LOGIC-INPUT CMOS QUAD DRIVERS

FEATURES

- **High Peak Output Current 1.2A**
- **Wide Operating Range ..... 4.5 to 18V**
- **Symmetrical Rise and Fall Times 25nsec**
- **Short, Equal Delay Times 75nsec**
- **Latchproof! Withstands 500mA Inductive Kickback**
- **3 Input Logic Choices**
  — AND / NAND / AND + Inv
- **2kV ESD Protection on All Pins**

APPLICATIONS

- **General-Purpose CMOS Logic Buffer**
- **Driving All Four MOSFETs in an H-Bridge**
- **Direct Small Motor Driver**
- **Relay or Peripheral Drivers**
- **CCD Driver**
- **Pin-Switching Network Driver**

GENERAL DESCRIPTION

The TC446X family of four-output CMOS buffer/drivers are an expansion from our earlier single- and dual-output drivers. Each driver has been equipped with a two-input logic gate for added flexibility.

The TC446X drivers can source up to 250 mA into loads referenced to ground. Heavily loaded clock lines, coaxial cables, and piezoelectric transducers can all be easily driven with the 446X series drivers. The only limitation on loading is that total power dissipation in the IC must be kept within the power dissipation limits of the package.

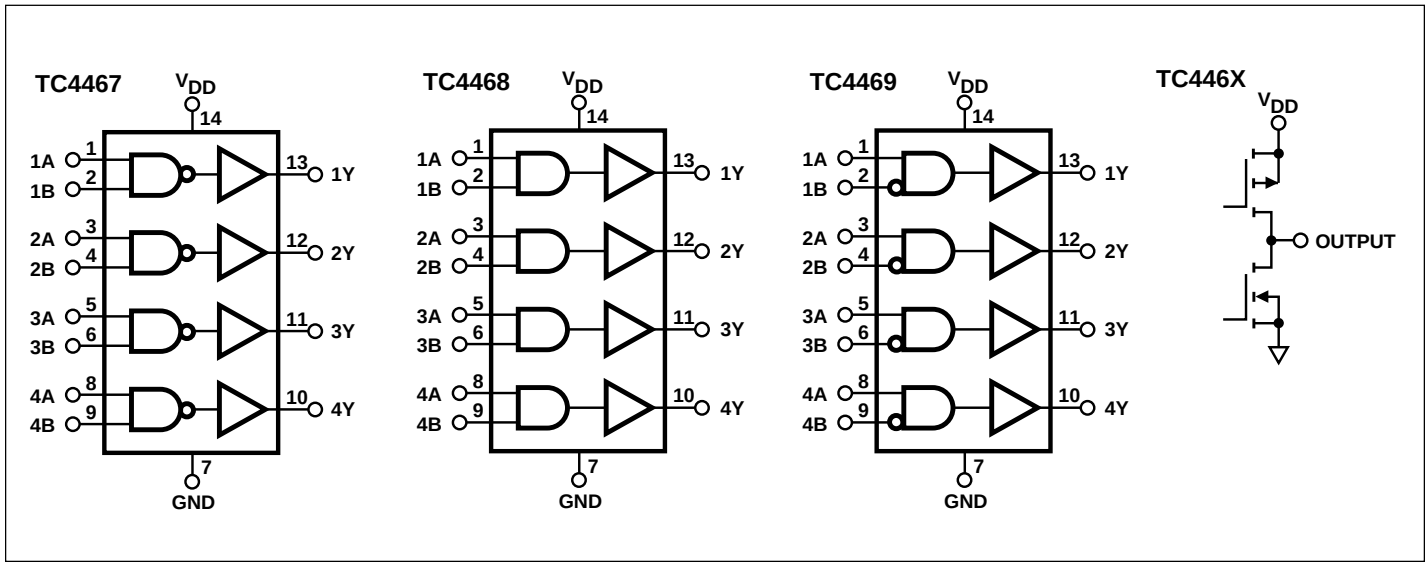
The TC446X series will not latch under any conditions within their power and voltage ratings. They are not subject to damage when up to 5V of noise spiking (either polarity) occurs on the ground line. They can accept up to half an amp of inductive kickback current (either polarity) into their outputs without damage or logic upset. In addition, all terminals are protected against ESD to at least 2000V.

ORDERING INFORMATION

Part No.	Package	Temp. Range
TC446xCOE	16-Pin SOIC (Wide)	0° to +70°C
TC446xCPD	14-Pin Plastic DIP	0° to +70°C
TC446xEJD	14-Pin CerDIP	– 40° to +85°C
TC446xMJD	14-Pin CerDIP	– 55° to +125°C

*A digit must be added in the "x" position to define the device input configuration: TC446x — 7 NAND
8 AND
9 AND with INV

LOGIC DIAGRAMS



© 2001 Microchip Technology Inc.

TC4467
TC4468
TC4469

ABSOLUTE MAXIMUM RATINGS*

Supply Voltage ..... +20V
Input Voltage ..... (GND – 5V) to (V_{DD} + 0.3V)
Maximum Chip Temperature
- Operating ..... +150°C
- Storage ..... – 65° to +150°C

Maximum Lead Temperature
- (Soldering, 10 sec) ..... +300°C

Operating Ambient Temperature Range
- C Device ..... 0° to +70°C
- E Device ..... – 40° to +85°C
- M Device ..... – 55° to +125°C

Package Power Dissipation ($T_A \leq 70°C$)
- 14-Pin CerDIP 840mW
- 14-Pin Plastic DIP 800mW
- 16-Pin Wide SOIC 760mW

Package Thermal Resistance

14-Pin CerDIP	$R_{\theta J-A}$	100°C/W
	$R_{\theta J-C}$	23°C/W
14-Pin Plastic DIP	$R_{\theta J-A}$	80°C/W
	$R_{\theta J-C}$	35°C/W
16-Pin Wide SOIC	$R_{\theta J-A}$	95°C/W
	$R_{\theta J-C}$	28°C/W

*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. 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 operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS: Measured at T_A = +25°C with 4.5V ≤ V_{DD} ≤ 18V, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Input						
V_{IH}	Logic 1, High Input Voltage	Note 3	2.4	—	V_{DD}	V
V_{IL}	Logic 0, Low Input Voltage	Note 3	0	—	0.8	V
I_{IN}	Input Current	$0V \leq V_{IN} \leq V_{DD}$	– 1	—	1	µA
Output						
V_{OH}	High Output Voltage	I_{LOAD} = 100µA (Note 1)	V_{DD} – 0.025	—	—	V
V_{OL}	Low Output Voltage	I_{LOAD} = 10mA (Note 1)	—	—	0.15	V
R_O	Output Resistance	I_{OUT} = 10mA, V_{DD} = 18V	—	10	15	Ω
I_{PK}	Peak Output Current		—	1.2	—	A
I_{DC}	Continuous Output Current	Single Output Total Package	—	—	300 500	mA
I	Latch-Up Protection Withstand Reverse Current	$4.5V \leq V_{DD} \leq 16V$	500	—	—	mA
Switching Time						
t_R	Rise Time	Figure 1	—	15	25	nsec
t_F	Fall Time	Figure 1	—	15	25	nsec
t_{D1}	Delay Time	Figure 1	—	40	75	nsec
t_{D2}	Delay Time	Figure 1	—	40	75	nsec
Power Supply						
I_S	Power Supply Current		—	1.5	4	mA
V_{DD}	Power Supply Voltage	Note 2	4.5	—	18	V

TRUTH TABLE

Part No.	TC4467 NAND				TC4468 AND				TC4469 AND/INV			
INPUTS A	H	H	L	L	H	H	L	L	H	H	L	L
INPUTS B	H	L	H	L	H	L	H	L	H	L	H	L
OUTPUTS TC446X	L	H	H	H	H	L	L	L	L	H	L	L

H = High L = Low

© 2001 Microchip Technology Inc.

