

# NB4N507A

## 3.3V/5V, 50 MHz to 200 MHz PECL Clock Synthesizer

### Description

The NB4N507A is a precision clock synthesizer which generates a very low jitter differential PECL output clock. It produces a clock output based on an integer multiple of an input reference frequency.

The NB4N507A accepts a standard fundamental mode crystal, using Phase-Locked-Loop (PLL) techniques, will produce output clocks up to 200 MHz. In addition, the PLL circuitry will produce a 50% duty cycle square-wave clock output (see Figure 7).

The NB4N507A can be programmed to generate a selection of input reference frequency multiples. An exact 155.52 MHz output clock can be generated from a 19.44 MHz crystal and the x8 multiplier selection. The NB4N507A is intended for low output jitter clock generation.

The PECL outputs are 15 mA open collector and must be DC loaded and AC terminated. See Figures 4 and 6.

### Features

- Input Crystal Frequency of 10 – 27 MHz
- Enable Usage of Common Low-Cost Crystal
- Differential PECL Output Clock Frequencies up to 200 MHz
- Duty Cycle of 48%/52%
- Operating Range:  $V_{CC} = 3.0 \text{ V to } 5.5 \text{ V}$
- Ideal for SONET Applications and Oscillator Manufacturers
- Available in Die Form
- Packaged in 16-Pin Narrow SOIC
- Pb-Free Packages are Available\*

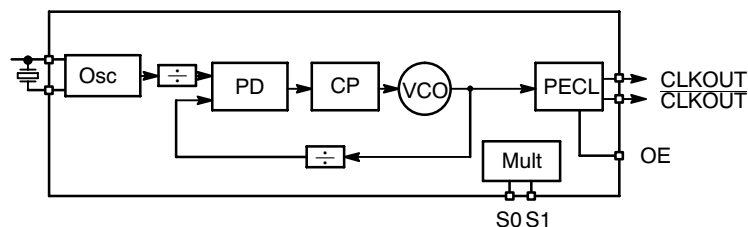
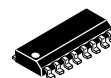


Figure 1. Simplified Logic Block Diagram



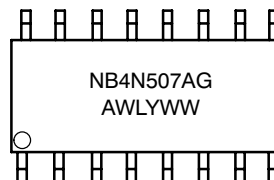
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SOIC-16  
D SUFFIX  
CASE 751B

### MARKING DIAGRAM



A = Assembly Location  
WL = Wafer Lot  
Y = Year  
WW = Work Week  
G = Pb-Free Package

