

1.5A High-Speed 30V MOSFET Drivers

Features

- High Peak Output Current – 1.5 A
- Wide Input Supply Operating Range:
 - 4.5V to 30V
- High Capacitive Load Drive Capability:
 - 1000 pF in 25 nsec
- Short Delay Times – <78 nsec Typ.
- Low Supply Current:
 - With Logic '1' Input – 2.5 mA
 - With Logic '0' Input – 300 μ A
- Low Output Impedance – 7 Ω
- Latch-Up Protected: Will Withstand >300 mA Reverse Current
- ESD Protected – 4 kV

Applications

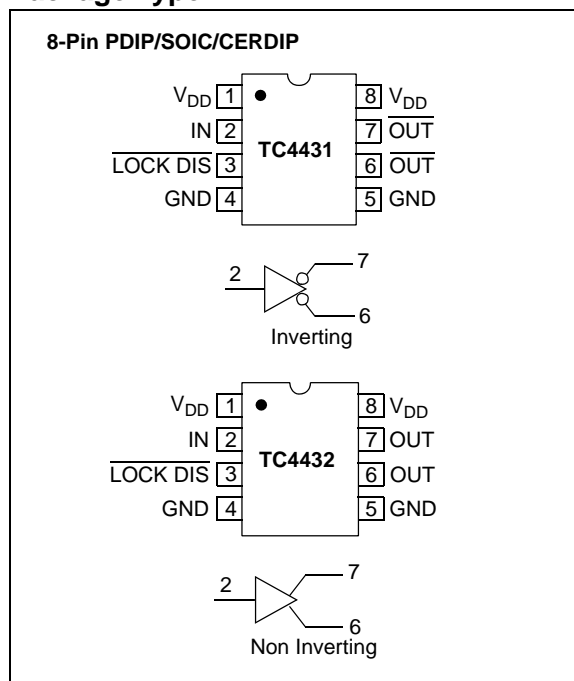
- Small Motor Drive
- Power MOSFET Driver
- Driving Bipolar Transistors

General Description

The TC4431/TC4432 are 30V CMOS buffer/drivers suitable for use in high-side driver applications. They will not latch up under any conditions within their power and voltage ratings. They can accept, without damage or logic upset, up to 300 mA of reverse current (of either polarity) being forced back into their outputs. All terminals are fully protected against up to 4 kV of electrostatic discharge.

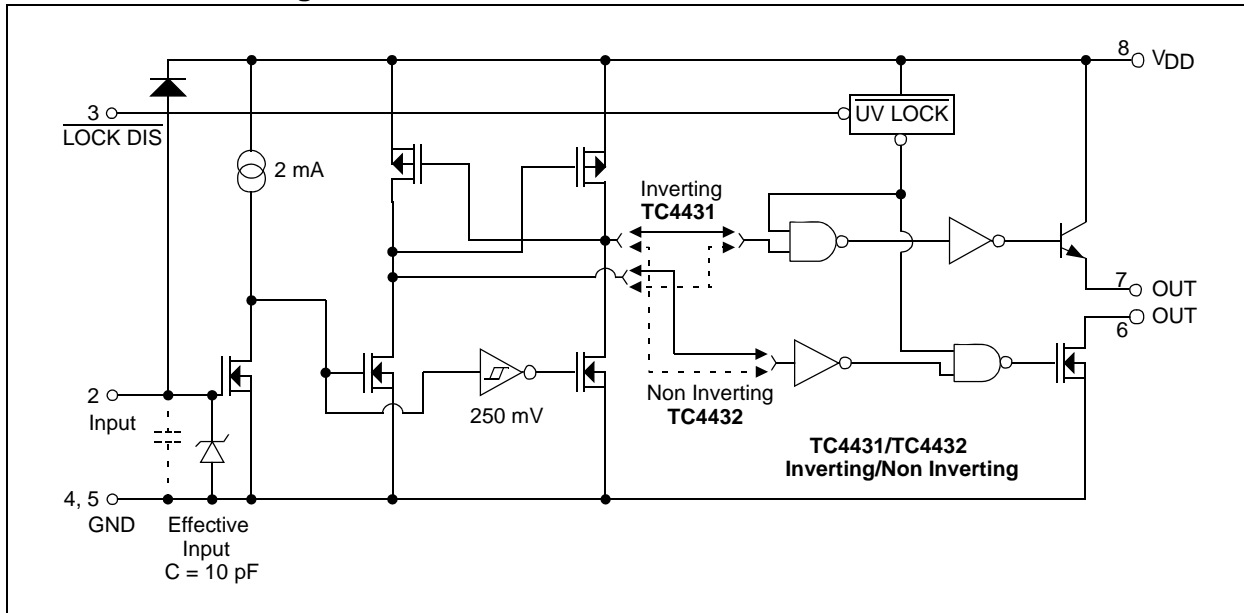
Under-voltage lockout circuitry forces the output to a 'low' state when the input supply voltage drops below 7V. For operation at lower voltages, disable the lockout and start-up circuit by grounding pin 3 (LOCK DIS); for all other situations, pin 3 (LOCK DIS) should be left floating. The under-voltage lockout and start-up circuit gives brown out protection when driving MOSFETS.

