Klassengesellschaft:

Grundtypen von EMV-Verstärkern

Heutige und zukünftige Funk-Technologien beanspruchen Frequenzressourcen in einem begrenzten Spektrum, sodass sich das Problem der gegenseitigen elektromagnetischen Beeinflussung verschärft. Daher wachsen auch die Anforderungen an die EMV-Mess- und Prüftechnik. Eine wichtige Rolle spielen hierbei speziell dafür entwickelte Verstärker. Nachdem in Heft 1 deren Kennwerte erläutert wurden, stellt dieser Beitrag die Grundtypen solcher EMV-Verstärker näher vor. Diese Kenntnisse sind wichtig für die Auswahl eines EMV-Verstärkers.

1 to 2 GHz, 1000 W Solid State Pulse Amplifier

Quelle:
Application Note #77
Specifying RF/Microwave Power Amplifiers for EMC Testing
AR RF/Microwave Instrumentations
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In general EMC amplifiers range in type, such as: Solid State, TWTA, CW, Pulse, and their class of operation – Class A and Class AB.

Class A and Class AB Amplifiers

Class A, and Class AB amplifiers have their strengths and weaknesses. Class A amplifiers are the most robust. They provide the highest levels of mismatch tolerance which is needed when significant RF levels reflect into the amplifier. This is a common effect with many EMC antennas and other transducers. Additionally, linearity and harmonic distortion are much better with Class A amplifiers compared to other amplifier classes.

Class AB amplifiers have their own benefits. Generally, the cost of the amplifier is less than Class A amplifiers. The physical size of these amplifiers is also generally smaller. These amplifiers are much better suited for use with matched loads. See AR App Note #27A.

Shown in Table 1 is summary of the differences between Class A, and Class AB amplifiers. A summary of mismatch performance for typical Class A and AB amplifiers is shown in Figure 1. The 100 W curve is representative of most AR amplifiers below 500 W. It is clearly seen that the amplifier delivers a Minimum Available Power (MAP) of 100 W irrespective of the load SWR, including output load opens and shorts. As output power increases it becomes increasingly difficult to absorb 100% of the reflected power uniformly. Hot spots at these elevated power levels can cause damage or at least affect reliability. Nevertheless, AR high-power amplifiers continue to offer 100% mismatch tolerance up to a load SWR of 6 (lower-power amplifiers deliver full power regardless of mismatch). Once this level is reached, the output power is limited to 50% of rated power.

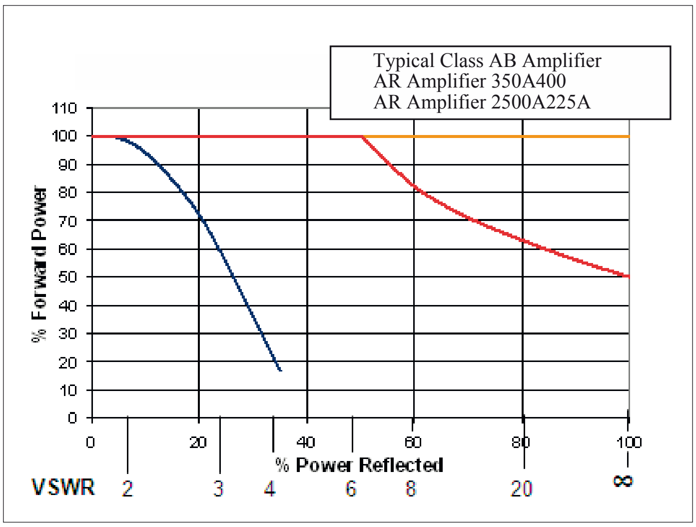

Figure 1: Minimum Available Power

For example, the AR model 2500A225A amplifier will provide a MAP of 2500 W up to a load SWR of 6. At this point, approximately 1250 W is reflected. From this point on, as load SWR increases the output power is gradually reduced until it reaches 1250 W for an infinite load SWR. Figure 1 clearly shows the advantage of this implementation when compared to the conventional "foldback" scheme used by typical Class AB amplifiers.

In practice, the AR's conservative SWR compromise of 6 works well in that the SWR of EMC antennas and transducers is often held to this value or better. If it strays beyond, rest assured your AR amplifier has sensed the increase and has implemented sufficient limiting to protect the amplifier from any damage.

Based on the above, mismatch tolerance can make the difference between meeting or failing the required power or field levels. As a result, mismatch tolerance is an important specification to consider when comparing offerings from different manufacturers, and where some manufacturers with use terms such as typical, or protection to confuse the issue.

