# TCA0372, TCA0372B

# 1.0 A Output Current, Dual Power Operational Amplifiers

The TCA0372 is a monolithic circuit intended for use as a power operational amplifier in a wide range of applications, including servo amplifiers and power supplies. No deadband crossover distortion provides better performance for driving coils.

### Features

- Output Current to 1.0 A
- Slew Rate of 1.3 V/μs
- Wide Bandwidth of 1.1 MHz
- Internal Thermal Shutdown
- Single or Split Supply Operation
- Excellent Gain and Phase Margins
- Common Mode Input Includes Ground
- Zero Deadband Crossover Distortion
- Pb−Free Packages are Available*

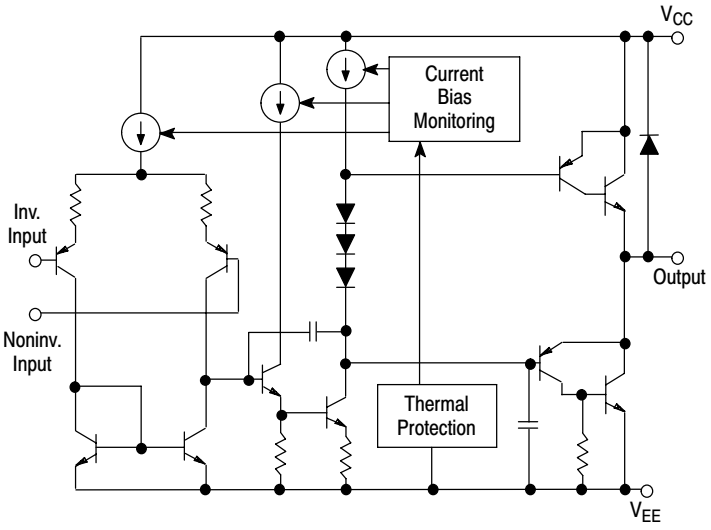
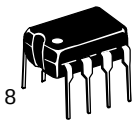


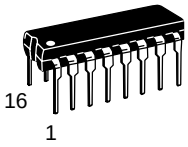

**Figure 1. Representative Block Diagram**

**ON Semiconductor®**

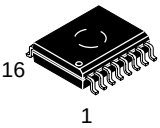
**http://onsemi.com**



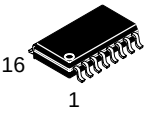

**PDIP−8**
**DP1 SUFFIX**
**CASE 626**




**PDIP−16**
**DP2 SUFFIX**
**CASE 648**




**SOIC−16W**
**DW SUFFIX**
**CASE 751G**




**SOEIAJ−16**
**DM2 SUFFIX**
**CASE 966**

## ORDERING INFORMATION

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

## DEVICE MARKING INFORMATION

See general marking information in the device marking 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.

**MAXIMUM RATINGS**

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Supply Voltage (from $V_{CC}$ to $V_{EE}$) | $V_S$ | 40 | V |
| Input Differential Voltage Range | $V_{IDR}$ | Note 1 | V |
| Input Voltage Range | $V_{IR}$ | Note 1 | V |
| Junction Temperature (Note 2) | $T_J$ | +150 | °C |
| Operating Temperature Range | $T_A$ | −40 to +125 | °C |
| Storage Temperature Range | $T_{stg}$ | −55 to +150 | °C |
| DC Output Current | $I_O$ | 1.0 | A |
| Peak Output Current (Nonrepetitive) | $I_{(max)}$ | 1.5 | A |
| Thermal Resistance, Junction−to−Air<br>Case 626<br>Case 648<br>Case 751G | $R_{\theta JA}$ | <br>137<br>72<br>80 | °C/W |
| Thermal Resistance, Junction−to−Case<br>Case 626<br>Case 648<br>Case 751G | $R_{\theta JC}$ | <br>23<br>10<br>12 | °C/W |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. Either or both input voltages should not exceed the magnitude of $V_{CC}$ or $V_{EE}$.
2. Power dissipation must be considered to ensure maximum junction temperature ($T_J$) is not exceeded.

**DC ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = +15 V, $V_{EE}$ = −15 V, $R_L$ connected to ground, $T_A$ = −40° to +125°C.)

