

Low-Voltage, Low R_{ON} Quad SPST Analog Switch

DESCRIPTION

The DG2041/2042/2043 are quad single-pole/single-throw monolithic CMOS analog switch designed for high performance switching of analog signals. Combining low power, fast switching, low on-resistance ($R_{DS(on)}$: 1Ω at 2.7 V) and small physical size, the DG2041/2042/2043 are ideal for portable and battery powered applications requiring high performance and efficient use of board space.

The DG2041/2042/2043 are built on Vishay Siliconix's new high density low voltage process. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks up to the power supply level when off.

FEATURES

- Halogen-free according to IEC 61249-2-21 Definition
- Low Voltage Operation (1.8 V to 5.5 V)
- Low On-Resistance - $R_{DS(on)}$: 1Ω
- Fast Switching - 14 ns t_{ON}
- Low Charge Injection - Q_{INJ} : 1 pC
- Low Power Consumption
- TTL/CMOS Compatible
- TSSOP-16 and QFN-16 Packages
- Compliant to RoHS Directive 2002/95/EC



RoHS
COMPLIANT
HALOGEN
FREE

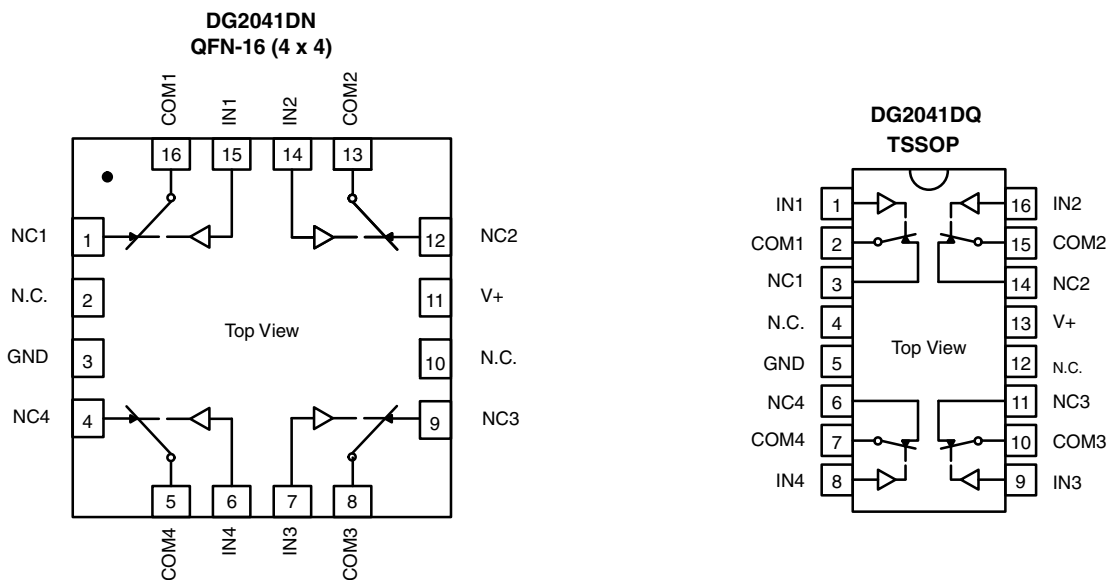
BENEFITS

- Reduced Power Consumption
- Simple Logic Interface
- High Accuracy
- Reduce Board Space

APPLICATIONS

- Cellular Phones
- Communication Systems
- Portable Test Equipment
- Battery Operated Systems
- Sample and Hold Circuits

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION - DG2041

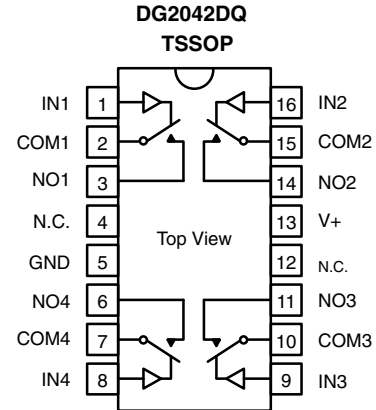
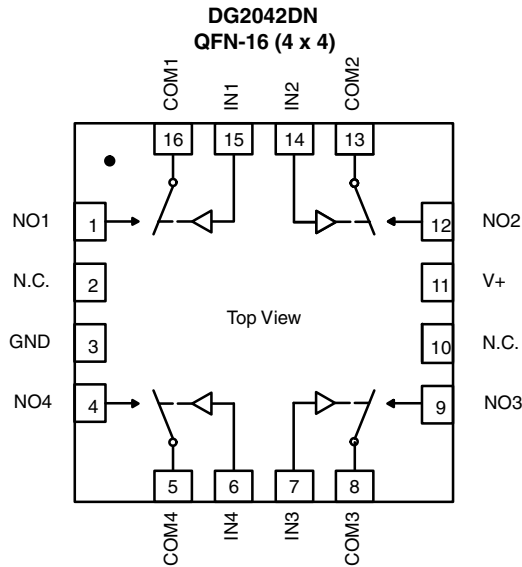


