

## 9A High-Speed MOSFET Drivers

### Features

- High Peak Output Current: 9A
- Wide Input Supply Voltage Operating Range:
  - 4.5V to 18V
- High Continuous Output Current: 2A Max
- Fast Rise and Fall Times:
  - 30 nsec with 4,700 pF Load
  - 180 nsec with 47,000 pF Load
- Short Propagation Delays: 30 nsec (typ)
- Low Supply Current:
  - With Logic '1' Input -- 200  $\mu$ A (typ)
  - With Logic '0' Input -- 55  $\mu$ A (typ)
- Low Output Impedance: 1.4 $\Omega$  (typ)
- Latch-Up Protected: Will Withstand 1.5A Output Reverse Current
- Input Will Withstand Negative Inputs Up To 5V
- Pin Compatible with TC4420/TC4429 6A MOSFET driver

### Applications

- Line Drivers for Extra-Heavily-Loaded Lines
- Pulse Generators
- Driving the Largest MOSFETs and IGBTs
- Local Power ON/OFF Switch
- Motor and Solenoid Driver

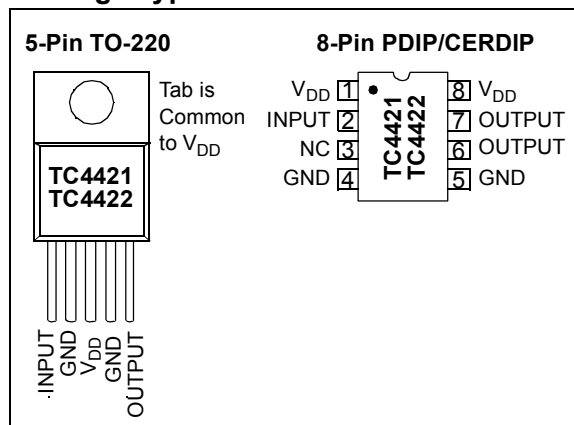
### General Description

The TC4421/TC4422 are high current buffer/drivers capable of driving large MOSFETs and IGBTs.

They are essentially immune to any form of upset, except direct overvoltage or over-dissipation – they cannot be latched under any conditions within their power and voltage ratings; they are not subject to damage or improper operation when up to 5V of ground bounce is present on their ground terminals; they can accept, without either damage or logic upset, more than 1A inductive current of either polarity being forced back into their outputs. In addition, all terminals are fully protected against up to 4 kV of electrostatic discharge.

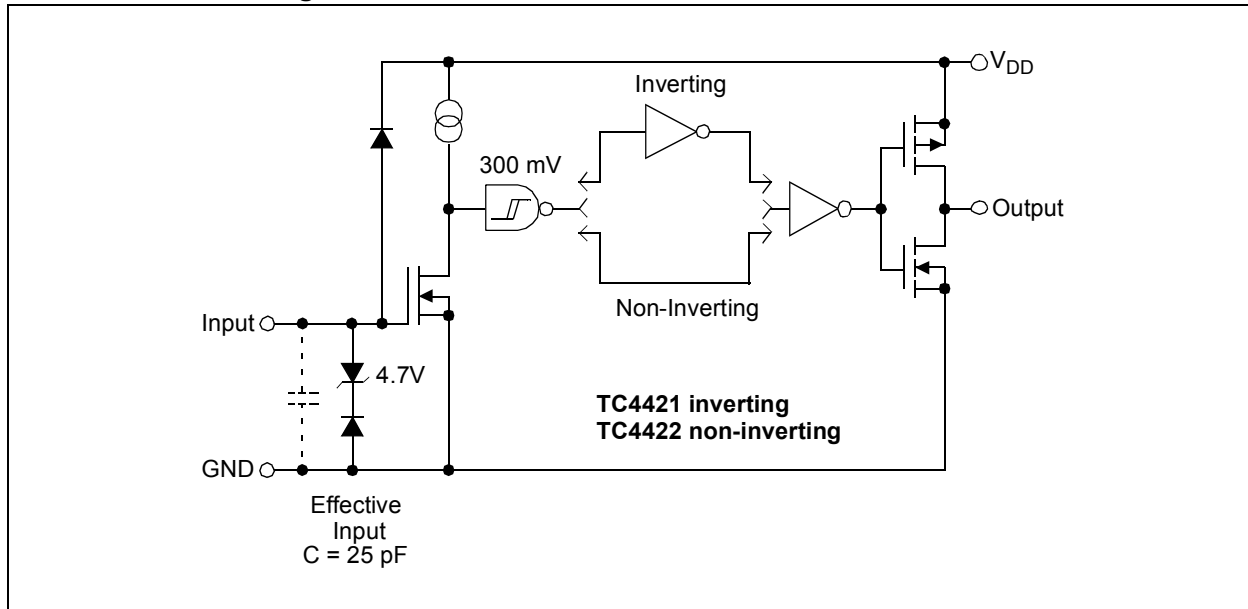
The TC4421/TC4422 inputs may be driven directly from either TTL or CMOS (3V to 18V). In addition, 300 mV of hysteresis is built into the input, providing noise immunity and allowing the device to be driven from slowly rising or falling waveforms.

