1 pC Charge Injection, 100 pA Leakage, CMOS, ±5 V/5 V/3 V, Quad SPST Switches

Enhanced Product

ADG613-EP

FEATURES

- 1 pC charge injection
- ±0.1 nA maximum at 25°C leakage currents
- 85 Ω on resistance
- Rail-to-rail switching operation
- Fast switching times
- 16-lead TSSOP
- Typical power consumption: ≤11 nW
- TTL-/CMOS-compatible inputs
- V_{SS} to V_{DD} analog signal range
  - ±2.7 V to ±5.5 V dual supply operation
  - 2.7 V to 5.5 V single-supply operation
- Fully specified at ±5 V, 3 V, and 5 V

ENHANCED PRODUCT FEATURES

- Supports defense and aerospace applications (AQEC standard)
- Military temperature range: −55°C to +125°C
- Controlled manufacturing baseline
- 1 assembly site
- 1 test site
- 1 fabrication site
- Enhanced product change notification
- Qualification data available on request

APPLICATIONS

- Automatic test equipment
- Data acquisition systems
- Battery-powered systems
- Communications systems
- Sample-and-hold systems
- Audio signal routing
- Relay replacement
- Avionics

FUNCTIONAL BLOCK DIAGRAM

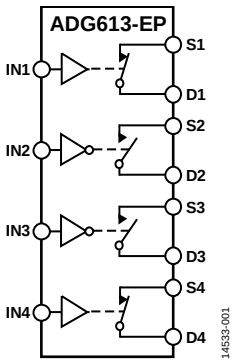

Figure 1.

GENERAL DESCRIPTION

The ADG613-EP is a monolithic CMOS device containing four independently selectable switches. This switch offers ultralow charge injection of 1 pC over the full input signal range and typical leakage currents of 0.01 nA at 25°C.

The device is fully specified for ±5 V, 5 V, and 3 V supplies. It contains four independent single-pole, single-throw (SPST) switches. The ADG613-EP contains two switches with digital control logic that turns on with logic low and two switches in which the logic is inverted.

Each switch conducts equally well in both directions when on and has an input signal range that extends to the supplies. The ADG613-EP exhibits break-before-make switching action.

The ADG613-EP is available in a small, 16-lead TSSOP package.

The ADG613-EP is also a TTL-compatible device.

Additional application and technical information can be found in the ADG613 data sheet.

PRODUCT HIGHLIGHTS

1. Ultralow charge injection (1 pC typically).
2. Dual ±2.7 V to ±5.5 V or single 2.7 V to 5.5 V operation.
3. Temperature range: −55°C to +125°C.
4. Small, 16-lead TSSOP.

Rev. A

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REVISION HISTORY

10/2016—Rev. 0 to Rev. A

Changes to Features Section and Enhanced Product Features Section....1

6/2016—Revision 0: Initial Revision

SPECIFICATIONS

DUAL-SUPPLY OPERATION

V_{DD} = 5 V ± 10%, V_{SS} = −5 V ± 10%, GND = 0 V, unless otherwise noted. V_S is the source voltage. V_D is the drain voltage.

Table 1.

