MOUNTAIN SPARK GAPS

NPARC—The Radio Club for the Watchung Mountain Area

Website: http://www.nparc.org
Club Calls: N2XJ, W2FMI
Facebook: New Providence Amateur Radio Club (NPARC)

VOLUME 53 NO. 11 November 2018

Regular Meeting

12/10
Monday 7:30
DeCorso Community Center

Upcoming Events

Holiday Luncheon
12/8 Chimney Rock
342 Valley Rd.
Gillette, NJ
11:30 AM

Kids Day
1/5 DeCorso Center

Meeting Schedule

Regular Meeting: 7:30—9:00 PM
2nd Monday of each month at the
NP Senior & Adult Center
15 East Forth Street
New Providence

Informal Meeting: 7:30—9:00 PM
4th Monday of each month
Same location
Everyone is Welcome
If a normal meeting night is a holiday, we usually meet the following night. Call one of the contacts below or check the web site

Club Officers for 2018

President: W2PTP Paul Wolfmeyer
201-406-6914
Vice President:K2GLS Bob Willis
973-543-2454
Secretary: K2AL: Al Hanzl
908-872-5021
Treasurer: K2YG Dave Barr
908-277-4283
Activities: KA2MPG Brian Lynch
973-738-7322

On the Air Activities

Club Operating Frequency
145.750 MHz FM Simplex

Sunday Night Phone Net
Murray Hill Repeater (W2LI) at 9:00 PM
Transmit on 147.855 MHz
With PL tone of 141.3 Hz
Receive on 147.255 MHz
Net Control K2AL

Digital Net
First & Third Mondays 9 PM
28,084 — 28,086
Will be using PSK and RTTY
Net control K2YG

Club Internet Address

Website: http://www.nparc.org
Webmaster KC2WUF David Bean
Reflector: nparc@mailman.qth.net
Contact K2UI, Jim

MOUNTAIN SPARK GAPS

Published Monthly by NPARC, Inc.
The Watchung Mountain Area Radio Club
P.O. Box 813
New Providence, NJ 07974

Editor: K2EZR Frank McAneny
Contributing Editors:
WB2QOQ Rick Anderson
W2PTP Paul Wolfmeyer
K2UI Jim Stekas

Climatological Data for New Providence for October 2018

The following information is provided by Rick, WB2QOQ, who has been recording daily weather events at his station for the past 37 years.

TEMPERATURE -
Maximum temperature this October, 77 deg. F (October 7, 10)
Last October(2017) maximum was 83 deg. F.
Average Maximum temperature this October, 61.6 deg. F
Minimum temperature this October, 37 deg. F (October 22, 26)
Last October(2017) minimum was 35 deg. F.
Average Minimum temperature this October, 50.1 deg. F
Minimum diurnal temperature range, 5 deg. (47-42 deg.)10/27
Maximum diurnal temperature range, 23 deg. (62-39 deg.)10/31

Average temperature this October, 55.9 deg. F
Average temperature last October, 60.5 deg. F

PRECIPITATION -
Total precipitation this October - 3.52" rain
Total precipitation last October - 5.33" rain
Maximum one day precip. event this October -

October 27, 1.09" rain
Measurable rain fell on 15 days this October, 10 days last October.

YTD Precipitation - 51.21"

======================

Rick Anderson
11/17/18
243 Mountain Ave.
New Providence, NJ
(908)464-8912
rick243@comcast.net

Lat = 40 degrees, 41.7 minutes North
Long = 74 degrees, 23.4 minutes West
Elevation: 380 ft.
CoCoRaHS Network Station #NJ-UN-10
CoCoRaHS Network Station #NJ-UN-10

President's Column
November 2018

Just a simple note this month—
Dates to keep in mind (all Saturdays):
December 8—Holiday Luncheon
January 5—Kids Day
February 23—Auction
We'll recap the year and make a couple of awards at the luncheon—see you there.
73 for now
Wolf
W2PTP
201-404-6914 or W2PTP@arrl.net

On Receiver Sensitivity and Noise

Jim Stekas - K2UI

Back in my novice days I drooled over the rigs in the Heathkit catalog. I can still remember the the sensitivity specs for the SB-300 receiver: 0.3 uV for 10 dB S/N. My HQ-110A manual didn't even contain a sensitivity spec. Guess Hammarlund was too embarrassed to provide it. Today, my Icom IC-751A manual gives a sensitivity spec of 0.15 uV for 10dB S/N. Wow, that's 6dB, a whole S-unit, better than the SB-300! Keep it up ICOM!

