# TCA0372, TCA0372B, NCV0372B

## 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
- NCV devices are AEC−Q100 Qualified and PPAP Capable
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

## ON Semiconductor®

**http://onsemi.com**

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

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

**SOIC−16W**
**DW SUFFIX**
**CASE 751G**
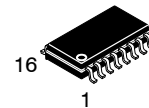
**SOEIAJ−16**
**DM2 SUFFIX**
**CASE 966**

### ORDERING INFORMATION

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

### DEVICE MARKING INFORMATION

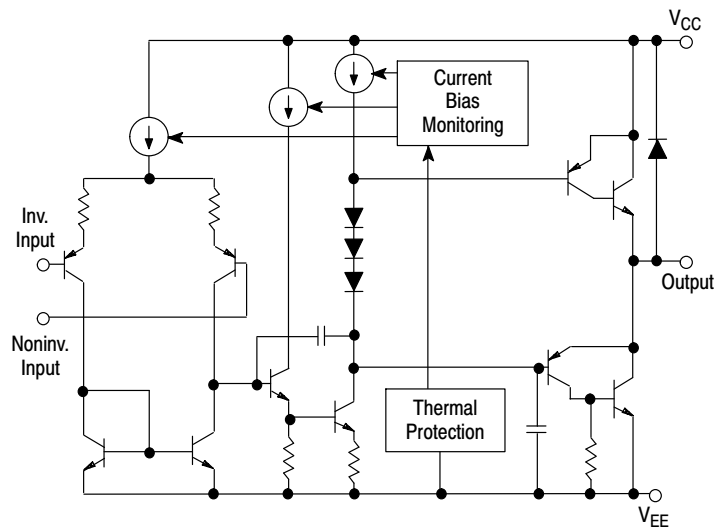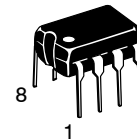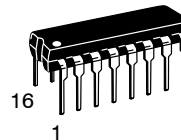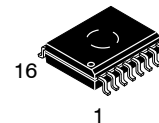See general marking information in the device marking section on page 6 of this data sheet.



**Figure 1. Representative Block Diagram**

**1**

**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 |

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.
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)<br>$T_A$ = +25°C<br>$T_A$, $T_{low}$ to $T_{high}$ | $V_{IO}$ | <br>−<br>− | <br>1.0<br>− | <br>15<br>20 | mV |
| 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<br>$V_O$ = ±10 V, $R_L$ = 2.0 k | $A_{VOL}$ | 30 | 100 | − | V/mV |
| Output Voltage Swing ($I_L$ = 100 mA)<br>$T_A$ = +25°C<br>$T_A$ = $T_{low}$ to $T_{high}$<br>$T_A$ = +25°C<br>$T_A$ = $T_{low}$ to $T_{high}$ | $V_{OH}$<br><br><br>$V_{OL}$ | <br>14.0<br>13.9<br>−<br>− | <br>14.2<br>−<br>−14.2<br>− | <br>−<br>−<br>−14.0<br>−13.9 | V |
| Output Voltage Swing ($I_L$ = 1.0 A)<br>$V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = +25°C<br>$V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = $T_{low}$ to $T_{high}$<br>$V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = +25°C<br>$V_{CC}$ = +24 V, $V_{EE}$ = 0 V, $T_A$ = $T_{low}$ to $T_{high}$ | $V_{OH}$<br><br><br>$V_{OL}$ | <br>22.5<br>22.5<br>−<br>− | <br>22.7<br>−<br>1.3<br>− | <br>−<br>−<br>1.5<br>1.6 | V |
| Input Common Mode Voltage Range<br>$T_A$ = +25°C<br>$T_A$ = $T_{low}$ to $T_{high}$ | $V_{ICR}$ | | $V_{EE}$ to ($V_{CC}$ −1.0)<br>$V_{EE}$ to ($V_{CC}$ −1.3) | | V |
| 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<br>$T_A$ = +25°C      TCA0372<br>            TCA0372B/NCV0372B<br>$T_A$ = $T_{low}$ to $T_{high}$  TCA0372<br>            TCA0372B/NCV0372B | $I_D$ | <br>−<br>−<br>−<br>− | <br>5.0<br>8.0<br>−<br>− | <br>10<br>10<br>14<br>14 | mA |

