TC429

6A Single High-Speed, CMOS Power MOSFET Driver

Features

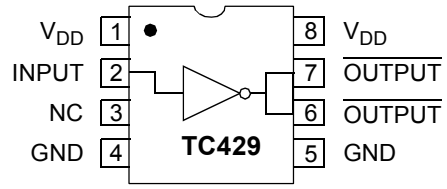
- High Peak Output Current: 6A
- Wide Input Supply Voltage Operating Range:
  - 7V to 18V
- High-Impedance CMOS Logic Input
- Logic Input Threshold Independent of Supply Voltage
- Low Supply Current:
  - With Logic '1' Input – 5 mA max.
  - With Logic '0' Input – 0.5 mA max.
- Output Voltage Swing Within 25 mV of Ground or V_{DD}
- Short Delay Time: 75 nsec max
- Available in the Space-Saving 8-Pin SOIC Package.
- High Capacitive Load Drive Capability:
  - t_{RISE}, t_{FALL} = 35 nsec max with C_{LOAD} = 2500 pF

Applications

- Switch-Mode Power Supplies
- CCD Drivers
- Pulse Transformer Drive
- Class D Switching Amplifiers

Package Types

CERDIP/PDIP/SOIC



NC = No Internal Connection
Note: Duplicate pins must both be connected for proper operation.

General Description

The TC429 is a high-speed, single output, CMOS-level translator and driver. Designed specifically to drive highly capacitive power MOSFET gates, the TC429 features a 2.5Ω output impedance and 6A peak output current drive.

A 2500 pF capacitive load will be driven to 18V in 25 nsec. The rapid switching times with large capacitive loads minimize MOSFET switching power losses.

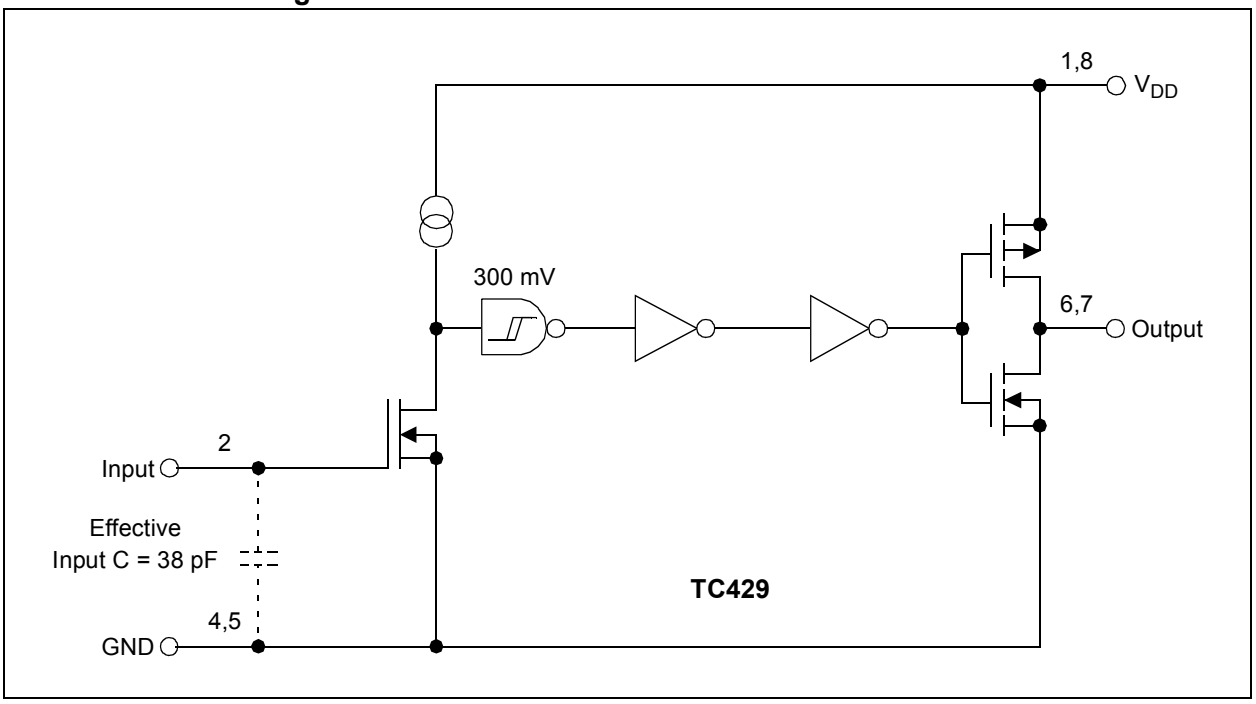
A TTL/CMOS input logic level is translated into an output voltage swing that equals the supply voltage and will swing to within 25 mV of ground or V_{DD}. Input voltage swing may equal the supply voltage. Logic input current is under 10 µA, making direct interface to CMOS/bipolar switch-mode power supply controllers easy. Input "speed-up" capacitors are not required.

The CMOS design minimizes quiescent power supply current. With a logic '1' input, power supply current is 5 mA maximum and decreases to 0.5 mA for logic '0' inputs.

For dual output MOSFET drivers, see the TC426/TC427/TC428 (DS21415), TC4426/TC4427/TC4428 (DS21422) and TC4426A/TC4427A/TC4428A (DS21423) data sheets.