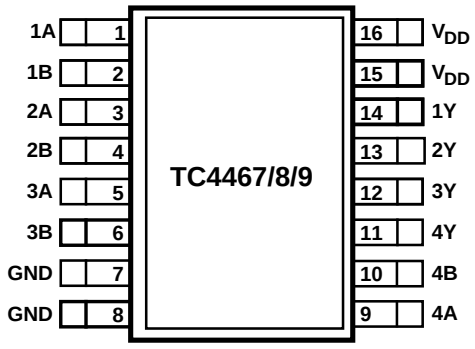
ELECTRICAL CHARACTERISTICS: Measured throughout operating temperature range with $4.5V \le V_{Dd} \le 18V$, unless otherwise specified.

Symbol	Parameter	Test Conditions	Min	Typ	Max	Unit
Input						
V_{IH}	Logic 1, High Input Voltage	(Note 3)	2.4	—	—	V
V_{IL}	Logic 0, Low Input Voltage	(Note 3)	—	—	0.8	V
I_{IN}	Input Current	$0V \le V_{IN} \le V_{DD}$	– 10	—	10	µA
Output						
V_{OH}	High Output Voltage	I_{LOAD} = 100µA (Note 1)	V_{DD} – 0.025	—	—	V
V_{OL}	Low Output Voltage	I_{LOAD} = 10mA (Note 1)	—	—	0.30	V
R_O	Output Resistance	I_{OUT} = 10mA, V_{DD} = 18V	—	20	30	Ω
I_{PK}	Peak Output Current		—	1.2	—	A
I	Latch-Up Protection Withstand Reverse Current	$4.5V \le V_{DD} \le 16V$	500	—	—	mA
Switching Time						
t_R	Rise Time	Figure 1	—	—	50	nsec
t_F	Fall Time	Figure 1	—	—	50	nsec
t_{D1}	Delay Time	Figure 1	—	—	100	nsec
t_{D2}	Delay Time	Figure 1	—	—	100	nsec
Power Supply						
I_S	Power Supply Current		—	—	8	mA
I_S	Power Supply Voltage	Note 2	4.5	—	18	V

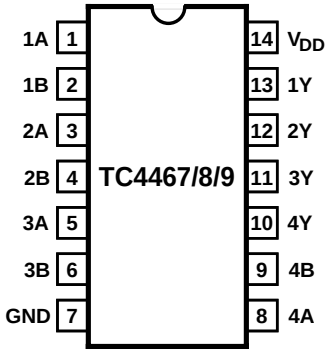
NOTES:
1. Totem-pole outputs should not be paralleled because the propagation delay differences from one to the other could cause one driver to drive high a few nanoseconds before another. The resulting current spike, although short, may decrease the life of the device.
2. When driving all four outputs simultaneously in the same direction, V_{DD} shall be limited to 16V. This reduces the chance that internal dv/dt will cause high-power dissipation in the device.
3. The input threshold has about 50mV of hysteresis centered at approximately 1.5V. Slow moving inputs will force the device to dissipate high peak currents as the input transitions through this band. Input rise times should be kept below 5µsec to avoid high internal peak currents during input transitions. Static input levels should also be maintained above the maximum or below the minimum input levels specified in the "Electrical Characteristics" to avoid increased power dissipation in the device.

PIN CONFIGURATIONS

16-Pin SOIC (Wide)



14-Pin Plastic DIP/CerDIP



Supply Bypassing

Large currents are required to charge and discharge large capacitive loads quickly. For example, charging a 1000pF load to 18V in 25nsec requires 0.72A from the device's power supply.

To guarantee low supply impedance over a wide frequency range, a 1µF film capacitor in parallel with one or two low-inductance 0.1µF ceramic disk capacitors with short lead lengths (<0.5 in.) normally provide adequate bypassing.

Grounding

The TC4467 and TC4469 contain inverting drivers. Potential drops developed in common ground impedances from input to output will appear as negative feedback and degrade switching speed characteristics. Instead, individual ground returns for input and output circuits, or a ground plane, should be used.

Input Stage

The input voltage level changes the no-load or quiescent supply current. The N-channel MOSFET input stage transistor drives a 2.5mA current source load. With logic "0" outputs, maximum quiescent supply current is 4mA. Logic "1" output level signals reduce quiescent current to 1.4mA maximum. Unused driver inputs must be connected to V_{DD} or V_{SS}. Minimum power dissipation occurs for logic "1" outputs.

The drivers are designed with 50mV of hysteresis. This provides clean transitions and minimizes output stage current spiking when changing states. Input voltage thresholds are approximately 1.5V, making any voltage greater than 1.5V up to V_{DD} a logic 1 input . Input current is less than 1 µA over this range.

Power Dissipation

The supply current versus frequency and supply current versus capacitive load characteristic curves will aid in determining power dissipation calculations. TelCom Semiconductor's CMOS drivers have greatly reduced quiescent DC power consumption.

Input signal duty cycle, power supply voltage and load type, influence package power dissipation. Given power dissipation and package thermal resistance, the maximum ambient operating temperature is easily calculated. The 14-pin plastic package junction-to-ambient thermal resistance is 83.3°C/W. At +70°C, the package is rated at 800mW maximum dissipation. Maximum allowable chip temperature is +150°C.

Three components make up total package power dissipation:

(1) Load-caused dissipation (P_L)
(2) Quiescent power (P_Q)
(3) Transition power (P_T).

A capacitive-load-caused dissipation (driving MOSFET gates), is a direct function of frequency, capacitive load, and supply voltage. The power dissipation is:

$$P_L = f\ C\ V_S^2,$$

where: f = Switching frequency
C = Capacitive load
V_S = Supply voltage.

A resistive-load-caused dissipation for ground-referenced loads is a function of duty cycle, load current, and load voltage. The power dissipation is:

$$P_L = D\ (V_S - V_L)\ I_L,$$

where: D = Duty cycle
V_S = Supply voltage
V_L = Load voltage
I_L = Load current.

