

8-Channel, Dual 4-Channel, Triple 2-Channel Multiplexers

DESCRIPTION

The DG9451, and DG9453 are high precision single and dual supply CMOS analog multiplexers. DG9451 is an 8-channel multiplexer, and the DG9453 is a triple 2-channel multiplexer or triple SPDT.

Designed to operate from a + 2.7 V to + 12 V single supply or from a ± 2.5 V to ± 5 V dual supplies, the DG9451, and DG9453 are fully specified at + 12 V, + 5 V and ± 5 V. All control logic inputs have guaranteed 1.4 V high limit when operating from + 5 V or ± 5 V supplies and 1.65 V when operating from a + 12 V supply.

The DG9451, and DG9453 are precision multiplexers of low leakage, low charge injection, and low parasitic capacitance. They conduct equally well in both directions, offer rail to rail analog signal handling and can be used both as multiplexers as well as de-multiplexers.

The DG9451, and DG9453 operating temperature is specified from - 40 °C to + 85 °C and are available in 16 pin TSSOP and the ultra compact 1.8 mm x 2.6 mm miniQFN16 packages.

FEATURES

- **Halogen-free According to IEC 61249-2-21 Definition**
- + 2.7 V to + 12 V single supply operation
- ± 2.5 V to ± 5 V dual supply operation
- Fully specified at + 12 V, + 5 V, ± 5 V
- Low charge injection (< 0.5 pC typ.)
- High bandwidth: 270 MHz
- Low switch capacitance ($C_{S(off)}$ 1 pF typ.)
- Good isolation and crosstalk performance (typ. - 44 dB at 100 MHz)
- MiniQFN16 package (1.8 mm x 2.6 mm)
- Compliant to RoHS directive 2002/95/EC

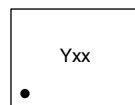
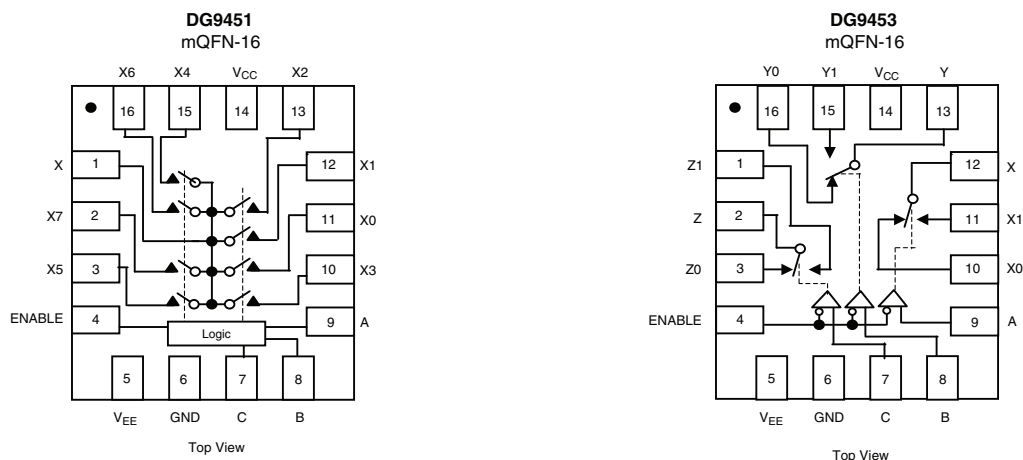


RoHS
COMPLIANT
HALOGEN
FREE

APPLICATIONS

- Data acquisition
- Medical and healthcare devices
- Control and automation equipments
- Test instruments
- Touch panels
- Consumer

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Device Marking: Yxx for DG9451
(miniQFN16) 4xx for DG9453

xx = Date/Lot Traceability Code

TRUTH TABLE					
Enable Input	Select Inputs			On Switches	
	C	B	A	DG9451	DG9453
H	X	X	X	All Switches Open	All Switches Open
L	L	L	L	X to X0	X to X0, Y to Y0, Z to Z0
L	L	L	H	X to X1	X to X1, Y to Y0, Z to Z0
L	L	H	L	X to X2	X to X0, Y to Y1, Z to Z0
L	L	H	H	X to X3	X to X1, Y to Y1, Z to Z0
L	H	L	L	X to X4	X to X0, Y to Y0, Z to Z1
L	H	L	H	X to X5	X to X1, Y to Y0, Z to Z1
L	H	H	L	X to X6	X to X0, Y to Y1, Z to Z1
L	H	H	H	X to X7	X to X1, Y to Y1, Z to Z1

ORDERING INFORMATION		
Temp. Range	Package	Part Number
DG9451, DG9453		
- 40 °C to 125 °C ^a	16-Pin miniQFN	DG9451EN-T1-E4
		DG9453EN-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 ^b	16-Pin miniQFN ^{c, d}	525	mW
Thermal Resistance ^b	16-Pin miniQFN ^d	152	°C/W
Latch-up (per JEESD78)		> 300	mA

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 6.6 mW/°C above 70 °C.