### Package Types



# TC4421/TC4422

## Functional Block Diagram



## 1.0 ELECTRICAL CHARACTERISTICS

### Absolute Maximum Ratings†

Supply Voltage .....	+20V
Input Voltage .....	( $V_{DD} + 0.3V$ ) to (GND – 5V)
Input Current ( $V_{IN} > V_{DD}$ ).....	50 mA
Package Power Dissipation ( $T_A \leq 70^\circ C$ )	
PDIP .....	730 mW
CERDIP .....	800 mW
5-Pin TO-220 .....	1.6W
Package Power Dissipation ( $T_A \leq 25^\circ C$ )	
5-Pin TO-220 (With Heatsink) .....	12.5W
Derating Factors (To Ambient)	
PDIP .....	8 mW/°C
CERDIP .....	6.4 mW/°C
5-Pin TO-220 .....	12 mW/°C
Thermal Impedances (To Case)	
5-Pin TO-220 $R_{\theta J-C}$ .....	10°C/W

† 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,  $T_A = +25^\circ C$  with  $4.5V \leq V_{DD} \leq 18V$ .

Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Input</b>						
Logic '1', High Input Voltage	$V_{IH}$	2.4	1.8	—	V	
Logic '0', Low Input Voltage	$V_{IL}$	—	1.3	0.8	V	
Input Current	$I_{IN}$	-10	—	+10	$\mu A$	$0V \leq V_{IN} \leq V_{DD}$
<b>Output</b>						
High Output Voltage	$V_{OH}$	$V_{DD} - 0.025$	—	—	V	DC TEST
Low Output Voltage	$V_{OL}$	—	—	0.025	V	DC TEST
Output Resistance, High	$R_{OH}$	—	1.4	—	$\Omega$	$I_{OUT} = 10 \text{ mA}$ , $V_{DD} = 18V$
Output Resistance, Low	$R_{OL}$	—	0.9	1.7	$\Omega$	$I_{OUT} = 10 \text{ mA}$ , $V_{DD} = 18V$
Peak Output Current	$I_{PK}$	—	9.0	—	A	$V_{DD} = 18V$
Continuous Output Current	$I_{DC}$	2	—	—	A	$10V \leq V_{DD} \leq 18V$ , $T_A = +25^\circ C$ (TC4421/TC4422 CAT only) <b>(Note 2)</b>
Latch-Up Protection Withstand Reverse Current	$I_{REV}$	—	>1.5	—	A	Duty cycle $\leq 2\%$ , $t \leq 300 \mu\text{sec}$
<b>Switching Time (Note 1)</b>						
Rise Time	$t_R$	—	60	75	nsec	<b>Figure 4-1</b> , $C_L = 10,000 \text{ pF}$
Fall Time	$t_F$	—	60	75	nsec	<b>Figure 4-1</b> , $C_L = 10,000 \text{ pF}$
Delay Time	$t_{D1}$	—	30	60	nsec	<b>Figure 4-1</b>
Delay Time	$t_{D2}$	—	33	60	nsec	<b>Figure 4-1</b>
<b>Power Supply</b>						
Power Supply Current	$I_S$	—	0.2	1.5	mA	$V_{IN} = 3V$
		—	55	150	$\mu A$	$V_{IN} = 0V$
Operating Input Voltage	$V_{DD}$	4.5	—	18	V	

**Note 1:** Switching times ensured by design.

**2:** Tested during characterization, not production tested.

# TC4421/TC4422

## DC CHARACTERISTICS (OVER OPERATING TEMPERATURE RANGE)

Electrical Specifications: Unless otherwise noted, over operating temperature range with $4.5V \leq V_{DD} \leq 18V$ .						
Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Input</b>						
Logic '1', High Input Voltage	$V_{IH}$	2.4	—	—	V	
Logic '0', Low Input Voltage	$V_{IL}$	—	—	0.8	V	
Input Current	$I_{IN}$	-10	—	+10	$\mu A$	$0V \leq V_{IN} \leq V_{DD}$
<b>Output</b>						
High Output Voltage	$V_{OH}$	$V_{DD} - 0.025$	—	—	V	DC TEST
Low Output Voltage	$V_{OL}$	—	—	0.025	V	DC TEST
Output Resistance, High	$R_{OH}$	—	2.4	3.6	$\Omega$	$I_{OUT} = 10 \text{ mA}, V_{DD} = 18V$
Output Resistance, Low	$R_{OL}$	—	1.8	2.7	$\Omega$	$I_{OUT} = 10 \text{ mA}, V_{DD} = 18V$
<b>Switching Time (Note 1)</b>						
Rise Time	$t_R$	—	60	120	nsec.	Figure 4-1, $C_L = 10,000 \text{ pF}$
Fall Time	$t_F$	—	60	120	nsec.	Figure 4-1, $C_L = 10,000 \text{ pF}$
Delay Time	$t_{D1}$	—	50	80	nsec.	Figure 4-1
Delay Time	$t_{D2}$	—	65	80	nsec.	Figure 4-1
<b>Power Supply</b>						
Power Supply Current	$I_S$	—	—	3	mA	$V_{IN} = 3V$ $V_{IN} = 0V$
Operating Input Voltage	$V_{DD}$	4.5	—	18	V	

