

High Voltage 4-Ω Quad SPST CMOS Analog Switch

DESCRIPTION

The DG451 series has four independently selectable high voltage (44 V) SPST switches, each with a typical on resistance of 4 Ω and a typical flatness of 0.2 Ω, ideal parameters for low distortion audio signal switching.

The DG451 (NC) and DG452 (NO) are identical except for the digital logic control input, which is inverted as shown in the Truth Table. The DG453 has two normally closed and two normally open switches.

These are high voltage switches that are fully specified with dual supplies at ± 5 V and ± 15 V and a single supply of 12 V and operating with ultra low power dissipation (18 μW).

Fast switching speeds coupled with high signal bandwidth makes these parts suitable for video switching applications.

All digital inputs have 0.8 V and 2.4 V logic thresholds ensuring low voltage TTL/CMOS compatibility. Each switch conducts equally well in both directions when on and can handle an input signal range that extends to the supply voltage rails.

The DG451, DG452, and DG453 are pin compatible with the DG411, DG412, and DG413.

FEATURES

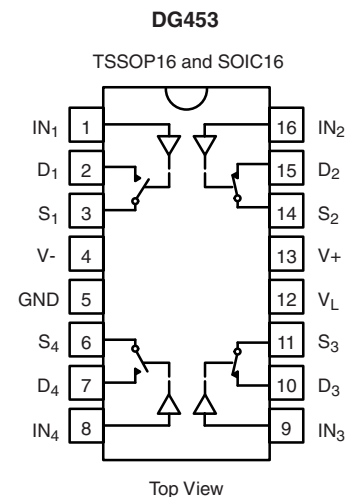
- Low on-resistance (4 Ω typical)
- On-resistance flatness (0.2 Ω typical)
- 100 mA continuous current
- 44 V supply maximum rating
- ± 15 V analog signal range
- Fully specified at supply voltages of ± 5 V, 12 V and ± 15 V
- Ultra low power dissipation of (18 μW)
- Fast switching speed:
 - t_{on} 80 ns
 - t_{off} 60 ns
- TTL/CMOS compatible
- ESD protection 2 kV
- Pin compatible with DG411, DG412, and DG413
- **Compliant to RoHS directive 2002/95/EC**


RoHS
COMPLIANT

APPLICATIONS

- Audio and video signal switching
- Precision automatic test equipment
- Precision data acquisition
- Relay replacement
- Communications systems
- Automotive and avionics applications
- Sample and hold systems

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE		
Logic	DG451	DG452
0	On	Off
1	Off	On

TRUTH TABLE		
Logic	SW ₁ , SW ₄	SW ₂ , SW ₃
0	Off	On
1	On	Off

ORDERING INFORMATION		
Temp. Range	Package	Part Number
DG451, DG452, DG453		
- 40 °C to 125 °C ^a	16 Pin TSSOP	DG451EQ-T1-E3 DG452EQ-T1-E3 DG453EQ-T1-E3
	16 Pin Narrow SOIC	DG451EY-T1-E3 DG452EY-T1-E3 DG453EY-T1-E3

Notes:

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

ABSOLUTE MAXIMUM RATINGS $T_A = 25\text{ °C}$, unless otherwise noted			
Parameter		Limit	Unit
V+ to V-		44	V
GND to V-		25	
V_L		(GND - 0.3) to (V+) + 0.3	
Digital Inputs ^a , V_S , V_D		(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first	
Continuous Current (D, S only)		100	mA
Peak Current, S or D (Pulsed 1 ms, 10 % Duty Cycle)		300	
Storage Temperature		- 65 to 150	°C
Power Dissipation (Package) ^b	16 Pin TSSOP ^c	450	mW
	16 Pin Narrow SOIC ^d	600	
Thermal Resistance (Package) ^b	16 Pin TSSOP	178	C/W
	16 Pin Narrow SOIC	125	
ESD (HBM)		2	kV

Notes:

a. Signals on S_X , D_X , or IN_X 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 8.0 mW/°C above 75 °C.

