LV8548MC

ON Semiconductor®

http://onsemi.com

Bi-CMOS integrated circuit

12V Low Saturation Voltage Drive

Forward/Reverse Motor Driver Application Note

Overview

The LV8548MC is a 2-channel low saturation voltage forward/reverse motor driver IC. It is optimal for motor drive in 12V system products and can drive either two DC motors, one DC motor using parallel connection , or it can drive a stepper motor in Full-step and Half-step.

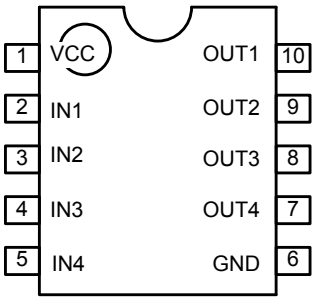
Function

- DMOS output transistor adoption (Upper and lower total RON = 1Ωtyp)
- The compact package (SOIC10) is adopted.
- VCC max = 20v, IO max = 1A
- Built-in brake function
- Our motor driver IC, LB1948MC, and compatible pin
- For one power supply (The control system power supply is unnecessary.)
- Current consumption 0 when standing by
- It is possible to connect it in parallel (parallel, connected operation of drive ch).

Typical Applications

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

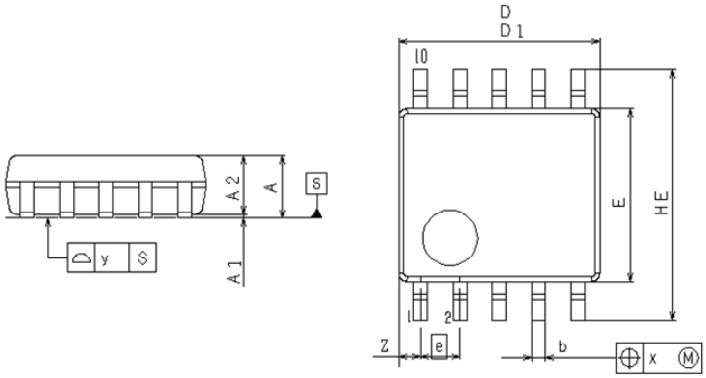
Pin Assignment



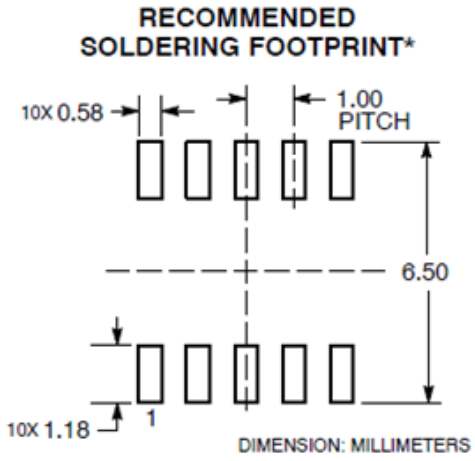
LV8548MC

（Top View）

Package Dimensions



	SOIC10		
symbol	MIN.	NOM.	MAX.
D			
D1	4.80	<4.90>	5.00
A			1.75
A1	0.10	<0.175>	0.25
A2	1.25		1.75
e		1.00	
L	0.40	<0.835>	1.27
b	0.31	<0.41>	0.51
c	0.17	<0.21>	0.25
x		0.25	
y		0.10	
HE	5.80	<6.00>	6.20
E	3.80	<3.90>	4.00
Θ	0.00		8.00
Z			