Parameter	25°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		V_{SS} to V_{DD}	V	
On Resistance, R_{ON}	85		Ω typ	V_S = ±3 V, I_S = −1 mA; see Figure 14
	115	160	Ω max	V_S = ±3 V, I_S = −1 mA; see Figure 14
On-Resistance Match Between Channels, ΔR_{ON}	2		Ω typ	V_S = ±3 V, I_S = −1 mA
	4	6.5	Ω max	V_S = ±3 V, I_S = −1 mA
On-Resistance Flatness, $R_{FLAT(ON)}$	25		Ω typ	V_S = ±3 V, I_S = −1 mA
	40	60	Ω max	V_S = ±3 V, I_S = −1 mA
LEAKAGE CURRENTS				V_{DD} = +5.5 V, V_{SS} = −5.5 V
Source Off Leakage, $I_{S(OFF)}$	±0.01		nA typ	V_D = ±4.5 V, V_S = ∓4.5 V; see Figure 15
	±0.1	±2	nA max	V_D = ±4.5 V, V_S = ∓4.5 V; see Figure 15
Drain Off Leakage, $I_{D(OFF)}$	±0.01		nA typ	V_D = ±4.5 V, V_S = ∓4.5 V; see Figure 15
	±0.1	±2	nA max	V_D = ±4.5 V, V_S = ∓4.5 V; see Figure 15
Channel On Leakage, $I_{D(ON)}$, $I_{S(ON)}$	±0.01		nA typ	V_D = V_S = ±4.5 V; see Figure 16
	±0.1	±6	nA max	V_D = V_S = ±4.5 V; see Figure 16
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	V_{IN} = V_{INL} or V_{INH}
Digital Input Capacitance, C_{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS[1]				
Delay from Digital Control Input and Output Switching On, t_{ON}	45		ns typ	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
	65	90	ns max	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
Delay from Digital Control Input and Output Switching Off, t_{OFF}	25		ns typ	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
	40	50	ns max	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
Break-Before-Make Time Delay, t_{BBM}	15		ns typ	R_L = 300 Ω, C_L = 35 pF, V_{S1} = V_{S2} = 3.0 V; see Figure 18
		10	ns min	R_L = 300 Ω, C_L = 35 pF, V_{S1} = V_{S2} = 3.0 V; see Figure 18
Charge Injection	−0.5		pC typ	V_S = 0 V, R_S = 0 Ω, C_L = 1 nF; see Figure 19
Off Isolation	−65		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz; see Figure 20
Channel to Channel Crosstalk	−90		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz; see Figure 21
−3 dB Bandwidth	680		MHz typ	R_L = 50 Ω, C_L = 5 pF; see Figure 22
Off Switch Source Capacitance, $C_{S(OFF)}$	5		pF typ	f = 1 MHz
Off Switch Drain Capacitance, $C_{D(OFF)}$	5		pF typ	f = 1 MHz
On Switch Capacitance, $C_{D(ON)}$, $C_{S(ON)}$	5		pF typ	f = 1 MHz
POWER REQUIREMENTS				V_{DD} = +5.5 V, V_{SS} = −5.5 V
Positive Supply Current, I_{DD}	0.001		μA typ	Digital inputs = 0 V or 5.5 V
		1.0	μA max	Digital inputs = 0 V or 5.5 V
Negative Supply Current, I_{SS}	0.001		μA typ	Digital inputs = 0 V or 5.5 V
		1.0	μA max	Digital inputs = 0 V or 5.5 V
V_{DD}/V_{SS}		±2.7	V min	
		±5.5	V max	
Power Consumption	11		nW typ	
	11		μW max	

[1] Guaranteed by design; not subject to production test.

SINGLE-SUPPLY OPERATION

V_{DD} = 5 V ± 10%, V_{SS} = 0 V, GND = 0 V, unless otherwise noted. V_S is the source voltage. V_D is the drain voltage.

Table 2.

Parameter	25°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 to V_{DD}	V	
On Resistance, R_{ON}	210		Ω typ	V_S = 3.5 V, I_S = −1 mA; see Figure 14
	290	380	Ω max	V_S = 3.5 V, I_S = −1 mA; see Figure 14
On-Resistance Match Between Channels, ΔR_{ON}	3		Ω typ	V_S = 3.5 V, I_S = −1 mA
	10	13	Ω max	V_S = 3.5 V, I_S = −1 mA
LEAKAGE CURRENTS				V_{DD} = 5.5 V
Source Off Leakage, $I_{S(OFF)}$	±0.01		nA typ	V_S = 1 V or 4.5 V, V_D = 4.5 V or 1 V; see Figure 15
	±0.1	±2	nA max	V_S = 1 V or 4.5 V, V_D = 4.5 V or 1 V; see Figure 15
Drain Off Leakage, $I_{D(OFF)}$	±0.01		nA typ	V_S = 1 V or 4.5 V, V_D = 4.5 V or 1 V; see Figure 15
	±0.1	±2	nA max	V_S = 1 V or 4.5 V, V_D = 4.5 V or 1 V; see Figure 15
Channel On Leakage, $I_{D(ON)}$, $I_{S(ON)}$	±0.01		nA typ	V_S = V_D = 1 V or 4.5 V; see Figure 16
	±0.1	±6	nA max	V_S = V_D = 1 V or 4.5 V; see Figure 16
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	V_{IN} = V_{INL} or V_{INH}
Digital Input Capacitance, C_{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS[1]				
t_{ON}	70		ns typ	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
	100	150	ns max	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
t_{OFF}	25		ns typ	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
	40	50	ns max	R_L = 300 Ω, C_L = 35 pF, V_S = 3.0 V; see Figure 17
Break-Before-Make Time Delay, t_{BBM}	25		ns typ	R_L = 300 Ω, C_L = 35 pF, V_{S1} = V_{S2} = 3.0 V; see Figure 18
		10	ns min	R_L = 300 Ω, C_L = 35 pF, V_{S1} = V_{S2} = 3.0 V; see Figure 18
Charge Injection	1		pC typ	V_S = 0 V, R_S = 0 Ω, C_L = 1 nF; see Figure 19
Off Isolation	−62		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz; see Figure 20
Channel to Channel Crosstalk	−90		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz; see Figure 21
−3 dB Bandwidth	680		MHz typ	R_L = 50 Ω, C_L = 5 pF; see Figure 22
$C_{S(OFF)}$	5		pF typ	f = 1 MHz
$C_{D(OFF)}$	5		pF typ	f = 1 MHz
$C_{D(ON)}$, $C_{S(ON)}$	5		pF typ	f = 1 MHz
POWER REQUIREMENTS				V_{DD} = 5.5 V
I_{DD}	0.001		μA typ	Digital inputs = 0 V or 5.5 V
		1.0	μA max	Digital inputs = 0 V or 5.5 V
V_{DD}		2.7	V min	
		5.5	V max	
Power Consumption	5.5		nW typ	
	5.5		μW max	

