TelCom Semiconductor, Inc.

TC4864

# 300mW Audio Power Amplifier with Shutdown Mode

## FEATURES

- **1.0% (Max) THD at 1kHz at 300mW Continuous Average Output Power into 8Ω**
- **1.0% (Max) THD at 1kHz at 300mW Continuous Average Output Power into 16Ω**
- **Shutdown Current 0.1µA (typ)**
- **MSOP Packaging**
- **No Output Coupling Capacitors, Bootstrap Capacitors, or Snubber Circuits are Necessary**
- **Unity-gain Stable**
- **External Gain Configuration Capability**
- **300mW Output Power Guaranteed**
- **Single Supply Operation**

## APPLICATIONS

- **Cellular Phones**
- **Personal Computers**
- **General Purpose Audio**

### TYPICAL OPERATING CIRCUIT

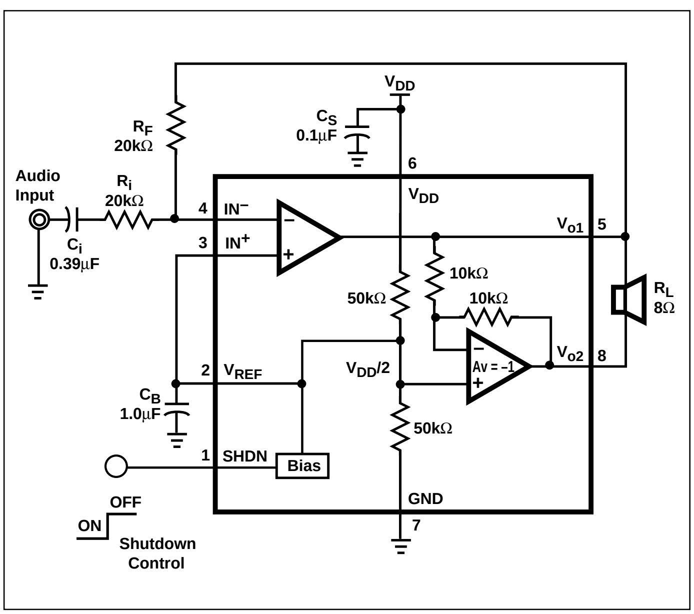



**Figure 1**

## GENERAL DESCRIPTION

The TC4864 is a bridged audio power amplifier capable of delivering 300 mW of continuous average power into an 8Ω load with 1% (THD) from a 5V power supply.

The TC4864 audio power amplifier is specifically designed to provide high quality output power from a low supply voltage, while requiring very few external components.

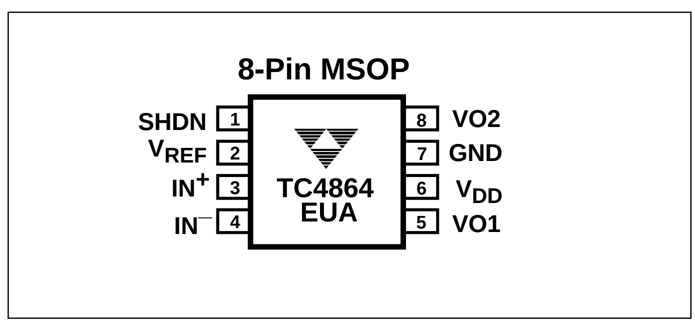
The TC4864 does not require output coupling, or bootstrap, capacitors; nor does it require snubber networks. Because of this, it is ideal for low-power portable applications.

The TC4864 features an externally controlled, low power consumption shutdown mode (Active High). The closed loop response of the unity-gain stable TC4864 can be configured by external gain-setting resistors. The device is offered in a space-saving 8-Pin MSOP package to suit applications where minimal board space layouts are essential. The TC4864 operates over an input supply voltage range of 2.7V to 5.5V.

## ORDERING INFORMATION

| Part Number | Package | Temp. Range |
|---|---|---|
| TC4864EUA | 8-Pin MSOP | –40°C to +85°C |

### PIN CONFIGURATION



## ABSOLUTE MAXIMUM RATINGS*

Supply Voltage .......................................................... 6.0V
Storage Temperature ............................ –65°C to +150°C
Input Voltage .................................... –0.3V to $V_{DD}$ + 0.3V
Power Dissipation ................................................ (Note 3)
ESD Susceptibility(Note 4) ..................................... 3500V
ESD Susceptibility (Note 5) ....................................... 250V
Junction Temperature ............................................. 150°C
Soldering Information:
Small Outline Package
Vapor Phase (60 sec.) ................................. 215°C
Infrared (15 sec.) .......................................... 220°C

Thermal Resistance
$\theta_{JC}$ (MSOP) .......................................................... 56°C/W
$\theta_{JA}$ (MSOP) ........................................................ 210°C/W
Operating Ratings
Temperature Range
$T_{MIN} \le T_A \le T_{MAX}$ .................. –40°C ≤ $T_A$ ≤ +85°C
Supply Voltage .................................... 2.7V ≤ $V_{DD}$ ≤ 5.5V

*Static-sensitive device. Unused devices must be stored in conductive material. Protect devices from static discharge and static fields. Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Rating Conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS: (Notes 1 and 2)

The following specifications apply for $V_{DD}$ = 5V unless otherwise specified. Limits apply for $T_A$ = 25°C

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $I_{DD}$ | Quiescent Power Supply Current | $V_{IN}$ = 0V, $I_O$ = 0A (Note 8) | — | 4.1 | 9 | mA |
| $I_{SD}$ | Shutdown Current | $V_{PIN1}$ = $V_{DD}$ | — | 0.1 | 1 | µA |
| $V_{OS}$ | Output Offset Voltage | $V_{IN}$ = 0V | — | 5 | 30 | mV |
| $P_O$ | Output Power | THD + N = 1% (max); f = 1kHz; $R_L$ = 8Ω (Note 9) | 300 | 740 | — | mW |
| | | THD+N = 1%(max); f=1kHz; $R_L$ = 16Ω | — | 590 | — | mW |
| THD+N | Total Harmonic Distortion+Noise | $P_O$ = 300mW; $A_{VD}$ = 2; $R_L$ = 8Ω; 20Hz ≤ f ≤ 20kHz | — | 0.1 | — | % |
| PSRR | Power Supply Rejection Ratio | $V_{DD}$ = 4.9V –5.1V | 55 | 75 | | dB |
| $V_{IH}$ | Shutdown High Level Input Voltage | | 2.5 | — | — | V |
| $V_{IL}$ | Shutdown Low Level Input Voltage | | — | — | 0.8 | V |

## ELECTRICAL CHARACTERISTICS: (Notes 1 and 2)

The following specifications apply for $V_{DD}$ = 3V unless otherwise specified. Limits apply for $T_A$ = 25°C

| Symbol | Parameter | Test Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $I_{DD}$ | Quiescent Power Supply Current | $V_{IN}$ = 0V, $I_O$ = 0A (Note 8) | — | 2.8 | 6.5 | mA |
| $I_{SD}$ | Shutdown Current | $V_{PIN1}$ = $V_{DD}$ | — | 0.1 | 1 | µA |
| $V_{OS}$ | Output Offset Voltage | $V_{IN}$ = 0V | — | 5 | — | mV |
| $P_O$ | Output Power | THD = 1% (max); f = 1 kHz; $R_L$ = 8Ω<br>THD = 1% (max); f = 1 kHz; $R_L$ = 16Ω | —<br>— | 240<br>200 | —<br>— | mW<br>mW |
| THD+N | Total Harmonic Distortion+Noise | $P_O$ = 100 mW; $A_{VD}$ = 2; $R_L$ = 8Ω; 20Hz ≤ f ≤ 20kHz | — | 0.1 | — | % |
| PSRR | Power Supply Rejection Ratio | $V_{DD}$ = 2.9V –3.1V | 55 | 75 | — | dB |
| $V_{IH}$ | Shutdown High Level Input Voltage | | 1.6 | — | — | V |
| $V_{IL}$ | Shutdown Low Level Input Voltage | | — | — | 0.8 | V |

