LB1838M

ON Semiconductor®

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Monolithic Digital IC

Low-Voltage, Low-Saturation Bidirectional Motor Driver Application Note

Overview

The LB1838M is a low-saturation two-channel bidirectional motor driver IC for use in low-voltage applications.

The LB1838M is a bipolar stepper-motor driver IC that is ideal for use in printers, cameras and other portable devices.

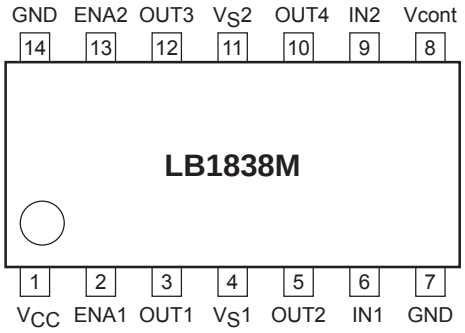
Functions

- Low voltage operation (2.5V min)
- Low saturation voltage (upper transistor + lower transistor residual voltage: 0.40V at 400mA)
- Built-in through-current prevention circuit
- Separate logic power supply and motor power supply
- Built-in spark killer diodes
- Built-in thermal shutdown circuit
- Compact package: MFP14S

Typical Applications

- Automotive speed meter
- Security camera
- Thermal Printer Unit
- Camera
- POS, Card Terminal

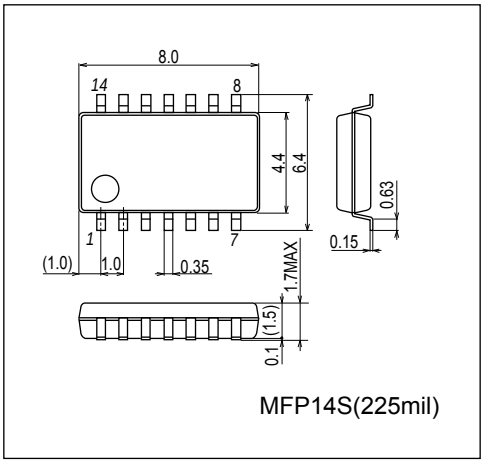
Pin Assignment



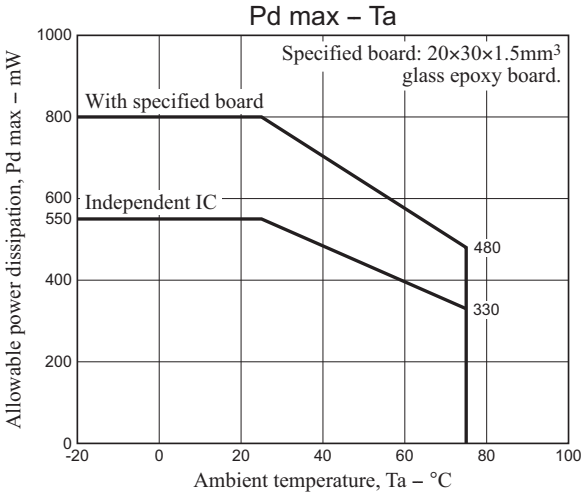
Note: Both GND pins should be connected to ground.

Package Dimensions

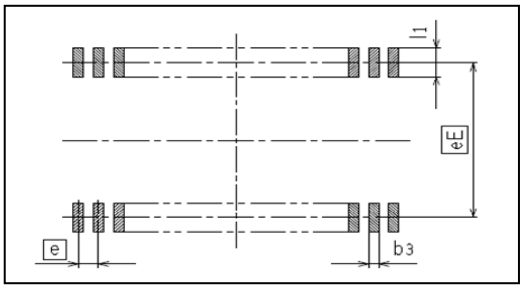
unit: mm (typ)



MFP14S(225mil)