[1] Guaranteed by design; not subject to production test.

V_{DD} = 3 V ± 10%, V_{SS} = 0 V, GND = 0 V, unless otherwise noted. V_S is the source voltage. V_D is the drain voltage.

Table 3.

Parameter	25°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH				
Analog Signal Range		0 to V_{DD}	V	
On Resistance, R_{ON}	380	460	Ω typ	V_S = 1.5 V, I_S = −1 mA; see Figure 14
LEAKAGE CURRENTS				V_{DD} = 3.3 V
Source Off Leakage, $I_{S(OFF)}$	±0.01		nA typ	V_S = 1 V or 3 V, V_D = 3 V or 1 V; see Figure 15
	±0.1	±2	nA max	V_S = 1 V or 3 V, V_D = 3 V or 1 V; see Figure 15
Drain Off Leakage, $I_{D(OFF)}$	±0.01		nA typ	V_S = 1 V or 3 V, V_D = 3 V or 1 V; see Figure 15
	±0.1	±2	nA max	V_S = 1 V or 3 V, V_D = 3 V or 1 V; see Figure 15
Channel On Leakage, $I_{D(ON)}$, $I_{S(ON)}$	±0.01		nA typ	V_S = V_D = 1 V or 3 V; see Figure 16
	±0.1	±6	nA max	V_S = V_D = 1 V or 3 V; see Figure 16
DIGITAL INPUTS				
Input High Voltage, V_{INH}		2.0	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	V_{IN} = V_{INL} or V_{INH}
Digital Input Capacitance, C_{IN}	2		pF typ	
DYNAMIC CHARACTERISTICS[1]				
t_{ON}	130		ns typ	R_L = 300 Ω, C_L = 35 pF, V_S = 2 V; see Figure 17
	185	260	ns max	R_L = 300 Ω, C_L = 35 pF, V_S = 2 V; see Figure 17
t_{OFF}	40		ns typ	R_L = 300 Ω, C_L = 35 pF, V_S = 2 V; see Figure 17
	55	65	ns max	R_L = 300 Ω, C_L = 35 pF, V_S = 2 V; see Figure 17
Break-Before-Make Time Delay, t_{BBM}	50		ns typ	R_L = 300 Ω, C_L = 35 pF, V_{S1} = V_{S2} = 2 V; see Figure 18
		10	ns min	R_L = 300 Ω, C_L = 35 pF, V_{S1} = V_{S2} = 2 V; see Figure 18
Charge Injection	1.5		pC typ	V_S = 0 V, R_S = 0 Ω, C_L = 1 nF; see Figure 19
Off Isolation	−62		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz; see Figure 20
Channel to Channel Crosstalk	−90		dB typ	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz; see Figure 21
−3 dB Bandwidth	680		MHz typ	R_L = 50 Ω, C_L = 5 pF; see Figure 22
$C_{S(OFF)}$	5		pF typ	f = 1 MHz
$C_{D(OFF)}$	5		pF typ	f = 1 MHz
$C_{D(ON)}$, $C_{S(ON)}$	5		pF typ	f = 1 MHz
POWER REQUIREMENTS				V_{DD} = 3.3 V
I_{DD}	0.001		μA typ	Digital inputs = 0 V or 3.3 V
		1.0	μA max	Digital inputs = 0 V or 3.3 V
V_{DD}		2.7	V min	
		5.5	V max	
Power Consumption	3.3		nW typ	
	3.3		μW max	

[1] Guaranteed by design; not subject to production test.

