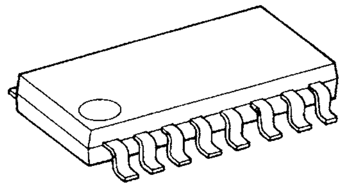
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

TA8473F/FG,TA8473FN/FNG

FAN MOTOR DRIVER IC

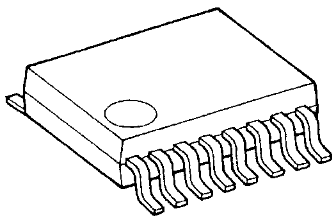
The TA8473F/FG and TA8473FN/FNG are fan motor driver ICs. The output current is 0.4 A (AVE.) and all functions needed for fan motor driving have been incorporated into 1 chip.
These are provided with the function to automatically change the motor speed by detecting ambient temperature through the externally mounted thermistor.
Furthermore, the TA8473F/FG and TA8473FN/FNG are 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.

TA8473F/FG



SSOP16-P-225-1.00A

TA8473FN/FNG



SSOP16-P-225-0.65B

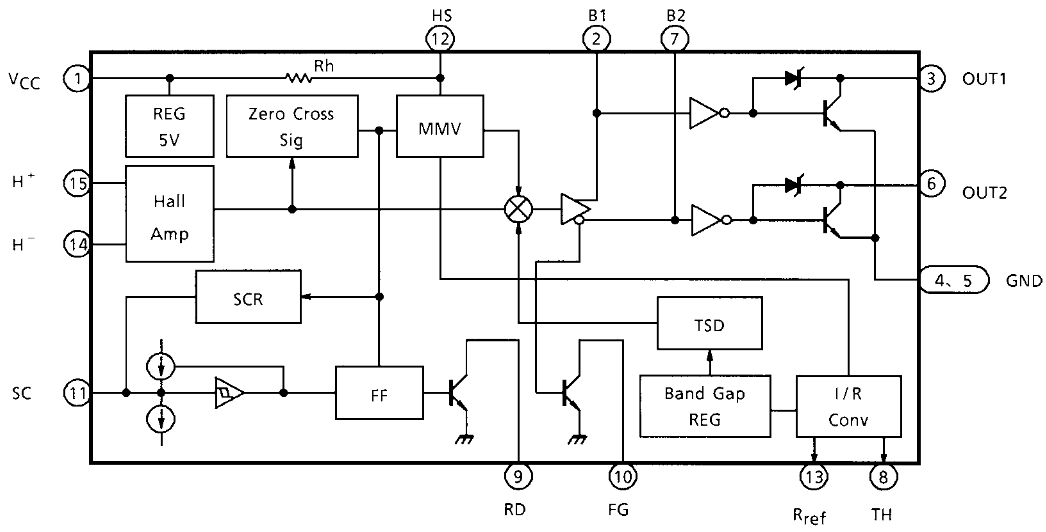
Weight:
SSOP16-P-225-1.00A: 0.14g (Typ.)
SSOP16-P-225-0.65B: 0.07g (Typ.)

FEATURES

- Built−in automatic self rotation recovery circuit after release of motor locking.
- Thermal shutdown circuit incorporated.
- Operating voltage : 6~13.8 V
- 2 kind of speed of full−speed and half−speed are variable according to ambient temperature.
- Speed change point temperature is externally settable.

TA8473FG/FNG:
The TA8473FG/FNG is a Pb-free product.
The following conditions apply to solderability:
*Solderability
1. Use of Sn-37Pb solder bath
   *solder bath temperature = 230°C
   *dipping time = 5 seconds
   *number of times = once
   *use of R-type flux
2. Use of Sn-3.0Ag-0.5Cu solder bath
   *solder bath temperature = 245°C
   *dipping time = 5 seconds
   *the number of times = once
   *use of R-type flux

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/FG and TA8473FN/FNG set 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.

