Department of Transportation
Federal Aviation Administration

System Specification

Ground-Based Transceiver (GBT)
For Broadcast Services Using the UAT

DRAFT

(For Industry Comment)

11/12/2002

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1.0 SCOPE AND BACKGROUND

This document is the subsystem specification for the Ground Based Transceiver (GBT). The fundamental role of the GBT is to support broadcast data link services. These services are known as Automatic Dependent Surveillance-Broadcast (ADS-B), Traffic Information Services-Broadcast (TIS-B) and Flight Information Services-Broadcast (FIS-B).

1.1 Broadcast Data Link Services

1.1.1 ADS-B

ADS-B is a system by which aircraft, certain equipped surface vehicles, and fixed ground locations can share (i.e., broadcast) position, velocity, and other information with one another. With such information made available by ADS-B from other proximate aircraft[1], it is possible to establish the relative position and movement of those aircraft with reference to one's own aircraft. It is also possible for ground-based facilities to monitor ADS-B broadcasts to enable basic surveillance capabilities, or to supplement existing surveillance systems. Other data that are shared using ADS-B include information related to the aircraft's intended flight path ("intent" data), aircraft type, and other information.

ADS-B is *automatic* in the sense that no pilot or controller action is required for the information to be broadcast. It is *dependent surveillance* in the sense that the aircraft surveillance-type information is derived from on-board navigation equipment.

ADS-B is considered to be a key enabling technology to enhance safety and efficiency in airspace operations. RTCA Special Committee SC-186 has documented a wide range of applications of ADS-B focused on those goals in RTCA/DO-242A. These include basic applications, such as the use of ADS-B to enhance the pilot's visual acquisition of other nearby aircraft, as well as more advanced applications, such as enabling enhanced closely spaced parallel approach operations. Other applications involving airport surface operations, improved surveillance in non-radar airspace, and advanced conflict management are also described.

1.1.2 TIS-B

Traffic Information Service - Broadcast (TIS-B) is a ground-based service to ADS-B-equipped aircraft to provide surveillance data on non-ADS-B-equipped aircraft. TIS-B may also be used in ADS-B implementations involving multiple ADS-B data links to provide a crosslink—or "gateway"—between ADS-B equipped aircraft using different data links. The service is intended to provide ADS-B-equipped aircraft with a more-complete traffic picture in situations where not all aircraft are equipped with ADS-B (or with the same ADS-B data link).

As commonly envisioned, TIS-B involves three major functions. First, another source of surveillance information on non-ADS-B aircraft (such as Secondary Surveillance Radar (SSR)) must be available. Second, this surveillance information must be converted and

[1] ADS-B can also be used for surveillance of ground vehicles on the airport surface. Use of the term "aircraft" includes ground vehicles equipped with ADS-B.

processed so as to be usable by ADS-B-equipped aircraft. And third, a broadcast facility and protocol is necessary to convey this information to ADS-B-equipped aircraft.

1.1.3 FIS-B

FIS-B is the ground-to-air broadcast of non-control, advisory information needed by pilots to operate more safely and efficiently in the National Airspace System and in international airspace. FIS provides to pilots the necessary weather graphics (e.g., NEXRAD reflectivity) and text (e.g., METAR and TAF), Special Use Airspace information, Notices to Airmen, and other information.

1.2 Basic Data Link Functions of the GBT

The GBT's primary function is that of translating data link traffic between the GBT's Air Interface (the RF medium) and the GBT's Ground Interface (interface to other ground systems). The GBT is an event driven system that performs the following three fundamental tasks:

- Reception of ADS-B messages received over the GBT's Air Interface are mapped into ADS-B reports for transmission over the GBT's Ground Interface to an end system.
- Reception of TIS-B reports over the GBT's Ground Interface are mapped into TIS-B messages for transmission over the GBT's Air Interface to aircraft.
- Reception of Uplink Data Blocks containing FIS information over the GBT's Ground Interface are mapped into Ground Uplink messages for transmission over the GBT's Air Interface to aircraft.
- Figure 1-1 is a simplified diagram of the GBT relative to other elements.

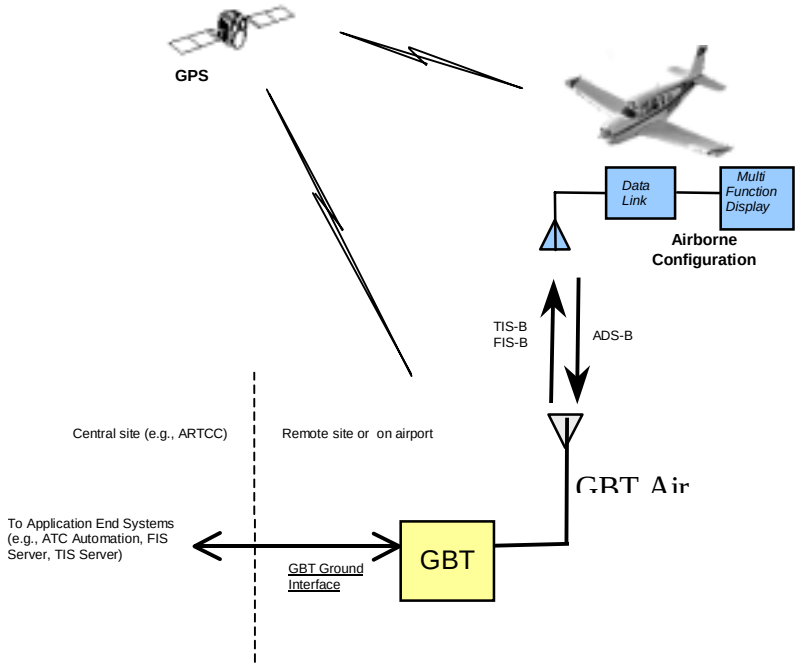


Figure 1-1 The GBT in Context of Other Elements

1.3 GBT External Interfaces

A simplified diagram of the GBT is shown in Figure 1-2 with each of the system's external interfaces.

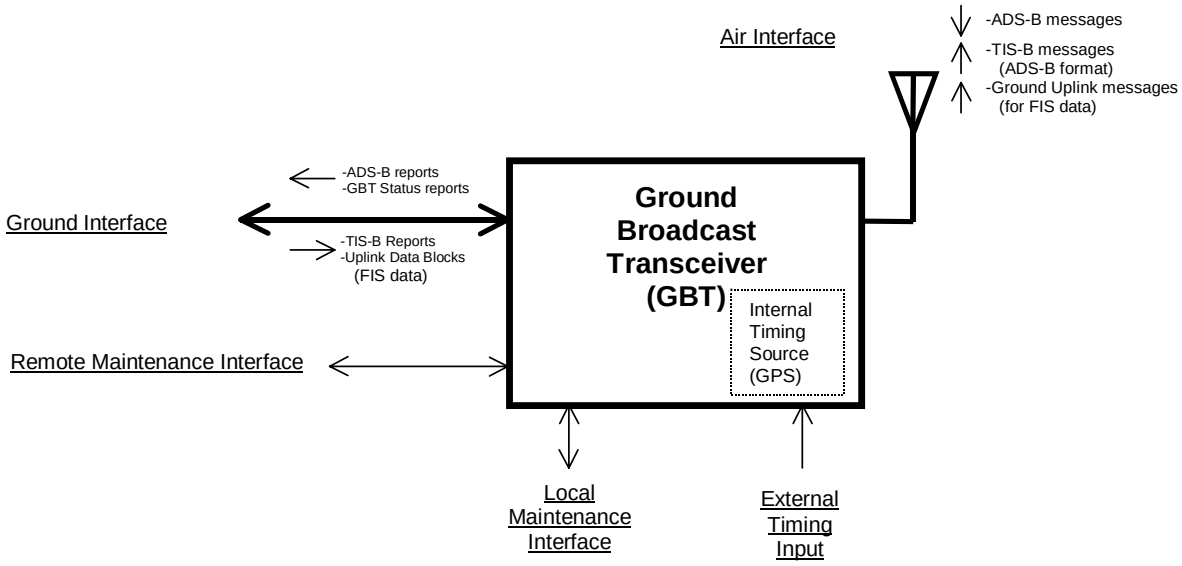


Figure 1-2. GBT External Interfaces

1.3.1 Air Interface

The GBT Air Interface carries *message* traffic over the data link RF medium. Message traffic includes ADS-B messages transmitted from aircraft, TIS-B messages transmitted from the GBT and Ground Uplink messages transmitted from the GBT.

1.3.2 Ground Interface

The GBT Ground Interface conveys ADS-B *reports* from the GBT, TIS-B reports to the GBT and Uplink Data Blocks (containing FIS data) to the GBT. The Ground Interface also conveys periodic Status reports from the GBT.

1.3.3 Local Maintenance Interface

The GBT's Local Maintenance Interface supports both monitoring and control of various GBT functions when the technician has physical access to the GBT equipment.

1.3.4 Remote Maintenance Interface

The GBT's Remote Maintenance Interface supports most of the monitoring and control functions offered by the local maintenance port. However this interface is intended to be accessed from a central site remote from the GBT equipment.

1.3.5 External Timing Input

The GBT requires timing information both to control media access for uplink transmissions and to support time stamping of ADS-B reports. The GBT is specified to have a GPS-based internal time reference. For cases where the GBT is in an environment

where the internal GPS time reference cannot be used, an external time source can be applied to the External Timing Input. Selection of internal vs external timing is configurable.

1.4 Data Link Medium for the Air Interface

The GBT governed by this specification employs the Universal Access Transceiver (UAT) data link as the RF medium. It could be more precisely called the "GBT_{UAT}". GBT functionality employing the 1090 MHz Extended Squitter data link (the "GBT_{1090}") will be specified subsequently. It is expected that a GBT system employing the 1090 MHz Extended Squitter data link will have external interfaces consistent with those defined by this specification as much as possible—with the exception of the Air Interface. Hereafter in this document the term "GBT" will be used to mean "GBT_{UAT}".

1.5 Overview of UAT Data Link

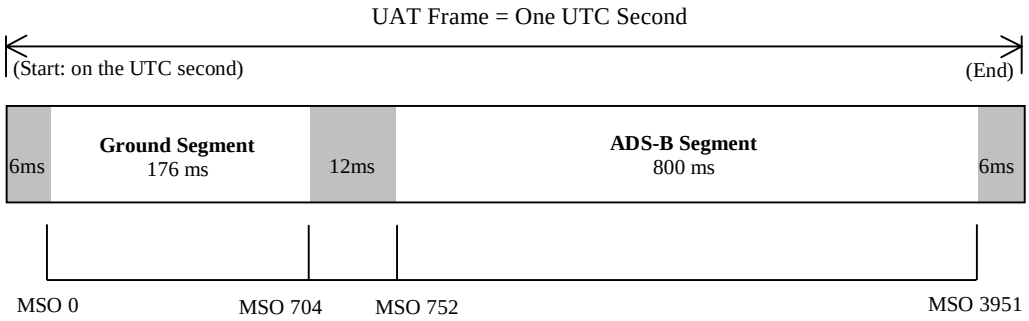
The UAT is a multi-purpose data link intended to operate globally on a single channel with a channel signaling rate of just over 1Mbps. By design, UAT supports multiple broadcast services including FIS-B and TIS-B in addition to ADS-B. This is accomplished using a hybrid medium access approach that incorporates both time-slotted and random unslotted access. By virtue of its waveform, signaling rate, precise time reference, and message-starting discipline, UAT can also support independent measurement of range to most other participants in the medium.

There are two basic types of broadcast transmissions - or *messages* - on the UAT channel: the ADS-B message, and the Ground Uplink message. The ADS-B message is broadcast by an aircraft. TIS-B information will be broadcast by the GBT but using the ADS-B message format. The Ground Uplink message is used by ground stations to uplink FIS data such as text and graphical weather data, advisories, and other aeronautical information, to any aircraft that may be in the service volume of the ground station. Regardless of type, each message has two fundamental components: the message *payload* that contains user information, and message overhead, principally consisting of forward error correction code parity, that supports the transfer of the data.

1.5.1 Medium Access Approach

UAT Message transmissions are governed by a combination of time-slotted and random-access techniques. Figure 1-3 illustrates the basic UAT Message timing structure called a UAT *frame*. A frame is one second long and begins at the start of each Universal Coordinated Time (UTC) second. Each frame is divided into two segments: the Ground Segment in which Ground Uplink messages are broadcast[2] in one or more time slots, and the ADS-B Segment in which ADS-B messages are broadcast by aircraft and, TIS-B messages from ground stations. Guard times are incorporated between the segments to allow for signal propagation and timing drift. The UAT frame is further divided into Message Start Opportunities (MSOs) that are spaced at 250μs intervals. This spacing represents the smallest time increment used by UAT for scheduling message transmissions, and all such transmissions must start only at a valid MSO.

[2] Ground Uplink messages are used by the GBT for transmitting FIS data, but need not be restricted to only FIS data in the future. However, throughout this specification, the Ground Uplink message is associated with FIS data.



Message Start Opportunities (MSOs)

Notes:

1. *Shaded segments represent guard times for signal propagation and timing drift (not to scale).*
2. *ADS-B transmissions will partially occur within the final guard interval when the last two MSO is selected.*

Figure 1-3. UAT Frame

As shown in Figure 1-3, 176 milliseconds in each 1-second UAT frame are devoted to Ground Uplink message transmissions and 800ms are devoted to ADS-B message transmissions. MSOs start at the end of the initial 6ms guard time, are spaced at 250μs intervals, and are numbered sequentially from 0 through 3951.

1.5.2 ADS-B Message Transmission

As shown in Figure 1-3, the ADS-B Segment of each UAT frame is 800 milliseconds long, and spans 3200 MSOs (i.e., from MSO 752 to, and including, MSO 3951). All aircraft-transmitted ADS-B messages (as well as ground-transmitted TIS-B messages) are transmitted in this segment of the frame. Each UAT-equipped aircraft makes exactly one ADS-B message transmission per frame, and makes a pseudo-random selection from among any of the 3200 MSOs in the segment to start transmission of the message. Approximately 6 milliseconds of guard time are appended after the ADS-B Segment to fill out the UAT frame to the end of the UTC second.

The pseudo-random selection of an MSO within each UAT frame for the start of an aircraft's ADS-B message is intended to prevent two aircraft from systematically interfering with each other's ADS-B message transmissions. Adherence to the MSO-based timing scheme enables the receiving UAT equipment to determine range to the UAT equipment that transmitted the message. This information could be used in validity checks of the position data conveyed in the ADS-B message itself.

1.5.3 TIS-B Transmission

From the perspective of a receiving aircraft, TIS-B transmissions will appear to be nearly identical to ADS-B messages both in terms of message format and media access. For clarity, the term “TIS-B message” will be used throughout this document, even though the ADS-B message format is used for TIS-B. Per this specification, TIS-B messages

will also be transmitted in the ADS-B segment of the UAT frame[3]. Detailed procedures for GBT transmission of TIS-B messages are provided in Section 3.2.1.4.

1.5.4 Ground Uplink Message Transmission (FIS-B)

Ground Uplink messages are used to support FIS-B. Ground Uplink messages will occur within one or more of the 32 time slots defined within the ground segment of the UAT frame. Detailed procedures for Ground Uplink message transmission are provided in Section 3.2.1.5.

2.0 Applicable Documents

2.1 Government Documents

The following documents form a part of this specification and are applicable to the extent specified here. In case of conflict between the documents referenced here and the contents of this specification, the contents of this specification **shall** take precedence.

2.1.1 Orders

FAA Order 6950.19A	Practices and Procedures for Lightning Protection, Grounding, Bonding, and Shielding Implementation, July 1, 1996

2.1.2 Specifications

FAA:	
FAA-C-1217F	Electrical Work, Interior, February 12, 1996
FAA-G-2100G	Electronic Equipment, General Requirements, September 28, 1999

2.1.3 Standards

FAA:	
FAA-STD-019C	Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities, June 1, 1999
FAA-STD-020B	Grounding, Bonding and Shielding, May 11, 1992
FAA-E-2911	NAS System Level Specification, March 26, 1998
ICD-GPS-060	GPS User Equipment (Phase III) Interface
Military:	
MIL-HDBK-454(A)	General Guidelines for Electronic Equipment, November 3, 2000

[3]Other approaches to uplinking TIS-B are possible using a special TIS-B format and the Ground Segment of the UAT frame. However, this is outside the scope of this specification.

MIL-STD-461E	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference, August 20, 1999
MIL-STD-810F	Environmental Test Methods and Engineering Guidelines, January 1, 2000
MIL-STD-889B	Dissimilar Metals, May 17, 1993

2.1.4 Other Government Documents

FAA:	
DOT/FAA/CT-96/1	Human Factors Design Guide for Acquisition of Commercial Off-the-Shelf Subsystems, Non-Developmental Items, and Developmental Systems, January 15, 1996
DOT/FAA/NAS-IC-51070000-2	NAS Infrastructure Management System Manager/Managed Subsystem Agent Using the Simple Network Management Protocol Version 3 (SNMPv3)
FCC:	
47 CFR Part 2	Frequency Allocations and Radio Treaty Matters; General Rules and Regulations, October 1998
47 CFR Part 87	Aviation Services, October 1998
NIST:	
FIPS PUB 140-1	Federal Information Processing Standards Publication, Security Requirements for Cryptographic Modules, National Institute of Standards and Technology, January 11, 1994
FIPS PUB 186-2	Federal Information Processing Standards Publication, Specifications for Digital Signature Standard (DSS), National Institute of Standards and Technology, January 27, 2000
NTIA:	
	Manual of Regulations and Procedures for Federal Radio Frequency Management, January 2000 Edition with January/May/September 2001 Revisions

2.2 Non-Government Documents

IEEE:	
IEEE 100-1996	Standard Dictionary of Electrical and Electronic Terms

RTCA:	
DO-282	Minimum Operational Performance Standards for Universal Access Transceiver (UAT), August, 2002
EIA:	
EIA-310-E	Cabinets, Racks, Panels, and Associated Equipment, March 17, 1999
IEEE/ANSI:	
C62.31-1987	IEEE Standard Test Specifications for Gas-Tube Surge Protective Devices
C62.36-1994	IEEE Standard Test Method for Surge Protectors Used in Low-Voltage Data, Communications, and Signaling Circuits
C62.41-1991	IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits
C62.47-1992	IEEE Guide on Electrostatic Discharge (ESD): Characterization of the ESD Environment
Std 519-1992	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
IETF:	
RFC 1157	A Simple Network Management Protocol (SNMP), May 1990
RFC 1901	Introduction to Community-based SNMPv2, Jan 1996
ISO/IEC:	
ISO/IEC 7498	Information Technology-Open Systems Interconnection-Basic Reference Model, November 1994
NFPA:	
NFPA-70	National Electric Code
NFPA-780	Lightning Protection Code

2.3 Documentation Sources

2.3.1 FAA Documents

Copies of FAA specifications, standards, and publications may be obtained from Marylyn Alfsen, Capstone Contracting Officer, FAA, 222 West 7th Avenue, Anchorage AK 99501, telephone (907) 271-5861. Requests should clearly identify the desired material by

number and state the intended use of the material. Revision FAA=G-2100G may be downloaded from the FAA at web site http://www.faa.gov/asd/standards/index.htm.

2.3.2 Military and Federal Documents

Single copies of unclassified military and federal specifications, standards, and publications may be obtained by writing the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120 or by calling (215) 697 3321 Monday through Friday, 8:00 a.m. to 4:30 p.m. (EST).

2.3.3 Federal Communications Commission Documents

Copies of 47 CFR, Part 2 and Part 87 may be obtained from the FCC, 445 12th Street, SW, Washington D.C. or by downloading from the FCC web site at www.fcc.gov/oet/info/rules.

2.3.4 Electronic Industries Alliance Documents

Copies of Electronic Industries Alliance (EIA) standards may be obtained from the Electronic Industries Alliance, 2500 Wilson Boulevard, Arlington, VA 22201-3834, by calling (703) 907-7500, or through the web site http://www.eia.org.

2.3.5 National Telecommunications and Information Administration Documents

Copies of National Telecommunications and Information Administration (NTIA) materials may be obtained from NTIA, Department of Commerce, 14th Street and Constitution Avenue NW, Washington, DC 20230, by calling (202) 377-1832, or through the web site http://www.ntia.doc.gov.

2.3.6 RTCA, Inc. Documents

Copies of RTCA, Inc. documents may be obtained from RTCA, Incorporated, 1828 L Street NW, Suite 805, Washington, DC 20036, by calling (202) 833-9339, or through the web site http://www.rtca.org.

2.3.7 ISO/IEC Documents

Copies of International Standards Organization documents may be obtained from American National Standards Institute, 11 West 42nd Street, 13th floor, New York, NY 10036. Telephone: (212) 642-4900, Telefax: (212) 398-0023, E-mail: info@ansi.org, Web: http://www.ansi.org/ or http://www.iso.ch/.

2.3.8 IEEE/ANSI Documents

Copies of IEEE/ANSI documents may be obtained from IEEE Customer Service, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, or by calling (800) 701-4333 (in U.S. and Canada), or (732) 981-0060 (outside of U.S. and Canada).

2.3.9 NIST Documents

Copies of National Institute of Standards and Technology may be obtained from NIST, 100 Bureau Drive, Gaithersburg, MD 20899-3460, or by calling (301) 975-6478.

2.3.10 NFPA Documents

Copies of National Fire Protection Association (NFPA) documents may be obtained from NFPA, 1 Batterymark Park, Quincy, MA 02269-9101 or by calling (617) 770-3000.

3.0 REQUIREMENTS

3.1 Definitions

3.1.1 "Shall"

When used in this specification, the word "**shall**" refers to an explicit requirement of a system component or the complete system

3.1.2 "Should"

When used in this specification, the word *"should"* refers to a desired characteristic of a system component or the complete system.

3.1.3 "Will"

When used in this specification, the word "will" provides information for a characteristic of a system component or a complete related system.

3.2 GBT Requirements

3.2.1 GBT Functions and Software Requirements

Figure 3-1 gives a conceptual overview of the partitioning of the functions of the GBT specified in the subsections below.

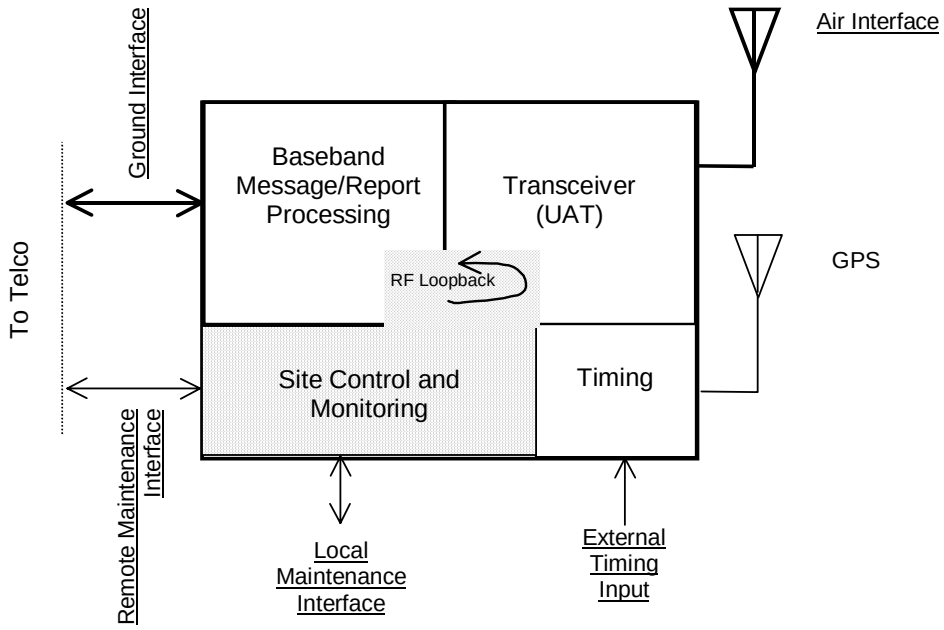


Figure 3-1. Conceptual Overview of the GBT

3.2.1.1 Software and Processor Requirements

a. Protocols and user access/synchronization schemes in the equipment **shall** be programmable.

Note: The purpose of requiring programmability is to allow ease of changes as data link standards are further refined/defined, and to allow implementation of future capabilities as the GBT system evolves to meet NAS needs.

b. The GBT **shall** use no more than 50 percent of its non-volatile memory (as defined in Section 5.2.9.1) or storage, under worst-case conditions (e.g., when the GBT has both the software–in-use and a second software version loaded).

c. The GBT **shall** use no more than 50 percent of its Random Access Memory (RAM), under worst-case conditions (e.g., when the GBT has both the software-in-use and a second software version loaded).

d. The processor utilization of the GBT **shall** peak at 50 percent or less.

e. If the GBT does not successfully restart after receipt and execution of the Switch Software Version control parameter command, the GBT equipment **shall** revert to the previous version of software and restart.

f. If the software upload is rejected, either by failed Cyclic Redundancy Check (CRC) or incorrect authentication, the GBT **shall** indicate the rejection and the reason for the rejection.

3.2.1.2 GBT State and State Transition

a. The GBT **shall** have the following states: Off, Power Up, Offline, Online, Recovery, Failed and Power Down (if exercised), as defined in Section 5, Figure 5-1, and Table 5-1, as applicable.

b. The GBT **shall** provide visual indication of the GBT state on the GBT front panel.

Note: For the definition of critical and non-critical equipment failures see Section 5.2.10.

3.2.1.2.1 State Transition

The GBT **shall** transition from state to state in accordance with Section 5, Figure 5-1, and Table 5-1, as applicable.

3.2.1.2.2 Off State

a. When in the OFF state, the GBT **shall** not transmit on the Air Interface.

b. When in the OFF state, the GBT **shall** not generate any form of data output.

c. When DC power is present at the GBT power input (i.e., not in the Off state), the GBT **shall** provide visual indication of power.

3.2.1.2.3 Power Up State

a. When in the Power Up state,

   1) the GBT **shall** not transmit on the Air Interface.

   2) the GBT **shall** not generate any form of data output.

b. The time between application/restoral of power to the GBT and the GBT's transition out of the Power Up state **shall** not exceed 30 seconds.

c. The GBT **shall** conduct and complete Power On Self Test functions in the Power Up state.

3.2.1.2.4 Off Line State

The GBT **shall** be in the Offline state during the period that a Control Session is active as defined in Section 3.2.3.3.1. When in the Offline state the GBT **shall**:

1. Discontinue operational ADS-B message reception and reporting (Section 3.2.1.3).

2. Discontinue operational TIS-B message transmission, if applicable (Section 3.2.1.4).

3. Discontinue operational Ground Uplink message transmission, if applicable (Section 3.2.1.5).

4. Continue Status reporting (Section 3.2.1.6) with an indication the GBT is in the Offline state.

5. Respond to control commands.

Note: Establishing a Control Session is the only condition that will place the GBT into the Offline state.

