MCP14E3/MCP14E4/MCP14E5

4.0A Dual High-Speed Power MOSFET Drivers With Enable

Features

- Passes Automotive AEC-Q100 Reliability Testing
- High Peak Output Current: 4.0A (typical)
- Independent Enable Function for Each Driver Output
- Low Shoot-Through/Cross-Conduction Current in Output Stage
- Wide Input Supply Voltage Operating Range:
  - 4.5V to 18V
- High Capacitive Load Drive Capability:
  - 2200 pF in 15 ns (typical)
  - 5600 pF in 26 ns (typical)
- Short Delay Times: 50 ns (typical)
- Latch-Up Protected: Will Withstand 1.5A Reverse Current
- Logic Input Will Withstand Negative Swing Up To 5V
- Space-Saving Packages:
  - 8-Lead 6x5 DFN-S, PDIP, SOIC

Applications

- Switch Mode Power Supplies
- Pulse Transformer Drive
- Line Drivers
- Motor and Solenoid Drive

General Description

The MCP14E3/MCP14E4/MCP14E5 devices are a family of 4.0A buffers/MOSFET drivers. Dual-inverting, dual-noninvertering, and complementary outputs are standard logic options offered.

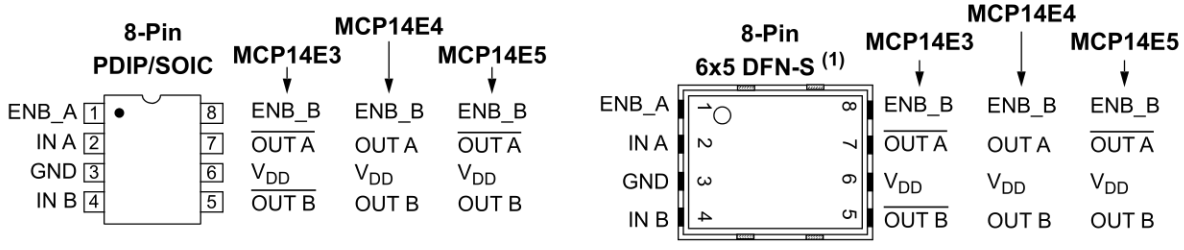
The MCP14E3/MCP14E4/MCP14E5 drivers are capable of operating from a 4.5V to 18V single power supply and can easily charge and discharge 2200 pF gate capacitance in under 15 ns (typical). They provide low impedance in both the ON and OFF states to ensure the MOSFET's intended state will not be affected, even by large transients. The MCP14E3/MCP14E4/MCP14E5 inputs may be driven directly from either TTL or CMOS (2.4V to 18V).

Additional control of the MCP14E3/MCP14E4/MCP14E5 outputs is allowed by the use of separate enable functions. The ENB_A and ENB_B pins are active high and are internally pulled up to V_{DD}. The pins maybe left floating for standard operation.

The MCP14E3/MCP14E4/MCP14E5 dual-output 4.0A driver family is offered in both surface-mount and pin-through-hole packages with a –40°C to +125°C temperature rating. The low thermal resistance of the thermally enhanced DFN-S package allows for greater power dissipation capability for driving heavier capacitive or resistive loads.

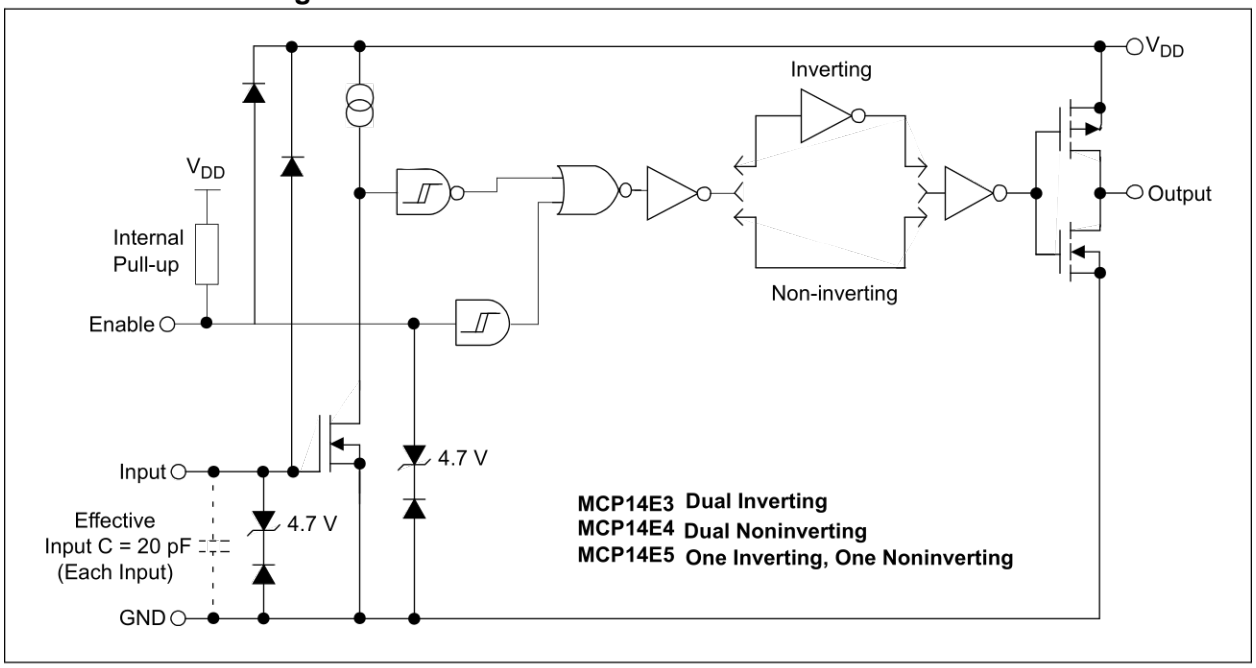
These devices are highly latch-up resistant under any conditions within their power and voltage ratings. They are not subject to damage when up to 5V of noise spiking (of either polarity) occurs on the ground pin. They can accept, without damage or logic upset, up to 1.5A of reverse current being forced back into their outputs. All terminals are fully protect against Electrostatic Discharge (ESD) up to 4 kV.

Package Types



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

Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings†

Supply Voltage ..... +20V
Input Voltage ..... (V_{DD} + 0.3V) to (GND – 5V)
Enable Voltage ..... (V_{DD} + 0.3V) to (GND – 5V)
Input Current (V_{IN}>V_{DD}) ..... 50 mA
Package Power Dissipation (T_A = 50°C)
8L-DFN-S ..... **Note 3**
8L-PDIP 1.10W
8L-SOIC ..... 665 mW

† **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}	—	2.5	3.5	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Output Resistance, Low	R_{OL}	—	2.5	3.0	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Peak Output Current	I_{PK}	—	4.0	—	A	V_{DD} = 18V **(Note 2)**
Latch-Up Protection Withstand Reverse Current	I_{REV}	—	>1.5	—	A	Duty cycle ≤ 2%, t ≤ 300 µs
Switching Time (Note 1)						
Rise Time	t_R	—	15	30	ns	**Figure 4-1, Figure 4-2** C_L = 2200 pF
Fall Time	t_F	—	18	30	ns	**Figure 4-1, Figure 4-2** C_L = 2200 pF
Propagation Delay Time	t_{D1}	—	46	55	ns	**Figure 4-1, Figure 4-2**
Propagation Delay Time	t_{D2}	—	50	55	ns	**Figure 4-1, Figure 4-2**
Enable Function (ENB_A, ENB_B)						
High-Level Input Voltage	V_{EN_H}	1.60	1.90	2.90	V	V_{DD} = 12V, LO to HI Transition
Low-Level Input Voltage	V_{EN_L}	1.30	2.20	2.40	V	V_{DD} = 12V, HI to LO Transition
Hysteresis	V_{HYST}	0.10	0.30	0.60	V	
Enable Leakage Current	I_{ENBL}	40	85	115	µA	V_{DD} = 12V, ENB_A = ENB_B = GND
Propagation Delay Time	t_{D3}	—	60	—	ns	Figure 4-3 **(Note 1)**

Note 1: Switching times ensured by design.
2: Tested during characterization, not production tested.
3: Package power dissipation is dependent on the copper pad area on the PCB.

