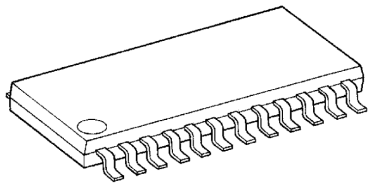
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

# TA2069AF

## 3V Stereo Headphone Amplifier (3V USE)

The TA2069AF is developed for play−back stereo headphone equipments (3V use).
It is built in dual preamplifiers, dual OCL power amplifiers, motor governor, DC volume control and volume limiter etc.



SSOP24-P-300-1.00

Weight: 0.32g (typ.)

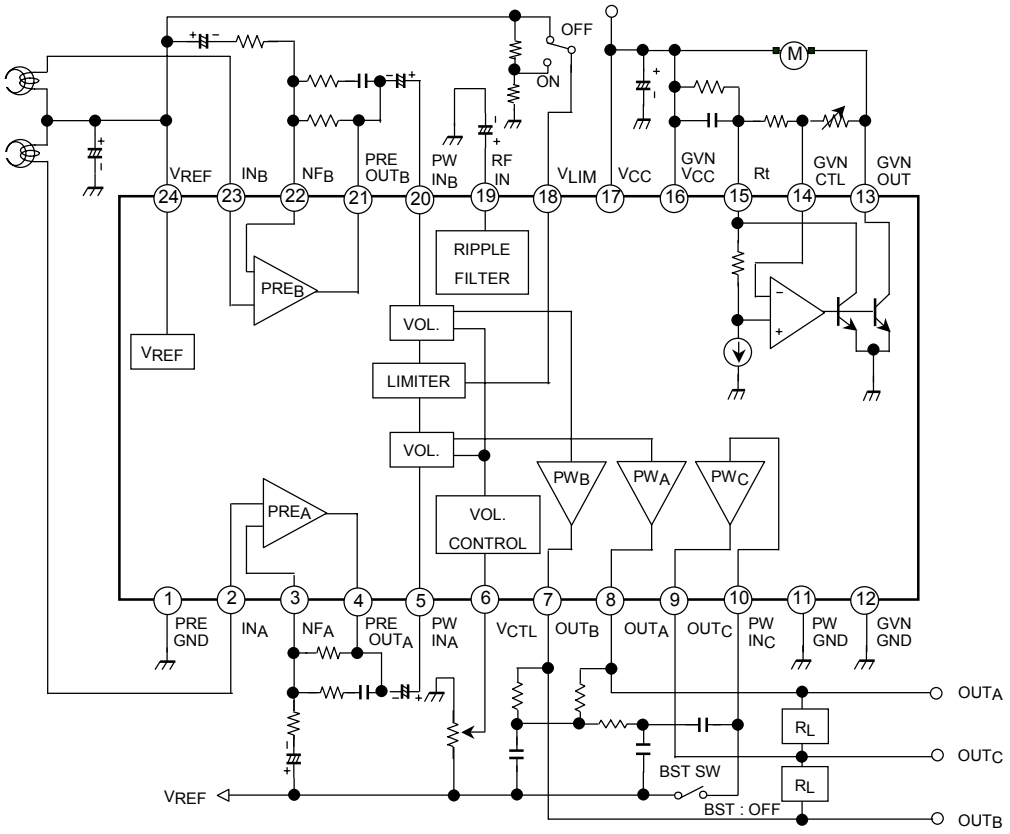
### Features

- Built−in preamplifier
  Input coupling condenser−less
  Built−in input capacitor for reducing buzz noise
  Low noise: $V_{ni}$ = 1.2 $\mu V_{rms}$ (typ.)
- Built−in power amplifier
  OCL (output condenser−less)
  Voltage gain : $G_V$ = 31dB (typ.)
- Built−in motor governor
  Current proportion type
- Built−in DC volume control function
  DC volume maximum attenuation : ATT = 82dB (typ.)
- Built−in volume limiter function
- Built−in bass boost function
- Operating supply voltage range (Ta = 25°C)
  PRE + PW: $V_{CC}$ (opr) = 1.8~3.6V
  GVN: $V_{CC}$ (opr) = 2.1~3.6V (motor voltage = 1.8V)
- Low supply current ($V_{CC}$ = 3V, f = 1kHz, Ta = 25°C, typ.)
  PRE + PW

| | No Signal | Output Power | |
|---|---|---|---|
| | | 0.1mW × 2 | 0.5mW × 2 |
| $R_L$ = 16Ω | 9.5mA | 14.2mA | 19.5mA |
| $R_L$ = 32Ω | 9.5mA | 12.5mA | 16.5mA |

GVN: $I_{CC}$ = 2.5mA

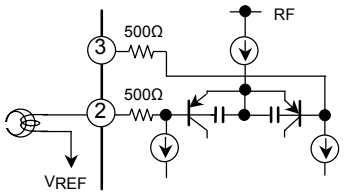
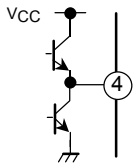
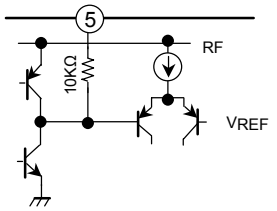
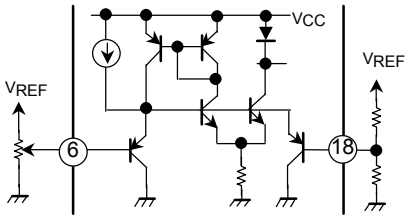
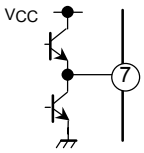
## Block Diagram

