LB1909MC

Bi-CMOS integrated circuit

12V Low Saturation Voltage Drive
Stepper Motor Driver
Application Note

ON Semiconductor®

http://onsemi.com

Overview

The LB1909MC is a low saturation voltage stepper motor driver IC. It is optimal for motor drive in 12V system products.

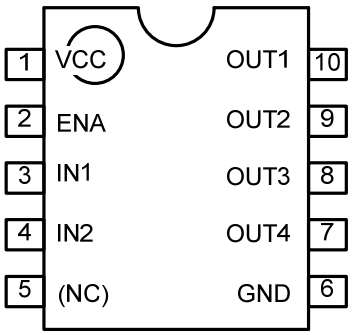
Function

- BIP output transistor adoption (Upper and lower total Vo(sat)=0.5V(typical) at Io=400mA)
- For one power supply (The control system power supply is unnecessary.)
- Our motor driver IC, LV8549M, and compatible pin
- The compact package (SOIC-10 NB) is adopted.
- V_{CC} max = 20v, I_O max = 0.8A
- Current consumption 0 when standing by

Typical Applications

- Refrigerators
- Time Recorder
- Label Printer
- Vacuum cleaner
- Refrigerators
- Time Recorder

Pin Assignment

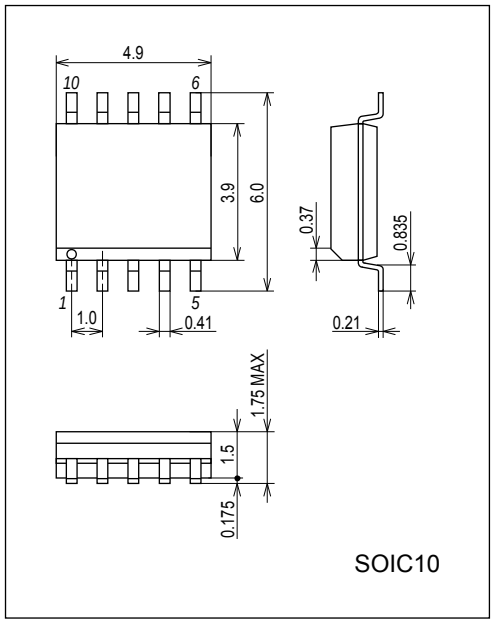


LB1909MC

(Top View)

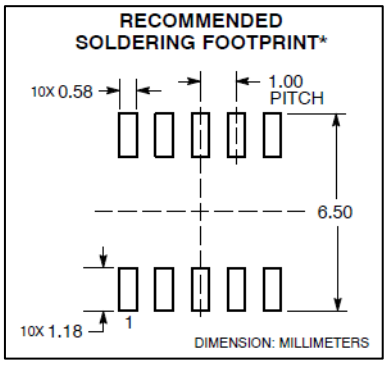
Package Dimensions

unit : mm (typ)



Caution: The package dimension is a
reference value,
which is not a guaranteed value.

