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MudScan: PC Based Sidescan Sonar Real-time Data Acquisition, Logging and Display System

by

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Introduction

MudScan is a PC based data acquisition and display system designed for the EG&G SMS990/996 digital sidescan sonar system. MudScan software was developed using the Microsoft C/C++ 7.0 compiler under DOS 5.0. The system architecture is based on a i486-33 mHz ISA Bus industrial embedded PC compatible computer using a VGA monitor for the graphical user interface (GUI) and system control. The actual sonar data is displayed with a high performance TI TMS34020-40mHz graphics coprocessor on a separate monitor.

Sonar data is acquired as a background task using a parallel IO board and the host DMA controller. MudScan records on any DOS disk media, although optical disk has proven to be best suited to the high logging rates and large volumes of data storage required. MudScan may be used to acquire sonar data directly from the SMS996 digital modem in real-time or it may be used to display and re-digitize sonar data from the EG&G SMS 960/Kennedy 9000 sea floor mapping system. This second mode of operation will allow data previously recorded from either the EG&G SMS 960/272 analog towfish or the SMS 990/996 digital towfish and modem to be recorded in a computer compatible format for later processing and enhancement. Data originally recorded on the EG&G SMS 960/Kennedy 9000 system from either the analog or digital towfish cannot be computer processed, thus the need for a more advanced aquisition and processing system. In either mode of operation, MudScan will record sonar data in the QMIPS[1] standard format that is compatible with other USGS developed mosaiking software.[2] MudScan is fully compatible with the current USGS YoNav integrated navigation system[3] Hard copy sonar record output is available in real-time or playback on the Raytheon TDU 850 thermal printer.

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[1]Triton Technology, Watsonville, CA

[2]Open-File 92-XXX XSonar by Bill W. Danforth, AMG

[3]Open File 92-565 YoNav: Your Own Navigation System by John T. Gann

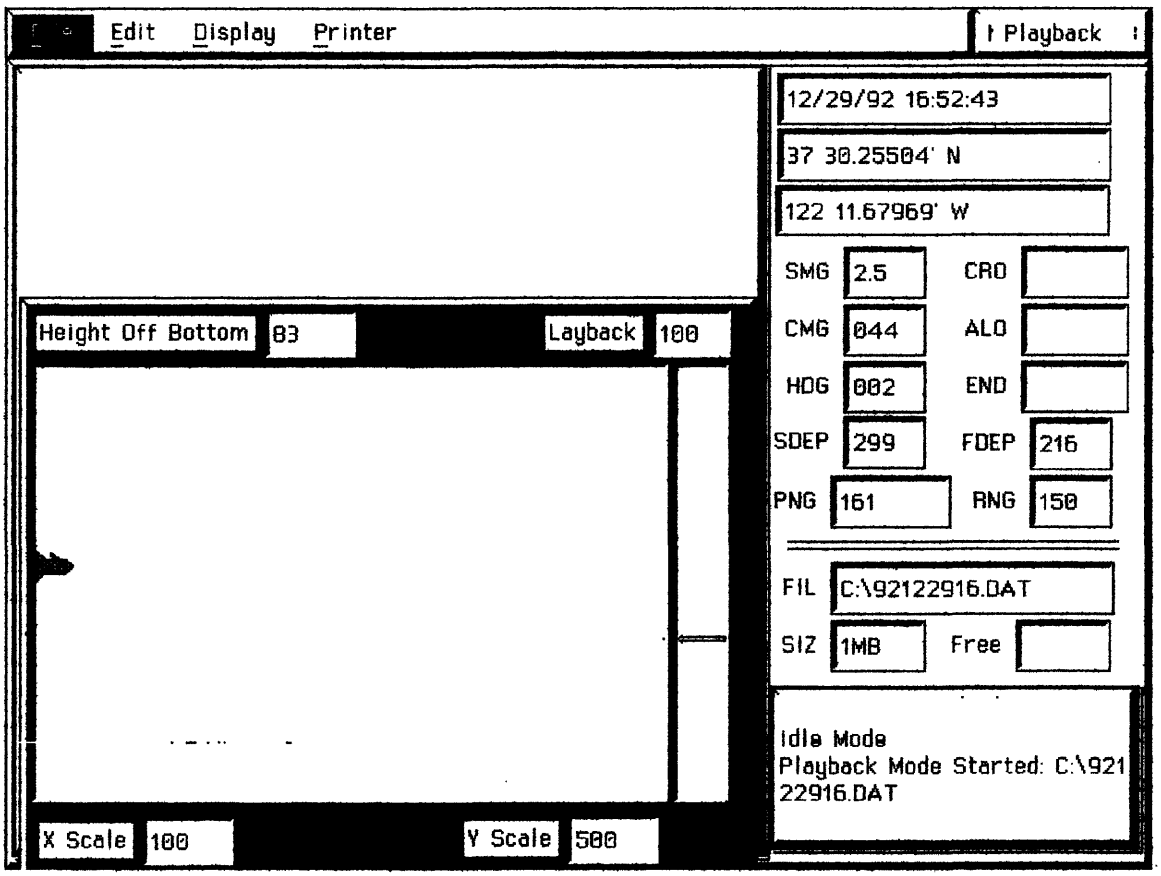

Figure 1. Anatomy of Main MudScan Display

Main MudScan Display

The main graphics display is comprised of 3 different windows: 1) the main drawing area, 2) the side panel display and 3) the scrolling message area in the lower right corner. Each part of the display serves a discrete function. Please refer to Figure 1. while reading the next few sections.