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Input Offset Voltage ($V_{CM}$ = 0) | $V_{IO}$ | | | | mV |
| $T_A$ = +25°C | | − | 1.0 | 15 | |
| $T_A$, $T_{low}$ to $T_{high}$ | | − | − | 20 | |
| Average Temperature Coefficient of Offset Voltage | $\Delta V_{IO}/\Delta T$ | − | 20 | − | μV/°C |
| Input Bias Current ($V_{CM}$ = 0) | $I_{IB}$ | − | 100 | 500 | nA |
| Input Offset Current ($V_{CM}$ = 0) | $I_{IO}$ | − | 10 | 50 | nA |
| Large Signal Voltage Gain | $A_{VOL}$ | 30 | 100 | − | V/mV |
| $V_O$ = ±10 V, $R_L$ = 2.0 k | | | | | |
| Output Voltage Swing ($I_L$ = 100 mA) | $V_{OH}$ | | | | V |
| $T_A$ = +25°C | | 14.0 | 14.2 | − | |
| $T_A$ = $T_{low}$ to $T_{high}$ | | 13.9 | − | − | |
| $T_A$ = +25°C | $V_{OL}$ | − | −14.2 | −14.0 | |
| $T_A$ = $T_{low}$ to $T_{high}$ | | − | − | −13.9 | |
| Output Voltage Swing ($I_L$ = 1.0 A) | $V_{OH}$ | | | | V |
| $V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = +25°C | | 22.5 | 22.7 | − | |
| $V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = $T_{low}$ to $T_{high}$ | | 22.5 | − | − | |
| $V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = +25°C | $V_{OL}$ | − | 1.3 | 1.5 | |
| $V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = $T_{low}$ to $T_{high}$ | | − | − | 1.5 | |
| Input Common Mode Voltage Range | $V_{ICR}$ | | | | V |
| $T_A$ = +25°C | | | $V_{EE}$ to ($V_{CC}$ −1.0) | | |
| $T_A$ = $T_{low}$ to $T_{high}$ | | | $V_{EE}$ to ($V_{CC}$ −1.3) | | |
| Common Mode Rejection Ratio ($R_S$ = 10 k) | CMRR | 70 | 90 | − | dB |
| Power Supply Rejection Ratio ($R_S$ = 100 Ω) | PSRR | 70 | 90 | − | dB |
| Power Supply Current | $I_D$ | | | | mA |
| $T_A$ = +25°C TCA0372 | | − | 5.0 | 10 | |
| TCA0372B | | − | 8.0 | 10 | |
| $T_A$ = $T_{low}$ to $T_{high}$ TCA0372 | | − | − | 14 | |
| TCA0372B | | − | − | 14 | |

**AC ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = +15 V, $V_{EE}$ = −15 V, $R_L$ connected to ground, $T_A$ = +25°C, unless otherwise noted.)

| Characteristics | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|
| Slew Rate ($V_{in}$ = −10 V to +10 V, $R_L$ = 2.0 k, $C_L$ = 100 pF) | SR | 1.0 | 1.4 | − | V/μs |
| $A_V$ = −1.0, $T_A$ = $T_{low}$ to $T_{high}$ | | | | | |
| Gain Bandwidth Product (f = 100 kHz, $C_L$ = 100 pF, $R_L$ = 2.0 k) | GBW | | | | MHz |
| $T_A$ = 25°C | | 0.9 | 1.4 | − | |
| $T_A$ = $T_{low}$ to $T_{high}$ | | 0.7 | − | − | |
| Phase Margin $T_J$ = $T_{low}$ to $T_{high}$ | $\phi_m$ | − | 65 | − | Degrees |
| $R_L$ = 2.0 k, $C_L$ = 100 pF | | | | | |
| Gain Margin | $A_m$ | − | 15 | − | dB |
| $R_L$ = 2.0 k, $C_L$ = 100 pF | | | | | |
| Equivalent Input Noise Voltage | $e_n$ | − | 22 | − | $nV/\sqrt{Hz}$ |
| $R_S$ = 100 Ω, f = 1.0 to 100 kHz | | | | | |
| Total Harmonic Distortion | THD | − | 0.02 | − | % |
| $A_V$ = −1.0, $R_L$ = 50 Ω, $V_O$ = 0.5 VRMS, f = 1.0 kHz | | | | | |

NOTE: In case $V_{EE}$ is disconnected before $V_{CC}$, a diode between $V_{EE}$ and Ground is recommended to avoid damaging the device.

