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TS419
TS421

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 ouput 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

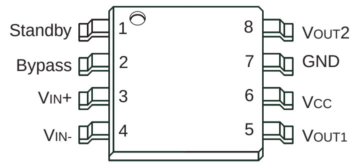
ORDER CODE

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

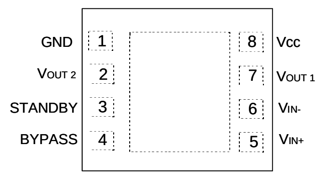
MiniSO & DFN only available in Tape & Reel with T suffix.
SO is available in Tube (D) and in Tape & Reel (DT)

PIN CONNECTIONS (top view)

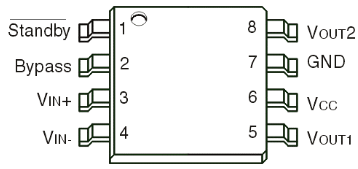
TS419IDT: SO8
TS419IST, TS419-xIST: MiniSO8



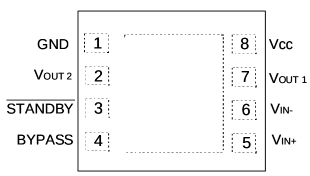
TS419IQT, TS419-xIQT: DFN8



TS421IDT: SO8
TS421IST, TS421-xIST: MiniSO8



TS421IQT, TS421-xIQT: DFN8



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 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. TS419 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	$\geq$ 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	 $1.5 \leq V_{STB} \leq V_{CC}$ GND $\leq V_{STB} \leq 0.4$ [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 (Cb = 1µF) [3]	$\geq$ 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

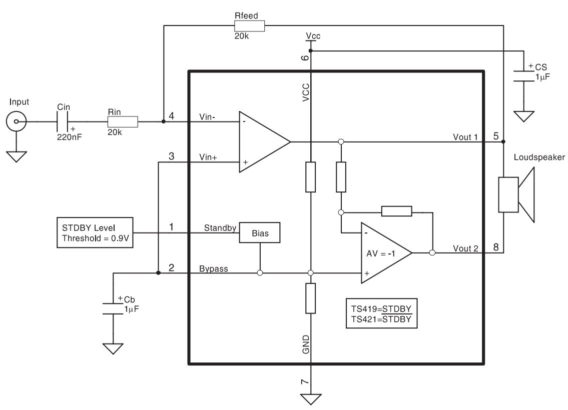
V_{CC} from **+5V to +2V**, GND = **0V**, T_{amb} = 25°C (unless otherwise specified)

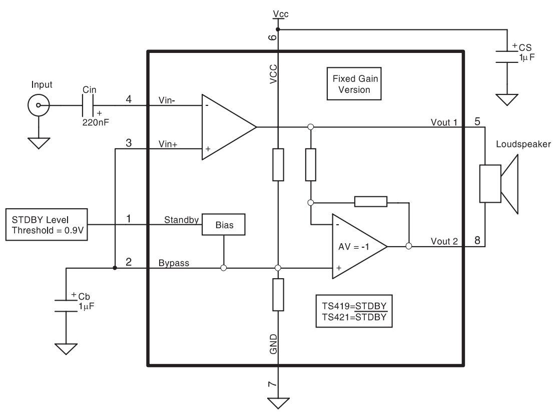
Symbol	Parameter	Min.	Typ.	Max.	Unit
R_{IN}	Input Resistance		20		kΩ
G	Gain value for Gain TS419/TS421-2 Gain value for Gain TS419/TS421-4 Gain value for Gain TS419/TS421-8		6dB 12dB 18dB		dB

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} (fcl = 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°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, $V_{STANDBY}$=Vcc for TS419		10	1000	nA
Voo	Output Offset Voltage No input signal, RL = 16 or 32Ω, Rfeed=20kΩ		5	25	mV
P_O	Output Power THD+N = 0.1% Max, F = 1kHz, R_L = 32Ω THD+N = 1% Max, F = 1kHz, R_L = 32Ω THD+N = 10% Max, F = 1kHz, R_L = 32Ω THD+N = 0.1% Max, F = 1kHz, R_L = 16Ω THD+N = 1% Max, F = 1kHz, R_L = 16Ω THD+N = 10% Max, F = 1kHz, R_L = 16Ω	166 240	190 207 258 270 295 367		mW
THD + N	Total Harmonic Distortion + Noise (A_V=2) R_L = 32Ω, P_{out} = 150mW, 20Hz ≤ F ≤ 20kHz R_L = 16Ω, P_{out} = 220mW, 20Hz ≤ F ≤ 20kHz		0.15 0.2		%
PSRR	Power Supply Rejection Ratio (A_V=2) [1)] F = 1kHz, Vripple = 200mVpp, input grounded, Cb=1µF	50	56		dB
SNR	Signal-to-Noise Ratio (Filter Type A, A_V=2) [1)] (R_L = 32Ω, THD +N < 0.5%, 20Hz ≤ F ≤ 20kHz)	85	98		dB
Φ_M	Phase Margin at Unity Gain R_L = 16Ω, C_L = 400pF		58		Degrees
GM	Gain Margin R_L = 16Ω, C_L = 400pF		18		dB
GBP	Gain Bandwidth Product R_L = 16Ω		1.1		MHz
SR	Slew Rate R_L = 16Ω		0.4		V/µS

1. 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 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, $V_{STANDBY}$=Vcc for TS419		10	1000	nA
Voo	Output Offset Voltage No input signal, RL = 16 or 32Ω, Rfeed=20kΩ		5	25	mV
P_O	Output Power THD+N = 0.1% Max, F = 1kHz, R_L = 32Ω THD+N = 1% Max, F = 1kHz, R_L = 32Ω THD+N = 10% Max, F = 1kHz, R_L = 32Ω THD+N = 0.1% Max, F = 1kHz, R_L = 16Ω THD+N = 1% Max, F = 1kHz, R_L = 16Ω THD+N = 10% Max, F = 1kHz, R_L = 16Ω	65 91	75 81 102 104 113 143		mW
THD + N	Total Harmonic Distortion + Noise (A_V=2) R_L = 32Ω, P_{out} = 50mW, 20Hz ≤ F ≤ 20kHz R_L = 16Ω, P_{out} = 70mW, 20Hz ≤ F ≤ 20kHz		0.15 0.2		%
PSRR	Power Supply Rejection Ratio inputs grounded, F = 1kHz, Vripple = 200mVpp, Cb=1µF	50	56		dB
SNR	Signal-to-Noise Ratio (Weighted A, A_V=2) (R_L = 32Ω, THD +N < 0.5%, 20Hz ≤ F ≤ 20kHz)	82	94		dB
Φ_M	Phase Margin at Unity Gain R_L = 16Ω, C_L = 400pF		58		Degrees
GM	Gain Margin R_L = 16Ω, C_L = 400pF		18		dB
GBP	Gain Bandwidth Product R_L = 16Ω		1.1		MHz
SR	Slew Rate R_L = 16Ω		0.4		V/µS

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

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 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, $V_{STANDBY}$=Vcc for TS419		10	1000	nA
Voo	Output Offset Voltage No input signal, RL = 16 or 32Ω, Rfeed=20kΩ		5	25	mV
P_O	Output Power THD+N = 0.1% Max, F = 1kHz, R_L = 32Ω THD+N = 1% Max, F = 1kHz, R_L = 32Ω THD+N = 10% Max, F = 1kHz, R_L = 32Ω THD+N = 0.1% Max, F = 1kHz, R_L = 16Ω THD+N = 1% Max, F = 1kHz, R_L = 16Ω THD+N = 10% Max, F = 1kHz, R_L = 16Ω	32 44	37 41 52 50 55 70		mW
THD + N	Total Harmonic Distortion + Noise (A_V=2) R_L = 32Ω, P_{out} = 30mW, 20Hz ≤ F ≤ 20kHz R_L = 16Ω, P_{out} = 40mW, 20Hz ≤ F ≤ 20kHz		0.15 0.2		%
PSRR	Power Supply Rejection Ratio (A_V=2) inputs grounded, F = 1kHz, Vripple = 200mVpp, Cb=1µF	50	56		dB
SNR	Signal-to-Noise Ratio (Weighted A, A_V=2) (R_L = 32Ω, THD +N < 0.5%, 20Hz ≤ F ≤ 20kHz)	80	91		dB
Φ_M	Phase Margin at Unity Gain R_L = 16Ω, C_L = 400pF		58		Degrees
GM	Gain Margin R_L = 16Ω, C_L = 400pF		18		dB
GBP	Gain Bandwidth Product R_L = 16Ω		1.1		MHz
SR	Slew Rate R_L = 16Ω		0.4		V/µS

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

ELECTRICAL CHARACTERISTICS

V_{CC} = **+2V**, GND = **0V**, T_{amb} = 25°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, $V_{STANDBY}$=Vcc for TS419		10	1000	nA
Voo	Output Offset Voltage No input signal, RL = 16 or 32Ω, Rfeed=20kΩ		5	25	mV
P_O	Output Power THD+N = 0.1% Max, F = 1kHz, R_L = 32Ω THD+N = 1% Max, F = 1kHz, R_L = 32Ω THD+N = 10% Max, F = 1kHz, R_L = 32Ω THD+N = 0.1% Max, F = 1kHz, R_L = 16Ω THD+N = 1% Max, F = 1kHz, R_L = 16Ω THD+N = 10% Max, F = 1kHz, R_L = 16Ω	 19 24	20 23 30 26 30 40		mW
THD + N	Total Harmonic Distortion + Noise (A_V=2) R_L = 32Ω, P_{out} = 13mW, 20Hz ≤ F ≤ 20kHz R_L = 16Ω, P_{out} = 20mW, 20Hz ≤ F ≤ 20kHz		0.1 0.15		%
PSRR	Power Supply Rejection Ratio (A_V=2) 1) inputs grounded, F = 1kHz, Vripple = 200mVpp, Cb=1µF	49	54		dB
SNR	Signal-to-Noise Ratio (Weighted A, A_V=2) 1) (R_L = 32Ω, THD +N < 0.5%, 20Hz ≤ F ≤ 20kHz)	80	89		dB
Φ_M	Phase Margin at Unity Gain R_L = 16Ω, C_L = 400pF		58		Degrees
GM	Gain Margin R_L = 16Ω, C_L = 400pF		20		dB
GBP	Gain Bandwidth Product R_L = 16Ω		1.1		MHz
SR	Slew Rate R_L = 16Ω		0.4		V/µS

1. Guaranteed by design and evaluation.

Index of Graphs

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THD + N vs Output Power	77 to 85	23 to 24
THD + N vs Frequency	86 to 88	24
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

