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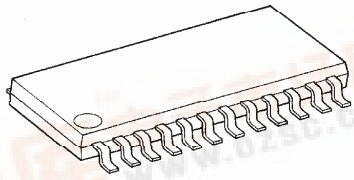
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

TA2002F, TA2002FN

STEREO HEADPHONE AMPLIFIER (3V USE)

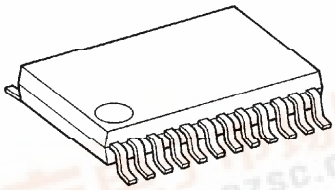
The TA2002F, TA2002FN are developed for play-back stereo headphone equipments (3V use).
They are built in dual auto-reverse preamplifier, dual OCL power amplifier, and a ripple filter.

TA2002F



SSOP24-P-300-1.00

TA2002FN



SSOP24-P-300-0.65A

Weight
SSOP24-P-300-1.00 : 0.32g (Typ.)
SSOP24-P-300-0.65A : 0.14g (Typ.)

FEATURES

Power amplifier stage

- OCL (Output Condenser-Less)
- Low noise : $V_{no} = 22\mu V_{rms}$ (Typ.)
- Excellent ripple rejection ratio : RR = 62dB (Typ.)
- Voltage gain : $G_V = 27dB$ (Typ.)
- Built-in a power amplifier mute
- Built-in input capacitor for reducing buzz noise

Preamplifier stage

- Auto-reverse with F/R control switch
- Input coupling condenser-less
- Low noise : $V_{ni} = 1.3\mu V_{rms}$ (Typ.)
- Built-in a preamplifier mute
- Built-in input capacitor for reducing buzz noise

Total

- Built-in a ripple filter
- Built-in a power switch
- Low quiescent current : $I_{CCQ} = 11.5mA$ (Typ.) ($V_{CC} = 3V$, Ta = 25°C)
- Operating supply voltage range : $V_{CC\ (opr)} = 1.8 \sim 4.5V$ (Ta = 25°C)

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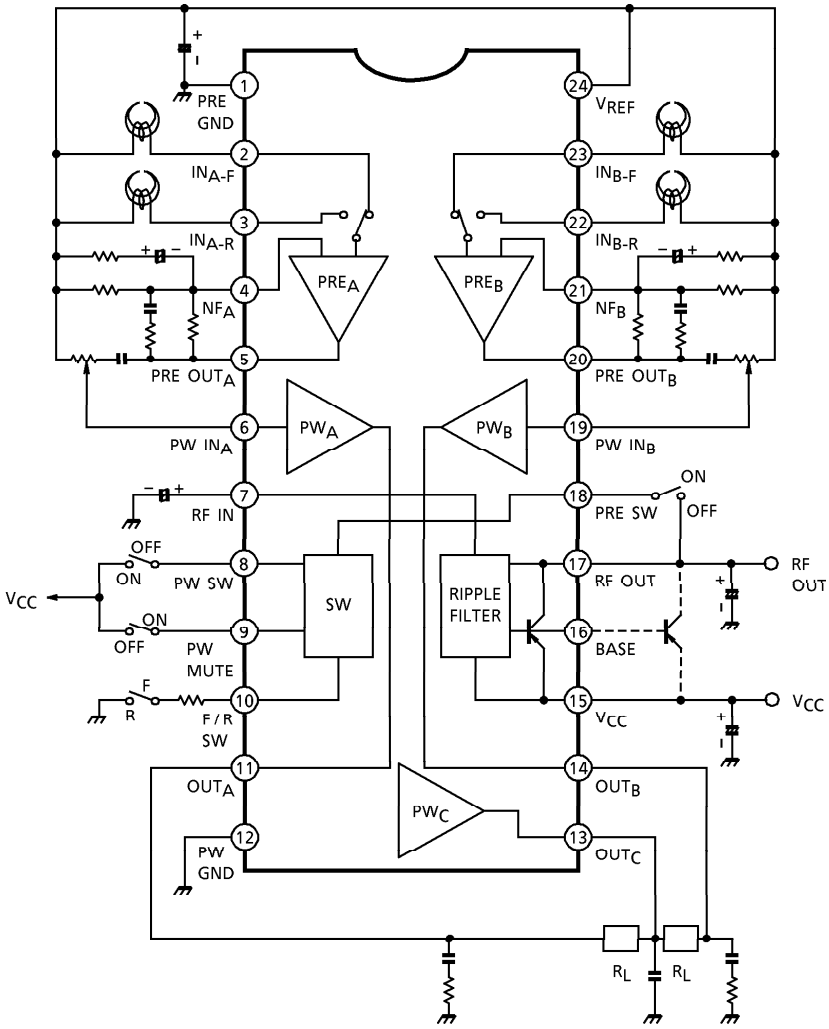
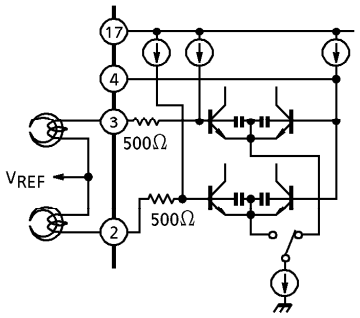
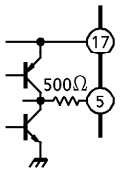
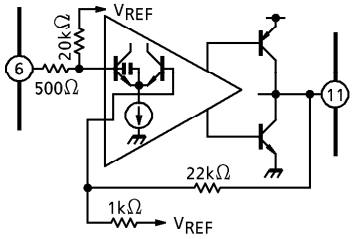
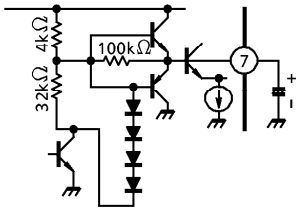
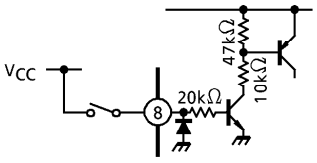
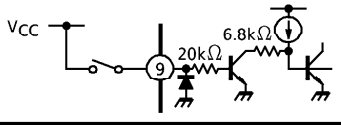
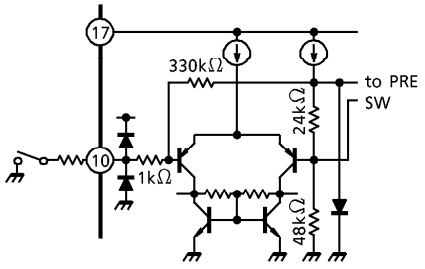
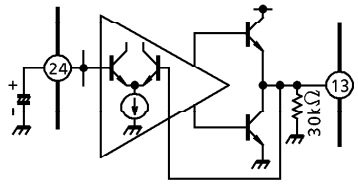
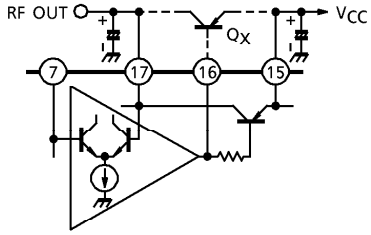
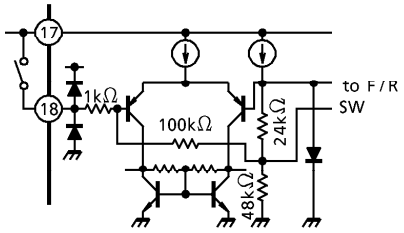
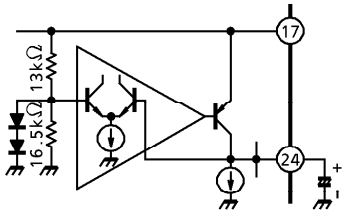
BLOCK DIRGRAM