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

Block Diagram

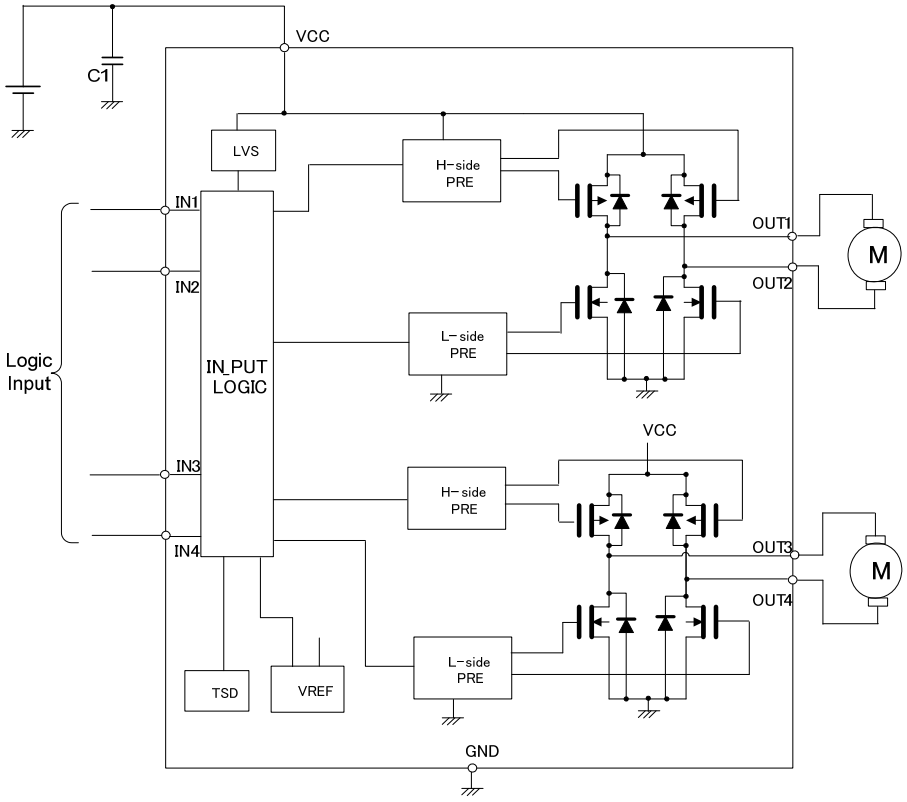


Figure1 Two DC motor drive

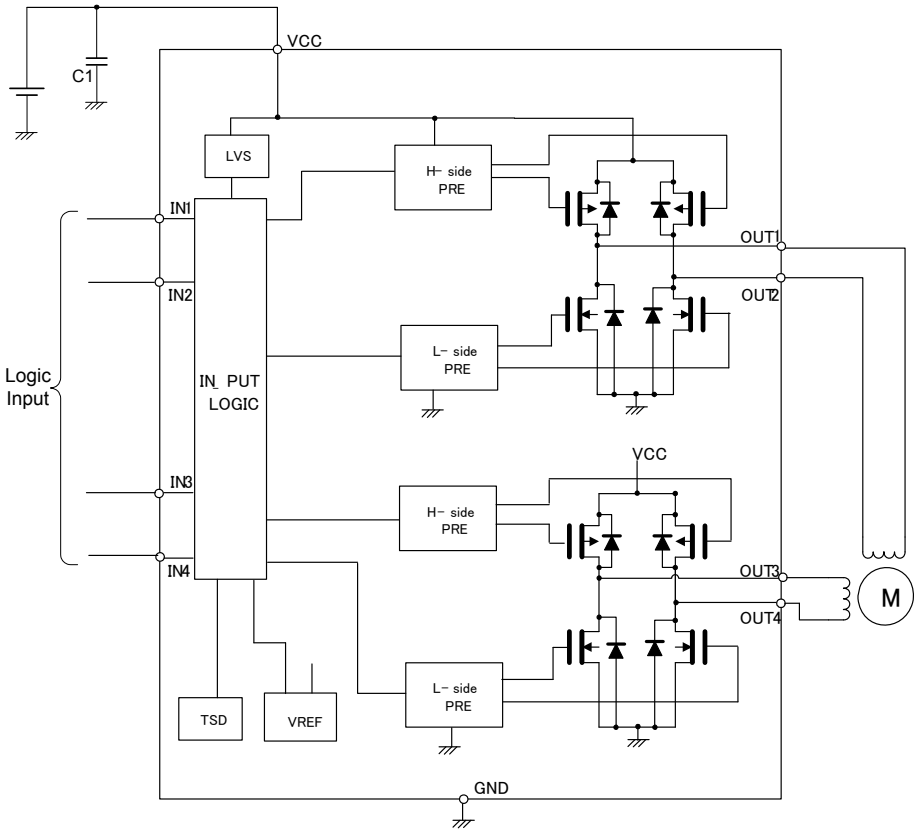


Figure2 One stepper motor drive

Specifications

Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum power supply voltage	V_{CC} max		-0.3 to +20	V
Output impression voltage	VOUT		-0.3 to +20	V
Input impression voltage	V_{IN}		-0.3 to +6	V
GND pin outflow current	IGND	For ch	1.0	A
Allowable Power dissipation	Pd max	*	1.05	W
Operating temperature	Topr		-30 to +85	°C
Storage temperature	Tstg		-40 to +150	°C

*: When mounted on the specified printed circuit board (57.0mm ×57.0mm × 1.6mm), glass epoxy, both sides

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 Condition at Ta = 25°C

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply voltage	V_{CC}		4		6	V
Input “H” level voltage	$V_{IN}H$		+1,8		+5.5	V
Input “L” level voltage	$V_{IN}L$		-0.3		+0.7	V

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

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Power supply current	$I_{CC}0$	Standby mode IN1 = IN2 = IN3 = IN4 = ”LOW”			1	μA
	$I_{CC}1$	It is "High" from IN1 as for either of IN4. Load opening		1.7	2.3	mA
Input current	I_{IN}	V_{IN} = 5V	35	50	65	μA
Thermal shutdown operating temperature	Ttsd	Design certification	150	180	210	°C
Width of temperature hysteria	ΔTtsd	Design certification		40		°C
Low voltage protection function operation voltage	VthV_{CC}		3.3	3.5	3.65	V
Release voltage	Vthret		3.55	3.8	3.95	V
Output ON resistance (Upper and lower total)	R_{ON}	I_{OUT} = 1.0A	0.7	1	1.25	Ω
Output leak current	$I_O$leak	V_O = 16V			10	μA
Diode forward voltage	VD	ID = 1.0A		1.0	1.2	V

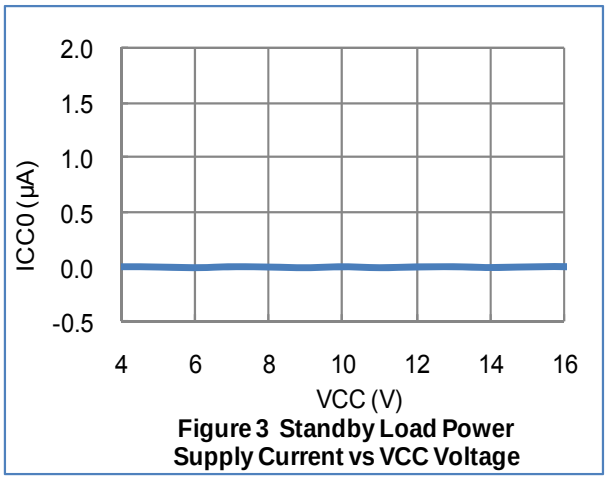


Figure 3 Standby Load Power Supply Current vs VCC Voltage

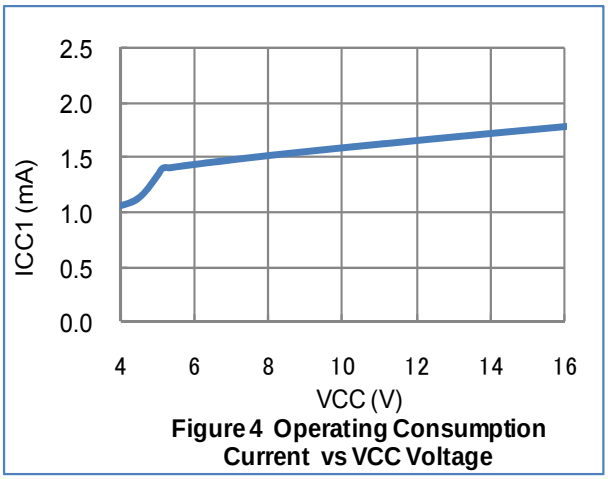


Figure 4 Operating Consumption Current vs VCC Voltage

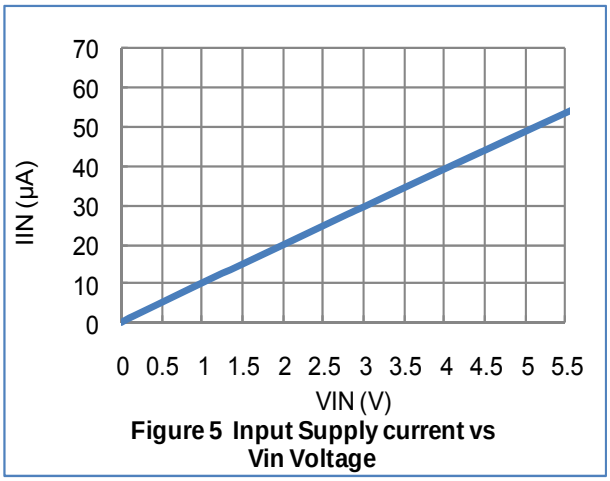


Figure 5 Input Supply current vs Vin Voltage

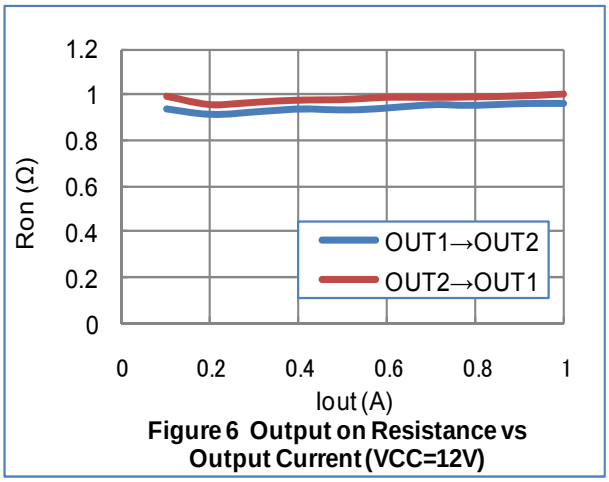


Figure 6 Output on Resistance vs Output Current (VCC=12V)

