SES-STA-20090728-00925 IB2009002520
TerreStar License Inc.

Approved by OMB
3060–0678

APPLICATION FOR EARTH STATION SPECIAL TEMPORARY AUTHORITY

APPLICANT INFORMATIONEnter a description of this application to identify it on the main menu:
1.8–m station, Phase II IOT, initial 30 days (July 2009)

1. Applicant

Name:	TerreStar License Inc.	**Phone Number:**	703–483–7800
DBA Name:		**Fax Number:**	
Street:	12010 Sunset Hills Road	**E–Mail:**	doug.brandon@terrestar.com
City:	Reston	**State:**	VA
Country:	USA	**Zipcode:**	20190 –
Attention:	Mr Douglas I Brandon		

With Condition

FEDERAL COMMUNICATIONS COMMISSION
GRANTED
International Bureau

File # SES-STA-20090728-00925
Call Sign ______ Grant Date 8/11/09
(or other identifier)
Term Dates
From 8/11/09 To: 9/10/09
Approved: Kathryn Medley
Chief, Satellite Engrs. Br

Attachment

SES-STA-20090728-00925

Condition:

All operations shall be on an unprotected and non-harmful interference basis, i.e., TerreStar License Inc. shall not cause harmful interference to, and shall not claim protection from, interference caused to it by any other lawfully operating station and it shall cease transmission(s) immediately upon notice of such interference.

With Condition

FEDERAL COMMUNICATIONS COMMISSION

GRANTED

International Bureau

File # SES-STA-20090728-00925

Call Sign ______ Grant Date 8/11/09

(or other identifier)

Term Dates

From 8/11/09 To: 9/10/09

Approved: Kathryn Medley

Chief Satellite Engrg Br.

2. Contact

Name:	Joseph A. Godles, Esq.	**Phone Number:**	202–429–4900
Company:	Goldberg Godles Wiener & Wright	**Fax Number:**	202–429–4912
Street:	1229 19th Street, NW	E–Mail:	jgodles@g2w2.com
City:	Washington	**State:**	DC
Country:	USA	**Zipcode:**	20036 –2413
Attention:		**Relationship:**	Legal Counsel

(If your application is related to an application filed with the Commission, enter either the file number or the IB Submission ID of the related application. Please enter only one.)

3. Reference File Number or Submission ID

4a. Is a fee submitted with this application?

◉ If Yes, complete and attach FCC Form 159. If No, indicate reason for fee exemption (see 47 C.F.R.Section 1.1114).

○ Governmental Entity ○ Noncommercial educational licensee

○ Other(please explain):

4b. Fee Classification CGX – Fixed Satellite Transmit/Receive Earth Station

5. Type Request

○ Use Prior to Grant ○ Change Station Location ◉ Other

6. Requested Use Prior Date 08/11/2009	
7. CityNorth Las Vegas	8. Latitude (dd mm ss.s h) 36 14 9.9 N

9. State NV	10. Longitude (dd mm ss.s h) 115 7 1.3 W

11. Please supply any need attachments.

Attachment 1: STA | Attachment 2: 1.8–m Documentation | Attachment 3:

12. Description. (If the complete description does not appear in this box, please go to the end of the form to view it in its entirety.)

Applicant hereby requests Special Temporary Authority for 30 days, commencing August 11, 2009, in accordance with the details of the attached exhibit, in order to conduct Phase II in-orbit testing (IOT) of the TerreStar-1 satellite using a 1.8-m mobile earth terminal that will be co-located with TerreStar's North Las Vegas gateway earth station.

13. By checking Yes, the undersigned certifies that neither applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti–Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.

(●) Yes ( ) No

14. Name of Person Signing Douglas I Brandon	15. Title of Person Signing General Counsel and Senior Vice President

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REQUEST FOR SPECIAL TEMPORARY AUTHORTY

TerreStar License Inc. ("TerreStar"), pursuant to Section 25.120 of the Commission's rules, hereby requests Special Temporary Authority ("STA") to conduct in-orbit testing ("IOT") of the TerreStar-1 satellite in the manner described below. This STA request covers IOT operations specific to the Satellite Beam-forming Network (SBN), following the successful launch of the TerreStar-1 satellite on July 1, 2009.

The Bureau previously granted TerreStar authority to conduct IOT with the TerreStar-1 satellite. In a series of applications,[1] TerreStar indicated that it was seeking authority under what was called Phase I operations, in which IOT would be conducted in the United States via three facilities to test the communications payload: (1) TerreStar-1, a Canadian-licensed satellite as to which TerreStar holds a letter of intent ("LOI") authorization (Call Sign S2633) to serve the United States; (2) the 6.3-m and 9.3-m antennas associated with TerreStar's licensed gateway earth station located in North Las Vegas, Nevada (Call Sign E070098); and (3) an unlicensed 1.8-m mobile earth terminal ("MET")[2] that is co-located with TerreStar's North Las Vegas gateway earth station. Phase I IOT is on-going consistent with the parameters sought in TerreStar's initial STA requests.

