1.0 pC Charge Injection, 100 pA Leakage, 4-Channel Multiplexer

DESCRIPTION

The DG604 is an analog 4-channel CMOS, multiplexer, designed to operate from a + 2.7 V to + 12 V single supply or from ± 2.7 V to ± 5 V, dual supplies. The DG604 is fully specified at + 3 V, + 5 V and ± 5 V. All control logic inputs have guaranteed 2 V logic high limits when operating from + 5 V or ± 5 V supplies and 1.4 V when operating from a 3 V supply. The DG604 switches conduct equally well in both directions and offer rail to rail analog signal handling. < 1 pC low charge injection, coupled with very low switch capacitance and leakage current makes this product ideal for use in precision instrumentation applications. Operating temperature range is specified from - 40 °C to + 125 °C. The DG604 is available in 14 lead TSSOP and the space saving 1.8 mm x 2.6 mm miniQFN package.

FEATURES

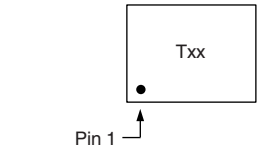
- **Halogen-free according to IEC 61249-2-21 Definition**
- Ultra low charge injection (± 1 pC, typ. over the full analog signal range)
- Leakage current < 0.5 nA max. at 85 °C (for DG604EQ-T1-E3)
- Low switch capacitance (C_{soff}, 3 pF typ.)
- Low $R_{DS(on)}$ - 115 Ω max.
- Fully specified with single supply operation at 3 V, 5 V and dual supplies at ± 5 V
- Low voltage, 2.5 V CMOS/TTL compatible
- 400 MHz, - 3 dB bandwidth
- Excellent isolation and crosstalk performance (typ. > - 60 dB at 10 MHz)
- Fully specified from - 40 °C to 85 °C and - 40 °C to + 125 °C
- 14 pin TSSOP and 16 pin miniQFN package (1.8 mm x 2.6 mm)
- **Compliant to RoHS Directive 2002/95/EC**

Pb-free
RoHS COMPLIANT
HALOGEN FREE

APPLICATIONS

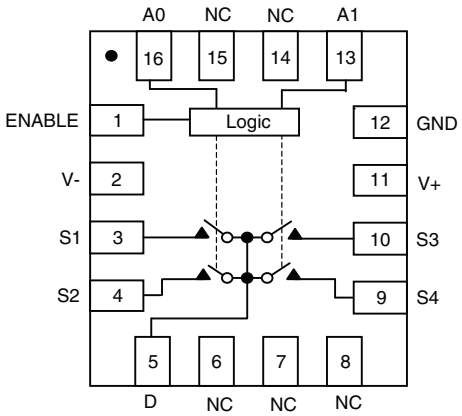
- High-end data acquisition
- Medical instruments
- Precision instruments
- High speed communications applications
- Automated test equipment
- Sample and hold applications

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



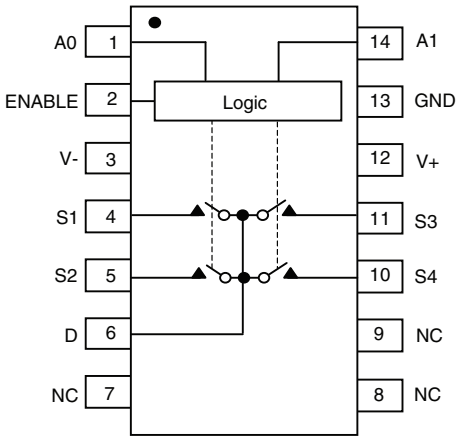
Device Marking: Txx for DG604 (miniQFN16)
xx = Date/Lot Traceability Code

DG604
mQFN-16



Top View

DG604
TSSOP14



Top View

TRUTH TABLE

Enable Input	Selected Input		On Switches
	A1	A0	DG604
L	X	X	All Switches Open
H	L	L	D to S1
H	L	H	D to S2
H	H	L	D to S3
H	H	H	D to S4

ORDERING INFORMATION

Temp. Range	Package	Part Number
- 40 °C to 125 °C[a]	14 pin TSSOP	DG604EQ-T1-E3
	16 pin miniQFN	DG604EN-T1-E4

Notes:
a. - 40 °C to 85 °C datasheet limits apply.

ABSOLUTE MAXIMUM RATINGS T_A = 25 °C, unless otherwise noted

Parameter		Limit	Unit
V+ to V-		14	V
GND to V-		7	
Digital Inputs[a], V_S, V_D		(V-) - 0.3 to (V+) + 0.3 or 30 mA, whichever occurs first	
Continuous Current (Any Terminal)		30	mA
Peak Current, S or D (Pulsed 1 ms, 10 % Duty Cycle)		100	
Storage Temperature		- 65 to 150	°C
Power Dissipation (Package)[b]	14 pin TSSOP[c]	450	mW
	16 pin miniQFN[d, e]	525	
Thermal Resistance (Package)[b]	14 pin TSSOP	178	C/W
	16 pin miniQFN	152	

Notes:
a. Signals on SX, DX, or INX exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
b. All leads welded or soldered to PC board.
c. Derate 5.6 mW/°C above 70 °C.
d. Derate 6.6 mW/°C above 70 °C.
e. Manual soldering with iron is not recommended for leadless components. The miniQFN-16 is a leadless package. The end of the lead terminal is exposed copper (not plated) as a result of the singulation process in manufacturing. A solder fillet at the exposed copper lip cannot be guaranteed and is not required to ensure adequate bottom side solder interconnection.

