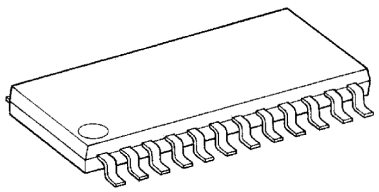
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

# TA8157AF,TA8157AFN

## Stereo Headphone Power Amplifier (1.5V USE)

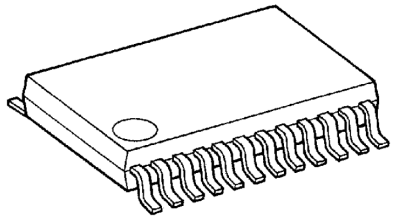
The TA8157AF and TA8157AFN are developed for play−back stereo headphone equipments at low voltage operation (1.5V use). Those are built in bass boost function.

TA8157AF



SSOP24-P-300-1.00

TA8157AFN



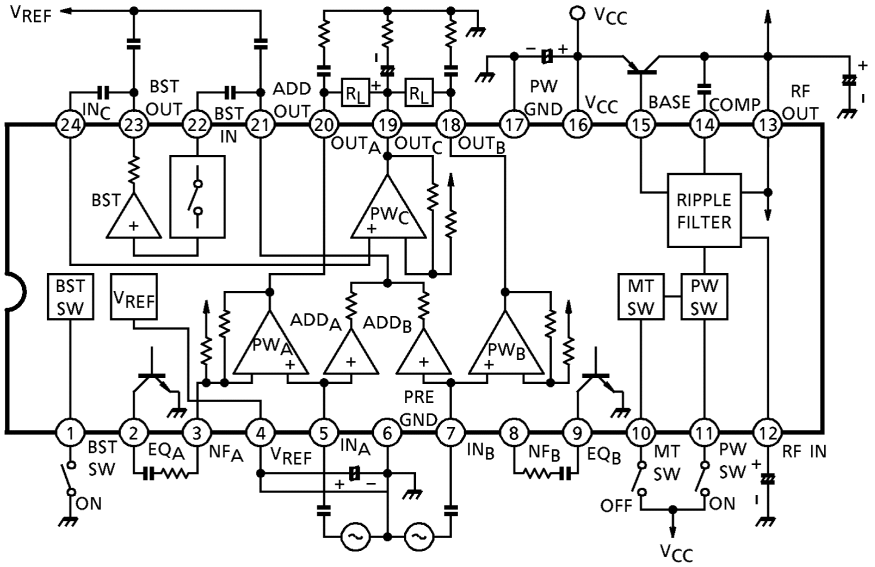
SSOP24-P-300-0.65A

Weight
SSOP24−P−300−1.00: 0.32g (typ.)
SSOP24−P−300−0.65A: 0.14g (typ.)

### Features

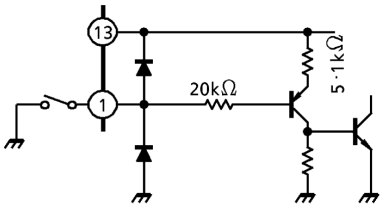
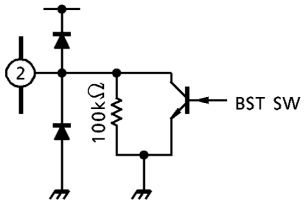
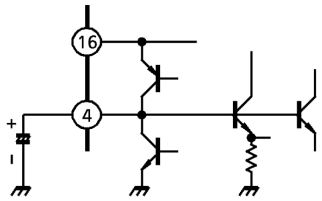
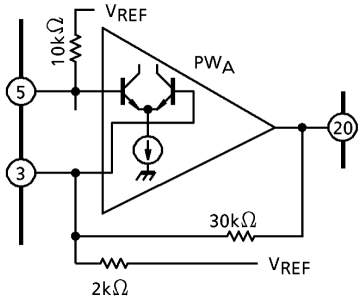
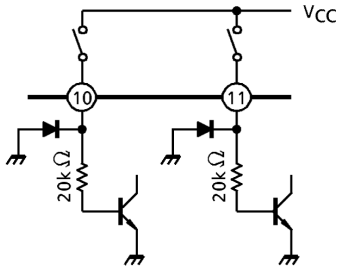
- OCL (output condenser less)
- Built−in ripple filter
- Output power ($V_{CC}$ = 1.5V, f = 1kHz, THD = 10%, $R_L$ = 16Ω)
  $P_o$ = 9mW (typ.)
- Voltage gain: $G_V$ = 24dB (typ.)
- Built−in boost amplifier
- Built−in power switch
- Built−in muting circuit
- Low quiescent supply current (Ta = 25°C)
  $I_{CCQ}$ = 8mA (typ.)
- Excellent ripple rejection ratio: RR = 55dB (typ.)
- Low noise: $V_{no}$ = 25μ$V_{rms}$ (typ.)
- Operating supply voltage range (Ta = 25°C)
  $V_{CC}$ (opr) = 0.9~2.2V

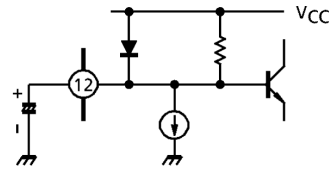
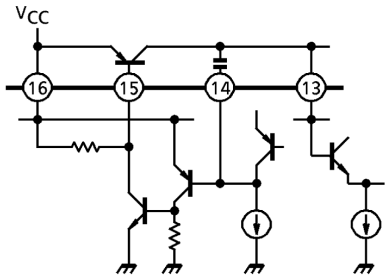
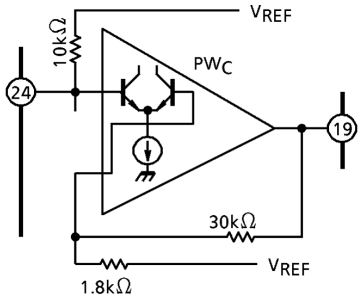
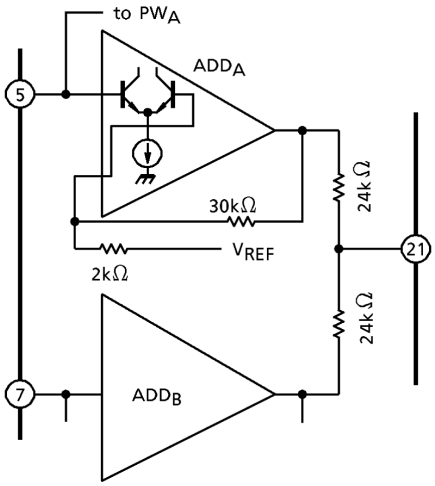
### Block Diagram

