

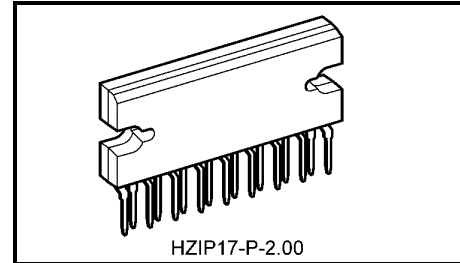
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

# TA8233BHQ

## 30W BTL × 2ch Audio Power Amplifier

The thermal resistance  $\theta_{j-T}$  of TA8233BHQ package designed for low thermal resistance, has high efficiency of heat radiation. The temperature rise of chip can be reduced, and the influence from the degradation of the features due to the temperature rise at the high output can also be reduced.

This stereo audio power IC, designed for car audio use, has two built-in channels to reduce the characteristic difference between L and R channels. It also contains output short detection circuit, output clip detection and various kind of protection.



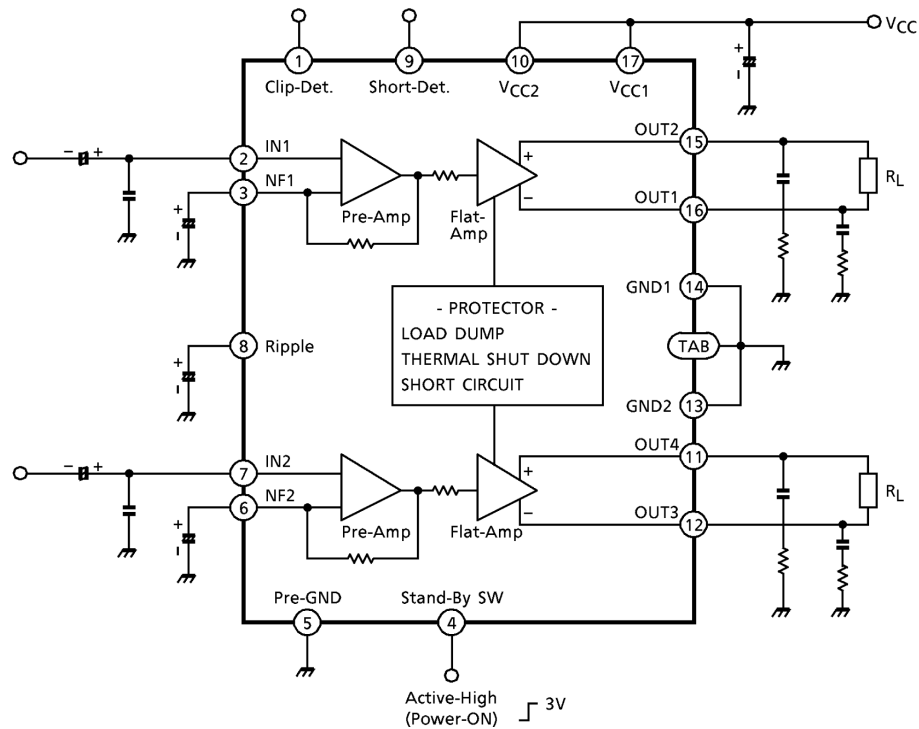
Weight: 9.8g (typ.)

### Features

- High power
  - :  $P_{OUT}(1) = 30W$  (typ.) / channel  
( $V_{CC} = 14.4V$ ,  $f = 1kHz$ ,  $THD = 10\%$ ,  $R_L = 2\Omega$ )
  - $P_{OUT}(2) = 26W$  (typ.) / channel  
( $V_{CC} = 13.2V$ ,  $f = 1kHz$ ,  $THD = 10\%$ ,  $R_L = 2\Omega$ )
  - $P_{OUT}(3) = 19W$  (typ.) / channel  
( $V_{CC} = 13.2V$ ,  $f = 1kHz$ ,  $THD = 10\%$ ,  $R_L = 4\Omega$ )
- Low thermal resistance:  $\theta_{j-T} = 1.5^\circ C / W$  (infinite heat sink)
- Low distortion ratio:  $THD = 0.04\%$  (typ.)  
( $V_{CC} = 13.2V$ ,  $f = 1kHz$ ,  $P_{OUT} = 1W$ ,  $R_L = 4\Omega$ ,  $G_V = 50dB$ )
- Low noise:  $V_{NO} = 0.30mV_{rms}$  (typ.)  
( $V_{CC} = 13.2V$ ,  $R_L = 4\Omega$ ,  $G_V = 50dB$ ,  $R_g = 0\Omega$ ,  $BW = 20Hz \sim 20kHz$ )
- Built-in stand-by function
  - : (with pin(4) set at low, power is turned off.)  $ISB = 1\mu A$  (typ.)
- Built-in output clip detection circuit
  - : (pin(1): Open collector (active low))
- Built-in output short detection circuit
  - : (pin(9): Open collector (active low))
- Built-in various protection circuits
  - : Thermal shut down, Over voltage, Out $\rightarrow$ V $_{CC}$  short, Out $\rightarrow$ GND short and Out-Out short.
- Operating supply voltage:  $V_{CC(opr)} = 9 \sim 18V$

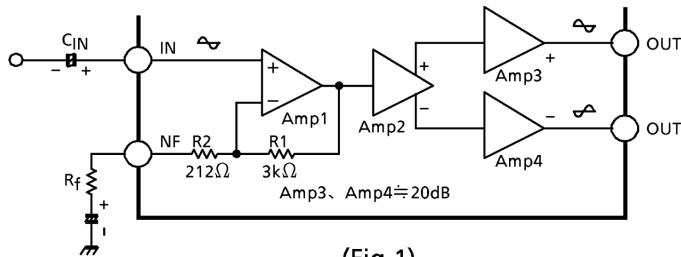
## Block Diagram

TA8233BHQ ( $G_V = 50\text{dB}$ )



## Caution And Application Method (description is made only on the single channel.)

### 1. Voltage gain adjustment



(Fig.1)

Amp1 : Pre-Amp  
Amp2 : Phase Amp  
Amp3 : POWER Amp (Flat-Amp)  
Amp4 : POWER Amp (Flat-Amp)

This IC has the amplifier constructions as shown in Fig.1. The pre-amp (amp 1) is provided to the primary stage, and the input voltage is amplified by the flat amps, amp 3 and amp 4 of each channel through the phase amp (amp 2).

