

## Advance Information

# 1.0 A 6.8 V H-Bridge Motor Driver IC

The 17511A is a monolithic H-Bridge designed to be used in portable electronic applications to control small DC motors or bipolar step motors. End applications include head positioners (CDROM or disk drive), camera focus motors, and camera shutter solenoids.

The 17511A can operate efficiently with supply voltages as low as 2.0 V to as high as 6.8 V. Its low  $R_{DS(ON)}$  H-Bridge output MOSFETs (0.46  $\Omega$  typical) can provide continuous motor drive currents of 1.0 A and handle peak currents up to 3.0 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.

This device contains an integrated charge pump and level shifter (for gate drive voltages), integrated shoot-through current protection (cross-conduction suppression logic and timing), and undervoltage detection and shutdown circuitry.

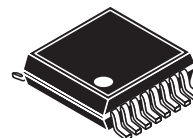
The 17511A has four operating modes: Forward, Reverse, Brake, and Tri-States (High Impedance).

### Features

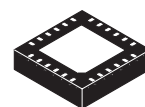
- 2.0 V to 6.8 V Continuous Operation
- Output Current 1.0 A (DC), 3.0 A (Peak)
- MOSFETs < 600 m $\Omega$   $R_{DS(ON)}$  @ 25°C Guaranteed
- 3.0 V/5.0 V TTL-/CMOS-Compatible Inputs
- PWM Frequencies up to 200 kHz
- Undervoltage Shutdown
- Cross-Conduction Suppression
- Low Power Consumption
- Pb-Free Packaging Designated by Suffix Codes EV and EP

# 17511A

## 1.0 A 6.8 V H-BRIDGE MOTOR DRIVER IC



EV (Pb-FREE) SUFFIX  
CASE 1563-01  
16-LEAD VMFP

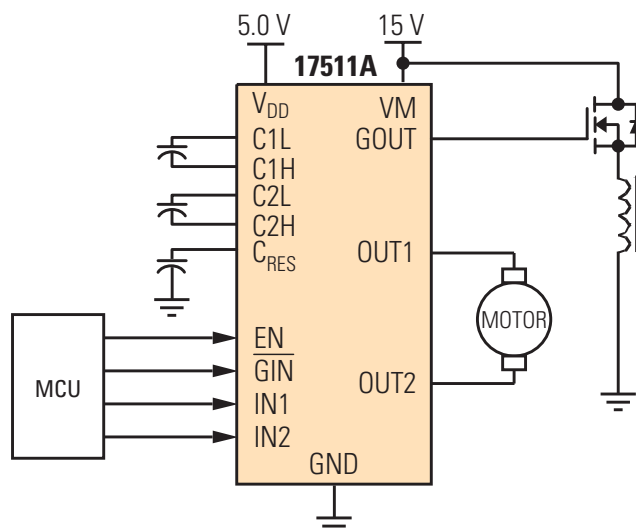


EP (Pb-FREE) SUFFIX  
CASE 1508-01  
24-LEAD QFN

### ORDERING INFORMATION

Device	Temperature Range (T <sub>A</sub> )	Package
MPC17511AEV/EL	-20°C to 65°C	16 VMFP
MPC17511AEP/R2		24 QFN

### 17511A Simplified Application Diagram



This document contains certain information on a new product. Specifications and information herein are subject to change without notice.

