**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℃）

| 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 | ℃ |
| STORAGE TEMPERATURE | Tstg | -55～150 | ℃ |
| JUNCTION TEMPERATURE | Tjmax | 150 | ℃ |

*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℃ reduce 22.4mW/℃.

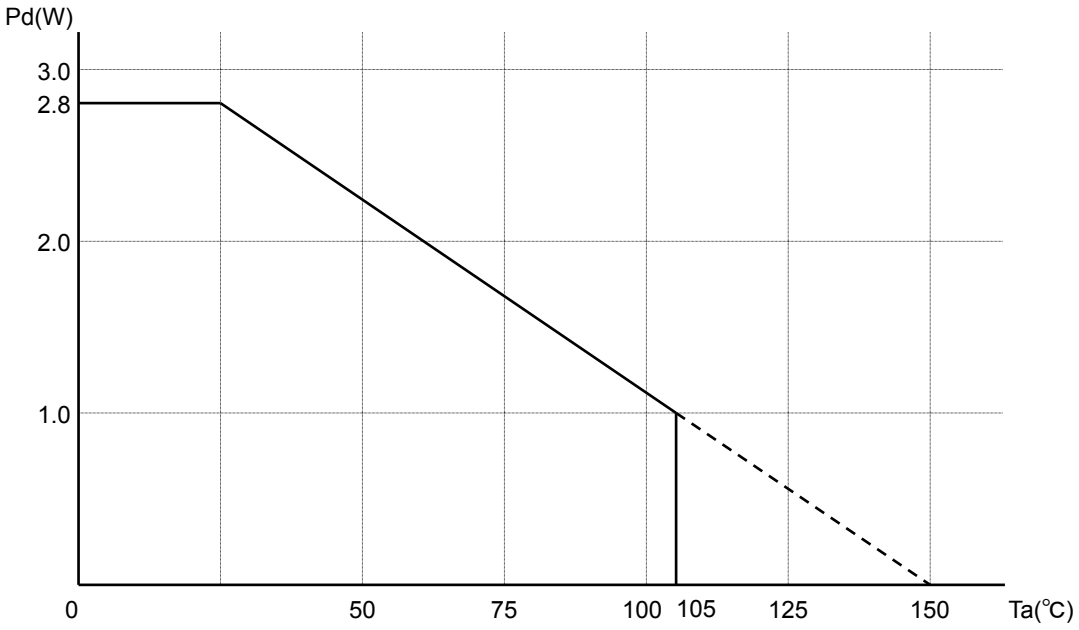
●Operating Range

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

●Electrical Characteristics（Unless otherwise specified, Vcc=8V～16V, Ta=-40℃～105℃）

| PARAMETER | SYMBOL | LIMIT | | | UNIT | CONDITIONS |
|---|---|---|---|---|---|---|
| | | MIN. | TYP. | MAX | | |
| Circuit current 1 | Icc1 | - | 0 | 10 | μA | Standby mode |
| Circuit current 2 | Icc2 | - | 3 | 8 | mA | Forward or reverse mode |
| Circuit current 3 | Icc3 | - | 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 | Vcc=12V, $I_{out}$ =0.5A, total drop |
| Output on voltage 2 | $V_{ON2}$ | - | - | 1.7 | V | Vcc=8～16V, $I_{out}$=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 | $V_{OUT}$=Vcc |
| 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 | $V_{PO}$=Vcc |
| 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 Ta=25℃ reduce 22.4mW/℃.