Traveling Wave Tube Amplifiers

For years, when discussing microwave, high field-strength electromagnetic compatibility (EMC) radiated susceptibility testing, Traveling Wave Tube Amplifiers (TWTAs) were the only choice for wide frequency coverage, and power. TWTAs are lower cost solutions, in most cases, but do have draw-

Characteristic	Class A Amplifier	Class AB Amplifier
Output distortion	Low distortion, highest linearity	Higher distortion, poor linearity than Class A
Bias scheme	Output current flows for 360° of the input	Output current flows somewhere between 180 and 360° of the input
Ruggedness	Amplifier will safely operate without damage regardless of load mismatch	Output limits are generally used to protect the amplifier when operated beyond a stated level of mismatch
AC power to RF power efficiency	Less efficient	More efficient than Class A amplifiers
Construction	More components required to share the heat load	Less components required to share the heat load than Class A amplifiers
Size/Weight	Larger/Heavier	Smaller/Lighter than Class A
Cost	Higher than Class AB	Lower than Class A

Table 1: Comparison of Amplifier Class of Operation

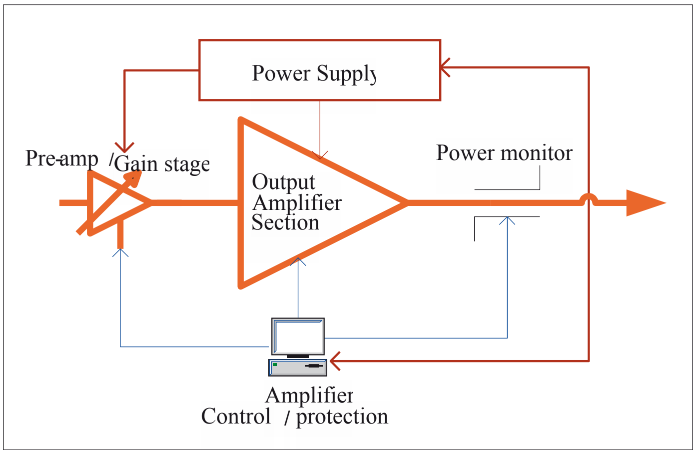

Figure 2: Basic Diagram of a Single Band Amplifier

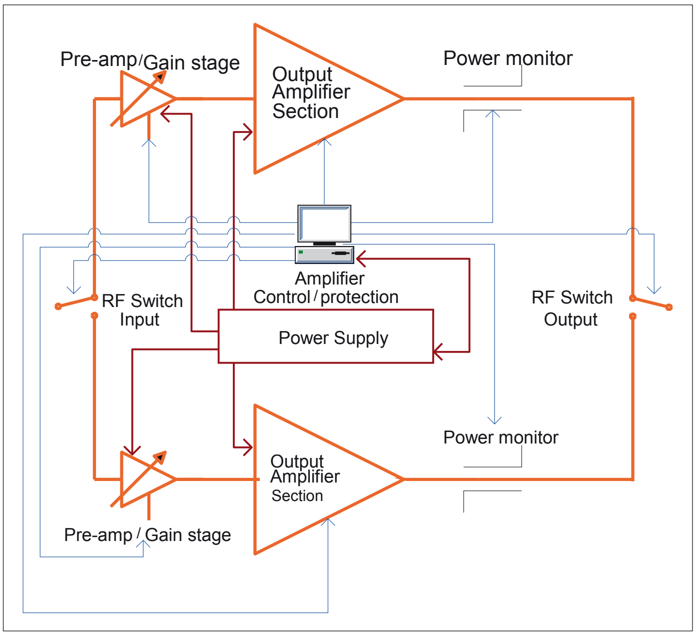

Figure 3: Basic Diagram of a Dual Band Amplifier

backs. Their unique properties allow them to be used in a pulsed mode, that can lower the total required average power, but maximize their peak power and thus reducing cost further. However, TWTAs produce high harmonics, have a greater noise floor, longer purchase lead times, longer repair times, and lower reliability than solid state amplifiers. Some advanced TWTAs combine multiple tubes together to reduce harmonic content and increase total power. Another solution to reduce harmonics is to use filters on the amplifier output.

It's important to remember that there are always losses associated with filters that must be considered for amplifier power sizing. The SWR associated with the filters is another consideration, which can cause amplifier foldback.

Solid State Pulse Amplifiers

The difficulties associated with pulse TWTAs are mitigated with a new, very attractive alternative. Solid State Pulse Amplifiers (SSPAs) now offer high-power RF levels that rival those of TWTAs. AR's SP-series amplifiers include various frequency ranges and output power levels to meet several standards and user requirements. These solid-state pulse amplifiers offer higher reliability, better mismatch tolerance, much better harmonic distortion, and better MTBF (Mean Time Between Failure) than TWTAs.

Dual Band Amplifiers

If a single band amplifier is not available over a desired frequency band, a dual band amplifier may be an attractive solution. A dual band amplifier consists of two amplifiers that are combined into one "box" with a single I/O interface, RF input and output, and two bandwidths equivalent to the two amplifiers it replaced. This approach simplifies the test setup.

While on the surface the system seems simplified, a closer look within the "box" reveals a different story. While the two amplifier modules in a dual-band amplifier may share a common power supply, the overall system is complicated by the fact that it now consists of not one, but two complex amplifier modules. Furthermore, additional RF switching, cabling and connectors are required which will adversely affect the RF output of both amplifiers. The additional components add insertion loss that may not present a problem at lower frequencies but can account for significant losses at higher frequencies. Also, simultaneous signal generation across the entire band is not possible, due to the required switching from one frequency band to the other. So, as you can see there are pros and cons to dual band amplifiers.

Figure 2 and Figure 3 show the schematic differences between a single band and dual band amplifier, respectively. ◄