

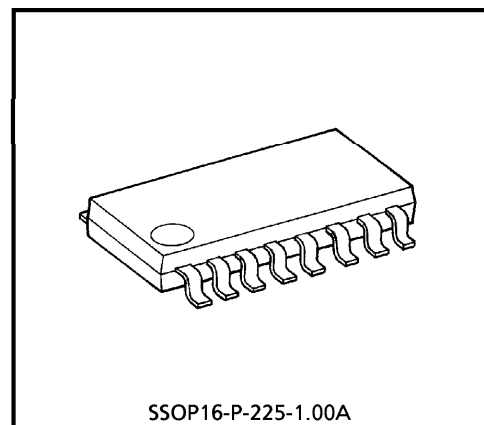
# TA7688F

## STEREO HEADPHONE AMPLIFIER (3V USE)

The TA7688F is a stereo headphone power amplifier IC designed for portable cassette player applications.

### FEATURES

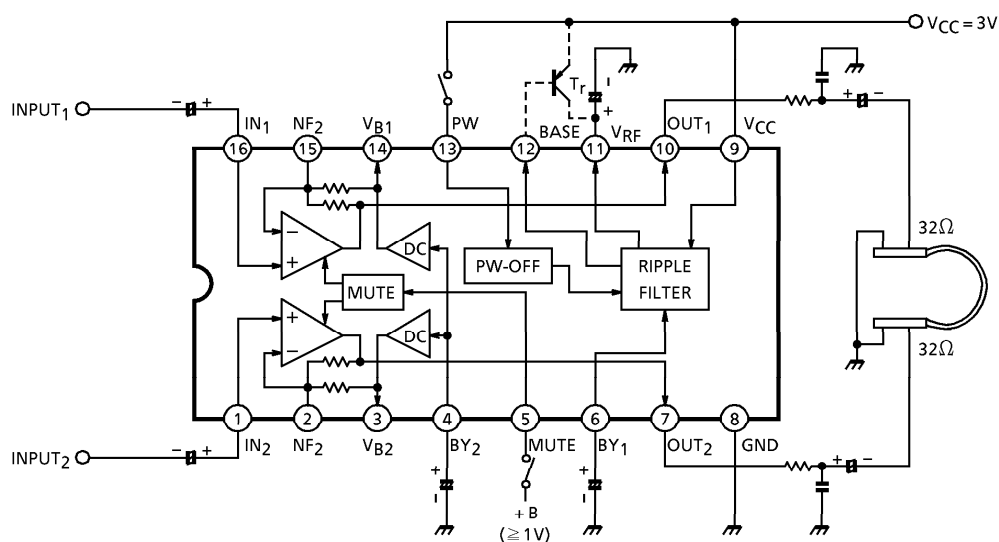
- Small installed area and few external parts
- Low supply current :  $I_{CCQ} = 7\text{mA}$  (Typ.) at 3V
- Built-in a ripple filter
- Built-in a power amplifier mute
- Built-in a power off circuit
- Operating supply voltage range :  $V_{CC}(\text{opr}) = 1.8\sim 5\text{V}$
- Recommended supply voltage :  $V_{CC} = 3\text{V}$
- The standard model is TA7688F (SO)



SSOP16-P-225-1.00A

Weight : 0.14g (Typ.)

### BLOCK DIAGRAM



Dotted Line is an additional circuit to boost the stabilized current. (Option)

## APPLICATION NOTE

## 1. Voltage gain adjustment

The closed loop Voltage gain  $G_V$  is determined by the ratio of  $R_1$  and  $R_2$  shown in Fig.1.

$$G_V = 20 \log \frac{R_1 + R_2}{R_2} = 32 \text{dB}$$

But the actual value is 30.5dB because of influence of the other circuit.

Fig.2 shows the application circuit of higher or lower gain than recommended one.