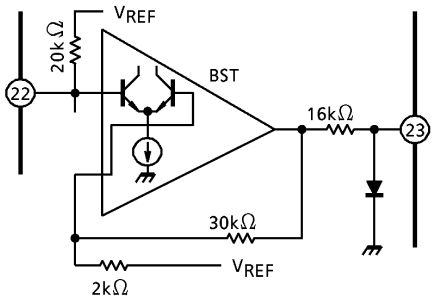


## Terminal Explanation

(terminal voltage: Typical terminal voltage at no signal with test circuit, $V_{CC}$ = 1.2V, Ta = 25°C)

| Terminal No. | Terminal Name | Function | Internal Circuit | Terminal Voltage (V) |
|---|---|---|---|---|
| 1 | BST SW | Boost amplifier on / off switch (synchronized with equalizer circuit)<br>$V_{CC}$ / OPEN: BST amp. ON<br>GND: BST amp. OFF |  | — |
| 2 | $EQ_A$ | Equalizer circuit (controlled by BST SW)<br>On resistance: 60Ω (typ.) |  | — |
| 9 | $EQ_B$ | | | |
| 4 | $V_{REF}$ | Reference voltage |  | 0.75 |
| 5 | $IN_A$ | Input of power amplifier (This terminal is common with input of adder amplifier.) |  | 0.75 |
| 7 | $IN_B$ | | | |
| 3 | $NF_A$ | NF of power amplifier | | 0.75 |
| 8 | $NF_B$ | | | |
| 20 | $OUT_A$ | Output of power amplifier | | 0.6 |
| 18 | $OUT_B$ | | | |
| 6 | PRE GND | — | — | 0 |
| 10 | MT SW | Muting switch for power amplifier<br>$V_{CC}$: Power amp. ON<br>GND / OPEN: Power amp. OFF |  | — |
| 11 | PW SW | Power switch<br>$V_{CC}$: Power ON<br>GND / OPEN: Power OFF | | — |

| Terminal No. | Terminal Name | Function | Internal Circuit | Terminal Voltage (V) |
|---|---|---|---|---|
| 12 | RF IN | Ripple filter terminal |  | 1.2 |
| 13 | RF OUT | Output of ripple filter<br>Ripple filter circuit supplies $V_{REF}$ circuit, adder amplifier and boost amplifier with power source. |  | 1.13 |
| 14 | COMP | Phase−compensation terminal for a ripple filter circuit | | 0.7 |
| 15 | Base | Base biasing terminal of transistor for ripple filter | | 0.5 |
| 16 | $V_{CC}$ | — | — | 1.2 |
| 17 | PW GND | — | — | 0 |
| 19 | $OUT_C$ | Output of center amplifier |  | 0.6 |
| 24 | $IN_C$ | Input of center amplifier | | 0.75 |
| 21 | ADD OUT | Output of adder amplifier<br>Input of adder amplifier is common with input of power amplifier. |  | 0.6 |

| Terminal | | Function | Internal Circuit | Terminal Voltage (V) |
|---|---|---|---|---|
| No. | Name | | | |
| 22 | BST IN | Input of boost amplifier |  | 0.75 |
| 23 | BST OUT | Output of boost amplifier (controlled by boost switch)<br>BST ON: BST amp. ON<br>BST OFF: BST amp. OFF (cut off input signal of BST amp.) | | 0.6 |

## Application Note

(1) PW SW

It is necessary to connect an external pull–down resistor with terminal PW SW (pin(11)), in case that this IC is turned on due to external noise etc.

(2) MT SW

The leak current flows through the terminal of MT SW (pin(10)), in case that this terminal is connected with $V_{CC}$ line independently, even though this IC is off–mode (the terminal of PW SW (pin(11)) is off–mode). It is necessary to connect an external pull–down resistor with terminal MT SW, in case that this IC is turned on due to external noise etc.

(3) BST SW

The leak current never flows through the terminal of BST SW (pin(1)) even though this terminal is at any condition, because the ripple filter circuit supplies the BST SW circuit with power source. The terminal of BST SW should not be applied higher voltage than $V_{CC}$, to prevent IC from destruction. It is necessary to connect an external pull–up resistor with terminal BST SW, in case that this IC doesn't operate normally due to external noise etc.
In case that boost amplifier is on, BST SW terminal should be appliied $V_{CC}$ ~($V_{CC}$–0.3V).

(4) Input of amplifier

Each input signal should be applied through a condenser. In case that DC current or DC voltage is applied to each amplifier, the internal circuit has unbalance and the each amplifier doesn't operate normally.
It is advised that input signal refer to voltage of $V_{REF}$, in order to reduce a pop sound.

(5) Ripple filter

It is necessary to connect a transistor for ripple filter, because this IC doesn't have transistor for ripple filter. Care should be taken to stabilize the ripple filter circuit, because the ripple filter circuit supplies $V_{REF}$ circuit, adder amplifier and boost amplifier with power source.

## Maximum Ratings (Ta = 25°C)

| Characteristic | | Symbol | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | | $V_{CC}$ | 4.5 | V |
| Output current | | $I_{O\ (Peak)}$ | 100 | mA |
| Power dissipation | TA8157AF | $P_D$ (Note) | 400 | mW |
| | TA8157AFN | | 500 | |
| Operating temperature | | $T_{opr}$ | −25~75 | °C |
| Storage temperature | | $T_{stg}$ | −55~150 | |

(Note) Derated above Ta = 25°C in the proportion of 3.2mW / °C for TA8157AF, and of 4mW / °C for TA8157AFN.

