Breitband-Verstärker und ihre Kennwerte

Immer mehr Technologien, wie Drohnen, mobiles Internet, medizinische Überwachung, Internet of Things oder autonomes Fahren, beruhen auf Funkverbindungen und benötigen Frequenzressourcen in einem begrenzten Spektrum. Das unerwünschte Resultat ist ein gestiegenes Potential für gegenseitige elektromagnetische Beeinflussungen. Diese können kleine Abweichungen, aber auch komplette Blockierungen in Produkten, Verfahren und Systemen verursachen. Daher wachsen die Anforderungen an die EMV. Das bedeutet auch erhöhte Anforderungen an EMV-Tests. Eine wichtige Rolle spielen hierbei speziell dafür entwickelte Verstärker. In diesem Beitrag werden die Charakteristika solcher Verstärker von einem renommierten Hersteller näher definiert.

The foundation for proper selection amplifier is in understanding critical amplifier specifications. While amplifiers have a broad spectrum of specification parameters, there are a few key parameters to keep in mind relating to EMC testing. These parameters and their relevance to EMC testing are shown on Table 1.

Amplifier Input Requirements

How much input power is required to achieve full rated output power is a common concern when choosing an amplifier, AR and other amplifier manufacturers have specified an input of 1 mW (not the case for every manufacturer). While the rated input power is defined as 1 mW, most amplifiers provide rated output power with less than 1 mW input. This is because the specified value will often have built-in conservatism.

AR Amplifier typical input levels:

- Signal Generator: 1 mW (0 dBm)
- Function Generator: 1 mW (224 mV on 50 ohms)
- Max input before damaging amplifier: 13 dBm (20 mW)

Note: Pay close attention to an amplifier's maximum input. It

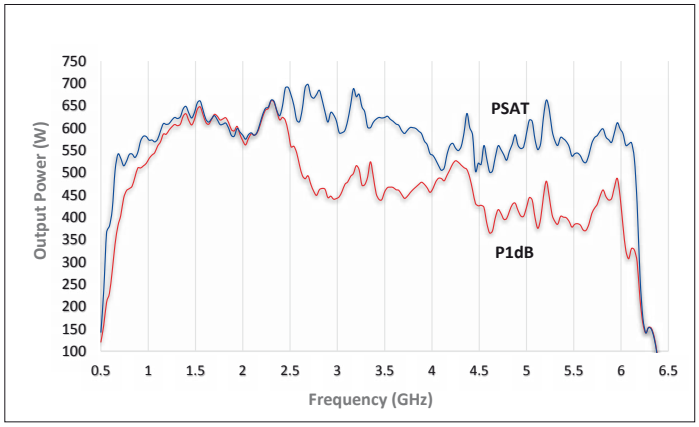

Figure 1: Performance of the AR Model 500S1G6 amplifier. This amplifier operates over the 700 MHz to 6 GHz frequency range