Main Drawing Area

The main drawing area optionally displays an operator controlled obstacle avoidance form. See Figure 1. The Obstacle Avoidance display is discussed in the Edit Menu section.

Side Panel Display

The side panel display is used to display the navigation, sonar and disk related parameters during both real-time and playback modes. See Figure 1. Starting at the top of the form, the time, latitude and longitude are displayed for the current ping. The other fields are described in Table 1.

Field Label	Description	Units	Source
SMG	Speed Made Good	Knots	YoNav
CMG	Course Made Good	Degrees	YoNav
HDG	Fish Compass Heading	Degrees	Sidescan sonar fish
SDEP	Bottom depth under ship	Meters	YoNav via shipboard bathymetry sensor.
CRO	CROss track distance from current survey line.	Meters	YoNav
ALO	ALOng track distance measured from start of current survey line.	Meters	YoNav
END	Distance to END of current survey line	Meters	YoNav
FDEP	Depth of sidescan sonar fish as measured by onboard pressure transducer	Meters	Sidescan sonar fish
PNG	Sequential ping number since the beginning of file	Unitless	MudScan System
RNG	Current sidescan swath width	Meters	Computed by MudScan using raw sidescan data
FIL	Current Filename	Unitless	MudScan
SIZ	Size of the current file	Megabytes	MudScan
Free	Amount of disk space remaining on the current drive	Megabytes	MudScan

Table 1. Side Panel Display Fields

Scroll Window

The Scroll Window at the lower right hand corner of the screen is used to display informational and diagnostic messages from MudScan to the operator.

The File Menu

The File Menu contains selections for configuring MudScan in Record, Playback or Test Mode as well as providing the means to exit to DOS. Please refer to Figure 2.

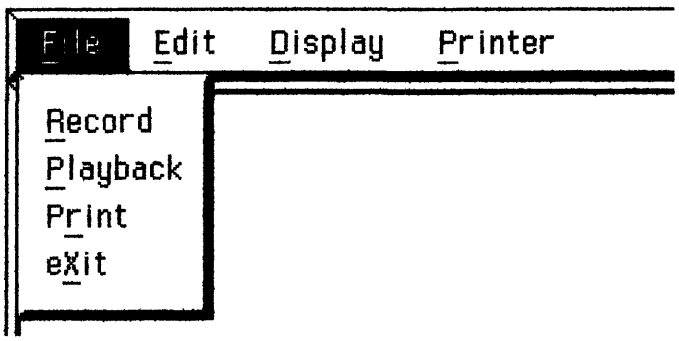

Figure 2. File Menu

Record

The Record menu selection allows the operator to begin the real-time recording of sidescan sonar data either from the SMS 996 modem or directly from the Kennedy 9000 tape drives. When recording real-time sidescan data from the SMS 996 modem be sure that the MudScan Interface Panel switch has been set to the **SMS 996 Modem/Real-time** position. When recording from the Kennedy 9000 tape drives the switch must be in the **Tape Read** position.
When the Record selection is chosen the operator is presented with a destination file dialog box. Please refer to Figure 3.

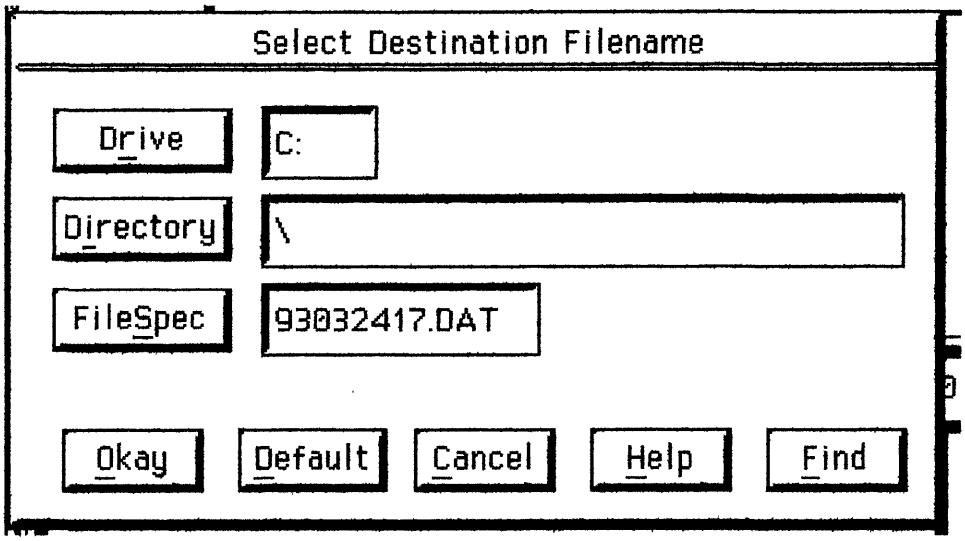

Figure 3. File Dialog Box

The file dialog box provides a consistent way to select files for input or output. The **Drive** button may be pressed to select a logical disk drive or the drive letter (followed by a colon) may be entered directly into the drive field area. The **Directory** button may be pressed to give a list of directories on the current drive or the directory path may be entered in the directory field. The **FileSpec** button may be pressed to get a list of all the files in the current directory that match the contents of the file specification field. Normal DOS wild card characters may be used to match a certain pattern of files. For example, to find all of the files in the directory that end with the "DAT" suffix, type "*.DAT" as the file specification and press either the **Okay** or **FileSpec** buttons. The Find button will search the entire drive for a file that matches the file specification field. Note that on large disk drives the **Find** function may not have enough memory to provide a complete list of directories or filenames.