Recommended Soldering Footprint



Block Diagram

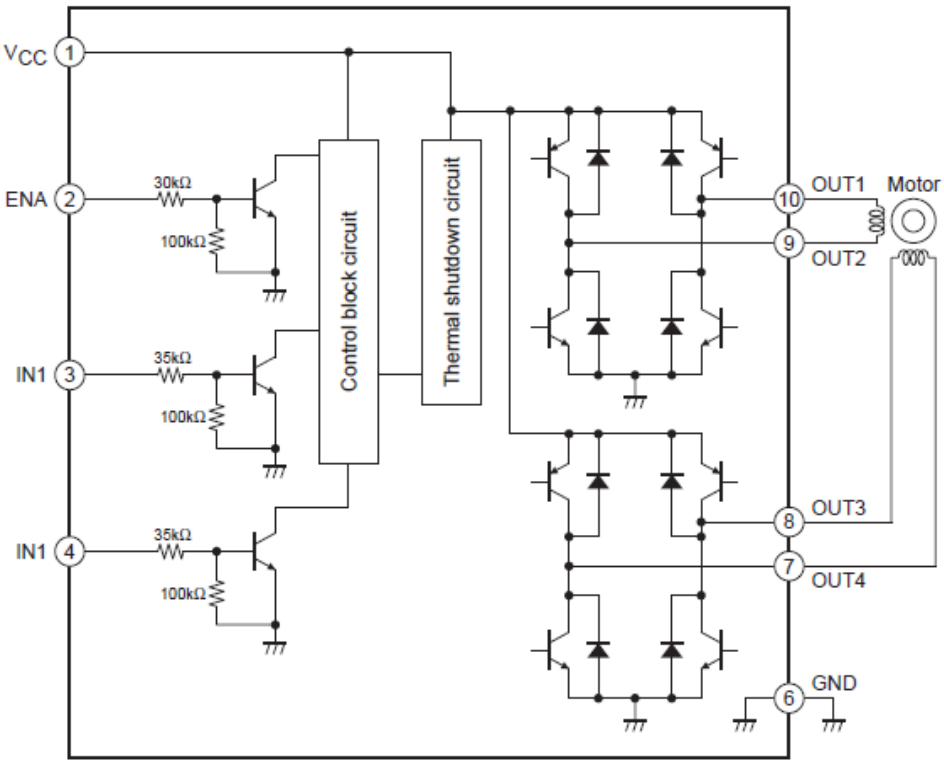


Figure1 One stepping motor drive

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage	V_{CC} max		-0.3 to +20	V
Applied output voltage	VOUT max		-0.3 to +20	V
Applied input voltage	V_{IN} max		-0.3 to +18	V
GND pin outflow current	IGND		800	mA
Allowable power consumption	Pd max	*	820	mW
Operating temperature	Topr		-30 to +85	°C
Storage temperature	Tstg		-40 to +150	°C

*: When mounted on the specified printed circuit board (114.3mm ×76.1mm × 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		1.6	V
Input high level voltage	V_{IH}		1.8		10	V
Input low level voltage	V_{IL}		-0.3		+0.7	V

Electrical Characteristics at Ta = 25°C, V_{CC} = 12V

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power source current	$I_{CC}0$	ENA=L		0.1	10	μA
	$I_{CC}1$	ENA=H		25	35	mA
Output saturation voltage	$V_{OUT}1$	I_{OUT}=200mA		0.25	0.35	V
	$V_{OUT}2$	I_{OUT}=400mA		0.50	0.75	V
Input current	I_{IN}	V_{IN} = 5V		85	110	μA
Thermal protection block *1						
Thermal shutdown operation temperature	T_{tsd}	Design guarantee *2		180		°C
Temperature hysteresis width	ΔT_{tsd}	Design guarantee *2		60		°C
Spark Killer Diode						
Reverse current	I_S(leak)				30	μA
Forward voltage	V_{SF}	I_{OUT}=400mA			1.7	V

*1 The thermal protection function is a feature to prevent the product from smoking and firing under unusual conditions. It is not intended guarantee operation of the product under an ambient temperature exceeding the operating temperature range.
*2 Design guarantee is not tested in individual units.

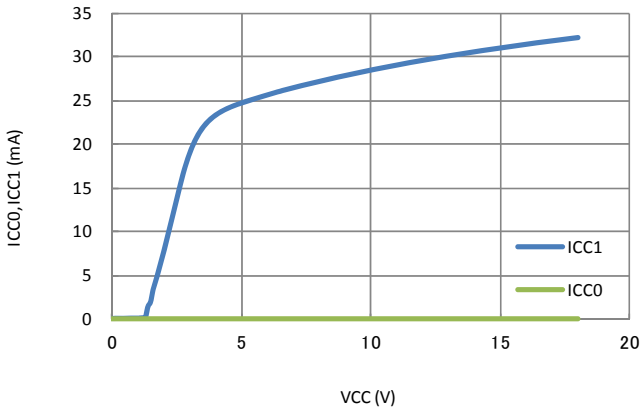


Figure 1 Current Drain vs VCC Voltage

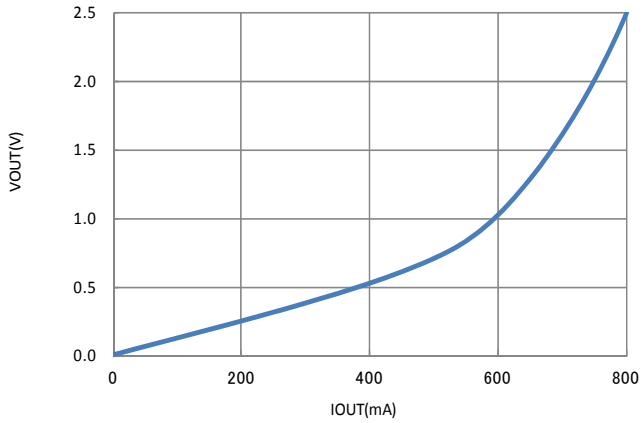


Figure 2 VOUT vs IOUT (VCC=VIN=12V)

