INTERFACE CONTROL DOCUMENT

For

NASA AIRBORNE SCIENCE DATA AND TELEMETRY SYSTEM

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REVISION HISTORY

REVISION	AUTHOR	DATE	LIST OF CHANGES
0	C. Barnes	6 May 2012	Initial Document
1	C. Barnes	27 July 2012	Corrected Appendix A: J1 - GPS pins
2	C. Barnes	15 Nov 2012	Changed re-power procedure & corrected p/n's in Table 1: NASDAT Connectors

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1. INTRODUCTION

1.1. Purpose/Background

The deployment of multiple instruments across a variety of research aircraft platforms is greatly enriched by standardized core services. Consistent, vehicle independent data interfaces lower integration costs. Basic services such as Ethernet and SatCom allow each instrument to be connected to the larger sensor-web in near real-time. Real-time interactive communication and situational awareness allows projects to adapt to changing conditions and leverage each mission for maximum scientific interest.

The purpose of the NASDAT is to provide baseline data services anywhere, on any platform. It provides aircraft and navigational data to instruments using standardized protocols, while serving as an abstraction layer isolating the instruments from the aircraft bus. It also serves as an NTP timeserver, and provides baseline network services. Built-in Iridium modems allow low rate satellite communications, and sensor-web connectivity anywhere in the world. Via onboard Ethernet, the NASDAT provides bidirectional UDP packet forwarding for instrument command and control; experimenter displays or arbitrary data formats, and is capable of in-flight troubleshooting for science instruments. It also supports legacy data system output from NASA research aircraft and instruments.

Built on open standards and dynamically reconfigurable, the NASDAT enables any research platform to participate in the wider sensor web, allowing experimenters to remotely monitor and control their instruments, as well as permitting near real-time visualization of data. It is capable of on-the-fly creation and customization of data stream outputs, designed to make hardware and software additions as simple as possible.

1.2. Scope

This document describes the NASA Airborne Science Data and Telemetry System (NASDAT) and its interfaces and installation on research aircraft.

1.3. Definitions, Acronyms and Abbreviations

1.3.1. ASCII — American Standard Code for Information Interchange
1.3.2. bps — Bits Per Second
1.3.3. GPS — Global Positioning System
1.3.4. LAN — Local Area Network
1.3.5. LRU — Line Replaceable Unit
1.3.6. NASA — National Aeronautics and Space Administration
1.3.7. NASDAT — NASA Airborne Science Data And Telemetry System
1.3.8. Nav — Navigational
1.3.9. NTP — Network Time Protocol
1.3.10. SatCom — Satellite Communications
1.3.11. SSH — Secure Shell remote access
1.3.12. UDP — User Datagram Protocol
1.3.13. USB — Universal Serial Bus

2. <u>PARTS & CONFIGURATION</u>

The NASDAT ingests the aircraft data, and produces a wide variety of outputs, which are further explored in Sections 4 and 5: Electrical and Data Interfaces. Figure 1, below, is a functional block diagram of the system, which illustrates the essential performance and components of the NASDAT.

