# Quad Complementary CMOS Analog Switch

## DESCRIPTION

The versatile DG213 analog switch has two NC and two NO switches. It can be used in various configurations, including four single-pole single-throw (SPST), two single-pole double-throw (SPDT), one “T” switch, one DPDT, etc. This device is fabricated in a Vishay Siliconix’ proprietary high-voltage silicon gate CMOS process, resulting in lower on-resistance, lower leakage, higher speed, and lower power consumption.

This analog switch was designed for a wide variety of general purpose applications in telecommunications, instrumentation, process control, computer peripherals, etc. An improved charge injection compensation design minimizes switching transients. These switches can handle up to ± 22 V, and have an improved continuous current rating of 30 mA. An epitaxial layer prevents latchup.

All switches feature true bi-directional performance in the on condition, and will block signals to the supply levels in the off condition.

For additional information, please refer to Application Note AN208 (FaxBack document #70606).

## FEATURES

- ± 22 V supply voltage rating
- TTL and CMOS compatible logic
- Low on-resistance - $r_{DS(on)}$: 45 Ω
- Low leakage - $I_{D(on)}$: 20 pA
- Single supply operation possible
- Extended temperature range
- Fast switching - $t_{ON}$: 85 ns

Pb-free Available

RoHS* COMPLIANT

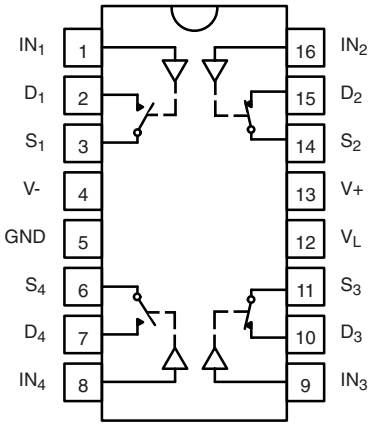
## BENEFITS

- Low charge injection - Q: 1 pC
- Wide analog signal range
- Simple logic interface
- Higher accuracy
- Minimum transients
- Reduced power consumption
- Low cost

## APPLICATIONS

- Industrial instrumentation
- Test equipment
- Communications systems
- Computer peripherals
- Portable instruments
- Sample-and-hold circuits

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Top View

| 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

* Pb containing terminations are not RoHS compliant, exemptions may apply.

| ORDERING INFORMATION | | | |
|---|---|---|---|
| **Temp. Range** | **Package** | **Standard Part Number** | **Lead (Pb)-free Part Number** |
| - 40 °C to 85 °C | 16-Pin Plastic DIP | DG213DJ | DG213DJ-E3 |
| | 16-Pin Narrow SOIC | DG213DY<br>DG213DY-T1 | DG213DY-E3<br>DG213DY-T1-E3 |
| | 16-Pin TSSOP | DG213DQ<br>DG213DQ-T1 | DG213DQ-E3<br>DG213DQ-T1-E3 |

| **ABSOLUTE MAXIMUM RATINGS** $T_A$ = 25 °C, unless otherwise noted | | | |
|---|---|---|---|
| **Parameter** | | **Limit** | **Unit** |
| Voltages Referenced V+ to V- | | 44 | V |
| GND | | 25 | |
| Digital Inputs[a] $V_S$, $V_D$ | | (V-) - 2 to (V+) + 2<br>or 30 mA, whichever occurs first | |
| Current, Any Terminal | | 30 | mA |
| Peak Current (Pulsed at 1 ms, 10 % duty cycle max.) | | 100 | |
| Storage Temperature | | - 65 to 125 | °C |
| Power Dissipation[b] | 16-Pin Plastic DIP[c] | 470 | mW |
| | 16-Pin Narrow SOIC[d] | 640 | |
| | 16-Pin TSSOP[d] | 500 | |

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 6.5 mW/°C above 75 °C.
d. Derate 7.6 mW/°C above 75 °C.

