High-Performance Amplifier Data Sheet Specifications: Read Between The Lines

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The data sheets of today's high-performance amplifiers are strategically written to sell the amplifier rather than display its performance under typical conditions. Care must be taken to ensure the amplifier will perform as you expect in your application. This TechNote explores some of the typical gotchas hidden in the data sheets and provides insight on how to obtain the performance listed in the data sheet.

Ac Specifications

The typical amplifier data sheet is broken into two main sections, ac and dc performance. A high-speed amplifier is typically *graded* by its ac performance. So, manufacturers specify the amplifier under the optimal conditions that best highlight the ac performance. Bandwidth (BW) and slew rate (SR) are the two most common ac specifications. The BW specification provides the amplifier manufacturer the most room for embellishment. These are the most common conditions that affect bandwidth:

- Output swing
- Load
- Gain (for voltage feedback amplifiers)
- Feedback resistance (for current feedback amplifiers)
- Supply voltage

Output Swing

Bandwidth is typically specified as small signal (BW_{SS}) or large signal (BW_{LS}). Also look for the peak-to-peak output voltage level. BW_{SS} is typically $V_O < 0.2\ V_{PP}$ and BW_{LS} is typically $V_O \geq 2\ V_{PP}$. If no indication is provided, the bandwidth number specified is more than likely BW_{SS}. Amplifiers with low to moderate slew rates, SR < 500V/µs, will typically have the BW Vs V_O relationship shown in Fig. 1. Higher output swings reduce bandwidth.

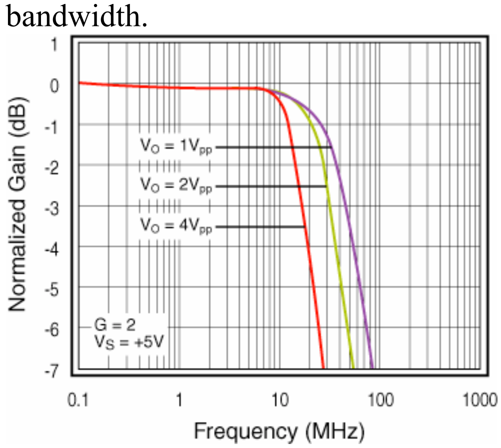

Fig. 1: BW Vs V_O

Load

In many high-performance amplifiers, bandwidth is also affected by the size of the load. Today's designers amplifiers use techniques to limit bandwidth changes for various loads. Fig. 2 shows the relative indifference the FHP3130 has with loads from 50 Ω to 5 kΩ.

Although this amplifier shows little variation, it is in the system designer’s best interest to review the data sheet. If no indication is provided, assume a high impedance > 1 kΩ load. In some amplifiers, BW will decrease as the value of the load decreases and some amplifiers may not be able to drive loads under 150 Ω.

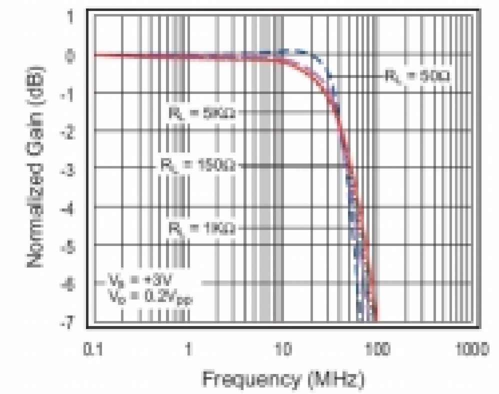

Fig. 2: FHP3130 Shows Minimal BW Vs R_L Variation

Gain And Feedback Resistance

The specification table usually lists BW at G = 1, also called unity-gain bandwidth or UGBW, because it results in the highest BW number.

Voltage-feedback amplifiers have a direct gain-bandwidth relationship. In either inverting or non-inverting topologies, as the absolute value of the gain increases, the bandwidth decreases (see Fig. 3).

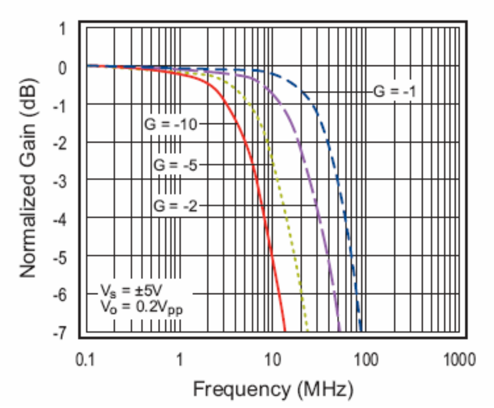

Fig. 3: BW Vs Gain

The gain-bandwidth product (GBWP) is typically provided in the specification table. GBWP is the product of the closed-loop gain of an amplifier and the bandwidth in that gain configuration. Ideally the GBWP remains constant and can be used to estimate the amplifier’s bandwidth for various gains.

For example:
GBWP = 100 MHz; BW at G = +10 = 10MHz; BW at G = +5 = 20MHz. A plot of BW Vs Gain will typically be provided; this will also help determine if the amplifier will provide adequate BW in an application.

Current-feedback amplifiers are known for their gain-bandwidth independence. BW is, however, affected by the value of the feedback resistor and the manufacturer's data sheet will provide a recommended value. The feedback resistance will vary with gain and an excessively large or small value will compromise stability. Within reason the feedback resistor can be used to adjust the frequency response. As a rule of thumb, if the recommended feedback resistance is doubled, the bandwidth will be cut in half.

Supply Voltage
BW is also affected by supply voltage (V_S), decreasing with lower V_S. Manufacturers will typically specify the amplifier under the most optimal condition, highest V_S.

Slew Rate
Slew rate is normally specified at large signal. Ensure that the slew rate provided in the data sheet tracks with the large signal bandwidth. $SR = 2\pi \, BW_{LS} \, V_p$. Where V_p is the peak output voltage.

The other ac specifications, like noise and distortion, vary with frequency and are specified at a certain frequency. Look for plots in the data sheet that show the noise or distortion variation versus frequency. Distortion will get worse as frequency increases, whereas noise will get worse as the frequency approaches dc. Distortion will also worsen with increasing output amplitude.

Dc Specifications

In general, the dc specifications provided in an amplifier data sheet are measured using industry standard techniques. Output current is a dc specification that exhibits the potential gotcha to a system design engineer. Most manufacturers specify output current with the output centered between the supplies: this is the least strenuous condition. This must be taken into consideration when running from a single supply and operating dc-coupled.

Summary

When shopping for a high-speed amplifier, be sure to read the fine print and review the plot section of the data sheet. After thorough investigation, the true behavior of the amplifier will become evident.

About The Author

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