Since the input offset is prevented by pre-amp when VCC is set to on, this circuit can remarkably reduce the pop noise.

The total closed loop gain  $G_V$  of this IC can be obtained by expression below when the closed loop voltage gain of amp 1 is  $G_{V1}$ .

$$G_{V1} = 20 \log \frac{R_1 + (R_f + R_2)}{R_f + R_2} \text{ (dB)} \dots \dots \dots (1)$$

The closed loop voltage gain of power amp, amp 3 and amp 4 is fixed at  $G_{V3} \cong G_{V4} = 20\text{dB}$ .

Therefore, the total closed circuit voltage gain  $G_V$  is obtained through BTL connection by the expression as below.

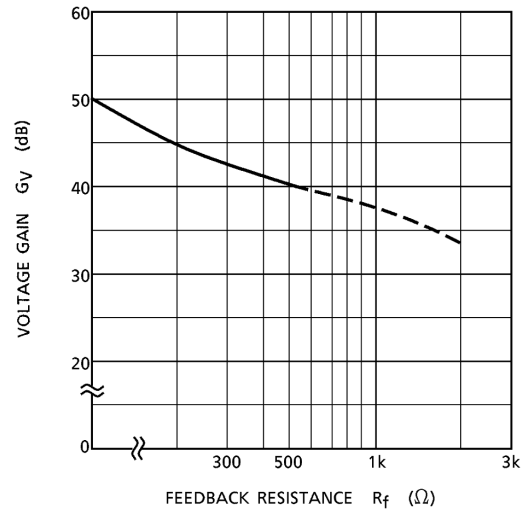
$$G_V = G_{V1} + G_{V3} + 6 \text{ (dB)} \dots \dots \dots (2)$$

For example, when  $R_f = 0\Omega$ ,  $G_V$  is obtained by the expressions (1) and (2) as below.

$$G_V \cong 24 + 20 + 6 = 50\text{dB}$$

The voltage gain is reduced when  $R_f$  is increased. (Fig.2)

With the voltage gain reduced, since (1) the oscillation stability is reduced, and (2) the pop noise changes when  $V_{CC}$  is set to on, refer to the items 3 and 4.



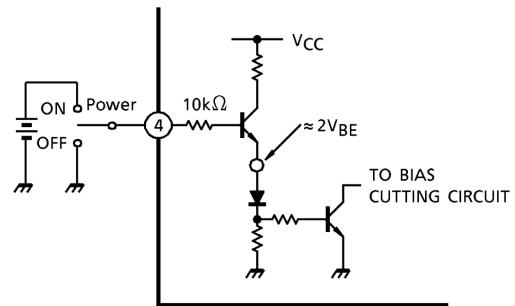
(Fig.2)

## 2. Stand-by SW function

By means of controlling pin(4) (stand-by terminal) to high and low, the power supply can be set to on and off. The threshold voltage of pin(4) is set at  $2.1\text{V}$  ( $3V_{BE}$ ), and the power supply current is about  $1\mu\text{A}$  (typ.) at the stand-by state.

Control voltage of pin(4):  $V_{(SB)}$

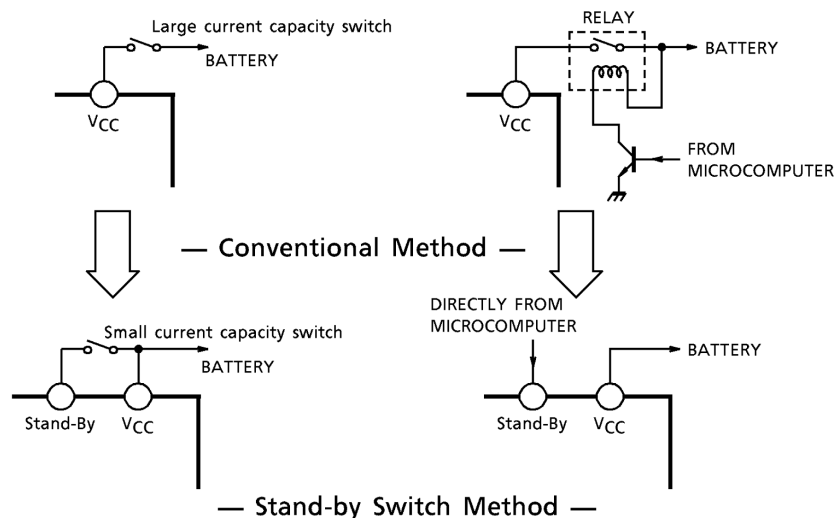
| Stand-By | Power | $V_{(SB)}$ (V) |
|----------|-------|----------------|
| On       | Off   | 0~2            |
| Off      | On    | 3~ $V_{CC}$    |



(Fig.3) With pin④ set to High, Power is turned ON

Adjustage of stand-by SW

- (1) Since  $V_{CC}$  can directly be controlled to on or off by the microcomputer, the switching relay can be omitted.
- (2) Since the control current is microscopic, the switching relay of small current capacity is satisfactory for switching



### 3. Preventive measure against oscillation

For preventing the oscillation, it is advisable to use C4, the condenser of polyester film having small characteristic fluctuation of the temperature and the frequency.