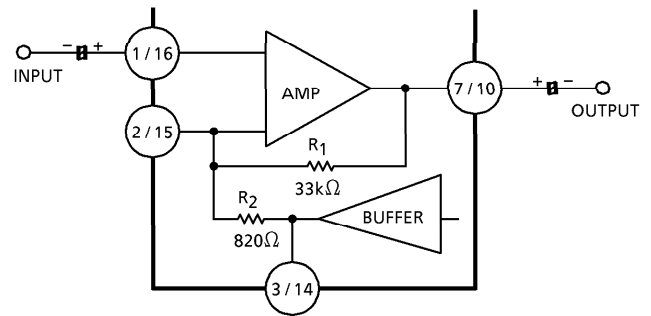


Fig.1

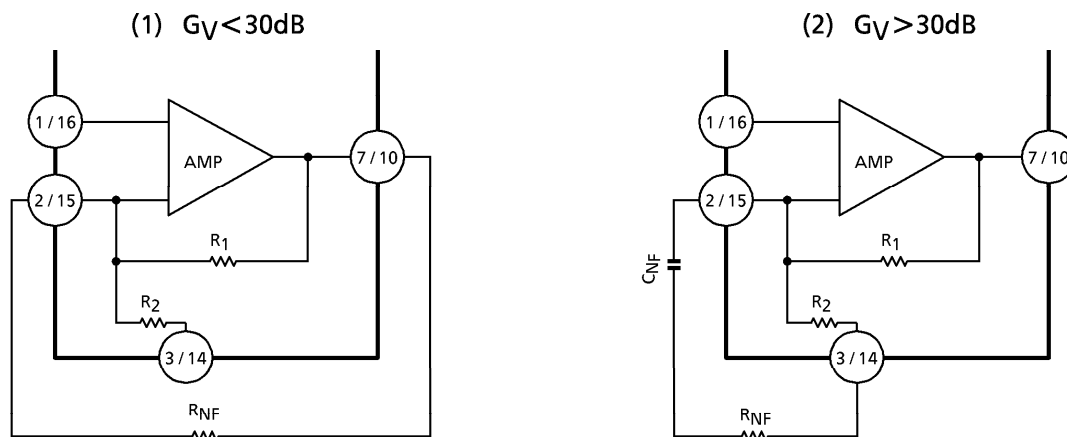


Fig.2

In the case of  $G_V < 30 \text{dB}$ , it happens to oscillate by phase delay at high frequency.

So this IC is not available at  $G_V < 30 \text{dB}$ . In the case of  $G_V > 30 \text{dB}$ , input offset is amplified, so that output DC voltage differs from center voltage. The unsymmetrical clipping wave is prevented by inserting capacitor  $C_{NF}$ .

Therefore this IC is available at  $G_V > 30 \text{dB}$  by using  $C_{NF}$ .

It is recommended to check pop noise based on  $C_{NF}$ .

## 2. Muting

Muting operates when the voltage is applied to pin 5 or the current is flowed into pin 5.

Supply current is about half at muting ON.

It is necessary that muting drive current  $I_{MUTE}$  is less than  $150\mu A$ .

## 3. Oscillation precaution

(1) Oscillation preventing capacitor between output pin and GND is recommended to use capacitor with less temperature drift.

So suitable capacitor is not celamic or electrolytic capacitor, but tantalum or polyester film capacitor.

When protector resistor  $3.9\Omega$  is rejected, output power increases.

In this case, it is necessary to insert  $3.9\Omega$  as shown in Fig.4.

When  $R_L = 0$ , output current is very large in the circuit.

(2) It is necessary to use tantalum capacitor at Pin 11 ( $22\mu F$ ).

(3) Decoupling capacitor  $C_{10}$  is necessary to be near the pin 9.

## 4. Radiation precaution

Because of wide band (about 200kHz), the radiation from the amplifier degrade S/N at radio. As shown in Fig.5, it recommended to limit the band by C and R.

In this case, phase compensation check is necessary.

When  $C = 100pF$ ,  $R = 15k\Omega$ ,  $f_{HC}$  is 30~50kHz.

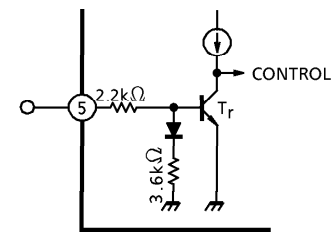


Fig.3

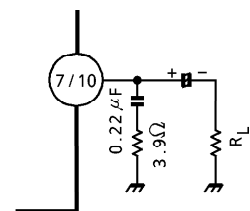


Fig.4

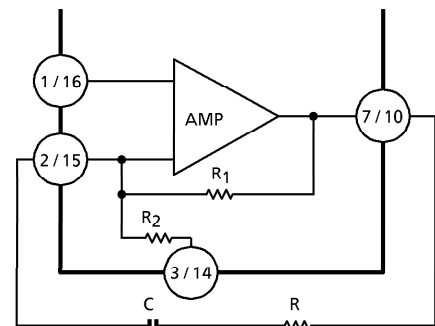


Fig.5

## MAXIMUM RATINGS ( $T_a = 25^\circ C$ )

| CHARACTERISTIC           | SYMBOL    | RATING   | UNIT       |
|--------------------------|-----------|----------|------------|
| Supply Voltage           | $V_{CC}$  | 7        | V          |
| Output Current           | $I_O$     | 160 / ch | mA         |
| Filter Output Current    | $I_R$     | 10       | mA         |
| Power Dissipation (Note) | $P_D$     | 350      | mW         |
| Operating Temperature    | $T_{opr}$ | - 25~75  | $^\circ C$ |
| Storage Temperature      | $T_{stg}$ | - 55~150 | $^\circ C$ |

Note : Derated above  $T_a = 25^\circ C$  in the proportion of  $2.8mW/^\circ C$ .

## ELECTRICAL CHARACTERISTICS

1. AC characteristics (Unless otherwise specified,  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 3\text{V}$ ,  $R_g = 600\Omega$ ,  $f = 1\text{kHz}$ )  
 $R_H = 3.9\Omega$ ,  $R_L = 32\Omega$