●Reference Data

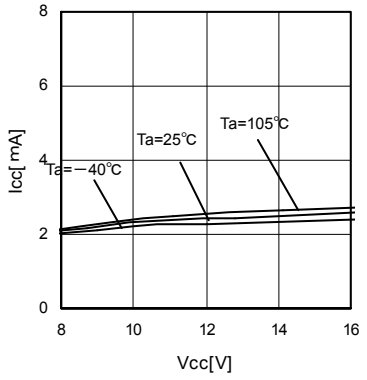



Fig.1 Circuit current
（Forward・Reverse・Brake）

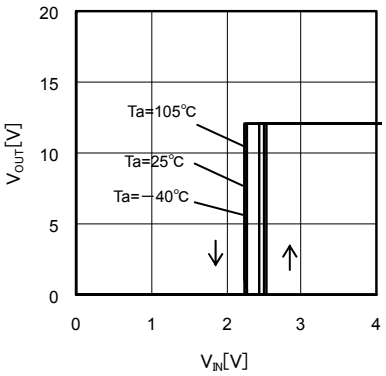



Fig.2 Input voltage vs. Output voltage

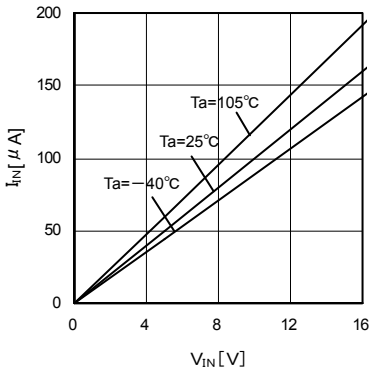



Fig.3 Input H current

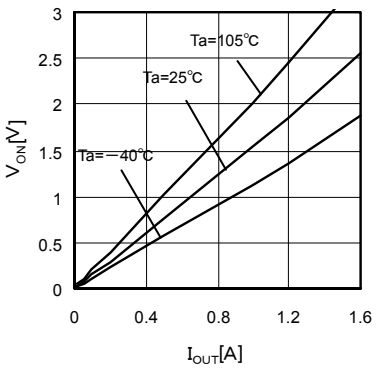



Fig.4 Output on voltage（Vcc=12V）

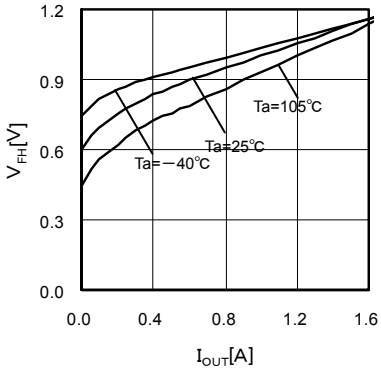



Fig.5 Upper free-wheeling diode forward voltage H

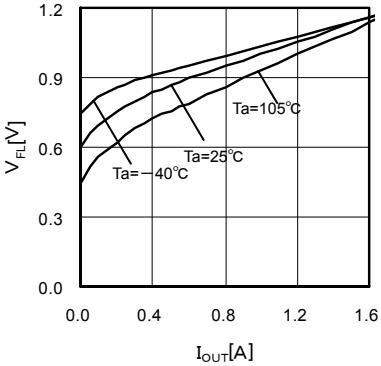



Fig.6 Upper free-wheeling diode forward voltage L