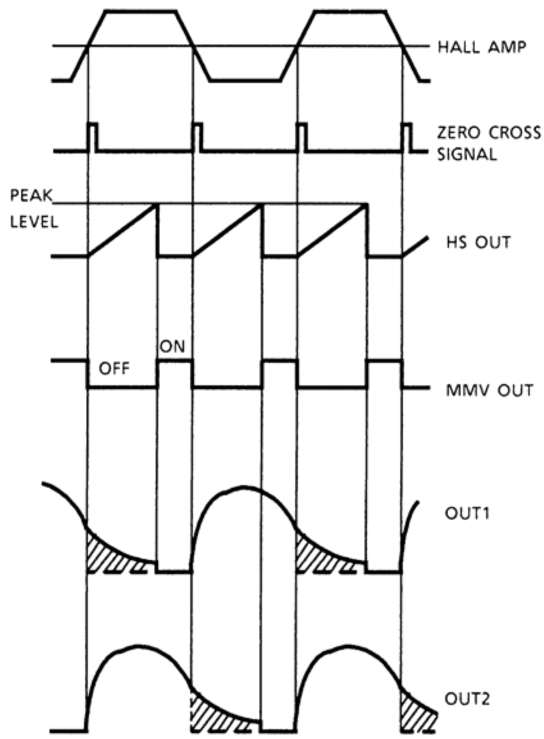


Fig. 1

(1) Determining Ch

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

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

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

(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/FG and TA8473FN/FNG compare 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/FG and TA8473FN/FNG internally apply a reference current of 100 μA to the R_{ref} terminal and generate at the TH terminal a reference voltage of 1 V at R_{ref} = 10 kΩ. 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 :

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

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 1 V and 5 V.
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 $R_{VR} \leq R_{ref}$, reaching the motor's full speed when R_{VR} is about $0.85 \times R_{ref}$.

<Example 1>

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

<Example 2>

When resistors are connected in series to the thermistor and RVR composite resistance is obtained, the resistance change ratio drops :

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

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/FG and TA8473FN/FNG are 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 Vsat (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/FG and TA8473FN/FNG are ICs that have cleared the above problems by the burning preventive automatic return circuit.

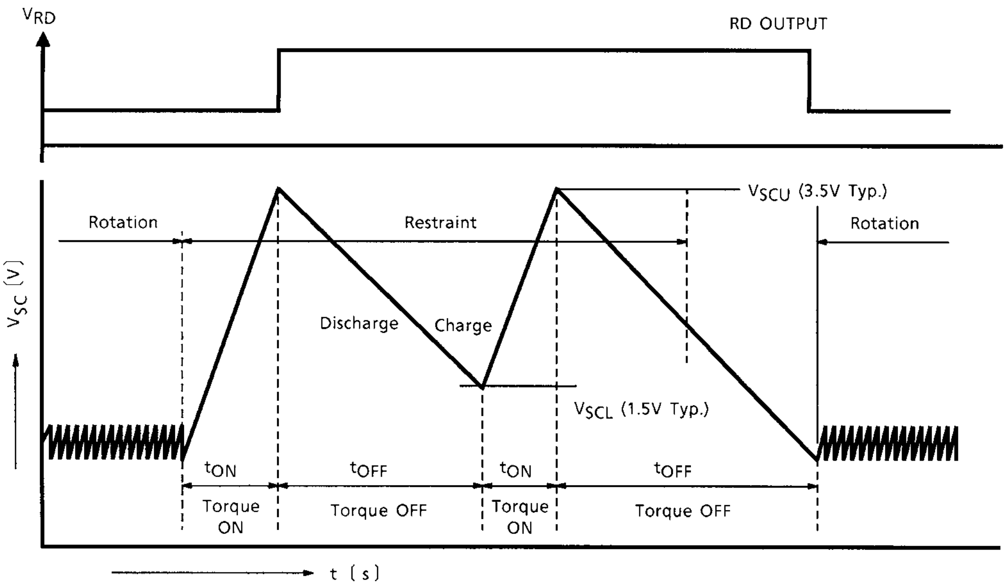


Fig. 2

This operation is shown in Fig.2.
The capacitor CSC connected to the CSC terminal is charged by the charging current ISL 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, CSC discharge by trigger pulse is stopped and the potential further increases. During this period, current flows continuously to the motor. If VSC (OSC potential) reaches VSCU, discharge starts slowly and at the same time, the output is turned OFF to cur off current flowing to the motor. When the VSC potential reaches VSCL, 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

