National Centre for Radio Astrophysics

Internal Technical Report
GMRT/SERVO/002 - June 2013

S01 BLDC System Commissioning: Site Acceptance Report

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Executive Summary

S01 is the fifth antenna in series of BLDC system installation in GMRT after C04, C10, C14 and C00.To validate the installation various tests were conducted before and after removing the old BLDC system. These tests were arrived at after much deliberation in servo group. This report presents the findings of the tests in different parts. The results show that there is no significant change in the servo performance of the antenna before and after the installation of BLDC. Transformer voltage levels are within 10% tolerance of expected values indicating healthy load behavior. DC Power Supply currents are normal indicating healthy operation of internal components of both control rack and BLDC System. Limit switch operation were checked and their positions were noted and found to be same as before.Windmeter reading were also checked and both windmeters are operating. Rotation tests conducted show that the speeds of the motors are as per requirements. For an input of 10V to Azimuth axis the speeds of the motor should be around 1600rpm while for Elevation axis the speeds should be close to 1400rpm which is visible from the readings. Study of the Velocity loop step responses show that there is lesser overshoot in the BLDC response when compared to PMDC but the settling band is wider in BLDC when compared to PMDC.The Position Loop responses have been included as position loop supersedes velocity loop and determines the overall behavior of GMRT servo system. Position Loop parameters such as rise time, peak overshoot have been calculated and show adherence to requirements of BLDC.The plots of the tracking profiles show a close adherence of antenna response to the targets given by ABC with rms tracking errors close to 5 arc sec which is very much within the servo requirements of GMRT.The RFI report conducted and circulated by the RFI Group states that the BLDC system complies to the RFI requirements of the GMRT antennas vindicating the extra effort taken to make BLDC system compatible to the requirements of GMRT.

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1. Velocity Loop Step Response:

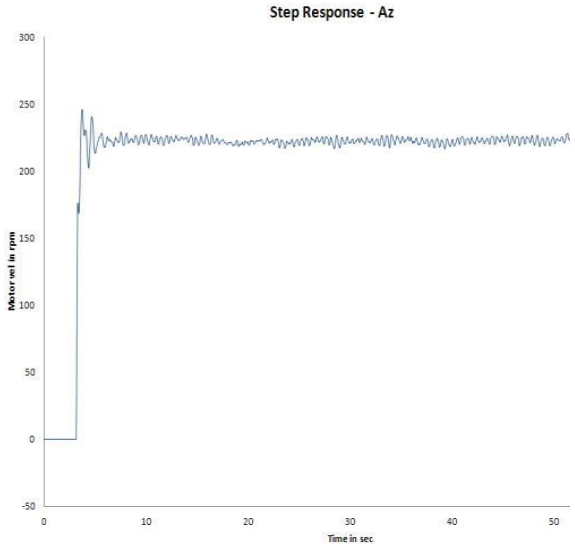
This test is performed by giving step voltage from a dc power supply to the speed loop which is housed in Delta Tau PMAC in BLDC system and counter torque card in PMDC.

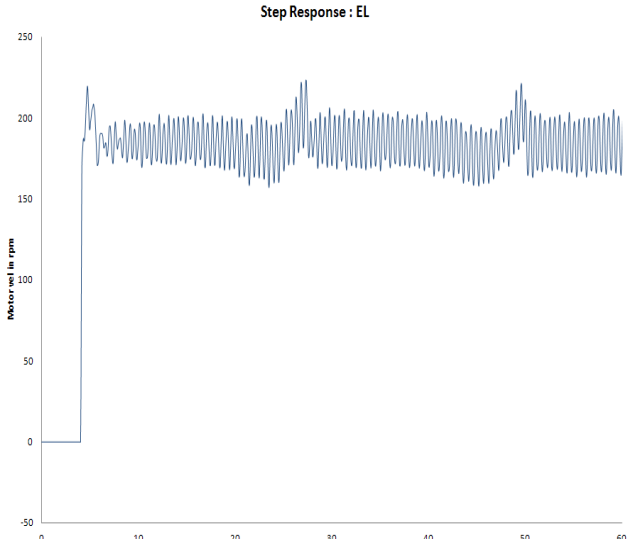
The motor responses are recorded using PMAC PLOT Pro in BLDC and LABVIEW in PMDC.

Produced below are the Step Responses of the speed loop of BLDC and PMDC.

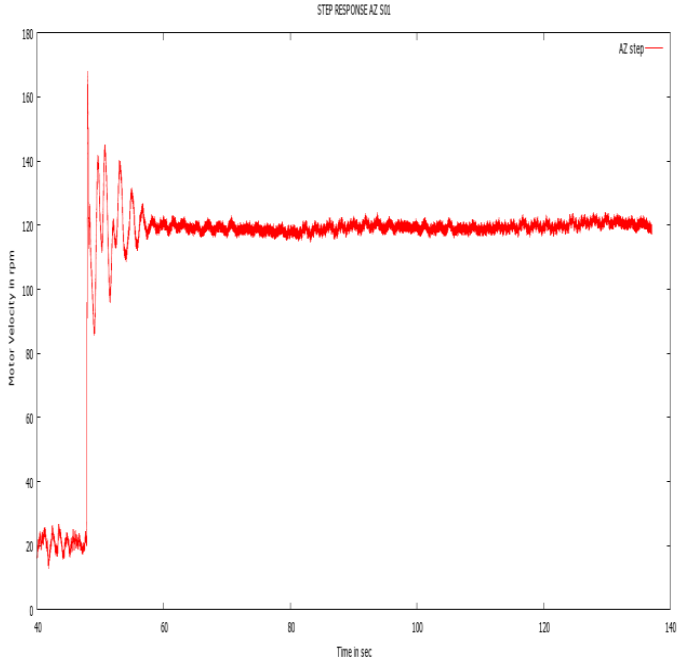
1.1 Conclusions: The step response parameters have been calculated for the position loop response only as this loop supersedes the speed loop.