In those same STA requests, TerreStar indicated that it would be filing a subsequent set of requests as part of Phase II operations in order to test the SBN. Accordingly, TerreStar is submitting the instant Phase II requests for that purpose. The Phase II requests cover IOT over the three facilities identified above and TerreStar's Calibration Earth Stations ("CES").[3]

This exhibit describes the operational parameters for Phase II IOT in the United States for the three facilities identified above and the CESs.

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[1] The Bureau granted TerreStar an initial 30-day Special Temporary Authority until August 4, 2009, to operate, respectively, the gateway antennas licensed under Call Sign E070098 and a 1.8-m mobile earth terminal pursuant to the application requests submitted as SES-STA-20090625-00794 and SES-STA-20090523-00646. Furthermore, TerreStar filed requests seeking 60-day extensions of those STA's pursuant to the application requests submitted as SES-STA-20090625-00795 and SES-STA-20090523-00644, which requests have been placed on Public Notice as accepted for filing.

[2] The 1.8-m MET, operating in a temporary fixed mode, uses a custom antenna that is designed for the express purpose of testing service link performance on TerreStar-1. The 1.8-m MET is entirely different from the MET handsets that will be used by TerreStar's customers.

[3] TerreStar submitted an application (File No. SES-LIC-20090403-00405; Call Sign E090061) on April 1, 2009, seeking authority to operate a network of 15 technically identical calibration earth stations, at fixed locations which point to the TerreStar-1 satellite and dynamically calibrate the channel responses of the satellite beams. TerreStar's application remains pending.

A copy of this exhibit accompanies each of the STA requests TerreStar is filing in connection with the Phase II IOT. The STA request form this exhibit is attached to identifies, for each Phase II IOT STA request: (1) the time period for which an STA is sought; and (2) the facility for which an STA is sought.

Based on discussions with the FCC's staff, and in light of the fact that no FCC radio license has been issued for TerreStar-1, TerreStar is not filing any request for special temporary authority for the satellite in connection with IOT. Rather, TerreStar is identifying in the IOT STA requests relating to TerreStar's gateway earth station in North Las Vegas the parameters for TerreStar-1's operations during IOT that deviate from the parameters on which the LOI authorization for TerreStar-1 are based.

STA is required because the technical operations required for IOT go beyond the operations authorized by TerreStar's FCC licenses and authorizations. In particular, TerreStar requires authority for the following operations that are not already authorized:

- ☐ <u>TerreStar-1</u>: Use of unmodulated (CW) carriers not covered by the LOI authorization and use of power levels higher than are authorized by the LOI authorization

- ☐ <u>NLV gateway</u>: Use of unmodulated (CW) carriers in the 12.75-13.25 GHz band that are not covered by the license and use of power levels higher than are authorized by the license (this STA request includes a Comsearch report reflecting temporary coordination of the unmodulated carriers)

- ☐ <u>NLV gateway</u>: Use of higher power and wider bandwidth for 12.751 and 12.999 GHz command carriers than is authorized by the license and corresponding changes to the emission designators for the carriers. The EIRP, EIRP density, and bandwidth of these command carriers have been increased to 72 dBW, 48.8 dBW, and 832 kHz, respectively, from what is currently licensed (this STA request includes a Comsearch report reflecting temporary coordination of the higher power and wider bandwidth)

- ☐ <u>NLV gateway</u>: Feeder link transmissions on discrete frequencies in the upper half of the 12.75-13.25 GHz band (the gateway license authorizes transmissions only in the lower half of the band; this STA request includes a Comsearch report reflecting temporary coordination of the additional frequencies)

- ☐ NLV gateway: Use of a different polarization and higher power for the 12.992 GHz CW pilot signal than is authorized by the license (the license shows right hand polarization; left hand polarization will be used). The EIRP and EIRP density of the pilot signal has been increased to 80 dBW from what is currently licensed (this STA request includes a Comsearch report reflecting temporary coordination of the CW carriers)

- ☐ NLV gateway: Use of wider bandwidth for 11.2005 GHz and 11.4495 GHz telemetry carriers than is authorized by the license and corresponding changes to the emission designators for the carriers. The bandwidth of these telemetry carriers have been increased to 400 kHz from what is currently licensed

- ☐ NLV gateway: Use of 5 MHz carriers in the 12.75-13.00 GHz band that are not covered by the license (this STA request includes a Comsearch report reflecting temporary coordination of the 5 MHz carriers)

