LB1938FA

Monolithic Digital IC

1ch, Low-saturation Forward/Reverse Motor Driver Application Note

ON Semiconductor®

http://onsemi.com

Overview

The LB1938FA is an H-bridge motor driver that supports low-voltage drive and features low-saturation outputs in an ultraminiature slim package. The LB1938FA provides forward, reverse, brake, and standby modes controlled by two input signals, and is an optimal DC motor driver for notebook personal computers, digital cameras, cell phones, and other portable equipment.

Function

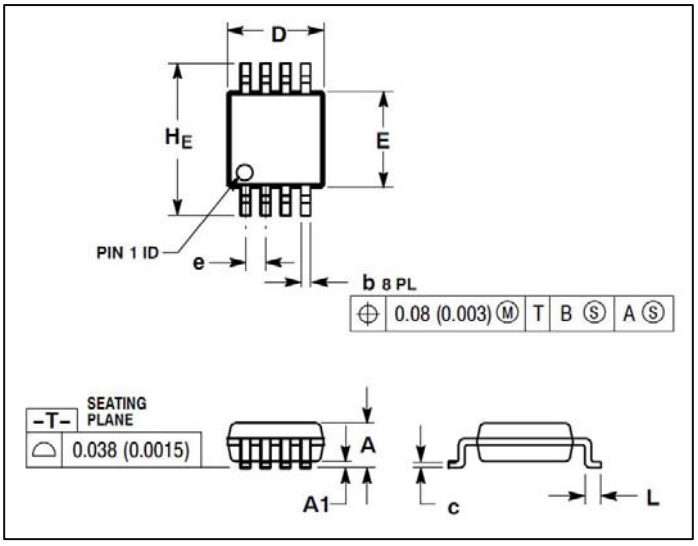
- Ultraminiature Micro8 package (3.0mm x 4.9mm x 1.1mm)
- The low saturation voltage means that the voltage applied to the motor is higher and IC heat generation is reduced.
  This allows this IC to be used in environments with higher ambient operating temperatures.
  Output saturation voltage (high side + low side): $V_O$sat = 0.15V typical (I_O = 100mA)
- The wide usable voltage range and the low standby mode current drain of 0.1 μA make this IC optimal for battery operated equipment.
- There are no constraints on the relationship between the input signal voltage and the supply voltage. For example, this IC can be use at V_{CC} = 3V and V_{IN} = 5V.
- Thermal protection circuit limits the drive current and prevents the IC from causing a fire or being destroyed if the IC chip temperature reaches or exceeds 180°C due to large currents flowing when the outputs are shorted due to, for example, motor layer shorting or other phenomena.

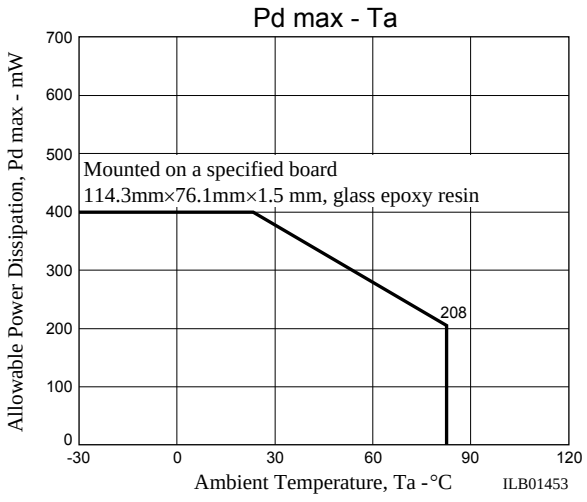
Typical Applications

- DSC
- Security camera
- CCTV

Package Dimensions

unit : mm (typ)

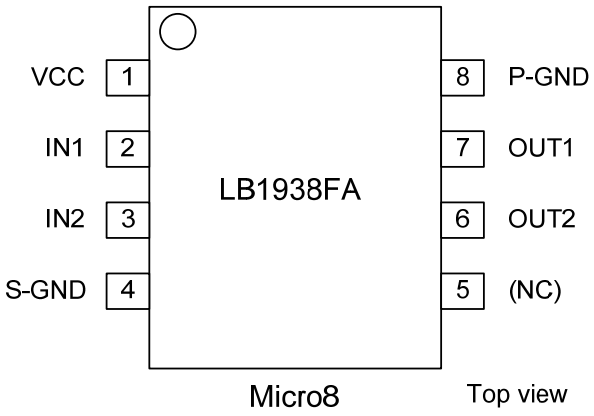




DIM	MILLIMETERS			INCHES		
	MIN	NOM	MAX	MIN	NOM	MAX
A	--	--	1.10	--	--	0.043
A1	0.05	0.08	0.15	0.002	0.003	0.006
b	0.25	0.33	0.40	0.010	0.013	0.016
c	0.13	0.18	0.23	0.005	0.007	0.009
D	2.90	3.00	3.10	0.114	0.118	0.122
E	2.90	3.00	3.10	0.114	0.118	0.122
e		0.65 BSC			0.026 BSC	
L	0.40	0.55	0.70	0.016	0.021	0.028
H_E	4.75	4.90	5.05	0.187	0.193	0.199