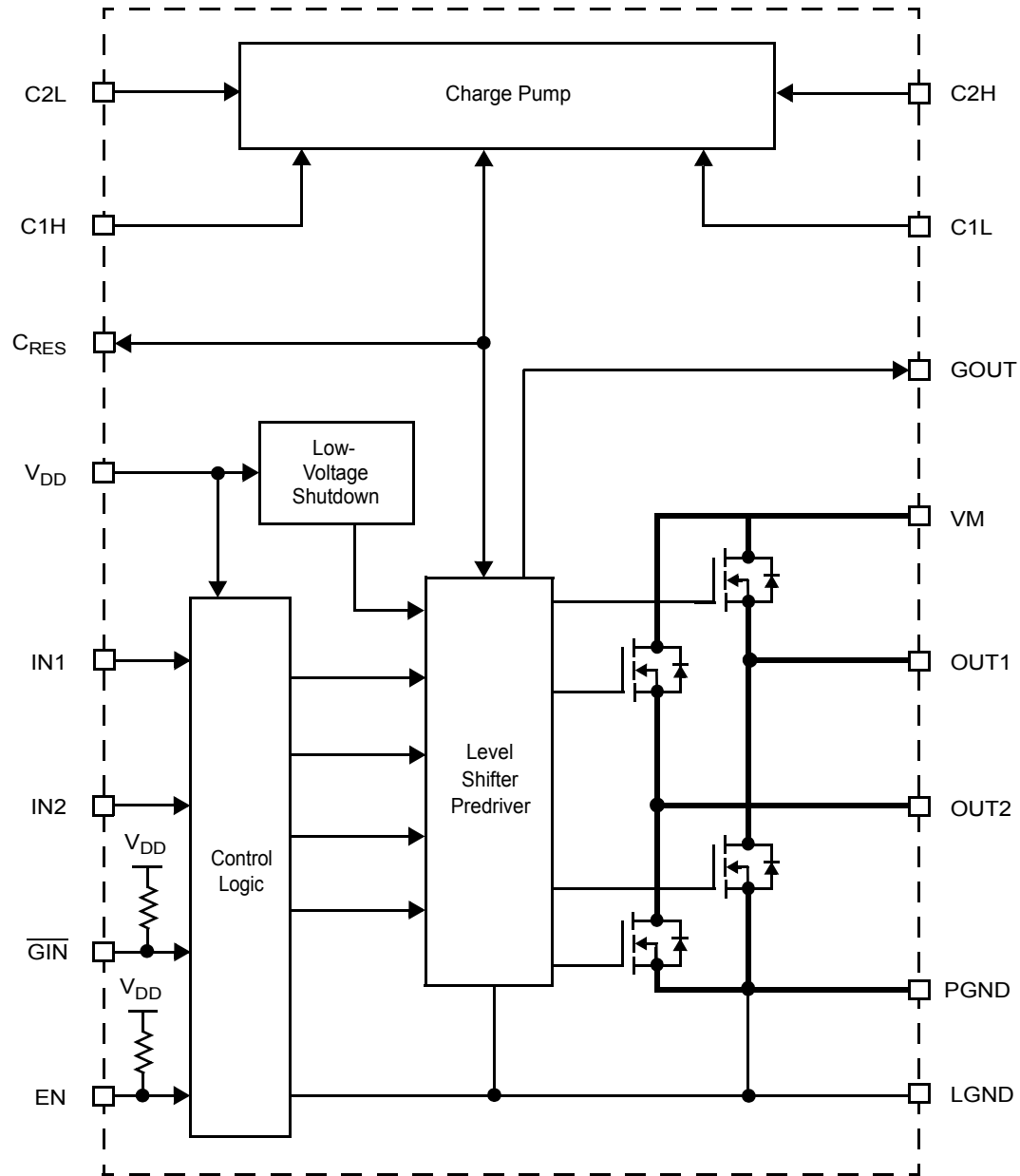
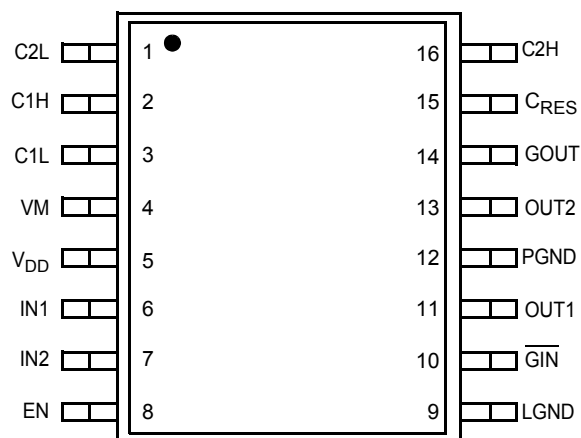


