

1A High-Speed MOSFET Drivers

Features

- Latch-Up Protected: Withstands 500 mA Reverse Current
- Input Withstands Negative Inputs Up to 5V
- Electrostatic Discharge (ESD) Protected: 2.0 kV (HBM) and 400V (MM)
- High Peak Output Current: 1A
- Wide Input Supply Voltage Operating Range:
 - 4.5V to 16V
- High Capacitive Load Drive Capability:
 - 1000 pF in 25 ns
- Short Delay Time: 30 ns typical
- Matched Delay Times
- Low Supply Current
 - With Logic '1' Input: 500 μ A
 - With Logic '0' Input: 100 μ A
- Low Output Impedance: 8 Ω
- Available in Space-Saving 8-pin MSOP Package
- Pinout – same as TC1410/TC1412/TC1413

Applications

- Switch Mode Power Supplies
- Pulse Transformer Drive
- Line Drivers
- Relay Driver

General Description

The TC1411/TC1411N are 1A CMOS buffers/drivers. They do not latch up under any conditions within their power and voltage ratings. They are not subject to damage when up to 5V of noise spiking of either polarity occurs on the ground pin. They can accept, without damage or logic upset, up to 500 mA of current of either polarity being forced back into their output. All terminals are fully protected against Electrostatic Discharge (ESD) up to 2.0 kV (HBM) and 400V (MM).

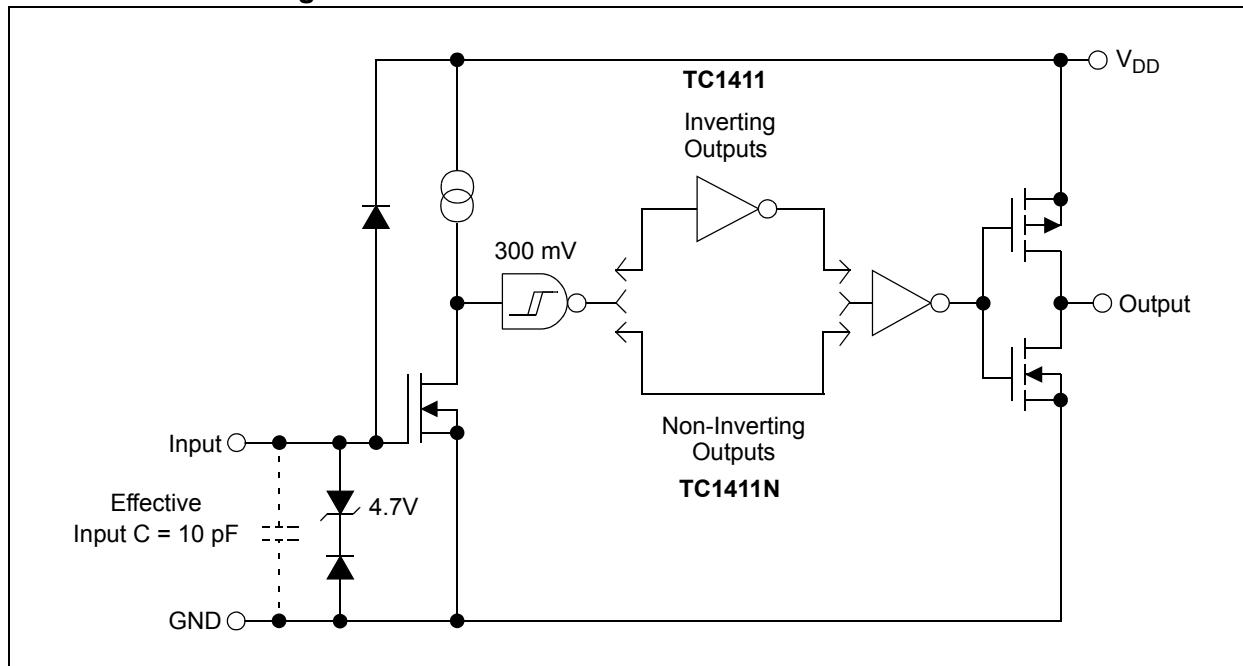
As MOSFET drivers, the TC1411/TC1411N can easily charge a 1000 pF gate capacitance in 25 ns with matched rise and fall times. To ensure that the MOSFET's intended state is not affected even by large transients, low enough impedance in both the 'ON' and 'OFF' states are provided. The leading and trailing edge propagation delay times are also matched to allow driving short-duration inputs with greater accuracy.