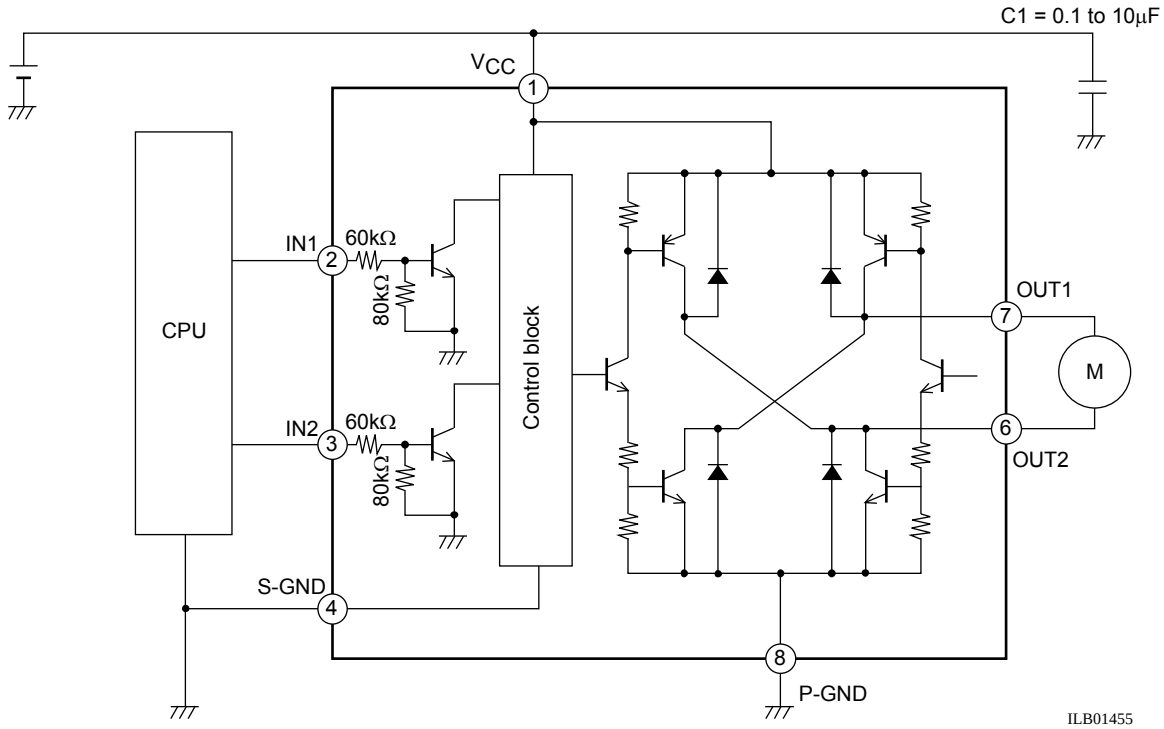
December, 2013

Pin Assignment



S-GND: GND for the control system
P-GND: GND for the power system

Application Circuit Example



Cautions:

V_{CC} and GND lines suffer substantial fluctuation in the current quantity, causing a problem of line oscillation in certain cases. In this case, take following points into account:

(1) Use a thick and short wiring to reduce the wiring inductance.
(2) Insert a capacitor with satisfactory frequency characteristics near IC.
*) Electrostatic capacitor C1 is used to stabilize power. Requirement for capacitance value varies depends on substrate wiring, motor, and power. The recommendation range of C1 is approximately 0.1μF to 10μF. Please check supply voltage waveform when motor is under operation and use a capacitor for stable operation.
(3) Connect S-GND to the control system GND on the CPU side and P-GND to the power system GND.

Specifications

Absolute Maximum Ratings at Ta = 25°C

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage	V_{CC} max		10.5	V
Output current	I_{OUT} max		800	mA
Output voltage	V_{OUT} max		$V_{CC}+V_{SF}$	V
Input applied voltage	V_IH max		10	V
Allowable power dissipation	Pd max	Mounted on a specified board *	400	mW
Operating temperature range	Topr		-30 to +85	°C
Storage temperature range	Tstg		-55 to +150	°C

Note *: Mounted on a specified board: 114.3mm x 76.1mm x 1.5mm, glass epoxy resin, wiring density 20%

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

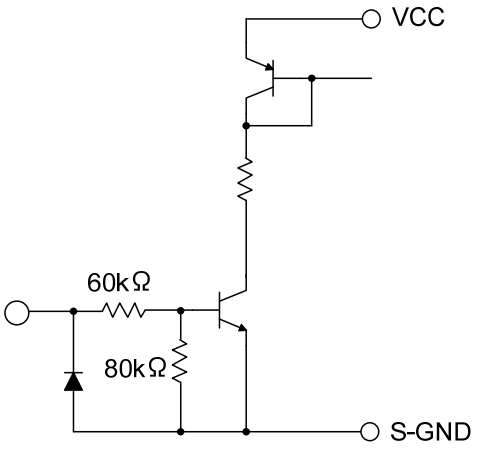
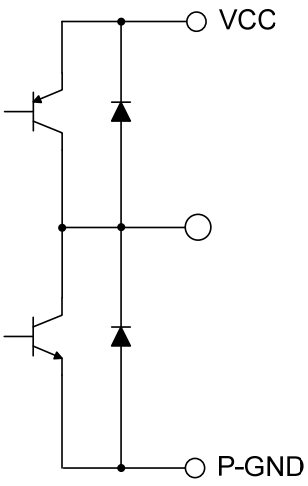
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Supply voltage	V_{CC}		2.2		10	V
Input high-level voltage	V_IH		2.0		9.5	V
Input low-level voltage	V_IL		-0.3		+0.3	V

