INCH-POUND

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PERFORMANCE SPECIFICATION

DYNAMIC REFERENCE UNIT-HYBRID-REPLACEMENT (DRU-H-R)

This specification is approved for use by the US Army ARDEC and is available for use by all Departments and Agencies of the Department of Defense

1. SCOPE

1.1 Scope. This specification covers the Dynamic Reference Unit-Hybrid-Replacement (DRU-H-R). The DRU-H-R is a Line Replaceable Unit (LRU) of the M109A6 self-propelled howitzer (Paladin) and the AN/TPQ-36 and TPQ-37 radars (FireFinder.)

1.2 Classification. DRU-H-Rs are of the following types, as specified (see 6.2).

1.2.1 Types. The types of DRU-H-Rs are as follows:

Type I – Finished for use inside a host where illumination is permitted (see 3.3.8.1.e and 3.5.4.1.a.).

Type II – Finished for use outside a host where illumination is not permitted (see 3.3.8.1.f, 3.3.8.1.g, and 3.5.4.1.b.)

1.3 Requirement types. Requirements identified as “threshold” must be met. It is desired, but not mandatory, that requirements identified as “objective” be met. Unless otherwise identified, all requirements are “threshold.”

Comments, suggestions, or questions on this document should be addressed to: Commander, U.S. Army ARDEC, ATTN: RDAR-QES-E, Picatinny, New Jersey 07806-5000, or emailed to usarmy.picatinny.ardec.list.ardec-stdzn-branch@mail.mil Since contact information can change, you may want to verify the currency of this address information using the ASSIST online database at https://assist.dla.mil.

AMC: N/A FSC : 1220

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 or 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all requirements documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks of the exact revision listed below form a part of this specification to the extent specified herein.

INTERNATIONAL STANDARDIZATION AGREEMENTS

QSTAG-1031	Consistent Sets of Nuclear Hardening Criteria for Classes of Equipment (U)

DEPARTMENT OF DEFENSE SPECIFICATIONS

MS27468J	Connector, Receptacle, Electrical Jam Nut Mounting, Crimp Type, Bayonet Coupling Series I
MIL-DTL-53072C	Chemical Agent Resistant Coating (CARC) System Application Procedures and Quality Control Inspection
MIL-DTL-64159A	Coating, Water Dispersible Aliphatic Polyurethane, Chemical Agent Resistant

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-130L	Identification Marking of U.S. Military Property
MIL-STD-461E	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-464A	Electromagnetic Environmental Effects Requirements For Systems
MIL-STD-810F	Environmental Engineering Considerations and Laboratory Tests
MIL-STD-1275D	Characteristics of 28 Volt DC Electrical Systems in Military Vehicles
MIL-STD-1472F	Human Engineering

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-217	Reliability Prediction of Electronic Equipment
MIL-HDBK-729	Corrosion and Corrosion Prevention Metals
MIL-HDBK-783	Chemical and Biological (CB) Contamination Avoidance and Decontamination
MIL-HDBK-784	Guidelines-Design to Minimize Contamination and to Facilitate Decontamination of Military Vehicles and Other Equipment: Interiors and Exteriors

(Copies of these documents are available on line at https://assist.dla.mil/quicksearch/ or from: Standardization Document Order Desk, Bldg. 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues are those cited herein.

U.S. ARMY TANK AUTOMOTIVE RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (TARDEC) DRAWINGS

12300005	Speedometer Assembly
12369002	Paint Systems for Aluminum, Interior Surfaces, White
12369004	Paint Systems for Steel, Interior Surfaces, White
12369016	Paint Systems for Plastic, Interior Surfaces, White
12384798	Speedometer Sender

(Copies of these drawings may be requested by email at usarmy.picatinny.ardec.list.drawing-request-help-desk@mail.mil and from US Army ARDEC, ATTN:RDAR-EIS-PE, Picatinny Arsenal, NJ 07806-5000.)

CODE OF FEDERAL REGULATION

40 CFR 1500-1508	National Environmental Policy Act Regulations

(CFRs are available online at www.gpoaccess.gov/cfr/ or from the Superintendent of Documents, U.S. Government Printing Office, North Capitol & "H" Streets, N.W., Washington, DC 20402-0002)

EXECUTIVE ORDER

EO 12114	Environmental Effects Abroad of Major Federal Actions

(Copy is available at http://www.archives.gov/federal-register/codification/executive-order/12114.html)

FIELD MANUAL

FM 3-11.5	Multiservice Tactics, Techniques, And Procedures For Chemical, Biological, Radiological, And Nuclear Decontamination

(FM 3-11.5 is available online at https://atiam.train.army.mil/soldierPortal/atia/adlsc/view/altfmt/22662-1)

GLOBAL POSITIONING SYSTEM PUBLICATIONS

IS-GPS-153D	GPS User Equipment Interface Specification for the GPS Standard Serial Interface Protocol (GSSIP) of DoD Standard GPS UE Radio Receivers
SS-M/V-600A	Performance (PRF) Specification Item Specification for the NAVSTAR Global Positioning System (GPS) Defense Advanced GPS Receiver (DAGR)

(Application for these documents may be made to Global Positioning System (GPS) Wing (GPSW)/ENR, 483 North Aviation Boulevard, El Segundo, CA 90245-2808.)

UNITED STATES CODE

42 USC 4321-4370d National Environmental Policy Act

(Copy is available at http://uscode.house.gov/)

RTCA DOCUMENTS

DO-160D	Environmental Conditions and Test Procedures for Airborne Equipment

(Copies of this drawing may be obtained from RTCA, Inc., 1140 Connecticut Avenue, NW, Suite 1020, Washington, DC 20036-4001.)

2.3 Non-Government publications. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

TELECOMMUNICATION INDUSTRY ASSOCIATION (TIA)

TIA-232-F	Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
TIA-422-B	Electrical Characteristics of Balanced Voltage Digital Interface Circuits

(TIA documents may be ordered from http://www.tiaonline.org, or from Telecommunications Industry Association, Standards and Technology Department, 2500 Wilson Blvd., Arlington VA 22201.)

2.4 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 Design verification. When specified in the contract (see 6.2), a sample of the DRU-H-R shall be subjected to design verification in accordance with 4.3.

3.2 First article. When specified in the contract or purchase order (see 6.2), a sample shall be subjected to first article inspection in accordance with 4.4.

3.3 Interface and interoperability requirements.

3.3.1 Configuration tailoring.

a. The DRU-H-R shall tailor its operation and relate input and output parameters to specific host configurations using fixed and changeable configuration data in accordance with Appendix A and Appendix C.

b. The DRU-H-R shall be delivered with the installed host vehicle configuration parameters specified in Appendix C, or as modified by the contract or purchase order (see 6.2).

c. Configuration data shall be retained until replaced by data received in an accepted ACCEPT CONFIGURATION DATA or ACCEPT ETHERNET CONFIGURATION DATA command.

3.3.2 Host/DRU-H-R data exchange.

a. The DRU-H-R shall receive commands and data from the host and send data to the host over Host TIA-422 data interfaces as specified in Appendix A.

b. Command and message formats and specific data elements shall be as specified in the detailed command and message descriptions given in Appendix A.

3.3.2.1 DRU-H-R status reporting.

a. The DRU-H-R shall indicate its operational status as specified in Appendix B.

b. Unless otherwise specified, the requirements to set and reset status indications are the same regardless of the data interface or output message.

3.3.2.2 DRU-H-R alert reporting.

a. The DRU-H-R shall indicate alert conditions, including illegal operations and invalid input data, as specified in Appendix B.

b. Unless otherwise specified, the requirements to set and reset alert indications are the same regardless of the data interface or output message.

c. In this document, a requirement to set or reset an alert indication also infers the requirement to appropriately set and reset STATUS DATA S2/1 (DRU-H-R Alert) and S5/3 (Change in ALERT DATA).

3.3.2.3 Failure reporting.

a. The DRU-H-R shall indicate failure conditions to the host as specified in Appendix B.

b. The requirements to set and reset failure indications are the same regardless of the data interface or output message.

c. A requirement to set or reset a failure indication also infers the requirement to appropriately set and reset STATUS DATA S2/5 (BIT Malfunction Detected) and S5/2 (Change in BIT DATA).

3.3.2.4 Command checking.

a. Except for the command assigned to suppliers, the DRU-H-R shall not accept any commands or data except those specified herein.

b. ALERT DATA D5/0 (Undefined Command Received) shall be set in response to any command containing an undefined command code, incorrect number of bytes, or transmission error.

c. If a defective command is received, a STATUS DATA message shall be returned.

3.3.2.5 Data entry checking.

a. Commands containing any data outside the allowable range(s), specified in the command description, shall be rejected.

b. ALERT DATA D5/2 (Invalid Data Received) shall be set in response to any command containing out of range data.

c. Additional alert indications shall be set for out of range position parameters as listed in Table I.

d. Specific out of range data values that indicate parameters are not to be updated (no change values) (3.3.6.5.3) shall not result in command rejection or alert indications.

Table I - Out of range alert indications.

PARAMETER	ALERT DATA Byte/Bit
Easting or Northing	D4/3 (Horizontal Position Update Rejected)
Altitude	D4/4 (Altitude Update Rejected)
Latitude or Longitude	D4/3 (Horizontal Position Update Rejected)
Datum ID	D1/5 (Datum Update Rejected)

3.3.3 Gun Drive interface. The DRU-H-R shall have a Gun Drive interface as specified in Appendix D.

3.3.4 Positioning.

a. At any time after communication with the host has been established, the DRU-H-R shall provide current estimates of position, velocity, and estimated position accuracy, when requested.

b. The DRU-H-R shall continuously determine position as it is moved.

c. STATUS DATA S1/4 (OK To Move) shall be set after position has been initialized and position accuracy requirements for Interrupted Static Align (3.6.2) are met.

d. While the host is nominally stationary more than 60 seconds, position values output by the DRU-H-R shall not change except to reflect position initialization or host position updates.

3.3.4.1 Motion reporting.

a. The DRU-H-R shall set STATUS DATA S3/2 (DRU-H-R In Motion) when the host is moving.

b. Within 5 seconds after the host has stopped, the DRU-H-R shall reset STATUS DATA S3/2.

c. Externally observable responses, which are dependent on motion detection, shall be consistent with the current state of STATUS DATA S3/2.

d. When the host is nominally stationary, motion from rotating/aiming the pointing device, crew and cargo movement, wind buffeting, engine operation, and weapon recoil shall not cause STATUS DATA S3/2 to set.

e. When the host is nominally stationary, isolated odometer signal pulses shall not cause STATUS DATA S3/2 to set.

3.3.4.2 Position reference.

a. Positions shall be referenced to the datum stored at the last shutdown or last accepted in an ACCEPT POSITION or ACCEPT GEODETIC DATA command in accordance with Appendix G.

b. The datum shall be initialized to WGS 84 (Datum ID WGD) in the event of an abnormal shutdown or corruption of stored data.

c. Positions shall be referenced to the vehicle offset point (Orientation 1) or pointing device offset point (Orientation 2) specified in configuration data.

d. Grid positions shall be for the UTM grid.

e. UTM positions shall be for the normal or extended UTM zone as designated in the data stored at the last shutdown or in the last accepted ACCEPT POSITION command.

f. The DRU-H-R shall reference positions to GPS when GPS aiding is enabled, acceptable GPS data are available, and the DRU-H-R is in motion.

g. DRU-H-R position outputs shall not wander with changes in GPS position while the DRU-H-R is stationary.

h. When an ACCEPT POSITION or ACCEPT GEODETIC DATA command has been accepted, DRU-H-R position outputs shall reflect the position coordinates in the ACCEPT POSITION or ACCEPT GEODETIC DATA command while the DRU-H-R remains nominally stationary.

3.3.5 Orientation.

a. Orientation reference frames, parameters and angular rates shall be as defined in 6.3.7, 6.3.8 and 6.3.9, respectively.

b. At any time after communication with the host has been established, the DRU-H-R shall provide current estimates of vehicle and pointing device azimuth, pitch, roll or cant, pointing device angular rates, and estimated azimuth accuracy, when requested

c. The DRU-H-R shall output geodetic or grid azimuth and roll or cant as specified in configuration data.

d. Grid azimuths shall be for the UTM grid.

e. UTM grid azimuths shall be for the normal or extended UTM zone as designated in the data stored at the last shutdown or in the last accepted ACCEPT POSITION command.

f. Orientation attitudes and angular rates shall be related to the host pointing device and vehicle coordinate frames, as defined by configuration data, boresight angles, orientation (1 or 2), and travel lock state.

g. After STATUS DATA S3/1 (Orientation Attitude Data Valid) is set, the DRU-H-R shall provide orientation and angular rate data to the specified accuracy requirements, when requested.

3.3.5.1 Orientation references.

a. The DRU-H-R shall reference position, orientation and angular rate data to host specific primary (Orientation 1) and secondary (Orientation 2) orientations.

b. Orientation 1 shall be defined by: a DRU-H-R Coordinate Frame code, vehicle boresight angles, pointing device boresight angles, and position offset distances.

c. Orientation 2 shall be defined by: a DRU-H-R Coordinate Frame code, pointing device boresight angles, and position offset distances.

d. Transition between Orientation 1 and Orientation 2 shall be triggered by receipt of an IN TRAVEL LOCK or OUT OF TRAVEL LOCK command.

e. STATUS DATA S3/7 (Orientation Transition In Process) shall be set while switching between Orientations 1 and 2.

f. STATUS DATA S3/7 shall be reset when orientation transition is complete and position, velocity, orientation and angular rate data are referenced to the new orientation.

g. The time to switch orientations and provide data referenced to the new orientation shall not exceed 3 seconds.

h. STATUS DATA S4/7 (DRU-H-R In Orientation 2) shall be set while in Orientation 2 and reset while in Orientation 1.

i. STATUS DATA S4/7, position data, velocity data, attitude data and attitude rate data may not be referenced to either orientation when STATUS DATA S3/7 is set.

3.3.6 Aiding. The DRU-H-R shall not use externally referenced aiding data except from the following

a. An external GPS receiver, meeting the interface requirements of SS-M/V-600A, when the GPS Installed flag (CFIG D26/7) is set. The DRU-H-R shall perform as specified herein when connected to any receiver that has an interface backward compatible with SS-M/V-600A.

b. An external odometer sensor (see 3.3.12.4.5, VMS interface, and 3.3.12.7, Speedometer sender interface) when the Odometer Installed flag (CFIG D28/0) is set.

c. Zero-velocity updates (ZUPTs) while stopped.

d. Host position updates while stopped.

3.3.6.1 Aiding selection.

a. The DRU-H-R shall allow the host to enable and inhibit each aiding source.

b. The DRU-H-R shall use an aiding source only if: the external aiding source is specified in configuration data; and the external aiding source and communications link are operational; and the aiding source is enabled; and aiding data from the source meets the source data acceptance criteria.

c. The DRU-H-R shall not require odometer sensor data or stops when useable GPS data are available.

d. When useable odometer sensor data are available and ZUPTs are enabled, the DRU-H-R shall not require a stop before the time since the last ZUPT or useable GPS data set, whichever occurred last, exceeds the Odometer Mode ZUPT Interval, specified in configuration data.

e. When ZUPTs are enabled, the DRU-H-R shall not require a stop before the time since the last ZUPT or usable GPS data set, whichever occurred last, exceeds the Exclusive ZUPT Mode Interval, specified in configuration data.

f. Host position updates may be required only when: an acceptable initial position isn't available from another source; or travel time since the last completed ZUPT or usable GPS data set, whichever occurred last, has exceeded 150 percent of the applicable ZUPT interval.

3.3.6.2 GPS aiding.

a. The DRU-H-R may use GPS aiding when: the GPS Installed flag (CFIG D26/7) is set; and the GPS receiver, antenna and communication link pass BIT; and GPS aiding is enabled; and current GPS data meet the acceptance criteria.

b. The DRU-H-R shall not use GPS aiding when: the GPS Installed flag (CFIG D26/7) is reset; or the GPS receiver or antenna or communications link fail BIT; or GPS aiding is inhibited; or current GPS data do not meet the acceptance criteria.

3.3.6.2.1 GPS data acceptance criteria.

a. The DRU-H-R may use current valid GPS data sets having an Estimated Position Error (EPE) ≤ the GPS Good Value specified in configuration data.

b. If a USE DEGRADED GPS DATA command is accepted, the DRU-H-R shall set STATUS DATA S6/6 (Degraded GPS Enabled) and may use valid GPS data sets having an EPE ≤ the GPS Poor Value.

c. When STATUS DATA S6/6 is set and a valid GPS data set with EPE ≤ the GPS EPE Good Value becomes available, the acceptance criteria shall become the GPS Good Value and STATUS DATA S6/6 shall be reset.

d. The DRU-H-R shall not use invalid GPS data sets, old (stale) GPS data sets or current GPS data sets having an EPE > the GPS Poor Value specified in configuration data.

e. GPS position data are valid if data in the current GPS data indicates the receiver has no failures, no GPS Antenna Fault is present (3.3.8.4.3.3), the PVT solution is valid, the PVT solution incorporates data from four or more satellites, and the code type(s) of the satellites used in the PVT solution is consistent with the selected code type (All Y-code, Mixed Y & P-code or C/A-code, only if configured for GPS SPS operation.)

3.3.6.3 Odometer sensor aiding.

a. The DRU-H-R may use odometer sensor aiding when: the Odometer Installed flag (CFIG D28/0) is set; and the odometer sensor BIT is not failed; and odometer sensor aiding is enabled; and STATUS DATA S2/4 (Pointing Device In Travel Lock) is set.

b. The DRU-H-R shall not use odometer sensor aiding when: the Odometer Installed flag (CFIG D28/0) is reset; or the odometer sensor failed BIT; or odometer sensor aiding is inhibited; or STATUS DATA S2/4 (Pointing Device In Travel Lock) is reset.

3.3.6.3.1 Faulty odometer sensor aiding data. When an odometer sensor malfunction or a significant amount of erroneous odometer sensor data is detected, the DRU-H-R shall:

a. Inhibit odometer aiding.

b. Set BIT DATA D2/1 (VMS Fail) and D2/0 (VMS Drive Fail).

c. If configured for a VMS odometer sensor, perform VMS hardware BIT. The DRU-H-R may wait until the host stops to perform VMS hardware BIT.

1) If the VMS passes hardware BIT, BIT DATA D2/1 (VMS Fail) and D2/0 (VMS Drive Fail) shall remain set.

2) If the VMS fails hardware BIT, BIT DATA D2/1 (VMS Fail) shall remain set and BIT D2/0 (VMS Drive Fail) shall be reset.

3.3.6.4 ZUPT aiding.

a. The DRU-H-R may utilize zero-velocity updates (ZUPTs) when STATUS DATA S3/2 (DRU-H-R In Motion) and S3/4 (ZUPTs Inhibited) are reset.

b. ZUPTs shall be initiated automatically.

c. The DRU-H-R shall not require stopping for more than 30 seconds to complete a ZUPT during Survey, interrupted Static Align, or Dynamic Align.

d. A ZUPT shall be terminated or interrupted when STATUS DATA S3/2 (DRU-H-R In Motion) is set or when motion would result in excessive position or attitude error.

e. Termination or interruption of a ZUPT shall not degrade DRU-H-R performance.

3.3.6.4.1 Valid unscheduled ZUPT requests.

a. When useable GPS data are not available, the DRU-H-R may request ZUPTs, no more frequently than the Exclusive ZUPT Mode Interval, when severe road/terrain conditions, such as soft sand, mud, snow, or ice, result in excessive erroneous odometer sensor data.

b. The DRU-H-R may request a ZUPT when gyro parameters must be adjusted because of severe thermal rates.

c. Neither of these conditions shall be considered relief from 3.5.2.3 and 3.5.7.

3.3.6.5 Host position updates. (see 6.6.1)

a. The DRU-H-R shall accept position updates via ACCEPT POSITION and ACCEPT GEODETIC DATA commands containing data meeting acceptance criteria.

b. Position updates shall be relative to the datum identified by the Datum ID in the ACCEPT POSITION and ACCEPT GEODETIC DATA command.

c. Grid coordinates shall be relative to the UTM grid.

d. Position updates include horizontal position or altitude updates (3.3.6.5.7), use of the relative offset flags (3.3.6.5.7.4), and datum updates (3.3.6.5.8).

3.3.6.5.1 Grid coordinate update.

a. If acceptance criteria are met, the DRU-H-R shall accept updates of any combination of the following parameters in an ACCEPT POSITION command: Datum; Extended Zone; Horizontal Position (Northing, Easting, Hemisphere & Zone); and Altitude.

b. The DRU-H-R shall accept UTM coordinate updates in terms of the normal zone or extended zone regardless of the designation of the zone/extended zone for output messages.

3.3.6.5.2 Geodetic coordinate update.

a. If acceptance criteria have been met, the DRU-H-R shall accept updates of any combination of the following parameters in an ACCEPT GEODETIC DATA command: Datum; Horizontal Position (Latitude and Longitude); and Altitude.

b. When an ACCEPT GEODETIC DATA command is used to initialize/update the DRU-H-R, UTM grid positions and grid azimuths shall be output in the normal zone until such time that an ACCEPT POSITION command specifying extended zone output has been accepted.

3.3.6.5.3 Parameter no-change values. The DRU-H-R shall accept the parameter values listed in Table II, which indicate a parameter grouping is not to be updated.

Table II - No update parameter values.

PARAMETER GROUP	VALUE
Horizontal Position	
Hemisphere/Zone, and	0
Easting, and	1,048,575
Northing	16,777,215
Or	
Latitude, and	91° 0’
Longitude	181° 0’
Altitude	16,383
Datum	6 ASCII spaces (20 hex)
Grid	15
Extended Zone	0

3.3.6.5.4 Position update characteristics.

a. The DRU-H-R shall not accept an update if any parameter is outside acceptance limits.

b. The DRU-H-R shall not accept partial updates of horizontal position.

c. The DRU-H-R shall not accept partial no-change value updates of horizontal position.

d. The DRU-H-R shall set ALERT DATA D5/7 (Invalid Update Request) if an invalid grouping is received.

e. The DRU-H-R may reject an update request and set ALERT DATA D5/7 (Invalid Update Request) if it is received while STATUS DATA S2/6 (Datum or Position Update In Progress) is set.

3.3.6.5.5 Position update reference. Positions input to the DRU-H-R will be for the applicable vehicle (Orientation 1) or pointing device (Orientation 2) offset point. The DRU-H-R shall relate the offset point position to the DRU-H-R location.

3.3.6.5.6 Position update duration.

a. When STATUS DATA S3/1 (Orientation Attitude Data Valid) is set, position updates shall be completed within 5 seconds after receipt of the update command.

b. When STATUS DATA S3/1 is reset, position updates shall be completed within 60 seconds after receipt of the update command.

3.3.6.5.7 Horizontal position and altitude updates.

a. The DRU-H-R shall accept host updates of the horizontal and altitude coordinates, while the host is stationary, upon receipt of an ACCEPT POSITION or ACCEPT GEODETIC DATA command.

b. If STATUS DATA S3/2 (DRU-H-R In Motion) is in the set state when the update command is received, the position update shall be rejected and ALERT DATA D3/5 (Motion During Update request) shall be set.

3.3.6.5.7.1 Acceptance criteria, GPS data not available. If valid GPS data are not available:

a. The DRU-H-R shall accept and use position parameters, input during Static Align via an ACCEPT POSITION or ACCEPT GEODETIC DATA command, meeting the allowable range limits.

b. The DRU-H-R shall compare position coordinates, input during Accelerated Align or Survey via an ACCEPT POSITION or ACCEPT GEODETIC DATA command, to the present internal estimate of DRU-H-R position. The DRU-H-R shall accept or reject the update based on the absolute values of position differences as specified in Table III. If any parameter is rejected, the entire update shall be rejected and the listed ALERT DATA bit(s) shall be set.

Table III. Position acceptance criteria - no GPS.

ABSOLUTE VALUE POSITION DIFFERENCE (meters)	ACCEPT REJECT	SET ALERT DATA
Horizontal Position		
$\Delta Pos \leq (3*DRU\text{-}H\text{-}R\_EHE + 10)$	accept	
$(3*DRU\text{-}H\text{-}R\_EHE + 10) < \Delta Pos \leq (12*DRU\text{-}H\text{-}R\_EHE + 150)$	reject	D4/0 (Horizontal Position Update Excessive)
$\Delta Pos > (12*DRU\text{-}H\text{-}R\_EHE + 150)$	reject	D4/3 (Horizontal Position Update Rejected)
Altitude		
$\Delta Alt \leq (3*DRU\text{-}H\text{-}R\_EVE + 5)$	accept	
$(3*DRU\text{-}H\text{-}R\_EVE + 5) < \Delta Alt \leq (12*DRU\text{-}H\text{-}R\_EVE + 50)$	reject	D4/1 (Altitude Update Excessive)
$\Delta Alt > (12*DRU\text{-}H\text{-}R\_EVE + 50)$	reject	D4/4 (Altitude Update Rejected)

3.3.6.5.7.2 Acceptance criteria, valid GPS data available.

a. When the DRU-H-R is in Align or Survey and valid GPS data are available, the DRU-H-R shall compare position coordinates in an ACCEPT POSITION or ACCEPT GEODETIC DATA command to the current GPS position, offset to a common reference point.

b. The DRU-H-R shall accept or reject the update based on the absolute values of position differences as specified in Table IV.

c. If any parameter is rejected, the entire update shall be rejected and the listed ALERT DATA bit(s) shall be set.

Table IV. Position acceptance criteria - GPS.

ABSOLUTE VALUE POSITION DIFFERENCE (meters)	ACCEPT REJECT	SET ALERT DATA
Horizontal Position		
$\Delta Pos \leq 3*(GPS\_EHE^2 + 900)^{1/2}$	accept	
$3*(GPS\_EHE^2 + 900)^{1/2} < \Delta Pos \leq 12*(GPS\_EHE^2 + 900)^{1/2}$	reject	D4/0 (Horizontal Position Update Excessive) & D4/2 (GPS Position and Update Disagree)
$\Delta Pos > 12*(GPS\_EHE^2 + 900)^{1/2}$	reject	D4/3 (Horizontal Position Update Rejected) & D4/2 (GPS Position and Update Disagree)
Altitude		
$\Delta Alt \leq 3*(GPS\_EVE^2 + 100)^{1/2}$	accept	
$3*(GPS\_EVE^2 + 100)^{1/2} < \Delta Alt \leq 12*(GPS\_EVE^2 + 100)^{1/2}$	reject	D4/1 (Altitude Update Excessive) & D4/2 (GPS Position & Update Disagree)
$\Delta Alt > 12*(GPS\_EVE^2 + 100)^{1/2}$	reject	D4/4 (Altitude Update Rejected) & D4/2 (GPS Position & Update Disagree)

3.3.6.5.7.3 Update after rejection.

a. When an update has been rejected, the data shall be retained for comparison if the data are reentered.

b. If: the reentered data are the same; and the host has remained stationary; and ALERT DATA D4/3 (Horizontal Position Update Rejected) or D4/4 (Altitude Update Rejected) was not previously set, the reentered update shall be accepted.

c. Otherwise, the data shall be tested in accordance with 3.3.6.5.7.1 or 3.3.6.5.7.2 as if the update was received for the first time.

3.3.6.5.7.4 Determine relative offsets. The DRU-H-R shall perform as follows when valid horizontal position or altitude updates are received (see 6.6.2):

a. If the Determine Relative Offsets flag = 1, and the update position meets the acceptance criteria (3.3.6.5.7.1 or 3.3.6.5.7.2): position shall be updated, and STATUS DATA S2/0 (Relative Offsets Determined) shall be set.

b. If the Determine Relative Offsets flag = 0, the update position meets the acceptance criteria (3.3.6.5.7.1 or 3.3.6.5.7.2), and the position update input datum is the same as the current datum: position shall be updated, and the current state of STATUS DATA S2/0 (Relative Offsets Determined) shall be retained.

c. If the Determine Relative Offsets flag = 0, the update position meets the acceptance criteria (3.3.6.5.7.1 or 3.3.6.5.7.2), and the position update input datum differs from the current datum: position shall be updated, and STATUS DATA S2/0 (Relative Offsets Determined) shall be reset.

d. If the position update is rejected, the current state of STATUS DATA S2/0 (Relative Offsets Determined) shall be retained regardless of the state of the Determine Relative Offsets flag.

e. Determination of Relative Offsets shall be independent of whether GPS aiding is enabled or inhibited.

f. The current state of STATUS DATA S2/0 (Relative Offsets Determined) shall be saved at shutdown.

3.3.6.5.8 Datum updates.

a. The DRU-H-R shall accept and then output coordinates referenced to the datum specified in a valid ACCEPT POSITION DATA or ACCEPT GEODETIC DATA command.

b. The DRU-H-R shall accept an ACCEPT POSITION DATA or ACCEPT GEODETIC DATA command containing valid data, in which all items except Datum ID Code are no-change values, whether stationary or moving.

3.3.7 Functional states. (see 6.6.3)

a. The DRU-H-R shall support the following functional states: Initialization, Accelerated Align, Static Align, Interrupted Static Align, Dynamic Align, Survey, Restart Required and Shutdown Complete.

b. As a minimum, the DRU-H-R shall transition between the states indicated in Table V in accordance with the conditions listed in Table VI.

Table V - DRU-H-R functional state transition matrix.

New State ⇒ ⇓ Current State ⇓	FS1	FS2	FS3	FS4	FS5	FS6	FS7	FS8
FS1 – Initialization		T12	T13					T18
FS2 - Accelerated Align	T21		T23		T25	T26	T27	T28
FS3 - Static Align	T31			T34	T35	T36	T37	T38
FS4 - Interrupted Static Align	T41		T43				T47	T48
FS5 - Dynamic Align	T51		T53			T56	T57	T58
FS6 - Survey	T61						T67	T68
FS7 - Restart Required	T71							T78
FS8 - Shutdown Complete								

Table VI - DRU-H-R state transition conditions

Transition(s)	Functional State Transition Conditions
T12	S1/6 (DRU-H-R Startup Complete) transitions to 1 AND DRU-H-R was shutdown with STORED HEADING SHUTDOWN Cmd. AND ALERT D1/0 (Previous Shutdown Abnormal) = 0 AND no RESTART command has been accepted
T13	S1/6 (DRU-H-R Startup Complete) transitions to 1 AND [DRU-H-R was shutdown with a SHUTDOWN Cmd. OR ALERT D1/0 (Previous Shutdown Abnormal) = 1 OR a RESTART command was previously accepted]
T18, T28, T38, T48, T58, T68, T78	S4/4 (DRU-H-R Shutdown Complete) = 1
T21, T31, T41, T51, T61, T71	RESTART command accepted
T23	Unable to successfully complete Accelerated Align
T25, T35	S3/2 (DRU-H-R in Motion) = 1 AND S5/6 (GPS Enabled) = 1
T26	Accelerated Align successfully completed

Table VI - DRU-H-R state transition conditions - Continued

Transition(s)	Functional State Transition Conditions
T27	[S3/2 (DRU-H-R in Motion) = 1 AND S5/6 (GPS Enabled) = 0] OR ALERT D3/1 (Excessive Rates) = 1
T34	[S3/2 (DRU-H-R in Motion) = 1 AND S5/6 (GPS Enabled) = 0] AND S1/4 (Ok to Move) = 1
T36	Static Align successfully completed
T37, T47	[ALERT D1/0 (Previous Shutdown Abnormal) = 1 AND 3.5 minutes of Static Align has been completed] OR ALERT D2/3 (Align Interrupt) = 1 OR ALERT D2/4 (Unable to Complete Align) = 1 OR ALERT D3/1 (Excessive Rates) = 1
T43	S3/2 (DRU-H-R in Motion) = 0 AND a ZUPT has been completed
T53	[S3/2 (DRU-H-R in Motion) = 0 AND a ZUPT has been completed] OR {[S1/4 (Ok to Move) = 1 OR S3/2 (DRU-H-R in Motion) = 0] AND [an ENABLE INERTIAL MODE command is received OR a GPS failure is detected]}
T56	Dynamic Align successfully completed with estimated azimuth error ≤ 0.67 mil PE
T57	ALERT D2/4 (Unable to Complete Align) = 1 OR ALERT D3/1 (Excessive Rates) = 1 OR estimated azimuth error > 3.0 mils PE at end of nominal Dynamic Align Interval OR estimated azimuth error > 0.67 mils PE at end of extended Dynamic Align Interval
T67	ALERT D3/1 (Excessive Rates) = 1

3.3.7.1 Initialization. Except where noted, within 20 seconds after application of power or after acceptance of a RESTART command the DRU-H-R shall:

a. Initialize STATUS DATA, ALERT DATA, and BIT DATA in accordance with Appendix B.

b. Set ALERT DATA D5/3 (Configuration Data Not Present) if configuration data are not present.

c. Set ALERT DATA D4/5 (Ethernet Configuration Data Not Present) if Ethernet configuration data are not initialized.

d. Set ALERT DATA D5/4 (Pointing Device Boresight Angles Not Present) if pointing device boresight angles are not present.

e. Set ALERT DATA D2/7 (Vehicle Boresight Angles Not Present) if vehicle boresight angles are not present.

f. While ALERT DATA D5/3, D5/4, or D2/7 is set, the STATUS DATA bits listed in Table VII shall remain in the states indicated.

Table VII - Initial STATUS settings.

STATUS DATA bit	STATE
S1/7 (DRU-H-R In Startup)	set
S1/5 (DRU-H-R In Align)	reset
S1/4 (OK To Move)	reset
S5/4 (DRU-H-R In Dynamic Align)	reset
S2/2 (DRU-H-R In Stored Heading Align)	reset

g. Determine BIT status of itself, and if there is any DRU-H-R failure, set BIT DATA D1/7 (DRU-H-R Fail). BIT DATA D1/6 (DRU-H-R Inertial Fail) shall be set to indicate that DRU-H-R determined position, attitude and rate data may be invalid. BIT DATA D1/5 (DRU-H-R Non-Inertial Fail) shall be set to indicate that all transmitted data may be invalid.

h. Set ALERT DATA D1/0 (Previous Shutdown Abnormal) and STATUS DATA S1/1 (Position Update Request) if the last shutdown was abnormal. Exception: These bits shall not be set again for RESTART if previously reset.

i. If the GPS Installed flag (CFIG D26/7) is reset, the DRU-H-R shall not: enable GPS aiding; or report GPS receiver, GPS Communication or GPS Antenna failures.

j. If the GPS Installed flag (CFIG D26/7) is set, the DRU-H-R shall determine BIT status of the GPS receiver, GPS Communications and GPS Antenna and set BIT DATA D2/2 (GPS Fail), D2/3 (GPS Communication Fail), or D2/4 (GPS Antenna Fault), as applicable.

k. If the Odometer Installed flag (CFIG D28/0) is reset, the DRU-H-R shall set STATUS DATA S1/3 (Odometer Inhibited) and shall not report VMS and VMS Drive failures.

l. If the Odometer Installed flag (CFIG D28/0) flag is set and the DRU-H-R is configured for a VMS odometer sensor (CFIG D28/1), the DRU-H-R shall initiate VMS hardware BIT. VMS BIT shall not be initiated prior to 3 seconds after application of power. If there is a BIT failure, the DRU-H-R shall set BIT DATA D2/1 (VMS Fail) and STATUS DATA S1/3 (Odometer Inhibited).

m. Set STATUS DATA S2/4 (Pointing Device In Travel Lock) unless: the Travel Lock Commands flag (CFIG D28/4) is set and an OUT OF TRAVEL LOCK command has been received.

n. Respond to commands, received from the host, within 10 seconds after power-on.

o. If initial position parameters have not been received, set ALERT DATA D2/6 (Align Initial Position Parameters Not Received).

p. If the previous shutdown was normal and the Reset Relative Offsets flag (CFIG D27/3) is reset, set STATUS DATA S2/0 (Relative Offsets Determined) to its stored state. Otherwise, reset STATUS DATA S2/0. Exception: Previously determined state of STATUS DATA S2/0 shall be retained following acceptance of a RESTART command.

q. Set the Relative Offsets Applied flag in output messages to the corresponding state of the Initialize Relative Output flag (CFIG D27/2).

r. Reset STATUS DATA S1/7 (DRU-H-R In Startup) and set STATUS DATA S1/6 (DRU-H-R Startup Complete) when: steps a. through q., above, have been completed; ALERT DATA D5/3, D5/4, and D2/7 all are reset; and the DRU-H-R is ready to align.

s. Transition to Align.

3.3.7.2 Position initialization. Before completing Accelerated Align, Static Align, or Dynamic Align and proceeding to Survey, the DRU-H-R shall initialize position.

Sources of initial positions, in priority order, shall be:

a. Position stored at shutdown, if in Accelerated Align.

b. Host position update via ACCEPT POSITION or ACCEPT GEODETIC DATA commands.

c. GPS data when STATUS DATA S6/1 (EPE ≤ GPS Good Level) is set.

d. Position stored at shutdown, if ALERT DATA D1/0 (Previous Shutdown Abnormal) is reset.

e. GPS data when ALERT DATA D1/0 (Previous Shutdown Abnormal) and STATUS DATA S6/0 (EPE ≤ GPS Poor Level) are set.

3.3.7.2.1 Host update after normal shutdown.

a. If ALERT DATA D1/0 (Previous Shutdown Abnormal) is reset, the DRU-H-R shall accept initial parameters input, using the ACCEPT POSITION or ACCEPT GEODETIC DATA commands, at anytime during Static Align if acceptance criteria are met (3.3.6.5.7.1 and 3.3.6.5.7.2).

b. If one of these commands is accepted, ALERT DATA D2/6 (Align Initial Position Parameters Not Received) shall be reset.

c. Until one of these commands is accepted, the DRU-H-R shall use the current stored or GPS position and the stored datum.

d. ALERT DATA D2/6 (Align Initial Position Parameters Not Received) shall be reset at successful completion of Static Align.

3.3.7.2.2 Host update after abnormal shutdown.

a. If ALERT DATA D1/0 (Previous Shutdown Abnormal) is set, the DRU-H-R shall accept initial parameters input, using the ACCEPT POSITION or ACCEPT GEODETIC DATA commands, during the first 3.5 minutes of Static Align, if acceptance criteria are met (3.3.6.5.7.1 and 3.3.6.5.7.2).

b. On acceptance of the initial parameters: align may automatically be restarted; and STATUS DATA S1/1 (Position Update Request), ALERT DATA D2/6 (Align Initial Position Parameters Not Received), and ALERT DATA D1/0 (Previous Shutdown Abnormal) shall be reset.

3.3.7.2.3 Host update during accelerated align.

a. If the DRU-H-R receives a valid ACCEPT POSITION or ACCEPT GEODETIC DATA command while in Accelerated Align, the DRU-H-R shall accept the command but may delay parameter update until transition to Survey or Static Align while stationary.

b. STATUS DATA S2/6 (Datum or Position Update In Progress) shall be set while the update is pending.

c. If STATUS DATA S3/2 (DRU-H-R In Motion) becomes set, the DRU-H-R shall: reject a pending position update; and set ALERT DATA D2/2 (Position Update Interrupt); and reset STATUS DATA S2/6 (Datum or Position Update In Progress).

3.3.7.2.4 Initialization with GPS data.

a. During Static Align, if a position update has not been accepted via an ACCEPT POSITION or ACCEPT GEODETIC DATA command and if STATUS DATA S5/6 (GPS Enabled) is set and:

1) If STATUS DATA S6/1 (EPE ≤ GPS Good Level) is set, the DRU-H-R shall: initialize position parameters using GPS data, reset ALERT DATA D2/6 (Align Initial Position Parameters Not Received), reset ALERT DATA D1/0 (Previous Shutdown Abnormal), and reset STATUS DATA S1/1 (Position Update Request).

2) If ALERT DATA D1/0 (Previous Shutdown Abnormal) is set and STATUS DATA S6/1 (EPE ≤ GPS Good Level) is reset and S6/0 (EPE ≤ GPS Poor Level) is set, the DRU-H-R shall perform an initial position parameters update using GPS data, reset ALERT DATA D2/6 (Align Initial Position Parameters Not Received), and reset ALERT DATA D1/0 (Previous Shutdown Abnormal).

b. The DRU-H-R shall initialize position, as specified above, at 120 seconds after entering Static Align or when GPS data meeting the acceptance criteria are available, whichever is later.

c. If orientation parameters are not sufficiently determined to accurately offset the GPS antenna location to the DRU-H-R, when initialization is performed, the DRU-H-R position shall be reinitialized when adequate orientation data are available.

d. The DRU-H-R may restart Static Align when position is initialized using GPS data.

3.3.7.3 Accelerated align.

a. Accelerated Align shall be completed within 60 seconds after entry.

b. For successful Accelerated Align completion, the DRU-H-R may require that: the last shutdown was normal; and the DRU-H-R remained stationary since the last shutdown.

c. Before indicating successful Accelerated Align completion, the DRU-H-R shall automatically transition to another align sub-mode if there is a high probability the DRU-H-R coordinate frame is not accurately aligned to the earth referenced coordinate frame.

3.3.7.3.1 Odometer aiding after accelerated align. Upon successful completion of Accelerated Align, the DRU-H-R may inhibit use of odometer aiding and set STATUS DATA S1/2 (ZUPT Stop Request), after each 3.75 minutes of travel since the last stop or GPS position update, until stopped time or valid GPS data with EPE ≤ the configuration data GPS EPE Good Value have been accumulated for 5 minutes.

3.3.7.4 Static align.

a. The DRU-H-R shall complete Static Align, within the time specified in configuration data, without requiring stored or entered orientation data.

b. The DRU-H-R shall be capable of Static Align in any orientation and after being elevated/rotated from its normal travel position.

c. STATUS DATA S1/4 (OK To Move) shall be set when the Interrupted Static Align Performance Criteria (3.6.2) can be met after movement, no later than 3.5 minutes after Static Align entry.

d. A reasonableness test shall be performed prior to completing Static Align. If the initial position or instrument biases are unreasonable; or if STATUS DATA 3/1 (Orientation Attitude Data Valid) is reset when Align Time To Go reaches zero, the DRU-H-R shall transition to the Restart Required state.

3.3.7.5 Interrupted static align.

a. In Static Align, if GPS aiding is inhibited and STATUS DATA S3/2 (DRU-H-R In Motion) and S1/4 (OK To Move) are set, the DRU-H-R shall transition to Interrupted Static Align.

b. In interrupted Static Align, STATUS DATA S1/2 (ZUPT Stop Request) may be set after each period of 3.75 minutes (minimum) of travel.

c. Align Time To Go is not required to decrement: while STATUS DATA S3/2 (DRU-H-R In Motion) is set; or for 30 seconds after stopping; or while excessive motion disturbances are present.

3.3.7.6 Dynamic align.

a. In Accelerated or Static Align, if GPS aiding is enabled and STATUS DATA S3/2 (DRU-H-R In Motion) is set, the DRU-H-R shall transition to Dynamic Align.

b. The DRU-H-R shall not require stops or host position updates during Dynamic Align.

3.3.7.7 Survey.

a. The DRU-H-R shall successfully complete Align prior to entering Survey.

b. During survey, the DRU-H-R shall provide position, orientation and angular rate parameters to the accuracy requirements specified in 3.6.2.

c. The DRU-H-R may use any available and enabled aiding source during Survey.

3.3.7.8 Restart required. The DRU-H-R shall be in the Restart Required state when it was unsuccessful in completing align or a condition was encountered which could result in seriously degraded accuracy.

3.3.7.9 Shutdown complete.

a. The DRU-H-R shall be in the Shutdown Complete state when a SHUTDOWN command or a STORED HEADING SHUTDOWN command was accepted, data has been saved for shutdown, and power can be removed without causing an abnormal shutdown condition.

b. The DRU-H-R shall enter Shutdown Complete within 4.5 seconds after receipt of the first bit of the initiating command.

c. When in Shutdown Complete, the DRU-H-R shall respond to data request commands but is not required to change operating modes.

3.3.8 BIT.

a. The DRU-H-R shall detect and report at least ninety-five percent of all malfunctions occurring in the DRU-H-R.

b. A BIT indication of a malfunction when there is no actual malfunction is considered a malfunction.

c. The DRU-H-R shall: perform VMS hardware BIT, when configured for a VMS; monitor GPS receiver BIT; monitor odometer sensor and GPS performance; and report VMS, VMS Drive, GPS receiver, GPS Communications and GPS Antenna failures.

3.3.8.1 BIT indications.

a. Two BIT indicators (DS) shall be located on a visible face of the DRU-H-R.

b. DS-1 shall indicate by a green display that the DRU-H-R is receiving proper primary power.

c. DS-2 shall indicate by a green display that the DRU-H-R is operating correctly.

d. The BIT indicators shall indicate a failed condition by a black or non-illuminated display.

e. Type I – BIT indicators DS-1 and DS-2 shall be visible during normal DRU-H-R operation and maintenance.

f. Type II – BIT indicators DS-1 and DS-2 shall not be visible during normal DRU-H-R operation.

g. Type II – The DRU-H-R shall provide the capability to view BIT indicators DS-1 and DS-2 during maintenance.

h. Failure of the DRU-H-R, GPS receiver, GPS Communications, GPS Antenna, VMS, or VMS Drive shall be reported over the serial data interfaces in accordance with Appendices A and B.

i. BIT DRU-H-R failure history, to the inertial instrument and LRU level, or below, shall be maintained in non-volatile memory. BIT history data shall be accessible and resetable, in vendor's format, via the host serial data interface (see 6.2).

3.3.8.2 Turn-on BIT.

a. At turn-on, if primary power voltage is outside the specified limits: the DRU-H-R shall remain off, and DS-1 shall indicate a failed condition.

b. If power is acceptable, the DRU-H-R shall energize.

3.3.8.3 Initialization BIT.

a. After being energized at turn-on or when commanded to RESTART, the DRU-H-R shall perform BIT of itself.

b. If the Odometer Installed flag (CFIG D28/0) is set and the DRU-H-R is configured for a VMS (CFIG D28/1), the DRU-H-R shall perform VMS hardware BIT; if reset, the DRU-H-R shall not report VMS failures.

c. If the GPS Installed flag (CFIG D26/7) is set, the DRU-H-R shall perform/monitor GPS related BIT; if reset, the DRU-H-R shall not report GPS failures.

3.3.8.4 Operational BIT. In addition to 3.3.8, the DRU-H-R shall perform BIT as specified in the following subparagraphs during operation.

3.3.8.4.1 DRU-H-R BIT.

a. If primary power is outside acceptable limits, the DRU-H-R shall de-energize, and DS-1 shall indicate a failed condition.

b. ALERT DATA D3/1 (Excessive Rates) shall be set if dynamic conditions have exceeded the DRU-H-R capability to maintain specified accuracy requirements.

3.3.8.4.2 Odometer sensor BIT.

a. If an odometer sensor is used, the DRU-H-R shall continuously evaluate the validity of odometer sensor data.

b. Should odometer sensor data be persistently in error or if there is a significant loss of odometer sensor data, the DRU-H-R shall:

1) Set BIT DATA D2/1 (VMS Fail) and D2/0 (VMS Drive Fail).

2) If configured for a VMS, automatically perform VMS hardware BIT, which may be delayed until the host is stopped:

a) If the VMS passes hardware BIT, BIT DATA D2/1 (VMS Fail) and D2/0 (VMS Drive Fail) shall remain set.

b) If the VMS fails hardware BIT, BIT DATA D2/1 (VMS Fail) shall remain set and D2/0 (VMS Drive Fail) shall be reset.