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 the power drive stage.	—	0
2	IN_{A-F}	Input of preamplifier. F / R SW (OPEN : ② / ㉓PIN "L" : ③ / ㉒PIN		1.3
3	IN_{A-R}			
22	IN_{B-R}			
23	IN_{B-F}			
4	NF_A	NF of preamplifier.		1.3
21	NF_B			
5	PRE OUT_A	Output of preamplifier.		1.3
20	PRE OUT_B			
6	PW IN_A	Input of power amplifier.		1.3
19	PW IN_B			
11	OUT_A	Output of power amplifier.		1.3
14	OUT_B			
7	RF IN	Ripple filter terminal.		2.6
8	PW SW	Power on / off switch. (V_{CC} : Power on OPEN or GND : Power off		—
9	PW MUTE	Muting switch for power amplifier. (V_{CC} : Power amp. on OPEN or GND : Power amp. off		—

TERMINAL No.	TERMINAL NAME	FUNCTION	INTERNAL CIRCUIT	TERMINAL VOLTAGE (V)
10	F / R SW	Forward / Reverse mode switch. (OPEN : Forward mode "L" level : Reverse mode ※ This terminal can't be connected with GND line directly. In case of reverse mode, a resistor (R = 180kΩ~270kΩ) should be connected to GND.		—
12	PW GND	GND for power drive stage.	—	0
13	OUT_C	Output terminal of center power amplifier.		1.3
15	V_{CC}	—	—	3
16	BASE	Base bias of an external PNP transistor for ripple filter.		2.3
17	RF OUT	Ripple filter output. Ripple filter circuit supplies internal circuit except power amplifier circuit with power source.		2.6
18	PRE SW	Muting switch for preamplifier. (V_{17} (RF OUT) : Preamp. off OPEN : Preamp. on ※ This terminal can't be connected with GND line directly. In case that terminal is connected with GND line, a resistor (R ≧ 10kΩ) should be connected to GND.		—
24	V_{REF}	Reference voltage. Preamplifier and power amplifier operate on this reference.		1.3

APPLICATION NOTE

(1) PW SW

It is necessary to connect an external pull-down resistor with the terminal PW SW (pin⑧), in case that this IC is turned on due to external noise etc.

(2) PW MUTE

The leak current flows through the terminal of PW MUTE (pin⑨), in case that the terminal is connected with V_{CC} line independently, even though this IC is off-mode (the terminal of PW SW (pin⑧) is off-mode).

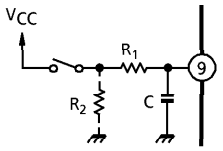


Fig.1 PW MUTE circuit reducing a pop sound

It is advised to connect R_1 and C with the terminal of PW MUTE, to reduce a pop sound in switchover between PW MUTE on / off. And it is advised to connect R_2, to shorten a switchover time from PW MUTE off-mode to PW MUTE on-mode (see Fig.1). It is better that the constants are $R_1 \fallingdotseq R_2 \fallingdotseq 100k\Omega$, $C \fallingdotseq 1\mu F$ at $V_{CC} = 3V$.

As for the constants, select the optimum one depending on each a set carefully.

(3) F / R SW

The terminal of F / R SW (pin⑩) should not be applied to higher voltage than V_{17} (RF OUT), because the ripple filter circuit supplies the F / R SW circuit with power source. And in reverse mode, the terminal of F / R SW should be connected with GND line through R_3 (180~270kΩ), because the F / R SW circuit doesn't operate normally. It is advised to connect an external capacitor ($C_3 \fallingdotseq 1\mu F$), in order to reduce a pop sound in switchover between F / R mode (see Fig.2). As for the constants, select the optimum one depending on each a set carefully.

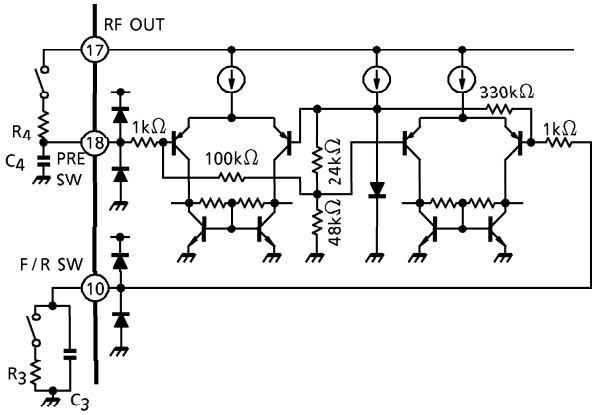


Fig.2 Internal equivalent circuit of F / R SW and PRE SW and the external circuits reducing a pop sound in switchover

In controlling the F/R SW with voltage source, it is applied as follows ;

(Forward mode : 0.8V~V_{17} (RF OUT)
\ Reverse mode : 0.15~0.35V

(4) PRE SW

The terminal of PRE SW (pin⑱) should not be applied to higher voltage than V_{17} (RF OUT), because ripple filter circuit supplies the PRE SW circuit with power source. And this terminal can't be connected with GND line directly, because the PRE SW circuit doesn't operate normally.
In case of preamplifier on-mode, this terminal should be opened or connected with GND line through a resister ($R \geqq 10k\Omega$).
It is advised to connect a external resistor ($R_4 = 100 \sim 330k\Omega$) and capacitor ($C_4 \fallingdotseq 1\mu F$), in order to reduce a pop sound in switchover between PRE SW on/off mode (see Fig.2). As for the constants, select the optimum one depending on each a set carefully.
In controlling the PRE SW with voltage source, it is applied as follows ;

(Preamplifier on-mode : 0.1~0.5V
\ Preamplifier off-mode : 1.0V~V_{17} (RF OUT)

(5) NF resistor of preamplifier

The NF resistor ($R = 39k\Omega$; see the test circuit) should be connected, to reduce a pop sound.

(6) Input of power amplifier

In case that the volume of power amplifier is less than 10kΩ, it can be connected with power amplifier directly as Fig.3-1. In case more than 10kΩ, it is necessary to insert the coupling capacitor between volume and PW IN terminal as Fig.3-2. In case that DC current or DC voltage is applied to the terminal of PW IN, the internal circuit has unbalance and the power amplifier doesn't operate normally.

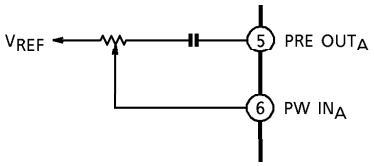


Fig.3-1 Volume connection (1)
($R \leqq 10k\Omega$)

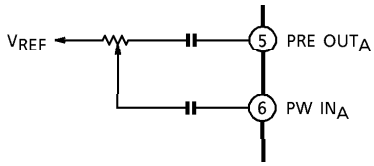


Fig.3-2 Volume connection (2)
($R > 10k\Omega$)

(7) Increase of ripple filter current

It is built in PNP transistor for a ripple filter, the current capacity is about 10mA.
Then this IC can be increased the current capacity of the ripple filter with an external transistor Q_X (exp. 2SA1362). In this case, as the current gain is up, it is necessary to connect external parts for phase-compensation (see Fig.4). And it is necessary to stabilize the ripple filter circuit carefully, because the ripple filter circuit supplies internal circuit except power amplifier circuit with power source.

