

Power Management IC Series for Automotive Body Control

Motor Driver



BD6941FM

No.09039EAT02

●Description

BD6941FM is the reversible motor driver for output 1.25A (1Motor), and can control a DC motor in four modes (Forward, Reverse, Standby, Brake) corresponding to two control logic inputs.

●Features

- 1) 1 ch DMOS H bridge output
- 2) Four output states (Forward,Reverse,Standby,Brake) by two control logic
- 3) Built-in surge-absorbing diodes
- 4) Low standby current
- 5) Output overcurrent protection with timer.
- 6) Over voltage detection switch off
- 7) TSD detects junction temperature and circuitry switches off the outputs at high temperature.
- 8) Built-in protection monitor pin (PO)

●Applications

Onboard devices(Vehicle equipment etc)

●Absolute Maximum Ratings (Ta=25°C)

| PARAMETER | SYMBOL | LIMIT | UNIT |
|-----------------------|-------------------------------------|------------|------|
| SUPPLY VOLTAGE | Vcc | 50 | V |
| INPUT VOLTAGE | V _{INP} , V _{INN} | -0.3~20 | V |
| OUTPUT CURRENT | I _O | 1.25 (* 1) | A |
| POWER DISSIPATION | Pd | 2.8 (* 2) | W |
| OPERATING TEMPERATURE | Topr | -40~105 | °C |
| STORAGE TEMPERATURE | Tstg | -55~150 | °C |
| JUNCTION TEMPERATURE | Tjmax | 150 | °C |

*1 Not to exceed Pd and ASO.

*2 Mounted on a glass epoxy PCB (70mm × 70mm × 1.6mm).

To use at temperature above Ta=25°C reduce 22.4mW/°C.

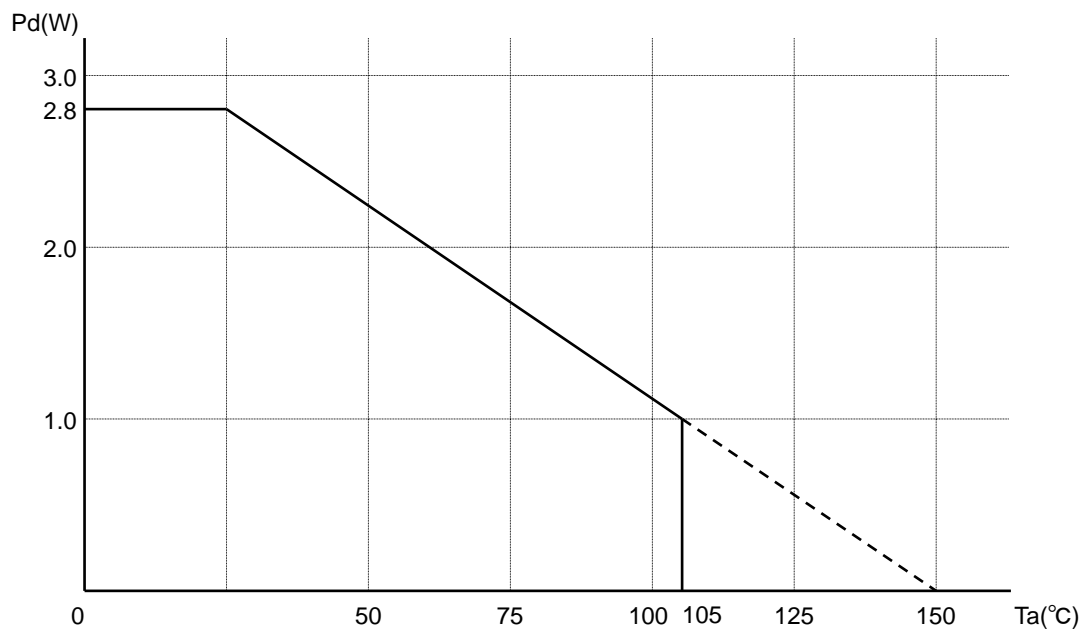
●Operating Range

| PARAMETER | SYMBOL | LIMIT | UNIT |
|----------------|--------|----------|------|
| SUPPLY VOLTAGE | Vcc | 8.0~16.0 | V |