Package Types



TC1411/TC1411N

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

| | |
|---|-------------------------------|
| Supply Voltage | +20V |
| Input Voltage | $V_{DD} + 0.3V$ to GND – 5.0V |
| Power Dissipation ($T_A \leq 70^\circ\text{C}$) | |
| MSOP | 340 mW |
| PDIP | 730 mW |
| SOIC..... | 470 mW |
| Storage Temperature Range | -65°C to +150°C |
| Maximum Junction Temperature | +150°C |

† **Notice:** 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, over the operating temperature range with $4.5V \leq V_{DD} \leq 16V$. Typical values are measured at $T_A = +25^\circ\text{C}$, $V_{DD} = 16V$.

| Parameters | Sym | Min | Typ | Max | Units | Conditions |
|--|-----------|------------------|-----|-------|---------------|--|
| Input | | | | | | |
| Logic '1', High Input Voltage | V_{IH} | 2.0 | — | — | V | |
| Logic '0', Low Input Voltage | V_{IL} | — | — | 0.8 | V | |
| Input Current | I_{IN} | -1.0 | — | 1.0 | μA | $0V \leq V_{IN} \leq V_{DD}$, $T_A = +25^\circ\text{C}$ |
| | | -10 | — | 10 | | $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ |
| Output | | | | | | |
| High Output Voltage | V_{OH} | $V_{DD} - 0.025$ | — | — | V | DC Test |
| Low Output Voltage | V_{OL} | — | — | 0.025 | V | DC Test |
| Output Resistance | R_O | — | 8 | 11 | Ω | $V_{DD} = 16V$, $I_O = 10\text{ mA}$, $T_A = +25^\circ\text{C}$ |
| | | — | 10 | 14 | | $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ |
| | | — | 10 | 14 | | $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$ |
| Peak Output Current | I_{PK} | — | 1.0 | — | A | $V_{DD} = 16V$ |
| Latch-Up Protection Withstand Reverse Current | I_{REV} | — | 0.5 | — | A | Duty cycle $\leq 2\%$, $t \leq 300\ \mu\text{s}$, $V_{DD} = 16V$ |
| Switching Time (Note 1) | | | | | | |
| Rise Time | t_R | — | 25 | 35 | ns | $T_A = +25^\circ\text{C}$ |
| | | — | 27 | 40 | | $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ |
| | | — | 29 | 40 | | $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$, Figure 4-1 |
| Fall Time | t_F | — | 25 | 35 | ns | $T_A = +25^\circ\text{C}$ |
| | | — | 27 | 40 | | $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ |
| | | — | 29 | 40 | | $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$, Figure 4-1 |
| Delay Time | t_{D1} | — | 30 | 40 | ns | $T_A = +25^\circ\text{C}$ |
| | | — | 33 | 45 | | $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ |
| | | — | 35 | 45 | | $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$, Figure 4-1 |
| Delay Time | t_{D2} | — | 30 | 40 | ns | $T_A = +25^\circ\text{C}$ |
| | | — | 33 | 45 | | $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ |
| | | — | 35 | 45 | | $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$, Figure 4-1 |

Note 1: Switching times ensured by design.

TC1411/TC1411N

DC CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise noted, over the operating temperature range with $4.5V \leq V_{DD} \leq 16V$. Typical values are measured at $T_A = +25^\circ C$, $V_{DD} = 16V$.

| Parameters | Sym | Min | Typ | Max | Units | Conditions |
|----------------------|-------|-----|-----|------|-------|-----------------------------|
| Power Supply | | | | | | |
| Power Supply Current | I_S | — | 0.5 | 1.0 | mA | $V_{IN} = 3V, V_{DD} = 16V$ |
| | | — | 0.1 | 0.15 | | $V_{IN} = 0V$ |

Note 1: Switching times ensured by design.

TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, all parameters apply with $4.5V \leq V_{DD} \leq 16V$.

| 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-MSOP | θ_{JA} | — | 211 | — | $^\circ C/W$ | |
| Thermal Resistance, 8L-PDIP | θ_{JA} | — | 89.3 | — | $^\circ C/W$ | |
| Thermal Resistance, 8L-SOIC | θ_{JA} | — | 149.5 | — | $^\circ C/W$ | |

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, over operating temperature range with $4.5V \leq V_{DD} \leq 16V$.

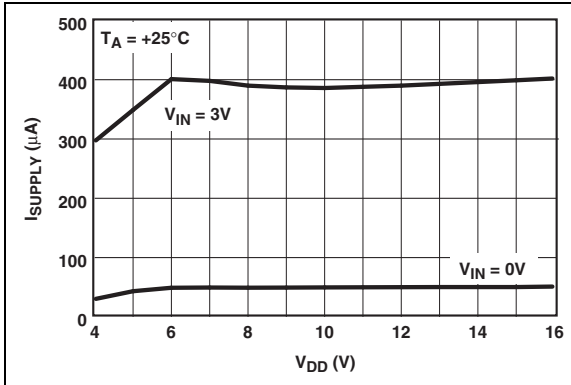


FIGURE 2-1: Quiescent Supply Current vs. Supply Voltage.

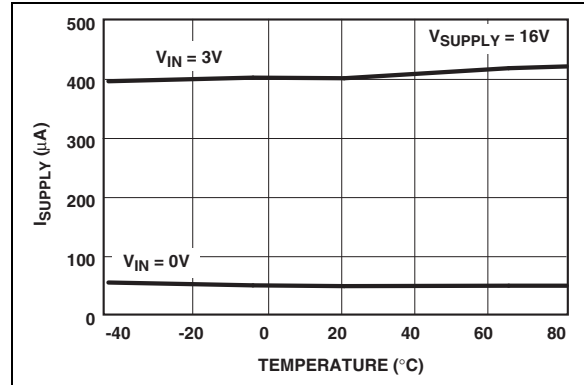


FIGURE 2-4: Quiescent Supply Current vs. Temperature.

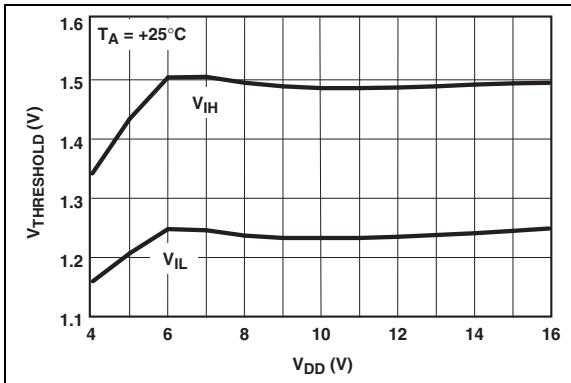


FIGURE 2-2: Input Threshold vs. Supply Voltage.

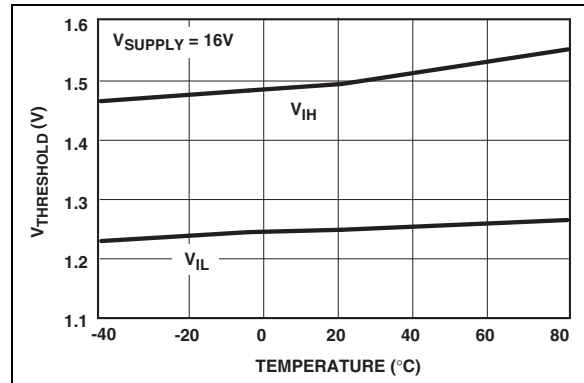


FIGURE 2-5: Input Threshold vs. Temperature.

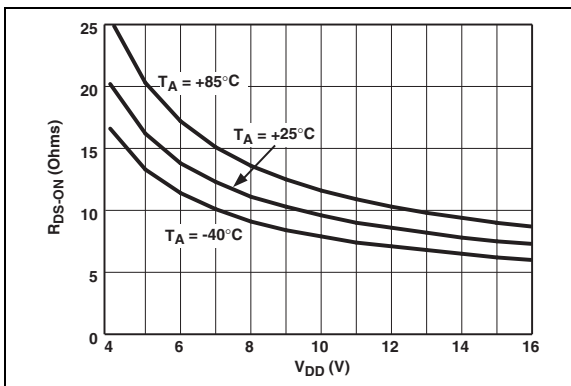


FIGURE 2-3: High-State Output Resistance vs. Supply Voltage.