d. 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 $V_{CC} = +5\text{ V}$, $V_{EE} = -5\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 1.4\text{ V}$, 0.3 V^a			Temp. ^b	Typ. ^c	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
		Min. ^d	Max. ^d	Min. ^d			Max. ^d				
Analog Switch											
Analog Signal Range ^e	V_{ANALOG}			Full			- 5	5	- 5	5	V
On-Resistance	R_{ON}	$I_S = 1\text{ mA}$, $V_D = -3\text{ V}, 0\text{ V}, +3\text{ V}$		Room Full	66		100 125		100 118	Ω	
On-Resistance Match	ΔR_{ON}	$I_S = 1\text{ mA}$, $V_D = \pm 3\text{ V}$		Room Full	3		6 10		6 8		
On-Resistance Flatness	$R_{FLATNESS}$	$I_S = 1\text{ mA}$, $V_D = -3\text{ V}, 0\text{ V}, +3\text{ V}$		Room Full	10.2		16 20		16 18		
Switch Off Leakage Current	$I_{S(off)}$	$V_+ = 5.5\text{ V}$, $V_- = -5.5\text{ V}$, $V_D = \pm 4.5\text{ V}$, $V_S = \mp 4.5\text{ V}$		Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	nA	
	$I_{D(off)}$			Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5		
Channel On Leakage Current	$I_{D(on)}$	$V_+ = 5.5\text{ V}$, $V_- = -5.5\text{ V}$, $V_S = V_D = \pm 4.5\text{ V}$		Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5		
Digital Control											
$V_{IN(A, B, C \text{ and } ENABLE)}$ Low	V_{IL}			Full			0.3		0.3	V	
$V_{IN(A, B, C \text{ and } ENABLE)}$ High	V_{IH}			Full		1.4		1.4			
Input Current, V_{IN} Low	I_{IL}	$V_{IN(A, B, C \text{ and } ENABLE)}$ under test = 0.3 V		Full	0.01	- 1	1	- 1	1	μA	
Input Current, V_{IN} High	I_{IH}	$V_{IN(A, B, C \text{ and } ENABLE)}$ under test = 1.4 V		Full	0.01	- 1	1	- 1	1		
Input Capacitance ^e	C_{IN}	$f = 1\text{ MHz}$		Room	3.4					pF	
Dynamic Characteristics											
Transition Time	t_{TRANS}	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ see figure 1, 2, 3			Room Full	66		180 218		180 207	ns
Enable Turn-On Time	t_{ON}				Room Full	152		250 295		250 282	
Enable Turn-Off Time	t_{OFF}				Room Full	60		125 136		125 131	
Break-Before-Make Time Delay	t_D				Room Full	32		13		13	
Off Isolation ^e	OIRR	$R_L = 50\ \Omega$, $C_L = 15\text{ pF}$			f = 100 kHz	Room	< - 90				dB
					f = 10 MHz	Room	- 65				
					f = 100 MHz	Room	- 44				
Channel-to-Channel Crosstalk ^e	X_{TALK}				f = 100 kHz	Room	< - 90				
					f = 10 MHz	Room	- 74				
					f = 100 MHz	Room	- 44				
Bandwidth, 3 dB	BW	$R_L = 50\ \Omega$			DG9451	Room	270			MHz	
					DG9453	Room	525				
Charge Injection ^e	Q	$V_g = 0\text{ V}$, $R_g = 0\ \Omega$, $C_L = 1\text{ nF}$			Room	0.20				pC	
Source Off Capacitance ^e	$C_{S(off)}$	$f = 1\text{ MHz}$			DG9451	Room	1			pF	
					DG9453	Room	1				
Drain Off Capacitance ^e	$C_{D(off)}$	$f = 1\text{ MHz}$			DG9451	Room	10				
					DG9453	Room	3				
Channel On Capacitance ^e	$C_{D(on)}$	$f = 1\text{ MHz}$			DG9451	Room	16				
					DG9453	Room	8				
Total Harmonic Distortion ^e	THD	Signal = 1 V_{RMS} , 20 Hz to 20 kHz, $R_L = 600\ \Omega$			Room	0.01				%	

SPECIFICATIONS FOR DUAL SUPPLIES									
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_{CC} = +5\text{ V}$, $V_{EE} = -5\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 1.4\text{ V}$, 0.3 V^a	Temp. ^b	Typ. ^c	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. ^d	Max. ^d	Min. ^d	Max. ^d	
Power Supplies									
Power Supply Current	I+	$V_{CC} = +5\text{ V}$, $V_{EE} = -5\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 0$ or 5 V	Room Full	0.05		1 10		1 10	μA
Negative Supply Current	I-		Room Full	- 0.05	- 1 - 10		- 1 - 10		
Ground Current	I _{GND}		Room Full	- 0.05	- 1 - 10		- 1 - 10		

SPECIFICATIONS FOR UNIPOLAR SUPPLIES									
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_{CC} = +5\text{ V}$, $V_{EE} = 0\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 1.4\text{ V}$, 0.3 V^a	Temp. ^b	Typ. ^c	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. ^d	Max. ^d	Min. ^d	Max. ^d	
Analog Switch									
Analog Signal Range ^e	V _{ANALOG}		Full		0	5	0	5	V
On-Resistance	R _{ON}	I _S = 1 mA, V _D = 0 V, + 3.5 V	Room Full	105		165 205		165 194	Ω
On-Resistance Match	ΔR _{ON}	I _S = 1 mA, V _D = + 3.5 V	Room Full	3.2		8 13		8 10	
On-Resistance Flatness	R _{FLATNESS}	I _S = 1 mA, V _D = 0 V, + 3 V	Room Full	17		26 30		26 28	
Switch Off Leakage Current	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	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	nA
	I _{D(off)}		Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	
Channel On Leakage Current	I _{D(on)}	V ₊ = + 5.5 V, V ₋ = 0 V V _D = V _S = 1 V/4.5 V	Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	
Digital Control									
V _{IN(A, B, C \text{ and } ENABLE)} Low	V _{IL}		Full			0.3		0.3	V
V _{IN(A, B, C \text{ and } ENABLE)} High	V _{IH}		Full		1.4		1.4		
Input Current, V _{IN} Low	I _L	V _{IN(A, B, C \text{ and } ENABLE)} under test = 0.3 V	Full	0.01	- 1	1	- 1	1	μA
Input Current, V _{IN} High	I _H	V _{IN(A, B, C \text{ and } ENABLE)} under test = 1.4 V	Full	0.01	- 1	1	- 1	1	
Dynamic Characteristics									
Transition Time	t _{TRANS}	R _L = 300 Ω, C _L = 35 pF See Figure 1, 2, 3	Room Full	79		205 295		205 285	ns
Enable Turn-On Time	t _{ON}		Room Full	220		335 403		335 393	
Enable Turn-Off Time	t _{OFF}		Room Full	93		150 173		150 163	
Break-Before-Make Time Delay	t _D		Room Full	36		20		20	
Charge Injection ^e	Q	V _g = 0 V, R _g = 0 Ω, C _L = 1 nF	Full	0.81					pC
Off Isolation ^e	OIRR	R _L = 50 Ω, C _L = 15 pF f = 100 kHz	Room	< - 90					dB
Channel-to-Channel Crosstalk ^e	X _{TALK}		Room	< - 90					



