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360mW MONO AMPLIFIER WITH STANDBY MODE

- **OPERATING FROM Vcc=2V to 5.5V**
- **STANDBY MODE ACTIVE HIGH** (TS419) or LOW (TS421)
- **OUTPUT POWER** into 16Ω: 367mW @ 5V with 10% THD+N max or 295mW @5V and 110mW @3.3V with 1% THD+N max.
- **LOW CURRENT CONSUMPTION:** 2.5mA max
- High Signal-to-Noise ratio: 95dB(A) at 5V
- PSRR: 56dB typ. at 1kHz, 46dB at 217Hz
- **SHORT CIRCUIT LIMITATION**
- ON/OFF click reduction circuitry
- Available in SO8, MiniSO8 & DFN 3x3

DESCRIPTION

The TS419/TS421 is a monaural audio power amplifier driving in BTL mode a 16 or 32Ω earpiece or receiver speaker. The main advantage of this configuration is to get rid of bulky output capacitors. Capable of descending to low voltages, it delivers up to 220mW per channel (into 16Ω loads) of continuous average power with 0.2% THD+N in the audio bandwidth from a 5V power supply. An externally controlled standby mode reduces the supply current to 10nA (typ.). The TS419/TS421 can be configured by external gain-setting resistors or used in a fixed gain version.

APPLICATIONS

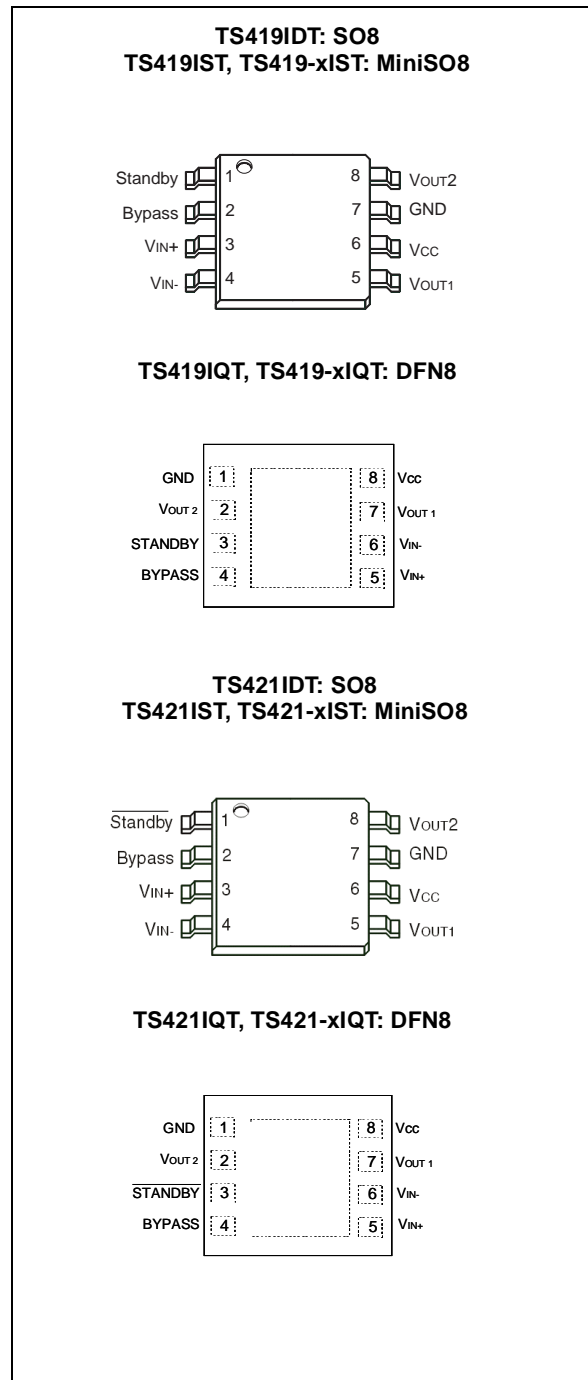
- 16/32 ohms earpiece or receiver speaker driver
- Mobile and cordless phones (analog / digital)
- PDAs & computers
- Portable appliances

ORDER CODE

Part Number	Temp. Range: I	Package			Gain	Marking	
		D	S	Q			
TS419	-40, +85°C	•			external	TS419I	
TS421		•			external	TS421I	
TS419			•	•		external	K19A
TS419-2		tba	tba	tba	x2/6dB		K19B
TS419-4		tba	tba	tba	x4/12dB		K19C
TS419-8		tba	tba	tba	x8/18dB		K19D
TS421			•	•		external	K21A
TS421-2		tba	tba	tba	x2/6dB		K21B
TS421-4		tba	tba	tba	x4/12dB		K21C
TS421-8		tba	tba	tba	x8/18dB		K21D

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)



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 SO8 MiniSO8 DFN8	175 215 70	°C/W
Pd	Power Dissipation ²⁾ SO8 MiniSO8 DFN8	0.71 0.58 1.79	W
ESD	Human Body Model (pin to pin): TS419 ³⁾ , TS421	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 V _{CC} or GND	continuous ⁴⁾	

1. All voltage values are measured with respect to the ground pin.

2. Pd has been calculated with T_{amb} = 25°C, T_{junction} = 150°C.

3. TS419 stands 1.5KV on all pins except standby pin which stands 1KV.

4. Attention must be paid to continuous 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 R _L = 16 to 100Ω R _L > 100Ω	400 100	pF
V _{ICM}	Common Mode Input Voltage Range	GND to V _{CC} -1V	V
V _{STB}	Standby Voltage Input TS421 ACTIVE / TS419 in STANDBY TS421 in STANDBY / TS419 ACTIVE	1.5 ≤ V _{STB} ≤ V _{CC} GND ≤ V _{STB} ≤ 0.4 ¹⁾	V
R _{THJA}	Thermal Resistance Junction to Ambient SO8 MiniSO8 DFN8 ²⁾	150 190 41	°C/W
T _{wu}	Wake-up time from standby to active mode (C _b = 1μF) ³⁾	≥ 0.12	s

1. The minimum current consumption (I_{STANDBY}) is guaranteed at V_{CC} (TS419) or GND (TS421) for the whole temperature range.

2. When mounted on a 4-layer PCB

3. For more details on T_{wu}, please refer to application note section on Wake-up time page 28.

FIXED GAIN VERSION SPECIFIC ELECTRICAL CHARACTERISTICS

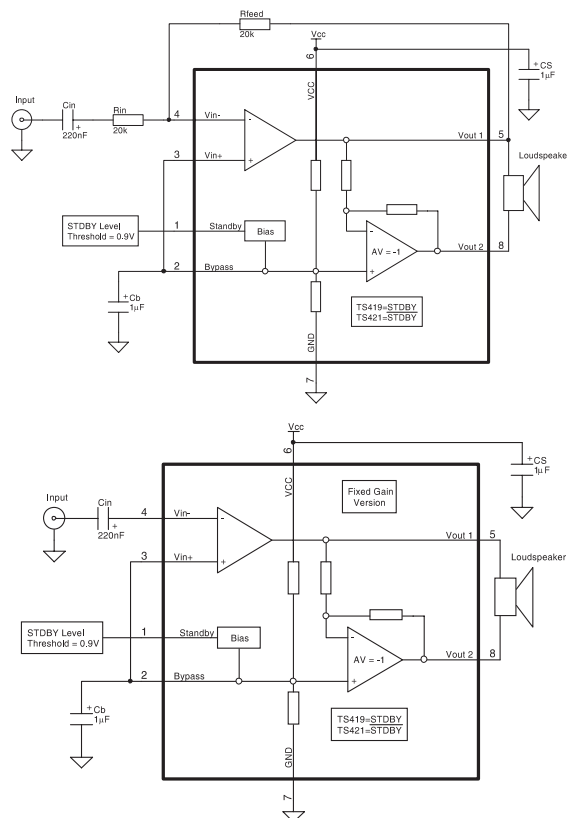
V_{CC} from +5V to +2V, GND = 0V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
R _{IN}	Input Resistance		20		kΩ
G	Gain value for Gain TS419/TS421-2		6dB		dB
	Gain value for Gain TS419/TS421-4		12dB		
	Gain value for Gain TS419/TS421-8		18dB		

APPLICATION COMPONENTS INFORMATION

Components	Functional Description
R _{IN}	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} (f _{cl} = 1 / (2 x Pi x R _{IN} x C _{IN})). Not needed in fixed gain versions.
C _{IN}	Input coupling capacitor which blocks the DC voltage at the amplifier's input terminal
R _{FEED}	Feedback resistor which sets the closed loop gain in conjunction with R _{IN} . A _V = Closed Loop Gain= 2xR _{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.

TYPICAL APPLICATION SCHEMATICS:



ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		1.8	2.5	mA
$I_{STANDBY}$	Standby Current No input signal, $V_{STANDBY}=GND$ for TS421 No input signal, $V_{STANDBY}=V_{CC}$ for TS419		10	1000	nA
V_{OO}	Output Offset Voltage No input signal, $R_L = 16$ or 32Ω , $R_{feed}=20k\Omega$		5	25	mV
P_O	Output Power THD+N = 0.1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 0.1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 16\Omega$	166 240	190 207 258 270 295 367		mW
THD + N	Total Harmonic Distortion + Noise ($A_v=2$) $R_L = 32\Omega$, $P_{out} = 150mW$, $20Hz \leq F \leq 20kHz$ $R_L = 16\Omega$, $P_{out} = 220mW$, $20Hz \leq F \leq 20kHz$		0.15 0.2		%
PSRR	Power Supply Rejection Ratio ($A_v=2$) ¹⁾ $F = 1kHz$, $V_{ripple} = 200mV_{pp}$, input grounded, $C_b=1\mu F$	50	56		dB
SNR	Signal-to-Noise Ratio (Filter Type A, $A_v=2$) ¹⁾ ($R_L = 32\Omega$, THD +N < 0.5%, $20Hz \leq F \leq 20kHz$)	85	98		dB
Φ_M	Phase Margin at Unity Gain $R_L = 16\Omega$, $C_L = 400pF$		58		Degrees
GM	Gain Margin $R_L = 16\Omega$, $C_L = 400pF$		18		dB
GBP	Gain Bandwidth Product $R_L = 16\Omega$		1.1		MHz
SR	Slew Rate $R_L = 16\Omega$		0.4		V/ μS

1. Guaranteed by design and evaluation.

ELECTRICAL CHARACTERISTICS

$V_{CC} = +3.3V$, $GND = 0V$, $T_{amb} = 25^{\circ}C$ (unless otherwise specified) ¹⁾

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		1.8	2.5	mA
$I_{STANDBY}$	Standby Current No input signal, $V_{STANDBY}=GND$ for TS421 No input signal, $V_{STANDBY}=V_{CC}$ for TS419		10	1000	nA
V_{OO}	Output Offset Voltage No input signal, $R_L = 16$ or 32Ω , $R_{feed}=20k\Omega$		5	25	mV
P_O	Output Power THD+N = 0.1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 0.1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 16\Omega$	65 91	75 81 102 104 113 143		mW
THD + N	Total Harmonic Distortion + Noise ($A_v=2$) $R_L = 32\Omega$, $P_{out} = 50mW$, $20Hz \leq F \leq 20kHz$ $R_L = 16\Omega$, $P_{out} = 70mW$, $20Hz \leq F \leq 20kHz$		0.15 0.2		%
PSRR	Power Supply Rejection Ratio inputs grounded, $F = 1kHz$, $V_{ripple} = 200mV_{pp}$, $C_b=1\mu F$	50	56		dB
SNR	Signal-to-Noise Ratio (Weighted A, $A_v=2$) ($R_L = 32\Omega$, THD +N < 0.5%, $20Hz \leq F \leq 20kHz$)	82	94		dB
Φ_M	Phase Margin at Unity Gain $R_L = 16\Omega$, $C_L = 400pF$		58		Degrees
GM	Gain Margin $R_L = 16\Omega$, $C_L = 400pF$		18		dB
GBP	Gain Bandwidth Product $R_L = 16\Omega$		1.1		MHz
SR	Slew Rate $R_L = 16\Omega$		0.4		V/ μS

1. All electrical values are guaranteed with correlation measurements at 2V and 5V

ELECTRICAL CHARACTERISTICS
 $V_{CC} = +2.5V$, $GND = 0V$, $T_{amb} = 25^{\circ}C$ (unless otherwise specified)¹⁾