SPECIFICATIONS FOR DUAL SUPPLIES									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 15\text{ V}$, $V_- = -15\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 2.4\text{ V}$, 0.8 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		- 15	15	- 15	15	V
On-Resistance	R_{ON}	$I_S = -10\text{ mA}$, $V_D = -10\text{ V to } +10\text{ V}$	Room Full	3.8		5.3 8.3		5.3 7.3	Ω
On-Resistance Match	ΔR_{ON}	$I_S = -10\text{ mA}$, $V_D = \pm 10\text{ V}$	Room Full	0.12		0.5 1		0.5 0.5	
On-Resistance Flatness	$R_{FLATNESS}$	$I_S = -10\text{ mA}$, $V_D = -5\text{ V}, 0\text{ V}, +5\text{ V}$	Room Full	0.25		0.5 0.5		0.5 0.5	
Switch Off Leakage Current	$I_{S(off)}$	$V_D = \pm 10\text{ V}$, $V_S = \mp 10\text{ V}$	Room Full	± 0.1	- 0.5 - 20	0.5 20	- 0.5 - 2.5	0.5 2.5	nA
	$I_{D(off)}$		Room Full	± 0.1	- 0.5 - 20	0.5 20	- 0.5 - 2.5	0.5 2.5	
Channel On Leakage Current	$I_{D(on)}$	$V_S = V_D = \pm 10\text{ V}$	Room Full	± 0.1	- 0.4 - 40	0.4 40	- 1 - 5	1 5	

SPECIFICATIONS FOR DUAL SUPPLIES									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 15\text{ V}$, $V_- = -15\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 2.4\text{ V}$, 0.8 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	
Digital Control									
Input Current, V_{IN} Low	I_{IL}	V_{IN} Under Test = 0.8 V	Full	0.005	- 0.5	0.5	- 0.5	0.5	μA
Input Current, V_{IN} High	I_{IH}	V_{IN} Under Test = 2.4 V	Full	0.005	- 0.5	0.5	- 0.5	0.5	
Input Capacitance ^e	C_{IN}	$f = 1\text{ MHz}$	Room	7					pF
Dynamic Characteristics									
Turn-On Time	t_{ON}	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ $V_S = \pm 10\text{ V}$, See Figure 2	Room	88		118		118	ns
Turn-Off Time	t_{OFF}		Room	69		97		97	
Break-Before-Make Time Delay	t_D	DG453 only, $V_S = 10\text{ V}$ $R_L = 300\ \Omega$, $C_L = 35\text{ pF}$	Room	18					
Charge Injection ^e	Q	$V_g = 0\text{ V}$, $R_g = 0\ \Omega$, $C_L = 1\text{ nF}$	Room	22					pC
Off Isolation ^e	OIRR	$R_L = 50\ \Omega$, $C_L = 5\text{ pF}$ $f = 1\text{ MHz}$	Room	- 60					dB
Channel-to-Channel Crosstalk ^e	X_{TALK}		Room	- 85					
Source Off Capacitance ^e	$C_{S(off)}$	$f = 1\text{ MHz}$	Room	31					pF
Drain Off Capacitance ^e	$C_{D(off)}$		Room	34					
Channel On Capacitance ^e	$C_{D(on)}$		Room	103					
Total Harmonic Distortion ^e	THD	Signal = 5 V_{RMS} , 20 Hz to 20 kHz, $R_L = 600\ \Omega$	Room	0.04					%
Power Supplies									
Power Supply Current	I_+	$V_+ = 16.5\text{ V}$, $V_- = -16.5\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 0$ or 5 V	Room	0.001		0.5		0.5	μA
Negative Supply Current	I_-		Full	- 0.001	- 0.5	- 5	- 0.5	- 5	
Logic Supply Current	I_L		Room	0.001		0.5		0.5	
Ground Current	I_{GND}		Full	- 0.001	- 0.5	- 5	- 0.5	- 5	

SPECIFICATIONS FOR DUAL SUPPLIES									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 5\text{ V}$, $V_- = -5\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 2.4\text{ V}$, 0.8 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}	$V_+ = +5\text{ V}$, $V_- = -5\text{ V}$ $I_S = -10\text{ mA}$, $V_D = -3.5\text{ V}$ to $+3.5\text{ V}$	Room	3.8		11		11	Ω
On-Resistance Match	ΔR_{ON}	$V_+ = +5\text{ V}$, $V_- = -5\text{ V}$, $I_S = -10\text{ mA}$, $V_D = \pm 3.5\text{ V}$	Room	0.13		0.5		0.5	
Dynamic Characteristics									
Turn-On Time ^e	t_{ON}	$R_L = 300\ \Omega$, $C_L = 35\text{ pF}$ $V_S = 3\text{ V}$, See Figure 2	Room	170		200		200	ns
Turn-Off Time ^e	t_{OFF}		Full	66		96		96	
Break-Before-Make ^e Time Delay	t_D	DG451 only, $V_S = 3\text{ V}$ $R_L = 300\ \Omega$, $C_L = 35\text{ pF}$	Room	98					
Charge Injection ^e	Q	$V_g = 0\text{ V}$, $R_g = 0\ \Omega$, $C_L = 1\text{ nF}$	Full	8					pC