3.3.8.4.3 GPS BIT. When a GPS receiver is configured, the DRU-H-R shall report GPS Fail BIT, GPS Communication BIT, and GPS Antenna Fault.

3.3.8.4.3.1 GPS receiver BIT fail.

a. If the GPS data indicates a receiver failure, the DRU-H-R shall inhibit GPS aiding, reset STATUS DATA S5/6 (GPS Enabled), and set BIT DATA D2/2 (GPS Fail).

b. BIT DATA D2/2 shall not be reset until (a RESTART command has been accepted or an ENABLE INTEGRATED MODE command has been received) and GPS data indicates no receiver failure.

3.3.8.4.3.2 GPS communication BIT.

a. The DRU-H-R shall monitor the GPS TIA-422 data interface and the GPS 1PPS Discrete for proper communications.

b. BIT DATA D2/3 (GPS Communication Fail) shall be set if communications are improper.

c. BIT DATA D2/3 shall be reset when proper communications with the GPS receiver are established.

3.3.8.4.3.3 GPS antenna fault.

a. BIT DATA D2/4 (GPS Antenna Fault) shall be set if the GPS Antenna Source, in GPS Message #5040 (Current Status), differs from that specified by the Integral/External Antenna flag (CFIG D26/3).

b. BIT DATA D2/4 shall be reset when matching antenna sources are indicated.

c. GPS aiding shall be inhibited when BIT DATA D2/4 is set.

3.3.9 GPS receiver control.

a. When the GPS Installed flag (CFIG D26/7) is set, the DRU-H-R shall: attempt to exchange messages with and control the GPS receiver, and report GPS status and warnings.

b. When the GPS Installed flag is reset, the DRU-H-R shall not: exchange messages with or control the GPS receiver; or report GPS related BIT failures.

3.3.9.1 GPS receiver initialization. The DRU-H-R shall initialize the GPS receiver as specified in Table VIII.

3.3.9.2 Updating GPS receiver settings.

a. The DRU-H-R shall update GPS receiver settings of the parameters listed in Table IX upon acceptance of any of the listed commands.

b. If the DRU-H-R and GPS receiver are not communicating when a command listed in Table IX is received, the DRU-H-R shall initialize or update the GPS receiver, using the new settings, when communications are (re)established.

3.3.9.3 GPS at shutdown. The DRU-H-R shall command the GPS receiver at shutdown as specified in Appendix C.

3.3.9.4 GPS status reporting. The DRU-H-R shall report the operational status of the GPS receiver as specified in Appendix B.

Table VIII. GPS receiver initial settings.

PARAMETER	SETTING
Mode	Continuous mode
Keyboard/display	Disable keyboard/display
SV Type	SV type stored at previous shutdown; or All Y-code if ALERT DATA D1/0 (Previous Shutdown Abnormal) is set, unless configured for GPS SPS operation.
Coordinate Reference	Lat/Lon in deg/min if the Geodetic/Grid GPS Data flag (CFIG D26/2) is set; or UTM/UPS if CFIG D26/2 is reset.
Distance Units	metric
Elevation Units	meters
Elevation Reference	MSL
Angular Units	Mils
North Reference	True North if CFIG D28/0 (Geodetic/Grid Azimuth) is set, or Grid North if D28/0 is reset.
MVAR Type	calculated by system
Navigation Type	2D Fast
Elevation Hold Type	manual
Time Reference	UTC time (ZULU)
Error Units	distance
Selected Datum	0
Auto Timer Off	5 minutes
HaveQuick	ON
1PPS	time mark
Datum Identifier	Datum identifier stored at previous shutdown; or WGD (WGS 84) if ALERT DATA D1/0 (Previous Shutdown Abnormal) is set.

Table IX. GPS receiver settings update.

PARAMETER	COMMAND(S)
SV Type	SELECT Y-CODE ONLY SATELLITES, or SELECT P OR Y-CODE SATELLITES, unless configured for GPS SPS operation.
Coordinate Reference	For ACCEPT CONFIGURATION DATA, ACCEPT POSITION or ACCEPT GEODETIC DATA set to: Lat/Lon in deg/min if the Geodetic/Grid GPS Data flag (CFIG D26/2) is set or UTM/UPS if CFIG D26/2 is reset.
North Reference	ACCEPT CONFIGURATION DATA set to: True North if CFIG D28/0 (Geodetic/Grid Azimuth) is set, or Grid North if D28/0 is reset.
Datum Identifier	ACCEPT POSITION, or ACCEPT GEODETIC DATA

3.3.9.5 GPS warning messages.

a. The DRU-H-R shall receive and queue, for later transmission, a minimum of eight GPS Warning Messages from the GPS receiver.

b. STATUS DATA S6/5 (GPS Warning Present) shall be set when a GPS Warning Message is received.

c. STATUS DATA S6/5 shall be reset when the last stored message has been deleted from the queue by the RETURN NEXT GPS WARNING command.

d. In the case of queue overflow, the oldest warning in the queue shall be replaced with the most recent.

3.3.10 Determination of travel lock. The DRU-H-R shall determine the travel lock state in accordance with the state of the Travel Lock Commands (CFIG D28/4) flag (see Appendix C.)

3.3.10.1 Out of travel lock transition. When the travel lock state transitions to “out of travel lock”, the DRU-H-R shall: freeze vehicle attitudes; freeze and store travel lock pointing device references (azimuth and pitch) in terms of the appropriate Orientation (1 or 2); reset STATUS DATA S2/4 (Pointing Device in Travel Lock); inhibit odometer aiding; and, if motion is detected, set ALERT DATA D3/0 (Motion with Pointing Device out of Travel Lock).

3.3.10.2 In travel lock transition. When the travel lock state transitions to “in travel lock”, the DRU-H-R shall: provide present vehicle attitudes; provide present pointing device azimuth and pitch for travel lock reference; set STATUS DATA S2/4 (Pointing Device in Travel Lock); enable odometer aiding and reset STATUS DATA S1/3 (Odometer Inhibited), if the Odometer Installed flag (CFIG D28/0) is set; and reset ALERT DATA D3/0 (Motion With Pointing Device Out of Travel Lock).

3.3.11 Shot detect. When STATUS DATA S1/4 (Ok to Move) is set and S2/4 (Pointing Device In Travel Lock) is reset, the DRU-H-R shall report gunfire shocks, at the sensor assembly, if the Shot Detect flag (CFIG D28/5) is set.

a. Upon detection of gunfire, STATUS DATA S2/3 (Shot Detect) shall be set.

b. At the completion of the Shot Detect Interval specified in configuration data, STATUS DATA S2/3 shall be reset.

3.3.12 Electrical interface. The electrical interface of the DRU-H-R shall be as defined in the following subparagraphs. The electrical signals at the DRU-H-R connectors consist of power, host TIA-422 serial data signals, GPS serial data signals, VMS signals, GPS 1PPS signal, configuration selection discretes, software download selection discrete, speedometer sender signal, Ethernet data signals, and test signals.

3.3.12.1 Connectors. The following connectors shall be in accordance with MS27468J.

a. The DRU-H-R shall have three external electrical connectors for interface with the host.

b. The main signal connector (J1) shall conform to MS27468T19F35S.

c. The power connector (J2) shall conform to MS27468T15F15P.

d. The supplemental signal connector (J3) shall conform to MS27468T19F35SA.

e. J1, J2 and J3 shall be located, oriented and identified in accordance with Appendix F.

3.3.12.1.1 Connector pin functions.

a. J1 pin functions shall be as specified in Table X.

b. J2 pin functions shall be as specified in Table XI.

c. J3 pin functions shall be as specified in Table XII.

d. Signal circuits shall be terminated in accordance with Figure 1. Termination resistor tolerance shall be ±20%.

e. Pins identified as RESERVED in Table X and Table XI shall not be connected within the DRU-H-R unless otherwise specified.

Table X. J1 pin functions.

J1 PIN	PIN FUNCTION	TERMINATION
1	Synchronous TIA-422 Interface B Clock - Hi	A
2	Spare	
3	Software Load Discrete	
4	Synchronous TIA-422 Interface B Data - Hi	B
5	Synchronous TIA-422 Interface B Clock - Lo	A
6	Spare	
7	Spare	
8	Synchronous TIA-422 Interface A Clock - Hi	A
9	Synchronous TIA-422 Interface A Clock - Lo	A
10	Synchronous TIA-422 Interface B Data - Lo	B
11	Signal Ground (for Configuration Discrete)	
12	RESERVED	
13	RESERVED	
14	Signal Ground (for Configuration Discrete)	
15	TIA-232 Interface E Receive	
16	Synchronous TIA-422 Interface A Data - Hi	B
17	RESERVED	
18	RESERVED	
19	Vehicle Configuration Discrete 3	
20	Chassis Ground	
21	28 Vdc Return	
22	28 Vdc Return	
23	28 Vdc Return	
24	Synchronous TIA-422 Interface A Data - Lo	B
25	GPS Data Interface, Transmit (TIA-422) - Hi	
26	Signal Ground (for Configuration Discrete)	
27	RESERVED (Optional +15 Vdc)	
28	Vehicle Configuration Discrete 4	
29	RESERVED (Optional +15 Vdc)	
30	+5 Vdc	
31	+5 Vdc	
32	Signal Ground (for Configuration Discrete)	
33	Vehicle Configuration Discrete 1	
34	GPS Data Interface, Transmit (TIA-422) - Lo	
35	TIA-232 Interface E Transmit	
36	+5 Vdc	
37	RESERVED (Optional -15 Vdc)	
38	RESERVED (Optional -15 Vdc)	
39	Power output DC Return	
40	Power output DC Return	
41	Signal Ground (for Configuration Discrete)	

Table X. J1 pin functions.-Continued

J1 PIN	PIN FUNCTION	TERMINATION
42	Vehicle Configuration Discrete 2	
43	GPS Data Interface, Receive (TIA-422) - Hi	
44	Signal Ground (for Configuration Discrete)	
45	Power output DC Return	
46	Spare	
47	GPS 1PPS Discrete	
48	No connection (Reserved for host use)	
49	VMS BIT Command 2 (TIA-422) - Hi	
50	VMS BIT Command 2 (TIA-422) - Lo	
51	GPS Data Interface, Receive (TIA-422) - Lo	
52	+28 Vdc	
53	VMS Reverse Data (TIA-422) - Hi	
54	VMS Reverse Data (TIA-422) - Lo	
55	No Connection (Reserved for host use)	
56	RESERVED	
57	VMS BIT Command 1 (TIA-422) - Hi	
58	+28 Vdc	
59	+28 Vdc	
60	Spare	
61	No Connection (Reserved for host use)	
62	Wired Spare 2 (Supplier Reserved)	
63	VMS BIT Command 1 (TIA-422) - Lo	
64	VMS Forward Data (TIA-422) - Hi	
65	VMS Forward Data (TIA-422) - Lo	
66	Wired Spare 1 (Supplier Reserved)	

Table XI. J2 pin functions.

J2 PIN(S)	PIN FUNCTION
A	+28 Vdc Power In
B	+28 Vdc Power In
C	RESERVED
D	RESERVED
E – H, J - L, R	No Connection
M	DC Power Return
N	DC Power Return
P	Chassis Ground

Table XII. J3 pin functions.

J3 PIN	PIN FUNCTION	TERMINATION
1	1000Base-T Signal, Bi-directional pair D- (BI_DD_M)	
2	1000Base-T Signal, Bi-directional pair D+ (BI_DD_P)	
3	1000Base-T Signal, Bi-directional pair C- (BI_DC_M)	
4	1000Base-T Signal, Bi-directional pair B- (BI_DB_M)	
5	1000Base-T Signal, Bi-directional pair B+ (BI_DB_P)	
6	1000Base-T Signal, Bi-directional pair A- (BI_DA_M)	
7	1000Base-T Signal, Bi-directional pair A+ (BI_DA_P)	
8	1000Base-T Signal, Bi-directional pair C+ (BI_DC_P)	
9 – 55, 57	Spare	
56	Asynchronous TIA-422 Interface C Receive - Hi	A
63	Asynchronous TIA-422 Interface C Receive – Lo	A
61	Asynchronous TIA-422 Interface C Transmit - Hi	
62	Asynchronous TIA-422 Interface C Transmit - Lo	
59	Asynchronous TIA-422 Interface D Receive - Hi	A
60	Asynchronous TIA-422 Interface D Receive – Lo	A
58	Asynchronous TIA-422 Interface D Transmit - Hi	
64	Asynchronous TIA-422 Interface D Transmit - Lo	
65	Speedometer Sender Signal	
66	Speedometer Sender Ground Isolated	

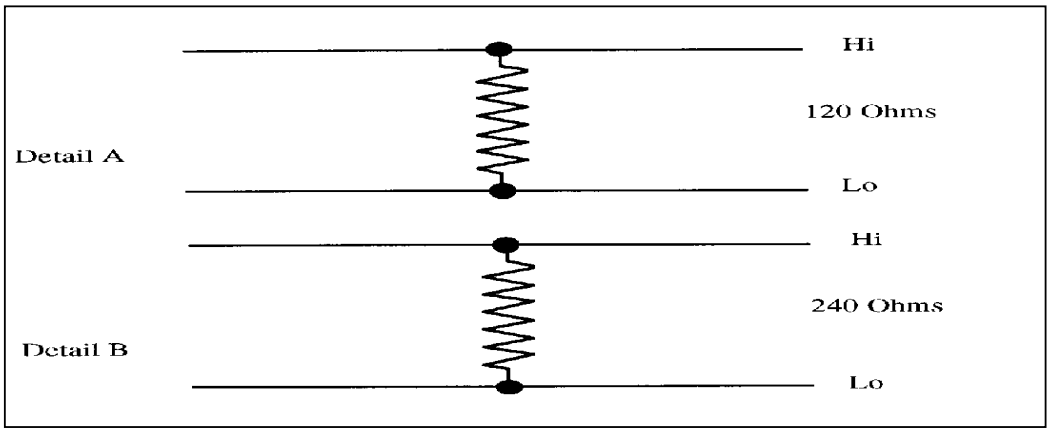


Figure 1. Termination details.

3.3.12.2 Bonding and shield grounding.

a. When secured to a conductive metal mount, the resistance between the DRU-H-R chassis and mount, through the electrical bonding surfaces identified in Appendix F, shall be less than 0.1 Ohm.

b. Shields of external cables mating with J1, J2, and J3 will be terminated to the connector backshells.

c. The DC resistance between J1, J2, and J3 connector shells and the DRU-H-R chassis shall be less than 2.5 milliohms.

3.3.12.3 Power.

a. The DRU-H-R shall operate from power provided from a nominal 28 Vdc vehicle power source.

b. Input power for the DRU-H-R shall not exceed 90 watts.

c. The DRU-H-R shall:

1) Activate and operate when the steady state primary power voltage is within the range 18.5 to 36.0 Vdc (threshold) or 18.5 to 40.0 Vdc (objective).

2) Remain activated and operational when the steady state primary power voltage is within the range 16.0 to 36.0 Vdc (threshold) or 12.0 to 40.0 Vdc (objective).

3) Be off when the steady state primary power voltage is 11.0 Vdc or less.

4) Operate with primary power ripple in the range of ±2 Volts, from the steady state voltage, within the range of 50 Hz to 200 kHz.

5) Operate with primary power surges and spikes in accordance with MIL-STD-1275D. Power spikes are limited to a range of ±100 Volts by the host.

6) Not be damaged by primary power voltage polarity reversal.

7) Not be damaged by surges, spikes, ripple, starting disturbances for normal operation and fault conditions of the primary power source, in accordance with MIL-STD-1275D, except spikes will be limited to a range of ±100 Volts peak by the host.

8) Not be affected by loss of power. Loss of power shall not affect DRU-H-R computer program(s), calibration data, or elapsed time data.

9) Not require special alignment procedures after an unexpected power loss.

10) Be able to reactivate within 5 seconds after power has been removed.

3.3.12.3.1 Regulated power output.

a. When activated, the DRU-H-R shall supply +5 Vdc ±5 percent, at currents up to 700 ma plus current surges required to charge capacitors, up to 5 microfarads in value, for external use.

b. Ripple shall not exceed 100 mv pk-pk.

c. Power output shall be protected from overloads and over voltages.

d. External overloads shall not cause the DRU-H-R to deactivate or fail.

3.3.12.3.2 Unregulated power output.

a. The DRU-H-R shall supply unregulated, 28 Vdc, primary power for external use whenever the DRU-H-R receives 28 Vdc primary input power.

b. The load power will not exceed 32 watts and the surge current will not exceed 2.0 amperes.

c. The DC returns, J1 pins 21 through 23, shall not connect to the DRU-H-R chassis at any point.

3.3.12.4 TIA-422 interfaces. The DRU-H-R shall interface with the signals listed in Table XIII, which shall be differential voltage circuits in accordance with TIA-422.

3.3.12.4.1 TIA-422 drivers and receivers.

a. TIA-422 line drivers shall comply with the generator electrical characteristics specified in TIA-422.

b. TIA-422 receivers shall comply with the requirements of TIA-422 with the following changes:

1) The common mode voltage range shall be ±15 volts.

2) Over the entire common mode voltage range, the receiver shall not require a differential input voltage of more than 500 millivolts to correctly assume the intended binary state.

c. The DRU-H-R shall not be damaged or malfunction when TIA-422 signal circuits are connected or disconnected with power on or off.

Table XIII. TIA-422 Signals.

TIA-422 INTERFACE	SIGNAL(S)	DRU-H-R INPUT/OUTPUT
Synchronous Host Data (Appendix A)	Interface A Clock	Input
	Interface A Data	Input/Output
	Interface B Clock	Input
	Interface B Data	Input/Output
Asynchronous Host Data (Appendix A)	Interface C Receive	Input
	Interface C Transmit	Output
	Interface D Receive	Input
	Interface D Transmit	Output
GPS Data (3.3.12.4.4)	GPS Transmit Interface	Output
	GPS Receive Interface	Input
VMS (3.3.12.4.5)	VMS Bit Command 1	Discrete Output
	VMS Bit Command 2	Discrete Output
	VMS Forward Data	Pulse Input
	VMS Reverse Data	Pulse Input

3.3.12.4.2 TIA-422 logic levels.

a. A binary logic "1" or "set" condition shall be represented by a positive voltage on the "Hi" line with respect to the "Lo" line.

b. A logic "0" or "reset" condition shall be represented by a positive voltage on the "Lo" line with respect to the "Hi" line.

3.3.12.4.3 Host TIA-422 data interface. The DRU-H-R shall have two half-duplex, synchronous host TIA-422 data interfaces and two full-duplex, asynchronous host TIA-422 data interfaces in accordance with Appendix A.

3.3.12.4.4 GPS TIA-422 data interface.

a. The DRU-H-R shall have an asynchronous, bi-directional, full-duplex, serial TIA-422 data interface for exchange of data messages between the DRU-H-R and GPS receiver.

b. The input impedance of the GPS Receive interface shall be ≥ 200 Ohms.

3.3.12.4.4.1 GPS message characteristics.

a. Protocols, formats, data elements, baud rates, and timing of messages exchanged by the DRU-H-R and GPS receiver shall be as specified in IS-GPS-153D.

b. Upon acceptance of a SHUTDOWN command or STORED HEADING SHUTDOWN command, the DRU-H-R shall place the GPS receiver in the STANDARD Remote Control mode.

c. The DRU-H-R shall observe the ACK/NAK and handshaking requirements of IS-GPS-153D.

d. The DRU-H-R shall determine received GPS message length directly from the received messages and shall not use fixed values for message length.

3.3.12.4.5 VMS interface. When configured for a VMS (CFIG D28/0 set and D28/1 reset), the DRU-H-R shall:

a. Accept forward and reverse odometer pulse signals, 800 ±80 micro-seconds in width at rates in the range of 0 to 711 pulses/second, from a VMS. The nominal scaling is 0.165 feet per pulse.

b. Not register false pulses indicating motion if the VMS lines are open.

c. Provide control signals (BIT Commands) to a VMS as specified in Table XIV.

Table XIV. VMS control and response signals.

BIT COMMAND		VMS RESPONSE (pulses/second)	
#1	#2	FORWARD PULSES	REVERSE PULSES
1	0	355 ±53	0
0	1	0	355 ±53
1	1	0	0
0	0	Normal Operating Condition	

3.3.12.5 GPS 1PPS interface. The DRU-H-R shall accept GPS 1PPS time mark output pulses conforming to IS-GPS-153D.

3.3.12.6 Vehicle configuration discretes.

a. The DRU-H-R shall provide four Vehicle Configuration discretes on connector J1.

b. Vehicle Configuration discretes shall be used to identify the configuration definition data to be used by the DRU-H-R. Configuration codes and data are tabulated in Appendix C for specific hosts.

c. An open circuit shall indicate logic "0". A connection to signal ground shall indicate logic "1".

d. The discrete input circuits shall require external drivers to source or sink no more than 2.0 milliamperes.

3.3.12.7 Speedometer sender interface.

a. When configured for a speedometer sender (CFIG D28/0 and D28/1 set), the DRU-H-R shall accept odometer pulse signals from a speedometer sender conforming to drawing 12384798 that is also connected to a speedometer assembly as specified on drawing 12300005.

b. When connected to a speedometer sender whose ground is connected to the vehicle chassis, DRU-H-R signal ground shall remain isolated from the vehicle chassis and power ground.

3.3.12.8 Gun Drive interface The DRU-H-R shall have a Gun Drive interface conforming to Appendix D.

3.3.12.9 Software loading interface. The DRU-H-R shall have an Ethernet or full-duplex TIA-232 serial reprogramming interface compatible with the Maintenance Support Device (MSD).

3.3.12.9.1 Software Load Discrete interface.

a. The DRU-H-R shall provide a Software Load Discrete on connector J1.

b. An open circuit shall indicate the DRU-H-R is to operate normally.

c. A connection to signal ground shall indicate that the DRU-H-R is to load software.

d. The discrete input circuit shall require external drivers to source or sink no more than 2.0 milliamperes.

3.3.13 Mechanical interface. Mechanical characteristics, mounting provisions, mechanical reference datums, and weight shall be in accordance with Appendix F.

3.4 Environmental requirements. Except as otherwise noted, the DRU-H-R shall not be damaged while powered or non-powered, meet the interface requirements of 3.3 - 3.3.12.9.1, and meet the performance requirements of 3.6 - 3.6.6.2 under any combination of the environmental conditions specified below.

3.4.1 Temperature.

3.4.1.1 Operational. The DRU-H-R shall operate in ambient air and on a mount with temperatures throughout the range of +140°F (+60°C) to -50°F (-46°C).

3.4.1.2 Storage and transportation. The DRU-H-R shall withstand storage and transportation temperatures throughout the range of +160°F (+71°C) to -50°F (-46°C) without any deterioration or adverse effects that may cause failure when the DRU-H-R is placed in operation.

3.4.2 Temperature shock. The DRU-H-R shall meet the performance requirements in 3.6 - 3.6.6.2 after exposure to variations in temperature from 70°F to -25°F in a 10-min interval, and from 70°F to 120°F in a 10-min interval.

3.4.3 Altitude.

3.4.3.1 Operating. The DRU-H-R shall meet the performance requirements in 3.6 - 3.6.6.2 and not be damaged during and after exposure to altitudes from 1312 ft (400 m, 15.4

psia) below sea level to 18,500 ft (5,640 m, 7.2 psia) above sea level, and ambient air temperatures reduced by 5°F per 1,000 feet for ground elevations above 3,000 feet.

3.4.3.2 Non-operating. The DRU-H-R shall comply with all performance requirements and not be damaged after exposure to altitudes from 1312 ft (400 m, 15.4 psia) below sea level to 50,000 ft (15,239 m, 1.69 psia) above sea level.

3.4.3.3 Rate of change. The DRU-H-R shall comply with all performance requirements and not be damaged by rates of ascent and descent of up to 39 ft/sec (12 meters/sec).

3.4.4 Humidity. The DRU-H-R shall not be damaged by operation, transportation, or storage with ambient relative humidity throughout the range of 1 to 100 percent.

3.4.5 Solar radiation.

a. The DRU-H-R shall operate during and after exposure to solar radiation of 360 BTU/ft^2/hr (1135 watts/m^2) for 4 hours at an ambient temperature of +125°F (+51.6°C) at winds of 8.5 ft/sec (2.6 m/sec) or less.

b. Maximum solar radiation will be higher by 4 BTU/ft^2/hr per 1,000 feet (43 w/m^2 per 1,000 m) and ambient air temperatures will be lower by 5°F per 1,000 feet for ground elevations above 3,000 feet, up to 15,000 feet.

3.4.6 Washdown. The DRU-H-R shall suffer no damage or leakage and shall meet the performance requirements in 3.6 - 3.6.6.2 after exposure to high pressure water washdown.

3.4.7 Salt fog. The DRU-H-R shall not be damaged and shall operate without degradation to specified performance levels during and after exposure to salt fog.

3.4.8 Fungus. The DRU-H-R shall not be damaged and shall operate after exposure for 28 days to a viable spore suspension containing at least the following fungi: Aspergillus Niger, Aspergillus Flavus, Aspergillus Versicolor, Penicillium Funiculosum, and Chaetomium Globosum.

3.4.9 Shock.

3.4.9.1 Operational (gunfire).

a. When installed on the DRU mount in a Paladin Self-Propelled Howitzer, the DRU-H-R shall not be damaged and shall operate during and after repeated firing of all allowable combinations of rounds and charges.

b. A non-operating DRU-H-R shall not be damaged by gun firing shock.

3.4.9.2 Transportation.

a. The DRU-H-R shall not be damaged and shall operate during and after exposure to three half sine wave pulses applied in both directions along each of three mutually perpendicular axes.

b. The half sine wave pulses shall have peak amplitudes of 30.0 ± 3.0 G for 18.0 ± 1.8 ms.

3.4.9.3 Bench handling.

a. The DRU-H-R shall not be damaged and shall operate after a face has been dropped onto a horizontal wooden bench top after one edge has been raised 4 inches above the bench top with the opposite edge resting on the bench top.

b. The DRU-H-R shall withstand multiple drops onto all practical faces about all practical edges.

3.4.10 Vibration.

a. The DRU-H-R shall operate and not be damaged while being subjected to the vibration environment of the Howitzer traveling over all types of roads and cross-country terrain at speeds ranging from zero to the maximum attainable.

b. A non-operating DRU-H-R shall not be damaged by the vibration environment.

3.4.11 Electromagnetic compatibility/interference (EMI/EMC).

a. The DRU-H-R shall meet the following MIL-STD-461E emission and susceptibility requirements: CE102, CS101, CS114, CS115, CS116, RE102, and RS103.

b. Imax for CS116 shall be 10 A.

3.4.12 Electrostatic discharge. The DRU-H-R shall conform to the requirements of MIL-STD-464A for electrostatic discharge.

3.4.13 Lightning. The DRU-H-R shall not be damaged and shall operate as specified in 3.6 during and after exposure to close lightning strikes as specified in MIL-STD-464A.

3.4.14 NBC survivability.

a. The DRU-H-R shall survive NBC contamination (see 6.3.5 and 6.3.6).

b. The DRU-H-R shall operate as specified herein for at least 72 hours while contaminated.

c. MIL-HDBK-784 provides guidance. An overview of potential threat agents, available decontamination and contamination avoidance countermeasures and design and material selection guidelines are given in MIL-HDBK-783. FM 3-11.5 describes decontamination operations.

3.4.15 Initial Nuclear Weapons Effects (INWE).

a. The DRU-H-R shall survive the initial nuclear weapons effects of blast, thermal radiation, initial nuclear radiation and electromagnetic pulse to the same levels where 50% of the vehicle operators will remain combat effective long enough to execute the mission in accordance with criteria levels specified in QSTAG 1031, Class III/IV (use midpoint levels between Class III (Main Battle Tanks) and Class IV (Light Armored Vehicles)).

b. The host may remove power, at the source, within 250 microseconds of detecting a nuclear event.

c. The DRU-H-R is permitted to shut down upon the occurrence of a nuclear event.

d. The DRU-H-R shall perform as specified when power is reapplied and the DRU-H-R is reinitialized after a nuclear event.

3.5 Support or ownership requirements.

3.5.1 Reliability.

a. The DRU-H-R shall have a Mean-Time-Between-Failure (MTBF) of 12000 hours or greater.

b. Failure of the GPS receiver or odometer sensor shall not inhibit the ability of the DRU-H-R to operate.

3.5.2 Maintainability.

3.5.2.1 Corrective maintenance. The DRU-H-R shall, upon occurrence of a single malfunction, be restored to operation, by replacement, within a meantime-to-repair (MTTR) of 30 minutes at the organizational level. Times include fault isolation, removal, and replacement, but do not include supply and administration time.

3.5.2.2 Preventive maintenance. The DRU-H-R shall not require any preventative maintenance other than cleaning of exterior surfaces to remove dust, dirt, and other foreign material.

3.5.2.3 Adjustments/calibration. The DRU-H-R shall not require any adjustments or calibrations in the field that require operator interaction, nor shall the DRU-H-R require stops more frequently than stated herein.

3.5.2.4 Software loading.

a. The DRU-H-R shall have a capability to load all DRU-H-R software using a MSD, or equivalent computer, connected to DRU-H-R J1 or J3 (3.3.12.9).

b. The DRU-H-R shall determine at start-up whether normal operation or software loading is to be performed.

c. A Software Load Discrete (3.3.12.9.1) shall be used to determine normal operation or software load mode.

d. The DRU-H-R shall remain in the selected mode (normal operation or software load) until power down.

e. Upon completion, proper loading of software shall be confirmed.

f. Interruption of software loading or power loss during software load shall not prevent subsequent correct loading of software.

3.5.3 Elapsed time indicator.

a. The DRU-H-R shall accumulate and retain its elapsed operating time.

b. Elapsed operating time shall be output in an ELAPSED TIME message when requested by a RETURN ELAPSED TIME command.

3.5.4 Treatment and finish.

a. All surfaces of the DRU-H-R shall be treated and finished for protection against corrosion. MIL-HDBK-729 provides guidance.

b. Dissimilar metal combinations shall be selected or protected to preclude corrosion.

3.5.4.1 Paint finishes.

a. Type I - External paint finishes shall conform to drawing 12369002, 12369004, or 12369016, as applicable to the substrate.

b. Type II – External paint finishes shall conform to MIL-DTL-53072C and MIL-DTL-64159A. MIL-DTL-64159A paint type and color shall be as specified in the purchase order or contract (see 6.2.)

c. Surface areas intended for electrical bonding shall be free of paint and have an electrically conductive, corrosion resistant finish.

3.5.5 Marking and identification.

a. The DRU-H-R shall be marked and serialized in conformance with MIL-STD-130L.

b. Marking shall include Unique Item Identification (UID).

3.5.6 Grounding.

a. Ground connection to the chassis and to other mechanical parts shall not be made to complete electrical circuits, but only to eliminate high-potential AC points.

b. The DC power return circuit shall not be completed through the DRU-H-R chassis to a grounded vehicle chassis.

3.5.7 Interchangeability.

a. The DRU-H-R shall be interchangeable from any host system to any other host system without requiring hardware changes, calibration procedures, vehicle driving constraints, or unscheduled ZUPTs.

b. All items with the same part number shall be functionally and dimensionally interchangeable without modification of the items or equipment.

c. Design tolerance shall permit parts, subassemblies and assemblies to be used in their parent assemblies without regard to the source of supply or manufacturer.

d. Parts, subassemblies and assemblies having the full range of dimensions and characteristics permitted by the drawing or specification governing the part, subassembly or assembly shall be usable as replacement items without selection and without deviation from the specified performance requirements of the parent item.

3.5.8 Safety. The DRU-H-R shall have no hazards with a risk level greater than “Medium” as specified in Table XV during installation, removal, handling, and operation.

Table XV - Risk level matrix.

Hazard Severity (see section 6.3.4)	Hazard Probability (See 6.3.3)				
	Frequent	Likely	Occasional	Seldom	Unlikely
Catastrophic	High	High	Serious	Serious	Medium
Critical	High	Serious	Serious	Medium	Medium
Marginal	Serious	Serious	Medium	Medium	Low
Negligible	Serious	Medium	Medium	Low	Low

3.5.8.1 Environment, Safety, and Occupational Health (ESOH). The DRU-H-R shall not present health hazards to personnel and shall comply with applicable sections of 42 U.S.C. 4321-4370d, 40 C.F.R. 1500-1508, and E.O. 12114.

3.5.8.2 Electrical connections. A mistake-proof means to prevent the inadvertent reversing or mismating of electrical connections shall be provided.

3.5.8.3 Electrical overload protection.

a. The DRU-H-R and the host vehicle shall be protected from damage resulting from electrical overloads induced by normal or abnormal (fault) DRU-H-R operation and conditions. SAE ARP 1199 provides design guidance.

b. Current overload protection devices shall not require manual reset.

c. The host may be required to turn off primary power to reset overload protection.

3.5.9 Human performance/human engineering.

a. The DRU-H-R shall conform to the requirements of MIL-STD-1472F.

b. The DRU-H-R shall be maintainable by no more than two, 5^{th} through 95^{th} percentile, male and female, maintenance personnel, wearing Advanced Combat Uniform (ACU), Battle Dress Uniform (BDU), arctic clothing and gear, and MOPP IV clothing and gear.

3.5.10 Useful life. The DRU-H-R shall have a useful life of at least 15 years under any combination of operation and storage.

3.5.11 Workmanship. Workmanship shall conform to the following:

a. After fabrication, parts and assembled equipment shall be cleaned of smudges; loose, spattered, or excess solder; weld metal; metal chips and mold release agents; or any other foreign material.

b. Screws, nuts and bolts shall show no evidence of cross threading, mutilation, or detrimental or hazardous burrs, and shall be firmly secured.

c. Bearing assemblies shall be free of rust, discoloration, and imperfections of ground, honed, or lapped surfaces. Contacting surfaces shall be free of tool marks, gouge marks, nicks, or other surface-type defects. There shall be no detrimental interference, binding, or galling.

d. Wires and cables shall be positioned or protected to avoid contact with rough or irregular surfaces and sharp edges and to avoid damage to conductors or adjacent parts.

e. Shielding on wires and cables shall be secured in a manner that prevents it from contacting or shorting exposed current-carrying parts. The ends of the shielding or braid shall be secured to prevent fraying.

f. The harness and cable form containment means shall be positioned to retain critical form factors and breakout locations. The containment means (lacing, ties, tiedown straps, etc.) shall not cause the wire or cable insulation to deform so that performance characteristics are adversely affected.

g. There shall be no evidence of burns, abrading, or pinch marks in the insulation that could cause short circuits or leakage.

3.6 Operating requirements.

3.6.1 General. Unless otherwise specified, operating requirements apply to performance under any and all combinations of conditions and environments specified herein.

3.6.2 Accuracy.

a. Accuracy requirements, when GPS aided, assume the DRU-H-R is receiving GPS positions accurate to 16 meters SEP, or better, at a minimum rate of one per minute.

b. The horizontal position and altitude accuracy requirements apply when the DRU-H-R has completed Accelerated Align, Static Align, Interrupted Static Align with one travel period ≤ 4 minutes, or Dynamic Align; or when the following conditions are applicable:

1) A position update is performed after interrupted Static Align (3.3.7.5) was completed with more than one vehicle travel period, or

2) A position update is performed after interrupted Static Align was completed when travel time between vehicle stops exceeded four minutes.

c. After completion of Static Align or Dynamic Align, positioning and azimuth accuracy may vary as a function of the maximum Static Align Time specified in configuration data. Position and azimuth accuracy requirements, specified herein, shall be met when the specified maximum Static Align Time is 15 minutes or greater.

d. Horizontal position and altitude accuracy requirements are relative to the previous host position update and do not include errors in host input position update coordinates. If position is initialized from GPS, with no host update, accuracy requirements are relative to "absolute" WGS 84 positions as shifted to the selected datum.

e. Horizontal position and altitude accuracy requirements apply when the DRU-H-R has been nominally stationary for 30 seconds and longer.

f. Accuracy requirements shall be met, without requiring host realign actions, during and after host operations such as: travel, deployment, antenna erection, stowing and pointing; radar activation; and weapon loading, aiming, firing and stowing.

3.6.2.1 Horizontal position accuracy.

a. Horizontal position errors shall not exceed the values given in Table XVI for the specified aiding conditions, latitude ranges, and distances traveled from the last position update.

b. No more than 1.0 percent of the radial errors shall exceed the value in the 99 percent column.

Table XVI. Horizontal position accuracy.

AIDING AVAILABLE	HORIZONTAL ERROR (meters)		
	LATITUDE 65°S - 65°N		65°S - 80°S 65°N - 84°N
	CEP	99 percent	CEP
VMS aided, no GPS, 60 min ZUPTs DIST ≤ 4,000 m DIST > 4,000 m	 10.0 0.0025 x DIST	 26.0 0.0065 x DIST	 10.0 0.0025 x DIST
VMS aided, no GPS, 10 min ZUPTs DIST ≤ 27,000 m DIST ≤ 63,900 x Cos(Lat) m	 18.0 n/a	 47.0 n/a	 n/a 18.0
No VMS, no GPS, 4 min ZUPTs DIST ≤ 27,000 DIST ≤ 63,900 x Cos(Lat) m	 18.0 n/a	 47.0 n/a	 n/a 18.0
GPS aided, any distance	10.0	47.0	10.0

3.6.2.2 Altitude accuracy.

a. Altitude errors shall not exceed the values given in Table XVII for the specified aiding conditions, latitude range, and distances traveled from the last altitude update.

b. No more than 1.0 percent of altitude errors shall be outside the range in the 99 percent column.

Table XVII. Altitude accuracy.

AIDING AVAILABLE	ALTITUDE ERROR (meters)	
	LATITUDE 80°S - 84°N	
	PE	99 percent
VMS aided, no GPS, 60 min ZUPTs DIST ≤ 10,000 m DIST > 10,000 m	 6.7 0.00067 x DIST	 ±26.0 ±.0026 x DIST
VMS aided, no GPS, 10 min ZUPTs DIST ≤ 35,000 m	 10.0	 ±39.0
No VMS, no GPS, 4 min ZUPTs DIST ≤ 35,000 m	 10.0	 ±39.0
GPS aided, any distance	10.0	±39.0

3.6.2.3 Attitude accuracy.

a. Attitude errors shall not exceed the values given in Table XVIII for the specified conditions and latitude ranges.

b. No more than 1.0 percent of attitude errors shall be outside the ranges in the 99 percent column.

Table XVIII. Pointing device attitude accuracy.

PARAMETER & ALIGN TYPE	ATTITUDE ERROR (mils)		
	LATITUDE 65°S-65°N		65°S-80°S & 65°N-84°N
	PE	99 percent	PE
Initial Azimuth After:			
Accelerated Align	0.1 (see note below)		0.1 (see note below)
Static Align	0.67	±2.6	0.283 x Secant(Lat)
Dynamic Align	0.67	±2.6	0.67
Survey Azimuth:	0.67	±2.6	0.283 x Secant(Lat)
Pitch:	0.34	±1.3	0.34
Roll/Cant:	0.34	±1.3	0.34
NOTE: RMS error relative to the Stored Heading value			

c. Initial azimuth requirements apply at completion of the specified align type. Survey azimuth, pitch, and roll/cant requirements apply at any time during missions of up to 24 hours in duration, commencing at align completion.

d. Attitude accuracy requirements stated herein shall be met at any DRU-H-R case orientation.

e. Attitude accuracy requirements apply to Pointing Device attitudes and assume that the DRU-H-R has been accurately aligned to the Pointing Device. Pointing Device Geodetic or Grid Azimuth may be in error when the pointing device's pointing axis is within 5 degrees of vertical.

f. Vehicle Attitudes shall be within 18 mils PE.

3.6.2.4 Angular rate accuracy. In Survey, Pointing Device Grid or Geodetic Azimuth rate, Pitch rate, and Roll rate errors shall not exceed:

a. 0.5 mil per second RMS for angular rates in the range of −356 to +356 mils per second. Non-linearity shall not exceed 1 percent.

b. 2.5 percent of the instantaneous rate RMS for angular rates in the ranges of -3276.8 to -356 and +356 to +3276.8 mils per second.

3.6.2.5 Data delay. Data delay shall be the sum of data latency and data staleness.

3.6.2.5.1 Data latency. Data latency is the delay between the time a sensor is strobed and the availability of data in the output buffers. For messages transmitted on the host interface, data latency shall not exceed: 10 msec for pointing device attitude data; 20 msec for pointing device attitude rate data; and 60 msec for position data.

3.6.2.5.2 Data staleness. Data staleness is the delay between the time the processed DRU-H-R data are available in the output buffers and the time transmission of the message, containing that data, is completed. Data staleness shall not exceed 10 msec to receive data request, 2 msec to start transmitting data from the output buffer, and the message transmit time specified for each message in Appendix A.

3.6.2.5.3 Gun Drive messages. Total data delay for the GUN POSITION DATA message to the Gun Drive shall not exceed 5 msec.

3.6.3 Reaction time.

3.6.3.1 Static align time

a. After application of power or acceptance of a RESTART command, Static Align shall be completed within the time specified in configuration data when the vehicle is nominally stationary for the entire period.

b. If Static Align is interrupted, reaction time may increase in accordance with 3.3.7.5.

3.6.3.2 Accelerated align time.

a. Accelerated Align shall be completed within 60 seconds if the DRU-H-R previously was shut down with a STORED HEADING SHUTDOWN command.

b. Time to achieve odometer sensor aiding following Accelerated Align shall be in accordance with 3.3.7.3.1.

3.6.3.3 Dynamic align time.

a. After application of power, Dynamic Align shall be completed within the Static Align Time specified in configuration data.

b. The nominal conditions for dynamic align are: vehicle speed greater than or equal to 20 Km/Hr; turns are performed along the vehicle trajectory; and usable GPS data, with EPE less than or equal to 16 meters, is available for the entire dynamic align period.

c. If, at the end of the nominal dynamic align time, the estimated azimuth error is less than or equal to 3.0 mils PE, but greater than 1.0 mil PE, the dynamic align time may be extended up to 12 additional minutes.

d. Dynamic align time may be extended if GPS data are invalid or are interrupted for periods greater than 60 seconds.

3.6.4 Mission length and duration. DRU-H-R survey missions may range from 0 to 100 Km in length and 15 minutes to 24 hours in duration. Position updates at distances traveled no shorter than those specified in Table XVI and Table XVII are permitted to maintain accuracy requirements when usable GPS aiding is not available.

3.6.5 Alignment conditions.

3.6.5.1 Off level. The DRU-H-R shall perform as specified herein when mounted in any orientation.

3.6.5.2 Base motion while stationary. The DRU-H-R shall perform as specified herein when the host vehicle, while nominally stationary, is subject to wind buffeting, normal crew movement, engine vibration, vibration from engine/generator sets, and other sources of motion usually found on the battlefield.

3.6.5.3 Base motion while in motion. The DRU-H-R shall perform interrupted Static Align and Dynamic Align as specified herein when the host is subject to vehicle dynamics for Survey conditions.

3.6.6 Survey conditions.

3.6.6.1 Vehicle dynamics. The DRU-H-R shall perform as specified herein when operated within the following dynamic conditions:

a. Horizontal velocity within the range of 0 to 80 miles per hour.

b. Vertical velocity within the range of 0 to 15 miles per hour up or down.

c. Acceleration (excluding shock and vibration) within the range of 0 to 1.5g (not including gravitational acceleration) in any direction due to vehicle starting, stopping and turning.

d. Vehicle pitch within the range of -40 to +40 degrees. Vehicle cant/roll within the range of -40 to +40 degrees.

e. Angular velocities within the range of 0 to 200 degrees per second around any axis.

f. Angular accelerations within the range of 0 to 6000 degrees per second^2 around any axis.

g. Shock and vibration generated by the transporting vehicle.

h. Variations in odometer scale factor and direction of travel alignment resulting from changes in vehicle loading, track slippage, turns, crabbing, terrain conditions, and any other conditions normally encountered by a host vehicle. No external calibrations of odometer scale factor and direction of travel alignment shall be required.

3.6.6.2 Deployment. In addition to operating when subjected to the above vehicle dynamics, the DRU-H-R shall perform as specified herein when operated under the following conditions:

a. Shock and vibration generated by weapon firing.

b. Rotation and elevation of a pointing device. When mounted to a pointing device, the DRU-H-R shall be capable of being elevated through an angle of 105 degrees or rotated 360 degrees in azimuth when the pointing device is erected.