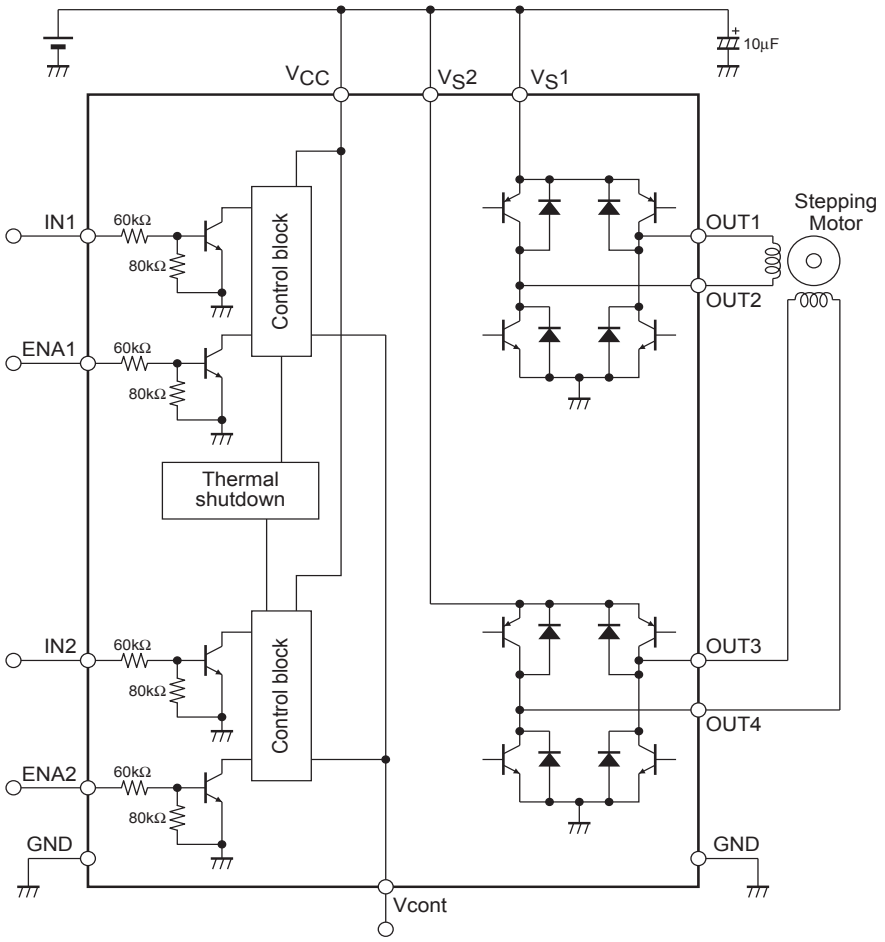
Recommended Soldering Footprint



(Unit:mm)

Reference Symbol	MFP14S (225mil)
eE	5.70
e	1.00
b3	0.47
l1	1.10

Block Diagram



Note: As long as the voltages applied to V_{CC}, V_S1, V_S2, ENA1, ENA2, IN1, and IN2 are within the limits set by the absolute maximum ratings, there are no restrictions on the relationship of each voltage level in comparison with the others (regarding which is higher or lower). (ex. V_{CC} = 3V, V_S1, 2 = 2V, ENA = IN = 5V)

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 applied voltage	V_{OUT}		V_S+V_{SF}	V
Input applied voltage	V_{IN}		-0.3 to +10	V
Ground pin flow-out current	I_{GND}	Per channel	1.0	A
Allowable power dissipation	Pd max	Independent IC	550	mW
		Mounted on a specified board *	800	mW
Operating temperature	Topr		-20 to +75	°C
Storage temperature	Tstg		-40 to +125	°C

* Specified board: 20mm × 30mm × 1.6mm, 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 high-level voltage	V_{IH}		1.8		9.0	V
Input Low-level voltage	V_{IL}		-0.3		+0.7	V

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

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Current drain	$I_{CC}0$	ENA1,2 = 0V, $V_{IN}1$ = 3V or 0V		0.1	10	μA
	$I_{CC}1$	ENA1 = 3V, $V_{IN}1$ = 3V or 0V		12	18	mA
Output saturation voltage	$V_{OUT}1$	ENA = 3V, V_{IN} = 3V or 0V, I_{OUT} = 200mA		0.2	0.28	V
	$V_{OUT}2$	ENA = 3V, V_{IN} = 3V or 0V, I_{OUT} = 400mA		0.4	0.6	V
Input current	I_{IN}	V_{CC} = 6V, V_{IN} = 6V			200	μA
	I_{ENA}	V_{CC} = 6V, ENA = 6V			200	μA
Output sustaining voltage	V_O(SUS)	I_{OUT} = 400mA	9			V
Spark killer diode						
Reverse current	I_S(leak)	$V_{CC}1$, V_S = 7V			30	μA
Forward voltage	V_{SF}	I_{OUT} = 400mA			1.7	V