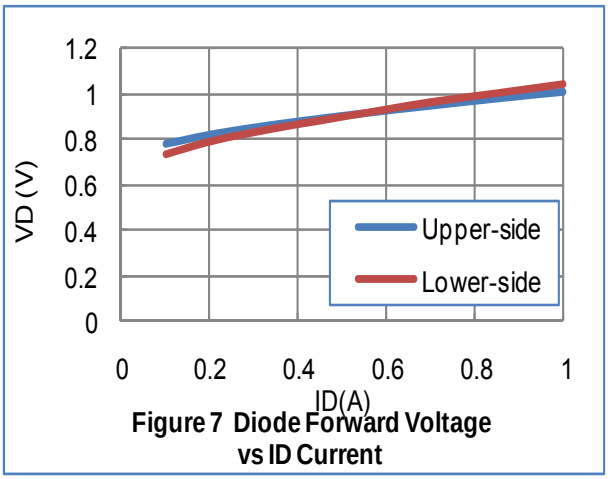


Figure 7 Diode Forward Voltage vs ID Current

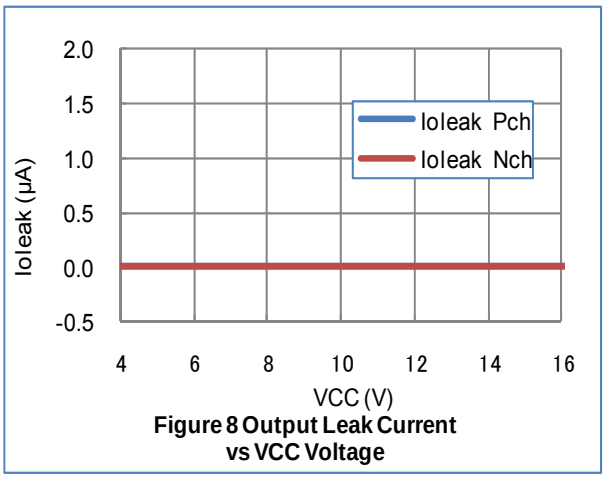


Figure 8 Output Leak Current vs VCC Voltage

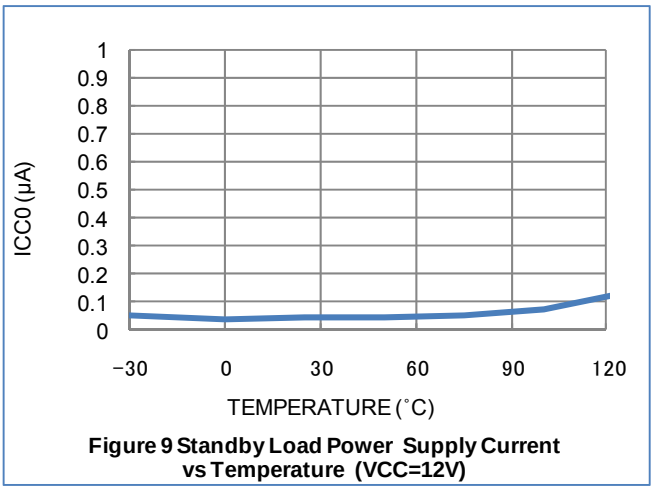


Figure 9 Standby Load Power Supply Current vs Temperature (VCC=12V)

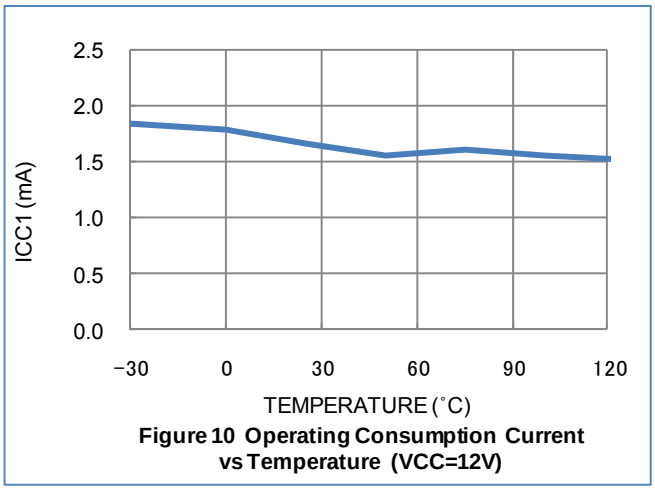


Figure 10 Operating Consumption Current vs Temperature (VCC=12V)

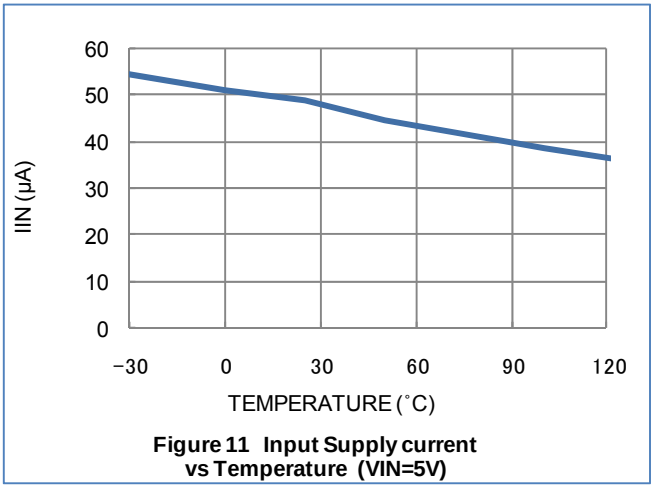


Figure 11 Input Supply current vs Temperature (VIN=5V)

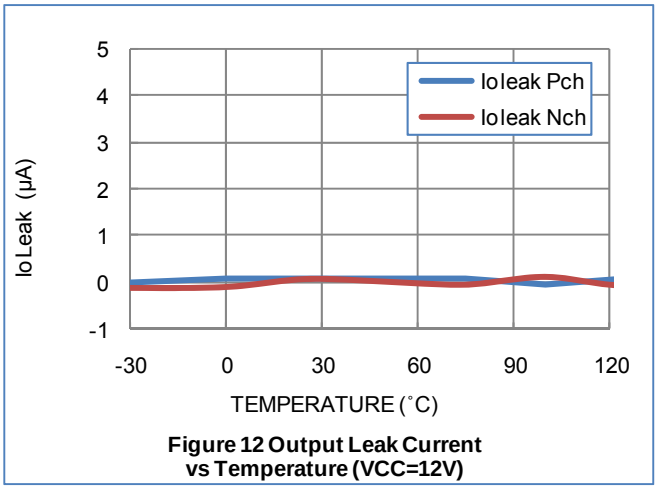


Figure 12 Output Leak Current vs Temperature (VCC=12V)

