Fault Protection and Detection, 10 Ω R_{ON}, Quad SPST Switches

Enhanced Product

ADG5412F-EP

FEATURES

Overvoltage protection up to −55 V and +55 V
Power-off protection up to −55 V and +55 V
Overvoltage detection on source pins
Low on resistance: 10 Ω
On-resistance flatness: 0.5 Ω
5.5 kV human body model (HBM) ESD rating
Latch-up immune under any circumstance
Known state without digital inputs present

ENHANCED PRODUCT FEATURES

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

APPLICATIONS

Avionics
Analog input/output modules
Process control/distributed control systems
Data acquisition
Instrumentation
Automatic test equipment
Communication systems
Relay replacement

FUNCTIONAL BLOCK DIAGRAM

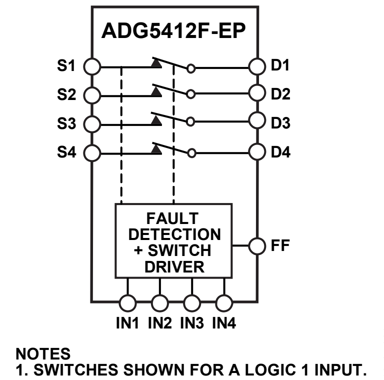

Figure 1.

GENERAL DESCRIPTION

The ADG5412F-EP contains four independently controlled single-pole/single-throw (SPST) switches. The ADG5412F-EP has four switches that turn on with Logic 1 inputs. Each switch conducts equally well in both directions when on, and each switch has an input signal range that extends to the supplies. The digital inputs are compatible with 3 V logic inputs over the full operating supply range.

When no power supplies are present, the switch remains in the off condition, and the switch inputs are high impedance. Under normal operating conditions, if the analog input signal levels on any Sx pin exceed V_{DD} or V_{SS} by a threshold voltage, V_T, the switch turns off. Input signal levels up to +55 V or −55 V relative to ground are blocked, in both the powered and unpowered condition.

The low on resistance of these switches, combined with on-resistance flatness over a significant portion of the signal range make them an ideal solution for data acquisition and gain switching applications where excellent linearity and low distortion are critical.

PRODUCT HIGHLIGHTS

1. Source pins are protected against voltages greater than the supply rails, up to −55 V and +55 V.
2. Source pins are protected against voltages between −55 V and +55 V in an unpowered state.
3. Overvoltage detection with digital output indicates operating state of switches.
4. Trench isolation guards against latch-up.
5. Optimized for low on resistance and on-resistance flatness.
6. The ADG5412F-EP can be operated from a dual supply of ±5 V up to ±22 V or a single power supply of +8 V up to +44 V.

Additional application and technical information can be found in the ADG5412F data sheet.

Rev. B Document Feedback

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8/2015—Rev. 0 to Rev. A

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7/2015—Revision 0: Initial Version

SPECIFICATIONS

±15 V DUAL SUPPLY

V_{DD} = 15 V ± 10%, V_{SS} = −15 V ± 10%, GND = 0 V, $C_{DECOUPLING}$ = 0.1 μF, unless otherwise noted.

Table 1.

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = 13.5 V, V_{SS} = −13.5 V, see Figure 30
Analog Signal Range			V_{DD} to V_{SS}	V	
On Resistance, R_{ON}	10			Ω typ	V_S = ±10 V, I_S = −10 mA
	11.2	14	16.5	Ω max	
	9.5			Ω typ	V_S = ±9 V, I_S = −10 mA
	10.7	13.5	16	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.05			Ω typ	V_S = ±10 V, I_S = −10 mA
	0.5	0.6	0.7	Ω max	
	0.05			Ω typ	V_S = ±9 V, I_S = −10 mA
	0.35	0.5	0.5	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	0.6			Ω typ	V_S = ±10 V, I_S = −10 mA
	0.9	1.1	1.1	Ω max	
	0.1			Ω typ	V_S = ±9 V, I_S = −10 mA
	0.4	0.5	0.5	Ω max	
Threshold Voltage, V_T	0.7			V typ	See Figure 26
LEAKAGE CURRENTS					V_{DD} = 16.5 V, V_{SS} = −16.5 V
Source Off Leakage, I_S (Off)	±0.1			nA typ	V_S = ±10 V, V_D = ∓10 V, see Figure 31
	±1.5	±5.0	±21.0	nA max	
Drain Off Leakage, I_D (Off)	±0.1			nA typ	V_S = ±10 V, V_D = ∓10 V, see Figure 31
	±1.5	±5.0	±18.0	nA max	
Channel On Leakage, I_D (On), I_S (On)	±0.3			nA typ	V_S = V_D = ±10 V, see Figure 32
	±1.5	±2.0	±4.5	nA max	
FAULT					
Source Leakage Current, I_S					
With Overvoltage			±78	μA typ	V_{DD} = 16.5 V, V_{SS} = 16.5 V, GND = 0 V, V_S = ±55 V, see Figure 35
Power Supplies Grounded or Floating			±40	μA typ	V_{DD} = 0 V or floating, V_{SS} = 0 V or floating, GND = 0 V, INx = 0 V or floating, V_S = ±55 V, see Figure 36
Drain Leakage Current, I_D					
With Overvoltage	±2.0			nA typ	V_{DD} = 16.5 V, V_{SS} = 16.5 V, GND = 0 V, V_S = ±55 V, see Figure 35
	±20	±30	±65	nA max	
Power Supplies Grounded	±10			nA typ	V_{DD} = 0 V, V_{SS} = 0 V, GND = 0 V, V_S = ±55 V, INx = 0 V, see Figure 36
	±30	±50	±100	nA max	
Power Supplies Floating	±10	±10	±10	μA typ	V_{DD} = floating, V_{SS} = floating, GND = 0 V, V_S = ±55 V, INx = 0 V, see Figure 36
DIGITAL INPUTS/OUTPUTS					
Input Voltage High, V_{INH}			2.0	V min	
Input Voltage Low, V_{INL}			0.8	V max	
Input Current, I_{INL} or I_{INH}	±0.7			μA typ	V_{IN} = V_{GND} or V_{DD}
			±1.2	μA max	
Digital Input Capacitance, C_{IN}	5.0			pF typ	
Output Voltage High, V_{OH}	2.0			V min	
Output Voltage Low, V_{OL}	0.8			V max	

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
DYNAMIC CHARACTERISTICS[1]					
t_{ON}	400			ns typ	R_L = 300 Ω, C_L = 35 pF
	495	525	550	ns max	V_S = 10 V, see Figure 44
t_{OFF}	410			ns typ	R_L = 300 Ω, C_L = 35 pF
	510	545	555	ns max	V_S = 10 V, see Figure 44
			185	ns min	V_{S1} = V_{S2} = 10 V, see Figure 44
Overvoltage Response Time, $t_{RESPONSE}$	460			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 39
	585	615	630	ns max	
Overvoltage Recovery Time, $t_{RECOVERY}$	720			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 40
	930	1050	1100	ns max	
Interrupt Flag Response Time, $t_{DIGRESP}$	85		115	ns typ	C_L = 10 pF, see Figure 41
Interrupt Flag Recovery Time, t_{DIGREC}	60		85	µs typ	C_L = 10 pF, see Figure 42
	600			ns typ	C_L = 10 pF, R_{PULLUP} = 1 kΩ, see Figure 43
Charge Injection, Q_{INJ}	680			pC typ	V_S = 0 V, R_S = 0 Ω, C_L = 1 nF, see Figure 45
Off Isolation	−70			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 33
Channel-to-Channel Crosstalk	−90			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 34
Total Harmonic Distortion Plus Noise, THD + N	0.0015			% typ	R_L = 10 kΩ, V_S = 15 V p-p, f = 20 Hz to 20 kHz, see Figure 38
−3 dB Bandwidth	270			MHz typ	R_L = 50 Ω, C_L = 5 pF, see Figure 37
Insertion Loss	−0.72			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 37
C_S (Off)	13			pF typ	V_S = 0 V, f = 1 MHz
C_D (Off)	12			pF typ	V_S = 0 V, f = 1 MHz
C_D (On), C_S (On)	24			pF typ	V_S = 0 V, f = 1 MHz
POWER REQUIREMENTS					V_{DD} = 16.5 V, V_{SS} = −16.5 V, GND = 0 V, digital inputs = 0 V, 5 V, or V_{DD}
Normal Mode					
I_{DD}	0.9			mA typ	
	1.2		1.3	mA max	
I_{GND}	0.4			mA typ	
	0.55		0.6	mA max	
I_{SS}	0.5			mA typ	
	0.65		0.7	mA max	
Fault Mode					V_S = ±55 V
I_{DD}	1.2			mA typ	
	1.6		1.8	mA max	
I_{GND}	0.8			mA typ	
	1.0		1.1	mA max	
I_{SS}	0.5			mA typ	
	1.0		1.8	mA max	
V_{DD}/V_{SS}			±5	V min	GND = 0 V
			±22	V max	GND = 0 V

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

±20 V DUAL SUPPLY

V_{DD} = 20 V ± 10%, V_{SS} = −20 V ± 10%, GND = 0 V, $C_{DECOUPLING}$ = 0.1 µF, unless otherwise noted.

