TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT   SILICON MONOLITHIC

TA8473F

FAN MOTOR DRIVER IC

The TA8473F is a fan motor driver IC.
The output current is 0.4A (AVE.) and all functions needed for fan motor driving have been incorporated into 1 chip.
This IC is provided with the function to automatically change the motor speed by detecting ambient temperature through the externally mounted thermistor.
Furthermore, the TA8473F is provided with the noise reduction terminal, the FG terminal to output pulses proportional to the motor speed and the RD terminal to detect the motor status.

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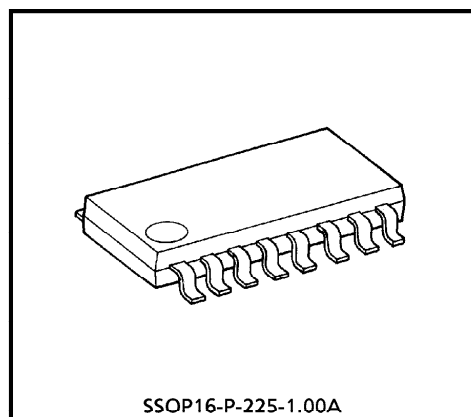
Weight : 0.14g (Typ.)

FEATURES

● Built-in automatic self rotation recovery circuit after release of motor locking.

● Thermal shutdown circuit incorporated.

● Operating voltage : 6~13.8V

● 2 kind of speed of full-speed and half-speed are variable according to ambient temperature.

● Speed change point temperature is externally settable.

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BLOCK DIAGRAM

PIN FUNCTION

PIN No.	SYMBOL	FUNCTIONAL DESCRIPTION
1	V_{CC}	Power voltage supply terminal.
2	B1	Noise reduction capacitor connection terminal.
3	OUT1	Output terminal.
4	GND	GND terminal.
5	GND	GND terminal.
6	OUT2	Output terminal.
7	B2	Noise reduction capacitor connection terminal.
8	TH	Thermistor connection terminal.
9	RD	Rotation detect output terminal.
10	FG	Rotation speed output terminal.
11	SC	Lock protect time constant determined terminal.
12	HS	Half-speed determined terminal.
13	R_{ref}	Reference resistor connection terminal.
14	H^-	Hall input terminal.
15	H^+	Hall input terminal.
16	NC	Non connection.

HALF-SPEED SYSTEM

To lower the motor speed, TA8473F sets the off-time during the output timings (Fig.1). Starting the multivibrator (MMV) enables the off-time. The off-time is set by the time constant of capacitor Ch connected to the HS terminal and IC internal resistor Rh. A thermistor can also be used to control off-time depending on the temperature.

(1)　Determining Ch

The MMV operation can be monitored through the HS terminal. About 100kΩ Rh is connected between V_{CC} and HS, generating a transient with the external Ch. The maximum peak level value is set to about 5V and the bottom level to about 1V.
The off-time is determined as follows :

$$T = Ch \cdot Rh \times \ell og \frac{V_{CC} - 1}{5 - 1}$$

For example, at Ch = 0.1μF, Rh = 100kΩ, and V_{CC} = 12V, off-time is about 4.4ms. Since Rh is an internal resistor, a fluctuation of ±30% is permitted. The temperature characteristic is 0.5% / °C.
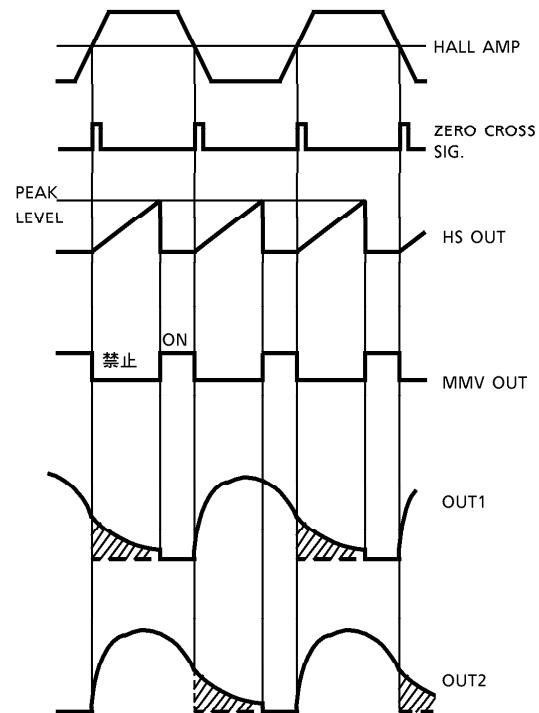

Fig.1

(2)　Determining off-time

If approximately the same off-time (× 1~1.3) is set for the on timing when the motor is running at full speed, a number of rotations decreases to about half. As the coefficient depends on the motor, determine the off-time value by experimenting.
The number of rotations can be set to any value. However, if the value is too low, the motor can be started but not run stably.

