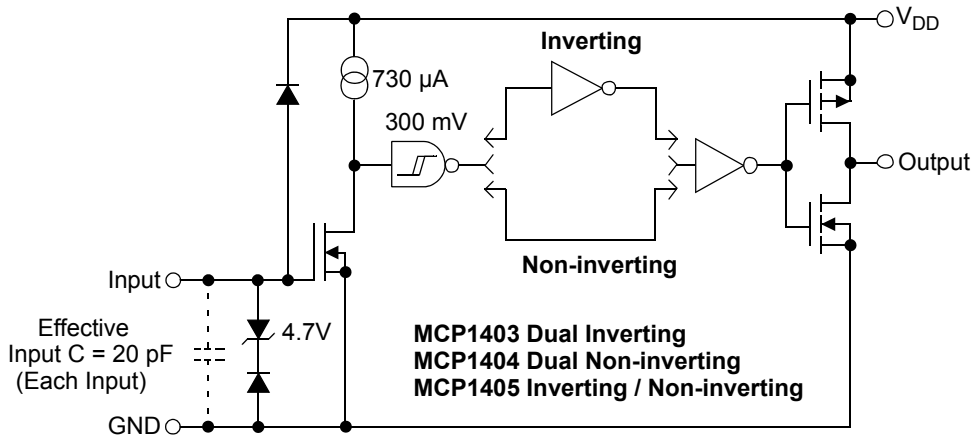
Functional Block Diagram (1)



Note 1: Unused inputs should be grounded.

1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage .....+20V
Input Voltage .....(V_{DD} + 0.3V) to (GND – 5V)
Input Current (V_{IN}>V_{DD}).....50 mA

† **Notice:** Stresses above those listed under "Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

DC CHARACTERISTICS (NOTE 2)

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

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input						
Logic '1', High Input Voltage	V_{IH}	2.4	1.5	—	V	
Logic '0', Low Input Voltage	V_{IL}	—	1.3	0.8	V	
Input Current	I_{IN}	–1	—	1	µA	0V ≤ V_{IN} ≤ V_{DD}
Input Voltage	V_{IN}	-5	—	V_{DD}+0.3	V	
Output						
High Output Voltage	V_{OH}	V_{DD} – 0.025	—	—	V	DC Test
Low Output Voltage	V_{OL}	—	—	0.025	V	DC Test
Output Resistance, High	R_{OH}	—	2.2	3.0	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Output Resistance, Low	R_{OL}	—	2.8	3.5	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Peak Output Current	I_{PK}	—	4.5	—	A	V_{DD} = 18V **(Note 2)**
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	>1.5	—	A	Duty cycle ≤ 2%, t ≤ 300 µsec.
Switching Time (Note 1)						
Rise Time	t_R	—	15	28	ns	Figure 4-1, Figure 4-2 C_L = 2200 pF
Fall Time	t_F	—	18	28	ns	Figure 4-1, Figure 4-2 C_L = 2200 pF
Delay Time	t_{D1}	—	40	48	ns	Figure 4-1, Figure 4-2
Delay Time	t_{D2}	—	40	48	ns	Figure 4-1, Figure 4-2
Power Supply						
Supply Voltage	V_{DD}	4.5	—	18.0	V	
Power Supply Current	I_S	—	1.0	2.0	mA	V_{IN} = 3V (Both Inputs)
	I_S	—	0.15	0.25	mA	V_{IN} = 0V (Both Inputs)

Note 1: Switching times ensured by design.
2: Tested during characterization, not production tested.

DC CHARACTERISTICS (OVER OPERATING TEMPERATURE RANGE)

Electrical Specifications: Unless otherwise indicated, operating temperature range with 4.5V ≤ V_{DD} ≤ 18V.

Parameters	Sym	Min	Typ	Max	Units	Conditions
Input						
Logic '1', High Input Voltage	V_{IH}	2.4	—	—	V	
Logic '0', Low Input Voltage	V_{IL}	—	—	0.8	V	
Input Current	I_{IN}	–10	—	+10	µA	0V ≤ V_{IN} ≤ V_{DD}
Output						
High Output Voltage	V_{OH}	V_{DD} – 0.025	—	—	V	DC TEST
Low Output Voltage	V_{OL}	—	—	0.025	V	DC TEST
Output Resistance, High	R_{OH}	—	3.1	6.0	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Output Resistance, Low	R_{OL}	—	3.7	7	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Switching Time (Note 1)						
Rise Time	t_R	—	25	40	ns	Figure 4-1, Figure 4-2 C_L = 2200 pF
Fall Time	t_F	—	25	40	ns	Figure 4-1, Figure 4-2 C_L = 2200 pF
Delay Time	t_{D1}	—	50	65	ns	Figure 4-1, Figure 4-2
Delay Time	t_{D2}	—	50	65	ns	Figure 4-1, Figure 4-2
Power Supply						
Power Supply Current	I_S	— —	2.0 0.2	3.0 0.3	mA	V_{IN} = 3V (Both Inputs) V_{IN} = 0V (Both Inputs)

Note 1: Switching times ensured by design.

2: Tested during characterization, not production tested.