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted

Table 4.

Parameter	Rating
V_{DD} to V_{SS}[1]	13 V
V_{DD} to GND[1]	−0.3 V to +6.5 V
V_{SS} to GND[1]	+0.3 V to −6.5 V
Analog Inputs[2]	V_{SS} − 0.3 V to V_{DD} + 0.3 V
Digital Inputs[2]	GND − 0.3 V to V_{DD} + 0.3 V or 30 mA, whichever occurs first
Peak Current, Sx or Dx	20 mA (pulsed at 1 ms, 10% duty cycle maximum)
Continuous Current, Sx or Dx	10 mA
3 V Operation, 85°C to 125°C	7.5 mA
Operating Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature	150°C
θ_{JA} Thermal Impedance	
16-Lead TSSOP	150.4°C/W
Lead Soldering	
Lead Temperature, Soldering (10 sec)	300°C
IR Reflow, Peak Temperature (<20 sec)	220°C
Pb-Free Soldering	
Reflow, Peak Temperature	260 (+0/−5)°C
Time at Peak Temperature	20 sec to 40 sec

[1] Tested at −55°C to +125°C.
[2] Overvoltages at INx, Sx, or Dx are clamped by internal diodes. Limit the current to the maximum ratings given. Tested at −55°C to +125°C.

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.

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

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.

PIN CONFIGURATION AND FUNCTION DESCRIPTIONS

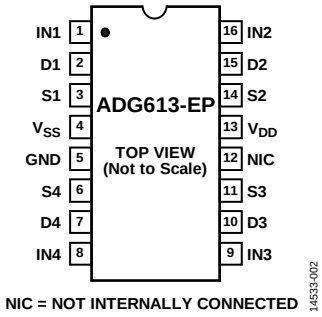

Figure 2. Pin Configuration

Table 5. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	IN1	Switch 1 Digital Control Input.
2	D1	Drain Terminal of Switch 1. This pin can be an input or output.
3	S1	Source Terminal of Switch 1. This pin can be an input or output.
4	V_{SS}	Most Negative Power Supply Terminal. Tie this pin to GND when using the device with single-supply voltages.
5	GND	Ground (0 V) Reference.
6	S4	Source Terminal of Switch 4. This pin can be an input or output.
7	D4	Drain Terminal of Switch 4. This pin can be an input or output.
8	IN4	Switch 4 Digital Control Input.
9	IN3	Switch 3 Digital Control Input.
10	D3	Drain Terminal of Switch 3. This pin can be an input or output.
11	S3	Source Terminal of Switch 3. This pin can be an input or output.
12	NIC	Not Internally Connected.
13	V_{DD}	Most Positive Power Supply Terminal.
14	S2	Source Terminal of Switch 2. This pin can be an input or output.
15	D2	Drain Terminal of Switch 2. This pin can be an input or output.
16	IN2	Switch 2 Digital Control Input.

