

1.5A Dual Open-Drain MOSFET Drivers

Features

- Independently Programmable Rise and Fall Times
- Low Output Impedance: 7Ω Typical
- High Speed t_R, t_F : <30 ns with 1000 pF Load
- Short Delay Times: <30 ns
- Wide Operating Range: 4.5V to 18V
- Latch-Up Protected: withstands > 500 mA Reverse Current (Either Polarity)
- Input Withstands Negative Swings up to -5V

Applications

- Motor Controls
- Driving Bipolar Transistors
- Driver for Non-Overlapping Totem Poles
- Reach-Up/Reach-Down Driver

TABLE 1: DEVICE SELECTION TABLE

Part Number	Package	Temp. Range
TC4404COA	8-Lead SOIC	0°C to +70°C
TC4404CPA	8-Lead PDIP	0°C to +70°C
TC4404EOA	8-Lead SOIC	-40°C to +85°C
TC4404EPA	8-Lead PDIP	-40°C to +85°C
TC4405COA	8-Lead SOIC	0°C to +70°C
TC4405CPA	8-Lead PDIP	0°C to +70°C
TC4405EOA	8-Lead SOIC	-40°C to +85°C
TC4405EPA	8-Lead PDIP	-40°C to +85°C

General Description

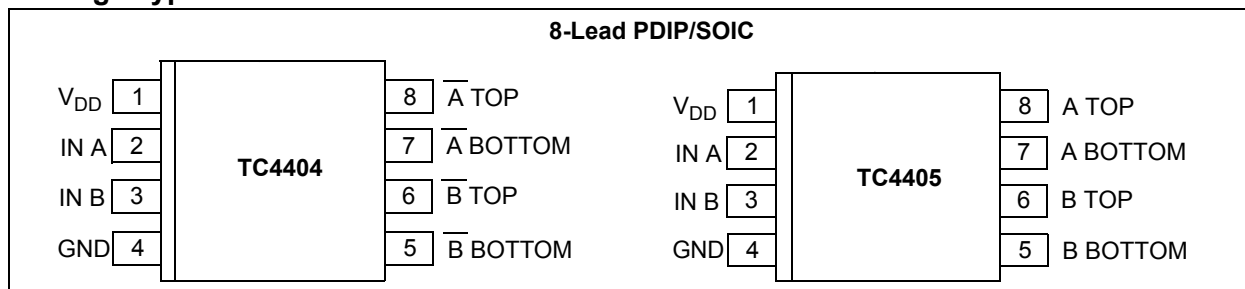
The TC4404/TC4405 are CMOS buffer-drivers constructed with complementary MOS outputs, where the drains of the totem-pole output have been left separated so that individual connections can be made to the pull-up and pull-down sections of the output. This allows the insertion of drain-current-limiting resistors in the pull-up and/or pull-down sections, allowing the user to define the rates of rise and fall for a capacitive load. It also enables a reduced output swing, if driving a resistive load, or limiting base current when driving a bipolar transistor. Minimum rise and fall times, with no resistors, will be less than 30 ns for a 1000 pF load.

For driving MOSFETs in motor-control applications, where slow-ON/fast-OFF operation is desired, these devices are superior to the previously used technique of adding a diode-resistor combination between the driver output and the MOSFET, because they allow accurate control of turn-on, while maintaining fast turn-off and maximum noise immunity for an OFF device.

When used to drive bipolar transistors, these drivers maintain the high speeds common to other Microchip drivers. They allow insertion of a base current-limiting resistor, while providing a separate half-output for fast turn-off. By proper positioning of the resistor, either NPN or PNP transistors can be driven.

For driving many loads in low-power regimes, these drivers require significantly less power at higher frequencies and can be helpful in meeting low-power budgets as they eliminate shoot-through currents in the output stage.

Package Type

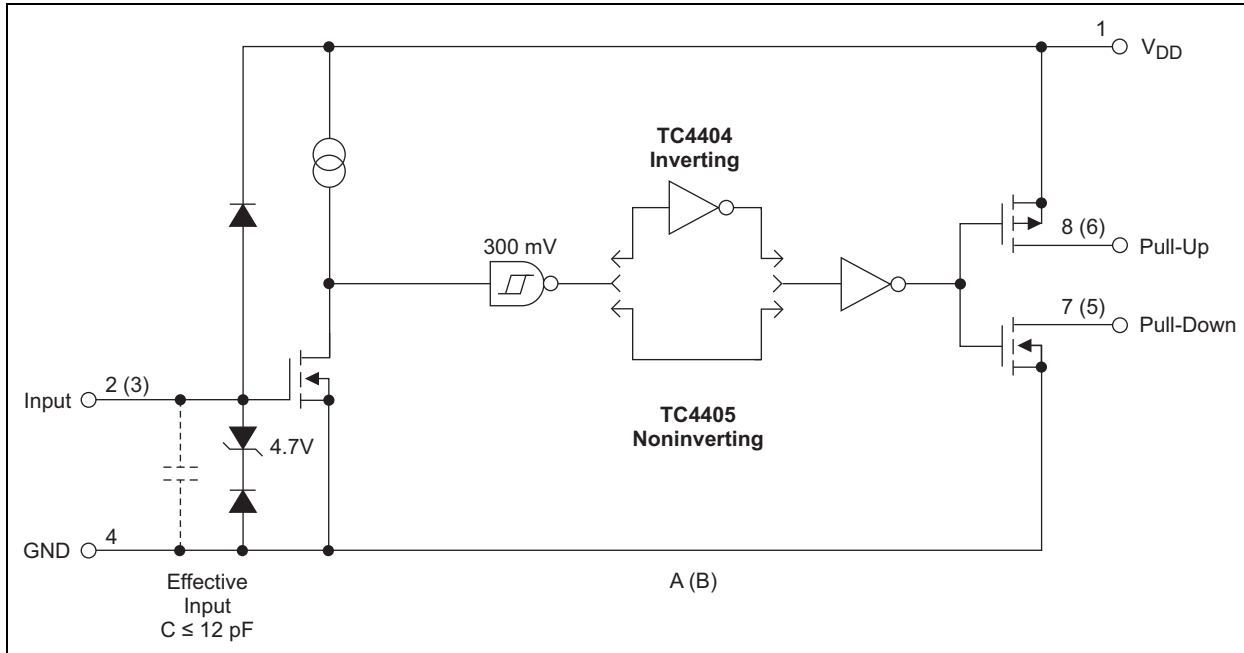


TC4404/TC4405

Because neither drain in an output is dependent on the other, these devices can also be used as open-drain buffer/drivers where both drains are available in one device, thus minimizing chip count. Unused open drains should be returned to the supply rail so that their device sources are connected (pull-downs to ground, pull-ups to V_{DD}), to prevent static damage. In addition, in situations where timing resistors or other means of limiting crossover currents are used, like drains from drivers A and B, they may be paralleled for greater current carrying capacity.

These devices are built to operate in the most demanding electrical environments. They will not latch-up 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 their ground pin; and they can accept, without damage or logic upset, up to 0.5A of reverse current (of either polarity) being forced back into their outputs. All terminals are fully protected against up to 2 kV (HBM) of electrostatic discharge.

