TOSHIBA Bi-CMOS Digital Integrated Circuit Silicon Monolithic

TB2901H

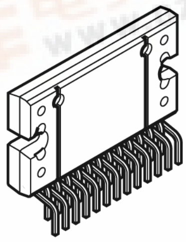
Maximum Power 47 W BTL × 4-ch Audio Power IC

The TB2901H is 4-ch BTL audio amplifier for car audio applications.

This IC can generate higher power: P_{OUT} MAX = 47 W as it includes the pure complementary P-ch and N-ch DMOS output stage.

It is designed to yield low distortion ratio for 4-ch BTL audio power amplifier, built-in standby function, muting function, and various kinds of protectors.

Additionally, high-side switch is built in.



HZIP25-P-1.00F

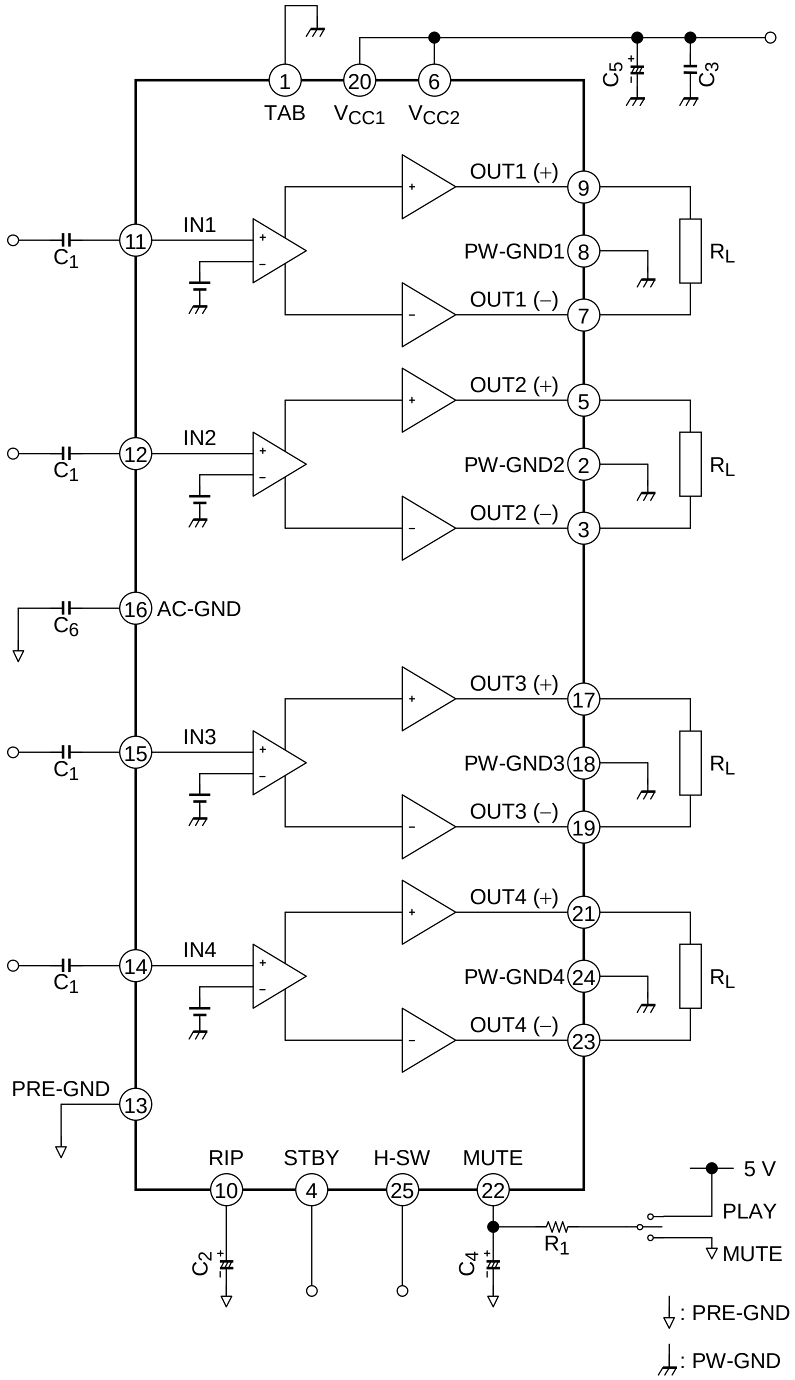
Weight: 7.7 g (typ.)

Features

- High power output
  - : P_{OUT} MAX (1) = 47 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, JEITA max, R_L = 4 Ω)
  - : P_{OUT} MAX (2) = 43 W (typ.)
    (V_{CC} = 13.7 V, f = 1 kHz, JEITA max, R_L = 4 Ω)
  - : P_{OUT} MAX (3) = 80 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, JEITA max, R_L = 2 Ω)
  - : P_{OUT} (1) = 29 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, THD = 10%, R_L = 4 Ω)
  - : P_{OUT} (2) = 25 W (typ.)
    (V_{CC} = 13.2 V, f = 1 kHz, THD = 10%, R_L = 4 Ω)
  - : P_{OUT} (3) = 55 W (typ.)
    (V_{CC} = 14.4 V, f = 1 kHz, THD = 10%, R_L = 2 Ω)
- Low distortion ratio: THD = 0.015% (typ.)
  (V_{CC} = 13.2 V, f = 1 kHz, P_{OUT} = 5 W, R_L = 4 Ω)
- Low noise: V_{NO} = 90 μVrms (typ.)
  (V_{CC} = 13.2 V, R_g = 0 Ω, BW = 20 Hz~20 kHz, R_L = 4 Ω)
- Built-in standby switch function (pin 4)
- Built-in muting function (pin 22)
- Built-in high-side switch function (pin 25)
- Built-in various protection circuits:
  Thermal shut down, overvoltage, out to GND, out to V_{CC}, out to out short
- Operating supply voltage: $V_{CC\ (opr)}$ = 9~18 V (R_L = 4 Ω)

Note 1: Since this device's pins have a low withstanding voltage, please handle it with care.

Block Diagram



Caution and Application Method

(Description is made only on the single channel.)

1. Voltage Gain Adjustment

This IC has no NF (negative feedback) Pins. Therefore, the voltage gain can not be adjusted, but it makes the device a space and total costs saver.

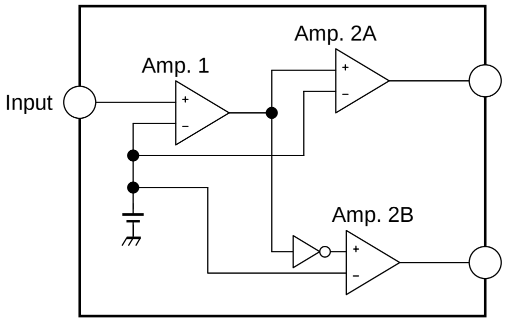


Figure 1 Block Diagram

The voltage gain of amp.1 : G_{V1} = 0dB
The voltage gain of amp.2A, B : G_{V2} = 20dB
The voltage gain of BTL connection: $G_{V\ (BTL)}$ = 6dB

Therefore, the total voltage gain is decided by expression below.

$G_V = G_{V1} + G_{V2} + G_{V\ (BTL)} = 0 + 20 + 6 = 26\text{dB}$

2. Standby SW Function (pin 4)

By means of controlling pin 4 (standby pin) to High and Low, the power supply can be set to ON and OFF. The threshold voltage of pin 4 is set at about $3V_{BE}$ (typ.), and the power supply current is about 2 μA (typ.) in the standby state.

Control Voltage of Pin 4: V_{SB}

Standby	Power	V_{SB} (V)
ON	OFF	0~1.5
OFF	ON	3.5~6 V

When changing the time constant of pin 4, check the pop noise.

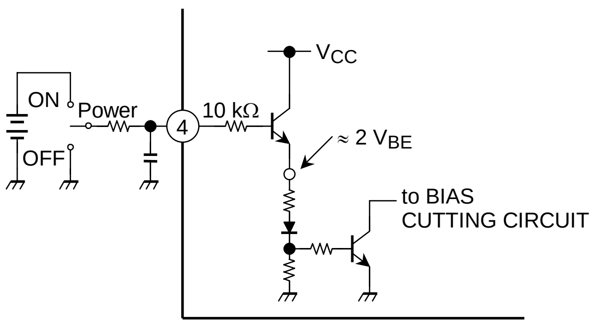


Figure 2 With pin 4 set to High, Power is turned ON

Advantage of Standby 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.

