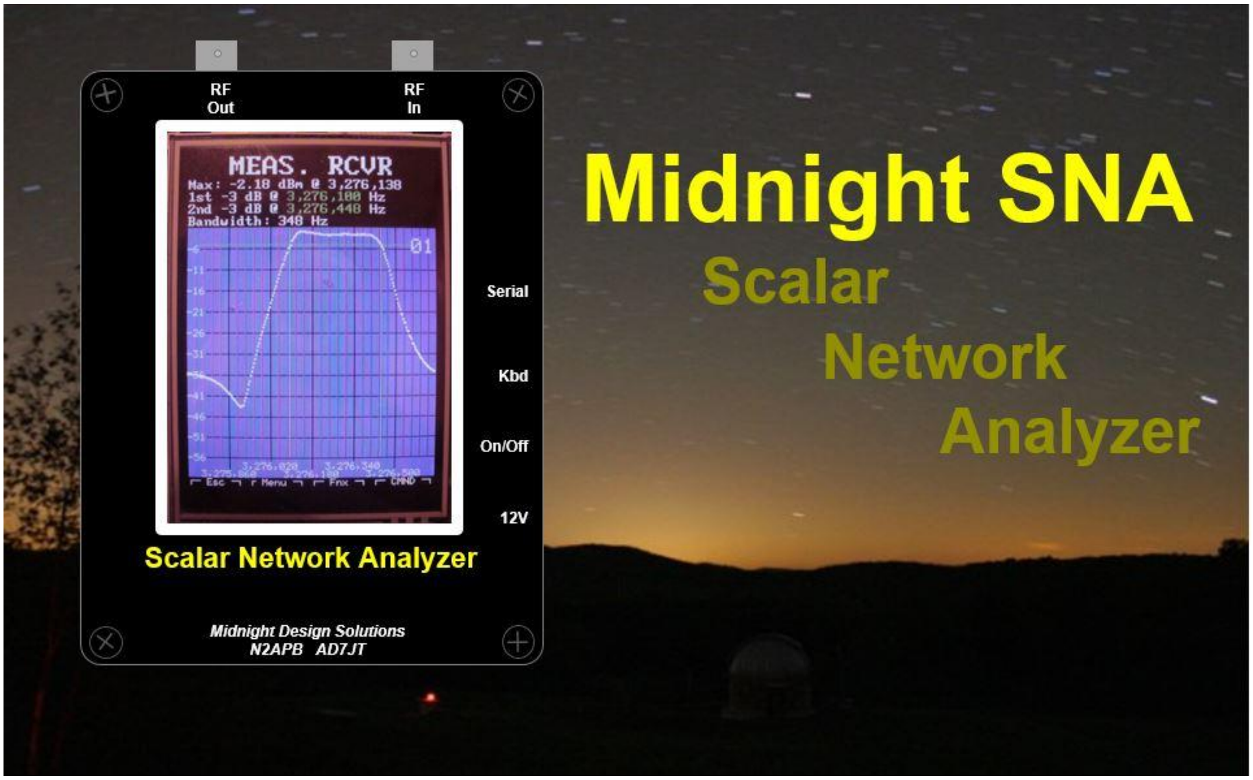


Quick Reference

for Firmware Version 5.00

By Dave Collins AD7JT
2016-04-01

This Quick Reference contains brief descriptions of many of the Midnight SNA screens and some of the basic operating procedures, menus, and hot-keys. For more detailed and complete information please see the Midnight SNA tutorials and User Guide.

Note that the screen shots in this document are current at the time of this writing. Future firmware releases may change their appearance and content.

Items new to this release are highlighted with ***red*** *headings.*

Contents

Revision History:

2015-11-01.....Revised to reflect changes made for firmware Version 4.20.
2016-04-01   Revised to reflect changes made for firmware Version 5.00

1. FEATURE OVERVIEW

Precision RF Power Meter ... *Nearly 100 dB dynamic range, typical noise floor below -65 dBm.*

Measures Filters ... *Low Pass, Band Pass, High Pass, Notch, Receiver IF stages, ...*

Measures Crystals ... *Frequency, Q, Motional Parameters*

Measures Antennas ... *Resonance point(s), VSWR*

Measures Component Parameters ... *Inductance and capacitance, built-in calibration aids.*

Measures Frequency ... *From 1 Hz to 40 MHz, built-in calibration aids.*

Signal Generator ... *From Below 1MHz to over 60 MHz, 1 Hz granularity, calibrated 0 dBm output level at 1 MHz*

Local Oscillator... *Test / Tune home-brew rigs, adjustable frequency offset, in-band containment.*

Built-in Power Meter Calibrator ... *Separate signal source, easy to set, 3 dBm, 1 MHz signal source*

Setup Mode ... *Specify serial interface baud rate, operating parameters, file names...test SD Cards and touch screen*

SD Card ... *Up to 1 GB of removable storage for Data logging, Firmware updating, Data playback, Data export/import ...*

DOS File System ... *On SD Card, file/data management, FAT16 format for PC compatibility*

320x240 pixel color graphic LCD ... *3.2 Inch high resolution screen, 16-bit color*

Touch-Screen ... *For convenient field use or as display on bench*

Keyboard input (optional) ... *For convenient text and data entry/edit*

Tuning Knob (optional)... *Support for rotational encoder to tune the signal generator/local oscillator*

Auto Scaling...*Band pass and band stop plots can be centered and scaled on command to increase accuracy and simplify setup.*

Measurement Receiver Support ... *High-resolution RF spectrum analysis plus harmonic measurements.*

Features new in this release are shown in **RED** *in the table of contents, here, and in section headings.*

2. QUICK START

1. Apply power

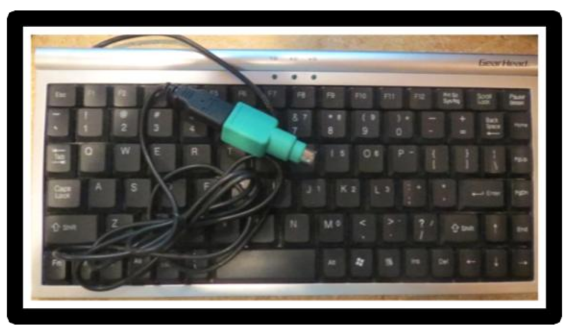
a. Use 2.1mm power plug (supplied), center positive

b. Voltage range: 7-to-14V DC. Batteries may be used (400 mA current draw). Six “Energizer E95” alkaline D-cells will power the GDT for about 8 hours.

2. **Load MSNA application** (if not already loaded). See *Appendix A LOADING AN APPLICATION* for step-by-step instructions for application loading and initial setup.

3. **See splash screen** and then, after about 3 seconds, see **SNA Mode**, Terminal Display screen

4. Connect Keyboard (optional, not supplied)

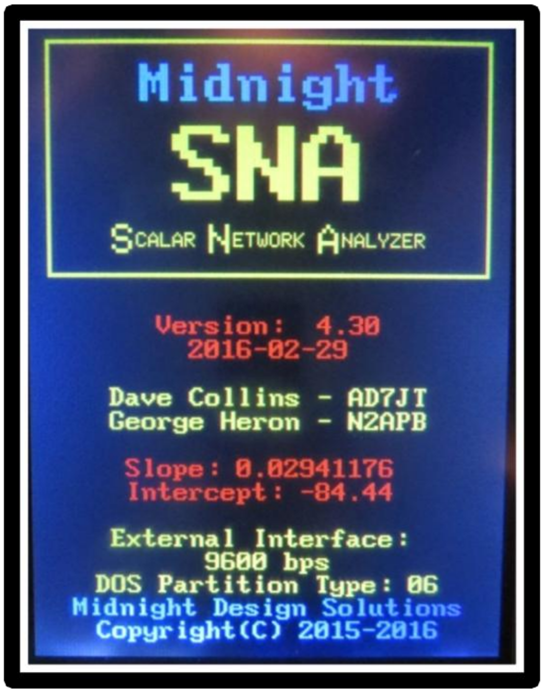


a. Use PS/2 keyboard, with round 6-pin mini DIN plug.

b. Or USB keyboard (that is PS/2 capable) with USB to PS/2 adapter.

5. Perform initial calibration procedures. Reference: ***Tutorial M1 - Power Level Calibrations***.

3. SPLASH SCREEN



Identifies the product and the firmware version, revision level, and release date.

Displays the current configuration of the external interface. Must agree with the device (if any) the Midnight SNA will interface to.

Displays the current slope and intercept values used to translate the RF power meter analog output to dBm. This information would be needed to set up the Windows PHSNA application.

Displays the SD card primary partition's type code. Must be 04, 06, or 0E to be recognized by the boot loader.

Touching the screen when the splash screen is displayed will keep the splash screen displayed, otherwise, the display will clear after about three seconds.

4. TOUCH SCREEN

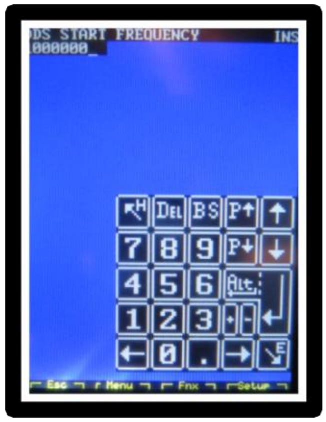
The display is covered with a transparent touch screen. Each screen display has at least one touch control (e.g., virtual button) and many have more. Touching an active area on the touch screen initiates an action just like entering the corresponding control code (shortcut or hot key) with the keyboard. When the stylus is raised, the firmware notes the last position touched and initiates the action assigned to that area of the screen. The stylus can be dragged to the desired area and then raised to make the selection.

In this and other MSNA documents, touch screen initiated operations are identified by their names on menus, legends on buttons, and text in the active area in **very bold text** and the corresponding keyboard entry is shown in square brackets ([...]). In many cases the identification and the key name are the same.

The main touch screen operation is the "tap". A tap is performed by touching the stylus to the screen, dragging it to the displayed control area (if necessary), and raising the stylus from the touch screen to make the selection.

Virtual controls include buttons, menu line items, and specific areas related to the response action to be performed. Sometimes, the entire screen is the active area.

5. NUMERIC KEY PAD (NUM PAD)



Touch the top line of the display to select and bring up the **NUM PAD** for numeric data entry from the touch screen.

The **NUM PAD** is closed when [Enter] is touched or with a tap outside of the **NUM PAD** area.

