Antenna Survey

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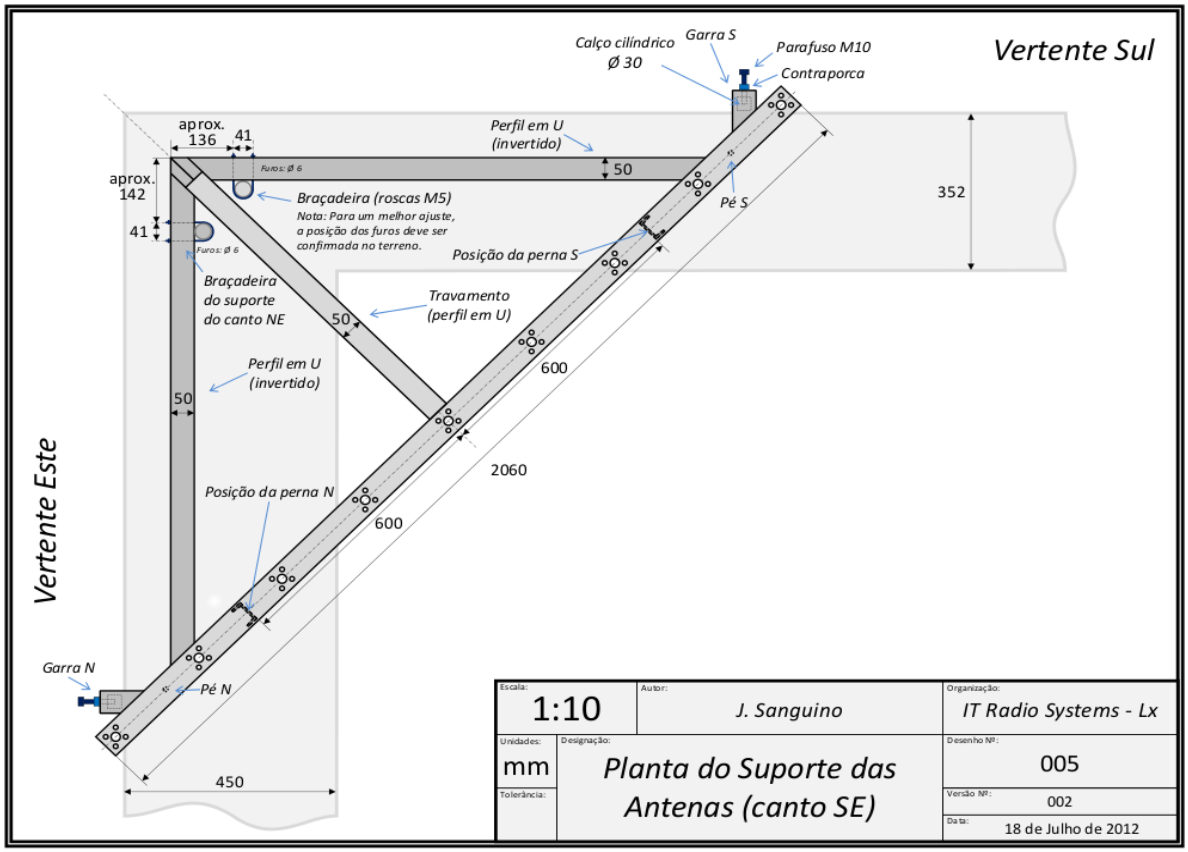
Introduction

This document aims to provide an accurate position to the antennas set up during 2013 in IT's GNSS station.

The antenna support, presented in Figure 1, consists of an arm with several holes equally spaced. The GNSS station contains two of these supports, each holding 3 antennas, with a spare cable for a fourth one. Each antenna is referred to as RFX, where X refers to the number coded in its cable.



The cables are coded with a binary system (red and yellow), where red stands for high (1) and yellow stands for low (0). This tag is present in both terminations to allow easy identification of the antennas the cables are connected to. Reading should start at the connector and the resulting number should be incremented by one.