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# NB4N507A

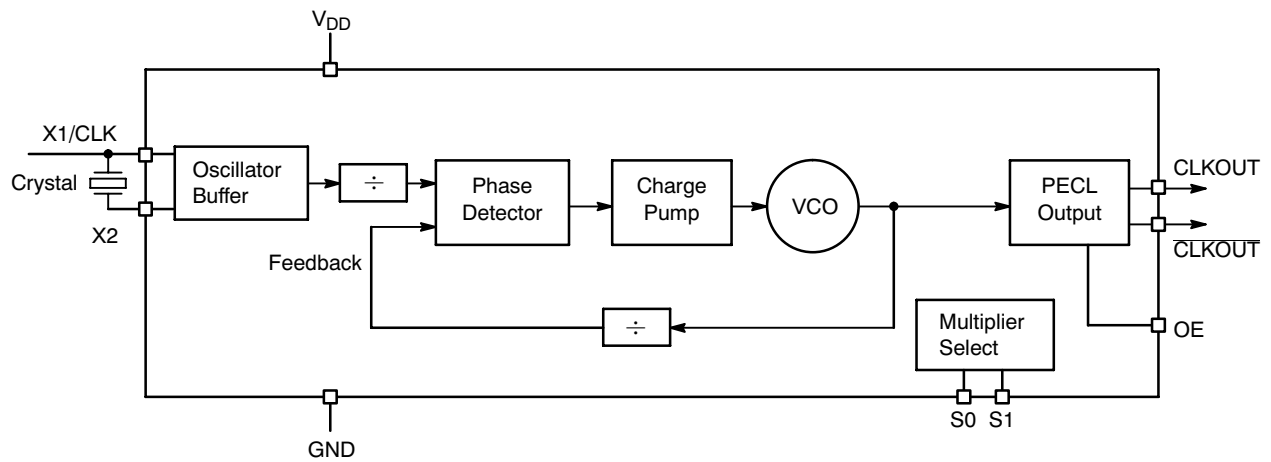


Figure 2. NB4N507A Logic Diagram

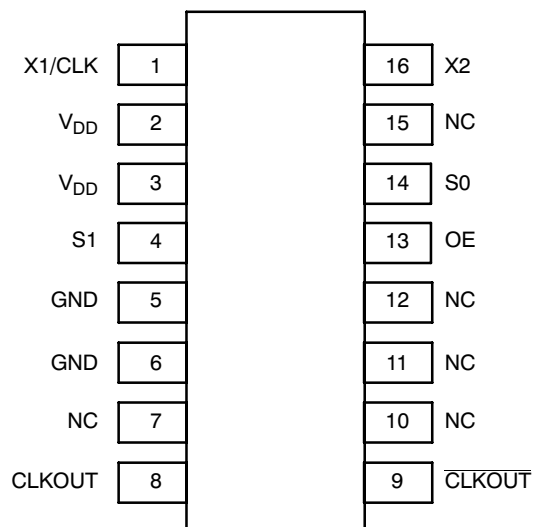


Figure 3. 16-Pin SOIC (Top View)

Table 1. CLOCK MULTIPLIER SELECT TABLE

| S1 | S0 | Multiplier |
|----|----|------------|
| L  | L  | 9.72X*     |
| L  | M  | 10X        |
| L  | H  | 12X        |
| M  | L  | 6.25X      |
| M  | M  | 8X         |
| M  | H  | 5X         |
| H  | L  | NA         |
| H  | M  | 3X         |
| H  | H  | 4X         |

\*Example Crystal = 16 MHz,  $f_{CLKOUT} = 155.52$  MHz  
 L = GND  
 H =  $V_{DD}$   
 M = OPEN

Table 2. OE, OUTPUT ENABLE FUNCTION

| OE | Function |
|----|----------|
| 0  | Disable  |
| 1  | Enable   |

# NB4N507A

**Table 3. PIN DESCRIPTION**

| Pin #<br>SOIC-16  | Name            | I/O                       | Description                                                                                                                                                                                           |
|-------------------|-----------------|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1                 | X1/CLK          | Crystal Input             | Crystal or Clock Input                                                                                                                                                                                |
| 2,3               | V <sub>DD</sub> | Power Supply              | Positive Supply Voltage (3.0 V to 5.5 V)                                                                                                                                                              |
| 4                 | S1              | Tri-Level Input           | Multiplier Select Pin; When Left Open, Defaults to V <sub>DD</sub> ÷ 2                                                                                                                                |
| 5,6               | GND             | Power Supply              | Negative Supply Voltage                                                                                                                                                                               |
| 7,10,11,12,<br>15 | NC              | No Connect                | Pin 10 does not require an external resistor. The NB4N507A will function with or without a resistor on Pin 10.                                                                                        |
| 8                 | CLKOUT          | PECL Output*              | Non-inverted differential PECL clock output.                                                                                                                                                          |
| 9                 | CLKOUT          | PECL Output*              | Inverted differential PECL clock output.                                                                                                                                                              |
| 13                | OE              | (LV)CMOS/(LV)TTL<br>Input | Output Enable for the CLKOUT/CLKOUT Outputs. Outputs are enabled when HIGH or when left open; OE pin has internal pullup resistor. Disables both outputs when LOW. CLKOUT goes LOW, CLKOUT goes HIGH. |
| 14                | S0              | Tri-Level Input           | Multiplier Select Pin; When Left Open, Defaults to V <sub>DD</sub> ÷ 2                                                                                                                                |
| 16                | X2              | Crystal Input             | Crystal Input                                                                                                                                                                                         |

\*The PECL Outputs are 15 mA open collector and must be DC loaded and AC terminated. See Figures 4, 5 and 6.