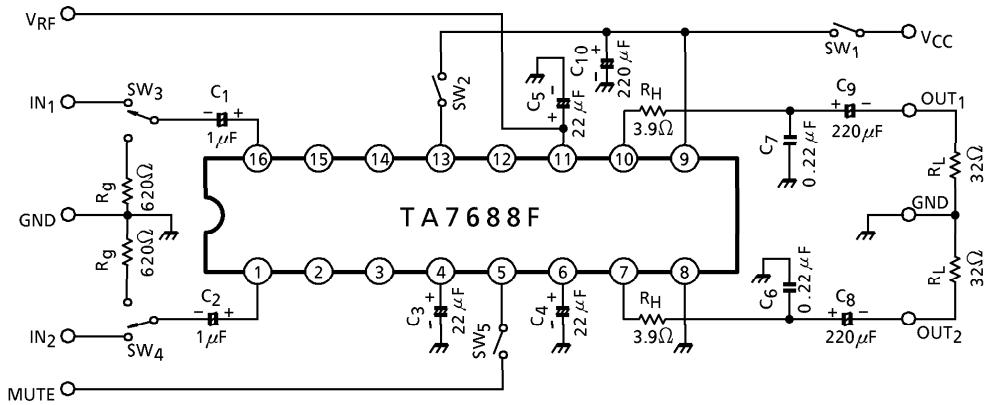
| CHARACTERISTIC               | SYMBOL        | TEST CIR-<br>CUIT | TEST CONDITION                                        | MIN. | TYP. | MAX.    | UNIT              |
|------------------------------|---------------|-------------------|-------------------------------------------------------|------|------|---------|-------------------|
| Quiescent Current            | $I_{CCO}(1)$  | —                 | $V_{in} = 0$                                          | —    | 7    | 12      | mA                |
|                              | $I_{CCO}(2)$  |                   | $V_{in} = 0$ , $SW_2$ : OFF                           | —    | 1    | 10      | $\mu\text{A}$     |
| Output Power                 | $P_O(1)$      | —                 | THD = 10%                                             | 20   | 27   | —       | mW                |
|                              | $P_O(2)$      |                   | $R_L = 16\Omega$ , THD = 10%                          | —    | 38   | —       |                   |
| Total Harmonic Distortion    | THD           | —                 | $P_O = 10\text{mW/ch}$                                | —    | 0.12 | 1.0     | %                 |
| Closed Loop Voltage Gain     | $G_V$         | —                 | $V_{in} = -42\text{dBV}$                              | 28.5 | 30.5 | 32.5    | dB                |
| Channel Balance              | $\Delta G_V$  | —                 | $V_{in} = -42\text{dBV}$                              | —    | 0    | $\pm 1$ | dB                |
| Cross Talk                   | CT            | —                 | $V_O = -2\text{dBV}$ , $ch1 \leftrightarrow ch2$      | 45   | 65   | —       | dB                |
| Ripple Rejection             | Headphone AMP | RR (1)            | $f_r = 1\text{kHz}$ , $V_r = -22\text{dBV}$           | 30   | 45   | —       | dB                |
|                              | Ripple Filter | RR (2)            | $f_r = 100\text{Hz}$ , $V_r = -22\text{dBV}$          | —    | 40   | —       | dB                |
| Output Noise Voltage         | $V_{no}$      | —                 | BPF = 20Hz~20kHz                                      | —    | 0.06 | 0.2     | $\text{mV}_{rms}$ |
| Input Resistance             | $R_{IN}$      | —                 | $f = 1\text{kHz}$                                     | 15   | 20   | 25      | $\text{k}\Omega$  |
| Ripple Filter Output Voltage | $V_{RF}(1)$   | —                 | $V_{CC} = 2\text{V}$ , $I_{RF} = 10\text{mA}$         | 1.45 | 1.6  | —       | V                 |
|                              | $V_{RF}(2)$   |                   | $I_{RF} = 10\text{mA}$                                | 2.1  | 2.3  | 2.5     |                   |
|                              | $V_{RF}(3)$   |                   | $V_{CC} = 4.5\text{V}$ , $I_{RF} = 10\text{mA}$       | —    | 3.4  | —       |                   |
| Muting Attenuation           | ATT           | —                 | $V_{MUTE} = 3\text{V}$ (0dB = 240 $\text{mV}_{rms}$ ) | 60   | 80   | —       | dB                |
| Muting Input Voltage         | $V_{MUTE}$    | —                 | ATT $\geq 50\text{dB}$ (0dB = 240 $\text{mV}_{rms}$ ) | —    | 0.7  | 1.0     | V                 |
| Muting Input Current         | $I_{MUTE}$    | —                 | ATT $\geq 50\text{dB}$ (0dB = 240 $\text{mV}_{rms}$ ) | —    | 35   | —       | $\mu\text{A}$     |
| Ripple Filter Current        | $I_B$         | —                 | —                                                     | —    | 0.05 | —       | mA                |

