TC4421/TC4422

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 µA (typ)
  - With Logic '0' Input -- 55 µA (typ)
- Low Output Impedance: 1.4Ω (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.
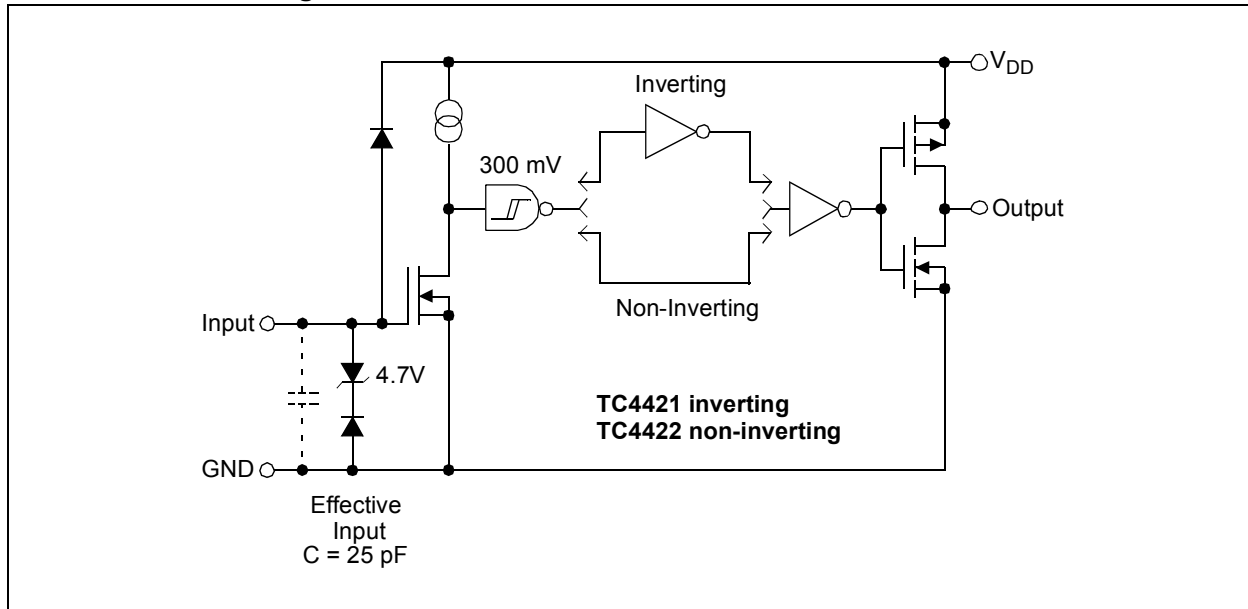
The TC4421/TC4422 inputs may be driven directly from either TTL or CMOS (3V to 18V). In addition, 300 mV of hysteresis is built into the input, providing noise immunity and allowing the device to be driven from slowly rising or falling waveforms.

Package Types
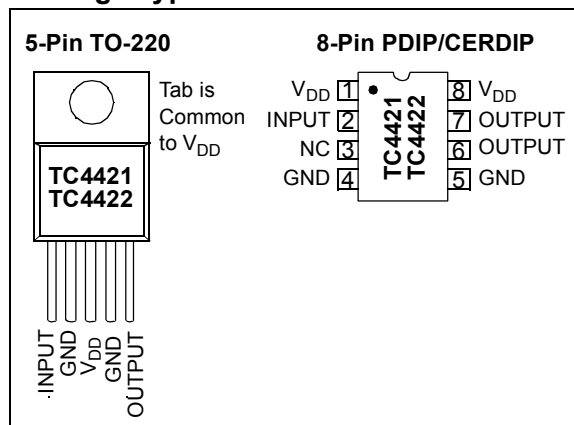
TC4421/TC4422

Functional Block Diagram

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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°C)
   PDIP ....730 mW
   CERDIP ....800 mW
   5-Pin TO-220 ....1.6W