The file dialog box will contain a suggested filename in which to store the recorded sonar data. The filename format is shown in Table 2as follows:

YYMMDDHH.nnn

where,

Symbol	Description	Range
YY	current Year	00-99
MM	current month	01-12
DD	current day of month	01-31
HH	current hour of day	00-23
nnn	required to create a unique file name	"DAT" or 001-999

Table 2. Automatic File Nomenclature

The suggested file name, which is based on the current time and date, is guaranteed to be a unique filename on the current logging disk. You may accept this unique filename or replace it with another. The automatically generated filenames are recommended because they provide a way of time stamping the recorded data. These filenames can also be chronologically sorted for playback or mosaic creation.

Playback

The Playback menu selection allows the operator to begin playback of prerecorded sonar data that is in the QMIPS format A File Dialog box is presented to allow the user to choose the file to playback. During Playback, the **Pg Up** and **Pg Dn** keys may be used to "fast-forward" and "fast-reverse" through the file to find a desired feature. Playback may be used to print sections of data on the Raytheon Thermal printer. However, if you wish to print the entire file, the Print option (next section) is a much faster way to do this. (See the section on Throughput).

Print

The Print menu selection allows the operator to print a prerecorded sonar data file on the Raytheon TDU-850 thermal printer. This is the fastest way to get a hard copy of a sonar data file. (See the section on Throughput).

The Edit Menu

The Edit Menu contains selections for configuring various MudScan operating parameters. Please refer to Figure 4.

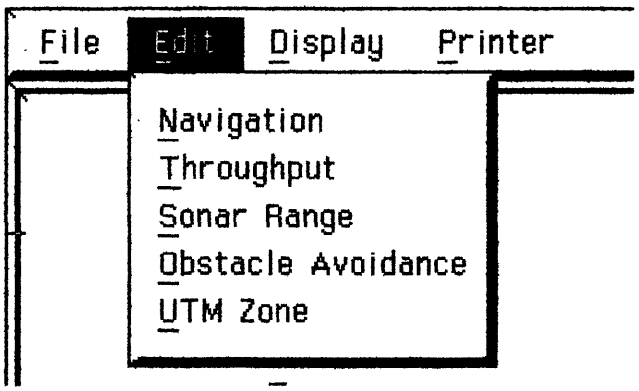

Figure 4. Edit Menu

The Edit Menu allows the operator to select the navigation input source, change the system throughput, manually change the input sonar range, setup the obstacle avoidance display and set the MudScan UTM Zone.

Navigation

The **Navigation** menu selection allows the operator to setup a navigation input function. See Figure 5.

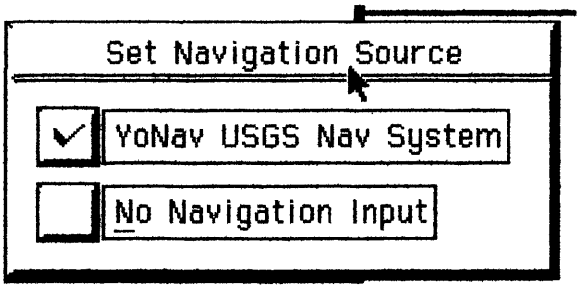

Figure 5. Navigation Source

The only options that are currently supported are the No Navigation and the YoNav[1] input options. The COM1 serial port is assigned to the navigation input. YoNav should be configured to output the **MudScan** data packet at 9600 baud, no parity 8 data bits and one stop bit.

Time Stamping Pings

If using MudScan without a navigation input be certain that the MudScan system time is synchronized with non-integrated navigation sensor so the sonar data can be correlated to the navigation data through accurate time stamping. MudScan time stamps each ping to the nearest millisecond. Since the data arriving from the sonar is not blocked by pings, a different approach was taken to time stamp each ping. Since a large block of sonar data is transferred to system memory during one data acquisition cycle, the sonar data block receives a single time stamp. The time for each ping within the sonar data block is computed by adding the milliseconds of delay between each sonar ping at the current sonar range.

Throughput

The **Throughput** menu selection allows the operator to set the speed at which the sonar data will be read and displayed during Playback. The actual Ping Throughput number is the number of pings that will be read in from the disk during a single read operation. Lower numbers result in a smoother yet slower waterfall display. Higher numbers give a jerkier yet faster playback. In either case every recorded ping will be displayed. Please refer to Figure 6.

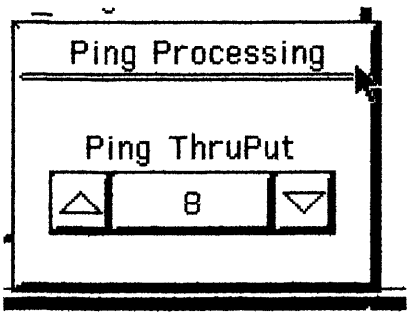

Figure 6. Throughput

The Throughput option has no effect during Record mode. In general, the higher the throughput number, the more pings that will be processed during playback. The throughput number is limited by available PC memory.