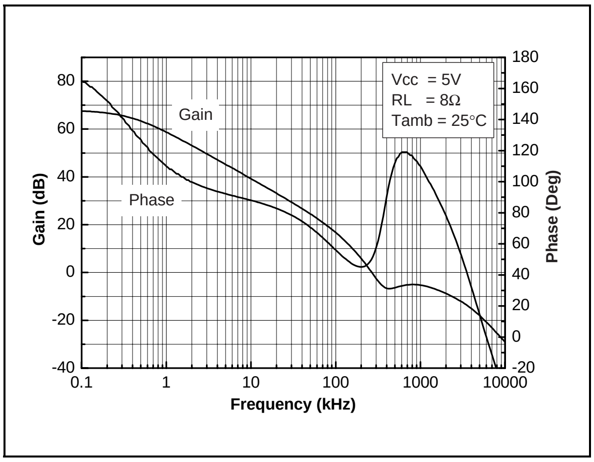

Fig. 2: Open Loop Gain and Phase vs Frequency

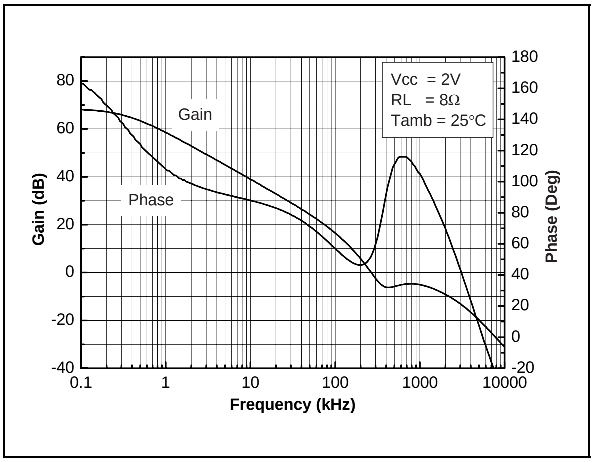

Fig. 3: Open Loop Gain and Phase vs Frequency

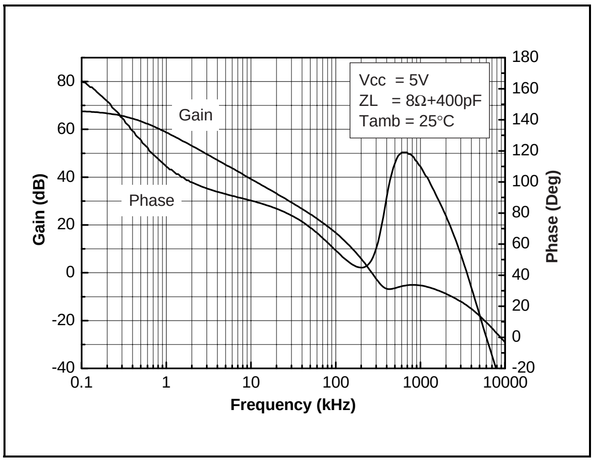

Fig. 4: Open Loop Gain and Phase vs Frequency

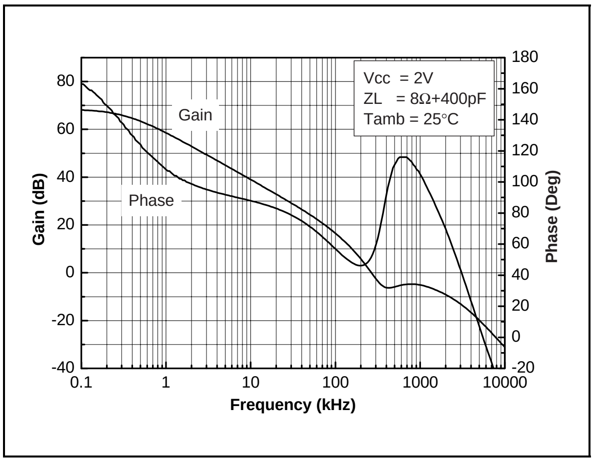

Fig. 5: Open Loop Gain and Phase vs Frequency

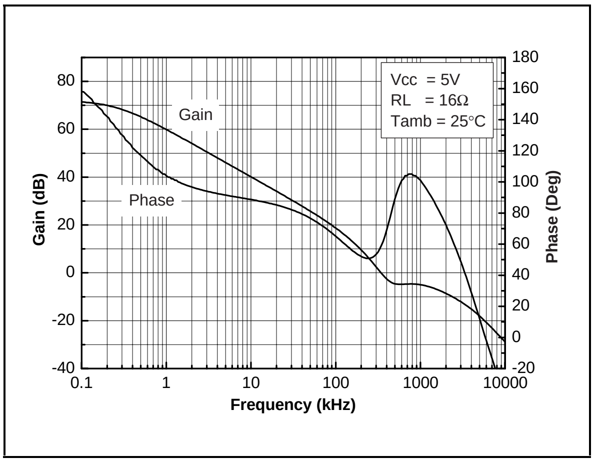

Fig. 6: Open Loop Gain and Phase vs Frequency

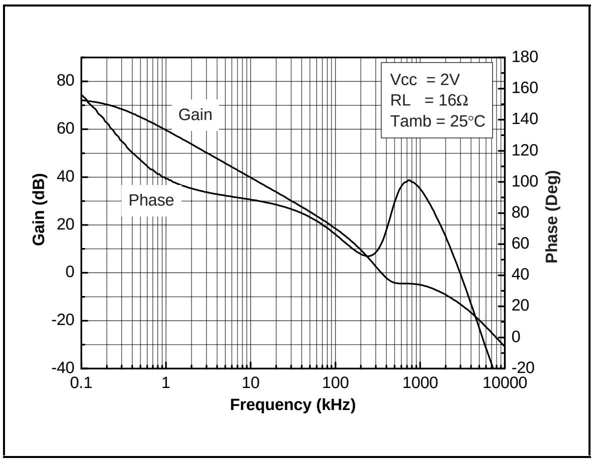

Fig. 7: Open Loop Gain and Phase vs Frequency

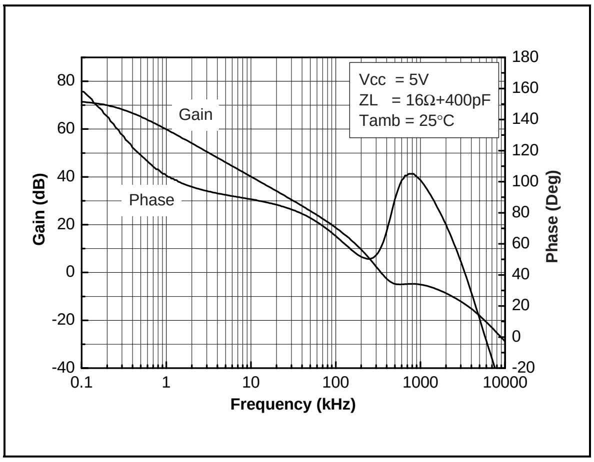

Fig. 8: Open Loop Gain and Phase vs Frequency

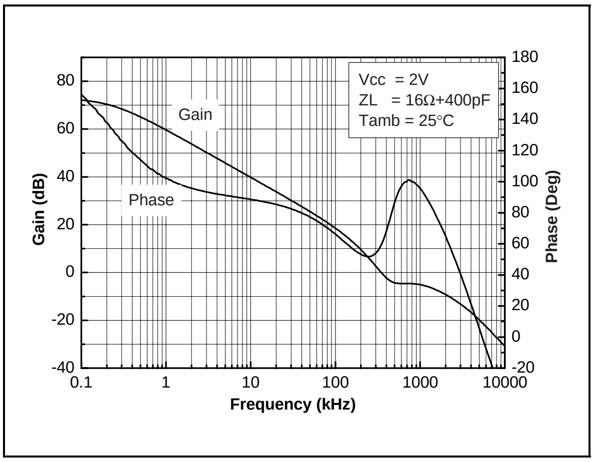

Fig. 9: Open Loop Gain and Phase vs Frequency

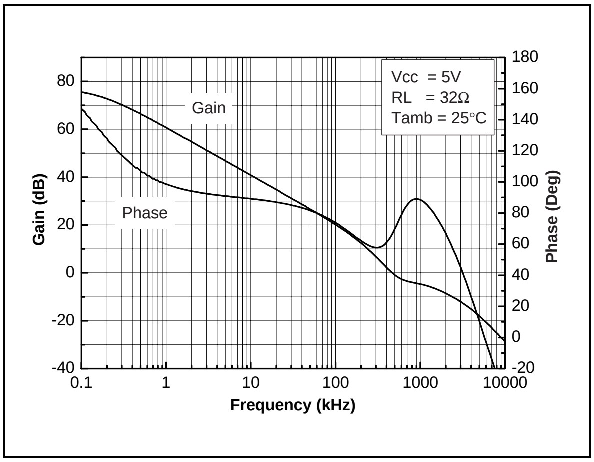

Fig. 10: Open Loop Gain and Phase vs Frequency

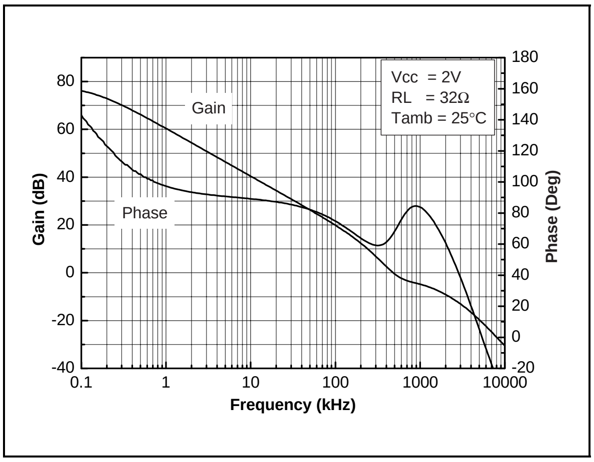

Fig. 11: Open Loop Gain and Phase vs Frequency

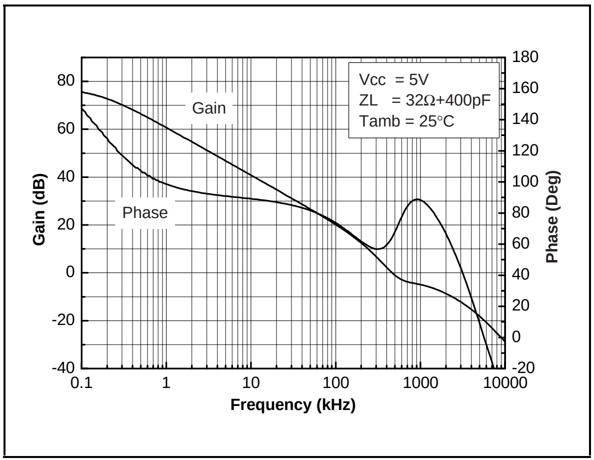

Fig. 12: Open Loop Gain and Phase vs Frequency

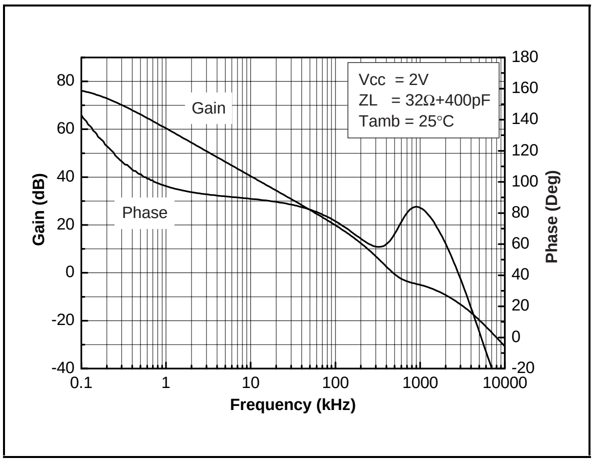

Fig. 13: Current Consumption vs Power Supply Voltage

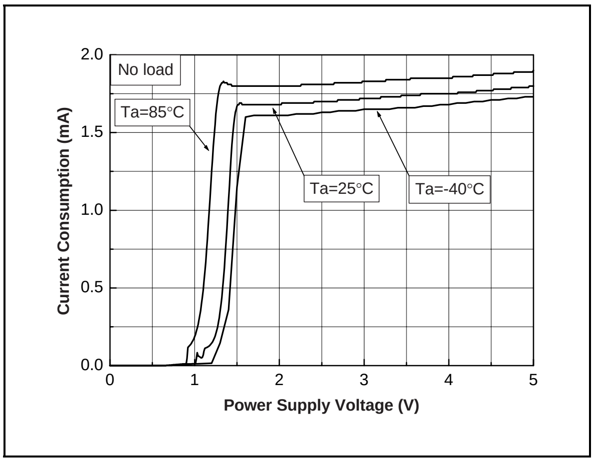

Fig. 14: Current Consumption vs Standby Voltage

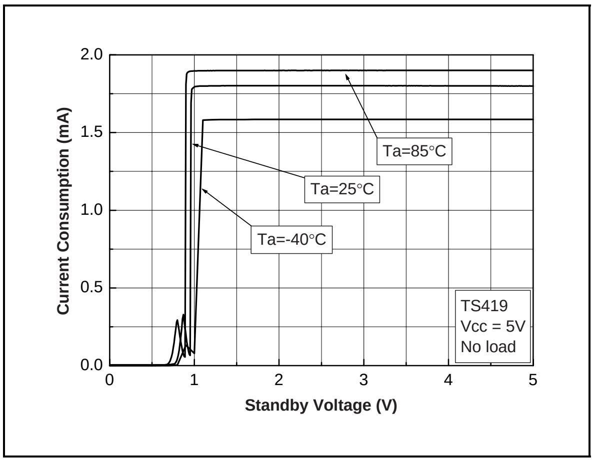

Fig. 15: Current Consumption vs Standby Voltage

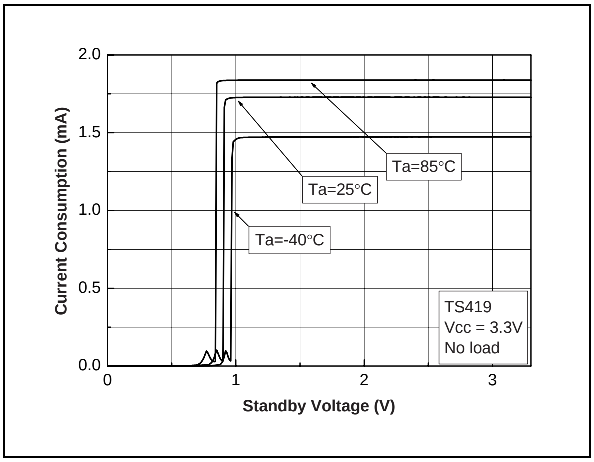

