Monolithic Digital IC

# LB1836M — Low-Saturation Bi-directional Motor Driver for Low-Voltage Drive

## 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.

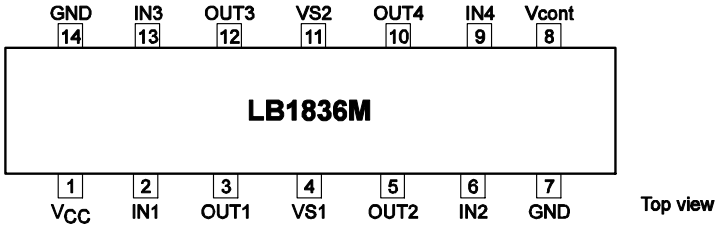
## Features

- 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

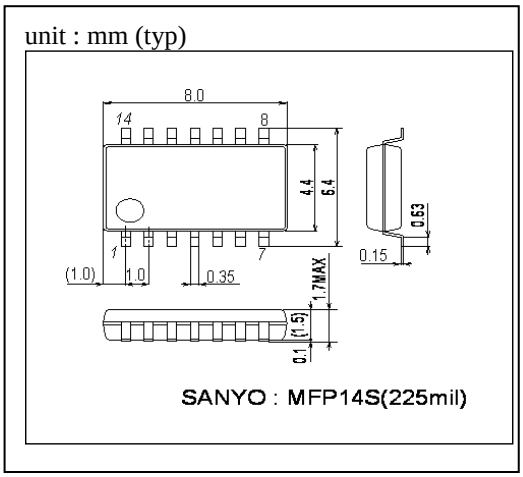
- Automotive audio
- Security Camera
- Camera
- TOY
- POS, Card Terminal (POS Printer, Thermal printer)

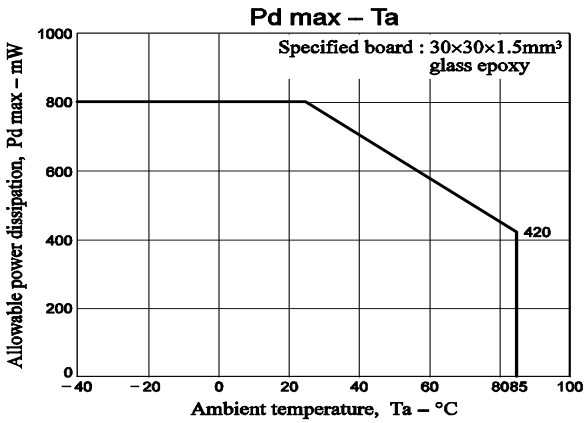
## Pin Assignment



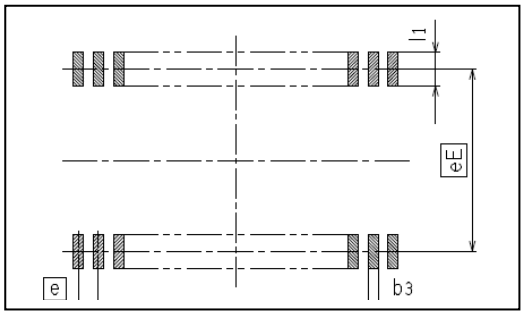

Note) Ground both GND pins.

