

TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

# TA8429H/HQ

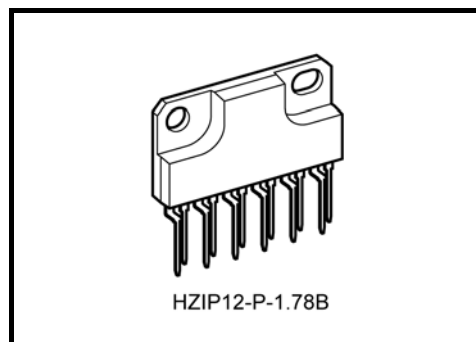
## Full-bridge Driver (H-Switch) for DC Motor (Driver for Switching between Forward and Reverse Rotation)

The TA8429H/HQ is full-bridge driver IC for brush motor rotation control that has a current capability of up to 3.0 A (AVE). Thermal shutdown and short current protection circuits are provided, and a stand-by function is also available.

### Features

- Output current of up to 3.0 A (AVE.) and 4.5 A (PEAK)
- Four different modes (forward rotation, reverse rotation, stop, and brake) are supported.  
A counter-electromotive force absorber diode is also incorporated.
- Stand-by mode available:  $I_{ST} \leq 100 \mu\text{A}$
- Built-in thermal shutdown and short circuit protection circuits
- HZIP power package sealed
- Wide range of operating voltage:  $V_{CC} = 7 \text{ to } 27 \text{ V}$   
 $V_S = 0 \text{ to } 27 \text{ V}$

\*Please consider the internal loss ( $V_{sat}$ ) to operate the IC though minimum  $V_S$  is defined zero.



Weight : 4.04 g (typ.)

The TA8429HQ:

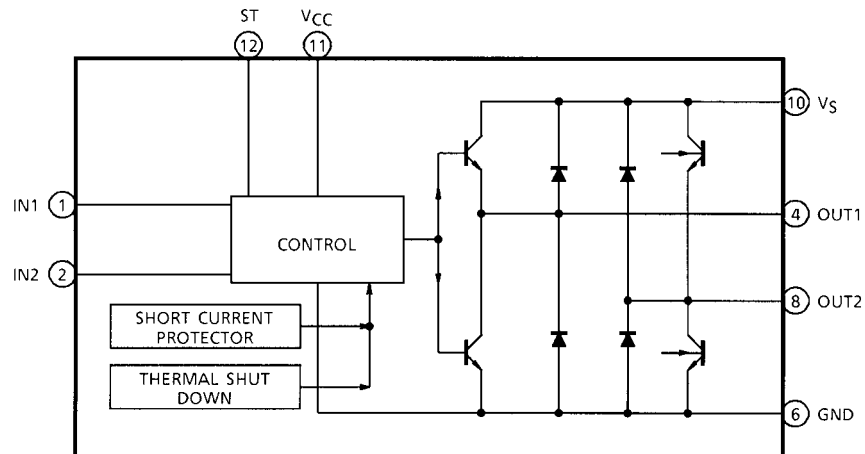
The TA8429HQ is Sn-Ag plated product including Pb.