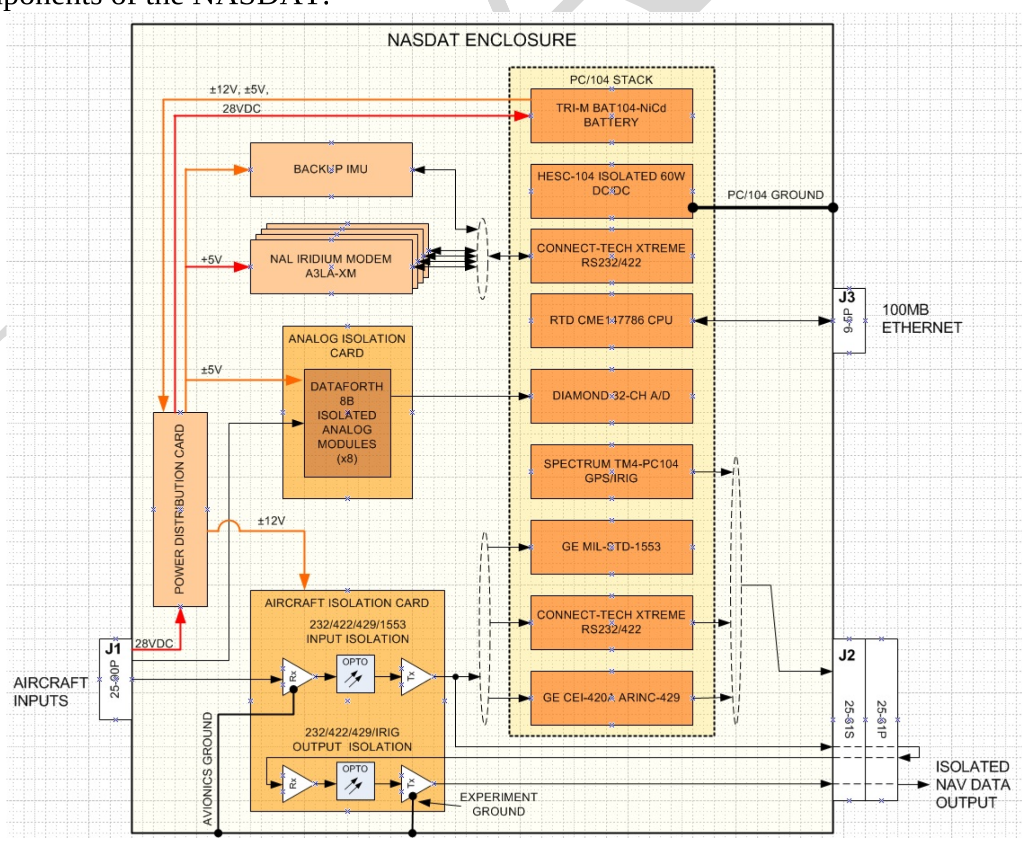

Figure 1: NASDAT Functional Block Diagram

The major components of the NASDAT are the PC-104 stack for data acquisition, processing, and output generation, a GPS splitter, the Aircraft Interface/Isolation Card, signals isolation card, power distribution and filter cards, and four Iridium modems.

The functions and components illustrated in Figure 1 are implemented in the NASDAT as shown in Figure 2. The fan, heater and power filters for the Iridium modems are located underneath the PC-104 stack tray, and are not visible in this figure.

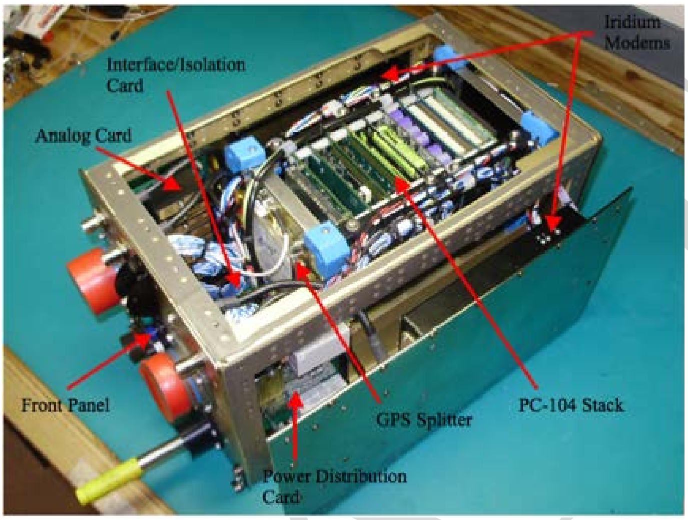

Figure 2: NASDAT Internal Components

The system also contains a number of internal sensors, listed below:

- Cabin Temp
- Cabin RH
- Cabin Pressure
- Input and rail power monitors
- Internal Temperature Monitors
- High-precision GPS clock
- Miniature GPS/IMU
- Omnistar-capable GPS

These sensors are useful for supplemental data on installations where the aircraft does not provide it, or to back-up the existing aircraft signals.

All of the electrical and data interfaces between the NASDAT and the aircraft are located on the front panel of the NASDAT. These interfaces are specified in detail in Sections 4 and 5: Electrical and Data Interfaces. The following figure, Figure 3, illustrates the layout of the front panel and connectors.