**Table 4. ATTRIBUTES**

| Characteristics                                                          | Value                       |
|--------------------------------------------------------------------------|-----------------------------|
| ESD Protection Human Body Model<br>Machine Model<br>Charged Device Model | > 1 kV<br>> 150 V<br>> 1 kV |
| Moisture Sensitivity, Indefinite Time Out of Drypack (Note 1)            | Level 1                     |
| Flammability Rating Oxygen Index: 28 to 34                               | UL 94 V-0 @ 0.125 in        |
| Transistor Count                                                         | 1145 Devices                |
| Meets or exceeds JEDEC Spec EIA/JESD78 IC Latchup Test                   |                             |

1. For additional information, see Application Note AND8003/D.

**Table 5. MAXIMUM RATINGS**

| Symbol           | Parameter                                | Condition 1                        | Condition 2 | Rating                                             | Unit         |
|------------------|------------------------------------------|------------------------------------|-------------|----------------------------------------------------|--------------|
| V <sub>CC</sub>  | Positive Power Supply                    | GND = 0 V                          |             | 6                                                  | V            |
| V <sub>I</sub>   | Input Voltage                            |                                    |             | GND – 0.5 ≤ V <sub>I</sub> ≤ V <sub>DD</sub> + 0.5 | V            |
| T <sub>A</sub>   | Operating Temperature Range              |                                    |             | –40 to +85                                         | °C           |
| T <sub>stg</sub> | Storage Temperature Range                |                                    |             | –65 to +150                                        | °C           |
| θ <sub>JA</sub>  | Thermal Resistance (Junction-to-Ambient) | 0 lfpm<br>500 lfpm                 | SOIC-16     | 100<br>60                                          | °C/W<br>°C/W |
| θ <sub>JC</sub>  | Thermal Resistance (Junction-to-Case)    | (Note 2)                           | SOIC-16     | 33 to 36                                           | °C/W         |
| T <sub>sol</sub> | Wave Solder Pb<br>Pb-Free                | < 3 sec @ 248°C<br>< 3 sec @ 260°C |             | 265<br>265                                         | °C           |

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

2. JEDEC standard multilayer board – 2S2P (2 signal, 2 power).

# NB4N507A

**Table 6. DC CHARACTERISTICS** ( $V_{DD} = 3.0\text{ V to }5.5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$  (Note 3))

| Symbol   | Characteristic                                                                                                              | Min                   | Typ          | Max          | Unit     |
|----------|-----------------------------------------------------------------------------------------------------------------------------|-----------------------|--------------|--------------|----------|
| $I_{DD}$ | Power Supply Current<br>(does not include output load resistor current)<br>$V_{DD} = 5\text{ V}$<br>$V_{DD} = 3.3\text{ V}$ | 15<br>10              | 27<br>23     | 35<br>30     | mA<br>mA |
| $V_{OH}$ | Output HIGH Voltage (Notes 5 & 6)<br>$V_{DD} = 5\text{ V}$<br>$V_{DD} = 3.3\text{ V}$                                       | 3.95<br>2.57          | 4.05<br>2.67 | 4.15<br>2.77 | V        |
| $V_{OL}$ | Output LOW Voltage (Notes 5 & 6)<br>$V_{DD} = 5\text{ V}$<br>$V_{DD} = 3.3\text{ V}$                                        | 3.12<br>1.90          | 3.20<br>2.00 | 3.30<br>2.10 | V        |
| $V_{IH}$ | Input HIGH Voltage (Note 4)<br>S0, S1, X1/CLK<br>OE                                                                         | $V_{DD} - 0.5$<br>2.0 |              | $V_{DD}$     | V        |
| $V_{IL}$ | Input LOW Voltage, (Note 4)<br>S0, S1, X1/CLK<br>OE                                                                         | 0                     |              | 0.5<br>0.8   | V        |
| $C_x$    | Internal Crystal Capacitance, X1 & X2                                                                                       |                       | 0            |              | pF       |
| $C_{in}$ | Input Capacitance, S0, S1, OE                                                                                               |                       | 5.0          |              | pF       |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

- PECL output parameters vary 1:1 with  $V_{DD}$ .
- S0 and S1 default to  $V_{DD} \div 2$  when left open.

