Low-Voltage 1.8/2.5/3.3V 16-Bit Transceiver

With 3.6 V-Tolerant Inputs and Outputs (3-State, Non-Inverting)

The 74VCX16245 is an advanced performance, non-inverting 16-bit transceiver. It is designed for very high-speed, very low-power operation in 1.8 V, 2.5 V or 3.3 V systems.

When operating at 2.5 V (or 1.8 V) the part is designed to tolerate voltages it may encounter on either inputs or outputs when interfacing to 3.3 V busses. It is guaranteed to be overvoltage tolerant to 3.6 V.

The VCX16245 is designed with byte control. It can be operated as two separate octals, or with the controls tied together, as a 16-bit wide function. The Transmit/Receive ($T/\overline{R}n$) inputs determine the direction of data flow through the bi-directional transceiver. Transmit (active-HIGH) enables data from A ports to B ports; Receive (active-LOW) enables data from B to A ports. The Output Enable inputs (\overline{OEn}), when HIGH, disable both A and B ports by placing them in a HIGH Z condition.

Features

- Designed for Low Voltage Operation: $V_{CC} = 1.65-3.6 \text{ V}$
- 3.6 V Tolerant Inputs and Outputs
- High Speed Operation: 2.5 ns max for 3.0 to 3.6 V

3.0 ns max for 2.3 to 2.7 V

6.0 ns max for 1.65 to 1.95 V

• Static Drive: ±24 mA Drive at 3.0 V

±18 mA Drive at 2.3 V

±6 mA Drive at 1.65 V

- Supports Live Insertion and Withdrawal
- I_{OFF} Specification Guarantees High Impedance When $V_{CC} = 0 \text{ V}$
- Near Zero Static Supply Current in All Three Logic States (20 μA)
 Substantially Reduces System Power Requirements
- Latchup Performance Exceeds ±250 mA @ 125°C
- ESD Performance: Human Body Model >2000 V;

Machine Model >200 V



ON Semiconductor®

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TSSOP-48 DT SUFFIX CASE 1201

MARKING DIAGRAM

48

AAAAAAAAAAAAAAAAAAA

VCX16245

AWLYYWW

O

A = Assembly Location

WL = Wafer Lot YY = Year WW = Work Week

ORDERING INFORMATION

| Device | Package | Shipping [†] |
|---------------|---------|-----------------------|
| 74VCX16245DT | TSSOP | 39 / Rail |
| 74VCX16245DTR | TSSOP | 2500/Tape & Reel |

[†]For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

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

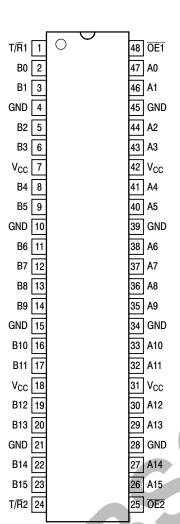


Figure 1. 48-Lead Pinout (Top View)

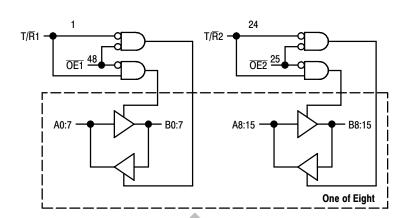


Figure 2. Logic Diagram

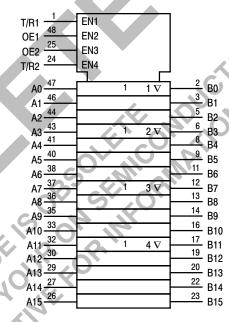


Figure 3. IEC Logic Diagram

| 25 OE2 48-Lead Pinout Top View) Table 1. PIN NAMES | A11 32 1 4 V 17 B11 B12 A13 29 20 B13 A14 26 23 B15 Figure 3. IEC Logic Diagram |
|--|--|
| Pins | Function |
| OEn T/Rn A0-A15 B0-B15 | Output Enable Inputs Transmit/Receive Inputs Side A Inputs or 3–State Outputs Side B Inputs or 3–State Outputs |