Currently (June 2013), six antennas were set up in supports as shown in Figures 2 and 3. The eight cables extending from the laboratory control stations to the rooftop are connected to dual (RF1 and RF5) and single (RF2-3, RF6-7) frequency antennas. Cables RF4 and RF8 are spares. In Figure 4, each connected antenna is represented by a circle containing its coder.

As for the following sections of this document, each antenna is described along side with its schemati. After that, the coordinates and distances between antennas are presented.

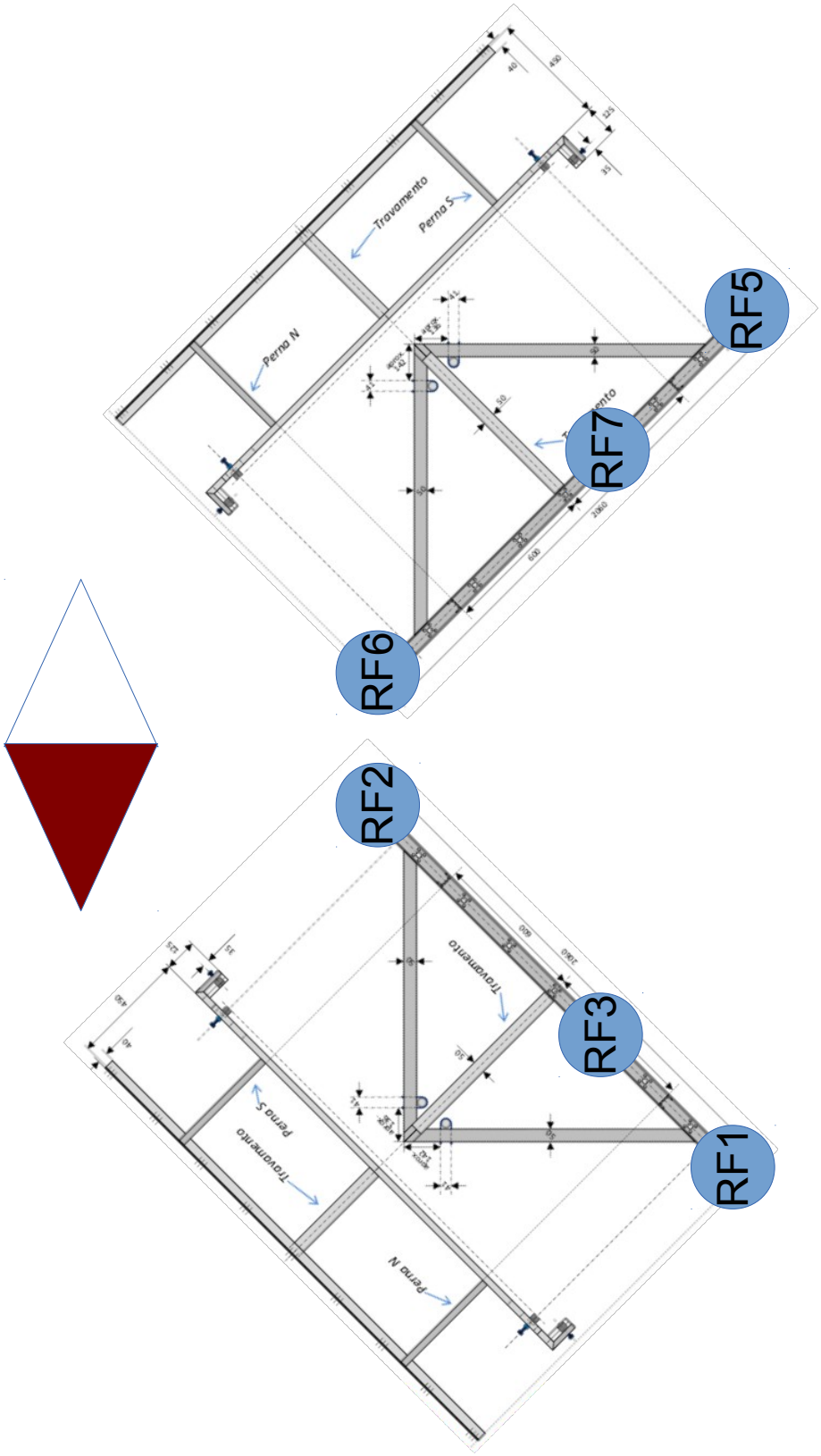


Figure 4: Antenna setup

Antenna Specification

This section contains information regarding the antenna's specification.