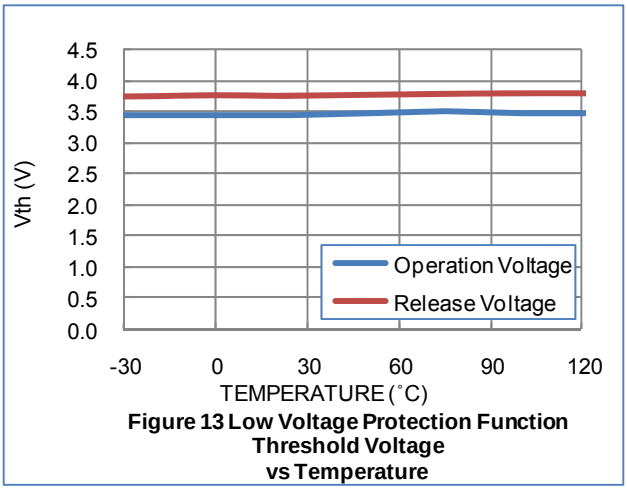


Figure 13 Low Voltage Protection Function Threshold Voltage vs Temperature

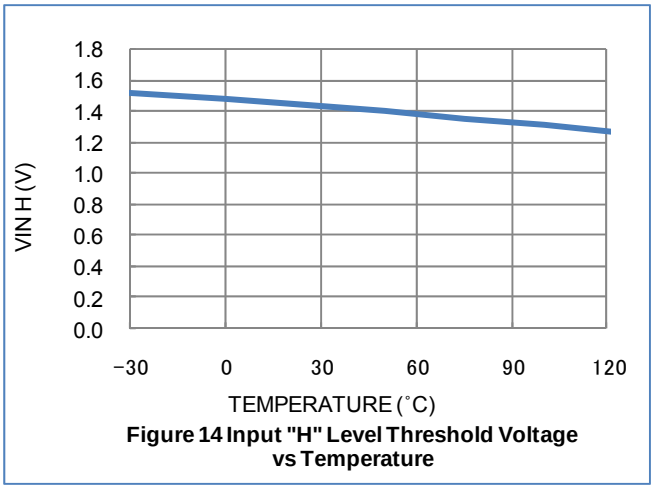


Figure 14 Input "H" Level Threshold Voltage vs Temperature

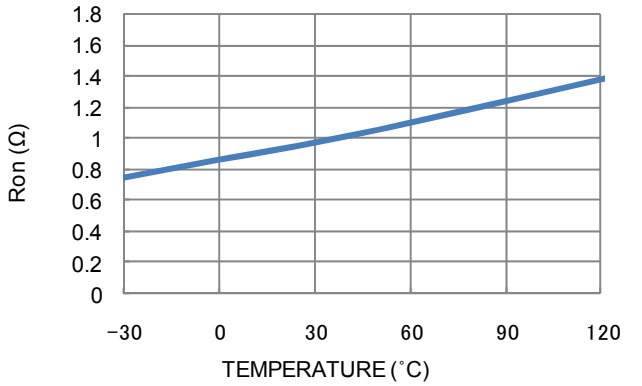


Figure 15 Output on Resistance vs Temperature (VCC=12V)

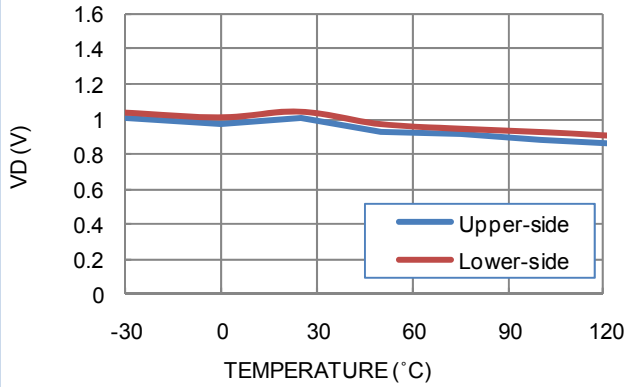
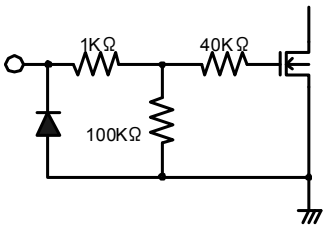
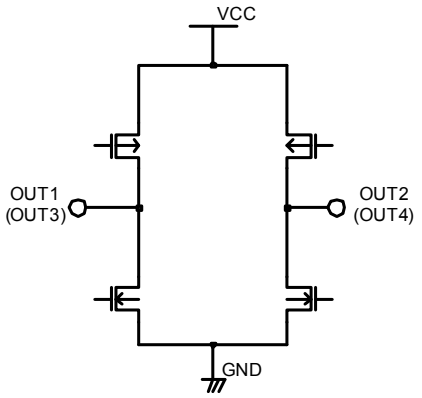


Figure 16 Diode Forward Voltage vs Temperature (VCC=12V)

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 4.0 to 16.0(V). The capacitor is connected for stabilization for GND pin (6pin).	
2	IN1	Motor drive control input pin. Driving control input pin of OUT1 (10pin) and OUT2 (9pin). It combines with IN2 pin (3pin) 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 5.5(V). PWM can be input. Pull-down resistance 100(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.	
3	IN2	Motor drive control input pin. Driving control input pin of OUT1 (10pin) and OUT2 (9pin). It combines with IN1 pin (2pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
4	IN3	Motor drive control input pin. Driving control input pin of OUT3 (8pin) and OUT4 (7pin). It combines with IN4 pin (5pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
5	IN4	Motor drive control input pin. Driving control input pin of OUT3 (8pin) and OUT4 (7pin). It combines with IN3 pin (4pin) and it uses it. PWM can be input. With built-in pull-down resistance.	
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. DCM output control logic

Input				Output				Remarks	
IN1	IN2	IN3	IN4	OUT1	OUT2	OUT3	OUT4		
L	L	L	L	OFF	OFF	OFF	OFF	Stand-by	
L	L			OFF	OFF			1CH	Stand-by
H	L			H	L				Forward
L	H			L	H				Reverse
H	H			L	L				Brake
		L	L			OFF	OFF	2CH	Stand-by
		H	L			H	L		Forward
		L	H			L	H		Reverse
		H	H			L	L		Brake

2. About the switch time from the stand-by to the operation
   When IN1, IN2, IN3, IN4 are "L", this IC has completely stopped operating. After the time of reset (about 7μs of an internal setting) it shifts to a prescribed output status corresponding to the state of the input when the signal enters the input terminal.
   Reset of about 7μs doesn't hang even if the motor is driven from the stand-by state when either CH drives and the output becomes an output status corresponding to the state of the input. As for full power TR between the reset time, turning off is maintained.

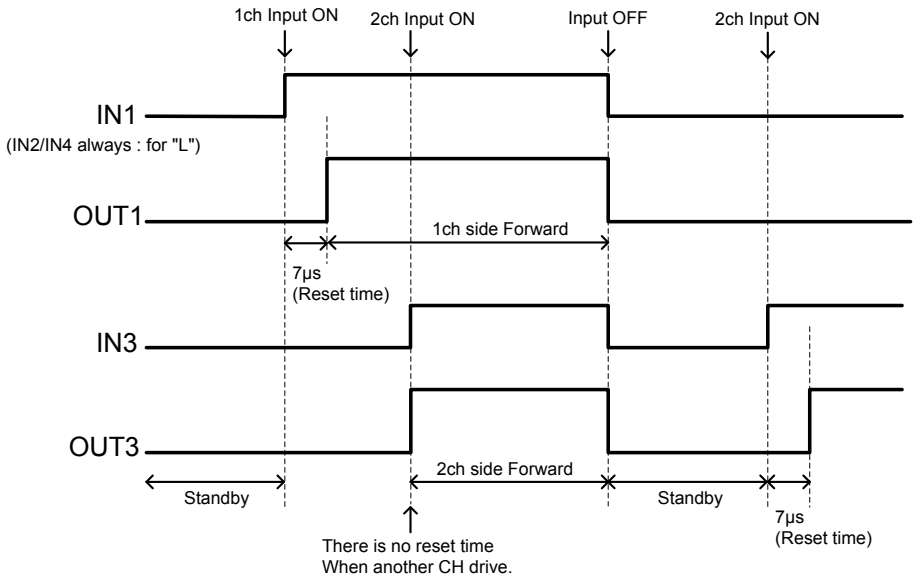


Figure17 Switch time from the stand-by to the operation

3. Thermal shutdown function
   The thermal shutdown circuit is incorporated and the output is turned off when junction temperature Tj exceeds 180°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 = 180°C (typ)
   ΔTSD = 40°C (typ)

4. Low voltage protection function
   When the power supply voltage is as follows typical 3.5V, the output does OFF.
When the power supply voltage is as above typical 3.8V, the IC outputs a set state.