Fig. 16: Current Consumption vs Standby Voltage

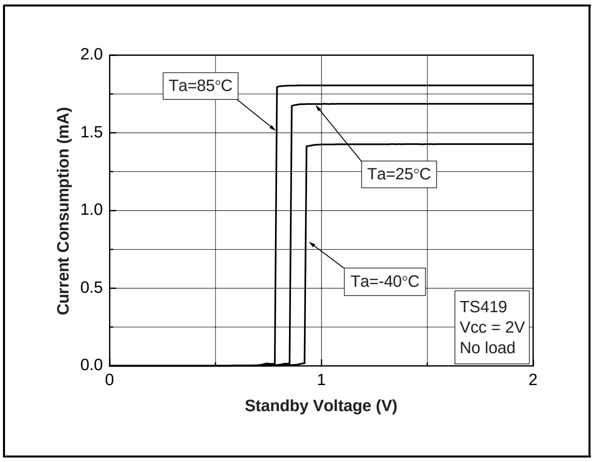

Fig. 17: Current Consumption vs Standby Voltage

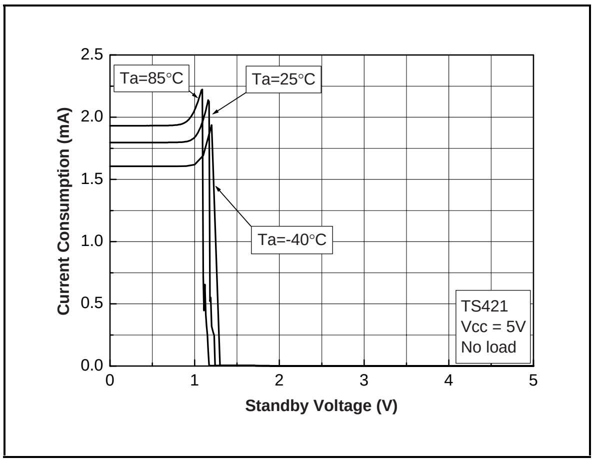

Fig. 18: Current Consumption vs Standby Voltage

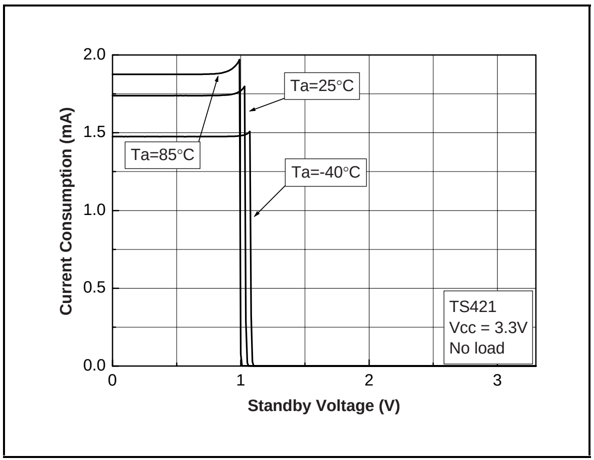

Fig. 19: Current Consumption vs Standby Voltage

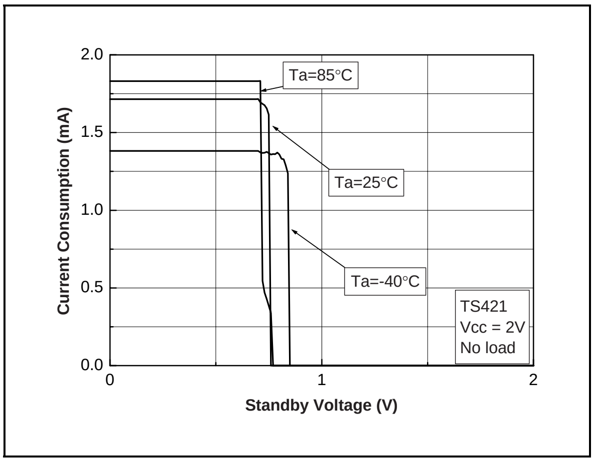

Fig. 20: Output Power vs Power Supply Voltage

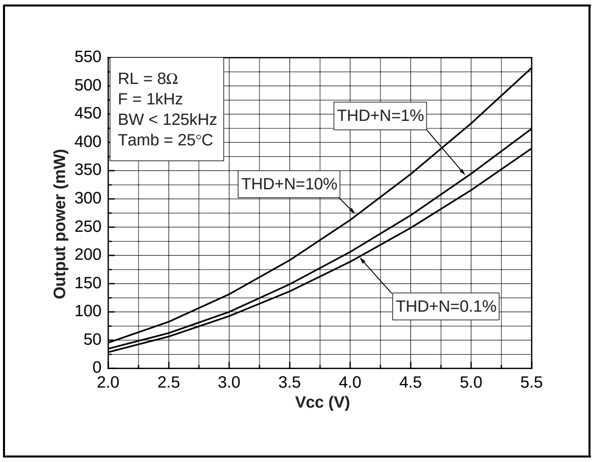

Fig. 21: Output Power vs Power Supply Voltage

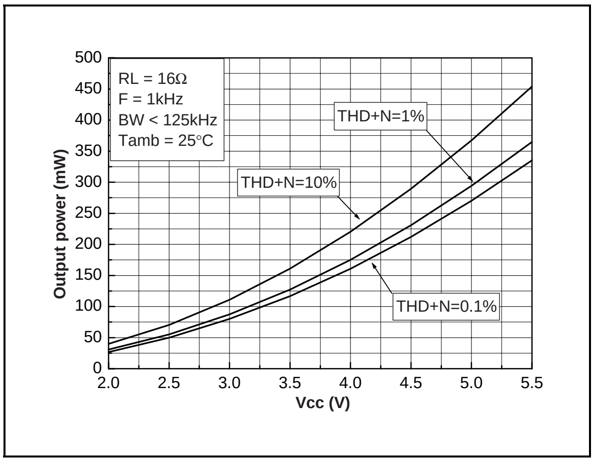

Fig. 22: Output Power vs Power Supply Voltage

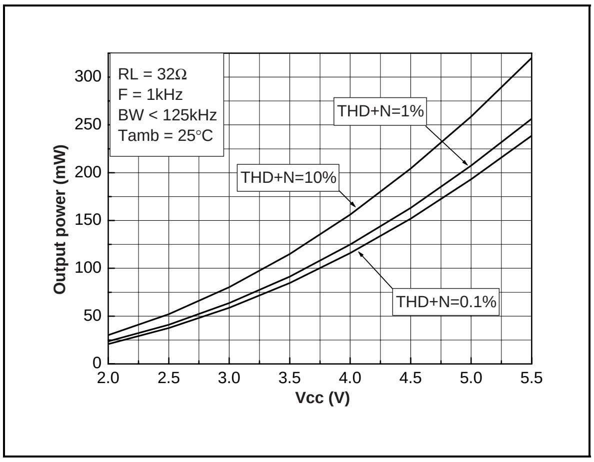

Fig. 23: Output Power vs Power Supply Voltage

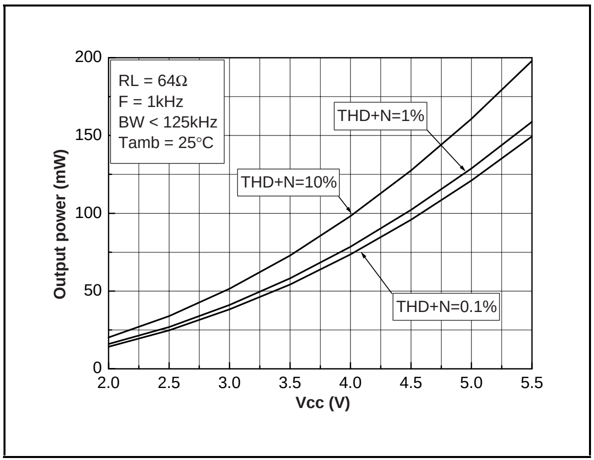

Fig. 24: Output Power vs Load Resistor

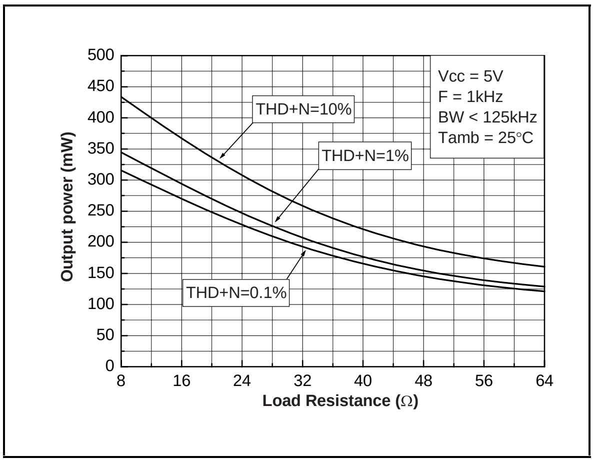

Fig. 25: Output Power vs Load Resistor

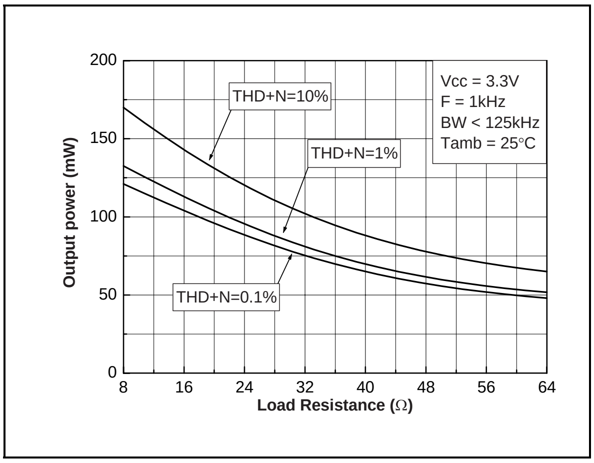

Fig. 26: Output Power vs Load Resistor

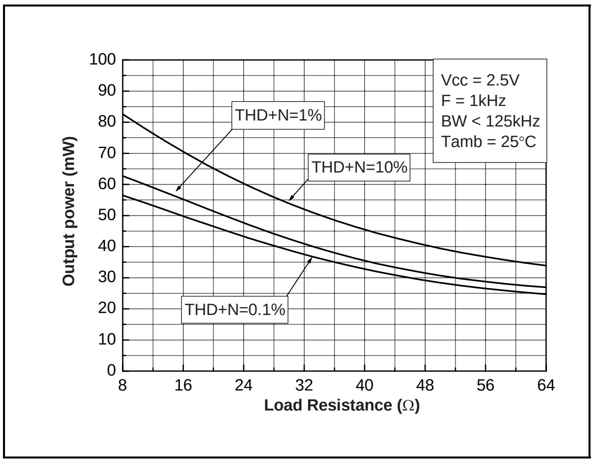

Fig. 27: Output Power vs Load Resistor

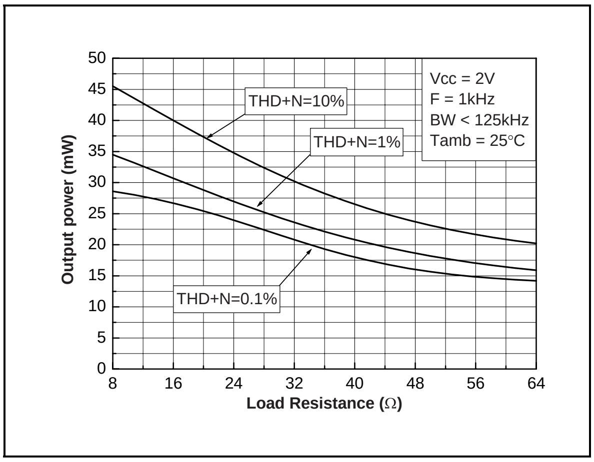

Fig. 28: Power Dissipation vs Output Power

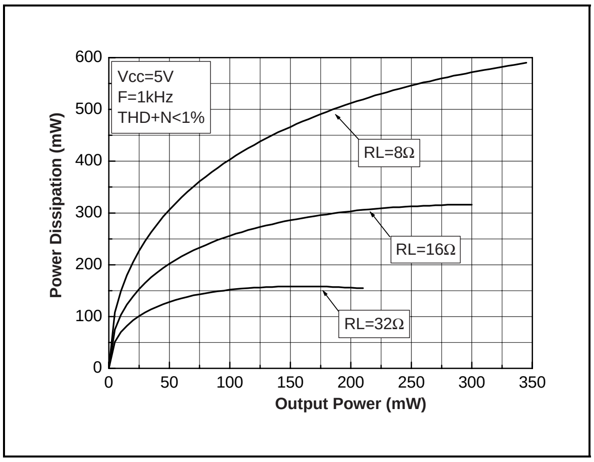

Fig. 29: Power Dissipation vs Output Power

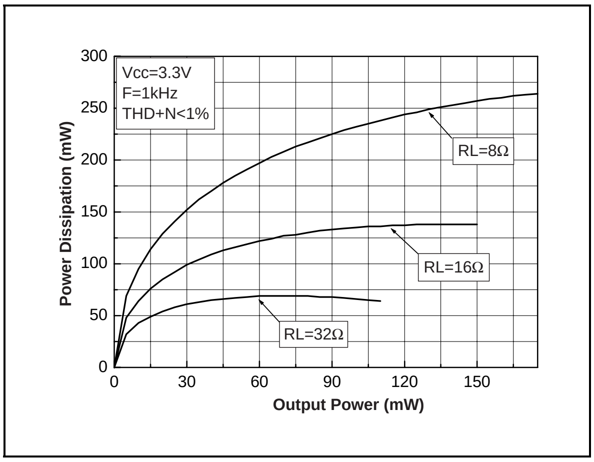

Fig. 30: Power Dissipation vs Output Power

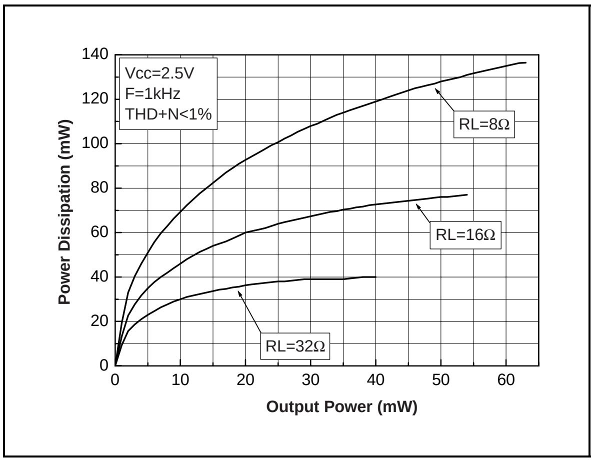

Fig. 31: Power Dissipation vs Output Power