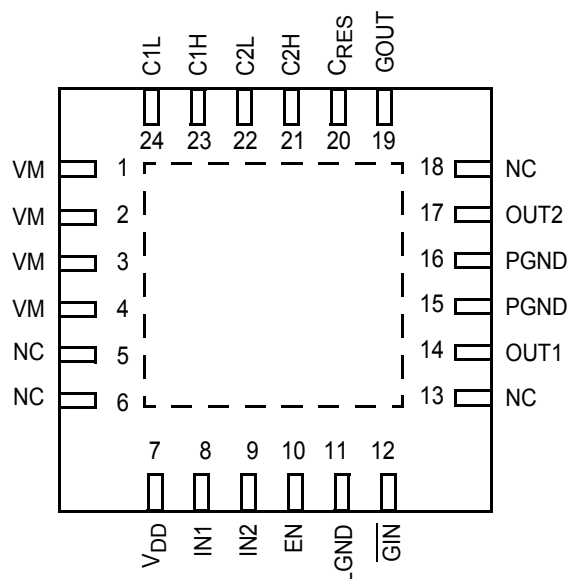
Figure 1. 17511A Simplified Internal Block Diagram

# Freescale Semiconductor, Inc.



## VMFP TERMINAL FUNCTION DESCRIPTION

Terminal	Terminal Name	Formal Name	Definition
1	C2L	Charge Pump 2L	Charge pump bucket capacitor 2 (negative pole).
2	C1H	Charge Pump 1H	Charge pump bucket capacitor 1 (positive pole).
3	C1L	Charge Pump 1L	Charge pump bucket capacitor 1 (negative pole).
4	VM	Motor Drive Power Supply	Driver power supply voltage input terminal.
5	V <sub>DD</sub>	Logic Supply	Control circuit power supply terminal.
6	IN1	Input Control 1	Control signal input 1
7	IN2	Input Control 2	Control signal input 2.
8	EN	Enable Control	Enable control signal input terminal.
9	LGND	Logic Ground	Logic ground terminal.
10	$\overline{\text{GIN}}$	Gate Driver Input	LOW = True control signal for GOUT terminal.
11	OUT1	H-Bridge Output 1	Driver output 1 (right half of H-Bridge).
12	PGND	Power Ground	Driver ground terminal.
13	OUT2	H-Bridge Output 2	Driver output 2 (left half of H-Bridge).
14	GOUT	Gate Driver Output	Output gate driver signal to external MOSFET switch.
15	C <sub>RES</sub>	Charge Pump Output Capacitor Connection	Charge pump reservoir capacitor terminal.
16	C2H	Charge Pump 2H	Charge pump bucket capacitor 2 (positive pole).



## QFN TERMINAL FUNCTION DESCRIPTION

Terminals	Terminal Name	Formal Name	Definition
1, 2, 3, 4	VM	Motor Drive Power Supply	Driver power supply voltage input terminal.
5, 6, 13, 18	NC	No Connect	This terminal is not used.
7	V <sub>DD</sub>	Logic Supply	Control circuit power supply terminal.
8	IN1	Logic Input Control 1	Control signal input 1.
9	IN2	Logic Input Control 2	Control signal input 2.
10	EN	Enable Control	Enable control signal input terminal.
11	LGND	Logic Ground	Logic ground terminal.
12	$\overline{\text{GIN}}$	Gate Driver Input	LOW = True control signal for GOUT terminal.
14	OUT1	Output 1	Driver output 1 (right half of H-Bridge).
15, 16	PGND	Power Ground	Driver ground terminal.
17	OUT2	Output 2	Driver output 2 (left half of H-Bridge).
19	GOUT	Gate Driver Output	Output gate driver signal to external MOSFET switch.
20	C <sub>RES</sub>	Pre-Driver Power Supply	Pre-driver circuit power supply terminal.
21	C2H	Charge Pump 2H	Charge pump bucket capacitor 2 (positive pole).
22	C2L	Charge Pump 2L	Charge pump bucket capacitor 2 (negative pole).
23	C1H	Charge Pump 1H	Charge pump bucket capacitor 1 (positive pole).
24	C1L	Charge Pump 1L	Charge pump bucket capacitor 1 (negative pole).

