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TC4467/TC4468/TC4469

Logic-Input CMOS Quad Drivers

Features

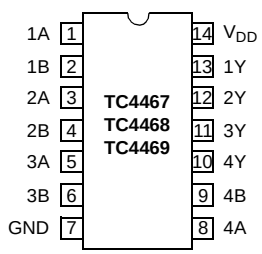
- High Peak Output Current: 1.2 A
- Wide Operating Range:
  - 4.5 V to 18 V
- Symmetrical Rise/Fall Times: 25 nsec
- Short, Equal Delay Times: 75 nsec
- Latch-proof. Will Withstand 500 mA Inductive Kickback
- 3 Input Logic Choices:
  - AND / NAND / AND + Inv
- ESD Protection on All Pins: 2 kV

Applications

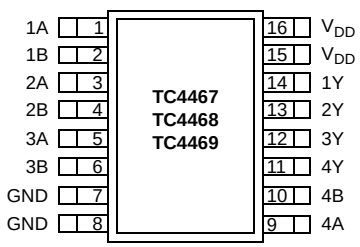
- General Purpose CMOS Logic Buffer
- Driving All Four MOSFETs in an H-Bridge
- Direct Small Motor Driver
- Relay or Peripheral Drivers
- CCD Driver
- Pin-Switching Network Driver

Package Types

14-Pin PDIP/CERDIP



16-Pin SOIC (Wide)



General Description

The TC4467/TC4468/TC4469 devices are a family of four-output CMOS buffers/MOSFET drivers with 1.2 A peak drive capability. Unlike other MOSFET drivers, these devices have two inputs for each output. The inputs are configured as logic gates: NAND (TC4467), AND (TC4468) and AND/INV (TC4469).

The TC4467/TC4468/TC4469 drivers can continuously source up to 250 mA into ground referenced loads. These devices are ideal for direct driving low current motors or driving MOSFETs in a H-bridge configuration for higher current motor drive (see Section 5.0 for details). Having the logic gates onboard the driver can help to reduce component count in many designs.

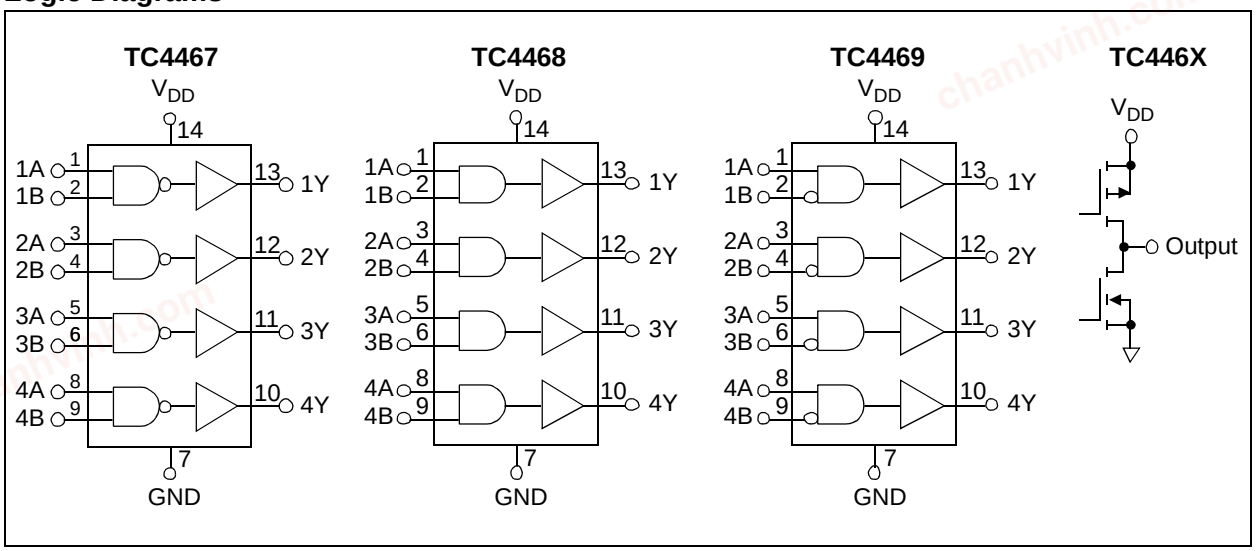
The TC4467/TC4468/TC4469 devices are very robust and highly latch-up resistant. They can tolerate up to 5 V of noise spiking on the ground line and can handle up to 0.5 A of reverse current on the driver outputs.

The TC4467/4468/4469 devices are available in commercial, industrial and military temperature ranges.

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Logic Diagrams



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1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Supply Voltage ..... +20 V
Input Voltage ..... (GND – 5 V) to (V_{DD} + 0.3 V)
Package Power Dissipation: ($T_A \leq 70°C$)
- PDIP ..... 800 mW
- CERDIP ..... 840 mW
- SOIC ..... 760 mW

Package Thermal Resistance:
- CERDIP $R_{\theta J-A}$ ..... 100°C/W
- CERDIP $R_{\theta J-C}$ ..... 23°C/W
- PDIP $R_{\theta J-A}$ ..... 80°C/W
- PDIP $R_{\theta J-C}$ ..... 35°C/W
- SOIC $R_{\theta J-A}$ ..... 95°C/W
- SOIC $R_{\theta J-C}$ ..... 28°C/W

Operating Temperature Range:
- C Version ..... 0°C to +70°C
- E Version ..... -40°C to +85°C
- M Version ..... -55°C to +125°C

Maximum Chip Temperature ..... +150°C
Storage Temperature Range ..... -65°C to +150°C

