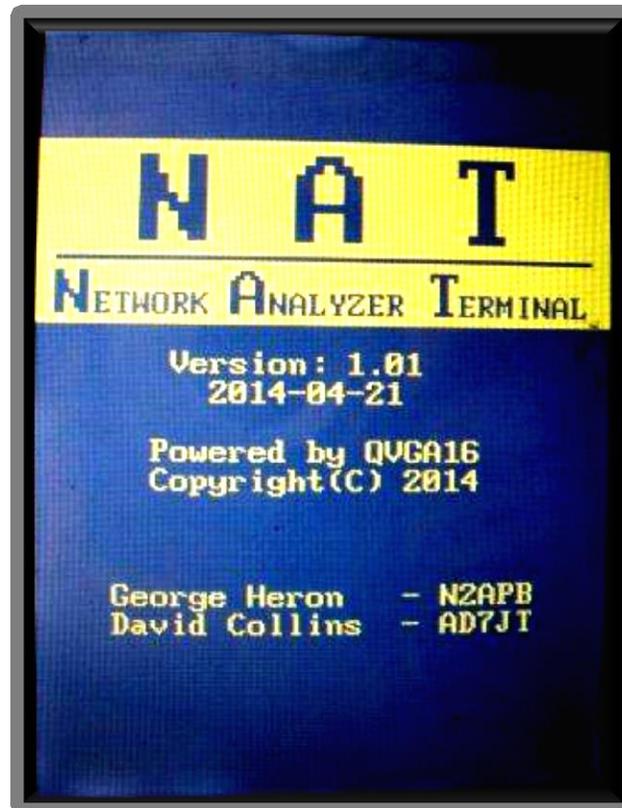


NETWORK ANALYZER TERMINAL

(NAT)

Quick Start Guide

Firmware Version 1



CONTENTS

1	GENERAL INFORMATION	2
2	INTRODUCTION	2
3	INITIAL SET-UP	3
3.1	SERIAL INTERFACE SET-UP	3
3.2	PHSNA FIRMWARE LOADING	4
3.3	KEYBOARD CONNECTION	4
3.4	START UP and SETTING THE SERIAL INTERFACE BAUD RATE	5
3.5	PREPARING THE SD CARD	5
4	TERMINAL MODE	8
4.1	THE TOP MENU	8
4.2	SPOOLING DATA IN TERMNAL MODE	9
4.3	PLOTTING DATA IN TERMINAL MODE	9
5	COMMAND MODE	10
5.1	EDITING THE LOG FILE NAME	10
5.2	PLX PARAMETER DATA ENTRY	11
6	DOS MODE	12
7	PLX (EXCEL) MODE	13
	APPENDIX A. HOT KEY SUMMARY	14
	APPENDIX B. NAT COMMAND SUMMARY	15
	APPENDIX C. NAT (rev A) SCHEMATIC	16

1 GENERAL INFORMATION

This manual describes many of the operations that can be performed with the Network Analyzer Terminal (NAT). Many of the descriptions are presented in the form of tutorials with step-by-step instructions. The emphasis is on how to do something without going into the details of what is going on and how it is done. This information is covered in detail in the NAT User Guide and the NAT Assembly Guide and the available PHSNA documentation.

```
*****
***   THIS FIRMWARE IS PROVIDED IN AN "AS IS" CONDITION. NO WARRANTIES,   ***
***   WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, BUT NOT LIMITED   ***
***   TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A       ***
***   PARTICULAR PURPOSE APPLY TO THIS SOFTWARE. THE AUTHOR(S) SHALL    ***
***   NOT, IN ANY CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL OR    ***
***   CONSEQUENTIAL DAMAGES, FOR ANY REASON WHATSOEVER.                 ***
*****
```

Additional NAT information can be obtained from the NAT web page at:

<http://midnightdesignsolutions.com/nat/>

Additional PHSNA information can be obtained from the PHSNA Yahoo group at:

<https://groups.yahoo.com/neo/groups/PHSNA/info>

Please direct any and all questions, comments, suggestions, critiques, etc to the authors:

George Heron – N2APB	n2apb@midnightdesignsolutions.com
David Collins – AD7JT	ad7jt@dnbrealty.com