## SPECIFICATIONS

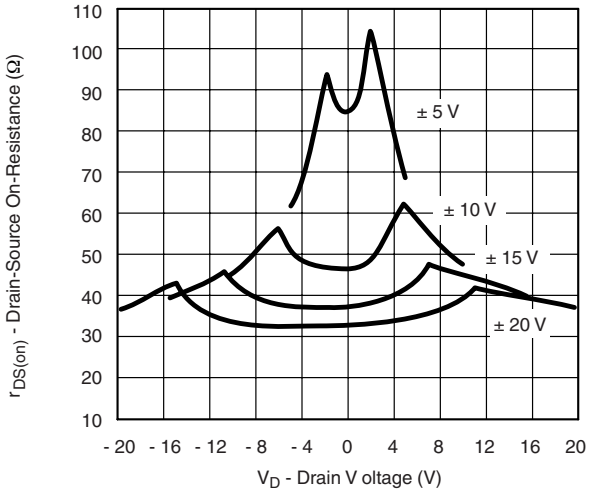
| Parameter | Symbol | Test Conditions Unless Otherwise Specified V+ = 15 V, V- = - 15 V, $V_L$ = 5 V, $V_{IN}$ = 2.4 V, 0.8 V[e] | Temp.[a] | D Suffix - 40 °C to 85 °C Min.[c] | Typ.[b] | Max.[c] | Unit |
|---|---|---|---|---|---|---|---|
| **Analog Switch** | | | | | | | |
| Analog Signal Range[d] | $V_{ANALOG}$ | | Full | V- | | V+ | V |
| Drain-Source On-Resistance | $r_{DS(on)}$ | $V_D$ = ± 10 V, $I_S$ = 1 mA | Room<br>Full | | 45 | 60<br>85 | Ω |
| $r_{DS(on)}$ Match | $\Delta r_{DS(on)}$ | | Room | | 1 | 2 | |
| Source Off Leakage Current | $I_{S(off)}$ | $V_S$ = ± 14 V, $V_D$ = ± 14 V | Room<br>Full | - 0.5<br>- 5 | ± 0.01 | 0.5<br>5 | nA |
| Drain Off Leakage Current | $I_{D(off)}$ | $V_D$ = ± 14 V, $V_S$ = ± 14 V | Room<br>Full | - 0.5<br>- 5 | ± 0.01 | 0.5<br>5 | |
| Drain On Leakage Current[f] | $I_{D(on)}$ | $V_S$ = $V_D$ = 14 V | Room<br>Full | - 0.5<br>- 10 | ± 0.02 | 0.5<br>10 | |
| **Digital Control** | | | | | | | |
| Input Voltage High | $V_{INH}$ | | Full | 2.4 | | | V |
| Input Voltage Low | $V_{INL}$ | | Full | | | 0.8 | |
| Input Current | $I_{INL}$ or $I_{INH}$ | $V_{INH}$ or $V_{INL}$ | Full | - 1 | | 1 | µA |
| Input Capacitance | $C_{IN}$ | | Room | | 5 | | pF |
| **Dynamic Characteristics** | | | | | | | |
| Turn-On Time | $t_{ON}$ | $V_S$ = 10 V<br>See Figure 2 | Room | | 85 | 130 | ns |
| Turn-Off Time | $t_{OFF}$ | | Room | | 55 | 100 | |
| Break-Before-Make Time Delay | $t_D$ | $V_S$ = 10 V, See Figure 3 | Room | 15 | 25 | | |
| Charge Injection | Q | $C_L$ = 1000 pF, $V_g$ = 0 V, $R_g$ = 0 Ω | Room | | 1 | | pC |
| Source-Off Capacitance | $C_{S(off)}$ | $V_S$ = 0 V, f = 1 MHz | Room | | 5 | | pF |
| Drain-Off Capacitance | $C_{D(off)}$ | | Room | | 5 | | |
| Channel On Capacitance | $C_{D(on)}$ | $V_D$ = $V_S$ = 0 V, f = 1 MHz | Room | | 16 | | |
| Off-Isolation | OIRR | $C_L$ = 15 pF, $R_L$ = 50 Ω<br>$V_S$ = 1 $V_{RMS}$, f = 100 kHz | Room | | 90 | | dB |
| Channel-to-Channel Crosstalk | $X_{TALK}$ | | Room | | 95 | | |
| **Power Supply** | | | | | | | |
| Positive Supply Current | I+ | $V_{IN}$ = 0 or 5 V | Room<br>Full | | | 1<br>5 | µA |
| Negative Supply Current | I- | | Room<br>Full | - 1<br>- 5 | | | |
| Logic Supply Current | $I_L$ | | Room<br>Full | | | 1<br>5 | |
| Power Supply Range for Continuous Operation | $V_{OP}$ | | Full | ± 3 | | ± 22 | V |

| **SPECIFICATIONS** for Unipolar Supply | | | | | | | |
|---|---|---|---|---|---|---|---|
| **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[e] | **Temp.[a]** | **D Suffix** - 40 °C to 85 °C **Min.[c]** | **Typ.[b]** | **Max.[c]** | **Unit** |
| **Analog Switch** | | | | | | | |
| Analog Signal Range[d] | $V_{ANALOG}$ | | Full | V- | | V+ | V |
| Drain-Source On-Resistance | $r_{DS(on)}$ | $V_D$ = 3 V, $I_S$ = 1 mA | Room<br>Full | | 90 | 110<br>140 | Ω |
| **Dynamic Characteristics** | | | | | | | |
| Turn-On Time | $t_{ON}$ | See Figure 2 | Room | | 125 | 200 | ns |
| Turn-Off Time | $t_{OFF}$ | | Room | | 45 | 100 | |
| Break-Before-Make Time Delay | $t_D$ | $V_S$ = 8 V, See Figure 3 | Room | 50 | 80 | | |
| Charge Injection | Q | $C_L$ = 1 nF, $V_{gen}$ = 6 V, $R_{gen}$ = 0 Ω | Room | | 4 | | pC |
| **Power Supply** | | | | | | | |
| Positive Supply Current | I+ | $V_{IN}$ = 0 or 5 V | Room<br>Full | | | 1<br>5 | µA |
| Negative Supply Current | I- | | Room<br>Full | - 1<br>- 5 | | | |
| Logic Supply Current | $I_L$ | | Room<br>Full | | | 1<br>5 | |
| Power Supply Range for Continuous Operation | $V_{OP}$ | | Full | + 3 | | + 40 | V |