## MAXIMUM RATINGS

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

Rating	Symbol	Value	Unit
Motor Supply Voltage	$V_M$	-0.5 to 8.0	V
Charge Pump Output Voltage	$V_{CRES}$	-0.5 to 14.0	V
Logic Supply Voltage	$V_{DD}$	-0.5 to 7.0	V
Signal Input Voltage (EN, IN1, IN2, $\overline{GIN}$ )	$V_{IN}$	-0.5 to $V_{DD}+0.5$	V
Driver Output Current			A
Continuous	$I_O$	1.0	
Peak (Note 1)	$I_{OPK}$	3.0	
ESD Voltage			V
Human Body Model (Note 2)	$V_{ESD1}$	$\pm 1800$	
Machine Model (Note 3)	$V_{ESD2}$	$\pm 100$	
Storage Temperature Range	$T_{STG}$	-65 to 150	°C
Operating Ambient Temperature	$T_A$	-20 to 65	°C
Operating Junction Temperature	$T_J$	-20 to 150	°C
Thermal Resistance (Note 4)	$R_{\theta JA}$	150	°C/W
Power Dissipation (Note 5)	$P_D$	830	mW
Soldering Temperature (Note 6)	$T_{SOLDER}$	260	°C

### Notes

- $T_A = 25^\circ\text{C}$ , 10 ms pulse width at 200 ms intervals.
- ESD1 testing is performed in accordance with the Human Body Model ( $C_{ZAP} = 100 \text{ pF}$ ,  $R_{ZAP} = 1500 \Omega$ ).
- ESD2 testing is performed in accordance with the Machine Model ( $C_{ZAP} = 200 \text{ pF}$ ,  $R_{ZAP} = 0 \Omega$ ).
- 37 x 50 x 1.6 [mm] glass EPOXY board mount.
- Maximum at  $T_A = 25^\circ\text{C}$ .
- Soldering temperature limit is for 10 seconds maximum duration. Not designed for immersion soldering. Exceeding these limits may cause malfunction or permanent damage to the device.

## STATIC ELECTRICAL CHARACTERISTICS

Characteristics noted under conditions  $T_A = 25^\circ\text{C}$ ,  $V_M = V_{DD} = 5.0\text{ V}$ ,  $\text{GND} = 0\text{ V}$  unless otherwise noted. Typical values noted reflect the approximate parameter means at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
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### POWER

Driver Circuit Power Supply Voltage	$V_M$	2.0	5.0	6.8	V
Logic Supply Voltage	$V_{DD}$	2.7	5.0	5.7	V
Capacitor for Charge Pump	C1, C2, C3	0.01	0.1	1.0	$\mu\text{F}$
Standby Power Supply Current	$I_{V_{MSTBY}}$ $I_{V_{DDSTBY}}$	–	–	1.0	$\mu\text{A}$
Motor Supply Standby Current					
Logic Supply Standby Current (Note 7)		–	–	1.0	mA
Operating Power Supply Current	$I_{V_{DD}}$ $I_{CRES}$	–	–	3.0	mA
Logic Supply Current (Note 8)					
Charge Pump Circuit Supply Current		–	–	0.7	mA
Low $V_{DD}$ Detection Voltage (Note 9)	$V_{DDDET}$	1.5	2.0	2.5	V
Driver Output ON Resistance (Note 10)	$R_{DS(ON)}$	–	0.46	0.60	$\Omega$

### GATE DRIVE

Gate Drive Voltage (Note 11) No Current Load	$V_{CRES}$	12	13	13.5	V
Gate Drive Ability (Internally Supplied) $I_{CRES} = -1.0\text{ mA}$	$V_{CRESload}$	10	11.2	–	V
Gate Drive Output $I_{OUT} = -50\text{ }\mu\text{A}$ $I_{IN} = 50\text{ }\mu\text{A}$	$V_{GOUTHIGH}$ $V_{GOUTLOW}$	$V_{CRES-0.5}$ LGND	$V_{CRES-0.1}$ LGND+0.1	$V_{CRES}$ LGND+0.5	V