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

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
Circuit current	$I_{CC}1$	Standby		0.1	5	μA
	$I_{CC}2$	Forward/reverse drive		14	19	mA
	$I_{CC}3$	Brake		20	29	mA
Output saturation voltage	$V_O$sat1	Upper + lower I_O = 100mA for forward/reverse rotation		0.15	0.2	V
	$V_O$sat2	Upper + lower I_O = 300mA for forward/reverse rotation		0.35	0.5	V
	$V_O$sat3	Upper I_O = 100mA for braking		0.1	0.15	V
Spark killer diode forward voltage	V_{SF}	I_O = 300mA		0.9	1.7	V
Spark killer diode inverse current	I_{RS}	V_{OUT} = 10V		0.1	5	μA
Input current	I_{IN}	V_{IN} = 5V		75	98	μA
Thermal protection operating temperature	TSD	Design target value *		180		°C

Note *: Design target value: Measurement with a single unit not made.

Pin Functions

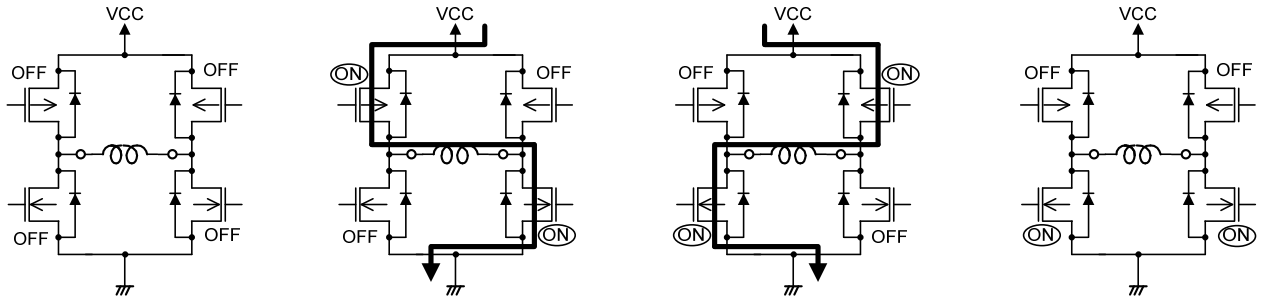
Pin No.	Pin name	Pin Function	Equivalent Circuit
2 3	IN1 IN2	Control signal input pin Control signal input pin	
7 6	OUT1 OUT2	Out pin Out pin	
1	V_{CC}	Power supply voltage pin	
4	S-GND	Signal ground pin	
8	P-GND	Power ground pin	
5	NC	No connect	

Truth Table

IN1	IN2	OUT1	OUT2	Mode
L	L	OFF	OFF	Standby
H	L	H	L	Forward rotation
L	H	L	H	Reverse rotation
H	H	H	H	Brake

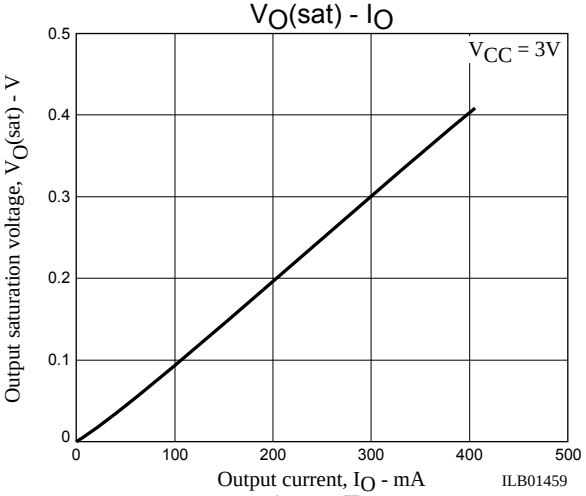
Operation explanation

- Output stage transistor function

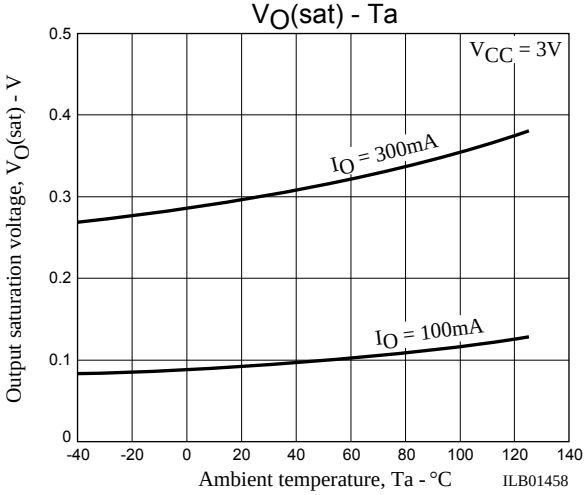


- Thermal protection function
  LB1938FA incorporates thermal shutdown circuitry. When junction temperature Tj exceeds 180°C, the output current flowing between OUT1 and OUT2 is reduced; therefore, the heat generation is reduced. The thermal shutdown circuit does not guarantee the protection of the final product because it operates when the temperature exceed the junction temperature of Tjmax=150°C.