TRUTH TABLE - DG2041

Logic	Switch
0	On
1	Off

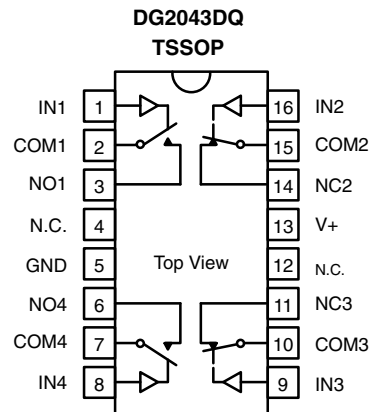
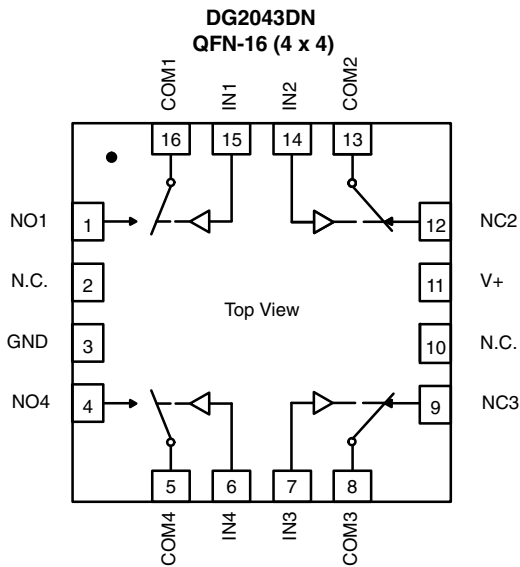
Switches Shown for Logic "0" Input

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION - DG2042, DG2043



TRUTH TABLE - DG2042	
Logic	Switch
0	Off
1	On

Switches Shown for Logic "0" Input



TRUTH TABLE - DG2043		
Logic	Switches 1, 4	Switches 2, 3
0	Off	On
1	On	Off

Switches Shown for Logic "0" Input



ORDERING INFORMATION		
Temp Range	Package	Part Number
- 40 °C to 85 °C	TSSOP-16	DG2041DQ-T1
		DG2041DQ-T1-E3
		DG2042DQ-T1
		DG2042DQ-T1-E3
		DG2043DQ-T1
		DG2043DQ-T1-E3
	QFN-16 (4 mm x 4 mm)	DG2041DN-T1-E4
		DG2042DN-T1-E4
		DG2043DN-T1-E4

ABSOLUTE MAXIMUM RATINGS			
Parameter	Symbol	Limit	Unit
Reference V+ to GND		- 0.3 to + 6	V
IN, COM, NC, NO ^a		- 0.3 to (V+ + 0.3)	
Continuous Current (Any terminal)		± 50	mA
Peak Current (Pulsed at 1 ms, 10 % duty cycle)		± 200	
Storage Temperature (D Suffix)		- 65 to 150	°C
Power Dissipation (Packages) ^b	TSSOP-16 ^c	450	mW
	QFN-16 (4 mm x 4 mm) ^d	1880	

Notes:

- a. Signals on NC, NO, or COM or IN exceeding 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 23.5 mW/°C above 70 °C
- e. Manual soldering with soldering iron is not recommended for leadless components. The QFN 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 (V+ = 2 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2 V, V _{IN} = 0.4 V or 1.6 V ^e	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
On- Resistance	R _{ON}	V+ = 2 V, V _{COM} = 0.2 V/1.2 V, I _{NO} , I _{NC} = 10 mA	Room Full		3	6.3 6.3	Ω
R _{ON} Flatness ^d	R _{ON} Flatness	V+ = 2 V, V _{COM} = 0 V to V+, I _{NO} , I _{NC} = 10 mA	Room			4.2	
R _{ON} Match Between Channels	ΔR _{ON}		Room			0.4	
Switch Off Leakage Current ^f	I _{NO(off)} I _{NC(off)}	V+ = 2.2 V V _{NO} , V _{NC} = 0.2 V/2 V, V _{COM} = 2 V/0.2 V	Room Full ^d	- 1 - 10		1 10	nA
	I _{COM(off)}		Room Full ^d	- 1 - 10		1 10	
Channel-On Leakage Current ^f	I _{COM(on)}	V+ = 2.2 V, V _{NO} , V _{NC} = V _{COM} = 0.2 V/2 V	Room Full ^d	- 1 - 10		1 10	

SPECIFICATIONS (V+ = 2 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 2 V, VIN = 0.4 V or 1.6 V ^e	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Digital Control							
Input High Voltage	V _{INH}		Full	1.6			V
Input Low Voltage	V _{INL}		Full			0.4	
Input Capacitance ^d	C _{in}		Full		4		pF
Input Current	I _{INL} or I _{INH}	V _{IN} = 0 V or V+	Full	- 1		1	μA
Dynamic Characteristics							
Turn-On Time	t _{ON}	V _{NO} or V _{NC} = 1.5 V, R _L = 300 Ω, C _L = 35 pF fig. 1 and 2	Room Full ^d		30	81 82	ns
Turn-Off Time	t _{OFF}		Room Full ^d		22	41 42	
Break-Before-Make Time Delay	t _D	V _{NO} or V _{NC} = 1.5 V, R _L = 300 Ω, C _L = 35 pF (DG2043 Only)	Room	5			
Charge Injection ^d	Q _{INJ}	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω, fig. 2	Room		1		pC
Off-Isolation ^d	OIRR	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk ^d	X _{TALK}		Room		- 95		
NO, NC Off Capacitance ^d	C _{NO(off)} C _{NC(off)}	V _{IN} = 0 V or V+, f = 1 MHz	Room		24		pF
Channel-On Capacitance ^d	C _{ON}		Room		48		
Power Supply							
Power Supply Current ^d	I+	V _{IN} = 0 V or V+			0.001	1	μA

SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, V _{IN} = 0.4 V or 2 V ^e	Temp. ^a	Limits - 40 to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
On-Resistance	R _{ON}	V+ = 2.7 V, V _{COM} = 0.7 V/1.5 V, I _{NO} , I _{NC} = 10 mA	Room Full		1.6	2.1 2.2	Ω
R _{ON} Flatness ^d	R _{ON} Flatness	V+ = 2.7 V, V _{COM} = 0 V to V+, I _{NO} , I _{NC} = 10 mA	Room			0.7	
R _{ON} Match Between Channels	ΔR _{ON}		Room			0.3	
Switch Off Leakage Current ^f	I _{NO(off)} I _{NC(off)}	V+ = 3.3 V V _{NO} , V _{NC} = 0.3 V/3 V, V _{COM} = 3 V/0.3 V	Room Full	- 1 - 10		1 10	nA
	I _{COM(off)}		Room Full	- 1 - 10		1 10	
Channel-On Leakage Current ^f	I _{COM(on)}	V+ = 3.3 V, V _{NO} , V _{NC} = V _{COM} = 0.3 V/3 V	Room Full	- 1 - 10		1 10	
Digital Control							
Input High Voltage ^d	V _{INH}		Full	1.6			V
Input Low Voltage	V _{INL}		Full			0.4	
Input Capacitance ^d	C _{in}		Full		4		pF
Input Current	I _{INL} or I _{INH}	V _{IN} = 0 V or V+	Full	- 1		1	μA



