16 Ω, Low Parasitic Capacitance and Leakage, +12 V / +5 V / +3 V / ± 5 V Quad SPST Switches

DESCRIPTION

The DG411LE, DG412LE, and DG413LE are monolithic quad single-pole-single-throw analog switches. The DG411LE and DG412LE differ only in that they respond to opposite logic levels. The DG413LE has two normally open and two normally closed switches. It can be given various configurations, including four SPST, two SPDT, and one DPDT.

The DG411LE, DG412LE, and DG413LE offer low on resistance of 16 Ω, low parasitic capacitance of 15 pF switch on capacitance, and low charge injection over the signal swing range.

The DG411LE, DG412LE, and DG413LE operate on single and dual supplies. Single supply voltage ranges from 3 V to 16 V while dual supply operation is recommended with ± 3 V to ± 8 V. Each switch conducts equally well in both direction when on, and blocks input voltages up to the supply levels when off.

The DG411LE, DG412LE, and DG413LE are available in 16 lead TSSOP, SOIC, and PDIP packages.

FEATURES

- 3 V to 16 V single supply or ± 3 V to ± 8 V dual supply
- On-resistance $R_{DS(on)}$: 16 Ω
- Low parasitic capacitance:
  $C_{D(ON)}$: 15 pF
  $C_{S(OFF)}$: 5 pF
- Less than 8 pC charge injection over the full signal swing range
- Fast switching t_{ON}: 16 ns
  t_{OFF}: 9 ns
- TTL, CMOS compatible
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Note

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

BENEFITS

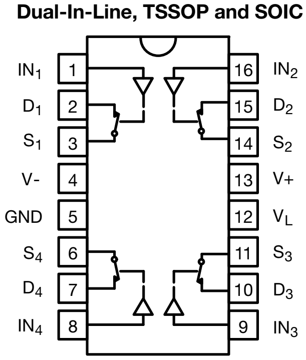
- Wide operation voltage range
- Low signal errors and distortion
- Fast switching time
- Minimized switching glitch

APPLICATIONS

- Automatic test equipment
- Data acquisition systems
- Meters and instruments
- Medical and healthcare systems
- Communication systems
- Audio and video signal routing
- Relay replacement
- Battery powered systems
- Computer peripherals
- Audio and video signal routing

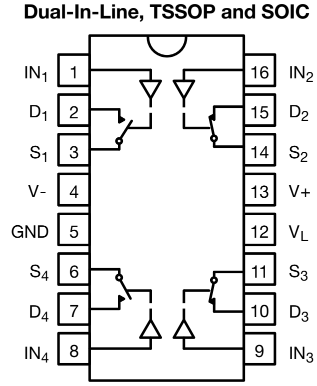
FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG411LE, DG412LE
Dual-In-Line, TSSOP and SOIC



Top View

DG413LE
Dual-In-Line, TSSOP and SOIC



Top View

TRUTH TABLE		
LOGIC	DG411LE	DG412LE
0	ON	OFF
1	OFF	ON

Logic "0" ≤ 0.8 V
Logic "1" ≥ 2.4 V

TRUTH TABLE		
LOGIC	SW_1, SW_4	SW_2, SW_3
0	OFF	ON
1	ON	OFF

Logic "0" ≤ 0.8 V
Logic "1" ≥ 2.4 V

ORDERING INFORMATION				
TEMP. RANGE	CONFIGURATION	PACKAGE	PART NUMBER	MIN. ORDER / PACK. QUANTITY
-40 °C to +85 °C Lead-free	DG411LE	16-pin TSSOP	DG411LEDQ-GE3	Tube 360 units
			DG411LEDQ-T1-GE3	Tape and reel, 3000 units
		16-pin SOIC	DG411LEDY-GE3	Tube 500 units
			DG411LEDY-T1-GE3	Tape and reel, 2500 units
		16-pin PDIP	DG411LEDJ-GE3	Tube 500 units
	DG412LE	16-pin TSSOP	DG412LEDQ-GE3	Tube 360 units
			DG412LEDQ-T1-GE3	Tape and reel, 3000 units
		16-pin SOIC	DG412LEDY-GE3	Tube 500 units
			DG412LEDY-T1-GE3	Tape and reel, 2500 units
		16-pin PDIP	DG412LEDJ-GE3	Tube 500 units
	DG413LE	16-pin TSSOP	DG413LEDQ-GE3	Tube 360 units
			DG413LEDQ-T1-GE3	Tape and reel, 3000 units
		16-pin SOIC	DG413LEDY-GE3	Tube 500 units
			DG413LEDY-T1-GE3	Tape and reel, 2500 units
		16-pin PDIP	DG413LEDJ-GE3	Tube 500 units

ABSOLUTE MAXIMUM RATINGS			
PARAMETER		LIMIT	UNIT
V+ to V-		-0.3 to +18	V
GND to V-		18	
V_L		(GND -0.3) to (V+) +0.3	
I_N [a], V_S, V_D		-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	(DQ, DY suffix)	-65 to +125	°C
	(AK suffix)	-65 to +150	
Power Dissipation (Packages) [b]	16-pin TSSOP [c]	450	mW
	16-pin SOIC [d]	650	
	16-pin CerDIP [e]	900	
ESD Human Body Model (HBM); per ANSI / ESDA / JEDEC® JS-001		2500	V
Latch Up Current, per JESD78D		400	mA

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 7 mW/°C above 75 °C
d. Derate 7.6 mW/°C above 75 °C
e. Derate 12 mW/°C above 75 °C

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.