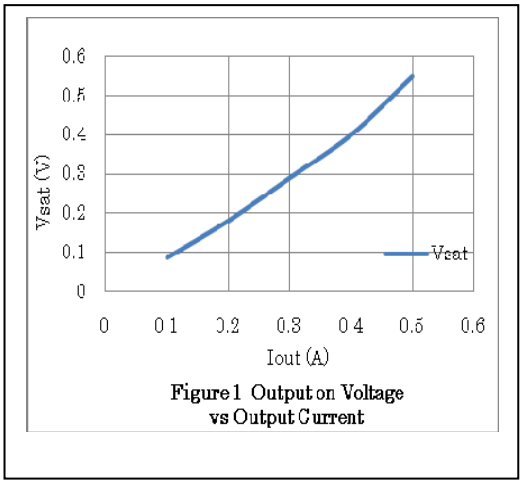


Figure 1 Output on Voltage vs Output Current

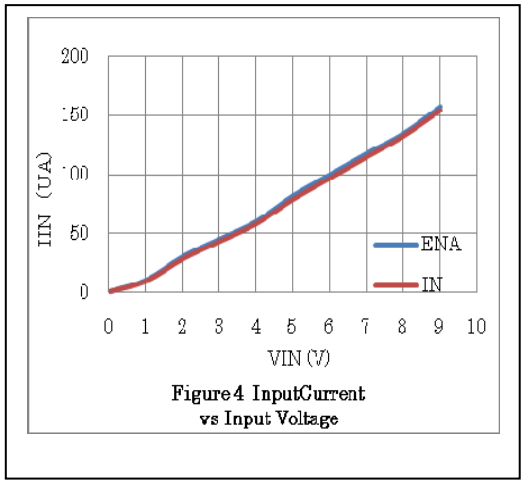


Figure 4 InputCurrent vs Input Voltage

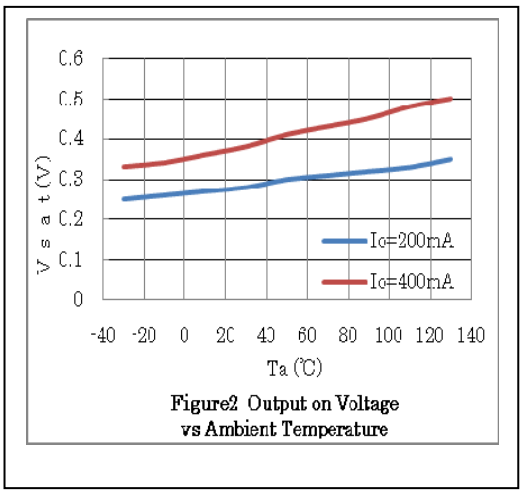


Figure2 Output on Voltage vs Ambient Temperature

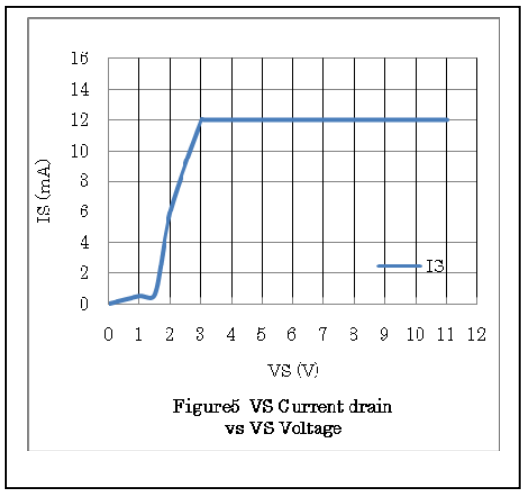


Figure5 VS Current drain vs VS Voltage

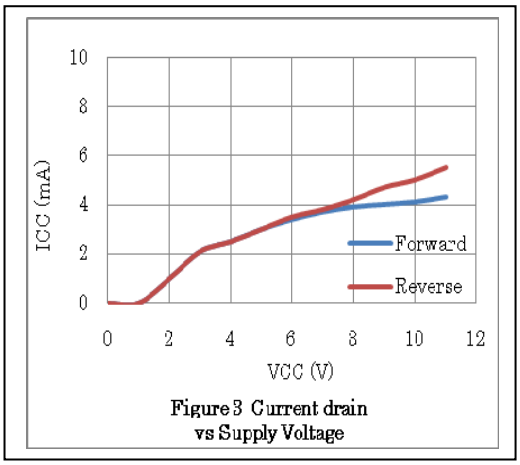
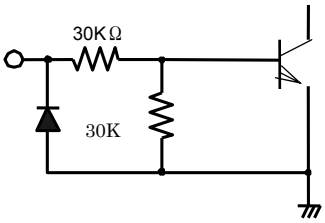
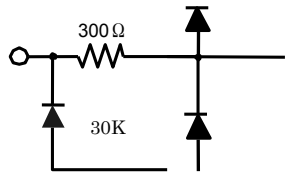


