Investigation on SAT-Finders for small radio telescopes in X-/Ku-band

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1. Introduction

In a previous SARA-article (Planning for the 2023 and 2024 Solar Eclipses at VHF, UHF and Ku-band) there was foresee to add a so-called SAT-Finder between LNB and receiver/spectrometer. This to support installation and configuration of the telescope, providing a tool with an optical and an acoustic indicator (beeper). It has been very useful to find the sun or a satellite with the telescope providing neither an azimuth- nor an elevation angle indicator. With beeper it is quite easy to position the dish such that the indicator shows maximum signal strength. A more detailed analysis showed that SAT-finder units have quite different performance in terms of attenuation at frequencies at the lower band as well as with respect to standing waves. During several test runs 4 different SAT-Finder have been investigated. To avoid interference from satellites during astronomical observations the plan was to go for frequencies below 10.8 GHz, close to the radio amateur X-band.

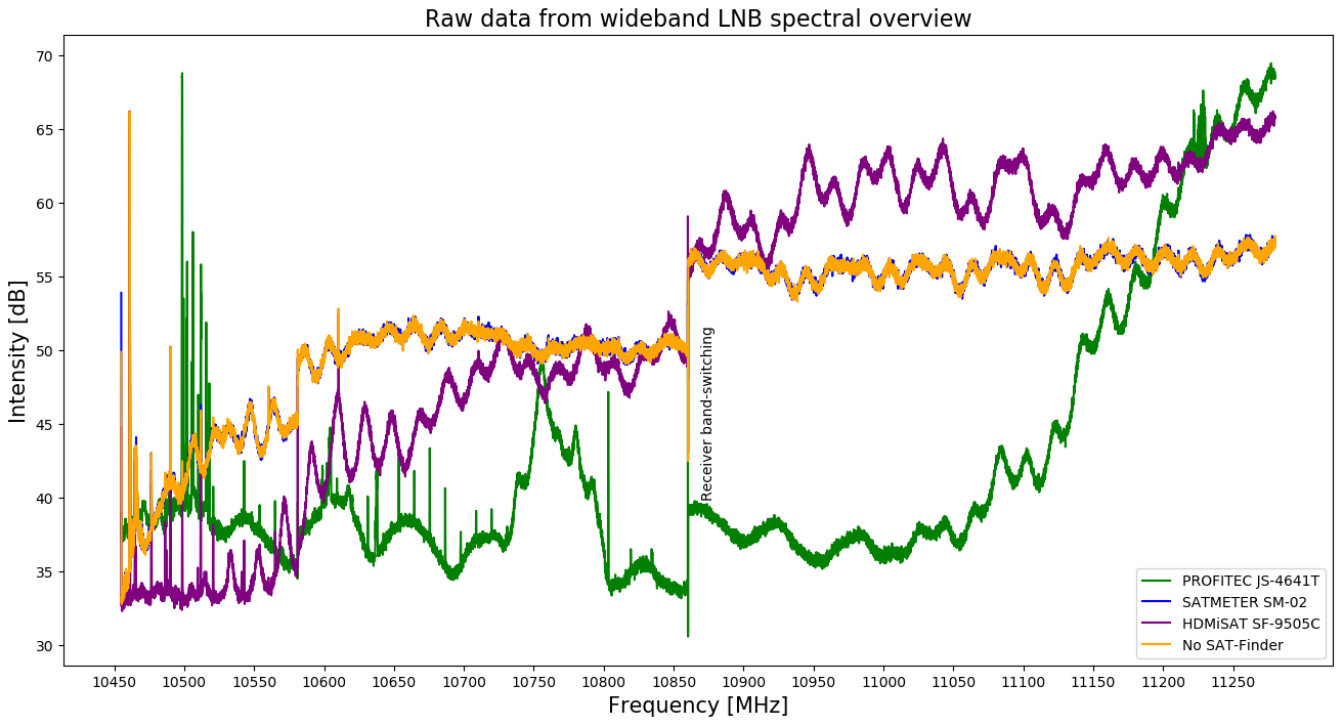

Figure 1 ~ Spectral response of 4 SAT-Finders, observed with function 'Save spectral overview' on CALLISTO frequency agile spectrometer. Quality in terms of attenuation and standing waves are quite different.