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**

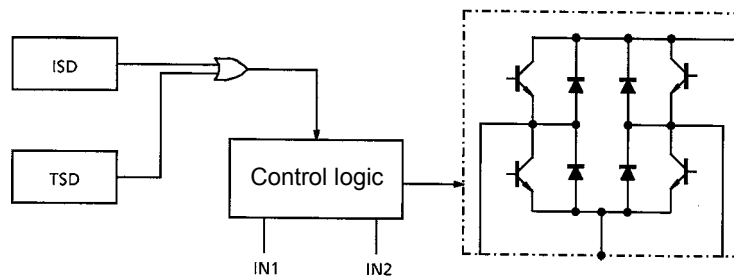


**Pin Function**

| Pin No. | Symbol          | Functional Description   |
|---------|-----------------|--|
| 1       | IN 1            | These pins receive inputs for controlling the state of the outputs. The input sections incorporate a PNP-type voltage comparator.  |
| 2       | IN 2            |  |
| 3       | N.C             | Non-connection   |
| 4       | OUT1            | This pin connects to a DC motor. It has a current carrying capacity of 3 A in both sink and source modes. A diode for absorbing counter-electromotive force in the motor is incorporated on both V <sub>CC</sub> and ground sides. |
| 5       | N.C             | Non-connection   |
| 6       | GND             | GND terminal   |
| 7       | N.C             | Non-connection   |
| 8       | OUT2            | This pin, along with pin 4, connects to a motor. It has the same function as pin 4. Its state is controlled with inputs to pins 1 and 2.   |
| 9       | N.C             | Non-connection   |
| 10      | V <sub>S</sub>  | Supply voltage terminal for motor drive  |
| 11      | V <sub>CC</sub> | This is a supply voltage pin for the control section. It is completely separated from V <sub>S</sub> .   |
| 12      | ST              | When this pin is open or connected to a ground, the current flowing through the motor is minimized (100 μA).   |

**How Multi-Protection Works**

The TA8429H/HQ incorporates two protection functions: over-current (ISD) and overheat (TSD).



Note 1: These protection functions are only a means of temporarily avoiding some output short circuits or other abnormal conditions and are not guaranteed to prevent damage to the IC.

Note 2: If used under conditions where the absolute maximum ratings are exceeded, the IC may break down before the protection circuits start operating.

## **Overheat Protection (TSD)**

- **Basic operation**

The input signal of the IC controls the output while the junction temperature (chip temperature) of the IC is equal to or lower than the TSD detection temperature. If the junction temperature becomes higher than the TSD detection temperature, the output enters a high-impedance state regardless of the level of the input signal.

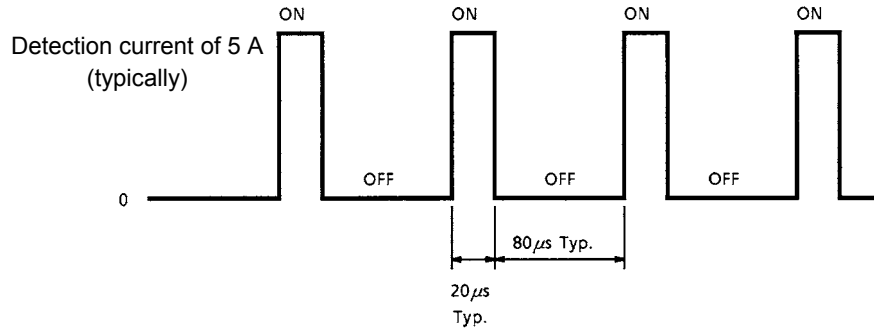
- **Explanation of the operation**

The junction temperature is detected by monitoring the VF of a diode on the chip. When the VF becomes lower than the internal reference voltage, the control logic is directed to turn off the output transistor. While the VF is higher than the reference voltage, the input signal at pins 1 and 2 controls the logic section.

## Over-current Protection (ISD)

- **Basic operation**

When the output current (pin 4 or 8, that is,  $I_{\text{sink}}$  or  $I_{\text{source}}$ ) is equal to or lower than the ISD detection current, the input signal controls the output. If the output current exceeds the detection current, it changes to a switching waveform shown in Figure 1.