SPECIFICATIONS FOR DUAL SUPPLIES

Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 5 V, V- = - 5 V $V_{IN\ A0,\ A1\ and\ ENABLE}$ = 2 V, 0.8 V[a]	Temp.[b]	Typ.[c]	- 40 °C to 125 °C Min.[d]	- 40 °C to 125 °C Max.[d]	- 40 °C to 85 °C Min.[d]	- 40 °C to 85 °C Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full		- 5	5	- 5	5	V
On-Resistance	$R_{DS(on)}$	I_S = 1 mA, V_D = - 3 V, 0 V, + 3 V	Room Full	70		115 160		115 140	Ω
On-Resistance Match	ΔR_{ON}	I_S = 1 mA, V_D = ± 3 V	Room Full	1		5 6.5		5 6.5	
On-Resistance Flatness	$R_{FLATNESS}$	I_S = 1 mA, V_D = - 3 V, 0 V, + 3 V	Room Full	10		20 33		20 22	

SPECIFICATIONS FOR DUAL SUPPLIES

Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 5 V, V- = - 5 V, $V_{IN\ A0,\ A1\ and\ ENABLE}$ = 2 V, 0.8 V[a]	Temp.[b]	Typ.[c]	- 40 °C to 125 °C Min.[d]	- 40 °C to 125 °C Max.[d]	- 40 °C to 85 °C Min.[d]	- 40 °C to 85 °C Max.[d]	Unit
Analog Switch									
Switch Off Leakage Current (for 14 pin TSSOP)	$I_{S(off)}$	V_+ = 5.5 V, V_- = - 5.5 V, V_D = ± 4.5 V, V_S = ∓ 4.5 V	Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	nA
	$I_{D(off)}$		Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	
Channel On Leakage Current (for 14 pin TSSOP)	$I_{D(on)}$	V_+ = 5.5 V, V_- = - 5.5 V, V_S = V_D = ± 4.5 V	Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	
Switch Off Leakage Current (for 16 pin miniQFN)	$I_{S(off)}$	V_+ = 5.5 V, V_- = - 5.5 V, V_D = ± 4.5 V, V_S = ∓ 4.5 V	Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
	$I_{D(off)}$		Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
Channel On Leakage Current (for 16 pin miniQFN)	$I_{D(on)}$	V_+ = 5.5 V, V_- = - 5.5 V, V_S = V_D = ± 4.5 V	Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
Digital Control									
Input Current, V_{IN} Low	I_{IL}	$V_{IN\ A0,\ A1\ and\ ENABLE}$ Under Test = 0.8 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	µA
Input Current, V_{IN} High	I_{IH}	$V_{IN\ A0,\ A1\ and\ ENABLE}$ Under Test = 2 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	
Input Capacitance[e]	C_{IN}	f = 1 MHz	Room	3.4					pF
Dynamic Characteristics									
Transition Time	t_{TRANS}	$V_{S(CLOSE)}$ = 3 V, $V_{S(OPEN)}$ = 0 V, R_L = 300 Ω, C_L = 35 pF	Room Full	20		70 105		70 80	ns
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF, V_S = ± 3 V	Room Full	16		60 90		60 65	
Turn-Off Time	t_{OFF}		Room Full	15		52 76		52 56	
Break-Before-Make Time Delay	t_D	V_S = 3 V, R_L = 300 Ω, C_L = 35 pF	Room Full	15	10		10		
Charge Injection[e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 1 nF	Room	0.7					pC
Off Isolation[e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz	Room	- 72					dB
Bandwidth[e]	BW	R_L = 50 Ω	Room	400					MHz
Channel-to-Channel Crosstalk[e]	X_{TALK}	R_L = 50 Ω, C_L = 5 pF, f = 10 MHz	Room	- 81					dB
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room	2.7					pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room	7.3					
Channel On Capacitance[e]	$C_{D(on)}$		Room	13.8					
Total Harmonic Distortion[e]	THD	Signal = 1 V_{RMS}, 20 Hz to 20 kHz, R_L = 600 Ω	Room	0.01					%
Power Supplies									
Power Supply Current	I+	V_{IN} = 0 V, or V+	Room Full	0.001		0.5 1		0.5 1	µA
Negative Supply Current	I-		Room Full	- 0.001	- 0.5 - 1		- 0.5 - 1		
Ground Current	I_{GND}		Room Full	- 0.001	- 0.5 - 1		- 0.5 - 1		