2 INTRODUCTION

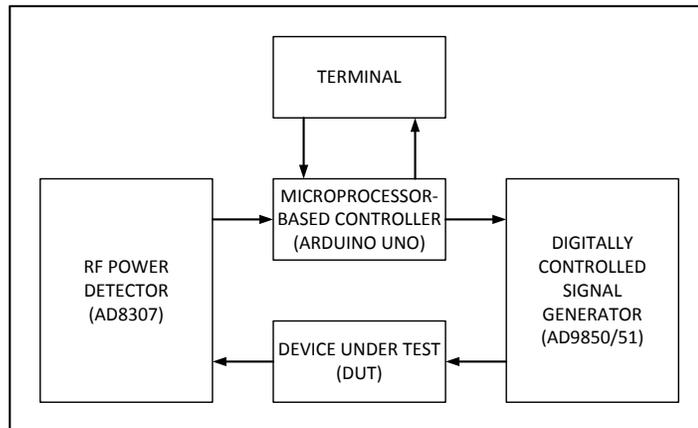
This manual contains five basic how-to sections covering the following topics:

- Initial Setup – Hardware and software/firmware setup operations.
- Terminal Mode – Basic operations using the PHSNA menus.
- Command Mode – Setting up NAT operating parameters
- DOS Mode – SD Card file maintenance operations.
- PLX Mode – Automated Operations

Appendixes contain a summary of NAT hot keys and commands and a reference schematic.

3 INITIAL SET-UP

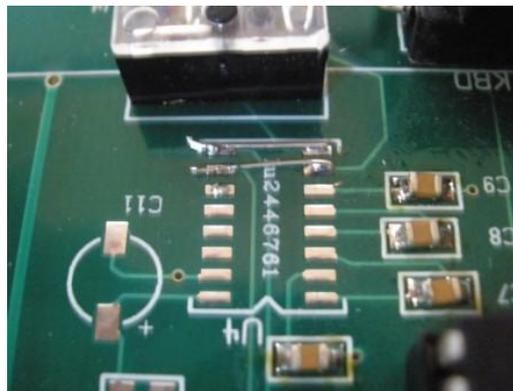
The following block diagram illustrates the basic architecture of an SSNA system:



The NAT is the block labeled “TERMINAL” and the interface to the MICROPROCESSOR is a simple, two-wire serial interface. Not shown in this diagram is the MICROPROCESSOR programmer which is normally a PC connected via a standard USB interface. This manual assumes this configuration with the MICROPROCESSOR being an Arduino UNO although the information herein would apply to any of the Arduino microprocessor modules including the Arduino Micro.

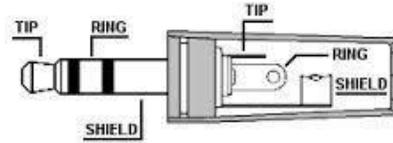
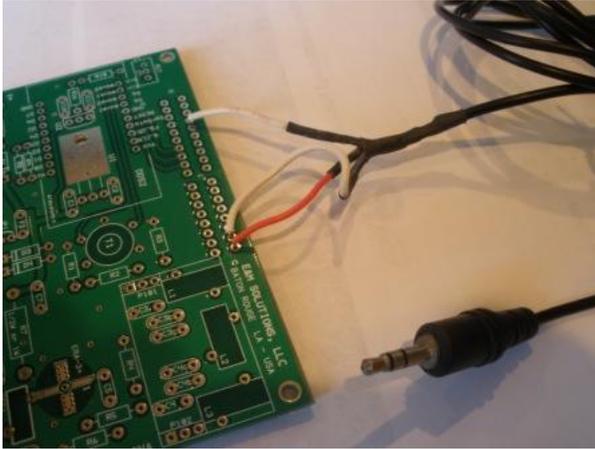
3.1 SERIAL INTERFACE SET-UP

The standard PHSNA interface does not use RS232 interface driver and receiver so the NAT interface converter (U4) must be omitted from the assembly and jumpers added between the IC mounting pads for the RxD (pads 8 and 9) and TxD (pads 7 and 10) signal paths as shown here:



If the PHSNA system you are using has a RS232 interface level converter than the jumpers should not be installed and U4 must be installed.

At the time of this writing the standard PHSNA DDS board does not have a connector for the serial interface but it does have a set of pads available to make direct connection to the RX (pin 0) and TX (pin 1) of the UNO board. A simple stereo audio cable with a 3.5 mm audio plug on one end may be soldered directly to these pins and a ground pin (pin GND) as shown below. The TX pin connects to the audio plug’s ring and the RX pin connects to the audio plug’s tip. The GND pin connects to the shield. The pin functions are marked on the back of the PHSNA DDS board and on the UNO board.