**Note 1:** Switching times ensured by design.

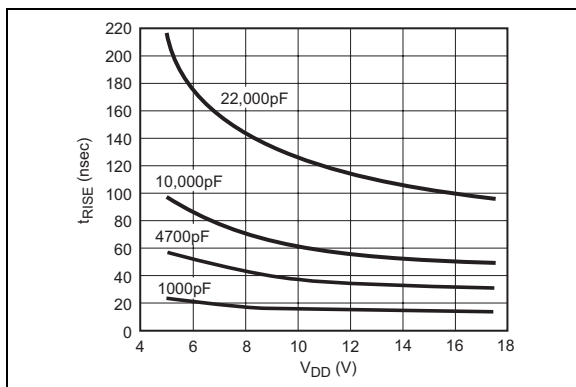
## TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, all parameters apply with $4.5V \leq V_{DD} \leq 18V$ .						
Parameters	Sym	Min	Typ	Max	Units	Conditions
<b>Temperature Ranges</b>						
Specified Temperature Range (C)	$T_A$	0	—	+70	$^{\circ}C$	
Specified Temperature Range (E)	$T_A$	-40	—	+85	$^{\circ}C$	
Specified Temperature Range (M)	$T_A$	-55	—	+125	$^{\circ}C$	
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	$^{\circ}C$	
<b>Package Thermal Resistances</b>						
Thermal Resistance, 8L-PDIP	$\theta_{JA}$	—	125	—	$^{\circ}C/W$	
Thermal Resistance, 8L-CERDIP	$\theta_{JA}$	—	150	—	$^{\circ}C/W$	
Thermal Resistance, 5L-TO-220	$\theta_{JA}$	—	71	—	$^{\circ}C/W$	

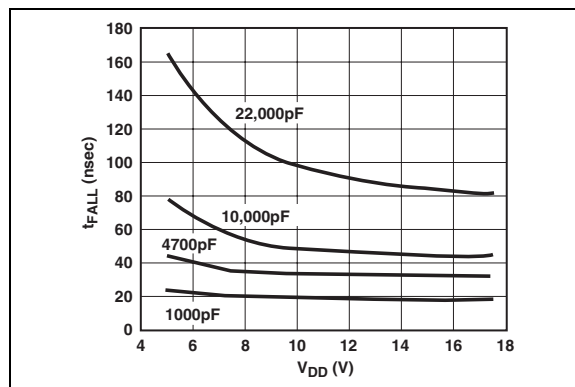
## 2.0 TYPICAL PERFORMANCE CURVES

**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.

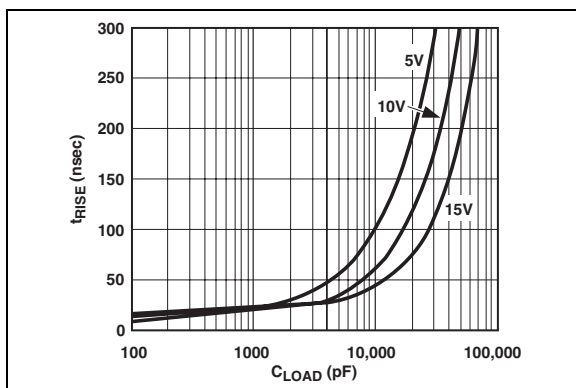
**Note:** Unless otherwise indicated,  $T_A = +25^\circ\text{C}$  with  $4.5\text{V} \leq V_{DD} \leq 18\text{V}$ .



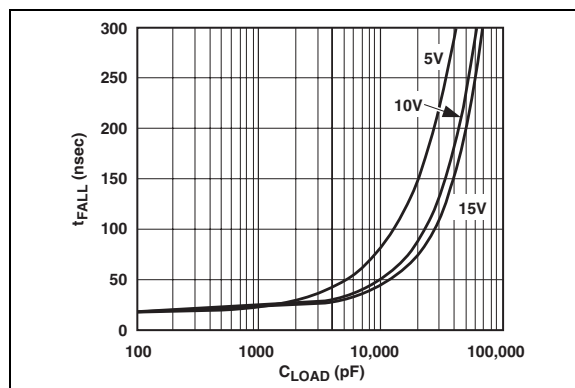
**FIGURE 2-1:** Rise Time vs. Supply Voltage.



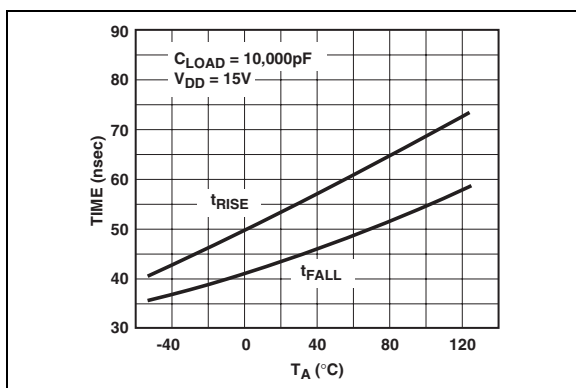
**FIGURE 2-4:** Fall Time vs. Supply Voltage.



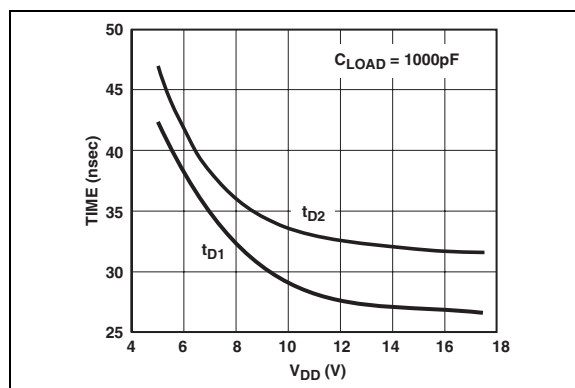
**FIGURE 2-2:** Rise Time vs. Capacitive Load.