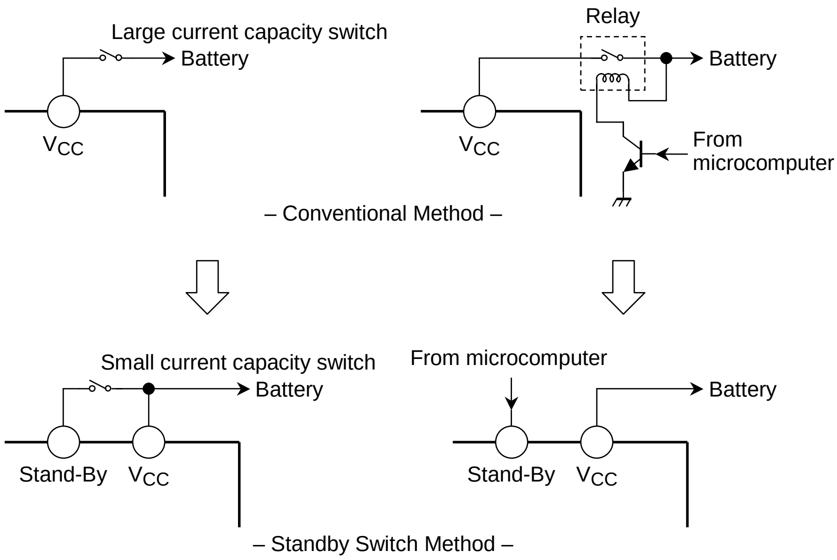


Figure 3

3. Muting Function (pin 22)

Audio muting function is enabled when pin 22 is Low. When the time constant of the muting function is determined by R_1 and C_4, it should take into account the pop noise. The pop noise which is generated when the power or muting function is turned ON/OFF will vary according to the time constant. (Refer to Figure 4 and Figure 5.)

The pin 22 is designed to operate off 5 V.

Moreover, this terminal (pin 22) serves as the source switch of current of an internal mute circuit. And it is designed so that the discharge current of this terminal (pin 22) may serve as 200 μA. The outside pull-up resistor R_1 is determind on the basic of this value.

ex) When control voltage is changed in to 6 V from 5 V.

6 V/5 V × 47 k = 56 k

To obtain enough mute attenuation, a series resistor, R_1 at pin 22 should be 47 kΩ or more.

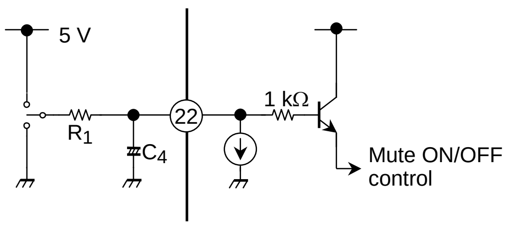


Figure 4 Muting Function

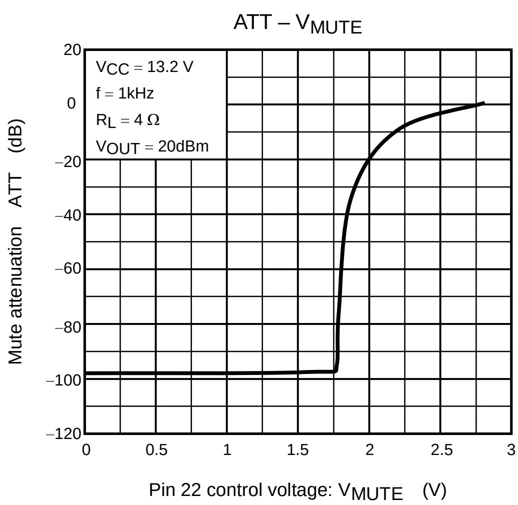


Figure 5 Mute Attenuation – V_{MUTE} (V)

4. High-Side Switch

Pin 25 of this device is used in concerned with V_{CC} as a high-side switch which operates with the standby pin. Thus, both the power amp IC and the connected external unit (the hideaway unit) can be turned ON/OFF by using of the standby switch.

5. Pop Noise Suppression

Since the AC-GND pin (pin 16) is used as the NF pin for all amps, the ratio between the input capacitance (C1) and the AC-to-GND capacitance (C6) should be 1:4.

Also, if the power is turned OFF before the C1 and C6 batteries have been completely charged, pop noise will be generated because of the DC input umbalance.

To counteract the noise, it is recommended that a longer charging time be used for C2 as well as for C1 and C6. Note that the time which audio output takes to start will be longer, since the C2 makes the muting time (the time from when the power is turned ON to when audio output starts) is fix.

The pop noise which is generated when the muting function is turned ON/OFF will vary according to the time constant of C4.

The greater the capacitance, the lower the pop noise. Note that the time from when the mute control signal is applied to C4 to when the muting function is turned ON/OFF will be longer.

6. External Component Constants

Component Name	Recommended Value	Purpose	Effect		Notes
			Lower than recommended value	Higher than recommended value	
C1	0.22 μF	To eliminate DC	Cut-off frequency is increased	Cut-off frequency is reduced	Pop noise is generated when V_{CC} is ON
C2	10 μF	To reduce ripple	Powering ON/OFF is faster	Powering ON/OFF takes longer	
C3	0.1 μF	To provide sufficient oscillation margin	Reduces noise and provides sufficient oscillation margin		
C4	1 μF	To reduce pop noise	High pop noise. Duration until muting function is turned ON/OFF is short	Low pop noise. Duration until muting function is turned ON/OFF is long	
C5	3900 μF	Ripple filter	Power supply ripple filtering		
C6	1 μF	NF for all outputs	Pop noise is suppressed when C1:C6 = 1:4		Pop noise is generated when V_{CC} is ON

Note: If recommended value is not used.

Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Peak supply voltage (0.2 s)	$V_{CC\ (surge)}$	50	V
DC supply voltage	$V_{CC\ (DC)}$	25	V
Operation supply voltage	$V_{CC\ (opr)}$	18	V
Output current (peak)	$I_{O\ (peak)}$	9	A
Power dissipation	P_D (Note 2)	125	W
Operation temperature	T_{opr}	−40~85	°C
Storage temperature	T_{stg}	−55~150	°C

Note 2: Package thermal resistance θ_{j-T} = 1°C/W (typ.) (Ta = 25°C, with infinite heat sink)

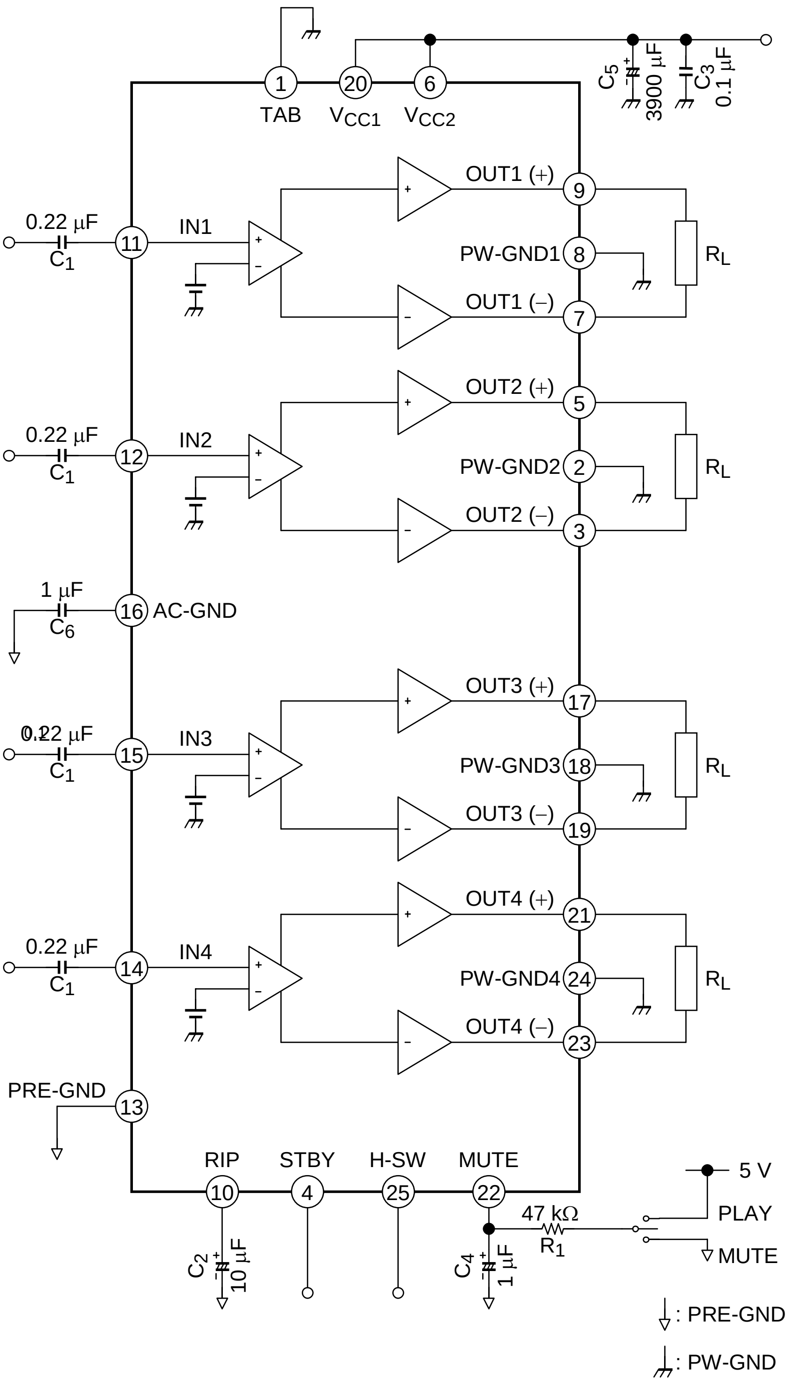
Electrical Characteristics
(unless otherwise specified, V_{CC} = 13.2 V, f = 1 kHz, R_L = 4 Ω, Ta = 25°C)