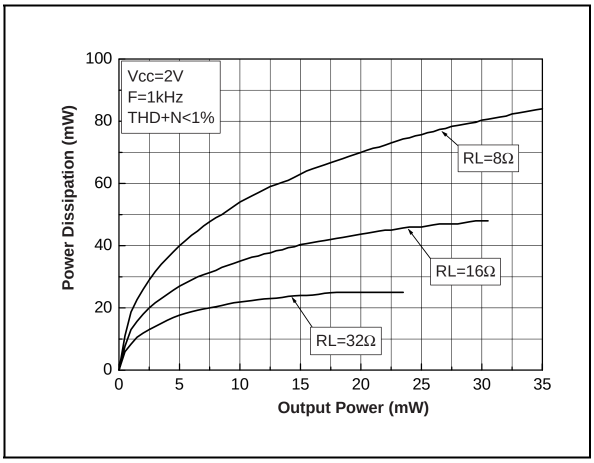

Fig. 32: Power Derating Curves

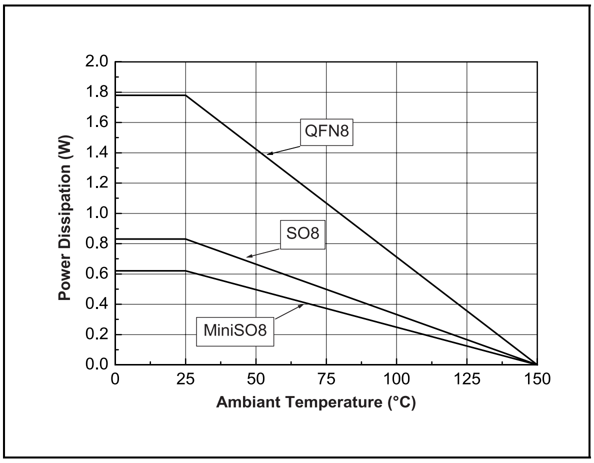

Fig. 33: Output Voltage Swing For One Amp. vs Power Supply Voltage

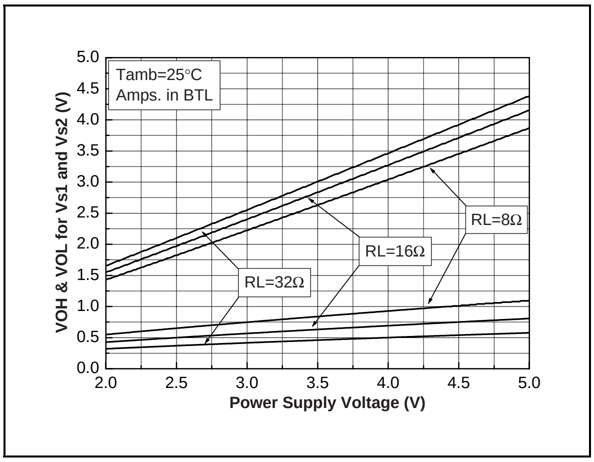

Fig. 34: Low Frequency Cut Off vs Input Capacitor for fixed gain versions

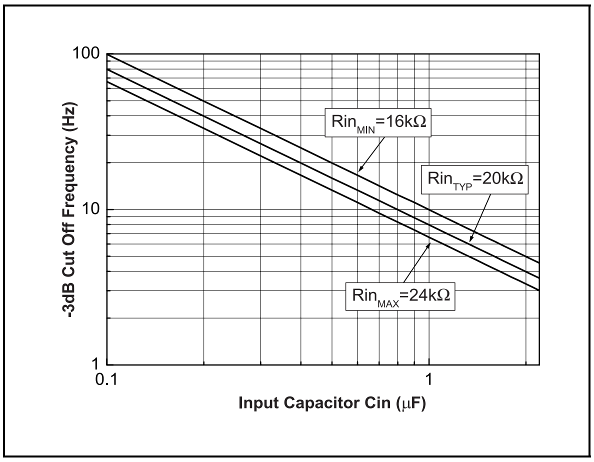

Fig. 35: THD + N vs Output Power

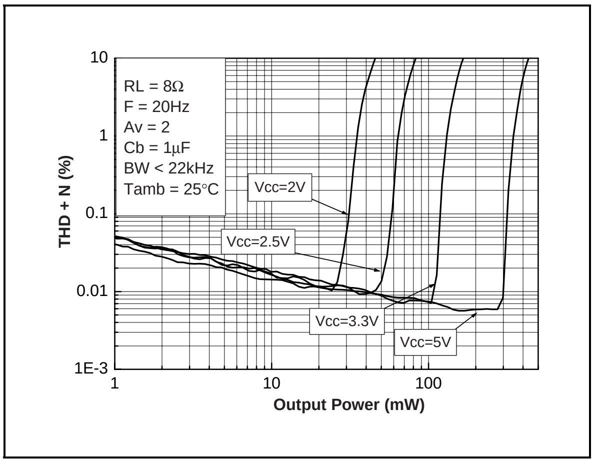

Fig. 36: THD + N vs Output Power

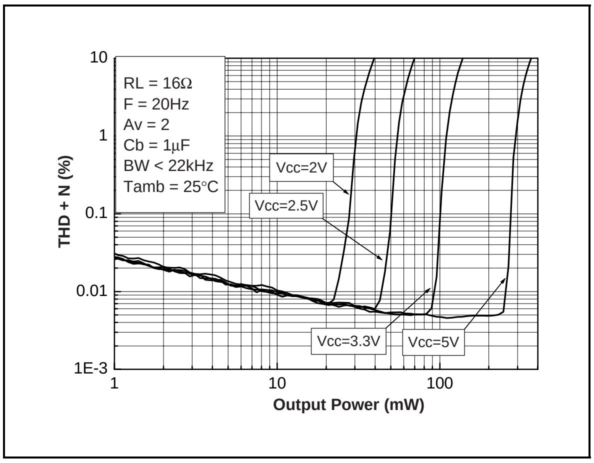

Fig. 37: THD + N vs Output Power

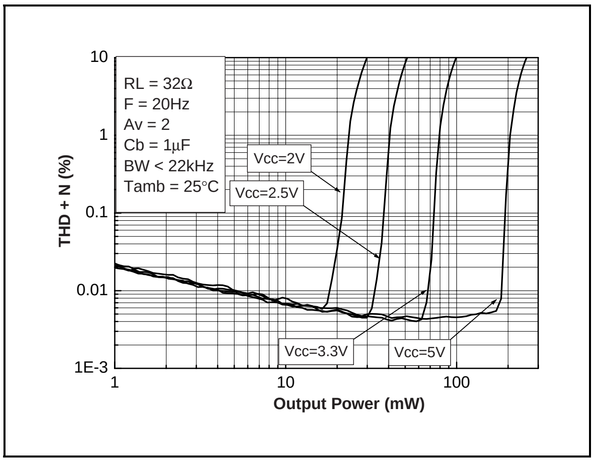

Fig. 38: THD + N vs Output Power

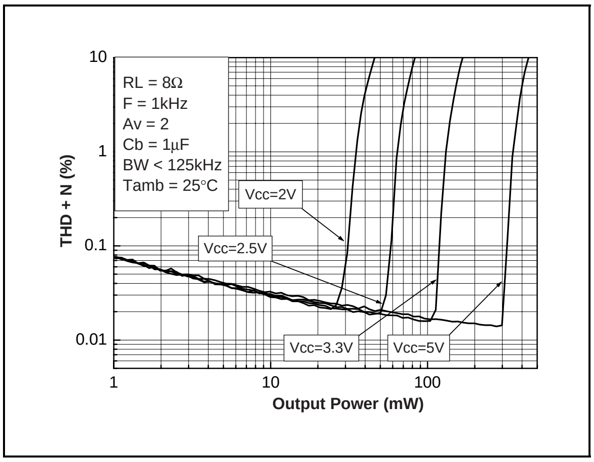

Fig. 39: THD + N vs Output Power

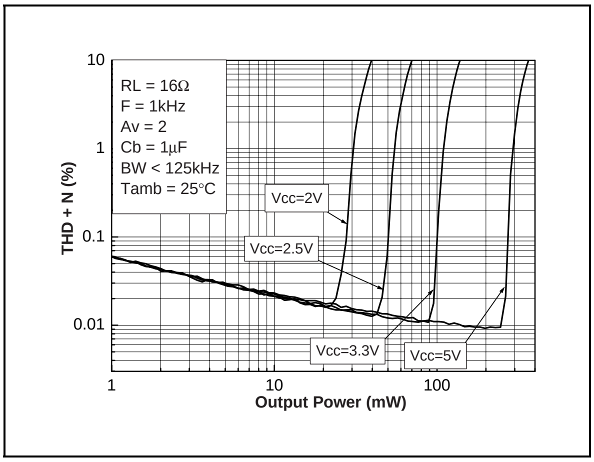

Fig. 40: THD + N vs Output Power

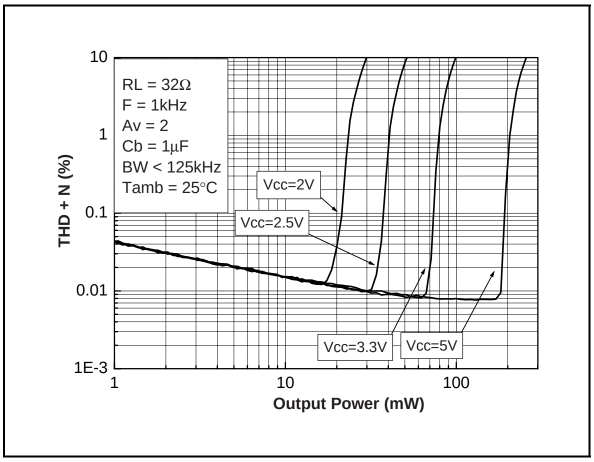

Fig. 41: THD + N vs Output Power

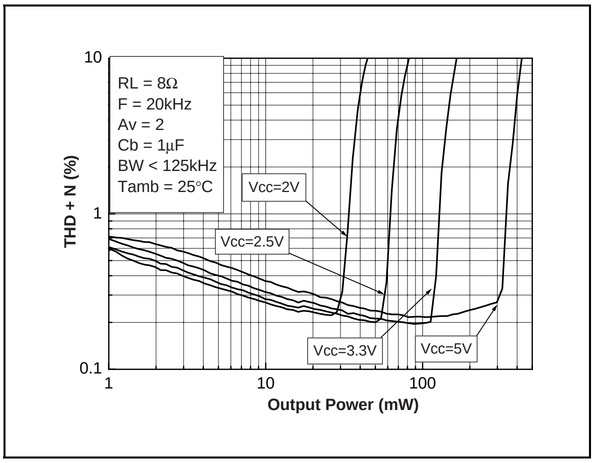

Fig. 42: THD + N vs Output Power

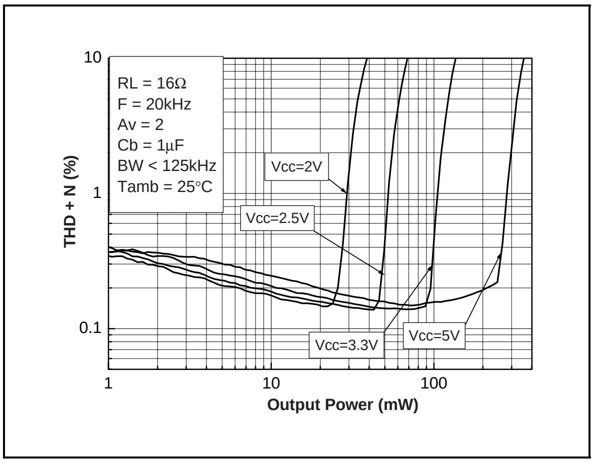

Fig. 43: THD + N vs Output Power

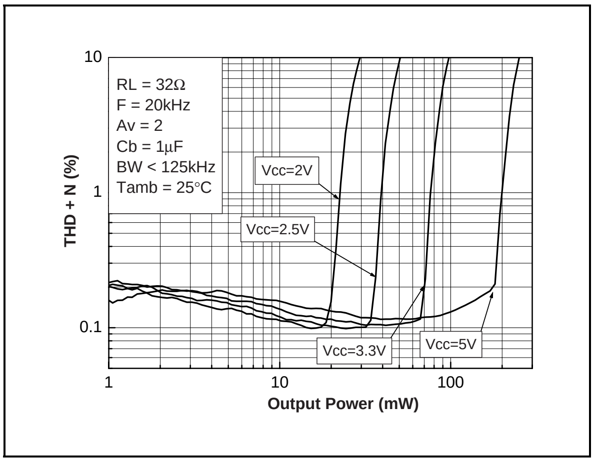

Fig. 44: THD + N vs Frequency

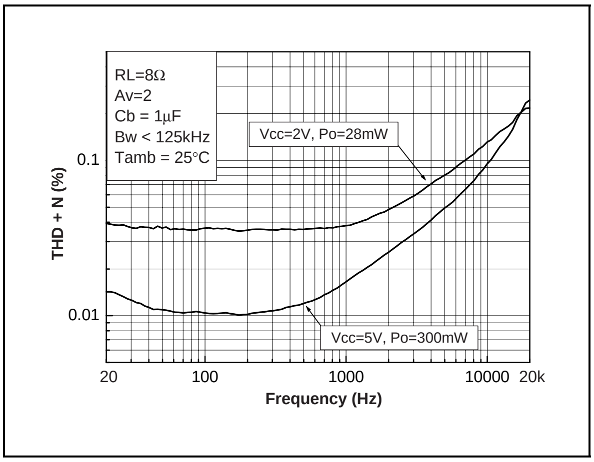

Fig. 45: THD + N vs Frequency

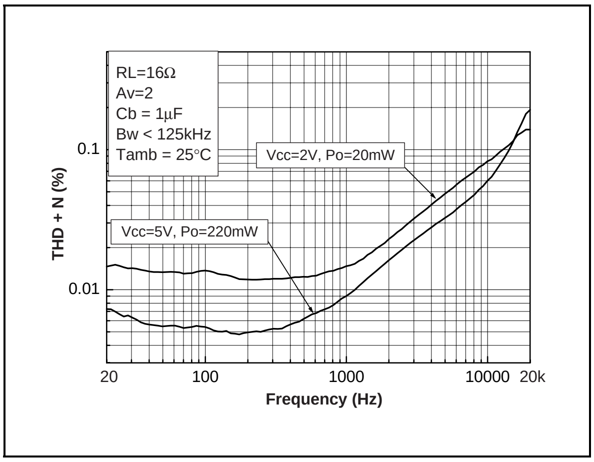

Fig. 46: THD + N vs Frequency

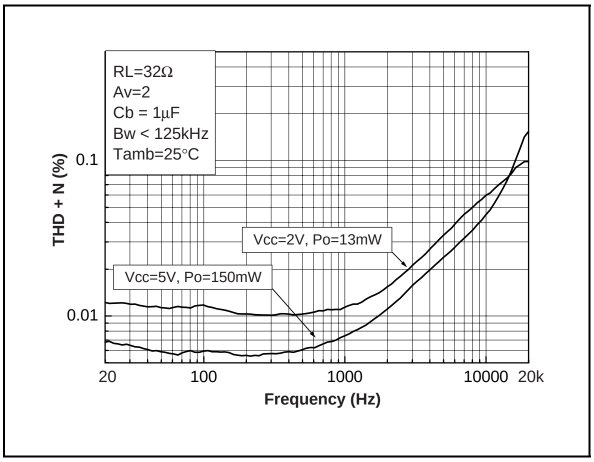

Fig. 47: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)