Sonar Range

The **Sonar Range** menu selection allows the operator to manually set the expected sonar range. Please refer to Figure 7.

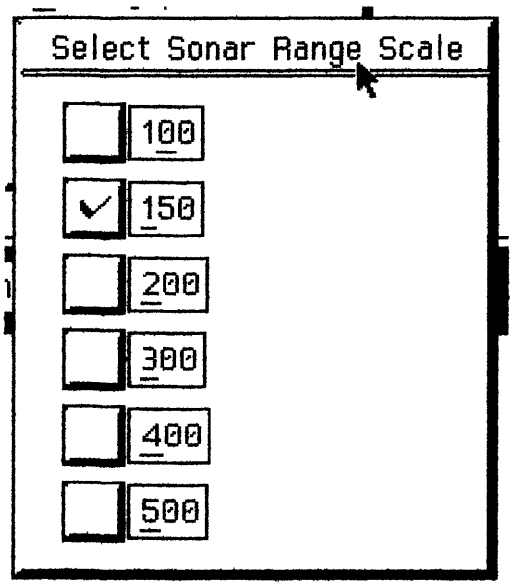

Figure 7. Sonar Range

The sonar range is half the current swath width of the side scanning sonar. This should be set prior to entering the record mode and has no effect during playback mode. MudScan will detect the incoming sonar range by looking at the number of samples per channel that are being acquired as long as the SMS 990/996 system is being operated in the fixed sampling frequency mode. In this mode, the SMS 996 digitizer operates at 6 kHz per channel so that each

different sonar range will produce a distinct number of samples.[4] If MudScan detects a change in the current sonar range scale during a recording session, it will automatically close the current file, open a new file on the current logging disk drive and restart the record mode. This built-in detection feature allows the sonar operator to change range scales at any time without worrying about changing the range scale on the MudScan system.

Obstacle Avoidance

The obstacle avoidance form is provided as an aid to determining the location of the towed sidescan sonar with respect to the bottom. Please refer to Figure 8.

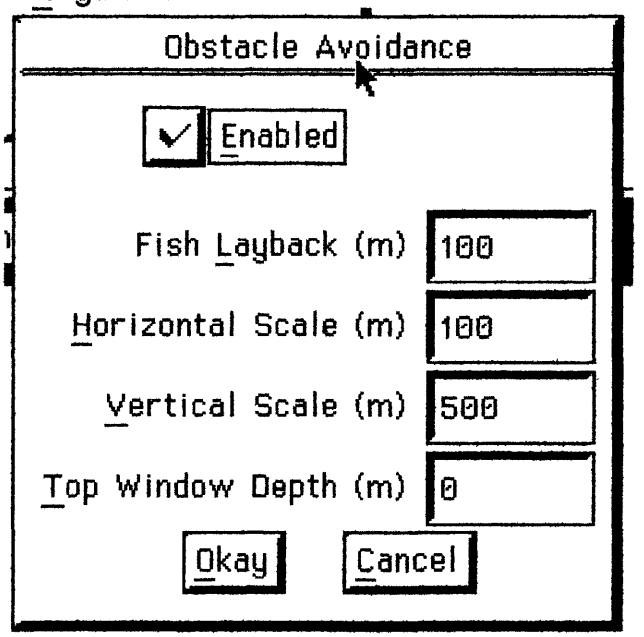

Figure 8. Obstacle Avoidance

The SMS 990 fish contains a hydrostatic pressure transducer that reports the depth of the fish. The depth under the towing vessel as well as the vessels' speed is used to complete the collision avoidance display. The fish icon will be positioned both horizontally and vertically according to the horizontal and vertical scales selected and the depth of the fish. The arrow icon will draw a line horizontally that represents the bottom depth under the ship. The fish layback value is used to horizontally position the fish within the collision avoidance window. **NOTE: This display is provided as an aid**

[4]MudScan has not been tested with the SMS 990/996 in variable digitizer frequency mode, but should work. The automatic range detection algorithm will always select a range of 100 meters (884 samples per channel). The reason for this is that in variable sampling frequency mode, both the SMS 990/996 and SMS960/272 always send out the same number of samples regardless of sonar range and that number of samples (884 / channel) is the same as the fixed frequency 100 meter range scale.

only! Since this form is only as accurate as the bathymetry, fish depth sensor and layback information provided, always use independent means to verify the location of the fish.

UTM Zone

In order to properly record navigation data in the QMIPS format, the Universal Transverse Mercator (UTM) Zone number is required. The UTM Zone for the given operating area can be obtained from the YoNav system or from most mapping text books. See Figure 9

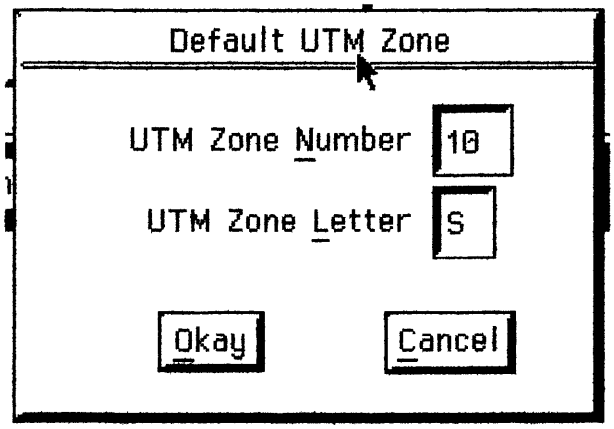

Figure 9. UTM Form

YoNav passes navigation information as latitude and longitude in the WGS84 datum. The QMIPS format specifies that the navigation information be recorded in UTM coordinates. NOTE: If the latitude and longitude displayed on the MudScan side panel does not agree with the YoNav display, it is most likely because the UTM zone number and letter have not been properly set in MudScan.