## Package Dimensions




## Recommended Soldering Footprint

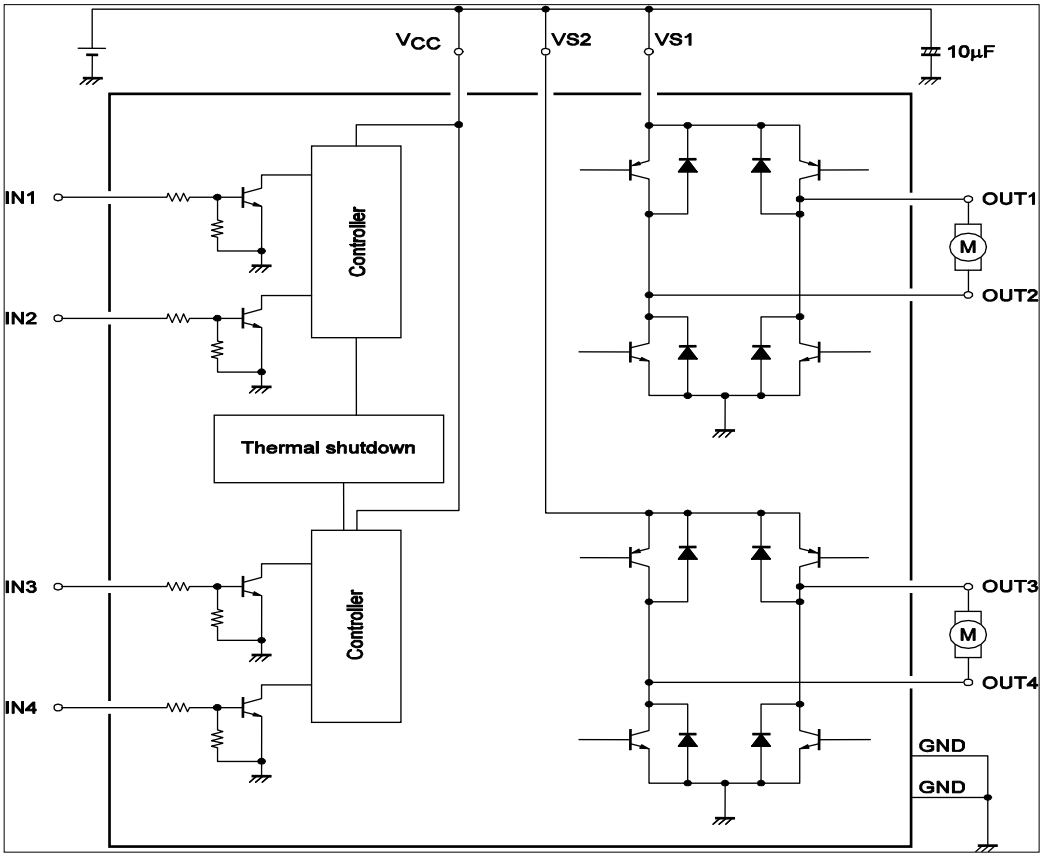



(Unit:mm)

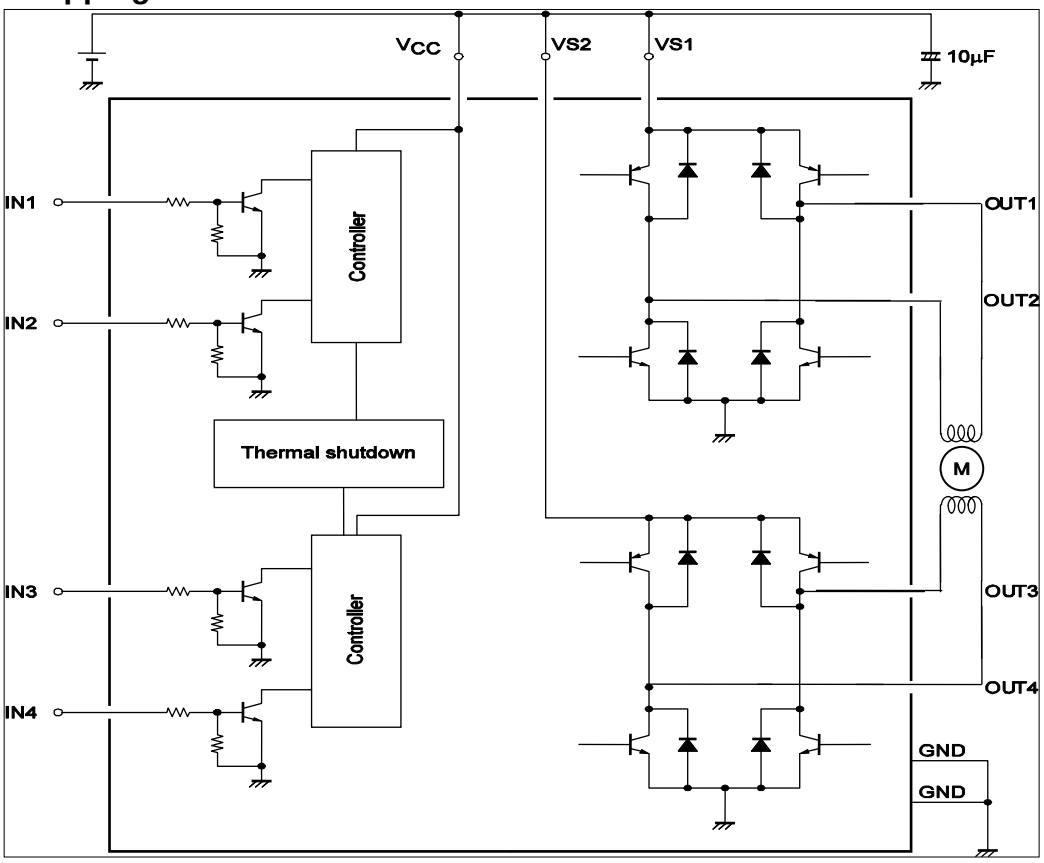
| Reference Symbol | MFP10S (225mil) |
|---|---|
| eE | 5.70 |
| e | 1.00 |
| b3 | 0.47 |
| l1 | 1.10 |

## Block Diagram

### 1. Two-DC motor drive



## 1 . 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.

### Allowable Operating Ranges at Ta = 25°C

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | 2.5 to 9.0 | V |
| | $V_S$ | | 1.8 to 9.0 | V |
| Input “H”-level voltage | $V_{IH}$ | | 1.8 to 9.0 | V |
| Input “L”-level voltage | $V_{IL}$ | | -0.3 to +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 |