4. VERIFICATION

Table XIX. Requirement/verification cross-reference matrix

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
3.3	Interface and interoperability	X								
3.3.1	Configuration tailoring			X		X	X			4.6.9
3.3.2	Host/DRU-H-R data exchange			X		X	X			4.6.9
3.3.2.1	DRU-H-R status reporting			X		X	X			4.6.9
3.3.2.2	DRU-H-R alert reporting			X		X	X			4.6.9
3.3.2.3	Failure reporting			X		X	X			4.6.9
3.3.2.4	Command checking			X		X	X			4.6.9
3.3.2.5	Data entry checking			X		X	X			4.6.9
3.3.3	Gun Drive interface			X		X	X			4.6.9
3.3.4	Positioning			X		X	X			4.6.9
				X		X	X	X		4.6.5
3.3.4.1	Motion reporting			X		X	X			4.6.9
3.3.4.2	Position reference			X		X	X			4.6.9
3.3.5	Orientation			X		X	X			4.6.9
				X		X	X	X		4.6.5
3.3.5.1	Orientation references			X		X	X			4.6.9
3.3.6	Aiding			X			X			4.6.9
				X			X	X		4.6.5
3.3.6.1	Aiding selection			X		X	X			4.6.9
3.3.6.2	GPS aiding			X		X	X			4.6.9
3.3.6.2.1	GPS data acceptance criteria			X		X	X			4.6.9
3.3.6.3	Odometer sensor aiding			X		X	X			4.6.9
3.3.6.3.1	Faulty odometer sensor aiding data			X		X	X			4.6.9
3.3.6.4	ZUPT aiding			X		X	X			4.6.9
3.3.6.4.1	Valid unscheduled ZUPT requests			X		X	X			4.6.9
				X			X	X		4.6.5
3.3.6.5	Host position updates			X			X			4.6.9
3.3.6.5.1	Grid coordinate update			X			X			4.6.9
3.3.6.5.2	Geodetic coordinate update			X			X			4.6.9

Table XIX. Requirement/verification cross-reference matrix - Continued

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
3.3.6.5.3	Parameter no-change values			X			X			4.6.9
3.3.6.5.4	Position update characteristics			X			X			4.6.9
3.3.6.5.5	Position update reference			X			X			4.6.9
3.3.6.5.6	Position update duration			X			X			4.6.9
3.3.6.5.7	Horizontal position and altitude updates			X			X			4.6.9
3.3.6.5.7.1	Acceptance criteria, GPS data not available			X			X			4.6.9
3.3.6.5.7.2	Acceptance criteria, valid GPS data available			X			X			4.6.9
3.3.6.5.7.3	Update after rejection			X			X			4.6.9
3.3.6.5.7.4	Determine relative offsets			X			X			4.6.9
3.3.6.5.8	Datum updates			X			X			4.6.9
3.3.7	Functional states		X	X		X	X			4.6.9
3.3.7.1	Initialization			X		X	X			4.6.9
3.3.7.2	Position initialization			X		X	X			4.6.9
3.3.7.2.1	Host update after normal shutdown			X		X	X			4.6.9
3.3.7.2.2	Host update after abnormal shutdown			X		X	X			4.6.9
3.3.7.2.3	Host update during accelerated align			X		X	X			4.6.9
3.3.7.2.4	Initialization with GPS data			X		X	X			4.6.9
3.3.7.3	Accelerated align			X		X	X			4.6.9
3.3.7.3.1	Odometer aiding after accelerated align			X		X	X			4.6.9
3.3.7.4	Static align			X		X	X			4.6.9
				X			X	X		4.6.5
				X				X	X	4.6.2
3.3.7.5	Interrupted static align			X		X	X			4.6.9

Table XIX. Requirement/verification cross-reference matrix - Continued

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
3.3.7.6	Dynamic align			X		X	X			4.6.9
3.3.7.7	Survey			X		X	X			4.6.9
				X			X	X		4.6.5
				X				X	X	4.6.2
3.3.7.8	Restart required			X		X	X			4.6.9
3.3.7.9	Shutdown complete			X		X	X			4.6.9
3.3.8	BIT		X	X			X			4.6.9
3.3.8.1	BIT indications			X			X			4.6.9
3.3.8.2	Turn-on BIT			X			X			4.6.9
3.3.8.3	Initialization BIT		X	X			X			4.6.9
3.3.8.4	Operational BIT	X								
3.3.8.4.1	DRU-H-R BIT		X	X			X			4.6.9
3.3.8.4.2	Odometer sensor BIT		X	X			X			4.6.9
3.3.8.4.3	GPS BIT		X	X			X			4.6.9
3.3.8.4.3.1	GPS receiver BIT fail		X	X			X			4.6.9
3.3.8.4.3.2	GPS communication BIT			X			X			4.6.9
3.3.8.4.3.3	GPS antenna fault			X			X			4.6.9
3.3.9	GPS receiver control			X		X	X			4.6.9
3.3.9.1	GPS receiver initialization			X		X	X			4.6.9
3.3.9.2	Updating GPS receiver settings			X		X	X			4.6.9
3.3.9.3	GPS at shutdown			X		X	X			4.6.9
3.3.9.4	GPS status reporting			X		X	X			4.6.9
3.3.9.5	GPS warning messages			X		X	X			4.6.9
3.3.10	Determination of travel lock			X			X			4.6.9
3.3.10.1	Out of travel lock transition			X			X			4.6.9
3.3.10.2	In travel lock transition			X			X			4.6.9
3.3.11	Shot detect			X			X			4.6.9
3.3.12	Electrical interface	X								
3.3.12.1	Connectors				X		X	X	X	4.6.1
3.3.12.1.1	Connector pin functions		X			X	X			4.6.9
3.3.12.2	Bonding and shield grounding					X	X			4.6.9

Table XIX. Requirement/verification cross-reference matrix - Continued

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
3.3.12.3	Power		X	X			X			4.6.9
				X				X	X	4.6.2
3.3.12.3.1	Regulated power output			X			X			4.6.9
				X				X	X	4.6.2
3.3.12.3.2	Unregulated power output			X			X			4.6.9
				X				X	X	4.6.2
3.3.12.4	TIA-422 interfaces	X								
3.3.12.4.1	TIA-422 drivers and receivers		X	X			X			4.6.9
3.3.12.4.2	TIA-422 logic levels		X	X			X			4.6.9
3.3.12.4.3	Host TIA-422 data interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.4.4	GPS TIA-422 data interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.4.4.1	GPS message characteristics			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.4.5	VMS interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.5	GPS 1PPS interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.6	Vehicle configuration discretes			X			X			4.6.9
				X				X	X	4.6.2
3.3.12.7	Speedometer sender interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.8	Gun Drive interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.9	Software loading interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.12.9.1	Software Load Discrete interface			X		X	X			4.6.9
				X				X	X	4.6.2
3.3.13	Mechanical interface				X		X	X	X	4.6.1

Table XIX. Requirement/verification cross-reference matrix - Continued

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
3.4	Environmental requirements	X								
3.4.1	Temperature	X								
3.4.1.1	Operational					X	X	X		4.6.4.4.1, 4.6.4.5.1
3.4.1.2	Storage and transportation					X	X	X		4.6.4.4.2, 4.6.4.5.2
3.4.2	Temperature shock					X	X	X		4.6.4.6
3.4.3	Altitude					X	X			4.6.4.3
3.4.3.1	Humidity					X	X			4.6.4.8
3.4.5	Solar Radiation					X	X			4.6.4.7
3.4.6	Washdown					X	X	X		4.6.4.9
3.4.7	Salt fog					X	X			4.6.4.10
3.4.8	Fungus		X				X			4.6.4.11
3.4.9	Shock	X								
3.4.9.1	Operational (gunfire)					X	X			4.6.4.12.3
3.4.9.2	Transportation					X	X	X		4.6.4.12.1
3.4.9.3	Bench handling					X	X	X		4.6.4.12.2
3.4.10	Vibration					X	X	X		4.6.4.13
3.4.11	Electromagnetic compatibility/interference (EMI/EMC)					X	X	X		4.6.4.14
3.4.12	Electrostatic discharge					X	X			4.6.4.15
3.4.13	Lightning		X				X			4.6.4.16
3.4.14	NBC survivability		X	X	X					4.6.4.17
3.4.15	Initial Nuclear Weapons Effects (INWE)		X			X	X			4.6.10
3.5	Support or ownership requirements	X								
3.5.1	Reliability		X				X			4.6.6
3.5.2	Maintainability	X								
3.5.2.1	Corrective maintenance			X			X			4.6.7

Table XIX. Requirement/verification cross-reference matrix - Continued

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
3.5.2.2	Preventative maintenance		X		X		X			4.6.7
3.5.2.3	Adjustments/calibration		X				X			4.6.7
3.5.2.4	Software loading			X		X	X			4.6.9
3.5.3	Elapsed time indicator				X		X	X	X	4.6.2
3.5.4	Treatment and finish		X		X	X	X			4.6.9
					X		X	X	X	4.6.1
3.5.4.1	Paint finishes		X		X	X	X			4.6.9
					X		X	X	X	4.6.1
3.5.5	Marking and identification				X		X	X	X	4.6.1
3.5.6	Grounding					X	X			4.6.9
3.5.7	Interchangeability		X	X			X			4.6.9
3.5.8	Safety		X	X	X		X			4.6.9
3.5.8.1	Environment, Safety, and Occupational Health (ESOH)		X				X			4.6.9
3.5.8.2	Electrical connections			X			X			4.6.9
3.5.8.3	Electrical overload protection		X	X		X	X			4.6.9
3.5.9	Human performance/human engineering		X		X		X			4.6.3
3.5.10	Useful life		X				X			4.6.9
3.5.11	Workmanship				X		X	X	X	4.6.1
3.6	Operating requirements	X								
3.6.1	General	X								
3.6.2	Accuracy	X								
3.6.2.1	Horizontal position accuracy		X	X			X			4.6.9
				X			X	X		4.6.5
				X				X	X	4.6.2
3.6.2.2	Altitude accuracy		X	X			X			4.6.9
				X			X	X		4.6.5
				X				X	X	4.6.2
3.6.2.3	Attitude accuracy		X	X			X			4.6.9
				X			X	X		4.6.5

Table XIX. Requirement/verification cross-reference matrix - Continued

METHOD OF VERIFICATION (6.3.14) N/A - NOT APPLICABLE 1 - ANALYSIS 2 - DEMONSTRATION 3 – EXAMINATION 4 - TEST		CLASSES OF VERIFICATION A - DESIGN VERIFICATION B - FIRST ARTICLE C - ACCEPTANCE								
SECTION 3 REQUIREMENT		VERIFICATION								
		METHOD					CLASS			SECTION 4
PARA.	TITLE	N/A	1	2	3	4	A	B	C	PARA.
				X				X	X	4.6.2
3.6.2.4	Angular rate accuracy		X			X	X			4.6.9
3.6.2.5	Data delay	X								
3.6.2.5.1	Data latency		X				X			4.6.9
3.6.2.5.2	Data staleness		X				X			4.6.9
3.6.2.5.3	Gun Drive messages		X			X	X			4.6.9
3.6.3	Reaction time	X								
3.6.3.1	Static align time		X	X			X			4.6.9
3.6.3.2	Accelerated align time			X			X			4.6.5
3.6.3.3	Dynamic align time		X	X			X			4.6.9
3.6.4	Mission length and duration		X	X			X			4.6.9
3.6.5	Alignment conditions	X								
3.6.5.1	Off level		X	X			X			4.6.9
3.6.5.2	Base motion while stationary		X	X			X			4.6.9
				X			X	X		4.6.5
3.6.5.3	Base motion while in motion		X	X			X			4.6.9
				X			X	X		4.6.5
3.6.6	Survey conditions	X								
3.6.6.1	Vehicle dynamics		X	X		X	X			4.6.9
				X			X	X		4.6.5
3.6.6.2	Deployment		X	X		X	X			4.6.9
				X			X	X		4.6.5

4.1 Verification conditions. Unless otherwise specified, test conditions shall be as specified in approved test plans and procedures.

4.2 Failure and rejection criteria.

a. The following failure and rejection criteria shall be used during verification unless otherwise specified.

b. The term failure includes: part or component deterioration or breakage; damage evident from equipment inspection; non-conformance to the requirements specified for

performance, operational, or physical characteristics; and deviations beyond the tolerances established in this specification, in the approved test procedures, or in the equipment design.

c. The following shall be classified as failures:

1) Adjustment, replacement, or repair of a part or assembly.

2) The need to reprogram the DRU-H-R.

3) Any Northing or Easting error within a static survey run exceeding 2 meters/hour (see 6.6.4).

4) Any altitude error within a static survey run exceeding 4 meters/hour (see 6.6.4).

5) Any BIT failure indication(s).

6) Failure to complete alignment or necessity of restarting alignment.

d. Upon occurrence of a failure, or whenever it becomes evident that the DRU-H-R will not meet a specified requirement, verification shall be stopped.

4.3 Design verification.

4.3.1 Design verification routine. Design verification units shall be subjected to verification of all requirements identified in Table XIX in accordance with the specified section 4 paragraph.

4.3.2 Sample size.

a. Unless otherwise specified, each verification shall be performed on one unit.

b. All units submitted for design verification shall undergo physical examination, operational demonstration, and operational low and high temperature testing.

c. Three units shall undergo low and high storage temperature testing.

4.3.3 Failures. Design verification must be completed without failure.

4.4 First article.

4.4.1 First article routine.

a. As determined by the Government, the first article sample may be subjected to any or all of the examinations, demonstrations and tests specified herein and be inspected for compliance with any or all requirements of the applicable drawings.

b. Unless otherwise specified in the contract or purchase order or stipulated by the Contracting Officer, the first article sample shall be subjected to verification of all requirements identified in Table XIX in accordance with the specified section 4 paragraph.

c. All units selected for first article Inspection shall have passed acceptance.

4.4.2 Sample size.

a. Unless otherwise specified, one unit shall undergo each first article verification.

b. Three units shall undergo low and high temperature testing.

c. All first article units shall undergo operational demonstration.

4.4.3 Failures. If any sample unit fails to comply with any applicable requirement, the first article sample shall be rejected.

4.5 Acceptance.

4.5.1 Acceptance routine. Units shall be subjected to verification of all requirements identified in Table XIX in accordance with the specified section 4 paragraph.

4.5.1.1 Sample size. All units shall undergo each acceptance inspection.

4.5.2 Failures. A unit must pass all acceptance verifications to be accepted. All failures shall be reported and analyzed.

4.5.3 Alternative inspection provisions. Unless otherwise specified, alternative acceptance procedures, methods, or equipment may be proposed to the Government by the contractor.

4.6 Methods of verification.

4.6.1 Physical examination. The equipment shall be examined for the following defects:

a. Configuration record incomplete or inaccurate.
b. Assemblies, parts or components missing or damaged.
c. Materials that don't meet performance requirements or are damaged.
d. Protective devices missing or damaged.
e. System interfaces which don't meet specified interface characteristics.
f. Treatment and painting missing or damaged.
g. Assembly incomplete or incorrect.
h. Identification marking missing, incomplete or not legible.
i. Parts, sub-assemblies and assemblies contaminated by foreign substances.
j. External paint finish not in accordance with the DRU-H-R Type (see 1.2.1) specified in the contract or purchase order.
k. BIT indicator visibility not in accordance with the DRU-H-R Type (see 1.2.1) specified in the contract or purchase order.
l. Default configuration parameters not as specified in the contract or purchase order.

The presence of one or more defect(s) listed above shall constitute a failure of the examination.

4.6.2 Acceptance quality tests.

a. Acceptance Quality Tests shall simulate normal operational conditions and verify BIT, Elapsed Time Indicator reporting, modes of operating, updating of parameters, host interfaces, Gun Drive interface, GPS interfaces, software loading interface, VMS interface, speedometer sender interface, discrete interfaces, power supply outputs, correct operation with high and low input voltages, turn-on/turn-off and functional characteristics by measurement.

b. Failure to meet specified values for any monitored parameter, any out of tolerance condition, or malfunction, shall constitute failure of the test and rejection of the DRU-H-R.

c. Acceptance Quality Tests shall include azimuth alignment and pitch and roll accuracy tests.

d. The unit shall be rejected if the azimuth error exceeds 0.67 mil PE or if the pitch error or roll error exceeds 0.34 mil PE.

e. Data sample size(s) shall be in accordance with the approved test procedure.

f. No data shall be excluded from a RMS calculation.

g. Acceptance Quality Tests shall verify inertial system position and survey azimuth accuracy.

4.6.3 Human factors demonstration.

a. The equipment shall be examined for compliance with the requirements of 3.5.9.

b. Equipment markings shall be viewed for legibility.

c. The DRU-H-R shall be installed in and removed from a Paladin, or simulated Paladin DRU-H-R installation.

d. Demonstration personnel shall be clothed in arctic and MOPP4 NBC clothing and gear.

e. Failure to conform to the requirements of 3.5.9 shall constitute failure of this demonstration.

4.6.4 Environmental tests.

4.6.4.1 General.

a. Where a test calls for a simulated survey mission, the DRU-H-R shall be operated without GPS and odometer sensor aiding with four minute simulated travel periods between 30 second ZUPTs.

b. The DRU-H-R shall be operated for equal time periods with the input supply voltage at the nominal level, the lowest specified limit, and the highest specified limit.

c. During a simulated survey mission the DRU-H-R shall be tested for: normal BIT, ALERT and STATUS indications; horizontal position and altitude values within approved limits; and azimuth within approved limits.

d. Failure to meet the specified value of any parameter shall constitute failure of the test.

4.6.4.2 Pre and post testing.

a. Prior to and after each test, where the equipment is tested in a static mode (chamber and mechanical tests), a series of tests shall be performed to verify proper operation of the equipment.

b. The equipment shall be inspected for physical damage, loose hardware, degradation of materials or any other defect after each test.

c. Should the system set up remain the same from one major test to the next, the post-test verification test may serve as the pre-test verification test for the next major test.

4.6.4.3 Altitude.

4.6.4.3.1 Operating. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 500.4, Procedure II. It shall be functionally tested throughout the exposure. A simulated survey mission shall be conducted at a simulated altitude of 18,500 ft (5,640 m, 7.2 psia), and

temperature of 62.5°F (16.9°C) for 4 hours minimum. At the conclusion of this time the DRU-H-R shall also be tested at 14.7 psia, 72°F, (ambient SL) for 1 hr minimum.

4.6.4.3.2 Non-operating. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 500.4, Procedure I. A simulated altitude of 50,000 ft (15,239 m, 1.69 psia), and ambient temperature of -50°F (-46°C), shall be maintained for 4 hours during the non operating test. At the conclusion of this time the pressure shall be increased to 14.7 psia, and temperature to 72°F, (ambient SL) functionally tested for one hour minimum. The non-operating altitude test shall be performed before the operating altitude test.

4.6.4.3.3 Rate of Change. Altitude rate of change during the operating and non-operating altitude tests shall be 39 ft/sec (12 meters/sec).

4.6.4.4 High temperature.

a. The same sample shall be used for the storage and operating tests.

b. The storage test shall be performed first.

4.6.4.4.1 Operational.

a. The DRU-H-R shall be tested as specified in MIL-STD-810F, Method 501.4, procedure II, with ambient temperature stabilized at 140°F throughout the test.

b. After temperature stabilization is achieved, a six hour simulated survey mission shall be conducted in accordance with 4.6.4.1, and correct operation of all external interfaces shall be verified.

c. If necessary, the chamber door may be opened to observe power and BIT lights.

4.6.4.4.2 Non-operational. The DRU-H-R shall be tested as specified in MIL-STD-810F, Method 501.4, procedure I.

4.6.4.5 Low temperature.

a. The same sample shall be used for the storage and operating tests.

b. The storage test shall be performed first.

4.6.4.5.1 Operational.

a. The DRU-H-R shall be tested as specified in MIL-STD-810F, Method 502.4, procedure II, with ambient temperature stabilized at -50°F throughout the test.

b. After temperature stabilization is achieved, a six hour simulated survey mission shall be conducted in accordance with 4.6.4.1, and correct operation of all external interfaces shall be verified.

c. If necessary, the chamber door may be opened to observe power and BIT lights.

4.6.4.5.2 Non-operational The DRU-H-R shall be tested as specified in MIL-STD-810F, Method 502.4, procedure I.

4.6.4.6 Temperature shock.

a. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 503.4, Procedure I.

b. The DRU-H-R shall be tested for operational conformance after exposure to abrupt temperature changes between -25°F and 70°F, and between 120°F and 70°F.

c. The DRU-H-R temperature shall be stabilized at -25°F and at 120°F for 90 minutes prior to initiating the abrupt temperature change.

d. The abrupt temperature change shall be performed within 10 minutes.

4.6.4.7 Solar radiation.

a. The DRU-H-R shall be subjected to a minimum of three, 24-hour, solar radiation and temperature cycles.

b. The diurnal temperature and solar radiation cycles shall represent exposure in a hot-dry climate and shall be applied simultaneously.

c. The DRU-H-R shall be operated during a 6 hour simulated survey mission at the peak temperature for each of the diurnal cycles.

d. MIL-STD-810F, Method 505.3, Procedure I provides guidance for solar radiation testing.

4.6.4.8 Humidity.

a. The DRU-H-R shall be subjected to 10, 24-hour, temperature and humidity cycles in accordance with MIL-STD-810F, Method 507.4.

b. The DRU-H-R shall be operated in simulated four hour survey missions near the ends of the fifth and tenth cycles.

c. The DRU-H-R shall be tested with electrical power source, host controller, and simulated Gun Drive electronics connected.

d. If necessary, the chamber door may be opened to observe power and BIT lights.

4.6.4.9 Washdown.

a. The DRU-H-R shall be exposed to a water stream from a 1-inch diameter nozzle fed by a pressure of 50 ±5 pounds per square inch for a period of 30 minutes.

b. The stream shall be directed onto each face, except the DRU-H-R mounting surface, of the DRU-H-R from a distance of 3 feet, for equal periods.

c. At the start of the test the DRU-H-R temperature shall be at least 18^{o}F higher than the water temperature.

d. Only the specified mating connectors or cap (J3) are permitted to cover connectors.

e. Failure to operate as specified or evidence of damage or leakage shall constitute failure of the test.

4.6.4.10 Salt fog.

a. The DRU-H-R shall be subjected to two 48-hour cycles of exposure to salt fog in accordance with MIL-STD-810F, Method 509.4.

b. The DRU-H-R shall be tested with electrical power source, host controller, and simulated Gun Drive electronics connected.

c. The DRU-H-R shall be operated in a simulated survey mission during the last four hours of each of the drying periods.

4.6.4.11 Fungus. The requirements of 3.4.8 shall be verified by analysis.

4.6.4.12 Shock.

4.6.4.12.1 Transportation.

a. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 516.5, Procedure I, using the criteria of 3.4.9.2.

b. The DRU-H-R shall be operating in Survey when the shock pulses are applied.

c. The test shall be repeated with the DRU-H-R powered off.

4.6.4.12.2 Bench handling. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 516.5, Procedure VI using the criteria specified in 3.4.9.3.

4.6.4.12.3 Operational (gunfire).

a. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 516.5, Procedure I, for 1000 shock impulses in each direction of each axis, using the gun firing spectra in Appendix E.

b. The DRU-H-R shall be operating in Survey when the shock pulses are applied.

c. The test shall be repeated with the DRU-H-R powered off.

4.6.4.13 Vibration.

a. The DRU-H-R shall be tested in accordance with MIL-STD-810F, Method 514.5, Procedure I, using the profiles and durations specified in Appendix E.

b. During exposure periods the DRU-H-R shall be operating in Survey and ZUPTs shall not be performed.

c. The procedure for verification of the performance (accuracy) criteria shall be detailed in the Government approved test procedures.

4.6.4.14 EMI-EMC. The DRU-H-R shall be tested for compliance with the requirements of 3.4.11 in accordance with MIL-STD-461E.

4.6.4.15 Electrostatic discharge. The DRU-H-R shall be tested for compliance with the requirements of 3.4.12 in accordance with DO-160D, Section 25.

4.6.4.16 Lightning. The DRU-H-R shall be verified by analysis for compliance with the requirements of section 3.4.13.

4.6.4.17 NBC survivability. The DRU-H-R shall be analyzed or tested for conformance with the requirements in 3.4.14. The following conditions apply:

a. Exterior surfaces are uniformly and separately contaminated with:

1) Ten g/m^2 of thickened droplets of soman (GD) having a mass median diameter (MMD) of 2-5 mm.

2) Ten g/m^2 of unthickened G-Agent (VX).

3) Ten g/m^2 of unthickened mustard (HD).

4) 10^5 spores/m^2 of biological agent 1-5 micrometers in size.

5) Four g/m^2 of insoluble radioactive contaminants 37-200 micrometers in size and 185 GBq/m^2 gamma activity.

b. Initial contamination levels on interior surfaces subject to contamination are a factor of 10 lower than on exterior surfaces in the absence of evidence to the contrary.

c. Decontamination begins one hour after contamination. The decontamination process, excluding monitoring, lasts no longer than 75 minutes.

d. Surface temperature is 30°C and exterior wind speed no greater than 1 m/sec.

e. Testing shall be conducted at facilities approved by the Government using accept/reject criteria established by appropriate Government Agencies.

4.6.5 Operational demonstration. The DRU-H-R shall be tested over a Government approved test course. The time to traverse the test course shall be approximately four hours. In addition to the initialization point, the test course shall have at least 12 survey control points, spaced approximately equally in time, for measurement of DRU-H-R survey parameters. The following missions shall be executed:

a. Accelerated align, odometer sensor aided.
b. Accelerated align, GPS aided.
c. Static align, odometer sensor aided.
d. Static align, odometer sensor aided with 10-minute ZUPT intervals.
e. Static align, GPS aided.
f. Static align, ZUPT aided.
g. Dynamic align, GPS aided.

The following parameters shall be measured:

a. Alignment time.
b. Time and duration of each zero-velocity stop.
c. Horizontal position, altitude, pointing device attitude (azimuth, pitch, roll) and distance traveled at the initialization point and each survey control point.
d. DRU-H-R BIT failure indications.

Using the above data:

a. the intervals between required ZUPTS shall be computed; and
b. the position, altitude, and pointing device attitude (azimuth, pitch, and roll) error characteristics shall be calculated.

A DRU-H-R BIT failure indication or failure to meet any of the following requirements shall constitute failure:

a. Align time requirements of 3.6.3.1
b. ZUPT interval requirements of 3.3.6.1 and 3.3.6.4.1
c. ZUPT duration requirements of 3.3.6.4; or
d. Accuracy requirements of 3.6.2.1, 3.6.2.2 or 3.6.2.3.

4.6.6 Reliability. MTBF shall be verified by a Parts Count Method analysis. MIL-HDBK-217 may be used as a guide. Physics of Failure analysis may be used to support the Parts Count Method analysis.

4.6.7 Maintainability.

a. Maintainability shall be verified by analysis and demonstration.

b. Failure to maintain the DRU-H-R as specified in 3.5.2 - 3.5.2.3 shall constitute failure of this test.

4.6.8 Performance demonstration.

a. The Government may test the DRU-H-R for compliance to any of the criteria specified in 3.6, including accuracy at high latitudes and for all align type and aiding combinations, and tolerance to gun firing shock.

b. Actual or simulated installation conditions, environments, and operational scenarios may be used. Failure of the DRU-H-R to perform as specified shall constitute failure of the test.

4.6.9 Design validation.

a. The requirements specified in 3 shall be verified as identified in Table XIX.

b. Characteristics to be verified shall include, but not be limited to, the following:

1) Static align accuracy (3.6.2.3) and time (3.6.2, 3.6.3.1) shall be demonstrated at the latitude of the test facility, over the specified operating temperatures (3.4.1.1), with the DRU-H-R oriented at each of the cardinal headings and 45 degrees to each of the cardinal headings. The DRU-H-R shall be turned off for 1 hour between alignments for tests performed at -50^{o}F.

2) Align accuracy (3.6.2.3), time (3.6.2, 3.6.3.1), and position and orientation accuracy shall be verified by analysis or demonstration at high latitudes in both hemispheres.

3) Dynamic align accuracy (3.6.2.3) and time (3.6.3.3) shall be tested over the allowable ranges of GPS availability and host dynamics (3.6.5.3).

4) Aiding selection characteristics (3.3.6.1) shall be verified for all combinations of allowable aids (3.3.6) by demonstration or test.

5) GPS aiding characteristics (3.3.6.2) and data acceptance criteria (3.3.6.2.1) shall be verified by demonstration or test.

6) ZUPT characteristics, acceptance and duration (3.3.6.4, 3.3.6.4.1) shall be verified by demonstration or test over the allowable range of base motion (3.6.5.2).

7) Odometer sensor aiding (3.3.6.3), handling of faulty odometer sensor data (3.3.6.3.1), and insensitivity to odometer calibration and alignment of DRU-H-R case to direction of travel (3.6.6.1h.) shall be verified by demonstration or test over the range of vehicle and terrain conditions.

8) Functional state characteristics and transitions (3.3.7 - 3.3.7.9) shall be verified by demonstration or test.

9) Connector pin functions (3.3.12.1.1) shall be verified by analysis or test.

10) Bonding and shield grounding (3.3.12.2) shall be verified by test.

11) Operation and power consumption over the input power voltage range, with ripple, surges and spikes, (3.3.12.3) shall be demonstrated.

12) Protection from loss of power, surges, spikes, over-voltages, starting disturbances, polarity reversal, and over-current (3.3.12.3, 3.5.8.3) shall be verified by demonstration or analysis.

13) Regulated output power voltage, current, ripple, and capacitor charging characteristics (3.3.12.3.1) shall be demonstrated.

14) Unregulated output power voltage and current characteristics (3.3.12.3.2) shall be demonstrated.

15) TIA-422 signal circuit characteristics (3.3.12.4.1) and logic levels (3.3.12.4.2) shall be verified by analysis or demonstration.

16) Host TIA-422 Data Interface (3.3.2, 3.3.12.4.3), command acceptance and response message format, timing and data element characteristics shall be verified by demonstration or test.

17) DRU-H-R status reporting (3.3.2.1) shall be verified by demonstration or test.

18) DRU-H-R alert reporting (3.3.2.2) shall be verified by demonstration or test.

19) Failure reporting (3.3.2.3) shall be verified by demonstration or test.

20) Command checking (3.3.2.4) shall be verified by demonstration or test.

21) Data entry checking (3.3.2.5) shall be verified by demonstration or test.

22) The Gun Drive interface (3.3.3, 3.3.12.8) shall be verified by demonstration or test.

23) Positioning (3.3.4), motion reporting (3.3.4.1), and position references (3.3.4.2) shall be verified by demonstration or test.

24) Orientation (3.3.5) and orientation references (3.3.5.1) shall be verified by demonstration or test.

25) GPS receiver control, status reporting, warning message, TIA-422 data command and message format, timing and data element characteristics (3.3.9 - 3.3.9.5, 3.3.12.4.4, 3.3.12.4.4.1), and 1 PPS interface (3.3.12.5) shall be verified by demonstration or test.

26) VMS interface control, data acceptance and BIT characteristics (3.3.12.4.5) shall be verified by analysis or demonstration.

27) The speedometer sender interface (3.3.12.6) shall be verified by demonstration or test.

28) The software loading interface (3.3.12.9, 3.3.12.9.1) and software loading (3.5.2.4) shall be verified by demonstration.

29) Travel lock determination, shot detect, and related STATUS DATA and ALERT DATA indications (3.3.10 - 3.3.11) shall be demonstrated.

30) Position update and datum acceptance and rejection characteristics (3.3.6.5 - 3.3.6.5.8) shall be demonstrated over the range of acceptable and unacceptable input data.

31) Configuration tailoring for fixed and host programmable configurations (3.3.1) shall be verified by demonstration or test over the allowable ranges of configuration codes and data elements.

32) Angular rate accuracy (3.6.2.4) shall be verified by analysis or test, over the allowable ranges of angular rates, in each axis.

33) Insensitivity to off-level alignment conditions (3.6.5.1) shall be verified by demonstration or analysis over the range of allowable orientations.

34) Interchangeability of DRU-H-Rs in host systems without hardware changes, calibration procedures, driving constraints and unscheduled ZUPTs (3.5.7) shall be demonstrated.

35) Interchangeability of parts, subassemblies and assemblies (3.5.7) shall be verified by analysis.

36) Data entry checking and accept/reject responses (3.3.2.5) shall be demonstrated.

37) Built-In-Test accuracy, characteristics, indications and reporting (3.3.8 - 3.3.8.4.3.3) shall be verified by demonstration or analysis.

38) Treatments and finishes (3.5.4, 3.5.4.1) shall be verified by analysis, examination, or test in accordance with the provisions of the applicable drawing(s).

39) Grounding (3.5.6) shall be verified by test.

40) Data delay (3.6.2.5 - 3.6.2.5.3) shall be verified by analysis or test.

41) Mission length and duration (3.6.4) shall be verified by analysis or demonstration.

42) Survey conditions (3.6.6.1, 3.6.6.2) shall be verified by analysis, demonstration, or test.

43) Safety (3.5.8-3.5.8.3) shall be verified by analysis, demonstration, examination or test for installation, operation, maintenance and repair.

44) Useful life (3.5.10) shall be verified by analysis of component expected lifetimes and degradation resulting from operational and storage conditions.

c. Failure to meet any specified requirement shall constitute failure of the verification.

4.6.10 Initial Nuclear Weapons Effects (INWE).

a. The requirements of 3.4.15 shall be verified by analysis.

b. The Government reserves the right to verify the requirements of 3.4.15 by test.

c. Failure to meet the requirements of 3.4.15 shall constitute failure of the verification.

5. PACKAGING

5.1 Packaging requirements. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When actual packaging of materiel is to be performed by DoD personnel, those personnel need to contact the responsible packaging activity to ascertain requisite packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activity within the Military Department or Defense Agency, or within the Military Department's System Command. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature which may be helpful, but is not mandatory.)

6.1 Intended use. The DRU-H-R is a positioning and orienting sub-system for use on weapon systems. Electronic odometer signals and GPS position and time data may optionally aid it. The DRU-H-R may be used in a variety of host system configurations.

The DRU-H-R covered by this specification is military unique. It is mounted to the gun trunnion of the M109A6 Self-Propelled Howitzer and must operate through the extreme levels of gunfire shock. It also must operate after exposure to the nuclear, biological and chemical warfare environments and subsequent decontamination. Commercial inertial navigation systems are not designed to withstand such extreme environmental conditions and would experience catastrophic failure. The DRU-H has extensive electronic data interchange requirements, which must be retained by the DRU-H-R for backward compatibility with the M109A6, AN/TPQ-36 and AN/TPQ-37. There is no commercial specification or standard covering the command and message formats.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number and date of this specification.

b. Type of DRU-H-R (see 1.2.1.)

c. Issue of individual documents referenced.

d. Requirements for design verification.

e. Requirements for submission of first article samples.

f. Any modifications to the Installed Configuration Data Tables of Appendix C (see 3.3.1.)

g. Documentation requirements for accessing and resetting BIT history data.

h. MIL-DTL-64159A paint type and color for Type II DRU-H-R (see 3.5.4.1).

i. Applicable National Stock Number (NSN).

j. Packaging requirements (see 5.1).

k. Serialization requirements, if applicable.

l. Certificate of conformance for each lot or shipment of product.

6.3 Definitions.

6.3.1 Ambient air temperature. Ambient air temperature conditions are those measured under standard conditions of ventilation and radiation shielding in a meteorological shelter at a height of 4 to 6 feet (1.2 to 1.8 meters) above the ground. (Source: AR 70-38, 1-3.c(1))

6.3.2 Ambient humidity. Ambient humidity conditions are those measured under standard conditions of ventilation and radiation shielding in a meteorological shelter at a height of 4 to 6 feet (1.2 to 1.8 meters) above the ground. (Source: AR 70-38, 1-3.c(1))

6.3.3 Hazard probability. Hazard probabilities are defined in Table XX.

Table XX - Hazard probability definitions.

Description	Level	Individual Item	Fleet or Inventory
Frequent	A	Likely to occur frequently	Continuously experienced
Probable	B	Will occur several times in life of item	Will occur frequently
Occasional	C	Likely to occur sometime in life of item	Will occur several times
Remote	D	Unlikely, but possible to occur in life of item	Unlikely, but can reasonably be expected to occur
Improbable	E	So unlikely it can be assumed occurrence may not be experienced	Unlikely to occur but possible

6.3.4 Hazard severity. Hazard severity levels are defined in Table XXI.

Table XXI - Hazard severity definitions.

Description	Category	Accident definition
Catastrophic	I	Death, system loss, or severe environmental damage
Critical	II	Severe injury, severe occupational illness, major system damage, or environmental damage
Marginal	III	Minor injury, minor occupational illness, minor system damage, or environmental damage
Negligible	IV	Less than minor injury, occupational illness, system damage, or environmental damage

6.3.5 NBC contamination. The deposit, adsorption, and/or absorption of residual radioactive material or biological or chemical agents on or by structures, areas, personnel, or objects. (Source: AR 70-75 glossary.)

6.3.6 NBC contamination survivability (NBCCS). The capability of a system (and its crew) to withstand a NBC-contaminated environment and relevant decontamination without losing the ability to accomplish the assigned mission. A NBC contamination-survivable system is hardened against NBC contamination and decontamination; is decontaminable, and is compatible with individual protective equipment. (Source: AR 70-75 glossary.)

6.3.7 Orientation reference frames. DRU-H-R orientation is defined by the relationship of the DRU-H-R case coordinate frame to an earth referenced coordinate frame. An intermediate DRU-H-R coordinate frame relates the case coordinate frame to the DRU-H-R mounting orientation. Suitable DRU-H-R coordinate frame codes and boresight angles should be selected

for each installation to insure proper definition of orientation parameters during pointing device deployment (DRU-H-R rotation).

6.3.7.1 DRU-H-R case coordinate frame. The DRU-H-R case reference frame (Figure 2) is a set of right hand orthogonal axes, $\overline{X}_C$, $\overline{Y}_C$, $\overline{Z}_C$. The origin and axes are related to the case mechanical datums, shown in Appendix F, as follows. The origin is located where the center axis of alignment hole R (DATUM axis V) intersects the precision mounting surface, DATUM plane G-U. The longitudinal axis, $\overline{X}_C$, is along the intersection of DATUM plane G-U and Section A-A, which passes through the centers of alignment holes R and D. The transverse axis, $\overline{Y}_C$, coincides with DATUM axis V. The vertical axis, $\overline{Z}_C$, is along the intersection of DATUM plane G-U and DATUM plane Z, which passes through the center of the mounting holes.

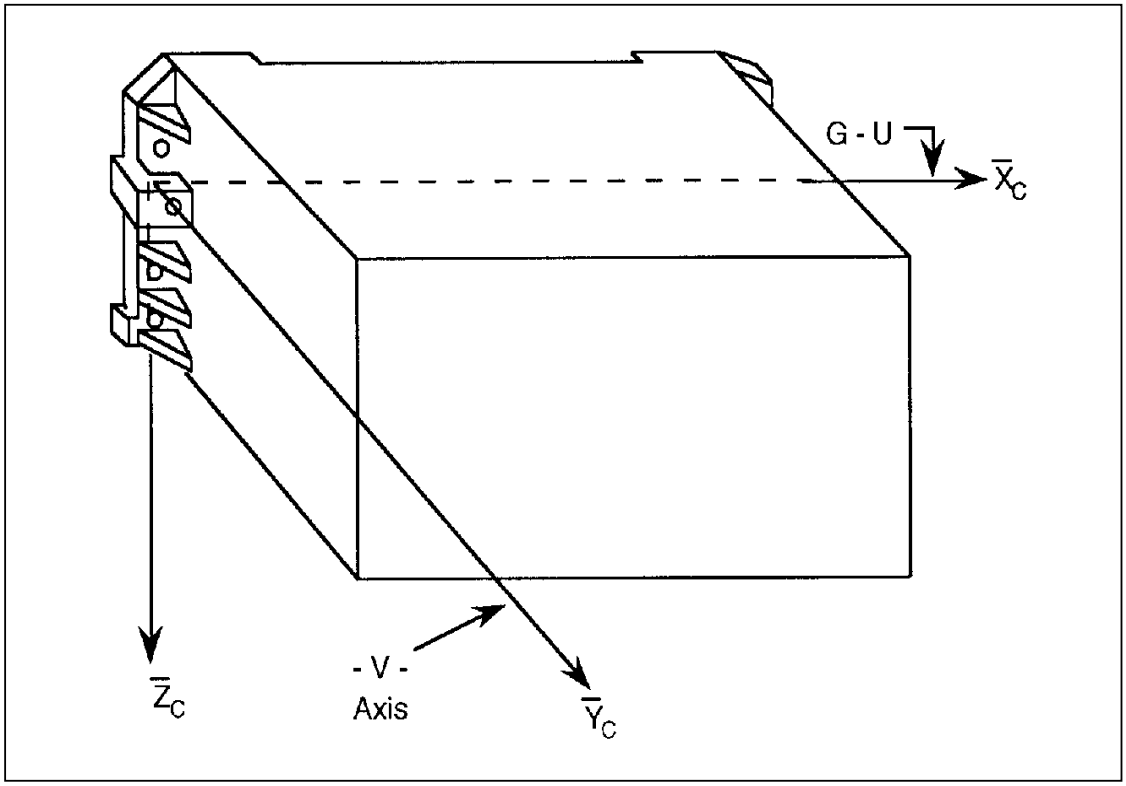


Figure 2. DRU-H-R case coordinate frame.

6.3.7.2 DRU-H-R coordinate frame. The DRU-H-R coordinate frame is an intermediate set of right hand orthogonal axes, $\overline{X}_D$, $\overline{Y}_D$, $\overline{Z}_D$, as shown in Figure 3a. The case coordinate frame is related to the DRU-H-R coordinate frame by a unit rotation matrix [R]. Elements of the rotation matrix, R_{ij}, may have the values -1, 0, 1. Examples are shown in Figure 3b and Figure 3c. The relationship between the case and DRU-H-R coordinate frames is specified by coordinate frame codes (see Appendix C.) There are separate coordinate frame codes for Orientations 1 and 2.

6.3.7.3 Pointing device reference frame. The Pointing Device reference frame is a body referenced set of right hand orthogonal axes, $\overline{X}_P$, $\overline{Y}_P$, $\overline{Z}_P$. The axes are related to the Pointing

Device as follows. The longitudinal axis, $\overline{X}_P$, is along the direction of pointing and is positive in the direction of pointing. The transverse axis, $\overline{Y}_P$, coincides with the Pointing Device cross axis. The vertical axis, $\overline{Z}_P$, is orthogonal to $\overline{X}_P$ and $\overline{Y}_P$ and is positive downward when $\overline{X}_P$ and $\overline{Y}_P$ are level. The Pointing Device reference frame and DRU-H-R coordinate frame are related by the Pointing Device Boresight Angles (see Appendix C.)

6.3.7.4 Vehicle reference frame. The Vehicle reference frame is a body referenced set of right hand orthogonal axes, $\overline{X}_V$, $\overline{Y}_V$, $\overline{Z}_V$. The axes are related to the vehicle chassis as follows. The longitudinal axis, $\overline{X}_V$, is along the direction of forward motion and is positive forward. The transverse axis, $\overline{Y}_V$, coincides with the Vehicle cross axis. The vertical axis, $\overline{Z}_V$, is orthogonal to $\overline{X}_V$ and $\overline{Y}_V$ and is positive downward when $\overline{X}_V$ and $\overline{Y}_V$ are level. The Vehicle reference frame and DRU-H-R coordinate frame are related by the Vehicle Boresight Angles (see Appendix C.)

6.3.7.5 Earth reference coordinate frame. The earth reference coordinate frame is an orthogonal coordinate set $\overline{X}_E$, $\overline{Y}_E$, $\overline{Z}_E$. $\overline{X}_E$ points north, $\overline{Y}_E$ east, and $\overline{Z}_E$ downward along the local vertical.

6.3.8 Orientation parameters. The DRU-H-R orientation parameters are defined in terms of rotations between the earth reference, intermediate, and DRU-H-R coordinate frames, as shown in Figure 4, and boresight angles (see Appendix C) relating the vehicle and pointing device reference frames to the DRU-H-R coordinate frame.

6.3.8.1 Pointing device cant. Pointing Device Cant is the vertical angle between the pointing device transverse axis, immediately clockwise from the direction of pointing, and the projection of that transverse axis onto the horizontal plane. Pointing Device Cant is positive when the transverse axis lies below the horizontal plane and negative when above.

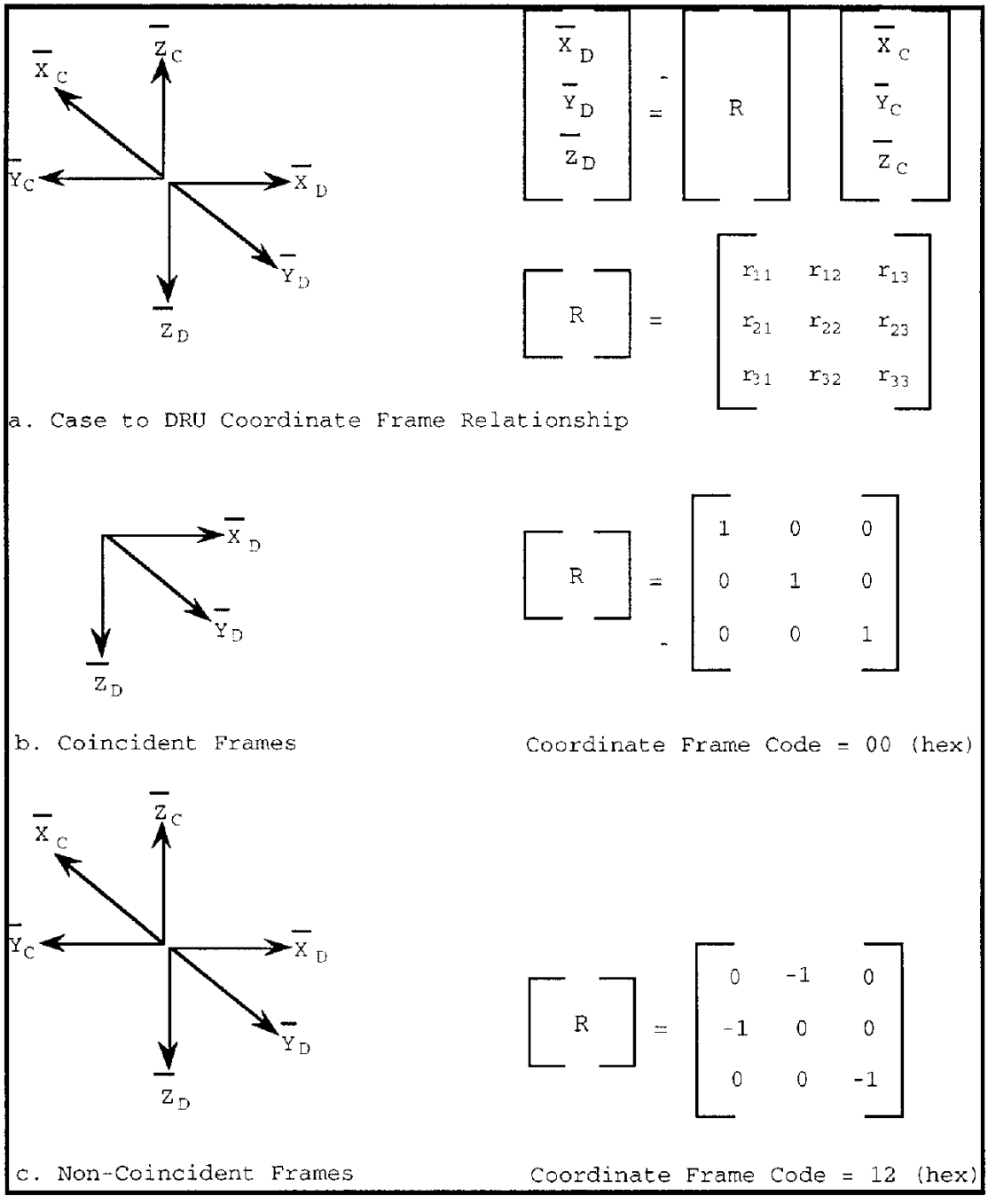
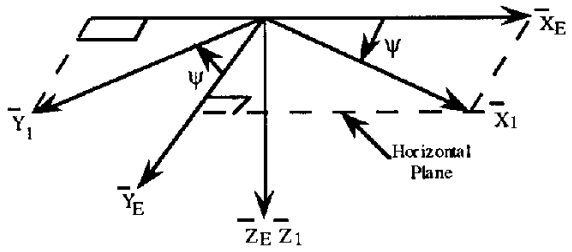


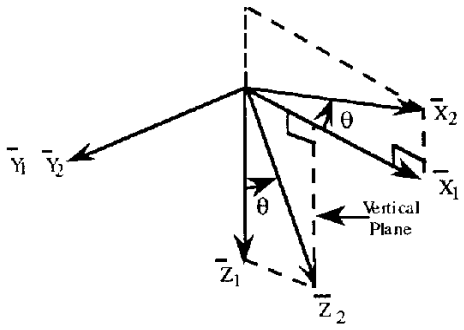
Figure 3. DRU-H-R coordinate frame.

$$\begin{bmatrix} \overline{X}_D \\ \overline{Y}_D \\ \overline{Z}_D \end{bmatrix} = \Phi * \Theta * \Psi \begin{bmatrix} \overline{X}_E \\ \overline{Y}_E \\ \overline{Z}_E \end{bmatrix}$$

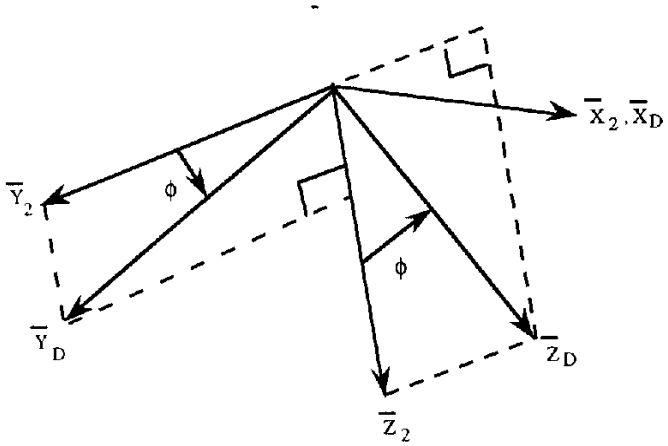
$$\Psi = \begin{bmatrix} Cos\ \Psi & Sin\ \Psi & 0 \\ -Sin\ \Psi & Cos\ \Psi & 0 \\ 0 & 0 & 1 \end{bmatrix}$$



$$\Theta = \begin{bmatrix} \text{Cos}\ \Theta & 0 & -\text{Sin}\ \Theta \\ 0 & 1 & 0 \\ \text{Sin}\ \Theta & 0 & \text{Cos}\ \Theta \end{bmatrix}$$



$$\Phi = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \text{Cos}\ \Phi & \text{Sin}\ \Phi \\ 0 & -\text{Sin}\ \Phi & \text{Cos}\ \Phi \end{bmatrix}$$



where:

Ψ = Azimuth

Θ = Pitch

Φ = Roll

Figure 4. Orientation parameters.