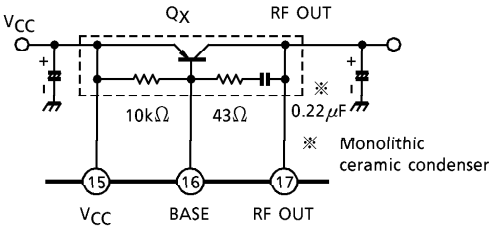


Fig.4 Increase of ripple filter current

(8) Pattern layout

(a) The GND line of pin① (PRE GND) should be isolated from that of pin⑫ (PW GND) at the GND point, where the V_{CC} decoupling condenser is placed.

(b) The GND line of capacitor (for ripple filter) should be isolated from that of compensation capacitor, at the point of pin⑫ (PW GND).

(c) The pattern diagram between the pin㉔ (V_{REF}) and capacitor should be made shortly. As for pin① (PRE GND), it's as well.

(d) The pattern diagram between the pin⑫ (PW GND) and compensation capacitor, should be shortly. And this positive line of compensation capacitor should be kept away from the terminals of PW IN, pin⑥, ⑲.

(e) The lines of PW IN should be kept away from those of PW OUT. And each of the PW OUT lines should be kept away.

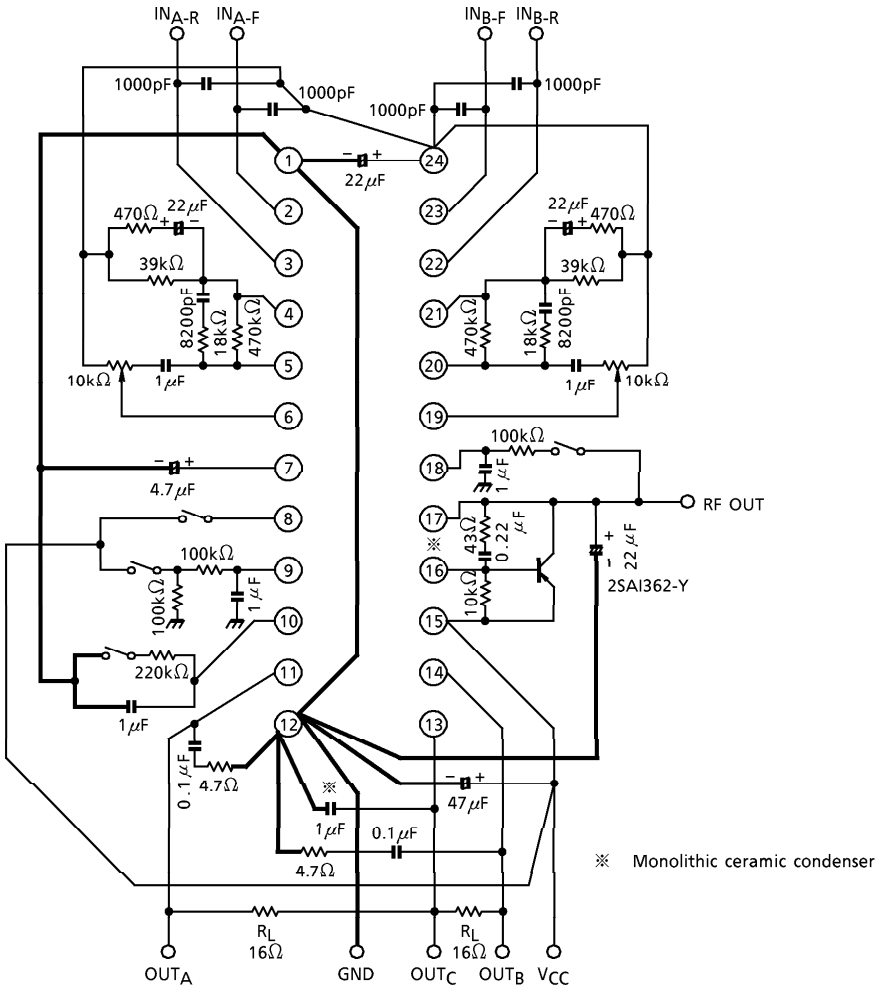
※ See the example of pattern layout as shown next page.

(9) Oscillation precaution

Small temperature coefficient and excellent frequency characteristic is needed by capacitors below.

- Oscillation preventing capacitors for power amplifier output.
- Bypass capacitor for ripple filter
- Capacitor between V_{CC} and GND
- Capacitor between V_{REF} and GND

AN EXAMPLE OF PATTERN LAYOUT



MAXIMUM RATINGS (Ta = 25°C)

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V_{CC}	6	V
Output Current	Power	$I_{o\ (peak)}$	60	mA
	Ripple Filter	I_{RF}	30	
Power Dissipation	TA2002F	P_D (Note)	400	mW
	TA2002FN		500	
Operating Temperature		T_{opr}	−25~75	°C
Storage Temperature		T_{stg}	−55~150	

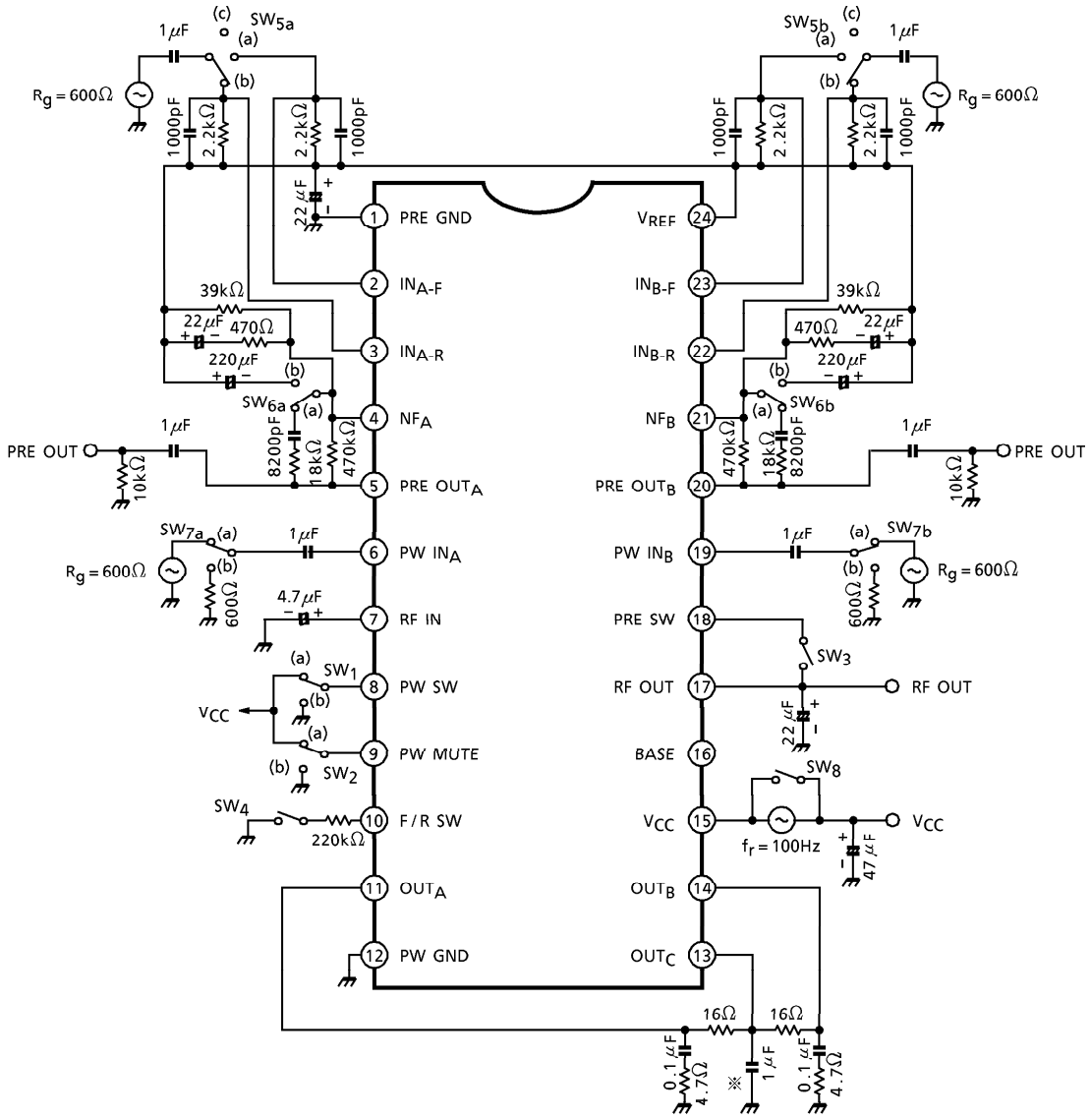
(Note) Derated above Ta = 25°C in the proportion of 3.2mW / °C for TA2002F, and of 4mW / °C for TA2002FN.

