IMAGENEX MODEL 831A
DIGITAL PIPE PROFILING SONAR

APPLICATIONS:

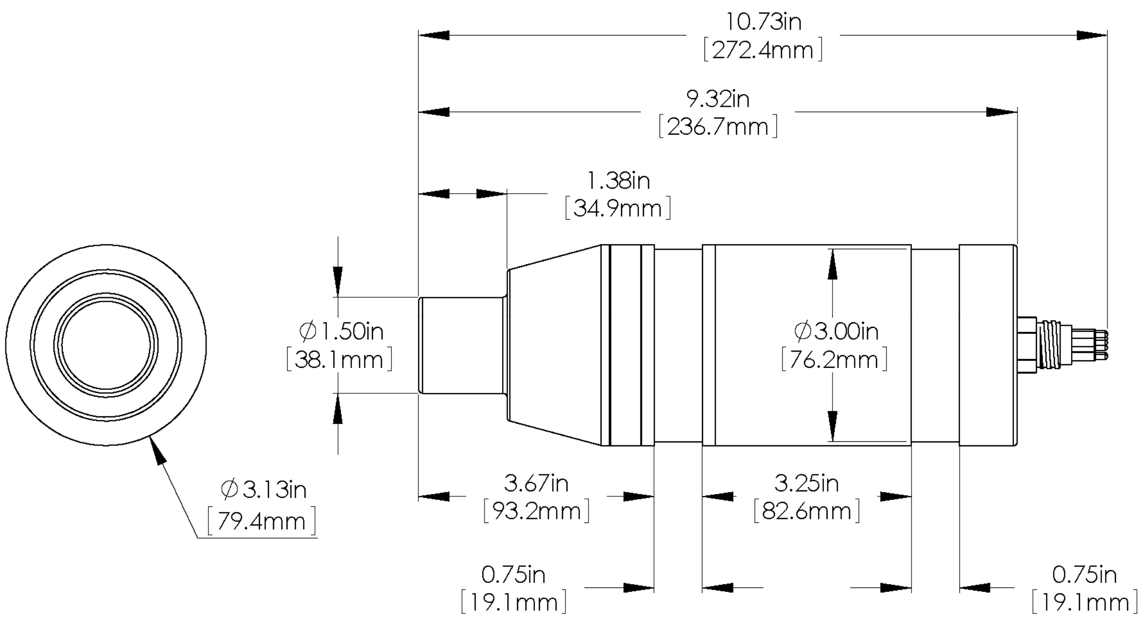
- Profiling
- Pipeline Inspection
- Scientific Research

FEATURES:

- Programmable
- High performance
- Scans 360° in 1 sec (up to 1 m range)
- Low power
- Digital telemetry
- 0.25 m to 6 m operation (full scale)
- Compact size
- Communication format available to user

HARDWARE SPECIFICATIONS:		
FREQUENCY	2.25 MHz	
TRANSDUCER	Profiling type, fluid compensated	
TRANSDUCER BEAM WIDTH	1.4° conical	
RANGE RESOLUTION	0.25 m: 1 mm	0.50 m: 2 mm
	0.75 m: 3 mm	1 m to 6 m: 2 mm
MIN. DETECTABLE RANGE	50 mm (~ 2”)	
MAX. OPERATING DEPTH	1000 m	
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	End mounted, four conductor, wet mateable (Subconn MCBH4M-AS)	
POWER SUPPLY	20 – 36 VDC at less than 5 Watts	
DIMENSIONS	79.4 mm (3.125”) diameter x 273 mm (10.73”) overall length	
WEIGHT: In Air	1.4 kg (3 lbs)	
In Water	0.5 kg (1 lb)	
MATERIALS	6061-T6 Aluminum & Polyurethane	
FINISH	Hard Anodize	

SOFTWARE SPECIFICATIONS:	**PipeSonar.exe**
WINDOWS™ OPERATING SYSTEM	Windows™ XP, Vista, 7, 8, 10
MODES	Polar
RANGE SCALES	0.25 m, 0.50 m, 0.75 m, 1 m, 2 m, 3 m, 4 m, 5 m, 6 m
STEP SIZE	0.9°
GRID TYPES	Polar
FILE FORMAT	(filename).31A
RECOMMENDED MINIMUM COMPUTER REQUIREMENTS:	100 MHz Pentium 16 MB RAM 1 GB Hard Disk 800 x 600 x 256 colour graphics



ORDERING INFORMATION:		
1000 m UNIT	Standard	831A-000-200
RS-232	Option	-006
Interface source code in “C” (TEST831A.C)	Option	-018

Imagenex Technology Corp.

MODEL 831A DIGITAL SONAR HEAD

SERIAL INTERFACE SPECIFICATION (v1.00)

Document Number	425-021	
Revision	**Date**	**Description**
00	July 16, 2009	Initial Draft
01	March 02, 2010	Updated Logo

OVERVIEW

The Model 831A Digital Sonar Head communicates over a 2-wire differential RS-485 serial data transmission line or optionally a half-duplex RS-232 data line.

The model 831A operates in **Sweep Mode**. A single switch data command is sent to the sonar, and the sonar will perform a full 360º revolution, collecting a profile point range for each 0.9º step / ping. After the full revolution is complete, the sonar will return a serial string back to the PC containing all the profile data for the current sweep.

To interrogate the head and receive echo data, a Switch Data Command string is sent via a serial command program at a baud rate of **115200 bps, No Parity, 8 Data Bits and 1 Stop Bit**.