DC CHARACTERISTICS (Note 2) (CONTINUED)

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

Parameters	Sym	Min	Typ	Max	Units	Conditions
Propagation Delay Time	t_{D4}	—	50	—	ns	Figure 4-3 **(Note 1)**
Power Supply						
Supply Voltage	V_{DD}	4.5	—	18.0	V	
Supply Current	I_{DD}	—	1.60	2.00	mA	V_{IN_A} = 3V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	0.60	0.90	mA	V_{IN_A} = 0V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	1.20	1.40	mA	V_{IN_A} = 3V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	1.20	1.40	mA	V_{IN_A} = 0V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	1.40	1.80	mA	V_{IN_A} = 3V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low
	I_{DD}	—	0.55	0.75	mA	V_{IN_A} = 0V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low
	I_{DD}	—	1.00	1.20	mA	V_{IN_A} = 3V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low
	I_{DD}	—	1.00	1.20	mA	V_{IN_A} = 0V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low

Note 1: Switching times ensured by design.

2: Tested during characterization, not production tested.

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

DC CHARACTERISTICS (OVER OPERATING TEMP. 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}	—	3.0	6.0	Ω	I_{OUT} = 10 mA, V_{DD} = 18V
Output Resistance, Low	R_{OL}	—	3.0	5.0	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	—	28	40	ns	**Figure 4-1**, **Figure 4-2** C_L = 2200 pF
Delay Time	t_{D1}	—	50	70	ns	**Figure 4-1**, **Figure 4-2**
Delay Time	t_{D2}	—	50	70	ns	**Figure 4-1**, **Figure 4-2**

Note 1: Switching times ensured by design.

DC CHARACTERISTICS (OVER OPERATING TEMP. RANGE) (CONTINUED)

Electrical Specifications: Unless otherwise indicated, operating temperature range with 4.5V ≤ V_{DD} ≤ 18V.						
Parameters	**Sym**	**Min**	**Typ**	**Max**	**Units**	**Conditions**
Enable Function (ENB_A, ENB_B)						
High-Level Input Voltage	V_{EN_H}	1.60	2.20	2.90	V	V_{DD} = 12V, LO to HI Transition
Low-Level Input Voltage	V_{EN_L}	1.30	1.80	2.40	V	V_{DD} = 12V, HI to LO Transition
Hysteresis	V_{HYST}	—	0.40	—	V	
Enable Leakage Current	I_{ENBL}	40	87	115	µA	V_{DD} = 12V, ENB_A = ENB_B = GND
Propagation Delay Time	t_{D3}	—	50	—	ns	Figure 4-3
Propagation Delay Time	t_{D4}	—	60	—	ns	Figure 4-3
Power Supply						
Supply Voltage	V_{DD}	4.5	—	18.0	V	
Supply Current	I_{DD}	—	2.0	3.0	mA	V_{IN_A} = 3V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	0.8	1.1	mA	V_{IN_A} = 0V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	1.5	2.0	mA	V_{IN_A} = 3V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	1.5	2.0	mA	V_{IN_A} = 0V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = High
	I_{DD}	—	1.8	2.8	mA	V_{IN_A} = 3V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low
	I_{DD}	—	0.6	0.8	mA	V_{IN_A} = 0V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low
	I_{DD}	—	1.1	1.8	mA	V_{IN_A} = 3V, V_{IN_B} = 0V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low
	I_{DD}	—	1.1	1.8	mA	V_{IN_A} = 0V, V_{IN_B} = 3V, $\overline{ENB\_A}$ = $\overline{ENB\_B}$ = Low

Note 1: Switching times ensured by design.

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}	—	35.7	—	°C/W	Typical four-layer board with vias to ground plane
Thermal Resistance, 8L-PDIP	θ_{JA}	—	89.3	—	°C/W	
Thermal Resistance, 8L-SOIC	θ_{JA}	—	149.5	—	°C/W	

2.0 TYPICAL PERFORMANCE CURVES

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

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

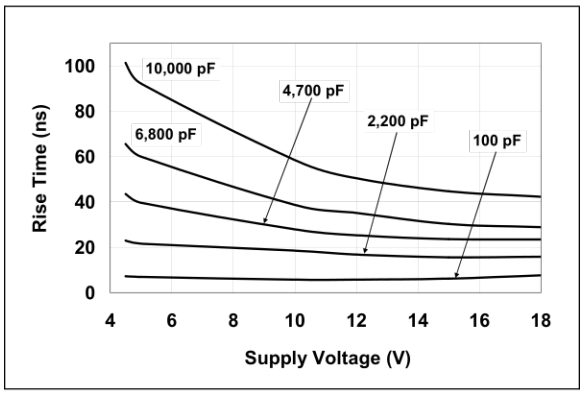


FIGURE 2-1: *Rise Time vs. Supply Voltage.*

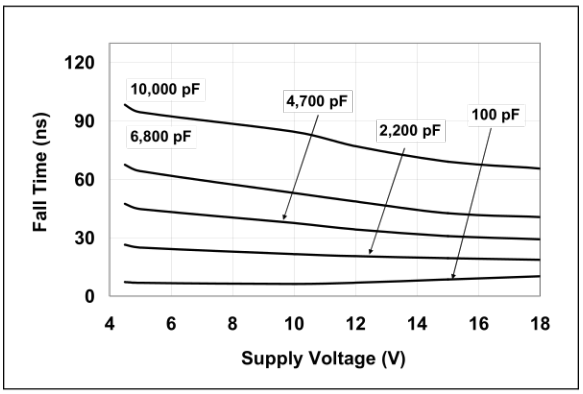


FIGURE 2-4: *Fall Time vs. Supply Voltage.*

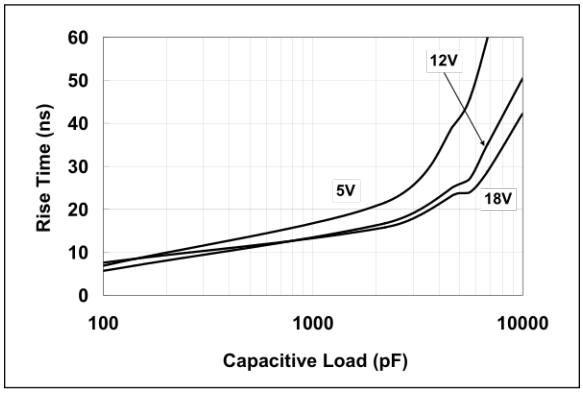


FIGURE 2-2: *Rise Time vs. Capacitive Load.*

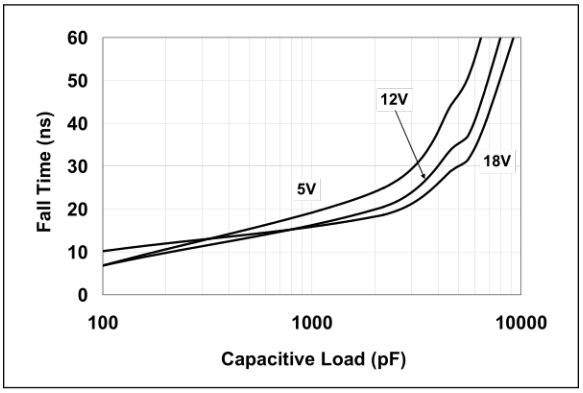


FIGURE 2-5: *Fall Time vs. Capacitive Load.*

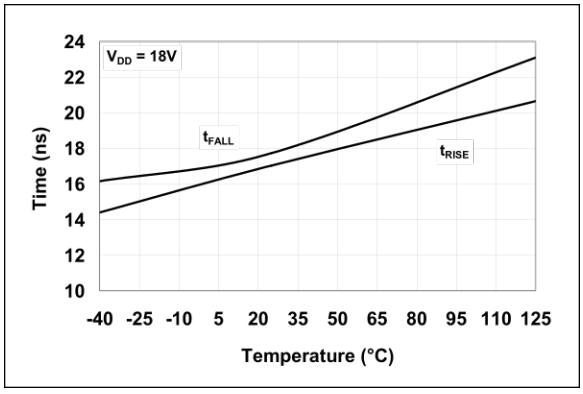


FIGURE 2-3: *Rise and Fall Times vs. Temperature.*

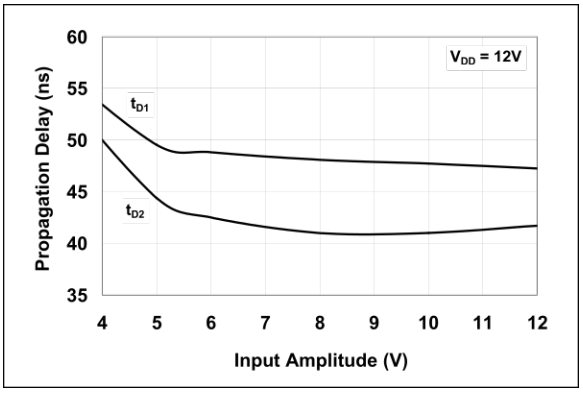


FIGURE 2-6: *Propagation Delay vs. Input Amplitude.*

Typical Performance Curves (Continued)

