TC4426/TC4427/TC4428

1.5A Dual High-Speed Power MOSFET Drivers

Features:

- High Peak Output Current – 1.5A
- Wide Input Supply Voltage Operating Range:
  - 4.5V to 18V
- High Capacitive Load Drive Capability – 1000 pF in 25 ns (typ.)
- Short Delay Times – 40 ns (typ.)
- Matched Rise and Fall Times
- Low Supply Current:
  - With Logic '1' Input – 4 mA
  - With Logic '0' Input – 400 µA
- Low Output Impedance – 7Ω
- Latch-Up Protected: Will Withstand 0.5A Reverse Current
- Input Will Withstand Negative Inputs Up to 5V
- ESD Protected – 4 kV
- Pin-compatible with the TC426/TC427/TC428
- Space-saving 8-Pin MSOP and 8-Pin 6x5 DFN Packages

Applications:

- Switch Mode Power Supplies
- Line Drivers
- Pulse Transformer Drive

General Description:

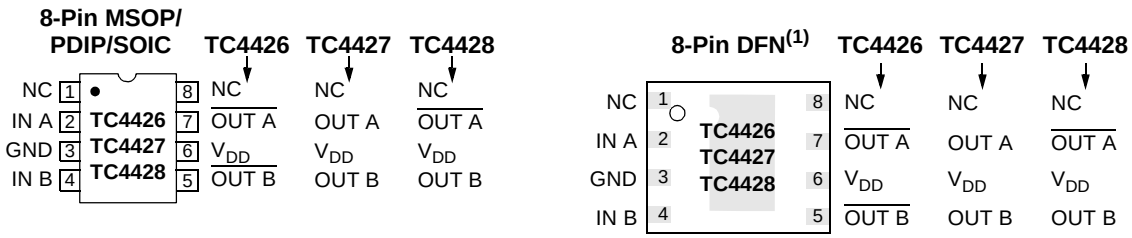
The TC4426/TC4427/TC4428 are improved versions of the earlier TC426/TC427/TC428 family of MOSFET drivers. The TC4426/TC4427/TC4428 devices have matched rise and fall times when charging and discharging the gate of a MOSFET.

These devices are highly latch-up resistant under any conditions within their power and voltage ratings. They are not subject to damage when up to 5V of noise spiking (of either polarity) occurs on the ground pin. They can accept, without damage or logic upset, up to 500 mA of reverse current (of either polarity) being forced back into their outputs. All terminals are fully protected against Electrostatic Discharge (ESD) up to 4 kV.

The TC4426/TC4427/TC4428 MOSFET drivers can easily charge/discharge 1000 pF gate capacitances in under 30 ns. These devices provide low enough impedances in both the on and off states to ensure the MOSFET's intended state will not be affected, even by large transients.

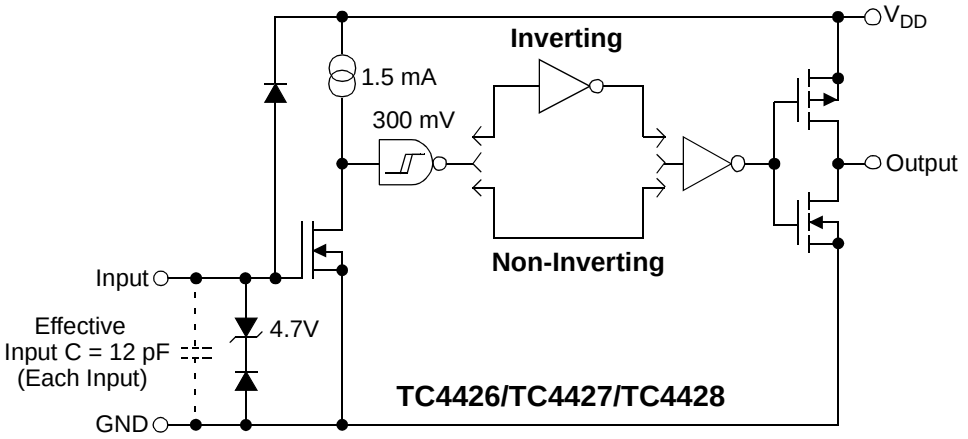
Other compatible drivers are the TC4426A/TC4427A/TC4428A family of devices. The TC4426A/TC4427A/TC4428A devices have matched leading and falling edge input-to-output delay times, in addition to the matched rise and fall times of the TC4426/TC4427/TC4428 devices.

Package Types



Note 1: Exposed pad of the DFN package is electrically isolated.

Functional Block Diagram



Note 1: TC4426 has two inverting drivers, while the TC4427 has two non-inverting drivers. The TC4428 has one inverting and one non-inverting driver.

2: Ground any unused driver input.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage ..... +22V

Input Voltage, IN A or IN B
..... (V_{DD} + 0.3V) to (GND – 5V)

Package Power Dissipation ($T_A \leq 70°C$)
DFN ..... **Note 3**
MSOP ..... 340 mW
PDIP ..... 730 mW
SOIC ..... 470 mW

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

Maximum Junction Temperature ..... +150°C

† 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.

PIN FUNCTION TABLE

Name	Function
NC	No Connection
IN A	Input A
GND	Ground
IN B	Input B
OUT B	Output B
V_{DD}	Supply Input
OUT A	Output A
NC	No Connection

DC CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T_A = +25ºC with 4.5V ≤ V_{DD} ≤ 18V.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input						
Logic ‘1’, High Input Voltage	V_{IH}	2.4	—	—	V	**Note 2**
Logic ‘0’, Low Input Voltage	V_{IL}	—	—	0.8	V	
Input Current	I_{IN}	-1.0	—	+1.0	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	R_O	—	7	10	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Peak Output Current	I_{PK}	—	1.5	—	A	V_{DD} = 18V
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	> 0.5	—	A	Duty cycle ≤ 2%, t ≤ 300 µs V_{DD} = 18V
Switching Time (Note 1)						
Rise Time	t_R	—	19	30	ns	**Figure 4-1**
Fall Time	t_F	—	19	30	ns	**Figure 4-1**
Delay Time	t_{D1}	—	20	30	ns	**Figure 4-1**
Delay Time	t_{D2}	—	40	50	ns	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	— —	— —	4.5 0.4	mA	V_{IN} = 3V (Both inputs) V_{IN} = 0V (Both inputs)

Note 1: Switching times ensured by design.

