IMAGENEX MODEL 881A-GS
GYRO STABILIZED
MULTI-FREQUENCY IMAGING SONAR

APPLICATIONS:

- ROV, AUV, & UUV
- Manned Submersibles
- Search & Recovery
- Borehole/cave work
- Drop sonar
- Scientific Research

FEATURES:

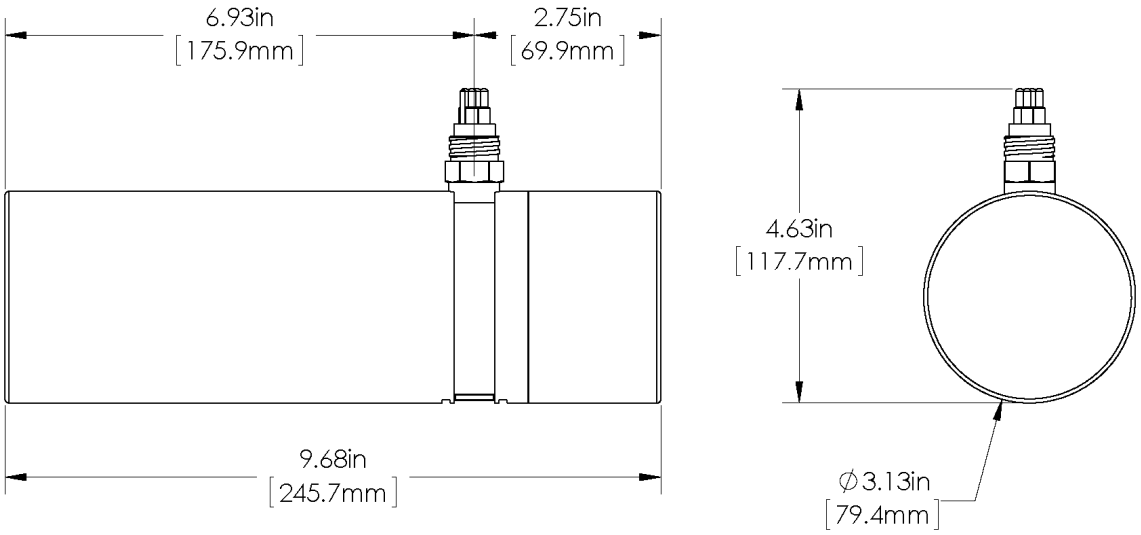
- Serial Communications
- Programmable (format available)
- Gyro stabilized transducer steering
- Simple set-up and installation
- Full scale range from 1 m to 200 m
- Orientation module

Gyro-stabilization of the Imagenex Model 881A-GS makes the high resolution 881A sonar into a system capable of crystal clear visualization of the ocean environment from moving platforms, no longer compromised by the blurring effects of host vehicle rotation. An advanced, low drift gyro is integrated directly into the sonar head, so the sonar can now compensate for vehicle motion in real time with unprecedented accuracy, stability, and robustness.

The enhanced capabilities of the 881A-GS have not compromised the performance of the 881A sonar. On short range, this sonar scans using a 2 mm range resolution, and can auto-adjust acoustic frequency and resolution to scan up to a 200 m radius, 360° surrounding area.

The Model 881A-GS still has low power, simple set-up, and small size that make it an ideal tool for large work ROV's and small inspection vehicles. On it's own it is now an amazingly simple drop sonar and borehole inspection package: just add a laptop computer and power supply and run the included Imagenex software.

HARDWARE SPECIFICATIONS:	
FREQUENCY	310 kHz, 675 kHz, or 1 MHz (standard default settings) -Other frequencies can be selected through programmable software configurations (Tunable from 280 kHz to 1.1 MHz in 5 kHz steps)
TRANSDUCER	Imaging type, fluid compensated
TRANSDUCER BEAM WIDTH	310 kHz: 4° x 40° 675 kHz: 1.8° x 20° 1 MHz: 0.9° x 10°
RANGE RESOLUTION	1 m – 4 m: 2 mm (0.08”) 5 m & up: 10 mm (0.4”)
ORIENTATION MODULE (accuracies):	
PITCH & ROLL	± 0.1° typical
HEADING (Magnetic)	± 1.0° typical
MIN. DETECTABLE RANGE	150 mm (6”)
MAX. OPERATING DEPTH	1000 m and 3000 m available
MAX. CABLE LENGTH	1000 m on typical twisted shielded pair (RS-485)
INTERFACE	RS-485 serial interface @ 115.2 kbps (or optional RS-232)
CONNECTOR	Side mounted, four conductor, wet mateable (Subconn MCBH4M-AS) Optional right angle or end mount connector
POWER SUPPLY	20 – 32 VDC at less than 7 Watts
DIMENSIONS (for both depths)	79.5 mm (3.13”) diameter x 245.7 mm (9.68”) length
WEIGHT: In Air **In Water**	1000 m unit: 1.6 kg (3.5 lbs) 3000 m unit: TBA 1000 m unit: TBA 3000 m unit: TBA
MATERIALS	1000 m unit: 6061-T6 Aluminum & Polyurethane 3000 m unit: Titanium, Polyurethane & 300 series stainless steel
FINISH	Hard Anodize



SOFTWARE SPECIFICATIONS:	Win881AL.exe
WINDOWS™ OPERATING SYSTEM	Windows™ XP, Vista, 7, 8, 10
MODES	Sector, Polar and Side Scan
GYRO MODES	North Up, Heading Up, Target Steering
RANGE SCALES	1 m, 2 m, 3 m, 4 m, 5 m, 10 m, 20 m, 30 m, 40 m, 50 m, 60 m, 80 m, 100 m, 150 m, 200 m
TRAIN ANGLES	Continuous rotation, 3° increments
SECTOR SIZE: **SECTOR MODE** **POLAR MODE**	 0° – 180°, 3° increments 0° – 357°, 3° increments, or Continuous rotation
STEP SIZES	Slow (0.3°), Medium (0.6°), Fast (0.9°), Faster (1.2°), Fastest (2.4°)
GRID TYPES	Polar and rectangular
FILE FORMAT	(filename).81R
RECOMMENDED MINIMUM COMPUTER REQUIREMENTS:	2 GHz Pentium 4 256 MB RAM 20 GB Hard Disk 1024 x 768 Screen Resolution

ORDERING INFORMATION:		
1000 m UNIT	Standard	881-000-400
3000 m UNIT	Standard	881-000-401
RS-232	Option	-006
End mount connector	Option	-009
Right angle connector	Option	-010
Gyro Stabilization	Option	-048

IMAGENEX TECHNOLOGY CORP.

Model 881A-GS
Gyro Stabilized Scanning Sonar

(Serial Version)

Quick Start

Number	430 - 031	
Revision	**Date**	**Description**
00	May 6, 2014	Release
01	January 22, 2015	Software update
02	July 6, 2015	Updated Gyro calibration description

Specifications subject to change without notice

Table of Contents

Table of Figures

Index of Tables

1.0 Introduction

The Model 881A-GS is an advanced gyro-stabilized, high-resolution scanning sonar system that has been designed to provide simple, reliable, and accurate representation of underwater images.

2.0 Getting Started:

The 881A-GS was designed to be user friendly and simple to set up in the field. It is generally recommended however to perform a preliminary setup before heading out into the field.

2.1 Step-By-Step Start Up Guide

1. Physically mount the sonar referring to S**ection 2.4** on **page 5** for details.
2. Ensure $24V_{DC}$@ 1A minimum power supply is off
3. Referring to **Appendix A – USB Converters and the Windows OS**, configure any necessary adaptors.
4. Connect the cable's DB9 connector to the PC's serial port.
5. Plug the underwater connector to the sonar.
6. Deploy to stable, flat location
7. Power up the 881A-GS.
8. Wait for gyro calibration to complete. The sonar, upon power up, will calibrate the motor, delay for 10 seconds and automatically perform a gyro calibration. No communication to the gyro sub system is available at this time.
9. Verify the "**Local Latitude**" setting in the ".ini" file and adjust if necessary. Refer to **Section 2.5.2** on **page 11** for details
10. Launch the "*Win881AL.exe*" program

    - If file playback is desired, use the menu command "*File->Open File to Playback*".
    - If real-time operation is desired, use the menu command "*File->Connect to Sonar Head*".

11. Proceed to **Section** 2.5 on **page** 6 for software instructions.

2.2 Gyro Calibration

All gyros are sensitive to the environment (i.e. temperature, motion, Earth's rotation, etc.) and will naturally drift with time. Therefore, from time to time, it is recommended to issue a gyro calibration (in manual mode) or recalibrate the motor (auto mode) to remove the accumulated drift.

2.2.1 Automatic Gyro Calibration

Imagenex Gyro enabled scanning sonars now incorporate an automatic gyro biasing feature which is selectable in the user program. This mode continuously re-bias's the gyro in real time accommodating for temperature fluctuations and internal drift. Refer to Table 2.1 on page 6 for details on enabling / disabling this mode. When first starting the sonar, the bias adjustment will be very rapid as the temperature stabilizes. While the gyro will still internally drift, the sonar image will be coherent, allowing the operator to continue to work. Note that the absolute heading will not be exact during this time as the sonar does not differentiate between induced drift and real movement. After a few minutes, re-calibrate the motor to realign the sonar and the transducer. This will reset the accumulated drift that occurred during the warmup period. It is recommended to periodically re-issue the calibrate motor command to reset the accumulated drift.

2.2.2 Manual Gyro Calibration

The information below describes the manual biasing mode which may be necessary in strong magnetic field environments.
Do not calibrate the gyro until the internal temperature of the sonar has stabilized, approximately 30-60minutes underwater.

1. Mount sonar on a level, stable surface, or settle the ROV on a flat bottom.
2. Under the "*Options*" Menu, select "*Calibrate Gyro*".
3. Standard sonar operation is suspended during gyro calibration.
4. The message "*Calibrating Gyro*" will appear. Calibration takes approximately 30secs.
5. Once the message disappears, standard operation commences.

When using **MANUAL** biasing, It is **ESSENTIAL** that the sonar is completely stationary and at constant temperature during gyro calibration. **ANY** movement will cause undesirable drift in the gyro.

2.3 Overview

While traditional scanning sonars provide excellent imagery, they have a significant short coming...they rely on the sonar being perfectly still during data acquisition. Imagenex has developed the ideal solution...the 881A-GS. Figure 2.1, below, shows a non stabilized image taken while the sonar was spinning. Note the wavy lines in the lower 2 quadrants. Now refer to the same area scanned with Gyro stabilization enabled (Figure 2.2, below). Now the image is well defined and straight.