3.2.1.2.5 On Line State

When in Online state, the GBT **shall** enable all functions with the exception of those requiring a Control Session.

Note: Being in the Online state does not automatically enable transmission over the Air Interface. The ability to transmit messages over the Air Interface must additionally be enabled through various GBT configuration items.

3.2.1.2.6 Recovery State

a. The GBT **shall** enter the Recovery state when the GBT detects a potentially recoverable failure.

b. Potentially recoverable failures **shall** include, but not be limited to, over temperature conditions.

c. When in Recovery state, the GBT **shall** not transmit.

d. When in Recovery state the GBT **shall** not generate any form of data output on the Ground Interface.

e. The GBT **shall** transition from the Recovery state to the previous state if the recovery process has been successful (e.g., the recoverable fault was eliminated).

f. The GBT **shall** transition from the Recovery state to the failed state if the recovery process was not successful (e.g., the potentially recoverable fault could not be eliminated).

3.2.1.2.7 Failed State

a. When in Failed state,

   1. the GBT **shall** not transmit on the Air Interface.

   2. the GBT **shall** not generate any form of data output on the Ground Interface.

   3. the GBT **shall** enable only those control parameter commands that can be executed accurately.

b. The GBT **shall** transition to the Failed state if the GBT detects a failure that as a minimum requires the restoral (warm start) action as defined in Section 5.2.8.

3.2.1.2.8 Power Down State

a. If the GBT employs a Power Down state, then when in Power Down state,

   1. the GBT transmitter **shall** not transmit.

   2. the GBT receiver **shall** not generate any form of data output.

3. all GBT functions **shall** be disabled, except logging/reporting and front panel indication.

4. the GBT **shall** provide visual indication on the front panel that the GBT is ready for transition to Off state.

b. If the Power Down state is implemented, the GBT **shall** accept the control parameter to transition to the Power Down state ("Power Down" (ID = 16)) only from the Local Maintenance Interface.

3.2.1.3 Procedures for ADS-B Message Reception and Reporting

a. The GBT **shall** decode received ADS-B messages per the message format described in Sections 2.2.3 through 2.2.3.1.3.2 of RTCA DO-282.

b. The GBT **shall** convert each such message into an ADS-B report on the GBT Ground Interface in the order received.

3.2.1.3.1 ADS-B Report Construction

a. The GBT **shall** generate ADS-B reports in response to each ADS-B message received.

b. ADS-B reports **shall** be in the format given in the ASTERIX Category 033 description of Appendix A.

c. Individual Data Items of Cat 033 **shall** be determined as given in Table 3-1.

d. The GBT **shall** encode only those data items required for each report and reflect the included data items in the FSPEC (see Appendix A, Section A.2).

Note: Systems receiving ADS-B reports from the GBT must parse the FSPEC for proper decoding of reports.

Table 3-1 Contents of Data Items in the ADS-B Report

Source used in Composing Data Item	ASTERIX Cat 33 Data Item		Criteria for Including Data Item
	FRN[4]	Name	
Data flow →			
Fixed field value of ONE	1	Version	Every ADS-B report
The value of SIC and SAC provided as configuration items	2	Data Source Id	Every ADS-B report
Bit 3 set; all others ZERO	3	Link Indicator	Every ADS-B report
Value computed per Section 3.2.1.3.3	4	Time of Applicability	Every ADS-B report
Derived from "ADDRESS QUALIFIER" and "ADDRESS" fields of ADS-B message payload.	5	Target Address	Every ADS-B report
Bit 16 (UTC Coupled): set to ONE if ADS-B message payload indicated "UTC-coupled". Bits 15-4: Derived from "NIC", "SIL" and "NACp" fields of ADS-B message payload. Bit 3 (Position Estimated): Always set to ZERO (for measured position). Bit 2 (Velocity Estimated): Always set to ZERO (for measured velocity)	6	Integrity and Accuracy Parameters	Every ADS-B report
Derived from "LATITUDE" and "LONGITUDE" fields of ADS-B message payload.	7	Latitude/Longitude	Every ADS-B report
Derived from the "ALTITUDE TYPE" and "ALTITUDE" fields of the ADS-B message payload	8	Pressure Altitude	Every ADS-B report
Derived from "A/G STATE", "HORIZONTAL VELOCITY" and "VERTICAL VELOCITY" fields of the ADS-B message	9	Velocity (Airborne)	Reported when the "A/G STATE" field of the ADS-B message indicates the AIRBORNE condition.
Derived from "A/G STATE", and "HORIZONTAL VELOCITY" fields of the ADS-B message.	10	Velocity (Surface)	Reported when the "A/G STATE" field of the ADS-B message indicates the ON GROUND condition.
Derived from the Flight Plan ID field of the ADS-B message when "CSID" flag = ZERO	11	Mode 3/A Code	Each of these Data Items reported only when present in the ADS-B message.
Derived from the "CALL SIGN" field of the ADS-B message	12	Target Identification	
Derived from the "EMITTER CATEGORY" field of the AD-B message	13	Emitter Category	
Derived from the "EMERGENCY PRIORITY STATUS" and "OPERATIONAL MODES" field of the ADS-B message.	14	Target Status	
Derived from the "ALTITUDE TYPE" and "SECONDARY ALTITUDE" fields of the ADS-B message payload	15	Geometric Altitude	Reported only when present in the ADS-B message AND reporting of this Item is enabled in the ADS-B_REPORT_FSPEC_FILTER configuration item.
N/A	16	Reserved	Never
Value computed per Section 3.2.1.3.4	17	Time of Message Transmission	Reported only when present in the ADS-B message AND reporting of this Item is enabled in the ADS-B_REPORT_FSPEC_FILTER configuration item.
Value computed per Section 3.2.1.3.2 truncated to the fractional seconds	18	Time of Message Receipt	Reported only when present in the ADS-B message AND reporting of this Item is enabled in the ADS-B_REPORT_FSPEC_FILTER configuration item.
N/A	19	Reserved	Never
N/A	20	Reserved	Never
N/A	21	Reserved	Never

[4] Field Reference Number from the ASTERIX definition (Appendix A)

3.2.1.3.2 Time of Message Receipt

a. The GBT **shall** declare a Time of Message Receipt (TOMR) for each ADS-B message received.

b. Time measurement **shall** be relative to the arrival of the optimum sample point of the first bit of the UAT synchronization sequence at the GBT antenna terminal.

Note: See Sections 2.2.2.3 and 2.2.6.2.2 of DO-282.

c. Time measurement **shall** be made to a resolution of 100 nanoseconds or less.

3.2.1.3.3 Time of Applicability

The GBT **shall** derive a Time of Applicability for each received ADS-B message based on the TOMR of Section 3.2.1.3.2 above as follows:

a. If the ADS-B message payload indicates "UTC Coupled" and the Non-Precision Condition, the Time of Applicability is the start of the 1 second UTC epoch containing the TOMR.

b. If the ADS-B message payload indicates "UTC Coupled" and the Precision Condition, the Time of Applicability is the start of the 0.2 second UTC epoch containing the TOMR.

c. If the ADS-B message payload indicates "Non-UTC Coupled", the Time of Applicability is the TOMR minus 1 second.

Note: See Section 2.2.4.5.2.8 of DO-282.

3.2.1.3.4 Time of Message Transmission

a. The GBT **shall** derive a Time of Message Transmission relative to the 1 second UTC epoch based on the "TRANSMIT MSO" field of the ADS-B message payload encoded per Section 2.2.4.5.4.7 of DO-282.

b. The GBT **shall** derive the Time of Transmission unambiguously based on the TOMR from Section 3.2.1.3.2.

Notes:

1. *The GBT is required to derive the Time of Message Transmission only for ADS-B messages with the Mode Status element: those with Payload Type Code of "1" or "3" (see DO-282, Section 2.2.4). These are transmitted at a once per 4 second rate.*

2. *This unambiguous derivation is required because only the 6 LSBs are provided in the "TRANSMIT MSO" field of the ADS-B message payload.*

3.2.1.3.5 ADS-B Message Discarding

a. The ADS-B Reporting Interval **shall** be one second and include the entire ADS-B segment of the current UAT frame and the entire Ground Segment of the subsequent UAT frame as depicted in Figure 3-2.

b. The GBT **shall** discard any ADS-B message that cannot be issued as an ADS-B report in the ADS-B Reporting Interval within which the corresponding ADS-B message was received.

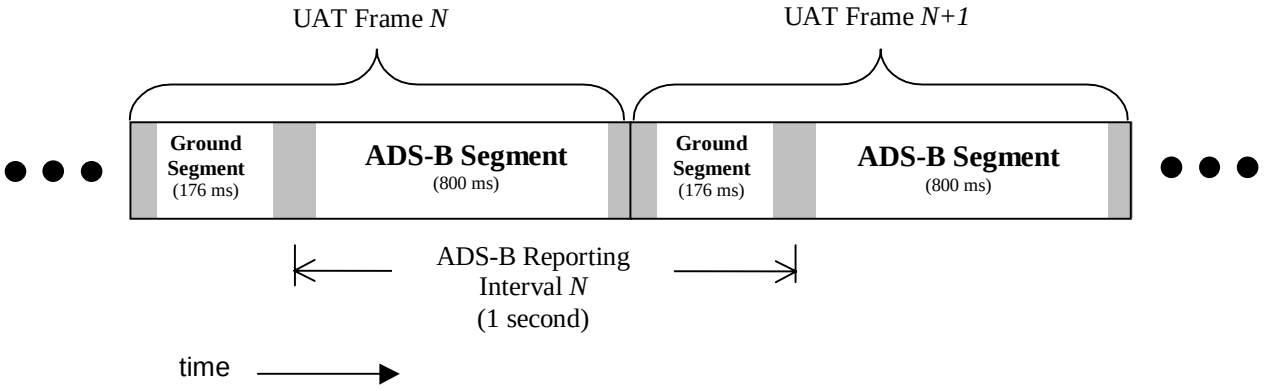


Figure 3-2. ADS-B Reporting Interval

Note: The purpose of the ADS-B reporting Interval is to establish a systematic method for discarding ADS-B messages when the ADS-B message arrival rate at the Air Interface exceeds the bandwidth available on the Ground Interface. Given the random nature of aircraft ADS-B message transmission within the UAT frame, this discard approach results in a graceful surveillance degradation should the number of ADS-B aircraft momentarily overload the Ground Interface.

c. When the `TIS-B_FILTER` configuration item is "On", the GBT **shall** discard all received messages whose ADDRESS QUALIFIER field (Section 2.2.4.5.1.2 of DO-282) indicates the message was a TIS-B transmission (i.e., the values "2" and "3").

Note: Since ADS-B and TIS-B use the same UAT message format, this filter is needed to prevent needless flooding of the Ground Interface due to TIS-B transmissions from co-sited or nearby GBTs.

3.2.1.3.6 Status Indication

The Status report **shall** provide a count of all ADS-B messages that have been discarded during the current status-reporting interval.

3.2.1.4 Procedures for TIS-B Message Transmission

The GBT **shall** receive TIS-B reports over the GBT Ground Side Interface and convert each such report into a TIS-B message on the GBT Air Interface.

3.2.1.4.1 TIS-B Message Construction

a. TIS-B messages **shall** use the ADS-B message format described in Sections 2.2.3 through 2.2.3.1.3.2 of RTCA DO-282.

b. The payload portion of a TIS-B message **shall** be determined by the data items present in the corresponding TIS-B report. Each data item present **shall** be mapped into its corresponding message payload element per Table 3-2.

Table 3-2. Payload Composition of TIS-B Message

	Source used in Composing Data Item	ADS-B Payload Field Name (RTCA DO-282)	
		Field Name	DO-282 Ref Para
	Data flow →		
State Vector Elements present in every TIS-B message	ZERO if all data items in the TIS-B report fit within the "Basic" ADS-B message, otherwise ONE	"PAYLOAD TYPE CODE"	2.2.4.5.1.1
	The Address Qualifier sub item from the "Target Address" (FRN 5) data item of the TIS-B report	"ADDRESS QUALIFIER"	2.2.4.5.1.2
	The "24 bit Address" sub item from the "Target Address" (FRN 5) data item of the TIS-B report	"ADDRESS"	2.2.4.5.1.3
	Derived from the "Aircraft Latitude and Longitude" (FRN 7) data item	"LATITUDE" and "LONGITUDE"	2.2.4.5.2.1
	Encode as ZERO if the "Pressure Altitude" (FRN 8) data item has information available; otherwise encode as ONE if the "Geometric Altitude" (FRN 15) data item has information available.	"ALTITUDE TYPE"	2.2.4.5.2.2
	Derive from the "Pressure Altitude" (FRN 8) data item if information available, otherwise derive from the "Geometric Altitude" (FRN 15) data item if information is available	"ALTITUDE"	2.2.4.5.2.3
	The "NIC" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item.	"NIC"	2.2.4.5.2.4
	Encode as "2" when "Velocity (Surface)" (FRN10) data item is present; encode as "1" if either N/S or E/W Velocities exceed 1000 kts; encode as "2" otherwise.	"A/G STATE"	2.2.4.5.2.5
	Derive from information contained in either the "Velocity (Airborne)" (FRN 9) data item or the "Velocity (Surface)" (FRN 10) data item	"HORIZONTAL VELOCITY"	2.2.4.5.2.6
	Derive from velocity information contained in either the "Velocity (Airborne)" (FRN 9) data item.	"VERTICAL VELOCITY"	2.2.4.5.2.7
	Configuration item `TIS-B_SITE_ID`	"TIS-B SITE ID"	2.2.4.5.3.1
Mode Status Element present in every TIS-B message generated from a TIS-B report that includes "Target Identification" (FRN 12)	Based on combination of "Emitter Category" (FRN 13) and "Target Identification" (FRN 12) data items encoded in compressed format per Section 2.2.4.5.4.3 of DO-282	"EMITTER CATEGORY AND CALL SIGN CHARACTERS #1 AND #2"	2.2.4.5.4.1 and 2.2.4.5.4.2
		"CALL SIGN CHARACTERS #3, #4 AND #5"	2.2.4.5.4.2
		"CALL SIGN CHARACTERS #6, #7 AND #8"	2.2.4.5.4.2
	Derive from the "Target Status" (FRN 9) data item if available; otherwise encode as "No emergency/Not reported"	"EMERGENCY/PRIORITY STATUS"	2.2.4.5.4.4
	Encode as "1"	"UAT MOPS VERSION"	2.2.4.5.4.5
	The "SIL" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item.	"SIL"	2.2.4.5.4.6
	The 6 LSBs of the MSO selected for this TIS-B message per the procedure in Section 3.2.1.4.2 of this specification	"TRANSMIT MSO"	2.2.4.5.4.7
	The "NACp" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item.	"NACp"	2.2.4.5.4.9
	The "NACv" sub item from the "Integrity and Accuracy Parameters" (FRN 6) data item.	"NACv"	2.2.4.5.4.10
	Always encode as ZERO	"NIC_{baro}"	2.2.4.5.4.11
	Always encode as: -CDTI Traffic Display Capability: NO -TCAS/ACAS Installed and Operational: YES	"CAPABILITY CODES"	2.2.4.5.4.12
	Always encode as: -TCAS/ACAS Resolution Advisory Flag: NO -IDENT Switch Active Flag: NOT ACTIVE -Receiving ATC Services Flag: NOT Receiving ATC services	"OPERATIONAL MODES"	2.2.4.5.4.13
	Always ZERO	"TRUE/MAG"	2.2.4.5.4.14
	Always ONE	"CSID"	2.2.4.5.4.15
	Always ALL ZEROs	Reserved	2.2.4.5.4.16

3.2.1.4.2 TIS-B Uplink Media Access

a. Each TIS-B message **shall** always begin on an even numbered MSO boundary.

b. TIS-B messages **shall** occur only within the designated TIS-B transmission window(s).

c. When the `TIS-B_OPERATING_MODE` = "Disabled", no TIS-B message transmissions **shall** occur regardless of TIS-B reports received on the GBT Ground Side Interface.

d. When the `TIS-B_OPERATING_MODE` = "Enabled", there **shall** be five TIS-B transmission windows each of 19 milliseconds (76 MSOs) duration. The TIS-B transmission windows **shall** occur within the ADS-B Segment of the UAT Frame beginning at each of the following times after the start of the UTC second:

194 milliseconds (MSO 752) + `OFFSET`
354 milliseconds (MSO 1392) + `OFFSET`
514 milliseconds (MSO 2032) + `OFFSET`
674 milliseconds (MSO 2672) + `OFFSET`
834 milliseconds (MSO 3312) + `OFFSET`

Where `OFFSET` is a configuration item that can take on one of the following mutually exclusive values:

"ZERO"
"20" milliseconds (80 MSOs)
"40" milliseconds (160 MSOs)
"60" milliseconds (240 MSOs)
"80" milliseconds (320 MSOs)
"100" milliseconds (400 MSOs)
"120" milliseconds (480 MSOs)
"140" milliseconds (560 MSOs)

Note: A maximum of 38 TIS-B messages can be packed into each transmission window for a maximum capacity of 190 TIS-B messages transmitted per second.

e. Within a TIS-B transmission window, the GBT transmitter **shall** only be active during actual TIS-B message transmission.

Note: It is important for the GBT to restrict its time on the air to the minimum necessary to convey the TIS-B information. Therefore depending on TIS-B report load, there may be significant periods of GBT "off air" time during TIS-B transmission windows.

3.2.1.4.3 Report Discarding

The GBT **shall** discard (i.e., not transmit) any TIS-B report that would incur more than a 400 millisecond TIS-B throughput delay (see Section 3.2.2.5).

3.2.1.4.4 Status Indication

The Status report **shall** provide the number of discarded TIS-B reports as part of the GBT Status report.

3.2.1.5 Procedures for Ground Uplink Message Transmission

Note: The GBT will receive Uplink Data Blocks in a form that will map directly into the Ground Uplink Application Data field of the Ground Uplink message payload. Therefore

each Uplink Data Block received over the GBT Ground Interface will result in a Ground Uplink message. The actual contents of the Ground Uplink Application Data will be transparent to the GBT.

The GBT **shall** receive Uplink Data Blocks over the GBT Ground Interface and convert each such Uplink Data Block for transmission in a Ground Uplink message.

3.2.1.5.1 Ground Uplink Message Construction

Ground Uplink Messages **shall** use the Ground Uplink message format described in RTCA DO-282 Sections 2.2.3.2 through 2.2.3.2.4. with each field of the message payload determined as described in Table 3-3.

Table 3-3. Payload Composition of Ground Uplink Message

Source used in Composing Data Item	Ground Uplink Payload Field Name (RTCA DO-282)	
	Field Name	DO-282 Ref Para
Data flow →		
Configuration item: `GBT_LATITUDE`	"GROUND STATION LATITUDE"	2.2.3.2.2.1.1
Configuration item: `GBT_LONGITUDE`	"GROUND STATION LONGITUDE"	2.2.3.2.2.1.2
Configuration item: `POS_VALID`	"POSITION VALID"	2.2.3.2.2.1.3
Current status of the UTC-coupled 1 PPS signal.	"UTC"	2.2.3.2.2.1.4
Configuration item: `APP_DATA_VALID`	"APPLICATION DATA VALID"	2.2.3.2.2.1.6
Time slot (1-32) used for this Ground Uplink message	"SLOT ID"	2.2.3.2.2.1.7
Configuration item: `TIS-B_SITE_ID`	"TIS-B SITE ID"	2.2.3.2.2.1.8
All bits set to ZERO	Reserved Bits	2.2.3.2.2.1.5 and 2.2.3.2.2.1.9
The Uplink Data Block received by the GBT over the Ground Interface mapped bit-for-bit for transmission in the Ground Uplink Application Data in the same order as received	Application Data	2.2.3.2.2.2

3.2.1.5.2 Ground Uplink Message Media Access

The GBT **shall** receive Uplink Data Blocks over the GBT Ground Interface and convert each into a Ground Uplink message on the GBT's Air Interface in the order received.

3.2.1.5.2.1 Time Slots

The GBT **shall** establish 32 time slots for transmission of Ground Uplink messages as defined in Table 3-4.

Table 3-4. Time Slot Definition for the UAT Ground Segment

Slot ID #	Time Slot Span		Slot ID #	Time Slot Span	
	Starting MSO	Ending MSO		Starting MSO	Ending MSO
1	0	22	**17**	352	374
2	22	44	**18**	374	396
3	44	66	**19**	396	418
4	66	88	**20**	418	440
5	88	110	**21**	440	462
6	110	132	**22**	462	484
7	132	154	**23**	484	506
8	154	176	**24**	506	528
9	176	198	**25**	528	550
10	198	220	**26**	550	572
11	220	242	**27**	572	594
12	242	264	**28**	594	616
13	264	286	**29**	616	638
14	286	308	**30**	638	660
15	308	330	**31**	660	682
16	330	352	**32**	682	704

3.2.1.5.2.2 Time Slot Rotation and "Channels"

a. Time Slot resources assignable to the GBT **shall** be made on a continually shifting basis. This assignable resource will be subsequently referred to as a "Channel" to distinguish it from a Time Slot.

b. Channel #1-32 **shall** increment by 1 Time Slot per second (modulo 32).

c. The Channel # and Time Slot # **shall** align at midnight GPS time and every 32 seconds thereafter (see Figure 3-3).

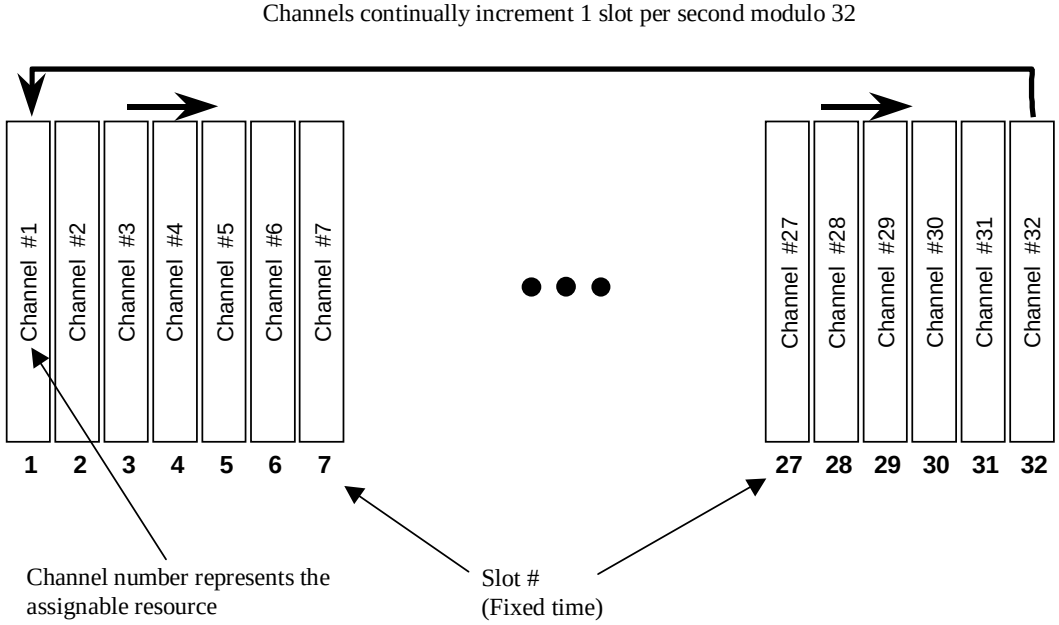


Figure 3-3. Relationship of "Channels" to Time Slots

Note: The reason for the Time Slot rotation is to make aircraft reception of Ground Uplink messages from a given GBT robust in the presence of other time synchronized transmissions in the band (i.e., Link 16).

3.2.1.5.2.3 Transmission of Ground Uplink Message

a. Ground Uplink message transmissions **shall** occur within the next available Channel specified in the `CHANNEL_LIST` configuration item.

b. Ground Uplink message transmissions **shall** begin at the start of the Time Slot determined by the next available assigned Channel.

Note: The duration of a Ground Uplink message is approximately 1.5 milliseconds less than the Time Slot duration. This additional time provides a propagation guard time when adjacent Channels (Time Slots) are assigned to GBT ground station sites with common line of sight to the same aircraft.

3.2.1.5.3 Discarding of Uplink Data Blocks

The GBT **shall** discard any uplink blocks queued for transmission more than 1.2 seconds.

3.2.1.5.4 Status Indication

The Status report **shall** provide the number of Uplink Data Blocks discarded within the previous Status Reporting interval.

3.2.1.6 Procedures for GBT Status Reporting

3.2.1.6.1 Status Report Construction

a. The GBT **shall** generate Status reports over the Ground Interface on a periodic basis.

b. Status report periodicity **shall** be configurable to one of the following intervals using the `STATUS_REPORT_INTERVAL` configuration item: 1, 2, 3, 4, 5, 6, 10, 15, and 30 seconds.

c. Status reports **shall** be issued within 1 second after the end of the Status Reporting Interval to which it applies.

d. Status reports **shall** be in the format given in the ASTERIX Category 243 description of Appendix B.

e. Individual Data Items of Cat 243 **shall** be determined as given in Table 3-5

Table 3-5 Contents of Data Items in the Status Report

Source used in Composing Data Item	ASTERIX Cat 243 Data Item		Criteria for Including Data Item
	FRN[5]	Name	
Data flow →			
Fixed field value of ONE	1	Version Number	Included in every Status report
The value of SIC and SAC provided as configuration items	2	Data Source Identifier	Included in every Status report
The UTC second that marks the end of the Status Reporting Interval.	3	Time of Status Report	Included in every Status report
Bit 8: GBT Timing status as of the end of the Status reporting interval. Bit 7: Receiver Status as of the end of the Status Reporting Interval. Bit 6: Transmitter status as of the end of the Status Reporting Interval. Bit 5: always ZERO Bits 4-2: GBT State as of the end of the Status Reporting Interval. Bit 1: always ZERO	4	GBT Status	Included in every Status report
NIC and NACp parameters determined by the GBT's internal GPS sensor at the end of the Status Reporting Interval	5	Internal GPS Integrity and Accuracy Parameters	Included in every Status report [
Position determined by the GBT's internal GPS sensor at the end of the Status Reporting Interval	6	Latitude/Longitude	Included in every Status report
Count of all ADS-B messages discarded during the Status Reporting Interval	7	ADS-B messages discarded	Included in every Status report
Count of all TIS-B reports discarded during the Status Reporting Interval	8	TIS-B reports discarded	Included in every Status report
Count of all Uplink Data Blocks discarded during the Status Reporting Interval	9	Uplink Data Blocks discarded	Included in every Status report

3.2.1.6.2 Status Report Discarding

Status reports **shall** not be discarded or delayed, i.e., they have higher priority than ADS-B reports when the report load exceeds the capacity of the Ground Interface line speed.