For non-inverting applications, or applications requiring latch-up protection, see the TC4420/TC4429 (DS21419) data sheet.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage ..... +20V

Input Voltage, Any Terminal ..... V_{DD} + 0.3V to GND – 0.3V

Power Dissipation ($T_A \leq 70°C$)

PDIP ..... 730 mW

CERDIP ..... 800 mW

SOIC ..... 470 mW

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

Maximum Junction Temperature, T_J ..... +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

Symbol	Description
V_{DD}	Supply input, 7V to 18V
INPUT	Control input. TTL/CMOS compatible logic input
NC	No connection
GND	Ground
GND	Ground
$\overline{\text{OUTPUT}}$	CMOS push-pull, common to pin 7
$\overline{\text{OUTPUT}}$	CMOS push-pull, common to pin 6
V_{DD}	Supply input, 7V to 18V

DC ELECTRICAL CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T_A = +25°C with 7V ≤ V_{DD} ≤ 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 ≤ V_{IN} ≤ V_{DD}
Output						
High Output Voltage	V_{OH}	V_{DD} – 0.025	—	—	V	
Low Output Voltage	V_{OL}	—	—	0.025	V	
Output Resistance	R_O	—	1.8	2.5	Ω	V_{IN} = 0.8V, V_{OUT} = 10 mA, V_{DD} = 18V
		—	1.5	2.5		V_{IN} = 2.4V, V_{OUT} = 10 mA, V_{DD} = 18V
Peak Output Current	I_{PK}	—	6.0	—	A	V_{DD} = 18V, **Figure 4-4**
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	0.5	—	A	Duty cycle ≤ 2%, t ≤ 300 µsec, V_{DD} = 16V
Switching Time (Note 1)						
Rise Time	t_R	—	23	35	nsec	C_L = 2500 pF, **Figure 4-1**
Fall Time	t_F	—	25	35	nsec	C_L = 2500 pF, **Figure 4-1**
Delay Time	t_{D1}	—	53	75	nsec	**Figure 4-1**
Delay Time	t_{D2}	—	60	75	nsec	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	—	3.5	5.0	mA	V_{IN} = 3V
		—	0.3	0.5		V_{IN} = 0V

Note 1: Switching times ensured by design.

DC ELECTRICAL CHARACTERISTICS (CONTINUED)

Electrical Specifications: Unless otherwise noted, over operating temperature range with 7V ≤ 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	
Low Output Voltage	V_{OL}	—	—	0.025	V	
Output Resistance	R_O	—	—	5.0	Ω	V_{IN} = 0.8V, V_{OUT} = 10 mA, V_{DD} = 18V
		—	—	5.0		V_{IN} = 2.4V, V_{OUT} = 10 mA, V_{DD} = 18V
Switching Time (Note 1)						
Rise Time	t_R	—	—	70	nsec	C_L = 2500 pF, **Figure 4-1**
Fall Time	t_F	—	—	70	nsec	C_L = 2500 pF, **Figure 4-1**
Delay Time	t_{D1}	—	—	100	nsec	**Figure 4-1**
Delay Time	t_{D2}	—	—	120	nsec	**Figure 4-1**
Power Supply						
Power Supply Current	I_S	—	—	12	mA	V_{IN} = 3V
		—	—	1.0		V_{IN} = 0V

Note 1: Switching times ensured by design.

TEMPERATURE CHARACTERISTICS

Electrical Specifications: Unless otherwise noted, T_A = +25°C with 7V ≤ V_{DD} ≤ 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	
Maximum Junction Temperature	T_J	—	—	+150	ºC	
Storage Temperature Range	T_A	-65	—	+150	ºC	
Package Thermal Resistances						
Thermal Resistance, 8L-CERDIP	θ_{JA}	—	150	—	ºC/W	
Thermal Resistance, 8L-PDIP	θ_{JA}	—	125	—	ºC/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	155	—	ºC/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 7V ≤ V_{DD} ≤ 18V.