2: For V temperature range devices, the V_{IH} (Min) limit is 2.0V.

3: Package power dissipation is dependent on the copper pad area on the PCB.

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	**Note 2**
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	R_O	—	9	12	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Peak Output Current	I_{PK}	—	1.5	—	A	V_{DD} = 18V
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	>0.5	—	A	Duty cycle ≤ 2%, t ≤ 300 µs V_{DD} = 18V
Switching Time (Note 1)						
Rise Time	t_R	—	—	40	ns	**Figure 4-1**
Fall Time	t_F	—	—	40	ns	**Figure 4-1**
Delay Time	t_{D1}	—	—	40	ns	**Figure 4-1**
Delay Time	t_{D2}	—	—	60	ns	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	— —	— —	8.0 0.6	mA	V_{IN} = 3V (Both inputs) V_{IN} = 0V (Both inputs)

Note 1: Switching times ensured by design.

2: For V temperature range devices, the V_{IH} (Min) limit is 2.0V.

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, 8L-6x5 DFN	θ_{JA}	—	33.2	—	°C/W	
Thermal Resistance, 8L-MSOP	θ_{JA}	—	206	—	°C/W	
Thermal Resistance, 8L-PDIP	θ_{JA}	—	125	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	155	—	°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 = +25ºC with 4.5V ≤ V_{DD} ≤ 18V.