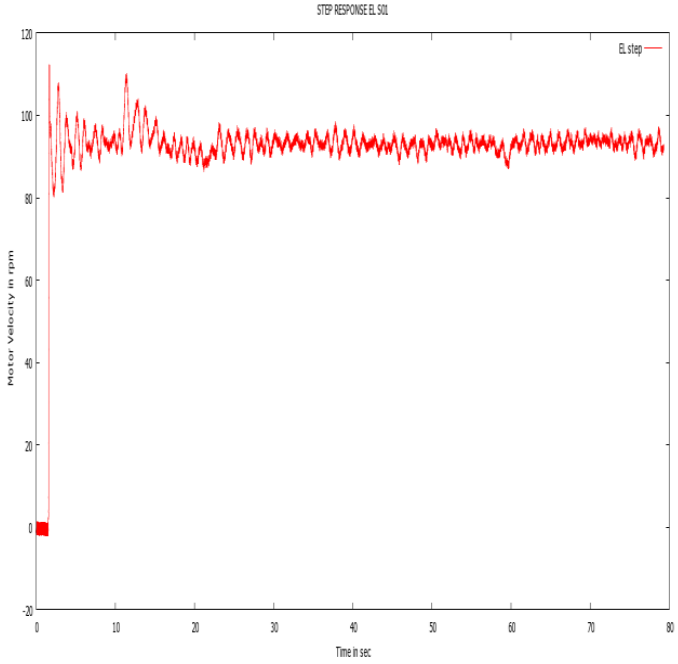
BLDC


Step Response - Az
Motor vel in rpm
Time in sec


Step Response : EL
Motor vel in rpm

PMDC


STEP RESPONSE AZ S01
AZ step
Motor Velocity in rpm
Time in sec


STEP RESPONSE EL S01
EL step
Motor Velocity in rpm
Time in sec

2. LRF (Locked rotor frequency tests)

Lrf test is conducted by introducing a sine – sweep waveform into the input of the speed loop and the motor response are recorded.

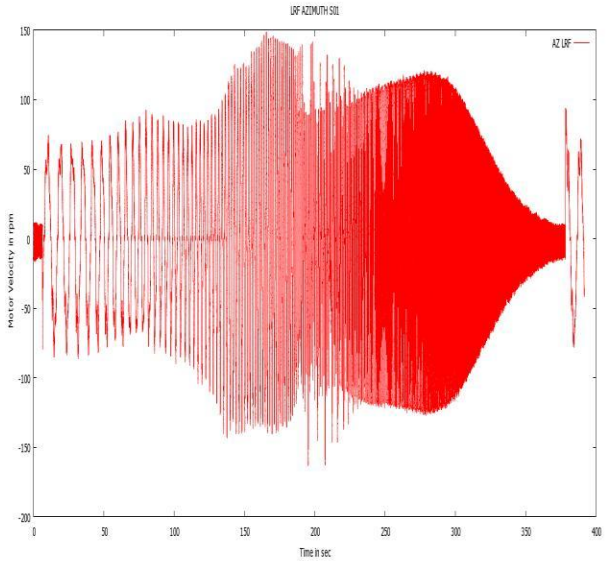
It is a very important tool for study of frequency domain stability of antenna.

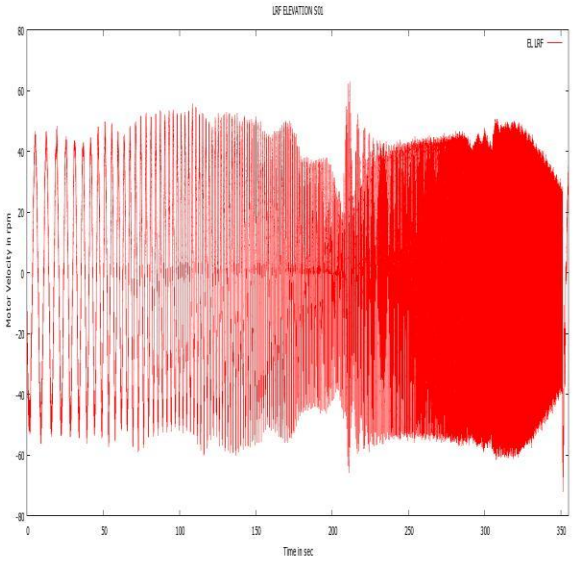
Tabulation of the results:

	Azimuth	Elevation
PMDC	1.1 Hz	1.25 Hz
BLDC	1.1 Hz	1.3 Hz

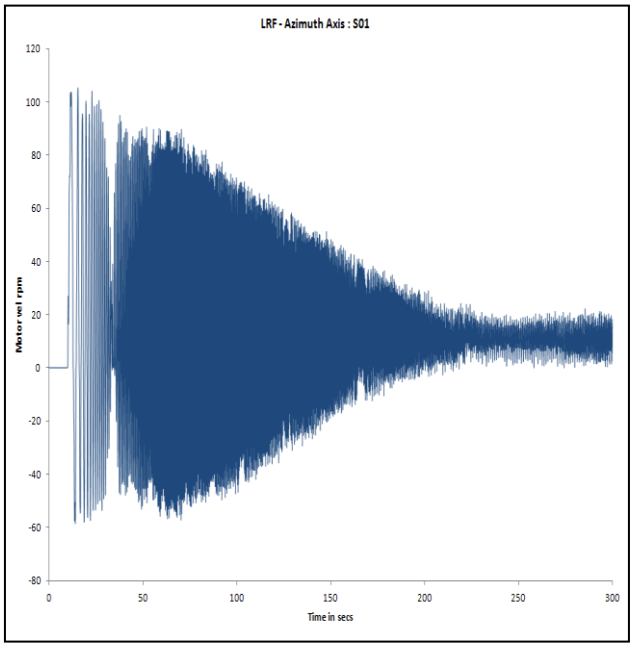
2.1 Conclusions: From the results it can be inferred that there is no significant change in the LRF before and after BLDC installation.

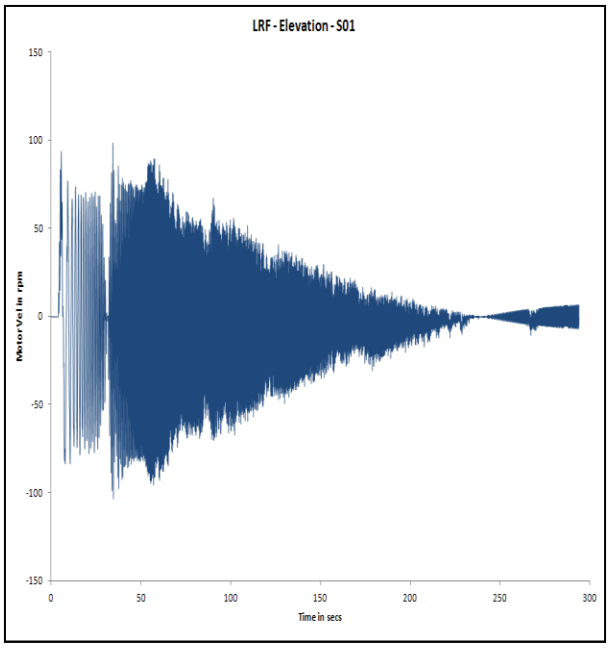
Produced below are the plots.





Above: LRF of PMDC





Above: LRF of BLDC

3. Position Loop Step Response:

These tests are conducted by giving step command of one degree and ten degree to the position loop and recording the encoder reading for the response. This can be done either with NEWSMU at the antenna base or from the control room.

These tests are the most important time domain study of the servo system. Since the position loop is the outermost loop, the response determines the stability of the overall system.

