Monolithic Digital IC

LB1669, 1669M

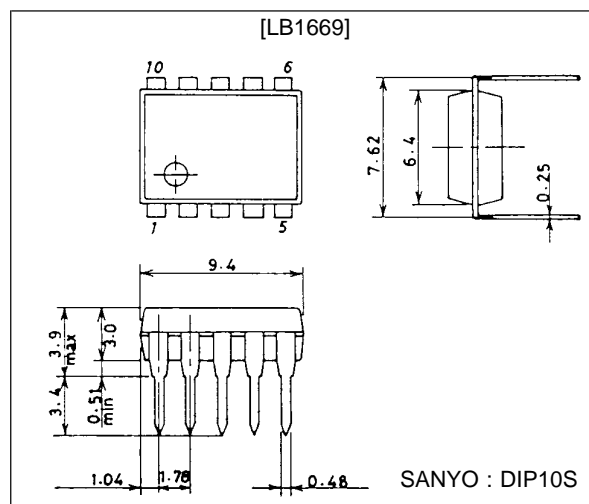## 2-Phase Unipolar Brushless Motor Driver

Overview

The LB1669, 1669M are 2-phase uniploar brushless motor drivers. They make it possible to configure motor lock protection and automatic recovery circuits with few extenal components.
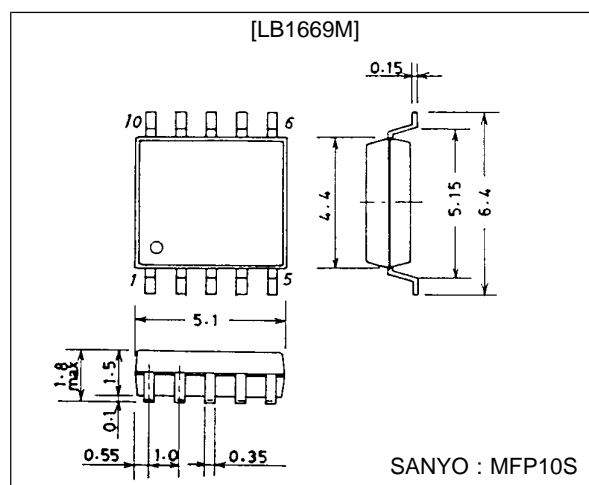
Features and Functions

- Hall element direct connection possible
- Output transistor with 1.5 A output current built in
- Rotation detect function (Drive mode: "L", Stop mode: "H") built in
- Motor lock protection and automatic recovery functions built in
- Thermal shutdown circuit built in
- DIP-10S and MFP-10S packages mean small mounting surfaces.
- Pin compatible with LB1663, so can replace 12 V types.

Package Dimensions

unit : mm

3098A-DIP10S

SANYO : DIP10S

unit : mm

3086A-MFP10S

SANYO : MFP10S

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D3096HA(II)/7120TA(GTPS) No.3513-1/5

Specifications

Absolute Maximum Ratings at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Maximum input current	I_{CC} max	$t \leqq 20$ ms	200	mA
Output applied voltage	V_{OUT}		−0.3 to +60	V
Output current	I_{OUT}		1.5	A
RD flow-in current	I_{RD}		10	mA
RD applied voltage	V_{RD}		30	V
Allowable power dissipation	Pd max	LB1669: Independent IC	1.2	W
		LB 1669M: Mounted on $20 \times 15 \times 1.5$ mm^3 glass epoxy board	800	mW
Operating temperature	Topr		−30 to +80	°C
Storage temperature	Tstg		−55 to +125	°C

Allowable Operating Conditions at Ta = 25 °C

Parameter	Symbol	Conditions	Ratings	Unit
Input current range	I_{CC}		6.0 to 50	mA
Common-mode input voltage range	V_{ICM}		0 to V_{IN}−1.5	V