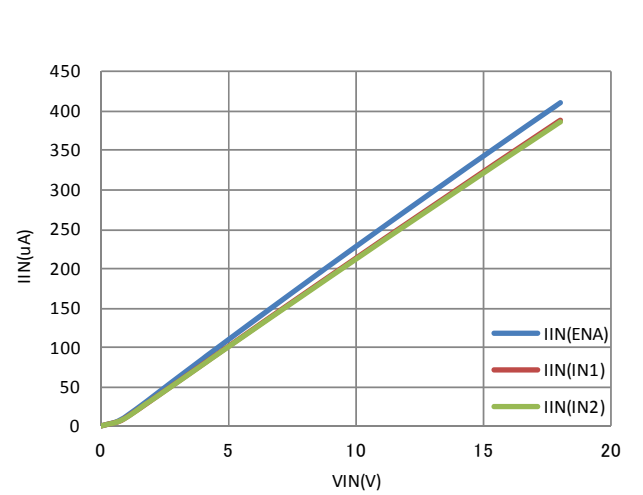


Figure 3 IIN vs VIN

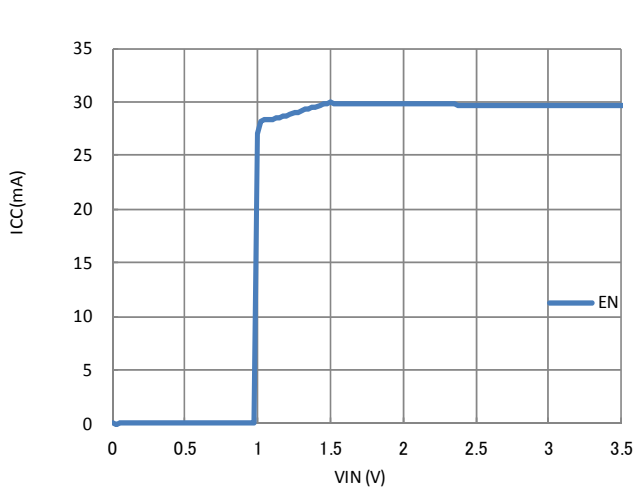


Figure 4 VOUT vs VIN (VCC=12V)

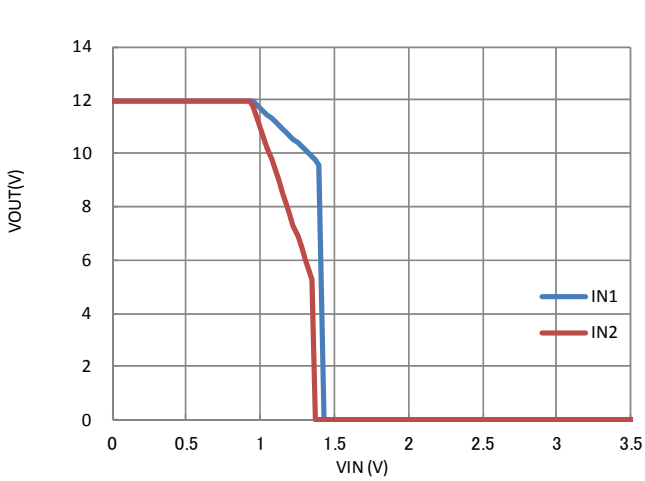


Figure 5 VOUT vs VIN (VCC=12V)

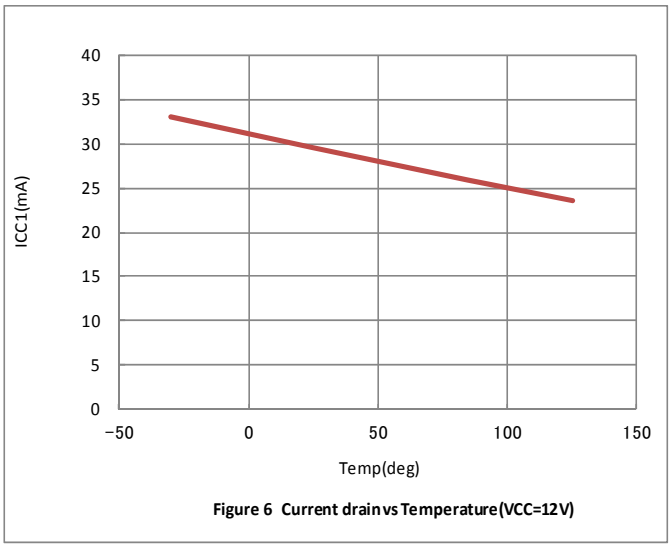


Figure 6 Current drain vs Temperature(VCC=12V)