SWITCH DATA COMMAND

The head accepts up to 27 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 28 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 – 7	**0xFE**	**0x44**	Reserved 0	Range Index	Reserved 0	Rev/ Hold	Reserved 43	Reserved 2
8 – 15	Start Gain	LOGF	Absorp-tion	Reserved 0	Reserved 0	Reserved 3	Pulse Length	Profile MinRange
16 – 23	Reserved 0	Reserved 0	Reserved 0	Reserved 25	Reserved 8	Reserved 0	Reserved 1	Calibrate
24 – 26	Switch Delay	Freq-uency	Term. **0xFD**					

Table 1 Model 831A 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 **0x44** (68 decimal)
Byte 2	**Reserved** Always 0x10
Byte 3	**Range Index** 25.0cm to 6 meters 4 = 25.0cm 6 = 50.0cm 8 = 75.0cm 10 = 1.0m 20 = 2.0m 30 = 3.0m 40 = 4.0m 50 = 5.0m 60 = 6.0m
Byte 4	**Reserved** Always 0
Byte 5	**Reverse** Bit 0 – 5 = 0 Bit 6 » 1 = Reverse Step Direction, 0 = Normal Operation Bit 7 = 0
Byte 6	**Reserved** Always 0x43
Byte 7	**Reserved** Always 2
Byte 8	**Start Gain** 0 to 40dB in 1dB increments
Byte 9	**LOGF** 0 = 10dB 1 = 20dB → Default 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 - 12	**Reserved** 0

Byte 13	**Reserved** Always 3
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 digitisation 0 – 250 → 0 to 2.5 meters in 0.01 meter increments Byte 15 = min range in meters * 100
Byte 16 - 18	**Reserved** Always 0
Byte 19	**Reserved** Always 25
Byte 20 - 21	**Reserved** 0
Byte 23	**Reserved** 1
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 2ms increments Byte 24 = delay_in_milliseconds/2 Do not use a value of 253!
Byte 25	**Frequency** 2.25MHz nominal 0 – 235 → 1.75MHz to 2.925Mhz in 5kHz increments Byte 25 = (frequency_in_khz - 2250)/5 + 100
Byte 26	**Termination Byte** The head will stop looking for Switch Data when it sees this byte. Always **0xFD** (253 decimal)

SONAR RETURN DATA

For every Switch Data Command received, the head will perform a complete sweep consisting of 400 shots (360deg/0.9deg = 400), return a 12 Byte header, 800 points of echo profile data, and a terminating byte value of 0xFC. The **total number of bytes** (**N**) returned will be 813.

Byte #	Description					
0 to 5	ASCII 'I'	ASCII 'S'	ASCII 'X'	Head ID	Serial Status	Head Pos (LO)
6 to 11	Head Pos (HI)	Range	Prof Rng (LO)	Prof Rng (HI)	Data Bytes (LO)	Data Bytes (HI)
12 to (N-2)	Echo Profile Data 400 Data Bytes					
N-1	Term. **0xFC**					

Table 2 Model 831A 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 '**IPX**'
'I' = 0x49, 'S' = 0x53, 'X' = 0x58

ASCII '**ISX**'
N = 813, (400 Points of Profile data)

Byte 3 **Head ID**
0x10

Byte 4 **Serial Status**
Bit 0 - 1 >= V1 firmware, (0 = V0)
Bit 1 - 0
Bit 2 - 0
Bit 3 - 0
Bit 4 - 0
Bit 5 - 0
Bit 6 - 1 = Switches Accepted
Bit 7 - 1 = Character Overrun

Byte 5 - 6 **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 0.9 Degree steps
0 = -180 Degrees
300 = -90 Degrees
600 = 0 Degrees (Center Position)
900 = +90 Degrees
1200 = +180 Degrees

Example angle calculation:

Angle = 0.9 * (Head Pos - 600)
Head Pos = 599
Angle = 0.9 * (599 - 600)
Angle = -0.9 Degrees

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

Byte 7 **Range Index**

Sonar Head Range: 25.5cm to 6 meters
4 = 25.0cm
6 = 50.0cm
8 = 75.0cm
10 = 1.0m
20 = 2.0m
30 = 3.0m
40 = 4.0m
50 = 5.0m
60 = 6.0m

Byte 8 - 9 **Number of Shots**

always 400 (360deg/0.9deg)

Byte 10 - 11 **Data Bytes**

Number of Profile Data Bytes returned. Always 800
Data Bytes (LO), Data Bytes (HI)

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

Byte 12-(N-2) **Start of Echo Profile Data**
(2*400 = 800) Bytes of data

First digitized range value above threshold in sample units for each step

Byte 12								Byte 13							
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 13 & 0x7E)>>1
Prof Rng Low Byte = [((Byte 13 & 0x01)<<7) | (Byte 12 & 0x7F)]
Profile Range = (Prof Rng High Byte<<8) | Prof Rng Low Byte

For ranges < 1m, one sample unit = range(m) / 250
For ranges >= 1m, one sample unit = 2mm

Sample units are based on a sound velocity of 1500m/s

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

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

831A PIPESONAR DATA STORAGE FILE FORMAT (.31A)

When recording the sonar data to a **.31A** file, the following bytes are appended and saved to the file every 'shot':