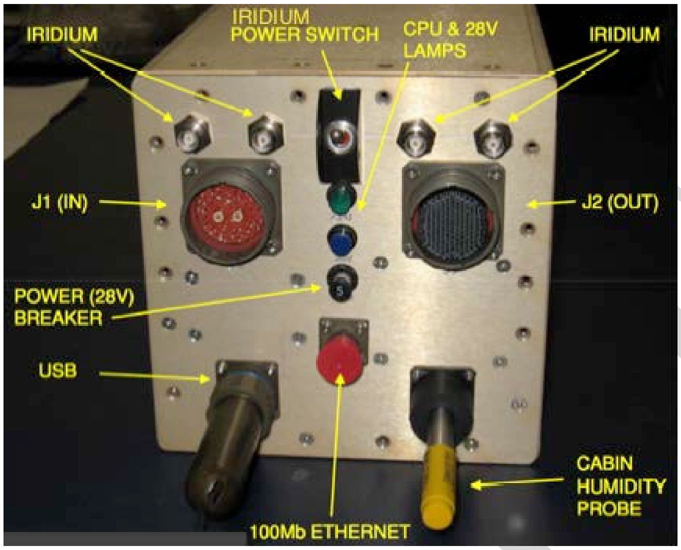

Figure 3: NASDAT Front Panel

The front panel contains the following:

- J1: Inputs
- J2: Outputs and aircraft-specific configuration
- J3: Ethernet
- J4: USB external memory
- J5 – J8: Iridium TNC Coax Connectors
- 28VDC total power indicator lamp
- 5VDC CPU power indicator lamp
- RH probe
- Klixon 5A Circuit breaker for Input power disable
- Switch (guarded) for Iridium power/disable
- J-hooks for ATR mounting

For more information on the connectors, see Section 4: Electrical Interface.

The Pressure Sensor and two pressure equalization vents are located on the back panel. Automatic thermal vents on the top and back panel open at an enclosure temperature of 40°C.

3. MECHANICAL INTERFACE

The NASDAT is mounted via a standard ¾ short-short ATR mounting tray (ARINC-404A). No vibration isolation is necessary. An image of the tray is shown below, in Figure 4.

Figure 4: 3/4 Short ATR Mounting Tray

The NASDAT mounts in the tray using rear alignment pins and standard thumbscrew hold-downs on the front. This mounting system should be used whenever possible, to facilitate removal and replacement of the NASDAT as a standard Airborne Science Program LRU. The overall footprint of the mounting tray is 14.90” x 7.63”, while the hold-downs extend 4” in front of the tray when not engaged. For further details and dimensions of the mounting tray, see EMTEQ Drawing # MT4-6300.

In extremely hot environments, it is possible to add exterior cooling fans to the back of the mounting tray, but no such requirement is anticipated for current aircraft.

The NASDAT itself weighs 20lbs, and is 12.62” x 7.5” x 7.62”, as shown in Figure 5. However, space must be reserved in front of the unit for the connectors, USB memory stick and temperature/humidity probe. The probe and memory stick extend 4” from the face of the unit.