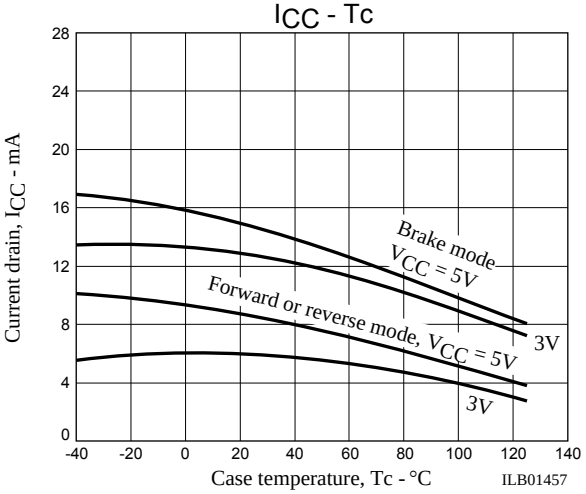
$V_O(sat) - I_O$



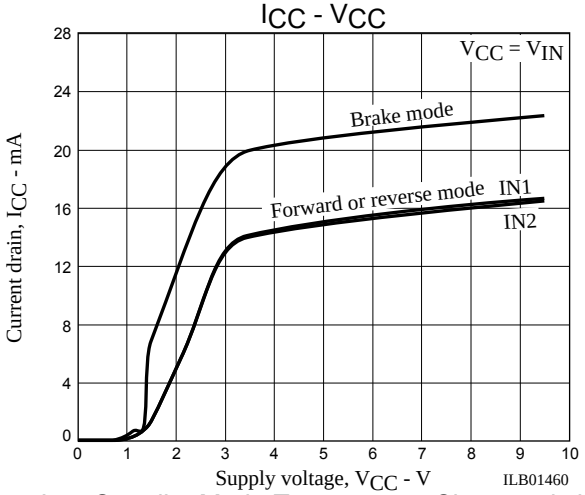
$V_O(sat) - Ta$



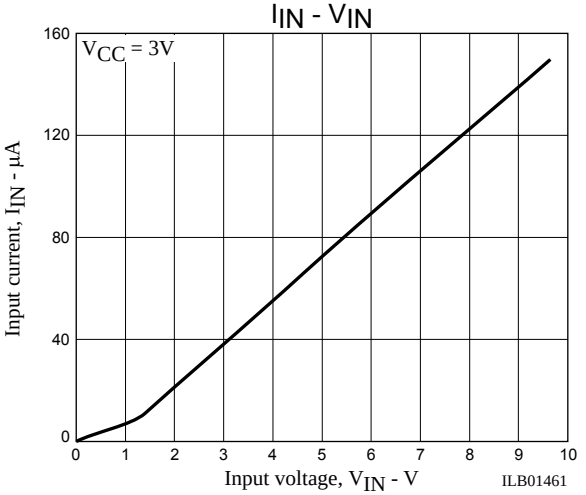
$I_{CC} - Tc$



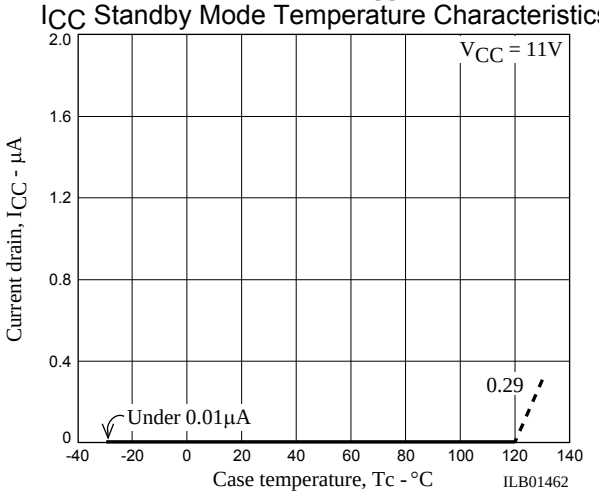
$I_{CC} - V_{CC}$



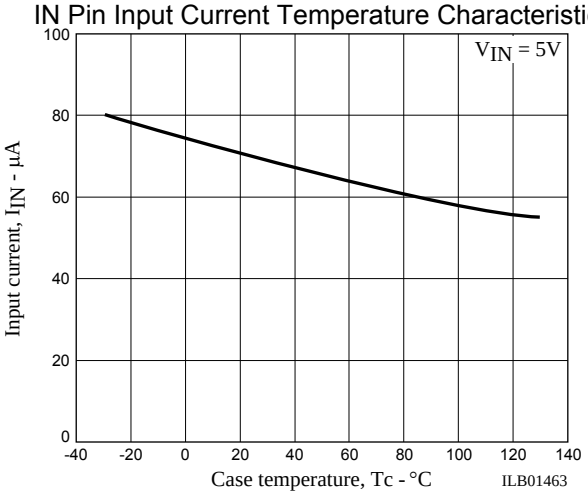
$I_{IN} - V_{IN}$



I_{CC} Standby Mode Temperature Characteristics



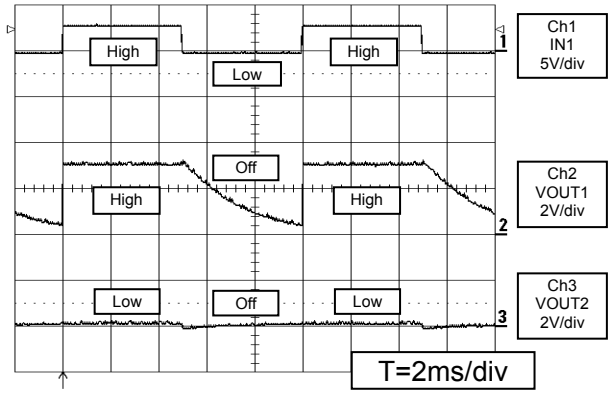
IN Pin Input Current Temperature Characteristics