## ELECTRICAL CHARACTERISTICS: (Notes 1 and 2) (Continued)

**Note 1:** All voltages are measured with respect to the ground pin, unless otherwise specified.

**Note 2**: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not guarantee specific performance limits. Electrical Characteristics state DC and AC electrical specifications under particular test conditions which guarantee specific performance limits. This assumes that the device is within the Operating Ratings. Specifications are not guaranteed for parameters where no limit is given; however, the typical value is a good indication of device performance.

**Note 3:** The maximum power dissipation must be derated at elevated temperatures and is dictated by $T_{JMAX}$ , $\theta_{JA}$, and the ambient temperature $T_{A}$. The maximum allowable power dissipation is $P_{DMAX} = (T_{JMAX} - T_A)/\theta_{JA}$ . For the TC4864, $T_{JMAX}$ = 150°C.The typical junction-to-ambient thermal resistance, when board mounted, is 210°C/W for the MSOP package.

**Note 4:** Human body model, 100pF discharged through a 1.5 kΩ resistor.

**Note 5:** Machine Model, 220pF –240pF discharged through all pins.

**Note 6:** Typicals are measured at 25°C and represent the parametric norm.

**Note 7**: Limits are guaranteed to TelCom's AOQL (Average Outgoing Quality Level).

**Note 8:** The quiescent power supply current depends on the offset voltage when a practical load is connected to the amplifier.

**Note 9:** The power dissipation limitation for the package occurs at 300mW of output power. This package limitation is based on 25°C ambient temperature and $\theta_{JA}$ = 210°C/W. For higher output power possibilities refer to the Power Dissipation Section.

## PIN DESCRIPTION

| Pin No. (MSOP) | Symbol | Description |
|---|---|---|
| 1 | SHDN | Shutdown Logic Input. |
| 2 | $V_{REF}$ | Reference Voltage Output ($V_{DD}$/2). |
| 3 | $IN^+$ | Non-Inverting Input. |
| 4 | $IN^-$ | Inverting Input. |
| 5 | $V_{O1}$ | Non-Inverting Amplifier Output. |
| 6 | $V_{DD}$ | Power Supply Input. |
| 7 | GND | Supply Power Return. |
| 8 | $V_{O2}$ | Inverting Amplifier Output. |

## EXTERNAL COMPONENTS DESCRIPTION

| Components | | Functional Description |
|---|---|---|
| 1 | $R_i$ | Inverting input resistance which sets the closed-loop gain in conjunction with $R_F$. This resistor also forms a high pass filter with $C_i$ at $f_c = 1/(2\pi R_i C_i)$. |
| 2 | $C_i$ | Input coupling capacitor which blocks the DC voltage at the amplifier's input terminals. Also creates a highpass filter with $R_i$ at $f_c = 1/(2\pi R_i C_i)$. Refer to the section **Proper Selection of External Components**, for an explanation of how to determine the value of $C_i$. |
| 3 | $R_F$ | Feedback resistance which sets the closed-loop gain in conjunction with $R_i$. |
| 4 | $C_S$ | Supply bypass capacitor which provides power supply filtering. Refer to the **Power Supply Bypassing** section for information concerning proper placement and selection of the supply bypass capacitor. |
| 5 | $C_B$ | Bypass pin capacitor which provides half-supply filtering. Refer to the **Proper Selection of External Components** for information concerning proper placement and selection of $C_B$. |

## DETAILED DESCRIPTION

### Application Information

#### Bridge Configuration Explanation

As shown in Figure 1, the TC4864 has two operational amplifiers internally, allowing for several different amplifier configurations.

The first amplifier's gain is externally configurable, while the second amplifier is internally fixed in a unity-gain, inverting configuration. The closed-loop gain of the first amplifier is set by selecting the ratio of $R_F$ to $R_i$ while the second amplifier's gain is fixed by the two internal 10kΩ resistors. Figure 1 shows that the output of amplifier one serves as the input to amplifier two which results in both amplifiers producing signals identical in magnitude, but out of phase 180°. Consequently, the differential gain for the IC is

$$A_{VD} = 2*(R_F/R_i)$$

The load is driven differentially through outputs $V_{O1}$ and $V_{O2}$, creating an amplifier configuration commonly referred to as a "bridged mode". Bridged mode operation is different from the classical single-ended amplifier configuration where one side of its load is connected to ground.

There are several distinct advantages to having a bridge amplifier design as opposed to a single-ended configuration. First, the bridge design provides differential drive to the load, thus doubling output swing for a predetermined supply voltage. Second, it is possible to generate four times the output power as that of a single-ended amplifier under the same conditions, provided that the amplifier is not current limited or clipped. For information on how to choose an amplifier's closed-loop gain while avoiding excessive clipping, please refer to the **Audio Power Amplifier Design** section.

A bridge configuration, such as the one used in the TC4864, also creates a third advantage over single-ended amplifiers. Since the differential outputs, $V_{O1}$ and $V_{O2}$ , are biased at half-supply, no net DC voltage exists across the load. Thus, the need for an output coupling capacitor is eliminated in a bridge. As opposed to a single supply, single-ended amplifier configuration, in which the capacitor is a requirement. If an output coupling capacitor is not used in a single-ended configuration, the half-supply bias across the load would result in both increased internal IC power dissipation as well as permanent loudspeaker damage.

#### POWER DISSIPATION

Power dissipation is an important factor when designing a successful amplifier, whether the amplifier be bridged or single-ended. Equation 1 illustrates the maximum power dissipation point for a bridge amplifier operating at a given supply voltage and driving a specified output load.

$$P_{DMAX} = (V_{DD})^2/(2\pi^2 R_L) \qquad \text{Single-Ended}$$

**Equation 1.**

However, a direct consequence of the increased power delivered to the load by a bridge amplifier is an increase in internal power dissipation point for a bridge amplifier operating under the same conditions.

$$P_{DMAX} = 4(V_{DD})^2/(\pi^2 R_L) \qquad \text{Bridge Mode}$$

**Equation 2.**

Since the TC4864 has two operational amplifiers in one package, the maximum internal power dissipation is 4 times that of a single-ended amplifier. Still, the TC4864 does not require heatsinking, even with this substantial increase in power dissipation, . From Equation 1, assuming a 5V power supply and an 8Ω load, the maximum power dissipation point is 625 mW. The maximum power dissipation point obtained from Equation 2 must not be greater than the power dissipation that results from Equation 3:

$$P_{DMAX} = (T_{JMAX} - T_A)/\theta_{JA}$$

**Equation 3.**

For the MSOP package, $\theta_{JA}$ = 210°C/W. $T_{JMAX}$ = 150°C for the TC4864. Depending on the ambient temperature, $T_A$, of the system surroundings, Equation 3 can be used to find the maximum internal power dissipation supported by the IC packaging. If the result of Equation 2 is greater than that of Equation 3, either the supply voltage must be decreased, the load impedance must be increased, the ambient temperature reduced, or, through heat-sinking, the $\theta_{JA}$ must be lowered.