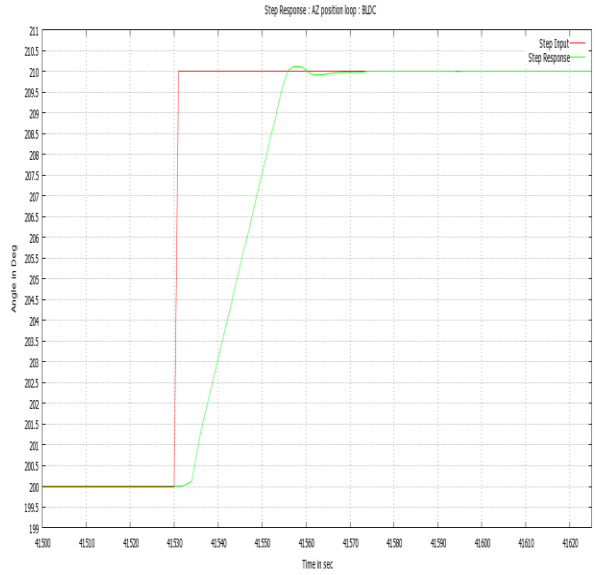
3.1 Conclusions:

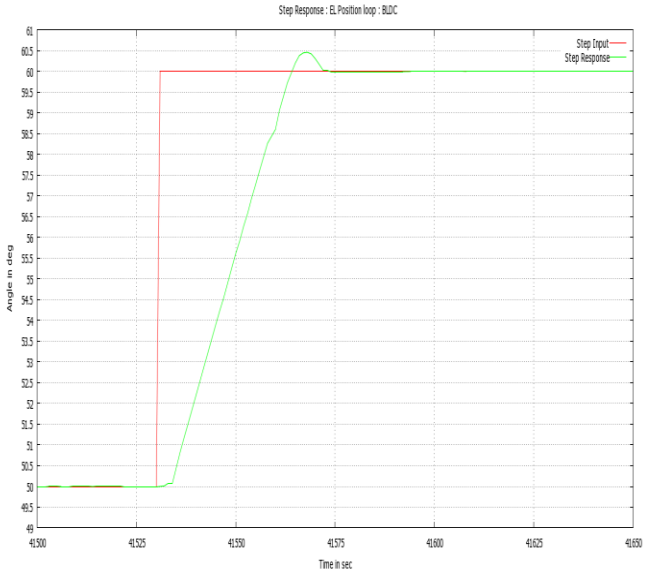
Since the position loop study was included for the first time there is no comparative study with the PMDC.

Produced below are the step response plots.

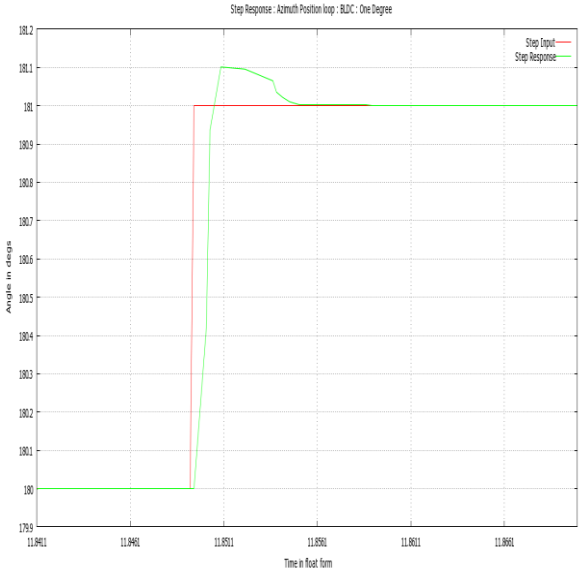
The various parameters for the step responses have been calculated and tabulated.

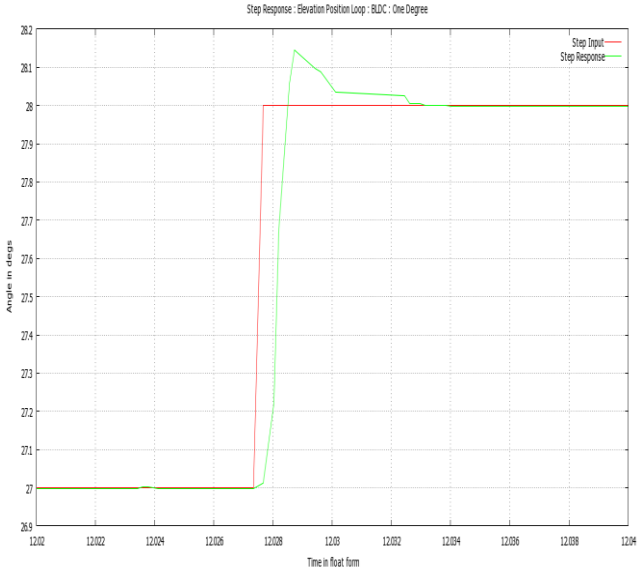
A comparative study will follow in subsequent reports.





Above plots are step responses for Ten degree step. Below are for One Degree step.





One Degree Step Response Analysis:

	Azimuth	Elevation
Overshoot (%)	10.11	14.5
Rise Time (sec)	2.88	2.16
Peak Time (sec)	11.851	12.027
Settling Time (sec)	18	18.36

4. Tracking Plots:

This test involves moving the antenna in different velocity tracking profiles and recording the target position issued by ABC and the encoder position achieved. Next step is plotting of the above two variables is done with respect to the time.

Plotted below are the tracking plots for various tracking profiles (5arcminpermin to 150arcminpermin)

The overlapping of encoder position and the target position and the linear slope shows that the tracking is smooth without much error.

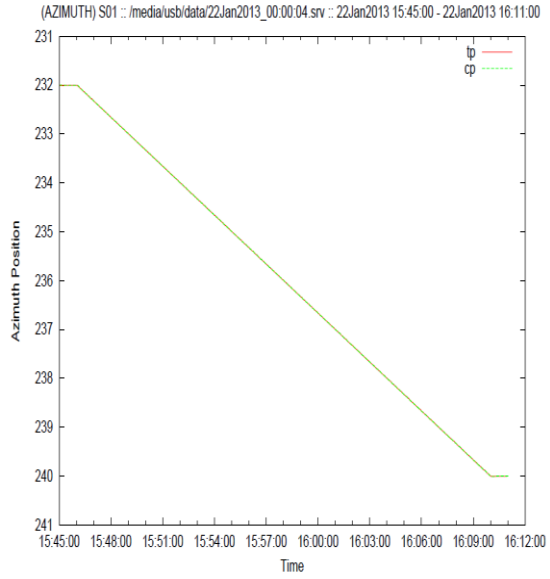
Also tracking error vs no. of samples plot has been included.