Figure 3 Current drain vs Supply Voltage

Pin function

Pin No.	Pin name	Pin function	Equivalent Circuit
1	V_{CC}	Power-supply voltage pin. （signal supply） 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） The permissible operation voltage is from 1.8 to 9.0(V). The capacitor is connected for stabilization for GND pin (7pin,14pin).	
2	ENA1	Motor stand-by (start-stop pin) control input pin. Start-stop control input pin of OUT1 (3pin) and OUT2 (5pin). . 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). Pull-down resistance 30(kΩ) is built into in the pin. It combines with ENA2 pin (4pin) and it uses it.	
6	IN1	Motor forward-reverse (direction pin) control input pin. Direction control input pin of OUT1 (3pin) and OUT2 (5pin). It combines with IN2 pin (9pin) and it uses it. With built-in pull-down resistance.	
13	ENA2	Motor stand-by (start-stop pin) control input pin. Start-stop control input pin of OUT3 (12pin) and OUT4 (10pin). It combines with ENA1 pin (2pin) and it uses it. With built-in pull-down resistance.	
9	IN2	Motor forward-reverse (direction pin) control input pin. Direction control input pin of OUT3 (12pin) and OUT4 (10pin). It combines with IN1 pin (6pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
7,14	GND	Ground pin.	
8	Vcont	Pre-drive monitor terminal. Please refer to Vcontpin explanation.	

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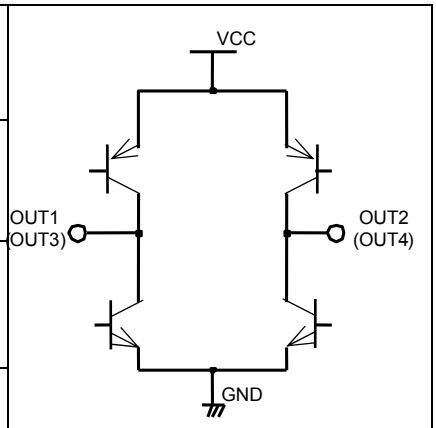
10	OUT4	Driving output pin. The motor coil is connected between terminal OUT3 (12pin).	
12	OUT3	Driving output pin. The motor coil is connected between terminal OUT4 (10pin).	
5	OUT2	Driving output pin. The motor coil is connected between terminal OUT1 (3pin).	
3	OUT1	Driving output pin. The motor coil is connected between terminal OUT2 (5pin).	