## 2. DC characteristics

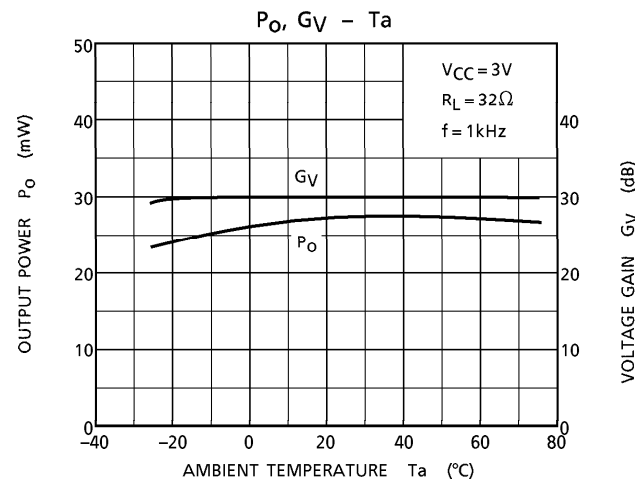
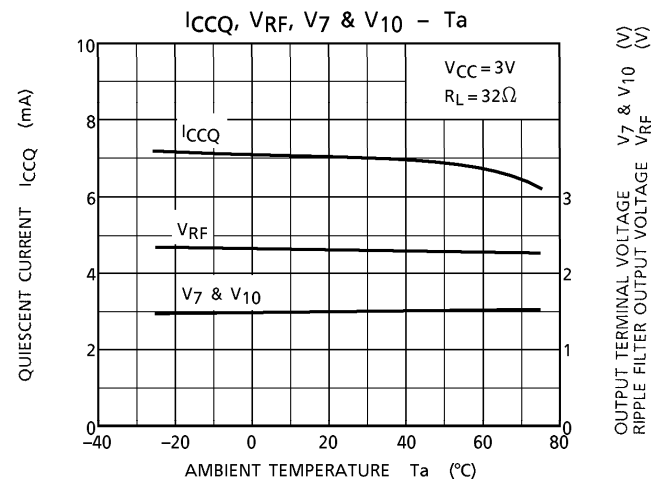
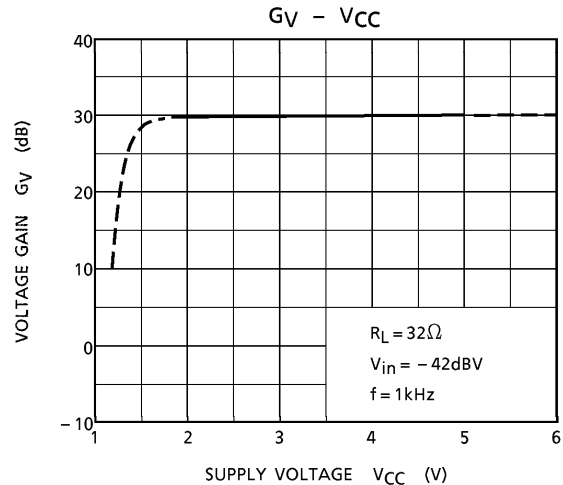
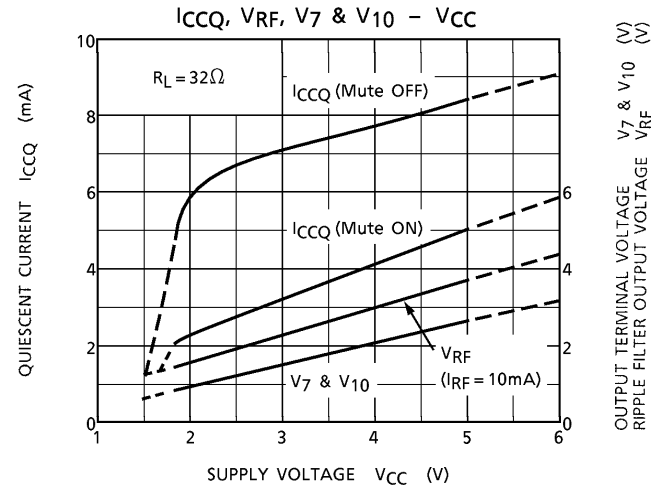
( $T_a = 25^\circ\text{C}$ ,  $V_{CC} = 3\text{V}$ , Terminal voltage at no signal)