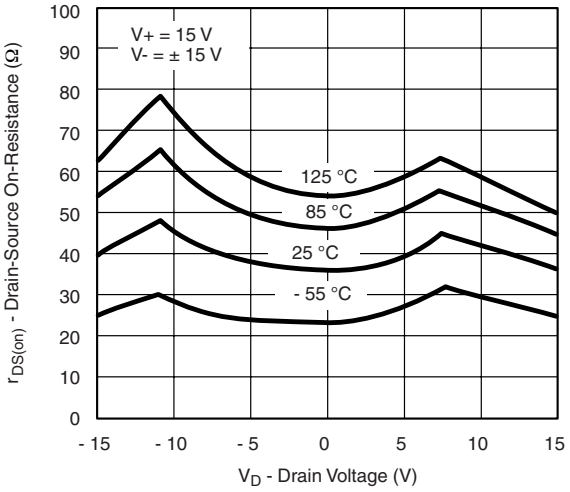
Notes:
a. Room = 25 °C, Full = as determined by the operating suffix.
b. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
c. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
d. Guarantee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

*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.*

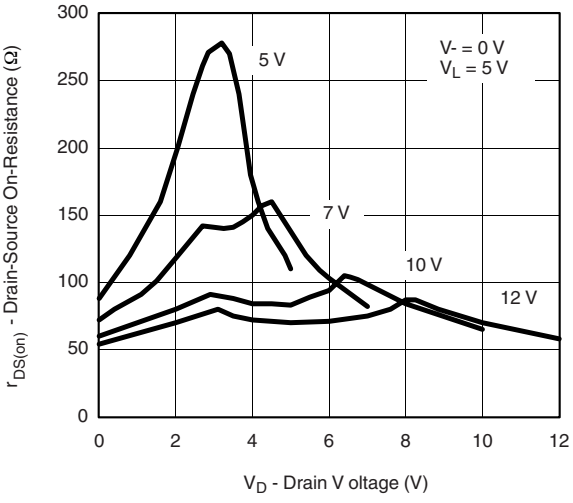
## TYPICAL CHARACTERISTICS $T_A$ = 25 °C, unless otherwise noted