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

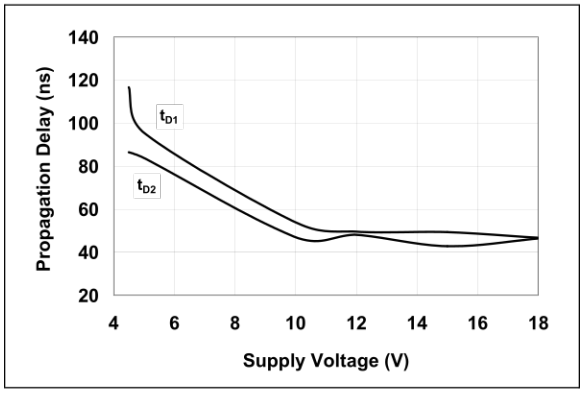


FIGURE 2-7: *Propagation Delay Time vs. Supply Voltage.*

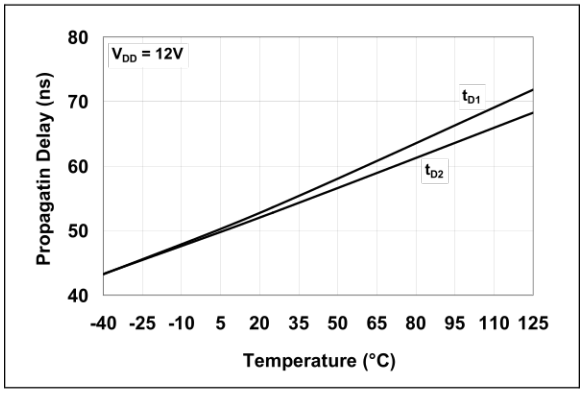


FIGURE 2-10: *Propagation Delay Time vs. Temperature.*

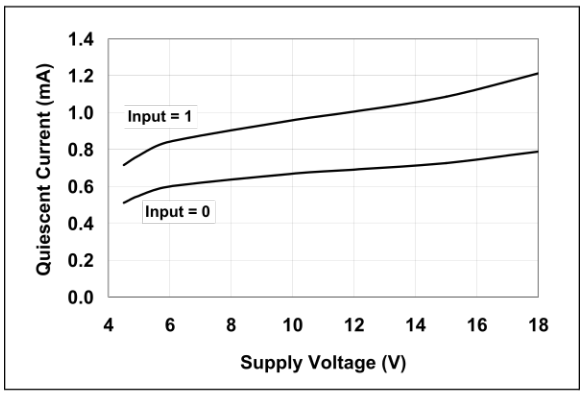


FIGURE 2-8: *Quiescent Current vs. Supply Voltage.*

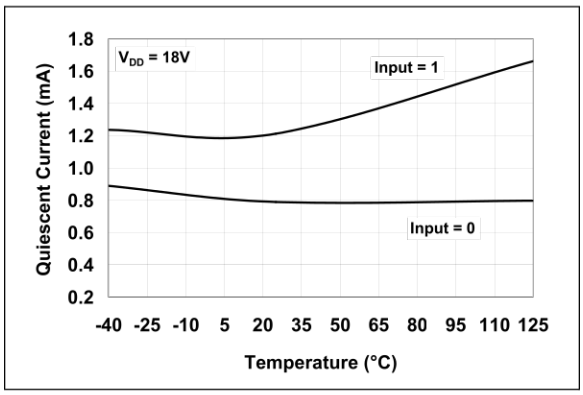


FIGURE 2-11: *Quiescent Current vs. Temperature.*

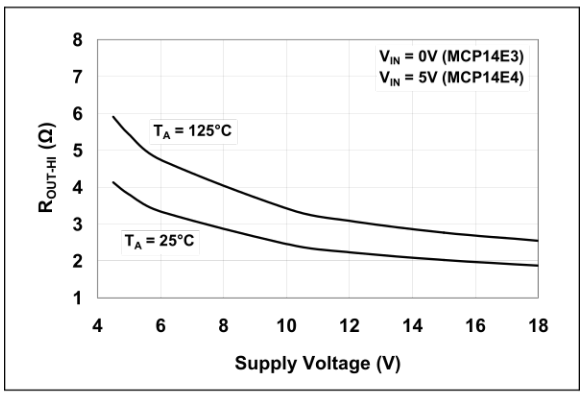


FIGURE 2-9: *Output Resistance (Output High) vs. Supply Voltage.*

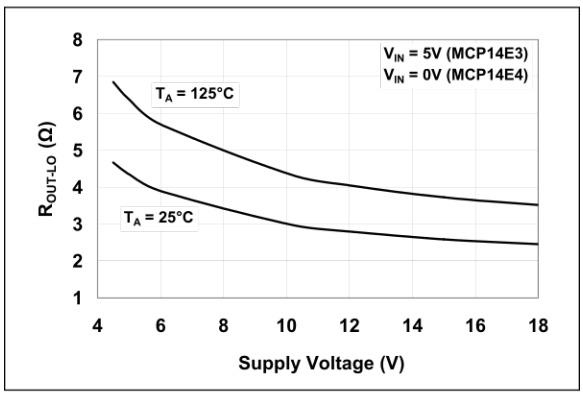


FIGURE 2-12: *Output Resistance (Output Low) vs. Supply Voltage.*

Typical Performance Curves (Continued)

