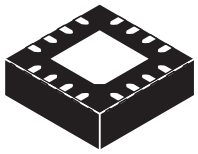
0.4 A Dual H-Bridge Motor Driver IC

17C724

MOTOR DRIVER



EP (Pb-FREE) SUFFIX
98ARL10566D
16-Pin QFN

The 17C724 is a compact monolithic dual channel H-Bridge power IC, ideal for portable electronic applications containing bipolar stepper motors or brush DC motors such as those used in camera lenses and shutters.

The 17C724 can operate efficiently with supply voltages from

2.7 V to 5.5 V and can provide continuous motor drive currents of 0.4 A with low $R_{DS(ON)}$ of 1.0 Ω. It is easily interfaced to low cost MCUs via parallel 3.0 V or 5.0 V compatible logic and has built-in shoot-through current protection circuit and undervoltage detector to avoid malfunction.

The 17C724 has four output control modes: forward, reverse, brake, and tri-state (high-impedance). The H-Bridge outputs are designed to be independently PWM'ed at up to 200 kHz for speed/ torque and current control.

ORDERING INFORMATION		
Device (For Tape and Reel, add an R2 Suffix)	**Temperature Range (T_A)**	**Package**
MPC17C724EP	-20 °C to 85 °C	16 QFN

Features

- Manufactured in SMOS7 process technology
- Built-in 2-channel H-Bridge driver
- Provides 4 driving modes (forward, reverse, break, high-impedance)
- Direct interface to MCU
- Low ON-Resistance, $R_{DS(ON)}$ = 1.0 Ω (typical)
- Dual channel parallel drive, $R_{DS(ON)}$ = 0.5 Ω (typical)
- Output current driver is 400 mA (continuous)
- Low power consumption
- Built-in shoot-through current prevention circuit
- Built-in low voltage shutdown circuit
- PWM control frequency 200 kHz (max)
- Very compact size, comes in 16-pin QFN Package (3x3 mm pin Pitch: 0.5 mm)

