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# TS486
# TS487

## 100mW STEREO HEADPHONE AMPLIFIER WITH STANDBY MODE

- OPERATING FROM Vcc=2V to 5.5V
- **STANDBY MODE** ACTIVE LOW (TS486) or HIGH (TS487)
- OUTPUT POWER: 102mW @5V, 38mW @3.3V into 16Ω with 0.1% THD+N max (1kHz)
- **LOW CURRENT CONSUMPTION**: 2.5mA max
- High Signal-to-Noise ratio: 103dB(A) at 5V
- High Crosstalk immunity: 83dB (F=1kHz)
- PSRR: 58 dB (F=1kHz), inputs grounded
- ON/OFF click reduction circuitry
- Unity-Gain Stable
- **SHORT CIRCUIT LIMITATION**
- Available in SO8, MiniSO8 & DFN 3x3mm

### DESCRIPTION

The TS486/7 is a dual audio power amplifier capable of driving, in single-ended mode, either a 16 or a 32Ω stereo headset.
Capable of descending to low voltages, it delivers up to 90mW per channel (into 16Ω loads) of continuous average power with 0.3% THD+N in the audio bandwitdth from a 5V power supply.
An externally-controlled standby mode reduces the supply current to 10nA (typ.). The unity gain stable TS486/7 can be configured by external gain-setting resistors or used in a fixed gain version.

### APPLICATIONS

- Headphone Amplifier
- Mobile phone, PDA, computer motherboard
- High end TV, portable audio player

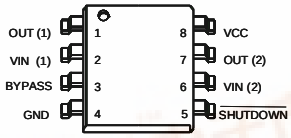
### ORDER CODE

| Part Number | Temperature Range: I | Package | | | Gain | Marking |
|---|---|---|---|---|---|---|
| | | D | S | Q | | |
| TS486 | -40, +85°C | • | | | external | TS486I |
| TS487 | | • | | | external | TS487I |
| TS486 | | | • | • | external | K86A |
| TS486-1 | | | tba | tba | x1/0dB | K86B |
| TS486-2 | | | tba | tba | x2/6dB | K86C |
| TS486-4 | | | tba | tba | x4/12dB | K86D |
| TS487 | | | • | • | external | K87A |
| TS487-1 | | | tba | tba | x1/0dB | K87B |
| TS487-2 | | | tba | tba | x2/6dB | K87C |
| TS487-4 | | | tba | tba | x4/12dB | K87D |

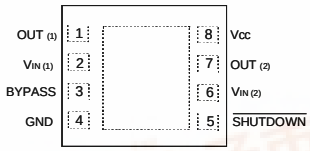
MiniSO & DFN only available in Tape & Reel with T suffix,
SO is available in Tube (D) and in Tape & Reel (DT)

### PIN CONNECTIONS (top view)

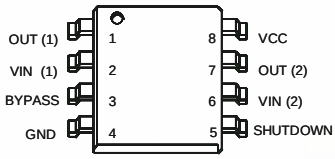
**TS486IDT: SO8, TS486IST, TS486-1IST, TS486-2IST, TS486-4IST: MiniSO8**



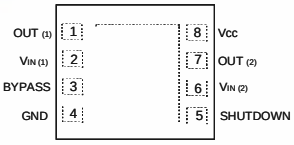

**TS486-IQT, TS486-1IQT, TS486-2IQT, TS486-4IQT: DFN8**




**TS487IDT: SO8, TS487IST, TS487-1IST, TS487-2IST, TS487-4IST: MiniSO8**




**TS487-IQT, TS487-1IQT, TS487-2IQT, TS487-4IQT: DFN8**



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## ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage [1] | 6 | V |
| $V_i$ | Input Voltage | -0.3v to $V_{CC}$ +0.3v | V |
| $T_{stg}$ | Storage Temperature | -65 to +150 | °C |
| $T_j$ | Maximum Junction Temperature | 150 | °C |
| $R_{thja}$ | Thermal Resistance Junction to Ambient<br>SO8<br>MiniSO8<br>DFN8 | <br>175<br>215<br>70 | °C/W |
| Pd | Power Dissipation [2]<br>SO8<br>MiniSO8<br>DFN8 | <br>0.71<br>0.58<br>1.79 | W |
| ESD | Human Body Model (pin to pin): TS486, TS487[3] | 1.5 | kV |
| ESD | Machine Model - 220pF - 240pF (pin to pin) | 100 | V |
| Latch-up | Latch-up Immunity (All pins) | 200 | mA |
| | Lead Temperature (soldering, 10sec) | 250 | °C |
| | Output Short-Circuit to Vcc or GND | continous [4] | |

1. All voltage values are measured with respect to the ground pin.
2. Pd has been calculated with Tamb = 25°C, Tjunction = 150°C.
3. TS487 stands 1.5KV on all pins except standby pin which stands 1KV.
4. Attention must be paid to continous power dissipation ($V_{DD}$ x 300mA). Exposure of the IC to a short circuit for an extended time period is dramatically reducing product life expectancy.

## OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage | 2 to 5.5 | V |
| $R_L$ | Load Resistor | ≥ 16 | Ω |
| $T_{oper}$ | Operating Free Air Temperature Range | -40 to + 85 | °C |
| $C_L$ | Load Capacitor<br>$R_L$ = 16 to 100Ω<br>$R_L$ > 100Ω | <br>400<br>100 | pF |
| $V_{STB}$ | Standby Voltage Input<br>TS486 ACTIVE / TS487 in STANDBY<br>TS486 in STANDBY / TS487 ACTIVE | <br>$1.5 \le V_{STB} \le V_{CC}$<br>$GND \le V_{STB} \le 0.4$ [1] | V |
| $R_{THJA}$ | Thermal Resistance Junction to Ambient<br>SO8<br>MiniSO8<br>DFN8[2] | <br>150<br>190<br>41 | °C/W |

1. The minimum current consumption ($I_{STANDBY}$) is guaranteed at GND (TS486) or $V_{CC}$ (TS487) for the whole temperature range.
2. When mounted on a 4-layer PCB.

## FIXED GAIN VERSION SPECIFIC ELECTRICAL CHARACTERISTICS

$V_{CC}$ from **+5V to +2V**, GND = **0V**, $T_{amb}$ = 25°C (unless otherwise specified)

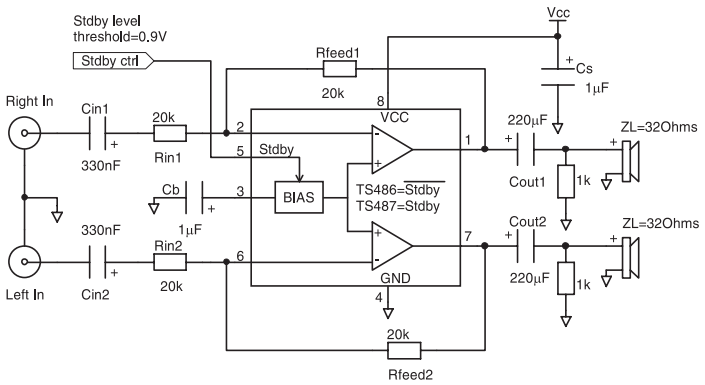
| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $R_{IN\ 1,2}$ | Input Resistance [1)] | | 20 | | kΩ |
| G | Gain value for Gain TS486/TS487-1<br>Gain value for Gain TS486/TS487-2<br>Gain value for Gain TS486/TS487-4 | | 0dB<br>6dB<br>12dB | | dB |

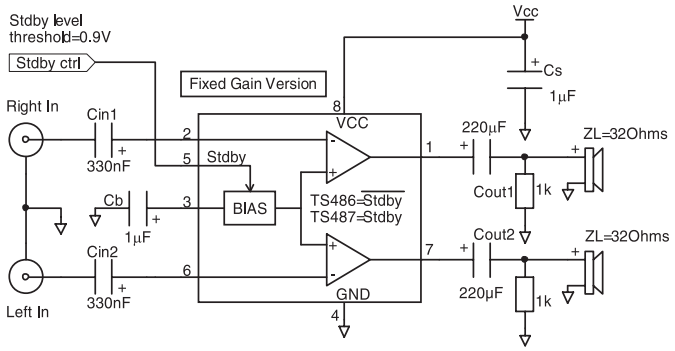
1. See figure 30 to establish the value of Cin vs. -3dB cut off frequency.

## APPLICATION COMPONENTS INFORMATION

| Components | Functional Description |
|---|---|
| $R_{IN1,2}$ | Inverting input resistor which sets the closed loop gain in conjunction with $R_{FEED}$. This resistor also forms a high pass filter with $C_{IN}$ (fc = 1 / (2 x Pi x $R_{IN}$ x $C_{IN}$)) . **Not needed in fixed gain versions.** |
| $C_{IN1,2}$ | Input coupling capacitor which blocks the DC voltage at the amplifier's input terminal. |
| $R_{FEED1,2}$ | Feedback resistor which sets the closed loop gain in conjunction with $R_{IN}$.<br>$A_V$= Closed Loop Gain= -$R_{FEED}$/$R_{IN}$. **Not needed in fixed gain versions.** |
| $C_S$ | Supply Bypass capacitor which provides power supply filtering. |
| $C_B$ | Bypass capacitor which provides half supply filtering. |
| $C_{OUT1,2}$ | Output coupling capacitor which blocks the DC voltage at the load input terminal.<br>This capacitor also forms a high pass filter with RL (fc = 1 / (2 x Pi x $R_L$ x $C_{OUT}$)). |

## TYPICAL APPLICATION SCHEMATICS



## ELECTRICAL CHARACTERISTICS

$V_{CC}$ = **+5V**, GND = **0V**, $T_{amb}$ = 25°C (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $I_{CC}$ | Supply Current<br>No input signal, no load | | 1.8 | 2.5 | mA |
| $I_{STANDBY}$ | Standby Current<br>No input signal, $V_{STANDBY}$=GND for TS486, $R_L$=32Ω<br>No input signal, $V_{STANDBY}$=Vcc for TS487, $R_L$=32Ω | | 10 | 1000 | nA |
| $V_{IO}$ | Input Offset Voltage ($V_{ICM}$ = $V_{CC}$/2) | | 1 | | mV |
| $I_{IB}$ | Input Bias Current ($V_{ICM}$ = $V_{CC}$/2) 1) | | 90 | 200 | nA |
| $P_O$ | Output Power<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 16Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 16Ω | <br>60<br><br>95 | <br>64<br>65<br>102<br>108 | | mW |
| THD + N | Total Harmonic Distortion + Noise ($A_v$=-1)<br>$R_L$ = 32Ω, $P_{out}$ = 60mW, 20Hz ≤ F ≤ 20kHz<br>$R_L$ = 16Ω, $P_{out}$ = 90mW, 20Hz ≤ F ≤ 20kHz | | <br>0.3<br>0.3 | | % |
| PSRR | Power Supply Rejection Ratio, inputs grounded 2)<br>($A_v$=-1), RL>=16Ω, $C_B$=1µF, F = 1kHz, Vripple = 200mVpp | 53 | 58 | | dB |
| $I_O$ | Max Output Current<br>THD +N ≤ 1%, $R_L$ = 16Ω connected between out and $V_{CC}$/2 | 106 | 115 | | mA |
| $V_O$ | Output Swing<br>$V_{OL}$ : $R_L$ = 32Ω<br>$V_{OH}$ : $R_L$ = 32Ω<br>$V_{OL}$ : $R_L$ = 16Ω<br>$V_{OH}$ : $R_L$ = 16Ω | <br><br>4.45<br><br>4.2 | <br>0.45<br>4.52<br>0.6<br>4.35 | <br>0.5<br><br>0.7 | V |
| SNR | Signal-to-Noise Ratio (A weighted, $A_v$=-1) 2)<br>($R_L$ = 32Ω, THD +N < 0.4%, 20Hz ≤ F ≤ 20kHz) | 80 | 103 | | dB |
| Crosstalk | Channel Separation, $R_L$ = 32Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz<br>Channel Separation, $R_L$ = 16Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz | | <br>83<br>79<br><br>80<br>72 | | dB |
| $C_I$ | Input Capacitance | | 1 | | pF |
| GBP | Gain Bandwidth Product ($R_L$ = 32Ω) | | 1.1 | | MHz |
| SR | Slew Rate, Unity Gain Inverting ($R_L$ = 16Ω) | | 0.4 | | V/µs |

1. Only for external gain version.
2. Guaranteed by design and evaluation.

## ELECTRICAL CHARACTERISTICS

$V_{CC}$ = **+3.3V**, GND = **0V**, $T_{amb}$ = 25°C (unless otherwise specified) [1)]

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $I_{CC}$ | Supply Current<br>No input signal, no load | | 1.8 | 2.5 | mA |
| $I_{STANDBY}$ | Standby Current<br>No input signal, $V_{STANDBY}$=GND for TS486, $R_L$=32Ω<br>No input signal, $V_{STANDBY}$=Vcc for TS487, $R_L$=32Ω | | 10 | 1000 | nA |
| $V_{IO}$ | Input Offset Voltage ($V_{ICM}$ = $V_{CC}$/2) | | 1 | | mV |
| $I_{IB}$ | Input Bias Current ($V_{ICM}$ = $V_{CC}$/2) [2)] | | 90 | 200 | nA |
| $P_O$ | Output Power<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 16Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 16Ω | <br>23<br><br>36 | <br>26<br>28<br>38<br>42 | | mW |
| THD + N | Total Harmonic Distortion + Noise ($A_v$=-1)<br>$R_L$ = 32Ω, $P_{out}$ = 16mW, 20Hz ≤ F ≤ 20kHz<br>$R_L$ = 16Ω, $P_{out}$ = 35mW, 20Hz ≤ F ≤ 20kHz | | <br>0.3<br>0.3 | | % |
| PSRR | Power Supply Rejection Ratio, inputs grounded [3)]<br>($A_v$=-1), RL>=16Ω, $C_B$=1µF, F = 1kHz, Vripple = 200mVpp | 53 | 58 | | dB |
| $I_O$ | Max Output Current<br>THD +N ≤ 1%, $R_L$ = 16Ω connected between out and $V_{CC}$/2 | 64 | 75 | | mA |
| $V_O$ | Output Swing<br>$V_{OL}$ : $R_L$ = 32Ω<br>$V_{OH}$ : $R_L$ = 32Ω<br>$V_{OL}$ : $R_L$ = 16Ω<br>$V_{OH}$ : $R_L$ = 16Ω | <br>2.85<br><br>2.68 | <br>0.3<br>3<br>0.45<br>2.85 | <br>0.38<br><br>0.52 | V |
| SNR | Signal-to-Noise Ratio (A weighted, $A_v$=-1) [3)]<br>($R_L$ = 32Ω, THD +N < 0.4%, 20Hz ≤ F ≤ 20kHz) | 80 | 98 | | dB |
| Crosstalk | Channel Separation, $R_L$ = 32Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz<br>Channel Separation, $R_L$ = 16Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz | | <br>80<br>76<br><br>77<br>69 | | dB |
| $C_I$ | Input Capacitance | | 1 | | pF |
| GBP | Gain Bandwidth Product ($R_L$ = 32Ω) | | 1.1 | | MHz |
| SR | Slew Rate, Unity Gain Inverting ($R_L$ = 16Ω) | | 0.4 | | V/µs |

1. All electrical values are guaranted with correlation measurements at 2V and 5V.
2. Only for external gain version.
3. Guaranteed by design and evaluation.

## ELECTRICAL CHARACTERISTICS

$V_{CC}$ = **+2.5V**, GND = **0V**, $T_{amb}$ = 25°C (unless otherwise specified)[1)]

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $I_{CC}$ | Supply Current<br>No input signal, no load | | 1.7 | 2.5 | mA |
| $I_{STANDBY}$ | Standby Current<br>No input signal, $V_{STANDBY}$=GND for TS486, $R_L$=32Ω<br>No input signal, $V_{STANDBY}$=Vcc for TS487, $R_L$=32Ω | | 10 | 1000 | nA |
| $V_{IO}$ | Input Offset Voltage ($V_{ICM}$ = $V_{CC}$/2) | | 1 | | mV |
| $I_{IB}$ | Input Bias Current ($V_{ICM}$ = $V_{CC}$/2) [2)] | | 90 | 200 | nA |
| $P_O$ | Output Power<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 16Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 16Ω | <br>12.5<br><br>17.5 | <br>13<br>14<br>21<br>22 | | mW |
| THD + N | Total Harmonic Distortion + Noise ($A_v$=-1)<br>$R_L$ = 32Ω, $P_{out}$ = 10mW, 20Hz ≤ F ≤ 20kHz<br>$R_L$ = 16Ω, $P_{out}$ = 16mW, 20Hz ≤ F ≤ 20kHz | | <br>0.3<br>0.3 | | % |
| PSRR | Power Supply Rejection Ratio, inputs grounded [3)]<br>($A_v$=-1), RL>=16Ω, $C_B$=1µF, F = 1kHz, Vripple = 200mVpp | 53 | 58 | | dB |
| $I_O$ | Max Output Current<br>THD +N ≤ 1%, $R_L$ = 16Ω connected between out and $V_{CC}$/2 | 45 | 56 | | mA |
| $V_O$ | Output Swing<br>$V_{OL}$ : $R_L$ = 32Ω<br>$V_{OH}$ : $R_L$ = 32Ω<br>$V_{OL}$ : $R_L$ = 16Ω<br>$V_{OH}$ : $R_L$ = 16Ω | <br>2.14<br><br>1.97 | <br>0.25<br>2.25<br>0.35<br>2.15 | <br>0.32<br><br>0.45 | V |
| SNR | Signal-to-Noise Ratio (A weighted, $A_v$=-1) [3)]<br>($R_L$ = 32Ω, THD +N < 0.4%, 20Hz ≤ F ≤ 20kHz) | 80 | 95 | | dB |
| Crosstalk | Channel Separation, $R_L$ = 32Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz<br>Channel Separation, $R_L$ = 16Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz | | <br>80<br>76<br><br>77<br>69 | | dB |
| $C_I$ | Input Capacitance | | 1 | | pF |
| GBP | Gain Bandwidth Product ($R_L$ = 32Ω) | | 1.1 | | MHz |
| SR | Slew Rate, Unity Gain Inverting ($R_L$ = 16Ω) | | 0.4 | | V/µs |

1. All electrical values are guaranted with correlation measurements at 2V and 5V.
2. Only for external gain version.
3. Guaranteed by design and evaluation.