3.2 PHSNA FIRMWARE LOADING

The NAT can be used with the standard PHSNA firmware; however, there is a modified version available that has been optimized to interface with the NAT. That version can be downloaded from the NAT website. The firmware name includes the PHSNA firmware version the modified version is based on and the minimum NAT firmware version and revision that can be used with this firmware. At the time of this writing, the latest modified PHSNA firmware is:

PHSNA_03_02_NAT_01_00

The firmware is packaged in a single folder containing several files. To load the Arduino microcontroller follow the directions for loading the Arduino IDE and connecting the PC to the USB port. Start the IDE and open the file in the firmware folder with the same name as the folder with a name extension of “.ino” (“PHSNA_03_02_NAT_01_00.ino” in this case). Follow the Arduino IDE instructions to compile and load the firmware.

WARNING

The Arduino USB interface uses the TX and RX serial interface lines to communicate with the Arduino processor. The serial interface connection to the NAT must be unplugged during the firmware down load operation or the down load will fail.

3.3 KEYBOARD CONNECTION

The initial NAT firmware version does not use the touch-screen feature; all operator input must be made by keyboard. The NAT supports most any standard PC keyboard and assumes the standard U.S. key layout and key codes. The NAT keyboard interface is IBM standard PS2. A USB keyboard can be used with a USB-to-PS2 adaptor as shown here:



← **USB keyboard connector with PS2 adaptor**

3.4 START UP and SETTING THE SERIAL INTERFACE BAUD RATE

With the NAT serial interface disconnected, turn NAT power on. After a pause you should see the splash screen like the one on the cover page of this guide. The initial pause is to allow the various peripheral controllers in the NAT time to complete their power-on initialization sequences. The splash screen will be displayed for about 3 seconds and then the NAT will start in Terminal mode. Before the NAT can communicate with the Arduino microcontroller, the serial interface baud rate must be set so both ends match. The standard PHSNA firmware serial interface baud rate is set to 9600 bps; the modified firmware serial interface baud rate is set to 19200 bps. To set the NAT serial interface baud rate do the following:

1. Press and release Scroll Lock, the Scroll Lock LED on the keyboard should come on. The Command mode menu will be displayed.
2. Select “B” (or “b”, commands are not case sensitive) and the BAUD RATE menu will be displayed.
3. Select “0” for 9600 bps or “2” for 19200 bps.
4. Press Enter to save your selection to EEPROM.
5. Turn off the NAT.



NOTICE

After changing the NAT serial interface baud rate it is generally necessary to cycle power to activate the serial interface with the new baud rate.

3.5 PREPARING THE SD CARD

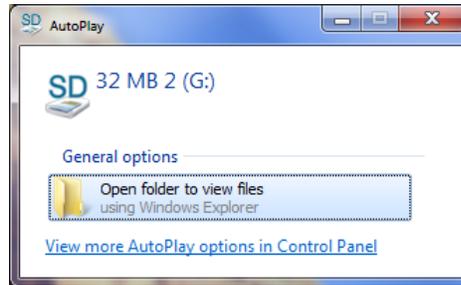
Many NAT functions utilize an SD card for spooling and playing back data. The SD card is also used for updating the NAT firmware. The following are the requirements for an SD card to be used in the NAT:

1. Maximum capacity of 1GB
2. Formatted for FAT16 file system.
3. 512-byte sectors.

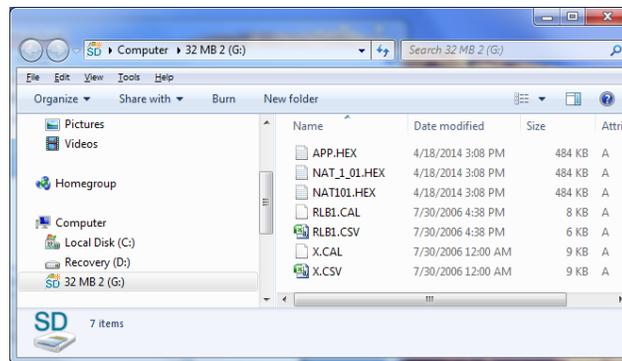
These requirements are generally the default settings for the formatter in a Windows system. The SD card connector is for standard sized SD cards but micro SD cards can be used with an adaptor. The

following sequence illustrates how to format an SD card. The screen shots are from a Windows 7 system; screen images from other Windows versions may look different but should be similar.