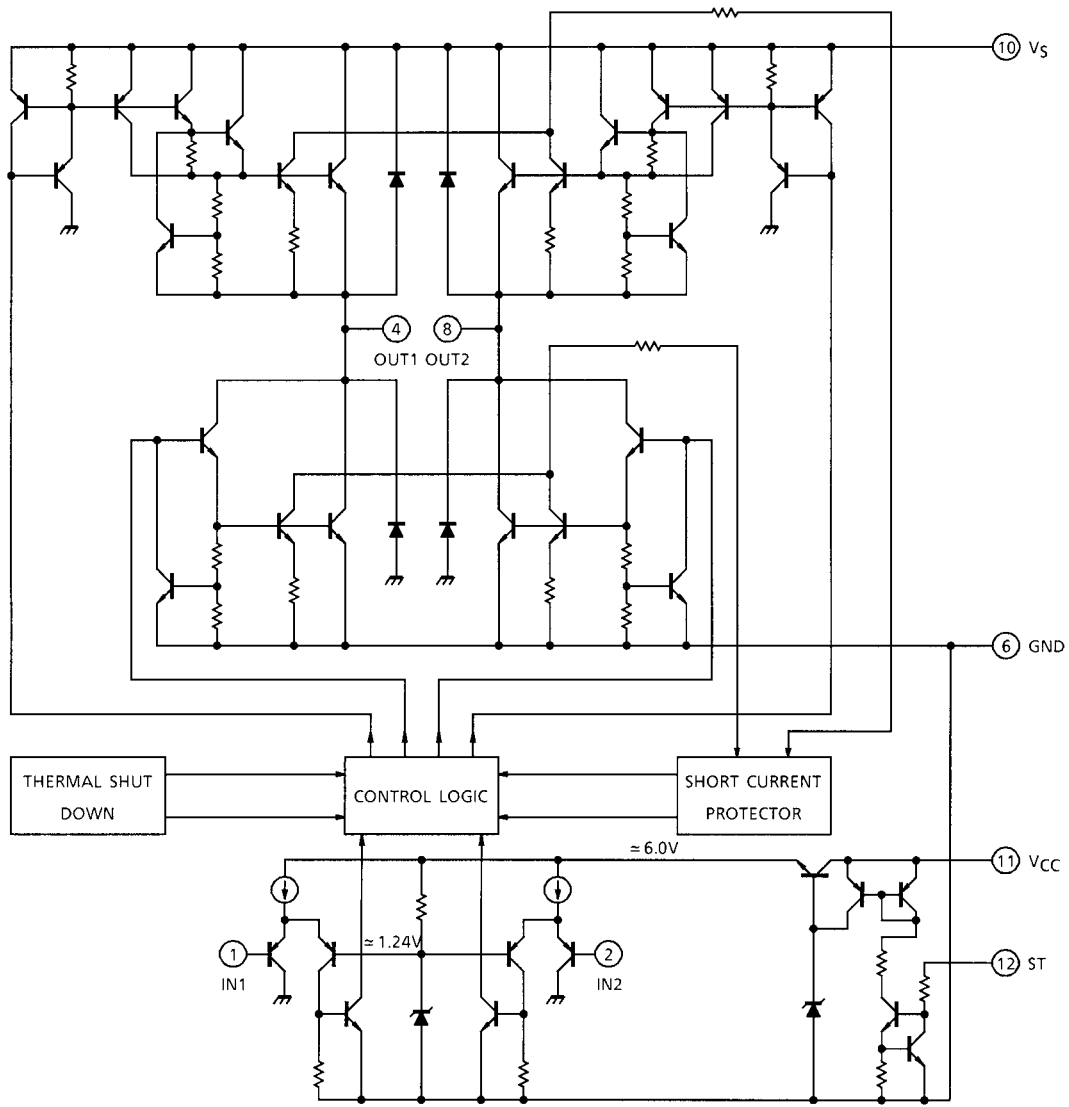
**Figure 1 Basic operation**

- **Explanation of the operation**

The output current is detected by monitoring the VBE of each output transistor. A detector element is connected to each output transistor and to a short-circuit prevention circuit. If a current higher than the ISD detection current flows through one of the four output transistors, the short-circuit prevention circuit starts operating. This circuit incorporates a timer. If the over-current mode lasts for 20 μs (typically), the output is switched to the high-impedance state. It returns to the ON mode in 80 μs (typically). If the IC is still in the over current mode, the switching mode stated above is repeated until the IC is released from the over-current mode.