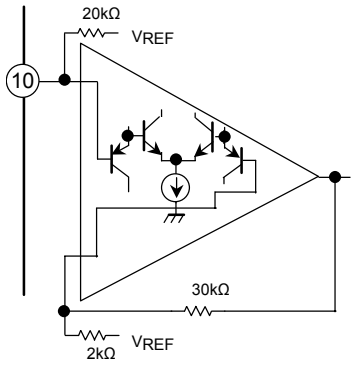
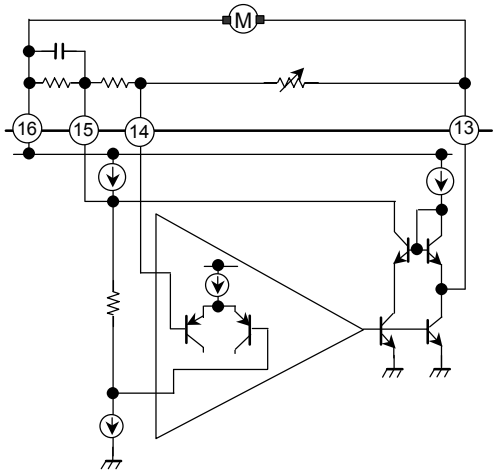
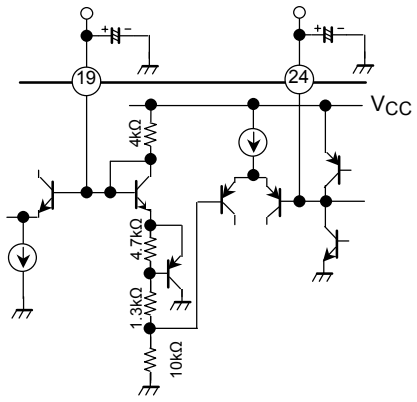


## Terminal Explanation

Terminal Voltage: Typical terminal voltage at no signal with test circuit

($V_{CC}$ = 3V, Ta = 25°C)

| Terminal No. | Terminal Name | Function | Internal Circuit | Terminal Voltage (V) |
|---|---|---|---|---|
| 1 | PRE GND | The GND, except for power drive stage and motor governer stage. | — | 0 |
| 2 | $IN_A$ | Input of preamplifier |  | 1.2 |
| 23 | $IN_B$ | | | 1.2 |
| 3 | $NF_A$ | NF of preamplifier | | 1.2 |
| 22 | $NF_B$ | | | 1.2 |
| 4 | PRE $OUT_A$ | Output of preamplifier |  | 1.2 |
| 21 | PRE $OUT_B$ | | | 1.2 |
| 5 | PW $IN_A$ | Input of power amplifier |  | 1.2 |
| 20 | PW $IN_B$ | | | 1.2 |
| 6 | $V_{CTL}$ | The terminal of DC volume control<br>・This terminal can be used also for $V_{LIM}$ terminal. |  | — |
| 18 | $V_{LIM}$ | The terminal of volume limiter level control<br>・This terminal can be used also for $V_{CTL}$ terminal. | | — |
| 7 | $OUT_B$ | Output of power amplifier |  | 1.2 |
| 8 | $OUT_A$ | | | 1.2 |
| 9 | $OUT_C$ | | | 1.2 |

| Terminal No. | Terminal Name | Function | Internal Circuit | Terminal Voltage (V) |
|---|---|---|---|---|
| 10 | PW $IN_C$ | Input of center amplifier |  | 1.2 |
| 11 | PW GND | GND for power drive stage | — | 0 |
| 12 | GVN GND | GND for motor governor stage | — | 0 |
| 13 | GVN OUT | Motor terminal |  | — |
| 14 | GVN CTL | The terminal of motor speed control | | — |
| 15 | Rt | The terminal of amateur compensation resistor | | — |
| 16 | GVN $V_{CC}$ | $V_{CC}$ for motor governor stage. | | 3 |
| 17 | $V_{CC}$ | $V_{CC}$ for preamplifier stage and power amplifier stage. | — | 3 |
| 19 | RF IN | Ripple filter of power supply |  | 2.5 |
| 24 | $V_{REF}$ | Reference voltage<br>・Preamplifier and power amplifier operate on this reference. | | 1.2 |

## Application Note

1. $V_{CC}$ and GND
   This IC has two $V_{CC}$ terminals and three GND terminals. Pattern layout should be designed carefully to reduce the common impedance.
   $V_{CC}$
   $V_{CC}$ (pin 17): Preamplifier stage and power amplifier stage.
   GVN $V_{CC}$ (pin 16): Motor governor stage.
   GND
   PRE GND (pin 1): Preamplifier stage and power amplifier stage except the power drive stage.
   PW GND (pin 11): Power drive stage of power amplifier.
   GVN GND (pin 12): Motor governor stage.

2. $V_{REF}$
   It is necessary to stabilize the $V_{REF}$ circuit, the internal circuit operate on this reference.

3. Preamplifier
   Input signal should be applied to $V_{REF}$ standard, otherwise pop noise become bigger when $V_{CC}$ is turned on and off.

4. Power amplifier
   It is necessary to insert the coupling capacitor through the PW IN terminal. In case that DC current or DC voltage is applied to the PW IN terminal, the internal circuit has unbalance and the power amplifier doesn't operate normally.

## Maximum Ratings (Ta = 25°C)

| Characteristic | Symbol | | Rating | Unit |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | | 4 | V |
| Power dissipation | $P_D$ | (Note 1) | 400 | mW |
| | | (Note 2) | 925 | |
| Output current (PW AMP.) | $I_{O\ (PW)}$ | | 200 | mA |
| Output current (GVN) | $I_{O\ (GVN)}$ | | 700 | mA |
| Operating temperature | $T_{opr}$ | | −25~75 | °C |
| Storage temperature | $T_{stg}$ | | −55~150 | °C |