Byte #	Description
0 to 99	**File Header** (100 Bytes)
100 to 111	**Sonar Return Data Header** (12 Bytes)
112 to 912	**Sonar Return Profile Point Data** (800 Bytes, 400 data points, 2 bytes per data point) Byte 912 always = **0xFC** (Termination Byte from sonar head)
913 to 1023	**Zero Fill** yyyy = 1023
1024 to 1151	**Extended Bytes** If Byte #34 (in the File Header) is greater than zero, multiply Byte #34 by 128 to derive the number of Extended Bytes for this shot. i.e. if Byte #34 = 0x01, Extended Bytes = 128 (Extended Bytes = 128 when Pitch, Roll and Distance is available).
N-1 N-2	**Pointer To Previous Shot** The last 2 bytes of this shot contain a 16-Bit number that is the sum of the number of bytes for this shot and the number of bytes for the previous shot. This number is used for reverse playback synchronization. **N** = 1024 + Extended Bytes Number of bytes to previos shot = ((N-2)<<8) | (N-1)

FILE HEADER

Bytes 0 through 99 contain the following **File Header** information:

0 **ASCII '3'**
1 **ASCII '1'**
2 **ASCII 'A'**

3 **nToReadIndex** - Index for Number of Data Bytes
4 = 1024 Data Bytes

Note: nToReadIndex may contain a value of 8 = 3200 Data Bytes in some older file versions

831A PIPESONAR DATA STORAGE FILE FORMAT (.31A) (con't)

4-5 **Total Bytes** - number of bytes that are written to the disk for this shot

Byte 4								Byte 5							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
1024 + Number of Extended Bytes															

Note: Total Bytes may contain a value of 3200 + Number of Extended Bytes in some older file versions

6-7 **nToRead** - Number of Bytes from the sonar head

Byte 6								Byte 7							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
813															

8-19 **Date** - null terminated date string (12 bytes)
"**DD-MMM-YYYY**"

20-28 **Time** - null terminated time string (9 bytes)
"**HH:MM:SS**"

29-32 **Hundredth of Seconds** - null terminated string (4 bytes)
"**.hh**"

33 **Reserved –** always 0

34 **Extended Bytes**
Used for adding extra information to the .31A file format (i.e. for Pitch, Roll and Distance information)
Multiply this number by 128. The resulting number of Extended Bytes is appended to the current file shot.
0: 0 * 128 = 0 Bytes
1: 1 * 128 = 128 Bytes
2: 2 * 128 = 256 Bytes, etc.

35-36 **Reserved** - always 0

831A PIPESONAR DATA STORAGE FILE FORMAT (.31A) (con't)

37 **Dir, Xdcr, Mode, Step**

Byte 37							
7	6	5	4	3	2	1	0
Dir	**Xdcr**	**Mode**			**Step Size**		
0=ccw 1=cw	0=Dn 1=Up	1 = Polar			2 = 0.9 Deg (Fast)		

38 **Start Gain**
0 to 40 in 1 dB increments

39 **(Sector Size)/3**
0 to 120 = 0 to 360 Degrees in 3 degree increments
Default: 120 = 360 Degrees

40 **(Train Angle)/3**
0 to 119 = 0 to 357 Degrees in 3 degree increments
Default: 0 = 0 Degrees

41 **Reserved** - always 0

42 **Absorption**
1 to 255 = 0.01 to 2.55dB/m in 0.01dB/m increments
Default: 170 = 1.7dB/m for 2.25MHz

43 **Profile Grid, Zero, Data Bits, LOGF**

Byte 43							
7	6	5	4	3	2	1	0
Profile Grid	**Zero**	**Data Bits**			**LOGF**		
0=OFF 1=ON	0=Up 1=Dn	1 = 8 Data Bits			1 = 20 dB		

44 (**Pulse Length)/10**
0 to 100 = 0 to 1000μs in 10μs increments
Default: 1 = 10μs

831A PIPESONAR DATA STORAGE FILE FORMAT (.31A) (con't)

45 **Profile**
1 = Points Only

46-47 **Sound Velocity**

Byte 46								**Byte 47**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
V	**Sound Velocity (in meters/second) * 10**														

If '**V**' = 0, Sound Velocity = 1500.0 m/s
If '**V**' = 1, Sound Velocity = [((Byte 46 & 0x7F)<<8) | (Byte 47)]/10.0

48-79 **User Text -** null terminated text string (32 bytes)

80-81 **Operating Frequency**

Byte 80								**Byte 81**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
Operating Frequency (in kHz)															

82-90 **Reserved** - always 0

91-92 **Vertical Angle Offset**

Byte 91								**Byte 92**							
7	6	5	4	3	2	1	0	7	6	5	4	3	2	1	0
(Vertical Angle Offset + 180) * 10															

93-99 **Reserved** - always 0

831A PIPESONAR DATA STORAGE FILE FORMAT (.31A) (con't)

SONAR RETURN DATA HEADER
SONAR RETURN PROFILE POINT DATA
ZERO FILL

The following bytes contain the **Sonar Return Data** that is acquired directly from the sonar head serial COM port:

* refer to document 425-021-00 – 831A Serial Interface Specification

ASCII '**ISX**':

Bytes 100 through 912 (813 bytes – **Sonar Return Data**)
Bytes 913 through 1023 (111 bytes - **Zero Fill**)
Bytes 1024 through 1151 (128 bytes – **Extended Bytes**)

SONAR RETURN PROFILE POINT DATA (starting at Byte 112)