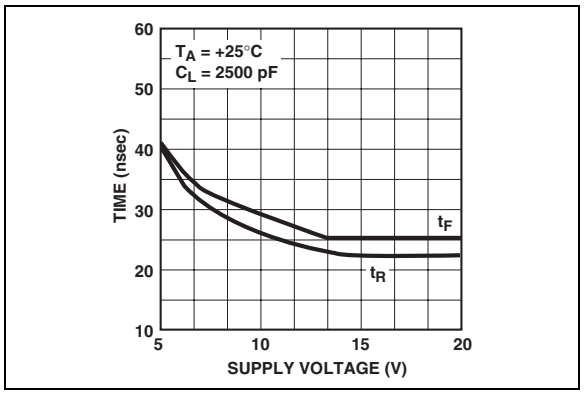


FIGURE 2-1: *Rise/Fall Times vs. Supply Voltage.*

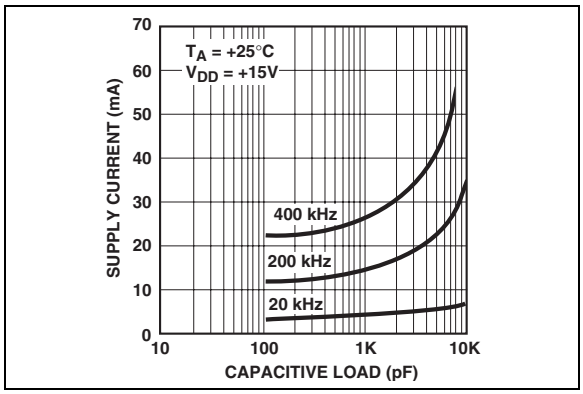


FIGURE 2-4: *Supply Current vs. Capacitive Load.*

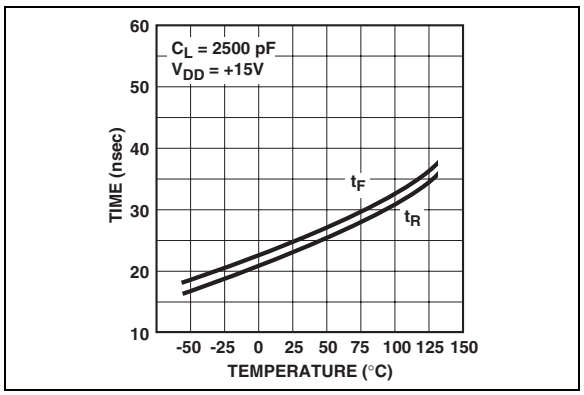


FIGURE 2-2: *Rise/Fall Times vs. Temperature.*

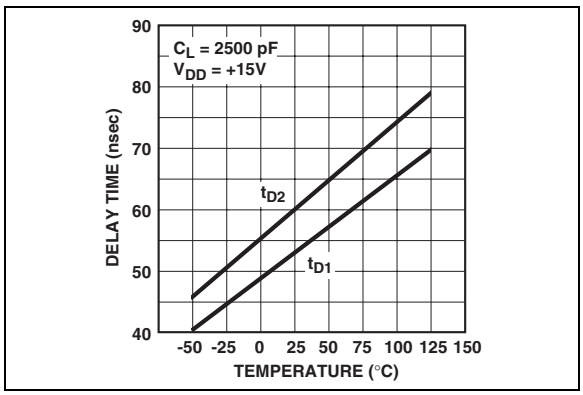


FIGURE 2-5: *Delay Times vs. Temperature.*

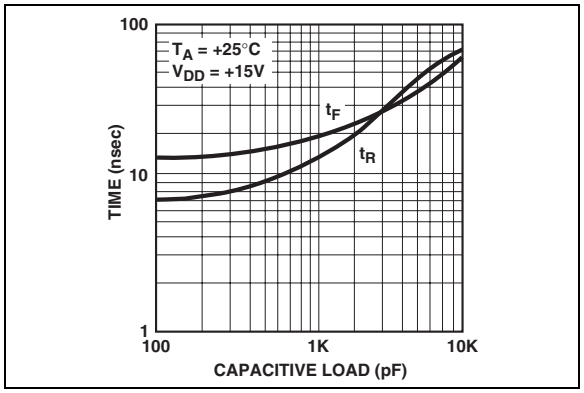


FIGURE 2-3: *Rise/Fall Times vs. Capacitive Load.*

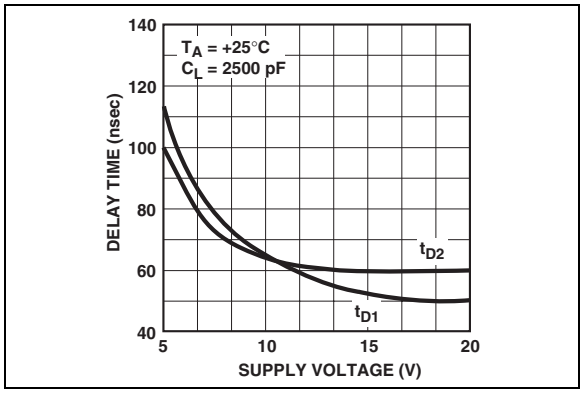


FIGURE 2-6: *Delay Times vs. Supply Voltage.*

Note: Unless otherwise indicated, T_A = +25°C with 7V ≤ V_{DD} ≤ 18V.