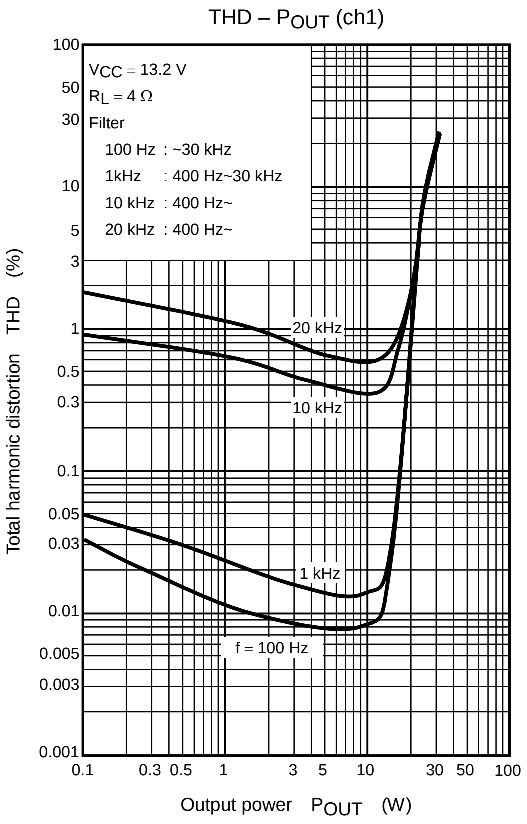
Characteristics	Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Quiescent current	I_{CCQ}	—	V_{IN} = 0	—	200	400	mA
Output power	P_{OUT} MAX (1)	—	V_{CC} = 14.4 V, max POWER	—	47	—	W
	P_{OUT} MAX (2)	—	V_{CC} = 13.7 V, max POWER	—	43	—	
	P_{OUT} (1)	—	V_{CC} = 14.4 V, THD = 10%	—	29	—	
	P_{OUT} (2)	—	THD = 10%	23	25	—	
Output power (R_L = 2 Ω)	P_{OUT} MAX (3)	—	V_{CC} = 14.4 V, max POWER	—	80	—	W
	P_{OUT} MAX (4)	—	V_{CC} = 13.7 V, max POWER	—	77	—	
	P_{OUT} (3)	—	V_{CC} = 14.4 V, THD = 10%	—	55	—	
	P_{OUT} (4)	—	THD = 10%	42	45	—	
Total harmonic distortion	THD	—	P_{OUT} = 5 W	—	0.015	0.15	%
Voltage gain	G_V	—	V_{OUT} = 0.775 Vrms	24	26	28	dB
Voltage gain ratio	ΔG_V	—	V_{OUT} = 0.775 Vrms	−1.0	0	1.0	dB
Output noise voltage	V_{NO} (1)	—	Rg = 0 Ω, DIN45405	—	100	—	μVrms
	V_{NO} (2)	—	Rg = 0 Ω, BW = 20 Hz~20 kHz	—	90	200	
Ripple rejection ratio	R.R.	—	f_{rip} = 100 Hz, R_g = 620 Ω V_{rip} = 0.775 Vrms	50	60	—	dB
Cross talk	C.T.	—	R_g = 620 Ω V_{OUT} = 0.775 Vrms	—	70	—	dB
Output offset voltage	V_{OFFSET}	—	—	−150	0	150	mV
Input resistance	R_{IN}	—	—	—	90	—	kΩ
Standby current	I_{SB}	—	Standby condition	—	2	10	μA
Standby control voltage	V_{SB} H	—	POWER: ON	3.5	—	6.0	V
	V_{SB} L	—	POWER: OFF	0	—	1.5	
Mute control voltage	V_M H	—	MUTE: OFF	3.0	—	6.0	V
	V_M L	—	MUTE: ON, R_1 = 47 kΩ	0	—	0.5	
Mute attenuation	ATT M	—	MUTE: ON V_{OUT} = 7.75 Vrms→Mute: OFF	80	90	—	dB

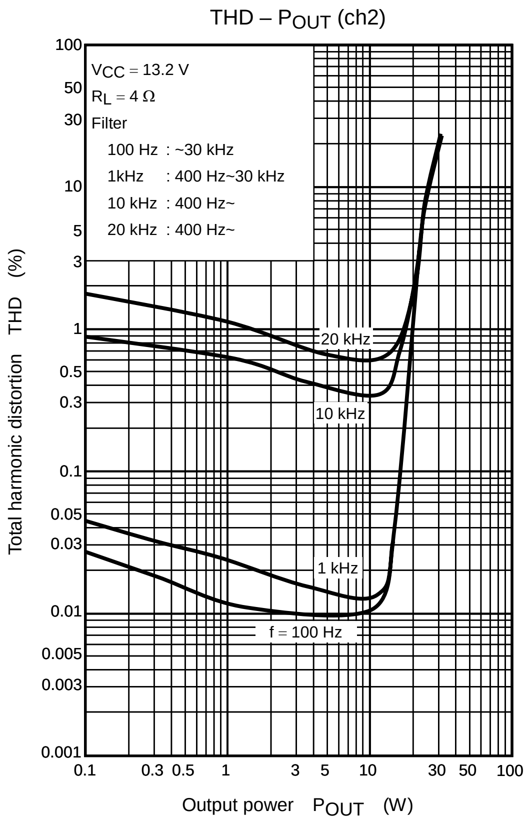
High-Side Switch

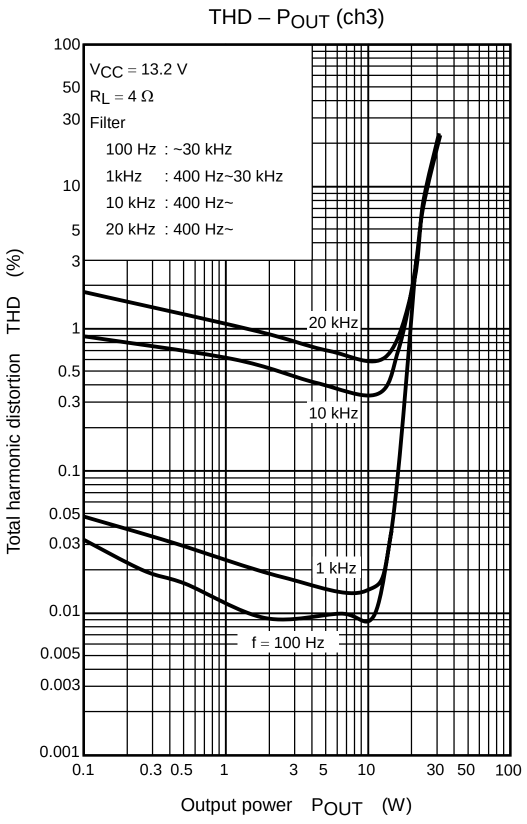
Output current	I_O	—		400	—	—	mA
Difference voltage between V_{CC} and output	ΔV_o	—	I_O = 400 mA, +B = 9.6 V	—	0.25	0.6	V