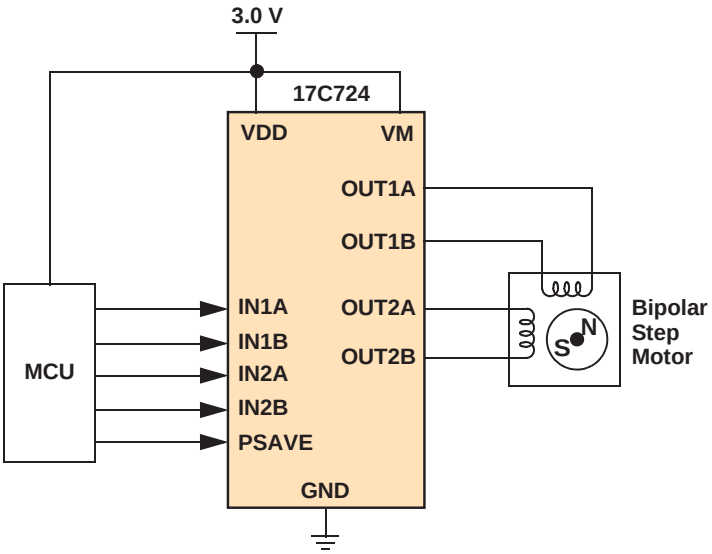


Figure 1. 17C724 Simplified Application Diagram

INTERNAL BLOCK DIAGRAM

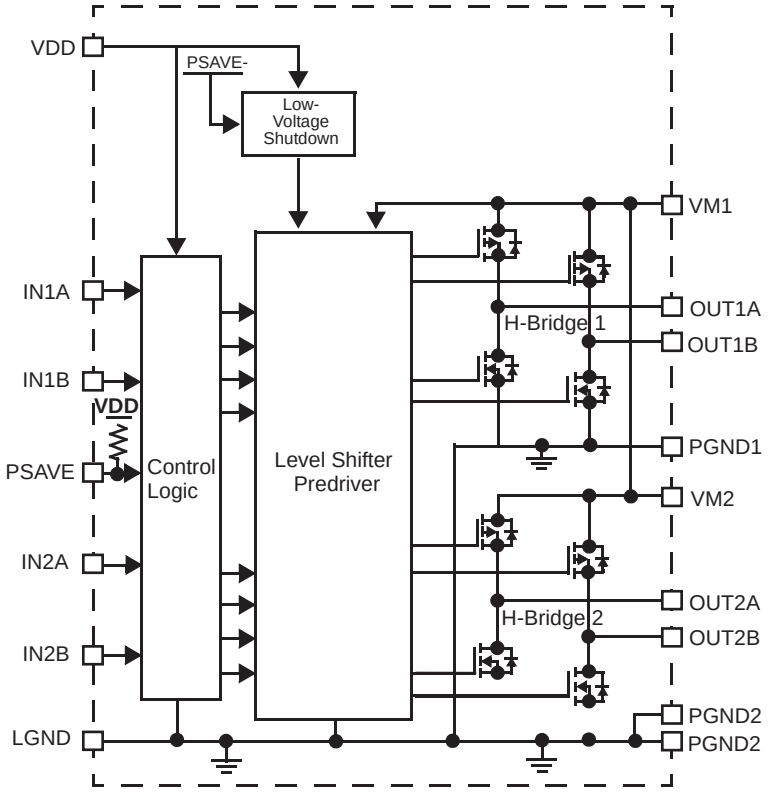


Figure 2. 17C724 Simplified Internal Block Diagram

PIN CONNECTIONS

Transparent Top View of Package

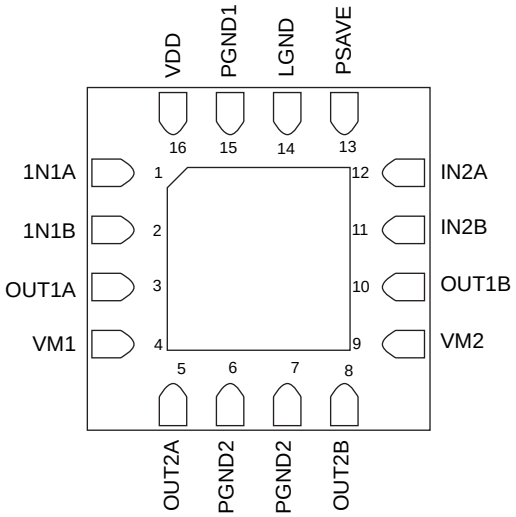


Figure 3. 17C724 Pin Connections

Table 1. 17C724 Pin Definitions

A functional description of each pin can be found in the Functional Pin Description section beginning on page 8.

Pin Number	Pin Name	Pin Function	Formal Name	Definition
1	IN1A	Logic	Logic Input Control 1A	Logic input control of OUT1A (refer to Table 5, Truth Table, page 7).
2	IN1B	Logic	Logic Input Control 1B	Logic input control of OUT1B (refer to Table 5, Truth Table, page 7).
3	OUT1A	Output	H-Bridge Output 1A	Output A of H-Bridge channel 1.
4	VM1	Power	Motor Driver Power Supply 1	Positive power source connection for H-Bridge 1 (Motor Driver Power Supply) (1).
5	OUT2A	Output	H-Bridge Output 2A	Output A of H-Bridge channel 2.
6, 7	PGND2	Ground	Power Ground 2	High-current power ground 2 (2).
8	OUT2B	Output	H-Bridge Output 2B	Output B of H-Bridge channel 2.
9	VM2	Power	Motor Driver Power Supply 2	Positive power source connection for H-Bridge 2 (Motor Driver Power Supply) (1).
10	OUT1B	Output	H-Bridge Output 1B	Output B of H-Bridge channel 1.
11	IN2B	Input	Logic Input Control 2B	Logic input control of OUT2B (refer to Table 5, Truth Table, page 7).
12	IN2A	Input	Logic Input Control 2A	Logic input control of OUT2A (refer to Table 5, Truth Table, page 7).
13	PSAVE	Input	Input Enable Control	Logic input enable control of H-Bridges to save power.
14	LGND	Ground	Logic Ground	Low-current logic signal ground (2).
15	PGND1	Ground	Power Ground 1	High-current power ground 1 (2).
16	VDD	Logic	Logic Circuit Power Supply	Positive power source connection for logic circuit.

