Section 5.12 RF Ground Suport Equipment (RF-EGSE)

ISIS Checkout box

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2011-02-09	1.0	S. Speretta	All	Initial version

Applicable Documents

Reference Documents

TBD/TBC/TBW

TBD/TBC/TBW	Responsible	Action	Page

Disclaimer

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ISIS warrants that the product is supplied after relevant tests had shown the product is in good order and functioning, as far as these tests may indicate and predict product functionality.

List of Acronyms

AFSK	Audio Frequency Shift Keying
BPSK	Binary Phase Shift Keying
DSP	Digital Signal Processing
ESD	Electro Static Discharge
FCS	Frame Check Sequence
FSK	Frequency Shift Keying
GUI	Graphical User Interface
KISS	Keep It Simple Stupid
OFDM	Orthogonal Frequency Division Multiplexing
PSK	Phase Shift Keying
RF	Radio Frequency
SDR	Software Defined Radio
VHF	Very High Frequency
UHF	Ultra High Frequency
USB	Universal Serial Bus
TNC	Terminal Node Controller

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1 Introduction

This document contains the user manual for the ISIS Checkout box.

The ISIS Checkout box is designed specifically for the test on ground of a satellite downlink and uplink. Radio signals demodulation and modulation is performed in software using DSP techniques: a digitized down-converted signal coming from the radio receiver is fed through the USB port into a PC, which is used to handle demodulation and data decoding. Uplink is performed again digitally: a digitized baseband stream in generated in the PC and it is sent through a USB connection to the radio for up-conversion.
The receiver uses a Binary Phase Shift Keying (BPSK) modulation scheme with Raised Cosine bit shaping: this modulation was selected because, of all common available modulation schemes, yields best performance in terms of Bit Error Rate vs. signal to noise ratio. It should be noted that, thanks to the inner noise level tolerance BPSK can achieve the same performances of a synchronous FSK demodulator with a 3 dB lower noise margin. Furthermore, the modulation scheme and the bit shaping allow to use a limited bandwidth for transmission, actually enabling a narrower bandwidth receiver (which has then a lower noise floor). By summing the previous consideration, it's easy to see the advantages with respect to other commonly used modulation schemes (like FSK derived ones). More advanced modulation schemes (like OFDM or high-order PSK) can give higher throughput but this requires a higher receiver complexity and link margin.
This receiver is compliant with the whole ISIS transmitter / transceiver family of products.
The transmitter uses an Audio Frequency Shift Keying (AFSK) scheme: this modulation was selected for its simplicity and for the implicit robustness that this will give to the satellite receiver. Due to spectrum usage, AFSK is only used at 1200 bps.
This transmitter is compliant with the whole ISIS receiver / transceiver family of products.

1.1 Purpose and Scope of Document

This document provides all information required to use and handle the ISIS Checkout box properly. This document is valid until it is declared obsolete or replaced with a succeeding version. Changes with respect to the previous version will be clear from the revision. As this document may be updated without prior notice, it is advised to check the ISIS website "www.isispace.nl" or ask us for the latest version at "support@isispace.nl" before using this document as reference.

1.2 Shipment contents

Item	Quantity	Check
ISIS Checkout box	1	
USB cable	1	
Monopole antenna	2	
90° SMA adapter	2	
Power supply	1	

Table 1.1: Shipment contents

1.3 Specifications

Parameter	Typical value	Comments
Overall Specifications		
Supply voltage	100 - 260 V AC (50 - 60 Hz)	
Supply current	600 mA	
Temperature range	0 - 50 °C	
Relative Humidity	max 95 %	
Mass	1 kg	
Transmitter		
Frequency range	50 - 2200 MHz	
Maximum output power	5 dBm (144 - 435 MHz)	
Modulation scheme	AFSK	
Data rate	1200 bps	
Protocol	AX.25	
Receiver		
Frequency range	50 - 2200 MHz	
Noise Figure	15 dB (144 - 435 MHz)	
Maximum Input Signal	-20 dBm	
Modulation scheme	Raised-Cosine BPSK	
Data rate	1200 - 9600 bps	
Protocol	AX.25	
Antennas		
Gain	0 dBi	
Radiation pattern	$\lambda/4$ monopole	

Table 1.2: ISIS Checkout box specifications

1.4 Requirements

Parameter	Typical value	Comments
CPU	Intel/AMD DualCore PC at least 1.6 GHz	
RAM	256 MB free	
Connectivity	1 x USB 2.0	
OS	Windows XP SP2 / SP3, 32- or 64-bits Windows 7, 32- or 64-bits Linux with at least kernel version 2.6.32, 32-bits (Preferred)	
Software	SUN Java JRE version 1.6 or higher 32- or 64-bits depending on OS SUN Java JDK version 1.6 or higher 32- or 64-bits depending on OS (Preferred)	

Table 1.3: ISIS Checkout box system requirements

1.5 Radio Spectrum Licensing

The ground station system is capable of generating RF signals on the VHF and UHF amateur radio frequency bands. It is also capable of receiving in these bands. Please make sure that all applicable laws in your country are met, and that you obtain the proper license(s) if needed. Also depending on your country, listening to certain stations may be restricted. The customer is responsible for acquiring all necessary licenses and the license fees are on your expense.

2 Handling and Storage

2.1 Handling

2.1.1 Electrostatic discharge ESD

CAUTION

The printed circuit boards contained in the ISIS Checkout box can be damaged by electrostatic discharge. Do not touch any of the boards unless it is absolutely necessary. If you must handle them, wear a grounded wrist strap and take other anti-static precautions. Wear a grounded wrist strap any time you must handle the board. Do not connect / disconnect the Antenna port without proper ESD control.

2.1.2 Receiver input power

WARNING

A higher input signals than the maximum specified input level (-20 dBm) on the receiver antenna port may damage the device.

2.1.3 Exposed Voltages

WARNING

Handling the system with an active supply connection is not recommended. The system itself could be damaged and there is a possibility of electric shock hazard In the event of Emergency, disconnect the power supply and proceed, if required, with first aid activities.

2.1.4 Operation Conditions

CAUTION

This system is intended for INDOOR use only and should not be operated outdoors as the board electronics might be damaged. Ensure that the system is always operated within its qualification temperature range: 0 to +55°C.

2.2 Storage

CAUTION

Store the ISIS Checkout box in an environment controlled area. The absolute maximum ratings for storage temperature are from -50 to +85°C with a Relative Humidity < 60%.

