TALLYSMAN®

When **precision** matters.®

Technical Note

Comparing GNSS Antenna Performance

Version 2.0

www.tallysman.com

E: info@tallysman.com ▪ **T: +1 613 591-3131**

NOTICE

This document contains Tallysman proprietary information. Use, disclosure, copying or distribution of information requires the written permission of Tallysman Inc.

The information in this document is subject to change without notice. Tallysman intends that the information contained herein is correct and accurate to the best of its knowledge. Tallysman assumes no responsibility of any errors or omissions in this document.

TABLE OF CONTENTS

1. Background

The Antenna and LNA elements in a GPS receiver are critical for achieving the ultimate available sensitivity of a given receiver. It is difficult to do absolute measurements on each antenna without an anechoic chamber and specialized equipment, but there is a simple way to do a comparative evaluation.

C/No is an absolute indicator primarily of antenna-plus-front-end performance. C/No is the ratio of carrier power to the noise power mixed with the signal, in a 1Hz bandwidth. This ratio defines a limit for the sensitivity of a given GPS receiver.

If the value of C/No is diminished for any cause, be it bandwidth limitations, or increased LNA noise figure, GNSS sensitivity will be reduced by the same amount. Once impaired, there is no way to recover C/No. Even additional gain does nothing because C and No are amplified equally, and so is to no avail.

The C/No test is like a “drug test” for the antenna + front end LNA performance. It cannot be bamboozled!

The simple way to compare the performance of a number of antennas (and hence judge merit) is to compare the values of C/No reported for particular satellites in the standard NMEA $GPGSV message. Among other parameters, this message reports the C/No value for each satellite in view, as determined at the receiver demodulator. Most GNSS chip manufacturers provide a PC utility to display values of C/No for each tracked satellite, often in a bar graph format. This usually requires that the $GPGSV NMEA output message be enabled using a supplied utility.

2. The “test” Method

The general idea is to briefly install the antennas to be compared in sequence, on a single receiver and to compare the reported values of C/No for the best specific two or three satellites.

The satellite constellation changes over the course of a few minutes, so that a reported value will vary due to the constellation changes over and above variation due to the antenna. It is important that: a) the reported values are related to the specific satellites, b) that the sequence be quick, and c) the measurement be repeated a few times.

The simplest case is for GPS L1. Because the GPS L1 signal is relatively narrow, antenna evaluation reduces simply to comparison of average reported C/No values for the best few GPS satellites

The situation is a little more complicated for the multi-constellation / multi-frequency antennas because the measurement must include multiple satellite constellations and multi-signals.

This can be done by “eyeballing” the bar-graph values for C/No but a better way is to capture the NMEA output with a logging terminal software.

The GNSS receiver and the antennas to be evaluated should be arranged so:

a) The antenna(s)-under-test must has clear sight of the whole sky, with a relatively low horizon
b) The receiver is set-up to output the NMEA $GPGSV message ($GLGSV for GLONASS,$GAGSV for Galileo, and $GBGSV for BeiDou),
c) The serial port of the receiver is connected to a computer running either a C/No bar-graph utility (for visual inspection) or a terminal utility with logging (Hyperterm).
d) Each antenna is placed on near identical ground plane (100mm, round or square is ideal),
e) The antennas-under-test are not closer to each other than 0.5meters (to ensure no coupling), and
f) It is possible to very quickly switch the antennas at the receiver.

The method is to connect each antenna in sequence ideally for not more than 30 seconds, and to record the NMEA data stream during that time. The antenna replacement should be slick, so that the receiver quickly re-acquires. The terminal utility can quickly log the NMEA output data.

Each NMEA $GxGSV message reports C/No at the antenna for up to 4 satellites in view (see excerpted NMEA spec. below for sentence parameters). The best reported parameter for specific satellites above 48dB are the values of interest. Satellites with low C/No values are not useful for comparison because low signal levels mask the antenna performance.

Quickly repeated measurements are useful to overcome variability of reported values and to accommodate continuous changes of the satellite constellation. The logged data allows the clerical work to be done later.

3. Format for the NMEA $GPGSV Message

The $GPGSV message provides detailed information regarding tracked satellites.

$GPGSV,x,x,xx,xx,xx,xxx,xx,……………xx,xx,xxx,xx*hh

GS = Number of SVs in view, PRN numbers, elevation, azimuth & SNR values.
*$GPGSV,3,1,11,03,12,174,,06,20,159,,13,14,315,,14,02,139,*7C*

1 = Total number of messages of this type in this cycle
2 = Message number
3 = Total number of SVs in view
4 = SV PRN number
5 = Elevation in degrees, 90 maximum
6 = Azimuth, degrees from true north, 000 to 359
7 = SNR, 00-99 dB (null when not tracking)
8-11 = Information about second SV, same as field 4-7
12-15 = Information about third SV, same as field 4-7
16-19 = Information about fourth SV, same as field 4-7
20 = Checksum

4. Interpreting the Results

For a multi-constellation receiver, C/No has the same significance for GLONASS, Galileo, and BeiDou as for GPS L1 satellites and the values for both should be compared GPS-L1 to GPS-L1, GLONASS to GLONASS, Galileo to Galileo, and BeiDou to BeiDou for specific satellites.

Better C/No values provide a reduction of GNSS drop-out, better acquisition, and better accuracy overall because the GNSS Horizontal Dilution of Precision (HDOP) is reduced.

To give some idea of values to be expected, 54dB is amazing, 53dB is excellent, 52dB is good and 49/50dB is “ho-hum”. These are small differences in log values; an antenna 3dB down is half as good. It is rare, but possible to encounter situations in which all reported values of C/No are below 48dB, in which case it may be better to wait for an hour or so for the constellation to change.

The level acquire a GNSS signal on start up is in the region of -143dBm. With signals vulnerable to destructive interference and attenuation by tree canopy etc. it is relatively easy for the value of C/No of satellites values to drop below the acquisition threshold, so the better the antenna the less often this will occur, and of course the better the GNSS receiver will track low level signals.

- In a consumer product, occasional transient GNSS loss might be acceptable. This being the case and if the aesthetics of low cost Asian antennas are acceptable, the choice is plain.
- If continuous availability is a requirement, then the choices will be between a good antenna and an excellent antenna, and a comparative evaluation of C/No of the contenders would be a good place to start.
- For precision GNSS applications, the only choice is a high quality dual feed antenna

Another consideration is that the antenna is usually a very visible part of a bigger system, and unavoidably represents the quality of the user equipment. In that case, the antenna housing robustness and appearance may also be a criterion to maintain the image of the end product.

About Tallysman

Tallysman® is a developer, provider, and manufacturer of global positioning components and intelligent location based wireless infrastructure solutions for tracking systems.

Based in Ottawa, Canada, Tallysman is focused on high function, high performance technology and solutions. Our core competencies include digital wireless networks, RF and Global Navigation Satellite Systems (GNSS) component design.

Tallysman is known for its brands of Accutenna® and VeraPhase®. These technologies have proven themselves to provide the highest performance antennas (low axial ratios, high multi-path signal rejection, tight PCV) in their size and weight, while setting lower economical price points. Tallysman's antennas are the antennas of choice for a wide variety of applications.

Learn more at www.tallysman.com.