Notes
1. VM1 and VM2 are internally connected.
2. LGND, PGND1, and PGND2 are internally connected.

MAXIMUM RATINGS

Table 2. Maximum Ratings

All voltages are with respect to ground unless otherwise noted. Exceeding these ratings may cause a malfunction or permanent damage to the device.

Ratings	Symbol	Value	Unit
ELECTRICAL RATINGS			
Power Supply Voltage (Motor Driver) Normal Operation (Steady-State) Transient Conditions (3)	 $V_{M(SS)}$ $V_{M(PK)}$	 -0.3 to 6.0 -0.3 to 6.5	V
Logic Supply Voltage	V_{DD}	6.0	V
Input Pin Voltage	V_{IN}	-0.3 to V_{DD} + 0.3	V
Driver Output Current (Continuous) (4)	I_O	400	mA
Driver Output Current (Peak) (5)	I_{OPK}	800	mA
ESD Voltage (6) Human Body Model Machine Model	 V_{ESD1} V_{ESD2}	 ±2000 ±200	V
TEMPERATURE RATINGS			
Storage Temperature	T_{STG}	-40 to 150	°C
Operating Temperature Ambient	 T_A	 -20 to 85	°C
Operating Junction Temperature	T_J	150 maximum	°C
Thermal Resistance (Junction-to-Ambient) Single-Layer PCB Mounting (9) Multi-Layer PCB (2S2P) Mounting (10)	 $R_{\theta JA}$ $R_{\theta JMA}$	 169 47	°C/W
Pin Soldering Temperature (7), (8)	T_{PPRT}	Note 8	°C

Notes

3. Transient condition within 500 ms.
4. Continuous output current must not be exceeded and at operating junction temperature below 150 °C.
5. Peak time is for 10 ms pulse width at 200 ms intervals.
6. ESD testing is performed in accordance with the Human Body Model (C_{ZAP}=100 pF, R_{ZAP}=1500 Ω), **and** the Machine Model (C_{ZAP}=200 pF, R_{ZAP}=0 Ω).
7. Pin soldering temperature limit is for 10 seconds maximum duration. Not designed for immersion soldering. Exceeding these limits may cause a malfunction or permanent damage to the device.
8. Freescale's Package Reflow capability meets Pb-free requirements for JEDEC standard J-STD-020C. For Peak Package Reflow Temperature and Moisture Sensitivity Levels (MSL), Go to www.freescale.com, search by part number [e.g. remove prefixes/suffixes and enter the core ID to view all orderable parts (i.e. MC33xxxD enter 33xxx), and review parametrics.
9. For cases using SEMI G38-87, JEDEC JESD51-2, JESD51-3, JESD51-5, single layer PCB mounting without thermal vias.
10. For cases using SEMI JEDEC JESD51-6, JESD51-5, JESD51-7, 2S2P PCB mounting with 4 thermal vias.

