Using the Overture Design Guide

Rev 1.5

Overview:

The Design Guide was created as an aid to the system designer to choose the correct part for a given application and make a complete and correct design. The Design Guide is provided in a common format (Excel 97 or Excel 5.0/95). It is recommended that these instructions be printed out and read while using the Design Guide. The Design Guide will give warnings about using the correct supply voltage, current limits, correct heat sink size as well as information about bridge and parallel use of the supported part numbers. All of the necessary information for a complete Class AB design using one of the listed part numbers is provided. Part numbers are split by number of channels (Stereo or Mono) and show in increasing output power capabilities. Lower output power parts are on the left with increasing output power capabilities for parts going to the right. There is also a power dissipation verses output power graph on the tab labeled '*Pd vs. Pout Curve*'. This graph shows the total power dissipation within each IC package verses increasing output power.

Assumptions, Limitations, and Accuracy:

All of the assumptions are listed in the Design Guide under **Assumptions**. They are:

1. Output power is only calculates for 4Ω, 6Ω, and 8Ω loads for a single ended design.
2. The amplifier is used in a non-inverting configuration.
3. A split power supply is used with Ground at the midpoint between the two supplies and considered 0Volts.
4. Thermal grease is used between the package and heat sink <u>without</u> the use of a micro washer.
5. Only the part numbers listed are supported.

Implied in assumption 2 and 3, the amplifier circuit is the same as the *Typical Application Circuit* found on any of the datasheets for the listed supported parts. Bridge calculations assumes two ICs of the same part number are used in a bridge configuration. For stereo parts, bridge calculations and thermals assume both channels are used to drive the load. For three channel parts, bridge calculations and thermals assumes two of the channels are in a bridge configuration with the third channel in a single-ended configuration driving the load impedance listed. Parallel calculations requires a minimum of two amplifiers (two ICs for mono amp. part numbers or one IC for stereo part numbers minimum). Using two stereo ICs in the parallel calculation means all four channels of amplification are tied in parallel to drive a single load. This load impedance value and output power are shown in the '*All Chs.*' column. The '*2 Chs.*' column is mostly for three channel parts and shows the load impedance value and output power if just two channels of the three are used in parallel with the load shown. The third channel is configured in single-ended mode and driving the load value entered.

The main limitation is that R_L can only be set to 4Ω, 6Ω and 8Ω loads. For the bridge calculations which uses $2*R_L$ the only supported loads are 8Ω, 12Ω and 16Ω. For the parallel calculations the supported loads are R_L/x where x is the number of power amplifiers. THD performance is not calculated at output powers below clipping (the 1% power point calculated) and is not guaranteed to any specification. See individual datasheets for the listed parts for more information on performance.

The accuracy of the Design Guide is very good when used within the constraints of the assumptions and limitations listed above. As with any IC fabrication, variations in the fab process will introduce a certain amount of performance variation from IC to IC. The Design Guide calculates what the typical performance may be for any given IC. It is best to verify performance on the bench for accuracy.

Features:

The following performance or component values are calculated in the Design Guide:
- Maximum supply voltage for the desired part number.
- Voltage headroom between desired supply voltage and maximum supply voltage.
- Peak voltage and current seen by the load.
- Output Power at clipping (1% THD).
- Gain in V/V and dB – Not for Bridge Tied Load configuration.
- Low frequency -3dB point.
- Input signal level needed for output power to reach 1% level.
- Mute resistor (if needed).
- Snubber values.
- Input impedance of the amplifier stage.
- Output power for maximum power dissipation (P_D).
- Total power dissipation per IC.
- Heat sink size for each available package type .
- Bridge output power if two amplifier channels are used with the bridge load impedance listed.
- Parallel output power if two or more amplifier channels are used with the parallel load impedance listed.
- Warnings when using a specified part outside of the recommended range.

How To Use:

Each major section of calculations has a purple header above the calculation box(es) describing what calculations are performed. Blue highlighted cells are input cells and yellow highlighted cells are calculations. Once a valid part number is entered in the **Part Number** box then all calculations are for that part number only. With protection turned on (default) it is not possible to enter data into any cells other than the blue highlighted input cells. An Orange highlighted cell indicates a possible problem that should be checked but a change is not necessarily needed. A Red highlighted cell is a design error indicating possible use outside of absolute specifications or a design that will not work as generally desired. All the boxed cells will fit on a monitor if the resolution of the monitor is set to 1280x960 or higher with Excel maximized. Thousands of colors (16 bit) is needed to see the color of each cell clearly. The revision and date of last update are displayed in the upper left corner.

The second tab is labeled '*Pd vs. Pout Curve*' and will show the total power dissipation within the IC package as a function of output power. There are no user inputs on this tab. All data is taken from the '*Calculations*' tab.

Explanation of Each Calculation Box:

The Design Guide starts with all the values entered for the standard solution used on the LM4780 demo boards and shown in the datasheet (a typical 60W/8Ω stereo solution). The main box labeled **Enter Information Below** is where all but two items of information are entered. Any of the part numbers listed to the right can be used. If an invalid part number is tried a warning will appear in the warning box and many calculations will show 0 or “ALERT!”. If the supply voltage is greater than the absolute maximum supply voltage a warning will show and “ALERT!” will show in the voltage headroom box. If there is less than 4 Volts between the entered operating supply voltage and the absolute maximum supply voltage then a warning will be shown. The load impedance must be entered as 4Ω, 6Ω or 8Ω. If an incorrect impedance is entered a warning will be shown and all output power calculations will show 0 (although the thermal calculations will show correctly for an unsupported load impedance). The values for the external components are entered next to their circuit designators. This circuit can be found on any of the datasheets for the parts listed as the *Typical Application Circuit* commonly found on the front page of the datasheet.