A resistive-load-caused dissipation for supply-referenced loads is a function of duty cycle, load current, and output voltage. The power dissipation is:

$$P_L = D\ V_O\ I_L,$$

where: f = Switching frequency
V_O = Device output voltage
I_L = Load current.

Quiescent power dissipation depends on input signal duty cycle. Logic HIGH outputs result in a lower power dissipation mode, with only 0.6 mA total current drain (all devices driven). Logic LOW outputs raise the current to 4 mA maximum. The quiescent power dissipation is:

$$P_Q = V_S\ (D(I_H) + (1-D)I_L),$$

where: I_H = Quiescent current with all outputs LOW (4 mA max)
I_L = Quiescent current with all outputs HIGH (0.6mA max)
D = Duty cycle
V_S = Supply voltage.

© 2001 Microchip Technology Inc.

Transition power dissipation arises in the complementary configuration (TC446X) because the output stage N-channel and P-channel MOS transistors are ON simultaneously for a very short period when the output changes. The transition power dissipation is approximately:

$P_T = f\ V_S\ (10 \times 10^{-9})$.

Package power dissipation is the sum of load, quiescent and transition power dissipations. An example shows the relative magnitude for each term:

C = 1000pF capacitive load
V_S = 15V
D = 50%
f = 200kHz
P_D = Package Power Dissipation = $P_L + P_Q + P_T$
= 45mW + 35 mW + 30 mW = 110mW.

Maximum operating temperature:

$T_J - \theta_{JA}\ (P_D) = 141°C$,

where: T_J = Maximum allowable junction temperature (+150°C)
θ_{JA} = Junction-to-ambient thermal resistance (83.3°C/W) 14-pin plastic package.

NOTE: Ambient operating temperature should not exceed +85°C for "EJD" device or +125°C for "MJD" device.

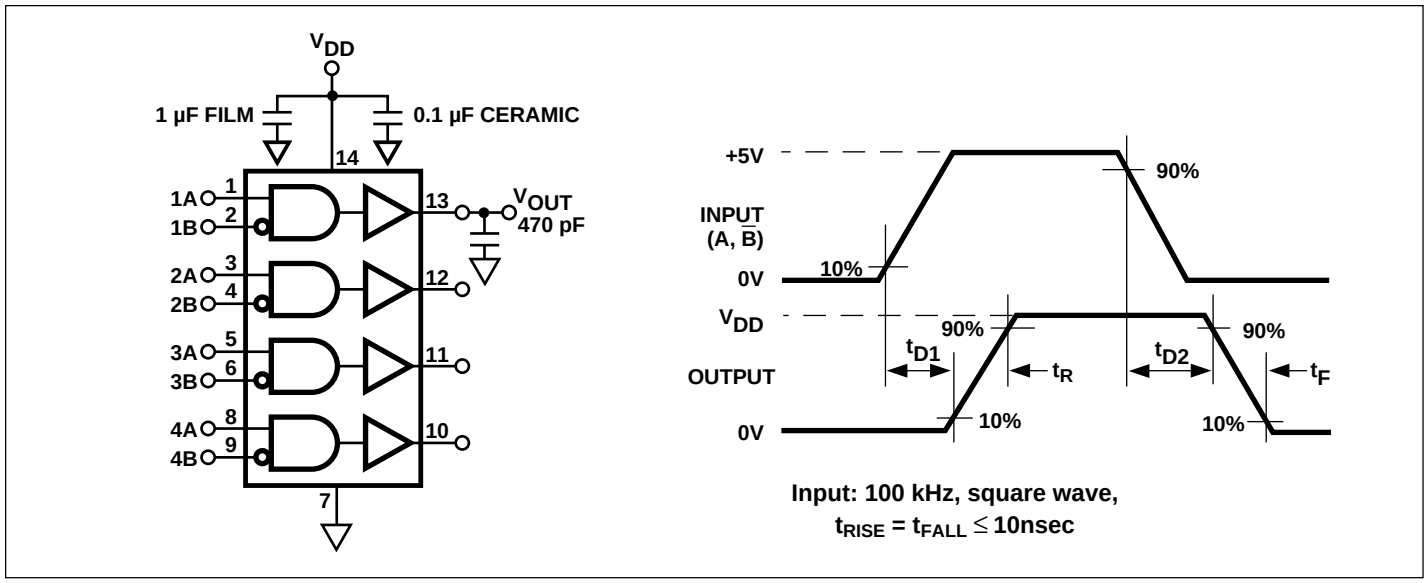
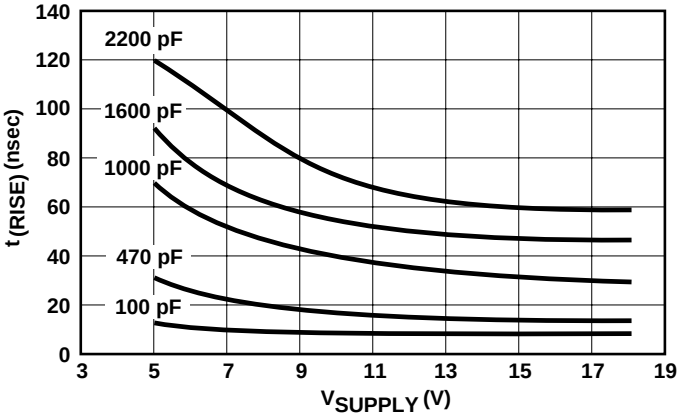


