J-STAR
FULL SPECTRUM
DIAGNOSTIC SOFTWARE

TECHNICAL & USER'S MANUAL

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2 OVERVIEW

J-STAR is a limited function, diagnostic topside for EdgeTech Full Spectrum® chirp sonar systems. J-STAR supports both sub-bottom and side scan sonar systems. It is furnished as an aid to help verify correct EdgeTech Full Spectrum® Sonar operation prior to or during deployment. J-STAR includes the following capabilities:

- Up to three waterfall data displays.
- Frequency data analysis for advanced system diagnostics.
- Data recording and playback.
- Limited thermal printer support for waterfall data output
- NMEA GPS navigation input
- Sonar command and control
- Sonar diagnostics

J-STAR is supported under Microsoft's Windows 98, Windows NT 4.0 (or higher), and Windows 2000 operating systems. J-STAR may be used standalone, as a control and monitoring function, or in addition to other topsides such as TEI's *(Triton Elics International)* ISIS and Delph seismic topsides.

The data and control connections to the J-STAR program are entirely through TCP/IP connections, allowing the J-STAR program to run (executed) on any Windows 98 / NT / 2000 based computer that can establish a TCP/IP connection to the EdgeTech Full Spectrum® sonar system. This connection may include, but is not limited to, computers connected directly using a crossover cable, computers connected via a standard Ethernet hub, or computers connected using the EdgeTech STARMUX™ digital telemetry link and FS-IU (topside Interface Unit). J-STAR can also be run on the actual EdgeTech Full Spectrum® sonar system computer.

EdgeTech Full Spectrum® sonar systems employ advanced Chirp technology to obtain high resolution, low noise data records. EdgeTech's advanced Chirp technology employs

long duration, wide band frequency modulated transmit pulses. Return sonar echo data is processed to remove the FM carrier, and produce high-resolution images of the echo field. J-STAR allows monitoring of this normal de-chirped sub-bottom and side scan data, as well as raw chirped data. This latter data type is often useful for diagnostic purposes.

3 INSTALLATION

J-STAR STAR consists of a single executable file "Jstar.exe" and a standard Windows initialization file, "Jstar.ini". The initialization file stores user options and configuration parameters. If the file does not exist, then default values are used, and it will be created when the current settings are saved or the program is exited.

Installation consists of copying the "Jstar.exe" executable to a suitable directory on the Windows PC, e.g.: C:\Edgetech\Topside.

4 SETUP AND CONFIGURATION

The first time the J-STAR program is run, the configuration parameters of the system must be set.

4.1 NETWORK HARDWARE INSTALLATION & OPERATING SYSTEM SOFTWARE SETUP

If the J-STAR and sonar applications are run on the same computer, then this section may be skipped, as no network cable is required.

The J-STAR connects to the sonar via TCP/IP protocol and an Ethernet connection.

- Verify that a network cable is attached between the topside computer and the computer running the sonar applications.
- Check that the hardware link is established by looking on the back of the network interface card. Most have an LED that lights when the hardware link is established. Make sure to check the lights at both ends of the connection.
- Verify that the TCP/IP protocol is installed on you computer and that each computer has a valid TCP/IP address on the same subnet. The subnet is the first three numbers of the IP address. For EdgeTech Full Spectrum® sonar systems, the standard addresses are:

System Type	IP Address	Subnet Mask
FS-IU	192.10.0.100	255.255.255.0
FS-SB	192.10.0.100	255.255.255.0
FS-AU (Bottle)	192.10.0.100	255.255.255.0
FS-DW (Bottle)	192.9.0.101	255.255.255.0

Do not use the same address for the topside computer. IP address must be unique for successful communications. The network settings can be checked in the windows "Control Panel" under the "Network" icon.

- Ping the sonar computer. Use the ping command to verify that the computers are connected and that the operating system software is set up correctly. Open a "Command Prompt" window and type "Ping 192.10.0.100" for example (for an FS-IU system). If the ping times out then the connection has not been established.

4.2 NETWORK ADDRESS SETUP

There are two values that the J-STAR requires to connect to the sonar, namely:

TCP/IP Address

TCP/IP Socket

If J-STAR is to be run on a PC connected to the FS-IU topside interface computer, or on the FS-IU computer itself, the TCP/IP address will be determined by the configuration of the FS-IU software. This is normally 192.10.0.100 with a socket number of 1600. The "fsiu.ini" file on the FSIU computer contains the actual address and socket numbers.

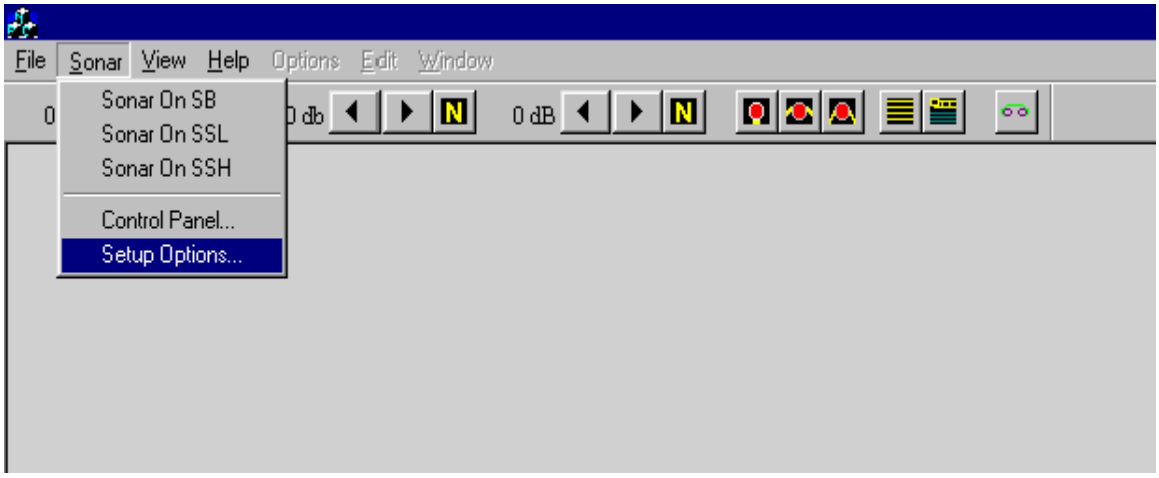
If J-STAR is to run on the FS-DW CPU itself, the TCP address will be that of the FS-DW application, which is normally 192.9.0.101 with socket number of 1700.

In either case make sure that no conflicting applications are attempting to access the sonar computer using the same socket number.

Having determined the correct TCP/IP address and socket values, proceed as follows:

Run J-STAR;

Access the SONAR pull down menu as shown below:



Select the “Setup Options” menu item and a set of options will appear. Select the "Network" tab to set the IP address and socket number.

Use the mouse to access the TCP/IP address and socket fields and set the correct values. The network indicator in the status bar at the bottom of the screen will change from blinking red to gray when the link to the sonar is established.

Important Note: J-STAR includes the ability to store and playback data files from the sonar. For playback only operation the network address need not be set. J-STAR automatically connects to the sonar upon startup. If J-STAR is used for playback, please be sure that it does not interfere with the normal runtime topside if both are on the same network.

The J-STAR program is now ready for use. To save any changes made above, select the “File / Save Configuration” menu item

5 BASIC CONCEPTS

5.1 SUBSYSTEMS AND CHANNELS

The EdgeTech Full Spectrum® sonar system provides control of, and data from, three subsystems. These subsystems are Sub-bottom, Side scan low and Side scan high. Each of these may be considered to be a quasi-independent subsystem of the EdgeTech Full Spectrum® sonar system, and each subsystem is allocated a subsystem number. See table below.

Each subsystem may provide up to two channels of data. Most EdgeTech Full Spectrum® sonar systems are configured to provide only **ONE** channel of Sub-bottom data. Associated with each of these receiving channels is a data stream, which is the echo data. This may be raw or de-chirped and ready for display. Each data stream is allocated a unique channel number.

The arrangement of these subsystems and channels is as follows:

Channel Type	**Subsystem Number**	**Data Channel Number**	**Frequency (Khz, typ)**
Sub-bottom	0	0	2-16
Sub-bottom (Optional)	0	1	
Side scan Low – Port	20	2	120 (75)
Side scan Low – Starboard	20	3	120 (75)
Side scan High – Port	21	4	410
Side scan High – Starboard	21	5	410

The subsystem name and number are important in determining control, and coupling and triggering modes.

The data channel numbers are important when determining which of these six streams are to be displayed on J-STARs three display screens.