TRUTH TABLE

| Inp | uts | | Inp | outs | |
|-----|------|----------------------------|-----|------|------------------------------|
| OE1 | T/R1 | Outputs | OE2 | T/R2 | Outputs |
| L | L | Bus B0:7 Data to Bus A0:7 | L | L | Bus B8:15 Data to Bus A8:15 |
| L | Н | Bus A0:7 Data to Bus B0:7 | L | Н | Bus A8:15 Data to Bus B8:15 |
| Н | Х | High Z State on A0:7, B0:7 | Н | Х | High Z State on A8:15, B8:15 |

H = High Voltage Level

L = Low Voltage Level

X = High or Low Voltage Level and Transitions Are Acceptable

ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Condition | Unit |
|------------------|----------------------------------|-----------------------------------|----------------------------------|------|
| V _{CC} | DC Supply Voltage | -0.5 to +4.6 | | V |
| VI | DC Input Voltage | $-0.5 \le V_{l} \le +4.6$ | | V |
| Vo | DC Output Voltage | $-0.5 \le V_0 \le +4.6$ | Output in 3-State | V |
| | | $-0.5 \le V_{O} \le V_{CC} + 0.5$ | Note 1; Outputs Active | V |
| I _{IK} | DC Input Diode Current | -50 | V _I < GND | mA |
| I _{OK} | DC Output Diode Current | -50 | V _O < GND | mA |
| | | +50 | V _O > V _{CC} | mA |
| I _O | DC Output Source/Sink Current | ±50 | | mA |
| I _{CC} | DC Supply Current Per Supply Pin | ±100 | | mA |
| I _{GND} | DC Ground Current Per Ground Pin | ±100 | | mA |
| T _{STG} | Storage Temperature Range | -65 to +150 | | °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.

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | | Min | Тур | Max | Unit |
|--|--|----------------------------------|-------------|------------|------------------------|------|
| V _{CC} | Supply Voltage | Operating Data Retention Only | 1.65 1.2 | 3.3 3.3 | 3.6 3.6 | V |
| VI | Input Voltage | 03 61 | -0.3 | | 3.6 | V |
| Vo | Output Voltage | (Active State) (3-State) | 0 0 | | V _{CC} 3.6 | ٧ |
| I _{OH} | HIGH Level Output Current, V _{CC} = 3.0 V - 3.6 V | 0.01 | | | -24 | mA |
| I _{OL} | LOW Level Output Current, V _{CC} = 3.0 V - 3.6 V | .0. | | | 24 | mA |
| I _{OH} | HIGH Level Output Current, V _{CC} = 2.3 V - 2.7 V | | | | -18 | mA |
| I_{OL} | LOW Level Output Current, V _{CC} = 2.3 V - 2.7 V | | | | 18 | mA |
| I _{OH} | HIGH Level Output Current, V _{CC} = 1.65 V - 1.95 V | | | | -6 | mA |
| I _{OL} | LOW Level Output Current, V _{CC} = 1.65 V - 1.95 V | | | | 6 | mA |
| T_A | Operating Free-Air Temperature | | -40 | | +85 | °C |
| Δt/ΔV | Input Transition Rise or Fall Rate, V_{IN} from 0.8 V to 2.0 V, V_{CC} = | 3.0 V | 0 | | 10 | ns/V |
| Δt/ΔV Input Transition Rise or Fall Rate, V _{IN} trom 0.8 V to 2.0 V, V _{CC} = 3.0 V 0 10 ns/V | | | | | | |

^{1.} I_O absolute maximum rating must be observed.