SPECIFICATIONS FOR SINGLE SUPPLY

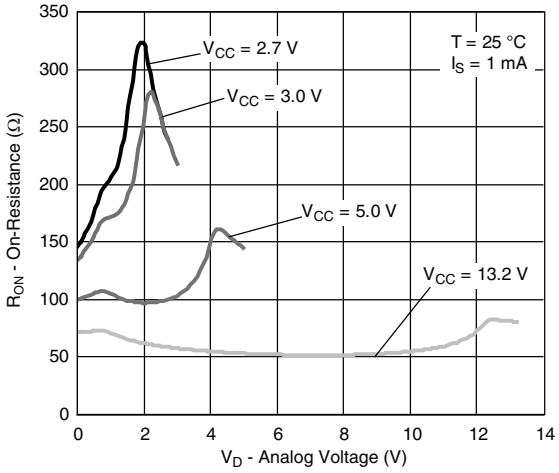
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 5 V, V- = 0 V $V_{IN\ A0,\ A1\ and\ ENABLE}$ = 2 V, 0.8 V[a]	Temp.[b]	Typ.[c]	- 40 °C to 125 °C Min.[d]	- 40 °C to 125 °C Max.[d]	- 40 °C to 85 °C Min.[d]	- 40 °C to 85 °C Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full			5		5	V
On-Resistance	$R_{DS(on)}$	I_S = 1 mA, V_D = + 3.5 V	Room Full	120		170 250		170 200	Ω
On-Resistance Match	ΔR_{ON}	I_S = 1 mA, V_D = + 3.5 V	Room Full	3		5 12		5 10	Ω
Switch Off Leakage Current (for 14 pin TSSOP)	$I_{S(off)}$	V+ = 5.5 V, V- = 0 V V_D = 1 V/4.5 V, V_S = 4.5 V/1 V	Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	nA
	$I_{D(off)}$		Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	
Channel On Leakage Current (for 14 pin TSSOP)	$I_{D(on)}$	V+ = 5.5 V, V- = 0 V V_S = V_D = 1 V/4.5 V	Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	
Switch Off Leakage Current (for 16 pin miniQFN)	$I_{S(off)}$	V+ = 5.5 V, V- = - 5.5 V V_D = 1 V/4.5 V, V_S = 4.5 V/1 V	Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
	$I_{D(off)}$		Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
Channel On Leakage Current (for 16 pin miniQFN)	$I_{D(on)}$	V+ = 5.5 V, V- = 0 V, V_S = V_D = 1 V/4.5 V	Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
Digital Control									
Input Current, V_{IN} Low	I_L	$V_{IN\ A0,\ A1\ and\ ENABLE}$ Under Test = 0.8 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	µA
Input Current, V_{IN} High	I_H	$V_{IN\ A0,\ A1\ and\ ENABLE}$ Under Test = 2 V	Full	0.005	- 0.1	0.1	- 0.1	0.1	µA
Input Capacitance	C_{IN}	f = 1 MHz	Room	4.3					pF
Dynamic Characteristics									
Transition Time	t_{TRANS}	$V_{S(CLOSE)}$ = 3 V, $V_{S(OPEN)}$ = 0 V, R_L = 300 Ω, C_L = 35 pF	Room Full	36		75 120		75 95	ns
Enable Turn-On Time	$t_{ON(EN)}$		Room Full	30		70 102		70 80	ns
Enable Turn-Off Time	$t_{OFF(EN)}$		Room Full	17		47 88		47 63	ns
Break-Before-Make-Time	t_{BMM}		Room Full	23	5		5		ns
Charge Injection	Q	C_L = 1 nF, R_{GEN} = 0 Ω, V_{GEN} = 0 V	Full	0.15					pC
Off-Isolation[e]	OIRR	f = 10 MHz, R_L = 50 Ω, C_L = 5 pF	Room	- 58					dB
Crosstalk[e]	X_{TALK}		Room	- 81					dB
Bandwidth[e]	BW	R_L = 50 Ω	Room	330					MHz
Total Harmonic Distortion	THD	Signal = 1 V_{RMS}, 20 Hz to 20 kHz, R_L = 600 Ω	Room	0.009					%
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room	3.1					pF
Drain Off Capacitance[e]	$C_{D(off)}$			11.6					pF
Channel On Capacitance[e]	$C_{D(on)}$			16.2					pF
Power Supplies									
Power Supply Current	I+	V_{IN} = 0 V, or V+	Room Full	0.001		0.5 1		0.5 1	µA
Negative Supply Current	I-		Room Full	- 0.001	- 0.5 - 1		- 0.5 - 1		µA
Ground Current	I_{GND}		Room Full	- 0.001	- 0.5 - 1		- 0.5 - 1		µA

SPECIFICATIONS FOR SINGLE SUPPLY

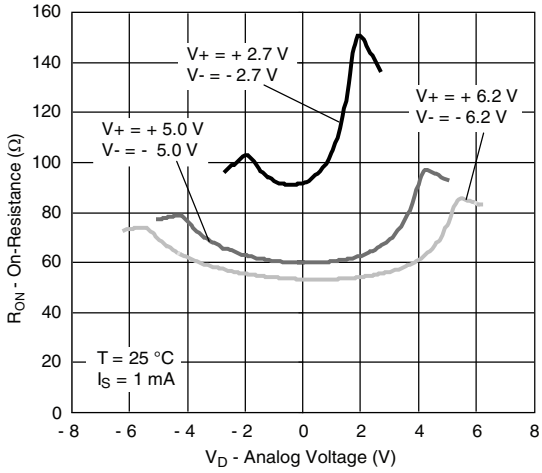
Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 3 V, V- = 0 V $V_{IN\ A0,\ A1\ and\ ENABLE}$ = 1.4 V, 0.6 V[a]	Temp.[b]	Typ.[c]	- 40 °C to + 125 °C Min.[d]	- 40 °C to + 125 °C Max.[d]	- 40 °C to + 85 °C Min.[d]	- 40 °C to + 85 °C Max.[d]	Unit
Analog Switch									
Analog Signal Range[e]	V_{ANALOG}		Full			3		3	V
On-Resistance	$R_{DS(ON)}$	I_S = 1 mA, V_D = + 1.5 V	Room Full	200		245 325		245 290	Ω
On-Resistance Match	ΔR_{ON}	I_S = 1 mA, V_D = + 1.5 V	Room Full	5		6 13		11 6	Ω
Switch Off Leakage Current (for 14 pin TSSOP)	$I_{S(off)}$	V+ = 3 V, V- = 0 V V_D = 1 V/3 V, V_S = 3 V/1 V	Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	nA
	$I_{D(off)}$		Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	
Channel On Leakage Current (for 14 pin TSSOP)	$I_{D(on)}$	V+ = 3 V, V- = 0 V V_S = V_D = 1 V/3 V	Room Full	± 0.01	- 0.1 - 18	0.1 18	- 0.1 - 0.5	0.1 0.5	
Switch Off Leakage Current (for 16 pin miniQFN)	$I_{S(off)}$	V+ = 3.3 V, V- = 0 V V_D = 1 V/3 V, V_S = 3 V/1 V	Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
	$I_{D(off)}$		Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
Channel On Leakage Current (for 16 pin miniQFN)	$I_{D(on)}$	V+ = 3.3 V, V- = 0 V V_D = 1 V/3 V, V_S = 3 V/1 V	Room Full	± 0.01	- 1 - 18	1 18	- 1 - 2	1 2	
Digital Control									
Input Current, V_{IN} Low	I_L	$V_{IN\ A0,\ A1\ and\ ENABLE}$ Under Test = 0.6 V	Full	0.005	- 1	1	- 1	1	µA
Input Current, V_{IN} High	I_H	$V_{IN\ A0,\ A1\ and\ ENABLE}$ Under Test = 1.4 V	Full	0.005	- 1	1	- 1	1	µA
Input Capacitance	C_{IN}	f = 1 MHz	Room	4.3					pF
Dynamic Characteristics									
Transition Time	t_{TRANS}	$V_{S(CLOSE)}$ = 3 V, $V_{S(OPEN)}$ = 0 V, R_L = 300 Ω, C_L = 35 pF	Room Full	95		130 190		130 160	ns
Enable Turn-On Time	$t_{ON(EN)}$		Room Full	77		108 161		108 131	ns
Enable Turn-Off Time	$t_{OFF(EN)}$		Room Full	35		76 112		76 88	ns
Break-Before-Make-Time	t_{BMM}		Room Full	45	5		5		ns
Charge Injection	Q	C_L = 1 nF, R_{GEN} = 0 Ω, V_{GEN} = 0 V	Full	0.1					pC
Off-Isolation[e]	OIRR	f = 10 MHz, R_L = 50 Ω, C_L = 5 pF	Room	- 58					dB
Crosstalk[e]	X_{TALK}		Room	- 90					dB
Bandwidth[e]	BW	R_L = 50 Ω	Room	290					MHz
Total Harmonic Distortion	THD	Signal = 1 V_{RMS}, 20 Hz to 20 kHz, R_L = 600 Ω	Room	0.09					%
Source Off Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room	3.1					pF
Drain Off Capacitance[e]	$C_{D(off)}$			11.7					pF
Channel On Capacitance[e]	$C_{D(on)}$			16.5					pF
Power Supplies									
Power Supply Current	I+	V_{IN} = 0 V, or V+	Room Full	0.001		0.5 1		0.5 1	µA
Negative Supply Current	I-		Room Full	- 0.001	- 0.5 - 1		- 0.5 - 1		µA
Ground Current	I_{GND}		Room Full	- 0.001	- 0.5 - 1		- 0.5 - 1		µA

