



MICROCHIP TC4426A/TC4427A/TC4428A

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 – 30 ns (typ.)
- Matched Rise, Fall and Delay Times
- Low Supply Current:
 - With Logic '1' Input – 1 mA (typ.)
 - With Logic '0' Input – 100 μ A (typ.)
- Low Output Impedance – 7 Ω (typ.)
- Latch-Up Protected: Will Withstand 0.5A Reverse Current
- Input Will Withstand Negative Inputs Up to 5V
- ESD Protected – 4 kV
- Pin-compatible with TC426/TC427/TC428 and TC4426/TC4427/TC4428
- Space-saving 8-Pin MSOP and 8-Pin 6x5 DFN Packages

Applications

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

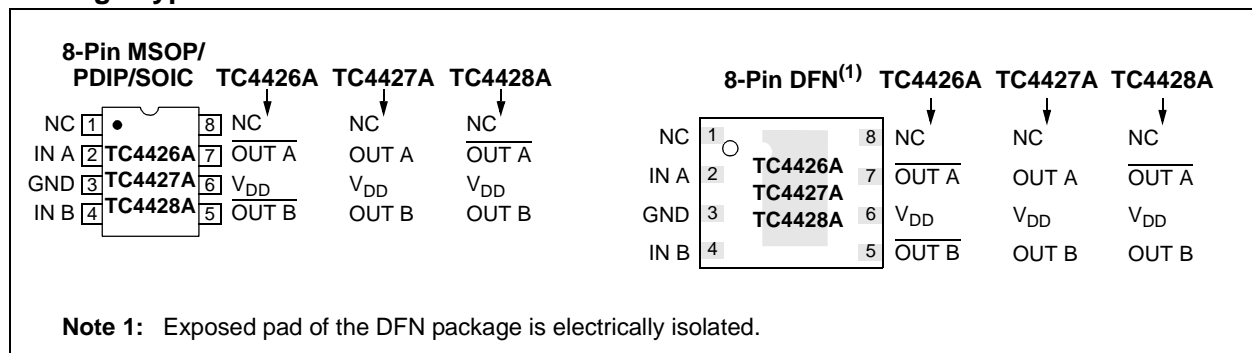
General Description

The TC4426A/TC4427A/TC4428A are improved versions of the earlier TC4426/TC4427/TC4428 family of MOSFET drivers. In addition to matched rise and fall times, the TC4426A/TC4427A/TC4428A devices have matched leading and falling edge propagation delay times.

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.

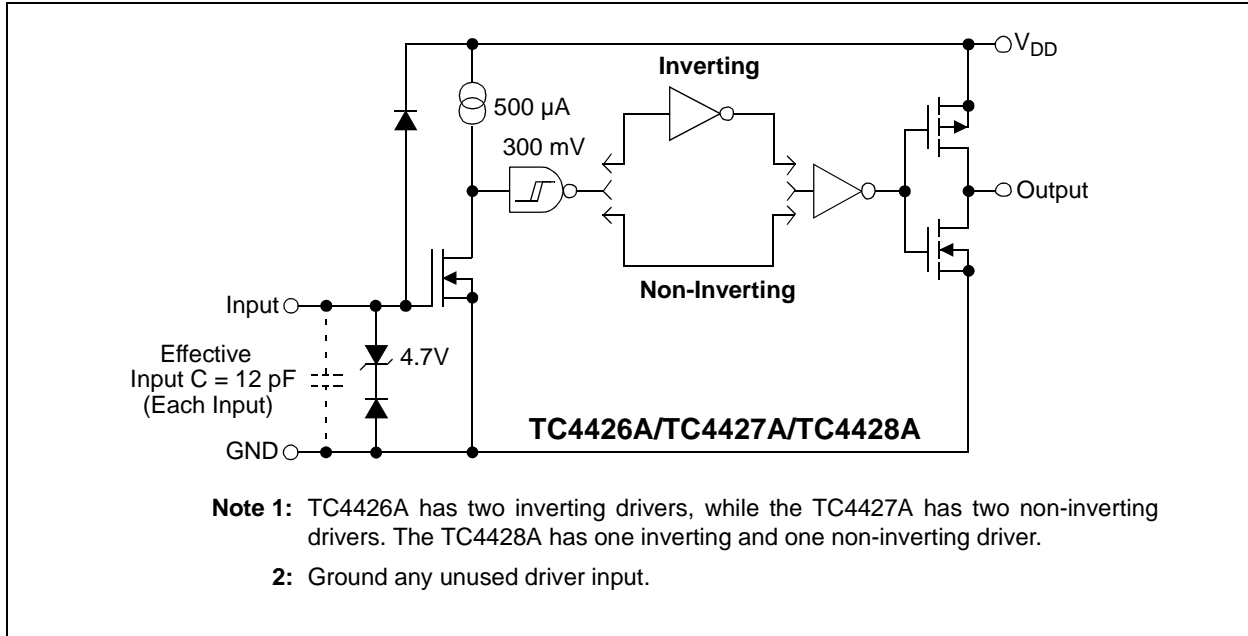
The TC4426A/TC4427A/TC4428A MOSFET drivers can easily charge/discharge 1000 pF gate capacitances in under 30 ns. These devices provide low enough impedances in both the on and off states to ensure the MOSFET's intended state will not be affected, even by large transients.

