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 ns with 4,700 pF Load
  - 180 ns with 47,000 pF Load
- Short Propagation Delays: 30 ns (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 the TC4420/TC4429 6A MOSFET Driver
- Space-saving 8-Pin 6x5 DFN Package

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

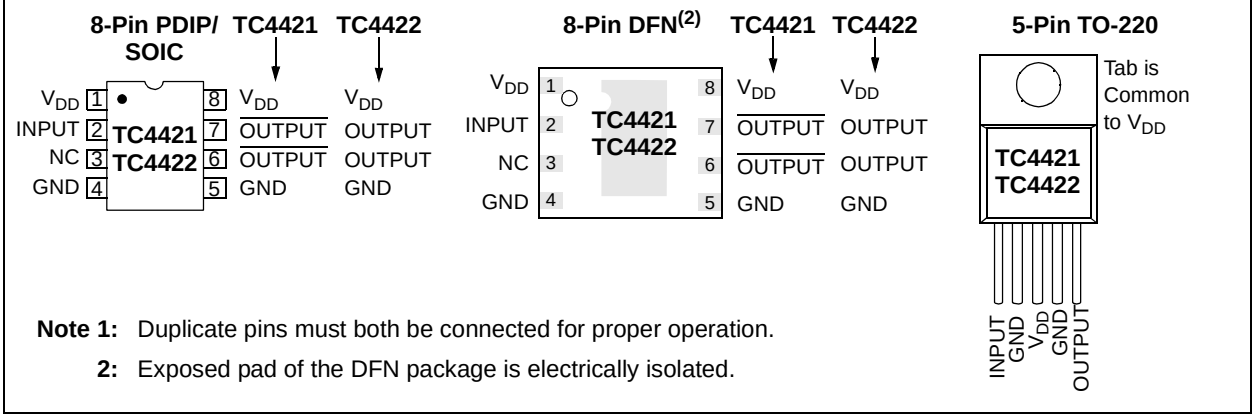
The TC4421/TC4422 are high-current buffer/drivers capable of driving large MOSFETs and IGBTs.

These devices 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. These parts 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 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.

With both surface-mount and pin-through-hole packages and four operating temperature range offerings, the TC4421/22 family of 9A MOSFET drivers fit into most any application where high gate/line capacitance drive is required.

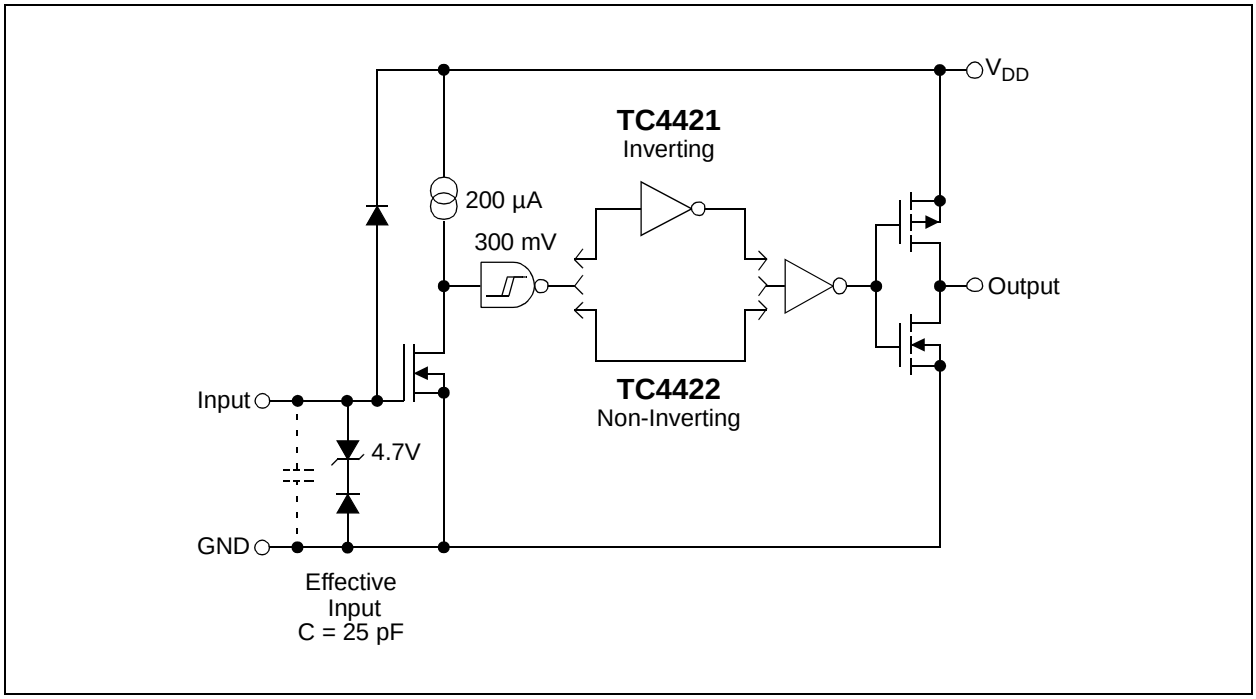
Package Types(1)



Note 1: Duplicate pins must both be connected for proper operation.

2: Exposed pad of the DFN package is electrically isolated.