†Notice: Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL SPECIFICATIONS

Electrical Characteristics: Unless otherwise noted, T_A = +25°C, with 4.5 V $\leq V_{DD} \leq$ 18 V.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input						
Logic 1, High Input Voltage	V_{IH}	2.4	—	V_{DD}	V	**Note 3**
Logic 0, Low Input Voltage	V_{IL}	—	—	0.8	V	**Note 3**
Input Current	I_{IN}	-1.0	—	+1.0	µA	$0 V \leq V_{IN} \leq V_{DD}$
Output						
High Output Voltage	V_{OH}	V_{DD} – 0.025	—	—	V	I_{LOAD} = 100 µA **(Note 1)**
Low Output Voltage	V_{OL}	—	—	0.15	V	I_{LOAD} = 10 mA **(Note 1)**
Output Resistance	R_O	—	10	15	Ω	I_{OUT} = 10 mA, V_{DD} = 18 V
Peak Output Current	I_{PK}	—	1.2	—	A	
Continuous Output Current	I_{DC}	—	—	300	mA	Single Output
		—	—	500		Total Package
Latch-Up Protection Withstand Reverse Current	I	—	500	—	mA	$4.5 V \leq V_{DD} \leq 16 V$
Switching Time (Note 1)						
Rise Time	t_R	—	15	25	nsec	Figure 4-1
Fall Time	t_F	—	15	25	nsec	Figure 4-1
Delay Time	t_{D1}	—	40	75	nsec	Figure 4-1
Delay Time	t_{D2}	—	40	75	nsec	Figure 4-1
Power Supply						
Power Supply Current	I_S	—	1.5	4	mA	
Power Supply Voltage	V_{DD}	4.5	—	18	V	**Note 2**

Note 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. Switching times are ensured by design.

2: When driving all four outputs simultaneously in the same direction, V_{DD} will be limited to 16 V. This reduces the chance that internal dv/dt will cause high-power dissipation in the device.

3: The input threshold has approximately 50 mV of hysteresis centered at approximately 1.5 V. Input rise times should be kept below 5 µsec 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.

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ELECTRICAL SPECIFICATIONS (OPERATING TEMPERATURES)

Electrical Characteristics: Unless otherwise noted, over operating temperature range with 4.5 V ≤ V_{DD} ≤ 18 V.						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Input						
Logic 1, High Input Voltage	V_{IH}	2.4	—	—	V	**Note 3**
Logic 0, Low Input Voltage	V_{IL}	—	—	0.8	V	**Note 3**
Input Current	I_{IN}	-10	—	10	µA	0 V ≤ V_{IN} ≤ V_{DD}
Output						
High Output Voltage	V_{OH}	V_{DD} – 0.025	—	—	V	I_{LOAD} = 100 µA **(Note 1)**
Low Output Voltage	V_{OL}	—	—	0.30	V	I_{LOAD} = 10 mA **(Note 1)**
Output Resistance	R_O	—	20	30	Ω	I_{OUT} = 10 mA, V_{DD} = 18 V
Peak Output Current	I_{PK}	—	1.2	—	A	
Continuous Output Current	I_{DC}	—	—	300	mA	Single Output
		—	—	500		Total Package
Latch-Up Protection Withstand Reverse Current	I	—	500	—	mA	4.5 V ≤ V_{DD} ≤ 16 V
Switching Time (Note 1)						
Rise Time	t_R	—	15	50	nsec	Figure 4-1
Fall Time	t_F	—	15	50	nsec	Figure 4-1
Delay Time	t_{D1}	—	40	100	nsec	Figure 4-1
Delay Time	t_{D2}	—	40	100	nsec	Figure 4-1
Power Supply						
Power Supply Current	I_S	—	—	8	mA	
Power Supply Voltage	V_{DD}	4.5	—	18	V	**Note 2**

Note 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. Switching times are ensured by design.

2: When driving all four outputs simultaneously in the same direction, V_{DD} will be limited to 16 V. This reduces the chance that internal dv/dt will cause high-power dissipation in the device.

3: The input threshold has approximately 50 mV of hysteresis centered at approximately 1.5 V. Input rise times should be kept below 5 µsec 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.

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

Legend: H = High L = Low

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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: T_A = +25°C, with 4.5 V $\leq V_{DD} \leq$ 18 V.