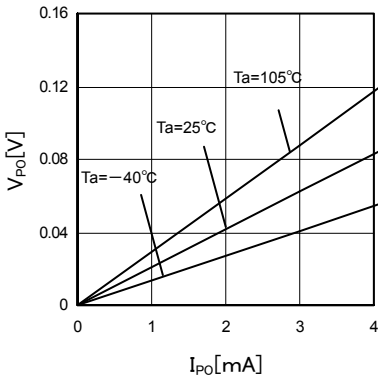



Fig.7 Protection monitor voltage

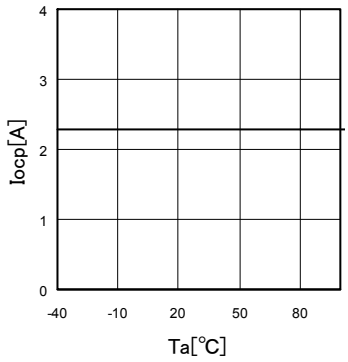



Fig.8 Over current protection switch on current

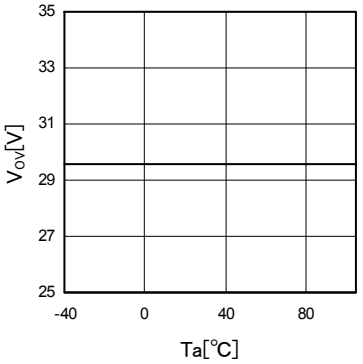



Fig.9 Over Voltage Lockout lockout switch on voltage

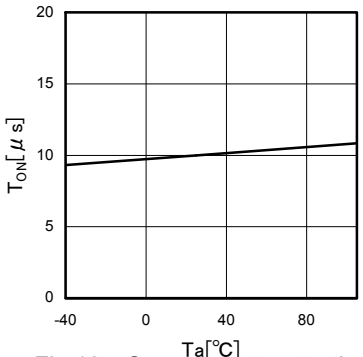



Fig.10 Over current protection monitor on time

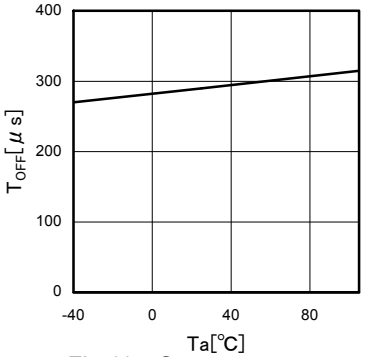



Fig.11 Over current protection monitor off time

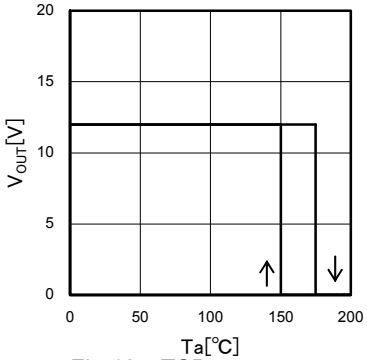
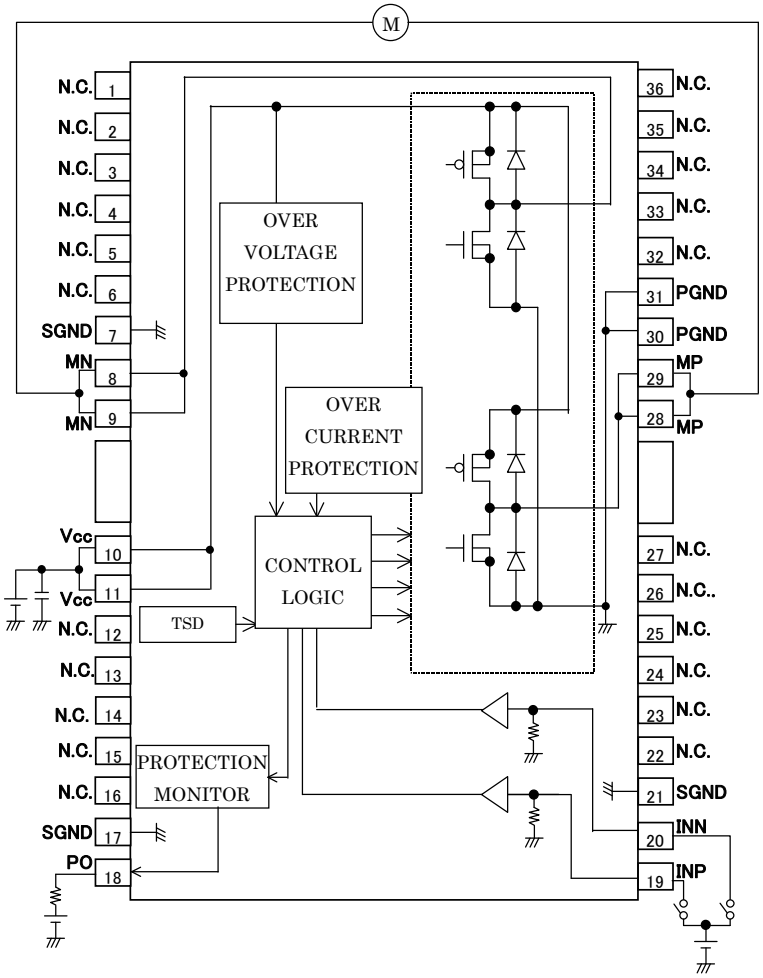



