

Precision Monolithic Quad SPST CMOS Analog Switches

DESCRIPTION

The DG411HS series of monolithic quad analog switches was designed to provide high speed, low error switching of precision analog signals. Combining low power (0.35 μ W) with high speed (t_{ON} : 68 ns), the DG411HS family is ideally suited for portable and battery powered industrial and military applications.

To achieve high-voltage ratings and superior switching performance, the DG411HS series was built on Vishay Siliconix's high voltage silicon gate process. An epitaxial layer prevents latchup.

Each switch conducts equally well in both directions when on, and blocks input voltages up to the supply levels when off.

The DG411HS and DG412HS respond to opposite control logic as shown in the Truth Table. The DG413HS has two normally open and two normally closed switches.

FEATURES

- 44 V supply max. rating
- ± 15 V analog signal range
- On-resistance - $R_{DS(on)}$: 25 Ω
- Fast switching - t_{ON} : 68 ns
- Ultra low power - P_D : 0.35 μ W
- TTL, CMOS compatible
- Single supply capability

BENEFITS

- Widest dynamic range
- Low signal errors and distortion
- Break-before-make switching action
- Simple interfacing

APPLICATIONS

- Precision automatic test equipment
- Precision data acquisition
- Communication systems
- Battery powered systems
- Computer peripherals



RoHS*
COMPLIANT

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



TRUTH TABLE

| Logic | DG411HS | DG412HS |
|-------|---------|---------|
| 0 | ON | OFF |
| 1 | OFF | ON |

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

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



| TRUTH TABLE | | |
|-------------|-----------------------------------|-----------------------------------|
| Logic | SW ₁ , SW ₄ | SW ₂ , SW ₃ |
| 0 | OFF | ON |
| 1 | ON | OFF |

| ORDERING INFORMATION | | |
|----------------------|---------------------|--|
| Temp. Range | Package | Part Number |
| - 40 °C to 85 °C | 16-Pin Plastic DIP | DG411HSDJ DG411HSDJ-E3 |
| | | DG412HSDJ DG412HSDJ-E3 |
| | 16-Pin Narrow SOIC | DG411HSDY DG411HSDY-E3 DG411HSDY-T1 DG411HSDY-T1-E3 |
| | | DG412HSDY DG412HSDY-E3 DG412HSDY-T1 DG412HSDY-T1-E3 |
| | 16-Pin QFN 4 x 4 mm | DG411HSDN-T1-E4 |
| | | DG412HSDN-T1-E4 |
| - 40 °C to 85 °C | 16-Pin Plastic DIP | DG413HSDJ DG413HSDJ-E3 |
| | | DG413HSDY DG413HSDY-E3 DG413HSDY-T1 DG413HSDY-T1-E3 |
| | 16-Pin Narrow SOIC | DG413HSDY DG413HSDY-E3 DG413HSDY-T1 DG413HSDY-T1-E3 |
| | | DG413HSDN-T1-E4 |



| ABSOLUTE MAXIMUM RATINGS | | | |
|---|------------------------------------|--|------|
| 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 (Any terminal) | | 30 | mA |
| Peak Current, S or D (Pulsed 1 ms, 10 % duty cycle) | | 100 | |
| Storage Temperature | (AK, AZ Suffix) | - 65 to 150 | °C |
| | (DJ, DY, DN Suffix) | - 65 to 125 | |
| Power Dissipation (Package) ^b | 16-Pin Plastic DIP ^c | 470 | mW |
| | 16-Pin Narrow SOIC ^d | 600 | |
| | 16-Pin CerDIP ^e | 900 | |
| | LCC-20 ^e | 900 | |
| | 16-Pin (4 x 4 mm) QFN ^f | 1880 | |

Notes:

- a. Signals on S_X, D_X, or I_{NX} 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 mW/°C above 25 °C.
- d. Derate 7.6 mW/°C above 75 °C.
- e. Derate 12 mW/°C above 75 °C.
- f. Derate 23.5 mW/°C above 70 °C.