Table 2.

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = 18 V, V_{SS} = −18 V, see Figure 30
Analog Signal Range			V_{DD} to V_{SS}	V	
On Resistance, R_{ON}	10			Ω typ	V_S = ±15 V, I_S = −10 mA
	11.5	14.5	16.5	Ω max	
	9.5			Ω typ	V_S = ±13.5 V, I_S = −10 mA
	11	14	16.5	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.05			Ω typ	V_S = ±15 V, I_S = −10 mA
	0.35	0.5	0.5	Ω max	
	0.05			Ω typ	V_S = ±13.5 V, I_S = −10 mA
	0.35	0.5	0.5	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	1.0			Ω typ	V_S = ±15 V, I_S = −10 mA
	1.4	1.5	1.5	Ω max	
	0.1			Ω typ	V_S = ±13.5 V, I_S = −10 mA
	0.4	0.5	0.5	Ω max	
Threshold Voltage, V_T	0.7			V typ	See Figure 26
LEAKAGE CURRENTS					V_{DD} = 22 V, V_{SS} = −22 V
Source Off Leakage, I_S (Off)	±0.1			nA typ	V_S = ±15 V, V_D = ∓15 V, see Figure 31
	±1.5	±5.0	±21.0	nA max	
Drain Off Leakage, I_D (Off)	±0.1			nA typ	V_S = ±15 V, V_D = ∓15 V, see Figure 31
	±1.5	±5.0	±18.0	nA max	
Channel On Leakage, I_D (On), I_S (On)	±0.3			nA typ	V_S = V_D = ±15 V, see Figure 32
	±1.5	±2.0	±4.5	nA max	
FAULT					
Source Leakage Current, I_S					
With Overvoltage			±78	µA typ	V_{DD} = 22 V, V_{SS} = −22 V, GND = 0 V, V_S = ±55 V, see Figure 35
Power Supplies Grounded or Floating			±40	µA typ	V_{DD} = 0 V or floating, V_{SS} = 0 V or floating, GND = 0 V, INx = 0 V or floating, V_S = ±55 V, see Figure 36
Drain Leakage Current, I_D					
With Overvoltage	±5.0			nA typ	V_{DD} = +22 V, V_{SS} = −22 V, GND = 0 V, V_S = ±55 V, see Figure 35
	±1.0	±1.0	±1.0	µA max	
Power Supplies Grounded	±10			nA typ	V_{DD} = 0 V, V_{SS} = 0 V, GND = 0 V, V_S = ±55 V, INx = 0 V, see Figure 36
	±30	±50	±100	nA max	
Power Supplies Floating	±10	±10	±10	µA typ	V_{DD} = floating, V_{SS} = floating, GND = 0 V, V_S = ±55 V, INx = 0 V, see Figure 36
DIGITAL INPUTS					
Input Voltage High, V_{INH}			2.0	V min	
Input Voltage Low, V_{INL}			0.8	V max	
Input Current, I_{INL} or I_{INH}	0.7			µA typ	V_{IN} = V_{GND} or V_{DD}
			1.2	µA max	
Digital Input Capacitance, C_{IN}	5.0			pF typ	
Output Voltage High, V_{OH}	2.0			V min	
Output Voltage Low, V_{OL}	0.8			V max	

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
DYNAMIC CHARACTERISTICS[1]					
t_{ON}	400			ns typ	R_L = 300 Ω, C_L = 35 pF
	500	530	555	ns max	V_S = 10 V, see Figure 44
t_{OFF}	415			ns typ	R_L = 300 Ω, C_L = 35 pF
	515	550	565	ns max	V_S = 10 V, see Figure 44
			200	ns min	V_{S1} = V_{S2} = 10 V, see Figure 44
Overvoltage Response Time, $t_{RESPONSE}$	370			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 39
	480	500	515	ns max	
Overvoltage Recovery Time, $t_{RECOVERY}$	840			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 40
	1200	1400	1700	ns max	
Interrupt Flag Response Time, $t_{DIGRESP}$	85		115	ns typ	C_L = 10 pF, see Figure 41
Interrupt Flag Recovery Time, t_{DIGREC}	60		85	µs typ	C_L = 10 pF, see Figure 42
	600			ns typ	C_L = 10 pF, R_{PULLUP} = 1 kΩ, see Figure 43
Charge Injection, Q_{INJ}	640			pC typ	V_S = 0 V, R_S = 0 Ω, C_L = 1 nF, see Figure 45
Off Isolation	−70			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 33
Channel-to-Channel Crosstalk	−90			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 34
Total Harmonic Distortion Plus Noise, THD + N	0.001			% typ	R_L = 10 kΩ, V_S = 20 V p-p, f = 20 Hz to 20 kHz, see Figure 38
−3 dB Bandwidth	270			MHz typ	R_L = 50 Ω, C_L = 5 pF, see Figure 37
Insertion Loss	−0.73			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 37
C_S (Off)	12			pF typ	V_S = 0 V, f = 1 MHz
C_D (Off)	11			pF typ	V_S = 0 V, f = 1 MHz
C_D (On), C_S (On)	23			pF typ	V_S = 0 V, f = 1 MHz
POWER REQUIREMENTS					V_{DD} = 22 V, V_{SS} = −22 V, digital inputs = 0 V, 5 V, or V_{DD}
Normal Mode					
I_{DD}	0.9			mA typ	
	1.2		1.3	mA max	
I_{GND}	0.4			mA typ	
	0.55		0.6	mA max	
I_{SS}	0.5			mA typ	
	0.65		0.7	mA max	
Fault Mode					V_S = ±55 V
I_{DD}	1.2			mA typ	
	1.6		1.8	mA max	
I_{GND}	0.8			mA typ	
	1.0		1.1	mA max	
I_{SS}	0.5			mA typ	
	1.0		1.8	mA max	
V_{DD}/V_{SS}			±5	V min	GND = 0 V
			±22	V max	GND = 0 V

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

12 V SINGLE SUPPLY

V_{DD} = 12 V ± 10%, V_{SS} = 0 V, GND = 0 V, $C_{DECOUPLING}$ = 0.1 µF, unless otherwise noted.

Table 3.

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = 10.8 V, V_{SS} = 0 V, see Figure 30
Analog Signal Range			0 V to V_{DD}	V	
On Resistance, R_{ON}	22			Ω typ	V_S = 0 V to 10 V, I_S = −10 mA
	24.5	31	37	Ω max	
	10			Ω typ	V_S = 3.5 V to 8.5 V, I_S = −10 mA
	11.2	14	16.5	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.05			Ω typ	V_S = 0 V to 10 V, I_S = −10 mA
	0.5	0.6	0.7	Ω max	
	0.05			Ω typ	V_S = 3.5 V to 8.5 V, I_S = −10 mA
	0.5	0.6	0.7	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	12.5			Ω typ	V_S = 0 V to 10 V, I_S = −10 mA
	14.5	19	23	Ω max	
	0.6			Ω typ	V_S = 3.5 V to 8.5 V, I_S = −10 mA
	0.9	1.1	1.3	Ω max	
Threshold Voltage, V_T	0.7			V typ	See Figure 26
LEAKAGE CURRENTS					V_{DD} = 13.2 V, V_{SS} = 0 V
Source Off Leakage, I_S (Off)	±0.1			nA typ	V_S = 1 V/10 V, V_D = 10 V/1 V, see Figure 31
	±1.5	±5.0	±21.0	nA max	
Drain Off Leakage, I_D (Off)	±0.1			nA typ	V_S = 1 V/10 V, V_D = 10 V/1 V, see Figure 31
	±1.5	±5.0	±18.0	nA max	
Channel On Leakage, I_D (On), I_S (On)	±0.3			nA typ	V_S = V_D = 1 V/10 V, see Figure 32
	±1.5	±2.0	±4.5	nA max	
FAULT					
Source Leakage Current, I_S					
With Overvoltage			±78	µA typ	V_{DD} = 13.2 V, V_{SS} = 0 V, GND = 0 V, V_S = ±55 V, see Figure 35
Power Supplies Grounded or Floating			±40	µA typ	V_{DD} = 0 V or floating, V_{SS} = 0 V or floating, GND = 0 V, INx = 0 V or floating, V_S = ±55 V, see Figure 36
Drain Leakage Current, I_D					
With Overvoltage	±2.0			nA typ	V_{DD} = 13.2 V, V_{SS} = 0 V or floating, GND = 0 V, V_S = ±55 V, see Figure 35
	±20	±30	±65	nA max	
Power Supplies Grounded	±10			nA typ	V_{DD} = 0 V, V_{SS} = 0 V, GND = 0 V, V_S = ±55 V, INx = 0 V, see Figure 36
	±30	±50	±100	nA max	
Power Supplies Floating	±10	±10	±10	µA typ	V_{DD} = floating, V_{SS} = floating, GND = 0 V, V_S = ±55 V, INx = 0 V, see Figure 36
DIGITAL INPUTS					
Input Voltage High, V_{INH}			2.0	V min	
Input Voltage Low, V_{INL}			0.8	V max	
Input Current, I_{INL} or I_{INH}	0.7			µA typ	V_{IN} = V_{GND} or V_{DD}
			1.2	µA max	
Digital Input Capacitance, C_{IN}	5.0			pF typ	
Output Voltage High, V_{OH}	2.0			V min	
Output Voltage Low, V_{OL}	0.8			V max	