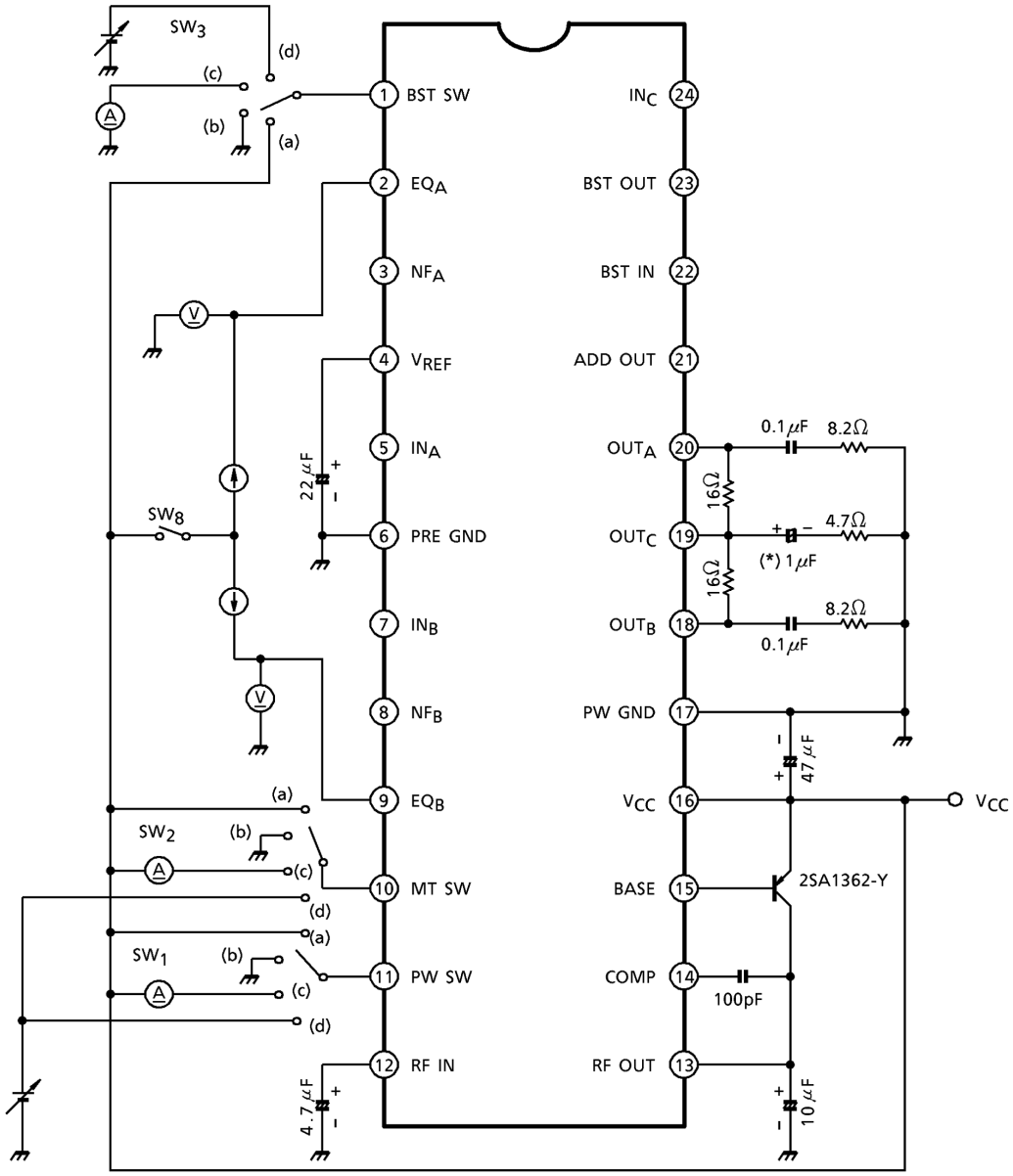
## Electrical Characteristics

Unless Otherwise Specified : $V_{CC}$ = 1.2V, $R_L$ = 16Ω, $R_g$ = 600Ω, f = 1kHz, Ta = 25°C
$SW_1$: a, $SW_2$: a, $SW_3$: b, $SW_4$: a, $SW_5$: a
$SW_6$: a, $SW_7$: ON, $SW_8$: OPEN

| Characteristic | | Symbol | Test Cir−cuit | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| Quiescent supply current | | $I_{CC1}$ | 1 | Power OFF, $SW_1$: b<br>$SW_2$: b | — | 0.1 | 5 | μA |
| | | $I_{CC2}$ | | Power amp. OFF, $SW_2$: b | — | 2.4 | 4.0 | mA |
| | | $I_{CC3}$ | | $V_{in}$ = 0 | — | 8 | 11.5 | |
| Power amplifier stage | Voltage gain 1 | $G_{V1}$ | 2 | $V_{o\ (A)} = V_{o\ (B)}$ = −22dBV | 22 | 24 | 26 | dB |
| | Channel balance | CB1 | | | — | 0 | 1.5 | |
| | Output power 1 | $P_{o1}$ | 2 | $V_{CC}$ = 1.5V<br>THD (A) = THD (B) = 10% | 5 | 9 | — | mW |
| | Output power 2 | $P_{o2}$ | | $V_{CC}$ = 1.5V<br>THD (A) = THD (B) = 10%<br>$V_{in\ (A)} = V_{in\ (B)} = -V_{in\ (C)}$<br>f = 100Hz, * BTL operation<br>$SW_3$: a, $SW_5$: b | 8 | 14 | — | |
| | Total harmonic distortion | THD | 2 | $P_{o\ (A)} = P_{o\ (B)}$ = 1mW | — | 0.6 | 1 | % |
| | Output noise voltage | $V_{no}$ | 2 | BPF = 20Hz~20kHz, $SW_4$: b | — | 25 | 40 | $\mu V_{rms}$ |
| | Cross talk | CT | 2 | Vo = −22dBV, SW4: b | 35 | 42 | — | dB |
| | Ripple rejection ratio | RR1 | 2 | $V_{CC}$ = 1.0V, $f_r$ = 100Hz<br>$V_r$ = −32dBV, $SW_7$: OPEN | 45 | 55 | — | |
| | Muting attenuation | ATT1 | 2 | $V_o$ = −22dBV, $SW_2$: a→b | — | 73 | — | |