4.1 Conclusion:

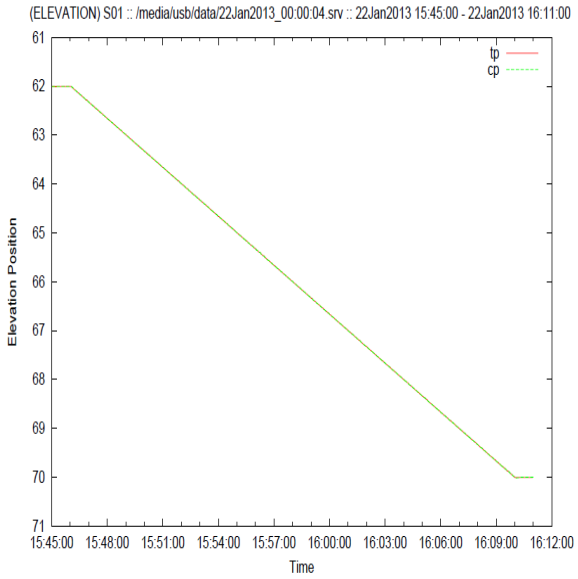
The overlapping of encoder position and the target position and the linear slope shows that the tracking is smooth without much error.

The errors obtained have been tabulated and are close to 5 arcsecs which is well within GMRT requirements.

