G/T estimation of a small X-/Ku-band radio telescope, based on a satellite dish and wide band LNB

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Abstract

To perform quality control and to prove system performance we need a simple method to estimate the system quality factor G/T.

Index: CALLISTO, Solar flux, sky- and ground-temperature

Contents

1 Introduction

The aim of this document is to describe two possible processes on the estimation of G/T of a small satellite dish in X- and Ku-band.

2 G/T process, based on cold sky and ground mesurements

With two measurements we are able to determine G/T. First measurement is called Icold which represents Tcold of about 12 kelvin in X-band. Tcold can be found in tables and papers of ITU or IEEE. Second measurement is called Ihot which represents Thot in the order of 300 kelvin. The exact value can be measured with a simple thermometer on the nearby ground, bushes or trees. In my case Tambient was 22°C, thus Thot = 273.15 K + 22°C = 295.15 kelvin. Observed data from CALLISTO, stored in FIT-files contain compressed logarithmic data which need to be linearized for further processing.

$$I_{dB} = \frac{I_{digit}}{255\ digit} \frac{2500\ mV}{25.4\ mV/dB} \tag{1}$$

With 255 digit denotes to the digital range of the ADC, 2500 mV to the voltage range of the ADC and 25.4 mV/dB to specification of the logarithmic detector AD8307 conversion factor.

$$I_{lin} = 10^{I_{dB}/10\ dB} \tag{2}$$

Ihot from the dynamic spectrum gave 503'196 units and Icold was 206'351 units. From those intensives we can derive the receiver temperature Trx as

$$T_{rx} = \frac{T_{hot} - Y * Tcold}{Y - 1} = 188\ K = 2.1\ dB \tag{3}$$

From data sheet of dish manufacturer we know the antenna gain which is specified as G = 36 dB. Now we can derive G/T as

$$G/T = \frac{10^{3.6}}{188\ K} = 21.2\ K^{-1} = 13.2\ dB/K \tag{4}$$

3 G/T process, based on cold sky and solar flux

We get Icold as function Tcold as in previous section. And solar radio flux we get either from ur own measurement or from Learmonth. In my case Tcold was again 12 kelvin leading to Icold of 20'6351 units. Solar noise was measured to Ihot = 577'294 units and flux was given to 400 sfu with an uncertainty of -40 sfu +20 sfu. In this calculation any beam correction factor α and atmospheric attenuation β are ignored and set to 1. Therefore, such measurements should only be performed during blue sky when the Sun is clearly above the horizon, e.g. during transit time.

$$G/T = \frac{8\ k\ \pi\ (Y-1)}{\lambda^2\ Ssun\ \alpha\ \beta} = 21.0\ K^{-1} = 13.2\ dB/K \tag{5}$$

4 Other results from above measurements TBD

4.1 Temperature resolution at given bandwidth and integration time (LC: 300 KHz * 10...80 * 1 ms), (FIT: 1...190 * 300 KHz * 1 ms)

4.2 Signal to noise ratio SNR as Y/rms

4.3 Estimation of Moon Y-factor and Moon-SNR

4.4 An other TBD, e.g. Moon antenna temperature

5 Conclusions

The process of G/T estimation is straight forward and simple to perform. The result helps to perform periodic tests to prove that the system is working es expected and no degradation has taken place.

6 Acknowledgement

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References

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