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



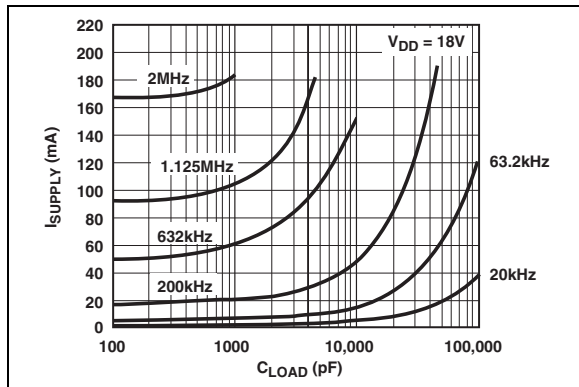
**FIGURE 2-3:** Rise and Fall Times vs. Temperature.



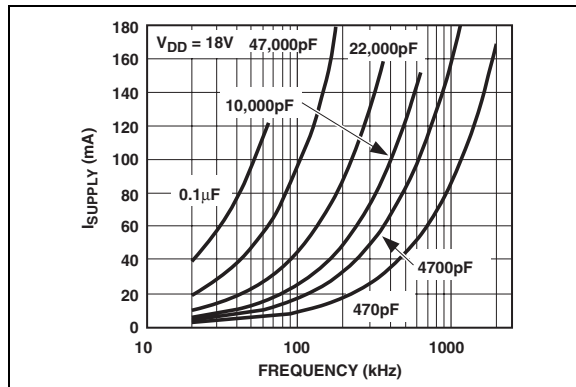
**FIGURE 2-6:** Propagation Delay vs. Supply Voltage.

# TC4421/TC4422

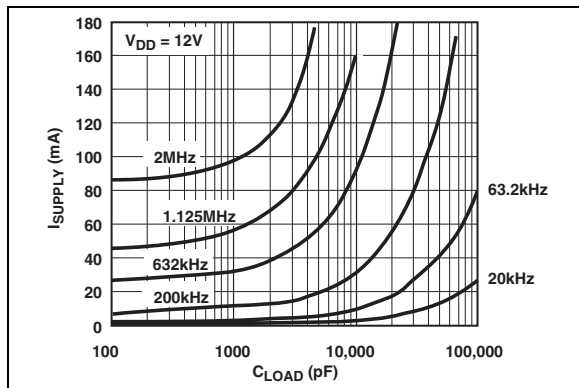
Note: Unless otherwise indicated,  $T_A = +25^\circ\text{C}$  with  $4.5\text{V} \leq V_{DD} \leq 18\text{V}$ .



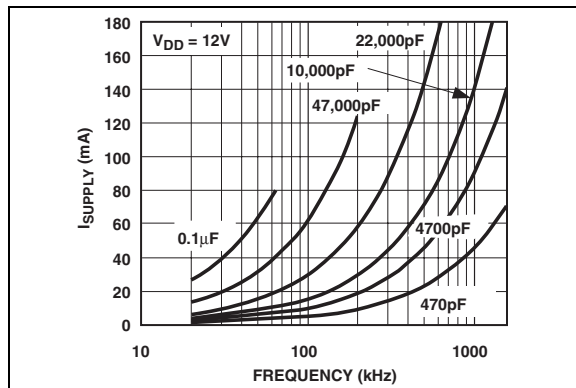
**FIGURE 2-7:** Supply Current vs. Capacitive Load ( $V_{DD} = 18\text{V}$ ).



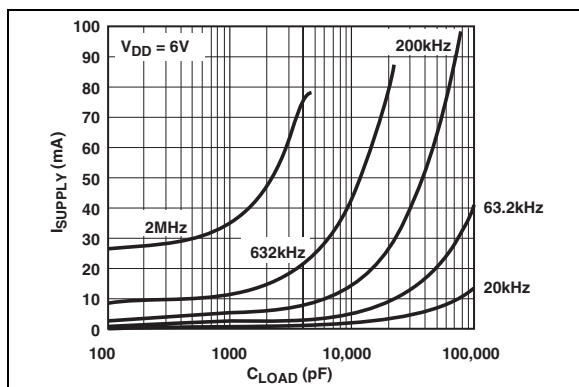
**FIGURE 2-10:** Supply Current vs. Frequency ( $V_{DD} = 18\text{V}$ ).



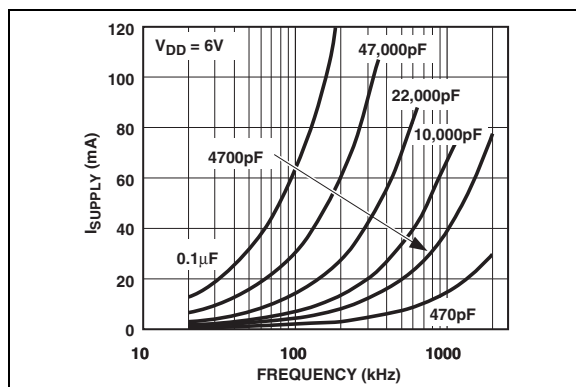
**FIGURE 2-8:** Supply Current vs. Capacitive Load ( $V_{DD} = 12\text{V}$ ).