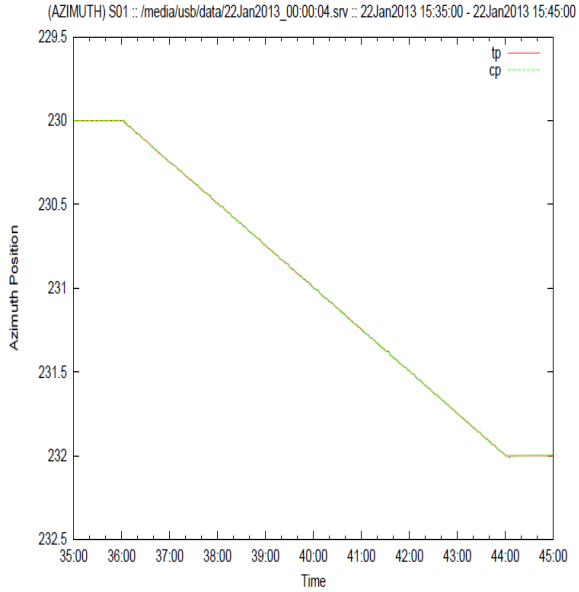
AZ Tracking 5arcmin per min



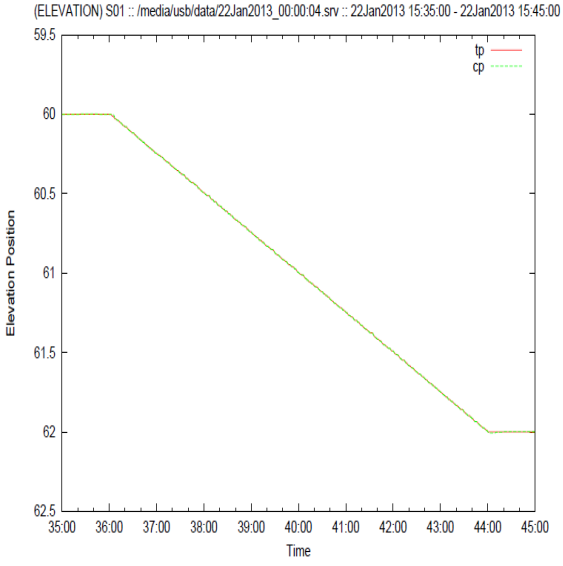
EL Tracking 5arcmin per min



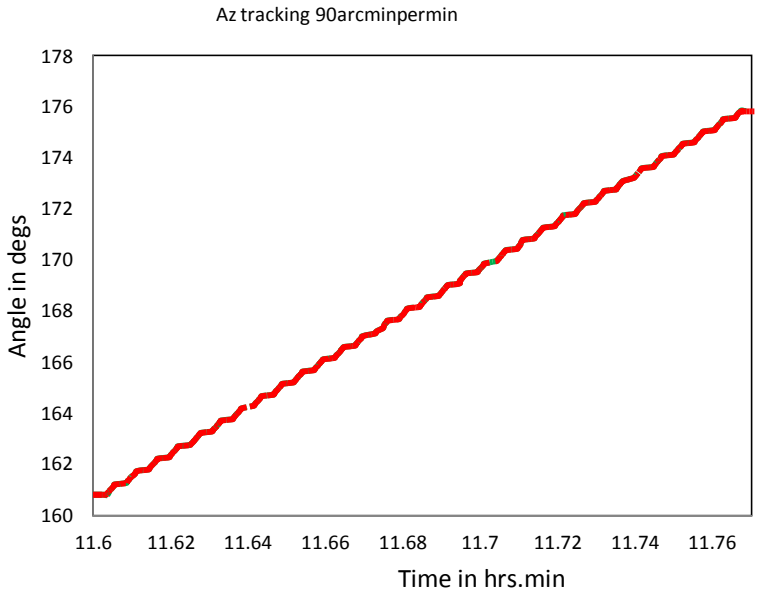
AZ 15 arcmin per min



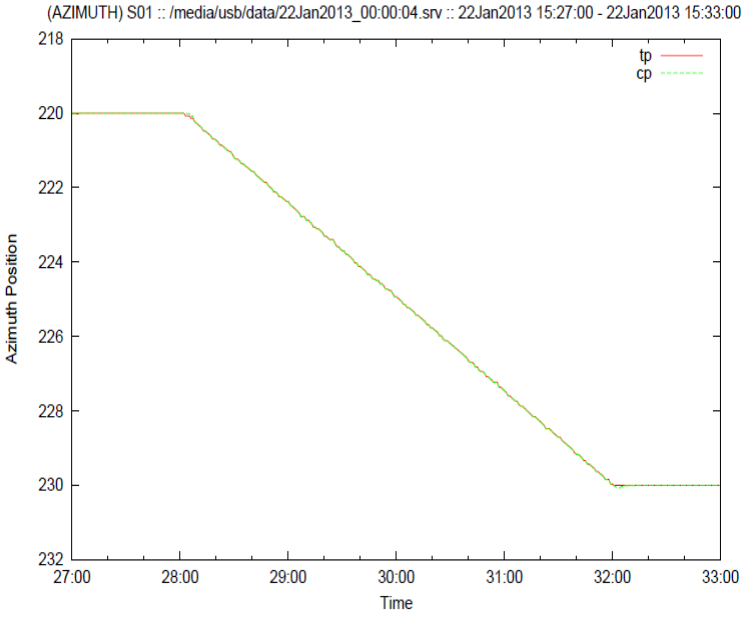
EL Tracking 15arcmin per min

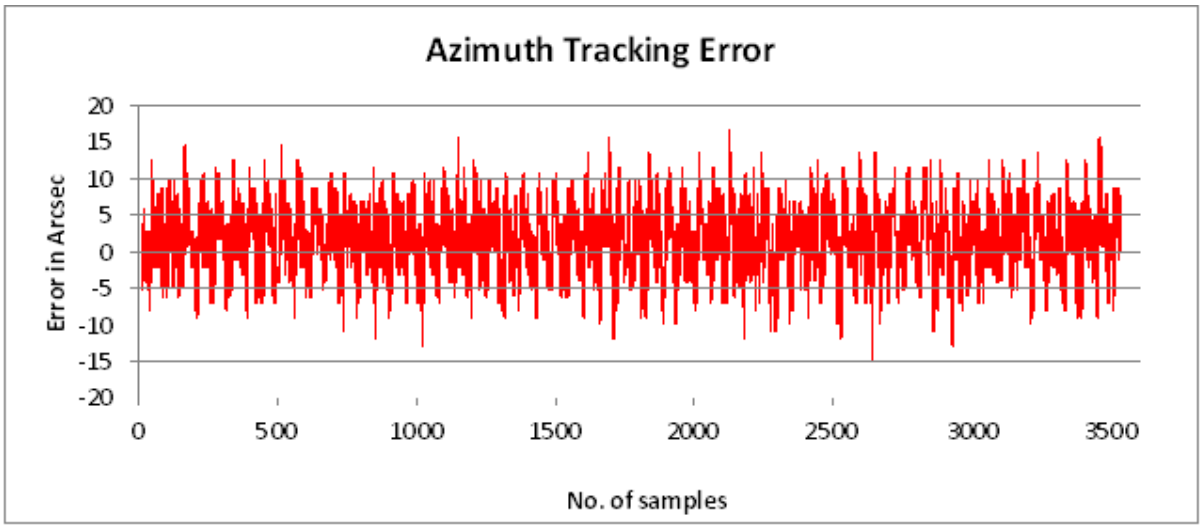


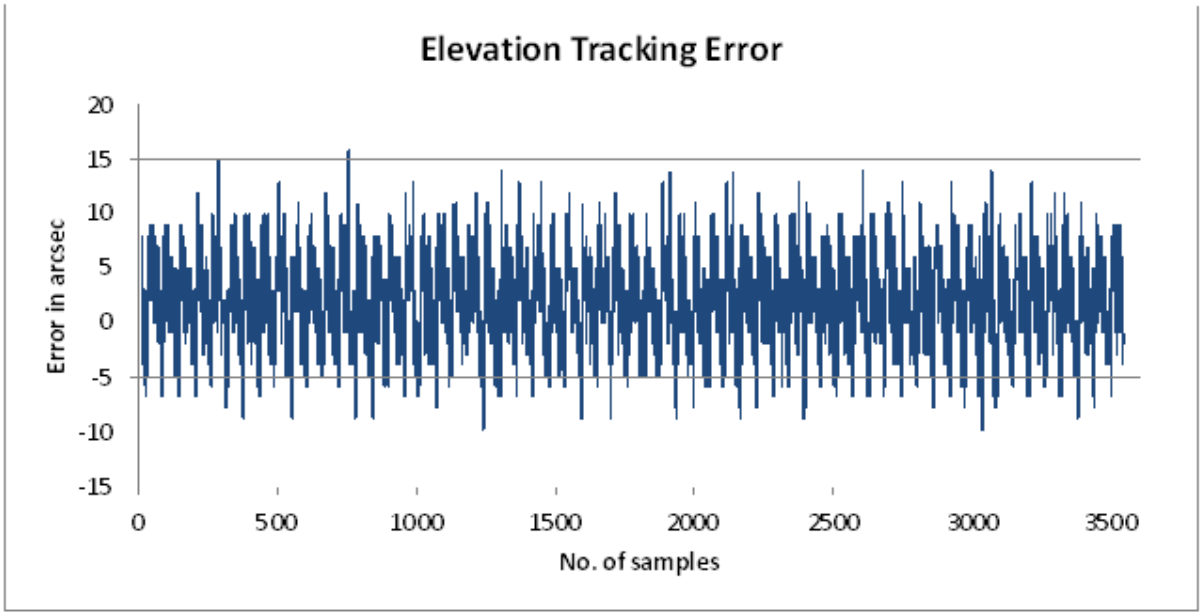
Azimuth 90arcmin per min



Azimuth 150 arcmin per min







RMS Error:

AZ : 5.2 arcsecs

EL : 4.88 arcsecs

5. RFI Test Report:

Reproduced below is the test report circulated by the RFI group.

5.1 Verdict: BLDC system has not created any RFI.

S-01 BLDC Servo System RFI Measurement Report

By :- SSK, PAR, SBB.

Following are the test result of RFI measurement done for BLDC System (before and after installation) at S-01 antenna.

Test Procedure:

1. Measurement done at 20 meter distance apart from S-01 antenna base with Rx LPDA antenna.
2. Log periodic antenna with 20dB amplifier used as receiver.
3. We observed RFI in 0-500MHz, 500-1000MHz and 1000-2000MHz frequency band for BLDC System from East, South, West and North direction.

Measurement Result :-

Before BLDC system Installation (old servo system)