5.2 TRIGGERING AND COUPLING

Each subsystem may be independently, internally triggered at a user specified fixed rate, regardless of inter channel interference problems. To avoid mutual interference, provision is also made to trigger **each** system as follows:

Trigger Modes: (applicable to each subsystem)

Internal Trigger: In this mode the user may specify the ping rate in Hertz (e.g. 3Hz) or ping range (in Meters). The system will use the closest available inter-ping interval (e.g. 332.99ms), and repeatedly re-trigger the subsystem at the expiration of this period.

Coupled Mode: This mode applies only to a combined sub-bottom and side scan system. In coupled mode the applicable subsystem is triggered when the master subsystem triggers. The trigger timing for coupled systems takes account of differing transmit pulse lengths and minimizes inter channel interference.

Gated: Gated and internal trigger modes are similar in that an internal timer determines the trigger rate. However, in gated mode a hardwired trigger input line is monitored. Whenever the trigger line is asserted (active low), the trigger is inhibited for the trigger delay period (as described below). If the next ping time is longer than the specified delay, then the asserted trigger input has no effect.

External Trigger: In this mode the subsystem is triggered by the external event received via one of the three external trigger signals. When the hardware trigger is asserted (active log) a new ping occurs.

Note that there is a minimum trigger interval (maximum rate) of each subsystem which is dependant on the Pulse Type used, and is proportional to the pulse length. That is, a longer pulse will also set a longer minimum interval, to keep the ON|OFF duty cycle of the Power Amplifier below the maximum allowed, typically 1:10. The actual trigger interval used will be the LARGER of the user interval and the Power Amplifier imposed limit.

5.2.1 Typical Setup: #1, No External Trigger

Sub-bottom (Subsystem 0) Internally Triggered, free running at 3 Hz.

Side Scan Low (subsystem 20) Coupled to Subsystem 0

Side Scan High (subsystem 21) Coupled to Subsystem 0

In this case the Sub-bottom system sets the pace, and the side scan channels are slaved to this. Other 3rd party, systems may be synchronized by using the FS-DW trigger OUT features.

In this case, stopping the Sub-bottom system will cause all subsystems to halt.

5.2.2 Typical Setup: #2, External Trigger

Sub-bottom (Subsystem 0) Coupled to Subsystem 20

Side Scan Low (subsystem 20) Externally Triggered.

Side Scan High (subsystem 21) Coupled to Subsystem 20

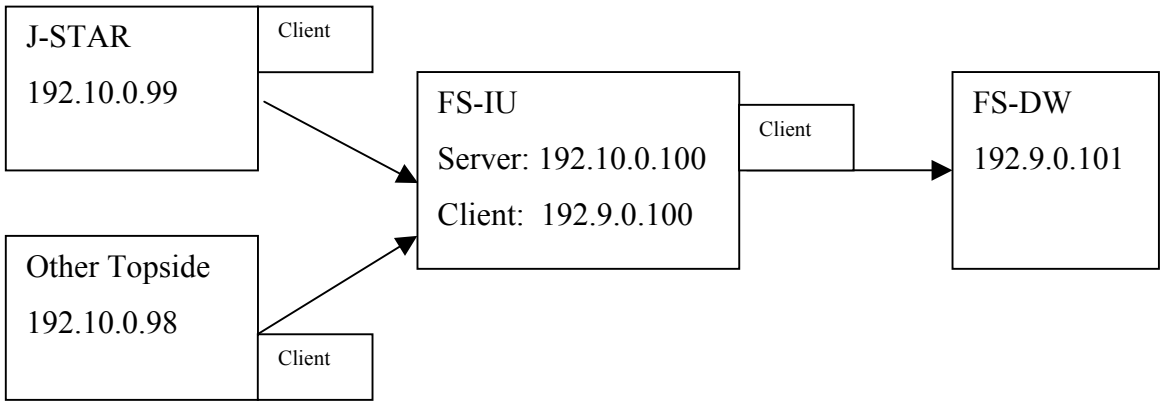
In this case the external Trigger IN sets the rate for the Side Scan Low. The Sub-bottom and Side Scan High subsystems are coupled to the Side Scan Low. Stopping the Side Scan Low, will stop the Sub-bottom and Side Scan High.

5.3 NETWORK CONNECTIONS

Communications between applications, such as the Sonar / FS-IU / J-STAR is via standard TCP/IP sockets. In a connection oriented socket there are two parties, the server, which "listens" for connection requests and accepts connections; and the client, which "connects" to the server. In order to communicate between two computers, each computer must have:

- A NIC (network interface card) Ethernet card.
- A cabled connection, typically via RJ-45 connectors and Category 5 cable.
- A valid TCP/IP stack installed in the software
- A common TCP/IP subnet address (or appropriate gateway translators).

Pictured below is a typical connection scenario:


J-STAR
192.10.0.99
Client
Other Topside
192.10.0.98
Client
FS-IU
Server: 192.10.0.100
Client: 192.9.0.100
Client
FS-DW
192.9.0.101

6 NORMAL OPERATION AND CONTROL

6.1 DISPLAY SUMMARY

The normal J-STAR display consists of the following:

- Main Sonar Data Displays
- Pull Down Menus for Command and Control
- Toolbars for frequently used commands.
- Status bar for sonar control and sonar data status.
- Control Panels - two sets of tabbing dialog boxes for modifying parameters.

These items are described in greater detail below.

6.1.1 Main Sonar Data Displays

The main sonar display is in the center. The components of the main display are:

Splitter Windows: The main display is split into sections three ways horizontally and two vertically. Each window can be resized by moving the mouse pointer to its splitter, then moving the mouse while holding down the left mouse button.

Waterfall Displays: Each of the three waterfall displays shows an independent waterfall view of the sonar data. When using a combined sub-bottom and dual frequency side scan display, one window is normally dedicated to each type of data.

Scope Displays: There is one scope display per waterfall display. Each scope display displays the waveform as an X-Y plot of the current sonar data. The scope display is a convenient method of adjusting the bottom tracker.

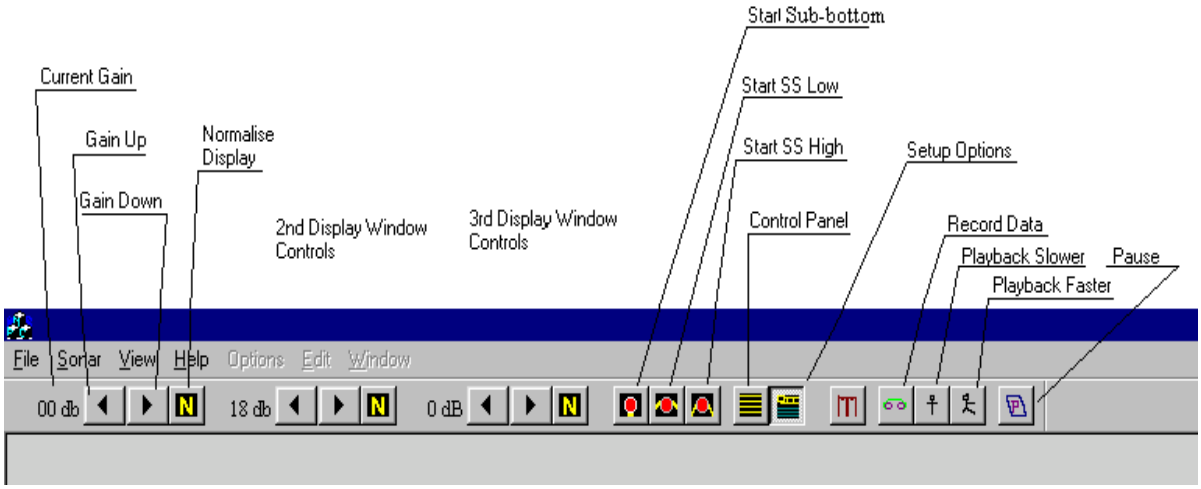
Sonar Data Cache: The data in the waterfall display is cached. Using the mouse a region can be selected to zoom in or out on the data or the scroll bars can be used to pan around inside the data set. Moving the mouse over a sonar data record in the waterfall will display information specific to that record in the status bar.

6.1.2 Pull Down Menus

Pull-down menus are provided for basic commands. The commands are summarized in the appendix. The main control of the J-STAR is via the control panels, which will be described later. The pull-down menus are rarely used during normal operation.

6.1.3 Toolbars

Toolbar buttons provide shortcuts for some of the most common control panel items. All items in the toolbar are duplicated in either a menu item or control panel item. Most of these options are summarized below:



Setup Options: This provides a short cut to the setup dialogue mentioned in section 4.2

Control Panel: This activates the main Control Panel, which allows user configuration of the displays (Size and Position) and the data to be displayed in each of the three available windows. See the description of the main control panel.