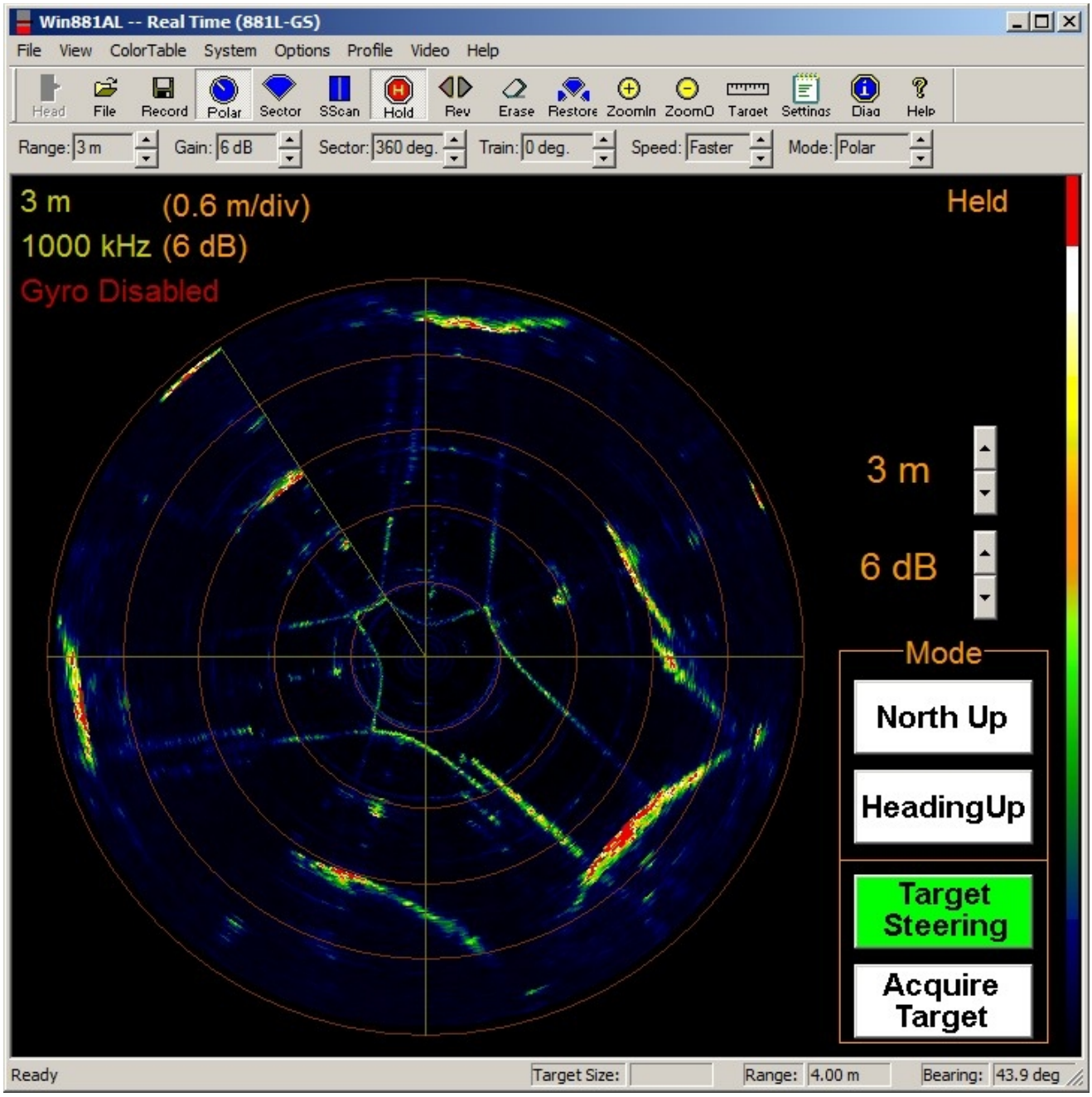


Figure 2.1: Unstabilized Image

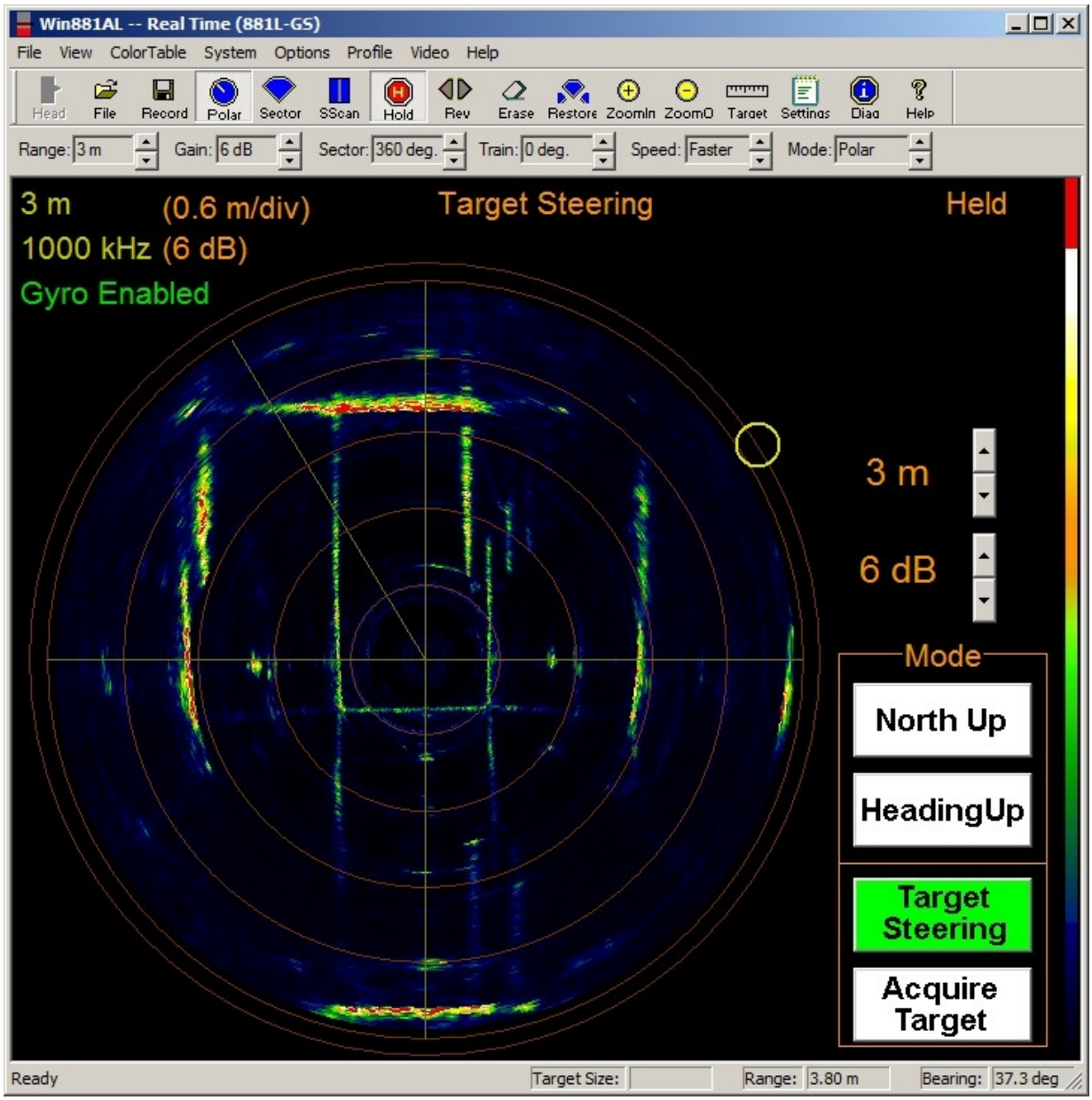


Figure 2.2: Stabilized Image

2.4 Hardware

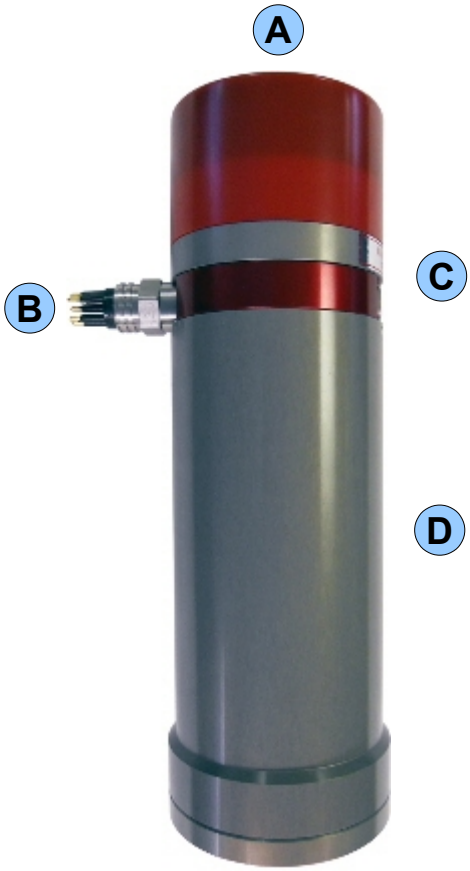


Figure 2.3: 881A-GS

Figure 2.3, above, indicates the 881A-GS in the “Transducer Up” orientation.

A Transducer End. **FRAGILE**. This area MUST be exposed to the water with no obstruction. Do not mount sonar using this area.

B Connect sonar cable. Ensure locking sleeve is used. Do not bend pins.

C Oil filling port. Do not remove. Transducer “zero” position (Transducer Position = 600)

D Electronics Bottle. Use this area for mounting the sonar.

2.5 Software

After installing the "*Win881AL.exe"* program (generally "*C:\Program Files (x86)\Imagenex*"), load the program by double-clicking on its icon.

The program, which supports the 881A, 881L, 881A-GS, and 881L-GS will need to be told which sonar type is being connected. Choose 881A-GS from:

"System => Sonar Type => 881A-GS"

This configures the program to operate in 881A-GS mode.

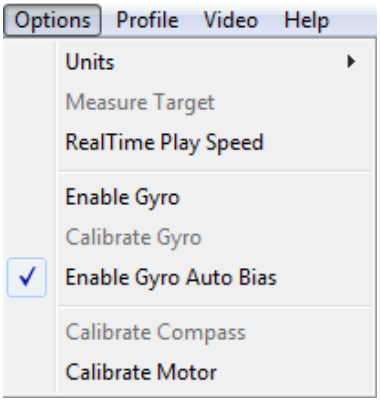


Figure 2.4: Options Menu

Ref	Item	Description
1	Enable Gyro	Enables Gyro Stabilized Image. Deselect to operate as standard 881A.
2	Calibrate Gyro	Calibrates gyro to compensate for drift.
3	Enable Gyro Auto Bias	Enabling this puts the sonar into auto bias mode where the sonar will continuously re-bias the gyro in real time. Disabling this mode requires a manual bias as described in Section 2.2.2 on page 2.
4	Calibrate Compass	Field Calibrates the internal Compass. To calibrate the compass, the sonar head MUST be rotated 360º (direction is irrelevant). Check "Calibrate Compass", rotate 360º, then un-check "Calibrate Compass" to store the settings.
5	Calibrate Motor	Calibrates Motor and realigns the sonar head position relative to the transducer position.