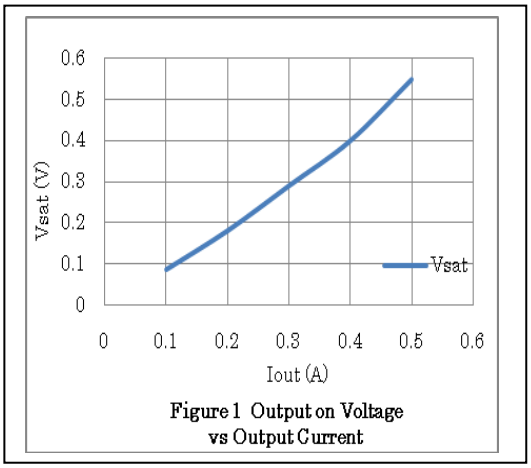


Figure 1 Output on Voltage vs Output Current

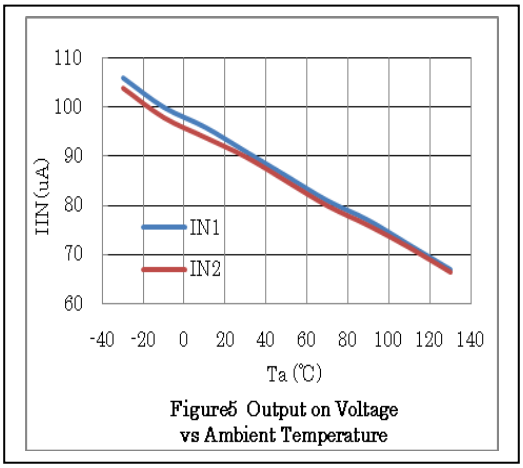


Figure5 Output on Voltage vs Ambient Temperature

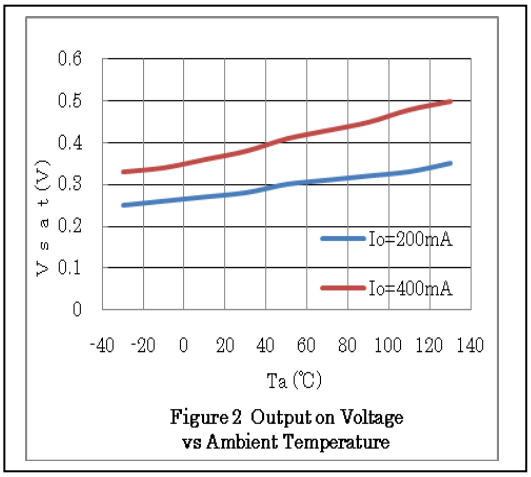


Figure 2 Output on Voltage vs Ambient Temperature

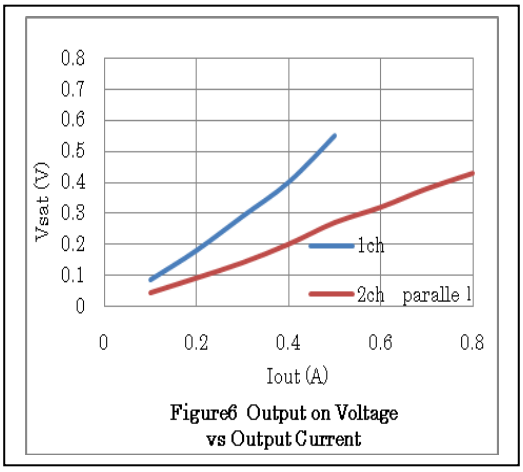


Figure6 Output on Voltage vs Output Current

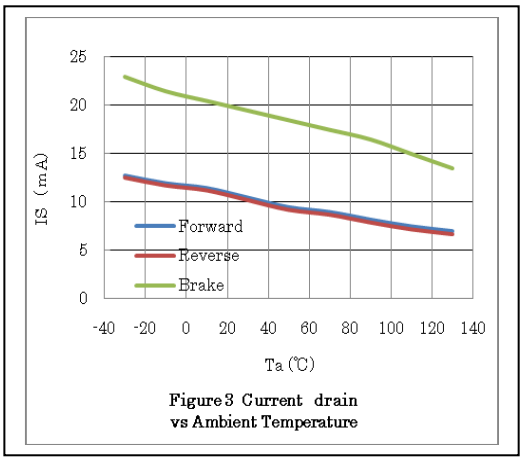


Figure 3 Current drain vs Ambient Temperature

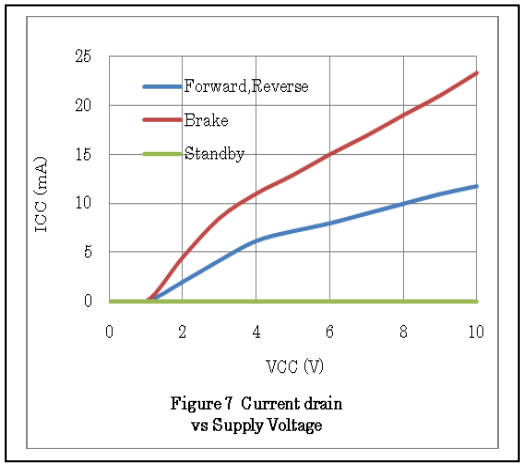


Figure 7 Current drain vs Supply Voltage

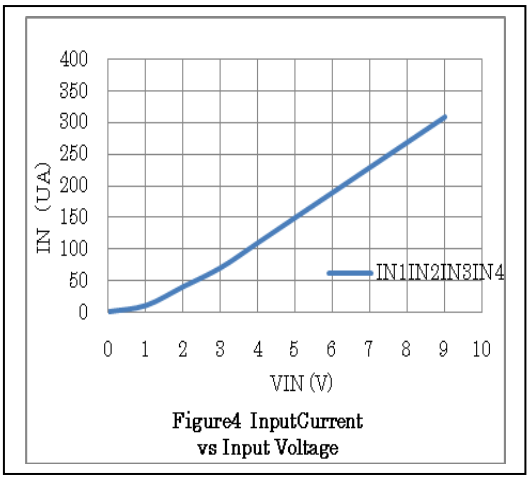



Figure4 InputCurrent vs Input Voltage

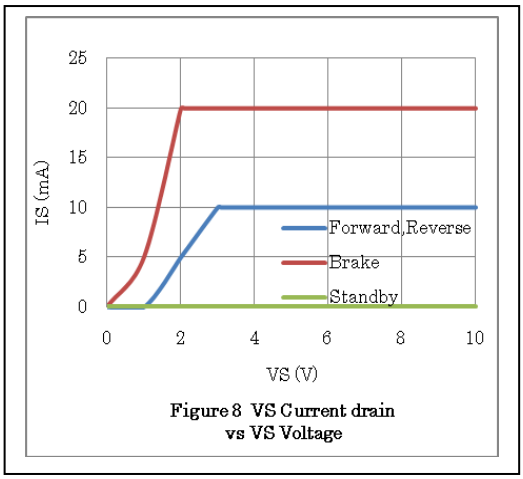



Figure 8 VS Current drain vs VS Voltage

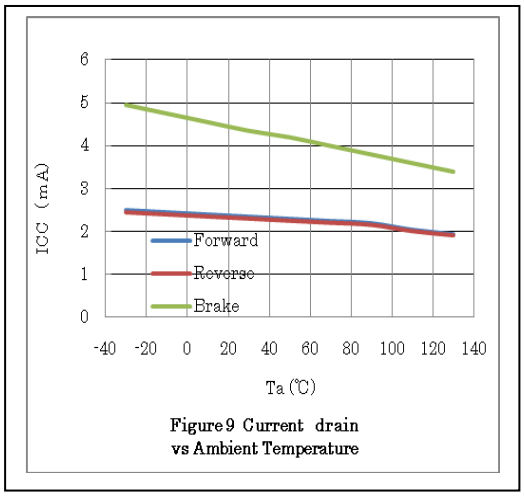
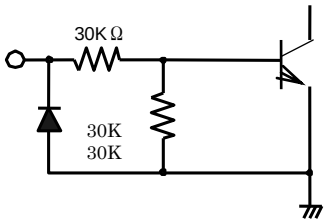
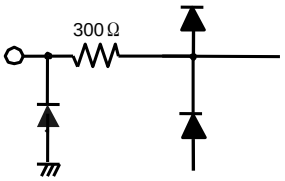
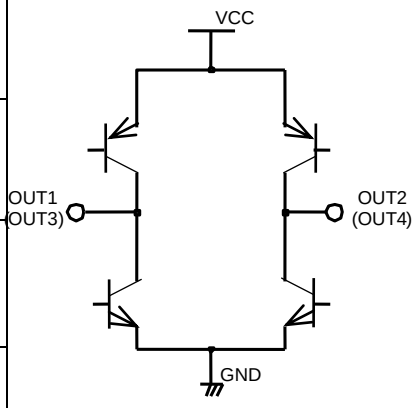



Figure 9 Current drain vs Ambient Temperature

Pin function

| Pin No. | Pin name | Pin function | Equivalent Circuit |
|---|---|---|---|
| 1 | $V_{CC}$ | Power-supply voltage pin.<br>$V_{CC}$ 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<br>11 | VS1<br>VS2 | Power-supply voltage pin. （motor supply voltage）<br>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.<br>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.<br>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.<br>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.<br>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.<br>Please refer to Vcontpin explanation. |  |
| 10 | OUT4 | Driving output pin.<br>The motor coil is connected between terminal OUT3 (12pin). |  |
| 12 | OUT3 | Driving output pin.<br>The motor coil is connected between terminal OUT4 (10pin). | |
| 5 | OUT2 | Driving output pin.<br>The motor coil is connected between terminal OUT1 (3pin). | |
| 3 | OUT1 | Driving output pin.<br>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.**