### CONTROL LOGIC

Logic Input Voltage	$V_{IN}$	0	–	$V_{DD}$	V
Logic Input Function ( $2.7\text{ V} < V_{DD} < 5.7\text{ V}$ )	$V_{IH}$ $V_{IL}$ $I_{IH}$ $I_{IL}$	$V_{DD} \times 0.7$	–	–	V
High-Level Input Voltage					
Low-Level Input Voltage		–	–	$V_{DD} \times 0.3$	V
High-Level Input Current		–	–	1.0	$\mu\text{A}$
Low-Level Input Current		-1.0	–	–	$\mu\text{A}$
Pull-Up Resistance (EN, $\overline{\text{GIN}}$ )	$R_{PU}$	50	100	200	k $\Omega$

#### Notes

- $I_{V_{DDSTBY}}$  includes current to the predriver circuit.
- $I_{V_{DD}}$  includes current to the predriver circuit.
- Detection voltage is defined as when the output becomes high-impedance after  $V_{DD}$  drops below the detection threshold. When the gate voltage  $V_{CRES}$  is applied from an external source,  $V_{CRES} = 7.5\text{ V}$ .
- $I_O = 1.0\text{ A}$  source + sink.
- Input logic signal not present.

## DYNAMIC ELECTRICAL CHARACTERISTICS

Characteristics noted under conditions  $T_A = 25^\circ\text{C}$ ,  $V_M = V_{DD} = 5.0\text{ V}$ ,  $\text{GND} = 0\text{ V}$  unless otherwise noted. Typical values noted reflect the approximate parameter means at  $T_A = 25^\circ\text{C}$  under nominal conditions unless otherwise noted.

Characteristic	Symbol	Min	Typ	Max	Unit
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### INPUT (EN, IN1, IN2, $\overline{\text{GIN}}$ )

Pulse Input Frequency	$f_{\text{IN}}$	–	–	200	kHz
Input Pulse Rise Time (Note 12)	$t_{\text{R}}$	–	–	1.0 (Note 13)	$\mu\text{s}$
Input Pulse Fall Time (Note 14)	$t_{\text{F}}$	–	–	1.0 (Note 13)	$\mu\text{s}$

### OUTPUT

Propagation Delay Time					$\mu\text{s}$
Turn-ON Time	$t_{\text{PLH}}$	–	0.55	1.0	
Turn-OFF Time	$t_{\text{PHL}}$	–	0.55	1.0	
GOUT Propagation Delay Time					$\mu\text{s}$
Turn-ON Time	$t_{\text{SON}}$	–	0.15	0.5	
Turn-OFF Time	$t_{\text{SOFF}}$	–	0.15	0.5	
Charge Pump Circuit (Note 15) Rise Time (Note 16)	$t_{\text{V}_{\text{CRESon}}}$	–	0.1	3.0	ms
Low-Voltage Detection Time	$t_{\text{V}_{\text{DDDET}}}$	–	–	10	ms

#### Notes

12. Time is defined between 10% and 90%.
13. That is, the input waveform slope must be steeper than this.
14. Time is defined between 90% and 10%.
15. When  $C1 = C2 = C3 = 0.1\text{ }\mu\text{F}$ .
16. Time to charge  $C_{\text{RES}}$  to 11 V after application of  $V_{\text{DD}}$ .