2.3 Disposal

WARNING

This product contains materials that can be harmful for the Environment and as such it should not be disposed of with conventional waste but treated according to WEEE regulations (EU Directives 2002/96/EC and further amendments) and brought to an appropriate recycling facility.

3 Hardware description

The ISIS Checkout box is composed by two main parts: a radio transceiver (down- and up-converter) and a software application running on a PC. The software will require to be installed on the target machine to allow data reception and transmission. The next two sections will provide a detailed installation guide for users. Please see Figure 3.1 for a block diagram of the ISIS Checkout box.

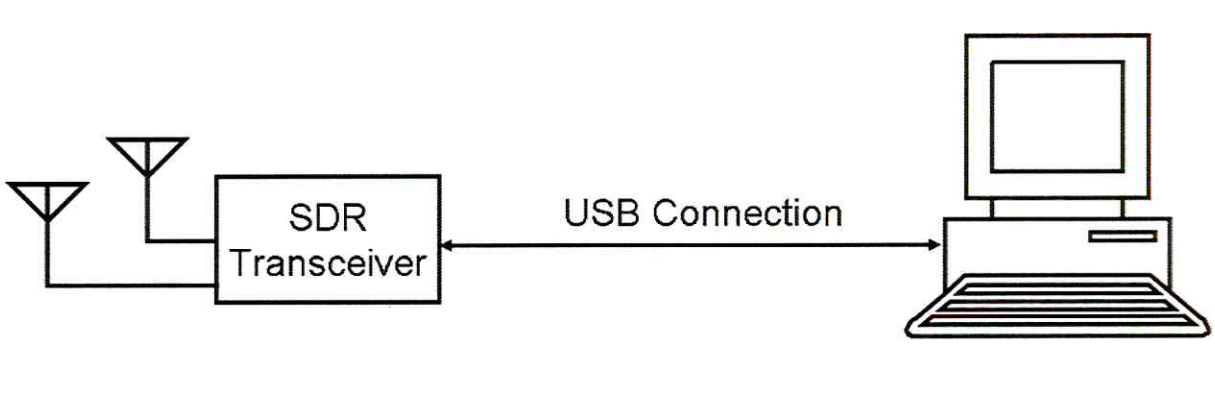

Figure 3.1: ISIS Checkout box hardware block diagram

3.1 Radio

The ISIS Checkout box uses a software defined radio that allows contemporary transmission and reception operations (receiving frequency range 50 - 2200 MHz, transmitting frequency range 50 - 2200 MHz). Output power is limited to 5 dBm (144 - 435 MHz) to limit interferences with other systems. Two independent antennas connections are provided for full-duplex operations.

4 Installation

This section will explain in details the installation procedure for the ISIS Checkout box software. You can find all the needed software on the provided CD.

4.1 Software Installation

ISIS Checkout box can successfully run on Windows (XP SP2 / SP3 and 7) or Linux (Debian, Ubuntu and others) systems. An installation procedure is provided in the following sections.

4.1.1 Windows

First, insert the provided software CD-ROM and open the unit. Now connect the ISIS Checkout box USB cable to the PC and connect the power supply. The windows New Device Found wizard should pop up requiring to install new software as in Figures 4.1, 4.2 and 4.3.
First, choose not to use Windows Updates, then select Manual Installation and then select the **RF Checkout Software\Drivers\Windows** directory in the ISIS Checkout box CD.
When device installation is complete, it is necessary to install Visual C++ 2010 Redistributable libraries: you can find the installer in the ISIS Checkout box CD in **RF Checkout Software\Drivers\Windows\vcredist_x86.exe**, as shown in Figure 4.4.
Under Windows 7, the installation wizard may not be shown by default. In this case it is necessary to go under *Control Panel->System->Hardware peripherals*, then right-click on device in the list (it should show a warning to notify that the driver was not successfully installed). Then select *Update Driver* and select the previously mentioned directory.
Before using the software, please ensure that you have SUN Java JDK version 1.6 or later installed on you system. SUN Java JDK is necessary to ensure that the Server Virtual Machine is installed: this VM guarantees higher performances with respect to the Client one (it is the default one used by most Java applications).

Figure 4.1: Windows New Device Found wizard (1/3)

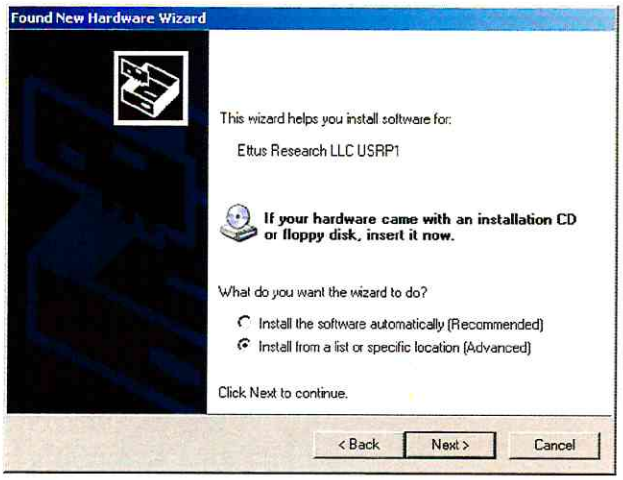

Figure 4.2: Windows New Device Found wizard (2/3)

If you run into troubles running the application you may need to select a different Java virtual machine than the default one: in this case please edit with a text editor the start.conf file in the main directory and insert you JVM path as explained by the notes in the file.
Now you only need to copy the **RF Checkout Software\Software** directory from ISIS installation CD-ROM to your PC and you are ready to use it. Please ensure you have write permissions on that directory because the software may need to write temporary files in that directory.

When software installation is completed, connect the ISIS Checkout box and start the application (double-click on the *start.jar* file). The application will now download the firmware into the software radio and Windows may require you to install again the device drivers: just repeat the previous procedure and when the New Found Hardware procedure is triggered, the application may report that no device was found. This is normal, just close the application and, as shown in Figure 4.5, follow the install procedure.

