Low Voltage, 2.4Ω 4:1 Multiplexer in 2mm × 2mm LGA Package

FEATURES

- ±1.08V to ±2.75V dual supply
- +1.08V to +5.5V single supply
- Low on resistance 2.4Ω
- 16-lead, 2mm × 2mm LGA
- 1.8V and 3V JEDEC compliant logic
- Fully specified at +5V, +3.3V, +1.8V, and ±2.5V
- Rail-to-rail signal range
- −40°C to +125°C operating temperature range

APPLICATIONS

- Automated test equipment
- Data acquisition systems
- Medical equipment
- FPGA and microcontroller systems
- Audio and video signal routing
- Communications systems
- Relay replacement

GENERAL DESCRIPTION

The ADG1704 is an analog 4:1 multiplexer and operates with a low-voltage single supply range from +1.08V to +5.5V or a low-voltage dual supply range from ±1.08V to ±2.75V. An EN input is used to disable all of the switches.

The ADG1704 is designed for small size without compromising on performance. The 2mm × 2mm land grid array (LGA) package is ideal for a broad range of applications where area is a concern.

The ADG1704 has a low on resistance of just 2.4Ω and a rail-to-rail input signal range. Each channel conducts equally well in both directions when on. The switches are turned on with a Logic 1 input on the corresponding digital control line, and the digital control inputs are 1.8V and 3V JEDEC compliant for ease of use with microcontrollers and field programmable gate arrays (FPGAs).

FUNCTIONAL BLOCK DIAGRAM

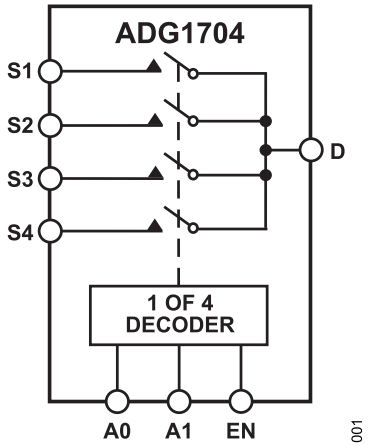

Figure 1. Functional Block Diagram

PRODUCT HIGHLIGHTS

1. 1.08V to 5.5V wide supply range
2. Low on-resistance of 2.4Ω
3. JEDEC standard compliant for both 1.8V and 3V logic levels.
4. 16-lead, 2mm × 2mm LGA.

One Analog Way, Wilmington, MA 01887-2356, U.S.A.

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REVISION HISTORY

12/2025—Revision 0: Initial Version

SPECIFICATIONS

OPERATING SUPPLY VOLTAGES

Table 1. Operating Voltage Range

Supply Voltage	Min	Max	Unit
Dual Supply	±1.08	±2.75	V
Single Supply	+1.08	+5.5	V

5V SINGLE SUPPLY

V_{DD} = 5V ± 10%, V_{SS} = 0V, GND = 0V, and V_L = 1.65V to 3.6V, unless otherwise noted.

Table 2. +5 V Single-Supply Specifications

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = +4.5V, V_{SS} = 0V
Analog Signal Range	V_{SS} to V_{DD}			V	
On Resistance, R_{ON}	2.4			Ω typ	Source voltage (V_S) = 0 to V_{DD}, source current (I_S) = −10mA, see Figure 48
	3.2	3.8	4.2	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.04			Ω typ	V_S = 0 to V_{DD}, I_S = −10mA
	0.12	0.15	0.3	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	0.56			Ω typ	V_S = 0 to V_{DD}, I_S = −10mA
	1.0	1.1	1.1	Ω max	
LEAKAGE CURRENTS					V_{DD} = +5.5V
Source Off Leakage, I_S (Off)	±0.1			nA typ	V_S = 4.5V/1V, drain voltage (V_D) = 1V/4.5V, see Figure 49
	±0.54	±2.1	±5.7	nA max	
Drain Off Leakage, I_D (Off)	±0.6			nA typ	V_S = 4.5V/1V, V_D = 1 V/4.5V, see Figure 49
	±2.16	±8.4	±22.8	nA max	
Channel On Leakage, I_D, I_S (On)	±0.11			nA typ	V_S = V_D = 1V or 4.5V, see Figure 50
	±1.66	±6.36	±17.4	nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			0.65 × V_L	V min	V_L = 1.65V to 1.95V
Input Low Voltage, V_{INL}			0.35 × V_L	V max	V_L = 1.65V to 1.95V
Input High Voltage, V_{INH}			2.0	V min	V_L = 2.7V to 3.6V
Input Low Voltage, V_{INL}			0.8	V max	V_L = 2.7V to 3.6V
Input Current, I_{INH} or I_{INL}	0.02			μA typ	V_{INx} = 0V or V_L
			0.8	μA max	
Digital-Input Capacitance, C_{IN}	5			pF typ	
DYNAMIC CHARACTERISTICS					
On Time, t_{ON}(EN)	23			ns typ	Load resistance (R_L) = 300Ω, load capacitance (C_L) = 35pF , V_S = 3V, V_L = 1.8V, see Figure 55
	27	29	31	ns max	
Off Time, t_{OFF}(EN)	72			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 3V, V_L = 1.8V, see Figure 55
	87	90	90	ns max	
Transition Time ($t_{TRANSITION}$)	35			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 3V, V_L = 1.8V, see Figure 56
	45	47	49	ns max	
Break-Before-Make Time Delay (t_D)	13			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 3V, V_L = 1.8V, see Figure 57
	8	7	7	ns min	
Charge Injection, Q_{INJ}	2.63			pC typ	V_S = 2.5V, R_S = 0Ω, C_L = 1nF, V_L = 1.8V, see Figure 58
Off Isolation	−68			dB typ	R_L = 50Ω, C_L = 5pF, frequency (f) = 1MHz, see Figure 51

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Table 2. +5 V Single-Supply Specifications (Continued)

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
	−48			dB typ	R_L = 50Ω, C_L = 5pF, f = 10MHz
Channel-to-Channel Crosstalk	−74			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 52
	−54			dB typ	R_L = 50Ω, C_L = 5pF, f = 10MHz
Total Harmonic Distortion, THD	−92			dB typ	R_L = 10kΩ, 3V p-p, f = 20kHz, see Figure 54
	−91			dB typ	R_L = 10kΩ, 3V p-p, f = 100kHz, see Figure 54
	−89			dB typ	R_L = 10kΩ, 3V p-p, f = 200kHz, see Figure 54
Total Harmonic Distortion + Noise, THD + N	0.003			% typ	R_L = 10kΩ, 3V p-p, f = 20Hz to 20kHz, see Figure 54
−3dB Bandwidth	194			MHz typ	R_L = 50Ω, C_L = 5pF, see Figure 53
Insertion Loss	−0.13			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 53
Source Off Capacitance, C_S (Off)	6			pF typ	V_S = 2.5V, f = 1MHz
Drain Off Capacitance, C_D (Off)	24			pF typ	V_S = 2.5V, f = 1MHz
Drain On Capacitance, C_D (On), Source On Capacitance, C_S (On)	30			pF typ	V_S = 2.5V, f = 1MHz
POWER REQUIREMENTS					V_{DD} = +5.5V, V_{SS} = 0V, V_L = 1.8V
Positive Supply Current, I_{DD}	1.0			μA typ	Digital inputs = 0V or V_L V
	1.4	1.62	1.62	μA max	
Negative Supply Current, I_{SS}	0.64			nA typ	Digital inputs = 0V or V_L V
	10	11	91	nA max	
Digital Supply Current, I_L	0.05			nA typ	Digital inputs = 0V or V_L V
	1.5	3.0	20	nA max	

+3V SINGLE SUPPLY

V_{DD} = +2.7V to 3.6V, V_{SS} = 0V, GND = 0V, and V_L = 1.65V to 3.6V, unless otherwise noted.

Table 3. +3V Single-Supply Specifications

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = 2.7V, V_{SS} = 0V
Analog Signal Range	V_{SS} to V_{DD}			V	
On Resistance, R_{ON}	3.9			Ω typ	V_S = 0 to V_{DD}, I_S = −10mA, see Figure 48
	6.8	7.6	8.0	max	
On-Resistance Match Between Channels, ΔR_{ON}	0.06			Ω typ	V_S = 0 to V_{DD} = −10mA
	0.21	0.25	0.3	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	1.1			Ω typ	V_S = 0 to V_{DD} = −10mA
	2.1	2.3	2.4	Ω max	
LEAKAGE CURRENTS					V_{DD} = 3.6V, V_{SS} = 0V
Source Off Leakage, I_S (Off)	±0.01			nA typ	V_S = 3.3V/1 V, V_D = 1V/3.3V, see Figure 49
	±0.032	±0.08	±0.5	nA max	
Drain Off Leakage, I_D (Off)	±0.04			nA typ	V_S = 3.3V/1V, V_D = 1V/3.3V, see Figure 49
	±0.128	±0.32	±2	nA max	
Channel On Leakage, I_D, I_S (On)	±0.04			nA typ	V_S = V_D = 3.3V or 1V, see Figure 50
	±0.136	±0.29	±1.77	nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			0.65 × V_L	V min	V_L = 1.65V to 1.95V
Input Low Voltage, V_{INL}			0.35 × V_L	V max	V_L = 1.65V to 1.95V
Input High Voltage, V_{INH}			2.0	V min	V_L = 2.7V to 3.6V
Input Low Voltage, V_{INL}			0.8	V max	V_L = 2.7V to 3.6V
Input High Current, I_{INH} or $_{INL}$	0.02			μA typ	V_{INx} = 0V or V_L

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Table 3. +3V Single-Supply Specifications (Continued)