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
DYNAMIC CHARACTERISTICS[1]					
t_{ON}	400			ns typ	R_L = 300 Ω, C_L = 35 pF
	485	515	540	ns max	V_S = 8 V, see Figure 44
t_{OFF}	375			ns typ	R_L = 300 Ω, C_L = 35 pF
	460	495	520	ns max	V_S = 8 V, see Figure 44
			170	ns min	V_{S1} = V_{S2} = 8 V, see Figure 44
Overvoltage Response Time, $t_{RESPONSE}$	560			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 39
	660	700	720	ns max	
Overvoltage Recovery Time, $t_{RECOVERY}$	640			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 40
	800	865	960	ns max	
Interrupt Flag Response Time, $t_{DIGRESP}$	85		115	ns typ	C_L = 10 pF, see Figure 41
Interrupt Flag Recovery Time, t_{DIGREC}	60		85	µs typ	C_L = 10 pF, see Figure 42
	600			ns typ	C_L = 10 pF, R_{PULLUP} = 1 kΩ, see Figure 43
Charge Injection, Q_{INJ}	340			pC typ	V_S = 6 V, R_S = 0 Ω, C_L = 1 nF, see Figure 45
Off Isolation	−65			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 33
Channel-to-Channel Crosstalk	−90			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 34
Total Harmonic Distortion Plus Noise, THD + N	0.007			% typ	R_L = 10 kΩ, V_S = 6 V p-p, f = 20 Hz to 20 kHz, see Figure 38
−3 dB Bandwidth	270			MHz typ	R_L = 50 Ω, C_L = 5 pF, see Figure 37
Insertion Loss	−0.74			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 37
C_S (Off)	16			pF typ	V_S = 6 V, f = 1 MHz
C_D (Off)	15			pF typ	V_S = 6 V, f = 1 MHz
C_D (On), C_S (On)	25			pF typ	V_S = 6 V, f = 1 MHz
POWER REQUIREMENTS					V_{DD} = 13.2 V, V_{SS} = 0 V, digital inputs = 0 V, 5 V, or V_{DD}
Normal Mode					
I_{DD}	0.9			mA typ	
	1.2		1.3	mA max	
I_{GND}	0.4			mA typ	
	0.55		0.6	mA max	
I_{SS}	0.5			mA typ	
	0.65		0.7	mA max	
Fault Mode					V_S = ±55 V
I_{DD}	1.2			mA typ	
	1.6		1.8	mA max	
I_{GND}	0.8			mA typ	
	1.0		1.1	mA max	
I_{SS}	0.5			mA typ	Digital inputs = 5 V
	1.0		1.8	mA max	V_S = ±55 V, V_D = 0 V
V_{DD}			8	V min	GND = 0 V
			44	V max	GND = 0 V

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

36 V SINGLE SUPPLY

V_{DD} = 36 V ± 10%, V_{SS} = 0 V, GND = 0 V, $C_{DECOUPLING}$ = 0.1 µF, unless otherwise noted.

Table 4.

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = 32.4 V, V_{SS} = 0 V, see Figure 30
Analog Signal Range			0 V to V_{DD}	V	
On Resistance, R_{ON}	22			Ω typ	V_S = 0 V to 30 V, I_S = −10 mA
	24.5	31	37	Ω max	
	10			Ω typ	V_S = 4.5 V to 28 V, I_S = −10 mA
	11	14	16.5	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.05			Ω typ	V_S = 0 V to 30 V, I_S = −10 mA
	0.5	0.6	0.7	Ω max	
	0.05			Ω typ	V_S = 4.5 V to 28 V, I_S = −10 mA
	0.35	0.5	0.5	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	12.5			Ω typ	V_S = 0 V to 30 V, I_S = −10 mA
	14.5	19	23	Ω max	
	0.1			Ω typ	V_S = 4.5 V to 28 V, I_S = −10 mA
	0.4	0.5	0.5	Ω max	
Threshold Voltage, V_T	0.7			V typ	See Figure 26
LEAKAGE CURRENTS					V_{DD} =39.6 V, V_{SS} = 0 V
Source Off Leakage, I_S (Off)	±0.1			nA typ	V_S = 1 V/30 V, V_D = 30 V/1 V, see Figure 31
	±1.5	±5.0	±21.0	nA max	
Drain Off Leakage, I_D (Off)	±0.1			nA typ	V_S = 1 V/30 V, V_D = 30 V/1 V, see Figure 31
	±1.5	±5.0	±18.0	nA max	
Channel On Leakage, I_D (On), I_S (On)	±0.3			nA typ	V_S = V_D = 1 V/30 V, see Figure 32
	±1.5	±2.0	±4.5	nA max	
FAULT					
Source Leakage Current, I_S					
With Overvoltage			±78	µA typ	V_{DD} = 39.6 V, V_{SS} = 0 V, GND = 0 V, V_S = +55 V, −40 V, see Figure 35
Power Supplies Grounded or Floating			±40	µA typ	V_{DD} = 0 V or floating, V_{SS} = 0 V or floating, GND = 0 V, INx = 0 V or floating, V_S = +55 V, −40 V, see Figure 36
Drain Leakage Current, I_D					
With Overvoltage	±2.0			nA typ	V_{DD} = 39.6 V, V_{SS} = 0 V or floating, GND = 0 V, V_S = +55 V, −40 V, see Figure 35
	±20	±30	±65	nA max	
Power Supplies Grounded	±10			nA typ	V_{DD} = 0 V, V_{SS} = 0 V, GND = 0 V, V_S = +55 V, −40 V, INx = 0 V, see Figure 36
	±30	±50	±100	nA max	
Power Supplies Floating	±10	±10	±10	µA typ	V_{DD} = floating, V_{SS} = floating, GND = 0 V, V_S = +55 V, −40 V, INx = 0 V, see Figure 36
DIGITAL INPUTS					
Input Voltage High, V_{INH}			2.0	V min	
Input Voltage Low, V_{INL}			0.8	V max	
Input Current, I_{INL} or I_{INH}	0.7			µA typ	V_{IN} = V_{GND} or V_{DD}
			1.2	µA max	
Digital Input Capacitance, C_{IN}	5.0			pF typ	
Output Voltage High, V_{OH}	2.0			V min	
Output Voltage Low, V_{OL}	0.8			V max	

Parameter	+25°C	−40°C to +85°C	−55°C to +125°C	Unit	Test Conditions/Comments
DYNAMIC CHARACTERISTICS[1]					
t_{ON}	400			ns typ	R_L = 300 Ω, C_L = 35 pF
	490	520	545	ns max	V_S = 18 V, see Figure 44
t_{OFF}	375			ns typ	R_L = 300 Ω, C_L = 35 pF
	460	485	510	ns max	V_S = 18 V, see Figure 44
			195	ns min	V_{S1} = V_{S2} = 18 V, see Figure 44
Overvoltage Response Time, $t_{RESPONSE}$	250			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 39
	350	360	375	ns max	
Overvoltage Recovery Time, $t_{RECOVERY}$	1500			ns typ	R_L = 1 kΩ, C_L = 2 pF, see Figure 40
	2000	2300	2700	ns max	
Interrupt Flag Response Time, $t_{DIGRESP}$	85		115	ns typ	C_L = 10 pF, see Figure 41
Interrupt Flag Recovery Time, t_{DIGREC}	60		85	µs typ	C_L = 10 pF, see Figure 42
	600			ns typ	C_L = 10 pF, R_{PULLUP} = 1 kΩ, see Figure 43
Charge Injection, Q_{INJ}	610			pC typ	V_S = 18 V, R_S = 0 Ω, C_L = 1 nF, see Figure 45
Off Isolation	−70			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 33
Channel-to-Channel Crosstalk	−90			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 34
Total Harmonic Distortion Plus Noise, THD + N	0.001			% typ	R_L = 10 kΩ, V_S = 18 V p-p, f = 20 Hz to 20 kHz, see Figure 38
−3 dB Bandwidth	270			MHz typ	R_L = 50 Ω, C_L = 5 pF, see Figure 37
Insertion Loss	−0.75			dB typ	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz, see Figure 37
C_S (Off)	12			pF typ	V_S = 18 V, f = 1 MHz
C_D (Off)	11			pF typ	V_S = 18 V, f = 1 MHz
C_D (On), C_S (On)	23			pF typ	V_S = 18 V, f = 1 MHz
POWER REQUIREMENTS					V_{DD} = 39.6 V, V_{SS} = 0 V, digital inputs = 0 V, 5 V, or V_{DD}
Normal Mode					
I_{DD}	0.9			mA typ	
	1.2		1.3	mA max	
I_{GND}	0.4			mA typ	
	0.55		0.6	mA max	
I_{SS}	0.5			mA typ	
	0.65		0.7	mA max	
Fault Mode					V_S = +55 V, −40 V
I_{DD}	1.2			mA typ	
	1.6		1.8	mA max	
I_{GND}	0.8			mA typ	
	1.0		1.1	mA max	
I_{SS}	0.5			mA typ	
	1.0		1.8	mA max	
V_{DD}			8	V min	GND = 0 V
			44	V max	GND = 0 V

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

CONTINUOUS CURRENT PER CHANNEL, Sx OR Dx

Table 5.