Package Types



TC4426A/TC4427A/TC4428A

Functional Block Diagram



TC4426A/TC4427A/TC4428A

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 ≤ 70°C)	
DFN	Note 2
MSOP	340 mW
PDIP	730 mW
SOIC	470 mW

† **Notice:** 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, 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}	-1.0 -10	— —	+1.0 +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	— — — —	7 7 8 8	9 10 11 12	Ω	I _{OUT} = 10 mA, V _{DD} = 18V, T _A = +25°C 0°C ≤ T _A ≤ +70°C -40°C ≤ T _A ≤ +85°C -40°C ≤ T _A ≤ +125°C
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 μsec V _{DD} = 18V
Switching Time (Note 1)						
Rise Time	t _R	— — — —	25 27 29 30	35 40 40 40	ns	T _A = +25°C 0°C ≤ T _A ≤ +70°C -40°C ≤ T _A ≤ +85°C -40°C ≤ T _A ≤ +125°C, Figure 4-1
Fall Time	t _F	— — — —	25 27 29 30	35 40 40 40	ns	T _A = +25°C 0°C ≤ T _A ≤ +70°C -40°C ≤ T _A ≤ +85°C -40°C ≤ T _A ≤ +125°C, Figure 4-1
Delay Time	t _{D1}	— — — —	30 33 35 38	35 40 45 50	ns	T _A = +25°C 0°C ≤ T _A ≤ +70°C -40°C ≤ T _A ≤ +85°C -40°C ≤ T _A ≤ +125°C, Figure 4-1
Delay Time	t _{D2}	— — — —	30 33 35 38	35 40 45 50	ns	T _A = +25°C 0°C ≤ T _A ≤ +70°C -40°C ≤ T _A ≤ +85°C -40°C ≤ T _A ≤ +125°C, Figure 4-1
Power Supply						
Power Supply Current	I _S	— —	1.0 0.1	2.0 0.2	mA	V _{IN} = 3V (Both inputs) V _{IN} = 0V (Both inputs), V _{DD} = 18V

- Note 1:** Switching times ensured by design.
Note 2: Package power dissipation is dependent on the copper pad area on the PCB.

TC4426A/TC4427A/TC4428A

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	°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	

TC4426A/TC4427A/TC4428A

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, over operating temperature range with $4.5V \leq V_{DD} \leq 18V$.

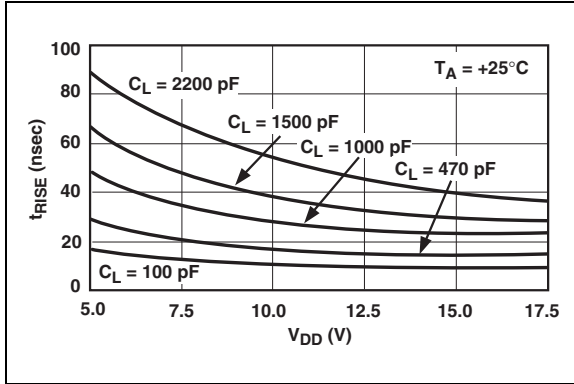


FIGURE 2-1: Rise Time vs. Supply Voltage.

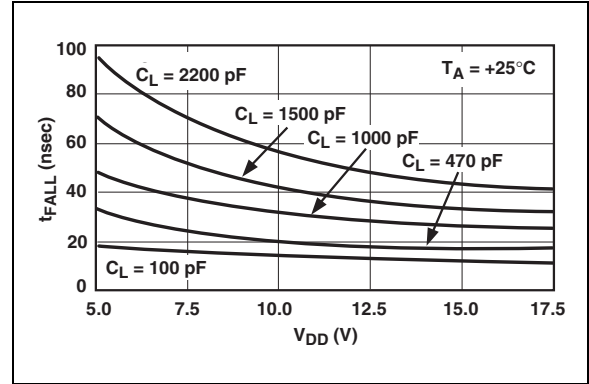


FIGURE 2-4: Fall Time vs. Supply Voltage.

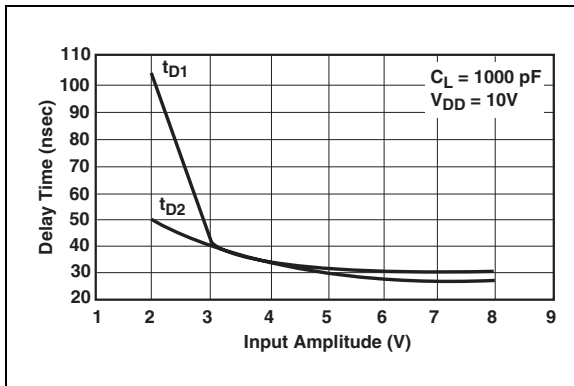


FIGURE 2-2: Delay Time vs. Input Amplitude.