**Table 7. AC CHARACTERISTICS** ( $V_{DD} = 3.0\text{ V to }5.5\text{ V}$ ,  $GND = 0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$  (Note 5))

| Symbol             | Characteristic                                  | Min | Typ | Max      | Unit |
|--------------------|-------------------------------------------------|-----|-----|----------|------|
| $f_{xtal}$         | Crystal Input Frequency (Note 7)                | 10  |     | 27       | MHz  |
| $f_{CLK}$          | Input Clock Frequency (Note 8)                  | 5   |     | 52       | MHz  |
| $f_{OUT}$          | Output Frequency Range                          | 50  |     | 200      | MHz  |
| $V_{out\ pk-pk}$   | Output Amplitude                                | 550 | 680 |          | mV   |
| DC                 | Clock Output Duty Cycle (Note 8)                | 48  |     | 52       | %    |
| PLL <sub>BW</sub>  | PLL Bandwidth (Note 8)                          | 10  |     |          | kHz  |
| $t_{jitter\ (pd)}$ | Period Jitter (RMS, 1 $\sigma$ , 10,000 Cycles) |     |     | 10       | ps   |
| $t_{jitter\ (pd)}$ | Period Jitter (Peak-to-Peak, 10,000 Cycles)     |     |     | $\pm 20$ | ps   |
| $t_r/t_f$          | Output Rise and Fall Times (Note 8)             | 50  | 270 | 500      | ps   |

NOTE: Device will meet the specifications after thermal equilibrium has been established when mounted in a test socket or printed circuit board with maintained transverse airflow greater than 500 lfpm. Electrical parameters are guaranteed only over the declared operating temperature range. Functional operation of the device exceeding these conditions is not implied. Device specification limit values are applied individually under normal operating conditions and not valid simultaneously.

- PECL outputs loaded with external resistors for proper operation (see Figures 4, 5 and 6).
- $V_{OH}$  and  $V_{OL}$  can be set by the external resistors, which can be modified.
- The crystal should be fundamental mode, parallel resonant. Do not use third overtone. For exact tuning when using a crystal, capacitors should be connected from pins X1 to ground and X2 to ground. The value of these capacitors is given by the following equation, where CL is the specified crystal load capacitance: Crystal caps (pF) = (CL-5) x 2. So, for a crystal with 16 pF load capacitance, use two 22 pF caps, including board trace capacitance (see Figure 7).
- Guaranteed by design and characterization.