So how do we make sense of the IC-751A sensitivity spec? To answer this let's consider how ICOM measured the sensitivity. The "classic" technique is to hook up a signal generator to the antenna input. With no signal applied the audio output power is measured (this is the noise). Then a signal is applied and its level raised until the audio output has increased by 10dB. This signal level was found to be 0.15 uV. Since the noise is 10dB below the signal, the noise level in ICOM's IC-751A was 0.05 uV.

When I was working on sonar systems at Bell Labs I remember talking to my buddy Tony about pulling out weak signals using some naively speculative techniques. Tony's reply has stuck with me all these years, "Jim, the signal is the easy part. It's the f***ing noise that's the problem. All that sh*t Mother Nature puts in the ocean." Tony knew what he was talking about. He was a Bell Labs Fellow wrote the book on detecting signals in noise. Literally.

An S9 signal is defined to be 50uV at the receiver antenna input. An S1 phone signal is 0.20 uV at the antenna input and should give an S/N at the IC-751A speaker of about 12dB, and it ***should*** be easily if I am to believe ICOM[1]. But I don't make QSOs with a signal generator in ICOM's lab. On a typical summer night the 40m SSB noise level at my QTH is about an S3, which means that an S1 signal on my IC-751A is 12dB ***below*** the noise and completely unreadable. Mother Nature inflicts a lot more noise in Murray Hill than she does in ICOM's lab.

When ICOM's signal generator was connected to the receiver with the signal off it looked to the receiver like a 50 Ω resistor across the antenna port. At room temperature the electrons in a resistor are in random thermal motion, each electron zig and zag contributes a tiny noise current. By Ohm's law the noise current in the resistor will produce a voltage across its terminals. At room temperature the power spectrum of the thermal noise is flat over all ham radio frequencies. In every 1Hz band the resistor will produce about 0.000000000000000004 Watts.

Watts is a very inconvenient unit for expressing the power in small received signals. Radio engineers use the much more convenient dBm, which is dB referenced to 1mW, or

$$dBm = 10 \cdot \log\left(\frac{P}{1\text{mW}}\right)$$ where P is in watts.

In dBm, the resistor will produce about -174 dBm of thermal noise per 1Hz band. Since the IF filter in the IC-751A is 2.3 kHz the total thermal noise passing through the receiver is -140.5 dBm.

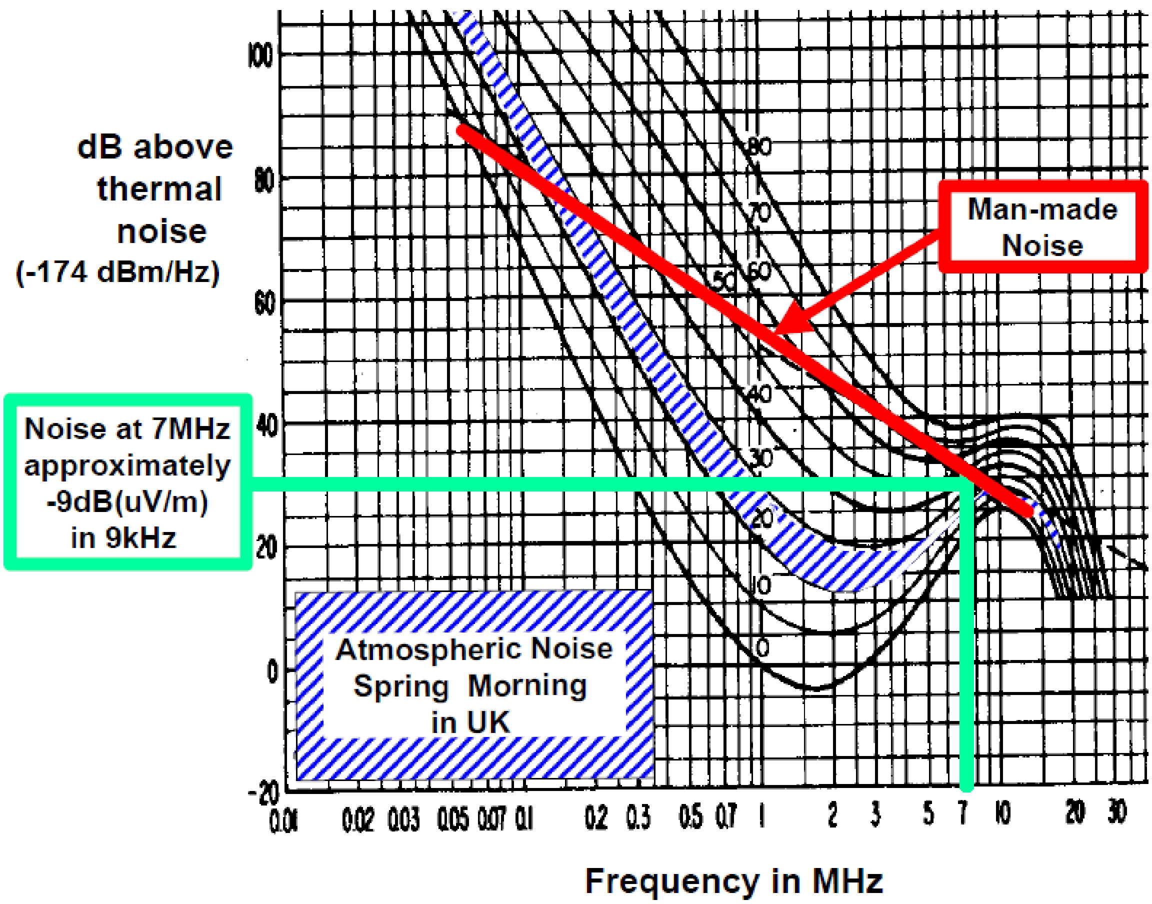
1 I do believe ICOM.

