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To: RFI Group

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Subject: Comparison of spectrum analyzers

A] Key parameters

The key performance parameters for a spectrum monitor are:

- 1] Input IP2 and IP3 referred to an input noise equivalent of 300 K.
- 2] The spectral processing efficiency in fractional units.

B] Explanation

Input IP2 and IP3 have little meaning unless they are used in conjunction with the spectrum analyzer noise figure. For example the input IP2 and IP3 for the NI are +48 and +19 dBm respectively. But the NI has a noise floor of -76 dBm/MHz which corresponds to a noise figure of 38 dB. In this case a perfect amplifier of 38 dB would be needed to reduce the noise to 300 K making the IP2 and IP3 for 300 K noise +10 and -19 dBm respectively.

Spectral processing efficiency is the fractional equivalent integration time at each resolution frequency. For example if a 1MHz filter is scanned from 30 to 1500 MHz with zero dead time each frequency will have an integration time of 1/1470 times real time or a spectral processing efficiency of 0.07%.

C] Comparison of 7 analyzers

Analyzer	IIP2 (dBm)	IIP3 (dBm)	DR2 (dB)	DR3 (dB)	Spectral eff (percent)*
NI	+10	-19	62	63	0.0001
Tek RSA3303A	+14	-3	64	74	0.001
R&S FS300	-4	-22	55	61	0.07
Agilent E4411B	+14	-13	64	67	0.05
Anritsu MS2721A	0	-16	57	65	0.07
Anritsu MS2711D	+2	-18	58	64	0.07
Acqiris AC240	-3	-32	55	55	100
* For case of analyzing 30 to 1500 MHz with 1 MHz resolution.					

For a particular resolution we define the dynamic range as the amount we need to reduce the signals with the strength of IIP2 or IIP3 in order to put the intermod at 300 K (-114 dBm/MHz).

For IIP2 (1 MHz resolution)

$$DR2 = (IIP2 + 114)/2$$

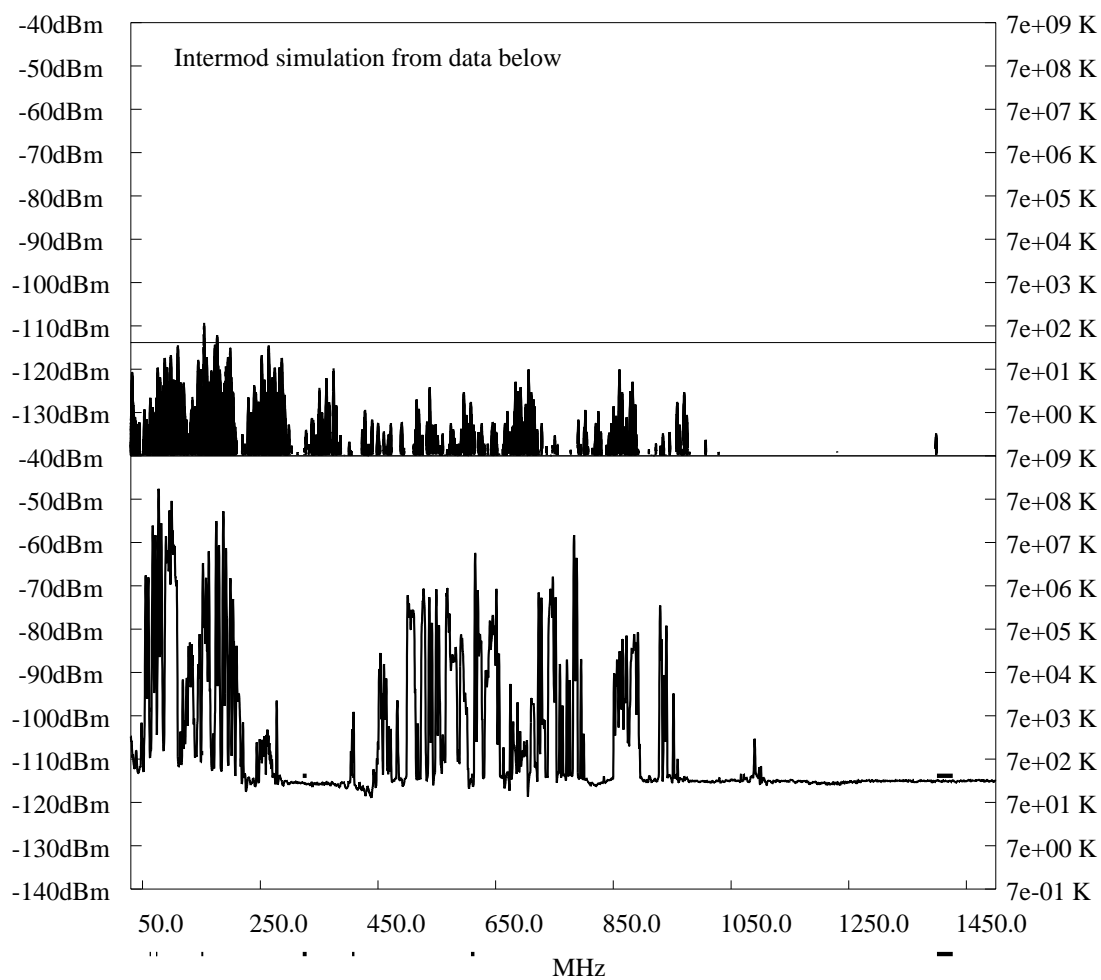
And for IIP3

$$DR3 = 2(IIP3 + 114)/3$$

The formulae tend to the worst case because they assume equal signal strength for the signals producing the intermod. It should be noted that the IIP2 normally sets the dynamic range. But it should also be emphasized that while prefilters can eliminate the IM2 products the IM3 products cannot always be eliminated by filtering if the strong signals are close in frequency. The R&S has the worst dynamic range but the spectral efficiency is close to the theoretical optimum for scanning filter.

The “real time” NI and Tektronix analyzers have much improved spectral processing efficiency when used with higher resolution because the FFT processing simultaneously provides a large number of spectral channels.

The Acquiris AC240 is a direct sampling FFT analyzer with double buffering so that data is continuously processed which results in 100 percent spectral efficiency. We tested the unit at 1 Gs/s to analyze a 500 MHz bandwidth but the unit is capable of running at 2 Gs/s to analyze a 1 GHz bandwidth. The noise figure measured with the input set to 1 volt peak to peak fullscale was about 40 dB which corresponds to about 1 bit rms out of the 8 bits of the analog to digital converter (ADC). While the 8 bit ADC limits the dynamic range the effective dynamic range using incoherent averaging and 3 position switching is comparable to the best analyzers.



spectrum from Tektronix RSA3308A with preamp
start 2005:079:00:01:19 stop 2005:079:12:11:45 resolution 1000.0 kHz

Mon Mar 21 01:39:33 2005