SPECIFICATIONS FOR DUAL SUPPLIES									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 5\text{ V}$, $V_- = -5\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 2.4\text{ V}$, 0.8 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+	$V_L = 5\text{ V}$, $V_{IN} = 0\text{ or }5\text{ V}$	Room Full	0.001		- 0.5 - 5		- 0.5 - 5	μA
Negative Supply Current	I-		Room Full	- 0.001	- 0.5 - 5		- 0.5 - 5		
Logic Supply Current	I _L		Room Full	0.001		- 0.5 - 5		- 0.5 - 5	
Ground Current	I _{GND}		Room Full	- 0.001	- 0.5 - 5		- 0.5 - 5		

SPECIFICATIONS FOR UNIPOLAR SUPPLIES									
Parameter	Symbol	Test Conditions Unless Specified $V_+ = 12\text{ V}$, $V_- = 0\text{ V}$ $V_L = 5\text{ V}$, $V_{IN} = 2.4\text{ V}$, 0.8 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			12		12	V
On-Resistance	R _{ON}	I _S = - 10 mA, V _D = 0 V to + 10 V	Room Full	5.5		8.1 12.4		8.1 10.4	Ω
On-Resistance Match	ΔR_{ON}	I _S = - 10 mA, V _D = + 10 V	Room Full	0.14		0.5 1		0.5 0.5	
On-Resistance Flatness	R _{FLATNESS}	I _S = - 10 mA, V _D = 0 V, + 5 V, + 10 V	Room Full	0.94		1.5 1.7		1.5 1.5	
Dynamic Characteristics									
Turn-On Time	t _{ON}	R _L = 300 Ω , C _L = 35 pF V _S = 8 V, See Figure 2	Room Full	132		162 238		162 210	ns
Turn-Off Time	t _{OFF}		Room Full	61		91 117		91 105	
Break-Before-Make Time Delay	t _D	DG453 only, V _S = 8 V R _L = 300 Ω , C _L = 35 pF	Room	70					
Charge Injection ^e	Q	V _g = 0 V, R _g = 0 Ω , C _L = 1 nF	Room	1					pC
Power Supplies									
Power Supply Current	I+	$V_L = 5\text{ V}$, $V_{IN} = 0\text{ or }5\text{ V}$	Room Full	0.001		0.5 5		0.5 5	μA
Negative Supply Current	I-		Room Full	- 0.001	- 0.5 - 5		- 0.5 - 5		
Logic Supply Current	I _L		Room Full	0.001		0.5 5		0.5 5	
Ground Current	I _{GND}		Room Full	- 0.001	- 0.5 - 5		- 0.5 - 5		

Notes:

- V_{IN} = input voltage to perform proper function.
- Room = 25 °C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- 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, $V_L = 5\text{ V}$, unless otherwise noted