Converting all the uV measurements to units of dBm gives the table below ...

	uV	dBm
Signal (lab gen)	0.15	-123
S1	0.20	-120.5
S3 (antenna noise)	0.80	-108.5
Noise (751A)	0.05	-133
Noise (thermal)		-140.5

The first thing to notice is that the S3 antenna noise (-108.5 dBm) coming into the IC-751A is 25.5 dB higher than the internal noise level (-133 dBm). In an S3 noise environment we could add 20dB of attenuation and not suffer any significant performance degradation. A good rule of thumb is that if you can hear the noise increase/decrease when an antenna is connected/disconnected your receiver has all the sensitivity it needs.

The plot below shows atmospheric and man-made noise levels collected by G3WJI for the RSGB. Numbers above plot lines show the percent of the time noise levels are below the line. On 40m, atmospheric noise varies from 20-40dB above the thermal background. On 10m, noise levels drop to 10dB over the thermal background. At VHF and UHF thermal noise is the dominant source of noise.



The second thing of note in the table is that the internal noise (-133 dBm) within the IC-751A is 6.5 dB higher than the thermal noise (-140.5 dBm). An ideal amplifier applies the same gain to the signal and noise, so the S/N ratio at the output is that same as at the input. An actual amplifier will add a bit of noise in addition to providing gain causing the S/N ratio at the output to be a bit lower than at the input. The decrease in S/N expressed in dB is the the noise figure (NF) of the amplifier. Some alternative ways of looking at NF are:

$$NF \; = \; (S/N)_{out} - (S/N)_{\text{in}} \; = \; N_{out} - N_{\text{in}} \text{ (all units in dB).}$$

The NF of the IC-751A is 6.5 dB, which tells us that it is about one S-unit (6 dB) worse than an ideal receiver. NF gives a much more intuitive quantification of sensitivity than the old uV for 10dB S/N. The NF for CW, SSB, AM, etc. are all the same assuming their filter bandwidths match the signal bandwidths.

The internal noise level of a receiver (-133 dBm in this example) is called the noise floor. If we adjusted out signal generator for a 3 dB increase in output power, the input signal power would be equal to the noise floor. This is called the Minimum Discernible Signal (MDS) and it is exactly equal to the noise floor. MDS is basically a sneaky way to refer to the noise floor given that NF has been claimed by noise figure. This leads to yet another expression for NF:

$$NF \; = \; MDS - N_{\text{thermal}}$$

What is really important from a practical standpoint is that the MDS of our receiver should be below the total noise coming into the antenna port, or $MDS \; < \; N_{antenna}$. This translates into a NF requirement of:

$$NF \; < \; N_{antenna} - N_{\text{thermal}} \text{ for an adequate NF.}$$

What appears on the right hand side of the above equation is exactly what is shown on the y-axis of the noise plot above. So we can think of the y-axis as giving a maximum value of NF for a given noise environment. For operating on 40m in England during the summer a NF < 30 dB is indicated, which is very easy to achieve. That’s why Googling “40m QRP kit” generates 130,000 hits.

Final Comments

1. If there is an obvious increase in noise when you connect your antenna your receiver has enough sensitivity to do the job.
2. If the ambient noise level is S3, crank down the RF gain or hit the Atten button and add some attenuation. If you can hear the noise, that’s good enough to hear signals. There is no benefit to amplifying the noise.
3. If the noise background at your QTH includes a large amount of man-made noise (buzzing, clicks, etc.) don’t even think about a better receiver until you eliminate the noise.
4. The test descriptions and calculations outlined above are simplistic but correct in principle. I have assumed the uV values are RMS averages, and I wasn’t overly careful to distinguish between S/N and (S+N)/N which is what we actually measure. But the calculations are good enough to illustrate the issues regarding noise and receiver sensitivity.