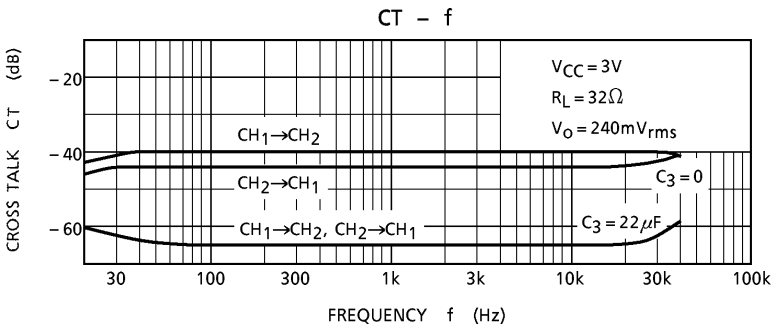
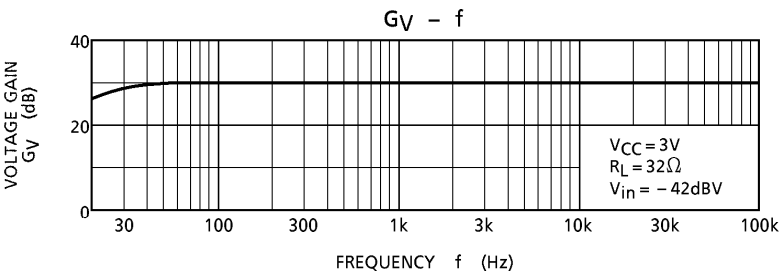
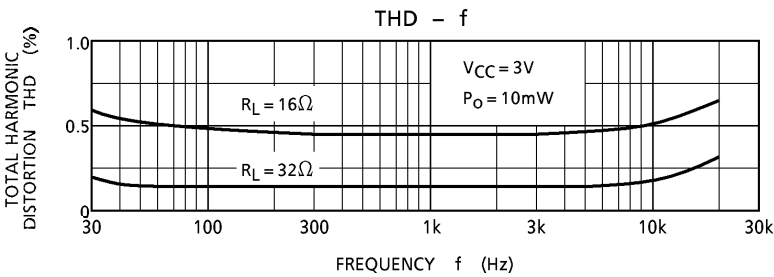
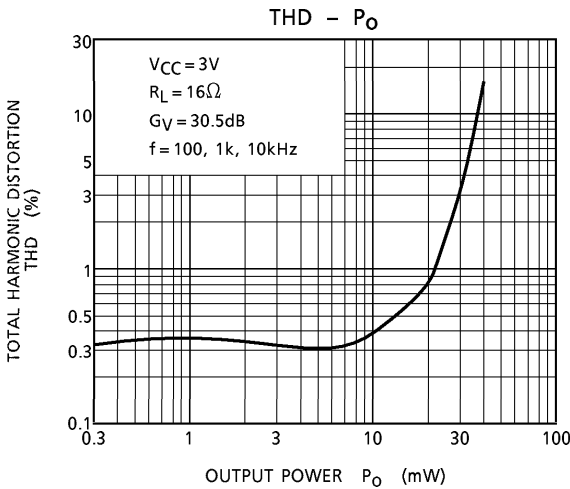
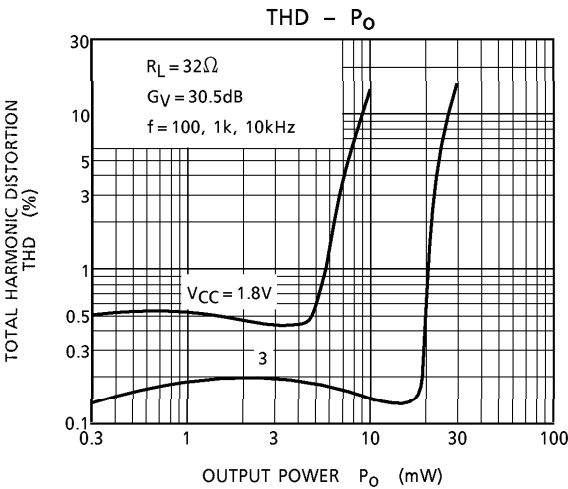
| ITEM                  | SYMBOL   | RATING | UNIT |
|-----------------------|----------|--------|------|
| Terminal 1 ( $IN_2$ ) | $V_1$    | 1.5    | V    |
| 2 ( $NF_2$ )          | $V_2$    | 1.5    | V    |
| 3 ( $VB_2$ )          | $V_3$    | 1.5    | V    |
| 4 ( $BYPASS_2$ )      | $V_4$    | 1.5    | V    |
| 5 (MUTE)              | $V_5$    | 0      | V    |
| 6 ( $BYPASS_1$ )      | $V_6$    | 2.2    | V    |
| 7 ( $OUT_2$ )         | $V_7$    | 1.5    | V    |
| 8 (GND)               | $V_8$    | 0      | V    |
| 9 ( $V_{CC}$ )        | $V_9$    | 3.0    | V    |
| 10 ( $OUT_1$ )        | $V_{10}$ | 1.5    | V    |
| 11 ( $V_{RF}$ )       | $V_{11}$ | 2.3    | V    |
| 12 (BASE)             | $V_{12}$ | 2.2    | V    |
| 13 (PW ON / OFF)      | $V_{13}$ | 3.0    | V    |
| 14 ( $VB_1$ )         | $V_{14}$ | 1.5    | V    |
| 15 ( $NF_1$ )         | $V_{15}$ | 1.5    | V    |
| 16 ( $IN_1$ )         | $V_{16}$ | 1.5    | V    |