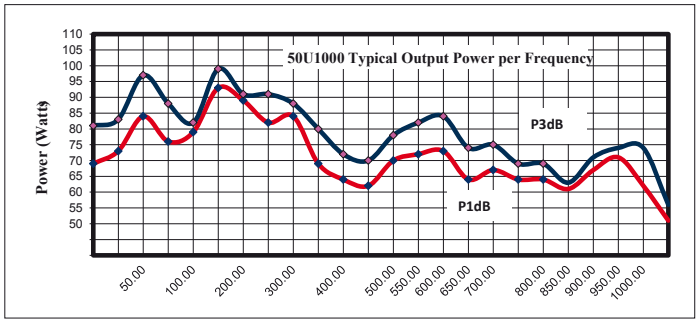

Figure 3: Example of P1dB & P3dB levels

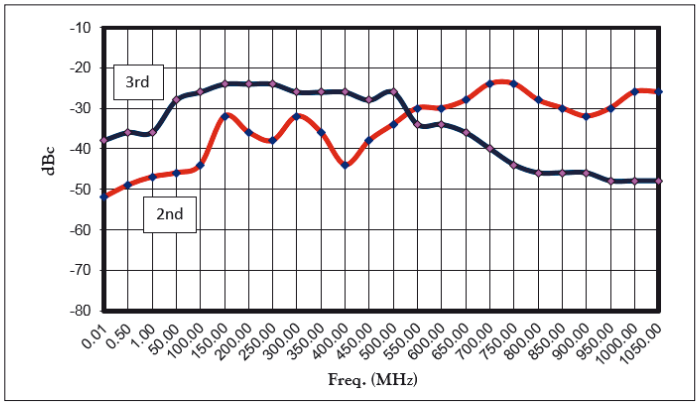

Figure 4: Typical harmonics @ 20 W, AR Model 25U100

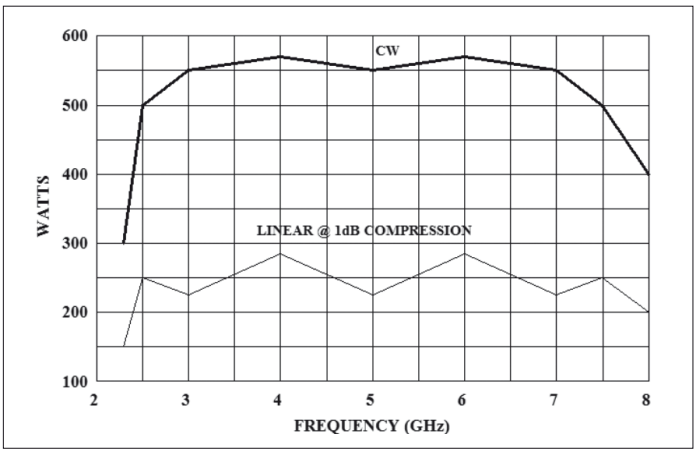

Figure 2: Example of TWTA 500T2G8 output power over frequency

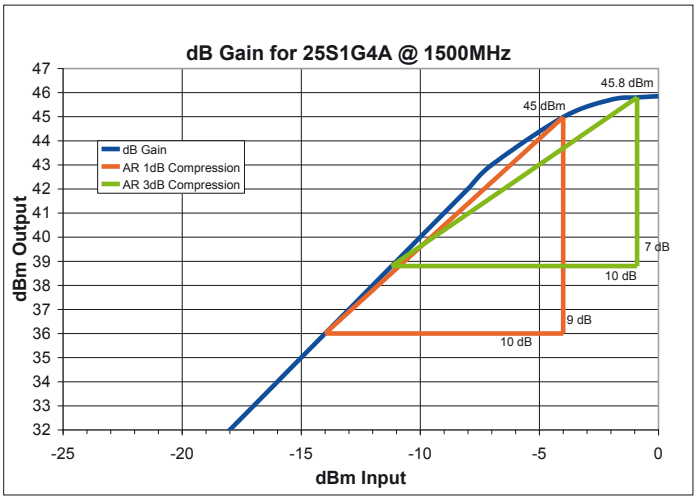

Figure 5: Linearity characteristics

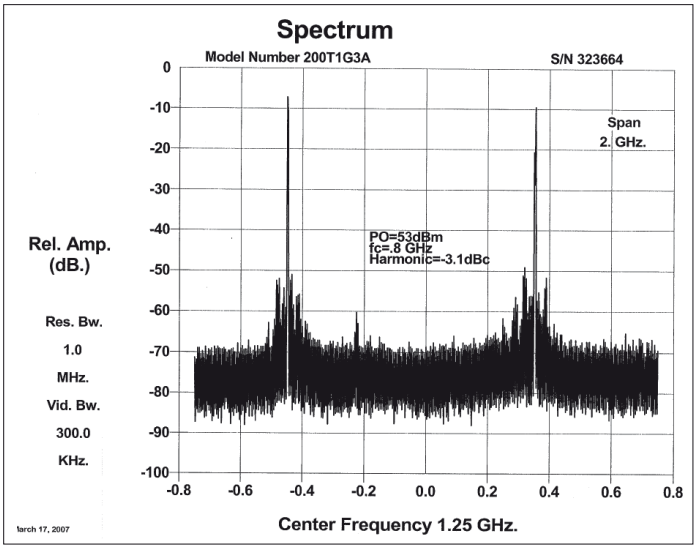

Figure 6: Fundamental signal and harmonic, Model 200G1T3A

Parameter	Definition	Relevance
Frequency Response	Instantaneous operational frequency band	Some solid-state amps will operate just outside of the band with significant power reduction (Figure 1), whereas TWTAs have much harder cutoff due to waveguide (Figure 2).
Rated Output Power	Power generated by amp at 1 mW (0 dBm) input	Important power rating for applications where there are not strict linearity requirements (MIL/DO/Automotive). 'Rated' power is similar to (but not necessarily) 'Saturated' power.
Power Output @ 1 dB Compression	Power generated by amp at the 1 dB compression point	Important power rating for applications where there are strict linearity requirements (IEC/EN). Can be considered the top-end of linear power. Amp saturation increases after P1dB. Shown in Figure 3 is an example of P1dB and P3dB levels.
Harmonic Distortion	Amplitude of harmonic distortion produced by amp	Majority of AR amps are -20 dBc @ P1dB, see Figure 4. Many test specifications require at least -6 dBc. See App Note #60.
Gain	Extent to which an analog amplifier boosts a signal, usually expressed in terms of power	Many amplifier factors are a result of an amplifier's gain, such as output power, size, and the power required to operate that amplifier. Gain is called S21 using S-parameter terminology.
Flatness	Flatness specifies how much the amplifier's gain can vary over the specified frequency range.	Variations in the flatness can cause distortion of signals passing through the amplifier.
Efficiency	Ratio between the power of the output and total power consumption	Although Class A amplifiers are inherently inefficient, design techniques can improve amplifier efficiency as seen by AR's amplifiers which are smaller and require less input power than other amplifiers equivalently rated.