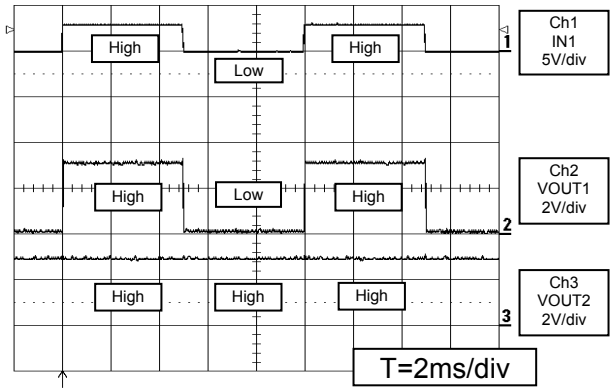
Waveform example

*Please refer to the following test circuit diagram 1.

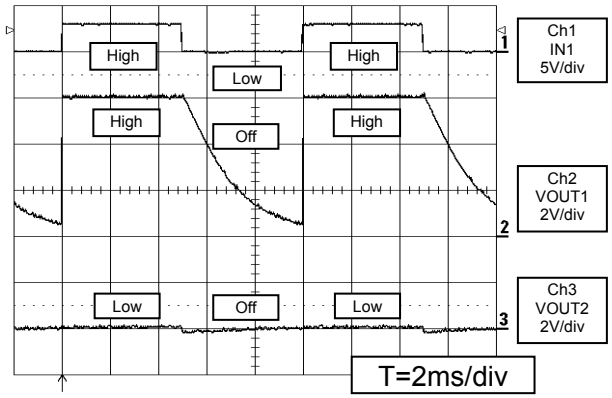
• No load VCC=3V IN2="L"



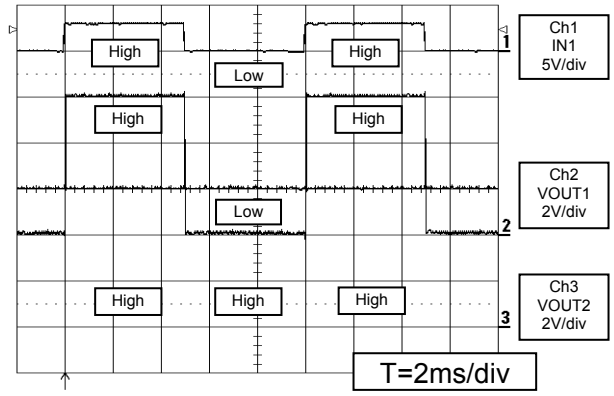
• No load VCC=3V IN2="H"



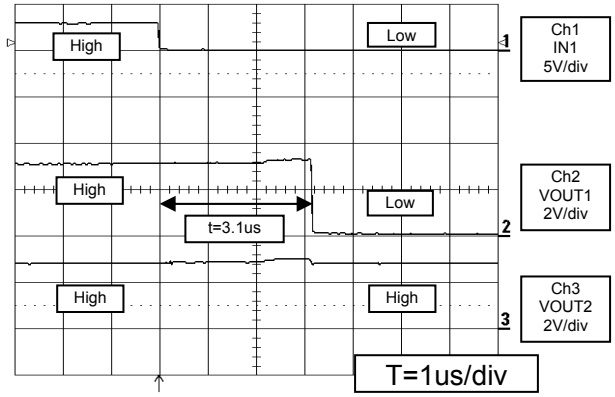
• No load VCC=6V IN2="L"



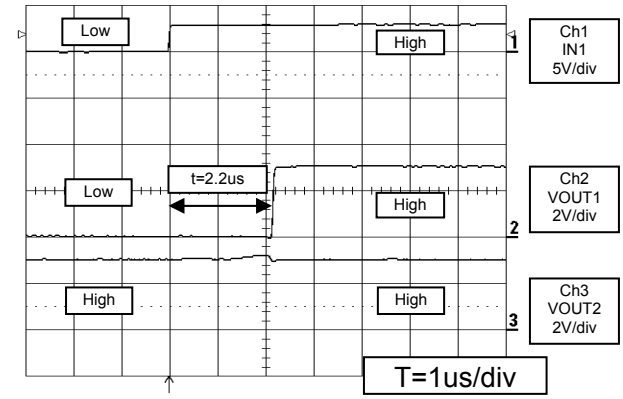
•No load VCC=6V IN2="H"



