LB1836M

Monolithic Digital IC

Low-Saturation Bi-directional Motor Driver for Low-Voltage Drive Application Note

ON Semiconductor®

http://onsemi.com

Overview

The LB1836M is a low-saturation two-channel bidirectional motor driver IC for use in low-voltage applications.
The LB1836M is a bipolar stepper-motor driver IC that is ideal for use in printers, FDDs, cameras and other portable devices.

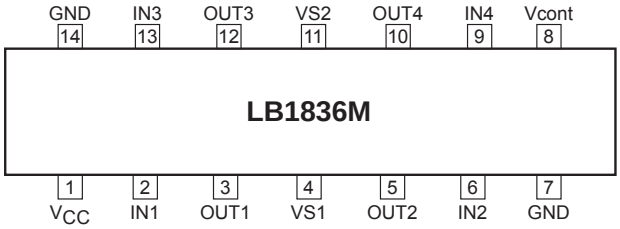
Functions

- Low voltage operation (2.5V min)
- Low saturation voltage (upper transistor + lower transistor residual voltage ; 0.40V typ at 400mA).
- Parallel connection (Upper transistor + lower transistor residual voltage ; 0.5V typ at 800mA).
- Separate logic power supply and motor power supply
- Brake function
- Spark killer diodes built in
- Thermal shutdown circuit built in
- Compact package (14-pin MFP)

Typical Applications

- Automotive audio
- Security camera
- Camera
- TOY
- POS, Card Terminal (POS Printer, Thermal printer)

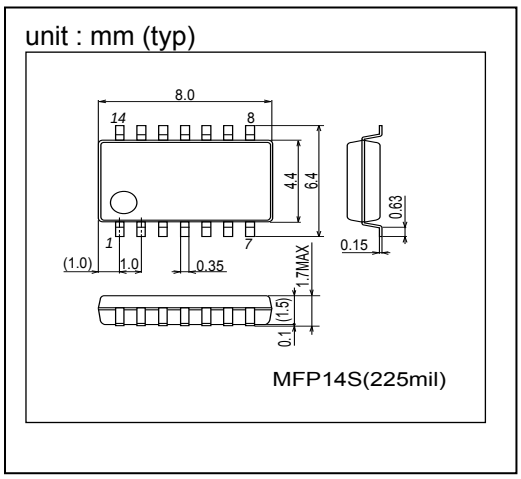
Pin Assignment

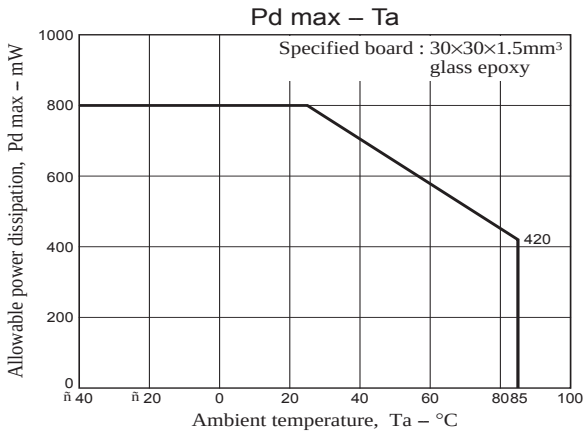


Top view

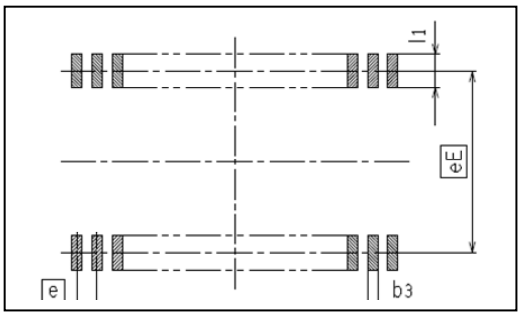
Note) Ground both GND pins.