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		1.7	2.5	mA
$I_{STANDBY}$	Standby Current No input signal, $V_{STANDBY}=GND$ for TS421 No input signal, $V_{STANDBY}=V_{CC}$ for TS419		10	1000	nA
V_{OO}	Output Offset Voltage No input signal, $R_L = 16$ or 32Ω , $R_{feed}=20k\Omega$		5	25	mV
P_O	Output Power THD+N = 0.1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 0.1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 16\Omega$	32 44	37 41 52 50 55 70		mW
THD + N	Total Harmonic Distortion + Noise ($A_v=2$) $R_L = 32\Omega$, $P_{out} = 30mW$, $20Hz \leq F \leq 20kHz$ $R_L = 16\Omega$, $P_{out} = 40mW$, $20Hz \leq F \leq 20kHz$		0.15 0.2		%
PSRR	Power Supply Rejection Ratio ($A_v=2$) inputs grounded, $F = 1kHz$, $V_{ripple} = 200mV_{pp}$, $C_b=1\mu F$	50	56		dB
SNR	Signal-to-Noise Ratio (Weighted A, $A_v=2$) ($R_L = 32\Omega$, THD +N < 0.5%, $20Hz \leq F \leq 20kHz$)	80	91		dB
Φ_M	Phase Margin at Unity Gain $R_L = 16\Omega$, $C_L = 400pF$		58		Degrees
GM	Gain Margin $R_L = 16\Omega$, $C_L = 400pF$		18		dB
GBP	Gain Bandwidth Product $R_L = 16\Omega$		1.1		MHz
SR	Slew Rate $R_L = 16\Omega$		0.4		V/ μS

1. All electrical values are guaranteed with correlation measurements at 2V and 5V

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply Current No input signal, no load		1.7	2.5	mA
$I_{STANDBY}$	Standby Current No input signal, $V_{STANDBY}=GND$ for TS421 No input signal, $V_{STANDBY}=V_{CC}$ for TS419		10	1000	nA
V_{OO}	Output Offset Voltage No input signal, $R_L = 16$ or 32Ω , $R_{feed}=20k\Omega$		5	25	mV
P_O	Output Power THD+N = 0.1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 32\Omega$ THD+N = 0.1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 1% Max, $F = 1kHz$, $R_L = 16\Omega$ THD+N = 10% Max, $F = 1kHz$, $R_L = 16\Omega$	19 24	20 23 30 26 30 40		mW
THD + N	Total Harmonic Distortion + Noise ($A_v=2$) $R_L = 32\Omega$, $P_{out} = 13mW$, $20Hz \leq F \leq 20kHz$ $R_L = 16\Omega$, $P_{out} = 20mW$, $20Hz \leq F \leq 20kHz$		0.1 0.15		%
PSRR	Power Supply Rejection Ratio ($A_v=2$) ¹⁾ inputs grounded, $F = 1kHz$, $V_{ripple} = 200mV_{pp}$, $C_b=1\mu F$	49	54		dB
SNR	Signal-to-Noise Ratio (Weighted A, $A_v=2$) ¹⁾ ($R_L = 32\Omega$, THD +N < 0.5%, $20Hz \leq F \leq 20kHz$)	80	89		dB
Φ_M	Phase Margin at Unity Gain $R_L = 16\Omega$, $C_L = 400pF$		58		Degrees
GM	Gain Margin $R_L = 16\Omega$, $C_L = 400pF$		20		dB
GBP	Gain Bandwidth Product $R_L = 16\Omega$		1.1		MHz
SR	Slew Rate $R_L = 16\Omega$		0.4		V/ μS

1. Guaranteed by design and evaluation.

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THD + N vs Output Power	77 to 85	23 to 24
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Signal to Noise Ratio vs Power Supply Voltage	89 to 90	25
Noise Floor	91 to 92	25
PSRR vs Frequency	93 to 97	25 to 26

Note : All measurements made with Rin=20kΩ, Cb=1μF, and Cin=10μF unless otherwise specified.