●Electrical Characteristics (Unless otherwise specified, $V_{CC}=8V\sim 16V$, $T_a=-40^{\circ}C\sim 105^{\circ}C$)

| PARAMETER | SYMBOL | LIMIT | | | UNIT | CONDITIONS |
|--|-----------|-------|------|-----|---------|--|
| | | MIN. | TYP. | MAX | | |
| Circuit current 1 | I_{CC1} | - | 0 | 10 | μA | Standby mode |
| Circuit current 2 | I_{CC2} | - | 3 | 8 | mA | Forward or reverse mode |
| Circuit current 3 | I_{CC3} | - | 3 | 8 | mA | Brake mode |
| Input Voltage "H" level | V_{IH} | 3.0 | - | - | V | |
| Input Voltage "L" level | V_{IL} | - | - | 1.0 | V | |
| "H" level input current | I_{IH} | - | 50 | 100 | μA | $V_{IN}=5.0V$, flowing in current |
| "L" level input current | I_{IL} | - | 0 | 10 | μA | $V_{IN}=0V$, flowing out current |
| Output on voltage 1 | V_{ON1} | - | 0.84 | 1.5 | V | $V_{CC}=12V$, $I_{out}=0.5A$, total drop |
| Output on voltage 2 | V_{ON2} | - | - | 1.7 | V | $V_{CC}=8\sim 16V$, $I_{out}=0.5A$, total drop |
| Output leakage current "H" | I_{LH} | - | 0 | 10 | μA | $V_{OUT}=0V$ |
| Output leakage current "L" | I_{LL} | - | 0 | 10 | μA | $V_{OUT}=V_{CC}$ |
| Upper free-wheeling diode forward voltage | V_{FH} | 0.3 | 1.0 | 1.5 | V | $I_F=0.6A$ |
| Lower free-wheeling diode forward voltage | V_{FL} | 0.3 | 1.0 | 1.5 | V | $I_F=0.6A$ |
| Protection monitor voltage | V_{LPO} | - | - | 0.6 | V | $I_{PO}=3mA$ |
| Protection monitor leakage current | I_{LPO} | - | 0 | 10 | μA | $V_{PO}=V_{CC}$ |
| Over current protection switch on current | I_{OCP} | 1.5 | - | 3.5 | A | |
| Over Voltage Lockout lockout switch on voltage | V_{OVP} | 25 | 30 | 35 | V | |

●Heat Reduction Curve



Mounted on a glass epoxy PCB (70mm × 70mm × 1.6mm)

To use at temperature above $T_a=25^{\circ}C$ reduce 22.4mW/°C.

●Reference Data

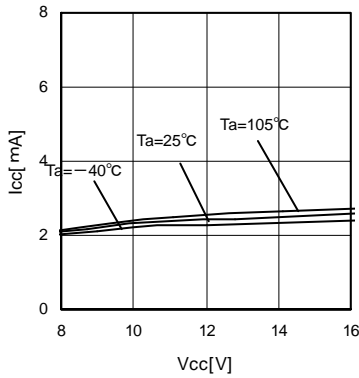


Fig.1 Circuit current
(Forward · Reverse · Brake)