Operation explanation

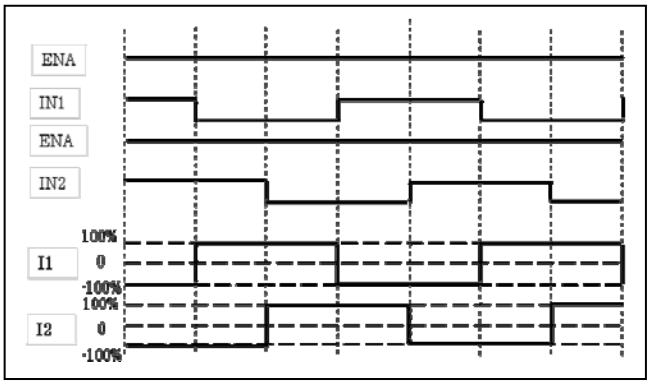
1. LB1838M Input-Output Logic

Truth Table

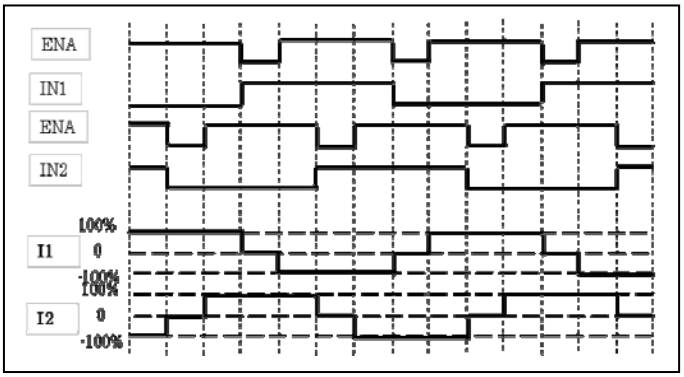
IN1,2	ENA1,2	OUT1,3	OUT2,4	Mode
L	H	H	L	Forward
H	H	L	H	Reverse
L	L	OFF	OFF	Standby
H	L	OFF	OFF	Standby

2. 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

3. Theory

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

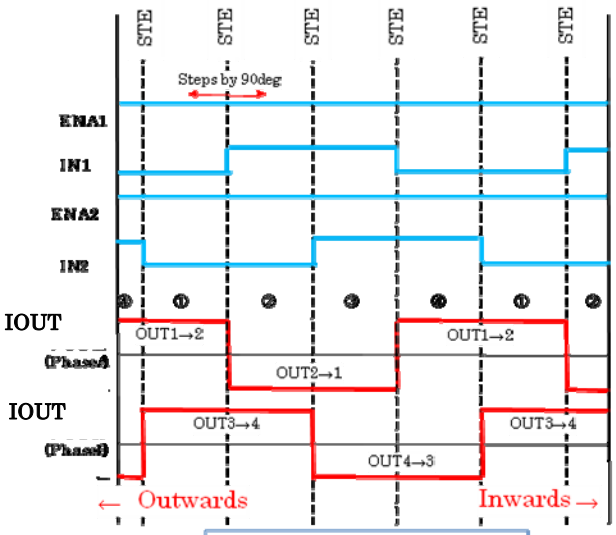


Figure 10. Full-Step Timing

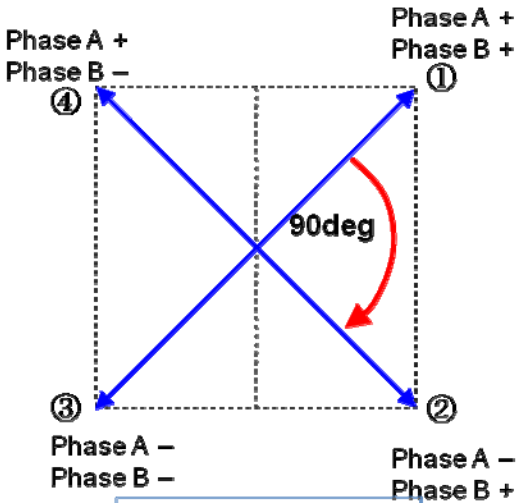


Figure 11. Motor electric angle (Full Step Drive)