4.1.2 Linux

Before beginning software installation, please ensure that your Linux kernel version 2.6.32 or later: this is required for fast USB operations using the provided driver (an older kernel version may not guarantee a high speed transfer between the SDR and the computer, actually limiting the maximum datarate achievable with the receiver).
Once the previous requirements are met, you can easily install the software. The following installation guide was compiled using a clean UBUNTU Lucid (10.04) distribution, but it can be used for other Debian based distributions. The software can also be installed on different Linux distributions.
First, insert the provided software CD-ROM in a CD reader and mount the unit. In the Linux directory on the CD (**RF Checkout Software/Drivers/Linux**) you should find the the driver install package for different Linux distributions (Debian and Fedora based) and you only need to

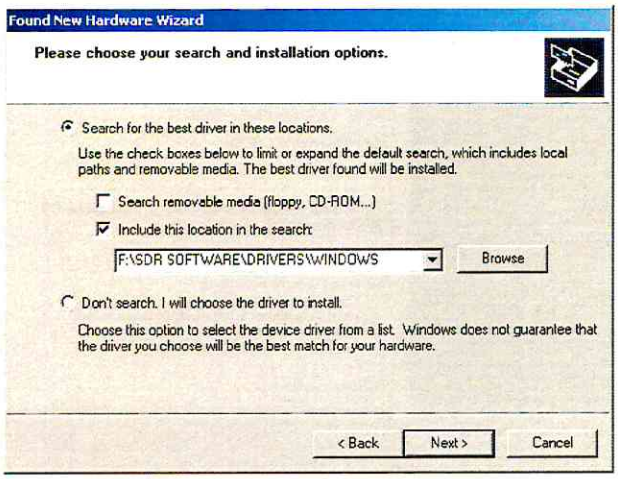

Figure 4.3: Windows New Device Found wizard (3/3)

install the proper one, according to your distribution.

Before using the software, please ensure that you have SUN Java JDK version 1.6 or later installed on you system. SUN Java JDK is necessary to ensure that the Server Virtual Machine is installed: this VM guarantees higher performances with respect to the Client one (it is the default one used by most Java applications).

If you run into troubles running the application you may need to select a different Java virtual machine than the default one: in this case please edit with a text editor the start.conf file in the main directory and insert you JVM path as explained by the notes in the file.
If you want to access the ISIS Checkout box from non-root users you also need to take two further steps: you should allow a non-root users to access a USB device and you should grant the user the permission to increase task priorities. USB plug and unplug events under Linux are handled by udev, so, for allowing non-root users to have access to USB devices, sou should define a udev rule for the USRP1 so that non-root users may access the device. Please type the following commands as root user (these commands were used under a Debian-based system; other distributions may require slightly different ones):

```
> echo 'ACTION=="add", BUS=="usb", SYSFS{idVendor}=="fffe",
  SYSFS{idProduct}=="0002", MODE:="0666"' > tmpfile
> chown root.root tmpfile
> mv tmpfile /etc/udev/rules.d/10-usrp.rules
> udevadm control --reload-rules
```

Furthermore, you need to allow non-root users to change the scheduling priority: add the following line to **/etc/security/limits.conf** file:

```
@<my_group> - rtprio 99
```

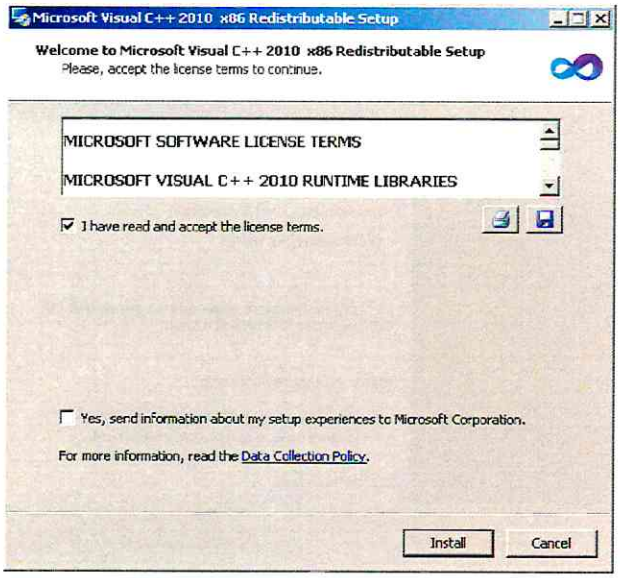

Figure 4.4: Visual C++ 2010 Redistributable install program

Replace $< my\_group >$ with a group to which your user belongs. Settings will not take effect until the user has logged in and out.

Now you only need to copy the **RF Checkout Software/Software** directory from ISIS installation CD-ROM to your PC and you are ready to use it. Please ensure you have write permissions on that directory because the software may need to write temporary files in that directory.

4.2 First Run

Once software was successfully installed, the application can be tested.
Under Windows you can simply double-click on the *start.jar* script, which will start the application.
If you are running the application from command line, you can start it by typing *java -jar start.jar*.
Figure 4.6 shows the ISIS Checkout box window, as you should see it.
If the application experiences problems, a log file is created for easier debug. You can access the file under the following folder: *$USER_HOME/.isis/transceiver.log* where $USER_HOME is your user home directory (for example */home/username* under Linux or *C:\Users\username* under Windows). If you are reporting an issue with the software, please attach the log file.