The Display Menu

The Display Menu contains selections for configuring the MudScan high resolution graphics display. Please refer to Figure 10.

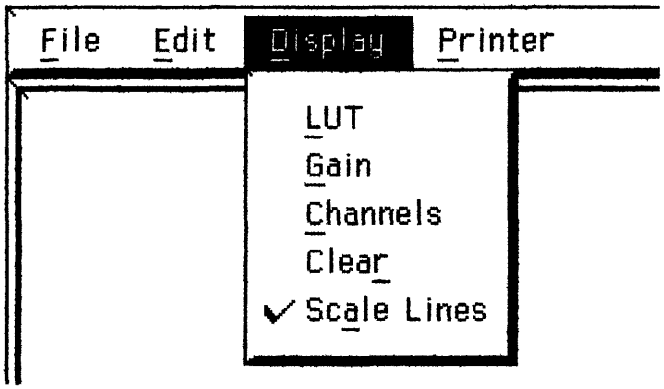

Figure 10. Display Menu

LUT

The **LUT** menu selection allows the selection of a color display **L**ook **U**p **T**able (LUT). The primary value of a LUT is to allow the graphics hardware to display the same digital image in various analog presentations by controlling the way the graphics hardware will respond to a certain digital value. The LUT instructs the graphics hardware how much red, green and blue to display for a certain digital value.

The user is presented a list of LUT files for the TIGA display and may choose the desired LUT from a list of suitable LUT files. See Figure 11

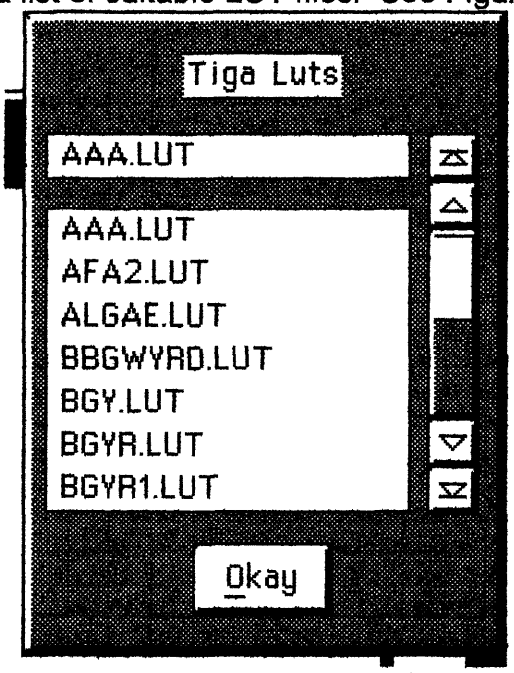

Figure 11. Display LUTs

The chosen LUT file will be immediately applied and its effects visible on the high resolution graphics display. The LUT can be changed at any time, during record, playback or idle mode. The LUT can be rotated to the left or the right

through the use of the Alt-F4 and Alt F5 function keys. The LUT can be inverted by pressing the Alt-F3 function key.

Gain

The **Gain** menu selection allows the operator to apply a digital gain the raw sonar sample before displaying it. Since both the EG&G SMS 960 and SMS 990/996 use a 6-bit digitizer all digital sonar values will be in the range of decimal 0-63. Use the gain control to select the number of bits to "shift" the raw display. Please see Figure 12.

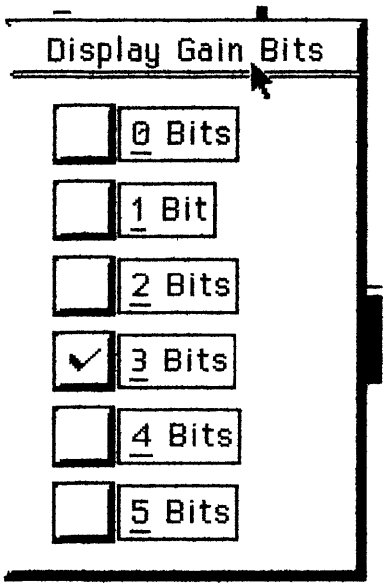

Figure 12. Display Gain

A shift is a multiplication by 2^n, where n is the display gain value. For example, if the display gain is set 3 bits and the raw sonar sample is 25, then the display will respond as if the sample was 200 (2^3 X 25). The gain value has no effect on the recorded data. It's only function is to enhance the graphics display. The recorded data is always written in its full raw format regardless of any display option setting.

Channels

The **Channels** menu selection allows the display of either Port & Starboard, Port Only or Starboard only sonar channels. See Figure 13.