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

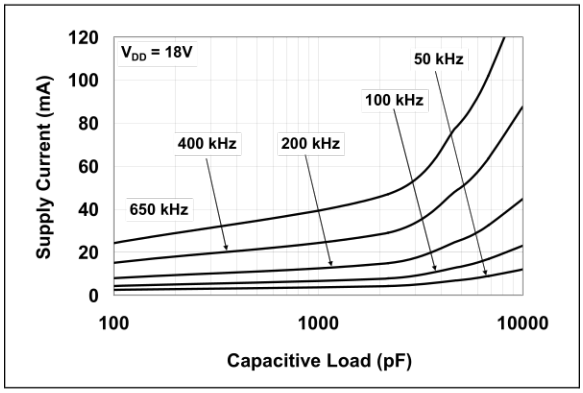


FIGURE 2-13: *Supply Current vs. Capacitive Load.*

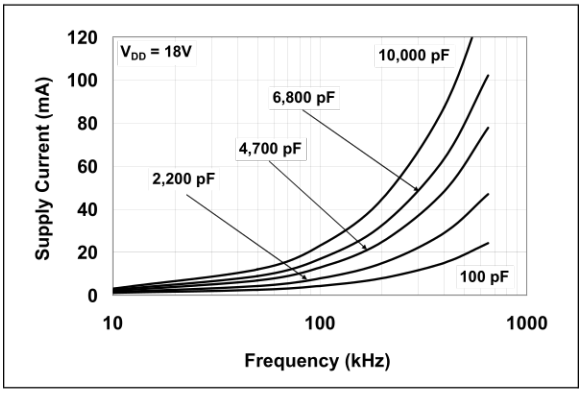


FIGURE 2-16: *Supply Current vs. Frequency.*

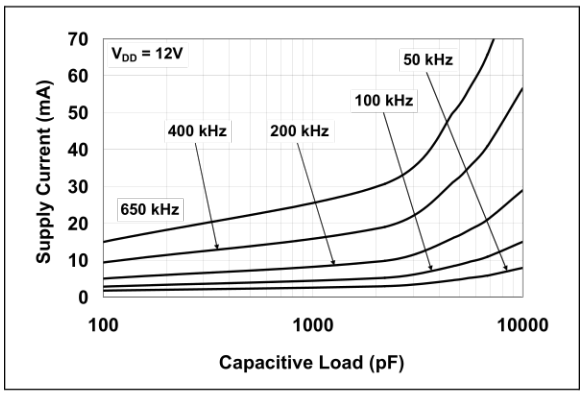


FIGURE 2-14: *Supply Current vs. Capacitive Load.*

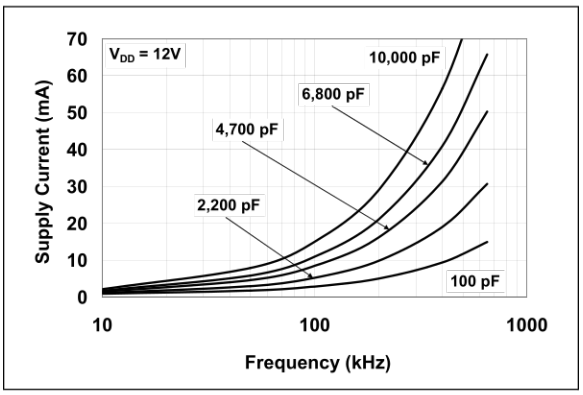


FIGURE 2-17: *Supply Current vs. Frequency.*

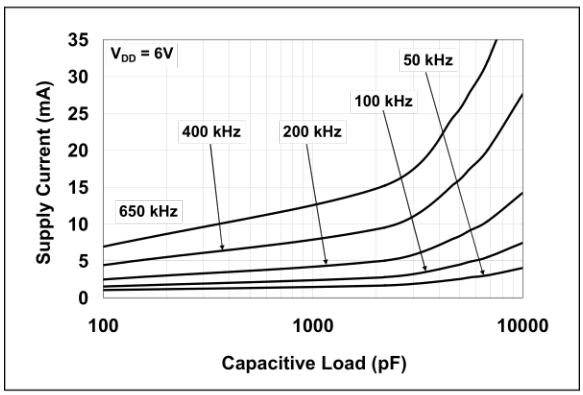


FIGURE 2-15: *Supply Current vs. Capacitive Load.*

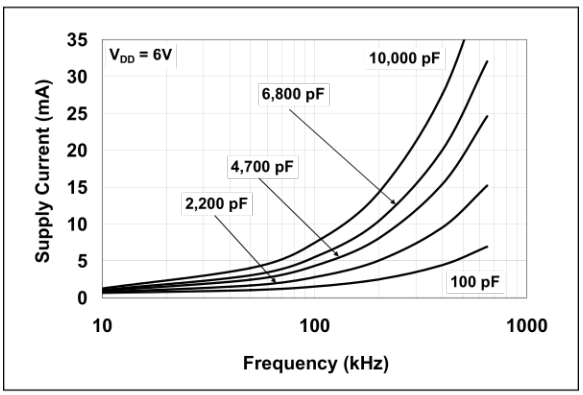


FIGURE 2-18: *Supply Current vs. Frequency.*

Typical Performance Curves (Continued)

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

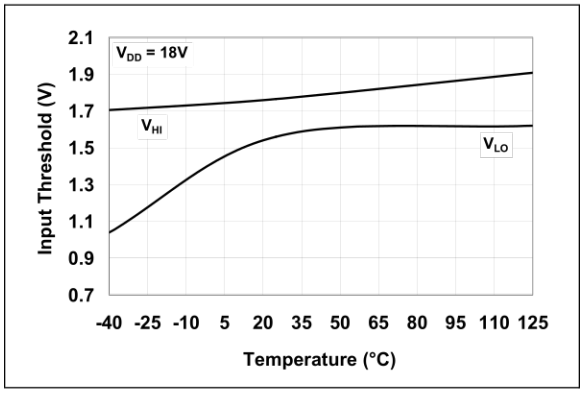


FIGURE 2-19: *Input Threshold vs. Temperature.*

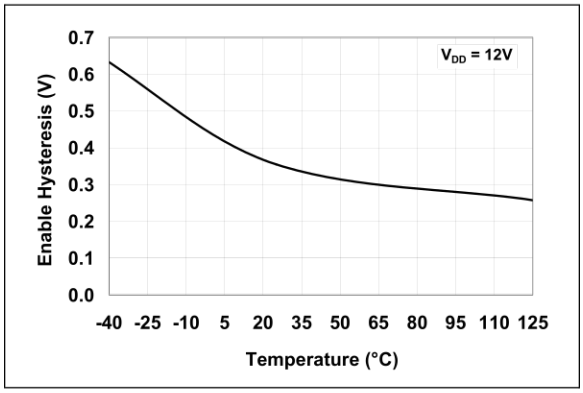


FIGURE 2-22: *Enable Hysteresis vs. Temperature.*

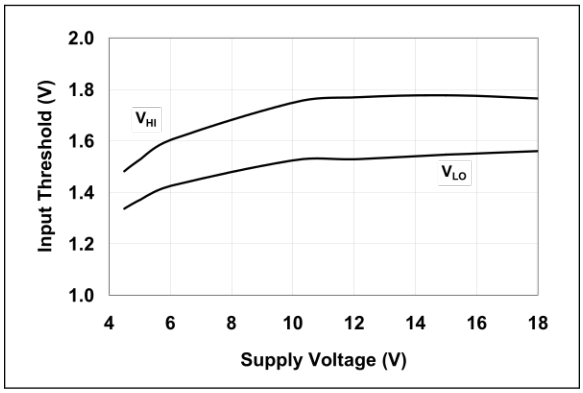


FIGURE 2-20: *Input Threshold vs. Supply Voltage.*

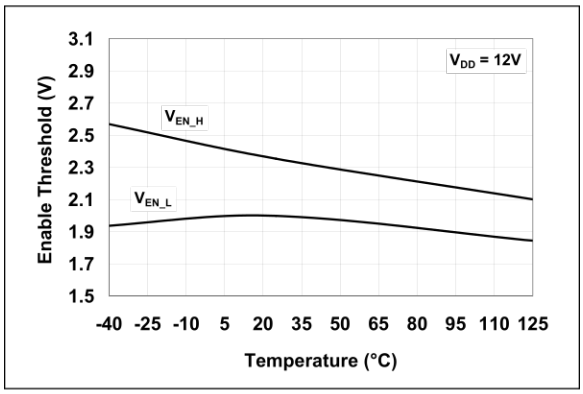
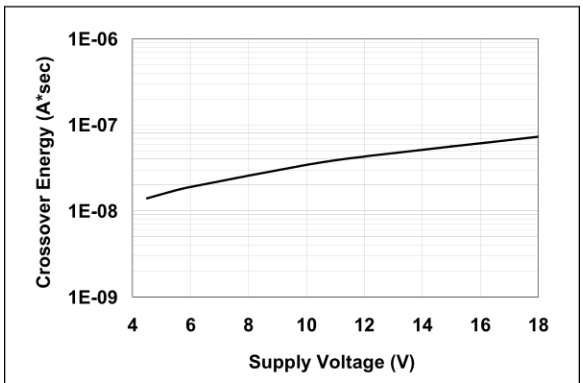


FIGURE 2-21: *Enable Threshold vs. Temperature.*



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 signal transition of a single driver, divide the state value by 4.

FIGURE 2-23: *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

8-Pin PDIP, SOIC	8-Pin 6x5 DFN-S	Symbol	Description
1	1	ENB_A	Output A Enable
2	2	IN A	Input A
3	3	GND	Ground
4	4	IN B	Input B
5	5	OUT B	Output B
6	6	V_{DD}	Supply Input
7	7	OUT A	Output A
8	8	ENB_B	Output B Enable
—	PAD	NC	Exposed Metal Pad

Note: Duplicate pins must be connected for proper operation.

3.1 Control Inputs A and B

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

3.2 Outputs A and B

Outputs A and B are CMOS push-pull outputs that are capable of sourcing and sinking 4.0A of peak current (V_{DD} = 18V). The low output impedance ensures the gate of the MOSFET will stay in the intended state even during large transients. These outputs also have a reverse latch-up rating of 1.5A.

