CHOOSING AN AMPLIFIER FOR SUSCEPTIBILITY TESTING

The ultimate value of susceptibility and compatibility tests can only be as good as the performance of each of the system components. When all the testing is over and the tested item is out in the field, many *un*controllable factors enter into most day-to-day EMI situations (physical movement of interference sources and affected equipment; unexpected objects entering and leaving the field; meteorological phenomena; etc.). And so it is important at the testing stage to minimize the variability of the test equipment, in order to rule out at least this possible source of error.

It is generally agreed that the establishment of a controllable and measurable field is paramount before susceptibility testing can even begin. However, while requirements for signal sources (sweep generators, frequency synthesizers), antennas, and shielded enclosures are generally familiar to most practitioners, this is not necessarily true for amplifiers.

Historically, amplifier performance specifications have tended to confuse even those who work frequently with them. Comparing one amplifier with another is no simple task, based upon universally accepted parameters, for the parameters have never been standardized as they have in other areas. One manufacturer's concept of, say, the power output of his amplifier, may vary considerably from that of another manufacturer. This is not to say that one is falsifying his product's performance while the other is telling the whole truth. It merely means that it pays to investigate thoroughly just what terms are being used and what to expect of an amplifier when it is put into service. For example:

Power

For practically every research application, the reliability of an amplifier's output-power rating is of extreme importance. Yet many amplifier specifications are stated as "peak" or "maximum" power, others as "nominal" power, and still others as "minimum" power.

Peak or maximum power is deceptive in that it indicates only the level that might be expected under optimum conditions, within usually a limited bandwidth, and with the gain control set all the way up. This is not a promise of linearity, flatness, or even of performance at all at certain input-signal strengths.

Nominal power, when used by some manufacturers, is a more useful term, since it indicates (or should indicate) that the power output can never be less than the amplifier's rated power *minus* the flatness specification. The converse is also true, as shown in Figure 1: The output power can never be *greater* than the amplifier's rated output *plus* the flatness specification.

For susceptibility and compatibility testing, the most meaningful and useful way to express amplifier power output is by *minimum power*. This specification assures the user that the amplifier will deliver *at least* the rated power across its entire bandwidth when driven with a specified input signal. Only if the input drive is reduced at the signal source or at the amplifier's attenuator control will the output fall below the amplifier's minimum rated power. See Figure 2.

An altogether reassuring inference that can be taken from Figure 2 is that the specification of "minimum power" cannot predict maximum power, since maximum will be the sum of the minimum plus the flatness. It is always better, then, to have reserve power that can be reduced by the front-panel control, to avoid possible distortion from an overloading input signal, than to be faced with insufficient power at certain frequencies and/or input-signal levels.

Bandwidth

Particularly for interference-testing applications, the right combination of broadband capability and high power is a requirement. Depending on the type of emanations being tested for, bandwidth may be as wide as 200 MHz or even wider. Some applications call