SPECIFICATIONS (V+ = 3 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 3 V, ± 10 %, VIN = 0.4 V or 2 V ^e	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Dynamic Characteristics							
Turn-On Time ^d	t _{ON}	V _{NO} or V _{NC} = 2 V, R _L = 300 Ω, C _L = 35 pF fig. 1 and 2	Room Full		19	51 52	ns
Turn-Off Time ^d	t _{OFF}		Room Full		17	36 37	
Break-Before-Make Time Delay	t _D	V _{NO} or V _{NC} = 2 V, R _L = 300 Ω, C _L = 35 pF (DG2043 Only)	Room	2			
Charge Injection ^d	Q _{INJ}	C _L = 1 nF, V _{GEN} = 0 V, R _{GEN} = 0 Ω, fig. 2	Room		3		pC
Off-Isolation ^d	OIRR	R _L = 50 Ω, C _L = 5 pF, f = 1 MHz	Room		- 63		dB
Crosstalk ^d	X _{TALK}		Room		- 94		
NO, NC Off Capacitance ^d	C _{NO(off)} C _{NC(off)}	V _{IN} = 0 V or V+, f = 1 MHz	Room		25		pF
Channel-On Capacitance ^d	C _{ON}		Room		49		
Power Supply							
Power Supply Current	I+	V _{IN} = 0 V or V+			0.001	1	μA

SPECIFICATIONS (V+ = 5 V)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified V+ = 5 V, ± 10 %, VIN = 0.8 V or 2.4 V ^e	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Analog Switch							
Analog Signal Range ^d	V _{NO} , V _{NC} V _{COM}		Full	0		V+	V
On-Resistance	R _{ON}	V+ = 4.5 V, V _{COM} = 0.7 V/2.5 V, I _{NO} , I _{NC} = 10 mA	Room Full		1	1.5 1.6	Ω
R _{ON} Flatness ^d	R _{ON} Flatness	V+ = 4.5 V, V _{COM} = 0 V to V+, I _{NO} , I _{NC} = 10 mA	Room			0.7	
R _{ON} Match Between Channels	ΔR _{ON}		Room			0.3	
Switch Off Leakage Current	I _{NO(off)} I _{NC(off)}	V+ = 5.5 V V _{NO} , V _{NC} = 1 V/4.5 V, V _{COM} = 4.5 V/1 V	Room Full	- 1 - 10		1 10	nA
	I _{COM(off)}		Room Full	- 1 - 10		1 10	
Channel-On Leakage Current	I _{COM(on)}	V+ = 5.5 V, V _{NO} , V _{NC} = V _{COM} = 1 V/4.5 V	Room Full	- 1 - 10		1 10	
Digital Control							
Input High Voltage	V _{INH}		Full	2.4			V
Input Low Voltage	V _{INL}		Full			0.8	
Input Capacitance	C _{in}		Full		4		pF
Input Current	I _{INL} or I _{INH}	V _{IN} = 0 V or V+	Full	- 1		1	μA



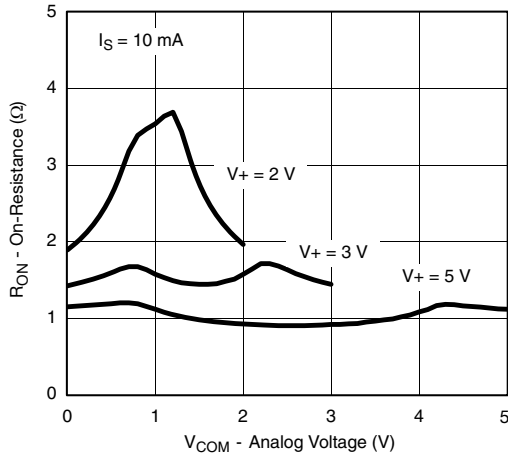
SPECIFICATIONS ($V_+ = 5\text{ V}$)							
Parameter	Symbol	Test Conditions Otherwise Unless Specified $V_+ = 5\text{ V}, \pm 10\%, V_{IN} = 0.8\text{ V or } 2.4\text{ V}^e$	Temp. ^a	Limits - 40 °C to 85 °C			Unit
				Min. ^b	Typ. ^c	Max. ^b	
Dynamic Characteristics							
Turn-On Time ^d	t_{ON}	V_{NO} or $V_{NC} = 3\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$ fig. 1 and 2	Room Full		13	42 43	ns
Turn-Off Time ^d	t_{OFF}		Room Full		19	32 33	
Break-Before-Make Time Delay	t_D	V_{NO} or $V_{NC} = 3\text{ V}, R_L = 300\ \Omega, C_L = 35\text{ pF}$ (DG2043 Only)	Room	1			
Charge Injection ^d	Q_{INJ}	$C_L = 1\text{ nF}, V_{GEN} = 0\text{ V}, R_{GEN} = 0\ \Omega$, fig. 2	Room		3		pC
Off-Isolation ^d	OIRR	$R_L = 50\ \Omega, C_L = 5\text{ pF}, f = 1\text{ MHz}$	Room		- 63		dB
Crosstalk ^d	X_{TALK}		Room		- 93		
Source-Off Capacitance ^d	$C_{NO(off)}$ $C_{NC(off)}$	$V_{IN} = 0\text{ V or } V_+, f = 1\text{ MHz}$	Room		26		pF
Channel-On Capacitance ^d	C_{ON}		Room		49		
Power Supply							
Power Supply Current	I+	$V_{IN} = 0\text{ V or } V_+$			0.001	1	μA