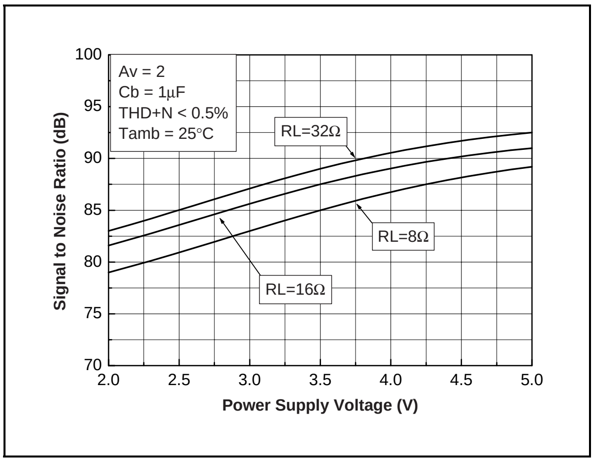

Fig. 48: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A

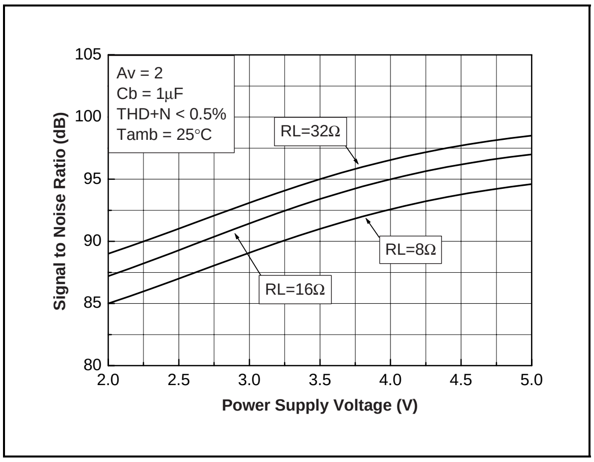

Fig. 49: Noise Floor

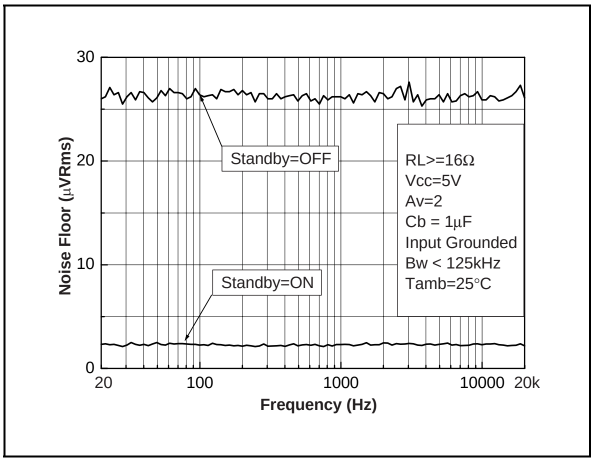

Fig. 50: Noise Floor

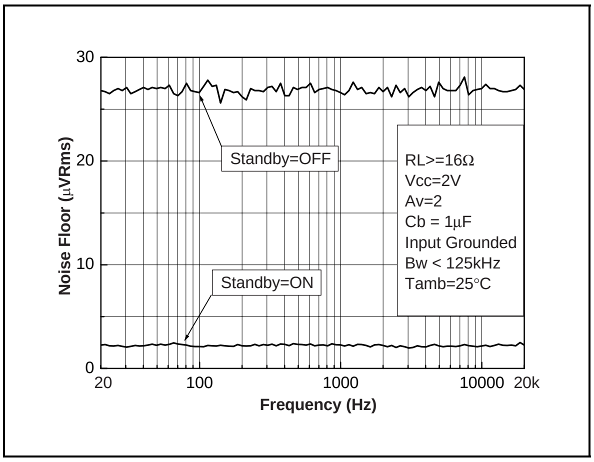

Fig. 51: PSRR vs Input Capacitor

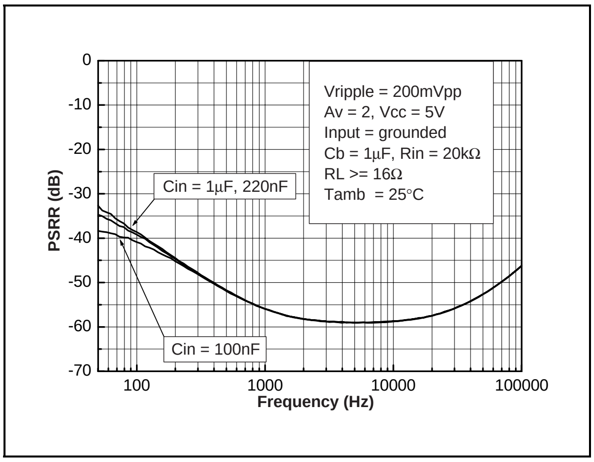

Fig. 52: PSRR vs Power Supply Voltage

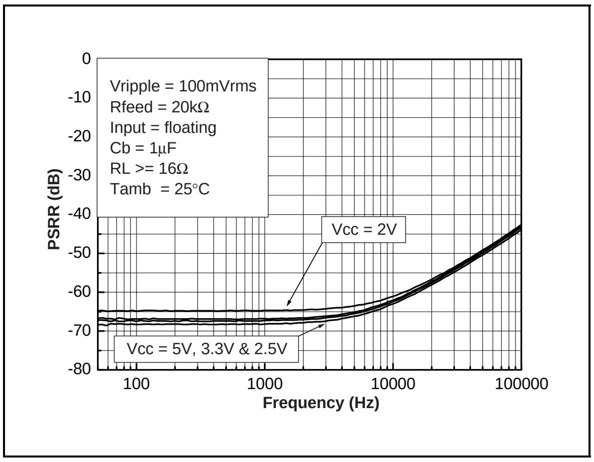

Fig. 53: PSRR vs Bypass Capacitor

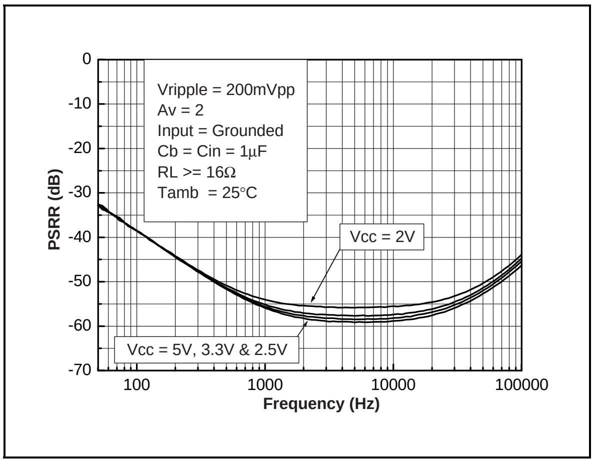

Fig. 54: PSRR vs Bypass Capacitor

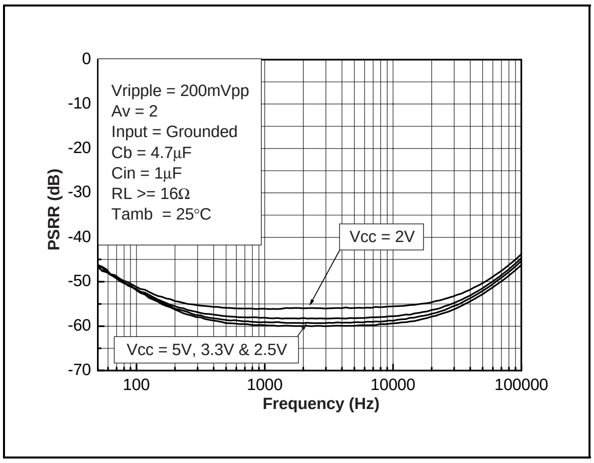

Fig. 55: PSRR vs Bypass Capacitor

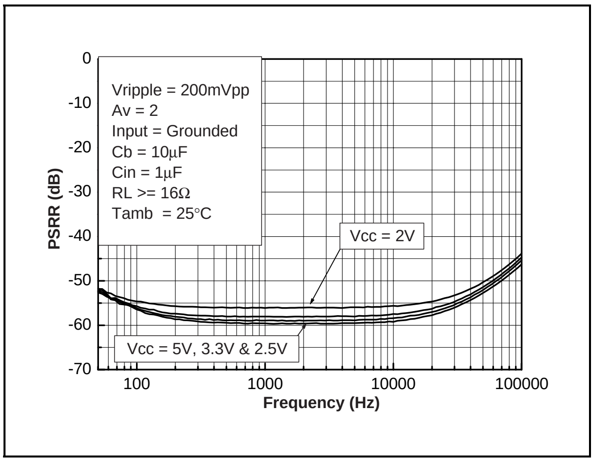

Fig. 56: THD + N vs Output Power

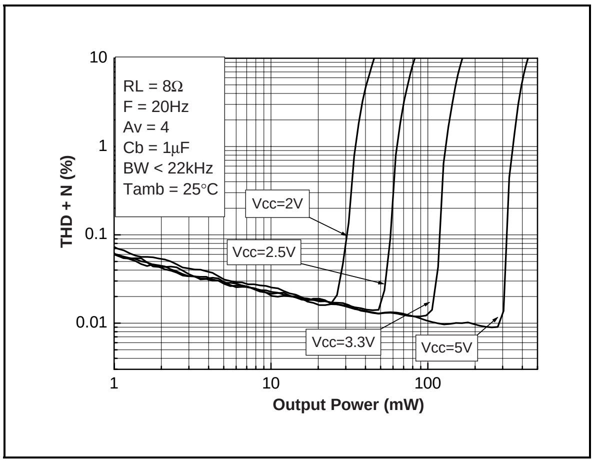

Fig. 57: THD + N vs Output Power

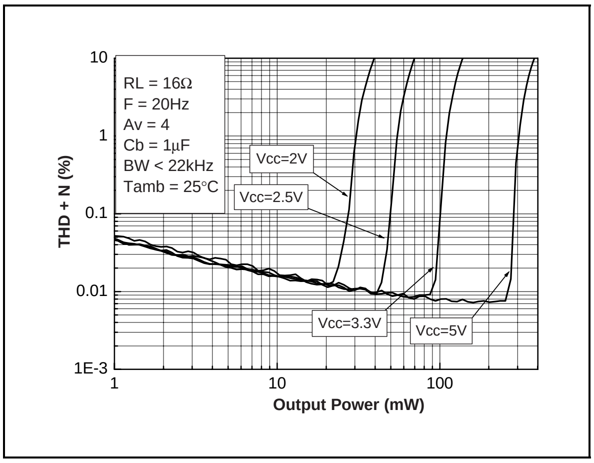