## NB4N507A

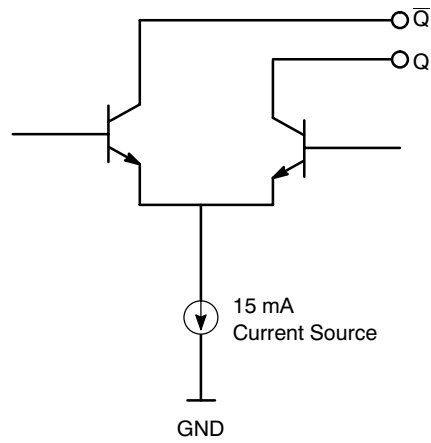


Figure 4. Output Structure

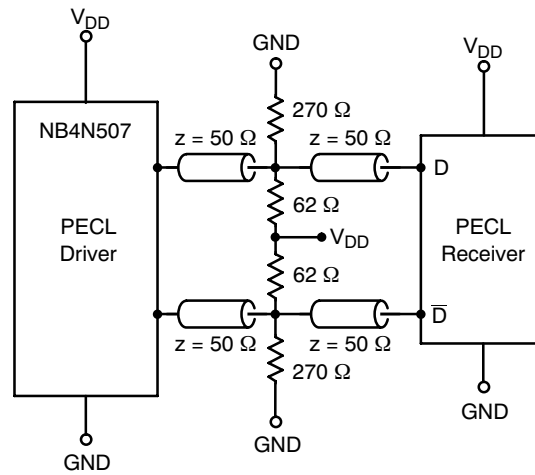


Figure 5. Evaluation Test Load for the NB4N507A

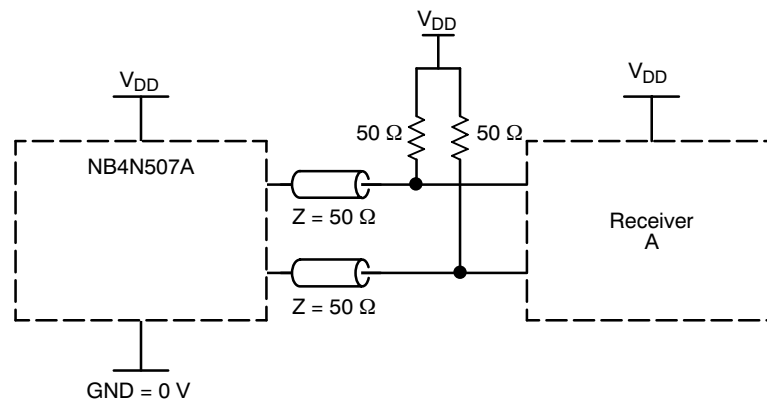


Figure 6. Alternate Termination for Output Driver and Device Evaluation

## APPLICATIONS INFORMATION

**High Frequency Differential PECL Oscillators:** The NB4N507A, along with a low frequency fundamental mode crystal, can build a high frequency differential PECL output oscillator. For example, a 10 MHz crystal connected to the NB4N507A with the 12X output selected (S1 = 0, S0 = 1) produces a 120 MHz PECL output clock.

### Crystal Oscillator Input Interface

The NB4N507A features an integrated crystal oscillator to minimize system implementation costs. The oscillator circuit is a parallel resonant circuit and thus, for optimum performance, a parallel resonant crystal should be used.

As the oscillator is somewhat sensitive to loading on its inputs, the user is advised to mount the crystal as close to the NB4N507A as possible to avoid any board level parasitics. Surface mount crystals are recommended, but not required.

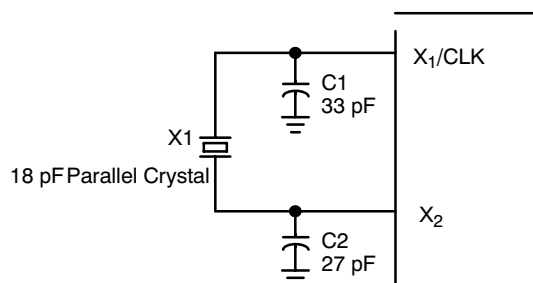


Figure 7. Crystal Input Interface

**High Frequency VCXO:** The bandwidth of the PLL is guaranteed to be greater than 10 kHz. This means that the PLL will track any modulation on the input with a frequency of less than 10 kHz. By using this property, a low frequency VCXO can be built. The output can then be multiplied by the NB4N507A, thereby producing a high frequency VCXO.

**High Frequency TCXO:** Extending the previous application, an inexpensive, low frequency TCXO can be built and the output frequency can be multiplied using the NB4N507A. Since the output of the chip is phase-locked to the input, the NB4N507A has no temperature dependence, and the temperature coefficient of the combined system is the same as that of the low frequency TCXO.

### Decoupling and External Components

The NB4N507A requires a 0.01  $\mu$ F decoupling capacitor to be connected between  $V_{DD}$  and GND on pins 2 and 5. It must be connected close to the NB4N507A. Other  $V_{DD}$  and GND connections should be connected to those pins, or to the  $V_{DD}$  and GND planes on the board. Another four resistors are needed for the PECL outputs as shown in Figure 4. Suggested values of these resistors are shown, but they can be varied to change the differential pair output swing, and the DC level.

## ORDERING INFORMATION

| Device       | Package              | Shipping <sup>†</sup> |
|--------------|----------------------|-----------------------|
| NB4N507AD    | SOIC-16              | 48 Units / Rail       |
| NB4N507ADG   | SOIC-16<br>(Pb-Free) | 48 Units / Rail       |
| NB4N507ADR2  | SOIC-16              | 2500 / Tape & Reel    |
| NB4N507ADR2G | SOIC-16<br>(Pb-Free) | 2500 / Tape & Reel    |

<sup>†</sup>For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

### Resource Reference of Application Notes

- AN1405/D - ECL Clock Distribution Techniques
- AN1406/D - Designing with PECL (ECL at +5.0 V)
- AN1503/D - ECLinPS™ I/O SPICE Modeling Kit
- AN1504/D - Metastability and the ECLinPS Family
- AN1568/D - Interfacing Between LVDS and ECL
- AN1672/D - The ECL Translator Guide
- AND8090/D - AC Characteristics of ECL Devices