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

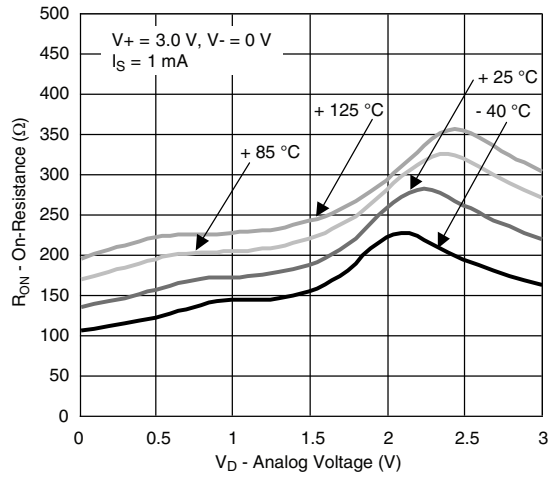
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



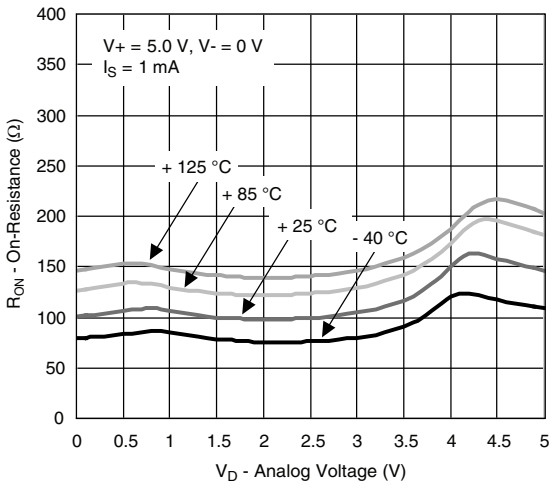
On-Resistance vs. V_D (Single Supply Voltage)



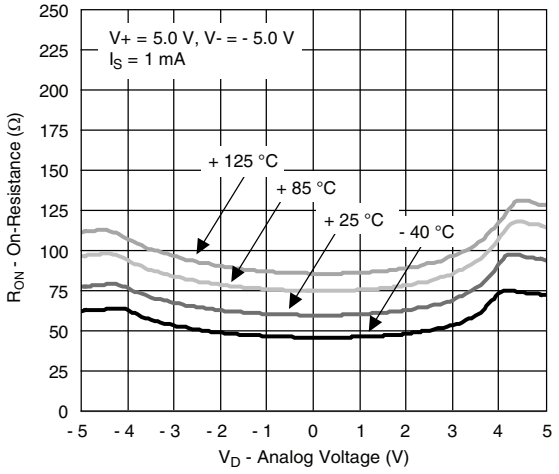
On-Resistance vs. V_D (Dual Supply Voltage)



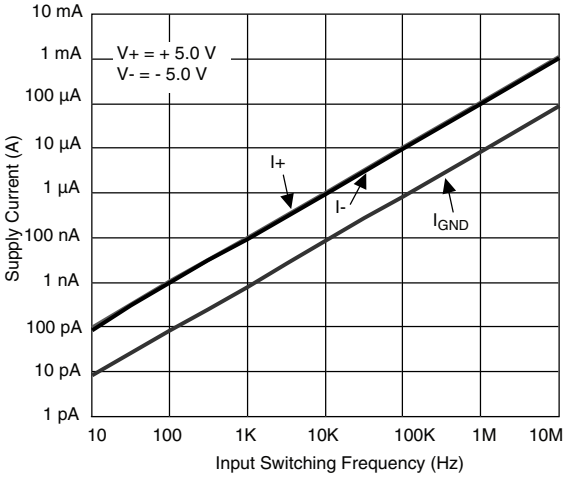
On-Resistance vs. Analog Voltage and Temperature