**FIGURE 2-11:** Supply Current vs. Frequency ( $V_{DD} = 12\text{V}$ ).

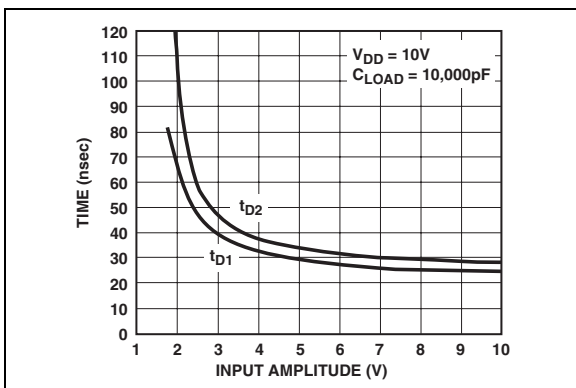


**FIGURE 2-9:** Supply Current vs. Capacitive Load ( $V_{DD} = 6\text{V}$ ).

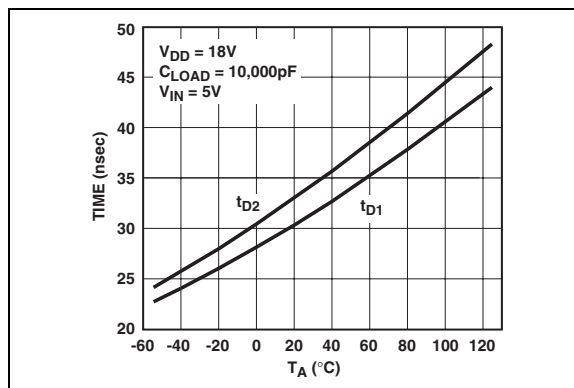


**FIGURE 2-12:** Supply Current vs. Frequency ( $V_{DD} = 6\text{V}$ ).

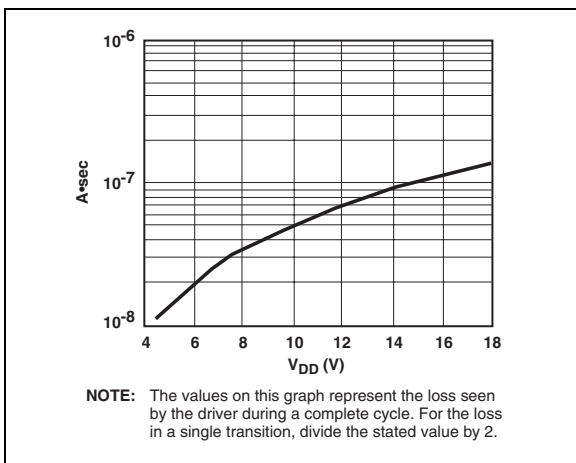
**Note:** Unless otherwise indicated,  $T_A = +25^\circ\text{C}$  with  $4.5\text{V} \leq V_{DD} \leq 18\text{V}$ .



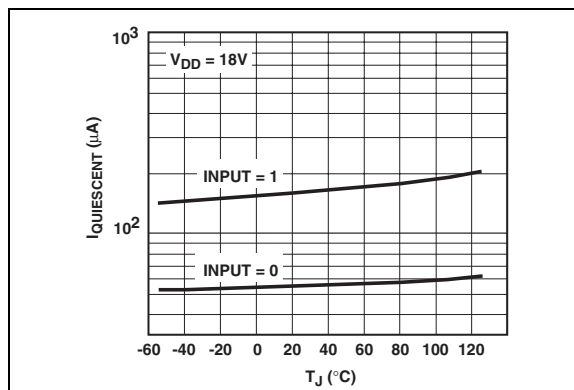
**FIGURE 2-13:** Propagation Delay vs. Input Amplitude.



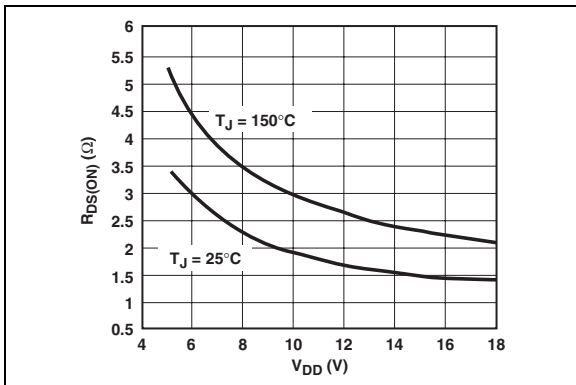
**FIGURE 2-16:** Propagation Delay vs. Temperature.



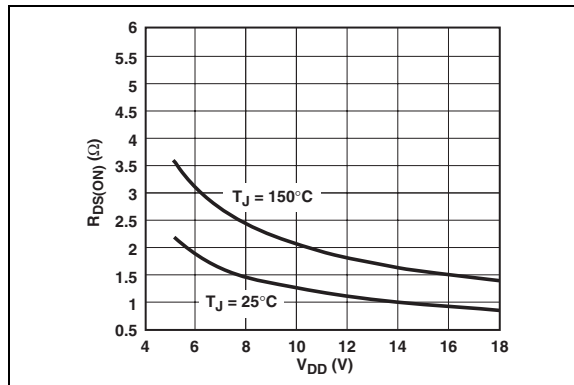
**FIGURE 2-14:** Crossover Energy vs. Supply Voltage.