Fig.12 TSD temperature

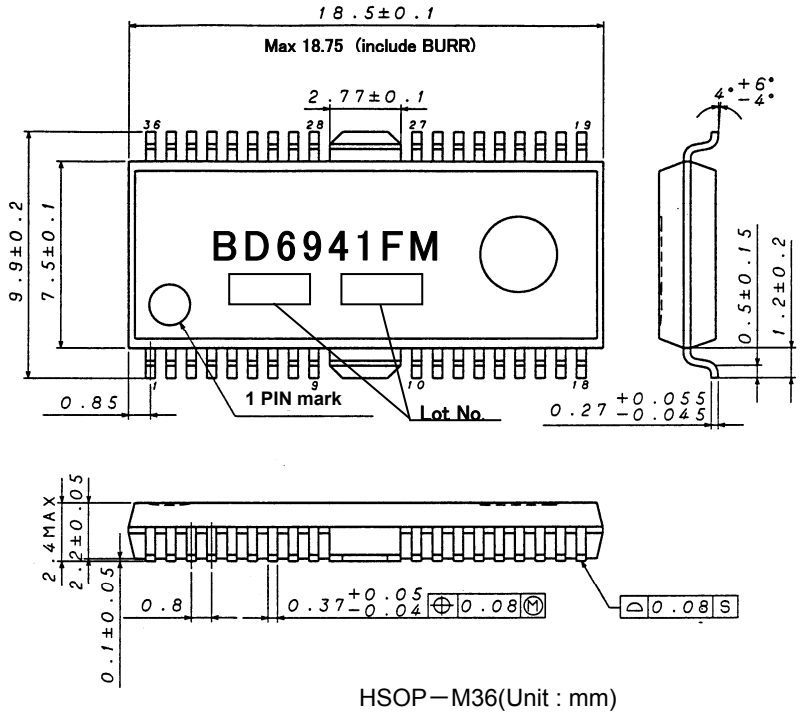
●Block Diagram




●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

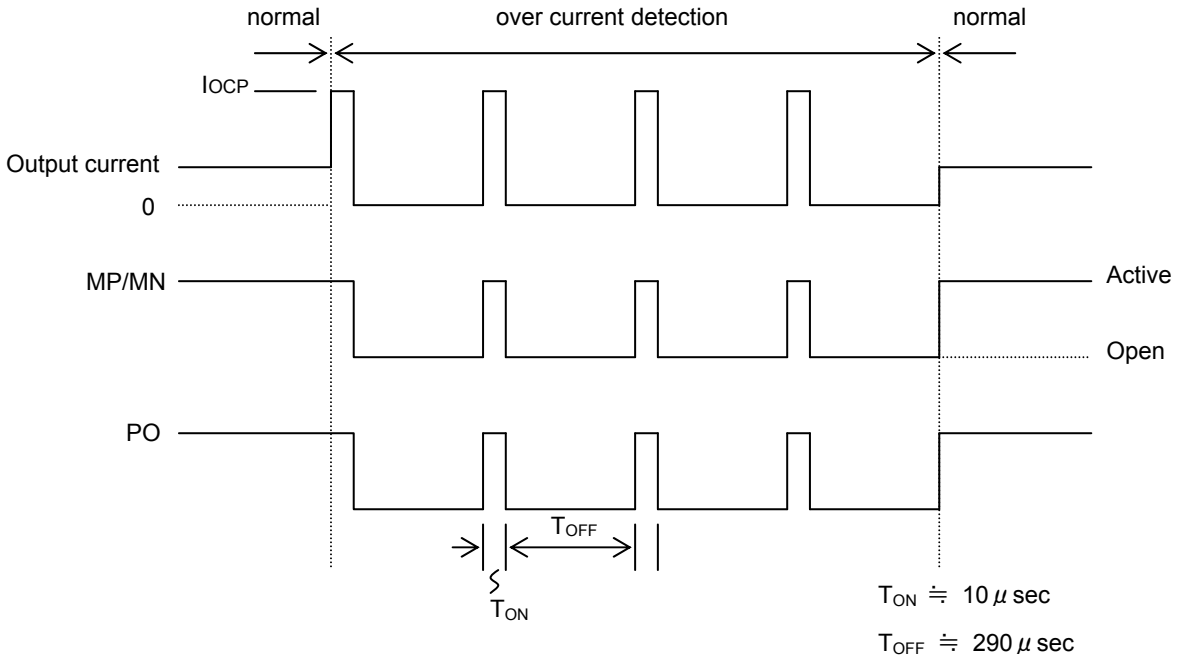
| IN | | OUT | | MODE |
|---|---|---|---|---|
| INP | INN | MP | MN | |
| H | H | L | L | BRAKE |
| H | L | H | L | FORWARD |
| L | H | L | H | REVERSE |
| L | L | Open | Open | STANDBY |