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

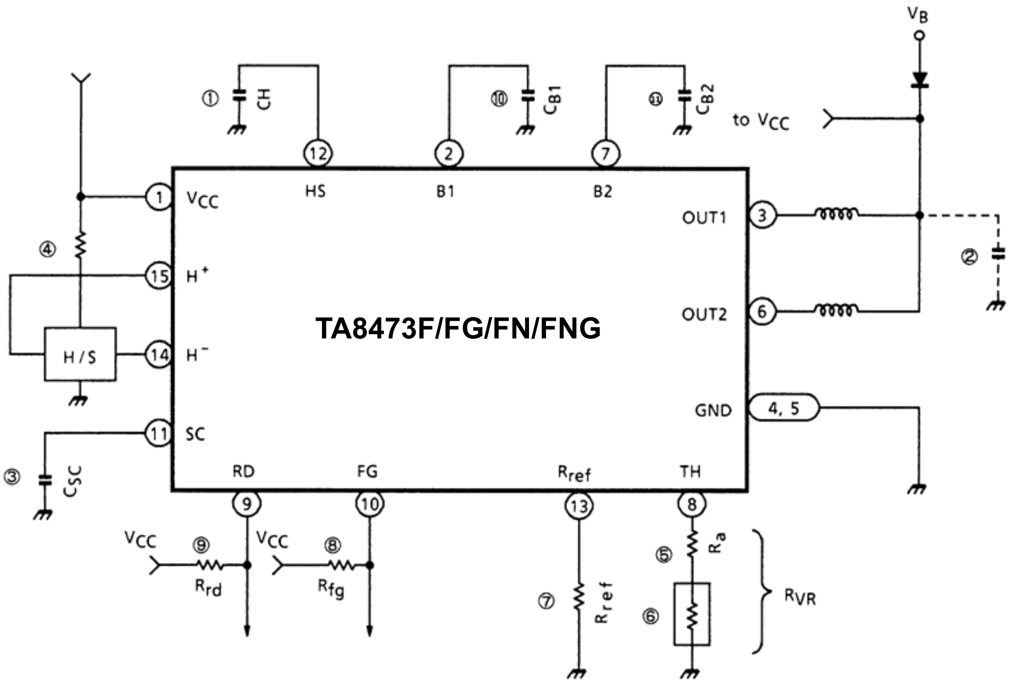
CHARACTERISTIC		SYMBOL	RATING		UNIT
Output Terminal Breakdown Voltage		V_{CER}	30		V
Operating Supply Voltage		$V_{CC\ (opr.)}$	13.8		V
Output Current	AVE.	$I_{O\ (AVE.)}$	0.4		A
	PEAK	$I_{O\ (PEAK)}$	1.2 (Note 1)		
RD Output Current		I_{RD}	10		mA
FG Output Current		I_{FG}	10		mA
Hall Input Voltage		V_{HM}	300 (Note 2)		mV
Power Dissipation		P_D	F/FG	800 (Note 3)	mW
			FN/FNG	735 (Note 3)	
Operating Temperature		T_{opr}	−30~85		°C
Storage Temperature		T_{stg}	−55~150		°C

Note 1: t = 0.1 s
Note 2: T_j = −25~150°C
Note 3: This value is obtained by 50 × 50 × 1.6 mm PCB mounting occupied in excess of 40% of copper area.

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

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Supply Current		I_{CC}	—	V_{CC} = 12 V, OUT1 "ON"	—	7.0	12.0	mA
Output Saturation Voltage		V_{sat1}	—	I_O = 0.2 A, T_j = 25°C	—	0.9	1.1	V
		V_{sat2}	—	I_O = 1.0 A, 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 = 0.22 μF, 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
	Opereating 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} = 5 mA	—	0.2	0.4	V
FG Output Saturation Voltage		$V_{sat\ (FG)}$	—	I_{FG} = 5 mA	—	0.2	0.4	V
Variable Speed	Terminal Voltage	V_{TH}	—	R_{TH} = 10 kΩ	0.7	1	1.5	V
	Full Speed	$R_{TH\ (FS)}$	—	R_{ref} = 10 kΩ	—	6	—	kΩ
	Half Speed	$R_{TH\ (HS)}$	—	R_{ref} = 10 kΩ	—	10	—	kΩ
Termal Shutdown Operating Temperature		T_{SD}	—	—	150	—	—	°C