(3)　Detecting temperature and controlling rotations

TA8473F compares the TH terminal thermistor and the value of the resistor externally connected to the R_{ref} terminal, and alters the off-time. Changes in off-time can be made by altering the peak operation level of MMV. That is, TA8473F internally applies a reference current of 100μA to the R_{ref} terminal and generates at the TH terminal a reference voltage of 1V at R_{ref} = 10kΩ. The peak level of MMV is controlled using the difference between the current at the TH terminal determined using the thermistor resistance, and another internal reference current.

The peak level can be represented as follows :

$V_{peak} = 5 - 240k\Omega \ (1_{ref1} \times R_{ref} / R_{VR} - 1_{ref2})$

Here, $1_{ref1} = 1_{ref2} = 100\mu A$ Typ.

$R_{VR} = R_{TH} + R_a$

In addition, only positive values within parentheses ( ) are valid. The value of V_{peak} is between 1V and 5V.

The thermistor resistance, R_{TH}, is generally shown as follows :

$R_{TH} \ (Ta) = Ro \times EXP \cdot B \ (1 / Ta - 1 / To)$

    Ro : Resistance (Ω) when reference temperature To (normally, 25°C = 298K)

    Ta : Ambient temperature (K)

    B : Characteristic temperature (K)

As the above equation shows, the thermistor has a negative temperature characteristic for ambient temperature, Ta. The resistance drops at high temperature. Using this characteristic, lowering the V_{peak} value at high temperature runs the motor at full speed ; raising the value at low temperature reduces the number of fan rotations with the maximum off-time.

The number of rotations begins to increase from the minimum when $R_{VR} \leqq R_{ref}$, reaching the motor's full speed when R_{VR} is about $0.85 \times R_{ref}$.

<Example 1>

When a thermistor with characteristics B = 4200K and Ro = 10kΩ (at Ta = 25°C) is used without other resistors, the motor speed slows down at 25°C or lower if R_{ref} = 10kΩ, and is at full speed at 30°C or higher if R_{TH} = 8.5kΩ.

<Example 2>

When resistors are connected in series to the thermistor and R_{VR} composite resistance is obtained, the resistance change ratio drops :

$$\frac{\partial R_{VR} / R_{VR}}{\partial R_{TH} / R_{TH}} < 1$$

Therefore, there is a wide range for the number of the rotations.

(4)   Miscellaneous

The thermistor should be connected to where the temperature is detected. Consequently, the thermistor may be located away from the IC. In this case, if the wire from the thermistor is accidentally disconnected, the TH terminal opens and rotation control switches to the low-speed condition.

To deal with this situation, TA8473F is designed so that when the thermistor wire is disconnected, the motor runs at full speed.

FG AND RD OUTPUTS

Both the FG and RD outputs are the open collector outputs.

The FG output is pulse proportional to the number of revolutions (the cycle is the same as OUT B) and the RD output is at the GND level (actually, at $V_{sat(RD)}$ level) when the motor is being driven and the RD output at the potential level that is to be applied to the RD terminal as shown in Fig.2 is output when the motor is kept restrained.

AUTOMATIC SELF ROTATION RECOVERY CIRCUIT

If the rotation of the fan motor is forced to stop by any physical power, the driving coil may be burnt as inducing voltage caused when the motor is running disappears and large current flows to the driving coil.

Therefore, it becomes necessary to provide the fan motor with a circuit to prevent the driving coil from being burned by detecting the forced stop of the motor rotation from the outside by some method and a circuit to automatically rotate the motor when it is released from the restraint.