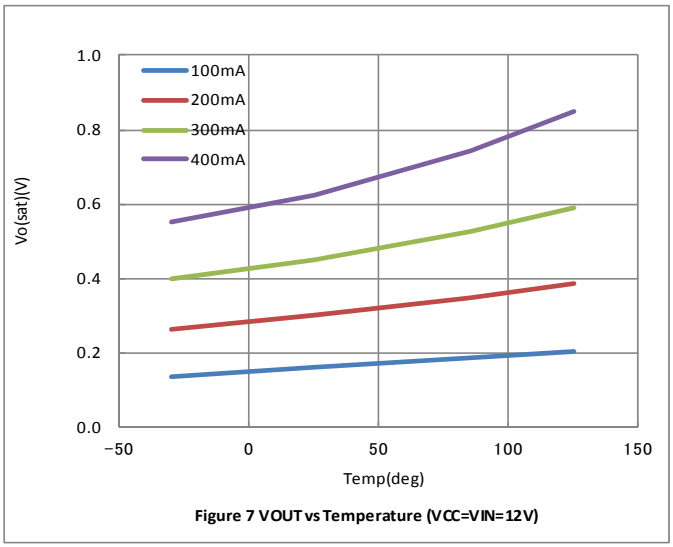
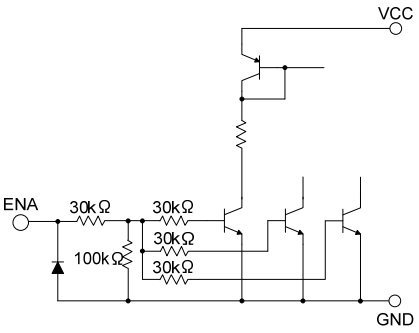
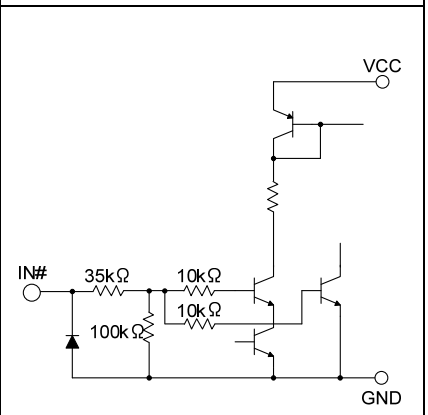
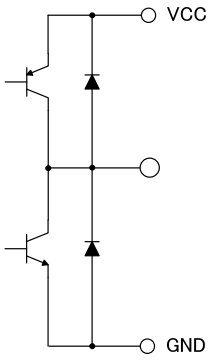


Figure 7 VOUT vs Temperature (VCC=VIN=12V)

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 16(V). The capacitor is connected for stabilization for GND pin (6pin).	
2	ENA	Motor drive control input pin. It shifts from the stand-by state to a prescribed output operation corresponding to the state of the input when the ENA pin becomes a standby mode by L, the circuit current can be adjusted to 0, and it makes it to H. It is a digital input, and the range of L level input is 0 to 0.7(V) and the range of H level input are 1.8 to 10(V). Pull-down resistance 80(kΩ) is built into in the terminal.	
3	IN1	Motor drive control input pin. Driving control input pin of OUT1 (10pin) and OUT2 (9pin). With built-in pull-down resistance.	
4	IN2	Motor drive control input pin. Driving control input pin of OUT3 (8pin) and OUT4 (7pin). With built-in pull-down resistance.	
5	NC		
6	GND	Ground pin.	
7	OUT4	Driving output pin. The motor coil is connected between terminal OUT3 (8pin).	
8	OUT3	Driving output pin. The motor coil is connected between terminal OUT4 (7pin).	
9	OUT2	Driving output pin. The motor coil is connected between terminal OUT1 (10pin).	
10	OUT1	Driving output pin. The motor coil is connected between terminal OUT2 (9pin).	

