CONSIDERATIONS FOR TEMPEST RECEIVER SELECTION

In a previous article[1] sensitivity of receivers for TEMPEST applications has been discussed. In that article, the point was made that sensitivity was usually the first performance parameter to be compared when receiving equipment is considered for critical applications. Sensitivity of receivers is best compared in terms of noise figure. As an aid to this comparison, the nomograph from the previous article has been reproduced.

Sensitivity, however, is only the beginning. A receiver may have the necessary sensitivity and yet be unsuitable for TEMPEST use. Other performance factors and operating features must be considered. The following discussion is applicable to all critical receiving applications. The user with particular interest in TEMPEST may refer to NACSEM-5100 and related documents to determine which of these considerations are most relevant to his requirements.

Dynamic Range

This is the feature that most quickly suffers when a receiver is designed for high sensitivity. Users should be aware that the dynamic range of a receiver may be limited not only by input overload, but also by constraints of I.F., detector or even of output circuitry. Because TEMPEST-type receivers are designed to give the operator great lattitude of control settings, a single figure for dynamic range cannot meaningfully be quoted. Results will vary with application, and with operator adjustment. The most useful data that can be given by the receiver manufacturer is individual dynamic range specifications for various circuits in the receiver. The user can then make comparisons between different receivers, and consider the factors most important to his application.

Input dynamic range is usually specified in terms of "intermodulation intercept." To be valid, test data must be taken with two signals both of which are within the receiver input passband. Data that does not specify such test conditions may be suspect.

I.F. dynamic range may not be quoted directly, as this figure is a function of the bandwidth employed. A TEMPEST receiver may have eighteen or twenty different bandwidths available. However, in a properly designed receiver, the limit of dynamic range for all I.F. bandwidths will be directly related to maximum available I.F. output level. This latter specification may be readily compared.

Detector dynamic range can be a limiting factor in some applications. A.M. detectors in particular cannot easily be made with high dynamic range. Figures for this detector should therefore always be checked. It is also wise to note if the receiver under consideration has the flexibility to allow the operator to make optimum use of the available A.M. detector dynamic range. Manual I.F. gain control is a must. Separate control of predetection gain is also useful.

Spurious Responses

This can be a touchy subject with makers of receivers. In days long gone, there was only one type of spurious response of concern in a superhetrodyne receiver: the unintended response of the receiver to the presence of an external signal at a frequency other than the desired frequency. Common examples of such spurious responses are images and I.F. feedthrough. Today, such problems are not too difficult to overcome, with the result that specifications for image rejection and I.F. feedthrough are commonly quoted.

Modern receivers, however, have an entire new class of spurious response: the apparent reception of a signal at a frequency at which no external signal whatever is applied. These responses are called "internal spurious responses," or, more commonly: "birds." Such problems arise because the modern receiver has not just a single local oscillator, tracked to the tuned frequency, but rather an entire host of fixed and tunable oscillators. TEMPEST receivers in particular face this difficulty, as a complex internal oscillator system is generally required to support necessary receiver features.

The receiver designer has the problem of making a receiver that will respond to sub-microvolt external signals, and yet not respond to internal signals that may well be 120 dB stronger. This is a formidable task, with the result that specifications for internal responses are not so commonly quoted. If such data is lacking, the prospective user should not hesitate to request this information from the manufacturer. The number and the effective level of "birds" in a well designed receiver should be known values. The user should expect the number to be very few, and the level to be only moderately above the sensitivity threshold of the receiver.

I.F. Shape Factor

For a communications-type receiver, and ideal I.F. filter might have a rectangular response in the frequency domain. It might, that is, if intermittant noise or signals need not be dealt with. The old-time C.W. radio operator will be familiar with the tendency of his narrow crystal filter to "ring" so that high-speed code signals could not be copied. The point to be noted is that the optimum filter response for a given application is not necessarily the sharpest. For critical applications, the response of a receiver to impulsive noise or signals should be known. I.F. shape factor gives an indication of this response. Alternately, impulsive overshoot of the receiver I.F. filters may be quoted.

Miscellaneous Features

If automation is contemplated as a future requirement, make certain that external control can be applied to the receiver under consideration. Check the cost of any conversion or interface that may be required.

If portability is necessary, don't forget to check the size and weight of the equipment. Be certain too that the operating temperature range suits the expected environment.

The type of input preselection employed can also be of concern to the user. The designer faces a trade-off between the improved input protection that can be obtained with tracked filtering, versus the lower insertion loss usually possible with fixed-tuned filters. If tracked filtering is used, be certain that the noise figure specification can be met with the input filter in operation. If fixed tuned filters are employed, consider your application to see if sufficient input protection is available at all frequencies.

The manual tuning controls should not be taken for granted. Any objectionable characteristic will grow in importance as the time spent using the equipment increases. Modern synthesizers can give nearly the same effect as truly continuous tuning. The best advice here is to actually operate the intended equipment. Any tuning idiosyncrasies will probably not be apparent from the data sheet.

Operating factors other than tuning can also be important. Is the display easy to read? Can all control settings be plainly seen? Are overload indicators provided to let the operator know when he has made an unacceptable adjustment of input signal versus gain and bandwidth? Is the equipment reliable? Such questions can sometimes be answered from the manufacturers literature. But don't overlook another excellent source: people in the TEMPEST community tend to know each other. An old acquaintance who uses the equipment you are considering may be the best "data sheet" of all.

References

(1)"Performance Considerations for TEMPEST Receivers," ITEM 1980, PPS 176-180.

---

*This article was prepared for **ITEM** by Ernest Greenwald, Manager, R.F. Systems, Dynamic Sciences, Inc., Van Nuys, CA 91406*