STATIC ELECTRICAL CHARACTERISTICS

Table 3. Static Electrical Characteristics

Characteristics noted under conditions T_A = 25 °C, V_{DD} = V_M = 3.0 V, unless otherwise noted. Typical values noted reflect the approximate parameter means at T_A = 25 °C under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
POWER INPUT (VDD, PSAVE)					
Supply Voltage Range					V
Motor Driver Supply Voltage	V_M	2.7	3.0	5.5	
Logic Supply Voltage	V_{DD}	2.7	3.0	5.5	
Standby Power Supply Current (11)					µA
V_M = 3.0 V	I_{VMSTBY}	–	–	1.0	
V_{DD} = 3.0 V	$I_{VDDSTBY}$	–	–	1.0	
Operating Power Supply Current (12)	I_C				µA
V_{DD} = 3.0 V		–	40	100	
Logic Input Function					
High-Level Input Voltage	V_{IH}	V_{DD} 0.7	–	–	V
Low-Level Input Voltage	V_{IL}	–	–	V_{DD} 0.3	V
High-Level Input Current	I_{IH}	–	–	1.0	µA
Low-Level Input Current	I_{IL}	-1.0	–	–	µA
PSAVE Pin Low Level Input Current (13)	I_{IL}	–	-30	-60	µA
Driver Output ON Resistance (14)	$R_{DS(ON)}$	–	1.0	1.5	Ω
Low Voltage Shutdown Detection Voltage (15)	V_{DDDET}	1.5	2.0	2.5	V

Notes

11. Power SAVE mode.
12. I_C is the sum of the current of V_{DD} monitor block “Low Voltage Detection Module” and the PSAVE pull-up resistor at f_{IN} = 200 kHz.
13. V_{DD} = 3.0 V.
14. R_{SOURCE} + R_{SINK} at I_O = 375 mA.
15. Detection voltage is defined as when the output becomes high impedance after V_{DD} voltage falls and when V_M = 5.5 V.

DYNAMIC ELECTRICAL CHARACTERISTICS

Table 4. Dynamic Electrical Characteristics

Characteristics noted under conditions T_A = 25 °C, V_{DD} = VM = 3.0 V, unless otherwise noted. Typical values noted reflect the approximate parameter means at T_A = 25 °C under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
INPUT					
Pulse Input Frequency	f_{IN}	–	–	200	kHz
Input Pulse Rise Time (16)	t_R	–	–	1.0 (17)	µs
Input Pulse Fall Time (18)	t_F	–	–	1.0 (17)	µs
OUTPUT					
Output Propagation Delay Time (19)					µs
Turn-ON Time	t_{PLH}	–	0.2	0.5	
Turn-OFF Time	t_{PHL}	–	0.1	0.5	
Low-Voltage Detection Time	t_{VDDDET}	–	0.02	1.0	ms

Notes

16. Time is defined between 10% and 90%.
17. That is, the input waveform slope must be steeper than this.
18. Time is defined between 90% and 10%.
19. R_L = 6.8 Ω. Slew time, rise time, and fall times are between 10% and 90% of output low and high levels with respect to the 50% level of the input.

TIMING DIAGRAMS

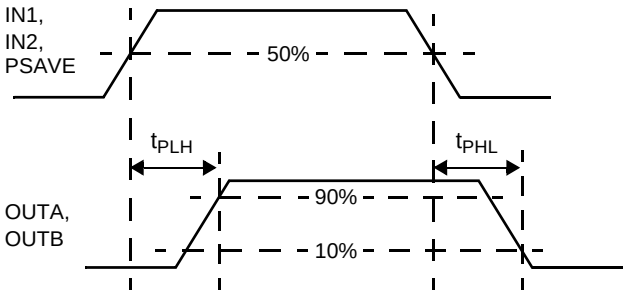


Figure 4. t_{PLH} and t_{PHL} Timing

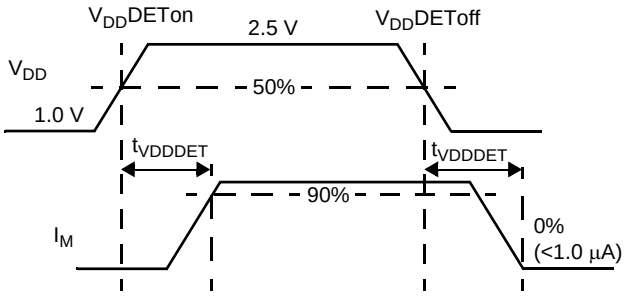


Figure 5. Low-Voltage Detection Timing

Table 5. Truth Table

INPUT			OUTPUT		$V_{DD}DET$[21]
PSAVE[19]	IN1A IN2A	IN1B IN2B	OUT1A OUT2A	OUT1B OUT2B	
L	L	L	L	L	Enabled
L	H	L	H	L	Enabled
L	L	H	L	H	Enabled
L	H	H	Z	Z	Enabled
H	X	X	Z	Z	Disabled