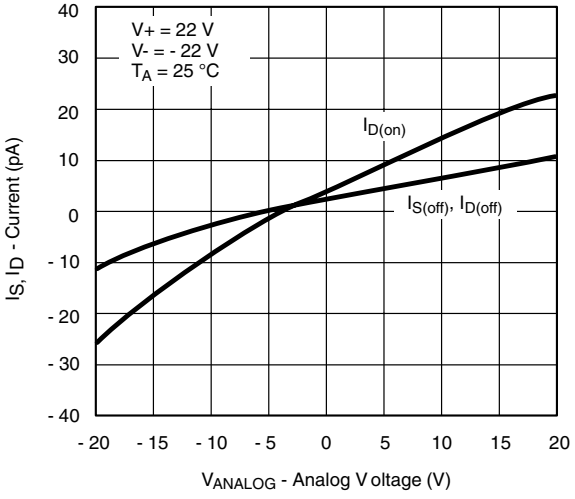

**$r_{DS(on)}$ vs. $V_D$ and Power Supply Voltages**



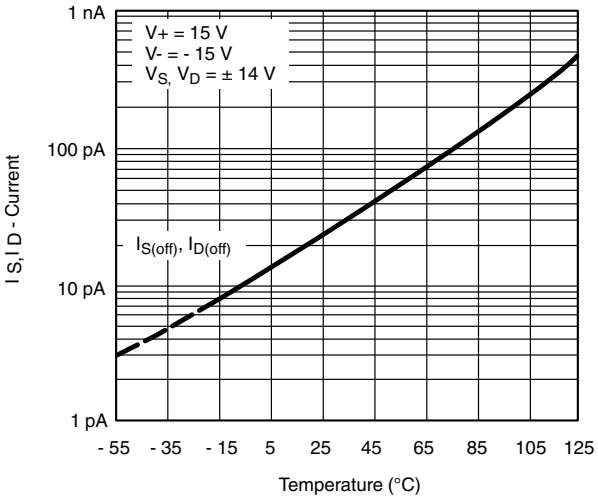

**$r_{DS(on)}$ vs. $V_D$ and Temperature**



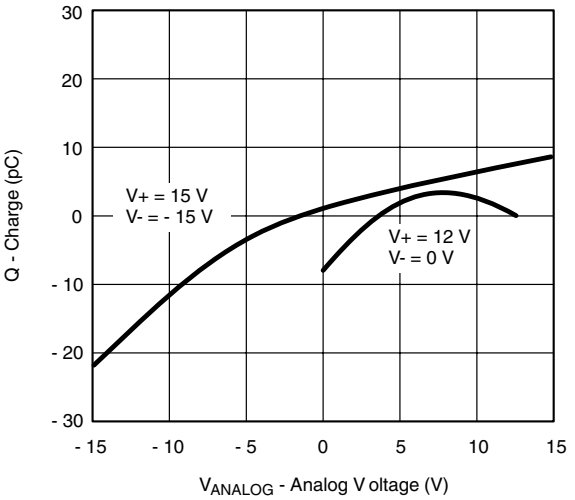

**$r_{DS(on)}$ vs. $V_D$ and Single Power Supply Voltages**




**Leakage Currents vs. Analog Voltage**

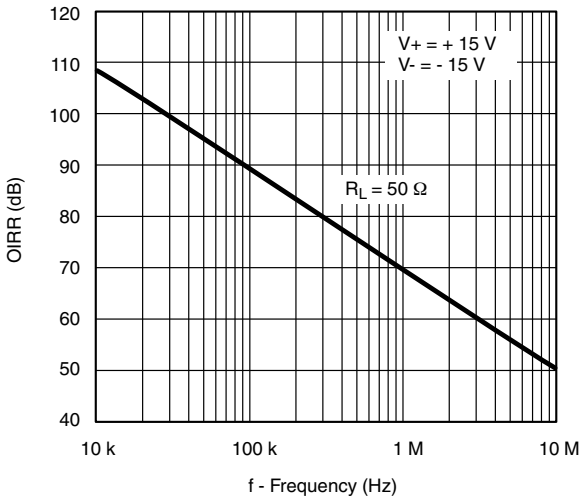



**Leakage Current vs. Temperature**




**$Q_S$, $Q_D$ - Charge Injection vs. Analog Voltage**

## TYPICAL CHARACTERISTICS $T_A$ = 25 °C, unless otherwise noted




**Off Isolation vs. Frequency**

## SCHEMATIC DIAGRAM Typical Channel

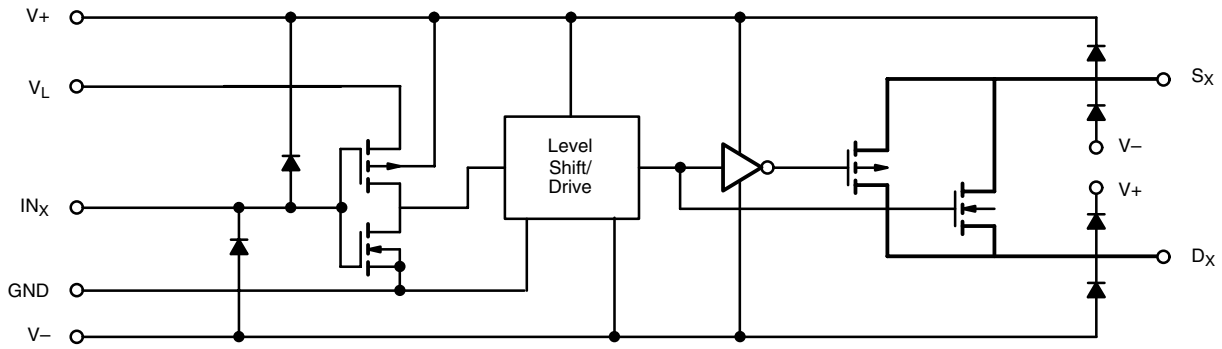



**Figure 1.**

## TEST CIRCUITS

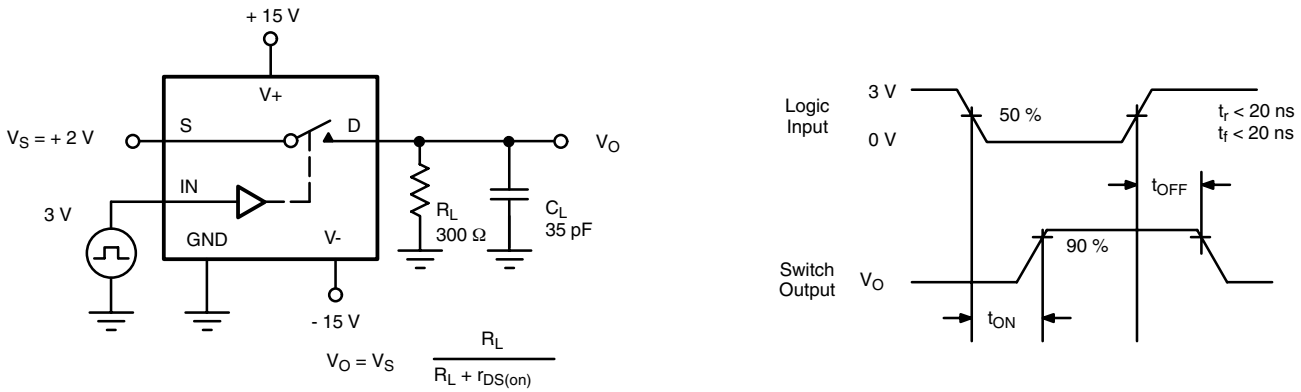
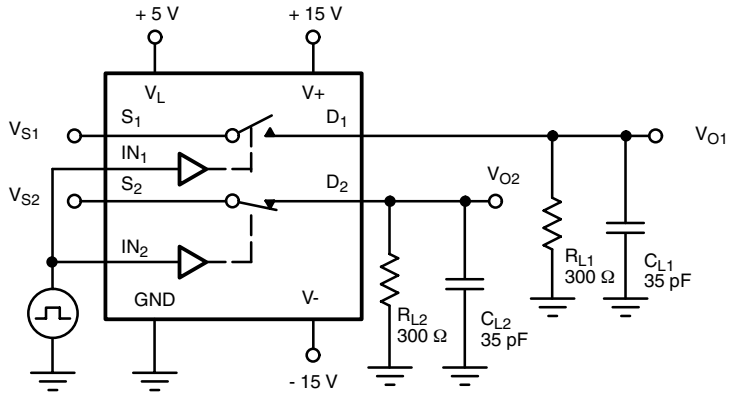