## ELECTRICAL CHARACTERISTICS

$V_{CC}$ = **+2V**, GND = **0V**, $T_{amb}$ = 25°C (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| $I_{CC}$ | Supply Current<br>No input signal, no load | | 1.7 | 2.5 | mA |
| $I_{STANDBY}$ | Standby Current<br>No input signal, $V_{STANDBY}$=GND for TS486, $R_L$=32Ω<br>No input signal, $V_{STANDBY}$=Vcc for TS487, $R_L$=32Ω | | 10 | 1000 | nA |
| $V_{IO}$ | Input Offset Voltage ($V_{ICM}$ = $V_{CC}$/2) | | 1 | | mV |
| $I_{IB}$ | Input Bias Current ($V_{ICM}$ = $V_{CC}$/2) 1) | | 90 | 200 | nA |
| $P_O$ | Output Power<br>THD+N = 0.1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 32Ω<br>THD+N = 0.3% Max, F = 1kHz, $R_L$ = 16Ω<br>THD+N = 1% Max, F = 1kHz, $R_L$ = 16Ω | <br>7<br><br>9.5 | <br>8<br>9<br>12<br>13 | | mW |
| THD + N | Total Harmonic Distortion + Noise ($A_v$=-1)<br>$R_L$ = 32Ω, $P_{out}$ = 6.5mW, 20Hz ≤ F ≤ 20kHz<br>$R_L$ = 16Ω, $P_{out}$ = 8mW, 20Hz ≤ F ≤ 20kHz | | <br>0.3<br>0.3 | | % |
| PSRR | Power Supply Rejection Ratio, inputs grounded 2)<br>($A_v$=-1), RL>=16Ω, $C_B$=1µF, F = 1kHz, Vripple = 200mVpp | 52 | 57 | | dB |
| $I_O$ | Max Output Current<br>THD +N ≤ 1%, $R_L$ = 16Ω connected between out and $V_{CC}$/2 | 33 | 41 | | mA |
| $V_O$ | Output Swing<br>$V_{OL}$ : $R_L$ = 32Ω<br>$V_{OH}$ : $R_L$ = 32Ω<br>$V_{OL}$ : $R_L$ = 16Ω<br>$V_{OH}$ : $R_L$ = 16Ω | <br>1.67<br><br>1.53 | <br>0.24<br>1.73<br>0.33<br>1.63 | <br>0.29<br><br>0.41 | V |
| SNR | Signal-to-Noise Ratio (A weighted, $A_v$=-1) 2)<br>($R_L$ = 32Ω, THD +N < 0.4%, 20Hz ≤ F ≤ 20kHz) | 80 | 93 | | dB |
| Crosstalk | Channel Separation, $R_L$ = 32Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz<br>Channel Separation, $R_L$ = 16Ω, $A_v$=-1<br>F = 1kHz<br>F = 20Hz to 20kHz | | <br>80<br>76<br><br>77<br>69 | | dB |
| $C_I$ | Input Capacitance | | 1 | | pF |
| GBP | Gain Bandwidth Product ($R_L$ = 32Ω) | | 1.1 | | MHz |
| SR | Slew Rate, Unity Gain Inverting ($R_L$ = 16Ω) | | 0.4 | | V/µs |

1. Only for external gain version.
2. Guaranteed by design and evaluation.

## Index of Graphs


| Description | Figure | Page |
|---|---|---|
| **Common Curves** | | |
| Open Loop Gain and Phase vs Frequency | 1 to 10 | 9 to 10 |
| Current Consumption vs Power Supply Voltage | 11 | 10 |
| Current Consumption vs Standby Voltage | 12 to 17 | 10 to 11 |
| Output Power vs Power Supply Voltage | 18 to19 | 11 to 12 |
| Output Power vs Load Resistor | 20 to 23 | 12 |
| Power Dissipation vs Output Power | 24 to 27 | 12 to 13 |
| Power Derating vs Ambiant Temperature | 28 | 13 |
| Output Voltage Swing vs Supply Voltage | 29 | 13 |
| Low Frequency Cut Off vs Input Capacitor for fixed gain versions | 30 | 13 |
| **Curves With 0dB Gain Setting (Av=-1)** | | |
| THD + N vs Output Power | 31 to 39 | 14 to 15 |
| THD + N vs Frequency | 40 to 42 | 15 |
| Crosstalk vs Frequency | 43 to 48 | 16 |
| Signal to Noise Ratio vs Power Supply Voltage | 49 to 50 | 17 |
| PSRR vs Frequency | 51 to 56 | 17 to 18 |
| **Curves With 6dB Gain Setting (Av=-2)** | | |
| THD + N vs Output Power | 57 to 65 | 19 to 20 |
| THD + N vs Frequency | 66 to 68 | 20 |
| Crosstalk vs Frequency | 69 to 72 | 21 |
| Signal to Noise Ratio vs Power Supply Voltage | 73 to 74 | 21 |
| PSRR vs Frequency | 75 to 79 | 22 |
| **Curves With 12dB Gain Setting (Av=-4)** | | |
| THD + N vs Output Power | 80 to 88 | 22 to 24 |
| THD + N vs Frequency | 89 to 91 | 24 |
| Crosstalk vs Frequency | 92 to 95 | 24 |
| Signal to Noise Ratio vs Power Supply Voltage | 96 to 97 | 25 |
| PSRR vs Frequency | 98 to 102 | 26 |

