MASTA 2015 (Micro-Satellite Technology) Team Pilot Project Final Poster

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TELEMETRY, TRACKING AND COMMAND (TT&C)

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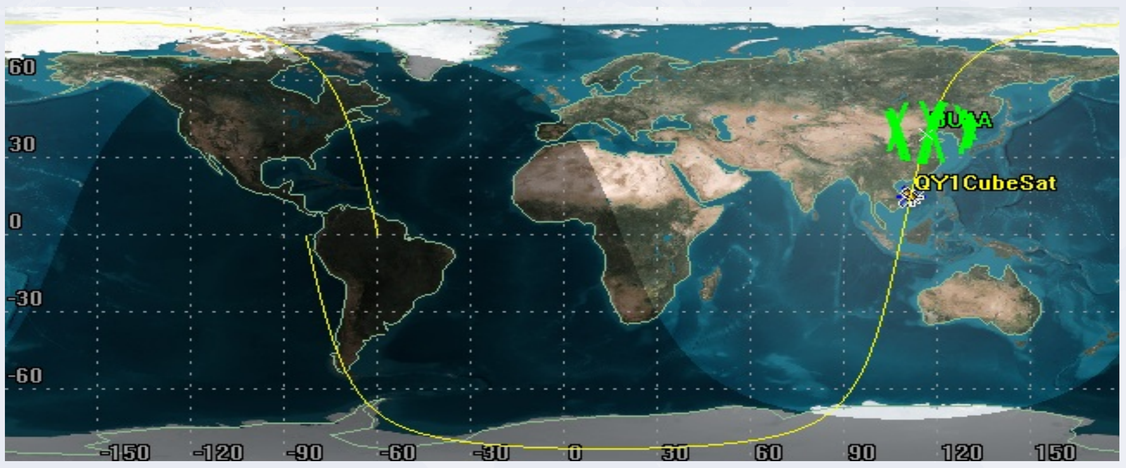
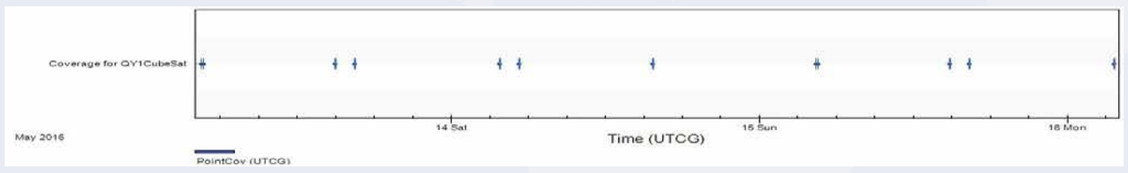
GROUND STATION COVERAGE

The BUAA ground station to communicate with the QY-1 CubeSat is localize in the Beihang University and the geographical coordinates are show in the next table. The figures was achieved in a simulation with Systems Tool Kit (STK) and is shows the Coverage Intervals for three days (13-16 May, 2016).

Grounsstation	Latitude(^{0})	Longitude(^{0})	Altitude(Km)	Heightaboveground(Km)
BUUA	-39.9802	116.344	0.05	0.055

Geographics coordinates of the BUAA Ground Station.

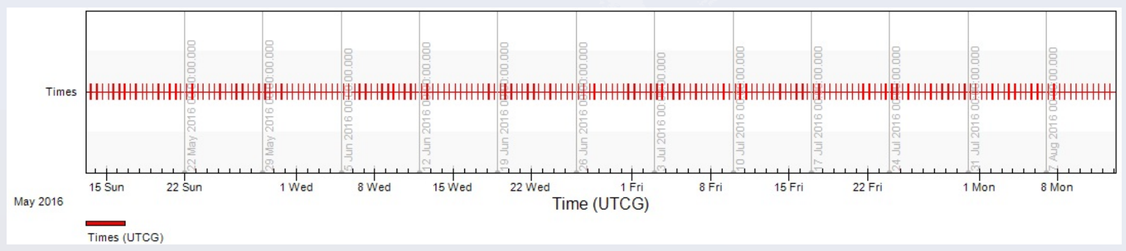




The minimum antenna elevation angle is 10 degree and according the STK software simulation results, the QY-1 CubeSat will pass over the BUAA ground station 3 times a day, of with the longest passing time can be 6.26min and the average is 4.88min. In the next figure are three moths (13 May-13 Aug, 2016). The next table show the principals values for communication between QY-1 CubeSat and ground station.