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	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	Typical four-layer board with vias to ground plane
Thermal Resistance, 8L-PDIP	θ_{JA}	—	125	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	155	—	°C/W	
Thermal Resistance, 16L-SOIC	θ_{JA}	—	155	—	°C/W	4-Layer JC51-7 Standard Board, Natural Convection

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

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

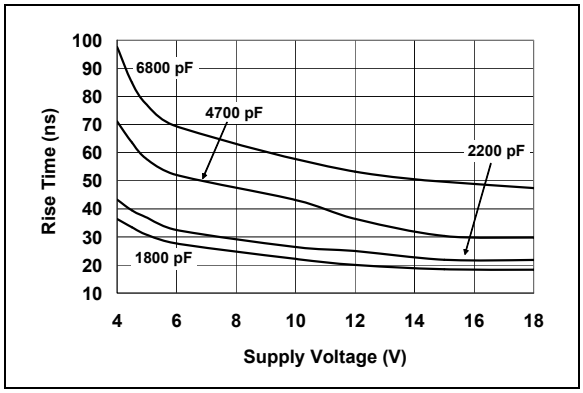


FIGURE 2-1: *Rise Time vs. Supply Voltage.*

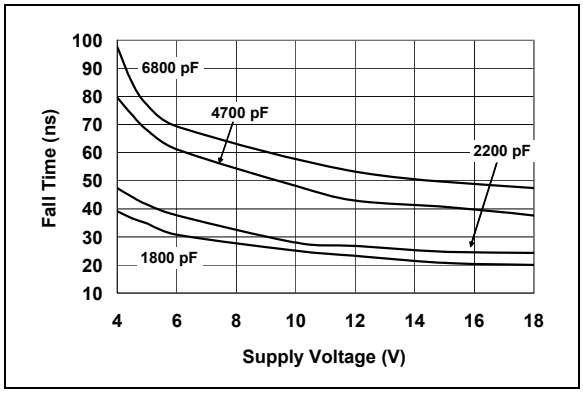


FIGURE 2-4: *Fall Time vs. Supply Voltage.*

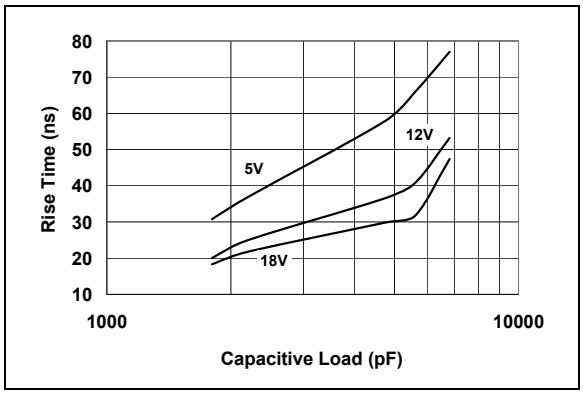


FIGURE 2-2: *Rise Time vs. Capacitive Load.*

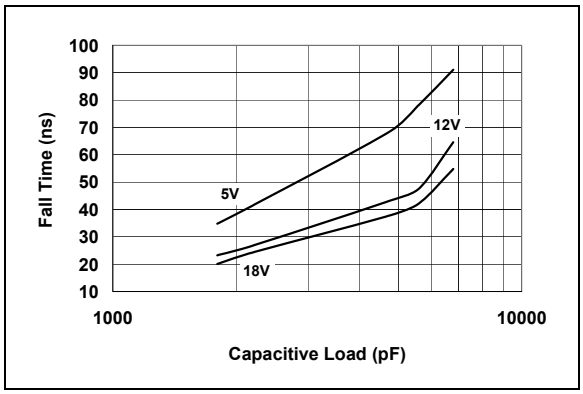


FIGURE 2-5: *Fall Time vs. Capacitive Load.*

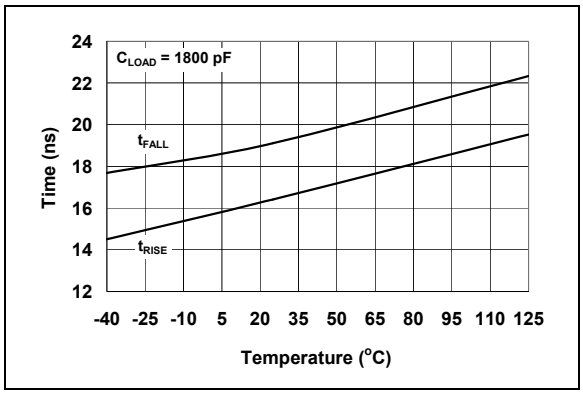


FIGURE 2-3: *Rise and Fall Times vs. Temperature.*

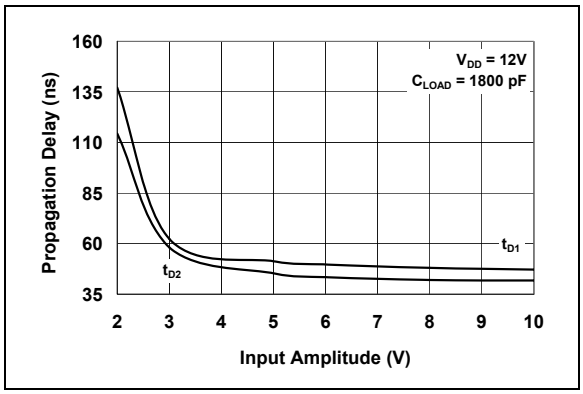


FIGURE 2-6: *Propagation Delay vs. Input Amplitude.*

Typical Performance Curves (Continued)