Start SS High, SS Low and Sub-bottom: Each of these activates the respective subsystem. Pressing this button will toggle between pinging on and off for this subsystem. These controls are ONLY active if the relevant subsystem is enabled for control, where the J-STAR is the master controller for the FS-DW. See the section detailing the control Panel tabs.

Normalize Display: This recalculates the scale factor, which is applied to the data prior to displaying it. This scale factor is chosen to cause the Peak value of the return to just reach maximum intensity on the displays, when the Associated gain value is set to 00dB. The scale factor is recomputed for each press of the normalization button.

Gain Setting: The gain setting should normally be set to 00 (dB). This will cause data with similar amplitudes to be correctly displayed once the Normalize button is pressed. Increasing the gain will cause the data to be further amplified in the display. Decreasing the gain has the opposite effect. The gain may be adjusted from -40dB to +40dB. Gain values between -20dB and +20dB tend to be the most useful.

6.1.4 Status Bar

The status bar consists of 2 lines at the bottom of the display. Included in the status bar are the following:

GPS Status: Indicates whether valid position information is being received from a GPS (navigation device).

NET Status: Indicates whether J-STAR is connected to the sonar.

Storage Status: Indicates whether J-STAR is recording data to a file, playing back or is idle.

Altitude Status: Indicates the estimated altitude above the seabed of the sonar. This is based on the selected bottom tracker.

Context Sensitive Help: Provides help or status information about the item that the mouse is pointing to. When the mouse is positioned over a waterfall or scope display, this displays sonar information specific to the mouse position. The information displayed can be customized in the "Status" tab of the Control Panel.

Run Time Status Line: Displays sonar status information about the most recent sonar return. This can include ping number, other sonar statistics, or GPS position information. The information displayed can be customized in the "Status" tab of the Control Panel.

6.1.5 Control Panels

There are 2 control panels, which are titled “Setup Options” and “Status and Control”. They can be enabled / disabled via the menu items “Sonar / Control Panel” and “Sonar / Setup Options”. The major tabs are described briefly below and again in greater detail in the Appendixes. When an option is modified the change takes effect when the “Enter” key is pressed or the edit cursor is moved to another field.

6.1.5.1 Setup Options

D0, D1, D2: There is one tab for each of the three waterfall displays. D0 is the highest display on the screen, and D2 is at the bottom near the status bar. The items on this page are used to select those display options that tend not to be changed often.

Status Bar: Used to select what is displayed on the status bar. For example, checking the “Lat/Long” item will display the current navigation fix in the status bar.

Network: Used to select the TCP/IP address for the sonar. Displays message statistics.

Nav: Used to select the serial port and baud rate for the GPS input. Displays details of the GPS data stream for diagnostic purposes.

6.1.5.2 Status And Control

D0, D1, D2: There is one tab for each of the three waterfall displays. D0 is the highest display on the screen, and D2 is at the bottom near the status bar. The items on this page are used to select options that are more likely to be altered.

SB, SSL, SSH: There is one tab for each sonar subsystem, “SB” for Sub-bottom, “SSL” for Side Scan Low Frequency, and “SSH” for Side Scan High Frequency.

Misc: Displays pitch / roll data, inserts event marks into recorded data, and selects the overall display units.

Printer: Controls the hardware printout. Currently only the primary display D0 can be printed.

Disk: Record and playback controls.

Graph: Time and frequency analysis graphs of any sonar data channel.

6.2 COMMON CONFIGURATION OPTIONS

6.2.1 Setup Options

The control panel allows user access to display configuration options of the system. Clicking on the Tabs (D0, D1, D2, Network, etc.) at the top will select that control pane.

6.2.1.1 Display Setup

Select a display tab (e.g.: D0).

6.2.1.2 Configure Side Scan Displays

Check the "SS Display Enable" check box to display both port and starboard data on the same waterfall display. In this case, the adjacent channel is displayed as the starboard data. For example, selecting either 2 or 3 will display both channels 2 and 3.

6.2.2 Control Panel

The control panel allows user access to the display and control configuration options of the system. Clicking on the Tabs (D0, D1, D2, SB etc.) at the top will select that control pane.

6.2.2.1 Display Setup

Select a display tab (e.g.: D0).

6.2.2.2 Channel Setup

Use the channel spin button to select the display channels. It is located in the left center of the window. The mapping from channels to subsystems is as follows:

Sonar Item	Display Channel Number
Sub-bottom	0
N/A	1
Side Scan Low, Port	2
Side Scan Low, Starboard	3
Side Scan High, Port	
Side Scan High, Starboard	5

6.2.2.3 Gain Control

The Normalize push button is the same as the Normalize toolbar button and is used to set the overall display intensity level. The gain spin buttons provide fine manual control over the normalized gain level.

The TVG (time varying gain) spin buttons apply a gain that increases with depth and begins at the found bottom track position. The TVG should be set to zero if the bottom is not being tracked.

6.2.3 Sonar Setup

Select a sonar control tab (e.g. SB).

Set the total number of samples desired per ping ("Depth In Samples").

Set the ping rate or range in hertz / meters.

Turn pinging on ("Ping On" check box).

You should see data scrolling across the waterfall screen in the window previously configured for data from this subsystem.

6.2.4 Basic Data Recording

Select the "Disk" tab.

Use the "Record Settings" area to specify the base file name and folder where data is to be recorded.

Press the “Record” button to begin storing data. A sequence number is added to the file name specified above.

Press the “Stop” button to stop recording.

Press the “Record” button again. A new file is created with the same base file name but the next sequence number.

6.3 BASIC DISPLAY CONTROL

Move the mouse to the axis label of the display. This is located between the waterfall and scope displays.

Zoom out: Click once to zoom out to full range.

Zoom in: Move the mouse to the top of an area you wish to zoom in on. Press and hold the left mouse button. Drag the mouse to the bottom of the zoom in area. Release the mouse button.

Scroll up and down: If not fully zoomed out, use the scroll bar on the right of the display to pan up and down in the display area.

Bottom tracker control: Move the mouse to a scope window near the first bottom return. Click once. A green horizontal line will indicate the new current bottom track position. A red vertical line will indicate the bottom track threshold. See the appendix for additional details on control of the bottom tracker.

7 DIAGNOSTIC APPLICATIONS

The J-STAR program may be used to assist in diagnosing many FS-DW system problems. The ability of the J-STAR program to operate the FS-DW system independently of any 3rd party topside display provides a means for testing the stability of the FS-DW system controls, data flows, and data integrity. In the event there is any question arising regarding the quality of FS-DW data, the J-STAR program should be used in a *standalone* mode to help isolate possible sonar problems from those related to your main control topside.

Important Note: After completing diagnostics with the J-STAR it is recommended that the sonar computers be rebooted to reset them to default values.

Some typical uses of the J-STAR are described below. Each use requires somewhat different parameter settings. It is often useful to have several copies of J-STAR in separate folders. Each folder will have its own JStar.ini file with independent settings.

7.1 RUB TEST

A rub test provides a rough check, of operation of a sub-bottom hydrophone or side scan array. When performing a rub test it is recommended that you display processed data (envelope data format). To perform a rub test:

- Start the J-STAR and verify that it is connected to the Sonar.
- Set the appropriate settings in the desired sonar control tab and turn pinging on.
- Data should begin scrolling on the waterfall display.
- Normalize the display.
- Set the gain between 0 – 3dB
- Rub the appropriate sensor.
- You should see increased signal return.

You should perform a rub test at least once when the system is operating properly, so that you are familiar with the expected display behavior when the system is rubbed.