RF1

Dual frequency antenna provided with the Pro Flex 500 receiver (Figure 5).

Operating frequency

- 1590 +/- 25 MHz,
- 1238 +/- 21.5 MHz

Gain

- 38 dB +/- 3dB

Voltage

- +4.25 to +15 VDC @ 65 mA

The antenna reference is AT1675-7MW-TNCFB-000-RG-38-NM-R. The reference number can be translated with the help of Figure 4 providing the following information:

- **AT1675-7M**: Antenna Identification number
- 7**MW: M**angellan **W**hite
- **TNCFB:** Connector (TNCF Bulkhead)
- **000:** Cable Length (inches)
- **RG:** Voltage, +4.25 to + 15 VDC
- **38:** Gain (+/- 3dB), 38 dB (55 mA)
- **NM: N**o **M**agnet
- **R: R**oHS Compliant

The serial number is 5401 and the date of manufacturing is March 2010.

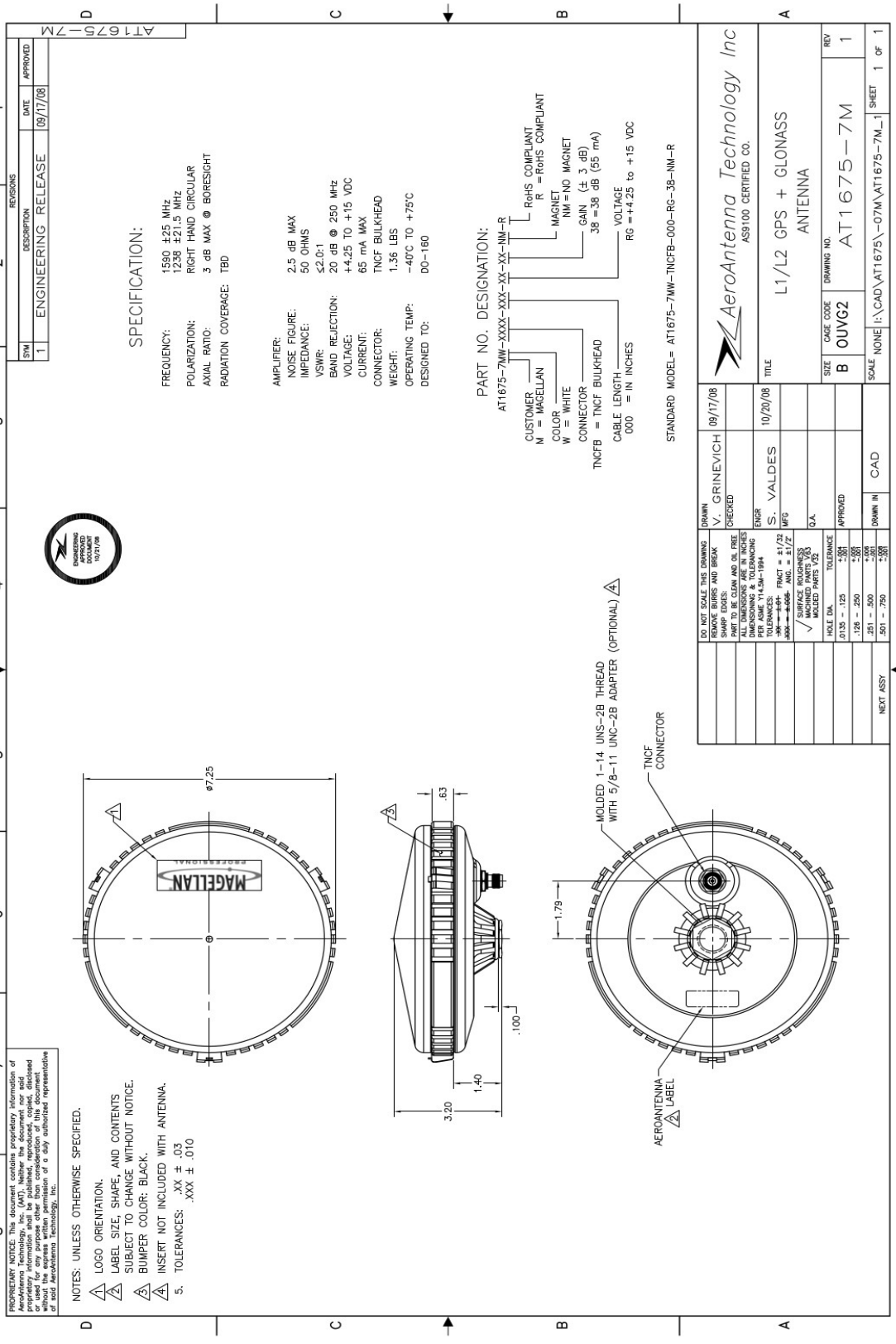


Figure 5: Pro Flex 500 antenna specification (L1/L2)

RF3 and RF7

Single frequency antenna, GPSAntenna Model 521 (Figure 6).

Operating frequency

- 1575.42 +/- 2 MHz

Gain

- 26db +/- 3 dB

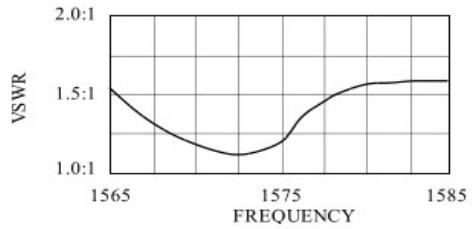
Voltage

- +4.0 to +24 VDC @ 25mA (max)

The antenna reference number is AT575-75NTW-TNCF-000-RG-26-NM and follows the same rules as those presented for RF1.

The part number for this antenna is 14004.531 and the date of manufacturing is August 1999.