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

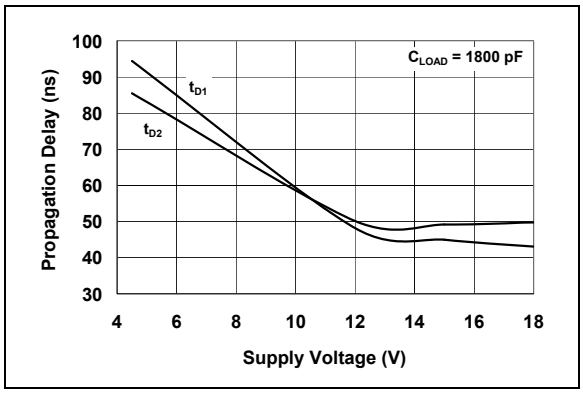


FIGURE 2-7: *Propagation Delay Time vs. Supply Voltage.*

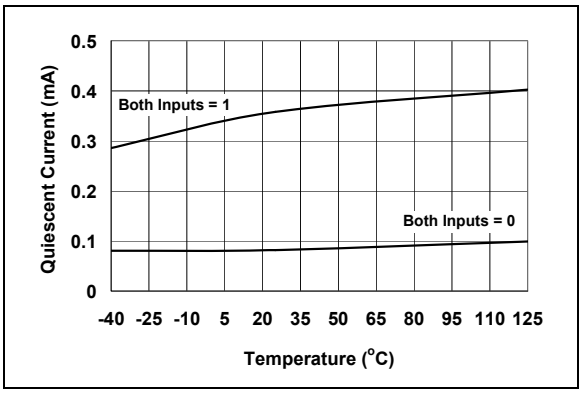


FIGURE 2-10: *Quiescent Current vs. Temperature.*

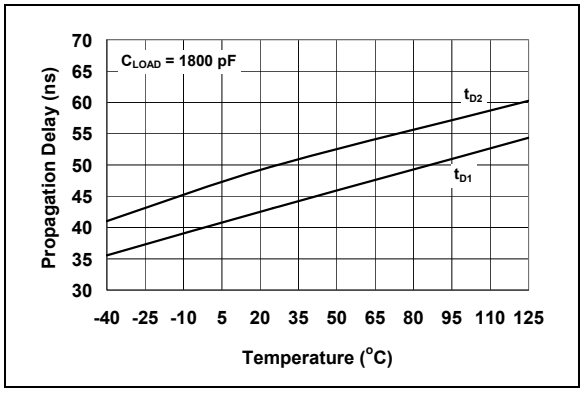


FIGURE 2-8: *Propagation Delay Time vs. Temperature.*

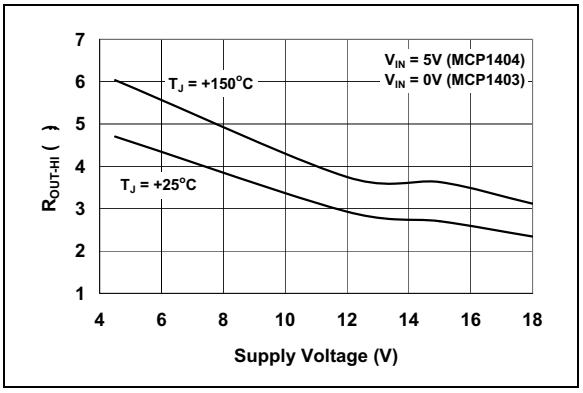


FIGURE 2-11: *Output Resistance (Output High) vs. Supply Voltage.*

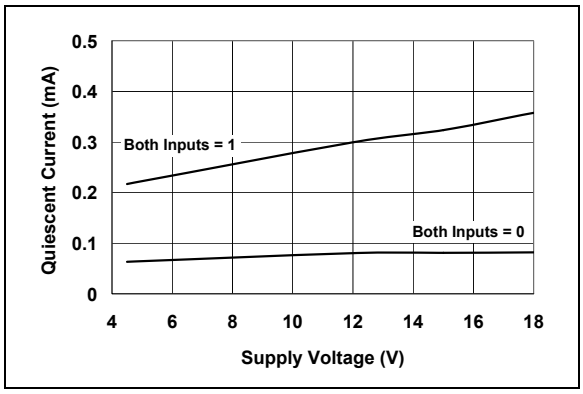


FIGURE 2-9: *Quiescent Current vs. Supply Voltage.*

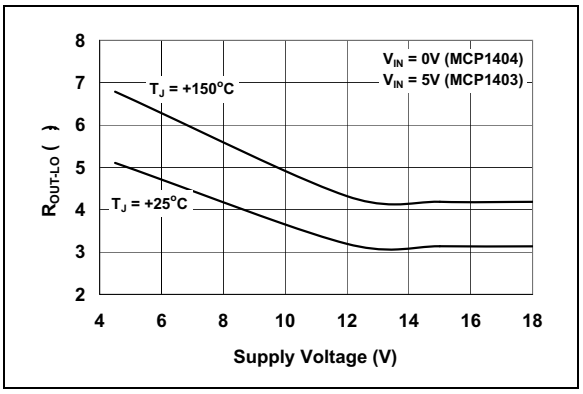


FIGURE 2-12: *Output Resistance (Output Low) vs. Temperature.*

Typical Performance Curves (Continued)