3.3 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 ceramic capacitor. This bypass capacitor provides a localized low-impedance path for the peak currents that are to be provided to the load.

3.4 Ground (GND)

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

3.5 Enable A (ENB_A)

The ENB_A pin is the enable control for Output A. This enable pin is internally pulled up to V_{DD} for active high operation and can be left floating for standard operation. When the ENB_A pin is pulled below the enable pin Low Level Input Voltage (V_{EN_L}), Output A will be in the off state regardless of the input pin state.

3.6 Enable B (ENB_B)

The ENB_B pin is the enable control for Output B. This enable pin is internally pulled up to V_{DD} for active high operation and can be left floating for standard operation. When the ENB_B pin is pulled below the enable pin Low-Level Input Voltage (V_{EN_L}), Output B will be in the off state regardless of the input pin state.

3.7 DFN-S Exposed Pad

The exposed metal pad of the DFN-S 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 MCP14E3/MCP14E4/MCP14E5 family can be used to provide additional source/sink current capability.

An additional degree of control has been added to the MCP14E3/MCP14E4/MCP14E5 family. There are separate enable functions for each driver that allow for the immediate termination of the output pulse regardless of the state of the input signal.

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 MCP14E3/MCP14E4/MCP14E5 family of drivers can typically charge and discharge a 2200 pF load capacitance in 15 ns along with a typical matched propagation delay of 50 ns. Figure 4-1 and Figure 4-2 show the test circuit and timing waveform used to verify the MCP14E3/MCP14E4/MCP14E5 timing.

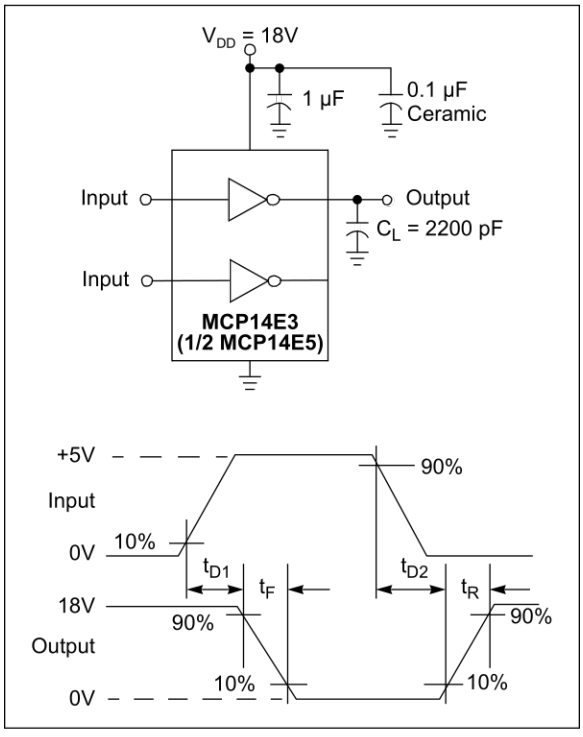


FIGURE 4-1: *Inverting Driver Timing Waveform.*

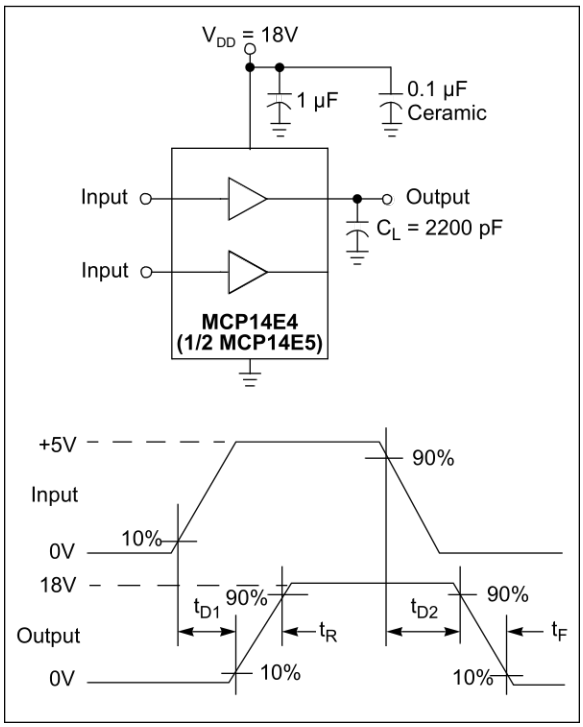


FIGURE 4-2: *Non-Inverting Driver Timing Waveform.*

4.3 Enable Function

The ENB_A and ENB_B enable pins allow for independent control of OUT A and OUT B respectively. They are active high and are internally pulled up to V_{DD} so that the default state is to enable the driver. These pins can be left floating for normal operation.

When an enable pin voltage is above the enable pin high threshold voltage, V_{EN_H} (2.4V typical), that driver output is enabled and allowed to react to changes in the INPUT pin voltage state. Likewise, when the enable pin voltage falls below the enable pin low threshold voltage, V_{EN_L} (2.0V typical), that driver output is disabled and does not respond the changes in the INPUT pin voltage state. When the driver is disabled, the output goes to a low state. Refer to Table 4-1 for enable pin logic. The threshold voltages of the enable function are compatible with logic levels. Hysteresis is provided to help increase the noise immunity of the enable function, avoiding false triggers of the enable signal during driver switching. For robust designs, it is recommended that the slew rate of the enable pin signal be greater than 1 V/ns.

There are propagation delays associated with the driver receiving an enable signal and the output reacting. These propagation delays, t_{D3} and t_{D4}, are graphically represented in Figure 4-3.

TABLE 4-1: ENABLE PIN LOGIC

				MCP14E3		MCP14E4		MCP14E5	
ENB_A	ENB_B	IN A	IN B	OUT A	OUT B	OUT A	OUT B	OUT A	OUT B
H	H	H	H	L	L	H	H	L	H
H	H	H	L	L	H	H	L	L	L
H	H	L	H	H	L	L	H	H	H
H	H	L	L	H	H	L	L	H	L
L	L	X	X	L	L	L	L	L	L

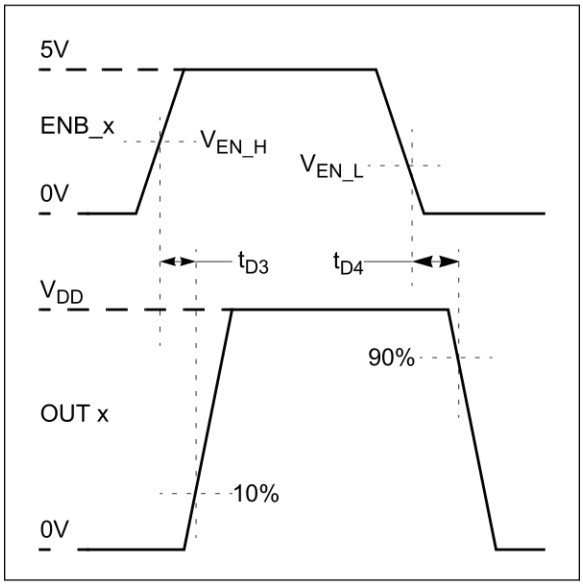


FIGURE 4-3: *Enable Timing Waveform.*

4.4 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 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.

4.5 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 MCP14E3/MCP14E4/MCP14E5 will help as a radiated noise shield as well as providing some heat sinking for power dissipated within the device.