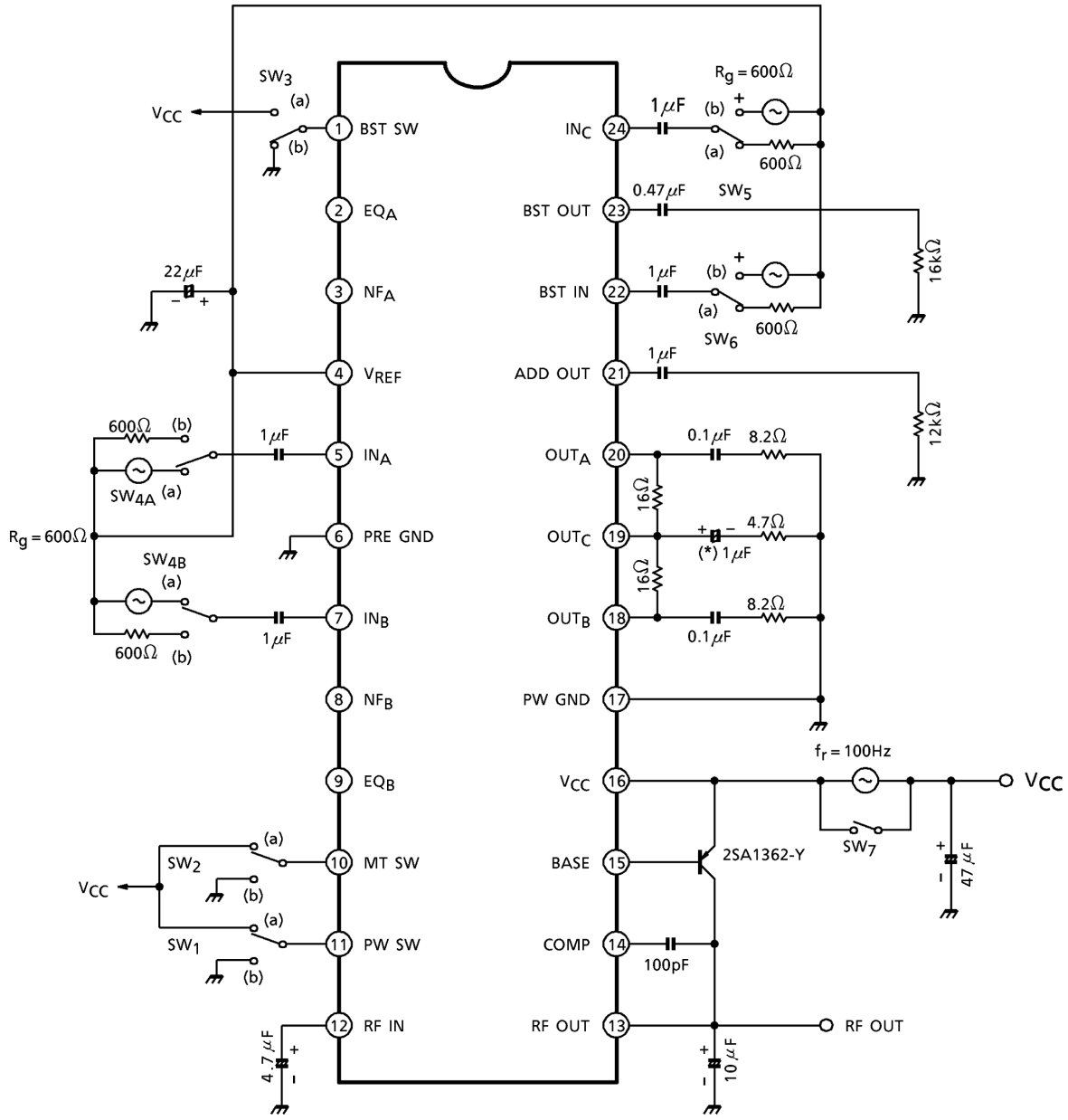
| Characteristic | | Symbol | Test Cir–cuit | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| Bass boost function stage | ADD amp. voltage gain | $G_{V2}$ | 2 | $V_{in\ (A)} = V_{in\ (B)}$, $R_L$ = 12kΩ<br>$V_{o\ (ADD)}$ = −22dBV<br>$SW_3$: a / b | 15 | 17.5 | 20 | dB |
| | ADD amp. maximum output voltage | $V_{om2}$ | 2 | $V_{in\ (A)} = V_{in\ (B)}$, $R_L$ = 12kΩ<br>THD (ADD) = 1%, $SW_3$: a / b | 80 | 130 | — | $mV_{rms}$ |
| | BST amp. voltage gain | $G_{V3}$ | 2 | $V_o$ = −37dBV, $R_L$ = 16kΩ<br>$SW_6$: b | 14 | 16.5 | 19 | dB |
| | BST amp. maximum output voltage | $V_{om3}$ | 2 | THD (BST) = 3%, $R_L$ = 16kΩ<br>$SW_6$: b | 55 | 90 | — | $mV_{rms}$ |
| | BST amp. attenuation | ATT3 | 2 | $V_o$ = −32dBV, $SW_3$: a→b<br>$SW_6$: b | — | 73 | — | dB |
| Ripple filter output voltage | | $V_{RF\ OUT}$ | 2 | $V_{CC}$ = 1V, $I_{RF}$ = 20mA | 0.9 | 0.93 | — | V |
| Ripple rejection ratio | | RR4 | 2 | $V_{CC}$ = 1V, $I_{RF}$ = 20mA<br>$f_r$ = 100Hz, $V_r$ = −37dBV<br>$SW_7$: OPEN | 35 | 43 | — | dB |
| Equalizer on resistance | | $R_{ON}$ | 1 | $I_{EQ}$ = 100μA, $SW_3$: a<br>$SW_8$: ON | — | 60 | — | Ω |
| Power switch | On current | $I_{11}$ | 1 | $V_{CC}$ = 0.9V, $V_4$ ≥ 0.5V<br>$SW_1$: c, $SW_2$: b | 5 | — | — | μA |
| | Off voltage | $V_{11}$ | 1 | $V_{CC}$ = 0.9V, $V_4$ ≤ 0.2V<br>$SW_1$: d, $SW_2$: b | 0 | — | 0.3 | V |
| Mute switch | Off current | $I_{10}$ | 1 | $V_{CC}$ = 0.9V, $I_{CC}$ ≥ 4.5mA<br>$SW_2$: c | 5 | — | — | μA |
| | On voltage | $V_{10}$ | 1 | $V_{CC}$ = 0.9V, $I_{CC}$ ≤ 3.5mA<br>$SW_2$: d | 0 | — | 0.3 | V |
| Boost switch | Off current | $I_1$ | 1 | $V_{CC}$ = 0.9V, $I_{EQ}$ = 100μA<br>$V_2$ ≥ 0.7V, $SW_3$: c, $SW_8$: ON | 5 | — | — | μA |
| | On voltage | $V_1$ | 1 | $V_{CC}$ = 0.9V, $I_{EQ}$ = 100μA<br>$V_2$ ≤ 0.2V, $SW_3$: d, $SW_8$: ON | 0.6 | — | 0.9 | V |