2. SAT-Finder observations

First SAT-Finder PROFITEC JS-4641T, procured from AMAZON showed quite strange behavior, there were a lot of unwanted signals were found, probably due to bad shielding below 10.8 GHz, see green plot in figure 1. But even more disturbing was the large attenuation of at least 20 dB below 10.8 GHz. Although one has to admit that the specification was given from 950 MHz - 2150 MHz at intermediate frequency level (IF) which corresponds to a

sky frequency (RF) of 11.36 GHz - 12.56 GHz in case of a wideband LNB. As a conclusion this SAT-Finder is useless, generating severe problems at lower frequencies below 10.8 GHz.

Figure 2 ~ Analogue Satellite Finder Profitec JS-4641T from Amazon with analogue display and beeper works fine for frequencies above about 11.15 GHz. But not usable below that frequency due to high attenuation. Button dB allows to change sensitivity of display and beeper.

Second SAT-Finder was an old SATMETER SM-02 (blue plot in figure 1) from a local supplier. This unit showed quite flat spectrum and only minor standing waves. This unit proved to be very useful for observations but, the prize of more that 200$ was not acceptable for a low-cost radio telescope.

Figure 3 ~ Satellite Finder DAGATRON SATMETER SM-02 from CONRAD works fine down to about 10.6 GHz. Unit is expensive because it also contains a battery and allows control of the LNB. Allows in addition to change polarization and to measure voltage as well as current of the connected LNB.

Third unit (violet plot in figure 1) was a HDMISAT SF-9509C, again from Amazon with specification for IF 950 MHz – 2150 MHz, corresponding to an RF of 11.36 GHz – 12.56 GHz in case of a wideband LNB. This unit obviously has not only an internal attenuator but also an internal amplifier with a gain of about 10 dB. It can be used below 10.8 GHz but, there are terrible standing waves which is very bad for spectral observations. In addition, attenuation below 10.7 GHz is in the order of 15 dB, too much for certain receivers.

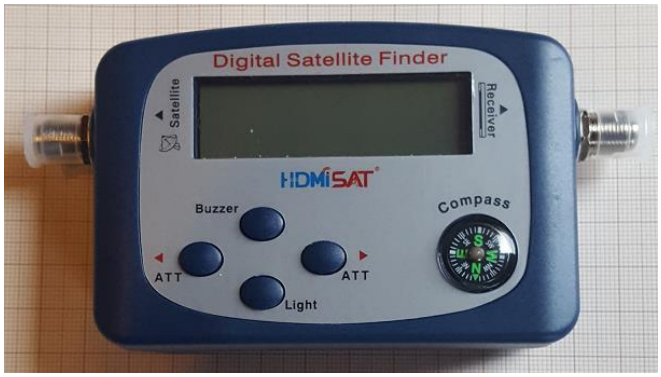

Figure 4 ~ Digital Satellite Finder HDMiSAT SF-9509C from Amazon with internal amplifier and attenuator. Compass bottom right can be used to roughly set azimuth direction of the telescope.

Unit number 4 is the best and the cheapest, namely no SAT-Finder at all. Spectral response (orange plot in figure 1) is given by LNB, cables, Bias-Tee and spectrometer and looks good so far. Attenuation in low band is only about 5 dB and standing waves are acceptable. Disadvantage there is no scale and no beeper, therefore

telescope positioning has to be done by observing level-meter, light curve or spectrum level on the receiver/spectrometer.

3. Conclusion

Before using any SAT-Finder as optical and acoustic indicator for your small radio telescope, check attenuation and standing waves. Cheap units can be acceptable or even good but it is worth to try several units to avoid strange results. A simple Nano-VNA is sufficient to test attenuation as well as standing waves, just need adapters from F-connector (male) to SMA-connector (male) to perform these tests.