In a lot of cases, larger traces near the output, $V_{DD}$ ,and GND pins can be used to lower the $\theta_{JA}$ . The larger areas of copper serve as a form of heatsinking, allowing a higher power dissipation. For the typical application of a 5V power supply, with an 8Ω load, the maximum ambient temperature possible without exceeding the maximum junction temperature, is approximately 44°C. (Provided that the device operation is around the maximum power dissipation point and assuming surface mount packaging.) Internal power dissipation is a function of output power. If typical operation is not around the maximum power dissipation point, the ambient temperature can be increased. For power dissipation information for lower output powers, refer to the **Typical Performance Characteristics** curves.

## POWER SUPPLY BYPASSING

As with any power amplifier, proper supply bypassing is essential for low noise performance and high power supply rejection. The location of the capacitor on both the bypass and power supply pins should be as near the device as possible. A larger half supply bypass capacitor has the effect of improved PSRR due to increased half-supply stability. Typical applications use a 5V regulator with 10µF and a 0.1µF bypass capacitor which aids in supply stability, but does not eliminate the need for bypassing the supply nodes of the TC4864. The selection of bypass capacitors, especially $C_B$, is thus dependent upon desired PSRR requirements, click and pop performance (as explained in the **Proper Selection of External Components** section), system cost, and size limitations.

## SHUTDOWN FUNCTION

The TC4864 contains a shutdown pin to externally turn off the amplifier's bias circuitry in order to reduce power consumption while not in use. This feature turns the amplifier off when a logic high is placed on the shutdown pin. Typically, half supply is the trigger point between a logic low and logic high level. To provide maximum device performance, it's best to switch between the $V_{IL}$ and $V_{IH}$ limits specified in the Electrical Characteristics tables. By switching the shutdown pin to $V_{DD}$, the TC4864 supply current draw will be minimized in the shutdown mode. While the device may be disabled with shutdown pin voltages less than the minimum $V_{IH}$, the shutdown current may be greater than the typical value of 0.1µA. Regardless of the conditions, the shutdown pin should be tied to a definite voltage so as to avoid unwanted state changes.

In many applications, a microcontroller or microprocessor output is used to control the shutdown circuitry which provides a quick, smooth transition into shutdown. Another solution is to use a single-pole, single-throw switch in tandem with an external pull-up resistor. When the switch is closed, the shutdown pin is connected to ground and enables the amplifier. Conversely, if the switch is open, the external pull-up resistor will disable the TC4864. This design ensures that the shutdown pin will not float, thus preventing undesireable state changes.

## PROPER SELECTION OF EXTERNAL COMPONENTS

Proper selection of external components in applications employing integrated power amplifiers is crucial in optimizing device and system performance. While the TC4864 is tolerant of a variety of external component combinations, consideration must be given to component values in order to maximize overall system quality.

The TC4864 is unity-gain stable, giving maximum system flexibility to the designer. The TC4864 is best used in low gain configurations to minimize THD+N values and maximize the signal to noise ratio. Low gain configurations require large input signals to obtain a specified output power. Audio CODECs are sources from which input signals equal to or greater than 1 $V_{RMS}$ are available. For a more complete explanation of proper gain selection please refer to the section, **Audio Power Amplifier Design**.

In addition to gain, one of the major considerations is the closed-loop bandwidth of the amplifier. The bandwidth is dictated, to a large extent, by the choice of external components shown in Figure 1. The input coupling capacitor, $C_i$ , forms a first order high pass filter which limits low frequency response. This value should be chosen based on needed frequency response for a few distinct reasons.

### Selection of Input Capacitor Size

Large input capacitors are too bulky and less cost effective for portable designs. There is clearly a need for a space-saving capacitor to couple in low frequencies without drastic attenuation. But, in many cases, the speakers used in portable systems, whether internal or external, lack the ability to reproduce signals below 150Hz. In this specific case, employing a large input capacitor may not increase system performance.

In addition to system cost and size, click and pop performance is effected by the size of the input coupling capacitor, $C_i$. A larger input coupling capacitor requires more charge to reach its inactive DC voltage (nominally 1/2 $V_{DD}$ ). This charge comes from the output via the feedback and is apt to create pops upon enabling the device. Thus, by minimizing the capacitor size based on necessary low frequency response, turn-on pops are minimized.

Besides minimizing the input capacitor size, careful attention should be paid to the bypass capacitor value. Bypass capacitor,$C_B$ is the most critical component in minimizing turn-on pops, since it determines how fast the TC4864 turns on. The slower the TC4864's outputs ramp to their quiescent DC voltage (nominally 1/ 2 $V_{DD}$ ), the smaller the turn-on pop. Choosing $C_B$ = 1.0µF along with a small value of $C_i$ (in the range of 0.1µF to 0.39µF), should produce a clickless and popless shutdown function. While the device will function properly (no oscillations or motorboating) with $C_B$ = 0.1µF , the device will be much more susceptible to turn-on clicks and pops. Thus, a value of $C_B$ = 1.0µF or larger is recommended in all but the most cost sensitive designs.

## AUDIO POWER AMPLIFIER DESIGN

### Design a 300mW/8Ω Audio Amplifier

Given:

| | |
|---|---|
| Power Output | 300mW |
| Load Impedance | 8Ω |
| Input Level | 1 $V_{RMS}$ |
| Input Impedance | 20kΩ |
| Bandwidth | 100Hz – 20kHz ± 0.25dB |

A designer must first determine the minimum supply rail to obtain the specified output power. By extrapolating from the Output Power vs Supply Voltage graphs in the **Typical Performance Characteristics** section, the supply rail can easily be found. Another way to determine the minimum supply rail is to calculate the required $V_{OPEAK}$ using Equation 4 and add the dropout voltage. Using this method, the minimum supply voltage would be ($V_{OPEAK}$ +(2*$V_{OD}$ )), where $V_{OD}$ is extrapolated from the Dropout Voltage vs Supply Voltage curve in the **Typical Performance Characteristics** section.

$$V_{OPEAK} = \sqrt{(2R_L P_O)}$$

**Equation 4.**

Using the Output Power vs Supply Voltage graph for an 8Ω load, the minimum supply rail is 3.5V. But since 5V is a standard supply voltage in most applications, it is chosen for the supply rail. Extra supply voltage creates a buffer that allows the TC4864 to reproduce peaks in excess of 500mW without producing audible distortion. At this point, the designer must ensure that the power supply choice and the output impedance does not violate the conditions set forth in the Power Dissipation section.