APPLICATION CIRCUIT

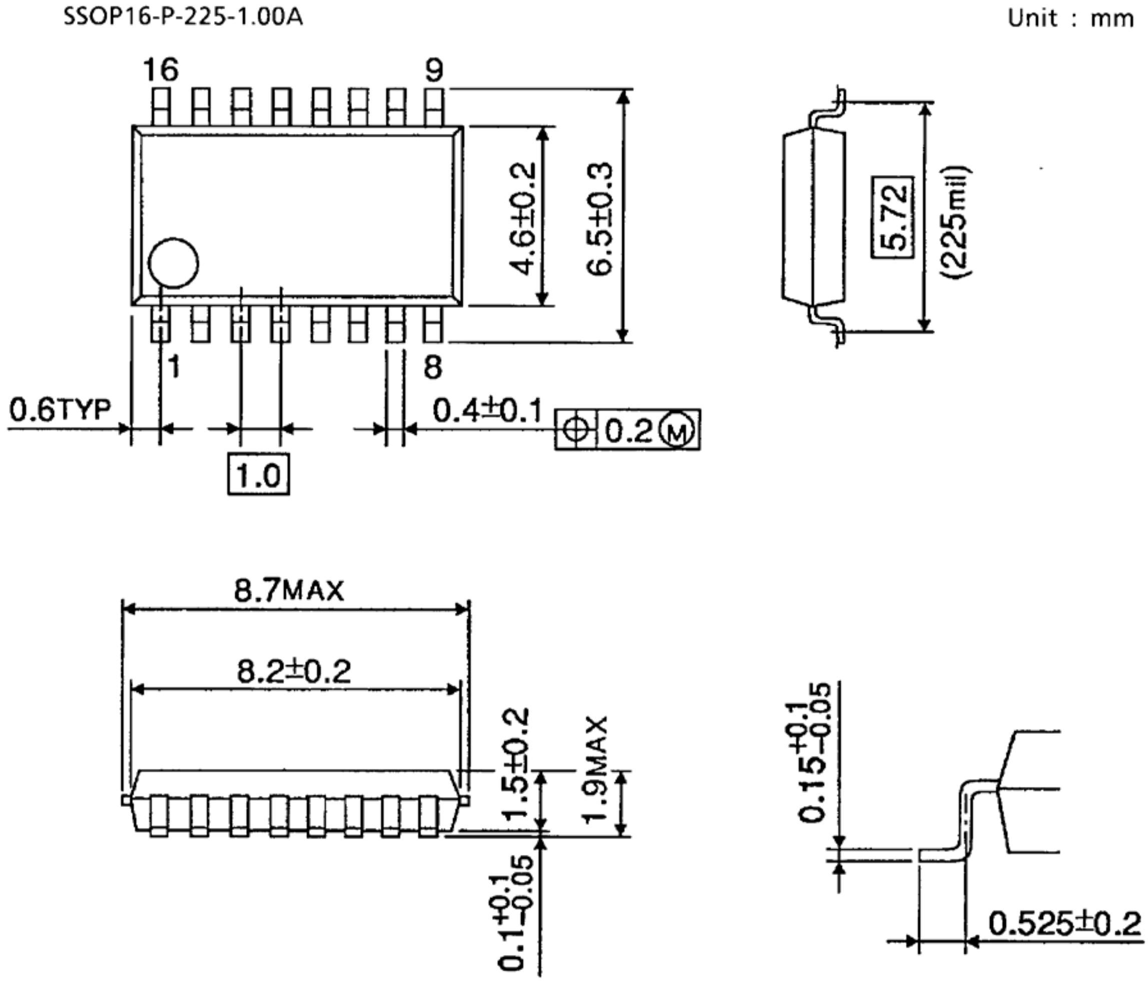


<External parts>

(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}	0.22 μF	Capacitor for burning protection circuit.
(4)		2 kΩ	Hall sensor bias resistor.
(5)	Ra	T.B.D	Resistor for adjusting temperature at which the motor speed changes.
(6)			Thermistor
(7)	R_{ref}	(10 kΩ)	Reference resistor
(8)	R_{fg}	10 kΩ	Pull−up resistor
(9)	R_{rd}	10 kΩ	Pull−up resistor
(10)	C_{B1}	(0.01 μF)	Capacitor for noise reduction
(11)	C_{B2}	(0.01 μF)	Capacitor for noise reduction