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

NOTE: In case $V_{EE}$ is disconnected before $V_{CC}$, a diode between $V_{EE}$ and Ground is recommended to avoid damaging the device.
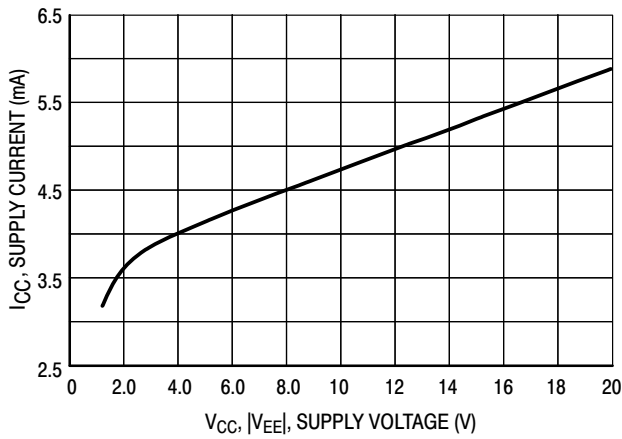
Figure 2. Supply Current versus Supply
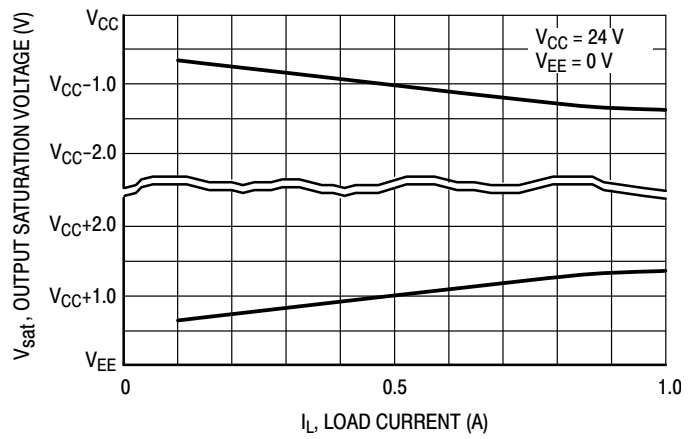Voltage with No Load



Figure 3. Output Saturation Voltage
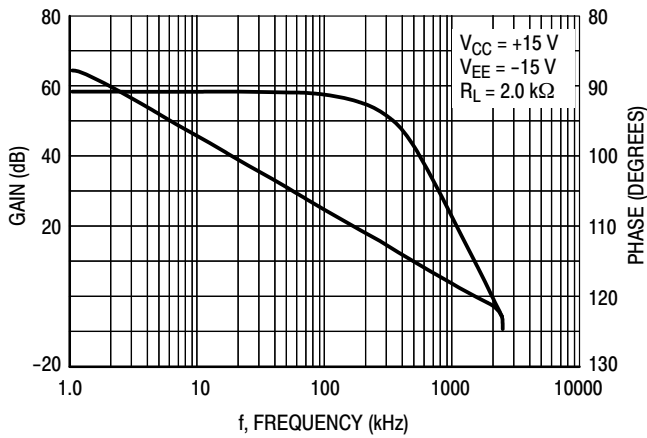versus Load Current