Table 6. Truth Table

Logic	S1 and S4	S2 and S3
0	Off	On
1	On	Off

TYPICAL PERFORMANCE CHARACTERISTICS

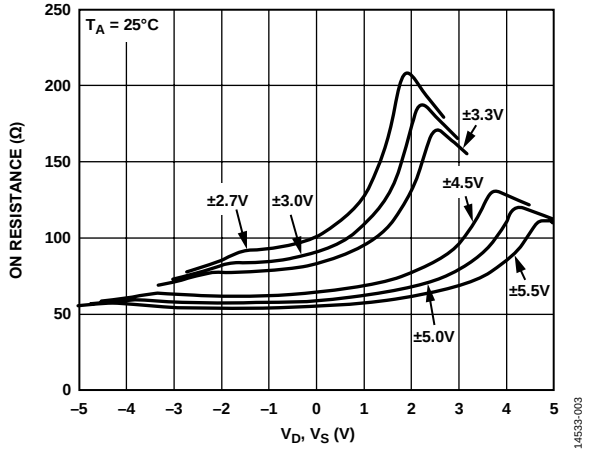

Figure 3. On Resistance vs. V_D, V_S; Dual Supplies

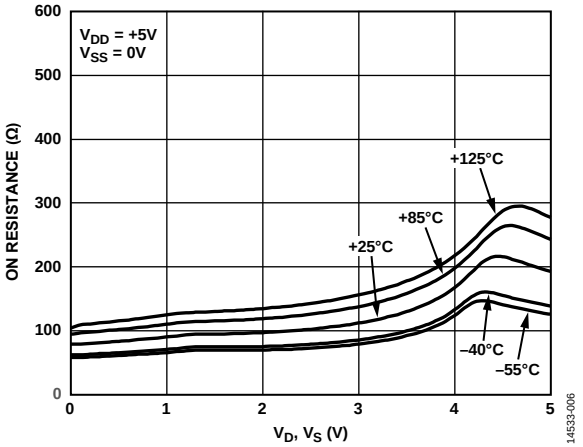

Figure 6. On Resistance vs. V_D, V_S for Various Temperatures, Single Supply

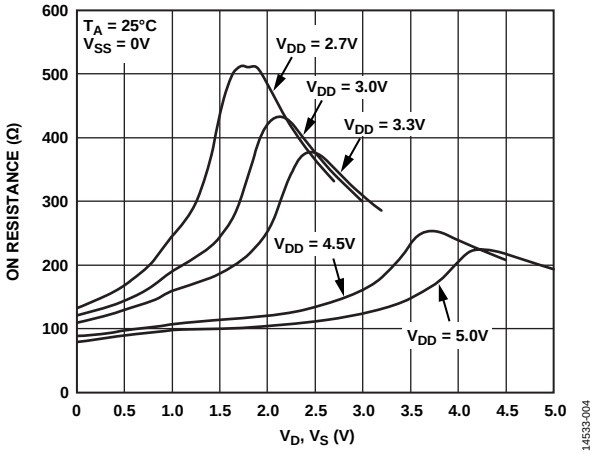

Figure 4. On Resistance vs. V_D, V_S; Single Supply