Once the power dissipation equations have been addressed, the required differential gain can be determined from Equation 5.

$$A_{VD} \geq \sqrt{P_O R_L)}/(V_{IN}) = V_{ORMS}/V_{INRMS}$$
$$R_F/R_i = A_{VD}/2$$

**Equation 5**.

From Equation 5, the minimum $A_{VD}$ is 1.55; use $A_{VD}$ = 2. Since the desired input impedance was 20kΩ, and with a $A_{VD}$ of 2, a ratio of 1:1 of $R_F$ to $R_i$ results in an allocation of $R_i$ = $R_F$ = 20kΩ. The final design step is to address the bandwidth requirements which must be stated as a pair of –3dB frequency points. Five times away from a pole gives 0.17dB down from passband response which is better than the required ±0.25dB specified.

$$f_L = 100\text{Hz}/5 = 20\text{Hz}$$
$$f_H = 20\text{kHz} \times 5 = 100\text{kHz}$$

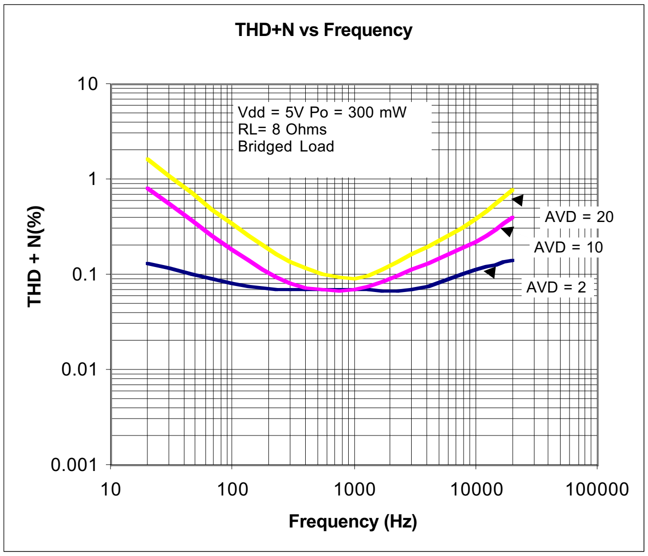
As stated in the **External Components** section, $R_i$ in conjunction with $C_i$ create a highpass filter.

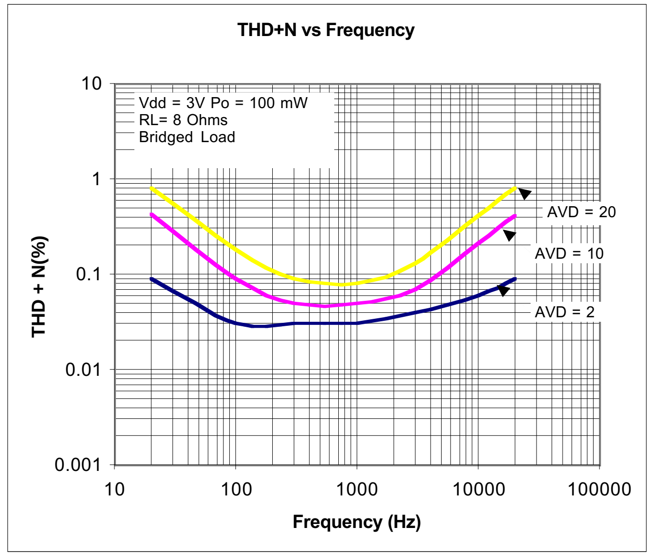
$$Ci \geq \frac{1}{2\pi R_i f_C}$$

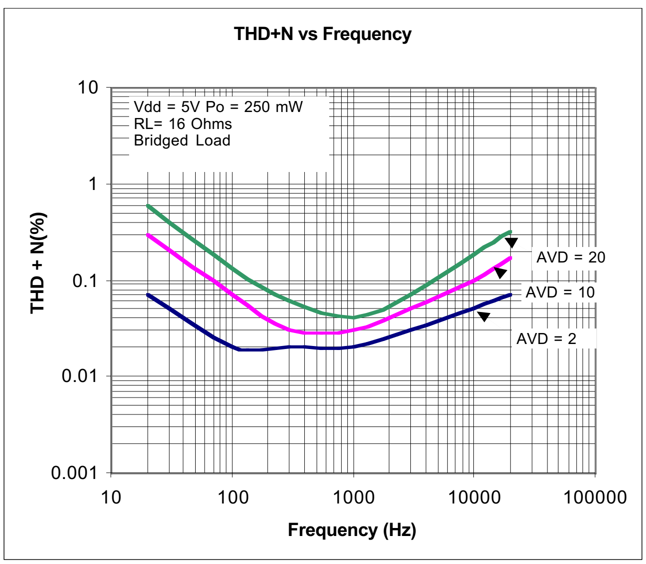
$C_i$ ≥ 1/(2π* 20kΩ* 20Hz) = 0.398µF; use 0.39µF

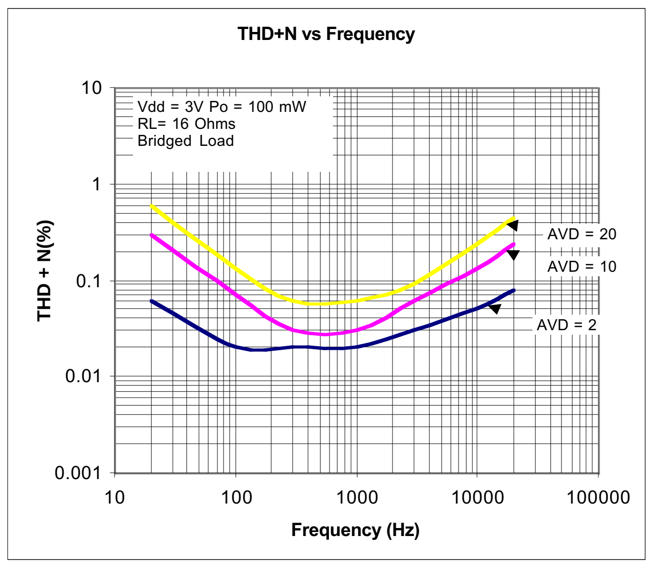
The high frequency pole is determined by the product of the desired high frequency pole, $f_H$ , and the differential gain, $A_{VD}$. With a $A_{VD}$ = 2 and $f_H$ = 100kHz, the resulting GBWP = 100kHz which is much smaller than the TC4864 GBWP of 18MHz. This figure illustrates a situation in which a designer needs to design an amplifier with a higher differential gain. The TC4864 can still be used without running into bandwidth problems.