- ☐ 1.8-m MET: Operation of this earth station, which has not been licensed

- ☐ CES terminals: Operation of TerreStar's 15 technically identical U.S. Calibration Earth Stations in accordance with the parameters specified in connection with application for a license to operate the Calibration Earth Stations

- ☐ CES terminals: Operation of unmodulated (CW) carriers (operation of these CW carriers is not requested in TerreStar's pending CES application), at higher EIRP than requested in TerreStar's CES application, by four of TerreStar's 15 U.S. CESs, located in San Manuel, AZ, Miami, FL, Austin, NV, and North Las Vegas, NV

I. Introduction

TerreStar launched its TerreStar-1 satellite on July 1, 2009. The satellite has since its launch reached its assigned orbital slot of 111.0° W.L. Currently, all satellite systems are functioning normally and the satellite is undergoing the initial check-up of its major subsystems, including both the bus and the communication payload. TerreStar needs to perform IOT of its SBN payload, herein called Phase II IOT, which will commence near the conclusion of the

Phase I IOT. The IOT will be performed by employees of TerreStar's satellite contractor, Space Systems Loral ("Loral"), under TerreStar's direction and supervision.

During this Phase II IOT, the components related to its Satellite Beam-forming Network will be tested as engineers check the combined payload performance with the Ground-Based Beam Forming ("GBBF") network to determine how well various S-band beams are formed. As the Commission is aware, the S-band antenna subsystem of TerreStar-1 satellite system is based on the so-called GBBF approach. As such, the ground GBBF equipment, which is housed at the TerreStar gateway sites at both North Las Vegas ("NLV"), NV and Allan Park ("AP"), Ontario, Canada, will need to be tested in a *combined* manner with the satellite S-band antenna and associated radiating elements to ascertain the actual beam-forming capabilities and performance. In addition, for the first time in orbit, TerreStar will obtain the actual beam patterns of the elemental beams which are essential to the beam-forming task and to compare them against the prediction.

The communication payload of the TerreStar-1 satellite consists of two repeater subsystems: one associated with the Forward channel and another one associated with the Return channel. The Forward channel refers to the Ku-to-S band signal path that originates from a Ku-band gateway facility to the satellite, and then traverses to an S-band device on the ground: in this instance the 1.8-m IOT antenna. The Return channel refers to the reverse link, *i.e.,* from an S-band device such as the 1.8-m IOT antenna to the satellite and then back to the Ku-band gateway on the ground.

Table 1 below summarizes the types of signals along with their characteristics that will be employed in each of the Forward payload and Return payload Phase II tests.

II. Forward Payload Tests

With the exception of one test (noted in this section below), all test signals required in Forward payload tests will be transmitted from the GBBF equipment and gateway RF equipment located at NLV at Ku-band and converted to S-band frequencies before being downlinked by the satellite at S-band. The following key tests are planned to be conducted:

- Payload bake-out: At the beginning of the Phase II IOT, and toward the conclusion of the Phase I IOT, any residual moisture in the feed array needs to be purged in order to reduce the chances of multipaction or arcing inside waveguide sections carrying high power. All 64 active S-band TWTAs will be driven near/at saturation to heat the feed array.

- Interface verification: The signal path from the GBBF equipment, through the gateway RF equipment, to the satellite forward link transponder, will be checked for connectivity for each of the 64 forward paths.

- Equalization verification: Verify that amplitude, phase, and delay equalization have been applied to two special single-element beams over NLV.

- Calibration verification: Verify that calibration circuitry can properly correct the feederlink-induced amplitude and phase errors.

- Pointing verification: Verify that GBBF equipment can correctly compensate for satellite pointing errors.

- Beamforming Accuracy test 1 (transmitted from NLV): Verify beam-forming accuracy by measuring each beam response over NLV and compare it against prediction. The GBBF will be operating over the NLV band.

- Beamforming Accuracy test 1 (transmitted from AP): Verify beam-forming accuracy by measuring each beam response over NLV and compare it against prediction. The GBBF will be operating over the AP band and the AP gateway RF equipment will be used.

- Frequency Response test: Verify the frequency response of a formed spot beam over NLV.

- Beamforming Advantage test: Verify the beam-forming gain of a formed spot beam over NLV compared to a single-element beam.

Regarding the S-band downlink, TerreStar is conscious of its interference-related responsibilities with respect to Fixed Service (FS) stations that are operating co-channel with TerreStar in the 2190-2200 MHz band in some locations. TerreStar has selected frequencies for S-band IOT test signals that are optimal for interference avoidance; all IOT test signals except the payload bake-out signals will be short in duration; and the number of transmissions during the test period will be limited. TerreStar has conducted a study and determined that these transmissions, including both the IOT test signals and the payload bake-out signals, satisfy the interference-avoidance standards specified in TIA's Telecommunication System Bulletin (TSB) 86.