On-Resistance vs. V_D and Dual Supply Voltage



On-Resistance vs. V_D and Single Supply Voltage



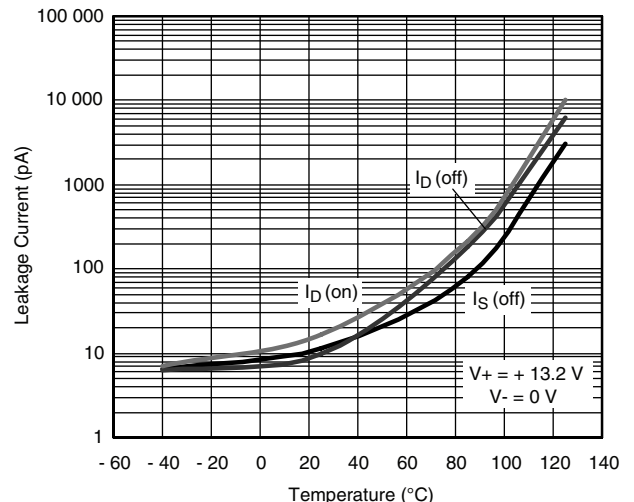
On-Resistance vs. V_D and Temperature



On-Resistance vs. V_D and Temperature



Leakage Current vs. Temperature



Leakage Current vs. Temperature

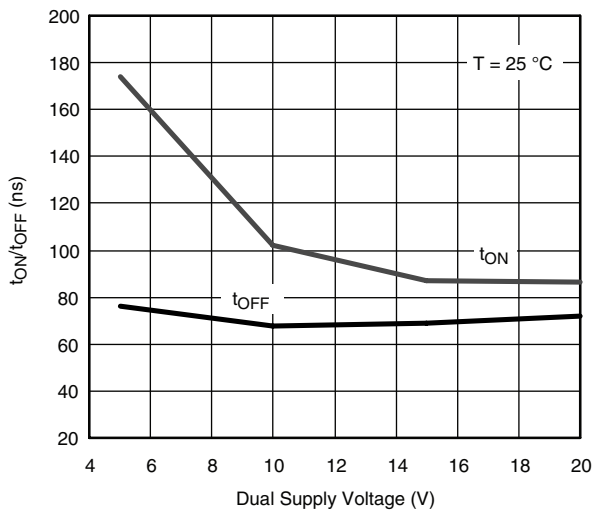
TYPICAL CHARACTERISTICS 25 °C, $V_L = 5$ V, unless otherwise noted



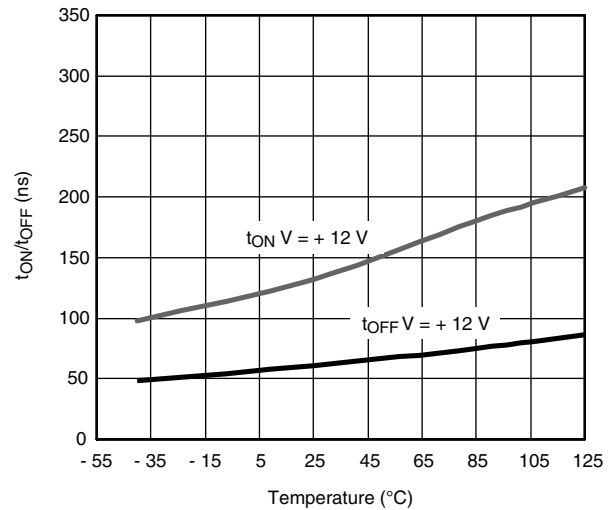
Charge Injection vs. Analog Voltage



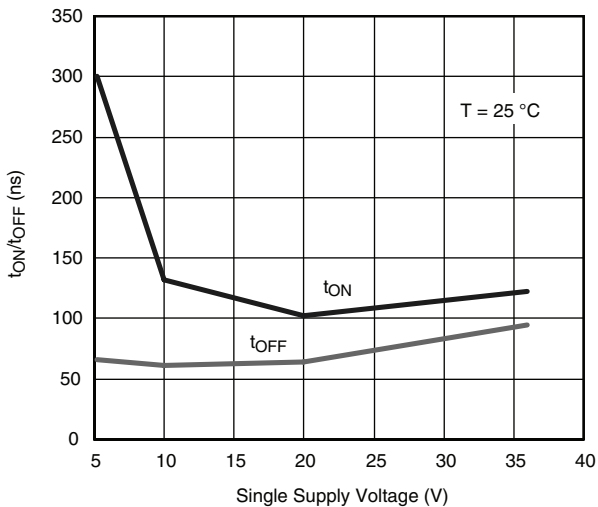
Switching Time vs. Temperature and Dual Supply Voltage