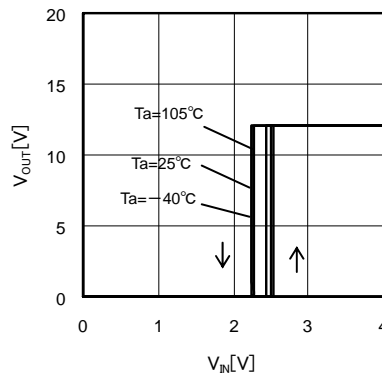


Fig.2 Input voltage vs. Output voltage

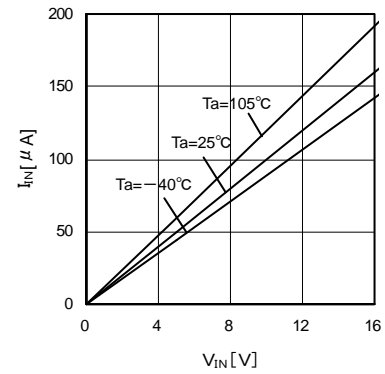


Fig.3 Input H current

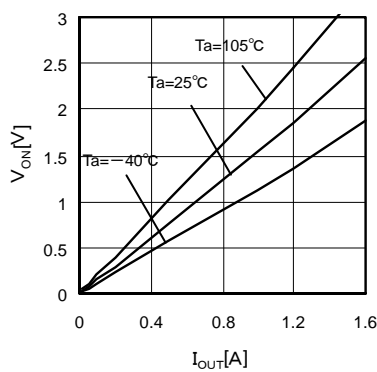


Fig.4 Output on voltage ($V_{cc}=12\text{V}$)