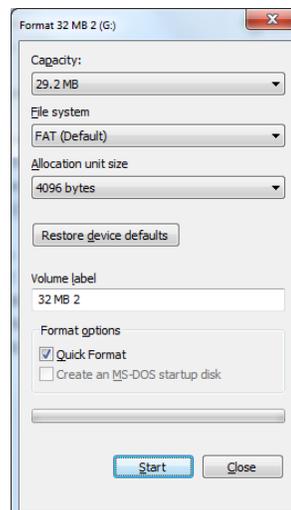
1. Insert the SD card in the slot on the PC. Most notebook and laptop PCs have a built-in SD card interface connector. If yours does not have one built in, an inexpensive USB Card Reader & Writer can be used (see below for another option).
2. Windows will detect the SD card and will display an AutoPlay message. The message may present a number of options depending on what is recorded on the SD card. Choose the option that says “Open folder to view files”. If the AutoPlay message does not appear, open the Windows file explorer and locate the SD card folder.



3. When the SD card folder is displayed, right click on it and select format from the context menu. This will display the format dialog box..



4. Verify that you are formatting the SD card and not your hard drive. Check the capacity and file system (“FAT16” or just “FAT”) are correct. Windows will select the optimum allocation unit size for the size of the SD card.



5. Enter a Volume label if desired. This will help you keep track of things when you use more than one SD card. The NAT will display the volume label in DOS mode.
6. Select the format option. Quick Format is fine and is much faster than the full format.
7. When you are satisfied with everything, left-click Start to initiate the format.
8. When the format is complete, left-click Close to close the Format dialog box.

The SD card is now ready to use in the NAT. Insert it in the SD card socket on the back of the display module. The SD card must be inserted with the connector pins up, towards the back of the display module's PCB.



CAUTION

The SD card will only go in the socket one way and it should slide in easily. If it does not slide in easily, do not force it. Forcing the SD card in wrong will permanently damage the socket.

HINT

If you do not have access to a PC with an SD card slot, you may be able to format the card with a digital camera that uses SD cards. In fact, I have seen one case where a camera would format a 2GB card so the NAT could use it. A PC uses a different format for SD cards above 1GB and the NAT only supports one format.

NOTE

If the SD card displays on the file explorer as more than one device it has been formatted to provide a special feature and will probably not work with the NAT, even though it works fine with a PC. Reformatting the SD card may not correct the problem.

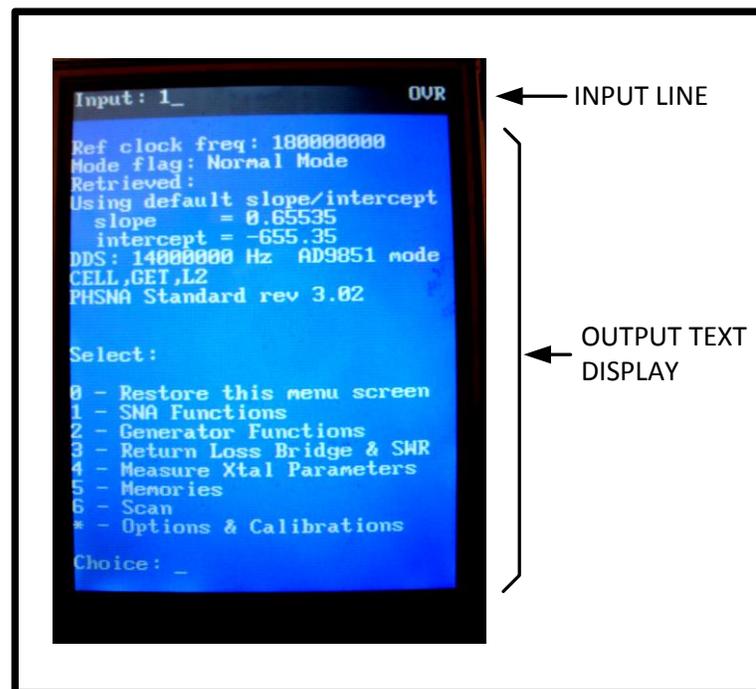
4 TERMINAL MODE

Once you have completed all the tasks outlined in the previous section, you are ready to give the NAT a test drive with the PHSNA system. If you have not yet assembled your PHSNA system, you can interface the NAT to a PC running a terminal emulation program (such as HyperTerminal) and do some basic testing.

The default mode for the NAT is Terminal mode and that is the mode it always starts in. In Terminal mode the display is divided into two sections, the input line and the output text display area. Text characters keyed by the operator are displayed on the input line. Up to 19 characters may be entered. Full editing capabilities are available including insert (INS) and overwrite (OVR) modes and cursor positioning using the left and right arrow keys. Pressing and releasing the Insert key will toggle between INS and OVR modes; the current editing mode is displayed at the end of the input line.