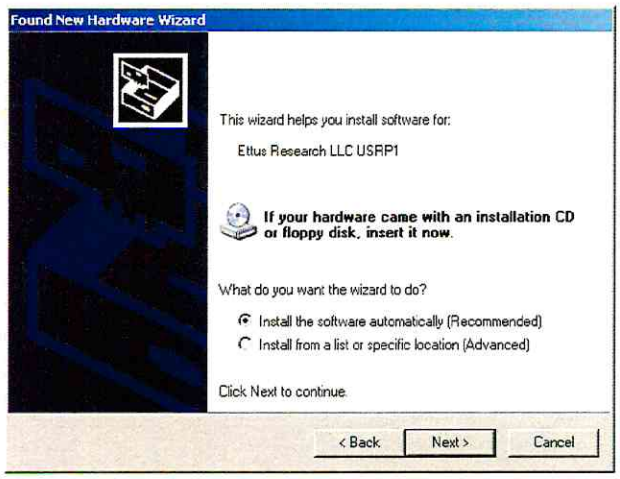

Figure 4.5: Windows New Device Found wizard

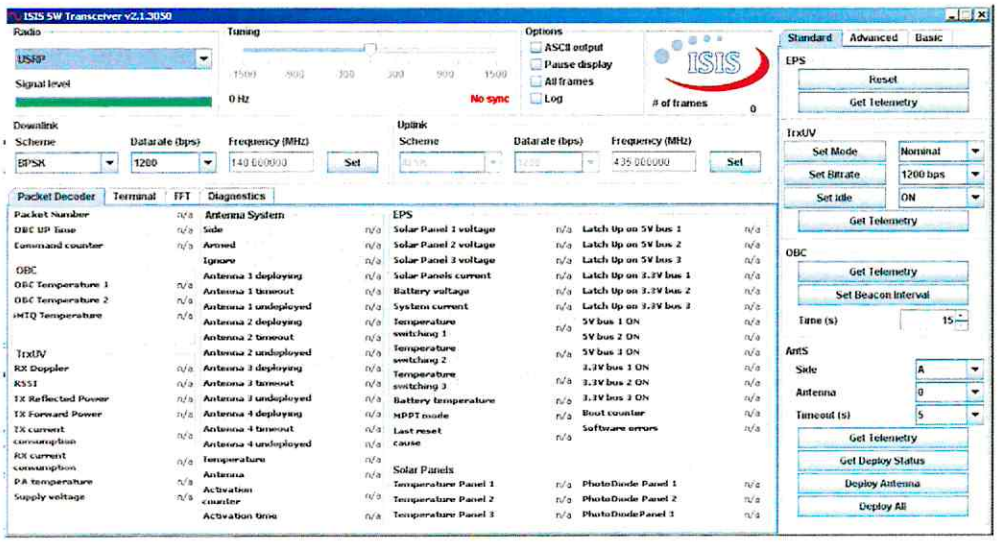

Figure 4.6: ISIS Checkout box main window

5 Receiver operations

The ISIS Checkout box employs a radio receiver for frequency down-conversion and a fast ADC to sample the incoming signal at an intermediate frequency. Data demodulation is performed digitally on the computer with digital signal processing techniques. The screenshots shown later can have minor differences with the actual software provided according to the different options that were selected for the device.

5.1 Graphical User Interface

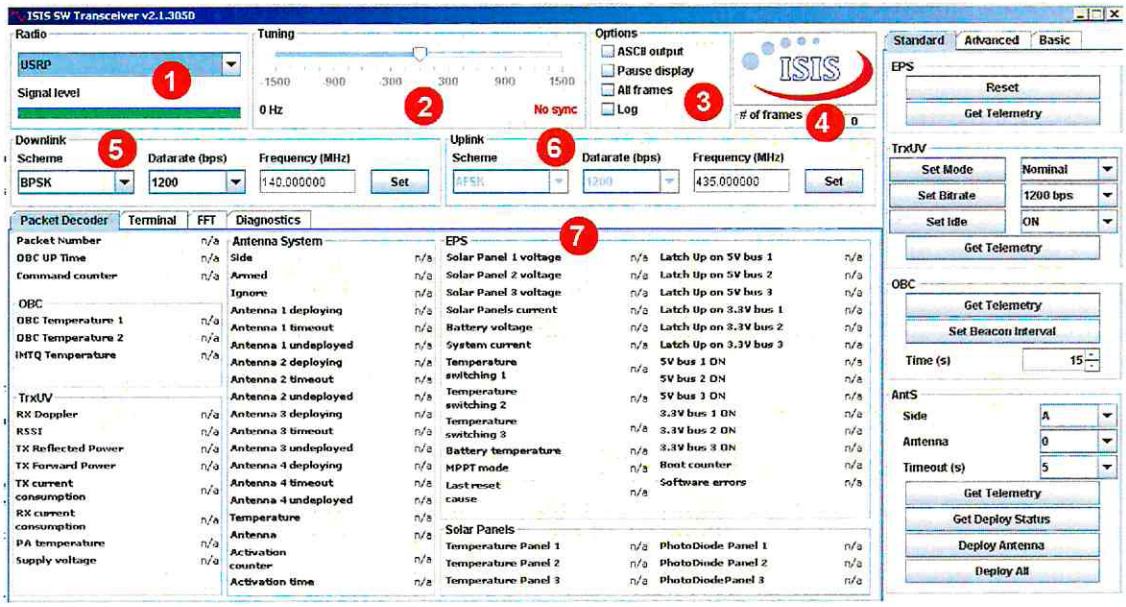

Figure 5.1: ISIS Checkout box main window

ISIS Checkout box can be controlled through his GUI, which is represented in Figure 5.1. The main available controls are highlighted in the Figure and are better detailed in the next paragraphs.

Input Source Selection: the top select box is used to select the desired input source. When a new source is selected the demodulator is restarted. The signal level indicator displays the input signal strength: if the indicator bar is red, the input signal is too weak or too strong for optimal operations, while a green bar indicates a good input level. The power indicator increases from left to right, so a full bar indicates a strong signal (item 1 in Figure 5.1).

Fine tuning: this control shows the actual reception frequency (relative to the radio center frequency). The frequency information is computed by the demodulation loop and when the receiver locks on an input signal, a lock indicator is displayed (green indicator) (item 2 in Figure 5.1).

Options panel: the *ASCII Output* control is used to display packets in the Terminal window as ASCII characters instead of hexadecimal data, the *Pause Terminal* check-box can be used to stop incoming packets display in the Terminal window and the *All Frames* check-box allows to disable the FCS check in AX-25 frames. The *Log* check-box instead enables packets logging (see Section 8 for details) (item 3 in Figure 5.1).

Received frames: displays the number of received frames. The counter can be reset by right-clicking on the counter and selecting clear (item 4 in Figure 5.1).

RX Channel settings: the *Modulation* select box allows to select one among the available modulation schemes; BPSK is the default value. The *Datarate* select box allows to choose the proper datarate. When a new modulation or datarate is selected the demodulator is restarted. You can also set the receiver center frequency by typing a new value (in MHz) in the text box and clicking the *Set* button (item 5 in Figure 5.1).

TX Channel settings: the *Modulation* select box allows to select one among the available modulation schemes; AFSK is the default value. The *Datarate* select box allows to choose the proper datarate. When a new modulation or datarate is selected the modulator is restarted. You can also set the transmitter center frequency by typing a new value (in MHz) in the text box and clicking the *Set* button (item 6 in Figure 5.1).

Display tab: This tab is a multi-function panel used to display a wide range of information regarding received packets, input spectrum and received signal statistics (item 7 in Figure 5.1) (see Section 5.2 for further details).