On-Resistance vs. Analog Voltage and Temperature

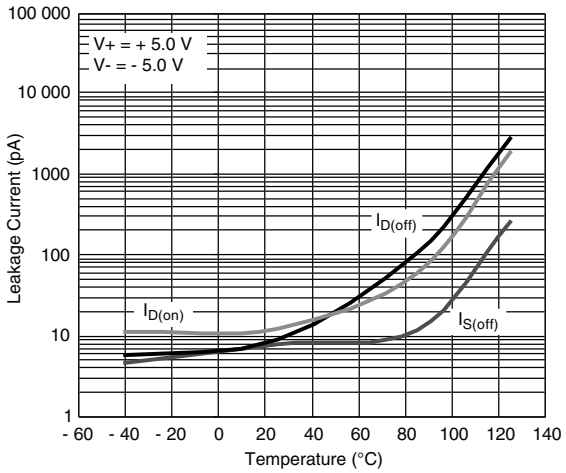


On-Resistance vs. Analog Voltage and Temperature

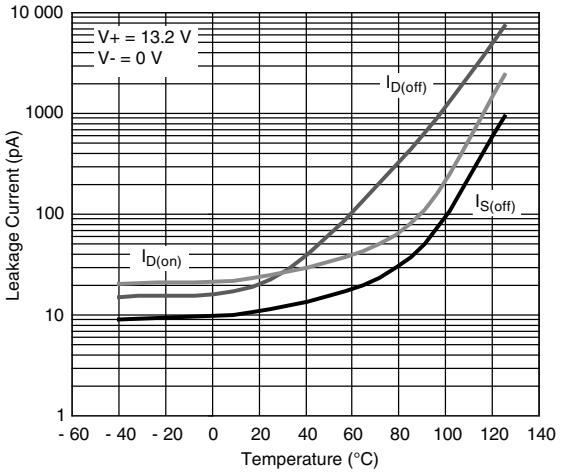


Supply Current vs. Input Switching Frequency

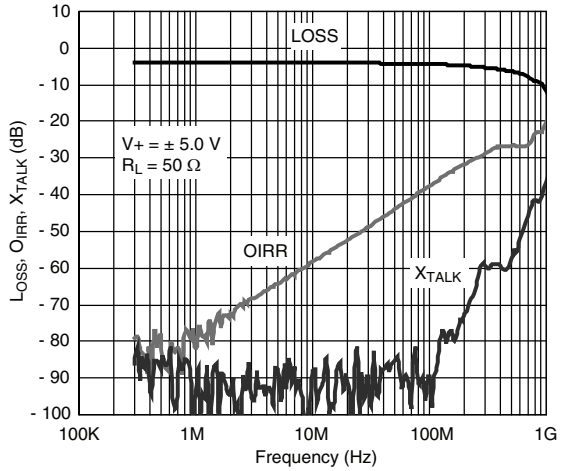
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



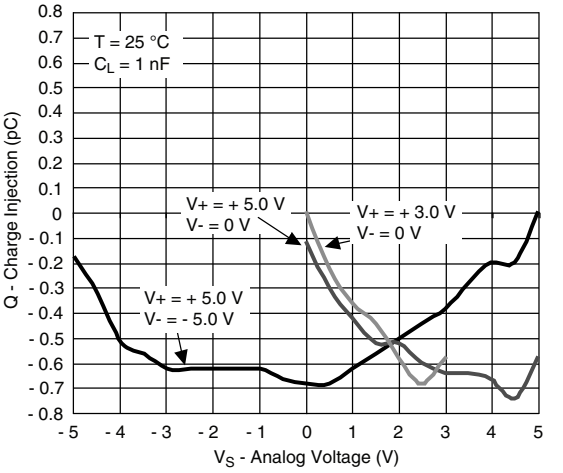
Leakage Current vs. Temperature



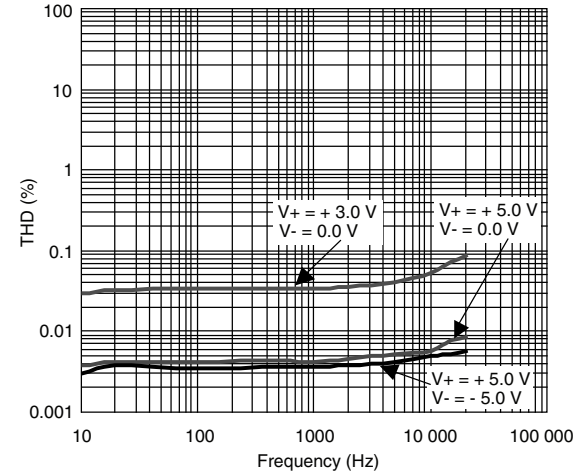
Leakage Current vs. Temperature



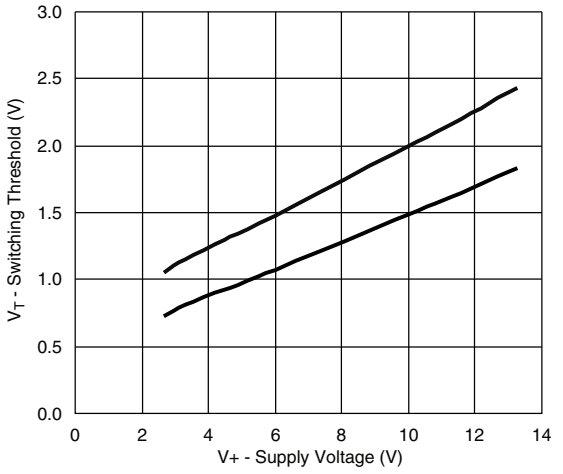
Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