ELECTRICAL CHARACTERISTICS

Unless otherwise specified : V_{CC} = 3V, f = 1kHz, Ta = 25°C, SW_1 : a, SW_2 : a, SW_3 : OPEN, SW_8 : ON
Preamplifier stage : R_g = 2.2kΩ, R_L = 10kΩ, SW_2 : OPEN, SW_4 : ON / OPEN, SW_5 : a / b, SW_6 : a
Power amplifier stage : R_g = 600Ω, R_L = 16Ω, SW_3 : ON, SW_7 : a

	CHARACTERISTIC		SYMBOL	TEST CIRCUIT	TEST CONDITION		MIN.	TYP.	MAX.	UNIT
	Quiescent Current		I_{CCQ1}	—	Power off, SW_1 : b, SW_2 : b SW_3 : ON		—	—	5	μA
			I_{CCQ2}		Power amp. off, SW_2 : b		—	5	9	mA
			I_{CCQ3}		V_{in} = 0		—	11.5	16.5	
Power amplifier stage	Voltage Gain		G_V	—	V_o = −12dBV		25	27	29	dB
	Channel Balance		CB				—	0	1.5	
	Output Power		P_{o1}		THD = 10%	R_L = 16Ω	35	50	—	mW
			P_{o2}			R_L = 32Ω	—	33	—	
	Total Harmonic Distortion		THD1		P_o = 1mW		—	0.2	0.8	%
	Output Noise Voltage		V_{no}	—	R_g = 600Ω, SW_7 : b		—	22	40	μV_{rms}
	Ripple Rejection Ratio		RR_1		f_r = 100Hz, V_r = −22dBV SW_8 : OPEN		45	62	—	dB
	Cross Talk (CH-A / CH-B)		CT_1		V_o = −12dBV		35	42	—	
	Power Muting Attenuation		ATT1		V_o = −12dBV, SW_2 : a→b		—	80	—	
Preamplifier stage	Open Loop Voltage Gain		G_{VO}	—	V_o = −12dBV, SW_6 : b		70	80	—	dB
	Closed Loop Voltage Gain		G_{VC}		V_o = −12dBV		—	35	—	
	Maximum Output Voltage		V_{om}		THD = 1%		600	850	—	mV_{rms}
	Total Harmonic Distortion		THD2		V_o = −12dBV		—	0.02	0.1	%
	Equivalent Input Noise Voltage		V_{ni}		R_g = 2.2kΩ, BPF = 20Hz~20kHz SW_5 : c NAB (G_V = 35dB, f = 1kHz)		—	1.3	2.8	μV_{rms}
	Cross Talk (CH-A / CH-B)		CT_2		V_o = −12dBV		—	70	—	dB
	Cross Talk (Forward / Reverse)		CT_3				—	70	—	
	Pre Muting Attenuation		ATT2		V_o = −12dBV, SW_3 : OPEN→ON		—	80	—	
Ripple Filter Output Voltage			V_{RF}	—	V_{CC} = 2V, I_{RF} = 0mA		1.76	1.8	—	V
Ripple Rejection Ratio Of Ripple Filter Output			RR_2		V_{CC} = 2V, I_{RF} = 10mA f_r = 100Hz, V_r = −22dBV SW_8 : OPEN		45	53	—	dB
Power On / Off Switch		Power On Current	I_8	—	V_{CC} = 1.8V, V_{24} ≧ 0.5V		5	—	—	μA
		Power Off Voltage	V_8		V_{CC} = 1.8V, V_{24} ≦ 0.3V		0	—	0.3	V
Power Amp. Mute Switch		Mute Off Current	I_9	—	V_{CC} = 1.8V, ATT1 ≦ 3dB		5	—	—	μA
		Mute On Voltage	V_9		V_{CC} = 1.8V, ATT1 ≧ 60dB		0	—	0.3	V

TEST CIRCUIT

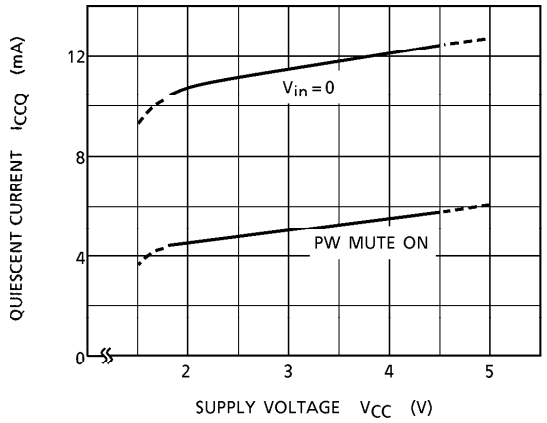


※ Monolithic ceramic condenser

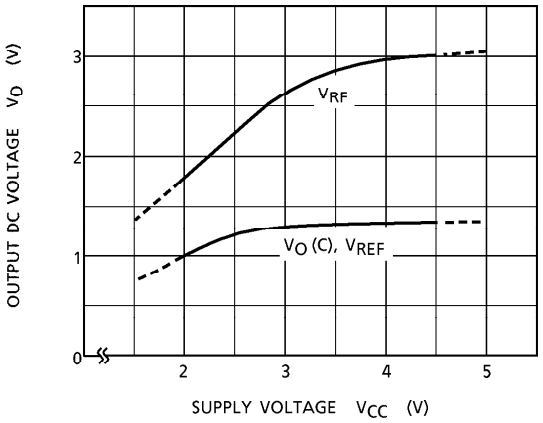
CHARACTERISTICS CURVES

Unless otherwise specified : V_{CC} = 3V, f = 1kHz, Ta = 25°C
power amplifier stage : R_g = 600Ω, R_L = 16Ω
preamplifier stage : R_g = 2.2kΩ, R_L = 10kΩ