DC ELECTRICAL CHARACTERISTICS

| | | | T _A = -40°C | C to +85°C | |
|------------------|---------------------------------------|---|------------------------|------------------------|------|
| Symbol | Characteristic | Condition | Min | Max | Unit |
| V _{IH} | HIGH Level Input Voltage (Note 2) | 1.65 V ≤ V _{CC} < 2.3 V | 0.65 x V _{CC} | | V |
| | | 2.3 V ≤ V _{CC} ≤ 2.7 V | 1.6 | | |
| | | 2.7 V < V _{CC} ≤ 3.6 V | 2.0 | | 1 |
| V _{IL} | LOW Level Input Voltage (Note 2) | 1.65 V ≤ V _{CC} < 2.3 V | | 0.35 x V _{CC} | V |
| | | 2.3 V ≤ V _{CC} ≤ 2.7 V | | 0.7 | 1 |
| | | 2.7 V < V _{CC} ≤ 3.6 V | | 0.8 | 1 |
| V _{OH} | HIGH Level Output Voltage | 1.65 V ≤ V _{CC} ≤ 3.6 V; I _{OH} = −100 μA | V _{CC} - 0.2 | | V |
| | | V _{CC} = 1.65 V; I _{OH} = -6 mA | 1.25 | | |
| | | V _{CC} = 2.3 V; I _{OH} = -6 mA | 2.0 | | 1 |
| | | V _{CC} = 2.3 V; I _{OH} = -12 mA | 1.8 | | |
| | | V _{CC} = 2.3 V; I _{OH} = -18 mA | 1.7 | | |
| | | V _{CC} = 2.7 V; I _{OH} = -12 mA | 2.2 | AP- | |
| | | V _{CC} = 3.0 V; I _{OH} = -18 mA | 2.4 | 0 | |
| | | V _{CC} = 3.0 V; I _{OH} = -24 mA | 2.2 | | 1 |
| V _{OL} | LOW Level Output Voltage | 1.65 V ≤ V _{CC} ≤ 3.6 V; I _{OL} = 100 μA | ~ · | 0.2 | V |
| | | V _{CC} = 1.65 V; I _{OL} = 6 mA | 6 . O | 0.3 | 1 |
| | | V _{CC} = 2.3 V; I _{OL} = 12 mA | | 0.4 | 1 |
| | | V _{CC} = 2.3 V; I _{OL} = 18 mA | | 0.6 | |
| | | V _{CC} = 2.7 V; I _{OL} = 12 mA | | 0.4 | |
| | | V _{CC} = 3.0 V; I _{OL} = 18 mA | | 0.4 | |
| | | V _{CC} = 3.0 V; I _{OL} = 24 mA | | 0.55 | |
| II | Input Leakage Current | 1.65 V ≤ V _{CC} ≤ 3.6 V; 0 V ≤ V _I ≤ 3.6 V | | ±5.0 | μΑ |
| I _{OZ} | 3-State Output Current | $1.65 \text{ V} \le \text{V}_{CC} \le 3.6 \text{ V}; 0 \text{ V} \le \text{V}_0 \le 3.6 \text{ V};$ $\text{V}_1 = \text{V}_{1H} \text{ or V}_{1L}$ | | ±10 | μΑ |
| I _{OFF} | Power-Off Leakage Current | V _{CC} = 0 V; V _I or V _O = 3.6 V | | 10 | μΑ |
| I _{CC} | Quiescent Supply Current (Note 3) | 1.65 V ≤ V _{CC} ≤ 3.6 V; V _I = GND or V _{CC} | | 20 | μΑ |
| | | 1.65 V ≤ V _{CC} ≤ 3.6 V; 3.6 V ≤ V _I , V _O ≤ 3.6 V | | ±20 | μΑ |
| ΔI_{CC} | Increase in I _{CC} per Input | $2.7 \text{ V} < \text{V}_{\text{CC}} \le 3.6 \text{ V}; \text{V}_{\text{IH}} = \text{V}_{\text{CC}} - 0.6 \text{ V}$ | | 750 | μΑ |

^{2.} These values of V_I are used to test DC electrical characteristics only.

AC CHARACTERISTICS (Note 4; $t_R = t_F = 2.0$ ns; $C_L = 30$ pF; $R_L = 500 \Omega$)

| | | | | | $T_A = -40^\circ$ | C to +85°C | | | |
|--------------------------------------|--|----------|-----------------------|------------|-----------------------|------------|------------------------|--------------|------|
| | | 2. | V _{CC} = 3.0 | V to 3.6 V | V _{CC} = 2.3 | V to 2.7 V | V _{CC} = 1.65 | V to1.95 V | |
| Symbol | Parameter | Waveform | Min | Max | Min | Max | Min | Max | Unit |
| t _{PLH} t _{PHL} | Propagation Delay Input-to-Output | 1 | 0.8 0.8 | 2.5 2.5 | 1.0 1.0 | 3.0 3.0 | 1.5 1.5 | 6.0 6.0 | ns |
| t _{PZH} t _{PZL} | Output Enable Time to High and Low Level | 2 | 0.8 0.8 | 3.8 3.8 | 1.0 1.0 | 4.9 4.9 | 1.5 1.5 | 9.3 9.3 | ns |
| t _{PHZ} t _{PLZ} | Output Disable Time From High and Low Level | 2 | 0.8 0.8 | 3.7 3.7 | 1.0 1.0 | 4.2 4.2 | 1.5 1.5 | 7.6 7.6 | ns |
| toshl toslh | Output-to-Output Skew (Note 5) | | | 0.5 0.5 | | 0.5 0.5 | | 0.75 0.75 | ns |