**FIGURE 2-17:** Quiescent Supply Current vs. Temperature.



**FIGURE 2-15:** High-State Output Resistance vs. Supply Voltage.



**FIGURE 2-18:** Low-State Output Resistance vs. Supply Voltage.

# TC4421/TC4422

## 3.0 PIN DESCRIPTIONS

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

**TABLE 3-1: PIN FUNCTION TABLE**

Pin No. (8-Pin PDIP, CERDIP)	Pin No. (5-Pin TO-220)	Symbol	Description
1	—	$V_{DD}$	Supply input, 4.5V to 18V
2	1	INPUT	Control input, TTL/CMOS compatible input
3	—	NC	No connection
4	2	GND	Ground
5	4	GND	Ground
6	5	OUTPUT	CMOS push-pull output
7	—	OUTPUT	CMOS push-pull output
8	3	$V_{DD}$	Supply input, 4.5V to 18V

### 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 18V 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 should be chosen based on the capacitive load that is being driven. A minimum value of 1.0  $\mu$ F is suggested.

### 3.2 Control Input

The MOSFET driver input is a high-impedance, TTL/CMOS-compatible input. The input also 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

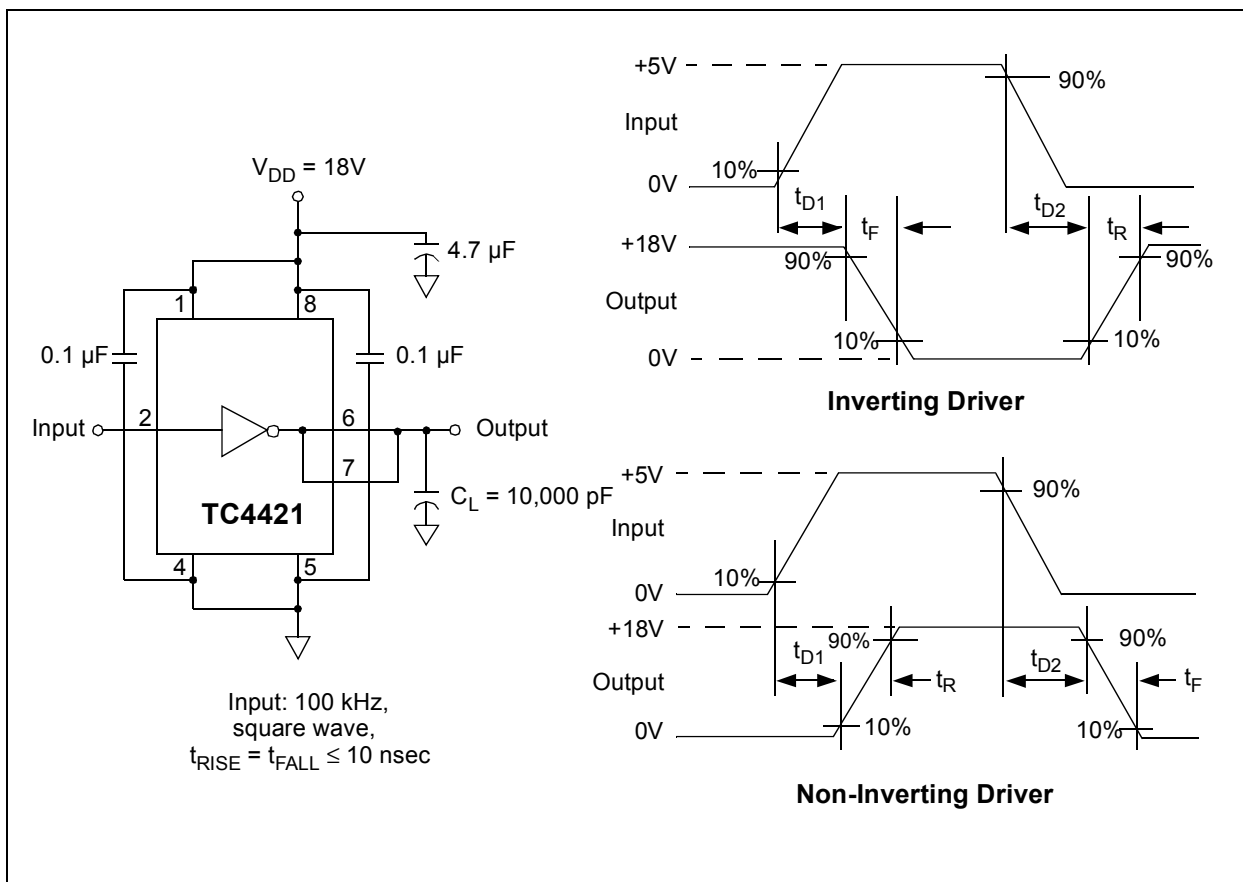
The MOSFET driver output is a low-impedance, CMOS, push-pull style output, capable of driving a capacitive load with 9.0A peak currents. The MOSFET driver output is capable of withstanding 1.5A peak reverse currents of either polarity.

### 3.4 Ground

The ground pins are the return path for the bias current and for the high peak currents that 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.



## 4.0 APPLICATIONS INFORMATION



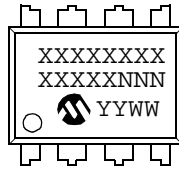
**FIGURE 4-1:** Switching Time Test Circuits.