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 |

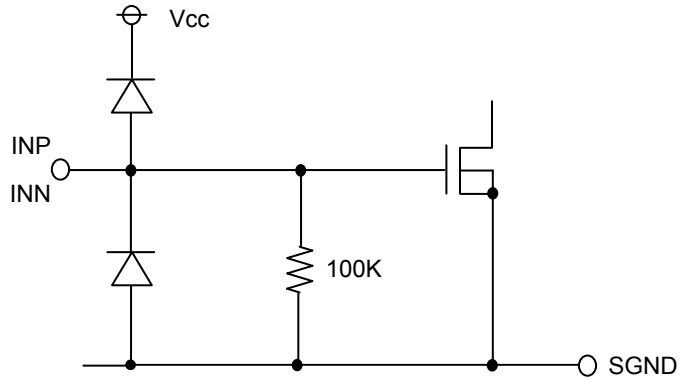
＊2 refer to timing chart

●PO Output Timing Chart

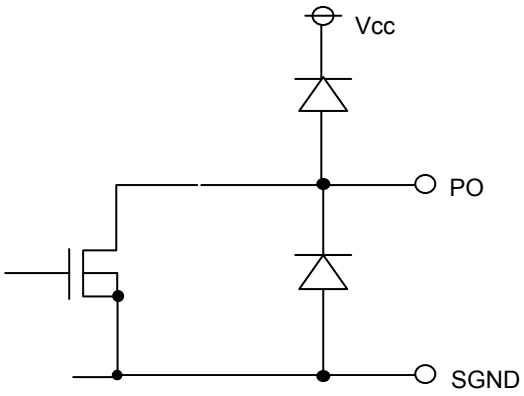


●I/O Circuit Diagram

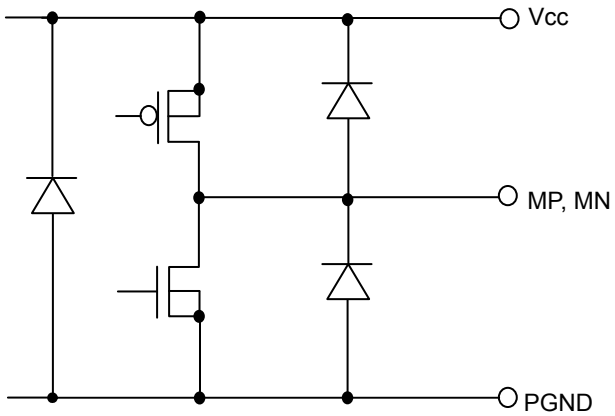
1) INP, INN




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 measuresuch 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.