This circuit cannot limit all types of over current. If the outputs are short-circuited to each other or to a ground, the IC may break down before the protection circuit starts operating. Therefore use a resistor or fuse in the supply voltage ( $V_S$ ) line.

**Internal Circuit**



**Function**

| Input |     | ST | Output               |      | Mode        |
|-------|-----|----|----------------------|------|-------------|
| IN1   | IN2 |    | OUT1                 | OUT2 | Motor       |
| H     | H   | H  | L                    | L    | Short brake |
| L     | H   | H  | L                    | H    | CW/CCW      |
| H     | L   | H  | H                    | L    | CCW/CW      |
| L     | L   | H  | OFF (high impedance) |      | Stop        |
| H/L   | H/L | L  | OFF (high impedance) |      | Stand-by    |

## Absolute Maximum Ratings (Ta = 25°C)

| Characteristics       |      | Symbol        | Rating           | Unit |
|-----------------------|------|---------------|------------------|------|
| Supply voltage        |      | $V_{CC}, V_S$ | 30               | V    |
| Input voltage         |      | $V_{IN}$      | -0.3 to $V_{CC}$ | V    |
| Output current        | AVE. | $I_O$ (AVE.)  | 3.0              | A    |
|                       | PEAK | $I_O$ (PEAK)  | 4.5 (Note 1)     |      |
| Power dissipation     |      | $P_D$         | 2.25 (Note 2)    | W    |
|                       |      |               | 21.6 (Note 3)    |      |
| Operating temperature |      | $T_{opr}$     | -30 to 85        | °C   |
| Storage temperature   |      | $T_{stg}$     | -55 to 150       | °C   |

Note 1:  $t = 100$  ms

Note 2: No heat sink

Note 3:  $T_c = 85^\circ\text{C}$

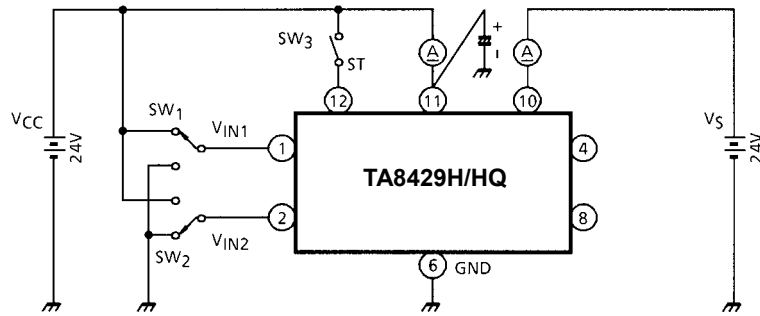
## Electrical Characteristics ( $V_{CC} = 24$ V, $V_S = 24$ V, $T_a = 25^\circ\text{C}$ )