Package Power Dissipation ($T_A \leq$ 25°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 = +25ºC with 4.5V $\leq V_{DD} \leq$ 18V.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input						
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	µA	$0V \leq V_{IN} \leq V_{DD}$
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, High	R_{OH}	—	1.4	—	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Output Resistance, Low	R_{OL}	—	0.9	1.7	Ω	I_{OUT} = 10 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°C (TC4421/TC4422 CAT only) **(Note 2)**
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	>1.5	—	A	Duty cycle $\leq$ 2%, t $\leq$ 300 µsec
Switching Time (Note 1)						
Rise Time	t_R	—	60	75	nsec	**Figure 4-1**, C_L = 10,000 pF
Fall Time	t_F	—	60	75	nsec	**Figure 4-1**, C_L = 10,000 pF
Delay Time	t_{D1}	—	30	60	nsec	**Figure 4-1**
Delay Time	t_{D2}	—	33	60	nsec	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	—	0.2	1.5	mA	V_{IN} = 3V
		—	55	150	µA	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
Input						
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	µA	$0V \leq V_{IN} \leq V_{DD}$
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, High	R_{OH}	—	2.4	3.6	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Output Resistance, Low	R_{OL}	—	1.8	2.7	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Switching Time (Note 1)						
Rise Time	t_R	—	60	120	nsec.	**Figure 4-1**, C_L = 10,000 pF
Fall Time	t_F	—	60	120	nsec.	**Figure 4-1**, C_L = 10,000 pF
Delay Time	t_{D1}	—	50	80	nsec.	**Figure 4-1**
Delay Time	t_{D2}	—	65	80	nsec.	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	—	—	3	mA	V_{IN} = 3V
		—	—	0.2		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
Temperature Ranges						
Specified Temperature Range (C)	T_A	0	—	+70	ºC	
Specified Temperature Range (E)	T_A	-40	—	+85	ºC	
Specified Temperature Range (M)	T_A	-55	—	+125	ºC	
Specified Temperature Range (V)	T_A	-40	—	+125	ºC	
Maximum Junction Temperature	T_J	—	—	+150	ºC	
Storage Temperature Range	T_A	-65	—	+150	ºC	
Package Thermal Resistances						
Thermal Resistance, 8L-PDIP	θ_{JA}	—	125	—	ºC/W	
Thermal Resistance, 8L-CERDIP	θ_{JA}	—	150	—	ºC/W	
Thermal Resistance, 5L-TO-220	θ_{JA}	—	71	—	ºC/W	

2.0   TYPICAL PERFORMANCE CURVES

Note: Unless otherwise indicated, T_A = +25ºC with 4.5V $\leq V_{DD} \leq$ 18V.
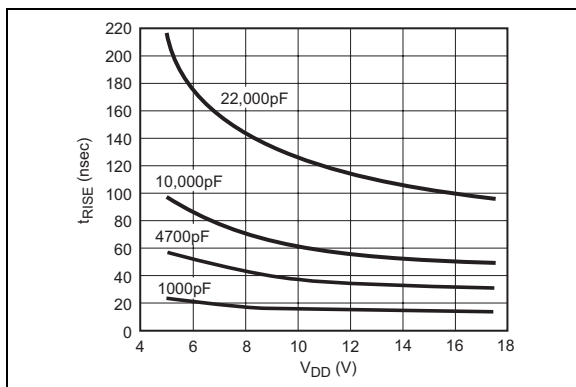
FIGURE 2-1:   Rise Time vs. Supply Voltage.

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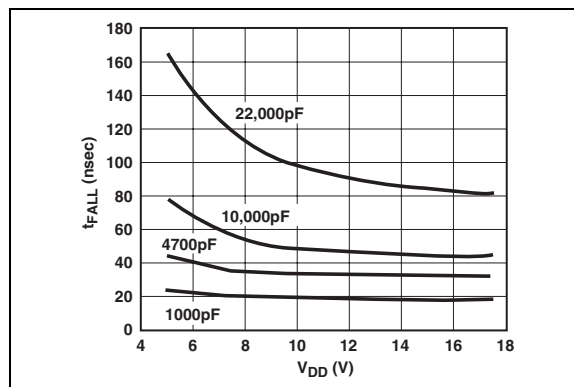

FIGURE 2-3:   Rise and Fall Times vs. Temperature.