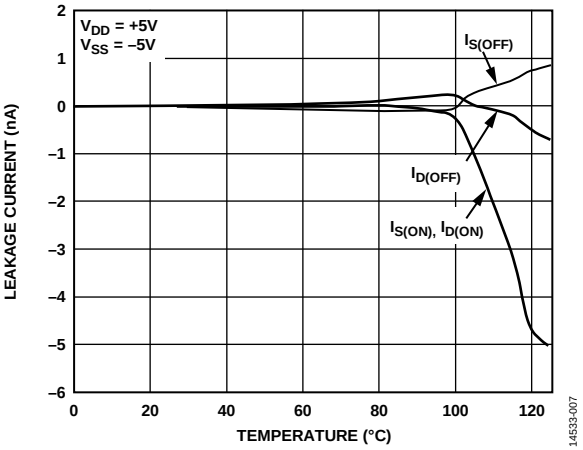

Figure 7. Leakage Current vs. Temperature, Dual Supplies

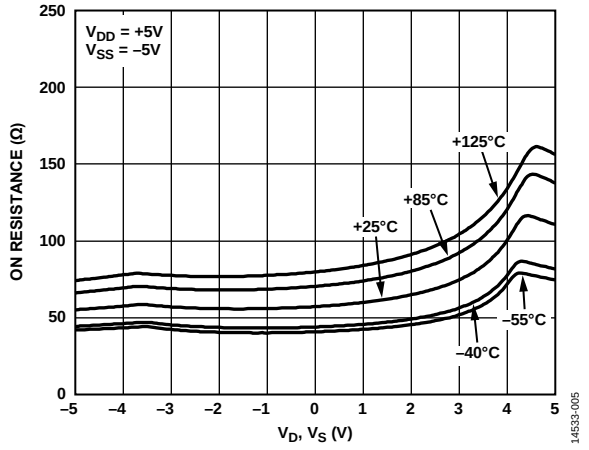

Figure 5. On Resistance vs. V_D, V_S for Various Temperatures, Dual Supplies

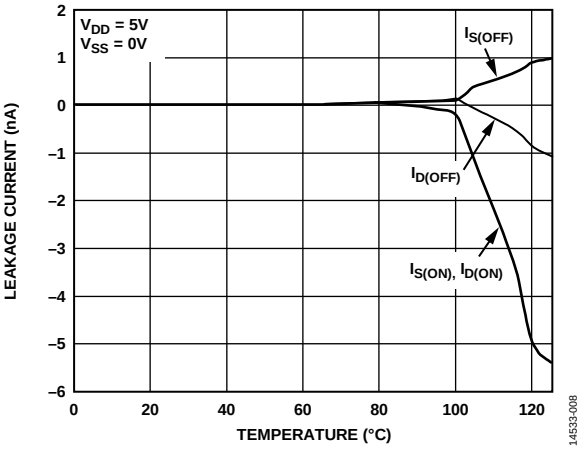

Figure 8. Leakage Current vs. Temperature, Single Supply

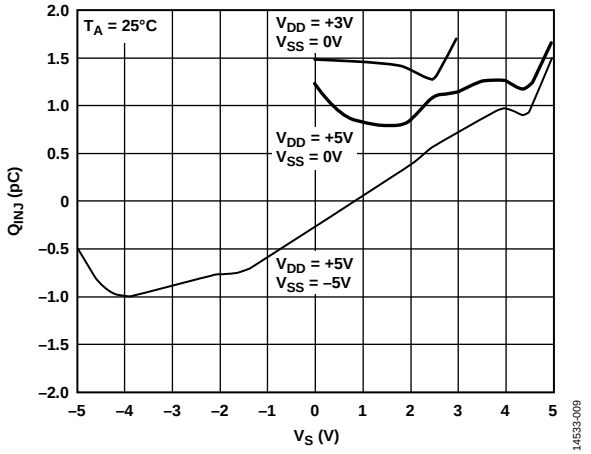

Figure 9. Charge Injection (Q_{INJ}) vs. Source Voltage (V_S)