## Timing Diagrams

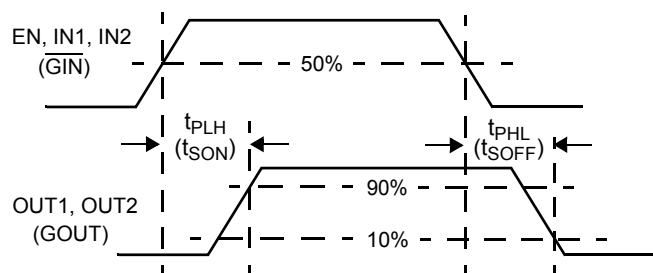


Figure 2.  $t_{PLH}$ ,  $t_{PHL}$ , and  $t_{PZH}$  Timing

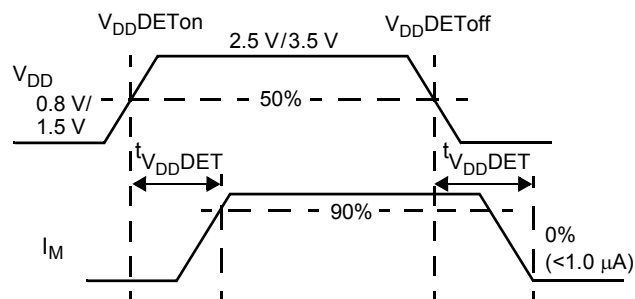


Figure 3. Low-Voltage Detection

Table 1. Truth Table

INPUT				OUTPUT		
EN	IN1	IN2	$\overline{GIN}$	OUT1	OUT2	GOUT
H	H	H	X	L	L	X
H	H	L	X	H	L	X
H	L	H	X	L	H	X
H	L	L	X	Z	Z	X
L	X	X	X	L	L	L
H	X	X	H	X	X	L
H	X	X	L	X	X	H

H = High.  
 L = Low.  
 Z = High impedance.  
 X = Don't care.



## SYSTEM/APPLICATION INFORMATION

### INTRODUCTION

The 17511A is a monolithic H-Bridge power IC applicable to small DC motors used in portable electronics. The 17511A can operate efficiently with supply voltages as low as 2.0 V to as high as 6.8 V, and it can provide continuous motor drive currents of 1.0 A while handling peak currents up to 3.0 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 17511A has four operating modes: Forward, Reverse, Brake, and Tri-States (High Impedance).

Basic protection and operational features (direction, dynamic braking, PWM control of speed and torque, main power supply undervoltage detection and shutdown, logic power supply undervoltage detection and shutdown), in addition to the 1.0 A rms output current capability, make the 17511A a very attractive, cost-effective solution for controlling a broad range of small DC motors. In addition, a pair of 17511A devices can be used to control bipolar step motors. The 17511A can also be used to excite transformer primary windings with a switched square wave to produce secondary winding AC currents.

As shown in [Figure 1, 17511A Simplified Internal Block Diagram](#), page 2, the 17511A is a monolithic H-Bridge with built-in charge pump circuitry. For a DC motor to run, the input conditions need to be set as follows: ENable input logic HIGH, one INput logic LOW, and the other INput logic HIGH (to define output polarity). The 17511A can execute dynamic braking by setting both IN1 and IN2 logic HIGH, causing both low-side MOSFETs in the output H-Bridge to turn ON. Dynamic braking can also be implemented by taking the ENable logic LOW. The output of the H-Bridge can be set to an open-circuit high-impedance (Z) condition by taking both IN1 and IN2 logic LOW. (refer to [Table 1, Truth Table](#), page 8).

The 17511A outputs are capable of providing a continuous DC load current of up to 1.2 A. An internal charge pump supports PWM frequencies to 200 kHz. The EN terminal also controls the charge pump, turning it off when EN = LOW, thus allowing the 17511A to be placed in a power-conserving sleep mode.

### FUNCTIONAL TERMINAL DESCRIPTION

#### OUT1 and OUT2

The OUT1 and OUT2 terminals provide the connection to the internal power MOSFET H-Bridge of the IC. A typical load connected between these terminals would be a small DC motor. These outputs will connect to either VM or PGND, depending on the states of the control inputs (refer to [Table 1, Truth Table](#), page 8).

#### PGND and LGND

The power and logic ground terminals (PGND and LGND) should be connected together with a very low-impedance connection.

#### C<sub>RES</sub>

The C<sub>RES</sub> terminal provides the connection for the external reservoir capacitor (output of the charge pump). Alternatively this terminal can also be used as an input to supply gate-drive voltage from an external source via a series current-limiting resistor. The voltage at the C<sub>RES</sub> terminal will be approximately three times the V<sub>DD</sub> voltage, as the internal charge pump utilizes a voltage tripler circuit. The V<sub>CRES</sub> voltage is used by the IC to supply gate drive for the internal power MOSFET H-Bridge.

#### VM

The VM terminals carry the main supply voltage and current into the power sections of the IC. This supply then becomes

controlled and/or modulated by the IC as it delivers the power to the load attached between OUT1 and OUT2. All VM terminals must be connected together on the printed circuit board with as short as possible traces offering as low impedance as possible between terminals.