4.1 THE TOP MENU

Once the PHSNA system and the NAT are powered up, resetting the Arduino microcontroller will send the current PHSNA status information followed by the top-level menu across the serial interface to the NAT. The NAT displays everything received on the serial interface in the output text area. The following screen shot shows the screen image generated by the modified PHSNA firmware:



The unmodified PHSNA firmware will generate a different display; the modified firmware includes changes to the menus to properly display on the NAT's 30-character wide display.

At this point, you can interface with the PHSNA firmware exactly as you would from a terminal emulator application running in a PC. Input data (to the PHSNA) is keyed onto the top line and is transmitted to the PHSNA firmware when Enter is pressed. The input line is followed by a Carriage Return (CR or 0x0d) character. The modified firmware will accept the CR with any input.

NOTE

The standard PHSNA firmware can get confused when some single-character inputs are followed by a CR. The input data will be sent without a following CR if the Alt key is held down when Enter is pressed. The modified firmware will accept either input form.

4.2 SPOOLING DATA IN TERMINAL MODE

Regardless of the mode, the NAT will spool received data to a file on the SD card as long as a file name is specified and the file does not already exist. The NAT will never overwrite or append to an existing file. In terminal mode, the spool file is referred to as the “log file” and must be specified before starting the frequency scan. The file name is specified in Command mode and described in the next section of this document.

Since the NAT does not know what menu items mean it has no way of knowing when a data stream is going to start; it must be told by you entering the hot key sequence Ctrl-R (for “Record”). Once enabled, the NAT will write all data records to the SD card in comma-separated-value (CSV) form to the log file (if any). A file in CSV format can be opened in an Excel spreadsheet for plotting and analysis. After the end of the data stream, enter Ctrl-R again to close the spool file.

WARNING

The spooled data is written to the SD card in 512 character blocks that the NAT buffers until complete. It is important for you to enter the second Ctrl-R so the NAT properly writes a partial buffer and properly closes the spool file. Failure to do so will result in the loss of data.

NOTE

During the receipt of data, scrolling is turned off and the last line of the display will be continuously overwritten as each data row is displayed. This is done to avoid the large amount of overhead involved in scrolling the 750-character display.

4.3 PLOTTING DATA IN TERMINAL MODE

Up to 960 data points of received data are buffered by the NAT in its RAM. Once loaded, the buffer will retain this data until a new data transfer is initiated (Ctrl-R). The hot key sequence Ctrl-P will plot the buffered data along with some additional information about the data. Here’s an example of a plot of the data received during a frequency scan of a 7MHz low pass filter:



The User Guide explains the plot screen format in detail and how to calibrate the system for more accurate results. Pressing the Esc key will clear the plot screen and return to Terminal mode.

5 COMMAND MODE

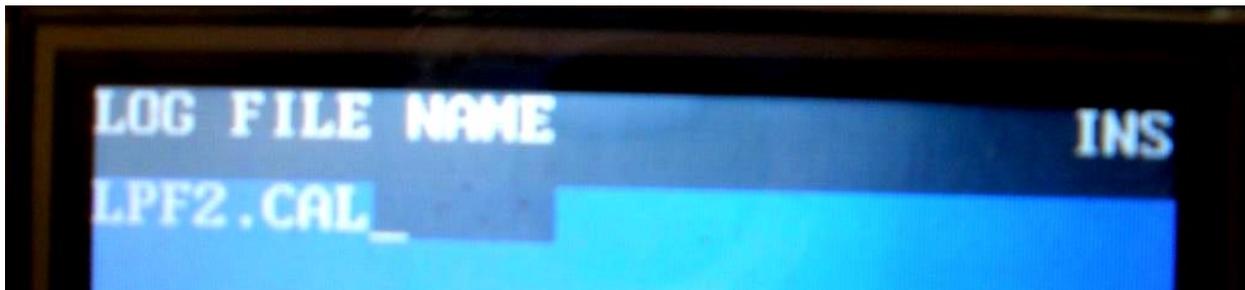
In Command mode you enter operating parameters used in Terminal mode and PLX mode (described in a later section). You enter Command mode by pressing and releasing the Scroll Lock key. The Scroll Lock LED on the keyboard will come on and the Command mode menu will be displayed.



We have already seen how to use the first menu item to set the serial interface baud rate. All commands are described in detail in the User Guide; here we will only cover two: Editing the log file name and PLX parameter data entry.