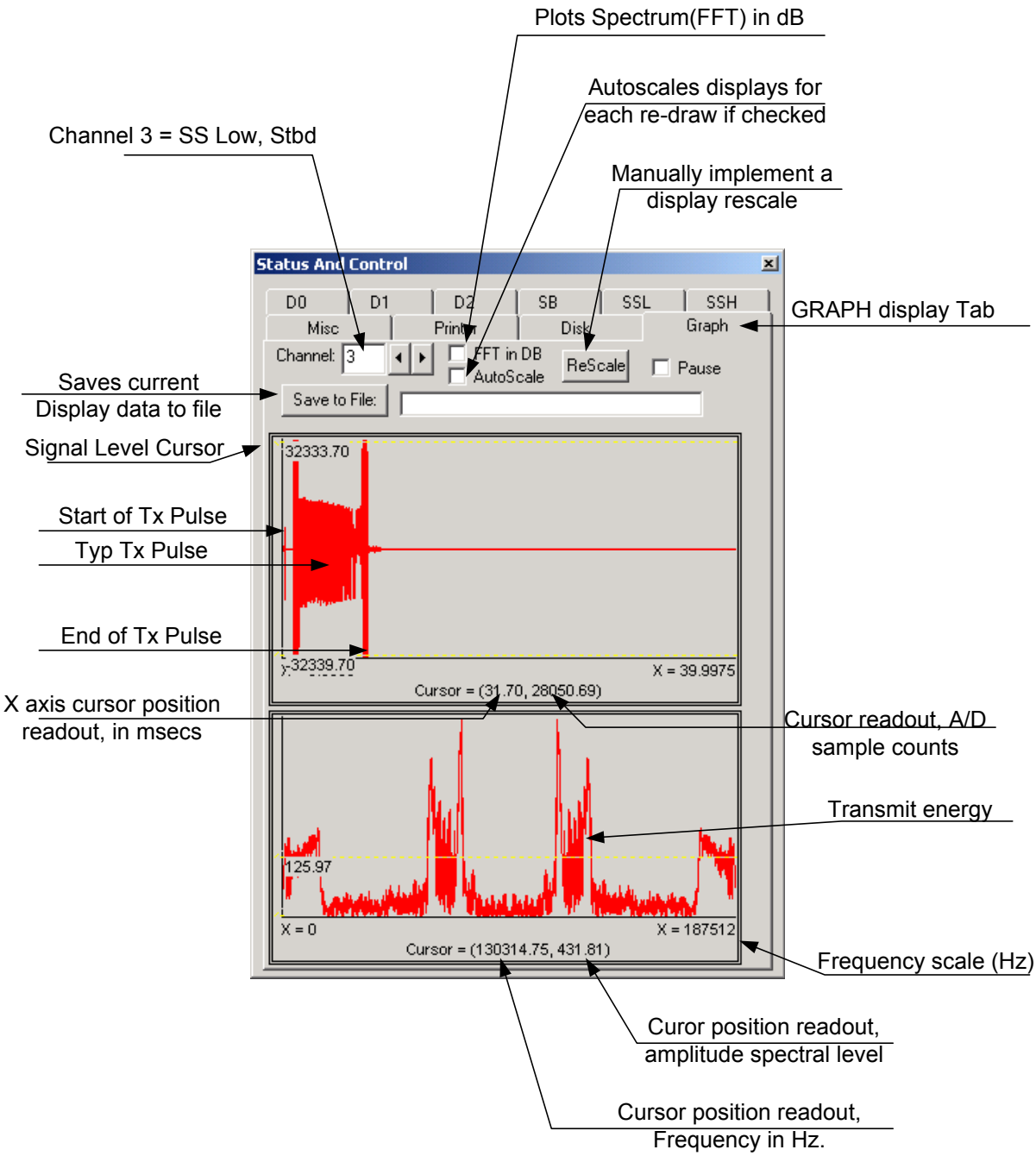
7.2 FREQUENCY PLOTS AND RAW DATA TIME SERIES ANALYSIS

The ability of the J-STAR program to request and display raw data (directly from the ADC converter) for each data channel is invaluable in diagnosing many FS-DW potential failure modes. Raw data (as opposed to processed and chirped data) allows direct interpretation (via scope like display). This helps to determine noise levels, and the proper operation of, transmit power electronics. The J-STAR program also assists interpretation with FFT analysis, that show interfering noise sources by frequency distribution and spectral amplitude.

The J-STAR program may also be used to acquire raw data from any subsystem, and log this data to disk for offline analysis. Having recorded raw data available for analysis by EdgeTech engineers will often speed up the resolution of suspected problems. Such files may be sent to EdgeTech in CDROM format or if small as email attachments. Many system control and setup parameters are recorded in these raw data files which will assist in problem diagnosis.

The Graphics tab on the Control Panel will display any channel of data and its FFT (frequency spectrum).

- Start the J-STAR
- Turn pinging on for the desired channel.
- Go to the Graphics Tab
- You should now see something like the following figure:



Raw Graphic display of a Side Scan Channel

The above figure show a typical raw data display for a side scan channel. The top half of the graph display shows one thousand samples of the raw ADC (analogue to digital converter) output, plotted as time vs. amplitude on the X –Y axes.

The lower half shows a frequency analysis (FFT) of the time series in the top half. The axes are Frequency (Hz) vs. Amplitude (x - y).

This raw data display was obtained by first setting the Side Scan Low system to send raw data (as opposed to de-chirped envelope data).

Display Description: (Refer to figure above for item/check box locations)

Channel Selector: [Edit Box] Accessed using the mouse / cursor. Type in the desired data channel to display:

0 = SB - sub-bottom

2 = SSL - Side Scan Low Port

3 = SSL - Side Scan Low Starboard

4 = SSH - Side Scan High Port

5 = SSH - Side Scan High Starboard

FFT in dB: [Check Box] If checked displays the FFT amplitudes in dB (a logarithmic display scale). If unchecked displays vertical scale as linear spectral amplitudes.

Autoscale: [Check Box]. If checked the displays are re-scaled for EACH redraw / data update, so that the min / max amplitudes of the current data span the available display range. This can be confusing to the eye if the amplitudes of the signals vary greatly from ping to ping, as each display will appear to have the same amplitude unless the axes values are carefully observed. It is SAFEST to leave this unchecked, and manually ReScale as required.

ReScale: [Push Button] A one time (for each push) activation of the display re-scale function. (See above description)

Save to File: [Push button and Edit Window]. The displayed graph data can be saved to a disk file for sending to EdgeTech Tech Support, for analysis. Enter a file save name in the edit window. (Hint, Use the pause check box to freeze the display, to make sure of the

data being saved.) NOTE: ONLY the data being displayed is saved, i.e. channel 3 in this case. No other channels are saved.

Signal Level Cursor: These 2 yellow lines can be dragged vertically to mark and display amplitude levels. For raw data, the amplitudes are in A/D counts. The ADC values are represented in 16 bits, which allows for 65536 discrete levels. These are interpreted as bipolar signals with an amplitude range of +/-32767.

Raw Data Display: All the raw data acquired by the A/D subsystem is displayed in the top window. The A/D capture sequence begins immediately prior to the start of the Transmit pulse for the channel (= 0). The entire transmit pulse (which is unavoidably coupled into the receive channel) is visible in the early part of the display. Following the transmit pulse (= 8.3msecs in this case) the lower amplitude received echo data is visible. The A/D converter is overloaded during the Transmit pulse by the extremely large amplitude signals injected into the receiver. For this reason, the signal may appear to collapse slightly during the Transmit pulse, but the display should show +32767 and –32767 amplitudes during the Transmit interval. See the figure below for raw data display where the Transmit power for the channel is set to zero.

In this case transmit power for the side scan channel has been set to zero in the SSL control tab. The Power Amplifier turn on and turn off transients, are still visible in the time record and indicate that the power to the amplifiers is good, and that the power amplifier on/off control is working correctly. The absence of transmit energy would indicate a failure in the transmit signal generator, if the power were not intentionally set to zero.

7.3 SECONDARY TOPSIDE OPERATION

The FS-IU will replicate data streams and interface to multiple topsides. This makes it possible to use the J-STAR as a data display monitor with no sonar control. Note that this requires that the J-STAR connect to the FS-IU. The main Sonar application supports only one connection. To configure the J-STAR as a monitor only program, do the following:

- Make sure you are disconnected from the sonar (e.g. unplug the network cable)
- Start the J-STAR.
- Go to each sonar control tab (all 3) in the Control Panel and verify that the "Enable Sonar Control" check boxes are NOT checked.
- Go to the network tab in the Setup Panel and verify that the assigned network address and socket number do not interfere with your primary topside. The fsiu.ini file specifies the number of topsides and their socket addresses.
- Exit and restart J-STAR
- Reattach the network cable

As long as the "Enable Sonar Control" boxes remain unchecked the J-STAR will remain in a passive monitor only mode. Use the main topside to control the sonar and monitor the data with the J-STAR's displays.

Note that multiple topside connections will increase network bandwidth requirements. To limit bandwidth, use the "Enable" check boxes on each sonar control tab. Only check the boxes for the data desired.