Package Type



TC4431/TC4432

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

| | |
|---|------------------------|
| Supply Voltage | 36V |
| Input Voltage (Note 1) | $V_{DD} + 0.3V$ to GND |
| Package Power Dissipation ($T_A \leq 70^\circ\text{C}$) | |
| PDIP | 730 mW |
| CERDIP | 800 mW |
| SOIC | 470 mW |
| Maximum Junction Temperature, T_J | +150°C |
| Storage Temperature Range | -65°C to +150°C |

† Stresses above 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 above those indicated in the operation sections of the specifications is not implied. Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

DC CHARACTERISTICS

| Electrical Specifications: Unless otherwise noted, $T_A = +25^\circ\text{C}$ with $4.5V \leq V_{DD} \leq 30V$. | | | | | | |
|---|-----------|----------------|----------------|-------|---------------|--|
| Parameters | Sym | Min | Typ | Max | Units | Conditions |
| Input | | | | | | |
| Logic '1', High Input Voltage | V_{IH} | 2.4 | — | — | V | |
| Logic '0', Low Input Voltage | V_{IL} | — | — | 0.8 | V | |
| Input Current (Note 1) | I_{IN} | -1 | — | 1 | μA | $0V \leq V_{IN} \leq 12V$ |
| Output | | | | | | |
| High Output Voltage | V_{OH} | $V_{DD} - 1.0$ | $V_{DD} - 0.8$ | — | V | $I_{OUT} = 100 \text{ mA}$ |
| Low Output Voltage | V_{OL} | — | — | 0.025 | V | |
| Output Resistance | R_O | — | 7 | 10 | Ω | $I_{OUT} = 10 \text{ mA}$, $V_{DD} = 30V$ |
| Peak Output Current | I_{PK} | — | 3.0 | — | A | Source: $V_{DD} = 30V$ Sink: $V_{DD} = 30V$ |
| Latch-Up Protection Withstand Reverse Current | I_{REV} | — | 0.3 | — | A | Duty cycle $\leq 2\%$, $t \leq 300 \mu\text{sec}$ |
| Switching Time (Note 2) | | | | | | |
| Rise Time | t_R | — | 25 | 40 | ns | Figure 4-1 |
| Fall Time | t_F | — | 33 | 50 | ns | Figure 4-1 |
| Delay Time | t_{D1} | — | 62 | 80 | ns | Figure 4-1 |
| Delay Time | t_{D2} | — | 78 | 90 | ns | Figure 4-1 |
| Power Supply | | | | | | |
| Power Supply Current | I_S | — | 2.5 | 4 | mA | $V_{IN} = 3V$ $V_{IN} = 0V$ |
| Start-up Threshold | V_S | — | 8.4 | 10 | V | |
| Drop-out Threshold | V_{DO} | 7 | 7.7 | — | V | Note 3 |

Note 1: For inputs >12V, add a 1 k Ω resistor in series with the input. See Section 2.0 "Typical Performance Curves" for input current graph.

2: Switching times are ensured by design.

3: For operation below 7V, pin 3 (LOCK DIS) should be tied to ground to disable the lockout and start-up circuit, otherwise, pin 3 **must** be left floating.