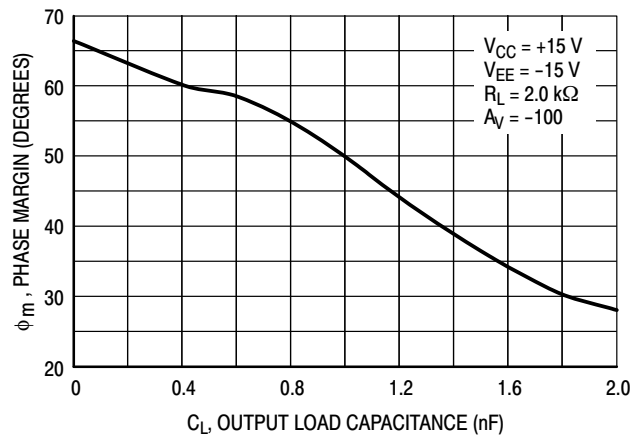Figure 4. Voltage Gain and Phase
versus Frequency



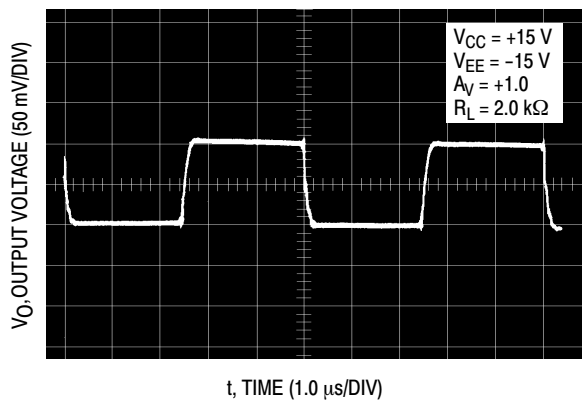Figure 5. Phase Margin versus Output
Load Capacitance



Figure 6. Small Signal Transient Response
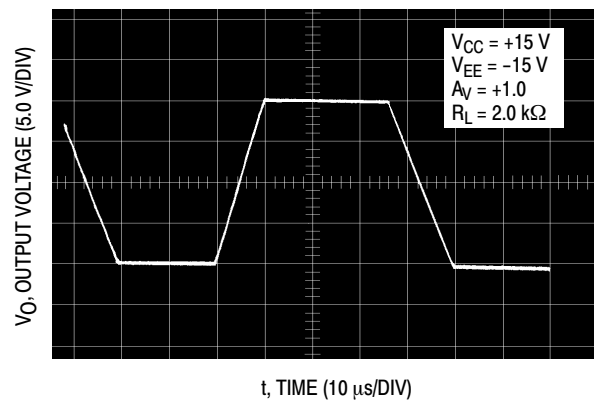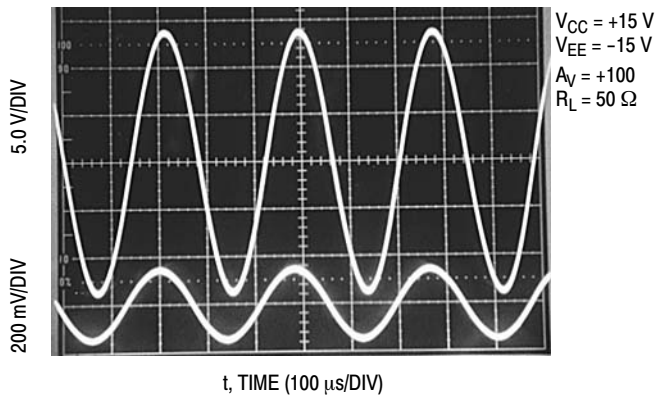


Figure 7. Large Signal Transient Response

$V_{CC} = +15$ V
$V_{EE} = -15$ V
$A_V = +100$
$R_L = 50$ $\Omega$

t, TIME (100 $\mu$s/DIV)