VM has an undervoltage threshold. If the supply voltage drops below the undervoltage threshold, the output power stage switches to a tri-state condition. When the supply voltage returns to a level that is above the threshold, the power stage automatically resumes normal operation according to the established condition of the input terminals.

#### IN1, IN2, and EN

The IN1, IN2, and EN terminals are input control terminals used to control the outputs. These terminals are 5.0 V CMOS-compatible inputs with hysteresis. The IN1, IN2, and EN work together to control OUT1 and OUT2 (refer to [Table 1, Truth Table](#)).

#### G<sub>IN</sub>

The G<sub>IN</sub> input controls the GOUT terminal. When G<sub>IN</sub> is set logic LOW, GOUT supplies a level-shifted high-side gate drive signal to an external MOSFET. When G<sub>IN</sub> is set logic HIGH, GOUT is set to GND potential.

## C1L and C1H, C2L and C2H

These two pairs of terminals, the C1L and C1H and the C2L and C2H, connect to the external bucket capacitors required by the internal charge pump. The typical value for the bucket capacitors is 0.1  $\mu\text{F}$ .

## GOUT

The GOUT output terminal provides a level-shifted, high-side gate drive signal to an external MOSFET with  $C_{iss}$  up to 500 pF.

## $V_{DD}$

The  $V_{DD}$  terminal carries the 5.0 V supply voltage and current into the logic sections of the IC.  $V_{DD}$  has an undervoltage threshold. If the supply voltage drops below the undervoltage threshold, the output power stage switches to a tri-state condition. When the supply voltage returns to a level that is above the threshold, the power stage automatically resumes normal operation according to the established condition of the input terminals.

## APPLICATIONS

Figure 4 shows a typical application for the 17511A. When applying the gate voltage to the  $C_{RES}$  terminal from an external

source, be sure to connect it via a resistor equal to, or greater than,  $R_G = V_{C_{RES}}/0.02 \Omega$ .

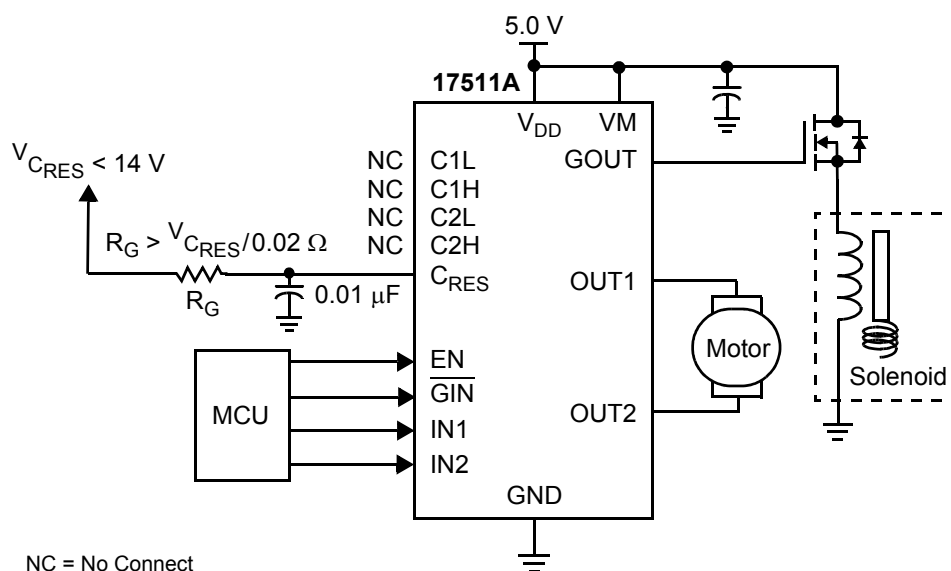


Figure 4. 17511A Typical Application Diagram

## 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 via placing a capacitor or zener at the supply terminal ( $V_M$ ) (see Figure 5).