^{4.} For $C_L = 50$ pF, add approximately 300 ps to the AC maximum specification.

^{3.} Outputs disabled or 3-state only.

Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device.
 The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}); parameter guaranteed by design.

AC CHARACTERISTICS ($t_R = t_F = 2.0 \text{ ns}$; $C_L = 50 \text{ pF}$; $R_L = 500 \Omega$)

| | | | | T _A = -40°C | to +85°C | | |
|--|---|----------|-----------------------|------------------------|-------------------|------------|------|
| | | | V _{CC} = 3.0 | V to 3.6V | V _{CC} = | 2.7 V | 1 |
| Symbol | Parameter | Waveform | Min | Max | Min | Max | Unit |
| t _{PLH} t _{PHL} | Propagation Delay Input-to-Output | 3 | 1.0 1.0 | 3.0 3.0 | | 3.6 3.6 | ns |
| t _{PZH} t _{PZL} | Output Enable Time to High and Low Level | 4 | 1.0 1.0 | 4.4 4.4 | | 5.4 5.4 | ns |
| t _{PHZ} t _{PLZ} | Output Disable Time From High and Low Level | 4 | 1.0 1.0 | 4.1 4.1 | | 4.6 4.6 | ns |
| t _{OSHL} t _{OSLH} | Output-to-Output Skew (Note 6) | | | 0.5 0.5 | | 0.5 0.5 | ns |

Skew is defined as the absolute value of the difference between the actual propagation delay for any two separate outputs of the same device.
 The specification applies to any outputs switching in the same direction, either HIGH-to-LOW (t_{OSHL}) or LOW-to-HIGH (t_{OSLH}); parameter guaranteed by design.

DYNAMIC SWITCHING CHARACTERISTICS

| | | | T _A = +25°C | |
|------------------|-----------------------------|--|------------------------|------|
| Symbol | Characteristic | Condition | Тур | Unit |
| V _{OLP} | Dynamic LOW Peak Voltage | $V_{CC} = 1.8 \text{ V}, C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0 \text{ V}$ | 0.25 | V |
| | (Note 7) | V_{CC} = 2.5 V, C_L = 30 pF, V_{IH} = V_{CC} , V_{IL} = 0 V | 0.6 | |
| | | V_{CC} = 3.3 V, C_L = 30 pF, V_{IH} = V_{CC} , V_{IL} = 0 V | 0.8 | |
| V _{OLV} | Dynamic LOW Valley Voltage | $V_{CC} = 1.8 \text{ V}, C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0 \text{ V}$ | -0.25 | V |
| | (Note 7) | $V_{CC} = 2.5 \text{ V}, C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0 \text{ V}$ | -0.6 | |
| | | V_{CC} = 3.3 V, C_L = 30 pF, V_{IH} = V_{CC} , V_{IL} = 0 V | -0.8 | |
| V _{OHV} | Dynamic HIGH Valley Voltage | $V_{CC} = 1.8 \text{ V}, C_L = 30 \text{ pF}, V_{IH} = V_{CC}, V_{IL} = 0 \text{ V}$ | 1.5 | V |
| | (Note 8) | $V_{CC} = 2.5 \text{ V, } C_L = 30 \text{ pF, } V_{IH} = V_{CC}, V_{IL} = 0 \text{ V}$ | 1.9 | |
| | | V_{CC} = 3.3 V, C_L = 30 pF, V_{IH} = V_{CC} , V_{IL} = 0 V | 2.2 | |

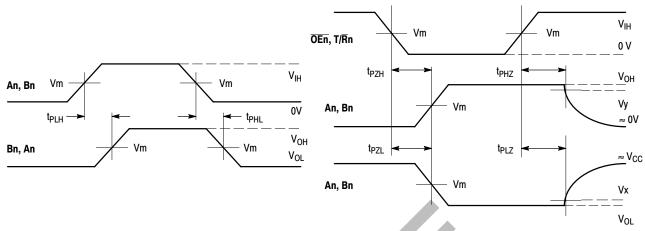
^{7.} Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the LOW state.