Fig. 1: Open Loop Gain and Phase vs Frequency

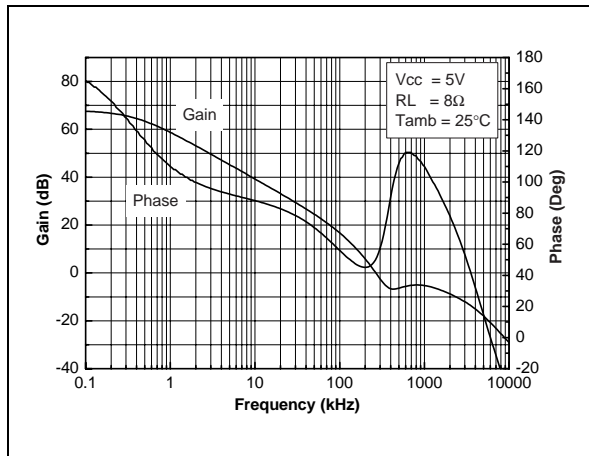


Fig. 2: Open Loop Gain and Phase vs Frequency

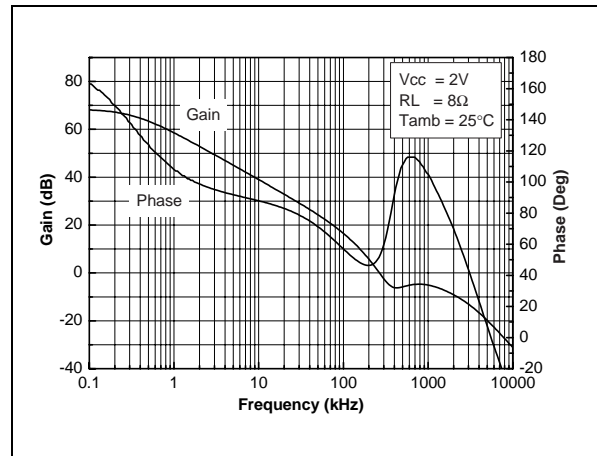


Fig. 3: Open Loop Gain and Phase vs Frequency

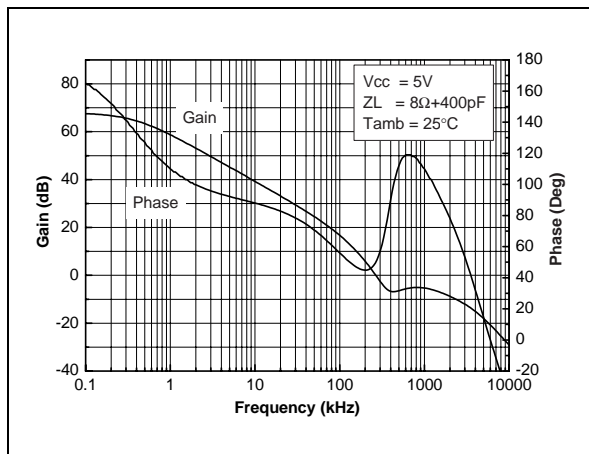


Fig. 4: Open Loop Gain and Phase vs Frequency

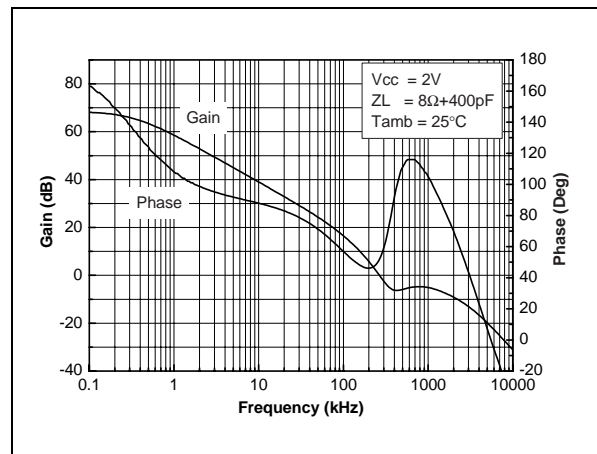


Fig. 5: Open Loop Gain and Phase vs Frequency

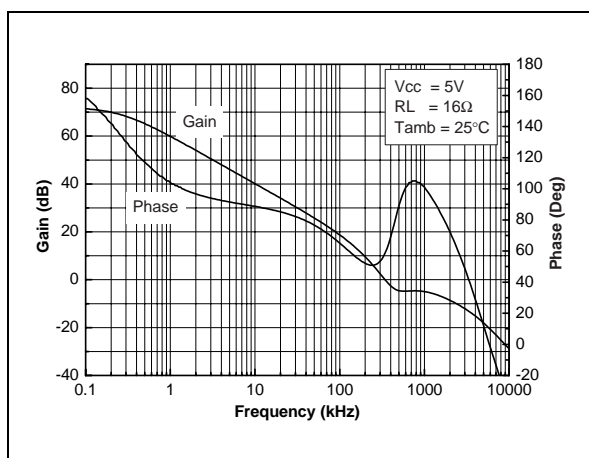


Fig. 6: Open Loop Gain and Phase vs Frequency

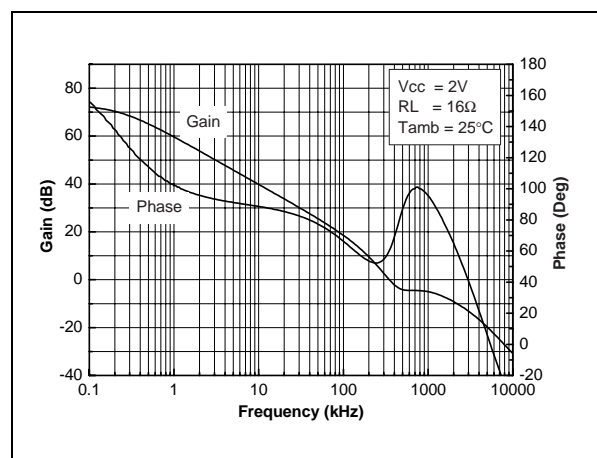


Fig. 7: Open Loop Gain and Phase vs Frequency

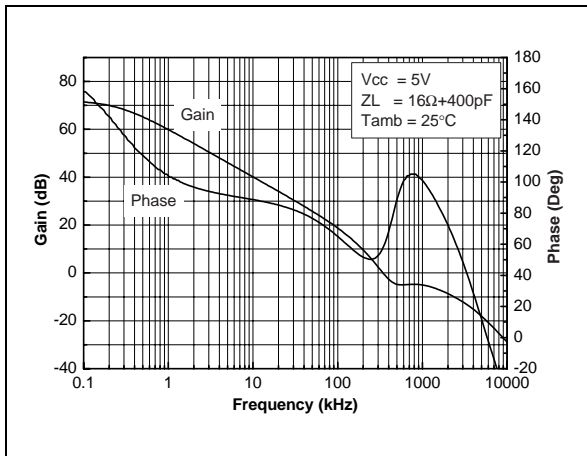


Fig. 8: Open Loop Gain and Phase vs Frequency

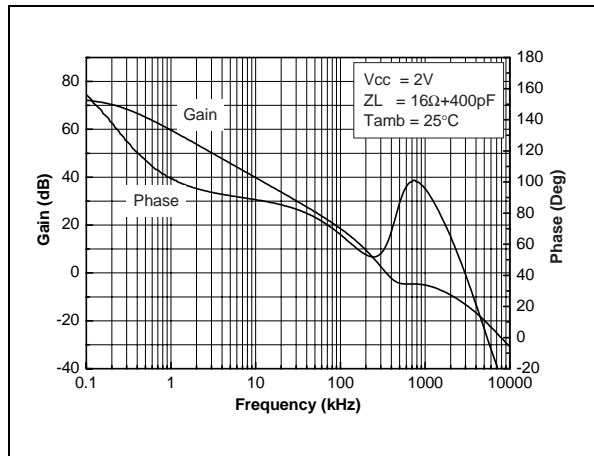


Fig. 9: Open Loop Gain and Phase vs Frequency

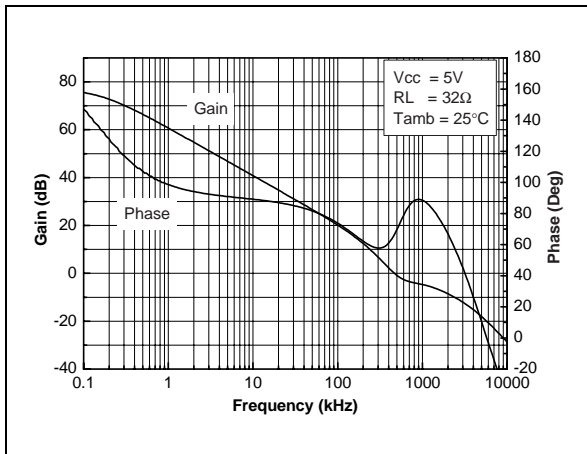


Fig. 10: Open Loop Gain and Phase vs Frequency

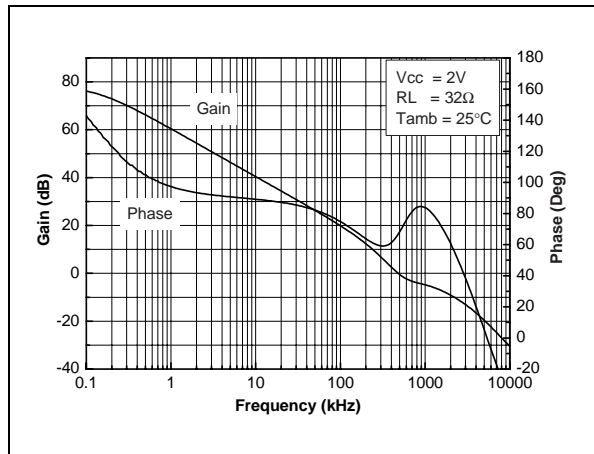


Fig. 11: Open Loop Gain and Phase vs Frequency

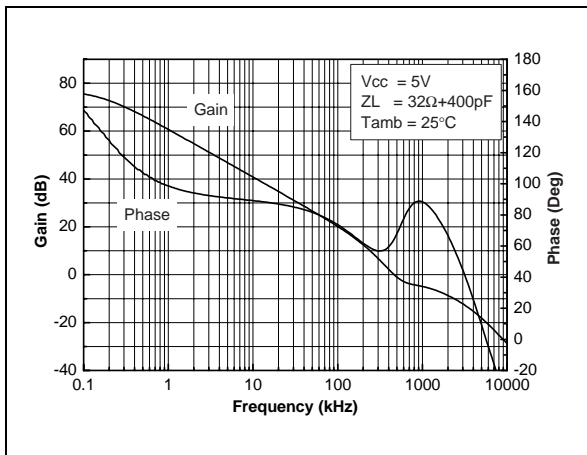


Fig. 12: Open Loop Gain and Phase vs Frequency

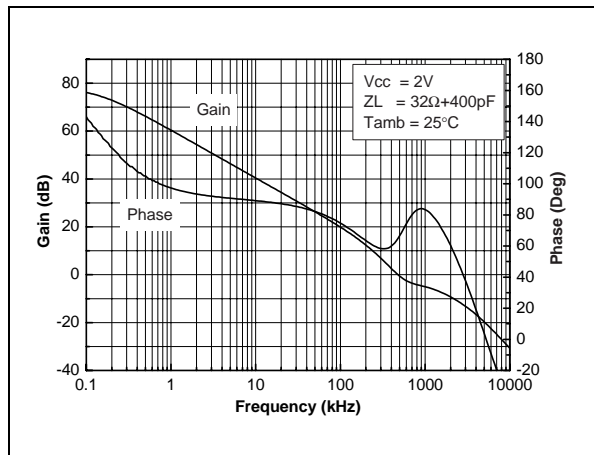


Fig. 13: Current Consumption vs Power Supply Voltage

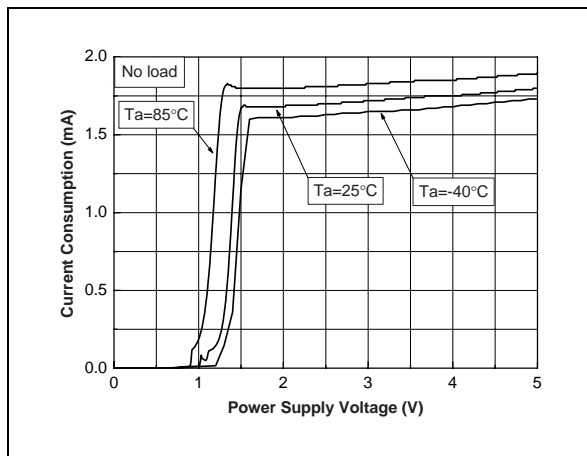


Fig. 14: Current Consumption vs Standby Voltage

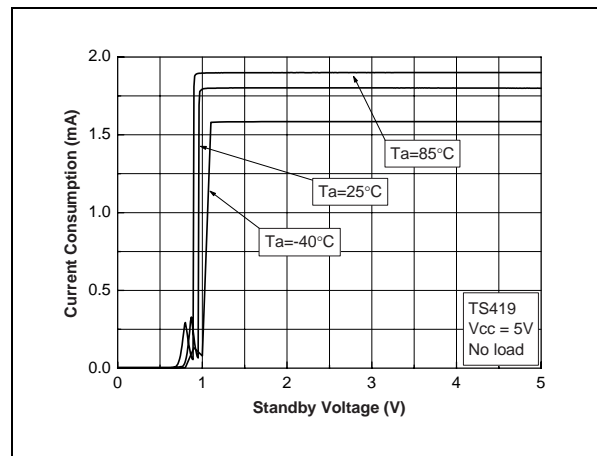


Fig. 15: Current Consumption vs Standby Voltage

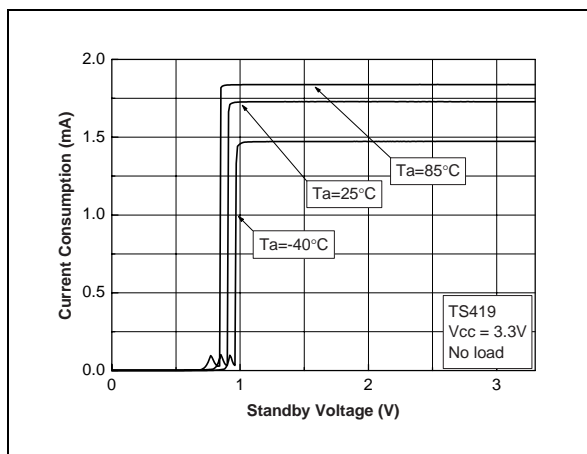