Package Dimensions





Recommended Soldering Footprint

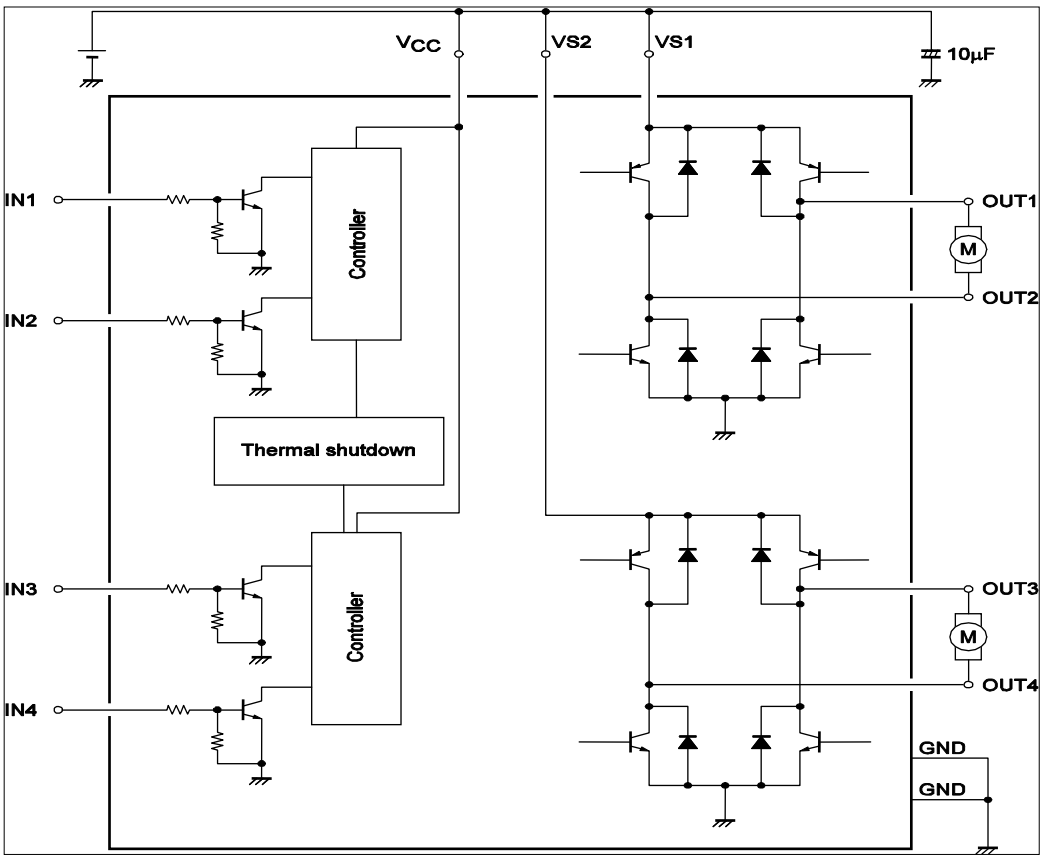


(Unit:mm)

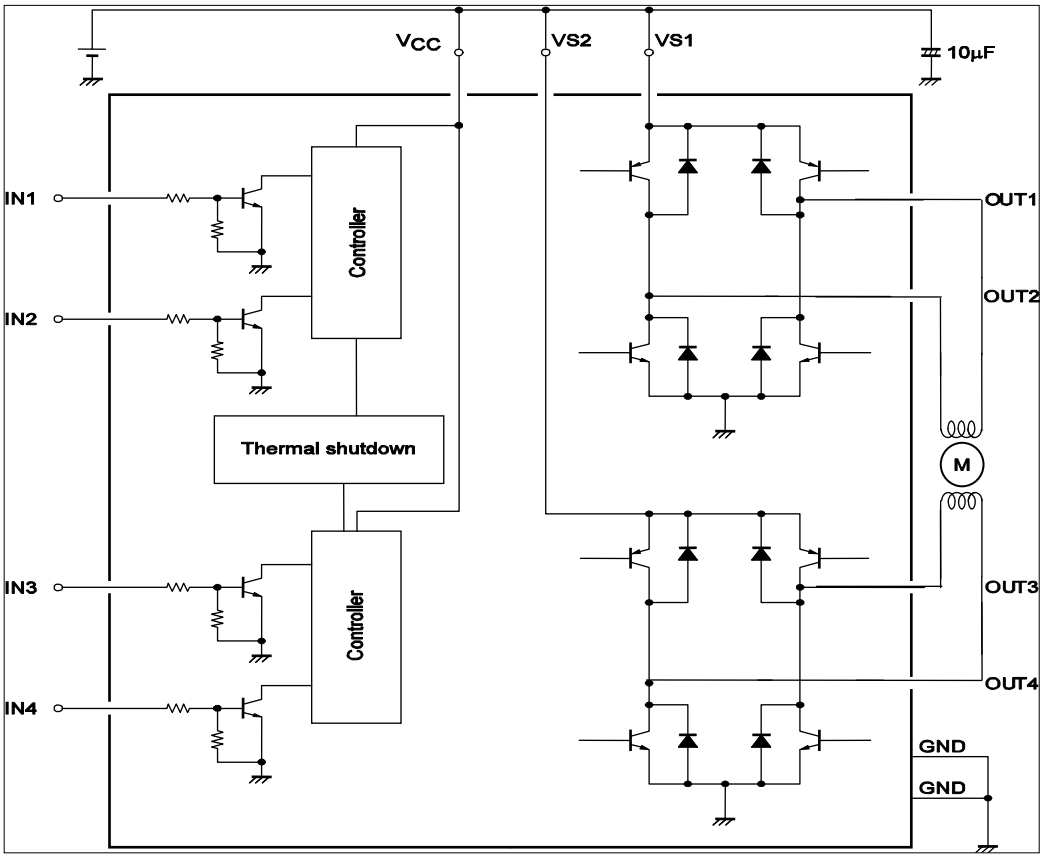
Reference Symbol	MFP10S (225mil)
eE	5.70
e	1.00
b3	0.47
l1	1.10

Block Diagram

1. Two-DC motor drive



2. Single stepping motor drive



Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum supply voltage	V_{CC} max		-0.3 to +10.5	V
	V_S max		-0.3 to +10.5	V
Output supply voltage	V_{OUT}		$V_S + V_{SF}$	V
Input supply voltage	V_{IN}		-0.3 to +10	V
GND pin flow-out current	IGND	Per channel	1.0	A
Allowable power dissipation	Pd max	* Mounted on a board.	800	mW
Operating temperature	Topr		-40 to +85	°C
Storage temperature	Tstg		-55 to +150	°C

* Mounted on a substrate: 30×30×1.5mm^3, glass epoxy board.

Caution 1) Absolute maximum ratings represent the value which cannot be exceeded for any length of time.
Caution 2) Even when the device is used within the range of absolute maximum ratings, as a result of continuous usage under high temperature, high current, high voltage, or drastic temperature change, the reliability of the IC may be degraded. Please contact us for the further details.