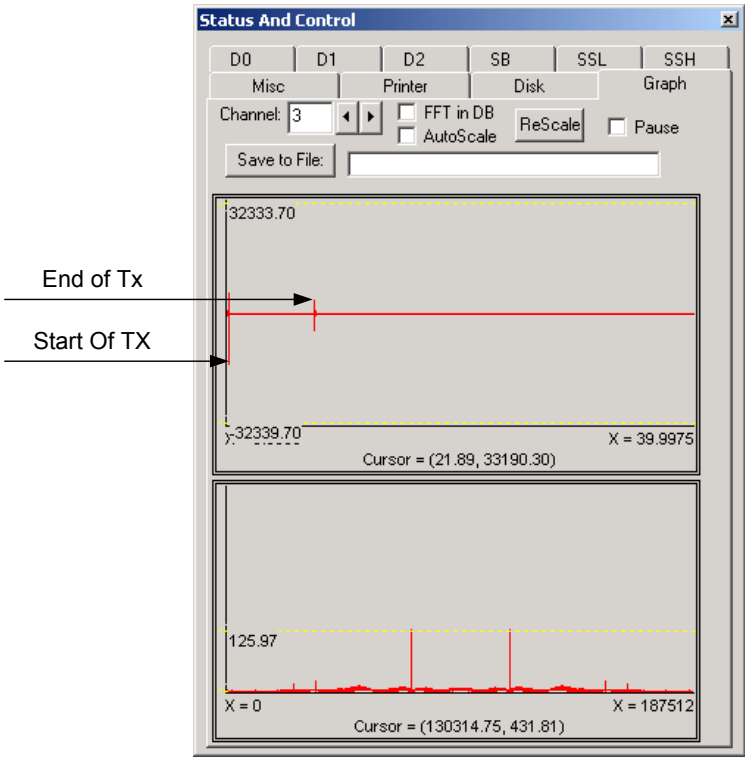


Figure : Raw Graph Display, with transmit power set to 0%

8 APPENDICES

8.1 SONAR TRIGGERS

8.1.1 Trigger Rate

The following sonar parameters effect the trigger rate:

Trigger Mode: EdgeTech Full Spectrum® chirp sonar systems support 4 trigger modes, as defined below:

Internal Trigger: An internal timer is used to trigger the sonar. The ping rate (in Hz) or ping range (in Meters) determines the frequency of the timer.

External Trigger: An external trigger line triggers the next ping. When the hardware trigger is asserted (active low) a new ping occurs.

Coupled: This mode only applies to a combined sub-bottom and side scan system. In coupled mode, the subsystem is triggered when the master subsystem triggers. For example, if sub-bottom is coupled to side scan low then when side scan low is triggered the sub-bottom is also triggered.

Gated: Gated and internal trigger modes are similar in that an internal timer determines the trigger rate. However, in gated mode a hardwired trigger input line is monitored. Whenever the trigger line is asserted (active low), the trigger is inhibited for the trigger delay period (as described below). If the next ping time is longer than the specified delay, then the asserted trigger input has no effect.

Trigger Delay: Delays the trigger event. In coupled or external trigger modes, a positive trigger delay will cause the outgoing ping to be delayed by the Trigger Delay amount. In gated mode, the trigger delay determines the period of time to delay the ping after the trigger in is received.

Trigger System: Master subsystem for coupled trigger modes.

Ping Rate or Range: Specifies the ping rate in hertz or ping range in meters. This parameter will only effect the true ping rate in internal or gated trigger modes. In coupled mode, this parameter is ignored and the ping rate is determined by the master subsystem. This value is also used to determine the expected amount of data to return per ping. In external trigger mode, the ping rate must be less than the actual trigger rate or data will be lost. Partial data records are not sent to the topside host for display. If a range is specified the actual ping rate must accommodate the full pulse duration.

Maximum Ping Rate: This is a pulse dependent item. Each pulse has a maximum ping rate, which cannot be exceeded. Higher ping rates are ignored.

Data Window Size: The data window determines how many samples are returned per ping. The special value of 0 returns the maximum amount of data per ping. If the amount of data requested is greater then the ping rate or range setting will allow then the ping rate is reduced to accommodate the requested amount of data. In coupled mode however, the window size is reduced instead if it is too large for the master subsystems ping rate.

8.1.2 External Trigger Input and Output Lines

EdgeTech Full Spectrum® chirp sonar systems supports 3 external trigger lines:

Trigger A

Trigger B

Trigger C

Any of these can be programmed to be either an external trigger input or trigger output for any subsystem. The sonar program has an initialization file, 'Sonar.ini' which determines how they are used. If programmed as a trigger output, the trigger out line can also be specified as either active low or active high, by a 'Sonar.Ini' parameter.

As a trigger input, a trigger event is detected on the negative edge of the line. A trigger input must be inactive (high) for a minimum of one millisecond. When asserted (active low), must be held low for a minimum of one microsecond.

8.2 J-STAR USER INTERFACE ITEM DEFINITIONS

8.2.1 Waterfall Display

Item	Description
Waterfall Data	Displays the intensity of sonar return data. The display is cached so that data can be repainted when zooming or panning and statistics of the data can be displayed.
Mouse: Zoom Out	Click and release the left mouse button to zoom out on the display so that all data is displayed.
Mouse: Zoom In	Press the left mouse button and drag to select a zoom in region.
Scroll Bar	Scroll up or down to pan around inside the waterfall.
Mouse: Current Statistics and Information.	Move the mouse pointer to a ping and the selected status information will be displayed in the main status bar.
Dashed Line	A dashed line on the waterfall indicates that an event mark or annotation is present at that position.
Green Line	A green line is drawn 1 display unit above the current bottom track position.

8.2.2 Scope Display

Item	Description
Scope Plot	Plots the current trace in an x – y plot.
Red Vertical Line	Indicates the current bottom track threshold
Green Horizontal Line	Indicates the current bottom track position.
Blue Horizontal Lines	Indicates the bottom track range.
Scroll Bar	Scroll up or down to pan around inside the waterfall.
Mouse: Current Statistics and Information.	Move the mouse pointer to a ping and the selected status information will be displayed in the main status bar.
Mouse: Set bottom track position and threshold	Click and release the left mouse button to set the current bottom track position and threshold
Mouse: Set bottom track range	Press the left mouse button and drag to select the bottom track range. If only a very small drag is performed then the track range is set to zero and the tracker is disabled.

8.2.3 Main Status Line

Item	Description
GPS Status	Displays the status of the GPS input. If GPS is not being received blinks red (alert state), otherwise it is gray.
Network Status	Displays the status of the sonar TCP/IP link. If not connected blinks red (alert state).
Record Status	Displays the status of the disk recording. If not recording blinks red (alert state).
Altitude Status	Indicates the altitude above bottom as determined by the selected bottom tracker. If too close to the bottom blinks red (alert state).
Current Mouse Position Status / Help	Displays help on the control that the mouse is on or statistics about the ping the mouse is pointing to.
Current Run Time Status	Displays information about the current ping (e.g. GPS fix, ping number, signal strength, etc) as specified in the "Status Bar" options page.

8.2.4 Toolbar

Item	Description
Gain Control: Up / Down	Increases or decreases the gain for any of the three displays. Use right mouse click to reset to reference.
Gain Control: Normalize	Re-scales data so that maximum value is maximum display intensity.
Ping On / Off	Turns pinging on and off for any of the three displays.
Show Control Panel	Displays and or hides the control panel.
Show Setup Panel	Displays and or hides the setup panel.
Insert Mark	Inserts a new mark and increments the mark number.
Toggle Record or Playback	Toggles between disk record and idle, or if in playback mode, pauses playback.
Playback slower	Slows down the playback rate.
Playback faster	Speeds up the playback rate.
Printer On / Off	Turns the waterfall printout on and off.

8.2.5 Pull Down Menus

Item	Description
File / New Mark	Inserts a new event mark and increments the mark number.
File / Record to file	Toggles between disk record and idle, or if in playback mode, pauses playback.
File / Playback slower	Slows down the playback rate.
File / Playback faster	Speeds up the playback rate.
File / Printer On / Off	Turns the waterfall printout on and off
File / Save Configuration	Save current settings in JStar.ini
File / Exit / Don't Save Settings	Exits without saving settings.
File / Exit – Save	Exits and saves current settings in JStar.ini
Sonar / On SB , SSL, SSH	Turns pinging on and off
Sonar / Control Panel	Displays and or hides the control panel
Sonar / Setup Options	Displays and or hides the setup panel
View / Toolbar	Displays and or hides the toolbar
View / Status Bar	Displays and or hides the status bar
View / Gain Up – Down - Reset	Modifies current gain
View / Normalize	Modifies reference gain.
View / Zoom	Zooms in and out in waterfall
Help / Topics	Displays on line help (if present)
Help / About	Displays current J-STAR version information.