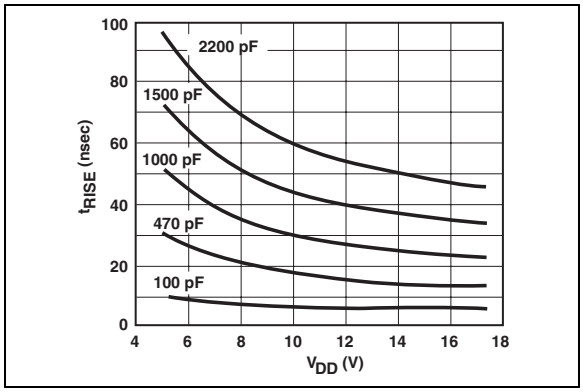


FIGURE 2-1: *Rise Time vs. Supply Voltage.*

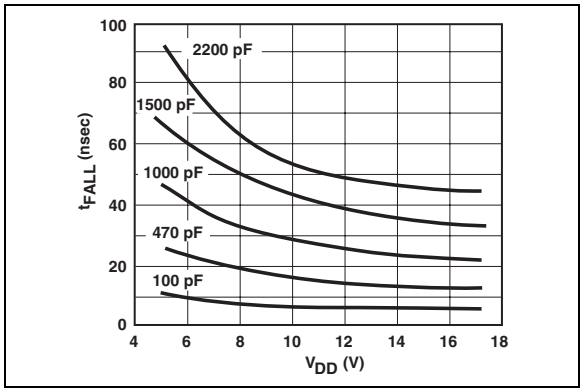


FIGURE 2-4: *Fall Time vs. Supply Voltage.*

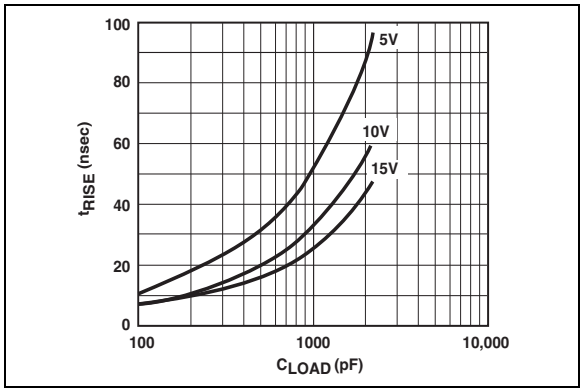


FIGURE 2-2: *Rise Time vs. Capacitive Load.*

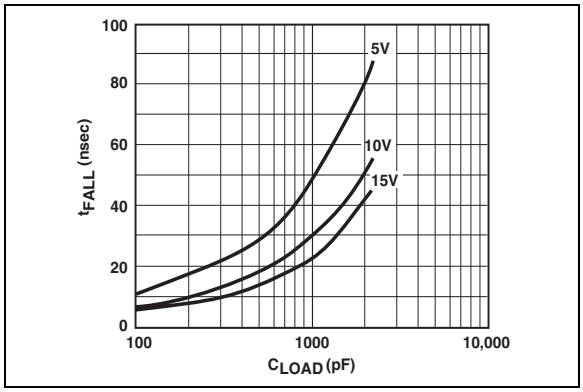


FIGURE 2-5: *Fall Time vs. Capacitive Load.*

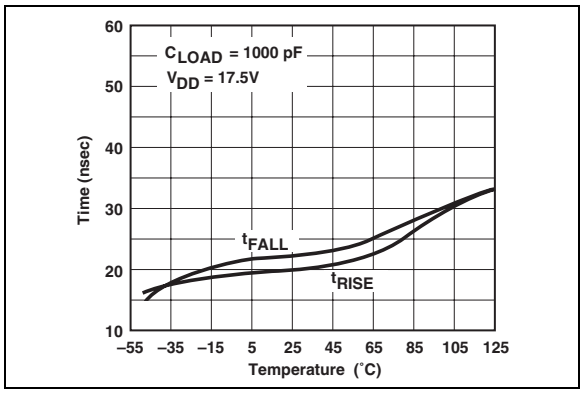


FIGURE 2-3: *Rise and Fall Times vs. Temperature.*

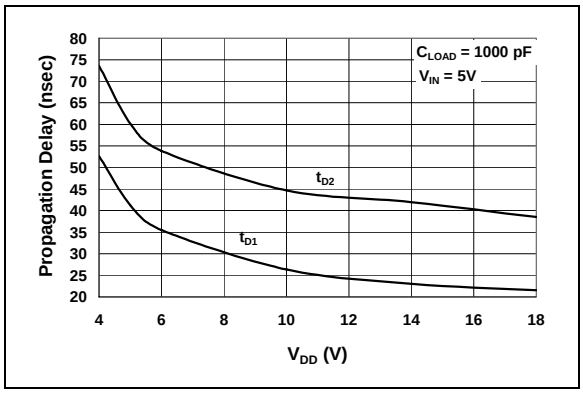


FIGURE 2-6: *Propagation Delay Time vs. Supply Voltage.*

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

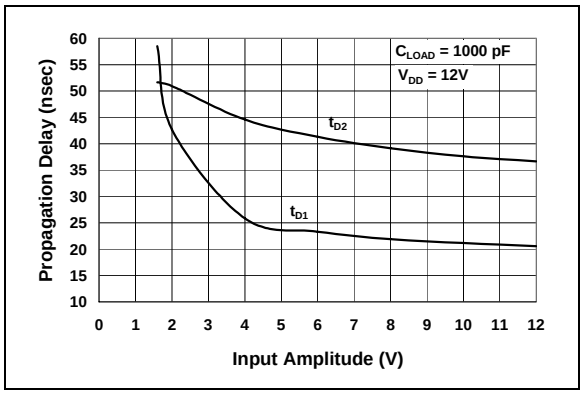


FIGURE 2-7: *Propagation Delay Time vs. Input Amplitude.*

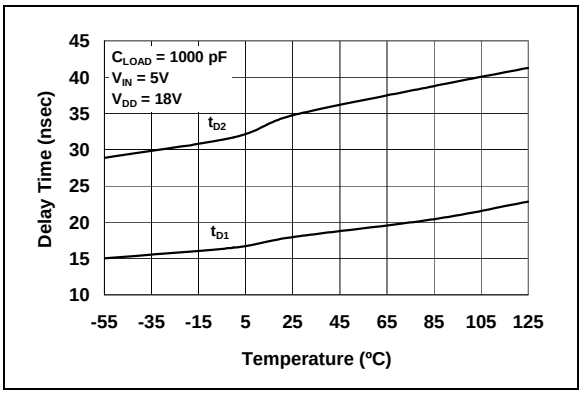


FIGURE 2-10: *Propagation Delay Time vs. Temperature.*

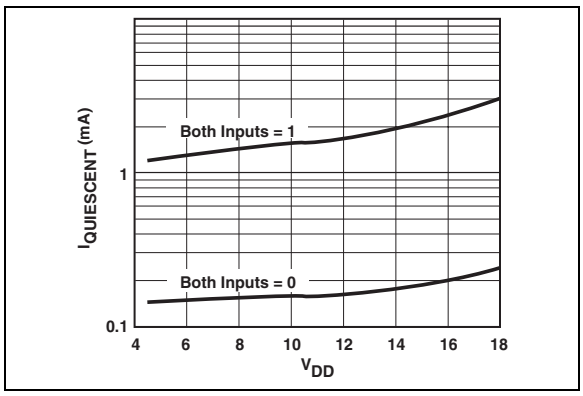


FIGURE 2-8: *Supply Current vs. Supply Voltage.*

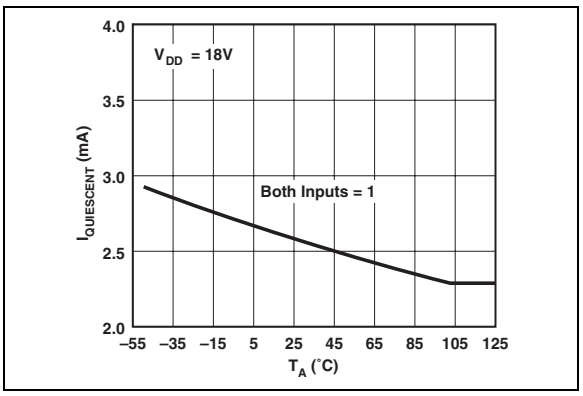


FIGURE 2-11: *Supply Current vs. Temperature.*

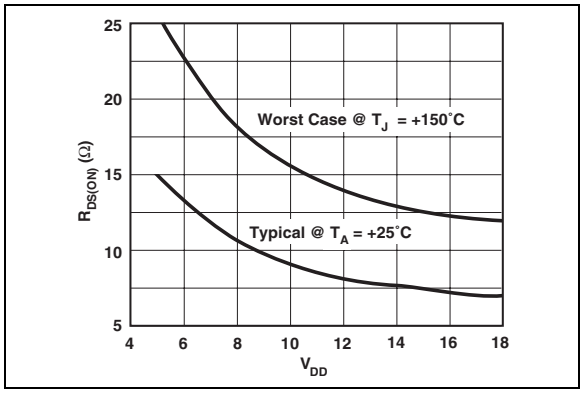


FIGURE 2-9: *Output Resistance (R_{OH}) vs. Supply Voltage.*