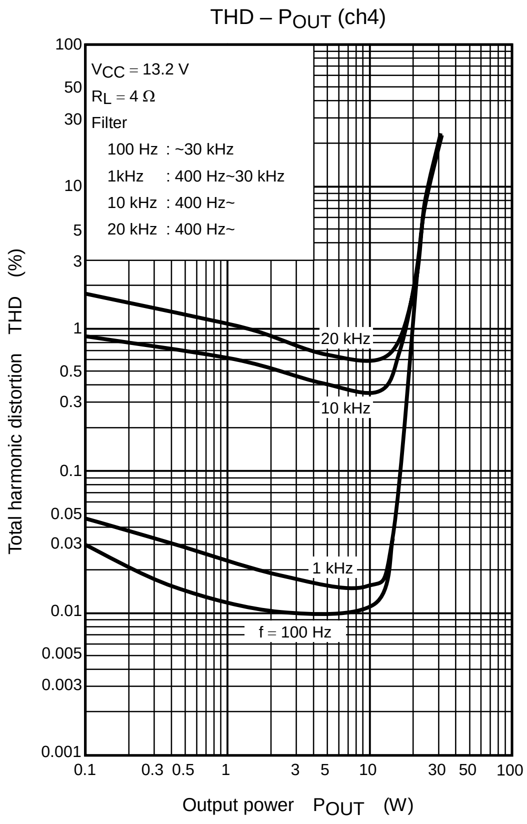
Test Circuit



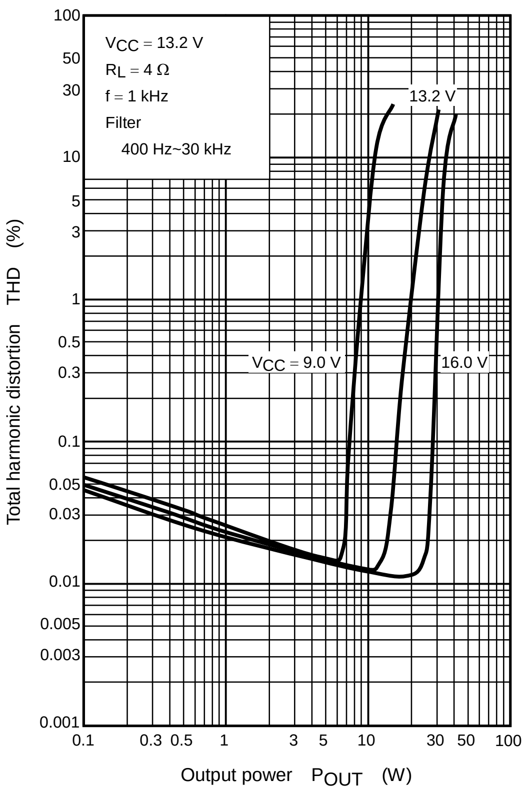

THD – P_{OUT} (ch1)
V_{CC} = 13.2 V
R_L = 4 Ω
Filter
100 Hz : ~30 kHz
1kHz : 400 Hz~30 kHz
10 kHz : 400 Hz~
20 kHz : 400 Hz~
20 kHz
10 kHz
1 kHz
f = 100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)


THD – P_{OUT} (ch2)
V_{CC} = 13.2 V
R_L = 4 Ω
Filter
100 Hz : ~30 kHz
1kHz : 400 Hz~30 kHz
10 kHz : 400 Hz~
20 kHz : 400 Hz~
20 kHz
10 kHz
1 kHz
f = 100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)

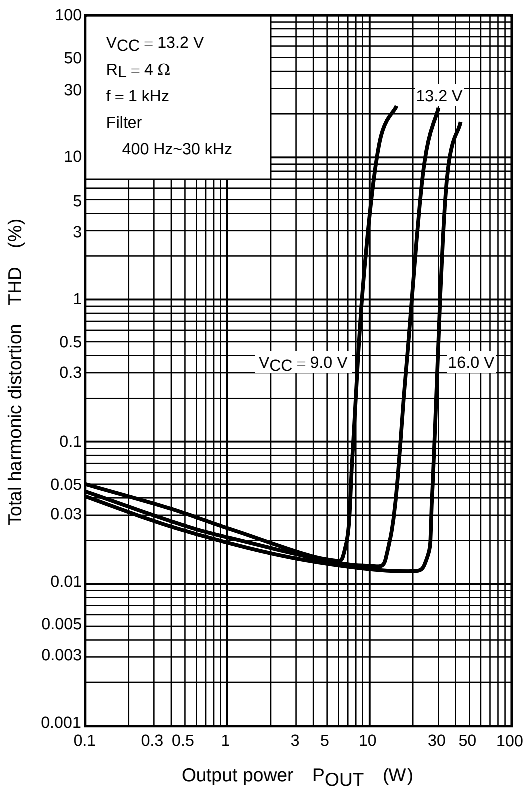

THD – P_{OUT} (ch3)
V_{CC} = 13.2 V
R_L = 4 Ω
Filter
100 Hz : ~30 kHz
1kHz : 400 Hz~30 kHz
10 kHz : 400 Hz~
20 kHz : 400 Hz~
20 kHz
10 kHz
1 kHz
f = 100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)


THD – P_{OUT} (ch4)
V_{CC} = 13.2 V
R_L = 4 Ω
Filter
100 Hz : ~30 kHz
1kHz : 400 Hz~30 kHz
10 kHz : 400 Hz~
20 kHz : 400 Hz~
20 kHz
10 kHz
1 kHz
f = 100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)

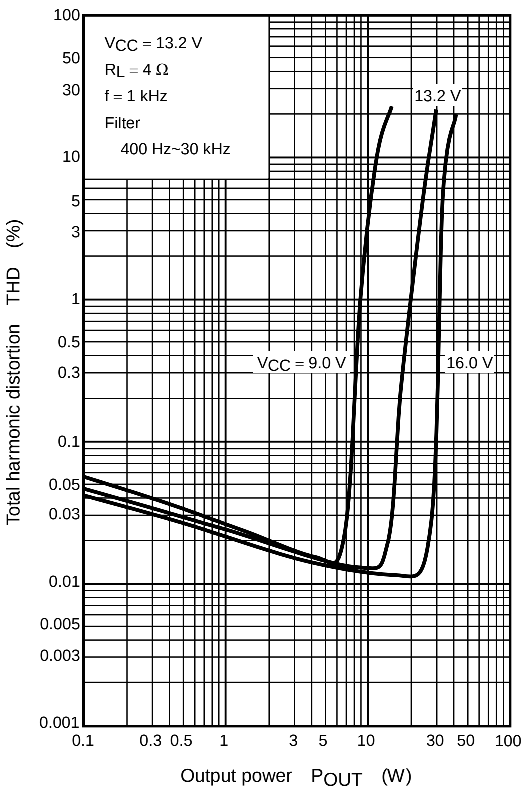
THD – P_{OUT} (ch1)



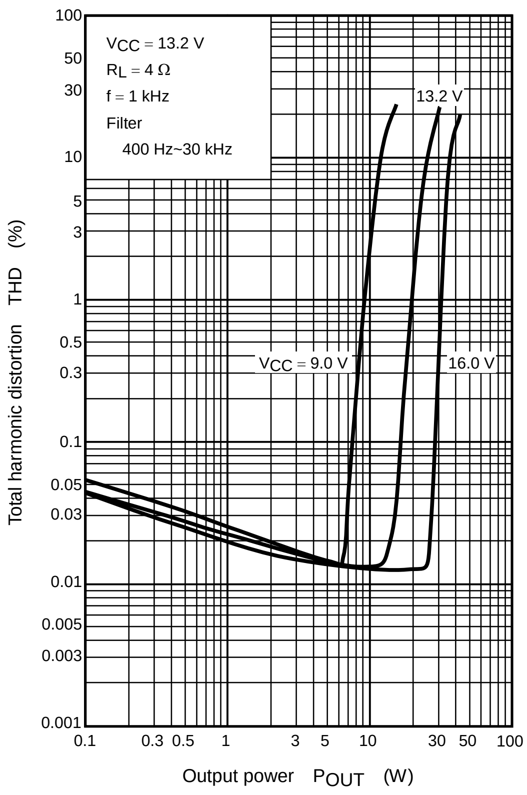
THD – P_{OUT} (ch2)