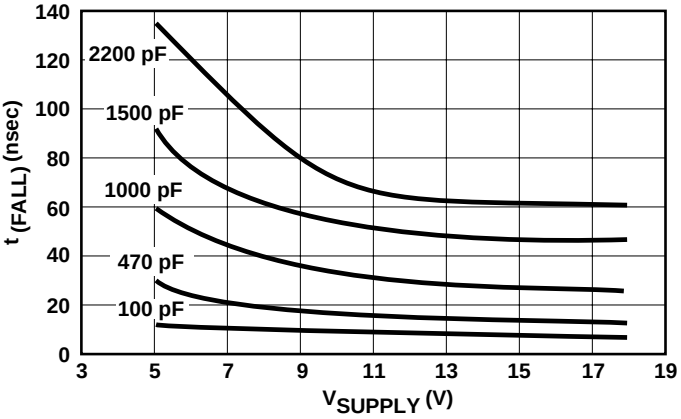
Figure 1. Switching Time Test Circuit

TYPICAL CHARACTERISTICS

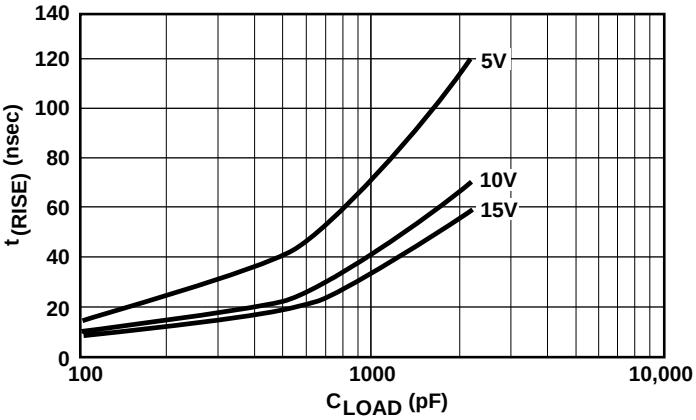
Rise Time vs. Supply Voltage



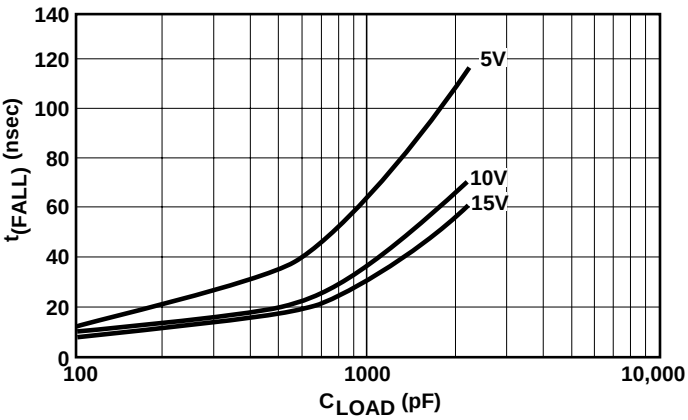
Fall Time vs. Supply Voltage



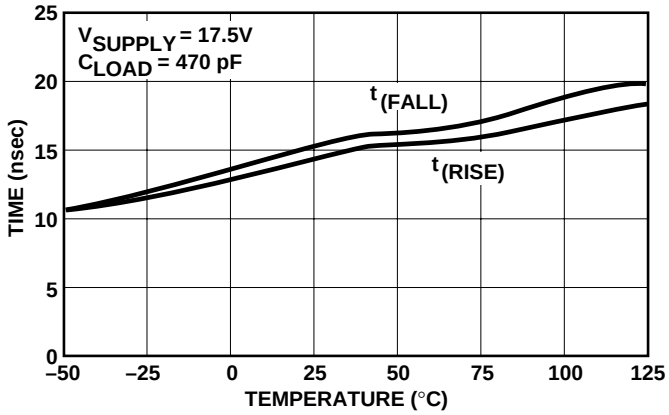
Rise Time vs. Capacitive Load



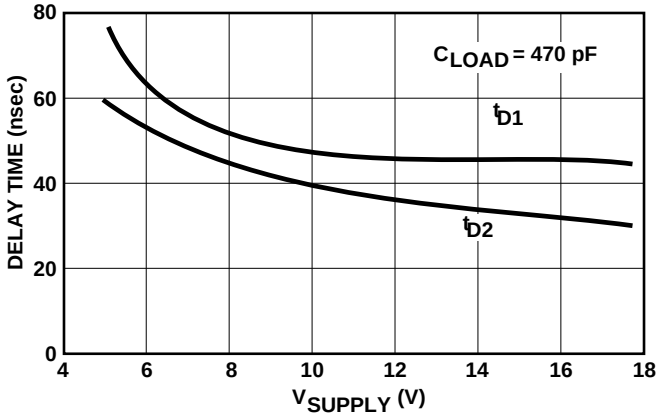
Fall Time vs. Capacitive Load



Rise/Fall Times vs. Temperature



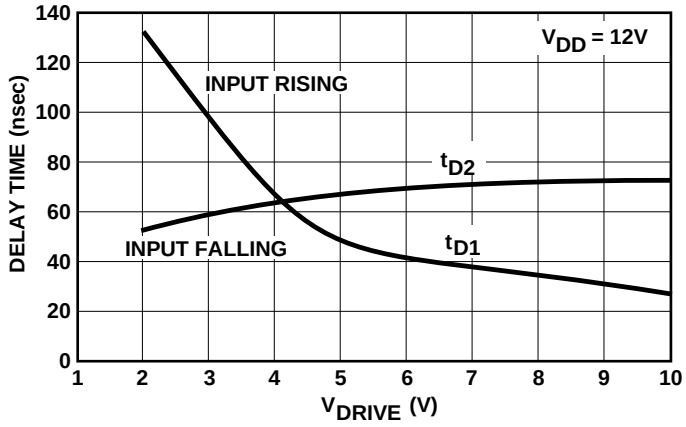
Propagation Delay Time vs. Supply Voltage



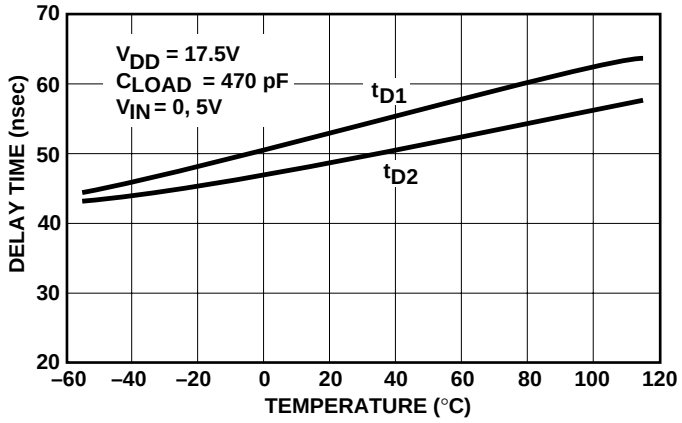
© 2001 Microchip Technology Inc.

TYPICAL CHARACTERISTICS (Cont.)