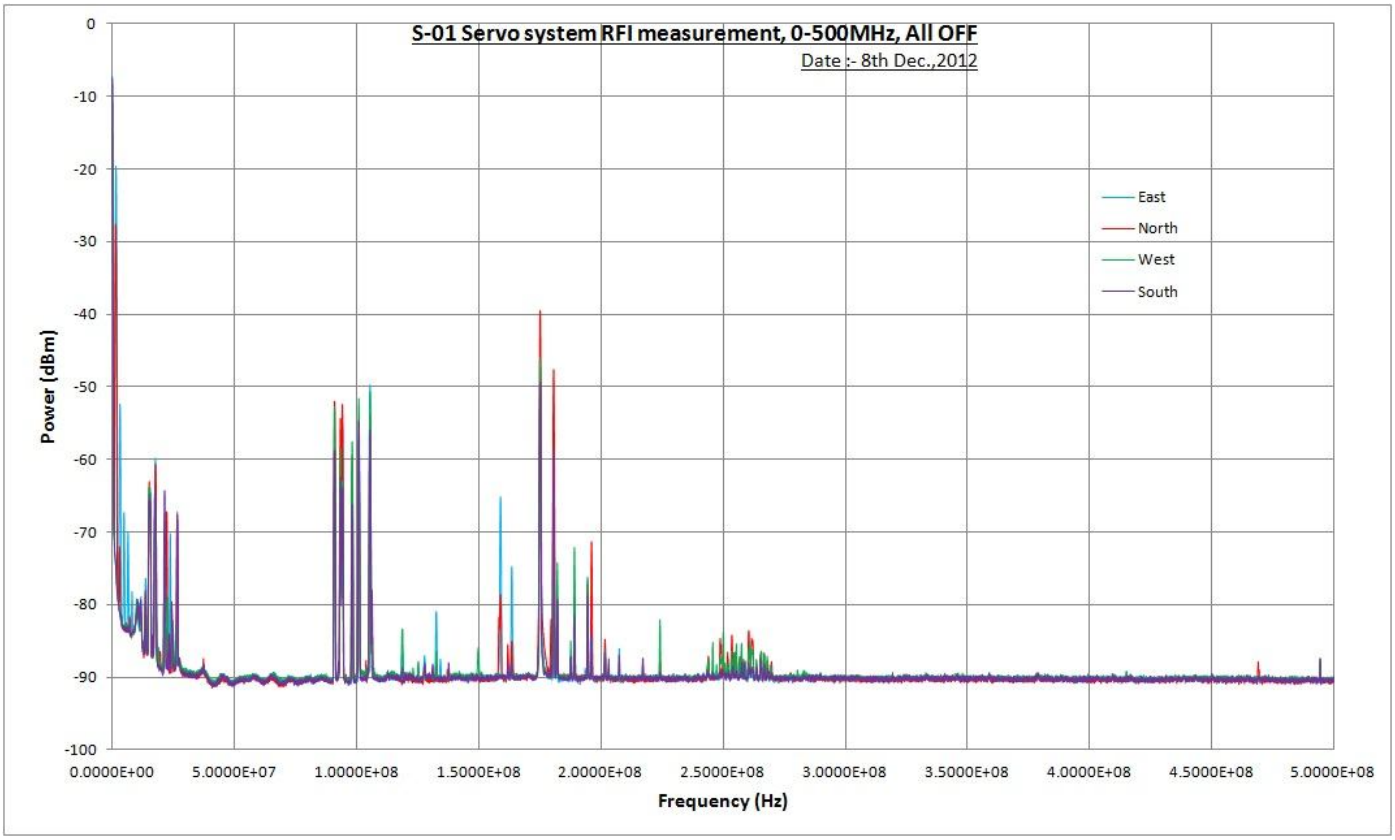


Fig.1: Above figure shows after Power OFF all system. (Measurement taken at 8th Dec., 2012).

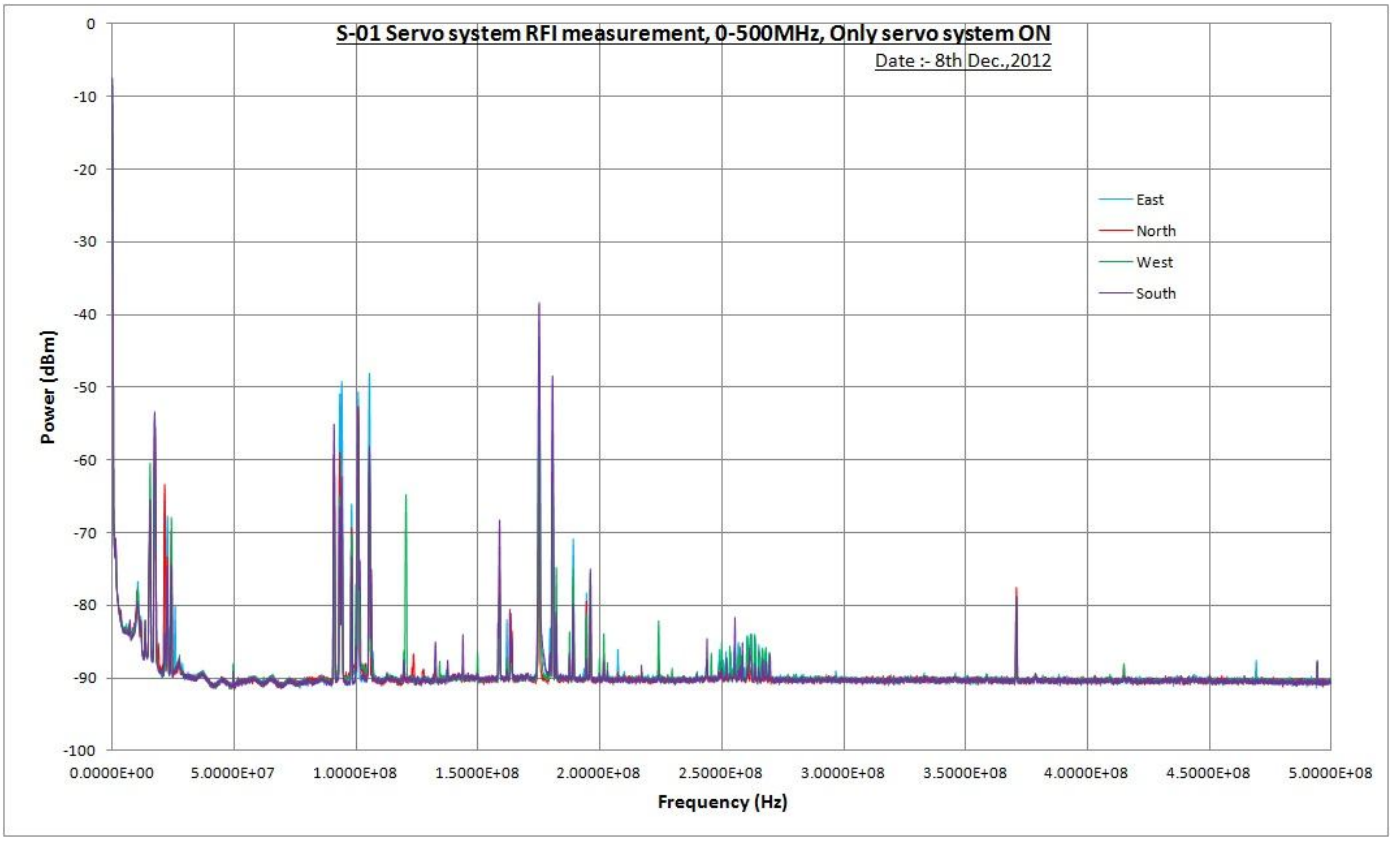


Fig.2: Above figure shows after Power ON only servo system. (Measurement taken at 8th Dec., 2012).

After BLDC system Installation (new servo system)