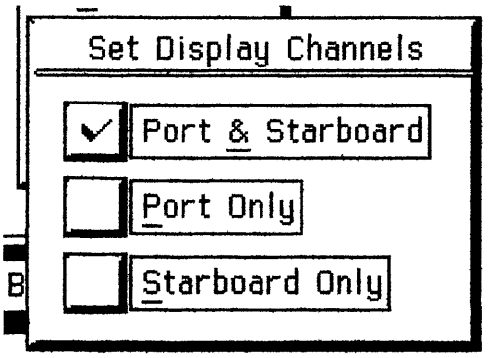

Figure 13. Display Channels

This option only affects the high resolution display. It has no effect on the hard copy display or the recorded data. The recorded data is always written in its full raw format regardless of any display option setting.

Clear

The **Clear** menu selection clears the high resolution graphics display. This option only affects the high resolution display. It has no effect on the hard copy display or the recorded data.

Scale Lines

The **Scale Lines** menu selection displays 5 proportional scale lines on the high resolution display. The scale lines will be displayed when the menu item is checked. See Table 3

Sonar Range Scale	Distance Between Scale Lines (m)
100	20
150	30
200	40
300	60
400	80
500	100

Table 3. Range Scale Lines

The Printer Menu

The Printer Menu contains selections for configuring the Raytheon TDU-850 thermal printer for hard copy output of sonar records in both record and playback modes. Please refer to Figure 14.

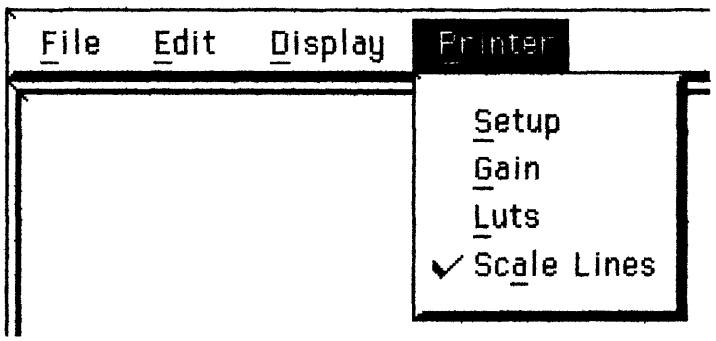

Figure 14. Printer Menu

Setup

The Setup menu allows the operator to select what channels, if any, to display on the Raytheon TDU-850. Please refer to Figure 15.

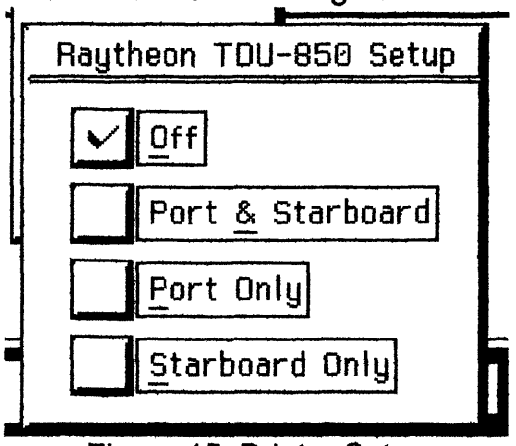

Figure 15. Printer Setup

The printer can display either port and starboard, port only or starboard only sonar channels. This option only affects the hard copy output. It has no effect on the high resolution video display or the recorded data. The recorded data is always written in its full raw format regardless of any printer option setting.

Gain

The **Gain** menu selection allows the operator to apply a digital gain the raw sonar sample before printing it. See Figure 16.

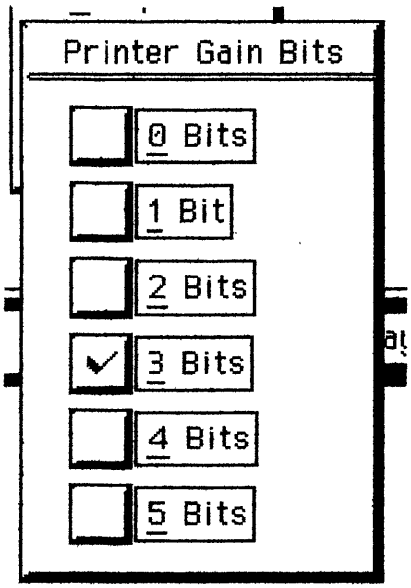

Figure 16. Printer Gain Control

Since both the EG&G SMS 960 and SMS 990/996 use a 6-bit digitizer all digital sonar values will be in the range of decimal 0-63. Use the printer gain control to select the number of bits to "shift" the raw display. A shift is a multiplication by 2^n, where n is the display gain value. For example, if the printer gain is set 3 bits and the raw sonar sample is 25, then the printer will respond as if the sample was 200 (2^3 X 25). The gain value has no effect on the recorded data. It's only function is to enhance the hard copy output. The recorded data is always written in its full raw format regardless of any printer option setting.

Luts

The **Luts** menu selection allows the selection of a gray scale LUT. Please refer to Figure 17.