| SPECIFICATIONS ^a | | | | | | | | | |
|-------------------------------------|---------------------|--|--------------------|-------------------|-------------------------------|-------------------|------------------------------|-------------------|------|
| Parameter | Symbol | Test Conditions Unless Specified V+ = 15 V, V- = - 15 V V _L = 5 V, V _{IN} = 2.4 V, 0.8 V ^f | Temp. ^b | Typ. ^c | A Suffix - 55 °C to 125 °C | | D Suffix - 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 |
| Drain-Source On-Resistance | R _{DS(on)} | V+ = 13.5 V, V- = - 13.5 V I _S = - 10 mA, V _D = ± 8.5 V | Room Full | 25 | | 35 45 | | 35 45 | Ω |
| Switch Off Leakage Current | I _{S(off)} | V+ = 16.5 V, V- = - 16.5 V V _D = ± 15.5 mA, V _S = ± 15.5 V | Room Full | ± 0.1 | - 0.25 - 20 | 0.25 20 | - 0.25 - 5 | 0.25 5 | nA |
| | I _{D(off)} | | Room Full | ± 0.1 | - 0.25 - 20 | 0.25 20 | - 0.25 - 5 | 0.25 5 | |
| Channel On Leakage Current | I _{D(on)} | V+ = 16.5 V, V- = - 16.5 V V _D = V _S = ± 15.5 V | Room Full | ± 0.1 | - 0.4 - 40 | 0.4 40 | - 0.4 - 10 | 0.4 10 | |
| 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 MHz | Room | 5 | | | | | pF |
| Dynamic Characteristics | | | | | | | | | |
| Turn-On Time | t _{ON} | R _L = 300 Ω, C _L = 35 pF V _S = ± 10 V, see figure 2 | Room Full | 68 | | 105 127 | | 105 116 | ns |
| Turn-Off Time | t _{OFF} | | Room Full | 42 | | 80 94 | | 80 90 | |
| Break-Before-Make Time Delay | t _D | DG413HS only, V _S = 10 V R _L = 300 Ω, C _L = 35 pF | Room | 20 | | | | | |
| Charge Injection ^e | Q | V _g = 0 V, R _g = 0 Ω, C _L = 10 nF | Room | 22 | | | | | pC |

| SPECIFICATIONS ^a | | | | | | | | | |
|---|---------------------|---|--------------------|-------------------|------------------------------|-------------------|-----------------------------|-------------------|------|
| Parameter | Symbol | Test Conditions Unless Specified V ₊ = 15 V, V ₋ = -15 V V _L = 5 V, V _{IN} = 2.4 V, 0.8 V ^f | Temp. ^b | Typ. ^c | A Suffix -55 °C to 125 °C | | D Suffix -40 °C to 85 °C | | Unit |
| | | | | | Min. ^d | Max. ^d | Min. ^d | Max. ^d | |
| Dynamic Characteristics (Cont'd) | | | | | | | | | |
| Off Isolation ^e | OIRR | R _L = 50 Ω, C _L = 5 pF f = 1 MHz | Room | -91 | | | | | dB |
| Channel-to-Channel Crosstalk ^e | X _{TALK} | | Room | -88 | | | | | |
| Source Off Capacitance ^e | C _{S(off)} | f = 1 MHz | Room | 12 | | | | | pF |
| Drain Off Capacitance ^e | C _{D(off)} | | Room | 12 | | | | | |
| Channel On Capacitance ^e | C _{D(on)} | | Room | 30 | | | | | |
| Power Supplies | | | | | | | | | |
| Positive Supply Current | I ₊ | V ₊ = 16.5 V, V ₋ = -16.5 V V _{IN} = 0 or 5 V | Room Full | 0.0001 | | 1 5 | | 1 5 | μA |
| Negative Supply Current | I ₋ | | Room Full | -0.0001 | -1 -5 | | -1 -5 | | |
| Logic Supply Current | I _L | | Room Full | 0.0001 | | 1 5 | | 1 5 | |
| Ground Current | I _{GND} | | Room Full | -0.0001 | -1 -5 | | -1 -5 | | |