5.1 EDITING THE LOG FILE NAME

When this menu item is selected, the following is displayed:



The top line identifies what is being edited. The top line of the text area shows the current value. The limit of the edited area is shown with a black background. If you attempt to enter more than allowed, you will get BEEPed. Full editing capabilities are provided; the INS/OVR applies to the text being edited. The Home key will clear any entered data and move the cursor to the start of the edit field.

All file names used by the NAT must be in the old DOS 8.3 format. That means they must have one to eight characters in the name ("LPF2" in this case) with none to three characters in the name extension ("CAL" in this case). The name and any name extension are separated by a period and all letters must be capital letters. The NAT does not verify file names, what you enter will be used; however, Windows may not be as forgiving if you try to read the file into a PC.

The log file name is used every time data is spooled in Terminal mode. If no log file is specified (use Home to clear), data will not be spooled. If you attempt to start a data spooling operation and a file with the log file name already exists on the SD card, data will not be spooled. To again spool data you will have to either change the log file name or delete the file on the SD card.

5.2 PLX PARAMETER DATA ENTRY

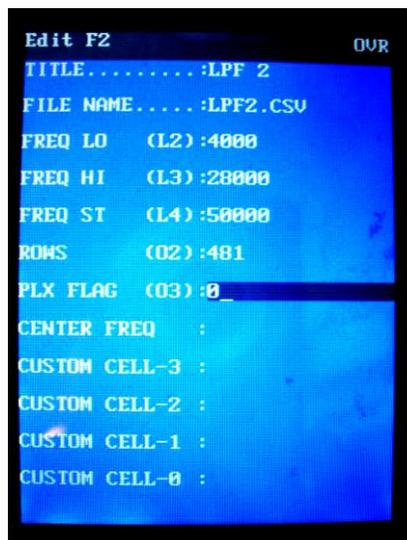
In PLX mode, the NAT emulates the PLX-DAQ spreadsheet macro. To do this, you must define certain parameters the PHSNA firmware needs to define the frequency sweep. These parameters are entered and edited in a data entry template. You can enter up to 14 sets of parameters; each set is associated with Function keys F1 through F7 and Alt-F1 through Alt-F7. The parameter sets are stored in EEPROM so they persist through NAT power cycles.

Pressing one of the fourteen function keys while in Command mode will display the data entry template and the current values (if any) for those parameters.

NOTE

On a new NAT, the EEPROM may not be totally initialized so the data entry screen may contain some weird stuff. If this happens, just step through each line and press Home to clear the garbage.

This data entry screen was brought up by pressing F2:



All of these entries are explained in detail in the User Guide. The parameters shown are what you would have keyed interactively in menu mode to get the plot example shown.

The currently active line is indicated by the black background showing the extent of the editable area. You move to the next active line using the up and down arrows. The parameters on each line are used as follows:

1. The title to be used for a plot
2. The spool file name
3. The starting sweep frequency (in KHz, up to three decimal places)
4. The ending sweep frequency (in KHz, up to three decimal places)
5. The frequency increment between steps (in Hz)
6. The number of data rows to generate.
7. When set to 100, the PHSNA firmware will terminate PLX mode.
8. The center frequency of the sweep (uses FREQ ST and ROWS to calculate FREQ LO and FREQ HI)

The last four lines are currently not used and are reserved for future/custom enhancements.

Pressing Enter will save the parameter set in EEPROM and exit Command mode back to Terminal mode. Pressing Esc will return you to Terminal mode without saving the parameter set to EEPROM.

6 DOS MODE

When in Command mode, pressing Esc will switch to DOS mode. DOS mode is modeled after the old DOS interface introduced with the PC. When DOS mode is entered, the contents of the first sixteen lines in the current directory are displayed. Entering a question mark (“?”) will bring up a list of the available DOS commands.

```

\>_
32 MB Z          Sector: 00
#  --NAME--  S I Z E  ADVSHR
1 Volume Name
2 RLB1.CAL    7585    A
3 RLB1.CSV   5466    A
4 X.CAL      8375    A
5 X.CSV     8456    A
6 APP.HEX   495576   A
7 NAT_1_01.HEX 495576   A
8 NAT101.HEX 495576   A
9 Deleted
10 Deleted
11 Deleted
12 Deleted
13 Dir End

```

```

\>_
***** DOS MODE *****
CD - Change Directory
DIR - Display Directory
DUMP - DUMP Physical Sector
DUMP <FILE> Dump File Sector
DEL <FILE> Delete File
TYPE <FILE> Disp. File Text
PLOT <FILE> Plot power Data
PLOTp <FILE> Plot power Data
PLOTv <FILE> Plot USWR Data
PENn - Render Penguins
? - Display DOS Menu

SDLD <FILE> Reload firmware
Esc - End DOS Mode

```

The DOS commands are described in detail in the User Guide. The PLOT commands will read and plot spooled data on the NAT. In PLX mode the parameter set used to generate the data is recorded at the beginning of the file. When the file is read back by a PLOT command, the first parameter (TITLE) is used as a title for the plot screen.