Fig. 16: Current Consumption vs Standby Voltage

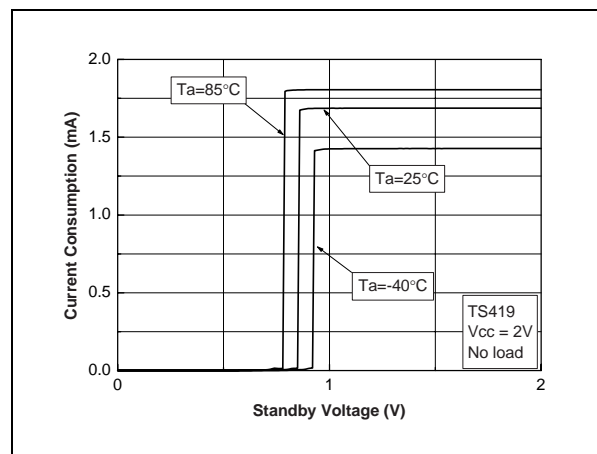


Fig. 17: Current Consumption vs Standby Voltage

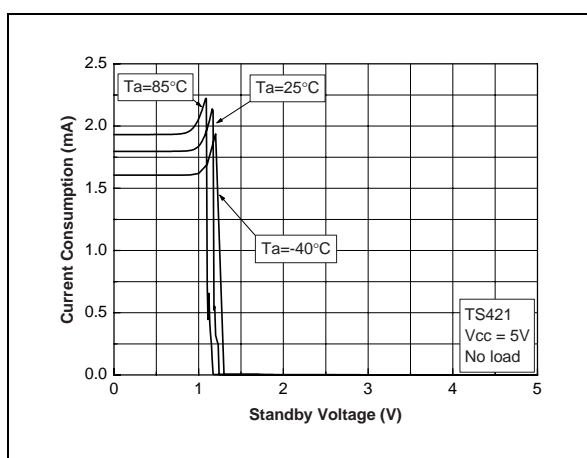


Fig. 18: Current Consumption vs Standby Voltage

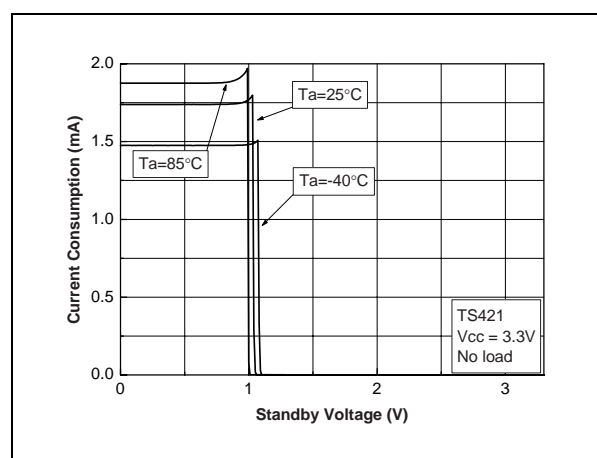


Fig. 19: Current Consumption vs Standby Voltage

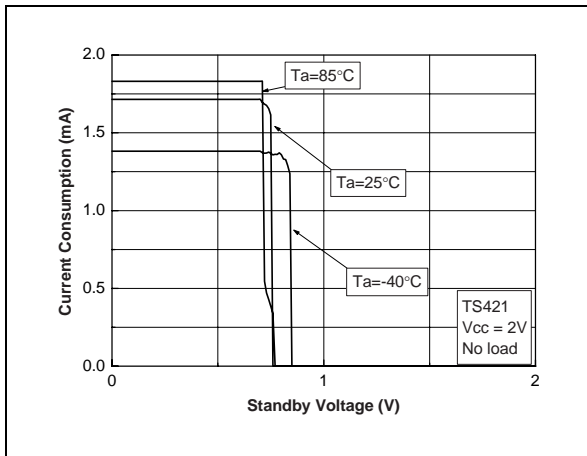


Fig. 21: Output Power vs Power Supply Voltage

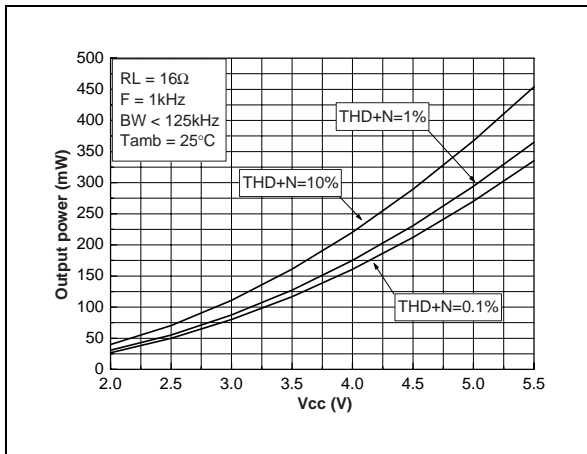


Fig. 23: Output Power vs Power Supply Voltage

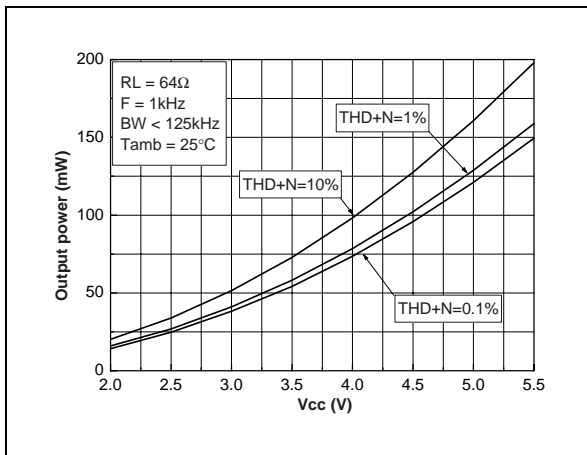


Fig. 20: Output Power vs Power Supply Voltage

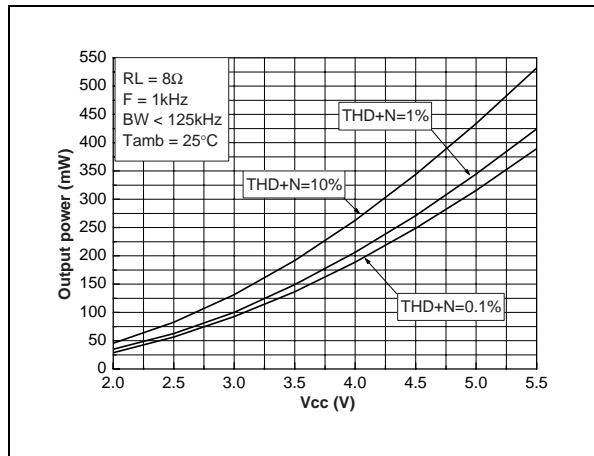


Fig. 22: Output Power vs Power Supply Voltage

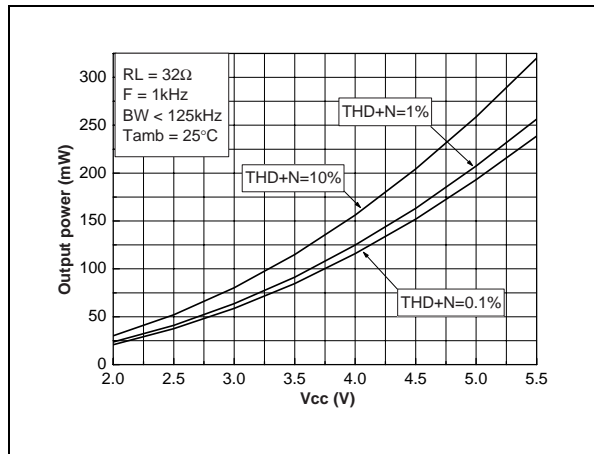


Fig. 24: Output Power vs Load Resistor

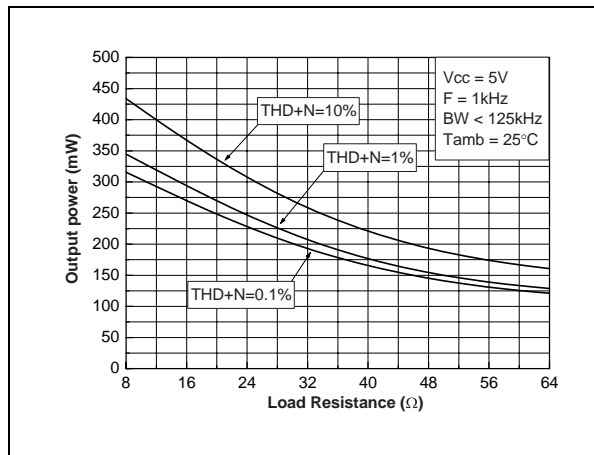


Fig. 25: Output Power vs Load Resistor

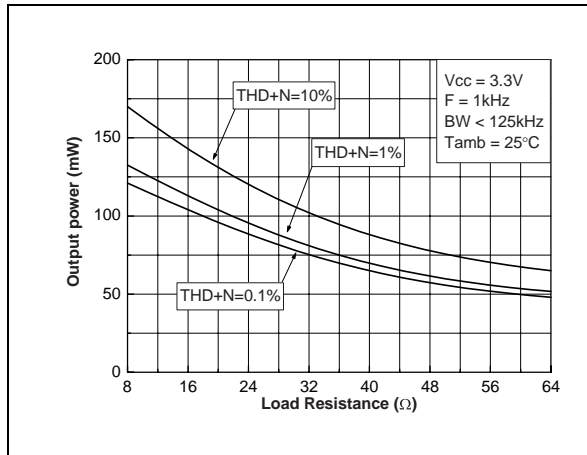


Fig. 26: Output Power vs Load Resistor

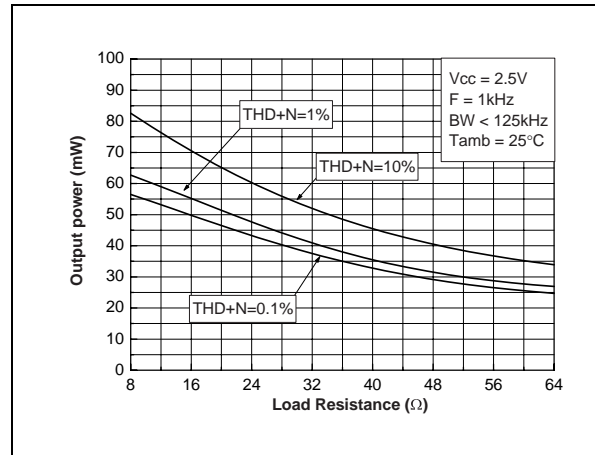


Fig. 27: Output Power vs Load Resistor

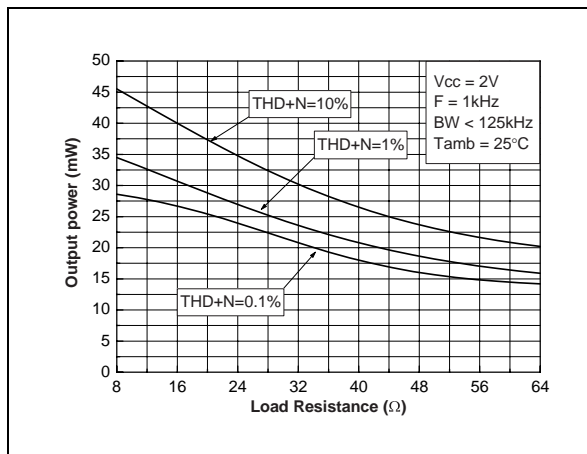


Fig. 28: Power Dissipation vs Output Power

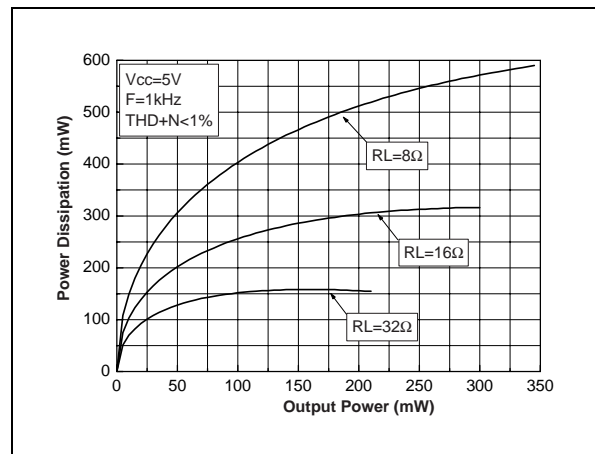


Fig. 29: Power Dissipation vs Output Power

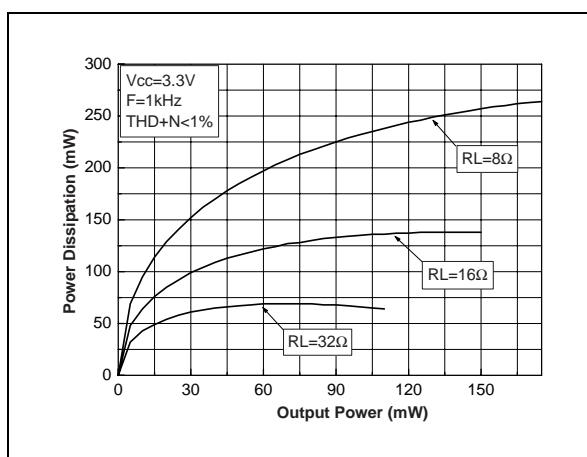


Fig. 30: Power Dissipation vs Output Power

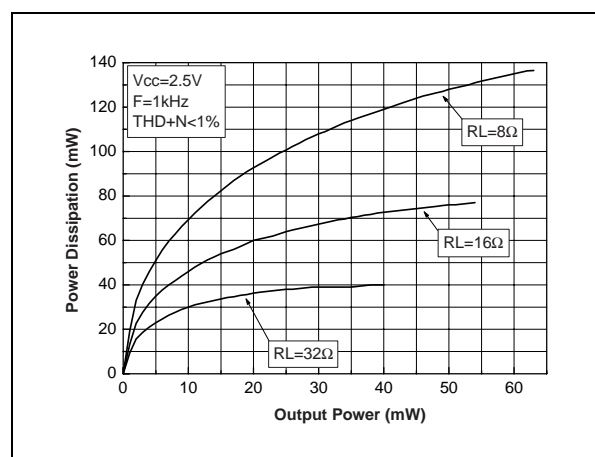