* 400 Profile Points in a circle (0.9 Degrees between points, 2 bytes per point)

Byte 112-113 **1st Profile Range Point**
First digitized range value above threshold in sample units
Prof Rng (LO), Prof Rng (HI)

Byte 112								**Byte 113**							
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 113 & 0x7E)>>1
Prof Rng Low Byte = [((Byte 113 & 0x01)<<7) | (Byte 112 & 0x7F)]
Profile Range Point = (Prof Rng High Byte<<8) | Prof Rng Low Byte

Byte 114-115 **2nd Profile Range Point**
Byte 116-117 **3rd Profile Range Point**
Byte 118-119 **4th Profile Range Point**
…
Byte 910-911 **Last Profile Range Point**

831A PIPESONAR DATA STORAGE FILE FORMAT (.31A) (con't)

To Calculate range:

For ranges < 1m, one sample unit = Range(m)/250
For ranges >= 1m, one sample unit = 2mm

Sample units are based on a sound velocity of 1500m/s

Range	Sample Units(mm)
25cm	0.001
50cm	0.002
75cm	0.003
1m	0.002
2m	0.002
3m	0.002
4m	0.002
5m	0.002
6m	0.002

Corrected Range = Profile Range Point * Sample Units * sound_velocity/1500

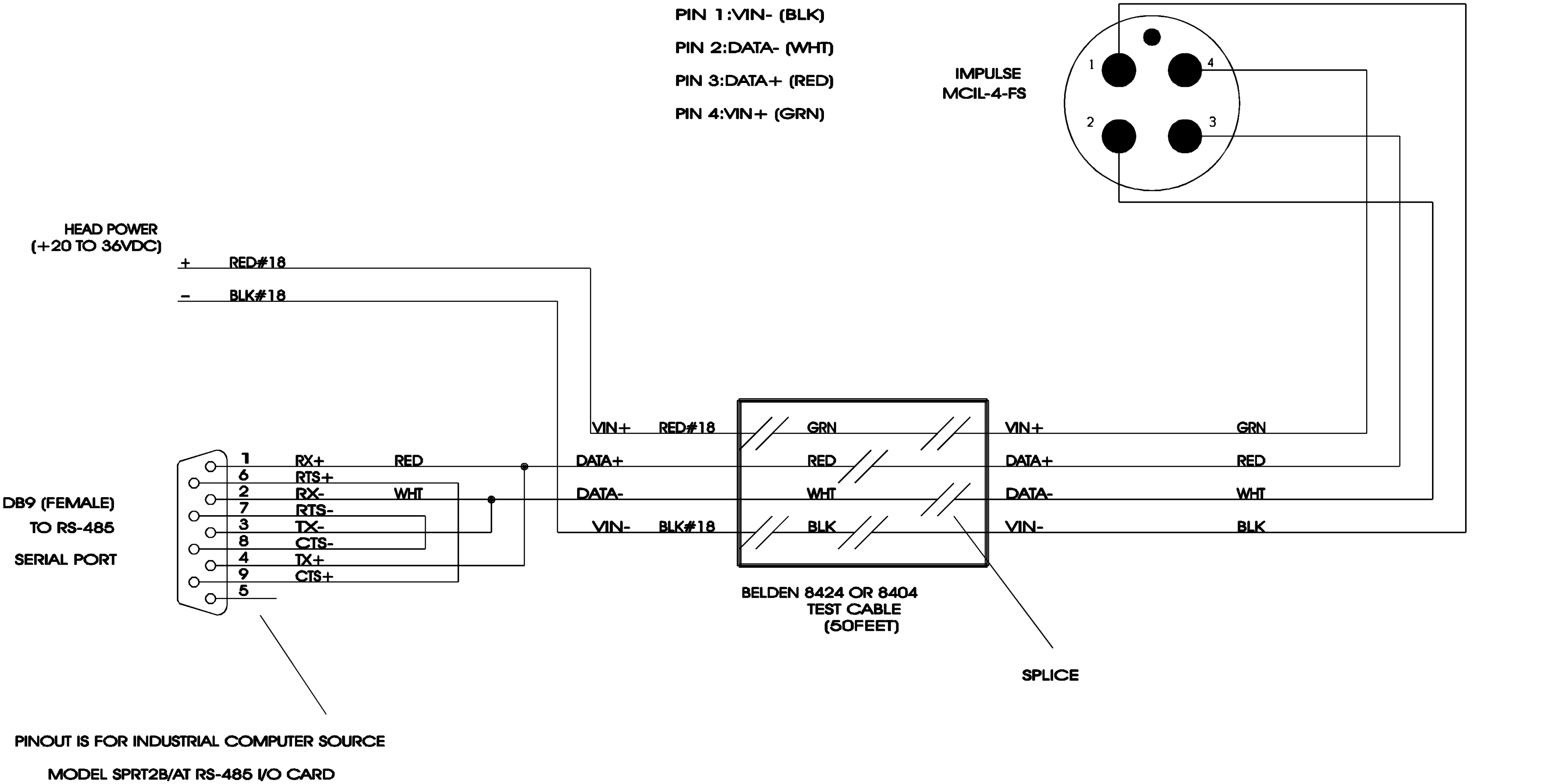
EXTENDED BYTES (starting at Byte 1024)

Byte 1098 Pitch, Roll, Distance Status Byte
Bit 0 = 1 - Pitch is available
Bit 1 = 1 - Roll is available
Bit 2 = 1 - Distance is available