- ↖H......... [**Home]** clear edit line text
- DEL....... [**Delete]** delete character at cursor
- BS........ [**Back Space]** delete character to left of cursor
- P↑ .... [**Page Up]** use depends on context
- ↑ .... [**Up Arrow]** cursor up one line
- P↓ .... [**Page Down]** use depends on context
- ↓ .... [**Down Arrow]** cursor down one line
- Alt↵........ [**ALT-Enter]** enter text without ending CR
- ↵ .... [**Enter]** enter test with ending CR
- ← .... [**Left Arrow]** cursor left one position
- → .... [**Right Arrow]** cursor right one position
- ↘E......... [**End]** cursor to end of edit line text

Not all **NUM PAD** buttons are used in every context. The **NUM PAD** is only available where numeric entry is possible.

6. PERMANENT BUTTONS

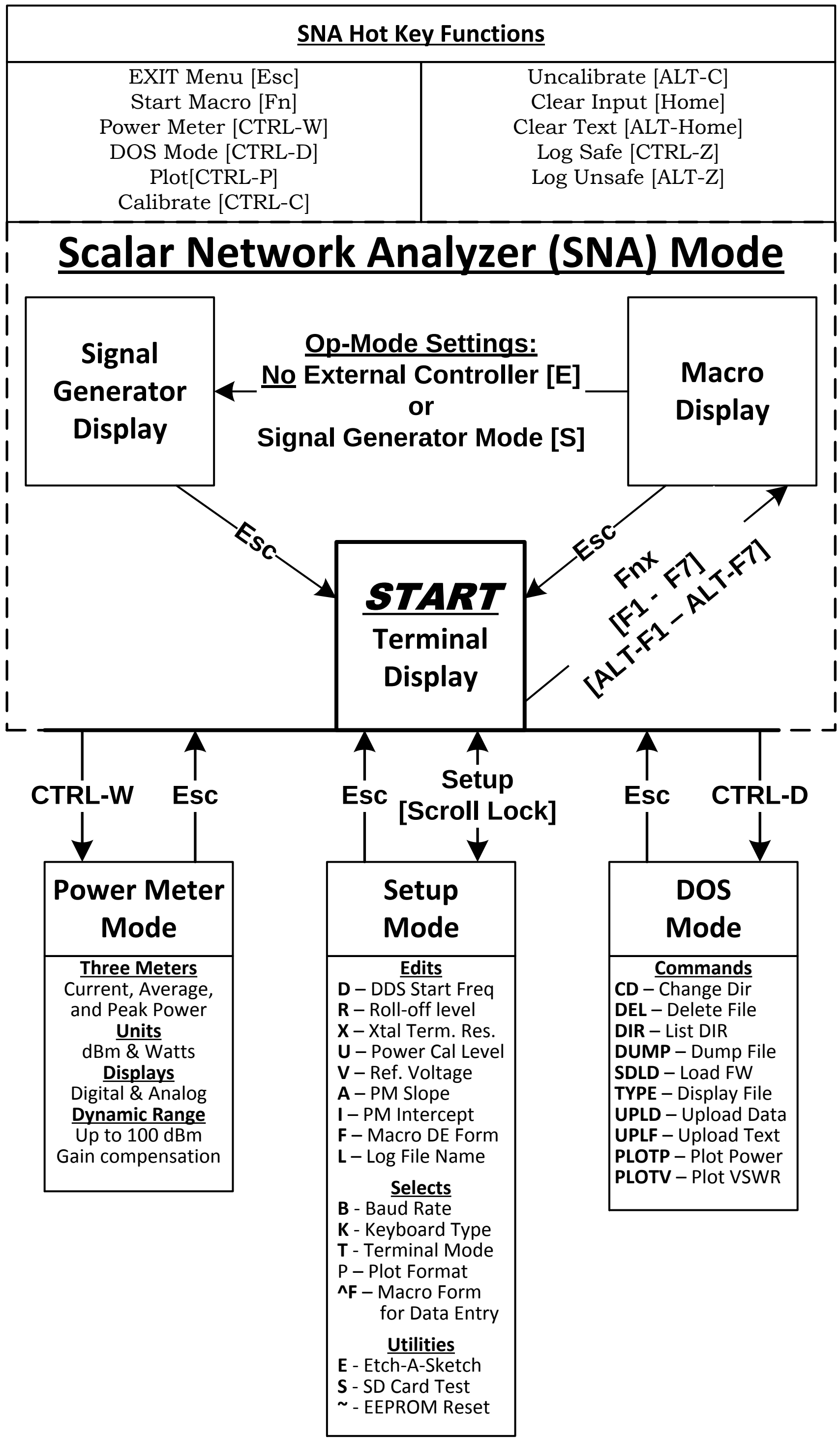
One of four virtual buttons located along the bottom of all displays can be activated by tapping the screen in the area defined for that button. As with all touch screen controls, activation comes at the end of the touch, when the stylus is raised. All displays may not use all buttons.

Simulates keyboard entry by generating the equivalent control codes as the corresponding keyboard keys:

- **Esc** [Esc]: Terminates a mode or display and returns to **SNA Mode**, Terminal Display.
- **Menu** [CTRL-M]: Brings up a context menu.
- **Fnx** [CTRL-F]: Brings up a menu of macro titles and associated Function keys.
- **Setup** [SCROLL-LOCK]: Navigates between **SNA Mode**, Terminal Display and **Setup mode**.

Note: **Fnx** and **Setup** change to **Left Arrow** [←] and **Right Arrow** [→] in **DOS Mode**. These arrow buttons navigate between sectors where appropriate.

7. NAVIGATION



The label on each transition path identifies the context menu line item that initiates the transition. The label also names the key(s) that may be used to make the transition with a keyboard.

When they are not the same, the key name is shown in square brackets ([...]).

SNA Mode is the mode that performs frequency scans and records power levels. Three different display formats are available: Terminal, Macro, and Signal Generator.

SNA Mode: Terminal Display is the initial mode and display the MSNA starts in at power up. All navigation to and from S**NA Mode** must bass through the Terminal Display.

SNA Mode: Macro Display is started when a macro is activated. In this mode, SNA operation is controlled by the contents of the macro data form. One field can specify an External application controller is on the serial interface and certain parameters in the macro data form are made available to the External application. The External application is essentially in charge and has access to MSNA resources. In this case, the Terminal Display shows the messages sent and received on the serial interface. Otherwise, the MSNA is in charge and uses the macro data form parameters to direct its operation using the DDS-60, RF Power meter, and/or the External Interface to perform the specified operation.

SNA MODE: Signal Generator Display is a display of the current frequency and limits of the sweep plus other values pertinent to the macro-specified operation. This display is always used when an External application is not involved and is always used when the macro specifies Signal Generator op mode regardless of the presence or absence of an External Application.

Esc [Esc] will terminate an in-process operation and switch to **SNA Mode: Terminal Display** from any other mode or display.

8. CONTEXT MENUS

Tapping **Menu** [CTRL-M] Will bring up a context menu (where available).The terminal display context menu is for navigation and basic functions associated with external applications. There are twenty-two additional context menus available in **SNA Mode.** The **DOS Mode** Context menu is described later; there are no context menus for **Power Meter Mode** and **Setup Mode**. Context menus are displayed with a red background.

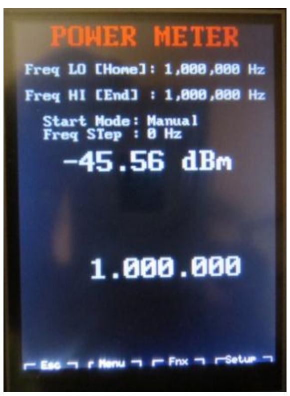
8.1 Terminal Display Context Menu

Starting a macro brings up the Macro Display showing the first page of the macro form. When the macro op codes specify the External Controller (**E**) modifier without the Signal Generator modifier (**S**), the Macro Display will remain displayed. The Terminal Display and the Macro Display share a common context menu. This context menu is arranged as two columns of buttons. Tapping a button generates the hot key character shown in square brackets on the button.

The four buttons on the left navigate between modes and displays. The remaining buttons perform the Network Analyzer Terminal functions shown.

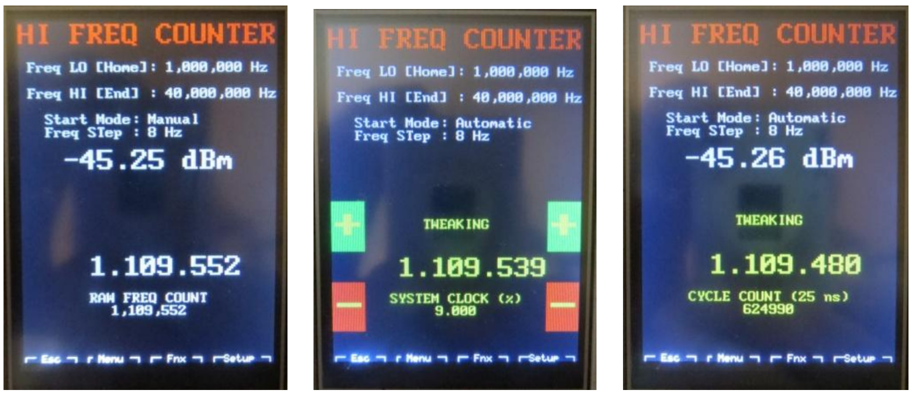
8.2 SNA Context Menus

When a macro op code does not specify the External Controller modifier (**E**) or specifies the Signal Generator modifier (**S**), the screen will switch to one of the Signal Generator displays depending on the specified op mode. Which menu to display depends on the op mode, the sub-state (if any), the operating mode (automatic or manual), and whether or not there is a band-pass or band-stop plot displayed. Rather than bore you with all 22 menus, the following are a few samples.

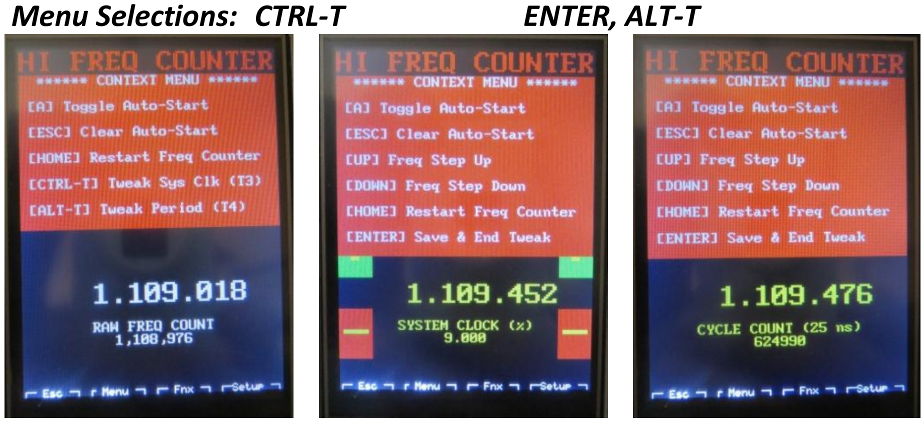


Menu Selections: ***A*** ***CTRL-S***

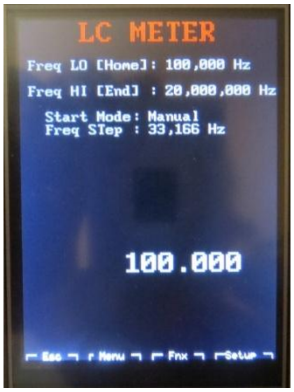
Here we see the context menus available during the power meter calibration sequence. The context menu is shown below the display when **Menu** [CTRL-M] was tapped. The second line item in the context menu changes according to the Start Mode. In manual Start Mode, tapping **Esc** [Esc] will terminate the macro. In automatic Start Mode, it will just switch to manual Start Mode. Selecting **Set-Slope-Intercept** [CTRL-S] also switches back to manual Start Mode.