4.6 Power Dissipation

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

EQUATION 4-1:

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

Where:

P_T	=	Total power dissipation
P_L	=	Load power dissipation
P_Q	=	Quiescent power dissipation
P_{CC}	=	Operating power dissipation

4.6.1 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:

EQUATION 4-2:

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

Where:

f	=	Switching frequency
C_T	=	Total load capacitance
V_{DD}	=	MOSFET driver supply voltage

4.6.2 QUIESCENT POWER DISSIPATION

The power dissipation associated with the quiescent current draw of the MCP14E3/MCP14E4/MCP14E5 depends upon the state of the input and enable pins. Refer to the DC Characteristic table for the quiescent current draw for specific combinations of input and enable pin states. The quiescent power dissipation is:

EQUATION 4-3:

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

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

4.6.3 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:

EQUATION 4-4:

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

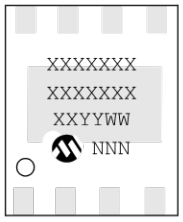
Where:

CC	=	Cross-conduction constant (A*sec)
f	=	Switching frequency
V_{DD}	=	MOSFET driver supply voltage

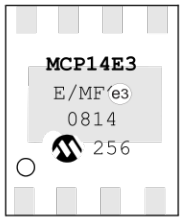
5.0 PACKAGING INFORMATION

5.1 Package Marking Information (Not to Scale)

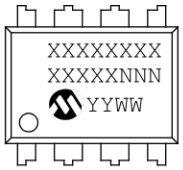
8-Lead DFN-S (6 mm x 5 mm)



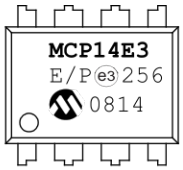
Example:



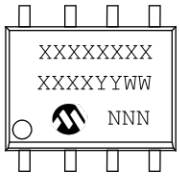
8-Lead PDIP (300 mil)



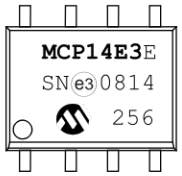
Example:



8-Lead SOIC (3.90 mm)



Example:

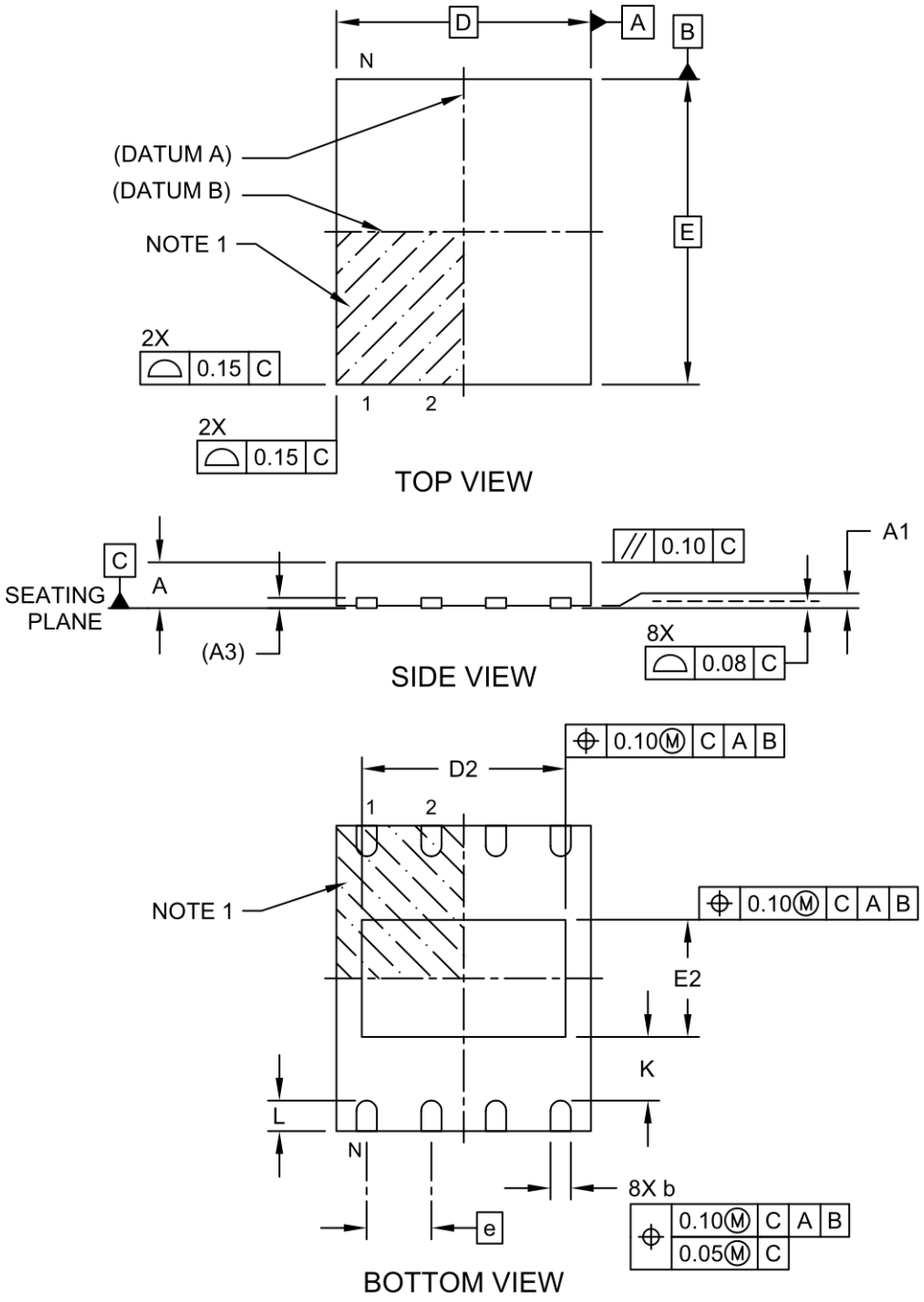


Legend:	XX...X	Product Code or Customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC designator for Matte Tin (Sn)
	*	This package is 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. Package may or not include the corporate logo.

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

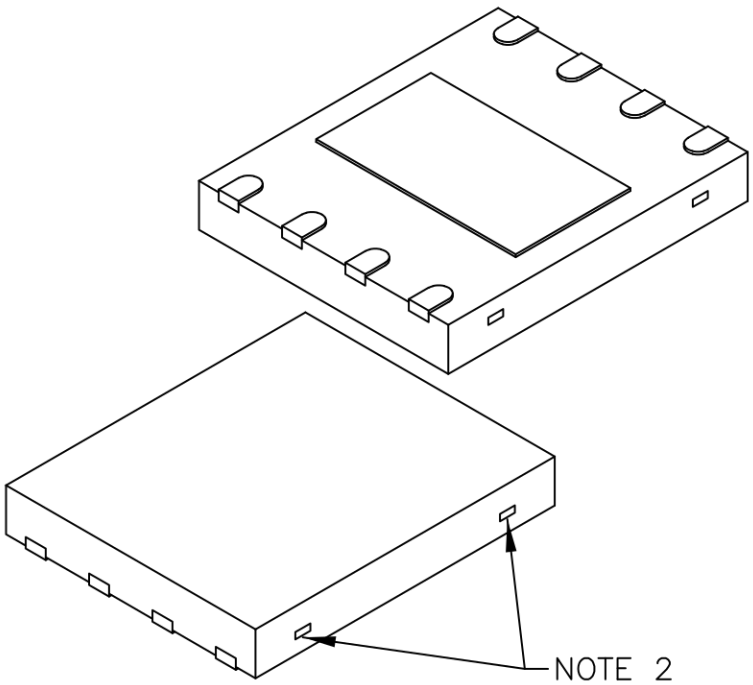
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-122 Rev D Sheet 1 of 2

8-Lead Plastic Dual Flat, No Lead Package (MF) - 6x5 mm Body [DFN-S] Saw 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 Terminals	N		8	
Pitch	e		1.27 BSC	
Overall Height	A	0.80	0.85	1.00
Standoff	A1	0.00	0.02	0.05
Terminal Thickness	A3		0.20 REF	
Overall Length	D		5.00 BSC	
Exposed Pad Length	D2	3.90	4.00	4.10
Overall Width	E		6.00 BSC	
Exposed Pad Width	E2	2.20	2.30	2.40
Terminal Width	b	0.30	0.40	0.50
Terminal Length	L	0.50	0.60	0.75
Terminal-to-Exposed-Pad	K	0.20	-	-

Notes:

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

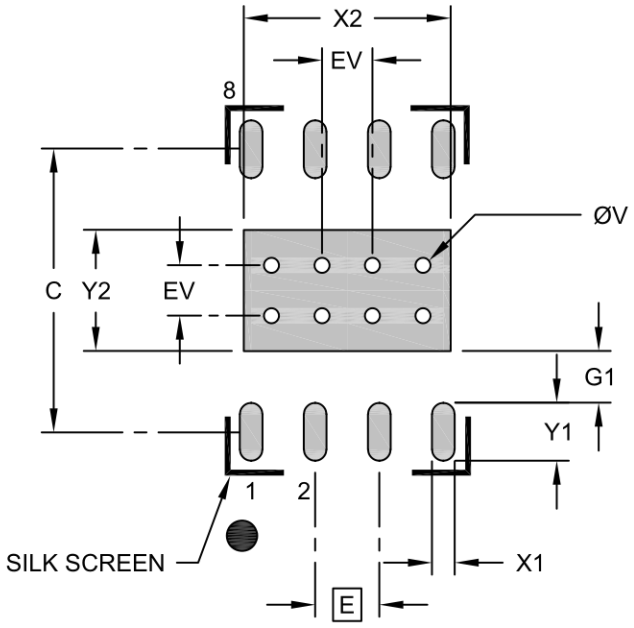
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

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

Microchip Technology Drawing C04-122 Rev D Sheet 2 of 2

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

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	
Optional Center Pad Length	X2			4.10
Optional Center Pad Width	Y2			2.40
Contact Pad Spacing	C		5.60	
Contact Pad Width (X20)	X1			0.45
Contact Pad Length (X20)	Y1			1.15
Contact Pad to Center Pad (X20)	G1	0.20		
Thermal Via Diameter	V		0.30	
Thermal Via Pitch	EV		1.00	

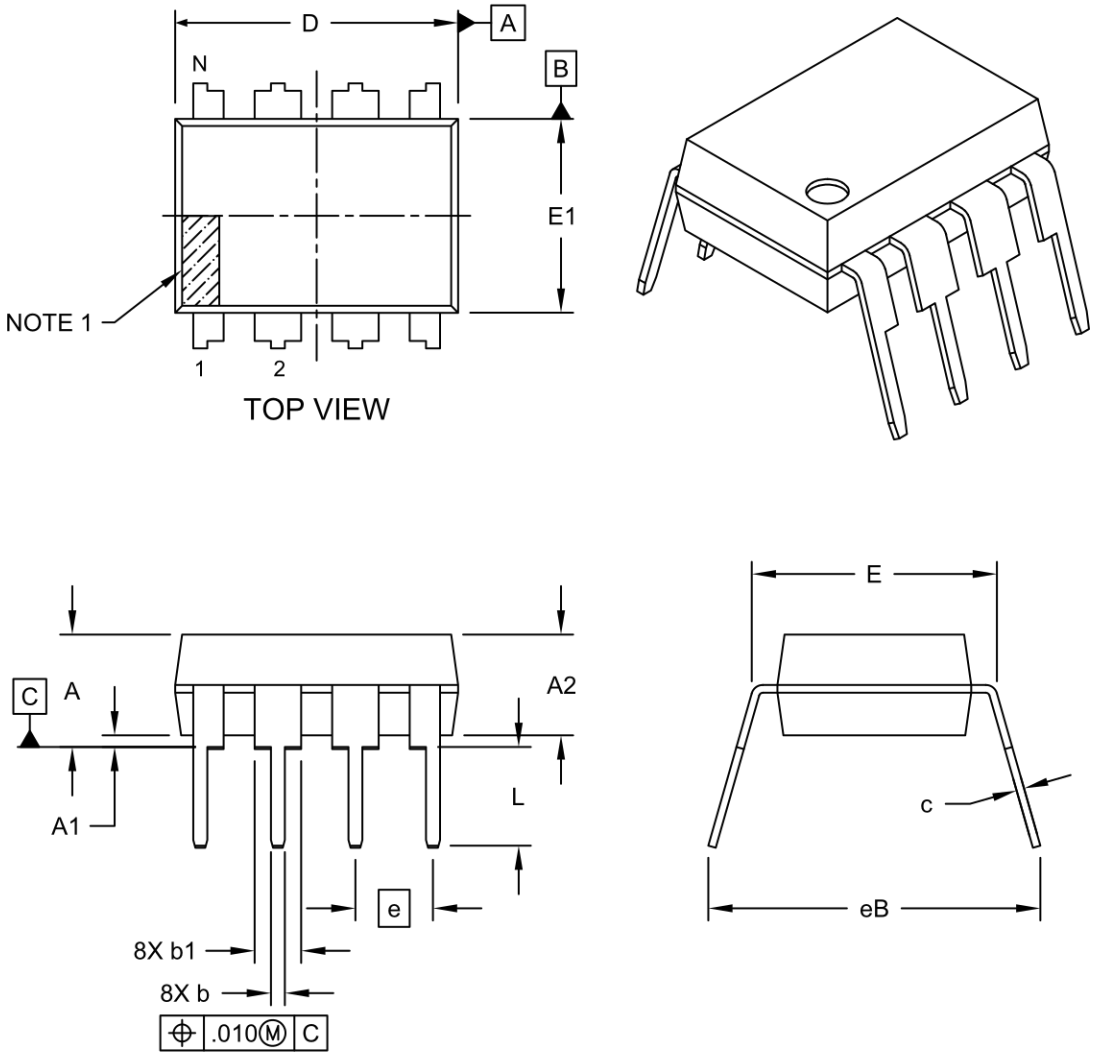
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-2122 Rev D

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

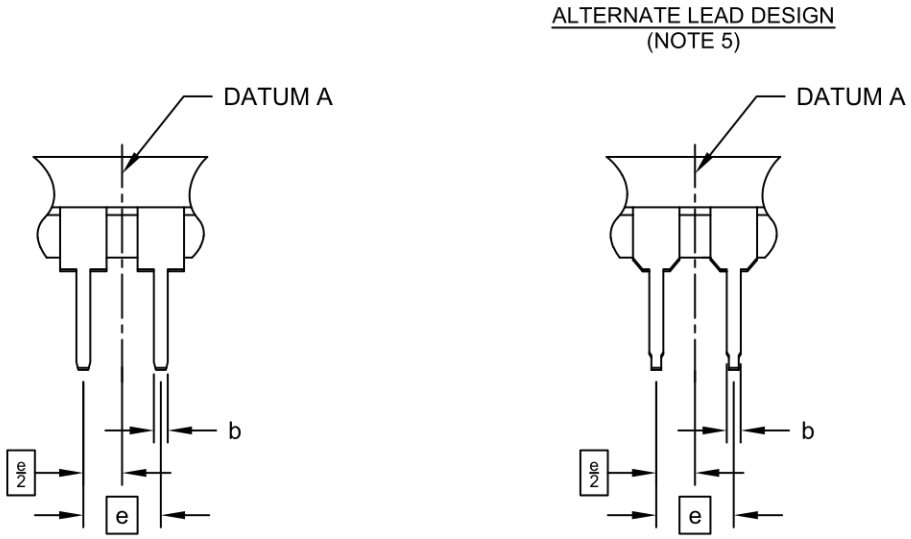
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-018-PA Rev F 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