GPSAntenna Model 521
VSWR Performance



Technical Specifications

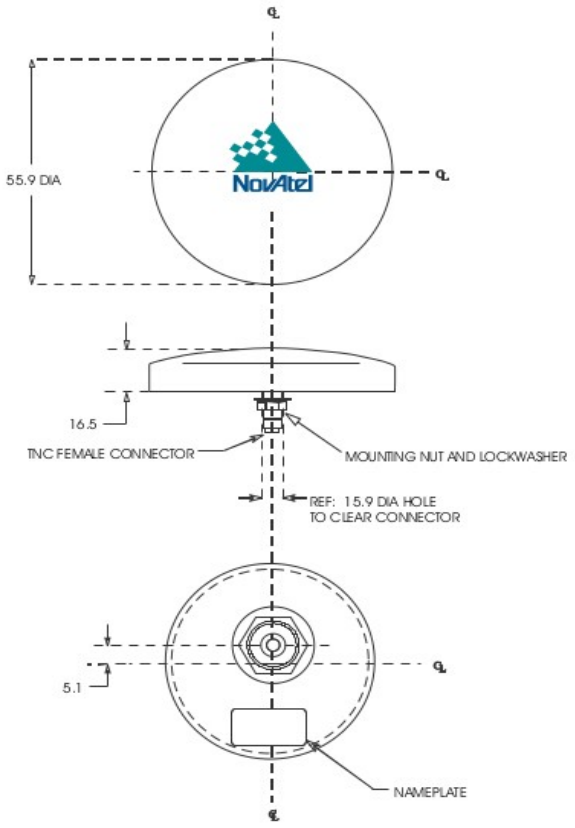
- Electrical -

Frequency	1575.42 ± 2 MHz
Polarization	RHCP
Impedance	50 ohms
Power Handling	100 mW (+20 dBm)
Axial Ratio (max)	3.0 dB
Gain (Antenna)	-1.0 dBic $0 \leq \varnothing < 75°$
	-2.5 dBic $75 \leq \varnothing < 80°$
	-4.5 dBic $80 \leq \varnothing < 85°$
	-7.5 dBic $\varnothing < 90°$ @ horizon
Gain (Preamp)	26 dB ± 3 dB
Supply Voltage	+4.0 to +24 Vdc @ 25 mA max
Band Reject	22 dB @ 1625 MHz
Lightening Protection	DC grounded

- Mechanical & Environmental -

Finish:	Thermoset plastic, natural white-base iridite, per MIL-C-541
Weight:	3 oz.
Height:	16.5 mm
Diameter:	55.9 mm
Material:	6061-T6 aluminum thermoset plastic
Connector:	TNC female
Temperature:	-55 °C to +85 °C
Vibration:	10 G's
Altitude:	-100 to 55,000 ft.

Mechanical Drawings



NOTE: All dimensions in millimetres
1 inch = 25.4 millimetres

RF2 and RF6

Single frequency antenna, GPSAntenna Model 521 (Figure 7).

Operating frequency

- 1575.42 +/- 2 MHz

Gain

- 26db +/- 3 dB

Voltage

- +4.0 to +24 VDC @ 25mA (max)

The antenna reference number is AT575-75NTW-TNCF-000-RG-26-NM and follows the same rules as those presented for RF1.

The part number for this antenna is 14004.531 and the date of manufacturing is August 1999.