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage	+22V
Power Dissipation ($T_A \leq +70^\circ\text{C}$)	
PDIP	730 mW
SOIC	470 mW
Operating Temperature Range	
C Version	0°C to $+70^\circ\text{C}$
E Version	-40°C to $+85^\circ\text{C}$
Storage Temperature Range	-65°C to $+150^\circ\text{C}$

† **Notice:** Stresses above those listed under “Absolute 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

Electrical Characteristics: Unless otherwise specified, all limits apply for typical values at ambient temperature $T_A = +25^\circ\text{C}$, with $4.5\text{V} \leq V_{DD} \leq 18\text{V}$.

Parameter	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	—	1	μA	$0\text{V} \leq V_{IN} \leq V_{DD}$
Output						
High Output Voltage	V_{OH}	$V_{DD} - 0.025$	—	—	V	
Low Output Voltage	V_{OL}	—	—	0.025	V	
Output Resistance	R_O	—	7	10	Ω	$I_{OUT} = 10\text{ mA}$, $V_{DD} = 18\text{V}$; any drain
Peak Output Current (Any Drain)	I_{PK}	—	1.5	—	A	Duty cycle $\leq 2\%$, $t \leq 300\ \mu\text{sec}$
Continuous Output Current (Any Drain)	I_{DC}	—	—	100	mA	
Latch-Up Protection (Any Drain) Withstand Reverse Current	I_R	—	> 500	—	mA	Duty cycle $\leq 2\%$, $t \leq 300\ \mu\text{sec}$
Switching Time (Note 1)						
Rise Time	t_R	—	25	30	ns	Figure 4-1, $C_L = 1000\text{ pF}$
Fall Time	t_F	—	25	30	ns	Figure 4-1, $C_L = 1000\text{ pF}$
Delay Time	t_{D1}	—	15	30	ns	Figure 4-1, $C_L = 1000\text{ pF}$
Delay Time	t_{D2}	—	32	50	ns	Figure 4-1, $C_L = 1000\text{ pF}$
Power Supply						
Power Supply Current	I_S	—	—	4.5 0.4	mA	$V_{IN} = 3\text{V}$ (both inputs) $V_{IN} = 0\text{V}$ (both inputs)

Note 1: Switching times ensured by design.

TC4404/TC4405

DC CHARACTERISTICS (OVER OPERATING TEMPERATURE RANGE)

Electrical Characteristics: Unless otherwise indicated, operating temperature range with $4.5V \leq V_{DD} \leq 18V$.						
Parameter	Sym.	Min.	Typ.	Max.	Units	Conditions
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	$0V \leq V_{IN} \leq V_{DD}$
Output						
High Output Voltage	V_{OH}	$V_{DD} - 0.025$	—	—	V	
Low Output Voltage	V_{OL}	—	—	0.025	V	
Output Resistance	R_O	—	9	12	Ω	$I_{OUT} = 10 \text{ mA}$, $V_{DD} = 18V$; any drain
Peak Output Current (Any Drain)	I_{PK}	—	1.5	—	A	Duty cycle $\leq 2\%$, $t \leq 300 \mu\text{sec}$
Continuous Output Current (Any Drain)	I_{DC}	—	—	100	mA	
Latch-Up Protection (Any Drain) Withstand Reverse Current	I_R	—	> 500	—	mA	Duty cycle $\leq 2\%$, $t \leq 300 \mu\text{sec}$
Switching Time (Note 1)						
Rise Time	t_R	—	—	40	ns	Figure 4-1, $C_L = 1000 \text{ pF}$
Fall Time	t_F	—	—	40	ns	Figure 4-1, $C_L = 1000 \text{ pF}$
Delay Time	t_{D1}	—	—	40	ns	Figure 4-1, $C_L = 1000 \text{ pF}$
Delay Time	t_{D2}	—	—	60	ns	Figure 4-1, $C_L = 1000 \text{ pF}$
Power Supply						
Power Supply Current	I_S	—	—	8 0.6	mA	$V_{IN} = 3V$ (both inputs) $V_{IN} = 0V$ (both inputs)

Note 1: Switching times ensured by design.

TEMPERATURE SPECIFICATIONS

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						
Operating Temperature Range, C Version	T_A	0	—	+70	$^{\circ}\text{C}$	
Operating Temperature Range, E Version	T_A	-40	—	+85	$^{\circ}\text{C}$	
Storage Temperature Range	T_A	-65	—	+150	$^{\circ}\text{C}$	
Package Thermal Resistances						
Thermal Resistance, 8-Lead PDIP	θ_{JA}	—	+94	—	$^{\circ}\text{C/W}$	
Thermal Resistance, 8-Lead PDIP	θ_{JC}	—	+45	—	$^{\circ}\text{C/W}$	
Thermal Resistance, 8-Lead SOIC	θ_{JA}	—	+163	—	$^{\circ}\text{C/W}$	
Thermal Resistance, 8-Lead SOIC	θ_{JC}	—	+42	—	$^{\circ}\text{C/W}$	

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.

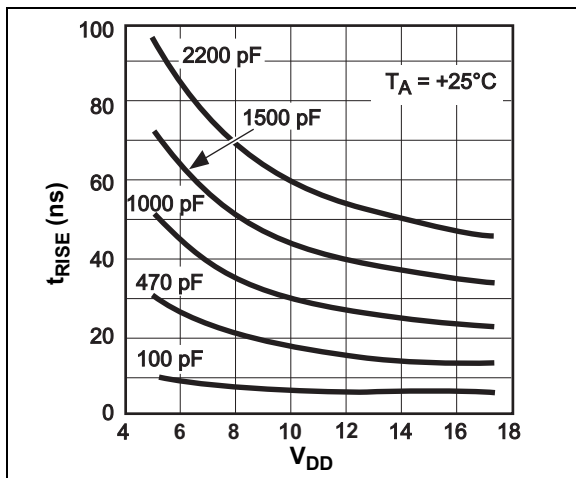


FIGURE 2-1: Rise Time vs. Supply Voltage.

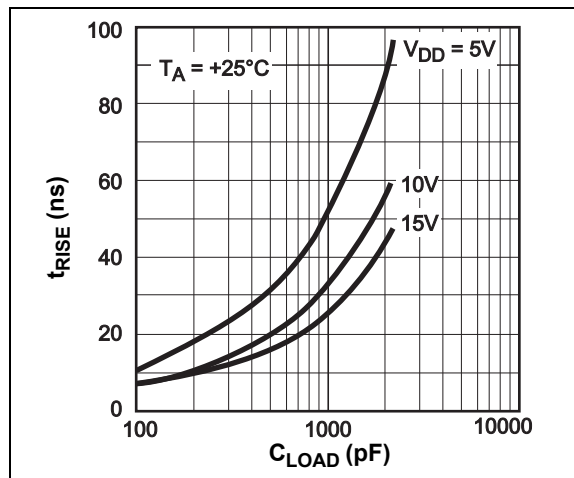


FIGURE 2-3: Rise Time vs. Capacitive Load.