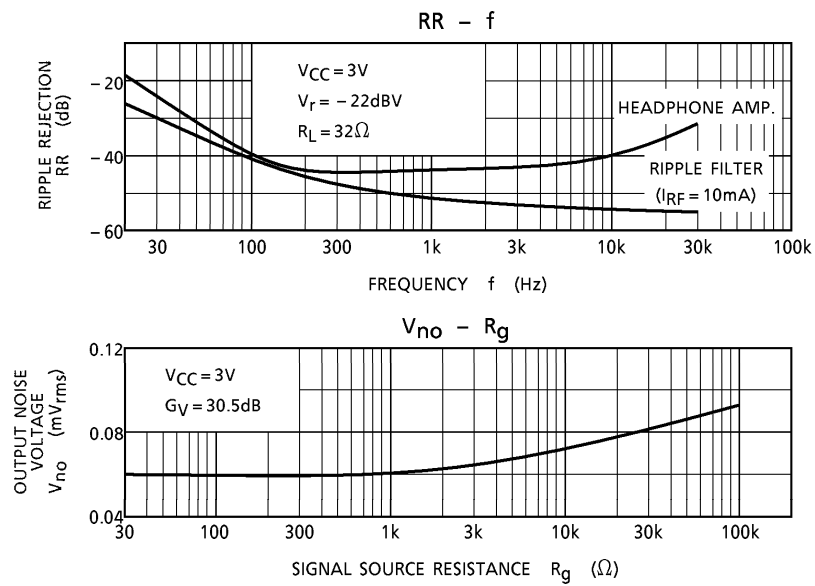
TEST CIRCUIT



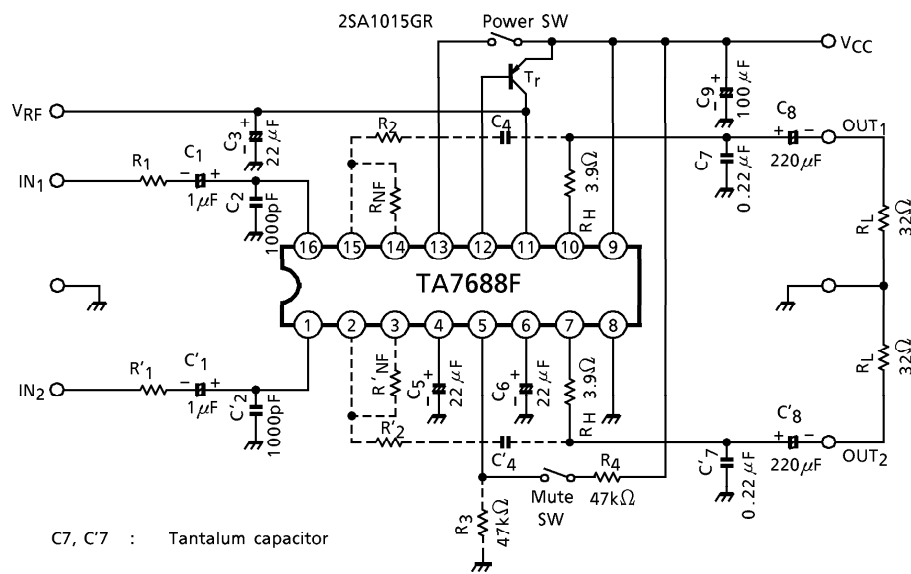
Note :  $R_H$  : Protection resistance  
 $C_6$  &  $C_7$  : Tantalum capacitor or polyester film capacitor  
 $C_5$  : Tantalum capacitor





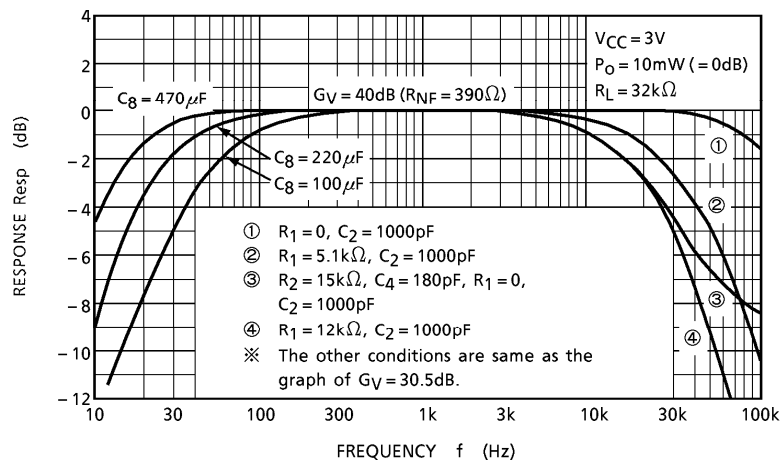
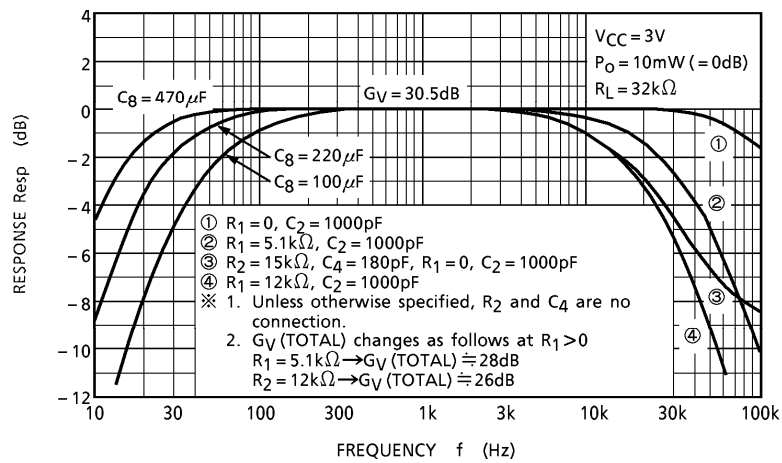