**Figure 8. Sine Wave Response**



$V_S$ = Logic Supply Voltage
Must Have $V_{CC} > V_S$
E1, E2 = Logic Inputs
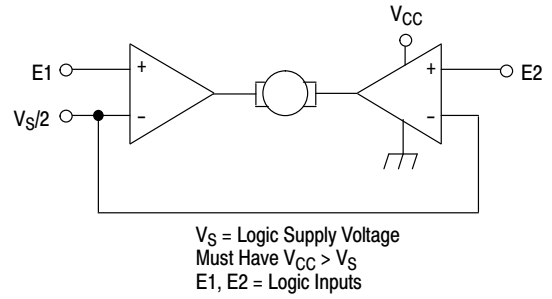
**Figure 9. Bidirectional DC Motor Control with Microprocessor−Compatible Inputs**
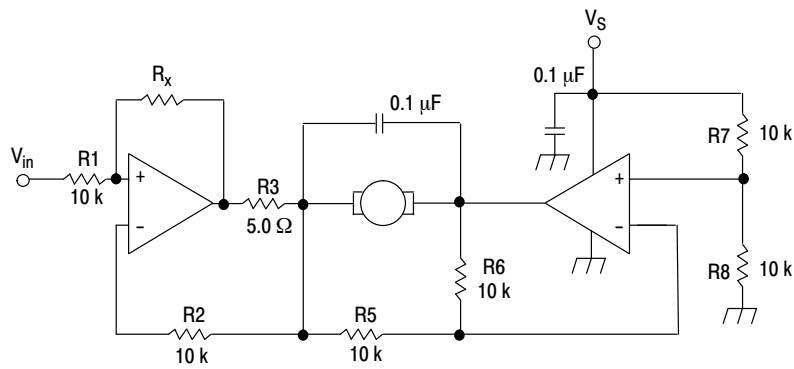


For circuit stability, ensure that $R_x > \dfrac{2R3 \cdot R1}{R_M}$ where, $R_M$ = internal resistance of motor.

The voltage available at the terminals of the motor is: $V_M = 2\left(V_1 - \dfrac{V_S}{2}\right) + |R_0| \cdot I_M$

where, $|R_0| = \dfrac{2R3 \cdot R1}{R_x}$ and $I_M$ is the motor current.

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

# TCA0372, TCA0372B, NCV0372B

## ORDERING INFORMATION

| Device | Package | Shipping[†] |
|---|---|---|
| TCA0372DWG | SOIC−16W (Pb−Free) | 47 Units / Rail |
| TCA0372DWR2G | SOIC−16W (Pb−Free) | 1000 / Tape & Reel |
| TCA0372BDWR2G | SOIC−16W (Pb−Free) | 1000 / Tape & Reel |
| NCV0372BDWR2G* | SOIC−16W (Pb−Free) | 1000 / Tape & Reel |
| TCA0372DP1G | PDIP−8 (Pb−Free) | 50 Units / Rail |
| TCA0372BDP1G | PDIP−8 (Pb−Free) | 50 Units / Rail |
| TCA0372DP2G | PDIP−16 (Pb−Free) | 25 Units / Rail |
| 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.
*AEC−Q100 Qualified and PPAP Capable

## MARKING DIAGRAMS

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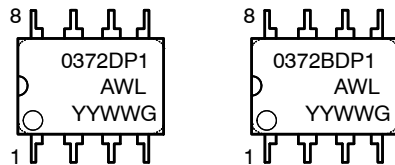


```
0372DP1
AWL
YYWWG
```

```
0372BDP1
AWL
YYWWG
```

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



```
TCA0372DP2
AWLYYWWG
```

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



```
TCA0372DW
AWLYYWWG
```

```
TCA0372BDW
AWLYYWWG
```
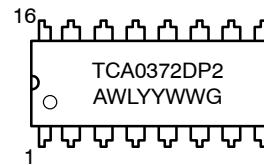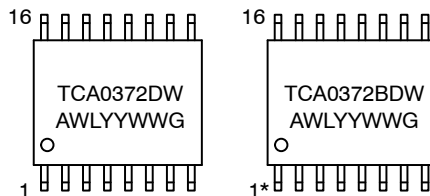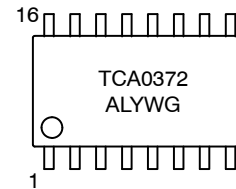
*Also applies to NCV0372BDWR2G.