Operation explanation

1. Truth table

Input			Output				Remarks	
ENA	IN1	IN2	OUT1	OUT2	OUT3	OUT4		
L	*	*	OFF	OFF	OFF	OFF	Standby mode	
H	L		H	L			Channel 1	Forward
	H		L	H				Reverse
		L			H	L	Channel 2	Forward
		H			L	H		Reverse

2. Thermal shutdown function

The thermal shutdown circuit is incorporated and the output is turned off when junction temperature Tj exceeds 200°C. 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 = 200°C (typ)

ΔTSD = 75°C (typ)

(1) Thermal shutdown temperature

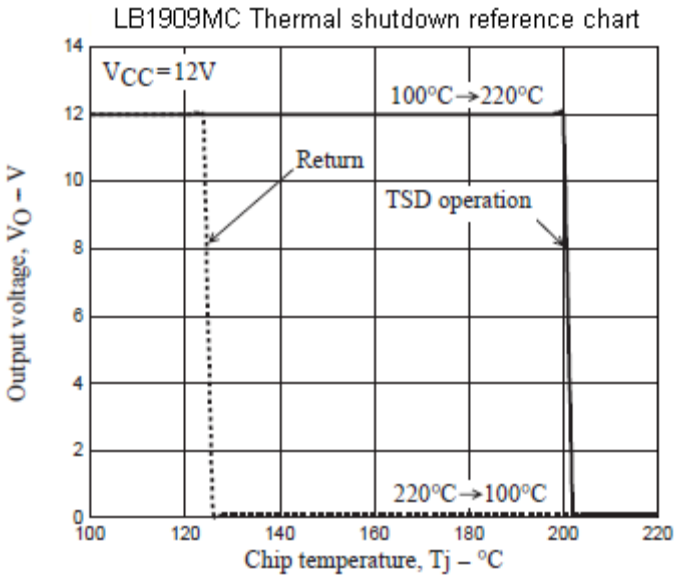
The thermal shutdown temperature Ttsd is 200±20°C with fluctuations.

(2) Thermal shutdown operation

The operation of the thermal shutdown circuit is shown in the figure below.

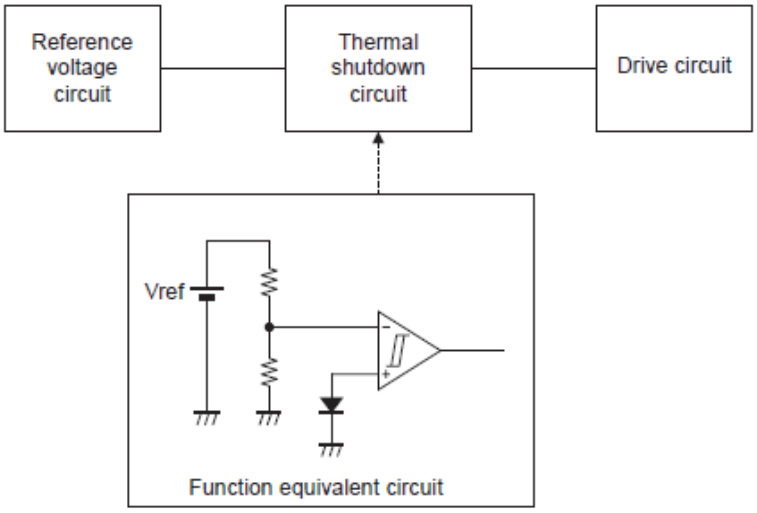
When the chip temperature Tj is in the direction of increasing (solid line), the output turns off at approximately 200°C.

When the chip temperature Tj is in the direction of decreasing (dotted line), the output turns on (returns) at approximately 125°C.



(Thermal shutdown circuit block diagram)

The thermal shutdown circuit compares the voltage of the heat sensitive element (diode) with the reference voltage and shuts off the drive circuit at a certain temperature to protect the IC chip from overheating.



Note: The above is an example of thermal shutdown circuits although ther are same differences from the actual internal circuit.