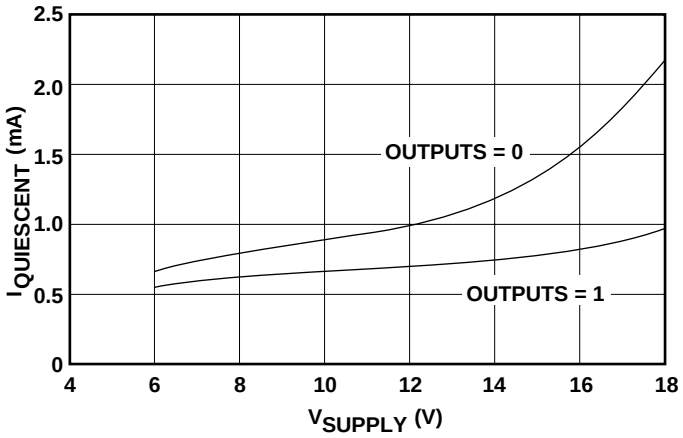
Input Amplitude vs. Delay Times



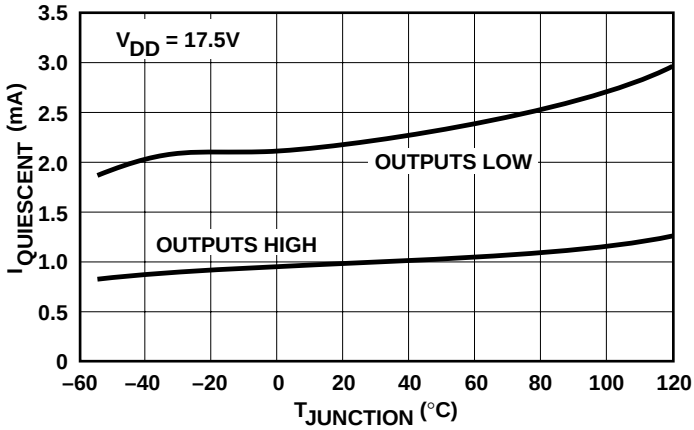
Propagation Delay Times vs. Temperature



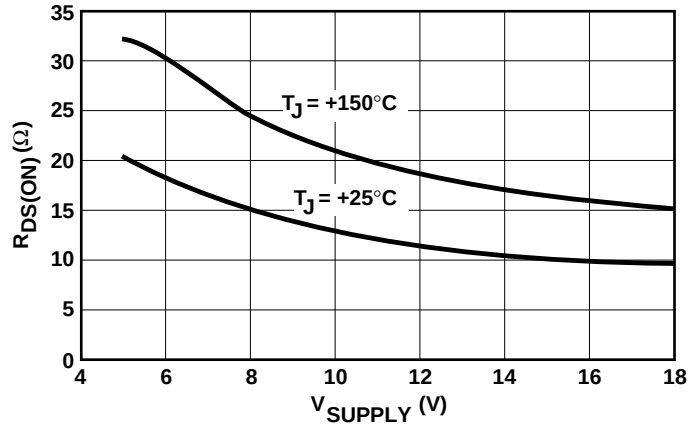
Quiescent Supply Current vs. Supply Voltage



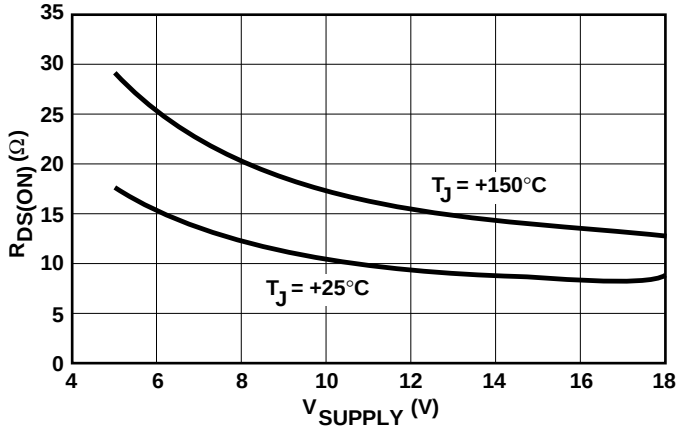
Quiescent Supply Current vs. Temperature



High-State Output Resistance

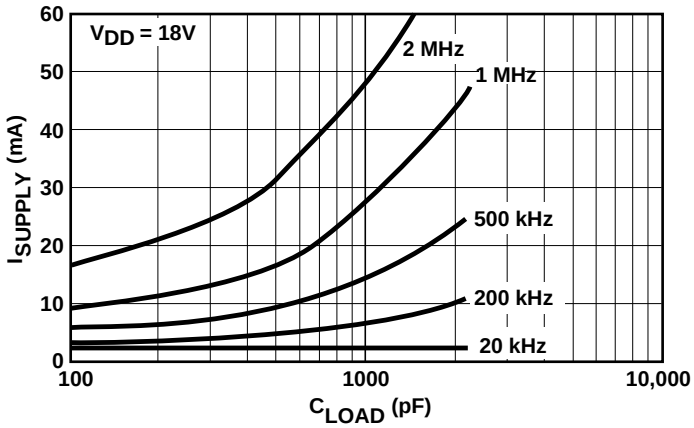


Low-State Output Resistance

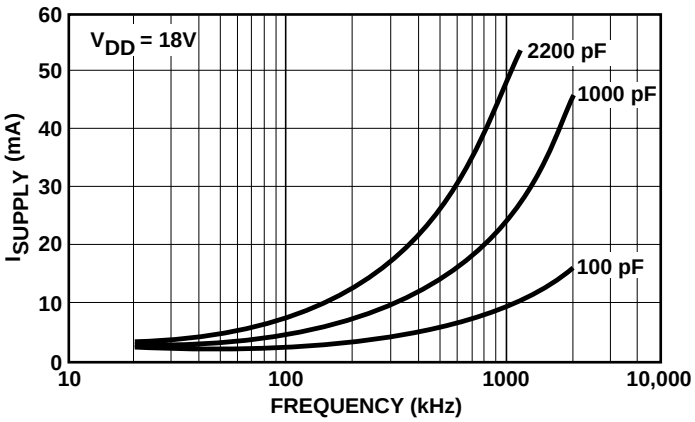


SUPPLY CURRENT CHARACTERISTICS (Load on Single Output Only)