## Test Circuit 1




(*) Tantalum condenser

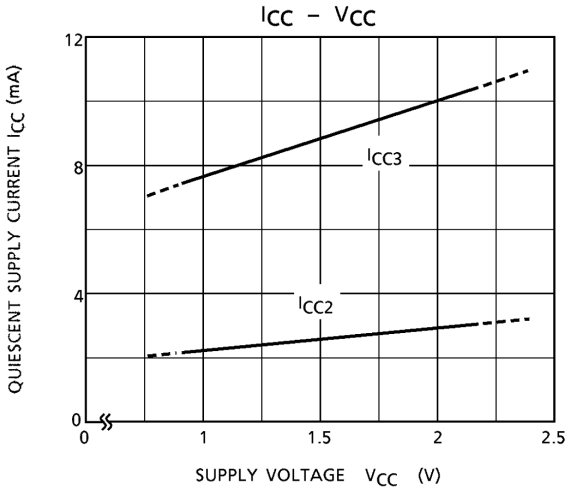
## Test Circuit 2

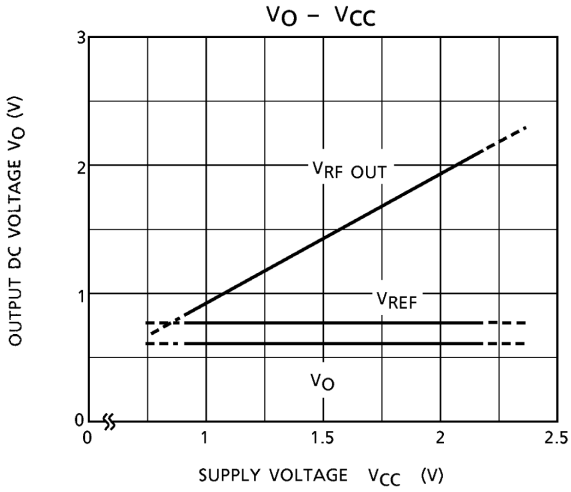


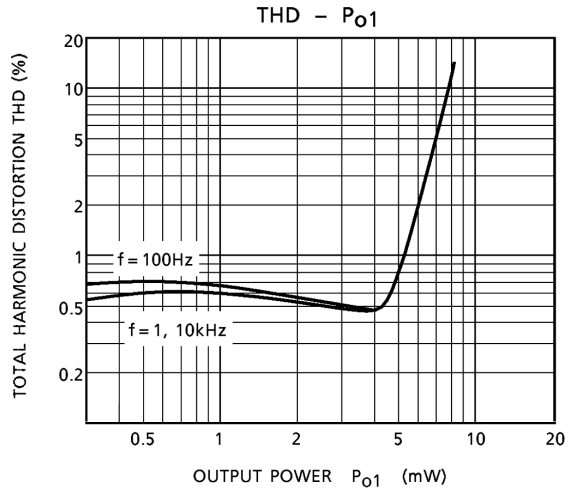

(*) Tantalum condenser

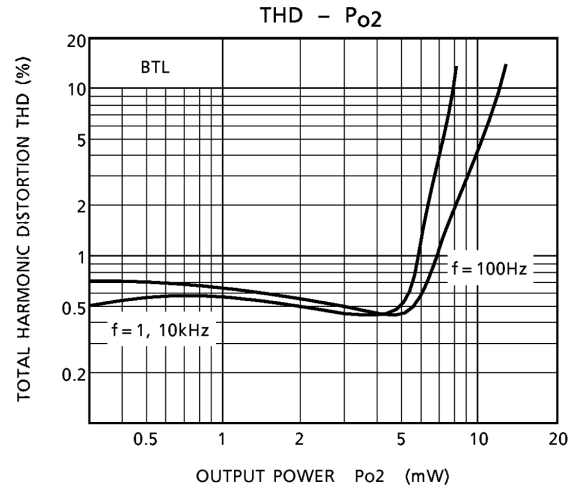
## Characteristic Curves

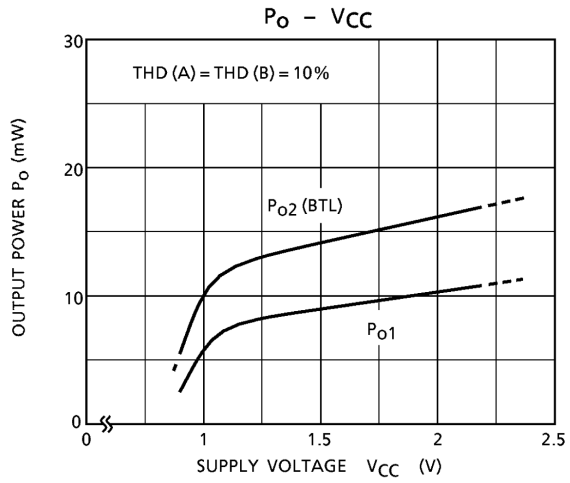
Unless Otherwise Specified: $V_{CC}$ = 1.2V, $R_L$ = 16Ω, $R_g$ = 600Ω, f = 1kHz, Ta = 25°C

