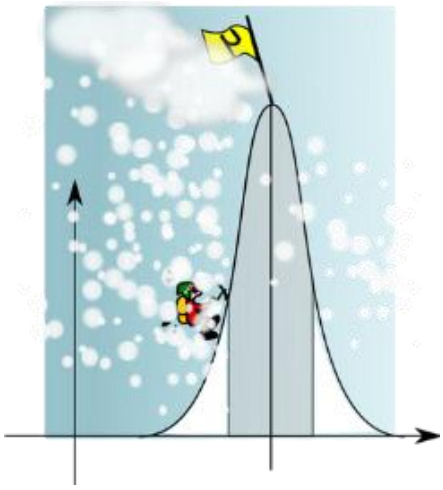
Products: BBGen and XGen

Noise in electronic systems is in the most unwanted. The higher the desired signal and the lower the accompanying noise, so much the better! We seek a high signal to noise ratio of course.

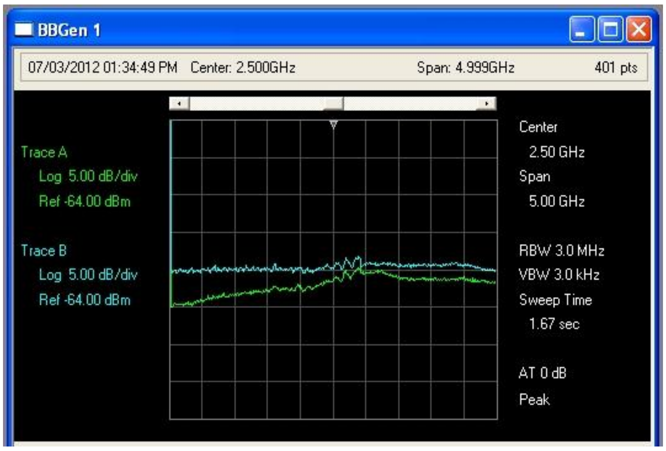
But there are a number of tasks that the controlled generation of 'white' noise suits very well. The instantaneous power level of white noise follows a Gaussian distribution as represented by the cartoon graphic here. An inexpensive white noise generator when carefully designed can be manufactured with exceptional 'flatness' over a very wide range of frequencies, for example the 100kHz to 5GHz frequency range for the BBGen. So, a noise generator with known characteristics can be a very useful 'signal' source for RF system testing.



Because the electrical energy in so called 'white' noise has a flat power spectral density against frequency, the power processed by your system under test is directly proportional to that system's operating band width.

For example, the noise power at the output of a CW receiver with 300Hz IF bandwidth is approximately one tenth that when a 3kHz SSB bandwidth is selected (if the filter shapes are identical, it will be exactly one tenth). So, white noise power values scale at 10dB per decade of bandwidth.

Introduction over, now for some practical!



The BBGen noise generator output flatness is demonstrated in this 1MHz to 5GHz plot.

The lower (green) trace is the noise floor of the HP8596E test instrument with 0dB input attenuation and with the BBGen switched off.

The upper (blue) trace is with BBGen powered on. The vertical graticule is 5dB/div for each trace.

The application examples demonstrated in AN-1:

A) Quick look sensitivity checks on HF receivers using a BBGen
B) Quick look sensitivity checks on broad band scanning receivers
C) Experiments with a 10GHz down converter using an XGen
D) Filter alignment

A) Quick look sensitivity checks on an HF receiver using a BBGen noise generator

For fast confidence testing, use the signal from a BBGen to hear noise level changes in the loudspeaker of an HF receiver. Here are the steps:

1) Connect the BBGen output to the antenna input of your receiver.
2) Ideally, set the receiver demodulator to SSB or CW, but use AM if those are not available.
3) Switching AGC off ensures the full noise level difference is audible, but this is not essential.
4) Turn the receiver front end attenuation to 0dB and turn RF gain to maximum.
5) Turn the power supply (11v to 15v) to the BBGen on and off. Use a pulse generator at about 1Hz square to automate this if you prefer.
6) Note the noise level change in the speaker between BBGen on and off. Switch through the bands on the receiver and note relative changes.

This test provides a rapid assessment of receiver sensitivity across its whole operating frequency range. There is enough level from the BBGen to produce a healthy audible noise increase in HF receivers with modest sensitivity, even with noise figures in excess of 20dB. The BBGen output is flat down to less than 100kHz, so LF bands can be checked too.

To measure values related to sensitivity and compare different receivers, connecting a basic AC voltmeter across the speaker drive will provide two values, BBGen noise on and noise off. These values can then be divided to produce a figure of merit to compare receivers.

The dB value of the noise difference, noise generator off to on, is the so called ‘Y-factor’. Basic AC voltmeters whilst not suitable to measure absolute noise voltages accurately are perfectly suitable to compare noise ratio results across the different bands on a receiver, or compare results between individual receivers.