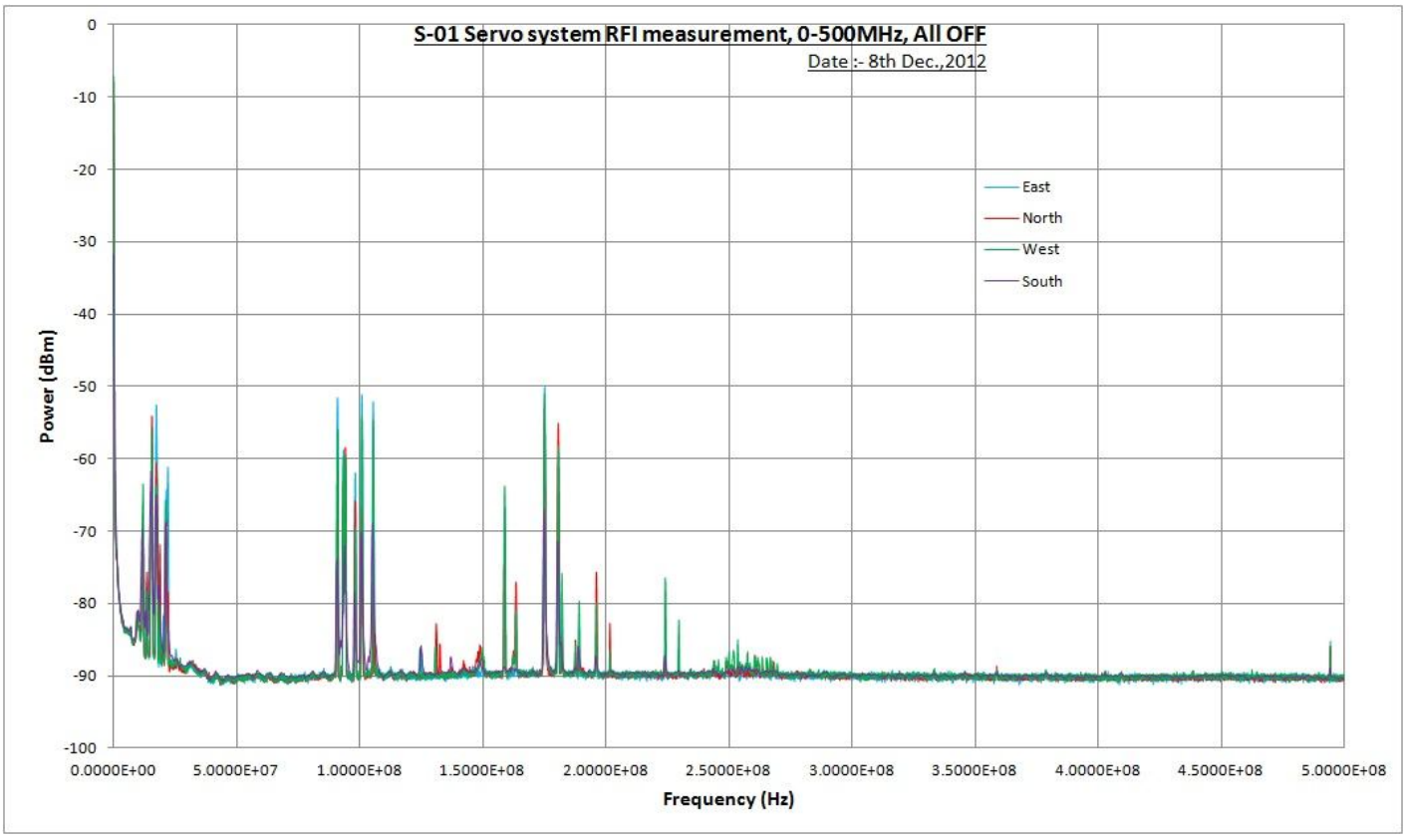


Fig.3: Above figure shows after Power OFF all system. (Measurement taken at 25th Jan., 2013).

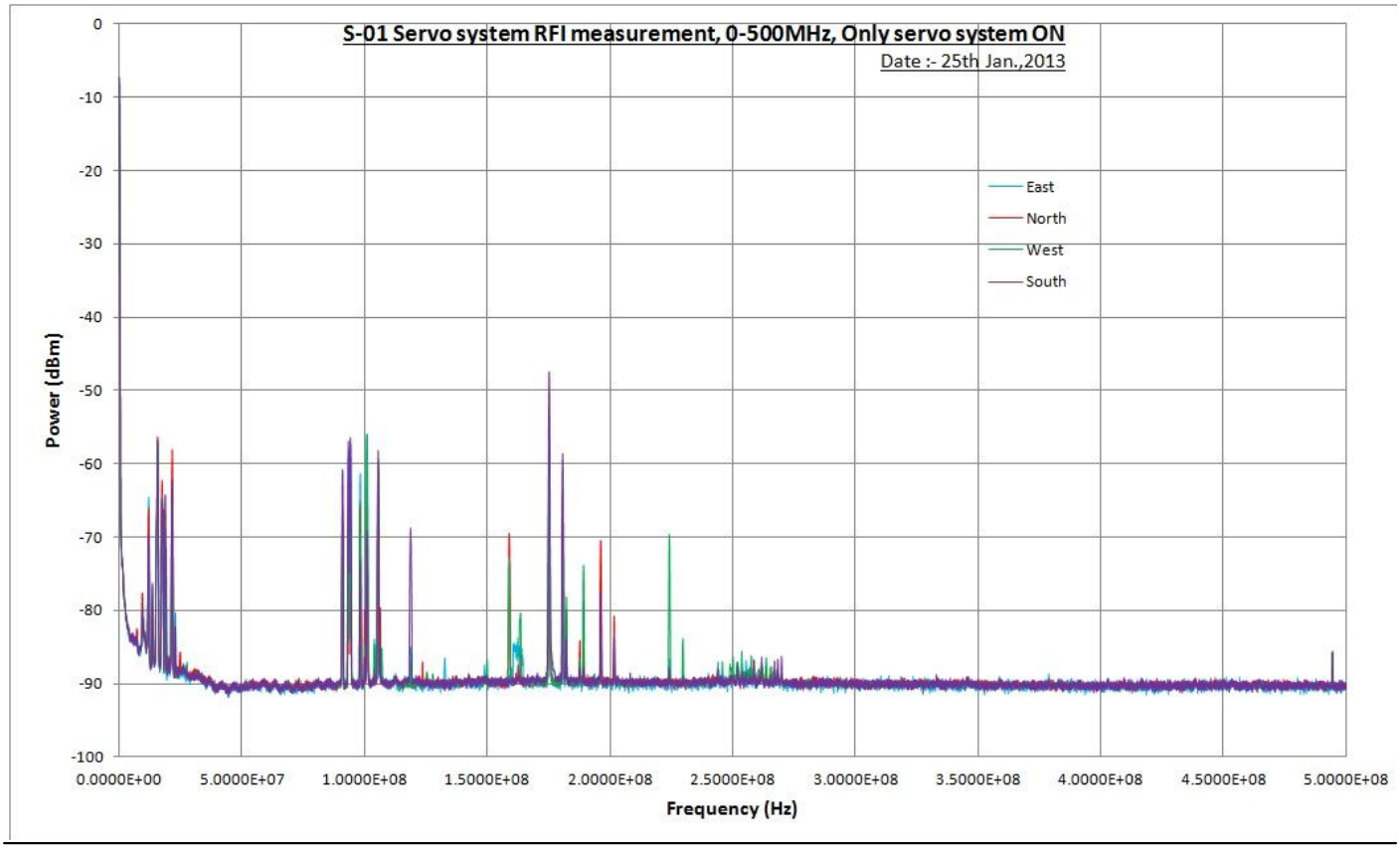


Fig.4: Above figure shows after Power ON only servo BLDC system. (Measurement taken at 25th Jan., 2013).