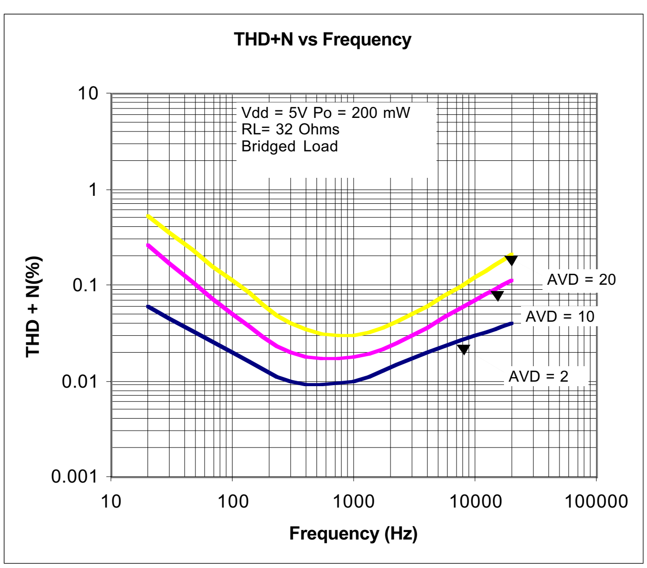
## TYPICAL CHARACTERISTICS

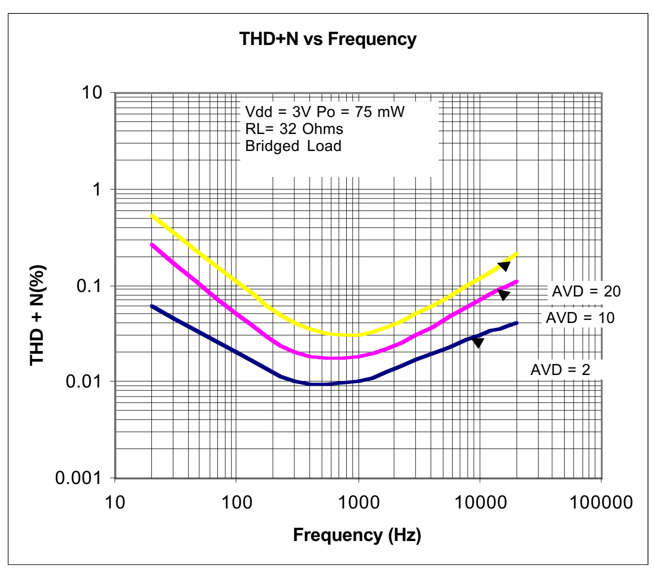


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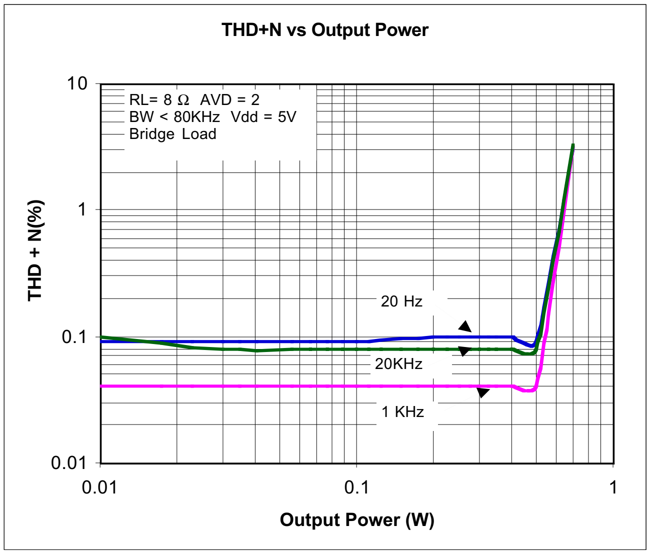
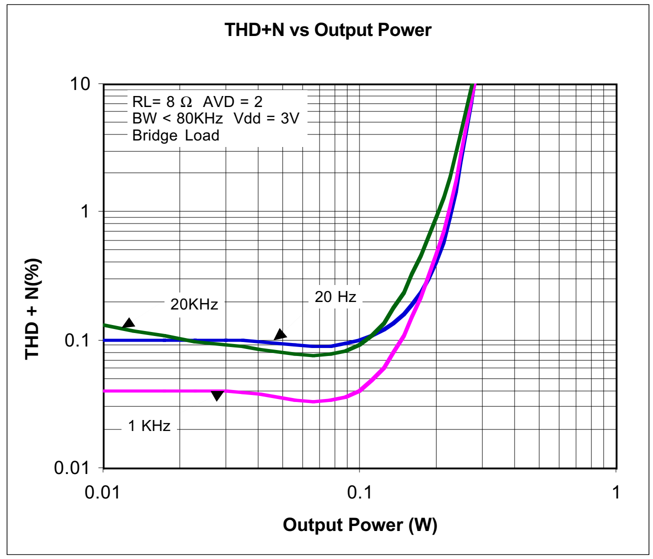
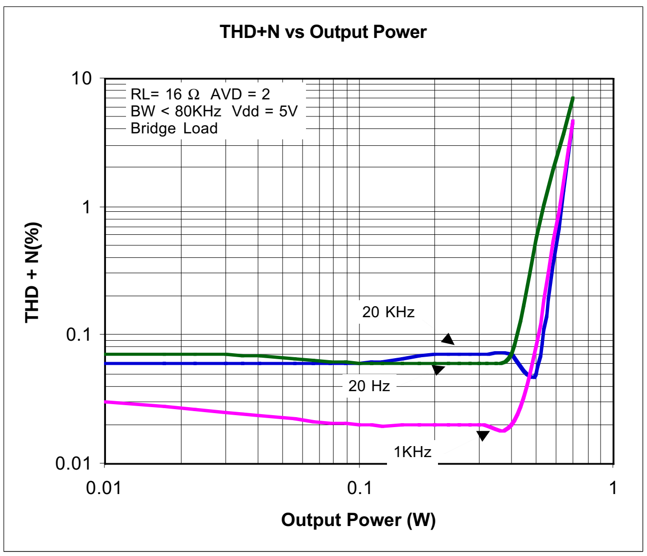
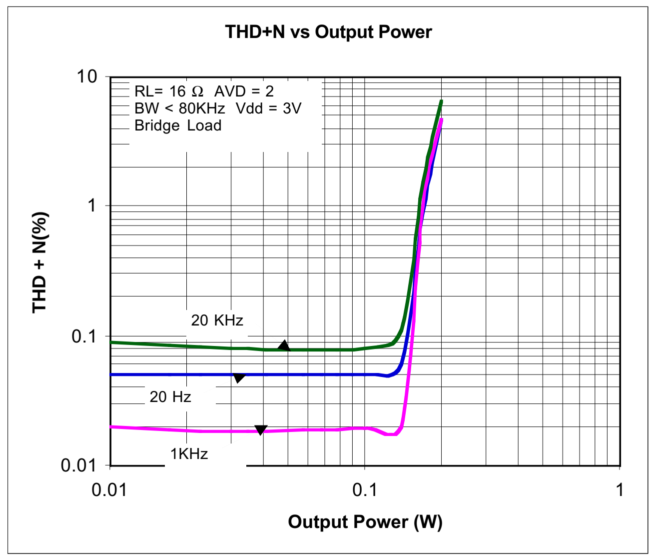
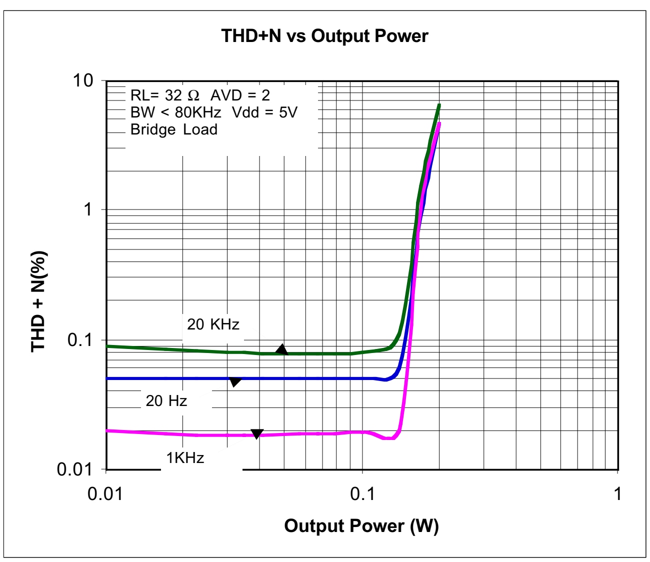
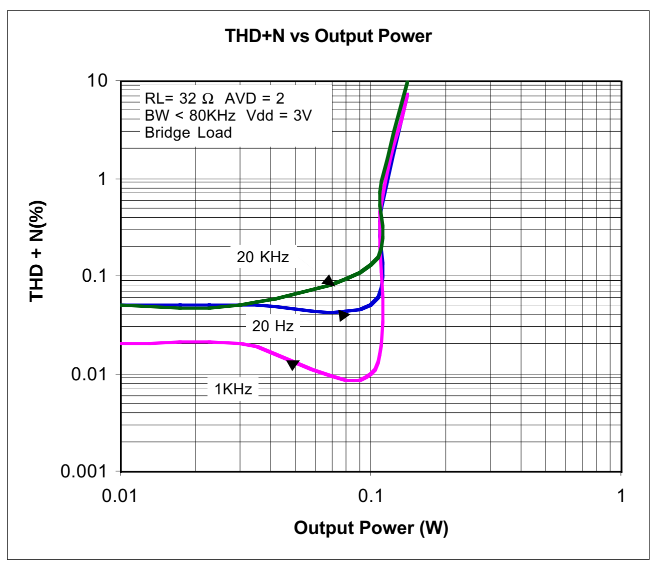