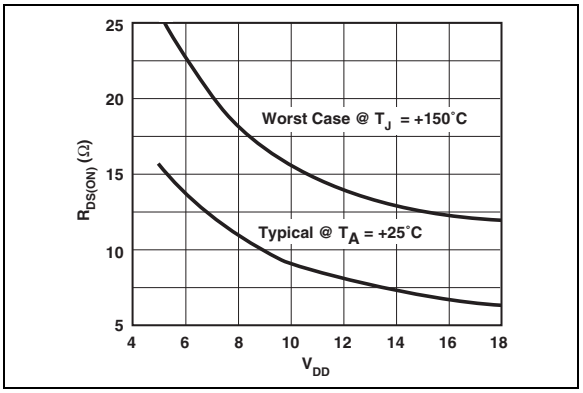


FIGURE 2-12: *Output Resistance (R_{OL}) vs. Supply Voltage.*

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

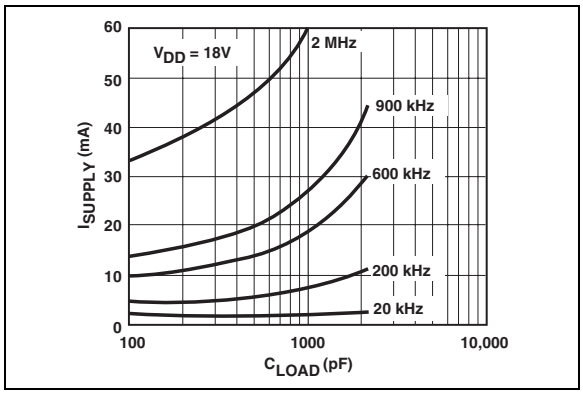


FIGURE 2-13: *Supply Current vs. Capacitive Load.*

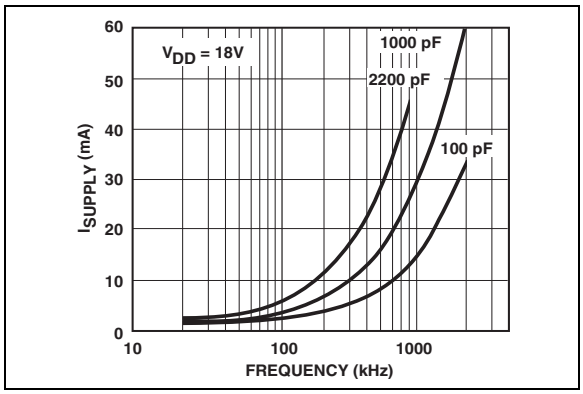


FIGURE 2-16: *Supply Current vs. Frequency.*

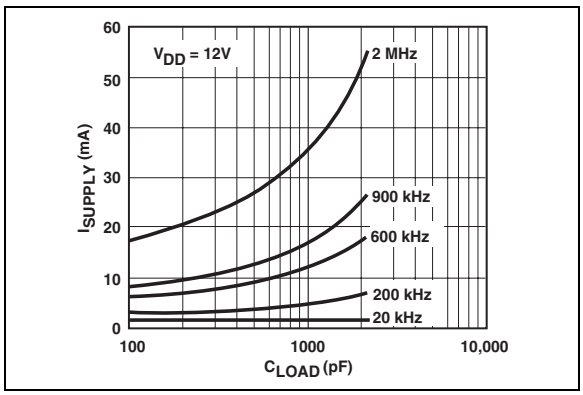


FIGURE 2-14: *Supply Current vs. Capacitive Load.*

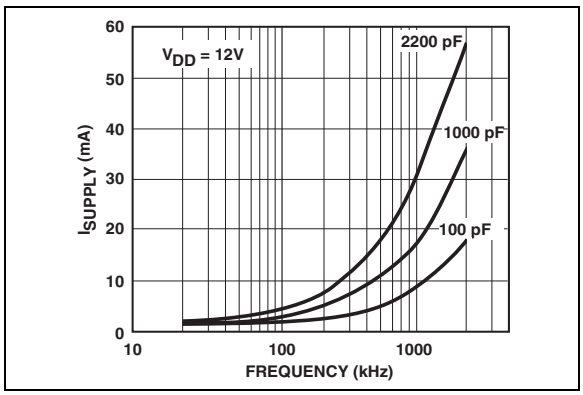


FIGURE 2-17: *Supply Current vs. Frequency.*

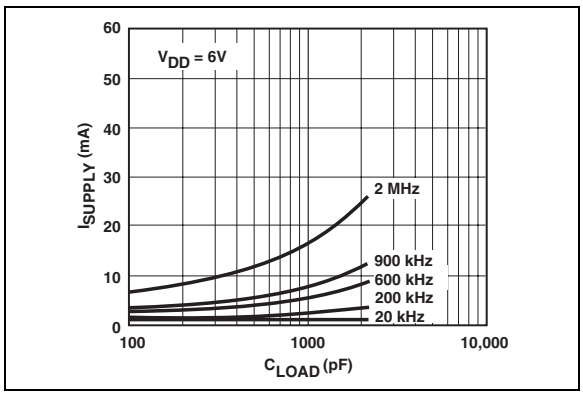


FIGURE 2-15: *Supply Current vs. Capacitive Load.*

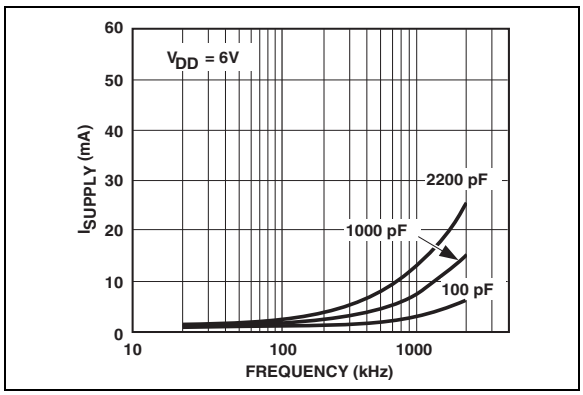
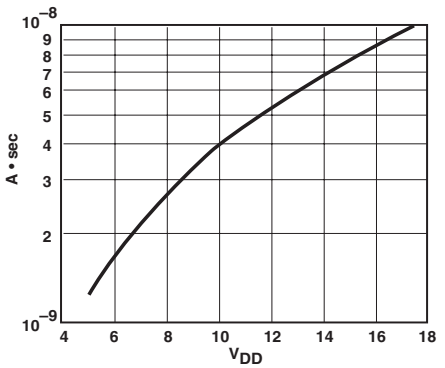


FIGURE 2-18: *Supply Current vs. Frequency.*

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



Note: The values on this graph represent the loss seen by both drivers in a package during one complete cycle. For a single driver, divide the stated values by 2. For a single transition of a single driver, divide the stated value by 4.