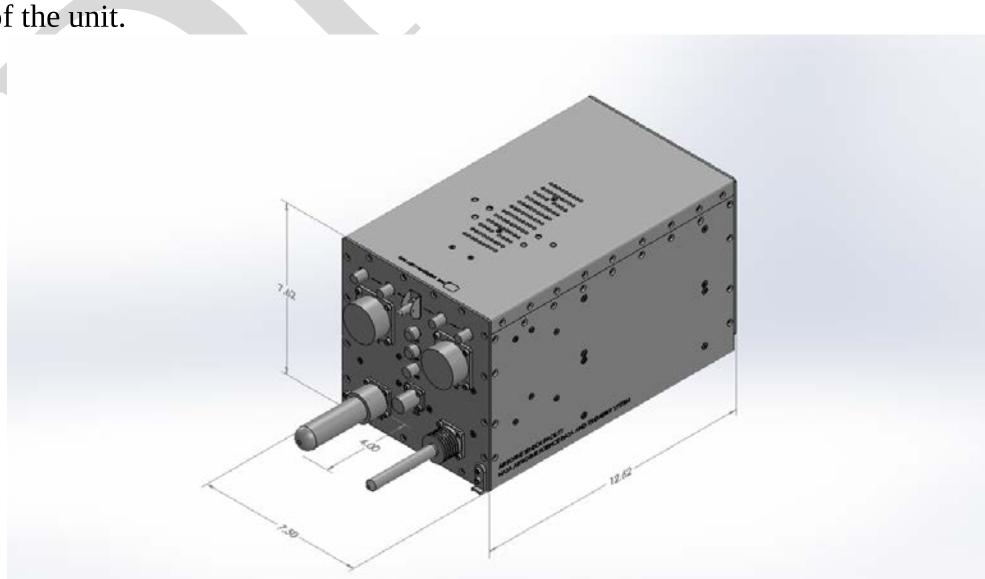

Figure 5: NASDAT Exterior Dimensions

In addition to mounting the unit itself, for full functionality the NASDAT requires 4 Iridium antennas and a GPS antenna mounted on the aircraft. The location of these antennas is subject to the needs of the primary payload, and is to be determined by aircraft personnel. The mounting locations for the Iridium antennas should be selected to maximize the view of the horizon in 360 degrees, and minimize cable loss. The total loss between the Iridium antennas and the NASDAT should be 2.0 dB or less, per the Iridium manufacturer.

4. ELECTRICAL INTERFACE

The NASDAT requires input power of +28VDC @ 5 A through the J1 connector (see Figure 6). Nominal current draw for the unit is 2.5A at temperatures above 0°C, when the 50W heater is not engaged. The unit is protected by a 5A circuit breaker located on the front panel (See Figure 3 for location).

When 28V is supplied to the unit, the blue lamp indicating system power will light. The power on debounce delay is 2 seconds. Shortly afterwards, the green lamp will also illuminate, which indicates that the CPU is on. After turning off power to the system, wait until **both** lights are off before disconnecting cables. The unit's internal battery will allow the CPU to remain on long enough for a graceful shutdown after the removal of external power. Power loss debounce delay is 30 seconds, and the time to shutdown after power loss is 60 seconds. The repower procedure for the NASDAT is to turn power off for three minutes.

All of the electrical and data interfaces to the NASDAT are located on the front panel, which contains the connectors shown previously in Figure 3. These connectors are specified below, in Table 1. The mating connector on the aircraft side is also listed.

Ref Des	NASDAT Connector Part #	Mating Connector Part #	Function
J1	D38999/20WJ-90PN	D38999/26WJ-90SN	Inputs
J2	Dc8999/20WJ-35SN	D38999/26WJ-35PN	Outputs
J3	TVP00RGQW-9-5P	TV06RGQW-9-5S	Ethernet
J4	USBFTV2SA2G10A	USBFTVKEY6A32768G	USB
J5-J8	Amphenol 122415		TNC Iridium Antenna Jacks

Table 1: NASDAT Connectors

4.1. J1 Connector (Avionics Inputs and Power)

The J1 connector provides 28VDC power to the system, 4 channels of ARINC-429 input, 1 dual-redundant MIL-STD-1553 channel, 2 channels of RS-232, 2 channels of RS-422, 8 Analog channels and a GPS antenna feed looped through an internal splitter. The Aux/Synchro inputs are normally not populated. All inputs are isolated from the aircraft.

Figure 6 graphically represents the pin groupings on the J1 connector:

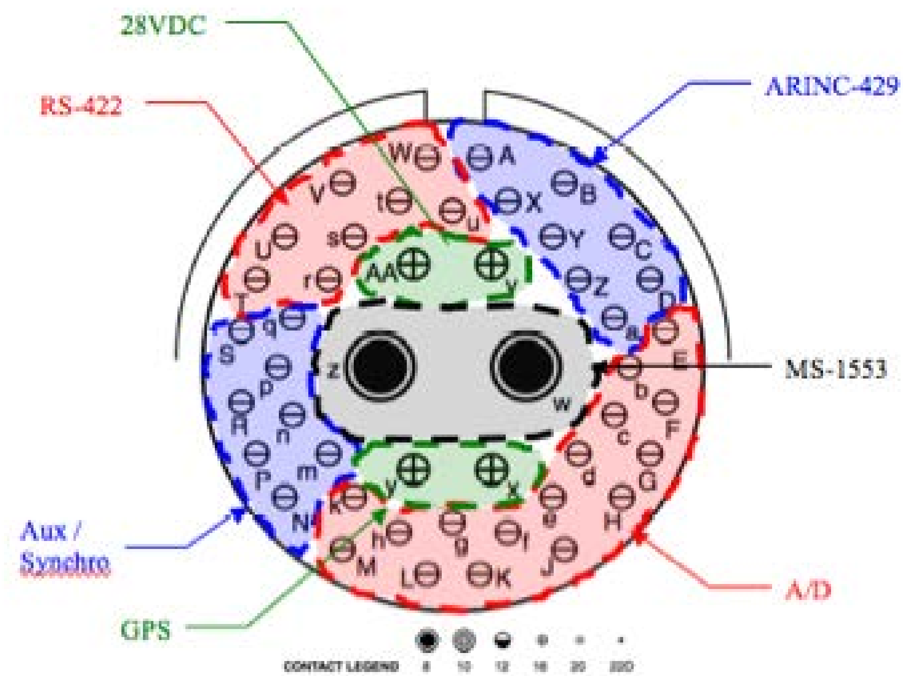

Figure 6: J1 Connector (Avionics Inputs and Power)

A full pin list for the J1 connector can be found in Appendix A: Table 1.

4.2. *J2 Connector (Outputs and Per-Aircraft Configuration)*

The J2 connector provides most of the signal outputs and configuration of the NASDAT. Figure 7, below, represents the pin groupings on the J2 connector.