Design Documentation

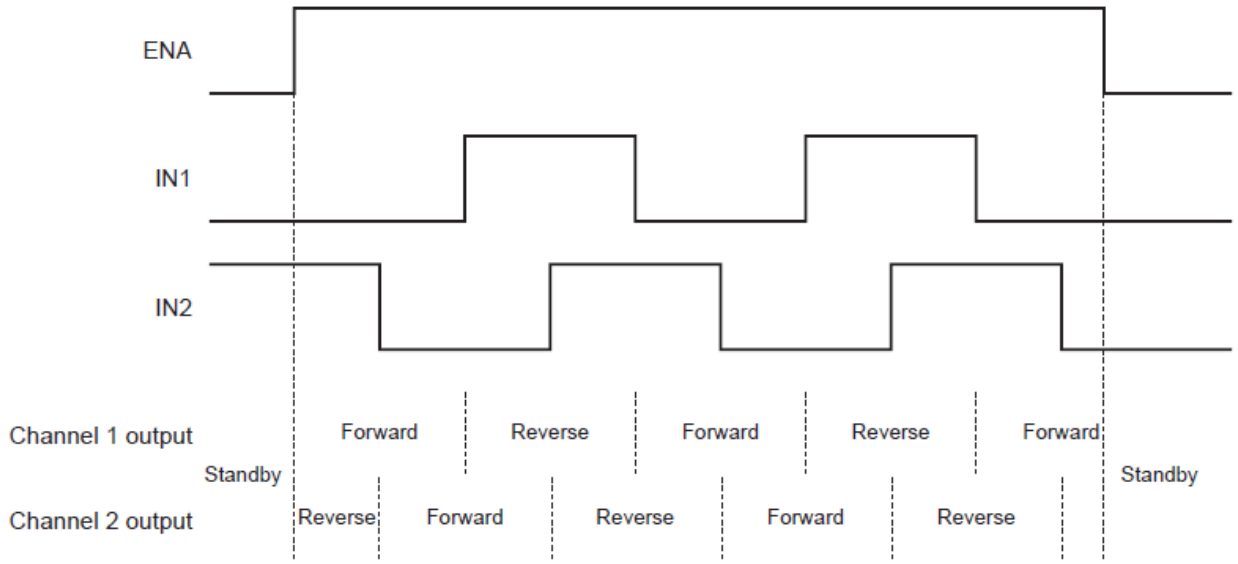
(1) Voltage magnitude relationship

There are no restrictions on the magnitude relationships between the voltage applied to Vcc and ENA,IN1,IN2.

(2) Observe the following points when designing the printed circuit board pattern layout.

- Make the Vcc and ground lines as wide and as short as possible to lower the wiring inductance.
- Insert bypass capacitors between Vcc and ground mounted as close as possible to the IC.
- Resistors of about 10KΩ must be inserted between the CPU output ports and the IN1 to IN4 pins if the microcontroller and the LB1909MC are mounted on different printed circuit boards and the ground potentials differ significantly.

Timing Chart - Full-Step (2phase excitation) drive-



Operation principal

- Full-Step Drive
  Motor advances 90 degree by inputting 1 step.

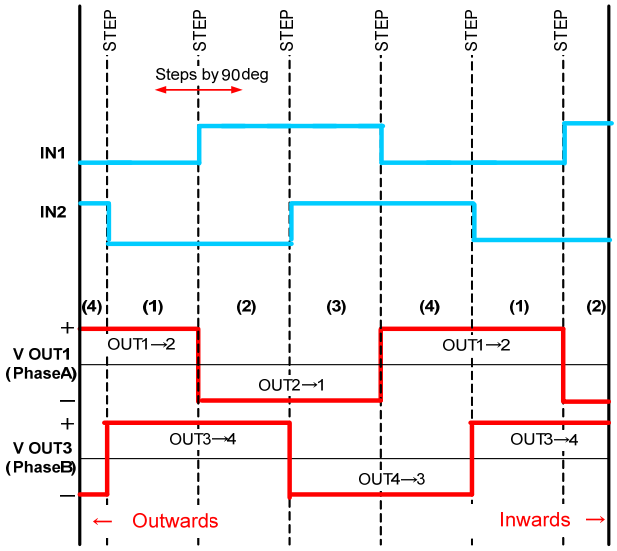


Figure 1. Full-Step Timing

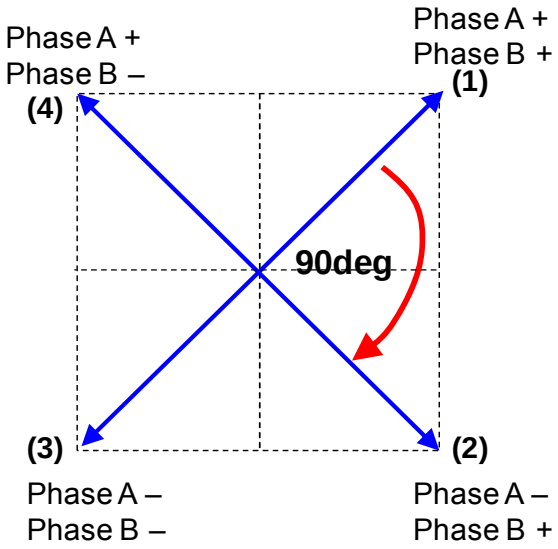
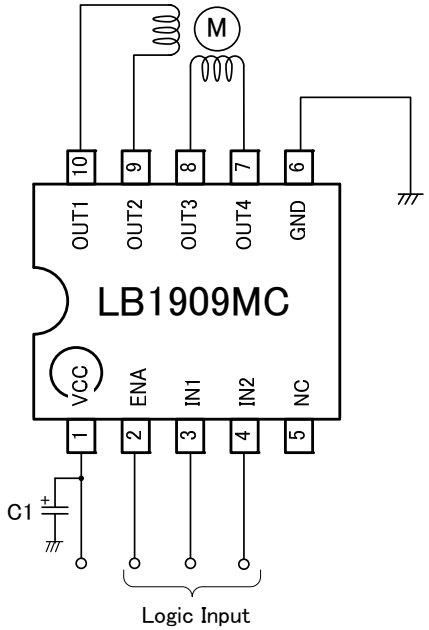