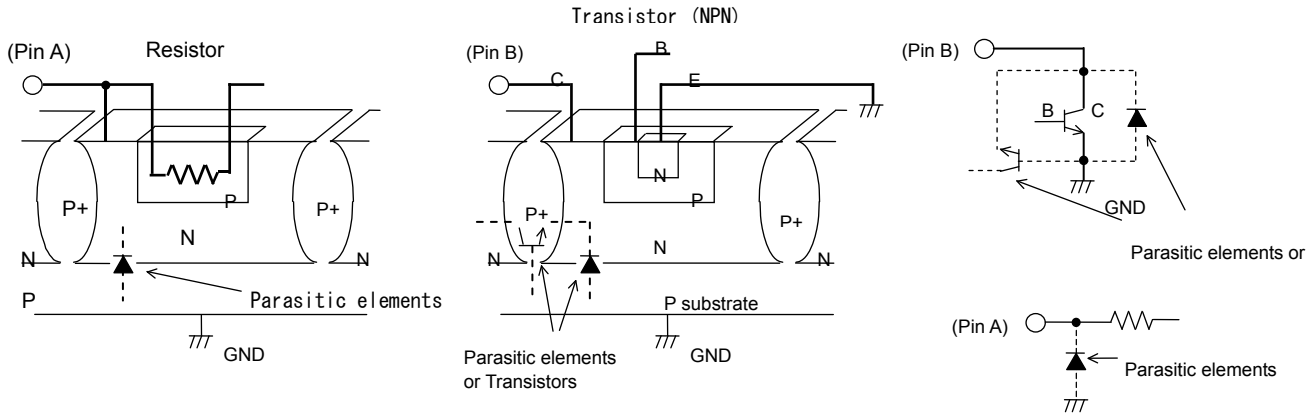
7) IC terminal input voltage

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 > Pin A for the resistor or GND > Pin B for the transistor(NPN).

○Similarly, when GND > 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 Vcc is not applied. And when the Vcc is applied, the voltage of input pin must not exceed Vcc. It is feared that output get malfunction, as input voltage is sweeped 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 (Tj) will trigger the TSD circuit to turn off all output power elements. The circuit automatically resets once the junction temperature (Tj) 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.

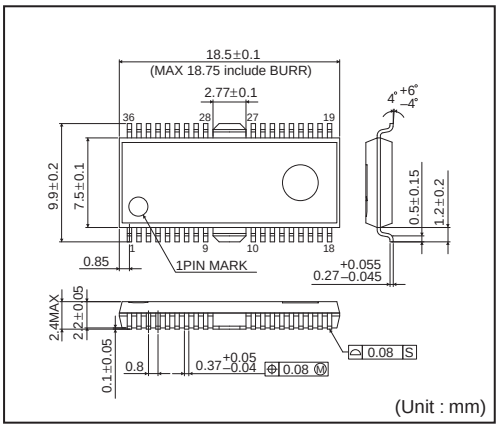
14）Over current protection

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 $\mu$ sec(typ.), this function turns off the output(output terminals become Hi-impedance) for 290 $\mu$ sec(typ.). After the period of turning off time (290 $\mu$ 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

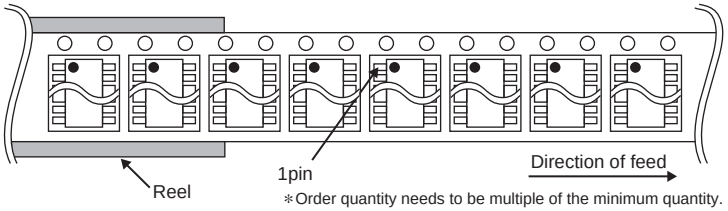
| B D | 6 9 4 1 | F M | - | E 2 |
|---|---|---|---|---|
| Part No. | Part No. | Package<br>FM : HSOP-M36 | | Packaging and forming specification<br>E2: Embossed tape and reel |

**HSOP-M36**




<Tape and Reel information>

| | |
|---|---|
| Tape | Embossed carrier tape (with dry pack) |
| Quantity | 1500pcs |
| Direction of feed | E2<br>( 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 ) |




∗Order quantity needs to be multiple of the minimum quantity.

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