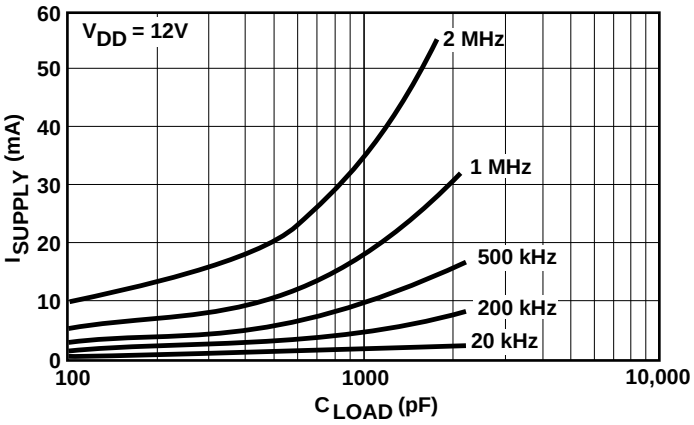
Supply Current vs. Capacitive Load



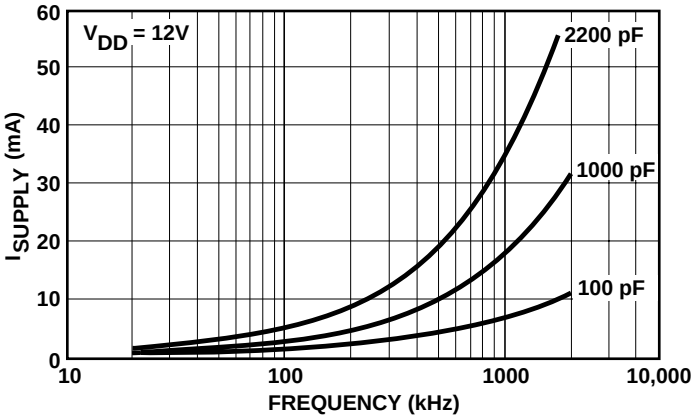
Supply Current vs. Frequency



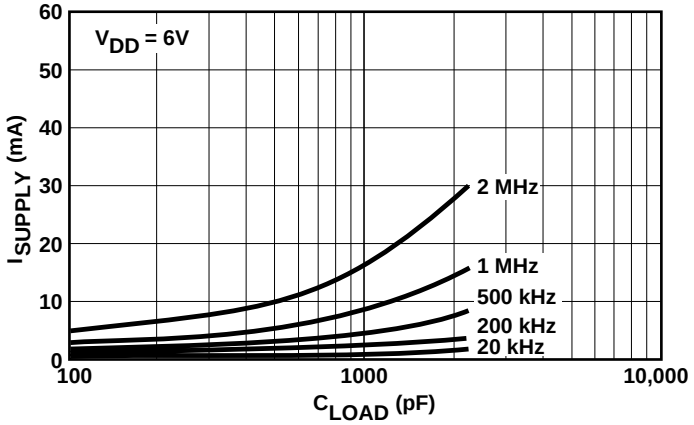
Supply Current vs. Capacitive Load



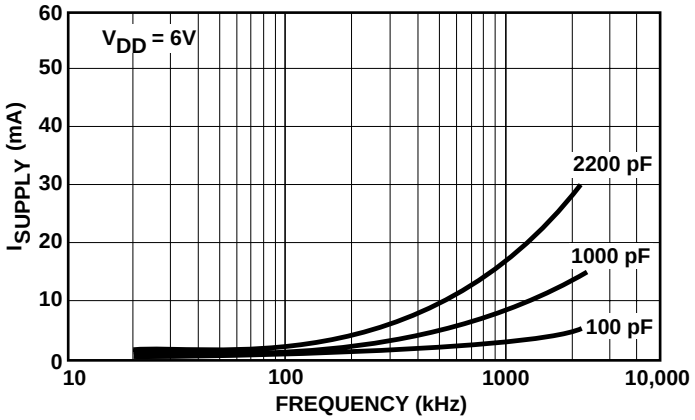
Supply Current vs. Frequency



Supply Current vs. Capacitive Load



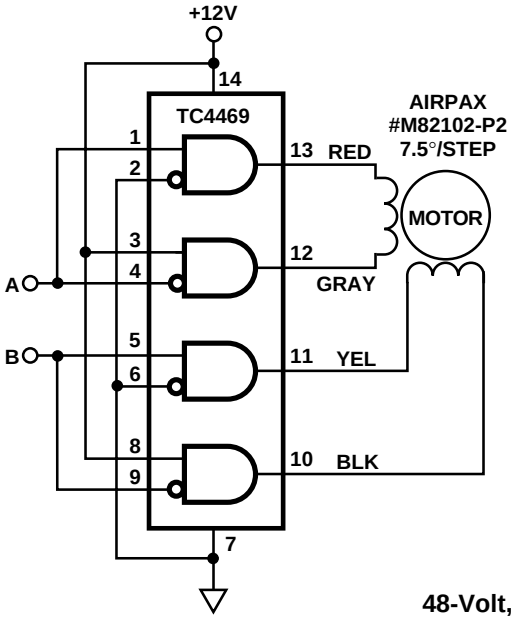
Supply Current vs. Frequency



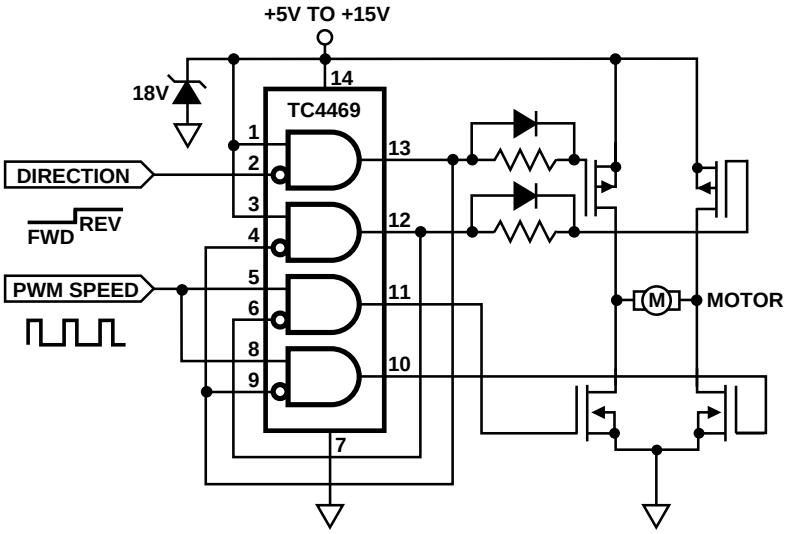
© 2001 Microchip Technology Inc.