Figure 2. Motor electric angle (Full Step Drive)

Application Circuit Example

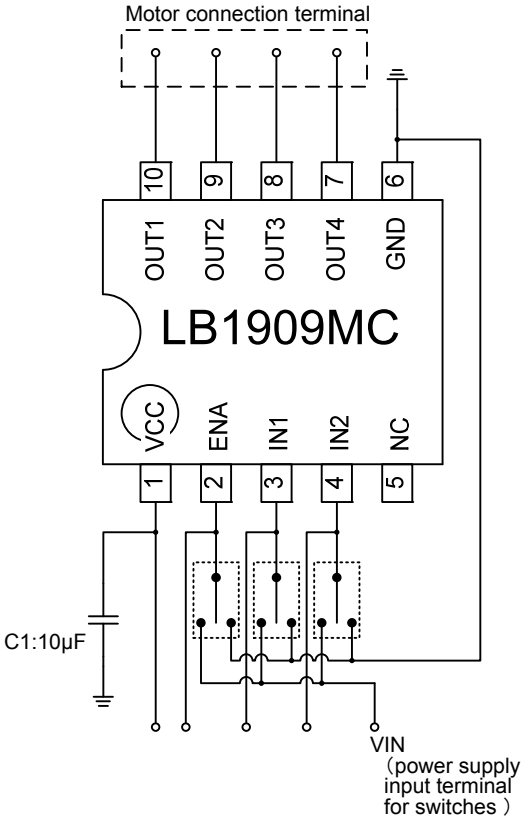
1. Example of applied circuit when one stepping motor driving



* Bypass capacitor (C1) connected between V_{CC}-GND of all examples of applied circuit recommends the electric field capacitor of 0.1μA to 10μA.
  Confirm there is no problem in operation in the state of the motor load including the temperature property about the value of the capacitor.
  Mount the position where the capacitor is mounted on nearest IC.