The Delete command (DEL) will remove the named file from the SD card and free the name for reuse (remember, the NAT will never overwrite or append to a file).

The NAT supports subdirectories and you can navigate the directory tree using the CD command. As with the original DOS CD command, “..” (dot-dot) represents the next higher directory in the tree (if any) and “CD ..” will change the currently active directory up one level. The DOS command prompt (“\>” here) will be expanded to show the full path to the current active directory.

7 PLX (EXCEL) MODE

Once you have set up a set of PLX parameters and saved them to EEPROM, you activate them by pressing the associated Function key. This switches the NAT to PLX mode in which it will receive and execute data and command directives from the PHSNA firmware. Resetting the Arduino microcontroller will start the process. The PHSNA firmware will ask the NAT for the parameters it needs to perform a sweep and will transfer back the results of the sweep to the NAT. The operation is very much like you did in Terminal mode except, once started, it runs to completion automatically. The parameter set remains in EEPROM so it can be used over and over again without having to go through the tedious, interactive process of entering them before each scan in Terminal mode.

At the end of a data set, the NAT will plot the data just as is done in Terminal mode except the plot title will come from the parameter set ("TITLE").

The data set will be spooled but not to the log file, it will be spooled to the file named in the data set (FILE NAME). If no file is named, the sweep and the plot will proceed after a message is displayed warning you that no file name is specified. If the named file already exists on the SD drive, the sweep and the plot will proceed after a message is displayed warning you that the named file already exists and will not be overwritten or appended to.

APPENDIX A. HOT KEY SUMMARY

EDITING, All Modes

- Home** Clears editable text area and moves cursor to the first editable position.
- End**..... Moves cursor to the first position past the end of the text in the edit field.
- Backspace** Deletes the character to the left of the cursor position and moves all following characters one position to the left.
- Delete** Deletes the character at the cursor position and moves all following characters one position to the left.
- Insert** Toggles between Insert and Overwrite entry modes.
- Left Arrow** Moves the cursor one position to the left.
- Right Arrow** .. Moves the cursor one position to the right.

TERMINAL MODE

- Alt-Home** Clears the output text display and moves the text entry point to the first character position.
- Alt-C** Clears the calibration constant buffer.
- Ctrl-C** Loads the calibration constant buffer with the current contents of the plot data buffer.
- Ctrl-R** Toggles data recording on and off.
- Ctrl-P** Plots the current contents of the plot data buffer if loaded.
- F1-7, Alt-F1-7**. Switch to PLX mode using parameter set associated with the hot key pressed.
- Esc** Terminate an in process operation and reinitialize Terminal mode. Will close an open file, if any, and post any pending error messages.

PLX MODE

- Alt-Home** Clears the output text display and moves the text entry point to the first character position.
- Alt-C** Clears the calibration constant buffer.
- Ctrl-C** Loads the calibration constant buffer with the current contents of the plot data buffer.
- Esc** Terminate PLX mode in the NAT and the PHSNA firmware and return to Terminal mode. If receiving data in automatic operation mode, the termination will wait until the end of the current sweep unless Esc is pressed a second time.

COMMAND MODE

- Esc** Switch to DOS mode.

DOS MODE

- Esc** Switch to Terminal mode.
- Alt-C** Clears the calibration constant buffer.
- Ctrl-C** Loads the calibration constant buffer with the current contents of the plot data buffer.

APPENDIX B. NAT COMMAND SUMMARY

COMMAND MODE COMMANDS

B.....Select serial port baud rate
F1-7 & Alt-F1-7 PLX data entry
F Edit data entry format template
L Edit log file name
X Edit crystal fixture termination resistance
~ Invalidate EEPROM content
Esc Switch to DOS mode

DOS MODE COMMANDS

DIRDisplays the contents of the first sector of the current directory.

CD <Directory Name>..... Change Directory. Subdirectories are supported.

DEL <File Name>Deletes the specified file from the current directory.