6.3.8.2 Pointing device geodetic azimuth. Pointing Device Geodetic Azimuth is the horizontal angle between geodetic (true) north and the vertical projection of the pointing device longitudinal axis, in the direction of pointing, onto the horizontal plane. Pointing Device Geodetic Azimuth is measured clockwise from geodetic north and is always positive.

6.3.8.3 Pointing device grid azimuth. Pointing Device Grid Azimuth is the horizontal angle between grid north (see Appendix G) and the vertical projection of the pointing device longitudinal axis, in the direction of pointing, onto the horizontal plane. Pointing Device Grid Azimuth is measured clockwise from grid north and is always positive.

6.3.8.4 Pointing device pitch. Pointing Device Pitch is the vertical angle between the projection of the pointing device longitudinal axis onto the horizontal plane and the axis. Pointing Device Pitch is positive when the axis, in the direction of pointing, lies above the horizontal plane and negative when below.

6.3.8.5 Pointing device roll. Pointing Device Roll is the angle between the horizontal plane and the pointing device transverse axis immediately clockwise from the direction of pointing measured in a plane normal to the pointing device longitudinal axis. Pointing Device Roll is positive when the transverse axis lies below the horizontal plane and negative when above.

6.3.8.6 Travel lock pointing device geodetic or grid azimuth reference. When the DRU-H-R is in travel lock, Travel Lock Geodetic or Grid Azimuth Reference equals the present Pointing Device Geodetic or Grid Azimuth. When the DRU-H-R is out of travel lock, Travel Lock Geodetic or Grid Azimuth Reference equals the value of Pointing Device Geodetic or Grid Azimuth when last in travel lock.

6.3.8.7 Travel lock pointing device pitch reference. When the DRU-H-R is in travel lock, Travel Lock Pitch Reference equals the present Pointing Device Pitch. When the DRU-H-R is out of travel lock, Travel Lock Pitch Reference equals the value of Pointing Device Pitch when the pointing device was last in travel lock.

6.3.8.8 Vehicle cant. When the DRU-H-R is in travel lock, Vehicle Cant is the vertical angle between the vehicle cross axis immediately clockwise from the direction of travel and the projection of that cross axis onto the horizontal plane. Vehicle Cant is positive when the cross axis lies below the horizontal plane and negative when above. When the DRU-H-R is out of travel lock, Vehicle Cant equals the value of Vehicle Cant when last in travel lock.

6.3.8.9 Vehicle geodetic or grid azimuth. When the DRU-H-R is in travel lock, Vehicle Geodetic or Grid Azimuth is the geodetic or grid azimuth of the vehicle longitudinal axis in the direction of travel and is the horizontal angle between geodetic or grid north (see Appendix G) and the vertical projection of the longitudinal axis onto the horizontal plane. Vehicle Geodetic or Grid Azimuth is measured clockwise from geodetic or grid north and is always positive. When the DRU-H-R is out of travel lock, Vehicle Geodetic or Grid Azimuth equals the value of Vehicle Geodetic or Grid Azimuth when last in travel lock.

6.3.8.10 Vehicle pitch. When the DRU-H-R is in travel lock, Vehicle Pitch is the vertical angle between the projection of the longitudinal axis of the vehicle onto the horizontal plane and the axis. Vehicle Pitch is positive when the axis in the direction of travel lies above the horizontal plane and negative when below. When the DRU-H-R is out of travel lock, Vehicle Pitch equals the value of Vehicle Pitch when last in travel lock.

6.3.8.11 Vehicle roll. When the DRU-H-R is in travel lock, Vehicle Roll is the angle between the horizontal plane and the vehicle cross axis, immediately clockwise from the direction of travel, measured in a plane normal to the vehicle longitudinal axis. Vehicle Roll is positive when the cross axis lies below the horizontal plane and negative when above. When the DRU-H-R is out of travel lock, Vehicle Roll equals the value of Vehicle Roll when last in travel lock.

6.3.9 Angular rate parameters. Pointing Device angular rate parameters are defined in terms of angular velocities around the Pointing Device reference frame axes. Pointing Device angular rates are body referenced, not earth referenced.

6.3.9.1 Pointing device azimuth rate. Pointing Device Azimuth Rate is the angular rate about the pointing device vertical axis, $\overline{Z}_P$. Pointing Device Azimuth Rate is positive when the pointing device reference frame is rotated about $\overline{Z}_P$ in a positive direction, as defined by the right hand rule.

6.3.9.2 Pointing device pitch rate. Pointing Device Pitch Rate is the angular rate about the pointing device transverse axis, $\overline{Z}_P$. Pointing Device Pitch Rate is positive when the pointing device reference frame is rotated about $\overline{Y}_P$ in a positive direction, as defined by the right hand rule.

6.3.9.3 Pointing device roll rate. Pointing Device Roll Rate is the angular rate about the pointing device longitudinal axis, $\overline{X}_P$. Pointing Device Roll Rate is positive when the pointing device reference frame is rotated about $\overline{X}_P$ in a positive direction, as defined by the right hand rule.

6.3.10 Error Parameters.

6.3.10.1 Circular error probable (CEP). CEP is the radius of a circle, centered about true, such that any measured position, selected from the total sample population, has a 50 percent probability of lying inside the circle.

$$CEP = 1.1774 \times \frac{RMS_N + RMS_E}{2}$$

Where: RMS_N and RMS_E are the RMS errors in Northing and Easting, respectively

6.3.10.2 Radial error.

Radial error is the linear difference in horizontal position between the measured reference values for a single position measurement.

$$\text{Radial Error} = [(m_E - M_E)^2 + (m_N - M_N)^2]^{1/2}$$

Where: m_E and m_N are the measured Easting and Northing, respectively
M_E and M_N are the reference Easting and Northing, respectively

6.3.10.3 RMS error. RMS error is the square root of the mean of the sum of the squared errors, relative to the reference value(s), for all measurements in the sample population.

$$RMS_x = \sqrt{\frac{\sum_{i=1}^{N} (x_i)^2}{N}}$$

Where:

N is the total number of measurements in the sample.
X_i is the error in the i'th measurement with respect to the reference value.
$X_i = m_i - M_i$ for linear or angular errors.

$X_i = 100 \times \frac{m_i - M_i}{S_i - S_0}$ for percent of distance traveled errors.

$X_i = \frac{(m_i - M_i) - (m_0 - M_0)}{T_i - T_0}$ for drift errors.

m_i is the i'th measurement in the sample. (m_0 is the initial measurement)
M_i is the reference value associated with the i'th measurement.
$S_i - S_0$ is the odometer distance traveled since the last position update.
$T_i - T_0$ is the travel time since the last alignment.

6.3.10.4 Probable error (PE) .PE is the equally likely deviation (50 percent probability) of a set of linear measurements about the true (reference) value.

$$PE = 0.6745 \times RMS_x$$

6.3.10.5 Standard deviation about the mean. The Standard Deviation about the Mean (σ) is the measurement of the dispersion of the measurements in a sample about the arithmetic mean.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} (m_i - \bar{m})^2}{N-1}}$$

Where:

N is the total number of measurements in the sample.
m_i is the i'th measurement in the sample.
$\bar{m}$ is the arithmetic mean of the sample.

$$\bar{m} = \frac{\sum_{i=1}^{N} m_i}{N}$$

6.3.11 Precise Positioning Service (PPS). All measurements used in the GPS position, velocity, and time (PVT) solution were obtained from P-code or Y-code transmissions from GPS satellites.

6.3.12 Standard Positioning Service (SPS). Any measurement used in the GPS PVT solution was obtained from a C/A-code transmission from a GPS satellite.

6.3.13 Travel lock. If the host has a pointing device, such as a gun tube, radar antenna, or sensor pod, the DRU-H-R is normally mounted to the pointing device. The DRU-H-R rotates with the pointing device in azimuth and elevation. When the pointing device is stowed for travel by physically clamping it to the vehicle chassis, it is said to be "in travel lock". When the gun tube is unclamped and elevated/rotated, it is said to be "out of travel lock".

6.3.14 Verification methods. Methods utilized to accomplish verification include:

a. Analysis. An element of verification that utilizes established technical or mathematical models or simulations, algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures to provide evidence that stated requirements were met.

b. Demonstration. An element of verification which generally denotes the actual operation, adjustment, or re-configuration of items to provide evidence that the designed functions were accomplished under specific scenarios. The items may be instrumented and quantitative limits of performance monitored.

c. Examination. An element of verification and inspection consisting of investigation, without the use of special laboratory appliances or procedures, of items to determine conformance to those specified requirements which can be determined by such investigations. Examination is generally nondestructive and typically includes the use of sight, hearing, smell, touch, and taste; simple physical manipulation; mechanical and electrical gauging and measurement; and other forms of investigation.

d. Test. An element of verification and inspection that generally denotes the determination, by technical means, of the properties or elements of items, including functional operation, and involves the application of established scientific principles and procedures.

6.4 Additional information.

6.4.1 Text conventions. The following conventions are used in the main text and appendices of this document:

a. For discrete (binary) data elements, set = 1 (binary) and reset = 0 (binary).

b. Command and message names are capitalized.

c. Configuration definition flags are identified by their data byte/bit locations in the TIA-422 ACCEPT CONFIGURATION DATA message (for example, CFIG D25/7). (Appendix C.)

d. Status indications are identified by their status byte/bit location in the TIA-422 STATUS DATA message (for example, STATUS DATA S2/6). (Appendix B.)

e. Alert indications are identified by their data byte/bit location in the TIA-422 ALERT DATA message (for example, ALERT DATA D4/7). (Appendix B.)

f. Failure indications (3.3.2.3) are identified by their data byte/bit location in the TIA-422 BUILT-IN-TEST (BIT) DATA message (for example, BIT DATA D1/7). (Appendix B.)

g. Expressions containing multiple uses of “and” or “or” are logical expressions. Punctuation, “()”, “[]”, and “{}” indicate evaluation order in logical expressions.

6.5 Acronyms and abbreviations.

The following acronyms and abbreviations may be used in the main text or appendices of this specification.

1PPS	One pulse per second
2b	Two's complement binary
ACK	Acknowledge
Alt	Altitude
ASCII	American Standard Code for Information Exchange
b	Binary
BIT	Built-In-Test
BTU	British Thermal Unit
C	Centigrade
CEP	Circular Error Probable
CFIG	Configuration Data
cGy	Centi-Gray
chan	Channel
cm	Centimeter
C/N_0	Carrier to Noise ratio (1 Hz bandwidth)
Cos	Cosine
CRC	Cyclic Redundancy Check
CSCI	Computer Software Configuration Item
DAGR	Defense Advanced GPS Receiver
dB	Decibels
DC	Direct Current
deg	Degrees
dis	Discrete
DIST	Distance
DRU-H	Dynamic Reference Unit Hybrid
DRU-H-R	Dynamic Reference Unit Hybrid Replacement
E	East
EIA	Electronic Industries Association
EHE	Estimated Horizontal Error
EMC	Electromagnetic Compatibility

EMI	Electromagnetic Interference
EMP	Electromagnetic Pulse
EPE	Estimated Position Error
EVE	Estimated Vertical Error
F	Fahrenheit
fp32	IEEE single precision (32-bit) floating point
fps	Feet per second
FREQ	Frequency
ft	Feet
g	Gram
G	Gravity
GBq	Giga-Becquerel
GHz	Giga-Hertz
GPS	Global Positioning System
hex	Hexadecimal
hi	High
hr	Hour
Hz	Hertz
ID	Identifier
in	Inch
IP	Internet Protocol
K	One thousand
kg	Kilogram
kHz	Kilohertz
km	Kilometer
Lat	Latitude
lbs	Pounds
Lo	Low
Lon	Longitude
LRU	Line Replaceable Unit
LSB	Least Significant Bit
m	Meter
M	Mil

m/sec	Meters per Second
ma	Milliampere
max	Maximum
MHz	Megahertz
min	Minutes
mm	Millimeter
MMD	Mass Median Diameter
mps	Meters per second
MSB	Most Significant Bit
msec	Millisecond
MSH	Most Significant Half
MSL	Mean-Sea-Level
MTBF	Mean-Time-Between-Failure
MTTR	Mean-Time-To-Repair
mv	Millivolt
N	North
n/a	Not Applicable
NAK	Negative Acknowledge
NBC	Nuclear-Biological-Chemical
nmi	Nautical miles
NRZ	Non-Return to Zero
PD	Pointing Device
PE	Probable Error
pk-pk	Peak-to-peak
Pos	Position
PPS	Precise Positioning Service
PSD	Power Spectral Density
rad	Radian
rad	Radiation unit
RCVR	Receiver
RES	Resolution
RMS	Root Mean Square
RPU	Receiver Processor Unit (GPS receiver)

S	South
sb	Signed Binary
SCC	Serial Communication Controller
SDLC	Synchronous Data Link Control
S/N	Serial Number
S/N	Signal to Noise ratio
SPS	Standard Positioning Service
SV	Space Vehicle (satellite)
S/W	Software
sec	Second
T	Time
TFOM	Time Figure Of Merit
ub	Unsigned binary
UDP	User Datagram Protocol
UPS	Universal Polar Stereographic
UTC	Universal Time Coordinated
UTM	Universal Transverse Mercator
V	Volts
VMS	Vehicle Motion Sensor
W	Watt
WGS	World Geodetic System
ZRP	Zero Reference Point
ZUPT	Zero Velocity Update

6.6 Explanations.

6.6.1 Position change. Change in position output by the DRU-H-R, during a position update, may reflect the update process, not host motion.

6.6.2 Relative GPS aiding. The DRUH has a requirement for relative GPS aiding which has been removed from this specification. For interface compatibility, DRU-H-R STATUS DATA reporting must reflect relative aiding even though the effective relative offsets are zero meters.

6.6.3 Functional States. Functional states are used to describe required DRU-H-R functionality. In general, state transition conditions are described in terms of responses that can be observed on the host interfaces. These descriptions are not intended to specify how functions are internally implemented.

6.6.4 Acceptance parameters. These values may vary depending on the contractor's test equipment and DRU-H-R mechanization. Any variation must be approved by the Government.

6.7 Changes from previous issue. Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of the changes.

6.8 Subject term (key word) listing.

Fire Control

MAPS

Navigation

Positioning System

DRU-H-R/HOST TIA-422 DATA INTERFACE

A.1 SCOPE

A.1.1 Scope. This appendix provides the requirements for a DRU-H-R/host digital interface using TIA-422 data interfaces. This appendix is a mandatory part of this specification. The information herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

A.2.1 General. The documents listed in this section are specified in section 3 or 4 of this appendix. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 of this appendix, whether or not they are listed.

A.2.2 Government documents.

A.2.2.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues are those cited in the solicitation or contract.

OTHER GOVERNMENT DOCUMENTS

IS-GPS-153D	GPS User Equipment Interface Control Document for the RS-232/TIA-422 Interface of DoD Standard GPS UE Radio Receivers

(Copies of IS-GPS-153D may be obtained from the Global Positioning System (GPS) Joint Program Office (JPO), SMC/CZ, SMC/CZ, 2435 Vela Way, Suite 1613, Los Angeles Air Force Base, El Segundo, CA 90245-5500.)

A.2.3 Non-Government documents. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents shall be those cited in the solicitation or contract.

INTERNET ENGINEERING STEERING GROUP

RFC 768 User Datagram Protocol1

RFC 791 Internet Protocol

(These documents are available on-line at http://www.ietf.org/rfc.html.)

TECHNICAL MANUALS

Z8030/8530 SCC	Zilog Serial Communications Controller

(Application for copies should be addressed to Zilog Inc., 210 Hacienda Avenue, Campbell, CA 95008-6609.)

A.3 REQUIREMENTS

A.3.1 Host TIA-422 data interface characteristics.

a. The DRU-H-R shall have two half-duplex, synchronous host TIA-422 data interfaces (Interface A and Interface B).

b. The DRU-H-R shall have two full-duplex, asynchronous host TIA-422 data interfaces (Interface C and Interface D).

c. The host TIA-422 data interfaces shall be bi-directional and independent.

d. Commands and messages may be exchanged between the host system and DRU-H-R via these data interfaces.

e. The electrical characteristics are specified in section 3 of the main body of this specification.

f. Unless otherwise specified, data formats shall be the same for the four host data interfaces.

A.3.1.1 Synchronous Host TIA-422 data interface protocols.

a. The two Synchronous Host TIA-422 interfaces shall use the normal Synchronous Data Link Control (SDLC) protocol compatible with the Zilog Z8030 Serial Communication Controller (SCC).

b. Data shall change after the falling edge and be valid on the rising clock edge.

A.3.1.1.2 Data encoding.

Data shall be encoded in the Non-Return-to-Zero (NRZ) format compatible with the Zilog Z8030 SCC.

A.3.1.1.2 Data rate.

a. The data rate shall be 38.4 kilobits per second.

b. The data interfaces shall operate properly when provided with 38.4 kHz, ±0.01 percent, symmetrical squarewave clock signals compatible with the Zilog Z8030 SCC.

A.3.1.1.3 SDLC flag.

Each command and message shall start and end with a single byte (8 bits) flag containing the fixed binary sequence 01111110.

A.3.1.1.4 Error detection.

a. Each command and message shall contain a two byte (16 bit) Cyclic Redundancy Check (CRC) compatible with the SDLC protocol as implemented in the Zilog Z8030 SCC (CRC-CCITT polynomial).

b. Each command received by the DRU-H-R shall be tested for correct reception.

c. If an error is detected, the DRU-H-R shall ignore the command, set ALERT DATA D5/0 (Undefined Command Received) and return a STATUS DATA message.

d. Each message sent by the DRU-H-R shall contain the CRC computed for the information being sent.

A.3.1.1.5 Half-duplex operation.

a. Each synchronous data interface shall be in receive mode unless the DRU-H-R is sending a message on that particular interface.

b. The DRU-H-R shall be able to receive a command, on the same data interface, within 1.0 milliseconds after sending the end of the last bit of a message.

c. The DRU-H-R shall not start sending a message until at least 3.0 milliseconds has elapsed after receipt of the end of the last bit of the command that initiated the message.

A.3.1.1.6 Message synchronization. The DRU-H-R shall automatically synchronize to received commands when the data stream or clock signal has been restored after interruption.

A.3.1.2 Asynchronous Host TIA-422 data interface protocols. The two Asynchronous Host TIA-422 interfaces shall use the following protocol:

A.3.1.2.2 Data encoding. Data shall be encoded in the Non-Return-to-Zero (NRZ) format.

A.3.1.2.2 Data rate. The data rate shall be 76.8 kilobits per second.

A.3.1.2.3 Character format. Information shall be communicated in 10-bit characters: start bit, 8-bit information byte, stop bit, and no parity bits, as shown in Figure A-1.

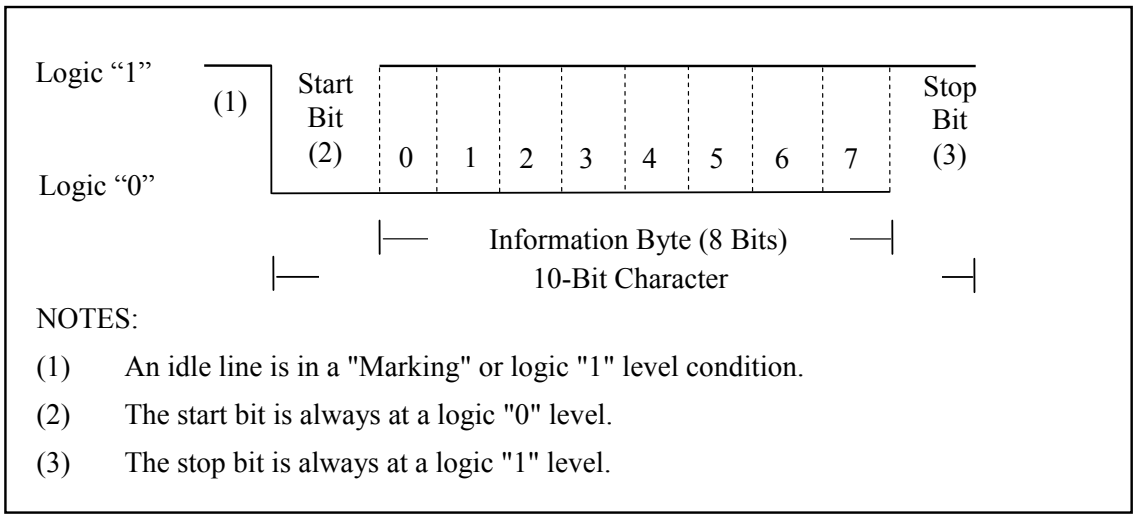


Figure A-1 Character format.

A.3.1.2.4 Start flag. Each command and message shall start with a 2-byte (16 bits) flag consisting of the ASCII DLE (00010000 binary) and SOH (00000001 binary) characters.

A.3.1.2.5 End flag. Each command and message shall end with a 2-byte (16 bits) flag consisting of the ASCII DLE and EOT (00000100 binary) characters.

A.3.1.2.6 ASCII DLE characters.

a. To allow reliable detection of the start and end flags, any occurrence of the ASCII DLE (00010000 binary) character between the start and end flags shall be preceded by an additional ASCII DLE character.

b. For transmission, any additional DLE characters shall be included in CRC computation. Additional DLE characters will be added to the CRC only after the final CRC has been calculated.

c. For reception, any added DLE characters shall be removed from the CRC before error detection is performed.

d. Any added DLE characters shall be removed from the remainder of the command or message after error detection is completed but before the command or message is parsed.

e. For commands containing data byte counts, the byte count shall equal the number of data bytes prior to insertion of additional DLE characters.

f. For messages containing data byte counts, the byte count in the message shall be compared to the number of data bytes remaining after additional DLE characters have been removed.

A.3.1.2.7 Error detection.

a. Each command and message shall contain a two byte (16 bit) CRC, as defined in A.4.1.

b. Each command received by the DRU-H-R shall be tested for correct reception.

c. If an error is detected, the DRU-H-R shall ignore the command, set ALERT DATA D5/0 (Undefined Command Received) and return a STATUS DATA message.

d. Each message sent by the DRU-H-R shall contain the CRC computed for the information being sent.

A.3.1.2.8 Message synchronization. The DRU-H-R shall automatically synchronize to received commands when the data stream has been restored after interruption.

A.3.1.3 Command and message protocols. Commands to and messages from the DRU-H-R on any TIA-422 Host Data Interface shall follow the protocols below:

a. The host shall be the interface master, which initiates commands to the DRU-H-R (slave).

b. The DRU-H-R shall not initiate a message without a request (command).

c. The DRU-H-R shall send a message in response to each command received. The message shall be returned only on the interface over which the command was received.

d. STATUS DATA and ALERT DATA indications applicable to only one data

interface, such as improper command received or error detected, shall be returned only on the applicable interface.

e. Commands and messages shall be constructed of 8-bit bytes. Bit positions within a byte are shown below:

msb lsb
7 6 5 4 3 2 1 0

f. Bytes shall be transmitted in the order specified. Multi-byte data fields shall be transmitted most significant byte first. The least significant bit within a byte shall be transmitted first.

A.3.1.4 Host TIA-422 data interface control.

a. STATUS DATA S1/0 (Auxiliary Interface Control Inhibited) shall be reset on all data interfaces, indicating Auxiliary Interface control is enabled.

b. The DRU-H-R shall accept commands specified herein if received on any Host TIA-422 Data interface.

A.3.2 Host TIA-422 commands and messages.

a. Host TIA-422 commands and associated DRU-H-R response messages are listed in Table A-I along with the decimal representation of the command code and subcode, if applicable, message ID, and the minimum command acceptance rate.

b. Messages transmitted over a Host TIA-422 data interface shall contain only mutually consistent samples of information.

c. Any invalid data transmitted over the data interface shall be indicated as invalid within the same message the data appears.

TABLE A-I. Commands and messages.

COMMAND			Rate	RESPONSE MESSAGE	
Code	SUB	NAME	(Hz)	ID	NAME
0		RETURN TRAVEL LOCK DATA	100[1]	3	TRAVEL LOCK DATA
1		RETURN ATTITUDE DATA	100[1]	2	ATTITUDE DATA
2		RESERVED			
3		ACCEPT CONFIGURATION DATA	5	0	STATUS DATA
4		RESERVED			
5		ACCEPT POSITION	5	0	STATUS DATA
6	xx	SUPPLIER RESERVED	12	xx	SUPPLIER RESERVED
7		RESERVED			
8		OVERRIDE ALERT	5	0	STATUS DATA
9		RETURN POSITION DATA	5	8	POSITION DATA
10		RESERVED			

[1] Limited to 60 Hz when using SDLC interfaces A and B.

TABLE A-I. Commands and messages.

COMMAND			Rate	RESPONSE MESSAGE	
Code	SUB	NAME	(Hz)	ID	NAME
11		ENABLE AUXILIARY INTERFACE CONTROL	5	0	STATUS DATA
12		RETURN POINTING DEVICE ATTITUDE DATA	100[1]	10	POINTING DEVICE ATTITUDE DATA
13		RESERVED			
14		RESERVED			
15		INHIBIT ZERO-VELOCITY UPDATE	5	0	STATUS DATA
16		RETURN STATUS	5	0	STATUS DATA
17		RETURN NAVIGATION DATA	5	1	NAVIGATION DATA
18		RETURN ALIGN TIME TO GO	5	7	ALIGN TIME TO GO DATA
19		RETURN ALERT DATA	5	6	ALERT DATA
20	1	INHIBIT ODOMETER REQUEST	5	0	STATUS DATA
20	2	ENABLE ODOMETER REQUEST	5	0	STATUS DATA
20	5	IN TRAVEL LOCK	5	0	STATUS DATA
20	6	OUT OF TRAVEL LOCK	5	0	STATUS DATA
20	7	RETURN CONFIGURATION DATA	5	18	CONFIGURATION DATA
20	8	RETURN POINTING DEVICE BORESIGHT	5	13	POINTING DEVICE BORESIGHT DATA
20	10	RETURN SURVEY QUALITY	5	15	SURVEY QUALITY
20	11	ACCEPT VEHICLE BORESIGHT	5	0	STATUS DATA
20	12	RETURN VEHICLE BORESIGHT	5	16	VEHICLE BORESIGHT
20	13	RETURN GEODETIC DATA	5	17	GEODETIC DATA
20	14	ACCEPT GEODETIC DATA	5	0	STATUS DATA
20	15	STORED HEADING SHUTDOWN	5	0	STATUS DATA
20	16	RESERVED			
20	17	RESERVED			
20	18	RESERVED			
20	19	CONNECT GUN POSITION DATA MESSAGE	5	0	STATUS DATA
20	20	ACCEPT ETHERNET CONFIGURATION DATA	5	0	STATUS DATA
20	21	RETURN ELAPSED TIME	5	30	ELAPSED TIME
20	22	RETURN ETHERNET CONFIGURATION DATA	5	29	ETHERNET CONFIGURATION DATA
21		ENABLE ZERO-VELOCITY UPDATE	5	0	STATUS DATA
22	1	ACCEPT USER DATUM	5	0	STATUS DATA
22	2	RESERVED			
22	3	RESERVED			

TABLE A-I. Commands and messages.

COMMAND			Rate	RESPONSE MESSAGE	
Code	SUB	NAME	(Hz)	ID	NAME
22	4	RESERVED			
22	5	ENABLE INERTIAL MODE	5	0	STATUS DATA
22	6	ENABLE INTEGRATED MODE	5	0	STATUS DATA
22	7	USE DEGRADED GPS DATA	5	0	STATUS DATA
22	8	SELECT Y-CODE ONLY SATELLITES	5	0	STATUS DATA
22	9	SELECT P OR Y-CODE SATELLITES	5	0	STATUS DATA
22	10	DO NOT APPLY RELATIVE OFFSETS	5	0	STATUS DATA
22	11	APPLY RELATIVE OFFSETS	5	0	STATUS DATA
22	12	RESET RELATIVE OFFSETS	5	0	STATUS DATA
22	19	RETURN DATUM DATA	5	19	DATUM DATA
22	20	RETURN GPS TIME & DAY DATA	5	20	GPS TIME & DAY DATA
22	21	RETURN GPS POSITION DATA	5	21	GPS POSITION DATA
22	22	RETURN GPS WARNING	5	22	GPS WARNING
22	23	RETURN NEXT GPS WARNING	5	22	GPS WARNING
22	24	RETURN PRECISION NAV DATA	5	24	PRECISION NAV DATA
22	25	RETURN DRU-H-R S/W ID DATA	5	25	DRU-H-R S/W ID DATA
23		ACCEPT POINTING DEVICE BORESIGHT	5	0	STATUS DATA
26		RESTART	5	0	STATUS DATA
27		RESERVED			
30		SHUTDOWN	5	0	STATUS DATA
31		RETURN BIT DATA	5	4	BIT DATA

A.3.2.1 TIA-422 command and message data description.

a. The requirements for data in TIA-422 commands and messages are set forth in tables. Each row specifies the requirements for a data field.

b. A data field shall occupy the byte(s) specified in the BYTE(s) column.

c. Unless otherwise specified, the field shall completely fill the byte(s) specified in the BYTE(s) column. When the field does not completely fill the bytes specified in the BYTE(s) column, the field length is specified in the BITs column.

d. The data format for the field is specified in the TYPE column and applies to the entire field, regardless of length. Available data types are listed in Table A-II.

TABLE A-II Data types.

TYPE	DESCRIPTION
ASCII	ASCII coded characters. Each character contains 8 bits.
dis	Discrete - Individual bit(s) having a value of 0 (reset) or 1 (set).
hex	Hexadecimal coded characters. Each character contains 4 bits.
sb	Signed Binary - The most significant bit represents the sign (0 = +, 1 = -). The rest of the field is Unsigned Binary.
ub	Unsigned Binary - The entire field is positive.
2b	Two's Complement Binary

e. The allowable range of values for a field is specified in the RANGE column. When a single value is given, it is the only permissible value.

f. All numeric fields are scaled binary. The resolution of the least significant bit is specified in the RES. column.

g. The units applicable to both the range and resolution are specified in the UNITS column.

h. The data to be input or output in the field is identified in the DATA ELEMENT column. Data elements are defined either within the table or elsewhere in this specification.

A.3.2.2 Host TIA-422 command formats. The DRU-H-R shall accept, for processing, input commands in the following format:

SF C D1.....DN E1 E2 EF

DESCRIPTION OF SYMBOLS

a. SF, Start Flag.

b. C, Command. The command byte identifies the requested DRU-H-R response. The command code consists of 5 bits as specified in the detailed command description. Some commands contain a subcode, in data byte D1, which further identifies the requested response. The command byte also contains a 3 bit message sequence number assigned by the host.

	MESSAGE SEQ. NO.	COMMAND CODE
	XXX	XXXXX
bit position	7 6 5	4 3 2 1 0

The DRU-H-R shall set ALERT DATA D5/0 (Undefined Command Received) and return a STATUS DATA message if an undefined command code or subcode is received.

c. D1.....DN, Data. A command may contain 0 to 64 data bytes as specified in the detailed command description. The DRU-H-R shall set ALERT DATA D5/0 (Undefined

Command Received), not further process the command, and return a STATUS DATA message if a command is received with an incorrect number of bytes.

d. E1, E2, error detection code. The two byte CRC, which encompasses the command byte through the last data byte, if any.

e. EF, End Flag.

f. X, symbol. An X indicates a binary "1" or "0".

A.3.2.3 Host TIA-422 command rates.

a. The DRU-H-R shall accept and process commands received on either the two SDLC or two asynchronous host data interfaces simultaneously within the range of zero to the minimum command acceptance rates listed in Table A-I.

b. The three combinations of commands that are required to be processed simultaneously are:

1) 5 HZ commands received on two SDLC or two asynchronous host data interfaces;

2) 5 HZ commands received on one SDLC interface and a 60 HZ command received on the other SDLC interface.

3) 5 HZ commands received on one asynchronous interface and a 100 HZ command received on the other asynchronous interface.

c. The DRU-H-R is not required to accept a new command on a particular interface until the message associated with a command previously received on that interface has been transmitted or until the required response time for the command previously received plus 10 milliseconds has elapsed with no message being sent.

A.3.2.4 Commands. Host interface commands are described in the following subparagraphs. Unless otherwise specified, the DRU-H-R shall perform the requested function(s) and return the message specified in Table A-I upon receipt of a command containing a valid command code.

A.3.2.4.1 RETURN TRAVEL LOCK DATA command.

Function: Requests the DRU-H-R to send a TRAVEL LOCK DATA message.

COMMAND CODE	0 (00000b)	**DATA BYTE COUNT**	0

A.3.2.4.2 RETURN ATTITUDE DATA command.

Function: Requests the DRU-H-R to send an ATTITUDE DATA message.

COMMAND CODE	1 (00001b)	**DATA BYTE COUNT**	0

A.3.2.4.3 ACCEPT CONFIGURATION DATA command.

Function: Requests the DRU-H-R to accept a configuration data update and tailor operation using the new configuration data. Configuration data elements are defined in Appendix C.

COMMAND CODE	3 (00011b)	DATA BYTE COUNT	53

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		2b	0	1	n/a	Reserved Spare
D2-D3		2b	-3199.9 to +3200.0	0.1	mil	1 - 2 Threshold Angle
D4-D5		2b	-3199.9 to +3200.0	0.1	mil	2 - 1 Threshold Angle
D6-D7		2b	-25.00 to +25.00	0.01	meter	Orientation 1 Vehicle ΔX
D8-D9		2b	-25.00 to +25.00	0.01	meter	Orientation 1 Vehicle ΔY
D10-D11		2b	-25.00 to +25.00	0.01	meter	Orientation 1 Vehicle ΔZ
D12-D13		2b	-25.00 to +25.00	0.01	meter	Orientation 2 PD ΔX
D14-D15		2b	-25.00 to +25.00	0.01	meter	Orientation 2 PD ΔY
D16-D17		2b	-25.00 to +25.00	0.01	meter	Orientation 2 PD ΔZ
D18-D19		ub	2 to 15	0.25	minute	Exclusive ZUPT mode ZUPT interval
D20-D21		ub	2 to 63	1	minute	Odometer Mode ZUPT interval
D22-D23		ub	3.5 to 34.0	0.25	minute	Static Align Time
D24-D25		ub	0 to 10 (0 valid only if D29/5 is reset)	1	second	Shot Detect Interval
D26-D29		dis	n/a	n/a	n/a	Configuration definition flags
D30-D31		ub	0.750 to 1.250	0.001	n/a	Odometer Scale Factor
D32-D33		2b	-3276.8 to +3276.7	0.1	μ-radian /km	Fuel Consumption Factor
D34		hex	00 to 3F	n/a	n/a	DRU-H-R Coordinate Frame Code for Orientation 1
D35		hex	00 to 3F	n/a	n/a	DRU-H-R Coordinate Frame Code for Orientation 2
D36-D37		2b	-25.00 to +25.00	0.01	meter	Odometer action point ΔX
D38-D39		2b	-25.00 to +25.00	0.01	meter	Odometer action point ΔY
D40-D41		2b	-25.00 to +25.00	0.01	meter	Odometer action point ΔZ
D42-D43		2b	-25.00 to +25.00	0.01	meter	GPS antenna ΔX
D44-D45		2b	-25.00 to +25.00	0.01	meter	GPS antenna ΔY
D46-D47		2b	-25.00 to +25.00	0.01	meter	GPS antenna ΔZ
D48-D49		ub	10 to 900	1	second	GPS Update Time-out Interval
D50-D51		ub	0 to 256	1	meter	GPS EPE Good Value
D52-D53		ub	0 to 32,535	1	meter	GPS EPE Poor Value

A.3.2.4.4 ACCEPT POSITION command.

Function: Requests the DRU-H-R to accept a grid coordinate position update.

COMMAND CODE	5 (00101b)	DATA BYTE COUNT	17

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D3		ub	0 to 10,000,000	1	meter	Northing
D4-D5	15	2b	-1,000 to +10,000	1	meter	Altitude
D6	7	2b	-61 to +61	1	n/a	Extended Zone Number + = northern hemisphere - = southern hemisphere (DRU-H-R shall ignore sign) ±61 = Normal Zone
D7	7	2b	-60 to +60	1	n/a	DRU-H-R Hemisphere & Zone + = northern hemisphere - = southern hemisphere
D8 bits 5-7	3	dis	0	n/a	n/a	Spare Bits
D8 bit 4	1	dis	0 or 1	n/a	n/a	Determine Relative Offsets flag
D8 bits 0-3	4	ub	0 to 1	1	n/a	DRU-H-R Grid 1 = UTM
D9-D11	20	ub	0 to 999,9999	1	meter	Easting
D12-D17		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code

A.3.2.4.5 OVERRIDE ALERT command.

Function: Requests the DRU-H-R to reset overrideable ALERT DATA bits.

COMMAND CODE	8 (01000b)	DATA BYTE COUNT	0

A.3.2.4.6 RETURN POSITION DATA command.

Function: Requests the DRU-H-R to send a POSITION DATA message.

COMMAND CODE	9 (01001b)	DATA BYTE COUNT	0

A.3.2.4.7 ENABLE AUXILIARY INTERFACE CONTROL command.

Function: Performs no function but must be accepted by the DRU-H-R.

COMMAND CODE	11 (01011b)	DATA BYTE COUNT	0

A.3.2.4.8 RETURN POINTING DEVICE ATTITUDE DATA command.

Function: Requests the DRU-H-R to send a POINTING DEVICE ATTITUDE DATA message.

COMMAND CODE	12 (01100b)	DATA BYTE COUNT	0

A.3.2.4.9 INHIBIT ZERO VELOCITY UPDATES command.

Function: Requests the DRU-H-R to inhibit zero-velocity updates while in Survey. The DRU-H-R shall not request stops when ZUPT aiding is inhibited.

During Align, the DRU-H-R may retain the current ZUPT aiding state and set ALERT DATA D5/6 (Invalid Mode Request).

COMMAND CODE	15 (01111b)	**DATA BYTE COUNT**	0

A.3.2.4.10 RETURN STATUS command.

Function: Requests the DRU-H-R to send a STATUS DATA message.

COMMAND CODE	16 (10000b)	**DATA BYTE COUNT**	0

A.3.2.4.11 RETURN NAVIGATION DATA command.

Function: Requests the DRU-H-R to send a NAVIGATION DATA message.

COMMAND CODE	17 (10001b)	**DATA BYTE COUNT**	0

A.3.2.4.12 RETURN ALIGN TIME TO GO command.

Function: Requests the DRU-H-R to send an ALIGN TIME TO GO message.

COMMAND CODE	18 (10010b)	**DATA BYTE COUNT**	0

A.3.2.4.13 RETURN ALERT DATA command.

Function: Requests the DRU-H-R to send an ALERT DATA message.

COMMAND CODE	19 (10011b)	**DATA BYTE COUNT**	0

A.3.2.4.14 INHIBIT ODOMETER REQUEST command.

Function: Requests the DRU-H-R to inhibit using odometer sensor data.

When the Odometer Installed flag (CFIG D29/0) is set and STATUS DATA S3/2 (DRU-H-R In Motion) is reset, the DRU-H-R shall: inhibit odometer aiding; inhibit VMS hardware BIT; inhibit odometer sensor software BIT; and reset BIT DATA D2/0 (VMS Drive Fail) and D2/1 (VMS Fail).

When the Odometer Installed flag (CFIG D29/0) is reset or STATUS DATA S3/2 (DRU-H-R In Motion) is set, the current odometer aiding state shall be maintained and ALERT DATA D5/6 (Invalid Mode Request) shall be set.

COMMAND CODE	20 (10100b)	**DATA BYTE COUNT**	1

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	1	1	n/a	Command Subcode

A.3.2.4.15 ENABLE ODOMETER REQUEST command.

Function: Requests the DRU-H-R to perform VMS BIT and use odometer sensor data.

When the Odometer Installed flag (CFIG D29/0) is set and the Odometer Sensor Type flag (CFIG D29/1) is reset and STATUS DATA S3/2 (DRU-H-R In Motion) is reset, VMS hardware BIT shall be initiated.

a. If the VMS fails hardware BIT, odometer sensor aiding shall be inhibited and STATUS DATA S1/3 (Odometer Inhibited) shall be set.

b. If the VMS passes hardware BIT: BIT DATA D2/1 (VMS Fail) and D2/0 (VMS Drive Fail) shall be reset; STATUS DATA S1/3 (Odometer Inhibited) shall be reset; and odometer sensor aiding and BIT shall be enabled.

When the Odometer Installed flag (CFIG D29/0) is set and the Odometer Sensor Type flag (CFIG D29/1) is set and STATUS DATA S3/2 (DRU-H-R In Motion) is reset: BIT DATA D2/1 (VMS Fail) and D2/0 (VMS Drive Fail) shall be reset; STATUS DATA S1/3 (Odometer Inhibited) shall be reset; and odometer sensor aiding and BIT shall be enabled.

When the Odometer Installed flag (CFIG D29/0) is reset or STATUS DATA S3/2 (DRU-H-R In Motion) is set, the current odometer sensor aiding state shall be maintained and ALERT DATA D5/6 (Invalid Mode Request) shall be set.

COMMAND CODE	20 (10100b)	**DATA BYTE COUNT**	1

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	2	1	n/a	Command Subcode

A.3.2.4.16 IN TRAVEL LOCK command.

Function: Indicates the DRU-H-R is stowed for travel.

COMMAND CODE	20 (10100b)	**DATA BYTE COUNT**	1

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	5	1	n/a	Command Subcode

A.3.2.4.17 OUT OF TRAVEL LOCK command.

Function: Indicates the DRU-H-R is not stowed for travel.

COMMAND CODE	20 (10100b)	**DATA BYTE COUNT**	1

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	6	1	n/a	Command Subcode

A.3.2.4.18 RETURN CONFIGURATION DATA command.

Function: Requests the DRU-H-R to send a CONFIGURATION DATA message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	7	1	n/a	Command Subcode

A.3.2.4.19 RETURN POINTING DEVICE BORESIGHT command.

Function: Requests the DRU-H-R to send a POINTING DEVICE BORESIGHT message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	8	1	n/a	Command Subcode

A.3.2.4.20 RETURN SURVEY QUALITY command.

Function: Requests the DRU-H-R to send a SURVEY QUALITY message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	10	1	n/a	Command Subcode

A.3.2.4.21 ACCEPT VEHICLE BORESIGHT command.

Function: If the Vehicle Boresight Angles flag (CFIG D29/6) is set, requests the DRU-H-R to accept a vehicle boresight angles update. Boresight angle parameters are defined in Appendix C.

If the Vehicle Boresight Angles flag (CFIG D29/6) is reset, the DRU-H-R shall reject the command and set ALERT DATA D5/7 (Invalid Update Request).

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	7

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	11	1	n/a	Command Subcode
D2-D3		ub	0 to 6399.9	0.1	mil	Vehicle α
D4-D5		2b	-1600.0 to +1600.0	0.1	mil	Vehicle β
D6-D7		2b	-3199.9 to 3200.0	0.1	mil	Vehicle γ

A.3.2.4.22 RETURN VEHICLE BORESIGHT command.

Function: Requests the DRU-H-R to send a VEHICLE BORESIGHT message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	12	1	n/a	Command Subcode

A.3.2.4.23 RETURN GEODETIC DATA command.

Function: Requests the DRU-H-R to send a GEODETIC DATA message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	13	1	n/a	Command Subcode

A.3.2.4.24 ACCEPT GEODETIC DATA command.

Function: Requests the DRU-H-R to accept a geodetic coordinate position update.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	25

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	14	1	n/a	Command Subcode
D2		2b	0	1	n/a	Reserved Spare
D3 bits 5-7	3	dis	0	n/a	n/a	Spare Bits
D3 bit 4	1	dis	0 or 1	n/a	n/a	Determine Relative Offsets input flag
D3 bits 0-3	4	ub	0 to 1	1	n/a	DRU-H-R Grid 1 = UTM
D4-D5		sb	-90 to +90	1	degree	Latitude Degrees * + = Northern hemisphere - = Southern hemisphere
D6-D9		ub	0 to (60 - $1/2^{24}$)	$1/2^{24}$	arc minute	Latitude Minutes *
D10-D11		sb	-180 to +180	1	degree	Longitude Degrees * + = East of Prime Meridian - = West of Prime Meridian
D12-D15		ub	0 to (60 - $1/2^{24}$)	$1/2^{24}$	arc minute	Longitude Minutes *
D16-D19		2b	-1,000 to +10,000	0.01	meter	Altitude
D20-D25		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code

* In addition to the individual field range limits for degrees and minutes, the combination of degrees and minutes shall not exceed the degrees field range limits for latitude and longitude, respectively.

A.3.2.4.25 STORED HEADING SHUTDOWN command.

Function: Requests the DRU-H-R to: save current position, attitude, and any other data necessary to initiate normal operation when the DRU-H-R is next energized; and automatically enter Accelerated Align at the next turn-on.

The command shall be rejected and ALERT DATA D3/7 (Motion During Shutdown Request) set if STATUS DATA S3/2 (DRU-H-R in Motion) is set when the command is received.

The command shall be rejected and ALERT DATA D3/4 (Insufficient Align Time) set if a STORED HEADING SHUTDOWN command is received prior to completing a Static Align or accumulating a total of 15 minutes stationary time after starting Accelerated Align.

An Accelerated Align shall not be completed at the next power-on if ALERT DATA D3/7 (Motion During Shutdown Request) was set during receipt of the STORED HEADING SHUTDOWN command, or a STORED HEADING SHUTDOWN command was received prior to completing a Static Align or accumulating a total of 15 minutes stationary time after starting Accelerated Align.

COMMAND CODE	20 (10100b)	**DATA BYTE COUNT**	1

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	15	1	n/a	Command Subcode

A.3.2.4.26 CONNECT GUN POSITION DATA MESSAGE command.

Function: Requests the DRU-H-R to connect, at the specified rate, or disconnect the GUN POSITION DATA message on the Gun Drive interface.

COMMAND CODE	20 (10100b)	**DATA BYTE COUNT**	2

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	19	1	n/a	Command Subcode
D2 Bits 3-7	5	dis	0	n/a	n/a	Spare
D2 Bit 0-2	3	ub	0 or 1	1	n/a	GUN TUBE POSITION DATA message 0 = Disconnect 1 = Connect at 1 Hz 2 = Connect at 12.5 Hz 3 = Connect at 25 Hz 4 = Connect at 50 Hz 5 = Connect at 100 Hz 6 = Connect at 200 Hz

A.3.2.4.27 ACCEPT ETHERNET CONFIGURATION DATA command.