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Recommended Operating Conditions at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V_{CC}		2.5		9.0	V
	V_S		1.8		9.0	V
Input “H”-level voltage	V_{IH}		1.8		9.0	V
Input “L”-level voltage	V_{IL}		-0.3		+0.7	V

Electrical Characteristics at Ta = 25°C, V_{CC} = VS = 3V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply current	$I_{CC}0$	$V_{IN}1$, 2, 3, 4 = 0V, I_{CC} + I_S		0.1	10	μA
	$I_{CC}1$	$V_{IN}1$ = 3V, $V_{IN}2$, 3, 4 = 0V, I_{CC} + I_S		14	20	mA
	$I_{CC}2$	$V_{IN}1$, 2 = 3V, $V_{IN}3$, 4 = 0V, I_{CC} + I_S		22	35	mA
Output saturation voltage (upper + lower)	$V_{OUT}1$	I_{OUT} = 200mA		0.20	0.28	V
	$V_{OUT}2$	I_{OUT} = 400mA		0.40	0.60	V
	$V_{OUT}3$	I_{OUT} = 400mA, Parallel connection		0.25	0.35	V
	$V_{OUT}4$	I_{OUT} = 800mA, Parallel connection		0.50	0.70	V
Output sustain voltage	V_O (SUS)	I_{OUT} = 400mA	9			V
Input current	I_{IN}	V_{IN} = 2V, V_{CC} = 6V			80	μA
Spark killer diode						
Reverse current	I_S (leak)	$V_{CC}1$, 2 = 9V			30	μA
Forward voltage	V_{SF}	I_{OUT} = 400mA			1.7	V