## **NB4N507A**

### **Resource Reference of Application Notes**

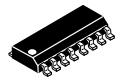
- AND8001/D** - Odd Number Counters Design
- AND8002/D** - Marking and Date Codes
- AND8020/D** - Termination of ECL Logic Devices
- AND8066/D** - Interfacing with ECLinPS
- AND8090/D** - AC Characteristics of ECL Devices

# MECHANICAL CASE OUTLINE

## PACKAGE DIMENSIONS

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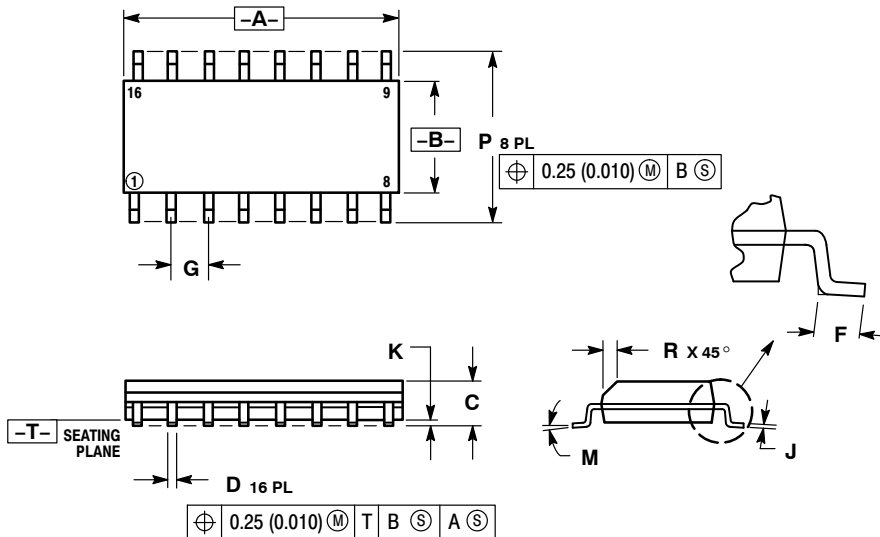
ON



SCALE 1:1

### SOIC-16 CASE 751B-05 ISSUE K

DATE 29 DEC 2006



#### NOTES:

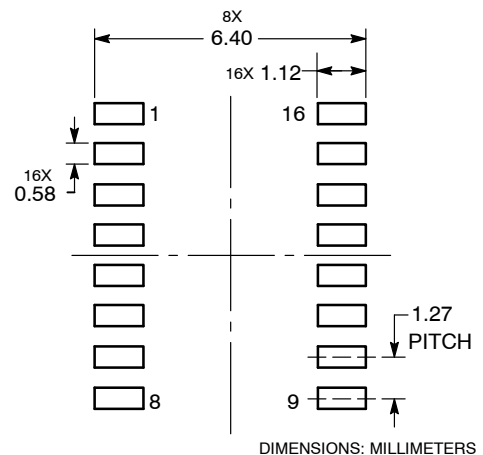
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS |       | INCHES    |       |
|-----|-------------|-------|-----------|-------|
|     | MIN         | MAX   | MIN       | MAX   |
| A   | 9.80        | 10.00 | 0.386     | 0.393 |
| B   | 3.80        | 4.00  | 0.150     | 0.157 |
| C   | 1.35        | 1.75  | 0.054     | 0.068 |
| D   | 0.35        | 0.49  | 0.014     | 0.019 |
| E   | 0.40        | 1.25  | 0.016     | 0.049 |
| F   | 1.27 BSC    |       | 0.050 BSC |       |
| G   | 0.19        | 0.25  | 0.008     | 0.009 |
| H   | 0.10        | 0.25  | 0.004     | 0.009 |
| I   | 0°          | 7°    | 0°        | 7°    |
| J   | 5.80        | 6.20  | 0.229     | 0.244 |
| K   | 0.25        | 0.50  | 0.010     | 0.019 |