H : High
L : Low
Z : High-impedance
X : Don’t care

Notes
20. Pin 13 (PSAVE) is pulled up by an internal resistor.
21. When V_{DD} is lower than V_{DDDET} while V_M is applied, output becomes “Z” (high-impedance); however, when PSAVE = “H”, the low voltage shutdown detection circuit is disabled.

FUNCTIONAL DESCRIPTION

INTRODUCTION

The 17C724 is a monolithic dual H-Bridge that is ideal in portable electronic applications to control bipolar step motors and brush DC motors, such as those used in camera lens and shutters. The 17C724 can operate efficiently with supply voltages as low as 2.7 V to as high as 5.5 V, and provide continuous motor drive currents of 0.4 A while handling peak currents up to 0.8 A. It is easily interfaced to low cost MCUs via parallel 3.0 V or 5.0 V compatible logic. The device can be pulse width modulated (PWM'ed) at up to 200 kHz.

The 17C724 can drive two motors simultaneously (see Figure 6), or it can drive one bipolar step motor as shown in the simplified application diagram on page 1. Dual channel parallel drive is also possible if higher current drive is desired (0.8 A). Two-motor operation is accomplished by hooking one motor between OUT1A and OUT1B, and the other motor between OUT2A and OUT2B.

This IC has a built-in shoot-through current protection circuit and undervoltage detector to avoid malfunction. It also allows for power-conserving Sleep mode by the setting of the PSAVE pin (refer to Table 5, Truth Table, page 7).

The device features four operating modes: forward, reverse, brake, and tri-stated (high-impedance).

FUNCTIONAL PIN DESCRIPTION

LOGIC CIRCUIT POWER SUPPLY (VDD)

The VDD pin carries the power source connection to the control (logic) circuit, and its input range is between 2.7 V to 5.5 V (3.0 V and 5.0 V compatible). V_{DD} has an undervoltage threshold. If the supply voltage to V_{DD} drops below 2.0 V (typical), then all the output of H-Bridges (OUT1A, OUT1B, OUT2A, OUT2B) will become open (high impedance = Z). When the supply voltage returns to a level that is above the threshold voltage the H-Bridge outputs automatically resume normal operation according to the established condition of the input pins.

LOGIC INPUT CONTROL (IN1A, IN1B, IN2A, AND IN2B)

These logic input pins control each H-Bridge output. For example, IN1A logic HIGH = OUT1A HIGH; likewise, IN1B logic HIGH = OUT1B HIGH. If both A and B inputs are HIGH, then both A and B outputs are Z (refer to Table 5, Truth Table, page 7).

INPUT ENABLE CONTROL (PSAVE)

The PSAVE input controls the functioning of the power output stages (the H-Bridges). When it is set logic LOW, the output stages are enabled and the H-Bridges function normally. When it is set logic HIGH, the output stages are disabled and all the outputs are opened (high impedance). In this mode, the built-in low voltage detection circuit is disabled.

H-BRIDGE OUTPUT (OUT1A, OUT1B, OUT2A, AND OUT2B)

These pins are the outputs of the power MOSFET H-Bridges. OUT1 is from H-Bridge Channel 1, and OUT2 from H-Bridge Channel 2. These pins will typically connect to an external load (step motor or brush DC motors).

MOTOR DRIVER POWER SUPPLY (VM1 AND VM2)

VM1 and VM2 carries the main supply voltage and current into the power sections (the H-Bridges) of the IC. Both of these pins are connected internally but they must be connected together on the printed circuit board with as short as possible traces. The input range is 2.7 V to 5.5 V.