Parameter	25°C	85°C	125°C	Unit	Test Conditions/Comments
16-LEAD TSSOP					
θ_{JA} = 112.6°C/W	83	59	39	mA max	$V_S = V_{SS} + 4.5$ V to $V_{DD} - 4.5$ V
	64	48	29	mA max	$V_S = V_{SS}$ to V_{DD}

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 6.

Parameter	Rating
V_{DD} to V_{SS}	48 V
V_{DD} to GND	−0.3 V to +48 V
V_{SS} to GND	−48 V to +0.3 V
Sx Pins to GND	−55 V to +55 V
Sx to V_{DD} or V_{SS}	80 V
V_S to V_D	80 V
Dx Pins[1]	V_{SS} − 0.7 V to V_{DD} + 0.7 V or 30 mA, whichever occurs first
Digital Inputs	GND − 0.3 V to +48 V
Peak Current, Sx or Dx Pins	288 mA (pulsed at 1 ms, 10% duty cycle maximum)
Continuous Current, Sx or Dx Pins	Data[2] + 15%
Digital Output	GND − 0.3 V to 6 V or 30 mA, whichever occurs first
Operating Temperature Range	−55°C to +125°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature	150°C
Thermal Impedance, θ_{JA}	
16-Lead TSSOP, θ_{JA} Thermal Impedance (4-Layer Board)	112.6°C/W
Reflow Soldering Peak Temperature, Pb Free	As per JEDEC J-STD-020
ESD (HBM: ANSI/ESD STM5.1-2007)	
Input/Output Port to Supplies	5.5 kV
Input/Output Port to Input/Output Port	5.5 kV
All Other Pins	5.5 kV

[1] Overvoltages at the Dx pins are clamped by internal diodes. Limit current to the maximum ratings given.
[2] See Table 5.

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

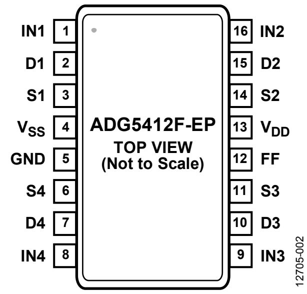


Figure 2. Pin Configuration

Table 7. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	IN1	Logic Control Input.
2	D1	Drain Terminal. This pin can be an input or an output.
3	S1	Overvoltage Protected Source Terminal. This pin can be an input or an output.
4	V_{SS}	Most Negative Power Supply Potential.
5	GND	Ground (0 V) Reference.
6	S4	Overvoltage Protected Source Terminal. This pin can be an input or an output.
7	D4	Drain Terminal. This pin can be an input or an output.
8	IN4	Logic Control Input.
9	IN3	Logic Control Input.
10	D3	Drain Terminal. This pin can be an input or an output.
11	S3	Overvoltage Protected Source Terminal. This pin can be an input or an output.
12	FF	Fault Flag Digital Output. This pin has a high output when the device is in normal operation or a low output when a fault condition occurs on any of the Sx inputs.
13	V_{DD}	Most Positive Power Supply Potential.
14	S2	Overvoltage Protected Source Terminal. This pin can be an input or an output.
15	D2	Drain Terminal. This pin can be an input or an output.
16	IN2	Logic Control Input.

Table 8. ADG5412F-EP Truth Table

INx	Switch Condition (S1 to S4)
1	On
0	Off

TYPICAL PERFORMANCE CHARACTERISTICS

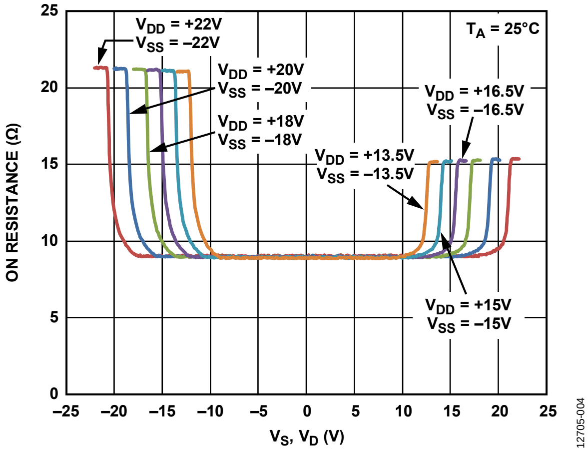


Figure 3. R_{ON} as a Function of V_S, V_D (Dual Supply)

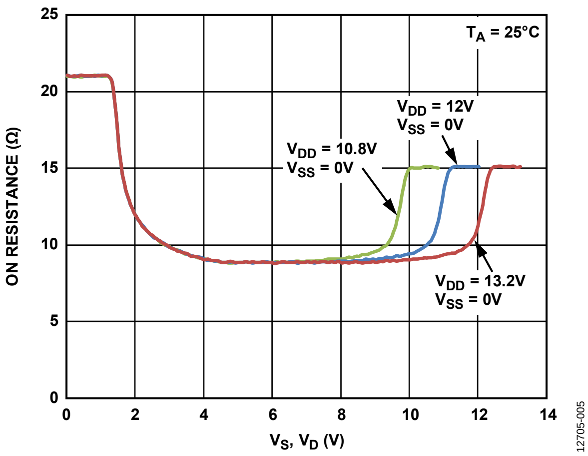


Figure 4. R_{ON} as a Function of V_S, V_D (12 V Single Supply)

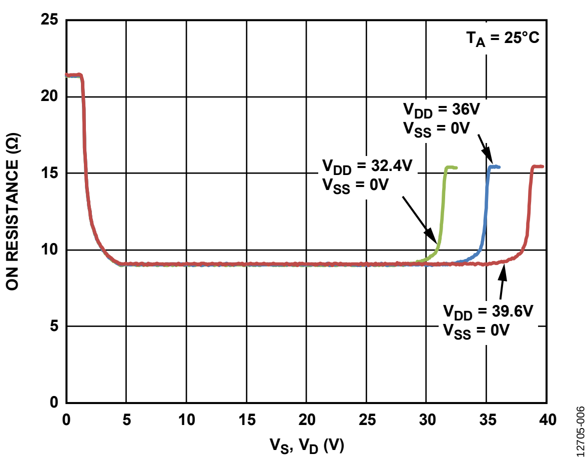


Figure 5. R_{ON} as a Function of V_S, V_D (36 V Single Supply)

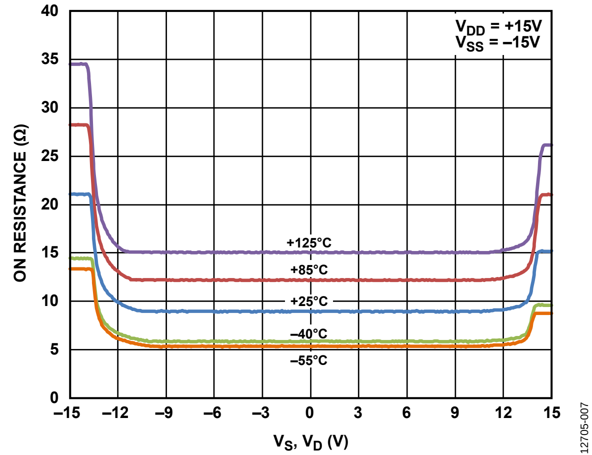


Figure 6. R_{ON} as a Function of V_S, V_D for Different Temperatures, ±15 V Dual Supply

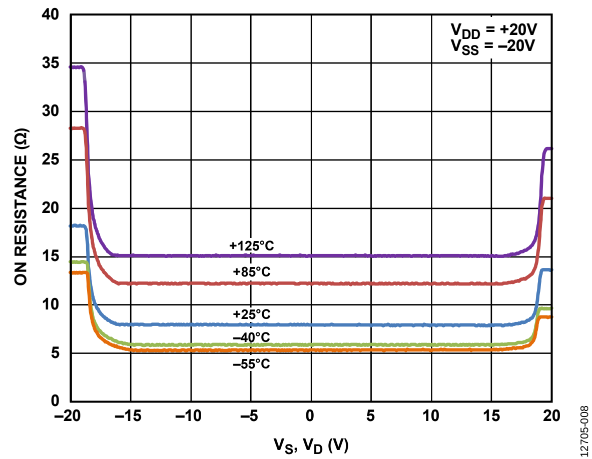


Figure 7. R_{ON} as a Function of V_S, V_D for Different Temperatures, ±20 V Dual Supply