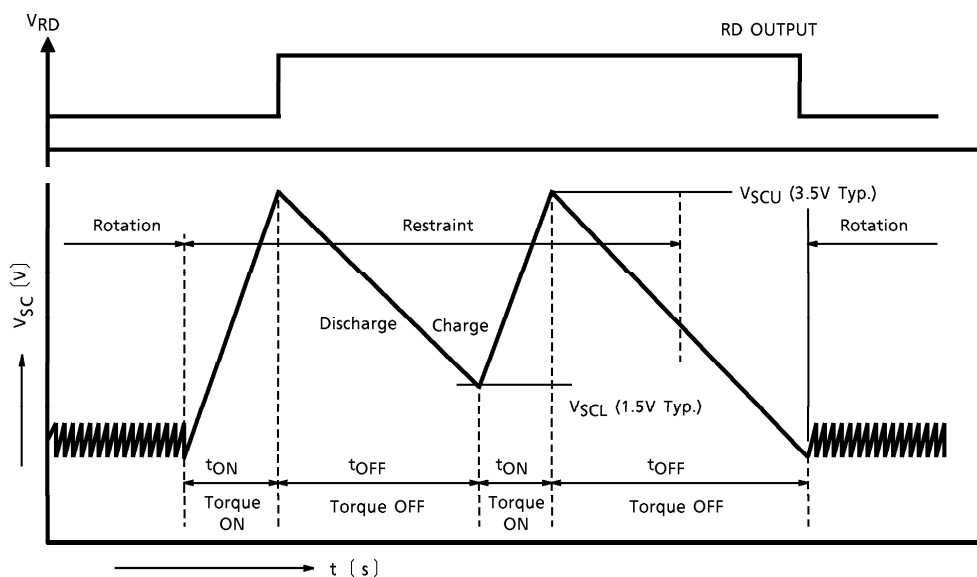The TA8473F is an IC that has cleared the above problems by the burning preventive automatic return circuit.

Fig.2

This operation is shown in Fig.2.

The capacitor C_{SC} connected to the C_{SC} terminal is charged by the charging current I_{SL} and its potential rises as shown below :

$$V = \frac{1}{C_{SC}} \int I_{SL}\, dt$$

When the motor is rotating, it is charged and discharged repeatedly by trigger pulse but if the motor rotation is physically restrained, C_{SC} discharge by trigger pulse is stopped and the potential further increases. During this period, current flows continuously to the motor. If V_{SC} (OSC potential) reaches V_{SCU}, discharge starts slowly and at the same time, the output is turned OFF to cur off current flowing to the motor. When the V_{SC} potential reaches V_{SCL}, the output is turned ON to allow current flow to the motor and torque is generated.

As long as the motor rotation is kept restrained, this operation is repeated and the output is turned ON / OFF at a ratio of nearly 1 : 5.

By this operation, the motor is heated and cooled and its temperature rise can be suppressed to a certain level. If the motor is released from the above restraint, the motor is started to run again by the generated torque and is continuously rotated by the generated trigger pulse.

FUNCTION

MODE	INPUT		OUTPUT	
	H + (⑮)	H − (⑭)	OUT1 (③)	OUT2 (⑥)
MODE 1	H	L	ON	OFF
MODE 2	L	H	OFF	ON

MAXIMUM RATINGS (Ta = 25°C)

| CHARACTERISTIC		SYMBOL	RATING	UNIT
Output Terminal Breakdown Voltage		V_{CER}	30	V
Operating Supply Voltage		$V_{CC (opr.)}$	13.8	V
Output Current	AVE.	$I_{O (AVE.)}$	0.4	A
	PEAK	$I_{O (PEAK)}$	1.2 (Note 1)	
RD Output Current		I_{RD}	10	mA
FG Output Current		I_{FG}	10	mA
Hall Input Voltage		V_{HM}	300 (Note 2)	mV
Power Dissipation		P_D	800 (Note 3)	mW
Operating Temperature		T_{opr}	– 30~85	°C
Storage Temperature		T_{stg}	– 55~150	°C

(Note 1) t = 0.1s

(Note 2) T_j = – 25~150°C

(Note 3) This value is obtained by 50 × 50 × 1.6mm PCB mounting occupied in excess of 40% of copper area.

ELECRICAL CHARACTERISTICS (Ta = 25°C, V_{CC} = 12V)