GPSAntenna Model 531 Rev 2
Technical Specifications

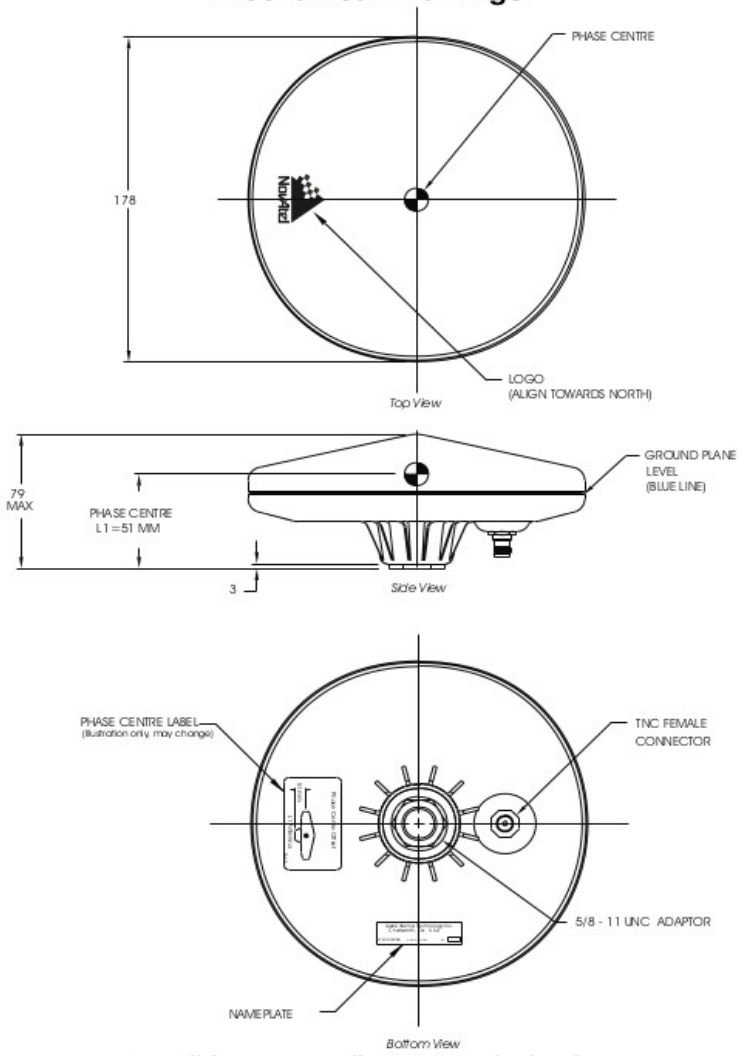
- ELECTRICAL -

3 dB pass band:	L1: 1575 ± 5 MHz			
Out-of-band rejection:	f_c - 50 MHz:	18 dB	f_c + 50 MHz:	56 dB
	f_c - 100 MHz:	36 dB	f_c + 100 MHz:	44 dB
	f_c - 150 MHz:	45 dB	f_c + 150 MHz:	44 dB
Antenna elev. pattern:	θ = 90°:	+ 6.8 dBic (typical)		
(90° = zenith)	20° ≤ θ < 90°:	- 0.7 dBic to 6.8 dBic (typical)		
	5° ≤ θ < 20°:	- 4.5 dBic to 1.0 dBic (typical)		
	0° ≤ θ < 5°:	- 7.0 dBic to -2.0 dBic (typical)		
	θ = 0°:	- 7.0 dBic to -2.0 dBic (typical)		
LNA gain:	26 ± 2 dB			
Polarization:	Right-hand circular			
Noise figure:	2.2 dB			
Axial ratio:	θ = 90°:	2.0 dB max.		
(90° = zenith)	30° ≤ θ < 90°:	5.0 dB max.		
	15° ≤ θ < 30°:	8.0 dB max.		
	5° ≤ θ < 15°:	11.0 dB max.		
	0° ≤ θ < 5°:	12.0 dB max.		
Nominal impedance:	50 Ω			
VSWR:	≤ 2.0:1			
Power requirements:	≤ 25 mA @ + 4.25 to + 18.0 V DC			
	18 mA (typical) @ 5.0 V DC			
Power handling:	≤ 1 W			

- MECHANICAL & ENVIRONMENTAL -

Finish:	Weatherable polymer
Weight:	≈ 375 g
Altitude:	≤ 3 658 m (12,000')
Temperature:	-40 °C to +70 °C

Mechanical Drawings



Note: All dimensions in millimetres except for thread size.

Figure 7: Standard antennas specification (L1)

RF5

Dual frequency antenna provided with the ZXW receiver (Figure 8).

Operating frequency

- 1575 +/- 10 MHz,
- 1227 +/- 10 MHz

Gain

- 36 dB +/- 2dB

Voltage

- +5 to +18 VDC @ 65 mA

The antenna reference is AT2775-42AW-TNCF-000-RG-36-NM. The reference number can be translated with the help of Figure 7 providing the following information:

- **AT2275-42**: Antenna Identification number
- **W: W**hite
- **TNCF:** Connector (TNCF Bulkhead)
- **000:** Cable Length (inches)
- **RG:** Voltage, +5 to + 18 VDC
- **38:** Gain (+/- 3dB), 38 dB (55 mA)
- **NM: N**o **M**agnet

The part number is 105645, serial number 18491 and the date of manufacturing is March 2008.