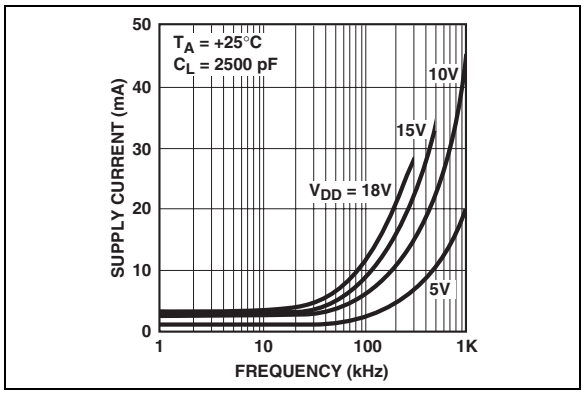


FIGURE 2-7: *Supply Current vs. Frequency.*

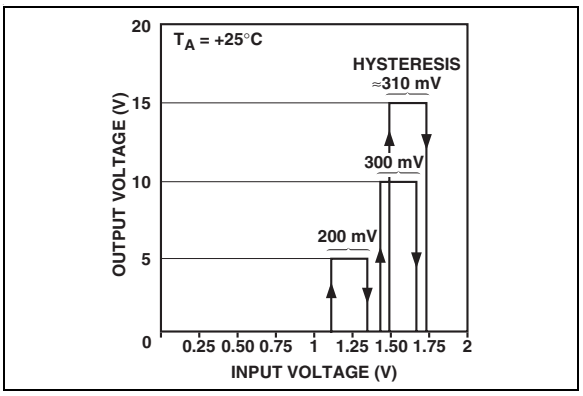


FIGURE 2-10: *Voltage Transfer Characterstics.*

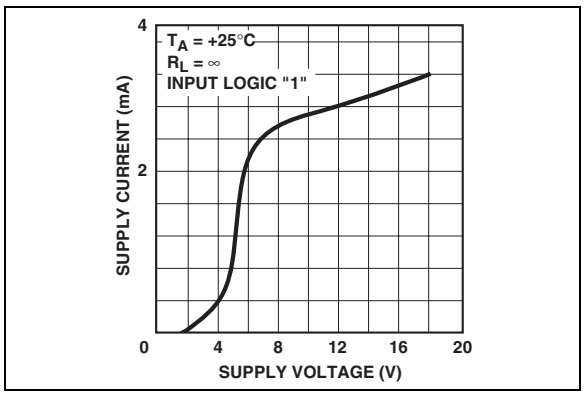


FIGURE 2-8: *Supply Current vs. Supply Voltage.*

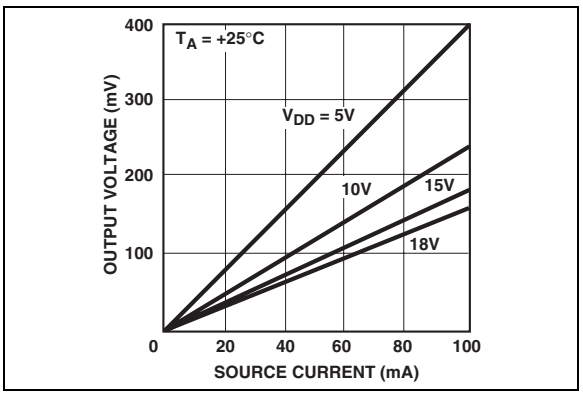


FIGURE 2-11: *High Output Voltage (V_{DD}-V_{OH}) vs. Output Source Current.*

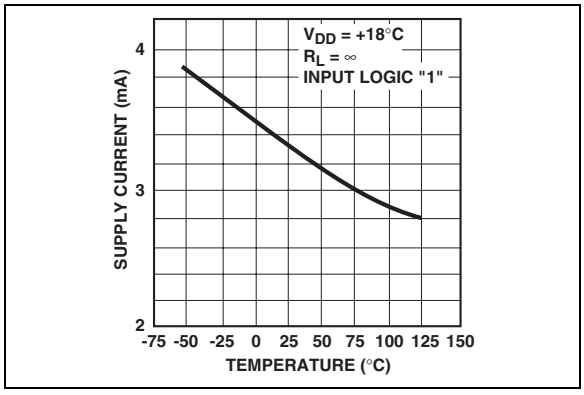


FIGURE 2-9: *Supply Current vs. Temperature.*

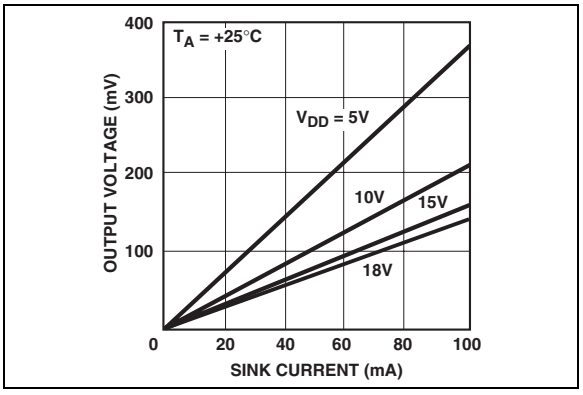


FIGURE 2-12: *Low Output Voltage vs. Output Sink Current.*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

Pin No.	Symbol	Description
1	V_{DD}	Supply input, 7V to 18V
2	INPUT	Control input. TTL/CMOS compatible logic input
3	NC	No connection
4	GND	Ground
5	GND	Ground
6	$\overline{\text{OUTPUT}}$	CMOS push-pull output, common to pin 7
7	$\overline{\text{OUTPUT}}$	CMOS push-pull output, common to pin 6
8	V_{DD}	Supply input, 7V to 18V

3.1 Supply Input (V_{DD})

The V_{DD} input is the bias supply for the MOSFET driver and is rated for 7.0V 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 value of 1.0 µF is suggested.

3.2 Control Input (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 (OUTPUT)

The MOSFET driver output is a low-impedance, CMOS push-pull style output, capable of driving a capacitive load with 6.0A peak currents.

3.4 Ground (GND)

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 No Connect (NC)

No connection.

4.0 APPLICATIONS INFORMATION

4.1 Supply Bypassing

Charging and discharging large capacitive loads quickly requires large currents. For example, charging a 2500 pF load to 18V in 25 nsec requires a 1.8A current from the device's power supply.

To ensure low supply impedance over a wide frequency range, a parallel capacitor combination is recommended for supply bypassing. Low-inductance ceramic disk capacitors with short lead lengths (< 0.5 in.) should be used. A 1 µF film capacitor in parallel with one or two 0.1 µF ceramic disk capacitors normally provides adequate bypassing.

4.2 Grounding

The high-current capability of the TC429 demands careful PC board layout for best performance. Since the TC429 is an inverting driver, any ground lead impedance will appear as negative feedback that can degrade switching speed. The feedback is especially noticeable with slow rise-time inputs, such as those produced by an open-collector output with resistor pull-up. The TC429 input structure includes about 300 mV of hysteresis to ensure clean transitions and freedom from oscillation, but attention to layout is still recommended.

Figure 4-3 shows the feedback effect in detail. As the TC429 input begins to go positive, the output goes negative and several amperes of current flow in the ground lead. A PC trace resistance of as little as 0.05Ω can produce hundreds of millivolts at the TC429 ground pins. If the driving logic is referenced to power ground, the effective logic input level is reduced and oscillations may result.

To ensure optimum device performance, separate ground traces should be provided for the logic and power connections. Connecting logic ground directly to the TC429 GND pins ensures full logic drive to the input and fast output switching. Both GND pins should be connected to power ground.