# TC4421/TC4422

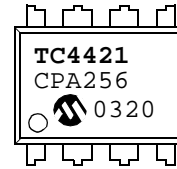
## 5.0 PACKAGING INFORMATION

### 5.1 Package Marking Information

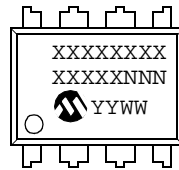
8-Lead PDIP (300 mil)



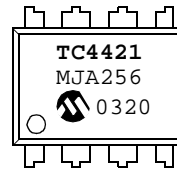
Example:



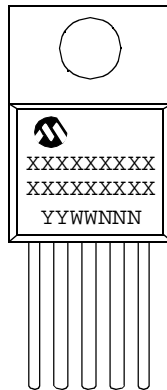
8-Lead CERDIP (300 mil)



Example:



5-Lead TO-220



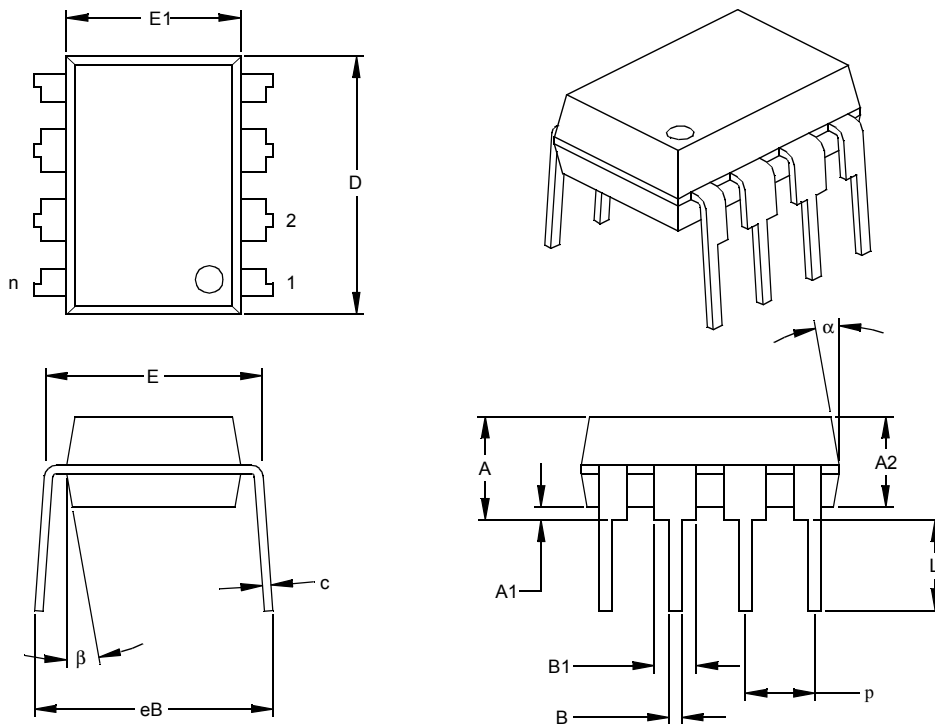
Example:



<b>Legend:</b>	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
<b>Note:</b>	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.	

\* Standard OTP marking consists of Microchip part number, year code, week code, and traceability code.

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



Dimension Limits	Units	INCHES*			MILLIMETERS		
		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
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	.360	.373	.385	9.14	9.46	9.78
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

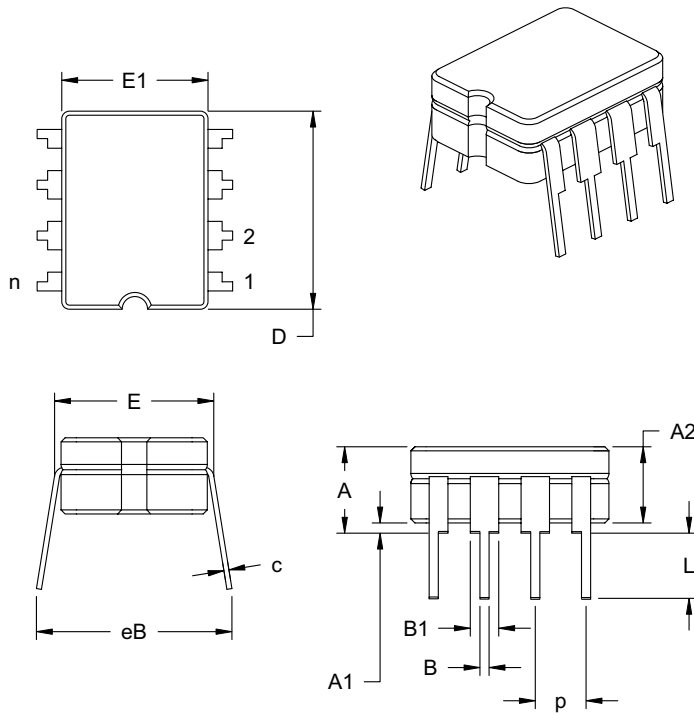
\* Controlling Parameter  
 § Significant Characteristic