Function: Provides data to configure the Gun Drive interface and complete the IP and UDP headers for Ethernet messaging. When accepted by the DRU-H-R, data in this command shall be saved in non-volatile memory and shall supersede any previously stored Ethernet configuration data.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	20

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	20	1	n/a	Command Subcode
D2		ub	0 to 255	1	n/a	Version (Note 1)
D3		dis	n/a	n/a	n/a	Type of Service (Note 1)
D4, D5		ub	0 to 2^{16} - 1	1	n/a	Identification (Note 1)
D6	0-2	dis	n/a	n/a	n/a	Flags (Note 1)
D7		ub	0 to 255	1	n/a	Time to Live (Note 1)
D8		ub	0 to 255	1	n/a	Protocol (Note 1)
D9-D12		n/a	Note 1	n/a	n/a	Source (DRU-H-R) Address (Note 1)
D13-D16		n/a	Note 1	n/a	n/a	Destination Address (Note 1)
D17, D18		ub	0 to 2^{16} - 1	1	n/a	Source (DRU-H-R) Port Number (Note 2)
D19, D20		ub	0 to 2^{16} - 1	1	n/a	Destination Port Number (Note 2)

NOTES:
1. In accordance with RFC 791.
2. In accordance with RFC 768.

A.3.2.4.28 RETURN ELAPSED TIME command.

Function: Requests the DRU-H-R to send an ELAPSED TIME message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	21	1	n/a	Command Subcode

A.3.2.4.29 RETURN ETHERNET CONFIGURATION DATA command.

Function: Requests the DRU-H-R to send an ETHERNET CONFIGURATION DATA message.

COMMAND CODE	20 (10100b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	22	1	n/a	Command Subcode

A.3.2.4.30 ENABLE ZERO-VELOCITY UPDATES command.

Function: Requests the DRU-H-R to enable zero-velocity updates while in survey.

During Align, the DRU-H-R may retain the current ZUPT aiding state and set ALERT DATA D5/6 (Invalid Mode Request).

COMMAND CODE	21 (10101b)	**DATA BYTE COUNT**	0

A.3.2.4.31 ACCEPT USER DATUM command.

Function: Requests the DRU-H-R to retain the input data for use as USER1 or USER2 datum parameters, corresponding to the validity flag. Acceptance of this command shall not change the datum parameters currently used by the DRU-H-R. (For the DRU-H-R to use newly entered user datum parameters, the host must send a position update command containing the appropriate Datum ID.)

The user defined datum parameters are delta values (WGS 84 minus local datum).

COMMAND CODE	22 (10110b)	**DATA BYTE COUNT**	40

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1		ub	1	1	n/a	Command Subcode
D2-D7		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code
D8-D11		2b	±2000.000	0.001	meter	User datum delta-a *
D12-D15		2b	±2000.000	0.001	n/a	User datum delta-f x10E7 *
D16-D17		2b	±2000.0	0.1	meter	User datum delta-x *
D18-D19		2b	±2000.0	0.1	meter	User datum delta-y *
D20-D21		2b	±2000.0	0.1	meter	User datum delta-z *
D22-D23		ub	0 to 26	1	n/a	MGRS Row Advance *
D24-D39		ASCII	See Appendix G	n/a	n/a	Datum Descriptor
D40		ub	0 thru 2	1	n/a	User Datum Validity: 0 = data not valid, 1 = data valid, DRU-H-R USER1 2 = data valid, DRU-H-R USER2

* When the GPS Installed flag (CFIG D27/7) is set, the DRU-H-R shall send these data elements to the GPS receiver via GPS message #5038 (User Datums). The GPS receiver range limits may differ from those of the DRU-H-R. If so, data outside the GPS receiver range limits may cause ALERT D1/6 (Datums Do Not Agree) to occur.

A.3.2.4.32 ENABLE INERTIAL MODE command.

Function: Requests the DRU-H-R to inhibit use of GPS aiding.

If the GPS Installed flag (CFIG D27/7) is set, the DRU-H-R shall: inhibit GPS aiding; and reset STATUS DATA S5/6 (GPS Enabled) unless [GPS aiding is enabled, and the DRU-H-R is in Dynamic Align, and STATUS DATA S1/4 (OK To Move) is reset, and STATUS DATA S3/2 (DRU-H-R In Motion) is set].

In which case the DRU-H-R shall: keep GPS aiding enabled; and set ALERT DATA D5/6

(Invalid Mode Request).

If the GPS Installed flag (CFIG D27/7) is reset, the DRU-H-R shall: inhibit GPS aiding; and set ALERT DATA D5/6 (Invalid Mode Request).

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	5	1	n/a	Command Subcode

A.3.2.4.33 ENABLE INTEGRATED MODE command.

Function: Requests the DRU-H-R to enable use of GPS aiding.

If the GPS Installed flag (CFIG D27/7) is set, the DRU-H-R shall determine BIT status of the GPS receiver, antenna, and communications link.

a. If BIT passes, the DRU-H-R shall: enable GPS aiding; and set STATUS DATA S5/6 (GPS Enabled).

b. If BIT fails, the DRU-H-R shall: inhibit GPS aiding; reset STATUS DATA S5/6 (GPS Enabled); and set ALERT DATA D5/6 (Invalid Mode Request).

If the GPS Installed flag (CFIG D27/7) is reset, the DRU-H-R shall: inhibit GPS aiding; and set ALERT DATA D5/6 (Invalid Mode Request).

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	6	1	n/a	Command Subcode

A.3.2.4.34 USE DEGRADED GPS DATA command.

Function: Requests the DRU-H-R to accept GPS updates when STATUS DATA S6/0 (EPE ≤ GPS Poor Level) is set and S6/1 (EPE ≤ GPS Good Level) is reset.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	7	1	n/a	Command Subcode

A.3.2.4.35 SELECT Y-CODE ONLY SATELLITES command.

Function: Requests the DRU-H-R to command the GPS receiver to use only Y-code satellites for GPS data.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	8	1	n/a	Command Subcode

A.3.2.4.36 SELECT P OR Y-CODE SATELLITES command.

Function: Requests the DRU-H-R to command the GPS receiver to use either P-code or Y-code satellites for GPS data.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	9	1	n/a	Command Subcode

A.3.2.4.37 DO NOT APPLY RELATIVE OFFSETS command.

Function: When received, the DRU-H-R shall reset the Relative Offsets Applied flag.

COMMAND CODE			22 (10110b)		DATA BYTE COUNT	1
BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	10	1	n/a	Command Subcode

A.3.2.4.38 APPLY RELATIVE OFFSETS command.

Function: When received, the DRU-H-R shall set the Relative Offsets Applied flag.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	11	1	n/a	Command Subcode

A.3.2.4.39 RESET RELATIVE OFFSETS command.

Function: When received, the DRU-H-R shall reset STATUS DATA S2/0 (Relative Offsets Determined).

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	12	1	n/a	Command Subcode

A.3.2.4.40 RETURN DATUM DATA command.

Function: Requests the DRU-H-R to send a DATUM DATA message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	2

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	19	1	n/a	Command Subcode
D2		ub	0-64	1	n/a	Number of Datum to be returned: 0 = DRU-H-R Datum In Use 1 thru 60 = DRU-H-R preprogrammed Datums 61 = DRU-H-R USER1 Datum 62 = DRU-H-R USER2 Datum 63 = GPS USER1 Datum 64 = GPS USER2 Datum

A.3.2.4.41 RETURN GPS TIME & DAY DATA command.

Function: Requests the DRU-H-R to send a GPS TIME & DAY message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	20	1	n/a	Command Subcode

A.3.2.4.42 RETURN GPS POSITION DATA command.

Function: Requests the DRU-H-R to send a GPS POSITION DATA message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	21	1	n/a	Command Subcode

A.3.2.4.43 RETURN GPS WARNING command.

Function: Requests the DRU-H-R to send the currently queued GPS warning in a GPS WARNING message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	22	1	n/a	Command Subcode

A.3.2.4.44 RETURN NEXT GPS WARNING command.

Function: Requests the DRU-H-R to delete the current GPS warning, and queue and send the next GPS warning in a GPS WARNING message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	23	1	n/a	Command Subcode

A.3.2.4.45 RETURN PRECISION NAVIGATION DATA command.

Function: Requests the DRU-H-R to send a PRECISION NAVIGATION DATA message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	24	1	n/a	Command Subcode

A.3.2.4.46 RETURN DRU-H-R S/W IDENTIFICATION DATA command.

Function: Requests the DRU-H-R to send a DRU-H-R S/W IDENTIFICATION DATA message.

COMMAND CODE	22 (10110b)	DATA BYTE COUNT	1

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		ub	25	1	n/a	Command Subcode

A.3.2.4.47 ACCEPT POINTING DEVICE BORESIGHT command.

Function: When the Pointing Device Boresight Angles flag (CFIG D29/7) is set, requests the DRU-H-R to accept a pointing device boresight angles update. Boresight angle parameters are defined in Appendix C.

When the Pointing Device Boresight Angles flag (CFIG D29/7) is reset, the DRU-H-R shall reject the command and set ALERT DATA D5/7 (Invalid Update Request).

COMMAND CODE	23 (10111b)	**DATA BYTE COUNT**	13

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1		2b	0	1	n/a	Reserved Spare
D2-D3		ub	0 to 6399.9	0.1	mil	Pointing Device Orientation 1 A
D4-D5		2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Orientation 1 B
D6-D7		2b	-3199.9 to +3200.0	0.1	mil	Pointing Device Orientation 1 Γ
D8-D9		ub	0 to 6399.9	0.1	mil	Pointing Device Orientation 2 A
D10-D11		2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Orientation 2 B
D12-D13		2b	-3199.9 to 3200.0	0.1	mil	Pointing Device Orientation 2 Γ

A.3.2.4.48 RESTART command.

Function: Requests the DRU-H-R to reinitiate Align. Upon receipt of a RESTART command the DRU-H-R shall reinitialize within 2 seconds and perform Static Align or Dynamic Align.

When GPS aiding is inhibited, the DRU-H-R shall accept a RESTART command only if STATUS DATA S3/2 (DRU-H-R in Motion) is reset; or ALERT DATA D2/4 (Unable to Complete Align), or D2/3 (Align Interrupt), or D3/1 (Excessive Rates) is set.

When GPS aiding is enabled, the DRU-H-R shall accept a RESTART command at any time.

COMMAND CODE	26 (11010b)	**DATA BYTE COUNT**	0

A.3.2.4.49 SHUTDOWN command.

Function: Requests the DRU-H-R to save current position, attitude, and any other data necessary to initiate normal operation when the DRU-H-R is next energized; and enter Static Align at the next turn-on.

ALERT DATA D3/7 (Motion During Shutdown Request) shall be set if STATUS DATA S3/2 (DRU-H-R in Motion) is set when the command is received. ALERT DATA D1/0 (Previous Shutdown Abnormal) shall be set at the next turn-on if STATUS DATA S3/2 (DRU-H-R in Motion) is set when the command is being processed.

COMMAND CODE	30 (11110b)	**DATA BYTE COUNT**	0

A.3.2.4.50 RETURN BIT DATA command.

Function: Requests the DRU-H-R to send the BIT DATA message.

COMMAND CODE	31 (11111b)	**DATA BYTE COUNT**	0

A.3.2.5 Host TIA-422 message response times.

a. The DRU-H-R shall complete transmission of a message in response to a 5 Hz command within 130 msec.

b. The DRU-H-R shall complete transmission of a message in response to a 100 Hz or 60 Hz command within 9 msec.

c. Response times are measured beginning with transmission of the first bit of the command by the host and ending with receipt of the last bit of the message by the host.

A.3.2.6 Host TIA-422 message formats.

The format of DRU-H-R output messages shall be:

SF I S1..S6 D1.....DN E1 E2 EF

DESCRIPTION OF SYMBOLS

a. SF, Start Flag.

b. I, Identifier.

The identifier byte shall indicate the type of message sent by the DRU-H-R. The identifier code is 5 bits, as specified in the detailed message description. The identifier shall contain the 3 bit sequence number echoed from the initiating command. The complete message identifier can be used by the host to correlate responses with requests.

	MESSAGE SEQ. NO.	COMMAND CODE
	XXX	XXXXX
bit position	7 6 5	4 3 2 1 0

c. S1.....S6, status data.

Six bytes of STATUS DATA as specified in Appendix B.

d. D1.....DN, Data.

The data field shall contain 0 to 64 bytes of data as specified in the detailed message description.

e. E1, E2, error detection code.

The two byte CRC.

f. EF, End Flag.

g. X, symbol.

An X indicates a binary "1" or "0".

A.3.2.7 Messages. Host TIA-422 messages are described in the following subparagraphs. Message contents shall be as specified therein.

A.3.2.7.1 STATUS DATA message.

Function: Provides the current status of the DRU-H-R.

IDENTIFIER	0 (00000b)	DATA BYTE COUNT	0

A.3.2.7.2 NAVIGATION DATA message.

Function: Provides grid position, vehicle attitudes, and distance traveled data.

IDENTIFIER	1 (00001b)	DATA BYTE COUNT	28

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D3		ub	0 to 10,000,000	1	meter	Northing
D4-D5	15	2b	-16,384 to +16,383 **	1	meter	Altitude
D6-D8	17	ub	0 to 1,310,710 **	10	meter	Distance Traveled ***
D9-D10		ub	0 to 6,399.9	0.1	mil	Pointing Device Geodetic Azimuth or Grid Azimuth
D11-D12	15	2b	-1,638.4 to +1,638.3**	0.1	mil	Vehicle Roll or Cant
D13-D14	15	2b	-1600.0 to +1600.0	0.1	mil	Vehicle Pitch
D15-D16		ub	0 to 6,399.9	0.1	mil	Vehicle Geodetic or Grid Azimuth
D17 bits 5-7	3	dis	0	n/a	n/a	Spare Bits
D17 bit 4	1	dis	0 or 1	n/a	n/a	Relative Offsets Applied output flag
D17 bits 0-3	4	ub	1	1	n/a	Host (DRU-H-R) Grid 1 = UTM
D18-D20	20	ub	0 to 999,999 *	1	meter	Easting
D21	7	2b	-61 to +61	1	n/a	Extended Zone Number 61 = normal zone DRU-H-R shall ignore sign
D22	7	2b	-60 to +60	1	n/a	DRU-H-R Hemisphere & Zone + = northern hemisphere - = southern hemisphere
D23-D28		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code (6 ASCII Characters)

* Actual limits are the UTM zone boundaries plus zone extension which are latitude and datum dependent.

** For values outside the range, the output value shall be fixed at the appropriate positive or negative range limit.

*** Total distance traveled since turn-on. Distance Traveled may not accurately reflect the actual vehicle trajectory during Dynamic Align.

A.3.2.7.3 ATTITUDE DATA message.

Function: Provides Pointing Device geodetic or grid azimuth, Pointing Device Pitch; Vehicle pitch; Vehicle cant or roll; and Pointing Device azimuth and pitch rates.

IDENTIFIER	2 (00010b)	DATA BYTE COUNT	12

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D2		ub	0 to 6,399.9	0.1	mil	Pointing Device Geodetic Azimuth or Grid Azimuth
D3-D4	15	2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Pitch
D5-D6	15	2b	-1638.4 to +1638.3 *	0.1	mil	Vehicle Roll or Cant
D7-D8	15	2b	-1600.0 to +1600.0	0.1	mil	Vehicle Pitch
D9-D10		2b	-5898.24 to +5898.06 *	0.18	mil/sec	Pointing Device Azimuth Rate
D11-D12		2b	-5898.24 to +5898.06 *	0.18	mil/sec	Pointing Device Pitch Rate

* For values outside the range, the output value shall be fixed at the appropriate positive or negative range limit.

A.3.2.7.4 TRAVEL LOCK DATA message.

Function: Provides Travel Lock Reference attitudes and associated data.

IDENTIFIER	3 (00011b)	DATA BYTE COUNT	12

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D2		ub	0 to 6,399.9	0.1	mil	Pointing Device Geodetic Azimuth or Grid Azimuth
D3-D4	15	2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Pitch
D5-D6		ub	0 to 6,399.9	0.1	mil	Travel Lock Pointing Device Geodetic or Grid Azimuth Reference
D7-D8		2b	-1600 to +1600	0.1	mil	Travel Lock Pointing Device Pitch Reference
D9-D10		2b	-5898.24 to +5898.06 *	0.18	mil/sec	Pointing Device Azimuth Rate
D11-D12		2b	-5898.24 to +5898.06 *	0.18	mil/sec	Pointing Device Pitch Rate

* For values outside the range, the output value shall be fixed at the appropriate positive or negative range limit.

A.3.2.7.5 BUILT-IN-TEST (BIT) DATA message.

Function: Provides BIT status.

IDENTIFIER	4 (00100b)	DATA BYTE COUNT	2

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D2		dis	n/a	n/a	n/a	BIT DATA per Appendix B

Spare BIT DATA bits shall be reset (= 0).

NOTE: Since spares may be activated in future revisions, host checking of spare BIT DATA bit values is not recommended.

A.3.2.7.6 ALERT DATA message.

Function: Provides DRU-H-R ALERT DATA.

IDENTIFIER	6 (00110b)	DATA BYTE COUNT	6

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D6		dis	n/a	n/a	n/a	ALERT DATA per Appendix B

Spare ALERT DATA bits shall be reset (= 0).

NOTE: Since spares may be activated in future revisions, host checking of spare ALERT DATA bit values is not recommended.

A.3.2.7.7 ALIGN TIME TO GO message.

Function: Indicates time remaining to complete Align related functions.

IDENTIFIER	7 (00111b)	DATA BYTE COUNT	2

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D2	11	ub	0 to 2047	1	second	Align Time To Go *

* Align Time To Go shall be the time remaining to complete Accelerated, Static, or Dynamic Align. It shall be zero when: [Accelerated Align is complete and the Odometer Installed flag (CFIG D29/0) is reset]; or Static Align is complete; or Dynamic Align is complete; or Align has been terminated.

When Accelerated Align is complete and the Odometer Installed flag is set, Align Time To Go shall be the time remaining until odometer sensor aiding can be used. It shall be zero when odometer sensor aiding can be used.

Align Time To Go may be frozen when moving and GPS aided time isn't being accumulated.

A.3.2.7.8 POSITION DATA message.

Function: Provides grid position data.

IDENTIFIER	8 (01000b)	DATA BYTE COUNT	16

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1 bits 5-7	3	dis	0	n/a	n/a	Spare Bits
D1 bit 4	1	dis	0 or 1	n/a	n/a	Relative Offsets Applied output flag
D1 bits 0-3	4	ub	0 to 1	1	n/a	Host (DRU-H-R) Grid 1 = UTM
D2	7	2b	-60 to +60	1	n/a	DRU-H-R Hemisphere & Zone + = northern hemisphere - = southern hemisphere
D3–D5	20	ub	0 to 999,9999 *	1	meter	Easting
D6-D8		ub	0 to 10,000,000	1	meter	Northing
D9-D10	15	2b	-16,384 to +16,384 **	1	meter	Altitude
D11-D16		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code

* Actual limits are the UTM zone boundaries plus zone extension which are latitude and datum dependent.

** For values outside the range, the output value shall be fixed at the appropriate positive or negative range limit.

A.3.2.7.9 POINTING DEVICE ATTITUDE DATA message.

Function: Provides Pointing Device Attitude data.

IDENTIFIER	10 (01010b)	DATA BYTE COUNT	6

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D2		ub	0 to 6,399.9	0.1	mil	Pointing Device Geodetic Azimuth or Grid Azimuth
D3-D4		2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Pitch
D5-D6		2b	-3199.9 to +3200.0	0.1	mil	Pointing Device Roll or Cant

A.3.2.7.10 POINTING DEVICE BORESIGHT message.

Function: Provides Pointing Device boresight angle values. If the Pointing Device Boresight Present flag is reset, the data returned in a POINTING DEVICE BORESIGHT message may be invalid. Pointing Device Boresight angles are defined in Appendix C.

IDENTIFIER	13 (01101b)	DATA BYTE COUNT	12

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D2		ub	0 to 6399.9	0.1	mil	Pointing Device Orient. 1 A
D3-D4		2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Orient. 1 B
D5-D6		2b	-3199.9 to +3200.0	0.1	mil	Pointing Device Orient. 1 Γ
D7-D8		ub	0 to 6399.9	0.1	mil	Pointing Device Orient. 2 A
D9-D10		2b	-1600.0 to +1600.0	0.1	mil	Pointing Device Orient. 2 B
D11-D12		2b	-3199.9 to +3200.0	0.1	mil	Pointing Device Orient. 2 Γ

A.3.2.7.11 SURVEY QUALITY message.

Function: Provides the values of relative offsets and current DRU-H-R estimates of DRU-H-R position and azimuth errors.

IDENTIFIER	15 (01111b)	DATA BYTE COUNT	20

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D2		ub	0 to 2047	0.0625	meter	DRU-H-R Estimated Horizontal CEP
D3-D4		ub	0 to 2047	0.0625	meter	DRU-H-R Estimated Vertical Probable Error
D5-D6		ub	0 to 2047	0.0625	meter	DRU-H-R Estimated Heading Probable Error
D7-D8		ub	0 to 2047	0.0625	meter	Odometer Damped Horizontal CEP Specification (0.25 percent x distance traveled since last position update)
D9-D10		ub	0 to 2047	0.0625	meter	Odometer Damped Vertical Probable Error Specification (0.067 percent x distance traveled since last altitude update)
D11-D12		ub	0.1 to 10.0	0.0625	n/a	Estimated Horizontal Spec Multiplier
D13-D14		ub	0.1 to 10.0	0.0625	n/a	Estimated Vertical Spec Multiplier
D15-D16		2b	±2000.0	0.1	meter	North Relative Offset
D17-D18		2b	±2000.0	0.1	meter	East Relative Offset
D19-D20		2b	±2000.0	0.1	meter	Altitude Relative Offset

A.3.2.7.12 VEHICLE BORESIGHT message.

Function: Provides Vehicle Boresight angle values. If the Vehicle Boresight Present Flag is reset, the data returned in a VEHICLE BORESIGHT message may be invalid. Vehicle Boresight angles are defined in Appendix C.

IDENTIFIER	16 (10000b)	**DATA BYTE COUNT**	6

BYTE(s)	**BITs**	**TYPE**	**RANGE**	**RES.**	**UNITS**	**DATA ELEMENT**
D1-D2		ub	0 to 6399.9	0.1	mil	Vehicle α
D3-D4		2b	-1600.0 to +1600.0	0.1	mil	Vehicle β
D5-D6		2b	-3199.9 to +3200.0	0.1	mil	Vehicle γ

A.3.2.7.13 GEODETIC DATA message.

Function: Provides geodetic position, altitude and velocity data.

IDENTIFIER	17 (10001b)	DATA BYTE COUNT	36

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D2		sb	-90 to +90	1	degree	Latitude Degrees * + = Northern hemisphere - = Southern hemisphere
D3-D6		ub	0 to (60 - $1/2^{24}$)	$1/2^{24}$	arc minute	Latitude Minutes *
D7-D8		sb	-180 to +180	1	degree	Longitude Degrees * + = East of Prime Meridian - = West of Prime Meridian
D9-D12		ub	0 to (60 - $1/2^{24}$)	$1/2^{24}$	arc minute	Longitude Minutes *
D13-D16		2b	-32,768 to +32,767	0.01	meter	Altitude
D17-D20		2b	-32,768 to +32,767	$1/2^{16}$	meter /sec	Velocity North
D21-D24		2b	-32,768 to +32,767	$1/2^{16}$	meter /sec	Velocity East
D25-D28		2b	-32,768 to +32,767	$1/2^{16}$	meter /sec	Velocity Up
D29		2b	0	1	n/a	Reserved Spare
D30 bits 5-7	3	dis	0	n/a	n/a	Spare Bits
D30 bit 4	1	dis	0 or 1	n/a	n/a	Relative Offsets Applied output flag
D30 bits 0-3	4	ub	0 to 1	1	n/a	Host (DRU-H-R) Grid 0 = RESERVED 1 = UTM
D31-D36		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code

* In addition to the individual field range limits for degrees and seconds, the combination of degrees and minutes shall not exceed the degrees field range limit for latitude and longitude, respectively.

A.3.2.7.14 CONFIGURATION DATA message.

Function: Provides the configuration data presently used by the DRU-H-R. If the Configuration Data Present flag is reset, the data returned in a CONFIGURATION DATA message may be invalid. Configuration data elements are defined in Appendix C.

IDENTIFIER	18 (10010b)	DATA BYTE COUNT	54

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D2		2b	-3199.9 to +3200.0	0.1	mil	1 - 2 Threshold Angle
D3-D4		2b	-3199.9 to +3200.0	0.1	mil	2 - 1 Threshold Angle
D5-D6		2b	-25.00 to +25.00	0.01	meter	Orientation 1 Vehicle ΔX
D7-D8		2b	-25.00 to +25.00	0.01	meter	Orientation 1 Vehicle ΔY
D9-D10		2b	-25.00 to +25.00	0.01	meter	Orientation 1 Vehicle ΔZ
D11-D12		2b	-25.00 to +25.00	0.01	meter	Orientation 2 PD ΔX
D13-D14		2b	-25.00 to +25.00	0.01	meter	Orientation 2 PD ΔY
D15-D16		2b	-25.00 to +25.00	0.01	meter	Orientation 2 PD ΔZ
D17-D18		2b	2 to 15	0.25	minute	Exclusive ZUPT mode ZUPT interval
D19-D20		ub	2 to 63	1	minute	Odometer Mode ZUPT interval
D21-D22		ub	3.5 to 34.0	0.25	minute	Static Align Time
D23-D24		ub	0 to 10 (0 valid only if D29/5 is reset)	1	second	Shot Detect Interval
D25-D28		dis	n/a	n/a	n/a	Configuration definition flags (See Appendix C)
D29-D30		ub	0.750 to 1.250	0.001	n/a	Odometer Scale Factor
D31-D32		2b	-3276.8 to +3276.7	0.1	μ-radian /km	Fuel Consumption Factor
D33		hex	00 to 3F	n/a	n/a	DRU-H-R Coordinate Frame Code for Orientation 1
D34		hex	00 to 3F	n/a	n/a	DRU-H-R Coordinate Frame Code for Orientation 2
D35-D36		ub	0 thru 15	1	n/a	Current Configuration Code Number
D37-D38		2b	-25.00 to +25.00	0.01	meter	Odometer action point ΔX
D39-D40		2b	-25.00 to +25.00	0.01	meter	Odometer action point ΔY
D41-D42		2b	-25.00 to +25.00	0.01	meter	Odometer action point ΔZ
D43-D44		2b	-25.00 to +25.00	0.01	meter	GPS antenna ΔX
D45-D46		2b	-25.00 to +25.00	0.01	meter	GPS antenna ΔY
D47-D48		2b	-25.00 to +25.00	0.01	meter	GPS antenna ΔZ
D49-D50		ub	10 to 900	1	second	GPS Update Time-out Interval
D51-D52		ub	0 to 256	1	meter	GPS EPE Good Value
D53-D54		ub	0 to 32,535	1	meter	GPS EPE Poor Value

A.3.2.7.15 DATUM DATA message.

Function: Provides datum data for the datum number in the requesting RETURN DATUM DATA command. Update of datums #63 and #64 may require up to two seconds following an ACCEPT USER DATUM command. Datum data elements are defined in Appendix G.

IDENTIFIER	19 (10011b)	DATA BYTE COUNT	40

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1		ub	1 to 64	1	n/a	Reference Number for DRU-H-R datum in use
D2		ub	0 to 64	1	n/a	Requested Datum Reference Number
D3-D8		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code
D9-D12		2b	±2000.000	0.001	meters	Datum delta-a
D13-D16		2b	±2000.000	0.001	n/a	Datum delta-f x10E7
D17-D18		2b	±2000.0	0.1	meters	Datum delta-x
D19-D20		2b	±2000.0	0.1	meters	Datum delta-y
D21-D22		2b	±2000.0	0.1	meters	Datum delta-z
D23-D24		ub	0 to 26	1	n/a	MGRS Row Advance
D25-D40		ASCII	See Appendix G	n/a	n/a	Datum Descriptor

A.3.2.7.16 GPS TIME & DAY DATA message.

Function: Passes time and day data provided to the DRU-H-R in GPS message #5040. The time represented is the time of validity of the last time mark message. If GPS message #5040 has never been received or has not been refreshed within two seconds of its previous reception, or if the GPS receiver has failed; GPS Time shall be zero and other data elements may be outside their specified limits.

IDENTIFIER	20 (10100b)	DATA BYTE COUNT	24

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D2	*	*	*	*	*	GPS Time (Word 1)
D3-D4	*	*	*	*	*	GPS Time (Word 2)
D5-D6	*	*	*	*	*	GPS Time (Word 3)
D7-D8	*	*	*	*	*	GPS Time (Word 4)
D9-D10	*	*	*	*	*	Time Reference (Word 19)
D11-D12	*	*	*	*	*	Hours (Word 20)
D13-D14	*	*	*	*	*	Minutes (Word 21)
D15-D16	*	*	*	*	*	Seconds (Word 22)
D17-D18	*	*	*	*	*	Day of Week (Word 23)
D19-D20	*	*	*	*	*	Day of Month (Word 24)
D21-D22	*	*	*	*	*	Month (Word 25)
D23-D24	*	*	*	*	*	Year (Word 26)

* Shall be as specified in IS-GPS-153D for the GPS message #5040 (Current Status) data elements and words specified in the DATA ELEMENT column.

A.3.2.7.17 GPS POSITION DATA message.

Function: Passes GPS receiver derived antenna position and status indicators of position accuracy provided to the DRU-H-R in GPS message #5040 (Current Status). If GPS message #5040 has never been received or has not been refreshed within two seconds of its previous reception, or if the GPS receiver has failed; GPS Time shall be set to 0 and other data elements may be outside the specified limits.

IDENTIFIER	21 (10101b)	DATA BYTE COUNT	64

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D2	*	*	*	*	*	GPS Time (Word 1)
D3-D4	*	*	*	*	*	GPS Time (Word 2)
D5-D6	*	*	*	*	*	GPS Time (Word 3)
D7-D8	*	*	*	*	*	GPS Time (Word 4)
D9-D10	*	*	*	*	*	Position (Word 5)
D11-D12	*	*	*	*	*	Position (Word 6)
D13-D14	*	*	*	*	*	Position (Word 7)
D15-D16	*	*	*	*	*	Position (Word 8)
D17-D18	*	*	*	*	*	Position (Word 9)
D19-D20	*	*	*	*	*	Position (Word 10)
D21-D22	*	*	*	*	*	Position (Word 11)
D23-D24	*	*	*	*	*	Position (Word 12)
D25-D26	*	*	*	*	*	Position (Word 13)
D27-D28	*	*	*	*	*	Position (Word 14)
D29-D30	*	*	*	*	*	Position (Word 15)
D31-D32	*	*	*	*	*	Position (Word 16)
D33-D34	*	*	*	*	*	Position (Word 17)
D35-D36	*	*	*	*	*	Position (Word 18)
D37-D38	*	*	*	*	*	FOM (Word 35)
D39-D40	*	*	*	*	*	TFOM (Word 36)
D41-D42	*	*	*	*	*	EPE (Word 40)
D43-D44	*	*	*	*	*	EPE (Word 41)
D45-D46	*	*	*	*	*	EPE Units (Word 42)
D47-D48	*	*	*	*	*	Nav Converge (Word 43)
D49-D50	*	*	*	*	*	Elevation Status (Word 44)
D51-D52	*	*	*	*	*	Current DOP (Word 45)
D53-D54	*	*	*	*	*	Current DOP (Word 46)
D55-D56	*	*	*	*	*	Datum Identifier (Word 86)
D57-D58	*	*	*	*	*	Datum Identifier (Word 87)
D59-D60	*	*	*	*	*	Datum Identifier (Word 88)
D61-D62	*	*	*	*	*	SA/A-S Message (Word 78)
D63-D64		ub	0	1	n/a	Spare

* Shall be as specified in IS-GPS-153D for the GPS message #5040 (Current Status) data elements and words specified in the DATA ELEMENT column.

A.3.2.7.18 GPS WARNING message.

Function: Outputs GPS Warning Message, #5044, ASCII character strings output by the GPS receiver and queued by the DRU-H-R.

In response to the RETURN GPS WARNING command, the currently queued warning shall be returned.

In response to the RETURN NEXT GPS WARNING the currently queued warning shall be deleted and the next saved warning shall become the current warning and be returned.

When no GPS Warning Messages are saved, the DRU-H-R shall return: GPS Time = 0; Warning ID = 0; and Warning Message, (W6-W9) = "No PLGR "; (W10-W13) = " "; (W14-W17) = "Warnings"; (W18-W21) = " ".

IDENTIFIER	22 (10110b)	DATA BYTE COUNT	42

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1-D2	*	*	*	*	*	GPS Time (Word 1)
D3-D4	*	*	*	*	*	GPS Time (Word 2)
D5-D6	*	*	*	*	*	GPS Time (Word 3)
D7-D8	*	*	*	*	*	GPS Time (Word 4)
D9-D10	*	*	*	*	*	Warning ID (Word 5)
D11-D12	*	*	*	*	*	Warning Message (Word 6)
D13-D14	*	*	*	*	*	Warning Message (Word 7)
D15-D16	*	*	*	*	*	Warning Message (Word 8)
D17-D18	*	*	*	*	*	Warning Message (Word 9)
D19-D20	*	*	*	*	*	Warning Message (Word 10)
D21-D22	*	*	*	*	*	Warning Message (Word 11)
D23-D24	*	*	*	*	*	Warning Message (Word 12)
D25-D26	*	*	*	*	*	Warning Message (Word 13)
D27-D28	*	*	*	*	*	Warning Message (Word 14)
D29-D30	*	*	*	*	*	Warning Message (Word 15)
D31-D32	*	*	*	*	*	Warning Message (Word 16)
D33-D34	*	*	*	*	*	Warning Message (Word 17)
D35-D36	*	*	*	*	*	Warning Message (Word 18)
D37-D38	*	*	*	*	*	Warning Message (Word 19)
D39-D40	*	*	*	*	*	Warning Message (Word 20)
D41-D42	*	*	*	*	*	Warning Message (Word 21)

* Shall be as specified in IS-GPS-153D for the GPS message #5044 (Warning Messages) data elements and words specified in the DATA ELEMENT column.

A.3.2.7.19 PRECISION NAVIGATION DATA message.

Function: Provides high resolution grid position data.

IDENTIFIER	24 (11000b)	DATA BYTE COUNT	48

BYTE(s)	BITs	TYPE	RANGE	RES.	UNITS	DATA ELEMENT
D1 bits 5-7	3	dis	0	n/a	n/a	Spare Bits
D1 bit 4	1	dis	0 or 1	n/a	n/a	Relative Offsets Applied output flag
D1 bits 0-3	4	ub	0 to 1	1	n/a	Host (DRU-H-R) Grid 1 = UTM
D2	7	2b	-60 to +60	1	n/a	DRU-H-R Hemisphere & Zone + = northern hemisphere - = southern hemisphere
D3–D6		ub	0 to 999,9999 *	0.01	meter	Easting
D7-D10		ub	0 to 10,000,000	0.01	meter	Northing
D11-D14		2b	-32,768.00 to +32,767.00	0.01	meter	Altitude
D15-D18	17	ub	0 to 1,310,710 **	10	meter	Distance Traveled ***
D19-D24		ASCII	Valid Datum ID Code (Appendix G)	n/a	n/a	Datum ID Code (6 ASCII Characters)
D25-D28		ub	0 to 6,399.99	0.01	mil	Pointing Device Geodetic Azimuth or Grid Azimuth
D29-D32		2b	-1600.00 to +1600.00	0.01	mil	Pointing Device Pitch
D33-D36		2b	-3199.99 to +3200.00	0.01	mil	Pointing Device Roll or Cant
D37-D40		ub	0 to 6,399.99	0.01	mil	Vehicle Geodetic or Grid Azimuth
D41-D44		2b	-1600.00 to +1600.00	0.01	mil	Vehicle Pitch
D45-D48		2b	-3199.99 to +3200.00	0.01	mil	Vehicle Roll or Cant

* Actual limits are the UTM zone boundaries plus zone extension, which are latitude and datum dependent.

** If the actual value of the parameter is outside the range, the output value shall be fixed at the appropriate positive or negative range limit.

*** Total distance traveled since turn-on or last RESET DISTANCE command. Distance Traveled may not accurately reflect the actual vehicle trajectory during Dynamic Align.

A.3.2.7.20 DRU-H-R S/W IDENTIFICATION DATA message.

Function: Provides the ID and revision numbers for the two CSCIs of the DRU-H-R, the DRU-H-R S/N, and the GPS receiver hardware and software version numbers.

IDENTIFIER	25 (11001b)	DATA BYTE COUNT	64

BYTES(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1-D4		ub	0 to 4,294,967,295	1	N/A	ID Number, DRU-H-R Tactical Software
D5-D8		ub	0 to 4,294,967,295	1	N/A	ID Number, Permanently Stored Default Ethernet Configuration Data
D9-D12		ub	0 to 4,294,967,295	1	N/A	ID Number, DRU-H-R Permanently Stored Default Configuration Data
D13-D16		ub	0 to 4,294,967,295	1	N/A	Reserved
D17-D20		ub	0 to 4,294,967,295	1	N/A	ID Number, DRU-H-R Loader Software
D21-D22		ub	0 to 65,535	1	N/A	Reserved
D23-D24		ub	0 to 65,535	1	N/A	Rev. Number, DRU-H-R Ethernet Config. Data
D25-D26		ub	0 to 65,535	1	N/A	Rev. Number, DRU-H-R Config. Data
D27-D28		ub	0 to 65,535	1	N/A	Rev. Number, DRU-H-R Datum Data
D29-D30		ub	0 to 65,535	1	N/A	Rev. Number, DRU-H-R Loader
D31-D32		ub	0 to 65,535	1	N/A	DRU-H-R Serial Number (Customer)
D33-D34		ub	0 to 65,535	1	N/A	DRU-H-R Serial Number (Vendor)
D35-D36		2b	-32,768 to + 32,767	1	N/A	GPS receiver S/W Version from GPS message #5040 (Word 48)
D37-D38		2b	-32,768 to + 32,767	1	N/A	GPS receiver H/W Version from GPS message #5040 (Word 49)
D39-D40		ASCII	A-Z, a-z, 0-9, -, space	N/A	N/A	Loader Software Revision ID (2 ASCII Characters)
D41-D45		ASCII	A-Z, a-z, 0-9, -, space	N/A	N/A	DRU-H-R Tactical Software Version ID (5 ASCII Characters)
D46-D56		ASCII	Note 1	N/A	N/A	DRU-H-R Software Build Date (11 ASCII Characters)
D57-D64		ASCII	Note 2	N/A	N/A	DRU-H-R Software Build Time (8 ASCII Characters)

Note 1: 11 ASCII characters shall be formatted as MMM/DD/YYYY, where:
MMM is the month code, for the build month, per Note 3
DD is the build day of the month (range: 01-31)
YYYY is the build year (for example, 1996)
/ is the ASCII / character

Note 2: 8 ASCII characters shall be formatted as hh:mm:ss, where:
hh is the build hour (range: 00 - 23)
mm is the build minute (range: 00 - 59)
ss is the build second (range: 00 - 59)
: is the ASCII : character

Note 3: Month Code/Month
JAN January
FEB February
MAR March
APR April
MAY May
JUN June
JUL July
AUG August
SEP September
OCT October
NOV November
DEC December

A.3.2.7.21 ETHERNET CONFIGURATION DATA message.

Function: Returns the presently stored Ethernet configuration data.

IDENTIFIER	29	DATA BYTE COUNT	20

BYTES(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1		ub	0	1	n/a	n/a
D2		ub	0 to 255	1	n/a	Version (Note 1)
D3		dis	n/a	n/a	n/a	Type of Service (Note 1)
D4, D5		ub	0 to 2^{16} - 1	1	n/a	Identification (Note 1)
D6	0-2	dis	n/a	n/a	n/a	Flags (Note 1)
D7		ub	0 to 255	1	n/a	Time to Live (Note 1)
D8		ub	0 to 255	1	n/a	Protocol (Note 1)
D9-D12		n/a	Note 1	n/a	n/a	Source (DRU-H-R) Address (Note 1)
D13-D16		n/a	Note 1	n/a	n/a	Destination Address (Note 1)
D17, D18		ub	0 to 2^{16} - 1	1	n/a	Source (DRU-H-R) Port Number (Note 2)
D19, D20		ub	0 to 2^{16} - 1	1	n/a	Destination Port Number (Note 2)

Note 1: In accordance with RFC 791.
Note 2: In accordance with RFC 768.

A.3.2.7.22 ELAPSED TIME message.

Function: Provides the DRU-H-R elapsed operating time in response to a RETURN ELAPSED TIME command.

IDENTIFIER	30	DATA BYTE COUNT	2

BYTES(s)	BITs	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1, 2		ub	0 to 2^{16} - 1	1	hours	DRU-H-R Elapsed Operating Time

A.4 Definitions.

A.4.1 Cyclical Redundancy Check (CRC).

The 16-bit (2-byte) CRC, defined below, shall be used as the checksum method for the asynchronous host data interfaces.

The feedback equation of the CRC is:

$$X^{16} + X^9 + X^5 + X^2 + 1$$

The LSB position is bit 0. The bit positions of the feedback taps, as defined by the above equation are: 15, 8, 4, 1.

For a given data transmission, the following process will be used on each 16-bit word, until the last word has yielded the final signature register, or Message Checksum. If the data to be included in the checksum has an odd number of bytes, an additional byte, with value 00 hex, will be appended to the last byte only for the purpose of checksum computation. This Message Checksum will be appended to the data stream as the command or message CRC. Since the value of the signature register at the initial start of the CRC calculation process cannot be a value of 0000 hex, an initial value of FFFF hex will be used. This value should be loaded into the signature register before the steps begin for a given message.

The CRC process used to calculate the signature of the data transmission, or Message Checksum, is (See Figure A-2):

1. Exclusive-or the signature with the next memory location.
2. Compute exclusive-or of tap bits of the signature.
3. Shift signature register left one bit (towards MSB), shifting a ‘0’ into the LSB.
4. Replace least significant bit with result of step 2.
5. Repeat steps 1-4 for all memory (all other 16-bit words).

On the receiving end, the check will be done on the bit stream AND the CRC. If this results in a value in the shift register of 0000 hex, then it will be assumed the message was received without error.

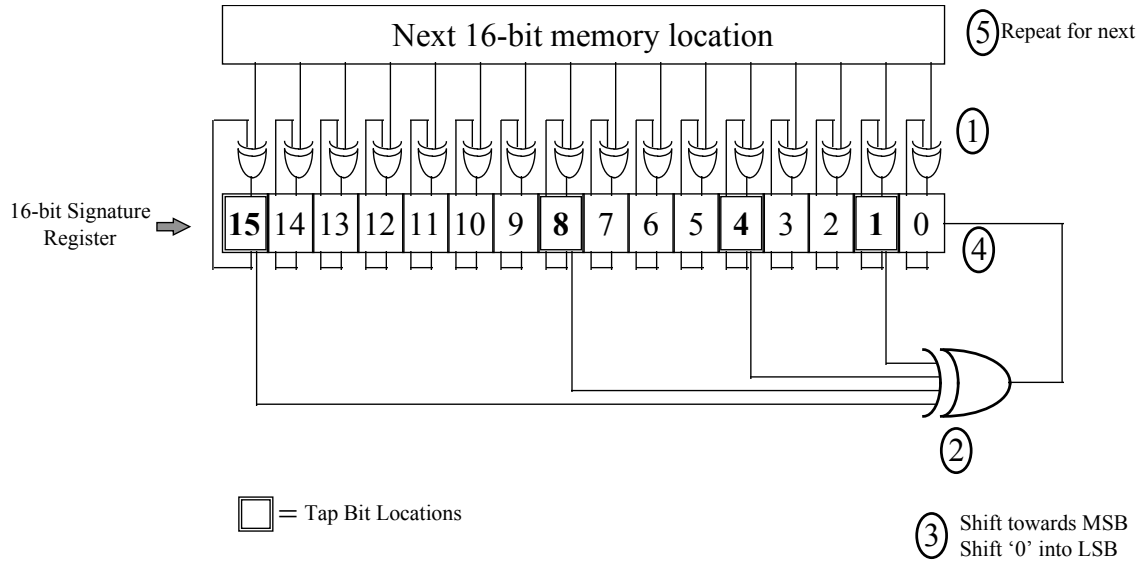


Figure A-2. CRC Process.

A.4.1.1 CRC example. The following is an example of the CRC creation and CRC check.

Assume the message to be transmitted has a length of 3 16-bit words, the 3rd word being the Message Checksum which will be calculated.

Data Word 1: B503 hex = 1011 0101 0000 0011 bin
Data Word 2: 3A19 hex = 0011 1010 0001 1001 bin

A.4.1.1.1 CRC Creation - Transmitting Element.

The initial value of the signature, or CRC, is FFFF hex.

STEP 1: XOR Data Word 1 with the initial value, placing result in the corresponding bits of the signature:

Data Word 1	1011 0101 0000 0011
XOR Signature	1111 1111 1111 1111
New Signature	0100 1010 1111 1100

MSB LSB

The tap bits (bit locations 15, 8, 4, and 1) are: 0, 0, 1, 0

STEP 2: XOR the tap bits together: 0 XOR 0 XOR 1 XOR 0 = 1

STEP 3: Shift signature register left one bit (towards MSB), shifting a '0' into the LSB:

New Signature 1001 0101 1111 1000

STEP 4: Replace LSB with result of Step 2: LSB=1 (do not shift register again)

New Signature 1001 0101 1111 1001

STEP 5: Repeat for next Data Word, using the signature in Step 4 as the initial value

Repeating the process for Data Word 2....

STEP 1: XOR Data Word 2 with the signature obtained in Step 4 from above:

Data Word 2	0011 1010 0001 1001
XOR Signature	1001 0101 1111 1001
New Signature	1010 1111 1110 0000

The tap bits (bit locations 15, 8, 4, and 1) are: 1, 1, 0, 0

STEP 2: XOR the tap bits together: 1 XOR 1 XOR 0 XOR 0 = 0

STEP 3: Shift signature register left one bit (towards MSB), shifting a '0' into the LSB:

New Signature 0101 1111 1100 0000

STEP 4: Replace LSB with result of Step 2: LSB=0 (do not shift register again)

New Signature 0101 1111 1100 0000 bin = 5FC0 hex *

* This is the value of the Message Checksum (5FC0 hex); there are no more data words to process.

A.4.1.1.2 CRC Check - Receiving Element. The receiving element will perform the process on all words (3) transmitted in the message, which includes the Message Checksum word:

Data Word 1:	B503 hex = 1011 0101 0000 0011 bin
Data Word 2:	3A19 hex = 0011 1010 0001 1001 bin
Checksum Word:	5FC0 hex = 0101 1111 1100 0000 bin

Perform the series of steps in the "CRC Creation" paragraph above for Data Words 1 & 2. After this is done, the signature should be 0101 1111 1100 0000 bin = 5FC0 hex. This will be the initial value of the signature used in Step 1 below.