TC4431/TC4432

DC CHARACTERISTICS

| Electrical Specifications: Unless otherwise noted, Over operating temperature range with $4.5V \leq V_{DD} \leq 30V$. | | | | | | |
|--|----------|----------------|-----|----------|----------|---|
| Parameters | Sym | Min | Typ | Max | Units | Conditions |
| Input | | | | | | |
| Logic '1', High Input Voltage | V_{IH} | 2.4 | — | — | V | |
| Logic '0', Low Input Voltage | V_{IL} | — | — | 0.8 | V | |
| Input Current (Note 1) | I_{IN} | -10 | — | 10 | μA | $0V \leq V_{IN} \leq 12V$ |
| Output | | | | | | |
| High Output Voltage | V_{OH} | $V_{DD} - 1.2$ | — | — | V | $I_{OUT} = 100 \text{ mA}$ |
| Low Output Voltage | V_{OL} | — | — | 0.025 | V | |
| Output Resistance | R_O | — | — | 12 | Ω | $I_{OUT} = 10 \text{ mA}, V_{DD} = 30V$ |
| Switching Time (Note 2) | | | | | | |
| Rise Time | t_R | — | — | 60 | ns | Figure 4-1 |
| Fall Time | t_F | — | — | 70 | ns | Figure 4-1 |
| Delay Time | t_{D1} | — | — | 100 | ns | Figure 4-1 |
| Delay Time | t_{D2} | — | — | 110 | ns | Figure 4-1 |
| Power Supply | | | | | | |
| Power Supply Current | I_S | — | — | 6 0.7 | mA | $V_{IN} = 3V$ $V_{IN} = 0V$ |
| Start-up Threshold | V_S | — | 8.4 | 10 | V | |
| Drop-out Threshold | V_{DO} | 7 | 7.7 | — | V | Note 3 |

Note 1: For inputs >12V, add a 1 k Ω resistor in series with the input. See **Section 2.0 “Typical Performance Curves”** for input current graph.

2: Switching times are ensured by design.

3: For operation below 7V, pin 3 ($\overline{\text{LOCK DIS}}$) should be tied to ground to disable the lockout and start-up circuit, otherwise, pin 3 **must** be left floating.

TEMPERATURE CHARACTERISTICS

| Electrical Specifications: Unless otherwise noted, all parameters apply with $4.5V \leq V_{DD} \leq 30V$. | | | | | | |
|--|---------------|-----|-----|------|---------------|------------|
| Parameters | Sym | Min | Typ | Max | Units | Conditions |
| Temperature Ranges | | | | | | |
| Specified Temperature Range (C) | T_A | 0 | — | +70 | $^{\circ}C$ | |
| Specified Temperature Range (E) | T_A | -40 | — | +85 | $^{\circ}C$ | |
| Specified Temperature Range (V) | T_A | -40 | — | +125 | $^{\circ}C$ | |
| Maximum Junction Temperature | T_J | — | — | +150 | $^{\circ}C$ | |
| Storage Temperature Range | T_A | -65 | — | +150 | $^{\circ}C$ | |
| Package Thermal Resistances: | | | | | | |
| Thermal Resistance, 8L-SOIC | θ_{JA} | — | 155 | — | $^{\circ}C/W$ | |
| Thermal Resistance, 8L-PDIP | θ_{JA} | — | 125 | — | $^{\circ}C/W$ | |
| Thermal Resistance, 8L-CERDIP | θ_{JA} | — | 150 | — | $^{\circ}C/W$ | |

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

Note: Unless otherwise indicated, $T_A = +25^\circ\text{C}$ with $4.5\text{V} \leq V_{DD} \leq 30\text{V}$.

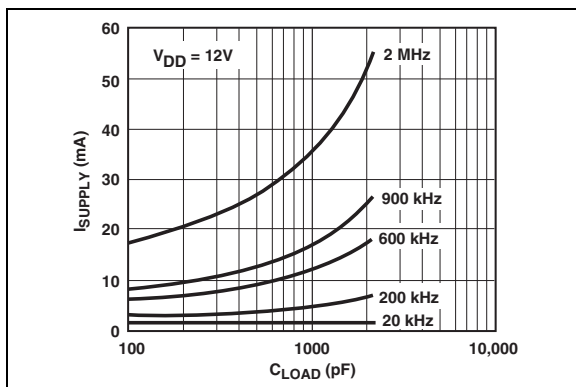


FIGURE 2-1: Supply Current vs. Capacitive Load.

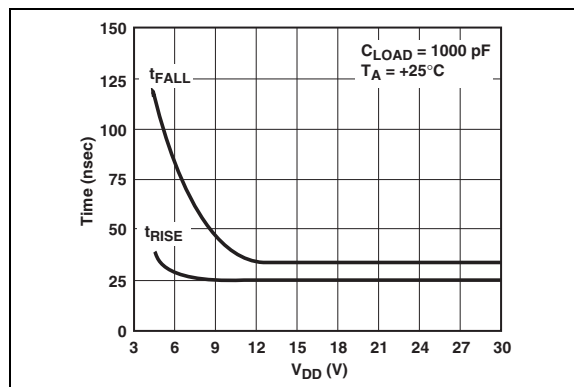


FIGURE 2-3: Rise/Fall Time vs. V_{DD} .