3.2.1.7 Characteristics of the Ground Interface

3.2.1.7.1 Interface Decomposition and Options

The GBT Ground Interface **shall** support multiple mutually exclusive interface options with their corresponding protocols as shown in Table 3-6. The protocol employed at each equivalent layer of the OSI model is described in the subparagraphs that follow.

[5] Field Reference Number from the ASTERIX definition (Appendix B)

Table 3-6. GBT Ground Interface Options and Protocols

Layer of OSI Model	Interface Option			
	Ethernet-TCP/IP	**Ethernet-UDP/IP**	**Serial**	
Application	Application Elements			
Presentation	Broadcast Services Data Unit (BSDU)			
Session	Session Layer Data Unit (SDU)			
Transport	TCP	UDP	Not used	
Network	IP		Not used	
Data Link	ANSI/IEEE 802.3		ASYNC	SYNC HDLC
Physical	EIA/TIA 568A		EIA-232	EIA-422

3.2.1.7.2 Application Layer: Application Elements

The application layer represents the transfer of the following *application elements*:

- Target Reports (ADS-B or TIS-B)
- Uplink Data Blocks
- GBT Status Reports

3.2.1.7.2.1 Target Reports

The GBT Ground Interface employs a common Target Report format for either TIS-B information to be uplinked by the GBT or ADS-B information that has just been received by the GBT from an aircraft. A single common All Purpose Structured Eurocontrol Surveillance Information Exchange (ASTERIX) encoding structure (Category 033) is used for Target Reports (ADS-B and TIS-B) as given in Appendix A.

3.2.1.7.2.2 Uplink Data Blocks

Uplink Data Blocks are provided to the GBT in a form for direct mapping into the Application Data Field of the UAT Ground Uplink message. The contents and format of the Uplink Data Block is transparent to the GBT.

3.2.1.7.2.3 GBT Status Reports

GBT Status Reports are issued periodically from the GBT to allow application end systems to monitor GBT health. ASTERIX encoding structure (Category 243) is used for periodic Status reports as given in Appendix B.

3.2.1.7.3 Presentation Layer: BSDU

The BSDU serves the following functions:

- Delimit application elements
- Identify application elements
- Provide error detection of the application element that may occur in transmission between the GBT and the ground application end system

a. Each BSDU **shall** encapsulate a single application element.

b. The format of the BSDU **shall** be as described in reduced font below:

Figure 3-4 below shows the format of the SDU.

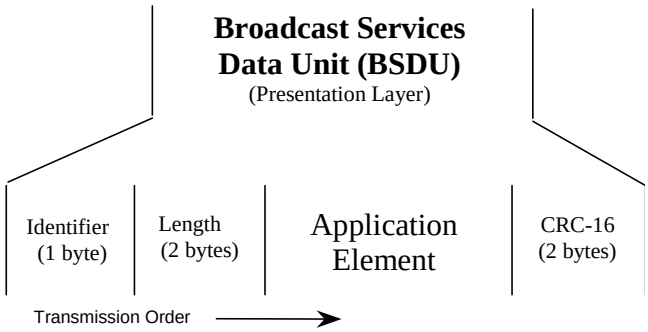


Figure 3-4. BSDU Construct

Identifier: This byte is used to distinguish between the different BSDU types indicated in Table 3-7 below. Since Target reports and periodic Status reports use the ASTERIX construction, their BSDU identifier is synonymous with the ASTERIX Category.

Table 3-7. BSDU ID Byte Values

Application Elements		**Value (decimal)**	**Direction (To/From GBT)**
Target Reports	(ADS-B)	33	From
	(TIS-B)		To
Periodic Status Reports		243	From
Uplink Data Blocks (FIS)		100	To

Length: This is a two byte field that gives the length in bytes of the BSDU components not including the CRC field (i.e., BSDU ID, BSDU length and Application Element). This definition of length allows compatibility between the BSDU and ASTERIX. "Stuffed" bytes that may be added as part of the procedure described in Section 3.3 are not part of the byte count reflected in this field. This field is encoded as a 16 bit binary integer with the Most Significant byte transmitted first and the Least Significant byte transmitted last.

Application Element: The encoding for each application element is given in the document appendices.

CRC 16: The CRC is inclusive of all fields within the BSDU up to, but not including, the CRC field. Once the CRC-16 value is calculated, it is appended to the end of the BSDU. This field is encoded as a 16 bit binary integer with the Most Significant byte transmitted first and the Least Significant byte transmitted last.

The CRC-16 is a table-driven calculation. The following code generates the 256-entry CRC table:

```
unsigned short int Crc16Table[256];
void InitCrc16 (void)
{
   unsigned short int i, bit, crc;

for (i = 0; i < 256; i++)
   {
      crc = (i << 8);
      for (bit = 0; bit < 8; bit++)
     crc = (crc << 1) ^ ((crc & 0x8000) ? 0x1021 : 0);
      Crc16Table[i] = crc & 0xFFFF;
   }
```

The following code uses the 256-entry CRC table to calculate the CRC-16. The `crc` variable must be initialized to zero for the first byte and then is set to the previous byte's calculated CRC-16 value for each of the remaining bytes of the message:

```
unsigned short int crc16(unsigned char *buf, unsigned int len)
{
  int i;
  unsigned short int crc;

  crc = 0;
  for (i=0; i < len; i++)
    crc = Crc16Table[((crc>>8) & 0xFF)] ^ (crc<<8) ^ buf[i];
  return (crc);
}
```

3.2.1.7.4 Session Layer: SDU

The SDU supports the following functions:

- Distribution of BSDUs to various ground application end systems
- Detection and delimiting of each individual BSDU

a. The GBT **shall** be configurable through the `SDU_WRAPPER` configuration item to either "implement" or "omit" the use of the SDU wrapper.

b. Each SDU **shall** encapsulate exactly one BSDU.

c. The format of the SDU **shall** be as described in reduced font below:

Figure 3-5 shows the format of the SDU.

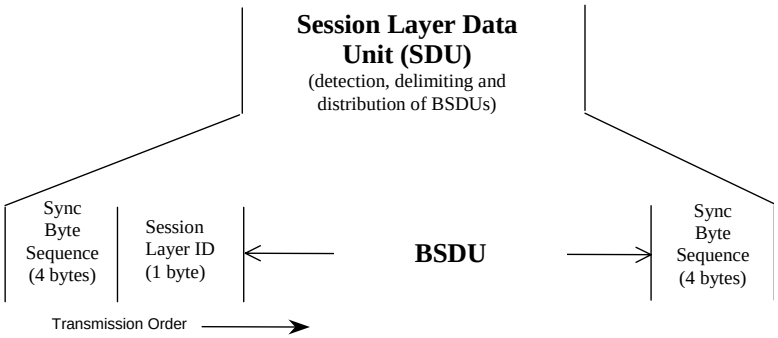


Figure 3-5. Session Layer Wrapper

Synchronizing Byte Sequence: synchronizing bytes are used to indicate the start and end of a BSDU in the data stream. The synchronizing byte sequence consists of the following hexadecimal bytes in their transmission order: 01 FF FF FF.

Byte stuffing is performed to eliminate the possibility of a synchronizing byte sequence occurring in an outgoing BSDU. When the first three bytes of the synchronizing byte sequence is found within the outgoing BSDU, one byte with a value of ZERO is inserted (or "stuffed") into the data stream following these three bytes. Byte de-stuffing is performed to remove the occurrence of stuffed bytes in the incoming data stream. When the first three bytes of the synchronizing frame sequence followed by a byte with a value of ZERO is found within the incoming data stream the byte with a value of ZERO is discarded and not used in the construction of a BSDU. The sequence 01 FF FF will only be followed by a 00 or a FF. Any other condition indicates an error in the data.

Note: When multiple SDUs are transmitted back-to-back, a single synchronizing byte sequence may delimit these messages.

Session Layer ID: This byte provides an application code for use by a distribution function as part of the ground system external to the GBT. This field is encoded as an 8 bit binary integer with the Most Significant bit transmitted first and the Least Significant bit transmitted last. Table 3-8 shows the encoding of this byte.

Table 3-8. Session Layer IDs

BSDU Type		BSDU ID (decimal)	SDU ID (hex)
Target Reports	ADS-B	33	0x25
	TIS-B		0x22
GBT Status Reports		243	0x29
Uplink Data Blocks (FIS)		100	0x20

3.2.1.7.5 Transport and Network Layers

Two interface types **shall** be available with the Ethernet option: TCP/IP and UDP/IP.

3.2.1.7.5.1 TCP/IP

When the GBT is configured to operate with the TCP/IP option, the following requirements **shall** apply:

a. The GBT **shall** establish a TCP client connection with the GBT host process.

Note: The external GBT host process acts as a TCP server running at a predefined transport layer port and network layer IP address that is predefined for that application end system (or the distribution function). BSDUs—wrapped in the session layer protocol defined in section 3.2.1.7.4—are sent between the GBT (TCP client) and the GBT host (TCP server) over the established TCP connection.

b. The GBT **shall** support communication over multiple subnets on a LAN.

3.2.1.7.5.2 UDP/IP

When the GBT is configured to operate with the UDP/IP option, the GBT **shall** utilize a predefined transport layer port number and the network layer broadcast IP address of the GBT's subnet for each application element type supported. This **shall** take the form of one of the following mutually exclusive configuration options:

a. Each application element is sent on its own unique transport layer port.

b. All application elements are sent on one common transport layer port.

c. All application elements originating from the GBT are sent on a common transport layer port. All application elements destined for the GBT are sent on a common transport layer port, distinct from the port used for data originating from the GBT.

Note: The GBT need not establish a Transport Layer connection since UDP is a connectionless unacknowledged protocol.

3.2.1.7.6 Data Link and Physical Layers for Serial Interface

The serial interface **shall** be configurable as Synchronous or Asynchronous when the serial interface option is selected.

3.2.1.7.6.1 Synchronous

The Synchronous interface **shall** operate according to the following:

- HDLC, NRM mode (unbalanced), ARM enabled (assumes a point-to-point full duplex communications interface), GBT acts as Primary sending only information frames. Supervisory frames and unnumbered frames disallowed in either direction.
- Electrical characteristics per EIA-422 interface at 1.2 to 115 kbps with speed selectable as a configuration item.

3.2.1.7.6.2 Asynchronous

The Asynchronous interface **shall** operate according to the following:

- Electrical characteristics per EIA-232 at 1.2 to 115 kbps with speed selectable as a configuration item,
- 8 data bits, 1 stop bit, No parity,
- No Flow control.

3.2.1.7.6.3 Ethernet

The Ethernet interface **shall** be industry standard Ethernet in accordance with ANSI/IEEE 802.3 (ISO/IEC 8802-3).

The physical layer **shall** perform at a minimum of 10 Mbps.

3.2.1.8 GBT Timing

a. The GBT **shall** support two sources of timing: an internal GPS-based source and an external source through the External Timing Interface.

b. The source used by the GBT **shall** be determined by the `TIMING_SOURCE` configuration item.

3.2.2 Performance Requirements

3.2.2.1 Receiver Characteristics

The GBT receiver **shall** meet all the requirements of RTCA DO-282 Sections 2.2.8.2 through 2.2.8.3.4 with exceptions or qualifications as detailed in the subparagraphs below.

3.2.2.1.1 Sensitivity for Long ADS-B Messages (supersedes DO-282 Section 2.2.8.2.1.1)

Long ADS-B messages applied to the Air Interface port at a level of –98 dBm **shall** produce a rate of Successful Message Reception of 90% or better under the following simultaneous conditions:

a. The desired signal is subject to the maximum permitted signal frequency offset plus air-to-ground Doppler at 600 knots closure/opening.

b. The desired signal is subject to the maximum modulation distortion allowed in DO-282 Section 2.2.2.4.

Notes:

1. This also ensures that the Basic ADS-B Message will be received at the same desired signal level.

2. *This **shall** include the effects of the T/R switch.*

3.2.2.1.2 Sensitivity for Ground Uplink Messages (supersedes DO-282 Section 2.2.8.2.1.2)

Ground Uplink messages applied to the Air Interface port at a level of –96 dBm **shall** produce a rate of Successful Message Reception of 90% or better under the following simultaneous conditions:

a. The desired signal is subject to the maximum permitted signal frequency offset.

b. The desired signal is subject to the maximum modulation distortion allowed in Section 2.2.2.4. of DO-282.

Notes:

1. This requirement ensures the baud rate accuracy supporting demodulation in the GBT equipment is adequate to properly receive the longer Ground Uplink message (assuming that the baud rate accuracy of the transmitter is 2 PPM).

2. *Since reception of the Ground Uplink message results in no output on the Ground Interface, the manufacturer **shall** provide the indication of Successful Message Reception in some other way (e.g., test point that provides count of Successful Message Reception).*

3. *This **shall** include the effects of the T/R switch.*

3.2.2.1.3 Receiver Selectivity

DO-282 Section 2.2.8.2.3 requirements applicable only to equipment classes A0, A1L, A1H, and A2 **shall** apply to the GBT.

3.2.2.1.4 Receiver Tolerance to Pulsed Interference

DO-282 Section 2.2.8.2.4 requirements applicable only to equipment classes A0, A1L, A1H, and A2 **shall** apply to the GBT.

3.2.2.1.5 Receiver Tolerance to Overlapping ADS-B Messages

DO-282 Section 2.2.8.2.5 requirements applicable only to equipment classes A0, A1L, A1H, and A2 **shall** apply to the GBT.

3.2.2.2 Transmitter Characteristics

The GBT transmitter **shall** meet all the requirements of RTCA DO-282 Sections 2.2.2.1 through 2.2.2.7 with exceptions or qualifications as detailed in the subparagraphs below.

3.2.2.2.1 Modulation Distortion

DO-282 Section 2.2.2.4 requirements for modulation distortion **shall** also be applicable for Ground Uplink message transmissions from the GBT.

3.2.2.2.2 Transmitter Power Levels and Ranges

a. The GBT **shall** support four power level settings within the ranges as shown in Table 3-9. Power levels are measured in terms of power presented at the Air Interface port of the GBT including the effects of the T/R switch.

Table 3-9: Transmitter Power Requirements

Power Level Setting	Nominal Power	Minimum Power	Maximum Power
"Off"	0 Watts		(-80 dBm)
"Low"	10 Watts	7 watts (+38.5 dBm)	14 watts (+41.5 dBm)
"Medium"	25 Watts	16 watts (+42 dBm)	32 watts (+45 dBm)
"High"	75 Watts	50 watts (+47 dBm)	100 watts (+50 dBm)

b. `POWER_LEVEL` **shall** be selectable as a configuration item.

3.2.2.2.3 Transmitter Power Output

DO-282 Section 2.2.2.5 requirements for the Time/Amplitude profile of transmitted messages **shall** be applicable with the following qualifications:

a. References to Table 2-1 and Table 2-2 in subparagraphs b), c), d) and e) of DO-282 Section 2.2.2.5 **shall** instead refer to Table 3-9 of this specification.

b. Time/Amplitude profile requirements are applicable for all messages transmitted from the GBT.

3.2.2.2.4 Transmitter Timeout

Whenever the RF level at the Air Interface Port exceeds –60 dBm for more than 50% of any 40 millisecond period, the GBT **shall**:

a. declare a transmitter timeout Alarm in the Status report.

b. Automatically assume the "Off" setting for the Transmitter Level control parameter.

Note: This requirement is structured for verification testing through intentional "over assignment" of Channels when configuring the GBT (see Section 3.2.2.2.5).

3.2.2.2.5 Transmitter Duty Cycle

The GBT transmitter **shall** be capable of operating with the simultaneous combination of TIS-B at a full target load of 190 per second and a maximum of 8 Ground Uplink messages per second in any combination of `OFFSET` and `CHANNEL_LIST` assignments.

Notes:

1. *A configuration constraint that requires successive Channel assignments to be spaced at most 4 apart is acceptable (e.g., Channel assignments of 1, 5, 9, 13…29 or 2, 6, 10, 14…30 etc).*

2. *However, the GBT **shall** support the configuration of any arbitrary list of channel assignments in order to support verification testing of the "Transmitter Timeout" requirement (Section 3.2.2.2.4).*

3.2.2.3 Receiver Availability

The GBT receiver **shall** be enabled and available for message reception except for the intervals that begin a maximum of 500 microseconds prior to the optimum sampling point of the first bit of the synchronization sequence of a transmitted message and ends within the transmit-receive turnaround time.

3.2.2.4 Transmit-Receive Turnaround Time

The GBT **shall** switch from transmission to reception and return to the sensitivity specified in Sections 3.2.2.1.1 and 3.2.2.1.2 within 500 microseconds after transmitting a message.

Note: *Transmit to Receive switching time is defined as the time between the optimum sampling point of the last information bit of one transmit message and the optimum sampling point of the first bit of the synchronization sequence of the subsequent receive message.*

3.2.2.5 GBT Throughput Performance

GBT throughput performance requirements vary depending on the Ground Interface option selected. The GBT **shall** meet the throughput and delay requirements given in Table 3-10. Each row of the table represents a set of throughput requirements that **shall** be met simultaneously.

Table 3-10. GBT Throughput Performance Requirements

		ADS-B Messages		TIS-B Reports		Uplink Data Blocks (FIS)	
		Req'd Input Load (Note 1) (Messages/sec)	Max Throughput Delay	Req'd Input Load (Note 2) (Reports/sec)	Max Throughput Delay (Note 3)	Req'd Input Load (Note 2) (Blocks/sec)	Max Throughput Delay (Note 4)
Ground Interface Option	Ethernet	500	All ADS-B messages must be reported within the ADS-B Reporting Interval in which the message was received	190	400 ms	8	1.2 sec
	56 K SYNC	115		115		0	
				50		8	
				0		8	
	19.2 ASYNC	31		31		0	
				15		2	
				0		4	
	9.6 ASYNC	15		15		0	
				7		1	
				0		2	

Notes:

1. *¼ of the total ADS-B input load will be back-to-back messages at the beginning of the ADS-B segment. The remainder will be random arrivals uniformly distributed across the remaining portion of ADS-B segment of the UAT frame.*

2. *The TIS-B report and Uplink Data Block input load on the Ground Interface are random arrivals uniformly distributed across the entire UAT frame.*

3. *Throughput delay for TIS-B is defined as the time from receipt of the complete TIS-B report over the GBT Ground Interface to the time the TIS-B message transmission over the GBT Air Interface for that target begins.*

4. *Throughput delay for Uplink Data Blocks is defined as the time from receipt of the complete Uplink Data Block over the GBT Ground Interface to the time the Ground Uplink message transmission over the GBT Air Interface for that target begins.*

5. *The three serial interface options each contain three separate test scenarios for uplink data load: All TIS-B with no FIS-B, all FIS-B with no TIS-B and one with a mixture of both. All scenarios include the full load of ADS-B messages.*

3.2.2.6 Internal Time Source

a. The GBT **shall** employ a GPS-based internal time source referenced to UTC that supports a timing accuracy of +/- 500 ns of UTC. When UTC timing is available from the internal GPS source, the GBT is in the UTC-coupled condition.

b. When the GBT has entered the ALARM condition for the GBT Timing Status monitor parameter, the GBT **shall** estimate—or "coast"—time such that the GBT assigns the "Time of Applicability" data item for ADS-B reports with an error of no greater than +/- 1 second from the actual time of applicability for up to 1 hour.

3.2.2.6.1 GPS Antenna

a. A matching GPS antenna **shall** be provided for the GPS system.

b. The requirement of Section 3.2.2.6.a., **shall** be met with up to 100 meters of GPS antenna cable through the use of a programmable cable delay, if required.

3.2.2.6.2 GPS Satellite Tracking and Masking

a. The GPS subsystem **shall** be capable of tracking a minimum of eight satellites simultaneously.

b. Accurate timing **shall** be capable of being generated from only one satellite.

c. Normal satellite masking **shall** apply for any satellites below 10 degrees above the horizon. This angle **shall** be reduced to 5 degrees above the horizon if insufficient satellites above 10 degrees above the horizon are available to provide accurate timing.

3.2.2.6.3 GPS Receiver System Sensitivity

The GPS system is designed to provide a –130 dBm signal at the earth surface. To provide a level of immunity from environmental attenuation, the GPS receiver **shall** have the capability to acquire signals of at least –136 dBm level at the antenna and remain tracking to a level of at least –143 dBm signal strength.

3.2.3 Site Control and Monitoring

3.2.3.1 Technician Access

The GBT **shall** support access by maintenance technicians for control and monitoring of GBT parameters in one of two ways:

a. A Local Maintenance Interface on the front panel of the GBT for connection of a local PC for test and control functions.

b. A Remote Maintenance Interface on the rear of the GBT for connection to the control facility.

3.2.3.1.1 Local Maintenance Interface

a. The GBT **shall** implement the Local Maintenance Interface IAW NAS-IC-51070000-2.

b. The GBT Local Maintenance Interface **shall** implement SNMPv1 in accordance with RFC 1157 and SNMPv2c in accordance with RFC 1901 for remote monitor and control in addition to the protocols required by NAS-IC-51070000-2.

Note: The FAA's NIMS management platform is only SNMPv1 and SNMPv2c compatible at this time. An upgrade to SNMPv3 is planned for the future. Until this upgrade is in place, FAA will need to have multilingual agents (e.g., the GBT) built for NIMS.

c. The GBT **shall** accept control input, provide control replies, and provide monitoring output and alarm/alert indications via the Local Maintenance Interface connector.

d. The GBT **shall** continue to operate with a local maintenance terminal connected, logged in, and upon removal of the local maintenance terminal.

3.2.3.1.2 Remote Maintenance Interface

a. The GBT **shall** implement the Remote Maintenance Interface IAW NAS-IC-51070000-2.

b. The GBT Remote Maintenance Interface **shall** implement SNMPv1 in accordance with RFC 1157 and SNMPv2c in accordance with RFC 1901 for remote monitor and control in addition to the protocols required by NAS-IC-51070000-2.

c. The GBT **shall** implement the Remote Maintenance Interface IAW NAS-IC-51070000-2.

d. The GBT Remote Maintenance Interfaces **shall** implement SNMPv1 and SNMPv2c for monitoring and control in addition to the protocols required by NAS-IC-51070000-2.

e. The GBT **shall** accept control input, provide control replies, and provide monitoring output and alarm/alert indications via the Remote Maintenance Interface connector.

f. The GBT **shall** continue to operate with the Remote Maintenance Interface connected, logged in, and upon removal of the Remote Maintenance Interface.

3.2.3.1.3 Management Information Base

The GBT Management Information Base (MIB) **shall** be implemented IAW NAS-IC-51070000-2.

3.2.3.2 GBT Internal RF Test Support

Note: The requirements of this section are intended to support monitoring of the GBT's RF performance on a remote basis. Differing support is need for each of the two following GBT conditions: when in the Online state (fully operational); and when placed in the Offline state by the maintenance technician (non-operational).

3.2.3.2.1 ADS-B Test Message (Online State)

a. The GBT **shall** generate an ADS-B Test message in the "Basic" ADS-B message format to verify operation of the ADS-B reception function.

b. The ADS-B Test message **shall** be composed according to Table 3-11.

Table 3-11. Payload Composition of ADS-B Test Message

ADS-B Message Payload Field		Contents
Field Name	DO-282 Ref Para	
"PAYLOAD TYPE CODE"	2.2.4.5.1.1	ZERO ("Basic" ADS-B message)
"ADDRESS QUALIFIER"	2.2.4.5.1.2	"5" (Code for "Fixed ADS-B Beacon")
"ADDRESS"	2.2.4.5.1.3	Configuration item ADS-B_TEST_MSG_ADDR
"LATITUDE" and "LONGITUDE"	2.2.4.5.2.1	Provided each second by internal GPS
"ALTITUDE TYPE"	2.2.4.5.2.2	ZERO
"ALTITUDE"	2.2.4.5.2.3	ALL ZEROS (Code for "Information not available")
"NIC"	2.2.4.5.2.4	Provided each second by internal GPS
"A/G STATE"	2.2.4.5.2.5	ALL ZEROs
"HORIZONTAL VELOCITY"	2.2.4.5.2.6	Provided each second by internal GPS
"VERTICAL VELOCITY"	2.2.4.5.2.7	ALL ZEROs
"TIS-B SITE ID"	2.2.4.5.3.1	ALL ZEROs

c. The ADS-B Test message **shall** be generated once every twelve seconds.

d. The ADS-B Test message **shall** not conflict with any ADS-B message reception during the ADS-B segment of the UAT frame.

e. The ADS-B report resulting from the ADS-B Test message **shall** always be reported in the reporting interval in which it was generated regardless of the ADS-B message load.

f. The ADS-B Test message **shall** be inserted into the receiver front end, to include any receiver power or pre-amplifiers, so that a complete system check can be initiated.

g. The level of the ADS-B Test message present at the receiver front end **shall** be at least 5 dB above the level required to achieve a rate of Successful Message Reception of 90% or better.

h. The level of the ADS-B Test message present at the Air Interface port **shall** not exceed –60 dBm.

3.2.3.2.2 Loopback Test Mode (Offline State)

Note: The Loopback mode samples and receives the GBT uplink transmissions at the receiver front end so the reception can be reported on the GBT's Ground Interface. Loopback mode also supports a power measurement of Ground Uplink messages. Loopback mode is intended only for maintenance use as a remote check on the transmitter functionality.

When placed in the Loopback test mode:

a. The GBT **shall** transmit a single TIS-B loopback message in accordance with the requirement of Section 3.2.1.4. through 3.2.1.4.2 within 2 seconds of receipt of a TIS-B report on the Ground Interface.

Note: The loopback test for TIS-B messages will be supported though a special loopback application external to the GBT. This loopback application provides a stimulus consisting of a single TIS-B report applied to the GBT's Ground Interface. The loopback application will expect an ADS-B report to be subsequently received from the GBT's Ground Interface for bit-wise comparison with the original TIS-B report.

b. The GBT **shall** transmit a single Ground Uplink loopback message in accordance with the requirements of Sections 3.2.1.5 through 3.2.1.5.2.3 in Channel #32 within 2 seconds of receipt of an Uplink Data Block on the Ground Interface.

Note: The loopback test for Ground Uplink messages will be supported though a special loopback application external to the GBT. This loopback application provides a stimulus consisting of a single Uplink Data Block applied to the GBT's Ground Interface. The loopback application will expect a "readback" of the Uplink Data Block to be subsequently received from the GBT's Ground Interface for bit-wise comparison.

c. The GBT **shall** transmit all messages in loopback mode according to the `POWER_LEVEL` configuration parameter.