Characteristics	Maximum(day)	Minimum(day)	Total(3moths)
Number of accesses	3	0	262
Accesses duration (min)	6.26	0.33	1281.13
Coverage time (min)	15.15	0.33	1281.13
Number of gaps (min)	4	1	263

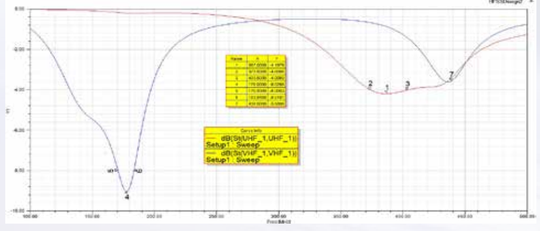
Simulation result with STK software.



S-PARAMETER

The VHF antenna have resonance in 178MHz but it also has resonance in UHF (see point 7) and is very well matched, with S11-parameter below -8dB (see points 5 and 6) for approximately 12.74MHz around the center frequency (it is narrowband, but remember that the required bandwidth is only 25kHz). The mismatch loss (ML) within this band is only 0.75dB (the efficiency is e = 0.84). This is the reduction the mismatch causes in the link margin, which is considered quite acceptable.

The UHF antenna have resonance in 387MHz and the results are not very good as compared to the VHF. The S11-parameter only went down to -4.1dB (see point 1), at the center and the mismatch loss within this band is only 2.2dB(with an efficiency of e = 0.6). On the other hand, it has become much more broadband, with a -4dB bandwidth of more than 29.8MHz (see points 2 and 3). That is not necessary for this application though.

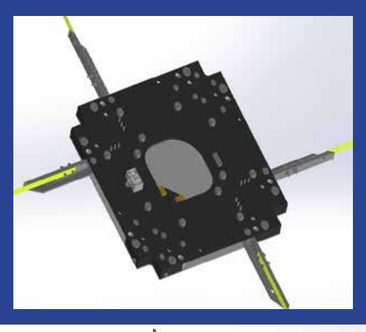


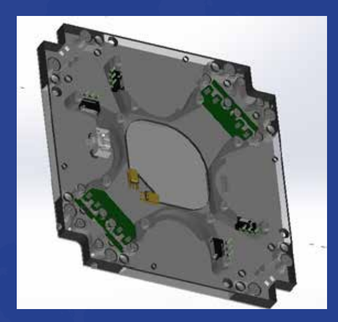
ISIS ANTENNA

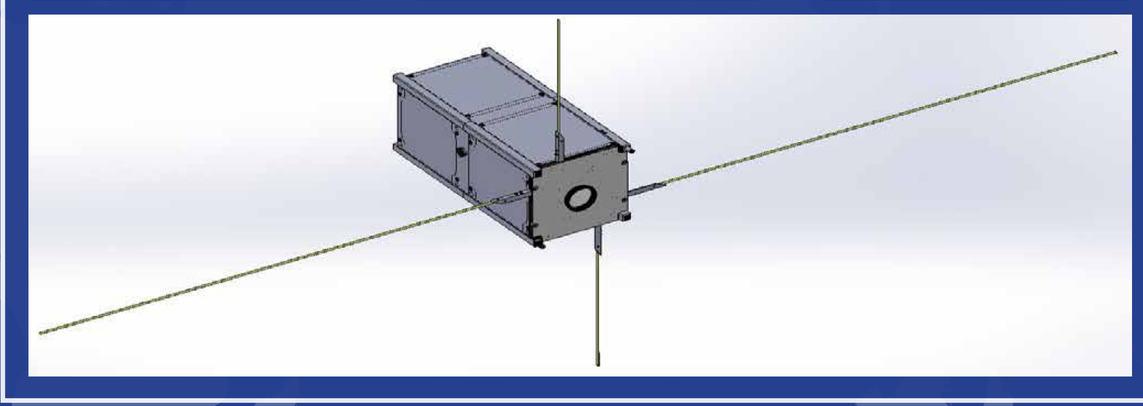
This kind of antenna selected for QY-1 CubeSat is the Manufacturing ISIS and the principals characteristics are show in the next table. The UHF antenna, which has the shorter elements, must be folded first. The VHF antenna is folded on top of that. Since each element of the VHF antenna goes more than halfway around the satellite, one of the elements must be folded on top of that on the other side. In the next figures we can see outside and inside (after and before of the deployment).

Parameters	Value
Configuration	Turnstile
RF Impedance (deployed)	50Ω
Insertion Loss	<1.5dB
Frequency range	130-500MHz
Frequency bandwidth	10-13Hz
Electrical power	Nominal <20mW During deployment: 2W
Mass	<100g
Envelope stowed: (lxwxh)	98mmx98mmx7mm
Supply voltage	3V (5V and 8V available on demand)
Antenna Polarization	Circular
Antenna Pointing Error (^{0})	0^0
Return Loss (S_{11})	<-10dB
VSWR	<1:2

Characteristic of the antenna ISIS.