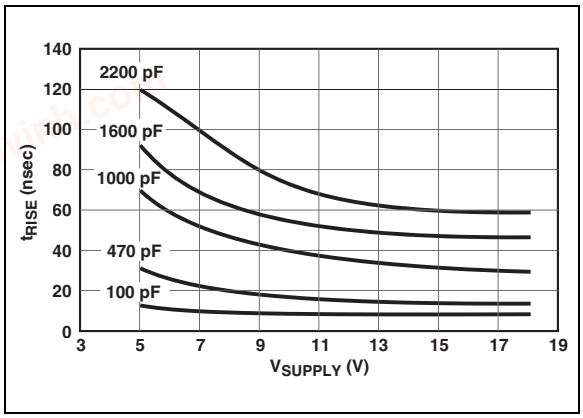


FIGURE 2-1: *Rise Time vs. Supply Voltage.*

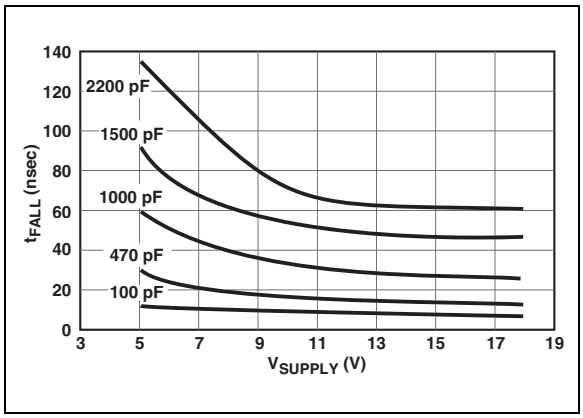


FIGURE 2-4: *Fall Time vs. Supply Voltage.*

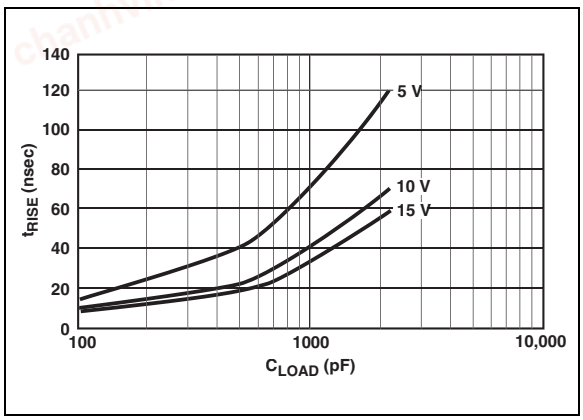


FIGURE 2-2: *Rise Time vs. Capacitive Load.*

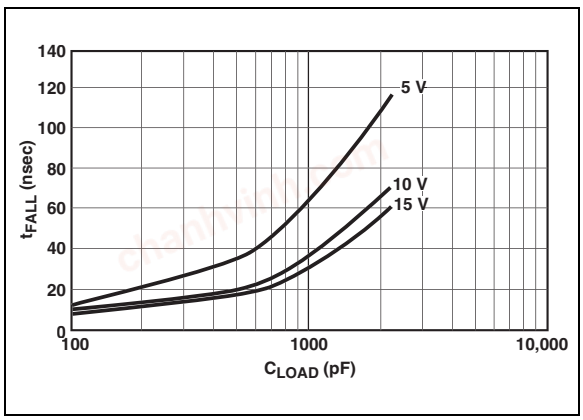


FIGURE 2-5: *Fall Time vs. Capacitive Load.*

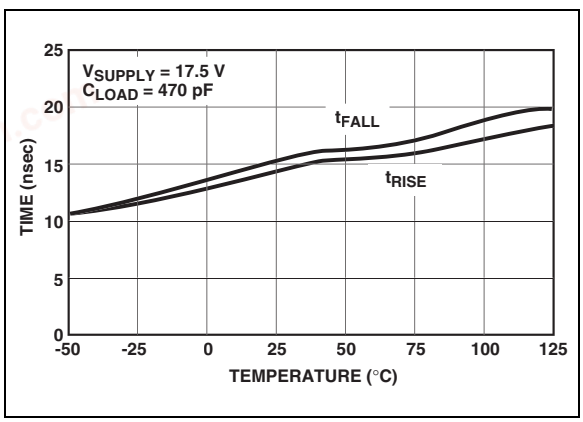


FIGURE 2-3: *Rise/Fall Times vs. Temperature.*

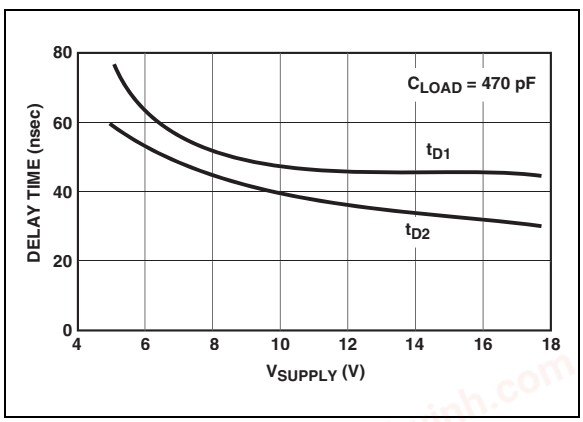


FIGURE 2-6: *Propagation Delay Time vs. Supply Voltage.*

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2.0 TYPICAL PERFORMANCE CURVES (CONTINUED)

Note: T_A = +25°C, with 4.5 V ≤ V_{DD} ≤ 18 V.