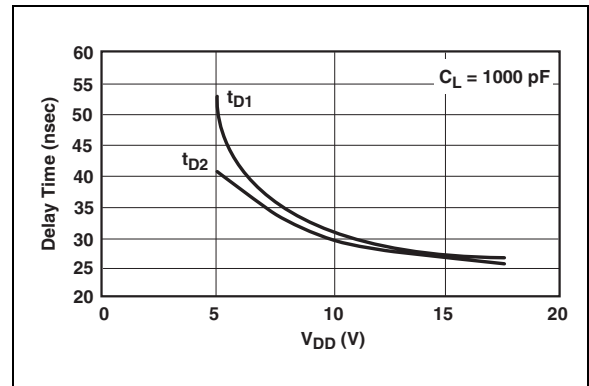


FIGURE 2-5: Propagation Delay Time vs. Supply Voltage.

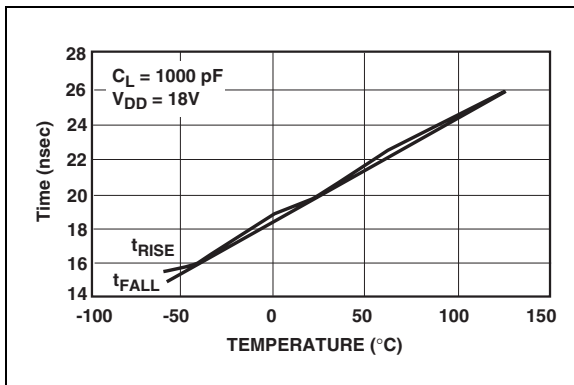


FIGURE 2-3: Rise and Fall Times vs. Temperature.

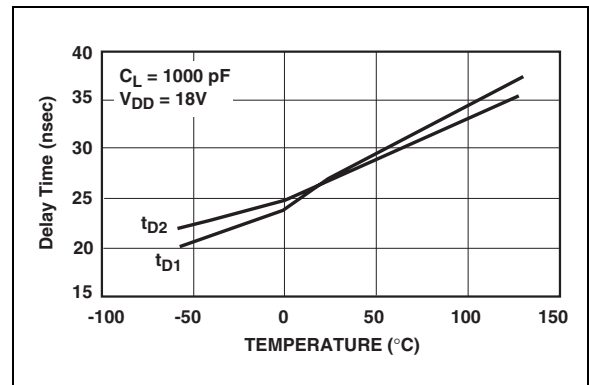


FIGURE 2-6: Propagation Delay Time vs. Temperature.

TC4426A/TC4427A/TC4428A

Note: Unless otherwise indicated, over operating temperature range with $4.5V \leq V_{DD} \leq 18V$.

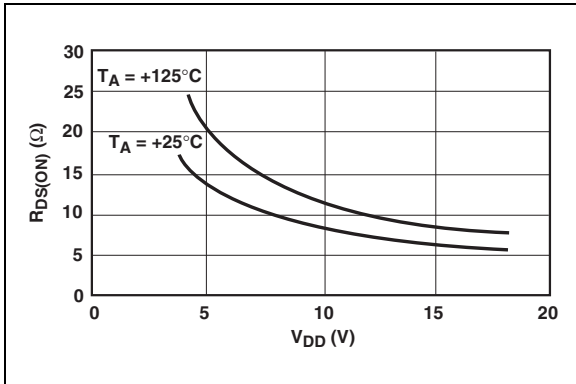


FIGURE 2-7: High-State Output Resistance.

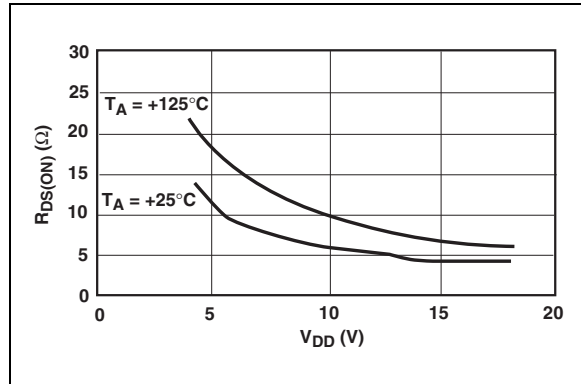


FIGURE 2-10: Low-State Output Resistance.

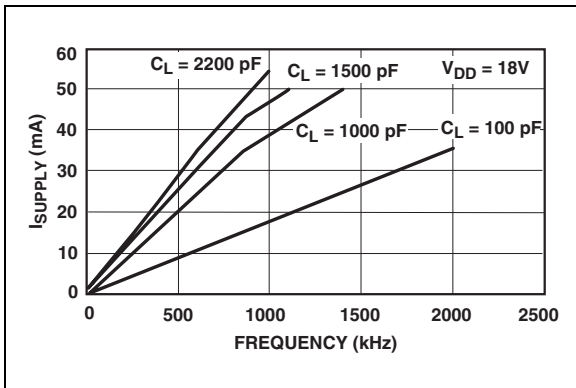


FIGURE 2-8: Supply Current vs. Frequency.