III. Return Payload Tests

Most of the test signals required in Return payload tests will be transmitted from the 1.8-m IOT antenna and associated equipment located at NLV at S-band and converted to Ku-band frequencies before being downlinked by the satellite at Ku-band. As described in one of the paragraphs below, one test will involve S-band transmissions by four of TerreStar's Calibration Earth Stations ("CES"). The following key tests are planned to be conducted:

- Doppler Correction verification: Verify that the Doppler frequency shifts have been corrected for two elements over NLV with significant feederlink frequency separation. Both NLV and AP GBBF equipment will be checked.

- Calibration verification: Verify that calibration circuitry can properly correct the feederlink-induced amplitude and phase errors.

- Pointing verification: Verify that GBBF equipment can correctly compensate for satellite pointing errors.

- Beamforming Accuracy test 1: Verify beam-forming accuracy by measuring each beam response over NLV and compare it against prediction. Both NLV and AP GBBF equipment will be checked.

- Beamforming Accuracy test 2 (transmitted by CES stations): In this test, CES stations will transmit, one at a time and in addition to their normal calibration signals, a CW signal for testing purpose. The test is designed to check the beamforming accuracy using feeds that cover the CES stations used in the test. Additionally, the test will check the ATC nulling accuracy in the return channel. Up to four of TerreStar's CESs in the United States, located in in San Manuel, AZ, Miami, FL, Austin, NV, and North Las Vegas, NV, will be used in connection with this test.

- Frequency Response test: Verify the frequency response of a formed spot beam over NLV.

- Beamforming Advantage test: Verify the beam-forming gain of a formed spot beam over NLV compared to a single-element beam.

Regarding the IOT test signal transmissions at 2 GHz, TerreStar understands from Sprint's submissions to the Commission that BAS stations in both Las Vegas and the near-by Phoenix DMA clusters have been relocated from BAS channels 1 and 2 in the 1990-2025 MHz band.[4] TerreStar has selected 2004.90 MHz and 2008.10 MHz for S-band IOT transmissions to eliminate the possibility of interference to any BAS receiver. The frequencies selected provide 18 MHz or more of separation between the TerreStar CW test signal and BAS users in the Las Vegas or Phoenix DMAs who have migrated to the new BAS channel plan above 2025 MHz.

Similarly, there will be no interference to BAS from the S-band transmissions. TerreStar demonstrated in its CES application that its 15 CES station are sufficiently removed from any BAS receive sites that there will be no interference to the receive sites from CES operations in accordance with the parameters specified in the application. Similarly, there will be no interference to BAS from operation of the four CES stations located in the US (at San Manuel, AZ, Miami, FL, Austin, NV, and North Las Vegas, NV) that are required in one of the return channel tests. This is because BAS channels 1 and 2 have been migrated out of the 1990-2025 MHz band in all four DMAs where the CES stations are located.

IV. Conclusion

TerreStar's request for STA is supported by good cause. Grant of the instant STA request is in the public interest, as it will enable TerreStar to perform in-orbit testing on its TerreStar-1 satellite and ensure the proper functioning of the satellite's communications payload in anticipation of providing service to the public over the satellite and the network's gateway antennas.

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[4] Sprint's BAS Relocation web site indicates all DMAs in southern California have successfully transitioned to the BAS channel plan above 2025 MHz including Los Angeles, San Diego, Palm Springs and Bakersfield. *See* http://www.2ghzrelocation.com/plugin/template/broadcast/Welcome/*.

Table 1. TerreStar SBN IOT Test Signal Characteristics

	S-band EIRP (in dBW)	Bandwidth Used	S-band Frequency (in MHz)	Estimated Duration for each Test Signal Transmission (in minutes; see Notes 1 & 2)	Estimated Number of Instances of Test Signal Transmission (see Note 1)	Ku-band EIRP from/at NLV (in dBW)	Ku-band Frequency (in MHz)
Forward Payload Tests							
Payload bake-out	68	5 MHz per feed with a total of 64 feeds	2195-2200	2160	1	75	12750-13000
Interface verification	54	CW	2199.900 2193.609	1	130	80 (see Note 3)	(see Table 2)
Equalization verification	51.6	5 MHz	2195-2200	60	2	62	12750-13000
Calibration verification	72	2*CW	2199.910 2199.920	1	5	59	12750-13000
Pointing verification	72	4*CW	2199.890 2199.900 2199.910 2199.920	720	1	59	12750-13000
Beamforming Accuracy test 1 (transmitted from NLV)	72	4*CW	2199.890 2199.900 2199.910 2199.920	180	1	59	12750-13000