Fig. 31: Power Dissipation vs Output Power

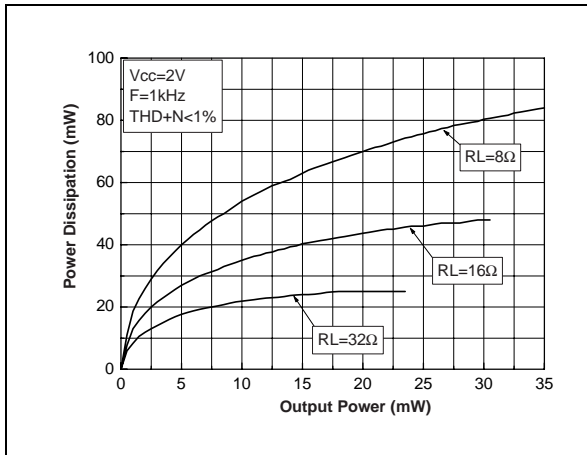


Fig. 32: Power Derating Curves

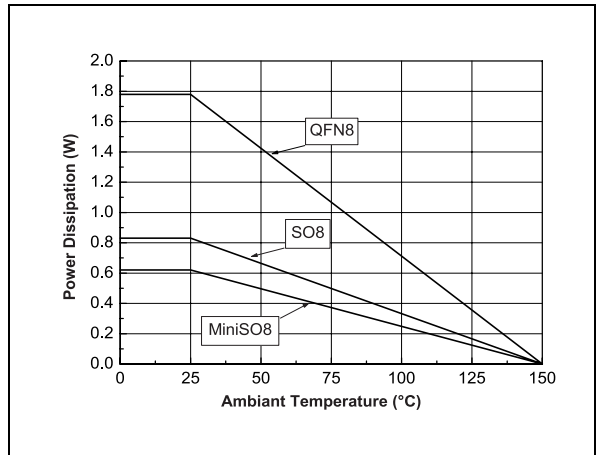


Fig. 33: Output Voltage Swing For One Amp. vs Power Supply Voltage

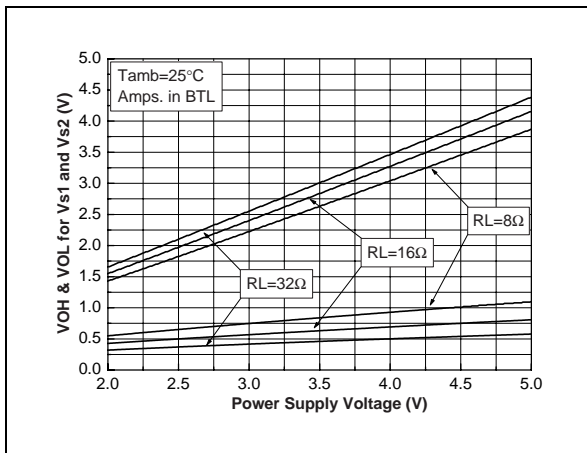


Fig. 34: Low Frequency Cut Off vs Input Capacitor for fixed gain versions

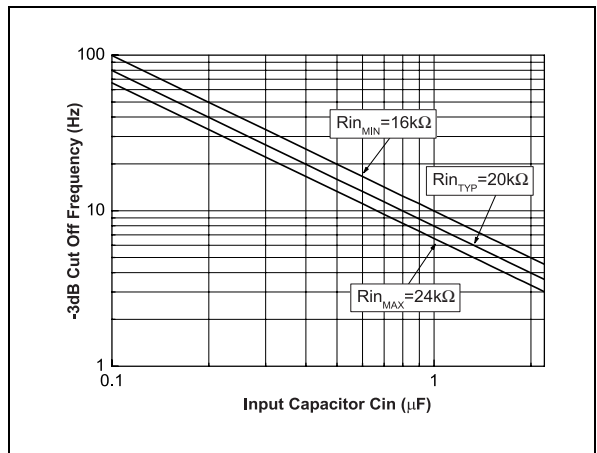


Fig. 35: THD + N vs Output Power

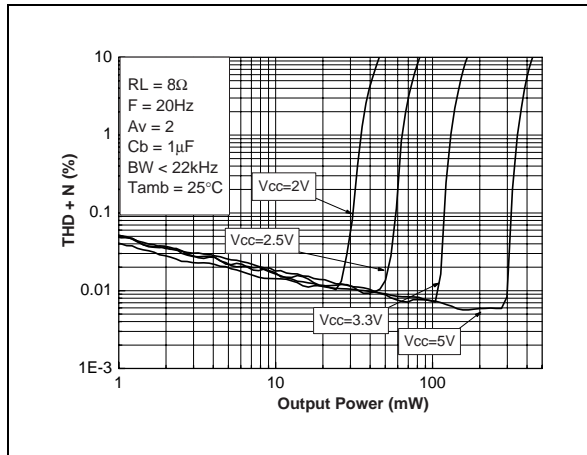


Fig. 36: THD + N vs Output Power

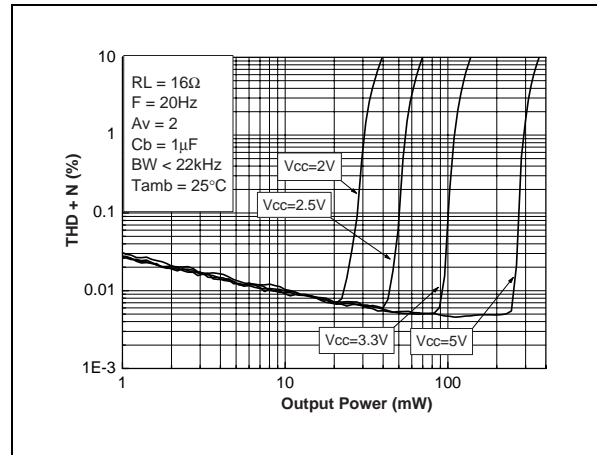


Fig. 37: THD + N vs Output Power

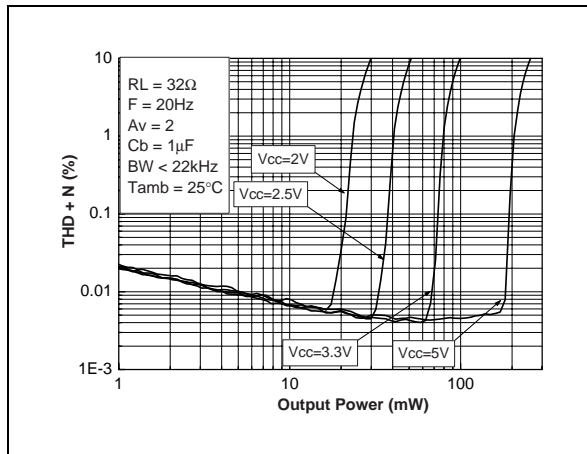


Fig. 38: THD + N vs Output Power

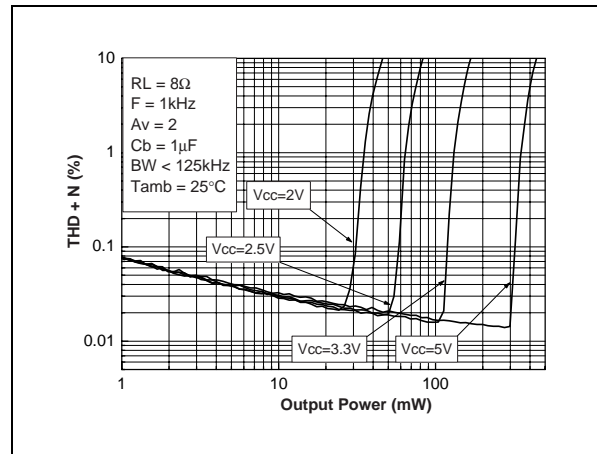


Fig. 39: THD + N vs Output Power

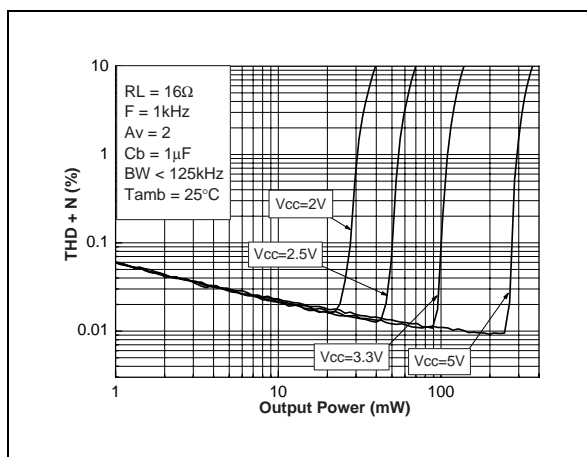


Fig. 40: THD + N vs Output Power

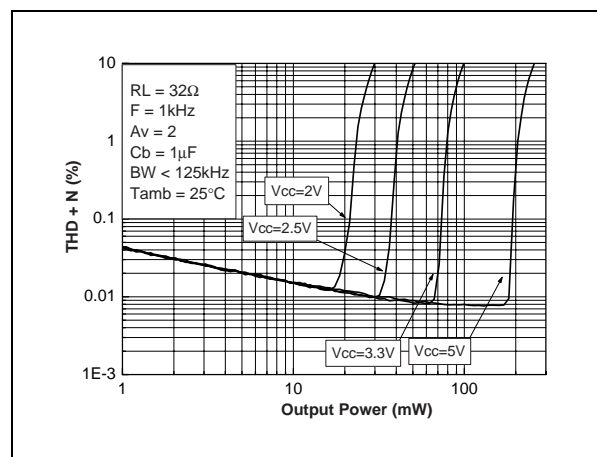


Fig. 41: THD + N vs Output Power

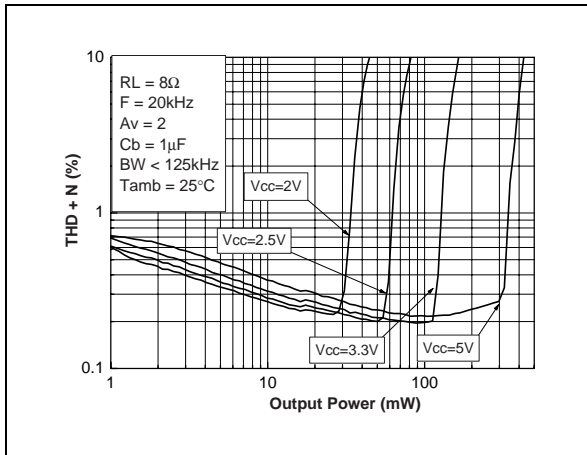


Fig. 42: THD + N vs Output Power

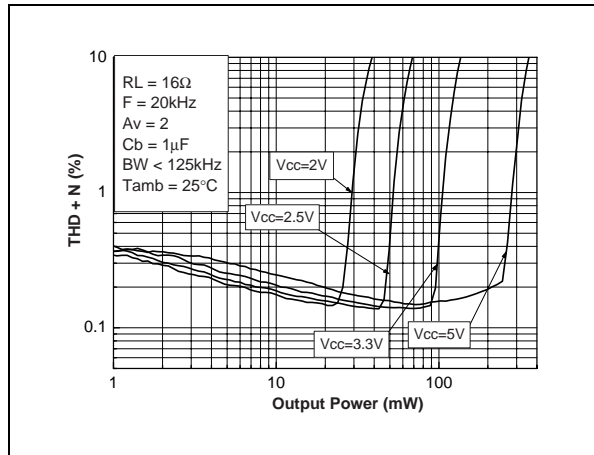


Fig. 43: THD + N vs Output Power

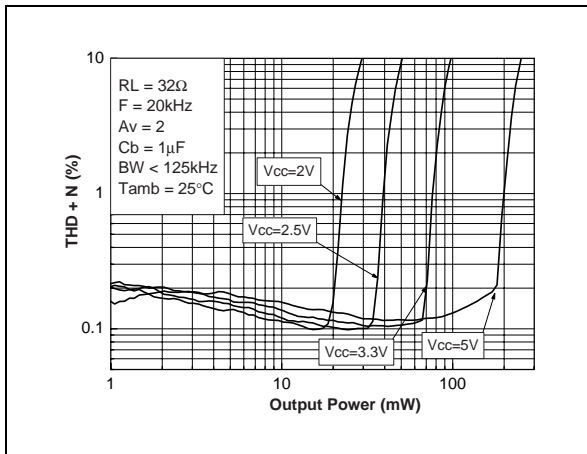


Fig. 44: THD + N vs Frequency

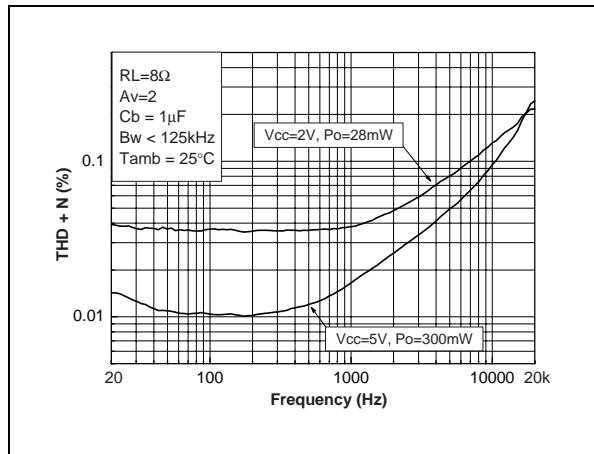


Fig. 45: THD + N vs Frequency

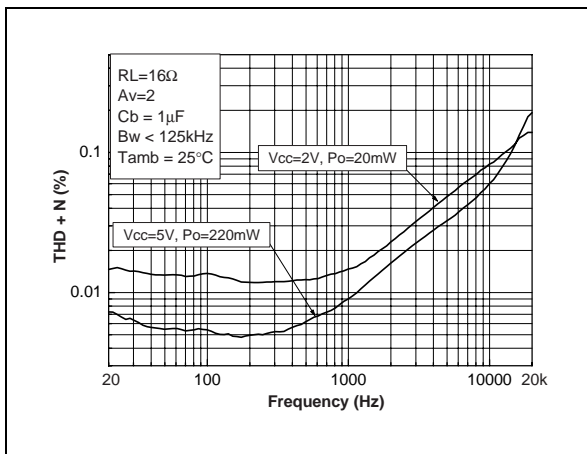


Fig. 46: THD + N vs Frequency

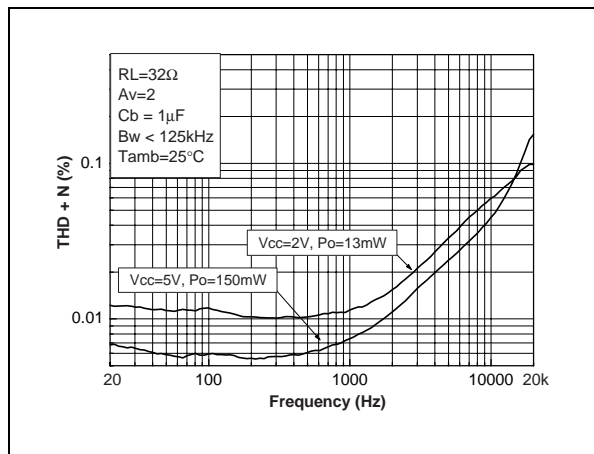


Fig. 47: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)