SPECIFICATIONS FOR UNIPOLAR SUPPLIES									
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_{CC} = +5\text{ V}$, $V_{EE} = 0\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 1.4\text{ V}$, 0.3 V^a	Temp. ^b	Typ. ^c	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. ^d	Max. ^d	Min. ^d	Max. ^d	
Dynamic Characteristics									
Source Off Capacitance ^e	$C_{S(off)}$	$f = 1\text{ MHz}$	DG9451 Room	1					pF
			DG9453 Room	1					
Drain Off Capacitance ^e	$C_{D(off)}$	$f = 1\text{ MHz}$	DG9451 Room	11					
			DG9453 Room	3					
Channel On Capacitance ^e	$C_{D(on)}$	$f = 1\text{ MHz}$	DG9451 Room	17					
			DG9453 Room	9					
Power Supplies									
Power Supply Current	I+	$V_{IN(A, B, C \text{ and } ENABLE)} = 0\text{ V}$ or 5 V	Room Full	0.05		1 10		1 10	μA
Negative Supply Current	I-		Room Full	- 0.05	- 1 - 10		- 1 - 10		
Ground Current	I_{GND}		Room Full	- 0.05	- 1 - 10		- 1 - 10		

SPECIFICATIONS FOR UNIPOLAR SUPPLIES									
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_{CC} = +12\text{ V}$, $V_{EE} = 0\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 1.6\text{ V}$, 0.5 V^a	Temp. ^b	Typ. ^c	- 40 °C to 125 °C		- 40 °C to 85 °C		Unit
					Min. ^d	Max. ^d	Min. ^d	Max. ^d	
Analog Switch									
Analog Signal Range ^e	V_{ANALOG}		Full		0	12	0	12	V
On-Resistance	R_{ON}	$I_S = 1\text{ mA}$, $V_D = 0.7\text{ V}$, 6.0 V , 11.3 V	Room Full	68		105 143		105 137	Ω
On-Resistance Match	ΔR_{ON}	$I_S = 1\text{ mA}$, $V_D = +0.7\text{ V}$	Room Full	4		7 10		7 8	
On-Resistance Flatness	$R_{FLATNESS}$	$I_S = 1\text{ mA}$, $V_D = 0.7\text{ V}$, $+11.3\text{ V}$	Room Full	32		45 49		45 47	
Switch Off Leakage Current	$I_{S(off)}$	$V_+ = +12\text{ V}$, $V_- = 0\text{ V}$ $V_D = 1\text{ V}/11\text{ V}$, $V_S = 11\text{ V}/1\text{ V}$	Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	nA
	$I_{D(off)}$		Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	
Channel On Leakage Current	$I_{D(on)}$	$V_+ = +12\text{ V}$, $V_- = 0\text{ V}$ $V_D = V_S = 1\text{ V}/11\text{ V}$	Room Full	± 0.02	- 1 - 50	1 50	- 1 - 5	1 5	
Digital Control									
$V_{IN(A, B, C \text{ and } ENABLE)}$ Low	V_{IL}		Full			0.5		0.5	V
$V_{IN(A, B, C \text{ and } ENABLE)}$ High	V_{IH}		Full		1.6		1.6		
Input Current, V_{IN} Low	I_L	$V_{IN(A, B, C \text{ and } ENABLE)}$ under test = 0.5 V	Full	0.01	- 1	1	- 1	1	μA
Input Current, V_{IN} High	I_H	$V_{IN(A, B, C \text{ and } ENABLE)}$ under test = 1.6 V	Full	0.01	- 1	1	- 1	1	
Dynamic Characteristics									
Transition Time	t_{TRANS}	$R_L = 300\text{ Ω}$, $C_L = 35\text{ pF}$ see figure 1, 2, 3	Room Full	55		135 166		135 155	ns
Enable Turn-On Time	t_{ON}		Room Full	106		185 219		185 205	
Enable Turn-Off Time	t_{OFF}		Room Full	65		130 144		130 137	
Break-Before-Make Time Delay	t_D		Room Full	30		12		12	
Charge Injection ^e	Q	$V_g = 0\text{ V}$, $R_g = 0\text{ Ω}$, $C_L = 1\text{ nF}$	Room	0.79					pC