Beamforming Accuracy test 1 (transmitted from AP)	72	4*CW	2193.599 2193.609 2193.619 2193.629	180	1	N/A	13000-13250
Frequency Response test	62	5 MHz	2195-2200	30	1	72.5	12750-13000
Beamforming Advantage test	72	2*CW	2199.910 2199.920	5	1	59	12750-13000
<u>Return Payload Tests</u>							
Doppler Correction verification	37.8	CW	2008.1 (NLV) 2004.9 (AP)	N/A	N/A	45	10700-10950 11200-11450
Calibration verification	37.8	CW	2008.1 (NLV)	N/A	N/A	45	10700-10950 11200-11450
Pointing verification	37.8	CW	2008.1 (NLV)	N/A	N/A	45	10700-10950 11200-11450
Beamforming Accuracy test 1	37.8	CW	2008.1 (NLV) 2004.9 (AP)	N/A	N/A	45	10700-10950 11200-11450
Beamforming Accuracy test 2 (transmitted by 4 CES stations)	25	CW	2008.1 (NLV)	N/A	N/A	40	10700-10950 11200-11450
Frequency Response test	35.5	5 MHz	2005-2010 (NLV)	N/A	N/A	40	10700-10950 11200-11450

Beamforming Advantage test	30	CW	2008.1 (NLV)	N/A	N/A	35	10700-10950 11200-11450

Note 1: Each 10 MHz sweep or each forward path testing using a steady CW is considered as one Test Signal Transmission.
Note 2: Duration is the duration of the actual signal transmission and does not include the time it takes to maneuver the satellite or position the beams.
Note 3: Satellite is in off-nominal attitude mode.
Note 4: All entries are estimates.

Table 2. Ku-band Element Frequencies that correspond to Two S-band Test Signal Frequencies in Forward Payload Tests

Element No.	S-band 2199.9 MHz Frequency	
1	12764.9	MHz
2	12771.9	MHz
3	12778.9	MHz
4	12785.9	MHz
5	12792.9	MHz
6	12799.9	MHz
7	12806.9	MHz
8	12813.9	MHz
9	12820.9	MHz
10	12827.9	MHz
11	12834.9	MHz
12	12841.9	MHz
13	12848.9	MHz
14	12855.9	MHz
15	12862.9	MHz
16	12869.9	MHz
17	12876.9	MHz
18	12883.9	MHz
19	12890.9	MHz
20	12897.9	MHz
21	12904.9	MHz
22	12911.9	MHz
23	12918.9	MHz
24	12925.9	MHz
25	12932.9	MHz
26	12939.9	MHz
27	12946.9	MHz
28	12953.9	MHz
29	12960.9	MHz
30	12967.9	MHz
31	12974.9	MHz
32	12981.9	MHz

Element No.	S-band 2193.609 MHz Frequency	
1	13008.609	MHz
2	13015.609	MHz
3	13022.609	MHz
4	13029.609	MHz
5	13036.609	MHz
6	13043.609	MHz
7	13050.609	MHz
8	13057.609	MHz
9	13064.609	MHz
10	13071.609	MHz
11	13078.609	MHz
12	13085.609	MHz
13	13092.609	MHz
14	13099.609	MHz
15	13106.609	MHz
16	13113.609	MHz
17	13120.609	MHz
18	13127.609	MHz
19	13134.609	MHz
20	13141.609	MHz
21	13148.609	MHz
22	13155.609	MHz
23	13162.609	MHz
24	13169.609	MHz
25	13176.609	MHz
26	13183.609	MHz
27	13190.609	MHz
28	13197.609	MHz
29	13204.609	MHz
30	13211.609	MHz
31	13218.609	MHz
32	13225.609	MHz

S

DOC CODE: SW
Document No.: E-TBD
Revision No.

3825 Fabian Way
1.0
Palo Alto, CA 94303-4604
CAGE 0DJH2

TerreStar IOT S-Band Antenna System Performance Requirements Specification

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PROGRAM:	PRIME CONTRACT NO.:
RESPONSIBLE ENGINEER	PROGRAM OFFICE
GROUND SEGMENT MANAGER	
MISSION OPERATIONS	PRODUCT ASSURANCE
	RELEASE DATE: Page 1 of 12

SPACE SYSTEMS LORAL

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CHANGE RECORD PAGE

Change Number	Reason For Change	Affected Pages

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TABLE OF FIGURES

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1.0 SCOPE

The TerreStar program requires an S-Band antenna system at the TerreStar ground facility in North Las Vegas to support In-Orbit Testing of TerreStar's S-Band payload. This antenna system shall be transportable and will also be used at yet to be determined site(s) to support further testing of the spacecraft communications payload subsystem. This document defines the technical requirements of the S-Band antenna system. Other programmatic requirements are specified in the referenced Statement of Work identified in Section 2 of this document.