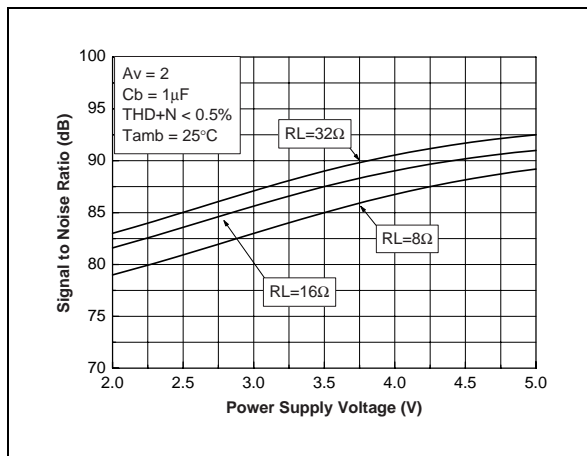


Fig. 48: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A

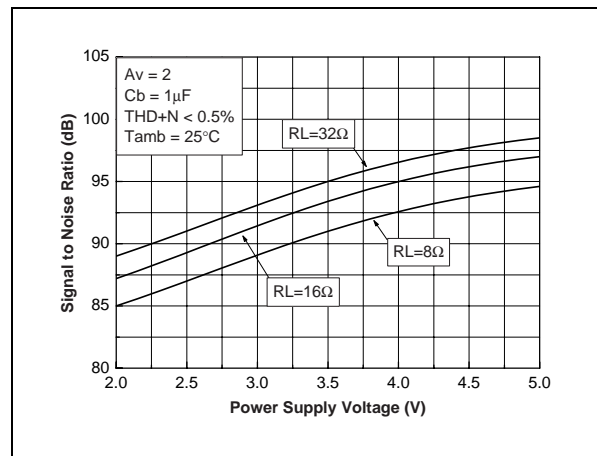


Fig. 49: Noise Floor

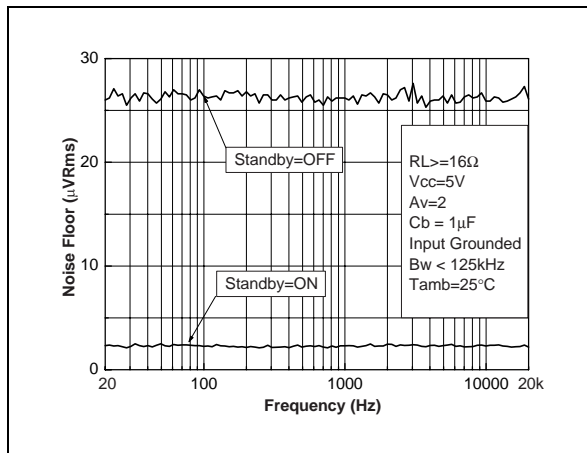


Fig. 50: Noise Floor

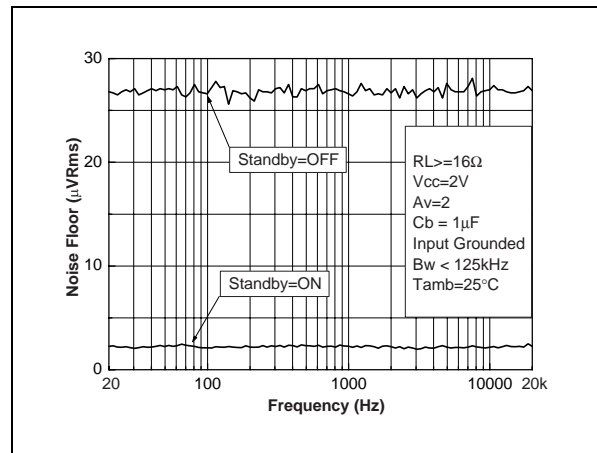


Fig. 51: PSRR vs Input Capacitor

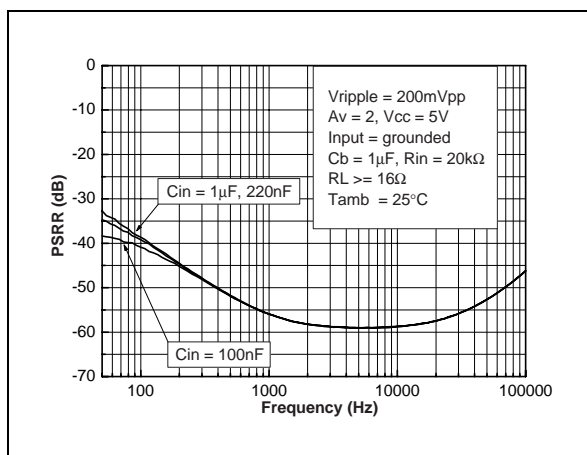


Fig. 52: PSRR vs Power Supply Voltage

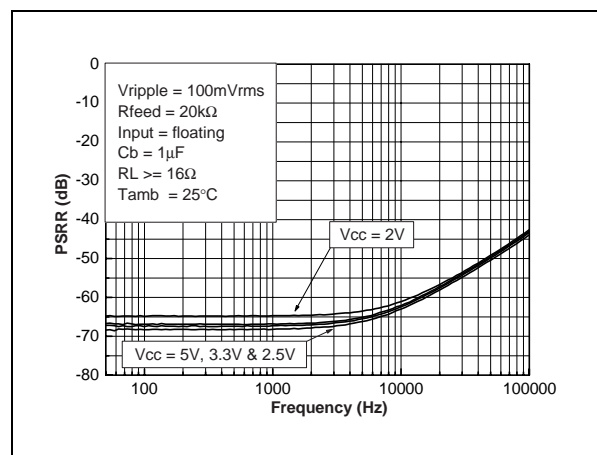


Fig. 53: PSRR vs Bypass Capacitor

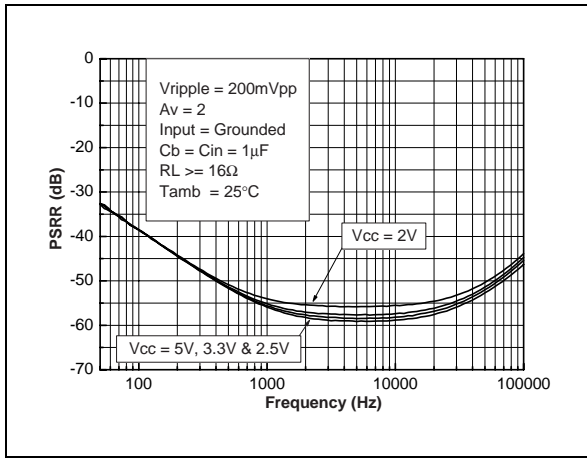


Fig. 54: PSRR vs Bypass Capacitor

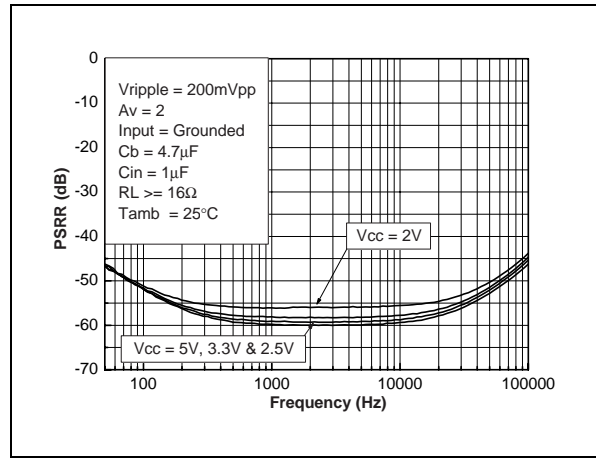


Fig. 55: PSRR vs Bypass Capacitor

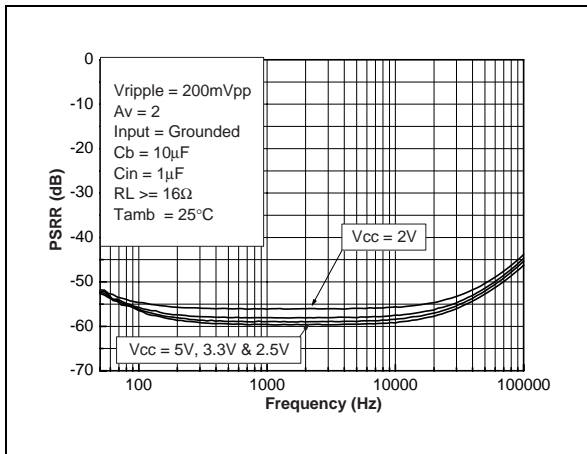


Fig. 56: THD + N vs Output Power

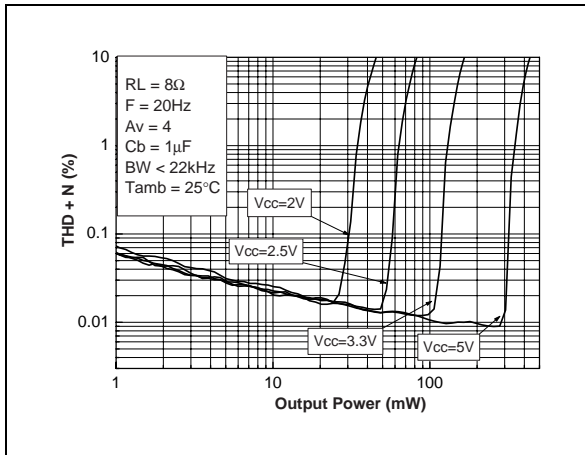


Fig. 57: THD + N vs Output Power

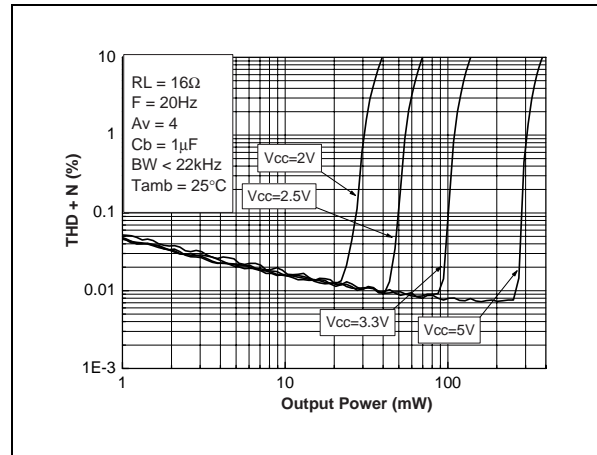


Fig. 58: THD + N vs Output Power

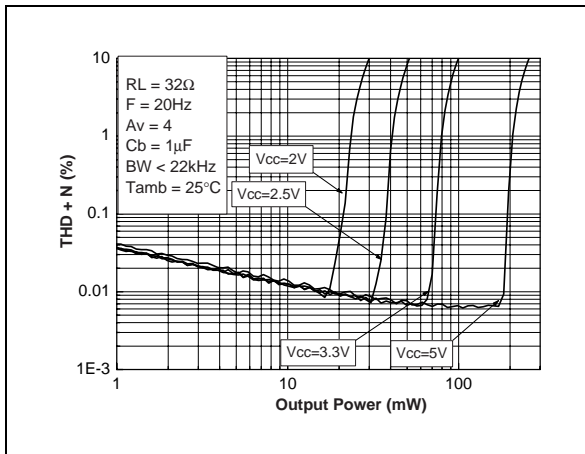


Fig. 59: THD + N vs Output Power

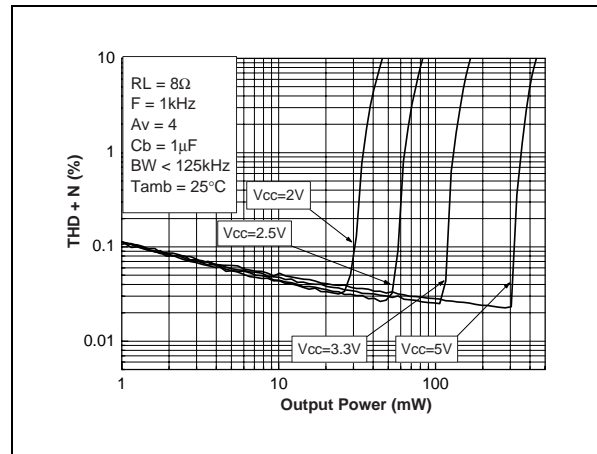


Fig. 60: THD + N vs Output Power

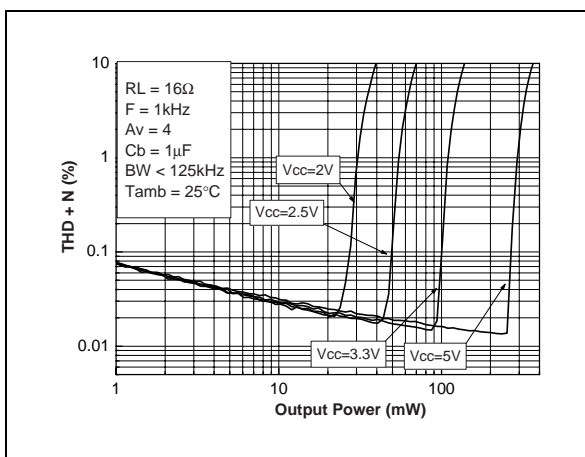


Fig. 61: THD + N vs Output Power

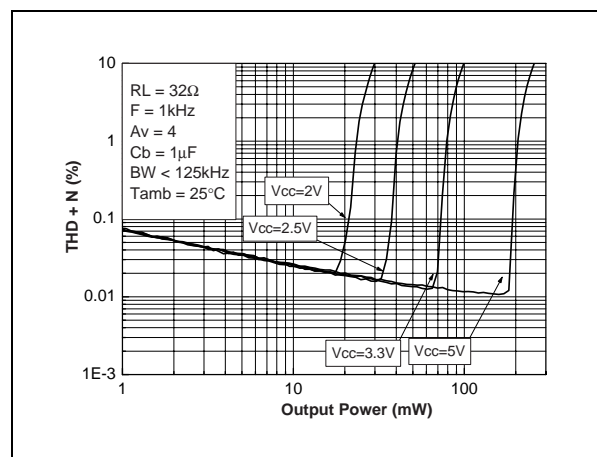


Fig. 62: THD + N vs Output Power

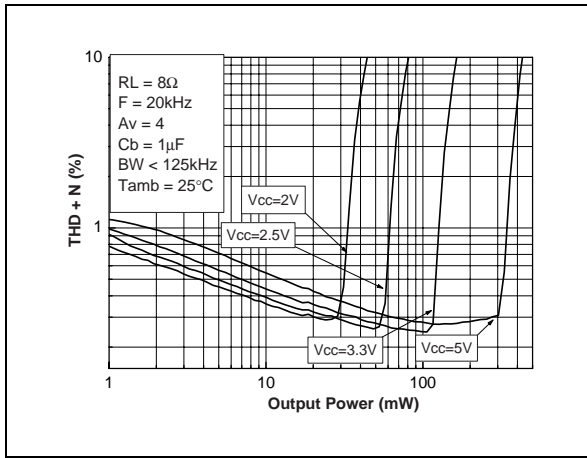


Fig. 63: THD + N vs Output Power

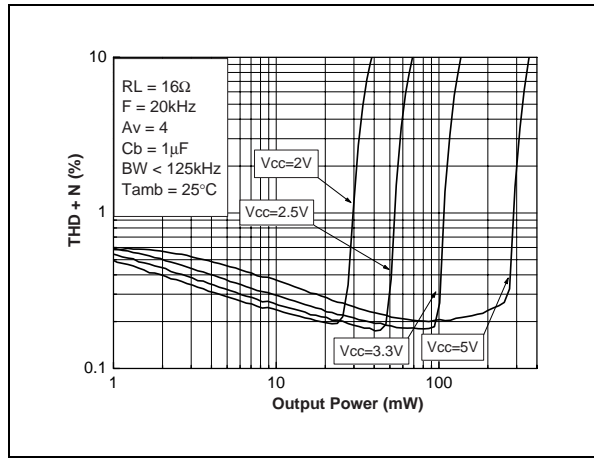


Fig. 64: THD + N vs Output Power

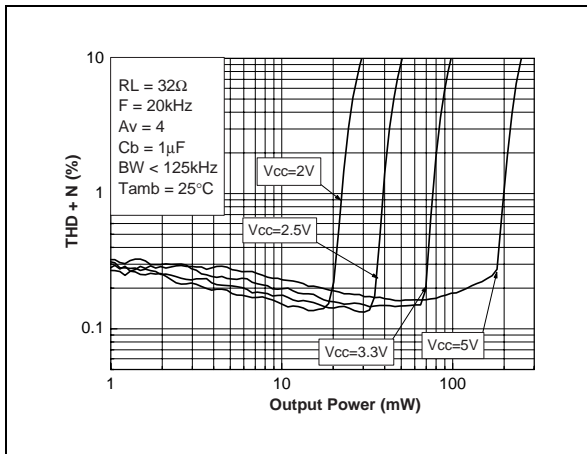


Fig. 65: THD + N vs Frequency

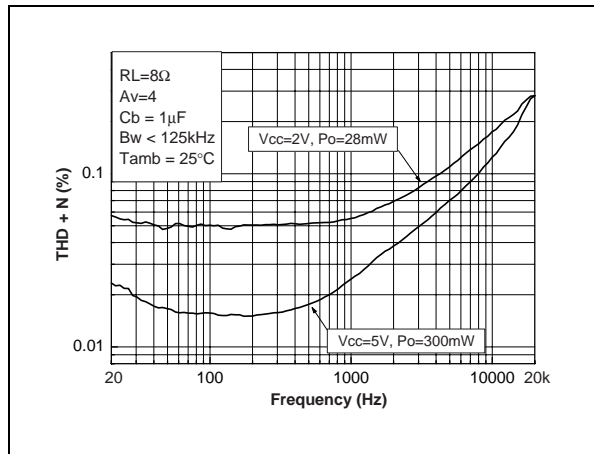


Fig. 66: THD + N vs Frequency

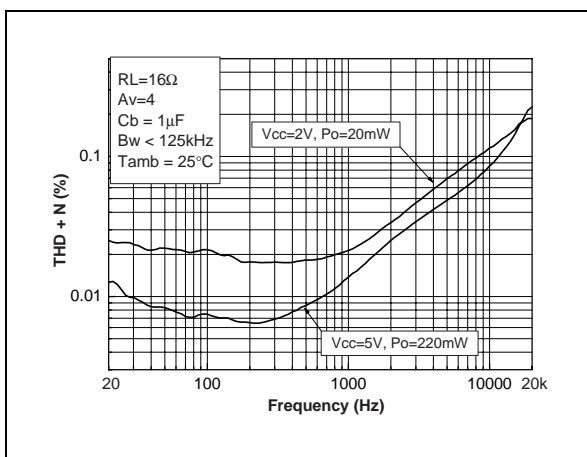


Fig. 67: THD + N vs Frequency

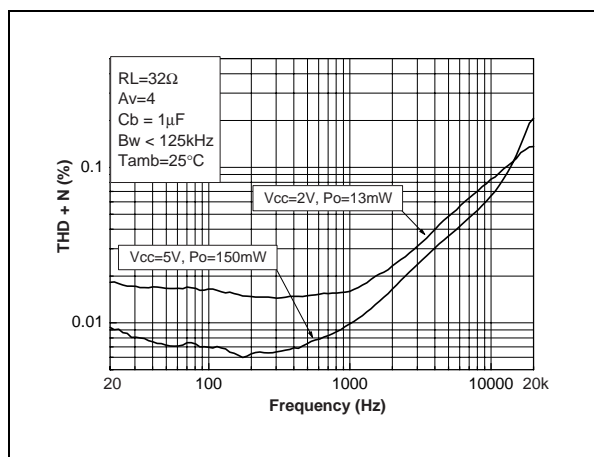


Fig. 68: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)