Operation principal

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

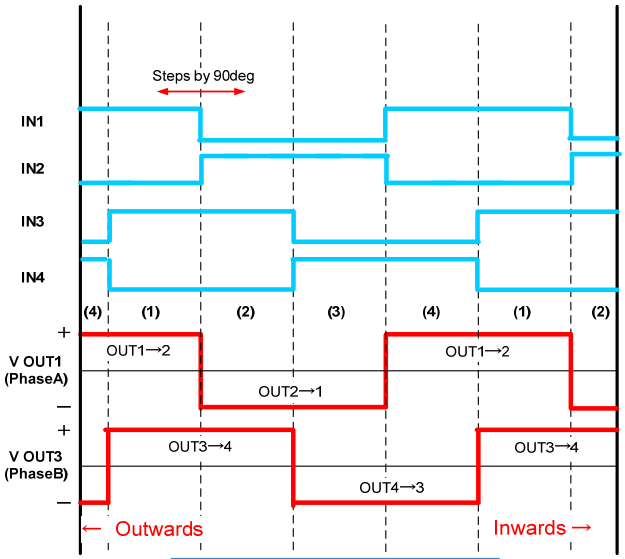


Figure 18. Full-Step Timing

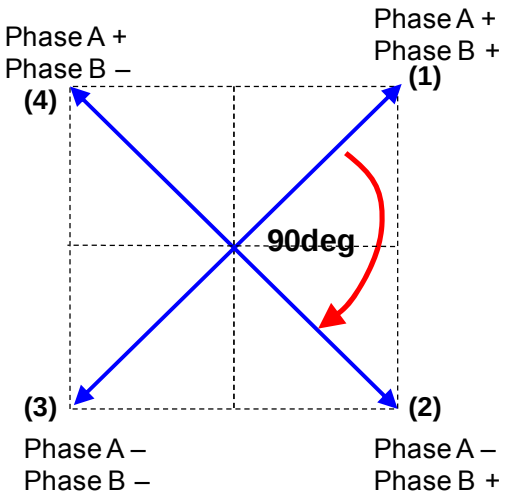


Figure 19. Motor electric angle
(Full Step Drive)

- Half-Step Drive
  Motor advances 45 degree by inputting 1 step.

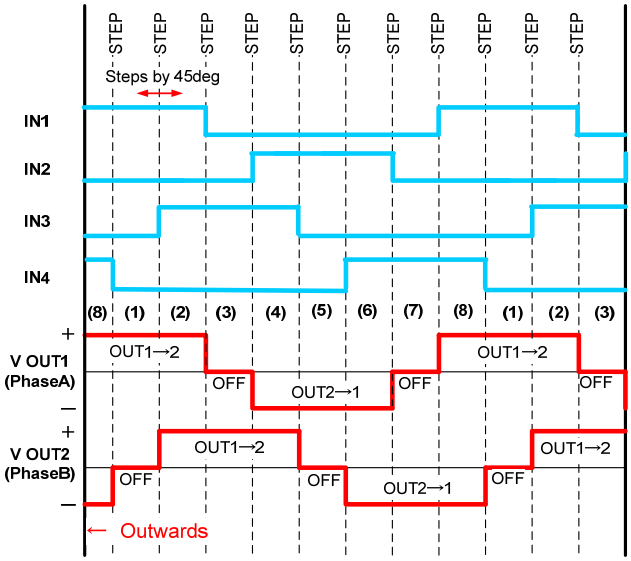


Figure 20. Half-Step Timing

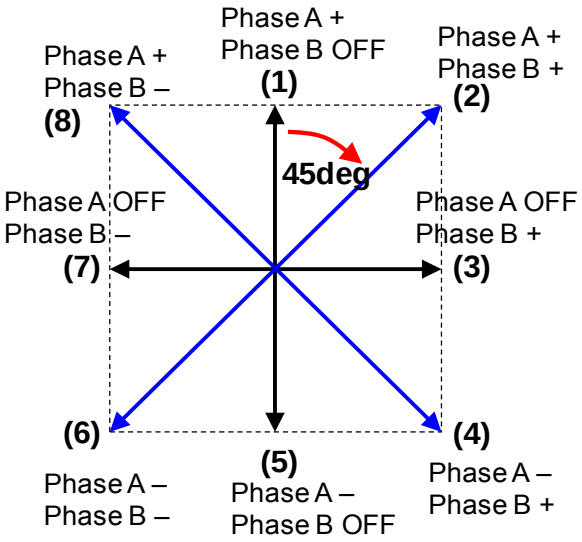
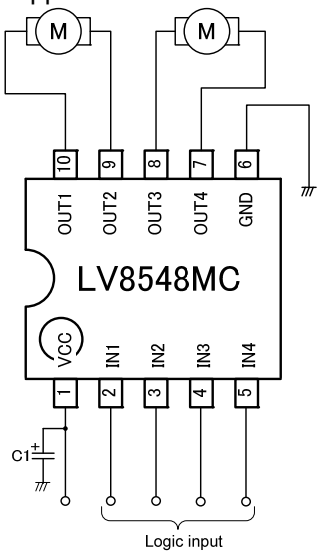


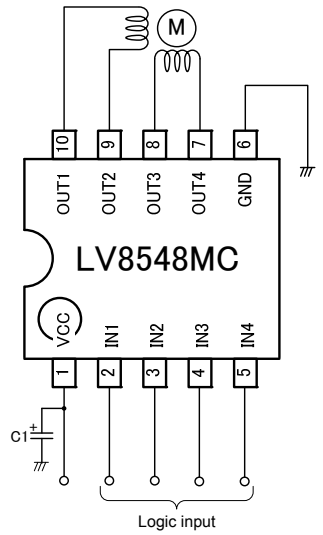
Figure 21. Motor electric angle
(Half Step Drive)