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

FIGURE 2-5:   Fall Time vs. Capacitive Load.
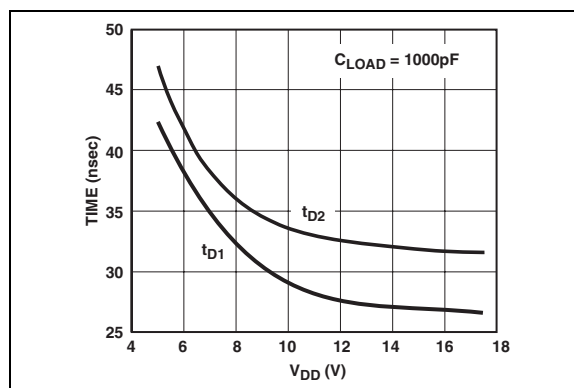
FIGURE 2-6:   Propagation Delay vs. Supply Voltage.

TC4421/TC4422
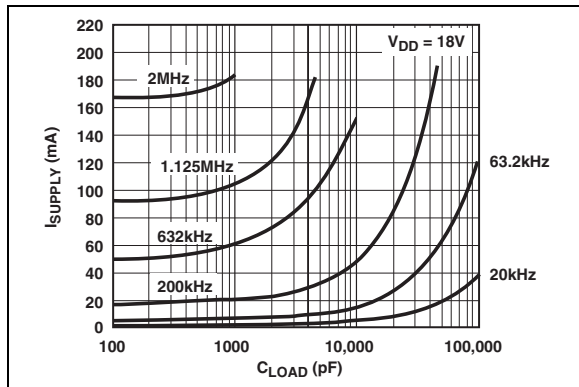
FIGURE 2-7: *Supply Current vs. Capacitive Load (V_{DD} = 18V).*
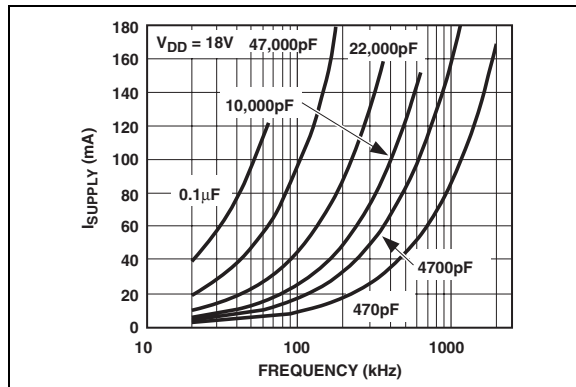
FIGURE 2-10: *Supply Current vs. Frequency (V_{DD} = 18V).*
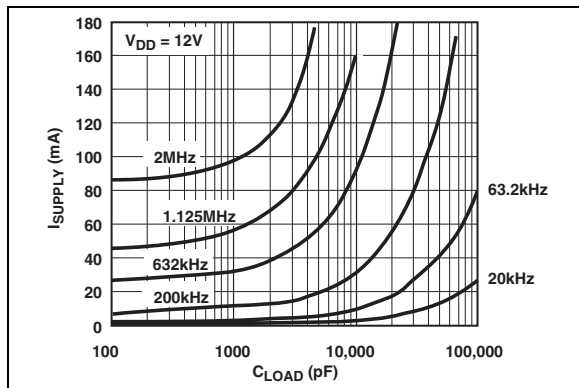
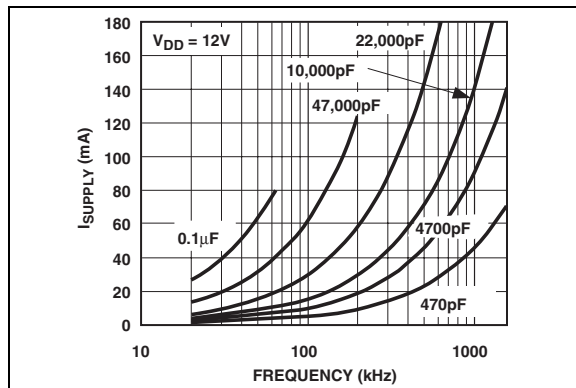**FIGURE 2-8:** *Supply Current vs. Capacitive Load (V_{DD} = 12V).*