**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. C04-018

# TC4421/TC4422

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



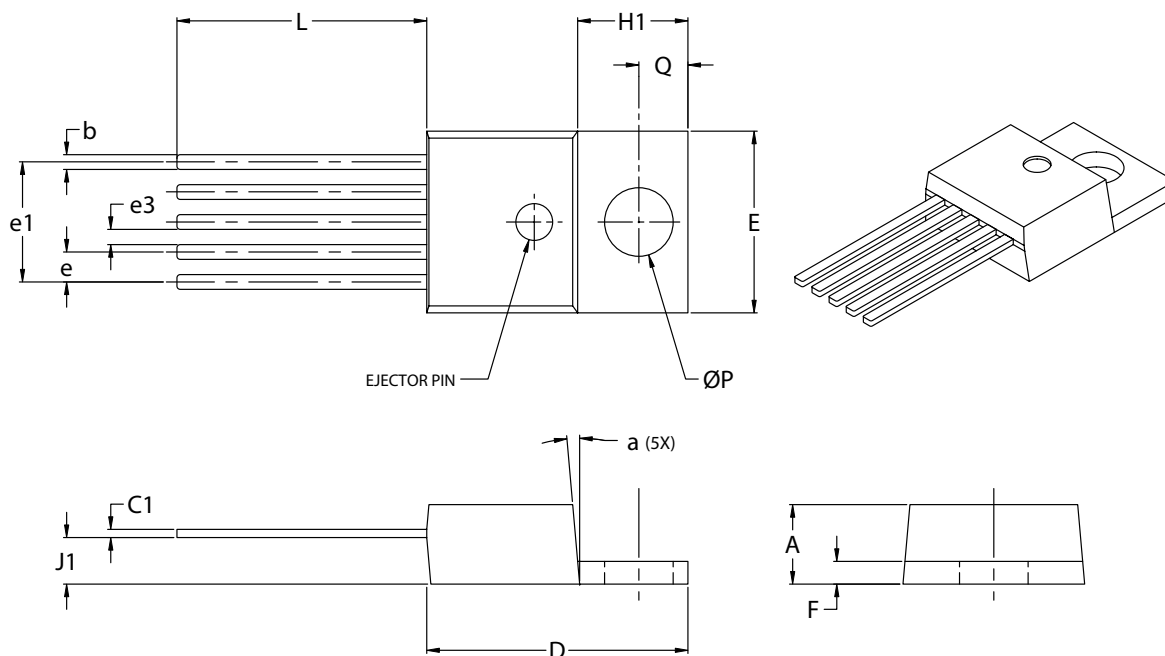
Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.160	.180	.200	4.06	4.57	5.08
Standoff §	A1	.020	.030	.040	0.51	0.77	1.02
Shoulder to Shoulder Width	E	.290	.305	.320	7.37	7.75	8.13
Ceramic Pkg. Width	E1	.230	.265	.300	5.84	6.73	7.62
Overall Length	D	.370	.385	.400	9.40	9.78	10.16
Tip to Seating Plane	L	.125	.163	.200	3.18	4.13	5.08
Lead Thickness	c	.008	.012	.015	0.20	0.29	0.38
Upper Lead Width	B1	.045	.055	.065	1.14	1.40	1.65
Lower Lead Width	B	.016	.018	.020	0.41	0.46	0.51
Overall Row Spacing	eB	.320	.360	.400	8.13	9.15	10.16

\*Controlling Parameter

JEDEC Equivalent: MS-030

Drawing No. C04-010

## 5-Lead TO-220



Dimension Limits	Units	INCHES*		MILLIMETERS	
		MIN	MAX	MIN	MAX
Lead Pitch	e	.060	.072	1.52	1.83
Overall Lead Centers	e1	.263	.273	6.68	6.93
Space Between Leads	e3	.030	.040	0.76	1.02
Overall Height	A	.160	.190	4.06	4.83
Overall Width	E	.385	.415	9.78	10.54
Overall Length	D	.560	.590	14.22	14.99
Flag Length	H1	.234	.258	5.94	6.55
Flag Thickness	F	.045	.055	1.14	1.40
Through Hole Center	Q	.103	.113	2.62	2.87
Through Hole Diameter	P	.146	.156	3.71	3.96
Lead Length	L	.540	.560	13.72	14.22
Base to Bottom of Lead	J1	.090	.115	2.29	2.92
Lead Thickness	C1	.014	.022	0.36	0.56
Lead Width	b	.025	.040	0.64	1.02
Mold Draft Angle	a	3°	7°	3°	7°

\*Controlling Parameter

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: TO-220

Drawing No. C04-036

# TC4421/TC4422

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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:	TC4421: 9A High-Speed MOSFET Driver, Inverting TC4422: 9A High-Speed MOSFET Driver, Non-Inverting		
Temperature Range:	C = 0°C to +70°C E = -40°C to +85°C V = -40°C to +125°C M = -55°C to +125°C (CERDIP Only)		
Package:	AT = TO-220, 5-lead JA = Ceramic Dual In-line (300 mil Body), 8-lead PA = Plastic DIP (300 mil Body), 8-lead		

<b>Examples:</b>	
a) TC4421CAT:	9A High-Speed Inverting MOSFET driver, TO-220 package, 0°C to +70°C.
b) TC4421MJA:	9A High-Speed Inverting MOSFET Driver, CERDIP package, -55°C to +125°C.
a) TC4422VPA:	9A High-Speed Non-Inverting MOSFET driver, PDIP package, -40°C to +125°C.
b) TC4422EPA:	9A High-Speed Non-Inverting MOSFET driver, PDIP package, -40°C to +85°C.

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# TC4421/TC4422

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NOTES:



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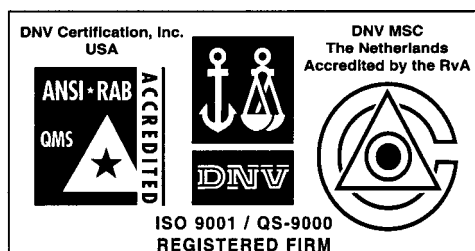
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