POWER GROUND (PGND1 AND PGND2)

These two are the power ground pins that connect to the power ground of the H-Bridges. The power grounds are for higher current handling capability from loads and they must be connected together on the PCB.

LOGIC GROUND (LGND)

LGND is the logic ground pin and its current handling level is lower than the PGND.

TYPICAL APPLICATIONS

Figure 6 shows a typical application for the 17C724.

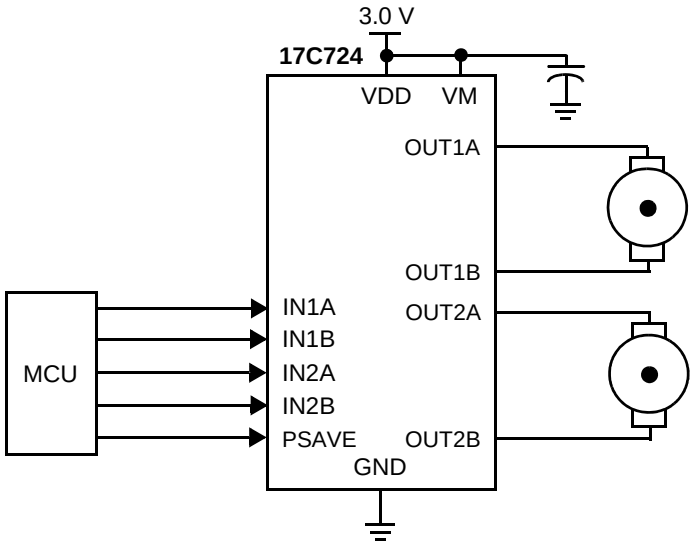


Figure 6. 17C724 Typical Application Diagram

CEMF SNUBBING TECHNIQUES

Care must be taken to protect the IC from potentially damaging CEMF spikes induced when commutating currents in inductive loads. Typical practice is to provide snubbing of voltage transients by placing a zener or capacitor at the supply pin (VM) (see Figure 7).

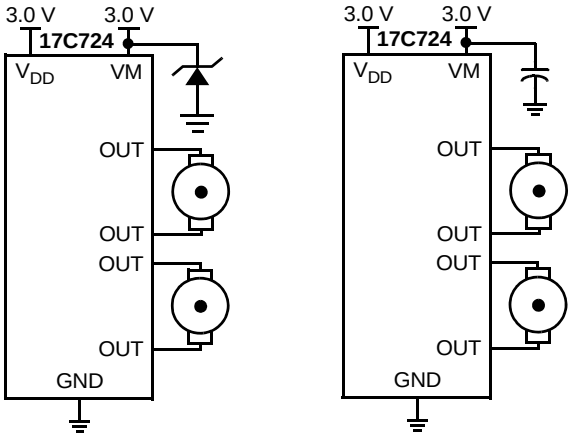


Figure 7. CEMF Snubbing Techniques

PCB LAYOUT

When designing the printed circuit board (PCB), connect sufficient capacitance between power supply and ground pins to ensure proper filtering from transients. For all high-current paths, use wide copper traces and shortest possible distance.

APPLICATION NOTES

Although VM1 and VM2 are connected internally, they must be connected externally to attain sufficient power distribution.

Take precautions to guard against electrostatic discharge when handling the device, especially when mounting and demounting the device to a PCB.