SPECIFICATIONS FOR UNIPOLAR SUPPLIES

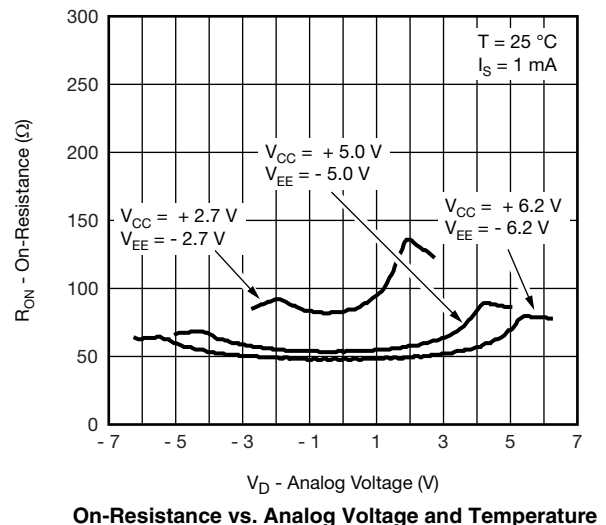
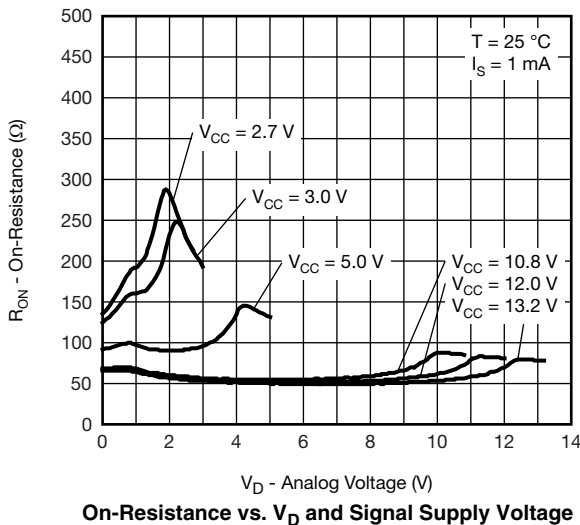
Parameter	Symbol	Test Conditions Unless Otherwise Specified $V_{CC} = +12\text{ V}$, $V_{EE} = 0\text{ V}$ $V_{IN(A, B, C \text{ and } ENABLE)} = 1.6\text{ V}$, 0.5 V^a	Temp. ^b	Typ. ^c	-40 °C to 125 °C		-40 °C to 85 °C		Unit
					Min. ^d	Max. ^d	Min. ^d	Max. ^d	
Dynamic Characteristics									
Off Isolation ^e	OIRR	$R_L = 50\ \Omega$, $C_L = 15\text{ pF}$ $f = 100\text{ kHz}$	Room	< -90					dB
Channel-to-Channel Crosstalk ^e	X_{TALK}		Room	< -90					
Source Off Capacitance ^e	$C_{S(off)}$	$f = 1\text{ MHz}$	DG9451	Room	1				pF
			DG9453	Room	1				
Drain Off Capacitance ^e	$C_{D(off)}$	$f = 1\text{ MHz}$	DG9451	Room	9				
			DG9453	Room	3				
Channel On Capacitance ^e	$C_{D(on)}$	$f = 1\text{ MHz}$	DG9451	Room	15				
			DG9453	Room	8				
Power Supplies									
Power Supply Current	I_+	$V_{IN(A, B, C \text{ and } ENABLE)} = 0\text{ V}$ or 12 V	Room Full	0.05		1 10		1 10	μA
Negative Supply Current	I_-		Room Full	-0.05	-1 -10		-1 -10		
Ground Current	I_{GND}		Room Full	-0.05	-1 -10		-1 -10		

Notes:

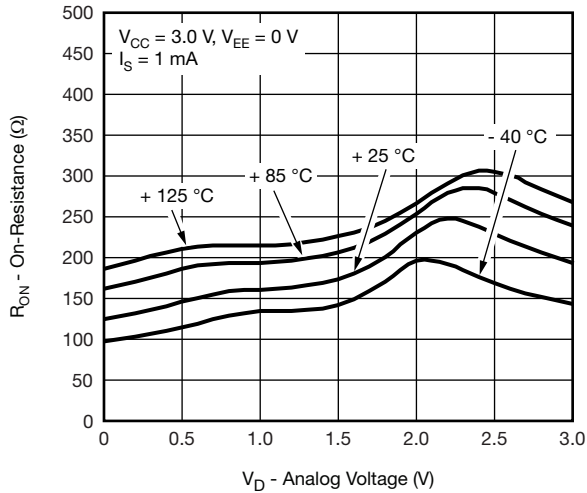
- a. V_{IN} = input voltage to perform proper function.
- b. Room - 25 °C, Full = as determined by the operating temperature suffix.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- e. Guaranteed by design, not subject to production test.

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.

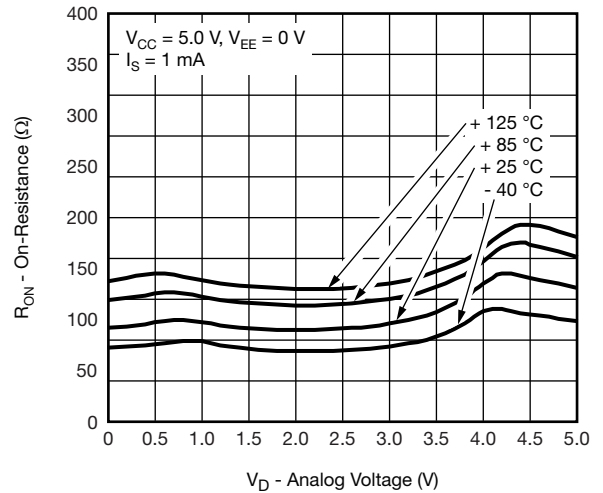
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



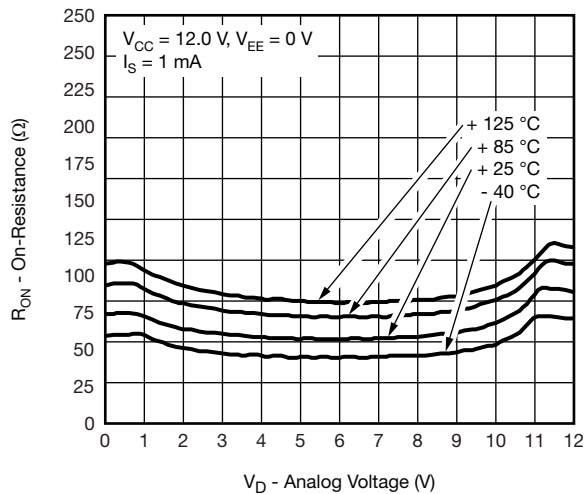
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