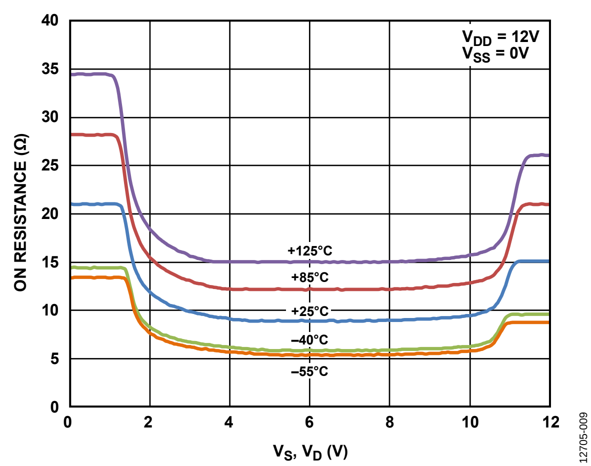


Figure 8. R_{ON} as a Function of V_S, V_D for Different Temperatures, 12 V Single Supply

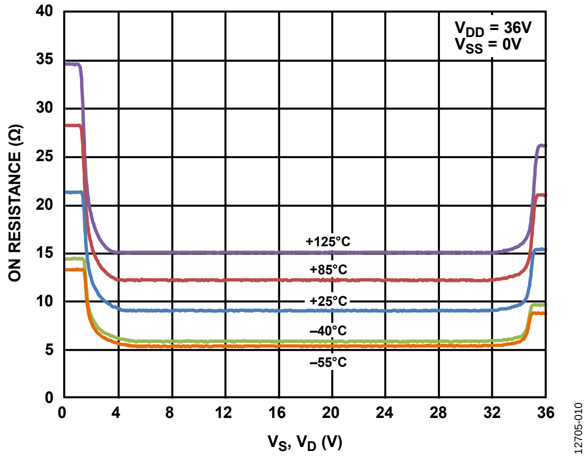


Figure 9. R_{ON} as a Function of V_S, V_D for Different Temperatures, 36 V Single Supply