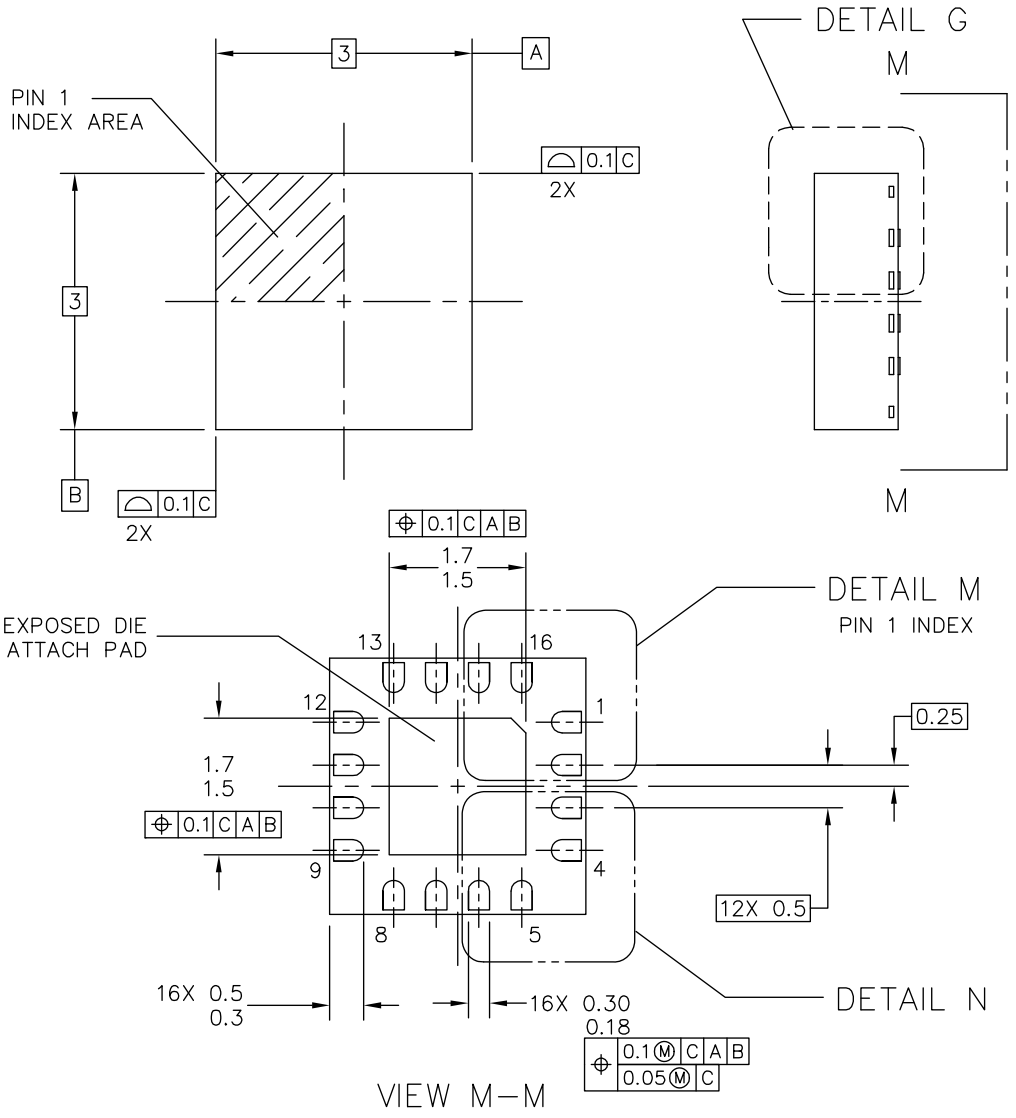
PACKAGING

PACKAGE DIMENSIONS

Package dimensions are provided in package drawings. To find the most current package outline drawing, go to www.freescale.com and perform a keyword search for the drawing's document number.

Table 6.