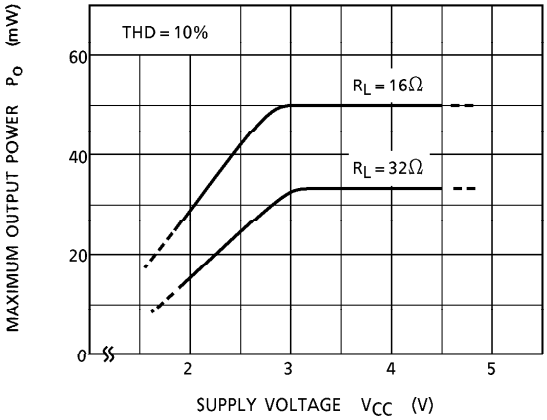
I_{CCQ} – V_{CC}



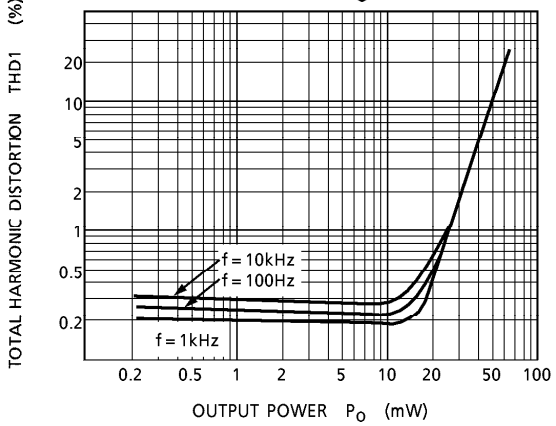
V_O – V_{CC}



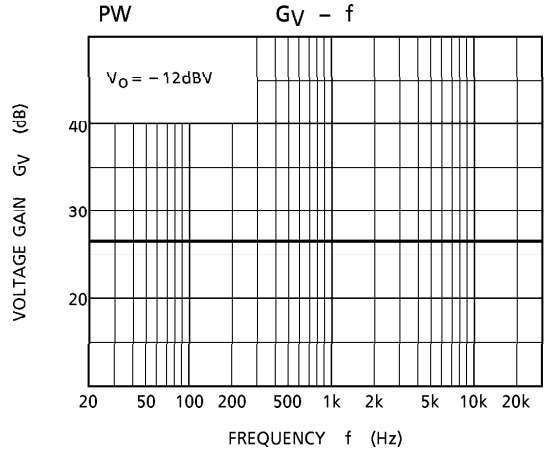
PW P_o – V_{CC}



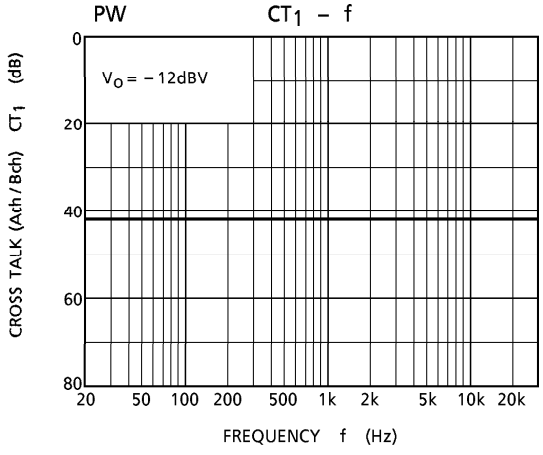
PW THD1 – P_o



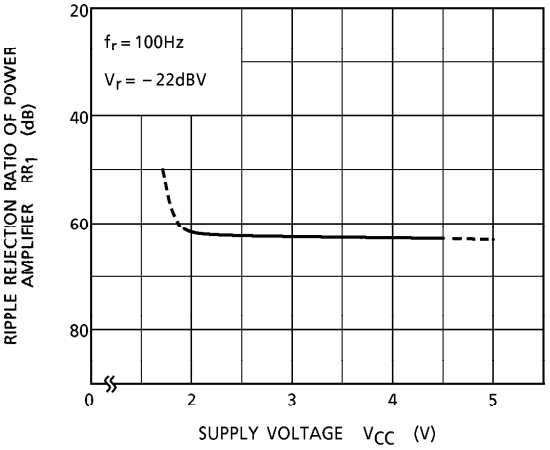
PW G_V – f



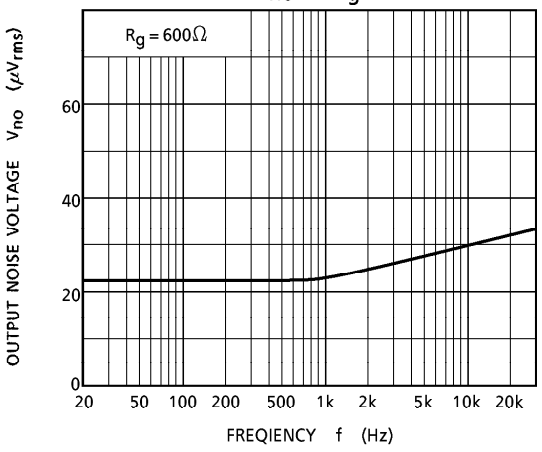
PW CT_1 – f



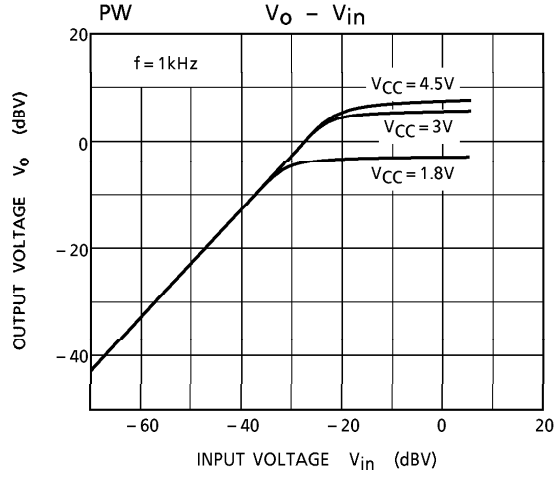
PW RR_1 – V_{CC}