Fig. 58: THD + N vs Output Power

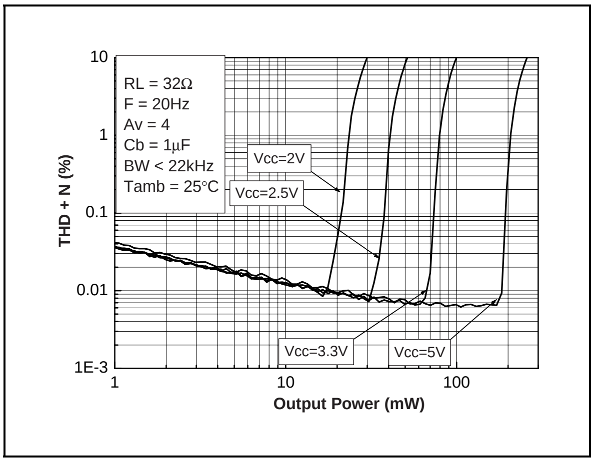

Fig. 59: THD + N vs Output Power

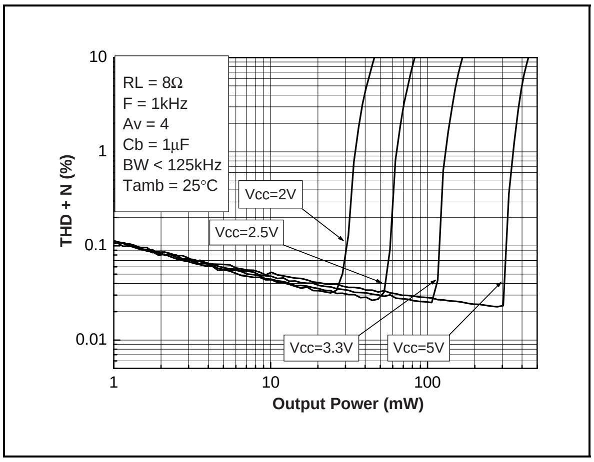

Fig. 60: THD + N vs Output Power

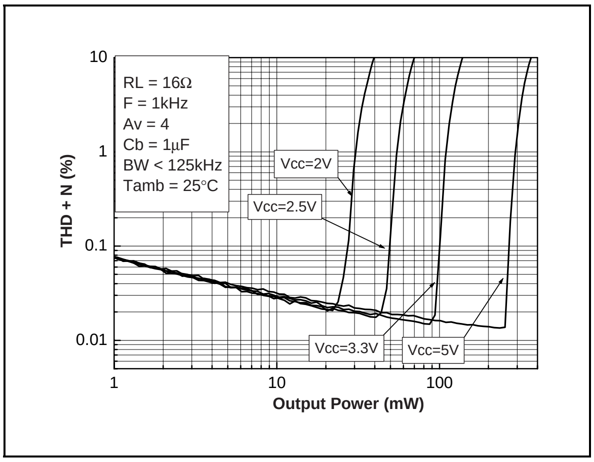

Fig. 61: THD + N vs Output Power

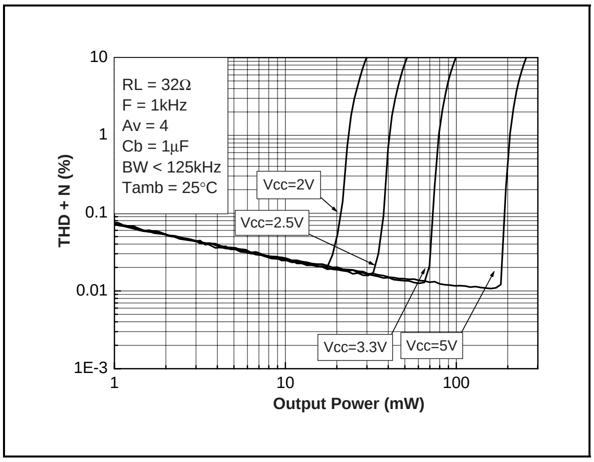

Fig. 62: THD + N vs Output Power

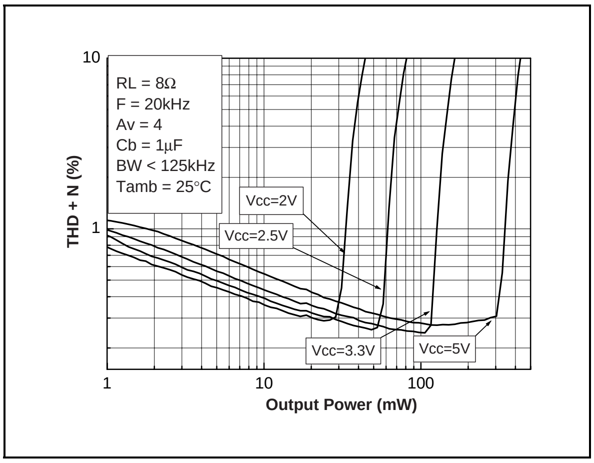

Fig. 63: THD + N vs Output Power

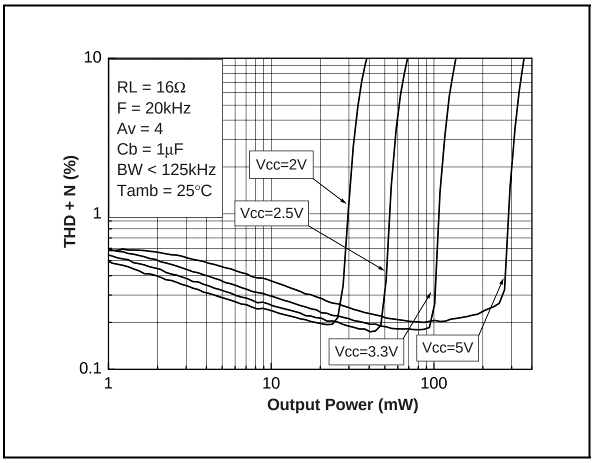

Fig. 64: THD + N vs Output Power

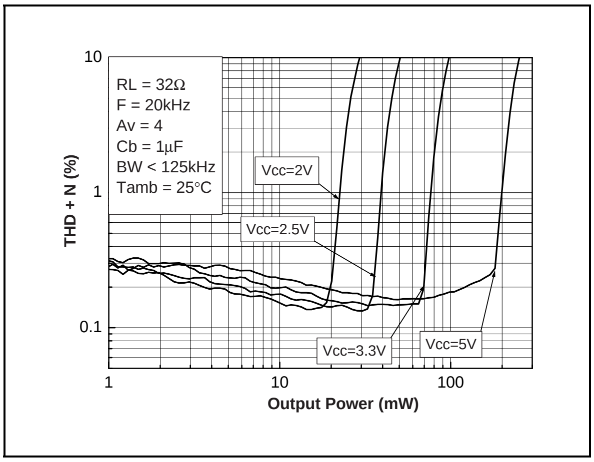

Fig. 65: THD + N vs Frequency

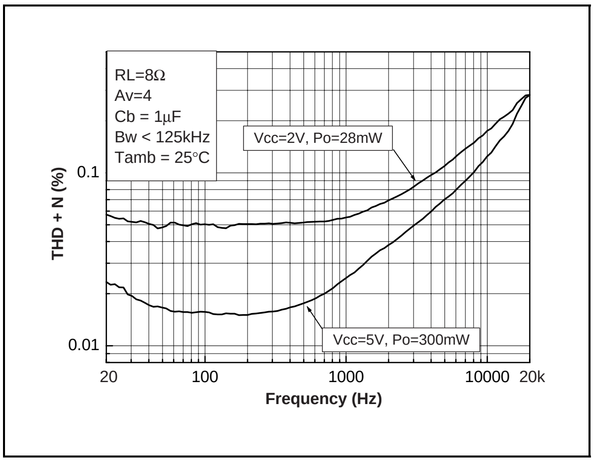

Fig. 66: THD + N vs Frequency

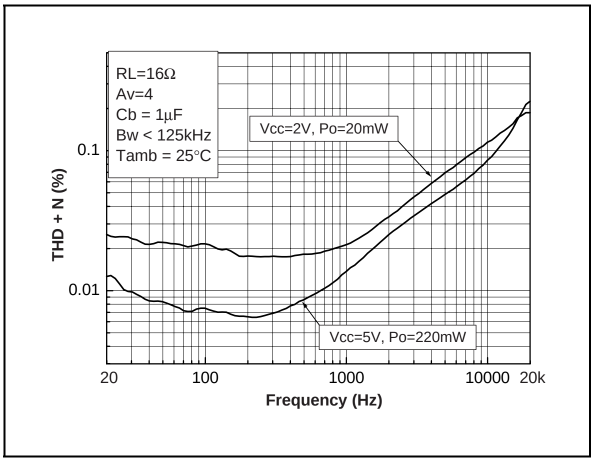

Fig. 67: THD + N vs Frequency

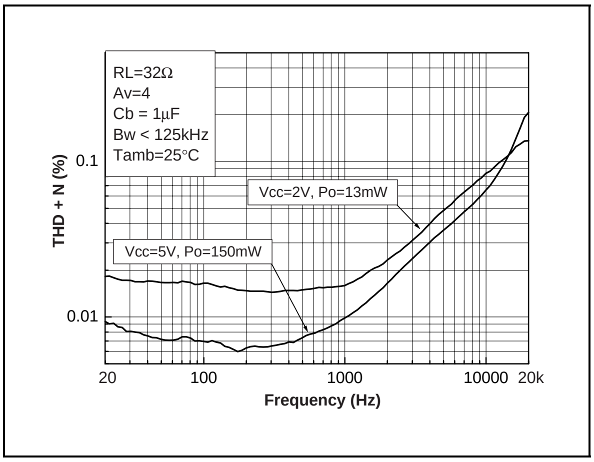

Fig. 68: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)