8.2.6 Control Panel

8.2.6.1 Sonar Control (SB, SSL, SSH)

Item	Description
Enable Sonar Control	When checked, parameters on this page are sent to the Sonar when they are modified. When not checked, the J-STAR is in passive observer mode. In this case it will receive data but not send sonar commands.

Ping On	When checked, the subsystem is enabled to ping.
Transmit: Pulse	Currently selected transmit pulse.
Power: C0%, C1%, C2%	Pulse power level (0 to 100 %). For a side-scan system C0 is Port, C1 is Starboard and C2 is unused.
Receive: Gain C0, C1	ADC Gain setting. This is only supported for a sub-bottom subsystem.
Receive: AGC0, AGC1	Enable automatic gain algorithm if checked. This is only implemented for sub-bottom. When enabled the AGC will adjust the gain so that dynamic range is preserved in the receive data, by modifying the true gain.
Receive: Enable 0, Enable 1	When checked, data is sent from the Sonar to J-STAR. If not checked no data is received. Keeping these boxes unchecked reduces network bandwidth.
Receive: Envelope / Analytic / Raw	Select the type of data to receive from the Sonar. Envelope is recommended for side scan and analytic is recommended for sub-bottom.
Acquire: Initial Depth in Samples	Sets the data window. Samples before this value are discarded by the Sonar to reduce network bandwidth. This can be used to exclude the water column from the displayed and stored data.
Acquire: Depth in Samples	Sets the data window. If zero, indicates that all data for the specified ping rate / range are returned.
Acquire: Ping Rate / Range	Specifies the ping rate in hertz or ping range in meters.
Acquire: Internal / External / Coupled / Gated	See Trigger mode, section 8.1.1
Acquire: Coupled Mode System	Subsystem to be used as the primary trigger if mode is set to coupled. The value is that of the sub-system: 0 for SB, 20 for SSL or 21 for SSH
Acquire: Coupled Mode Delay	Trigger delay in msec.
Configuration: Subsystem	Refer to section 5.1 for settings
Status Line at Bottom	Shows the current actual ping rate as returned from the Sonar, the current ADC sample rate, the current ping numbers, current ADC pre-amp gain and current signal meter (ADC Max)

8.2.6.2 Displays (D0, D1, D2)

Item	Description
Gain Control: Norm	Normalize data. When pressed, the display data is re-scaled so that the maximum value of the next ping is set to display as maximum display intensity. When the normalization is completed, the Norm dB field is set to the new overall scale factor.
Gain Control: Gain	Gain in dB to apply to every pixel of data
Gain Control: TVG	Time Varying Gain in dB per 500 meters of depth to apply to the pixel data. The TVG is applied beginning at the seabed as determined by the bottom tracker and continues until the MAX value is reached.
Gain Control: MAX	TVG Maximum value in dB.
Gain Control: Norm dB	Current scaling factor for the data as computed when the Norm button is pressed. Increasing this value has the same effect as increasing the Gain.
Display: Channel	Sonar display channel to process (0: Sub-bottom, 2: Side Scan Low Port, 3: Side Scan Low Starboard, 4: Side Scan High Port, 5: Side Scan High Starboard.
Display: Zoom	Sub-sampling or replication factor for pixel data.
Bottom Tracker: Current Bottom	Current bottom in nominal display units. The bottom tracker adjusts this value when enabled. TVG is applied beginning at this position. Note that for a dual (side scan) display, a negative value indicates that the bottom tracker will operate on the first channel (usually port) and a positive value indicates that the tracker will operate on the second channel (usually starboard).
Bottom Tracker: Threshold	Minimum value required for a detected seabed bottom. The bottom tracker will not modify the current bottom unless the sonar return is above this value.
Bottom Tracker: Range	Search range from the current bottom in display units for the bottom tracker algorithm. A value above threshold must be within this range of the current bottom for the tracker to adjust the current bottom. If 0 then the tracker is disabled.
Bottom Tracker: Hold off	Minimum depth for the bottom tracker. The bottom tracker will not move the current bottom below this

	value.

8.2.6.3 Misc.

Item	Description
Calibrate Pitch Roll	Sends a recalibrate command to the EdgeTech furnished pitch roll sensor. Ignored if there is no such sensor installed.
Heave Estimation Scale Factor	Calibration factor for the heave sensor (if present). Nominal value is 1.0.
Display Units: Meters / MS / Samples	Sets the display user units for most displays. The waterfall axis will display the scale in these units.
Mark	When changed, a mark number / annotation will be inserted into the data stream.
Annotation	When changed, a mark number / annotation will be inserted into the data stream.
Status lines	Displays pitch / roll sensor detailed values and other custom diagnostic information.

8.2.6.4 Disk

Item	Description
Record	When pressed, begins recording data to the record file. The record file name includes a sequence number, which is incremented when recording begins.
Playback	When pressed, begins playback of data from the playback file.
Stop	When pressed, stops recording or playback. In the case of recording, the file is closed, and the next time the record button is pressed a new file will be created.
Pause	When checked disk IO is paused. When in the pause state, data to be recorded is discarded.
Status	Indicates the current state of disk IO. Indicates the true record file name when recording is active (including the sequence number).
Record Settings: File	Base file name for recording.
Record Settings: Dir	Base directory for recording.

Record Settings: …	Opens a dialog box to select the recording directory.
Playback Settings: File	Current file name for playback.
Playback Settings: Dir	Base directory for playback.
Playback Settings: …	Opens a dialog box to select the playback directory.
Playback Settings: Auto Playback	When checked, automatically sequences through files in the playback directory. Currently, sequencing only occurs when the Disk tab is visible.
Playback Settings: Playback Rate	Sets the playback rate in messages per second. A message is normally a channel of data. So, for example for side scan low, there will be 2 messages per ping.
Queue Status	Indicates the internal queue status of the record queue. The record queue holds the data pending to be written to disk. If the processor / disk combination is not fast enough for the data rate then data inside the queues could be dropped. This status line indicates whether the performance is adequate.

8.2.6.5 Printer

Item	**Description**
Printer On	When checked enables data output to the printer. Note that only the Raytheon TDU850 is currently supported as a printer type, and that only the data on D0 can currently be printed.
Status line	Indicates the depth of the printer queue. If the printer is not fast enough then data to be printed may be dropped in record mode. In this case the overflow count in the status will increment.
Decimation Factor	Positive value. A decimation of 1 will print every ping of data, 2 every other line, etc. For a slow printer increasing the decimation factor should reduce or eliminate printer queue overflows and provide a more uniform printout.
Printer Gain dB	Additional gain applied to the waterfall data prior to printing.
First Grey Level	First printable gray level in a scale of 0 to 255. This value is used to calibrate the printer / paper.

Last Grey Level:	Last printable gray level in a scale of 0 to 255. This value is used to calibrate the printer / paper.
Start Depth	Starting depth in display units for the printout.
Total Depth	Total depth in display units for the printout.
Grid Width in Traces	Spacing between grid marks in pings.
Grid Spacing	Spacing between grid marks down the page in display units.

8.2.6.6 Graph

Item	**Description**
Channel	Channel to graph data for. The default of 0 will display sub-bottom data.
FFT in dB	When checked, display shows the frequency graph in logarithmic scale in units of dB (20 * log10(value)).
Auto Scale	When checked re-scales the data on every ping. When not checked the previous display scale is used so that the relative return levels can be compared from ping to ping.
Rescale	If Auto Scale is not checked, does a one time re-scale (normalization) of the data.
Pause	Pauses the graphics displays so that they can be carefully examined.
Save to File	Saves the current ping of data to file for post run diagnostic analysis. The button is ignored unless a valid file name is specified. The file name is appended with a sequence number so that the data file name is unique and old files are not overwritten.
Top Graph	Displays time domain data. In the case of analytic signal data (complex), displays the envelope of the data.
Bottom Graph	Displays the FFT of the data in the gated region.
Mouse Operations: Zoom in	Press the left mouse button and drag to select a zoom in region. The FFT (frequency data) is displayed only for the selected / zoomed in region.
Mouse Operations: Zoom out	Press and release the left mouse button to zoom out by 50%
Mouse Operations: Cursor	The cursor text displays the x and y coordinates of the

value	pointer tip of the mouse. Note that for the frequency plot, the x coordinate is the frequency, and for the time plot, the x coordinate is the time in user units. The y coordinate for the time plot is the actual number of counts on the ADC converter if raw data is being displayed.