TIP: *For very sensitive receivers with no ‘AGC off’ mode it may be necessary to introduce front end attenuation or back off the RF gain control slightly when measuring the noise on / off ratio (Y-factor) described above. Otherwise the AGC action may reduce the receiver’s full sensitivity and noise level presented to the speaker when the BBGen is powered on.*

Why the blue box? Note the BBGen DC power supply used in the photo. The blue ‘Noise Source PSU’ contains two 9v PP3 batteries in series and uses an external resistor to drop the on load voltage delivered to the BBGen to around 13.5v. Whilst a bench PSU is fine for many tests, this screened DC source with short leads ensures very low levels of off air HF signals are fed through to the RX under test. If you do suffer from off air signals during testing you can of course re-tune the RX very slightly to a quiet area of the band.

B) Quick look sensitivity check on a broadband scanning receiver using a BBGen noise generator

Since the BBGen output extends from LF to 5000MHz and with a level that is flat to within 1dB or so, it's also suitable for checking the sensitivity of receivers (and test equipment) beyond the UHF region.

Using the same procedures described in A) above, here are the results we measured from an ICOM IC-R10 from 500kHz to 1.3GHz:

Frequency	BBGen ON / OFF noise voltage ratio at the speaker terminals*	Y factor dB value (20 times the log of the numeric ratio in previous column)
500kHz	4.6	13.3
10MHz	6.7	16.5
50MHz	8.7	18.8
144MHz	11.6	21.3**
432MHz	5.8	15.3
1296MHz	4.0	12.0

*Taken with Fluke DVM across an external speaker terminals. USB mode. RF gain max. The DVM reading will vary a little so estimate a value in the middle.
**This R10 is indeed quite 'hot' on 144MHz, using an HP 8657B signal generator we measured -135dBm minimum discernible signal (MDS) and -129.5dBm on 432MHz.

please see our other application notes for precision sensitivity measurements using calibrated noise sources

---

C) Experiments with the G4HJW 10GHz down converter using an XGen noise generator

The 3cm amateur band RX converter has an IF output in the 18MHz region. For these experiments we couple the 3cm noise power from an XGen using a 16dB gain horn antenna. The 18MHz IF output of the 3cm converter is taken to the ICOM R10.

The horn to LNB spacing is approximately 15cm, free space path loss of approximately 36dB at 10GHz.

The audio noise measurement increase using the DVM was approximately 7dB with XGen switched on.

So, with approximately 20dB ENR at the XGen 50 ohm output, plus 16dB horn gain, a Y factor (ratio of the noise on to noise off) of several dB is observed well into the far field of a 'bare foot' LNB.

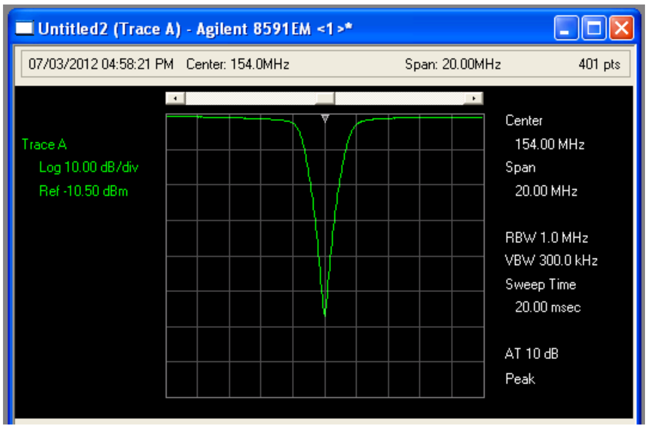
These 'free space' tests whilst not providing precision sensitivity values to be determined, do provide a repeatable test bed for experimentation, validation and comparison by cross checking with other known performance values.

D) Filter experiments and alignment using BBGen

The output from BBGen can be used to adjust filter responses when coupled with a sensitive receiver, which is fortunately something that can be usually found where filters are being tweaked!

The BBGen flat output characteristic against frequency is particularly useful in this application.

The plot shown here is of a VHF notch filter centred on 154MHz, measured using a spectrum analyser with a -10dBm tracking generator test source. The notch depth is approximately 56dB and approximately 100 kHz wide at the 3dB points.



Using a BBGen and ICOM R10 RX tuned to 154MHz, tweaking the filter achieved results that were repeatedly within 3dB of the 56dB seen on the spectrum analyser. The adjustments were made by ear on minimum audible noise from the RX speaker.

Whilst the 'barefoot' BBGen will allow for example a 56dB notch to be centred to within a few dB, adding an amplifier after the BBGen, increases the dynamic range of your measurement to achieve adjustment to the last tenths of dB.

When amplifying the BBGen output take care not to overload your test RX front end. The BBGen output total noise power from 100kHz to 5GHz is approximately -53dBm, so adding for example a 40dB amplifier with a bandwidth from LF to 5GHz would take that up to around -14dBm. Most receivers will of course not be 'wide open' to such a huge bandwidth.

This brings us nicely back to where we began on page 1, white noise power scales at 10dB per decade of bandwidth. The BBGen output is approximately -90dBm per MHz, -80dBm per 10MHz and so on, so ensure you factor that into your amplified BBGen applications to stay safe and linear!

Please contact us at support@rfdesignuk.com if you need any help with your tests!