Notes:

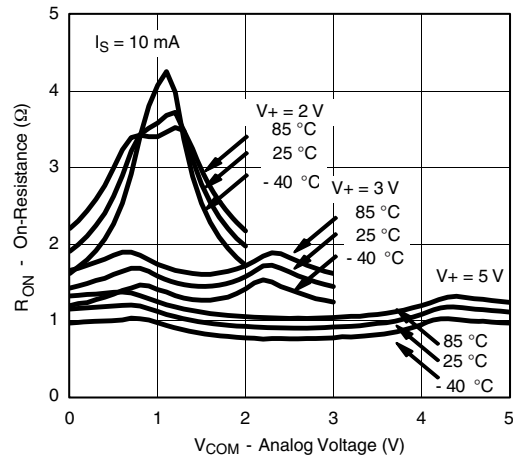
- Room = 25 °C, full = as determined by the operating suffix.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Typical values are for design aid only, not guaranteed nor subject to production testing.
- Guarantee by design, nor subjected to production test.
- V_{IN} = input voltage to perform proper function.
- Guaranteed by 5 V leakage testing, not production tested.

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.

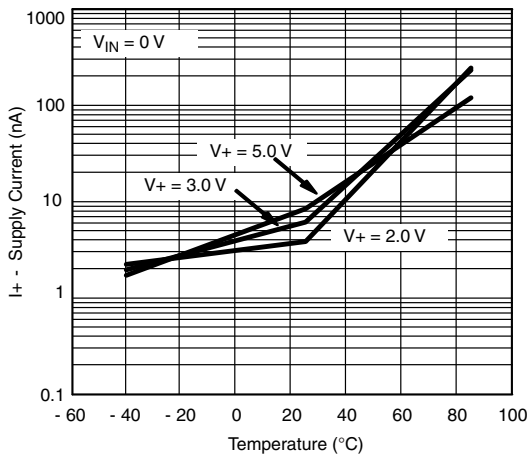
TYPICAL CHARACTERISTICS (25 °C unless noted)