Table 2.1: Option Menu

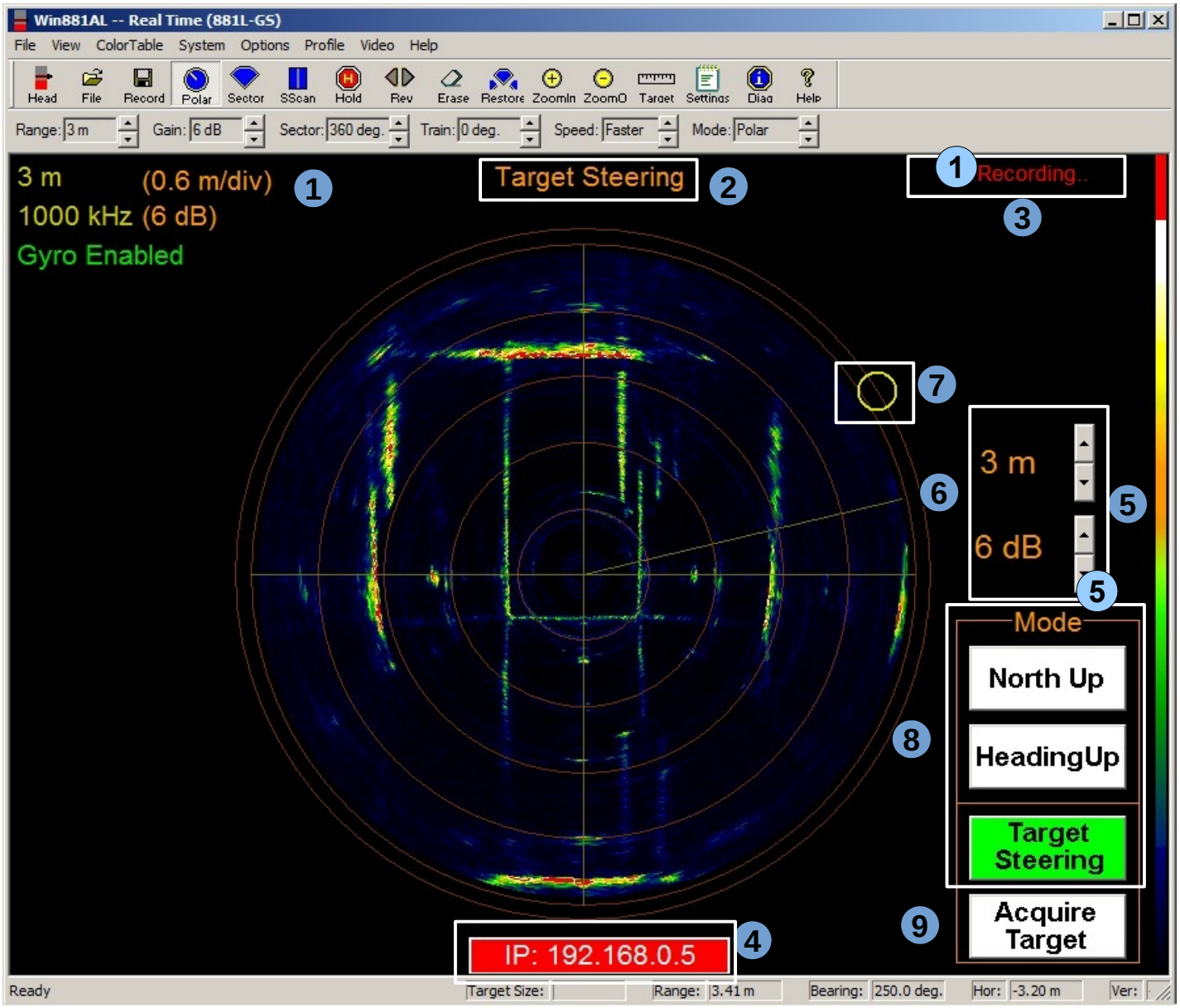


Figure 2.5: Standard 881A-GS Display

Ref	Item	Description
1	Range / Frequency Display	Display current acoustic range and frequency of sonar in yellow. Displays Grid scale and current gain in orange
2	Gyro stabilized operating mode	Displays only when Gyro Stabilized Image is enabled. One of: North Up, Heading Up, or Target Steering.
3	File Recording information	Displays “Not Recording” or “Recording...”
4	Communication Error Status	Displays “No Connection” when communication to the sonar is interrupted.
5	Quick Setting	Quick Setting for sonar range and gain
6	Wiper	Current transducer position for the “ping”
7	Sonar Position Indicator	The yellow circle indicates the current sonar position independent of the transducer position. In North Up mode, the circle will transverse around the perimeter of the sonar image which remains stationary in a North up orientation. In Heading Up mode, the circle will remain stationary at the top of the screen, while the sonar image rotates. In Target Steering mode, the circle will transverse around the perimeter of the sonar image which remains stationary
8	Gyro Stabilized Image mode selection	Selects the various modes of display. In North Up mode, the circle will transverse around the perimeter of the sonar image which remains stationary in a North up orientation. In Heading Up mode, the circle will remain stationary at the top of the screen, while the sonar image rotates according to the heading. In Target Steering mode, the circle will transverse around the perimeter of the sonar image which remains stationary
9	Acquire Target	Only active in “Target Steering mode, “Acquire Target” allow the user to select a target location. The sector will then be centred on the selected target and rotated to place the target at the top of the display. See Section 2.5.1, below for details.

Table 2.2: Main Display

2.5.1 Acquire Target

The 881A-GS has the ability to select a target of interest, and automatically centre and scan that target on screen. The procedure is as follows.

1. Ensure the gyro is enabled and in “Target Steering” mode. *The image will perform a full polar scan.*
2. Select the button “Acquire Target”. *The mouse cursor will change to* 
3. Select desired target on screen *The screen will automatically change to a top sector view with the target centred within the sector*

This is described further below.

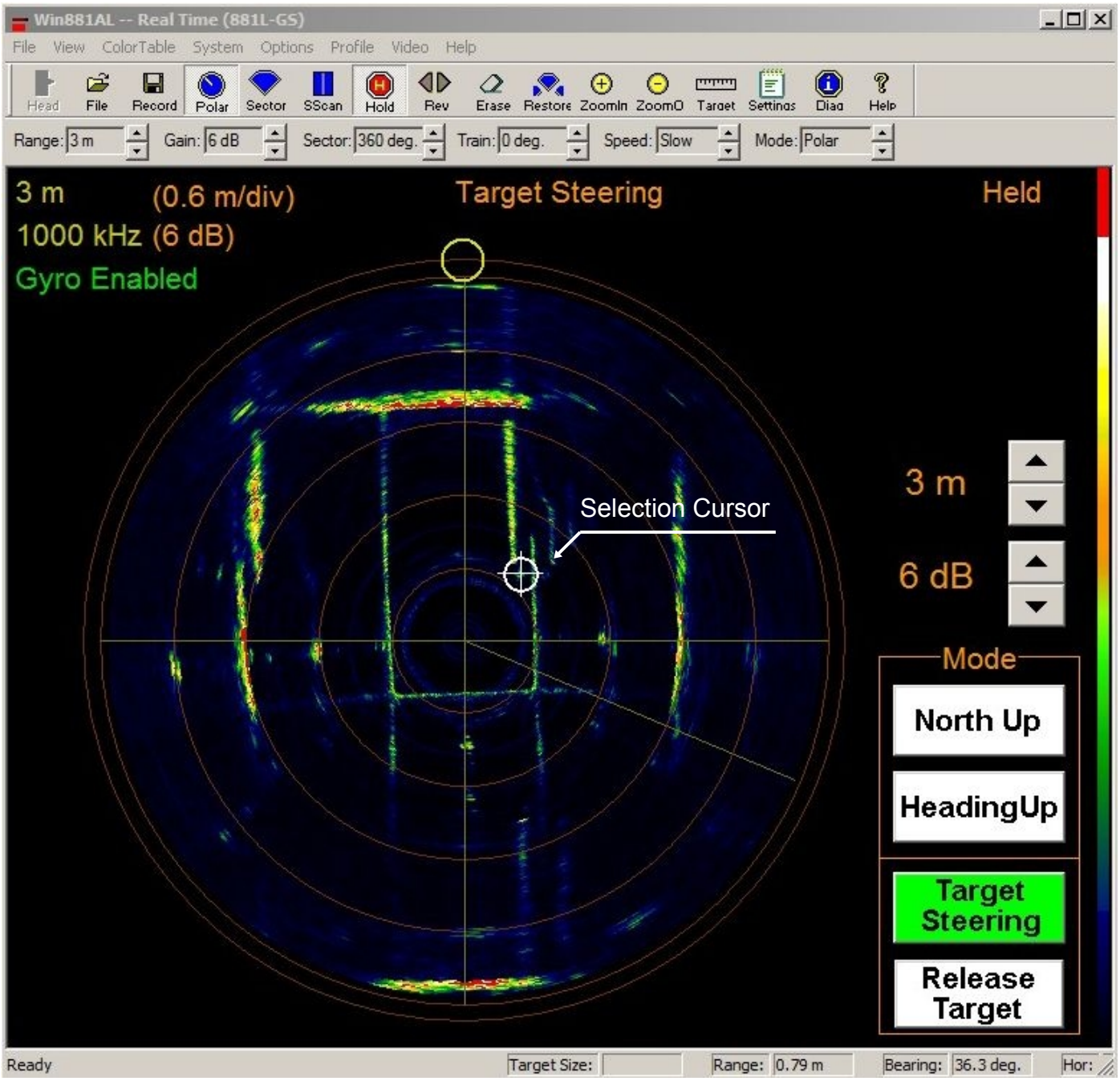


Figure 2.6: Acquire Target button has been selected

In Figure 2.6, above, the "Acquire Target" was selected and the mouse cursor changed to  . In this example, the target of interest is positioned under the target cursor.