**Figure 2. Switching Time**

## TEST CIRCUITS




$C_L$ (includes fixture and stray capacitance)

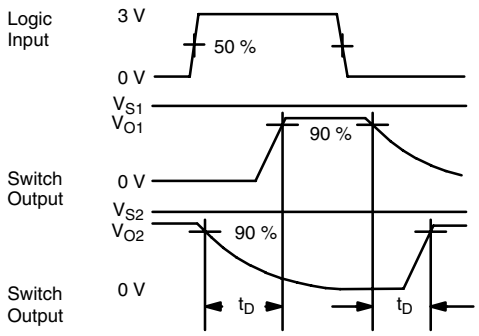



**Figure 3. Break-Before-Make**

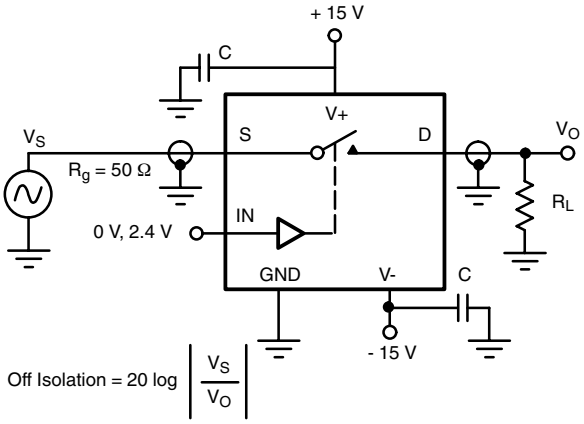



**Figure 4. Off Isolation**

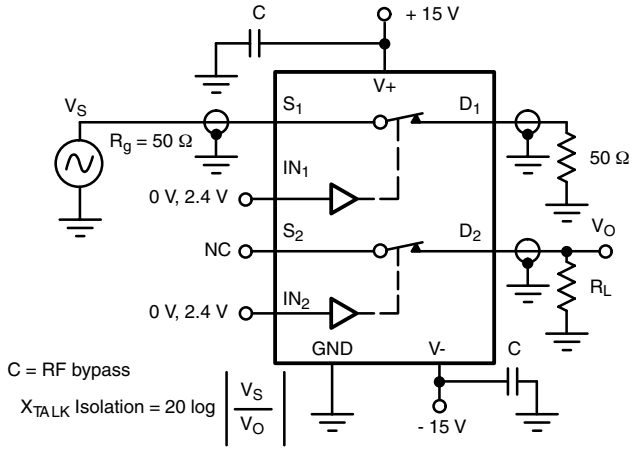
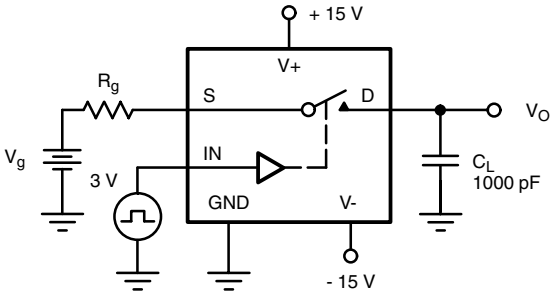
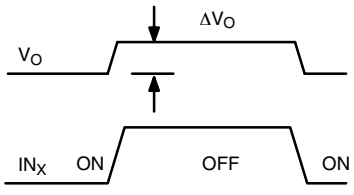



**Figure 5. Channel-to-Channel Crosstalk**




$\Delta V_O$ = measured voltage error due to charge injection
The charge injection in coulombs is $Q = C_L \times \Delta V_O$