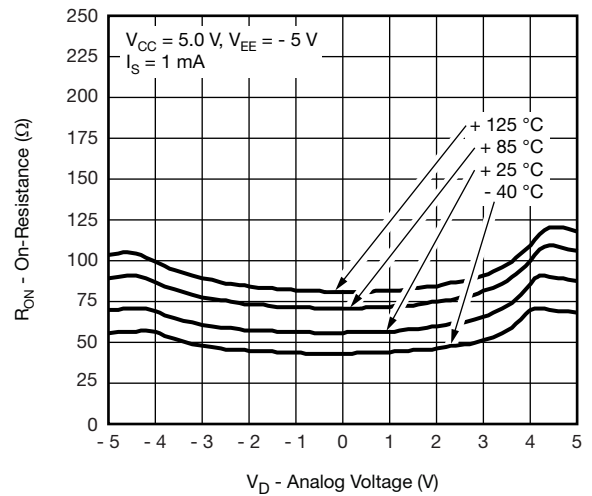
On-Resistance vs. Analog Voltage and Temperature



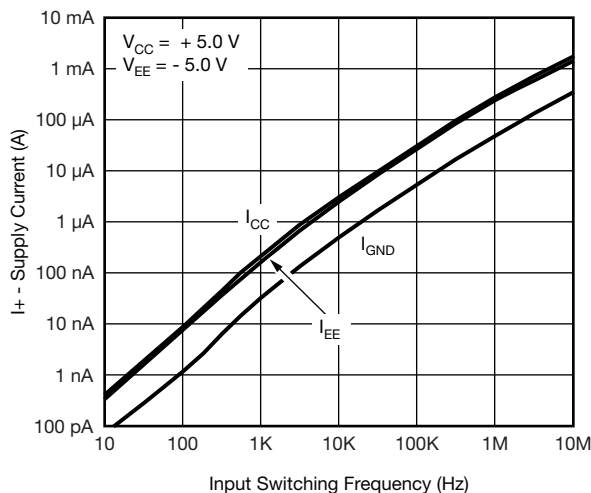
On-Resistance vs. Analog Voltage and Temperature



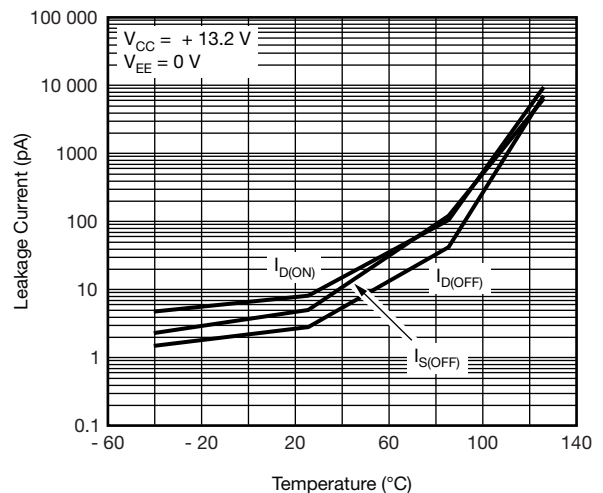
On-Resistance vs. Analog Voltage and Temperature



On-Resistance vs. Analog Voltage and Temperature

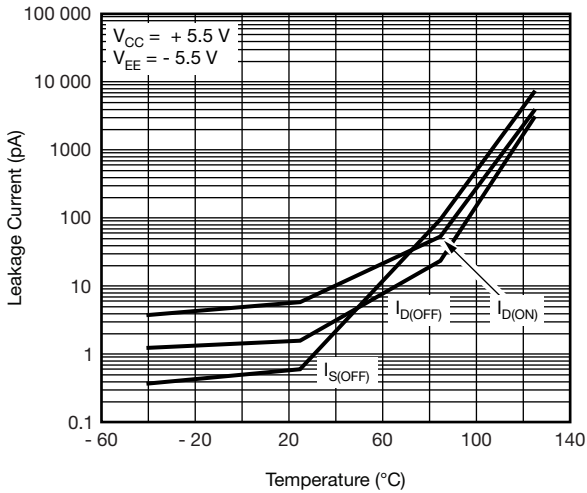


Supply Current vs. Input Switching Frequency

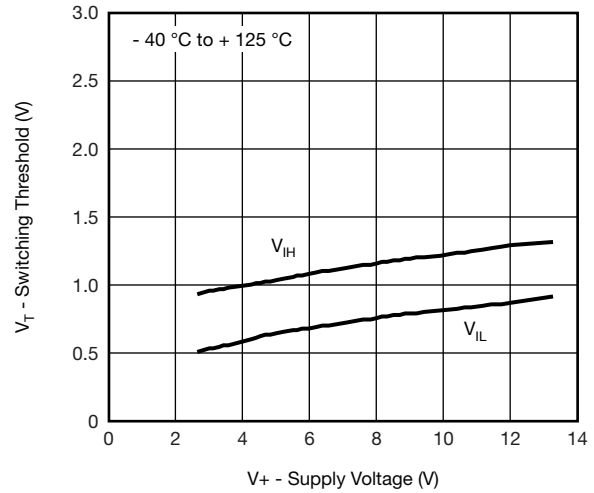


Leakage Current vs. Temperature

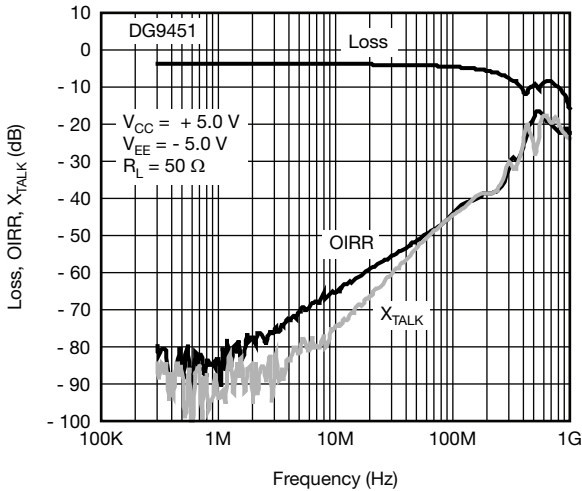
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