**Fig. 1: Open Loop Gain and Phase vs Frequency**

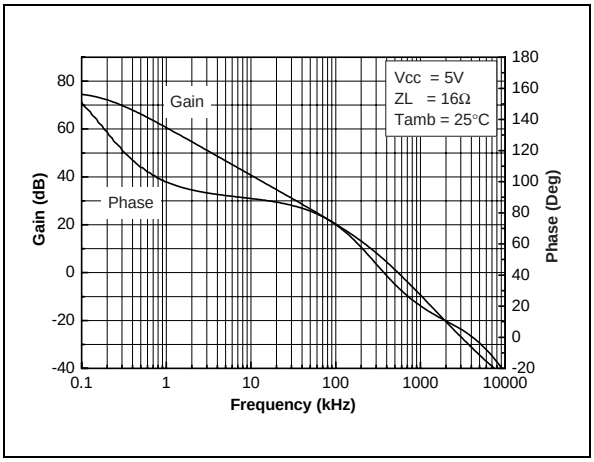



**Fig. 2: Open Loop Gain and Phase vs Frequency**

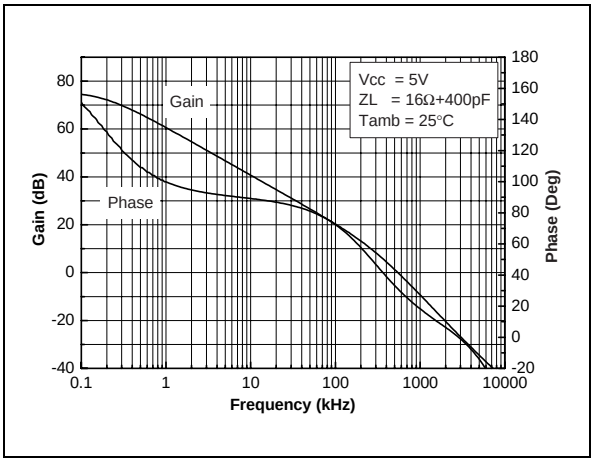



**Fig. 3: Open Loop Gain and Phase vs Frequency**

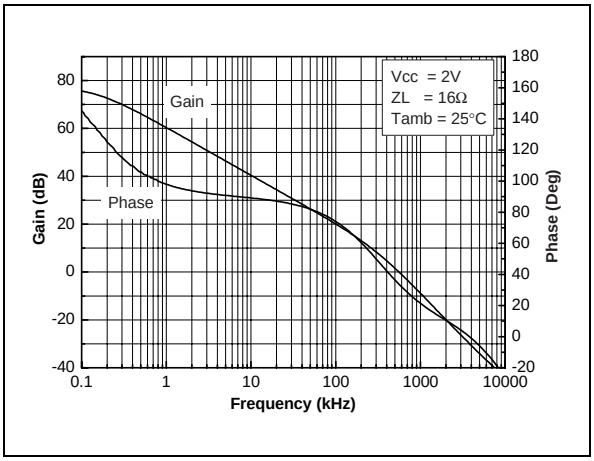



**Fig. 4: Open Loop Gain and Phase vs Frequency**

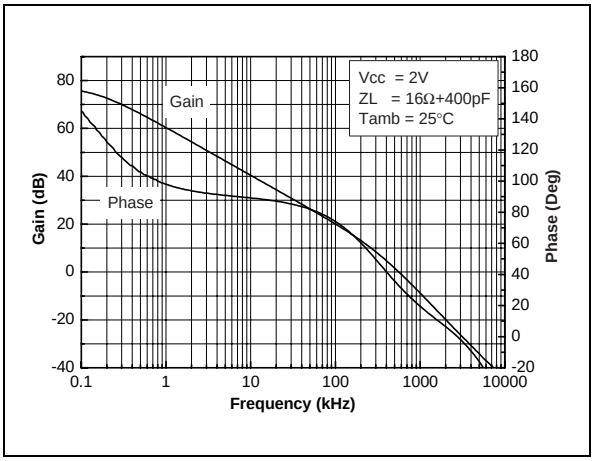



**Fig. 5: Open Loop Gain and Phase vs Frequency**

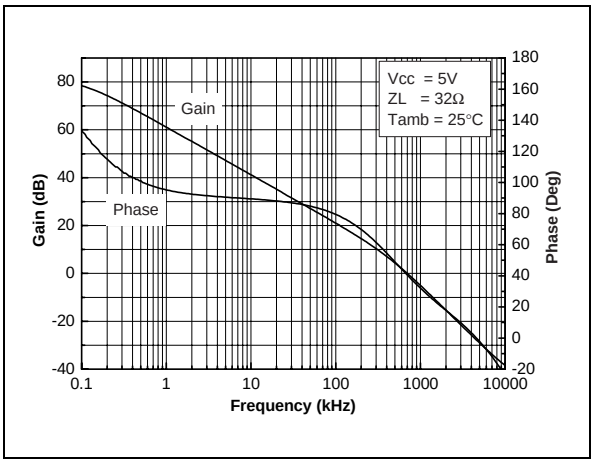



**Fig. 6: Open Loop Gain and Phase vs Frequency**

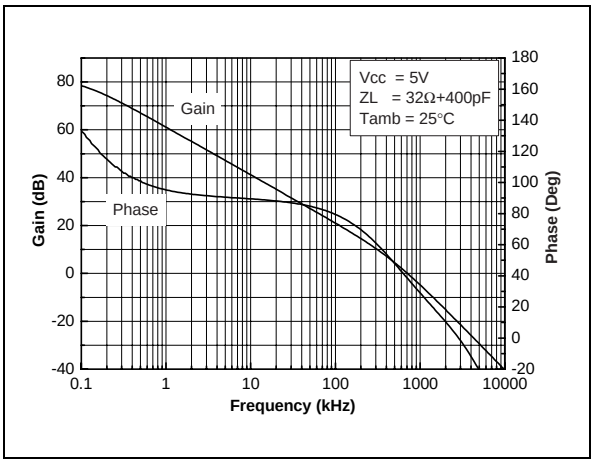


**Fig. 7: Open Loop Gain and Phase vs Frequency**

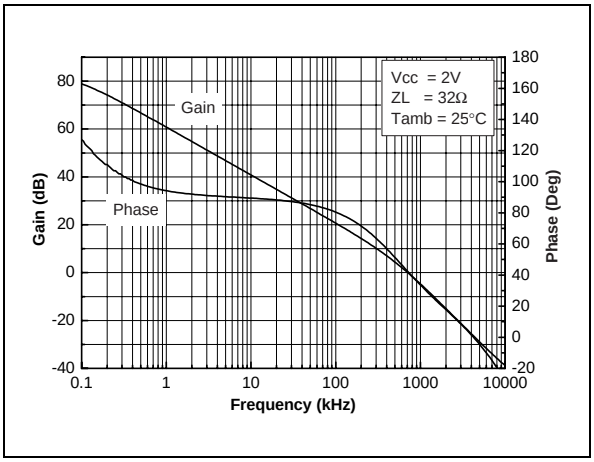



**Fig. 8: Open Loop Gain and Phase vs Frequency**

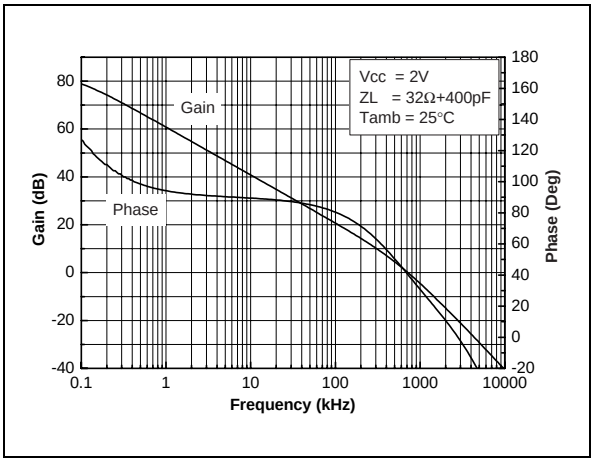



**Fig. 9: Open Loop Gain and Phase vs Frequency**

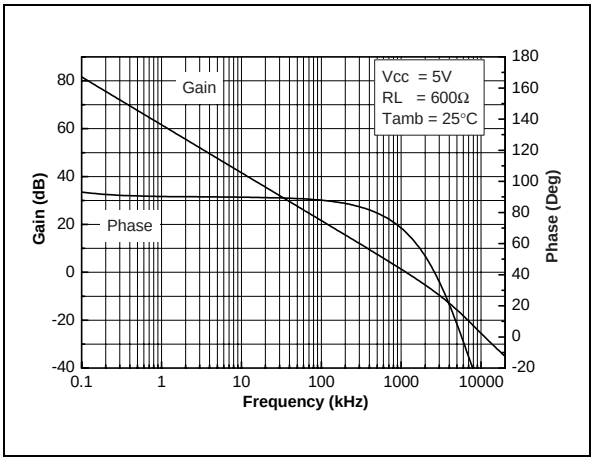



**Fig. 10: Open Loop Gain and Phase vs Frequency**

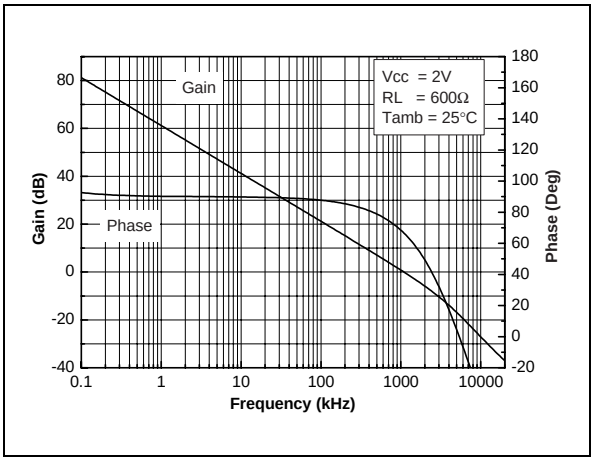



**Fig. 11: Current Consumption vs Power Supply Voltage**

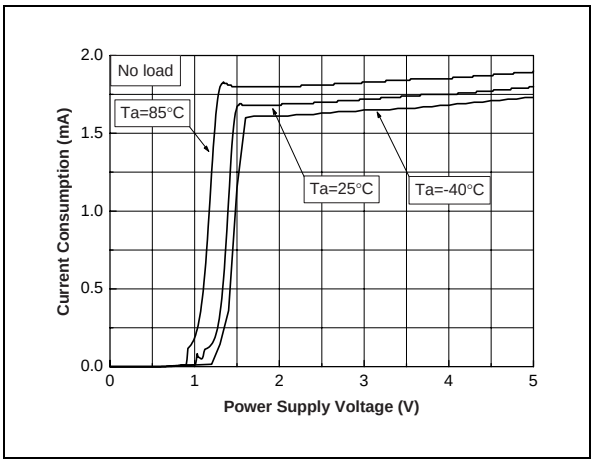



**Fig. 12: Current Consumption vs Standby Voltage**

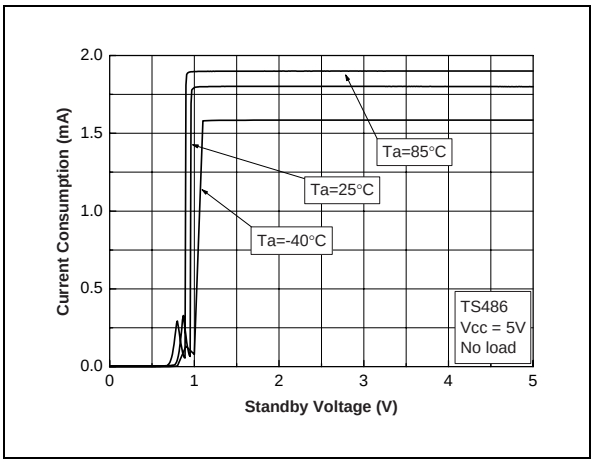


**Fig. 13: Current Consumption vs Standby Voltage**

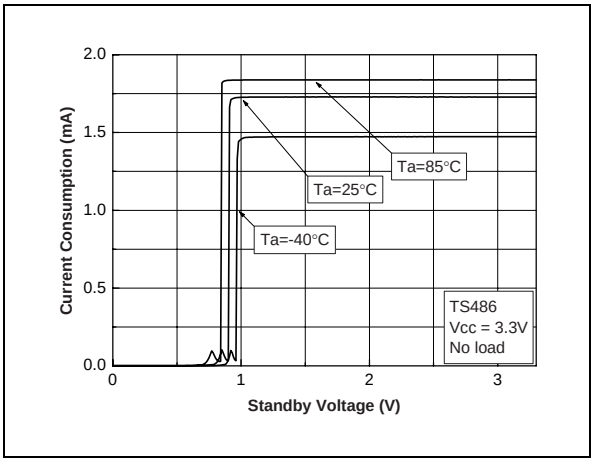



**Fig. 14: Current Consumption vs Standby Voltage**

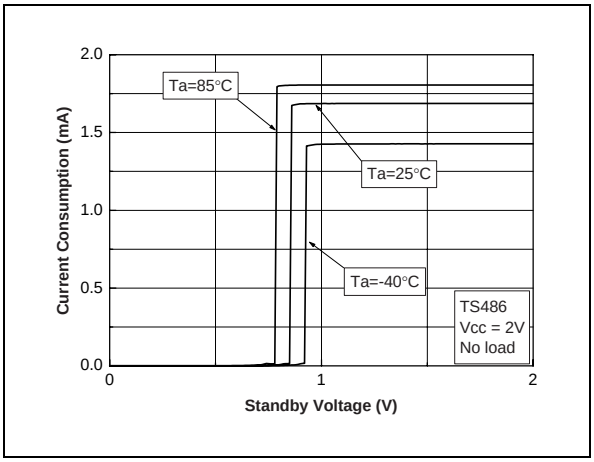



**Fig. 15: Current Consumption vs Standby Voltage**

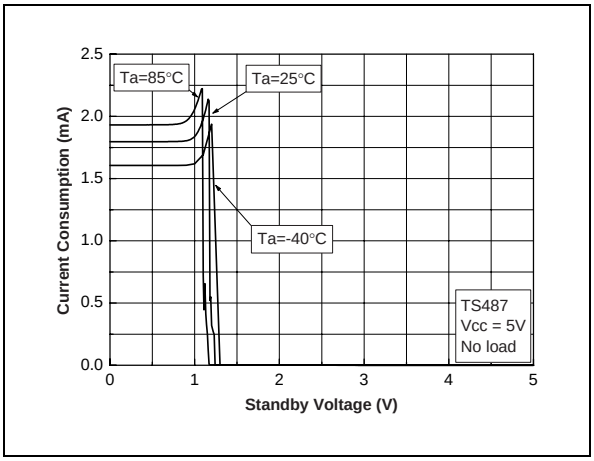



**Fig. 16: Current Consumption vs Standby Voltage**

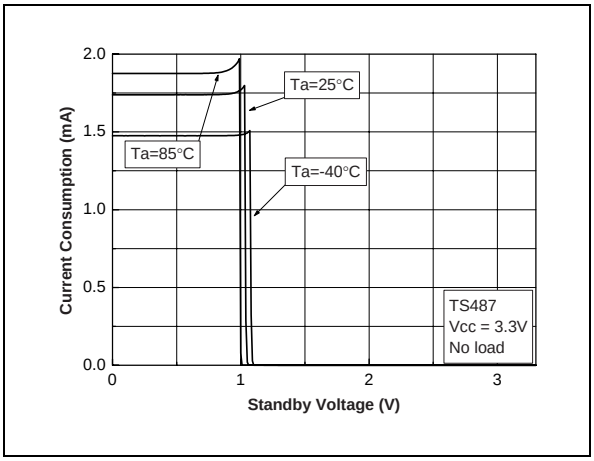



**Fig. 17: Current Consumption vs Standby Voltage**

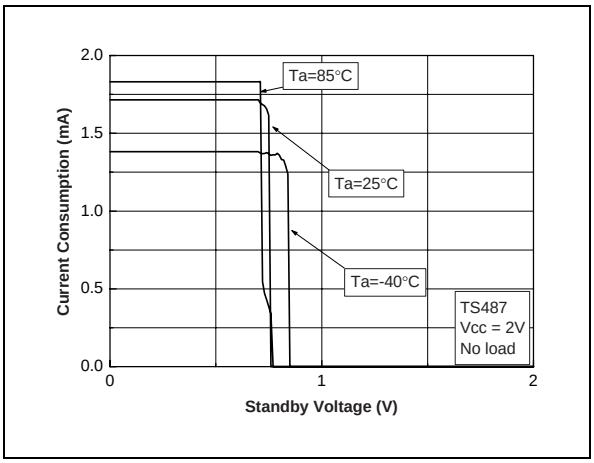



**Fig. 18: Output Power vs Power Supply Voltage**

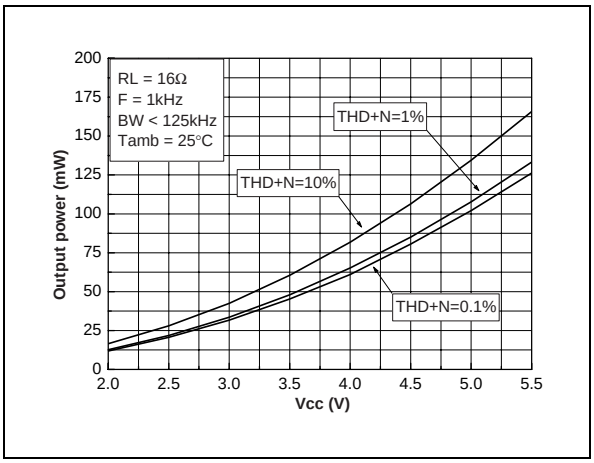


**Fig. 19: Output Power vs Power Supply Voltage**

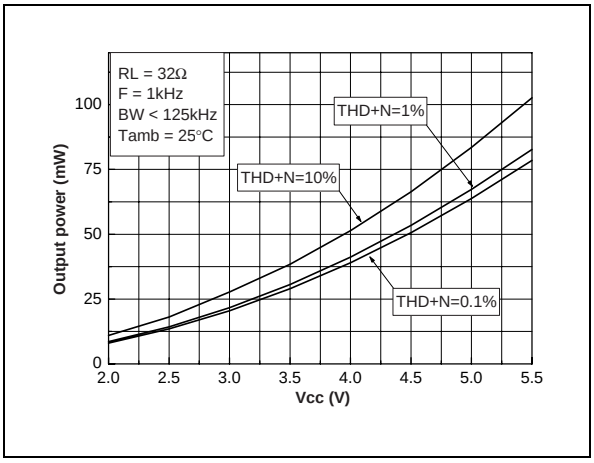



**Fig. 20: Output Power vs Load Resistor**

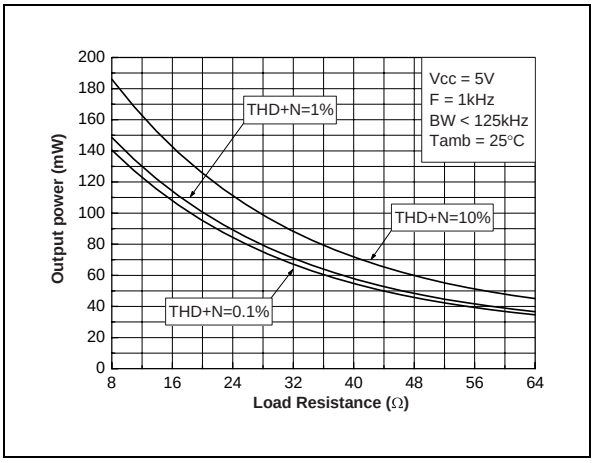



**Fig. 21: Output Power vs Load Resistor**

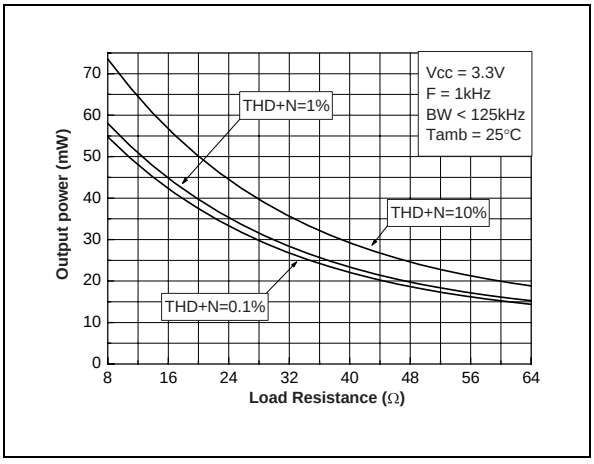



**Fig. 22: Output Power vs Load Resistor**

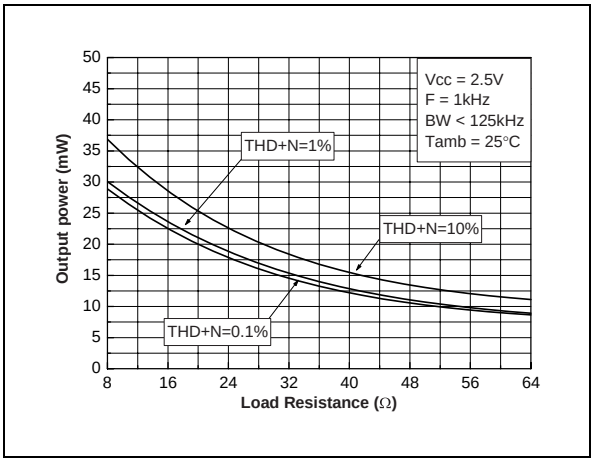



**Fig. 23: Output Power vs Load Resistor**

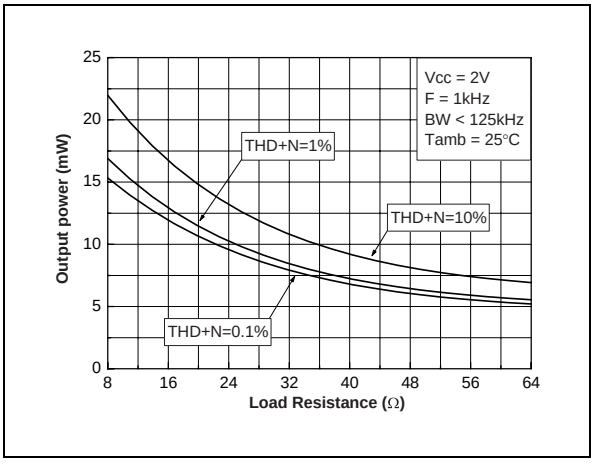



**Fig. 24: Power Dissipation vs Output Power**

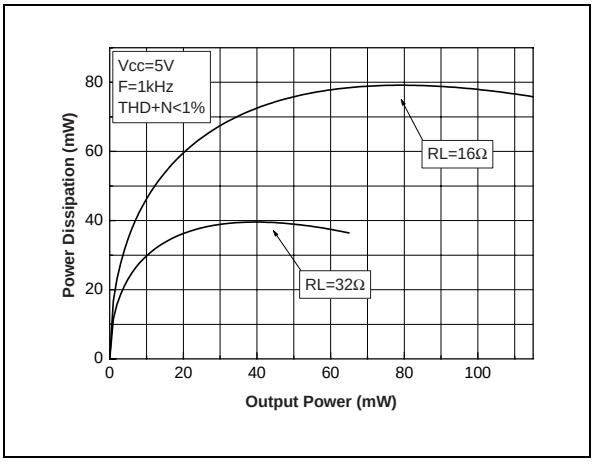


**Fig. 25: Power Dissipation vs Output Power**

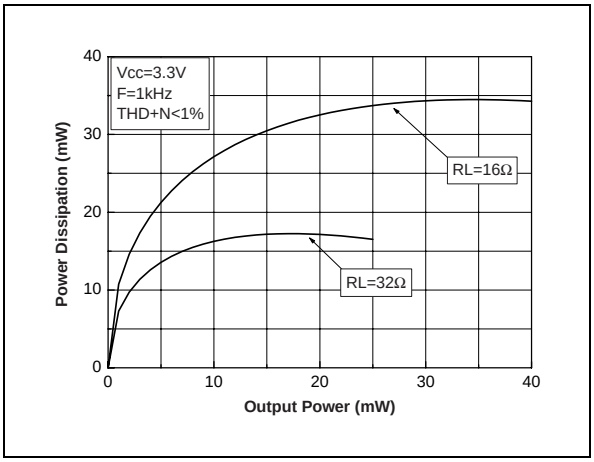



**Fig. 26: Power Dissipation vs Output Power**

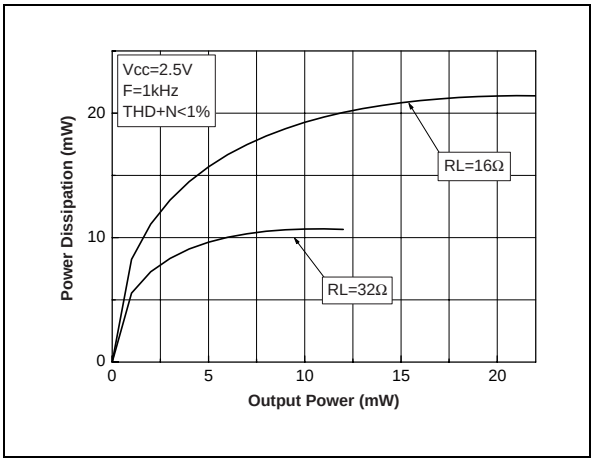