Pulse Capabilities	Limitations on Pulse Width, Pulse Rate and Duty Cycle	Pulsed SSPAs and TWTAs produce higher-peak power than CW-power, but are limited in how much RF can be passed through amp. See App Note #39.
Mismatch Tolerance	Ability of an amplifier to handle un-matched loads and thus varying amounts of reflected power	In EMC applications, especially at lower frequencies, transducers (antennas/clamps etc.) can be a very poor match to 50 ohms. Field reflections/standing waves can cause significant reflected power as well. During test, it is important to continue to deliver forward power as well as protect the amp from reflected power damage. See App Note #27.

Table 1: Amplifier Specification Definitions (TWTA Traveling Wave Tube Amplifier, SSPA Solid State Power Amplifier)

varies by vendor and possibly by model family.

Amplifier Output Requirements

The input signal strength has a profound effect on the amplified output signal. It determines the operating region and thus, the degree to which the amplifier output is compressed. Ideally, an amplifier will simply amplify the input signal without adding any additional signals or artifacts. Unless operated in the extreme linear region, amplifiers will distort the input to some degree. The extent to which the amplifier affects the input signal is a function of the output compression. The higher the amplitude of the input signal, the risk of higher the output compression increases. At the 1dB compression point there may be a slight flattening at the top and bottom of a CW sine wave signal. As the amplifier is driven further into saturation, additional distortion will become apparent and eventually the CW input signal will approach a square wave output. Distortion creates new unwanted signals at frequencies not present at the input of the amplifier, as observed in the frequency domain with a spectrum analyzer. The 1 dB and 3 dB compression points are shown in Figure 5. Figure 6 shows the effect of driving a TWTA amplifier into saturation. This figure shows the harmonic having only a slightly lower amplitude compared to the fundamental signal. This situation causes unnecessary problems for the test engineer. ◄

HIRF Test System

Quelle:
Application Note #77
Specifying RF/Microwave Power Amplifiers for EMC Testing
AR RF/Microwave Instrumentations
info@arworld.us
www.arworld.us