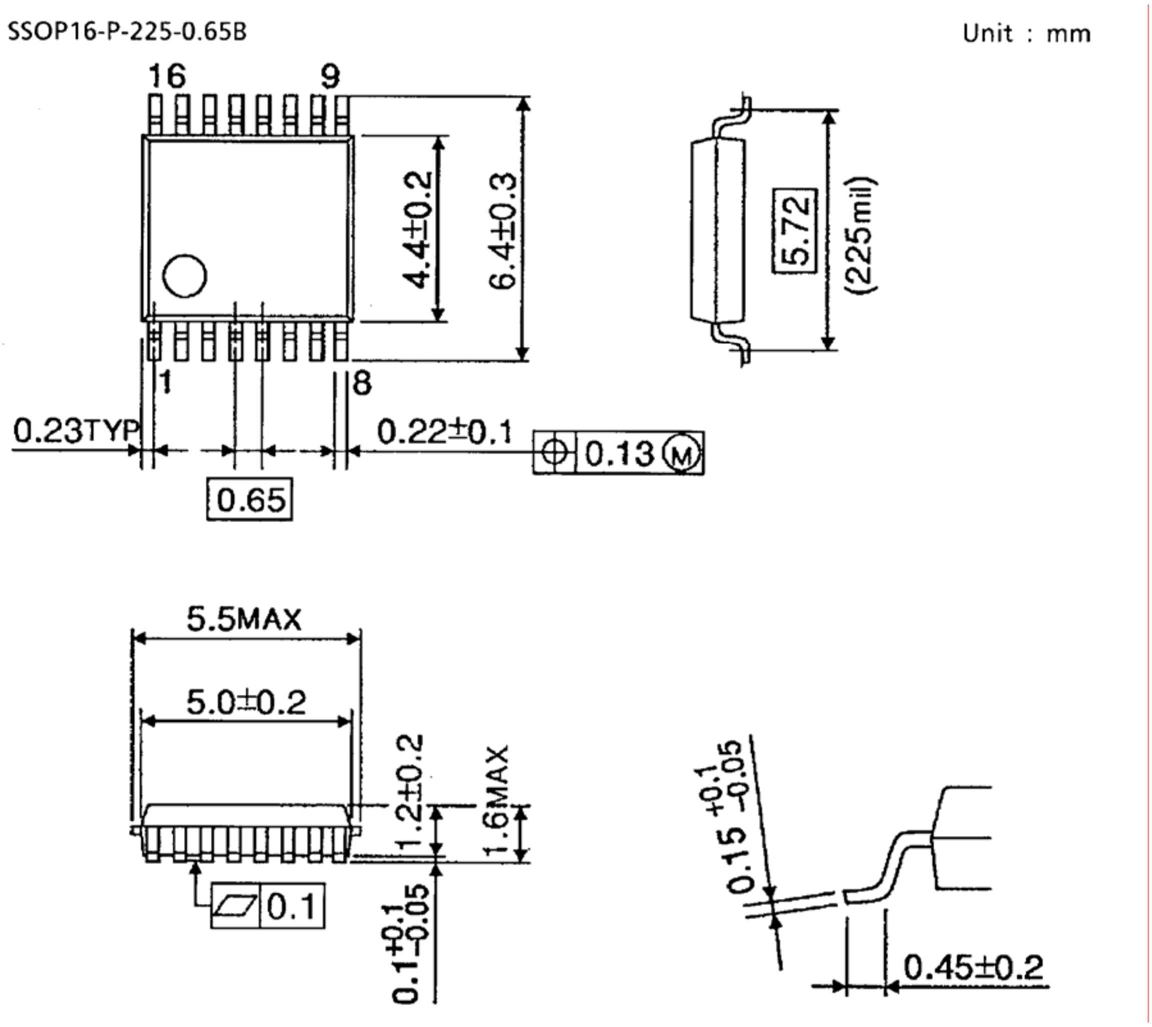
Note: Utmost care is necessary in the design of the output, V_{CC}, V_M, and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.

PACKAGE DIMENSIONS



Weight : 0.14 g (Typ.)

PACKAGE DIMENSIONS



Weight : 0.07 g (Typ.)

Notes on Contents

1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

3. Timing Charts

Timing charts may be simplified for explanatory purposes.

4. Application Circuits

The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.

Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

IC Usage Considerations

Notes on handling of ICs

[1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.
Exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.

[2] Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

[3] If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

[4] Do not insert devices in the wrong orientation or incorrectly.
Make sure that the positive and negative terminals of power supplies are connected properly.
Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause the device breakdown, damage or deterioration, and may result injury by explosion or combustion.
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

Points to remember on handling of ICs

(1) Thermal Shutdown Circuit

Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

(2) Heat Radiation Design

In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (T_J) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

(3) Back-EMF

When a motor rotates in the reverse direction, stops or slows down abruptly, a current flow back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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