**Fig. 27: Power Dissipation vs Output Power**

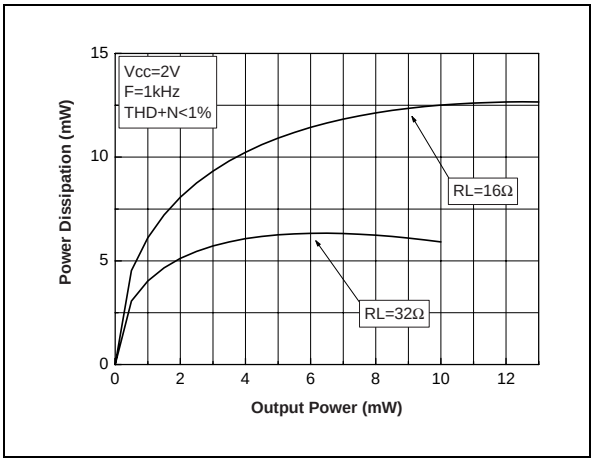



**Fig. 28: Power Derating vs Ambiant Temperature**

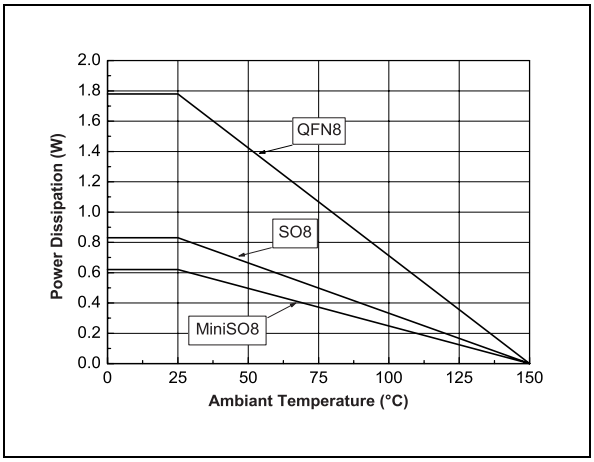



**Fig. 29: Output Voltage Swing vs Power Supply Voltage**

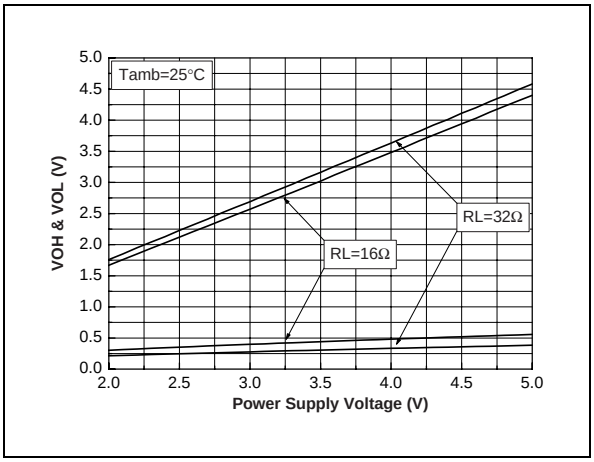



**Fig. 30: Low Frequency Cut Off vs Input Capacitor for fixed gain versions.**

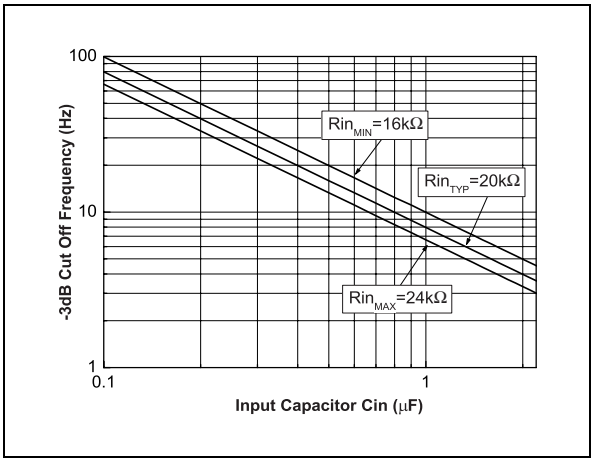


**Fig. 31: THD + N vs Output Power**

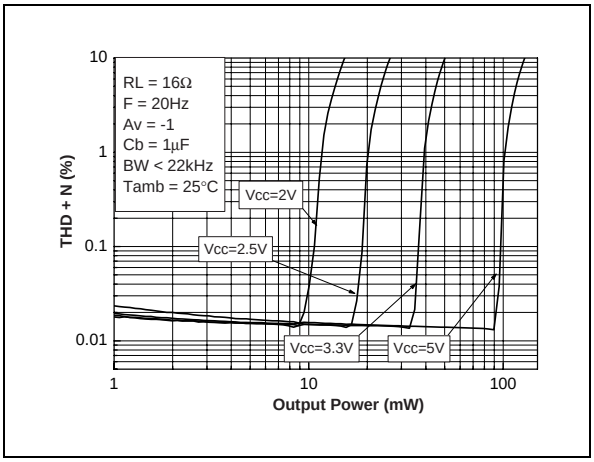



**Fig. 32: THD + N vs Output Power**

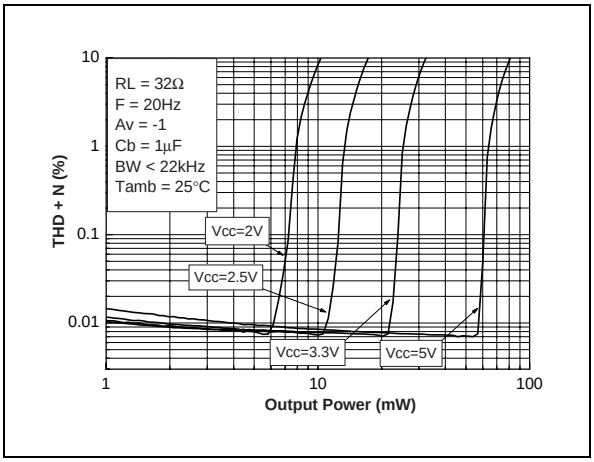



**Fig. 33: THD + N vs Output Power**

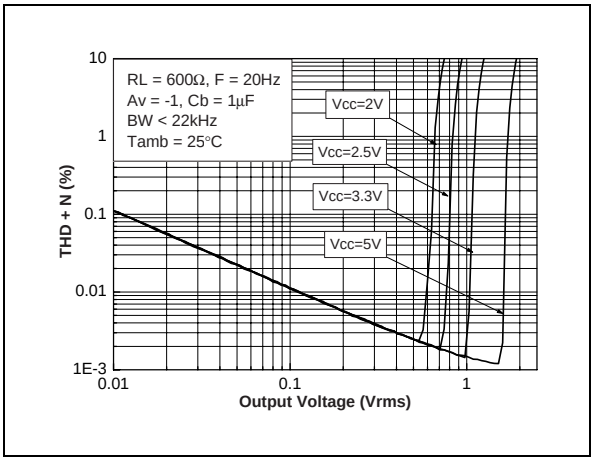



**Fig. 34: THD + N vs Output Power**

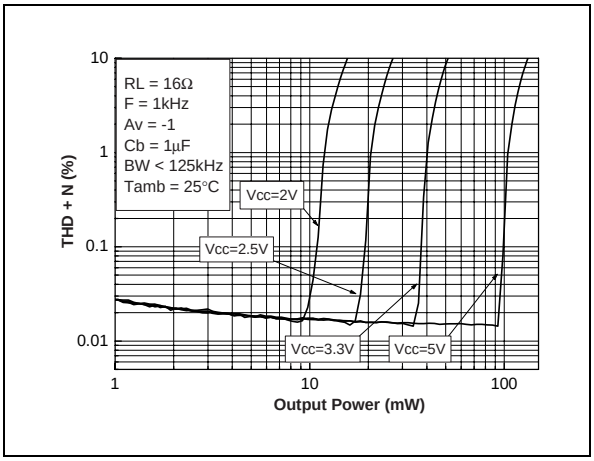



**Fig. 35: THD + N vs Output Power**

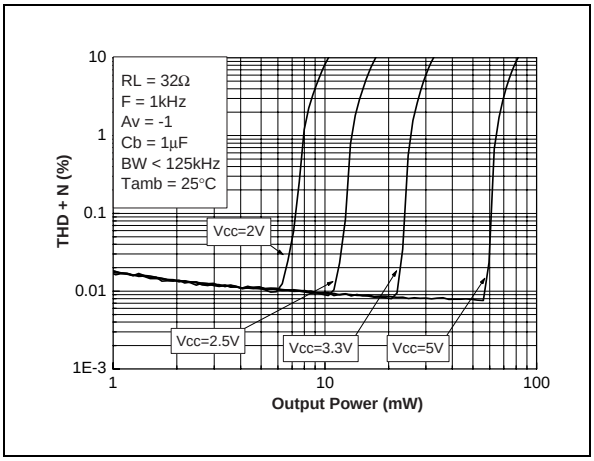



**Fig. 36: THD + N vs Output Power**

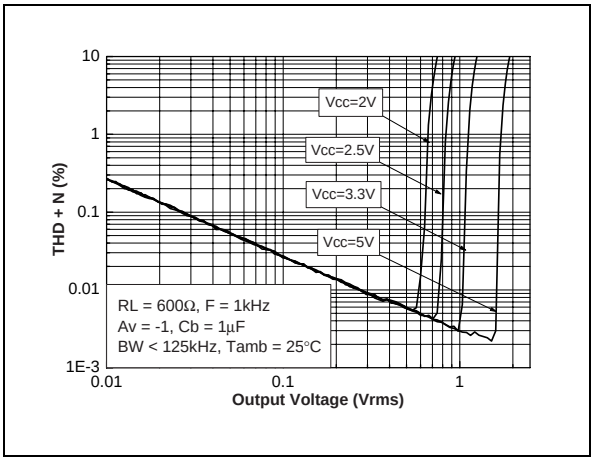


**Fig. 37: THD + N vs Output Power**

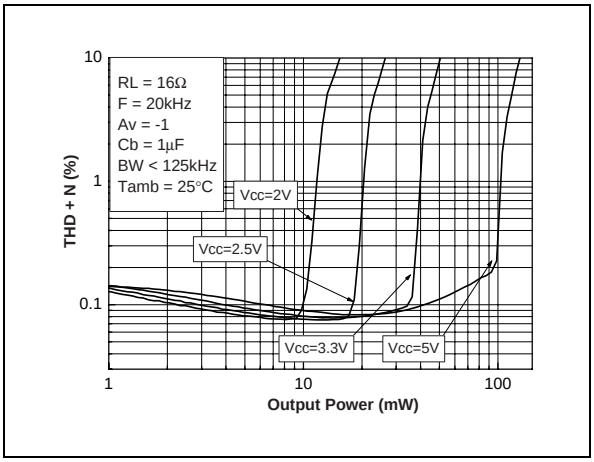



**Fig. 38: THD + N vs Output Power**

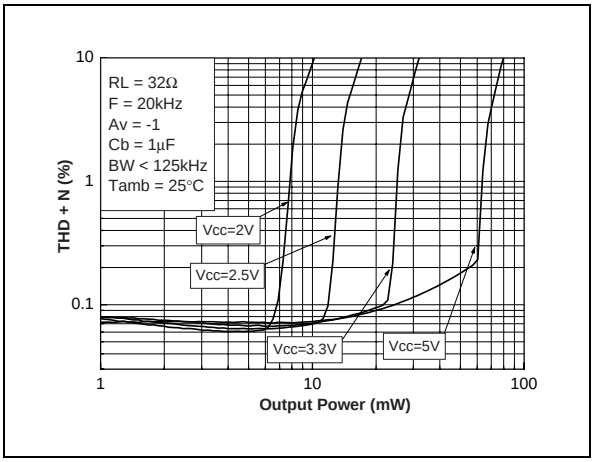



**Fig. 39: THD + N vs Output Power**

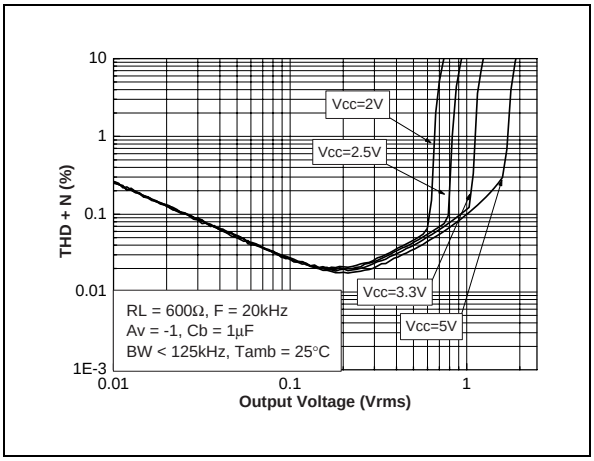



**Fig. 40: THD + N vs Frequency**

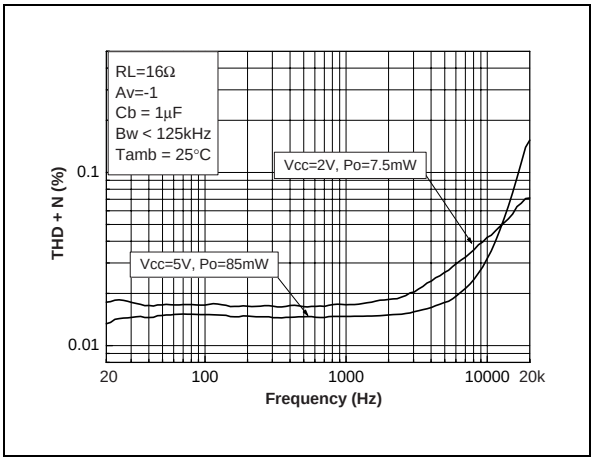



**Fig. 41: THD + N vs Frequency**

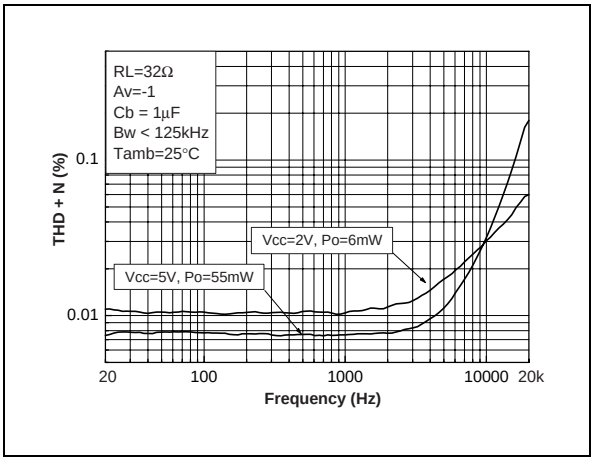



**Fig. 42: THD + N vs Frequency**

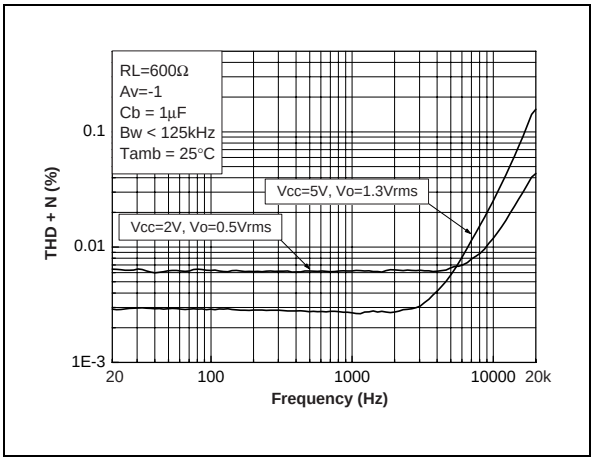


**Fig. 43: Crosstalk vs Frequency**

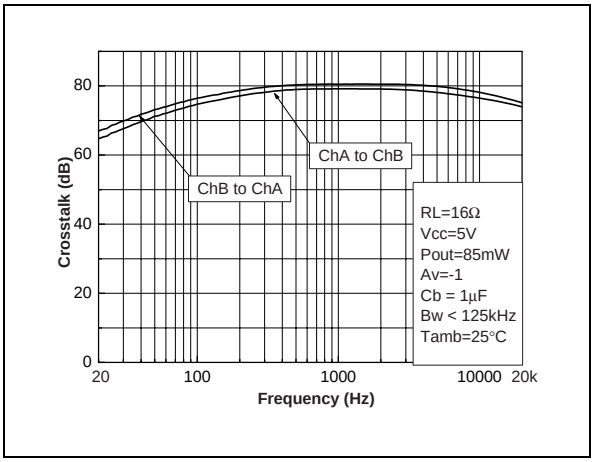



**Fig. 44: Crosstalk vs Frequency**

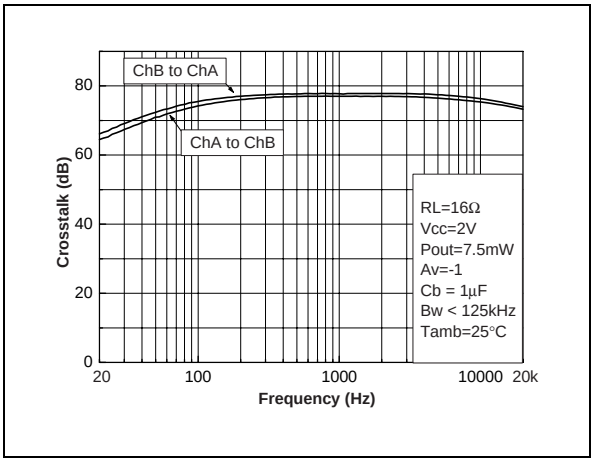



**Fig. 45: Crosstalk vs Frequency**

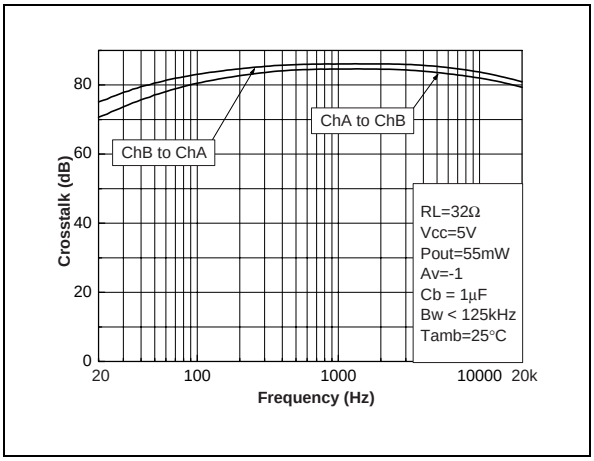



**Fig. 46: Crosstalk vs Frequency**

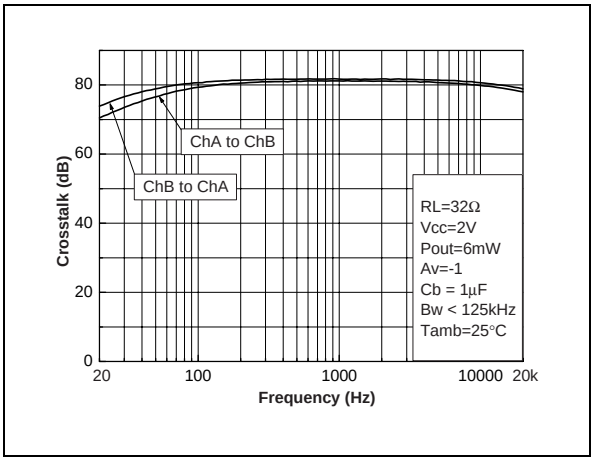



**Fig. 47: Crosstalk vs Frequency**

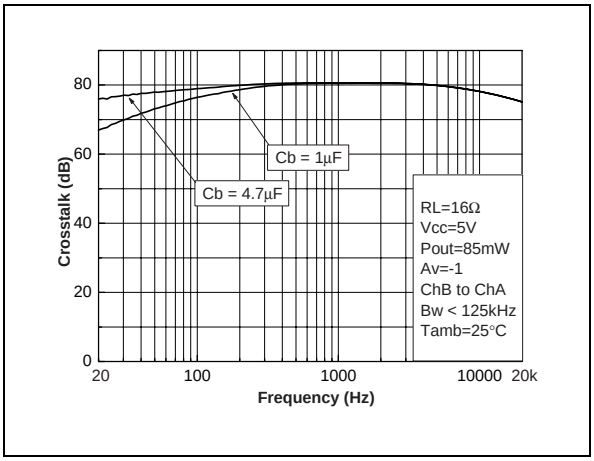



**Fig. 48: Crosstalk vs Frequency**

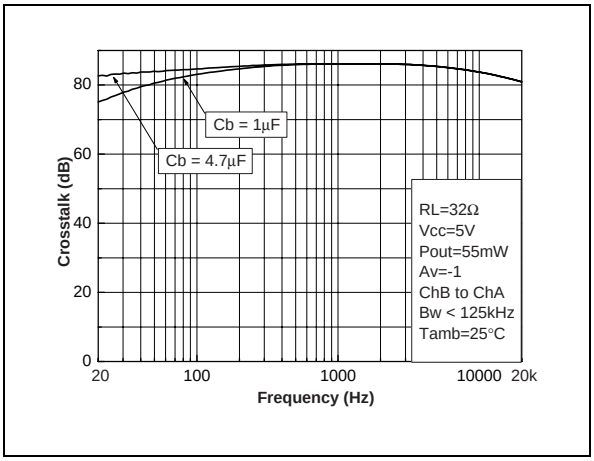


**Fig. 49: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)**

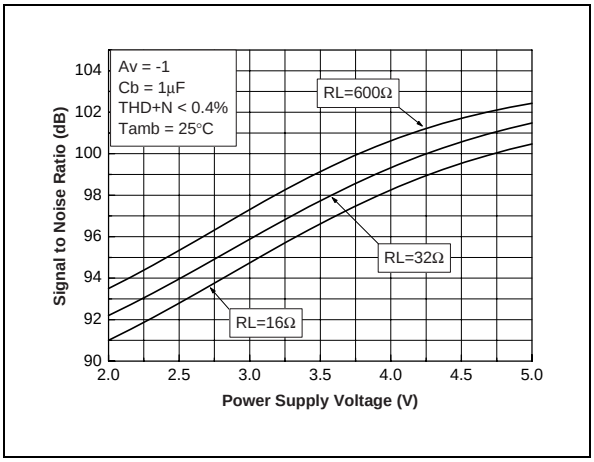



**Fig. 50: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A**

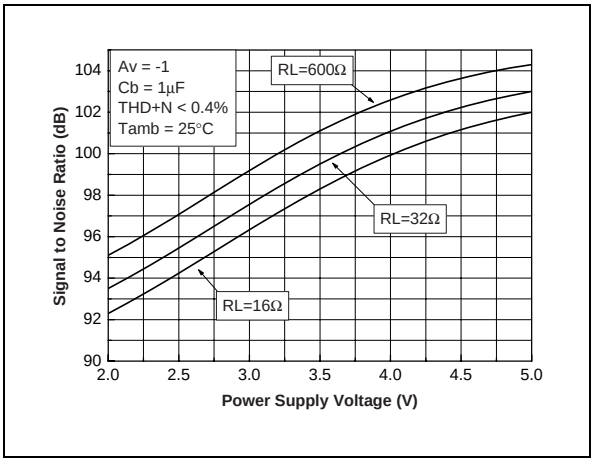



**Fig. 51: PSRR vs Power Supply Voltage**

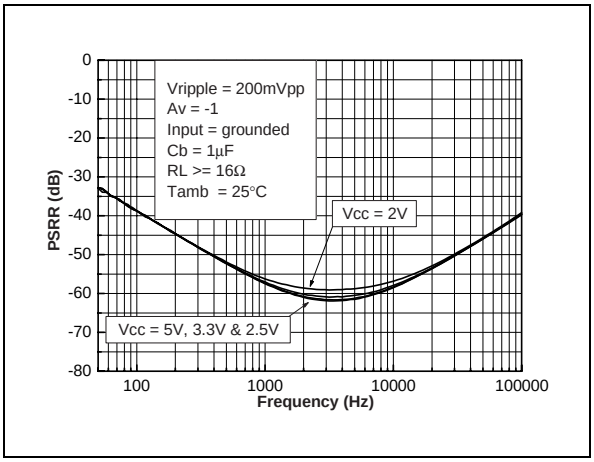



**Fig. 52: PSRR vs Bypass Capacitor**

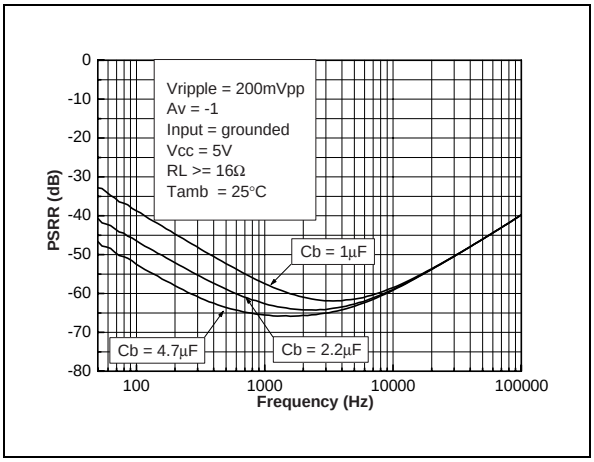



**Fig. 53: PSRR vs Input Capacitor**

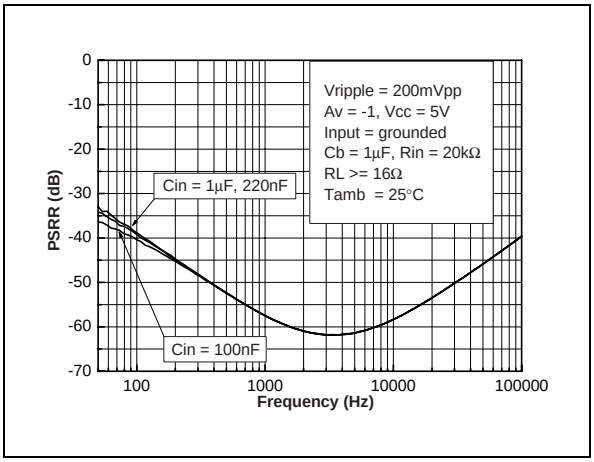