SPECIFICATIONS [a] (Single Supply 12 V)									
PARAMETER	**SYMBOL**	**TEST CONDITIONS UNLESS OTHERWISE SPECIFIED** V+ = 12 V, V- = 0 V V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]	**TEMP.** [b]	**TYP.** [c]	**A SUFFIX LIMITS** -55 °C to +125 °C		**D SUFFIX LIMITS** -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
Drain-Source On-Resistance	$R_{DS(on)}$	V+ = 10.8 V, V- = 0 V I_S = 10 mA, V_D = 2/9 V	Room	16	-	26	-	26	Ω
			Full	-	-	40	-	35	
Switch Off Leakage Current	$I_{S(off)}$	V_D = 1/11 V, V_S = 11/1 V	Room	-	-1	1	-1	1	nA
			Full	-	-15	15	-10	10	
	$I_{D(off)}$		Room	-	-1	1	-1	1	
			Full	-	-15	15	-10	10	
Channel On Leakage Current	$I_{D(on)}$	V_S = V_D = 11/1 V	Room	-	-1	1	-1	1	
			Full	-	-15	15	-10	10	
Digital Control									
Input Current, VIN Low	I_{IL}	V_{IN} under test = 0.8 V	Full	0.01	-1.5	1.5	-1	1	µA
Input Current, VIN High	I_{IH}	V_{IN} under test = 2.4 V	Full		-1.5	1.5	-1	1	
Dynamic Characteristics									
Turn-On Time	t_{ON}	R_L = 300 Ω, C_L = 35 pF, V_S = 5 V, see figure 2	Room	16	-	50	-	50	ns
			Full	-	-	70	-	60	
Turn-Off Time	t_{OFF}		Room	9	-	30	-	30	
			Full	-	-	48	-	40	
Break-Before-Make Time Delay	t_D	DG413L only, V_S = 5 V, R_L = 300 Ω, CL = 35 pF	Room	5	-	-	-	-	
Charge Injection [e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 10 nF	Room	6.6	-	-	-	-	pC
Off-Isolation [e]	OIRR	R_L = 50 Ω, C_L = 5 pF, f = 1 MHz	Room	68.4	-	-	-	-	dB
Channel-to-Channel Crosstalk [e]	X_{TALK}		Room	114	-	-	-	-	
Source Off Capacitance [e]	$C_{S(off)}$	f = 1 MHz	Room	5	-	-	-	-	pF
Drain Off Capacitance [e]	$C_{D(off)}$		Room	6	-	-	-	-	
Channel-On Capacitance [e]	$C_{D(on)}$		Room	15	-	-	-	-	
Power Supplies									
Positive Supply Current	I+	V_{IN} = 0 V or 5 V	Room	0.02	-	1	-	1	µA
			Full	-	-	7.5	-	5	
Negative Supply Current	I-		Room	-0.002	-1	-	-1	-	
			Full	-	-7.5	-	-5	-	
Logic Supply Current	I_L		Room	0.002	-	1	-	1	
			Full	-	-	7.5	-	5	
Ground Current	I_{GND}		Room	-0.002	-1	-	-1	-	
			Full	-	-7.5	-	-5	-	

Notes

a. Refer to PROCESS OPTION FLOWCHART
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 datasheet
e. Guaranteed by design, not subject to production test
f. V_{IN} = input voltage to perform proper function
g. Leakage parameters are guaranteed by worst case test conditions and not subject to test

SPECIFICATIONS [a] (Dual Supply ± 5 V)									
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED $V+ = 5$ V, $V- = -5$ V $V_L = 5$ V, $V_{IN} = 2.4$ V, 0.8 V [f]	TEMP. [b]	TYP. [c]	A SUFFIX LIMITS -55 °C to +125 °C		D SUFFIX LIMITS -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
Drain-Source On-Resistance	$R_{DS(on)}$	$V+ = 5$ V, $V- = -5$ V, $I_S = 10$ mA, $V_D = \pm 3.5$ V	Room	18	-	30	-	30	Ω
			Full	-	-	42	-	37	
Switch Off Leakage Current [g]	$I_{S(off)}$	$V+ = 5.5$, $V- = -5.5$ V, $V_D = \pm 4.5$ V, $V_S = \pm 4.5$ V	Room	-	-1	1	-1	1	nA
			Full	-	-15	15	-10	10	
	$I_{D(off)}$		Room	-	-1	1	-1	1	
			Full	-	-15	15	-10	10	
Channel On Leakage Current [g]	$I_{D(on)}$	$V+ = 5.5$ V, $V- = -5.5$ V, $V_S = V_D = \pm 4.5$ V	Room	-	-1	1	-1	1	
			Full	-	-15	15	-10	10	
Digital Control									
Input Current, V_{IN} Low [e]	I_{IL}	V_{IN} under test = 0.8 V	Full	0.05	-1.5	1.5	-1	1	µA
Input Current, V_{IN} High [e]	I_{IH}	V_{IN} under test = 2.4 V	Full	0.05	-1.5	1.5	-1	1	
Dynamic Characteristics									
Turn-On Time [e]	t_{ON}	$R_L = 300\ \Omega$, $C_L = 35$ pF, $V_S = \pm 3.5$ V, see figure 2	Room	17	-	50	-	50	ns
			Full	-	-	70	-	60	
Turn-Off Time [e]	t_{OFF}		Room	12	-	35	-	35	
			Full	-	-	50	-	40	
Break-Before-Make Time Delay [e]	t_D	DG413L only, $V_S = 3.5$ V, $R_L = 300\ \Omega$, $C_L = 35$ pF	Room	5	-	-	-	-	
Charge Injection [e]	Q	$V_g = 0$ V, $R_g = 0\ \Omega$, $C_L = 10$ nF	Room	5.8	-	-	-	-	pC
Off Isolation [e]	OIRR	$R_L = 50\ \Omega$, $C_L = 5$ pF, f = 1 MHz	Room	68	-	-	-	-	dB
Channel-to-Channel Crosstalk [e]	X_{TALK}		Room	113	-	-	-	-	
Source Off Capacitance [e]	$C_{S(off)}$	f = 1 MHz	Room	5	-	-	-	-	pF
Drain Off Capacitance [e]	$C_{D(off)}$		Room	6	-	-	-	-	
Channel On Capacitance [e]	$C_{D(on)}$		Room	14	-	-	-	-	
Power Supplies									
Positive Supply Current [e]	I+	$V_{IN} = 0$ V or 5 V	Room	0.03	-	1	-	1	µA
			Full	-	-	7.5	-	5	
Negative Supply Current [e]	I-		Room	-0.002	-1	-	-1	-	
			Full	-	-7.5	-	-5	-	
Logic Supply Current [e]	I_L		Room	0.002	-	1	-	1	
			Full	-	-	7.5	-	5	
Ground Current [e]	I_{GND}		Room	-0.002	-1	-	-1	-	
			Full	-	-7.5	-	-5	-	

Notes

a. Refer to PROCESS OPTION FLOWCHART
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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 datasheet
e. Guaranteed by design, not subject to production test
f. V_{IN} = input voltage to perform proper function
g. Leakage parameters are guaranteed by worst case test conditions and not subject to test

For technical questions, contact: analogswitchsupport@vishay.com

SPECIFICATIONS [a] (Single Supply 5 V)									
PARAMETER	SYMBOL	TEST CONDITIONS UNLESS OTHERWISE SPECIFIED V+ = 5 V, V- = 0 V V_L = 5 V, V_{IN} = 2.4 V, 0.8 V [f]	TEMP. [b]	TYP. [c]	A SUFFIX LIMITS -55 °C to +125 °C		D SUFFIX LIMITS -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	V
Drain-Source On-Resistance [e]	$R_{DS(on)}$	V+ = 4.5 V, I_S = 5 mA, V_D = 1 V, 3.5 V	Room	36	-	50	-	50	Ω
			Full	-	-	88	-	75	
Dynamic Characteristics									
Turn-On Time [e]	t_{ON}	R_L = 300 Ω, C_L = 35 pF, V_S = 3.5 V, see figure 2	Room	27	-	50	-	50	ns
			Hot	-	-	90	-	60	
Turn-Off Time [e]	t_{OFF}		Room	15	-	30	-	30	
			Hot	-	-	55	-	40	
Break-Before-Make Time Delay [e]	t_D	DG413L only, V_S = 3.5 V, R_L = 300 Ω, C_L = 35 pF	Room	11	-	-	-	-	
Charge Injection [e]	Q	V_g = 0 V, R_g = 0 Ω, C_L = 10 nF	Room	3.3	-	-	-	-	pC
Power Supplies									
Positive Supply Current [e]	I+	V_{IN} = 0 V or 5 V	Room	0.02	-	1	-	1	µA
			Hot	-	-	7.5	-	5	
Negative Supply Current [e]	I-		Room	-0.002	-1	-	-1	-	
			Hot	-	-7.5	-	-5	-	
Logic Supply Current [e]	I_L		Room	0.002	-	1	-	1	
			Hot	-	-	7.5	-	5	
Ground Current [e]	I_{GND}		Room	-0.002	-1	-	-1	-	
			Hot	-	-7.5	-	-5	-	