FIGURE 2-6: Low-State Output Resistance vs. Supply Voltage.

TC1411/TC1411N

Note: Unless otherwise indicated, over operating temperature range with $4.5V \leq V_{DD} \leq 16V$.

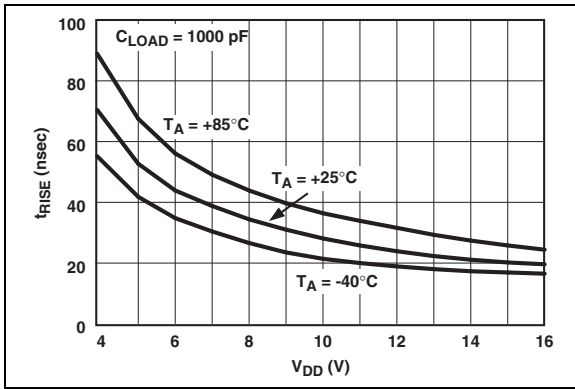


FIGURE 2-7: Rise Time vs. Supply Voltage.

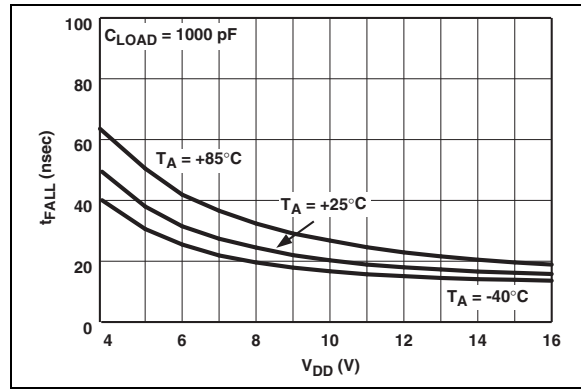


FIGURE 2-10: Fall Time vs. Supply Voltage.

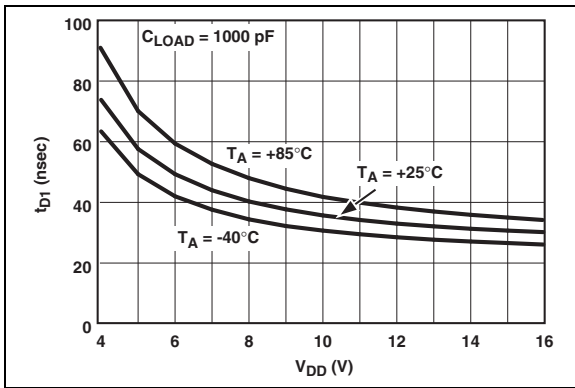


FIGURE 2-8: Propagation Delay vs. Supply Voltage.

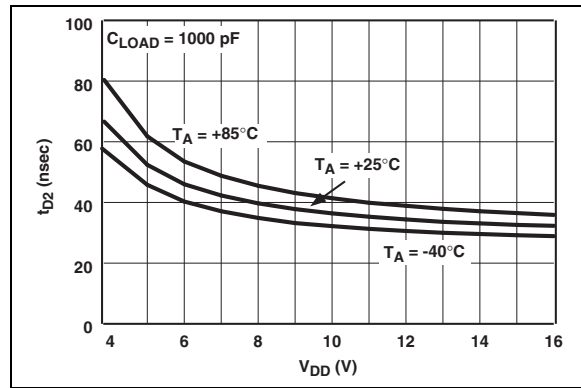


FIGURE 2-11: Propagation Delay vs. Supply Voltage.

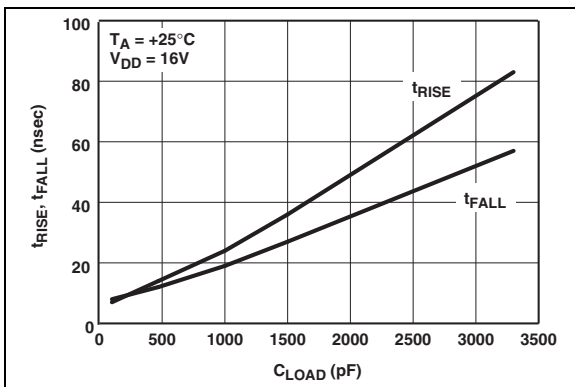


FIGURE 2-9: Rise and Fall Times vs. Capacitive Load.