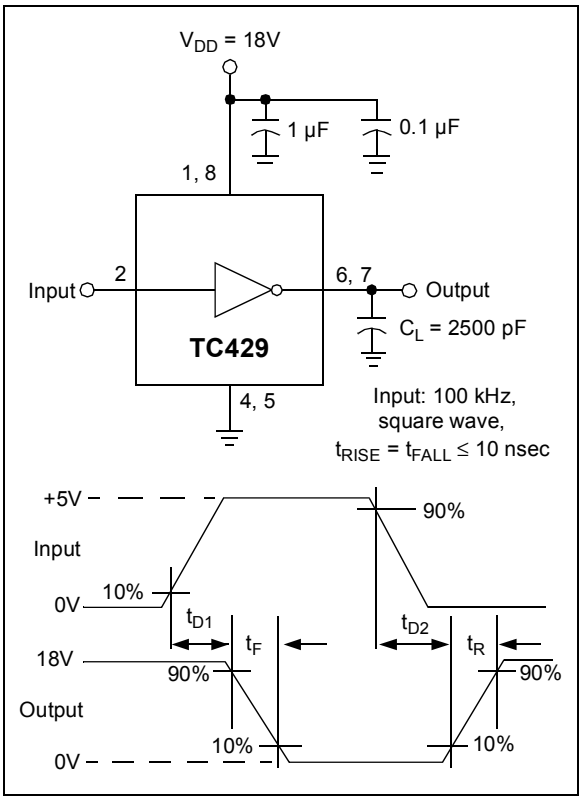


FIGURE 4-1: *Inverting Driver Switching Time Test Circuit.*

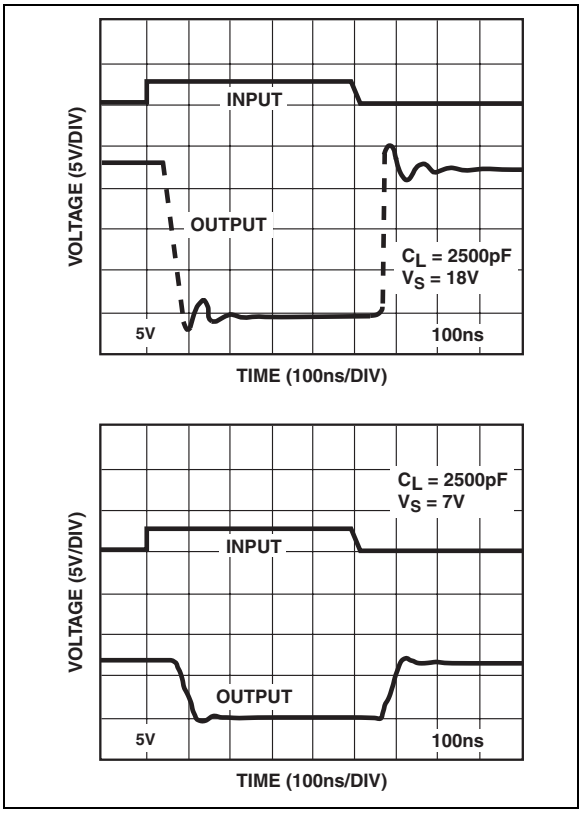


FIGURE 4-2: *Switching Speed.*

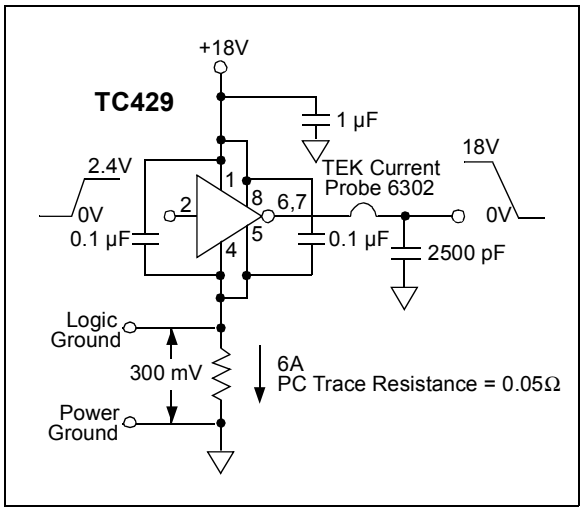


FIGURE 4-3: *Switching Time Degradation Due To Negative Feedback.*

4.3 Input Stage

The input voltage level changes the no-load or quiescent supply current. The N-channel MOSFET input stage transistor drives a 3 mA current source load. With a logic '1' input, the maximum quiescent supply current is 5 mA. Logic '0' input level signals reduce quiescent current to 500 µA maximum.

The TC429 input is designed to provide 300 mV of hysteresis, providing clean transitions and minimizing output stage current spiking when changing states. Input voltage levels are approximately 1.5V, making the device TTL-compatible over the 7V to 18V operating supply range. Input pin current draw is less than 10 µA over this range.

The TC429 can be directly driven by TL494, SG1526/1527, SG1524, SE5560 or similar switch-mode power supply integrated circuits. By off-loading the power-driving duties to the TC429, the power supply controller can operate at lower dissipation, improving performance and reliability.

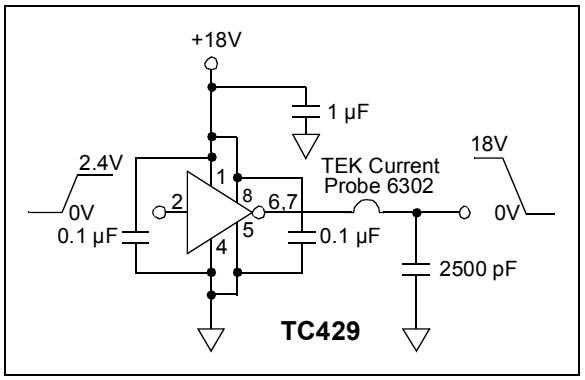


FIGURE 4-4: *Peak Output Current Test Circuit.*

4.4 Power Dissipation

CMOS circuits usually permit the user to ignore power dissipation. Logic families such as the 4000 and 74C have outputs that can only supply a few milliamperes of current, and even shorting outputs to ground will not force enough current to destroy the device. The TC429, however, can source or sink several amperes and drive large capacitive loads at high frequency. Since the package power dissipation limit can easily be exceeded, some attention should be given to power dissipation when driving low-impedance loads and/or operating at high frequency.

The supply current versus frequency and supply current versus capacitive load characteristic curves will aid in determining power dissipation calculations. Table 4-1 lists the maximum operating frequency for several power supply voltages when driving a 2500 pF load. More accurate power dissipation figures can be obtained by summing the three components that make up the total device power dissipation.

Input signal duty cycle, power supply voltage and capacitive load influence package power dissipation. Given power dissipation and package thermal resistance, the maximum ambient operation temperature is easily calculated. The 8-pin CERDIP junction-to-ambient thermal resistance is 150°C/W. At +25°C, the package is rated at 800 mW maximum dissipation. Maximum allowable junction temperature is +150°C.

Three components make up total package power dissipation:

- Capacitive load dissipation (P_C)
- Quiescent power (P_Q)
- Transition power (P_T)

The capacitive load-caused dissipation is a direct function of frequency, capacitive load and supply voltage.

The device capacitive load dissipation is:

EQUATION

$$P_C = fCV_S^2$$

Where:

f = Switching frequency
C = Capacitive load
V_S = Supply voltage

Quiescent power dissipation depends on input signal duty cycle. A logic low input results in a low-power dissipation mode with only 0.5 mA total current drain. Logic-high signals raise the current to 5 mA maximum.

The quiescent power dissipation is:

EQUATION

$$P_Q = V_S(D(I_H) + (1 - D)I_L)$$

Where:

I_H = Quiescent current with input high (5 mA max)
I_L = Quiescent current with input low (0.5 mA max)
D = Duty cycle

Transition power dissipation arises because the output stage N- and P-channel MOS transistors are ON simultaneously for a very short period when the output changes.