8.2.7 Setup Panel

8.2.7.1 Displays (D0, D1, D2)

Item	**Description**
Palette	Used to select a color palette file for data display.
Invert	If checked, the data is inverted prior to being processed by the palette.
Starboard Xtra Gain DB	For a dual (port / starboard) display, specifies the extra gain amount to be applied to the starboard channel to adjust display intensity. The gain and TVG values are otherwise applied to both port and starboard channels.
Heave Sensor Compensation Enable	If checked, the heave sensor readings will be used to adjust the display and printout.
Swell Filter in Pings	As an alternative to a heave sensor, a swell filter can be applied to the bottom track position and used to adjust the display and printout. A value of 0 disables the swell filter.
HPF Samples	High Pass Filter in samples. The mean value over the high pass filter extent is removed from the data. A value of 0 disables.
Median Samples	Applies a median filter of the specified number of points to remove shot noise. A value of 0 disables.
Clamp Neg Values to Zero	If checked, negative values (as a result of filtering or in the raw data) are set to 0. If not checked, the absolute value of each value is displayed.
Display Subsample Method: None / Avg / Max	If the display is zoomed out so that not all data can be displayed this selects what to do with the intermediate values. "Avg" will average them, Max will display the maximum value in each pixel bin.
Display Cache Lines	Number of pings to cache on the display. A lower cache

	size reduces memory requirements. A greater cache size allows more of or all of the screen to be repainted when zooming in and out or panning in the waterfall.

8.2.7.2 Status Bar

Item	Description
SB Ping / SSL Ping / SSH Ping	Displays the respective ping numbers on the main status line if checked
SB Signal / SSL Signal / SSH Signal	Displays the respective signal meter values in tenths of a percent on the main status line if checked.
SB Gain	Displays the ADC gain on the main status line if checked.
Lat / Long	Display the GPS position fix on the main status line if checked.
Course / Speed	Displays the GPS derived course and speed on the main status line if checked.
Time	Displays the GPS derived time on the main status line if checked.
Pitch Roll	Displays the pitch and roll reading on the main status line if checked.
Mark #	Displays the mark number and annotation on the main status line if checked.
Overflow Check	Displays the data overflow counter on the main status line if checked. If the overflow count increases then some data is being dropped, either inside the bottle or in the topside. It is normal to see this value increment when the pinging is turned on or off.
Sample #	Displays the sample # of the mouse pointer on the main status line if checked.
Depth	Displays the depth in user units of the mouse pointer on the main status line if checked.
Special Fields Check Boxes	These are user defined fields which can be displayed on the status line. For each check box there are several tuning parameters in the JStar.Ini file which specify (1) The label that appears here (2) The channel number that it applies to (3) The SEG-Y header data field offset to

	display (4) Whether this item is enabled or disabled.
Status Font Size	Used to select the font (text size) of the status display.
Bottom Tracker Display #	Display number (0, 1, or 2) for the Altitude display on the status line.
Warning Level	Altitude in user units at which the status line altitude will display a warning indicator if the bottom tracker altitude is less than. This may indicate a potential collision of the fish with the sea bottom.

8.2.7.3 Nav

Item	**Description**
Show	Refreshes the display of parsed navigation data in the pull down list when pressed.
Show Raw	Refreshes the display of raw navigation data in the pull down list when pressed
Baud Rate	Baud rate of navigation input.
Port Name	Communications port to receive navigation data on.
Status	Displays serial IO data statistics of the GPS serial port for diagnostic purposes.
Pull Down List	Displays parsed or raw serial data for diagnostic purposes.

8.2.7.4 Network

Item	**Description**
TCP/IP Address	Address of the sonar computer or FS-IU topside to connect to. This should be in the form of four digits separated by periods, e.g. 192.10.0.100
TCP/IP Socket	Socket number of the sonar computer of FS-IU topside to connect to. This should be a decimal integer and is typically 1600 for the FS-IU.
XMIT Buf Size	TCP/IP Socket transmit buffer size in bytes.
RECV Buf Size	TCP/IP Socket receive buffer size in bytes. Increasing this number can improve performance of the network interface.
Status Line	Displays the current status of the command and data

	sockets. If the connect count is odd (C=1 for example) then the socket is connected. When both the data socket and the command socket are connected then network status on the main status bar should change from blinking red to gray.

8.3 SONAR DATA FORMATS

8.3.1 J-STAR Sonar Data File Format

The J-STAR stores data in a variation of the SEG-Y format. The J-STAR variant eliminates the standard SEG-Y EBCDIC and binary reel headers, and adds a message header to the beginning of each trace header. A J-STAR standard format (JSF) file consists of a collection of trace records with the following components:

- A 16 byte message header
- A 240 byte trace header
- Trace Data

A J-STAR data file might also contain non-trace data messages. Applications other than J-STAR should ignore these and proceed to the next message header. Non trace data messages are not described here.

8.3.1.1 The J-STAR Message Header

The J-STAR has a sixteen byte long header that precedes every J-STAR message. It identifies the type and size of the message, as well as the originating subsystem and channel. Only messages of type 80 contain Sonar Trace Data.

Byte Offsets	Description
0 - 1	Marker for the Start of Header 0x1601
2	Version of Protocol used
3	Session Identifier
4 – 5	Message Type 80 = Sonar Trace Data
6	Command Type
7	Subsystem for a Multi-System Device 0 = Sub-bottom 20 = 75 or 120 kHz Side Scan 21 = 410 kHz Side Scan
8	Channel for a Multi-Channel Subsystem For Side Scan Subsystems 0 = Port 1 = Starboard
9	Sequence Number
10 – 11	Reserved
12 – 15	Size of following Message in Bytes

8.3.1.2 The J-STAR Trace Header

The J-STAR Trace Header follows the SEG-Y trace header where possible. Some SEG-Y fields that are not directly applicable to SONAR data have been replaced with fields that are.

Byte Offsets	Description
0 – 3	Trace Sequence Number within line (always 0)
4 - 7	Starting Depth (window offset) in samples
8 – 11	Ping Number (increments with ping)
12 - 15	Channel Number
16 - 27	Unused
28 - 29	ID Code (always 1) 1 = Seismic Data
30 - 33	Unused
34 - 35	Data Format 0 = 1 short per sample - Envelope Data 1 = 2 shorts per sample - Analytic Signal Data, (Real, Imaginary) 2 = 1 short per sample - Raw Data, Prior to Matched Filter 3 = 1 short per sample - Real portion of Analytic Signal Data 4 = 1 short per sample - Pixel Data / CEROS Data
36 - 37	Distance from Tow Fish to Antennae in Centimeters
38 - 39	Distance from Tow Fish to Antennae starboard direction in Centimeters
40 – 71	RS-232 Data

8.3.1.3 Navigation data

The representation of the navigation data depends on the coordinate-units field. For Latitude / Longitude representations a positive value designates east of the Greenwich Meridian or north of the equator.

Byte Offsets	Description
72 – 75	X in Meters Longitude in Seconds
76 – 79	Y in Meters Latitude in Seconds
80 – 83	X in Millimeters Longitude in 0.0001 Minutes
84 – 87	Y in Millimeters Latitude in 0.0001 Minutes
88 – 89	Coordinate Units 1 = X, Y 2 = Longitude, Latitude

8.3.1.4 Pulse Information

This data describes the outgoing pulse characteristics, as well as sampling parameters.

Byte Offsets	Description
90 – 113	Annotation String
114 – 115	Number of Samples in this packet Note: Large sample sizes require multiple packets.
116 – 119	Sample Interval in Nanoseconds
120 – 121	Gain Factor of ADC
122 – 123	User Pulse Power Setting (0 – 100) percent
124 – 125	Correlated Data 1 – No 2 – Yes
126 – 127	Starting Frequency in 10 * Hz
128 – 129	Ending Frequency in 10 * Hz
130 – 131	Sweep Length in Milliseconds
132 – 139	Unused
140 – 141	Alias Frequency

	(sample frequency / 2)
142 – 143	Outgoing pulse identifier
144 – 155	Unused

8.3.1.5 CPU Time

The time that the data was recorded.

Byte Offsets	**Description**
156 – 157	Year
158 – 159	Day
160 – 161	Hour
162 – 163	Minute
164 – 165	Second
166 – 167	Time Basis (always 3) (other not specified by SEG-Y standard)

8.3.1.6 Weighting Factor

The trace data is transmitted as sixteen bit integers in block floating point format. This saves bandwidth and storage space while preserving dynamic range. The weighting factor is applied to each of the sixteen bit integer values to restore the original floating point value.