The condenser (C6) between input and GND is effective for preventing oscillation which is generated with a feedback signal from a output stage.

The resistance R to be series applied to C4 is effective for phase correction of high frequency, and improves the oscillation allowance.

- (1) Voltage gain to be used (GV setting)
- (2) Capacity value of condenser
- (3) Kind of condenser
- (4) Layout of printed board

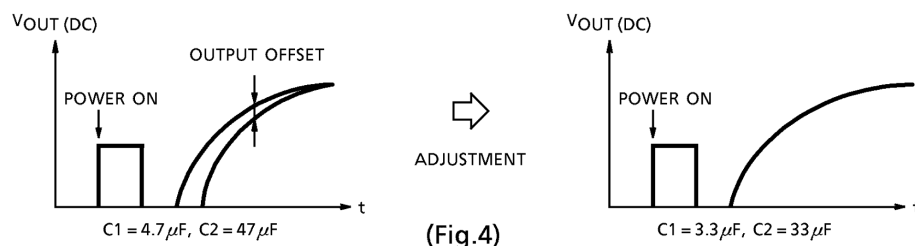
In case of its use with the voltage gain GV reduced or with the feedback amount increased, care must be taken because the phase-inversion is caused by the high frequency resulting in making the oscillation liable generated.

### 4. Adjustment of output offset (when the power supply turn on)

As this IC is constructed with DC circuit on the pre-amp stage, it is necessary to lower a input offset or output offset by agreement with the each leading edge time constant of the input voltage in the pre-amp stage and NF terminal voltage.

Concretely, monitor the output DC voltage and vary the capacity value in input condenser and NF condenser (see Fig.4)

(Reference) In case of setting the condition (GV = 40dB) with  $R_f = 470\Omega$



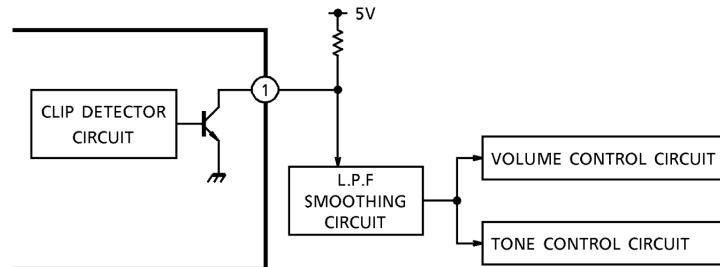
(Fig.4)

5. Output clip detection function (pin(1))

The output clip detection terminal of pin(1) has the open collector output structure on chip as shown in Fig.5. In case that the output waveform is clipping, the clip detection circuit is operated and NPN Tr. is turned on. It is possible to improve the tone quality with the current of flowing into pin(1) and with controlling the volume, tone control circuit through L.P.F smoothing circuit as shown in Fig.5.

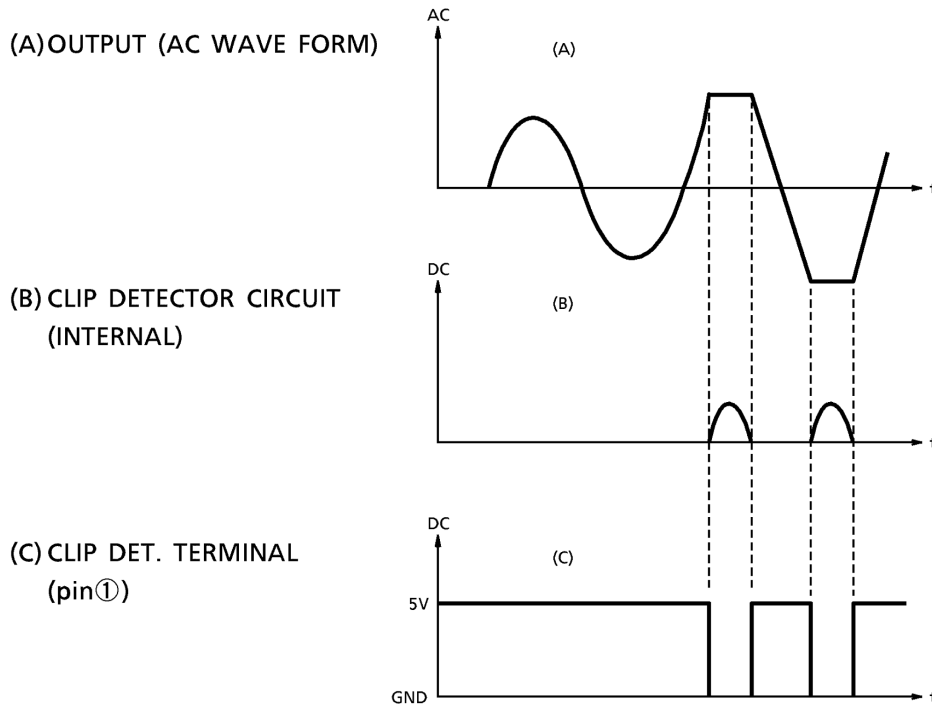
In case of being unused this function, use this IC as open connection on pin(1).