The device transition power dissipation is approximately:

EQUATION

$$P_T = fV_S\left(3.3 \times 10^{-9} A \bullet Sec\right)$$

An example shows the relative magnitude for each item.

C = 2500 pF
V_S = 15V
D = 50%
f = 200 kHz
P_D = Package power dissipation:
= $P_C + P_T + P_Q$
= 113 mW + 10 mW + 41 mW
= 164 mW

Maximum ambient operating temperature:
= $T_J - \theta_{JA}(P_D)$
= 150ºC - (150ºC/W)(0.164W)
= 125°C

Where:

T_J = Maximum allowable junction temperature (+150°C)
θ_{JA} = Junction-to-ambient thermal resistance (150°C/W, CERDIP)

Note: Ambient operating temperature should not exceed +85ºC for EPA or EOA devices or +125ºC for MJA devices.

TABLE 4-1: MAXIMUM OPERATING FREQUENCIES

V_S	f_{MAX}
18V	500 kHz
15V	700 kHz
10V	1.3 MHz
5V	>2 MHz

Conditions:

1. CERDIP Package (θ_{JA} =150°C/W)
2. T_A = +25°C
3. C_L = 2500 pF

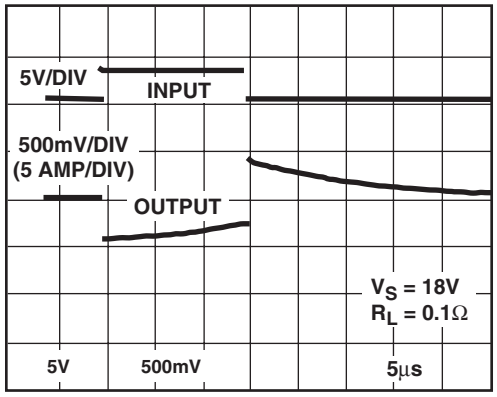


FIGURE 4-5: *Peak Output Current Capability.*

4.5 POWER-ON OSCILLATION

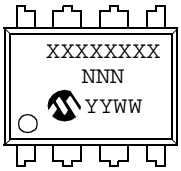
Note: It is extremely important that all MOSFET driver applications be evaluated for the possibility of having high-power oscillations occur during the power-on cycle.

Power-on oscillations are due to trace size, layout and component placement. A 'quick fix' for most applications that exhibit power-on oscillation problems is to place approximately 10 kΩ in series with the input of the MOSFET driver.

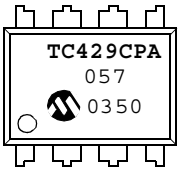
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

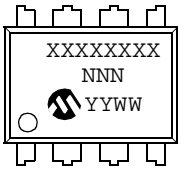
8-Lead PDIP (300 mil)



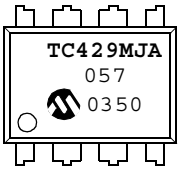
Example:



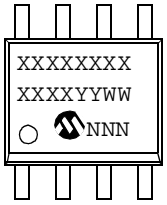
8-Lead CERDIP (300 mil)



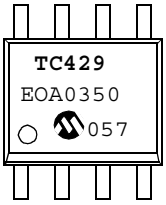
Example:



8-Lead SOIC (150 mil)



Example:

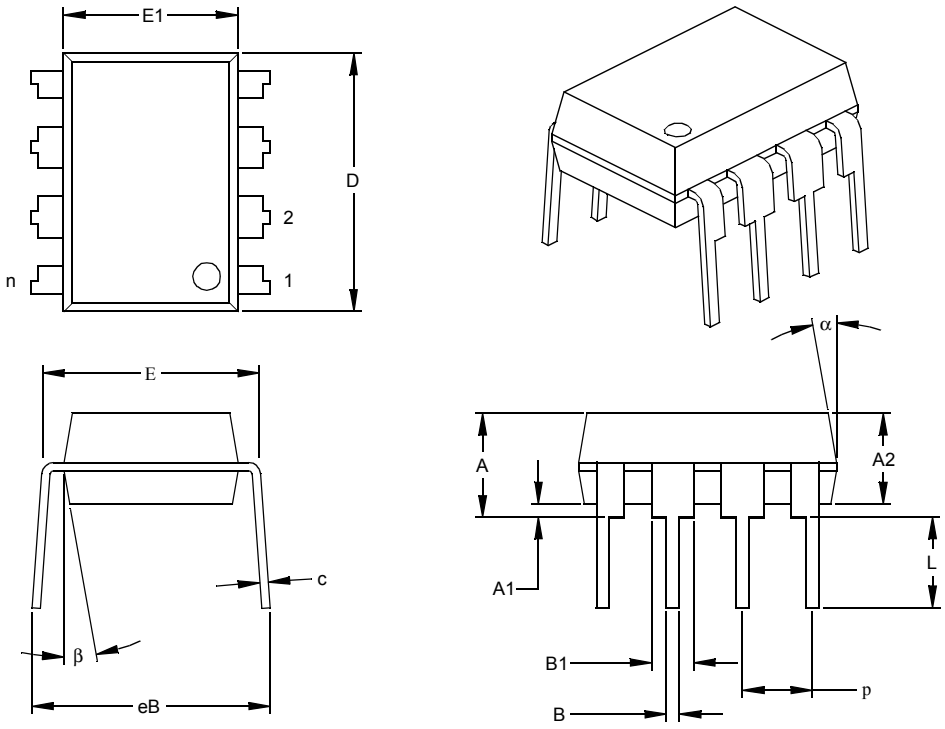


Legend:	XX...X	Customer specific information*
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code

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). For marking beyond this, certain price adders apply. Please check with your Microchip Sales Office.