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



```
TCA0372
ALYWG
```

| | |
|---|---|
| A | = Assembly Location |
| WL, L | = Wafer Lot |
| YY, Y | = Year |
| WW, W | = Work Week |
| G | = Pb−Free Package |

# TCA0372, TCA0372B, NCV0372B

## PIN CONNECTIONS

**CASE 648**

Output A  1 ▢        16  GND
V<sub>CC</sub>  2 ▢        15  GND
Output B  3 ▢        14  GND
V<sub>EE</sub>/GND  4 ▢        13  GND
Inputs B { 5 ▢        12  GND
6 ▢        11  GND
Inputs A { 7 ▢        10  GND
8 ▢         9  GND

(Top View)
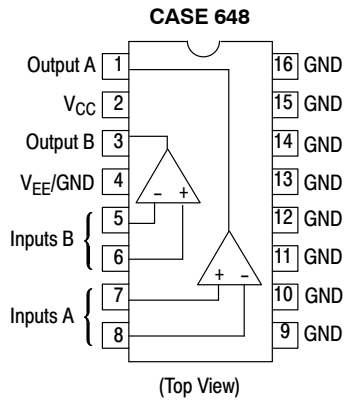
*Pins 4 and 9 to 16 are internally connected.

**CASE 626**

Output A  1 ▢        8  } Inputs A
V<sub>CC</sub>  2 ▢        7
Output B  3 ▢        6  } Inputs B
V<sub>EE</sub>/GND  4 ▢        5

(Top View)

**CASE 751G**

V<sub>CC</sub>  1 ▢        16  Output A
Output B  2 ▢        15  NC
NC  3 ▢        14  NC
V<sub>EE</sub>/GND { 4 ▢        13 } V<sub>EE</sub>/GND
5 ▢        12
NC  6 ▢        11  NC
Inputs B { 7 ▢        10 } Inputs A
8 ▢         9

(Top View)

**CASE 966**

V<sub>EE</sub>/GND  1 ▢        16  V<sub>EE</sub>/GND
NC  2 ▢        15  NC
Output A  3 ▢        14 } Inputs A
V<sub>CC</sub>  4 ▢        13
Output B  5 ▢        12 } Inputs B
NC  6 ▢        11
NC  7 ▢        10  NC
V<sub>EE</sub>/GND  8 ▢         9  V<sub>EE</sub>/GND

(Top View)