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
			0.8	µA max	
Digital-Input Capacitance, C_{IN}	5			pF typ	
DYNAMIC CHARACTERISTICS					
On Time, t_{ON}(EN)	30			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V, V_L = 1.8V, see Figure 55
	36	39	41	ns max	
Off Time, t_{OFF}(EN)	77			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V V_L = 1.8V, see Figure 55
	94	94	96	ns max	
Transition Time ($t_{TRANSITION}$)	45			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V V_L = 1.8V, see Figure 56
	62	64	66	ns max	
Break-Before-Make Time Delay (t_D)	17			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V V_L = 1.8V, see Figure 57
	11	10	10	ns min	
Charge Injection, Q_{INJ}	1.5			pC typ	V_S = 1.5V, R_S = 0 Ω, C_L = 1nF, V_L = 1.8V, see Figure 58
Off Isolation	−68			dB typ	R_L = 50Ω, C_L = 5pF, frequency (f) = 1MHz, see Figure 51
	−48				R_L = 50Ω, C_L = 5pF, f = 10MHz
Channel-to-Channel Crosstalk	−74			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 52
	−54			dB typ	R_L = 50Ω, C_L = 5pF, f = 10MHz
Total Harmonic Distortion, THD	−86			dB typ	R_L = 10kΩ, 1.5V p-p, f = 20kHz, see Figure 54
	−85			dB typ	R_L = 10kΩ, 1.5V p-p, f = 100kHz, see Figure 54
	−83			dB typ	R_L = 10kΩ, 1.5V p-p, f = 200kHz, see Figure 54
Total Harmonic Distortion + Noise, THD + N	0.005			% typ	R_L = 10kΩ, 1.5V p-p, f = 20Hz to 20kHz, see Figure 54
−3dB Bandwidth	194			MHz typ	R_L = 50Ω, C_L = 5pF, see Figure 53
Insertion Loss	−0.22			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 53
Source Off Capacitance, C_S (Off)	6			pF typ	V_S = 1.5V, f = 1MHz
Drain Off Capacitance, C_D (Off)	24			pF typ	V_S = 1.5V, f = 1MHz
Drain On Capacitance, C_D (On), Source On Capacitance, C_S (On)	30			pF typ	V_S = 1.5V, f = 1MHz
POWER REQUIREMENTS					V_{DD} = 3.6V, V_{SS} = 0V, V_L = 1.8V
Positive Supply Current, I_{DD}	0.21			µA typ	Digital inputs = 0V or V_L V
	0.26	0.31	0.31	µA max	
Negative Supply Current, I_{SS}	0.64			nA typ	Digital inputs = 0V or V_L V
	10	11	91	nA max	
Digital Supply Current, I_L	0.05			nA typ	Digital inputs = 0V or V_L V
	1.5	3.0	20	nA max	

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+1.8V SINGLE SUPPLY

V_{DD} = 1.71V to 1.95V, V_{SS} = 0V, GND = 0V, and V_L = 1.65V to 3.6V, unless otherwise noted.

Table 4. +1.8V Single-Supply Specifications

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = 1.71V, V_{SS} = 0V
Analog Signal Range	V_{SS} to V_{DD}			V	
On Resistance, R_{ON}	19.2			Ω typ	V_S = 0 to V_{DD}, I_S = −10mA, see Figure 48
	63	77	77	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.21			Ω typ	V_S = 0 to V_{DD} = −10mA
	0.9	1.2	1.2	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	14.5			Ω typ	V_S = 0 to V_{DD} = −10mA
	56	72	72	Ω max	
LEAKAGE CURRENTS					V_{DD} = 1.95V, V_{SS} = 0V
Source Off Leakage, I_S (Off)	±0.01			nA typ	V_S = 0.6V/1.65V, V_D = 1.65V/0.6 V, see Figure 49
	±0.032	±0.08	±0.5	nA max	
Drain Off Leakage, I_D (Off)	±0.04			nA typ	V_S = 1.65V/0.6V, V_D = 0.6V/1.65 V, see Figure 49
	±0.128	±0.32	±2	nA max	
Channel On Leakage, I_D, I_S (On)	±0.04			nA typ	V_S = V_D = 0.6V or 1.65V, see Figure 50
	±0.136	±0.29	±1.77	nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			0.65 × V_L	V min	V_L = 1.65V to 1.95V
Input Low Voltage, V_{INL}			0.35 × V_L	V max	V_L = 1.65V to 1.95V
Input High Voltage, V_{INH}			2.0	V min	V_L = 2.7V to 3.6V
Input Low Voltage, V_{INL}			0.8	V max	V_L = 2.7V to 3.6V
Input High Current, I_{INH} or $_{INL}$	0.02			μA typ	V_{INx} = 0V or V_L
			0.8	μA max	
Digital-Input Capacitance, C_{IN}	5			pF typ	
DYNAMIC CHARACTERISTICS					
On Time, t_{ON}	56			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1V, V_L = 1.8V, see Figure 55
	73	77	81	ns max	
Off Time, t_{OFF}(EN)	88			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1V V_L = 1.8V, see Figure 55
	105	108.3	109	ns max	
Transition Time ($t_{TRANSITION}$)	73			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1V V_L = 1.8V, see Figure 56
	93.4	107.3	107.3	ns max	
Break-Before-Make Time Delay (t_D)	33			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1V V_L = 1.8V, see Figure 57
	25.3	23.7	23.7	ns min	
Charge Injection, Q_{INJ}	0.72			pC typ	V_S = 0.9V, R_S = 0Ω, C_L = 1nF, V_L = 1.8V, see Figure 58
Off Isolation	−68			dB typ	R_L = 50Ω, C_L = 5pF, frequency (f) = 1MHz, see Figure 51
	−48				R_L = 50Ω, C_L = 5 pF, f = 10MHz
Channel-to-Channel Crosstalk	−74			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 52
	−54			dB typ	R_L = 50Ω, C_L = 5pF, f = 10MHz
Total Harmonic Distortion, THD	−66			dB typ	R_L = 10kΩ, 1.5V p-p, f = 20kHz, see Figure 54
	−62			dB typ	R_L = 10kΩ, 1.5V p-p, f = 100kHz, see Figure 54
	−58			dB typ	R_L = 10kΩ, 1.5V p-p, f = 200kHz, see Figure 54
Total Harmonic Distortion + Noise, THD + N	0.08			% typ	R_L = 10kΩ, 1.5V p-p, f = 20Hz to 20kHz, see Figure 54
−3dB Bandwidth	230			MHz typ	R_L = 50Ω, C_L = 5pF, see Figure 53
Insertion Loss	−0.36			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 53

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Table 4. +1.8V Single-Supply Specifications (Continued)

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
Source Off Capacitance, C_S (Off)	6			pF typ	V_S = 0.9V, f = 1MHz
Drain Off Capacitance, C_D (Off)	24			pF typ	V_S = 0.9V, f = 1MHz
Drain On Capacitance, C_D (On), Source On Capacitance, C_S (On)	30			pF typ	V_S = 0.9V, f = 1MHz
POWER REQUIREMENTS					V_{DD} = 1.95V, V_{SS} = 0V, V_L = 1.8V
Positive Supply Current, I_{DD}	0.01			nA typ	Digital inputs = 0V or V_L V
	0.26	0.31	0.31	µA max	
Negative Supply Current, I_{SS}	0.64			nA typ	Digital inputs = 0V or V_L V
	10	11	91	nA max	
Digital Supply Current, I_L	0.05			nA typ	Digital inputs = 0V or V_L V
	1.5	3.0	20	nA max	

±2.5V DUAL SUPPLY

V_{DD} = +2.5V ± 10%, V_{SS} = −2.5V ± 10%, GND = 0V, and V_L = 1.65V to 1.95V, unless otherwise noted.

Table 5. ±2.5 V Dual-Supply Specifications

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
ANALOG SWITCH					V_{DD} = +2.25V, V_{SS} = −2.25V
Analog Signal Range	V_{SS} to V_{DD}			V	
On Resistance, R_{ON}	2.4			Ω typ	V_S = V_{SS} to V_{DD}, I_S = −10mA, see Figure 48
	3.2	3.8	4.2	Ω max	
On-Resistance Match Between Channels, ΔR_{ON}	0.04			Ω typ	V_S = V_{SS} to V_{DD} = −10mA
	0.12	0.15	0.3	Ω max	
On-Resistance Flatness, $R_{FLAT(ON)}$	0.56			Ω typ	V_S = V_{SS} to V_{DD} = −10mA
	1.0	1.1	1.1	Ω max	
LEAKAGE CURRENTS					V_{DD} = +2.75V, V_{SS} = −2.75V
Source Off Leakage, I_S (Off)	±0.3			nA typ	V_S = +2.25V/−2.25V, V_D = −2.25V/+2.25V, see Figure 49
	±0.54	±2.1	±5.7	nA max	
Drain Off Leakage, I_D (Off)	±1.14			nA typ	V_S = +2.25 V/−2.25 V, V_D = −2.25V/+2.25V, see Figure 49
	±2.16	±8.4	±22.8	nA max	
Channel On Leakage, I_D, I_S (On)	±0.95			nA typ	V_S = V_D = −2.25V or +1.25V, see Figure 50
	±1.66	±6.36	±17.4	nA max	
DIGITAL INPUTS					
Input High Voltage, V_{INH}			0.65 × V_L	V min	V_L = 1.65V to 1.95V
Input Low Voltage, V_{INL}			0.35 × V_L	V max	V_L = 1.65V to 1.95V
Input High Current, I_{INH} or I_{INL}	0.02			µA typ	V_{INx} = 0V or V_L
			0.8	µA max	
Digital-Input Capacitance, C_{IN}	5			pF typ	
DYNAMIC CHARACTERISTICS					
On Time, t_{ON}	24			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V,V_L = 1.8V, see Figure 55
	29	31	33	ns max	
Off Time, t_{OFF}(EN)	72			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V V_L = 1.8V, see Figure 55
	87.3	89	90	ns max	
Transition Time ($t_{TRANSITION}$)	41			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V V_L = 1.8V, see Figure 56
	54.8	56.7	58.2	ns max	
Break-Before-Make Time Delay (t_D)	14			ns typ	R_L = 300Ω, C_L = 35pF, V_S = 1.5V V_L = 1.8V, see Figure 57

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Table 5. ±2.5 V Dual-Supply Specifications (Continued)

Parameter	25°C	−40°C to +85°C	−40°C to +125°C	Unit	Test Conditions/Comments
	7.6	6.6	6.6	ns min	
Charge Injection, Q_{INJ}	2.65			pC typ	V_S = 0V, R_S = 0Ω, C_L = 1nF, V_L = 1.8V, see Figure 58
Off Isolation	−68			dB typ	R_L = 50Ω, C_L = 5pF, frequency (f) = 1MHz, see Figure 51
	−48				R_L = 50Ω, C_L = 5pF, f = 10MHz
Channel-to-Channel Crosstalk	−74			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 52
	−54			dB typ	R_L = 50Ω, C_L = 5pF, f = 10MHz
Total Harmonic Distortion, THD	−98			dB typ	R_L = 10kΩ, 3V p-p, f = 20kHz, see Figure 54
	−92			dB typ	R_L = 10kΩ, 3V p-p, f = 100kHz, see Figure 54
	−87			dB typ	R_L = 10kΩ, 3V p-p, f = 200kHz, see Figure 54
Total Harmonic Distortion + Noise, THD + N	0.003			% typ	R_L = 10kΩ, 3V p-p, f = 20Hz to 20kHz, see Figure 54
−3dB Bandwidth	200			MHz typ	R_L = 50Ω, C_L = 5pF, see Figure 53
Insertion Loss	−0.15			dB typ	R_L = 50Ω, C_L = 5pF, f = 1MHz, see Figure 53
Source Off Capacitance, C_S (Off)	6			pF typ	V_S = 0V, f = 1MHz
Source Off Capacitance, C_D (Off)	24			pF typ	V_S = 0V, f = 1MHz
Drain On Capacitance, C_D (On), Source On Capacitance, C_S (On)	30			pF typ	V_S = 0V, f = 1MHz
POWER REQUIREMENTS					V_{DD} = +2.75V, V_{SS} = −2.75V, V_L = 1.8V
Positive Supply Current, I_{DD}	0.013			µA typ	Digital inputs = 0V or V_L
	0.26	0.31	0.31	µA max	
Negative Supply Current, I_{SS}	0.06			nA typ	Digital inputs = 0V or V_L
	10	13	105	nA max	
Digital Supply Current, I_L	0.05			µA typ	Digital inputs = 0V or V_L
	1.5	3.0	20	nA max	