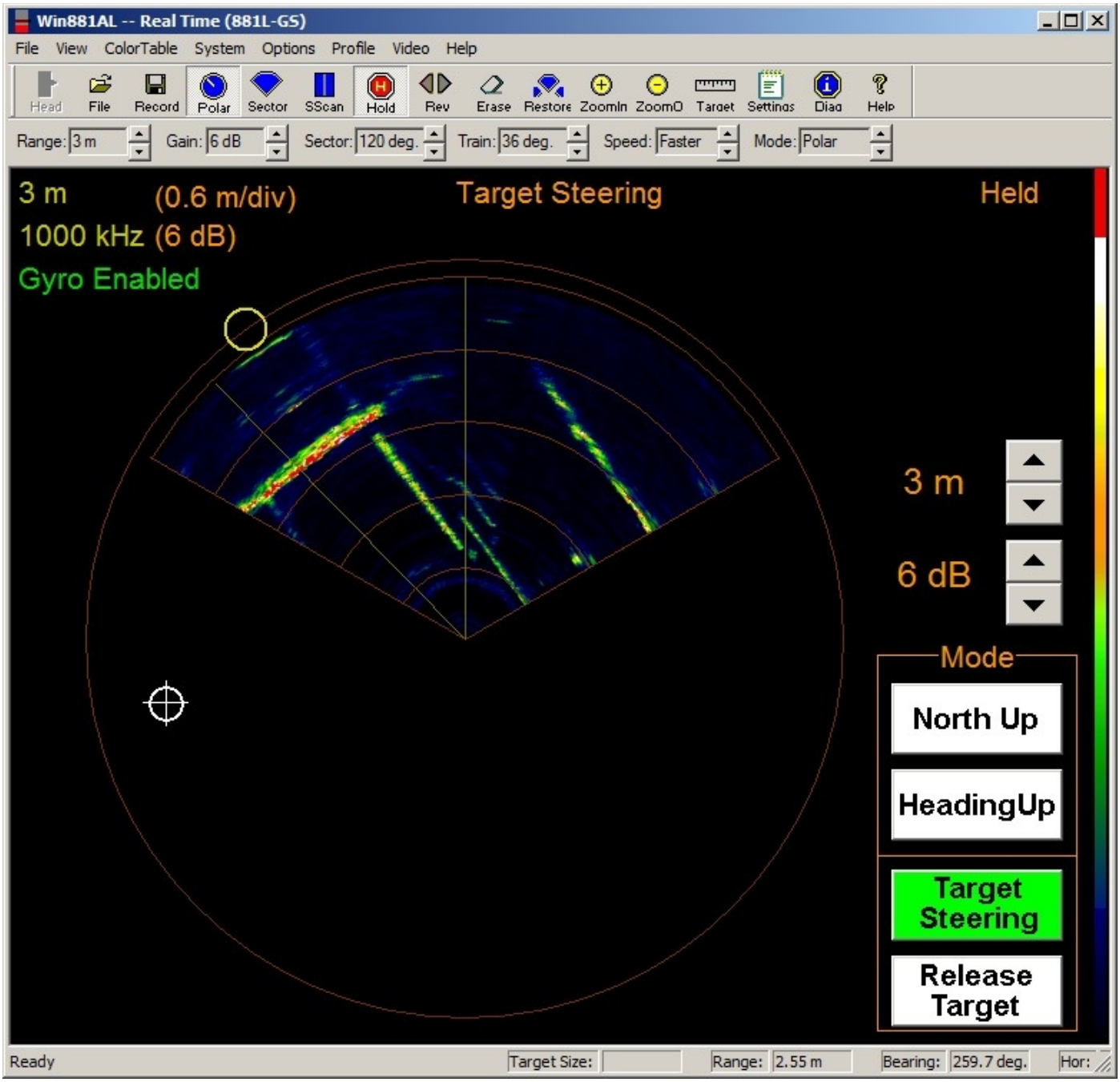


Figure 2.7: Target has been selected

In Figure 2.7, above, the desired target from Figure 2.6 was selected. The screen automatically centred the target within a sector and rotated the sector to the top of the screen. The sonar will now scan the sector with the centred target.

To return, select “Release Target” to remove the sector restrictions and train angle.

2.5.2 Latitude Adjustment and Compass Declination

The geographical local latitude compensates for drift caused by the Earth's rotation. To set the latitude of the current location, open the file "*Win881AL.ini*" in a text editor and edit the lines:

- Local Latitude=49.250000 → (0 to 90 for northern latitudes, 0 to -90 for southern latitudes)
- CompassDeclination=16.5 → (±180º, offset to Magnetic North. West is negative, East is positive).

To match the approximate location of the sonar.
Once these are set, run the "*Win881AL.exe*" program as per usual.

The "Local Latitude" will not take effect until a "**CALIBRATE GYRO**" command is initiated manually under the "*Options*" menu.

The compass declination angle is used for displaying the sonar image referenced to True North rather than Magnetic North.
The default values are for Vancouver, BC, Canada which has a latitude of 49.25º North and a magnetic compass declination of 16.5º East (as of 2014).

2.5.3 File Size Limits

Storing video can generate very large files, The software is able to automatically split the recorded file in predefined file sizes as shown below in Figure 2.8

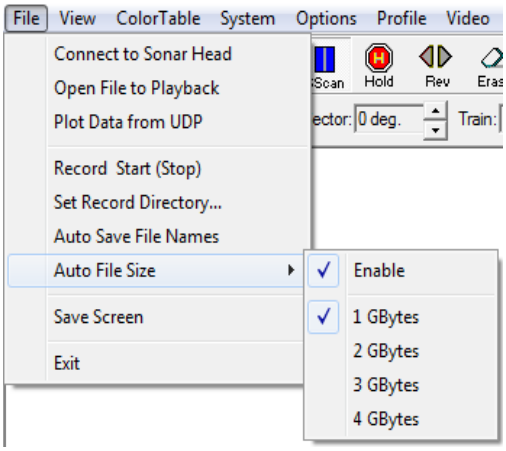


Figure 2.8: Auto File Sizes

In order to re-join two split files, from the command prompt type:

copy /b "Source1.81R"+"Source2.81R" "dest.81R"

without the quotes.

Appendix A – USB Converters and the Windows OS

With the proliferation of the "*Universal Serial Bus*" (USB) compatible devices available for notebook and desktop computers, manufacturers are rapidly omitting physical serial ports on their products in order to cut production costs. The USB bus is extremely versatile as there are are no Com Port conflicts, no IRQ's to deal with, and has support for up to 256 devices on one bus (while there are usually multiple USB ports on a computer, there are usually only two physical USB buses).

With all that is going for it, one would wonder why use serial devices at all. Good question. Major factors in retaining a true physical serial device are:

- Cable length – USB has a maximum cable length support of 5m (~16')
- Latency – USB is a packet driven technology and as such delays occur due to USB driver packaging schemes.

A.1 - Virtual Communication Ports

To get a serial device (RS-232 or RS-485) connected to a computer that only has USB ports, a converter needs to be installed in-line between the USB port and the serial device. These converters install a special driver in Windows called a "Virtual Com Port" This software will emulate a serial port so that serial enabled software can simply "see" the USB port as a serial port. See the figure below for an overview.

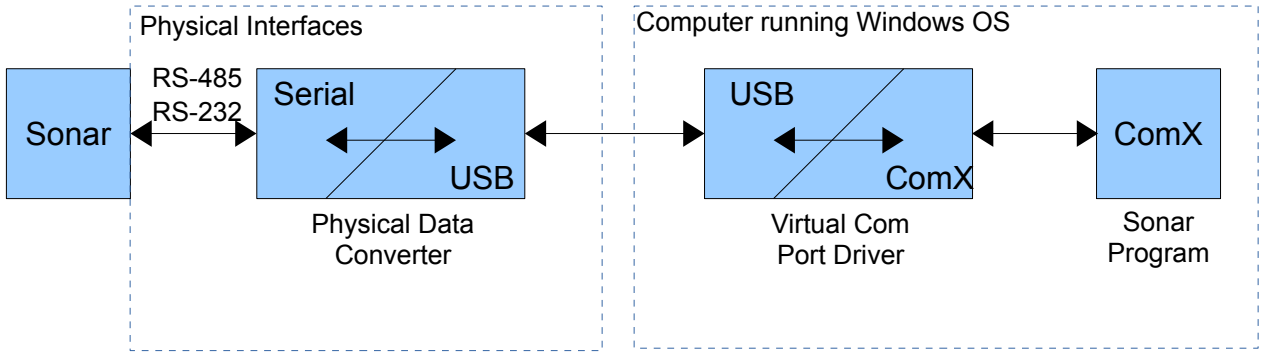


Figure A.1: Overview of USB Data Converter Logic Flow

One caveat is that Windows can get confused if a device is plugged into a USB port while there is data being transmitted through it. Windows thinks that the device is a "pen mouse" and the mouse cursor will behave erratically. If this happens, the computer will need to be restarted. To circumvent this phenomena, **DO NOT** connect GPS, or other devices to the USB convertor until the convertor is fully functional (i.e. plug the converter into the computer and wait until Windows sets it up and assigns it a Com Port number BEFORE plugging a serial device into the converter).

Generally, once a converter is correctly installed, Windows will assign a Com Port number to **A PARTICULAR** device on **A PARTICULAR** USB port. Once this is done, things run pretty smoothly....until the operator changes something....

A.2 - Common Windows© Issues related to all USB <--> Serial Converters

Windows XP will assign a Com Port number to a USB device when it is first installed in the system. However, it will assign a **DIFFERENT Com Port** number to the same device when it is plugged into a **DIFFERENT USB port** on the same computer. To further complicate matters, Windows XP will assign a **DIFFERENT Com Port** number to a **DIFFERENT** device when it is plugged into the **SAME USB port** on the same computer.

Converter	USB Port	Assigned Com Port
A	A	4
A	B	5
A	A	4
B	A	5

Table A.1: Windows Com Port Assignment Scheme

The table above indicates a possible scenario where various converters are plugged into various USB ports. The assigned Com Port numbers above are only for illustration purposes. Windows will actually assign the device the next available Com number.

For example, If you first plug the device into the BACK USB port of the laptop, Windows will assign it a Com Port number of (for arguments sake) '4' When you start the SportScan software, you set the Com Port to '4', and it runs fine. The next time you use the device, you plug the same device into the SIDE USB port on the laptop. Windows will then assign the device a Com Port number of (again, for arguments sake) '5'. Now when you start the SportScan software, it cannot open, or find, Com Port '4' as the device is now set to Com Port '5'. You set the Com Port in SportScan to '5' and it again runs fine.

There is no solution for this behaviour. It is a Windows function, and we have no control how the Com Ports are assigned to a device.

Our suggestion is to only use the same USB port for each device. For example, only use the BACK USB port for the device to run the sonar, and to only use the SIDE USB port for the device used for GPS input.

Also, if a different serial device is plugged into the same USB port, Windows will assign it a different Com Port again. For example, if Com Ports '4' and '5' are already taken, Windows will assign it Com Port '6'.

To make a long story short. Windows assigns a single Com Port to a specific serial device plugged into a specific USB port. If either changes, Windows will assign it a different Com Port.

The above only applies to convertors that have a unique serial number.