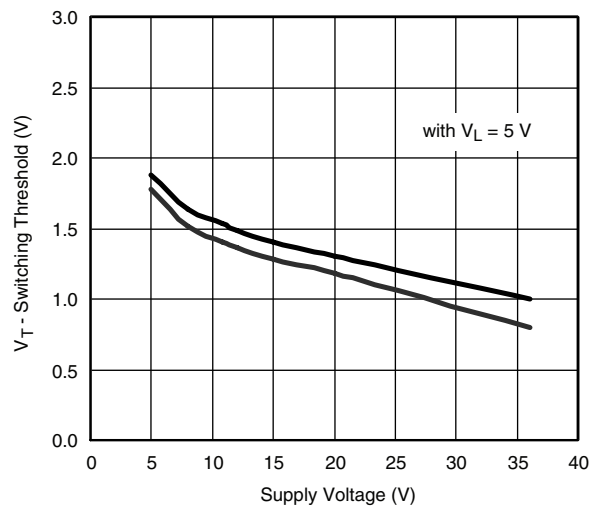
Switching Time vs. Dual Supply Voltage



Switching Time vs. Temperature and Single Supply Voltage

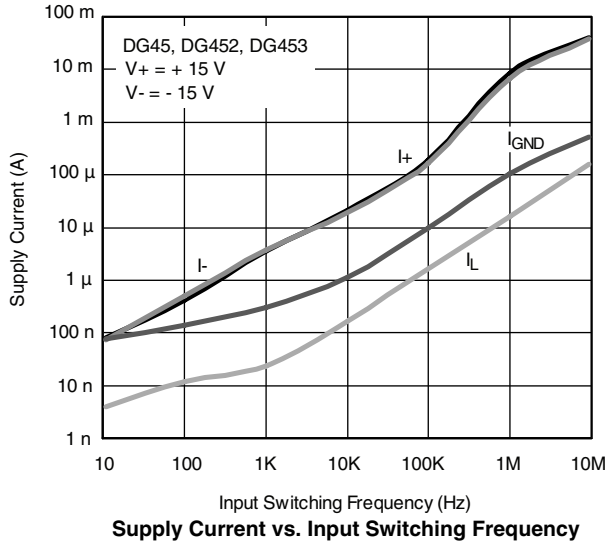


Switching Time vs. Single Supply Voltage



Switching Threshold vs. Supply Voltage

TYPICAL CHARACTERISTICS 25 °C, $V_L = 5\text{ V}$, unless otherwise noted

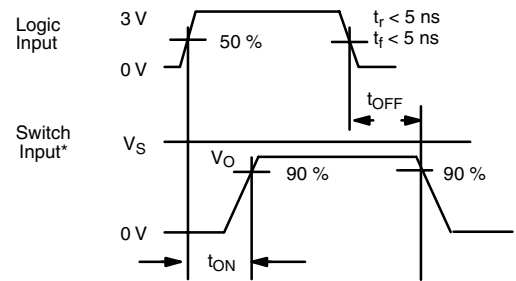


TEST CIRCUITS



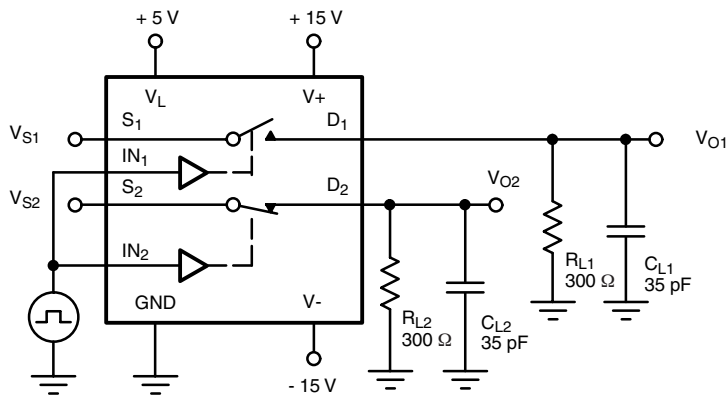
C_L (includes fixture and stray capacitance)

$$V_O = V_S \frac{R_L}{R_L + R_{DS(on)}}$$



Note: Logic input waveform is inverted for switches that have the opposite logic sense control

Figure 1. Switching Time



C_L (includes fixture and stray capacitance)

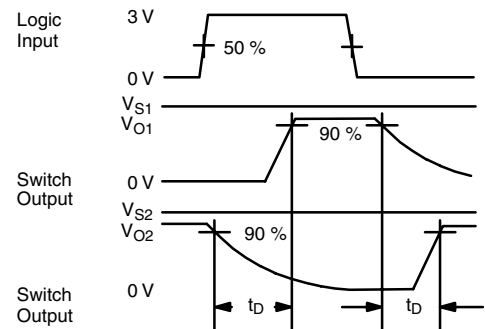


Figure 2. Break-Before-Make (DG453)

