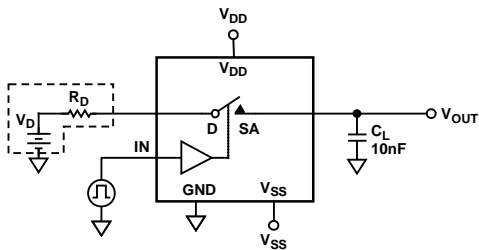


Figure 19. Charge Injection

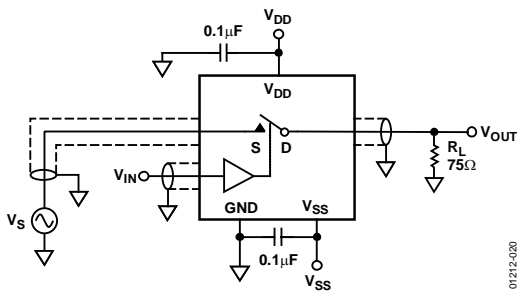


Figure 20. Off Isolation

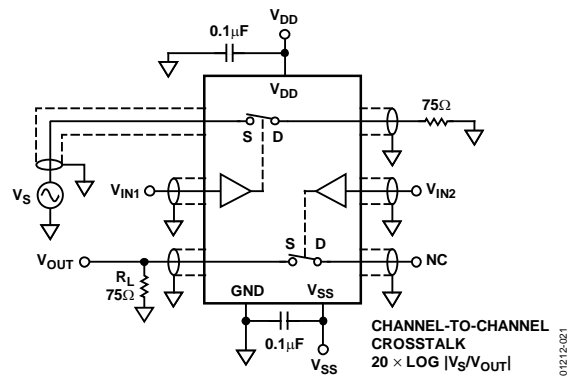


Figure 21. Channel-to-Channel Crosstalk

## APPLICATIONS INFORMATION

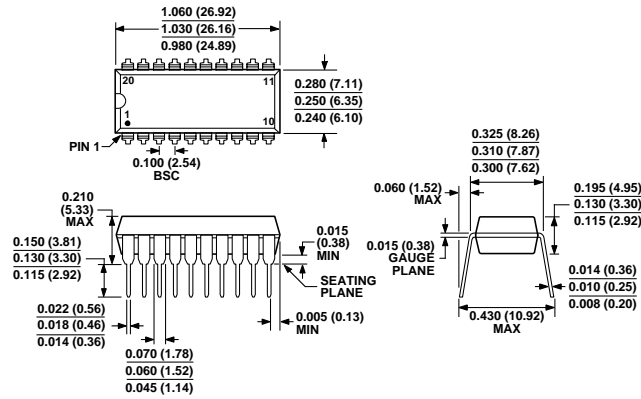
### ADG333A SUPPLY VOLTAGES

The ADG333A can operate from a dual or signal supply.  $V_{SS}$  should be connected to GND when operating with a single supply. When using a dual supply, the ADG333A can also operate with unbalanced supplies; for example  $V_{DD} = 20\text{ V}$  and  $V_{SS} = -5\text{ V}$ . The only restrictions are that  $V_{DD}$  to GND must not exceed 30 V,  $V_{SS}$  to GND must not drop below  $-30\text{ V}$ , and  $V_{DD}$  to  $V_{SS}$  must not exceed +44 V. It is important to remember that the ADG333A supply voltage directly affects the input signal range, the switch on resistance and the switching times of the device. The effects of the power supplies on these characteristics can be clearly seen from the Typical Performance Characteristics curves.