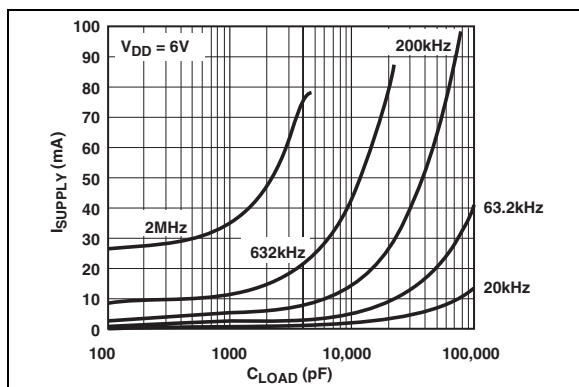**FIGURE 2-11:** *Supply Current vs. Frequency (V_{DD} = 12V).*

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

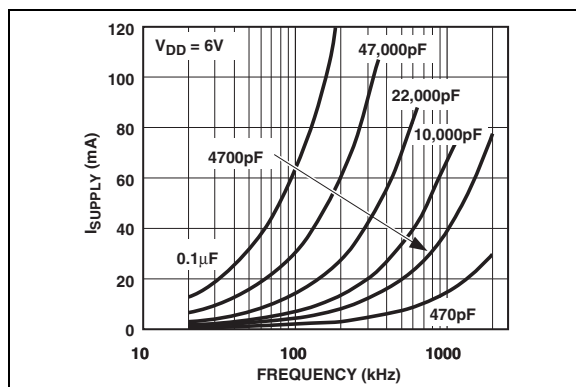**FIGURE 2-12:** *Supply Current vs. Frequency (V_{DD} = 6V).*

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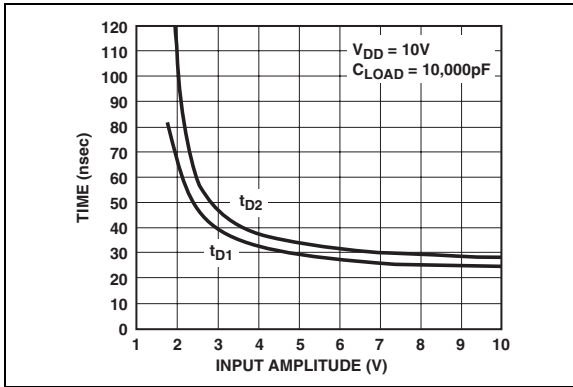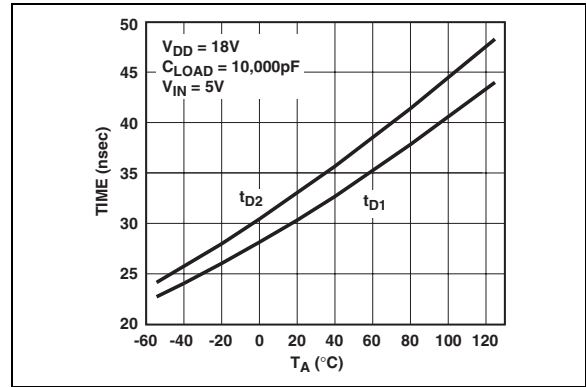

FIGURE 2-13: *Propagation Delay vs. Input Amplitude.*

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

NOTE: The values on this graph represent the loss seen by the driver during a complete cycle. For the loss in a single transition, divide the stated value by 2.

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

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

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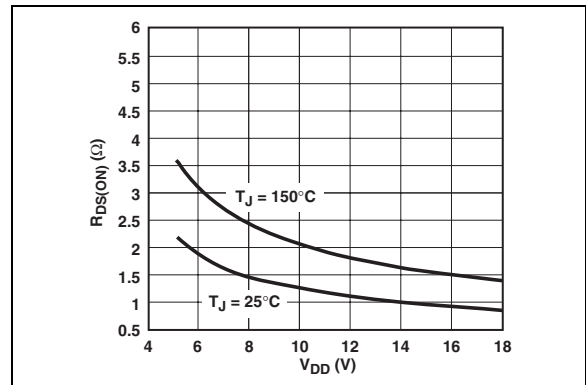