FIGURE 2-19: *Crossover Energy vs. Supply Voltage.*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE (1)

8-Pin PDIP/ MSOP/SOIC	8-Pin DFN	Symbol	Description
1	1	NC	No connection
2	2	IN A	Input A
3	3	GND	Ground
4	4	IN B	Input B
5	5	OUT B	Output B
6	6	V_{DD}	Supply input
7	7	OUT A	Output A
8	8	NC	No connection
—	PAD	NC	Exposed Metal Pad

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

3.1 Inputs A and B

MOSFET driver inputs A and B are high-impedance, TTL/CMOS compatible inputs. These inputs also have 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.

3.2 Ground (GND)

Ground is the device return pin. The ground pin(s) should have a low-impedance connection to the bias supply source return. High peak currents will flow out the ground pin(s) when the capacitive load is being discharged.

3.3 Output A and B

MOSFET driver outputs A and B are low-impedance, CMOS push-pull style outputs. The pull-down and pull-up devices are of equal strength, making the rise and fall times equivalent.

3.4 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 with local ceramic capacitors. The value of these capacitors should be chosen based on the capacitive load that is being driven. A value of 1.0 µF is suggested.

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

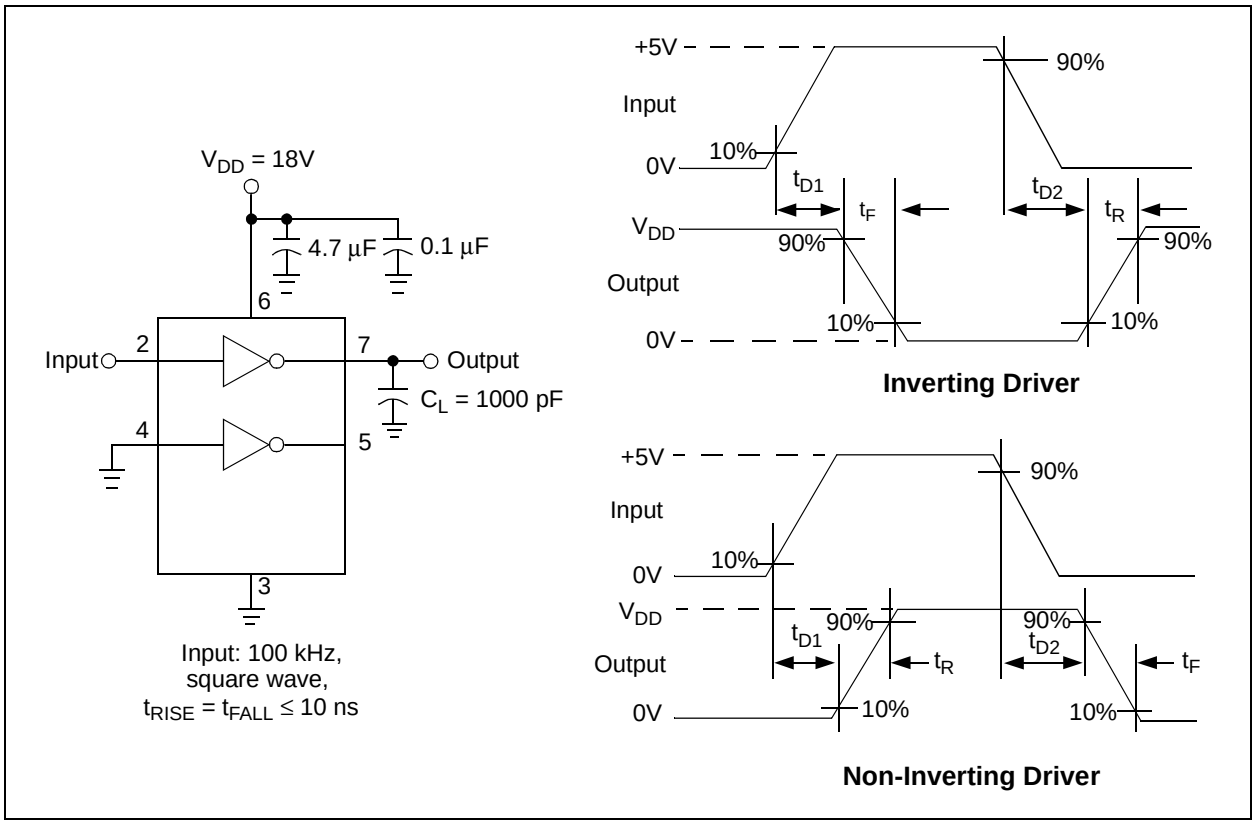
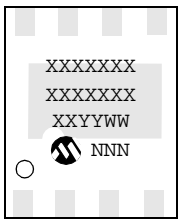


FIGURE 4-1: *Switching Time Test Circuit.*

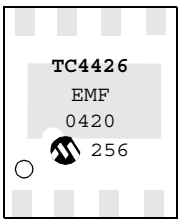
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

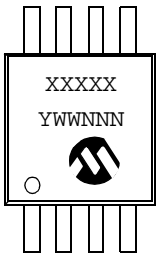
8-Lead DFN



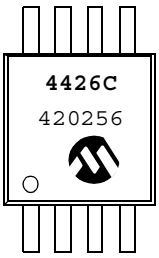
Example:



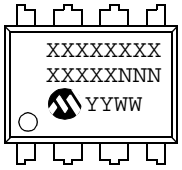
8-Lead MSOP



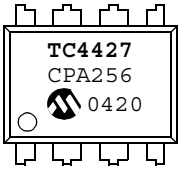
Example:



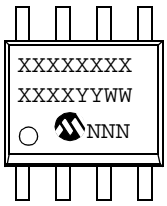
8-Lead PDIP (300 mil)



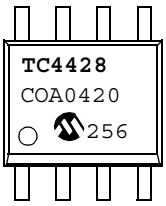
Example:



8-Lead SOIC (150 mil)



Example:

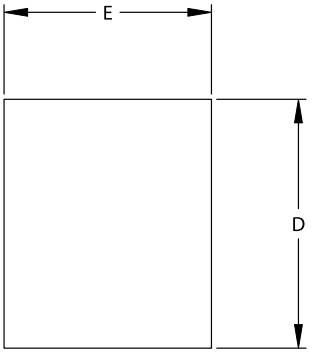


Legend:	XX...X	Customer specific information*
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code

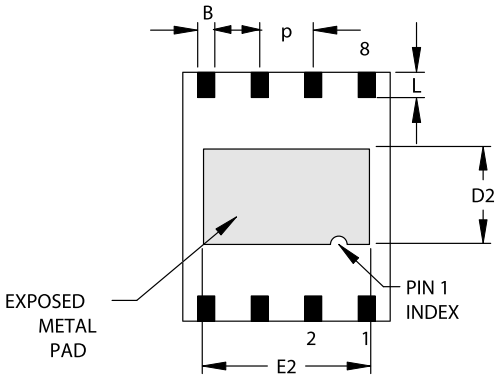
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line thus limiting the number of available characters for customer specific information.

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

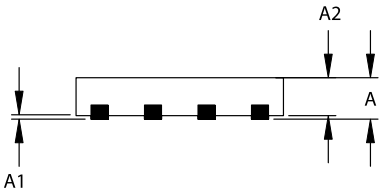
8-Lead Plastic Dual Flat No Lead Package (MF) 6x5 mm Body (DFN-S) – Saw Singulated

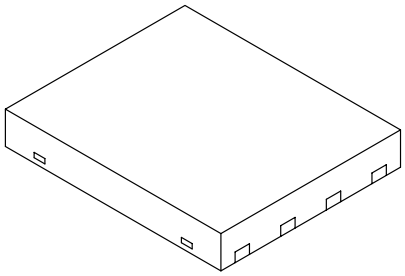


TOP VIEW



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

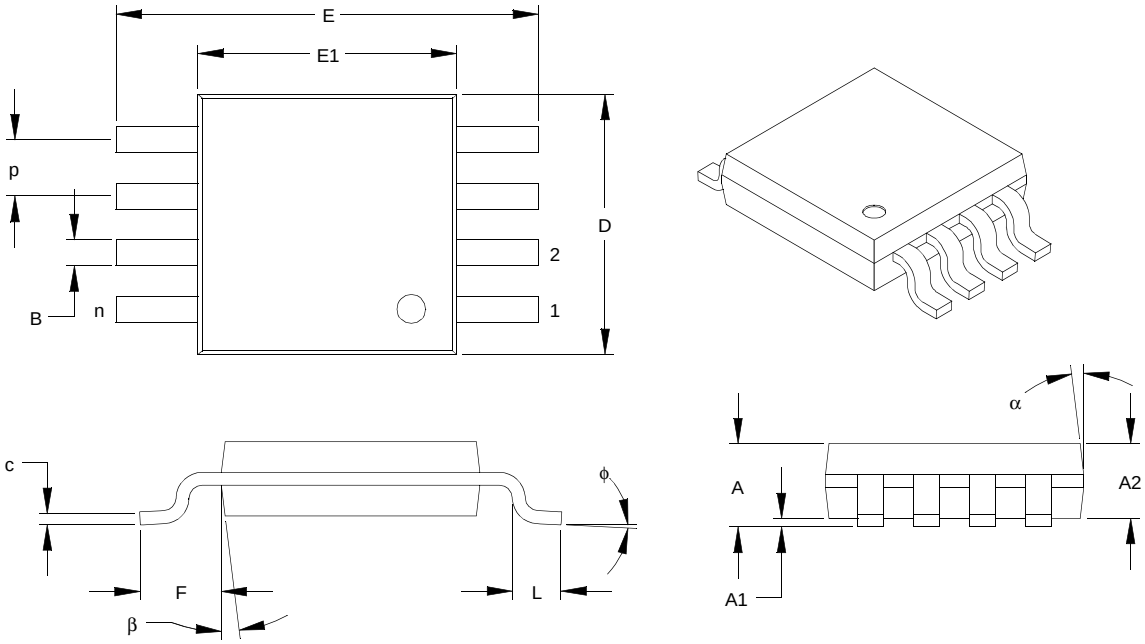
Notes:

JEDEC equivalent: MO-220

Drawing No. C04-122

Revised 11/3/03

8-Lead Plastic Micro Small Outline Package (MS) (MSOP)



Units		INCHES			MILLIMETERS*		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.026 BSC			0.65 BSC	
Overall Height	A	-	-	.043	-	-	1.10
Molded Package Thickness	A2	.030	.033	.037	0.75	0.85	0.95
Standoff	A1	.000	-	.006	0.00	-	0.15
Overall Width	E		.193 BSC			4.90 BSC	
Molded Package Width	E1		.118 BSC			3.00 BSC	
Overall Length	D		.118 BSC			3.00 BSC	
Foot Length	L	.016	.024	.031	0.40	0.60	0.80
Footprint (Reference)	F		.037 REF			0.95 REF	
Foot Angle	φ	0°	-	8°	0°	-	8°
Lead Thickness	c	.003	.006	.009	0.08	-	0.23
Lead Width	B	.009	.012	.016	0.22	-	0.40
Mold Draft Angle Top	α	5°	-	15°	5°	-	15°
Mold Draft Angle Bottom	β	5°	-	15°	5°	-	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.