**Fig. 54: PSRR vs Output Capacitor**

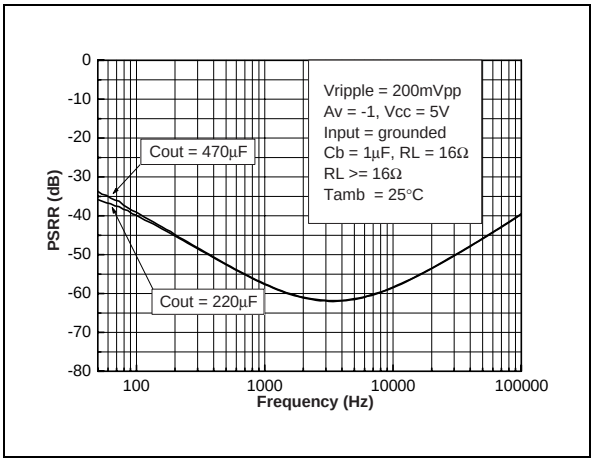


**Fig. 55: PSRR vs Output Capacitor**

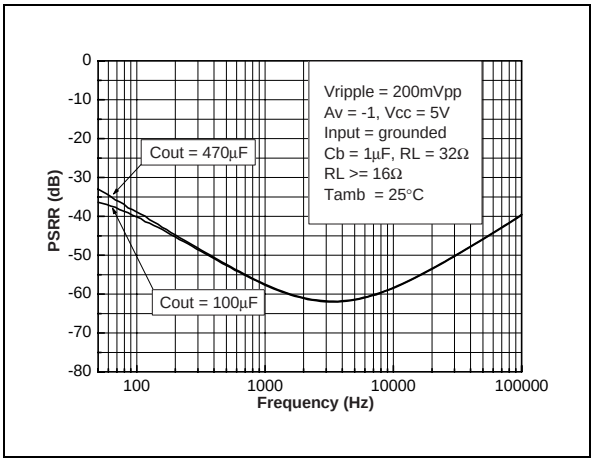



**Fig. 56: PSRR vs Power Supply Voltage**

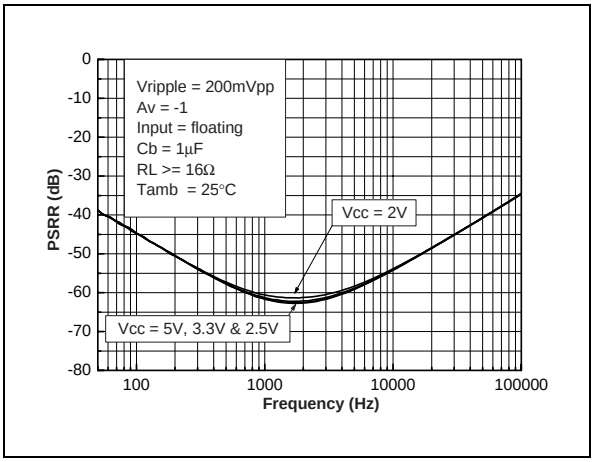


**Fig. 57: THD + N vs Output Power**

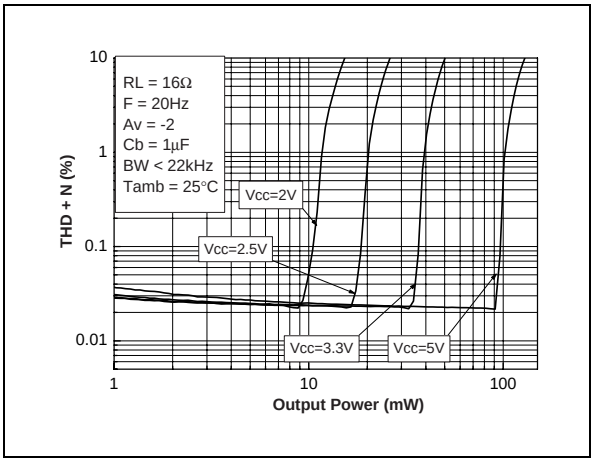



**Fig. 58: THD + N vs Output Power**

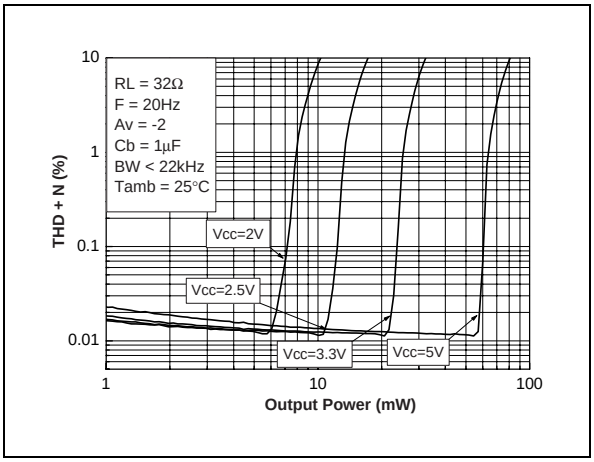



**Fig. 59: THD + N vs Output Power**

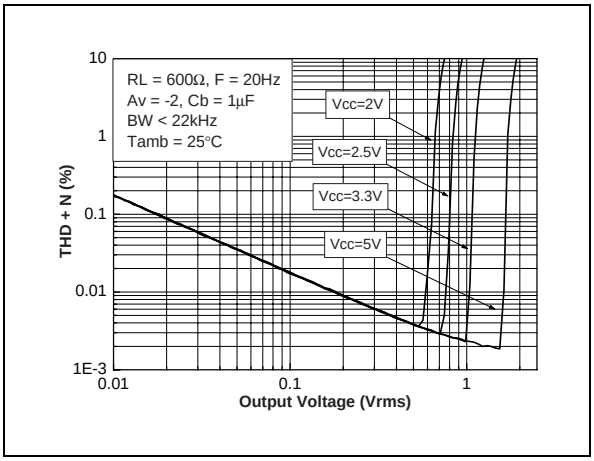



**Fig. 60: THD + N vs Output Power**

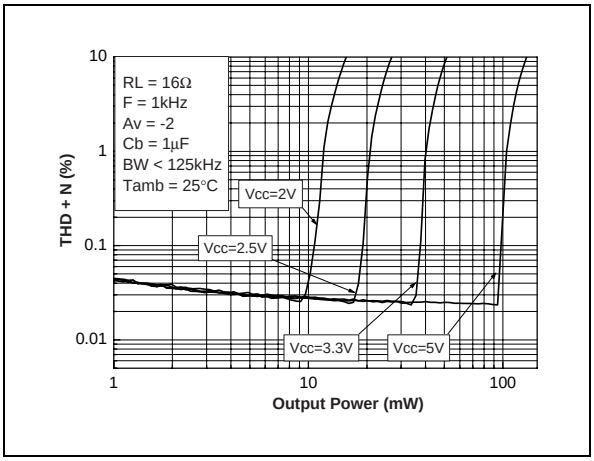



**Fig. 61: THD + N vs Output Power**

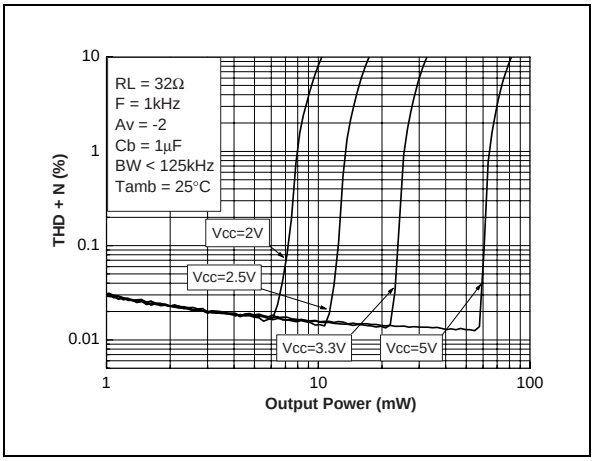



**Fig. 62: THD + N vs Output Power**

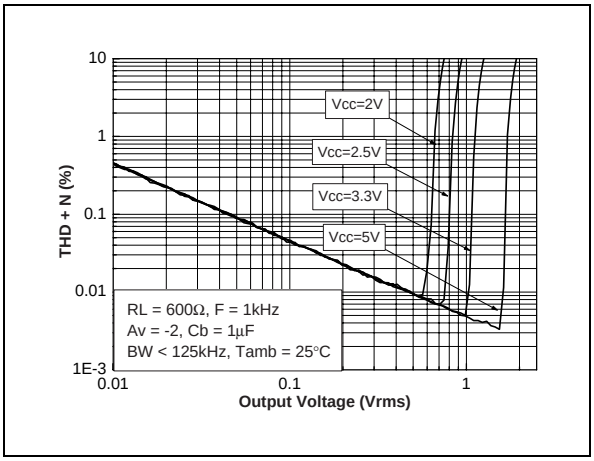


**Fig. 63: THD + N vs Output Power**

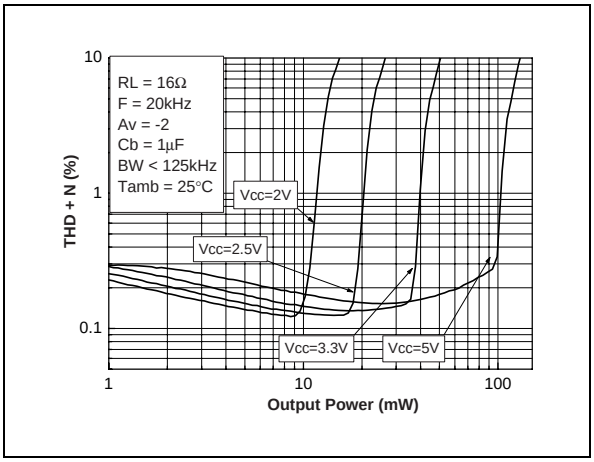



**Fig. 64: THD + N vs Output Power**

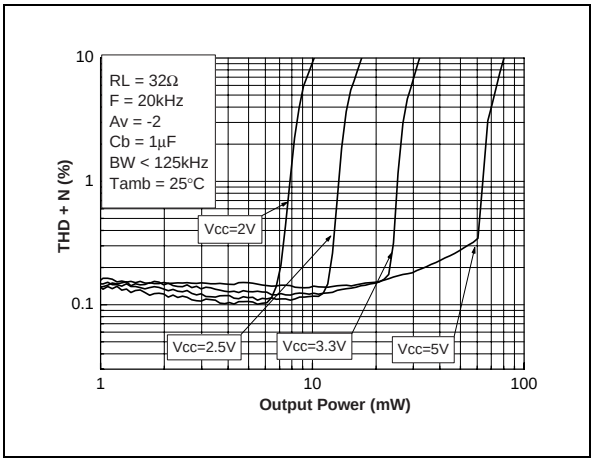



**Fig. 65: THD + N vs Output Power**

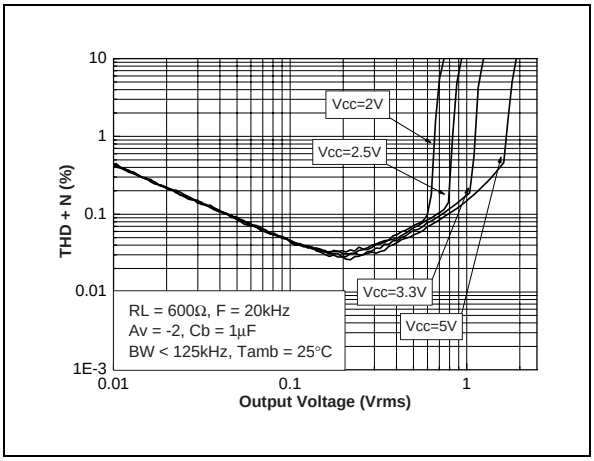



**Fig. 66: THD + N vs Frequency**

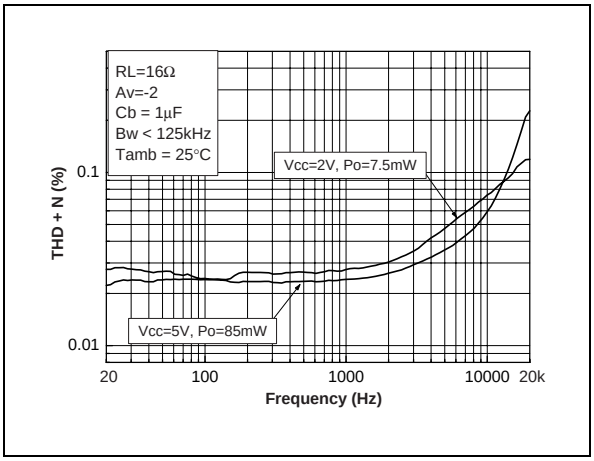



**Fig. 67: THD + N vs Frequency**

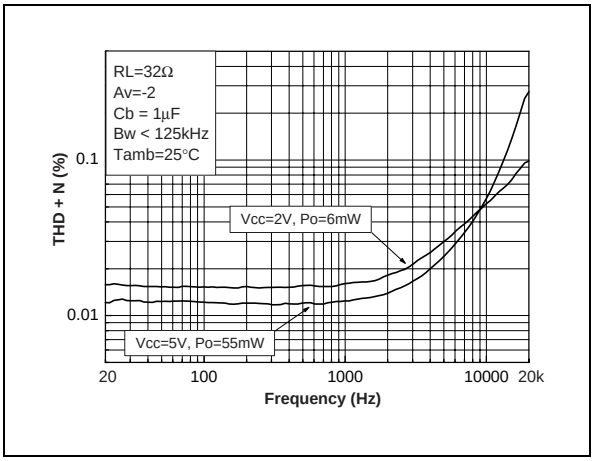



**Fig. 68: THD + N vs Frequency**

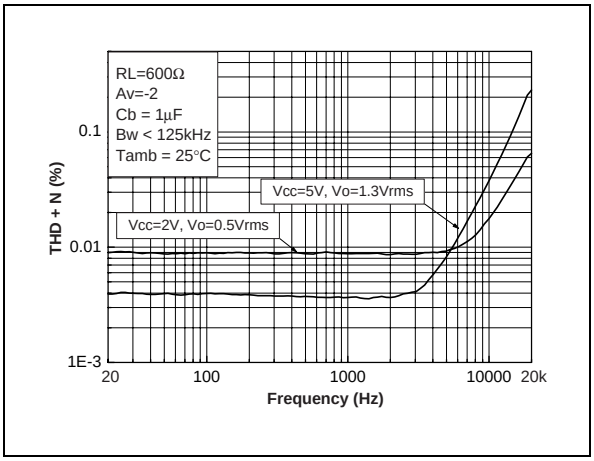


**Fig. 69: Crosstalk vs Frequency**

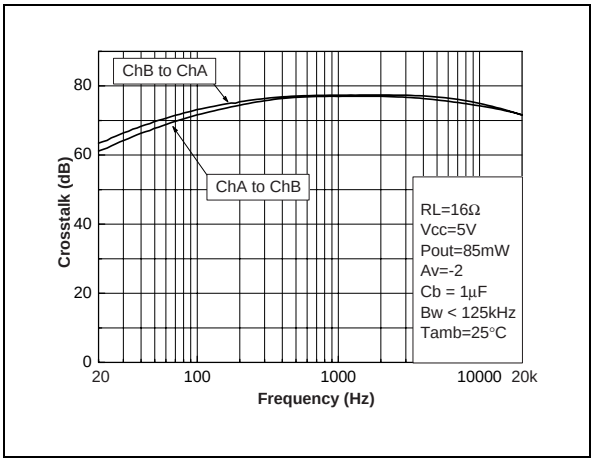



**Fig. 70: Crosstalk vs Frequency**

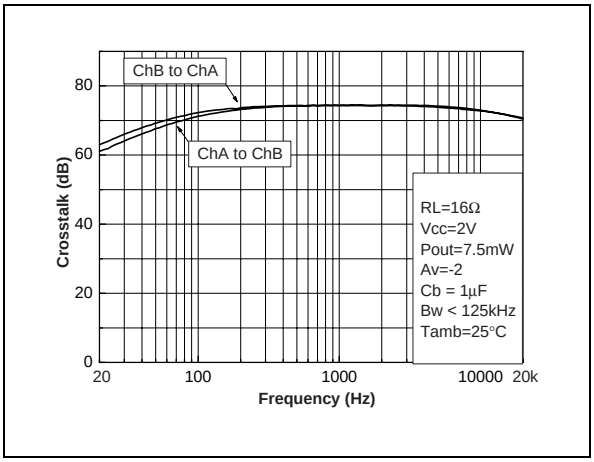



**Fig. 71: Crosstalk vs Frequency**

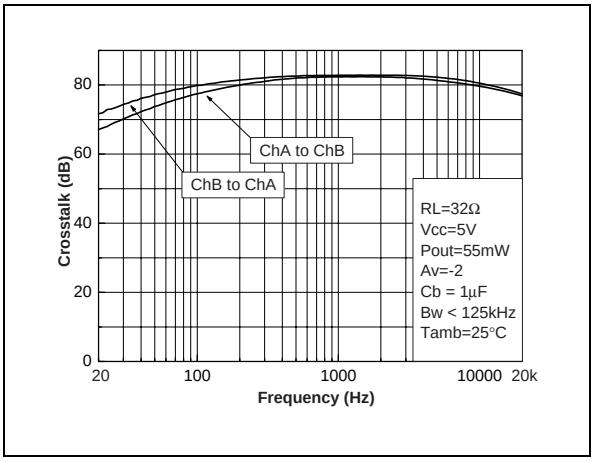



**Fig. 72: Crosstalk vs Frequency**

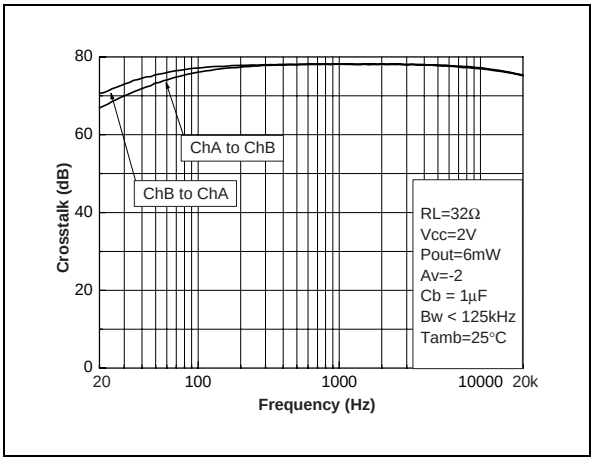



**Fig. 73: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)**

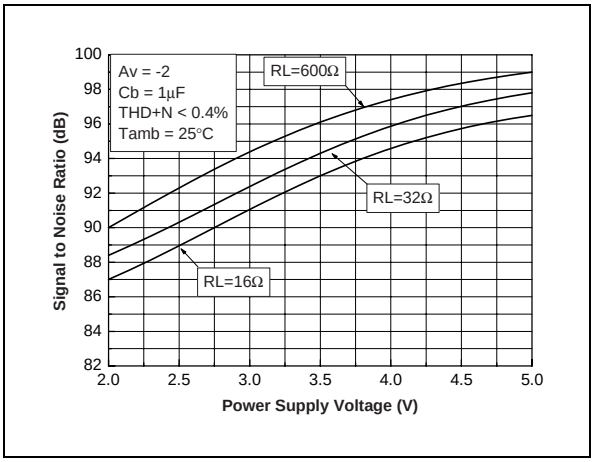



**Fig. 74: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A**

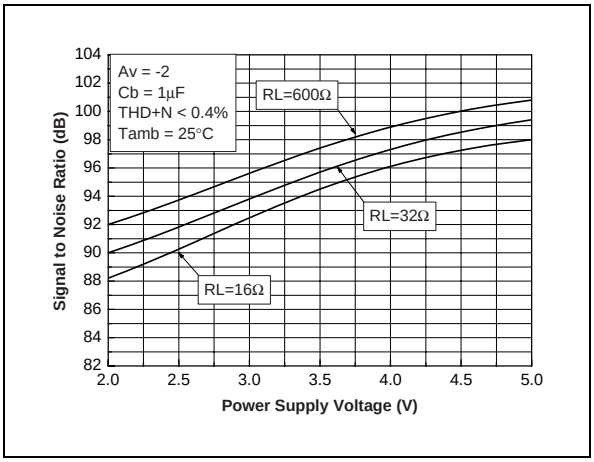


**Fig. 75: PSRR vs Power Supply Voltage**

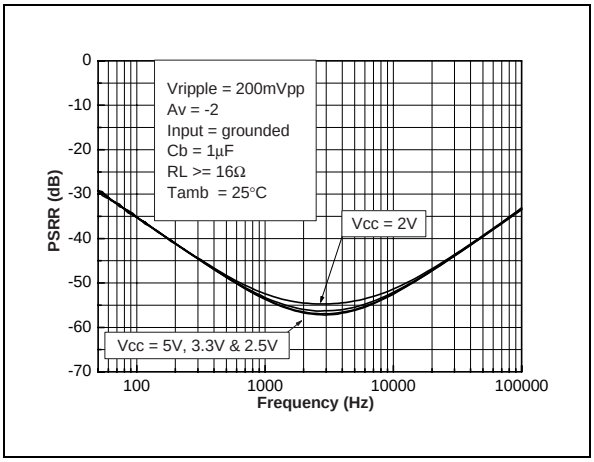



**Fig. 76: PSRR vs Bypass Capacitor**

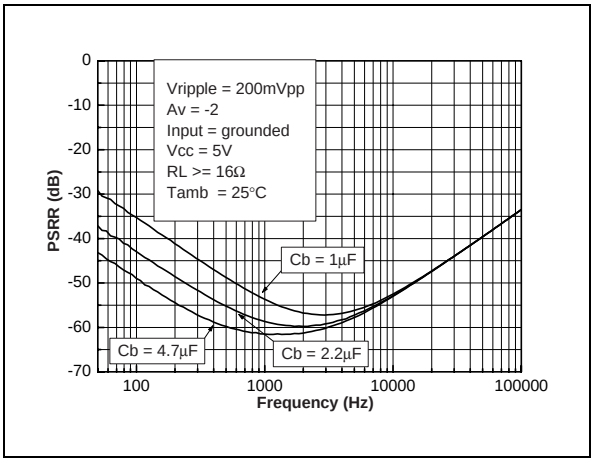



**Fig. 77: PSRR vs Input Capacitor**

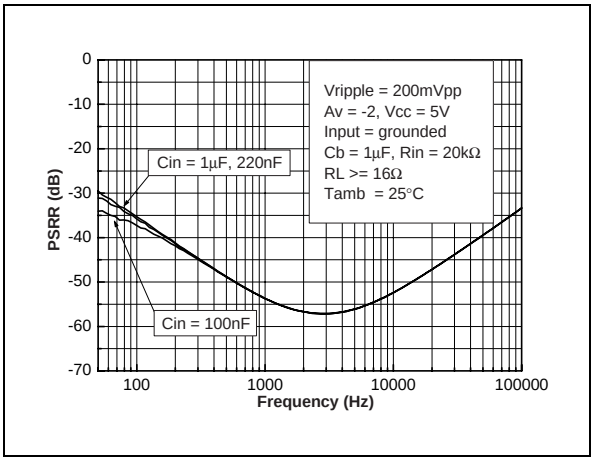



**Fig. 78: PSRR vs Output Capacitor**

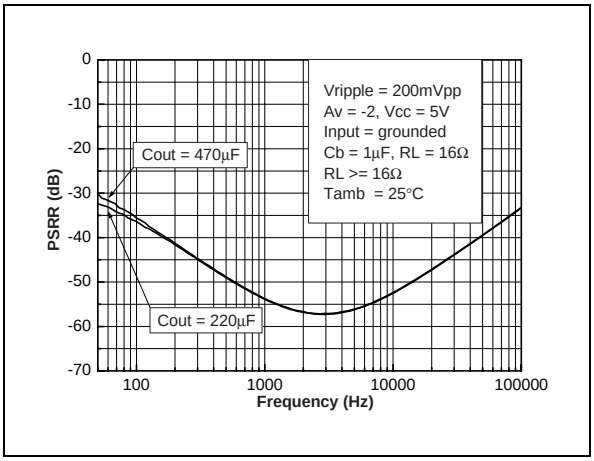



**Fig. 79: PSRR vs Output Capacitor**

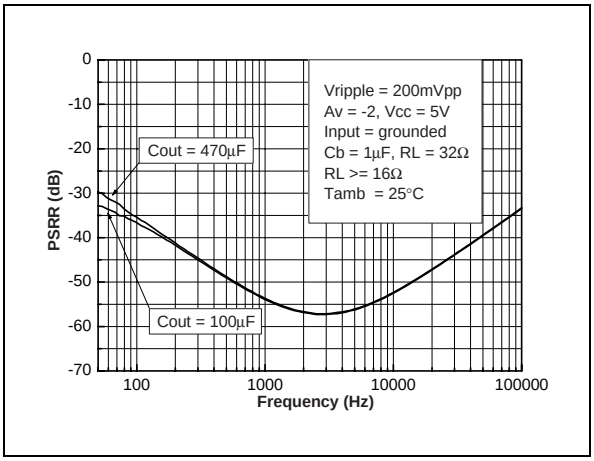



**Fig. 80: THD + N vs Output Power**

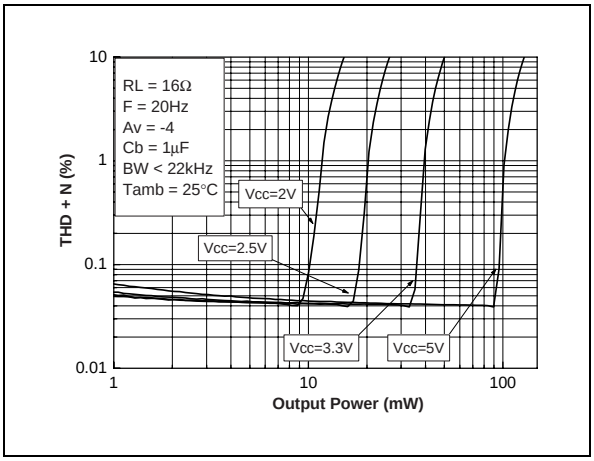


**Fig. 81: THD + N vs Output Power**

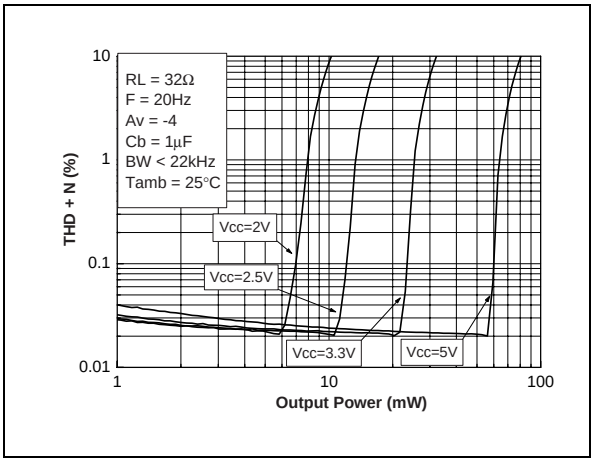



**Fig. 82: THD + N vs Output Power**

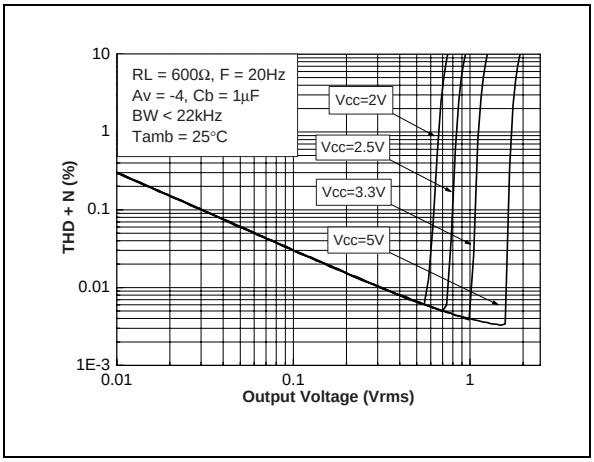