A.3 - Determining the Assigned Com Port For All USB <--> Serial Converters

This section describes various procedures for determining the assigned Com Port of a converter. This document assumes the Windows XP Pro operating system and other computers may appear differently. However, the procedures will be similar regardless of the Windows version.

To access the Device Manager from the Desktop:

- Right click on "My Computer"
- Left click "Properties"

Follow the following Illustrations to Set the Com Port Number of the Device. Note these Illustrations are for the ATEN UC-232A Device. The procedure for the Sealevel 2104 is the same. Also, Ignore the baud rate settings. Imagenex software automatically opens the port at the correct parameters.

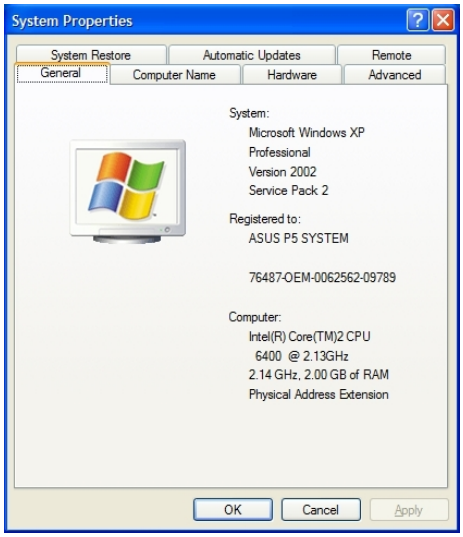


Figure A.2: System Properties

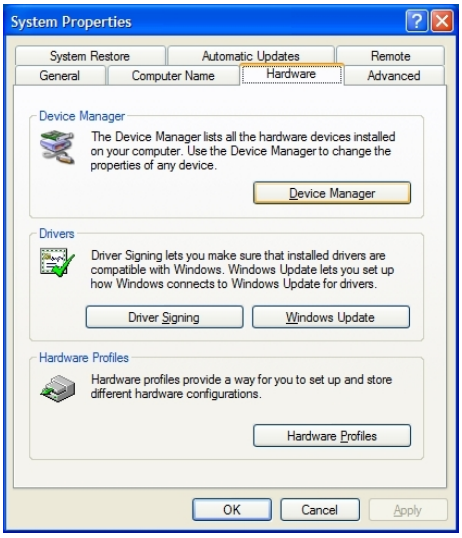


Figure A.3: System Properties - Select Hardware Tab

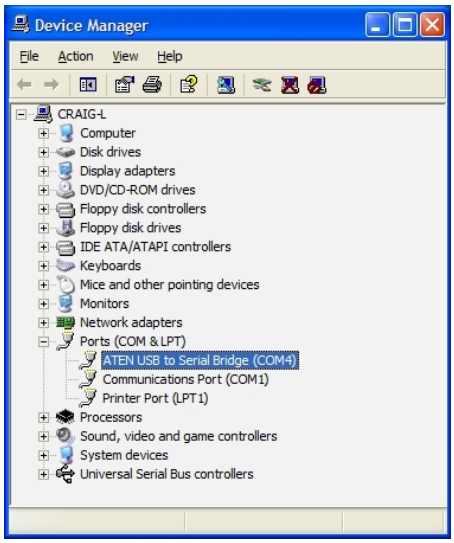


Figure A.4: Device Manager – Select Ports and double click device

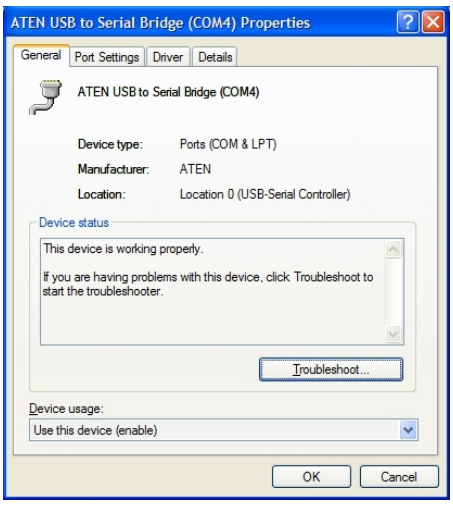


Figure A.5: Port Properties – Select "Port Settings"

Quick Tip

To make a shortcut to the Device Manager on the Windows desktop:

- Right click on the Windows desktop
- Select “New” --> Shortcut
- Enter “devmgmt.msc”
- Select “Next”
- Enter “Device Manager”
- Select Finish

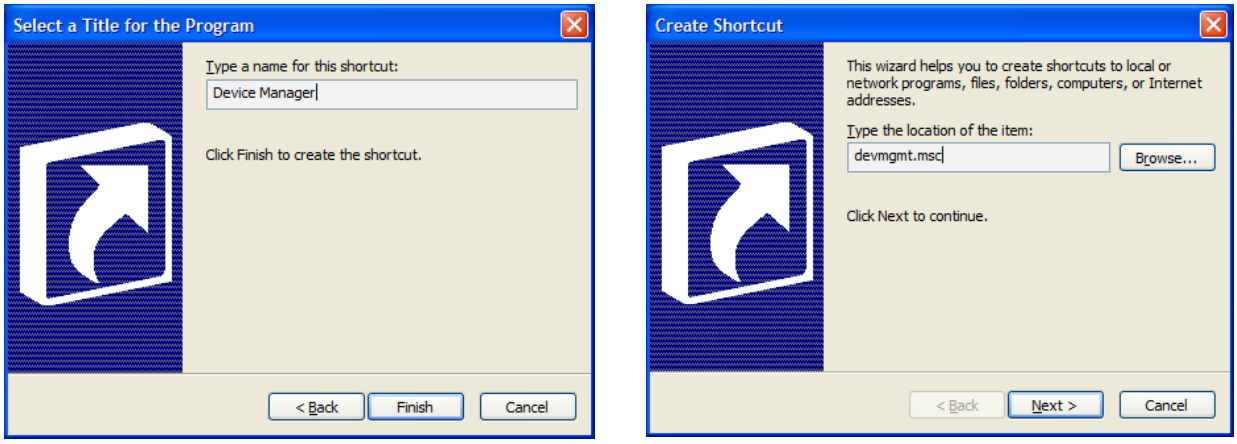


Figure A.6: Creating a Device Manager Shortcut

IMAGENEX .81R RAW DATA FILE FORMAT

Version: 1.00

The .81R file format is used for the following gyro stabilized sonar heads:

Model 881A-GS
Model 881L-GS
Model 882A
Model 882L

For each sonar ping, the following sections are written to the .81R file.

1. Ping Header - 1024 bytes
2. Device List - 1024 bytes
3. Raw Sonar Data - variable length
4. Internal Sensor Data
5. External Sensor Data
6. Future Expansion
7. Video Frame (if available)

1. Ping Header
- contains overhead information such as total number of bytes this ping, byte offsets and lengths of each section, ping timestamp, frequency, range, gain, etc.

2. Device List
- contains information on all connected devices (i.e. sonar head, GPS, MRU, Gyro/Heading, Sound Velocity sensor, etc.). Includes the device name, transfer speed, rep-rate, mounting offsets, mounting angles and data latency. Information in this section is not required and may be zero filled.

3. Raw Sonar Data
- contains Switch Data Command, Sonar Return Header and Raw Sonar Data

4. Internal Sensor Data
- contains values from optional sensors installed inside the sonar head (i.e. MRU)

5. External Sensor Data
- contains values from external sensors

6. Future Expansion

7. Video Frame
- if video is available from a connected USB frame grabber, the video frame is written to the file after the current ping data

Storage Format

All data is stored LSB first (least significant byte first or "Little-Endian" mode). The following conventions are used:

char	1-byte signed value	
BYTE	1-byte unsigned value	
ASCII	1-byte unsigned value	
short	2-byte signed value	(LSB,MSB)
WORD	2-byte unsigned value	(LSB,MSB)
int	4-byte signed value	(LSB,MDL,MDH,MSB)
DWORD	4-byte unsigned value	(LSB,MDL,MDH,MSB)
float	4-byte single precision floating point value	(LSB,MDL,MDH,MSB)

Section 1: **Ping Header** (length = 1024 bytes)

Byte	Description	Format
0	'**8**' - Ping Header byte 0	ASCII
1	'**1**' - Ping Header byte 1	ASCII
2	'**R**' - Ping Header byte 2	ASCII
3	Sonar Type 0 = Model 881L-GS 1 = Model 881A-GS 2 = Model 882L 3 = Model 882A	BYTE
4-7	Total Bytes This Ping (including Ping Header)	DWORD
8 - 9	.81R File Version 0 = 1.00 - initial release	WORD
10 - 27	Ping Timestamp - (18 bytes) DDMMYYYYHHMMSSmmmh 10-11: DD - day, 01-31 12-13: MM - month, 01-12 14-17: YYYY - year 18-19: HH - hours, 00-23 20-21: MM - minutes, 00-59 22-23: SS - seconds, 00-59 24-26: mmm - milliseconds, 000-999 27: NULL	ASCII
28	Reserved - always 0 (1 byte)	BYTE
29 - 58	Sonar Control Program Version Number (30 bytes) i.e. "Version 1.0.1.5 (19Sept14)" plus zero fill	ASCII
59 - 62	Byte offset to previous 81R Ping Header **Note: all byte offsets are referenced to the beginning of the current Ping Header**	DWORD
63	Status Byte 1 Bit 0: 1 = internal sensors available Bit 1: 1 = external sensors available Bit 2-7: Reserved	BYTE
64	Status Byte 2 - Reserved - always 0	BYTE
65	Status Byte 3 - Reserved - always 0	BYTE
66	Status Byte 4 - Reserved - always 0	BYTE
67	Status Byte 5 - Reserved - always 0	BYTE
68	Status Byte 6 - Reserved - always 0	BYTE
69	Status Byte 7 - Reserved - always 0	BYTE
70	Status Byte 8 - Reserved - always 0	BYTE
71 - 74	Reserved - always 0 (4 bytes)	BYTE
75 - 78	Ping Header length - 1024	DWORD
79 - 82	Byte offset to Device List - 1024	DWORD
83 - 86	Device List length - 1024	DWORD
87 - 90	Byte offset to Raw Sonar Data - 2048	DWORD
91 - 94	Raw Sonar Data length - variable	DWORD