FIGURE 2-18: *Low-State Output Resistance vs. Supply Voltage.*

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 µF 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.
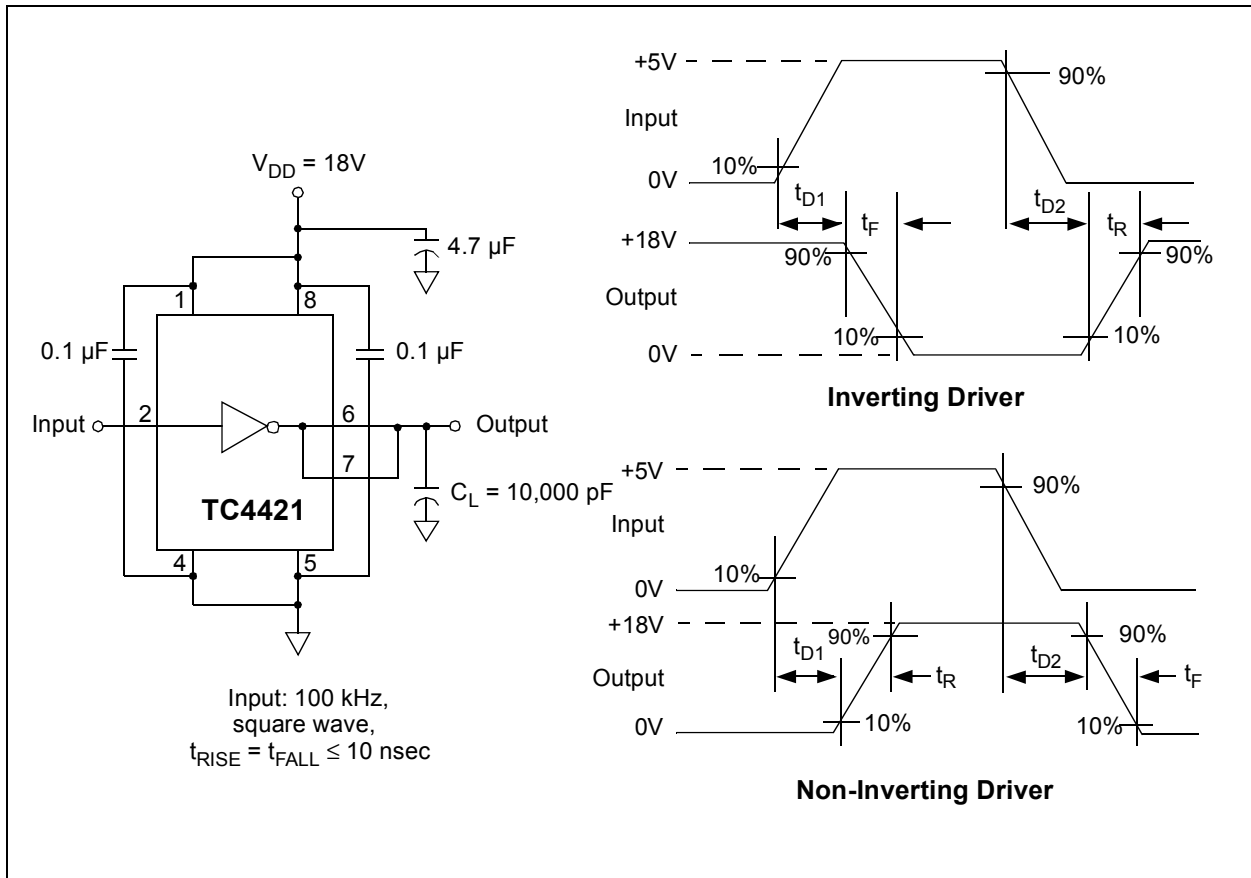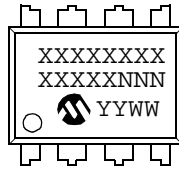
4.0   APPLICATIONS INFORMATION

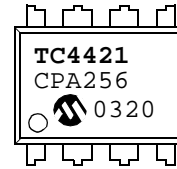*FIGURE 4-1:*   *Switching Time Test Circuits.*

TC4421/TC4422

5.0   PACKAGING INFORMATION

5.1   Package Marking Information

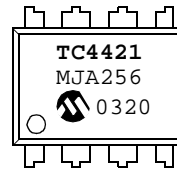8-Lead PDIP (300 mil)

```
XXXXXXXX
XXXXXNNN
   Ⓜ YYWW
```