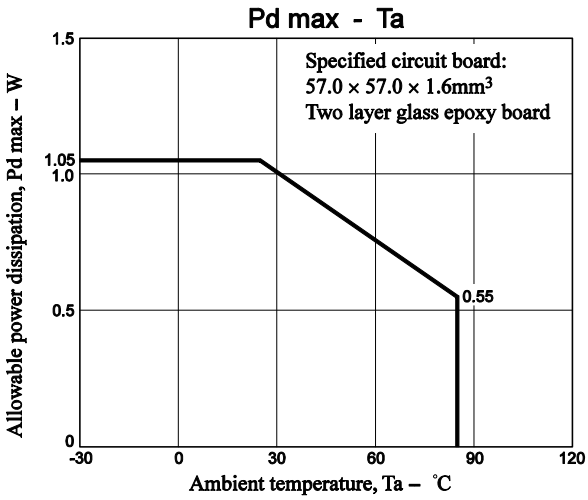
Evaluation Board Manual

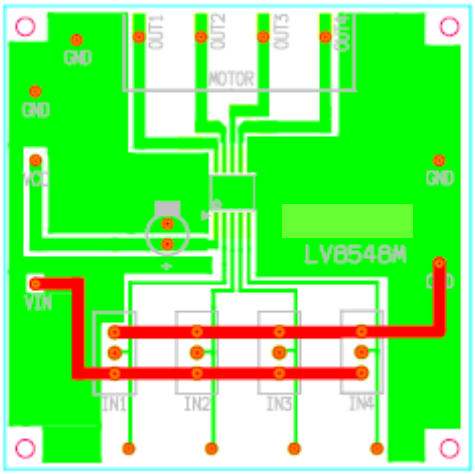
1. Evaluation Board circuit diagram



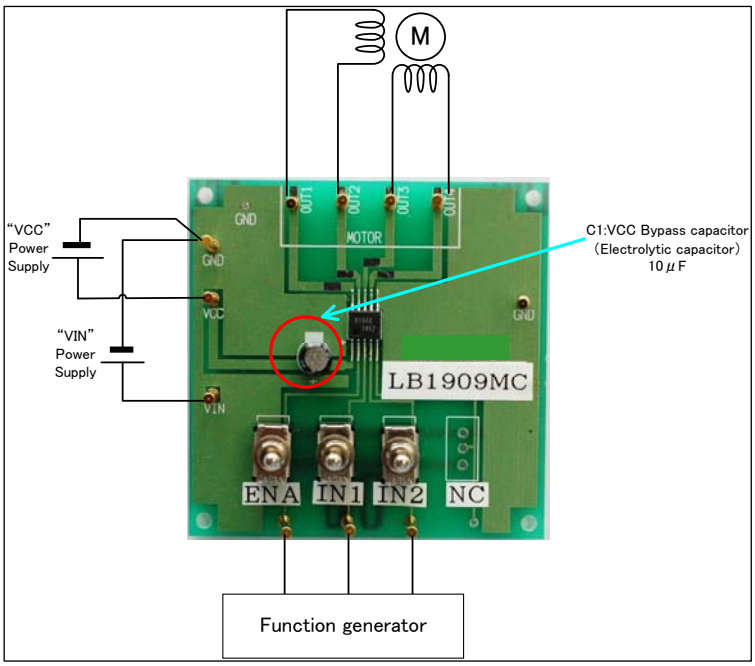
Bill of Materials for LB1909MC Evaluation Board

Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			SOIC-10 NB	ON semiconductor	LB1909MC	No	Yes
C1	1	VCC Bypass capacitor	10μF 50V	±20%		SUN Electronic Industries	50ME10HC	Yes	Yes
SW1-SW3	3	Switch				MIYAMA	MS-621-A01	Yes	Yes
TP1-TP11	11	Test points				MAC8	ST-1-3	Yes	Yes





2. One stepping motor drive

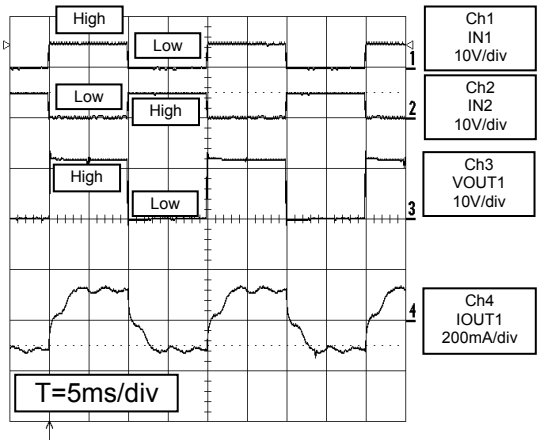


- Connect a stepping motor with OUT1, OUT2, OUT3 and OUT4.
- Connect the motor power supply with the terminal VCC, the control power supply with the terminal VIN. Connect the GND line with the terminal GND.
- STP motor drives it in a Full-Step, Half-Step by inputting a signal such as follows into IN1~IN4.
- For input signal to function generator, refer to p.8.
  To reverse motor rotation, make sure to input signal to outward direction.

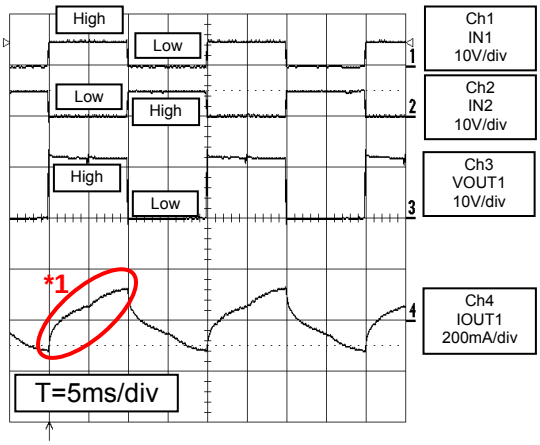
Waveform of LB1909MC evaluation board when driving stepping motor

- Full-Step Drive

LB1909MC Full-Step (VCC=12V, 200pps)



LB1909MC Full-Step (VCC=12V, 500pps)



*1. When the motor rotation is at a high speed, current gradient increases by the inductance of motor (L).