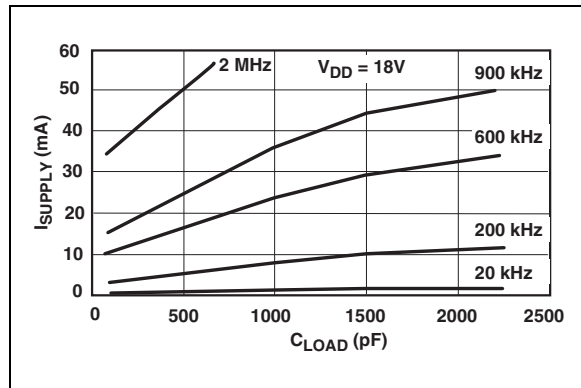


FIGURE 2-11: Supply Current vs. Capacitive Load.

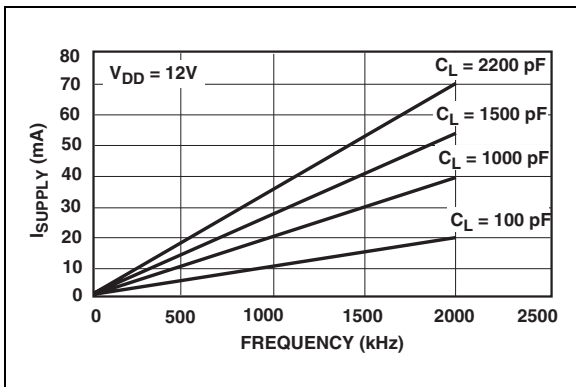


FIGURE 2-9: Supply Current vs. Frequency.

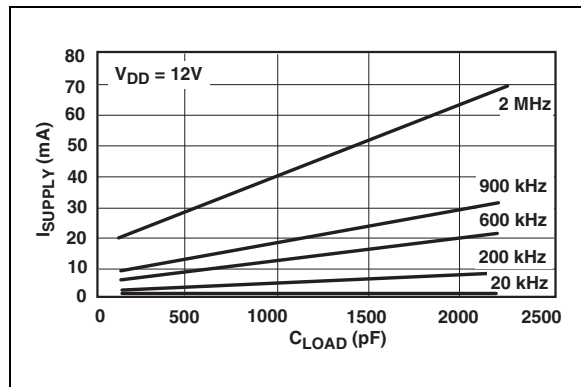


FIGURE 2-12: Supply Current vs. Capacitive Load.

TC4426A/TC4427A/TC4428A

Note: Unless otherwise indicated, over operating temperature range with $4.5V \leq V_{DD} \leq 18V$.

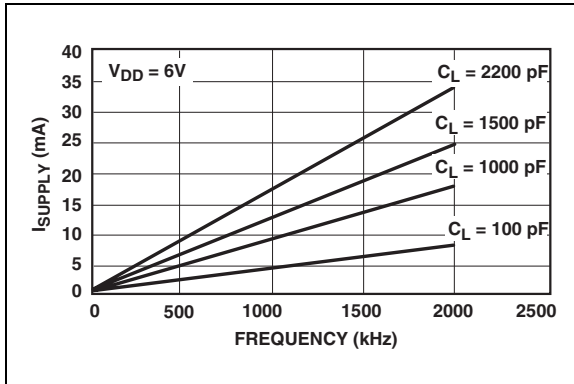


FIGURE 2-13: Supply Current vs. Frequency.

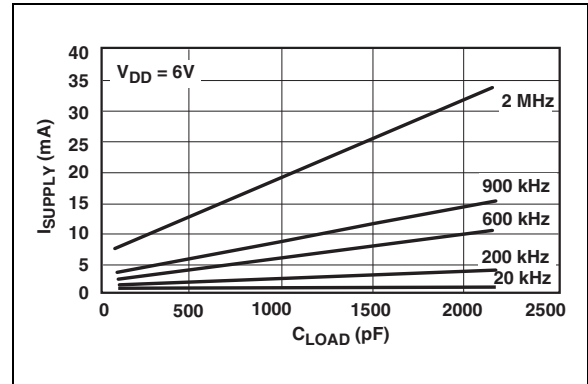


FIGURE 2-15: Supply Current vs. Capacitive Load.

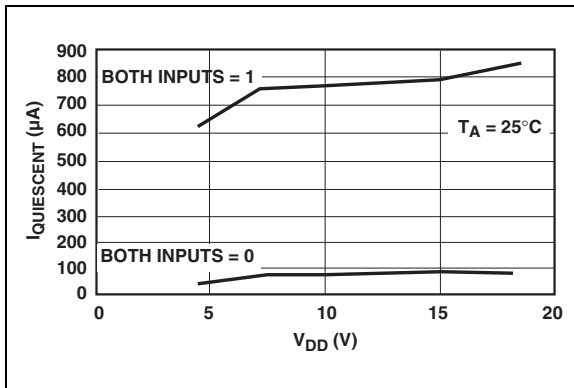


FIGURE 2-14: Quiescent Supply Current vs. Voltage.

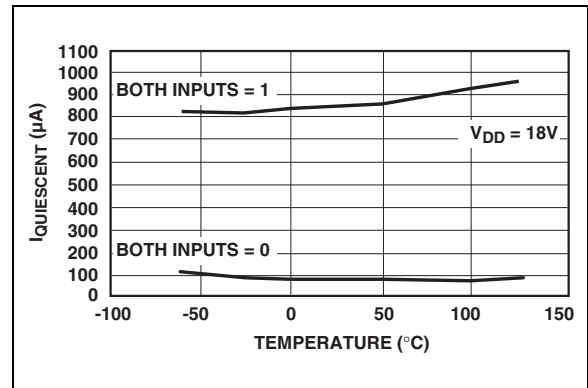


FIGURE 2-16: Quiescent Supply Current vs. Temperature.