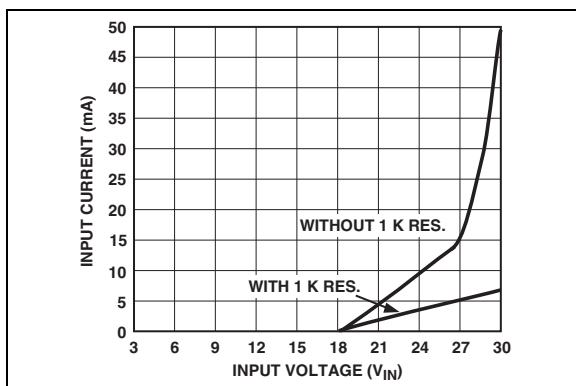


FIGURE 2-2: Input Current vs. Input Voltage.

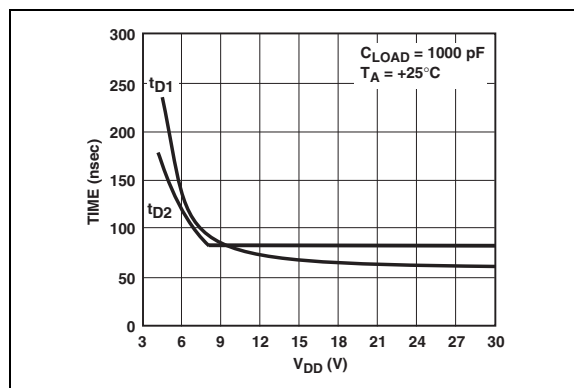


FIGURE 2-4: t_{D1} and t_{D2} Delay vs. V_{DD} .

TC4431/TC4432

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

TABLE 3-1: PIN FUNCTION TABLE

| Pin No. | Symbol | Description |
|---------|------------------------------|--|
| 1 | V_{DD} | Supply Input, 4.5V to 30V |
| 2 | IN | TTL/CMOS Compatible Input |
| 3 | $\overline{\text{LOCK DIS}}$ | Input Pin, Enable/Disable for UV Lockout |
| 4 | GND | Ground |
| 5 | GND | Ground |
| 6 | OUT | Drive Output, Pull Down |
| 7 | OUT | Drive Output, Pull Up |
| 8 | V_{DD} | Supply Input, 4.5V to 30V |

3.1 Supply Input (V_{DD})

The V_{DD} input is the bias supply input for the MOSFET driver and is rated for 4.5V to 30V with respect to the ground pins. The V_{DD} input should be bypassed to ground with a local ceramic capacitor. The value of this capacitor should be chosen based on the capacitive load that is being driven.

3.2 Control Input (IN)

The MOSFET driver input is a TTL/CMOS compatible input with 250 mV of hysteresis between the high and low threshold voltages. If an input signal level of greater than 12V is applied to the device, a series current limiting resistor is recommended.

3.3 Lockout Disable ($\overline{\text{LOCK DIS}}$)

The lockout pin enables/disables the undervoltage lockout feature of the device. If undervoltage lockout is desired (output is not enabled until the bias voltage reaches 8.4V (typical) on the rising edge and is disabled when the bias voltage reaches 7.7V (typical) on the falling edge), the lockout pin should be left floating. If operation below 7V is desired, the lockout pin should be tied to ground.

3.4 Ground (GND)

The ground pins are the return path for the bias current and for the high peak currents which discharge the load capacitor. Both ground pins should be used to ensure proper operation. The ground pins should be tied into a ground plane or have short traces to the bias supply source return.

3.5 Drive Output (OUT)

The TC4431/TC4432 devices have individual source and sink output pins. This feature can be used to adjust the rise and fall time independently by adding separate charge and discharge resistors external to the device. Pin 7 (source output) can source 3 A peak currents into capacitive loads and pin 6 (sink output) can sink 1.5 A peak currents from a capacitive load.