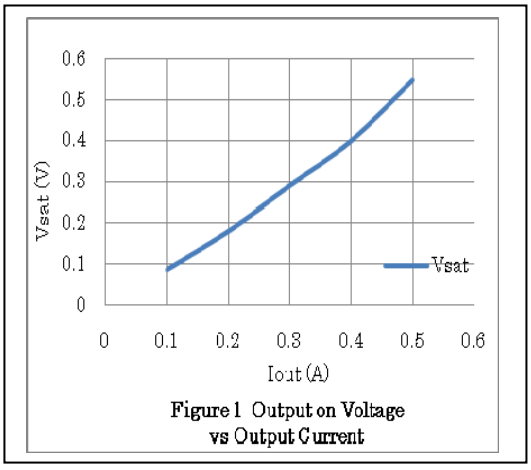


Figure 1 Output on Voltage vs Output Current

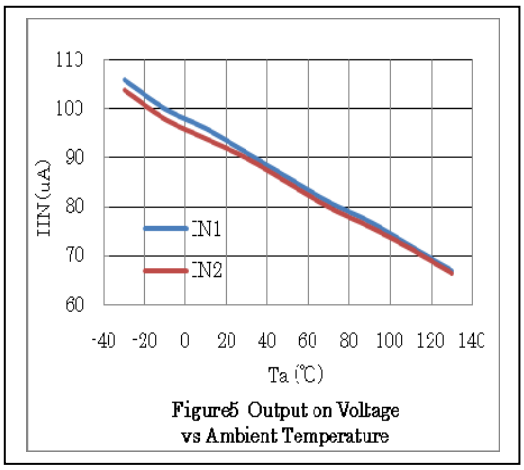


Figure5 Output on Voltage vs Ambient Temperature

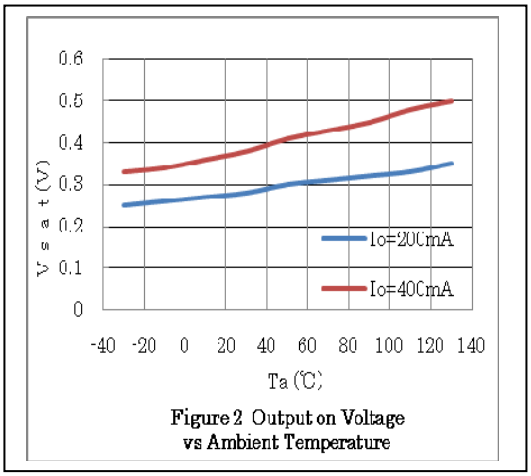


Figure 2 Output on Voltage vs Ambient Temperature

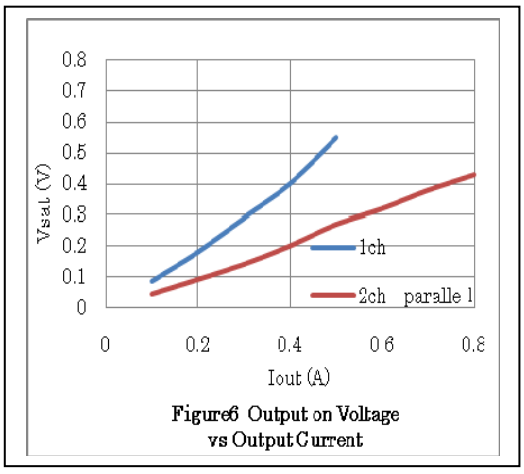


Figure6 Output on Voltage vs Output Current

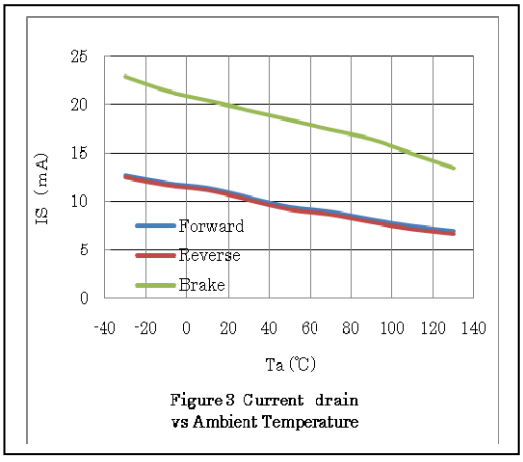


Figure 3 Current drain vs Ambient Temperature

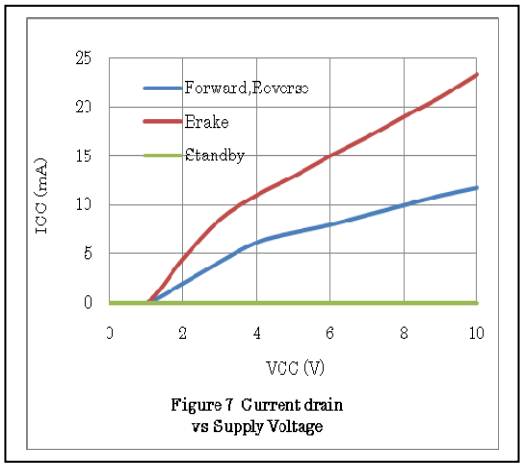


Figure 7 Current drain vs Supply Voltage

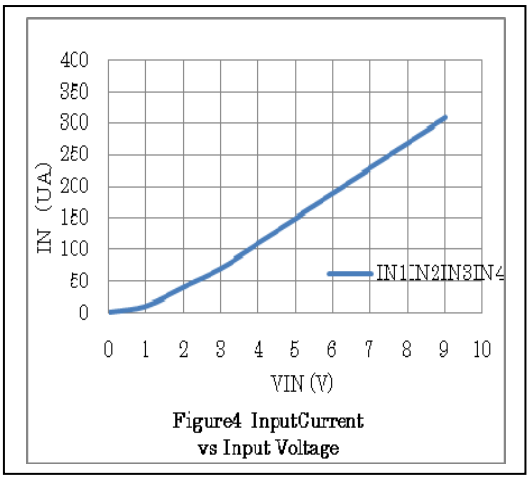


Figure4 InputCurrent vs Input Voltage

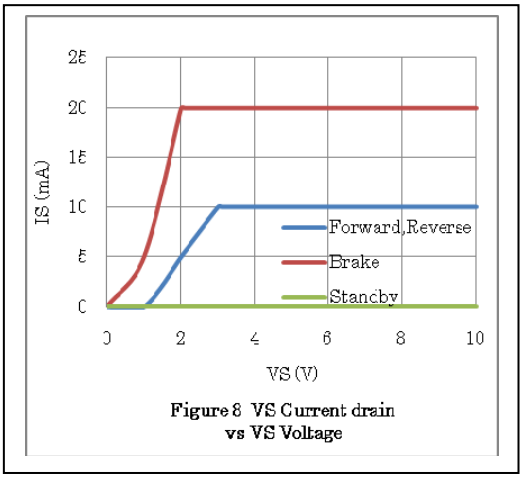


Figure 8 VS Current drain vs VS Voltage

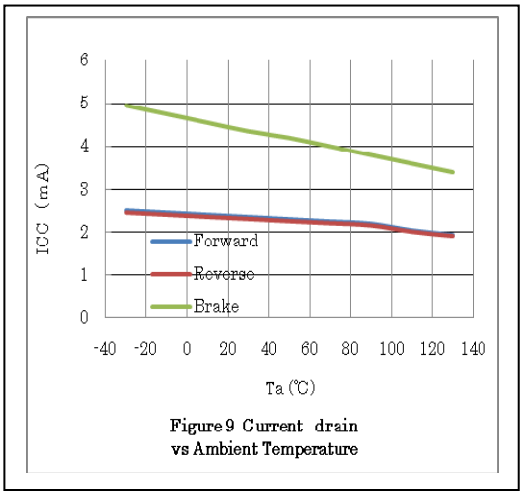
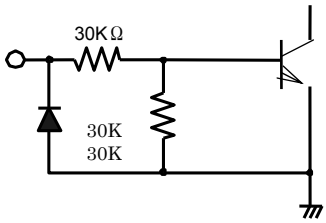
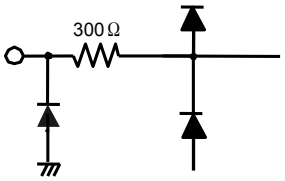
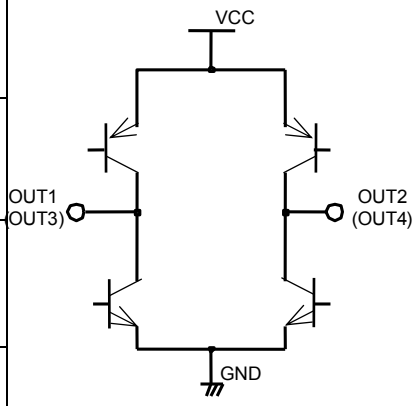


Figure 9 Current drain vs Ambient Temperature

Pin function

Pin No.	Pin name	Pin function	Equivalent Circuit
1	V_{CC}	Power-supply voltage pin. V_{CC} voltage is impressed. The permissible operation voltage is from 2.5 to 9.0(V). The capacitor is connected for stabilization for GND pin (7pin, 14pin).	
4 11	VS1 VS2	Power-supply voltage pin. （motor supply voltage） The permissible operation voltage is from 2.5 to 9.0(V). The capacitor is connected for stabilization for GND pin (7pin,14pin).	
2	IN1	Motor drive control input pin. Driving control input pin of OUT1 (3pin) and OUT2 (5pin). It combines with IN2 pin (6pin) and it fights desperately. The digital input it, range of the "L" level input is 0 to 0.7(V), range of the "H" level input is from 1.8 to 9.0(V). PWM can be input. Pull-down resistance 30(kΩ) is built into in the pin. It becomes a standby mode because all IN1, IN2, IN3, and IN4 pins are made "L", and the circuit current can be adjusted to 0.	
6	IN2	Motor drive control input pin. Driving control input pin of OUT1 (3pin) and OUT2 (5pin). It combines with IN1 pin (2pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
13	IN3	Motor drive control input pin. Driving control input pin of OUT3 (12pin) and OUT4 (10pin). It combines with IN4 pin (9pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
9	IN4	Motor drive control input pin. Driving control input pin of OUT3 (12pin) and OUT4 (10pin). It combines with IN3 pin (13pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
4,14	GND	Ground pin.	
8	Vcont	Pre-drive monitor terminal. Please refer to Vcontpin explanation.	
10	OUT4	Driving output pin. The motor coil is connected between terminal OUT3 (12pin).	
12	OUT3	Driving output pin. The motor coil is connected between terminal OUT4 (10pin).	
5	OUT2	Driving output pin. The motor coil is connected between terminal OUT1 (3pin).	
3	OUT1	Driving output pin. The motor coil is connected between terminal OUT2 (5pin).	

