



Advanced Noise Technology

Techtrol Cyclonetics, Inc. The Leader in ultra low noise technology

REAL TIME AMPLIFIER NOISE MEASUREMENT USING THE 3712 RESIDUAL NOISE MEASUREMENT SYSTEM

by Perry C. Bates
Techtrol Cyclonetics, Inc.

Recently, forty specialized amplifiers were purchased for a state of the art X-Band multiplier chain. Of the forty amplifiers purchased, only about half met the required performance criteria. Arrangements were made to provide the amplifier manufacturer with a 3712 Real Time Noise Measurement System to rework the amplifiers. By using this system, the problem which caused the amplifiers not to meet the performance criteria was determined within four hours. The amplifiers were modified and retested using the 3712 system to confirm their performance within an additional eight hours. The specifications for the amplifier are below.

AMPLIFIER SPECIFICATION TCI P/N 905-A2	
FREQUENCY RANGE	9.0 to 11.0 GHz
SMALL SIG. GAIN	24 dB min. 28 dB max.
GAIN FLATNESS	±.5 dB @ 25°C
GAIN VARIATION	
OVER TEMPERATURE	±.5 dB
NOISE FIGURE	5 dB max.
P1dB (dBm)	24 dBm min.
PM NOISE @ 10 KHz	-165 dBc/Hz max.
AM NOISE @ 10 KHz	-153 dBc/Hz max.
INPUT POWER HANDLING	+20 dBm max. CW
VSWR (:1)	2/2 i/o
OPERATING VOLTAGE	+12 VDC
OPERATING CURRENT	< 500 ma
SPEC. TEMPERATURE	-20°C to +70°C
CONNECTORS	DC - Solder Pin RF IN - SMA (F) RF OUT - SMA (F)

The AM noise was measured to evaluate the performance of the amplifiers. In most cases, amplifiers are specified for PM noise. The PM noise, however, has been found to be a direct result of deficient AM noise performance. AM to PM noise conversion within the amplifier is the primary factor which results in the lacking performance of the amplifier. Under gain compression, amplifiers exhibit useful noise signatures, which can be used to determine the causal effect reducing amplifier performance. Semi-conductor selection, bias configuration and level, inter stage matching, and voltage regulator noise, to name a few factors, can all effect amplifier performance. A block diagram is shown in Figure 1.

AM and PM REAL TIME NOISE MEASUREMENT
USING THE 3712 SYSTEM ANALYZER

AM Noise of the Carrier	(NOISE SIGNATURE INPUT)
Amplifier Residual PM Noise	
Amplifier Residual AM Noise	(AMPLIFIER NOISE)
Amplifier Spurious Components	

Resulting PM Noise	
Resulting AM Noise	(NOISE SIGNATURE OUTPUT)
Resulting Spurious Components	

The Input and Output PM and AM noise to the amplifier are measured using an absolute noise measurement technique. Where extremely low PM noise is required, two carrier sources are used to make the PM noise measurement. AM noise is measured from only one carrier source. If a single carrier source is used to measure PM noise, such as is shown in Figure 1, a residual noise measurement will result. The carrier source PM noise is canceled in the phase discriminator with only the residual noise of the amplifier being measured. The phase discriminator acts to cancel both carriers which are fed into it and base band noise from the discriminator results. Using this process effectively converts the small phase noise fluctuations into voltage fluctuations which can then be measured with a low frequency spectrum analyzer.

AM noise is a different issue. Only one carrier source is measured using a detector diode and therefore carrier cancellation can not be used. As a result, only absolute AM noise can be measured. Additive or residual noise can only be determined by subtracting the output AM noise results from the input AM noise. If a carrier source which has lower noise than the amplifier residual noise is used as an input signal to the amplifier, the inherent residual noise of the amplifier can be determined. The AM noise measurement technique is however, the same.

The 3712 is a Real Time Measurement System which allows very accurate and rapid measurement of residual PM and absolute AM noise. Amplifiers can be monitored while changes are made to them. Within a few seconds of turning an amplifier on for the first time, its performance can be determined. With signature identification techniques, corrections take minutes.

Even though each amplifier engineer designs uses different design techniques and components, there are a limited number of additive noise signature types. With a sampling of many amplifier manufacturers, it has been found that the noise personality of each manufacturer is different. Semi-conductor selection is another critical issue for extremely low noise amplifiers. Again it has been found that not every semi-conductor is useable, even from the same lot. The 3712 Real Time Measurement System provides a platform to select usable semi-conductors very quickly.

Several frequency configurations of the 3712 Real Time Measurement System are available. The system can be supplied with or without a low frequency spectrum analyzer.