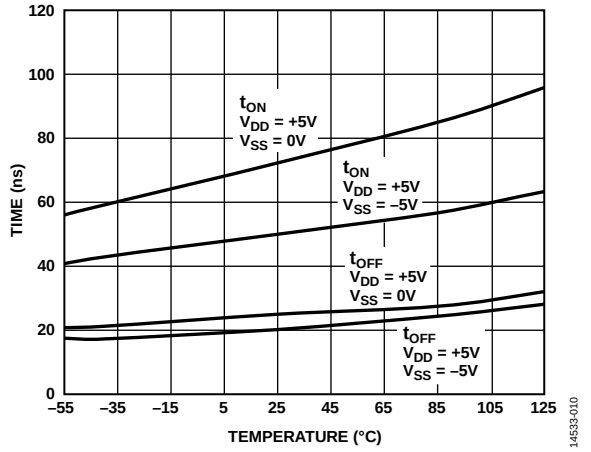

Figure 10. t_{ON}/t_{OFF} Times vs. Temperature

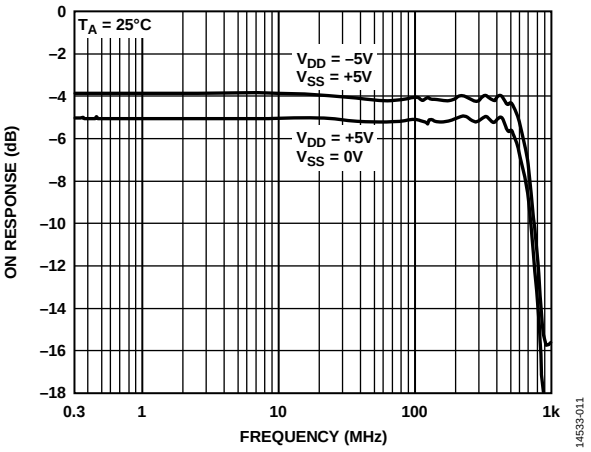

Figure 11. On Response vs. Frequency

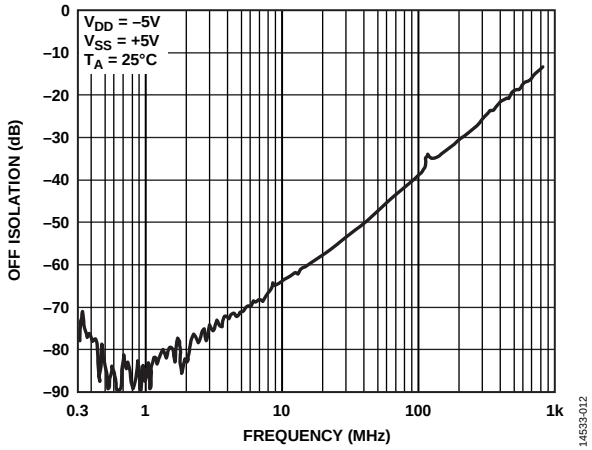

Figure 12. Off Isolation vs. Frequency

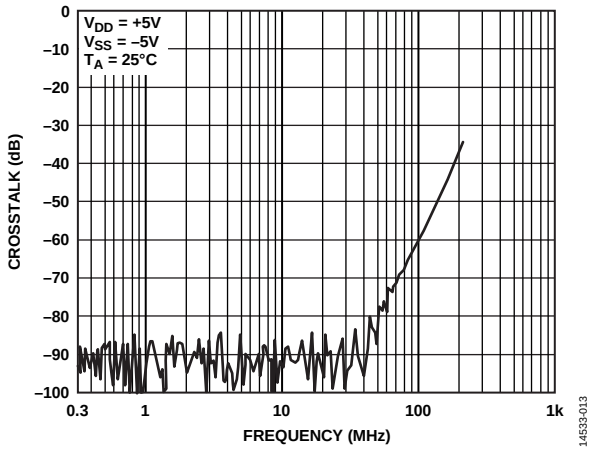

Figure 13. Crosstalk vs. Frequency

TEST CIRCUITS

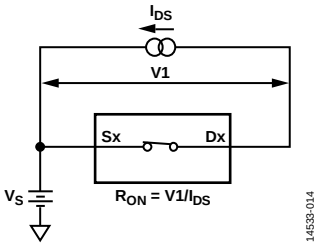

Figure 14. On Resistance

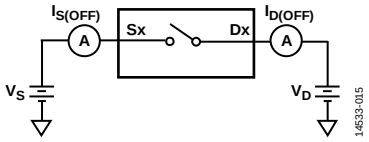

Figure 15. Off Leakage

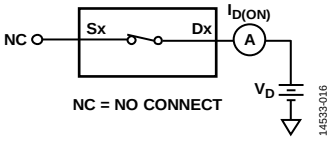

Figure 16. On Leakage

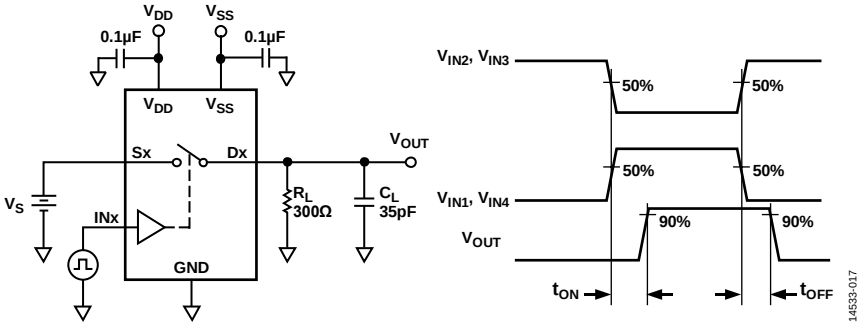

Figure 17. Switching Times

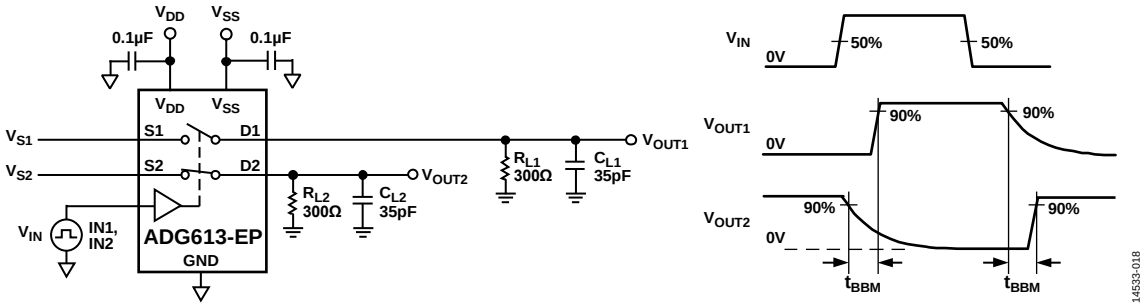

Figure 18. Break-Before-Make Time Delay