(Note 1) IC only : Derated above Ta = 25°C in the proportion 3.2mW / °C

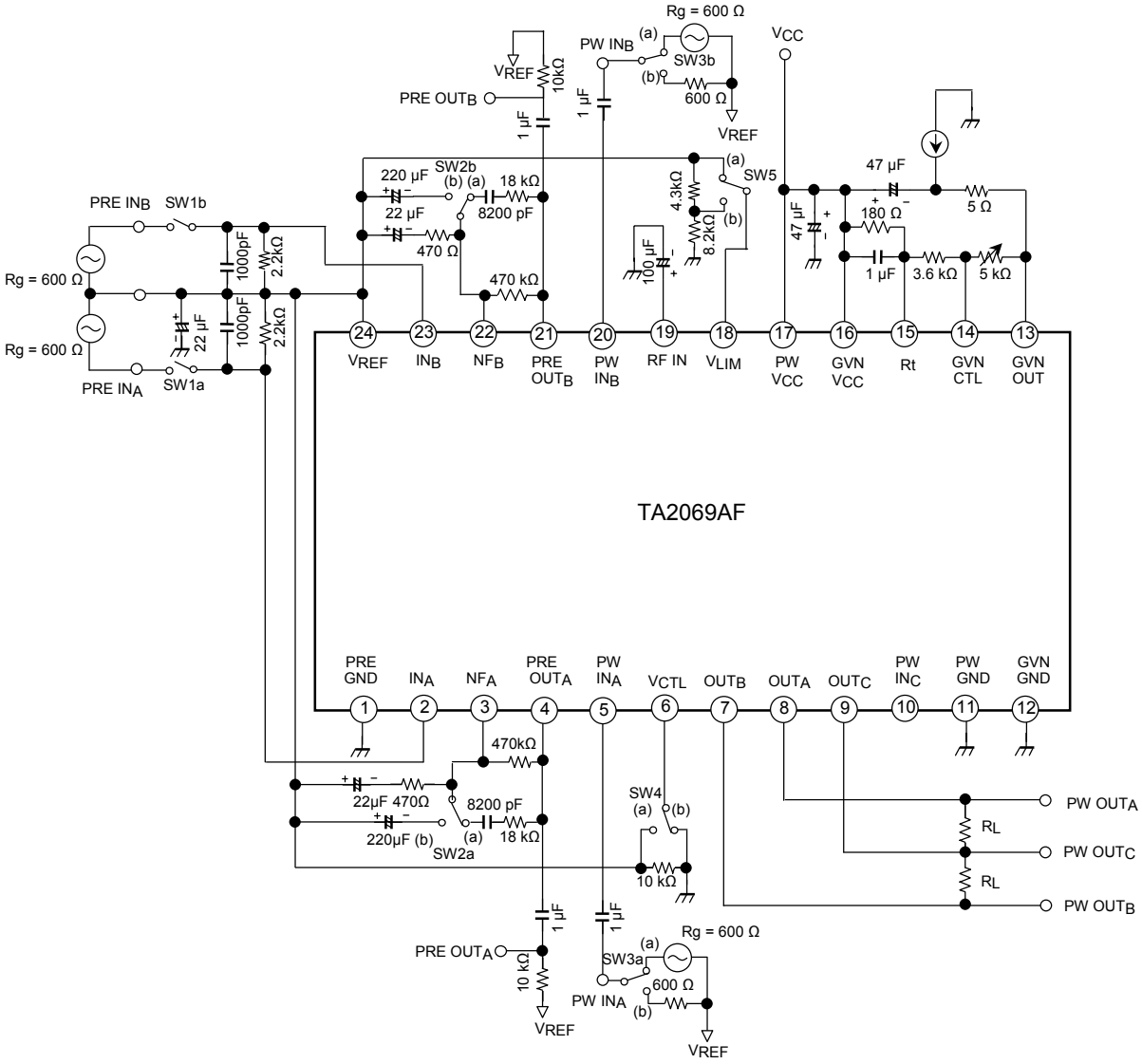
(Note 2) IC + PCB (TOSHIBA typical PCB): Derated above Ta = 25°C in the proportion 7.4mW / °C

## Electrical Characteristics

Unless otherwise specified, $V_{CC}$ = 3V, Ta = 25°C, f = 1kHz, SW2: a, SW5: a
Preamplifier: $R_g$ = 2.2kΩ, $R_L$ = 10kΩ, SW1: ON, SW3: b, SW4: b
Power amplifier: $R_g$ = 600Ω, $R_L$ = 16Ω, Vol: Max, SW1: OPEN, SW3: a, SW4: a
Motor governor: $I_m$ = 100mA, SW1: OPEN, SW3: b, SW4: b

| | Characteristic | Symbol | Test Cir–cuit | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|---|
| | Quiescent supply current | $I_{CCQ}$ | — | PRE + PW + GVN<br>$V_{in}$ = 0, VOL: Min, SW4: b | — | 12 | 18 | mA |
| Pre AMP. | Open loop voltage gain | $G_{VO}$ | — | $V_o$ = −10dBV, SW2: b | — | 86 | — | dB |
| | Closed loop voltage gain | $G_{VC}$ | — | $V_o$ = −10dBV | — | 35 | — | dB |
| | maximum output voltage | $V_{om}$ | — | THD = 1% | 550 | 720 | — | $mV_{rms}$ |
| | Total harmonic distortion | THD1 | — | $V_o$ = −10dBV | — | 0.02 | 0.3 | % |
| | Equivalent input noise voltage | $V_{ni}$ | — | $R_g$ = 2.2kΩ, SW1: OPEN<br>BPF = 20Hz~20kHz, NAB ($G_V$ = 35dB, f = 1kHz) | — | 1.2 | 2.4 | $\mu V_{rms}$ |
| | Cross talk | CT1 | — | $V_o$ = −10dBV | — | 70 | — | dB |
| | Ripple rejection ratio | RR1 | — | $f_r$ = 100Hz, $V_r$ = −20dBV | — | 48 | — | dB |
| Power AMP. | Voltage gain 1 | $G_{V1}$ | — | $V_o$ = −10dBV | 29 | 31 | 33 | dB |
| | Channel balance | CB | — | | −1.5 | 0 | +1.5 | dB |
| | Voltage gain 2 | $G_{V2}$ | — | $V_o$ = −10dBV, SW5: b | — | 5 | — | dB |
| | Output power 1 | $P_{o1}$ | — | $R_L$ = 16Ω, THD = 10% | 17 | 28 | — | mW |
| | Output power 2 | $P_{o2}$ | — | $R_L$ = 32Ω, THD = 10% | — | 20 | — | mW |
| | Total harmonic distortion | THD2 | — | $P_o$ = 1mW | — | 0.5 | — | % |
| | Output noise voltage 1 | $V_{no1}$ | — | $R_g$ = 600Ω, SW3: b<br>BPF = 20Hz~20kHz | — | 270 | 400 | $\mu V_{rms}$ |
| | Output noise voltage 2 | $V_{no2}$ | — | $R_g$ = 600Ω, SW3: b<br>SW5: b, BPF = 20Hz~20kHz | — | 45 | — | $\mu V_{rms}$ |
| | Ripple rejection ratio | RR2 | — | $f_r$ = 100Hz, $V_r$ = −20dBV | — | 52 | — | dB |
| | Cross talk | CT2 | — | $V_o$ = −10dBV | — | 32 | — | dB |
| | DC volume maximum attenuation | ATT | — | $V_o$ = −10dBV<br>SW4: a→b<br>(VOL: Max→min) | — | 82 | — | dB |
| Motor Governor | Supply current | $I_{CC}$ | — | $I_m$ = 0 | — | 2.5 | 4.3 | mA |
| | Saturation voltage | $V_{CE\ (sat)}$ | — | $I_m$ = 200mA | — | — | 0.5 | V |
| | Reference voltage | $V_{REF}$ | — | $I_m$ = 100mA | 0.76 | 0.81 | 0.86 | V |
| | Reference voltage fluctuation 1 | $\Delta V_{REF1}$ | — | $V_{CC}$ = 2.1~3.6V | — | 0.25 | — | % / V |
| | Reference voltage fluctuation 2 | $\Delta V_{REF2}$ | — | $I_m$ = 25~250mA | — | 0.003 | — | % / mA |
| | Reference voltage fluctuation 3 | $\Delta V_{REF3}$ | — | Ta = −25~75°C | — | 0.005 | — | % / °C |
| | Current ratio | K | — | | 34.5 | 37.5 | 40.5 | |
| | Current ratio fluctuation 1 | ΔK1 | — | $V_{CC}$ = 2.1~3.6V | — | 0.25 | — | % / V |
| | Current ratio fluctuation 2 | ΔK2 | — | $I_m$ = 25~250mA | — | 0.08 | — | % / mA |
| | Current ratio fluctuation 3 | ΔK3 | — | Ta = −25~75°C | — | 0.005 | — | % / °C |