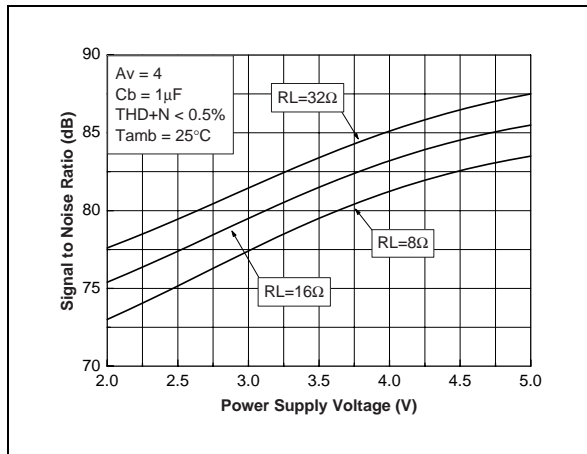


Fig. 69: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A

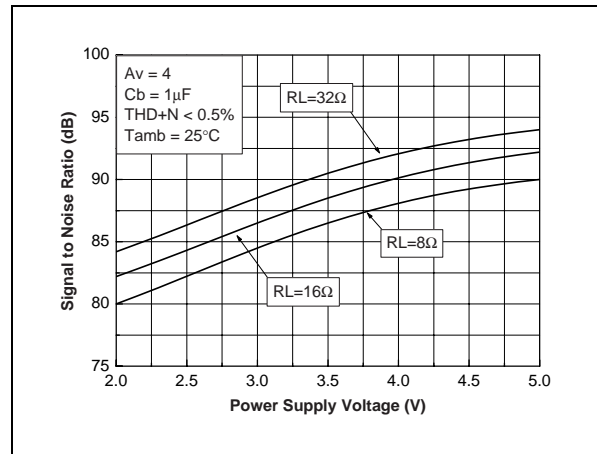


Fig. 70: Noise Floor

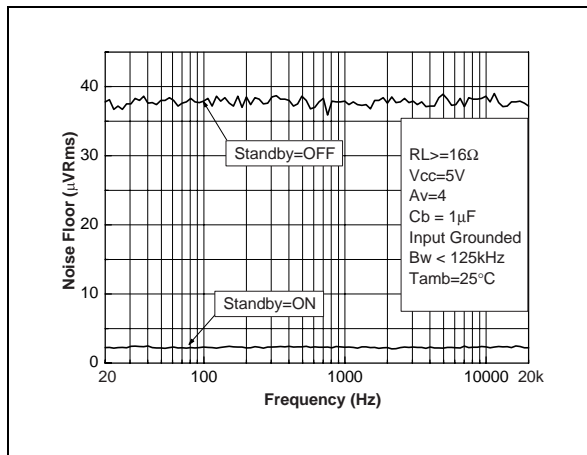


Fig. 71: Noise Floor

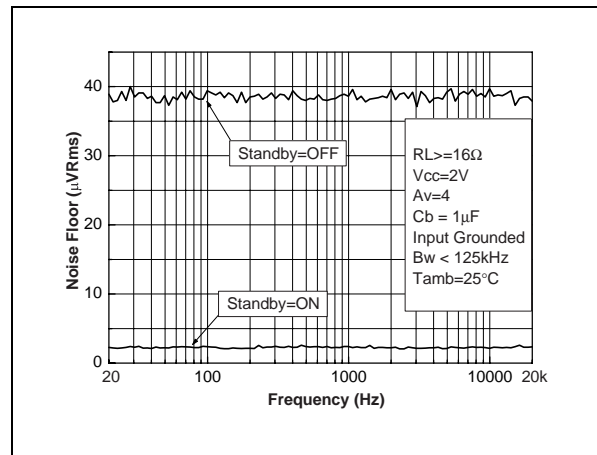


Fig. 72: PSRR vs Power Supply Voltage

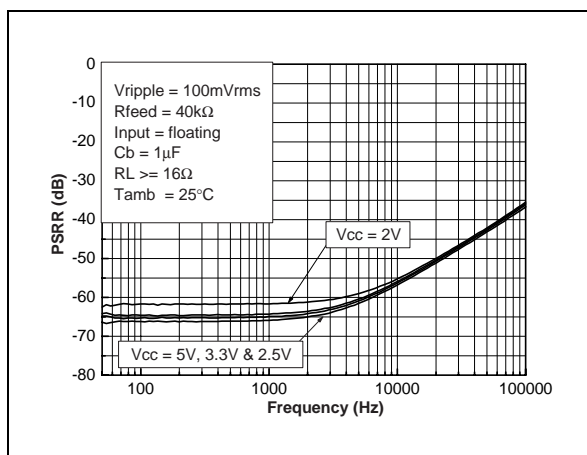


Fig. 73: PSRR vs Input Capacitor

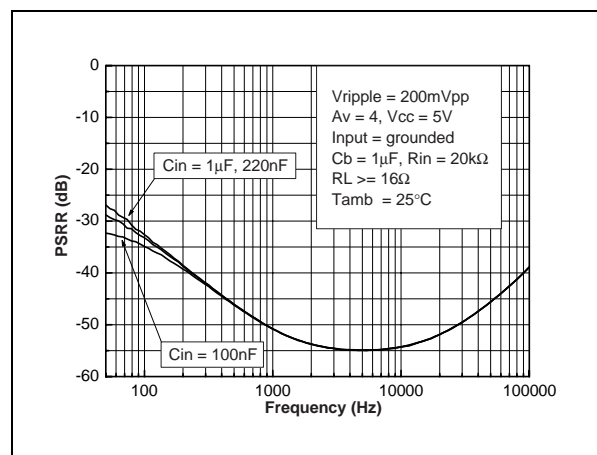


Fig. 74: PSRR vs Bypass Capacitor

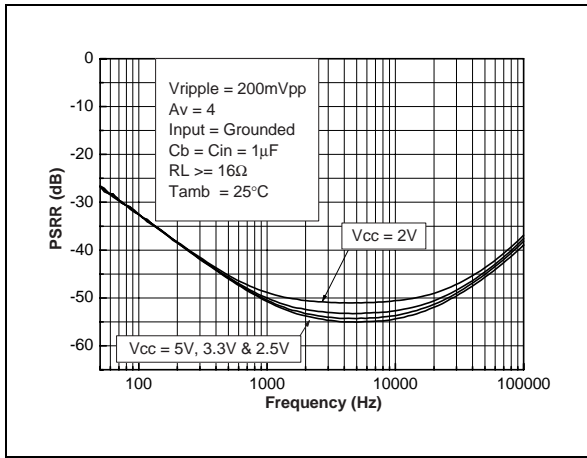


Fig. 75: PSRR vs Bypass Capacitor

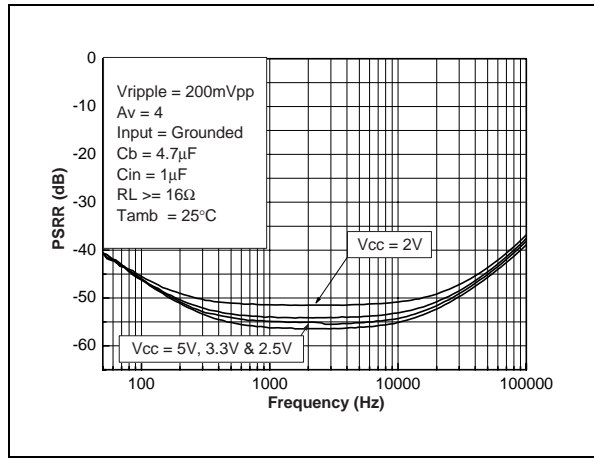


Fig. 76: PSRR vs Bypass Capacitor

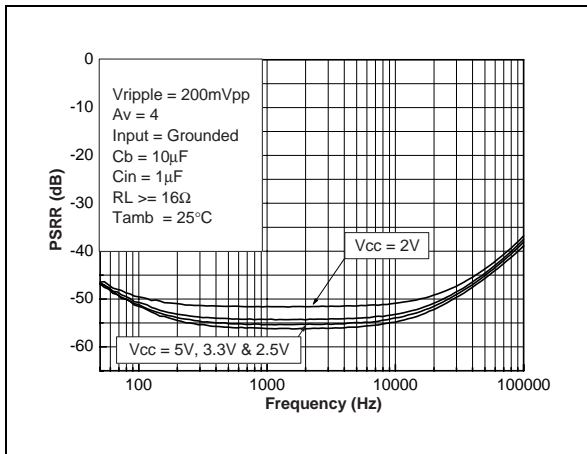


Fig. 77: THD + N vs Output Power

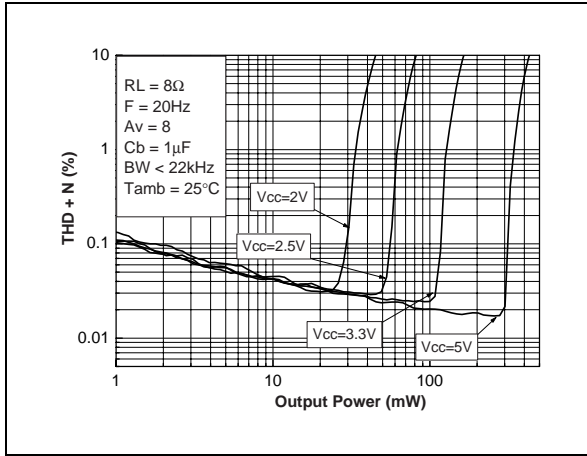


Fig. 78: THD + N vs Output Power

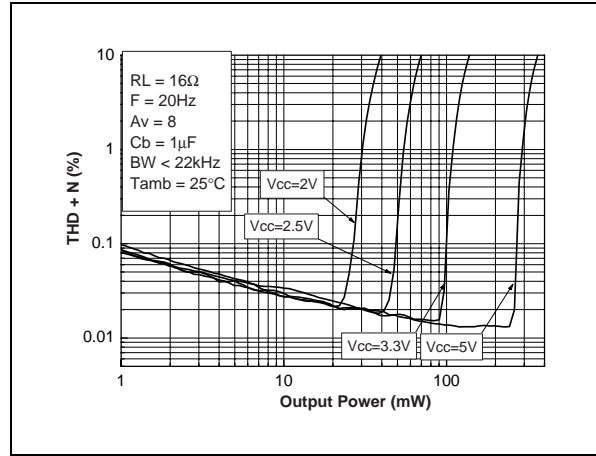


Fig. 79: THD + N vs Output Power

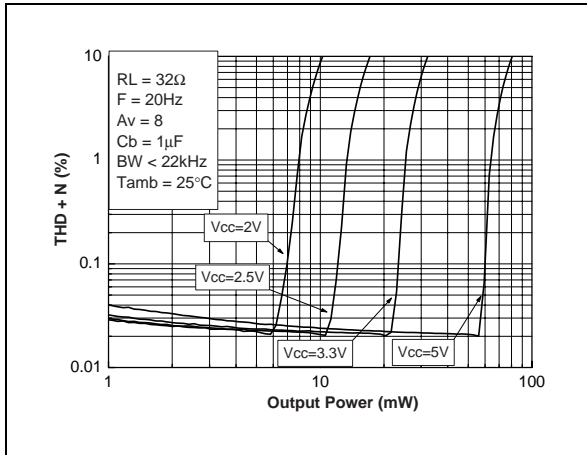


Fig. 80: THD + N vs Output Power

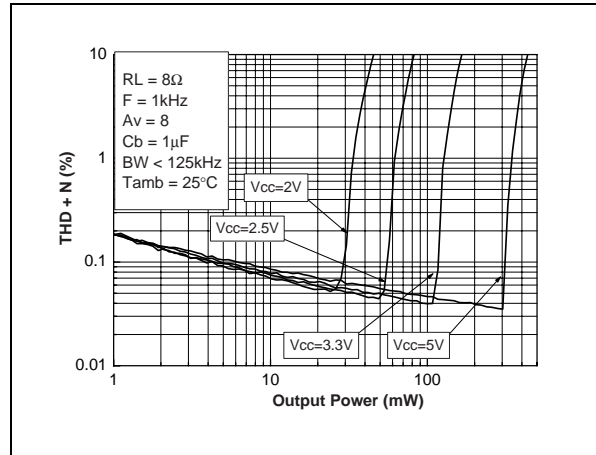


Fig. 81: THD + N vs Output Power