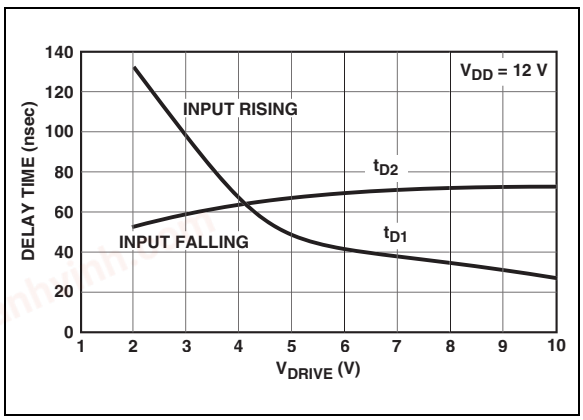


FIGURE 2-7: *Input Amplitude vs. Delay Times.*

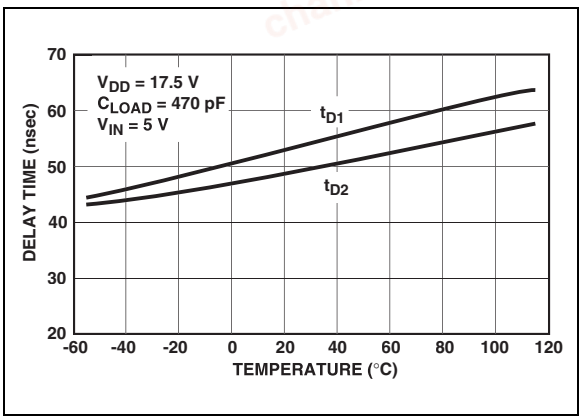


FIGURE 2-10: *Propagation Delay Times vs. Temperatures.*

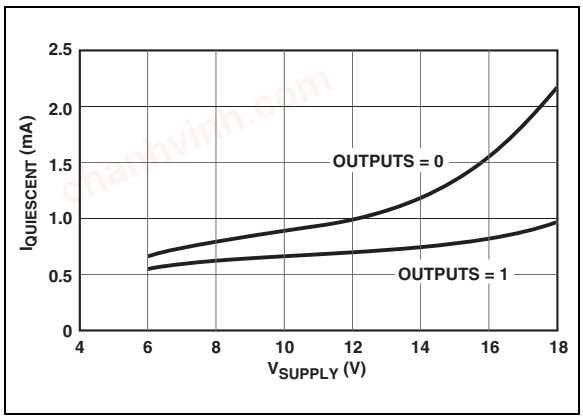


FIGURE 2-8: *Quiescent Supply Current vs. Supply Voltage.*

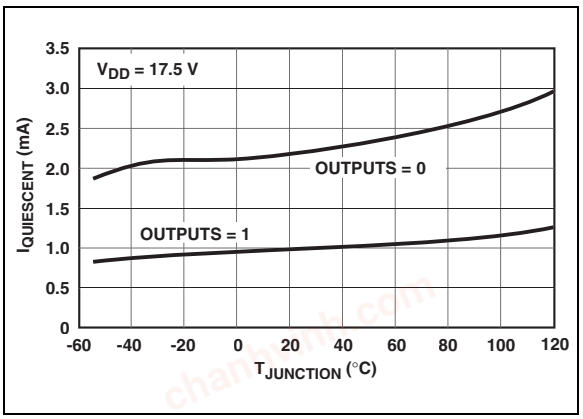


FIGURE 2-11: *Quiescent Supply Current vs. Temperature.*

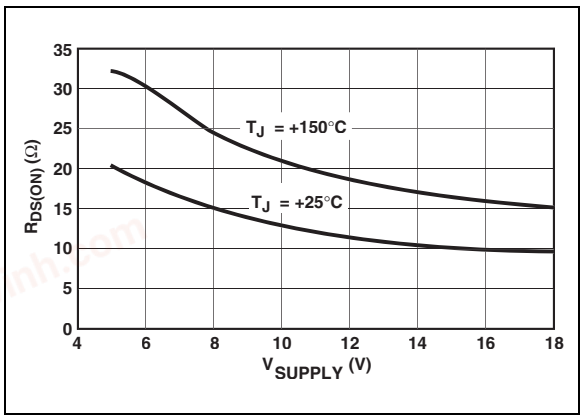


FIGURE 2-9: *High-State Output Resistance.*

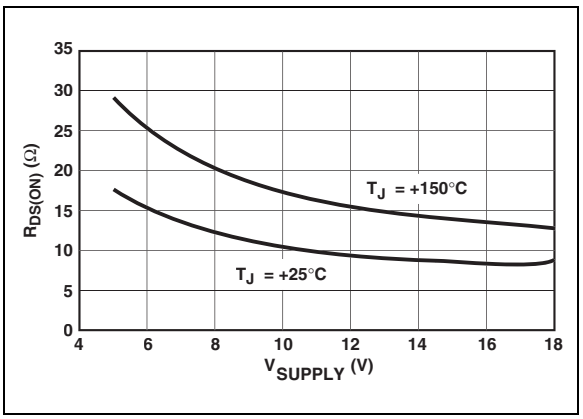


FIGURE 2-12: *Low-State Output Resistance.*

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2.0 TYPICAL PERFORMANCE CURVES (CONTINUED)

Note: (Load on single output only).