4.0 APPLICATIONS INFORMATION

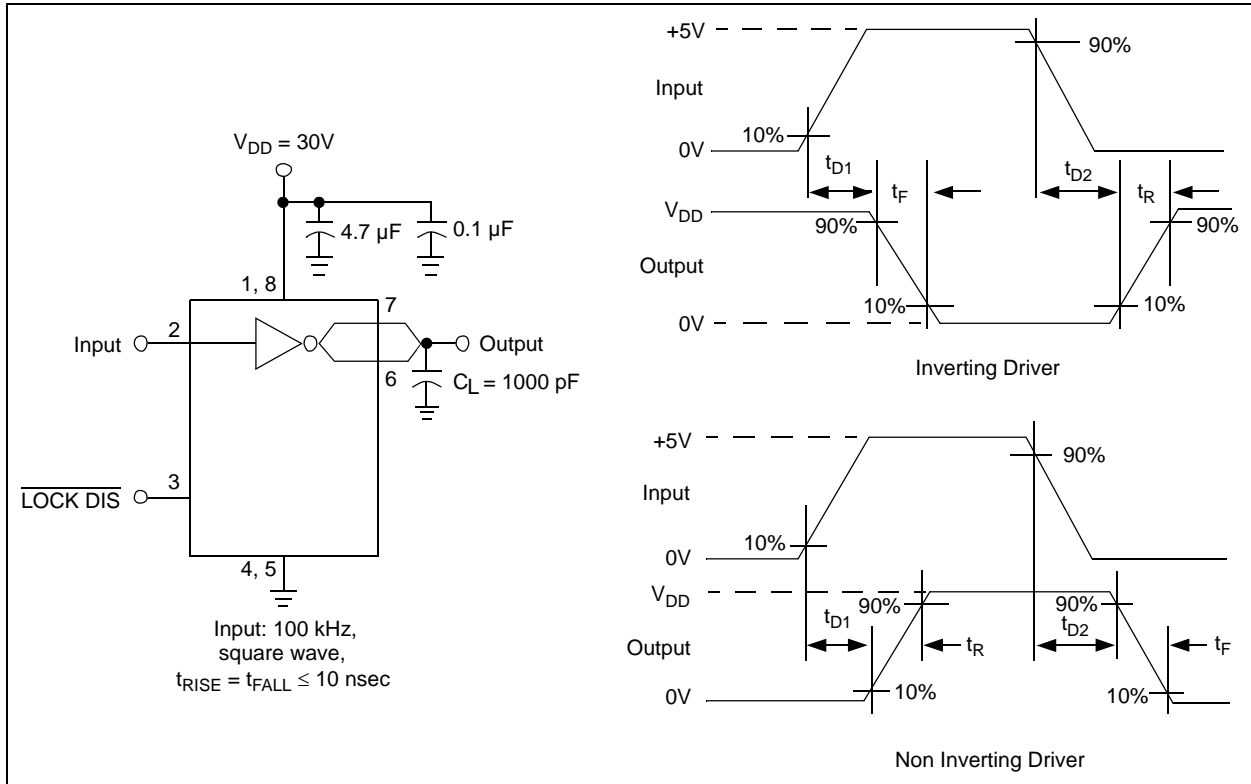


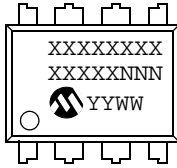
FIGURE 4-1: Switching Time Test Circuit.

TC4431/TC4432

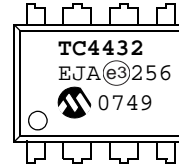
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

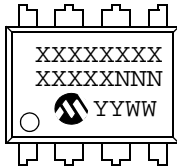
8-Lead CERDIP (300 mil)



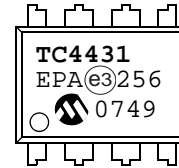
Example:



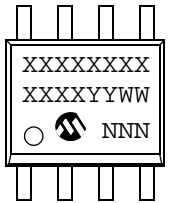
8-Lead PDIP (300 mil)



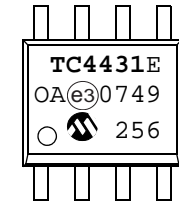
Example:



8-Lead SOIC (150 mil)



Example:

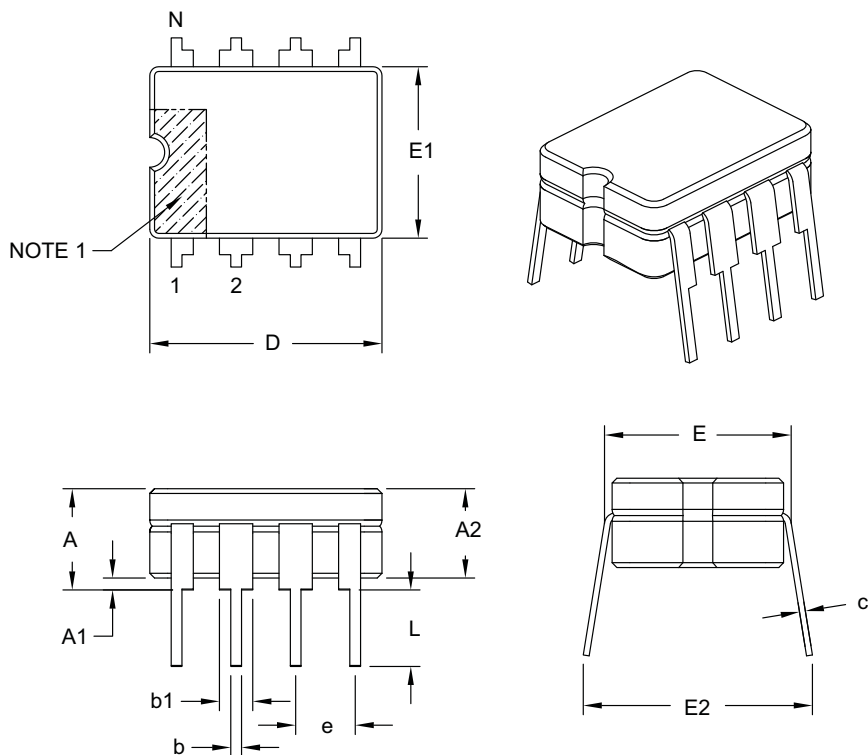


| | | |
|----------------|--------|--|
| Legend: | XX...X | Customer-specific information |
| | Y | Year code (last digit of calendar year) |
| | YY | Year code (last 2 digits of calendar year) |
| | WW | Week code (week of January 1 is week '01') |
| | NNN | Alphanumeric traceability code |
| | (e3) | Pb-free JEDEC designator for Matte Tin (Sn) |
| | * | This package is Pb-free. The Pb-free JEDEC designator (e3) can be found on the outer packaging for this package. |

Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

8-Lead Ceramic Dual In-Line (JA) – .300" Body [CERDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Dimension Limits | Units | INCHES | | |
|----------------------------|-------|----------|------|------|
| | | MIN | NOM | MAX |
| Number of Pins | N | 8 | | |
| Pitch | e | .100 BSC | | |
| Top to Seating Plane | A | – | – | .200 |
| Standoff § | A1 | .015 | – | – |
| Ceramic Package Height | A2 | .140 | – | .175 |
| Shoulder to Shoulder Width | E | .290 | – | .320 |
| Ceramic Package Width | E1 | .230 | .248 | .300 |
| Overall Length | D | .370 | .380 | .400 |
| Tip to Seating Plane | L | .125 | – | .200 |
| Lead Thickness | c | .008 | – | .015 |
| Upper Lead Width | b1 | .045 | – | .065 |
| Lower Lead Width | b | .015 | – | .023 |
| Overall Row Spacing | E2 | .314 | – | .410 |

Notes:

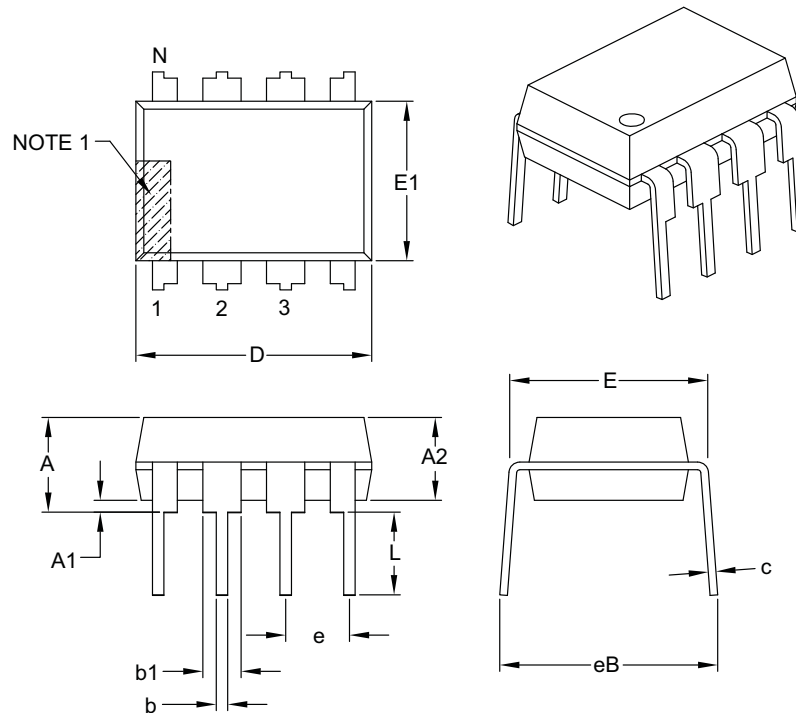
- Pin 1 visual index feature may vary, but must be located within the hatched area.
- § Significant Characteristic.
- Dimensioning and tolerancing per ASME Y14.5M.
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-001B