CAPACITIVE CHARACTERISTICS

| Symbol | Parameter | Condition | Typical | Unit |
|------------------|-------------------------------|----------------|---------|------|
| C _{IN} | Input Capacitance | Note 9 | 6 | pF |
| C _{OUT} | Output Capacitance | Note 9 | 7 | pF |
| C _{PD} | Power Dissipation Capacitance | Note 9, 10 MHz | 20 | pF |

^{9.} $V_{CC} = 1.8 \text{ V}, 2.5 \text{ V or } 3.3 \text{ V}; V_I = 0 \text{ V or } V_{CC}.$

^{8.} Number of outputs defined as "n". Measured with "n-1" outputs switching from HIGH-to-LOW or LOW-to-HIGH. The remaining output is measured in the HIGH state.



WAVEFORM 1 - PROPAGATION DELAYS

 t_R = t_F = 2.0 ns, 10% to 90%; f = 1 MHz; t_W = 500 ns

WAVEFORM 2 - OUTPUT ENABLE AND DISABLE TIMES

 $t_R = t_F = 2.0 \text{ ns}, 10\% \text{ to } 90\%; f = 1 \text{ MHz}; t_W = 500 \text{ ns}$

Figure 4. AC Waveforms

Table 2. AC WAVEFORMS

| | | V _{CC} | |
|-----------------|-------------------------|--------------------------|--------------------------|
| Symbol | 3.3 V ± 0.3 V | 2.5 V ± 0.2 V | 1.8 V ± 0.15 V |
| V _{IH} | 2.7 V | V _{CC} | V _{CC} |
| V _m | 1.5 V | V _{CC} /2 | V _{CC} /2 |
| V _x | V _{OL} + 0.3 V | V _{OL} + 0.15 V | V _{OL} + 0.15 V |
| Vy | V _{OH} – 0.3 V | V _{OH} – 0.15 V | V _{OH} – 0.15 V |

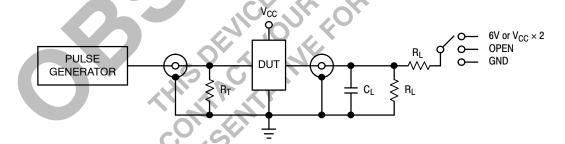


Figure 5. Test Circuit

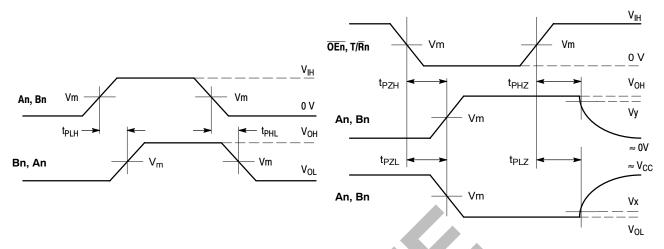
Table 3. TEST CIRCUIT

| TEST | SWITCH |
|-------------------------------------|--|
| t _{PLH} , t _{PHL} | Open |
| t _{PZL} , t _{PLZ} | 6 V at V_{CC} = 3.3 ± 0.3 V; V_{CC} × 2 at V_{CC} = 2.5 ± 0.2 V; 1.8 ± 0.15 V |
| t _{PZH} , t _{PHZ} | GND |

 C_L = 30 pF or equivalent (Includes jig and probe capacitance)

 $R_L = 500 \Omega$ or equivalent

 $R_T = Z_{OUT}$ of pulse generator (typically 50 Ω)



WAVEFORM 3 - PROPAGATION DELAYS

WAVEFORM 4 - OUTPUT ENABLE AND DISABLE TIMES $t_R = t_F = 2.0$ ns, 10% to 90%; f = 1 MHz; $t_W = 500$ ns $t_R = t_F = 2.0 \text{ ns}, 10\% \text{ to } 90\%; f = 1 \text{ MHz}; t_W = 500 \text{ ns}$