Operation explanation

1. LB1836M Input-Output-Logic

Truth Table

IN1/3	IN2/4	OUT1/3	OUT2/4	Mode
H	L	H	L	Forward
L	H	L	H	Reverse
H	H	L	L	Brake
L	L	OFF	OFF	Standby

2. DC motor operation sequence

- The following table shows the example of DC-motor sequence from Standby, Forward, Reverse, Brake, and Forward mode.
  When IN1, IN2, IN3, IN4 are "L", the operation of this IC is stopped.
  Please put standby mode for 10usec between Forward and Reverse mode.
  Likewise, please put standby mode for 10usec between Forward and Brake mode, as well as Reverse and Brake mode.

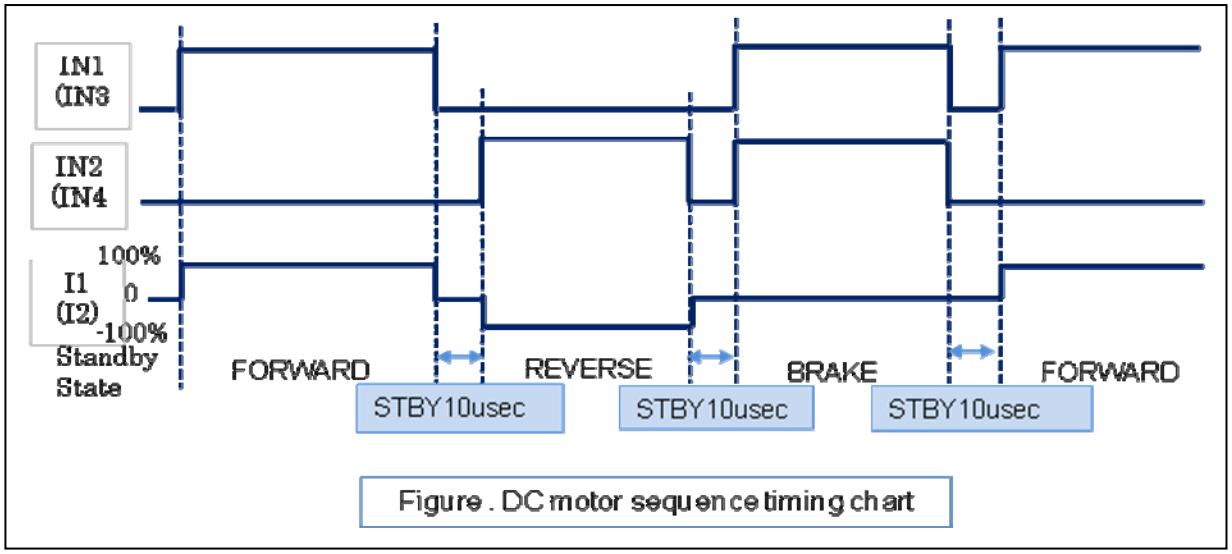
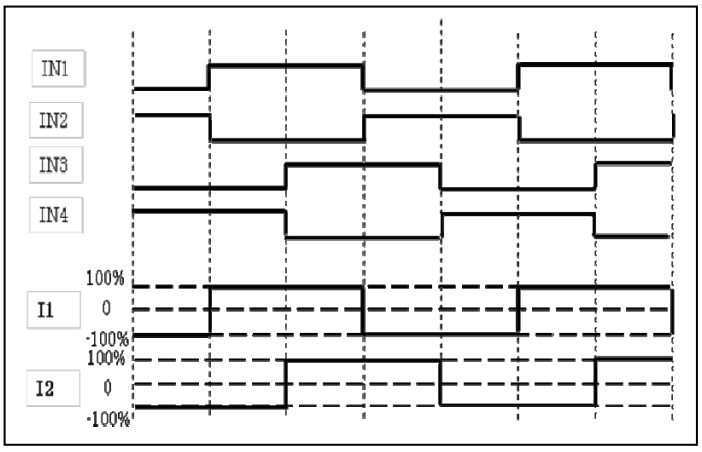
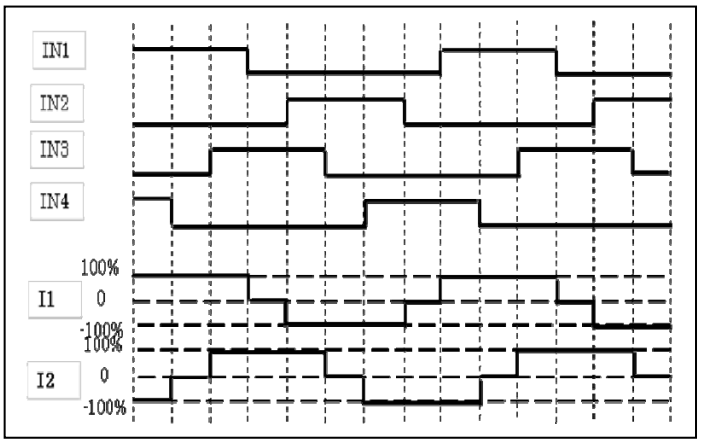


Figure . DC motor sequence timing chart

3. Stepping motor operation sequence
   Example of current wave type in each excitation mode when stepping motor parallel input is controlled.