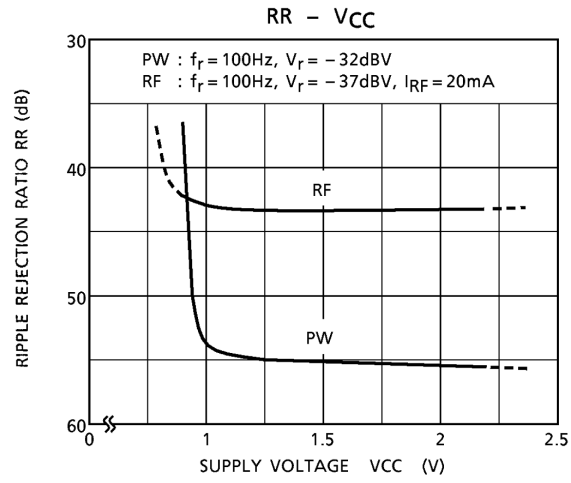


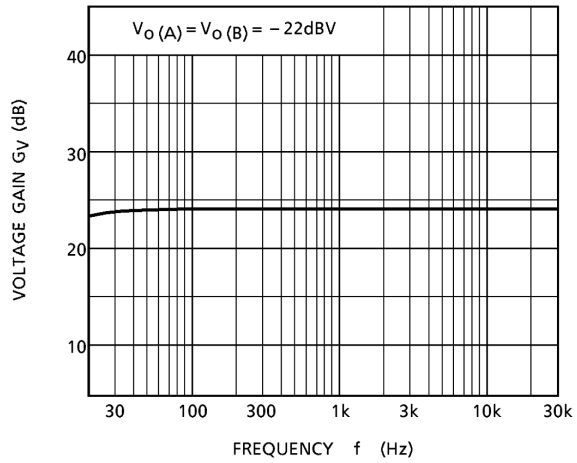



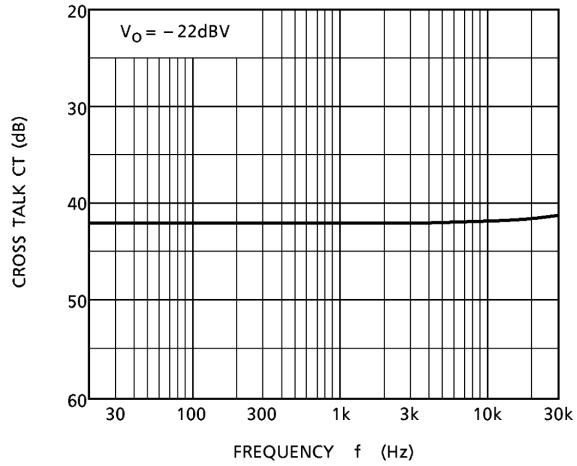



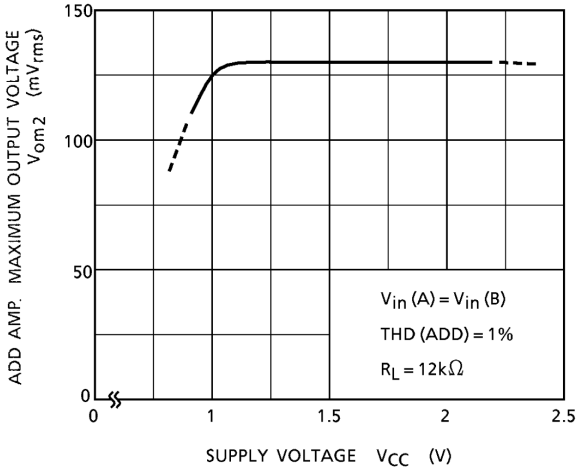
$G_V$ – f



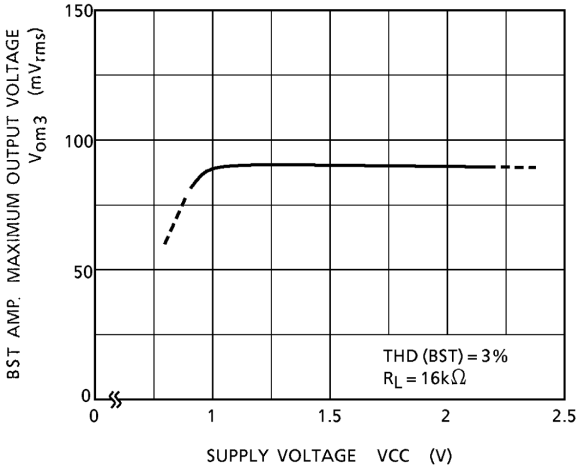

CT – f



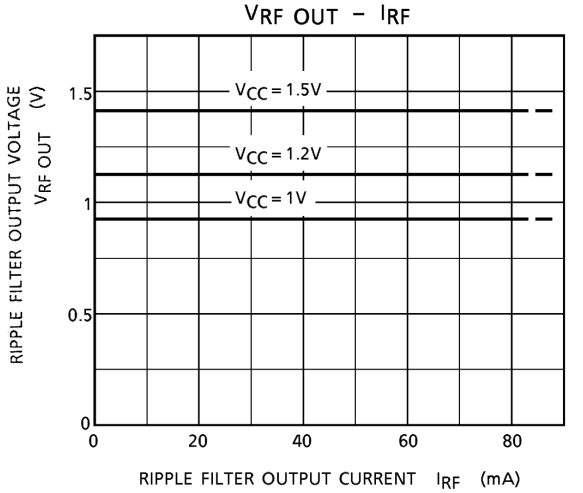

$V_{om2}$ – $V_{CC}$