STEP 1: XOR the last word, checksum word, with the signature:

Checksum Word	0101 1111 1100 0000
XOR Signature	0101 1111 1100 0000
New Signature	0000 0000 0000 0000

The tap bits (bit locations 15, 8, 4, and 1) are: 0, 0, 0, and 0

STEP 2: XOR the tap bits together: 0 XOR 0 XOR 0 XOR 0 = 0

STEP 3: Shift signature register left one bit (towards MSB), shifting a '0' into the LSB:

New Signature 0000 0000 0000 0000

STEP 4: Replace LSB with result of Step 2: LSB=0 (do not shift register again)

Result 0000 0000 0000 0000 bin = 0000 hex *

* The result is 0000 hex, which indicates there were no errors in the transmission.

APPENDIX B

STATUS, ALERT, AND BIT DATA

B.1 SCOPE

B.1.1 Scope. This appendix provides the requirements for DRU-H-R use of STATUS DATA, ALERT DATA, and BIT DATA. This appendix is a mandatory part of this specification. The information herein is intended for compliance.

B.2 APPLICABLE DOCUMENTS

(This section is not applicable to this appendix.)

B.3 REQUIREMENTS

B.3.1 STATUS DATA.

a. The DRU-H-R shall report STATUS DATA in every DRU-H-R/host RS-422 interface response message.

b. STATUS DATA indications, word/byte and bit positions, and set and reset conditions shall be as specified in Table B-I.

c. Additional requirements for setting and resetting STATUS DATA bits are specified throughout this document.

B.3.1.1 Status states and initialization.

a. At turn-on, all STATUS DATA bits shall be reset (= 0) unless otherwise indicated in Table B-I.

b. A STATUS DATA bit shall be set (= 1) when a condition specified in the SET CONDITION column of Table B-I occurs.

c. A set STATUS DATA bit shall be reset (= 0) when a condition specified in the RESET CONDITION column of Table B-I occurs.

d. Unless otherwise indicated in Table B-I, STATUS DATA bits shall retain their current state upon acceptance of a RESTART command.

B.3.1.2 Alert status reporting.

a. STATUS DATA S2/1 (DRU-H-R Alert) and S5/3 (Change In ALERT DATA) shall be reported separately for each data interface.

b. STATUS DATA S2/1 (DRU-H-R Alert), for a data interface, shall be set whenever any ALERT DATA bit applicable to that interface is set.

c. STATUS DATA S2/1 (DRU-H-R Alert), for a data interface, shall be reset whenever all ALERT DATA bits applicable to that interface are reset.

d. STATUS DATA S5/3 (Change In ALERT DATA) shall be set when any ALERT DATA bit applicable to that interface changes state.

e. When a RETURN ALERT DATA command is received, STATUS DATA S5/3, only for that interface, shall be reset prior to sending the response ALERT DATA message.

B.3.1.3 Change in BIT status reporting.

a. STATUS DATA S5/2 (Change In BIT DATA) shall be reported separately for each data interface.

b. STATUS DATA S5/2 shall be set when any BIT DATA bit changes state.

c. When a RETURN BUILT-IN-TEST DATA command is received, STATUS DATA S5/2, only for that interface, shall be reset prior to sending the response BUILT-IN-TEST DATA message.

B.3.2 ALERT DATA.

a. The DRU-H-R shall report ALERT DATA in the DRU-H-R/host RS-422 interface ALERT DATA message.

b. ALERT DATA indications, word/byte and bit positions, data interface requirements, and set and reset conditions shall be as specified in Table B-II.

c. Additional requirements for setting and resetting ALERT DATA bits are specified throughout this document.

d. ALERT DATA shall be reported separately for each data interface. Interface applicability requirements are given in the INTERFACE(S) SET ON column of Table B-II.

B.3.2.1 Alert states.

a. At initialization, the default (initial) state for all ALERT DATA bits shall be reset (= 0).

b. An ALERT DATA bit shall be set (= 1) when a condition specified in the ALERT SET CONDITION column of Table B-II occurs.

c. A set ALERT DATA bit shall be reset (= 0) when a condition specified in the ALERT RESET CONDITION column of Table B-II occurs.

B.3.2.2 OVERRIDE ALERT command.

a. Upon receipt of an OVERRIDE ALERT command, the DRU-H-R shall reset all overrideable ALERT DATA bits which were transmitted in the last ALERT DATA message.

b. ALERT DATA bits set after the last ALERT DATA message shall not be reset.

c. Non-overrideable ALERT DATA bits shall not be reset until the appropriate reset action has occurred.

d. Overrideable ALERT DATA bits are indicated by “OVERRIDE ALERT command” in the ALERT RESET CONDITION column of Table B-II. All other ALERT DATA bits are non-overrideable.

B.3.3 STATUS DATA and ALERT DATA timing.

a. A change in the following STATUS DATA bits, triggered by receipt of a command, shall be available for output within 200 msec of command receipt and shall be reported in the command response message:

S1/6 (DRU-H-R Startup Complete)
S1/5 (DRU-H-R In Align)

S1/1 (Position Update Request)
S1/0 (Auxiliary Interface Control Inhibited)
S2/6 (Datum or Position Update In Progress)
S2/4 (Pointing Device In Travel Lock)
S3/7 (Orientation Transition In Process)
S3/4 (ZUPTs Inhibited)
S5/4 (DRU-H-R In Dynamic Align)
S6/5 (GPS Warning Present)

b. The ALERT DATA bit(s) and STATUS DATA S2/1 (DRU-H-R Alert) and S5/3 (Change in ALERT DATA) shall be set within 1 second after receipt of a command that triggers any of the following ALERT DATA bits:

D2/2 (Position Update Interrupt)
D2/0 (Shutdown Interrupt)
D3/7 (Motion During Shutdown Request)
D3/6 (Motion During Restart Request)
D3/5 (Motion During Update Request)
D4/7 (DRU-H-R Datum Change)
D4/6 (DRU-H-R Hemisphere/Zone Change)
D4/4 (Altitude Update Rejected)
D4/3 (Horizontal Position Update Rejected)
D4/2 (GPS Position and Update Disagree)
D4/1 (Altitude Update Excessive)
D4/0 (Horizontal Position Update Excessive)

c. For deferred commands, the above requirement shall apply within 1 second of end of the deferring condition.

d. For a command that triggers any of the following ALERT DATA bits, the ALERT DATA bit(s) shall be set before the command response message is sent and STATUS DATA S2/1 (DRU-H-R Alert) and S5/3 (Change in ALERT DATA) shall be set in the command response message:

D5/7 (Invalid Update Request)
D5/6 (Invalid Mode Request)
D5/5 (Invalid Data Request)
D5/2 (Invalid Data Received)
D5/0 (Undefined Command Received)

B.3.4 BIT DATA

a. The DRU-H-R shall report BIT DATA in the DRU-H-R/host RS-422 interface BUILT-IN-TEST-DATA message.

b. BIT DATA indications, word/byte and bit positions, and set and reset conditions shall be as specified in Table B-III.

c. Additional requirements for setting and resetting BIT DATA bits are specified throughout this specification.

B.3.4.1 BIT states.

a. At initialization, the default state for all BIT DATA bits shall be reset (= 0).

b. A BIT DATA bit shall be set (= 1) when a condition specified in the SET CONDITION column of Table B-III occurs.

c. A set BIT DATA bit shall be reset (= 0) when a condition specified in the RESET CONDITION column of Table B-III occurs.

TABLE B-I. Status

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S1/7	DRU-H-R In Startup	Turn-on.	DRU-H-R operations are sufficient for proceeding with alignment.
S1/6	DRU-H-R Startup Complete	DRU-H-R operations are sufficient for proceeding with alignment.	A RESTART command is accepted.
S1/5	DRU-H-R In Align	DRU-H-R is in Accelerated, Static or Dynamic Align.	DRU-H-R completes Accelerated, Static or Dynamic Align; or DRU-H-R in Restart Required state; or A RESTART command is accepted. Shall reset within 8 seconds of Align Time To Go becoming zero.
S1/4	OK To Move	In Static or Dynamic Align, when alignment accuracy can support Interrupted Static Align positioning accuracy (the host system can be moved); or Successful Accelerated Align completion.	DRU-H-R in Restart Required state; or A RESTART command is accepted.
S1/3	Odometer Inhibited	Odometer sensor aiding is inhibited.	Odometer sensor aiding is enabled; or RESTART command accepted.

TABLE B-I. Status-Continued

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S1/2	ZUPT Stop Request	DRU-H-R determines it needs a ZUPT. Shall not transition to set while S3/2 (DRU-H-R In Motion) = 0.	Requested ZUPT completed; or useable GPS data available; or A RESTART command accepted.
S1/1	Position Update Request	Position not initialized after an abnormal shutdown; or Position initialized from GPS with EPE > good value; or Time since last completed ZUPT or last usable GPS data > 150 percent of the applicable ZUPT interval; or Time since last ZUPT in Interrupted Static Align > 6 minutes.	Host position update or GPS position update accepted; or In Dynamic Align.
S1/0	Auxiliary Interface Control Inhibited	Never set.	Always reset
S2/7	ZUPT In Progress	ZUPT initiation.	Completion or interruption of a ZUPT; or A RESTART command accepted.
S2/6	Datum or Position Update In Progress	Receipt of a position or datum update from the host.	Completion or termination of a position or datum update.
S2/5	BIT Malfunction Detected	Any BIT DATA bit is set.	All BIT DATA bits are reset.

TABLE B-I. Status-Continued

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S2/4	Pointing Device in Travel Lock	Host signals pointing device is in travel lock. [Default state at turn-on if: CFIG D29/4 (Travel Lock Commands) is set; or CFIG D29/4 and D29/3 (Travel Lock Discrete) are both reset.]	Host signals pointing device is out of travel lock.
S2/3	Shot Detect	DRU-H-R detects a gun shot.	Completion of Shot Detect Interval delay; or A RESTART command accepted. Shall always be reset if CFIG D29/5 (Shot Detect) is reset.
S2/2	In Stored Heading Align	DRU-H-R is in Accelerated Align.	DRU-H-R is not in Accelerated Align; or a RESTART command is accepted. Shall be reset within 8 seconds of Align Time To Go becoming zero.
S2/1	DRU-H-R Alert	Any ALERT DATA bit is set. (Data interface dependent)	All ALERT DATA bits are reset. (Data interface dependent)
S2/0	Relative Offsets Determined	At initialization CFIG D28/3 (Reset Relative Offsets) is reset and the previously stored state of S2/0 was true; or Relative offset determination was requested in an accepted position update.	At initialization CFIG D28/3 (Reset Relative Offsets) is set; or A RESET RELATIVE OFFSETS command is received; or The datum is changed without offset determination being requested.

TABLE B-I. Status-Continued

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S3/7	Orientation Transition in Process	STATUS DATA S3/1 & S4/7 may be invalid and orientation/attitude accuracy may be degraded because the Orientation (1 or 2) or boresight angles are in the process of being changed.	Orientation (1 or 2) or boresight angle changes are completed; or A RESTART command is accepted.
S3/6	Odometer Damping in Process	DRU-H-R starts odometer aiding.	DRU-H-R stops odometer aiding; or A RESTART command is accepted.
S3/5	Odometer Calibration Completed	Accurate DRU-H-R-to-Host alignment and odometer sensor scale factor determined.	DRU-H-R-to-Host alignment or odometer sensor scale factor inadequate to maintain odometer aided accuracy requirements; or A RESTART command is accepted.
S3/4	ZUPTs Inhibited	INHIBIT ZERO-VELOCITY UPDATES command accepted.	ENABLE ZERO-VELOCITY UPDATES, or RESTART command is accepted.
S3/3	DRU-H-R Zone Extension Enabled	DRU-H-R is operating in Extended Zone mode.	DRU-H-R is operating in Normal Zone mode.
S3/2	DRU-H-R In Motion	Linear motion, in excess of nominal stationary conditions, is detected by the DRU-H-R.	Linear motion is within the nominal stationary conditions; or A RESTART command is accepted.
S3/1	Orientation Attitude Data Valid	In Static or Dynamic Align, when the DRU-H-R estimated azimuth error ≤ 1.0 mil PE; or Successful completion of Accelerated Align.	A RESTART command is accepted.
S3/0	RESERVED *		

* RESERVED bits shall be reset (=0).

TABLE B-I. Status-Continued

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S4/7	DRU-H-R In Orientation 2	DRU-H-R in Orientation 2.	DRU-H-R in Orientation 1.
S4/6	RESERVED *		
S4/5	RESERVED *		
S4/4	DRU-H-R Shutdown Complete	The DRU-H-R has completed shutdown processing and is ready to have power removed.	The DRU-H-R has not completed shutdown processing and is not ready to have power removed.
S4/3	Supplier Reserved	Supplier Specified.	Supplier Specified.
S4/2	Supplier Reserved	Supplier Specified.	Supplier Specified.
S4/1	RESERVED *		
S4/0	RESERVED *		

* RESERVED bits shall be reset (=0).

TABLE B-I. Status-Continued

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S5/7	GPS Damping in Process	A usable GPS data set is available to aid the DRU-H-R.	Time since the last accepted GPS update exceeds the GPS Update Time-out Interval (configuration data); or GPS aiding is inhibited; or A RESTART command is accepted.
S5/6	GPS Enabled	[CFIG D27/7 (GPS Installed) is set at initialization, or An ENABLE INTEGRATED MODE command is accepted] and BIT DATA D2/2 (GPS Fail) is reset.	CFIG D27/7 (GPS Installed) is reset; or An ENABLE INERTIAL MODE or RESTART command is accepted; or BIT DATA D2/2 (GPS Fail) is set.
S5/5	Y-code SVs Selected	The GPS receiver was last set up to select Y-code satellites only.	The GPS receiver was last setup to select P or Y-code satellites. Default setting if configured for SPS GPS.
S5/4	DRU-H-R In Dynamic Align	DRU-H-R is in Dynamic Align.	DRU-H-R is not in Dynamic Align; or A RESTART command is accepted. Shall be reset within 8 seconds of Align Time To Go becoming zero.
S5/3	Change In ALERT DATA	An ALERT DATA bit has changed state since the last ALERT DATA message. (Data interface dependent)	Transmission of an ALERT DATA message; or A RESTART command is accepted. (Data interface dependent)
S5/2	Change in BIT DATA	A BIT DATA bit has changed state since the last BIT DATA message. (Data interface dependent)	Transmission of a BIT DATA message; or A RESTART command is accepted. (Data interface dependent)
S5/1	RESERVED *		
S5/0	RESERVED *		

* RESERVED bits shall be reset (=0).

TABLE B-I. Status-Continued

BYTE/ BIT	STATUS NAME	SET CONDITION	RESET CONDITION
S6/7	RESERVED*		
S6/6	Degraded GPS Enabled	A USE DEGRADED GPS DATA command is accepted.	DRU-H-R accepts a GPS update with EPE ≤ GPS Good Level; or An INERTIAL MODE or RESTART command is accepted.
S6/5	GPS Warning Present	DRU-H-R receives and queues a warning from GPS message #5044 (Warning Messages).	RETURN NEXT GPS WARNING command has deleted the last queued warning.
S6/4	RESERVED*		
S6/3 & 2	GPS Tracking	Indicates number of GPS SVs currently tracked in state 3, 4 or 5 by receiver channels 1-4: 11 signifies = 4 SVs, 10 signifies = 3 SVs, 01 signifies = 1 or 2 SVs, 00 signifies = no SVs	Set = 00 if: CFIG D27/7 (GPS Installed) = 0; or BIT DATA D2/3 (GPS Commo Fail) = 1; or A RESTART command is accepted; or GPS data not received for ≥ 2 seconds.
S6/1	EPE ≤ GPS Good Level	Valid GPS data received with EPE ≤ GPS Good Level (configuration data); and CFIG D27/7 (GPS Installed) = 1; and BIT DATA D2/3 (GPS Commo Fail) = 0.	GPS data received with EPE > GPS Good Level; or Invalid GPS data received; or CFIG D27/7 (GPS Installed) = 0; or BIT DATA D2/3 (GPS Commo Fail) = 1; or A RESTART command is accepted; or GPS data not received for ≥ 2 seconds.
S6/0	EPE ≤ GPS Poor Level	Valid GPS data received with EPE ≤ GPS Poor Level (configuration data); and CFIG D27/7 (GPS Installed) = 1; and BIT DATA D2/3 (GPS Commo Fail) = 0.	GPS data received with EPE > GPS Poor Level; or Invalid GPS data received; or CFIG D27/7 (GPS Installed) = 0; or BIT DATA D2/3 (GPS Commo Fail) = 1; or A RESTART command is accepted; or GPS data not received for ≥ 2 seconds.

* RESERVED bits shall be reset (=0).

TABLE B-II. Alerts.

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D1/7	Datum Not Initialized	The DRU-H-R datum has not been initialized.	All data interfaces.	Completion of update with valid datum from accepted ACCEPT POSITION or ACCEPT GEODETIC DATA command.
D1/6	Datums Do Not Agree	The datums used by the DRU-H-R and GPS receiver do not match. (Datums match when: pre-programmed datum IDs are the same; or user datum shift parameters are the same.)	All data interfaces.	CFIG D27/7 (GPS Installed) = 0; or BIT DATA D2/3 (GPS Commo Fail) = 1; or the datums used by the DRU-H-R and GPS receiver match.
D1/5	Datum Update Rejected	A requested datum ID is invalid or an ACCEPT USER DATUM command data element parameter is outside its allowable range.	Data interface which sent the ACCEPT POSITION, ACCEPT GEODETIC DATA or ACCEPT USER DATUM command.	OVERRIDE ALERT command.
D1/4	GPS Unkeyed	GPS message #5040 (Current Status) indicates the GPS receiver is not keyed.	All data interfaces.	CFIG D27/7 (GPS Installed) = 0; or BIT DATA D2/3 (GPS Commo Fail) = 1; or GPS message #5040 (Current Status) indicates GPS is keyed.
D1/3	Update Rejected GPS Invalid	Rejection of position update, with Determine Relative Offsets flag = 1, because current GPS data wasn't usable.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D1/2	RESERVED *			
D1/1	RESERVED *			

* RESERVED bits shall be reset (=0).

TABLE B-II. Alerts-Continued.

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D1/0	Previous Shutdown Abnormal	The DRU-H-R last turned off while: STATUS DATA S3/2 (DRU-H-R in Motion) is set; or Shutdown processing wasn't complete; or Align wasn't completed; or ALERT DATA D2/4 (Unable to Complete Align) or D2/3 (Align Interrupt) or D3/1 (Excessive rates) was set.	All data interfaces.	ACCEPT POSITION or ACCEPT GEODETIC DATA command, or GPS Position Update is accepted.
D2/7	Vehicle Boresight Angles Not Present	Vehicle Boresight Angles are not initialized.	All data interfaces.	ACCEPT VEHICLE BORESIGHT Command is accepted.
D2/6	Align Initial Position Parameters Not Received	Position has not been initialized by the host or GPS receiver; or Accelerated Align is terminated before successful completion.	All data interfaces.	In Accelerated Align; or ACCEPT POSITION or ACCEPT GEODETIC DATA command, or GPS Position Update is accepted; or Static Align completed with stored position.
D2/5	Stored Heading/ Attitude No Good	The saved heading/attitude data are not adequate to accurately complete Accelerated align; or Accelerated Align is terminated for motion.	All data interfaces.	OVERRIDE ALERT command.

TABLE B-II. Alerts-Continued.

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D2/4	Unable to Complete Align	Align can't be completed to the required accuracy within the allotted time.	All data interfaces.	RESTART command is accepted.
D2/3	Align Interrupt	[STATUS DATA S3/2 (DRU-H-R in Motion) is set during Accelerated Align or the first 3.5 minutes (maximum) of Static Align and GPS aiding is inhibited]; or [A GPS failure is detected during Dynamic Align and S3/2 (DRU-H-R in Motion) is set and S1/4 (OK to Move) is reset].	All data interfaces.	RESTART command is accepted.
D2/2	Position Update Interrupt	STATUS DATA S3/2 (DRU-H-R in Motion) is set while a position update is processed and the update is rejected.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	ACCEPT POSITION or ACCEPT GEODETIC DATA command is accepted; or After 60 seconds, if S1/1 (Position Update Request) is reset.
D2/1	ZUPT Interrupt	STATUS DATA S3/2 (DRU-H-R in Motion) transitions to set while S1/2 (ZUPT Stop Request) is set.	All data interfaces.	Completion of a ZUPT.
D2/0	RESERVED *			

* RESERVED bits shall be reset (=0).

TABLE B-II. Alerts-Continued

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D3/7	Motion During Shutdown Request	STATUS DATA S3/2 (DRUH in Motion) is set when a SHUTDOWN or STORED HEADING SHUTDOWN command is received.	Data interface which sent the command.	OVERRIDE ALERT command.
D3/6	Motion During Restart Request	RESTART command was rejected because the DRU-H-R was moving.	Data interface which sent the command.	OVERRIDE ALERT command.
D3/5	Motion During Update Request	STATUS DATA S3/2 (DRU-H-R in Motion) is set when an update command is received.	Data interface which sent the command.	OVERRIDE ALERT command.
D3/4	Insufficient Align Time	A STORED HEADING SHUTDOWN command was rejected because Static align or 15 minutes (maximum) stationary time wasn't completed.	All data interfaces.	OVERRIDE ALERT command.
D3/3	Position Update Beyond Range of Zone Extension	The grid position in an ACCEPT POSITION command is outside the extended boundaries of the designated zone.	Data interface which sent the command.	OVERRIDE ALERT command.
D3/2	Verify Input Coordinates	The coordinates in an ACCEPT POSITION or ACCEPT GEODETIC DATA command are more than 2500 meters from the current DRU-H-R position.	Data interface which sent the command.	OVERRIDE ALERT command.
D3/1	Excessive Rates	DRU-H-R linear or angular rate capability was exceeded and survey data may be erroneous.	All data interfaces.	RESTART command is accepted.
D3/0	Motion with Pointing Device Out of Travel Lock	STATUS DATA S3/2 (DRU-H-R in Motion) transitions to set while S2/4 (Pointing Device in Travel Lock) is reset.	All data interfaces.	OVERRIDE ALERT command.

TABLE B-II. Alerts-Continued.

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D4/7	DRU-H-R Datum Change	The datum in use was changed via a host position update.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D4/6	DRU-H-R Hemisphere/ Zone Change	The DRU-H-R hemisphere or UTM zone was changed via a host position update.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D4/5	Ethernet Configuration Data Not Present	Ethernet Configuration Data are not initialized.	All data interfaces.	ACCEPT ETHERNET CONFIGURATION DATA command is accepted.
D4/4	Altitude Update Rejected	A host position update was rejected because the altitude closure error exceeded the “reject” criteria.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D4/3	Horizontal Position Update Rejected	A host position update was rejected because the horizontal position closure error exceeded the “reject” criteria.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D4/2	GPS Position and Update Disagree	A host position update was rejected because the difference between GPS and update positions exceeded the acceptance criteria.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D4/1	Altitude Update Excessive	A position update was rejected because the altitude closure error exceeded the “excessive” criteria.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.
D4/0	Horizontal Position Update Excessive	A position update was rejected because the horizontal position closure error exceeded the “reject” criteria.	Data interface which sent the ACCEPT POSITION or ACCEPT GEODETIC DATA command.	OVERRIDE ALERT command.

TABLE B-II. Alerts-Continued

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D5/7	Invalid Update Request	A data update request was rejected because the DRU-H-R cannot currently accept it.	Data interface which made the request.	OVERRIDE ALERT command.
D5/6	Invalid Mode Request	A mode change request was rejected because the DRU-H-R cannot currently accept it.	Data interface which made the request.	OVERRIDE ALERT command.
D5/5	Invalid Data Request	A command was rejected because the requested data is invalid.	Data interface which made the request.	OVERRIDE ALERT command.
D5/4	Pointing Device Boresight Angles Not Present	Pointing Device Boresight Angles are not initialized.	All data interfaces.	ACCEPT POINTING DEVICE BORESIGHT command is accepted.
D5/3	Configuration Data Not Present	Configuration Data are not initialized.	All data interfaces.	ACCEPT CONFIGURATION DATA command is accepted.
D5/2	Invalid Data Received	A data update command was rejected because a data element was outside the allowable range.	Data interface that sent the invalid data.	OVERRIDE ALERT command.
D5/1	RESERVED *			
D5/0	Undefined Command Received	An unrecognized command was received.	Data interface which sent the undefined command.	OVERRIDE ALERT command.

* RESERVED bits shall be reset (=0).

TABLE B-II. Alerts-Continued.

BYTE/ BIT	ALERT NAME	ALERT SET CONDITION	INTERFACE(S) SET ON	ALERT RESET CONDITION
D6/7	Supplier Reserved	Supplier Specified.	Supplier Specified.	OVERRIDE ALERT command.
D6/6	Supplier Reserved	Supplier Specified.	Supplier Specified.	OVERRIDE ALERT command.
D6/5	Supplier Reserved	Supplier Specified.	Supplier Specified.	OVERRIDE ALERT command.
D6/4	Supplier Reserved	Supplier Specified.	Supplier Specified.	OVERRIDE ALERT command.
D6/3	Boundary Crossed	The DRU-H-R has crossed the equator, or normal or extended UTM zone boundary.	All data interfaces.	OVERRIDE ALERT command.
D6/2	DRU-H-R Using Previous VMS Calibration	Having been unable to establish the current DRU-H-R to host alignment and VMS scale factor, the DRU-H-R is using the values from the last successful VMS calibration on the current host.	All data interfaces.	OVERRIDE ALERT command. *
D6/1	VMS Calibration Failed	The DRU-H-R was unable to establish the current DRU-H-R to host alignment and VMS scale factor within the Exclusive ZUPT Mode Interval (configuration data).	All data interfaces.	OVERRIDE ALERT command. *
D6/0	VMS Data Unusable	VMS aiding has been discontinued for the current mission leg because VMS data are unacceptable for aiding.	All data interfaces.	Completion of a ZUPT.

* When overridden, this alert may immediately set again if the condition which caused the alert has not changed.

NOTE: Integrators should not implement checking of “spare”, “reserved” or “supplier reserved” ALERT DATA bits. They are subject to future change.

TABLE B-III. BIT data

BYTE / BIT	FAULT NAME	SET CONDITION	RESET CONDITION
D1/7	DRU-H-R Fail	DRU-H-R fault(s) present. Once set, shall remain set until shutdown.	No DRU-H-R faults present.
D1/6	DRU-H-R Inertial Fail	DRU-H-R sensor related fault(s) present.	No DRU-H-R sensor related faults present.
D1/5	DRU-H-R Non-Inertial Fail	DRU-H-R non-sensor related fault(s) present.	No DRU-H-R non-sensor related faults present.
D1/4	spare		Always reset.
D1/3	spare		Always reset.
D1/2	spare		Always reset.
D1/1	spare		Always reset.
D1/0	spare		Always reset.
D2/7	spare		Always reset.
D2/6	spare		Always reset.
D2/5	spare		Always reset.
D2/4	GPS Antenna Fault	CFIG D27/7 (GPS Installed) = 1; and GPS communications OK; and Antenna source in GPS message #5040 (Current Status) ≠ CFIG D27/3 (Integral/External Antenna).	CFIG D27/7 (GPS Installed) = 0; or GPS communications failed; or Antenna source in GPS message #5040 (Current Status) = CFIG D27/3 (Integral/External Antenna).

TABLE B-III. BIT data-Continued.

BYTE / BIT	FAULT NAME	SET CONDITION	RESET CONDITION
D2/3	GPS Communication Fail	CFIG D27/7 (GPS Installed) = 1; and DRU-H-R and GPS receiver are not properly communicating serial data and/or 1 PPS time mark pulses.	CFIG D27/7 (GPS Installed) = 0; or DRU-H-R and GPS receiver are properly communicating serial data and 1 PPS time mark pulses.
D2/2	GPS Fail	CFIG D27/7 (GPS Installed) = 1; and GPS communications OK; and RCVR failure is indicated by the GPS receiver..	CFIG D27/7 (GPS Installed) = 0; or GPS communications failed; or RCVR failure not indicated by the GPS receiver and a RESTART or ENABLE INTEGRATED MODE command has been accepted.
D2/1	VMS Fail	CFIG D29/0 (Odometer Installed) = 1; and An odometer sensor fault was detected.	CFIG D29/0 (Odometer Installed) = 0; or No odometer sensor faults detected; or (CFIG D29/1 (Odometer Sensor Type) = 1 and an ENABLE ODOMETER REQUEST command is received).
D2/0	VMS Drive Fail	CFIG D29/0 (Odometer Installed) = 1; and An odometer sensor fault was detected; and [VMS hardware BIT passed or VMS hardware BIT not performed].	CFIG D29/0 (Odometer Installed) = 0; or No odometer sensor faults detected; or VMS hardware BIT failed; or (CFIG D29/1 (Odometer Sensor Type) = 1 and an ENABLE ODOMETER REQUEST command is received).

NOTE: Integrators should not implement checking of “spare” BIT DATA bits. They are subject to future change.

APPENDIX C

CONFIGURATION DATA

C.1 SCOPE

C.1.1 Scope. This appendix contains requirements for using configuration data to tailor DRU-H-R functionality to specific hosts. This appendix is a mandatory part of this specification. The information herein is intended for compliance.

C.2 APPLICABLE DOCUMENTS

C.2.1 General. The documents listed in this section are specified in section 3 of this appendix. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all requirements documents cited in section 3 of this appendix, whether or not they are listed.

C.2.2 Non-Government documents. The following documents form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

INTERNET ENGINEERING STEERING GROUP

RFC 768	User Datagram Protocol
RFC 791	Internet Protocol

(These documents are available on line at http://www.ietf.org/rfc.html.)

C.3 REQUIREMENTS

C.3.1 Configuration data. The DRU-H-R shall use configuration data to tailor its operation to host requirements. The DRU-H-R shall contain 15 sets of installed configuration data and shall accept changeable configuration data via the host data interfaces. Unless otherwise specified, the requirements associated with configuration data apply whether the data were initially installed or were entered via ACCEPT CONFIGURATION DATA, ACCEPT VEHICLE BORESIGHT, ACCEPT POINTING DEVICE BORESIGHT or ACCEPT ETHERNET CONFIGURATION DATA commands.

C.3.2 Initializing configuration data. Upon activation, the DRU-H-R shall:

a. Determine the configuration code number from the configuration discretes on J1.

b. For configuration codes 0 - 14, use the corresponding installed configuration data set.

c. For configuration code 15, use configuration data loaded via an ACCEPT CONFIGURATION DATA command.

d. Determine the validity of configuration and Ethernet configuration data.

C.3.2.1 Invalid configuration data. The DRU-H-R shall:

a. Set BIT DATA D1/7 (DRU-H-R Fail) if installed configuration data (configuration codes 0 - 14) are invalid.

b. Set ALERT DATA D5/3 (Configuration Data Not Present); set STATUS DATA S1/7 (DRUH In Startup); reset STATUS DATA S1/4 (OK to Move), S1/5 (DRUH In Align), S2/2 (DRUH In Stored Heading Align) and S5/4 (DRUH In Dynamic Align); and remain in initialization if configuration code 15 configuration data are invalid.

c. Set ALERT DATA D6/7 (Ethernet Configuration Data Not Present) if Ethernet configuration data are invalid.

C.3.2.2 ACCEPT CONFIGURATION DATA command response. For configuration code 15, when an ACCEPT CONFIGURATION DATA command is received, the DRU-H-R:

a. Shall accept the command if all data elements are within their allowable ranges and STATUS DATA S3/2 (DRU-H-R in Motion) is reset.

b. Shall reject the command and set ALERT DATA D5/2 (Invalid Data Received) if any data element is outside the allowable range.

c. Shall reject the command and set ALERT DATA D3/5 (Motion During Update Request) if STATUS DATA S3/2 (DRU-H-R in Motion) is set.

When an ACCEPT CONFIGURATION DATA command is accepted, the DRU-H-R:

a. Shall retain and use the new configuration data until changed or rendered invalid.

b. Shall set STATUS DATA S1/1 (Position Update Request).

c. Shall set ALERT DATA D5/4 (Pointing Device Boresight Angles Not Present) if the Pointing Device Boresight Angles flag (CFIG D29/7) is set.

d. Shall set ALERT DATA D2/7 (Vehicle Boresight Angles Not Present) if the Vehicle Boresight Angles flag (CFIG D29/6) is set.

e. Shall reset ALERT DATA D5/3 (Configuration Data Not Present).

f. Shall complete initialization and start alignment if STATUS DATA S1/7 (DRU-H-R In Startup) is set and boresight data requirements have been satisfied.

For configuration codes 0 - 14, the DRU-H-R shall reject the command and set ALERT DATA D5/7 (Invalid Update Request) when an ACCEPT CONFIGURATION DATA command is received.

C.3.2.3 ACCEPT ETHERNET CONFIGURATION DATA command response. When an ACCEPT ETHERNET CONFIGURATION DATA command is received, the DRU-H-R shall:

a. Accept the command if all data elements are within their allowable ranges.

b. Reject the command and set ALERT DATA D5/2 (Invalid Data Received) if any data element is outside the allowable range.

When an ACCEPT ETHERNET CONFIGURATION DATA command is accepted, the DRU-H-R shall:

a. Retain and use the new configuration data until changed or rendered invalid.

b. Reset ALERT DATA D6/7 (Ethernet Configuration Data Not Present) if valid Ethernet configuration data are present.

C.3.3 Configuration data output. Upon receipt of a RETURN CONFIGURATION DATA command, the DRU-H-R shall return the values of configuration data presently being used via a CONFIGURATION DATA message.

C.3.4 Configuration data elements. The following subparagraphs describe the configuration data elements.

C.3.4.1 Configuration definition flags. The DRU-H-R shall use configuration definition flags as indicated in the following subparagraphs. Bit references in the following sub-paragraphs are for the CONFIGURATION DATA message. Table C-I cross-references flag locations in the CONFIGURATION DATA message and ACCEPT CONFIGURATION DATA command.

TABLE C-I. Configuration Definition Flags.

COMMAND BYTE/BIT	MESSAGE BYTE/BIT	CONFIGURATION DEFINITION FLAG
D26/7	D25/7	Orientation 2 Based on Travel Lock
D26/6-0	D25/6-0	RESERVED
D27/7	D26/7	GPS Installed
D27/6	D26/6	Spare
D27/5	D26/5	SPS GPS
D27/4	D26/4	Spare
D27/3	D26/3	Integral/External Antenna
D27/2	D26/2	Geodetic/Grid GPS Position Data
D27/1	D26/1	GPS Command at DRU-H-R Shutdown
D27/0	D26/0	GPS OFF/STANDBY at DRU-H-R Shutdown
D28/7	D27/7	Supplier Reserved
D28/6	D27/6	Supplier Reserved
D28/5	D27/5	Supplier Reserved
D28/4	D27/4	Pointing Device Roll/Cant
D28/3	D27/3	Reset Relative Offsets
D28/2	D27/2	Initialize Relative Output
D28/1	D27/1	Vehicle Roll/Cant
D28/0	D27/0	Geodetic/Grid Azimuth
D29/7	D28/7	Pointing Device Boresight Angles
D29/6	D28/6	Vehicle Boresight Angles
D29/5	D28/5	Shot Detect
D29/4	D28/4	Travel Lock Commands
D29/3	D28/3	Travel Lock Discrete
D29/2	D28/2	Tracked/Wheeled Vehicle
D29/1	D28/1	Odometer sensor type
D29/0	D28/0	Odometer Installed

C.3.4.1.1 Orientation 2 based on travel lock (CFIG D25/7).

a. When set, the DRU-H-R shall transition between Orientations 1 and 2 based on the state of STATUS DATA S2/4 (Pointing Device In Travel Lock).

b. When STATUS DATA S2/4 is set, the DRU-H-R shall operate as defined by the Orientation 1: Coordinate Frame code, Vehicle and Pointing Device Boresight Angles, and position offset distances.

c. When STATUS DATA S2/4 is reset, the DRU-H-R shall operate as defined by the Orientation 2: Coordinate Frame code, Pointing Device Boresight Angles, and position offset distances.

d. While STATUS DATA S2/4 is reset, the DRU-H-R shall output the frozen travel lock pointing device reference values in terms of Orientation 2.

C.3.4.1.2 RESERVED (CFIG D25/6-0). The DRU-H-R shall accept ACCEPT CONFIGURATION DATA commands regardless of RESERVED bit states. No action shall be taken based on RESERVED bit states.

C.3.4.1.3 GPS installed (CFIG D26/7). When set, this flag indicates a GPS receiver is installed and the DRU-H-R shall use GPS aiding unless otherwise inhibited.

C.3.4.1.4 Spare (CFIG D26/6, D26/4, D27/7-5 and D28/1).

a. Spare configuration definition flags should be set to zero in ACCEPT CONFIGURATION DATA commands.

b. Spares may be output in either state in CONFIGURATION DATA messages. CFIG D27/7-5 are supplier reserved.

C.3.4.1.5 SPS GPS (CFIG D26/5).

a. When set, the DRU-H-R shall use GPS data, based on SPS GPS signals, which meet the acceptance criteria.

b. When reset, the DRU-H-R shall only use GPS data, based on PPS GPS signals, which meet the acceptance criteria.

C.3.4.1.6 Integral/external antenna (CFIG D26/3). This flag indicates which GPS antenna is used in the host. When reset, the GPS receiver is expected to use an external antenna.

C.3.4.1.7 Geodetic/grid GPS data (CFIG D26/2).

a. When this flag is set, the DRU-H-R shall request the GPS receiver to format position data in GPS message #5040 as Latitude and Longitude.

b. When this flag is reset, the DRU-H-R shall request the GPS receiver to format position data in GPS message #5040 as UTM/UPS data.

C.3.4.1.8 GPS shutdown control. When a SHUTDOWN or STORED HEADING SHUTDOWN command has been accepted, the DRU-H-R shall command the GPS receiver to turn off or go to stand-by, according to the states of the GPS Command at Shutdown (CFIG D26/1) and GPS OFF/Standby at Shutdown (CFIG D26/0) flags, in accordance with Table C-II.

TABLE C-II. GPS shutdown flags.

CFIG		GPS COMMAND AT DRU-H-R SHUTDOWN
D26/1	D26/0	
0	0 or 1	No command at shutdown
1	0	GPS message #5001, Stand-by mode (Word 5 = 05h)
1	1	GPS message #5001, Turn RCVR off (Word 5 = 14h)

C.3.4.1.9 Pointing device roll/cant (CFIG D27/4).

a. When this flag is set, the DRU-H-R shall output Pointing Device Roll.

b. When this flag is reset, the DRU-H-R shall output Pointing Device Cant.

C.3.4.1.10 Reset relative offsets (CFIG D27/3).

a. When this flag is set, the DRU-H-R shall reset STATUS DATA S2/0 (Relative Offsets Determined) at initialization.

b. When this flag is reset, the DRU-H-R shall initialize STATUS DATA S2/0 to the state stored at shutdown.

C.3.4.1.11 Initialize relative output (CFIG D27/2).

a. When this flag is set, the DRU-H-R shall initialize to output relative (biased) positions.

b. When this flag is reset, the DRU-H-R shall initialize to output unbiased positions.

C.3.4.1.12 Vehicle roll/cant (CFIG D27/1).

a. When this flag is set, the DRU-H-R shall output Vehicle Roll.

b. When this flag is reset, the DRU-H-R shall output Vehicle Cant.

C.3.4.1.13 Geodetic/grid azimuth (CFIG D27/0).

a. When this flag is set, the DRU-H-R shall output Geodetic Azimuth in all messages providing azimuth output.

b. When this flag is reset, the DRU-H-R shall output Grid Azimuth, referenced to the current UTM grid zone (normal or extended), in all messages providing azimuth output.

C.3.4.1.14 Pointing device boresight angles (CFIG D28/7). When this flag is set, the DRU-H-R shall use Pointing Device Boresight Angles entered via an ACCEPT POINTING DEVICE BORESIGHT command.

C.3.4.1.15 Vehicle boresight angles (CFIG D28/6). When this flag is set, the DRU-H-R shall use Vehicle Boresight Angles entered via the ACCEPT VEHICLE BORESIGHT command.

C.3.4.1.16 Shot detect (CFIG D28/5). When this flag is set, the DRU-H-R shall set STATUS DATA S2/3 (Shot Detect) for the Shot Detect Interval when a shot is detected.

C.3.4.1.17 Travel lock commands (CFIG D28/4).

a. When this flag is set, the DRU-H-R shall change travel lock state based on receipt of IN TRAVEL LOCK and OUT OF TRAVEL LOCK commands.

b. At activation, the DRU-H-R shall assume it is in travel lock when the Travel Lock Commands Flag is set.

c. When this flag is reset, the DRU-H-R shall assume it is always in travel lock, shall reject IN TRAVEL LOCK and OUT OF TRAVEL LOCK commands, and shall set ALERT DATA D5/6 (Invalid Mode Request) if either command is received.

C.3.4.1.18 Travel lock discrete (CFIG D28/3). The DRU-H-R does not use the Travel Lock discrete. DRU-H-R shall ignore the travel lock discrete configuration command bit.

C.3.4.1.19 Tracked/wheeled vehicle (CFIG D28/2). When this flag is set, this flag indicates the host is a tracked vehicle.

C.3.4.1.20 Odometer sensor type (CFIG D28/1).

a. When this flag is set, this flag indicates the odometer sensor is a speedometer sender.

b. When this flag is reset, this flag indicates the odometer sensor is a VMS.

c. This flag shall be ignored when Odometer installed (CFIG D28/0) is reset.

C.3.4.1.21 Odometer installed (CFIG D28/0). When set, this flag indicates an odometer sensor is connected and the DRU-H-R may use useable odometer data.

C.3.4.2 DRU-H-R coordinate frame code. The DRU-H-R shall use DRU-H-R Coordinate Frame Codes, as defined in Table C-III, to relate the case coordinate frame to the intermediate DRU-H-R Coordinate Frame (see 6.3.7), for Orientations 1 and 2.

TABLE C-III. DRU-H-R Case Coordinate Frame Codes.

CODE (hex)	CONNECTORS	BOTTOM COVER	MOUNTING SURFACE
00	Forward	Down	Left
10	Right	Down	Forward
20	Aft	Down	Right
30	Left	Down	Aft
02	Forward	Up	Right
12	Right	Up	Aft
22	Aft	Up	Left
32	Left	Up	Forward
03	Forward	Right	Down
13	Right	Aft	Down
23	Aft	Left	Down
33	Left	Forward	Down
01	Forward	Left	Up
11	Right	Forward	Up
21	Aft	Right	Up
31	Left	Aft	Up
04	Up	Forward	Left
07	Up	Right	Forward
06	Up	Aft	Right
05	Up	Left	Aft
0E	Down	Forward	Right
0F	Down	Right	Aft
0C	Down	Aft	Left
0D	Down	Left	Forward

C.3.4.3 Vehicle boresight angles.

The DRU-H-R shall use Vehicle Boresight Angles, α, β, γ, to calculate Vehicle Pitch, Vehicle Cant, Vehicle Roll, Vehicle Grid Azimuth, and Vehicle Geodetic Azimuth.

α, β, γ relate the DRU-H-R coordinate frame (see 6.3.7.2) to the host vehicle coordinate frame when the DRU-H-R is stowed for travel.

a. α is the horizontal angle between the vehicle longitudinal axis and the vertical projection of $\overline{X}_D$ onto the horizontal plane when the vehicle longitudinal and cross axes are level. α is measured clockwise from the vehicle longitudinal axis direction of travel and is always positive.

b. β is the vertical angle between the vertical projection of $\overline{X}_D$ onto the horizontal plane and $\overline{X}_D$ when the vehicle longitudinal and cross axes are level. β is negative when $\overline{X}_D$ lies above the horizontal plane and positive when below.

c. γ is the angle between the horizontal plane and $\overline{Y}_D$ measured in the $\overline{Y}_D$, $\overline{Z}_D$ plane when the vehicle longitudinal and cross axes are level. γ is positive when $\overline{Y}_D$ lies below the horizontal plane and negative when above.

C.3.4.3.1 Vehicle boresight angle initialization.

a. The DRU-H-R shall use valid Vehicle Boresight Angles entered via an ACCEPT VEHICLE BORESIGHT command.

b. If Vehicle Boresight Angles are invalid, the DRU-H-R shall:

(1) set ALERT DATA D2/7 (Vehicle Boresight Angles Not Present);

(2) set STATUS DATA S1/7 (DRU-H-R In Startup);

(3) reset STATUS DATA S1/4 (OK To Move), S1/5 (DRU-H-R In Align), S2/2 (DRU-H-R In Stored Heading Align), and S5/4 (DRU-H-R In Dynamic Align).

C.3.4.3.2 ACCEPT VEHICLE BORESIGHT command response.

a. When the Vehicle Boresight Angles flag (CFIG D28/6) is set and an ACCEPT VEHICLE BORESIGHT command is received, the DRU-H-R:

1) Shall accept the command if all data elements are within their allowable ranges and STATUS DATA S3/2 (DRU-H-R in Motion) is reset.

2) Shall reject the command and set ALERT DATA D5/2 (Invalid Data Received) if any data element is outside the allowable range.

3) Shall reject the command and set ALERT DATA D3/5 (Motion During Update Request) if STATUS DATA S3/2 (DRU-H-R in Motion) is set.

b. When an ACCEPT VEHICLE BORESIGHT command is accepted, the DRU-H-R shall:

1) Retain and use the new Vehicle Boresight Angles until changed or rendered invalid.

2) Set STATUS DATA S3/7 (Orientation Transition In Progress) if orientation parameters aren't referenced to the new boresight values. STATUS DATA S3/7 shall be reset when orientation parameters are referenced to the new boresight values.

3) Reset ALERT DATA D2/7 (Vehicle Boresight Angles Not Present).

4) Complete initialization and start Align if STATUS DATA S1/7 (DRU-H-R In Startup) is set and pointing device boresight and configuration data requirements have been satisfied.

C.3.4.3.3 Invalid vehicle boresight angles.

a. Upon activation, changeable Vehicle Boresight Angles shall be considered invalid when:

1) The current configuration code number differs from the configuration code number when the DRU-H-R was last shut off; or

2) A fault condition is detected where the stored Vehicle Boresight Angles may have been altered.

b. Once determined invalid, changeable Vehicle Boresight Angles shall not be considered valid until an ACCEPT VEHICLE BORESIGHT command has been accepted.

C.3.4.3.4 Output of vehicle boresight angles. Upon receipt of a RETURN VEHICLE BORESIGHT command, the DRU-H-R shall transmit the currently used Vehicle Boresight Angles in a VEHICLE BORESIGHT Message.

C.3.4.4 Pointing device boresight angles.

a. The DRU-H-R shall use Orientation 1 and 2 pointing device boresight angles, A, B, Γ, to calculate Pointing Device Grid Azimuth, Pointing Device Geodetic Azimuth, Pointing Device Pitch, Pointing Device Cant, Pointing Device Roll, Pointing Device Pitch Rate, Pointing Device Roll Rate, and Pointing Device Azimuth Rate.

b. A, B, Γ relate the DRU-H-R coordinate frame (see 6.3.7.2) to that of the pointing device.

1) A is the horizontal angle between the axis of the pointing device and the vertical projection of $\overline{X}_D$ onto the horizontal plane when the pointing device axis and cross axis are level. A is measured clockwise from the direction of pointing and is always positive.

