Monolithic Digital IC



LB1692

# **Three-Phase Brushless Motor Driver**

## **Overview**

The LB1692 is a three-phase brushless motor driver IC. It is optimal for use with DC fan motors in equipment such as air conditioners or water heaters. The LB1692 is a high-breakdown voltage version of the LB1690.

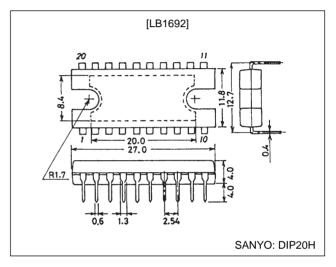
# **Functions and Features**

- Three-phase brushless motor driver
- 60 V breakdown voltage, 2.5 A output current
- Built-in current limiter
- Built-in low voltage protection circuit
- Built-in thermal protection circuit
- Built-in Hall amplifier with hysteresis
- FG output function

# **Package Dimensions**

unit: mm

3037A-DIP20H



# Specifications

## Absolute Maximum Ratings at Ta = $25^{\circ}C$

Parameter	Symbol	Conditions	Ratings	Unit
	V <sub>CC</sub> max		10	V
Maximum supply voltage	V <sub>M</sub> max		60	V
Output current	lo		2.5	A
	Pd max1	Independent IC	3	W
Allowable power dissipation	Pd max2	With an arbitrarily large heat sink	20	W
Operating temperature	Topr		-20 to +100	°C
Storage temperature	Tstg		-55 to +150	°C

### Allowable Operating Ranges at $Ta = 25^{\circ}C$

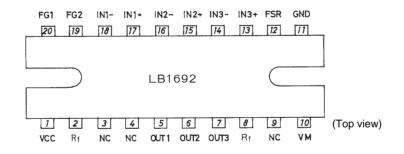
Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage renge	V <sub>CC</sub>		4.5 to 5.5	V
Supply voltage range	V <sub>M</sub>		5 to 56	V

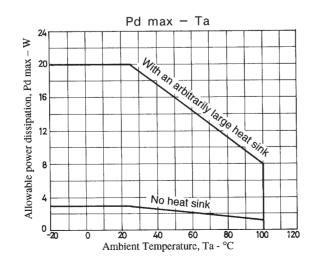
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Parame	ter	Symbol	Conditions	min	typ	max	Unit
Current drain		I <sub>CC1</sub>	When stopped		4	6	mA
		I <sub>CC2</sub>			10	15	mA
0	- 14	V <sub>O</sub> sat1	$I_0 = 1 \text{ A}, V_0 (\text{sink}) + V_0 (\text{source})$		2.1	3.0	V
Output saturation v	oltage	V <sub>O</sub> sat2	$I_0 = 2 \text{ A}, V_0 (\text{sink}) + V_0 (\text{source})$		3.0	4.2	V
Output leakage cur	rent	l <sub>O</sub> leak				100	μΑ
[Hall amplifier]				·			
Input bias current		I <sub>HB</sub>			1	4	μA
Common mode inp range	ut voltage			1.5		3.2	V
Hysteresis		$\Delta V_{IN}$		23	30	37	mV
1	V <sub>SLH</sub>	$L \rightarrow H$	5	15	25	mV	
Input voltage		V <sub>SHL</sub>	$H \rightarrow L$	-25	-15	-5	mV
[FG pin] (Speed pu	lse output)			·			
Output low level vo	ltage	V <sub>FGL</sub>	I <sub>FG</sub> = 5 mA		0.16	0.4	V
Pull-up resistance		R <sub>FG</sub>		7.5	10	12.5	kΩ
Forward, reverse,	Forward	V <sub>FSR1</sub>			0	0.8	V
and stop	Stop	V <sub>FSR2</sub>		2.1	2.5	2.9	V
operation	Reverse	V <sub>FSR3</sub>		4.2	5.0		V
Current control ope	ration limiter	V <sub>Rf</sub>		0.42	0.5	0.6	V
Thermal cutoff oper temperature	rating	T <sub>SD</sub>	Design target value	150	180		°C
Hysteresis		$\Delta T_{SD}$			25		°C
Low voltage protect operating voltage	tion	V <sub>LVSD</sub>		3.5	3.8	4.1	V
Hysteresis		$\Delta V_{LVSD}$		0.2	0.3	0.4	V