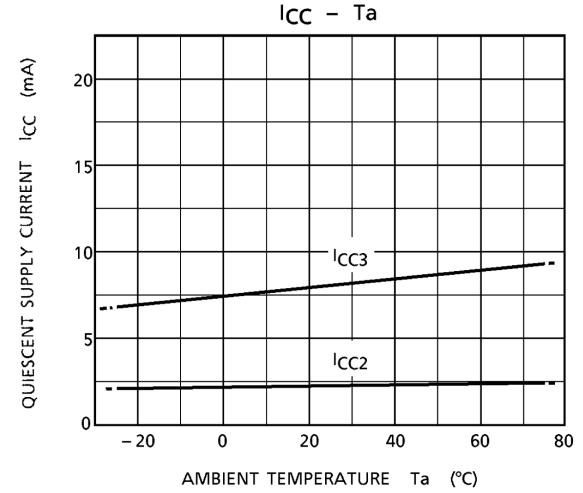

$V_{om3}$ – $V_{CC}$



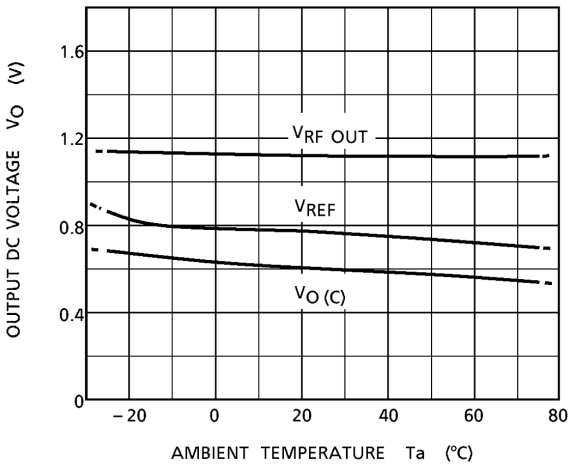

$V_{RF\ OUT}$ – $I_{RF}$



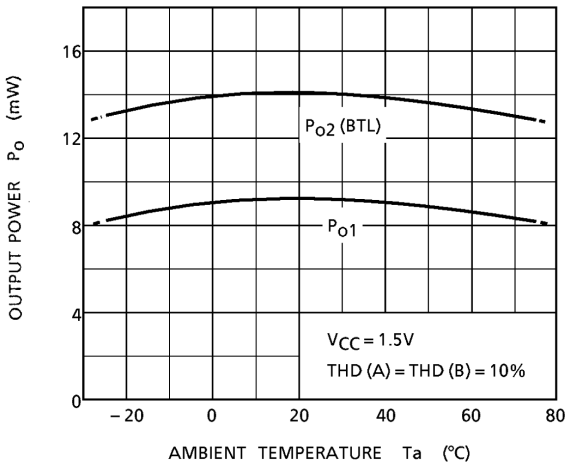

$I_{CC}$ – Ta



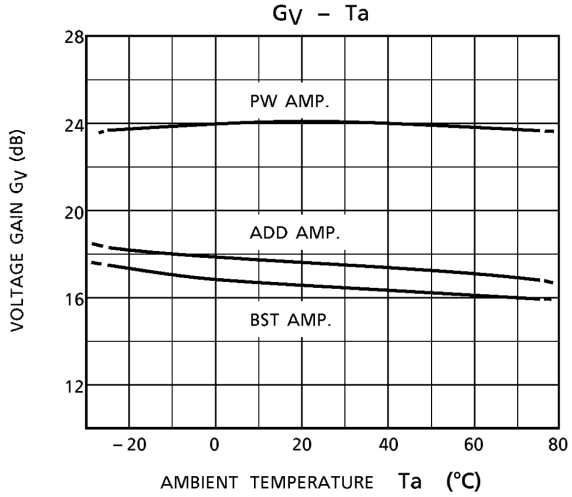
$V_O$ – Ta



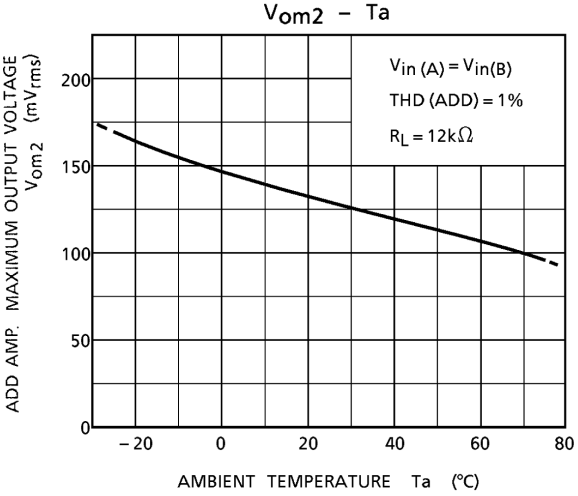

$P_O$ – Ta



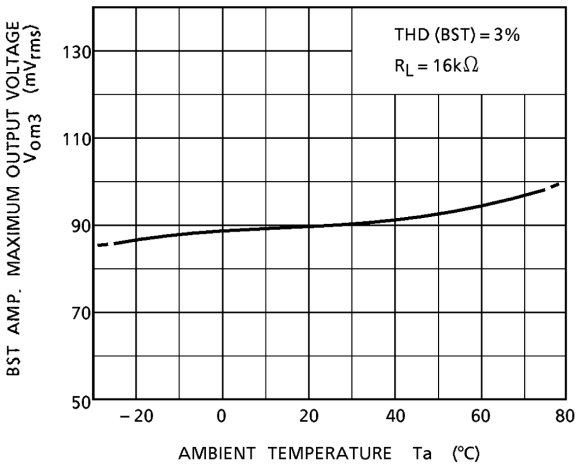