Notes

a. Refer to PROCESS OPTION FLOWCHART
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e. Guaranteed by design, not subject to production test
f. V_{IN} = input voltage to perform proper function
g. Leakage parameters are guaranteed by worst case test conditions and not subject to test

SPECIFICATIONS [a] (Single Supply 3 V)										
PARAMETER	**SYMBOL**	**TEST CONDITIONS UNLESS OTHERWISE SPECIFIED** $V+ = 3$ V, $V- = 0$ V $V_L = 3$ V, $V_{IN} = 0.4$ V, 2.0 V [f]	**TEMP.** [b]	**TYP.** [c]	**A SUFFIX LIMITS** -55 °C to +125 °C		**D SUFFIX LIMITS** -40 °C to +85 °C		**UNIT**
					MIN. [d]	**MAX.** [d]	**MIN.** [d]	**MAX.** [d]	
Analog Switch									
Analog Signal Range [e]	V_{ANALOG}		Full	-	0	3	0	3	V
Drain-Source On-Resistance	$R_{DS(on)}$	$V+ = 2.7$ V, $V- = 0$ V, $I_S = 5$ mA, $V_D = 0.5$, 2.2 V	Room	106	-	130	-	130	Ω
			Full	-	-	150	-	140	
Switch Off Leakage Current [g]	$I_{S(off)}$	$V+ = 3.3$, $V- = 0$ V, $V_D = 1$, 2 V, $V_S = 2$, 1 V	Room	-	-1	1	-1	1	nA
			Full	-	-15	15	-10	10	
	$I_{D(off)}$		Room	-	-1	1	-1	1	
			Full	-	-15	15	-10	10	
Channel On Leakage Current [g]	$I_{D(on)}$	$V+ = 3.3$ V, $V- = 0$ V, $V_S = V_D = 1$, 2 V	Room	-	-1	1	-1	1	
			Full	-	-15	15	-10	10	
Digital Control									
Input Current, V_{IN} Low	I_{IL}	V_{IN} under test = 0.4 V	Full	0.005	-1.5	1.5	-1	1	µA
Input Current, V_{IN} High	I_{IH}	V_{IN} under test = 2.4 V	Full	0.005	-1.5	1.5	-1	1	
Dynamic Characteristics									
Turn-On Time	t_{ON}	$R_L = 300$ Ω, $C_L = 35$ pF, $V_S = 1.5$ V, see figure 2	Room	57	-	85	-	85	ns
			Full	-	-	150	-	110	
Turn-Off Time	t_{OFF}		Room	25	-	60	-	60	
			Full	-	-	100	-	85	
Break-Before-Make Time Delay	t_D	DG413L only, $V_S = 1.5$ V, $R_L = 300$ Ω, $C_L = 35$ pF	Room	24	-	-	-	-	
Charge Injection [e]	Q	$V_g = 0$ V, $R_g = 0$ Ω, $C_L = 10$ nF	Room	2	-	-	-	-	pC
Off Isolation [e]	OIRR	$R_L = 50$ Ω, $C_L = 5$ pF, f = 1 MHz	Room	68	-	-	-	-	dB
Channel-to-Channel Crosstalk [e]	X_{TALK}		Room	107	-	-	-	-	
Source Off Capacitance [e]	$C_{S(off)}$	f = 1 MHz	Room	6	-	-	-	-	pF
Drain Off Capacitance [e]	$C_{D(off)}$		Room	7	-	-	-	-	
Channel On Capacitance [e]	$C_{D(on)}$		Room	15	-	-	-	-	

Notes

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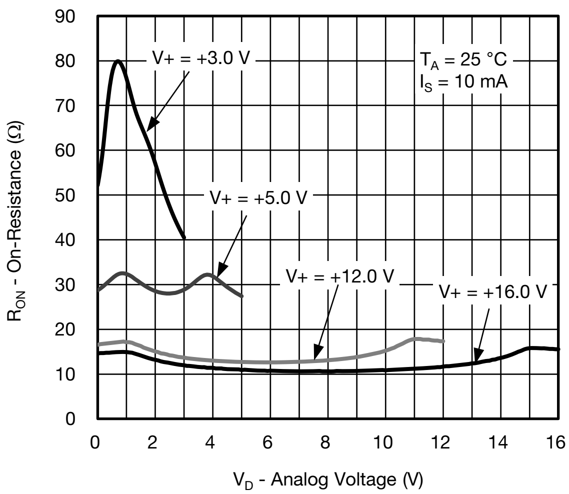
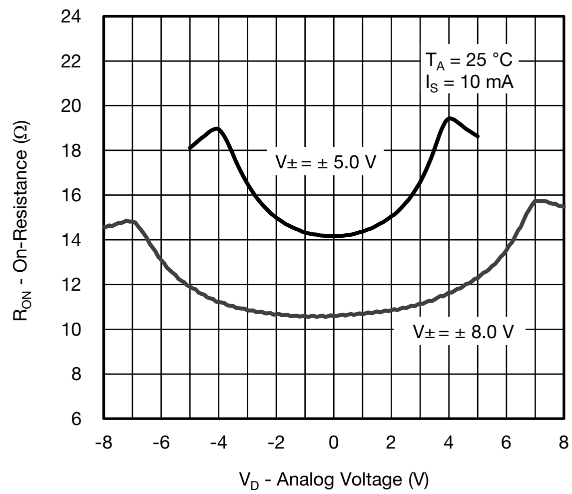
d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this datasheet
e. Guaranteed by design, not subject to production test
f. V_{IN} = input voltage to perform proper function
g. Leakage parameters are guaranteed by worst case test conditions and not subject to test