Example:

```
TC4421
CPA256
   Ⓜ 0320
```

8-Lead CERDIP (300 mil)

```
XXXXXXXX
XXXXXNNN
   Ⓜ YYWW
```

Example:

```
TC4421
MJA256
   Ⓜ 0320
```

5-Lead TO-220

```
     Ⓜ
XXXXXXXXX
XXXXXXXXX
YYWWNNN
```

Example:

```
     Ⓜ
TC4421CAT
0320256
```
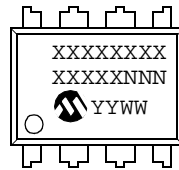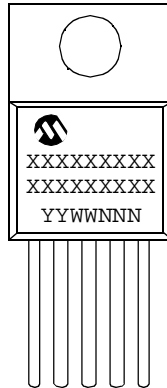
Legend:	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
Note:		In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line thus limiting the number of available characters for customer specific information.

*   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)
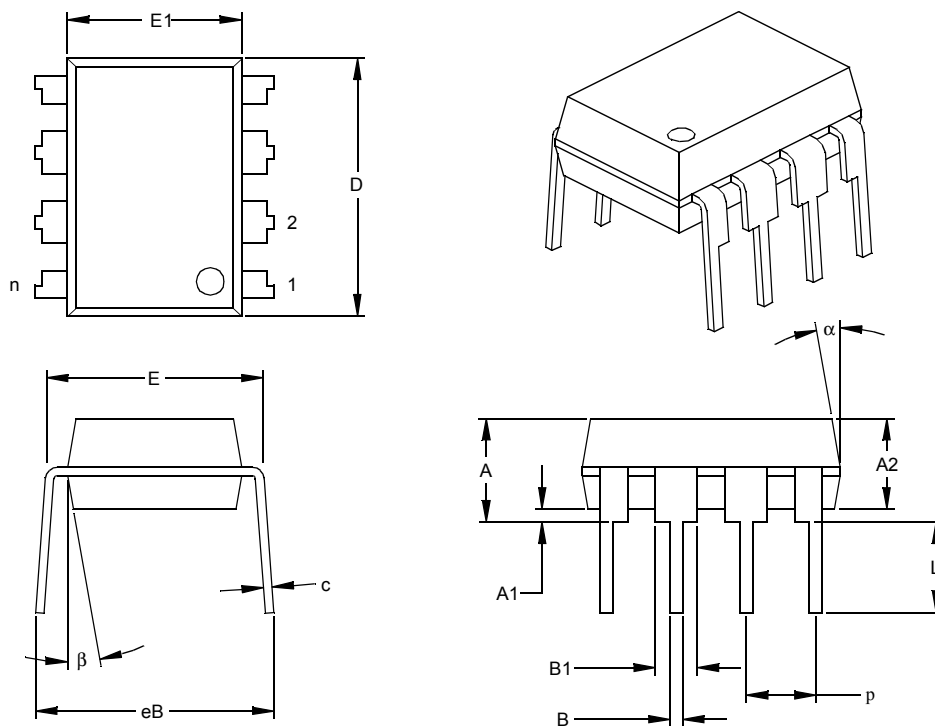
	Units	INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.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
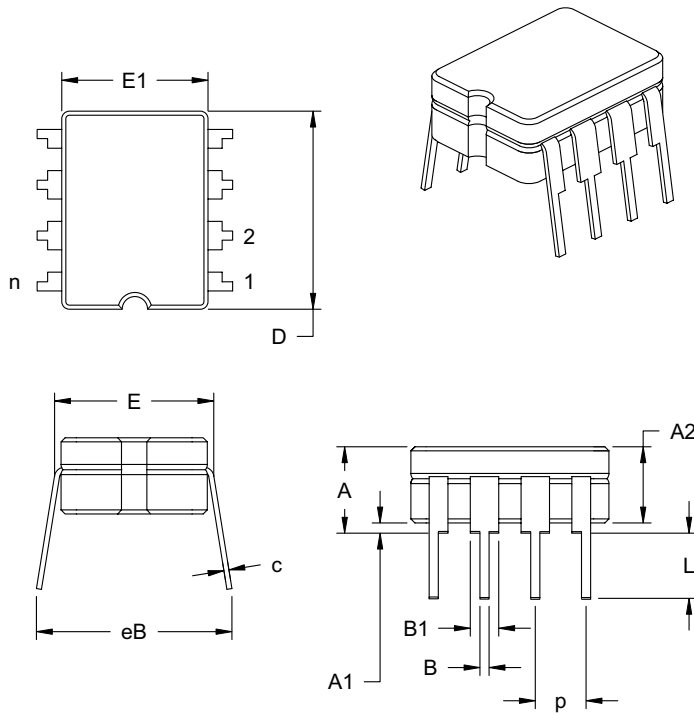§ Significant Characteristic