SPECIFICATIONS

CONTINUOUS CURRENT PER CHANNEL, SX OR D

Table 6. One Channel On, Per Channel Specifications

Parameter	25°C	85°C	125°C	Unit
CONTINUOUS CURRENT, Sx OR D[1] (θ_{JA} = 150°C/W.)				
V_{DD} = +5V, V_{SS} = 0V	254	111	44	mA maximum
V_{DD} = +3V, V_{SS} = 0V	196	97	43	mA maximum
V_{DD} = 1.8V, V_{SS} = 0V	123	73	39	mA maximum
V_{DD} = 2.5V, V_{SS} = −2.5V	239	108	44	mA maximum

[1] Sx refer to S1 to S4 pins

ABSOLUTE MAXIMUM RATINGS

T_A = 25°C, unless otherwise noted.

Table 7. Absolute Maximum Ratings

Parameter	Rating
V_{DD} to V_{SS}	6V
V_{DD} to GND	–0.3V to +6V
V_{SS} to GND	+0.3V to −6V
V_L to GND	–0.3V to +6V
V_L to V_{SS}	6V
Analog Inputs[1]	V_{SS} − 0.3 V to V_{DD} + 0.3V or 30mA, whichever occurs first
Digital Inputs[2]	GND − 0.3V to 6V or 30mA, whichever occurs first
Peak Current, Sx or D Pins[3]	682mA (pulsed at 1ms, 10% duty-cycle maximum)
Continuous Current, Sx or D Pins[3]	Data Table 6 + 15%
Temperature	
Operating Range	–40°C to +125°C
Storage Range	–65°C to +150°C
Junction	150°C
Reflow Soldering Peak, Pb-Free	As per JEDEC J-STD-020

[1] Overvoltages at the Ax, Sx, and D pins are clamped by internal diodes. Current must be limited to the maximum ratings given.

[2] Overvoltages at the A0 and A1 digital-input pins are clamped by internal diodes.

[3] Sx refers to the S1 to S4 pins.

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.

THERMAL RESISTANCE

Thermal performance is directly linked to printed circuit board (PCB) design and operating environment. Careful attention to PCB thermal design is required.

θ_{JA} is the natural convection junction-to-ambient thermal resistance measured in a one cubic foot sealed enclosure, and θ_{JCB} is the junction to the bottom of case thermal resistance.

Table 8. Thermal Resistance

Package Type	θ_{JA}	θ_{JCB}	Unit
CC-16-10[1]	150	74.8	°C/W

[1] Thermal impedance simulated values are based on JEDEC 2S2P thermal test board without thermal vias. See JEDEC JESD-51.

ELECTROSTATIC DISCHARGE (ESD) RATINGS

The following ESD information is provided for handling of ESD-sensitive devices in an ESD-protected area only.

Human body model (HBM) per ANSI/ESDA/JEDEC JS-001.

Field induced charged-device model (FICDM) per ANSI/ESDA/JEDEC JS-002.

ESD Ratings for the ADG1704

Table 9. ADG1704, 16-Lead LGA

ESD Model	Withstand Threshold (V)	Class
HBM[1]	±4000	3A
FICDM	±1250	C3

[1] For the input and output port to the supplies, the input and output port to the input and output port, and all other inputs.

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

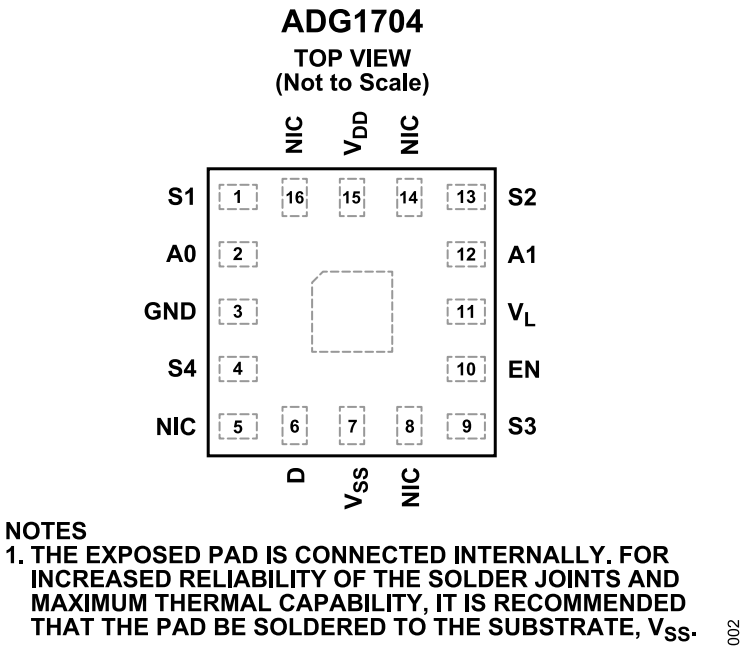

Figure 2. Pin Configuration

Table 10. Pin Function Descriptions

Pin No.	Mnemonic	Description
1	S1	Source Terminal 1. This pin can be an input or output.
2	A0	Logic Control Input A0
3	GND	Ground (0V) Reference.
4	S4	Source Terminal 4. This pin can be an input or output.
5, 8, 14, 16	NIC	Not Internally Connected.
6	D	Drain Terminal. This pin can be an input or output.
7	V_{SS}	Most Negative Power-Supply Potential. Decouple the V_{SS} pin using a 0.1µF capacitor to GND.
9	S3	Source Terminal 3. This pin can be an input or output.
10	EN	Active High Digital Input. When the EN pin is low, the device is disabled, and all switches are off. When the EN pin is high, Ax logic inputs determine the on switches.
11	V_L	Digital Logic Power Supply.
12	A1	Digital Control Input A1.
13	S2	Source Terminal 2. This pin can be an input or output.
15	V_{DD}	Most Positive Power-Supply Potential. Decouple the V_{DD} pin using a 0.1µF capacitor to GND.
EP	Exposed Pad	The exposed pad is connected internally. For increased reliability of the solder joints and maximum thermal capability, it is recommended that the pad be soldered to the substrate, VSS.

Table 11. ADG1704 Truth Table

EN	A1	A0	S1	S2	S3	S4
0	X[1]	X[1]	Off	Off	Off	Off
1	0	0	On	Off	Off	Off
1	0	1	Off	On	Off	Off
1	1	0	Off	Off	On	Off
1	1	1	Off	Off	Off	On

[1] X is don't care.