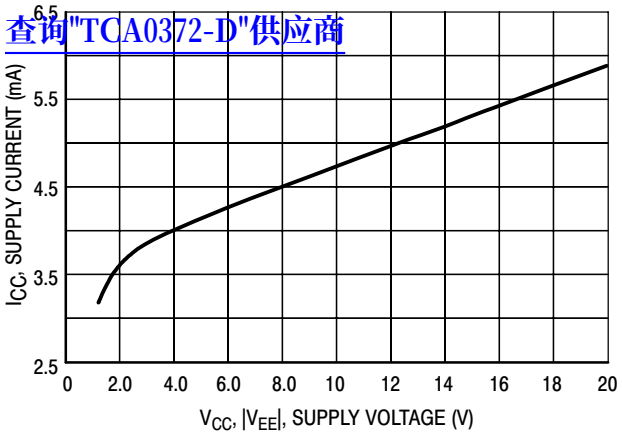



**Figure 2. Supply Current versus Supply Voltage with No Load**

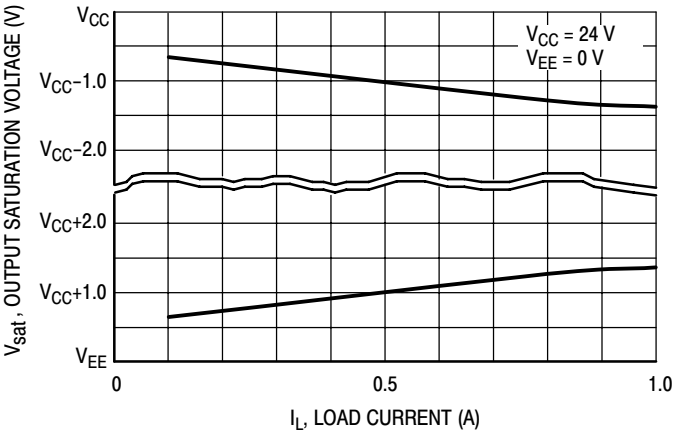



**Figure 3. Output Saturation Voltage versus Load Current**

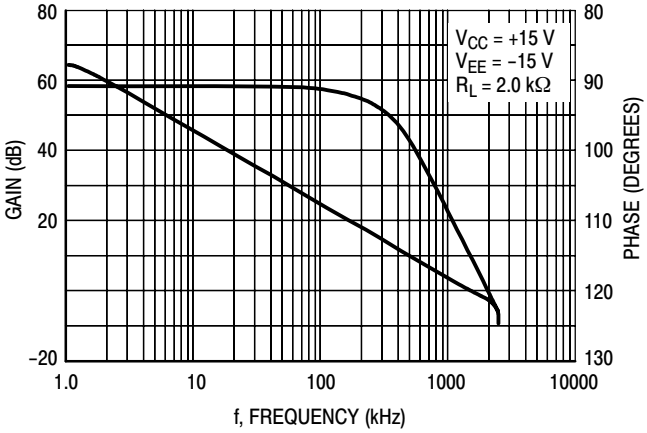



**Figure 4. Voltage Gain and Phase versus Frequency**

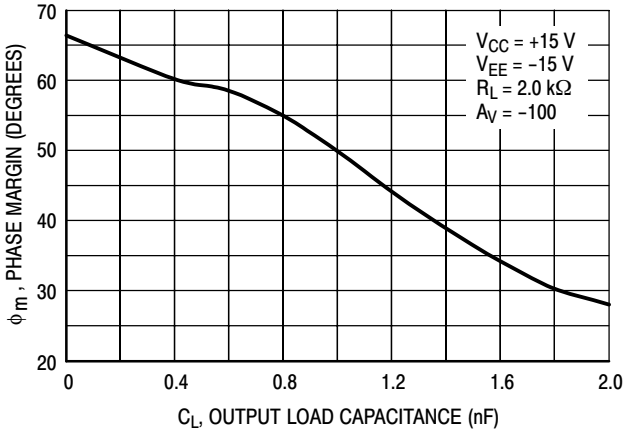



**Figure 5. Phase Margin versus Output Load Capacitance**

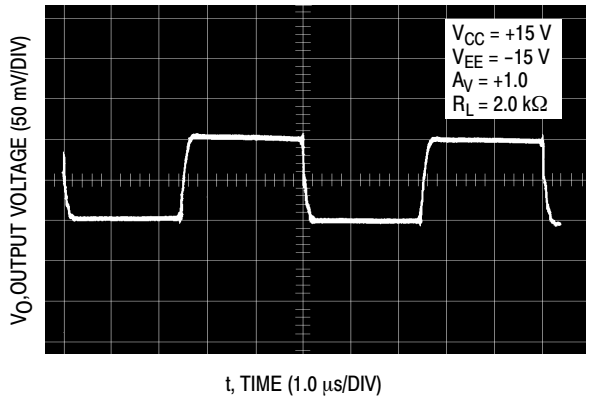



**Figure 6. Small Signal Transient Response**

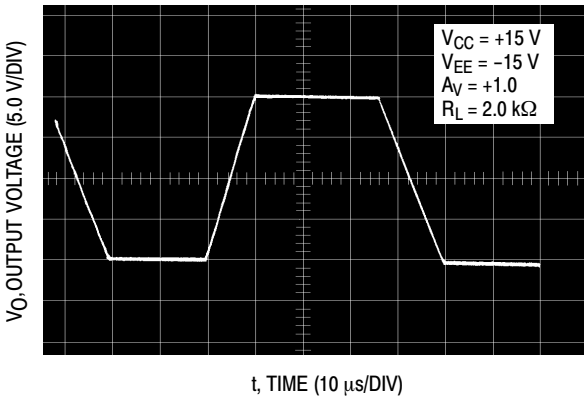