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

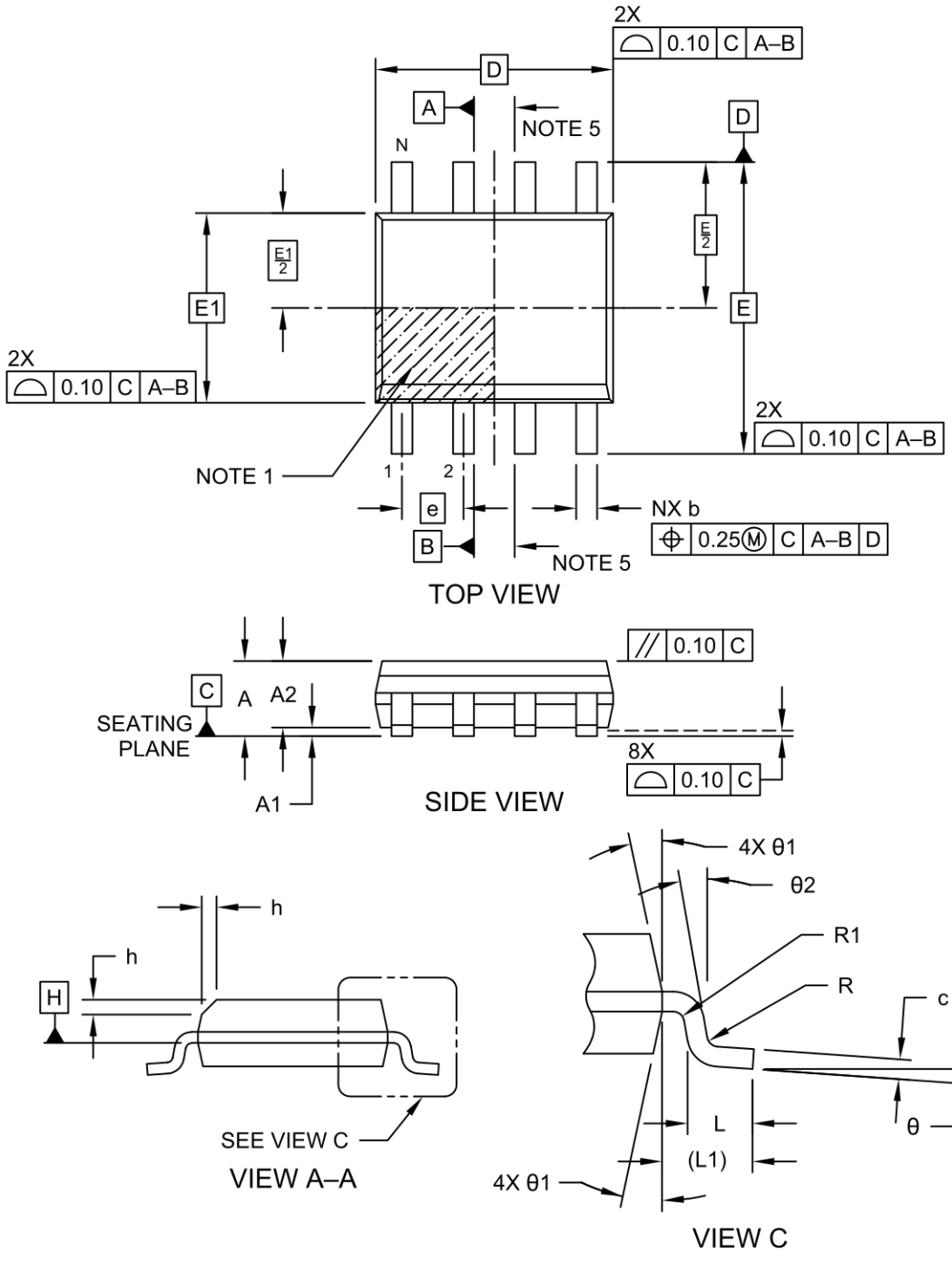
Notes:

1. Pin 1 visual index feature may vary, but must be located 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 .010" per side.
4. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
5. Lead design above seating plane may vary, based on assembly vendor.

Microchip Technology Drawing No. C04-018-PA Rev F Sheet 2 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) Body [SOIC]

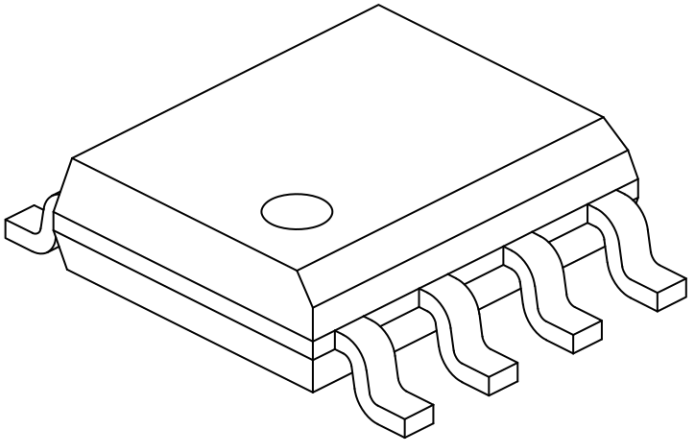
Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing No. C04-057-SN Rev J Sheet 1 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) 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	
Lead Thickness	c	0.17	–	0.25
Lead Width	b	0.31	–	0.51
Lead Bend Radius	R	0.07	–	–
Lead Bend Radius	R1	0.07	–	–
Foot Angle	θ	0°	–	8°
Mold Draft Angle	θ1	5°	–	15°
Lead Angle	θ2	0°	–	8°

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 0.15mm per side.
4. Dimensioning and tolerancing per ASME Y14.5M

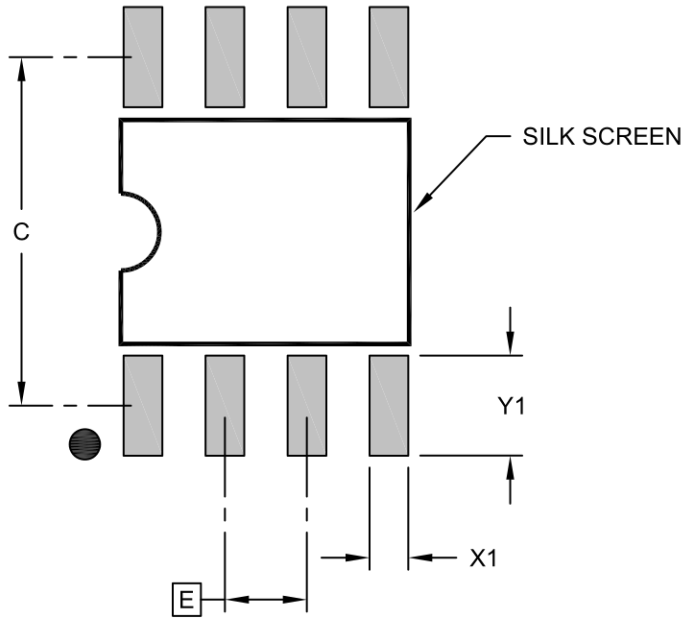
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

   REF: Reference Dimension, usually without tolerance, for information purposes only.
5. Datums A & B to be determined at Datum H.

Microchip Technology Drawing No. C04-057-SN Rev J Sheet 2 of 2

8-Lead Plastic Small Outline (SN) - Narrow, 3.90 mm (.150 In.) 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 C04-2057-SN Rev J

APPENDIX A: REVISION HISTORY

Revision C (November 2022)

- Updated document layout.
- Updated **Section 5.0 "Packaging Information"**.
- Added automotive qualifications to Features and examples to Product Identification System.

Revision B (April 2008)

- Correct examples in Product identification System page.

Revision A (September 2007)

- 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.	[T](1)	-X	/XX	XXX
Device	Tape and Reel	Temperature Range	Package	Qualification

Device:	MCP14E3:	4.0A Dual MOSFET Driver, Inverting
	MCP14E4:	4.0A Dual MOSFET Driver, Non-Inverting
	MCP14E5:	4.0A Dual MOSFET Driver, Complementary
Tape and Reel Option:	(Blank)	= Standard Packaging (tube or tray)
	T	= Tape and Reel(1)
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
		* All package options are Pb Free (Lead Free)
Qualification:	(Blank)	= Standard Part
	VAO	= Automotive AEC-Q100 Qualified
		**All currently available VAO variants are shown in examples (entry f). Contact your local Microchip sales office to request automotive qualified variants for other devices or package types.

Examples:

a) MCP14E3-E/MF: 4.0A Dual Inverting MOSFET Driver, 8LD DFN-S package.

b) MCP14E3-E/P: 4.0A Dual Inverting MOSFET Driver, 8LD PDIP package.

c) MCP14E3T-E/SN: Tape and Reel, 4.0A Dual Inverting MOSFET Driver, 8LD SOIC package.

d) MCP14E4-E/MF:4.0A Dual Non-Inverting MOSFET Driver, 8LD DFN-S package.

e) MCP14E4-E/P: 4.0A Dual Non-Inverting MOSFET Driver, 8LD PDIP package.

f) MCP14E4T-E/SNVAO: Tape and Reel, 4.0A Dual Non-Inverting MOSFET Driver, 8LD SOIC package, Automotive Qualified

g) MCP14E5T-E/MF:Tape and Reel, 4.0A Dual Complementary MOSFET Driver, 8LD DFN-S package.

h) MCP14E5-E/P: 4.0A Dual Complementary MOSFET Driver, 8LD PDIP package.

i) MCP14E5-E/SN: 4.0A Dual Complementary MOSFET Driver, 8LD SOIC package.

Note 1: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

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