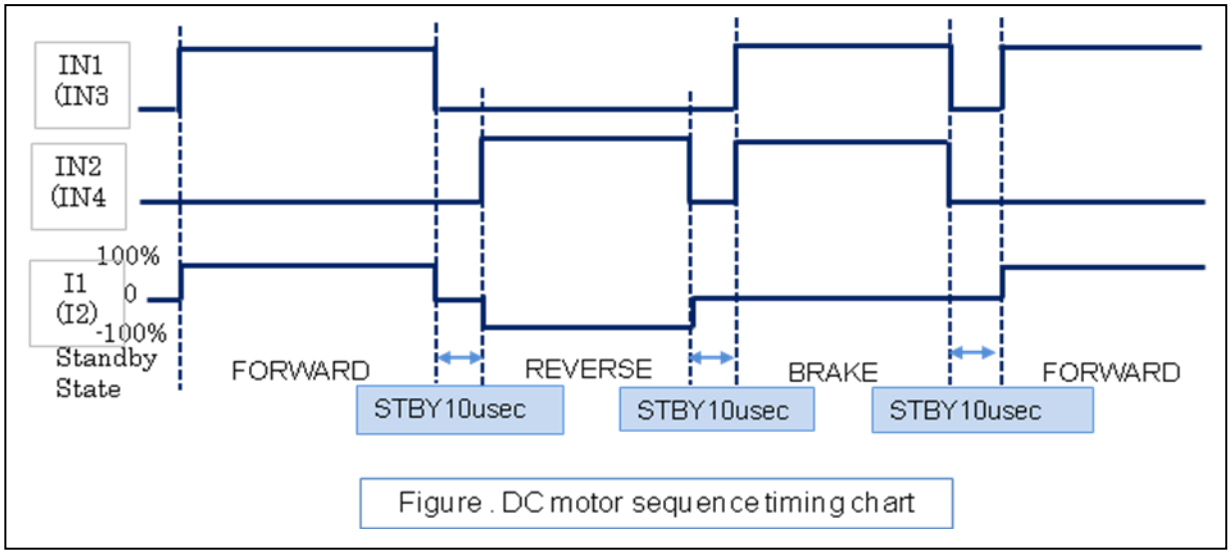
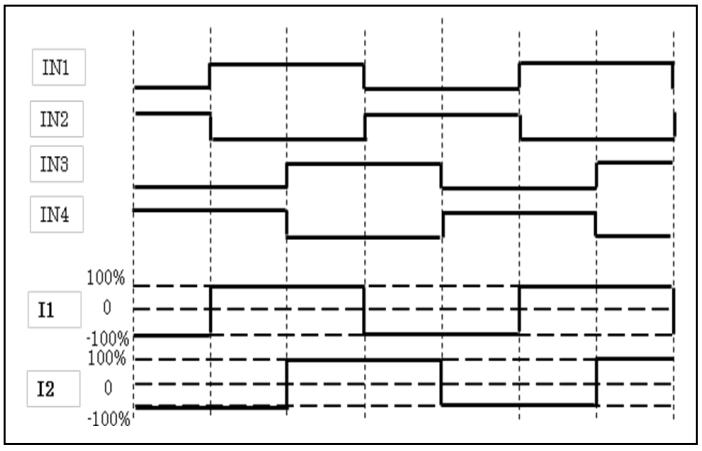