95 - 98	Byte offset to Internal Sensors (0 if not available)	DWORD
99 - 102	Internal Sensor length (0 if not available)	DWORD
103 - 106	Byte offset to External Sensors (0 if not available)	DWORD
107 - 110	External Sensor length (0 if not available)	DWORD
111 - 318	Reserved - always 0 (208 bytes)	BYTE
319	Transducer Up/Down, Display Mode Bits 0-2: 000 = North Up 001 = Heading Up 010 = Target Steering Bits 3-6: Reserved Bit 7: Transducer Up/Down 0 = Down, 1 = Up	BYTE
320	Start Gain (dB)	BYTE
321	Sector Width Command 0 to 120 = 0 to 360 Degrees in 3 degree increments	BYTE
322	Train Angle Command 0 to 119 = 0 to 357 Degrees in 3 degree increments	BYTE
323	Step Size Command 0 = No Step 1 = 0.3 Degrees (Slow) 2 = 0.6 Degrees (Medium) 3 = 0.9 Degrees (Fast) 4 = 1.2 Degrees (Faster) 8 = 2.4 Degrees (Fastest)	BYTE
324	Mode 0 = Sector 1 = Polar 2 = Sidescan	BYTE
325 - 328	Range Offset (meters)	float
329 - 332	Absorption (dB/meter)	float
333	Reserved - always 0	BYTE
334 - 337	Pulse Length (microseconds)	DWORD
338 - 341	Sound Velocity (meters/second)	float
342 - 345	Acoustic Transmit Frequency (Hz)	float
346 - 349	Sonar Ping Repetition Rate (seconds)	float
350 - 352	Reserved - always 0	BYTE
353 - 356	Samples per ping	DWORD
357 - 360	Sector Size (degrees)	float
361 - 364	Train Angle (degrees)	float
365 - 368	Step Size - Angle Increment (degrees)	float
369 - 372	Acoustic Range Setting (meters)	float
373 - 376	Range Resolution (meters)	float
377 - 380	Ping Number	DWORD
381	System Information Flag	BYTE
382	Gyro Status (0=Disabled, 1=Enabled)	BYTE
383 - 386	Mounting Angle Offset (-180 to +180 in decimal degrees)	float
387 - 390	Local Latitude (-90 South to +90 North in decimal degrees)	float
391 - 394	Compass Declination (-180 to +180 in decimal degrees)	float
395 - 1023	Reserved - always 0 (629 bytes)	BYTE

Section 2: **Device List** (length = 1024 bytes)

Note: information in this section is not required and may be zero filled.

Each connected device contains the following 64-byte structure:

Byte	Description	Format
0 - 15	Device Name (16 bytes) i.e. "881L-GS Sonar" plus zero fill	ASCII
16 - 19	Transfer Speed (bits per second)	DWORD
20 - 23	Repetition Rate (seconds)	float
24 - 27	Starboard mounting offset (meters, portside is negative)	float
28 - 31	Forward mounting offset (meters, aft is negative)	float
32 - 35	Vertical mounting offset (meters, up is negative)	float
36 - 39	Yaw - mounting offset (degrees, counter-clockwise is negative)	float
40 - 43	Pitch - mounting offset (degrees, nose down is negative)	float
44 - 47	Roll - mounting offset (degrees, portside roll is negative)	float
48 - 51	Latency (seconds)	float
52 - 63	Reserved - always 0 (12 bytes)	BYTE

Device 1 (Sonar Head):
- Byte 0 = Byte offset to Device List (from Ping Header, Bytes 79-82)
- note: sonar head transfer speed is 10 for 10Mbps or 100 for 100Mbps

Device 2 (GPS Antenna):
- Byte 0 = Byte offset to Device List + 64

Device 3 (MRU):
- Byte 0 = Byte offset to Device List + 128

Device 4 (Gyro/Heading):
- Byte 0 = Byte offset to Device List + 192

Section 3: **Raw Sonar Data** (length = Variable)

The Raw Sonar Data section contains the communications transfers to and from the sonar head for the current ping. The transfers consist of the Switch Data Command to the sonar head as well as the Sonar Return Header and Sonar Echo Data from the sonar head. The length of this section varies depending on the type of sonar head.

The following tables describe the total number of bytes stored for each sonar head type:

Sonar Type = Model 881L-GS
Ping Header Byte 3 = 0

1. Switch Data Command - 128 bytes
2. Sonar Return Header - 256 bytes
3. Sonar Echo Data - 500 bytes (IBX mode)
Total = 884 bytes

Byte Offset	**Description**	**Length**
0000 - 1023	Ping Header	1024
1023 - 2047	Device List	1024
2048 - 2175	Switch Data Command	128
2176 - 2431	Sonar Return Header	256
2432 - 2931	Sonar Echo Data	500

For IBX mode, the Sonar Echo Data starts at byte offset 2432 and consists of 500 range bins of 8-Bit (0-255) echo intensity values. Each range bin is (Range/500) in length. Range (in meters) is located in "Range" (Bytes 20-21) of the Sonar Return Header. Range bins assume a sound velocity of 1500m/s. The angular position of the ping echo is encoded in "Transducer Head Position" (Bytes 35-36) of the Sonar Return Header.

Please refer to document **"425-050-01 - 881L - GS Ethernet Specifcation.pdf"** for detailed information about the Sonar Return Data format for the Model 881L-GS sonar head.

Sonar Type = Model 881A-GS
Ping Header Byte 3 = 1

1. Switch Data Command - 40 bytes
2. Sonar Return Header - 32 bytes
3. Sonar Echo Data - 500 bytes (INB mode)
Total = 572 bytes

Byte Offset	Description	Length
0000 - 1023	Ping Header	1024
1023 - 2047	Device List	1024
2048 - 2087	Switch Data Command	40
2088 - 2119	Sonar Return Header	32
2120 - 2619	Sonar Echo Data	500

For INB mode, the Sonar Echo Data starts at byte offset 2120 and consists of 500 range bins of 7-Bit (0-127) echo intensity values. Each range bin is (Range/500) in length. Range (in meters) is located in "Range" (Byte 7) of the Sonar Return Header. Range bins assume a sound velocity of 1500m/s. The angular position of the ping echo is encoded in "Transducer Head Position" (Bytes 5-6) of the Sonar Return Header.

Please refer to document "**425-051-03 - 881A - gyro Serial Specifcation.pdf"** for detailed information about the Sonar Return Data format for the Model 881A-GS sonar head.

Sonar Type = Model 882L
Ping Header Byte 3 = 2

1. Switch Data Command - 128 bytes
2. Sonar Return Header - 256 bytes
3. Sonar Echo Data - 500 bytes (IBX mode)
Total = 884 bytes

Byte Offset	**Description**	**Length**
0000 - 1023	Ping Header	1024
1023 - 2047	Device List	1024
2048 - 2175	Switch Data Command	128
2176 - 2431	Sonar Return Header	256
2432 - 2931	Sonar Echo Data	500

For IBX mode, the Sonar Echo Data starts at byte offset 2432 and consists of 500 range bins of 8-Bit (0-255) echo intensity values. Each range bin is (Range/500) in length. Range (in meters) is located in "Range" (Bytes 20-21) of the Sonar Return Header. Range bins assume a sound velocity of 1500m/s. The angular position of the ping echo is encoded in "Transducer Head Position" (Bytes 35-36) of the Sonar Return Header.

Please refer to document **"425-xxx-xx - 882L - GS Ethernet Specifcation.pdf"** for detailed information about the Sonar Return Data format for the Model 882L sonar head.

Sonar Type = Model 882A
Ping Header Byte 3 = 3

1. Switch Data Command - 40 bytes
2. Sonar Return Header - 32 bytes
3. Sonar Echo Data - 500 bytes (INB mode)
Total = 572 bytes

Byte Offset	**Description**	**Length**
0000 - 1023	Ping Header	1024
1023 - 2047	Device List	1024
2048 - 2087	Switch Data Command	40
2088 - 2119	Sonar Return Header	32
2120 - 2619	Sonar Echo Data	500

For INB mode, the Sonar Echo Data starts at byte offset 2120 and consists of 500 range bins of 7-Bit (0-127) echo intensity values. Each range bin is (Range/500) in length. Range (in meters) is located in "Range" (Byte 7) of the Sonar Return Header. Range bins assume a sound velocity of 1500m/s. The angular position of the ping echo is encoded in "Transducer Head Position" (Bytes 5-6) of the Sonar Return Header.

Please refer to document **"425-054-0C - 882A - Serial Specifcation.pdf"** for detailed information about the Sonar Return Data format for the 882A sonar head.

Section 4: **Internal Sensor Data**

This section is reserved for future use.

Byte offset to Internal Sensors, (Ping Header, Bytes 95-98) = 0
Internal Sensor length, (Ping Header, Bytes 99-102) = 0

Section 5: **External Sensor Data**

This section is reserved for future use.

Byte offset to External Sensors, (Ping Header, Bytes 103-106) = 0
External Sensor length, (Ping Header, Bytes 107-110) = 0

Section 6: **Future Expansion**

This section is reserved for future use.

Section 7: **Video Frame** (length is variable)

Byte	Description	Format
	Bitmap Header	
0	'**B**' - Video Frame Header byte 0	ASCII
1	'**M**' - Video Frame Header byte 1	ASCII
2 - 5	Video Frame Filesize 14 + 40 + (ImageWidth x ImageHeight x 3) bytes	DWORD
6 - 7	Reserved1 - always 0	WORD
8 - 9	Reserved2 - always 0	WORD
10 - 13	Image Data Offset = 54	DWORD
	Bitmap Information Header	
14 - 17	HeaderSize = 40	DWORD
18 - 21	ImageWidth (in pixels)	DWORD
22 - 25	ImageHeight (in pixels)	DWORD
26 - 27	NumberOfImagePlanes = 1	WORD
28 - 29	BitsPerPixel = 24	WORD
30 - 33	CompressionMethod = 0	DWORD
34 - 37	SizeOfBitmap = (ImageWidth x ImageHeight x 3)	DWORD
38 - 41	HorzResolution = 0	DWORD
42 - 45	VertResolution = 0	DWORD
46 - 49	NumColorsUsed = 0	DWORD
50 - 53	NumSignificantColors = 0	DWORD
	24 Bit ImageData (stored as 3 bytes per pixel)	
54 - 57	Pixel 0 - Blue, Green, Red (lower-left corner of image)	BYTE
58 - 60	Pixel 1 - Blue, Green, Red	BYTE
.	.	.
.	.	.
Video Frame Filesize-3	Pixel N (ImageWidth x ImageHeight - 1) - Blue, Green, Red (upper-right corner of image)	BYTE

Imagenex Technology Corp.

IMAGENEX MODEL 881A-GS

with GYRO STABLIZED Option

MULTI-FREQUENCY SCANNING DIGITAL SONAR HEAD
Imager / Profiler

SERIAL INTERFACE SPECIFICATION

Version 2.0

Document Number	425-051	
Revision	**Date**	**Description**
0A	March 31, 2014	New Format
0B	April 22, 2014	Updates
00	May 1, 2014	Initial Release
01	July 21, 2014	Added variable gyro biasing time
02	September 5, 2014	Added Compass calibrating status
03	November 25, 2014	Adds motion tolerent gyro biasing, gyro compass

Specifications subject to change

OVERVIEW

The Model 881A-GS Digital Sonar Head communicates over a serial communications link. To receive echo data, a command program must interrogate the sonar head by sending a Switch Data Command. When the Switch Data command is accepted, the sonar head transmits, receives and sends its return data back to the command program.