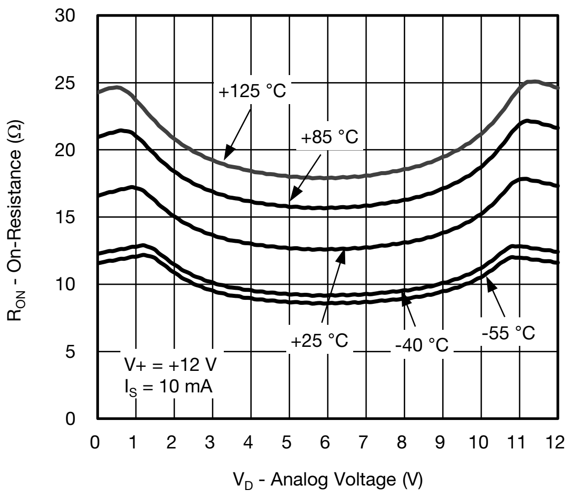
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



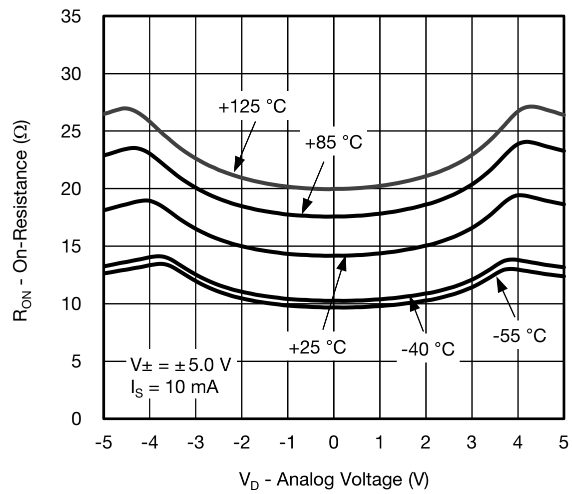
$R_{DS(on)}$ vs. Drain Voltage (Single Supply)



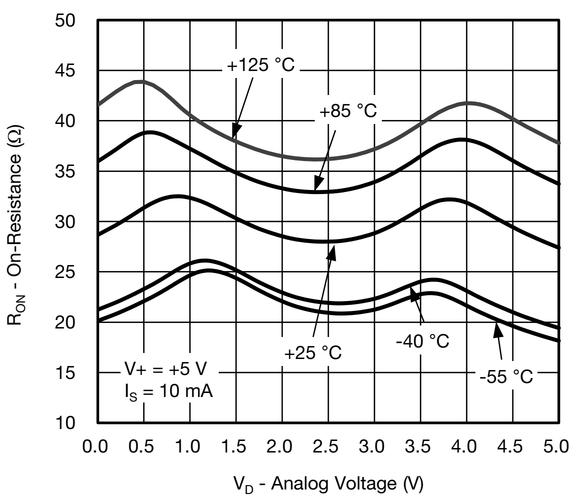
$R_{DS(on)}$ vs. Drain Voltage and Temperature (Single Supply)



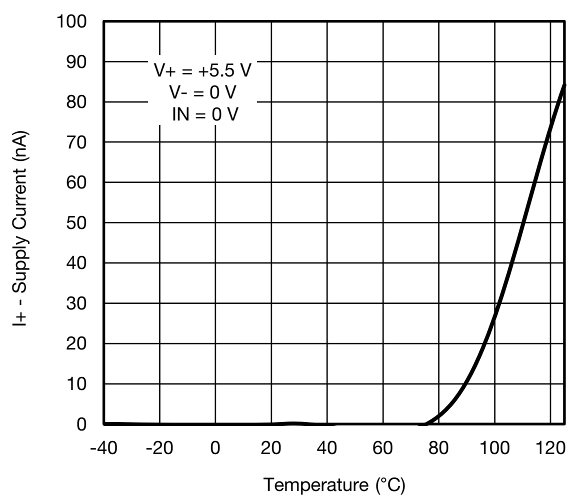
$R_{DS(on)}$ vs. Drain Voltage and Temperature



Supply Current vs. Temperature

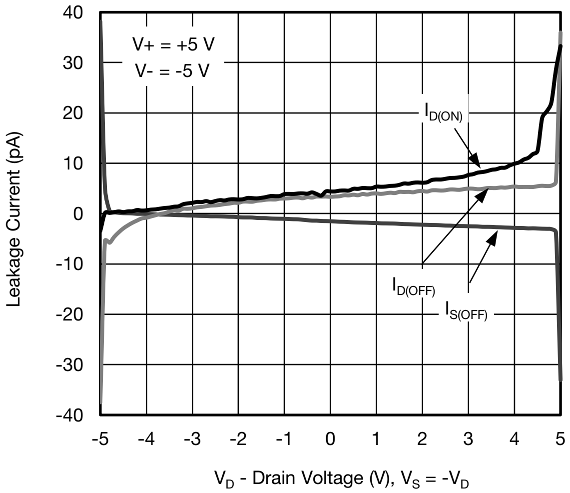


$R_{DS(on)}$ vs. Drain Voltage and Temperature

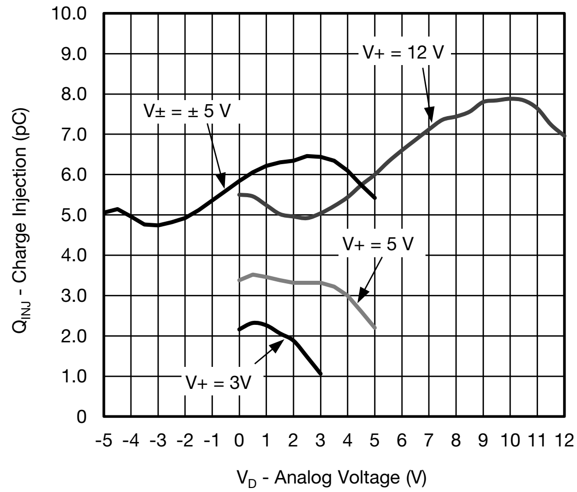


Switching Time vs. Single Supply

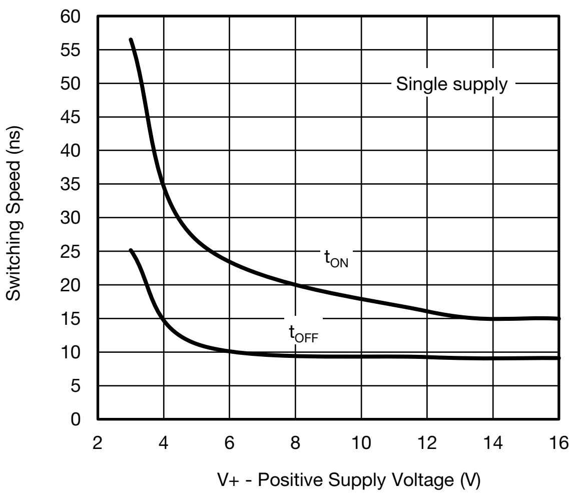
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