Menu Selections: CTRL-T ENTER, ALT-T

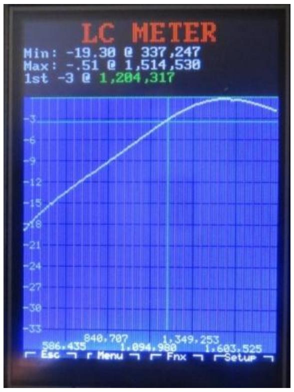


This example illustrates how the context menu adds line items when needed. Note also that in this case, **Freq STep** is not used so it is not displayed nor are the yellow markers above and below the frequency display.



Menu Selections: *Tap [SPACE]* ***Auto Scale BWx2****[2]*

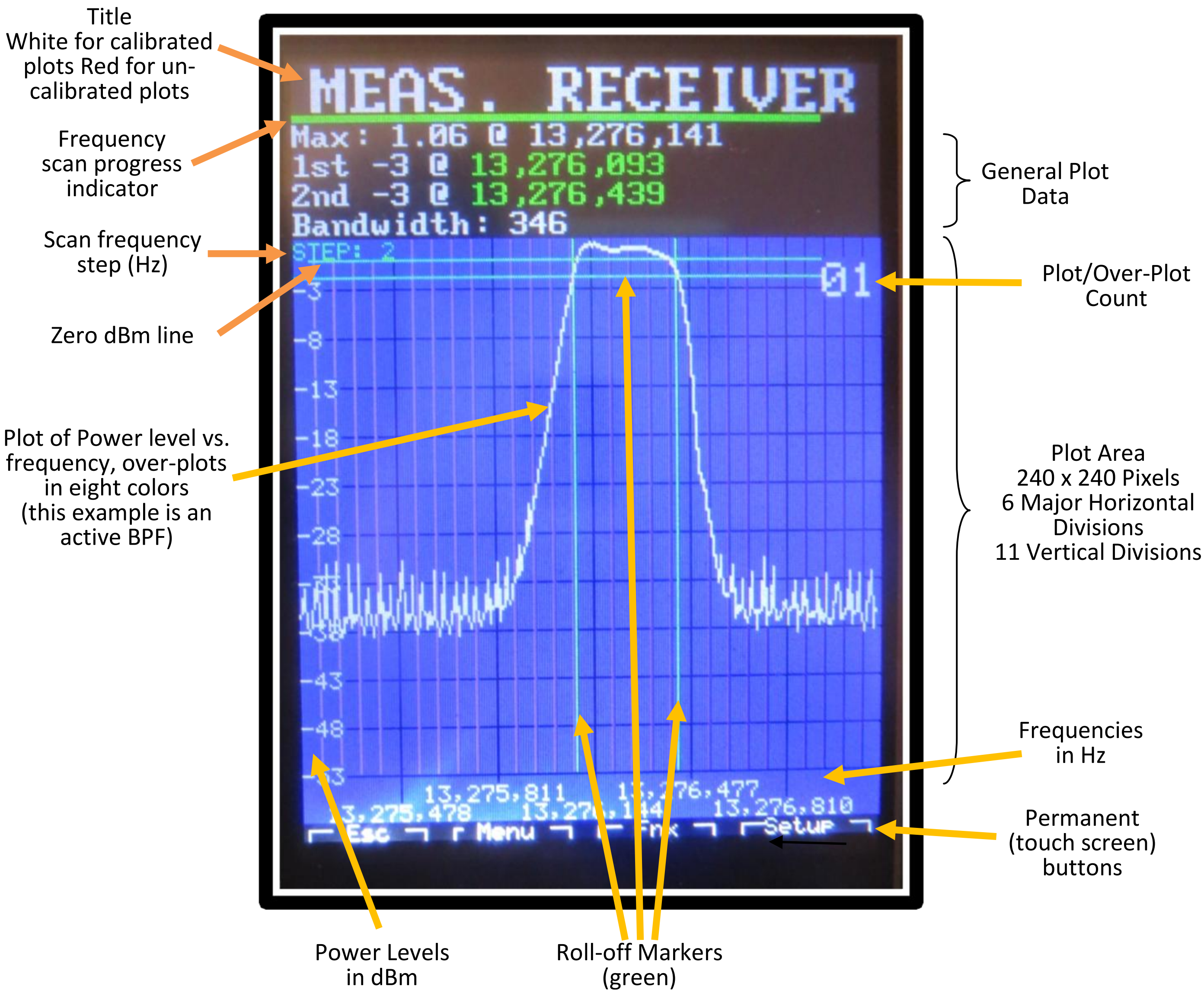
This example illustrates how the context menu changes when there is a band pass or band stop curve plotted. These two plots were made with LC meter terminals shorted together for calibration. Selecting **Auto Scale BWx2** [2] rescaled the plot such that the range was changed to twice the bandwidth and centered on the resonant frequency. This significantly reduces the frequency step size and improves the accuracy of the readings. At this point, tapping **Calibrate LC Mtr** [CTRL-L] will capture the calibration data.



Menu Selections: ***Restore Original Scale*** *[0]* ***Auto Scale BWx2*** *[2]*

Next, the short was replaced with a .001 uF capacitor and another scan was run. This shifted the plot so that, at this scale, it was not recognized as a band pass curve so the added capacitance was not computed. The problem was solved by restoring the original scale.

9. PLOT SCREEN



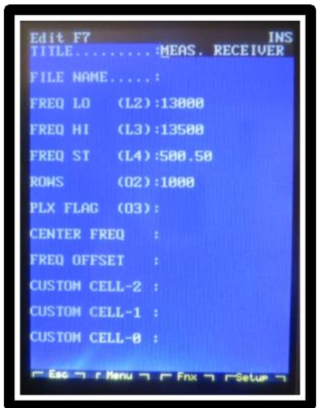
Five plot types are recognized:

1. Low-Pass Filter (LPF)	One roll-off point plus Min and Max
2. High-Pass Filter (HPF)	One roll-off point plus Min and Max
3. Band-Pass Filter (BPF)	Two roll-off points plus Max
4. Band-Stop Filter (BSF)	Two roll-off points plus Min
5. None of the above	No roll-off points just Min and Max

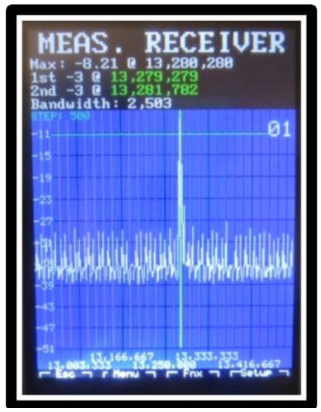
Roll-off point power level may be changed in **Setup mode**.

9.1 Auto Scaling

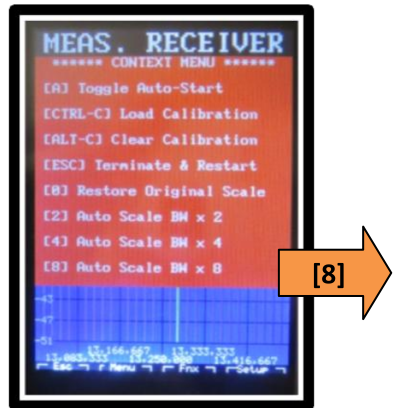
Context menu line items are provided for Band-Pass and Band-Stop plots to be rescaled so that the pass-band is centered in the plot area and the plot frequency range is changed to two, four, or eight times the bandwidth. The Step number in the upper left corner of the plot area is updated to show the current frequency step in Hz (an integer greater than zero).



Macro form, p1



Plot 1



Context Menu

Selecting one of the Auto Scale options with a band pass plot displayed initiates the following process:

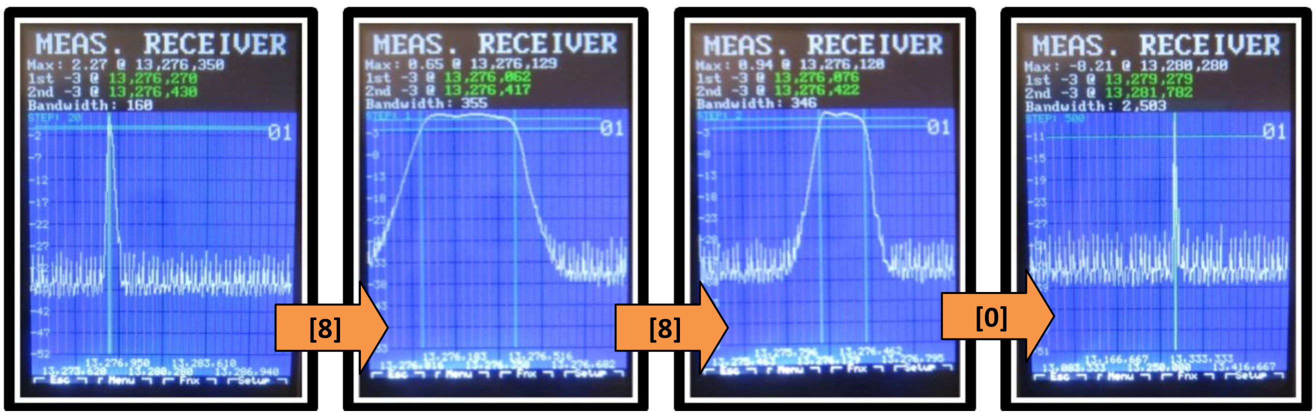
- Compute new frequency range by multiplying the band pass by the selected multiple.
- Divide the new frequency range by the number of frequency steps (ROWS) to compute the new FREQ ST value.
- Force the new FREQ ST value to an integer greater than zero.
- Multiply the new FREQ ST by the number of frequency steps to recompute the frequency range.
- Set FREQ LO to center the bandwidth from the previous frequency scan minus half of the new frequency range.
- Set FREQ HI to FREQ LO plus the new frequency range.
- Truncate the lower end of the frequency range, if necessary, to avoid negative frequencies.
- Set the plot count to zero.