| Characteristics                                | Symbol     | Test circuit | Test Condition        | Min | Typ. | Max | Unit          |
|--|------------|--------------|-----------------------|-----|------|-----|---------------|
| Quiescent current (I)<br>( $V_{CC}$ Line)      | $I_{CC1}$  | 1            | Stop mode             | —   | 6    | 12  | mA            |
|  | $I_{CC2}$  |              | Forward/reverse mode  | —   | 20   | 40  |               |
|  | $I_{CC3}$  |              | Brake mode            | —   | 20   | 40  |               |
| Quiescent current (II)<br>( $V_S$ Line)        | $I_{S1}$   | 1            | Stop mode             | —   | 3    | 8   | mA            |
|  | $I_{S2}$   |              | Forward/reverse mode  | —   | 16   | 40  |               |
|  | $I_{S3}$   |              | Brake mode            | —   | 3    | 8   |               |
| Input voltage                                  | $V_{INL}$  | 2            | —                     | —   | —    | 0.8 | V             |
|  | $V_{INH}$  |              | —                     | 2.0 | —    | —   |               |
| Input current                                  | $I_{INL}$  | 2            | $V_{IN} = \text{GND}$ | —   | —    | 12  | $\mu\text{A}$ |
|  | $I_{INH}$  |              | $V_{IN} = V_{CC}$     | —   | —    | 10  |               |
| Output saturation voltage (Note)               | $V_{sat1}$ | 3            | $I_O = 1.5$ A         | —   | 2.1  | 2.8 | V             |
|  | $V_{sat2}$ |              | $I_O = 3.0$ A         | —   | 3.3  | 4.1 |               |
| Output leakage current                         | $I_{LU}$   | 4            | $V_L = 25$ V          | —   | —    | 50  | $\mu\text{A}$ |
|  | $I_{LL}$   |              | $V_L = 25$ V          | —   | —    | 50  |               |
| Diode forward voltage                          | $V_{FU}$   | 5            | $I_F = 3.0$ A         | —   | 5.0  | —   | V             |
|  | $V_{FL}$   |              | $I_F = 3.0$ A         | —   | 1.5  | —   |               |
| Thermal shutdown circuit operating temperature | $T_{SD}$   | —            | —                     | —   | 150  | —   | °C            |
| Stand-by current                               | $I_{ST}$   | 1            | —                     | —   | —    | 100 | $\mu\text{A}$ |
| Propagation delay time                         | $t_{pLH}$  | 2            | —                     | —   | 1    | —   | $\mu\text{s}$ |
|  | $t_{pHL}$  | 2            | —                     | —   | 1    | —   |               |