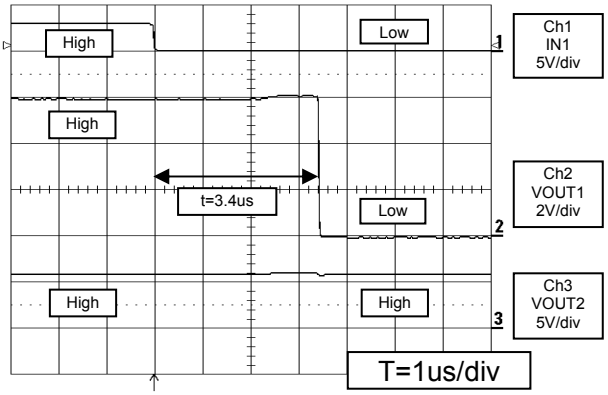
• No load VCC=3V IN2=
Time scale expansion "fall time"



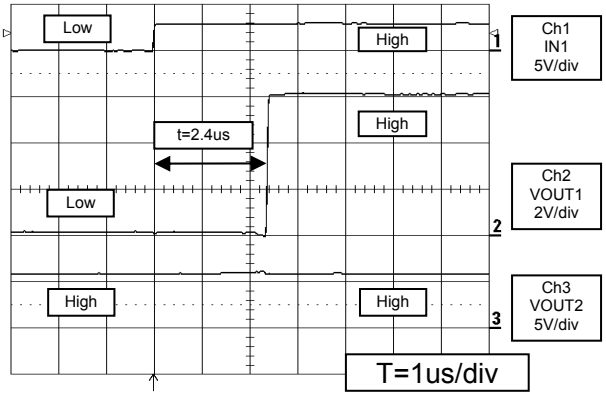
• No load VCC=3V IN2="H"
Time scale expansion "rise time"



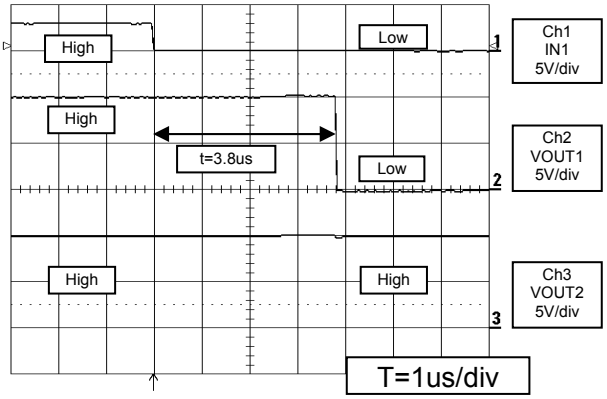
• No load VCC=6V IN2="H"
Time scale expansion "fall time"



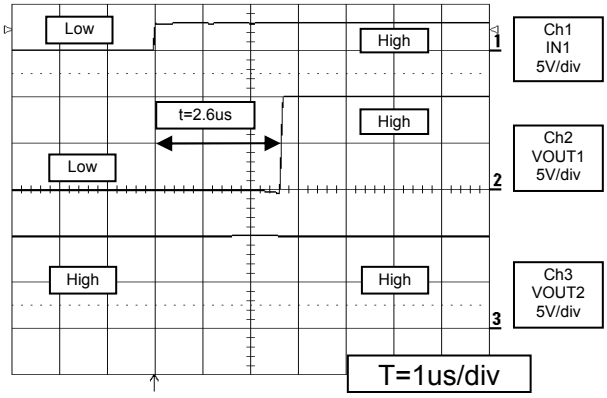
• No load VCC=6V IN2="H"
Time scale expansion "rise time"



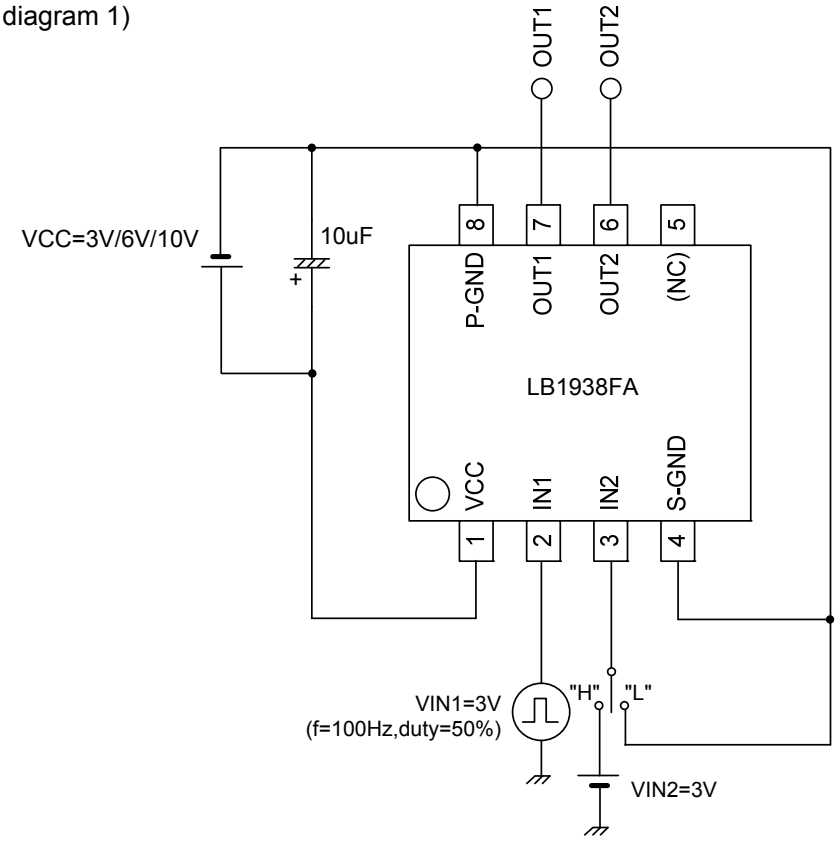
• No load VCC=10V IN2="H"
Time scale expansion "fall time"