**Fig. 83: THD + N vs Output Power**

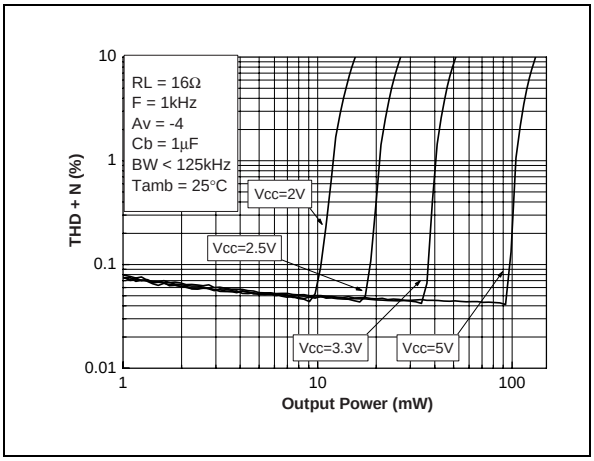



**Fig. 84: THD + N vs Output Power**

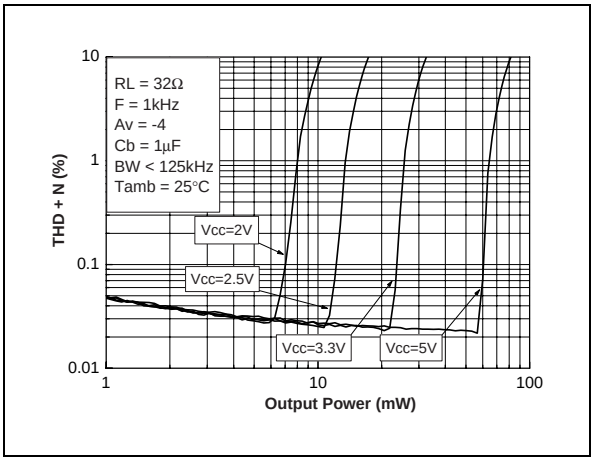



**Fig. 85: THD + N vs Output Power**

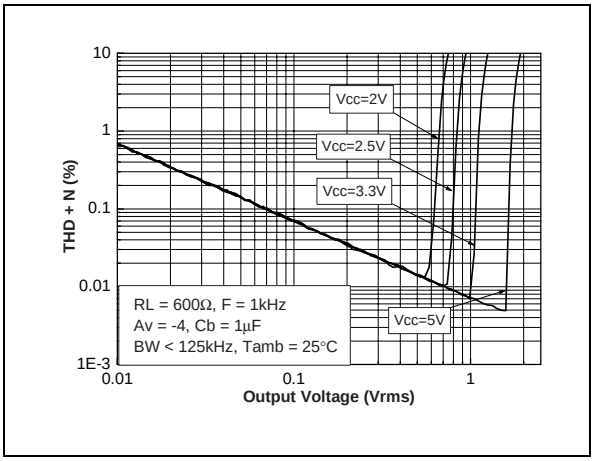



**Fig. 86: THD + N vs Output Power**

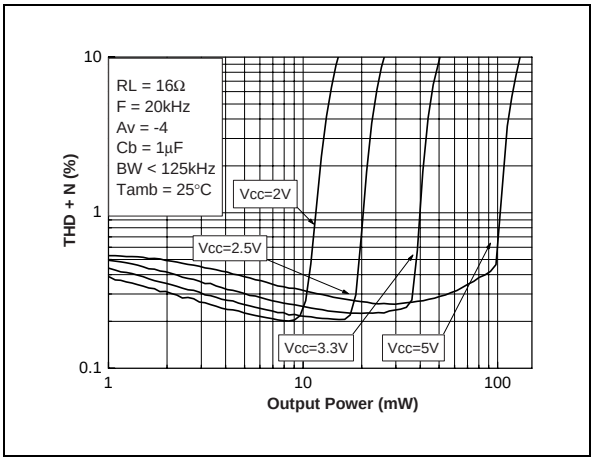


**Fig. 87: THD + N vs Output Power**

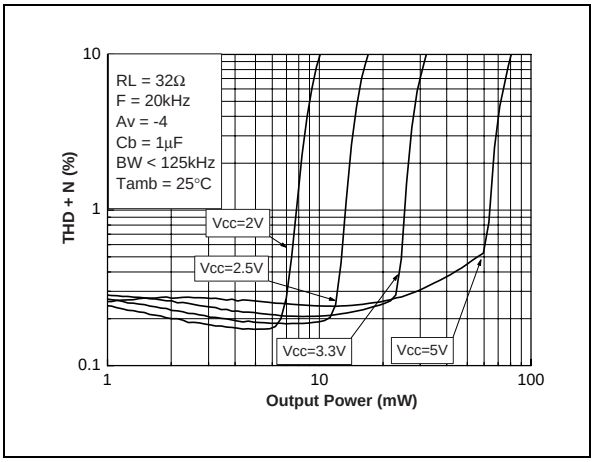



**Fig. 88: THD + N vs Output Power**

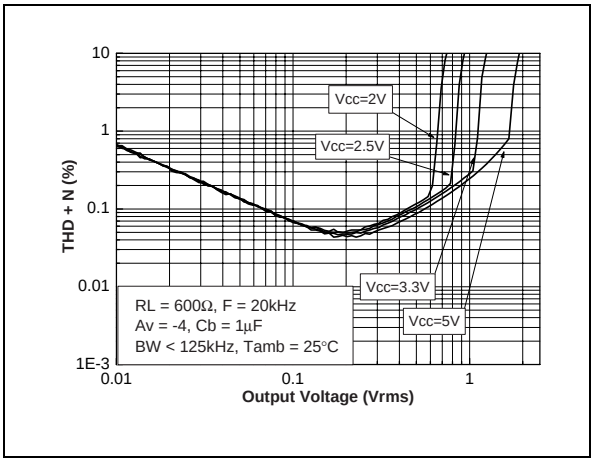



**Fig. 89: THD + N vs Frequency**

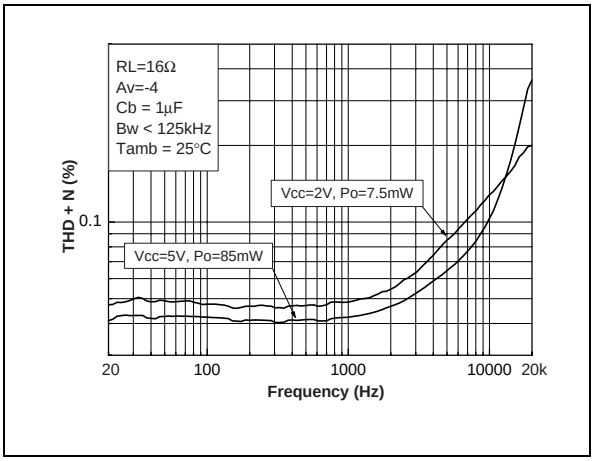



**Fig. 90: THD + N vs Frequency**

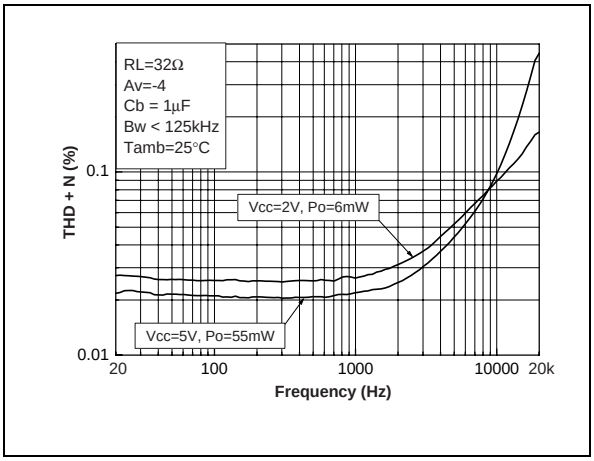



**Fig. 91: THD + N vs Frequency**

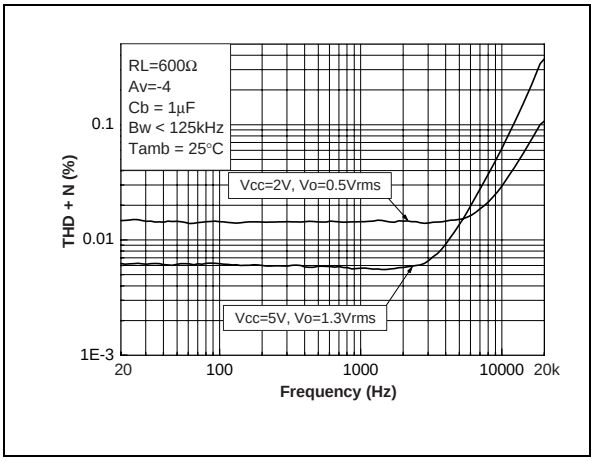



**Fig. 92: Crosstalk vs Frequency**

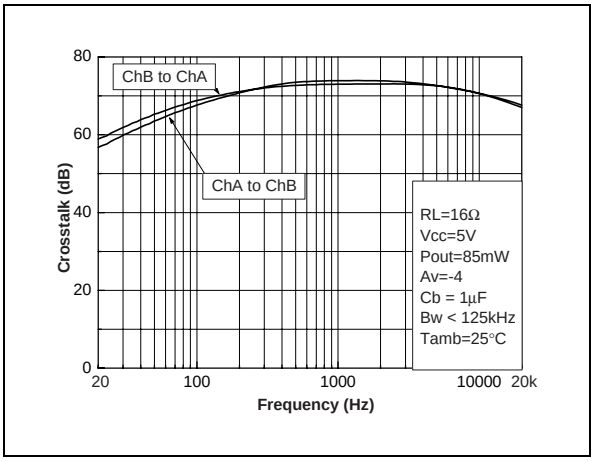


**Fig. 93: Crosstalk vs Frequency**

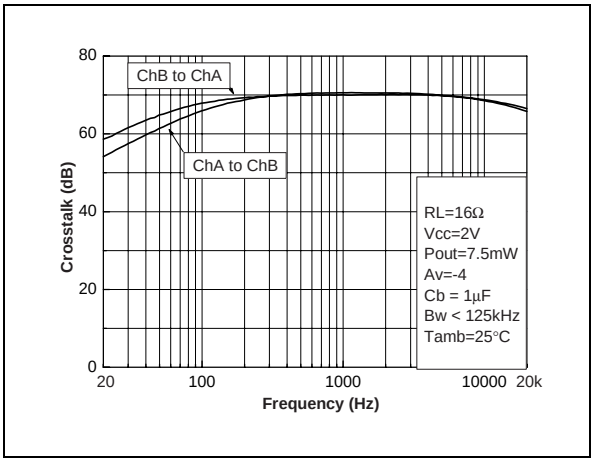



**Fig. 94: Crosstalk vs Frequency**

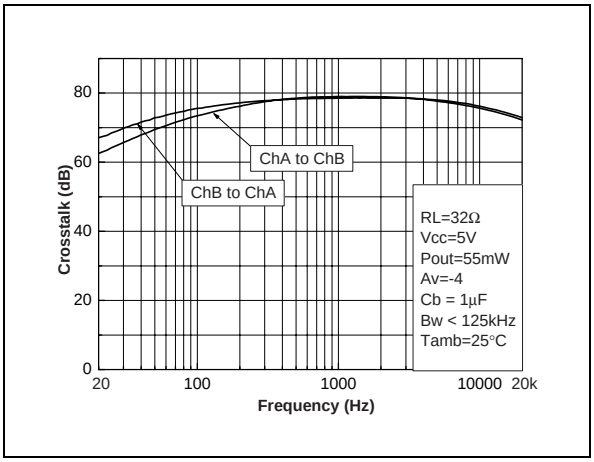



**Fig. 95: Crosstalk vs Frequency**

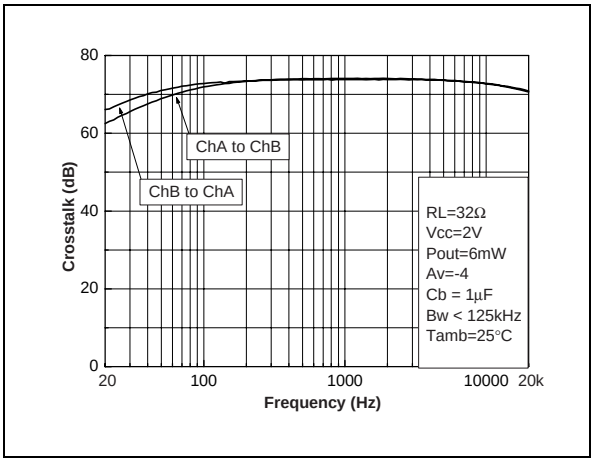



**Fig. 96: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)**

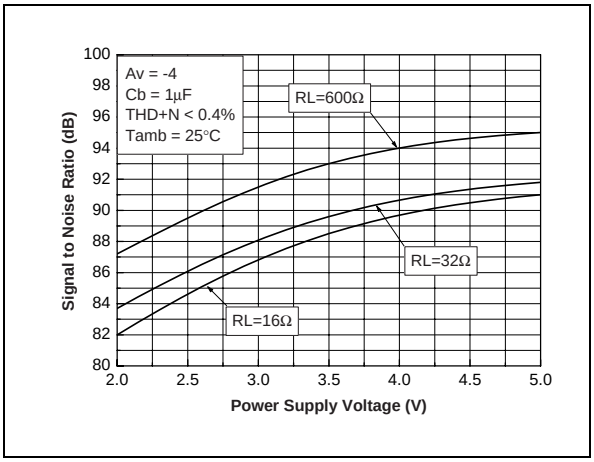



**Fig. 97: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A**

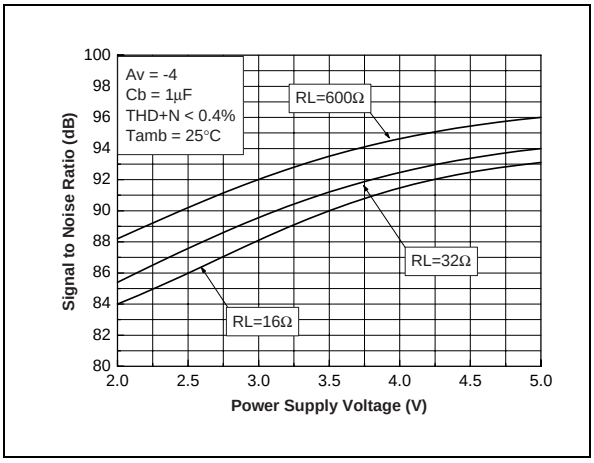



**Fig. 98: PSRR vs Power Supply Voltage**

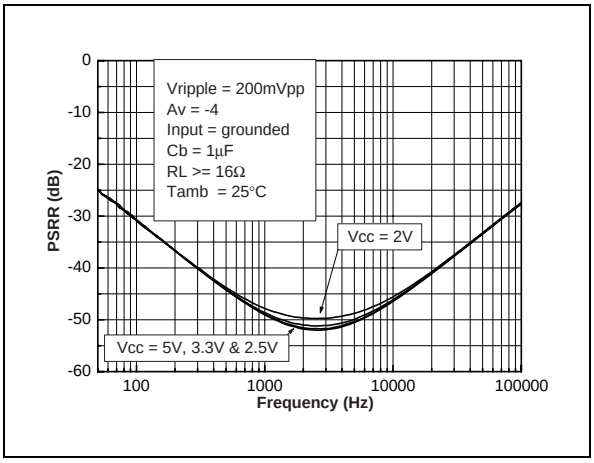


**Fig. 99: PSRR vs Input Capacitor**

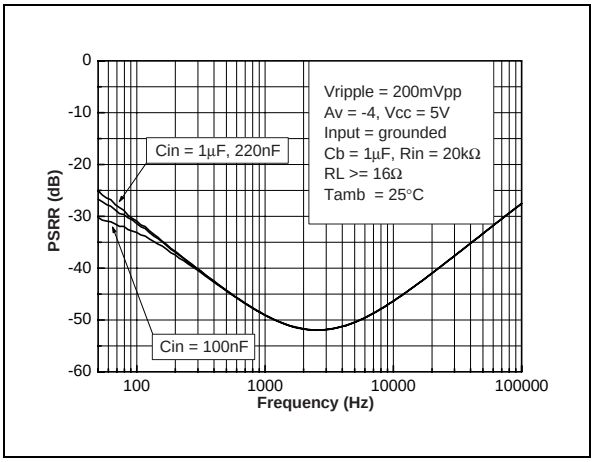



**Fig. 100: PSRR vs Bypass Capacitor**

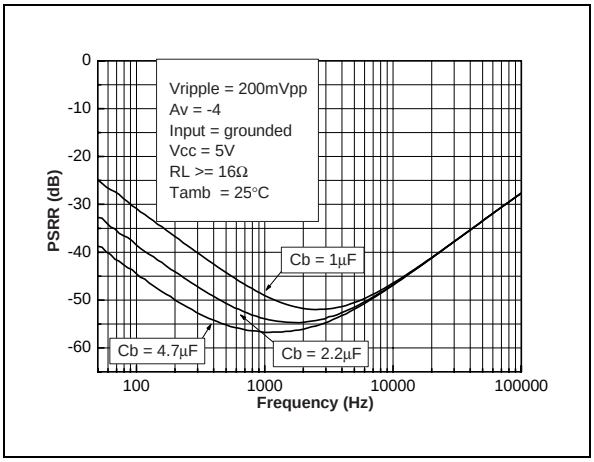



**Fig. 101: PSRR vs Output Capacitor**

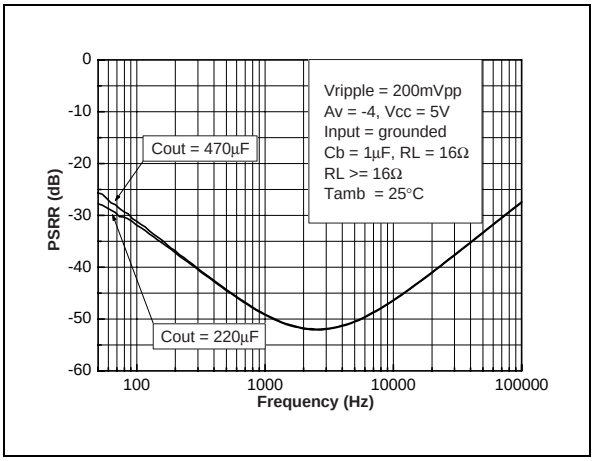
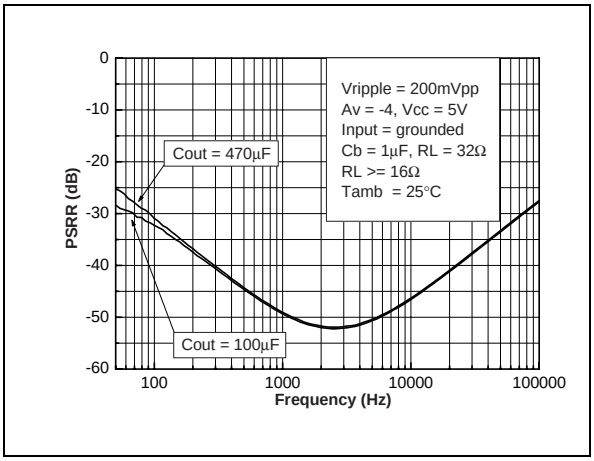
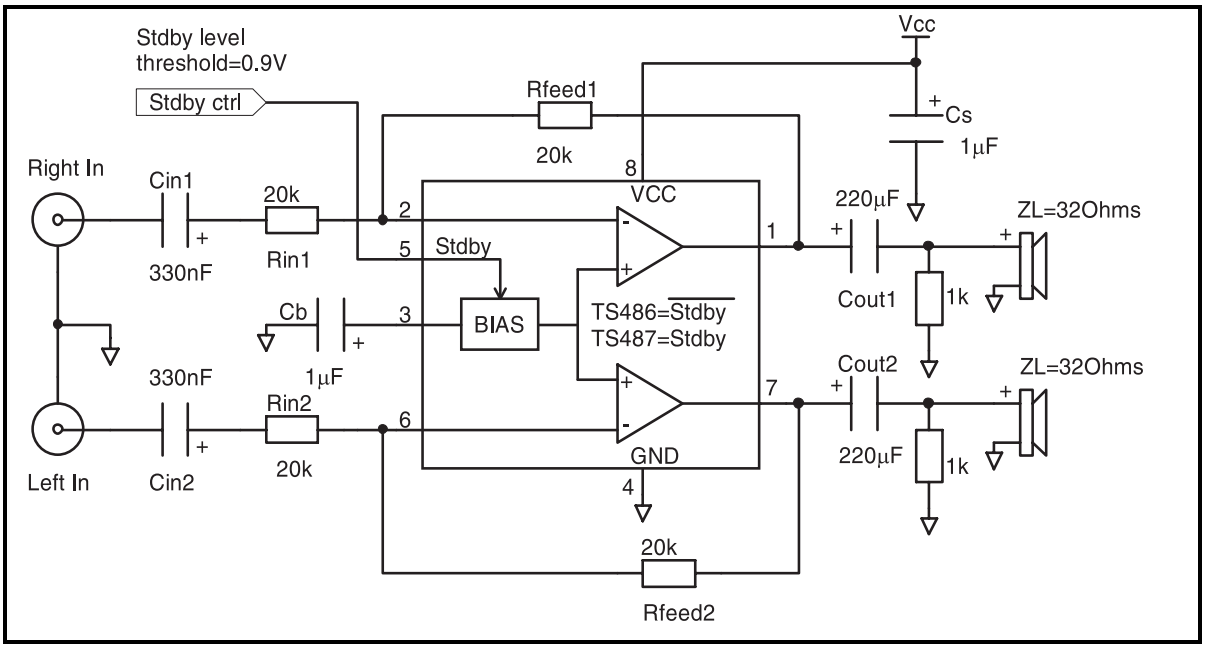



**Fig. 102: PSRR vs Output Capacitor**



**APPLICATION NOTE:**




**TS486/487 GENERAL DESCRIPTION**

TS486/487 is a family of dual audio amplifiers able to drive 16Ω or 32Ω headsets. Working in the 2V to 5.5V supply voltage range, they deliver 100mW at 5V and 12mW at 2V in a 16Ω load. An internal output current limitation, offers protection against short-circuits at the output over a limited time period.

Fixed gain versions of the TS486 and TS487 including the feedback resistor and the input resistors are also proposed to reduce the number of external parts.

The TS486 and TS487 exhibit a low quiescent current of typically 1.8mA, allowing usage in portable applications.