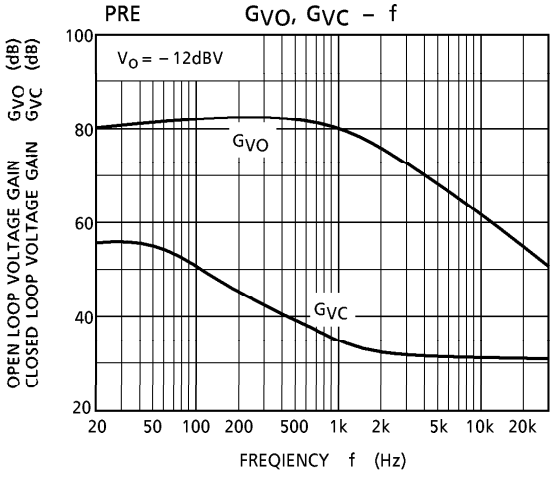
PW V_{no} – R_g



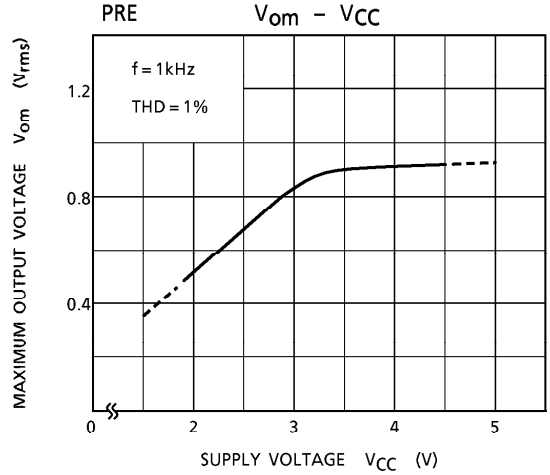
PW V_o – V_{in}



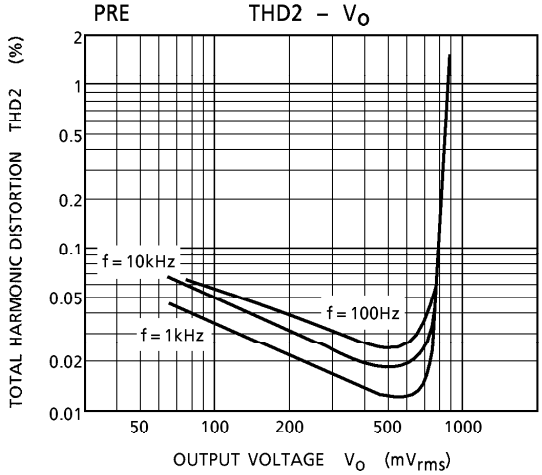
PRE G_{VO}, G_{VC} – f



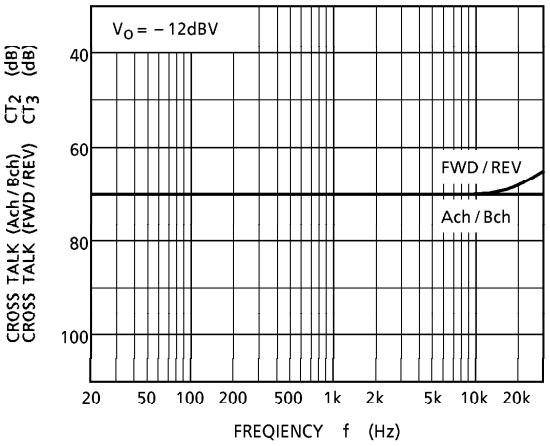
PRE V_{om} – V_{CC}



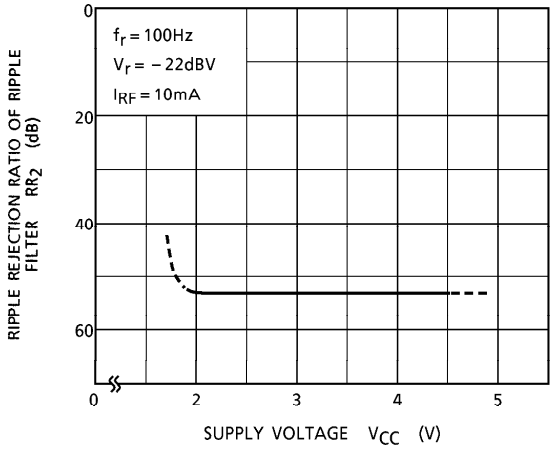
PRE THD2 – V_o



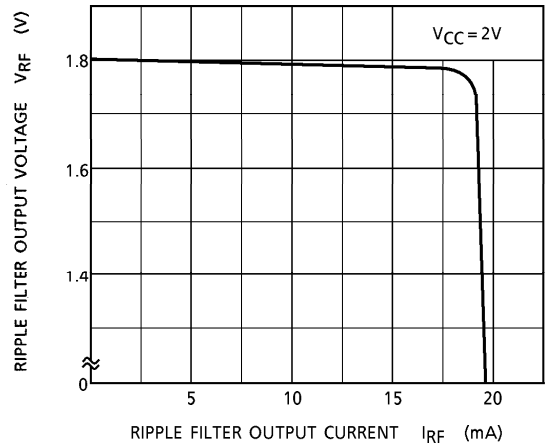
PRE CT – f



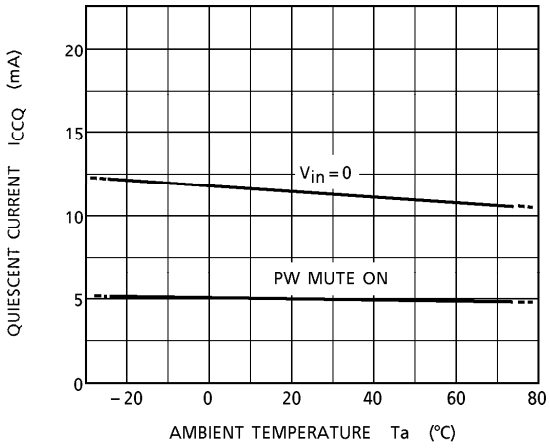