Byte 1099-1102 Pitch in degrees(4 bytes, IEEE floating point)

Byte 1103-1106 Roll in degrees (4 bytes, IEEE floating point)

Byte 1107-1110 Distance in meters (4 bytes, IEEE floating point)



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	

SONAR THEORY AND APPLICATIONS

EXCERPT FROM IMAGENEX MODEL 855

COLOR IMAGING SONAR USER'S MANUAL

IMAGENEX TECHNOLOGY CORP.
#209 - 1875 BROADWAY ST.
PORT COQUITLAM, B.C. V3C 4Z1
CANADA

TEL: (604) 944-8248
FAX: (604) 944-8249

ABOUT YOUR SONAR

TERMINOLOGY:

The following is an explanation of the basic terms used by Imagenex to describe their sonar techniques.

Color: The different colors used to represent the varying echo return strengths.
Echo: The reflected sound wave
Echo Return: The time required for the echo to return to the source of the sound
Sonar: The principle used to measure the distance between a source and a reflector (target) based on the echo return time
Target: The object that you wish to obtain information about.

IMAGING:

Fan shaped beam
Scans surfaces at shallow angles, usually through a horizontal angle
Displays color images or pictures
Complete echo strength information for each point
Primarily for visual interpretation

In **Imaging** a fan-shaped sonar beam scans a given area, by either rotating or moving in a straight line, through a series of small steps, (see **Figure 1**). The beam's movement through the water generates points that form a sonar image of the given area. The different colored points, representing the time (or slant range) of each echo return, plot a line on a video display screen. The image, consisting of the different colored lines, depicts the various echo return strengths. The following characteristics are necessary to produce a visual or video image of the sonar image:

- the angle through which the beam is moved is small
- the fan-shaped beam has a narrow angle
- the transmitted pulse is short
- the echo return information is accurately treated

These visual images provide the viewer with enough data to draw conclusions about the environment being scanned. The operator should be able to recognize sizes, shapes and surface reflecting characteristics of the chosen target. The primary purpose of the imaging sonar is as a viewing tool.

PROFILING:

Narrow pencil shaped beams
Scans surfaces at a steep angle usually on a vertical plane
Displays individual points or lines
Accurately cross-sections a surface
Echo strength for each point higher than a set threshold
Digitizes a data set for interfacing with external devices
Data set is small enough to be manipulated in a small computer
Primarily a measurement tool

In **Profiling** a narrow pencil-shaped sonar beam scans across the surface of a given area generating a single profile line on the display monitor, (see **Figure 2**). This line, consisting of a few thousand points, accurately describes the cross-section of the targeted area. A key to the

Profiling process is the selection of the echo returns for plotting. The sonar selects the echo returns, typically one or two returns for each "shot", based on a given criterion for the echo return strength and the minimum profiling range. The information gathered from the selection criteria forms a data set containing the range and bearing figures. An external device, such as a personal computer or data logger, accesses the data set through an RS-232 interface with the sonar.

The profile data is useful for making pen plots of bottom profiles, trench profiles, internal and external pipeline profiles. The primary purpose of the profiling sonar is as a quantitative measuring tool.

USING AN IMAGING SONAR ON AN ROV

The imaging sonar is a useful substitute for a positioning system on an ROV. Without an imaging sonar, an ROV relies on traveling underwater to bring new targets into view. With an imaging sonar, instead of traveling it is more useful to spend some time with the vehicle sitting on the bottom while the sonar scans the surrounding area. Scanning a large area takes only a short time, and the vehicle pilot can quickly assess the nature of the surrounding area. The ability to "see" a long distance underwater allows the pilot to use natural or man-made features and targets as position references.

The combination of an imaging sonar and an ROV leads to fast and effective training in sonar interpretation. If the ROV pilot is searching for a particular object, recognition can take place directly from the sonar image. In other cases a number of potential targets may be seen. A pilot can sharpen his sonar interpretation skills by viewing these targets with the vehicle's video camera and correctly identify them.

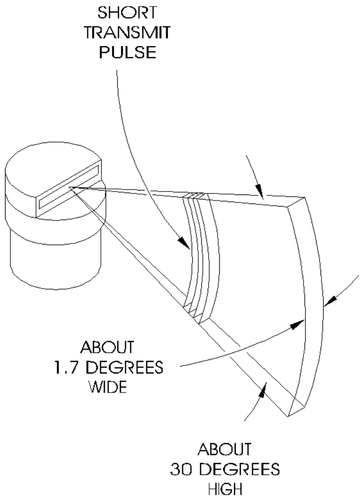
INTERPRETATION OF SONAR IMAGES

In many cases the sonar image of a target will closely resemble an optical image of the same object. In other cases, the sonar image may be difficult to interpret and quite unlike the expected optical image. The scanning process used to create a sonar image is different from the process used by the human eye or a camera to produce optical images. A sonar image will always have less resolution than an optical image, due to the nature of the ultrasonic signals used to generate it.