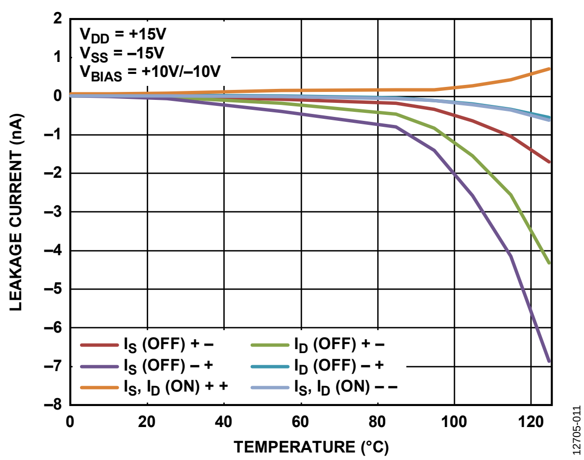


Figure 10. Leakage Current vs. Temperature, ±15 V Dual Supply

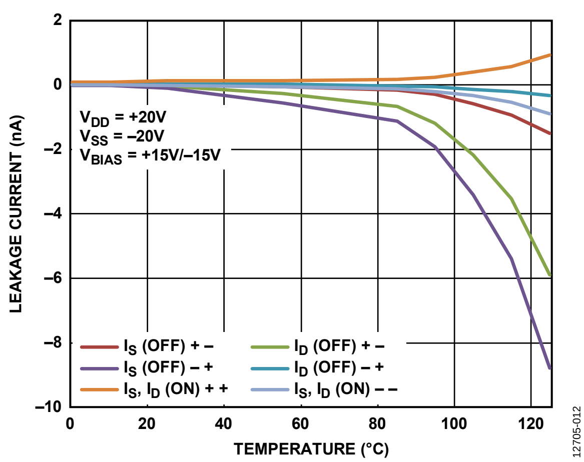


Figure 11. Leakage Current vs. Temperature, ±20 V Dual Supply

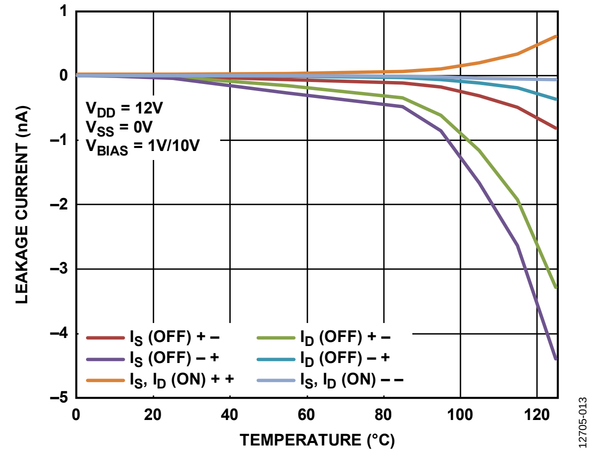


Figure 12. Leakage Current vs. Temperature, 12 V Single Supply

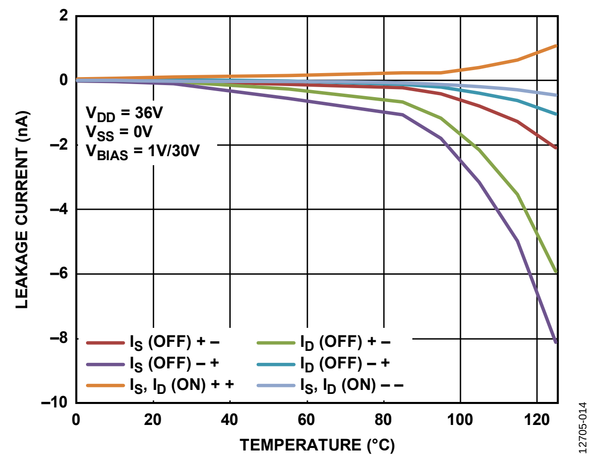


Figure 13. Leakage Current vs. Temperature, 36 V Single Supply

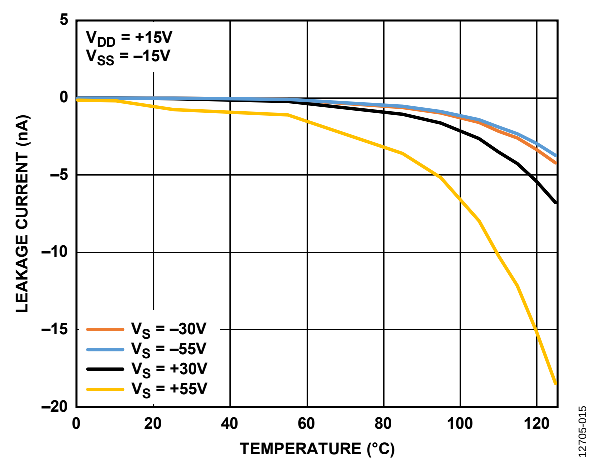


Figure 14. Overvoltage Leakage Current vs. Temperature, ±15 V Dual Supply

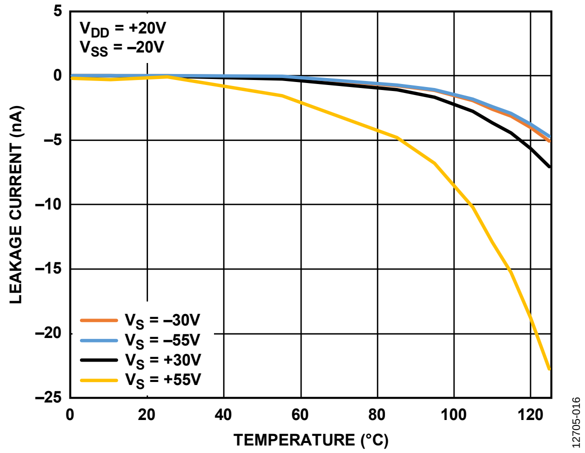


Figure 15. Overvoltage Leakage Current vs. Temperature, ±20 V Dual Supply

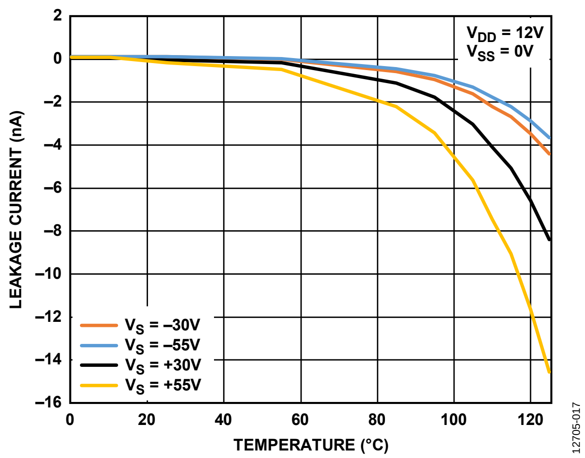


Figure 16. Overvoltage Leakage Current vs. Temperature, 12 V Single Supply

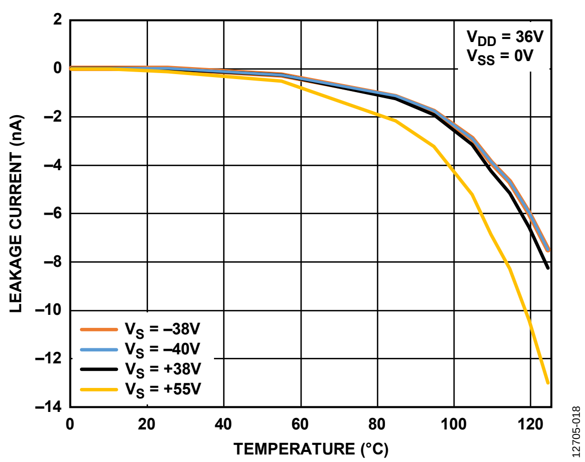


Figure 17. Overvoltage Leakage Current vs. Temperature, 36 V Single Supply

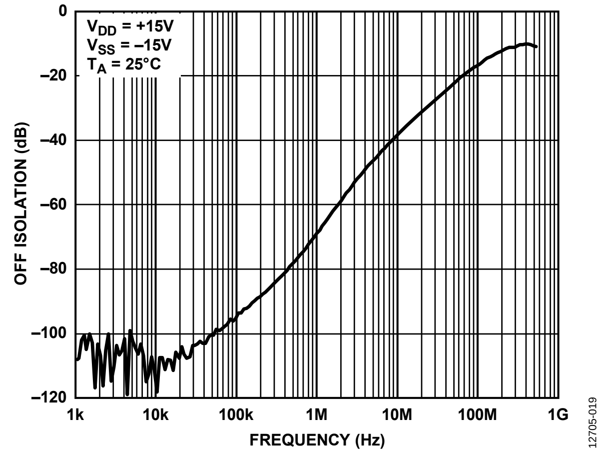


Figure 18. Off Isolation vs. Frequency, ±15 V Dual Supply

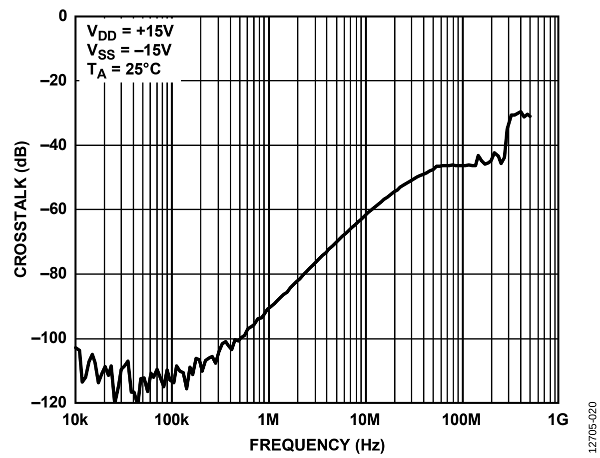


Figure 19. Crosstalk vs. Frequency, ±15 V Dual Supply

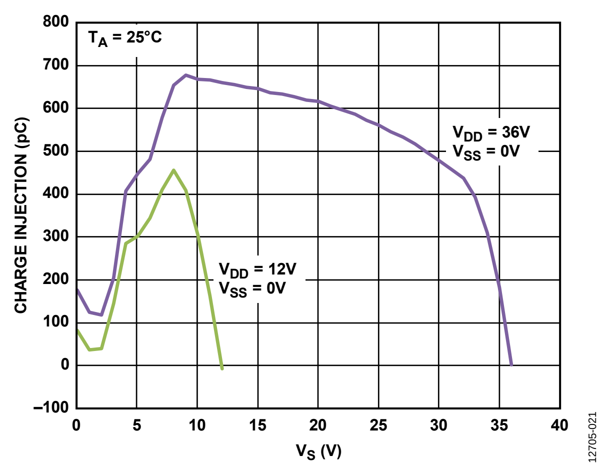


Figure 20. Charge Injection vs. Source Voltage (V_S), Single Supply

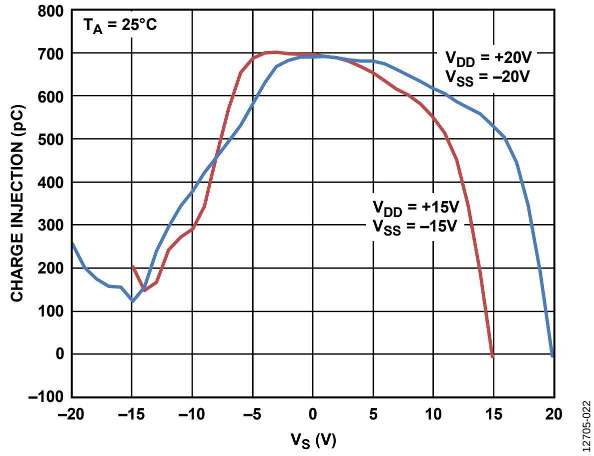


Figure 21. Charge Injection vs. Source Voltage (V_S), Dual Supply