Package	Suffix	Package Outline Drawing Number
16-PIN VMFP	EP	98ARL10566D



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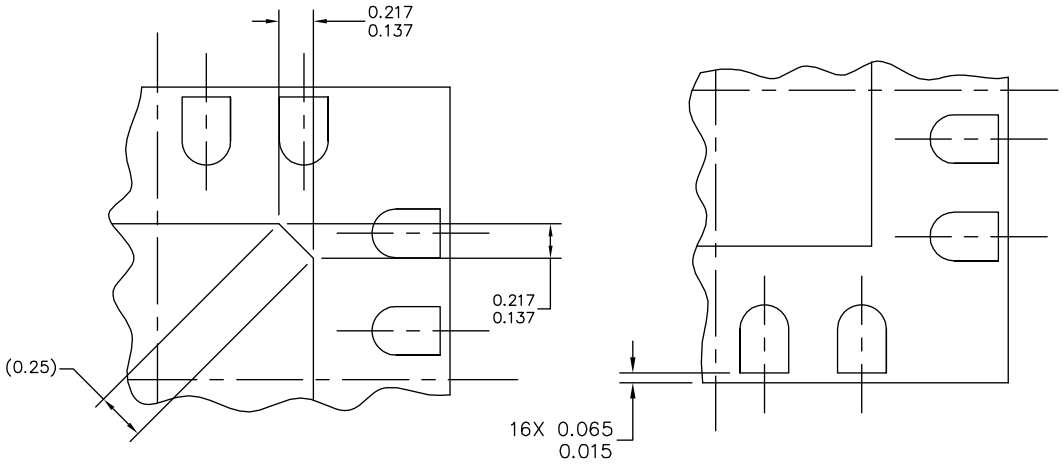
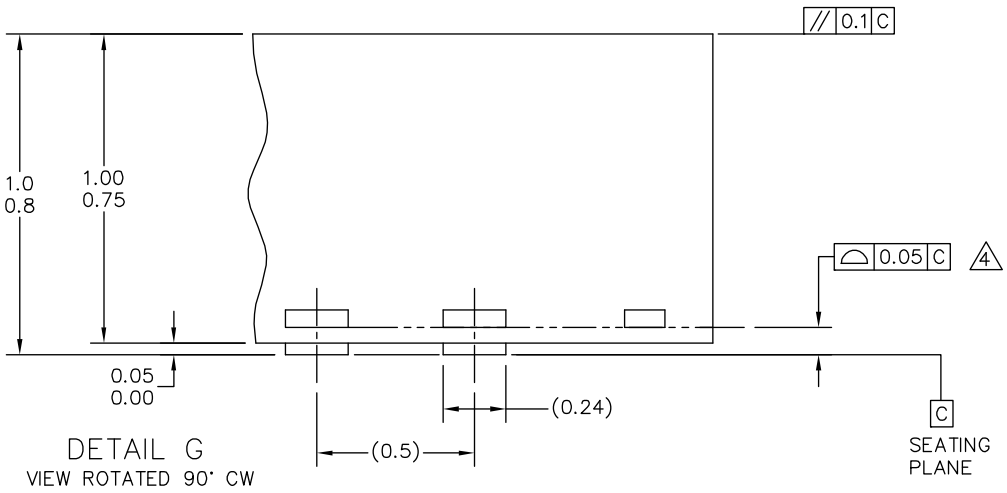
TITLE: THERMALLY ENHANCED QUAD FLAT NON–LEADED PACKAGE (QFN) 16 TERMINAL, 0.5 PITCH (3 X 3 X 1)	DOCUMENT NO: 98ARL10566D	REV: A
	CASE NUMBER: 1524–01	09 AUG 2005
	STANDARD: NON–JEDEC	

EP (Pb-FREE) SUFFIX
16-Pin QFN
98ARL10566D
ISSUE A

17C724





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EP (Pb-FREE) SUFFIX
16-Pin QFN
98ARL10566D
ISSUE A

17C724

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DIMENSIONING AND TOLERANCING PER ASME Y14.5M–1994.
3. THE COMPLETE JEDEC DESIGNATOR FOR THIS PACKAGE IS: HF–PQFP–N.
4. COPLANARITY APPLIES TO LEADS AND DIE ATTACH PAD.

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EP (Pb-FREE) SUFFIX
16-Pin QFN
98ARL10566D
ISSUE A

17C724

REVISION HISTORY

REVISION	DATE	DESCRIPTION OF CHANGES
2.0	2005	• Initial Release
	12/2013	• No technical changes • Revised back page • Updated document properties

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12/2013