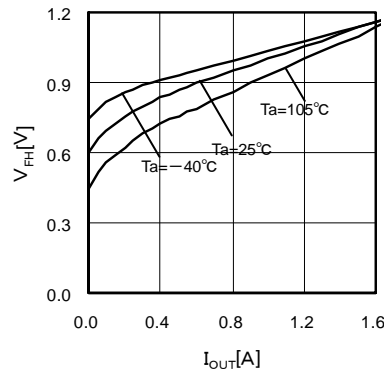


Fig.5 Upper free-wheeling
diode forward voltage H

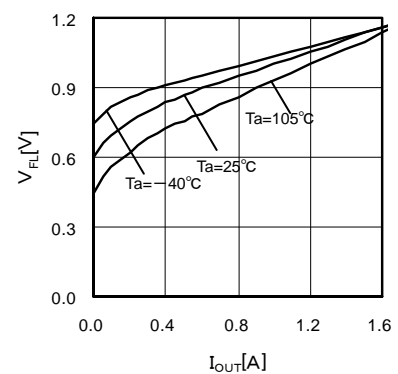


Fig.6 Upper free-wheeling
diode forward voltage L

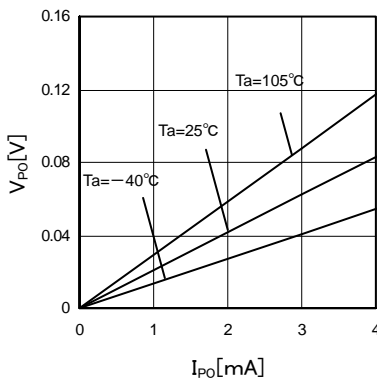


Fig.7 Protection monitor voltage

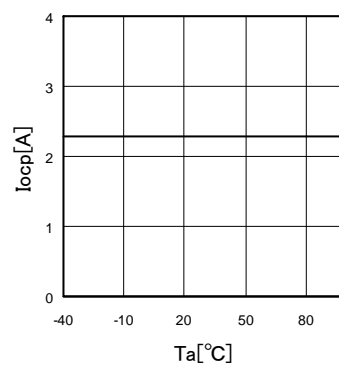


Fig.8 Over current protection
switch on current

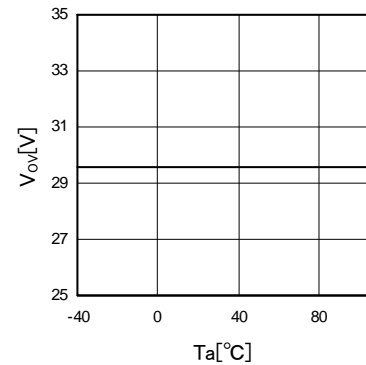


Fig.9 Over Voltage Lockout
lockout switch on voltage

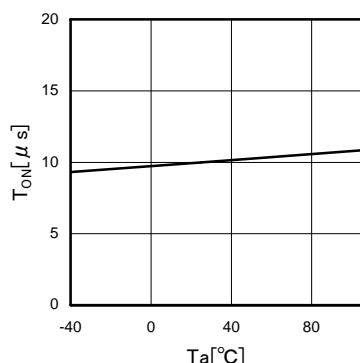


Fig.10 Over current protection
monitor on time

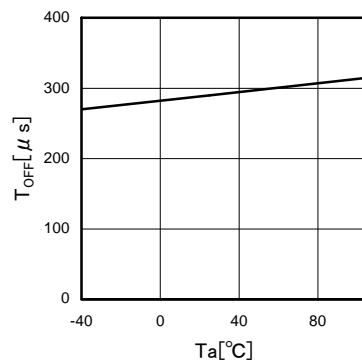


Fig.11 Over current protection
monitor off time

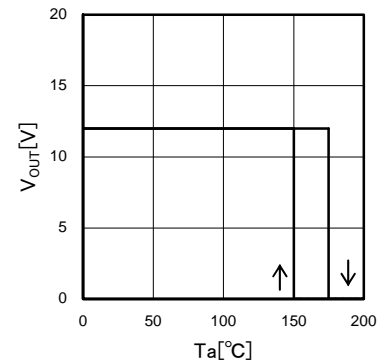
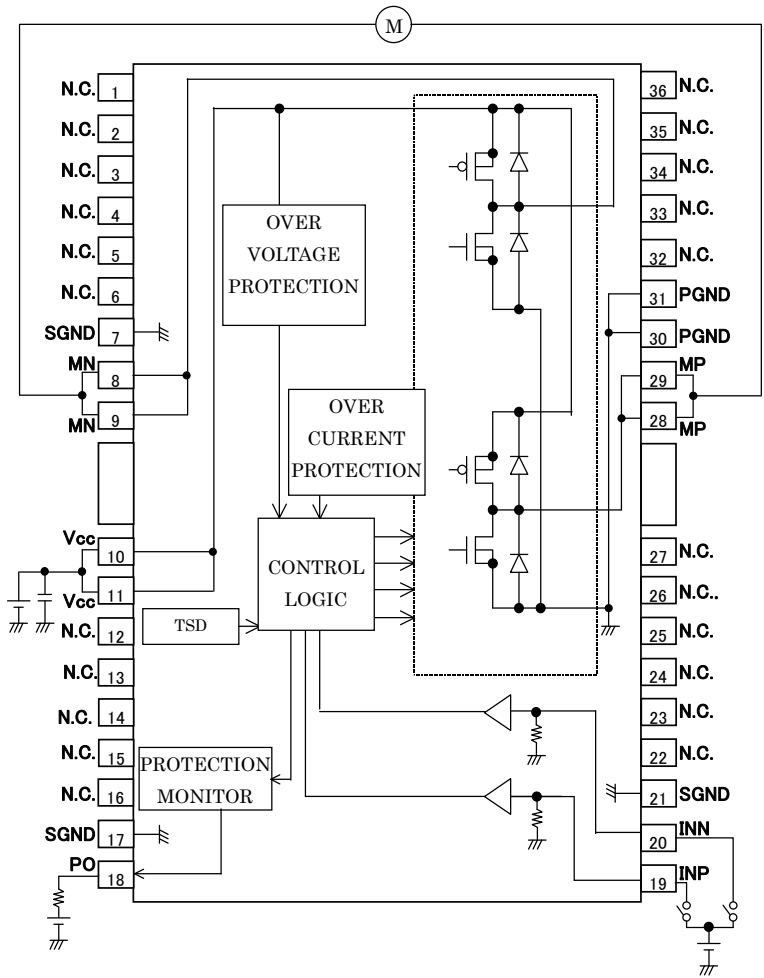