2) B is the vertical angle between the vertical projection of $\overline{X}_D$ onto the horizontal plane and $\overline{X}_D$ when the pointing device axis and cross axis are level. B is negative when $\overline{X}_D$ lies above the horizontal plane and positive below.

3) Γ is the angle between the horizontal plane and $\overline{Y}_D$ measured in the $\overline{Y}_D$, $\overline{Z}_D$ plane when the pointing device axis and cross axis are level. Γ is positive when $\overline{Y}_D$ lies below the horizontal plane and negative when above.

C.3.4.4.1 Pointing device boresight angle initialization.

a. The DRU-H-R shall use valid Pointing Device Boresight Angles entered via an ACCEPT POINTING DEVICE BORESIGHT command.

b. When Pointing Device Boresight Angles are invalid, the DRU-H-R shall: set ALERT DATA D5/4 (Pointing Device Boresight Angles Not Present); set STATUS DATA S1/7 (DRU-H-R In Startup); and reset STATUS DATA S1/4 (OK To Move), S1/5 (DRU-H-R In Align), S2/2 (DRU-H-R In Stored Heading Align), and S5/4 (DRU-H-R In Dynamic Align).

C.3.4.4.2 ACCEPT POINTING DEVICE BORESIGHT command response.

a. When the Pointing Device Boresight Angles flag (CFIG D28/7) is set and an ACCEPT POINTING DEVICE BORESIGHT command is received, the DRU-H-R:

1) Shall accept the command if all data elements are within their allowable ranges and STATUS DATA S3/2 (DRU-H-R in Motion) is reset.

2) Shall reject the command and set ALERT DATA D5/2 (Invalid Data Received) if any data element is outside the allowable range.

3) Shall reject the command and set ALERT DATA D3/5 (Motion During Update Request) if STATUS DATA S3/2 (DRU-H-R in Motion) is set.

b. When an ACCEPT POINTING DEVICE BORESIGHT command is accepted, the DRU-H-R shall:

1) Retain and use the new Pointing Device Boresight Angles until changed or rendered invalid.

2) Set STATUS DATA S3/7 (Orientation Transition In Progress) if orientation parameters aren't referenced to the new boresight values. STATUS DATA S3/7 shall be reset when orientation parameters are referenced to the new boresight values.

3) Reset ALERT DATA D5/4 (Pointing Device Angles Not Present).

4) Complete initialization and start Align if STATUS DATA S1/7 (DRU-H-R In Startup) is set and vehicle boresight and configuration data requirements have been satisfied.

C.3.4.4.3 Invalid pointing device boresight angles.

a. Upon activation, changeable Pointing Device Boresight Angles shall be considered invalid when:

1) The current configuration code number differs from the configuration code number when the DRU-H-R was last shut off; or

2) A fault condition is detected where the stored Pointing Device Boresight Angles may have been altered.

b. Once determined invalid, changeable Pointing Device Boresight Angles shall not be considered valid until an ACCEPT POINTING DEVICE BORESIGHT command has been accepted.

C.3.4.4.4 Output of pointing device boresight angles. Upon receipt of a RETURN POINTING DEVICE BORESIGHT command, the DRU-H-R shall transmit the currently used pointing device boresight angles in a POINTING DEVICE BORESIGHT message.

C.3.4.4.5 Position offset distances.

a. The DRU-H-R shall use position offset distances to transfer positions to/from a reference point on the host.

b. There shall be separate sets of position offset distances for Orientation 1, Orientation 2, GPS antenna reference points and odometer action point.

C.3.4.5.1 Orientation 1 offset distances. In Orientation 1, the position offset distances, ΔX, ΔY, and ΔZ, are in the vehicle coordinate frame and are measured from the DRU-H-R case reference frame origin.

a. ΔX, the offset along the vehicle longitudinal axis, is positive if the offset point is forward of the DRU-H-R in the direction of travel and is negative if behind.

b. ΔY, the offset along the vehicle cross axis, is positive if the offset point is to the right of the DRU-H-R, looking in the direction of forward travel, and is negative if to the left.

c. ΔZ, the offset along the vehicle vertical axis, is positive if the offset point is above the DRU-H-R and is negative if below.

C.3.4.5.2 Orientation 2 offset distances. In Orientation 2, the position offset distances, ΔX, ΔY, and ΔZ, are in the pointing device coordinate frame. They are measured from the

DRU-H-R case reference frame origin to the offset point on the pointing device when the pointing device pointing axis and cross-axis are level.

a. ΔX, the offset along the pointing device pointing axis, is positive if the offset point is forward of the DRU-H-R in the direction of pointing and is negative if behind.

b. ΔY, the offset along the pointing device cross-axis, is positive if the offset point is to the right of the DRU-H-R, looking in the direction of pointing, and is negative if to the left.

c. ΔZ, the offset along the pointing device vertical axis, is positive if the offset point is above the DRU-H-R and is negative if below.

C.3.4.5.3 GPS antenna offset distances.

a. The DRU-H-R shall use GPS antenna offset distances to compensate GPS data from the GPS antenna location to the DRU-H-R case reference frame origin.

b. The offset distances from the DRU-H-R to the GPS antenna, ΔX, ΔY, and ΔZ, are in a local level coordinate frame when the vehicle is level. GPS antenna offset distances are measured from the DRU-H-R case reference frame origin.

1) ΔX, the offset along the vehicle longitudinal axis, is positive if the antenna is forward of the DRU-H-R in the direction of travel and is negative if behind.

2) ΔY, the offset along the vehicle cross axis, is positive if the antenna is to the right of the DRU-H-R, looking in the direction of forward travel, and is negative if to the left.

3) ΔZ, the offset along the vehicle vertical axis, is positive if the antenna is above the DRU-H-R and is negative if below.

c. The DRU-H-R may use the same GPS offset distances in Orientations 1 and 2. Only one set is specified in the ACCEPT CONFIGURATION DATA commands and CONFIGURATION DATA messages.

C.3.4.5.4 Odometer action offset distances. The DRU-H-R may use the offset distances from the DRU-H-R to the odometer action point, ΔX, ΔY, and ΔZ. These offsets are in the vehicle coordinate frame with the DRU-H-R operating in Orientation 1 (pointing device in travel lock or ready for travel) and are measured from the DRU-H-R case reference frame origin.

a. ΔX, the offset along the vehicle longitudinal axis, is positive if the action point is forward of the DRU-H-R in the direction of travel and is negative if behind.

b. ΔY, the offset along the vehicle cross axis, is positive if the action point is to the right of the DRU-H-R, looking in the direction of forward travel, and is negative if to the left.

c. ΔZ, the offset along the vehicle vertical axis, is positive if the action point is above the DRU-H-R and is negative if below.

C.3.4.6 Time intervals.

C.3.4.6.1 Exclusive ZUPT mode ZUPT interval. The DRU-H-R may request ZUPTs at no more frequent intervals than the Exclusive ZUPT Mode ZUPT Interval when usable GPS and VMS aiding data are not available.

C.3.4.6.2 Odometer mode ZUPT interval. The DRU-H-R may request ZUPTs at no more frequent intervals than the Odometer Mode ZUPT Interval when usable GPS aiding data are not available and usable VMS data are available.

C.3.4.6.3 Static align time. The DRU-H-R shall complete Static Align within the Static Align time.

C.3.4.6.4 Shot detect interval.

a. When the Shot Detect flag (CFIG D28/5) is set, the DRU-H-R shall set STATUS DATA S2/3 (Shot Detect) for the Shot Detect Interval when a shot is detected.

b. When the Shot Detect flag (CFIG D28/5) is reset:

1) STATUS DATA S2/3 (Shot Detect) shall always be reset.

2) An ACCEPT CONFIGURATION DATA command shall not be rejected for an out-of-range Shot Detect Interval.

C.3.4.6.5 GPS update time-out interval. The DRU-H-R shall reset STATUS DATA S5/7 (GPS Damping In Process) if the time since the last usable GPS update exceeds the GPS Update Time-out Interval.

C.3.4.7 Odometer scale factor. The DRU-H-R may use the nominal odometer scale factor which is [(nominal number of VMS pulses/mile)/(32000 pulses/mile)] or [(nominal number of speedometer sensor pulses/kilometer)/(28,000 pulses/kilometer)].

C.3.4.8 Fuel consumption factor. The DRU-H-R may use the Fuel Consumption Factor which is the change in vehicle pitch per unit distance traveled due to consumption of fuel.

C.3.4.9 GPS EPE criteria.

C.3.4.9.1 GPS EPE good value. When the GPS EPE (estimated position error) associated with a GPS position update is less than or equal to the GPS EPE Good Value, the DRU-H-R may accept the update.

C.3.4.9.2 GPS EPE poor value.

a. When the GPS EPE associated with a GPS position update is less than or equal to the GPS EPE Poor Value but greater than the GPS EPE Good Value, the DRU-H-R may accept the update only if STATUS DATA S6/6 (Degraded GPS Enabled) is set.

b. When the GPS EPE associated with a GPS position update is greater than the GPS Poor Value, the DRU-H-R shall reject the update.

c. The DRU-H-R may require the GPS EPE Poor Value to be greater than the GPS EPE Good Value.

C.3.5 Initial configuration data.

Initial values for permanently stored configuration data shall be as listed in Table C-IV.

TABLE C-IV. Initial configuration data.

CODE HOST CONFIG. DISCRETE	UNITS	1234	1234	1234	1234
0 - Paladin		0000			
1 - unassigned			0001		
2 - AN/TPQ-36 (V)				0010	
3 - AN/TPQ-36 (FMS)					0011
DRU-H-R COORDINATE FRAME CODE:					
Orientation 1:	hex	00	00	03	03
Orientation 2:	hex	00	00	03	03
BORESIGHT ANGLES:					
Vehicle Orientation α:	mils	0.0	0.0	0.0	0.0
Vehicle Orientation β:	mils	0.0	0.0	0.0	0.0
Vehicle Orientation γ:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 A:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 B:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 Γ:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 A:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 B:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 Γ:	mils	0.0	0.0	0.0	0.0
ZRP OFFSET DISTANCES:					
Orientation 1 Vehicle ΔX:	meters	0.00	0.00	1.00	1.00
Orientation 1 Vehicle ΔY:	meters	0.00	0.00	0.45	0.45
Orientation 1 Vehicle ΔZ:	meters	0.00	0.00	-0.86	-0.86
Orientation 2 PD ΔX:	meters	0.00	0.00	0.00	0.00
Orientation 2 PD ΔY:	meters	0.00	0.00	0.00	0.00
Orientation 2 PD ΔZ:	meters	0.00	0.00	0.00	0.00
Odometer Action Point 1 ΔX:	meters	0.80	0.00	0.40	0.40
Odometer Action Point 1 ΔY:	meters	-1.59	0.00	-0.42	-0.42
Odometer Action Point 1 ΔZ:	meters	-1.92	0.00	-0.56	-0.56
GPS Antenna ΔX:	meters	-3.02	0.00	-0.02	-0.02
GPS Antenna ΔY:	meters	-2.19	0.00	-0.19	-0.19
GPS Antenna ΔZ:	meters	1.50	0.00	1.05	1.05
TIME INTERVALS:					
ZUPT (Exclusive ZUPT Mode):	minutes	4.00	4.00	4.00	4.00
ZUPT (Odometer Mode):	minutes	60	60	60	60
Static Align Time:	minutes	15.00	15.00	15.00	15.00
Shot Detect Interval:	seconds	4	0	0	0
GPS Update Time-out Interval:	seconds	20	20	20	20
VMS SCALE FACTOR:					
VMS Scale Factor:	n/a	1.000	1.000	1.000	1.000
FUEL CONSUMPTION FACTOR:					
Consumption Factor:	μ-rad/km	-42.0	0.0	0.0	0.0
THRESHOLD ANGLES:					
1-2 Threshold Angle:	mils	0.0	0.0	0.0	0.0
2-1 Threshold Angle:	mils	0.0	0.0	0.0	0.0
GPS ACCEPTANCE CRITERIA:					
EPE 'Good' Criteria:	meters	16	16	16	16
EPE 'Poor' Criteria:	meters	76	76	76	76

TABLE C-IV. Initial configuration data. – Continued.

CODE HOST CONFIG. DISCRETE 0 - Paladin 1 - unassigned 2 - AN/TPQ-36 (V) 3 - AN/TPQ-36 (FMS)		1234 0000	1234 0001	1234 0010	1234 0011
CHAR/BIT *	**MODE OR CONDITION**	**0**	**1**	**2**	**3**
D26/7	Orient. 2 Based on Travel Lock	1	0	0	0
D26/6	Reserved	0	0	0	0
D26/5	Reserved	0	0	0	0
D26/4&3	Reserved	00	00	00	00
D26/2&1	Reserved	00	00	00	00
D26/0	Reserved	0	0	0	0
D27/7	GPS Installed.	1	0	1	1
D27/6	Spare	1	0	0	0
D27/5	SPS GPS	0	0	0	1
D27/4	Spare	1	0	0	0
D27/3	Integral/External Antenna.	0	0	0	0
D27/2	Geodetic/Grid GPS Data	0	0	0	0
D27/1	GPS Command at Shutdown	1	0	0	0
D27/0	OFF/STANDBY at Shutdown	0	0	0	0
D28/7	Supplier Reserved	0	0	0	0
D28/6	Supplier Reserved	0	0	0	0
D28/5	Supplier Reserved	0	0	0	0
D28/4	Pointing Device Roll/Cant	0	0	0	0
D28/3	Reset Relative Offsets	0	0	0	0
D28/2	Initial Relative Output	1	0	1	1
D28/1	Vehicle Roll/Cant	0	0	0	0
D28/0	Geodetic/Grid Azimuth	0	0	0	0
D29/7	PD Boresight Angles	1	0	1	1
D29/6	Vehicle Boresight Angles	1	0	0	0
D29/5	Shot Detect	1	0	0	0
D29/4	Travel Lock Commands	1	0	0	0
D29/3	Travel Lock Discretes	0	0	0	0
D29/2	Tracked/Wheeled Vehicle	1	0	0	0
D29/1	Odometer Sensor Type	0	0	0	0
D29/0	Odometer Installed	1	0	1	1

* Character references are for the ACCEPT CONFIGURATION DATA command. Corresponding character references for the CONFIGURATION DATA message are D25 - D28.

TABLE C-IV. Initial configuration data. –Continued.

CODE HOST CONFIG. DISCRETE	UNITS	1234	1234	1234	1234
4 - unassigned		0100			
5 - unassigned			0101		
6 - AN/TPQ-37				0110	
7 - AN/TPQ-37 (FMS)					0111
DRU-H-R COORDINATE FRAME CODE:					
Orientation 1:	hex	00	00	01	01
Orientation 2:	hex	00	00	0D	0D
BORESIGHT ANGLES:					
Vehicle Orientation α:	mils	0.0	0.0	0.0	0.0
Vehicle Orientation β:	mils	0.0	0.0	0.0	0.0
Vehicle Orientation γ:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 A:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 B:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 Γ:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 A:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 B:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 Γ:	mils	0.0	0.0	0.0	0.0
ZRP OFFSET DISTANCES:					
Orientation 1 Vehicle ΔX:	meters	0.00	0.00	1.58	1.58
Orientation 1 Vehicle ΔY:	meters	0.00	0.00	-0.80	-0.80
Orientation 1 Vehicle ΔZ:	meters	0.00	0.00	-2.68	-2.68
Orientation 2 PD ΔX:	meters	0.00	0.00	-0.30	-0.30
Orientation 2 PD ΔY:	meters	0.00	0.00	-0.80	-0.80
Orientation 2 PD ΔZ:	meters	0.00	0.00	-4.80	-4.80
Odometer Action Point 1 ΔX:	meters	0.00	0.00	0.15	0.15
Odometer Action Point 1 ΔY:	meters	0.00	0.00	-0.80	-0.80
Odometer Action Point 1 ΔZ:	meters	0.00	0.00	-2.22	-2.22
GPS Antenna ΔX:	meters	0.00	0.00	0.49	0.49
GPS Antenna ΔY:	meters	0.00	0.00	0.44	0.44
GPS Antenna ΔZ:	meters	0.00	0.00	0.70	0.70
TIME INTERVALS:					
ZUPT (Exclusive ZUPT Mode):	minutes	4.00	4.00	10.00	10.00
ZUPT (Odometer Mode):	minutes	60	60	60	60
Static Align Time:	minutes	15.00	15.00	15.00	15.00
Shot Detect Interval:	seconds	0	0	8	8
GPS Update Time-out Interval:	seconds	20	20	20	20
VMS SCALE FACTOR:					
VMS Scale Factor:	n/a	1.000	1.000	1.000	1.000
FUEL CONSUMPTION FACTOR:					
Consumption Factor:	μ-rad/km	0.0	0.0	0.0	0.0
THRESHOLD ANGLES:					
1-2 Threshold Angle:	mils	0.0	0.0	0.0	0.0
2-1 Threshold Angle:	mils	0.0	0.0	0.0	0.0
GPS ACCEPTANCE CRITERIA:					
EPE 'Good' Criteria:	meters	16	16	16	16
EPE 'Poor' Criteria:	meters	76	76	76	76

TABLE C-IV. Initial configuration data. – Continued.

CODE HOST CONFIG. DISCRETE 4 - unassigned 5 - unassigned 6 - AN/TPQ-37 7 - AN/TPQ-37 (FMS)		**1234** 0100	**1234** 0101	**1234** 0110	**1234** 0111
CHAR/BIT *	**MODE OR CONDITION**	**4**	**5**	**6**	**7**
D26/7	Orient. 2 Based on Travel Lock	0	0	1	1
D26/6	Reserved	0	0	0	0
D26/5	Reserved	0	0	0	0
D26/4&3	Reserved	00	00	00	00
D26/2&1	Reserved	00	00	00	00
D26/0	Reserved	0	0	0	0
D27/7	GPS Installed.	0	0	1	1
D27/6	Spare	0	0	0	0
D27/5	SPS GPS	0	0	0	1
D27/4	Spare	0	0	0	0
D27/3	Integral/External Antenna.	0	0	0	0
D27/2	Geodetic/Grid GPS Data	0	0	0	0
D27/1	GPS Command at Shutdown	0	0	0	0
D27/0	OFF/STANDBY at Shutdown	0	0	0	0
D28/7	Supplier Reserved	0	0	0	0
D28/6	Supplier Reserved	0	0	0	0
D28/5	Supplier Reserved	0	0	0	0
D28/4	Pointing Device Roll/Cant	0	0	0	0
D28/3	Reset Relative Offsets	0	0	0	0
D28/2	Initial Relative Output	0	0	1	1
D28/1	Vehicle Roll/Cant	0	0	0	0
D28/0	Geodetic/Grid Azimuth	0	0	0	0
D29/7	PD Boresight Angles	0	0	1	1
D29/6	Vehicle Boresight Angles	0	0	0	0
D29/5	Shot Detect	0	0	0	0
D29/4	Travel Lock Commands	0	0	1	1
D29/3	Travel Lock Discretes	0	0	0	0
D29/2	Tracked/Wheeled Vehicle	0	0	0	0
D29/1	Odometer Sensor Type	0	0	0	0
D29/0	Odometer Installed	0	0	1	1

* Character references are for the ACCEPT CONFIGURATION DATA command. Corresponding character references for the CONFIGURATION DATA message are D25 - D28.

TABLE C-IV. Initial configuration data.- Continued

CODE HOST CONFIG. DISCRETE 8 - unassigned 9 - unassigned 10 - unassigned 11 - unassigned	UNITS	1234 1000 1001 1010 1011	1234	1234	1234
DRU-H-R COORDINATE FRAME CODE:					
Orientation 1:	hex	00	00	00	00
Orientation 2:	hex	00	00	00	00
BORESIGHT ANGLES:					
Vehicle Orientation α:	mils	0.0	0.0	0.0	0.0
Vehicle Orientation β:	mils	0.0	0.0	0.0	0.0
Vehicle Orientation γ:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 A:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 B:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 1 Γ:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 A:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 B:	mils	0.0	0.0	0.0	0.0
Pointing Device Orient. 2 Γ:	mils	0.0	0.0	0.0	0.0
ZRP OFFSET DISTANCES:					
Orientation 1 Vehicle ΔX:	meters	0.00	0.00	0.00	0.00
Orientation 1 Vehicle ΔY:	meters	0.00	0.00	0.00	0.00
Orientation 1 Vehicle ΔZ:	meters	0.00	0.00	0.00	0.00
Orientation 2 PD ΔX:	meters	0.00	0.00	0.00	0.00
Orientation 2 PD ΔY:	meters	0.00	0.00	0.00	0.00
Orientation 2 PD ΔZ:	meters	0.00	0.00	0.00	0.00
Odometer Action Point 1 ΔX:	meters	0.00	0.00	0.00	0.00
Odometer Action Point 1 ΔY:	meters	0.00	0.00	0.00	0.00
Odometer Action Point 1 ΔZ:	meters	0.00	0.00	0.00	0.00
GPS Antenna ΔX:	meters	0.00	0.00	0.00	0.00
GPS Antenna ΔY:	meters	0.00	0.00	0.00	0.00
GPS Antenna ΔZ:	meters	0.00	0.00	0.00	0.00
TIME INTERVALS:					
ZUPT (Exclusive ZUPT Mode):	minutes	4.00	4.00	4.00	4.00
ZUPT (Odometer Mode):	minutes	60	60	60	60
Static Align Time:	minutes	15.00	15.00	15.00	15.00
Shot Detect Interval:	seconds	0	0	0	0
GPS Update Time-out Interval:	seconds	20	20	20	20
VMS SCALE FACTOR:					
VMS Scale Factor:	n/a	1.000	1.000	1.000	1.000
FUEL CONSUMPTION FACTOR:					
Consumption Factor:	μ-rad/km	0.0	0.0	0.0	0.0
THRESHOLD ANGLES:					
1-2 Threshold Angle:	mils	0.0	0.0	0.0	0.0
2-1 Threshold Angle:	mils	0.0	0.0	0.0	0.0
GPS ACCEPTANCE CRITERIA:					
EPE 'Good' Criteria:	meters	16	16	16	16
EPE 'Poor' Criteria:	meters	76	76	76	76

TABLE C-IV. Initial configuration data. - Continued

CODE	HOST	CONFIG. DISCRETE	1234	1234	1234	1234
8	- unassigned		1000			
9	- unassigned			1001		
10	- unassigned				1010	
11	- unassigned					1011
CHAR/BIT *	**MODE OR CONDITION**		**8**	**9**	**10**	**11**
D26/7	Orient. 2 Based on Travel Lock		0	0	0	0
D26/6	Reserved		0	0	0	0
D26/5	Reserved		0	0	0	0
D26/4&3	Reserved		00	00	00	00
D26/2&1	Reserved		00	00	00	00
D26/0	Reserved		0	0	0	0
D27/7	GPS Installed.		0	0	0	0
D27/6	Spare		0	0	0	0
D27/5	SPS GPS		0	0	0	0
D27/4	Spare		0	0	0	0
D27/3	Integral/External Antenna.		0	0	0	0
D27/2	Geodetic/Grid GPS Data		0	0	0	0
D27/1	GPS Command at Shutdown		0	0	0	0
D27/0	OFF/STANDBY at Shutdown		0	0	0	0
D28/7	Supplier Reserved		0	0	0	0
D28/6	Supplier Reserved		0	0	0	0
D28/5	Supplier Reserved		0	0	0	0
D28/4	Pointing Device Roll/Cant		0	0	0	0
D28/3	Reset Relative Offsets		0	0	0	0
D28/2	Initial Relative Output		0	0	0	0
D28/1	Vehicle Roll/Cant		0	0	0	0
D28/0	Geodetic/Grid Azimuth		0	0	0	0
D29/7	PD Boresight Angles		0	0	0	0
D29/6	Vehicle Boresight Angles		0	0	0	0
D29/5	Shot Detect		0	0	0	0
D29/4	Travel Lock Commands		0	0	0	0
D29/3	Travel Lock Discretes		0	0	0	0
D29/2	Tracked/Wheeled Vehicle		0	0	0	0
D29/1	Odometer Sensor Type		0	0	0	0
D29/0	Odometer Installed		0	0	0	0

* Character references are for the ACCEPT CONFIGURATION DATA command. Corresponding character references for the CONFIGURATION DATA message are D25 - D28.

TABLE C-IV. Initial configuration data – Continued.

CODE	HOST	CONFIG. DISCRETE	1234	1234	1234	1234
12	- AN/TPQ-37 (V)		1100			
13	- unassigned			1101		
14	- unassigned				1110	
15	- ACCEPT CONFIG. DATA cmd.	UNITS				1111
DRU-H-R COORDINATE FRAME CODE:						
Orientation 1:		hex	00	00	00	n/a
Orientation 2:		hex	00	00	00	n/a
BORESIGHT ANGLES:						
Vehicle Orientation α:		mils	0.0	0.0	0.0	n/a
Vehicle Orientation β:		mils	0.0	0.0	0.0	n/a
Vehicle Orientation γ:		mils	0.0	0.0	0.0	n/a
Pointing Device Orient. 1 A:		mils	0.0	0.0	0.0	n/a
Pointing Device Orient. 1 B:		mils	0.0	0.0	0.0	n/a
Pointing Device Orient. 1 Γ:		mils	0.0	0.0	0.0	n/a
Pointing Device Orient. 2 A:		mils	0.0	0.0	0.0	n/a
Pointing Device Orient. 2 B:		mils	0.0	0.0	0.0	n/a
Pointing Device Orient. 2 Γ:		mils	0.0	0.0	0.0	n/a
ZRP OFFSET DISTANCES:						
Orientation 1 Vehicle ΔX:		meters	0.00	0.00	0.00	n/a
Orientation 1 Vehicle ΔY:		meters	0.00	0.00	0.00	n/a
Orientation 1 Vehicle ΔZ:		meters	0.00	0.00	0.00	n/a
Orientation 2 PD ΔX:		meters	0.00	0.00	0.00	n/a
Orientation 2 PD ΔY:		meters	0.00	0.00	0.00	n/a
Orientation 2 PD ΔZ:		meters	0.00	0.00	0.00	n/a
Odometer Action Point 1 ΔX:		meters	0.00	0.00	0.00	n/a
Odometer Action Point 1 ΔY:		meters	0.00	0.00	0.00	n/a
Odometer Action Point 1 ΔZ:		meters	0.00	0.00	0.00	n/a
GPS Antenna ΔX:		meters	0.00	0.00	-0.02	n/a
GPS Antenna ΔY:		meters	0.00	0.00	-0.19	n/a
GPS Antenna ΔZ:		meters	0.00	0.00	1.05	n/a
TIME INTERVALS:						
ZUPT (Exclusive ZUPT Mode):		minutes	4.00	4.00	4.00	n/a
ZUPT (Odometer Mode):		minutes	60	60	60	n/a
Static Align Time:		minutes	15.00	15.00	15.00	n/a
Shot Detect Interval:		seconds	0	0	0	n/a
GPS Update Time-out Interval:		seconds	20	20	20	n/a
VMS SCALE FACTOR:						
VMS Scale Factor:		n/a	1.000	1.000	1.000	n/a
FUEL CONSUMPTION FACTOR:						
Consumption Factor:		μ-rad/km	0.0	0.0	0.0	n/a
THRESHOLD ANGLES:						
1-2 Threshold Angle:		mils	0.0	0.0	0.0	n/a
2-1 Threshold Angle:		mils	0.0	0.0	0.0	n/a
GPS ACCEPTANCE CRITERIA:						
EPE 'Good' Criteria:		meters	16	16	16	n/a
EPE 'Poor' Criteria:		meters	76	76	76	n/a

TABLE C-IV. Initial configuration data. - Continued

CODE	HOST CONFIG. DISCRETE	1234	1234	1234	1234
12	- AN/TPQ-37 (V)	1100			
13	- unassigned		1101		
14	- unassigned			1110	
15	- use ACCEPT CONFIG. DATA cmd.				1111
CHAR/BIT *	**MODE OR CONDITION**	**12**	**13**	**14**	**15**
D26/7	Orient. 2 Based on Travel Lock	0	0	0	n/a
D26/6	Reserved	0	0	0	n/a
D26/5	Reserved	0	0	0	n/a
D26/4&3	Reserved	00	00	00	n/a
D26/2&1	Reserved	00	00	00	n/a
D26/0	Reserved	0	0	0	n/a
D27/7	GPS Installed.	0	0	0	n/a
D27/6	Spare	0	0	0	n/a
D27/5	SPS GPS	0	0	0	n/a
D27/4	Spare	0	0	0	n/a
D27/3	Integral/External Antenna.	0	0	0	n/a
D27/2	Geodetic/Grid GPS Data	0	0	0	n/a
D27/1	GPS Command at Shutdown	0	0	0	n/a
D27/0	OFF/STANDBY at Shutdown	0	0	0	n/a
D28/7	Supplier Reserved	0	0	0	n/a
D28/6	Supplier Reserved	0	0	0	n/a
D28/5	Supplier Reserved	0	0	0	n/a
D28/4	Pointing Device Roll/Cant	0	0	0	n/a
D28/3	Reset Relative Offsets	0	0	0	n/a
D28/2	Initial Relative Output	0	0	0	n/a
D28/1	Vehicle Roll/Cant	0	0	0	n/a
D28/0	Geodetic/Grid Azimuth	0	0	0	n/a
D29/7	PD Boresight Angles	0	0	0	n/a
D29/6	Vehicle Boresight Angles	0	0	0	n/a
D29/5	Shot Detect	0	0	0	n/a
D29/4	Travel Lock Commands	0	0	0	n/a
D29/3	Travel Lock Discretes	0	0	0	n/a
D29/2	Tracked/Wheeled Vehicle	0	0	0	n/a
D29/1	Odometer Sensor Type	0	0	0	n/a
D29/0	Odometer Installed	0	0	0	n/a

* Character references are for the ACCEPT CONFIGURATION DATA command. Corresponding character references for the CONFIGURATION DATA message are D25 - D28.

C.3.6 Ethernet configuration data output. Upon receipt of a RETURN ETHERNET CONFIGURATION DATA command, the DRU-H-R shall return the values of Ethernet configuration data presently being used via an ETHERNET CONFIGURATION DATA message.

C.3.7 Ethernet configuration data elements. The following subparagraphs describe the Ethernet configuration data elements.

C.3.7.1 Version. The IP protocol version identified in the IP header shall be in accordance with RFC-791.

C.3.7.2 Type of Service. Type of Service flags in the IP header shall be in accordance with RFC-791.

C.3.7.3 Identification. Identification in the IP header shall be in accordance with RFC-791.

C.3.7.4 Flags. Flags in the IP header shall be in accordance with RFC-791.

C.3.7.5 Time to Live. Time to Live in the IP header shall be in accordance with RFC-791.

C.3.7.6 Protocol. Protocol in the IP header shall be in accordance with RFC-791.

C.3.7.7 Source Address. Source (DRU-H-R) Address in the IP header shall be in accordance with RFC-791.

C.3.7.8 Destination Address. Destination Address in the IP header shall be in accordance with RFC-791.

C.3.7.9 Source Port. Source (DRU-H-R) Port in the IP header shall be in accordance with RFC-768.

C.3.7.10 Destination Port. Destination Port in the IP header shall be in accordance with RFC-768.

C.3.8 Initial Ethernet configuration data. Installed values for Ethernet configuration data shall be as listed in Table C-V.

TABLE C-V. Initial Ethernet configuration data.

DATA ELEMENT	VALUE
Version	4 (decimal)
Type of Service	0
Identification	N/A*
Flags	010 (binary)
Time to Live	64 (decimal seconds)
Protocol	17 (decimal)
Source (DRU-H-R) Address	192.168.1.105
Destination Address	192.168.1.006/24
Source Port Number	N/A*
Destination Port Number	50010

* Data element values are not applicable to User Datagram Protocol (UDP).

APPENDIX D

DRU-H-R/GUN DRIVE DATA INTERFACE

D.1 SCOPE

D.1.1 Scope. This appendix provides the requirements for a DRU-H-R/Gun Drive digital interface using a Gigabit Ethernet interface. This appendix is a mandatory part of this specification. The information herein is intended for compliance.

D.2 APPLICABLE DOCUMENTS

D.2.1 General. The documents listed in this section are specified in section 3 of this appendix. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all requirements documents cited in section 3 of this appendix, whether or not they are listed.

D.2.2 Non-Government publications. The following other Government documents, drawings, and publications of the exact revision level shown form a part of this document to the extent specified herein.

INSTITUTE OF ELECTRONIC AND ELECTRICAL ENGINEERS (IEEE)

IEEE 802.3 - 2008	Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) access method and physical layer specifications
IEEE 754 - 2008	Standard for Floating-Point Arithmetic

(These documents are available on-line at http://standards.ieee.org/.)

INTERNET ENGINEERING STEERING GROUP

RFC 768	User Datagram Protocol
RFC 791	Internet Protocol, DARPA Internet Program, Protocol Specification

(These documents are available on-line at http://www.ietf.org .)

D.3 REQUIREMENTS

D.3.1 Gun drive data interface characteristics. The DRU-H-R shall have a full-duplex, bi-directional, Gigabit Ethernet interface meeting the 1000BASE-T requirements of IEEE 802.3-2008.

D.3.1.1 Data interface protocol. Data shall be communicated as a User Datagram Protocol (UPD) datagram, in accordance with RFC 768, using the Internet Protocol (IP), in accordance with RFC 791.

D.3.1.1.1 IP header. The IP header shall be in accordance with RFC 791.

Version, Type of Service, Identification, Flags, Time to Live, Protocol, Source Address, and Destination Address shall be as specified in Configuration Data.

D.3.1.1.2 UDP header. The UDP header shall be in accordance with RFC 768.

Source Port and Destination Port shall be as specified in Configuration Data.

D.3.1.1.3 Data. Data in a message shall be sent as a single UDP datagram in network byte order (big endian) format.

D.3.1.1.4 Command and message data description.

a. The requirements for data in Gun Drive interface messages are set forth in tables. Each row specifies the requirements for a data field.
b. A data field shall occupy the byte(s) specified in the BYTE(s) column.
c. Unless otherwise specified, the field shall completely fill the byte(s) specified in the BYTE(s) column. When the field does not completely fill the bytes specified in the BYTE(s) column, the field length is specified in the BITs column.
d. The data format for the field is specified in the TYPE column and applies to the entire field, regardless of length. Available data types are listed in TABLE D - 1.

TABLE D - 1 Data Types.

TYPE	DESCRIPTION
ub	Unsigned Binary - The entire field is positive.
fp32	IEEE 754 single precision (32-bit) floating point

e. The allowable range of values for a field is specified in the RANGE column. When a single value is given, it is the only permissible value.
f. The resolution of the least significant bit of binary fields is specified in the RES. column.
g. The units applicable to both the range and resolution are specified in the UNITS column.
h. The data to be input or output in the field is identified in the DATA ELEMENT column. Data elements are defined either within the table or elsewhere in this specification.

D.3.1.2 Messages.

D.3.1.2.1 GUN POSITION DATA message.

Function: When requested by a valid CONNECT GUN POSITION DATA MESSAGE command, the DRU-H-R shall output this message continuously, at the rate specified in the command, on the Gun Drive interface. The Gun Drive will not return a message when a GUN POSITION DATA message is received.

BYTES(s)	BIT(s)	TYPE	RANGE	RES.	UNITS	DESCRIPTION
D1, D2		ub	0 to 255	1	N/A	Sequence number (Note 1)
D3, D4		ub	0, 1	1	N/A	Gun Position Data Validity: 0 = Invalid 1 = Valid (Note 2)
D5 - D8		ub	0 to 2^{32}-1	1	msec	Time Stamp (Note 3)
D9 – D12		fp32	0 to 6,399.9	N/A	mil	Pointing Device Geodetic Azimuth or Grid Azimuth
D13 - D16		fp32	-1600.0 to +1600.0	N/A	mil	Pointing Device Pitch
D17 - D20		fp32	-3199.9 to +3200.0	N/A	mil	Pointing Device Roll or Cant

NOTES:

1. The sequence number shall increment for each message sent except the sequence number following 255 shall be 0.

2. Gun Position Data shall be Invalid if: BIT DATA D1/7 (DRU-H-R Fail) = 1; or STATUS DATA S3/7 (Orientation Transition in Process) = 1; or STATUS DATA S3/1 (Orientation Attitude Data Valid) = 0.

3. Relative time of the data sample since power-on. Relative time shall roll over from 2^{32} -1 msec to 0 msec.

APPENDIX E

SHOCK AND VIBRATION TEST PROFILES

E.1 SCOPE

E.1.1 Scope. This appendix provides vibration and gun fire shock profiles for use in vibration and reliability testing of the DRU-H-R. This appendix is a mandatory part of this specification. The information herein is intended for compliance.

E.2 APPLICABLE DOCUMENTS

(This section is not applicable to this appendix.)

E.3 REQUIREMENTS

E.3.1 Vibration test profiles.

a. Vibration test swept narrowband random-on-random vibration profiles are listed in Table E-I for the vertical, transverse and longitudinal axes.

b. The frequency and power spectral density (PSD) for each breakpoint are tabulated in the BP1, BP2, and Ampl. columns, respectively.

c. The PSD bandwidth between breakpoints shall be as shown in Table E-I.

d. No vibration excitation is required below 5 Hz or above 500 Hz. There are five profiles per axis.

e. The DRU-H-R shall be subjected to 54 minutes of vibration for each vibration profile.

f. The narrowband excitation shall be swept the number of times indicated in the No. Sweeps column for each 54 minute vibration period.

g. The total vibration time for each axis shall be 270 minutes.

h. The total vibration time for the three axes shall be 810 minutes.

E.3.1.1. Swept narrowband random-on-random explanation.

a. The vibration profiles contain swept narrowband random with the bandwidth always equal to ½ of the defined narrowband (see Figure E-1). The center frequency of the sweeping band is swept up or down ½ of the defined narrowband such that when the sweeping band center frequency is at its lowest frequency the lower frequency band edge (BP1) of the sweeping band and the lower band edge of the narrowband coincide. When the center frequency of the sweeping band is at its highest frequency, the upper band edge (BP2) of the sweeping band and the upper band edge of the narrowband coincide.

b. A sweep is defined as moving the sweeping band up in frequency. Two sweeps is a sweep up in frequency and a sweep down in frequency to the original position. Three sweeps will be an up, down, and an up frequency movement, etc.

c. When it is an option the sweep shall be linear rather than logarithmic. Linear sweep best simulates the original intent of simulating tracked vehicle speed changes.

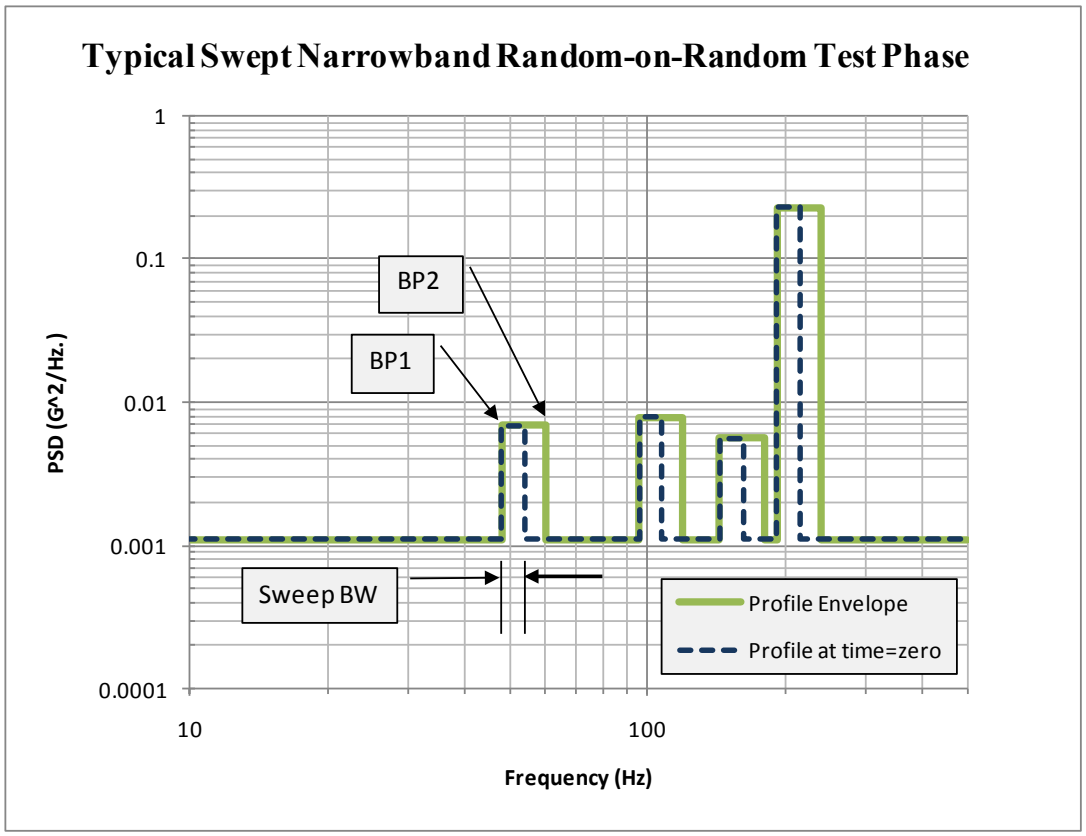


FIGURE E-1. Typical Swept Narrowband Random-on-Random Profile

E.3.2 Gun fire shock profiles.

a. Simulated gun fire shock profiles are shown in Figures E-2, E-3 and E-4 for the vertical, transverse and longitudinal axes, respectively.

b. The DRU-H-R shall be subjected to equal numbers of simulated gun shocks in each of the three axes.

E.3.2.1 Gun fire shock tolerances.

a. Acceleration levels of the test control signal shall be within +6/-3 dB of the specified values over the entire test frequency range. However deviations of -6 dB in the test control signal may be granted above 500 Hz.

b. The cumulative bandwidth for this deviation shall not exceed 5 percent of the test frequency range (see Figure E-5).

c. In no case shall the acceleration levels be less than 6 dB below the specified requirements.

d. No deviation shall be granted for frequencies below 500 Hz.

e. Tolerance levels in terms of dB are defined as:

$$dB = 20 \log (W_m/W_s)$$

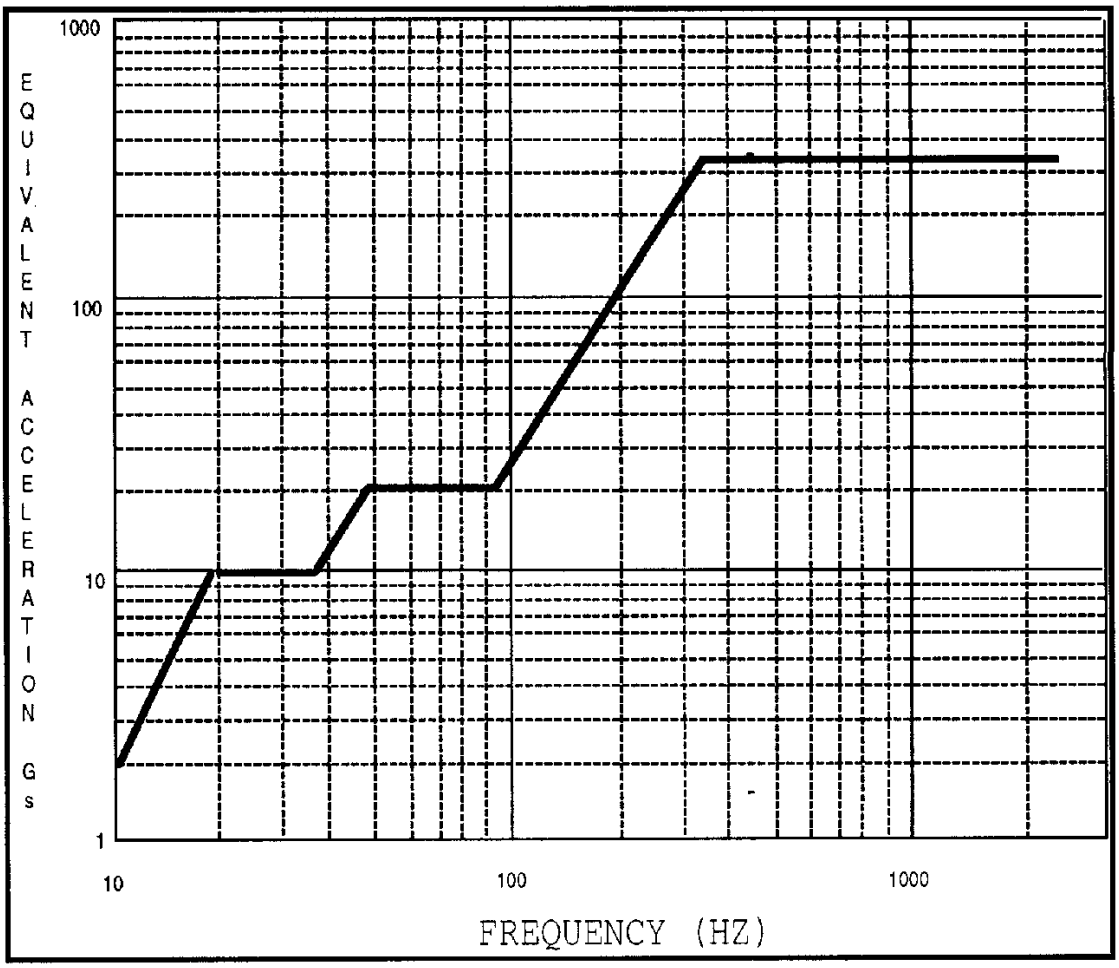
where:

W_m = measured acceleration level in g's.

W_s = specified level in g's.