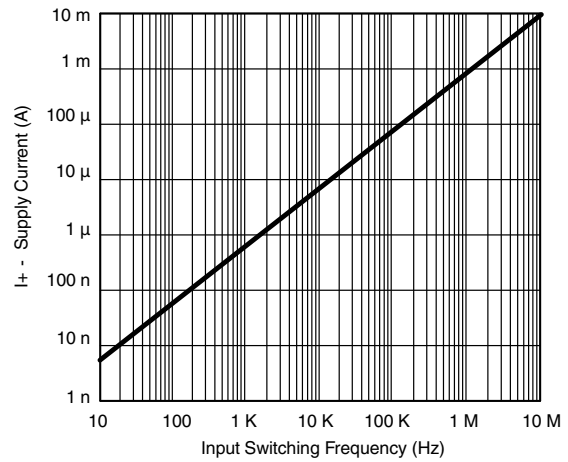
RON vs. VCOM and Supply Voltage



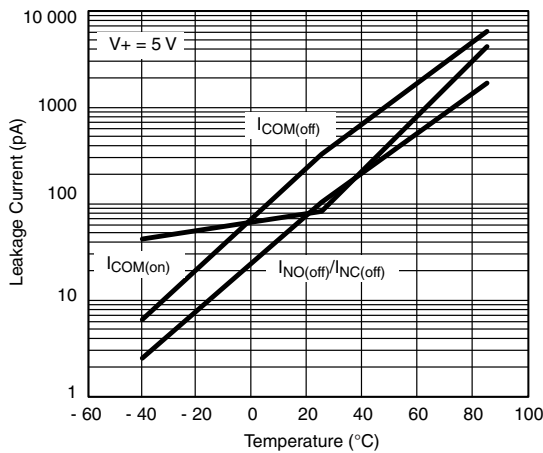
RON vs. Analog Voltage and Temperature



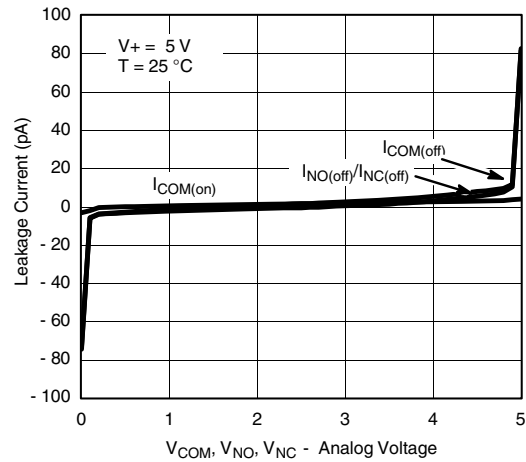
Supply Current vs. Temperature



Supply Current vs. Input Switching Frequency

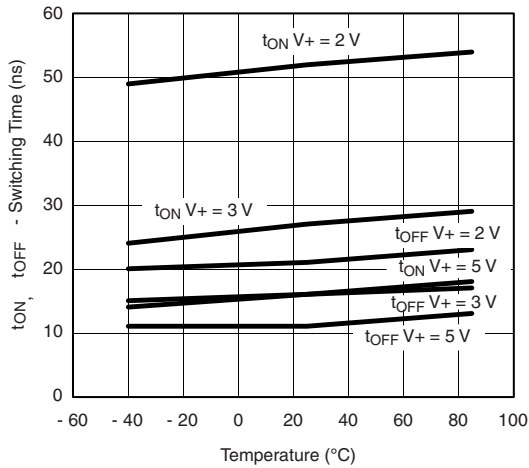


Leakage Current vs. Temperature

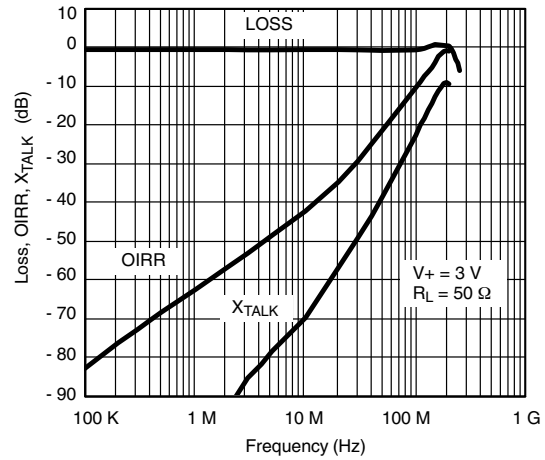


Leakage vs. Analog Voltage

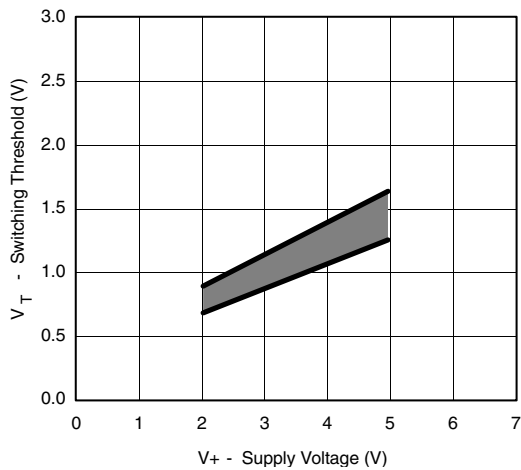
TYPICAL CHARACTERISTICS (25 °C unless noted)



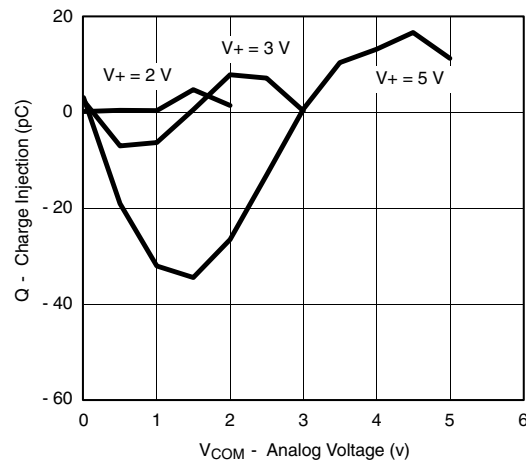
Switching Time vs. Temperature and Supply Voltage



Insertion Loss, Off-Isolation Crosstalk vs. Frequency

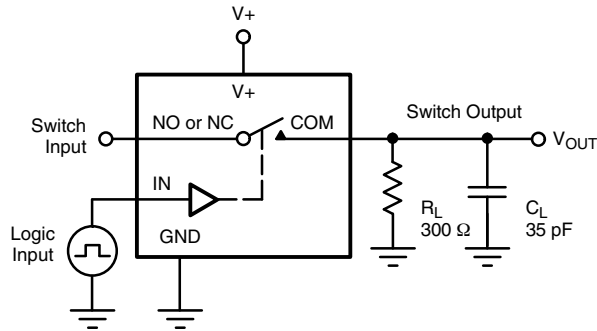


Switching Threshold vs. Supply Voltage



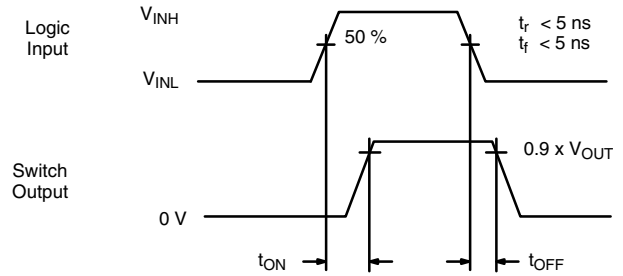
Charge Injection vs. Analog Voltage

TEST CIRCUITS



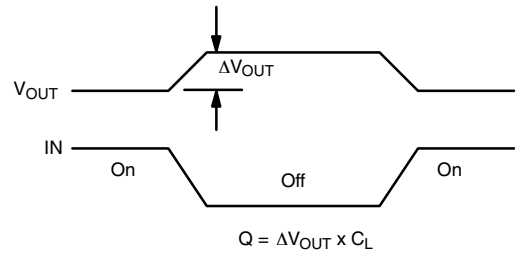
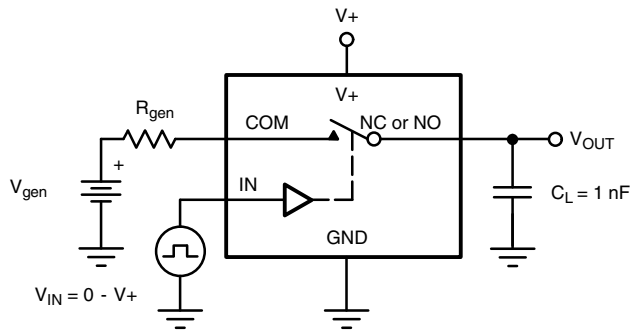
C_L (includes fixture and stray capacitance)

$$V_{OUT} = V_{COM} \left(\frac{R_L}{R_L + R_{ON}} \right)$$



Logic "1" = Switch On
 Logic input waveforms inverted for switches that have the opposite logic sense.

Figure 1. Switching Time



IN depends on switch configuration: input polarity determined by sense of switch.