### POWER SUPPLY SEQUENCING

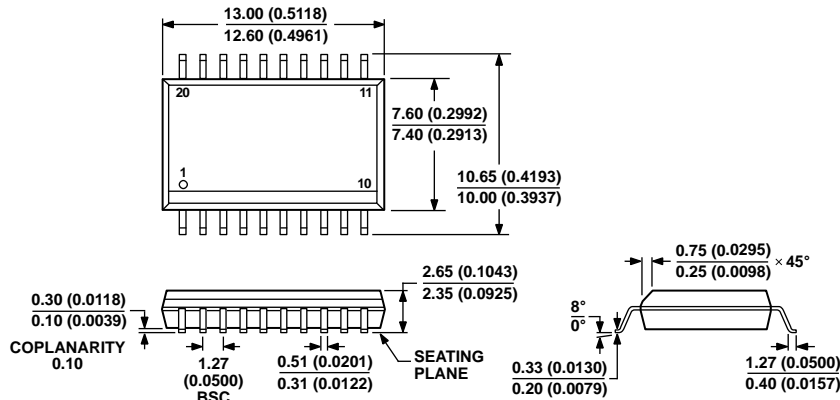
When using CMOS devices, care must be taken to ensure correct power-supply sequencing. Incorrect power-supply sequencing can result in the device being subjected to stresses beyond those listed in the Absolute Maximum Ratings. This is also true for the ADG333A. Always turn on  $V_{DD}$  first, followed by  $V_{SS}$  and the logic signals. An external signal within the maximum specified ratings can then be safely presented to the source or drain of the switch.

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MS-001-AD  
 CONTROLLING DIMENSIONS ARE IN INCHES; MILLIMETER DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF INCH EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN. CORNER LEADS MAY BE CONFIGURED AS WHOLE OR HALF LEADS.

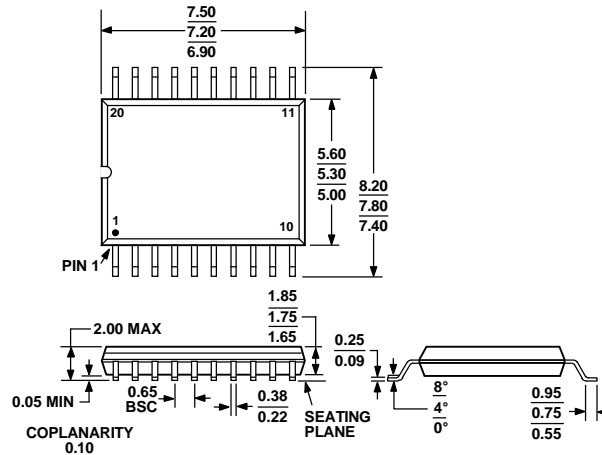
Figure 22. 20-Lead Plastic Dual In-Line Package [PDIP] Narrow Body (N-20)  
 Dimensions shown in inches and (millimeters)



COMPLIANT TO JEDEC STANDARDS MS-013-AC  
 CONTROLLING DIMENSIONS ARE IN MILLIMETERS; INCH DIMENSIONS (IN PARENTHESES) ARE ROUNDED-OFF MILLIMETER EQUIVALENTS FOR REFERENCE ONLY AND ARE NOT APPROPRIATE FOR USE IN DESIGN.

Figure 23. 20-Lead Standard Small Outline Package [SOIC\_W] Wide Body (RW-20)  
 Dimensions shown in millimeters and (inches)

06-07-2006-A



COMPLIANT TO JEDEC STANDARDS MO-150AE  
 Figure 24. 20-Lead Shrink Small Outline Package [SSOP]  
 (RS-20)  
 Dimensions shown in millimeters

**ORDERING GUIDE**

Model <sup>1</sup>	Temperature Range	Package Description	Package Option
ADG333ABNZ	-40°C to +85°C	20-Lead Plastic Dual In-Line Package [PDIP]	N-20
ADG333ABR	-40°C to +85°C	20-Lead Standard Small Outline Package [SOIC_W]	RW-20
ADG333ABR-REEL	-40°C to +85°C	20-Lead Standard Small Outline Package [SOIC_W]	RW-20
ADG333ABRZ	-40°C to +85°C	20-Lead Standard Small Outline Package [SOIC_W]	RW-20
ADG333ABRZ-REEL	-40°C to +85°C	20-Lead Standard Small Outline Package [SOIC_W]	RW-20
ADG333ABRS	-40°C to +85°C	20-Lead Shrink Small Outline Package [SSOP]	RS-20
ADG333ABRS-REEL	-40°C to +85°C	20-Lead Shrink Small Outline Package [SSOP]	RS-20
ADG333ABRSZ	-40°C to +85°C	20-Lead Shrink Small Outline Package [SSOP]	RS-20
ADG333ABRSZ-REEL	-40°C to +85°C	20-Lead Shrink Small Outline Package [SSOP]	RS-20

<sup>1</sup> Z = RoHS Compliant Part.