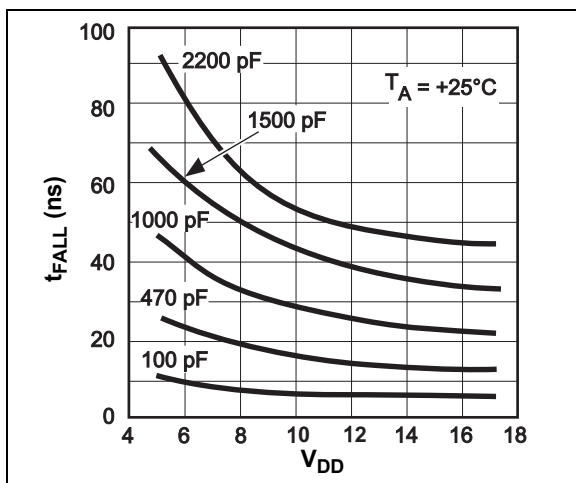


FIGURE 2-2: Fall Time vs. Supply Voltage.

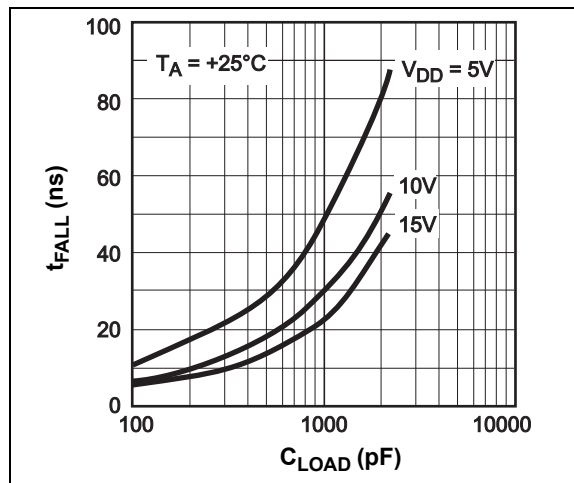


FIGURE 2-4: Fall Time vs. Capacitive Load.

TC4404/TC4405

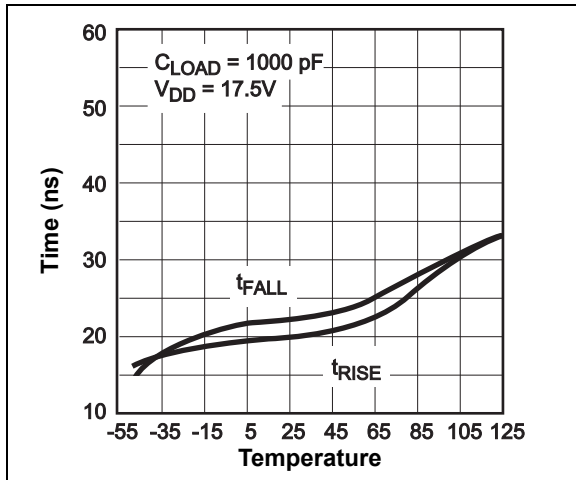


FIGURE 2-5: Rise and Fall Times vs. Temperature.

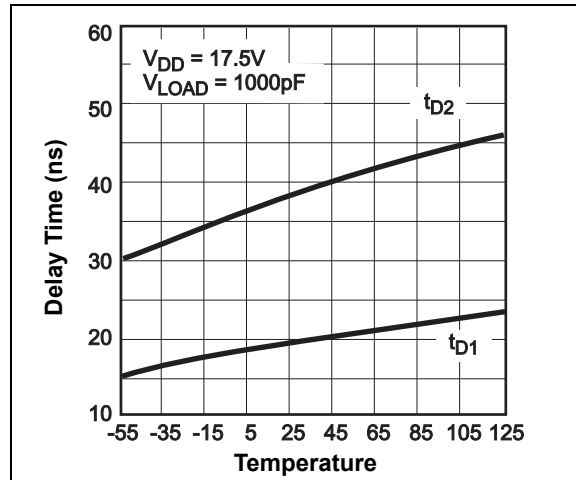


FIGURE 2-8: Propagation Delay Time vs. Temperature.

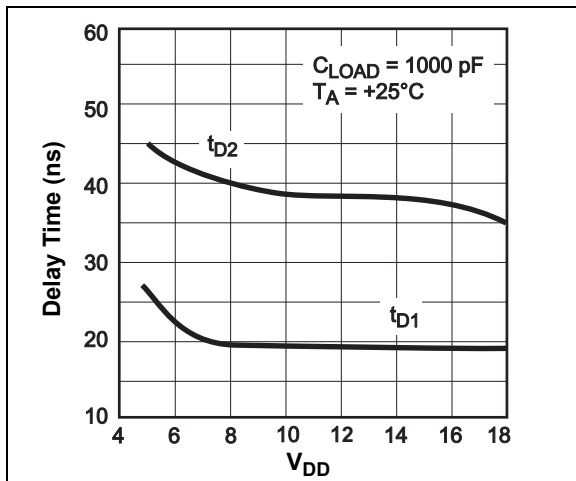


FIGURE 2-6: Propagation Delay vs. Supply Voltage.

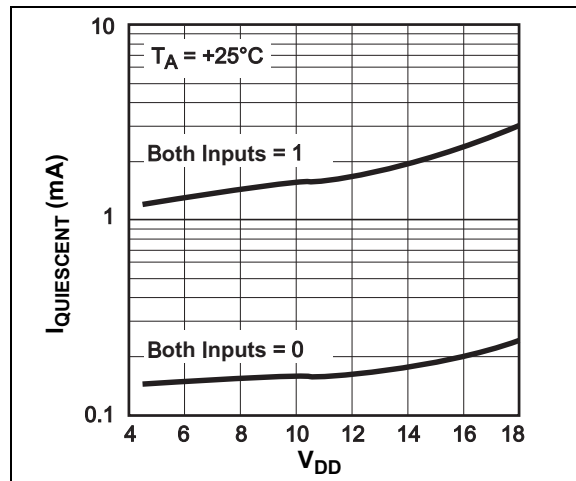


FIGURE 2-9: Quiescent Supply Current vs. Voltage.

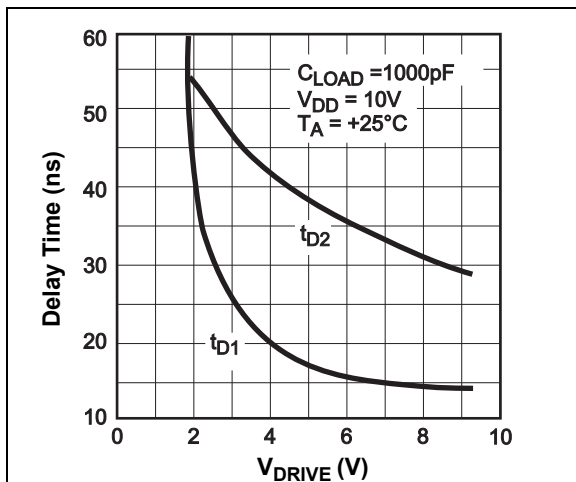


FIGURE 2-7: Effect of Input Amplitude on Delay Time.