Figure 2. Charge Injection

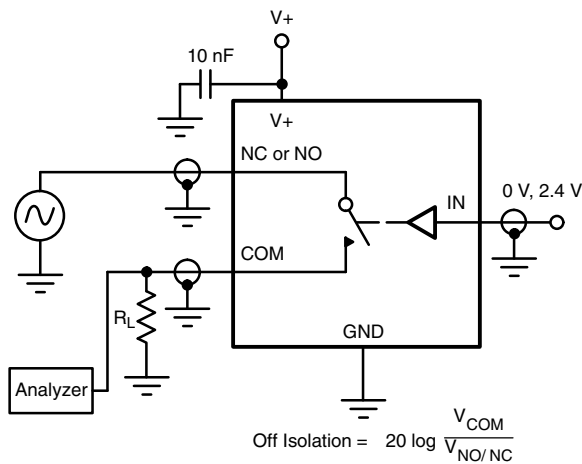


Figure 3. Off-Isolation

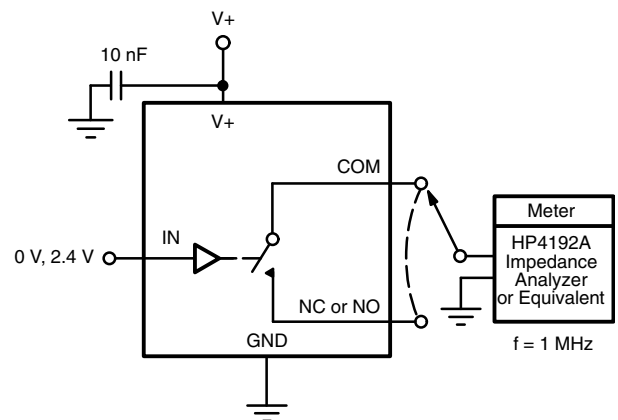
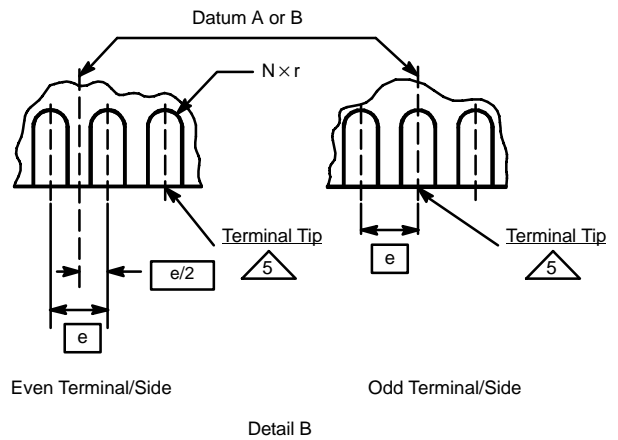
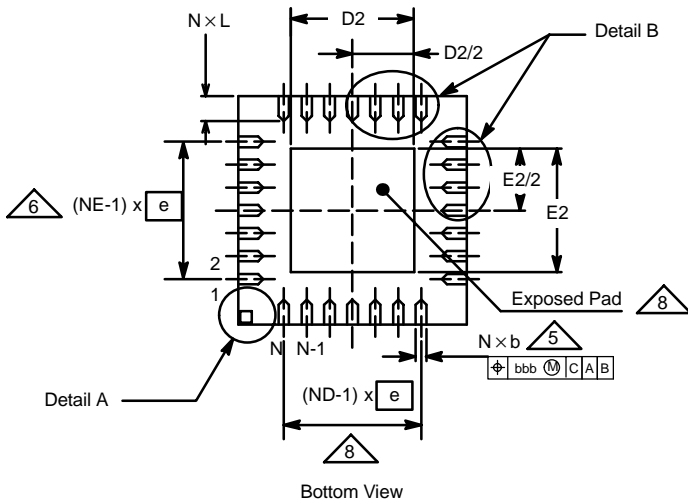
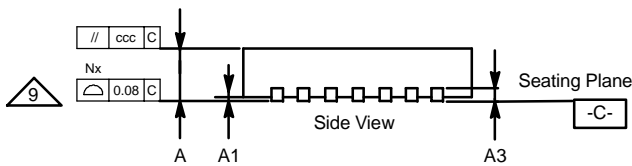
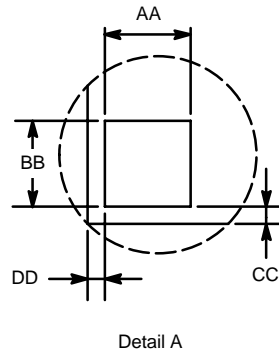
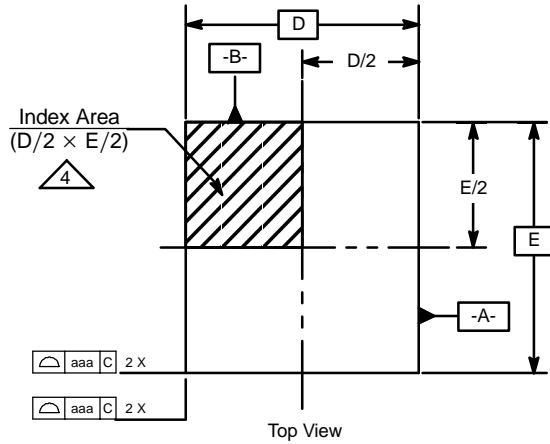


Figure 4. Channel Off/On Capacitance

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?72091.