RF RR_2 – V_{CC}



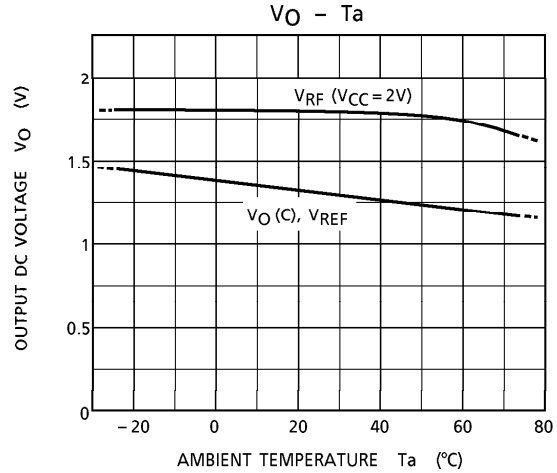
RF V_{RF} – I_{RF}



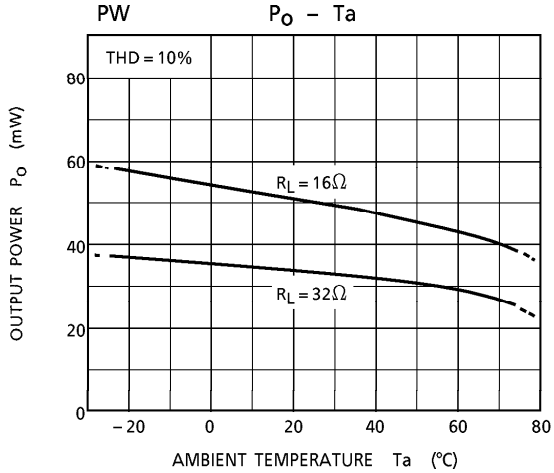
I_{CCQ} – Ta



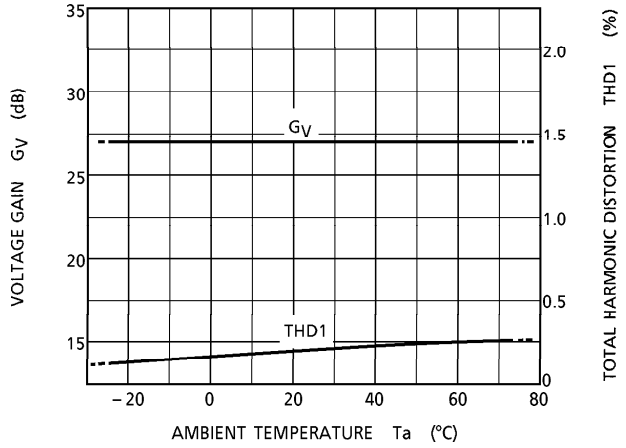
V_O – Ta



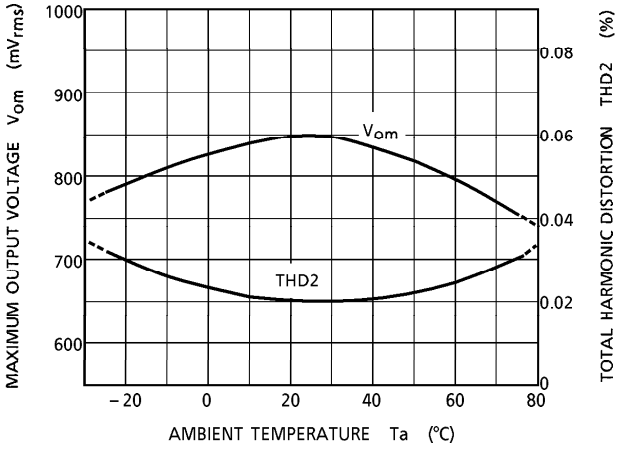
PW P_O – Ta



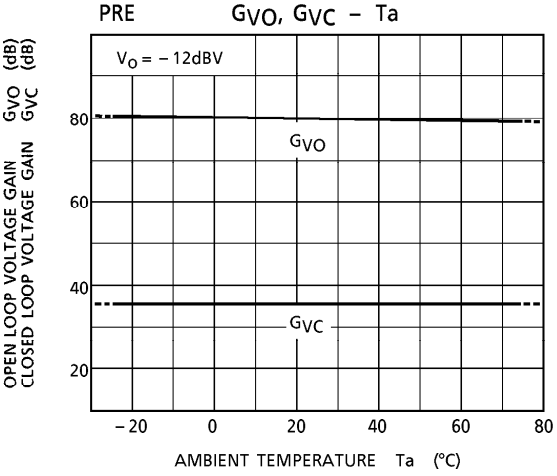
PW G_V, THD1 – Ta



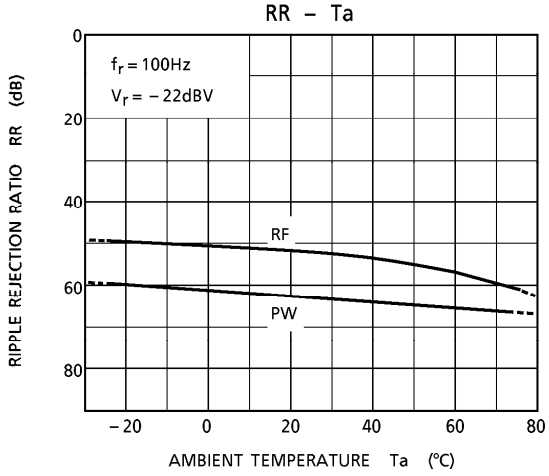
PRE V_{om}, THD2 – Ta