SWITCH DATA COMMAND

The head accepts up to 40 bytes of switch data from the serial interface and must see the switch data header (2 bytes: **0xFE** and **0x44** HEX) in order to process the switches. The head will stop accepting switch data when it sees the termination byte (**0xFD** HEX), or 41 bytes (whichever comes first). The termination byte must be present for the head to process the switches.

Note: the Termination Byte is the only switch value allowed to have a value of 0xFD. All other switches should be set higher or lower than 0xFD (253 Decimal) so they are not interpreted as a termination byte!

Byte	Description									
0-9	0xFE	0x22	Head ID	Range	*Reserved 0*	Rev/ Hold	Master/ Slave	Reserved 0	Start Gain	LOGF
10-19	Absorption	Train Angle	Sector Width	Step Size	Pulse Length	Profile MinRange	*Reserved 0*	*Reserved 0*	*Reserved 0*	Data Points
20-29	Data Bits	Up Baud	Profile	Calibrate	Switch Delay	Frequency	Sensor Cmd LO	Sensor Cmd HI	Latitude LO	Latitude HI
30-39	*Gyro Biasing*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	Term. **0xFD**

Table 1: ***Model 881A-GS Switch Data Command To Sonar Head***

BYTE DESCRIPTIONS
Note: All Byte values are shown in decimal unless noted with a '0x' (hexadecimal) prefix.

Byte 0 **Switch Data Header (1st Byte)**
Always **0xFE** (254 decimal)

Byte 1 **Switch Data Header (2nd Byte)**
Always **0x22** (34 decimal)

Byte 2 **Head ID**
Normally 0x10

Byte 3 **Range**
1, 2, 3, 4, 5, 10, 20, 30, 40, 50, 60, 80, 100, 150, 200 Meters

Byte 4 **Reserved**
Always 0

Byte 5 **Rev / Hold**

Bit 0 - 1 = Hold (or pause) Head, 0 = Resume
Bit 1 - 0
Bit 2 - 0
Bit 3 - 0
Bit 4 - 0
Bit 5 - 0
Bit 6 - 1 = Reverse Step Direction, 0 = Normal Operation
Bit 7 - 0

Byte 6 **Master / Slave**

The sonar head can be operated as a master or as a slave. The default mode on power-up is Slave mode (Bit 6 = 1). Slave mode allows the user to command the head to transmit and send its return data at any given time.

Bit 0 - 1 = Transmit if Bit 6 = 1 (Slave Mode)
Bit 1 - 1 = Send Data if Bit 6 = 1 (Slave Mode)
Bit 2 - 0
Bit 3 - 0
Bit 4 - 0
Bit 5 - 0
Bit 6 - 0 = Master, 1 = Slave
Bit 7 - 0

Byte 7 **Reserved**

Always 0

Byte 8 **Start Gain**

0 to 40dB in 1dB increments

Byte 9 **LOGF**

0 = 10dB
1 = 20dB
2 = 30dB
3 = 40dB

Byte 10 **Absorption**

0 to 255 = 0.00dB/m to 2.55dB/m
Byte 10 = absorption_in_dB_per_m * 100
Do not use a value of 253!

Byte 11 **Train Angle**

0 to 120 (-180 Deg to +180 Deg = 360 Deg Total) in 3 Degree steps.
Byte 11 = (train_angle_in_degrees + 180)/3
i.e.
0 = -180 Degrees
30 = -90 Degrees
60 = 0 Degrees
90 = +90 Degrees
120 = +180 Degrees

Byte 12 **Sector Width**
0 to 120 (0 Deg to 360 Deg) in 3 Degree steps
Byte 12 = sector_width_in_degrees/3
i.e.
0 = 0 Degrees
30 = 90 Degrees
60 = 180 Degrees
120 = 360 Degrees

Byte 13 **Step Size**
0 to 8 in 0.3 Degree increments
i.e.
0 = No Step
1 = 0.3 Degrees/Step
2 = 0.6 Degrees/Step
3 = 0.9 Degrees/Step
4 = 1.2 Degrees/Step
8 = 2.4 Degrees/Step

Byte 14 **Pulse Length**
Length of acoustic transmit pulse.
1-100 → 10 to 1000 μsec in 10 μsec increments
Byte 14 = pulse_length_in_microseconds / 10

Byte 15 **Profile Minimum Range**
Minimum range for profile point digitization
0 – 250 □ 0 to 25 meters in 0.1 meter increments
Byte 15 = min range in meters * 10

Byte 16 **Reserved**
Always 0

Byte 17 **Reserved**
Always 0

Byte 18 **Reserved**
Always 0

Byte 19 **Data Points**
25 - 250 data points are returned by the head
The return data will have an ASCII '**INA**' header.
50 - 500 data points are returned by the head
The return data will have an ASCII '**INB**' header.

Byte 20 **Data Bits**
Resolution (number of data bits) of the returned echo data
4 - Data width = 4 Bits, 2 data points per byte
8 - Data width = 8 Bits, 1 data point per byte
16 - Data width = 16 Bits, 2 bytes per data point

Byte 21 **Up Baud**

****** NOTE: THIS FEATURE IS NOT YET AVAILABLE ******

The head receives switch data at 115200 baud, but can transmit its return data at various baud rates. The Up Baud value sets the head to transmit at a new baud rate. The default Up Baud value on power-up is 115200 baud.

0x0B - 9600 baud
0x03 - 14400 baud
0x0C - 19200 baud
0x04 - 28800 baud
0x02 - 38400 baud
0x05 - 57600 baud
0x06 - 115200 baud

Byte 22 **Profile**

0 = OFF
1 = ON --> The return data will have an ASCII '**INC**' header.

Byte 23 **Calibrate**

0 = Normal Operation
1 = Calibrate sonar head transducer (move to 0 degrees).

Byte 24 **Switch Delay**

The head can be commanded to pause (from 0 to 510 msec) before sending its return data to allow the commanding program enough time to setup for serial reception of the return data.
0 to 255 in 2 msec increments
Byte 24 = delay_in_milliseconds/2
Do not use a value of 253!

Byte 25 **Frequency**

675kHz +/- 500kHz
0 – 200 → 175kHz to 1175khz in 5kHz increments
Byte 25 = (frequency_in_khz - 675)/5 + 100

Bytes 26-27 **Sensor Command**

Byte 26								Byte 27							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
LO								HI							

Bit	Function
0	Enable Gyro
1	Enable Pitch, Roll, Heading
2	Gyro Set
3	Transducer = UP
4	ReBias Gyro
5	Start compass calibration
6	Stop compass calibration
7	**Always 0**
8	*Reserved*
9	Store Latitude
10	Gyro Set Target Location
11	Motion Bias Enable
12	*Reserved*
13	*Reserved*
14	*Reserved*
15	**Always 0**

Bytes 28-29 **Latitude**

Current Latitude of Sonar Location

Byte 28								Byte 29							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	Latitude (LO)							**0**	Latitude (HI)						**L**

Latitude High Byte = (Byte 29 & 0x7E)>>1
Latitude Low Byte = [((Byte 29 & 0x01)<<7) | (Byte 28 & 0x7F)]
Latitude = (Latitude High Byte<<8) | Latitude Low Byte

Bits 0-6 = Latitude in Degrees = 0 -> 90
Bit 7 = 0 -> North
Bit 7 = 1 -> South

ex.
+90º = byte 18 = 00, byte 19 = 0x5A
-90º = byte 18 = 01, byte 19 = 0x5A

Byte 30 **Gyro Biasing Delay**

1 – 252 → 1sec to 252 seconds

Byte 31 **Reserved**

Always 0

Byte 32 **Reserved**

Always 0

Byte 33 **Reserved**

Always 0

Byte 34 **Reserved**
Always 0

Byte 35 **Reserved**
Always 0

Byte 36 **Reserved**
Always 0

Byte 37 **Reserved**
Always 0

Byte 38 **Reserved**
Always 0

Byte 39 **Termination Byte**
The head will stop looking for Switch Data when it sees this byte.
Always 0xFD (253 decimal)

SONAR RETURN DATA

Every shot, the head returns a 32 Byte header, up to 500 points of echo data (depending on the Switch Data command that was sent) and a terminating byte value of 0xFC. The **total number of bytes** (**N**) returned will be 33, 161, 285 or 533.

Byte #	Description									
0-9	ASCII 'I'	ASCII 'N'	ASCII 'A', 'B', C'	Head ID	Serial Status	Xdcr Head Pos (LO)	Xdcr Head Pos (HI)	Range	Prof Rng (LO)	Prof Rng (HI)
10-19	Data Bytes (LO)	Data Bytes (HI)	Sonar Head Pos (LO)	Sonar Head Pos (HI)	Pitch (LO)	Pitch (HI)	Roll (LO)	Roll (HI)	Heading (LO)	Heading (HI)
20-29	Firmware	Gyro Heading (LO)	Gyro Heading (HI)	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*	*Reserved 0*
30-(N-2)	*Reserved 0*	*Reserved 0*	*Echo Data 0, 128, 252, 500 Data Bytes*							
N-1	0xFC									

Table 2: ***Model 881A-GS Sonar Head Return Data***

BYTE DESCRIPTIONS

Note: All Byte values are shown in decimal unless noted with a '0x' prefix.
N = total number of return bytes

Byte 0 - 2 **Imagenex Return Data Header**
ASCII '**INA**', '**INB**' or '**INC**'
'I' = 0x49, 'N' = 0x4E', 'A' = 0x41, 'B' = 0x42, 'C' = 0x43

ASCII '**INA**'
In response to a Switch Data Command with Data Points = 25
If Data Bits was set to 4: N = 161, (128 Data Bytes, 256 Points, 32 Byte Header)
If Data Bits was set to 8: N = 285, (252 Data Bytes, 252 Points, 32 Byte Header)
If Data Bits was set to 16: N = 533, (500 Data Bytes, 250 Points, 32 Byte Header)

ASCII '**INB**'
In response to a Switch Data Command with Data Points = 50
If Data Bits was set to 4: N = 285, (252 Data Bytes, 504 Points, 32 Byte Header)
If Data Bits was set to 8: N = 533, (500 Data Bytes, 500 Points, 32 Byte Header)
If Data Bits was set to 16: N = 533, (500 Data Bytes, 250 Points, 32 Byte Header)

ASCII '**INC**'
In response to a Switch Data Command with Profile = ON
N = 33, (0 Data Bytes, 0 Points, 32 Byte Header)