(Application)



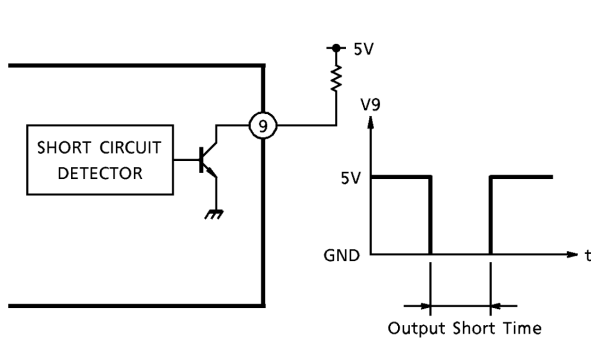
pin① : Open Collector Output (Active Low)

(Fig.5)



6. Output to VCC, output to gnd short detection function (pin(9))

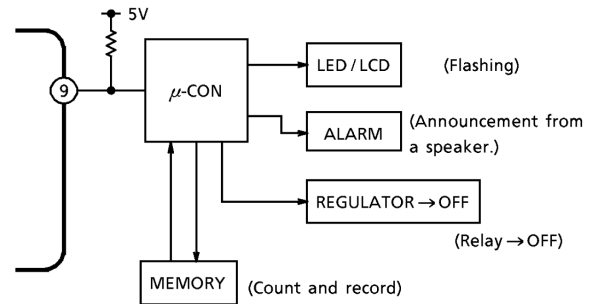
The output short detection terminal of pin(9) has open collector output structure on chip as shown in Fig.6.  
In unusual case that output terminal of power amp. Is condition of output to VCC or output to GND short, it is possible to protect all the system of apparatus as well as power IC protection.  
In case of being unused this function, use this IC as open-connection on pin(9).



pin⑨ : Open Collector Output (Active Low)

(Fig.6)

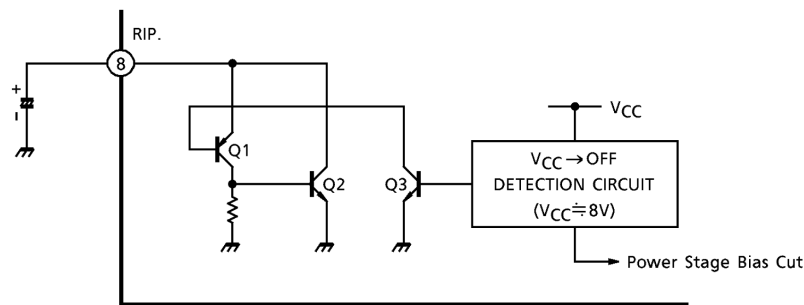
(Application)



(Fig.7)

7. Rapid ripple discharging circuit at the time of VCC off

This circuit is effective in such a mode where the VCC and the stand-by terminals become high or low simultaneously; for instance, for a pop noise produced when the power is turned on or off repeatedly by operating the ignition key.



(Fig.8)

When VCC is off, this detection circuit detect  $V_{CC} \approx 8V$  internally on IC.

- (1) The power stage bias circuit is cut.
- (2) pin(8): Ripple capacitor is rapidly discharged by turning Q3 on and then Q1 and Q2 on.

## (Precaution 1)

When the stand-by terminal was put to the low level after the ripple rapid discharging circuit was operated ( $V_{CC} \approx 8V$ ) at the time when  $V_{CC}$  was turned off, a pop noise may be generated. Therefore,  $V_{CC}$  which makes the stand-by terminal low shall be set at 8V or above so that (1) the stand-by terminal is put at the low level and (2) the ripple rapid discharging circuit is turned on when  $V_{CC}$  is turned off (in order of (1) and (2)). An example of application is shown in Fig.9.

## (Precaution 2)

If the falling time constant of the  $V_{CC}$  line is large (the fall is gentle), the pop noise may become worse.

In this case, it is possible to prevent the pop noise from becoming worse by reducing the ability of “ripple rapid discharging circuit at the time of  $V_{CC}$  off” according to the increase of the capacity of ripple capacitor of pin(8). However, it shall be kept in mind that the time for turning the power on becomes longer as the result of this method.

## 8. External part list and description

| Sym-<br>bol | Recommended<br>Value | Feature                | Influence                                                                                                                                       |                                                                     | Remarks                              |
|-------------|----------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------|--------------------------------------|
|             |                      |                        | Smaller Than<br>Recommended Value                                                                                                               | Larger Than<br>Recommended Value                                    |                                      |
| C1          | 4.7 $\mu$ F          | DC blocking            | Related to pop noise at $V_{CC} \rightarrow \text{on}$ .                                                                                        |                                                                     | Related to gain.<br>Refer to item 4. |
| C2          | 47 $\mu$ F           | Feedback condenser     | Related to pop noise at $V_{CC} \rightarrow \text{on}$ .<br>Determination of low cut-off frequency<br>$C2 = \frac{1}{2\pi \cdot f_L \cdot R_f}$ |                                                                     |                                      |
| C3          | 220 $\mu$ F          | Ripple reduction       | Time constant is small<br>at $V_{CC} \rightarrow \text{on}$ or off.                                                                             | Time constant is large<br>at $V_{CC} \rightarrow \text{on}$ or off. |                                      |
| C4          | 0.12 $\mu$ F         | Oscillation prevention | Made liable to oscillate.                                                                                                                       | Oscillation allowance                                               | Refer to item 3.                     |
| C5          | 1000 $\mu$ F         | Ripple filter          | For filtering power supply hum and ripple.<br>Large at using AC rectified power supply.<br>Small at using DC power supply.                      |                                                                     |                                      |
| C6          | 1000pF               | Oscillation prevention | Oscillation allowance improved.<br>Noise reduction                                                                                              |                                                                     | Refer to item 3.                     |

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

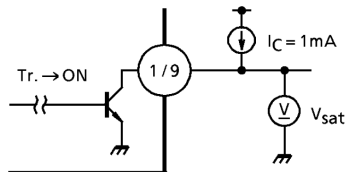
| Characteristic             | Symbol                  | Rating  | Unit |
|----------------------------|-------------------------|---------|------|
| Peak supply voltage (0.2s) | V <sub>CC</sub> (surge) | 50      | V    |
| DC supply voltage          | V <sub>CC</sub> (DC)    | 25      | V    |
| Operating supply voltage   | V <sub>CC</sub> (opr)   | 18      | V    |
| Output current (peak)      | I <sub>O</sub> (peak)   | 9       | A    |
| Power dissipation          | P <sub>D</sub>          | 50      | W    |
| Operating temperature      | T <sub>opr</sub>        | -30~85  | °C   |
| Storage temperature        | T <sub>stg</sub>        | -55~150 | °C   |