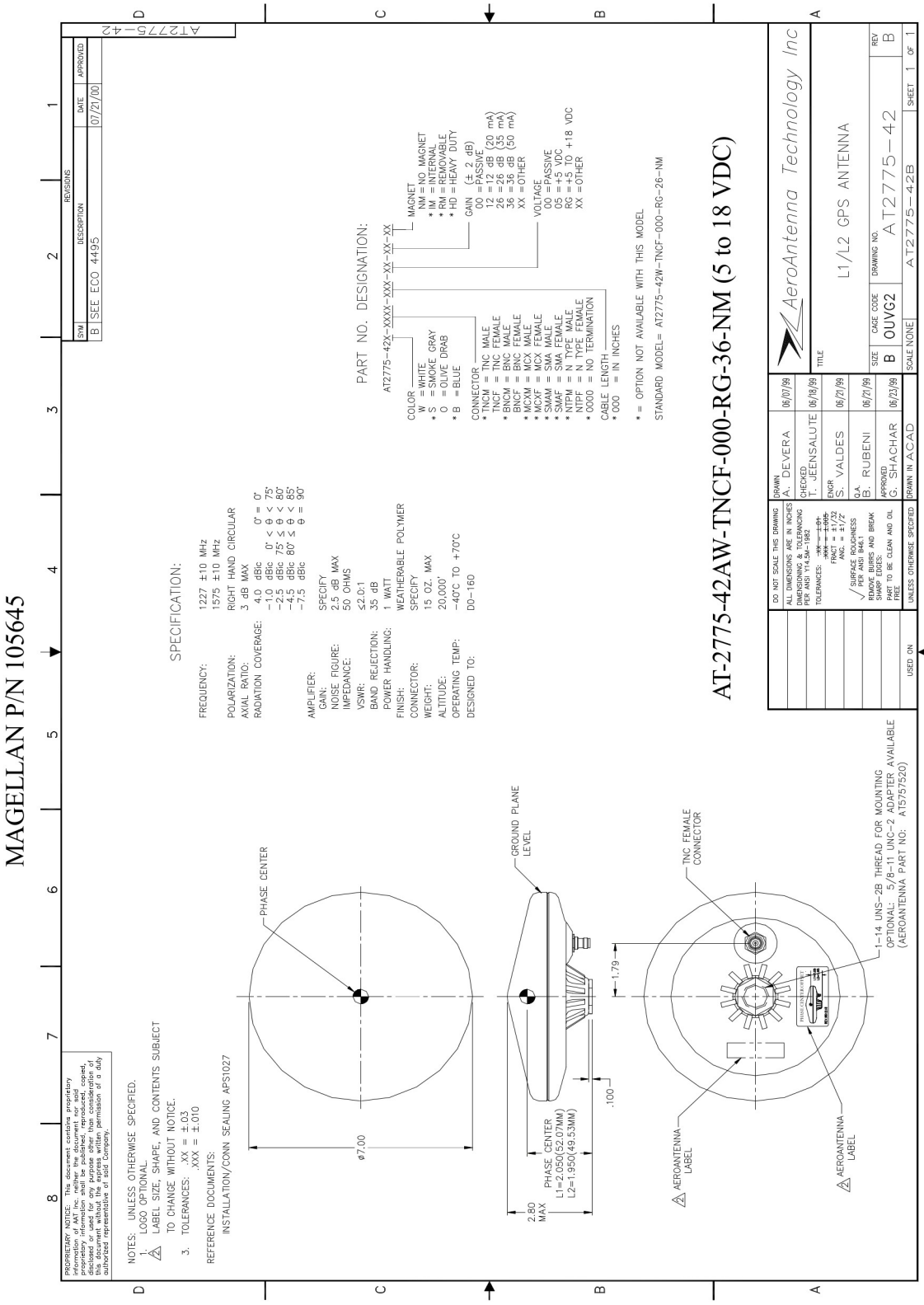


Figure 8: ZXW antenna (L1/L2)

Coordinates

This section contains the location of the several antennas either in ECEF and LLA.

RF1

ECEF	4918528.02 m	-791210.72 m	3969759.39 m
LLA	38.7376000 º	-9.1385000 º	195.563 m
Sigmas (95%)	0.002 m	0.003 m	0.009 m

Comment: This position was obtained through the CSRS-PPP application. The input data was obtained with the Pro Flex 500 receiver and its internal rinex converter was used. GPS and GLONASS data were used.

RF2

ECEF	4918525.18 m	-791212.21 m	3969762.19 m
LLA	38.7376341 º	-9.1385221 º	195.312 m
Sigmas (mean)	0.001		

Comment: This position was obtained through the survey-in mode of the ublox 6T receivers.

RF3

ECEF	4918524.42 m	-791213.05 m	3969762.24 m
LLA	38.7376379 º	-9.1385330 º	194.862 m
Sigmas (mean)	0.004		

Comment: This position was obtained through the survey-in mode of the ublox 6T receivers.