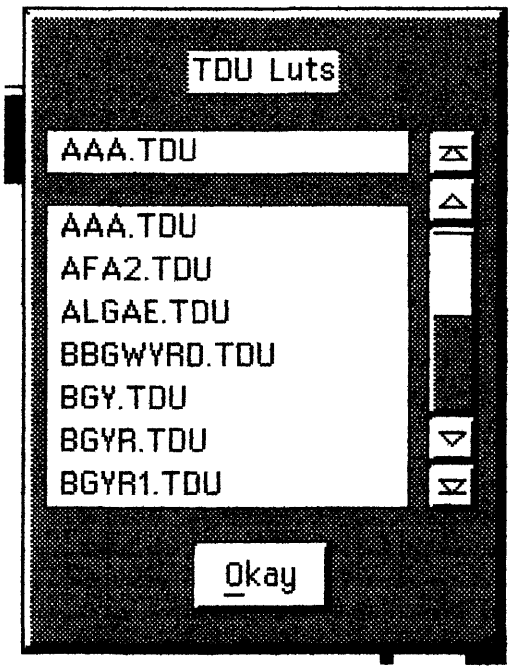

Figure 17. Printer LUTs

The user is presented a list of LUT files for the Raytheon TDU-850 and may choose the desired LUT from a list of suitable LUT files. The chosen LUT file will be immediately applied and its effects visible on the next printed sonar ping. The LUT can be changed at any time, during record, playback or idle mode. The printer LUTs differ from the display LUTs in that the printer is a black and white device not a color device. The LUT files for the printer were developed by taking the color display luts and mapping the red intensities to gray levels for each of the 256 entries.

Scale Lines

The **Scale Lines** menu selection displays 5 proportional scale lines on the thermal printer output. The scale lines will be displayed when the menu item is checked. See Table 3 for the size of the scale line increments.

MudScan Hardware Components

EG&G SMS 996 Digital Modem

The data for real-time operation of MudScan comes from the SMS 996 Modem. Data frame synchronization is accomplished with a 12 kHz strobe signal and by having the two most significant bits of each 8-bit serial data word coming up the coax telemetry cable encoded with the type of data sent. The lowest six bits are actual data bytes. For the port and starboard data, each byte is one 6-bit word. For the sensor data, each pair of bytes makes up a 12-bit word. The high frequency up-link data are received by a UART (Universal Asynchronous Receiver Transmitter) and converted back into parallel data for export to the

outside world. The parallel outputs of the modem are negative true open collector logic and are not suitable for direct importation into a computer based data acquisition and processing system. A custom interface was designed and built for bringing the digital data stream from either the EG&G SMS 990/996 or Kennedy 9000 9 track tape system into MudScan.

MudScan i486 Rack Mount Digital Signal Processor

The MudScan i486 digital signal processor is an ISA Bus embedded PC compatible computer running at 33 MHz. It is constructed with an active motherboard utilizing industry standard off-the-shelf components. Refer to figure18

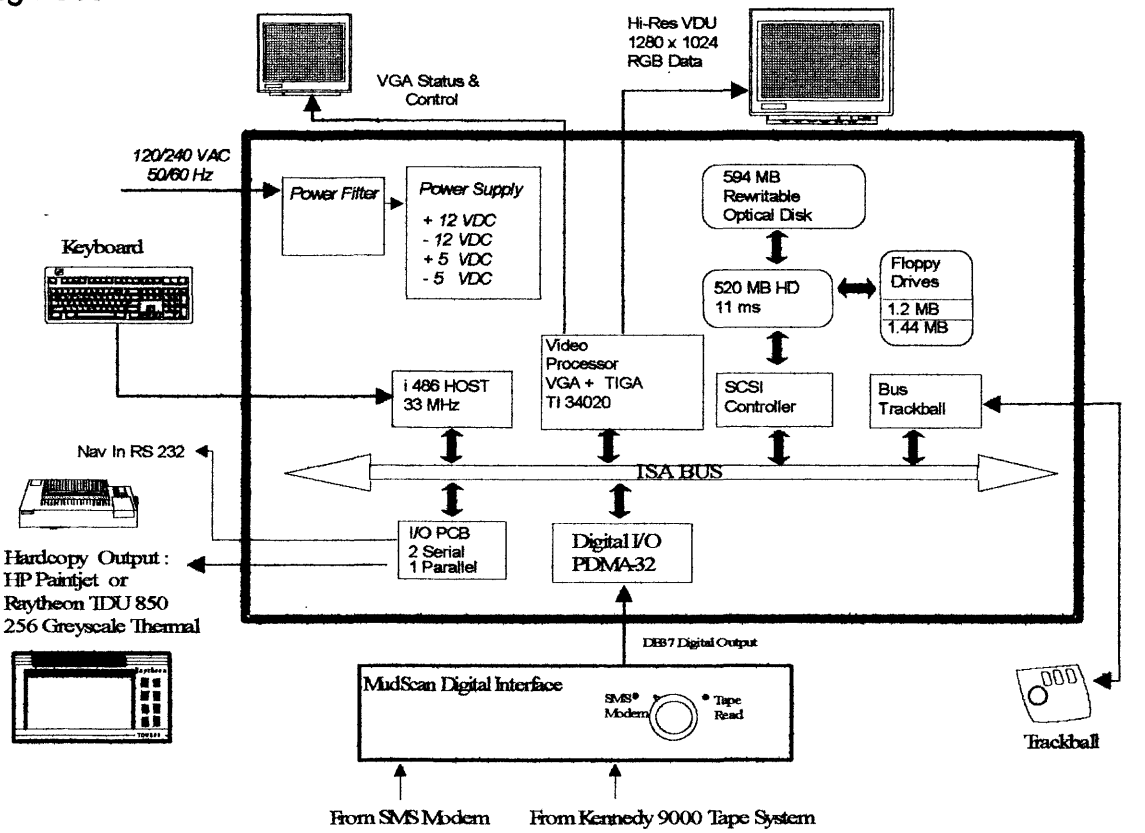

Figure 18. MudScan System Diagram

MudScan Digital Interface Box

MudScan comes equipped with a digital interface box that contains circuitry for two functions. Refer to Figure 19 while reading this section.