THD+N vs Output Power
RL= 8 Ω AVD = 2
BW < 80KHz Vdd = 5V
Bridge Load
20 Hz
20KHz
1 KHz
THD + N(%)
10
1
0.1
0.01
0.01
0.1
1
Output Power (W)

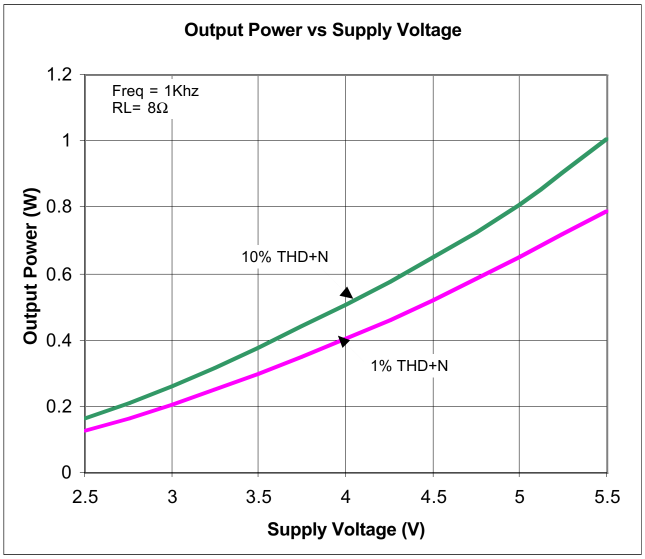

THD+N vs Output Power
RL= 8 Ω AVD = 2
BW < 80KHz Vdd = 3V
Bridge Load
20KHz
20 Hz
1 KHz
THD + N(%)
10
1
0.1
0.01
0.01
0.1
1
Output Power (W)

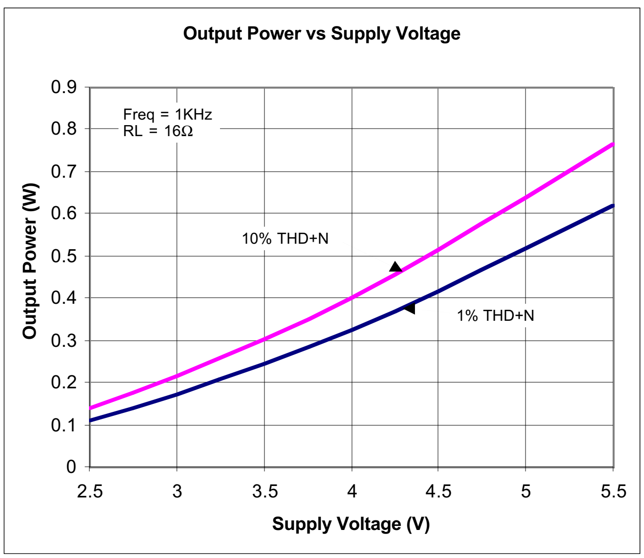

THD+N vs Output Power
RL= 16 Ω AVD = 2
BW < 80KHz Vdd = 5V
Bridge Load
20 KHz
20 Hz
1KHz
THD + N(%)
10
1
0.1
0.01
0.01
0.1
1
Output Power (W)

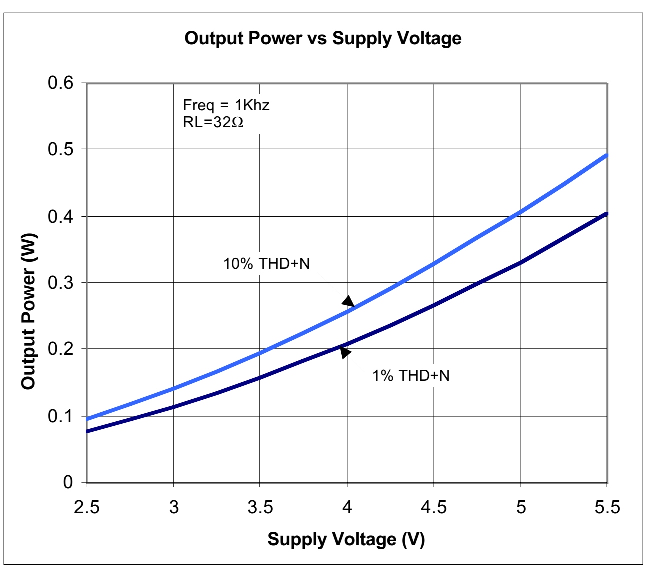

THD+N vs Output Power
RL= 16 Ω AVD = 2
BW < 80KHz Vdd = 3V
Bridge Load
20 KHz
20 Hz
1KHz
THD + N(%)
10
1
0.1
0.01
0.01
0.1
1
Output Power (W)

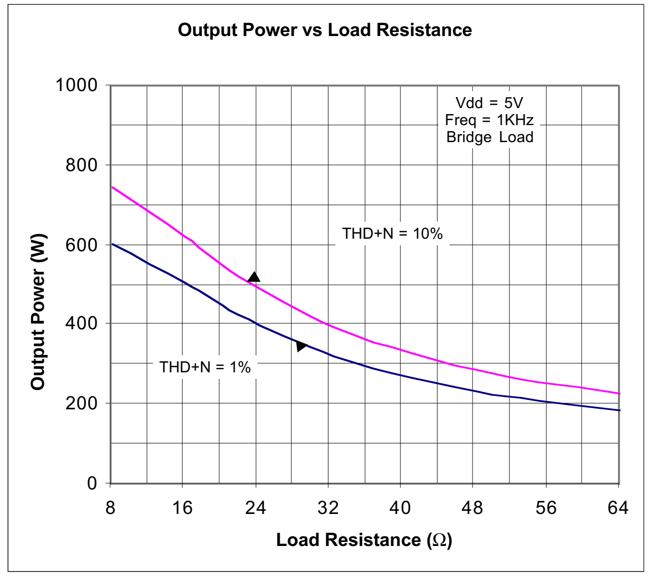

THD+N vs Output Power
RL= 32 Ω AVD = 2
BW < 80KHz Vdd = 5V
Bridge Load
20 KHz
20 Hz
1KHz
THD + N(%)
10
1
0.1
0.01
0.01
0.1
1
Output Power (W)