RF4 (Not in use)

ECEF			
LLA			
Sigmas (95%)			

RF5

ECEF	4918534.82 m	-791211.81 m	3969750.68 m
LLA	38.7375000 º	-9.1384999 º	195.484 m
Sigmas (95%)	0.002 m	0.004 m	0.010 m

Comment: This position was obtained through the CSRS-PPP application. The input data was obtained with the Pro Flex 500 receiver and its internal rinex converter was used. GPS and GLONASS data were used.

RF6

ECEF	4918532.10 m	-791212.61 m	3969754.61 m
LLA	38.7375420 º	-9.1385140 º	195.948 m
Sigmas (mean)	0.002		

Comment: This position was obtained through the survey-in mode of the ublox 6T receivers.

RF7

ECEF	4918531.12 m	-791213.20 m	3969753.51 m
LLA	38.7375392 º	-9.1385225 º	194.578 m
Sigmas (mean)	0.003		

Comment: This position was obtained through the survey-in mode of the ublox 6T receivers.

RF8 (Not in use)

ECEF			
LLA			
Sigmas (95%)			

Distances

The following tables (Table 1 and 2) present the 3D and 2D distances between the antennas' coordinates.

It is important to note that these distances fall short from what was expected, since RF1 and RF2 are offset by 1250 mm (5 x 250mm). Table 2 is reporting a distance that is almost the double. Despite the up error that is still present in the y coordinate of the ECEF coordinates, this error is not big enough to decrease the distance to the expected value.

Table 1: 3D distances between antennas

3D Distance (m)	RF1	RF2	RF3	RF5	RF6	FR7
RF1	0	4.257	5.149	11.104	6.562	7.095
RF2	4.257	0	1.134	15.019	10.271	10.564
RF3	5.149	1.134	0	15.599	10.835	11.006
RF5	11.104	15.019	15.599	0	4.846	4.861
RF6	6.562	10.271	10.835	4.846	0	1.587
RF7	7.095	10.564	11.006	4.861	1.587	0

Table 2: 2D distances between antennas

2D Distance (m)	RF1	RF2	RF3	RF5	RF6	FR7
RF1	0	3.207	4.288	6.886	4.496	3.969
RF2	3.207	0	1.133	9.648	6.932	6.023
RF3	4.288	1.133	0	10.473	7.693	6.702
RF5	6.886	9.648	10.473	0	2.835	3.952
RF6	4.496	6.932	7.693	2.835	0	1.143
RF7	3.969	6.023	6.702	3.952	1.143	0

Conclusion

The aim of this study was to provide accurate coordinates for the antennas in IT's GNSS station.

Throughout the work, the several antennas and the support where they were mounted was presented and characterised.

In order to obtain the antennas' coordinates, the CSRS-PPP application was used for the dual frequency data, while the single frequency data was processed by ublox's proprietary software (survey in function of the devices).

The result are not satisfactory, since the distance fall short from what was expected. For example, RF1 and RF2 are supposed to be, more a less, 1 meter apart, which is much less than the computed 3 meters.

Therefore, for a future study, it is recommended that the dual frequency receiver is used in order to survey all the positions in the antenna's support.

ANNEX
Coordinates Summary

Table 3 – Coordinates in ECEF and LLA

	ECEF		
RF1	4918528.02	-791210.72	3969759.39
RF2	4918525.18	-791212.21	3969762.19
RF3	4918524.42	-791213.05	3969762.24
RF5	4918534.82	-791211.81	3969750.68
RF6	4918532.10	-791212.61	3969754.61
RF7	4918531.12	-791213.20	3969753.51

	LLA		
RF1	38.7376000	-9.1385000	195.563
RF2	38.7376341	-9.1385221	195.312
RF3	38.7376379	-9.1385330	194.862
RF5	38.7375000	-9.1384999	195.484
RF6	38.7375420	-9.1385140	195.948
RF7	38.7375392	-9.1385225	194.578