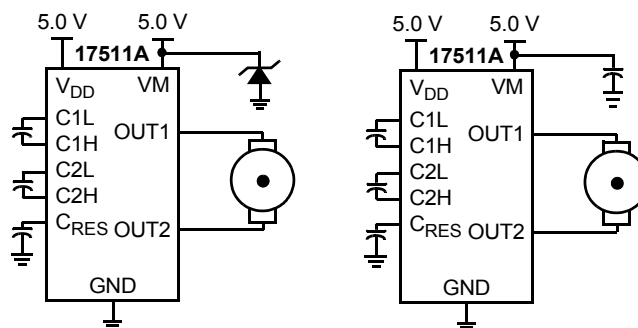
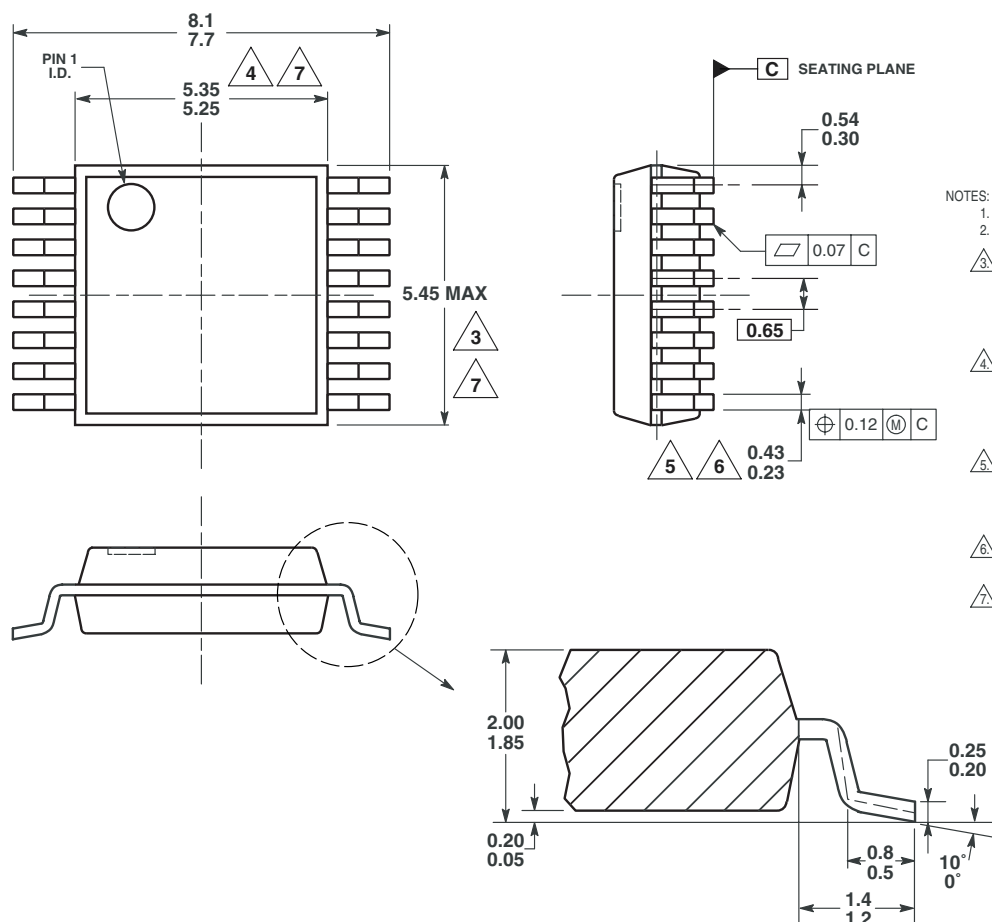
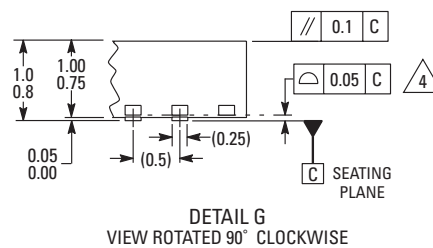


Figure 5. CEMF Snubbing Techniques

## PACKAGE DIMENSIONS

**EV (Pb-FREE) SUFFIX**  
**16-LEAD VMFP**  
**PLASTIC PACKAGE**  
**CASE 1563-01**  
**ISSUE O**





**NOTES**

**NOTES**

**NOTES**

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