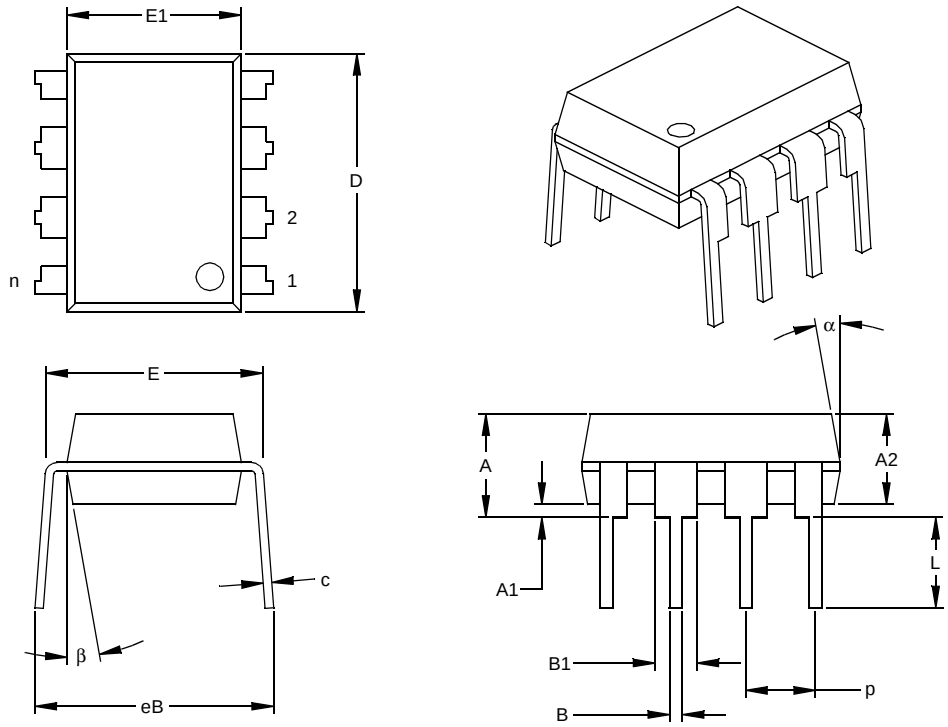
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
See ASME Y14.5M

REF: Reference Dimension, usually without tolerance, for information purposes only.
See ASME Y14.5M

JEDEC Equivalent: MO-187 Revised 07-21-05

Drawing No. C04-111

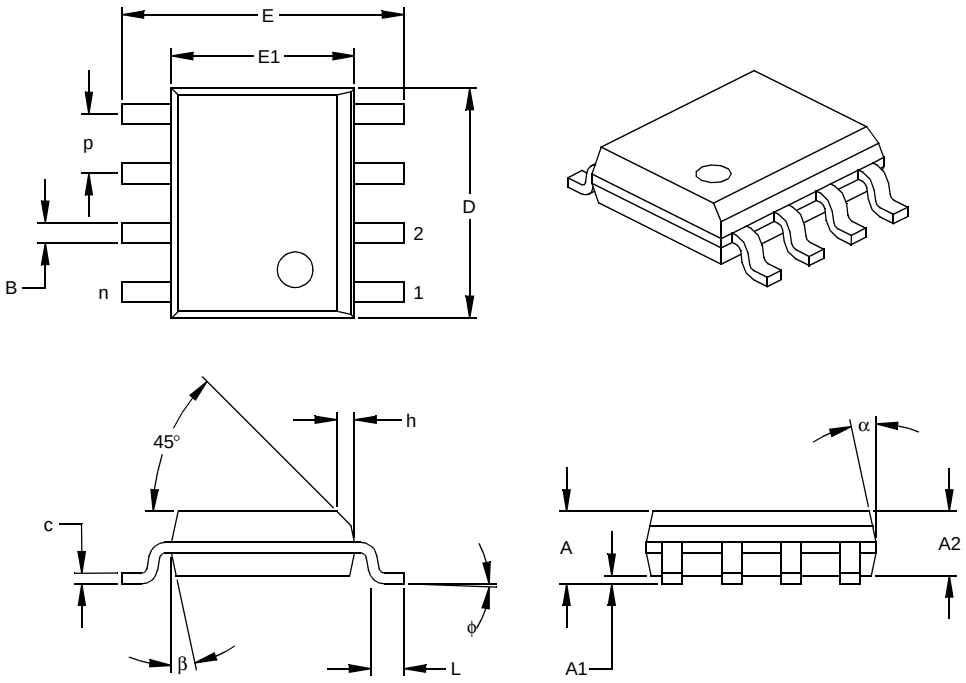
8-Lead Plastic Dual In-line (P) – 300 mil (PDIP)



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 (SN) – Narrow, 150 mil (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	.053	.061	.069	1.35	1.55	1.75
Molded Package Thickness	A2	.052	.056	.061	1.32	1.42	1.55
Standoff §	A1	.004	.007	.010	0.10	0.18	0.25
Overall Width	E	.228	.237	.244	5.79	6.02	6.20
Molded Package Width	E1	.146	.154	.157	3.71	3.91	3.99
Overall Length	D	.189	.193	.197	4.80	4.90	5.00
Chamfer Distance	h	.010	.015	.020	0.25	0.38	0.51
Foot Length	L	.019	.025	.030	0.48	0.62	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	.013	.017	.020	0.33	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-012
Drawing No. C04-057

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	XXX	X
Device	Temperature Range	Package	Tape & Reel	PB Free