Application Circuit Example

1. Example of applied circuit when two DC motor driving

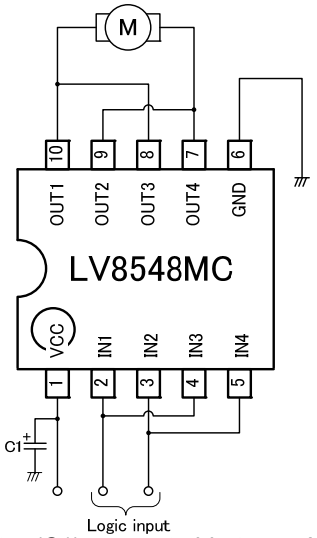


2. Example of applied circuit when one stepper motor driving



3. Example of applied circuit when connecting it in parallel

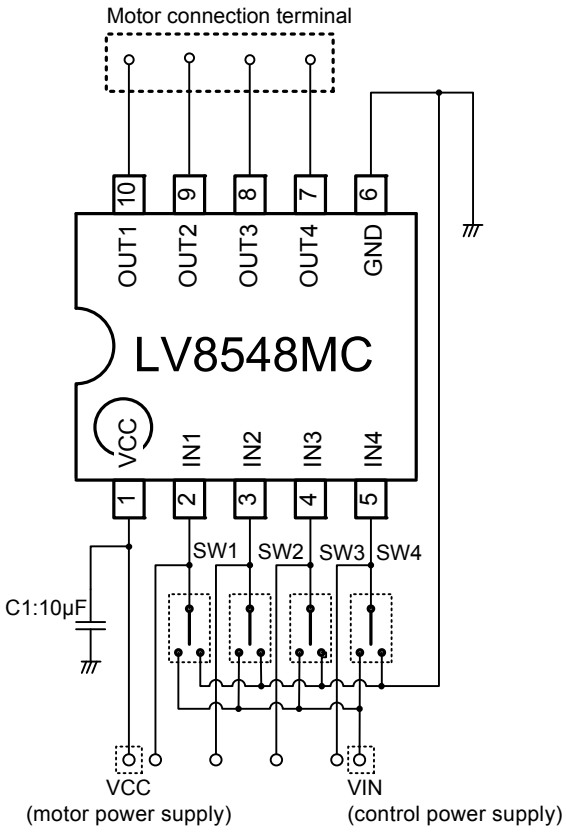
   The use likened to H-Bridge 1ch is shown possible in the figure below by connecting IN1 with IN3, IN2 with IN4, OUT1 with OUT3, and OUT2 with OUT4. (I_O max = 2.0A, Upper and lower total R_{ON} = 0.5Ω)



* 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.

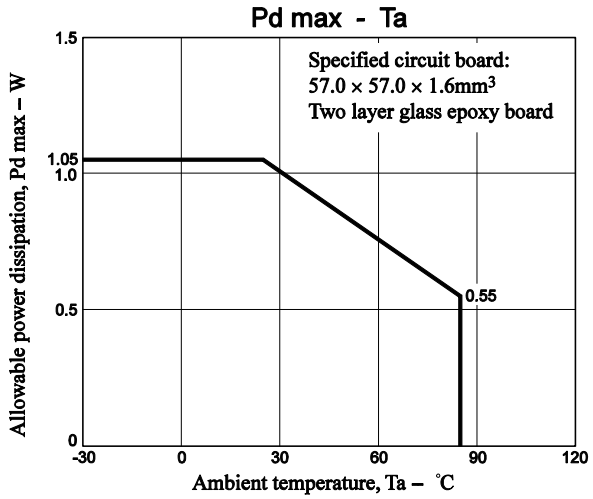
Evaluation Board Manual

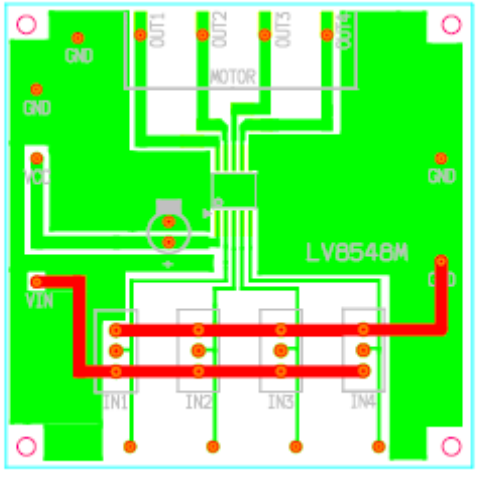
1. Evaluation Board circuit diagram



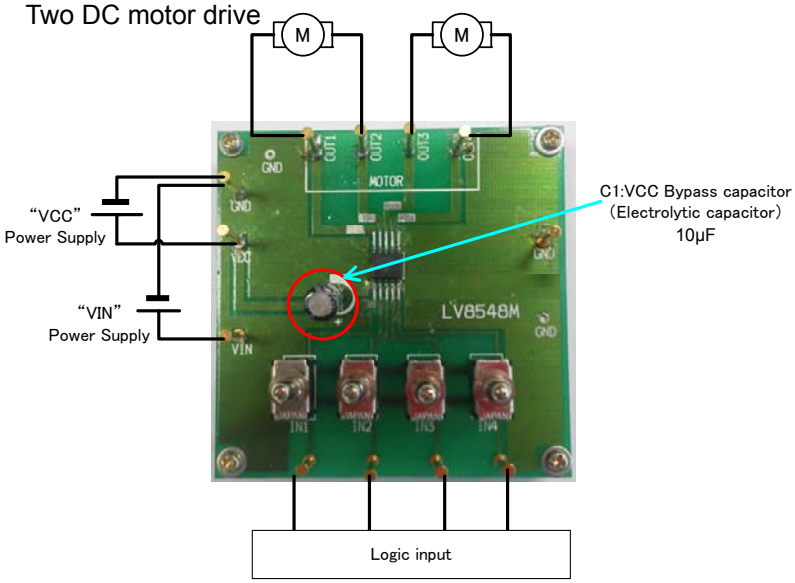
Bill of Materials for LV8548MC Evaluation Board

Designator	Qty	Description	Value	Tol	Footprint	Manufacturer	Manufacturer Part Number	Substitution Allowed	Lead Free
IC1	1	Motor Driver			SOIC10	ON semiconductor	LV8548MC	No	Yes
C1	1	VCC Bypass capacitor	10μF 50V	±20%		SUN Electronic Industries	50ME10HC	Yes	Yes
SW1-SW4	4	Switch				MIYAMA	MS-621-A01	Yes	Yes
TP1-TP12	12	Test points				MAC8	ST-1-3	Yes	Yes





2. 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 a signal such as the following truth value table into IN1~IN4.
- See the table in p.8 for further information on input logic.

When you drive DC motor with LV8548MC, caution is required to switch motor rotation from forward to reverse because when doing so, electromotive force (EMF) is generated and in some cases, current can exceed the ratings which may lead to the destruction and malfunction of the IC .
Coil current (Iout) for each operation is obtained as follows when switching motor rotation from forward to reverse.

- Starting up motor operation
  Coil current Iout = (VCC – EMF) / coil resistance
  At startup, Iout is high because EMF is 0. As the motor starts to rotate, EMF becomes higher and Iout becomes lower.

- When switching motor rotation from forward to reverse:
  Coil current Iout = (VCC + EMF) / coil resistance
  When EMF is nearly equal to VCC at a max, make sure that the current does not exceed Iomax since a current which is about double the startup current may flow at reverse brake.

- Short brake:
  Coil current: Iout = EMF / coil resistance
  Since EMF is 0 when the rotation of motor stops, Iout is 0 as well.