Fig.12 TSD temperature

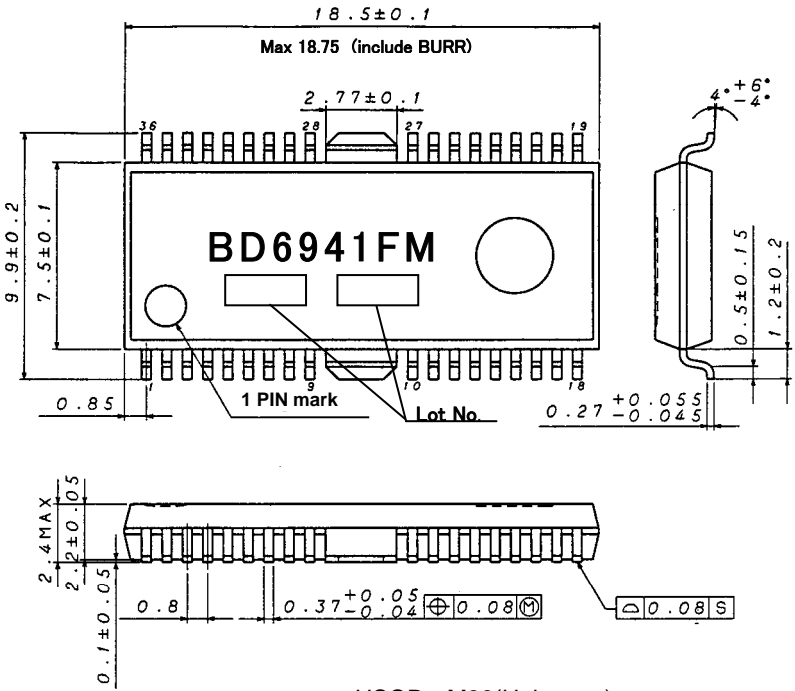
●Block Diagram



●Terminal Function Table

| PIN No. | Terminal Name | Function |
|---------|---------------|------------------------------------|
| 1-6 | N.C. | N.C. |
| 7 | SGND | Signal GND Pin |
| 8 | MN | Motor Output Pin |
| 9 | MN | Motor Output Pin |
| FIN | FIN | FIN |
| 10 | Vcc | Power Supply Pin |
| 11 | Vcc | Power Supply Pin |
| 12-16 | N.C. | N.C. |
| 17 | SGND | Signal GND Pin |
| 18 | PO | Protection Monitor Pin(Open drain) |
| 19 | INP | Logic Input Pin |
| 20 | INN | Logic Input Pin |
| 21 | SGND | Signal GND Pin |
| 22-27 | N.C. | N.C. |
| FIN | FIN | FIN |
| 28 | MP | Motor Output Pin |
| 29 | MP | Motor Output Pin |
| 30 | PGND | Power GND Pin |
| 31 | PGND | Power GND Pin |
| 32-36 | N.C. | N.C. |

●Package



HSOP—M36(Unit : mm)

●Signal Table

Input/Output Truth Table

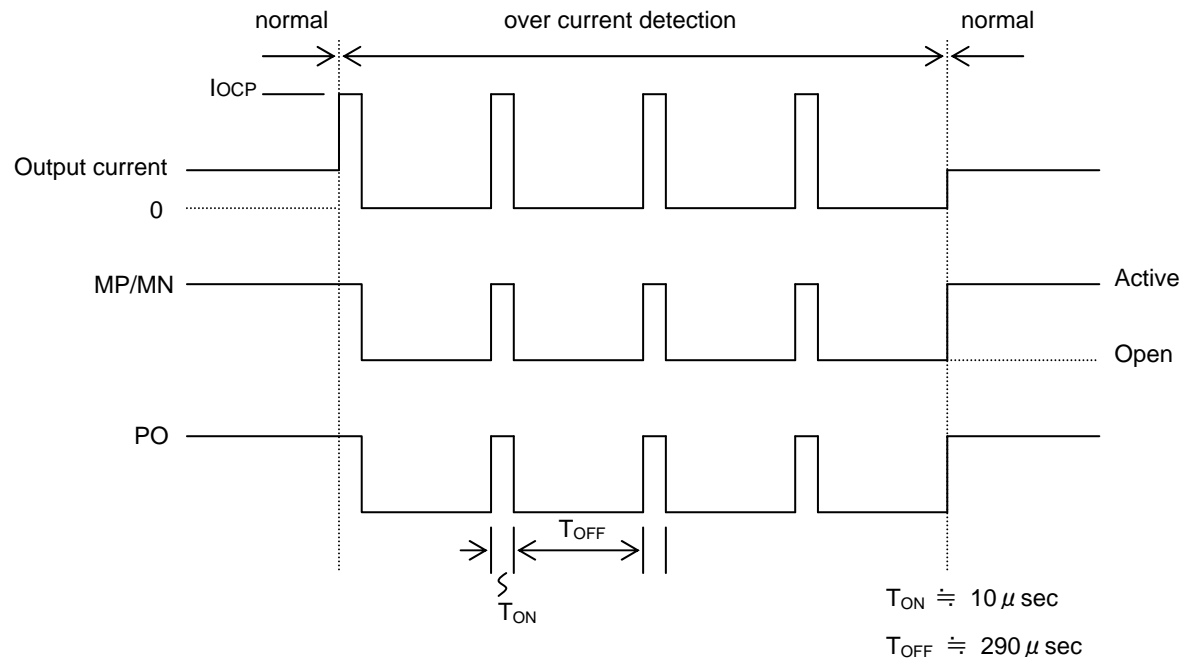
| IN | | OUT | | MODE |
|-----|-----|------|------|---------|
| INP | INN | MP | MN | |
| H | H | L | L | BRAKE |
| H | L | H | L | FORWARD |
| L | H | L | H | REVERSE |
| L | L | Open | Open | STANDBY |