Byte Offsets	Description
168 – 169	Weighting Factor defined as 2^{-N} volts for Least Significant Byte
170 – 171	Unused

8.3.1.7 Orientation Sensor Data

Byte Offsets	Description
172 – 173	Compass Heading
174 – 175	Pitch
176 – 177	Roll
178 – 179	Temperature (10 * degrees C)

8.3.1.8 User defined area from 180-239

Byte Offsets	Description
180 – 181	Heave Compensation offset (samples)
182 – 183	Trigger Source 0 = Internal 1 = External
184 – 185	Mark Number 0 = No Mark

8.3.1.9 NMEA Navigation Data

Byte Offsets	Description
186 – 187	Hour
188 – 189	Minutes
190 – 191	Seconds
192 – 193	Course
194 – 195	Speed
196 – 197	Day
198 – 199	Year

8.3.1.10 Other User Defined Data

Byte Offsets	Description
200 – 203	Milliseconds
204 – 205	Maximum Absolute Value for ADC samples in this packet
206 – 207	System Constant in tenths of a dB
208 – 209	Vehicle ID
210 – 215	Software Version Number
216 – 219	Initial Spherical Correction Factor (useful for multi-ping / deep application) * 100
220 – 221	Packet Number Each ping starts with packet 1
222 – 223	A/D Decimation before the FFT
224 – 225	Decimation Factor after the FFT
226 – 239	Unused

8.3.1.11 The J-STAR Trace Data

J-STAR trace data consists of sixteen bit integer values. The number of integers can be found by multiplying the number of samples in the trace by the number of integers per sample for the data type used.

Each of these integer values then needs to be scaled by the weighting factor.

8.3.2 J-STAR Palette File Format

Each display channel can have a color palette, which is specified by a .jsp (J-STAR Palette) file. These files are text files with numbers separated by white space. The numbers must be ordered in groups of 4. For each group the values are:

- Index (0 to 255)
- Red Intensity (0 to 255)
- Green Intensity (0 to 255)
- Blue Intensity (0 to 255)

The indices must be increasing in value. If there are gaps in the index then intermediate color values will be interpolated. Here is an example table for a linear gray step wedge type palette:

0 0 0 0

255 255 255 255

8.3.3 J-STAR Raw Data Capture Format

The Graphics tab has an option to capture it current data and save it to a file. This data is stored with no header as 32-bit floating point values (IEEE). The size of the file determines the number of samples in the trace.

8.3.4 Sonar Data Formats

The J-STAR supports three types of sonar data, which are useful to display.

Raw Data: Unprocessed data directly from the ADC. This data is useful for diagnostic purposes

Analytic Signal: Match filtered data. This data is complex and consists of real and imaginary pairs. Sub-bottom data is normally transmitted in this format because it contains additional frequency information not present in envelope data.

Envelope: This is the square root of the sum of the squares of the real and imaginary components of the analytic signal data. This is how waterfall data is normally displayed. Side scan data is normally transmitted in this format. Only ½ the bandwidth is required as compared to analytic signal data.

8.4 THEORY OF OPERATIONS

8.4.1 General

EdgeTechs' Full Spectrum™ Sonar system transmits FM pulses. This type of pulse has been used in radar and sonar systems for over 30 years and is sometimes referred to as a

"chirp" or swept frequency pulse. The advent of modern digital signal processing components has provided tools for realizing the full potential of this method.

Full Spectrum™ signal processing technology does not use a conventional matched filter (the correlation filter that is widely used to compress FM signals) to process wide band signals. Instead it uses proprietary amplitude and phase weighting functions for the transmitted pulse and a pulse compression filter that maximizes the SNR (signal to noise ratio) of the acoustic images over a wide band of operating frequencies. These functions provide a significant SNR improvement in the acoustic image over other impulse and chirp sonar with band limited components which are restricted in dynamic range.

The Full Spectrum™ acoustic projectors are constructed from wideband piston type transducers and the acoustic receivers are discrete line arrays of PZT crystals. The acoustic sensors are designed for profiling at ship speeds varying from zero (drifting) to 7 knots. Separate receiving and transmitting arrays are used to preserve linearity and to allow simultaneous transmission and reception.

The hydrophone arrays receive the low amplitude sub-bottom reflections. The received signal is then sent to a 24-dB gain preamplifier, located inside the pressure vessel. A Software controlled programmable gain amplifier provides a final amplification stage before the signal is digitized with a 16-bit A/D (Analog-to-Digital) converter at a sampling rate of 24, 40, 50 or 66 kHz depending upon the transmitted pulse. To achieve the theoretical temporal resolution predicted by the inverse of the bandwidth, the FM pulse is compressed using a special digital compression filter.

The correlation process is implemented in real time with forward and inverse Fast Fourier Transforms. The compressed pulse resulting from this signal processing procedure has a time duration approximately equal to the inverse of the bandwidth of the FM pulse.

High temporal resolution allows for the measurement of fine layering. Good resolution is an important factor in sediment classification because it provides a more precise impulse response of the sediment. Thus a realistic picture of the true geologic variability of the

seafloor and accurate determination of the depositional processes can be achieved. When the time duration of the processed pulse is too large, individual reflections will be lumped together with random phase causing constructive and destructive interference, thereby making it difficult to estimate the impedance and examine the geologic features.

In addition to the resolution improvement, correlation processing achieves a signal processing gain over the background noise. This gain is approximately ten times the log of the time-bandwidth product. The improvement is due to the signal having a time duration longer than the inverse of the bandwidth, thus increasing signal energy without increasing the power of the outgoing pulse. To equal the typical performance of the Full Spectrum™ sonar pulse, a conventional pulse sonar would have to operate at a peak pulse power 100 times greater than the Full Spectrum™ pulse with a time-bandwidth product of 100.

Another important feature of the Full Spectrum™-Sub Bottom sonar is that the computer generates a signal that optimizes the performance of the system. The sonar contains many components, each with a unique dynamic range and linearity characteristic, which are frequency dependent.

In addition to this, the amplitude spectrum of the outgoing pulse is chosen to be approximately Gaussian in shape to limit the sidelobe level and temporal resolution losses due to attenuation. As a wavelet with a Gaussian shaped spectrum is attenuated by the sediment, energy is lost but its bandwidth is nearly preserved. Thus even after being attenuated by sand, for example, the acoustic pulse has approximately the same resolution as an unattenuated pulse.

Another important feature of the Full Spectrum™ sonar is the reduction of sidelobes in the effective transducer aperture. The wide bandwidth of the swept frequency has the effect of smearing the side lobes of the transducer and thus achieving a beam pattern with virtually no sidelobes. The effective spatial beam width obtained after processing the Full Spectrum™ 2-10 kHz signal is 20 degrees measured to -3db points.

Another important feature is since the transmitted Full Spectrum™ pulse is highly repeatable and its peak amplitude is precisely known, the sediment reflectivity values can be estimated from the peak pulse amplitude measurements of the bottom returns.

8.4.2 Frequently Asked Questions

- How does the system interface to a navigation device?
- J-STAR interfaces with Navigation devices through serial NMEA input.
- How do the environmental conditions affect the performance of the system?
- Geological Conditions:

The J-STAR operating parameters and specifications are greatly affected by the geologic conditions that the acoustic energy transmitted from the vehicle encounters. A very dense geologic interface such as rock, coral, sand, stone, shell beds, etc, will limit the penetration into the sub-bottom. This is caused by the density interface reflecting most, if not, all normal incidence acoustic energy back to the receiver, resulting in little sub-bottom penetration.

Air / Water Interface:

The air / water interface reflects 99.8 percent of all acoustic energy it receives. It is therefor evident that when air or gas is encountered in the water column or sub-bottom geology the acoustic energy transmitted by the DW transducer will be reflected back to the vehicle resulting in little or no penetration beyond the air or gas interface.

Ship's Wake:

The ship's wake is a very turbulent area just behind the towing ship. When operating a towed acoustic device in or near the wake the transmitted acoustic energy encounters highly charged aerated water caused by cavitation of the ship's screws. If the DW series sensors are operated in this area, the acoustic energy transmitted into the aerated water is reflected back to its source, as in the case discussed in the preceding paragraph.

The DW series sensors are designed to operate in a horizontal position relative to the sea floor. The turbulence encountered when operated in or near the ships wake will cause

instability in the vehicle reducing the effectiveness of the output energy in penetrating the sub-bottom sediments.

Noise:

Operating other acoustic instruments, with frequencies within the system bandwidth, simultaneously with the system can result in data distortion.

Ship's motion:

The DW series sensors are designed to tow in a stable horizontal plane. Excessive ship motion can cause instability in the vehicles' attitude, resulting in reduced performance. Rough sea conditions, sharp turns made by the ship and any comparable external induced motions on the vehicle will have a similar effect on the system operation.