## PACKAGE DIMENSIONS

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

**TOP VIEW**

**END VIEW**
NOTE 3

**SIDE VIEW**

⊕ | 0.010 Ⓜ | C | A

**END VIEW**
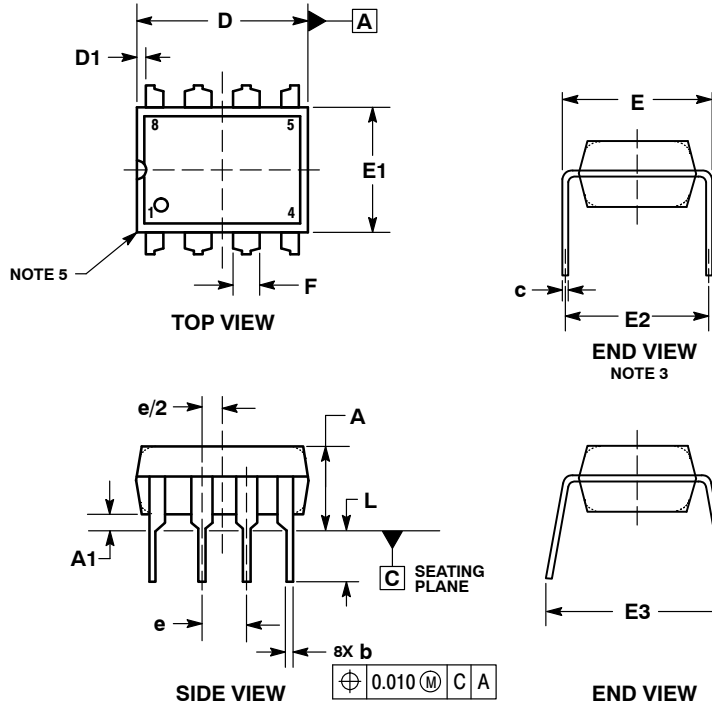
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCHES.
3. DIMENSION E IS MEASURED WITH THE LEADS RE-STRAINED PARALLEL AT WIDTH E2.
4. DIMENSION E1 DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | | MILLIMETERS | | |
|-----|--------|--------|--------|--------|--------|--------|
|     | MIN | NOM | MAX | MIN | NOM | MAX |
| A | ---- | ---- | 0.210 | ---- | ---- | 5.33 |
| A1 | 0.015 | ---- | ---- | 0.38 | ---- | ---- |
| b | 0.014 | 0.018 | 0.022 | 0.35 | 0.46 | 0.56 |
| C | 0.008 | 0.010 | 0.014 | 0.20 | 0.25 | 0.36 |
| D | 0.355 | 0.365 | 0.400 | 9.02 | 9.27 | 10.02 |
| D1 | 0.005 | ---- | ---- | 0.13 | ---- | ---- |
| E | 0.300 | 0.310 | 0.325 | 7.62 | 7.87 | 8.26 |
| E1 | 0.240 | 0.250 | 0.280 | 6.10 | 6.35 | 7.11 |
| E2 | 0.300 BSC | | | 7.62 BSC | | |
| E3 | ---- | ---- | 0.430 | ---- | ---- | 10.92 |
| e | 0.100 BSC | | | 2.54 BSC | | |
| L | 0.115 | 0.130 | 0.150 | 2.92 | 3.30 | 3.81 |

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

SEATING PLANE

⊕ | 0.25 (0.010) Ⓜ | T | A Ⓜ
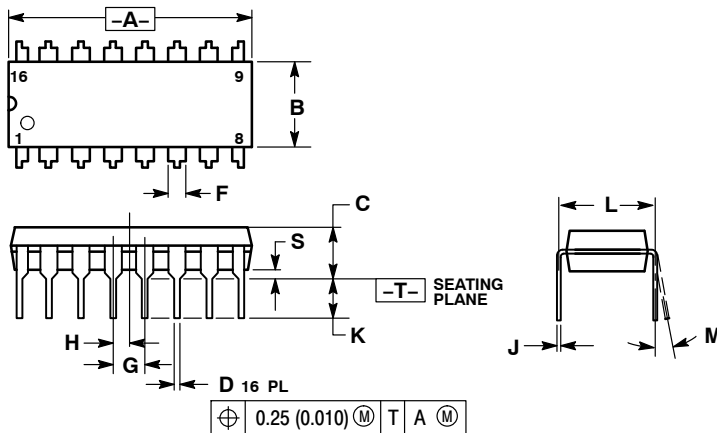
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|--------|--------|--------|--------|
|     | 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 |