Output Condition

| IN | | OUT | | PO |
|-----|-----|---------------------|--------|-------|
| INP | INN | MODE | LOAD | |
| H | H | BRAKE | NORMAL | H |
| | | | SHORT | L * 2 |
| H/L | L/H | FORWARD/ REVERSE | NORMAL | H |
| | | | SHORT | L * 2 |
| L | L | STANDBY | - | H |

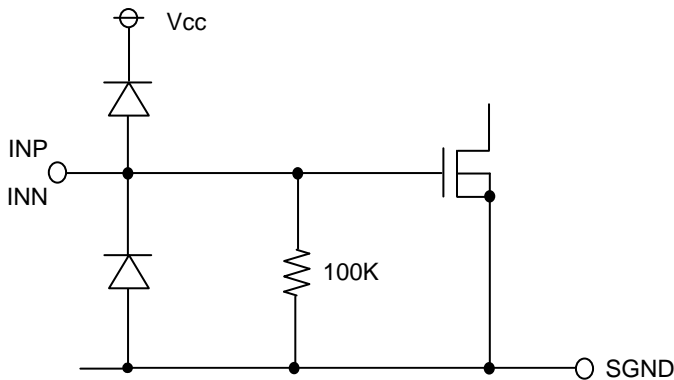
* 2 refer to timing chart

●PO Output Timing Chart

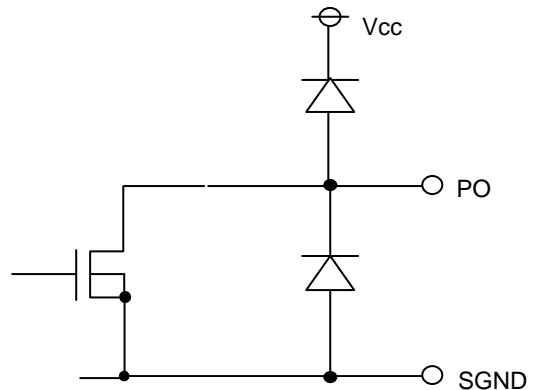


● I/O Circuit Diagram

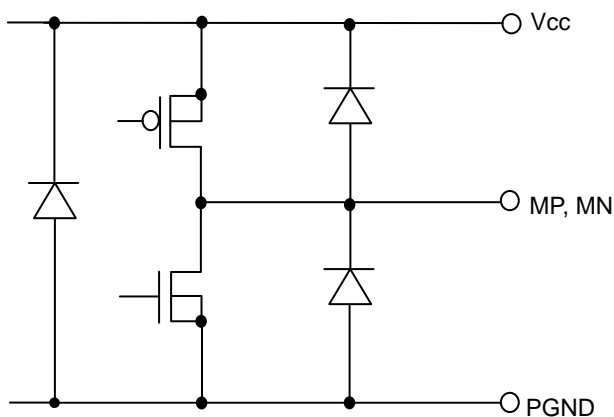
1) INP, INN



2) PO



3) MP, MN



● Operating Notes

1) Absolute maximum ratings

Use of the IC in excess of absolute maximum ratings such as the applied voltage or operating temperature range may result in IC damage. Assumptions should not be made regarding the state of the IC (short mode or open mode) when such damage is suffered. A physical safety measure such as a fuse should be implemented when use of the IC in a special mode where the absolute maximum ratings may be exceeded is anticipated.