• No load VCC=10V IN2="H"
Time scale expansion "rise time"

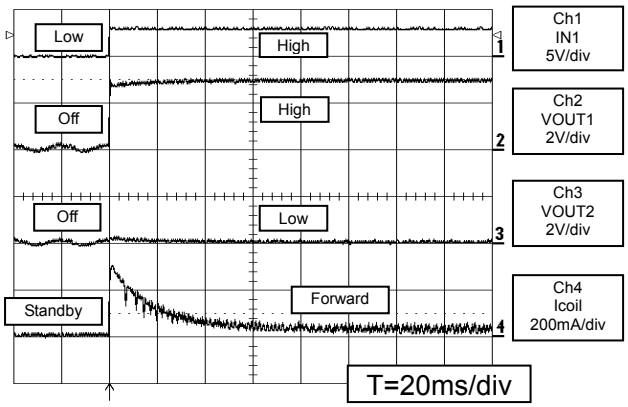


(Test circuit diagram 1)



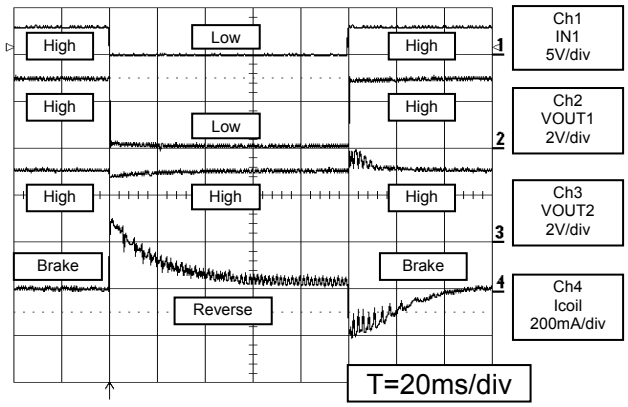
*Please refer to the following test circuit diagram 2.

- DC motor load VCC=3V IN2="L"
  Current waveform example "motor start"



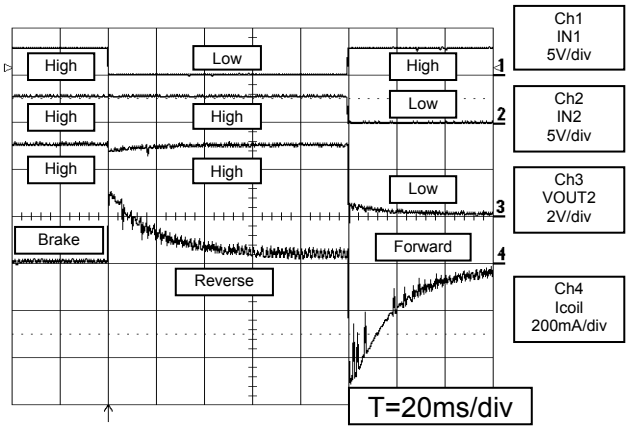
When DC motor starts up, the current value becomes high. However, rotation of DC motor starts, induced voltage Ea is generated and current decreases according to the rotation frequency.
If a coil resistance is set to Rcoil and motor voltage is set to VCC, then motor current is obtained as follows:
Im = (VCC-Ea)/Rcoil.

- DC motor load VCC=3V IN2="H"
  Current waveform example "brake current"



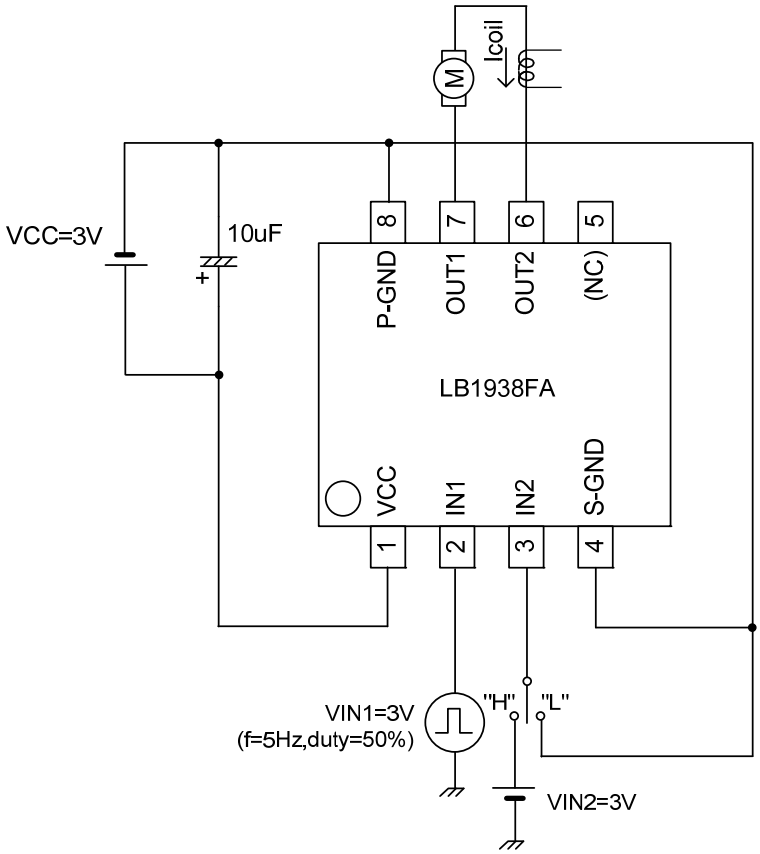
When DC motor is under rotation, if brake mode is set, then DC motor becomes short-brake status, and speed falls rapidly.
In this case, current Im (Im = Ea / Rcoil) flows to the opposite direction by the induced voltage Ea generated during motor rotation. If DC motor stops rotation, then Ea=0, and current becomes 0.