Note: Upper and lower side total

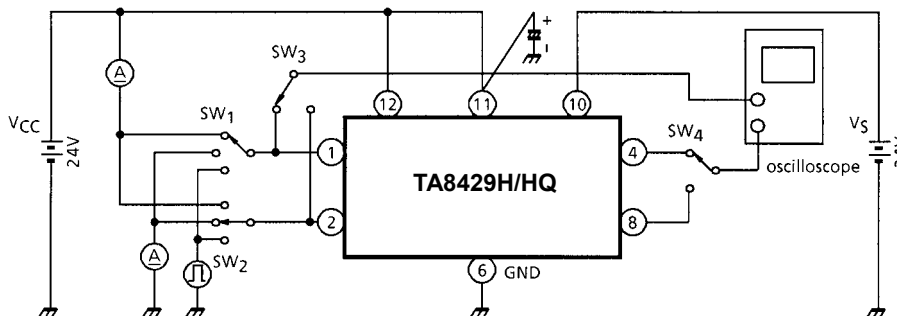
## Test Circuit 1

$I_{S1}$ ,  $I_{S2}$ ,  $I_{S3}$ ,  $I_{CC1}$ ,  $I_{CC2}$ ,  $I_{CC3}$ ,  $I_{ST}$



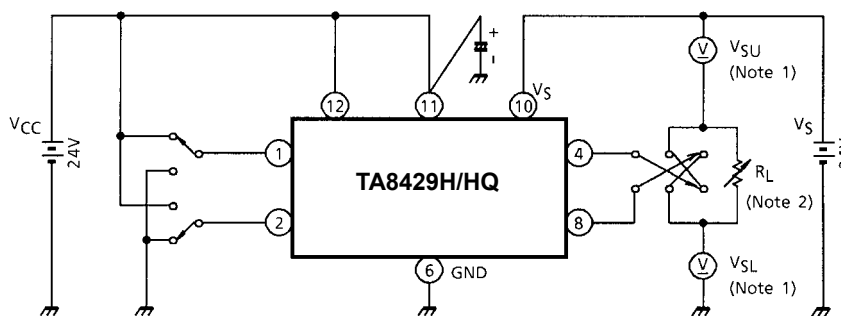
## Test Circuit 2

$V_{INH}$ ,  $V_{INL}$ ,  $I_{INH}$ ,  $I_{INL}$ ,  $t_{pHL}$ ,  $t_{pLH}$



## Test Circuit 3

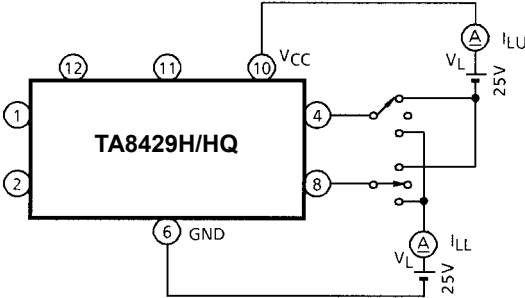
$V_{sat}$



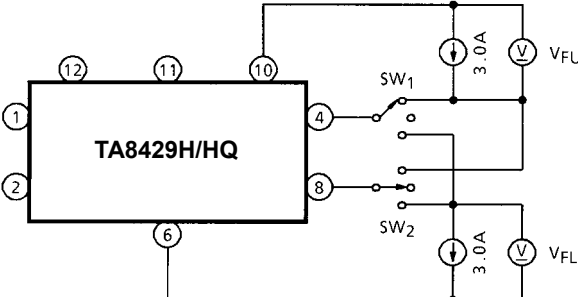
Note 1:  $V_{sat} = V_{SU} + V_{SL}$

Note 2: Calibrate  $I_O$  to 1.5 / 3.0 A by  $R_L$

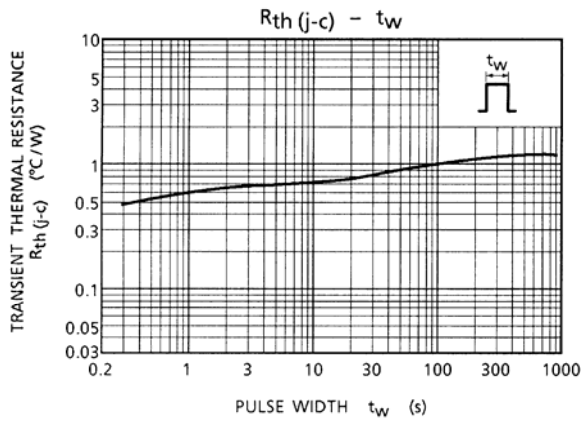
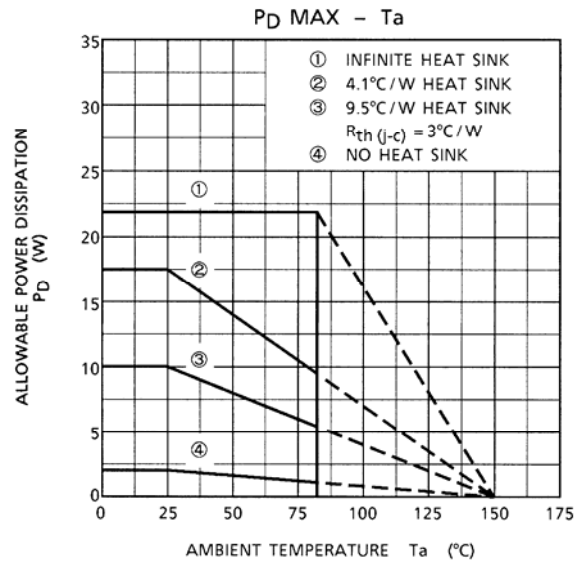
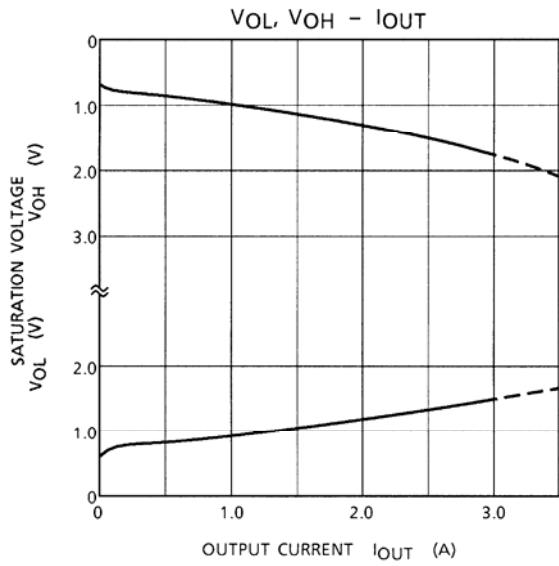
**Test Circuit 4**  
 $I_{LU}$ ,  $I_{LL}$