## Electrical Characteristics at Ta = 25°C, $V_{CC}$ = 5 V, $V_M$ = 45 V

#### **Pin Assignment**



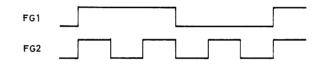


## Truth Table

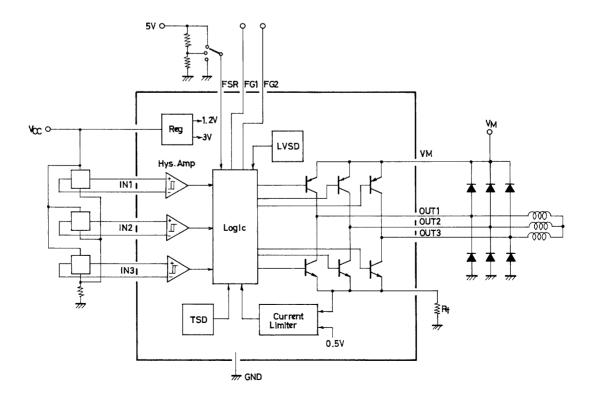
lterr			Input		
Item	$\text{Source} \rightarrow \text{Sink}$	IN1	IN2	IN3	FSR
4	$OUT3 \rightarrow OUT2$	— н			L
1	$OUT2 \rightarrow OUT3$	н	Н	L	Н
	$OUT3 \rightarrow OUT1$		L	L	L
2	$OUT1 \rightarrow OUT3$	— Н			Н
2	$OUT2 \rightarrow OUT3$		L	н	L
3	$OUT3 \rightarrow OUT2$				Н
4	$OUT1 \rightarrow OUT2$				L
4	$OUT2 \rightarrow OUT1$		Н	L	Н
F	$OUT2 \rightarrow OUT1$	— н			L
5	$OUT1 \rightarrow OUT2$	н	L	Н	Н
6	$OUT1 \rightarrow OUT3$				L
6	$OUT3 \rightarrow OUT1$		н	н	Н

FSR Forward: L (0 to 0.8 V) Reverse: H (4.2 to 5.0 V)

### **FG Output**



## **Block Diagram and Peripheral Circuits**



#### **Pin Functions**

Pin	Pin No.	Function		
IN1+, IN1– IN2+, IN2– IN3+, IN3–	17, 18 15, 16 13, 14	OUT1: A logic high level indicates that the Hall device input pins are in the state IN+ > IN OUT2: A logic high level indicates that the Hall device input pins are in the state IN+ > IN OUT3: A logic high level indicates that the Hall device input pins are in the state IN+ > IN		
OUT1 OUT2 OUT3	5 6 7	Output pin 1 Output pin 2 Output pin 3		
V <sub>CC</sub>	1	Power supply for all sections other than the output block		
V <sub>M</sub>	10	Power supply that provides the output power		
Rf	2, 8	Output current detection pin. The output current is converted to a voltage for detection by a resistor connect between this pin and GND.		
GND	11	Ground for all sections other than the output block The Rf pin voltage will be the lowest output transistor potential.		
FSR	12	Forward/stop/reverse control pin The voltage on this pin controls the IC forward, stop, or reverse operation. Forward: 0 to 0.8 V Stop: 2.1 to 2.9 V Reverse: 4.2 to 5.0 V		
FG1 FG2	20 19	Speed pulse output pin 1. A pull-up resistor is built in. Speed pulse output pin 2. A pull-up resistor is built in.		

1. Position Detection Circuit (Hall device input circuit)

The position detection circuit is a differential amplifier with hysteresis (typically 30 mV). Voltages within the common mode input voltage range (1.5 V to  $V_{CC} - 1.8$  V) should be used as the operating DC level. We recommend using an input level that is more than three times the hysteresis, i.e., on the order of 120 to 160 mVp-p.

#### 2. Current Control Circuit

Current control is performed by switching the sink side transistor from the saturated to the unsaturated range. Therefore, it is possible for ASO to be a problem.

$$I = \frac{V_{Rf}}{Rf} \qquad (A)$$

Therefore, if at all possible, applications should be designed so that the current limiter does not operate. Also, be especially careful to design applications so that the maximum output current (2.5 A) is not exceeded when the current limiter operates. Note that a current limiter must be added to the  $V_M$  power supply. (We recommend a current limiter with a short delay time and with a design current that is about 60 to 70% of the current control circuit's current value.)

- 3. Protection Circuits
  - Low voltage protection circuit

The sink side output drivers are turned off if the  $V_{CC}$  pin voltage falls below the stipulated range. This circuit is provided to prevent incorrect operation.

- Thermal cutoff protection circuit If the junction temperature exceeds the stipulated temperature range, the sink side output drivers are turned off. This is identical to the operation of the circuit described in 3-1 above.
- 4. V<sub>M</sub> power supply minimum voltage

The  $V_M$  power supply voltage should be greater than or equal to the  $V_{CC}$  voltage.

$$V_M \ge V_{CC}$$

5. FG Output Circuit

The position detection inputs IN1, IN2, and IN3 are combined and the output is generated using waveform shaping. The frequencies of those outputs are proportional to the rotational speed signal, and, as seen from the position detectors, are equal to the input frequency itself (FG1) and three times the input frequency (FG2).

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