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

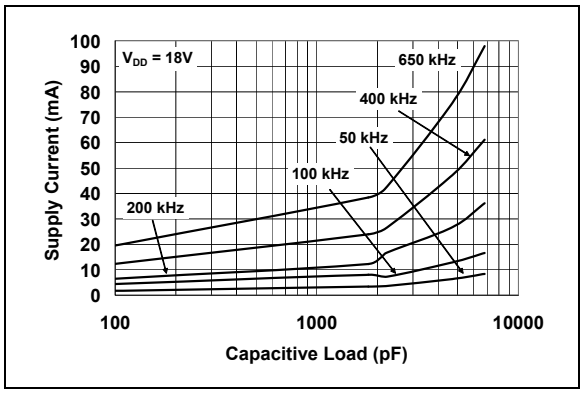


FIGURE 2-13: *Supply Current vs. Capacitive Load.*

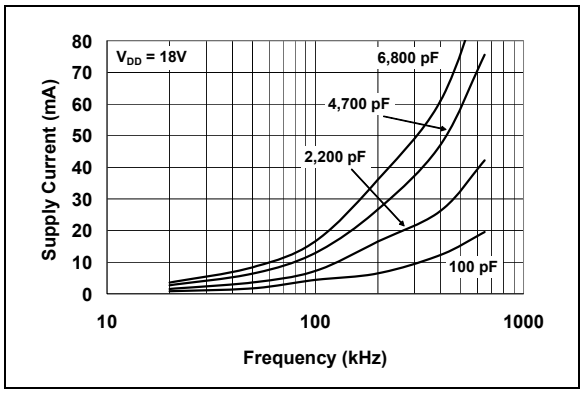


FIGURE 2-16: *Supply Current vs. Frequency.*

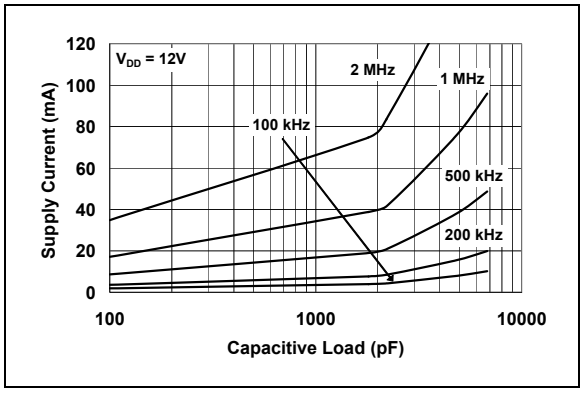


FIGURE 2-14: *Supply Current vs. Capacitive Load.*

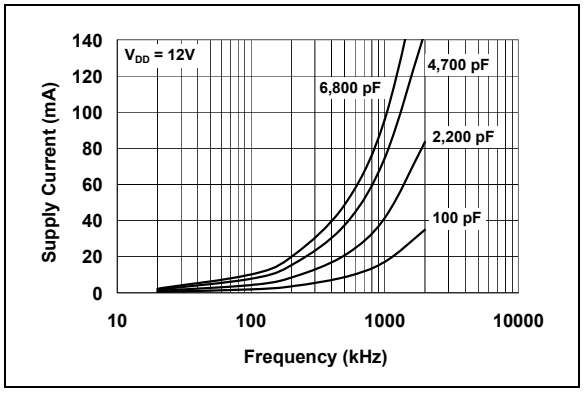


FIGURE 2-17: *Supply Current vs. Frequency.*

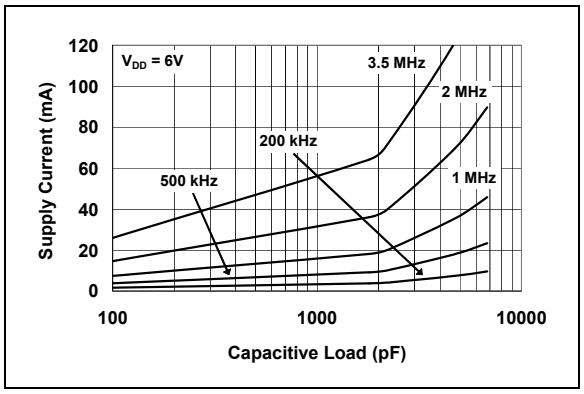


FIGURE 2-15: *Supply Current vs. Capacitive Load.*

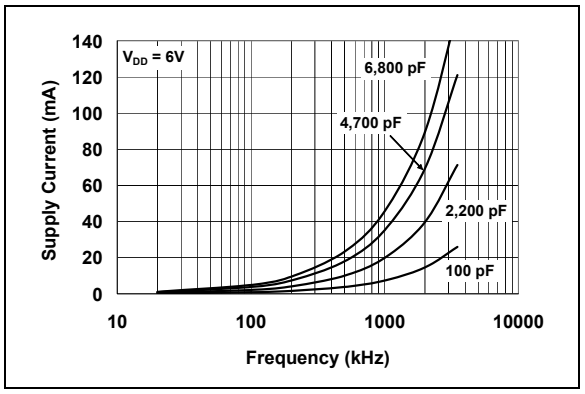
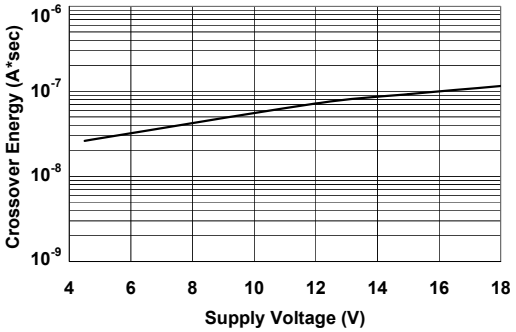


FIGURE 2-18: *Supply Current vs. Frequency.*

Typical Performance Curves (Continued)

Note: Unless otherwise indicated, T_A = +25°C 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 value 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 SOIC	8-Pin DFN	16-Pin SOIC	Symbol	Description
1	1	1	NC	No Connection
2	2	2	IN A	Control Input for Output A
—	—	3	NC	No Connection
3	3	4	GND	Ground
—	—	5	GND	Ground
—	—	6	NC	No Connection
4	4	7	IN B	Control Input for Output B
—	—	8	NC	No Connection
—	—	9	NC	No Connection
5	5	10	OUT B	Output B
—	—	11	OUT B	Output B
6	6	12	V_{DD}	Supply Input
—	—	13	V_{DD}	Supply Input
7	7	14	OUT A	Output A
—	—	15	OUT A	Output A
8	8	16	NC	No Connection
—	PAD	—	NC	Exposed Metal Pad

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

3.1 Supply Input (V_{DD})

V_{DD} is the bias supply input for the MOSFET driver and has a voltage range of 4.5V to 18V. This input must be decoupled to ground with a local capacitor. This bypass capacitor provides a localized low-impedance path for the peak currents that are to be provided to the load.