The standby mode is selected using the SHUTDOWN input. For TS486 (respectively TS487), the device is in sleep mode when PIN 5 is connected at GND (resp. $V_{CC}$).

**GAIN SETTING**

The gain of each inverter amplifier of the TS486 and TS487 is set by the resistors $R_{IN}$ and $R_{FEED}$.

$Gain_{LINEAR} = -(R_{FEED}/R_{IN})$

$Gain_{dB} = 20\ Log(R_{FEED}/R_{IN})$

Fixed gain versions TS486-n and TS487-n including $R_{IN}$ and $R_{FEED}$ are proposed to reduce external parts.

**LOW FREQUENCY ROLL-OFF WITH INPUT CAPACITORS**

The low roll-off frequency of the headphone amplifiers depends on the input capacitors $C_{IN1}$ and $C_{IN2}$ and the input resistors $R_{IN1}$ and $R_{IN2}$.

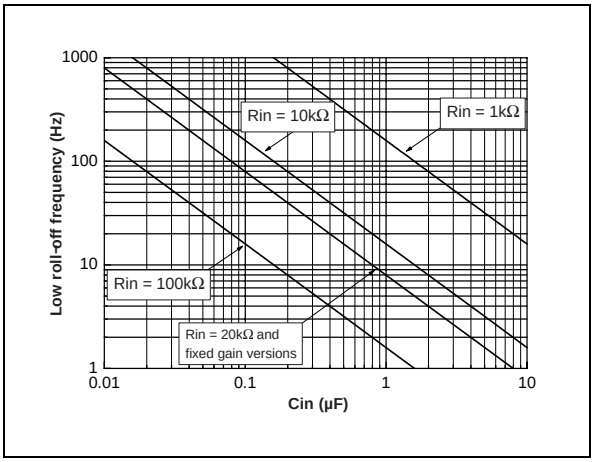
The $C_{IN}$ capacitor in series with the input resistor $R_{IN}$ of the amplifier is equivalent to a first order high pass filter.

Assuming that $F_{min}$ is the lowest frequency to be amplified (with a 3dB attenuation), the minimum value of $C_{IN}$ is:

$C_{IN} > 1 / (2*\pi*F_{min}*R_{IN})$

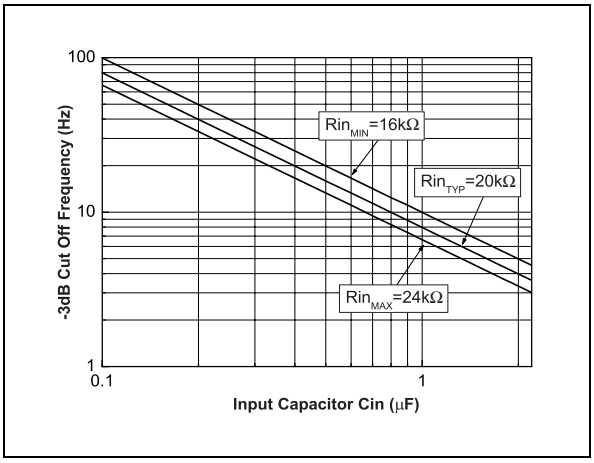
The following curve gives directly the low frequency roll-off versus the input capacitor $C_{IN}$

and for various values of the input resistor $R_{IN}$ .




The input resistance of the fixed gain version is typically 20kΩ.

The following curve shows the limits of the roll off frequency depending on the min. and max. values of Rin:



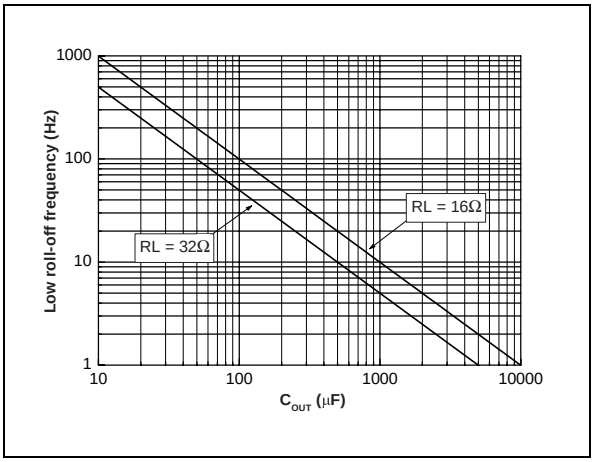

## LOW FREQUENCY ROLL OFF WITH OUTPUT CAPACITORS

The DC voltage on the outputs of the TS486/487 is blocked by the output capacitors $C_{OUT1}$ and $C_{OUT2}$ . Each output capacitor $C_{OUT}$ in series with the resistance of the load $R_L$ is equivalent to a first order high pass filter.

Assuming that $F_{min}$ is the lowest frequency to be amplified (with a 3dB attenuation), the minimum value of $C_{OUT}$ is:

$C_{OUT} > 1 / (2*\pi*F_{min}*R_L)$

The following curve gives directly the low roll-off frequency versus the output capacitor $C_{OUT}$ in µF and for the two typical 16Ω and 32Ω impedances:




## DECOUPLING CAPACITOR $C_B$

The internal bias voltage at Vcc/2 is decoupled with the external capacitor $C_B$.

The TS486 and TS487 have a specified Power Supply Rejection Ratio parameter with $C_B$ = 1µF. A higher value of $C_B$ improves the PSRR, for example, a 4.7µF improves the PSRR by 15dB at 200Hz (please, refer to fig. 76 "PSRR vs Bypass Capacitor").

## POP PRECAUTIONS

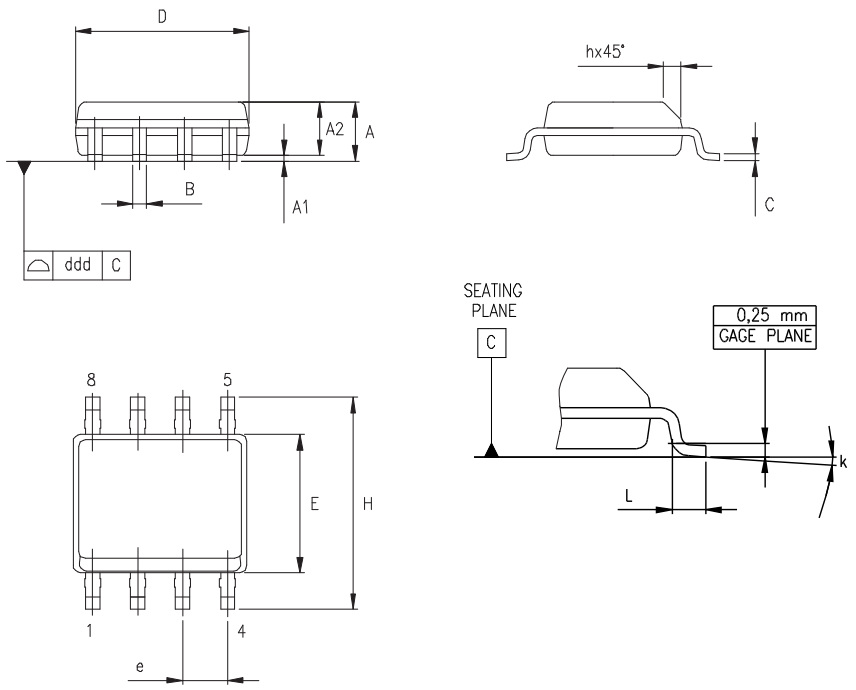