## Electrical Characteristics

(unless otherwise specified, V<sub>CC</sub> = 13.2V, R<sub>L</sub> = 4Ω, f = 1kHz, Ta = 25°C)

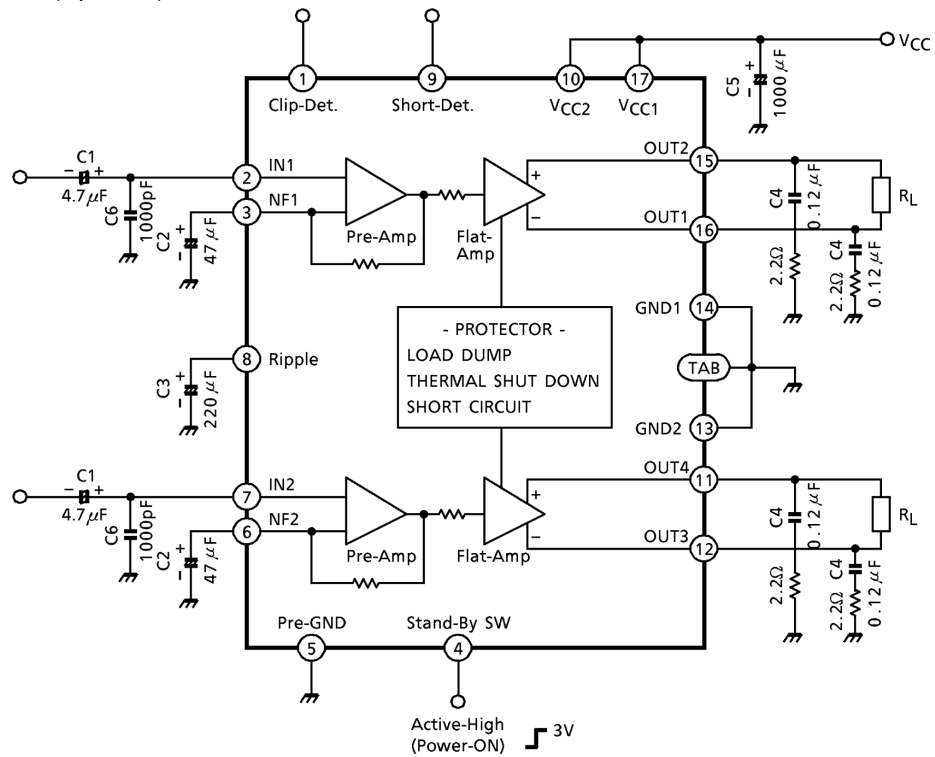
| Characteristic                        | Symbol               | Test Circuit | Test Condition                                                           | Min. | Typ. | Max.            | Unit              |
|---------------------------------------|----------------------|--------------|--------------------------------------------------------------------------|------|------|-----------------|-------------------|
| Quiescent supply current              | I <sub>CCQ</sub>     | —            | V <sub>IN</sub> = 0                                                      | —    | 120  | 250             | mA                |
| Output power                          | P <sub>OUT</sub> (1) | —            | V <sub>CC</sub> = 14.4V, R <sub>L</sub> = 2Ω<br>THD = 10%                | —    | 30   | —               | W                 |
|                                       | P <sub>OUT</sub> (2) | —            | R <sub>L</sub> = 2Ω, THD = 10%                                           | 17   | 26   | —               |                   |
|                                       | P <sub>OUT</sub> (3) | —            | THD = 10%                                                                | 16   | 19   | —               |                   |
| Total harmonic distortion ratio       | THD                  | —            | P <sub>OUT</sub> = 1W                                                    | —    | 0.04 | 0.4             | %                 |
| Voltage gain                          | G <sub>V</sub>       | —            | —                                                                        | 48   | 50   | 52              | dB                |
| Voltage gain ratio                    | ΔG <sub>V</sub>      | —            | —                                                                        | -1.0 | 0    | 1.0             | dB                |
| Output noise voltage                  | V <sub>NO</sub>      | —            | R <sub>g</sub> = 0Ω, BW = 20Hz~20kHz                                     | —    | 0.3  | 0.7             | mV <sub>rms</sub> |
| Ripple rejection ratio                | R.R.                 | —            | f <sub>ripple</sub> = 100Hz, R <sub>g</sub> = 600Ω                       | 40   | 54   | —               | dB                |
| Input resistance                      | R <sub>IN</sub>      | —            | —                                                                        | —    | 30   | —               | kΩ                |
| Output offset voltage                 | V <sub>offset</sub>  | —            | V <sub>IN</sub> = 0                                                      | -100 | 0    | 100             | mV                |
| Current at stand-by state             | I <sub>SB</sub>      | —            | —                                                                        | —    | 1    | 10              | μA                |
| Cross talk                            | C.T.                 | —            | R <sub>g</sub> = 600Ω<br>V <sub>OUT</sub> = 0.775V <sub>rms</sub> (0dBm) | —    | 60   | —               | dB                |
| Pin(4) control voltage                | V <sub>SB</sub>      | —            | Stand-by→off<br>(power→on)                                               | 2.5  | —    | V <sub>CC</sub> | V                 |
| Pin(1) (clip DET) saturation voltage  | V <sub>sat</sub> (1) | —            | I <sub>C</sub> = 1mA                                                     | —    | 100  | —               | mV                |
| Pin(9) (short DET) saturation voltage | V <sub>sat</sub> (9) | —            | I <sub>C</sub> = 1mA                                                     | —    | 100  | —               | mV                |