Conculsion **:-** There is no Radio Frequency Interference seen due to the BLDC System at S-01 antenna.

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OPERATIONAL TESTS REPORT

ANTENNA: S01 *Date: 22:01:2013*

COLD TESTING

1	Power Connection check (Put OFF the rack power, check all the power wiring for loose connection etc.)	OK	
2	Transformer Neutral wire connection check (Check transformer secondary neutral wire is connected to the rack body from transformers)	CONTROL RACK: OK	BLDC RACK: OK
3	Rack Earth connection to shielded cage (Control/BLDC earth wires from rack top is thick and connected to shielded cage)	OK	OK
4	Check the value of HRC-FUSE in control rack	Ph. 16 A	Nu 16 A

HOT TESTING

5	3-Phase Voltage of transformer (*IF ALL THE ABOVE CHECKS ARE OKAY THEN, PUT ON THE POWER FOR SERVO BLDC SYSTEM.*)	PRIMARY				SECONDARY			
			VOLTAGE	CURRENT	VOLTAGE		VOLTAGE	CURRENT	VOLTAGE
		R	232 V	2.9 A	R-Y= 409 V	R	234 V	2.9 A	R-Y= 409 V
		Y	236 V	4.5 A	R-B= 408 V	Y	237 V	3.9 A	R-B= 403 V
		B	230 V	4.0 A	Y-B= 408 V	B	232 V	2.0 A	Y-B= 410 V
6	Measure the AC voltage between Nu and Earth	**0.8 V**				**0.8 V**			
7	DC power supply voltage check (Note down the power supply voltages, current & Ripple mVac)	5V	+ 15V	-15V	24V CONTROL	24V BLDC	5V	+ 15V	-15V	24V CONTROL	24V BLDC
		5.1	14.9	-15.0	23.9	24.2	3mVac	3mVac	3.4 mVac	4.8 mVac	6mVac
		7.3 A	0.2 A	0.2 A	0.4 A	8.0 A					
8	**Servo Computer checks** (change the mode selector SW and look for status display flag) - put **ok**	**MAN OK**		**LOC OK**		**REM OK**					
9	Servo Star Drive GUI program file & firmware version details	**Soft. Ver. S01_servostar712setting.par**				**Firmware. Ver. 5.18**					
10	PMAC PLC PROGRAM DETAILS.	**AZ_EL_Velocity_PLC**									
11	Put target angle display to read wind & note down	**W1=** 9 kmph				**W2**= 11 kmph					

Created By-Shailendra J.Bachal

12	Note the AZ/EL Encoder Error entered (M,S-E)	AZ + 00:00:00				EL -00:36:59		
13	**Limit SW check** – Put on each axis and press each limit SW one by one and see the axis stops. ALL LS OKAY PUT ok	270P OK 268:55:53	-270P OK-277:18:00			15P OK 15:55:38	110P OK 106:26:07	
		270F OK -68:29:03	-270F OK +68:11:08			15F OK 15:24:00	110F OK 107:31:43	
		CWRP&AOVL +42,-57	0DEGOK0:57:0to3:59:40			STP OK 90:02:48	90D OK	
14	See the display of SS712,PMAC,Newsmu for current, tacho monitor Is all approx.to zero.by adding offset in SS712 drive.ALL OKAY PUT ok	**All SS712**		**PMAC**		**NEWSMU**		
		OK		OK		OK		
ROTATIONAL TESTING								
15	***Manual mode testing***	AZ-A	AZ-B	AZ-A	AZ-B	EL-A	EL-B	EL-A	EL-B
	Set the POT voltage to 6V & Direction of Antenna Rotation	~~CW~~/CCW				~~UP~~/DOWN			
	Tacho & Current voltage given on SSI monitor point	4.1 V	4.0 V	68mV	-22mV	3.3 V	-3.6 V	81 mV	10 mV
	Read the motor speed & current thru HHT/NEWSMU	973 rpm	971 rpm	2 A	0 A	828 rpm	-859rpm	+2 A	0 A
	Read the motor speed & current thru SS712	961rpm	951 rpm	1.89A	0.8A	822 rpm	-840rpm	+2.4 A	0.3 A
	Set the POT voltage to -6V & Direction of Antenna Rotation	CW/~~CCW~~				UP/~~DOWN~~			
	Tacho & Current voltage given on SSI monitor point	-3.7 V	-3.7 V	23 mV	-68 mV	-3.6V	+3.6V	23 mV	70mV
	Read the motor speed & current thru HHT/NEWSMU	-888pm	-891rpm	0 A	-1 A	-851rpm	840rpm	0 A	1 A
	Read the motor speed & current thru SS712	-880rpm	-878rpm	0.7 A	-1.7 A	-868rpm	860rpm	0.5A	1.8 A
16	***Local mode testing for positioning***	AZ-A	AZ-B	AZ-A	AZ-B	EL-A	EL-B	EL-A	EL-B
	Put CMD thru HHT & Direction of antenna (10V)	~~CW~~/CCW				~~UP~~/DOWN			
	Tacho & Current voltage given on SSI monitor point	6.1 V	6.1 V	100mv	75mv	6.0 V	-6.1 V	75mV	24mV
	Read the motor speed & current thru HHT/NEWSMU	1478rpm	1436rpm	1 A	0 A	1342rpm	-1384rpm	+2 A	0 A
	Read the motor speed & current thru SS712	1443rpm	1441rpm	2.6 A	1.0 A	1408rpm	-1450rpm	2.5A	1.6 A

	Put CMD thru HHT & Direction of antenna(-10V)	CW/~~CCW~~				UP/~~DOWN~~			
	Tacho & Current voltage given on SSI monitor point	-6.7V	-6.6V	18mV	-77mV	-5.7V	+6.0V	30mV	70mV
	Read the motor speed & current thru HHT/NEWSMU	-1592rpm	-1582rpm	0 A	-1A	-1400rpm	1433rpm	0 A	2 A
	Read the motor speed & current thru SS712	-1550rpm	-1535rpm	2.1 A	2.6 A	-1379rpm	1375rpm	1.6A	2.7 A
17	***Local mode testing for tracking***	AZ-A	AZ-B	AZ-A	AZ-B	EL-A	EL-B	EL-A	EL-B
	Put CMD thru HHT & Direction of antenna	CW/CCW				UP/DOWN			
	Note down track command Deg/min	Put up in section 4							
18	***Stow IN/REL Testing***								
	Keep EL at 80D and then at 100D and press "PARK". Check the Operation.	UP		DN		UP		DN	
		OK		OK		OK		OK	
19	***Antenna Tuning testing***								
	Velocity loop Step response Result	Put up in section 1							
	LRF conclusion	Put up in section 2							
	Position loop Step response	Put up in section 3							
20	***RFI Compliance***	Put up in section 5							

Installed By :SJB,AKA,ACP ,SSA

Tested By : SJB,ACP,AKA

Approved By : SGM