Generally headphones are connected using a connector as a jack. To prevent a pop in the headphones when plugged in the jack, a resistor should be connected in parallel with each headphone output. This allows the capacitors Cout to be charged even when no headphone is plugged.

A resistor of 1 kΩ is high enough to be a negligible load, and low enough to charge the capacitors Cout in less than one second.

## PACKAGE MECHANICAL DATA

### SO-8 MECHANICAL DATA

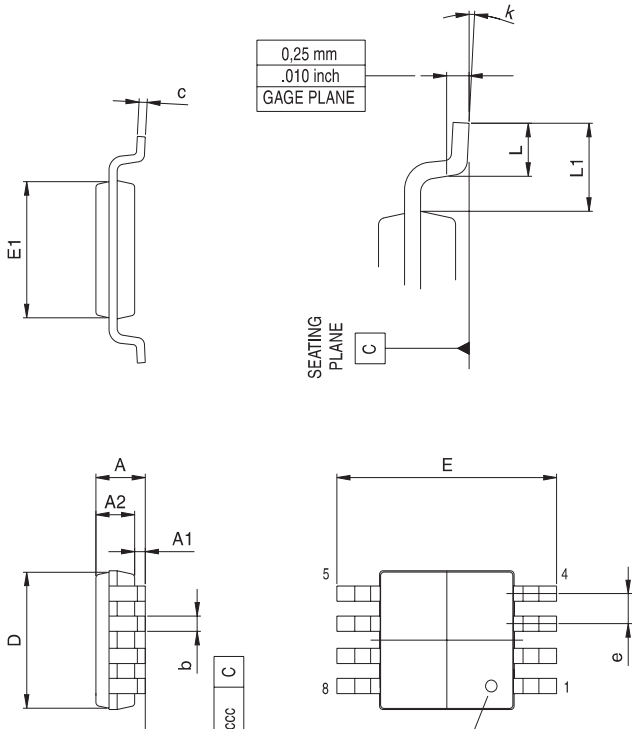
| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 1.35 | | 1.75 | 0.053 | | 0.069 |
| A1 | 0.10 | | 0.25 | 0.04 | | 0.010 |
| A2 | 1.10 | | 1.65 | 0.043 | | 0.065 |
| B | 0.33 | | 0.51 | 0.013 | | 0.020 |
| C | 0.19 | | 0.25 | 0.007 | | 0.010 |
| D | 4.80 | | 5.00 | 0.189 | | 0.197 |
| E | 3.80 | | 4.00 | 0.150 | | 0.157 |
| e | | 1.27 | | | 0.050 | |
| H | 5.80 | | 6.20 | 0.228 | | 0.244 |
| h | 0.25 | | 0.50 | 0.010 | | 0.020 |
| L | 0.40 | | 1.27 | 0.016 | | 0.050 |
| k | 8° (max.) | | | | | |
| ddd | | | 0.1 | | | 0.04 |




0016023/C

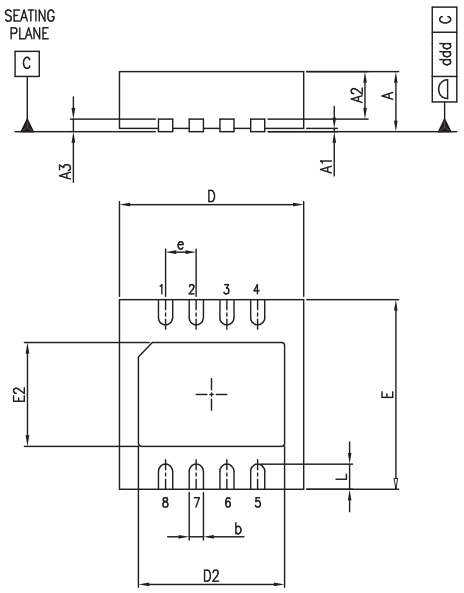
## PACKAGE MECHANICAL DATA

| DIM. | mm. | | | inch | | |
|---|---|---|---|---|---|---|
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.1 | | | 0.043 |
| A1 | 0.05 | 0.10 | 0.15 | 0.002 | 0.004 | 0.006 |
| A2 | 0.78 | 0.86 | 0.94 | 0.031 | 0.031 | 0.037 |
| b | 0.25 | 0.33 | 0.40 | 0.010 | 0.13 | 0.013 |
| c | 0.13 | 0.18 | 0.23 | 0.005 | 0.007 | 0.009 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E | 4.75 | 4.90 | 5.05 | 0.187 | 0.193 | 0.199 |
| E1 | 2.90 | 3.00 | 3.10 | .0114 | 0.118 | 0.122 |
| e | | 0.65 | | | 0.026 | |
| K | 0° | | 6° | 0° | | 6° |
| L | 0.40 | 0.55 | 0.70 | 0.016 | 0.022 | 0.028 |
| L1 | | | 0.10 | | | 0.004 |



## PACKAGE MECHANICAL DATA

| DFN8 (3x3) MECHANICAL DATA | | | | | | |
|---|---|---|---|---|---|---|
| DIM. | mm. | | | inch | | |
| | MIN. | TYP | MAX. | MIN. | TYP. | MAX. |
| A | 0.80 | 0.90 | 1.00 | 31.5 | 35.4 | 39.4 |
| A1 | | 0.02 | 0.05 | | 0.8 | 2.0 |
| A2 | | 0.70 | | | 27.6 | |
| A3 | | 0.20 | | | 7.9 | |
| b | 0.18 | 0.23 | 0.30 | 7.1 | 9.1 | 11.8 |
| D | | 3.00 | | | 118.1 | |
| D2 | 2.23 | 2.38 | 2.48 | 87.8 | 93.7 | 97.7 |
| E | | 3.00 | | | 118.1 | |
| E2 | 1.49 | 1.64 | 1.74 | 58.7 | 64.6 | 68.5 |
| e | | 0.50 | | | 19.7 | |
| L | 0.30 | 0.40 | 0.50 | 11.8 | 15.7 | 19.7 |

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