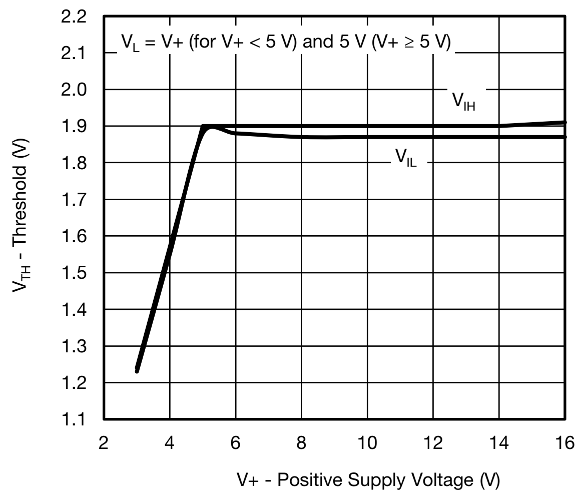
Leakage Current vs. Drain Voltage



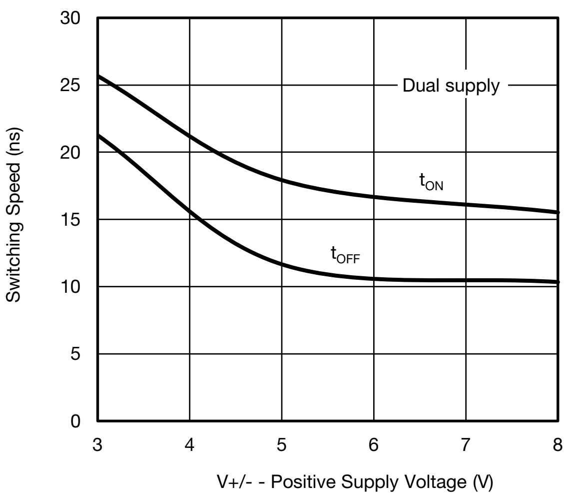
Charge Injection vs. Drain Voltage



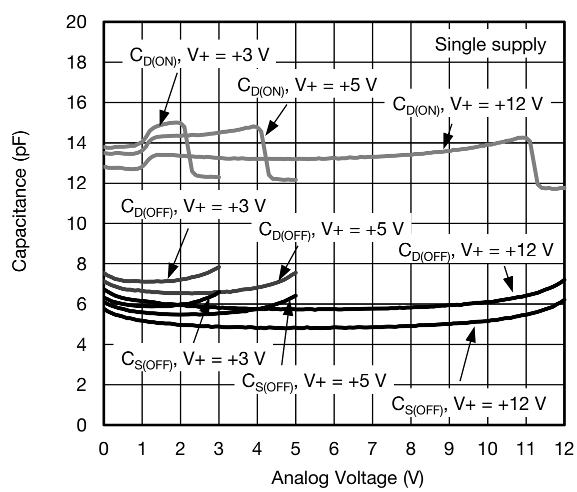
Switching Time vs. Single Supply Voltage



Threshold vs. Single Supply Current

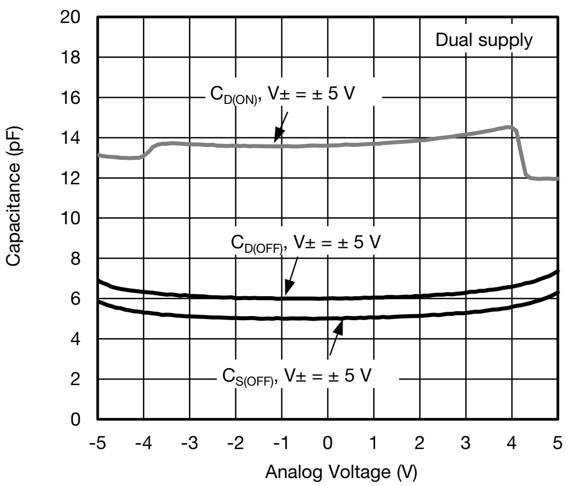


Switching Time vs. Dual Supply Voltage

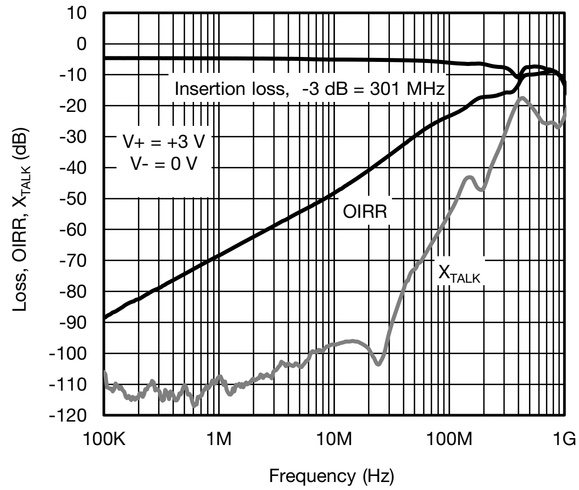


Drain Capacitance vs. Drain Voltage (Single Supply)

TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



Drain Capacitance vs. Drain Voltage (Dual Supply)



Insertion Loss, Off Isolation and Crosstalk vs. Frequency

SCHEMATIC DIAGRAM (Typical Channel)