3.2 Control Inputs A and B

The MOSFET driver input is a high-impedance, TTL/CMOS-compatible input. The input also has hysteresis between the high and low input levels, allowing them to be driven from slow rising and falling signals, and to provide noise immunity.

3.3 Ground (GND)

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

3.4 Outputs A and B

Outputs A and B are CMOS push-pull output that is capable of sourcing and sinking 4.5A of peak current (V_{DD} = 18V). The low output impedance ensures the gate of the external MOSFET will stay in the intended state even during large transients. These output also has a reverse current latch-up rating of 1.5A.

3.5 Exposed Metal Pad

The exposed metal pad of the 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 APPLICATION INFORMATION

4.1 General Information

MOSFET drivers are high-speed, high current devices which are intended to source/sink high peak currents to charge/discharge the gate capacitance of external MOSFETs or IGBTs. In high frequency switching power supplies, the PWM controller may not have the drive capability to directly drive the power MOSFET. A MOSFET driver like the MCP1403/4/5 family can be used to provide additional source/sink current capability.

4.2 MOSFET Driver Timing

The ability of a MOSFET driver to transition from a fully off state to a fully on state are characterized by the drivers rise time (t_R), fall time (t_F), and propagation delays (t_{D1} and t_{D2}). The MCP1403/4/5 family of drivers can typically charge and discharge a 2200 pF load capacitance in 15 ns along with a typical matched propagation delay of 40 ns. Figure 4-1 and Figure 4-2 show the test circuit and timing waveform used to verify the MCP1403/4/5 timing.

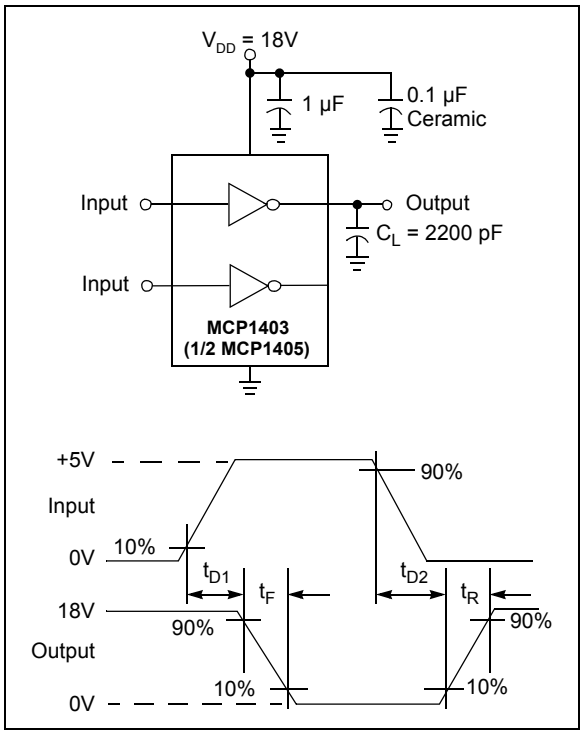


FIGURE 4-1: *Inverting Driver Timing Waveform.*

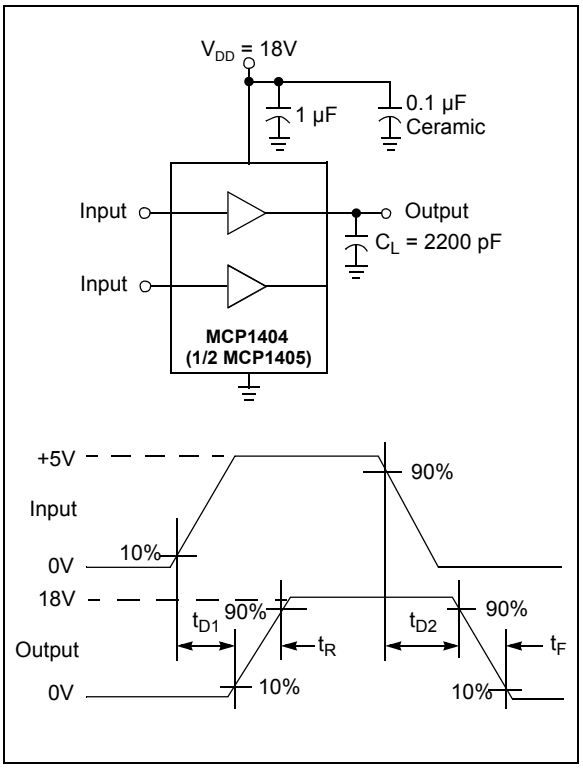


FIGURE 4-2: *Non-Inverting Driver Timing Waveform.*

4.3 Decoupling Capacitors

Careful layout and decoupling capacitors are highly recommended when using MOSFET drivers. Large currents are required to charge and discharge capacitive loads quickly. For example, 2.5A are needed to charge a 2200 pF load with 18V in 16 ns.

To operate the MOSFET driver over a wide frequency range with low supply impedance a ceramic and low ESR film capacitor are recommended to be placed in parallel between the driver V_{DD} and GND. A 1.0 µF low ESR film capacitor and a 0.1 µF ceramic capacitor placed between V_{DD} and GND pins should be used. These capacitors should be placed close to the driver to minimized circuit board parasitics and provide a local source for the required current.