Electrical Characteristics at Ta = 25 °C, I_{CC} = 10 mA

Parameter	Symbol	Conditions	min	typ	max	Unit
Output withstand voltage 1	V_{OR}		60			V
Output withstand voltage 2	V_O(sus)	$I_O = 0.1$ A	40			V
Output saturation voltage	V_O sat1	$I_O = 0.5$ A		0.95	1.2	V
	V_O sat2	$I_O = 1.0$ A		1.15	1.5	V
V_{IN} voltage	V_{IN}	$I_{CC} = 7.0$ mA	6.4	6.7	7.0	V
Amp input offset voltage	V_{OFF}		−7	0	7.0	mV
Amp input bias current	I_{BA}		−250			nA
RD output saturation voltage	V_{RD}(sat)	$I_{RD} = 5$ mA		0.1	0.2	V
C flow-out current	I_C1		2.1	3	3.9	μA
C discharge current	I_C2		0.31	0.44	0.59	μA
Comparator input threshold voltage	$V_{TH}1$		0.77	$0.8V_{IN}$	0.83	V
	$V_{TH}2$		0.42	$0.45V_{IN}$	0.48	V

Pd max − Ta LB1669 — Independent IC

Pd max − Ta LB1669M — Mounted on $20 \times 15 \times 1.5$ mm^3 Glass epoxy board
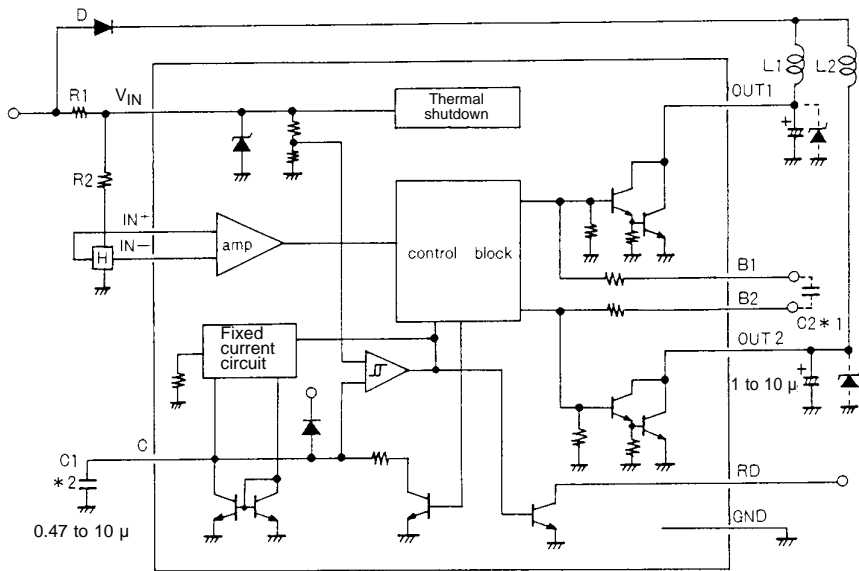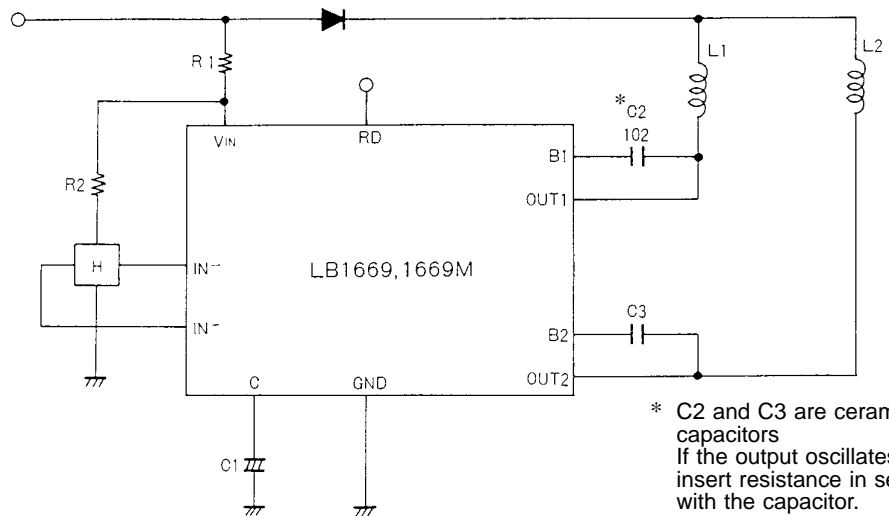
Pin Assignments