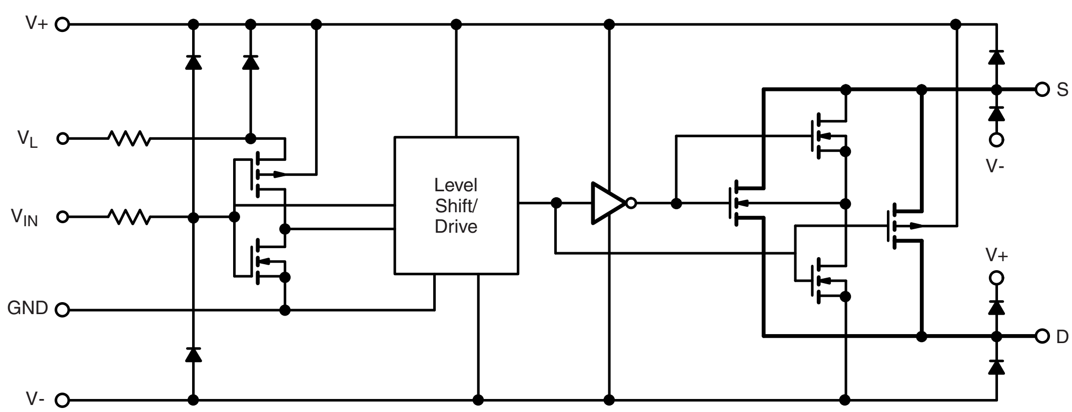


Fig. 1

TEST CIRCUITS

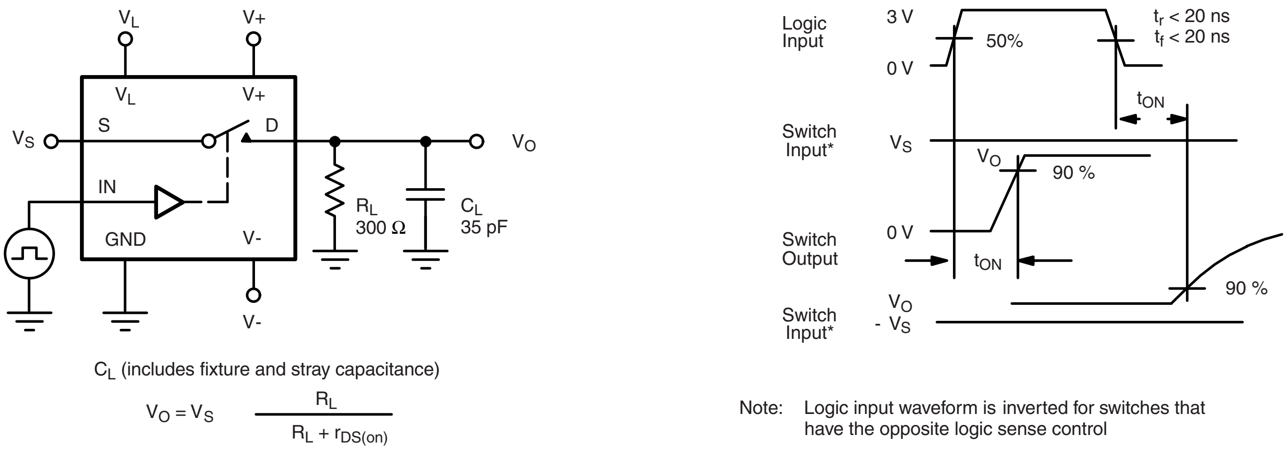


Fig. 2 - Switching Time

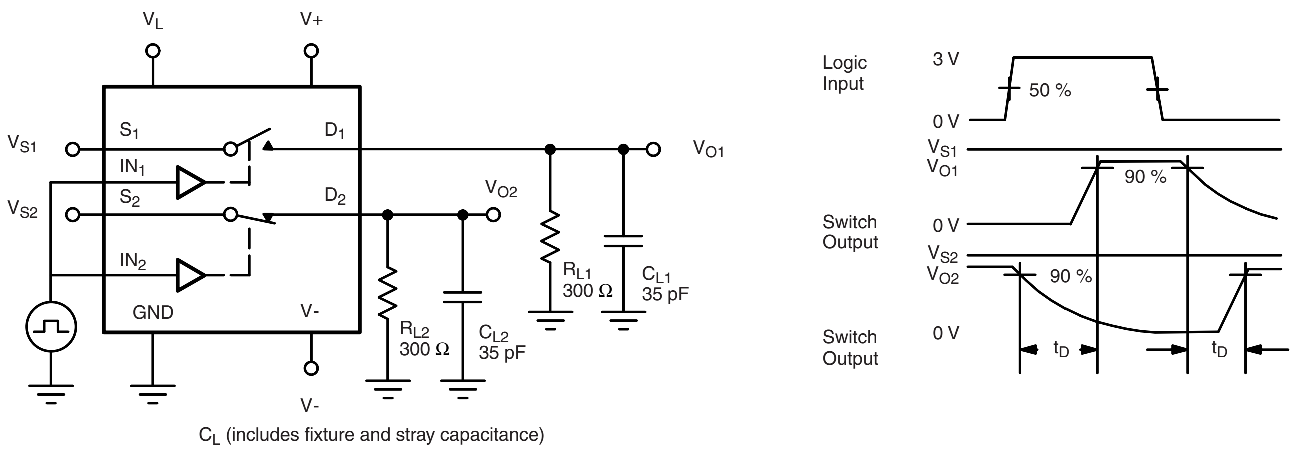


Fig. 3 - Break-Before-Make (DG413LE)