Charge Injection vs. Analog Voltage



Total Harmonic Distortion vs. Frequency



Switching Threshold vs. Supply Voltage

TEST CIRCUITS

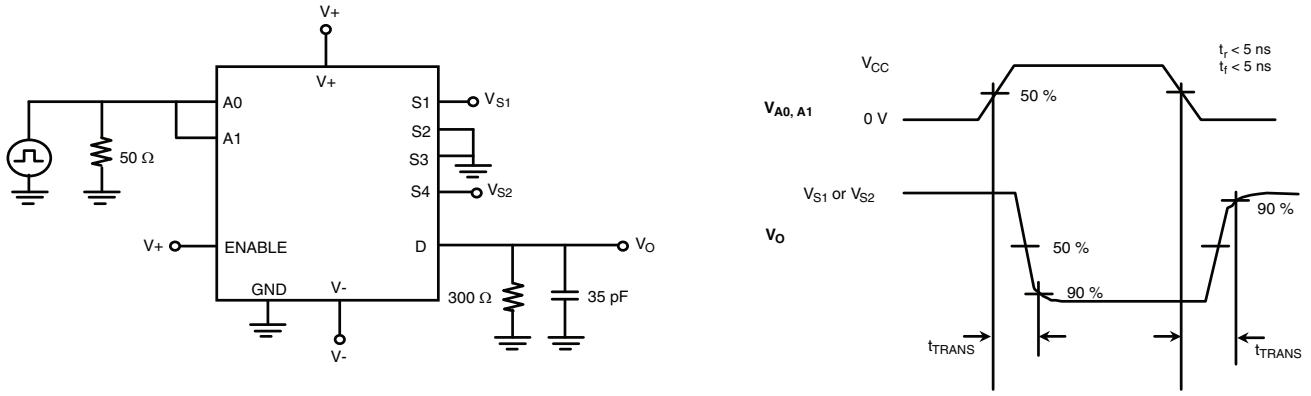


Figure 1. Transition Time

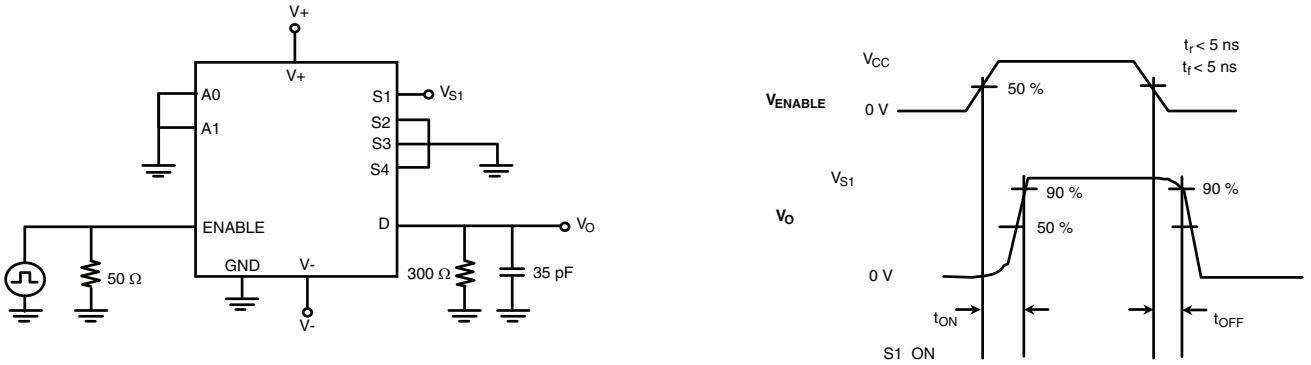


Figure 2. Enable Switching Time

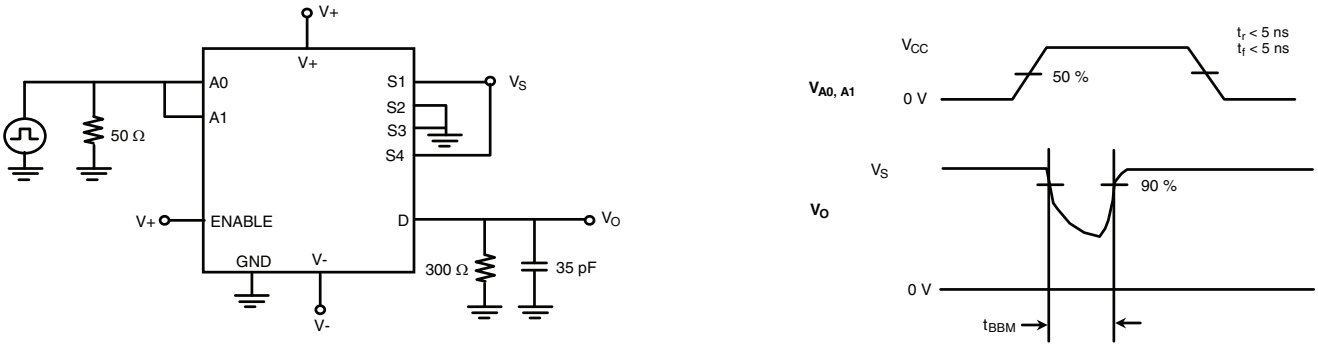


Figure 3. Break-Before-Make

Document Number: 69934
S11-1429-Rev. C, 18-Jul-11

TEST CIRCUITS

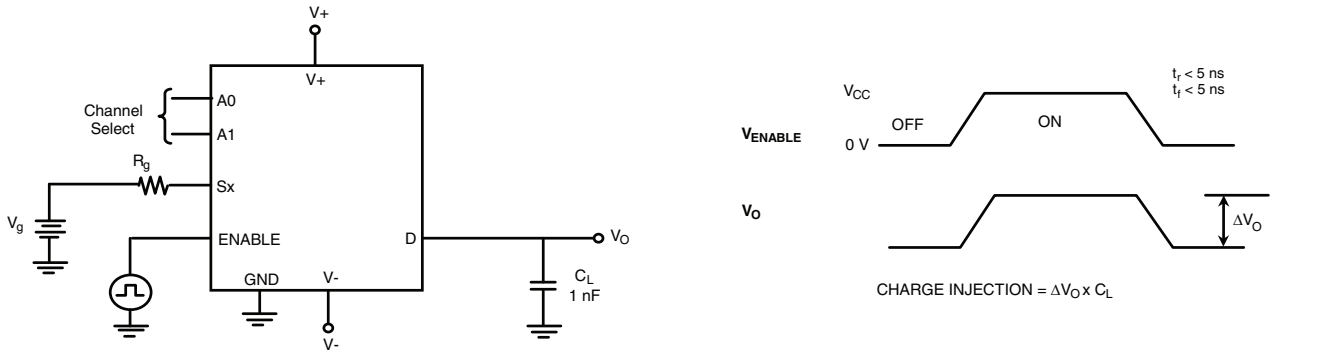


Figure 4. Charge Injection

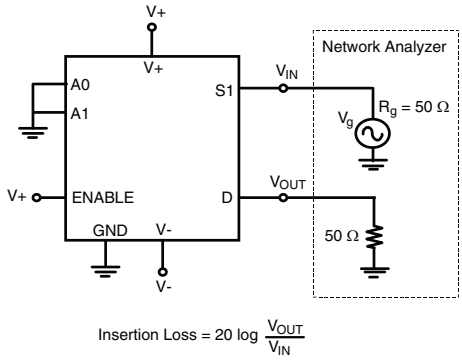


Figure 5. Insertion Loss

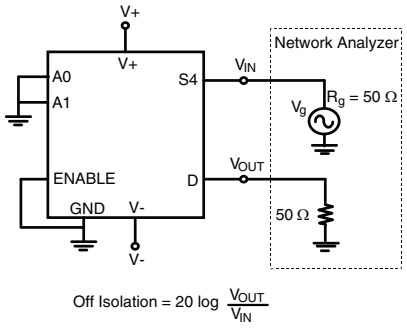


Figure 6. Off-Isolation

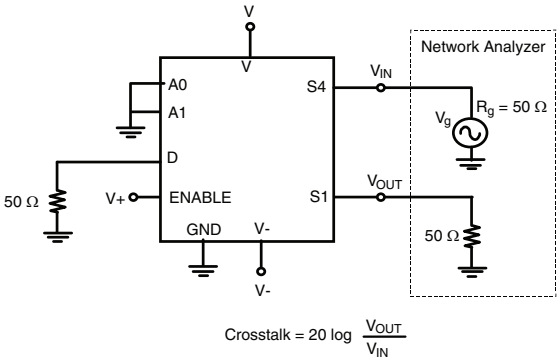


Figure 7. Crosstalk

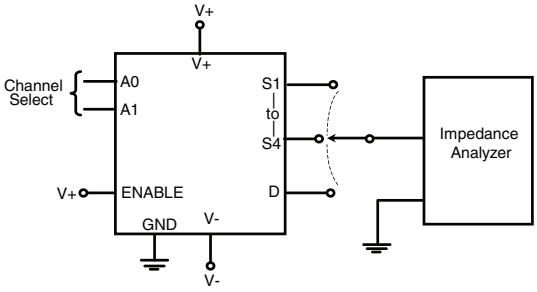
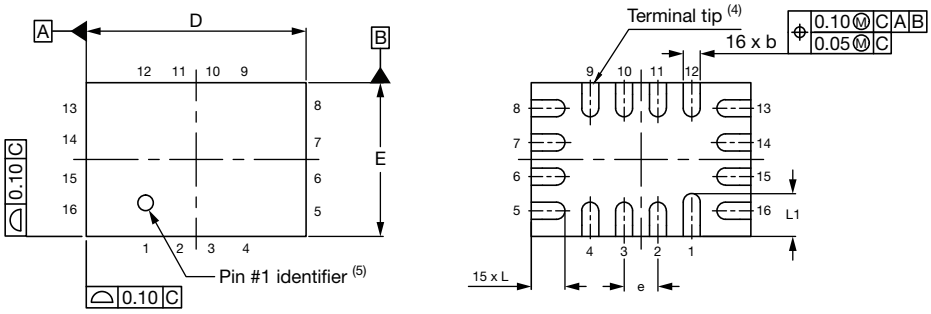


Figure 8. Source/Drain Capacitance

Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see www.vishay.com/ppg?69934.

Thin miniQFN16 Case Outline



DIMENSIONS	MILLIMETERS (1)			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.50	0.55	0.60	0.020	0.022	0.024
A1	0	-	0.05	0	-	0.002
A3	0.15 ref.			0.006 ref.		
b	0.15	0.20	0.25	0.006	0.008	0.010
D	2.50	2.60	2.70	0.098	0.102	0.106
e	0.40 BSC			0.016 BSC		
E	1.70	1.80	1.90	0.067	0.071	0.075
L	0.35	0.40	0.45	0.014	0.016	0.018
L1	0.45	0.50	0.55	0.018	0.020	0.022
N (3)	16			16		
Nd (3)	4			4		
Ne (3)	4			4		

Notes

(1) Use millimeters as the primary measurement.

(2) Dimensioning and tolerances conform to ASME Y14.5M. - 1994.

(3) N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.