TYPICAL PERFORMANCE CHARACTERISTICS

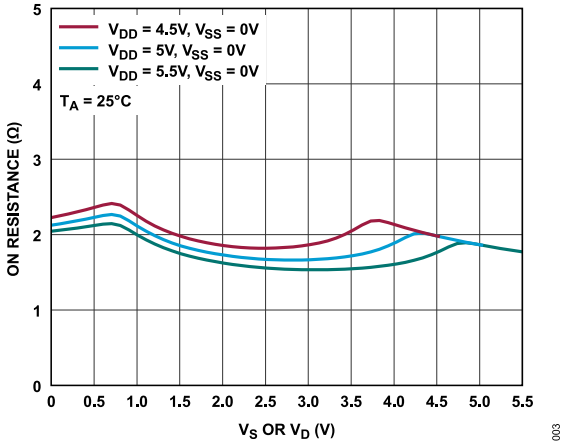

Figure 3. On Resistance vs. V_D or V_S, 5V Single Supply

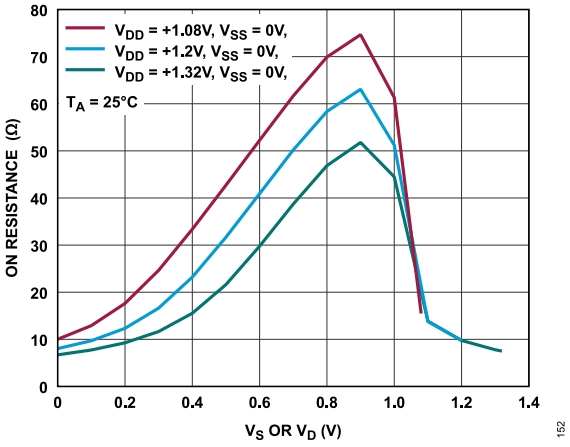

Figure 6. On Resistance vs. V_S or V_D, 1.2V Single Supply

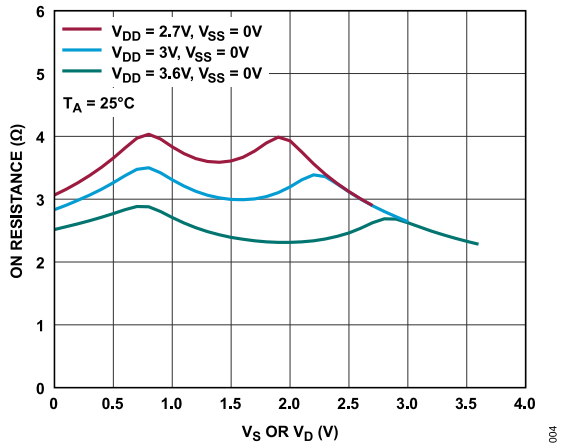

Figure 4. On Resistance vs. V_D or V_S, 3V Single Supply

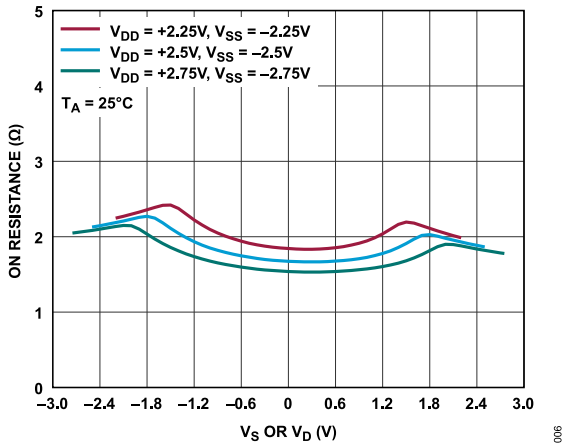

Figure 7. On Resistance vs. V_D or V_S, 2.5V Dual Supply

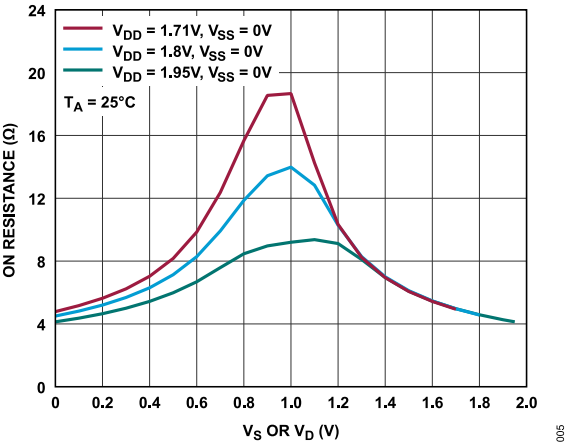

Figure 5. On Resistance vs. V_D or V_S, 1.8V Single Supply

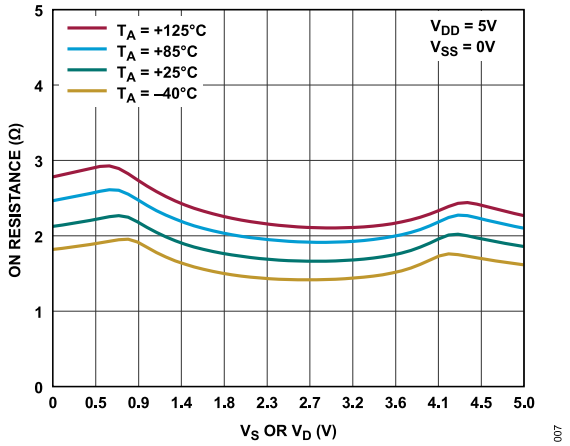

Figure 8. On Resistance vs. V_D or V_S for Different Temperatures, +5V Single Supply

TYPICAL PERFORMANCE CHARACTERISTICS

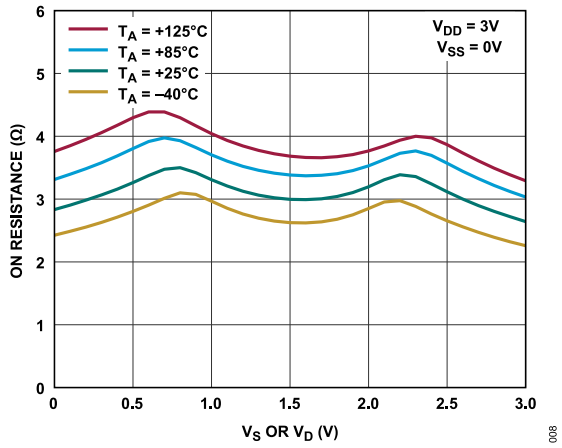

Figure 9. On Resistance vs. V_D or V_S for Different Temperatures, +3V Single Supply

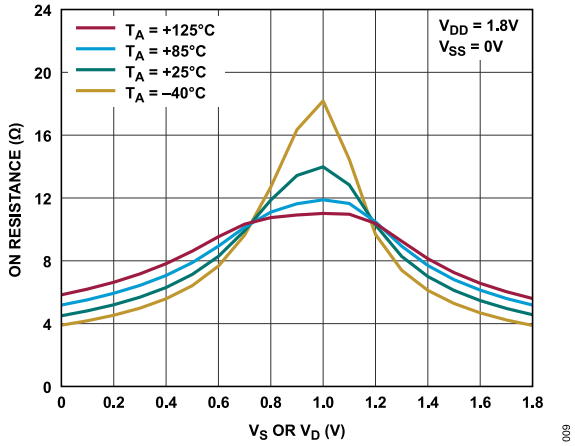

Figure 10. On Resistance vs. V_D or V_S for Different Temperatures, +1.8V Single Supply

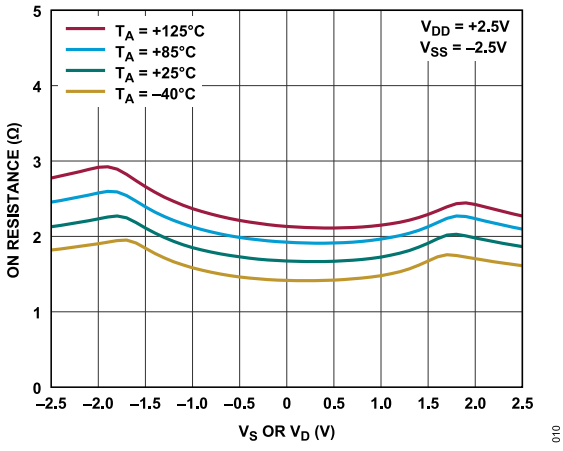

Figure 11. On Resistance vs. V_D or V_S for Different Temperatures, ±2.5V Dual Supply