**Figure 6. Charge Injection**

## APPLICATIONS

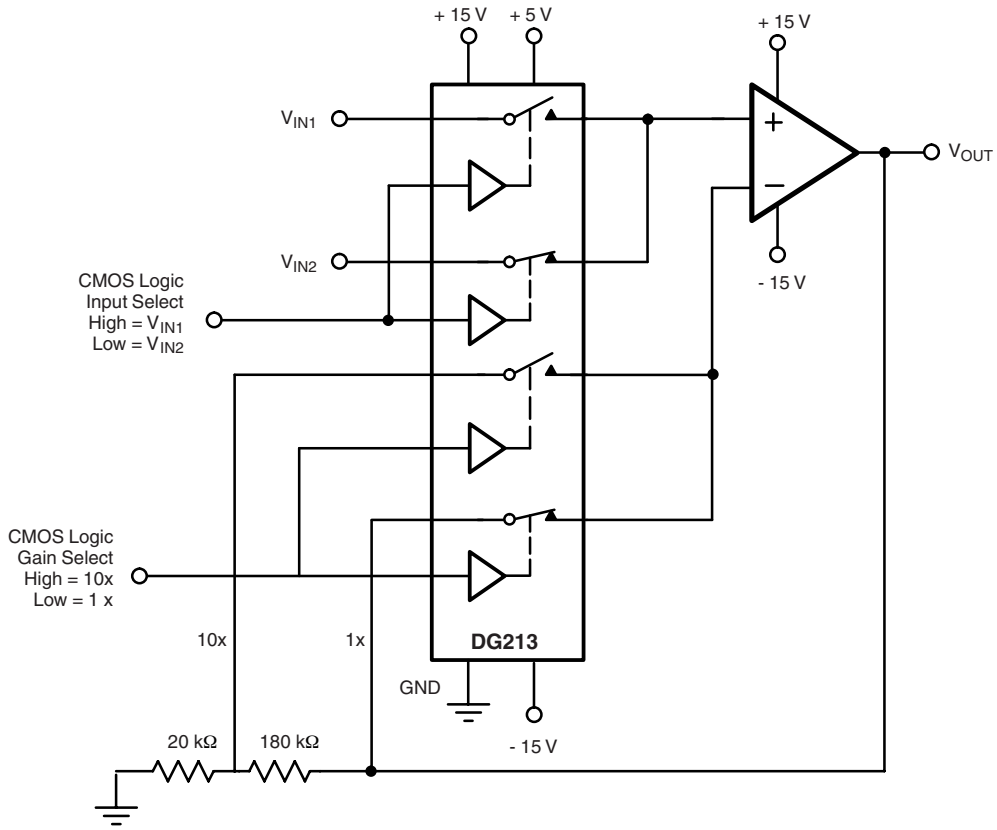



**Figure 7. Low Power Non-Inverting Amplifier with Digitally Selectable Inputs and Gain**

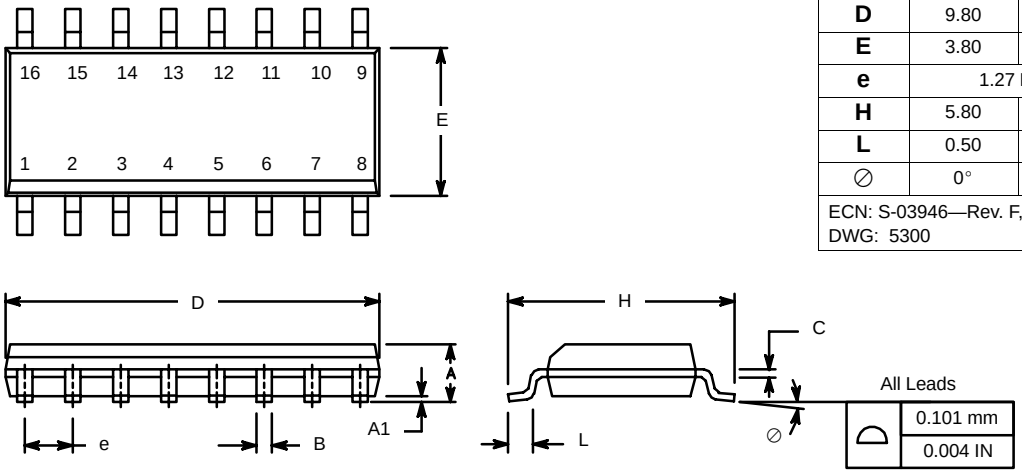
*Vishay Siliconix maintains worldwide manufacturing capability. Products may be manufactured at one of several qualified locations. Reliability data for Silicon Technology and Package Reliability represent a composite of all qualified locations. For related documents such as package/tape drawings, part marking, and reliability data, see http://www.vishay.com/ppg?70662.*