5.1.1 Tuning

The tuning panel reports the tuning status of the Costas loop PLL: a lock indicator (as can be seen in Figure 5.2 and 5.3) is provided which shows if the received has locked on an incoming carrier. Furthermore, a frequency indicator is provided to show the actual receiving frequency (the frequency read-out should be considered as an offset to the radio frequency).

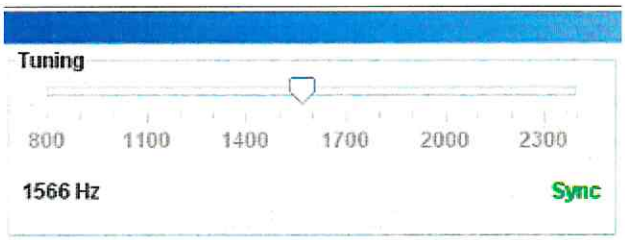

Figure 5.2: Tuning panel with receiver in LOCK

5.2 Display Tab

The display tab is a multi-function tab used to display a wide range of information regarding received packets, input spectrum and received signal statistics. This tab may have minor differences with the actual software provided according to the different options that were selected for the device.

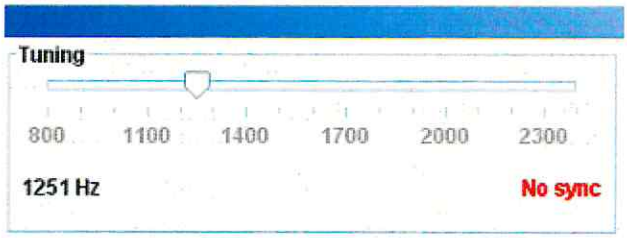

Figure 5.3: Tuning panel with receiver unlocked

5.2.1 Telemetry decoder panel

The frames decoder panel is used to decode incoming telemetry packets and display the actual received data. This panel is used only to display the last received packet and it is not possible to load a previously received packet only to display it. The panel updates the values on the screen, as can be seen in Figure 5.4: all the received values are displayed, while the parameters which were not received are marked as *not available* (n/a) or grayed if they are outdated.

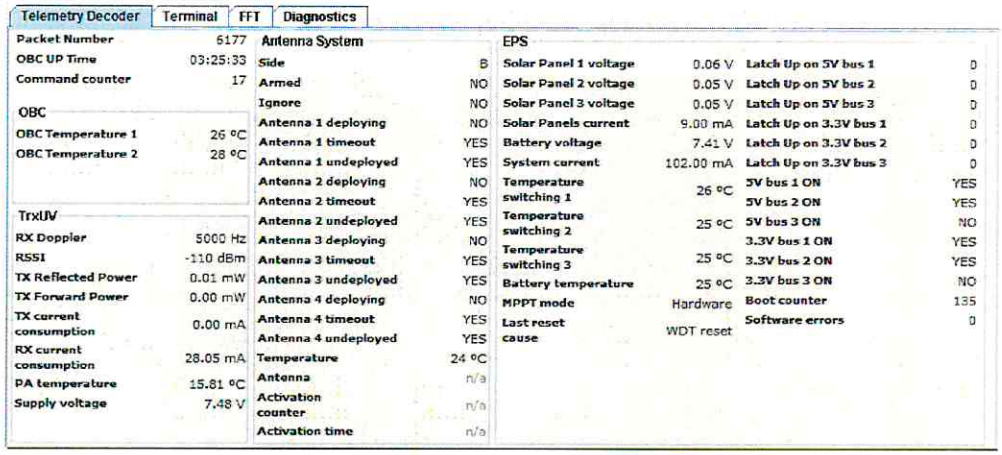

Figure 5.4: Decoder panel displaying one received packet

5.2.2 Terminal Panel

The terminal panel is used to display the received packets, as can be seen in Figure 5.5. This panel is used to display all the received and sent packets. The user can select to display the content of the packet in HEX or in ASCII on the *Option Panel* (item 3 in Figure 5.1). This panel keeps track of the most recent 100 received / transmitted packets.

5.2.3 Spectrum Monitoring

Beyond data demodulation, the ISIS Checkout box can also be used to perform spectrum monitoring: this is achieved by performing a Fourier transform on the acquired samples. Figure 5.6

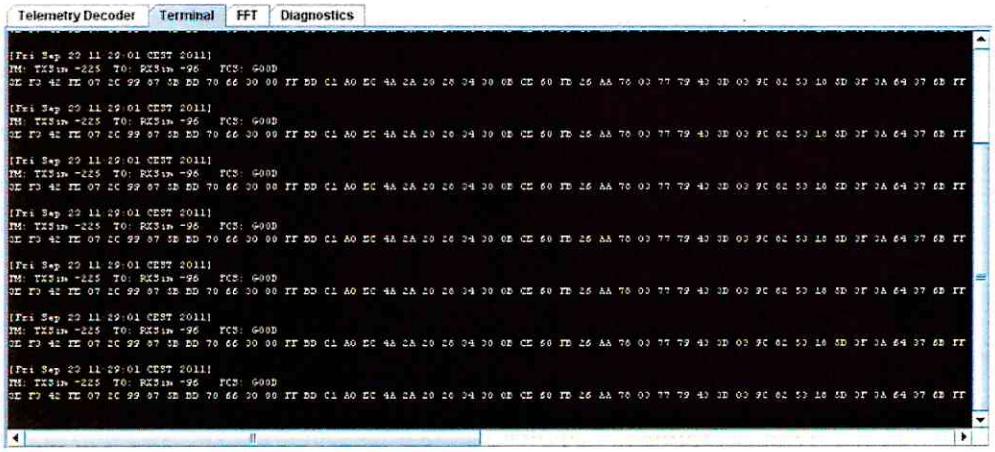

Figure 5.5: Terminal panel during data demodulation

shows the spectrum analysis panel.