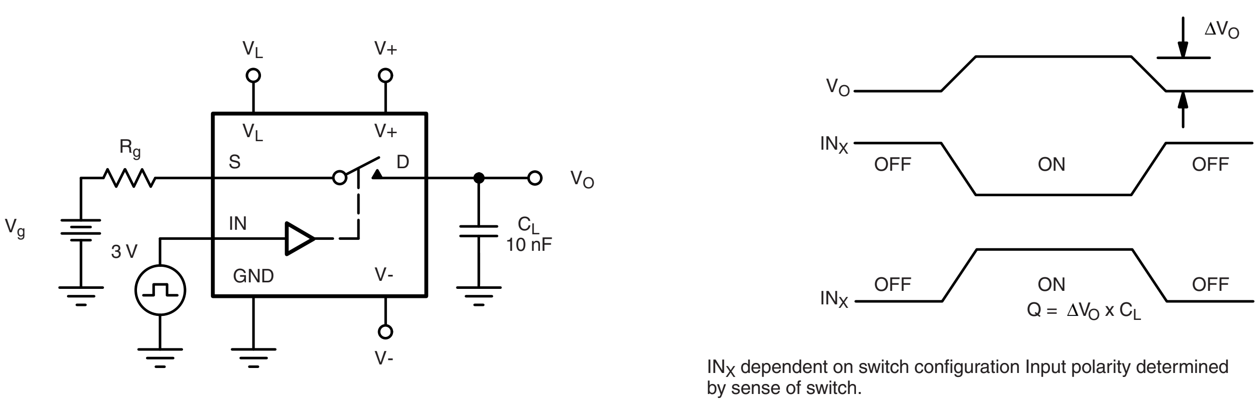


Fig. 4 - Charge Injection

TEST CIRCUITS

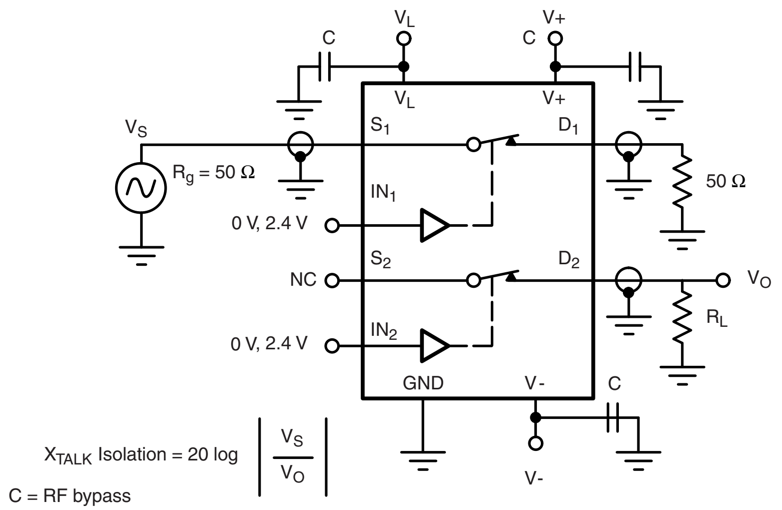


Fig. 5 - Crosstalk

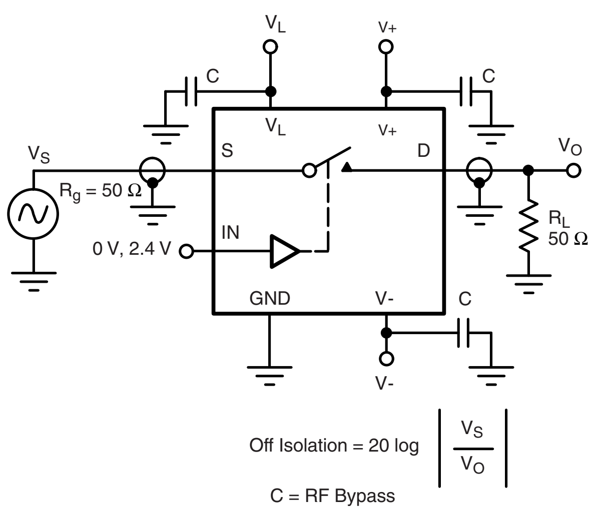


Fig. 6 - Off-Isolation

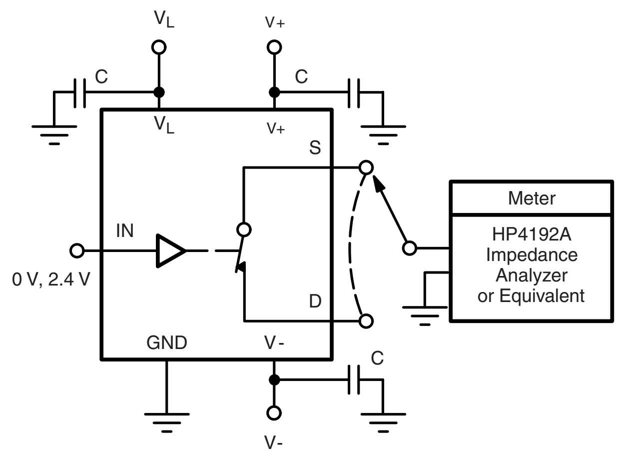
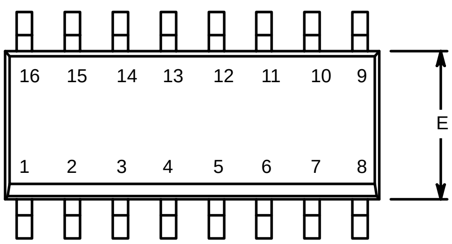


Fig. 7 - Source / Drain Capacitances

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?78091.

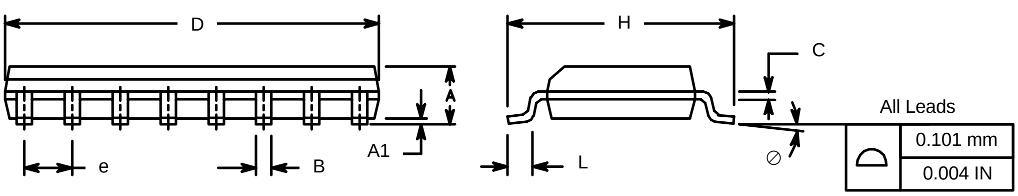
SOIC (NARROW): 16-LEAD

JEDEC Part Number: MS-012

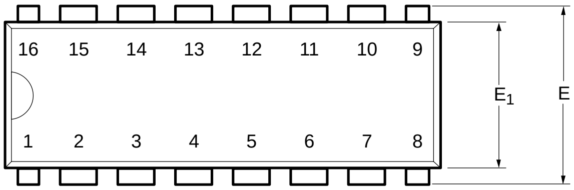


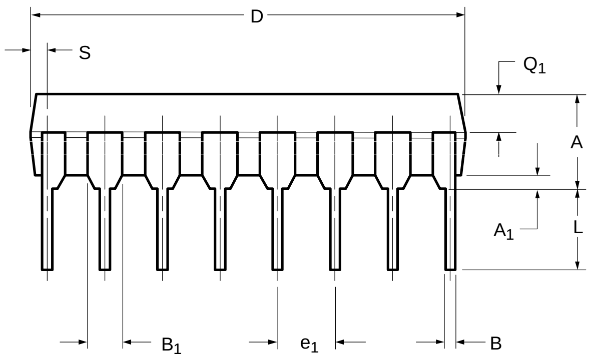
Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	1.35	1.75	0.053	0.069
A_1	0.10	0.20	0.004	0.008
B	0.38	0.51	0.015	0.020
C	0.18	0.23	0.007	0.009
D	9.80	10.00	0.385	0.393
E	3.80	4.00	0.149	0.157
e	1.27 BSC		0.050 BSC	
H	5.80	6.20	0.228	0.244
L	0.50	0.93	0.020	0.037
∅	0°	8°	0°	8°

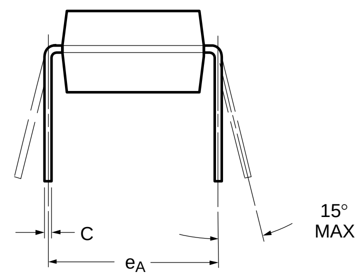
ECN: S-03946—Rev. F, 09-Jul-01
DWG: 5300



PDIP: 16-LEAD

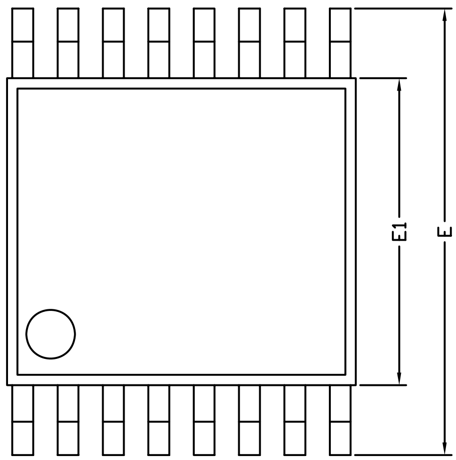


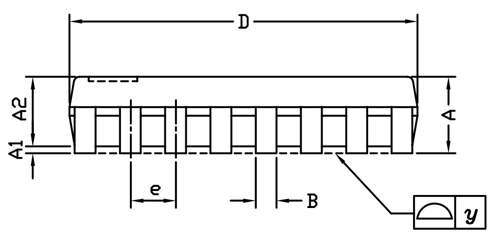


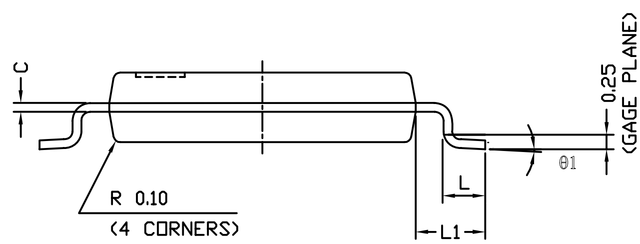


Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	3.81	5.08	0.150	0.200
A_1	0.38	1.27	0.015	0.050
B	0.38	0.51	0.015	0.020
B_1	0.89	1.65	0.035	0.065
C	0.20	0.30	0.008	0.012
D	18.93	21.33	0.745	0.840
E	7.62	8.26	0.300	0.325
E_1	5.59	7.11	0.220	0.280
e_1	2.29	2.79	0.090	0.110
e_A	7.37	7.87	0.290	0.310
L	2.79	3.81	0.110	0.150
Q_1	1.27	2.03	0.050	0.080
S	0.38	1.52	.015	0.060
ECN: S-03946—Rev. D, 09-Jul-01 DWG: 5482				