- Replot the data using the new parameters.

Consider the following example:

To test a measurement receiver with an IF frequency of 3.2768 MHz, an IF filter with a 400 MHz (nominal) pass band, an RF signal input of 10 MHz, the **RF Out** signal from an MSNA executing the macro defined by the data form shown above provided the local oscillator input to the measurement receiver. The measurement receiver output was connected to the MSNA's **RF In**.

The first pass of the macro resulted in ***Plot 1*** shown above. Since this is a band pass plot, the context menu includes the Auto Scale menu options. Selecting **Auto Scale BW x 8** [8] generated the first of the following four plots (***Plot 2***):



Plot 2 ***Plot 3*** ***Plot 4*** ***Plot 1***

The initial plot was made with a 500 Hz step which left a lot of room for error in determining the frequency and bandwidth of the output of a 400 Hz filter. This error is compounded by the ***Plot 1*** scaling 1,000 steps of a 500 KHz frequency range to fit in a plot display only 240 pixels wide. These factors led to what appeared to be a 2,503 Hz bandwidth centered at 13,280,280 in the first plot.

Plot 2 is considerably better with a bandwidth of 160 Hz and a FREQ ST of 20 Hz. The frequency at maximum has been adjusted down somewhat so the resulting peak is not in the center of the plot so we know there is still a lot of error in the plot. The next iteration produced ***Plot 3*** which is starting to look somewhat accurate. The bandwidth is 355 Hz and the step is 1 Hz. The peak is still off center. One more iteration produces ***Plot 4*** Which is the most accurate representation of the peak. Additional iterations will not change the plot. That's how we know we have the most accurate plot.

Depending on the initial scan parameters and the true nature of the signal being plotted, it may be necessary to try different Auto Scale options to find the one that works best. For example, if we had chosen **Auto Scale BW x 2** [2] to rescale this plot, ***Plot 2*** would have been garbage. In this case you can return to the original scale parameters and re-generate ***Plot 1*** again by selecting **Restore Original Scale** [0]. The original scan parameters are not overwritten by the new parameters generated by the Auto Scaling process and can be recalled to get back to the original starting point.

If you are using a keyboard, you can do Auto Scales of BW x 3, 5, 6, and 7 in addition to the x 2, 4, and 8 on the context menu. In most (maybe all) cases, x 2, 4, and/or 8 will do the job.

This example would be a good place to use the FREQ OFFSET function. Setting the FREQ OFFSET to the IF frequency would have resulted in the plot being centered at the RF frequency input to the measurement receiver. The FREQ OFFSET feature is described in a following section of this document.

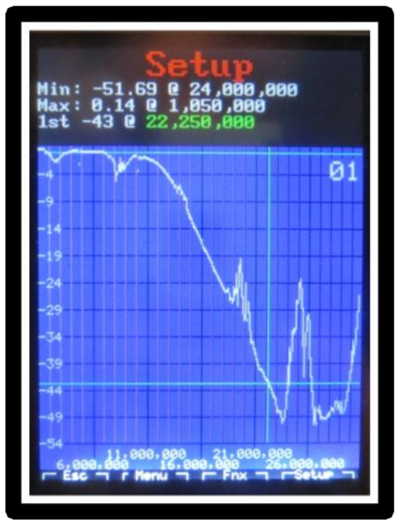
9.2 Plot Formats

Four plot format selections are available on the **Plot Format Select** menu (selection **P** on the **Setup** menu):

- **0** Plot 2-pixel by 2-pixel points.
- **1** Plot N-pixel by 1-pixel vertical bars.
- **2** Plot N-pixel by 2-pixel vertical bars.
- **3** Plot N-pixel by 3-pixel vertical bars.

N is determined so the bar extends up and down from the current point to half-way between the previous and next points.

Plot Format 0



Plot Format 1

Plot Format 2

10.SETUP MODE

Tap **Setup** [**Scroll Lock**] to enter **Setup Mode**. Tap **>** [Right Arrow] and **<** [Left Arrow] to switch between the Setup and Edit Menus. Completing a selection (including **Esc**) or tapping **Setup** [**Scroll Lock**] again will exit **Setup mode** back to **SNA Mode**: **Terminal Display** and (if connected) restart an External application.

Make a selection by tapping the menu line or the line below it or by keying the first character of the menu line.

The **Configure Ext. Interface** [B] selection must match the external device (if any) interface requirements.

Terminal Mode Select [T] sets the terminal mode to one of three as follows:

- **Normal** [0] - Editing functions and permanent buttons are active, NUM PAD is activated by tapping input line, entered text is displayed on the Input line and transmitted with **Enter**. This terminal mode is the **SNA Mode**: **Terminal Display** and gives External applications access to some of the special SNA application functions like data plotting and spooling.

- **Transparent** [1] - Similar to **NORMAL** except the **Esc**, **Menu**, and **Fnx** permanent buttons are not active. When entered, these characters will be sent as Special Extension Codes (SEC). Once this terminal mode is selected, all navigation is disabled except **Setup** [Scroll Lock].
- **Direct** [2] - Editing functions and buttons (except **Setup** [Scroll Lock]) are disabled. Entered text is not displayed but is transmitted as it is entered and without any filtering. Received characters are displayed. Special SECs are defined to select the display area (Input line or main text area), to select font colors, and to clear the display areas. Once this terminal mode is selected, all navigation is disabled except **Setup** [Scroll Lock].

Macro Data Entry [Ctrl-F] brings up a list of the macros displaying their shortcut key and the content of the title field. Selecting a macro brings up the macro edit form with the current field values shown. Fields may be edited and saved in EEPROM.

Etch-a-sketch [E] can only be terminated by pressing **Esc** on the keyboard or by cycling power. This enables you to check touch screen operation and calibration over the entire screen.

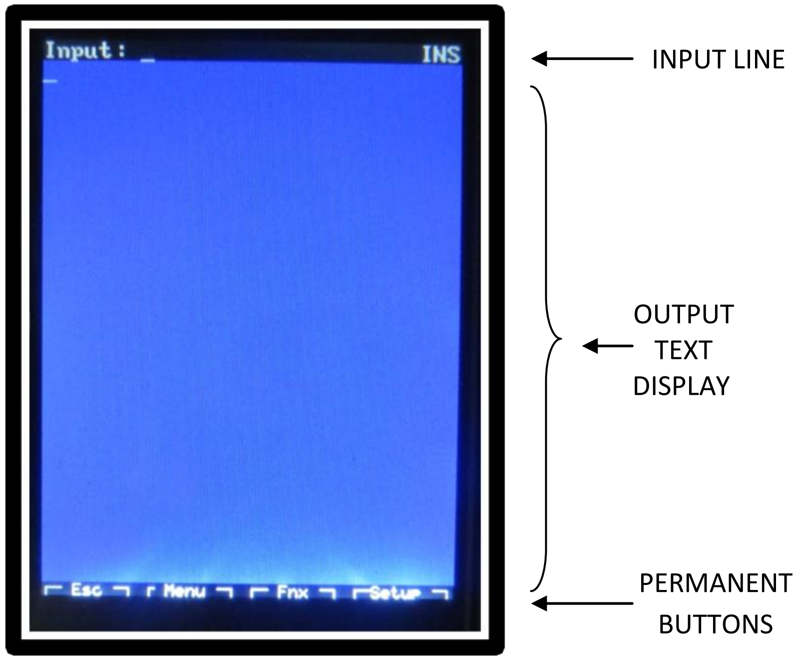
SD Card Test [S] writes ten files on the SD card, verifies their content, and deletes the files one at a time checking the contents of the remaining files after each delete. The test pauses after each test part for manual input (any input).

11.EDIT MENU ITEMS

EDIT MENU ITEM	ENTRY TYPE	EXAMPLE
D - DDS Start Frequency	Positive integer (Hz)	1000000
R - Roll off power level	Positive mixed no.(dB)	43
X - Xtal term. resistance	Positive mixed no.(ohms)	12.5
U - Power Cal. Level	Signed mixed no.(dBm)	3.00
V - ADC Reference Voltage	Positive mixed no.(V)	3.00
A - PM Slope*	Positive fraction (dBm/n)	0.02989537
I - PM Intercept*	Negative mixed no.(dBm)	-81.99
F - Macro Form Template	12 rows of 15 characters	
L - Log File Name	8.3 DOS file name	LOG.CSV
C - LC Meter Capacitor	Positive integer (pF)	1000

* PM Slope and PM Intercept are usually set by the firmware (see Quick Reference entry titled "SLOPE-INTERCEPT").

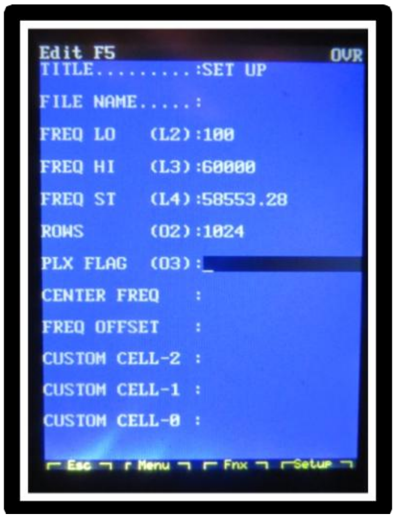
12.TERMINAL DISPLAY



SNA Mode, Terminal Display is normally used only with an External application like PHSNA. It can also be used to test the serial interface with a loop-back connection to echo TxD to RxD. Text entered on the **Input** line is sent when Enter is pressed. Text can be edited. Tap **INS**/**OVR** [Ins] in the upper right corner to toggle between overwrite and insert editing modes.

The OUTPUT TEXT DISPLAY area displays received text. Menus can be generated by the External application and displayed here. Menu selections are made by touching the menu line or inputting the first character of the menu line.

13.MACRO FORM DATA ENTRY



Page 1

Page 2

Start macro data entry by selecting a FUNCTION key in **Setup Mode** (**Setup** > **[Ctrl-F]** > **Fn**).

Touching the left half of a line selects that line for editing. Touching the right half of a line selects that line for editing and displays the **NUM PAD** for numeric data entry.