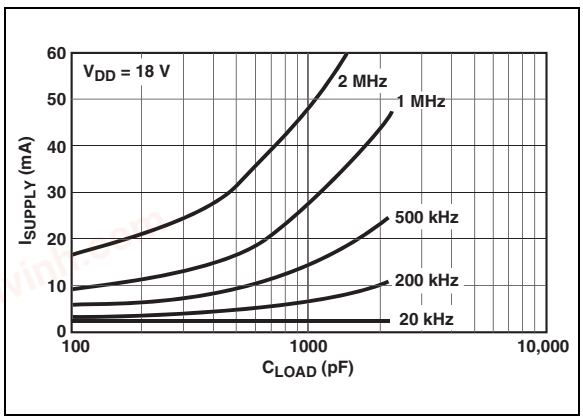


FIGURE 2-13: *Supply Current vs. Capacitive Load.*

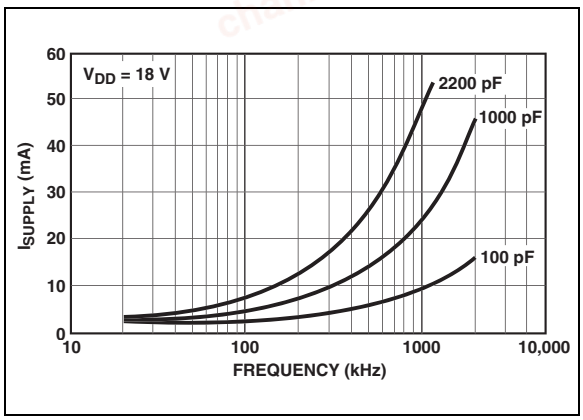


FIGURE 2-16: *Supply Current vs. Frequency.*

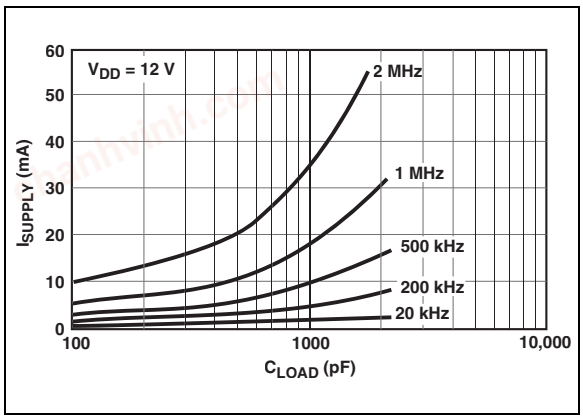


FIGURE 2-14: *Supply Current vs. Capacitive Load.*

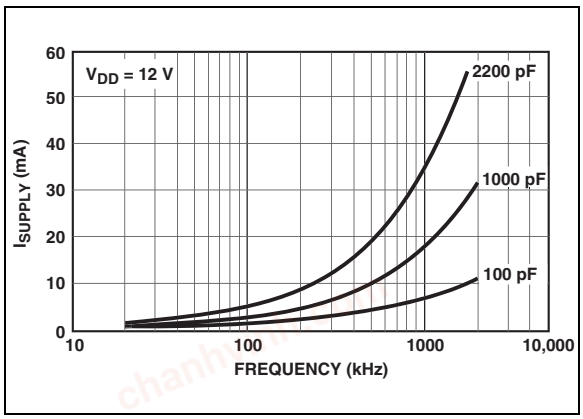


FIGURE 2-17: *Supply Current vs. Frequency.*

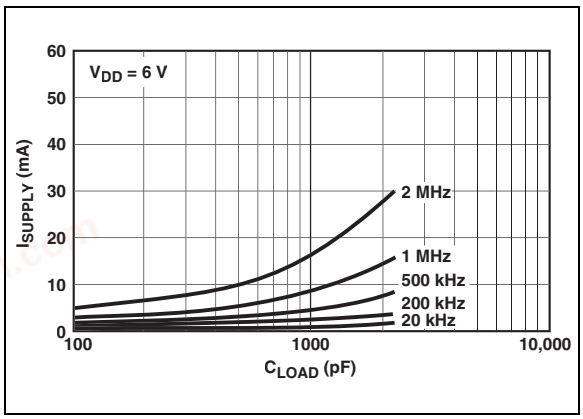


FIGURE 2-15: *Supply Current vs. Capacitive Load.*

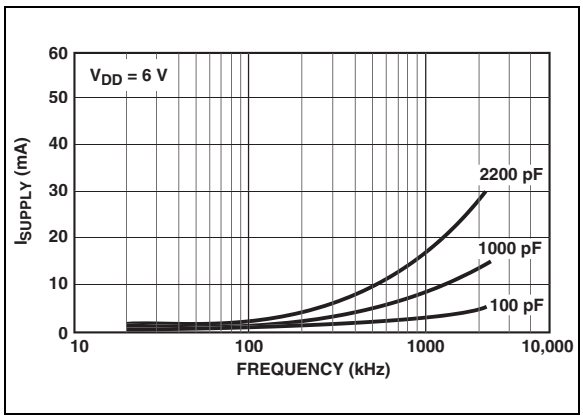


FIGURE 2-18: *Supply Current vs. Frequency.*

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3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

14-Pin PDIP, CERDIP	16-Pin SOIC (Wide)	Description
Symbol	Symbol	
1A	1A	Input A for Driver 1, TTL/CMOS Compatible Input
1B	1B	Input B for Driver 1, TTL/CMOS Compatible Input
2A	2A	Input A for Driver 2, TTL/CMOS Compatible Input
2B	2B	Input B for Driver 2, TTL/CMOS Compatible Input
3A	3A	Input A for Driver 3, TTL/CMOS Compatible Input
3B	3B	Input B for Driver 3, TTL/CMOS Compatible Input
GND	GND	Ground
—	GND	Ground
4A	4A	Input A for Driver 4, TTL/CMOS Compatible Input
4B	4B	Input B for Driver 4, TTL/CMOS Compatible Input
4Y	4Y	Output for Driver 4, CMOS Push-Pull Output
3Y	3Y	Output for Driver 3, CMOS Push-Pull Output
2Y	2Y	Output for Driver 2, CMOS Push-Pull Output
1Y	1Y	Output for Driver 1, CMOS Push-Pull Output
V_{DD}	V_{DD}	Supply Input, 4.5 V to 18 V
—	V_{DD}	Supply Input, 4.5 V to 18 V

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4.0 DETAILED DESCRIPTION

4.1 Supply Bypassing

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

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

4.2 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.

4.3 Input Stage