Note: This is necessary to simultaneously support the remote power level measurement. Maintenance procedures and the loopback application will ensure resulting messages are infrequent and formatted such that they will be ignored by avionics equipment.

d. The GBT **shall** provide a power level measurement for each Ground Uplink message transmitted and report the measured level in the Measured Power Output monitoring parameter (ID # 57).

e. Message receptions in Loopback test mode:

1. **Shall** be processed through the receiver's RF section, to include the T/R switch when present.

2. **Shall** result in an ADS-B report on each Successful Message Reception of the TIS-B loopback message.

3. **Shall** result in an Uplink Data Block (sent from the GBT) on each Successful Message Reception of the Ground Uplink loopback message.

f. The GBT **shall** remain in Loopback test mode until explicitly taken out of Loopback test mode, or until the Control Session is terminated, which ever comes first.

3.2.3.2.3 Sensitivity Test Mode (Offline State)

Note: The Sensitivity test mode causes ADS-B Test messages to be internally generated and injected into the receiver. This mode allows the maintenance technician to control the level of the ADS-B Test message as applied to the receiver front end. By comparing the ADS-B report rate to the known rate of internal ADS-B Test messages transmitted, the technician is able to estimate the receiver sensitivity. Sensitivity test mode is intended only for maintenance use as a remote check on the receiver.

When placed in the Sensitivity test mode:

a. The GBT **shall** generate ADS-B Test messages in accordance with the requirements of Section 3.2.3.2.1 with the exception that the ADS-B test message is generated at a rate of once per second.

b. The GBT **shall** support adjustment of the level of the ADS-B Test message in a range of at least ± 10 dB relative to the sensitivity threshold for Basic ADS-B messages (see Section 3.2.2.1.1) in 1 dB increments.

c. The level of the ADS-B Test message provided to the receiver for each adjustment step **shall** be stable and repeatable to within ± 1 dB.

d. A sample of the ADS-B Test message being injected into the receiver **shall** be provided at an externally accessible test point.

3.2.3.3 GBT Control

3.2.3.3.1 Control Session

Note: A control session is used by to convey control parameters, and receive both control replies and solicited monitoring messages. A control session is not required for unsolicited radio monitoring messages.

Note: A user will log in either via the Remote Maintenance Interface or the Local Maintenance Interface to initiate a control session. A session is initiated after receipt of a Log-In and authentication of a security key. A session ends with a log-out, physical disconnection of the Local Terminal, or when no control parameters are received within 30 minutes.

a. The GBT **shall** initiate a control session upon successful authentication of log on / security key.

b. As long as a valid session is active on one control interface, the GBT **shall** reject all control parameters from the other control interface.

c. The GBT **shall** terminate the control session upon log-out, disconnection of local maintenance terminal, or after no control parameter is received within 30 minutes.

d. The GBT **shall** be in the Offline State during a control session.

e. A control parameter command shall be processed within an average of 1 second and a maximum time of 2 seconds.

3.2.3.3.2 Control Parameter Adjustments

a. The GBT **shall** allow modification of the control parameters of the GBT equipment summarized in Table 3-12.

b. The GBT equipment **shall** set parameters to within the tolerance of the associated monitoring parameter (i.e., same Parameter ID).

Note: In some cases the step size is finer than the resolution to allow for finer tuning of the parameters using external test equipment.

Note: The control parameter value ranges, maximum step sizes and default values are summarized in Table 3-12.

c. The GBT **shall** reply to request messages with a reply message containing the parameter setting actually enacted by the GBT.

d. Rejected request messages **shall** contain the original parameter setting with an error code indicating the reason for rejection.

Table 3-12. GBT Control Parameters

ID	Control Parameter	Arguments (if applicable)	Settings			
			Min	Max	Step	Initialization Default
	GBT Configuration Items (see Table 3-11A for description):					
1.1	SIC	N/A	Value in the range 0-255			0
1.2	SAC	N/A	Value in the range 0-255			0
1.3	TIS-B_FILTER	N/A	"On"/"Off"			"On"
1.4	TIS-B_OPERATING_MODE	N/A	"Enabled"/"Disabled"			"Disabled"
1.5	OFFSET	N/A	0 ms	140 ms	20 ms	0
1.6	GBT_LATITUDE	N/A	-90° (S)	90° (N)	0.001 minutes	0°
1.7	GBT_LONGITUDE	N/A	-180°	180°	0.001 minutes	0°
1.8	POS_VALID	N/A	TRUE/FALSE			FALSE
1.9	APP_DATA_VALID	N/A	TRUE/FALSE			TRUE
1.10	TIS-B_SITE_ID	N/A	Value in the range of "0" to "16"			"0"
1.11	CHANNEL_LIST	N/A	List of up to 8 values in the range of 1- 32			NULL set
1.12	<Ground Interface Parameters>	See Table 3-12				
1.13	(Reserved)					
1.14	POWER_LEVEL	N/A	4 fixed settings (See Table 3-8)			"Medium"
1.15	TIMING_SOURCE	N/A	"Internal"/"External"			"Internal"
1.16	STATUS_REPORT_INTERVAL	N/A	One of the following values: 1, 2, 3, 4, 5, 6, 10, 15, or 30 seconds			6 seconds
1.17	ADS-B_REPORT_FSPEC_FILTER	N/A	List of FRN #s from Cat 33 that will always be suppressed in ADS-B reports. Possible values are: 15 through 21			NULL set
1.18	ADS-B_TEST_MSG_ADDR	N/A	1	2^{24}-1	1	ALL ONES
5	**Real Time Read Back**: Requests real time monitoring values for the desired monitoring parameter based on the	-Monitoring Parameter -Interval -# of iterations	N/A	N/A	N/A	N/A
6	**Event Log Read Back**: Requests the GBT event log entries for the desired monitoring parameter	Filter criteria (Section 3.2.3.5.8)	N/A	N/A	N/A	N/A
7	**GPS Satellite Observation Log Readback**: Requests the satellite observation log entries specified.	Filter criteria (Section 3.2.3.6)	N/A	N/A	N/A	N/A
10	**Alarm/Alert Threshold Setting**: The Threshold Setting parameter provides new alert and alarm threshold values for the various monitoring parameters. This parameter includes the parameter ID and the new alert and alarm thresholds.	Monitoring Parameter (See Table 3-13)	Anywhere in range of Monitoring Parameter			See Table 3-13
11	**Suppress Alert/Alarm**: The Suppress Alert/Alarm parameter is an action signal to command the GBT to cease transmitting alert and alarm messages to the Local and Remote Maintenance Interfaces or resume normal alert and alarming.	Monitoring parameter	Two discrete values: -Suppress, -Normal			Normal
15	**Reset**: This is an action signal that commands the GBT to do a warm boot reset (restart while retaining control parameter settings) or a factory reset (restart after returning all control parameters to initialization default values)	N/A	Two discrete values: -Warm Reset, -Factory Reset			N/A
16	**Power Down (if implemented):**	N/A	N/A			N/A
20	**Software Upload Enable/Disable**: This is an action signal that enables the equipment to upload operational software.	N/A	Two discrete values: -Enable Upload, -Disable Upload			Disable Upload
21	**Software Upload**: This is the mechanism for actually uploading the operational software executable image. This parameter is used in conjunction with parameter 22.	-Block Number, -Total Blocks, -Binary Data Block (variable length)	N/A	N/A	N/A	N/A
22	**Switch Software Version**: This is an action signal that indicates to the equipment to reboot with the stored software image indicated.	N/A	N/A	N/A	N/A	N/A
25	**Test Mode**: This places the GBT in the Loopback test mode, the Sensitivity test mode or Test mode OFF to allow remote checks of the transmitter (and receiver remotely.	N/A	Three possible settings: -"Loopback test mode", -"Sensitivity test mode", -"Test mode OFF"			Test mode OFF

ID	Control Parameter	Arguments (if applicable)	Settings			
			Min	Max	Step	Initialization Default
26	**ADS-B Test Message Level**: Allows the maintenance technician to adjust the level in 1 dB steps to ascertain the receiver sensitivity. This control parameter is only available when the Test Mode parameter is set to "Sensitivity test mode"	N/A	A range of at least +/- 10 dB around the sensitivity threshold (90% Successful Message Reception) in 1 dB increments			N/A

Notes:

1. *The Initialization Default values for each parameter represents the "hard-coded" factory settings required upon GBT initialization.*

3.2.3.3.2.1 GBT Configuration Items (ID = 1.1 through 1.15)

The GBT configuration items **shall** perform the functions indicated in Table 3-13 and Table 3-14

Table 3-13. Description of GBT Configuration Items

ID	GBT Configuration Item	Description
1.1	SIC	System Area Code: used to identify regions of the world
1.2	SAC	System Identification Code: used to identify individual systems
1.3	TIS-B_FILTER	When set, this flag eliminates reporting of TIS-B messages
1.4	TIS-B_OPERATING_MODE	When set, this flag enables TIS-B message transmissions when the GBT is in the Online state
1.5	OFFSET	Controls the offset timing for TIS-B message transmissions for a particular GBT. This value will vary among proximate GBT sites to ensure TIS-B message transmissions will not be subject to "same slot" interference
1.6	GBT_LATITUDE	Surveyed location provided to the GBT
1.7	GBT_LONGITUDE	Surveyed location provided to the GBT
1.8	POS_VALID	Set to indicate to avionics that the Ground Uplink message contains a valid position
1.9	APP_DATA_VALID	Set to indicate to avionics that the Ground Uplink message contains a valid application data
1.10	TIS-B_SITE_ID	Allows avionics to link TIS-B messages with physical location of the GBT from which they are transmitted (via the position encoded in the Ground Uplink messages)
1.11	CHANNEL_LIST	List of Channels available to this GBT as a resource for transmitting Ground Uplink messages
1.12	<Ground Interface Parameters>	(see Table 3-12)
1.13	(Reserved)	
1.14	POWER_LEVEL	Sets the GBTs power level to one of four settings
1.15	TIMING_SOURCE	Selects either the GBTs internal (GPS) timing source or the external timing source for purposes of controlling media access and time stamping reports
1.16	STATUS_REPORT_INTERVAL	Selects the periodic reporting interval for the Status report
1.17	ADS-B_REPORT_FSPEC_FILTER	Determines which optional Data Items from the Cat 33 report definition (Appendix A) are to be included in ADS-B reports
1.18	ADS-B_TEST_MSG_ADDR	Establishes the "ADDRESS QUALIFIER" and "ADDRESS" fields of the ADS-B test message

Table 3-14. GBT Ground Interface Configuration Items

Configuration Item	Possible values	Default	Description
PHYSICAL_INTERFACE_TYPE	"Ethernet" or "Serial"	"Serial"	The ground side interface will be limited to one physical connection, either Ethernet or serial.
Ethernet Parameters:			Ethernet parameters: The Ethernet parameters are only applicable when the physical interface is set to 'Ethernet'.
NETMASK	Class C Address	255.255.255.0	The network layer IP subnet mask value. This value, combined with the SOURCE_IP_ADDR defines the address space and range on the subnet.
SOURCE_IP_ADDR	Class C Address	192.168.1.1	The IP address of the GBT.
DESTINATION_IP_ADDR	Class C Address	192.168.1.255	The IP address of the network node communicating with the GBT. All data received from the air-side interface will be sent to this IP address. This will be the IP address of the TCP server if the TCP transport layer protocol is used.
GATEWAY_IP_ADDR	Class C Address	192.179.1.254	The IP address of the network node used for communicating with external subnets.
TRANSPORT_LAYER_PROTOCOL	"UDP" or "TCP"	"UDP"	The ground side interface will be limited to one logical connection using either the TCP or UDP transport layer protocol.
SOURCE_PORT	0 to 99999	22222	Port number to receive uplink data.
DESTINATION_PORT	0 to 99999	33333	Port number to transmit downlink data.
LISTEN_PORT			Port number to connect to the TCP server. Both uplink and downlink data will be sent over this port.
Serial Parameters:			The serial parameters are only applicable when the physical interface is set to 'serial'. The GBT serial interface will be wired as data communications equipment (DCE).
BAUD_RATE	1.2, 2.4, 4.8, 9.6, 19.2, 38.4, or 57.6 Kbps	19.2 Kbps	All standard serial communications baud rate values are acceptable. Values represent Kilobits per second.
DATALINK	"Sync " or "Async"	"Async"	When the asynchronous protocol is selected, the serial interface will be set to 8 data bits, no parity, and one stop bit (8-none-1). When the synchronous protocol is selected, HDLC, NRM mode (unbalanced), ARM enabled (assumes a point-to-point full duplex communications interface), GBT acts as Primary sending only information frames. Supervisory frames and Unnumbered frames disallowed in either direction.
Session Layer Parameters:			
SDU_HEADER	"On" or "Off"	"On"	Use or omit the session layer header
SDU_SYNC_FRAMES	"On" or "Off"	"On"	Use or omit the message delimiting synchronizing sequence

3.2.3.3.2.2 Real Time Read Back (ID = 5)

The real time read back parameter **shall**:

a. Cause the GBT equipment to reply with a monitoring message containing the real time monitored value of the monitoring parameter specified.

b. Accept three arguments: monitoring parameter, Interval, and number of iterations.

Note: This supports the requirement of Section 3.2.3.4.b.1.

3.2.3.3.2.3 Event Log Read Back (ID = 6)

The event log read back parameter **shall** cause the GBT equipment to reply with the event log entries for the filter criteria specified.

Note: This supports the requirement of Section 3.2.3.5.7.

3.2.3.3.2.4 GPS Satellite Observation Log Readback (ID = 7)

The GPS Satellite Observation log read back parameter **shall** cause the GBT equipment to reply with the log entries for the filter criteria specified.

Note: This supports the requirement of Section 3.2.3.6.

3.2.3.3.2.5 Alarm/Alert Threshold Setting (ID = 10)

The threshold setting parameter **shall**:

a. Establish new alert and alarm threshold values for the monitoring parameter specified.

b. Contain thresholds for low Alarm, high Alarm, low Alert, high Alert (as applicable) of variable type with values anywhere in the range of the associated parameter values specified in Table 3-15.

3.2.3.3.2.6 Suppress Alert/Alarm (ID = 11)

The suppress alert/alarm parameter **shall** cause the GBT equipment to cease or resume transmitting alert and alarm messages to the Local and Remote Maintenance Interfaces for the monitoring parameter specified.

3.2.3.3.2.7 Reset (ID = 15)

The reset parameter **shall**:

a. Have two values: Warm Reset and Factory Reset.

b. Cause the GBT to transition to the Power Up state (and initiate Power Up sequence) after two Reset (Warm Reset) control parameters are received within 1 second.

c. Restore all control parameters to their default value and cause the GBT to clear the link and then to transition to the Power Up state (and initiate Power Up sequence) after two Reset (Factory Reset) control parameters are received within 1 second.

3.2.3.3.2.8 Power Down (ID = 16)

If implemented, the Power Down parameter **shall** force the GBT into the OFF state.

3.2.3.3.2.9 Software Upload Enable/Disable (ID = 20)

The software upload enable/disable parameter **shall**:

a. Enable the GBT equipment to upload operational software to support the programmability requirements of Sections 3.2.3.3.2.11.

b. Have two discrete values: Enable Upload and Disable Upload.

c. Have a default value of Disable Upload.

3.2.3.3.2.10 Software Upload (ID = 21)

The software upload parameter **shall**:

a. Communicate blocks of the new operational software executable image to reprogram the GBT to support the programmability requirements of Section 3.2.3.3.2.11

b. Be ignored unless the Software Upload Enable/Disable parameter indicates that an upload is enabled.

c. Not include the Binary Data in the Control reply message.

d. Have Three Fields: Block Number, Total Blocks, Program Binary Block (variable length).

3.2.3.3.2.11 Switch Software Version (ID = 22)

The switch software version parameter **shall**:

a. Indicate to the GBT equipment to reboot to the alternate stored software image provided in the procedure of Section 3.2.3.3.2.10.

b. Cause the GBT to transition to the Power Up state and begin operation using the alternate software image (and initiate Power Up sequence) after two Switch Software Version control parameters are received within 1 second.

3.2.3.3.2.12 Test Mode (ID = 25)

The Test Mode parameter **shall**:

a. Establish the GBT in special test modes that support testing of transmitter and receiver performance per Sections 3.2.3.2.2 and 3.2.3.2.3.

b. Have three discrete values: Loopback test mode, Sensitivity test mode, and Test mode OFF.

c. Have a default value of Test mode OFF.

3.2.3.3.2.13 ADS-B Test Message Level (ID = 26)

When in the Sensitivity test mode, the GBT **shall** support control of the level of the ADS-B Test message.

3.2.3.4 GBT Monitoring and Reporting

a. The GBT monitoring function **shall** perform real-time system performance monitoring and provide real-time system performance reporting when the GBT is in the Online state.

b. There **shall** be three instances where monitoring messages are sent to the Local and Remote Maintenance Interfaces:

    1. Upon request via a Control message with parameter ID = 5.

2. When an alert or alarm threshold is crossed, and

3. When a monitored parameter returns to a value within the normal range.

c. The alert or alarm status messages **shall** be sent within an average of 2 seconds and a maximum time of 4 seconds of when the parameter being monitored crosses the threshold level.

3.2.3.4.1 Non-Congesting Monitoring

a. The GBT **shall** monitor automatically on a continuous basis without blocking or delaying operational communications and management and without the need for the insertion of an external command.

b. The GBT monitoring **shall** not cause the GBT function to degrade below requirements during operation of the system.

c. Regardless of the frequency of alarm and alert status messages, the GBT monitoring **shall** not prevent the reception and processing of commands.

3.2.3.4.2 Alarm/Alert Monitoring Suppression

a. The GBT equipment **shall** suppress alarm and alert status messages to the Local and Remote Maintenance Interfaces upon command.

b. The GBT equipment **shall** send an alert event acknowledging the command to suppress alarm and alert status messages before suppressing alarm and alert monitoring messages.

3.2.3.4.3 Alarm/Alert Processing

a. The GBT parameters to be monitored **shall** be described by three monitor parameter states:

Normal
Alert
Alarm

b. The monitored parameter states **shall** be defined by a range of values that are adjoined such that the value range of the alert state is bordering on the normal state at one end of its range and the alarm state on the other side of its range. Figure 3-6 illustrates Normal, Alert and Alarm Range for a Parameter that has both an upper and lower alert and alarm range.

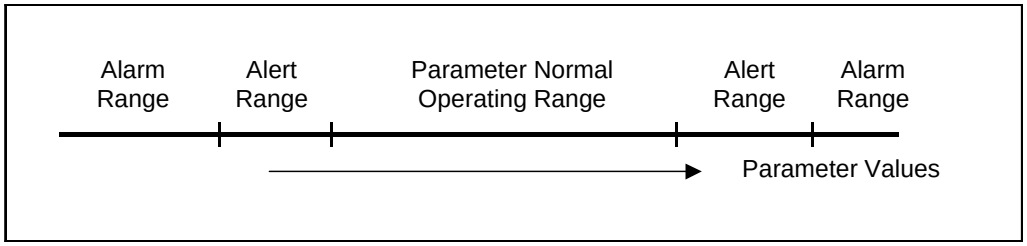


Figure 3-6 Normal, Alert and Alarm Range for a Parameter

c. A monitored parameter **shall** change state when the monitored parameter value transitions from a value within one range to a value within another range, if applicable for the parameter.

d. The GBT **shall** determine the change between normal state, alert state, and alarm state of GBT status parameter by comparing data to pre-established thresholds.

e. The GBT **shall** apply a discriminating function (hysteresis) at the boundaries of the ranges to minimize the declaration of alarms and alerts generated under monitored parameter transient conditions.

f. The GBT **shall** automatically declare an alert event when a monitored parameter and/or element status changes to a value that is outside the normal range but within the alert range.

g. The alert event **shall** be reported once per occurrence.

h. The GBT **shall** not generate spurious alert events in any state or transition.

i. The GBT **shall** automatically declare a return to normal event when a monitored parameter and/or element status that was previously outside the normal range changes to a value that is inside the normal range.

j. The return to normal event **shall** be reported once per occurrence.

k. The GBT **shall** automatically declare an alarm event when a monitored parameter and/or element status changes to a value crossing from the normal or alert range to the alarm range.

l. The alarm event **shall** be reported once per occurrence.

m. The GBT **shall** not generate spurious alarm events in any state or transition.

n. The GBT **shall** automatically declare a state change event when the value changes for a monitored parameter and/or element status that indicates a configuration or mode change to the GBT.

o. The GBT State change event **shall** be reported once per occurrence.

3.2.3.4.4 GBT Monitoring Parameters

a. The GBT equipment **shall** monitor the parameters summarized in Table 3-15.

b. An event notification or request for data **shall** be processed within an average of 2 seconds and a maximum time of 4 seconds.

Table 3-15 GBT Monitoring Parameters

ID	Monitoring Parameter	Arguments (if applicable)	Monitored Values					
			Min	Max	Step	Tolerance (Acceptable Error)	Alert Values	Alarm Values
1	**GBT Configuration Items:** Current setting for GBT Configuration items	The specific Configuration Item requested (ID=1.x)	Current setting in use by the GBT			N/A	Alert on acceptance of new value with Item and new value	N/A
4	**GBT State**: The GBT State parameter indicates that the GBT is in one of six states: Power-Up, Power-Down (if exercised), Online, Offline, Recovery or Fail.	N/A	One of 4 discrete values -Off Line -On Line -Recovery -Fail			N/A	Alert on State change (other than to Fail)	Alarm on Fail
11	**Suppress Alert/Alarm Setting**: The Suppress Alarm/Alert Setting parameter indicates whether Alarms and Alerts are suppressed or enabled	Monitoring Parameter	Two discrete values: -Suppress, -Normal			N/A	N/A	N/A
20	**Software Upload Setting**: The Software Upload Setting parameter indicated whether software uploading is prohibited or enabled	N/A	Two discrete values: -Enable Upload, -Disable Upload			N/A	N/A	N/A
23	**Software Version**: The Software Version parameter indicates the current version of the software active, as well as the standby software version.	N/A	1	255	1	0	N/A	N/A
31	**Receiver Status**	N/A	"Normal" or "Alarm condition" (i.e., fault detected)			N/A	N/A	On Alarm condition
32	**Transmitter Status**	N/A	"Normal" or "Alarm condition" (i.e., fault detected)			N/A	N/A	On Alarm condition
33	**Discard Event**: Alarm issued when either the ADS-B, TIS-B or Uplink Data Block discard Data Items in the Status Report are non-zero.	N/A	N/A	N/A	N/A	N/A	N/A	Alarm when any discard count in Status report is non-zero
53	**In-Service Time**: The In-Service Time parameter indicates the number of hours the GBT component has been powered.	N/A	0 hrs	$2^{24} - 1$ hrs	1 hr	+/- 1 hr	N/A	N/A
55	**Transmit Antenna VSWR**: The Transmit Antenna VSWR parameter indicates whether the VSWR of the transmit antenna is within an acceptable operating range.	Three Discrete Values: Normal, Alert, Alarm	N/A	N/A	N/A	N/A	Alert (reflected power is >9.5 dB below Output Power, i.e., VSWR is > 2:1 but less than 4:1)	Alarm (reflected power is >4.5 dB below Output Power, i.e., VSWR is >= 4:1)
56	**Transmitter Timeout**: Alarm to indicate a condition where the GBT transmitter has exceeded duty cycle limits resulting in automatic transmitter shutdown.	N/A	NORMAL or ALARM			N/A	N/A	ALARM on transmitter timeout
57	**Measured Power Output**: The Measured Power Output parameter indicates the current, actual RF transmission power at the GBT RF output. This measurement is only available during the Loopback test mode when the GBT is in the Offline state	Power in dBm	30 dBm	50 dBm	0.5 dB	+/- 1 dB	N/A	N/A
91	**GBT Timing Status (TFOM):** The status of the internal or external timing source which ever is selected in the GBT configuration.	N/A	1	10	1	0	4	≥5

Shaded rows indicate monitor parameters that are also reflected in the Status report.

3.2.3.4.4.1 GBT Configuration Items (ID = 1.1 through 1.15)

The GBT **shall** provide the current setting for the Configuration Item specified.

3.2.3.4.4.2 GBT State (ID = 4)

The GBT state parameter **shall**:

a. Indicate the GBT equipment is in one of five states as per Section 3.2.1.2.

b. Be one of 6 discrete values: Offline, Online, Power Up, Power Down (if exercised), Recovery or Fail.

c. Have an alarm value if transition to Fail state.

d. Have an alert value for other state transitions.

3.2.3.4.4.3 Suppress Alarm/Alert Setting (ID=11)

The suppress alarm/alert Setting parameter **shall**:

a. Indicate the setting of the Suppress Alarm/Alert parameter.

b. Be one of two discrete values, either “Suppress” or “Normal”.

3.2.3.4.4.4 Software Upload Setting (ID=20)

The software upload setting parameter **shall**:

a. Indicate the setting of the Software Upload parameter.

b. Be one of two discrete values, either “Enable Upload” or “Disable Upload”.

3.2.3.4.4.5 Software Version (ID = 23)

The software version parameter **shall**:

a. Indicate the current version of the software active in the GBT equipment, as well as the version number of the standby software version.

b. Be one of 255 discrete values for each field.

c. Have a minimum value of 1.

d. Have a maximum value of 255.

e. Use a value of 0 to indicate an invalid or non-existent version.

f. Have a resolution (step size) of 1.

3.2.3.4.4.6 In-Service Time (ID = 53)

The in-service time parameter **shall**:

a. Indicate the number of hours the GBT equipment have been continuously powered.

b. Be provided in hours.

c. Have a minimum value of 0 hours.

d. Have a maximum value of 2^{24}-1 hours.

e. Have a resolution (step size) of 1 hour.

f. Have a tolerance (acceptable error) of +/- 1 hour.

g. Provide a reset (to ZERO) by a reset action accessible only locally.

Note: This reset need not be part of the Local Maintenance interface.

3.2.3.4.4.7 Receiver Status

The receiver status parameter **shall** indicate the GBT's receiver as either in a "normal" condition (no fault detected by the GBT) or an "alarm" condition (fault detected by the GBT).

3.2.3.4.4.8 Transmitter Status

The transmitter status parameter **shall** indicate the GBT's transmitter as either in a "normal" condition (no fault detected by the GBT) or an "alarm" condition (fault detected by the GBT).

3.2.3.4.4.9 Discard Event

The discard event parameter **shall** indicate:

a. the "normal" condition when all discard counts are zero in a Status reporting interval.

b. the "alarm" condition when any discard counts are non-zero in a Status reporting interval.