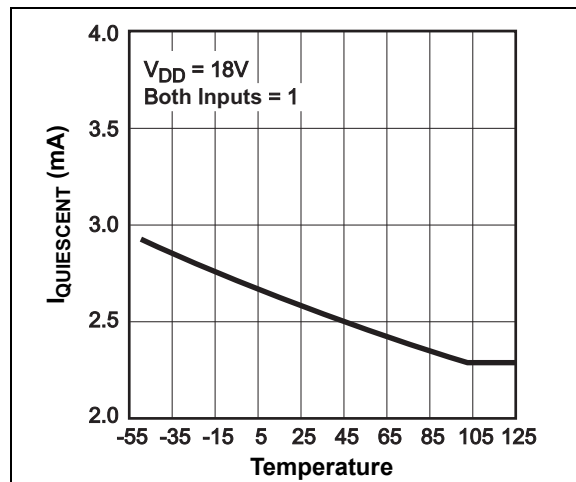


FIGURE 2-10: Quiescent Supply Current vs. Temperature.

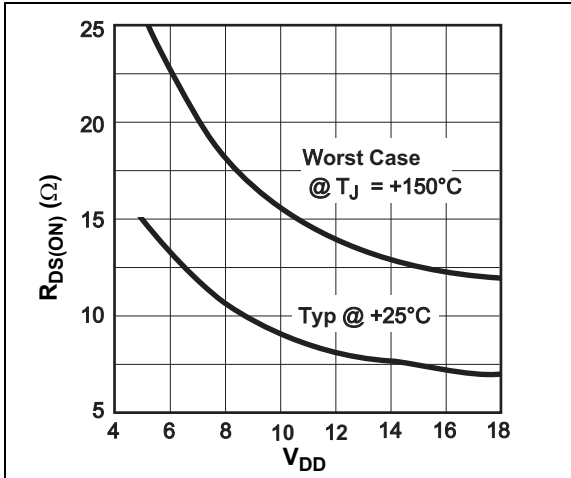


FIGURE 2-11: Pull-Up Output Resistance.

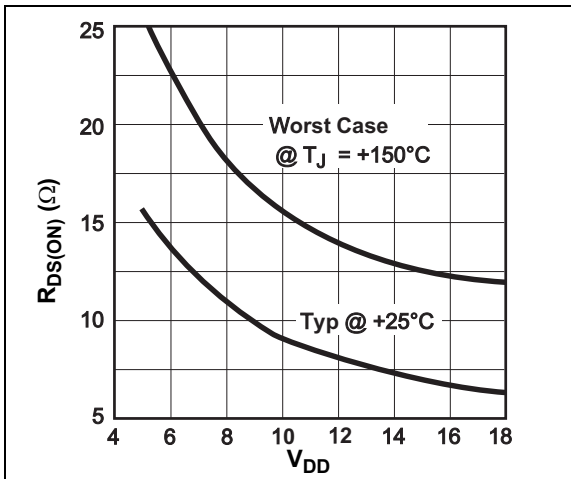


FIGURE 2-12: Pull-Down Output Resistance.

TC4404/TC4405

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in [Table 3-1](#).

TABLE 3-1: PIN FUNCTION TABLE

8-Lead PDIP/SOIC	Symbol	Description
1	V _{DD}	Supply Input, 4.5V to 18V
2	IN A	Control Input A, TTL/CMOS compatible input
3	IN B	Control Input B, TTL/CMOS compatible input
4	GND	Ground
5	B BOTTOM	Output B, pull-down
6	B TOP	Output B, pull-up
7	A BOTTOM	Output A, pull-down
8	A TOP	Output A, pull-up

4.0 APPLICATIONS INFORMATION

4.1 Circuit Layout Guidelines

Long power supply and ground traces should be avoided as the added inductance causes unwanted voltage transients. Power and ground planes should be used wherever possible.

In addition, it is advisable that low ESR (Equivalent Series Resistance) bypass capacitors (4.7 μF or 10 μF tantalum) be placed as close to the driver as possible. In order to minimize the length of the output trace, the driver should be physically located as close as possible to the device it is driving.

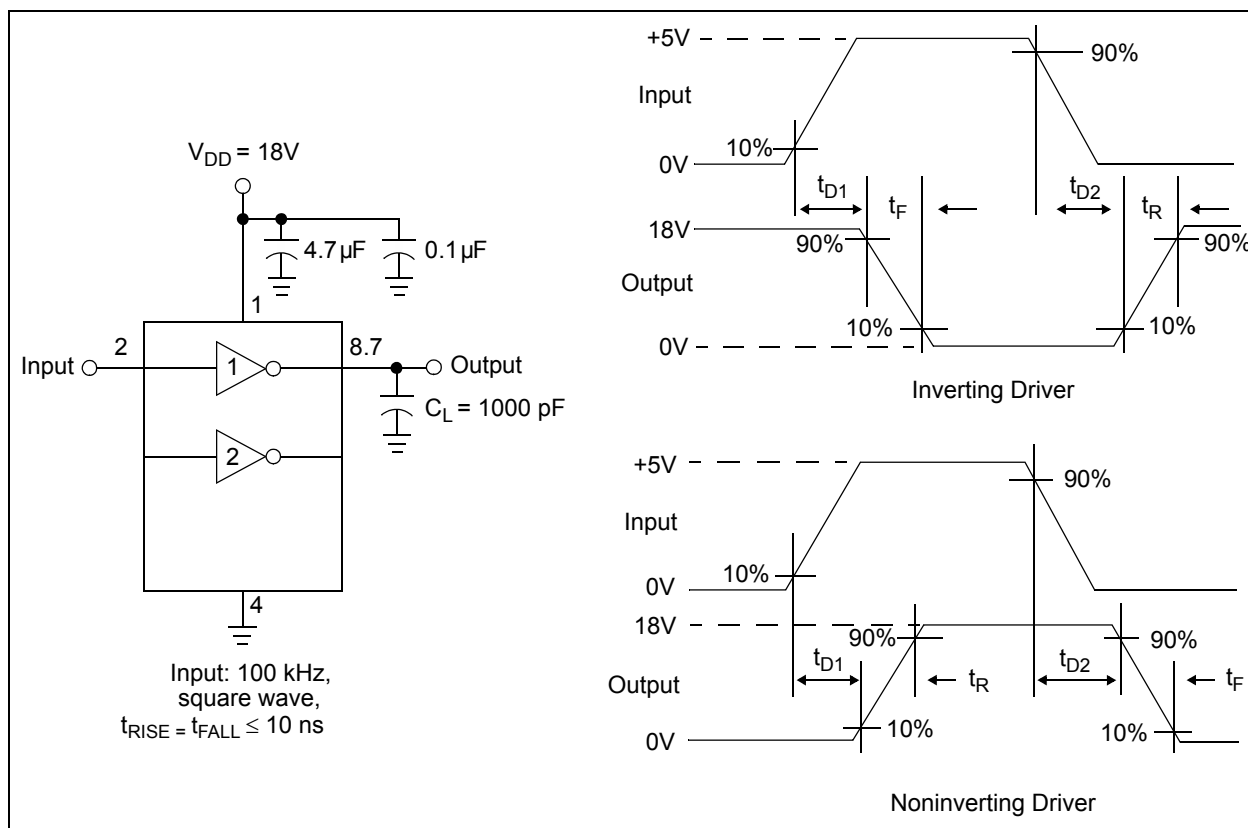


FIGURE 4-1: Switching Time Test Circuit.