- DC motor load VCC=3V
  Current waveform example “active reverse brake current”

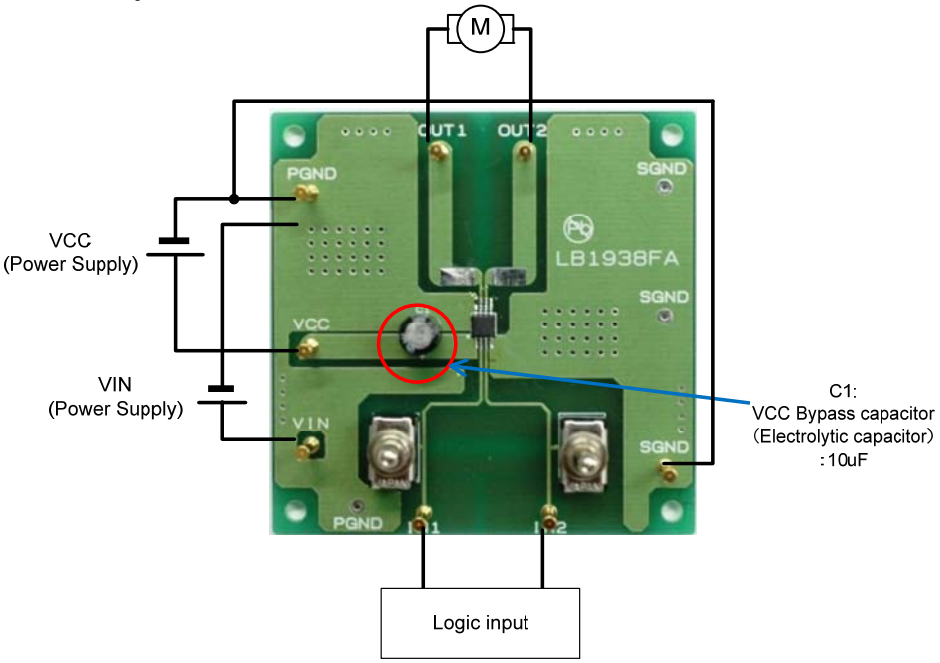


If rotation direction is switched while DC motor is rotating, then torque of reverse-rotation is generated, the speed of motor rotation becomes slow and reverse rotation is performed.
In this case, since voltage of VCC is added to induced voltage Ea generated during motor rotation, the motor current flows into the motor coil which is obtained as follows: Im= (VCC+Ea) / Rcoil.
When you switch from forward to reverse, if the current exceeds Iomax, make sure to set brake mode until the induced voltage is reduced between forward and reverse.

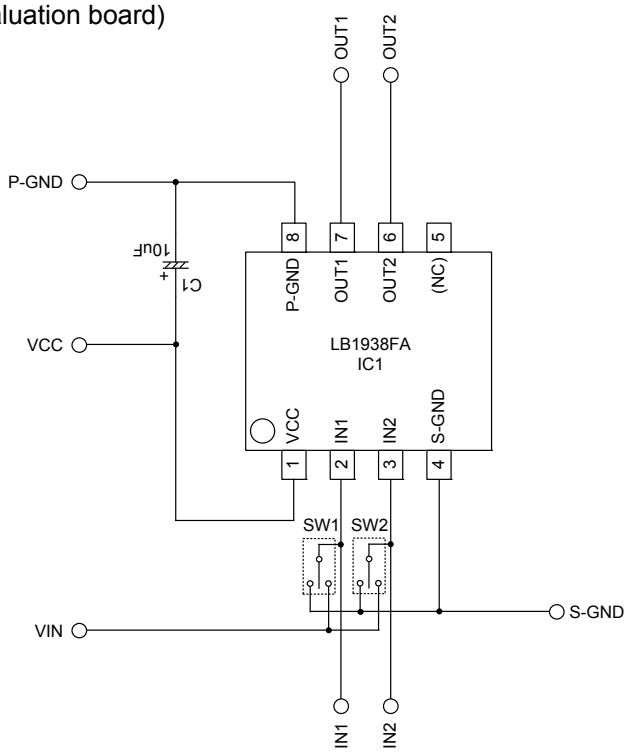
(Test circuit diagram 2)



Evaluation board description



(Circuit diagram of the evaluation board)



*VIN terminal is a power supply input terminal for switches.
5V are to impress it and can perform the setting that is in a state by the switch operation and logic input.

- **Operation method**
  Power supply injection order: VCC → VIN

- **Truth value table**

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

Recommended Soldering Footprint