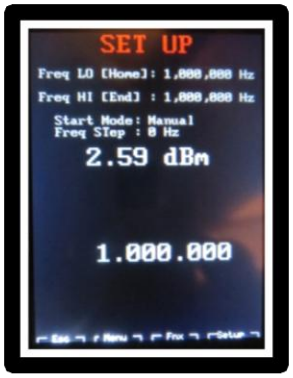
Note that **FREQ LO** and **FREQ HI** are entered in KHz and can have up to three places after a decimal point. **FREQ ST** and **FREQ OFFSET** entered in Hz and decimals are ignored.

Enter any three of **FREQ LO**, **FREQ HI**, **FREQ ST**, and **ROWS** and the fourth one will be calculated. Enter **FREQ ST**, **ROWS**, and **CENTER FREQ** and **FREQ LO** and **FREQ HI** will be calculated.

All entries can be made using the **NUM PAD** but a keyboard would be best for entering **TITLE**s, **FILE NAME**s, and **XTAL PREFIX**s. Once entered, these fields can be edited using the **NUM PAD** to add serial numbers.

14. SLOPE – INTERCEPT

F5 Page 2



After F5

After CTRL-S

After ENTER

To calibrate the RF Power Meter slope and intercept:

1. Set up a macro form with **op mode** (page 2) **Power Meter Calibration** (0 or [**P**]) specified. The remainder of the form is ignored. The frequency will be locked at 1 MHz.
2. Connect **PWRCAL** output directly to **RF In**.
3. Start the macro.
4. Tap **Set Slope-Intercept** [CTRL-S] on the context menu to capture the first power reading (+3 dBm).
5. Insert a -20 dB attenuator in series with the **PWRCAL** output.
6. Tap anywhere on the display [**Enter**] to capture the second power reading.
7. Tap the screen just below the frequency display [SPACE] to verify -17.0 dBm (approximate) reading.
8. Tap **Esc** [Esc] to end the macro.

The slope and intercept are now computed and captured in the EEPROM. Their values will be displayed on the splash screen.

15.REFERENCE CLOCK FREQUENCY

Page 2 ***Set frequency*** ***Adjust ref clock***

To set the reference clock frequency:

1. Set up a macro form to cover the frequency to be used and specify **Signal Generator** ([5 or S]) op mode.
2. Connect **RF out** to a frequency counter.
3. Start the macro and set the frequency (e.g., 10 MHz).
4. Tap **tweak Ref. clock** [CTRL-R] on the context menu. The sig gen frequency display will show the current reference clock frequency (nominally 180 MHz).
5. Tap the **+** (green)[+ or UP-ARROW] and **-** (red)[- or DOWN-ARROW] buttons to adjust the reference clock frequency until the frequency meter reads the frequency you set in step 3.
6. Tap the screen [Enter] to capture the new reference clock frequency and save it to EEPROM.
7. Tap **Esc** [Esc] to end the macro.

If a frequency counter is not available, add an antenna to the RF signal output and use a communications receiver to zero-beat the signal with WWV.

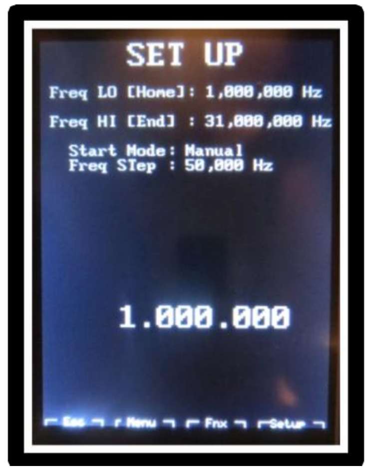
16. CALIBRATION

Page 2 | Before Calibration | After Calibration

To load the calibration buffer:

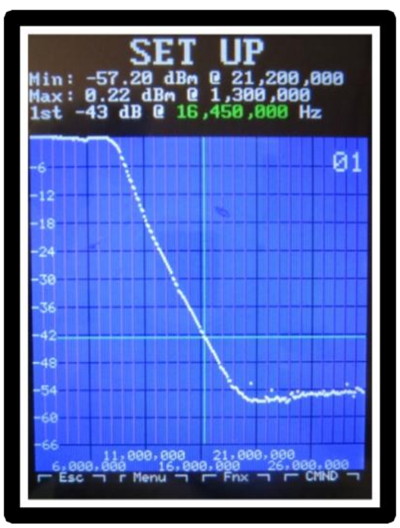
1. Set up a macro form to cover the frequency range of interest (e.g., 1 MHz to 31 MHz) and specify no **op modes**.
2. Connect **RF out** direct to **RF in**.
3. Tap **Uncalibrate** [ALT-C] on the context menu to clear the calibration buffer.
4. Start macro and tap the screen [SPACE] to do a sweep.
5. Tap **Calibrate** [CTRL-C] to load the calibration buffer. Observe the plot of a straight line at the 0.00 dBm level.
6. Tap **Esc** [Esc] to clear the plot screen.
7. Restart the macro and tap the screen [SPACE] to do a sweep.
8. Verify the **TITLE** is now rendered in white and the trace is nearly a straight line at the 0.00 dBm level.
9. Tap **Esc** [Esc] to end the macro.

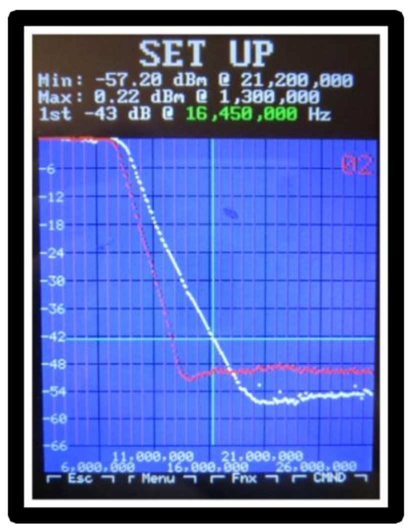
17.MACRO DISPLAY



Macro start Sig Gen Display

Start a macro by selecting the macro from the **Fnx** menu [Fn or ALT-Fn]. The contents of page one of the macro form are displayed briefly and then the Signal Generator Display. The scan operation commences when the display is tapped below the frequency display [SPACE]. Tapping the plot [SPACE] again will initiate another scan and an over-plot.





First Plot (white) Second (over-)Plot (red)

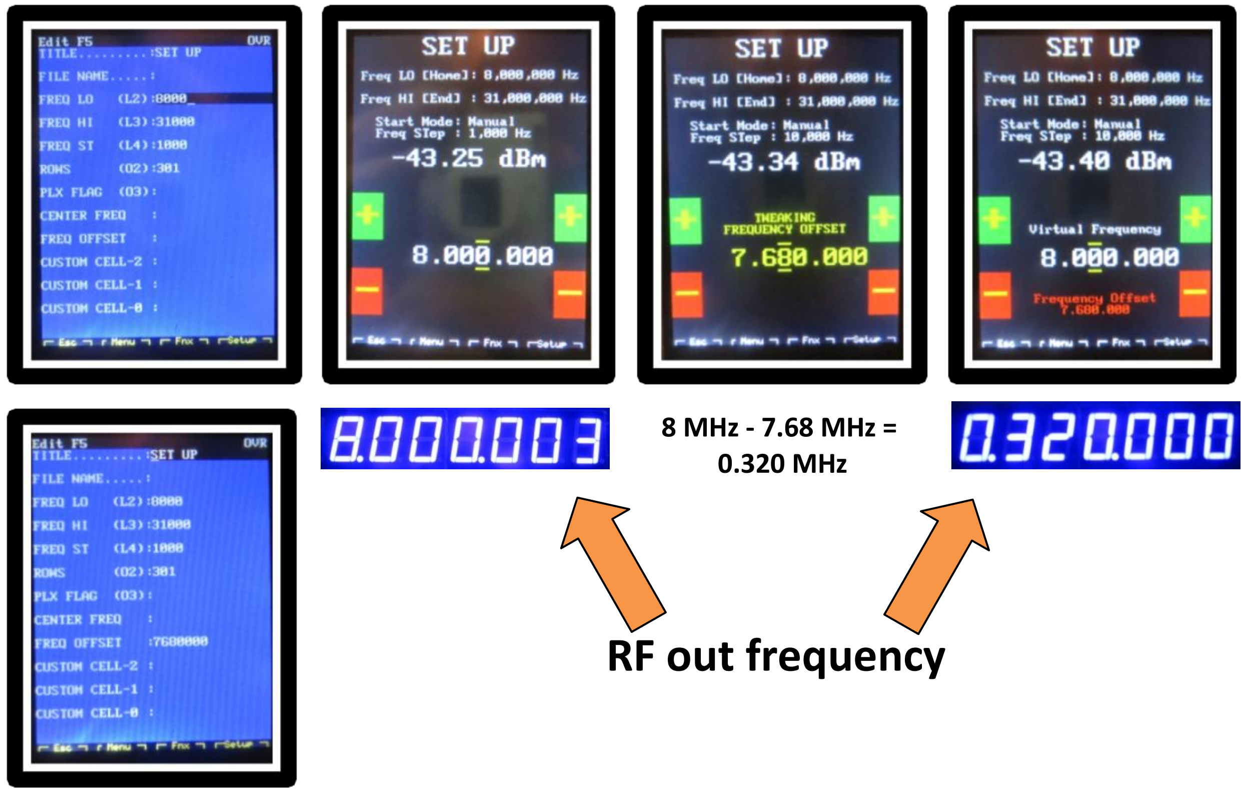
18.SIGNAL GENERATOR DISPLAY

Setting S op mode   Sig Gen Display

This **op mode** gives us manual control of the RF frequency. The **+** (green) [+ or UP-ARROW] and **-** (red) [- or DOWN-ARROW] buttons will increment or decrement the frequency by the **Freq STep** value. Tap a digit in the frequency display [LEFT- / RIGHT-Arrow] to change the **Freq STep** and move the yellow position markers. Tap **Freq LO** [Home] to set the frequency to the start frequency and tap **Freq HI** [End] to set the frequency to the end frequency.

In manual start mode, a power level reading is taken and displayed each time the frequency is changed or the screen is tapped just below the frequency display [SPACE]. In automatic start mode, a power level reading is taken and displayed about four times per second. Tapping **Enable Auto-Start** [A] on the context menu will toggle between automatic and manual start modes.

19.LOCAL OSCILLATOR



When the RF out signal is mixed with a second RF signal, the result will contain an RF component the frequency of which will be the sum of the two input frequencies. The signal source is referred to as a "local oscillator" and the resulting frequency is said to be "offset" from the second RF signal's frequency.

When an offset is specified by the **FREQ OFFSET** entry on page one of the macro data form, the RF out signal frequency will be set to that shown on the frequency display **minus** the **FREQ OFFSET** value. FREQ OFFSET can be either a positive or a negative value.