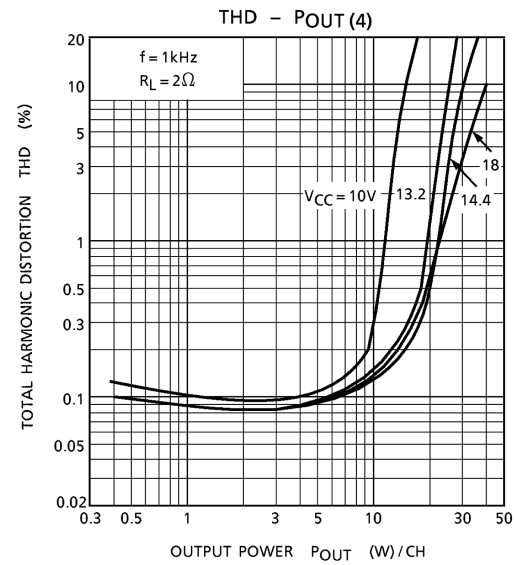
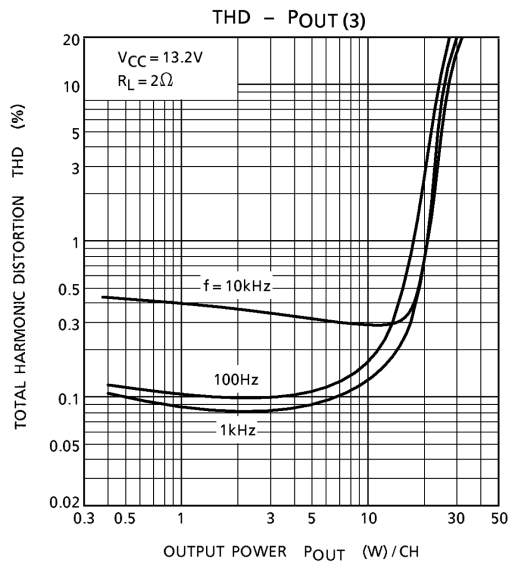
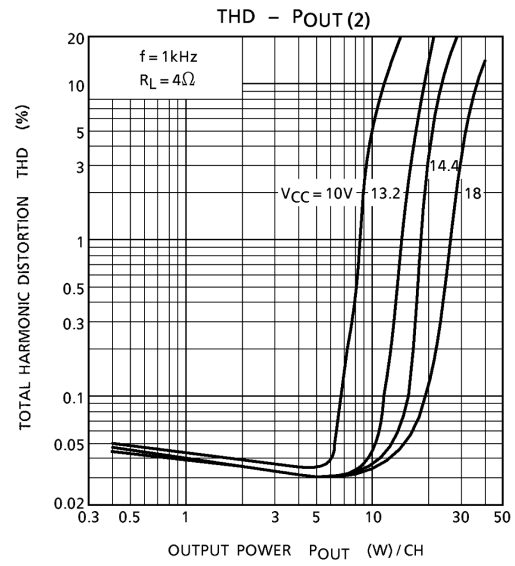
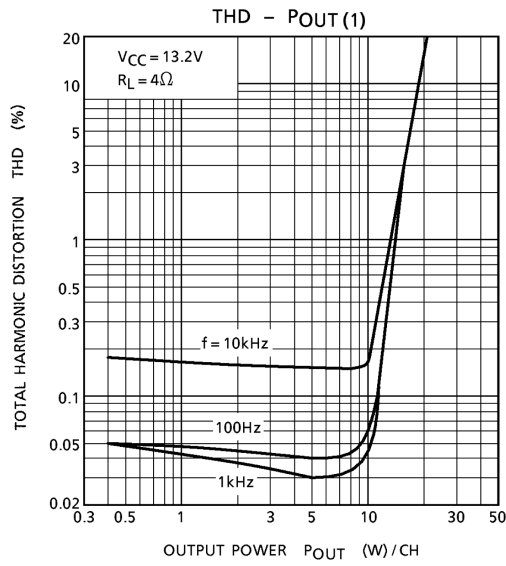
V<sub>sat</sub> (1), V<sub>sat</sub> (9) Test Circuit