TC4431/TC4432

8-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packageing>



| Dimension Limits | Units | INCHES | | |
|----------------------------|-------|----------|------|------|
| | | MIN | NOM | MAX |
| Number of Pins | N | 8 | | |
| Pitch | e | .100 BSC | | |
| Top to Seating Plane | A | – | – | .210 |
| Molded Package Thickness | A2 | .115 | .130 | .195 |
| Base to Seating Plane | A1 | .015 | – | – |
| Shoulder to Shoulder Width | E | .290 | .310 | .325 |
| Molded Package Width | E1 | .240 | .250 | .280 |
| Overall Length | D | .348 | .365 | .400 |
| Tip to Seating Plane | L | .115 | .130 | .150 |
| Lead Thickness | c | .008 | .010 | .015 |
| Upper Lead Width | b1 | .040 | .060 | .070 |
| Lower Lead Width | b | .014 | .018 | .022 |
| Overall Row Spacing § | eB | – | – | .430 |

Notes:

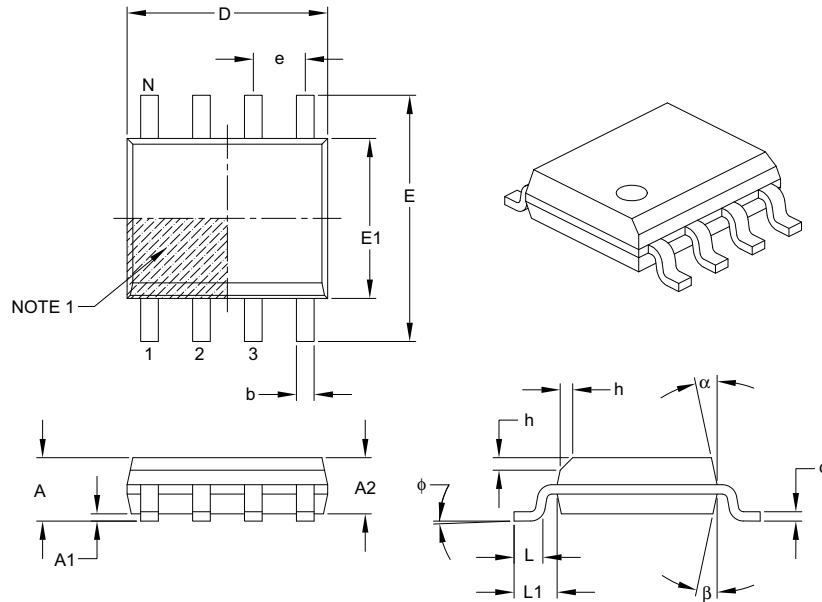
- Pin 1 visual index feature may vary, but must be located with the hatched area.
- § Significant Characteristic.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
- Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-018B

8-Lead Plastic Small Outline (SN) – Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



| Dimension Limits | Units | MILLIMETERS | | |
|--------------------------|----------|-------------|-----|------|
| | | MIN | NOM | MAX |
| Number of Pins | N | 8 | | |
| Pitch | e | 1.27 BSC | | |
| Overall Height | A | – | – | 1.75 |
| Molded Package Thickness | A2 | 1.25 | – | – |
| Standoff § | A1 | 0.10 | – | 0.25 |
| Overall Width | E | 6.00 BSC | | |
| Molded Package Width | E1 | 3.90 BSC | | |
| Overall Length | D | 4.90 BSC | | |
| Chamfer (optional) | h | 0.25 | – | 0.50 |
| Foot Length | L | 0.40 | – | 1.27 |
| Footprint | L1 | 1.04 REF | | |
| Foot Angle | ϕ | 0° | – | 8° |
| Lead Thickness | c | 0.17 | – | 0.25 |
| Lead Width | b | 0.31 | – | 0.51 |
| Mold Draft Angle Top | α | 5° | – | 15° |
| Mold Draft Angle Bottom | β | 5° | – | 15° |