4.2 Typical Applications

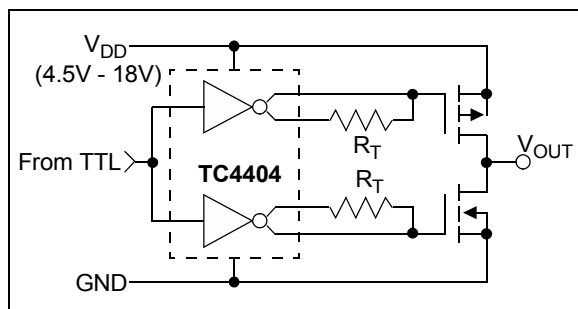


FIGURE 4-2: Zero Crossover Current Totem-Pole Switch.

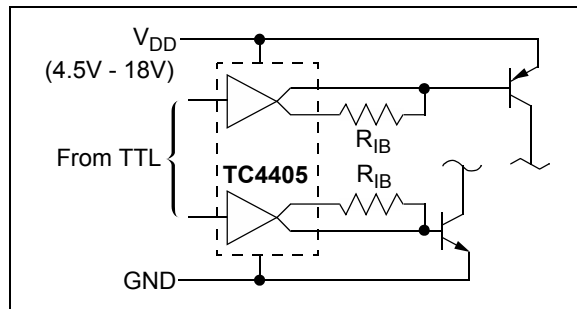


FIGURE 4-3: Driving Bipolar Transistors.

TC4404/TC4405

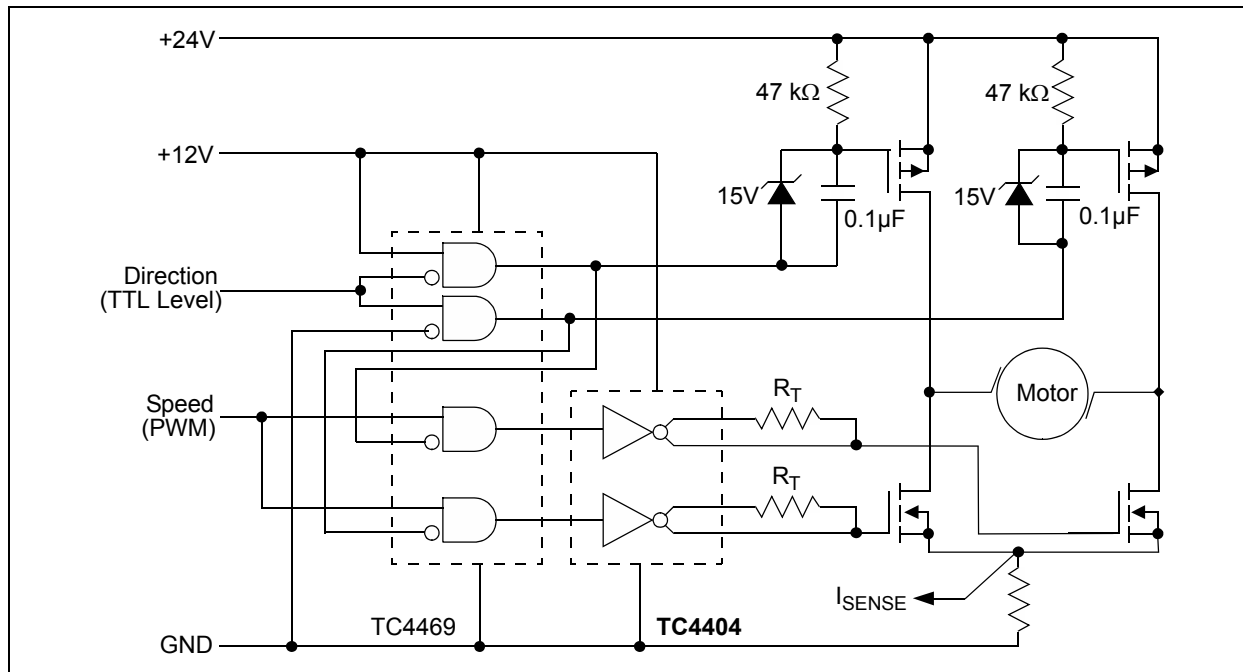


FIGURE 4-4: Servo Motor Control.

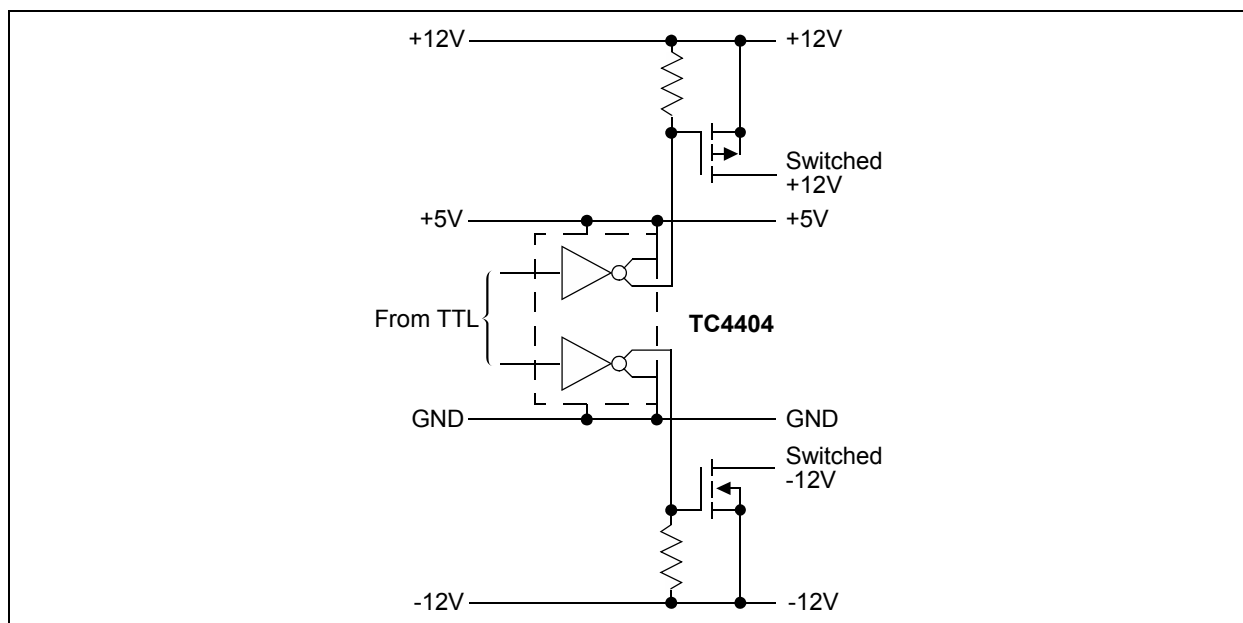
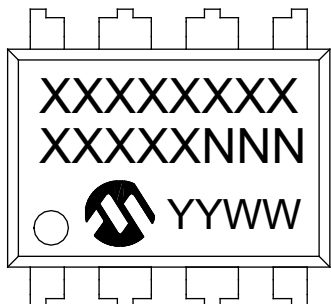


FIGURE 4-5: Reach-Up and Reach-Down Driving.