Figure 6. AC Waveforms

Table 4. AC WAVEFORMS

| | V _{cc} | | |
|-----------------|-------------------------|-------------------------|--|
| Symbol | 3.3 V ± 0.3 V | 2.7 V | |
| V _{IH} | 2.7 V | 2.7 V | |
| V _m | 1.5 V | 1.5 V | |
| V _x | V _{OL} + 0.3 V | V _{OL} + 0.3 V | |
| V _y | V _{OH} - 0.3 V | V _{OH} – 0.3 V | |

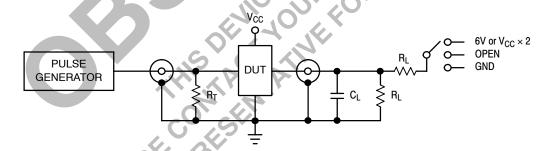


Figure 7. Test Circuit

Table 5. TEST CIRCUIT

| TEST | SWITCH | |
|-------------------------------------|--|--|
| t _{PLH} , t _{PHL} | Open | |
| t _{PZL} , t _{PLZ} | 6 V at V_{CC} = 3.3 ± 0.3 V; V_{CC} × 2 at V_{CC} = 2.5 ± 0.2 V; 1.8 ± 0.15 V | |
| t _{PZH} , t _{PHZ} | GND | |

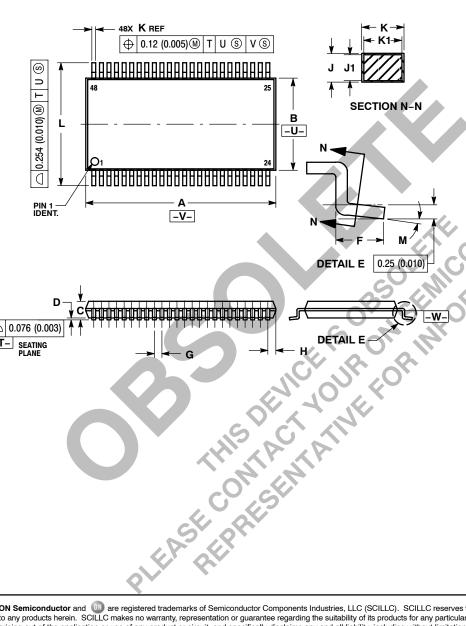
C_L = 50 pF or equivalent (Includes jig and probe capacitance)

 $R_L = 500 \Omega$ or equivalent

 $R_T = Z_{OUT}$ of pulse generator (typically 50 Ω)

PACKAGE DIMENSIONS

TSSOP DT SUFFIX CASE 1201-01 **ISSUE A**



NOTES:

- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982. CONTROLLING DIMENSION: MILLIMETER.
 - DIMENSIONS A AND B DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS
- SHALL NOT EXCEED 0.15 (0.006) PER SIDE. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM
- EXCESS OF THE R DIMENSION AT MAXIM MATERIAL CONDITION.
 TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
 DIMENSIONS A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

| | MILLIMETERS | | INCHES | |
|-----|-------------|-------|------------|-------|
| DIM | MIN | MAX | MIN | MAX |
| A 4 | 12.40 | 12.60 | 0.488 | 0.496 |
| В | 6.00 | 6.20 | 0.236 | 0.244 |
| C | | 1.10 | | 0.043 |
| D | 0.05 | 0.15 | 0.002 | 0.006 |
| F | 0.50 | 0.75 | 0.020 | 0.030 |
| G | 0.50 BSC | | 0.0197 BSC | |
| H | 0.37 | | 0.015 | |
| J | 0.09 | 0.20 | 0.004 | 0.008 |
| J1 | 0.09 | 0.16 | 0.004 | 0.006 |
| K | 0.17 | 0.27 | 0.007 | 0.011 |
| K1 | 0.17 | 0.23 | 0.007 | 0.009 |
| L | 7.95 | 8.25 | 0.313 | 0.325 |
| M | 0 ° | 8° | 0 ° | 8° |

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