2 phase excitation

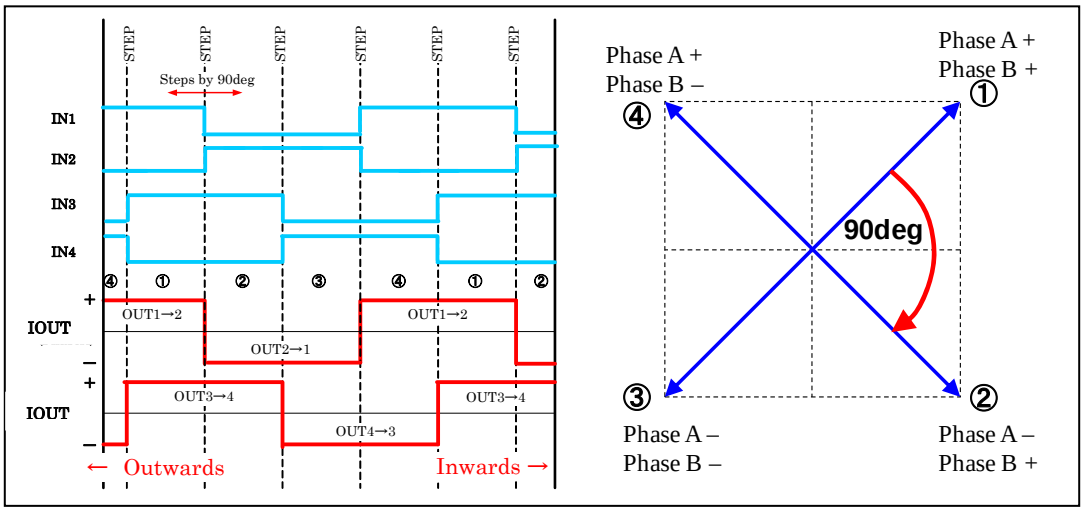


1-2 phase excitation

4. Theory

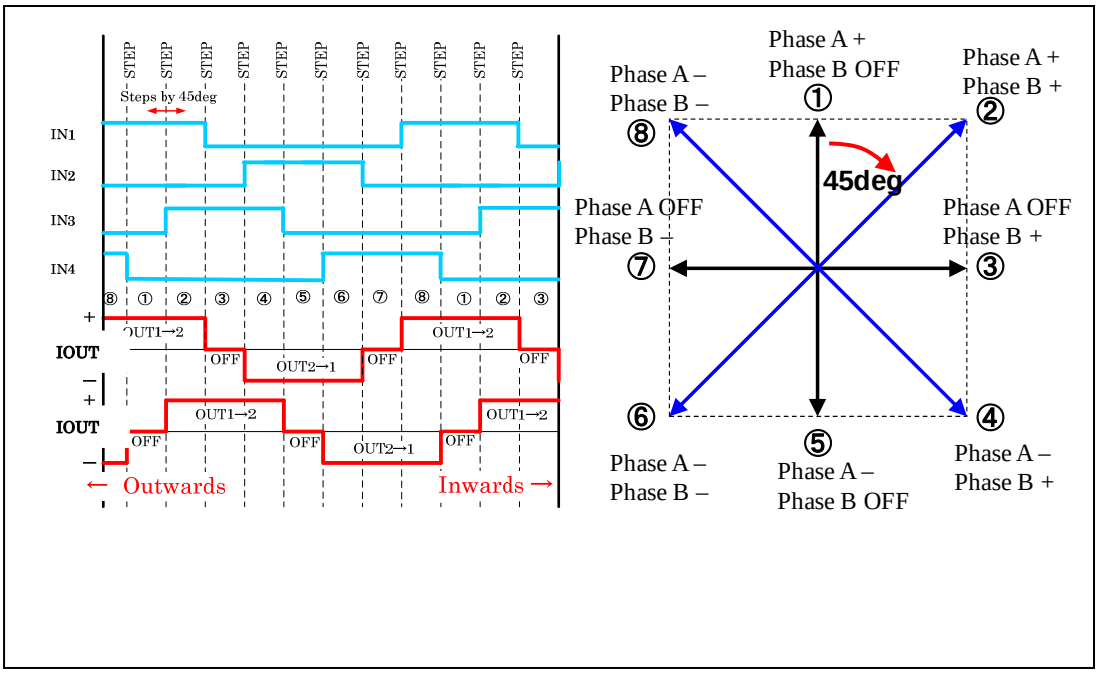
- Full-Step MODE

  The motor moves 90 degrees in an electric corner when I input 1Step.



- Half-Step MODE

  The motor moves 45 degrees in an electric corner when I input 1Step



Design Notes

If large current flows on the power supply (V_S) line and the GND line, then in some applications and layouts, misoperation due to line oscillation may result.

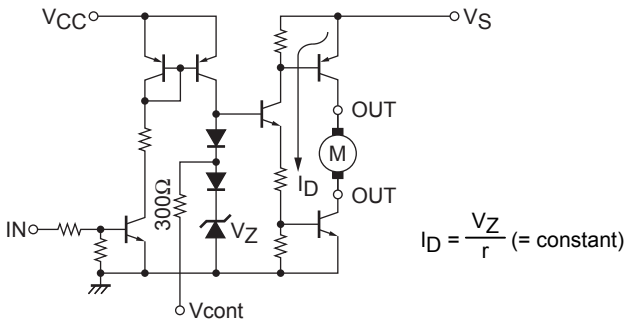
The modes during which large current flows are as follows:

- Motor surge current when the DC motor starts up or when it shifts rotation directions (forward ↔ reverse).
- Passthrough current generated within the IC when shifting rotation directions (forward ↔ reverse) or when shifting from forward/reverse rotation to braking, or vice versa.

The following points should be kept in mind regarding the pattern layout :

- Keep the wiring lines thick and short in order to reduce wiring inductance between the power supply (V_S) and GND.
- Insert a passthrough capacitor near the IC. (Maximum effect is obtained by inserting the passthrough capacitor between VS and the pin 7 GND at the closest distance possible.
- If the CPU and the LB1836M are mounted on separate boards and the difference between the ground potential of each board is large, install resistors of about 10kΩ in series between the CPU and the LB1836M inputs.

5. Vcont pin



As shown in the above diagram, the Vcont pin outputs the voltage of the band gap Zener $V_Z + V_F$ (=1.93V). In normal use, this pin is left open.
The drive current ID is varied by the Vcont voltage. However, because the band gap Zener is shared, it functions as a bridge.
The motor can stop by making vcont terminal GND in emergency.