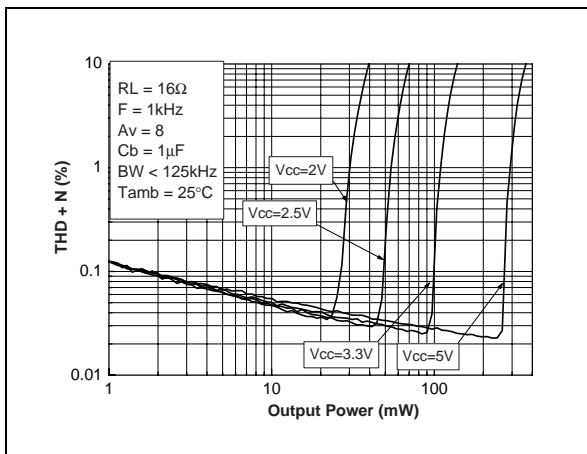


Fig. 82: THD + N vs Output Power

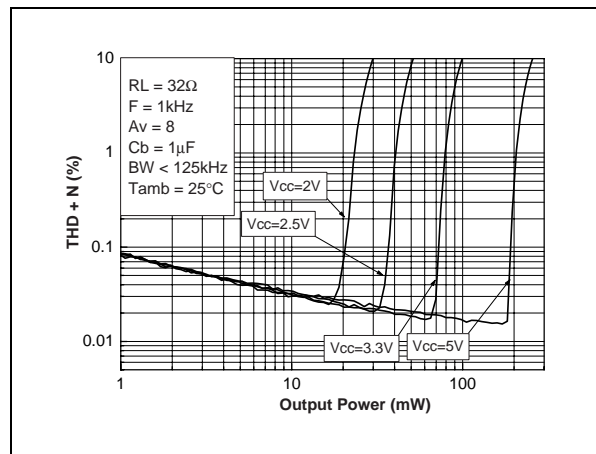


Fig. 83: THD + N vs Output Power

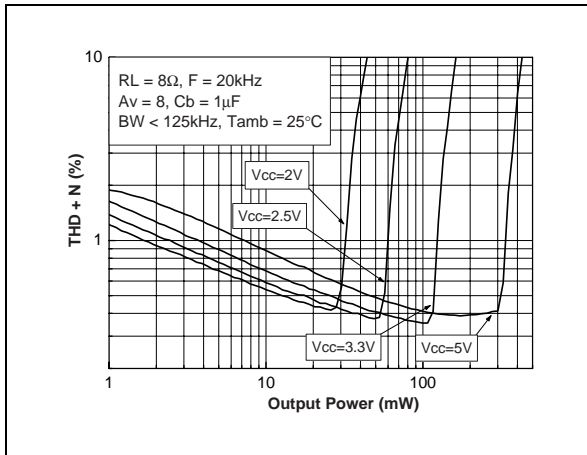


Fig. 84: THD + N vs Output Power

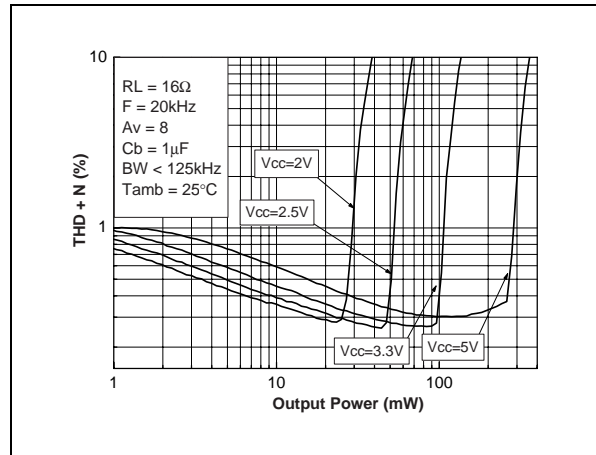


Fig. 85: THD + N vs Output Power

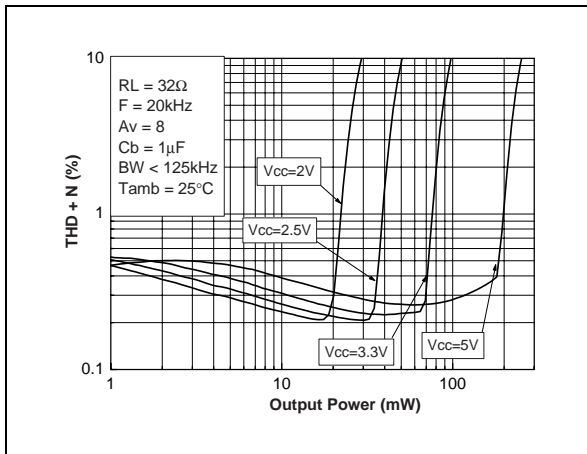


Fig. 86: THD + N vs Frequency

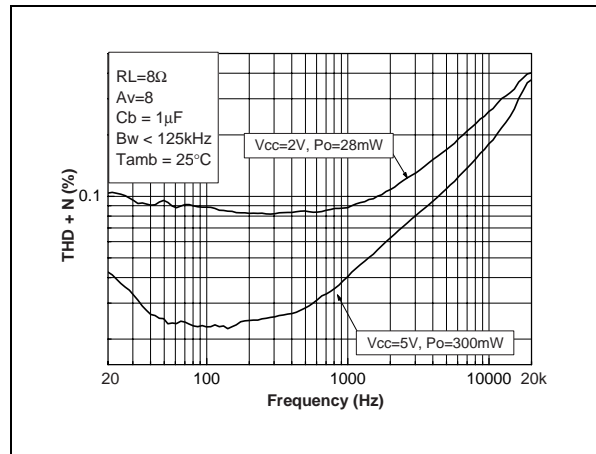


Fig. 87: THD + N vs Frequency

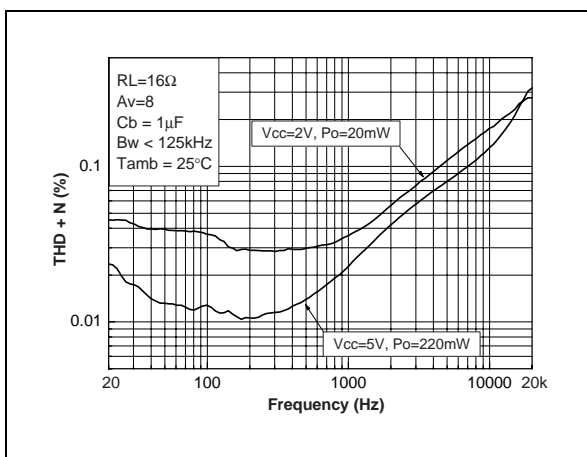


Fig. 88: THD + N vs Frequency

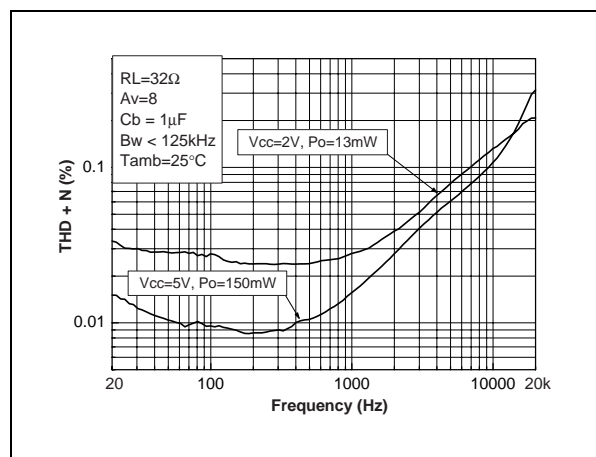


Fig. 89: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)

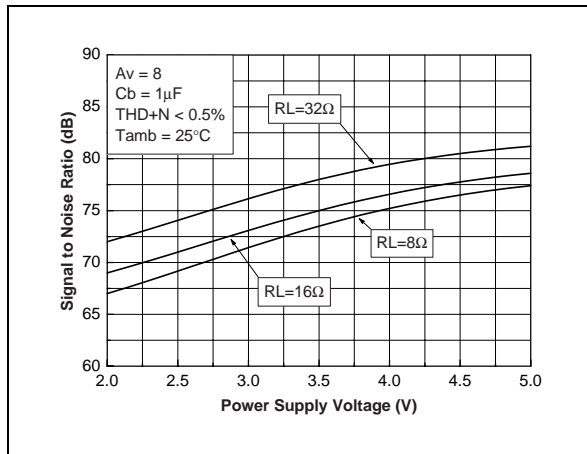


Fig. 90: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A

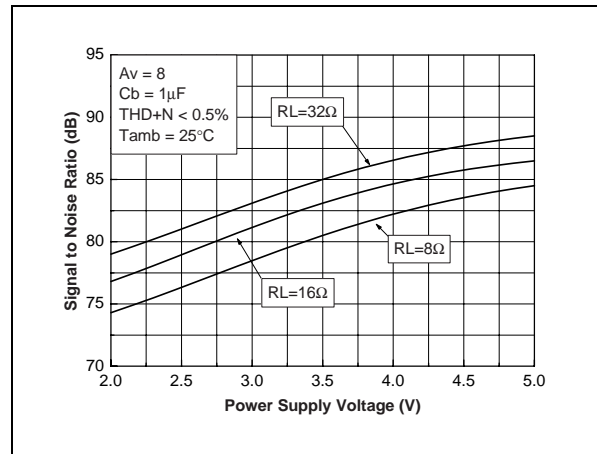


Fig. 91: Noise Floor

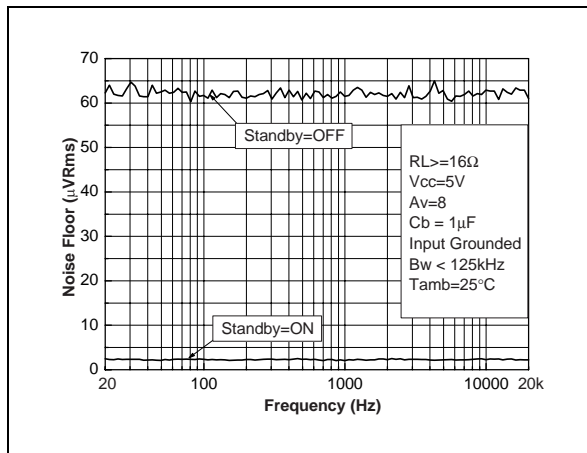


Fig. 92: Noise Floor

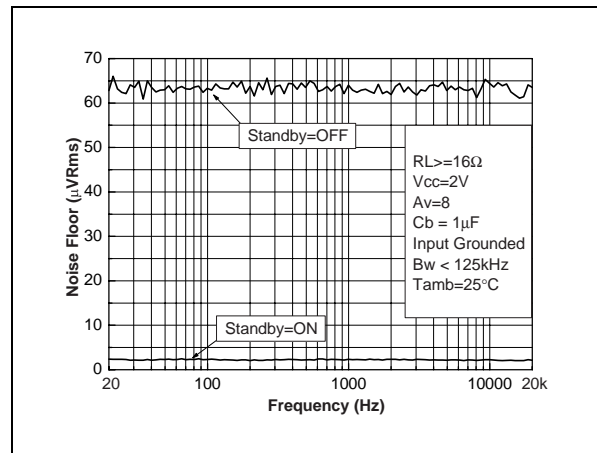


Fig. 93: PSRR vs Power Supply Voltage

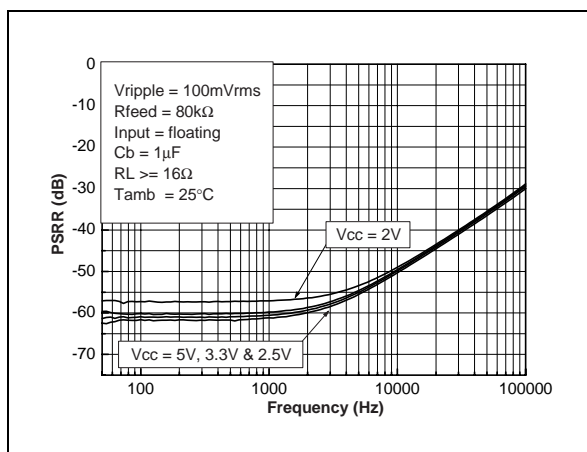


Fig. 94: PSRR vs Input Capacitor