Device:	TC4426:	1.5A Dual MOSFET Driver, Inverting
	TC4427:	1.5A Dual MOSFET Driver, Non-Inverting
	TC4428:	1.5A Dual MOSFET Driver, Complementary
Temperature Range:	C =	0°C to +70°C (PDIP and SOIC only)
	E =	-40°C to +85°C
	V =	-40°C to +125°C
Package:	MF =	Dual, Flat, No-Lead (6X5 mm Body), 8-lead
	MF713 =	Dual, Flat, No-Lead (6X5 mm Body), 8-lead (Tape and Reel)
	OA =	Plastic SOIC, (150 mil Body), 8-lead
	OA713 =	Plastic SOIC, (150 mil Body), 8-lead (Tape and Reel)
	PA =	Plastic DIP (300 mil Body), 8-lead
	UA =	Plastic Micro Small Outline (MSOP), 8-lead
	UA713 =	Plastic Micro Small Outline (MSOP), 8-lead (Tape and Reel)

Examples:

a)	TC4426COA:	1.5A Dual Inverting MOSFET driver, 0°C to +70°C SOIC package.
b)	TC4426EUA:	1.5A Dual Inverting MOSFET driver, -40°C to +85°C. MSOP package.
c)	TC4426EMF:	1.5A Dual Inverting MOSFET driver, -40°C to +85°C, DFN package.
a)	TC4427CPA:	1.5A Dual Non-Inverting MOSFET driver, 0°C to +70°C PDIP package.
b)	TC4427EPA:	1.5A Dual Non-Inverting MOSFET driver, -40°C to +85°C PDIP package.
a)	TC4428COA713:	1.5A Dual Complementary MOSFET driver, 0°C to +70°C, SOIC package, Tape and Reel.
b)	TC4428EMF:	1.5A Dual Complementary, MOSFET driver, -40°C to +85°C DFN package.

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
3. The Microchip Worldwide Site (www.microchip.com)

Please specify which device, revision of silicon and Data Sheet (include Literature #) you are using.

Customer Notification System
Register on our web site (www.microchip.com/cn) to receive the most current information on our products.

NOTES:

Note the following details of the code protection feature on Microchip devices:

- 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.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of their code. Code protection does not mean that we are guaranteeing the product as "unbreakable."

Code protection is constantly evolving. We at Microchip are committed to continuously improving the code protection features of our products. Attempts to break Microchip's code protection feature may be a violation of the Digital Millennium Copyright Act. If such acts allow unauthorized access to your software or other copyrighted work, you may have a right to sue for relief under that Act.

Trademarks

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
ISO/TS 16949:2002

Microchip received ISO/TS-16949:2002 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona and Mountain View, California in October 2003. The Company's quality system processes and procedures are for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, nonvolatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001:2000 certified.

WORLDWIDE SALES AND SERVICE

AMERICAS

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

Atlanta
Alpharetta, GA
Tel: 770-640-0034
Fax: 770-640-0307

Boston
Westborough, MA
Tel: 774-760-0087
Fax: 774-760-0088

Chicago
Itasca, IL
Tel: 630-285-0071
Fax: 630-285-0075

Dallas
Addison, TX
Tel: 972-818-7423
Fax: 972-818-2924

Detroit
Farmington Hills, MI
Tel: 248-538-2250
Fax: 248-538-2260

Kokomo
Kokomo, IN
Tel: 765-864-8360
Fax: 765-864-8387

Los Angeles
Mission Viejo, CA
Tel: 949-462-9523
Fax: 949-462-9608

San Jose
Mountain View, CA
Tel: 650-215-1444
Fax: 650-961-0286

Toronto
Mississauga, Ontario,
Canada
Tel: 905-673-0699
Fax: 905-673-6509

ASIA/PACIFIC

Australia - Sydney
Tel: 61-2-9868-6733
Fax: 61-2-9868-6755

China - Beijing
Tel: 86-10-8528-2100
Fax: 86-10-8528-2104

China - Chengdu
Tel: 86-28-8676-6200
Fax: 86-28-8676-6599

China - Fuzhou
Tel: 86-591-8750-3506
Fax: 86-591-8750-3521

China - Hong Kong SAR
Tel: 852-2401-1200
Fax: 852-2401-3431

China - Qingdao
Tel: 86-532-8502-7355
Fax: 86-532-8502-7205

China - Shanghai
Tel: 86-21-5407-5533
Fax: 86-21-5407-5066

China - Shenyang
Tel: 86-24-2334-2829
Fax: 86-24-2334-2393

China - Shenzhen
Tel: 86-755-8203-2660
Fax: 86-755-8203-1760

China - Shunde
Tel: 86-757-2839-5507
Fax: 86-757-2839-5571

China - Wuhan
Tel: 86-27-5980-5300
Fax: 86-27-5980-5118

China - Xian
Tel: 86-29-8833-7250
Fax: 86-29-8833-7256

ASIA/PACIFIC

India - Bangalore
Tel: 91-80-2229-0061
Fax: 91-80-2229-0062

India - New Delhi
Tel: 91-11-5160-8631
Fax: 91-11-5160-8632

India - Pune
Tel: 91-20-2566-1512
Fax: 91-20-2566-1513

Japan - Yokohama
Tel: 81-45-471- 6166
Fax: 81-45-471-6122

Korea - Gumi
Tel: 82-54-473-4301
Fax: 82-54-473-4302

Korea - Seoul
Tel: 82-2-554-7200
Fax: 82-2-558-5932 or
82-2-558-5934

Malaysia - Penang
Tel: 60-4-646-8870
Fax: 60-4-646-5086

Philippines - Manila
Tel: 63-2-634-9065
Fax: 63-2-634-9069

Singapore
Tel: 65-6334-8870
Fax: 65-6334-8850

Taiwan - Hsin Chu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

Taiwan - Kaohsiung
Tel: 886-7-536-4818
Fax: 886-7-536-4803

Taiwan - Taipei
Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham
Tel: 44-118-921-5869
Fax: 44-118-921-5820

10/31/05