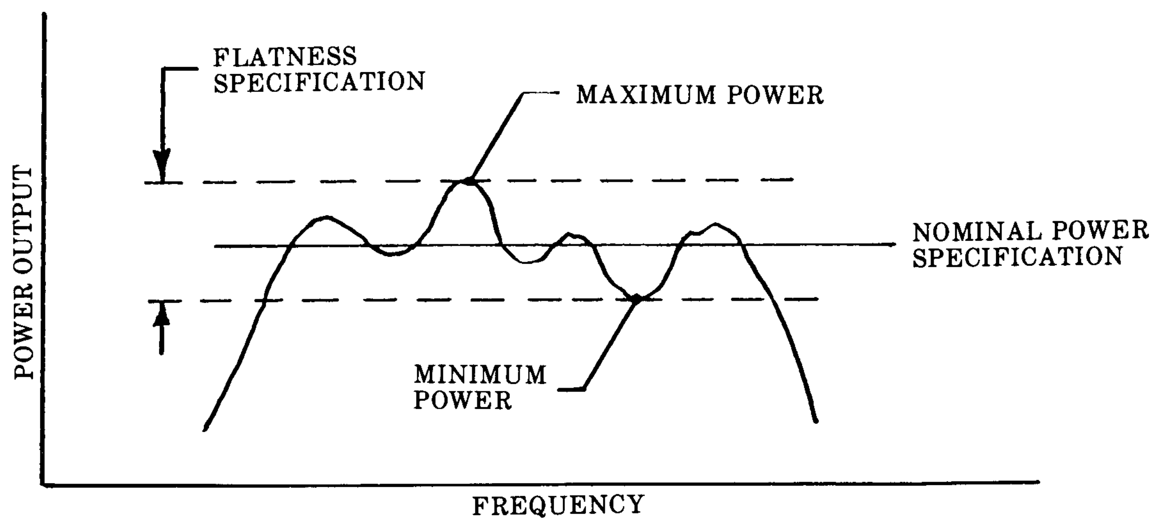

Figure 1

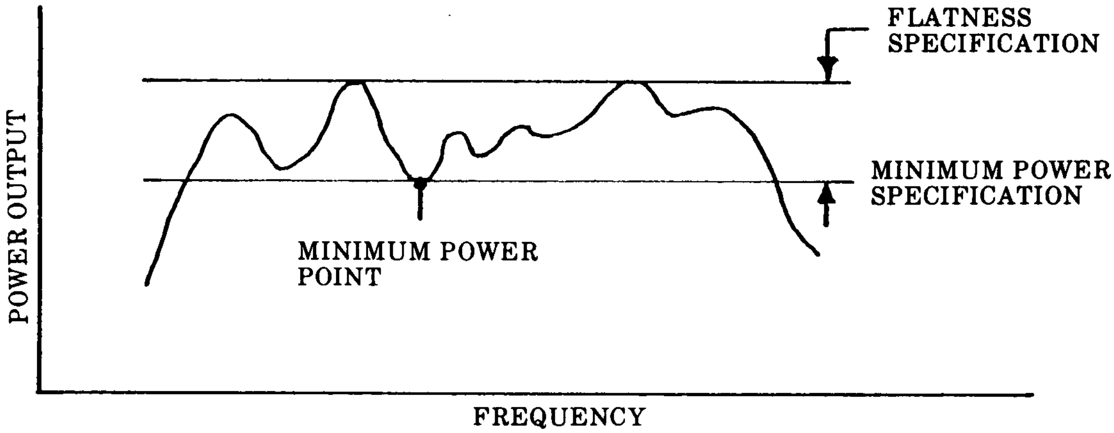

Figure 2

for a limited rf bandwidth, such as 300-500 MHz, and some require a very wide sweep range such as 1-1000 MHz. Others, while requiring amplifier response in the MHz to GHz range, may be examining only a suboctave band within that range. In any case, no single amplifier can be expected to be all things to all people, and it is best to know what the upper and lower limits of frequency will be for any application before the amplifier is selected. Most laboratories find a need for many different amplifiers to meet their requirements, and the manufacturer who can supply the widest range of power and bandwidth, with good linearity and freedom from distortion, is clearly the best supplier to deal with.

It should be emphasized that there is an inverse relationship between clean, instant bandwidth and power output. Since maximum power and maximum bandwidth cannot be achieved in the same amplifier at the present state of the art, we satisfy ourselves with tradeoffs which can be accommodated very well with such measures as more powerful signal sources, more efficient antennas, SNR conditioners, and leveling preamplifiers. However, usually the best frequency synthesizer can produce only 10 mW of rf signal, and so the major responsibility for obtaining a suitable field remains with the power amplifier. This fact makes it even more apparent that the researcher must insist on the amplifier with the best, most honestly and conservatively-stated power and bandwidth specifications.

Mismatch Immunity

Since susceptibility testing is *per se* an activity during which unfamiliar and grossly mismatched loads are placed upon the article under test and the testing system itself, the power amplifier selected must be able to withstand any degree of load impedance without damage to itself or (alternately) shutdown of the system. Energy reflected from a shielded room typically results in extremely high VSWR loads, which many amplifiers cannot accept. Also, poor cable connections are a source of mismatch which, at best, can produce erroneous readings, or, at worst, can demolish an amplifier not able to withstand such abuse.

Therefore, the researcher should satisfy himself that all the amplifiers used in EMI susceptibility testing be totally immune to even a short or open-output condition. But only a few amplifiers are available which cover the widest range of power and frequency with total immunity to load impedance.

Summary

Obviously, the desired field level for testing begins with the available output power of the source (usually no higher than 1 mW with sweep generators or 10 mW with frequency synthesizers), and so must depend on the gain of the antenna, the size of the test object, and the true power of the rf amplifier chosen for the application.

Broadband untuned amplifiers which deliver "instant" full bandwidth without need for adjustment as the test proceeds through the selected frequency range are to be desired over equipment such as tuned power oscillators or so-called broadband amplifiers which in fact cannot accommodate a full frequency sweep without adjustment. This instant-bandwidth capability makes tedious point-to-point measurements unnecessary, and permits the realization of the full potential of a swept signal source.

The gain of the amplifier should be closely checked out for flatness and stability. Susceptibility testing should, as much as possible, produce the same findings one day as another day, barring changes in setup and conditions. Therefore, the amplifer's stability and reliability throughout its bandwidth is of major importance in assuring repeatability of results.

As the field of susceptibility testing broadens, it becomes increasingly evident that reserve bandwidth, though it may not be called on today, will eventually turn out to be a welcome feature on any power amplifier under consideration. In fact, in the combination of power and bandwidth, the more important consideration in most laboratory-scale experiments is probably bandwidth, since clean, flat, instantaneous bandwidth is harder to find than sheer power.

This article was provided by Donald R. Shepherd, President, Amplifier Research Corporation, Souderton, PA.