4.4 PCB Layout Considerations

Proper PCB layout is important in a high current, fast switching circuit to provide proper device operation and robustness of design. PCB trace loop area and inductance should be minimized by the use of ground planes or trace under MOSFET gate drive signals, separate analog and power grounds, and local driver decoupling.

Placing a ground plane beneath the MCP1403/4/5 will help as a radiated noise shield as well as providing some heat sinking for power dissipated within the device.

4.5 Power Dissipation

The total internal power dissipation in a MOSFET driver is the summation of three separate power dissipation elements.

$$P_T = P_L + P_Q + P_{CC}$$

Where:

P_T = Total power dissipation

P_L = Load power dissipation

P_Q = Quiescent power dissipation

P_{CC} = Operating power dissipation

4.5.1 CAPACITIVE LOAD DISSIPATION

The power dissipation caused by a capacitive load is a direct function of frequency, total capacitive load, and supply voltage. The power lost in the MOSFET driver for a complete charging and discharging cycle of a MOSFET is:

$$P_L = f \times C_T \times V_{DD}^2$$

Where:

f = Switching frequency

C_T = Total load capacitance

V_{DD} = MOSFET driver supply voltage

4.5.2 QUIESCENT POWER DISSIPATION

The power dissipation associated with the quiescent current draw depends upon the state of the input pin. The MCP1403/4/5 devices have a quiescent current draw when both inputs are high of 1.0 mA (typ) and 0.15 mA (typ) when both inputs are low. The quiescent power dissipation is:

$$P_Q = (I_{QH} \times D + I_{QL} \times (1 - D)) \times V_{DD}$$

Where:

I_{QH} = Quiescent current in the high state

D = Duty cycle

I_{QL} = Quiescent current in the low state

V_{DD} = MOSFET driver supply voltage

4.5.3 OPERATING POWER DISSIPATION

The operating power dissipation occurs each time the MOSFET driver output transitions because for a very short period of time both MOSFETs in the output stage are on simultaneously. This cross-conduction current leads to a power dissipation describes as:

$$P_{CC} = CC \times f \times V_{DD}$$

Where:

CC = Cross-conduction constant (A*sec)

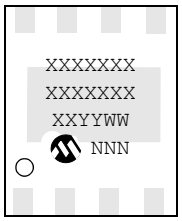
f = Switching frequency

V_{DD} = MOSFET driver supply voltage

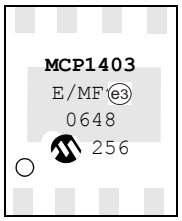
5.0 PACKAGING INFORMATION

5.1 Package Marking Information (Not to Scale)

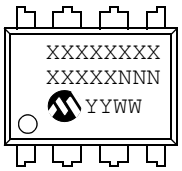
8-Lead DFN



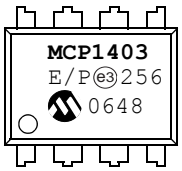
Example:



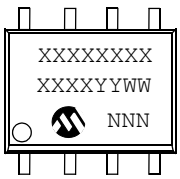
8-Lead PDIP (300 mil)



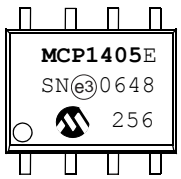
Example:



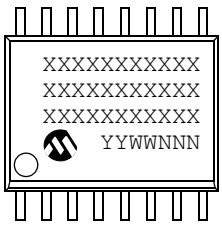
8-Lead SOIC (150 mil)



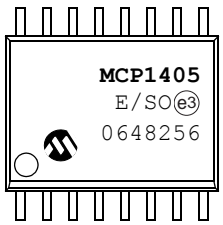
Example:



16-Lead SOIC (300 mil)



Example:

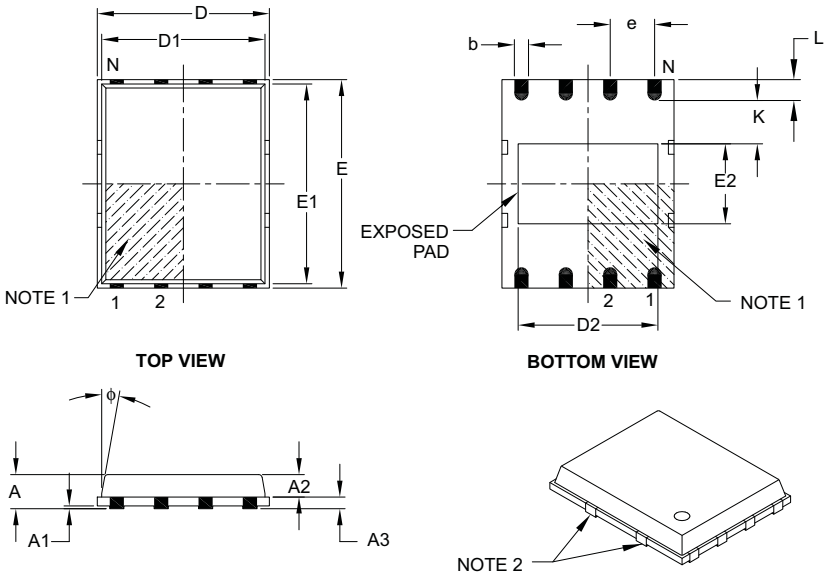


Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.

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.