The input voltage level changes the no-load or quiescent supply current. The N-channel MOSFET input stage transistor drives a 2.5 mA current source load. With logic "0" outputs, maximum quiescent supply current is 4 mA. Logic "1" output level signals reduce quiescent current to 1.4 mA, 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 50 mV of hysteresis, which provides clean transitions and minimizes output stage current spiking when changing states. Input voltage thresholds are approximately 1.5 V, making any voltage greater than 1.5 V, up to V_{DD}, a logic "1" input. Input current is less than 1 µA over this range.

4.4 Power Dissipation

The supply current versus frequency and supply current versus capacitive load characteristic curves will aid in determining power dissipation calculations. Microchip Technology'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 800 mW 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:

EQUATION

$$P_L = fCV_S^2$$

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:

EQUATION

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

D = *Duty Cycle*
V_S = *Supply Voltage*
V_L = *Load Voltage*
I_L = *Load Current*

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

EQUATION

$$P_L = DV_O I_L$$

D = *Duty Cycle*
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:

EQUATION

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

I_H = *Quiescent Current with all outputs LOW (4 mA max.)*
I_L = *Quiescent Current with all outputs HIGH (0.6 mA max.)*
D = *Duty Cycle*
V_S = *Supply Voltage*

Transition power dissipation arises in the complimentary 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:

EQUATION

$$P_T = fV_s(10 \times 10^{-9})$$

C = *1000 pF Capacitive Load*
V_S = *15 V*
D = *50%*
f = *200 kHz*

P_D = *Package Power Dissipation*
$= P_L + P_Q + P_T$
$= 45mW + 35mW + 30mW$
$= 110mW$

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

Maximum operating temperature is:

EQUATION

$$T_J - \theta_{JA}(P_D) = 141°C$$

T_J = *Maximum allowable junction temperature (+150°C)*
θ_{JA} = *Junction-to-ambient thernal 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.

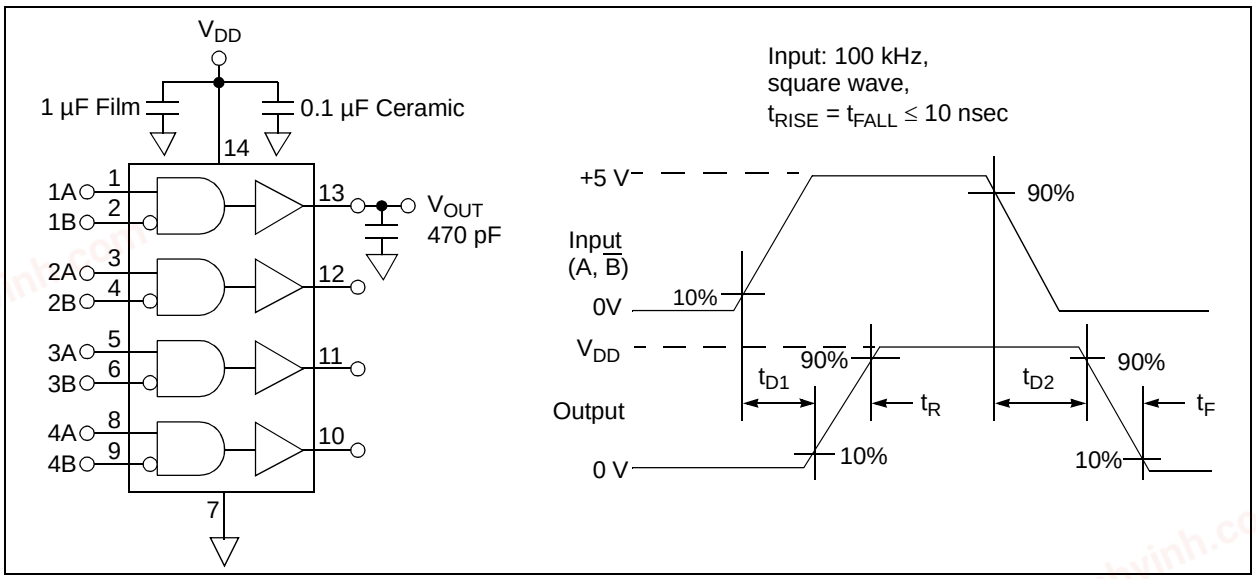


FIGURE 4-1: *Switching Time Test Circuit.*

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5.0 APPLICATIONS INFORMATION