DUMPDisplays physical sectors in a combined hex and ASCII format.

DUMP <File Name>Displays file data in the dump format.

TYPE <File Name>Displays the contents of the specified file as text.

PLOT <File Name>Plots the Power data in the named file.

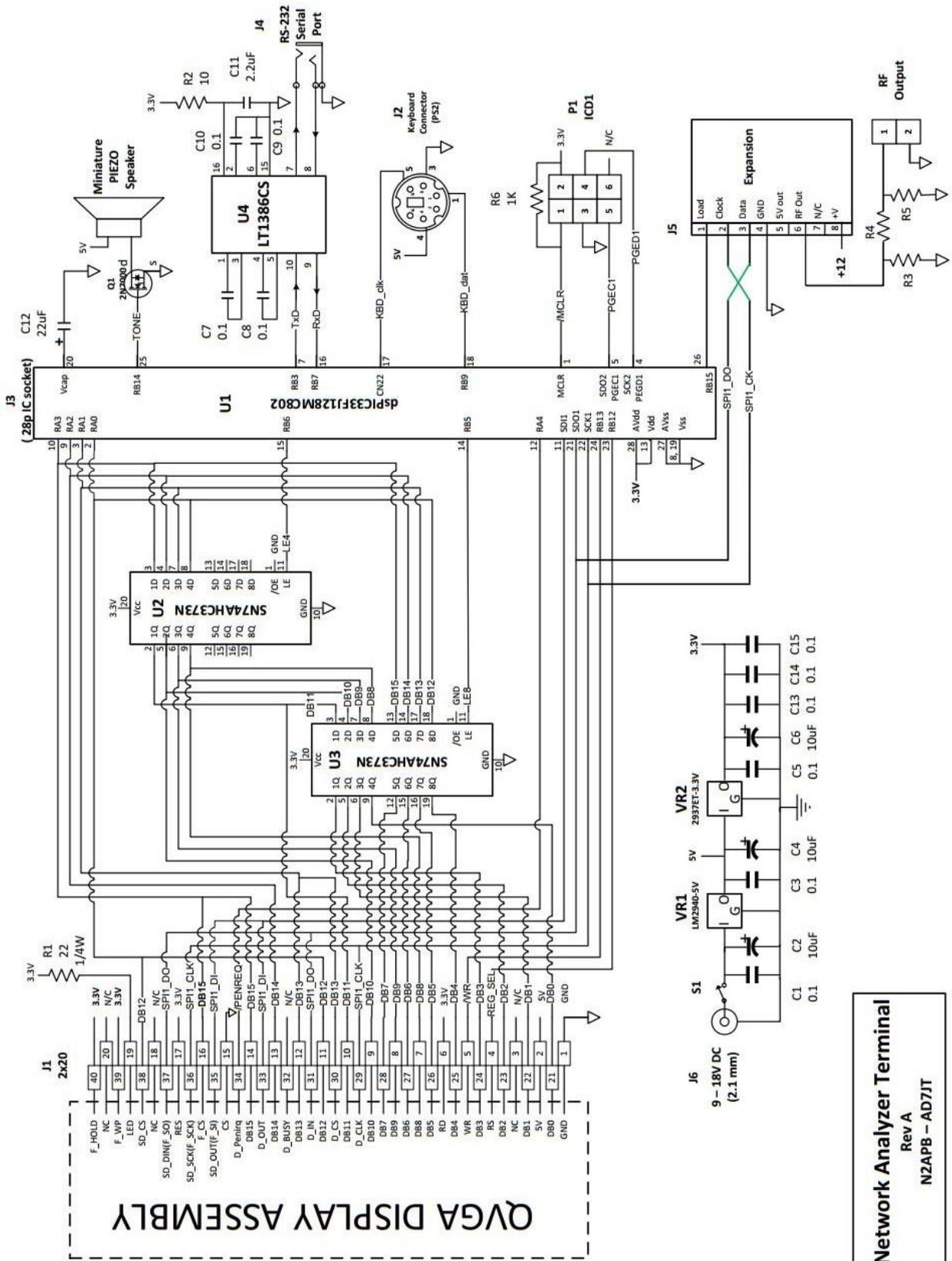
PLOTP <File Name>Plots the Power data in the named file.

PLOTV <File Name>Plots the VSWR data in the named file.

SDLD <File Name>Reload the NAT Firmware from the named file.

?Show a menu of available DOS commands

APPENDIX C. NAT (rev A) SCHEMATIC



Network Analyzer Terminal
 Rev A
 N2APB - AD7JT