## APPLICATION CIRCUIT

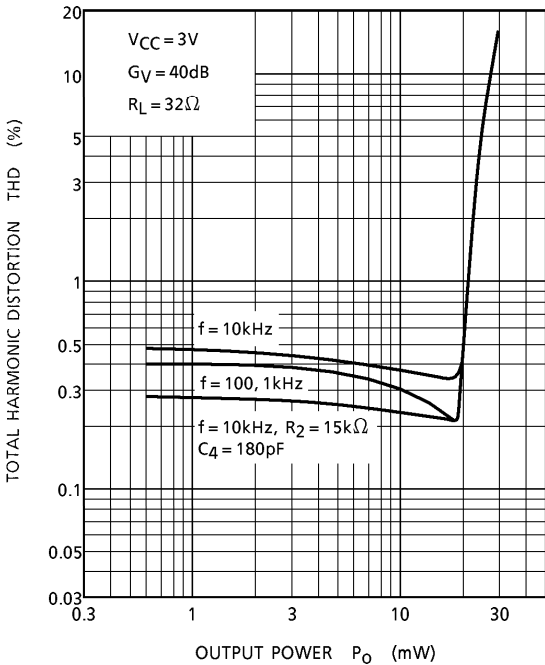
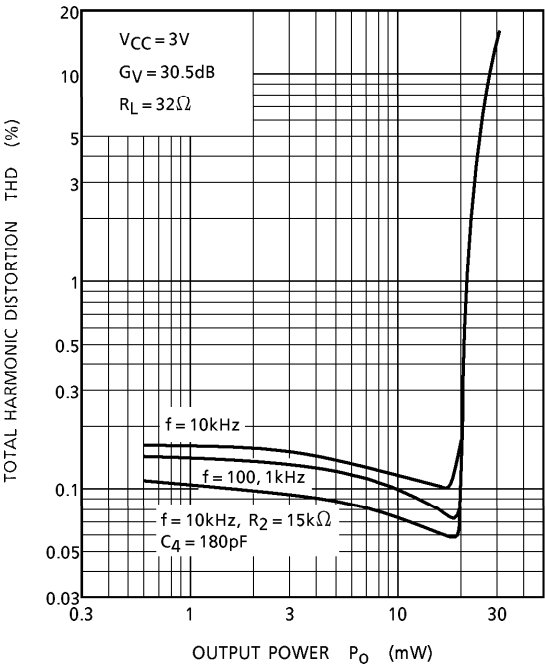


EXTERNAL PARTS TABLE (Mention only CH<sub>1</sub>)

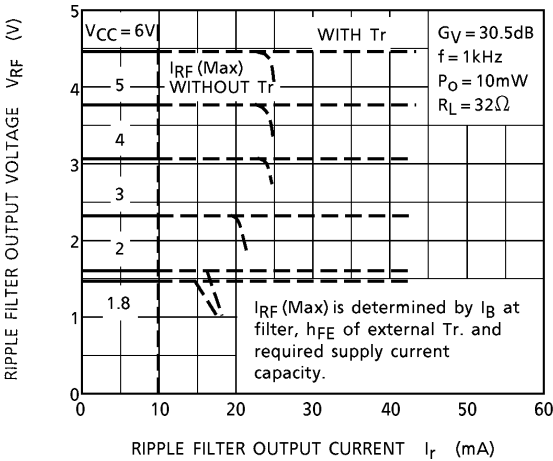
| PARTS No.       | TYPICAL         | PURPOSE                                           | INFLUENCE                                                                                                                                       |                                              | NOTE                                          |
|-----------------|-----------------|---------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------|-----------------------------------------------|
|                 |                 |                                                   | SMALLER THAN TYP.                                                                                                                               | GREATER THAN TYP.                            |                                               |
| C <sub>1</sub>  | 1 $\mu$ F       | Coupling                                          | Bad low frequency response                                                                                                                      | "P <sub>op</sub> " noise is high.            | Input                                         |
| C <sub>2</sub>  | 1000pF          | LPF                                               | $f_{CH} = \frac{1}{2\pi C_2 (R_1 // Z_{in})}$ – 3dB (30kHz) at R <sub>1</sub> = 5.6k $\Omega$<br>– 3dB (20kHz) at R <sub>1</sub> = 12k $\Omega$ |                                              | Noise receiving protection                    |
| R <sub>1</sub>  | —               |                                                   |                                                                                                                                                 |                                              | Equivalent signal source impedance            |
| C <sub>3</sub>  | 22 $\mu$ F      | Decoupling for V <sub>RF</sub>                    | Stability (OSC) decreases, V <sub>no</sub> at V <sub>RF</sub> increases                                                                         | (It is better to connect to input side GND)  | Use tantalum capacitor                        |
| R <sub>NF</sub> | —               | G <sub>V</sub> Adjustment                         | Not available at G <sub>V</sub> < 30dB<br>If necessary devide at input level by resistors                                                       |                                              | —                                             |
| R <sub>2</sub>  | (15k $\Omega$ ) | f-response control, THD improvement at high freq. | – 3dB point is 20kHz.<br>Check ringing at clip by OSC margine down.                                                                             |                                              | Low OSC margine at G <sub>V</sub> < 40dB      |
| C <sub>4</sub>  | (180pF)         |                                                   |                                                                                                                                                 |                                              |                                               |
| C <sub>5</sub>  | 22 $\mu$ F      | Bypass capacitor for bias                         | THD and V <sub>no</sub> Degradation                                                                                                             | —                                            | It is better to connect to input side GND.    |
| C <sub>6</sub>  | 22 $\mu$ F      | Bypass capacitor for ripple filter                | Ripple rejection ratio degradation                                                                                                              | —                                            | It is better to connect to output side GND.   |
| R <sub>3</sub>  | 47k $\Omega$    | Pull down resistor at mute pin                    | I <sub>CC</sub> increases at mute ON                                                                                                            | Pull down effect down                        | Additional resistor at long pattern only      |
| R <sub>4</sub>  | 47k $\Omega$    | I <sub>MUTE</sub> limiter                         | I <sub>MUTE</sub> increases (Unnecessary at V <sub>CC</sub> = 3V)                                                                               | I <sub>MUTE</sub> decreases                  | I <sub>MUTE</sub> < 150 $\mu$ A               |
| R <sub>H</sub>  | 3.9 $\Omega$    | Protection resistance. Phase compensation         | Rush current increases. Phase compensation is out.                                                                                              | Output decreases. Phase compensation is out. | CR filter with C <sub>7</sub>                 |
| C <sub>7</sub>  | 0.22 $\mu$ F    | Phase compensation                                | Oscillation                                                                                                                                     | THD degradation by load capacitance          | Recommended to use tantalum or film capacitor |
| C <sub>8</sub>  | 220 $\mu$ F     | Coupling                                          | Bad low frequency response                                                                                                                      | "P <sub>op</sub> " noise is high.            | Output                                        |
| C <sub>9</sub>  | 100 $\mu$ F     | V <sub>CC</sub> decoupling                        | Oscillation margin decreases                                                                                                                    | —                                            | Necessary to be near pin 9                    |
| T <sub>r</sub>  | 2SA1015GR       | Booster for V <sub>RF</sub>                       | —                                                                                                                                               | —                                            | To be added at I <sub>RF</sub> > 10mA         |