**Figure 7. Large Signal Transient Response**

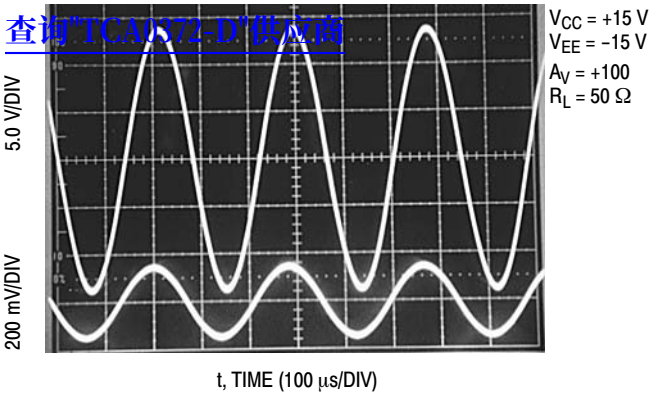



**Figure 8. Sine Wave Response**

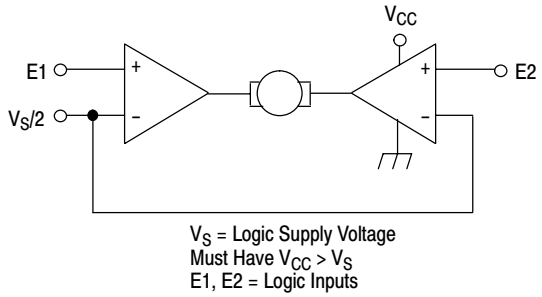
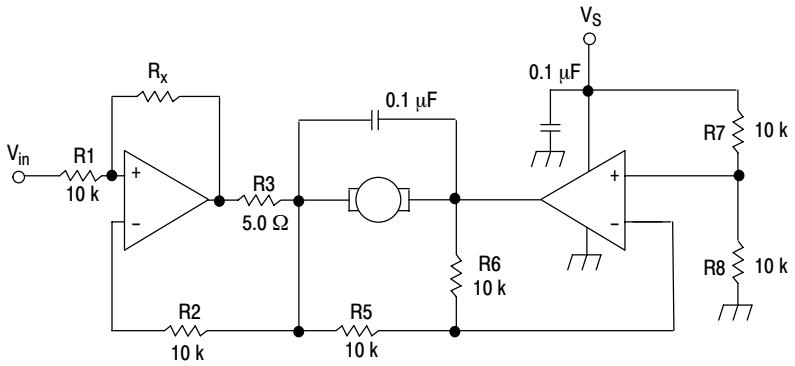



**Figure 9. Bidirectional DC Motor Control with Microprocessor−Compatible Inputs**




For circuit stability, ensure that $R_x > \frac{2R3 \cdot R1}{R_M}$ where, $R_M$ = internal resistance of motor.

The voltage available at the terminals of the motor is: $V_M = 2\left(V_1 - \frac{V_S}{2}\right) + |R_o| \cdot I_M$

where, $|R_o| = \frac{2R3 \cdot R1}{R_x}$ and $I_M$ is the motor current.