TC4426A/TC4427A/TC4428A

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

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)

The ground pin is the return path for both the bias current and the high peak current that discharges the external load capacitance. The ground pin should be tied into a ground plane or have a very short trace to the bias supply source return.

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.

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.

TC4426A/TC4427A/TC4428A

4.0 APPLICATIONS INFORMATION

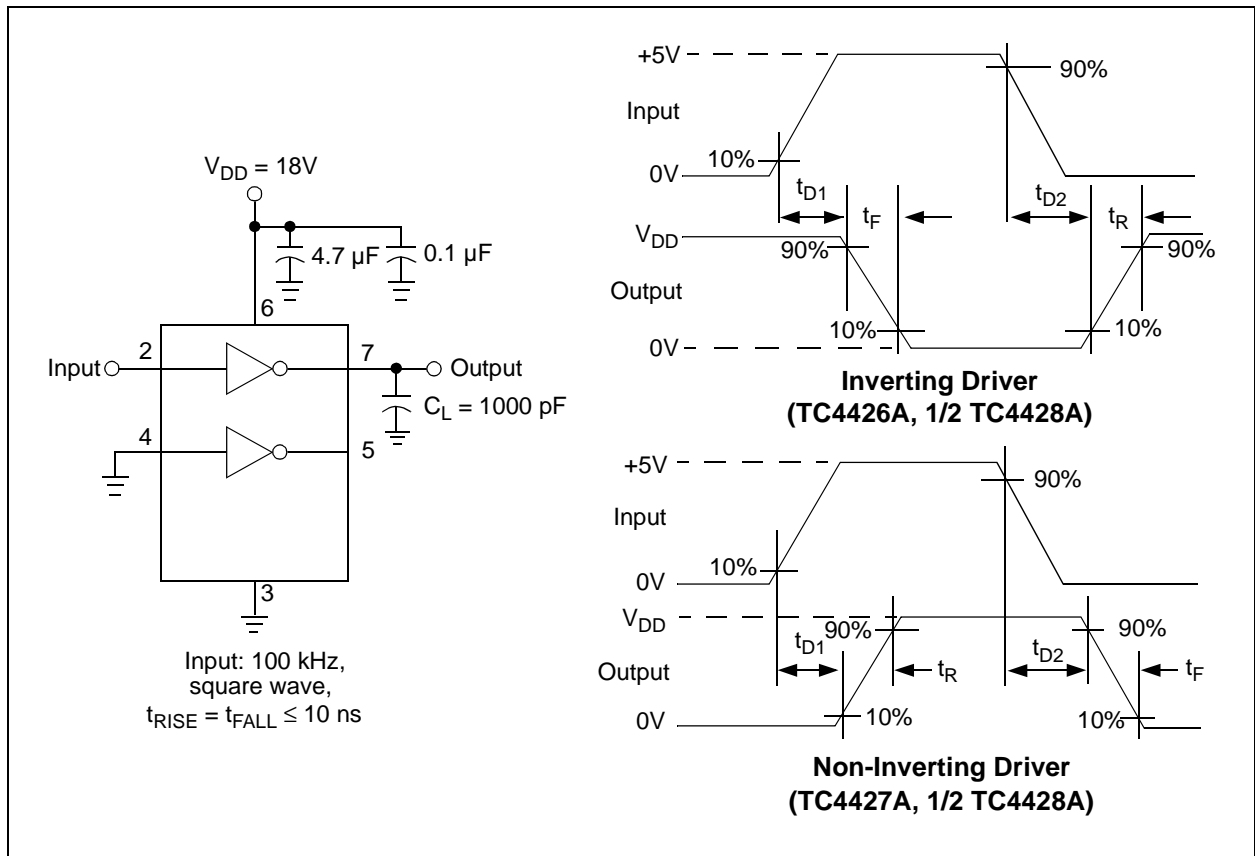


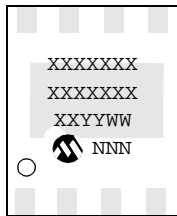
FIGURE 4-1: Switching Time Test Circuit.

TC4426A/TC4427A/TC4428A

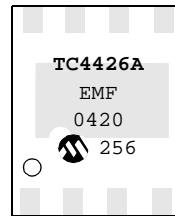
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

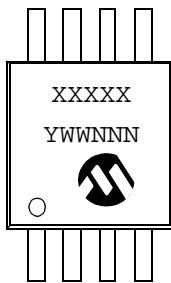
8-Lead DFN



Example:



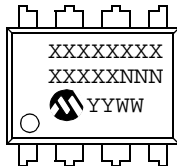
8-Lead MSOP



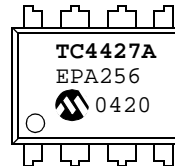
Example:



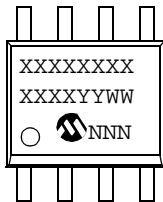
8-Lead PDIP (300 mil)