1.1 OVERVIEW

The TerreStar IOT S-Band Antenna System will be installed at the TerreStar Ground Facility which is located in North Las Vegas. This facility provides TT&C supports for the TerreStar spacecraft, and is one of the gateway sites for the Space Based Communications Network. IOT campaign will be conducted at this facility, using the deliverable IOT S-Band Antenna Subsystem along with other IOT equipment that SS/L will provide. After the initial testing at the North Las Vegas facility is complete, the deliverable IOT S-Band Antenna System will be transported to and set up at other location(s) to support further testing of the spacecraft payload subsystem. For this reason, it is essential that the S-Band Antenna System must be transportable, and can be set up and tear down by a crew of two.

The deliverable IOT S-Band Antenna System consists of the necessary antenna assembly, selective uplink and downlink RF components, and optional equipment Monitor and Control (M&C) subsystem. A simplified block diagram of the deliverable antenna system is shown in Figure 1 below.

The deliverable system shall have built-in equipment M&C capability that provide for central control and status monitoring of relevant equipment. (see Figure 1 for details.) It shall also support equipment M&C by remote user.

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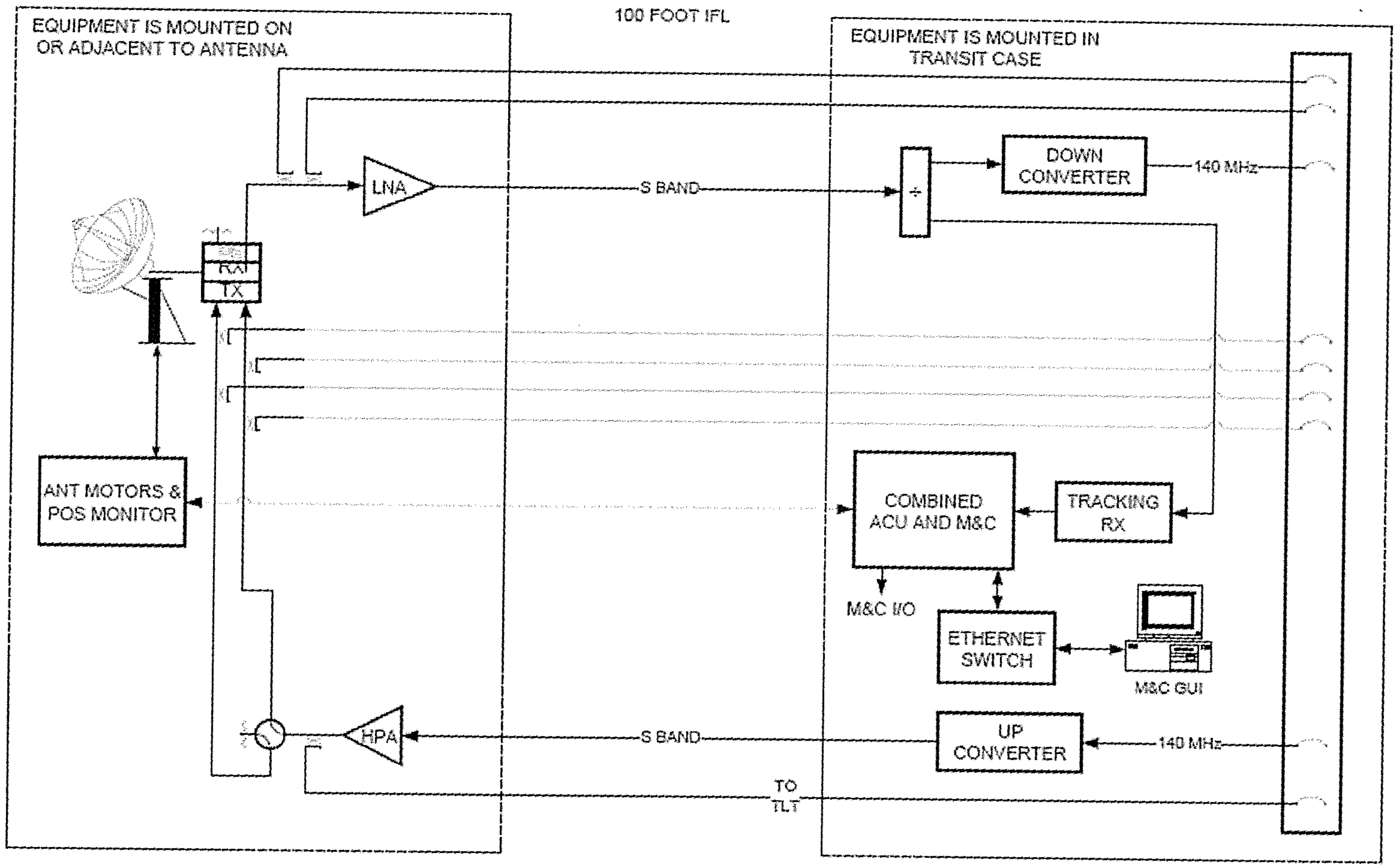