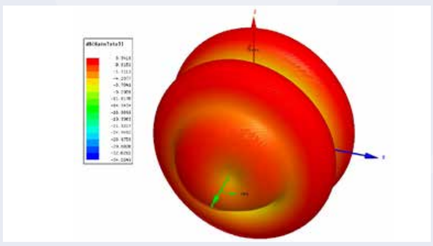


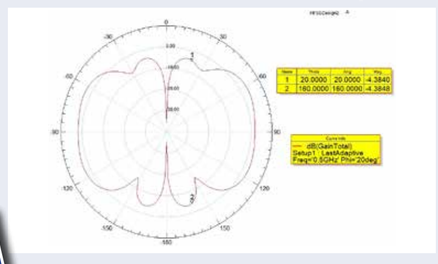
UHF UPLINK MONOPOLE RESULT

The 3D result are shown in next the figure. The maximum gain is 3.34dB. The gains in 10 degree tracking elevation angles are represented in the next table for the deployed pattern. In the figure are shown the polar graph of the antenna gain at nadir patn over ground station. The ground station will communicate with the CubeSat in 1-2.

ψ^0	θ^0	AverageGain(dB)
20	[20,160]	-4.3840
160	[20,160]	-4.3848
The UHF antenna gain in minimum elevation angle		-4.38

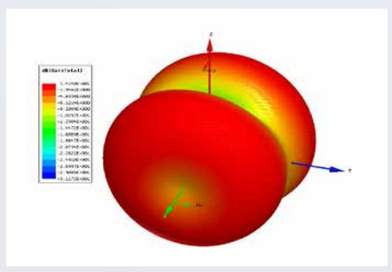
The UHF antenna gain in minimun elevation angle.

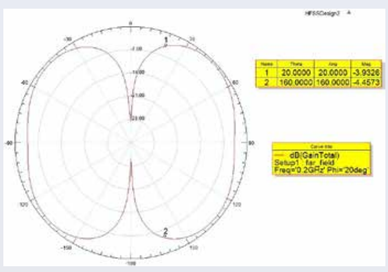




UHF UPLINK MONOPOLE RESULT

The 3D result are shown in the next figure. The maximum gain is 1.41dB. The gains in 10 degree tracking elevation angles are represented in the next table for the deployed pattern. The other figure shown the polar graph of the antenna gain at nadir patn over ground station. The Ground Station will communicate with the CubeSat in 1-2.





ψ^0	θ^0	AverageGain(dB)
20	[20,160]	-4.9326
160	[20,160]	-4.4573
Minimum average gain		-4.19

The VHF antenna gain in minimun elevation angle.

TRANSCEIVER

The transceiver that was select is the manufacturing ISIS and its characteristics are show in the next table, has I2C communication capability to provide power switching to the receiver and transmitter independently. Once the radio is commanded to power on either the transmitter or receiver over the I2C communication, there is a digital universal asynchronous receiver transmitter interface to send and receive data to and from the transceiver.

Parameter	Transceivervalue
Power supply	6.5-12.5V DC
Power consumption (DC)	<1.55W (transmitter on), <0.2W (receiver only)
Mass	±85g depending on configuration
Dimensions	96x90x15 mm
Transmitter frequency range	Single frequency in 130 - 160MHz range (crystal controlled)
Transmitter power	22dBm average
Transmitter modulation scheme	Raise-Cosine Binary Phase Shift Keying (BPSK)
Transmitter data rate	4800bps
Transmitter bandwidth	14 KHz
Receiver frequency range	Single frequency in 400 - 450MHz range (crystal controlled)
Receiver sensibility	-104dBm for 10^{-5} Bit Error Rate
Downlink data rate	1200 / 2400 / 4800 / 9600 bps
Receiver bandwidth	15 KHz
Protocol	AX.25

Table 9: Parameter of the transceiver for the QY-1 CubeSat.

GROUND STATION SPECIFICATIONS

The BUAA VHF & UHF ground station has utilized the Chinese customized tracking software and hardware. The BUAA ground Station will be used for receive telemetry and mission data and send telecommand to QY-1 CubeSat, when it passes over the ground station. The performance speciation are provided in the next table.

Ground Station Parameter	Value
Minimum elevation angle	10^0
Antenna gain (UHF)	22dB
Antenna gain (VHF)	17dB
Antenna bean width (UHF)	21^0
Antenna bean width (VHF)	38^0
Antenna polarization	Switchable Circular Polarization
Antenna or Sky noise temperature (VHF)	1000K
Antenna or Sky noise temperature (UHF)	500K
Maximum Transmitter Power (VHF)	100W
Maximum Transmitter Power (UHF)	50W
Transmitting bandwidth (FM)	16KHz
Antenna VSWR	< 1.5:1.0
Ground Station antenna pointing loss	0.6dB
Ground Station antenna total transmission line loss	0.6dB

Link Parameter of Ground Station.