The offset value may be entered directly in the form or may be set or adjusted by selecting **tweak freq. Offset** [CTRL-O] from the signal generator context menu and using the **+** and **-**

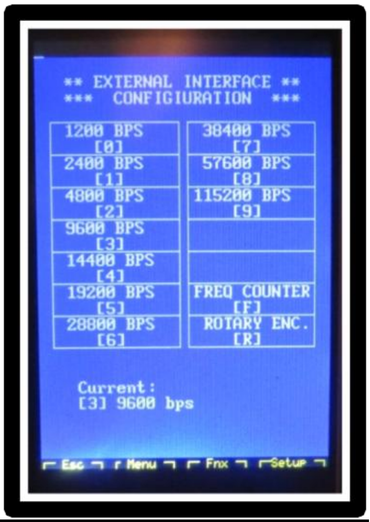
buttons to set (or tweak) the amount of offset. When the tweaking screen is closed by tapping the display below the offset value [Enter], the final offset value is stored in the macro data form in the EEPROM and will be used each time the macro is started.

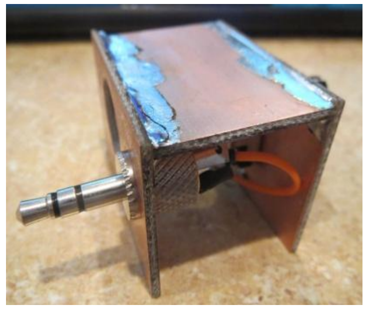
The above example shows the signal generator outputting an RF signal at 8.0 MHz when no offset is specified. When an offset of 7.68 MHz is specified, the output signal frequency changes to 320 KHz (8 MHz - 7.68 MHz). When the offset is non-zero, the frequency display shows what we refer to as the "Virtual Frequency" which is the output frequency of the mixer. The offset frequency is displayed in red below the virtual frequency.

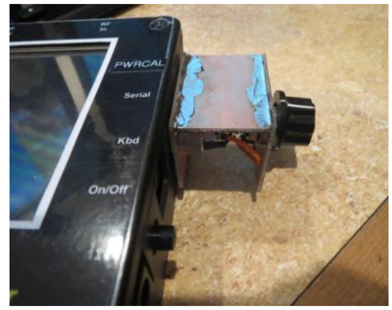
The offset frequency can only be tweaked in signal generator op mode but it is used whenever a macro containing a non-zero **FREQ OFFSET** is running. This means it may be possible, using a mixer and an external reference oscillator, to extend the usable SNA operating frequency range up beyond VHF to the limit of the RF Power Meter (500 MHz).

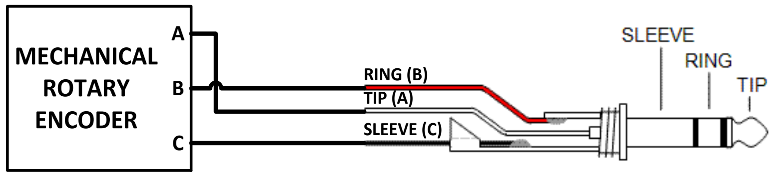
Since the offset is subtracted from the virtual frequency, it is possible to have a negative result. When this happens, the DDS is turned off by setting its frequency to 0 Hz.

20. TUNING KNOB









Selecting **ROTARY ENC.** [R] from the **EXTERNAL INTERFACE CONFIGURATION** menu will disable the serial port UART and condition the interface to process input from a rotary encoder to tune the Signal Generator. The above schematic shows how to connect a rotary encoder to a stereo audio plug. The pictures are of a prototype assembly made from PCB stock. The stereo plug mounts to the copper clad with a clearance hole next to it for the PWR CAL BNC connector. This arrangement keeps the assembly from rotating on the audio jack when the knob is turned.

Each pulse from the encoder produces the same input as tapping the **+** or **-** buttons on the signal generator display. The + code is produced when the knob is turned clock-wise. Most any mechanical rotary encoder can be used (e.g., Mouser p/n 688-EC12E2420802 or 652-PEC11L-4015F-N0020). Pull-up resistors are enabled on the dsPIC input pins so external resistors are not required. If you use a cable and noise pickup becomes a problem, 0.1 UF decoupling capacitors can be mounted on the stereo plug.

21. FREQUENCY COUNTERS

[CTRL-T] [ENTER] [ALT-T] [ENTER]

There are two frequency counter ranges as specified by the op modes. The low frequency counter (**f** [f]) has a useful range from 1 Hz to 11 MHz. The high frequency counter (**F** [F] has a useful range from 1 MHz to 40 MHz. The upper frequency is limited by the system clock frequency. External counters could be used to extend the upper frequencies.

Cycles are counted over a one second time period. The main frequency display shows a 10-point running average. The current "raw" count is shown below. Tapping **Freq LO** [Home] will clear the running average and start over using the next raw count as the starting point. This reduces the time to catch up after a sudden frequency change or calibration tweak.

The **RF out** signal or an external, calibrated signal generator can be used to calibrate the frequency counters. The RF out frequency will be the **FREQ LO** value in the macro data sheet. To turn off the DDS when not calibrating to minimize stray noise and reduce power consumption, leave **FREQ LO** blank or set to zero.

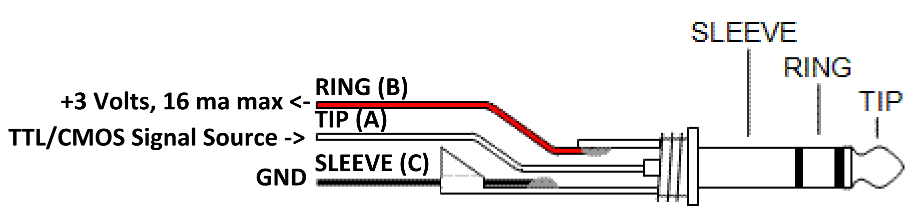
Two levels of tweaking are provided. **Tweak sys clock** [Ctrl-T] enables gross calibration by adjusting the system clock frequency (± 12% in 30 KHz increments). **Tweak Period** [Alt-T] enables fine calibration by adjusting the 1 second timer period (± 80 ms in 16 uS increments).

The SNA does not contain a precision timing source so the frequency count error may change with temperature and age. Typical frequency count errors should be less than 1 KHz following calibration.

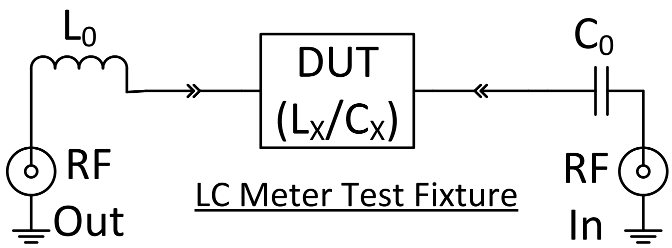
The counter input must be a TTL or CMOS logic level. If the signal source is a guaranteed to never exceed 5V or go below 0V, it may be input directly into the external interface connector on the tip connection. General RF signals must be conditioned to meet logic signal level requirements and to avoid damaging the SNA. The frequency counter tutorial contains the description of a simple RF conditioning circuit.

When configured for frequency counter input, the external interface connector "ring" connection is driven high. This connection can provide about 16 ma at 3 volts, enough to power a simple RF signal conditioner.

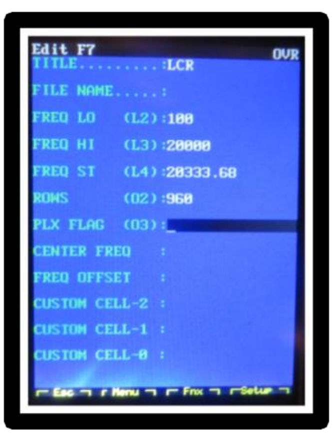
Frequency Counter interface to External Interface Connector



22.LC METER



A detailed description of one possible LC Meter Test Fixture is included in the LC Meter Tutorial. Before use, the value of $\mathbf{C_0}$ must be entered using the **LC Meter Capacitor (pF)** [C] item in the Setup Menu. Here we used a .001 uF, 1% silver mica for $\mathbf{C_0}$. The value of $\mathbf{L_0}$ will be determined during calibration. Here we used a axial-lead inductor marked 25 uH and 10%. Calibration is done inserting a short for the DUT and doing a broad frequency scan. The objective is to determine the series resonant frequency of the series LC circuit and calculate the inductance of $\mathbf{L_0}$. When a capacitor or inductor is inserted as the DUT, its capacitance or inductance can then be calculated from the new series resonant frequency.




To calibrate the test fixture, set up a macro form for a broad range starting at a low frequency. Here we used 100 KHz to 20 MHz with 960 rows. Set the op modes to **Reinitialize each**

plot [R] and **Lc meter** [L]. Once the macro is started, do a frequency scan by tapping the screen [SPACE]. You should get something like the third picture above. Tapping **Auto Scale BW x 2** [2] will center the plot on the resonant frequency and set the frequency range to two times the bandwidth giving a plot like the fourth picture above. The yellow frame displays the value of **C_0** from the EEPROM, the frequency of the high-point on the plot (**F_0**), and the computed value of (**L_0**). Tapping **Calibrate LC Mtr** [Ctrl-L] will save the new values to EEPROM for use on all future LC measurements. Stop the macro and remove the DUT short.

The following plots were made with a 100 uH inductor (**L_X**) as the DUT and with a .001 uF capacitor (**C_X**) as the DUT, both of unknown tolerance.

23.DOS MODE

Fist DIR Sector

DIR Mid-Sector

Last DIR Sector

Enter DOS mode by tapping **DOS Mode** [Ctrl-D] on the **SNA Mode** context menu. The first sector of the current directory is displayed.

Tapping **NEXT** [Right Arrow] and **LAST** [Left Arrow] move between directory sectors.

Two right-most permanent buttons changed to left and right arrows.

Two ways to execute a DOS command:

1. Enter command followed by file name (if required) and press Enter.
2. Tap the file name on the DIR display then select a command from the Command menu and select **Yes** from the Confirmation screen. The complete DOS command is shown on the top line of the Confirmation screen.

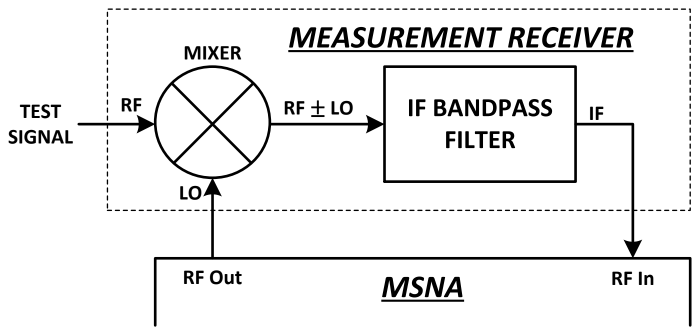
The context menu for **DOS Mode** is two columns of buttons all but one generates a DOS command. See the User Guide for detailed DOS command descriptions.