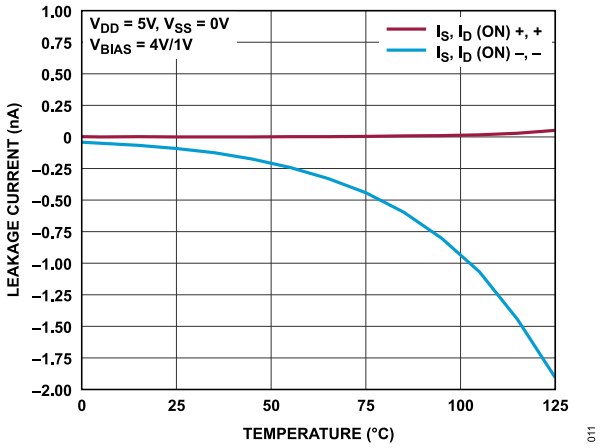

Figure 12. On Leakage Currents vs. Temperature, +5V Single Supply

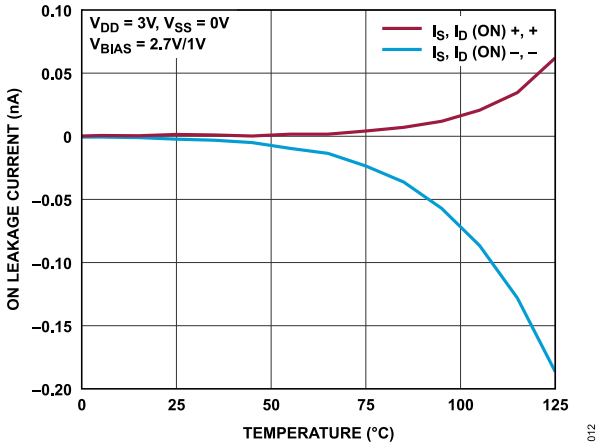

Figure 13. On Leakage Currents vs. Temperature, +3V Single Supply

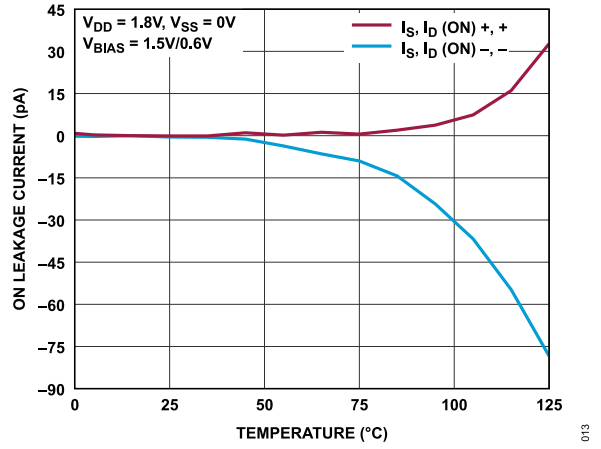

Figure 14. On Leakage Currents vs. Temperature, +1.8V Single Supply

TYPICAL PERFORMANCE CHARACTERISTICS

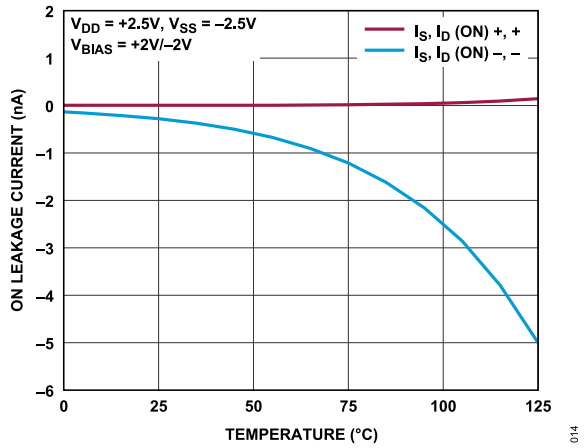

Figure 15. On Leakage Currents vs. Temperature, ±2.5V Dual Supply

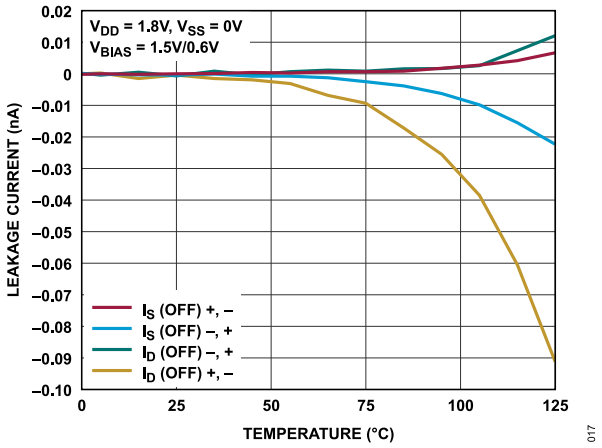

Figure 18. Off Leakage Currents vs. Temperature, +1.8V Single Supply

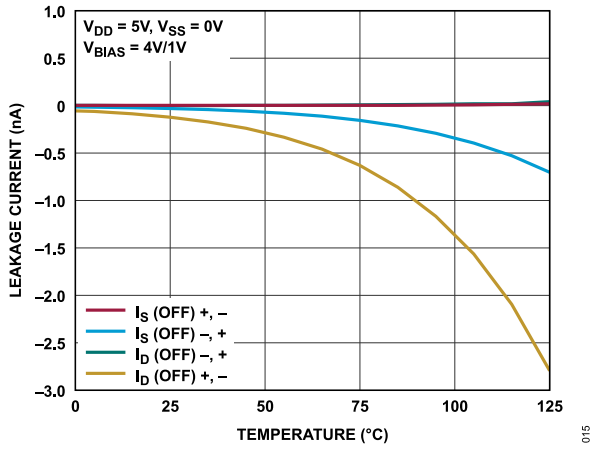

Figure 16. Off Leakage Currents vs. Temperature, +5V Single Supply

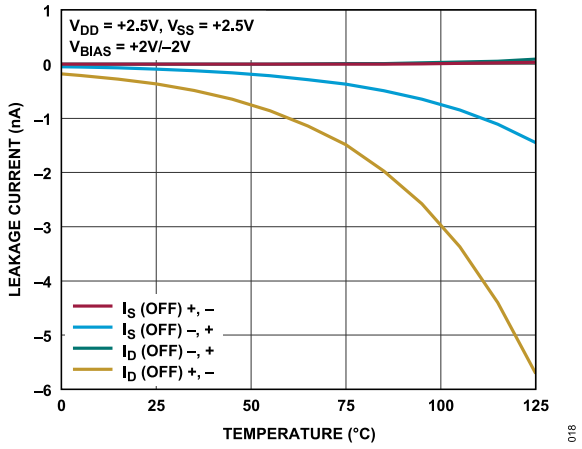

Figure 19. Off Leakage Currents vs. Temperature, ±2.5V Dual Supply

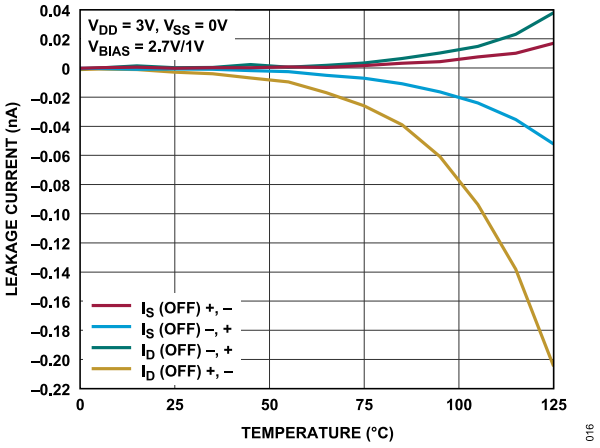

Figure 17. Off Leakage Currents vs. Temperature, +3V Single Supply

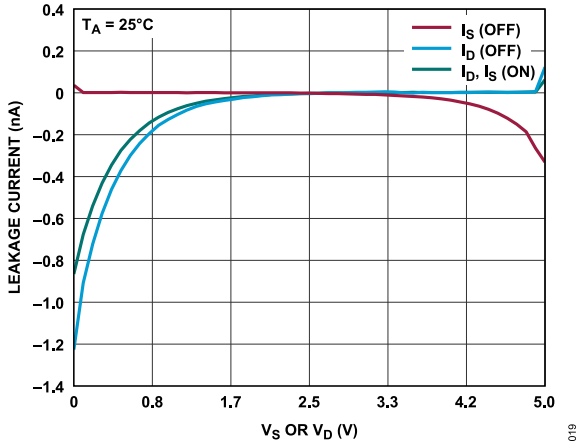

Figure 20. Leakage Currents as a Function of V_S (V_D), +5V Single Supply, 25°C

TYPICAL PERFORMANCE CHARACTERISTICS

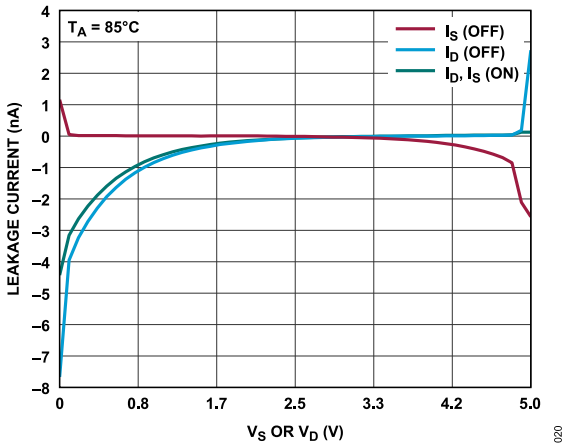

Figure 21. Leakage Currents as a Function of V_S (V_D), +5V Single Supply, 85°C

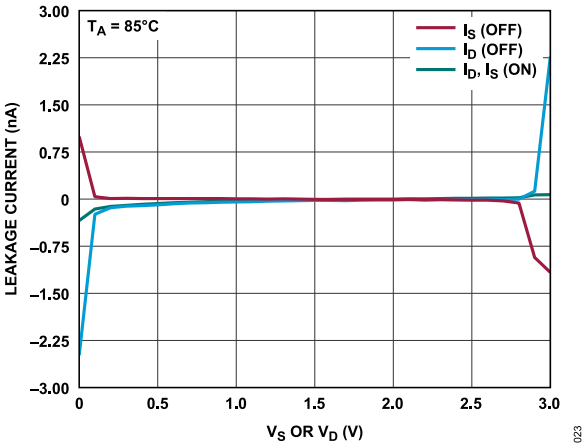

Figure 24. Leakage Currents as a Function of V_S (V_D), +3V Single Supply, 85°C

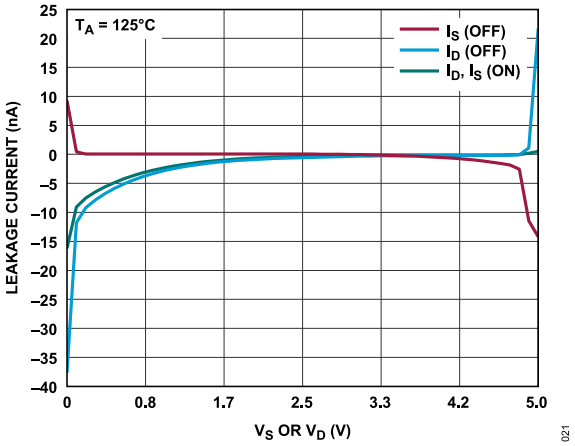

Figure 22. Leakage Currents as a Function of V_S (V_D), +5V Single Supply, 125°C

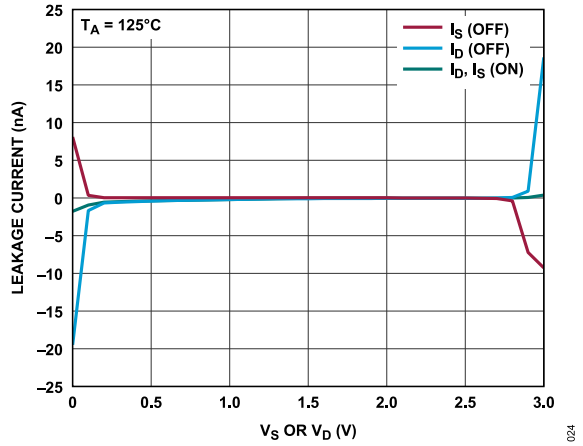

Figure 25. Leakage Currents as a Function of V_S (V_D), +3V Single Supply, 125°C

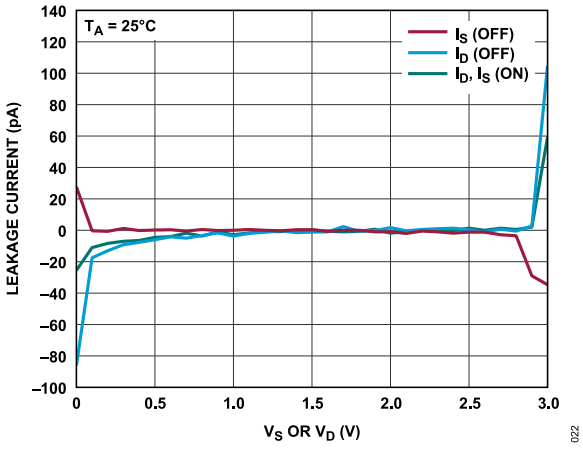

Figure 23. Leakage Currents as a Function of V_S (V_D), +3V Single Supply, 25°C

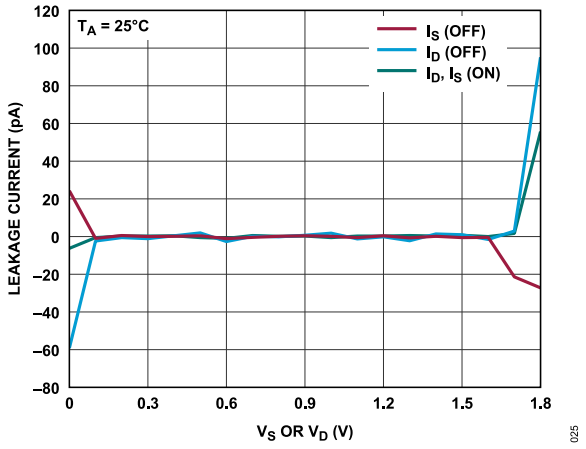

Figure 26. Leakage Currents as a Function of V_S (V_D), +1.8V Single Supply, 25°C

TYPICAL PERFORMANCE CHARACTERISTICS

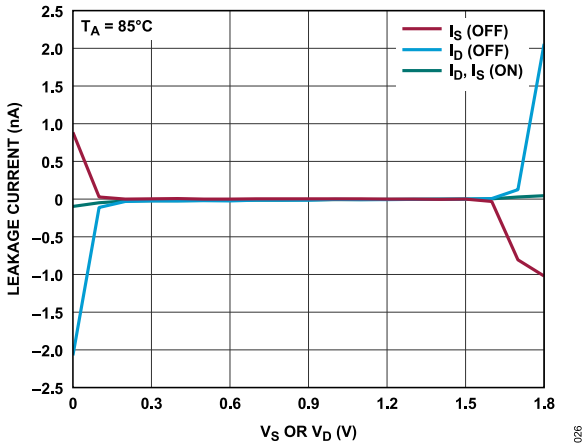

Figure 27. Leakage Currents as a Function of V_S (V_D), +1.8V Single Supply, 85°C

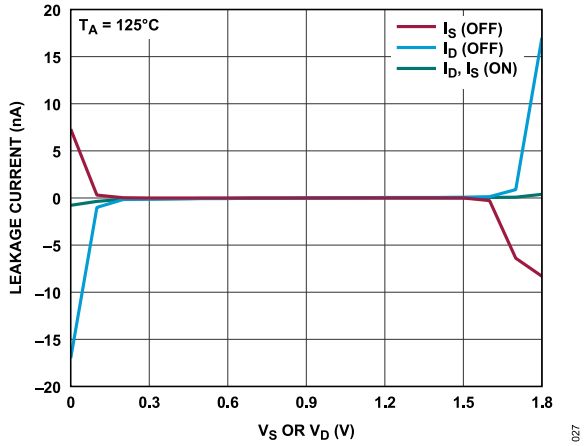

Figure 28. Leakage Currents as a Function of V_S (V_D), +1.8V Single Supply, 125°C