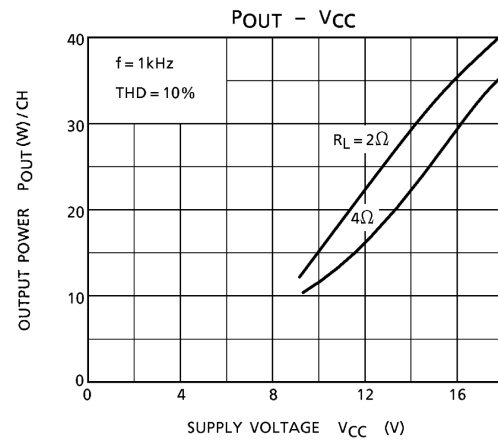
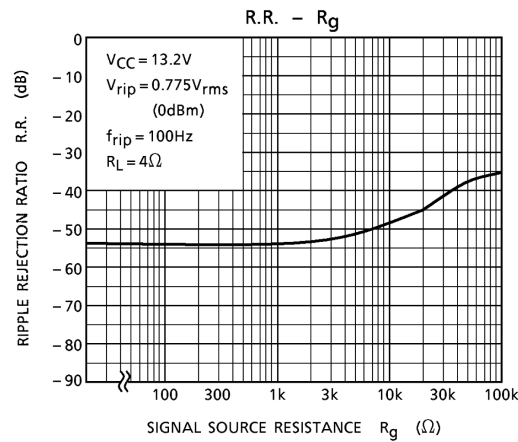
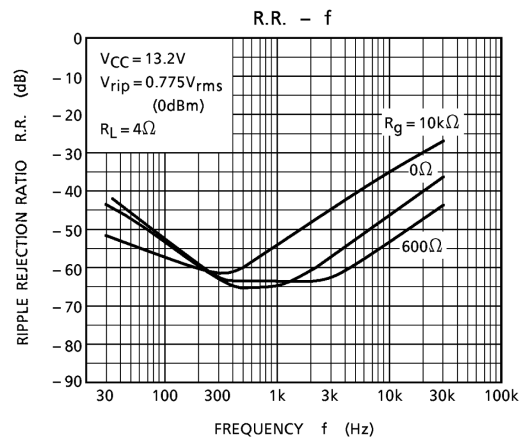
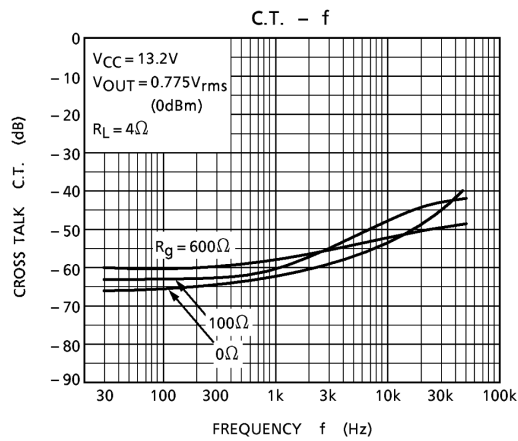
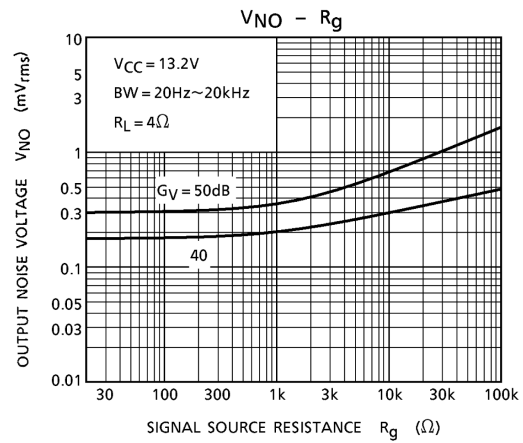
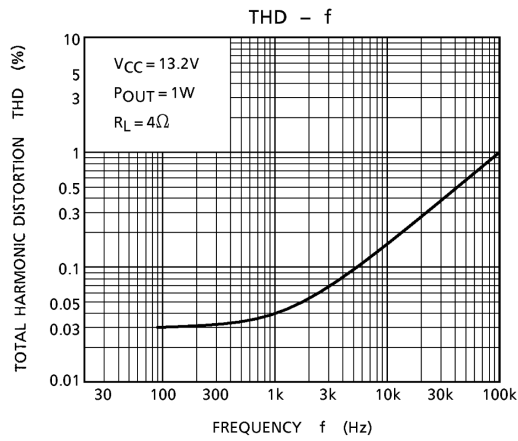


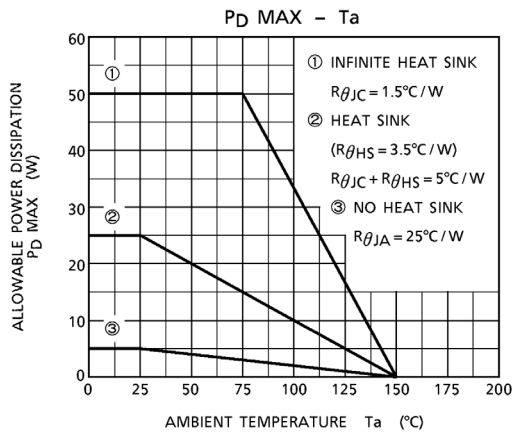
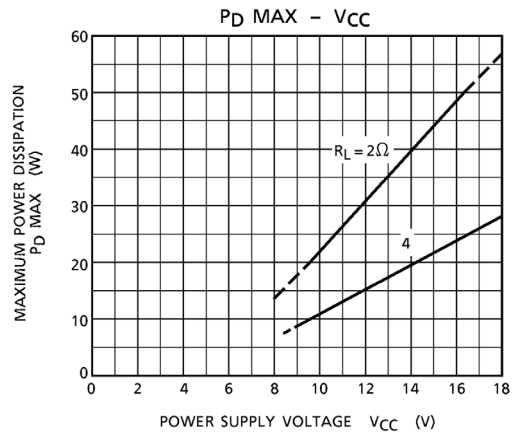
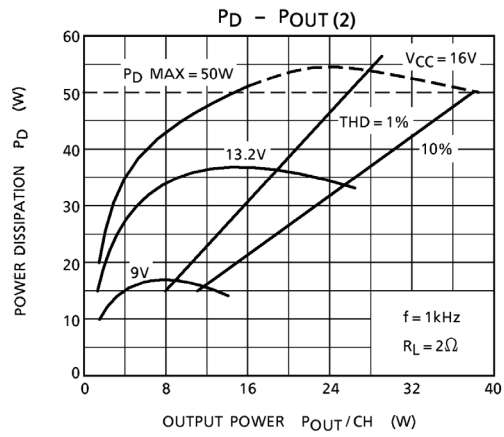
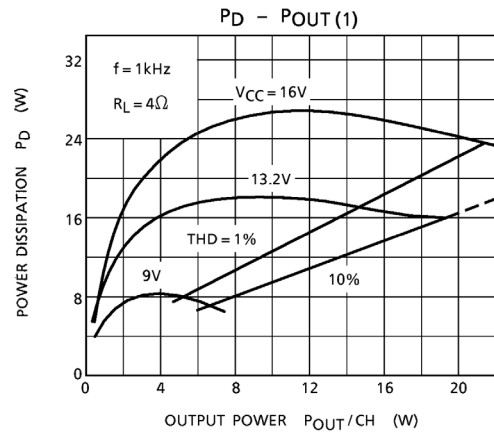
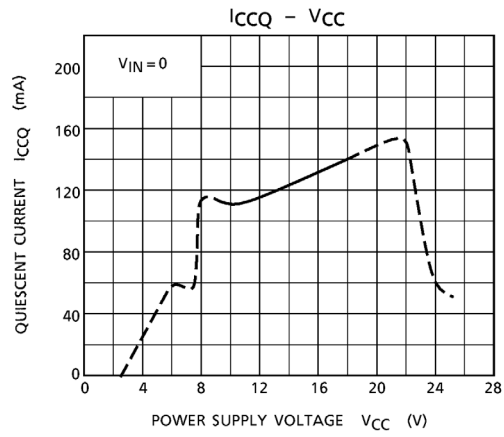
## Test Circuit