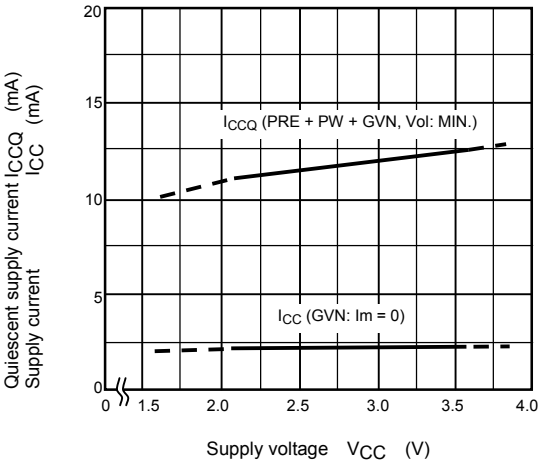
## Test Circuit



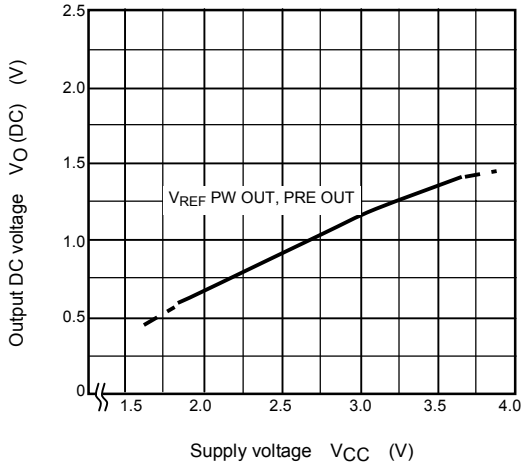
## Characteristic Curves

Unless otherwise specified $V_{CC}$ = 3V, Ta = 25°C, f = 1kHz
Preamplifier: Rg = 2.2kΩ, $R_L$ = 10kΩ
Power amplifier: Rg = 600Ω, $R_L$ = 16Ω, Vol = max.
Motor governor: $I_m$ = 100mA