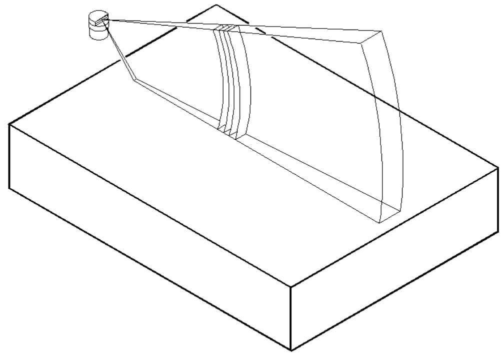
Generally, rough objects reflect sound well in many directions and are therefore good sonar targets. Smooth angular surfaces may give a very strong reflection in one particular direction, but almost none at all in other directions. Some objects, such as smooth plane surfaces, may be difficult to see with a sonar. They can act as a perfect mirror (so called specular reflectors), reflecting the sonar pulse off in unexpected directions, never to return. This happens to people visually, when they see an object reflected in a window. The human eye deals with such reflections daily but it is surprising to see the same thing occur with a sonar image. As with normal vision, it is often useful to scan targets from different positions, to help identify them. A target which is unrecognizable from one direction may be quite easy to identify from another.

It is very important to note that the ranges shown to the targets on the sonar image are "slant" ranges. Usually the relative elevations of the targets are not known, only the range from the transducer. This means that two targets, which are displayed in the same location on the screen may be at different elevations. For example, you might see a target on the bottom, and a target floating on the surface in the same place. By analyzing the shadows you can estimate the height of objects above the bottom. An example of this calculation is shown in **Figure 4**.

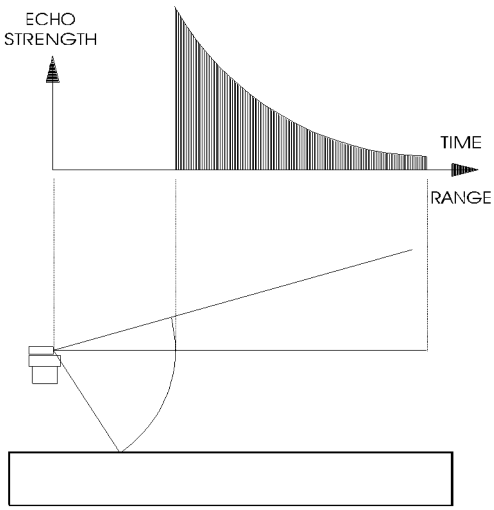
The diagrams following this chapter are examples of the sonar scanning process. Studying the diagrams will help you to better understand the images that you see. A basic knowledge of this process will help users to interpret what otherwise might be confusing images.



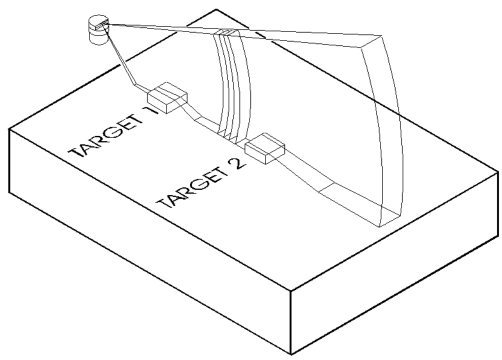
TYPICAL FAN SHAPED BEAM
AS USED ON IMAGING SONARS