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

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## 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
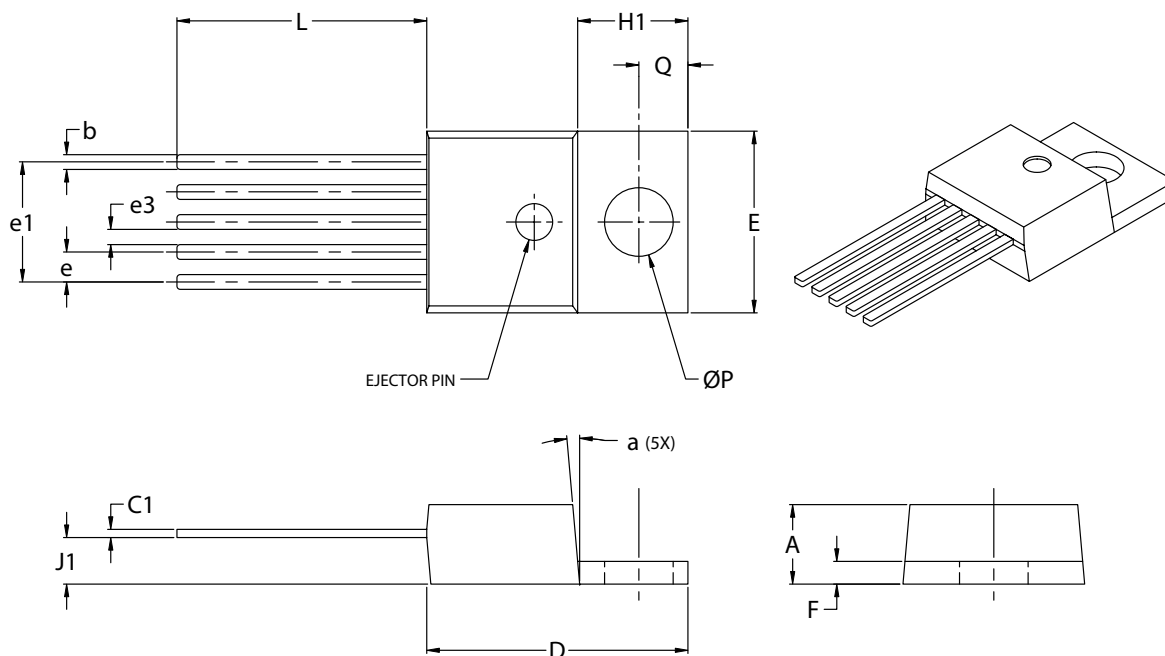
	Units	INCHES*		MILLIMETERS	
Dimension Limits		MIN	MAX	MIN	MAX
Lead Pitch	e	.060	.072	1.52	1.83
Overall Lead Centers	e1	.263	.273	6.68	6.93
Space Between Leads	e3	.030	.040	0.76	1.02
Overall Height	A	.160	.190	4.06	4.83
Overall Width	E	.385	.415	9.78	10.54
Overall Length	D	.560	.590	14.22	14.99
Flag Length	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

NOTES:

PRODUCT IDENTIFICATION SYSTEM

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

PART NO.	X	/XX
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

Examples:

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, -55ºC to +125ºC.

a) TC4422VPA: 9A High-Speed Non-Inverting MOSFET driver, PDIP package, -40ºC to +125ºC.

b) TC4422EPA: 9A High-Speed Non-Inverting MOSFET driver, PDIP package, -40°C to +85°C.

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