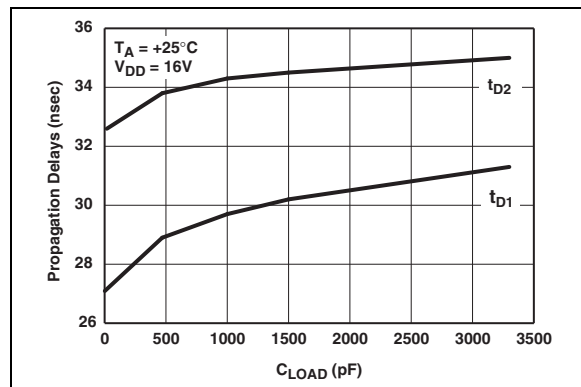


FIGURE 2-12: Propagation Delays vs. Capacitive Load.

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

| Pin No. | TC1411 MSOP, PDIP, SOIC | TC1411N MSOP, PDIP, SOIC | Description |
|---------|----------------------------|-----------------------------|--|
| 1 | V _{DD} | V _{DD} | Supply input, 4.5V to 16V |
| 2 | IN | IN | Control input |
| 3 | NC | NC | No connection |
| 4 | GND | GND | Ground |
| 5 | GND | GND | Ground |
| 6 | $\overline{\text{OUT}}$ | OUT | CMOS push-pull output, common to pin 7 |
| 7 | $\overline{\text{OUT}}$ | OUT | CMOS push-pull output, common to pin 6 |
| 8 | V _{DD} | V _{DD} | Supply input, 4.5V to 16V |

3.1 Supply Input (V_{DD})

The V_{DD} input is the bias supply for the MOSFET driver and is rated for 4.5V to 16V with respect to the ground pin. The V_{DD} input should be bypassed to ground with a local ceramic capacitor. The value of the capacitor is chosen based on the capacitive load that is being driven. A value of 1.0 μF is suggested.

3.2 Control Input (IN)

The MOSFET driver input is a high-impedance, TTL/CMOS-compatible input. The input has 300 mV of hysteresis between the high and low thresholds that prevents output glitching even when the rise and fall time of the input signal is very slow.

3.3 CMOS Push-pull Output (OUT, $\overline{\text{OUT}}$)

The MOSFET driver output is a low impedance, CMOS push-pull style output, capable of driving a capacitive load with 1A peak currents.

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. The ground pins should be tied into a ground plane or have very short traces to the bias supply source return.

3.5 No Connect (NC)

No internal connection.

TC1411/TC1411N

4.0 APPLICATION INFORMATION



FIGURE 4-1: Switching Time Test Circuit.

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

8-Lead PDIP (300 mil)



Example



OR



| | | |
|----------------|--------|--|
| 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) | RoHS Compliant JEDEC designator for Matte Tin (Sn) |
| | * | This package is RoHS Compliant. The RoHS Compliant 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.

TC1411/TC1411N

8-Lead SOIC (3.90 mm)



Example



OR



8-Lead MSOP (3x3 mm)



Example



8-Lead Plastic Micro Small Outline Package (UA) [MSOP]

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



Microchip Technology Drawing C04-111C Sheet 1 of 2

TC1411/TC1411N

8-Lead Plastic Micro Small Outline Package (UA) [MSOP]

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 | 0.65 BSC | | |
| Overall Height | A | - | - | 1.10 |
| Molded Package Thickness | A2 | 0.75 | 0.85 | 0.95 |
| Standoff | A1 | 0.00 | - | 0.15 |
| Overall Width | E | 4.90 BSC | | |
| Molded Package Width | E1 | 3.00 BSC | | |
| Overall Length | D | 3.00 BSC | | |
| Foot Length | L | 0.40 | 0.60 | 0.80 |
| Footprint | L1 | 0.95 REF | | |
| Foot Angle | φ | 0° | - | 8° |
| Lead Thickness | c | 0.08 | - | 0.23 |
| Lead Width | b | 0.22 | - | 0.40 |

Notes:

- Pin 1 visual index feature may vary, but must be located within the hatched area.
- Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm 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 C04-111C Sheet 2 of 2

