Minimum Discernible Signal MDS and Noise Figure NF of HPSDR Boards

All HPSDR boards currently use in the RX path the LTC 2208, a 130 Msps, sampling 16-bit A/D converter. This high performing device provides a dynamic range of 100 dB at a noise figure of typ. 30 dB, i.e. a preamp can be needed for higher HF bands. Therefore the RX path consists of a series array of a 31 dB step attenuator - 50 MHz LPF – 20 dB fix gain amp – 50 MHz LPF - 16 bit ADC.

The knowledge of the overall sensitivity and the local noise collected by the antenna is determining the best utilization of the 100 dB ADC dynamic range. Since HPSDR boards are great measurement equipment too, no external instruments are necessary to measure the MDS or the noise figure of the radio. It is only recommended to verify the correct level calibration of the S-meter:

Apply a signal source of known level, e.g. - 20 dBm (10 µW), to the antenna RX input port and read the S-meter. If the value deviates make a new calibration using the calibration utility of PowerSDR setup. It is recommended to work with this high level a small amount below 'full scale' to achieve best resolution.

At first MDS has to be measured: Connect 50 Ohm to RX port, ATT/S-ATT = 0 dB, bandwidth B = 2400 Hz, Dither off and S-meter (Sig Avg) shows the MDS of the radio at that chosen bandwidth. Using the well-known equation

$$MDS_{dBm} = -174_{dBm} + 10 \log B_{dB} + NF_{dB}$$

the noise figure can be calculated by permuting the equation:

$$NF_{dB} = MDS_{dBm} + 174_{dBm} - 10 \log B_{dB}$$

Example: Hermes @ B = 2400 Hz (= 33.8 dB), reads MDS = -131,3 dBm on the 20 m band

$$NF = -131,3 + 174 - 33,8 = 8,9 \text{ dB}$$

For this kind of NF measurement the averaged noise floor of the panadapter can be also used. In this case the measuring bandwidth is determined by the Bin Width (Hz), selectable at the display settings of PowerSDR. Both indicators, S-meter or noise floor will show the same result. Please note that the displayed noise floor doesn't depend on the bandwidth of the 'channel' filter, only on the Bin width.

What is the useful effect of MDS or Noise figure evaluation?

Connected to an antenna the radio's S-meter or noise floor of the panadapter jumps to much higher levels as connected to a 50 Ohm termination. The local or 'man-made-noise collected by the antenna will be displayed. The ITU-Recommendation P.372-8 is based on commercial measurements for different areas affected with man-made-noise. This diagram is also helpful for hams to rate their own location.
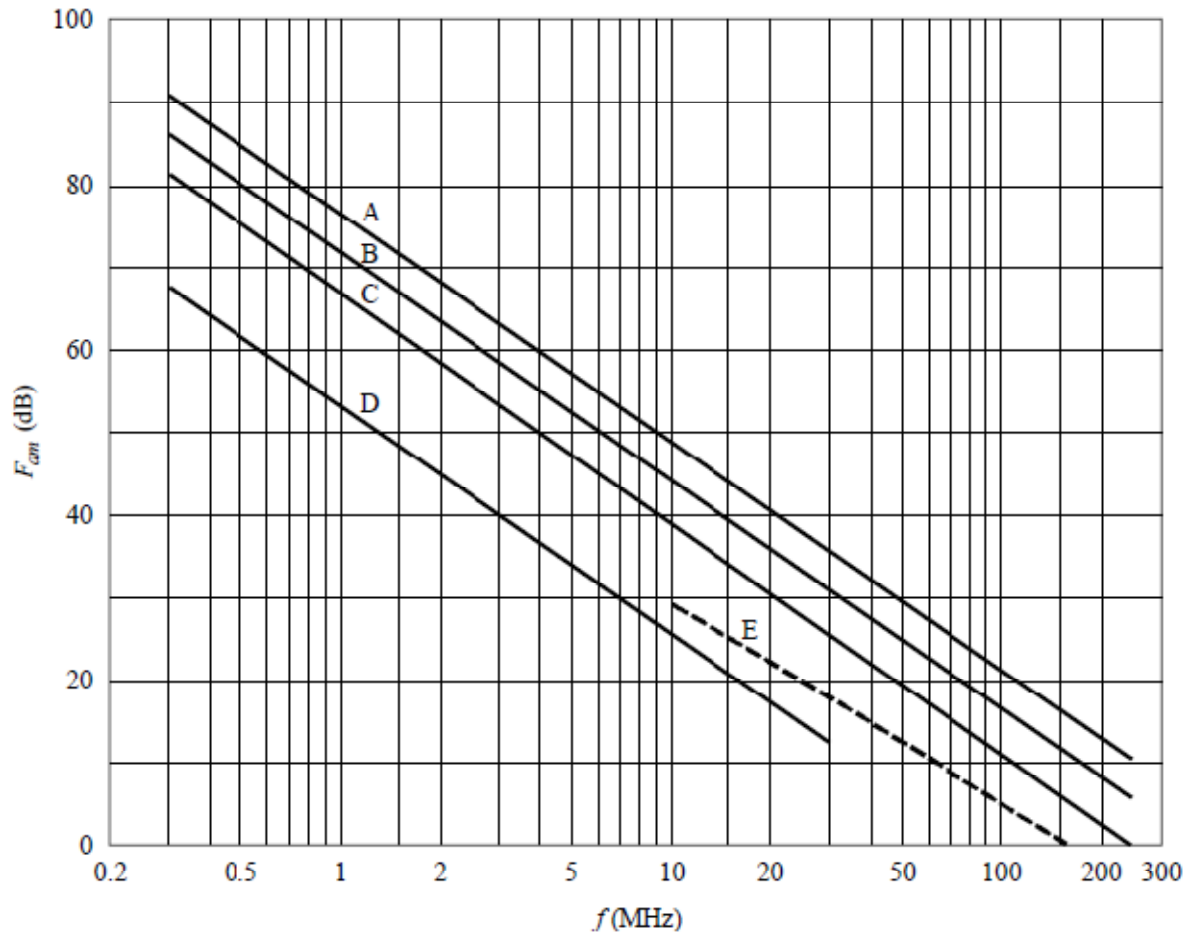
Environmental category:

Curves A: business
B: residential
C: rural
D: quiet rural
E: galactic (see § 6)

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When antenna noise is 30 dB or more, no preamp should be used. With a typical NF of 9dB an attenuation of 21 can be selected without any loss of sensitivity, but with 21 dB more dynamic range for the ADC (wasted before). Check each band, add S-ATT starting at zero and watch noise floor until increasing, so get optimal DR. All 'matched' attenuation will be saved at the database.