| SPECIFICATIONS ^a (for Unipolar Supplies) | | | | | | | | | |
|---|---------------------|---|--------------------|-------------------|------------------------------|-------------------|-----------------------------|-------------------|------|
| Parameter | Symbol | Test Conditions Unless 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 -55 °C to 125 °C | | D Suffix -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 |
| Drain-Source On-Resistance | R _{DS(on)} | V ₊ = 10.8 V, I _S = -10 mA V _D = 3 V, 8 V | Room Full | 49 | | 80 100 | | 80 100 | Ω |
| Dynamic Characteristics | | | | | | | | | |
| Turn-On Time | t _{ON} | R _L = 300 Ω, C _L = 35 pF V _S = 8 V, see figure 2 | Room Hot | 95 | | 140 180 | | 140 160 | ns |
| Turn-Off Time | t _{OFF} | | Room Hot | 36 | | 70 79 | | 70 74 | |
| Break-Before-Make Time Delay | t _D | DG413HS only, V _S = 8 V R _L = 300 Ω, C _L = 35 pF | Room | 60 | | | | | |
| Charge Injection | Q | V _g = 6 V, R _g = 0 Ω, C _L = 1 nF | Room | 60 | | | | | pC |
| Power Supplies | | | | | | | | | |
| Positive Supply Current | I ₊ | V ₊ = 13.2 V, V _{IN} = 0 or 5 V | Room Hot | 0.0001 | | 1 5 | | 1 5 | μA |
| Negative Supply Current | I ₋ | | Room Hot | -0.0001 | -1 -5 | | -1 -5 | | |
| Logic Supply Current | I _L | | Room Hot | 0.0001 | | 1 5 | | 1 5 | |
| Ground Current | I _{GND} | | Room Hot | -0.0001 | -1 -5 | | -1 -5 | | |

Notes:

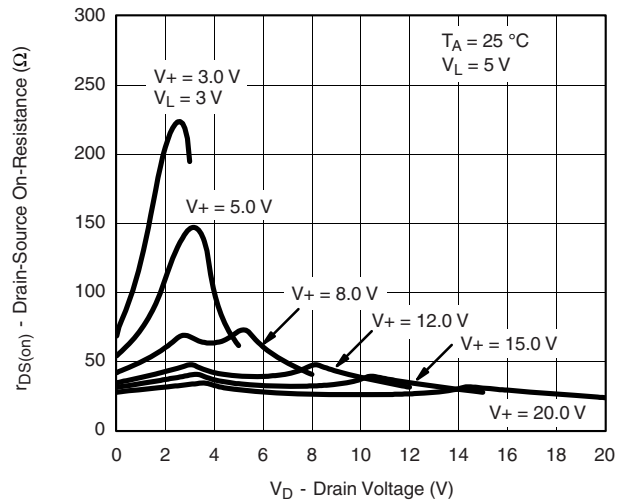
- Refer to PROCESS OPTION FLOWCHART.
- Room = 25 °C, Full = as determined by the operating temperature suffix.
- Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- Guaranteed by design, not subject to production test.
- 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 (25 °C, unless otherwise noted)



On-Resistance vs. V_D and Dual Supply Voltage



On-Resistance vs. V_D and Unipolar Supply Voltage



Leakage Current vs. Analog Voltage



On-Resistance vs. V_D and Temperature



On-Resistance vs. V_D and Temperature



Insertion Loss, Off-Isolation, Crosstalk vs. Frequency

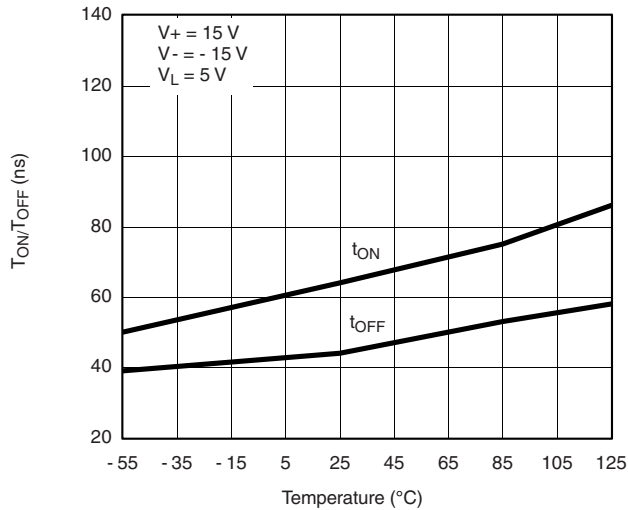
TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