TEST CIRCUITS



Figure 3. Charge Injection

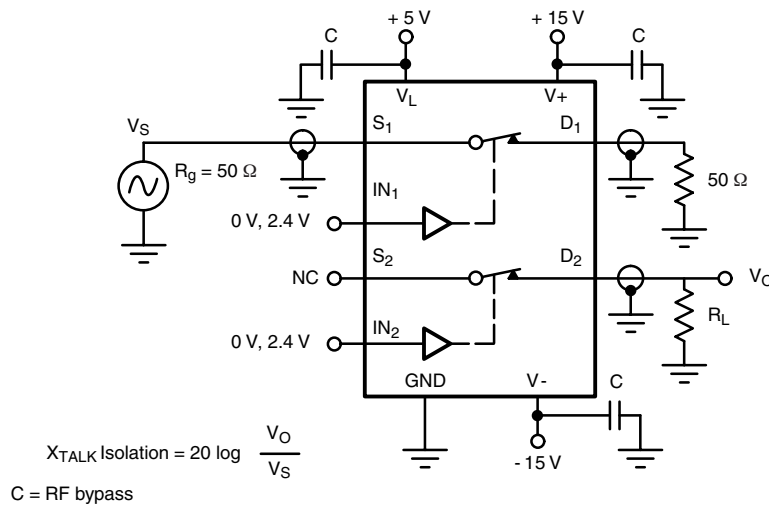


Figure 4. Crosstalk

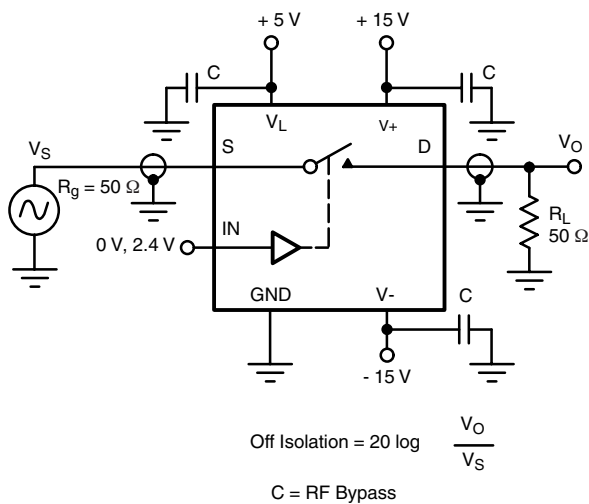


Figure 5. Off-Isolation

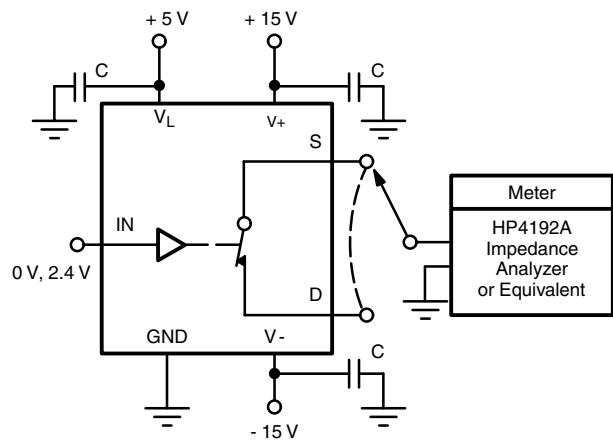


Figure 6. Source/Drain Capacitances

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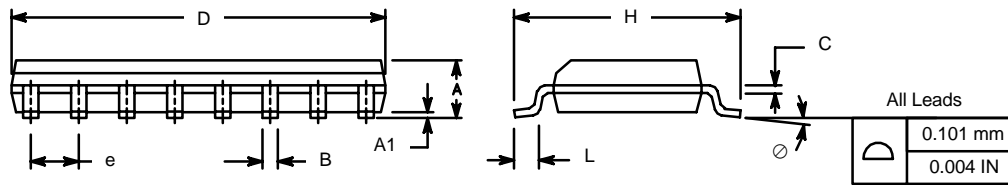