CHARACTERISTIC		SYMBOL	TEST CIR- CUIT	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Supply Current		I_{CC}	—	V_{CC} = 12V, OUT1 "ON"	—	7.0	12.0	mA
Output Saturation Voltage		V_{sat1}	—	I_O = 0.2A, T_j = 25°C	—	0.9	1.1	V
		V_{sat2}	—	I_O = 1.0A, T_j = 25°C	—	1.3	1.8	
Automatic Self Rotation Recovery Circuit	Discharge Current	I_{SL}	—	—	0.2	0.5	1.0	μA
	Charge Current	I_{SU}	—	—	1.4	2.0	3.0	μA
	Discharge Voltage	V_{SL}	—	—	—	1.5	—	V
	Charge Voltage	V_{SU}	—	—	—	4	—	V
	Time Constant	T_{SC}	—	C = 0.22μF, ON time	—	0.25	—	s
	Duty	DR	—	—	3	5	8	
Hall Amp.	Hall Input Voltage	V_{HM}	—	—	± 10	± 50	± 300	mV
	Hysterisis	ΔV_H	—	—	—	8	—	mV
	Offset Voltage	V_{HO}	—	—	—	0	—	mV
	Operating DC Potential	CMR	—	—	0	—	V_{CC}-2	V
	Input Bias Current	I_{IN}	—	—	—	1	3.0	μA
RD Output Saturation Voltage		$V_{sat (RD)}$	—	I_{RD} = 5mA	—	0.2	0.4	V
FG Output Saturation Voltage		$V_{sat (FG)}$	—	I_{FG} = 5mA	—	0.2	0.4	V
Variable Speed	Terminal Voltage	V_{TH}	—	R_{TH} = 10kΩ	0.7	1	1.5	V
	Full Speed	$R_{TH (FS)}$	—	R_{ref} = 10kΩ	—	6	—	kΩ
	Half Speed	$R_{TH (HS)}$	—	R_{ref} = 10kΩ	—	10	—	kΩ
Termal Shutdown Operating Temperature		T_{SD}	—	—	150	—	—	°C

APPLICATION CIRCUIT

<External parts>
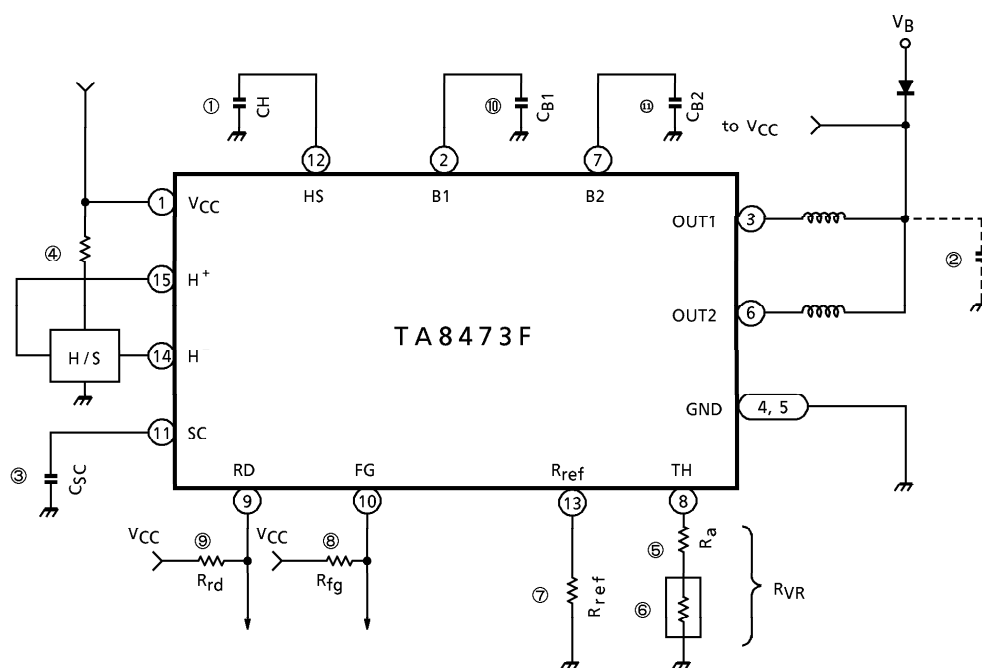
①   CH   The Half-speed is decided by CH and RH

②   T.B.D   Insert this if a noise comes in from the Power Supply.

③ C_{SC} 0.22μF   Capacitor for burning protection circuit.

④   2kΩ Hall sensor bias resistor.

⑤   Ra   T.B.D   Resistor for adjusting temperature at which the motor speed changes.

⑥   Thermistor

⑦ R_{ref} (10kΩ)   Reference resistor

⑧ R_{fg} 10kΩ Pull-up resistor

⑨ R_{rd} 10kΩ Pull-up resistor

⑩ C_{B1} (0.01μF)   Capacitor for noise reduction

⑪ C_{B2} (0.01μF)   Capacitor for noise reduction

(Note)   Utmost care is necessary in the design of the output line, V_{CC} and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

OUTLINE DRAWING
SSOP16-P-225-1.00A   Unit : mm

Weight : 0.14g (Typ.)