8-Lead Plastic Dual Flat, No Lead Package (MF) – 6x5 mm Body [DFN-S] PUNCH SINGULATED

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	–	0.85	1.00
Molded Package Thickness	A2	–	0.65	0.80
Standoff	A1	0.00	0.01	0.05
Base Thickness	A3		0.20 REF	
Overall Length	D		4.92 BSC	
Molded Package Length	D1		4.67 BSC	
Exposed Pad Length	D2	3.85	4.00	4.15
Overall Width	E		5.99 BSC	
Molded Package Width	E1		5.74 BSC	
Exposed Pad Width	E2	2.16	2.31	2.46
Contact Width	b	0.35	0.40	0.47
Contact Length	L	0.50	0.60	0.75
Contact-to-Exposed Pad	K	0.20	–	–
Model Draft Angle Top	ϕ	–	–	12°

Notes:

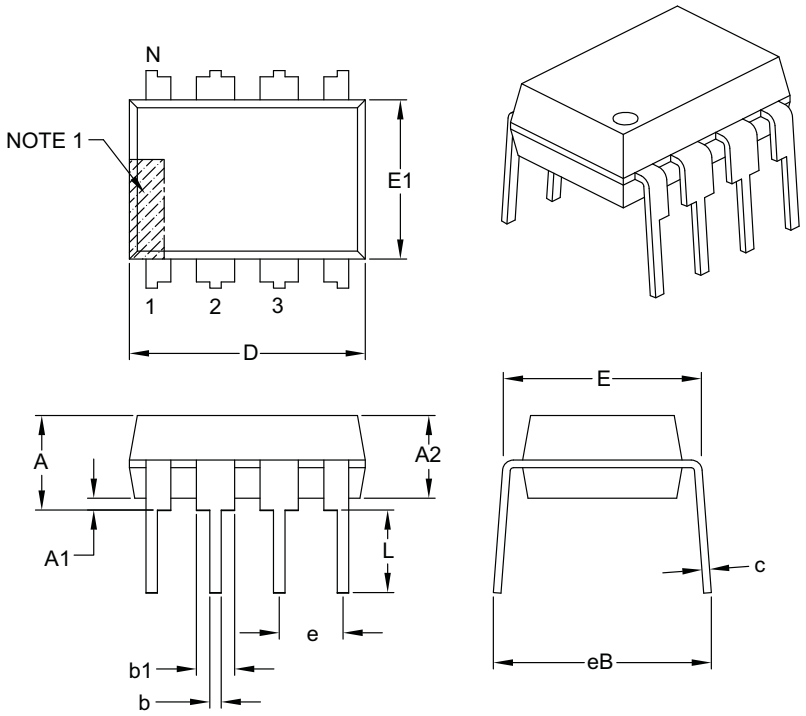
1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package may have one or more exposed tie bars at ends.
3. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-113B

8-Lead Plastic Dual In-Line (P) – 300 mil Body [PDIP]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		INCHES		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		.100 BSC	
Top to Seating Plane	A	–	–	.210
Molded Package Thickness	A2	.115	.130	.195
Base to Seating Plane	A1	.015	–	–
Shoulder to Shoulder Width	E	.290	.310	.325
Molded Package Width	E1	.240	.250	.280
Overall Length	D	.348	.365	.400
Tip to Seating Plane	L	.115	.130	.150
Lead Thickness	c	.008	.010	.015
Upper Lead Width	b1	.040	.060	.070
Lower Lead Width	b	.014	.018	.022
Overall Row Spacing §	eB	–	–	.430

Notes:

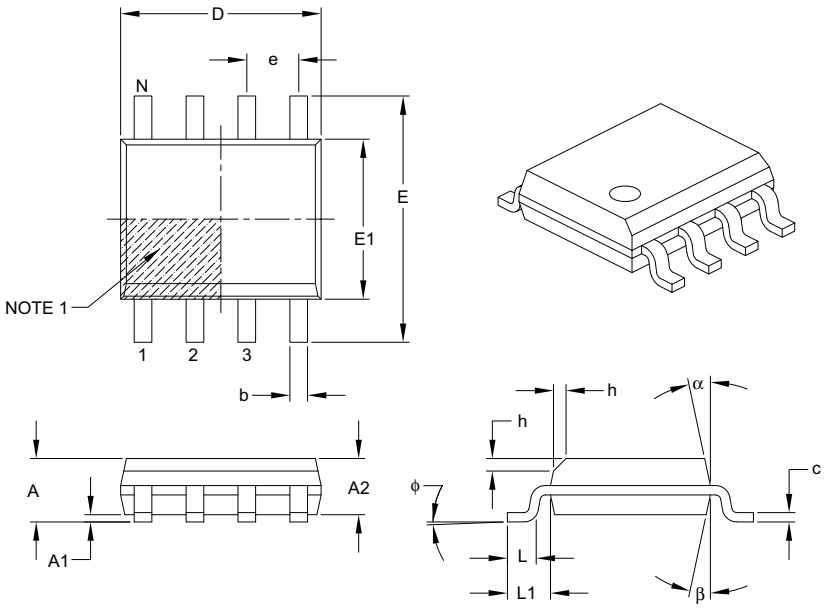
1. Pin 1 visual index feature may vary, but must be located with the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing C04-018B

8-Lead Plastic Small Outline (SN) – Narrow, 3.90 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	–	–	1.75
Molded Package Thickness	A2	1.25	–	–
Standoff §	A1	0.10	–	0.25
Overall Width	E		6.00 BSC	
Molded Package Width	E1		3.90 BSC	
Overall Length	D		4.90 BSC	
Chamfer (optional)	h	0.25	–	0.50
Foot Length	L	0.40	–	1.27
Footprint	L1		1.04 REF	
Foot Angle	φ	0°	–	8°
Lead Thickness	c	0.17	–	0.25
Lead Width	b	0.31	–	0.51
Mold Draft Angle Top	α	5°	–	15°
Mold Draft Angle Bottom	β	5°	–	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