QFN-16 (4 × 4 mm)
JEDEC Part Number: MO-220



Vishay Siliconix

QFN-16 (4 × 4 mm)

JEDEC Part Number: MO-220

Dim	MILLIMETERS*			INCHES			Notes
	Min	Nom	Max	Min	Nom	Max	
A	0.80	0.90	1.00	0.0315	0.0354	0.0394	
A1	0	0.02	0.05	0	0.0008	0.0020	
A3	-	0.20 Ref	-	-	0.0079	-	
AA	-	0.345	-	-	0.0136	-	
aaa	-	0.25	-	-	0.0098	-	
BB	-	0.345	-	-	0.0136	-	
b	0.23	0.30	0.38	0.0091	0.0118	0.0150	5
bbb	-	0.10	-	-	0.0039	-	
CC	-	0.18	-	-	0.0071	-	
ccc	-	0.10	-	-	0.0039	-	
D	4.00 BSC			0.1575 BSC			
D2	2.00	2.15	2.25	0.0787	0.0846	0.0886	
DD	-	0.18	-	-	0.0071	-	
E	4.00 BSC			0.1575 BSC			
E2	2.00	2.15	2.25	0.0787	0.0846	0.0886	
e	0.65 BSC			0.0256 BSC			
L	0.45	0.55	0.65	0.0177	0.0217	0.0256	
N	16			16			3, 7
ND	-	4	-	-	4	-	6
NE	-	4	-	-	4	-	6
r	b(min)/2	-	-	b(min)/2	-	-	

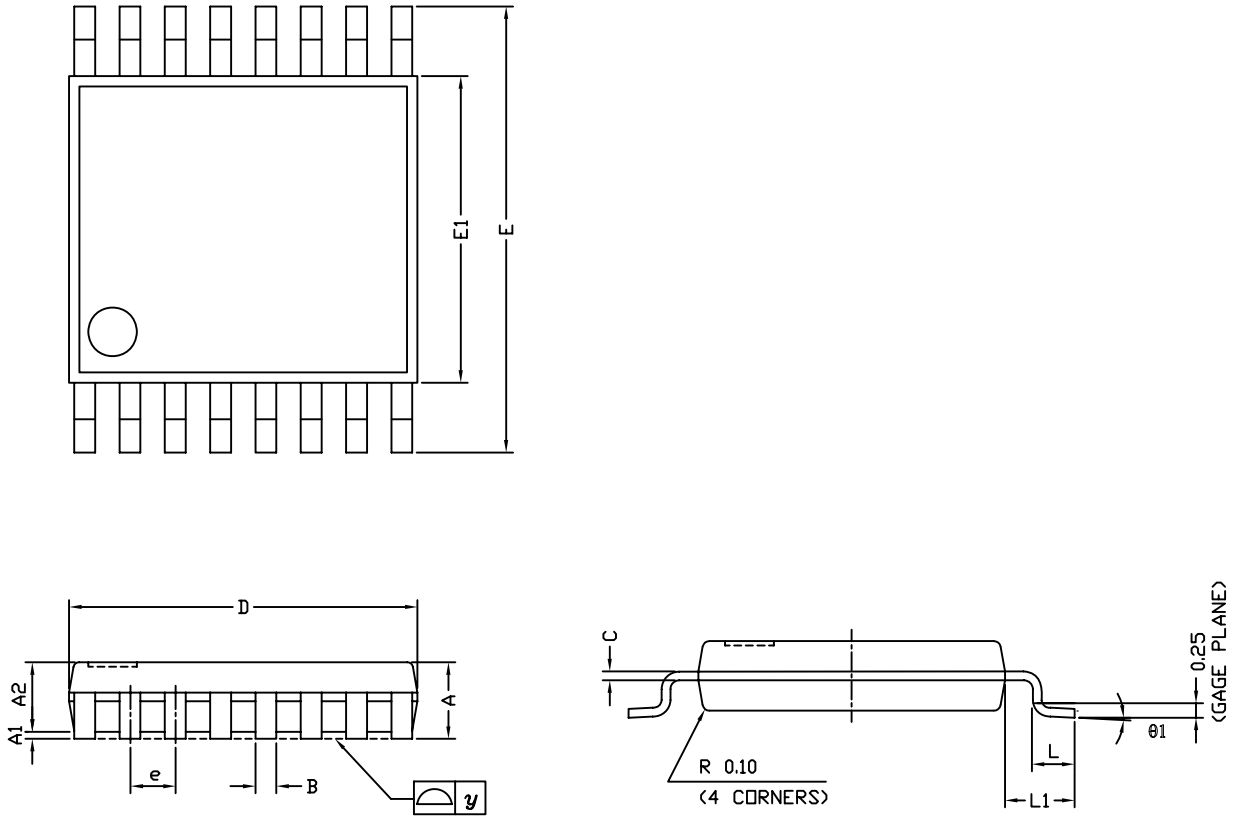
* Use millimeters as the primary measurement.

ECN: S-21437—Rev. A, 19-Aug-02
DWG: 5890

NOTES:

1. Dimensioning and tolerancing conform to ASME Y14.5M-1994.
2. All dimensions are in millimeters. All angles are in degrees.
3. N is the total number of terminals.
4. The terminal #1 identifier and terminal numbering convention shall conform to JESD 95-1 SPP-012. Details of terminal #1 identifier are optional, but must be located within the zone indicated. The terminal #1 identifier may be either a molded or marked feature. The X and Y dimension will vary according to lead counts.
5. Dimension b applies to metallized terminal and is measured between 0.25 mm and 0.30 mm from the terminal tip.
6. ND and NE refer to the number of terminals on the D and E side respectively.
7. Depopulation is possible in a symmetrical fashion.
8. Variation HHD is shown for illustration only.
9. Coplanarity applies to the exposed heat sink slug as well as the terminals.