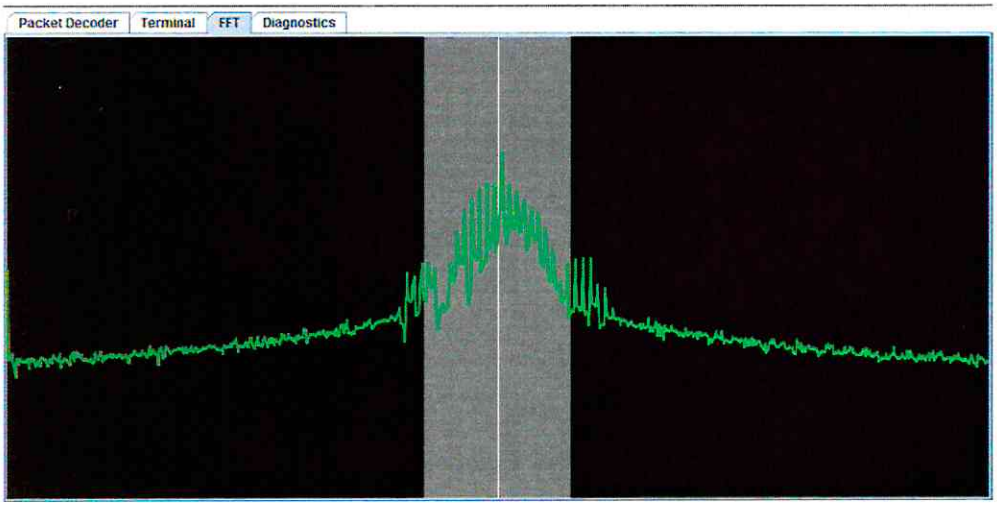

Figure 5.6: FFT panel

The vertical axis represents the received signal power (even if this is non calibrated in W or dBm), while the horizontal axis represents frequency, as in a common spectrum analyzer.
The vertical line in the center of the tab corresponds to the center downlink frequency, while the gray vertical bar represents the receiver reception bandwidth. To successfully receive a signal, it should be within this gray band.
The cursor can be used to estimate the frequency of a signal displayed in the spectrum tab: when the cursor is moved on this tab, a tooltip will be displayed showing the current frequency (as difference with respect to the center frequency and as absolute frequency in Hz). Please see Figure 5.7 for details.

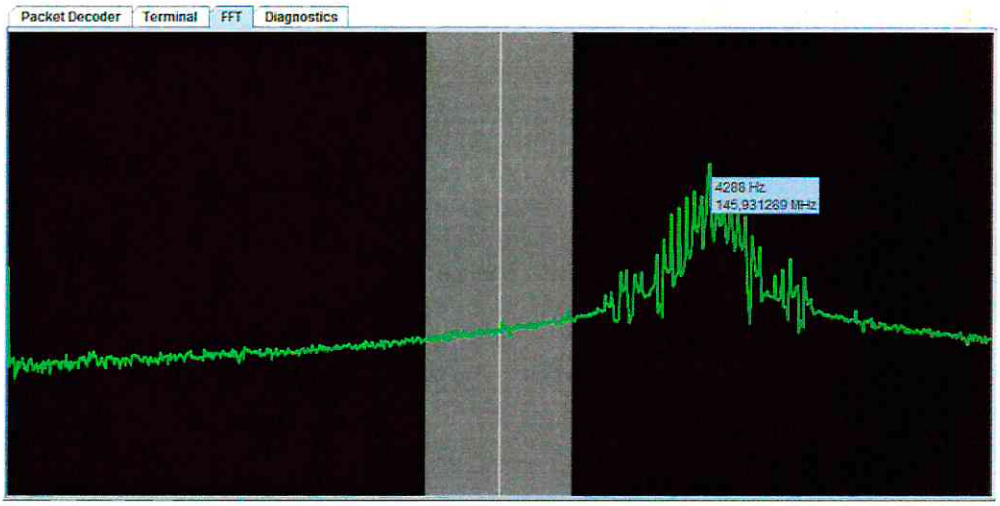

Figure 5.7: FFT panel with frequency indication

If the signal to be received is outside the gray band, two things can be done:

- the center frequency can be adjusted using the *Set* button
- the user can double click on the signal in the FFT tab: this will retune the receiver and move the gray band on the signal (see Figure 5.8 for details).

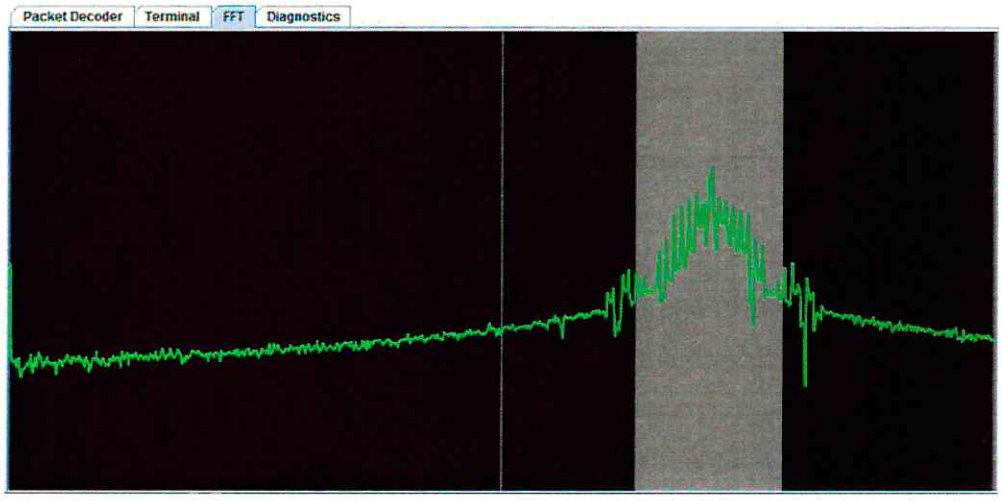

Figure 5.8: FFT center frequency offset

In case the received signal strength is too high or too low to properly visualize the signal, the user can drag the vertical scale up or down.

5.2.4 Link diagnostics

The diagnostic panel displays diagnostics on the receiver link, in particular the measured datarate and a quality indicator are displayed. The datarate is measured by the demodulator clock tracking loop and it is continuously updated during reception. The tracking loop can compensate a datarate error of approximately ± 5%. The QOS (Quality of Signal) indicator provides an estimation of the eye amplitude (computed through an eye diagram) in relative terms: 100 % corresponds to a perfect synchronization and 50 % represents an amplitude of the eye equal to half of that in the ideal case. For best results the QOS should be above 60 - 70 %. Please see Figure 5.9 for further details.