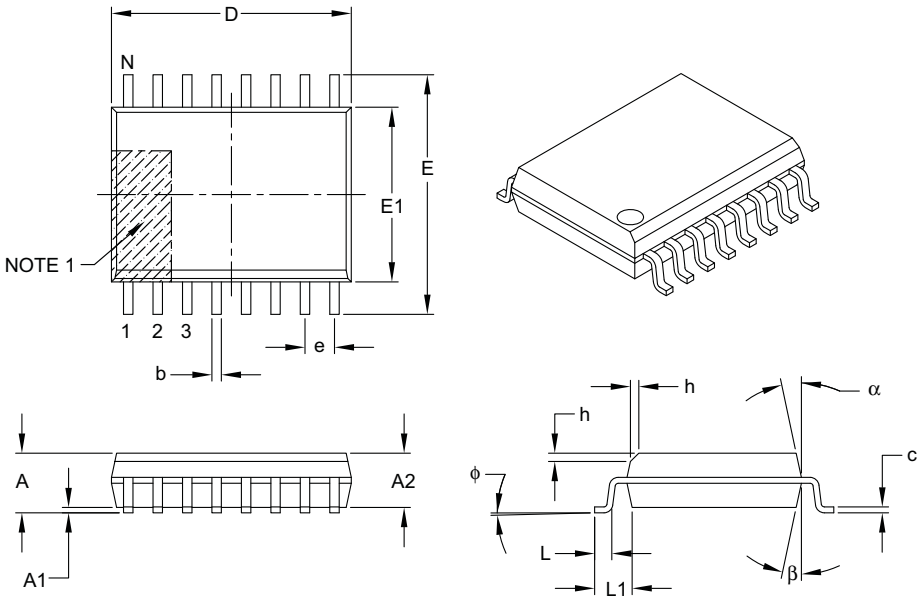
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-057B

16-Lead Plastic Small Outline (SO) – Wide, 7.50 mm Body [SOIC]

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Number of Pins	N		16	
Pitch	e		1.27 BSC	
Overall Height	A	–	–	2.65
Molded Package Thickness	A2	2.05	–	–
Standoff §	A1	0.10	–	0.30
Overall Width	E		10.30 BSC	
Molded Package Width	E1		7.50 BSC	
Overall Length	D		10.30 BSC	
Chamfer (optional)	h	0.25	–	0.75
Foot Length	L	0.40	–	1.27
Footprint	L1		1.40 REF	
Foot Angle	φ	0°	–	8°
Lead Thickness	c	0.20	–	0.33
Lead Width	b	0.31	–	0.51
Mold Draft Angle Top	α	5°	–	15°
Mold Draft Angle Bottom	β	5°	–	15°

Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. § Significant Characteristic.
3. Dimensions D and E1 do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.15 mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M.

BSC: Basic Dimension. Theoretically exact value shown without tolerances.
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-102B

APPENDIX A: REVISION HISTORY

Revision B (May 2007)

- Page 13: Updated Package Outline Drawing
- Page 14: Updated Package Outline Drawing
- Page 15: Updated Package Outline Drawing
- Page 16: Updated Package Outline Drawing
- Page 17: Updated Revision History
- Page 19: Corrected Package Codes in Product Identification System

Revision A (December 2006)

- Original Release of this Document.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

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

PART NO.	X	XX
Device	Temperature Range	Package

Device:	MCP1403:	4.5A Dual MOSFET Driver, Inverting
	MCP1403T:	4.5A Dual MOSFET Driver, Inverting (Tape and Reel)
	MCP1404:	4.5A Dual MOSFET Driver, Non-Inverting
	MCP1404T:	4.5A Dual MOSFET Driver, Non-Inverting (Tape and Reel)
	MCP1405:	4.5A Dual MOSFET Driver, Complementary
	MCP1405T:	4.5A Dual MOSFET Driver, Complementary (Tape and Reel)
Temperature Range:	E =	-40°C to +125°C
Package: *	MF =	Dual, Flat, No-Lead (6x5 mm Body), 8-lead
	P =	Plastic DIP, (300 mil body), 8-lead
	SN =	Plastic SOIC (150 mil Body), 8-Lead
	SO =	Plastic SOIC (Wide), 16-Lead

* All package offerings are Pb Free (Lead Free)

Examples:

a) MCP1403-E/SN: 4.5A Dual Inverting MOSFET Driver, 8LD SOIC package.

b) MCP1403-E/P: 4.5A Dual Inverting MOSFET Driver, 8LD PDIP package.

c) MCP1403-E/MF: 4.5A Dual Inverting MOSFET Driver, 8LD DFN package.

d) MCP1403-E/SO: 4.5A Dual Inverting MOSFET Driver, 16LD SOIC package.

a) MCP1404T-E/SN: Tape and Reel. 4.5A Dual Non-Inverting, MOSFET Driver, 8LD SOIC package,

b) MCP1404-E/P: 4.5A Dual Non-Inverting, MOSFET Driver, 8LD PDIP package.

a) MCP1405-E/SN: 4.5A Dual Complementary, MOSFET Driver, 8LD SOIC package.

b) MCP1405-E/P: 4.5A Dual Complementary, MOSFET Driver, 8LD PDIP package.

c) MCP1405T-E/SO: Tape and Reel, 4.5A Dual Complementary MOSFET Driver, 16LD SOIC package.

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."

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