## SOIC (NARROW): 16-LEAD

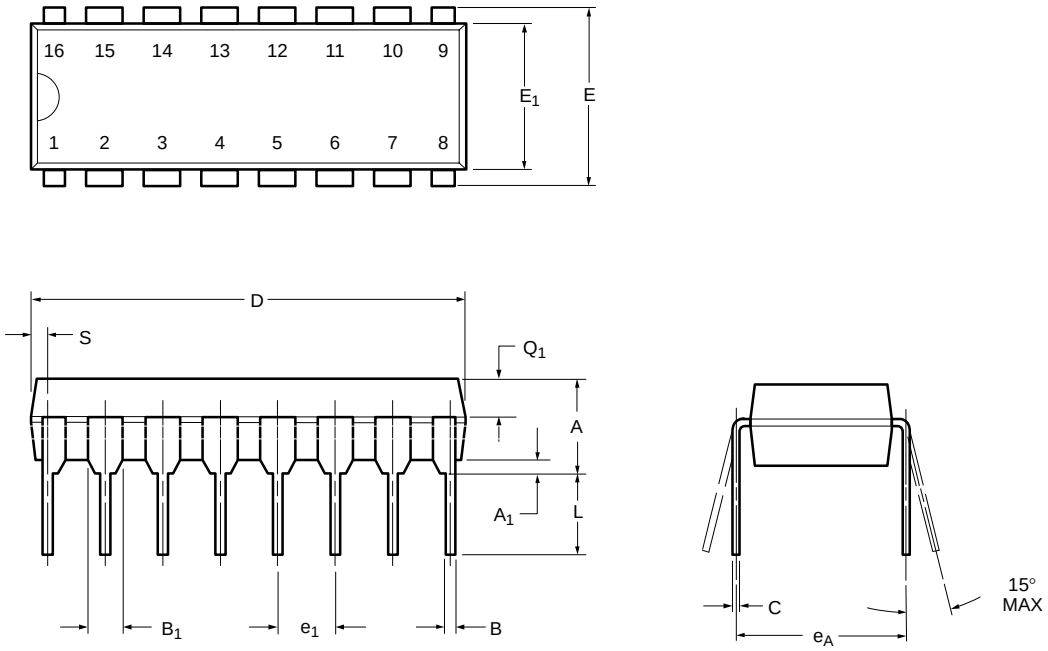
**JEDEC Part Number: MS-012**

| 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

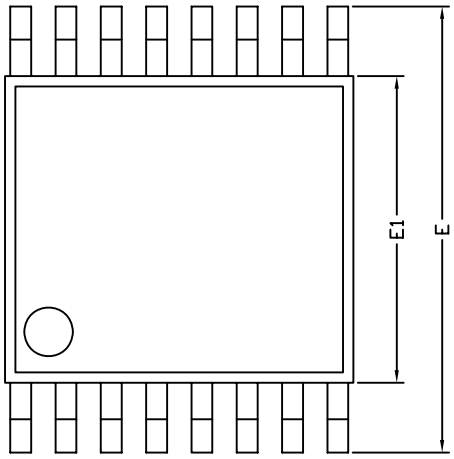


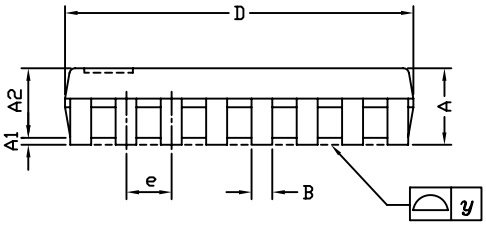
## PDIP: 16-LEAD

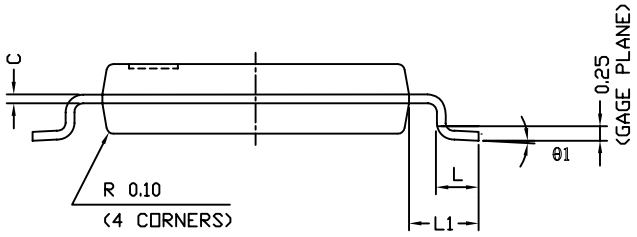



| Dim | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| | Min | Max | Min | Max |
| **A** | 3.81 | 5.08 | 0.150 | 0.200 |
| **$A_1$** | 0.38 | 1.27 | 0.015 | 0.050 |
| **B** | 0.38 | 0.51 | 0.015 | 0.020 |
| **$B_1$** | 0.89 | 1.65 | 0.035 | 0.065 |
| **C** | 0.20 | 0.30 | 0.008 | 0.012 |
| **D** | 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<br>DWG: 5482 | | | | |