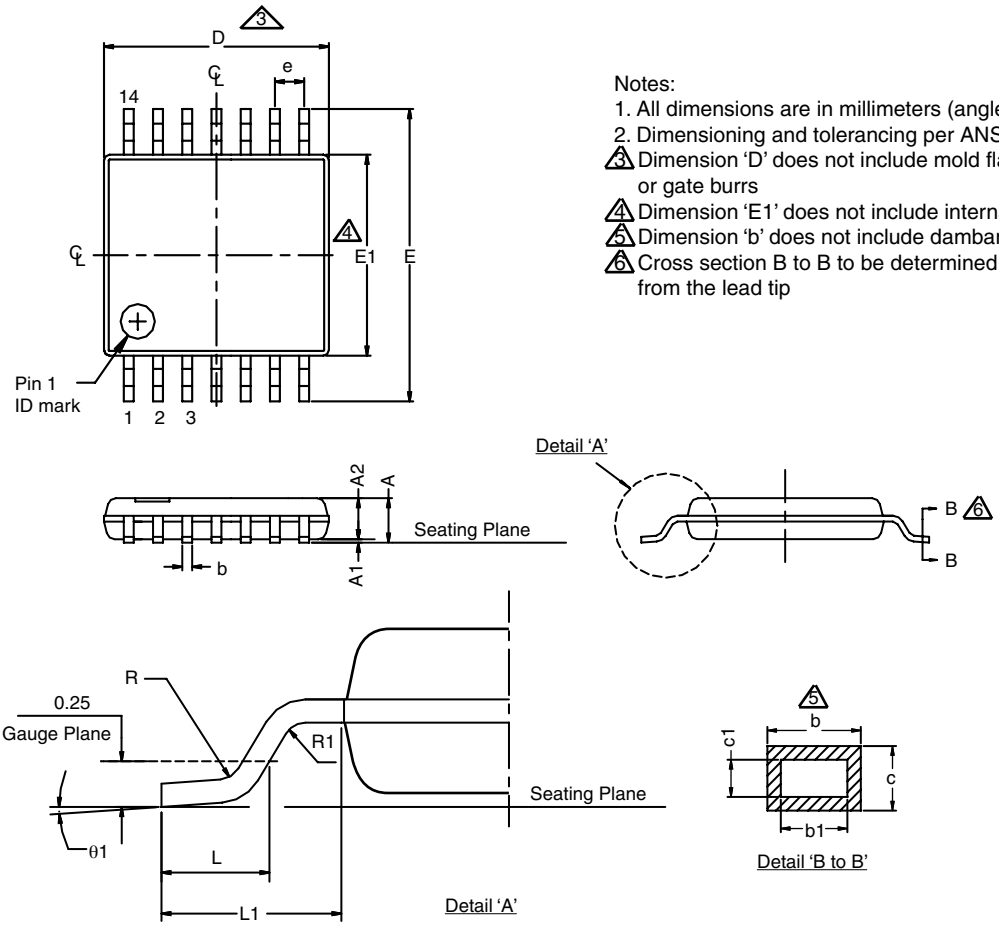
(4) Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

(5) The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.

(6) Package warpage max. 0.05 mm.

ECN: T16-0226-Rev. B, 09-May-16
DWG: 6023

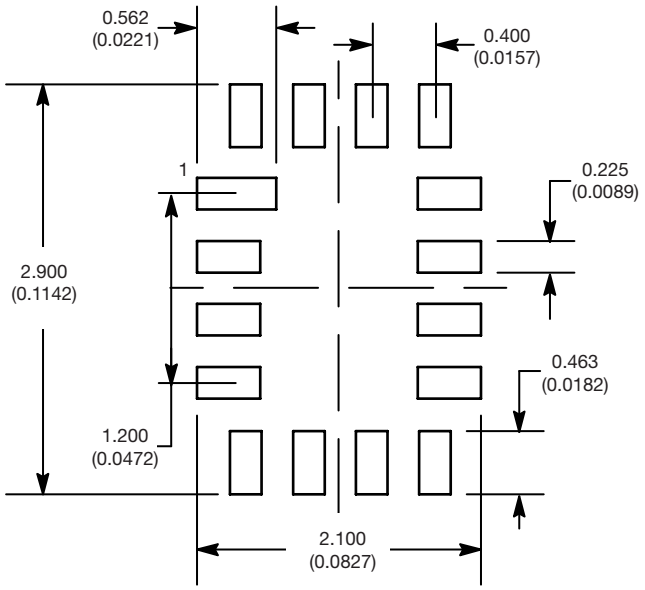
14L TSSOP



Notes:
1. All dimensions are in millimeters (angles in degrees)
2. Dimensioning and tolerancing per ANSI Y14.5M-1982
3. Dimension 'D' does not include mold flash, protrusions or gate burrs
4. Dimension 'E1' does not include internal flash or protrusion
5. Dimension 'b' does not include dambar protrusion
6. Cross section B to B to be determined at 0.10 mm to 0.25 mm from the lead tip

SYMBOL	MINIMUM	NOMINAL	MAXIMUM
A	-	-	1.20
A1	0.05	-	0.15
A2	0.80	0.90	1.05
D	4.9	5.0	5.1
E1	4.3	4.4	4.5
E	6.2	6.4	6.6
L	0.45	0.60	0.75
R	0.09	-	-
R1	0.09	-	-
b	0.19	-	0.30
b1	0.19	0.22	0.25
c	0.09	-	0.20
c1	0.09	-	0.16
θ1	0°	-	8°
L1	1.0 ref.		
e	0.65 BSC		
ECN: T-07766-Rev. A, 14-Jan-08 DWG: 5962			

RECOMMENDED MINIMUM PADS FOR MINI QFN 16L



Mounting Footprint
Dimensions in mm (inch)

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