Figure 1. Simplified Block Diagram of Deliverable IOT S-Band Antenna System

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2.0 APPLICABLE DOCUMENTS

1) TerreStar IOT S-Band Antenna Subcontract Statement of Work, doc number: E-TBD

3.0 REQUIREMENTS

3.1 GENERAL REQUIREMENTS

The deliverable antenna system shall provide the capability to support TerreStar In-Orbit Test. It shall be capable of autonomously tracking the spacecraft as the spacecraft makes its daily figure-eight movements in orbit. It shall also be capable of program track based on externally provided 2-line element set. The system shall be capable of supporting IOT operations with the spacecraft positioned at the required orbital location. At this orbital location, the IOT antenna shall be pointed to the nominal direction of approx. 111 West with inclination of 6 degrees (eccentricity = 0);

The system shall be transportable. It shall be capable of being setup and tear down by a crew of up to two people. It shall have design features that allow the antenna assembly to be set up in leveled and stable ground, with or without concrete foundation or support. The equipment assembly shall be contained in self-contained transportable rack enclosures. Each rack assembly shall require no more than two person to lift and set up.

The system shall support the space-to-ground interface required for IOT operations. It shall also support interface with Customer Furnished Equipment (CFE) necessary to conduct IOT.

3.2 PERFORMANCE REQUIREMENTS

The system and its subsystem elements shall be capable of performance characteristics defined in this section.

3.2.1 Antenna subsystem

The antenna subsystem shall consist of the antenna assembly, antenna control unit, power control unit, tracking receiver, etc. This section defines requirements associated with the antenna subsystem.

PARAMETER	SPEC
Antenna Type	Limited-motion steerable, Az-El mount

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Reflector feed Reflector Size	Centre or offset fed 1.8 meter (nominal)
Tracking	Program and manual
Drive Mechanism	Azimuth Anti-backlash, precision steel teeth gear drive Elevation Jackscrew
Antenna Control Unit (ACU)	Indoor unit with multi-position memory
Sky Coverage	El = 10 to 90 degrees; Az = +/- 90 degrees (TBC) minimum
Location Preferred	ground or pole mounting
Weight limits	TBD and design should minimize single point loads and offer load spreading plate options
Interfaces	Data interfaces for PC, modem, printer & GPS
Remote Controller	Remote Windows based PC capability
Power requirements	Capable of operating from NLV local mains (UPS) supply
Rx Frequency, MHz	2180 – 2200
Tx Frequency, MHz	2000 – 2020
Antenna Gain, Rx band, dB min	28.3[1]
Antenna Gain, Tx band, dB min	27.5
Polarization	LHCP for RX, selectable LHCP or RHCP for TX
Axial ratio (dB max)	1.5
Antenna Pattern Requirements	Per FCC Part 25 outside of main beam and first sidelobe (+10°)
Noise Temperature at 35 degree elevation, K max	80
VSWR Rx and Tx bands, max	1.3 (equivalent to 17.7 dB return loss)
Loss in Polarizer and filter, dB max	1.5
Rejection of Tx frequencies at the LNB Input, dB min	78
Tracking Loss without wind, dB max	0.25
Wind Load, Operational, MPH	60 (TBC)
Tracking Loss AT MAX Operational Wind of 80 mph, dB MAX	NA (Testing will stop if high winds occur)
Wind Load, Survival, MPH	120
Operating Temperature, degree C	-15 to + 50

[1] Gain measurements with accuracy of better than +/- 0.5 dB shall be required upon final measurement of the antenna

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3.2.2 LNA

PARAMETER	SPEC
Frequency, MHz	2180 – 2200
Gain, dB	50 - 65
Gain Flatness	≤ 1.0 dB across the 20 MHz band
Noise Figure, dB	60°K or 0.9 dB @ 50 deg C Note Guaranteed G/T of 5 dB/K exceeds original requirement.
Output 1dB compression point, min	5 dBm
Input third-order intercept point, min	-55 dBm
RX input signal range	-110 to -90 (TBC) dBm single carrier -85dBm (composite)
Unconditional Stability	Unconditionally stable with any input or output load conditions at any phase angle