Top view

Top view
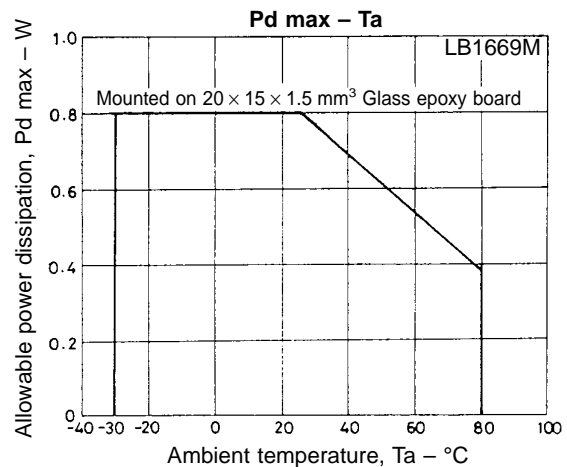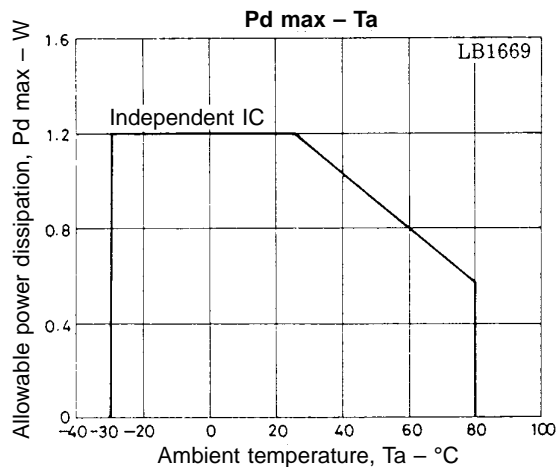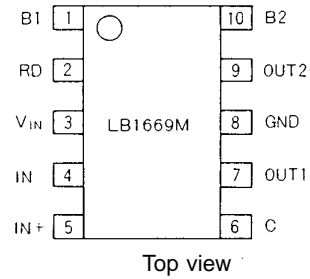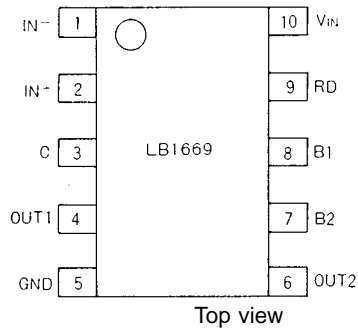
Equivalent Circuit Block Diagram and Sample Application Circuit 1

Note * 1: If radio noise is a problem, 0.01 to 0.1μF
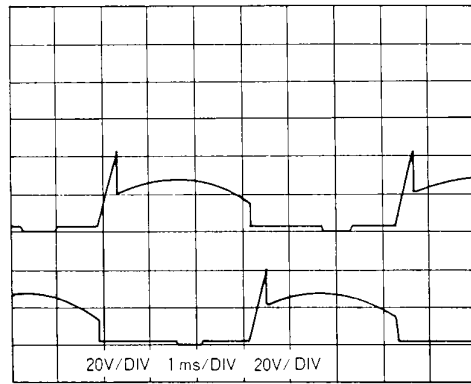   * 2: Use a low-leak capacitor.

Unit (capacitance: F)

Sample Application Circuit 2

* C2 and C3 are ceramic capacitors
If the output oscillates, insert resistance in series with the capacitor.

Sample Application Circuit 2 Output Waveform Diagram

20V/DIV   1 ms/DIV   20V/DIV

Truth Table

IN+	IN–	C	OUT1	OUT2
H	L	L	H	L
L	H	L	L	H
H	L	H	H	H
L	H	H	H	H

Design Notes (See Sample Application Circuits.)

(1) Supply Voltage (V_{IN} pin)

The LB1669 series have the internal parallel regulator which supplies power to the Hall amplifier circuit and the control block. Therefore, the driver ICs are not affected by power source fluctuations and kickbacks from the motor. They maintain the stable operations even if noise signals such as surge are generated.

Set the resistance R1 between V_{CC} and V_{IN} so that the I_{CC} current of 6 mA to 50 mA can flow into the V_{IN} pin within the supply voltage range of a fan motor.

V_{IN} is 6.7 V typ at I_{CC} = 7 mA.