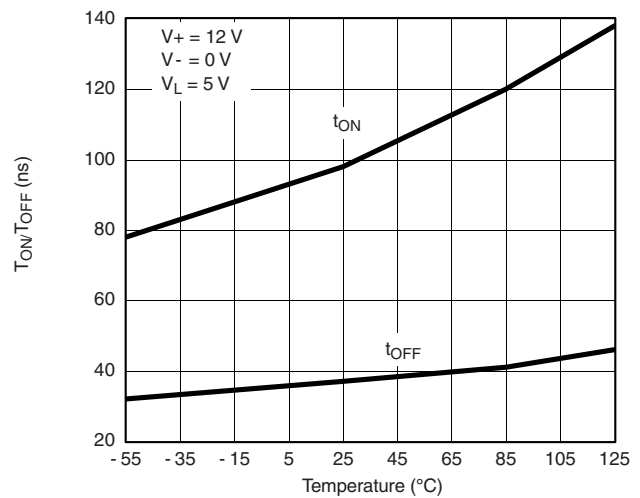
Charge Injection vs. Analog Voltage



Charge Injection vs. Analog Voltage



Switching Time vs. Temperature



Switching Time vs. Temperature



Supply Current vs. Input Switching Frequency

SCHEMATIC DIAGRAM (Typical Channel)

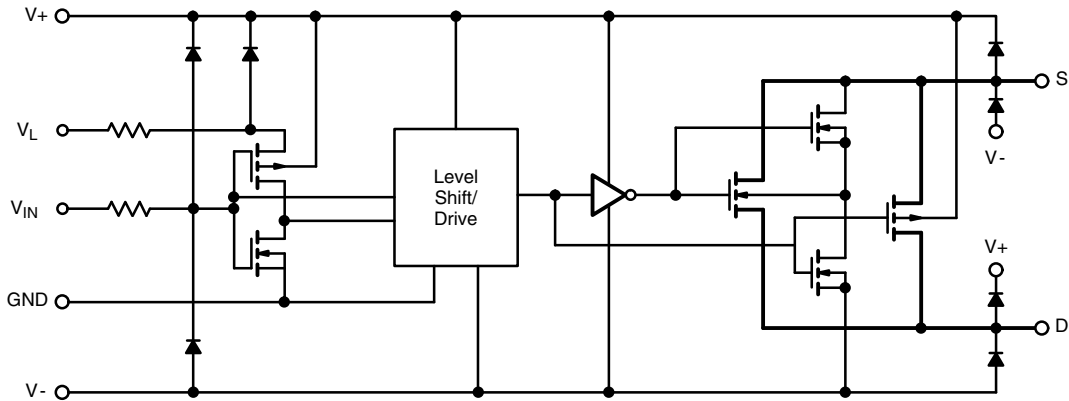
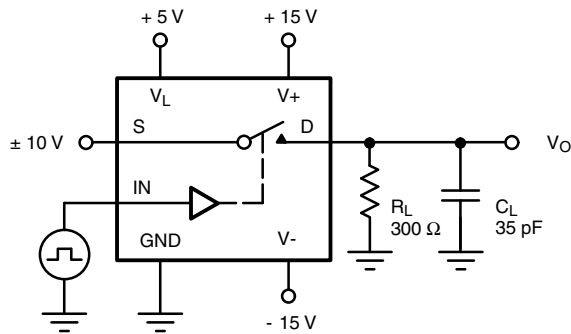


Figure 1.

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 2. Switching Time



C_L (includes fixture and stray capacitance)

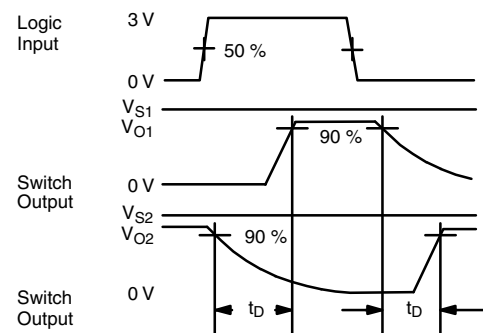


Figure 3. Break-Before-Make (DG413HS)

TEST CIRCUITS



Figure 4. Charge Injection



Figure 5. Crosstalk



Figure 6. Off-Isolation



Figure 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?72053.