24.SEGMENTED FREQUENCY SCANS

There are two types of segmented frequency scans:

1. Contiguous - Used when scanning a wide frequency spectrum with a small FREQ_ST resulting in more data points than the data buffer can hold.
2. Noncontiguous - Used when several areas of a wide frequency spectrum are to be individually scanned and the results consolidated.

Mainly used with a Measurement (or "Measuring") Receiver (MR) for spectrum analysis and measuring harmonics.

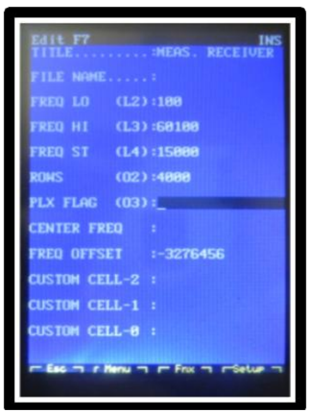


A segmented scan is initiated by the operator after a "normal" scan has been completed and plotted. The normal scan provides the data the MSNA needs to compute the parameters for the segmented scan. Each type has a set of helper functions to aid the generation and analysis of the segmented scan.

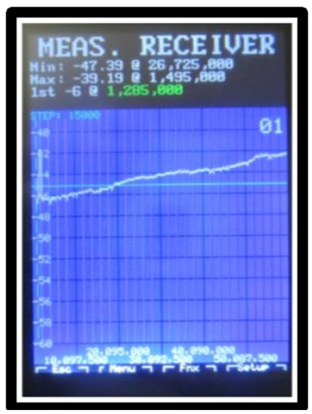
The FREQ_ST for a segmented scan is specified by the operator and stored in EEPROM using the **MR/Seg Scan FREQ_ST (Hz)** menu item [Scroll Lock > M].

24.1 Contiguous Segmented Scans

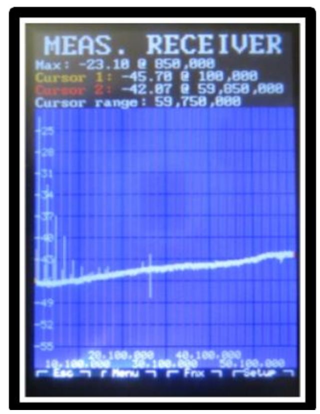
The normal, pre-scan is setup to cover the entire frequency range to be scanned with the number of steps (ROWS) set to the buffer size (4,000 for V5.00 on). Once the normal scan is complete, Tapping **Do Segmented Scan** [S] on the context menu will start the segmented scan. The firmware will divide the frequency range into segments each of which are scanned and the data processed before making the next scan. Segments are divided into sub-segments, one for each horizontal pixel in the MSNA plot area. The maximum and minimum values in each sub-segment is saved to be plotted as a vertical line between the two values.



Macro Page 1



[SPACE] Normal Scan



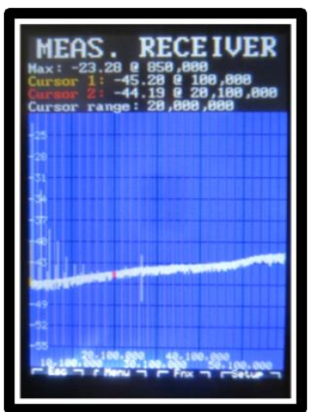
[S] Segmented Scan

Once the segmented scan is displayed, two cursors are activated, one at each end with the current locations and distance between them displayed above the plot. Cursors are displayed as colored, three-wide bars in the otherwise white data plot. Cursors may be positioned by dragging them on the touch screen or with these hot keys:

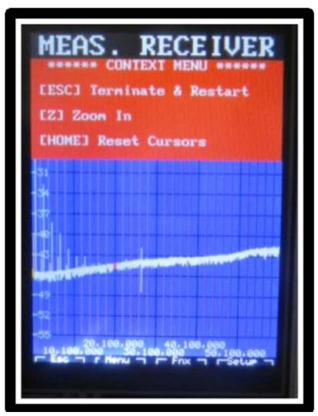
- [UP-ARROW] Move cursor 10 pixels right.
- [RIGHT-ARROW] Move cursor 1 pixel right.
- [DOWN-ARROW] Move cursor 10 pixels left.

- [LEFT-ARROW] Move cursor 1 pixel left.
- [ALT] When held down, right cursor selected; otherwise left cursor is selected.
- [CTRL] When held down, both cursors are selected; distance between them will be maintained.
- [HOME] Return cursors to ends of plot area (positions 0 and 239).

Moving a cursor beyond the end or before the start of the plot will disable the cursor and turn off both the cursor display and the position information above the plot. When both cursors are displayed, Tapping **Zoom In** on the context menu [Z] will generate a normal plot of the data between the two cursors. Tapping **Do Segmented Scan** [S] on the context menu will generate a new segmented plot over the current data range.

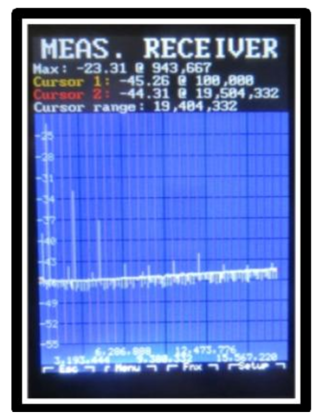


Right Cursor Moved



[CTRL-M]Context Menu

[Z]Zoom and Plot



[S] Zoomed Seg Plot

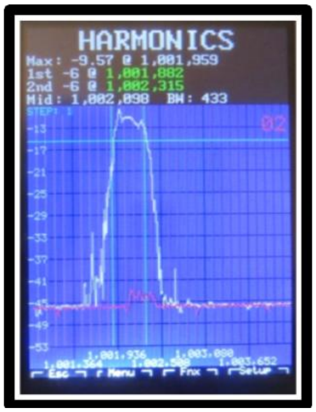
24.2 Noncontiguous Segmented Scans

Here the normal, pre-scan is set up to cover the first segment which is centered on the fundamental (or first harmonic) frequency. During the segmented (harmonic) scan, this segment is duplicated nine more times centered on harmonics two through ten. The data from all ten segments are then plotted showing the maximum and minimum signal levels in each segment.

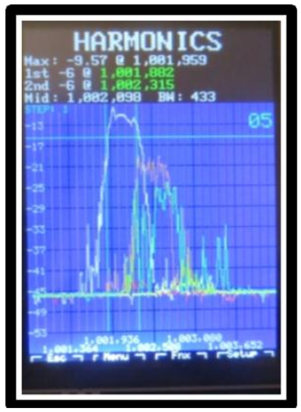
The pre- scan is done covering a frequency range just below to just above the nominal fundamental frequency. The step size should be less than the MR IF filter band pass and the step count (ROWS) should be the data buffer size (4,000). Before the harmonic scan can be done, the segment scan parameters must be optimized by reducing the frequency step size and accurately locating the fundamental frequency. This is done by tapping **Auto Scale BW x 8** [8] until the step size is 1 and the bandwidth (BW) is approximately the same as the MR IF filter bandwidth.

Macro Page 1 *[SPACE] Normal Scan* *[8]Optimized Seg.*

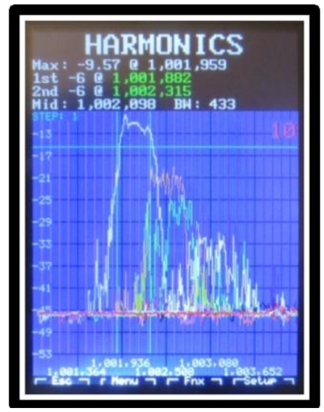
Once you are satisfied with the fundamental plot, tap **Plot Harmonics** [H] on the context menu. The first harmonic (fundamental) will be plotted again. Each time the display is tapped or SPACE is pressed, a new harmonic will be scanned and plotted until all ten have been scanned and plotted. Pressing [A] or tapping **Menu** [Ctrl-M] will temporarily turn on automatic start mode and the remainder of the harmonics will be scanned without human intervention. (There is only one context option here so there is no context menu.)