Byte 3 **Head ID**

16 Head ID's allowed: 0x10 to 0x1F

Byte 4 **Serial Status**

Bit 0 - 1
Bit 1 - 0
Bit 2 - 1 => Auto Bias Adjustment has occured
Bit 3 - 1 => Gyro / PRH Error
Bit 4 - 1 => Gyro Calibrating
Bit 5 - 1 => Compass Calibrating
Bit 6 - 1 => Switches Accepted
Bit 7 - 1 => Character Overrun

Byte 5 - 6 **Transducer Head Position**

Byte 5								**Byte 6**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Head Pos (LO)**							**0**	**D**	**Head Pos (HI)**					**L**

Head Pos (LO), Head Pos (HI), Step Direction (D)
Head Pos High Byte = (Byte 6 & 0x3E)>>1
Head Pos Low Byte = [((Byte 6 & 0x01)<<7) | (Byte 5 & 0x7F)]
Head Position = (Head Pos High Byte<<8) | Head Pos Low Byte

Head Position = 0 to 1200 (-180 to +180 Degrees) in 0.3 Degree steps
0 = -180 Degrees
300 = -90 Degrees
600 = 0 Degrees (Center Position)
900 = +90 Degrees
1200 = +180 Degrees

Example angle calculation:

Angle = 0.3 * (Head Pos - 600)
Head Pos = 900
Angle = 0.3 * (900 - 600)
Angle = +90 Degrees

Step Direction = (Byte 6 & 0x40)>>6
0 = counter-clockwise
1 = clockwise

Byte 7 **Range**

Sonar Head Range: 1 to 200 Meters

Byte 8 - 9 **Profile Range (***Sample units are based on a sound velocity of 1500m/s***)**

First digitized range value above threshold in sample units
Prof Rng (LO), Prof Rng (HI)

Byte 8								**Byte 9**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Prof Rng (LO)**							**0**	**Prof Rng (HI)**						**L**

Prof Rng High Byte = (Byte 9 & 0x7E)>>1
Prof Rng Low Byte = [((Byte 9 & 0x01)<<7) | (Byte 8 & 0x7F)]
Profile Range = (Prof Rng High Byte<<8) | Prof Rng Low Byte

For ranges < 5m, one sample unit = 2mm
For ranges >= 5m, one sample unit = 10mm

Byte 10 - 11 **Data Bytes**

Byte 10								Byte 11							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Data Bytes (LO)**							**0**	**Data Bytes (HI)**						**L**

Data Bytes High Byte = (Byte 11 & 0x7E)>>1
Data Bytes Low Byte = [((Byte 11 & 0x01)<<7) | (Byte 10 & 0x7F)]
Data Bytes = (Data Bytes High Byte<<8) | Data Bytes Low Byte

Bytes 12 - 13 **Sonar Position**
Angular position of the physical unit

Byte 12								Byte 13							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Sonar Pos (LO)**							**0**	**Sonar Pos (HI)**						**L**

Sonar Pos (LO), Sonar Pos (HI)
Sonar Pos High Byte = (Byte 13 & 0x7E)>>1
Sonar Pos Low Byte = [((Byte 13 & 0x01)<<7) | (Byte 12 & 0x7F)]
Sonar Position = (Sonar Pos High Byte<<8) | Sonar Pos Low Byte

Sonar Position = 0 to 1200 (-180 to +180 Degrees) in 0.3 Degree steps
0 = -180 Degrees
300 = -90 Degrees
600 = 0 Degrees (Centre Position)
900 = +90 Degrees
1200 = +180 Degrees

Example angle calculation:
Angle = 0.3 * (Head Pos - 600)
Sonar Pos = 900
Angle = 0.3 * (900 - 600)
Angle = +90 Degrees

Bytes 14 - 15 **Pitch**

Byte 14								Byte 15							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Pitch (LO)**							**0**	**Pitch (HI)**						**L**

Pitch High Byte = (Byte 15 & 0x7E)>>1
Pitch Low Byte = [((Byte 15 & 0x01)<<7) | (Byte 14 & 0x7F)]
Pitch = (Pitch High Byte<<8) | Pitch Low Byte

if Byte 15 - Bit 6 = 0:
Pitch = Pitch * 360/16384 in degrees

if Byte 15 - Bit 6 = 1:
Pitch = [Pitch - 16384] * 360/16384 in degrees

Byte 16 - 17 **Roll**

Byte 16								Byte 17							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Roll (LO)**							**0**	**Roll (HI)**						**L**

Roll High Byte = (Byte 17 & 0x7E)>>1
Roll Low Byte = [((Byte 17 & 0x01)<<7) | (Byte 16 & 0x7F)]
Roll = (Roll High Byte<<8) | Roll Low Byte

if Byte 17 - Bit 6 = 0:
Roll = Roll * 360/16384 in degrees

if Byte 17 - Bit 6 = 1:
Roll = [Roll - 16384] * 360/16384 in degrees

Byte 18 - 19 **Heading**

Byte 18								Byte 19							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Heading (LO)**							**0**	**Heading(HI)**						**L**

Heading High Byte = (Byte 19 & 0x7E)>>1
Heading Low Byte = [((Byte 19 & 0x01)<<7) | (Byte 18 & 0x7F)]
Heading = [(Heading High Byte<<8) | Heading Low Byte] * 360/16384 in degrees
0 = 0º
3599 = 359.9º

Byte 20 **Firmware Version**
0 = No Support for Automatic Gyro Biasing
1 = Supports Automatic Gyro Biasing (and corrects Backwards heading)

Byte 21 - 22 **Gyro Heading**

Byte 21								Byte 22							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
0	**Gyro Heading (LO)**							**0**	**Gyro Heading(HI)**						**L**

Gyro High Byte = (Byte 22 & 0x7E)>>1
Gyro Low Byte = [((Byte 22 & 0x01)<<7) | (Byte 21 & 0x7F)]
Gyro Heading = [(Gyro High Byte<<8) | Gyro Low Byte] * 360/16384 in degrees
0 = 0º
3599 = 359.9º

Bytes 23-31 **Reserved**
Always 0

Byte 32 **Start of Echo Data**
(N-33) Bytes of data

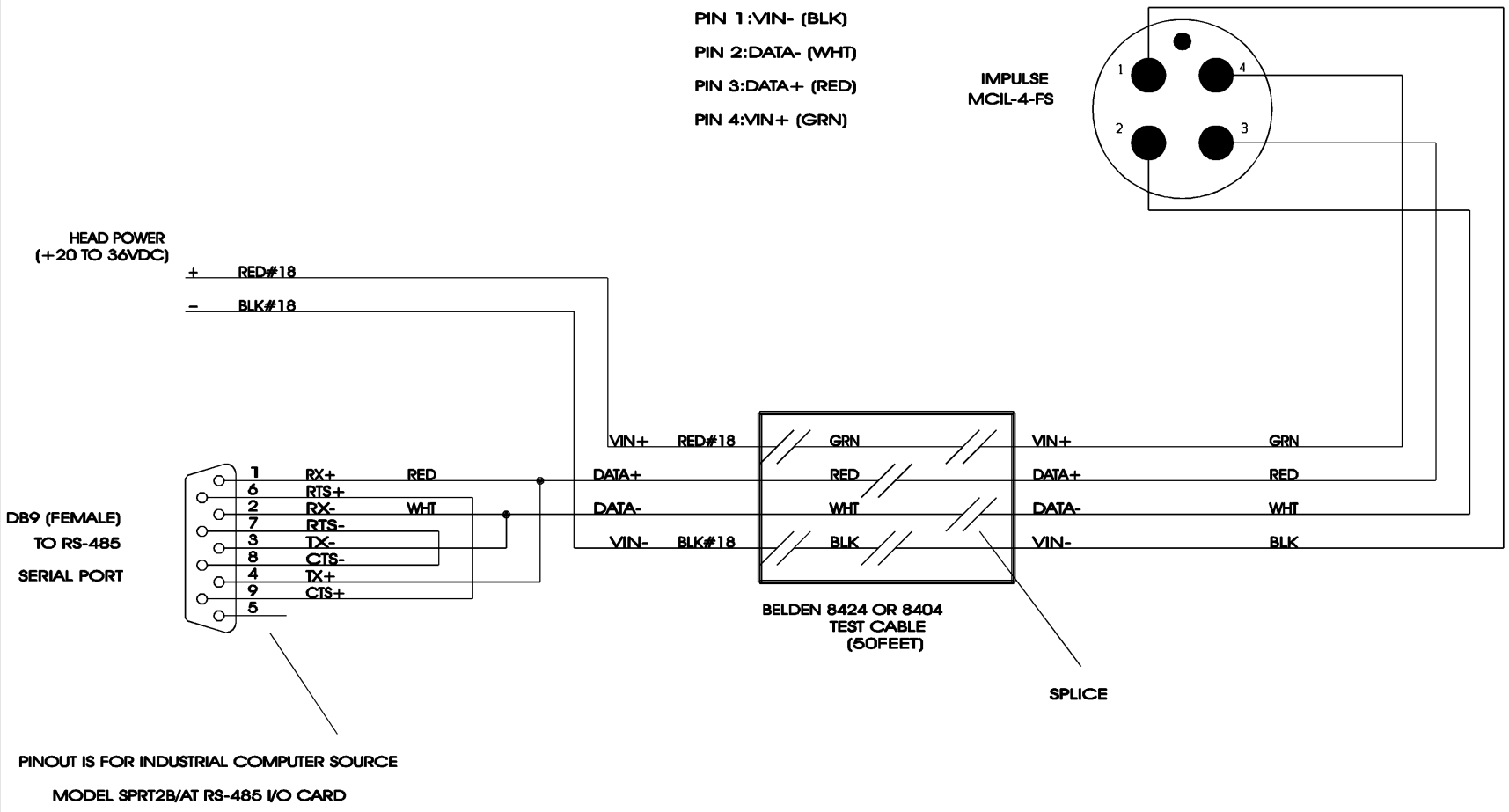
If Header is ASCII '**INA**':
If Data Bits was set to 8: N = 285, (252 Data Bytes, 252 Points)
1st Range Point = Byte 32
2nd Range Point = Byte 33
3rd Range Point = Byte 34
4th Range Point = Byte 35
etc. ...

If Header is ASCII '**INB**':
If Data Bits was set to 8: N = 533, (500 Data Bytes, 500 Points)
1st Range Point = Byte 32
2nd Range Point = Byte 33
3rd Range Point = Byte 34
4th Range Point = Byte 35
etc. ...

If Header is ASCII '**INC**':
There is no echo data and this byte is the termination byte **0xFC** (N = 33). Use Profile Range Bytes from the Header.

Byte (N-2) **End of Echo Data**

Byte (N-1) **Termination Byte**
0xFC



IMAGENEX Technology Corp.		
Title: MODEL 881A SONAR HEAD TEST CABLE		
Size: A	Document Number: 881-200-110	REV: 01
Date: April 9, 2002	Sheet 1 of 1	