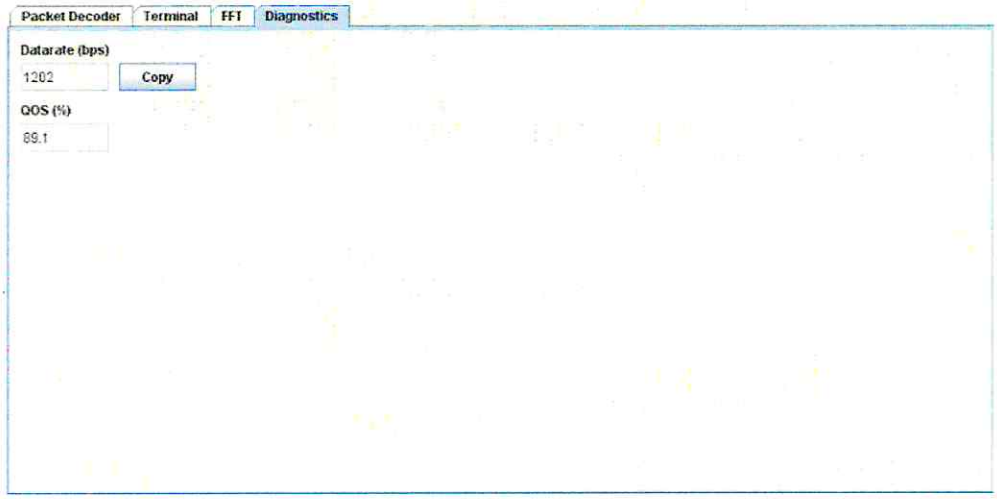

Figure 5.9: Diagnostics tab

5.3 How to operate the receiver

This section shows the recommended use procedure for successfully receive data through ISIS Checkout box.

1. connect the ISIS Checkout box to the PC with a USB cable
2. connect the ISIS Checkout box power supply cable
3. start the ISIS Checkout box application
4. set proper frequency, modulation scheme and datarate
5. select USRP from the Radio selection box to start

6 Transmitter operations

The ISIS Checkout box employs a radio transmitter for frequency up-conversion and a fast DAC to generate the desired signal at an intermediate frequency. Data modulation is performed digitally on the computer with digital signal processing techniques. The screenshots shown later can have minor differences with the actual software provided according to the different options that were selected for the device.

6.1 Graphical User Interface

ISIS Checkout box can be controlled through its GUI, which is represented in Figure 6.1. The main available controls are highlighted in the Figure and are better detailed in the next paragraphs.

Uplink panel: this panel is used to send commands to the satellite (item 1 in Figure 6.1). When a new command has been sent, it will also be displayed in the Terminal panel.

6.1.1 Uplink panel

The *Uplink Panel* is used to directly send commands to the satellite (see Figure 6.2): for sending a new command to the satellite you just need to press the corresponding button and command will be sent (some commands require also the user to select some options, please refer to the satellite user manual for details about every command). Before being able to transmit packets, a valid radio amateur callsign should be specified: the first time a command is sent, if no valid callsign has been provided yet, a pop-up window will show up (see Figure 6.3). Only radio amateur license holders are legally allowed to transmit packets, and their callsign should be put

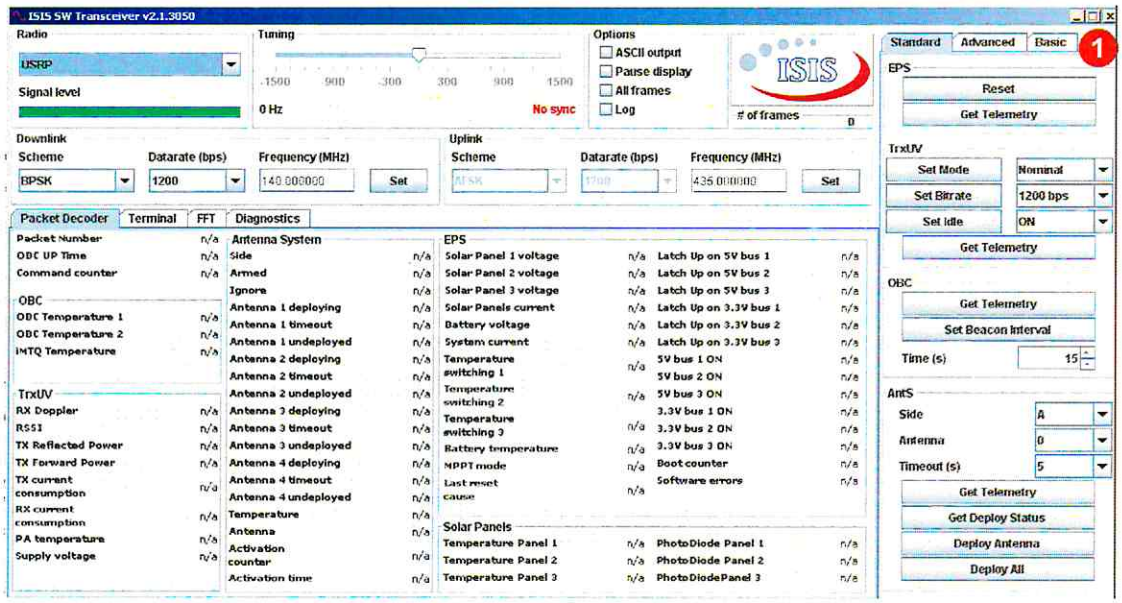

Figure 6.1: ISIS Checkout box main window

in every packet. Legislation may vary according to the country in which operations are performed.

6.2 How to operate the transmitter

This section shows the recommended use procedure for successfully transmit data through ISIS Checkout box. Once the receiver has been started (see section 5.3 for details), the transmitter is ready for operations:

1. set proper frequency, modulation scheme and datarate
2. select USRP from the Radio selection box to start (if not already selected)
3. send a command by pressing the proper button in the *Uplink* panel

Radio tuning is particularly important because the receiver bandwidth is particularly narrow (this allows to reduce the input noise and improve performances).