3.2.3 SSPA

Parameter	spec
Tx Frequency, MHz	2000 – 2020
Output Power, Watt	50
$P_{1\text{-dB}}$, Watt minimum	40
Gain, dB	70 (TBC)
Gain Flatnes, dB	+/-0.3 dB/40 MHz, +/-0.5 dB/full band
Gain Stability, max	Gain Stability 1.5 dB over -40 to +50°C
Output Dynamic Range and Power Control	20 dB in 1 dB intervals
Noise Figure, dB max	11 at max gain
NUMBER OF CARRIERS AND MODULATION TYPE OF EACH CARRIER	1
Max Output Power When Carrier Off	0 dBm typical
Phase Noise	TBD
AM/PM Conversion, °/dB, max	3.5 at $P_{1\text{-dB}}$
Unconditional Stability	Unconditionally stable with any input or output load conditions at any phase angle. The HPA is protected against all load VSWR values.
Output Spurious	Per FCC, and CCIR requirements
Input VSWR, max	1.3
Output VSWR, max	1.3
Intermodulation Requirement, dBc max	-25 at 3 dB backoff from $P_{1\text{-dB}}$
Fault Condition Detection and Response to Fault Conditions	Required

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3.2.4 SYSTEM

Parameter	spec
EIRP	Minimum of 40 dBW @ (HPA operating at 3dB backoff power)
G/T	Minimum of 4.5 dB/K
Environmental	Antenna assembly, including interconnect cables and waveguide shall be designed for outdoor use. Equipment installed in transportable rack enclosures shall be designed for use in sheltered environment.
Operating	
Temperature, deg C	-15 to + 50
Survival	
Temperature, deg C	-50 to + 70
Grounding	
Lightning and Surge Protection	Per standard commercial practice. Surge protectors are proposed on all cables.
Regulatory Requirements	
SAFETY	Per ANSI and UL
EMISSIONS	Per CFR 47, FCC Part 15 (Excluding Transmit Band)
IMMUNITY	Per standard commercial practice.
Fault Condition Detection, Alarm, and Response to Fault Conditions	TBD
Maintenance	Minimum maintenance required. Easy access to all parts requiring any maintenance
Spares	Any low cost, consumable spare parts to be provided at outset. Supplier contact details and all part type / serial numbers to be provided.
Warranty	1 year warranty with extension options
Technical Support	Access to technical support cost options required for (i) during normal office hours (ii) 24 x 7

3.2.5 Up/Down conversion

Both in transmit and receive direction, it shall be possible to interface the antenna system with communications equipment operating at 140 MHz. As a consequence, suitable upconverter and downconverter shall be provided as well as patch panel for interface at the 140 MHz frequency.

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3.2.6 Test Couplers

Two Inline 30 dB couplers shall be provided in the both uplink and downlink signal paths. In the downlink signal path, coupler shall be provided between antenna and input to LNA, in order for test signal be injected to the LNA via the test coupler. In the uplink signal path, coupler shall be installed prior to antenna connector. The test coupler shall support measurement of uplink transmitter power. Two sets of separate couplers are required for the uplink transmitter power monitoring; two for RHCP path and two for LHCP path. All Couplers should be calibrated across the band in 4 MHz. intervals.

3.2.7 Ground Equipment Monitor and Control Subsystem

The optional Ground Equipment Monitor and Control (M&C) Subsystem software shall monitor and control all relevant ground TT&C station equipment, including:

a. Antenna and associated equipment, such as tracking receiver, and ACU;

b. RF equipment, such as HPA, LNA;

c. Up and down conversion equipment

d. Signal routing switches

The M&C software shall provide the capability for the operator to perform interactive ground equipment control and status monitor functions.

Manual Control. Relevant ground station equipment shall be capable of being manually controlled from the equipment front panel or other means. It shall be possible to manually override the remote control of the equipment.

Displays. The M&C software shall provide the capability for ground equipment control and status monitoring by an operator using block diagram displays (mimics).

3.2.8 Standalone Transportable Rack

A standalone transportable shall be provided for use by the purchaser to install their own equipment.

3.2.9 Spare Parts List

The list of spares in the following table shall be provided:

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Description	Quantity
Low Noise Amplifier (LNA)	1
High Power Amplifier (HPA)	1
Antenna Control spare kit	1
Tracking receiver	1
Upconverter	1
Downconverter	1

3.3 INTERFACE REQUIREMENTS

Refer to Figure 1 for interface described in this section.

Interface points for access to signals should be at an easily accessible point, i.e. a rack mount panel with Type N connectors.

At a minimum, the following access points shall be provided:

1) S Band Transmitter input
2) S Band LNA Output
3) LHCP Uplink Power Coupler monitor
4) RHCP Uplink Power Coupler monitor
5) Downlink Coupler inject
6) 140 MHz IF Input
7) 140 MHz IF Output
8) TLT Input

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9) TLT Output

10) Polarization Switch Control (connector TBD)

11) Ground Equipment Monitor and Control

3.4 OTHERS

System calibration data shall be provided. The measurements should be made across the band of interest in 4 MHz. steps.

Exterior cables and connectors shall be designed for outdoor use and “weatherized” to help protect from rust/corrosion.

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