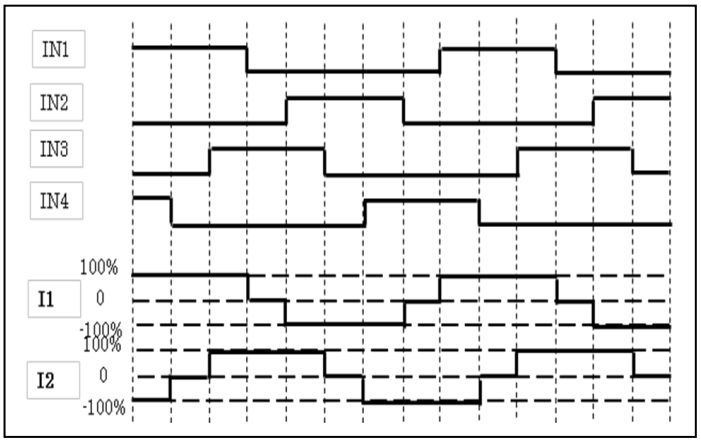

Figure . DC motor sequence timing chart

### 3. Stepping motor operation sequence

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




2 phase excitation

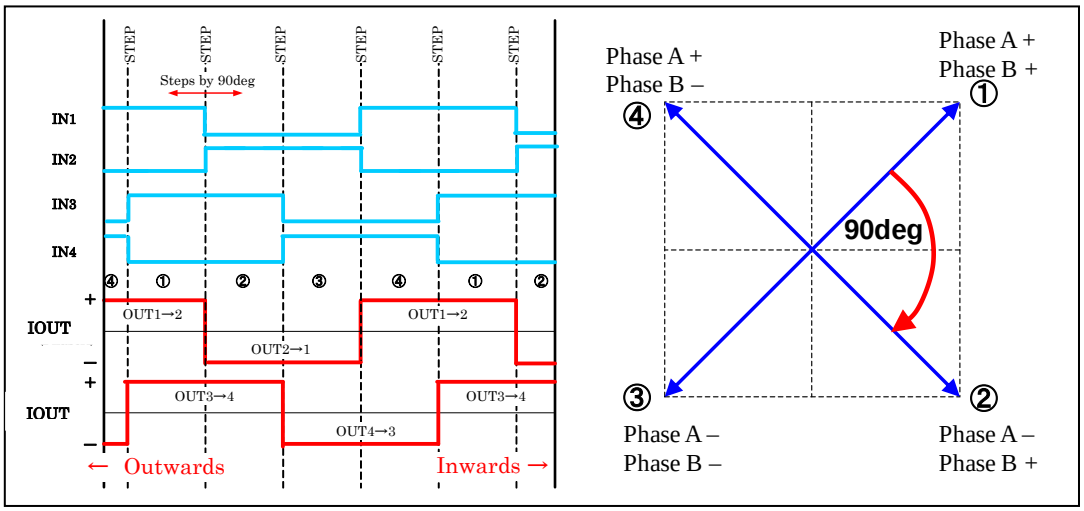



1-2 phase excitation

## 4. Theory

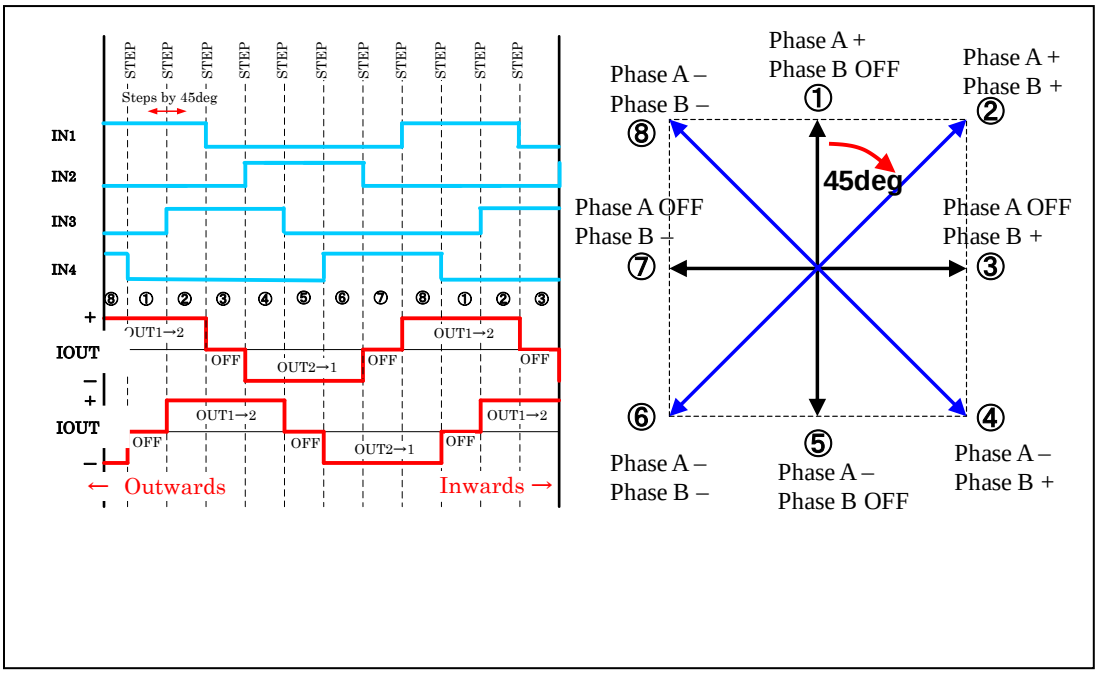
- **Full-Step MODE**

**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.

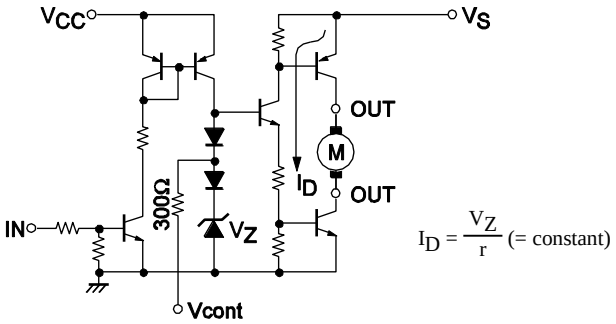
The modes during which large current flows are as follows :

- 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**




$$I_D = \frac{V_Z}{r} \text{ (= constant)}$$

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.

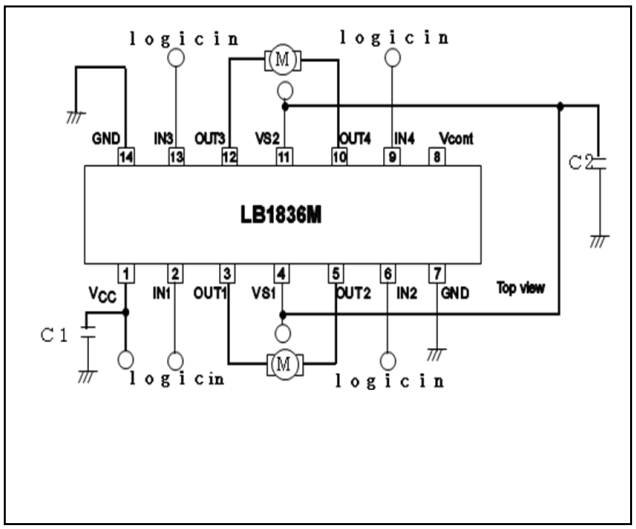
## 6. Thermal Shutdown circuit

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.