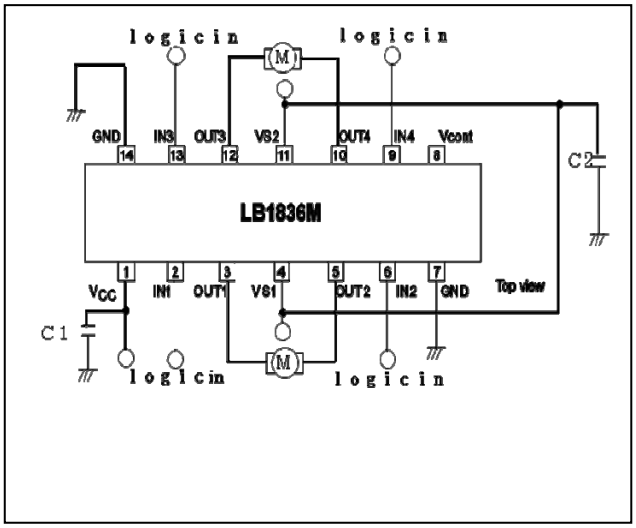
6. Thermal Shutdown circuit

The thermal shutdown circuit in incorporated and the output is turned off when junction temperature Tj exceeds 180°C and the abnormal state warning output is turned on. As the temperature falls by hysteresis, the output turned on again (automatic restoration).
The thermal shutdown circuit does not guarantee the protection of the final product because it operates when the temperature exceed the junction temperature of Tjmax=150°C.

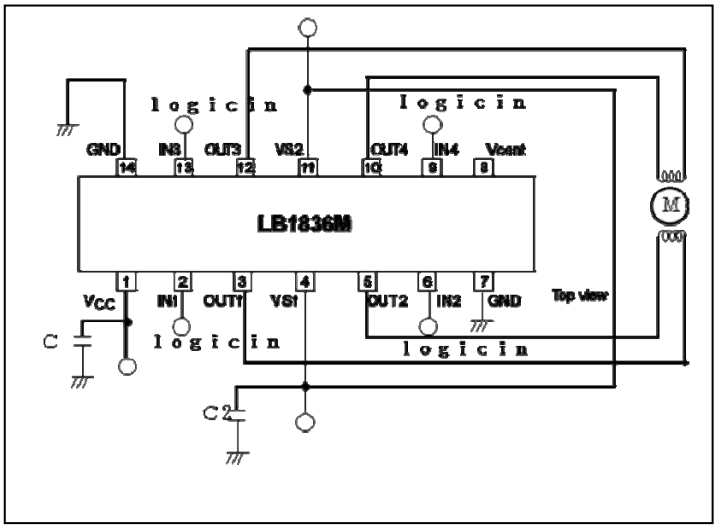
TSD = 180°C (typ)
ΔTSD = 40°C (typ)

Application Circuit Example

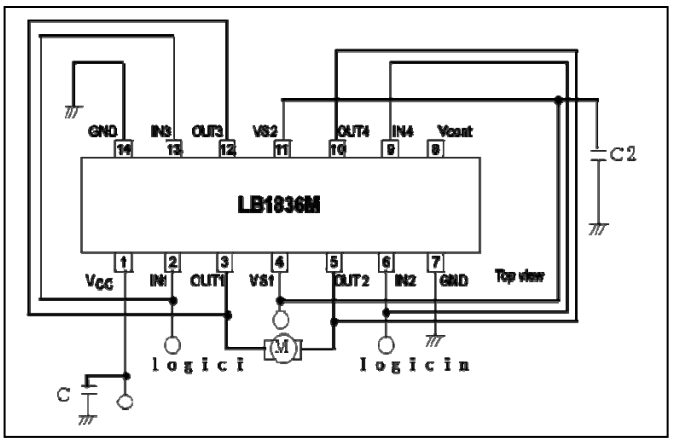
1. Example of applied circuit with two DC motor driving



2. Example of applied circuit with one stepping motor driving

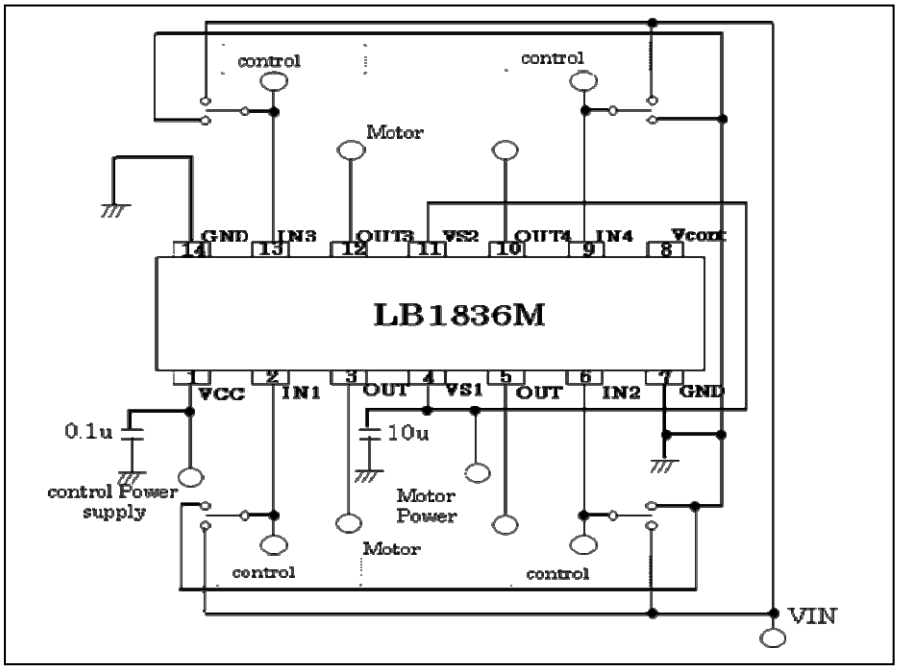


3. Example of applied circuit when connecting it in parallel
   The use likened to H bridge 1ch is shown possible in the figure below by connecting IN1 with IN3, IN2 with IN4, OUT1 with OUT3, OUT2, and OUT4. (I_O max=2.0A, Upper and lower total R_{ON}=0.5Ω)