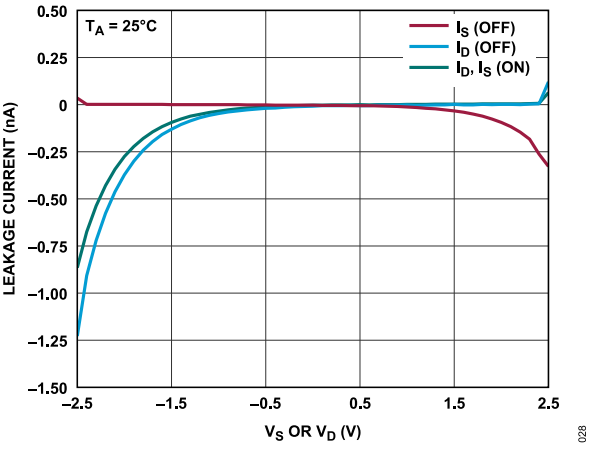

Figure 29. Leakage Currents as a Function of V_S (V_D), ±2.5V Dual Supply, 25°C

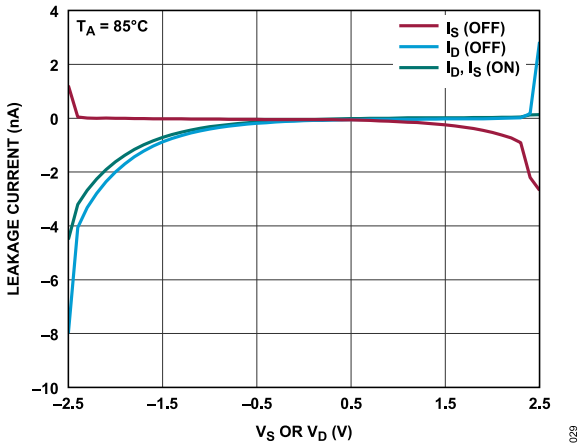

Figure 30. Leakage Currents as a Function of V_S (V_D), ±2.5V Dual Supply, 85°C

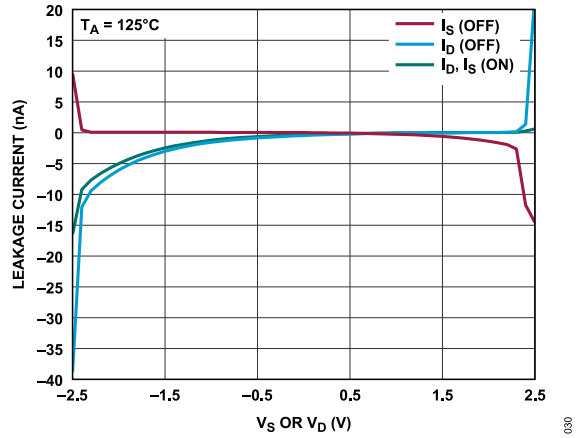

Figure 31. Leakage Currents as a Function of V_S (V_D), ±2.5V Dual Supply, 125°C

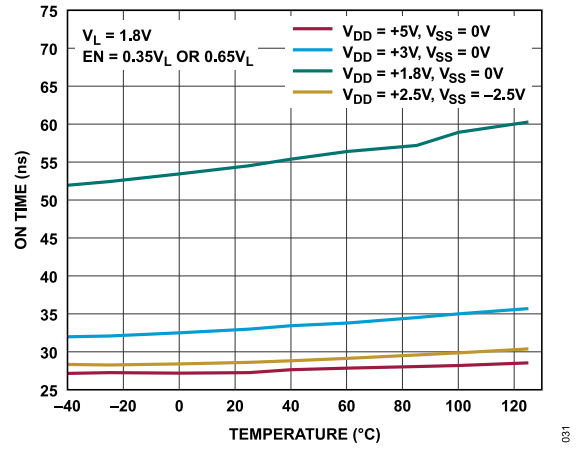

Figure 32. On Time vs. Temperature

TYPICAL PERFORMANCE CHARACTERISTICS

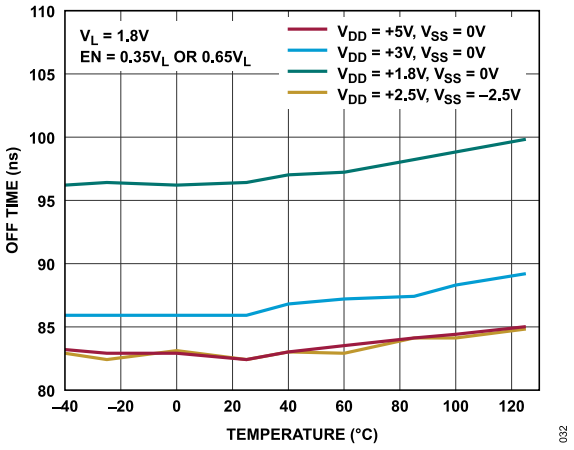

Figure 33. Off Time vs. Temperature

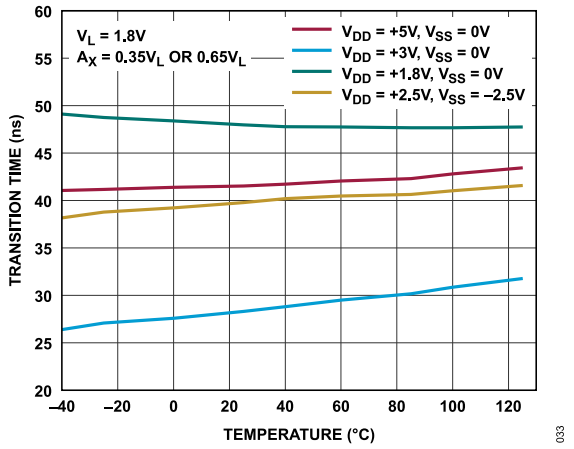

Figure 34. Transition Time vs. Temperature

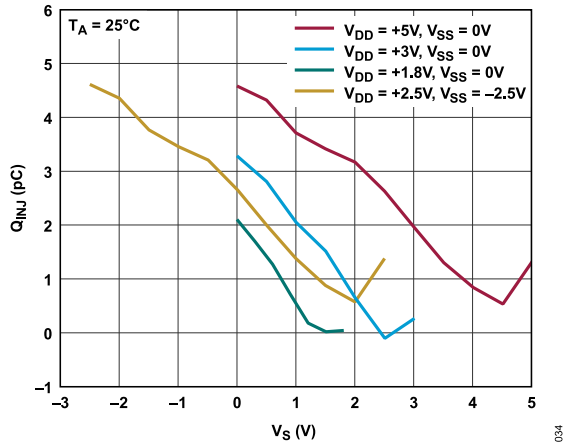

Figure 35. Charge Injection vs. V_S

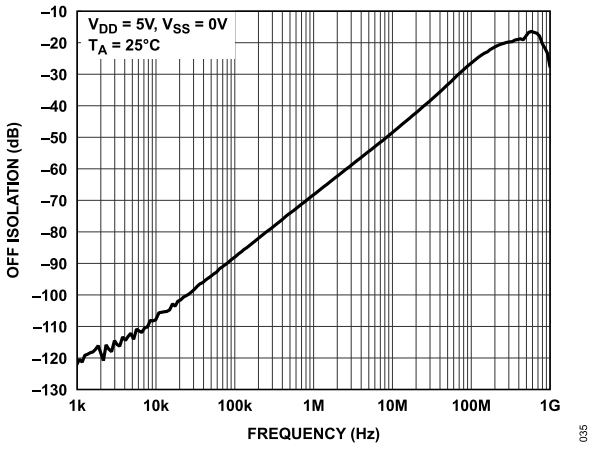

Figure 36. Off Isolation vs. Frequency, +5V Single Supply

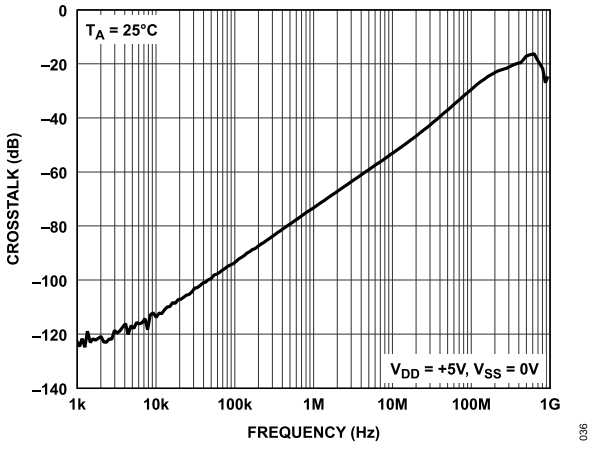

Figure 37. Crosstalk vs. Frequency, +5V Single Supply

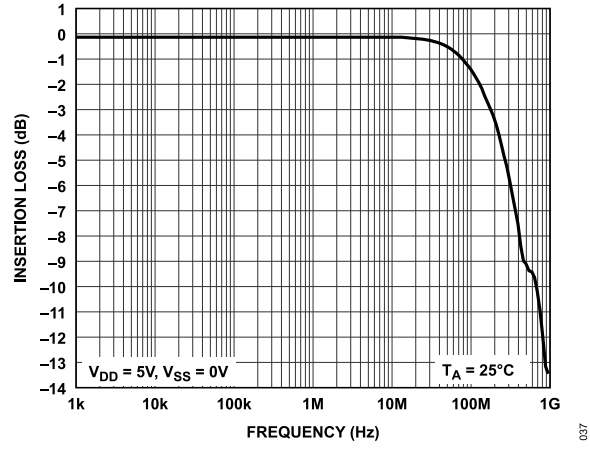

Figure 38. Insertion Loss vs. Frequency, +5V Single Supply

TYPICAL PERFORMANCE CHARACTERISTICS

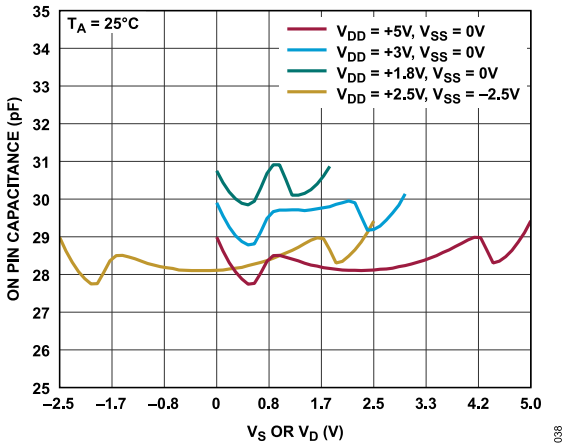

Figure 39. On Pin Capacitance vs. V_S (V_D)