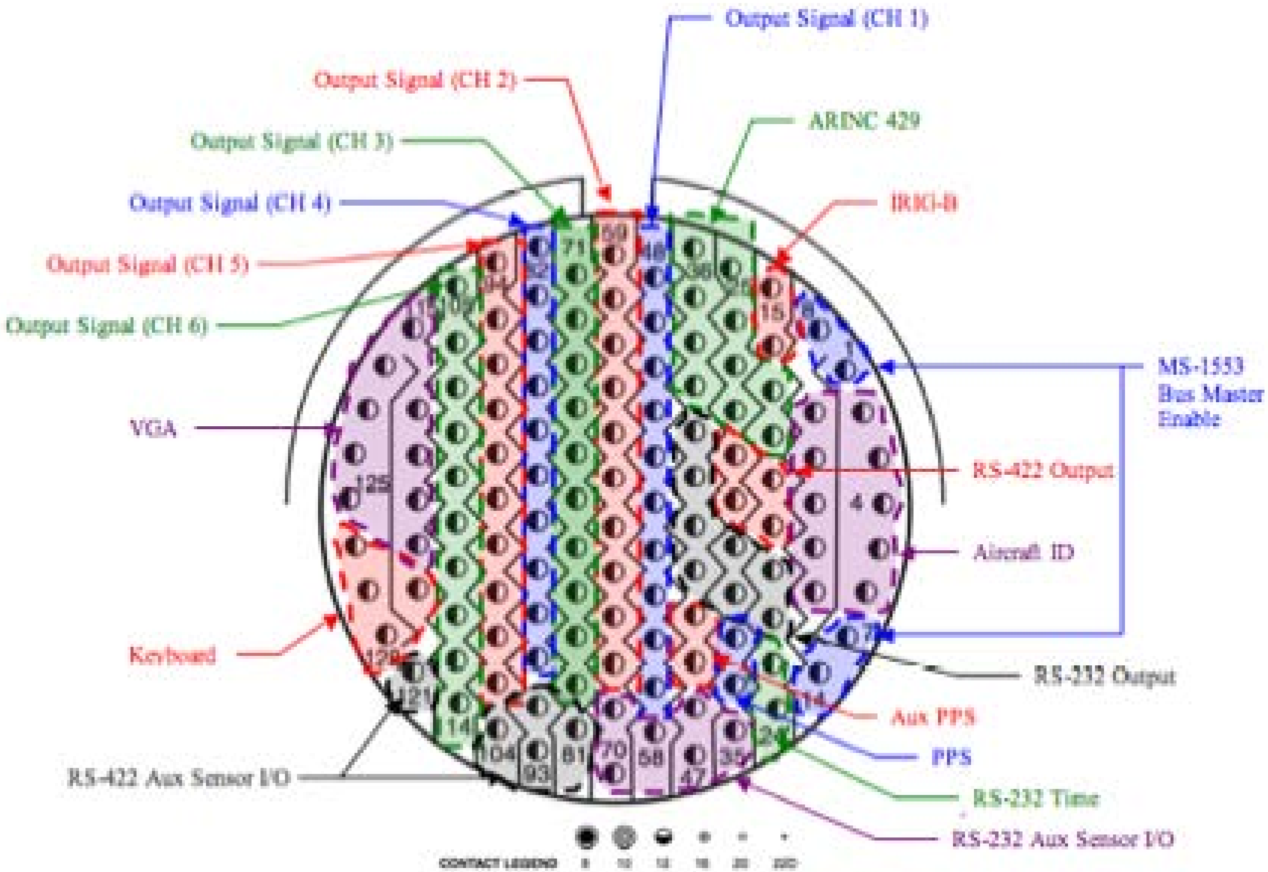

Figure 7: J2 Connector (Outputs and Configuration)

There are 6 buffered outputs each split four ways (Channels 1 – 6 in Figure 7) which can be selected from the isolated inputs (ARINC-429, RS-232, RS-422) and from internally generated outputs (ARINC-429, RS-232, IRIG-B, PPS). Selection occurs by using twisted pair jumpers from the desired output source to one of the six output channels. Aircraft ID and 1553 Bus Controller Enable are configured in the same way. These jumpers are set by the aircraft-side wiring as required by the specific payload.

The system can provide two full duplex RS-232 connections for facility instruments, and one full duplex RS-422 connection. However, these are not isolated ports.

For a full pin list for the J2 connector, see Appendix A: Table 2.

4.3. J3 Connector (Ethernet)

The J3 connector is a quadrax Ethernet connector, as shown below in Figure 8, labeled "Pin Contact Mating Face." The mating/aircraft-side connector is labeled "Socket Contact Mating Face" in Figure 8.

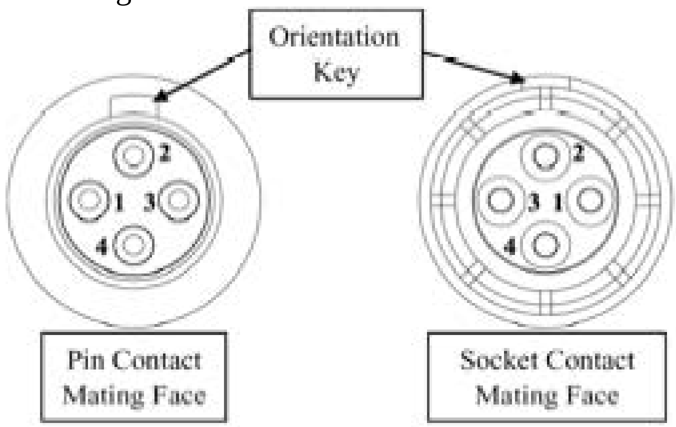

Figure 8: J3 Connector (Quadrax Ethernet)

Note that the **pin-out is per ARINC Specification 664P2-1,** 6/30/06 Pub. Date, **NOT per the Amphenol recommended pin-out.** The recommended cable for the quadrax Ethernet wire is Tensolite NF24Q100.

The pin list for the J3 connector can be found in Appendix A: Table 3.

4.4. J4 Connector (USB)

The USB external memory stick is detachable for post-flight data download, and has a 32 GB capacity. The memory stick and the J4 USB connector are shown below in Figure 9:

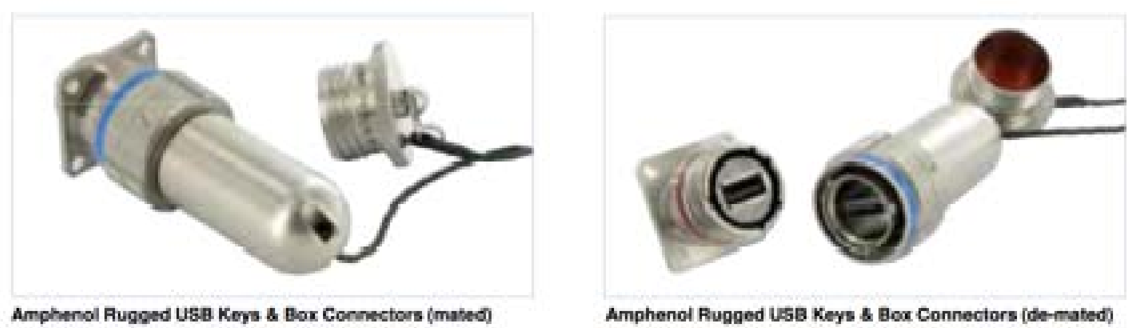

Figure 9: J4 Connector (USB Memory, Detachable)

Note that the USB drive is formatted as Linux EXT3. The pin-out for J4 is per the USB standard.

4.5. J5-J8 (Iridium Antenna TNC Connectors)

J5 through J8 are TNC connectors used to connect the four internal Iridium modems with four Iridium antennas. As specified in Section 3: Mechanical Interface, the total loss between the Iridium antennas and the NASDAT should be 2.0 dB or less for optimum performance. This will depend on the cabling used, number of bulkheads and length of cable. Where possible without exceeding the stated maximum loss, LMR-240 cabling is recommended. However, final cable selection must be determined by aircraft personnel.

5. DATA INTERFACES

5.1. Ethernet

The NASDAT is designed to interface with an on-board aircraft LAN. There is one quadrax Ethernet connector on the front panel (See Figure 3), details of which can be found in the Section 4.3: J3 Connector (Ethernet). Each NASDAT is assigned a unique IP address for the specific aircraft on which it is deployed. These addresses for the various platforms are found in Table 2.

AIRCRAFT	NASDAT IP ADDRESS
DC-8 (N817NA)	10.1.1.10
Global Hawk (N872NA)	10.3.1.10
Global Hawk (N871NA)	10.4.1.10
ER-2 (N806NA)	10.6.1.10
Ikhana (N870NA)	10.7.1.10
DFRC G-III (30-502AS)	10.8.1.10
ER-2 (N809NA)	10.9.1.10
WB-57 (N926NA)	10.11.1.10
WB-57 (N927NA)	10.12.1.10
JSC G-III (N992NA)	10.14.1.10
P-3B (N426NA)	10.15.1.10

Table 2: NASDAT Aircraft IP Addresses

The NASDAT provides the following standard data products to instruments:

- IWG1-formatted 1 Hz Nav/Housekeeping Data which is:
  - UDP broadcast to the aircraft LAN
  - UDP telemetry to the ground via Iridium at 0.1 Hz
  - Recorded in its entirety on-board
- NTP, PPS and IRIG-B time
- Instrument status packet telemetry and monitoring
- Instrument low-rate UDP telemetry
- “Kitchen Sink” file of most available data at 1 Hz
- “Dynamics” file of attitude/accelerations and rates at 20 Hz

In addition, the NASDAT can produce several optional data products, since other formats or parameters are easily configurable, the system can repeat or generate various signals as needed, and higher rate data can be available depending upon the installation. If necessary, the NASDAT can also read or drive external instruments.

The following legacy data products are also provided via Ethernet on certain installations:

- ER-2 Nav Format
- ER-2 Time Format
- DC-8 ASCII Format

5.2. Iridium

The NASDAT will connect the aircraft LAN to a terrestrial network via four Iridium satellite links, as noted in Section 4.5. These links are bonded together to provide 9600 bps nominal bandwidth. The number of operational links may vary due to a variety of circumstances (poor satellite coverage, interference, or other reasons). They will usually re-establish themselves without intervention when conditions improve.

5.3. Legacy Data Interfaces

In addition to data via Ethernet, the NASDAT also provides RS-232, RS-422 and ARINC 429 Nav Data as legacy signals and formats when needed. Electrical interfaces for these outputs can be found in Section 4.2: J2 Connector (Outputs and Per-Aircraft Configuration). For further information on these formats, see the Experimenter Handbook for the aircraft in question.