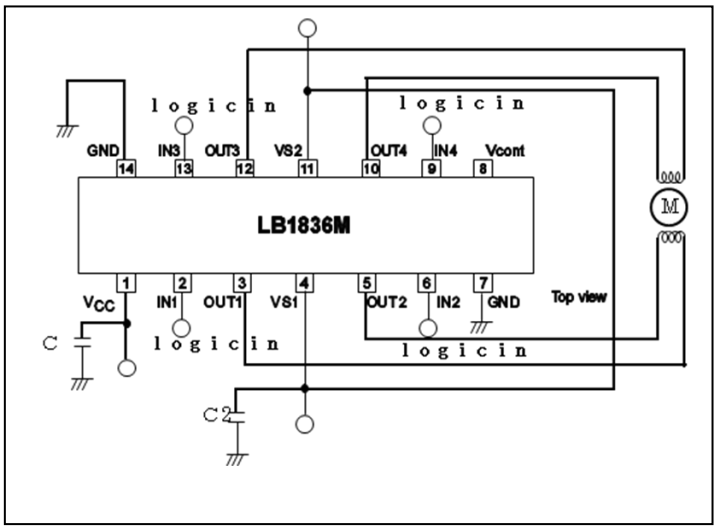
TSD = 180°C (typ)
ΔTSD = 40°C (typ)