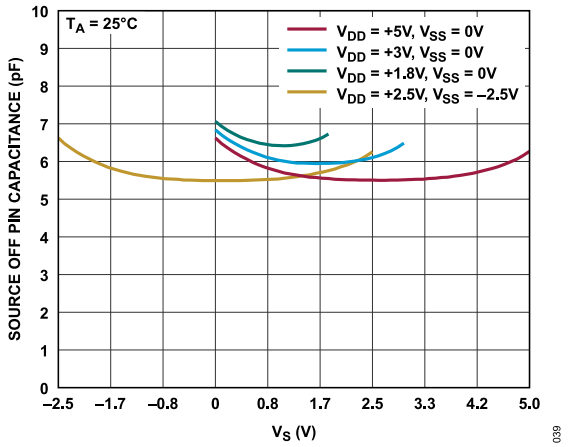

Figure 40. Off Pin Capacitance vs. V_S

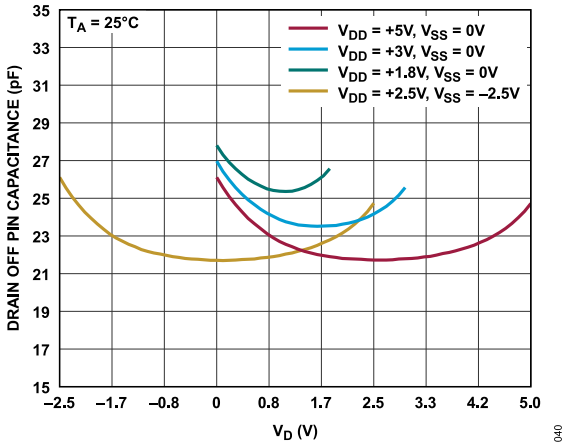

Figure 41. Drain Off Pin Capacitance vs. V_D

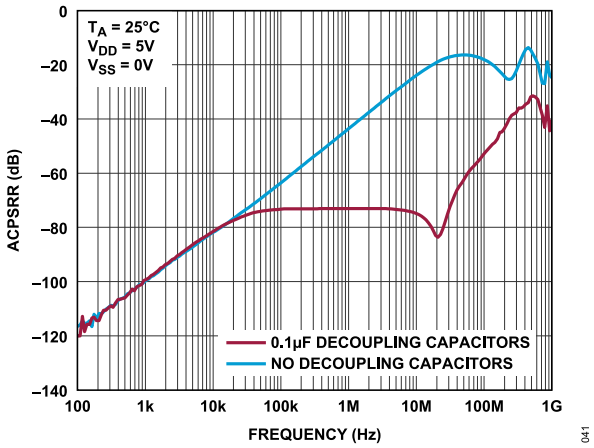

Figure 42. AC PSRR vs. Frequency, +5V Single Supply

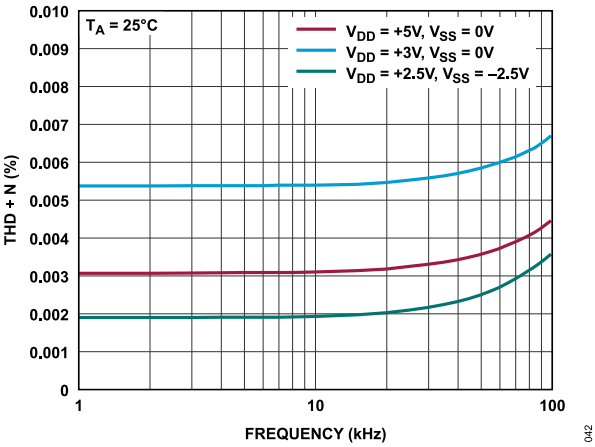

Figure 43. THD + N vs. Frequency

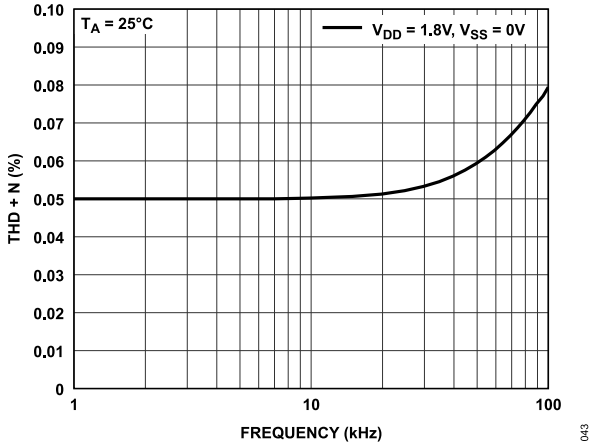

Figure 44. THD + N vs. Frequency, +1.8V Single Supply

TYPICAL PERFORMANCE CHARACTERISTICS

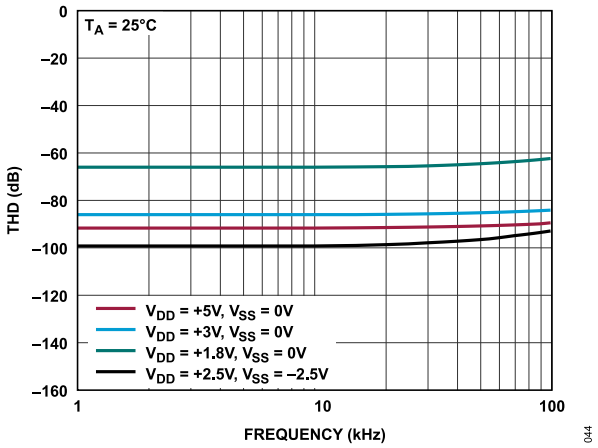

Figure 45. THD vs. Frequency

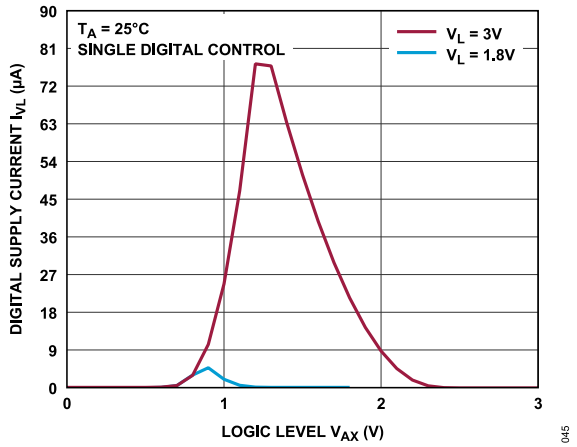

Figure 46. Digital Supply Current vs. Logic Level

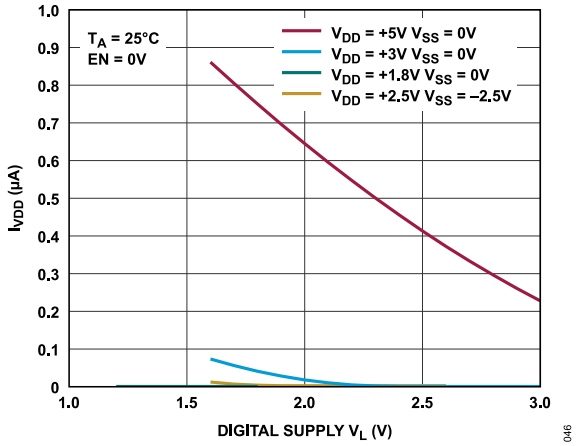

Figure 47. Positive Supply Current vs. Digital Supply

TEST CIRCUITS

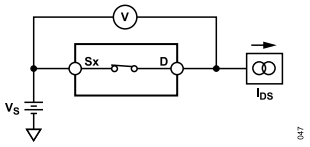

Figure 48. On Resistance

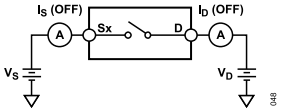

Figure 49. Off Leakage

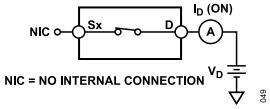

Figure 50. On Leakage

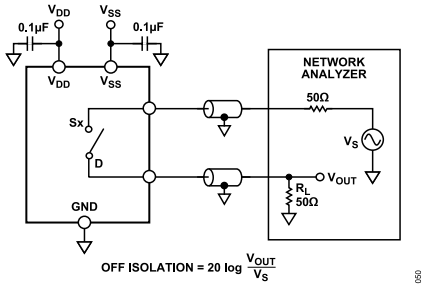

Figure 51. Off Isolation

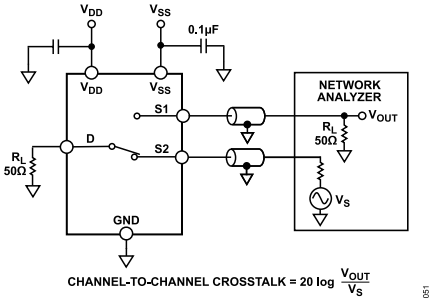

Figure 52. Channel-to-Channel Crosstalk

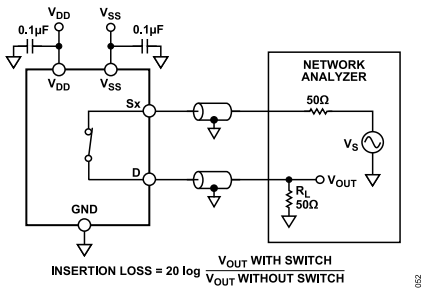

Figure 53. Bandwidth

TEST CIRCUITS

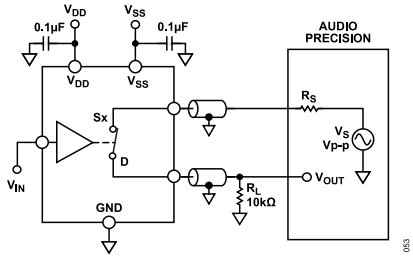

Figure 54. THD + Noise

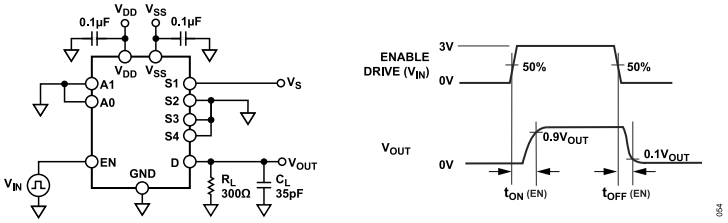

Figure 55. Enable Delay, $t_{ON}(EN)$ and $t_{OFF}(EN)$

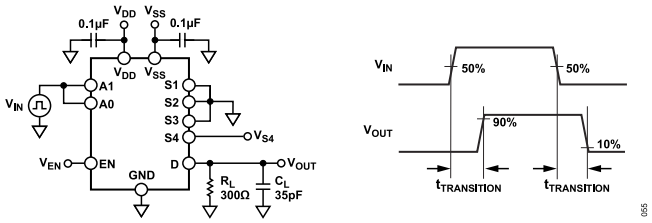

Figure 56. Switching Times

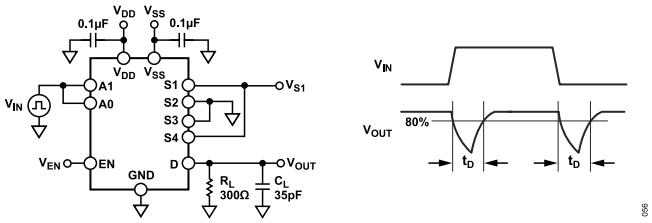

Figure 57. Break-Before-Make Time Delay, t_D

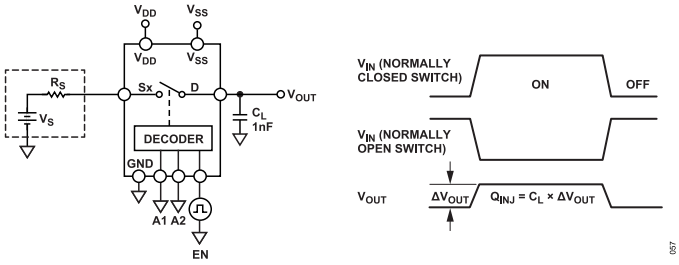

Figure 58. Charge Injection

TERMINOLOGY

I_{DD}

The positive supply current.