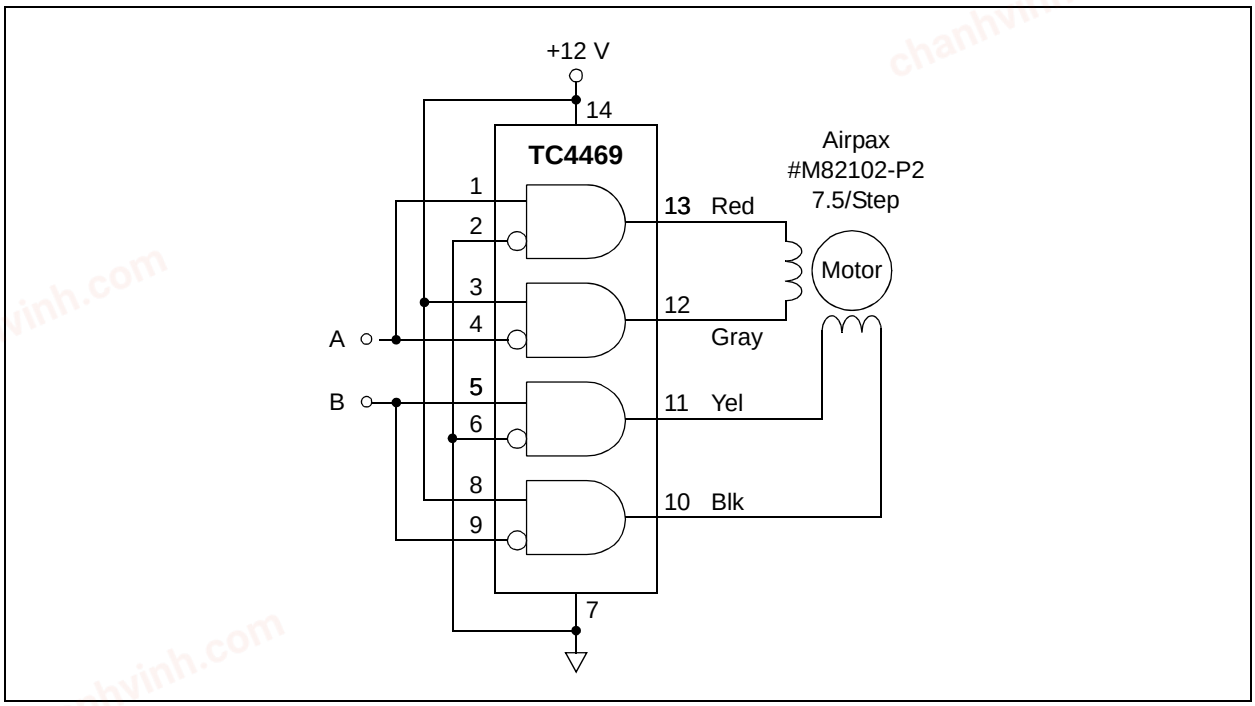


FIGURE 5-1: *Stepper Motor Drive.*

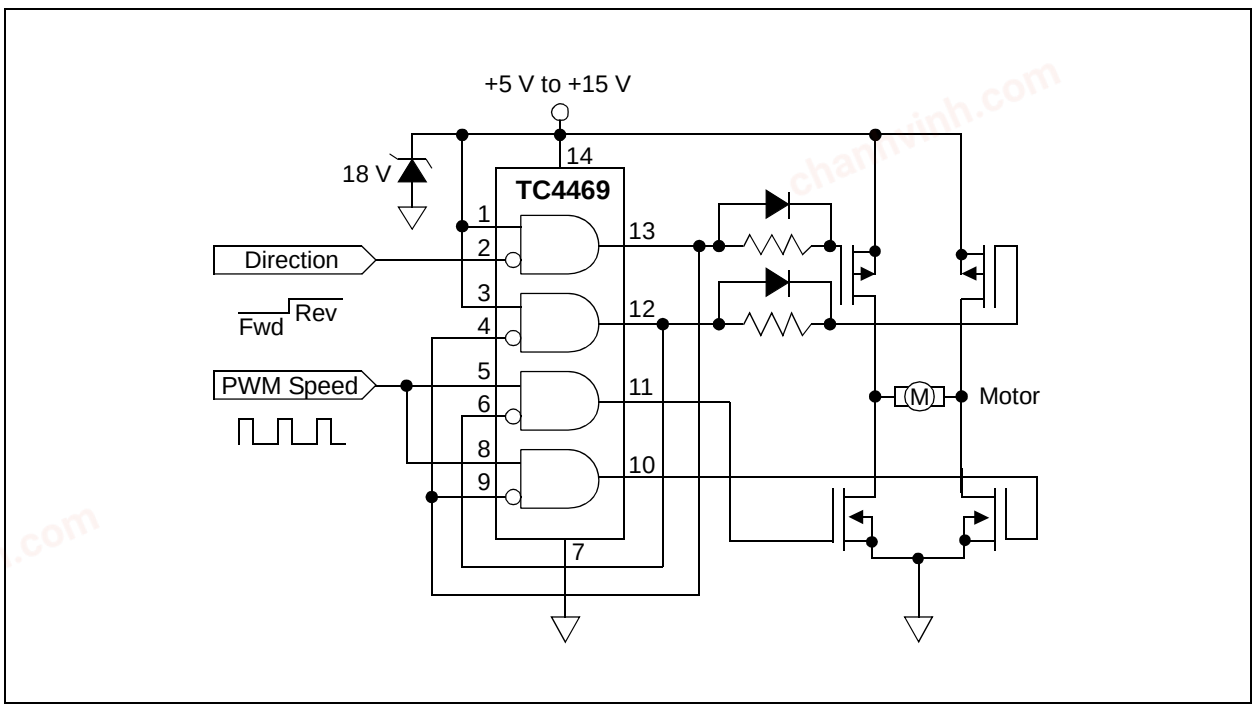


FIGURE 5-2: *Quad Driver For H-bridge Motor Control.*

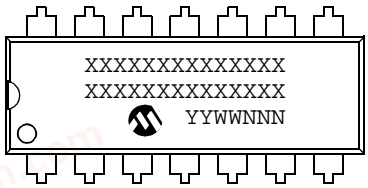
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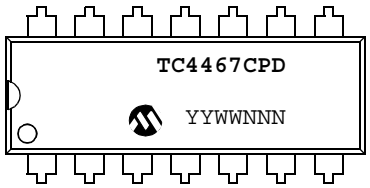
6.0 PACKAGING INFORMATION

6.1 Package Marking Information

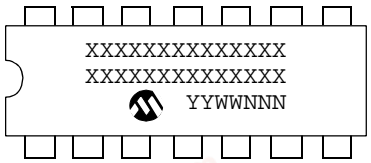
14-Lead PDIP (300 mil)



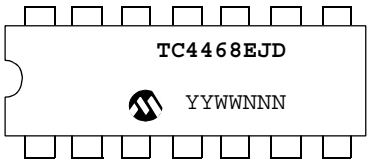
Example:



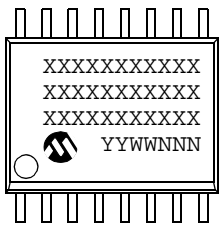
14-Lead CERDIP (300 mil)



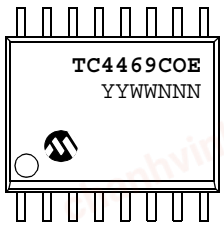
Example:



16-Lead SOIC (300 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.

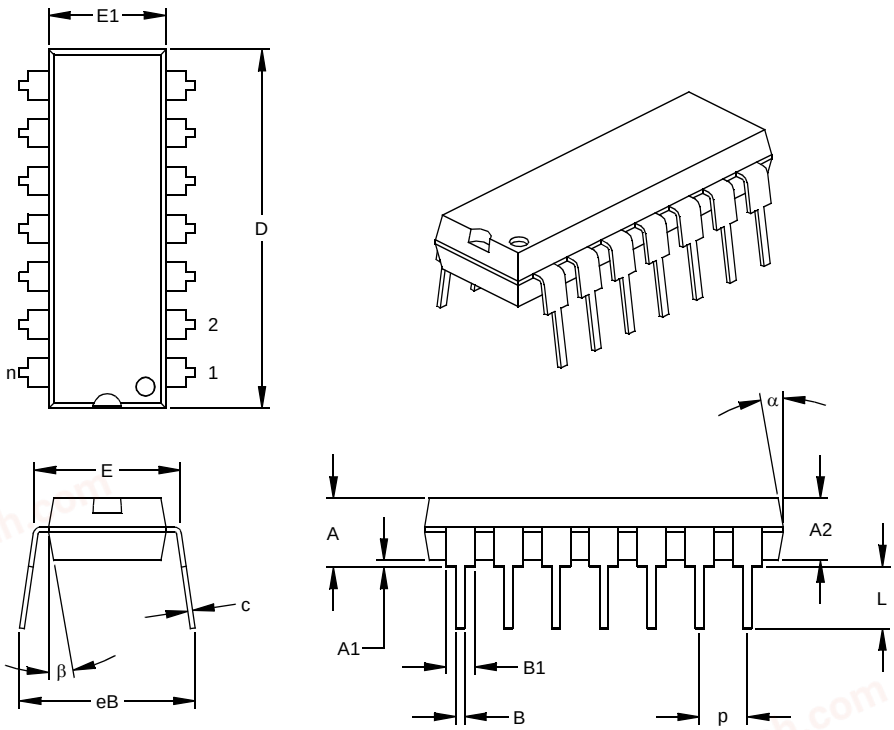
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information.

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14-Lead Plastic Dual In-line (P) – 300 mil (PDIP)

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



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		14			14	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.313	.325	7.62	7.94	8.26
Molded Package Width	E1	.240	.250	.260	6.10	6.35	6.60
Overall Length	D	.740	.750	.760	18.80	19.05	19.30
Tip to Seating Plane	L	.125	.130	.135	3.18	3.30	3.43
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.058	.070	1.14	1.46	1.78
Lower Lead Width	B	.014	.018	.022	0.36	0.46	0.56
Overall Row Spacing §	eB	.310	.370	.430	7.87	9.40	10.92
Mold Draft Angle Top	α	5	10	15	5	10	15
Mold Draft Angle Bottom	β	5	10	15	5	10	15