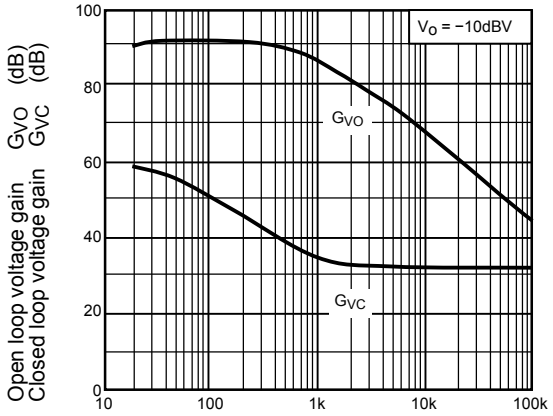
$I_{CCQ}$, $I_{CC}$ – $V_{CC}$



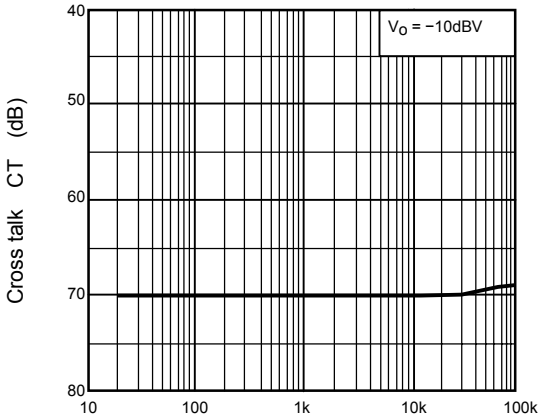

$V_{O\ (DC)}$ – $V_{CC}$



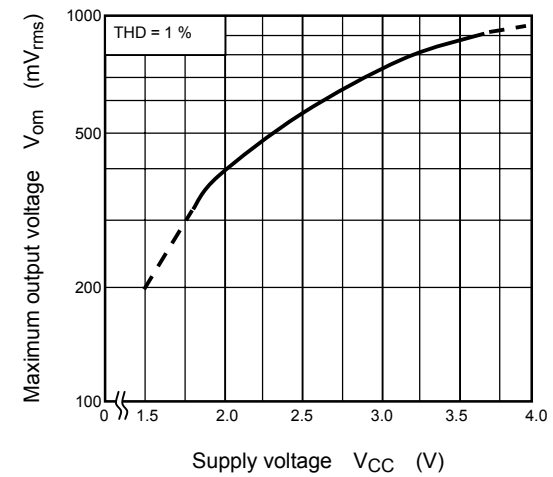

PRE $G_{VO}$, $G_{VC}$ – f



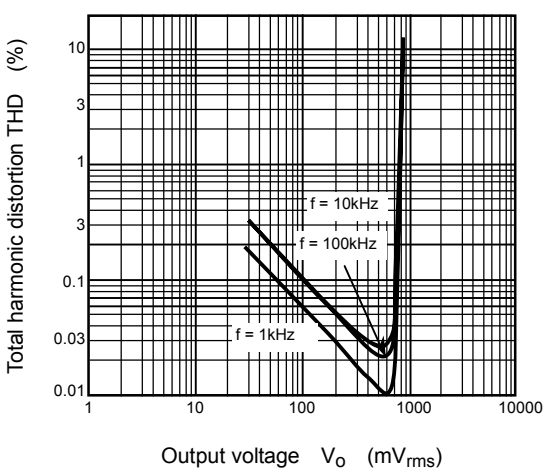

PRE CT – f



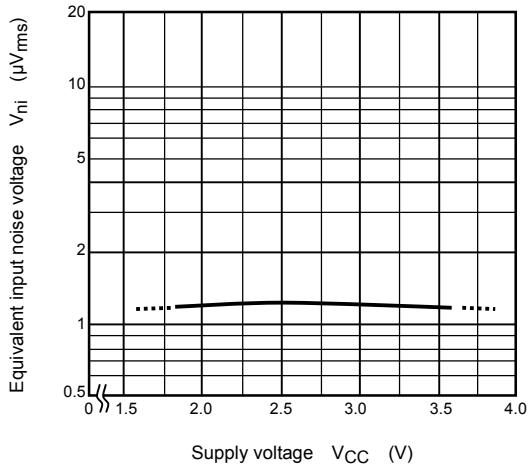

PRE $V_{om}$ – $V_{CC}$



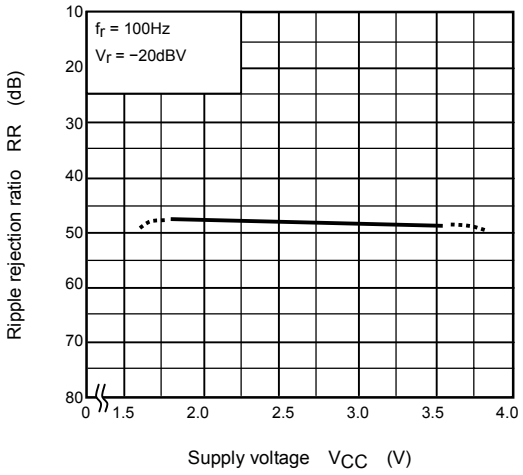

PRE THD – Vo



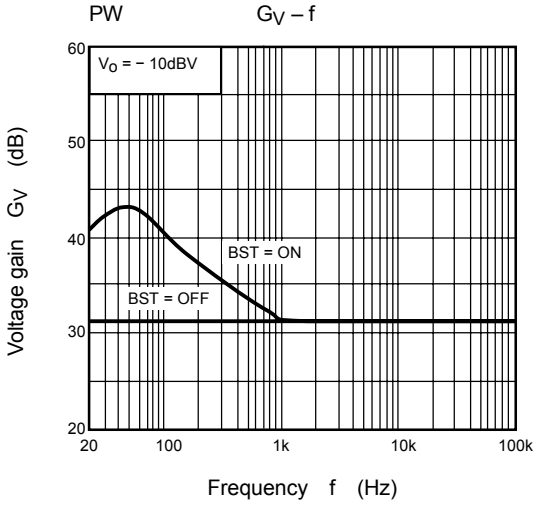
PRE $V_{ni} - V_{CC}$