I_{SS}

The negative supply current.

I_{VL}

The digital supply current.

V_D and V_S

The analog voltage on Terminal D and Terminal S.

R_{ON}

The ohmic resistance between Terminal D and Terminal S.

$R_{FLAT(ON)}$

The difference between the maximum and minimum value of on resistance measured over the specified analog signal range.

ΔR_{ON}

The difference between the R_{ON} of any two channels.

I_S Off

The source leakage current with the switch off.

I_D Off

The drain leakage current with the switch off.

I_D I_S On

The channel leakage current with the switch on.

V_D AND V_S

Analog voltages on Terminal D and Terminal S.

V_{INL}

The maximum input voltage for Logic 0.

V_{INH}

The minimum input voltage for Logic 1.

I_{INL}, I_{INH}

The input current of the digital input when high or when low.

C_S (Off) and C_D (Off)

The off switch source and drain capacitance for the off condition, which is measured with reference to ground.

C_D (On) and C_S (On)

The on switch drain and source capacitance for the on condition, which is measured with reference to ground.

C_{IN}

The digital input capacitance.

t_{ON}

The delay between the 50% and 90% points of the digital control input and the output switching on.

t_{OFF}

The delay between the 50% and 10% points of the digital control input and the output switching off.

$t_{Transition}$

The delay time between the 50% and 90% points of the digital input and switch on condition when switching from one address to another.

t_D

The off-time measured between the 80% point of both switches when switching from one address state to another.

Charge Injection

A measure of the glitch impulse transferred from the digital input to the analog output during switching.

Off Isolation

A measure of unwanted signal coupling through an off switch.

Channel-to-Channel Crosstalk

A measure of unwanted signal that is coupled through from one channel to another as a result of parasitic capacitance.

Bandwidth

The frequency at which the output is attenuated by 3 dB.

Insertion Loss

The loss due to the on resistance of the switch.

Total Harmonic Distortion (THD)

THD is the ratio of the sum of the powers of all harmonic components to the power of the fundamental frequency.

Total Harmonic Distortion + Noise (THD + N)

The ratio of the harmonic amplitude plus noise of the signal to the fundamental.

AC Power Supply Rejection Ratio (AC PSRR)

A measure of the ability of the device to avoid coupling noise and spurious signals that appear on the supply voltage pin to the output of the switch. The DC voltage on the device is modulated by a sine wave of 0.62V p-p. The ratio of the amplitude of the signal on the output to the amplitude of the modulation is the AC PSRR.

THEORY OF OPERATION

SWITCH ARCHITECTURE

The ADG1704 is a 4:1 multiplexer that is compatible with a wide range of power supply voltages.

The ADG1704 is designed for precision applications where size and channel density are a priority. The ADG1704 gives an optimal balance of low on resistance (2.4Ω typical), and low leakage currents (0.01nA, typical) in a small 2mm × 2mm LGA package, to suit a broad range of user applications.

V_L FLEXIBILITY

The absolute maximum voltage rating for the digital control input pins (INx) is −0.3V to 6V for single supply operation or V_{SS} for dual supply operation. The digital control inputs are not limited to the external V_L supply or V_{DD}. This allows the digital input voltages to be present without the V_L supply and gives the ability to use the V_L pin as an enable pin for all four switch channels in the ADG1704. Regardless of the input voltage on the digital input pins, if V_L = 0 V, all of the switch channels will be off. This flexibility also allows V_L voltages higher than V_{DD} if required, just ensure not to violate the 6V maximum voltage rating between V_L and V_{SS}.

3V AND 1.8V JEDEC COMPLIANCE

An external V_L supply provides flexibility for lower logic levels. The following V_L conditions must be satisfied for the switch to operate in either 3V or 1.8V logic operation:

- V_L = 2.7V to 3.6V for 3V logic
- V_L = 1.65V to 1.95V for 1.8V logic

APPLICATIONS INFORMATION

DATA ACQUISITION SYSTEM MULTIPLEXED INPUT

The ADG1704 can be used in a broad variety of applications to add flexibility and configurations to systems that require low voltage multiplexing or switching of precision analog signals, digital signals, and low voltage power supplies. Figure 59 shows a typical application where the ADG1704 is used to multiplex multiple sensor inputs into one analog-to-digital converter (ADC). The small package size of the ADG1704 provides advantages in applications that are area constrained, and the flexible supply voltage allows the ADG1704 to adapt to the existing system power supply ranges.

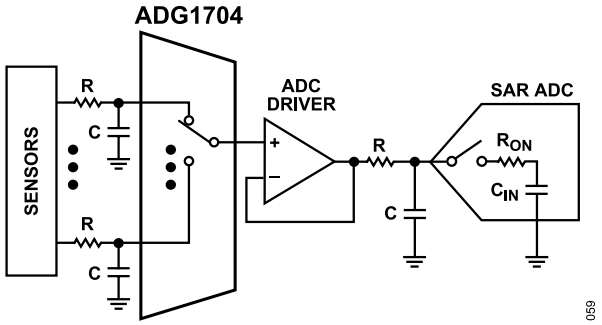

Figure 59. Typical Application

OUTPUT LOAD FOR REDUCED OVERSHOOT

Each channel of the ADG1704 can toggle at a high speed—typically 23ns for T_{ON} and 72ns for T_{OFF}. These high switching speeds are an advantage in systems such as high speed digital circuits or communications systems. However, the fast switching action can cause voltage overshoots to occur. The level of the overvoltage is dependent on the switch supply voltage, the level of the signal voltage through the switch, and value of the load capacitance at the output of the switch. An overshoot can cause the voltage at the output of the switch to go beyond the supply voltage and exceed the absolute ratings for the ADG1704. Adding extra load capacitance is a practical solution to mitigate these overshoots, ensuring the output voltage remains within safe limits.

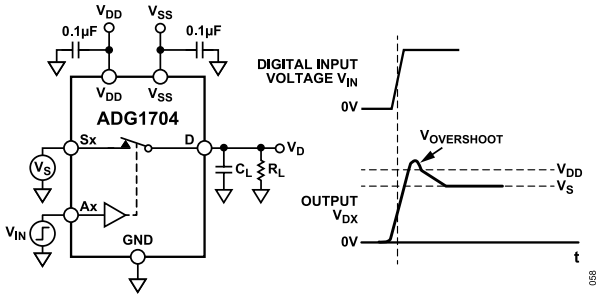

Figure 60. ADG1704 Overshoot

POWER-SUPPLY RAILS

To guarantee correct operation of the ADG1704, 0.1µF decoupling capacitors are required on the V_{DD}, V_{SS}, and V_L supply pins.

The ADG1704 can operate with single supplies from +1.08V to +5.5V and dual supplies between ±1.08V to ±2.75V. The supplies on V_{DD} and V_{SS} do not have to be symmetrical. However, the V_{DD} to V_{SS} range must not exceed 5.5V as stated in Table 1.

POWER SUPPLY RECOMMENDATIONS

Analog Devices, Inc., has a wide range of power management products to meet the requirements of most high performance signal chains.

An example of a 3V unipolar power solution is shown in Figure 61. The ADP162 ultra-low quiescent current, 150mA, CMOS linear regulator generates a positive supply rail for the ADG1704 along with other components such as amplifiers and/or a precision converter in a typical signal chain.

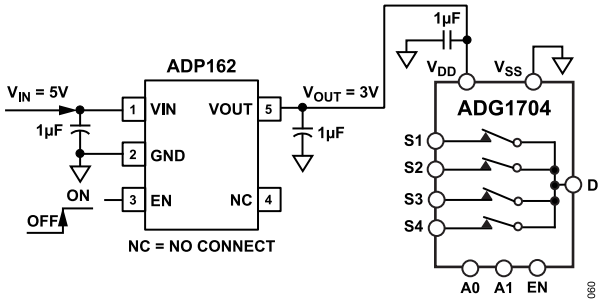

Figure 61. Power Supply Recommendation

OUTLINE DIMENSIONS

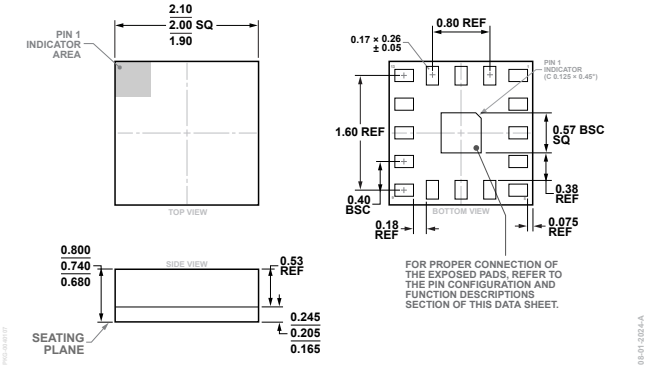

Figure 62. 16-Lead Land Grid Array [LGA]
2mm × 2mm Body and 0.74mm Package Height
(CC-16-10)
Dimensions shown in millimeters

ORDERING GUIDE

Model[1]	Temperature	Package Description	Package Option	Package Quantity
ADG1704BCCZ-RL7	−40°C to +125°C	16-Terminal Land Grid Array [LGA]	CC-16-10	Reel, 3000

[1] Z = RoHS Compliant Part.