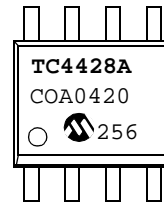
Example:



8-Lead SOIC (150 mil)



Example:

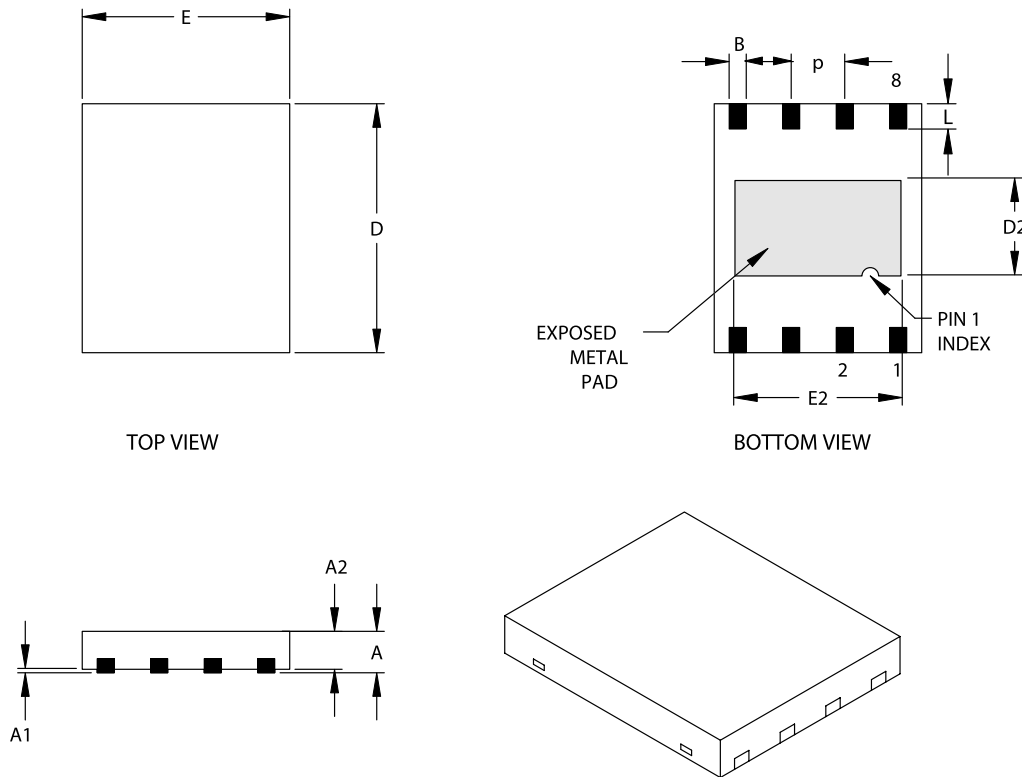


Legend:	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
Note:	In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line thus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

* Standard marking consists of Microchip part number, year code, week code, traceability code (facility code, mask rev#, and assembly code).

TC4426A/TC4427A/TC4428A

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



Dimension Limits	Units	INCHES			MILLIMETERS*		
		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:

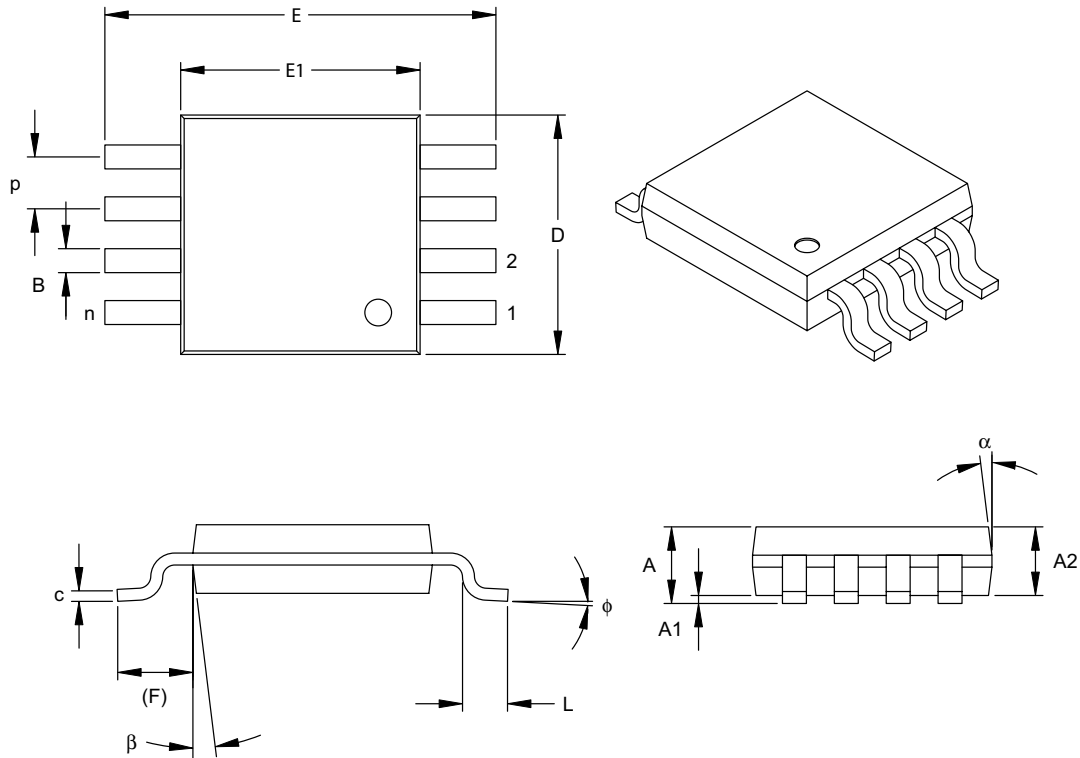
JEDEC equivalent: MO-220

Drawing No. C04-122

Revised 11/3/03

TC4426A/TC4427A/TC4428A

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



Dimension Limits	Units	INCHES			MILLIMETERS*		
		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 TYP.			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:

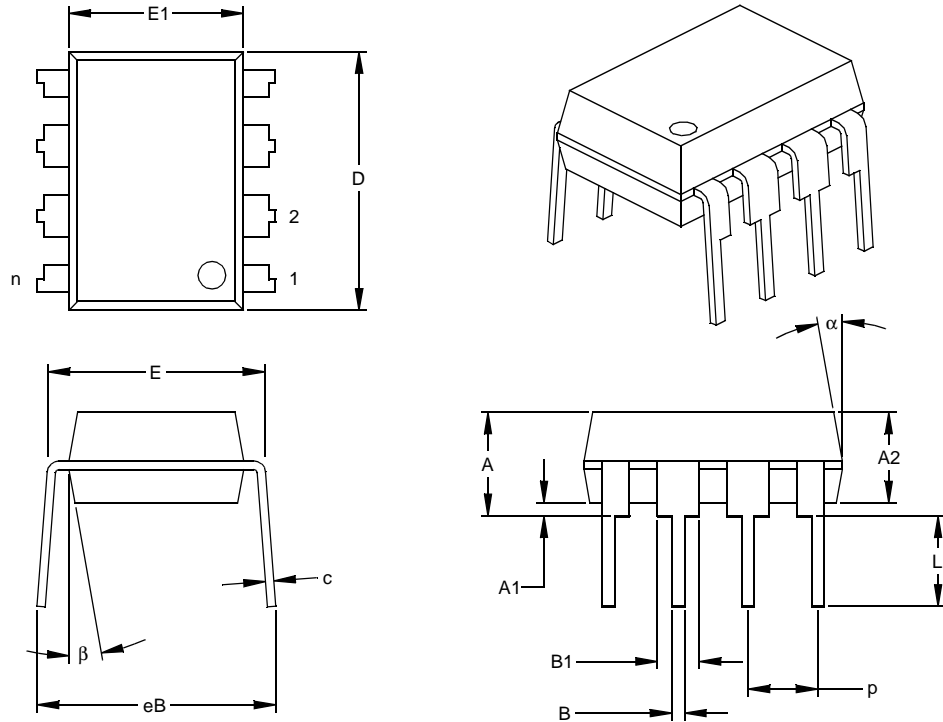
Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" (0.254mm) per side.

JEDEC Equivalent: MO-187

Drawing No. C04-111

TC4426A/TC4427A/TC4428A

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



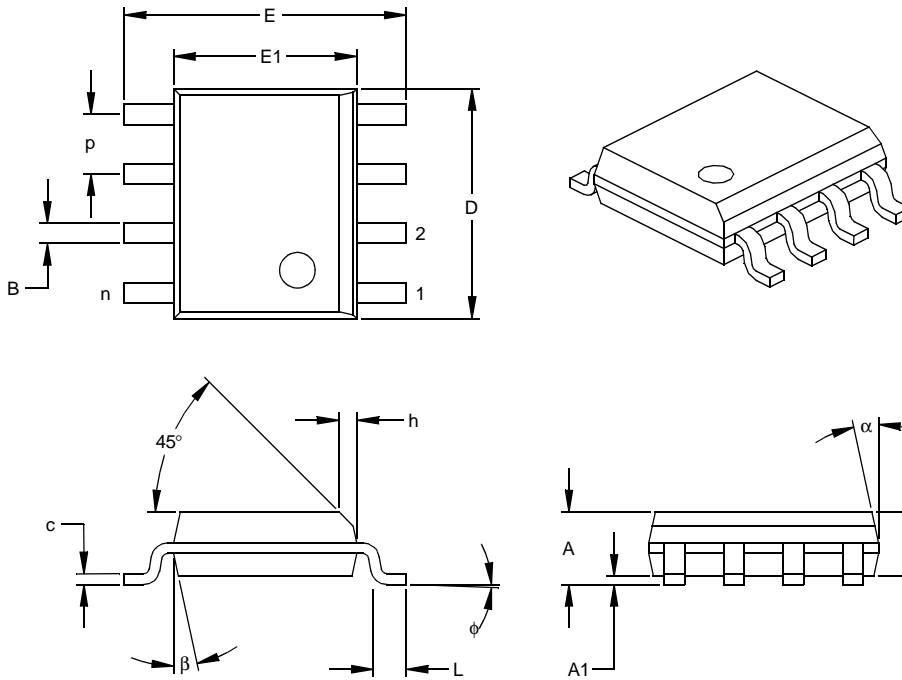
Dimension Limits	Units	INCHES*			MILLIMETERS		
		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300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