SOIC (NARROW): 16-LEAD
JEDEC Part Number: MS-012

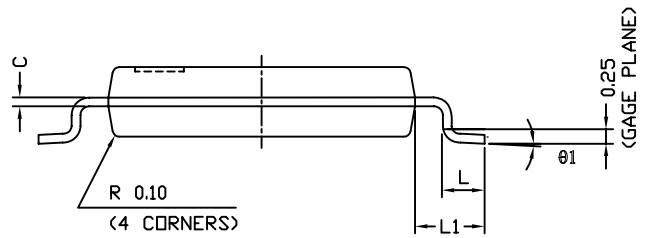
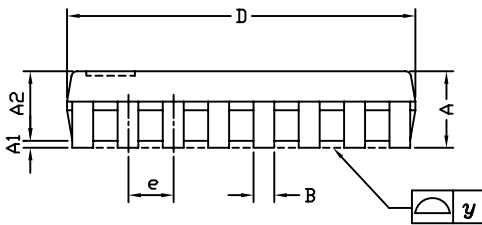
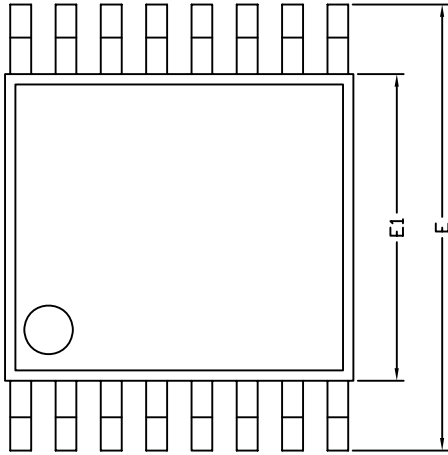


Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A ₁	0.10	0.20	0.004	0.008
B	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	9.80	10.00	0.385	0.393
E	3.80	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
∅	0°	8°	0°	8°

ECN: S-03946—Rev. F, 09-Jul-01
DWG: 5300



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
theta1	0°	3°	6°

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

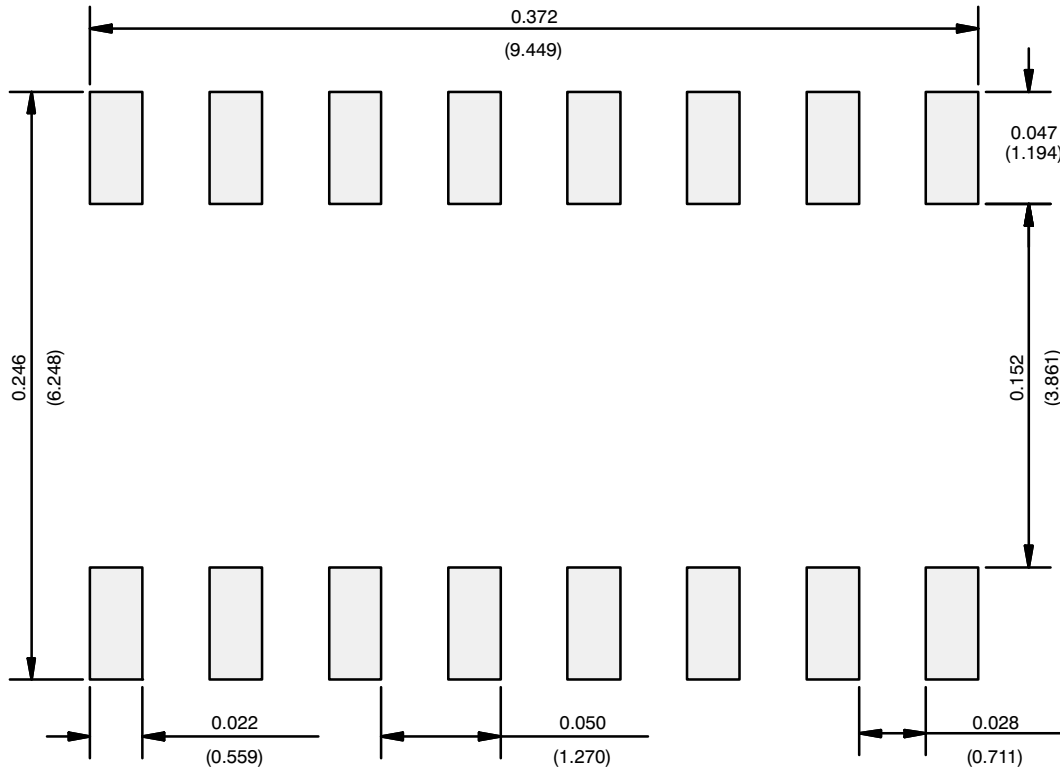


RECOMMENDED MINIMUM PAD FOR TSSOP-16



Recommended Minimum Pads
Dimensions in inches (mm)

RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads
Dimensions in Inches/(mm)

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