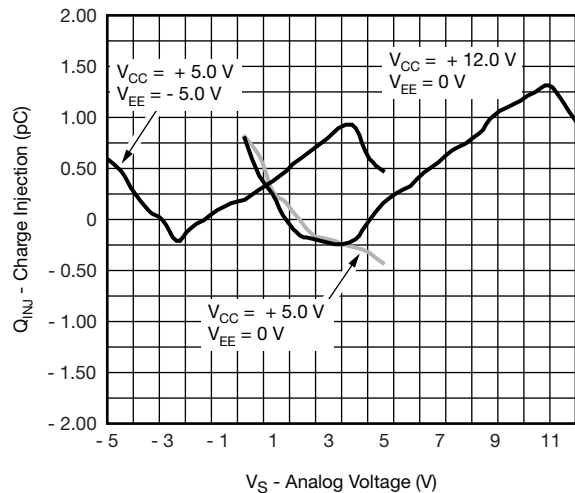
Leakage Current vs. Temperature



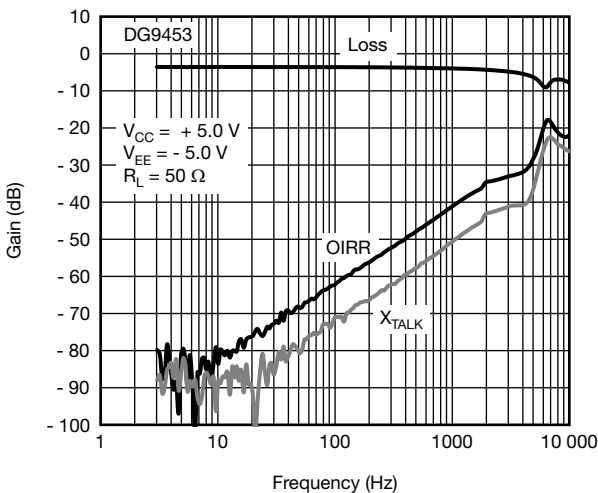
Switching Threshold vs. Supply Voltage



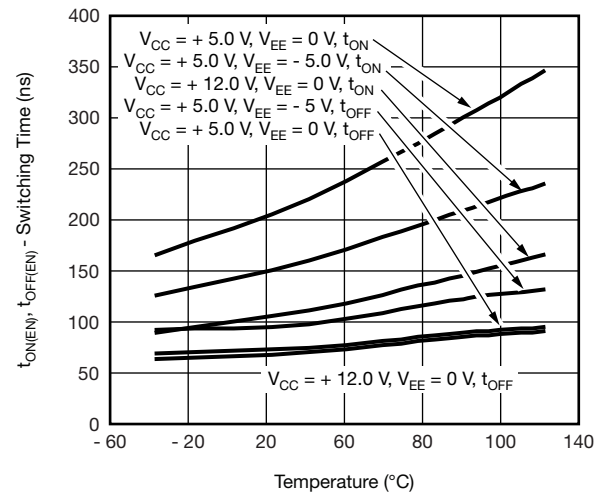
DG9451 Insertion Loss, Off-Isolation, Crosstalk vs. Frequency