3.2.3.4.4.10 Transmit Antenna VSWR (ID = 55)

The transmit antenna VSWR parameter **shall**:

a. Be one of three discrete values as given below:

Condition	Relative Power	VSWR
NORMAL	Reflected power is at most 9.5 dB below the forward power	2:1 or less
ALERT	Reflected power is between 4.5 and 9.5 dB below the forward power	Between 2:1 and 4:1
ALARM	Reflected power is 4.5 dB or less below the forward power	4:1 or greater

3.2.3.4.4.11 Transmitter Timeout (ID = 56)

The Transmitter Timeout parameter **shall** report a Transmitter Timeout Alarm when the transmitter duty cycle exceeds the limit established in Section 3.2.2.2.4.

3.2.3.4.4.12 Measured Power Output (ID = 57)

The measured power output parameter **shall**:

a. Measure the average RF power at the Air Interface during transmission of a Ground Uplink loopback message.

b. Be a power level in dBm.

c. Have a minimum value of 30 dBm.

d. Have a maximum value of 50 dBm.

e. Have a resolution (step size) of 0.5 dB for all GBT transmitter configurations.

f. Have a tolerance (acceptable error) of ±1 dB for all GBT transmitter configurations.

3.2.3.4.4.13 GBT Timing Status (ID = 91)

The GBT Timing Status parameter **shall**:

a. Be based on the Time Figure of Merit (TFOM) parameter derived by the internal or external time source (whichever is selected via the GBT configuration).

b. Be three discrete values:

NORMAL	TFOM <= 3
ALERT	TFOM = 4
ALARM	TFOM >= 5

Note: The range and meaning of TFOM values is as follows:

TFOM Value	*Timing Uncertainty*
1	*<= +/- 1 nanosecond*
2	*<= +/- 10 nanoseconds*
3	*<= +/- 100 nanoseconds*
4	*<= +/- 1microsecond*
5	*<= +/- 10 microseconds*

3.2.3.5 Event Logging Requirements

The GBT **shall** log the following events:

a. State change events, defined as the transition from one state to any other state.

b. Log-in/Log-out events, defined as the initiation/termination of a Control Session.

c. Control events, defined as receipt of any control parameter command except ID#5, Real Time Readback, and ID#6, event Log Readback.

d. Failure events, defined as the detection of any failure.

e. Alarm/Alert/Return to Normal events, defined as a monitored parameter crossing of any active alarm or alert threshold.

3.2.3.5.1 State Transition Log Entry

a. For state transitions, the GBT **shall** log the:

Event Type as State Change.
FROM state.
TO state.
Date/time of event to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The Event Type field **shall** contain a coded indication of the event type.

3.2.3.5.2 Log-In / Log-Out Log Entry

a. For Log-in/Log-out events, the GBT **shall** log the:

Event Type as Log-in/Log-out.
Date/time of event to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).
Session Action.
User Identification.
User Terminal Identification.
Authentication Result.

b. The Session Action field **shall** indicate whether the Log-In/Log-Out Event was a Log-In, Commanded Log Out, or Automatic Log-Out.

c. Authentication Result field **shall** indicate whether the Digital Signature associated with the Log- In was authenticated or rejected.

3.2.3.5.3 Control Event Log Entry

a. For Control events, the GBT **shall** log the:

Event Type as Control.
Control Parameter ID.
Control Parameter BEFORE value.
Control Parameter value except software update payload.
Date/time (of Control command receipt) to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).
User Identification.
User Terminal identification.
GBT Response.

b. The GBT Response field **shall** indicate whether the GBT accepted or rejected the control parameter command.

c. If the GBT rejects the control parameter command, the GBT Response field **shall** contain the error code.

3.2.3.5.4 Failure Event Log Entry

a. For Failure events, the GBT **shall** log the:

Event Type as Failure.
FROM state.
TO state (Recovery or Failed).
Failure code.
Date/time (of Failure) to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The Failure code field **shall** contain text or numeric codes to indicate the specific failure type.

3.2.3.5.5 Alarm/Alert/Return to Normal (RTN) Log Entry

a. For Alarm/Alert/RTN events, the GBT **shall** log the:

Event Type as Alarm/Alert/RTN.
Monitored Parameter ID.
Monitored Parameter value.
Date/time of event to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The Event Type field **shall** be coded to indicate whether the event was an Alarm, an Alert or a Return to Normal.

3.2.3.5.6 GBT Event Log Maintenance

a. The GBT **shall** log at least 1000 events, in any combination of events, and log events on a First In, First Out basis.

b. The GBT log and log entries **shall** be retained while the GBT is any state, including OFF state, and through any transition, including power loss and restoral, for the life of the GBT equipment.

3.2.3.5.7 Event Log Readback

The GBT **shall** reply to a Control Parameter #6, Event Log Readback with the Event Log entries that match the Filter and Qualifier criteria, as follows:

FILTER	QUALIFIER	GBT reads back:
All		all event log entries
All	Date/Time	all event log entries since Date/Time
State Change		all state change event log entries
State Change	Date/Time	all state change event log entries since Date/Time
Control		all control event log entries
Control-DT	Date/Time	all control event log entries since Date/Time
Control-ID	ID	all control event log entries with Control parameter ID specified
Failure		all failure event log entries
Alarm/Alert/RTN		all alarm/alert/RTN event log entries
Alarm/Alert/RTN-DT	Date/Time	all alarm/alert/RTN event log entries since Date/Time
Alarm/Alert/RTN-ID	ID	all alarm/alert/RTN event log entries with alarm/alert/RTN set against Monitored parameter ID specified
Log-In/Log-Out		all log-in/log-out event log entries
Log-In/Log-Out	Date/Time	all log-in/log-out event log entries since Date/Time
Security		all log entries (see Section 3.2.3.7.3.d)

3.2.3.6 GPS Satellite Observation Log Requirements

a. Once per minute, the GBT **shall** log the following GPS satellite observation data:

   1. List of Tracked Satellites including the following data for each:

      Satellite Anti-Spoof Flag.
      Satellite Unhealthy Flag.
      Satellite Inaccurate Flag.
      Satellite Parity Error Flag.
      Elevation angle of each satellite above the horizon.
      Azimuth angle of each satellite from north (0-359°).
      Satellite ID.
      Satellite Signal To Noise Ratio (SNR).

   2. Date/time of satellite observation to the nearest second UTC in the format (MM/DD/YYYY/HH:MM:SS).

b. The GBT **shall** be capable of holding at least 1000 GPS satellite observations on a First In First Out basis.

c. The GPS Satellite Observation log and log entries **shall** be retained while the GBT is in any state, including the OFF state, and through any transition, including power loss and restoral, for the life of the GBT equipment.

d. The GBT **shall** reply to a Control Parameter #7 GPS Satellite Observation Readback that matches the Filter and Qualifier criteria, as follows:

FILTER	QUALIFIER	GBT reads back:
All		all log entries
All	Date/Time	all log entries since Date/Time

3.2.3.7 INFOSEC Requirements

The GBT equipment **shall** ensure that appropriate technical, administrative, physical, and personnel security requirements are implemented to ensure integrity, availability, and confidentiality throughout the service period of performance and subsequent retirement.

3.2.3.7.1 Verification

a. The GBT **shall** verify the authenticity, integrity and time validity of the digital signed information received via the Local and Remote Maintenance Interfaces.

b. The digital signature algorithm that performs this verification **shall** correspond to at least one of the algorithms defined in FIPS 186-2.

c. The digital signature function **shall** meet or exceed security level 1 as defined in FIPS 140-1.

d. The digital signature function **shall** be validated according to FIPS 140-1 by an accredited FIPS 140-1 testing laboratory.

3.2.3.7.2 Keys

a. The GBT **shall** provide storage for 10 public keys, any of which may be used in verifying the digital signature defined in 3.2.3.8.1.

b. The storage for public keys **shall** be in non-volatile memory and be maintained through power loss and restoral.

c. The GBT **shall** provide a mechanism to add and delete public keys via the Local and Remote Maintenance Interfaces.

3.2.3.7.3 Security Procedures

a. All control parameter commands, except ID#30 Request Readback, **shall** be accepted only if the requesting device establishes a Control session, by providing a valid digitally signed authorization key ("security key") as defined in FIPS PUB 140-1.

Note: The Request Readback control parameter is the only control parameter that the GBT will accept when no Control session has been established.

Note: The "security key" will consist of a FAA-generated digital signature of an FAA-selected data field. The FAA-selected data field may be unique to each User Terminal. The security key will be supplied through the Local or Remote Maintenance Interface.

b. All control parameter commands, except ID#30 Request Readback, received without establishment of, or outside of, a Control session, or are associated with a security key that fails digital signature verification, **shall** be rejected.

c. The GBT **shall** receive and authenticate the security key each time a login is attempted through the Local and Remote Maintenance Interfaces.

d. The GBT **shall** maintain a log of security keys, signatures, and related events so that an access history can be tracked. This log **shall** be permanent and unalterable and contain a minimum of the most recent 500 occurrences. The security log **shall** include the following:

1. Authorized access and by which security key
2. Unauthorized access attempts
3. Log or function accessed
4. Change date and time of software
5. Change date and time of security key codes

Note: Security procedures apply to Control sessions only. These security requirements apply only to the GBT processing of control parameters. These security requirements do not apply to the GBT's Ground Interface or Air Interface.

3.2.3.7.3.1 Software Upload Security

a. Software uploads that are not digitally signed or contain an invalid digital signature **shall** be rejected.

Note: The Software Upload control parameter (ID#21) message will contain, in the last delivered program binary block, a digital signature appended to the software binary image as a signature specifically for the software image contained in the program binary blocks.

b. If the Software Upload capability is still enabled when a user's control session is ended, the Software Upload parameter **shall** be set to disable

3.2.3.7.4 Boot Cycle

The GBT boot cycle or equivalent **shall** be secured such that the possibility of an unintentional switch of the GBT operating software during the boot cycle or equivalent is extremely low.

3.2.3.7.5 Physical Security

a. The GBT equipment **shall** utilize tamper-proof seals, an example being of those used by quality inspectors, to indicate the physical security of any item (LRU) integral to the GBT equipment.

Note: This is required by FIPS PUB 140-1, paragraph 4-5.

b. The physical security of the end item GBT will be encompassed by the FAA installation site security.

3.2.3.8 Vendor Built In Test

The vendor **shall** make its built-in test accessible to the FAA.

3.2.3.9 GBT Failure Detection and Reporting

The GBT **shall** detect and report critical equipment failures to the Local and Remote Maintenance Interfaces automatically when the GBT is in the Offline and Online states and during Recovery.

Note: See Section 5.2.1 for definitions of critical and non-critical equipment failures.

3.3 Interfaces

3.3.1 Air Interface

a. The GBT **shall** support two Air Interface configuration options:

1. Combined transmit and receive through a single GBT antenna port.

2. Separate GBT antenna ports for transmit and receive.

b. The Air Interface **shall** be configurable to either Air Interface option by an on site technician without opening the GBT.

c. Air Interface connectors **shall** be 50 ohm coaxial type N female.

d. The transmit/receive switch **shall** be integral to the GBT

Note: See Figure 3-7 for one possible implementation for configuring the air interface option.

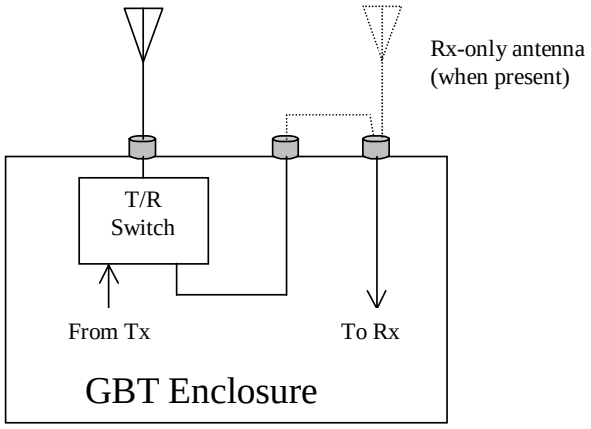


Figure 3-7. An Example Implementation of the Air Interface Option

3.3.2 Ground Interface

There **shall** be three Ground Interface connector options: Two for Serial and one for Ethernet.

3.3.2.1 Serial

The GBT **shall** support synchronous and asynchronous Serial interface configurations.

3.3.2.1.1 Asynchronous

This interface option **shall** be supported with a female DB9 RS-232.

3.3.2.1.2 Synchronous

This interface option **shall** be supported with a female DB25 (RS-530 pinout) EIA RS-422.

3.3.2.2 Ethernet

The Ethernet interface option **shall** be supported with a female RJ-45 for supporting Cat 5 wire media.

3.3.3 External Timing Input

a. An external timing interface **shall** be provided and consist of a Precise Time and Time Interval (PTTI) interface in accordance with ICD-GPS-060, Revision B.

b. PTTI signals **shall** include 1 PPS, BCD Time Code, and Timing Fault Discrete.

c. The 1 PPS physical interface **shall** be 50 ohm, BNC.

d. The BCD Time Code and Timing Fault Discrete signals **shall** share a common DB9 female connector.

Note: This external timing interface is required to support installations where use of an external timing source may be preferable to the internal GPS source.

3.3.4 Electrical Input Power

a. Electrical input power connectors **shall** be of the male, two conductor type polarized for DC inputs.

b. The power connector **shall** conform to FAA-G-2100G, Section 3.3.1.3.3. Commercial equivalent connectors are acceptable if available.

3.3.5 Remote Maintenance Interface

The Remote Maintenance interface **shall** be a female DB9, RS 232 serial interface.

3.3.6 Local Maintenance Interface

The Local Maintenance interface **shall** be a female DB9, RS 232 serial interface.

3.3.7 Internal GPS RF Connector

The GPS RF connector **shall** be a 50 ohm coaxial type TNC female.

3.4 Construction Requirements

3.4.1 Physical Requirements

3.4.1.1 Reserved

3.4.1.1.1 Workmanship

Workmanship **shall** be in accordance with the requirements of this specification, FAA-G-2100G, and MIL-HDBK-454, Guideline 9.

3.4.1.1.2 Equipment Size

a. The GBT equipment **shall** be constructed to allow for installation into a standard 19 inch equipment rack (EIA 3U).

b. Mounting hole dimensions, spacing, and panel size **shall** be as specified in EIA-310E (old designation EIA-RS-310D).

c. The GBT equipment **shall** not exceed 3 units in height and 19 inches in depth. (1 unit is equal to 1.75 inches).

d. More than one chassis is permissible, however the 3 unit total height limitation still applies.

e. The GBT equipment **shall** not protrude greater than 2 inches from the front mounting plane.

3.4.1.1.3 Equipment Weight

The individual GBT rack mounted equipment chassis weight **shall** not exceed 37 pounds for each unit in accordance with FAA-G-2100G, Section 3.3.6.3, to be lifted by one person.

3.4.1.1.4 Equipment Slides

a. The GBT equipment **shall** allow access to control, monitoring and maintenance activities with the equipment bolted to the FAA standard 19 inch equipment rack.

b. The GBT equipment **shall** include slides that:

1. extend the GBT equipment the full length of the GBT equipment.

2. have end-stops that prevent over-extension,

3. meet FAA-G-2100G, Section 3.1.2.4.3,

4. have the slide component attached to the GBT be separable, without tools, from the slide-component that will be attached to the equipment rack.

3.4.1.1.5 Nameplates

Each GBT equipment or subsystem furnished **shall** have a nameplate mounted on the front of the chassis as specified in FAA-G-2100G, Section 3.3.3.1 and associated Subsections.

3.4.1.1.6 Pin Layout Identification

a. Numbering or lettering on, or immediately adjacent to, the connectors **shall** identify all connector pins.

b. All cable connectors furnished on the equipment for making external connections **shall** be clearly identified on the plug-in side by labels descriptive of their specific function and by the proper reference designation. Non-COTS cable connectors **shall** be mechanically keyed to prevent incorrect installation and hookup. The mating connector part (connector or plug) that is electrically energized **shall** contain female contacts, unless approved by the FAA. All cable connectors **shall** be mechanically retained in place, excluding internal power cables. Connectors **shall** comply with paragraph 3.3.1.3.3 of FAA-G-2100G.

3.4.1.1.7 GBT Installation/Removal

The GBT equipment **shall** be constructed to be installed, removed, and reinstalled with a minimum of common tools and without extensive disassembly.

3.4.1.1.8 GBT Set-Up

The GBT equipment **shall** be initially set up and adjusted under normal operating conditions (see Section 3.4.3.1), following the procedures in the technical instruction book.

3.4.1.1.9 GBT Warm-up

The GBT equipment **shall** meet the requirements of full power operation within 30 seconds of turn on.

3.4.1.1.10 Thermal Protection

a. The GBT equipment **shall** not be damaged by over-temperature/over-heat conditions.

b. The thermal conditions **shall** not cause a reduction in operation when operating within the duty cycle and environmental conditions specified.

3.4.1.1.11 Shock and Vibration Protection

a. Shock and vibration protection **shall** conform to MIL-STD-810, Method 516.5, Procedure VI - Bench Handling.

b. In all cases, no fixed part **shall** become loose.

c. No movable part or permanently set adjustment **shall** shift its setting or position.

d. No degradation in GBT performance **shall** occur under the environmental service and operational conditions specified herein.

3.4.1.1.12 Grounding, Bonding, and Shielding

The GBT equipment grounding, bonding, and shielding protection **shall** be as specified in FAA-STD-020B, Sections 3.8, 3.9, and 3.10, and associated Subsections.

3.4.1.1.13 Lightning Protection

All GBT equipment **shall** be protected from the effects of lightning as specified in FAA Order 6950.19, Chapter 2, Section 6. The subsystem antenna assemblies **shall** be in compliance with NFPA-780, Lightning Protection Code.

3.4.1.1.14 Acoustical Noise Criteria Requirement

Sound pressure and acoustic noise levels generated by the GBT equipment in normal operation **shall** not exceed the limits as specified in FAA-G-2100G, Section 3.3.6.1, Subsection c.

3.4.1.1.15 Materials, Processes, and Parts

a. Selection of materials **shall** be consistent with the requirement of economically producing a system that performs its specified functions with ruggedness and durability for a 20-year operational period.

b. The components **shall** be equal to or better than those components meeting the applicable EIA standards and suitable for the purpose intended.

c. All parts used in the GBT equipment **shall** be operated within their electrical ratings and the environmental requirements of this specification.

d. The materials chosen **shall** be non-nutrient to fungus and insects, non-hygroscopic and not adversely affected by the environmental conditions specified herein.

e. All electrical, electronic or electromechanical parts used in the GBT equipment **shall** be new. Recycled metals or plastics may be used for mechanical or structural parts as appropriate.

3.4.1.1.15.1 Ferrous Materials

Ferrous materials, if used, **shall** be corrosion resisting types.

3.4.1.1.15.2 Arc-Resistant Materials

Arc-resistant materials **shall** be used for insulation of electrical power circuits where arcing is likely to occur.

3.4.1.1.15.3 Dissimilar Metals

Selection and protection of dissimilar metal combinations **shall** be in accordance with FAA-G-2100G, Section 3.3.1.1.1 and MIL-STD-889.

3.4.1.1.15.4 Fibrous Material

Fibrous material **shall** not be used.

3.4.1.1.15.5 Flammable Materials

Flammable materials **shall** not be used without prior FAA approval in accordance with FAA-G-2100G, Section 3.3.1.1.3.

3.4.1.1.16 Antenna Assembly Materials and Finish

All Antenna Assemblies, including all exterior RF wires and waveguides, **shall** utilize materials, coatings and finishes that are inherently resistant to a corrosive environment. The latter includes environments with high salt content (5 percent salt concentration by weight) and/or with industrial pollutants of particulates and sulfur and/or nitrogen oxides at maximum allowable ambient concentrations. Certain materials for any exposed portion(s) of the antenna radiating elements (reference paragraph 3.3.5.6 of FAA-G-2100G) may require written approval of the FAA. All electrical performance requirements of this specification **shall** be met with finish applied.

3.4.1.1.17 Safety

a. A GBT equipment malfunction **shall** in no way contribute to the destruction of the equipment or any part of its environment.

b. Safety **shall** conform to the requirements of FAA-G-2100G, Section 3.3.5 and associated Subsections.

c. Any exposed or accessible area of the GBT equipment that could pose a thermal contact hazard, as defined in the FAA Human Factors Guide, section 12.10.1, **shall** be clearly labeled as a Thermal Contact Hazard.

3.4.1.1.18 Human Performance/Human Engineering

The GBT equipment **shall** conform to the applicable criteria contained in FAA-G-2100G, Section 3.3.6 and the FAA Human Factors Design Guide.

3.4.1.1.19 Removable Parts and Mating Connectors

a. The GBT equipment **shall** permit removal of all modules and printed circuit assemblies without causing damage to the modules, printed circuit assemblies or any other equipment. Mechanical interlocks or keyed elements may be used to disconnect power temporarily from modules or components during removal or insertion. The GBT system **shall** use mechanical means (interlocks or keys) to prevent insertion or connection of plug-in modules that are incorrectly oriented. When redundant modules are incorporated into the GBT equipment, it **shall** be possible to remove any one of the redundant modules without interruption of service. All GBT equipment **shall** meet accessibility requirements defined in section 3.1.2.4 of FAA-G-2100G.

b. When two or more pieces of equipment require interconnection, the necessary mating connectors (except coaxial) **shall** be supplied for both the GBT and associated equipment that interfaces with the GBT in accordance with FAA-G-2100G, Section 3.1.2.1.

3.4.1.2 Controls

3.4.1.2.1 Detents

The controls with an "OFF" position **shall** have a detent or equivalent in the ON position to prevent inadvertent operation.

3.4.1.2.2 Adjustment Range

a. The adjustment range of the GBT equipment operation and maintenance controls **shall** be constructed to preclude damage to the equipment or its subassemblies when adjusted to the limits of the control travel.

b. The range of control **shall** be constructed to reduce the sensitivity and criticality of the adjustment task to the maximum extent possible.

3.4.1.2.3 Power Switches/Power On Indicators

a. The GBT equipment **shall** have a front panel mounted DC power switch.

b. A DC Power On indicator **shall** be located adjacent to the DC Power switch, and be lit when DC Power is applied to the GBT and the DC Power Switch is in the On position.

c. Power switches **shall** be protected from inadvertent action (operation).

3.4.1.2.4 Front Panel Display

a. The GBT equipment front panel **shall** provide three separate visual indicators (e.g., LEDs) for quick-look status.

b. The GBT visual indicators **shall** provide visual indications on the front panel as follows:

1. A red indicator that is lit in the event of a failure or when the GBT is in Failed state.

2. A yellow indicator that is lit in the event of an alert, and flashes in the event of an alarm.

3. A green indicator that is lit when the GBT is in Offline or Online state and flashes when in the Recovery state.

4. The visual indications for failure events, alarm events and alert events **shall** remain until the failure, alarm or alert is cleared by the respective Return to Normal.

5. The visual indicators **shall** be viewable for at least +/- 60 degrees off horizontal or vertical axis and be clearly visible from 10 feet away in a brightly lit room.

3.4.1.2.5 Functions and Labeling

a. Labeling **shall** be permanent, legible, and mounted so that the data are visible to personnel without the need to disassemble the part or adjacent functional or structural parts.

b. Connectors **shall** be identified on the plug-in side by labels that describe their specific functions.

c. All fuse positions **shall** be marked with the rated current capacity, voltage rating, and type of fuse to be used.

d. Delayed action fuses **shall** have the additional designation "SLOW".

e. All fuse markings **shall** be on the insertion side, so as to be visible when replacing fuses.

f. The following functions and corresponding labels **shall** be available on the equipment as specified in Table 3-16:

Table 3-16 GBT Functions and Labeling

Functions	Labeling
DC Power ON/OFF Switch	DC PWR ON/OFF
DC Power ON Indication Light	DC PWR
Alert Indication Light	Amber
Alarm Indication Light	Red
Online/Offline/Recovery Indication Light	ONLINE (on) / OFFLINE (off) /RECOVER (flashing)
RF Transmit Indication Light	RF TRANSMIT
RF Receive Indication Light	RF RECEIVE
Data Transmit Indication Light	DATA TRANSMIT
Data Receive Indication Light	DATA RECEIVE
DC Fuse Holder/Circuit Breaker AMP (TBS)	24 VDC/ (TBS) Amps (Slow*)
DC Input Power Connector	24 +/- 6 VDC
GBT Antenna RF Out Connector	GBT RF
GBT Antenna GPS Connector	GPS ANT
Local Maintenance Interface Connector	LOCAL MAINT INTERFACE
Remote Maintenance Interface Connector	REMOTE MAINT INTERFACE
ADS-B Test Message Output	ADS-B TEST MSG OUT

* If applicable

3.4.1.3 GBT Identification (ID) Numbering

Each GBT **shall** have a permanent, non-changeable and unique identification (ID) number which is marked on the exterior and visually accessible when the GBT is mounted in a standard 19 inch rack.

3.4.2 Electrical Requirements

3.4.2.1 Input Power Requirements

a. The GBT equipment **shall** meet the requirements of this specification with input voltage of 24 VDC (± 6 volts), negative ground.

b. The GBT equipment **shall** operate under varying conditions, such as slow variations of DC line voltage, within the range specified herein.

c. The GBT equipment **shall** operate without degradation of performance and automatically resume normal operation when subjected to partial or complete power interruptions and/or outages of up to 20 ms at a time in accordance with FAA-G-2100G, Section 3.1.1.7.

d. DC voltage input **shall** be from the rear of the GBT equipment, and when practical, be located on the lower right side of the GBT equipment as viewed from the rear.

e. The maximum current limits for the GBT equipment **shall** be 15 amperes for DC power.

f. The GBT equipment **shall** not sustain damage to or alteration of its equipment, nor cause false operation or false output, when DC power is outside its normal limits of operation, including total loss of power. If proper operations cannot be maintained due to power conditions, the GBT system **shall** cease operation. Automated means for startup after such stoppage **shall** be provided.

g. The GBT equipment electrical features **shall** meet the electrical power source requirements of FAA-G-2100G, section 3.1.1 and associated subsections. The power distribution design and implementation **shall** be in accordance with National Electric Code, NFPA-70, and FAA-C-1217F.

*Note: The actual average current values **shall** be supplied by the vendor.*

3.4.2.1.1 Power Cord

a. The equipment **shall** be provided with a removable six-foot, two-conductor DC power cord, matching with the respective connector on the GBT equipment.

b. Power connectors **shall** be compliant with paragraph 3.3.1.3.3.3 of FAA-G-2100G.

3.4.2.2 Reverse Polarity Protection

The GBT equipment **shall** incorporate reverse polarity protection to prevent damage to the GBT equipment if the polarity of the 24 VDC input voltage is reversed.

3.4.2.3 Circuit Protection

a. All GBT equipment input/output circuits **shall** include circuit protection which prevents opens or shorts at the input/output terminals from damaging the equipment.

b. When the short or open is removed, circuit performance **shall** show no sign of performance degradation in accordance with FAA-G-2100G, Section 3.1.1.7.