* Controlling Parameter
§ Significant Characteristic

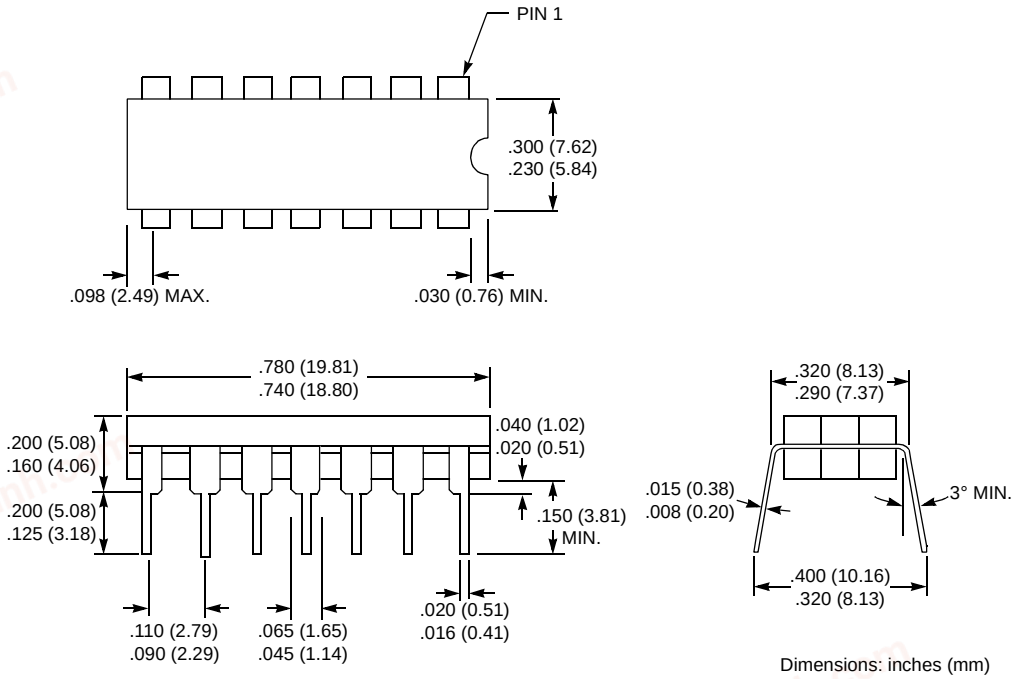
Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: MS-001
Drawing No. C04-005

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14-Lead Ceramic Dual In-line – 300 mil (CERDIP)

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

14-Pin CERDIP (Narrow)



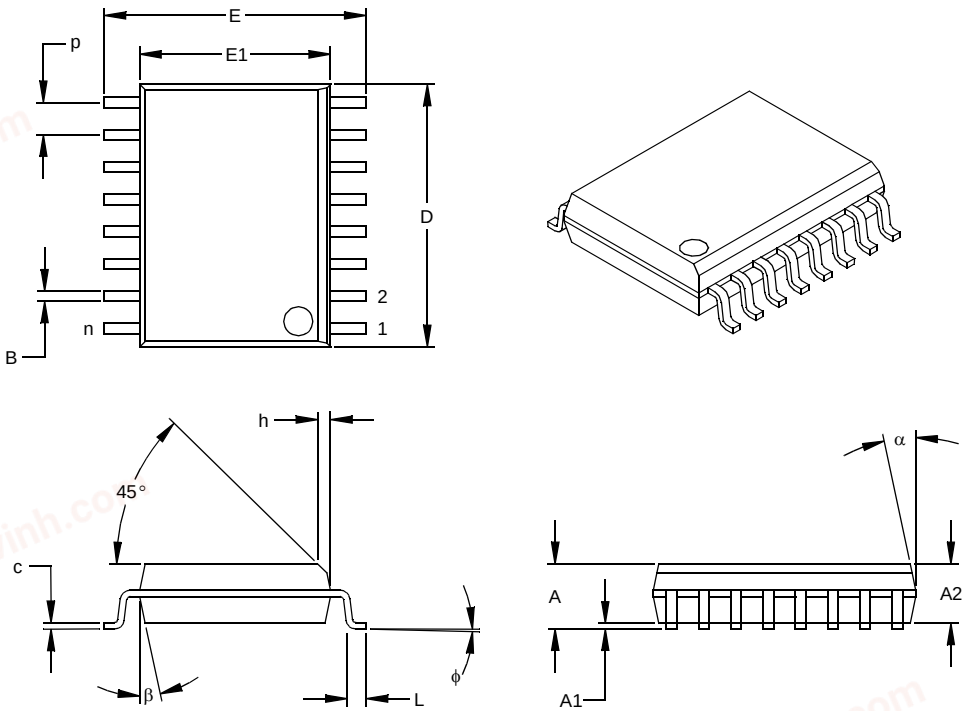
Dimensions: inches (mm)

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16-Lead Plastic Small Outline (SO) – Wide, 300 mil (SOIC)

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



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		16			16	
Pitch	p		.050			1.27	
Overall Height	A	.093	.099	.104	2.36	2.50	2.64
Molded Package Thickness	A2	.088	.091	.094	2.24	2.31	2.39
Standoff §	A1	.004	.008	.012	0.10	0.20	0.30
Overall Width	E	.394	.407	.420	10.01	10.34	10.67
Molded Package Width	E1	.291	.295	.299	7.39	7.49	7.59
Overall Length	D	.398	.406	.413	10.10	10.30	10.49
Chamfer Distance	h	.010	.020	.029	0.25	0.50	0.74
Foot Length	L	.016	.033	.050	0.41	0.84	1.27
Foot Angle	ϕ	0	4	8	0	4	8
Lead Thickness	c	.009	.011	.013	0.23	0.28	0.33
Lead Width	B	.014	.017	.020	0.36	0.42	0.51
Mold Draft Angle Top	α	0	12	15	0	12	15
Mold Draft Angle Bottom	β	0	12	15	0	12	15

* Controlling Parameter
§ Significant Characteristic

Notes:
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010” (0.254mm) per side.
JEDEC Equivalent: MS-013
Drawing No. C04-102

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7.0 REVISION HISTORY

Revision C (December 2012)

Added a note to each package outline drawing.

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PART NO.	X	XX
Device	Temperature Range	Package

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	TC4468:	1.2A Quad MOSFET Driver, AND
	TC4469:	1.2A Quad MOSFET Driver, AND/INV
Temperature Range:	C =	0°C to +70°C
	E =	-40°C to +85°C (CERDIP only)
	M =	-55°C to +125°C (CERDIP only)
Package:	PD =	Plastic DIP, (300 mil body), 14-lead
	JD =	Ceramic DIP, (300 mil body), 14-lead
	OE =	SOIC (Wide), 16-lead
	OE713 =	SOIC (Wide), 16-lead (Tape and Reel)

Examples:

a) TC4467COE: Commerical Temperature, SOIC package.
b) TC4467CPD: Commercial Temperature, PDIP package.
c) TC4467MJD: Military Temperature, Ceramic DIP package.

a) TC4468COE713: Tape and Reel, Commerical Temp., SOIC package.
b) TC4468CPD: Commercial Temperature, PDIP package.

a) TC4469COE: Commercial Temperature, SOIC package.
b) TC4469CPD: Commercial Temperature, PDIP package.

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