2) GND potential

Ensure a minimum GND pin potential in all operating conditions.

3) Thermal design

Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

4) Pin short and mistake mounting

Use caution when orienting and positioning the IC for mounting on printed circuit boards. Improper mounting may result in damage to the IC. Shorts between output pins and the power supply and GND pins caused by the presence of a foreign object may result in damage to the IC. Ensure a minimum GND pin potential in all operating conditions.

5) Actions in strong magnetic field

Keep in mind that the IC may malfunction in strong magnetic fields.

6) Testing on application boards

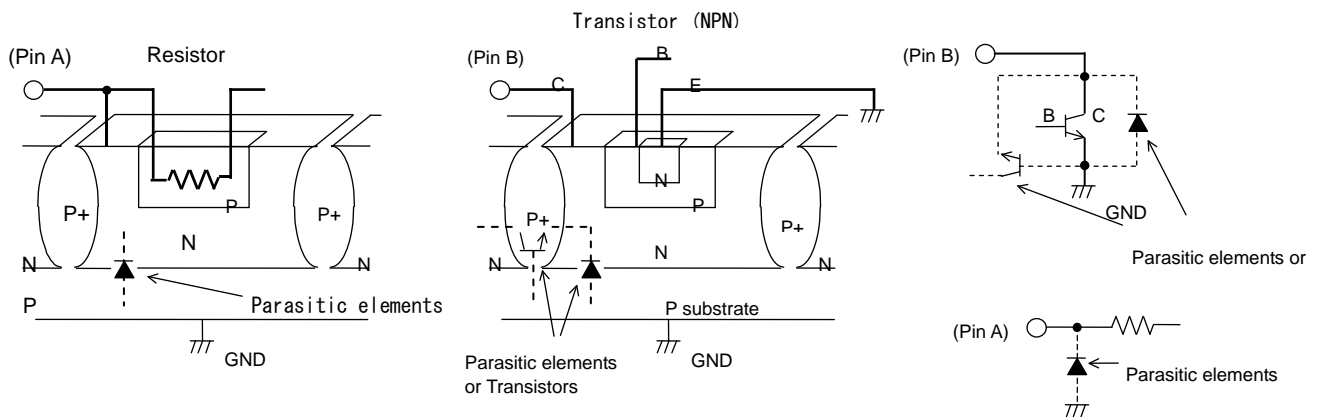
When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure, and use similar caution when transporting or storing the IC.

7) IC terminal input voltage

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P/N junctions are formed at the intersection of these P layers with the N layers of other elements to create a variety of parasitic elements. For example, when the resistors and transistors are connected to the pins as shown in the following figure,

- The P/N junction functions as a parasitic diode when $GND > \text{Pin A}$ for the resistor or $GND > \text{Pin B}$ for the transistor (NPN).
- Similarly, when $GND > \text{Pin B}$ for the transistor (NPN), the parasitic diode described above combines with the N layer of other adjacent elements to operate as a parasitic NPN transistor.

The formation of parasitic elements as a result of the relationships of the potentials of different pins is an inevitable result of the IC's architecture. The operation of parasitic elements can cause interference with circuit operation as well as IC malfunction and damage. For these reasons, it is necessary to use caution so that the IC is not used in a way that will trigger the operation of parasitic elements, such as by the application of voltages lower than the GND (P substrate) voltage to input pins.



8) Input terminals

Do not apply the voltage to input pin when the V_{CC} is not applied. And when the V_{CC} is applied, the voltage of input pin must not exceed V_{CC} . It is feared that output get malfunction, as input voltage is swept slowly near the H, L threshold voltage. Please pay attention to input slew rate.

9) Back electro motive force (BEMF)

There is a possibility that the BEMF is changed by use of the operating condition, environment and the individual characteristics of motor. Please make sure there is no problem of operating the IC although the BEMF is occurred.

10) The note of pattern design at printed circuit

This IC flows large current between power supply for motor division and GND. So, it is feared that get undesirable result malfunction, oscillation and so on, as input lines is affected by large output current. Please consider pattern design at printed circuit doesn't have common impedance on output large current lines-input lines. Please consider to keep low impedance of power supply for fear of oscillation from power supply high impedance, also.