1. f-Resp (Mention Only CH<sub>1</sub>)

2. P<sub>O</sub>-THD (Correspond to 1. f-Resp)

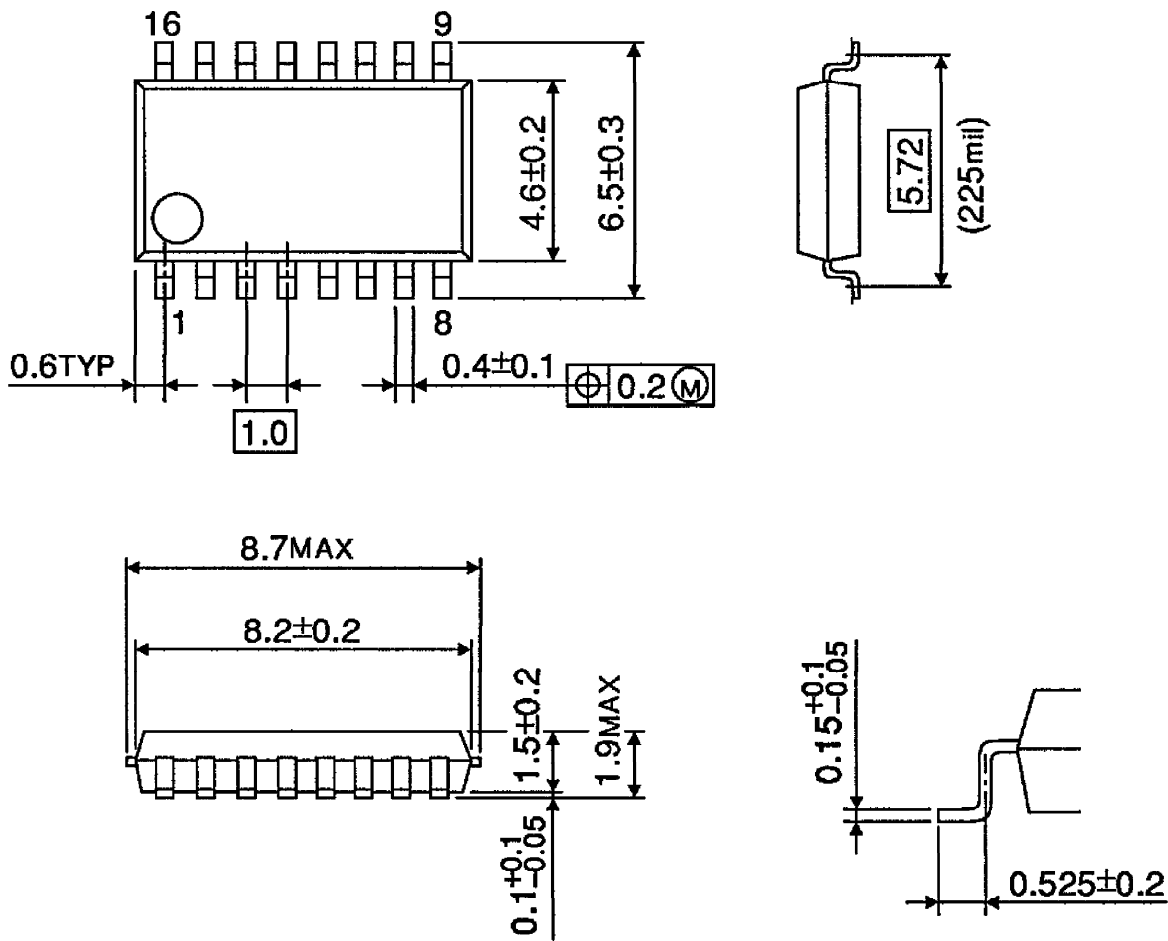


3. I<sub>RF</sub>-V<sub>RF</sub>



PACKAGE DIMENSIONS  
SSOP16-P-225-1.00A

Unit : mm



Weight : 0.14g (Typ.)

**RESTRICTIONS ON PRODUCT USE**

000707EBA

- 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..
- 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.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.