When you switch motor rotation form forward to reverse, if Iout is higher than Iomax, you can operate short brake mode between forward and reverse either to slow down or stop the motor.

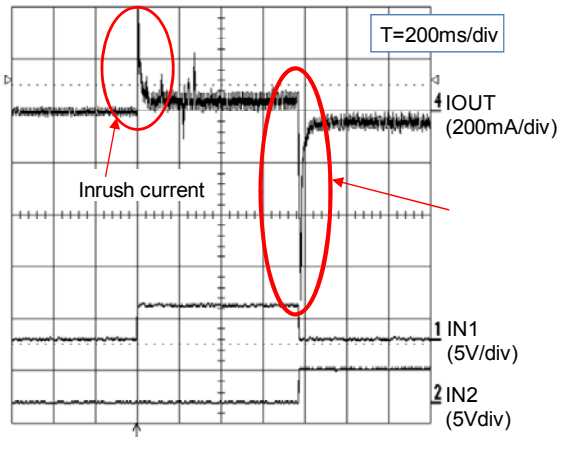


Figure22 Without Break MODE

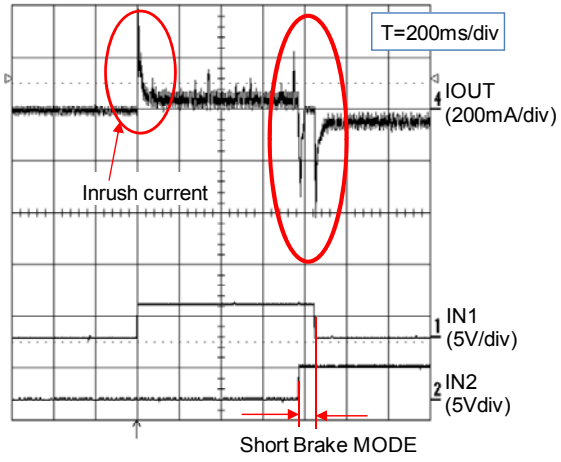


Figure23 With Break MODE

Input and output characteristics of H-Bridge

LV8548MC can be driven by direct PWM control of H-Bridge by inputting PWM signal to IN.
However output response of H-Bridge worsens around On-duty 0%, which generates dead zone. As a result, IC control loses lineality.
If you intend to drive motor in such control range, make sure to check the operation of your motor.

Input-Output Characteristics of H-Bridge (reference data)
Forward/Reverse⇔Brake
Vcc=12V

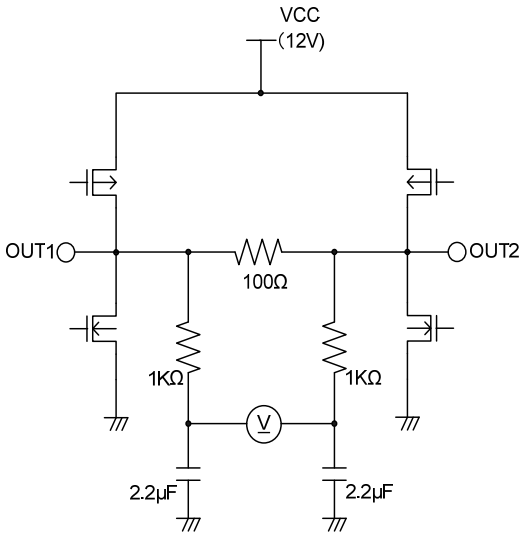
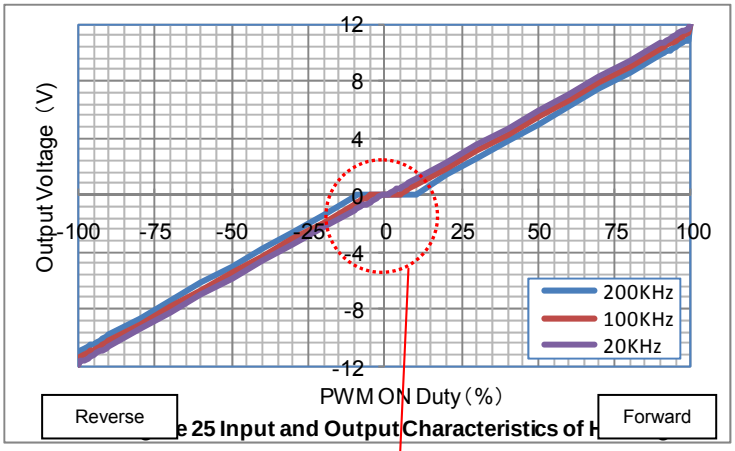


Figure24 Measurement connection diagram



e 25 Input and Output Characteristics of H

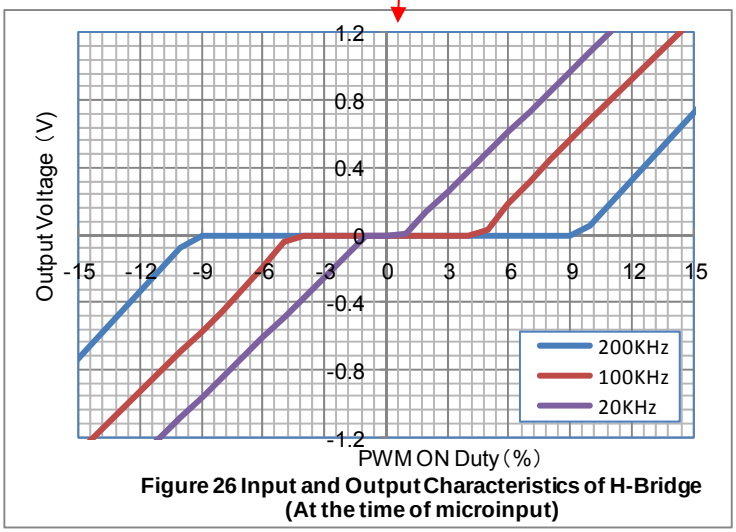
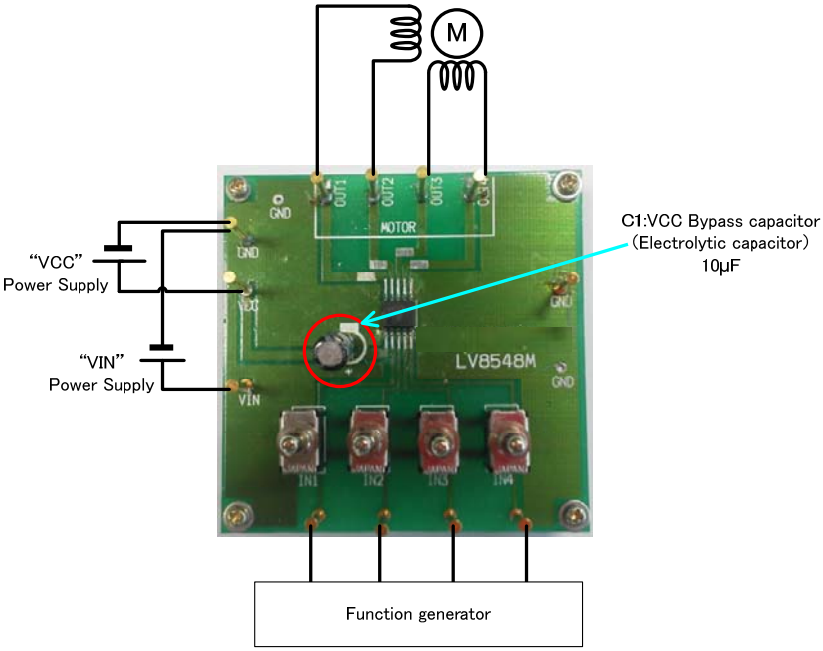