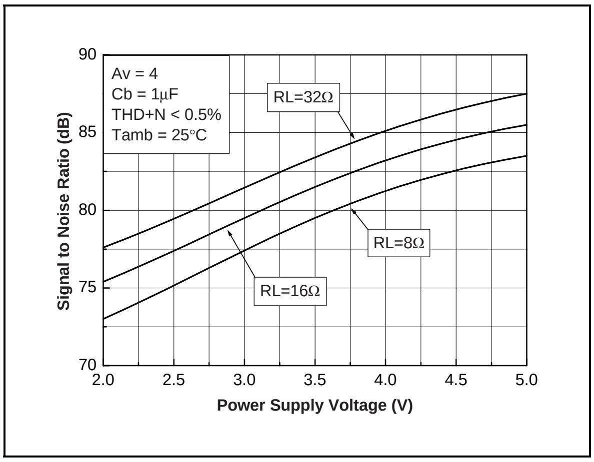

Fig. 69: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A

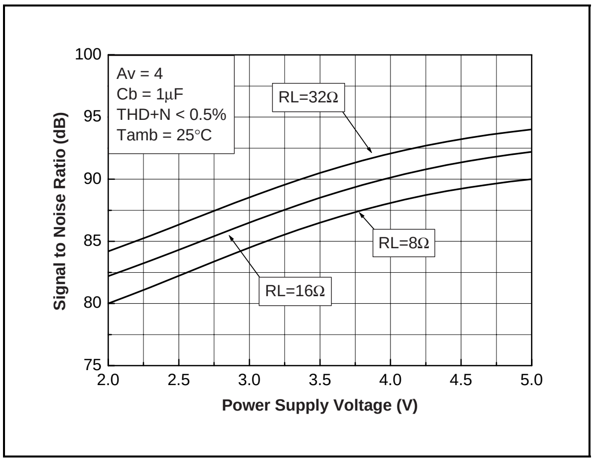

Fig. 70: Noise Floor

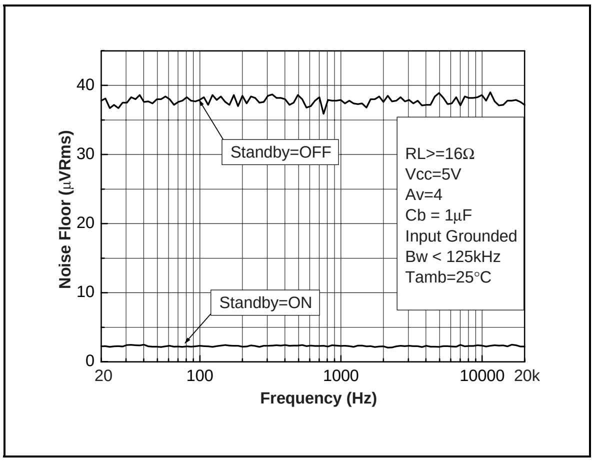

Fig. 71: Noise Floor

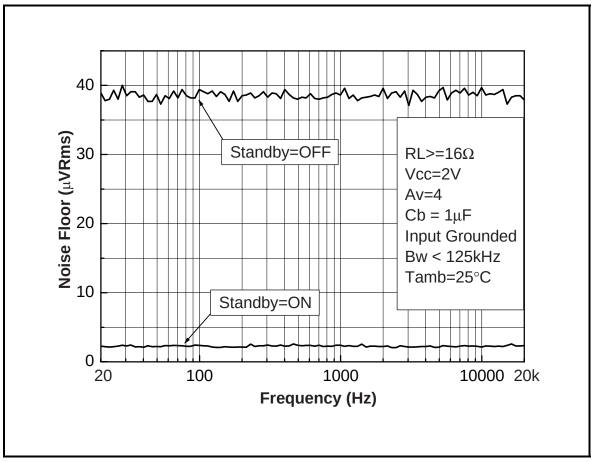

Fig. 72: PSRR vs Power Supply Voltage

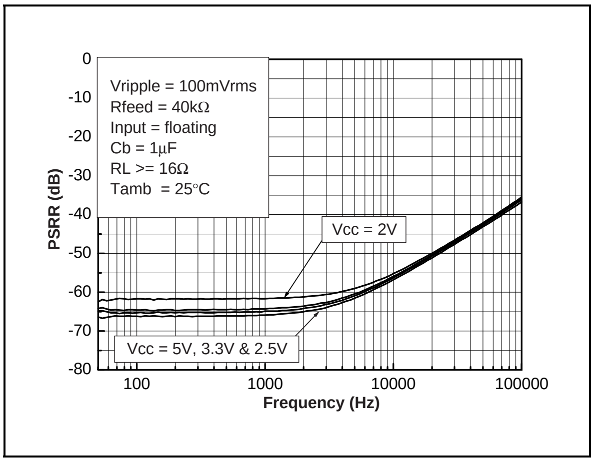

Fig. 73: PSRR vs Input Capacitor

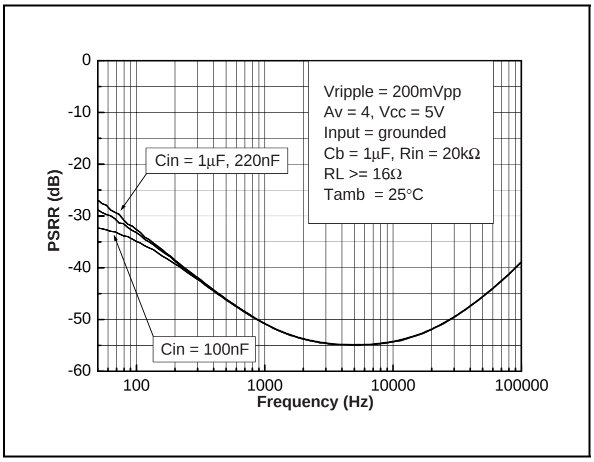

Fig. 74: PSRR vs Bypass Capacitor

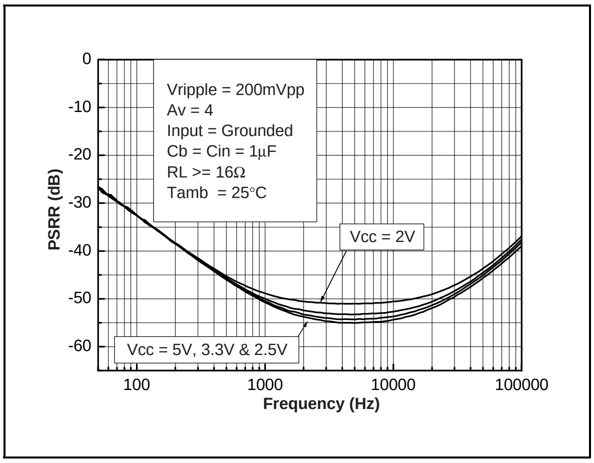

Fig. 75: PSRR vs Bypass Capacitor

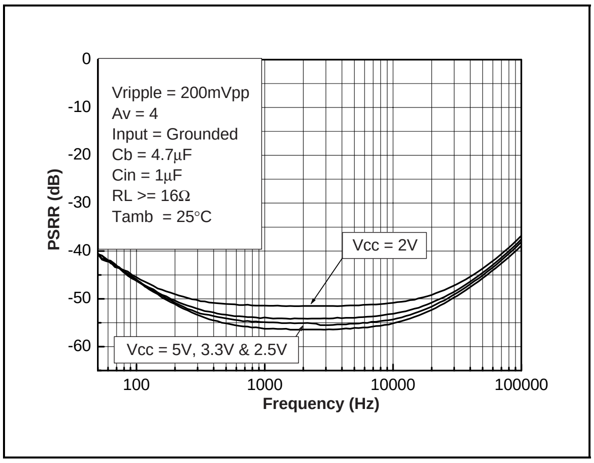

Fig. 76: PSRR vs Bypass Capacitor

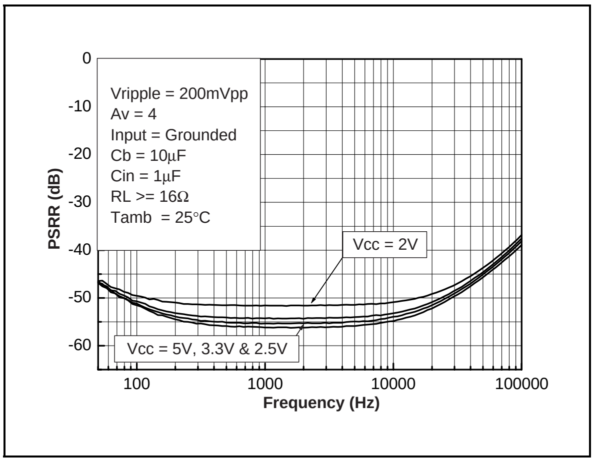

Fig. 77: THD + N vs Output Power

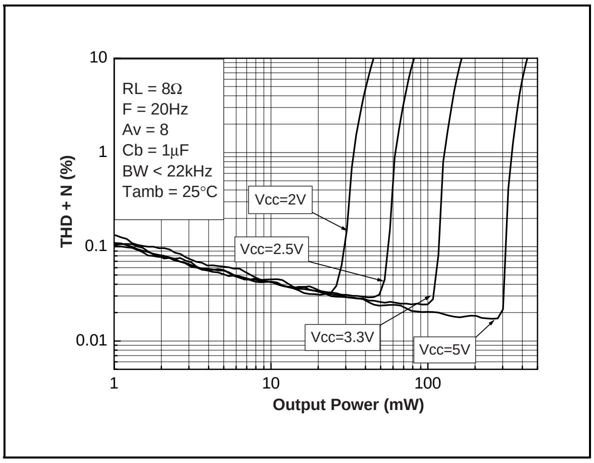

Fig. 78: THD + N vs Output Power

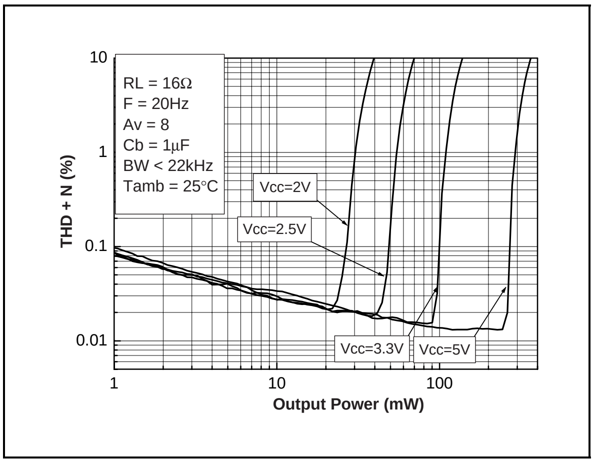

Fig. 79: THD + N vs Output Power

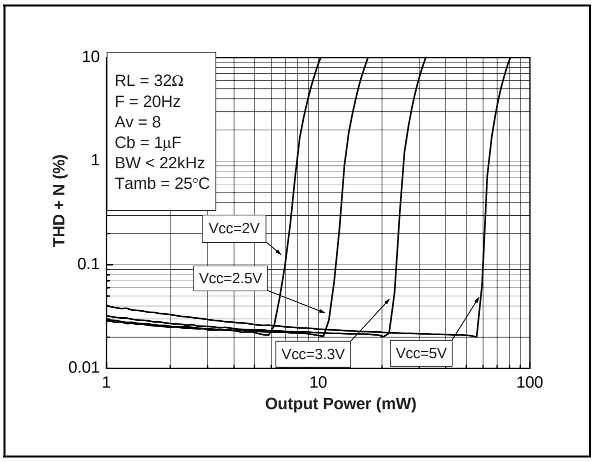

Fig. 80: THD + N vs Output Power

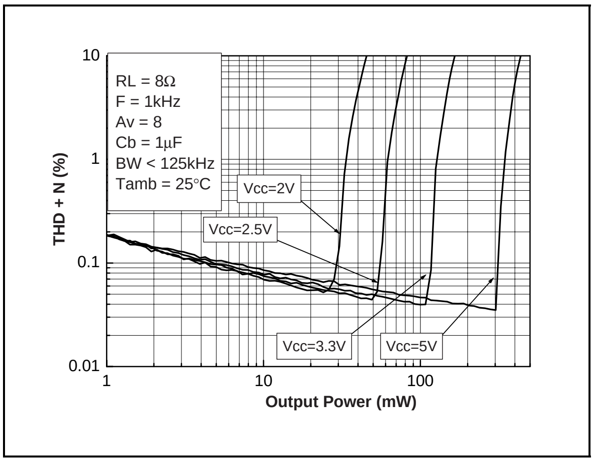

Fig. 81: THD + N vs Output Power

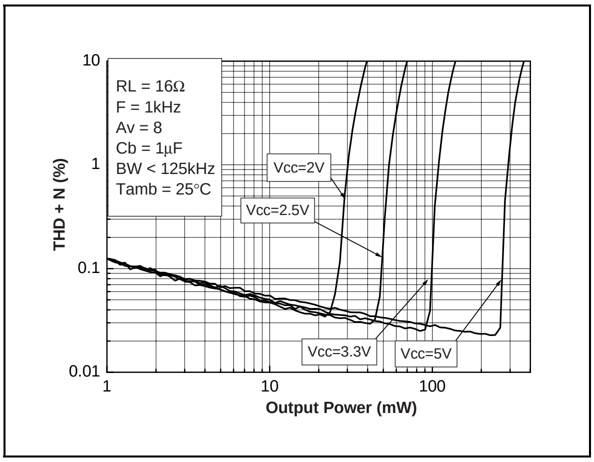