**Figure 10. Bidirectional Speed Control of DC Motors**

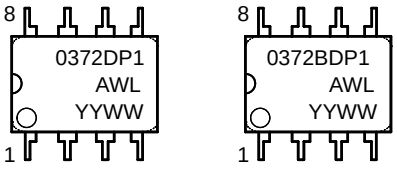
## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| TCA0372DW | SOIC−16W | 47 Units / Rail |
| TCA0372DWG | SOIC−16W (Pb−Free) | 47 Units / Rail |
| TCA0372DWR2 | SOIC−16W | 1000 Tape & Reel |
| TCA0372DWR2G | SOIC−16W (Pb−Free) | 1000 Tape & Reel |
| TCA0372BDWR2 | SOIC−16W | 1000 Tape & Reel |
| TCA0372BDWR2G | SOIC−16W (Pb−Free) | 1000 Tape & Reel |
| TCA0372DP1 | PDIP−8 | 50 Units / Rail |
| TCA0372DP1G | PDIP−8 (Pb−Free) | 50 Units / Rail |
| TCA0372BDP1 | PDIP−8 | 50 Units / Rail |
| TCA0372BDP1G | PDIP−8 (Pb−Free) | 50 Units / Rail |
| TCA0372DP2 | PDIP−16 | 25 Units / Rail |
| TCA0372DP2G | PDIP−16 (Pb−Free) | 25 Units / Rail |
| TCA0372DM2EL | SOEIAJ−16 | 2500 Tape & Reel |
| TCA0372DM2ELG | SOEIAJ−16 (Pb−Free) | 2500 Tape & Reel |

†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.

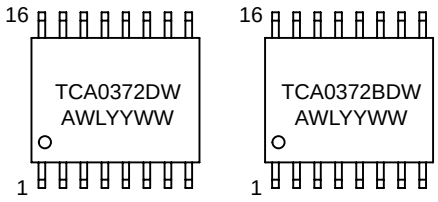
## MARKING DIAGRAMS

**PDIP−8**
**DP1 SUFFIX**
**CASE 626**

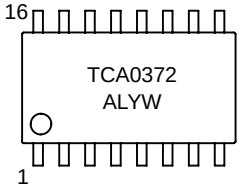



**PDIP−16**
**DP2 SUFFIX**
**CASE 648**


**SOIC−16W**
**DW SUFFIX**
**CASE 751G**



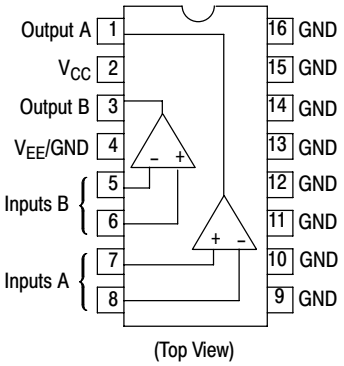

**SOEIAJ−16**
**DM2 SUFFIX**
**CASE 966**




A = Assembly Location
WL, L = Wafer Lot
YY, Y = Year
WW, W = Work Week

## PIN CONNECTIONS

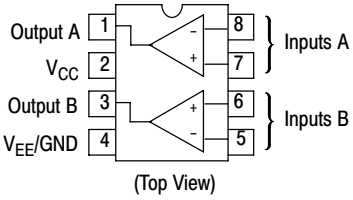
**CASE 648**




(Top View)

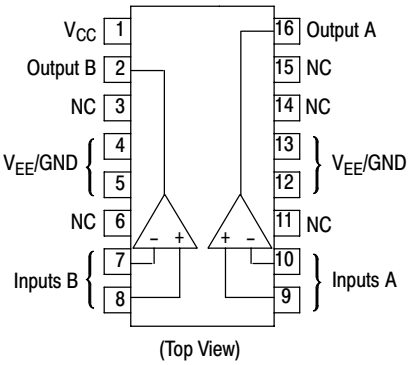
*Pins 4 and 9 to 16 are internally connected.