**TSSOP: 16-LEAD**

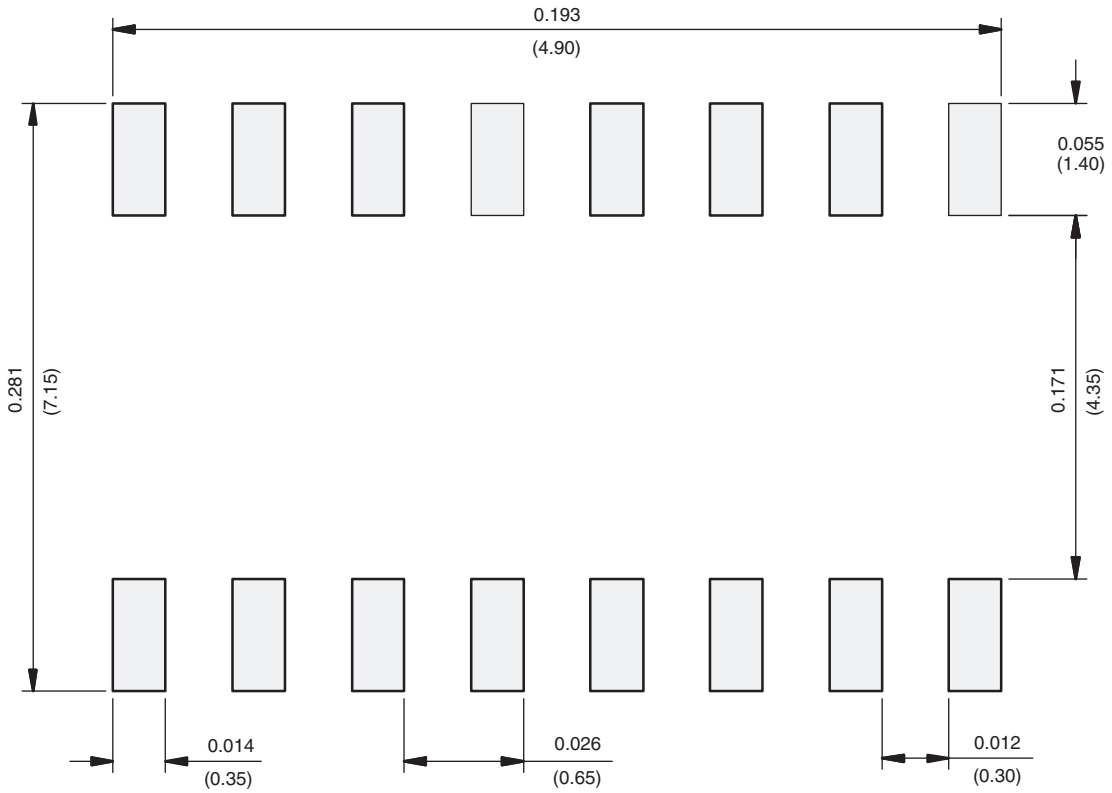


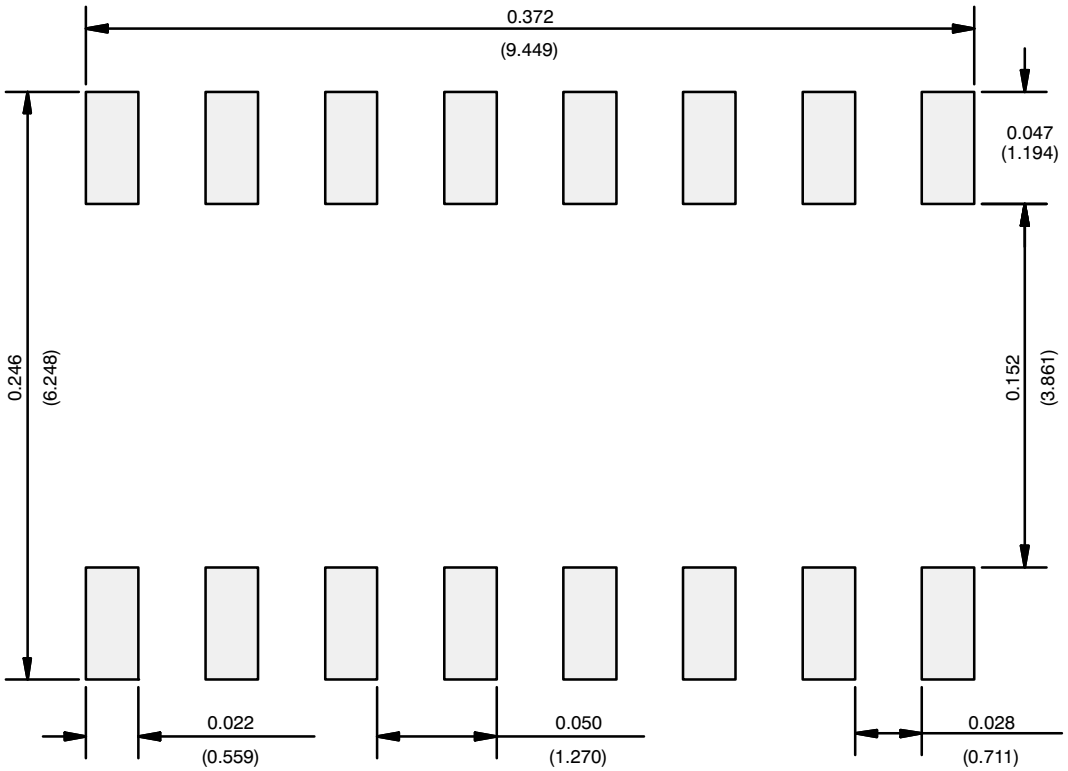

| Symbols | DIMENSIONS IN MILLIMETERS | | |
|---|---|---|---|
| | Min | Nom | Max |
| A | - | 1.10 | 1.20 |
| A1 | 0.05 | 0.10 | 0.15 |
| A2 | - | 1.00 | 1.05 |
| B | 0.22 | 0.28 | 0.38 |
| C | - | 0.127 | - |
| D | 4.90 | 5.00 | 5.10 |
| E | 6.10 | 6.40 | 6.70 |
| E1 | 4.30 | 4.40 | 4.50 |
| e | - | 0.65 | - |
| L | 0.50 | 0.60 | 0.70 |
| L1 | 0.90 | 1.00 | 1.10 |
| y | - | - | 0.10 |
| θ1 | 0° | 3° | 6° |
| ECN: S-61920-Rev. D, 23-Oct-06<br>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)

Return to Index

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