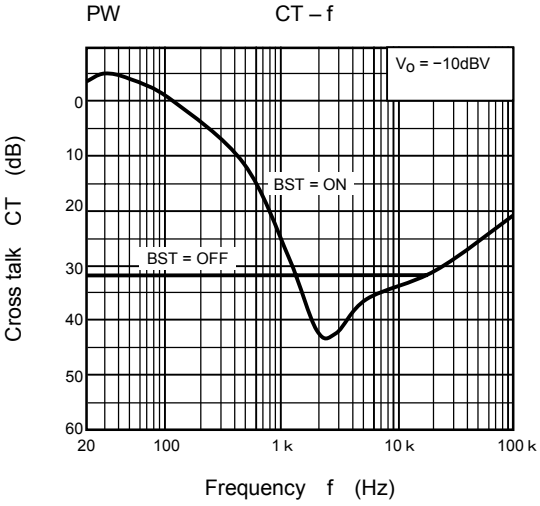

PRE $RR - V_{CC}$



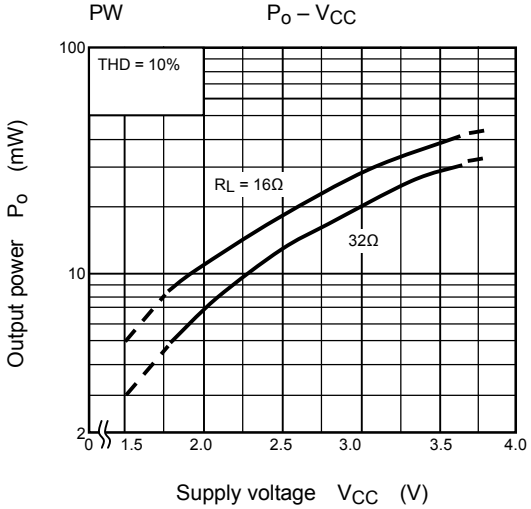

PW $G_V - f$



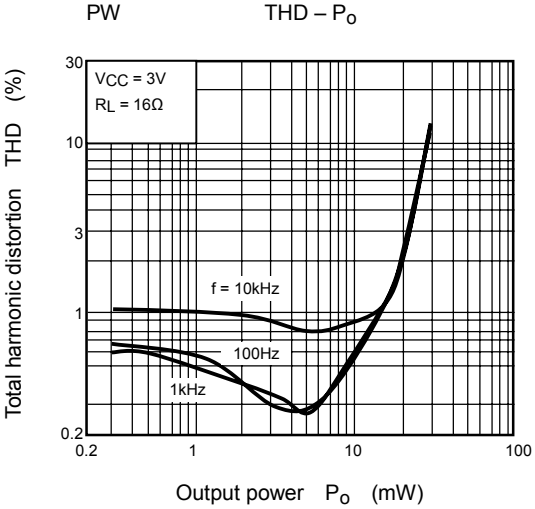

PW $CT - f$



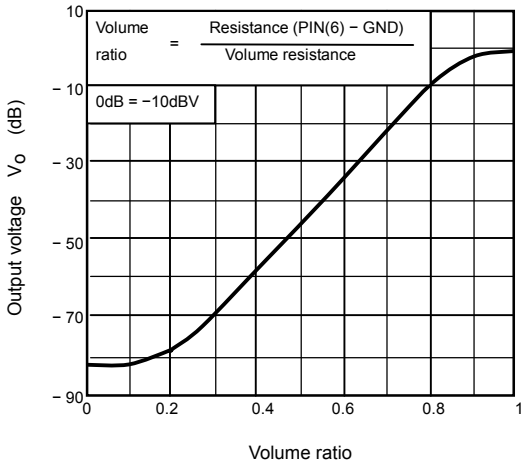

PW $P_o - V_{CC}$



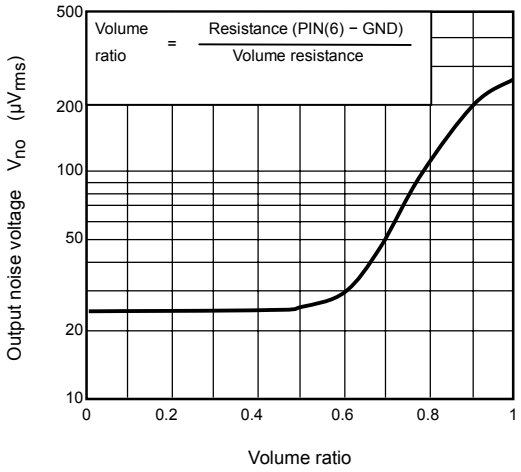

PW $THD - P_o$



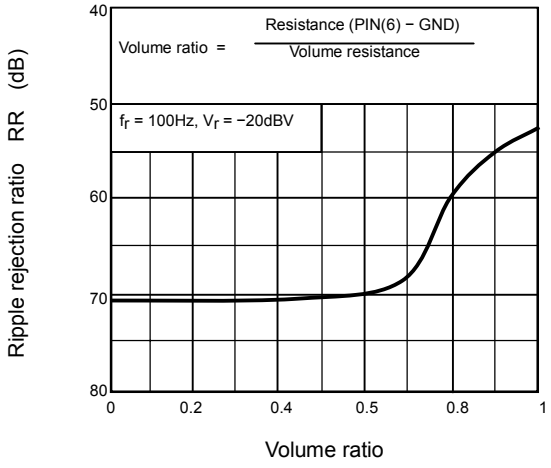
PW $V_o$ – Vol.



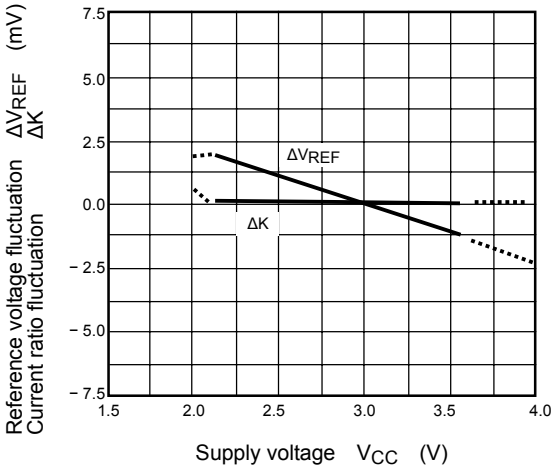

PW $V_{no}$ – Vol.



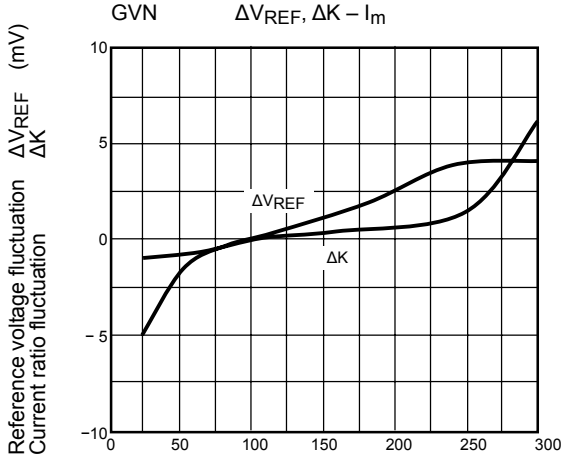

PW RR – Vol.