3.4.2.3.1 Current Overload Protection

a. The GBT equipment **shall** be protected to prevent damage from current overload as specified in FAA-G-2100G paragraph 3.1.1.6 and FAA-STD-020B.

b. Current overload protection for the GBT equipment **shall** be provided by fuses, circuit breakers, or other protective devices for the primary input DC circuit as specified in FAA-G-2100G, Section 3.3.1.3.2, 3.3.1.4.1 and associated Subsections.

3.4.2.3.2 Protective Caps

Protective caps for mating with normally unmated or infrequently used connectors (i.e. test/diagnostic input/output connectors) on the GBT receiver and transmitter **shall** be provided in accordance with FAA-G-2100G, Section 3.3.1.3.3.4.

3.4.2.3.3 Electrostatic Discharge Control

All circuits and components used in the GBT equipment that are susceptible to damage by ESD **shall** be protected as specified in FAA-G-2100G, Section 3.2.7 and FAA-STD-020B, Section 3.12.3.

3.4.2.3.4 Surge Protection

Protective devices **shall** be provided as necessary to prevent damage to the equipment from surges on the DC power line or the signal/communications cables. The devices **shall** withstand repeated surges without damage or change in operating characteristics. The

protective devices **shall** be in accordance with the applicable parts of Paragraphs 3.1 through 3.7 of FAA-STD-020B.

3.4.2.3.5 Transient Protection

a. The GBT equipment **shall** be protected to prevent damage from electrical transients as specified in FAA-G-2100G, section 3.1.1.7, and FAA-STD-020B, section 3.7 and associated subsections.

b. The GBT system **shall** not produce false operational or maintenance signals resulting from intentional operation by operators or maintenance personnel. All GBT equipment **shall** comply with FAA Order 6950.19, Section 6, and paragraph 3.1.1.7 of FAA-G-2100G. All supporting equipment **shall** not provide any false data during operation under the environmental conditions specified in Sections 3.4.2 and 3.4.3, inclusive.

3.4.2.4 Test Points

External test points, if applicable, **shall** be female BNC type connectors.

3.4.2.5 VSWR Protection

The GBT equipment **shall** not sustain permanent damage from infinite VSWR.

3.4.2.6 Loss of Input Voltage

The loss or variance of input voltage, including loss of voltage caused by activation of circuit protector devices, **shall** not cause or induce any damage to any component in the GBT equipment or other interfacing equipment.

3.4.3 Environmental Conditions

The GBT equipment **shall** be constructed of materials to withstand any combination of environmental and service conditions specified below without causing damage or degradation of performance below the requirements of this specification.

3.4.3.1 Operating Conditions

3.4.3.1.1 Indoor Operating Conditions

The GBT equipment **shall** be able to operate in a facility under the operating conditions specified in Table 3-15:

Table 3-15 Indoor Operating Conditions

Temperature Range	-10° C to +50° C (+14°C to +122°F)
Relative Humidity	5 to 90 percent (above 40°C (104°F), the relative humidity is based on the dew point of 40° C)
Altitude	-300 to 15,000 Feet

3.4.3.1.2 Outdoor Operating Conditions

a. Any external components of the GBT equipment **shall** be weather resistant and accessible for repair considering human factors criteria in accordance with FAA Human Factors Guide, Section 12.10.1.

b. Any vendor-provided GBT equipment located outdoors, such as GPS antenna, **shall** operate in environmental conditions as defined in FAA-G-2100G Standards, Section 3.2.1.1.2. An exception to the environment is that the lower end of the temperature range **shall** be as defined in MIL-STD-810F, Table CE, for the entire set of conditions defined as SEVERE COLD (i.e. at -51° C (-60° F)). The equipment **shall** survive without deformation hailstones up to 0.5 inches in diameter during the environmental conditions defined. Exceptions to these standards will be identified and are subject to FAA approval.

3.4.3.2 Non-Operating Conditions

Non-operating conditions for the GBT equipment are those conditions affecting equipment in storage, in shipment, in the process of being installed at a site, and installed at a site but non-operating. The GBT equipment **shall** meet the requirements for a non-operating conditions in Table 3-16:

Table 3-16 Non-Operating Conditions

Temperature Range	-40° C to +70° C (-40° F to +158°F)
Relative Humidity	Up to 100 percent including condensation due to temperature changes
Altitude	-300 to 50,000 Feet

3.4.3.3 Equipment Ventilation and Cooling

a. The GBT front panel **shall** not present a thermal contact hazard to personnel in accordance with FAA Human Factors Guide, Section 12.10.1.

b. The GBT **shall** not require a ventilating or cooling fan.

3.4.4 Electromagnetic Compatibility Requirements

a. Electromagnetic emission and susceptibility of the GBT equipment **shall** not exceed the limits in MIL-STD-461 requirements CE-102, CE106, CS-101, CS-114, CS-115, CS-116, RE-102, RE103, RS101 and RS-103. Where conflict exists between “Ground Navy Procurement”, “Ground Air Force Procurement”, and “Ground Army Procurement”, the “Ground Navy Procurement” takes precedence (MIL-STD-461, Table V).

b. The materials used for GBT equipment shielding **shall** be in compliance with the requirements of FAA-STD-020B, Section 3.10.

3.5 Quality Factors

3.5.1 Reliability

3.5.1.1 Mean Time Between Failures

The predicted Mean Time Between Failures (MTBF) for the GBT equipment **shall** be not less than 26,280 hours (3 years).

3.5.2 Maintainability

a. The GBT equipment **shall** provide parameter adjustments for routine maintenance.

b. The GBT equipment **shall** consist of the following minimum LRUs by approximate functional boundary as indicated below:

-RF Transceiver
-GPS Sensor
-Perishable items (e.g. lithium batteries)
-All other functionality

3.5.2.1 Mean Time To Repair

The Mean Time To Repair (MTTR) of the GBT equipment **shall** not be greater than 30 minutes at the site (LRU Replacement).

3.5.2.2 Periodic Maintenance

a. The GBT equipment **shall** be configured so that periodic maintenance can be performed without disrupting other GBTs that are on-line.

b. Periodic maintenance intervals **shall** meet or exceed one year.

3.5.3 Service Life

The GBT equipment **shall** have a minimum useful service life of 20 years.

3.6 Flexibility and future services and capabilities

The GBT specified within the document does not represent the desired end-state GBT. Certain features and capabilities could not be specified at the time of writing of the specification because standards did not exist at the time or the capability was not yet mature enough, and/or cost and schedule constraints demanded that the capabilities be delayed to later builds.

3.6.1 Flexibility

It is desired that the GBT be designed taking into account the future services and capabilities listed in section 3.6.2 so the GBT does not require a later major redesign and replacement after they are initially fielded. The GBT **shall** employ a modular hardware and software design that allows these future services and capabilities to be incorporated into it with minimal effort and cost.

3.6.2 Future Services, capabilities, and changes

Future services and capabilities may include but are not limited to the following:

1. The incorporation of an additional data link receiver(s)/transceiver(s) including but not limited to 1090. Each data link receiver/transceiver should have separate data, RF, and maintenance ports. Each data link receiver/transceiver should be its own LRU .

2. Changes to the ADS-B and TIS-B definition, standards, and formats. Because ADS-B and especially TIS-B are still new evolving concepts, it is likely that changes to these concepts will occur.

3. The incorporation of a shared external timing source, rather than an internal timing source within the GBT, may be adopted.

4. RMM capabilities are likely to change and evolve as the FAA's national RMM system evolves.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Responsibility For Inspection

Not applicable

4.2 Special Tests And Examinations

Not Applicable

4.3 Requirement Cross Reference

The Contractor Verification Requirement Traceability Matrix provides a mapping of requirement "**shall**s". [this specification FAA # to be assigned]

4.4 Qualification Test Requirements

4.4.1 Test Planning/Procedures

The test and evaluation process will be used to ensure that the contractor has met and implemented the requirements of the Traceability Matrix [this specification FAA # to be assigned]. The contractor will perform the requirement verification in accordance with the contract SOW.

4.4.2 Test Phases and Levels

The GBT test efforts will consist of five distinct test phases:

a. Contractor-conducted Development Test (DT) and Factory Acceptance Test (FAT).

b. Contractor-conducted Production Acceptance Test (PAT).

c. Contractor-conducted Site Acceptance Test (SAT) (includes KEYSITE ACCEPTANCE TEST & SITE ACCEPTANCE TEST).

d. Government - conducted Operational Test (OT).

e. Government - conducted Independent Operational Test & Evaluation (IOT&E).

4.4.2.1 Development Test and Factory Acceptance Test Phase

Development Test (DT) and Factory Acceptance Test (FAT) are to demonstrate that all technical and performance requirements specified in the contract have been met. DT and FAT will be conducted according to Government-approved DT and FAT plans, procedures, and reports. DT and FAT will be performed by the contractor and witnessed by Government representatives at the factory. DT begins with a series of hardware and software tests. Hardware tests begin at the board level or component level and proceed to the system level. The hardware tests verify achievement of requirements relating to such factors as timing, leakage current, thermal stress, and electromagnetic interference. Software testing begins by verifying the most detailed requirements at the unit level and proceeds to verifying higher-level integrated requirements at the segment level and, finally, to verifying requirements at the Computer Software Configuration Item (CSCI) level. DT concludes with a design qualification test that demonstrates the system's ability to satisfy the system specification. Factory acceptance is contingent on successful completion of the design qualification tests. If necessary, DT may be continued at the WJHTC in an environment that more closely replicates the actual field environment, i.e., real versus simulated interfaces. DT and FAT verify that the full GBT configuration items meet contract requirements.

4.4.2.2 Production Acceptance Test Phase

Production Acceptance Test (PAT) is a contractor-conducted test. PAT will be conducted at the contractor's facility. All PAT testing will be conducted according to Government-approved test plans, test procedures, and test reports. PAT will be conducted by the contractor and witnessed by an authorized Government representative(s). PAT testing will be the basis for determining compliance to all applicable specifications, is free from manufacturing defects, and is identical to the qualified hardware.

4.4.2.3 Site Acceptance Test Phase

Site Acceptance Test (SAT) is a contractor-conducted test. SAT will be conducted at the FAA Key Site(s) and at each site where the contractor performs the installation of a GBT. All SAT testing will be conducted according to Government-approved test plans, test procedures, and test reports. SAT will be conducted by the contractor and witnessed by an authorized Government representative(s). SAT testing will be the basis for determining compliance of the GBT at each site. SAT testing will address site unique configuration and capabilities.

4.4.2.4 Operational Test

Operational Test (OT) is a Government-conducted test. It will be conducted at the William J. Hughes Technical Center (WJHTC), Atlantic City, NJ. OT will evaluate the degree to which the GBT product accomplishes its mission when used by representative personnel in the expected operational environment. Effectiveness and suitability testing and evaluation may be continued at the Key Site(s) if a complete assessment cannot be accomplished at the WJHTC. There are a number of prerequisites to the conduct of OT which may include: successful completion of FAT, a GBT configured baseline, approved

technical documentation and completion of System Test and Evaluation training for Government representative(s).

4.4.2.5 Independent Operational Test and Evaluation (IOT&E)

Independent Operational Test and Evaluation (IOT&E) is a Government-conducted test. IOT&E is a full system level evaluation conducted in a realistic operational environment to confirm the operational readiness of the GBT system to be part of the NAS.

4.5 Qualification/Verification Methods

The GBT will undergo test and evaluation to verify that the GBT meets specification requirements. The verification methods noted below will be mandatory for GBT requirement verification.

4.5.1 Inspection

Inspection of GBT will include verifying physical characteristics to determine compliance with requirements without the use of special laboratory equipment, procedures, items or services. Inspection will verify workmanship, physical condition, construction features, and document/drawing compliance. All tests are non-destructive, static-state examinations of the hardware, the technical data and documentation.

4.5.2 Test

The GBT testing will measure hardware performance during or after the controlled application of functional stimuli. Measurements require the use of laboratory equipment, procedures, items, and/or services. Quantitative measurements are analyzed to determine the degree of compliance.

4.5.3 Demonstration

Demonstration verification method is used to indicate a general “pass/fail” condition. The items being verified are observed but not quantitatively measured in a dynamic state. This method may use technical data and documentation to determine the qualitative properties of the item being tested. This method does not require special test equipment or instruction to vary characteristics such as operational performance, human engineering features, and service, access features, or transportability.

4.5.4 Analysis

The GBT analysis will encompass any or all of the following:

a. Engineering analysis is usually an engineering design function involving study, calculations, or modeling of the known or potential failure modes, and reaction or interactions of the specified parts, materials, and the design configuration with the known function, performance and/or probable effects of the operational environments. This analysis is normally used to verify margin when it is not desirable to test to failure.

b. Similarity analysis is a method applied to end items or components that are identical in design and manufacturing processes to end items or components that have been previously qualified to equivalent or more stringent requirements.

c. Validation of records analysis is a method of verification wherein manufacturing records are used to verify compliance of concealed construction features or processes of manufacturing (e.g. vendor items).

4.6 Tests

4.6.1 Electromagnetic Compatibility Tests

The GBT equipment EMC compatibility will be carried out in accordance with the conditions specified in Section 3.4.4.

4.7 Verification Methods

Verification methods will be utilized in measuring equipment performance and compliance of individual requirements contained in this specification. The four verification methods, TEST, DEMONSTRATION, ANALYSIS, and INSPECTION, listed in decreasing order of complexity, are described as follows:

1. TEST. Test is a method of verification wherein performance is measured during or after the controlled application of functional and/or environ-mental stimuli. Quantitative measurements are analyzed to determine the degree of compliance. The process uses laboratory equipment, procedures, items, and services.

2. DEMONSTRATION. Demonstration is a method of verification where qualitative determination of properties is made for an end item, including the use of technical data and documentation. The items being verified are observed, but not quantitatively measured, in a dynamic state.

3. ANALYSIS. Analysis is a method of verification that consists of comparing hardware design with known scientific and technical principles, procedures and practices to estimate the capability of the proposed design to meet the mission and system requirements.

4. INSPECTION. Inspection is a method of verification to determine compliance without the use of special laboratory appliances, procedures, or services, and consists of a non-destructive static-state examination of the hardware, the technical data and documentation.

5.0 DEFINITIONS

5.1 Notes on Information Items

The contents of this Section are for informational purposes only and are not a part of the requirements of this specification. They are not contract requirements nor binding on either the Government or the Contractor. In order for these terms to become a part of the resulting contract, they must be specifically incorporated in the schedule of the contract. Any reliance placed by the Contractor on the information in these Subsections is wholly at the Contractor's own risk.

5.2 Applicable Definitions

5.2.1 Mean Time Between Failures (MTBF)

A basic measure of reliability for LRUs is the sum of the operating time for the failed LRUs divided by the number of failures.

5.2.2 Mean Time To Repair (MTTR)

A basic measure of maintainability: the sum of corrective maintenance times at any specific level of repair, divided by the total number of failures within an item repaired at that level, during a particular interval under stated conditions.

5.2.3 Mean Time To Repair Maximum

The maximum time taken to repair a unit, at a depot level work station, to return it to an operational state.

5.2.4 Duty Cycle

Duty cycle is defined as the percentage of time that the transmitter is keyed in proportion to total service time.

5.2.5 Modular Construction

Equipment constructed so all subassemblies are modules that plug into the main chassis.

5.2.6 Line Replaceable Unit (LRU)

An item which may consist of a unit, an assembly (circuit card assembly, electronic component assembly, etc.), a subassembly, or a part, that is removed and replaced at the site maintenance level in order to restore the system/equipment to operational status.

5.2.7 Initialization

Initialization (also cold start) occurs when (a) the GBT equipment is first turned on when delivered from the factory, and (b) when the GBT receives the Reset command with Value of Factory Reset. A result of initialization is that all control parameters return to their default values.

5.2.8 Restoral

Restoral (also warm start) occurs when the power is returned to the GBT equipment under all conditions other than initialization. As a result of restoral function all configuration items are automatically restored to the values that were in effect in the operational state before the restoral stimulus occurs.

5.2.9 GBT State Definitions

- OFF GBT does not receive power sufficient for GBT operation.

- POWER UP The state the GBT is in during the time between power restoral, power turn on or Operator commanded Reset, and the GBT is:

a) entering Online or Offline, or
b) entering Failed state after detecting a non-recoverable failure, or
c) entering Failed state after detecting that the GBT was in Failed state immediately prior to most recent power down or power loss, or
d) entering Recovery state after detecting a potentially recoverable failure. The GBT will conduct initial self testing (e.g. BIT or POST) during the Power Up state.

- OFFLINE The non-operational state the GBT assumes during a Control Session invoked by the maintenance technician. The GBT will conduct background built-in testing to verify GBT health.

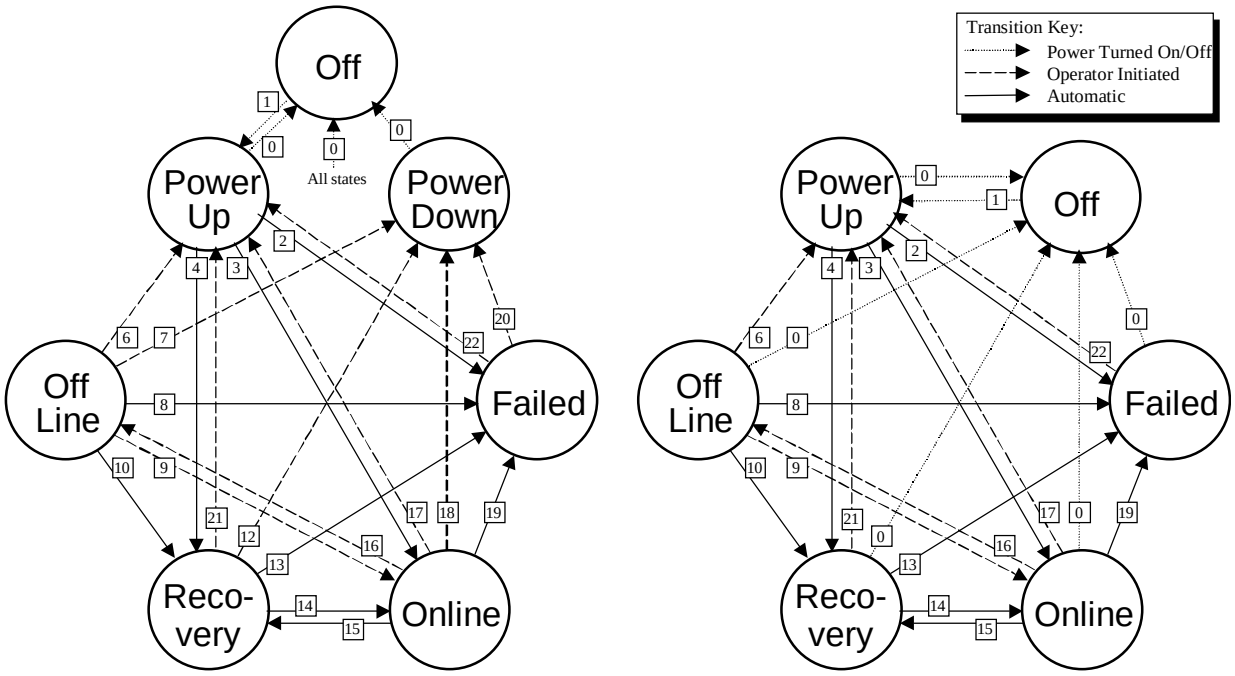
- ONLINE The operational state in which the GBT meets all operational requirements and all functions are enabled except most control commands. The GBT will conduct background built-in testing to verify GBT health.

- RECOVERY A non-operational state entered after the GBT detects a potentially recoverable error, in which only certain monitor and control functions are enabled.

- FAILED The non-operational state the GBT enters after a non-recoverable failure has been detected or the Recovery process has failed. During Failed state, only those monitor and control functions that can be performed accurately, despite the failure are enabled.

- POWER DOWN The state the GBT enters after an Operator-commanded Shutdown, but before the power is removed. All GBT functions, except those required to complete the Power Down process, are disabled.

Note: This is an optional state that a vendor's implementation may require. If the vendor's implementation includes a power down sequence other than removing power (i.e. that takes any time), the Power Down state requirements apply.



Power Down State present

No Power Down State

Figure 5-1 GBT State Diagram

Table 5-1 State Transition Table

Transition	From State	To State	Auto/Manual	Description (Condition for Transition)
0	Any	Off	M/(A)	Whenever power is turned off (or lost)
1	Off	Power Up	M/(A)	Whenever power is turned on (or restored)
2	Power Up	Failed	A	When Power Up sequence fails or Failed State entered before last Power Down/Off
3	Power Up	Online	A	a) successful completion of Power Up sequence, and b) State before Power Down/Off was Offline
4	Power Up	Recovery	A	Power Up sequence completed but recoverable error detected
5 (reserved)				
6	Offline	Power Up	M	Operator commanded Reset
7	Offline	Power Down	M	Local operator initiates power-down
8	Offline	Failed	A	GBT detects unrecoverable error (e.g., POST, BIT, etc.)
9	Offline	Online	M	Operator commands Online mode
10	Offline	Recovery	A	Potentially recoverable error detected while Offline
11 (reserved)				
12	Recovery	Power Down	M	Local Operator initiates power down
13	Recovery	Failed	A	Recovery sequence unsuccessful
14	Recovery	Online	A	a) Recovery sequence successful and b) Previous state was Online
15	Online	Recovery	A	Potentially recoverable error detected while Online
16	Online	Offline	M	Maintenance technician initiates Control Session via maintenance interface
17	Online	Power Up	M	Operator commanded Reset
18	Online	Power Down	M	Local Operator initiates power-down
19	Online	Failed	A	GBT detects unrecoverable error (e.g., POST, BIT, etc.)
20	Failed	Power Down	M	Local Operator initiates power-down
21	Recovery	Power Up	M	Operator commanded Reset
22	Failed	Power Up	M	Operator commanded Reset

5.2.9.1 Non-Volatile Memory

The GBT memory storage will retain data for the life of the equipment.

5.2.10 Equipment Failures

Equipment failure is classified into non-critical failure and critical failure.

5.2.10.1 Non-critical Equipment Failure

Non-critical equipment failures are failures of the GBT that will not affect the operations of the GBT, e.g., front panel display and power indicator failures.

5.2.10.2 Critical Equipment Failure

Critical equipment failures are failures of the GBT that will either disrupt the operational traffic flow or that will result in loss of capabilities and functions required for continued safe operation of the GBT. Examples of the former include failure to the power amplifier

in the transmitter, failure to the RF front end in the receiver, and failure to the power supply subsystem of the GBT. Examples of the latter include failures of the control or monitoring capabilities in the MMC system.

5.2.11 GBT RF Output

The transmitter connector to which the antenna would be connected in a particular configuration.

5.2.12 GBT RF Input

The receiver connector to which the antenna would be connected in a particular configuration.

5.2.13 Message

A broadcast transmission containing a payload of user information and overhead coding that supports the transfer of data.

6.0 ACRONYMS

A/G	Air-Ground
AC	Alternating Current
ACAC	Area Command Aviation Coordinator
ACK	Acknowledgment
ADS-B	Automatic Dependent Surveillance, Broadcast
AF	Airway Facilities
AGC	Automatic Gain Control
AM	Amplitude Modulation
AM(R)S	Aeronautical Mobile (Route) Services
AMP	Ampere(s)
ANSI	American National Standards Institute
APDU	Application Protocol Data Unit
ARTCC	Air Route Traffic Control Center
ASTERIX	All Purpose Structured Eurocontrol suRveillance Information Exchange
ASTM	American Society of Testing and Materials
ATC	Air Traffic Control
ATCRBS	ATC Radar Beacon System
ATM	Air Traffic Management
ATN	Aeronautical Telecommunications Network
BER	Bit Error Rate
BIT	Built in Test
BSDU	Broadcast Services Data Unit
C	Centigrade
CAT	Category
CDTI	Cockpit Display of Traffic Information
CFIT	Controlled Flight into Terrain
CFR	Code of Federal Regulations
CNS	Communications, Navigation, and Surveillance
COTS	Commercial Off The Shelf
CRC	Cyclic Redundancy Check
CW	Continuous Wave
D-burst	Data Burst
D8PSK	Differential 8 Phase Shift Keying
dB	Decibel
dBc	Decibels referenced to carrier
dBi	Decibels referenced to isotropic
dBm	Decibels referenced to 1 milliwatt
DC	Direct Current
DLS	Data Link Service
DME	Distance Measuring Equipment
DOT	Department of Transportation
DSB-AM	Double Side-Band Amplitude Modulation
DSRCE	Down Scoped Radio Control Equipment
EIA	Electronic Industries Alliance
EMC	Electromagnetic Compatibility
EPU	Estimated Position Uncertainty
ERP	Effective Radiated Power
ESD	Electrostatic Discharge
ETSI	European Telecommunications standards Institute

EVM	Error Vector Magnitude
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FEC	Forward Error Correction
FIR	Finite Duration Impedance Response (filter)
FIS-B	Flight Information Services, Broadcast
FM	Frequency Modulation
FRN	Field Reference Number [ASTERIX]
Freq	Frequency
FSPEC	Field Specification [ASTERIX]
FX	Field Extension Indicator [ASTERIX]
GBT	Ground Based Transceiver
GME	Global Management Entity
GNI	Ground Network Interface
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HAE	Height Above ellipsoid
Hz	Hertz
HD	Header
HDLC	High Level Data Link Control
HFOM	Horizontal Figure of Merit
HPL	Horizontal Protection Limit
ICAO	International Civil Aviation Organization
ICD	Interface Control Document
ID	Identification
IEC	International Engineering Consortium
IEEE	Institute of Electrical and Electronic Engineers
IP	Internet Protocol
ISO	International Standards Organization
Kbps	Kilo Bytes Per Second
kHz	kilohertz
km	kilometer
LAAS	Local Area Augmentation System
LAN	Local Area Network
LBAC	Logical Burst Access Channel
LED	Light Emitting Diodes
LEN	Length
LRU	Line Replaceable Unit
LSB	Least Significant Bit
M	Meter
mA	milliampere
MAC	Media Access Control
MASPS	Minimum Aviation System Performance Standards
Mbps	Mega-Bytes Per second
MDT	Maintenance Data Terminal
MEARTS	Micro-Enroute Automated Radar Tracking System
METAR	Meteorological Aviation Report
MHz	Megahertz
MMC	Maintenance Management Center
MOPS	Minimum Operational Performance Standards
ms	milliseconds
MSB	Most Significant Bit
MSO	Message Start Opportunity
MTBF	Mean Time Between Failures

MTTR	Mean Time To Repair
N/A	Not Applicable
NACp	Navigation Accuracy Category for Position
NACv	Navigation Accuracy Category for Velocity
NAS	National Airspace System
NEMA	National Electrical Manufacturers Association
NEXRAD	Next Generation Weather Radar
NFPA	National Fire Protection Association
NIC	Navigation Integrity Category
NIMS	NAS Infrastructure Management System
NIST	National Institute of Standards and Technology
NOTAM	Notice To Airmen
nm	nautical mile
nsec	nanosecond
NTIA	National Telecommunications and Information Administration
OEM	Original Equipment Manufacturer
OSI	Open System Interconnection
PC	Personal Computer
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
POST	Power-up Operational Self Test
PPM	parts per million
PPS	Pulse(s) Per Second
PWR	Power
RAM	Random Access Memory
RCAG	Remote Center Air/Ground
RCE	Remote Control Equipment
RCO	Remote Communications Outlet
RD	Ramp-down
Ref	Reference
RF	Radio Frequency
RIU	Remote Interface Unit
RMM	Remote Maintenance Monitoring
RMMC	Remote Maintenance Monitoring Control
RMS	Remote Monitoring Subsystem
RNP	Required Navigational Performance
RTCA	RTCA, Inc. (formerly Radio Technical Commission for Aeronautics)
RTN	Return to Normal
RTR	Remote Transmitter Receiver
RU	Ramp-up and Power Stabilization
Rx	Receiver
SA	Selective Availability
SAC	System Area Code
SDU	Session Layer Data Unit
SIC	System Identification Code
SIL	Surveillance Integrity Level
SINAD	Ratio of Signal plus Noise plus Distortion to Noise plus Distortion
SMR	Successful Message Reception
SNAcP	Sub-Network Access Protocol
SOC	System Operations Centers
SRD	System Requirements Document
SRS	Software Requirements Document
SSR	Secondary Surveillance Radar
SSS	Sub-System Specification

SUA	Special User Airspace
TACAN	Tactical Air Navigation
TBD	To Be Determined
TBS	To Be Selected
TCAS	Traffic Alert and Collision Avoidance System
TCP	Transmission Control Protocol
TCS	Tower Communications System
TDMA	Time Division Multiple Access
TAF	Terminal Area Forecast
TFOM	Time Figure of Merit
THD	Total Harmonic Distortion
TIS-B	Traffic Information Services, Broadcast
TOA	Time of Arrival
TOMR	Time Of Message Receipt
TOT	Time of Transmission
TRP	Timing Reference Point
TTL	Transistor-transistor logic
Tx	Transmitter
UAP	User Application Profile
UAT	Universal Access Transceiver
UDP	User Datagram Protocol
UHF	Ultra High Frequency
UTC	Universal Coordinated Time
VA	Volt Ampere
VAC	Volts Alternating Current
VDC	Volts Direct Current
VDL	VHF Digital Link
VFOM	Vertical Figure of Merit
VHF	Very High Frequency
V	Volt
VPL	Vertical Protection Limit
VRTM	Verification Requirements Traceability Matrix
VSWR	Voltage Standing Wave Ratio
W	Watt
WAAS	Wide Area Augmentation System

APPENDIX A

ASTERIX CAT 033 (12 NOV 2002)

A.1 General

The format for target reports is based on the ASTERIX message standard adopted by Eurocontrol for surveillance data exchange. For background information on the ASTERIX structure and encoding see the document entitled, "Eurocontrol Standard Document for Surveillance Data Exchange, Part 1, ASTERIX," SUR.ET1.ST05.2000-STD-01-01, November 1997. This document is available at http://www.eurocontrol.be/projects/eatchip/asterix.