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 ($T_A \leq 70°C$)
5-Pin TO-220 ..... 1.6W
DFN ..... **Note 2**
PDIP ..... 730 mW
SOIC ..... 750 mW
Package Power Dissipation ($T_A \leq 25°C$)
5-Pin TO-220 (With Heatsink) 12.5W
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°C 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 3)**
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	>1.5	—	A	Duty cycle ≤ 2%, t ≤ 300 µsec
Switching Time (Note 1)						
Rise Time	t_R	—	60	75	ns	**Figure 4-1**, C_L = 10,000 pF
Fall Time	t_F	—	60	75	ns	**Figure 4-1**, C_L = 10,000 pF
Delay Time	t_{D1}	—	30	60	ns	**Figure 4-1**
Delay Time	t_{D2}	—	33	60	ns	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	— —	0.2 55	1.5 150	mA µA	V_{IN} = 3V V_{IN} = 0V
Operating Input Voltage	V_{DD}	4.5	—	18	V	

Note 1: Switching times ensured by design.
2: Package power dissipation is dependent on the copper pad area on the PCB.
3: Tested during characterization, not production tested.

DC CHARACTERISTICS (OVER OPERATING TEMPERATURE RANGE)

Electrical Specifications: Unless otherwise noted, over operating temperature range with 4.5V ≤ V_{DD} ≤ 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 ≤ V_{IN} ≤ 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	ns	**Figure 4-1**, C_L = 10,000 pF
Fall Time	t_F	—	60	120	ns	**Figure 4-1**, C_L = 10,000 pF
Delay Time	t_{D1}	—	50	80	ns	**Figure 4-1**
Delay Time	t_{D2}	—	65	80	ns	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	— —	— —	3 0.2	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 ≤ V_{DD} ≤ 18V.						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Temperature Ranges						
Specified Temperature Range (C)	T_A	0	—	+70	°C	
Specified Temperature Range (E)	T_A	–40	—	+85	°C	
Specified Temperature Range (V)	T_A	–40	—	+125	°C	
Maximum Junction Temperature	T_J	—	—	+150	°C	
Storage Temperature Range	T_A	–65	—	+150	°C	
Package Thermal Resistances						
Thermal Resistance, 5L-TO-220	θ_{JA}	—	71	—	°C/W	
Thermal Resistance, 8L-6x5 DFN	θ_{JA}	—	33.2	—	°C/W	Typical 4-layer board with vias to ground plane
Thermal Resistance, 8L-PDIP	θ_{JA}	—	125	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	120	—	°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°C with 4.5V ≤ V_{DD} ≤ 18V.

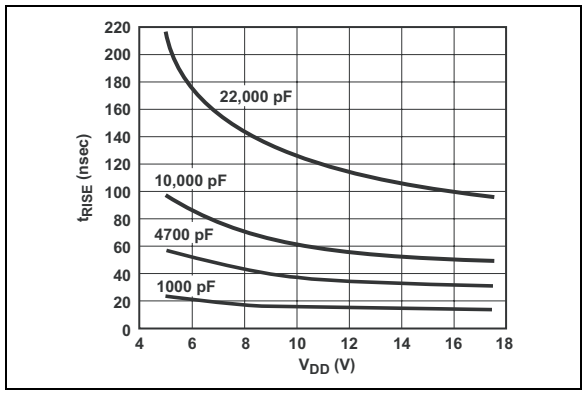


FIGURE 2-1: *Rise Time vs. Supply Voltage.*

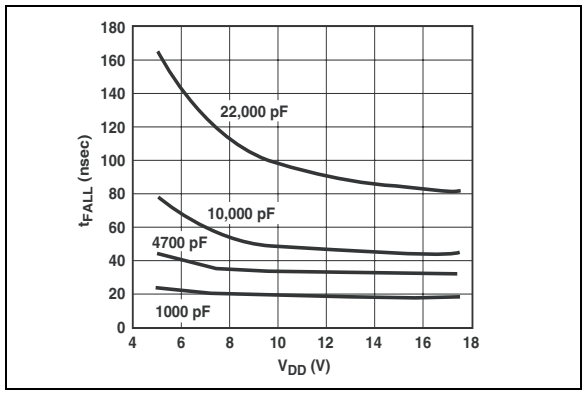


FIGURE 2-4: *Fall Time vs. Supply Voltage.*

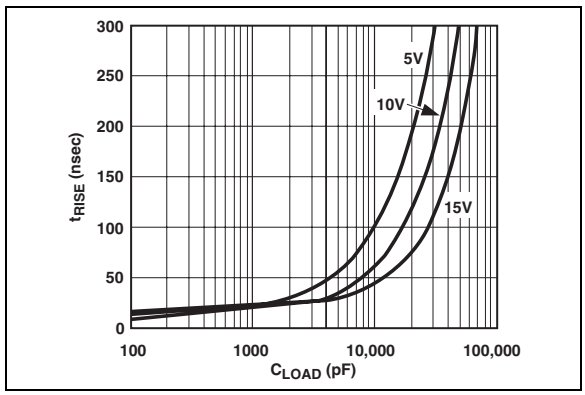


FIGURE 2-2: *Rise Time vs. Capacitive Load.*

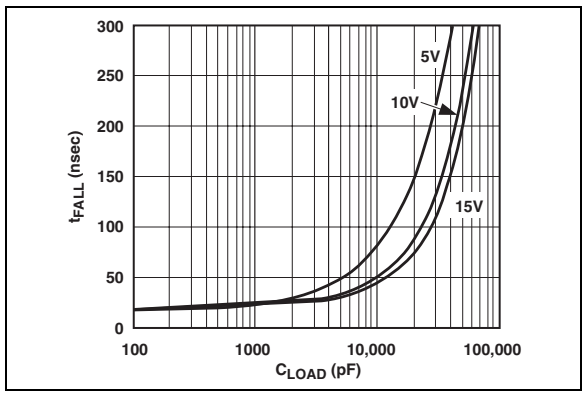


FIGURE 2-5: *Fall Time vs. Capacitive Load.*

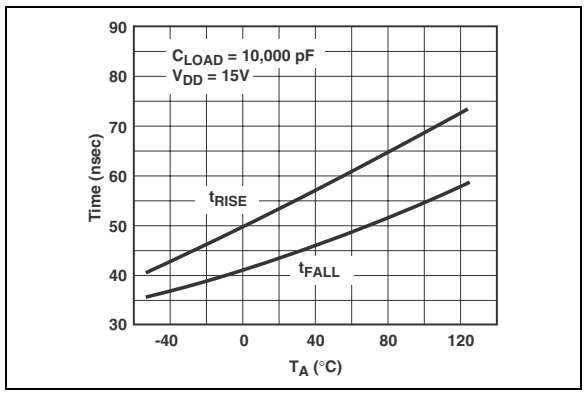


FIGURE 2-3: *Rise and Fall Times vs. Temperature.*

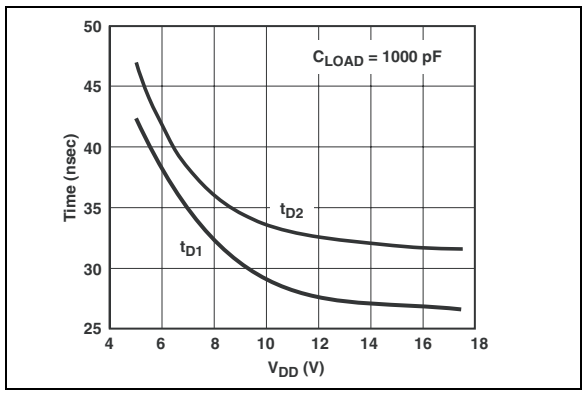


FIGURE 2-6: *Propagation Delay vs. Supply Voltage.*

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

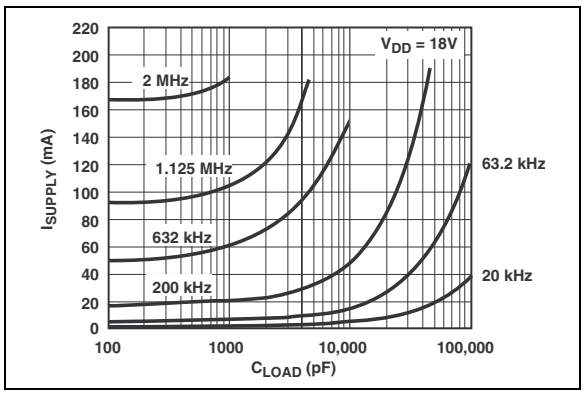


FIGURE 2-7: *Supply Current vs. Capacitive Load (V_{DD} = 18V).*

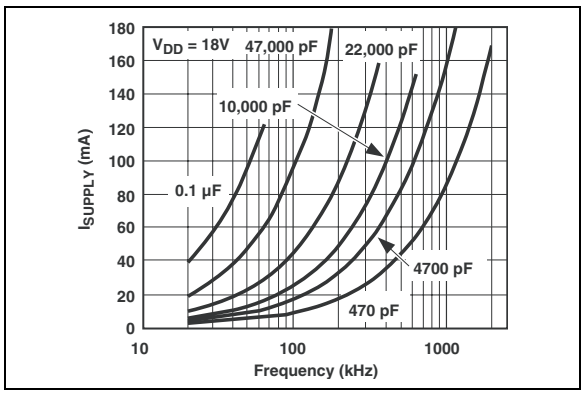


FIGURE 2-10: *Supply Current vs. Frequency (V_{DD} = 18V).*

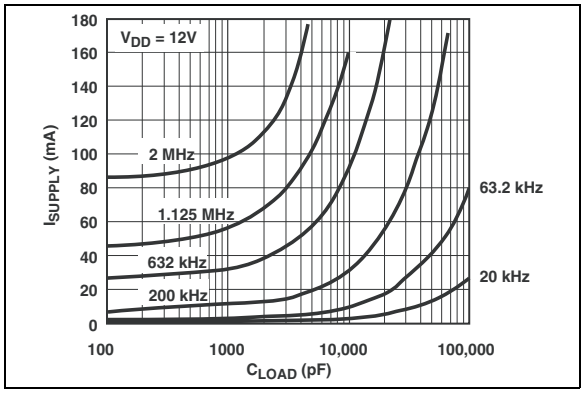


FIGURE 2-8: *Supply Current vs. Capacitive Load (V_{DD} = 12V).*

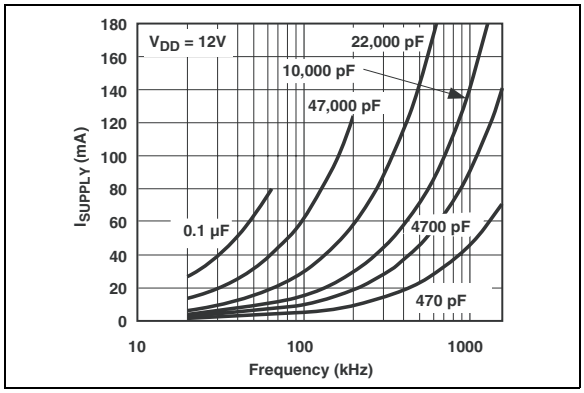


FIGURE 2-11: *Supply Current vs. Frequency (V_{DD} = 12V).*

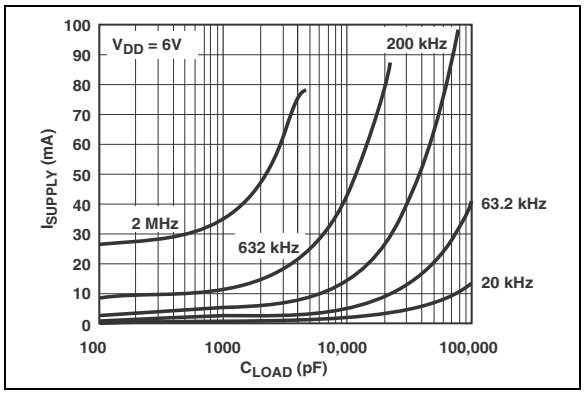


FIGURE 2-9: *Supply Current vs. Capactive Load (V_{DD} = 6V).*

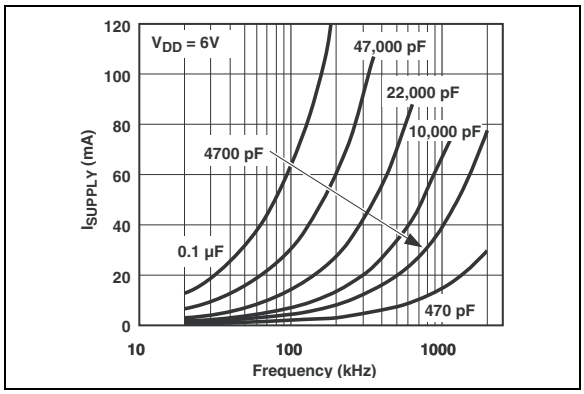


FIGURE 2-12: *Supply Current vs. Frequency (V_{DD} = 6V).*

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

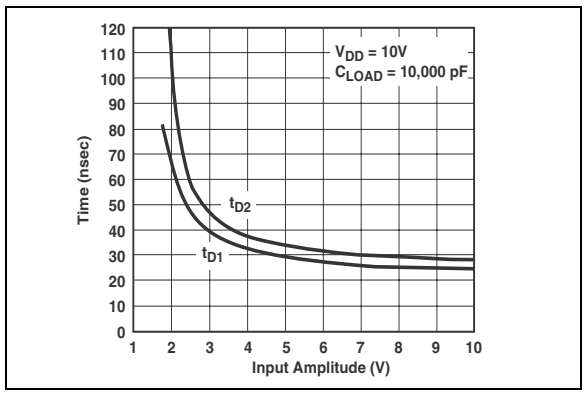


FIGURE 2-13: *Propagation Delay vs. Input Amplitude.*

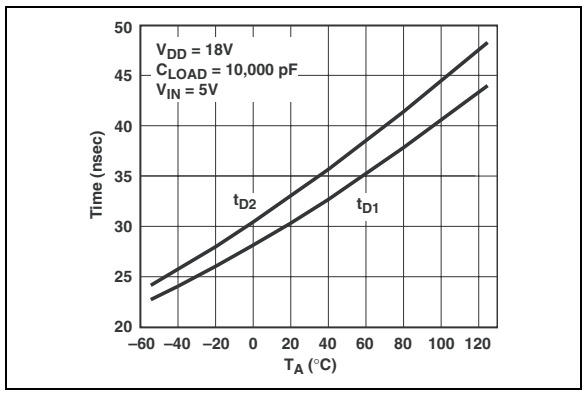


FIGURE 2-16: *Propagation Delay vs. Temperature.*

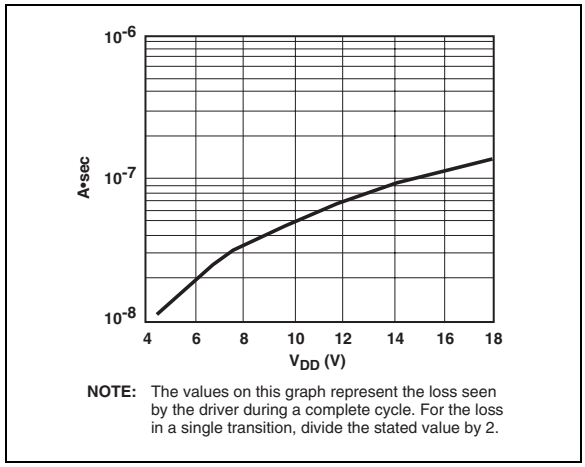


FIGURE 2-14: *Crossover Energy vs. Supply Voltage.*

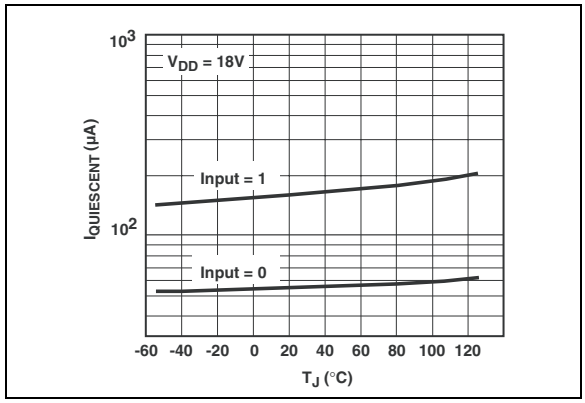


FIGURE 2-17: *Quiescent Supply Current vs. Temperature.*

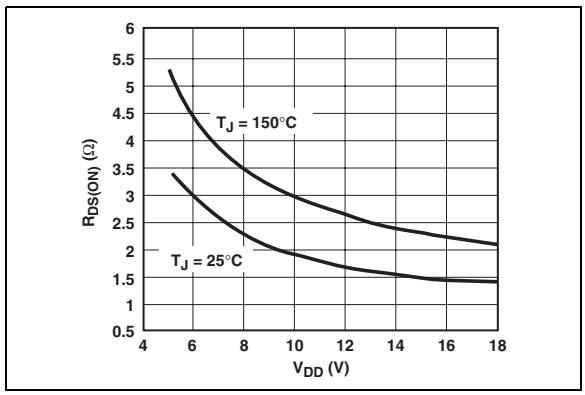


FIGURE 2-15: *High-State Output Resistance vs. Supply Voltage.*

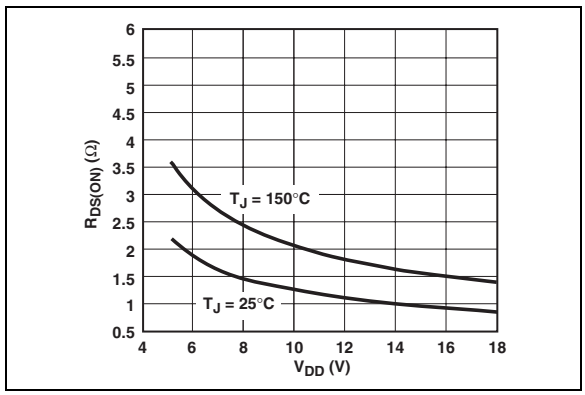


FIGURE 2-18: *Low-State Output Resistance vs. Supply Voltage.*

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, SOIC	Pin No. 8-Pin DFN	Pin No. 5-Pin TO-220	Symbol	Description
1	1	—	V_{DD}	Supply input, 4.5V to 18V
2	2	1	INPUT	Control input, TTL/CMOS compatible input
3	3	—	NC	No connection
4	4	2	GND	Ground
5	5	4	GND	Ground
6	6	5	OUTPUT	CMOS push-pull output
7	7	—	OUTPUT	CMOS push-pull output
8	8	3	V_{DD}	Supply input, 4.5V to 18V
—	PAD	—	NC	Exposed metal pad
—	—	TAB	V_{DD}	Metal tab is at the V_{DD} potential

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.

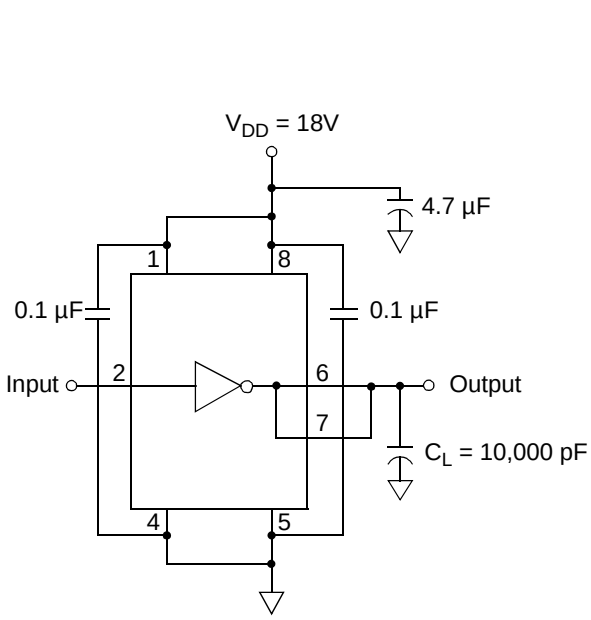
3.4 Ground

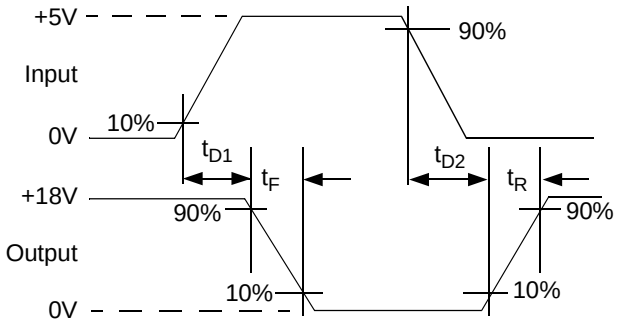
The ground pins are the return path for the bias current and for the high peak currents that discharge the load capacitor. The ground pins should be tied into a ground plane or have very short traces to the bias supply source return.

3.5 Exposed Metal Pad

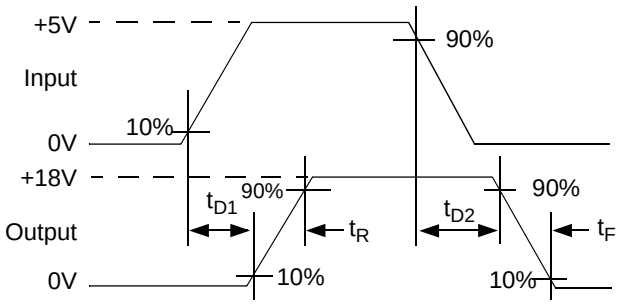
The exposed metal pad of the 6x5 DFN package is not internally connected to any potential. Therefore, this pad can be connected to a ground plane or other copper plane on a printed circuit board to aid in heat removal from the package.

4.0 APPLICATIONS INFORMATION





Inverting Driver
TC4421



Non-Inverting Driver
TC4422

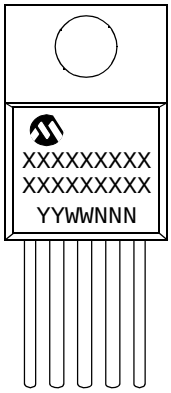
Note: Pinout shown is for the DFN, PDIP and SOIC packages.

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

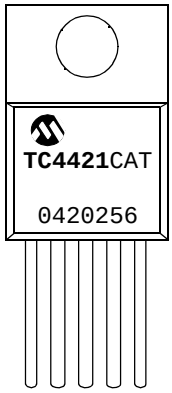
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

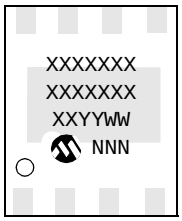
5-Lead TO-220



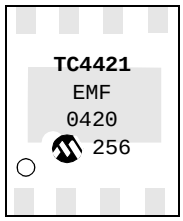
Example:



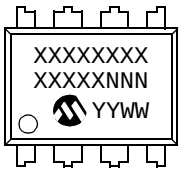
8-Lead DFN



Example:



8-Lead PDIP (300 mil)



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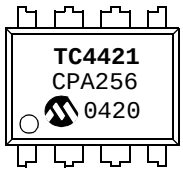
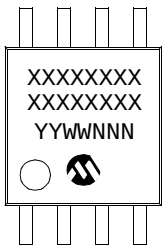
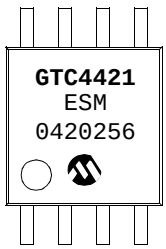


8-Lead SOIC (208 mil)



Example:

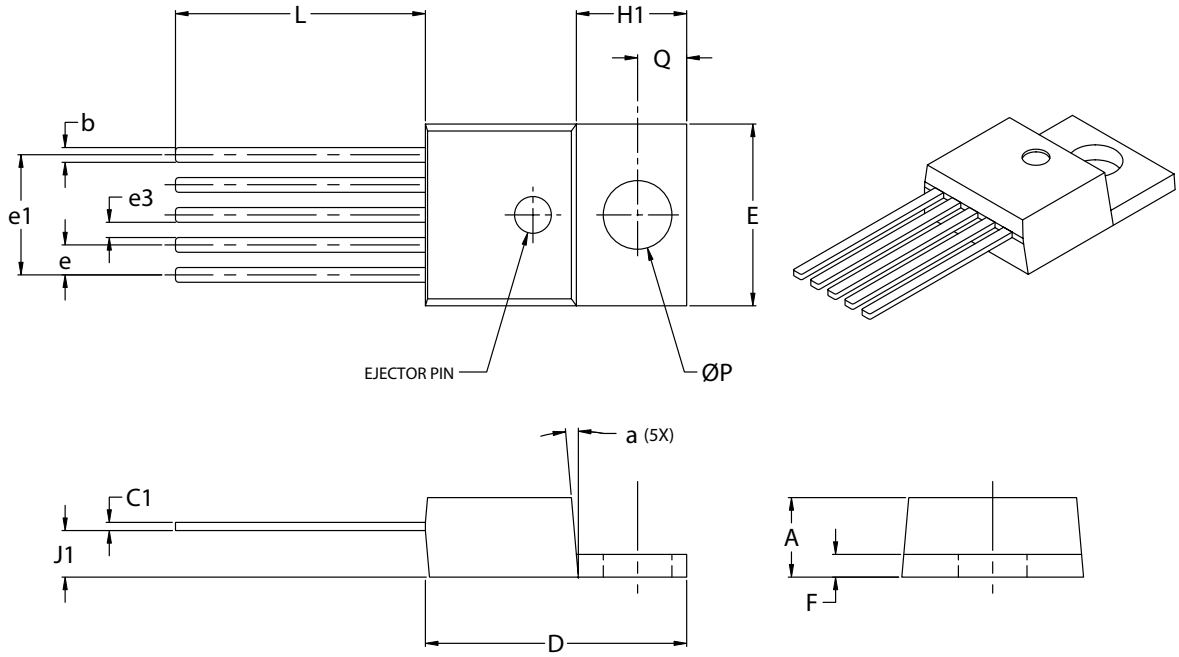


Legend:	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code

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.

5-Lead Plastic Transistor Outline (AT) (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

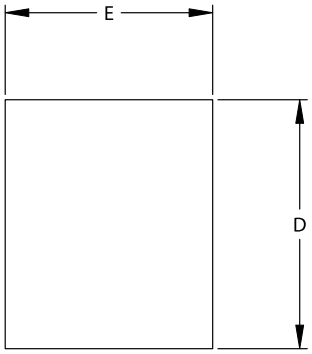
Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

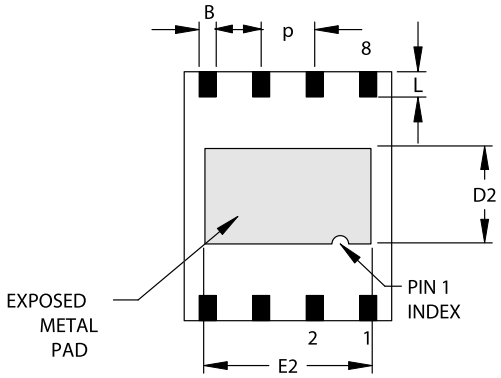
JEDEC equivalent: TO-220

Drawing No. C04-036

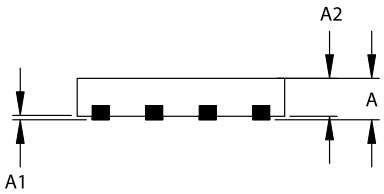
8-Lead Plastic Dual Flat No Lead Package (MF) 6x5 mm Body (DFN-S) – Saw Singulated

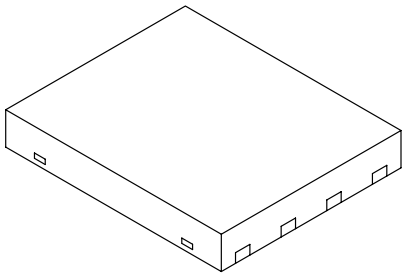


TOP VIEW



BOTTOM VIEW





Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.050 BSC			1.27 BSC	
Overall Height	A	.033	.035	.037	0.85	0.90	0.95
Package Thickness	A2	.031	.035	.037	0.80	0.89	0.95
Standoff	A1	.000	.0004	.002	0.00	0.01	0.05
Base Thickness	A3	.007	.008	.009	0.17	0.20	0.23
Overall Length	E	.195	.197	.199	4.95	5.00	5.05
Exposed Pad Length	E2	.152	.157	.163	3.85	4.00	4.15
Overall Width	D	.234	.236	.238	5.95	6.00	6.05
Exposed Pad Width	D2	.089	.091	.093	2.25	2.30	2.35
Lead Width	B	.014	.016	.019	0.35	0.40	0.47
Lead Length	L	.024		.026	0.60		0.65

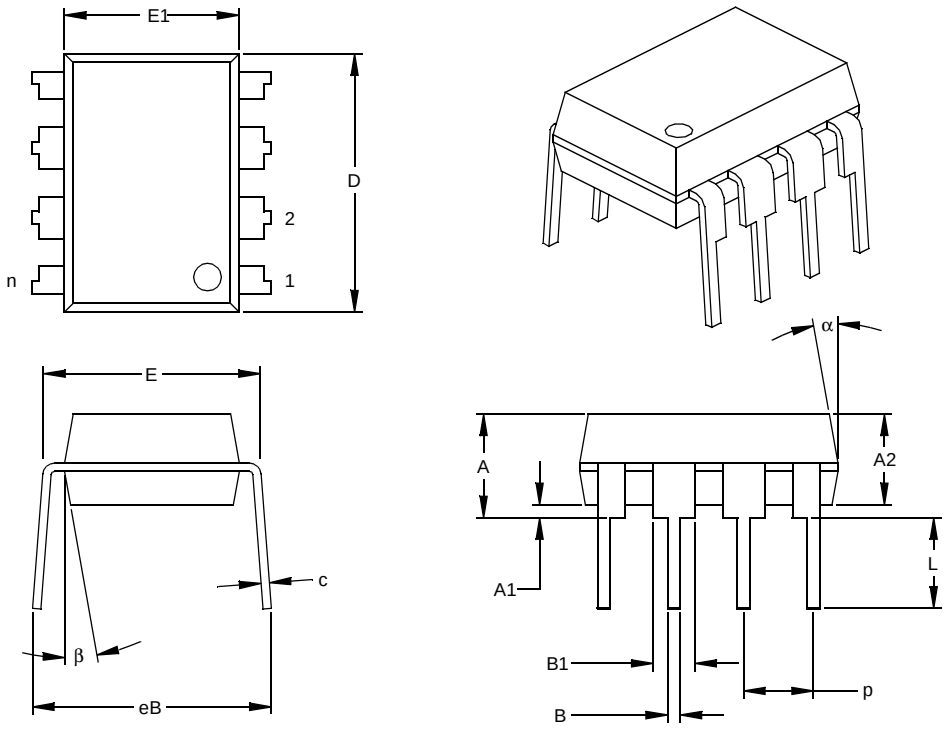
Notes:

JEDEC equivalent: MO-220

Drawing No. C04-122

Revised 11/3/03

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



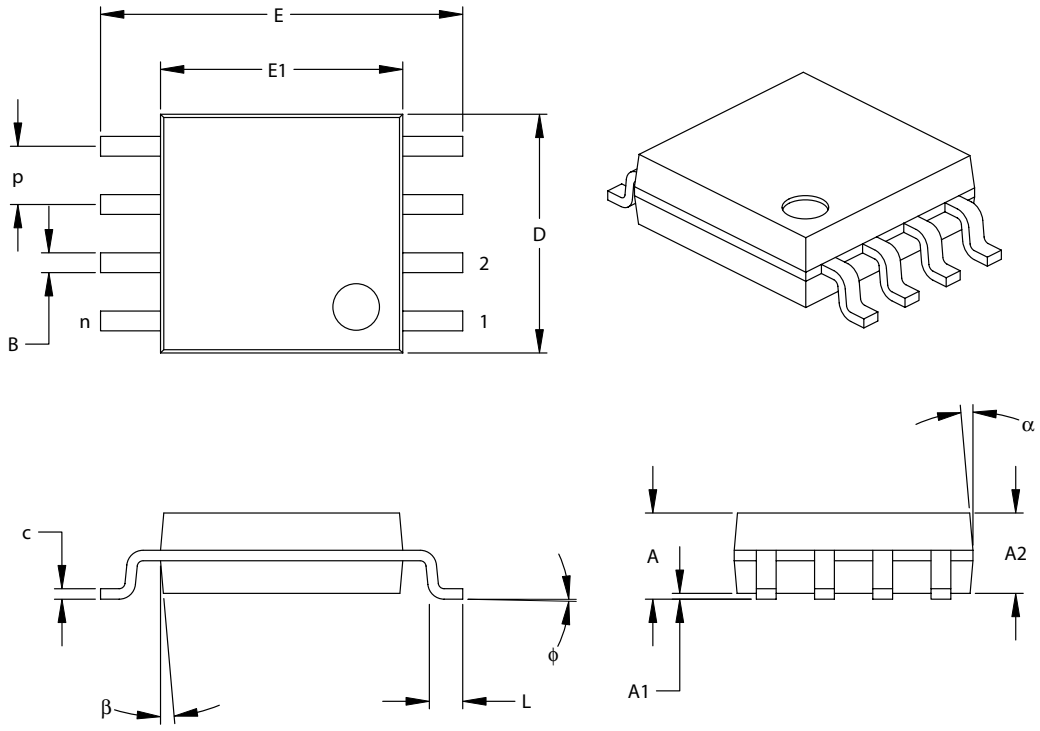
Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300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

8-Lead Plastic Small Outline (SM) – Medium, 208 mil Body (SOIJ)

(JEITA/EIAJ Standard, Formerly called SOIC)



Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.050			1.27	
Overall Height	A	.070	.075	.080	1.78	1.97	2.03
Molded Package Thickness	A2	.069	.074	.078	1.75	1.88	1.98
Standoff	A1	.002	.005	.010	0.05	0.13	0.25
Overall Width	E	.300	.313	.325	7.62	7.95	8.26
Molded Package Width	E1	.201	.208	.212	5.11	5.28	5.38
Overall Length	D	.202	.205	.210	5.13	5.21	5.33
Foot Length	L	.020	.025	.030	0.51	0.64	0.76
Foot Angle	ϕ	0	4	8	0	4	8
Lead Thickness	c	.008	.009	.010	0.20	0.23	0.25
Lead Width	B	.014	.017	.020	0.36	0.43	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

Notes:

Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

Drawing No. C04-056

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	XXX	X
Device	Temperature Range	Package	Tape & Reel	PB Free

Device:	TC4421:	9A High-Speed MOSFET Driver, Inverting
	TC4422:	9A High-Speed MOSFET Driver, Non-Inverting
Temperature Range:	C =	0°C to +70°C (PDIP and TO-220 Only)
	E =	-40°C to +85°C
	V =	-40°C to +125°C
Package:	AT =	TO-220, 5-lead (C-Temp Only)
	MF =	Dual, Flat, No-Lead (6x5 mm Body), 8-lead
	MF713 =	Dual, Flat, No-Lead (6x5 mm Body), 8-lead (Tape and Reel)
	PA =	Plastic DIP (300 mil Body), 8-lead
	SM =	Plastic SOIC (208 mil Body), 8-lead
	SM713 =	Plastic SOIC (208 mil Body), 8-lead (Tape and Reel)
PB Free	G =	Lead-Free device
	=	Blank

***** Available on selected packages. Contact your local sales representative for availability

Examples:

a) TC4421CAT: 9A High-Speed Inverting MOSFET Driver, TO-220 package, 0°C to +70°C.

b) TC4421ESMG: 9A High-Speed Inverting MOSFET Driver, PB Free SOIC package, -40°C to +85°C.

c) TC4421VMF: 9A High-Speed Inverting MOSFET Driver, DFN package, -40°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.

c) TC4422EMF: 9A High-Speed Inverting MOSFET Driver, DFN package, -40°C to +85°C.

Sales and Support

Data Sheets

Products supported by a preliminary Data Sheet may have an errata sheet describing minor operational differences and recommended workarounds. To determine if an errata sheet exists for a particular device, please contact one of the following:

1. Your local Microchip sales office
2. The Microchip Corporate Literature Center U.S. FAX: (480) 792-7277
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Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

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