TYPICAL APPLICATIONS

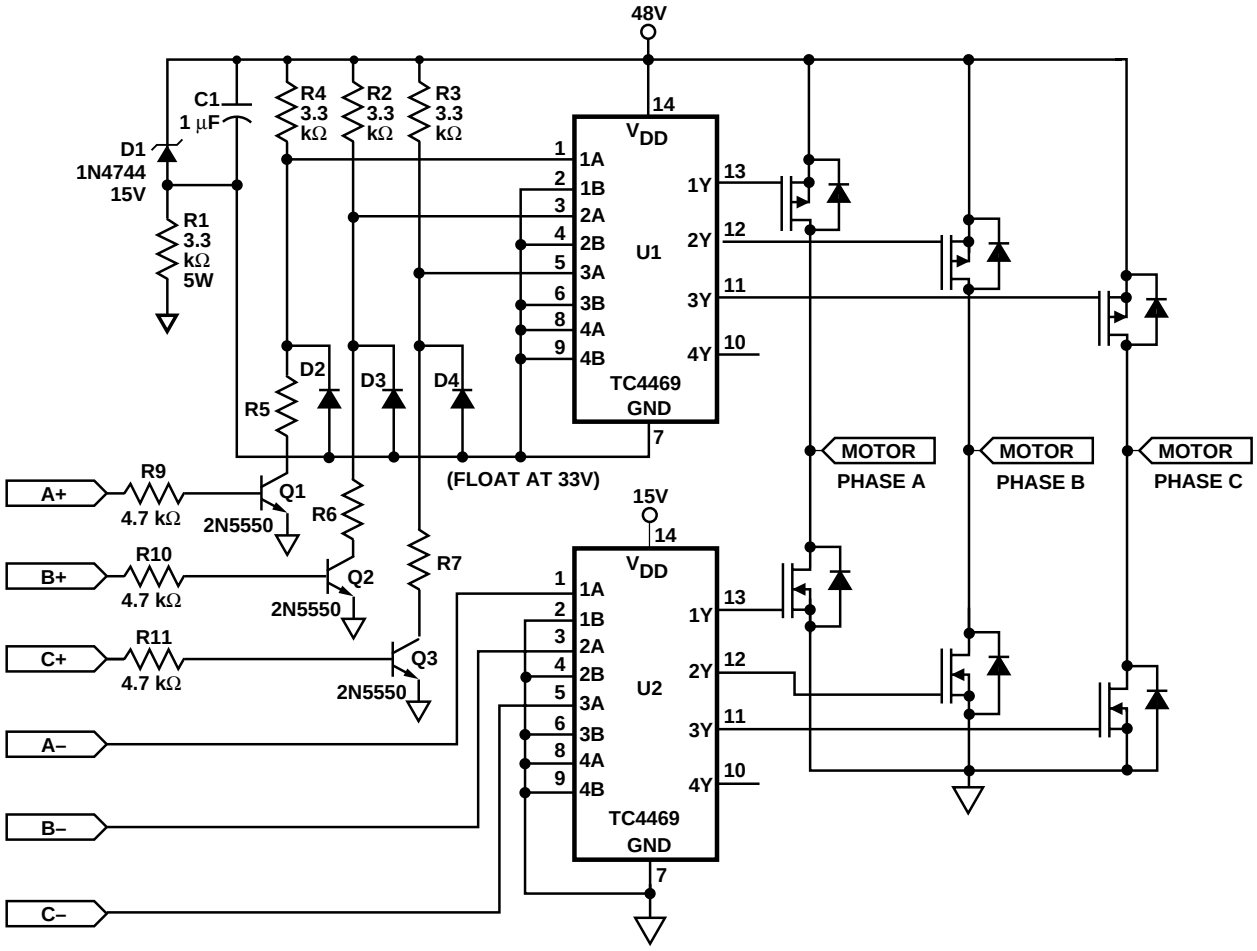
Stepper Motor Drive



Quad Driver for H-Bridge Motor Control



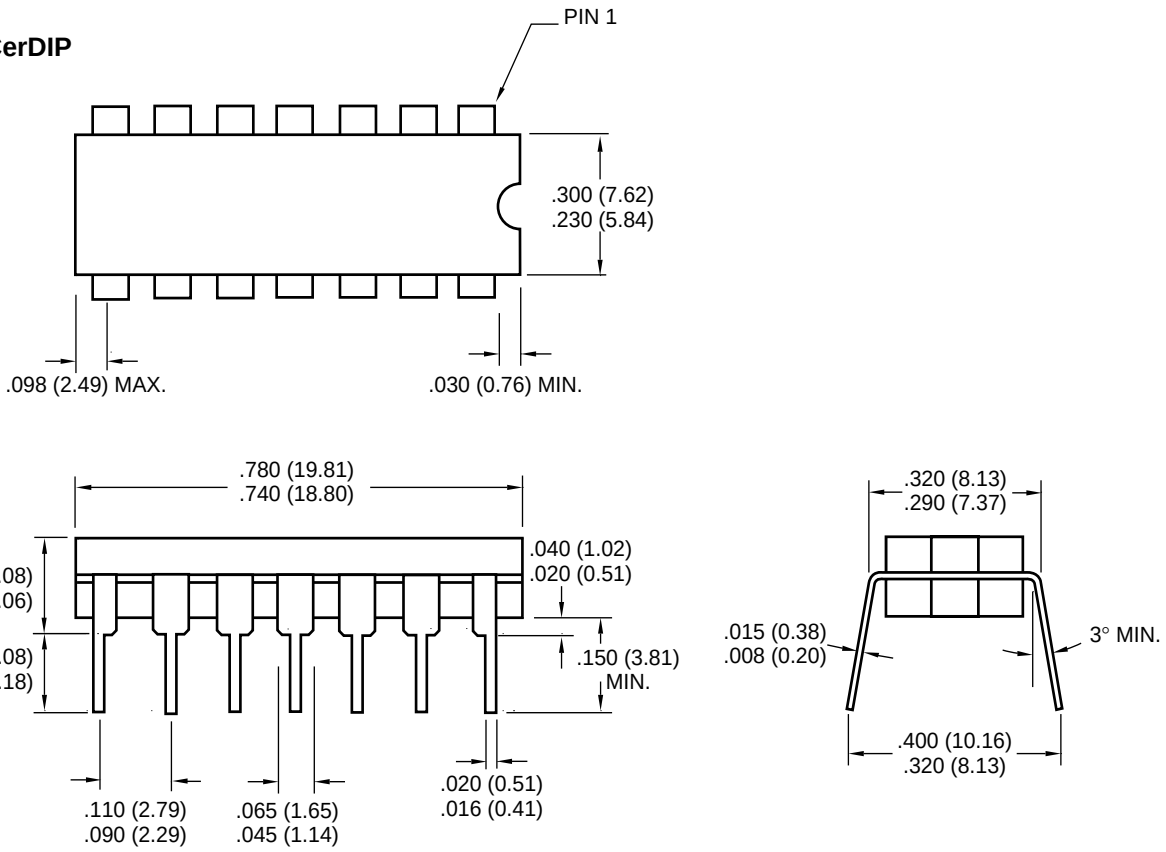
48-Volt, 3-Phase Brushless Output Stage



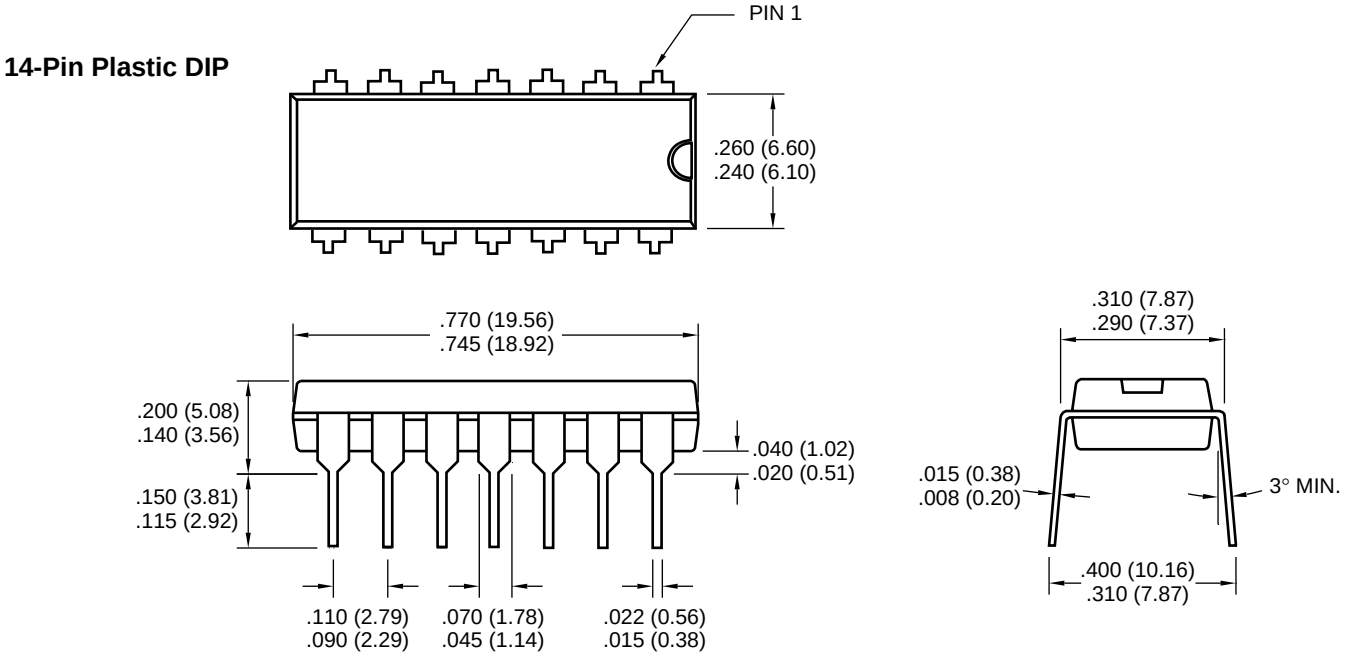
TC4467
TC4468
TC4469

PACKAGE DIMENSIONS

14-Pin CerDIP



14-Pin Plastic DIP

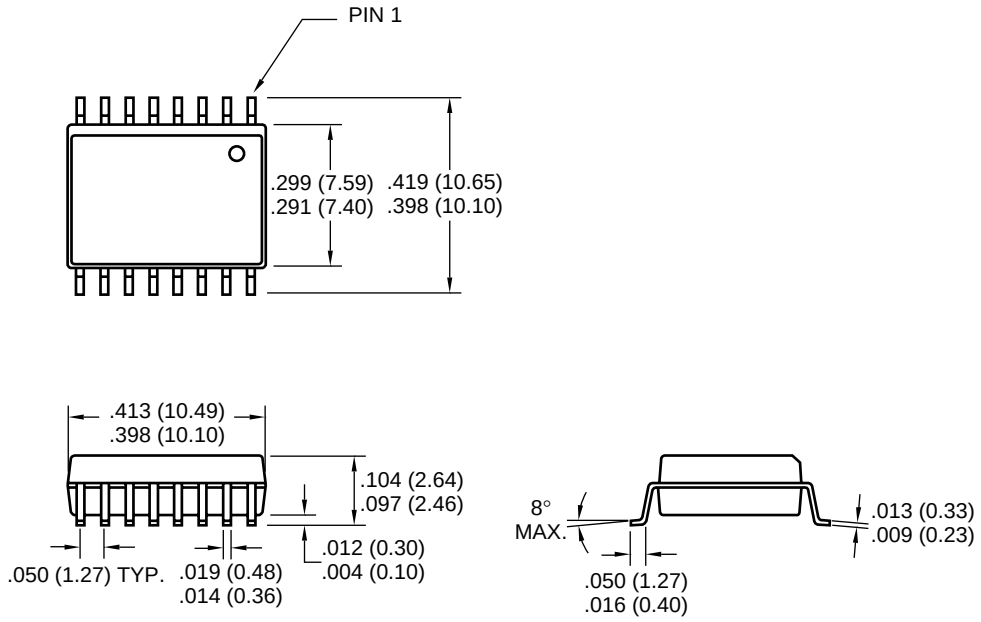


Dimensions: inches (mm)

© 2001 Microchip Technology Inc.

PACKAGE DIMENSIONS (Cont.)

16-Pin SOIC (Wide)



Dimensions: inches (mm)

WORLDWIDE SALES AND SERVICE

AMERICAS

Corporate Office
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7200 Fax: 480-792-7277
Technical Support: 480-792-7627
Web Address: http://www.microchip.com

Rocky Mountain
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-7456

Atlanta
500 Sugar Mill Road, Suite 200B
Atlanta, GA 30350
Tel: 770-640-0034 Fax: 770-640-0307

Austin
Analog Product Sales
8303 MoPac Expressway North
Suite A-201
Austin, TX 78759
Tel: 512-345-2030 Fax: 512-345-6085

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Boston
Analog Product Sales
Unit A-8-1 Millbrook Tarry Condominium
97 Lowell Road
Concord, MA 01742
Tel: 978-371-6400 Fax: 978-371-0050

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Dayton
Two Prestige Place, Suite 130
Miamisburg, OH 45342
Tel: 937-291-1654 Fax: 937-291-9175

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

Mountain View
Analog Product Sales
1300 Terra Bella Avenue
Mountain View, CA 94043-1836
Tel: 650-968-9241 Fax: 650-967-1590

New York
150 Motor Parkway, Suite 202
Hauppauge, NY 11788
Tel: 631-273-5305 Fax: 631-273-5335

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

China - Beijing
Microchip Technology Beijing Office
Unit 915
New China Hong Kong Manhattan Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Shanghai
Microchip Technology Shanghai Office
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

Hong Kong
Microchip Asia Pacific