## Application Circuit Example

1. Example of applied circuit with two DC motor driving

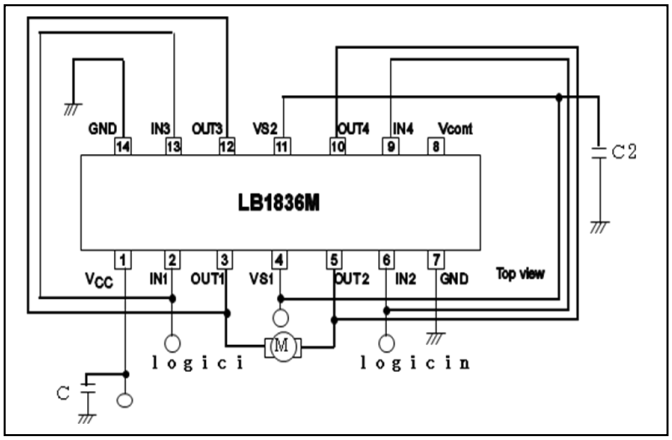



2. Example of applied circuit with one stepping motor driving



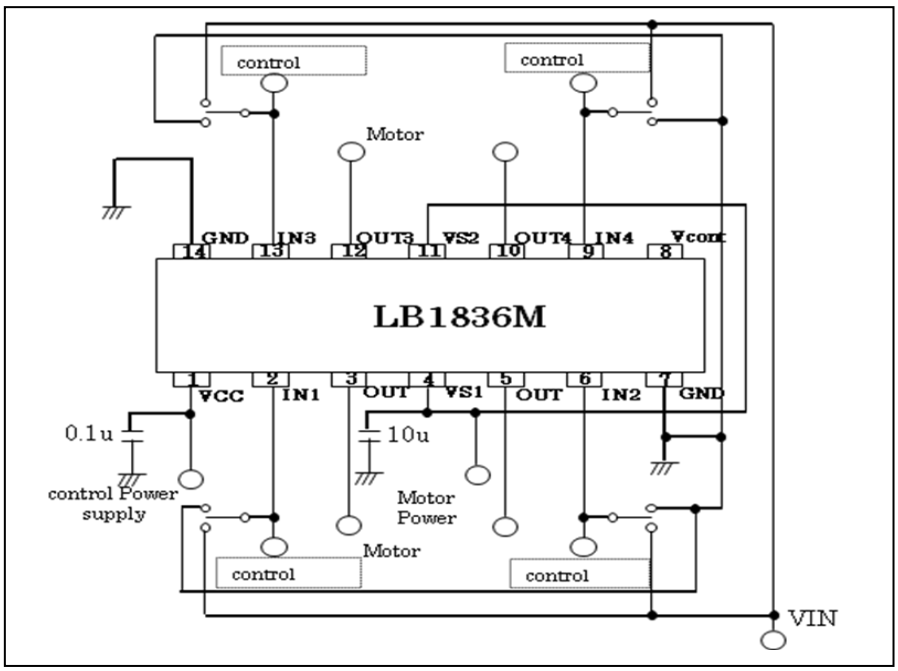

3. Example of applied circuit when connecting it in parallel

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

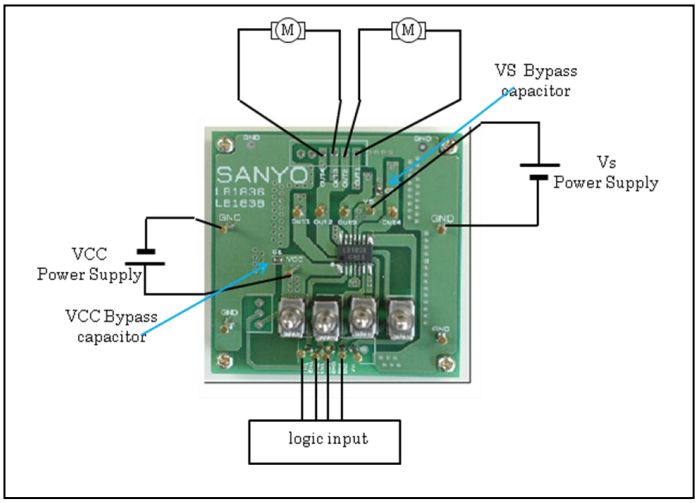
1. Eva-Board circuit diagram




Bill of Materials for LB1836M Evaluation Board

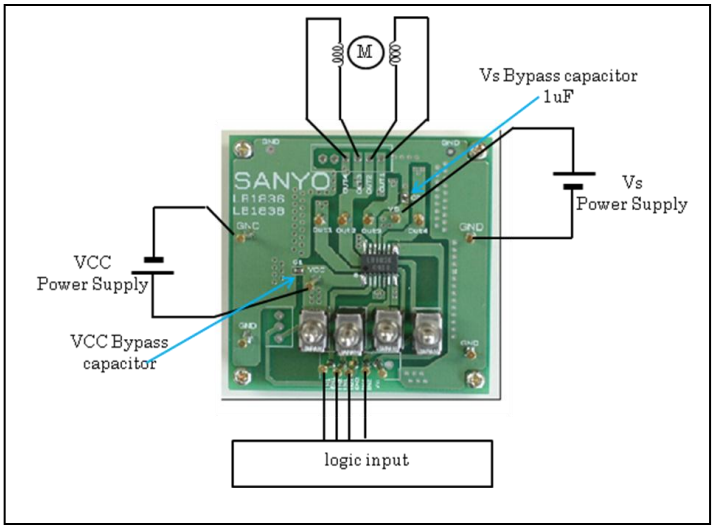
| Designator | Qty | Description | Value | Tol | Footprint | Manufacturer | Manufacturer Part Number | Substitution Allowed | Lead Free |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| IC1 | 1 | Motor Driver | | | MFP14S (225mil) | SANYO semiconductor | LB1836M | No | Yes |
| C1 | 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.

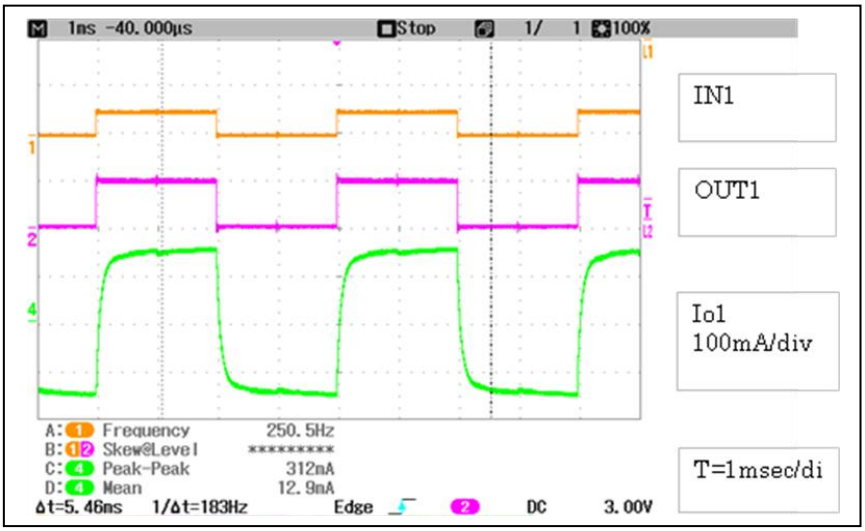
(2) One stepping motor drive



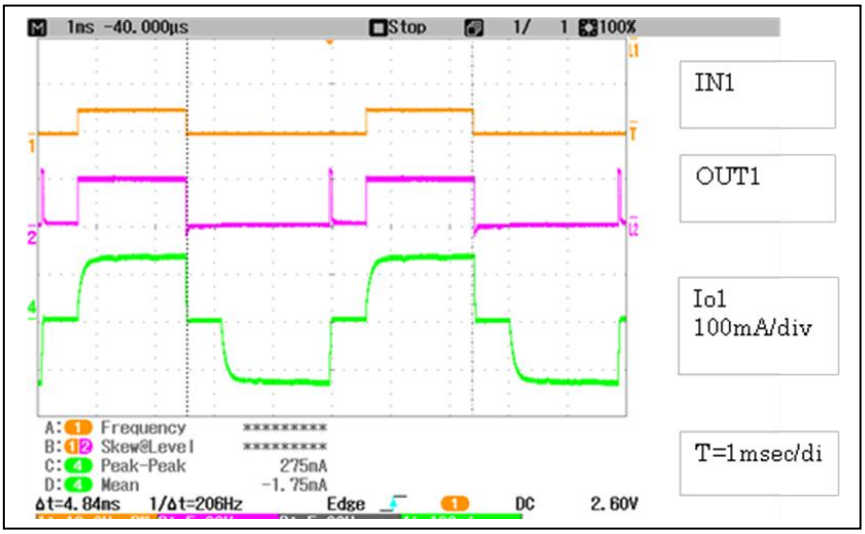

- Connect a stepping motor with OUT1, OUT2, OUT3 and OUT4.
- Connect the motor power supply with the terminal VCC, the control power supply with the terminal VIN. Connect the GND line with the terminal GND.
- STP motor drives it in an 2 phase excitation, 1-2 phase excitation by inputting an input signal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



This catalog provides information as of May, 2011. Specifications and information herein are subject to change without notice.