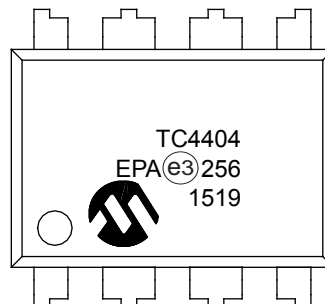
5.0 PACKAGING INFORMATION

5.1 Package Marking Information

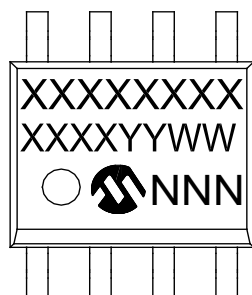
8-Lead PDIP (300 mil)



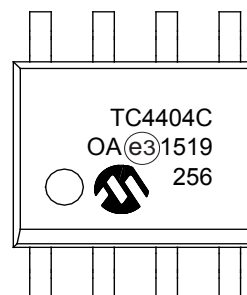
Example



8-Lead SOIC (3.90 mm)



Example



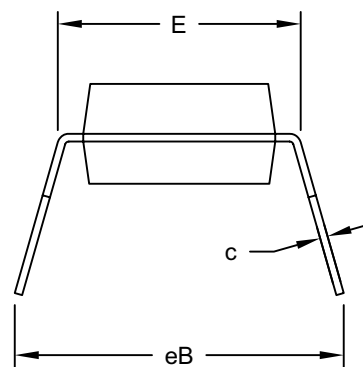
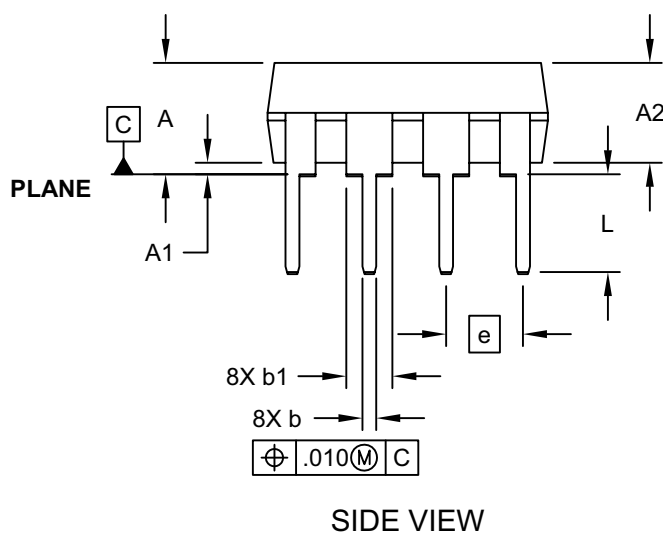
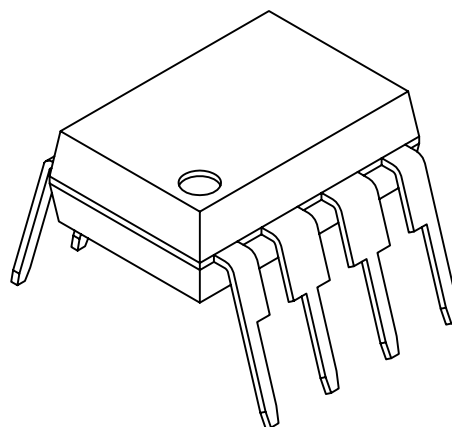
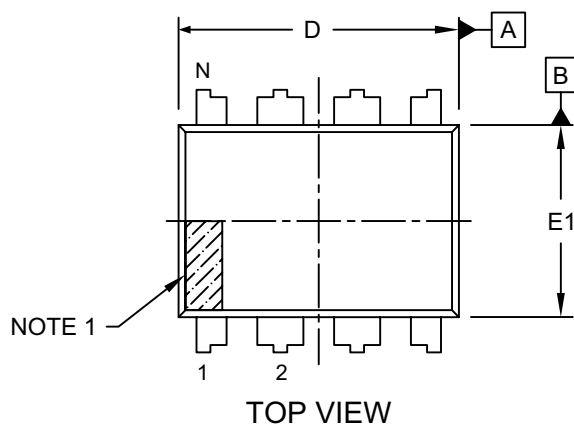
Legend:	XX...X	Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free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

TC4404/TC4405

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

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

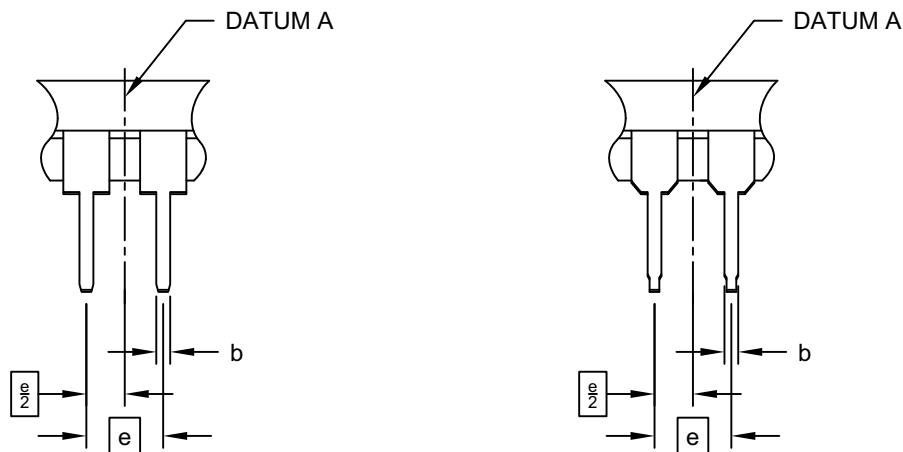


Microchip Technology Drawing No. C04-018D Sheet 1 of 2

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

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

ALTERNATE LEAD DESIGN (VENDOR DEPENDENT)



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:

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

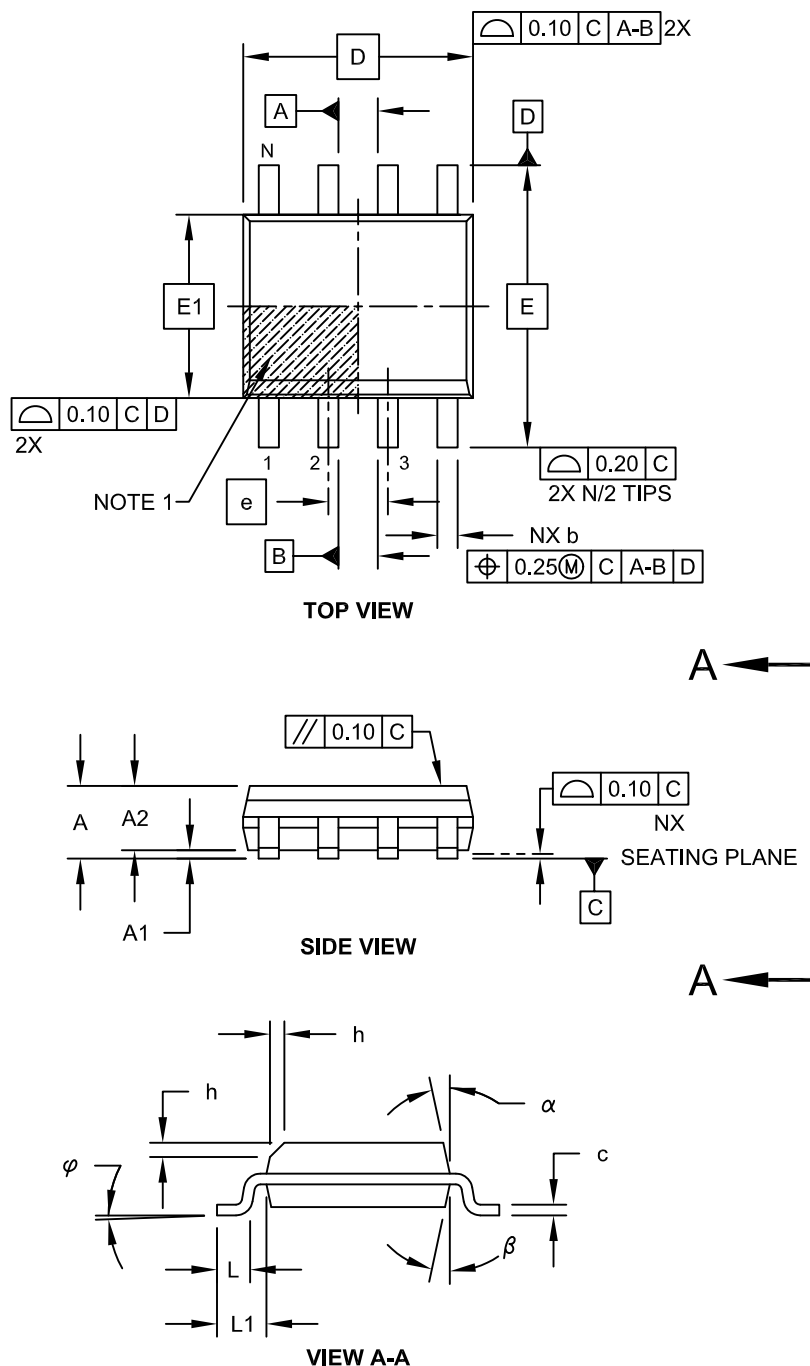
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-018D Sheet 2 of 2

TC4404/TC4405

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

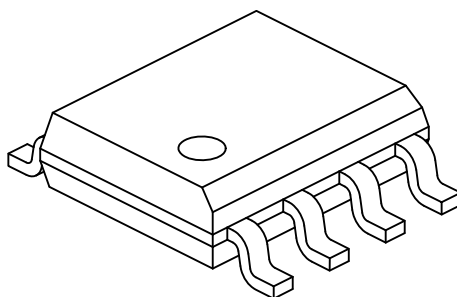
Note: For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing No. C04-057C Sheet 1 of 2

8-Lead Plastic Small Outline (OA) - 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>



Dimension Limits	Units	MILLIMETERS		
		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:

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

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

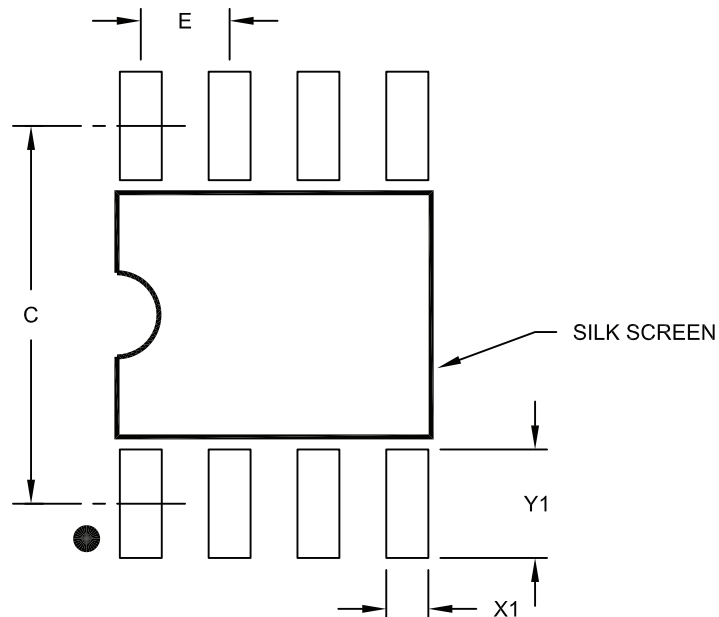
REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing No. C04-057C Sheet 2 of 2

TC4404/TC4405

8-Lead Plastic Small Outline (OA) – 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>



RECOMMENDED LAND PATTERN

Units		MILLIMETERS		
Dimension Limits		MIN	NOM	MAX
Contact Pitch	E	1.27 BSC		
Contact Pad Spacing	C		5.40	
Contact Pad Width (X8)	X1			0.60
Contact Pad Length (X8)	Y1			1.55

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M

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

Microchip Technology Drawing No. C04-2057A

APPENDIX A: REVISION HISTORY

Revision E (April 2016)

The following is the list of modifications:

1. Removed all information regarding the discontinued CERDIP package.
2. Added [Temperature Specifications](#) Table.
3. Added [Section 5.0, Packaging Information](#).
4. Added [Product Identification System](#) page.

Revision D (December 2012)

Added a note to each package outline drawing.

TC4404/TC4405

NOTES:

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>
Device		Temperature Range		Package
Device:	TC4404:	Dual Open-Drain MOSFET Driver		
	TC4405:	Dual Open-Drain MOSFET Driver		
Temperature Range:	C	=	0°C to +70°C	
	E	=	-40°C to +85°C	
Package:	OA	=	Plastic Small Outline (3.90 mm Body),8-Lead, SOIC	
	PA	=	Plastic Dual In-Line (300 mil Body), 8-Lead, PDIP	
	OA713	=	Plastic Small Outline (3.90 mm Body),8-Lead, SOIC	
			(Tape and Reel)	

Examples:

a) TC4404COA: 1.5A Dual Open-Drain MOSFET Driver, 0°C to +70°C, 8LD SOIC Package

b) TC4404EOA: 1.5A Dual Open-Drain MOSFET Driver, -40°C to +85°C, 8LD SOIC Package

c) TC4404CPA: 1.5A Dual Open-Drain MOSFET Driver, 0°C to +70°C, 8LD PDIP Package

d) TC4405EPA: 1.5A Dual Open-Drain MOSFET Driver, -40°C to +85°C, 8LD PDIP Package

e) TC4404EOA713: 1.5A Dual Open-Drain MOSFET Driver, -40°C to +85°C, 8LD SOIC Package, Tape and Reel

TC4404/TC4405

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 provided only for your convenience and may be superseded by updates. It is your responsibility to ensure that your application meets with your specifications. MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION, INCLUDING BUT NOT LIMITED TO ITS CONDITION, QUALITY, PERFORMANCE, MERCHANTABILITY OR FITNESS FOR PURPOSE. Microchip disclaims all liability arising from this information and its use. Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

Microchip received ISO/TS-16949:2009 certification for its worldwide headquarters, design and wafer fabrication facilities in Chandler and Tempe, Arizona; Gresham, Oregon and design centers in California and India. The Company's quality system processes and procedures are for its PIC® MCUs and dsPIC® DSCs, 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.