# TCA0372, TCA0372B, NCV0372B

## PACKAGE DIMENSIONS

**SOIC−16 WB**
CASE 751G−03
ISSUE D
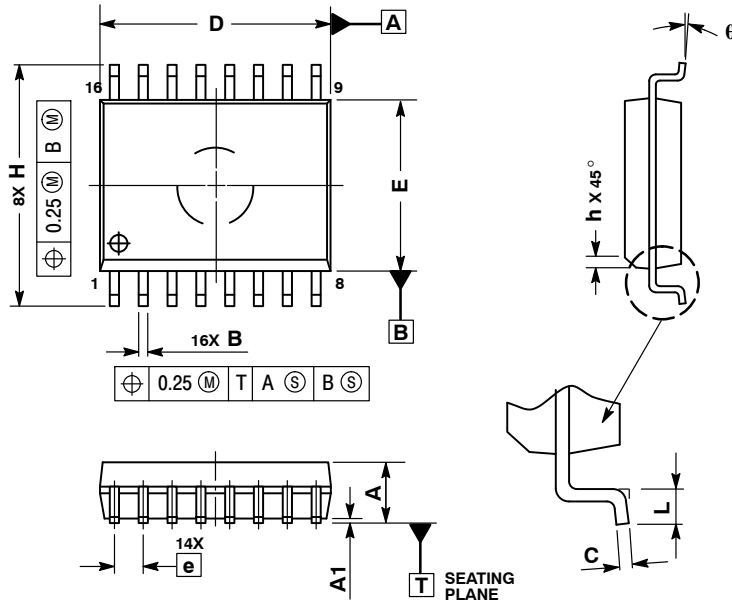
NOTES:
1. DIMENSIONS ARE IN MILLIMETERS.
2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M, 1994.
3. DIMENSIONS D AND E DO NOT INLCUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.13 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

| DIM | MILLIMETERS | |
| --- | --- | --- |
| | 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 |
| q | 0 ° | 7 ° |

## SOLDERING FOOTPRINT*

16X 0.58

11.00

1

16X 1.62

1.27 PITCH
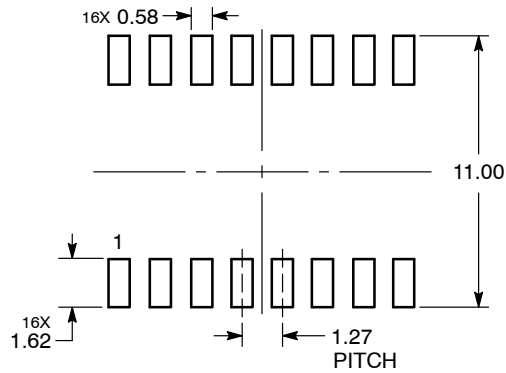
DIMENSIONS: MILLIMETERS

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

# TCA0372, TCA0372B, NCV0372B
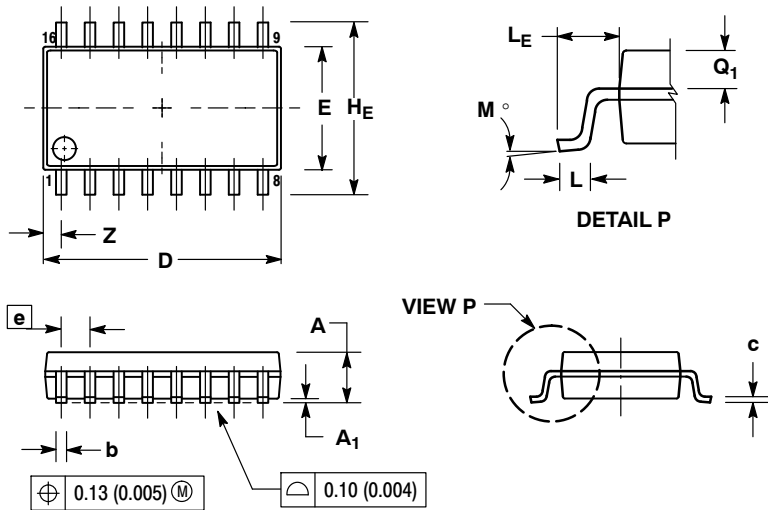
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR 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).

DETAIL P

VIEW P

$\bigoplus$ | 0.13 (0.005) Ⓜ

$\bigtriangleup$ | 0.10 (0.004)

| DIM | MILLIMETERS | | INCHES | |
|-----|-----|-----|-----|-----|
| | 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 | 0.10 | 0.20 | 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 |

**TCA0372/D**

单击下面可查看定价，库存，交付和生命周期等信息

>>ON Semiconductor(安森美)