TC4426A/TC4427A/TC4428A

8-Lead Plastic Small Outline (OA) – Narrow, 150 mil (SOIC)



Dimension Limits	Units	INCHES*			MILLIMETERS		
		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

TC4426A/TC4427A/TC4428A

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>	<u>XXX</u>	<u>X</u>	Examples:
Device	Temperature Range	Package	Tape & Reel	PB Free	
Device:	TC4426A: 1.5A Dual MOSFET Driver, Inverting TC4427A: 1.5A Dual MOSFET Driver, Non-Inverting TC4428A: 1.5A Dual MOSFET Driver, Complementary				a) TC4426ACOA: 1.5A Dual Inverting MOSFET driver, 0°C to +70°C, 8LD SOIC package.
Temperature Range:	C = 0°C to +70°C (PDIP & SOIC Only) E = -40°C to +85°C V = -40°C to +125°C				b) TC4426AEOA: 1.5A Dual Inverting MOSFET driver, -40°C to +85°C, 8LD SOIC package. c) TC4426AEMF: 1.5A Dual Inverting MOSFET driver, -40°C to +85°C, 8LD DFN package.
Package:	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 OA = Plastic SOIC, (150 mil Body), 8-lead OA713 = Plastic SOIC, (150 mil Body), 8-lead (Tape and Reel) UA = Plastic Micro Small Outline (MSOP), 8-lead UA713 = Plastic Micro Small Outline (MSOP), 8-lead (Tape and Reel)				a) TC4427ACPA: 1.5A Dual Non-Inverting MOSFET driver, 0°C to +70°C, 8LD PDIP package. b) TC4427AEPA: 1.5A Dual Non-Inverting MOSFET driver, -40°C to +85°C, 8LD PDIP package. c) TC4427AVMF713: 1.5A Dual Non-Inverting MOSFET driver, -40°C to +125°C, 8LD DFN package, Tape and Reel.
PB Free:	G = Lead-Free device * = Blank				a) TC4428AEPA: 1.5A Dual Complementary MOSFET driver, -40°C to +85°C, 8LD PDIP package. b) TC4428ACOA713: 1.5A Dual Complementary MOSFET driver, 0°C to +70°C, 8LD SOIC package, Tape and Reel. c) TC4428AVMF: 1.5A Dual Complementary MOSFET driver, -40°C to +125°C, 8LD DFN package.
* Available on selected packages. Contact your local sales representative for availability.					

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.

TC4426A/TC4427A/TC4428A

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.

Information contained in this publication regarding device applications and the like is intended through suggestion only and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. No representation or warranty is given and no liability is assumed by Microchip Technology Incorporated with respect to the accuracy or use of such information, or infringement of patents or other intellectual property rights arising from such use or otherwise. Use of Microchip's products as critical components in life support systems is not authorized except with express written approval by Microchip. No licenses are conveyed, implicitly or otherwise, under any intellectual property rights.

Trademarks

The Microchip name and logo, the Microchip logo, Accuron, dsPIC, KEELOQ, microID, MPLAB, PIC, PICmicro, PICSTART, PRO MATE, PowerSmart, rfPIC, and SmartShunt are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AmpLab, FilterLab, MXDEV, MXLAB, PICMASTER, SEEVAL, SmartSensor and The Embedded Control Solutions Company are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Application Maestro, dsPICDEM, dsPICDEM.net, dsPICworks, ECAN, ECONOMONITOR, FanSense, FlexROM, fuzzyLAB, In-Circuit Serial Programming, ICSP, ICEPIC, Migratable Memory, MPASM, MPLIB, MPLINK, MPSIM, PICkit, PICDEM, PICDEM.net, PICLAB, PICtail, PowerCal, PowerInfo, PowerMate, PowerTool, rLAB, rfPICDEM, Select Mode, Smart Serial, SmartTel and Total Endurance are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

All other trademarks mentioned herein are property of their respective companies.

© 2004, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

 Printed on recycled paper.

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:
480-792-7627
Web Address:
www.microchip.com

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

Boston
Westford, MA
Tel: 978-692-3848
Fax: 978-692-3821

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: 86-591-750-3506
Fax: 86-591-750-3521

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

China - Shanghai
Tel: 86-21-6275-5700
Fax: 86-21-6275-5060

China - Shenzhen
Tel: 86-755-8290-1380
Fax: 86-755-8295-1393

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

China - Qingdao
Tel: 86-532-502-7355
Fax: 86-532-502-7205

ASIA/PACIFIC

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

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

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

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

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

Taiwan - Kaohsiung
Tel: 886-7-536-4816
Fax: 886-7-536-4817

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

Taiwan - Hsinchu
Tel: 886-3-572-9526
Fax: 886-3-572-6459

EUROPE

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

Denmark - Ballerup
Tel: 45-4420-9895
Fax: 45-4420-9910

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

Germany - Ismaning
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

England - Berkshire
Tel: 44-118-921-5869
Fax: 44-118-921-5820

08/24/04