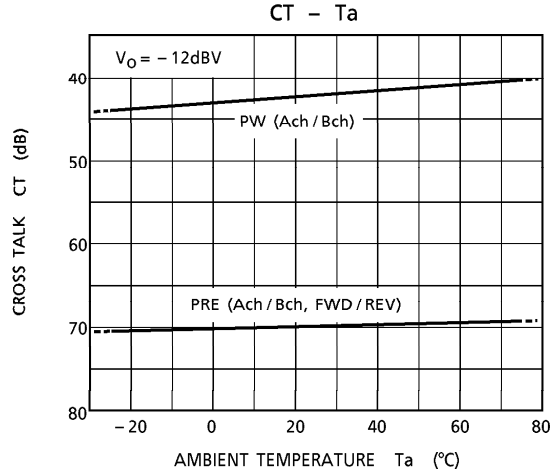
PRE G_{VO}, G_{VC} – Ta



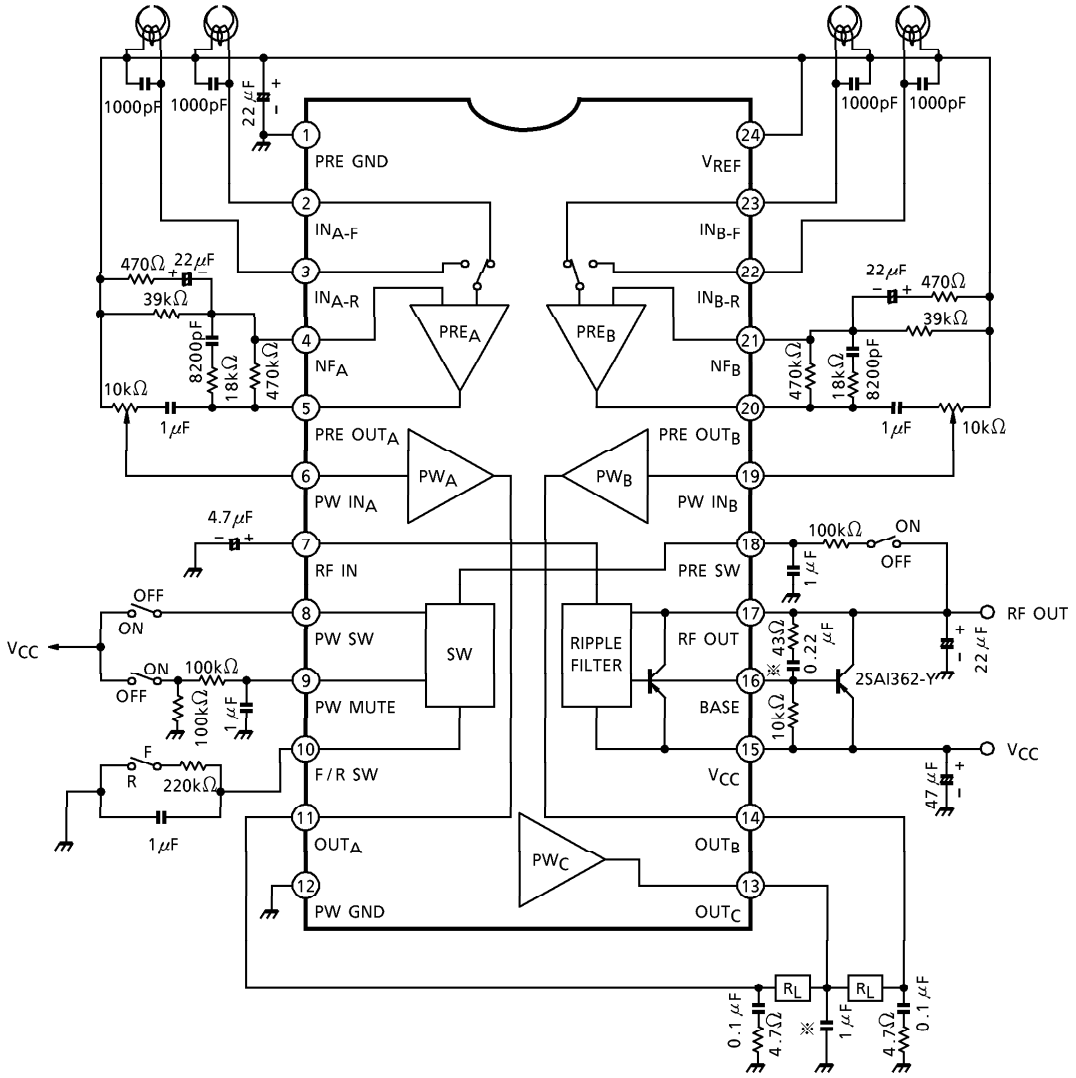
RR – Ta



CT – Ta



APPLICATION CIRCUIT

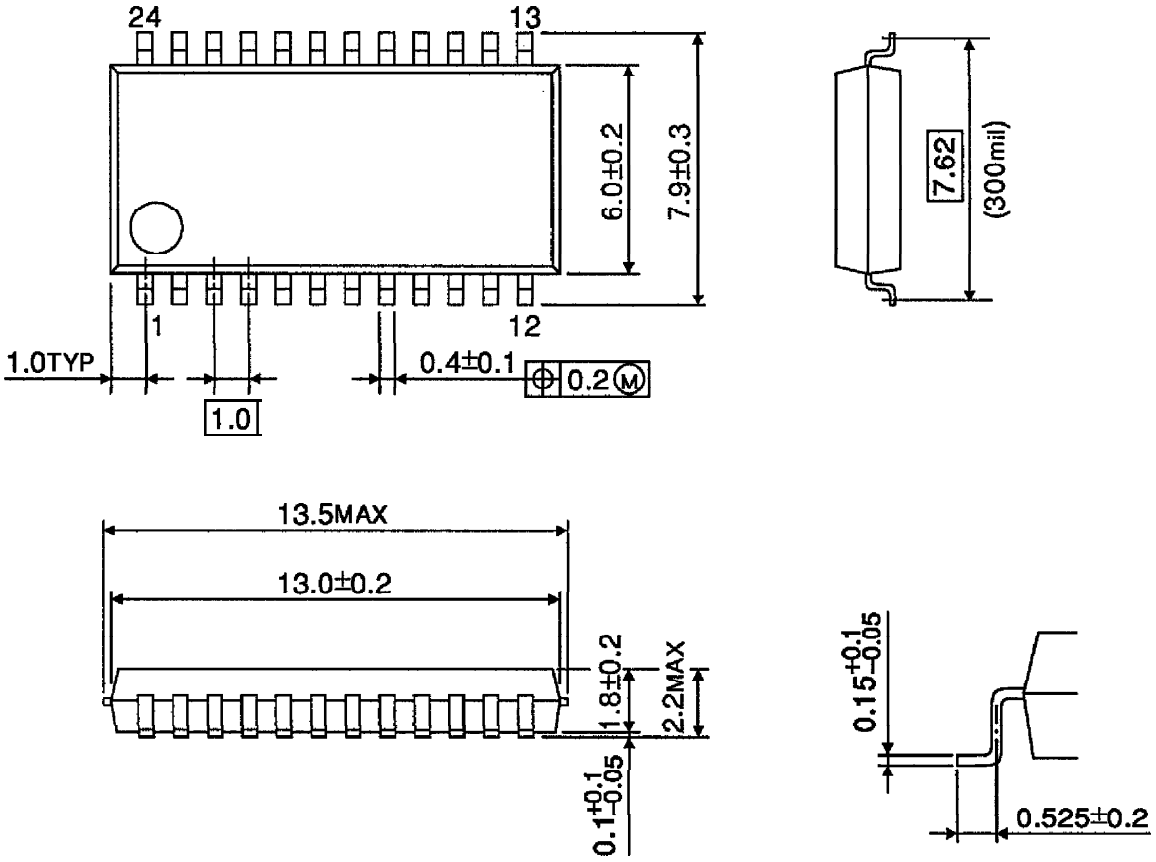


※ Monolithic ceramic condenser

OUTLINE DRAWING

SSOP24-P-300-1.00

Unit : mm

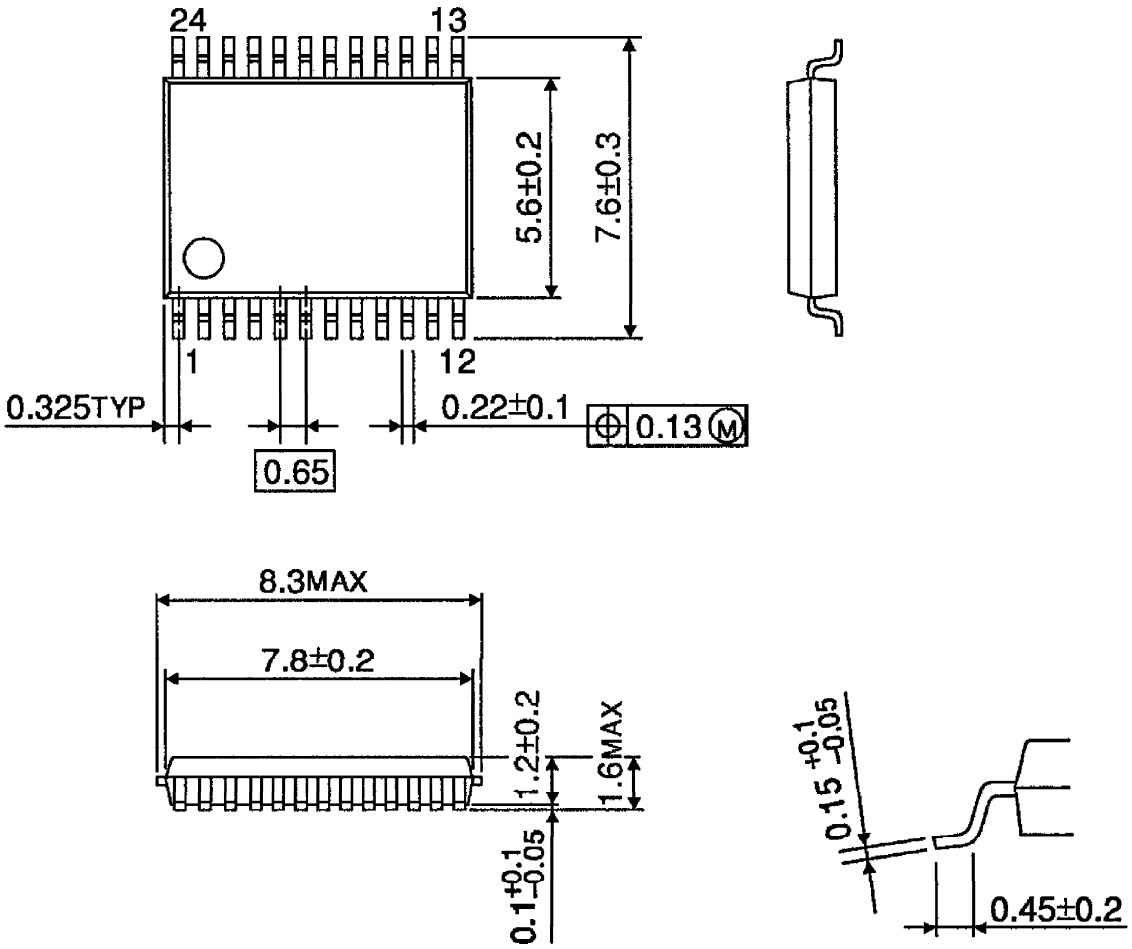


Weight : 0.32g (Typ.)

OUTLINE DRAWING

SSOP24-P-300-0.65A

Unit : mm



Weight : 0.14g (Typ.)