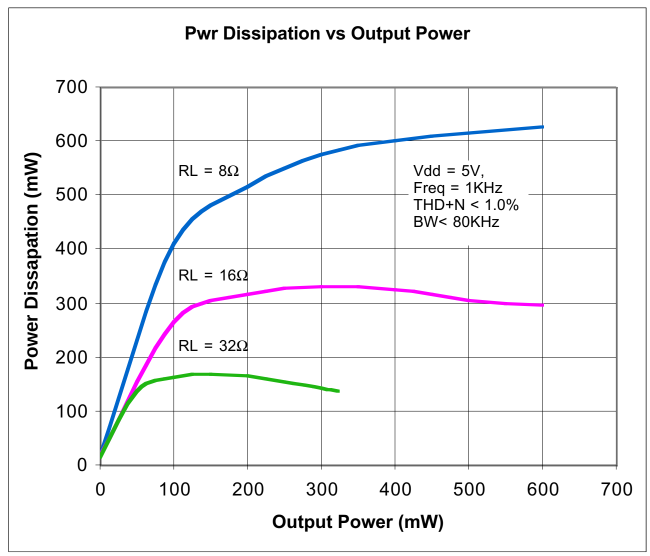

THD+N vs Output Power
RL= 32 Ω AVD = 2
BW < 80KHz Vdd = 3V
Bridge Load
20 KHz
20 Hz
1KHz
THD + N(%)
10
1
0.1
0.01
0.001
0.01
0.1
1
Output Power (W)

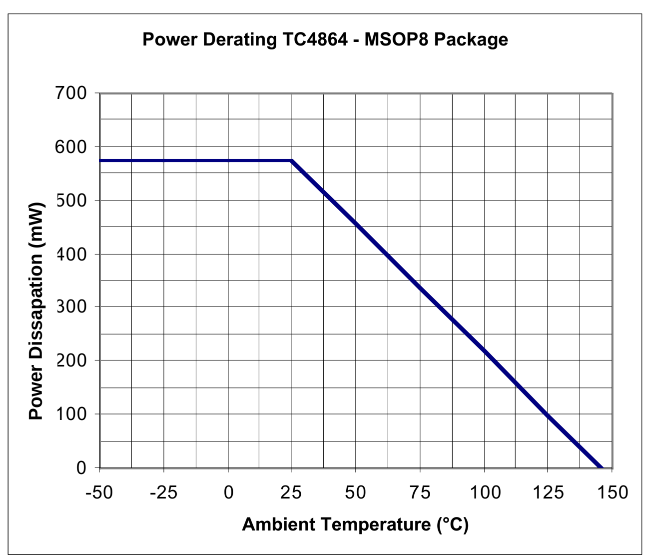

Output Power vs Supply Voltage
Freq = 1Khz
RL= 8Ω
10% THD+N
1% THD+N
Output Power (W)
Supply Voltage (V)
1.2
1
0.8
0.6
0.4
0.2
0
2.5
3
3.5
4
4.5
5
5.5


Output Power vs Supply Voltage
Freq = 1KHz
RL = 16Ω
10% THD+N
1% THD+N
Output Power (W)
Supply Voltage (V)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
2.5
3
3.5
4
4.5
5
5.5


Output Power vs Supply Voltage
Freq = 1Khz
RL=32Ω
10% THD+N
1% THD+N
Output Power (W)
Supply Voltage (V)
0.6
0.5
0.4
0.3
0.2
0.1
0
2.5
3
3.5
4
4.5
5
5.5

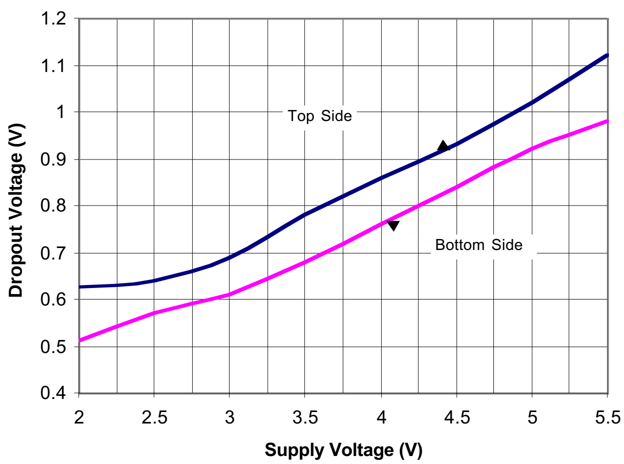

Output Power vs Load Resistance
Vdd = 5V
Freq = 1KHz
Bridge Load
THD+N = 10%
THD+N = 1%
Output Power (W)
Load Resistance (Ω)
1000
800
600
400
200
0
8
16
24
32
40
48
56
64


Pwr Dissipation vs Output Power
RL = 8Ω
RL = 16Ω
RL = 32Ω
Vdd = 5V,
Freq = 1KHz
THD+N < 1.0%
BW< 80KHz
Power Dissapation (mW)
Output Power (mW)
700
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700

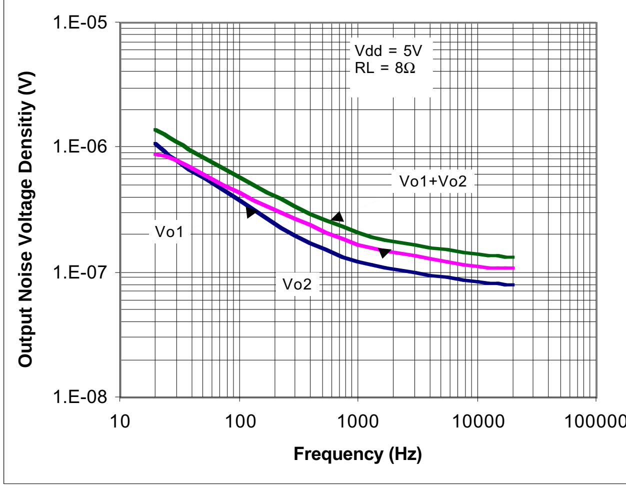

Power Derating TC4864 - MSOP8 Package
Power Dissapation (mW)
Ambient Temperature (°C)
700
600
500
400
300
200
100
0
-50
-25
0
25
50
75
100
125
150