TSSOP: 16-LEAD

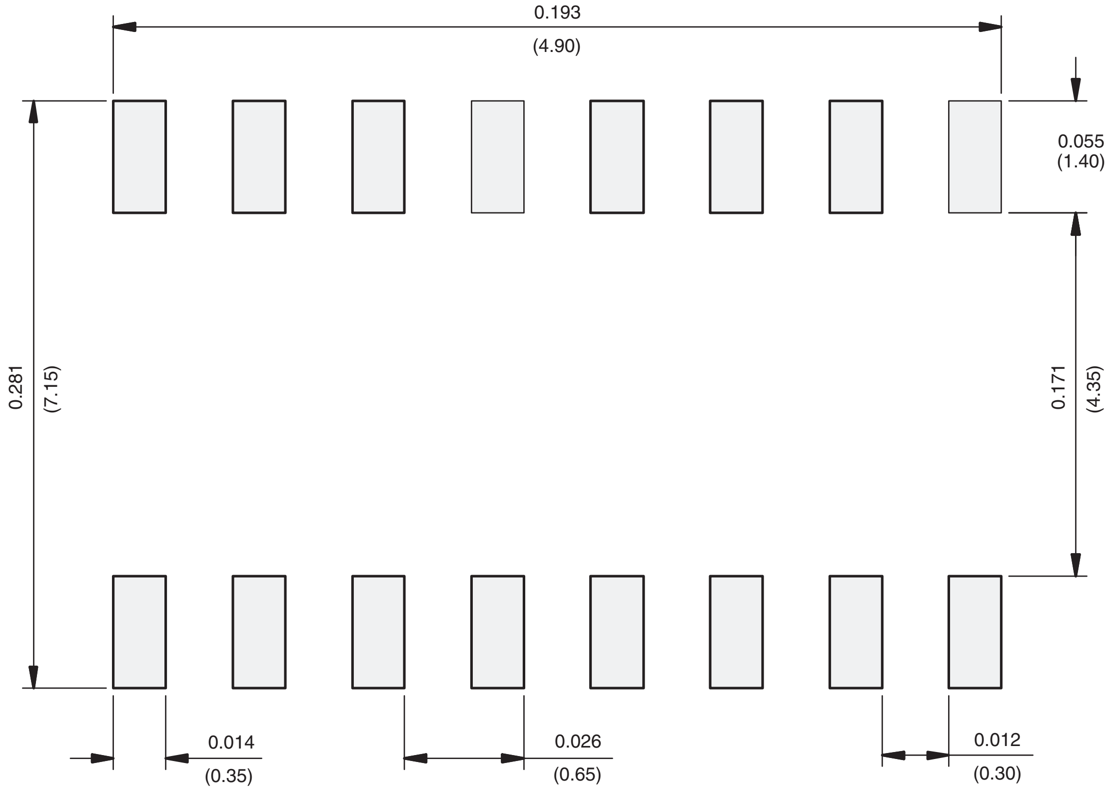






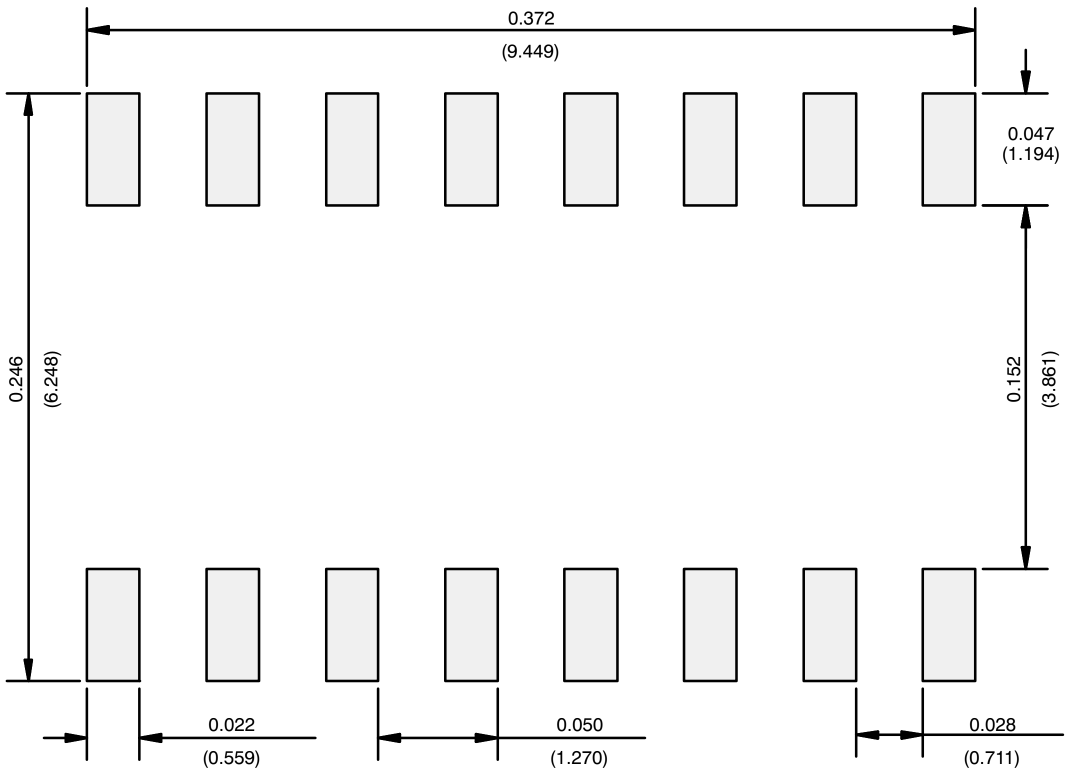
Symbols	DIMENSIONS IN MILLIMETERS		
	Min	Nom	Max
A	-	1.10	1.20
A1	0.05	0.10	0.15
A2	-	1.00	1.05
B	0.22	0.28	0.38
C	-	0.127	-
D	4.90	5.00	5.10
E	6.10	6.40	6.70
E1	4.30	4.40	4.50
e	-	0.65	-
L	0.50	0.60	0.70
L1	0.90	1.00	1.10
y	-	-	0.10
$\theta 1$	0°	3°	6°
ECN: S-61920-Rev. D, 23-Oct-06 DWG: 5624			

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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