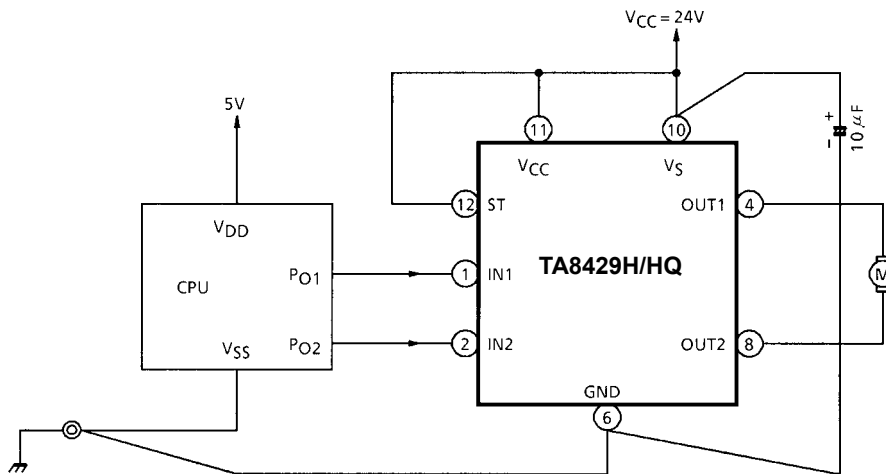
**Test Circuit 5**  
 $V_{FU}$ ,  $V_{FL}$



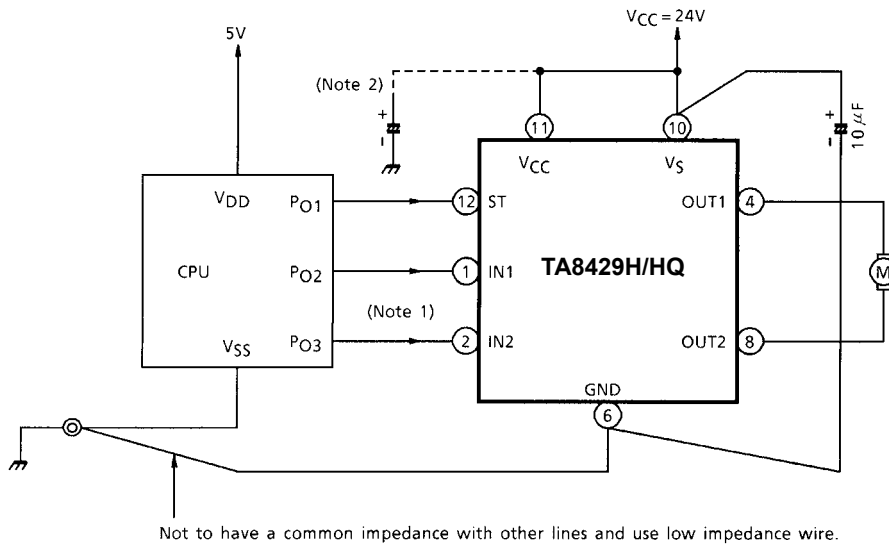




**Application Circuit 1**



**Application Circuit 2 (Separated standby function)**

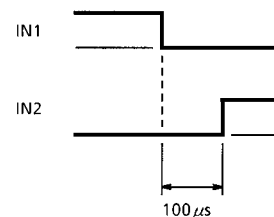


Note 1: Insert OFF-TIME (100  $\mu$ s or more) when the input signal is switched (between forward and reverse rotation and between forward/reverse rotation and brake).

Note 2: Connect if required.