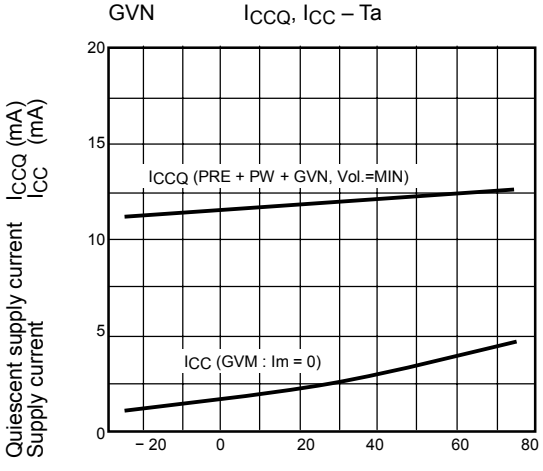

GVN $\Delta V_{REF}$, $\Delta K$ – $V_{CC}$



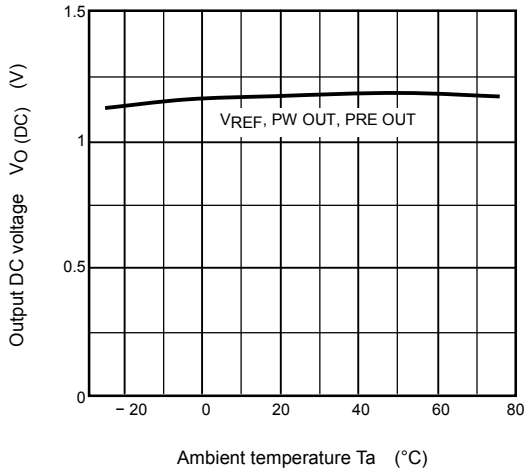

GVN $\Delta V_{REF}$, $\Delta K$ – $I_m$



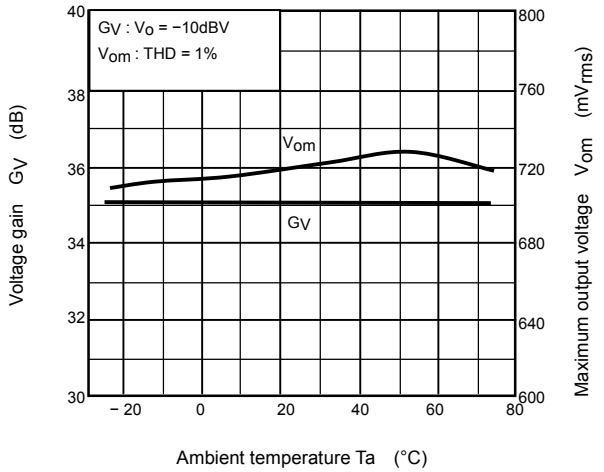

GVN $I_{CCQ}$, $I_{CC}$ – Ta



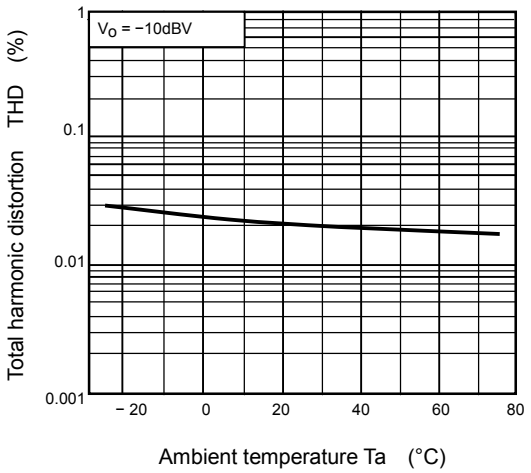
$V_{O\ (DC)}$ – Ta



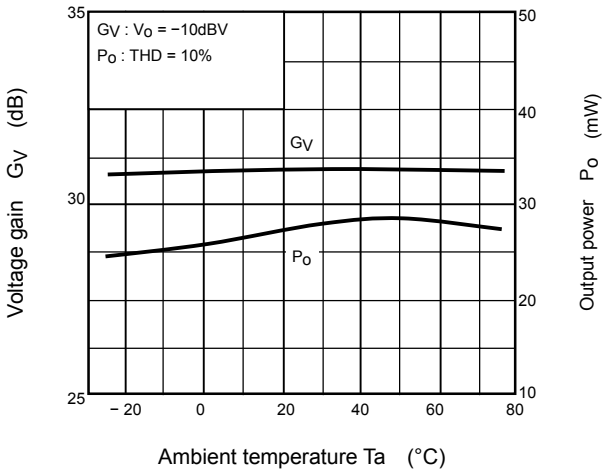

PRE $G_V$ , $V_{om}$ – Ta



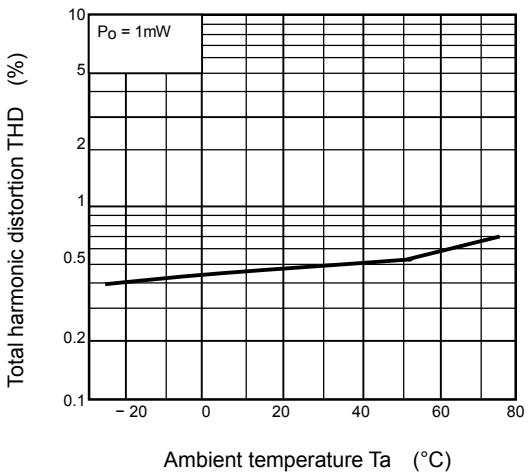