TABLE E-I. Vibration test profiles

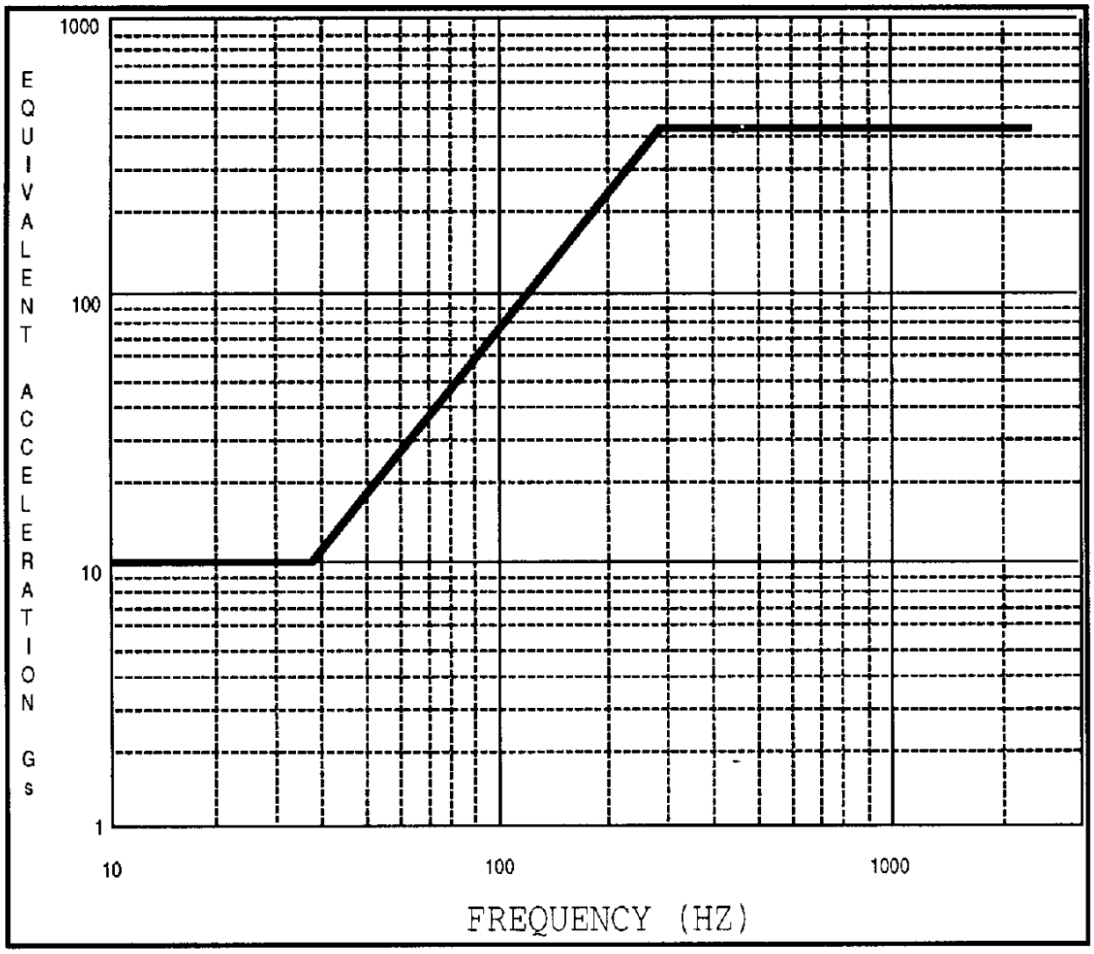
					Narrowband 1				Narrowband 2				Narrowband 3				Narrowband 4			
Test Phase	5-500 Hz Floor (g^2/Hz)	No. Sweeps	Overall RMS (g)	Time (min)	BP1 (Hz)	BP2 (Hz)	Ampl (g^2/Hz)	Sweep BW (Hz)	BP1 (Hz)	BP2 (Hz)	Ampl (g^2/Hz)	Sweep BW (Hz)	BP1 (Hz)	BP2 (Hz)	Ampl (g^2/Hz)	Sweep BW (Hz)	BP1 (Hz)	BP2 (Hz)	Ampl (g^2/Hz)	Sweep BW (Hz)
Vertical Axis																				
V1	0.0038	9	1.80	54	24	30	0.2179	3	48	60	0.1110	6	72	90	0.1112	9	-	-	-	-
V2	0.0038	9	1.70	54	36	42	0.2967	3	72	84	0.0071	6	108	126	0.0157	9	-	-	-	-
V3	0.0044	4	2.17	54	48	60	0.2279	6	96	120	0.0355	12	144	180	0.0490	18	-	-	-	-
V4	0.0047	3	2.97	54	66	84	0.4500	9	132	168	0.0565	18	198	252	0.0624	27	-	-	-	-
V5	0.0038	2	2.32	54	90	120	0.1079	15	180	240	0.0548	30	270	360	0.0129	45	-	-	-	-
Transverse Axis																				
T1	0.0009	7	1.24	54	24	30	0.0049	3	72	90	0.0020	9	96	120	0.0905	12	-	-	-	-
T2	0.0009	7	1.63	54	36	42	0.0083	3	72	86	0.0033	7	100	126	0.0013	13	144	168	0.1810	12
T3	0.0011	3	2.48	54	48	60	0.0069	6	96	120	0.0078	12	144	180	0.0056	18	192	240	0.2272	24
T4	0.0012	2	2.94	54	66	84	0.0176	9	132	168	0.0036	18	198	252	0.0033	27	264	336	0.2172	36
T5	0.0038	2	2.23	54	90	120	0.1079	15	180	240	0.0548	30	-	-	-	-	-	-	-	-
Longitudinal Axis																				
L1	0.0009	9	1.25	54	24	30	0.0467	3	48	60	0.0043	6	72	90	0.1086	9	-	-	-	-
L2	0.0009	10	0.74	54	36	42	0.0273	3	72	84	0.0054	6	-	-	-	-	-	-	-	-
L3	0.0011	3	3.09	54	48	60	0.0252	6	96	120	0.0033	12	144	180	0.1780	18	192	240	0.2353	24
L4	0.0014	2	4.13	54	66	84	0.0927	9	132	168	0.0027	18	198	252	0.1689	27	264	336	0.3077	36
L5	0.0011	2	3.22	54	90	120	0.0250	15	180	240	0.0027	30	270	360	0.2107	45	-	-	-	-



Spectrum Break Points

FREQUENCY (HZ)	ACCELERATION (Gs)
10.3	2
19.5	10
36.9	10
55.2	22
92.9	22
350.8	350
2359.7	350

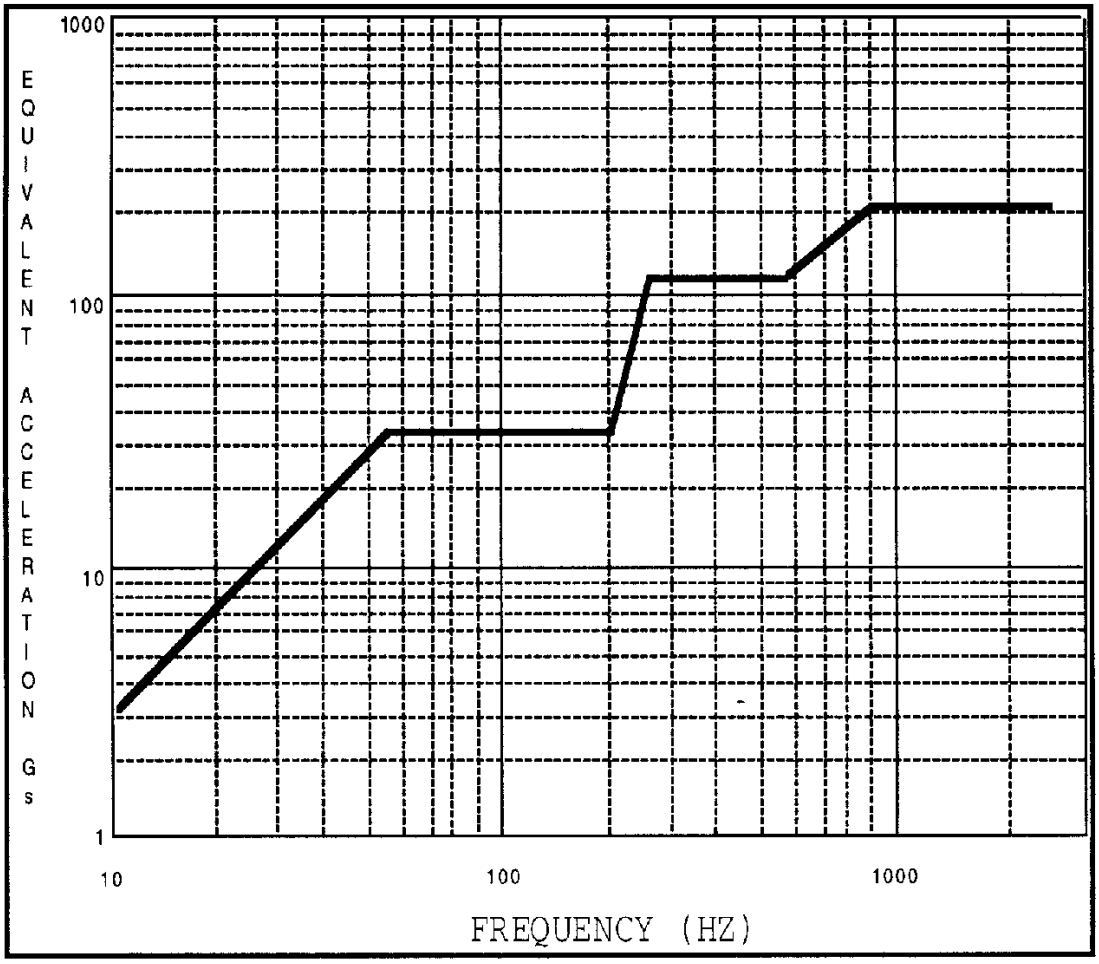
FIGURE E-2. Gun firing shock spectrum - vertical axis.



Spectrum Break Points

FREQUENCY (HZ)	ACCELERATION (Gs)
10.3	10
36.9	10
295.0	435
2359.7	435

FIGURE E-3. Gun firing shock spectrum - transverse axis.



Spectrum Break Points

FREQUENCY (HZ)	ACCELERATION (Gs)
10.3	3.3
55.2	35
196.9	35
262.8	120
556.8	120
883.9	220
2359.7	220

FIGURE E-4. Gun firing shock spectrum - longitudinal axis.

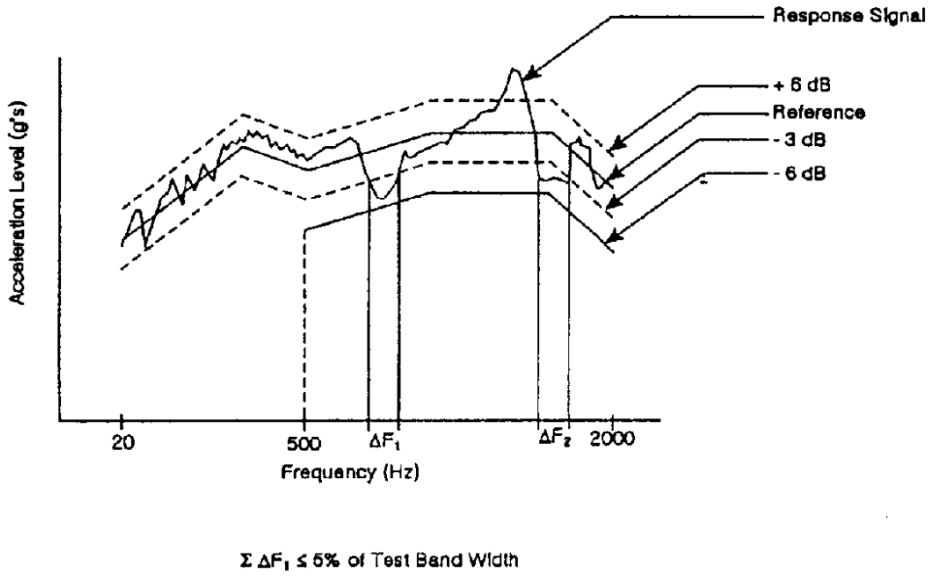


FIGURE E-5. Gun firing shock tolerances.

APPENDIX F

MECHANICAL INTERFACE AND ENVELOPE

F.1 SCOPE

F.1.1 Scope.

This appendix is a mandatory part of this specification. The information herein is intended for compliance.

F.2 APPLICABLE DOCUMENTS

F.2.1 General. The documents listed in this section are specified in section 3 of this appendix. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 of this appendix, whether or not they are listed.

F.2.2 Non-Government documents. The following documents of the exact revision listed below form part of this specification to the extent specified herein.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME Y 14.5-1994 Dimensioning and Tolerancing

(ASME publications may be obtained online at http://store.asme.org/default.asp.)

F.2.3 Order of Precedence. In the event of a conflict between the text of this appendix and the references cited herein, the text of this appendix shall take precedence. Nothing in this appendix, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

F3. REQUIREMENTS

F.3.1 Mechanical interface and envelope.

a. The DRU-H-R shall fit within the overall mechanical envelope of Figures F-1 through F-6.

b. The DRU-H-R shall mount to and maintain alignment with the DRU-H-R Mounting Plate shown in Figure F-7.

c. The DRU-H-R shall utilize existing mounting hardware (10910174-27 Washer, Flat, and NAS1351-5-16P Screw, Cap, Socket Head).

d. The DRU-H-R shall provide protection for the critical mounting surfaces when set on a nominally flat surface.

e. The DRU-H-R shall provide protection for the bottom when set on a nominally flat surface (i.e. the "feet".).

f. Connectors J1, J2, and J3, shall be located approximately as shown.

g. Alignment pin socket dimensions/tolerances shall be maintained through repeated installations and removals.

F.3.1.1 BIT indicators. BIT indicators, DS-1 and DS-2, shall be located on the surface shown and shall be clearly labeled.

F.3.1.2 Handles.

a. Handles shall be provided for lifting the DRU-H-R.

b. Handles shall be located approximately as shown, consistent with good balance for lifting, removal and replacement of the DRU-H-R.

c. When not extended for use, handles shall: be within the overall DRU-H-R envelope; not swing freely; and not interfere with access to DRU-H-R connectors, mating connectors and mounting bolts.

F.3.2 Weight. The DRU-H-R weight shall not exceed 50 pounds.

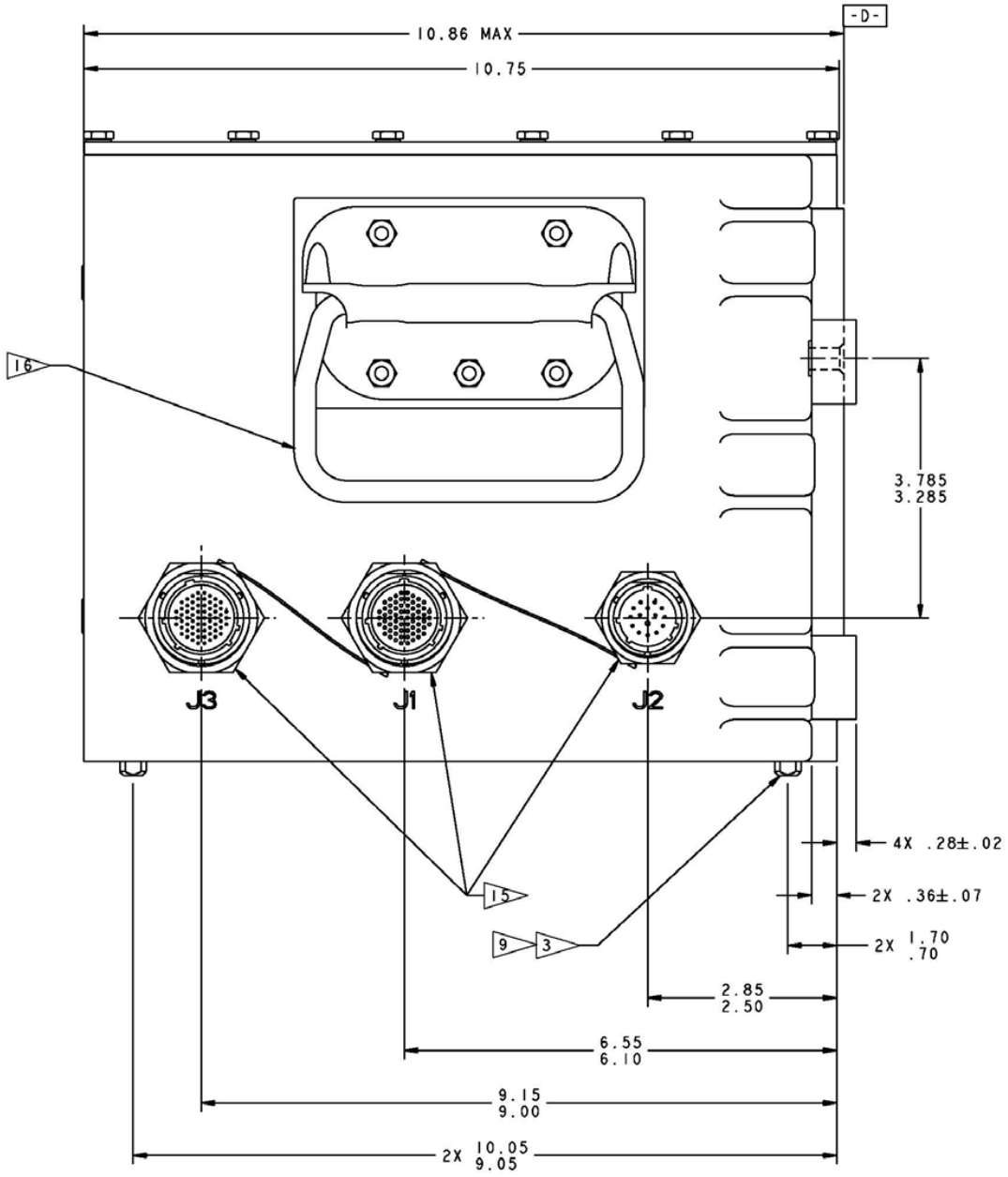


FIGURE F-1. DRU-H-R right side.

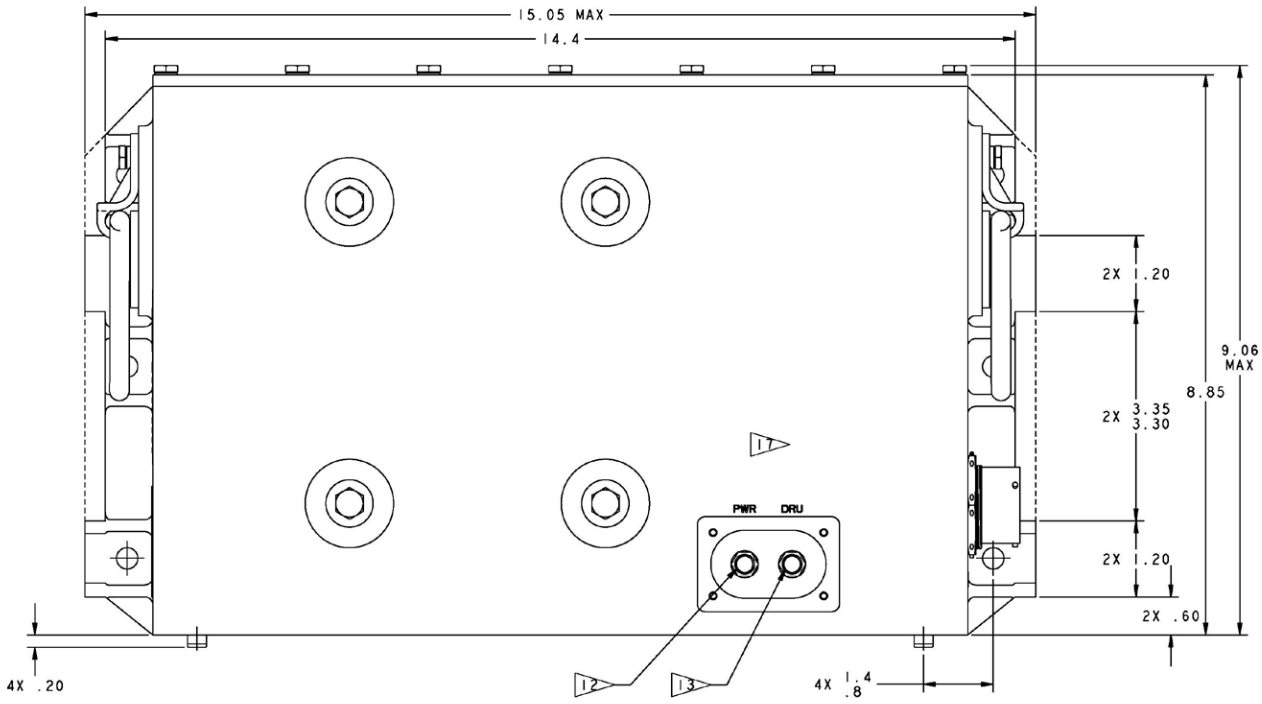


FIGURE F-2. DRU-H-R front.

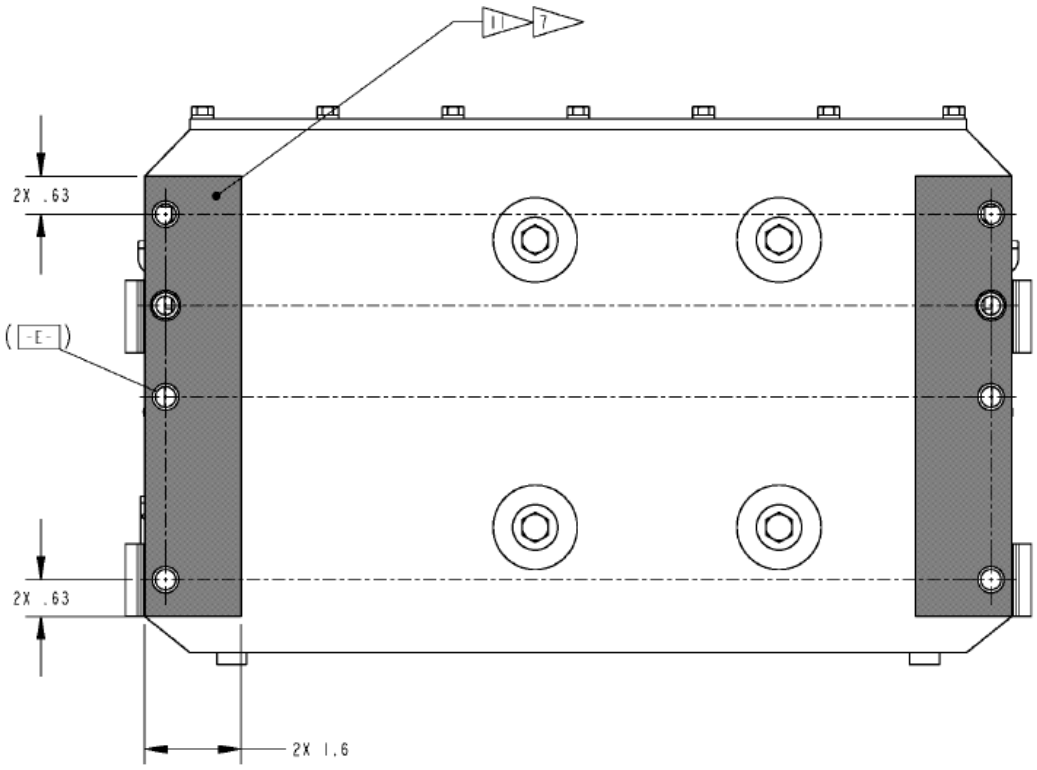


FIGURE F-3. DRU-H-R back/mounting surface.

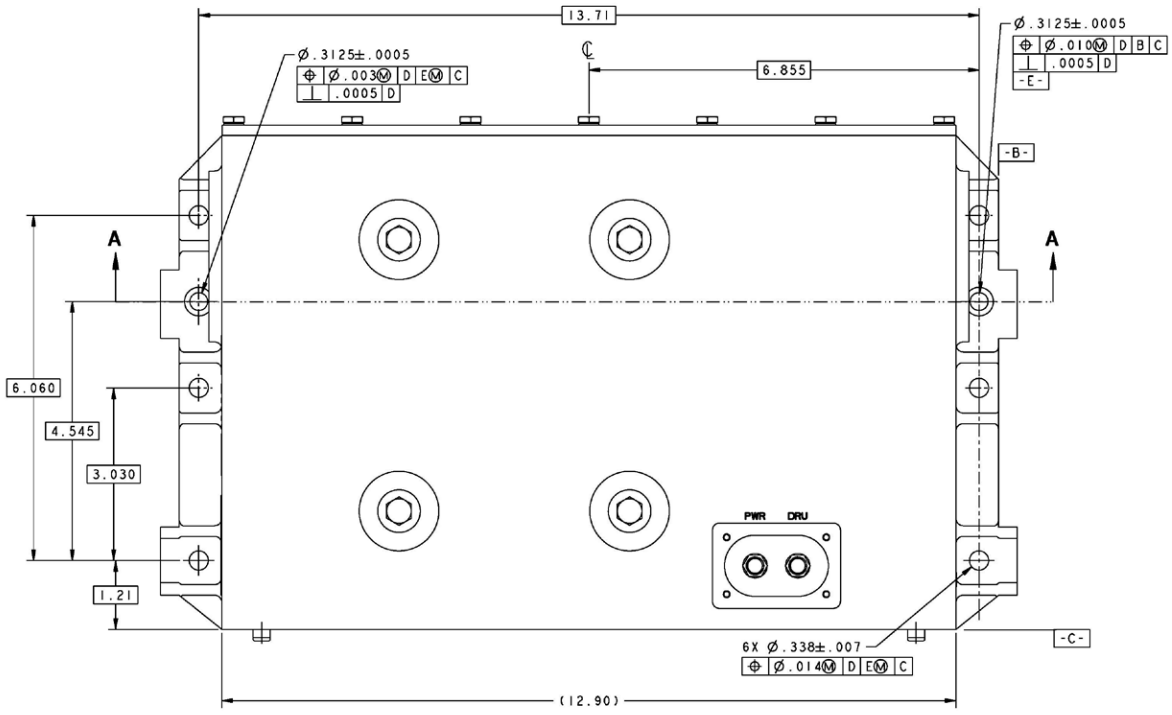


FIGURE F-4. DRU-H-R hole location.

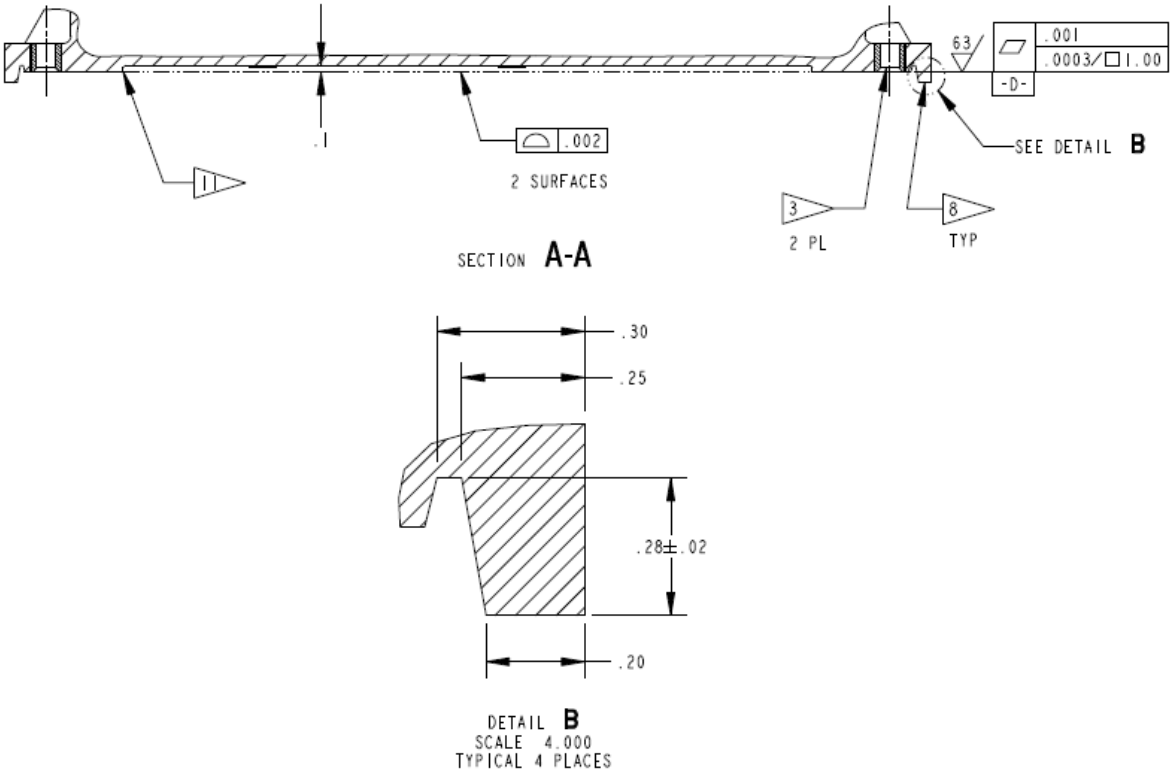


FIGURE F-5. Section A-A and Detail B

NOTES:

1.	Dimensioning and tolerancing per ASME Y 14.5M 1994.
2.	Material: coefficient of expansion compatible with AL alloy 6061-T651/QQ-A-250/11.
3.	Low wear, corrosion resistant material.
4.	Reserved
5.	Dimensions are in inches.
6.	Unless otherwise specified, tolerances on .X ±.1, .XX ±.01, .XXX ±.005.
7.	Shading indicates precision mounting surface.
8.	Protective ridges shall not interfere with mounting or visual access to verify proper mating of DRU-H-R and mount.
9.	Shape, location, and height of feet are optional.
10.	Reserved
11.	Mounting surfaces shall be free of paint for electrical bonding.
12.	BIT Indicator DS-1 shall be labeled “PWR”.
13.	BIT Indicator DS-2 shall be labeled “DRU”.
14.	Reserved
15.	Connectors J1, J2, and J3 shall be installed with key locations as shown and shall be labeled “J1”, “J2”, and “J3” respectively.
16.	See F.3.1.2 for handles.
17.	Cover for DS-1 and DS-2 on Type II DRU-H-R not shown.

FIGURE F-6. Drawing notes.

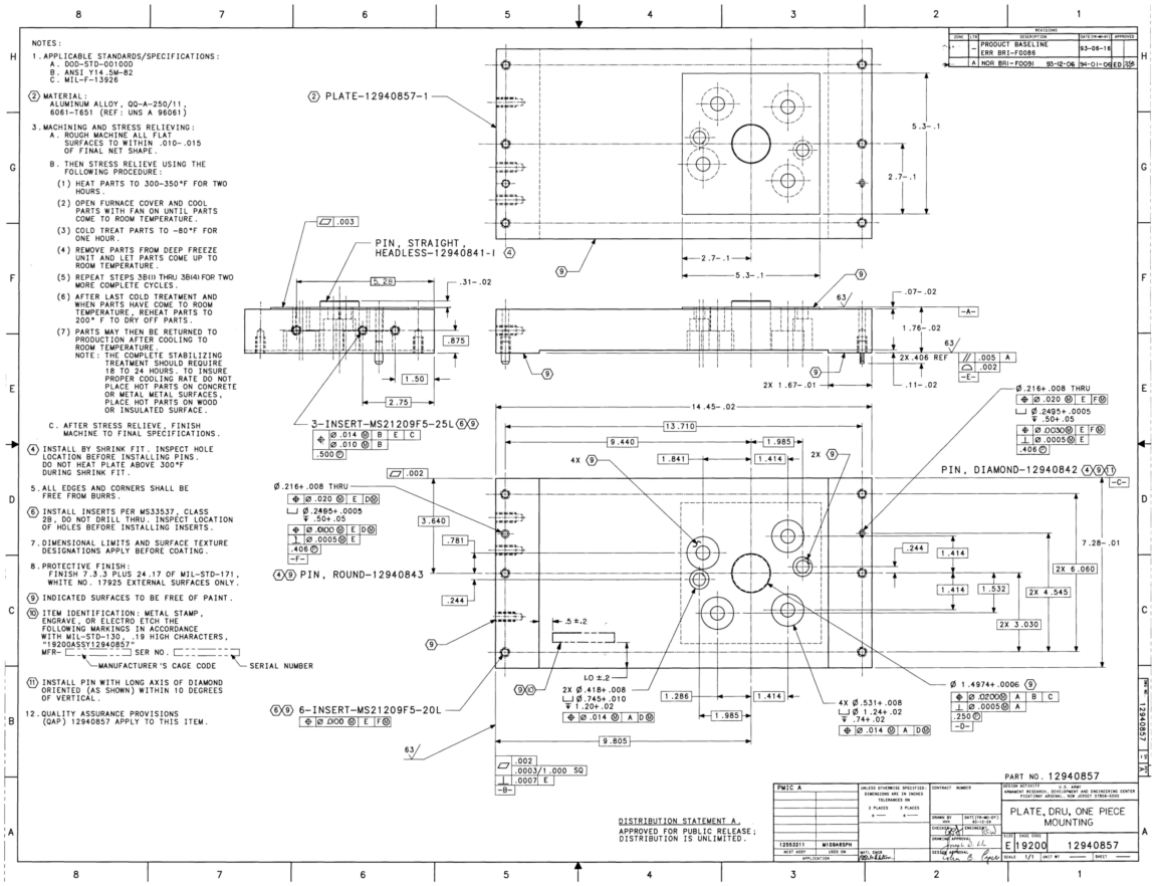


FIGURE F-7. DRU-H-R Mounting Plate

APPENDIX G

GRID COORDINATES, ALTITUDE AND DATUMS

G.1 SCOPE

G.1.1 Scope. This appendix provides the requirements for DRU-H-R use of grid coordinates, altitude and datums. This appendix is a mandatory part of this specification. The information herein is intended for compliance..

G.2 APPLICABLE DOCUMENTS

G.2.1 General. The documents listed in this section are specified in section 3 of this appendix. This section does not include documents in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements documents cited in section 3 of this appendix, whether or not they are listed.

G.2.2 Government documents.

G.2.2.1 Other Government documents, drawings, and publications. The following other Government documents, drawings, and publications form a part of this specification to the extent specified herein. Unless otherwise specified, the issues of these documents are those specified in the solicitation or contract.

NATIONAL GEOSPATIAL-INTELLIGENCE AGENCY (NGA) PUBLICATIONS

TR 8350.2	Department of Defense World Geodetic System 1984, Its Definition and Relationships with Local Geodetic Systems
TM 8358.1	Datums, Ellipsoids, Grids and Grid Reference Systems
TM 8358.2	The Universal Grids: Universal Transverse Mercator (UTM) and Universal Polar Stereographic (UPS)

(Copies of these documents may be obtained online from http://earth-info.nga.mil/GandG/publications/.)

G.3 REQUIREMENTS

G.3.1 Grid coordinates. The DRU-H-R shall reference grid coordinates and grid azimuths to the Universal Transverse Mercator (UTM) grid.

The grid type shall be reported in the Host (DRU-H-R) Grid field in messages that output position.

G.3.1.1 UTM grid.

a. Horizontal position, in the UTM grid, is given by the hemisphere, numerical grid zone, Easting and Northing. UTM grid coordinates can be referenced to several different spheroids (ellipsoids). The UTM grid is described in NIMA TM 8358.1. Formulae for computing UTM grid coordinates are given in NIMA TM 8358.2.

b. When the DRU-H-R crosses the equator or a UTM zone or extended zone boundary, the DRU-H-R shall automatically reference UTM coordinates and grid azimuth to the new hemisphere or zone and set ALERT DATA D6/3 (Boundary Crossed).

G.3.1.1.1 UTM grid north.

a. Grid north is offset from geodetic north by the grid convergence as described in NIMA TM 8358.2.

b. When operating in an extended UTM zone, grid convergence shall be calculated in terms of the present position in the extended zone, hemisphere, and reference spheroid.

G.3.1.1.2 UTM grid zone. The DRU-H-R UTM grid zone is the numerical designation for the zone in which the DRU-H-R is located. The numerical designation of the zone input at the start of a mission may represent the normal zone or the extended zone, depending on the coordinates available. When output is requested, the numerical designation of the zone in a message may represent the normal zone or the extended zone, depending on the coordinates associated with the zone.

G.3.1.1.2.1 Normal zone. When operating in the UTM grid and the Extended Zone Number in the last accepted ACCEPT POSITION command was ±61, or when the DRU-H-R is outside the boundaries of a designated extended zone, the DRU-H-R shall reference output UTM coordinates and grid azimuths to the normal zone.

G.3.1.1.2.2 Extended zone. When operating in the UTM grid and the Extended Zone Number in the last accepted ACCEPT POSITION command was in the range ±60, the DRU-H-R shall reference output UTM coordinates and grid azimuths to the designated extended zone when its position is within the extended zone boundaries.

The boundaries for extended UTM zones are:

$\lambda_E = \lambda_Z \pm 100{,}000/[R \times \mathrm{Cos}(\phi)]$

Where:

R = Ellipsoidal Radius of the Earth (meters)

λ_E = Geographic Longitude of Extended Zone Boundary (radians)

λ_Z = Geographic Longitude of the Normal Zone Boundary (radians)

ϕ = Geographic Latitude of the DRU-H-R (radians)

G.3.1.2 Altitude.

a. Altitude is the distance between the present DRU-H-R position and the reference geoid (an equipotential surface of the earth approximated by mean sea level) measured along the local gravity vector (normal to the geoid).

b. Altitude is positive when the DRU-H-R is above the geoid and negative when below.

c. The altitude reference shall be the WGS 84 geoid, which is described in NIMA TR 8350.2.

d. GPS altitudes shall be based on the complete 1/4° x 1/4° EGM96, or higher accuracy, geoid model.

G.3.2 Datum reference.

a. The DRU-H-R shall reference horizontal positions and azimuths to the datum specified by the host in an ACCEPT POSITION or ACCEPT GEODETIC DATA command.

b. The DRU-H-R shall retain the datum reference after a normal shutdown.

c. Until changed, the DRU-H-R shall use the last datum that was entered.

d. If the datum wasn't previously initialized or after an abnormal shutdown, the datum reference shall default to WGS 84.

G.3.2.1 Datum shifts.

a. Datum shifts, except between WGS 72 and WGS 84, shall be implemented by a method that provides results equivalent to the standard Molodensky datum transformation formulas specified in NIMA TR 8350.2.

b. Datum shifts between WGS 72 and WGS 84 shall be implemented by a method that provides results equivalent to the formulae specified in NIMA TR 8350.2.

G.3.2.2 Pre-programmed datums.

a. The DRU-H-R shall support at least 60 pre-programmed datums.

b. The data associated with pre-programmed datums shall not be alterable in normal DRU-H-R operation but shall be reprogrammable via the reprogramming interface(s).

c. The DRU-H-R shall utilize the pre-programmed datums listed for reference numbers 1 through 60 in Table G-I.

G.3.2.3 User defined datums.

a. Upon receipt of a valid ACCEPT USER DATUM command, the DRU-H-R shall store, as a user defined datum, and pass to the GPS receiver datum parameters for one of two user defined datums (USER1 or USER2).

b. The ACCEPT USER DATUM command shall be invalid if: any data element is outside the allowable range limits; the DATUM ID Code is the same as the ID Code for any of the pre-programmed datums; or the User Datum Validity character indicates "data not valid".

c. If an ACCEPT USER DATUM command is determined to be invalid, the DRU-H-R shall reject the command and set ALERT DATA D5/2 (Invalid Data Received).

d. DRU-H-R user defined datum parameters shall be retained after shutdown.

e. Entry of user defined datum data shall be independent of the current datum selection.

f. If a user defined datum is currently in use and the parameter values for that datum are updated, the new values shall not be used until that user defined datum has been reselected via an ACCEPT POSITION or ACCEPT GEODETIC DATA command.

G.3.2.4 DRU-H-R/GPS datum compatibility.

a. Upon initialization of the GPS receiver or update of the GPS USER datums, the DRU-H-R shall request and store the GPS USER1 and USER2 datum parameters.

b. When an ACCEPT POSITION or ACCEPT GEODETIC DATA command, which requires a datum change of the GPS datum, has been accepted, the DRU-H-R shall pass the new Datum ID to the GPS receiver.

c. The DRU-H-R shall determine if it and the GPS receiver are using the same Datum ID codes or, if USER1 or USER2 is being used, the same values for datum parameters.

d. If the DRU-H-R determines that the datums are not the same, ALERT DATA D1/6 (Datums Do Not Agree) shall be set.

G.3.3 Datum data elements.

G.3.3.1 Datum ID.

a. For input and output, a datum identifier (ID) consisting of six ASCII characters shall identify the datum.

b. The datum ID shall be left justified in the data field.

c. Should the ID have fewer than six characters, the field shall be right filled with ASCII spaces.

d. Valid IDs for pre-programmed datums shall be as listed in Table G-I for reference numbers 1 through 60.

e. IDs for DRU-H-R user defined datums shall be as entered by the host.

f. The allowable ASCII characters for datum IDs shall be A-Z, a-z, -, 0-9, and space.

G.3.3.2 Ellipsoid parameters.

a. Ellipsoid parameters are given by the differences between the WGS 84 and local ellipsoid semi-major axes (Δa) and flattening (Δf).

b. The differences are computed as WGS 84 minus the local ellipsoid.

c. Δf is scaled times 10^7.

d. Ellipsoid parameters for pre-programmed datums shall be as listed in Table G-I.

e. The Semi-major Axis (a) and Inverse Flattening (1/f) for the WGS 84 ellipsoid are 6378137 meters and 298.257223563, respectively.

G.3.3.3 Origin offsets.

a. Origin offsets are given by the differences between the WGS 84 and local datum ellipsoid centers in the WGS 84 coordinate frame in three axes (ΔX, ΔY, ΔZ).

b. The differences are computed as WGS 84 minus the local system.

c. Origin offsets for pre-programmed datums shall be as listed in Table G-I..

G.3.3.4 Datum descriptor.

a. The datum descriptor consists of 16 ASCII characters.

b. The datum descriptor shall be left justified in the data field.

c. Should the descriptor have fewer than 16 characters, the field shall be right filled with ASCII spaces.

d. Descriptors for pre-programmed datums shall be as listed in Table G-I for reference numbers 1 through 60.

e. Descriptors for DRU-H-R user defined datums shall be as entered by the host.

f. The allowable ASCII characters for datum descriptors shall be A-Z, a-z, -, 0-9, and space.

G.3.3.5 WGS 72. Table G-I does not contain all parameters needed to implement WGS 72. They are provided in NIMA-TR-8350.2.

G.3.4 Datum data output.

a. When requested by the host, the DRU-H-R shall output datum data for a designated datum reference number.

b. Data for reference numbers 1 through 60 shall be for the corresponding pre-programmed datums specified in Table G-I.

c. Data for reference number 0 shall be for the datum currently used by the DRU-H-R.

d. Data for reference numbers 61 and 62 shall be for DRU-H-R user defined datums 1 and 2, respectively.

e. If DRU-H-R user datum parameters weren't previously entered, the DRU-H-R shall output the default values listed in Table G-I.

f. Data for reference numbers 63 and 64 shall be for the GPS receiver user defined datums 1 and 2, respectively.

g. GPS user datum data shall not be retained after shutdown.

h. GPS user datum data shall be retrieved during receiver initialization and after update by the DRU-H-R.

i. If GPS user datum data isn't available, the DRU-H-R shall output the default values listed in Table G-I.

TABLE G-I Datums.

Ref No. *	ID	Reference Ellipsoid Parameters			Origin Offsets (meters)			16 Character Datum Descriptor
		Name	Δa(m)	Δfx10E7	ΔX	ΔY	ΔZ	
* 0	WGD	WGS 84	0	0	0	0	0	WGS-84
1	ARF-M	Clark 1880	-112.145	-547.507	-143	-90	-294	ARC 1950
2	ARS	Clark 1880	-112.145	-547.507	-160	-6	-302	ARC 1960
3	AUA	Australian National	-23	-0.812	-133	-48	148	Australia Geo 66
4	AUG	Australian National	-23	-0.812	-134	-48	149	Australia Geo 84
5	BOO	International	-251	-141.927	307	304	-318	Bogota Obsrvtory
6	CAI	International	-251	-141.927	-148	136	90	Campo Inchauspe
7	CAP	Clark 1880	-112.145	-547.507	-136	-108	-292	Cape
8	CGE	Clark 1880	-112.145	-547.507	-263	6	431	Carthage
9	CHI	International	-251	-141.927	175	-38	113	Chatam
10	CHU	International	-251	-141.927	-134	229	-29	Chua Astro
11	COA	International	-251	-141.927	-206	172	-6	Corrego Astro
12	EUR-A	International	-251	-141.927	-87	-96	-120	Euro50-West Euro
13	EUR-E	International	-251	-141.927	-104	-101	-140	Eiro50-Cyprus
14	EUR-F	International	-251	-141.927	-130	-117	-151	Euro50-Egypt
15	EUR-H	International	-251	-141.927	-117	-132	-164	Euro50-Iran
16	EUR-J	International	-251	-141.927	-97	-88	-135	Euro50-Sicily
17	EUS	International	-251	-141.927	-86	-98	-119	European 1979
18	FAH	Clark 1880	-112.145	-547.507	-346	-1	224	Ohman
19	GAA	International	-251	-141.927	-133	-321	50	Gan 1970
20	GEO	International	-251	-141.927	84	-22	209	Geodetic Dtm 49
21	HJO	International	-251	-141.927	-73	46	-86	Hjorsey 1955
22	INF-A	Everest	860.655	283.614	217	823	299	India 54 - Thai
23	IND-I	Everest	835.757	283.614	295	736	257	India-Ind/Nepal
24	IRL	Modified Airy	796.811	119.6	506	-122	611	Ireland 1965
25	KEA	Modified Everest	832.937	283.614	-11	851	5	Kertau 1948
26	LIB	Clark 1880	-112.145	-547.507	-90	40	88	Liberia 1964
27	LUZ-A	Clark 1866	-69.4	-372.646	-133	-77	-51	Luzon

TABLE G-I Datums.- Continued.

Ref No. *	ID	Reference Ellipsoid Parameters			Origin Offsets (meters)			16 Character Datum Descriptor
		Name	Δa(m)	Δfx10E7	ΔX	ΔY	ΔZ	
28	MAS	Bessel 1841	739.845	100.375	639	405	60	Massawa
29	MER	Clark 1880	-112.145	-547.507	31	146	47	Merchich
30	MIN-B	Clark 1880	-112.145	-547.507	-92	-93	122	Minna-Nigeria
31	NAH-C	Clark 1880	-112.145	-547.507	-243	-192	477	Nahrwan
32	NAR	GRS 80	0	0	0	0	0	North Amer 1983
33	NAS-C	Clark 1866	-69.4	-372.646	-8	160	176	No Amer-CONUS
34	NAS-D	Clark 1866	-69.4	-372.646	-5	135	172	No Amer-Alaska
35	NAS-E	Clark 1866	-69.4	-372.646	-10	158	187	No Amer-Canada
36	NAS-N	Clark 1866	-69.4	-372.646	0	125	194	No Amer-Cent Am
37	OEG	Helmert 1906	-63	4.808	-130	110	-13	Old Egyptian
38	OGB-M	Airy	573.604	119.6	375	-111	431	Ord Surv GrBR 36
39	OHA-M	Clark 1866	-69.4	-372.646	61	-285	-181	Old Hawaiian
40	PIT	International	251	-141.927	185	165	42	Pitcairn 1967
41	QAT	International	-251	-141.927	-128	-283	22	Qatar National
42	QUO	International	251	-141.927	164	138	-189	Qornog
43	SAN-M	South American 1969	-23	-0.812	-57	1	-41	South America 69
44	SCK	Bessel 1841	653.135	100.375	616	97	-251	Schwarzeck
45	TIL	Everest	838.444	283.614	-679	669	-48	Timbalai 1948
46	TOY-M	Bessel 1841	739.845	100.375	-148	507	685	Tokyo
47	WGD	WGS-84	0	0	0	0	0	WGS-84
48	WGS	WGS-72	2	0.312	0	0	4.5	WGS-72
49	ZAN	International	-251	-141.927	-265	120	-358	Zanderij
50-60		WGS-84	0	0	0	0	0	
* 61			0	0	0	0	0	DRUH User 1
* 62			0	0	0	0	0	DRUH User 2
** 63	USER1		0	0	0	0	0	GPS User 1
** 64	USER2		0	0	0	0	0	GPS User 2

* #0, #61 and #62 data are data stored at last shutdown. (Default values shown.) #0 data are updated by the host via ACCEPT POSITION or ACCEPT GEODETIC DATA commands. #61 and #62 data are updated by the host via ACCEPT USER DATUM command.

** #63 and #64 data are initialized from the GPS receiver via User Datums Message, #5088. (Default values shown.)

APPENDIX G

Preparing activity:

Army – AR

(Project 1220-2012-002)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.