**CASE 626**



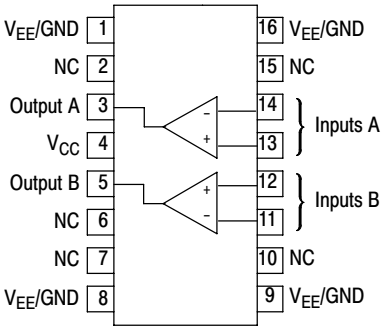

(Top View)

**CASE 751G**




(Top View)

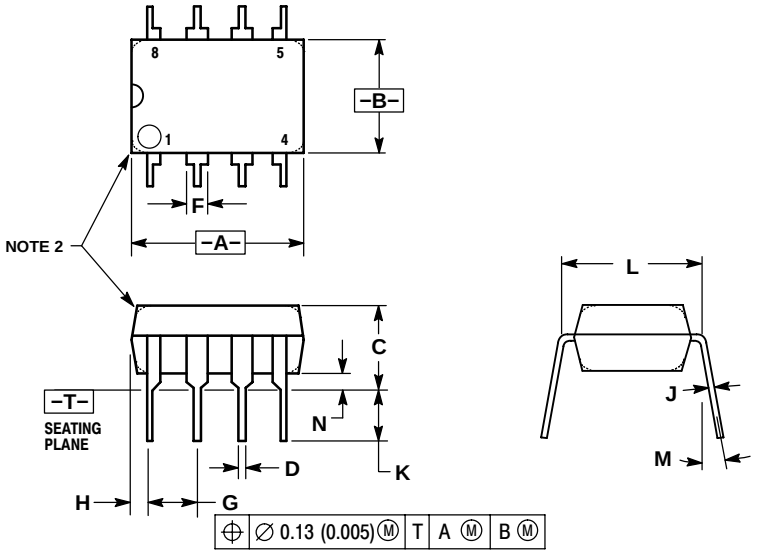
**CASE 966**




(Top View)

## PACKAGE DIMENSIONS

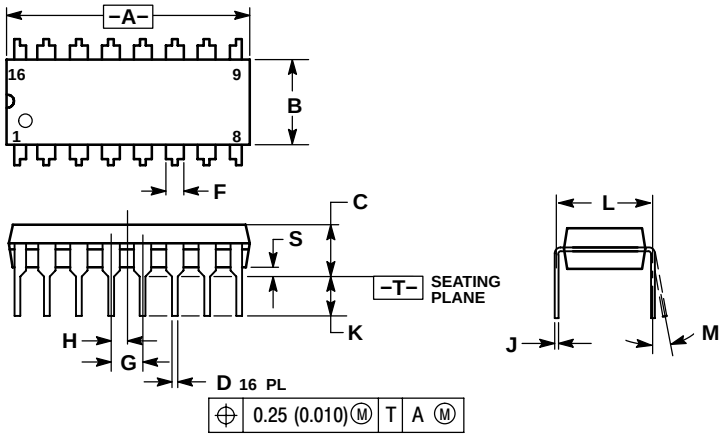
**PDIP−8**
**DP1 SUFFIX**
CASE 626−05
ISSUE L




NOTES:
1. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
2. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
3. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 9.40 | 10.16 | 0.370 | 0.400 |
| B | 6.10 | 6.60 | 0.240 | 0.260 |
| C | 3.94 | 4.45 | 0.155 | 0.175 |
| D | 0.38 | 0.51 | 0.015 | 0.020 |
| F | 1.02 | 1.78 | 0.040 | 0.070 |
| G | 2.54 BSC | | 0.100 BSC | |
| H | 0.76 | 1.27 | 0.030 | 0.050 |
| J | 0.20 | 0.30 | 0.008 | 0.012 |
| K | 2.92 | 3.43 | 0.115 | 0.135 |
| L | 7.62 BSC | | 0.300 BSC | |
| M | --- | 10° | --- | 10° |
| N | 0.76 | 1.01 | 0.030 | 0.040 |

**PDIP−16**
**DP2 SUFFIX**
CASE 648−08
ISSUE T

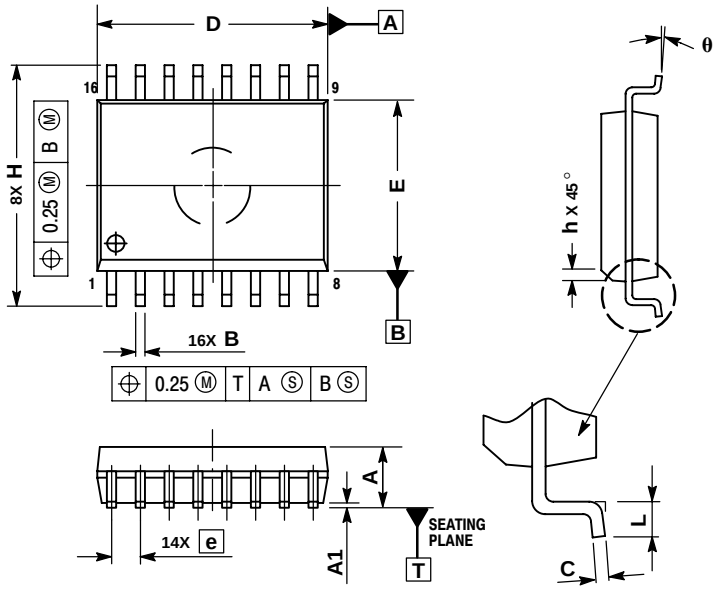



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.740 | 0.770 | 18.80 | 19.55 |
| B | 0.250 | 0.270 | 6.35 | 6.85 |
| C | 0.145 | 0.175 | 3.69 | 4.44 |
| D | 0.015 | 0.021 | 0.39 | 0.53 |
| F | 0.040 | 0.70 | 1.02 | 1.77 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.050 BSC | | 1.27 BSC | |
| J | 0.008 | 0.015 | 0.21 | 0.38 |
| K | 0.110 | 0.130 | 2.80 | 3.30 |
| L | 0.295 | 0.305 | 7.50 | 7.74 |
| M | 0° | 10° | 0° | 10° |
| S | 0.020 | 0.040 | 0.51 | 1.01 |

## PACKAGE DIMENSIONS

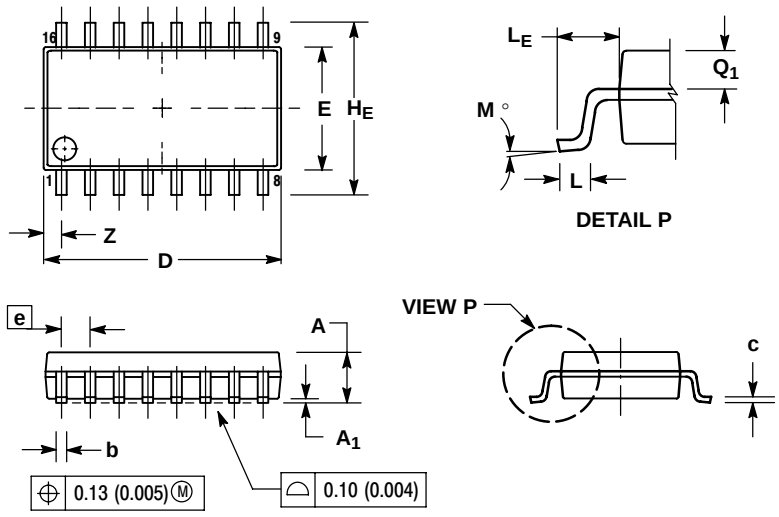
**SOIC−16W**
**DW SUFFIX**
CASE 751G−03
ISSUE B




NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INLCUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

| | MILLIMETERS | |
|---|---|---|
| DIM | MIN | MAX |
| A | 2.35 | 2.65 |
| A1 | 0.10 | 0.25 |
| B | 0.35 | 0.49 |
| C | 0.23 | 0.32 |
| D | 10.15 | 10.45 |
| E | 7.40 | 7.60 |
| e | 1.27 BSC | |
| H | 10.05 | 10.55 |
| h | 0.25 | 0.75 |
| L | 0.50 | 0.90 |
| θ | 0° | 7° |

**SOEIAJ−16**
**DM2 SUFFIX**
CASE 966−01
ISSUE O




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 ( 0.018).

| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | --- | 2.05 | --- | 0.081 |
| $A_1$ | 0.05 | 0.20 | 0.002 | 0.008 |
| b | 0.35 | 0.50 | 0.014 | 0.020 |
| c | 0.18 | 0.27 | 0.007 | 0.011 |
| D | 9.90 | 10.50 | 0.390 | 0.413 |
| E | 5.10 | 5.45 | 0.201 | 0.215 |
| e | 1.27 BSC | | 0.050 BSC | |
| $H_E$ | 7.40 | 8.20 | 0.291 | 0.323 |
| L | 0.50 | 0.85 | 0.020 | 0.033 |
| $L_E$ | 1.10 | 1.50 | 0.043 | 0.059 |
| M | 0° | 10° | 0° | 10° |
| $Q_1$ | 0.70 | 0.90 | 0.028 | 0.035 |
| Z | --- | 0.78 | --- | 0.031 |

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