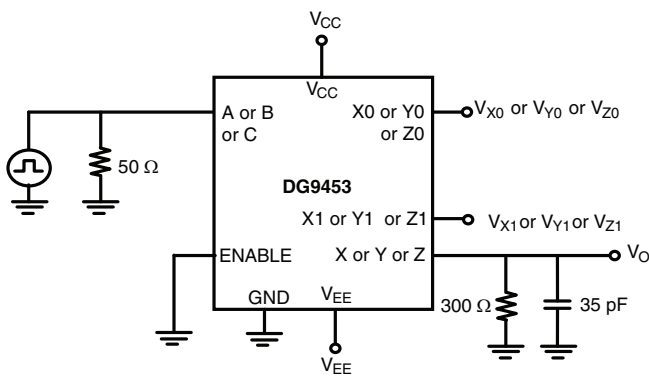
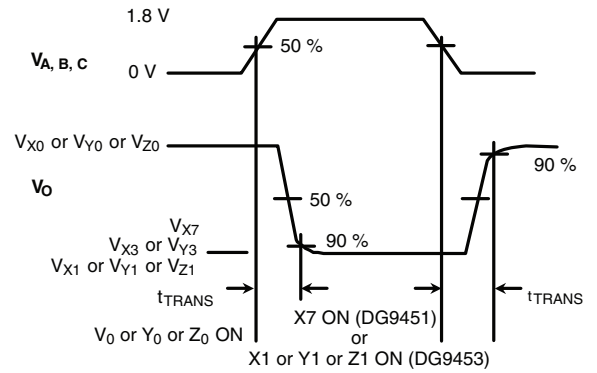
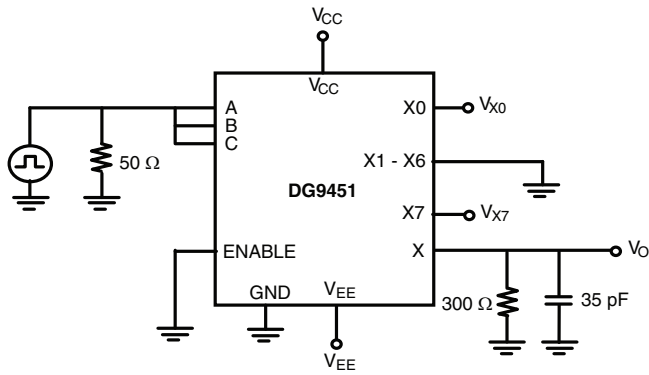
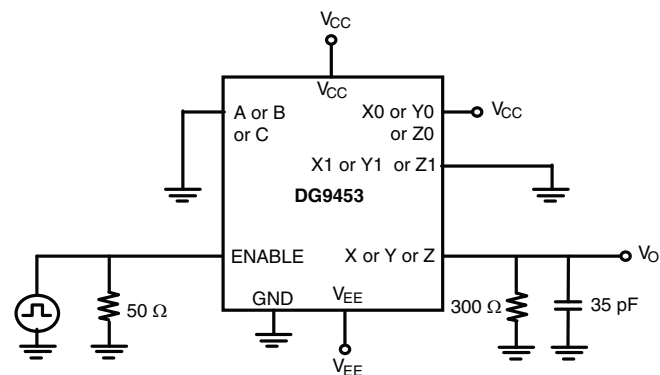
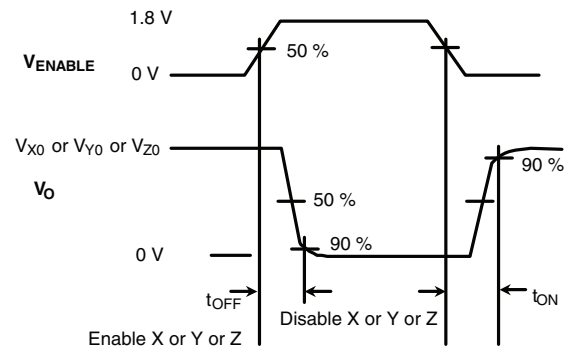
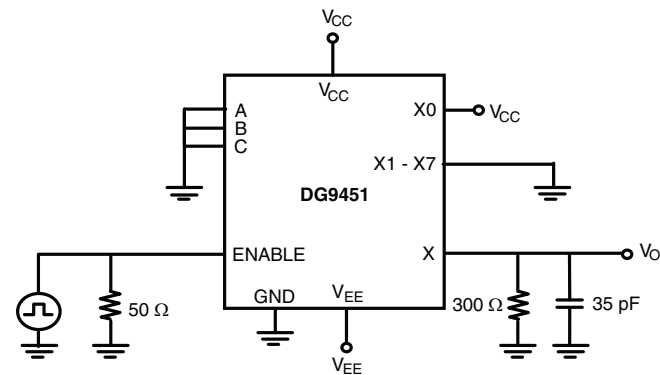
DG9451 Charge Injection vs. Analog Voltage



Frequency Response



Switching Time vs. Temperature

TEST CIRCUITS

Figure 1. Transition Time

Figure 2. Enable Switching Time

TEST CIRCUITS

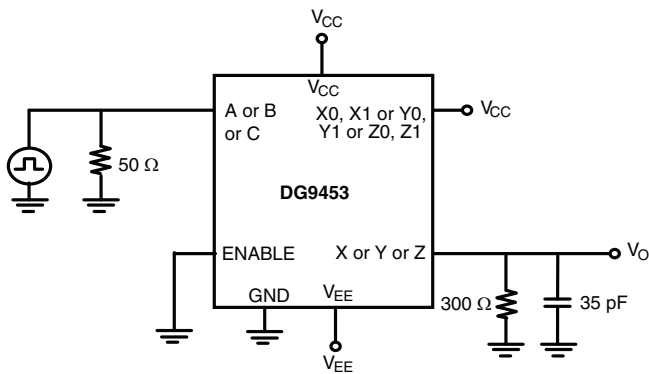
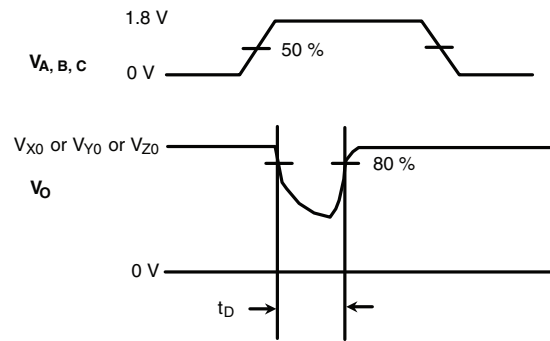
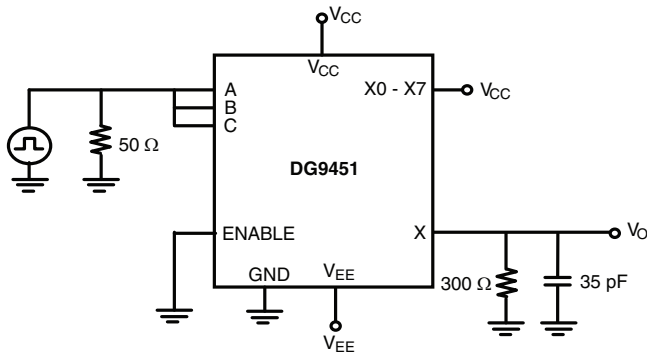


Figure 3. Break-Before-Make

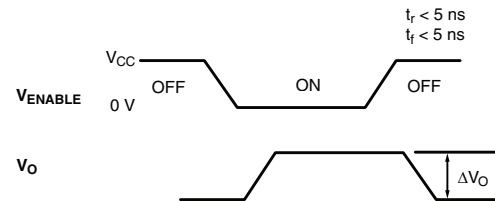
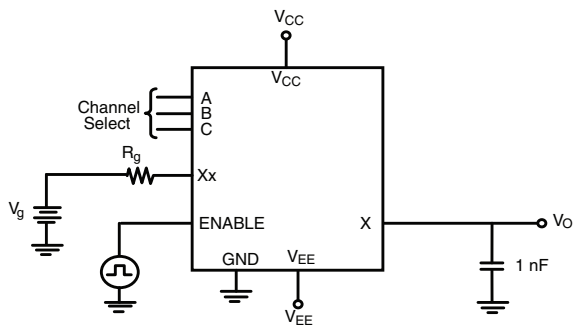
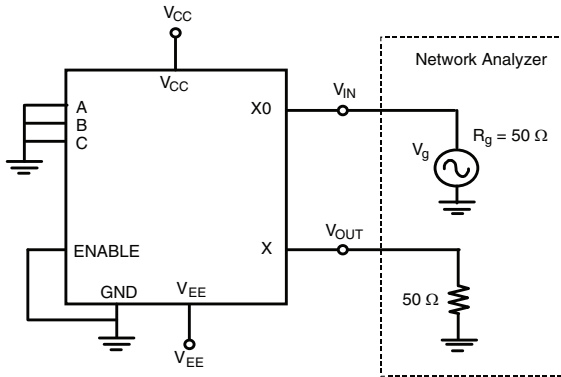