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 |
| A₁ | 0.38 | 1.27 | 0.015 | 0.050 |
| B | 0.38 | 0.51 | 0.015 | 0.020 |
| B₁ | 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 |
| E₁ | 5.59 | 7.11 | 0.220 | 0.280 |
| e₁ | 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 |
| Q₁ | 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



CERDIP: 16-LEAD



| Dim | MILLIMETERS | | INCHES | |
|----------------|-------------|-------|-----------|-------|
| | Min | Max | Min | Max |
| A | 4.06 | 5.08 | 0.160 | 0.200 |
| A ₁ | 0.51 | 1.14 | 0.020 | 0.045 |
| B | 0.38 | 0.51 | 0.015 | 0.020 |
| B ₁ | 1.14 | 1.65 | 0.045 | 0.065 |
| C | 0.20 | 0.30 | 0.008 | 0.012 |
| D | 19.05 | 19.56 | 0.750 | 0.770 |
| E | 7.62 | 8.26 | 0.300 | 0.325 |
| E ₁ | 6.60 | 7.62 | 0.260 | 0.300 |
| e ₁ | 2.54 BSC | | 0.100 BSC | |
| e _A | 7.62 BSC | | 0.300 BSC | |
| L | 3.18 | 3.81 | 0.125 | 0.150 |
| L ₁ | 3.81 | 5.08 | 0.150 | 0.200 |
| Q ₁ | 1.27 | 2.16 | 0.050 | 0.085 |
| S | 0.38 | 1.14 | 0.015 | 0.045 |
| ∞ | 0° | 15° | 0° | 15° |

ECN: S-03946—Rev. G, 09-Jul-01
DWG: 5403



20-LEAD LCC

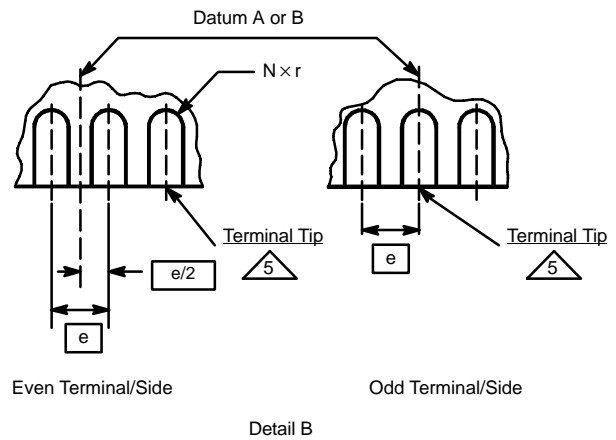
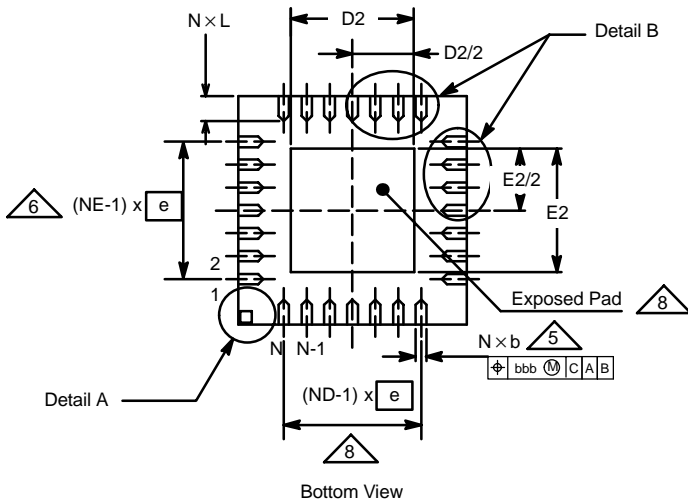
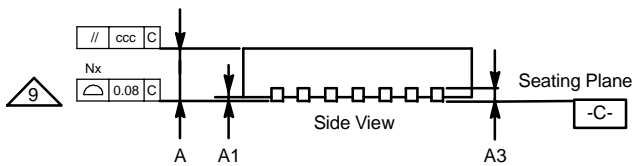
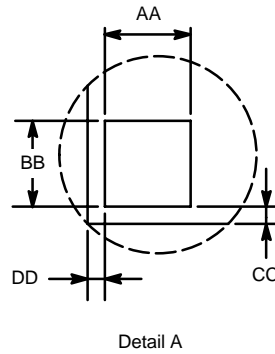
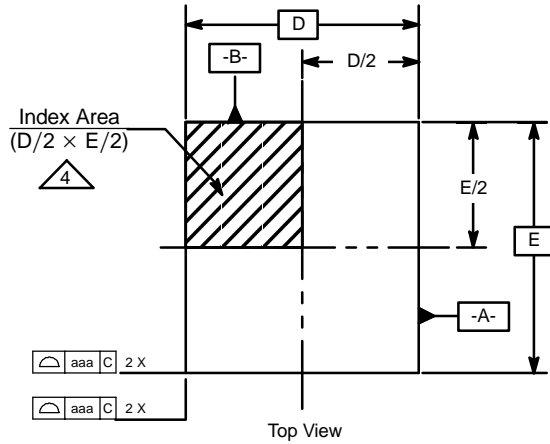