|                   |                   |                          |                          |
|-------------------|-------------------|--------------------------|--------------------------|
| STYLE 1:          | STYLE 2:          | STYLE 3:                 | STYLE 4:                 |
| PIN 1. COLLECTOR  | PIN 1. CATHODE    | PIN 1. COLLECTOR, DYE #1 | PIN 1. COLLECTOR, DYE #1 |
| 2. BASE           | 2. ANODE          | 2. BASE, #1              | 2. COLLECTOR, #1         |
| 3. EMITTER        | 3. NO CONNECTION  | 3. EMITTER, #1           | 3. COLLECTOR, #2         |
| 4. NO CONNECTION  | 4. CATHODE        | 4. COLLECTOR, #1         | 4. COLLECTOR, #2         |
| 5. EMITTER        | 5. CATHODE        | 5. COLLECTOR, #2         | 5. COLLECTOR, #3         |
| 6. BASE           | 6. NO CONNECTION  | 6. BASE, #2              | 6. COLLECTOR, #3         |
| 7. COLLECTOR      | 7. ANODE          | 7. EMITTER, #2           | 7. COLLECTOR, #4         |
| 8. COLLECTOR      | 8. CATHODE        | 8. COLLECTOR, #2         | 8. COLLECTOR, #4         |
| 9. BASE           | 9. CATHODE        | 9. COLLECTOR, #3         | 9. BASE, #4              |
| 10. EMITTER       | 10. ANODE         | 10. BASE, #3             | 10. EMITTER, #4          |
| 11. NO CONNECTION | 11. NO CONNECTION | 11. EMITTER, #3          | 11. BASE, #3             |
| 12. EMITTER       | 12. CATHODE       | 12. COLLECTOR, #3        | 12. EMITTER, #3          |
| 13. BASE          | 13. CATHODE       | 13. COLLECTOR, #4        | 13. BASE, #2             |
| 14. COLLECTOR     | 14. NO CONNECTION | 14. BASE, #4             | 14. EMITTER, #2          |
| 15. EMITTER       | 15. ANODE         | 15. EMITTER, #4          | 15. BASE, #1             |
| 16. COLLECTOR     | 16. CATHODE       | 16. COLLECTOR, #4        | 16. EMITTER, #1          |

|                      |                |                           |
|----------------------|----------------|---------------------------|
| STYLE 5:             | STYLE 6:       | STYLE 7:                  |
| PIN 1. DRAIN, DYE #1 | PIN 1. CATHODE | PIN 1. SOURCE N-CH        |
| 2. DRAIN, #1         | 2. CATHODE     | 2. COMMON DRAIN (OUTPUT)  |
| 3. DRAIN, #2         | 3. CATHODE     | 3. COMMON DRAIN (OUTPUT)  |
| 4. DRAIN, #2         | 4. CATHODE     | 4. GATE P-CH              |
| 5. DRAIN, #3         | 5. CATHODE     | 5. COMMON DRAIN (OUTPUT)  |
| 6. DRAIN, #3         | 6. CATHODE     | 6. COMMON DRAIN (OUTPUT)  |
| 7. DRAIN, #4         | 7. CATHODE     | 7. COMMON DRAIN (OUTPUT)  |
| 8. DRAIN, #4         | 8. CATHODE     | 8. SOURCE P-CH            |
| 9. GATE, #4          | 9. ANODE       | 9. SOURCE P-CH            |
| 10. SOURCE, #4       | 10. ANODE      | 10. COMMON DRAIN (OUTPUT) |
| 11. GATE, #3         | 11. ANODE      | 11. COMMON DRAIN (OUTPUT) |
| 12. SOURCE, #3       | 12. ANODE      | 12. COMMON DRAIN (OUTPUT) |
| 13. GATE, #2         | 13. ANODE      | 13. GATE N-CH             |
| 14. SOURCE, #2       | 14. ANODE      | 14. COMMON DRAIN (OUTPUT) |
| 15. GATE, #1         | 15. ANODE      | 15. COMMON DRAIN (OUTPUT) |
| 16. SOURCE, #1       | 16. ANODE      | 16. SOURCE N-CH           |

#### SOLDERING FOOTPRINT



DIMENSIONS: MILLIMETERS

|                  |             |                                                                                                                                                                                     |
|------------------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
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