PRE THD – Ta



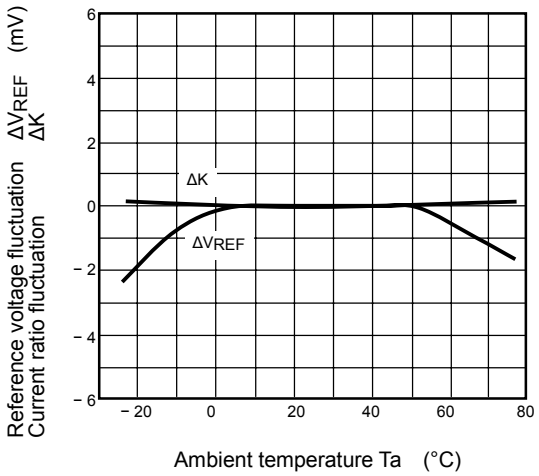

PW $G_V$, $P_O$ – Ta



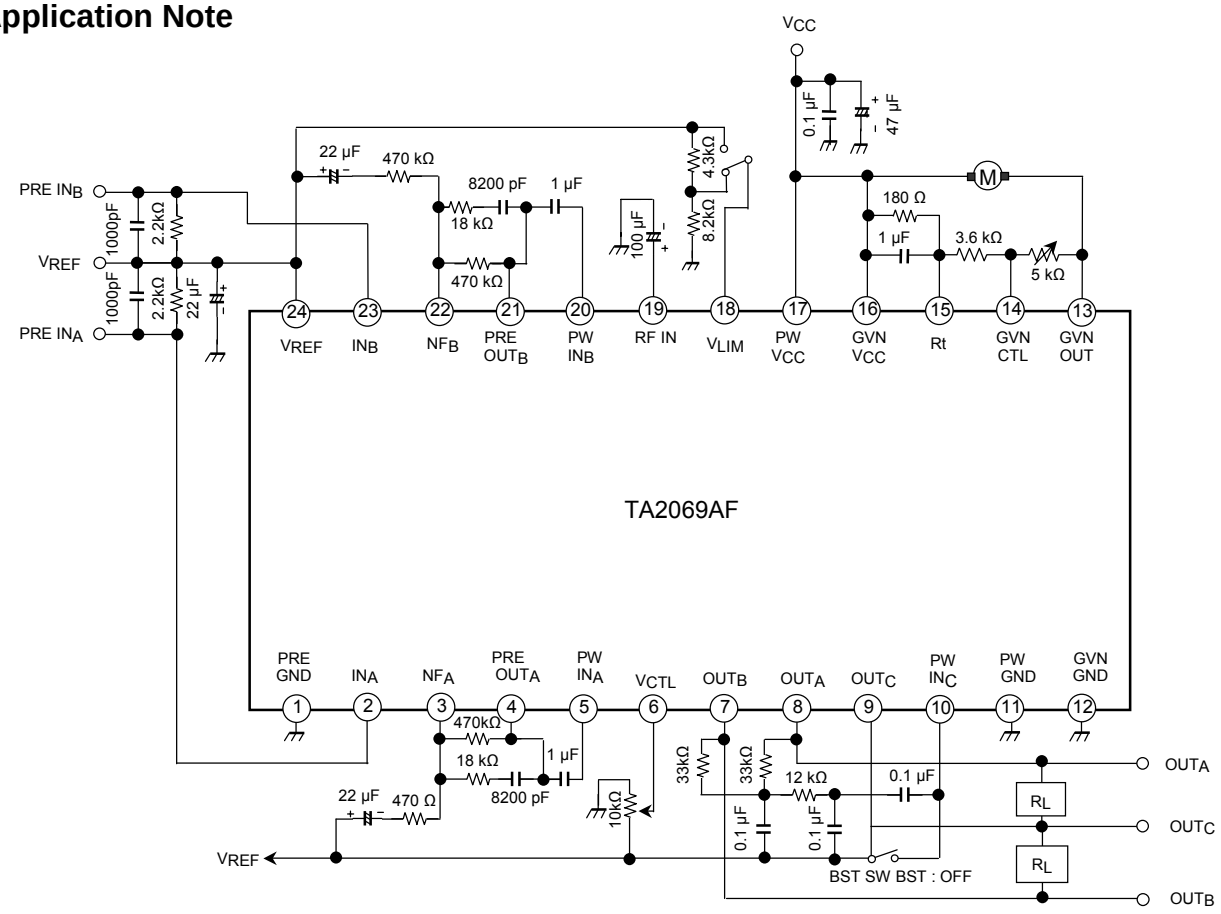

PW THD – Ta




GVN $\Delta V_{REF}$, $\Delta K$ – Ta

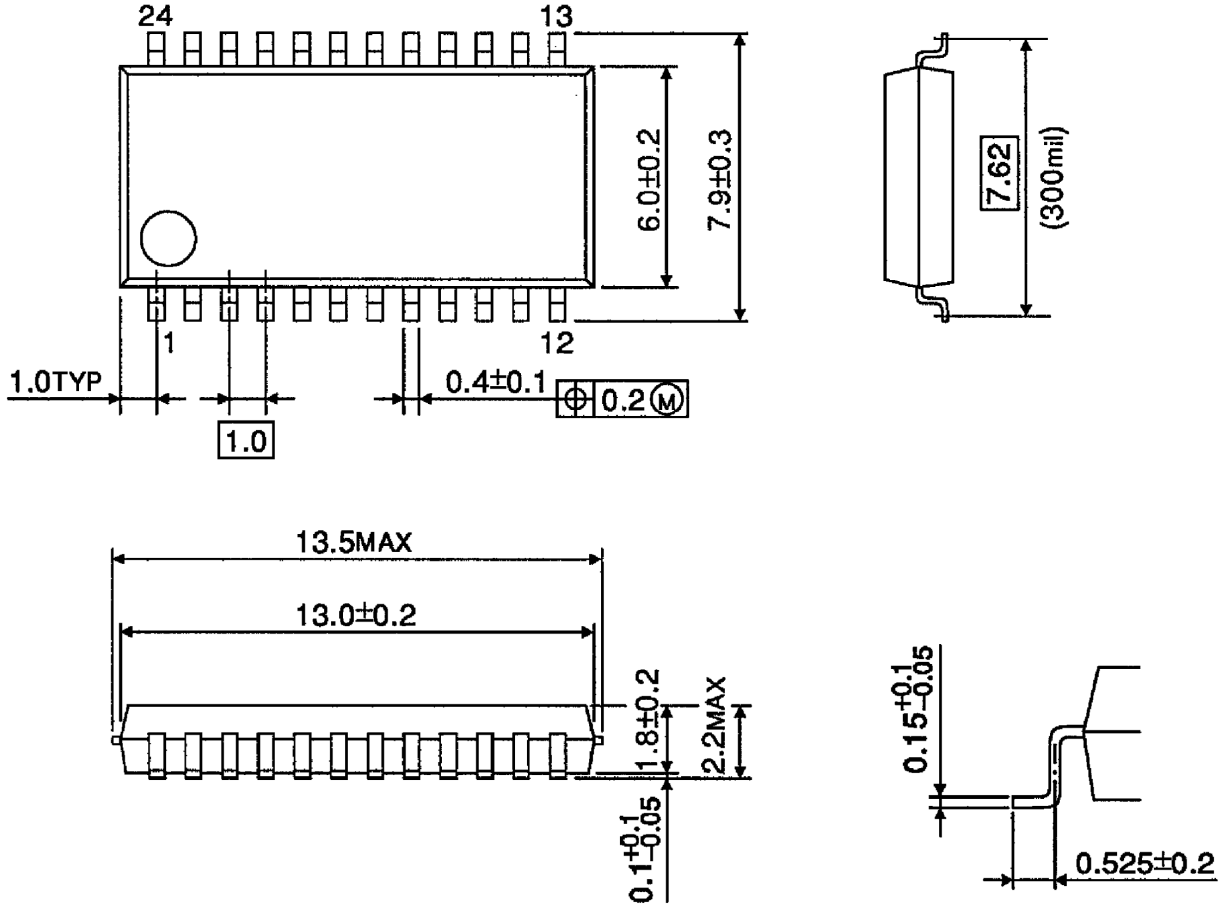


## Application Note



## Package Dimensions

SSOP24-P-300-1.00 Unit : mm




Weight: 0.32g (typ.)

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000707EBA

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