TA8233BHQ ( $G_V = 50\text{dB}$ )





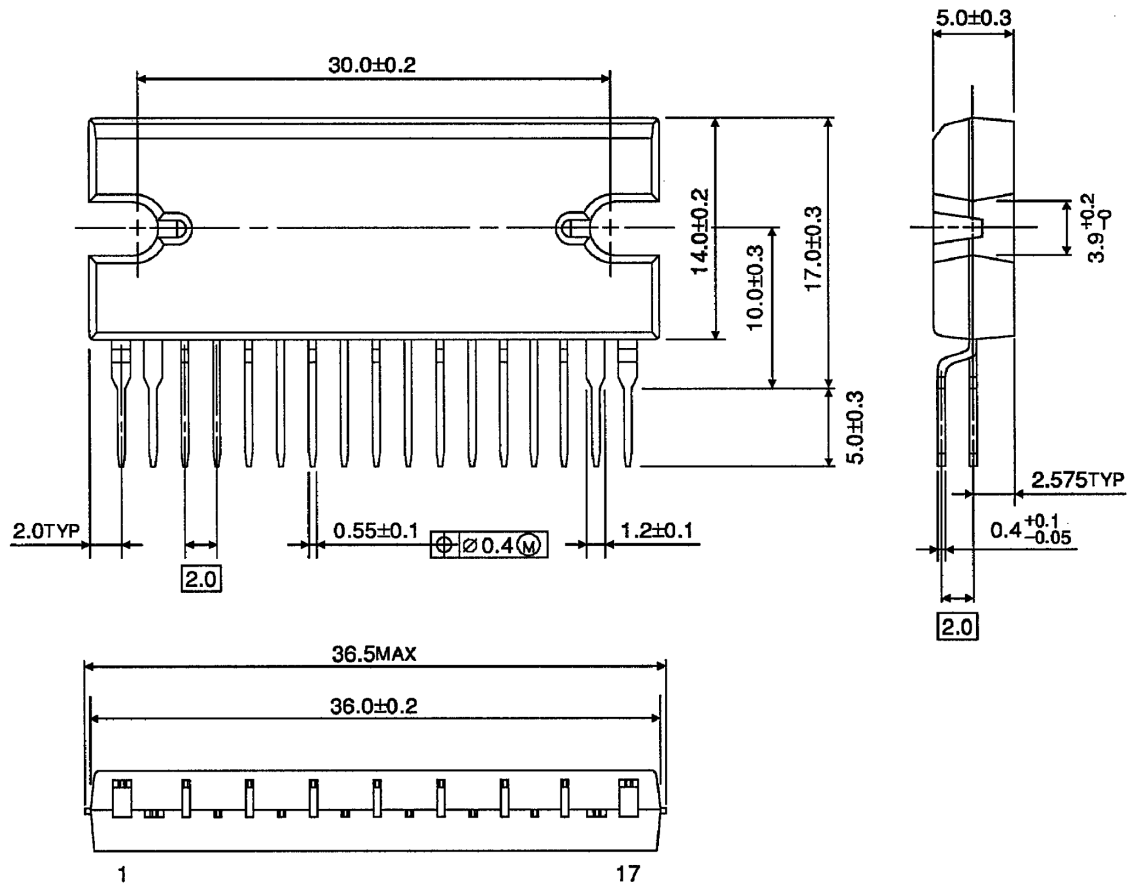




## Package Dimensions

HZIP17-P-2.00

Unit : mm



Weight: 9.8g (typ.)



- 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.
- 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. For details on how to connect a protection circuit such as a current limiting resistor or back electromotive force adsorption diode, refer to individual IC datasheets or the IC databook. 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.
- Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator. If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.
- 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.
- 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.
- Heat Radiation Design  
When 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.
- Installation to Heat Sink  
Please install the power IC to the heat sink not to apply excessive mechanical stress to the IC. Excessive mechanical stress can lead to package cracks, resulting in a reduction in reliability or breakdown of internal IC chip. In addition, depending on the IC, the use of silicon rubber may be prohibited. Check whether the use of silicon rubber is prohibited for the IC you intend to use, or not. For details of power IC heat radiation design and heat sink installation, refer to individual technical datasheets or IC databooks.

## RESTRICTIONS ON PRODUCT USE

060116EBF

- The information contained herein is subject to change without notice. 021023\_D
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.  
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc. 021023\_A
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk. 021023\_B
- The products described in this document shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations. 060106\_Q
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patent or patent rights of TOSHIBA or others. 021023\_C
- The products described in this document are subject to the foreign exchange and foreign trade laws. 021023\_E
- This product generates heat during normal operation. However, substandard performance or malfunction may cause the product and its peripherals to reach abnormally high temperatures.  
The product is often the final stage (the external output stage) of a circuit. Substandard performance or malfunction of the destination device to which the circuit supplies output may cause damage to the circuit or to the product. 030619\_R

About solderability, following conditions were confirmed

- Solderability
  - (1) Use of Sn-37Pb solder Bath
    - solder bath temperature = 230°C
    - dipping time = 5 seconds
    - the 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