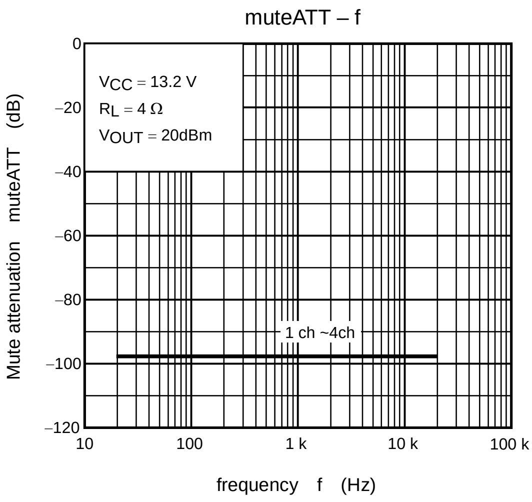


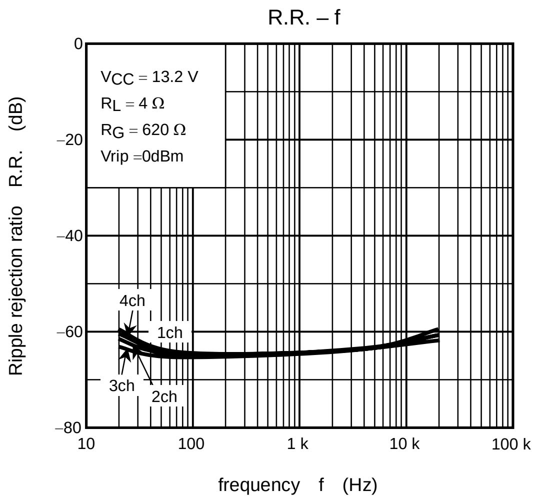
THD – P_{OUT} (ch3)

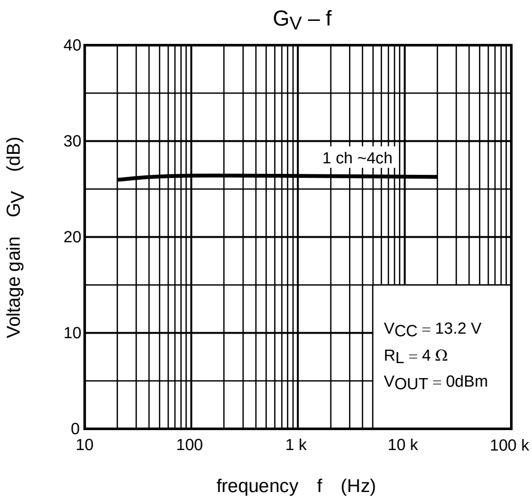


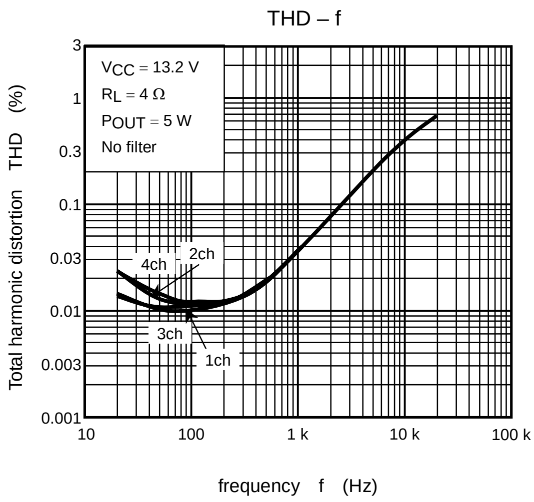
THD – P_{OUT} (ch4)

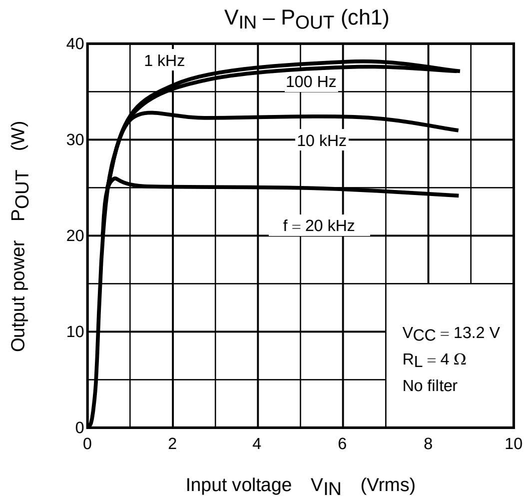


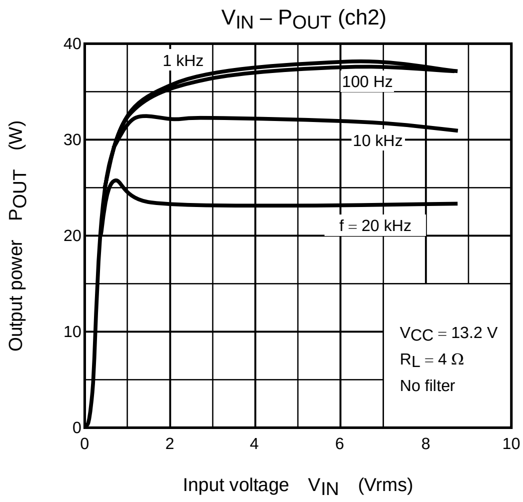

muteATT – f
VCC = 13.2 V
RL = 4 Ω
VOUT = 20dBm
1 ch ~4ch
Mute attenuation muteATT (dB)
0
−20
−40
−60
−80
−100
−120
10
100
1 k
10 k
100 k
frequency f (Hz)

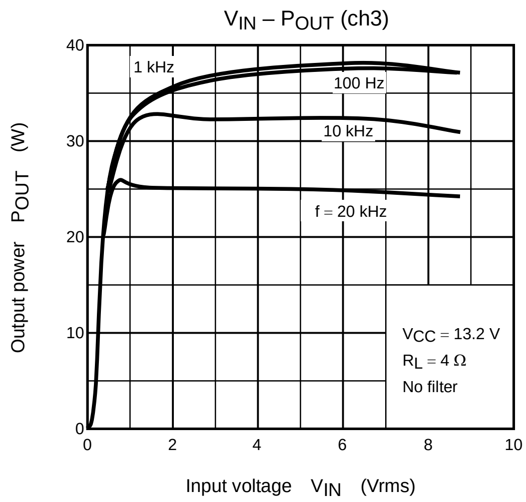

R.R. – f
VCC = 13.2 V
RL = 4 Ω
RG = 620 Ω
Vrip =0dBm
4ch
1ch
3ch
2ch
Ripple rejection ratio R.R. (dB)
0
−20
−40
−60
−80
10
100
1 k
10 k
100 k
frequency f (Hz)

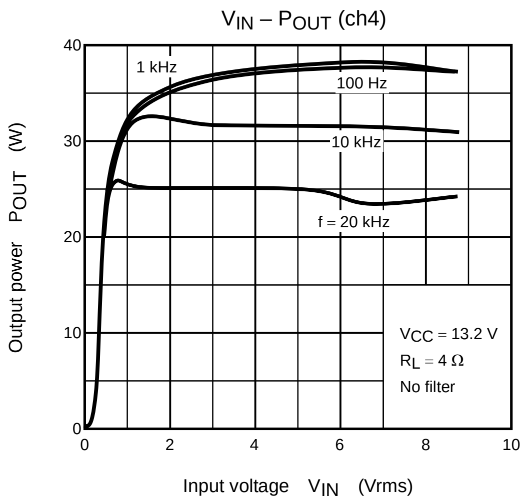

GV – f
1 ch ~4ch
VCC = 13.2 V
RL = 4 Ω
VOUT = 0dBm
Voltage gain GV (dB)
40
30
20
10
0
10
100
1 k
10 k
100 k
frequency f (Hz)