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

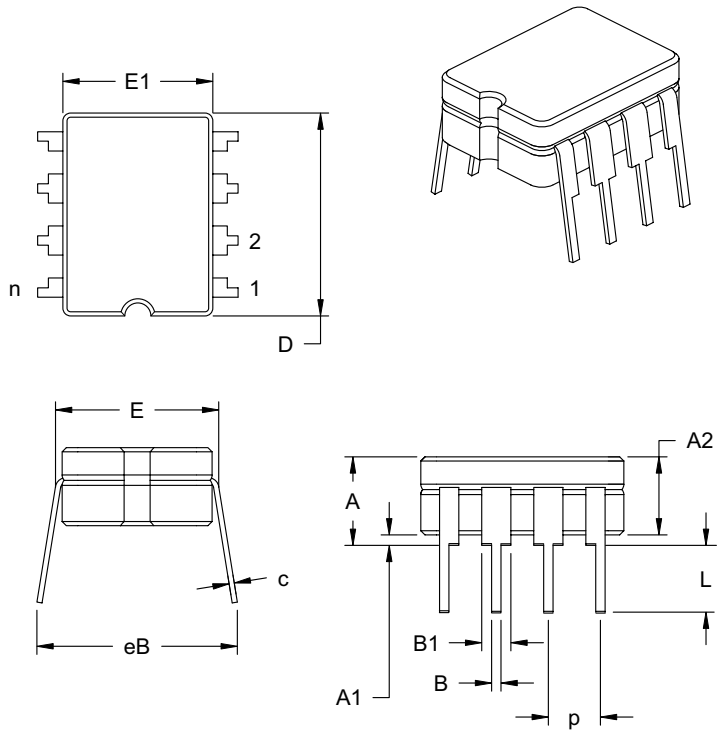


Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.140	.155	.170	3.56	3.94	4.32
Molded Package Thickness	A2	.115	.130	.145	2.92	3.30	3.68
Base to Seating Plane	A1	.015			0.38		
Shoulder to Shoulder Width	E	.300	.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	a	5	10	15	5	10	15
Mold Draft Angle Bottom	b	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 Ceramic Dual In-line – 300 mil (CERDIP)



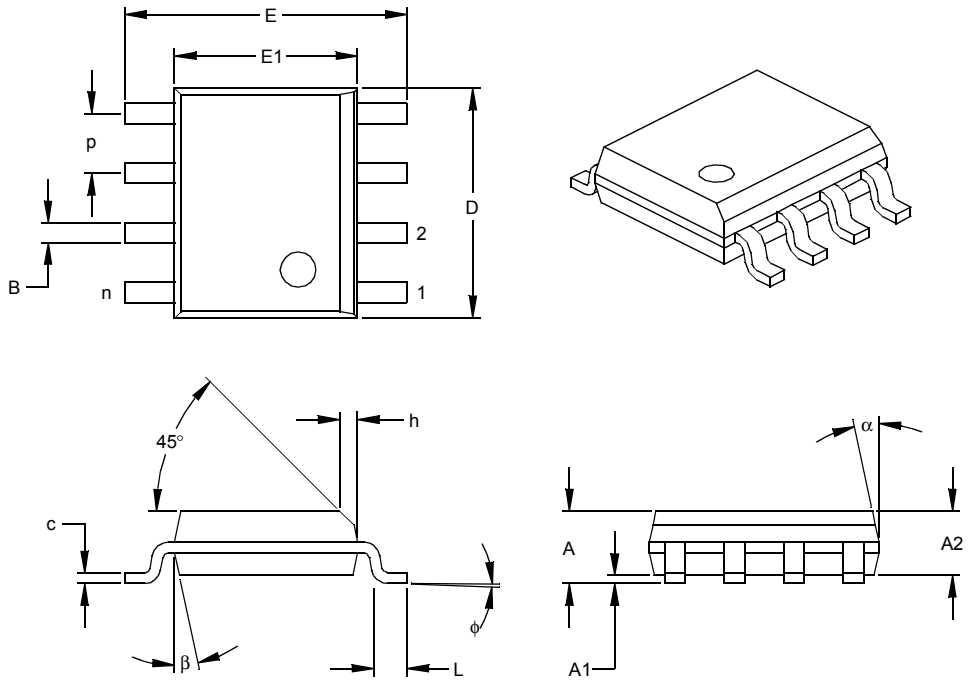
Units		INCHES*			MILLIMETERS		
Dimension Limits		MIN	NOM	MAX	MIN	NOM	MAX
Number of Pins	n		8			8	
Pitch	p		.100			2.54	
Top to Seating Plane	A	.160	.180	.200	4.06	4.57	5.08
Standoff §	A1	.020	.030	.040	0.51	0.77	1.02
Shoulder to Shoulder Width	E	.290	.305	.320	7.37	7.75	8.13
Ceramic Pkg. Width	E1	.230	.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

8-Lead Plastic Small Outline (OA) – 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

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:	TC429:	6A Single MOSFET Driver
Temperature Range:	C =	0°C to +70°C
	E =	-40°C to +85°C
	M =	-55°C to +125°C (CERDIP only)
Package:	JA =	Plastic CERDIP, (300 mil Body), 8-lead
	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

* SOIC package offered in E-Temp only

Examples:

a) TC429CPA: 6A Single MOSFET driver, PDIP package, 0°C to +70°C.

b) TC429MJA: 6A Single MOSFET driver, CERDIP package, -55°C to +125°C.

c) TC429EPA: 6A Single MOSFET driver, PDIP package, -40°C to +85°C.

d) TC429EOA713: Tape and Reel, 6A Single MOSFET driver, SOIC 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
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.