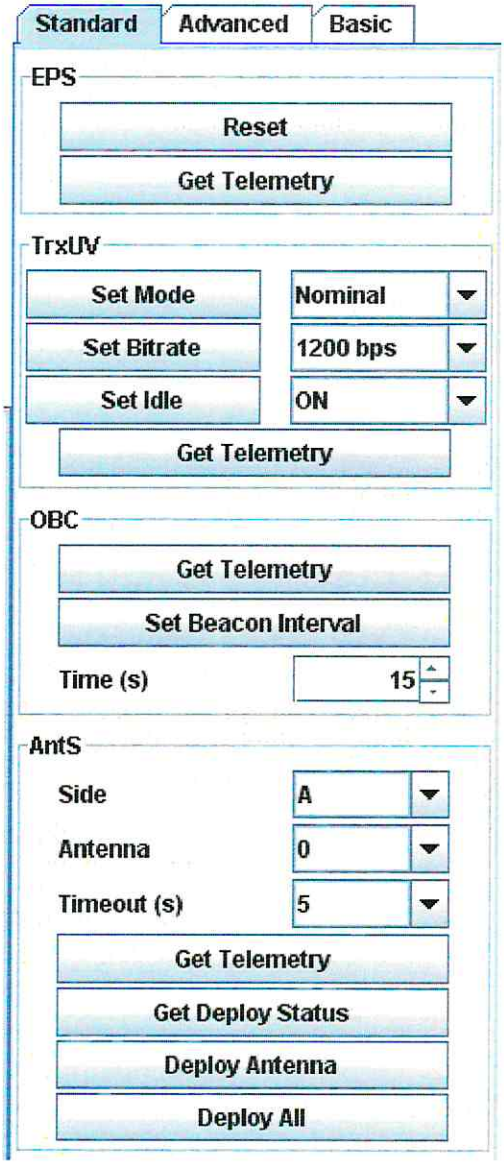

Figure 6.2: Uplink panel

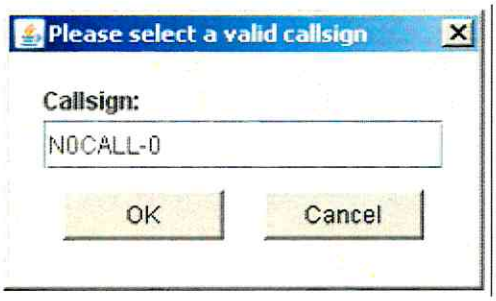

Figure 6.3: Callsign selection box

7 Data interface

Received data packets can be transferred to other applications by using a dedicated TCP/IP socket interface on port 3210. If you are using it, please ensure the computer Firewall is not blocking it. According to the software option, two data interfaces could be available, one based on KISS frames (see Section 7.1 for further details) or a binary one (see Section 7.2 for further details).

7.1 KISS interface

The full AX-25 received packet (beginning with callsigns and ending with the Info field, excluding the FCS) is transmitted on the socket enclosed in a KISS frame, to simplify the use of existing software for data decoding.

The socket connection is bi-directional, so user-defined packets can be sent to the satellite through this application, too. As in the downlink case, AX-25 frames (beginning with callsigns and ending with the Info field, thus excluding the FCS) should be enclosed in KISS frames, as for the receive case.
To retrieve the received packets it is necessary to connect a socket client on the receiver PC machine IP. A simple terminal application, like Realterm can be used on a Windows machine to check the received packets. This application is not necessary for correct data reception.
Applications designed to operate using a serial port can be used if their output is redirected to a TCP socket. Linux applications can use *socat* for tunneling (please check *man socat* for further info) while Windows users can use *com0com* and *com0tcp* (please see `http://com0com.sourceforge.net/doc/UsingCom0com.pdf` for further details).
Please see `http://www.ka9q.net/papers/kiss.html` for further details on the KISS TNC protocol.

7.2 Binary interface

The binary interface is used to transfer the received packets or the packets to send, together with further information regarding the packet (RSSI or reception timestamp). This is useful to acquire statistics about the received data to characterize the link. Table 7.1 summarizes the data structure that encapsulates every received packet. Multi-byte fields, like *double* or *int* are sent in **little endian** order (so, least significant byte first). This is the common byte order for Intel CPU and for C/C++ applications (this simplifies copy / conversion routines). The **Frame command** is 0x55 for received packets. EPOCH (or UNIX timestamp) is defined as January 1^{st} 1970, 00:00:00 UTC. The **Frame length** field expresses the length of the whole frame, taking into account every field listed in Table 7.1.

The uplink frames interface works in a similar way: communication details can be found in Table 7.2. The **Frame command** should be 0x56 for the command to be sent. The **Frame length** field expresses the length of the whole frame, taking into account every field listed in Table 7.2.

	Downlink Frame description	
	Field	**Data type**
HEADER	Frame command	unsigned char
	Frame length [bytes]	unsigned int32
PAYLOAD	Datarate [bps]	unsigned int32
	Modulation name length [bytes]	unsigned char
	Modulation name	unsigned char[]
	RSSI [dBm] (uncalibrated)	IEEE 754 double
	Frequency [Hz]	IEEE 754 double
	Packet length [bytes]	unsigned short
	Packet	unsigned char[]
	UTC Time from EPOCH [ms]	unsigned long

Table 7.1: Downlink data structure

	Uplink Frame description	
	Field	**Data type**
HEADER	Frame command	unsigned char
	Frame length [bytes]	unsigned int32
PAYLOAD	Packet	unsigned char[]

Table 7.2: Uplink data structure

8 Data logging

As described in Section 5 and 6, all the received and transmitted packets can be logged to a text file. **The logging engine only records a limited number received and transmitted packets: this is intended for debug and verification only. It is not intended as the main logging system for the data exchanged with the satellite.** If you need a recording system for received and transmitted packets, please use the data interface (see Section 7 for details).

Log files are stored in the following folder: *$USER_HOME/.isis/transceiver.log* where $USER_HOME is your user home directory (for example */home/username* under Linux or *C:\Users\username* under Windows).

Received packets are logged in a file called *downlink.log* while transmitted ones are logged in *uplink.log*. Packets logging is OFF by default and it should be turned manually on by ticking the Log check box on the user interface (see section 5 for further details).

An example log file can be found below.

```
[Thu Jul 12 17:12:47 CEST 2012] A8 A4 B0 AA AC 40 60 A6 A6 A6 40 40 40 E1 03 F0 48 65 6C
6C 6F 20 57 6F 72 6C 64 A7 DC
[Thu Jul 12 17:13:11 CEST 2012] A8 A4 B0 AA AC 40 60 A6 A6 A6 40 40 40 E1 03 F0 49 6E 73
65 72 74 20 74 65 78 74 20 68 65 72 65 00 54
[Thu Jul 12 17:14:28 CEST 2012] A8 A4 B0 AA AC 40 60 A6 A6 A6 40 40 40 E1 03 F0 30 30 30
30 30 30 30 A1 DD
```

Reception time (or transmission time depending on the file) is at the beginning of each line, then the packet HEX representation follows. The full AX-25 packet is represented, also including the FCS at the end.

9 Support

For support, please contact:

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