Notes:

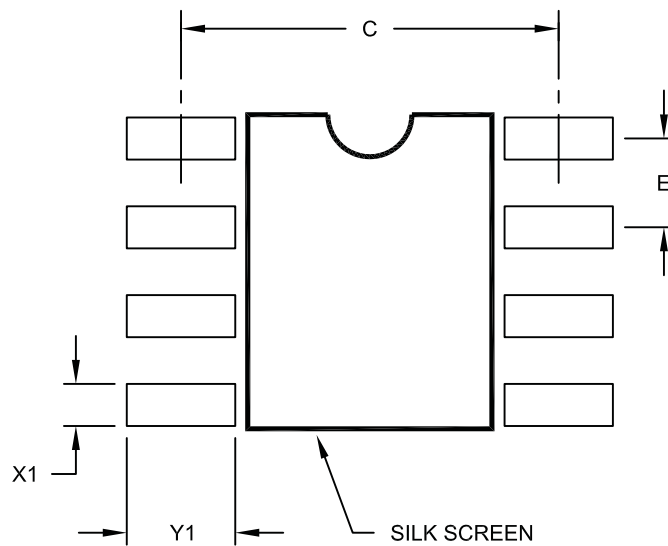
- Pin 1 visual index feature may vary, but must be located within the hatched area.
- § Significant Characteristic.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
- Dimensioning and tolerancing per ASME Y14.5M.
 BSC: Basic Dimension. Theoretically exact value shown without tolerances.
 REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-057B

TC4431/TC4432

8-Lead Plastic Small Outline (SN) – Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



RECOMMENDED LAND PATTERN

| Dimension Limits | Units | MILLIMETERS | | |
|-------------------------|-------|-------------|------|------|
| | | MIN | NOM | MAX |
| Contact Pitch | E | 1.27 BSC | | |
| Contact Pad Spacing | C | | 5.40 | |
| Contact Pad Width (X8) | X1 | | | 0.60 |
| Contact Pad Length (X8) | Y1 | | | 1.55 |

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2057A

APPENDIX A: REVISION HISTORY

Revision D (December 2007)

The following is the list of modifications:

1. **Section 1.0 “Electrical Characteristics”:**
Added V temperature information to Temperature Characteristics table.
2. Added Revision History.
3. Added V temperature range to Product identification System page.

Revision C (May 2003)

The following is the list of modifications:

1. Undocumented changes

Revision B (May 2002)

The following is the list of modifications:

1. Undocumented changes

Revision A (April 2002)

- Original Release of this Document.

TC4431/TC4432

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, refer to the factory or the listed sales office.

| <u>PART NO.</u> | <u>X</u> | <u>/XX</u> |
|--------------------|--|------------|
| Device | Temperature Range | Package |
| Device: | TC4431: 1.5A High-Speed 30V MOSFET Driver, Inverting | |
| | TC4432: 1.5A High-Speed 30V MOSFET Driver, Non Inverting | |
| Temperature Range: | C = 0°C to +70°C | |
| | E = -40°C to +85°C | |
| | V = -40°C to +125°C | |
| Package: | JA = Ceramic Dual In-line (300 mil Body), 8-lead * | |
| | OA = Plastic SOIC, (150 mil Body), 8-lead | |
| | OA713 = Plastic SOIC, (150 mil Body), 8-lead (Tape and Reel) | |
| | PA = Plastic DIP (300 mil Body), 8-lead* * | |
| | * Offered in E-temp range only. | |
| | ** The only package offered in the V temp range. | |

Examples:

a) TC4431COA: 1.5A MOSFET driver, SOIC package, 0°C to +70°C.

b) TC4431EJA: 1.5A MOSFET driver, CERDIP package, -40°C to +85°C.

c) TC4431VPA: 1.5A MOSFET driver, PDIP package, -40°C to +125°C.

a) TC4432CPA: 1.5A MOSFET driver, PDIP package, 0°C to +70°C.

b) TC4432EPA: 1.5A MOSFET driver, PDIP package, -40°C to +85°C.

c) TC4432VOA713: Tape and Reel, 1.5A MOSFET driver, SOIC package, -40°C to +125°C.

TC4431/TC4432

NOTES:

Note the following details of the code protection feature on Microchip devices:

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