Note 3: When turning on the power ( $V_{CC}/V_S$ ), keep both IN1 and IN2 on a low level. Do not switch the inputs (IN1/IN2) before the  $V_{CC}/V_S$  reaches its rated value (as shown in Application Circuit Example 1). If the ST pin is connected to a CPU (Application Circuit Example 2), turn on the power while ST, IN1, and IN2 are kept on a low level. After this, switch the ST/IN1/IN2.

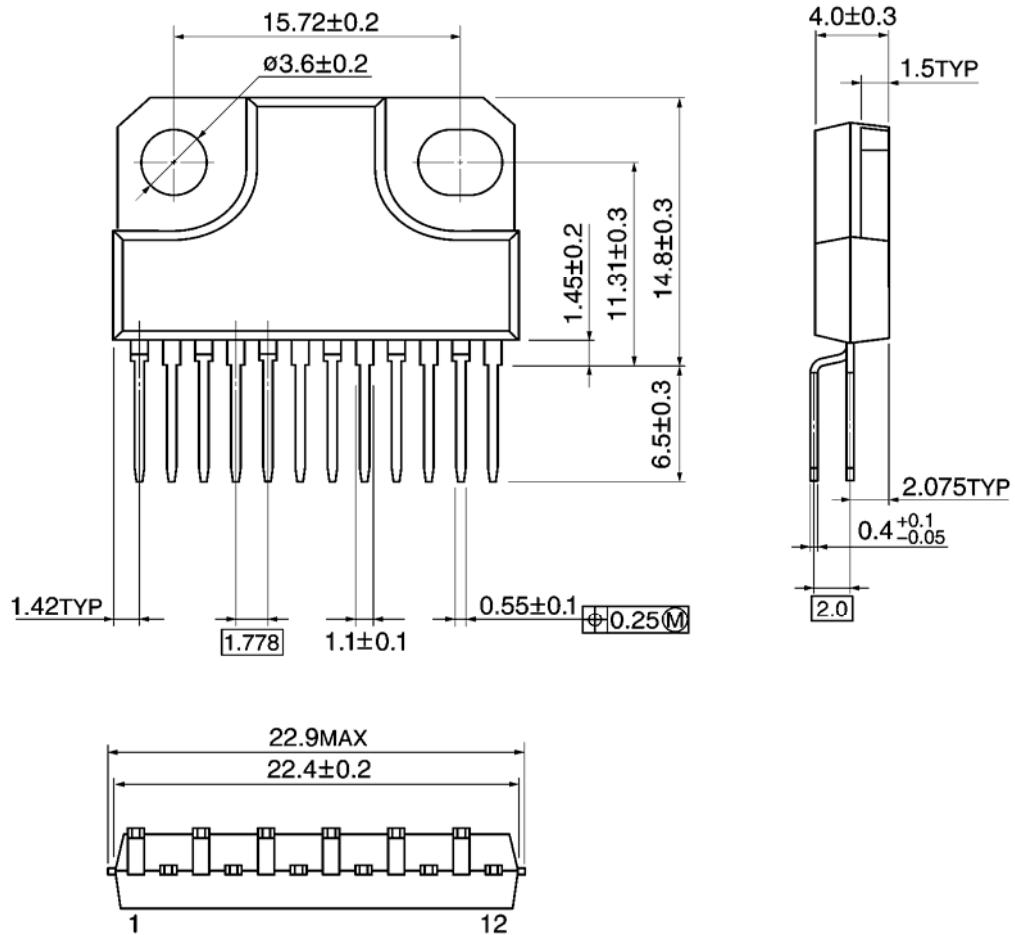
Note 4: Utmost care is necessary in the design of the output,  $V_{CC}$ ,  $V_M$ , and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.



**Package Dimensions**

HZIP12-P-1.78B

Unit: mm



Weight: 4.04 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 in 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 to 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 in 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) Over current Protection Circuit**

Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the Over current protection circuits operate against the over current, clear the over current status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

**(2) 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.

**(3) 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 consideration the effect of IC heat radiation with peripheral components.

**(4) 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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