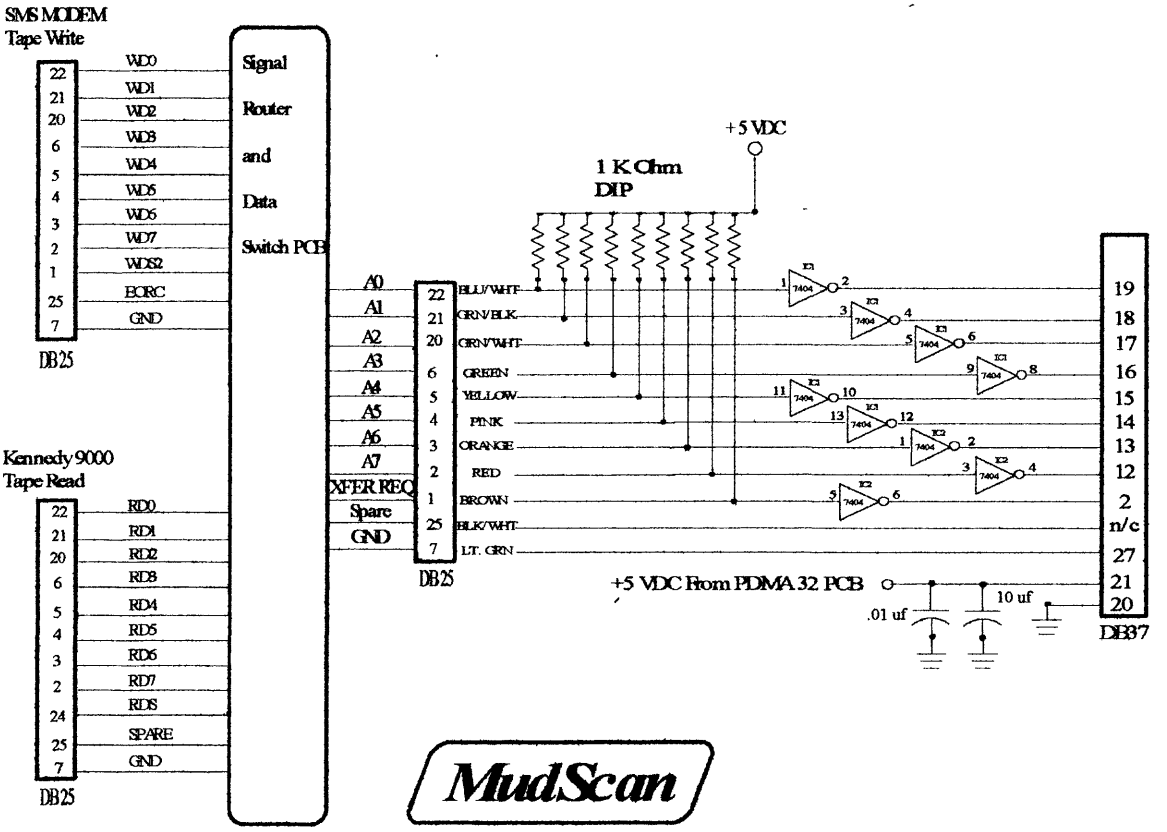

Figure 19. MudScan Digital Signal Processor

The main circuit transforms the parallel data into TTL level positive true logic levels. This is accomplished by pulling up the modem open collector outputs and inverting all data and Xfer request (strobe) lines. The second printed circuit board performs signal routing and data switching functions to allow for selecting between real-time input from the SMS 996 Modem or re-digitizing tapes from the Kennedy 9000 tape system to allow for later image processing and computer generated mosaics. The interface box has a front panel radial knob for selecting either input function. The rear of the interface box has two DB-25 pin connectors that mate with a standard parallel data cable to both the SMS 996 Modem and the Kennedy 9000 tape deck. Also on the rear of the interface is a DB-37 pin connector that mates with a 37 line flat ribbon cable to bring the parallel data into the MudScan via the PDMA-32 PCB assembly.

High Speed & High Resolution Graphics
The high resolution graphics display is produced by using the Number Nine GXi Level 25 graphics board. This single board contains both a standard VGA adapter as well as a high resolution (1280 X 1024 X 256) graphics co-processor (Texas Instruments TMS34020). MudScan uses the VGA graphics monitor to provide an easy to use Graphical User Interface (GUI) while displaying the sonar data on the high resolution display. The sonar display software takes advantage of the Texas Instruments Graphics Architecture (TIGA) driver and should be portable to any other video card that supports the TIGA interface.

Recording Media
MudScan uses a Sony Rewritable Magneto Optical SCSI disk for recording the voluminous amounts of sidescan sonar data. The MudScan software will record to any standard DOS device such as a standard hard or floppy drive but typically these devices do not have sufficient volume for sidescan applications.
The advantages to using rewritable disks is both the ability to recycle the rather expensive optical disk media and the rapid disk access times.

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