| Dim | MILLIMETERS | | INCHES | |
|---|-------------|------|-----------|-------|
| | Min | Max | Min | Max |
| A | 1.37 | 2.24 | 0.054 | 0.088 |
| A₁ | 1.63 | 2.54 | 0.064 | 0.100 |
| B | 0.56 | 0.71 | 0.022 | 0.028 |
| D | 8.69 | 9.09 | 0.342 | 0.358 |
| E | 8.69 | 9.09 | 0.442 | 0.358 |
| e | 1.27 BSC | | 0.050 BSC | |
| L | 1.14 | 1.40 | 0.045 | 0.055 |
| L₁ | 1.96 | 2.36 | 0.077 | 0.093 |
| ECN: S-03946—Rev. B, 09-Jul-01 DWG: 5321 | | | | |



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 | - | - | |

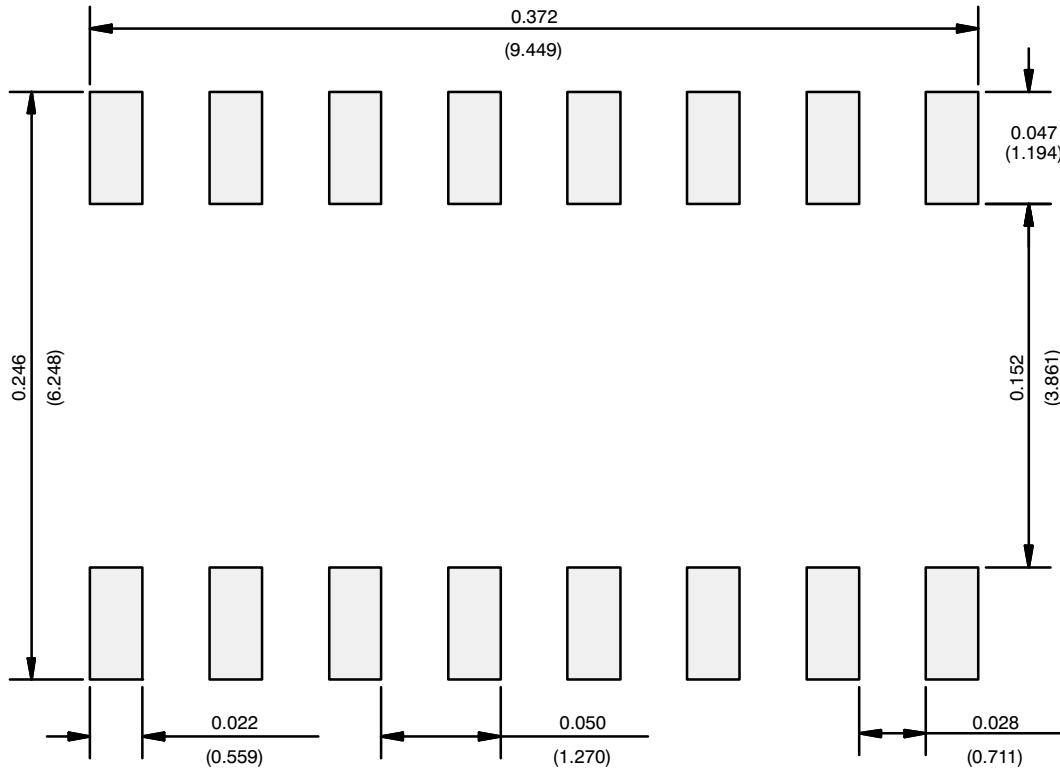
* Use millimeters as the primary measurement.

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.

RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads
Dimensions in Inches/(mm)

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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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Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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