Figure 26 Input and Output Characteristics of H-Bridge (At the time of microinput)

3. One stepper motor drive

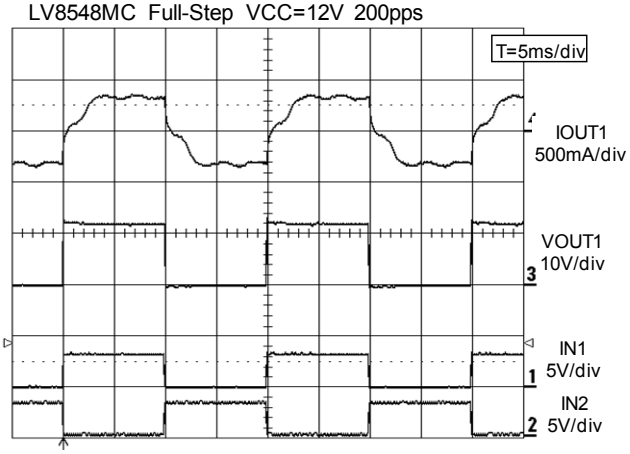


- Connect a stepper motor with OUT1, OUT2, OUT3 and OUT4.
- Connect the motor power supply with the terminal VCC, the control power supply with the terminal VIN. Connect the GND line with the terminal GND.
- STP motor drives it in a Full-Step, Half-Step by inputting a signal such as follows into IN1~IN4.
- For input signal to function generator, refer to p.9.
  To reverse motor rotation, make sure to input signal to outward direction.

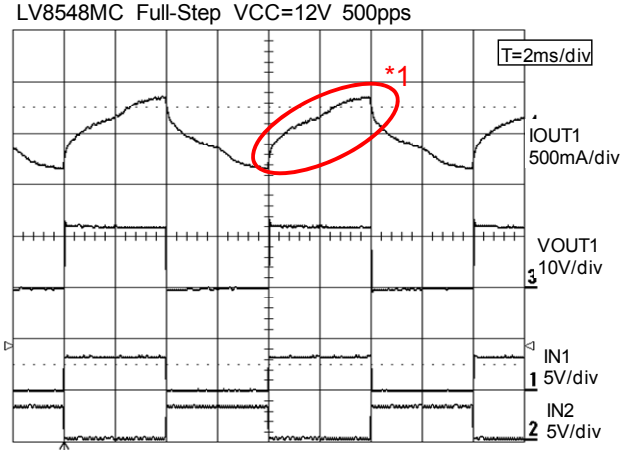
Waveform of LV8548MC evaluation board when driving stepper motor

- Full-Step Drive

LV8548MC Full-Step VCC=12V 200pps



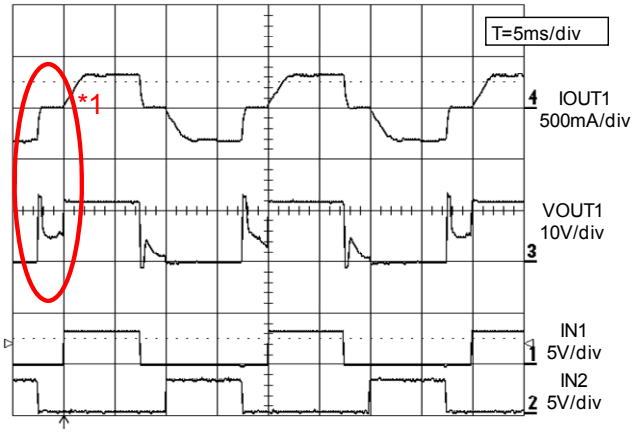
LV8548MC Full-Step VCC=12V 500pps



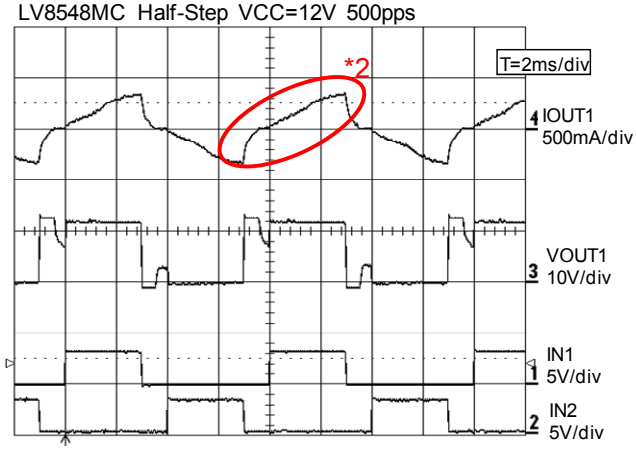
*1. When the motor rotation is at a high speed, current gradient increases by the inductance of motor (L).

- Half-Step Drive

LV8548MC Half-Step VCC=12V 200pps



LV8548MC Half-Step VCC=12V 500pps



*1.With Half-Step mode, voltage kick-back and electromotive force occur in current OFF period.
*2.When the motor rotation is at a high speed, current gradient increases by inductance of motor (L).

- IC surface temperature when a motor is in operation (reference)

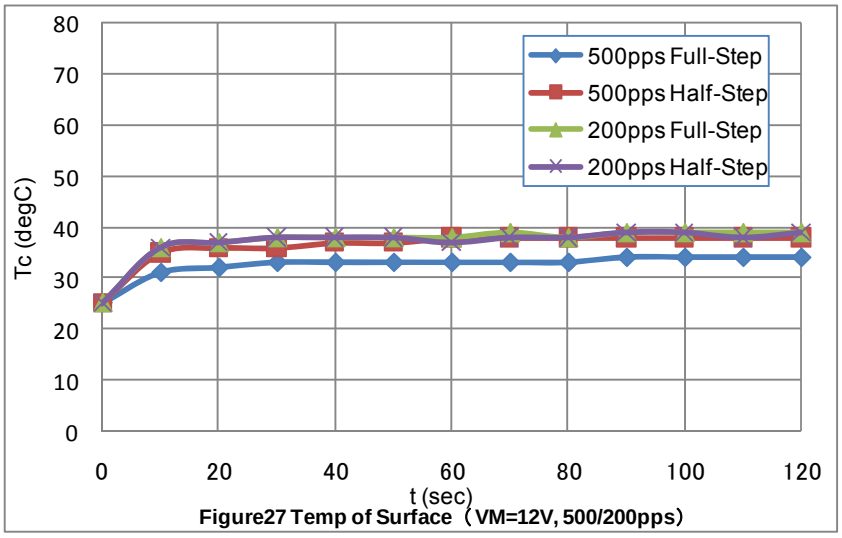


Figure27 Temp of Surface（VM=12V, 500/200pps）

[Stepper motor driven by LV8548MC]
Motor diameter: 20.5mm
Coil resistance: 30.8Ω