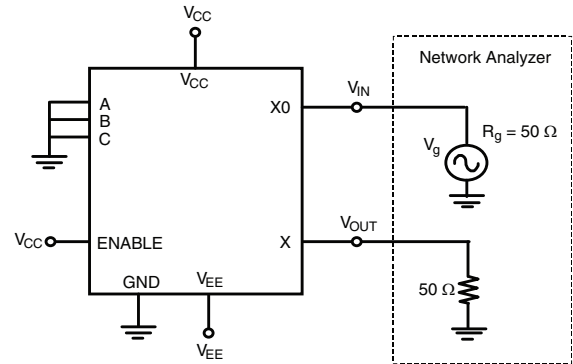
Figure 4. Charge Injection

TEST CIRCUITS



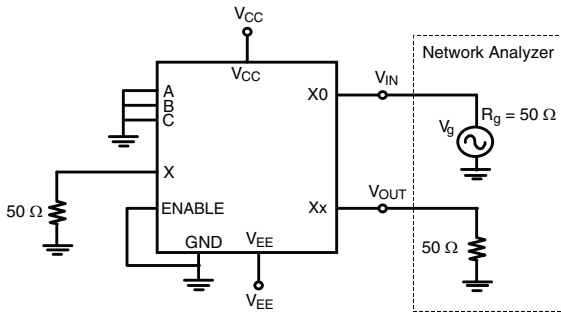
$$\text{Insertion Loss} = 20 \log \frac{V_{OUT}}{V_{IN}}$$

Figure 5. Insertion Loss



$$\text{Off Isolation} = 20 \log \frac{V_{OUT}}{V_{IN}}$$

Figure 6. Off Isolation



$$\text{Crosstalk} = 20 \log \frac{V_{OUT}}{V_{IN}}$$

Figure 7. Crosstalk

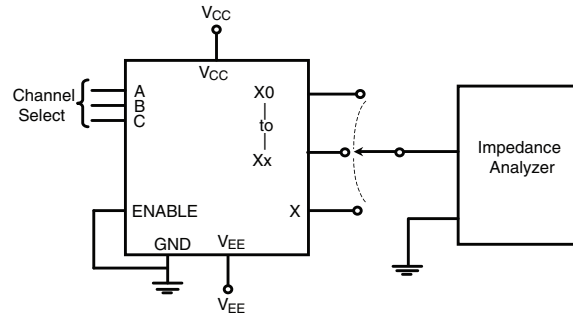
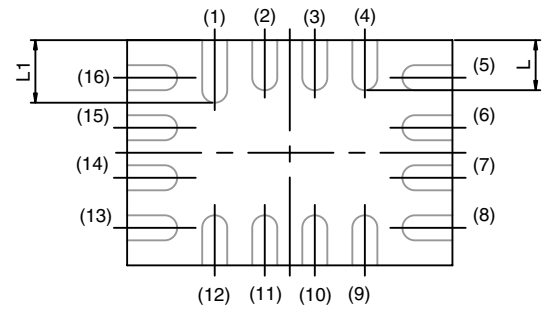
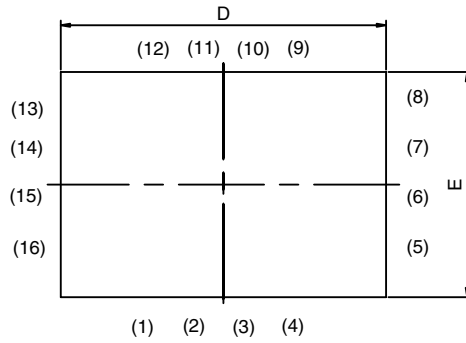


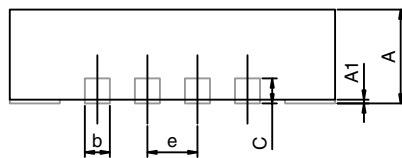
Figure 8. Source, Drain Capacitance

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?65020.

MINI QFN-16L



BACK SIDE VIEW



DIM	MILLIMETERS			INCHES		
	MIN.	NAM	MAX.	MIN.	NAM	MAX.
A	0.70	0.75	0.80	0.0275	0.0295	0.0315
A1	0	-	0.05	0	-	0.002
b	0.15	0.20	0.25	0.0059	0.0078	0.0098
C	0.15	0.20	0.25	0.0059	0.0078	0.0098
D	2.60 BSC			0.1023 BSC		
E	1.80 BSC			0.0708 BSC		
e	0.40 BSC			0.0157 BSC		
L	0.35	0.40	0.45	0.0137	0.0157	0.0177
L1	0.45	0.50	0.55	0.0177	0.0196	0.0216

ECN T-06380-Rev. A, 14-Aug-06
DWG: 5954



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and/or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk and agree to fully indemnify and hold Vishay and its distributors harmless from and against any and all claims, liabilities, expenses and damages arising or resulting in connection with such use or sale, including attorneys fees, even if such claim alleges that Vishay or its distributor was negligent regarding the design or manufacture of the part. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.