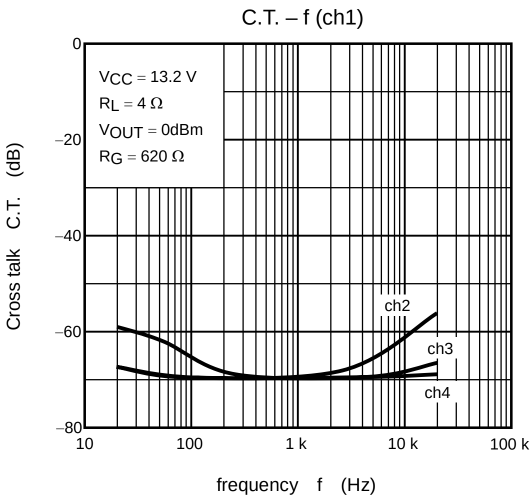

THD – f
VCC = 13.2 V
RL = 4 Ω
POUT = 5 W
No filter
4ch
2ch
3ch
1ch
Total harmonic distortion THD (%)
3
1
0.3
0.1
0.03
0.01
0.003
0.001
10
100
1 k
10 k
100 k
frequency f (Hz)

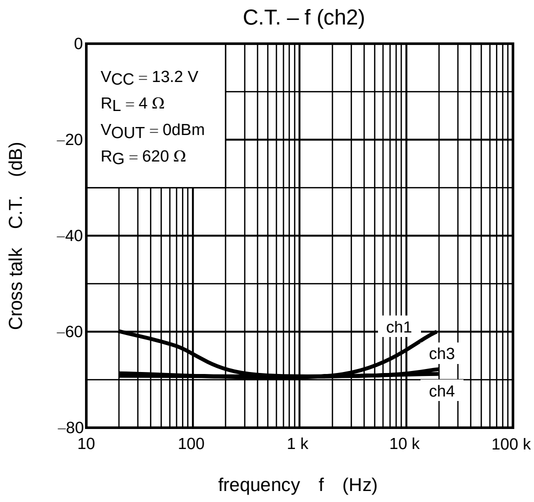

VIN – POUT (ch1)
1 kHz
100 Hz
10 kHz
f = 20 kHz
VCC = 13.2 V
RL = 4 Ω
No filter
Output power POUT (W)
Input voltage VIN (Vrms)
0
10
20
30
40
0
2
4
6
8
10

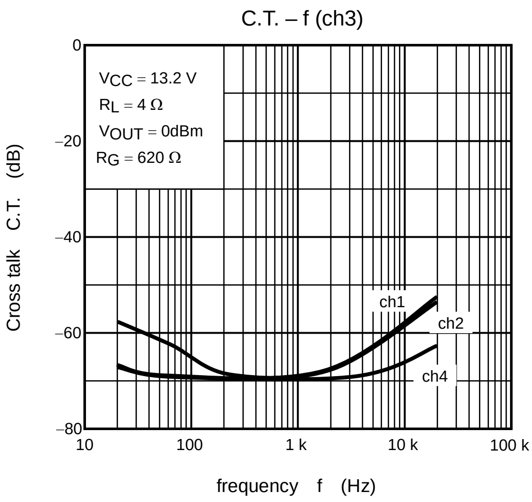

VIN – POUT (ch2)
1 kHz
100 Hz
10 kHz
f = 20 kHz
VCC = 13.2 V
RL = 4 Ω
No filter
Output power POUT (W)
Input voltage VIN (Vrms)
0
10
20
30
40
0
2
4
6
8
10

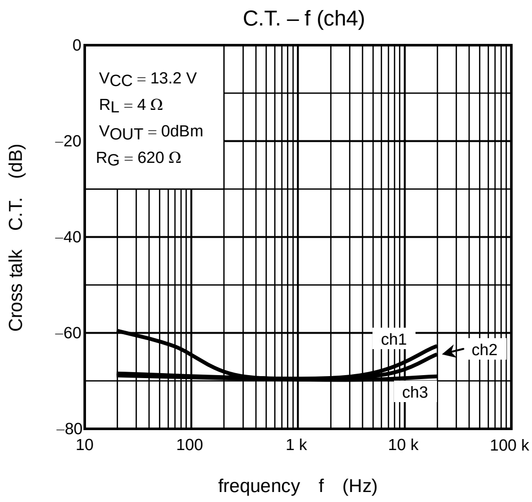

VIN – POUT (ch3)
1 kHz
100 Hz
10 kHz
f = 20 kHz
VCC = 13.2 V
RL = 4 Ω
No filter
Output power POUT (W)
Input voltage VIN (Vrms)
0
10
20
30
40
0
2
4
6
8
10

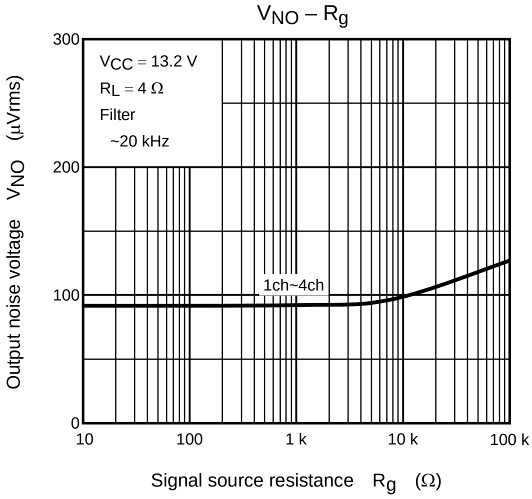

VIN – POUT (ch4)
1 kHz
100 Hz
10 kHz
f = 20 kHz
VCC = 13.2 V
RL = 4 Ω
No filter
Output power POUT (W)
Input voltage VIN (Vrms)
0
10
20
30
40
0
2
4
6
8
10

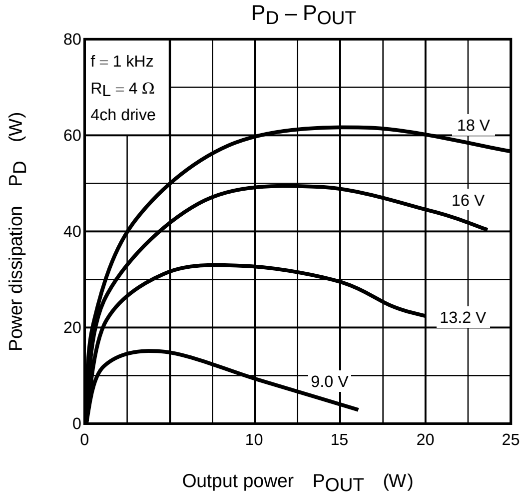

C.T. – f (ch1)
VCC = 13.2 V
RL = 4 Ω
VOUT = 0dBm
RG = 620 Ω
ch2
ch3
ch4
Cross talk C.T. (dB)
0
−20
−40
−60
−80
10
100
1 k
10 k
100 k
frequency f (Hz)

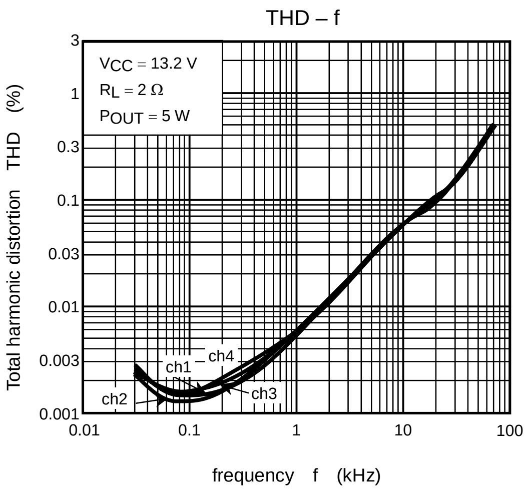

C.T. – f (ch2)
VCC = 13.2 V
RL = 4 Ω
VOUT = 0dBm
RG = 620 Ω
ch1
ch3
ch4
Cross talk C.T. (dB)
0
−20
−40
−60
−80
10
100
1 k
10 k
100 k
frequency f (Hz)

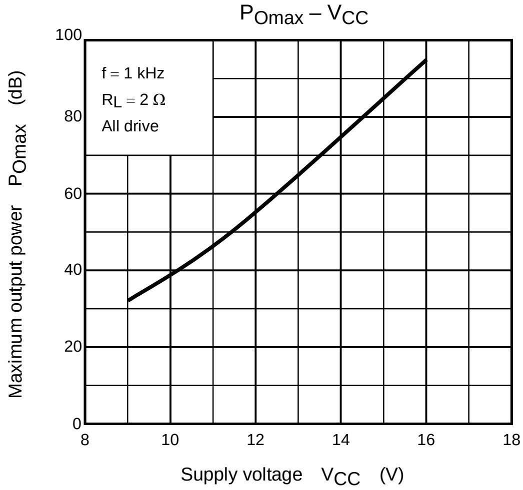

C.T. – f (ch3)
VCC = 13.2 V
RL = 4 Ω
VOUT = 0dBm
RG = 620 Ω
ch1
ch2
ch4
Cross talk C.T. (dB)
0
−20
−40
−60
−80
10
100
1 k
10 k
100 k
frequency f (Hz)