11) Rash current

This IC doesn't have current limit circuit for rash current. Therefore physical security countermeasure, like current limit resistor is to be given.

12) Thermal shutdown circuit

This IC incorporates a built-in TSD circuit for the protection from thermal destruction. The IC should be used within the specified power dissipation range. However, in the event that the IC continues to be operated in excess of its power dissipation limits, the attendant rise in the junction temperature (T_j) will trigger the TSD circuit to turn off all output power elements. The circuit automatically resets once the junction temperature (T_j) drops. Operation of the TSD circuit presumes that the IC's absolute maximum ratings have been exceeded. Application designs should never make use of the TSD circuit.

13) Over voltage lock out function

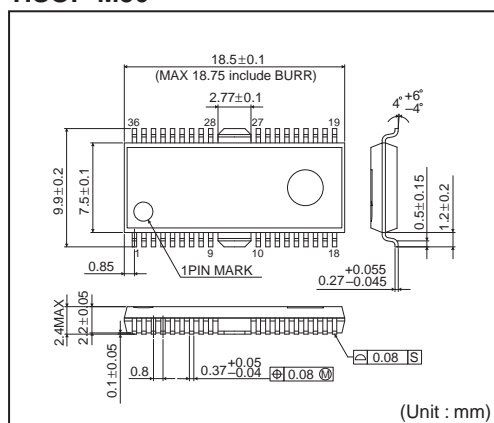
This IC has the function of turning off the output when detecting the over voltage. More than 30V(typ.) triggers this function. But in the standby mode, this function does not work. Although this IC has over voltage lockout function, the voltage that exceeds absolute maximum ratings might destroy the IC. Please do not exceed the absolute maximum ratings.

14) Over current protection

This IC has the function of turning off the output when detecting the over current. More than 2.25A(typ.) triggers this function. When detecting the over current for 10 μ sec(typ.), this function turns off the output(output terminals become Hi-impedance) for 290 μ sec(typ.). After the period of turning off time (290 μ sec) , the output current recovers. But if the over current is still detected, this function will work again.This function is for protecting IC because of the output short etc. but the continuing detection of over current might cause the extreme heat and damage the IC. It is recommended to change the IC's state to standby mode by the application. And please pay attention to the power dissipation.

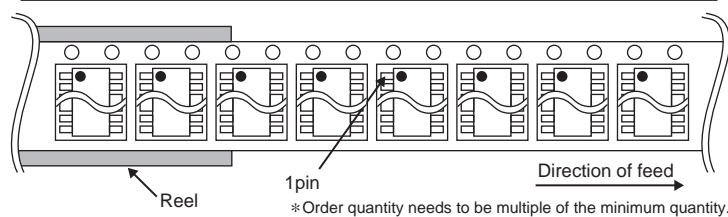
● Ordering part number

| | | | | | | | | | | |
|----------|---|----------|---|---|---|--------------------------|---|---|---|---|
| B | D | 6 | 9 | 4 | 1 | F | M | - | E | 2 |
| Part No. | | Part No. | | | | Package FM : HSOP-M36 | | | Packaging and forming specification E2: Embossed tape and reel | |

HSOP-M36

<Tape and Reel information>

| | |
|-------------------|---|
| Tape | Embossed carrier tape (with dry pack) |
| Quantity | 1500pcs |
| Direction of feed | E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand) |



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- Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment ^(Note 1), transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

| JAPAN | USA | EU | CHINA |
|-----------|-----------|------------|-----------|
| CLASS III | CLASS III | CLASS II b | CLASS III |
| CLASS IV | | CLASS III | |

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 - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
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 - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
 - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
 - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
 - Sealing or coating our Products with resin or other coating materials
 - Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
 - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
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Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
 - [a] the Products are exposed to sea winds or corrosive gases, including Cl₂, H₂S, NH₃, SO₂, and NO₂
 - [b] the temperature or humidity exceeds those recommended by ROHM
 - [c] the Products are exposed to direct sunshine or condensation
 - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

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