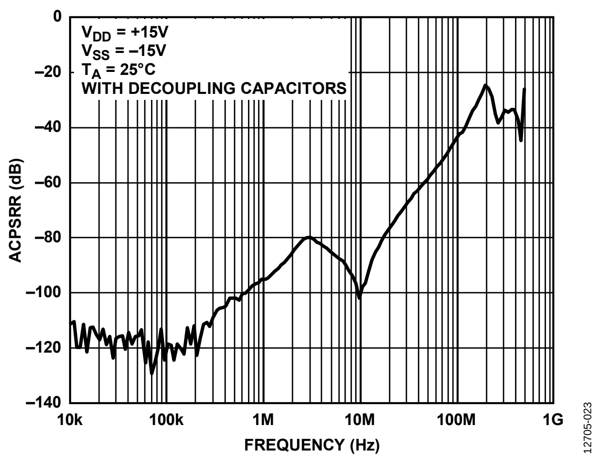


Figure 22. ACPSRR vs. Frequency, ±15 V Dual Supply

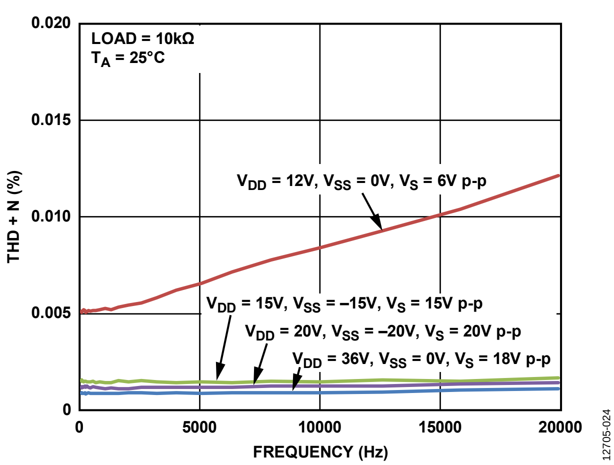


Figure 23. THD + N vs. Frequency

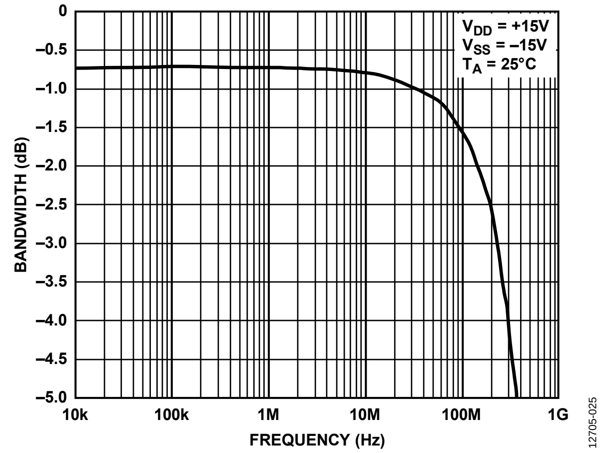


Figure 24. Bandwidth vs. Frequency, ±15 V Dual Supply

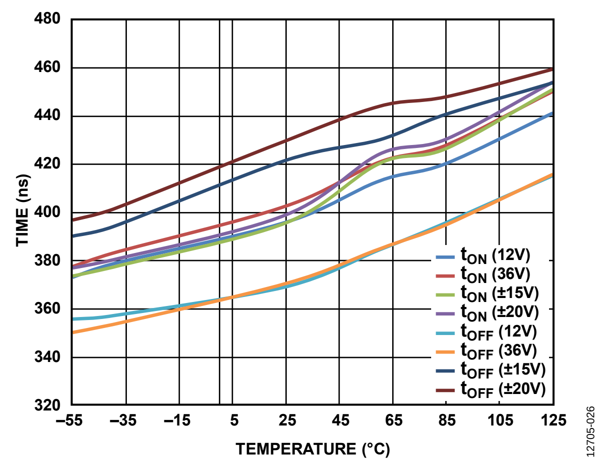


Figure 25. t_{ON}, t_{OFF} Times vs. Temperature

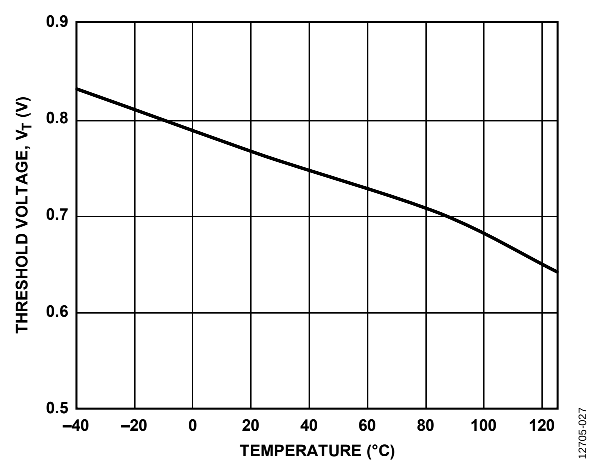


Figure 26. Threshold Voltage (V_T) vs. Temperature

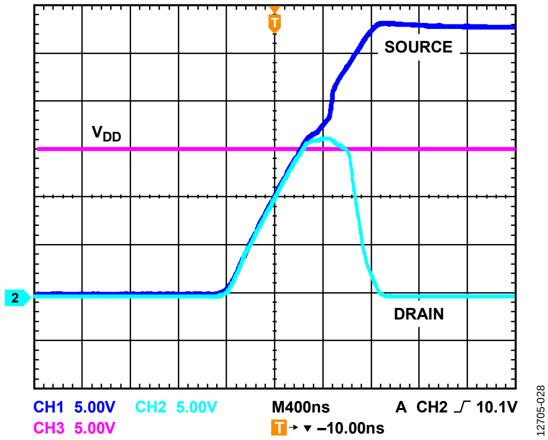


Figure 27. Drain Output Response to Positive Overvoltage

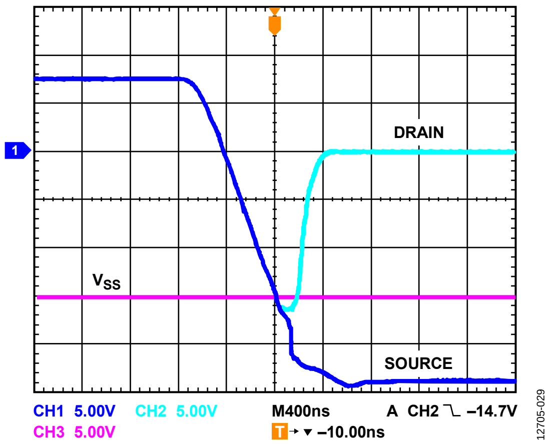


Figure 28. Drain Output Response to Negative Overvoltage

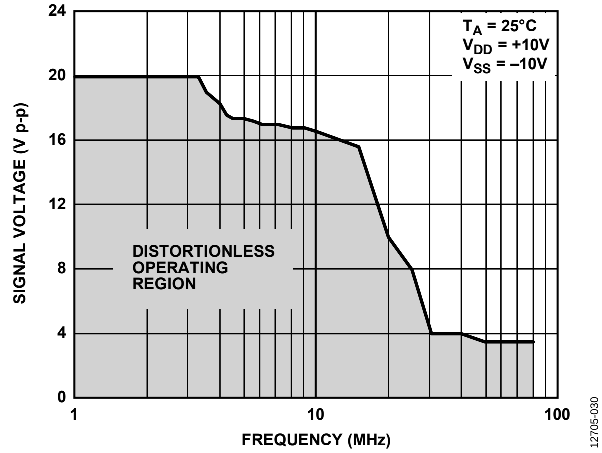


Figure 29. Large Signal Voltage Tracking vs. Frequency

TEST CIRCUITS

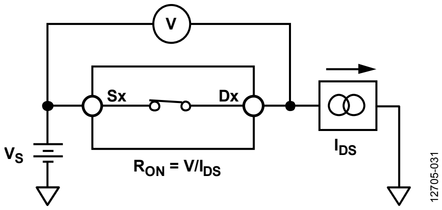


Figure 30. On Resistance

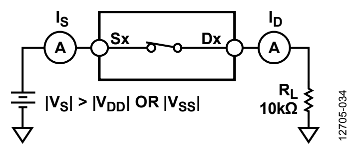


Figure 35. Switch Overvoltage Leakage

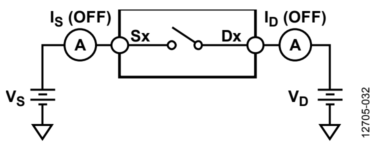


Figure 31. Off Leakage

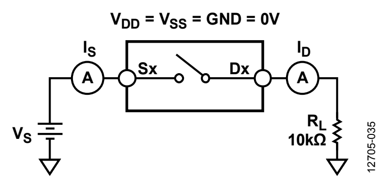


Figure 36. Switch Unpowered Leakage

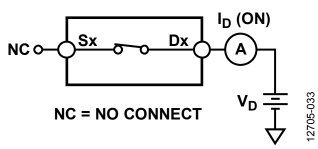


Figure 32. On Leakage

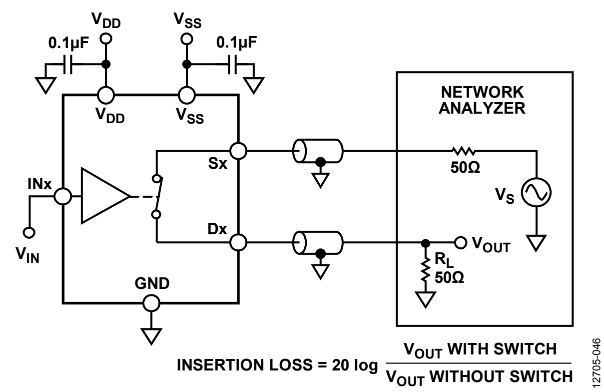


Figure 37. Bandwidth

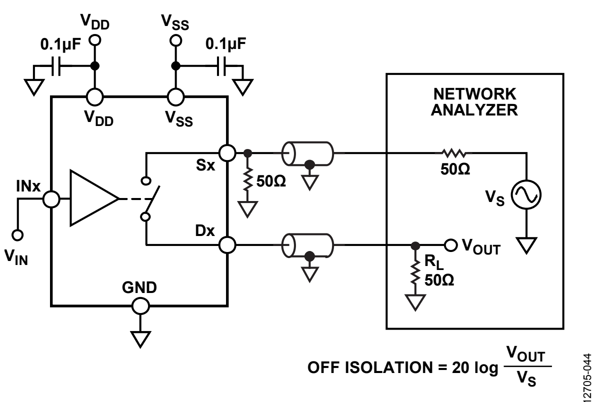


Figure 33. Off Isolation