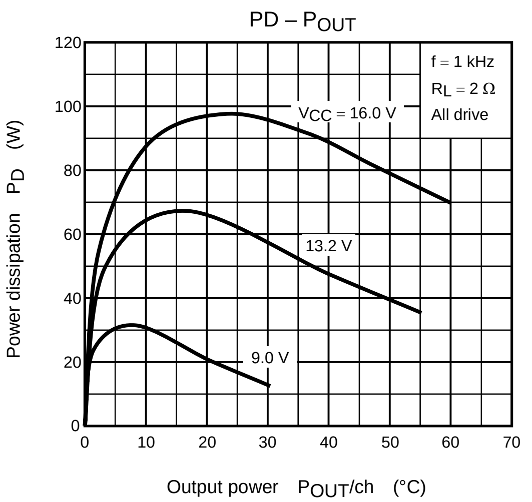

C.T. – f (ch4)
VCC = 13.2 V
RL = 4 Ω
VOUT = 0dBm
RG = 620 Ω
ch1
ch2
ch3
Cross talk C.T. (dB)
0
−20
−40
−60
−80
10
100
1 k
10 k
100 k
frequency f (Hz)

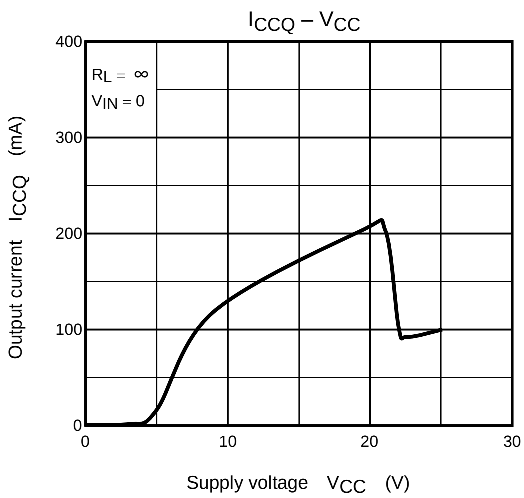

V_{NO} – R_g
V_{CC} = 13.2 V
R_L = 4 Ω
Filter
~20 kHz
1ch~4ch
Output noise voltage V_{NO} (μVrms)
Signal source resistance R_g (Ω)
0
100
200
300
10
100
1 k
10 k
100 k

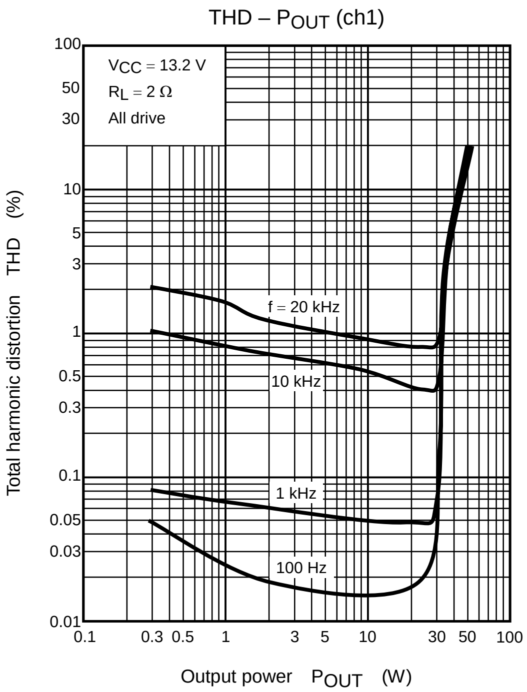

P_D – P_{OUT}
f = 1 kHz
R_L = 4 Ω
4ch drive
18 V
16 V
13.2 V
9.0 V
Power dissipation P_D (W)
Output power P_{OUT} (W)
0
20
40
60
80
0
10
15
20
25

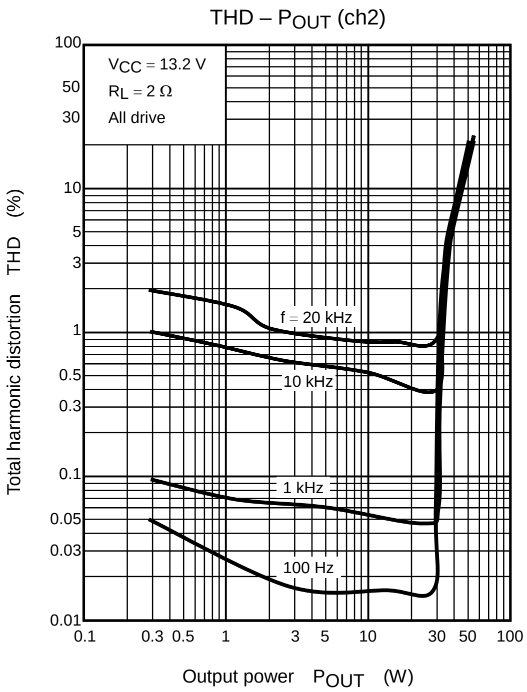

THD – f
V_{CC} = 13.2 V
R_L = 2 Ω
P_{OUT} = 5 W
ch1
ch2
ch3
ch4
Total harmonic distortion THD (%)
frequency f (kHz)
0.001
0.003
0.01
0.03
0.1
0.3
1
3
0.01
0.1
1
10
100

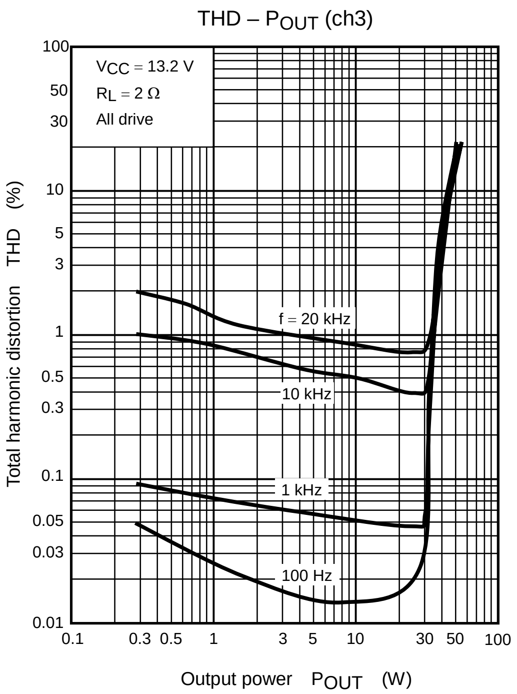

P_{Omax} – V_{CC}
f = 1 kHz
R_L = 2 Ω
All drive
Maximum output power P_{Omax} (dB)
Supply voltage V_{CC} (V)
0
20
40
60
80
100
8
10
12
14
16
18

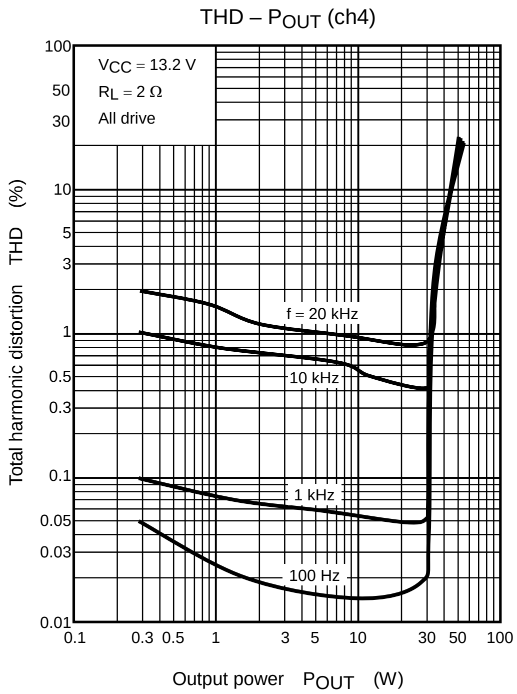

PD – P_{OUT}
f = 1 kHz
R_L = 2 Ω
All drive
V_{CC} = 16.0 V
13.2 V
9.0 V
Power dissipation P_D (W)
Output power P_{OUT}/ch (°C)
0
20
40
60
80
100
120
0
10
20
30
40
50
60
70