Fig. 82: THD + N vs Output Power

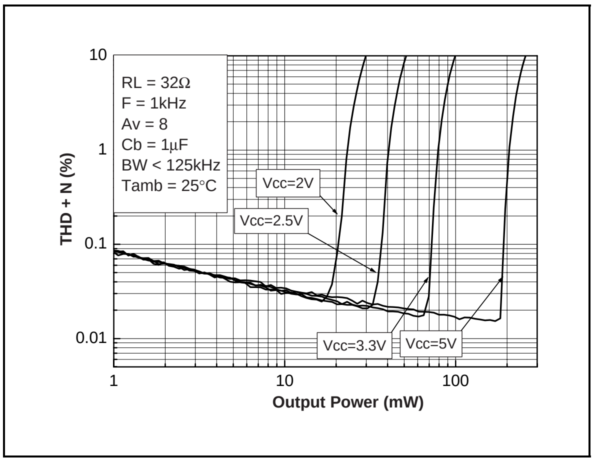

Fig. 83: THD + N vs Output Power

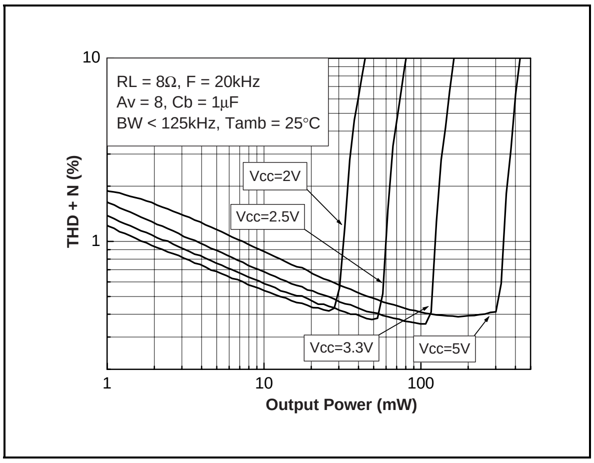

Fig. 84: THD + N vs Output Power

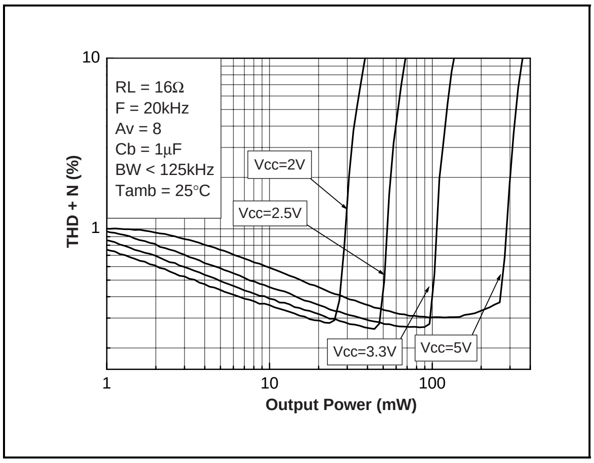

Fig. 85: THD + N vs Output Power

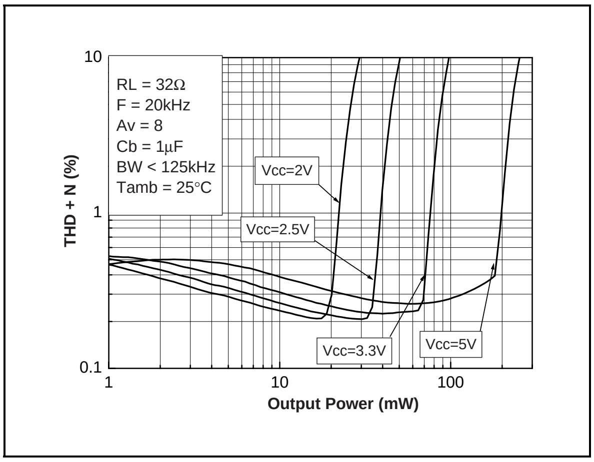

Fig. 86: THD + N vs Frequency

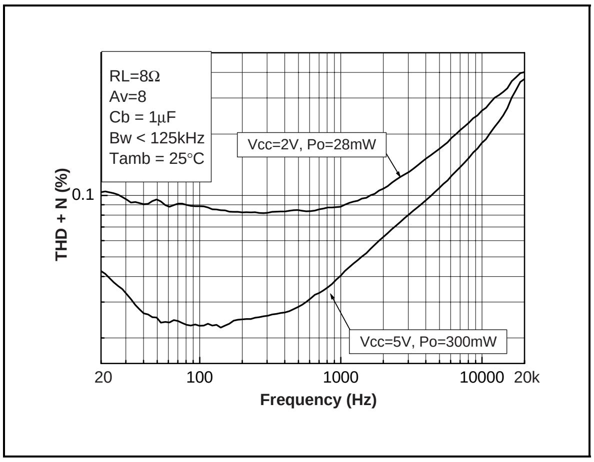

Fig. 87: THD + N vs Frequency

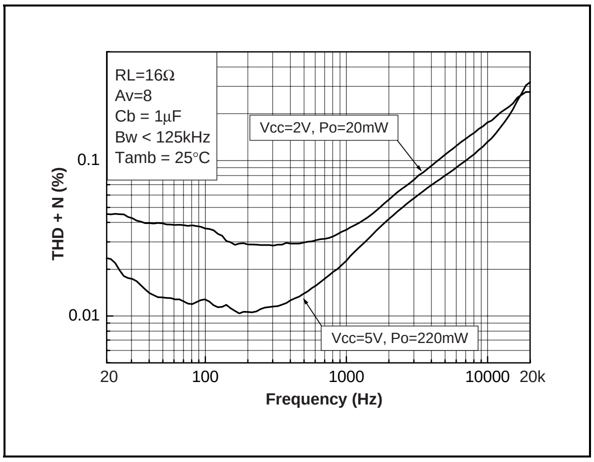

Fig. 88: THD + N vs Frequency

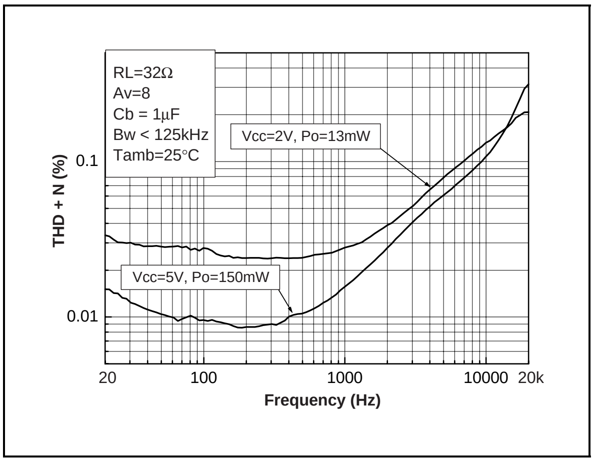

Fig. 89: Signal to Noise Ratio vs Power Supply Voltage with Unweighted Filter (20Hz to 20kHz)

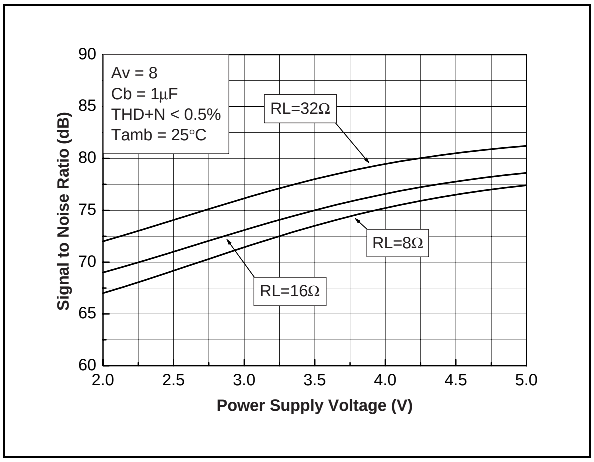

Fig. 90: Signal to Noise Ratio vs Power Supply Voltage with Weighted Filter Type A

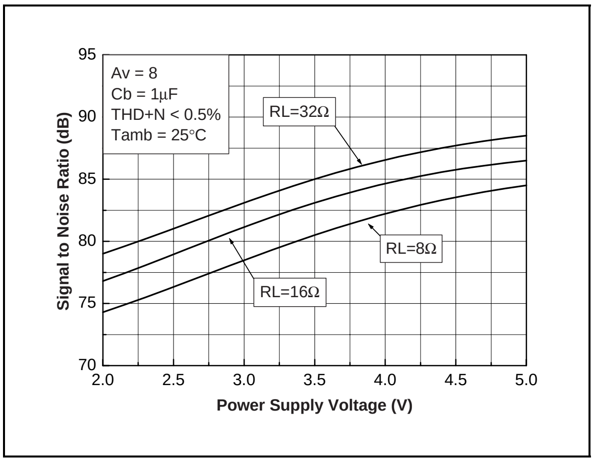

Fig. 91: Noise Floor

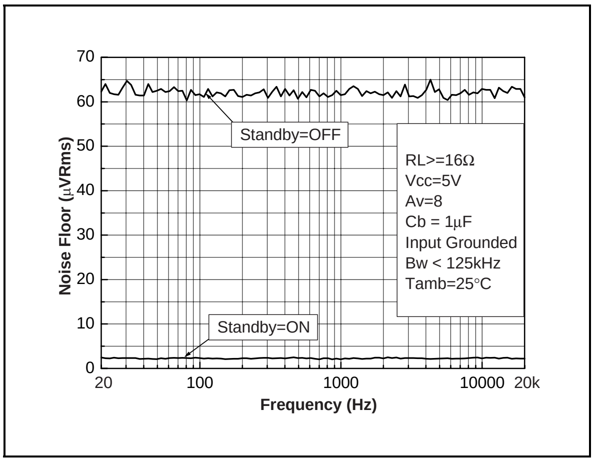

Fig. 92: Noise Floor

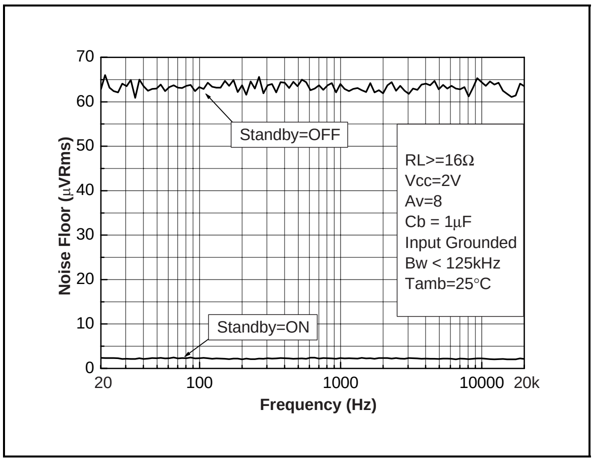

Fig. 93: PSRR vs Power Supply Voltage

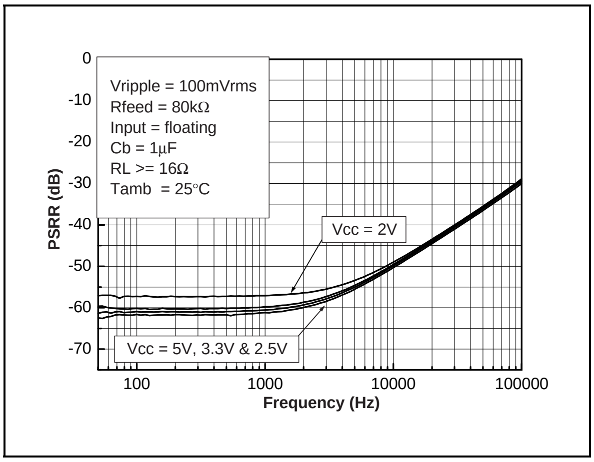

Fig. 94: PSRR vs Input Capacitor