FAN SHAPED SONAR BEAM
INTERSECTS WITH A FLAT BOTTOM

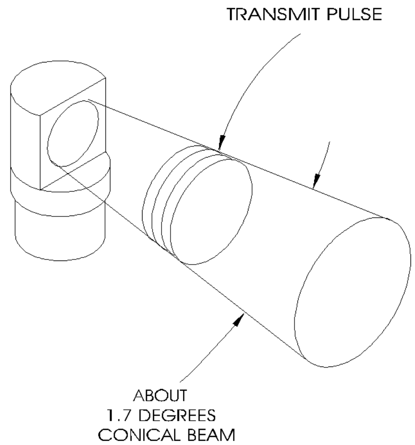


ECHO STRENGTH VS TIME WHEN
FAN SHAPED SONAR BEAM
INTERSECTS WITH A FLAT BOTTOM

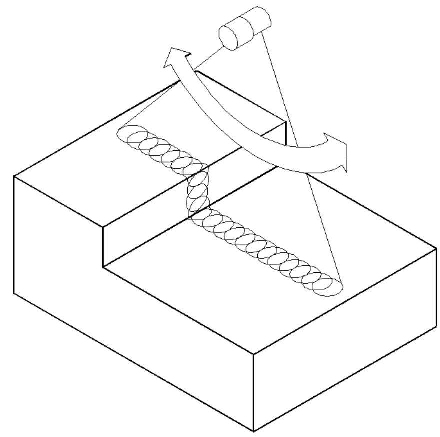


FAN SHAPED SONAR BEAM
INTERSECTS WITH A FLAT BOTTOM
AND TARGETS

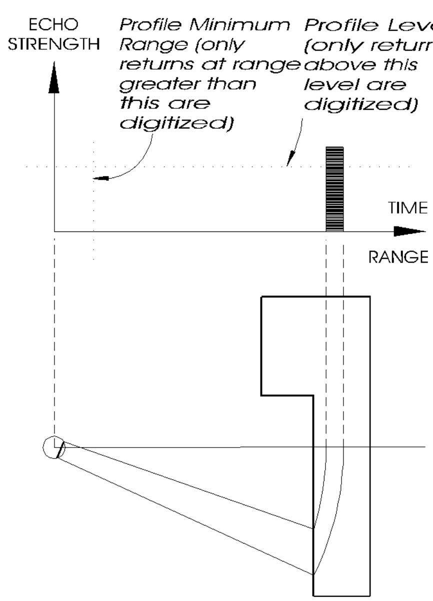
FIGURE 1



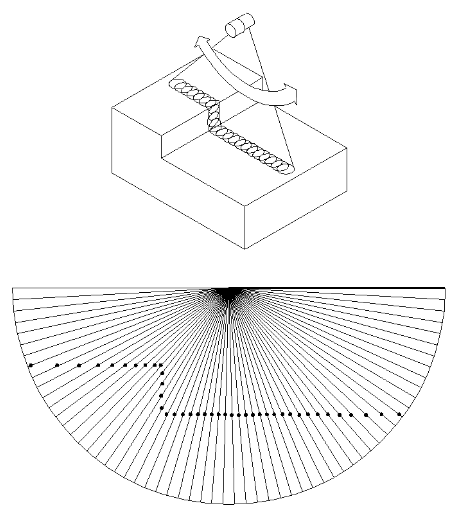
TYPICAL PENCIL SHAPED BEAM
AS USED ON PROFILING SONARS



PENCIL SHAPED SONAR BEAM
SCANS IN A VERTICAL PLANE
TO MEASURE BOTTOM PROFILE



ECHO RETURN FROM PENCIL BEAM



PLOT DIGITIZED ECHO RETURNS
TO SHOW PROFILE (CROSS
SECTION) OF BOTTOM

FIGURE 2

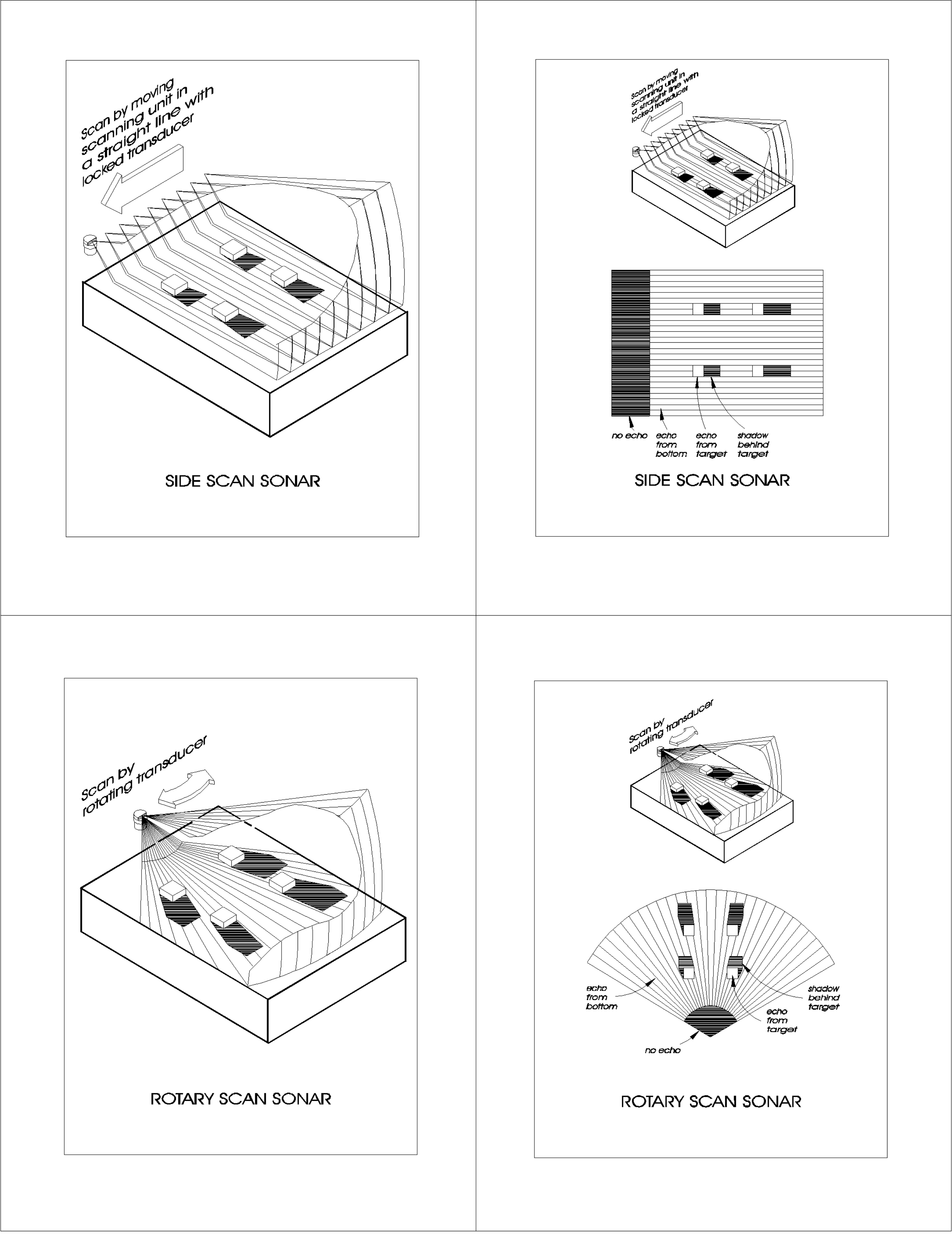

Scan by moving scanning unit in a straight line with locked transducer
SIDE SCAN SONAR
Scan by moving scanning unit in a straight line with locked transducer
no echo
echo from bottom
echo from target
shadow behind target
SIDE SCAN SONAR
Scan by rotating transducer
ROTARY SCAN SONAR
Scan by rotating transducer
echo from bottom
shadow behind target
echo from target
no echo
ROTARY SCAN SONAR