Eva-Board Manual

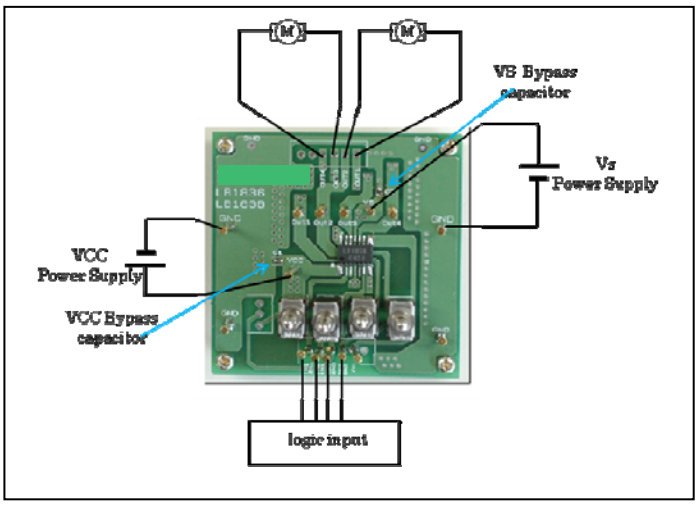
1. Eva-Board circuit diagram



Bill of Materials for LB1836M Evaluation Board

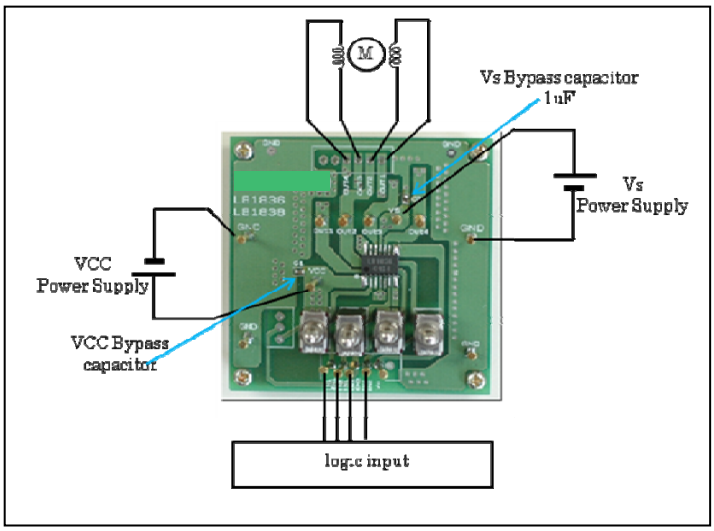
Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			MFP14S (225mil)	ON semiconductor	LB1836M	No	Yes
C1	1	VCC Bypass capacitor	1μF 50V			KOA	GRM188B11A 105K	Yes	Yes
C2	1	Vs Bypass capacitor	0.1u 100v			Murata	GRM188R72A 104KA35D	Yes	Yes
SW1-SW4	4	Switch				MIYAMA	MS-621-A01	Yes	Yes
TP1-TP11	14	Test points				MAC8	ST-1-3	Yes	Yes

2. (1) Two DC motor drive



- Connect OUT1 and OUT2, OUT3 and OUT4 to a DC motor each.
- Connect the motor power supply with the terminal VCC, the control power supply with the terminal VIN. Connect the GND line with the terminal GND.
- DC motor becomes the predetermined output state corresponding to the input state by inputting an input signal such as the following truth value table into IN1~IN4.

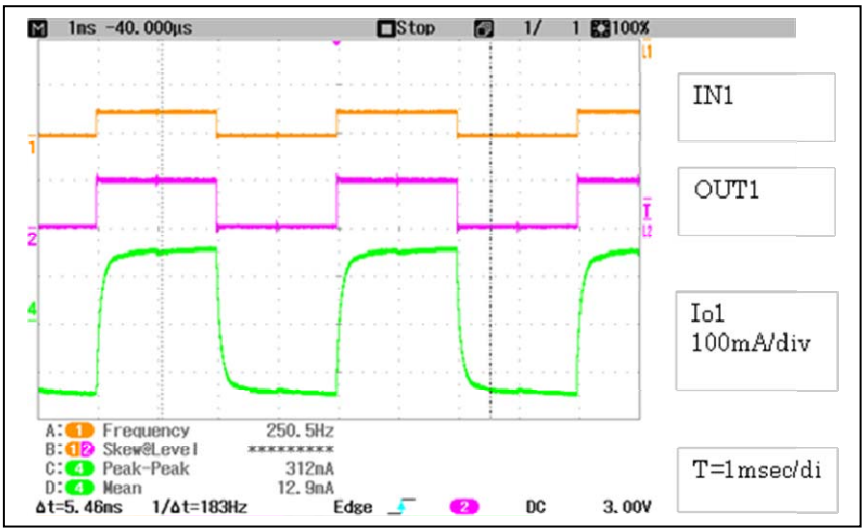
(2) One stepping motor drive



- Connect a stepping motor with OUT1, OUT2, OUT3 and OUT4.
- Connect the motor power supply with the terminal VCC, the control power supply with the terminal VIN. Connect the GND line with the terminal GND.
- STP motor drives it in an 2 phase excitation, 1-2 phase excitation by inputting an input signal such as follows into IN1~IN4.

Waveform of LB1836M evaluation board when driving stepping motor

- Full-Step Drive VCC=5V, VS=5V 1000pps



- Half-Step Drive VCC=5V, VS=5V 1600pps