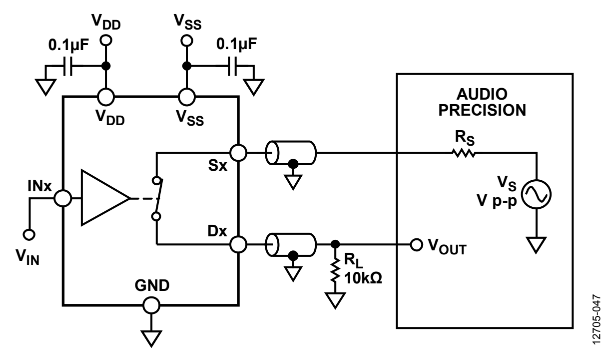


Figure 38. THD + N

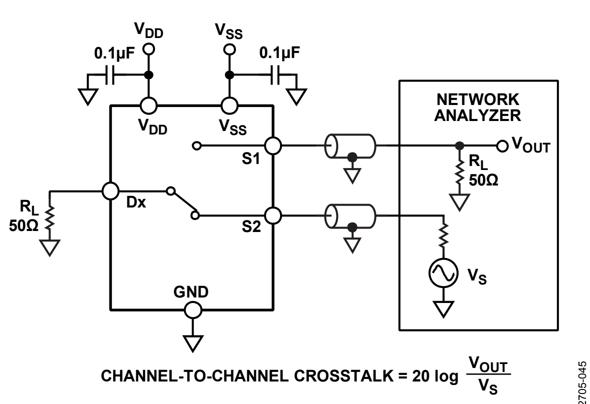


Figure 34. Channel-to-Channel Crosstalk

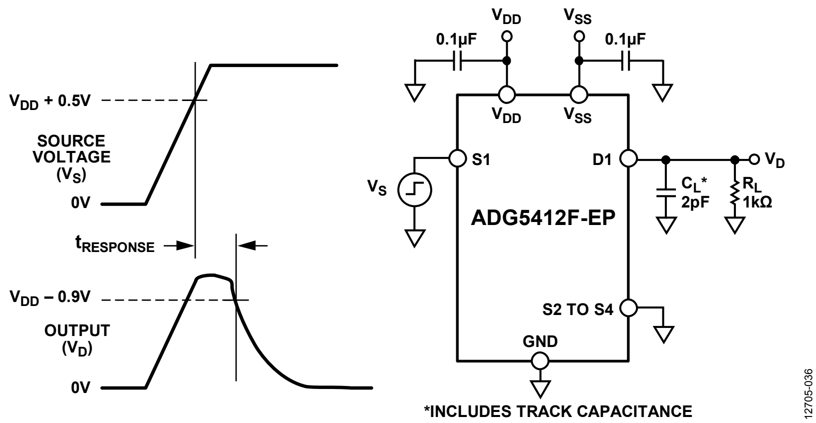


Figure 39. Overvoltage Response Time, $t_{RESPONSE}$

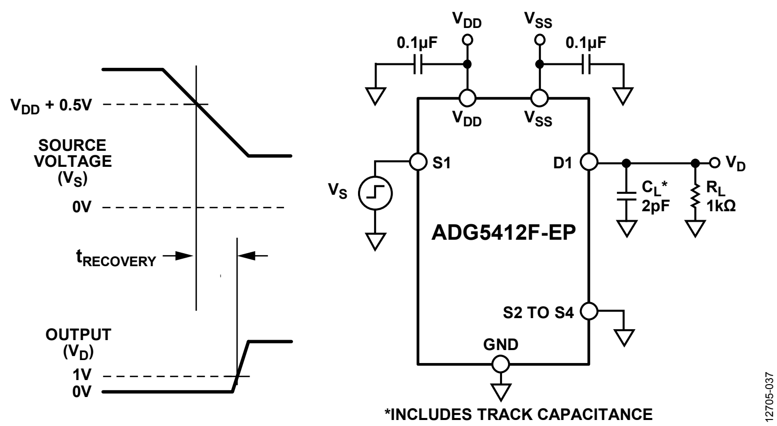


Figure 40. Overvoltage Recovery Time, $t_{RECOVERY}$

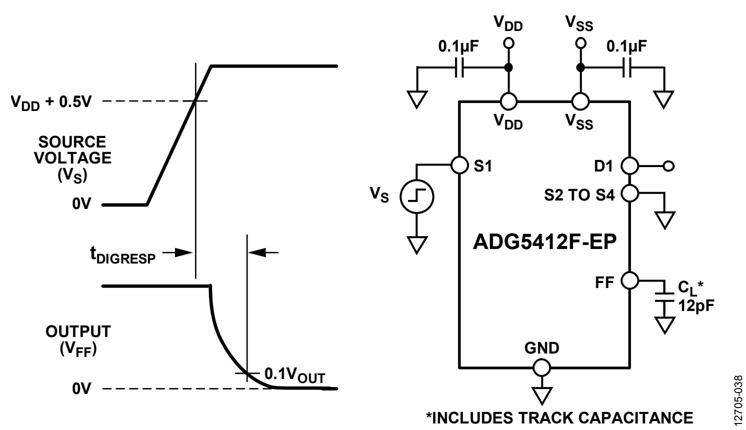


Figure 41. Interrupt Flag Response Time, $t_{DIGRESP}$

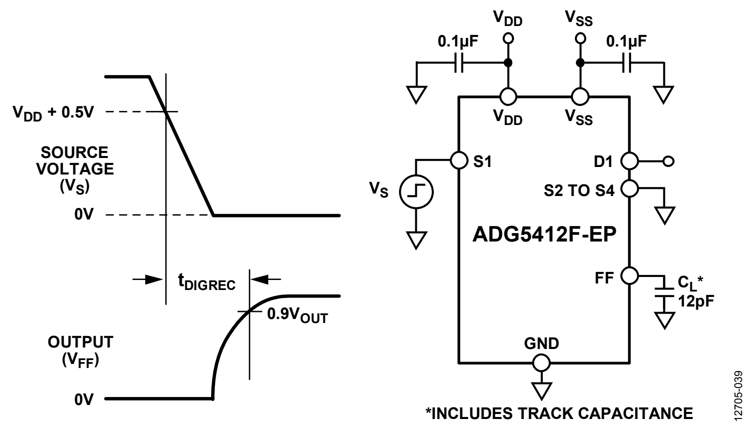


Figure 42. Interrupt Flag Recovery Time, t_{DIGREC}

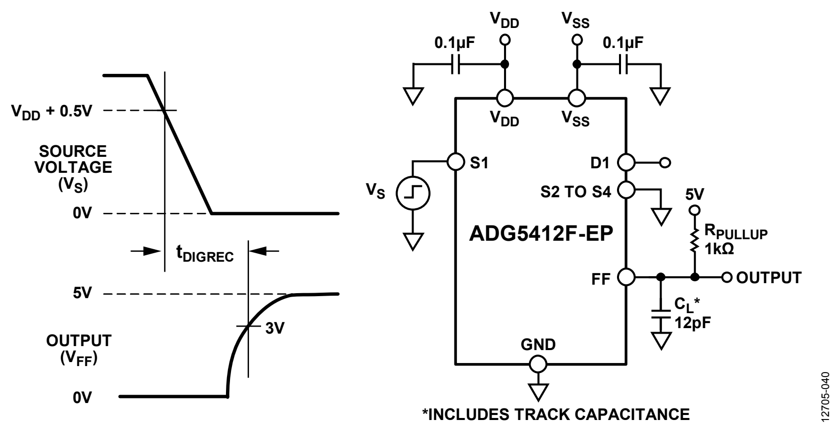


Figure 43. Interrupt Flag Recovery Time, t_{DIGREC}, with a 1 kΩ Pull-Up Resistor

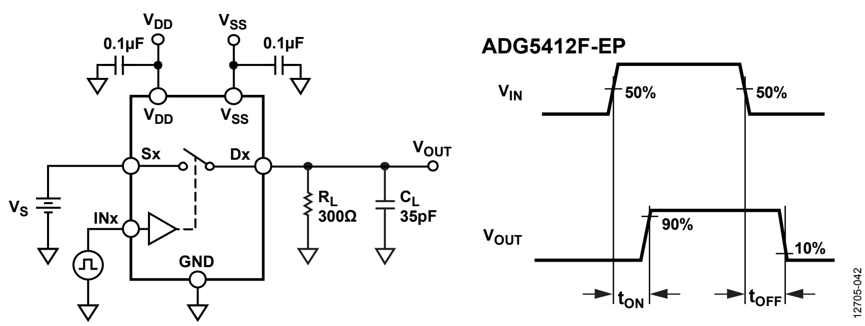


Figure 44. Switching Times, t_{ON} and t_{OFF}

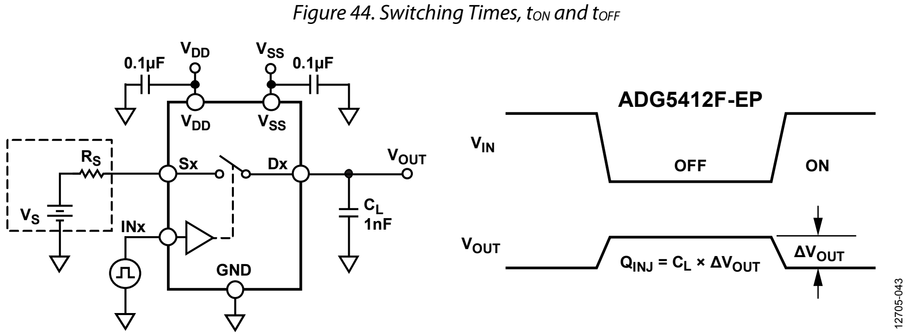
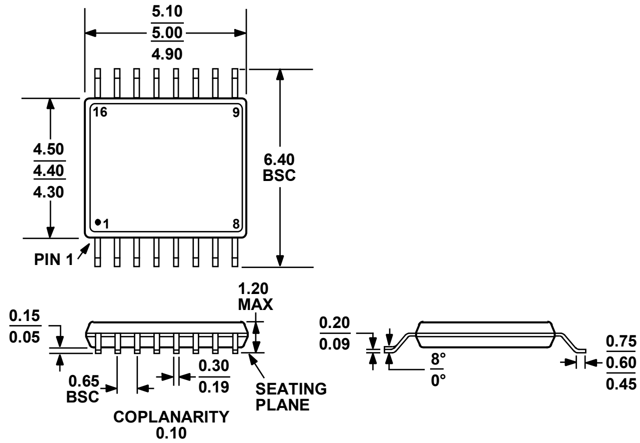


Figure 45. Charge Injection, Q_{INJ}

OUTLINE DIMENSIONS



COMPLIANT TO JEDEC STANDARDS MO-153-AB

Figure 46. 16-Lead Thin Shrink Small Outline Package [TSSOP] (RU-16) Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature Range	Package Description	Package Option
ADG5412FTRUZ-EP	−55°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16
ADG5412FTRUZ-EP-R7	−55°C to +125°C	16-Lead Thin Shrink Small Outline Package [TSSOP]	RU-16

[1] Z = RoHS Compliant Part.