QUALITY MANAGEMENT SYSTEM
CERTIFIED BY DNV
== ISO/TS 16949 ==

Trademarks

The Microchip name and logo, the Microchip logo, AnyRate, dsPIC, FlashFlex, flexPWR, Helder, JukeBlox, KeeLoq, KeeLoq logo, Klear, LANCheck, LINK MD, MediaLB, MOST, MOST logo, MPLAB, OptoLyzer, PIC, PICSTART, PIC32 logo, RightTouch, SpyNIC, SST, SST Logo, SuperFlash and UNI/O are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

ClockWorks, The Embedded Control Solutions Company, ETHERSYNCH, Hyper Speed Control, HyperLight Load, IntelliMOS, mTouch, Precision Edge, and QUIET-WIRE are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, BodyCom, chipKIT, chipKIT logo, CodeGuard, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, EtherGREEN, In-Circuit Serial Programming, ICSP, Inter-Chip Connectivity, JitterBlocker, KlearNet, KlearNet logo, MiWi, motorBench, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PureSilicon, RightTouch logo, REAL ICE, Ripple Blocker, Serial Quad I/O, SQL, SuperSwitcher, SuperSwitcher II, Total Endurance, TSHARC, USBCheck, VariSense, ViewSpan, WiperLock, Wireless DNA, and ZENA 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.

Silicon Storage Technology is a registered trademark of Microchip Technology Inc. in other countries.

GestIC is a registered trademarks of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

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

© 2002-2016, Microchip Technology Incorporated, Printed in the U.S.A., All Rights Reserved.

ISBN: 978-1-5224-0445-3



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://www.microchip.com/
support](http://www.microchip.com/support)

Web Address:

www.microchip.com

Atlanta

Duluth, GA

Tel: 678-957-9614

Fax: 678-957-1455

Austin, TX

Tel: 512-257-3370

Boston

Westborough, MA

Tel: 774-760-0087

Fax: 774-760-0088

Chicago

Itasca, IL

Tel: 630-285-0071

Fax: 630-285-0075

Cleveland

Independence, OH

Tel: 216-447-0464

Fax: 216-447-0643

Dallas

Addison, TX

Tel: 972-818-7423

Fax: 972-818-2924

Detroit

Novi, MI

Tel: 248-848-4000

Houston, TX

Tel: 281-894-5983

Indianapolis

Noblesville, IN

Tel: 317-773-8323

Fax: 317-773-5453

Los Angeles

Mission Viejo, CA

Tel: 949-462-9523

Fax: 949-462-9608

New York, NY

Tel: 631-435-6000

San Jose, CA

Tel: 408-735-9110

Canada - Toronto

Tel: 905-673-0699

Fax: 905-673-6509

ASIA/PACIFIC

Asia Pacific Office

Suites 3707-14, 37th Floor
Tower 6, The Gateway
Harbour City, Kowloon

Hong Kong

Tel: 852-2943-5100

Fax: 852-2401-3431

Australia - Sydney

Tel: 61-2-9868-6733

Fax: 61-2-9868-6755

China - Beijing

Tel: 86-10-8569-7000

Fax: 86-10-8528-2104

China - Chengdu

Tel: 86-28-8665-5511

Fax: 86-28-8665-7889

China - Chongqing

Tel: 86-23-8980-9588

Fax: 86-23-8980-9500

China - Dongguan

Tel: 86-769-8702-9880

China - Hangzhou

Tel: 86-571-8792-8115

Fax: 86-571-8792-8116

China - Hong Kong SAR

Tel: 852-2943-5100

Fax: 852-2401-3431

China - Nanjing

Tel: 86-25-8473-2460

Fax: 86-25-8473-2470

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: 86-755-8864-2200

Fax: 86-755-8203-1760

China - Wuhan

Tel: 86-27-5980-5300

Fax: 86-27-5980-5118

China - Xian

Tel: 86-29-8833-7252

Fax: 86-29-8833-7256

ASIA/PACIFIC

China - Xiamen

Tel: 86-592-2388138

Fax: 86-592-2388130

China - Zhuhai

Tel: 86-756-3210040

Fax: 86-756-3210049

India - Bangalore

Tel: 91-80-3090-4444

Fax: 91-80-3090-4123

India - New Delhi

Tel: 91-11-4160-8631

Fax: 91-11-4160-8632

India - Pune

Tel: 91-20-3019-1500

Japan - Osaka

Tel: 81-6-6152-7160

Fax: 81-6-6152-9310

Japan - Tokyo

Tel: 81-3-6880-3770

Fax: 81-3-6880-3771

Korea - Daegu

Tel: 82-53-744-4301

Fax: 82-53-744-4302

Korea - Seoul

Tel: 82-2-554-7200

Fax: 82-2-558-5932 or

82-2-558-5934

Malaysia - Kuala Lumpur

Tel: 60-3-6201-9857

Fax: 60-3-6201-9859

Malaysia - Penang

Tel: 60-4-227-8870

Fax: 60-4-227-4068

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: 886-3-5778-366

Fax: 886-3-5770-955

Taiwan - Kaohsiung

Tel: 886-7-213-7828

Taiwan - Taipei

Tel: 886-2-2508-8600

Fax: 886-2-2508-0102

Thailand - Bangkok

Tel: 66-2-694-1351

Fax: 66-2-694-1350

EUROPE

Austria - Wels

Tel: 43-7242-2244-39

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 - Dusseldorf

Tel: 49-2129-3766400

Germany - Karlsruhe

Tel: 49-721-625370

Germany - Munich

Tel: 49-89-627-144-0

Fax: 49-89-627-144-44

Italy - Milan

Tel: 39-0331-742611

Fax: 39-0331-466781

Italy - Venice

Tel: 39-049-7625286

Netherlands - Drunen

Tel: 31-416-690399

Fax: 31-416-690340

Poland - Warsaw

Tel: 48-22-3325737

Spain - Madrid

Tel: 34-91-708-08-90

Fax: 34-91-708-08-91

Sweden - Stockholm

Tel: 46-8-5090-4654

UK - Wokingham

Tel: 44-118-921-5800

Fax: 44-118-921-5820

07/14/15