RM 2101, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

India
Microchip Technology Inc.
India Liaison Office
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, OíShaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Intl. Inc.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea
Tel: 82-2-554-7200 Fax: 82-2-558-5934

ASIA/PACIFIC (continued)

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-334-8870 Fax: 65-334-8850

Taiwan
Microchip Technology Taiwan
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Australia
Microchip Technology Australia Pty Ltd
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

Denmark
Microchip Technology Denmark ApS
Regus Business Centre
Lautrup hoj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Arizona Microchip Technology SARL
Parc díActivite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Arizona Microchip Technology GmbH
Gustav-Heinemann Ring 125
D-81739 Munich, Germany
Tel: 49-89-627-144 0 Fax: 49-89-627-144-44

Germany
Analog Product Sales
Lochhamer Strasse 13
D-82152 Martinsried, Germany
Tel: 49-89-895650-0 Fax: 49-89-895650-22

Italy
Arizona Microchip Technology SRL
Centro Direzionale Colleoni
Palazzo Taurus 1 V. Le Colleoni 1
20041 Agrate Brianza
Milan, Italy
Tel: 39-039-65791-1 Fax: 39-039-6899883

United Kingdom
Arizona Microchip Technology Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

All rights reserved. © 2001 Microchip Technology Incorporated. Printed in the USA. 1/01 Printed on recycled paper.

01/09/01

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchipís products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, except as maybe explicitly expressed herein, under any intellectual property rights. The Microchip logo and name are registered trademarks of Microchip Technology Inc. in the U.S.A. and other countries. All rights reserved. All other trademarks mentioned herein are the property of their respective companies.