8-Lead Plastic Micro Small Outline Package (UA) [MSOP]

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 | 0.65 BSC | | |
| Contact Pad Spacing | C | 4.40 | | |
| Overall Width | Z | | | 5.85 |
| Contact Pad Width (X8) | X1 | | | 0.45 |
| Contact Pad Length (X8) | Y1 | | | 1.45 |
| Distance Between Pads | G1 | 2.95 | | |
| Distance Between Pads | GX | 0.20 | | |

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2111A

TC1411/TC1411N

8-Lead Plastic Dual In-Line (PA) – 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 (OA) - 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>



Microchip Technology Drawing No. C04-057C Sheet 1 of 2

TC1411/TC1411N

8-Lead Plastic Small Outline (OA) - 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:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15mm per side.
4. 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 No. C04-057C Sheet 2 of 2

8-Lead Plastic Small Outline (OA) – 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

TC1411/TC1411N

NOTES:

APPENDIX A: REVISION HISTORY

Revision E (June 2013)

The following is the list of modifications:

- Updated the values for Electrostatic Discharge (ESD) in the [Features](#) and [General Description](#) columns.
- Updated the Pin Description table in [Section 3.0, Pin Descriptions](#).
- Updated package marking information and drawings in [Section 5.0, Packaging Information](#).
- Minor grammatical and spelling corrections.

Revision D (September 2006)

- Added -40°C to +125°C temperature range to Temperature Characteristics table and Product Information System page.
- Added disclaimer to package outline drawings.

Revision C (March 2003)

- Added 8-Lead MSOP Package.

Revision B (May 2002)

- Converted TELCOM data sheet for Embedded Control Handbook

Revision A (March 2001)

- Original Release of this Document.

TC1411/TC1411N

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 | |
| <p>Device: TC1411: 1 A Single MOSFET Driver, Inverting TC1411N: 1 A Single MOSFET Driver, Non-Inverting</p> <p>Temperature Range: C = 0°C to +70°C E = -40°C to +85°C V = -40°C to +125°C</p> <p>Package: OA = Plastic SOIC, (150 mil Body), 8-lead OA713 = Plastic SOIC, (150 mil Body), 8-lead (Tape and Reel) UA = Plastic Micro Small Outline (MSOP), 8-lead * UA713 = Plastic Micro Small Outline (MSOP), 8-lead * (Tape and Reel) PA = Plastic DIP (300 mil Body), 8-lead * MSOP package is only available in E-Temp.</p> | | | |
| | | | <p>Examples:</p> <p>a) TC1411COA: 1A Single MOSFET driver, 8LD SOIC package, 0°C to +70°C.</p> <p>b) TC1411CPA: 1A Single MOSFET driver, 8LD PDIP package, 0°C to +70°C.</p> <p>c) TC1411EUA713: Tape and Reel, 1A Single MOSFET driver, 8LD MSOP package, -40°C to +85°C.</p> <p>d) TC1411VOA713: Tape and Reel, 1A Single MOSFET driver, 8LD SOIC package, -40°C to +125°C.</p> <p>a) TC1411NCPA: 1A Single MOSFET driver, 8LD PDIP package, 0°C to +70°C.</p> <p>b) TC1411NEPA: 1A Single MOSFET driver, 8LD PDIP package, -40°C to +85°C.</p> <p>c) TC1411NEUA: 1A Single MOSFET driver, 8LD MSOP package, -40°C to +85°C.</p> <p>d) TC1411NVPA: 1A Single MOSFET driver, 8LD PDIP package, -40°C to +125°C.</p> |

TC1411/TC1411N

NOTES:

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- **General Technical Support** – Frequently Asked Questions (FAQ), technical support requests, online discussion groups, Microchip consultant program member listing
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Technical support is available through the web site at: <http://microchip.com/support>

TC1411/TC1411N

NOTES:

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

- Microchip products meet the specification contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is one of the most secure families of its kind on the market today, when used in the intended manner and under normal conditions.
- There are dishonest and possibly illegal methods used to breach the code protection feature. All of these methods, to our knowledge, require using the Microchip products in a manner outside the operating specifications contained in Microchip's Data Sheets. Most likely, the person doing so is engaged in theft of intellectual property.
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