$G_V$ – Ta




$V_{om2}$ – Ta

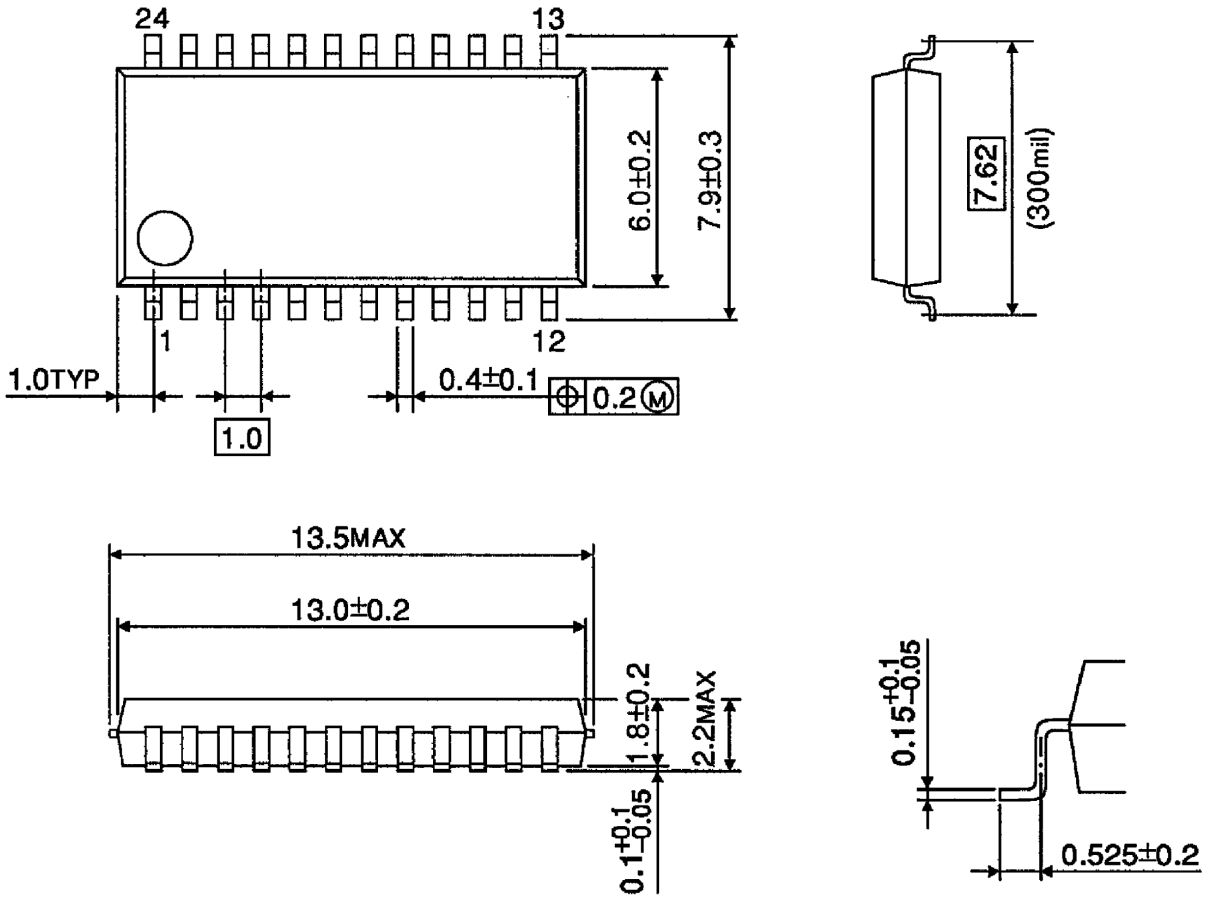



$V_{om3}$ – Ta



## Package Dimensions

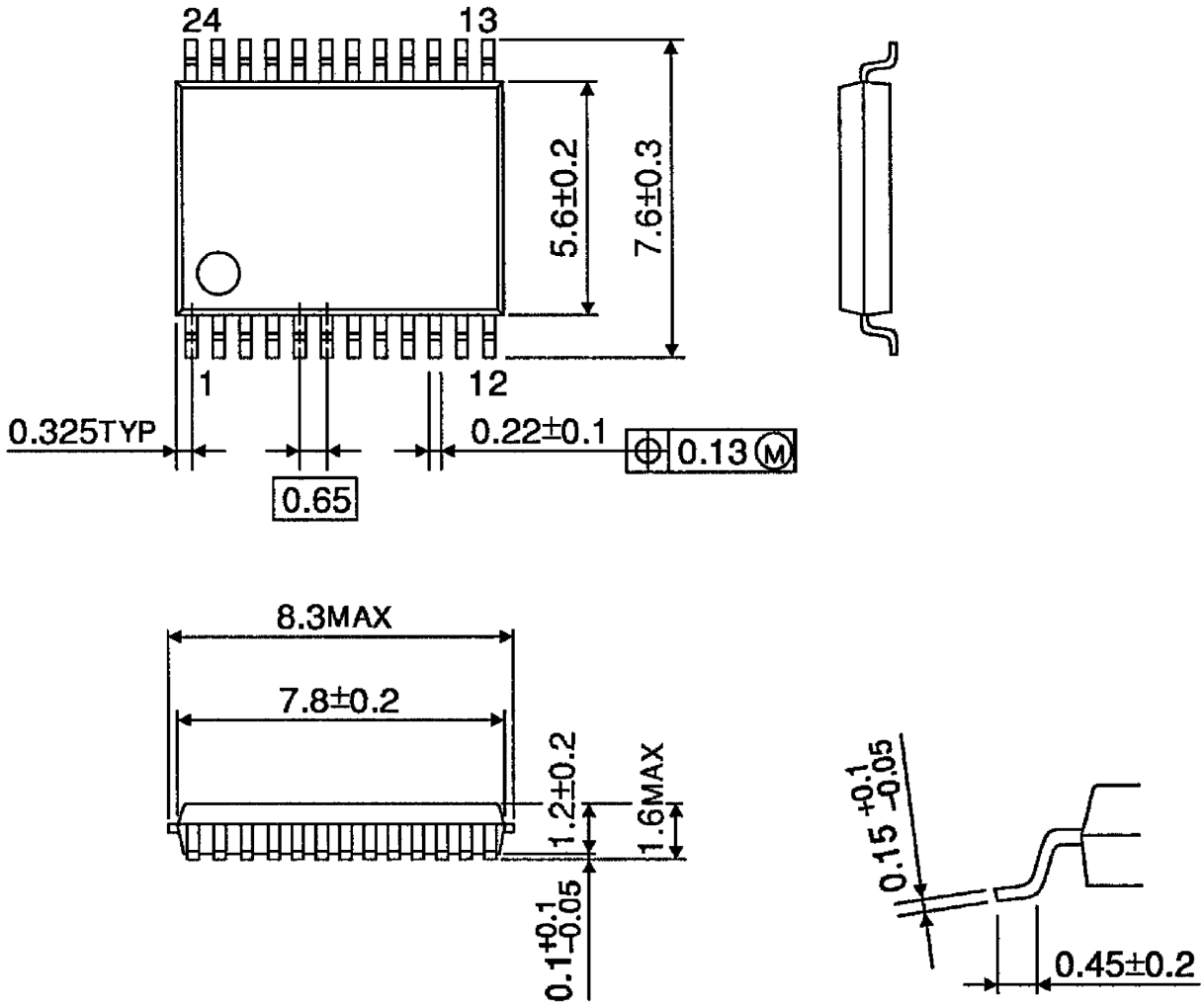
SSOP24-P-300-1.00 Unit : mm




Weight: 0.32g (typ.)

## Package Dimensions

SSOP24-P-300-0.65A 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.