The current flowing into V_{IN} is calculated using the equation shown below.

$$I_{CC} = \frac{V_{CC} - V_{IN}}{R1} \quad \ldots \ldots \text{(1)}$$

• Consideration given to surge voltage

The maximum allowable current at V_{IN} pin is 200 mA, so the withstand voltage level is designed as follows.

$$Vsurge = V_{IN} + R1 \times 200 \text{ mA} \ldots \ldots \text{(2)}$$

(2) Hall input pin voltage (IN– and IN+ pins)

IN– and IN+ are input pins for the Hall element output. Set the Hall element output voltage to within the range of 0 V to V_{IN} – 1.5 V.

The gain between the Hall input pin and the output pin is 100 dB or greater. The offset voltage of the Hall input amplifier is ±7 mV therefore, the Hall element output must be set with the offset voltage (±7 mV) considered.

(3) Output transistors (OUT1 and OUT2 pins)

Output current I_O = 1.5 A max.

Output saturation voltage V_O sat = 1.15 V/1.0 A (typ.)

The LB1669 requires one of the three types of output protection.

① When external capacitors are connected between OUT and GND, the capacitance should not exceed 10 μF. Use capacitance that will hold kickback voltage and back voltage to 60 V or less.

② When external Zener diodes are connected, use one that will have a cutoff voltage of 40 V or less. If radio noise is a problem, insert a capacitor of 0.01 to 0.1μF between B1 and B2.

③ When external capacitors are connected between OUT and B, use one that will hold kickback voltage to 40 V or less. If it oscillates, insert resistance in series with the capacitor.

(4) Output protection function (C pin)

Capacitor pin used in forming an automatic recovery circuit. If rotation is stopped due to overload, the pin voltage level increases and then forces the output to become inactive. In this case, after proper load adjustment, the output returns to the 'drive' mode from the 'stop' mode automatically. By changing the capacitor value, the lock detect time period can be set.

For 1 μF   lock detection time about 2 seconds

lock protection time (output ON) about 1 second

(output OFF) about 6 seconds
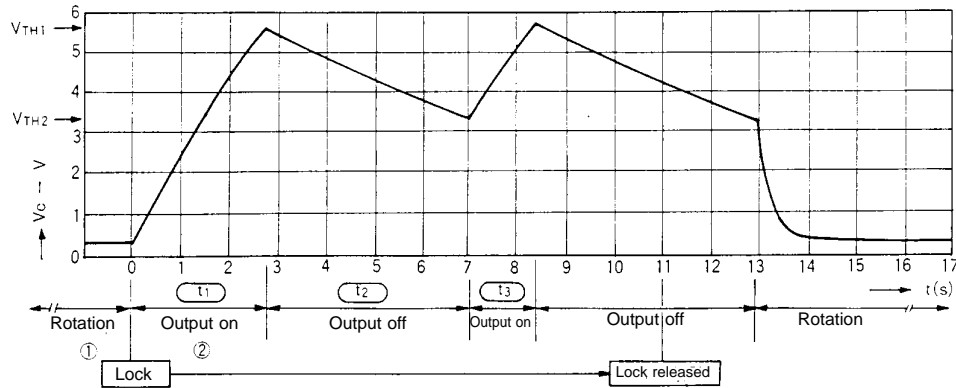
Automatic Recovery Circuit C Pin Voltage

① When a fan is rotating, the capacitor is charged at 3 μA (typ) and discharged through the C with pulses according to the rotational speed.

② When a fan is locked, no discharge occurs through the C and the C voltage rises, turning OFF the output at $0.8 \times V_{IN}$.

③ When the output is turned OFF, discharge occurs through the C at 0.44 μA (typ). If the lock is not released when the C voltage drops to $V_{TH}2$, the capacitor is charged to $V_{TH}1$ again. (At this moment, the output is turned ON.)

These operations ② and ③ are repeated at a cycle of approximately $t_{on} : t_{off} = 1 : 6$ to protect the motor.

④ If the lock is released when the C voltage drops to $V_{TH}2$, the output is turned ON, starting rotation.

(5) Rotation detect signal (RD pin)

Open collector output (Drive mode: "L", Stop mode: "H")

(6) Radio noise reducing (pins B1 and B2)

These are the base pins for Darlington connected output transistors.

If radio noise is a problem, add a capacitor of 0.01 to 0.1μF or less.

(7) Thermal shutdown function

Shutdown the driver output in case of coil short-circuiting and abnormal IC heating.