DNV Certification, Inc. USA — ANSI-RAB QMS ACCREDITED — DNV — DNV MSC The Netherlands Accredited by the RvA — ISO 9001 / QS-9000 REGISTERED FIRM

Microchip received QS-9000 quality system certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona in July 1999 and Mountain View, California in March 2002. The Company's quality system processes and procedures are QS-9000 compliant for its PICmicro® 8-bit MCUs, KEELOQ® code hopping devices, Serial EEPROMs, microperipherals, non-volatile memory and analog products. In addition, Microchip's quality system for the design and manufacture of development systems is ISO 9001 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: http://www.microchip.com

Atlanta
3780 Mansell Road, Suite 130
Alpharetta, GA 30022
Tel: 770-640-0034 Fax: 770-640-0307

Boston
2 Lan Drive, Suite 120
Westford, MA 01886
Tel: 978-692-3848 Fax: 978-692-3821

Chicago
333 Pierce Road, Suite 180
Itasca, IL 60143
Tel: 630-285-0071 Fax: 630-285-0075

Dallas
4570 Westgrove Drive, Suite 160
Addison, TX 75001
Tel: 972-818-7423 Fax: 972-818-2924

Detroit
Tri-Atria Office Building
32255 Northwestern Highway, Suite 190
Farmington Hills, MI 48334
Tel: 248-538-2250 Fax: 248-538-2260

Kokomo
2767 S. Albright Road
Kokomo, Indiana 46902
Tel: 765-864-8360 Fax: 765-864-8387

Los Angeles
18201 Von Karman, Suite 1090
Irvine, CA 92612
Tel: 949-263-1888 Fax: 949-263-1338

Phoenix
2355 West Chandler Blvd.
Chandler, AZ 85224-6199
Tel: 480-792-7966 Fax: 480-792-4338

San Jose
Microchip Technology Inc.
2107 North First Street, Suite 590
San Jose, CA 95131
Tel: 408-436-7950 Fax: 408-436-7955

Toronto
6285 Northam Drive, Suite 108
Mississauga, Ontario L4V 1X5, Canada
Tel: 905-673-0699 Fax: 905-673-6509

ASIA/PACIFIC

Australia
Microchip Technology Australia Pty Ltd
Marketing Support Division
Suite 22, 41 Rawson Street
Epping 2121, NSW
Australia
Tel: 61-2-9868-6733 Fax: 61-2-9868-6755

China - Beijing
Microchip Technology Consulting (Shanghai) Co., Ltd., Beijing Liaison Office
Unit 915
Bei Hai Wan Tai Bldg.
No. 6 Chaoyangmen Beidajie
Beijing, 100027, No. China
Tel: 86-10-85282100 Fax: 86-10-85282104

China - Chengdu
Microchip Technology Consulting (Shanghai) Co., Ltd., Chengdu Liaison Office
Rm. 2401-2402, 24th Floor,
Ming Xing Financial Tower
No. 88 TIDU Street
Chengdu 610016, China
Tel: 86-28-86766200 Fax: 86-28-86766599

China - Fuzhou
Microchip Technology Consulting (Shanghai) Co., Ltd., Fuzhou Liaison Office
Unit 28F, World Trade Plaza
No. 71 Wusi Road
Fuzhou 350001, China
Tel: 86-591-7503506 Fax: 86-591-7503521

China - Hong Kong SAR
Microchip Technology Hongkong Ltd.
Unit 901-6, Tower 2, Metroplaza
223 Hing Fong Road
Kwai Fong, N.T., Hong Kong
Tel: 852-2401-1200 Fax: 852-2401-3431

China - Shanghai
Microchip Technology Consulting (Shanghai) Co., Ltd.
Room 701, Bldg. B
Far East International Plaza
No. 317 Xian Xia Road
Shanghai, 200051
Tel: 86-21-6275-5700 Fax: 86-21-6275-5060

China - Shenzhen
Microchip Technology Consulting (Shanghai) Co., Ltd., Shenzhen Liaison Office
Rm. 1812, 18/F, Building A, United Plaza
No. 5022 Binhe Road, Futian District
Shenzhen 518033, China
Tel: 86-755-82901380 Fax: 86-755-82966626

China - Qingdao
Rm. B505A, Fullhope Plaza,
No. 12 Hong Kong Central Rd.
Qingdao 266071, China
Tel: 86-532-5027355 Fax: 86-532-5027205

India
Microchip Technology Inc.
India Liaison Office
Marketing Support Division
Divyasree Chambers
1 Floor, Wing A (A3/A4)
No. 11, O'Shaugnessey Road
Bangalore, 560 025, India
Tel: 91-80-2290061 Fax: 91-80-2290062

Japan
Microchip Technology Japan K.K.
Benex S-1 6F
3-18-20, Shinyokohama
Kohoku-Ku, Yokohama-shi
Kanagawa, 222-0033, Japan
Tel: 81-45-471- 6166 Fax: 81-45-471-6122

Korea
Microchip Technology Korea
168-1, Youngbo Bldg. 3 Floor
Samsung-Dong, Kangnam-Ku
Seoul, Korea 135-882
Tel: 82-2-554-7200 Fax: 82-2-558-5934

Singapore
Microchip Technology Singapore Pte Ltd.
200 Middle Road
#07-02 Prime Centre
Singapore, 188980
Tel: 65-6334-8870 Fax: 65-6334-8850

Taiwan
Microchip Technology (Barbados) Inc., Taiwan Branch
11F-3, No. 207
Tung Hua North Road
Taipei, 105, Taiwan
Tel: 886-2-2717-7175 Fax: 886-2-2545-0139

EUROPE

Austria
Microchip Technology Austria GmbH
Durisolstrasse 2
A-4600 Wels
Austria
Tel: 43-7242-2244-399
Fax: 43-7242-2244-393

Denmark
Microchip Technology Nordic ApS
Regus Business Centre
Lautrup hoj 1-3
Ballerup DK-2750 Denmark
Tel: 45 4420 9895 Fax: 45 4420 9910

France
Microchip Technology SARL
Parc d'Activite du Moulin de Massy
43 Rue du Saule Trapu
Batiment A - ler Etage
91300 Massy, France
Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79

Germany
Microchip Technology GmbH
Steinheilstrasse 10
D-85737 Ismaning, Germany
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy
Microchip Technology SRL
Via Quasimodo, 12
20025 Legnano (MI)
Milan, Italy
Tel: 39-0331-742611 Fax: 39-0331-466781

United Kingdom
Microchip Ltd.
505 Eskdale Road
Winnersh Triangle
Wokingham
Berkshire, England RG41 5TU
Tel: 44 118 921 5869 Fax: 44-118 921-5820

03/25/03