The **Calculations** boxes show all the information about the circuits performance. Output power at 1% THD, Gain in both V/V and dB, low frequency cutoff, Input level needed to obtain the full output power calculated, Mute resistor value if needed, Snubber values, and the input impedance of the amplifier circuit.

The **Power Dissipation and Thermal Design** box lets the user enter in the ambient temperature and shows the appropriate heat sink size (θ_{SA} in °C/W) for each package type if available. There is also information on what output power point the maximum power dissipation occurs and the total power dissipation for each IC. This information is helpful for the stereo ICs since it is easy to forget that there are two power amplifiers in a single package. The thermals section is also correct for the bridge and parallel output power calculations when using the load impedance shown with the number of ICs listed.

The **Bridge Mode** and **Parallel Mode** power calculation boxes are limited to only the load impedance shown. This load impedance is calculated from the R_L entered earlier. These calculations are more limited. To design a 8Ω bridge amplifier, enter 4Ω in the load value in the user enterable section. The thermal calculation and power dissipation curve will then show the amount of power dissipation and heat sink needed for each IC in the bridge if using a mono part number. For multi channel parts the calculations will be for a single IC if using both channels in a bridge configuration or two of the three in a bridge with the third channel in single-ended mode driving the load impedance entered by the user.

As the number of ICs in increased in the parallel mode box the load impedance will drop accordingly by the equation (R_L/# of power amps) in the '*All Chs*' column. The '*2 Chs.*' column is mainly for three channel amplifiers and shows the load impedance and output power when two channels of a three channel part are configured for parallel operation. The third channel is assumed to be in single-ended configuration driving the load value entered in by the user in the upper left section. This option is helpful for using a three channel part to create a two channel amplifier with higher power in one channel. Applications might be a 2-way self amplified speaker and the desire is to have twice the output power in the subwoofer portion as compared to the tweeter portion.

Warnings Box:

The warnings box will show a warning when trying to use a entered part number incorrectly. The warnings are listed below with the corrective action(s) needed. One or more actions may be needed.

1. *Part cannot operate as this voltage* or *Supply headroom may be too low* or *Supply voltage minimum is +/-10V.*
   Actions:
   a. Lower or raise supply voltage.
   b. Choose a part with a higher absolute supply voltage to increase headroom, a part number further to the right.

2. *Required heat sink size is too large* (θ_{SA} is below 1°C/W) or a warning will occur when θ_{SA} is below 1.5°C/W.
   Actions:
   a. Decrease supply voltage.
   b. Increase load impedance.
   c. Choose a different part number.
   d. Use only the TA package if waning is for TF package and part is available in both packages.

3. I*C output current limit reached.*
   Actions:
   a. Lower supply voltage.
   b. Increase load impedance.
   c. Choose a part number with high current capabilities (parts to the right).

4. *Load impedance not supported.*
   Action:
   a. Enter either '4', '6' or '8' in the "R_L (load impedance)" box.

5. *Gain is too low or too high.*
   Action:
   a. Adjust the values of R_f and R_i until gain falls within the range of 10 – 50 V/V.

6. *Invalid part number.*
   Action:
   b. Choose a correct part number. Part numbers are listed across the **Calculations** box.

7. *Not enough power amplifiers for the parallel calculations* or *Integer number of ICs only.*
   Action:
   a. Be sure number of amplifiers is an integer number.
   b. Enter 2 or more in the "Number of ICs (packages)" box. This only happens when using mono amplifiers.

Pd vs. Pout Curve Tab:

This sheet does not have any user enterable data but instead takes the inputs from the '*Calculations*' tab. The graph is a plot of the power dissipation in each IC package verses the output power or output power per channel if more than one channel is available. The graph will automatically take into account stereo or three channel parts and show the total amount of power dissipation in a single IC package. The y-axis is auto scaling for readability for all parts under all conditions of operation. The graph is also accurate for power dissipation for each IC in a bridge or parallel configuration but the Output Power scale will be ~ ½ of the actual output power of a bridge configuration and ~1/X scale for parallel operation where X is the number of amplifiers in parallel. This number is shown in the Yellow highlight box just below the '*Number of ICs*' user enterable blue box in the Parallel Mode section. For mono part numbers the '*Number of ICs*' and '*Number of Power Amps*'. will be the same number. For stereo part numbers the '*Number of ICs*' will be ½ the '*Number of Power Amps*'. This graph is to assist in thermal design and power supply design. Total supply power can be found by adding power dissipation and output power.

Helpful Tips:

Finding the right part for a particular application.

In general, more powerful parts are more expensive (due to die size). Start with a part number on the left and change part numbers as needed to remove warnings moving one part to the right each time.

Lower -3dB frequency

Based on a combination of C_{in} and R_{in} with C_i affecting the feedback frequency range. Increasing the values will lower the –3dB point.