TSSOP: 16-LEAD

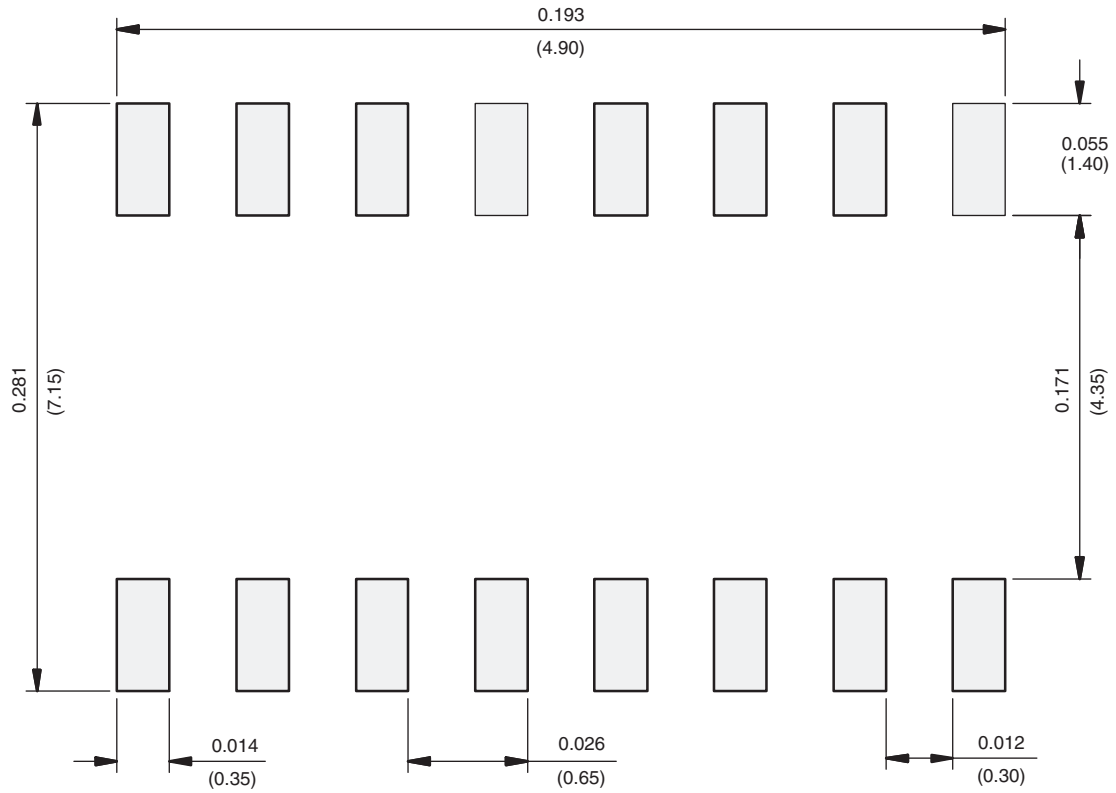


Symbols	DIMENSIONS IN MILLIMETERS		
	Min	Nom	Max
A	-	1.10	1.20
A1	0.05	0.10	0.15
A2	-	1.00	1.05
B	0.22	0.28	0.38
C	-	0.127	-
D	4.90	5.00	5.10
E	6.10	6.40	6.70
E1	4.30	4.40	4.50
e	-	0.65	-
L	0.50	0.60	0.70
L1	0.90	1.00	1.10
y	-	-	0.10
θ1	0°	3°	6°

ECN: S-61920-Rev. D, 23-Oct-06
DWG: 5624

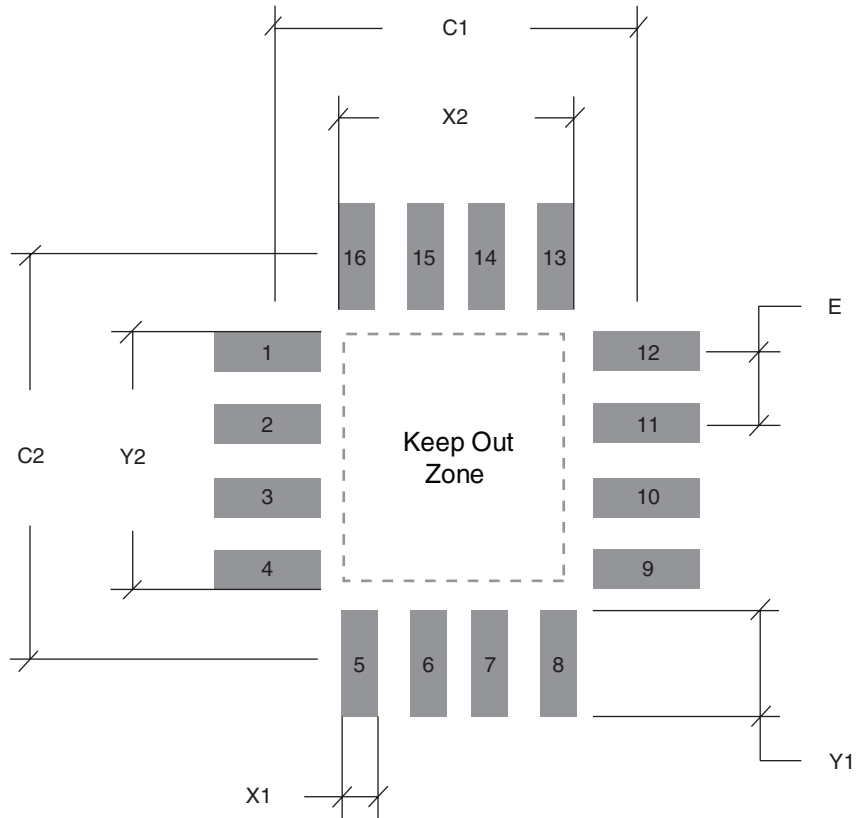


RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads
Dimensions in inches (mm)

RECOMMENDED MINIMUM PADS FOR QFN-16 (4 x 4 MM BODY)



	Inches	Millimeters
C1	0.142	3.60
C2	0.142	3.60
E	0.026	0.65
X1	0.014	0.35
X2	0.089	2.25
Y1	0.037	0.95
Y2	0.089	2.25

Note:
QFN-16 (4 x 4) has an exposed center pad that must not come into contact with any metalized structure on the PCB. This area is considered a Keep Out Zone.



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