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

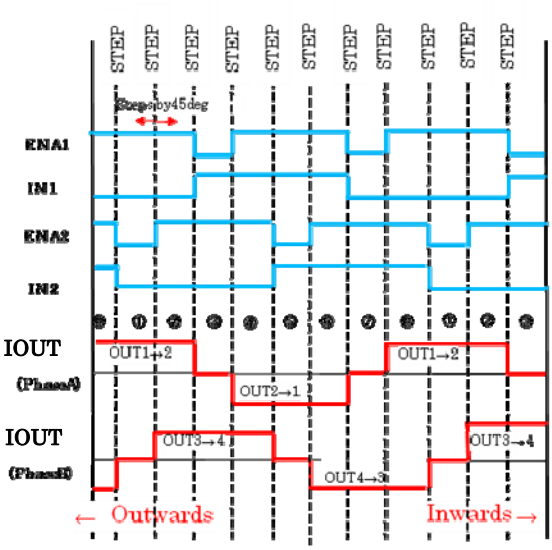


Figure 12 Half-Step Timing

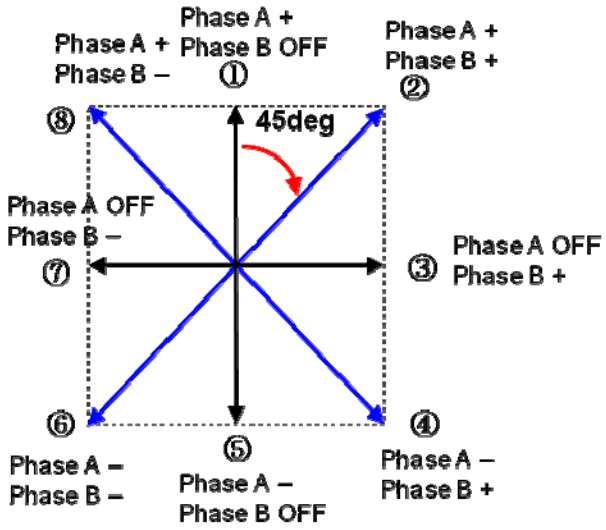
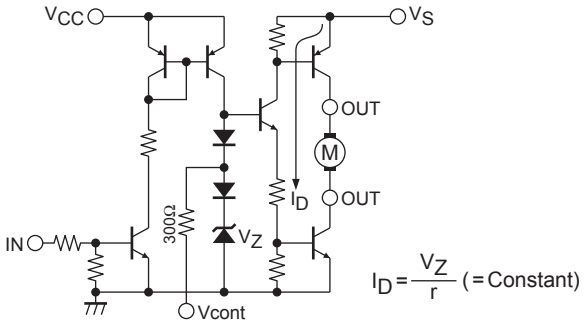


Figure 13. Motor electric angle (Half-Step Drive)

4. Vcont pin



As shown in the left 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 I_D 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.

5. 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).

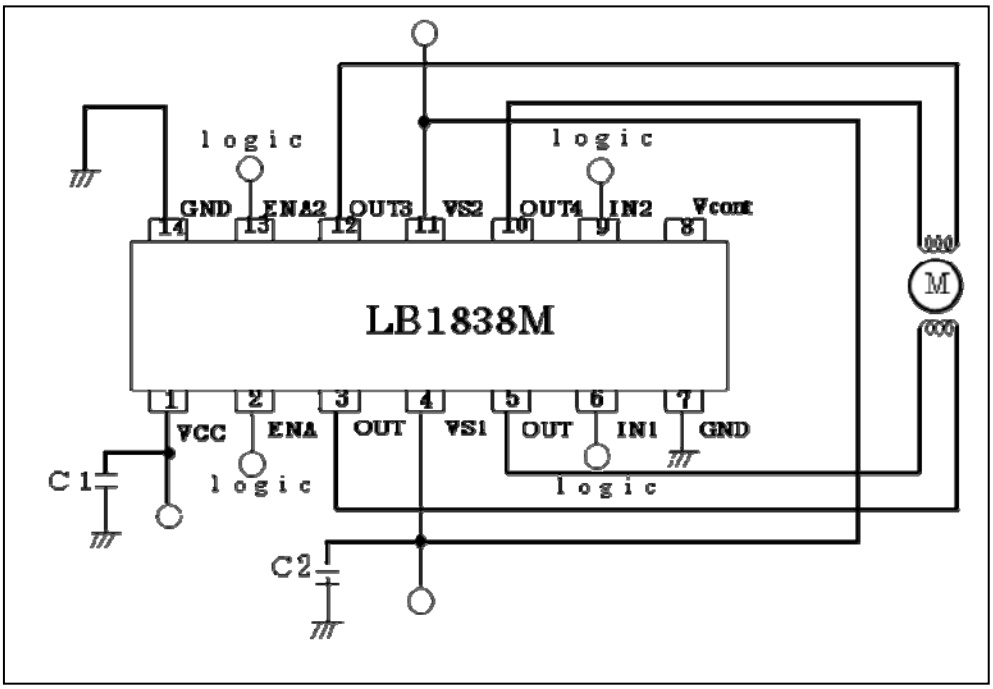
The thermal shutdown circuit does not guarantee the protection of the final product because it operates when the temperature exceed the junction temperature of Tjmax=150°C.