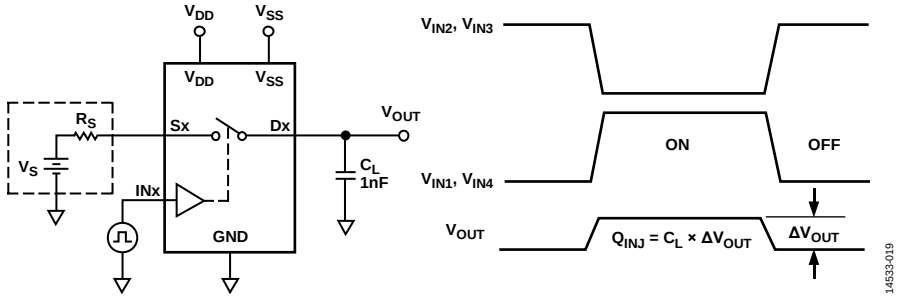

Figure 19. Charge Injection

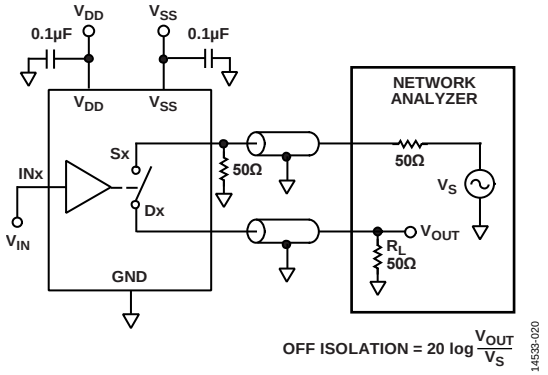

Figure 20. Off Isolation

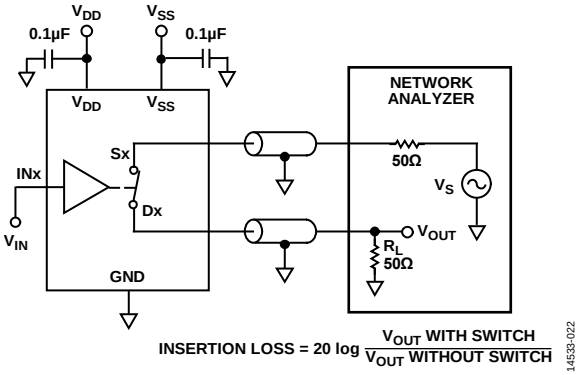

Figure 22. Bandwidth

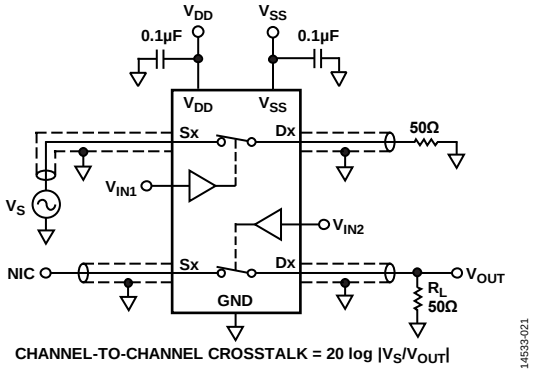

Figure 21. Channel-to-Channel Crosstalk

OUTLINE DIMENSIONS

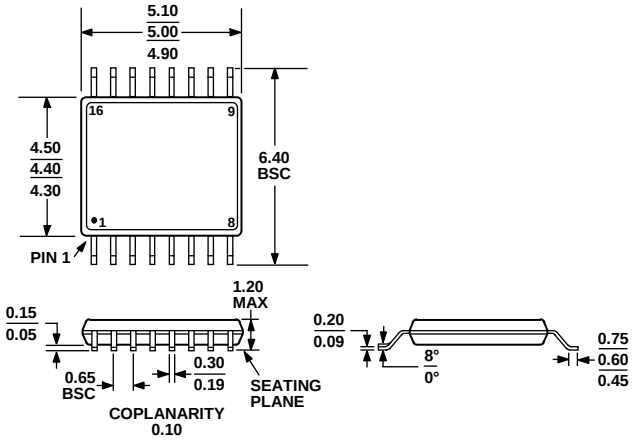

Figure 23. 16-Lead Thin Shrink Small Outline Package [TSSOP]
(RU-16)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Package Option
ADG613SRUZ-EP	−55°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG613SRUZ-EP-RL7	−55°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16

[1] Z = RoHS Compliant Part.

D14533-0-10/16(A)

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