2 Harmonics Scanned

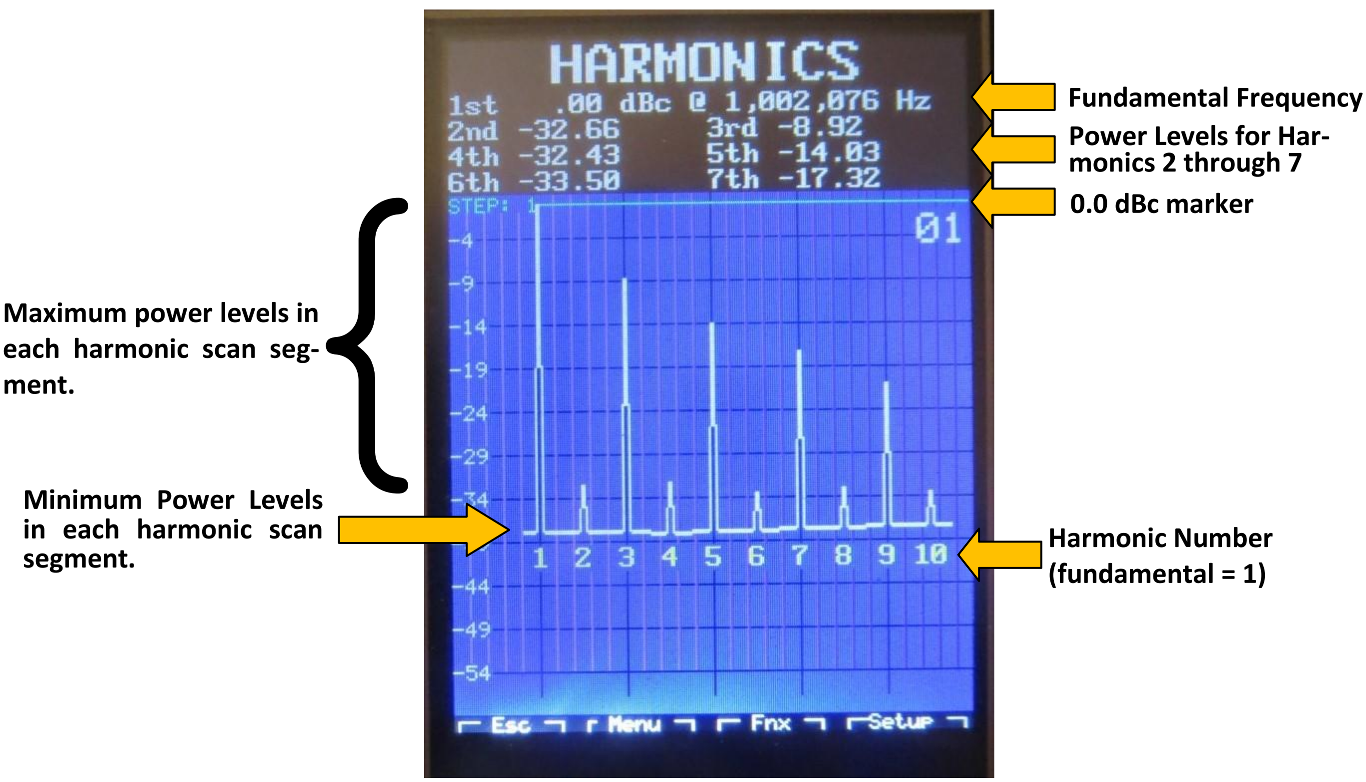


5 Harmonics Scanned



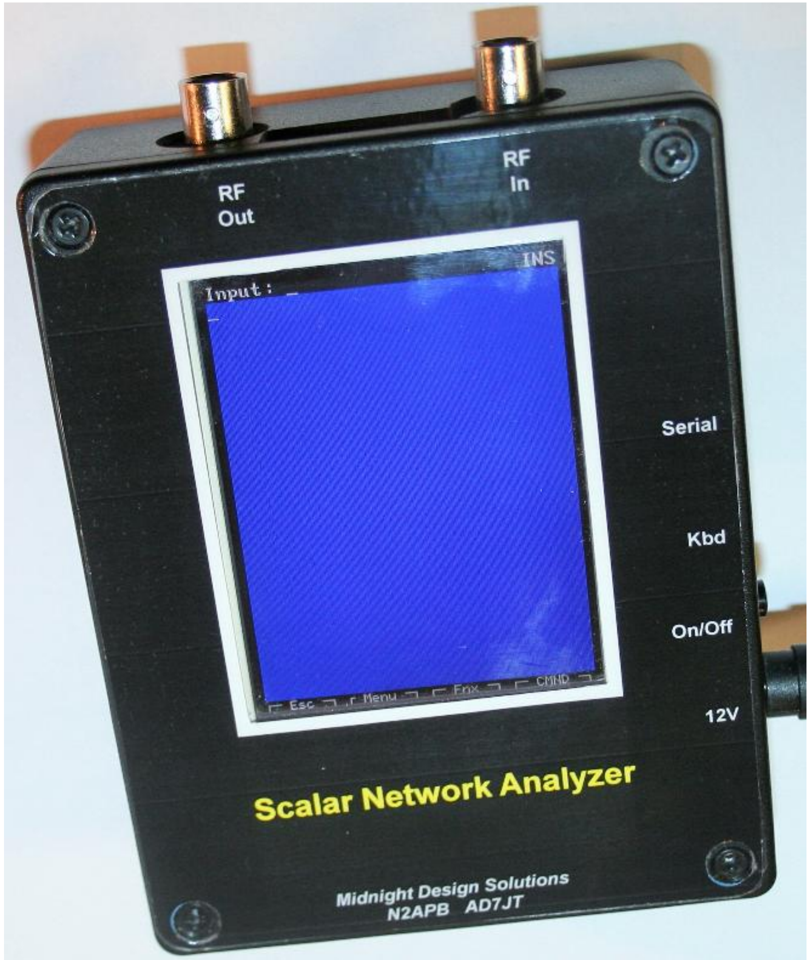
10 Harmonics Scanned

After the tenth harmonic has been scanned the results are plotted as ten segment sweeps by harmonic number instead of by frequency.



Harmonic Summery Plot

25. GENERAL SPECIFICATIONS



25.1 Physical and Power

- PCB: .... *4.47" x 3.31"*
- Enclosure: .... *4.82" x 3.77" x 1.39"*
- Display: .... *QVGA, 64K color depth*
- Power: .... *7-12.6V DC @ 300 ma (typ)*
- Weight: .... *7 oz (approx)*

25.2 Interfaces

- RF Out (RF Signal Source):
  - Connector: .... BNC
  - Wave Form: .... Sine Wave
  - Output Impedance: .... 50 Ohm
  - Signal Strength:
    - 0 dBm (1 mW) @ 1MHz
    - -3.0 dBm (0.5 mW) minimum @ 30 MHz
    - -6.0 dBm (0.25 mW) minimum @ 60 MHz
- RF In (Logarithmic Power Meter input):
  - Connector: .... BNC
  - Input Impedance: .... 50 Ohm
  - Coupling: ....AC (0.01 uF)
  - Maximum Power Level: .... +20 dBm (100 mW)
  - Dynamic Range: ....90 dBm
  - Minimum Frequency: .... 50 KHz
  - Maximum Frequency: ....500 MHz
- PWRCAL (Power Meter Calibration):
  - Connector: .... BNC
  - Output Impedance: .... 50 Ohm
  - Wave Form: .... 50% Square Wave
  - Frequency: .... 1 MHz ±0.375% (calibrated)
  - Signal Strength: .... +3 dBm (2 mW)
  - Output Low Level: ....20 mV (approx.)
- External Interface:
  - Connector: ......3.5 mm (1/8th inch) stereo audio female connector
  - Absolute Maximum Input Ranges:
    - Tip: .... -0.3V to +5.6V ("5V tolerant" input)
    - Ring: ....-0.3V to +3.6V
  - Serial Interface:
    - Signal Levels: ....Standard 3.3V logic levels (TxD and RxD)
    - Pin Assignments: .... TxD - Ring, RxD - Tip
    - Baud Rate: ....User selectable (1.2, 2.4, 4.8. 9.6, 14.4,19.2, 28.8, 38.4, 57.6, and 115.2 Kbps.)
    - Data Format: ....8, N, 1 (8-bit data, No Parity, 1 Stop Bit)

- Rotary Encoder:
  - Signal Levels: .... Open and Closed (grounded to sleeve)
  - Pin Assignments: .... A - Tip, B - Ring, C - Sleeve
  - Weak pull-ups (~260 uA to 3.3V): ....on Tip and Ring
- Frequency Counter:
  - Pin Assignments: .... Signal - Tip, Power Out - Ring
  - Power Out: ....+3V, 4 ma maximum
    ....+2V, 11 ma maximum
    ....+1.5V, 15 ma maximum
  - Low Frequency Counter:
    - Max Frequency: 11MHz
    - Minimum High Time: ....45 ns
    - Minimum Low Time: ....45 ns
  - High Frequency Counter:
    - Max Frequency: ....40 MHz
    - Minimum High Time: ....20 ns
    - Minimum Low Time: ....20 ns

- Keyboard:
  - Standard: .... IBM PS/2
  - Connector: ....6--pin mini-DIN
  - Pin Assignments:
    - Pin1: ....+Data
    - Pin2: .... No Connection
    - Pin3: ....Ground
    - Pin4: .... +5V DC, 275 mA max
    - Pin5: ....+Clock
    - Pin6: .... No Connection
  - Absolute Maximum Input Voltage Range: ....-0.3V to +5.6V
  - Protocol: .... Serial, Synchronous, and Bidirectional
  - Data Format:................ 1 Start, 8 Data, 1 Parity (odd), and 1 Stop bit
  - Encoding: .... IBM PC AT (set 2) Scan Codes
  - Scan Codes Per Key Press: ....1 or 2 supported
  - Keys Not Supported: .... [Prt Scr] and [Pause Break]
  - Data Rate: .... 10 to 16 Kbps (keyboard controlled)
  - Keyboard Layouts Supported: ....US and UK
  - Buffer:.. 16 Scan Code Characters

- Mass Storage:
  - Media: ....Full-size, Secure Digital Standard Capacity (SDSC) Card
  - Format: .... Industry Standard FAT16
  - File Name Format: .... DOS 8.3
  - Fixed Sector Size: ....512 Bytes
  - Maximum Capacity Supported:..1 GB
  - Interface Protocol: .... Small Peripheral Interface (SPI)
  - Instantaneous Transfer Rate: .... 5 Mbps
  - Hot Swappable
-

25.3 Functional

- Frequency Scanning:
  - Types: .... Normal, Segmented, and Harmonic
  - Rate: .... About 0.75 Seconds/4000 Samples
  - Minimum Frequency Step: .... 1 Hz
  - Data Buffer: .... 4,000 samples
  - Sample Range (calibrated and scaled): ....-300 dBm to +300 dBm
  - Calibration: .... Semi-automatic, Persistent
  - Calibration Buffer: .... 200 Points
  - Calibration Algorithm: .... Interpolation to Nearest Frequency
-

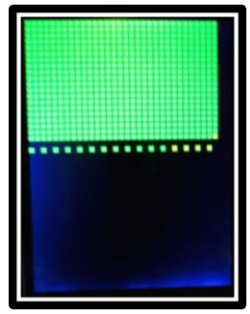
APPENDIX A. LOADING A NEW APPLICATION

To load a new application on a QVGA16 platform when the current application **has** a DOS **SDLD** (SD LoaD) command or equivalent:

1. Copy the .HEX file to the root directory of an SD card (1 GB or less, FAT16 format).
2. Insert the SD card in the SD card slot on the back of the display assembly.
3. Power on.
4. Go to **DOS Mode** and locate the .HEX file in the root directory.
5. Tap the file name in the directory listing. This will bring up the context menu which lists the available DOS commands.
6. Select the **SDLD Reload ...** from the menu. This will bring up the confirmation screen.
7. Check the complete command displayed on the prompt line and, if correct, tap **Yes**.
8. The display will be cleared and, after a few seconds, the progress display will start. Lines of yellow and green squares will be displayed as the new application is loaded.
9. When the load is complete, the display will pause for a second and then start the new application. The whole load process should complete in about two minutes.

APPENDIX A. LOADING A NEW APPLICATION (cont.)






To load a new application on a QVGA16 platform when the old application does **<u>not</u>** have a DOS **SDLD** (SD LoaD) command:

1. Copy the .HEX file to the root directory of an SD card (1 GB or less, FAT16 format). Rename the HEX file "**APP.HEX**".
2. Insert the SD card in the SD card slot on the back of the display assembly.
3. Power on.
4. After a few seconds, the progress display will start. Lines of yellow and green squares will be displayed as the new application is loaded.
5. When the load is complete, the display will pause for a second and then start the new application. The whole load process should complete in about two minutes.
6. Delete or rename the APP.HEX file to avoid reloading the firmware every time you turn power on.