TSD = 180°C (typ)

ΔTSD = 40°C (typ)

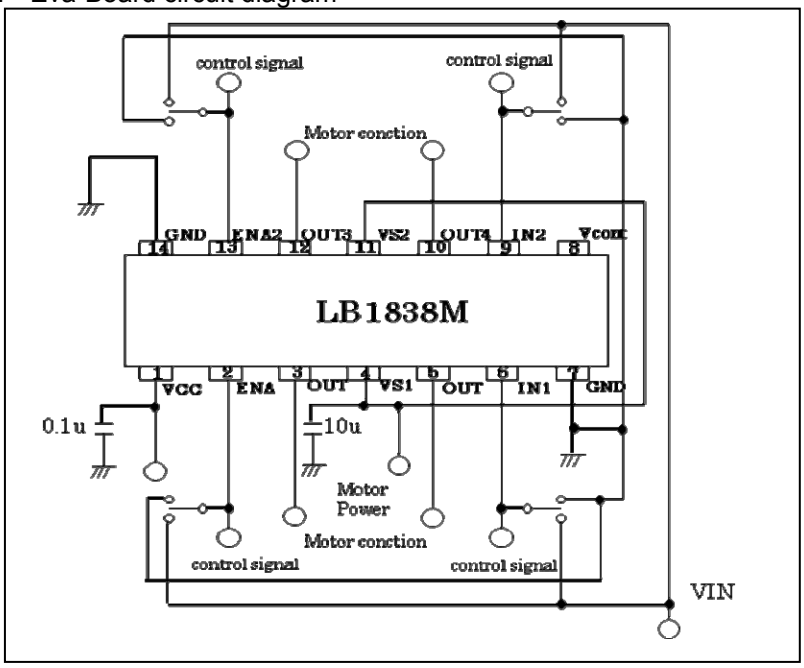
Application Circuit Example

Example of applied circuit with one stepping motor



Eva-Board Manual

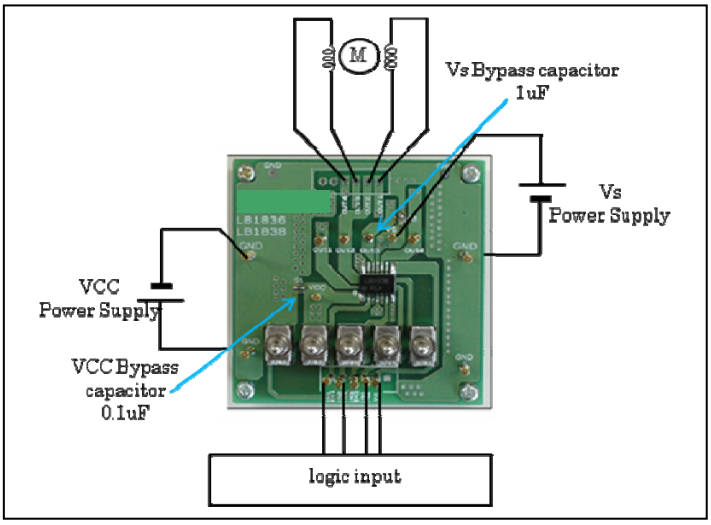
1. Eva-Board circuit diagram



Bill of Materials for LB1838M Evaluation Board

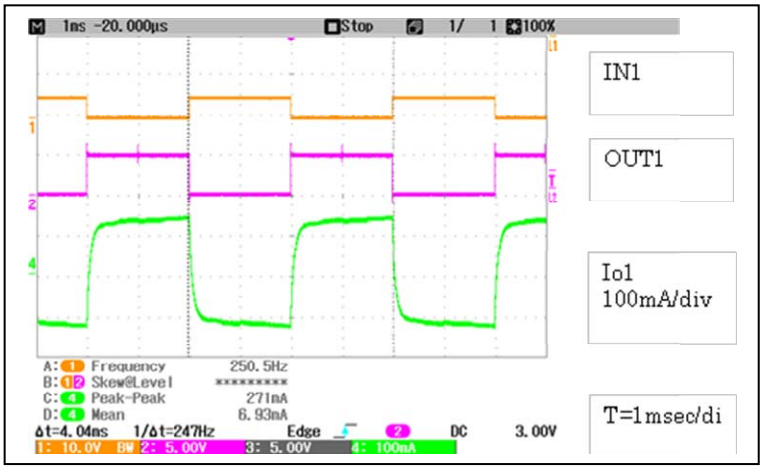
Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			MFP14S (225mil)	ON semiconductor	LB1838M	No	Yes
C1	1	VCC Bypass capacitor	1μF 50V			KOA	GRM188B11A 105K	Yes	Yes
C2	1	Vs Bypass capacitor	0.1u 100v			Murata	GRM188R72A 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) One stepping motor drive



(2) Stepping motor drive connection explanation

- 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 ENA1,N1,ENA2,IN2.
  Waveform of LB1838M evaluation board when driving stepping motor
- Full-Step Drive VCC=5V, VS=5V 1000pps



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