I_{CCQ} – V_{CC}
R_L = ∞
V_{IN} = 0
Output current I_{CCQ} (mA)
Supply voltage V_{CC} (V)
0
100
200
300
400
0
10
20
30

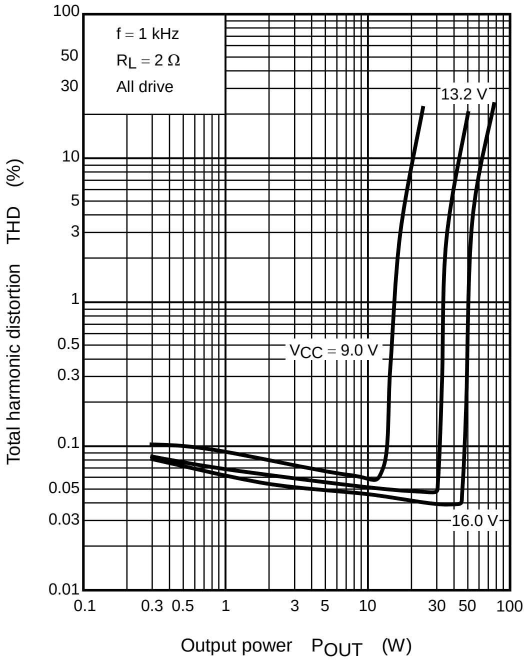

THD – P_{OUT} (ch1)
V_{CC} = 13.2 V
R_L = 2 Ω
All drive
f = 20 kHz
10 kHz
1 kHz
100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)


THD – P_{OUT} (ch2)
V_{CC} = 13.2 V
R_L = 2 Ω
All drive
f = 20 kHz
10 kHz
1 kHz
100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)

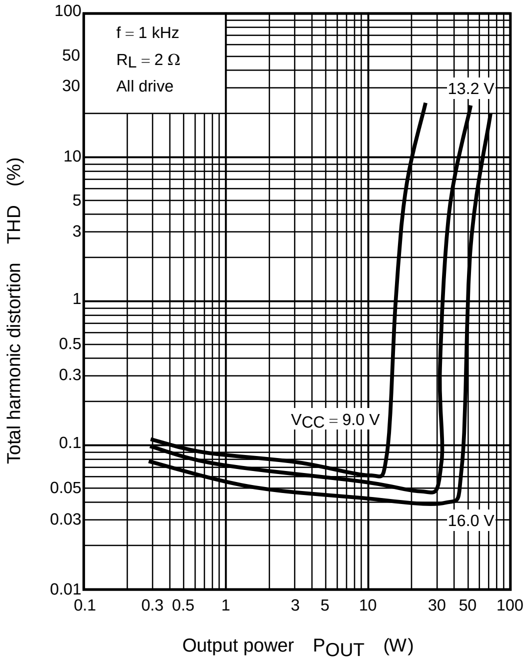

THD – P_{OUT} (ch3)
V_{CC} = 13.2 V
R_L = 2 Ω
All drive
f = 20 kHz
10 kHz
1 kHz
100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)


THD – P_{OUT} (ch4)
V_{CC} = 13.2 V
R_L = 2 Ω
All drive
f = 20 kHz
10 kHz
1 kHz
100 Hz
Total harmonic distortion THD (%)
Output power P_{OUT} (W)

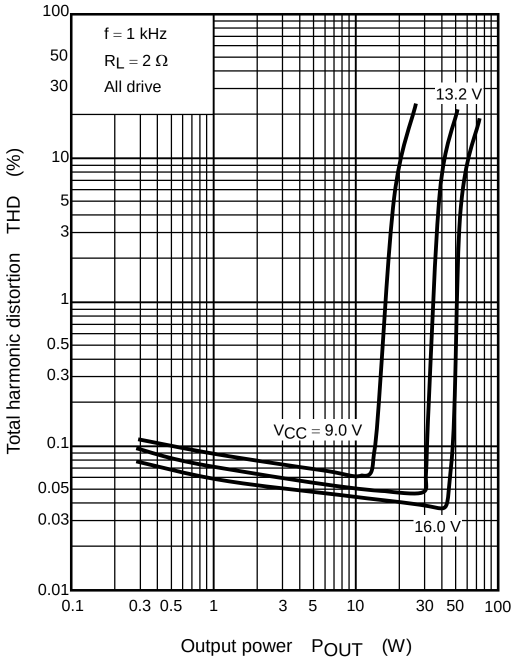
THD – P_{OUT} (ch1)



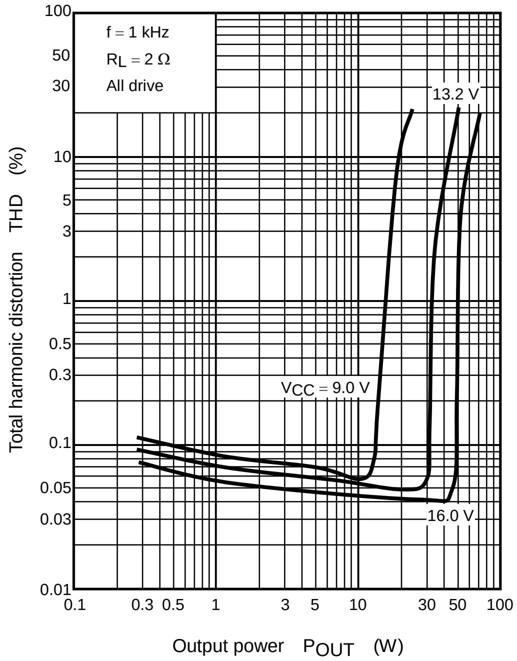
THD – P_{OUT} (ch2)



THD – P_{OUT} (ch3)



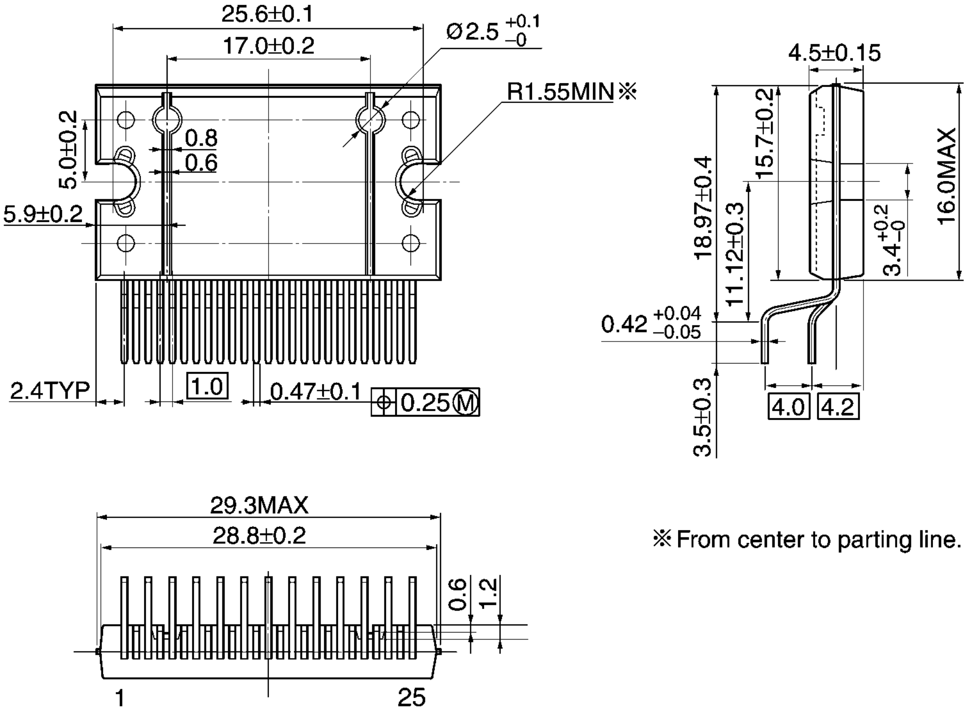
THD – P_{OUT} (ch4)



Package Dimensions

HZIP25-P-1.00F

Unit: mm



Weight: 7.7 g (typ.)

RESTRICTIONS ON PRODUCT USE

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