FIGURE 3

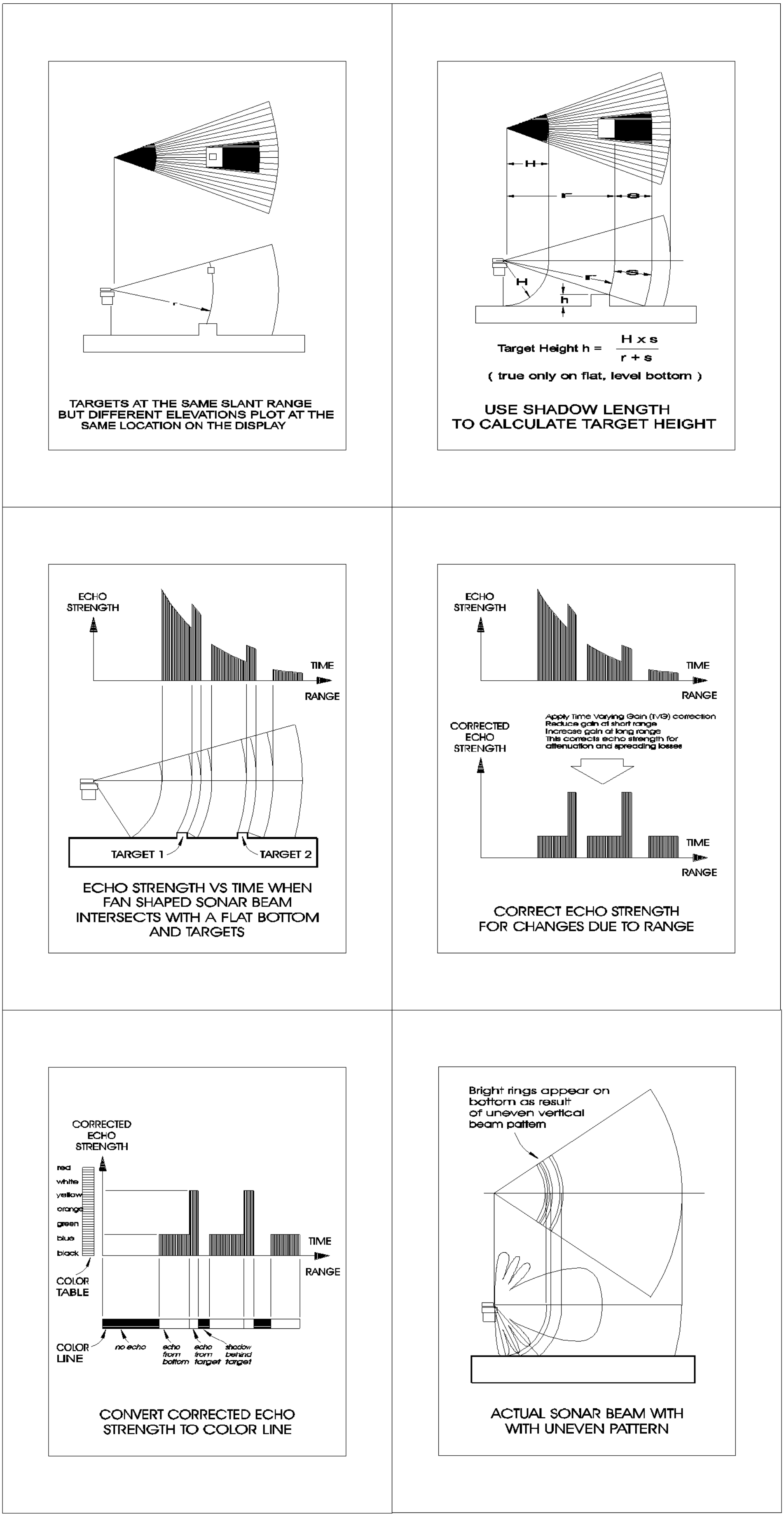

r
TARGETS AT THE SAME SLANT RANGE BUT DIFFERENT ELEVATIONS PLOT AT THE SAME LOCATION ON THE DISPLAY
H
r
s
H
r
s
h
Target Height h = $\frac{H \times s}{r + s}$
(true only on flat, level bottom)
USE SHADOW LENGTH TO CALCULATE TARGET HEIGHT
ECHO STRENGTH
TIME
RANGE
TARGET 1
TARGET 2
ECHO STRENGTH VS TIME WHEN FAN SHAPED SONAR BEAM INTERSECTS WITH A FLAT BOTTOM AND TARGETS
ECHO STRENGTH
TIME
RANGE
CORRECTED ECHO STRENGTH
Apply Time Varying Gain (TVG) correction
Reduce gain at short range
Increase gain at long range
This corrects echo strength for attenuation and spreading losses
TIME
RANGE
CORRECT ECHO STRENGTH FOR CHANGES DUE TO RANGE
CORRECTED ECHO STRENGTH
red
white
yellow
orange
green
blue
black
COLOR TABLE
TIME
RANGE
COLOR LINE
no echo
echo from bottom
echo from target
shadow behind target
CONVERT CORRECTED ECHO STRENGTH TO COLOR LINE
Bright rings appear on bottom as result of uneven vertical beam pattern
ACTUAL SONAR BEAM WITH WITH UNEVEN PATTERN

FIGURE 4