# TC4864

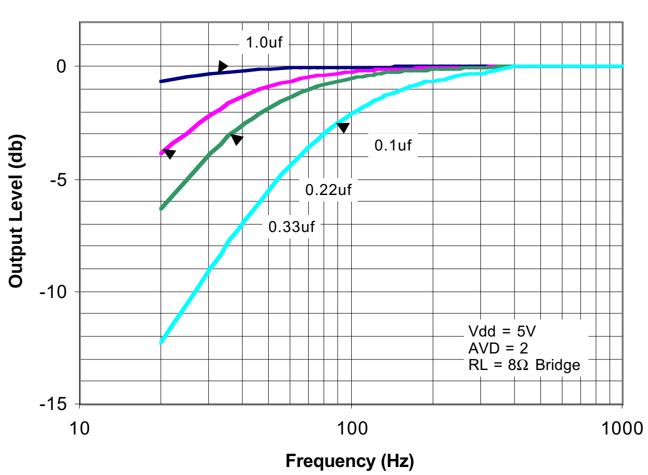
**Dropout Voltage vs Supply Voltage**



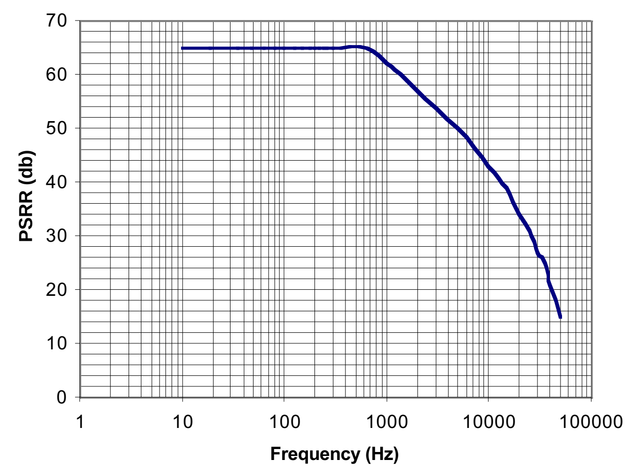

**Noise Density**



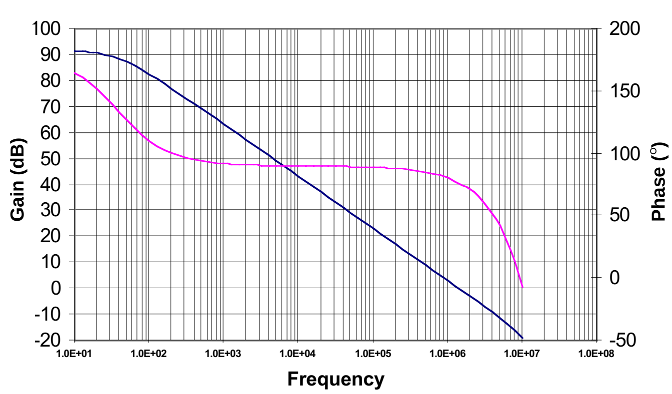

**Frequency Response vs Input Capacitor Size**



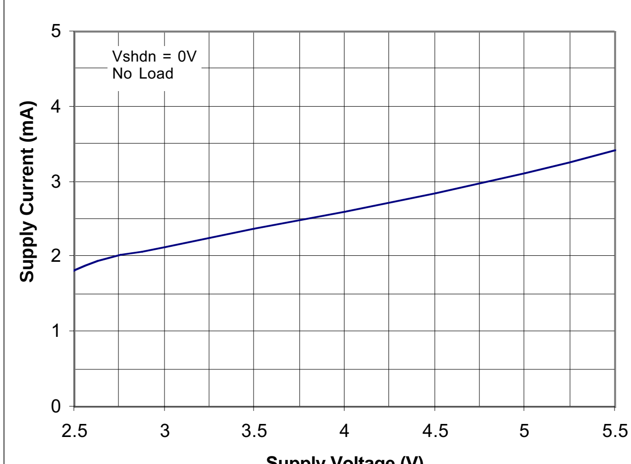

**Power Supply Rejection Ratio**




**Open Loop Frequency Response**

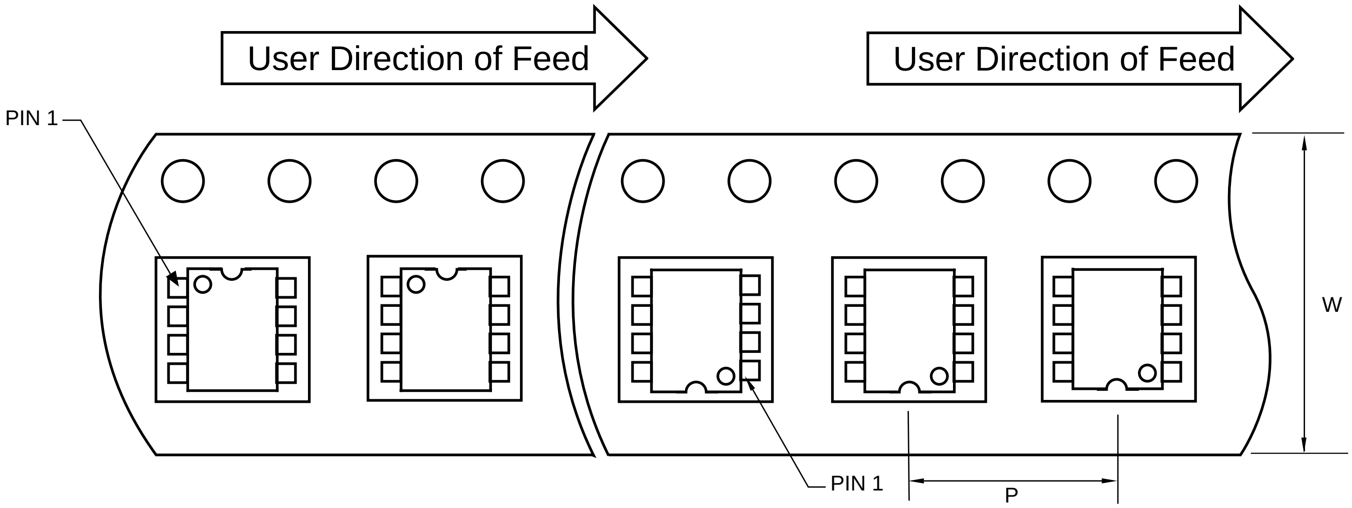



**Supply Current vs Supply Voltage**



## TAPING FORM

Component Taping Orientation for 8-Pin MSOP Devices




Standard Reel Component Orientation for TR Suffix Device

Reverse Reel Component Orientation for RT Suffix Device

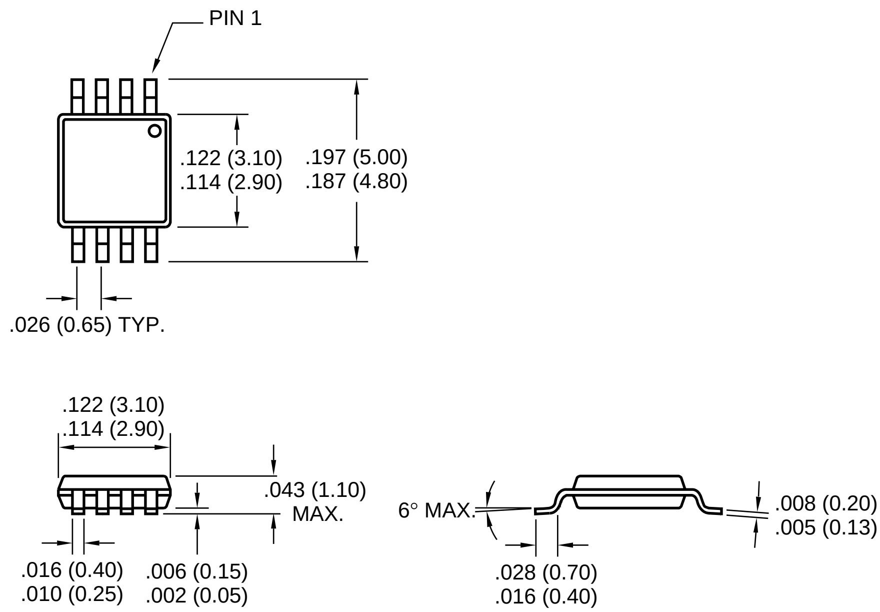
**Carrier Tape, Number of Components Per Reel and Reel Size**

| Package | Carrier Width (W) | Pitch (P) | Part Per Full Reel | Reel Size |
|---|---|---|---|---|
| 8-Pin MSOP | 12 mm | 8 mm | 2500 | 13 in |

# TC4864

## PACKAGE DIMENSIONS

8-Pin MSOP




**Dimensions: inches (mm)**

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