A User Application Profile (UAP) is a mechanism for assigning Data Item to Data Fields of ASTERIX messages and containing all necessary information which needs to be standardized for the successful encoding and decoding of the messages. An ASTERIX Data Category (CAT) is defined by a set of Data Items that could be included in valid messages of that category. The ASTERIX Data Category for Target Reports To/From the GBT has been given the assignment "033". This value, which is normally the first Data Item in a Data Block, is also interpreted to be the BSDU ID field (Section 3.2).

The Field Reference Number (FRN) establishes the order of the items in the FSPEC, and along with the Category code serves to uniquely identify each data item. In order to maximize compatibility with future versions of this category, these data items will retain the same FRN and order in the FSPEC while new items may be added onto the end of the FSPEC.

A.2 Target Report Construction Example

time →

FSPEC	FRN 1 Version Number	FRN 2 Data Source ID	FRN 3 Data Link Indicator	FRN 4 Time of Applicab-ility	FRN 5 Target Addreess	FRN 6 Integrity and Accuracy Params	FRN 7 Latitude/ Longitude	FRN 8 Pressure Altitude	FRN 10 Velocity (Surface)

F1	F2	F3	F4	F5	F6	F7	FX	F8	F9	F10	F11	F12	F13	F14	FX
1	1	1	1	1	1	1	1	1	0	1	0	0	0	0	0

1. *Within each Data Item, Byte 1 is transmitted first*
2. *"FX" is the Field Extension bit. A ONE in this bit indicates the field extends into the next byte.*

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ASTERIX CAT 033 (12 NOV 2002)

A.3 User Application Profile and Construction for Cat 033 Target Reports

Table A-1. Cat 033 (V 1) User Application Profile and Construction

FRN	Data Item	Length in Bytes (when present)
1	Version Number	1
2	Data Source Identifier	2
3	Link Technology Indicator	1
4	Time of Applicability	3
5	Target Address	4
6	Integrity and Accuracy Parameters	2
7	Latitude/Longitude	6
8	Pressure Altitude	2
9	Velocity (Airborne)	5
10	Velocity (Surface)	3
11	Mode 3/A Code	2
12	Target Identification	6
13	Emitter Category	1
14	Target Status	1
15	Geometric Altitude	2
16	*Reserved for Future Definition*	N/A
17	Time of Message Transmission	4
18	Time of Message Reception	4
19	*Reserved for Future Definition*	N/A
20	*Reserved for Future Definition*	N/A
21	*Reserved for Future Definition*	N/A
22	*Reserved for Future Definition*	N/A

Note: Systems receiving Cat 033 reports must parse the FSPEC for proper decoding since some Data Items are optional in any given report.

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A.4 Format and Encoding of Cat 033 (V 1.0) Data Items

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ASTERIX CAT 033 (12 NOV 2002)

FRN 1: Version Number

Definition: Version of this Cat 033 format.
Structure: One byte fixed length data item.

Byte 1							
8	7	6	5	4	3	2	1
Spare bit	Spare bit	Version Status	Msb Version Number Lsb				

Encoding:

Bits 8/7: Spare bits set to ZERO
Bit 6: ZERO=Version for operational use; ONE=Version is for experimental use only
Bits 5/1: Cat 033 version number encoded as binary numeral in the range of 1 to 31 (Value of ZERO represents "unknown" version regardless of "Version Status"

Category 33 messages conforming to this document shall be encoded with the value ONE in the Version Number field (Bits 5/1).

Notes:

1. This provides an upgrade path for evolution of this Category without incrementing the Category number modulo 32.

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ASTERIX CAT 033 (12 NOV 2002)

FRN 2: Data Source Identifier

Definition: Identification of the system supplying surveillance data.
Structure: Two byte fixed length data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Msb							Lsb	Msb							Lsb
--SAC--								--SIC--							

Encoding:

Bits 16/9: (SAC) System Area Code (0 → 255)
Bits 8/1: (SIC) System Identification Code (0 → 255)

Notes:

1. The SAC is used to identify regions of the world.
2. The SIC is used to identify individual systems (e.g., ADS-B receiver or TIS-B transmitter, radar/beacon sensor, multisensor fusion processor, etc).

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ASTERIX CAT 033 (12 NOV 2002)

FRN 3: Link Technology Indicator

Definition: Used to specify the data link or link(s) to which the Target Report is applicable.
Structure: One byte fixed length data item.

Byte 1							
8	7	6	5	4	3	2	1
Spare Bits				1090 ES	UAT	VDL4	Other

Encoding:

Bits 8/5	spare bits set to ZERO
Bit 4	1090 ES (ZERO=not used, ONE=used)
Bit 3	UAT (ZERO=not used, ONE=used)
Bit 2	VDL4 (ZERO=not used, ONE=used)
Bit 1	Other data link (ZERO=not used, ONE=used)

Notes**:**

The information conveyed in this data item supports the case where a multilink-capable transceiver is operating with a single SAC/SIC code allocation.

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FRN 4: Time of Applicability

Definition: Time at which the target position and velocity information was recorded.
Structure: Three byte fixed data item.

Byte 1							
24	23	22	21	20	19	18	17
Msb --Time of Applicability--							

Byte 2								Byte 3							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Time of Applicability--															Lsb

Encoding:

Bits 24/8	whole seconds elapsed since UTC midnight binary encoded
Bits 7/1	fractional seconds elapsed since UTC midnight binary encoded

Notes:

1. The time of the day value is reset to 0 at every midnight. The time of the day is specified in UTC.
2. The Lsb represents 1/128 of a second.

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FRN 5: Target Address

Definition: Identifies a target through a 24 bit address associated with the target plus 4 bits of address qualifier.
Structure: Four byte fixed length data item.

Byte 1								Byte 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Spare bits					Address Qualifier			Msb --24 bit Address--							
Byte 3								Byte 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--24-bit Address--															Lsb

Encoding:

Bits 32/28: spare bits always set to ZERO

Bits 27/25:

ADDRESS QUALIFIER

Address Qualifier (binary)				***Address Type***
Bit 27	*Bit 26*	*Bit 25*		
0	*0*	*0*		*ADS-B target with ICAO 24-bit address*
0	*0*	*1*		*ADS-B target with self-assigned temporary address*
0	*1*	*0*		*TIS-B target with ICAO 24-bit address*
0	*1*	*1*		*TIS-B target with track file identifier*
1	*0*	*0*		*Surface Vehicle*
1	*0*	*1*		*Fixed ADS-B Beacon*
1	*1*	*0*		*(Reserved)*
1	*1*	*1*		*(Reserved)*

Bits 24/1: 24 bit Address

Notes:

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FRN 6: Integrity and Accuracy Parameters (Page 1 of 3)

Definition: This data item conveys the accuracy and integrity parameters reported by the ADS-B target.
Structure: Two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
UTC	Msb --NIC--			Lsb	--SIL--				Msb --NACp--			Lsb	Pos Est	Vel Est	Spare bit

Encoding:

Bit 16: ONE = ADS-B message payload indicates the "UTC coupled" condition
ZERO = ADS-B message payload indicates the "non-UTC coupled" condition

Bits 15/12: Navigation Integrity Categories (NIC)

The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported position has an acceptable level of integrity for the intended use. The value of the NIC parameter specifies an integrity containment radius, R_C.

NIC bits Msb Lsb	**Horizontal and Vertical Containment Bounds**	**Comment**
0000	$R_C \geq 37.04$ km (20 NM)	Unknown Integrity
0001	$R_C < 37.04$ km (20 NM)	RNP-10 containment radius
0010	$R_C < 14.816$ km (8 NM)	RNP-4 containment radius
0011	$R_C < 7.408$ km (4 NM)	RNP-2 containment radius
0100	$R_C < 3.704$ km (2 NM)	RNP-1 containment radius
0101	$R_C < 1852$ m (1 NM)	RNP-0.5 containment radius
0110	$R_C < 1111.2$ m (0.6 NM)	RNP-0.3 containment radius
0111	$R_C < 370.4$ m (0.2 NM)	RNP-0.1 containment radius
1000	$R_C < 185.2$ m (0.1 NM)	RNP-0.05 containment radius
1001	$R_C < 75$ m and VPL < 112m	e.g., WAAS HPL, VPL
1010	$R_C < 25$ m and VPL < 37.5m	e.g., WAAS HPL, VPL
1011	$R_C < 7.5$ m and VPL < 11m	e.g., LAAS HPL, VPL

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FRN 6: Integrity and Accuracy Parameters (Page 2 of 3)

Bits 11/9: Surveillance Integrity Levels (SIL)

The value of the SIL parameter specifies the probability of the true position lying outside the NIC-specified containment radius, R_C, without alerting, including the effects of the airborne equipment condition, which airborne equipment is in use, and which external signals are used. SIL is a static (unchanging) value that depends on the position sensor being used on the aircraft.

SIL Bits			**Probability of Unknowingly Exceeding the R_C Integrity Containment Radius**
Bit 11	Bit 10	Bit 9	
0	x	x	SIL Not Available in this Reporting Interval
1	0	0	SIL Reported as Unknown
1	0	1	1×10^{-3} per flight hour or per operation
1	1	0	1×10^{-5} per flight hour or per operation
1	1	1	1×10^{-7} per flight hour or per operation

Bits 8/4: Navigation Accuracy Categories for Position (NACp)

The Navigation Accuracy Category for Position (NACp) is reported so that surveillance applications may determine whether the reported position has an acceptable level of accuracy for the intended use. The Estimated Position Uncertainty (EPU) is a 95% accuracy bound on horizontal position. EPU is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position being outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit). Likewise, Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position. VEPU is defined as a vertical position limit, such that the probability of the actual vertical position differing from the reported vertical position by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).

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FRN 6: Integrity and Accuracy Parameters (Page 3 of 3)

NACp Bits		95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)	Comment
Bit 8	Bits 7-4 Msb Lsb		
0	xxxx	NACp not available in this reporting interval	
1	0000	EPU ≥ 18.52 km (10 NM)	
1	0001	EPU < 18.52 km (10 NM)	RNP-10 accuracy
1	0010	EPU < 7.408 km (4 NM)	RNP-4 accuracy
1	0011	EPU < 3.704 km (2 NM)	RNP-2 accuracy
1	0100	EPU < 1852 m (1NM)	RNP-1 accuracy
1	0101	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy
1	0110	EPU <555.6 m (0.3 NM)	RNP-0.3 accuracy
1	0111	EPU < 185.2 m (0.1 NM)	RNP-0.1 accuracy
1	1000	EPU <92.6 m (0.05 NM)	e.g., GPS (with SA)
1	1001	EPU < 30 m and VEPU < 45 m	e.g., GPS (SA off)
1	1010	EPU < 10 m and VEPU < 15 m	e.g., WAAS
1	1011	EPU < 3 m and VEPU < 4 m	e.g., LAAS

Bit 3: Position Estimated: Set to ZERO when position reported is measured data; set to ONE when position data reported is estimated data

Bit 2: Velocity Estimated: Set to ZERO when velocity reported is measured data; set to ONE when velocity reported is estimated data

Bit 1 Spare bit always be set to ZERO

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FRN 7: Latitude and Longitude (page 1 of 2)

Definition: Target latitude and longitude position.
Structure: Fixed 6 byte data item.

Byte 1								Byte 2							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Msb --Latitude--															
Byte 3								Byte 4							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
--Latitude-- Lsb								Msb --Longitude--							
Byte 5								Byte 6							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Longitude--															Lsb

Encoding:

Bits 48/1: Latitude and Longitude

LATITUDE AND LONGITUDE

Quadrant	**Latitude or Longitude bits**	**Meaning** $INCR = Lsb = \frac{360}{2^{24}} = 0.00002146\ °$	
	Msb Lsb	**Latitude**	**Longitude**
1st quadrant	0000 0000 0000 0000 0000 0000	ZERO degrees (Equator)	ZERO degrees (Prime Meridian)
	0000 0000 0000 0000 0000 0001	*INCR* degrees North	*INCR* degrees East
	…	**…**	**…**
	0011 1111 1111 1111 1111 1111	(90-*INCR*) degrees North	(90-*INCR*) degrees East
2nd quadrant	0100 0000 0000 0000 0000 0000	90 degrees (North Pole)	90 degrees East
	0100 0000 0000 0000 0000 0001	<Illegal Values>	(90+*INCR*) degrees East
	…	<Illegal Values>	**…**
	0111 1111 1111 1111 1111 1111	<Illegal Value>	(180-*INCR*) degrees East
3rd quadrant	1000 0000 0000 0000 0000 0000	<Illegal Value>	180 degrees East or West
	1000 0000 0000 0000 0000 0001	<Illegal Value>	(180-*INCR*) degrees West
	…	<Illegal Values>	**…**
	1011 1111 1111 1111 1111 1111	<Illegal Values>	(90-INCR) degrees West
4th quadrant	1100 0000 0000 0000 0000 0000	-90 degrees (South Pole)	90 degrees West
	1100 0000 0000 0000 0000 0001	(90-*INCR*) degrees South	(90-*INCR*) degrees West
	…	**…**	**…**
	1111 1111 1111 1111 1111 1111	*INCR* degrees South	*INCR* degrees West

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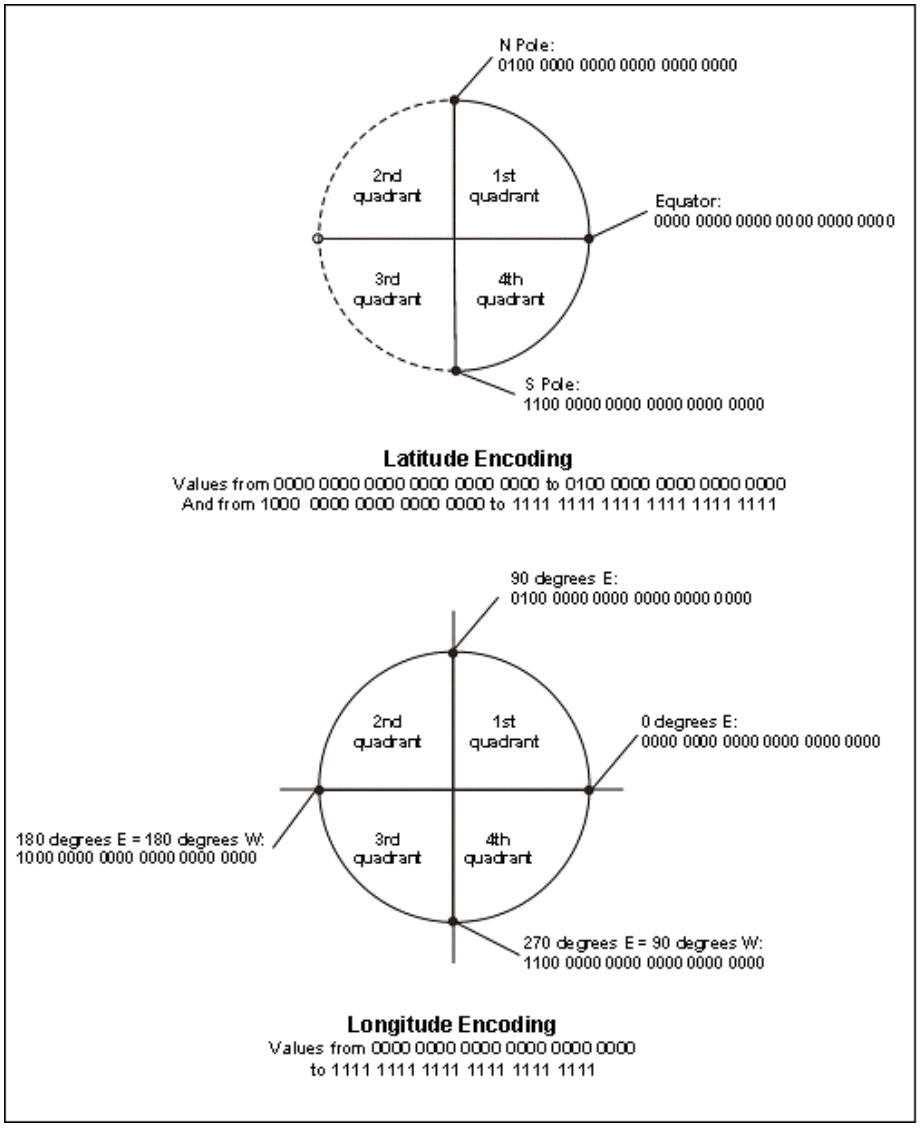
FRN 7: Latitude and Longitude (page 2 of 2)

Notes:

1. This encoding is consistent with that of GPS/GNSS avionics providing Latitude/Longitude inputs to ADS-B (ARINC data labels 110, 111, 120,121). It is also illustrated in the figure below.



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FRN 8: Pressure Altitude

Definition: Barometric Aircraft altitude referenced to standard atmospheric pressure of 29.92.
Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
RES	Spare	Msb --Pressure Altitude--													Lsb

Encoding:

Bit 16 Resolution of altitude encoding (ZERO=100 feet; ONE=25 feet)
Bit 15 Spare bit always set to ZERO
Bits14/1 Binary 2's compliment encoding of altitude with 25' Lsb

PRESSURE ALTITUDE

Pressure Altitude bits Msb Lsb	**Meaning**
10 0000 0000 0000	No pressure altitude information available
10 0000 0000 0001	-204775 feet
10 0000 0000 0010	-204750 feet
***	
11 1111 1111 1110	-50 feet
11 1111 1111 1111	-25 feet
00 0000 0000 0000	ZERO feet
00 0000 0000 0001	25 feet
00 0000 0000 0010	50 feet
***	
01 1111 1111 1110	204750 feet
01 1111 1111 1111	204775 feet

Notes:

Airborne ADS-B transmitters are restricted to a range of values for Pressure Altitude of –1000 feet to + 101, 325 feet.

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ASTERIX CAT 033 (12 NOV 2002)

FRN 9: Velocity (Airborne)(page 1 of 2)

Definition: The Velocity reported by the aircraft indicated by the North/South and East/West Velocity and vertical rate of change.

Structure: Fixed five byte data item.

Byte 1								Byte 2							
40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25
sb	VV Src	SO	NS	Msb --N/S Velocity--											Lsb

Byte 3								Byte 4							
24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9
EW	Msb --E/W Velocity--											Lsb	U D	Msb	

Byte 5							
8	7	6	5	4	3	2	1
--Vertical Rate--							Lsb

Encoding:

Bit 40 Spare bit, always set to ZERO

Bit 39 VV Src: Indicates the source of vertical velocity (ZERO=Baro; ONE=GNSS)

Bit 38 SO: Indicates the scale factor to be used for N/S and E/W velocities (ZERO=Subsonic--0.25 kt Lsb; ONE=Supersonic—2 kt Lsb)

Bit 37 NS Indicates the direction of the N/S velocity (ZERO=North; ONE=South).

Bits 36/25 N/S Velocity (Ground Referenced)

NORTH/SOUTH VELOCITY (Ground Referenced)

N/S Velocity bits Msb Lsb	**Meaning (when "SO"=ZERO)** (N/S Velocity in knots)	**Meaning (when "SO"=ONE)** (N/S Velocity in knots)
000 0000 0000	No Information available	
000 0000 0001	ZERO	
000 0000 0010	0.25	2
000 0000 0011	0.5	4
***	***	***
111 1111 1110	1023.5	8188
111 1111 1111	> 1023.5	> 8188

The encoding shown in the table represents Positive Magnitude data only. Direction is given completely by the North/South Direction Bit.

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FRN 9: Velocity (Airborne) (page 2 of 2)

Bit 24 EW Indicates the direction of the E/W velocity (ZERO=East; ONE=West).
Bits 23/12 E/W Velocity (Ground Referenced).

EAST/WEST VELOCITY (Ground Referenced)

E/W Velocity bits Msb Lsb	**Meaning (when "SO"=ZERO)** (E/W Velocity in knots)	**Meaning (when "SO"=ONE)** (E/W Velocity in knots)
000 0000 0000	No Information Available	
000 0000 0001	ZERO	
000 0000 0010	0.25	2
000 0000 0011	0.5	4
***	***	***
111 1111 1110	1023.5	8188
111 1111 1111	> 1023.5	> 8188

The encoding shown in the table represents Positive Magnitude data only. Direction is given completely by the East/West Direction Bit.

Bit 11 UD Indicates vertical rate direction (ZERO=Up; ONE=Down)
Bits 10/1 Vertical rate of change with 32 fpm Lsb

VERTICAL RATE

Vertical Rate bits Msb Lsb	**Meaning** (VERTICAL RATE in feet / minute)
00 0000 0000	No Information Available
00 0000 0001	ZERO
00 0000 0010	32
00 0000 0011	64
***	***
11 1111 1110	32,704
11 1111 1111	32,736

The encoding shown in the table represents Positive Magnitude data only. Direction is given completely by the Vertical Rate Sign Bit.

Notes:

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FRN 10: Velocity (Surface) (page 1 of 2)

Definition: Velocity format reported when target is known to be ON GROUND.
Structure: Fixed three byte data item.

Byte 1							
24	23	22	21	20	19	18	17
Trk/Hdg Valid	Trk/Hdg	True/Mag	Msb --Grnd Trk/Hdg--				

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Grnd Trk/Hdg-- Lsb					Msb --Ground Speed--										Lsb

Encoding:

Bit 24 Track/Hdg Valid (ZERO = Ground Track/Hdg data is NOT Valid; ONE = Ground Track/Hdg data is Valid

Bit 23 Track/Heading bit (ZERO= Track; ONE=Heading)

Bit 22 True/Magnetic bit (ZERO=True; ONE=Magnetic)

Bits 21/12 Ground Track represented as a binary number

GROUND TRACK/HEADING

Grnd Trk/Hdg bits Msb Lsb	**Meaning** $INCR = Lsb = \frac{360}{2^{10}} = 0.3515625°$
00 0000 0000	ZERO degrees
00 0000 0001	*INCR* degrees
***	
01 1111 1111	(180-*INCR*) degrees
10 0000 0000	180 degrees
10 0000 0001	(180+*INCR*) degrees
***	
11 1111 1111	(360-*INCR*) degrees

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FRN 10: Velocity (Surface) (page 2 of 2)

Bits 11/1 Binary encoding (linear) of Ground Speed with 0.125 kt Lsb

GROUND SPEED

Ground Speed bits Msb Lsb	**Meaning**
000 0000 0000	Ground Speed Not Available
000 0000 0001	ZERO
000 0000 0010	0.125 kts
000 0000 0011	0.250 kts
***	***
111 1111 1110	255.625 kts
111 1111 1111	255.750 kts

Notes:

1. Surface (Polar) format is different from airborne format because the ability to discern a track angle from the Airborne (Cartesian) format suffers at low speeds. Also use of polar format allows for a heading input if available. Heading (if available) can provide more reliable information on aircraft orientation on the surface when stationary or moving very slowly.
2. Aircraft are allowed to report velocity in this format when it is known for certain they are on the surface. It is also used by surface vehicles.

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ASTERIX CAT 033 (12 NOV 2002)

FRN 11: Mode 3/A Code

Definition: Aircraft's Mode-3/A code as entered into the aircraft's currently active transponder.

Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Spare Bit	Spare Bit	Spare Bit	Spare Bit	Msb Mode-3/A Code											Lsb

Encoding:

Bits 16/13	Spare
Bits 12/1	Mode-3/A code

Notes:

1. Having ADS-B transmit this information has been proposed as a convenient way for existing ATC automation systems to correlate ADS-B targets with their filed flight plans as is currently done with SSR. This data item responds to Alaska Capstone Program desire to add a Mode-A code reporting capability to ADS-B in Alaska. (Provisions for this requirement are under coordination with SC-186/WG6 for possible inclusion in a future version of the ADS-B MASPS (DO-242A). (See RTCA Paper Number SC-186-WG5/UAT-WP-14-02, dated 24 July 2002, by Mosher, Jennings, Pagano, Furr.) SC186 WG3 is considering whether to add the Mode A code to the 1090 MHz ES system

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FRN 12: Target Identification (page 1 of 2)

Definition: Target Identification (in 8 characters) reported by the aircraft/vehicle. This is generally the radio call sign.

Structure: Six byte fixed length data item.

Byte 1								Byte 2							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Msb (b6)		--Char 1--			Lsb (b1)	Msb (b6)		--Char 2--			Lsb (b1)	Msb (b6)		--Char 3--	
Byte 3								Byte 4							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
	Lsb (b1)	Msb (b6)		--Char 4--			Lsb (b1)	Msb (b6)		--Char 5--			Lsb (b1)	Msb (b6)	
Byte 5								Byte 6							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Char 6--			Lsb (b1)	Msb (b6)		--Char 7--			Lsb (b1)	Msb (b6)		--Char 8--			Lsb (b1)

Encoding:

Bits 48/1 Characters 1-8, coded as 6 bits per character

CHARACTER ENCODING

Character *N* bits				b6	0	0	1	1
				b5	0	1	0	1
b4	b3	b2	b1					
0	0	0	0			P	sp	0
0	0	0	1		A	Q		1
0	0	1	0		B	R		2
0	0	1	1		C	S		3
0	1	0	0		D	T		4
0	1	0	1		E	U		5
0	1	1	0		F	V		6
0	1	1	1		G	W		7
1	0	0	0		H	X		8
1	0	0	1		I	Y		9
1	0	1	0		J	Z		
1	0	1	1		K	Illegal Values		
1	1	0	0		L			
1	1	0	1		M			
1	1	1	0		N			
1	1	1	1		O			

Notes:

1. Character 1 is leftmost.
2. Characters must be left justified using <space> fill if less than 8 characters are used.

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ASTERIX CAT 033 (12 NOV 2002)

FRN 13: Emitter Category

Definition: The target's category code for the current position report.
Structure: Fixed one byte data item.

Byte 1							
8	7	6	5	4	3	2	1
Msb --Category Code-- Lsb						sb	

Encoding:

Bits 8/3 Category Code

CATEGORY CODE

Category Code bits (decimal)	Category Code bits Msb Lsb	Meaning
0	00 0000	No aircraft type information
1	00 0001	Light (< 15 500 lbs)
2	00 0010	Small (15 500 to 75 000 lbs)
3	00 0011	Large (75 000 to 300 000 lbs)
4	00 0100	High Vortex Large
5	00 0101	Heavy (> 300 000 lbs)
6	00 0110	High Performance (> 5G acceleration)
7	00 0111	Rotocraft
8	00 1000	(Unassigned)
9	00 1001	Glider/sailplane
10	00 1010	Lighter than air
11	00 1011	Parachutist/sky diver
12	00 1100	Ultra light/hang glider/paraglider
13	00 1101	(Unassigned)
14	00 1110	Unmanned aerial vehicle
15	00 1111	Space/transatmospheric vehicle
16	01 0000	(Unassigned)
17	01 0001	Surface vehicle—emergency vehicle
18	01 0010	Surface vehicle—service vehicle
19	01 0011	Fixed ground or tethered obstruction
20	01 0100	Cluster Obstacle
21	01 0101	Line Obstacle
22-63		(Unassigned)

Bits 2/1 Spare Bits always set to ZERO

Notes:

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ASTERIX CAT 033 (12 NOV 2002)

FRN 14: Target Status

Definition: Status information currently being reported by the target.
Structure: Fixed one byte data item.

BYTE DATA ITEM

Byte 1							
8	7	6	5	4	3	2	1
Receiving ATC Services	IDENT	Spare bit	Spare bit	Msb Status Code			Lsb

Encoding:

Bit 8	ONE indicates the airspace user is receiving ATC services; ZERO indicates the airspace user is NOT receiving ATC services
Bit 7	ONE indicates the avionics is in the IDENT condition; ZERO indicates the avionics is NOT in the IDENT condition
Bits 6/5	Spare bits always set to ZERO
Bits 4/1	Status Code

STATUS CODES

Status Code bits (decimal)	Msb Lsb	**Meaning**
0	0000	No emergency/Not reported
1	0001	General emergency
2	0010	Lifeguard/medical emergency
3	0011	Minimum fuel
4	0100	No communications
5	0101	Unlawful interference (hijacking)
6	0110	Downed Aircraft
7-15	0111-1111	(Reserved for future definition

Notes:

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FRN 15: Geometric Altitude

Definition: Aircraft altitude derived from GNSS, INS or ground-based measurement (e.g., Multilateration) represented as Height Above Ellipsoid (HAE).

Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Msb															Lsb
--Geometric Altitude (HAE)--															

Encoding:

Bits16/1 Binary 2's compliment encoding of altitude with 6.25' Lsb

ALTITUDE (GEOMETRIC)

Geometric Altitude bits Msb Lsb	**Meaning**
1000 0000 0000 0000	No geometric altitude information available
1000 0000 0000 0001	-204793.75 feet
1000 0000 0000 0100	-204775 feet
1000 0000 0000 1000	-204750 feet
***	
1111 1111 1111 1000	-50 feet
1111 1111 1111 1100	-25 feet
1111 1111 1111 1111	-6.25 feet
0000 0000 0000 0000	ZERO feet
0000 0000 0000 0001	6.25 feet
0000 0000 0000 0100	25 feet
0000 0000 0000 1000	50 feet
***	
0111 1111 1111 1000	204750 feet
0111 1111 1111 1100	204775 feet
0111 1111 1111 1111	204793.75 feet

Notes:

1. Encoding consistent with Pressure Altitude item with the exception of two additional bits of precision which appear here.

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FRN 16: ***Reserved for Future Data Item***

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ASTERIX CAT 033 (12 NOV 2002)

FRN 17: Time of Message Transmission

Definition: The time at which the ADS-B message was transmitted from the aircraft/vehicle expressed as fractional seconds from the UTC second.

Structure: Fixed four byte data item.

Byte 1								Byte 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Msb --Time of Message Transmission--															
Byte 3								Byte 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Time of Message Transmission--															Lsb

Encoding:

Bits 32/1 Time of message transmission encoded as nanoseconds elapsed after the UTC 1 second time mark.

TIME OF MESSAGE TRANSMISSION

Time of Message Transmission bits Msb Lsb	**Meaning** $INCR = Lsb = \frac{1 \text{ sec}}{2^{32}} = 0.2328$ nanosecond
0000 0000 0000 0000 0000 0000 0000 0000	Message transmitted on the UTC second
0000 0000 0000 0000 0000 0000 0000 0001	Message transmitted on the UTC second plus *INCR*
…	**…**
1111 1111 1111 1111 1111 1111 1111 1111	Message transmitted on the UTC second plus (1- *INCR*)

Notes:

1. This data item, in conjunction with FRN 18 (Time of Message Reception) can be used to derive a range to target that is independent of the ADS-B-derived range. This can be used to provide a degree of added surveillance integrity.
2. FRN #4 (Time of Applicability) defines the whole second part to which this fractional second measurement applies.
3. This data item will have to be derived within the GBT based on protocols specific to a particular ADS-B data link.

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ASTERIX CAT 033 (12 NOV 2002)

FRN 18: Time of Message Reception

Definition: The time at which the ADS-B message was received at the GBT expressed as fractional seconds from the UTC second.

.

Structure: Fixed four byte data item.

Byte 1								Byte 2							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
Msb --Time of Message Reception--															
Byte 3								Byte 4							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Time of Message Reception-- Lsb															

Encoding:

Bits 32/1 Time of message reception encoded as nanoseconds elapsed after the UTC 1 second time mark

TIME OF MESSAGE RECEPTION

Time of Message Reception bits Msb Lsb	**Meaning** $INCR = Lsb = \frac{1 \text{ sec}}{2^{32}} = 0.2328$ nanosecond
0000 0000 0000 0000 0000 0000 0000 0000	Message received on the UTC second
0000 0000 0000 0000 0000 0000 0000 0001	Message received on the UTC second plus *INCR*
…	**…**
1111 1111 1111 1111 1111 1111 1111 1111	Message received on the UTC second plus (1- *INCR*)

Notes:

1. This data item, in conjunction with FRN 17 (Time of Message Transmission) can be used to derive a range to target that is independent of the ADS-B-derived range. Additionally, when a given target is in coverage of multiple networked GBTs, this data item can be used to perform a time difference of arrival localization of the target. This is also independent of the ADS-B reported position. These techniques can be used to provide a degree of added surveillance integrity.
2. FRN #4 (Time of Applicability) defines the whole second part to which this fractional second measurement applies.
3. This data item will have to be derived within the GBT based on protocols specific to a particular ADS-B data link.

APPENDIX B
ASTERIX CAT 243 (12 NOV 2002)

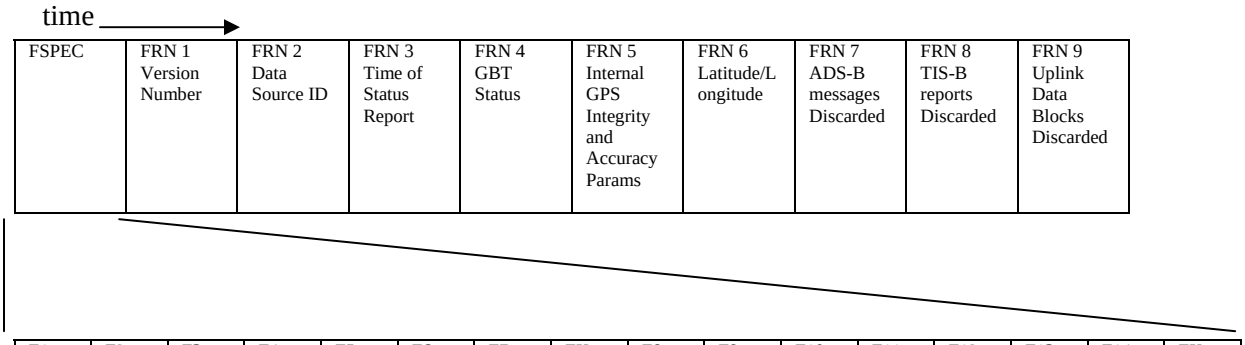
B.1 General

The format for target reports is based on the ASTERIX message standard adopted by Eurocontrol for surveillance data exchange. For background information on the ASTERIX structure and encoding see the document entitled, "Eurocontrol Standard Document for Surveillance Data Exchange, Part 1, ASTERIX," SUR.ET1.ST05.2000-STD-01-01, November 1997. This document is available at http://www.eurocontrol.be/projects/eatchip/asterix.

A User Application Profile (UAP) is a mechanism for assigning Data Item to Data Fields of ASTERIX messages and containing all necessary information which needs to be standardized for the successful encoding and decoding of the messages. An ASTERIX Data Category (CAT) is defined by a set of Data Items that could be included in valid messages of that category. The ASTERIX Data Category for periodic Status reports from the GBT has been given the assignment "243". This value, which is normally the first Data Item in a Data Block, is also interpreted to be the BSDU ID field (Section 3.2).

The Field Reference Number (FRN) establishes the order of the items in the FSPEC, and along with the Category code serves to uniquely identify each data item. In order to maximize compatibility with future versions of this category, these data items will retain the same FRN and order in the FSPEC while new items may be added onto the end of the FSPEC.

B.2 Target Report Construction Example



F1	F2	F3	F4	F5	F6	F7	FX	F8	F9	F10	F11	F12	F13	F14	FX
1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0

1. *Within each Data Item, Byte 1 is transmitted first*
2. *"FX" is the Field Extension bit. A ONE in this bit indicates the field extends into the next byte.*

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ASTERIX CAT 243 (12 NOV 2002)

B.3 User Application Profile and Construction for Cat 243 Target Reports

Table B-2. Cat 243 (V 1) User Application Profile and Construction

FRN	Data Item	Length in Bytes (when present)
1	Version Number	1
2	Data Source Identifier	2
3	Time of Status Report	3
4	GBT Status	1
5	Internal GPS Integrity and Accuracy Parameters	2
6	Latitude/Longitude	6
7	ADS-B Messages Discarded	2
8	TIS-B Reports Discarded	2
9	Uplink Data Blocks Discarded	2

Note: Systems receiving Cat 243 reports must parse the FSPEC for proper decoding since some Data Items are optional in any given report.

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B.4 Format and Encoding of Cat 243 (V 1.0) Data Items

APPENDIX B
ASTERIX CAT 243 (12 NOV 2002)

FRN 1: Version Number

Definition: Version of this Cat 033 format.
Structure: One byte fixed length data item.

Byte 1							
8	7	6	5	4	3	2	1
Spare bit	Spare bit	Version Status	Msb				Lsb
			Version Number				

Encoding:

Bits 8/7: Spare bits always set to ZERO
Bit 6: ZERO=Version for operational use; ONE=Version is for experimental use only
Bits 5/1: Cat 243 version number encoded as binary numeral in the range of 1 to 31 (Value of ZERO represents "unknown" version regardless of "Version Status".

Category 243 messages conforming to this document shall be encoded with the value ONE in the Version Number field (Bits 5/1).

Notes:
1. This provides an upgrade path for evolution of this Category without incrementing the Category number modulo 32.

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ASTERIX CAT 243 (12 NOV 2002)

FRN 2: Data Source Identifier

Definition: Identification of the system supplying surveillance data.
Structure: Two byte fixed length data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Msb							Lsb	Msb							Lsb
--SAC--								--SIC--							

Encoding:

Bits 16/9: (SAC) System Area Code ($0 \rightarrow 255$)
Bits 8/1: (SIC) System Identification Code ($0 \rightarrow 255$)

Notes:

1. The SAC is used to identify regions of the world.
2. The SIC is used to identify individual systems (e.g., ADS-B receiver or TIS-B transmitter, radar/beacon sensor, multisensor fusion processor, etc).

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ASTERIX CAT 243 (12 NOV 2002)

FRN 3: Time of Status Report

Definition: Time at which the Status report information was recorded.
Structure: Three byte fixed data item.

Byte 1							
24	23	22	21	20	19	18	17
Msb --Time of Status Report--							

Byte 2								Byte 3							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Time of Status Report--															Lsb

Encoding:

Bits 24/8	whole seconds elapsed since UTC midnight binary encoded
Bits 7/1	fractional seconds elapsed since UTC midnight binary encoded

Notes:
1. The time of the day value is reset to 0 at every midnight. The time of the day is specified in UTC.
2. The Lsb represents 1/128 of a second.

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ASTERIX CAT 243 (12 NOV 2002)

FRN 4: GBT Status

Definition: Reports the status of the GBT functional elements.
Structure: One byte fixed length data item.

Byte 1							
8	7	6	5	4	3	2	1
GBT Timing Status	Receiver Status	Transmitter Status	Spare bit	GBT State (Msb … Lsb)			FX

Encoding:

Bit 8: GBT Timing Status: ONE = UTC coupled; ZERO = non-UTC coupled (i.e., coasting)

Bit 7: Receiver Status: ONE = Normal; ZERO = Alarm condition (i.e., GBT-detected fault)
Bit 6: Transmitter Status: ONE = Normal; ZERO = Alarm condition (i.e., GBT-detected fault)
Bit 5: Spare bit always set to ZERO
Bits 4/3 GBT State: (see table below)

GBT State bits Msb Lsb	**Meaning**
000	Off Line State
001	On Line State
010	(Reserved)
011	(Reserved)
100	(Reserved)
101	(Reserved)
110	(Reserved)
111	(Reserved)

Bit 1: Spare bit always set to ZERO

Notes:
1. Only two of the GBT states are reportable in a Status report since all other states result in no data output on the Ground Interface.

APPENDIX B
ASTERIX CAT 243 (12 NOV 2002)

FRN 5: Internal GPS Integrity and Accuracy Parameters (Page 1 of 2)

Definition: This data item conveys the accuracy and integrity parameters reported by the GBT internal GPS timing source.

Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
sb	Msb --NIC-- Lsb				Spare bits			Msb --NACp-- Lsb					sb	sb	sb

Encoding:

Bit 16: Spare bit always set to ZERO.

Bits 15/12: Navigation Integrity Categories (NIC)

The Navigation Integrity Category (NIC) is reported so that surveillance applications may determine whether the reported position has an acceptable level of integrity for the intended use. The value of the NIC parameter specifies an integrity containment radius, R_C.

NIC bits Msb Lsb	**Horizontal and Vertical Containment Bounds**	**Comment**
0000	$R_C \geq 37.04$ km (20 NM)	Unknown Integrity
0001	$R_C < 37.04$ km (20 NM)	RNP-10 containment radius
0010	$R_C < 14.816$ km (8 NM)	RNP-4 containment radius
0011	$R_C < 7.408$ km (4 NM)	RNP-2 containment radius
0100	$R_C < 3.704$ km (2 NM)	RNP-1 containment radius
0101	$R_C < 1852$ m (1 NM)	RNP-0.5 containment radius
0110	$R_C < 1111.2$ m (0.6 NM)	RNP-0.3 containment radius
0111	$R_C < 370.4$ m (0.2 NM)	RNP-0.1 containment radius
1000	$R_C < 185.2$ m (0.1 NM)	RNP-0.05 containment radius
1001	$R_C < 75$ m and VPL < 112m	e.g., WAAS HPL, VPL
1010	$R_C < 25$ m and VPL < 37.5m	e.g., WAAS HPL, VPL
1011	$R_C < 7.5$ m and VPL < 11m	e.g., LAAS HPL, VPL

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FRN 5: Integrity and Accuracy Parameters (Page 2 of 2)

Bits 8/4: Navigation Accuracy Categories for Position (NACp)

The Navigation Accuracy Category for Position (NACp) is reported so that surveillance applications may determine whether the reported position has an acceptable level of accuracy for the intended use. The Estimated Position Uncertainty (EPU) is a 95% accuracy bound on horizontal position. EPU is defined as the radius of a circle, centered on the reported position, such that the probability of the actual position being outside the circle is 0.05. When reported by a GPS or GNSS system, EPU is commonly called HFOM (Horizontal Figure of Merit). Likewise, Vertical Estimated Position Uncertainty (VEPU) is a 95% accuracy limit on the vertical position. VEPU is defined as a vertical position limit, such that the probability of the actual vertical position differing from the reported vertical position by more than that limit is 0.05. When reported by a GPS or GNSS system, VEPU is commonly called VFOM (Vertical Figure of Merit).

NACp Bits		**95% Horizontal and Vertical Accuracy Bounds (EPU and VEPU)**	**Comment**
Bit 8	Bits 7-4 Msb Lsb		
0	xxxx	NACp not available in this reporting interval	
1	0000	EPU ≥ 18.52 km (10 NM)	
1	0001	EPU < 18.52 km (10 NM)	RNP-10 accuracy
1	0010	EPU < 7.408 km (4 NM)	RNP-4 accuracy
1	0011	EPU < 3.704 km (2 NM)	RNP-2 accuracy
1	0100	EPU < 1852 m (1NM)	RNP-1 accuracy
1	0101	EPU < 926 m (0.5 NM)	RNP-0.5 accuracy
1	0110	EPU <555.6 m (0.3 NM)	RNP-0.3 accuracy
1	0111	EPU < 185.2 m (0.1 NM)	RNP-0.1 accuracy
1	1000	EPU <92.6 m (0.05 NM)	e.g., GPS (with SA)
1	1001	EPU < 30 m and VEPU < 45 m	e.g., GPS (SA off)
1	1010	EPU < 10 m and VEPU < 15 m	e.g., WAAS
1	1011	EPU < 3 m and VEPU < 4 m	e.g., LAAS

Bits 3/1: Spare bits always set to ZERO

APPENDIX B

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FRN 6: Latitude and Longitude (page 1 of 2)

Definition: GBT latitude and longitude position as determined from the GBT internal GPS sensor.
Structure: Fixed 6 byte data item.

Byte 1								Byte 2							
48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33
Msb --Latitude--															
Byte 3								Byte 4							
32	31	30	29	28	27	26	25	24	23	22	21	20	19	18	17
--Latitude--							Lsb	Msb --Longitude--							
Byte 5								Byte 6							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
--Longitude--															Lsb

Encoding:

Bits 48/1: Latitude and Longitude

LATITUDE AND LONGITUDE

Quadrant	**Latitude or Longitude bits**	**Meaning** $INCR = Lsb = \frac{360}{2^{24}} = 0.00002146\ °$	
	Msb Lsb	**Latitude**	**Longitude**
1st quadrant	0000 0000 0000 0000 0000 0000	ZERO degrees (Equator)	ZERO degrees (Prime Meridian)
	0000 0000 0000 0000 0000 0001	*INCR* degrees North	*INCR* degrees East
	…	…	…
	0011 1111 1111 1111 1111 1111	(90-*INCR*) degrees North	(90-*INCR*) degrees East
2nd quadrant	0100 0000 0000 0000 0000 0000	90 degrees (North Pole)	90 degrees East
	0100 0000 0000 0000 0000 0001	<Illegal Values>	(90+*INCR*) degrees East
	…	<Illegal Values>	…
	0111 1111 1111 1111 1111 1111	<Illegal Value>	(180-*INCR*) degrees East
3rd quadrant	1000 0000 0000 0000 0000 0000	<Illegal Value>	180 degrees East or West
	1000 0000 0000 0000 0000 0001	<Illegal Value>	(180-*INCR*) degrees West
	…	<Illegal Values>	…
	1011 1111 1111 1111 1111 1111	<Illegal Values>	(90-INCR) degrees West
4th quadrant	1100 0000 0000 0000 0000 0000	-90 degrees (South Pole)	90 degrees West
	1100 0000 0000 0000 0000 0001	(90-*INCR*) degrees South	(90-*INCR*) degrees West
	…	…	…
	1111 1111 1111 1111 1111 1111	*INCR* degrees South	*INCR* degrees West

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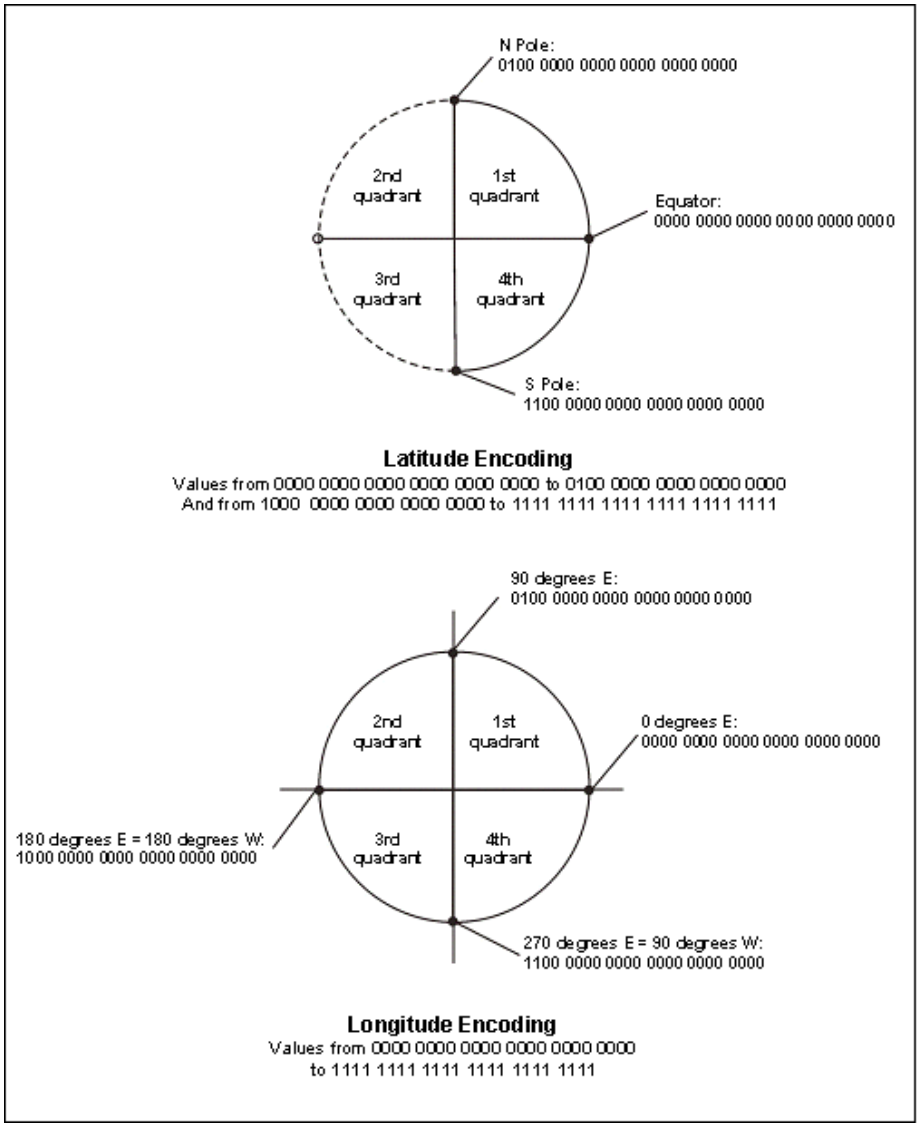
FRN 6: Latitude and Longitude (page 2 of 2)

Notes:

1. This encoding is consistent with that of GPS/GNSS avionics providing Latitude/Longitude inputs to ADS-B (ARINC data labels 110, 111, 120,121). It is also illustrated in the figure below.



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FRN 7: ADS-B Messages Discarded

Definition: A count of ADS-B messages that were discarded this Status reporting interval.
Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Msb															Lsb
--Discard Count--															

Encoding:

Bit 16/1 Count of discarded ADS-B messages this Status reporting interval binary encoded

Notes:

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FRN 8: TIS-B Reports Discarded

Definition: A count of TIS-B reports that were discarded this Status reporting interval.
Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Msb															Lsb
--Discard Count--															

Encoding:

Bit 16/1 Count of discarded TIS-B reports this Status reporting interval binary encoded

Notes:

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FRN 9: Uplink Data Blocks Discarded

Definition: A count of Uplink Data Blocks that were discarded this Status reporting interval.
Structure: Fixed two byte data item.

Byte 1								Byte 2							
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Msb															Lsb
--Discard Count--															

Encoding:

Bit 16/1 Count of discarded Uplink Data Blocks this Status reporting interval binary encoded

Notes: