



NAT-SNA

Network Analyzer Terminal - Scalar Network Analyzer



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*Ozarkcon 2015
April 10-11*



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Midnight
Design
Solutions

www.MidnightDesignSolutions.com/NAT



Network Analyzer Terminal



What can YOU do with a Scalar Network Analyzer?

Test Filters ... Low Pass, Band Pass, Receiver IF stages

Match Crystals ... Frequency, Pass Band, Motional Parameters

Analyze Antennas ... SWR, Return Loss

Generate RF Signals ... Stable reference frequencies

Measure QRP Power Levels... Current, Average, Peak

Measure Coax Cables ... Integrity, length, shorts

Measure Inductors, Capacitors ... *and more!*

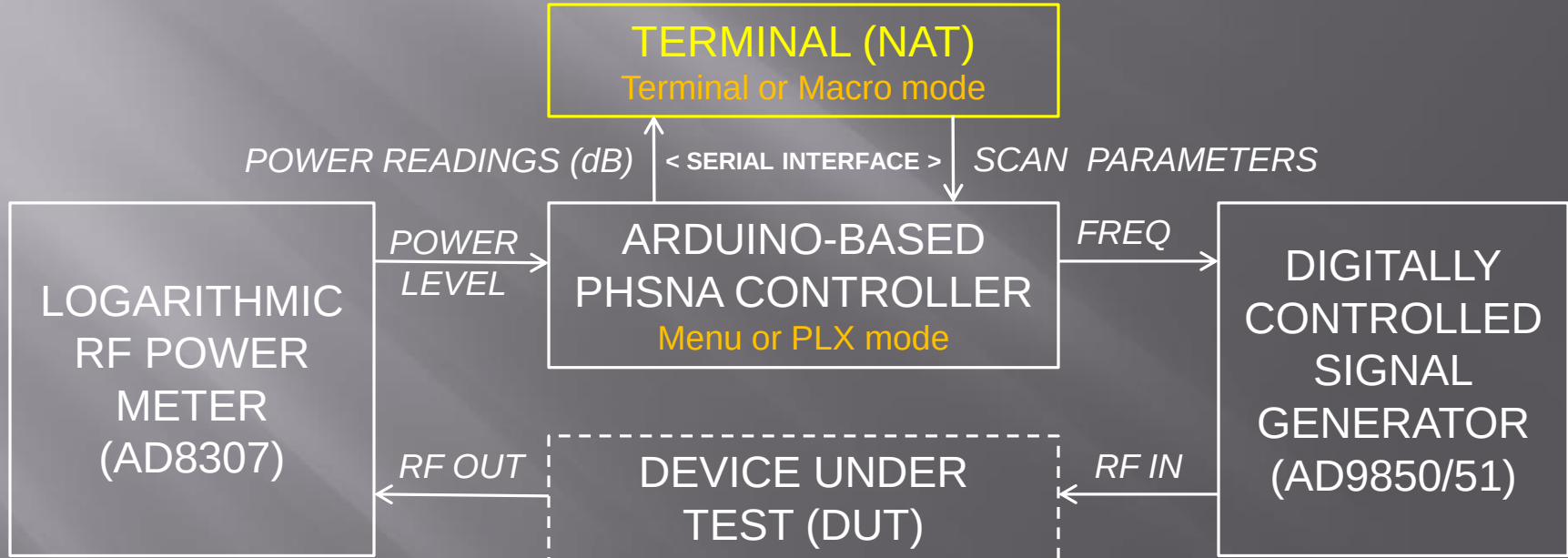


Network Analyzer Terminal



Poor Ham's Scalar Network Analyzer (PHSNA)

*With Network Analyzer Terminal (NAT)
replacing the PC*



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



Network Analyzer Terminal



General NAT Specifications

PCB: 4.47" x 3.31"

Enclosure: 4.82" x 3.77" x 1.39"

Display: 3.2" QVGA, 64K color depth

Serial data rate: 1.2 to 38.4 kbaud

Keyboard: PS2 US and UK

Power: 8-12V DC @ 120 ma (typ.)

Weight: 7 oz. (approx.)

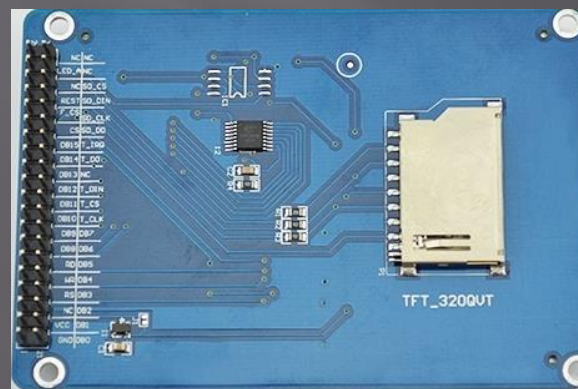


Network Analyzer Terminal



Display module :

- 240 x 320 Pixel (QVGA), 16-bit color, 3.2" LCD
- SSD1289 display controller
- Resistive touch screen with ADS7843 controller
- SD Card socket
- Pads and interconnect for serial (SPI) EEPROM
- Single, 40-pin interface connector
- **Under \$20 on eBay!**

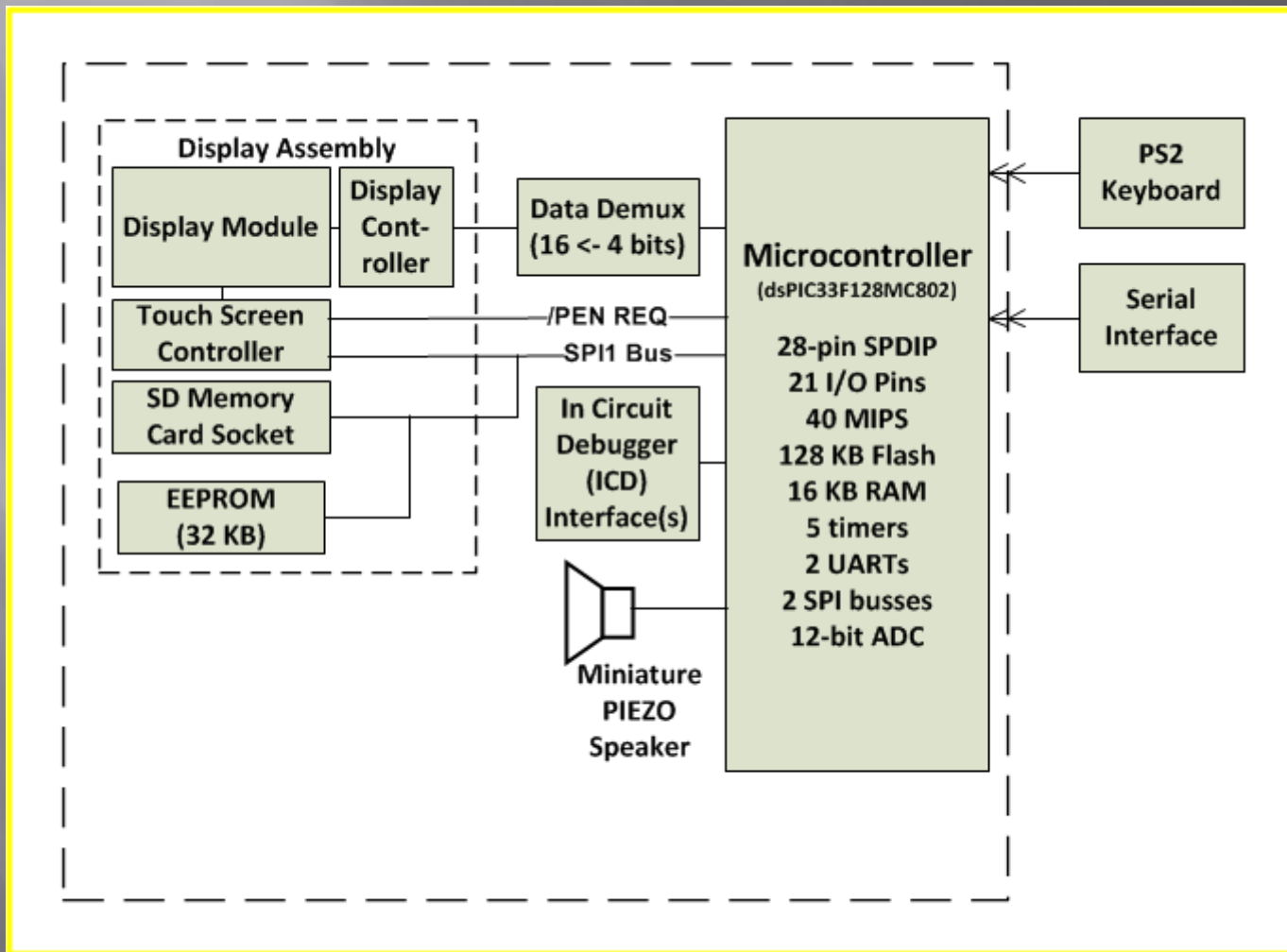




Network Analyzer Terminal



Basic NAT Block Diagram (Versions 1 and 2)

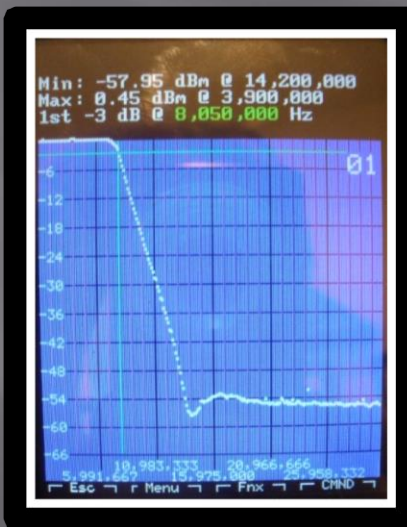
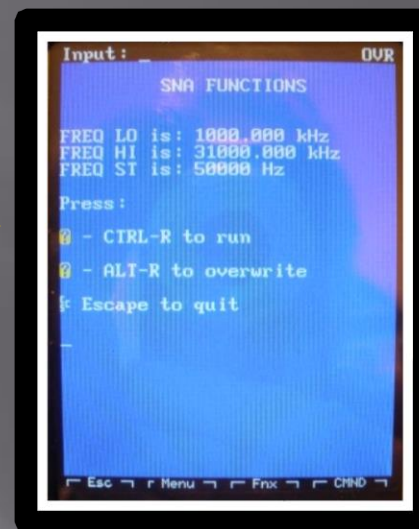
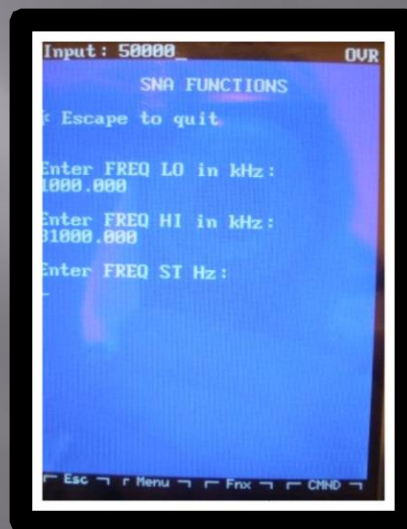
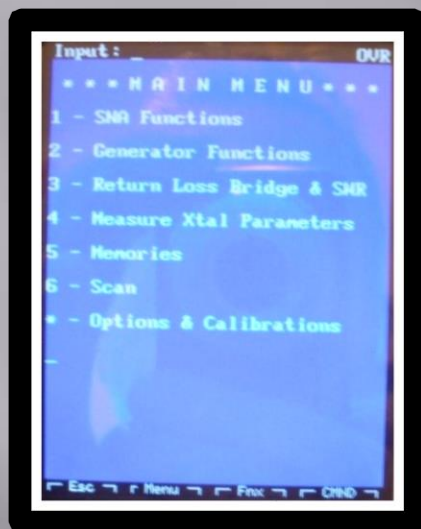




Network Analyzer Terminal



Menu Mode screen shots

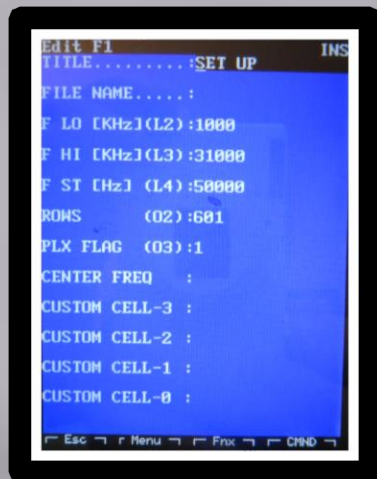




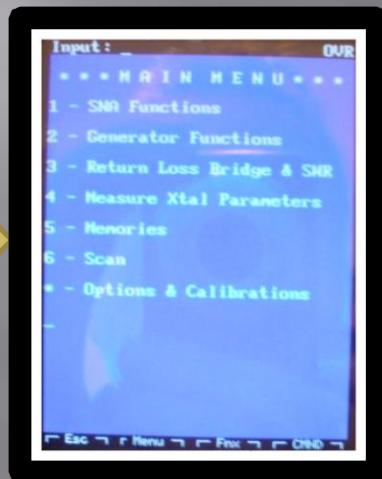
Network Analyzer Terminal



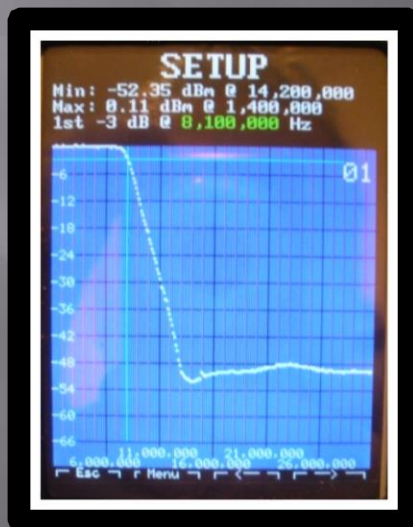
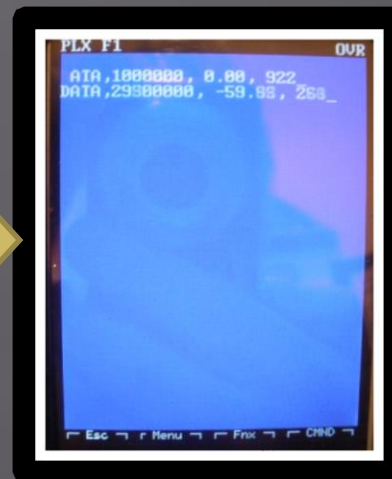
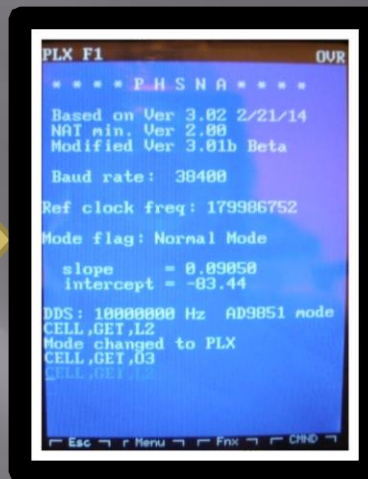
Macro Mode screen shots



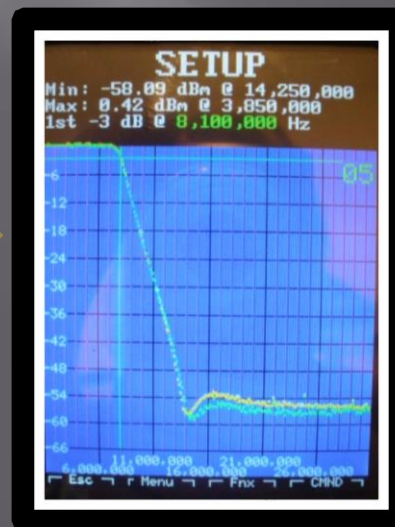
Enter



F1



SPACE

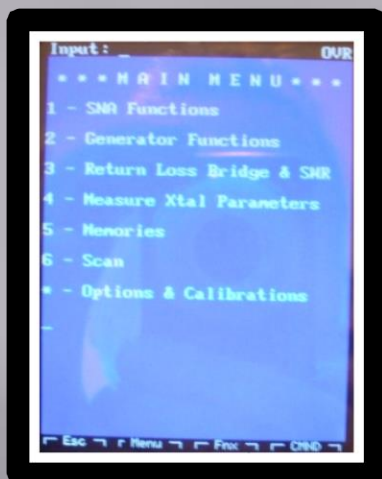




Network Analyzer Terminal



DOS Mode screen shots



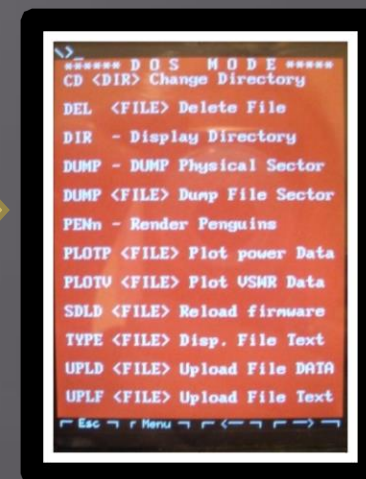
Scroll
Lock



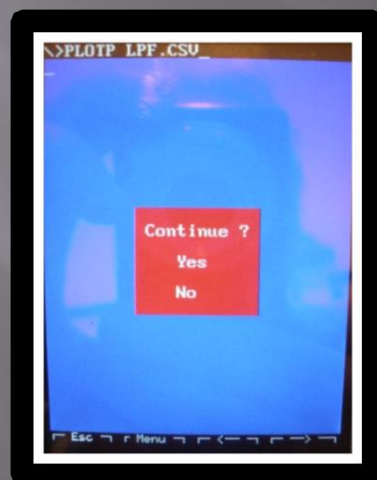
Escape



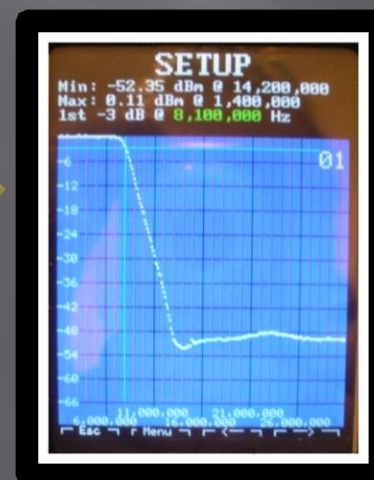
touch



touch



Y

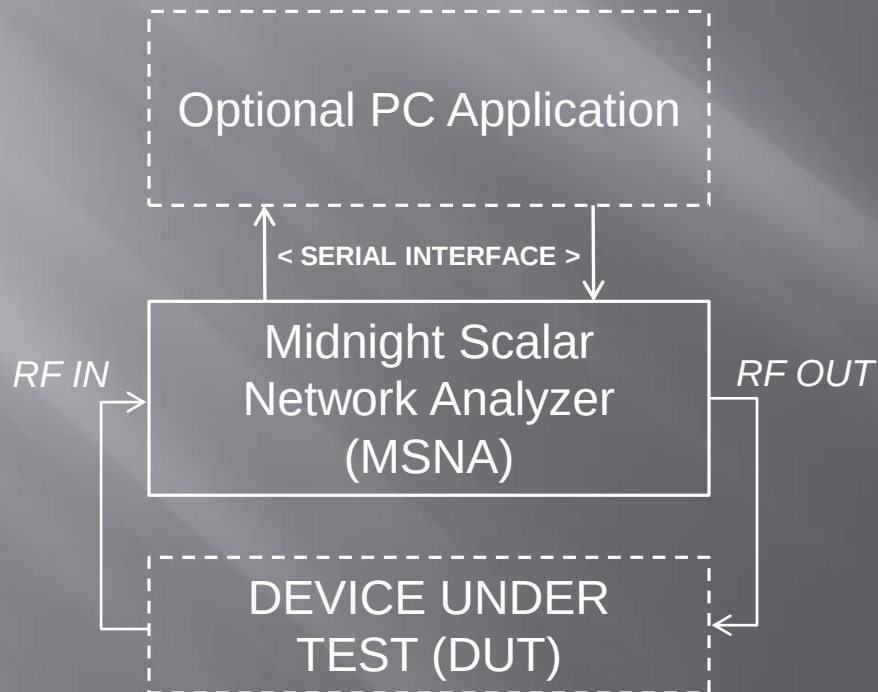




Midnight Scalar Network Analyzer



Midnight Scalar Network Analyzer (MSNA) Version 4

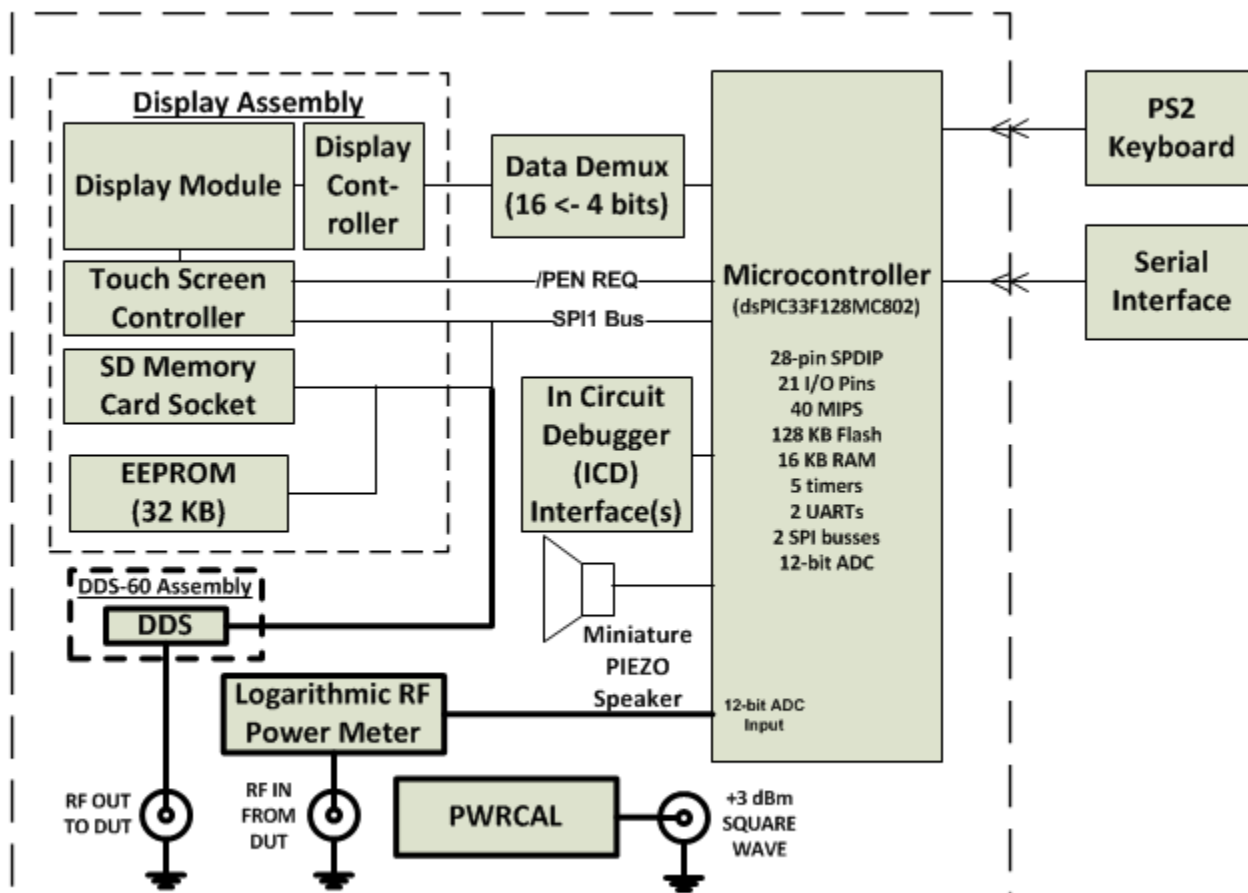




Midnight Scalar Network Analyzer



NAT-SNA: NAT-Scalar Network Analyzer Block Diagram (Version 4)

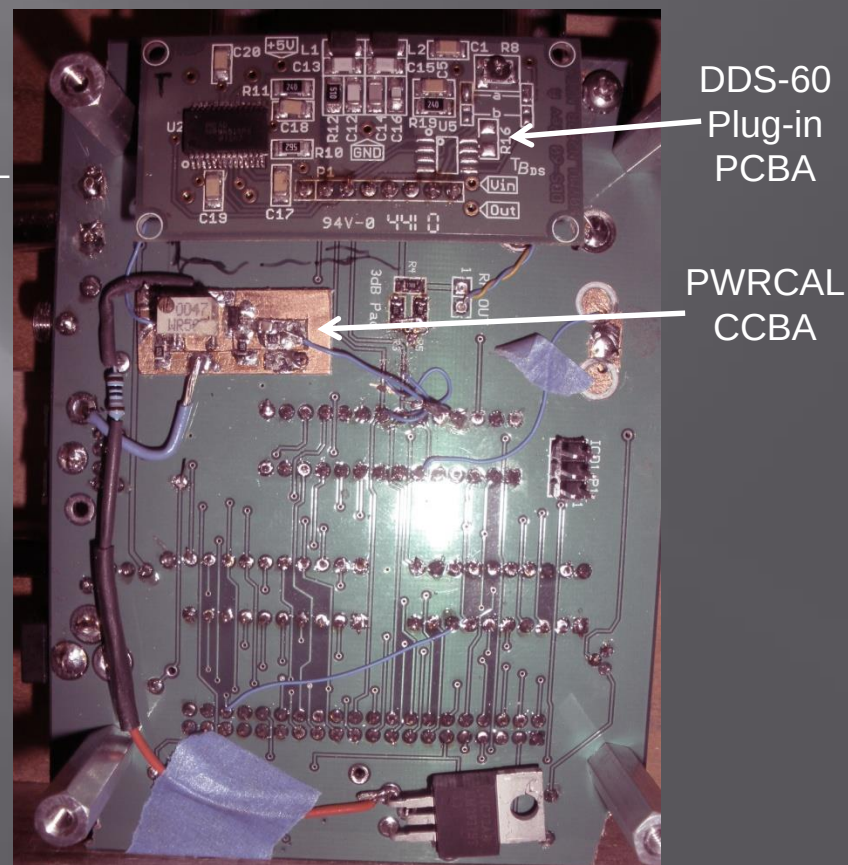
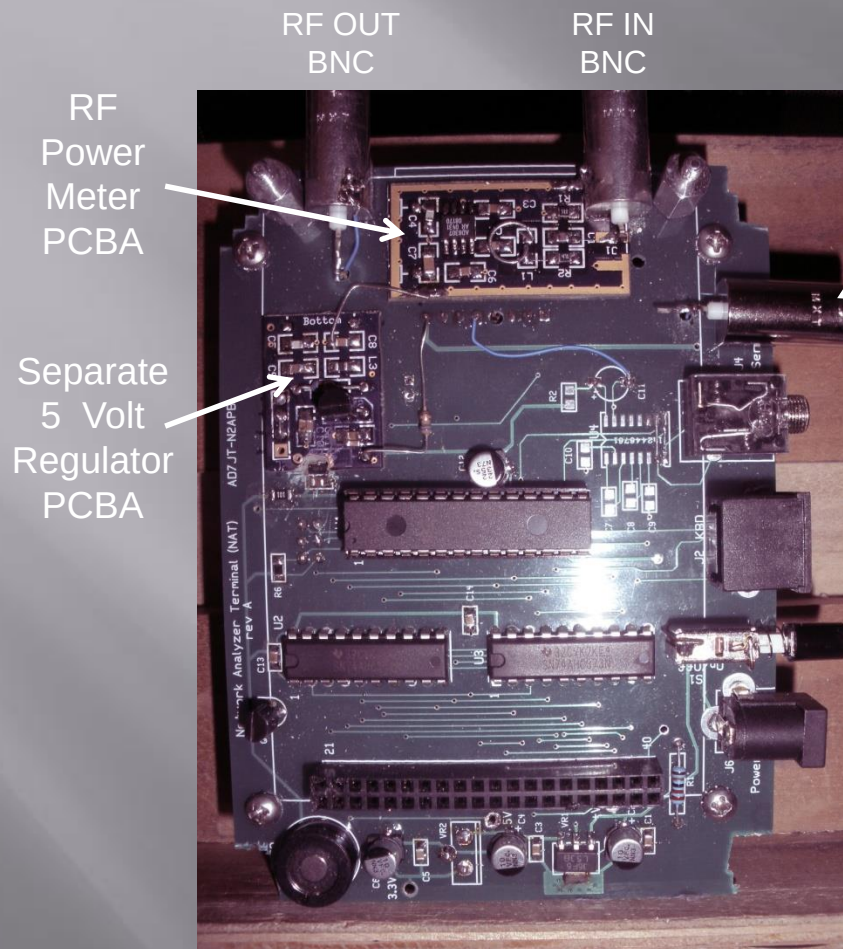




Midnight Scalar Network Analyzer



NAT to MSNA conversion



RF Power Meter by Dick Faust, K9IVB
http://www.k9ivb.net/RF_Power_Meter/



Midnight Scalar Network Analyzer



- SIGNAL GENERATOR MODE
 - Manual frequency control (1 MHz to 60+ MHz)
 - Manual and automatic power readings



F1

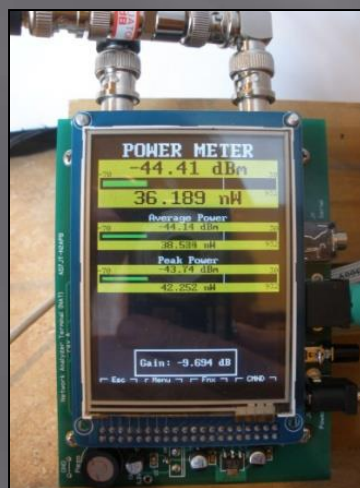




Midnight Scalar Network Analyzer



- QRP RF Power Meter
 - Power reading taken about 200 times/second (every 5 ms)
 - ~97 dBm range: -80 dBm to +20 dBm (approx.)
 - Use attenuators to shift the range
 - DDS used only for calibration
- Three Power Meters Displayed
 - Current power reading (10-point RA)
 - Average Power (200-point RA)
 - Peak Power (updated every 200 samples)

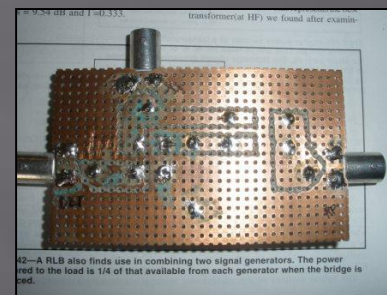
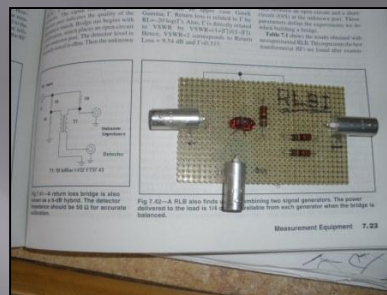
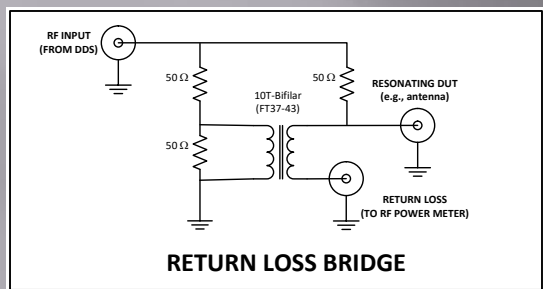




Midnight Scalar Network Analyzer

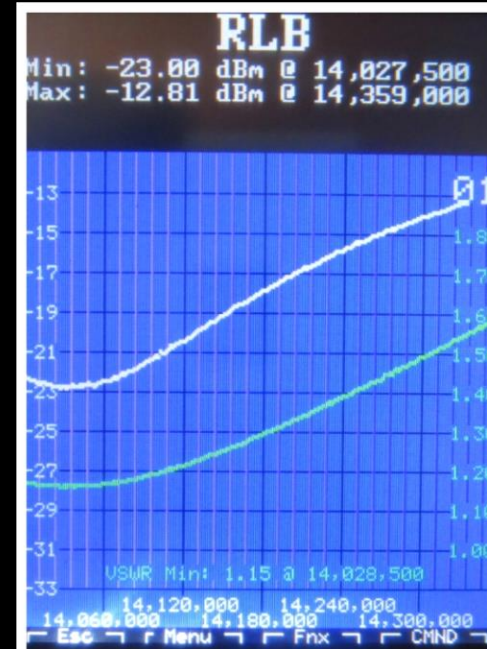


Antenna analysis with Return Loss Bridge (RLB)



```
Edit F4                               INS
AUTO DELAY(ms):
XTAL PREFIX...
...reserved...
...reserved...
OP MODES.....:V
- - - O P   M O D E S   - - -
A(1) Automatic start
R(2) Reinitialize each plot
V(3) Usur plot
W(4) overWrite existing file
S(5) Signal generator mode
E(6) External SNA Controller
P(7) Power Meter Calibration
Esc  Menu  Fnx  CMND
```

```
RLB
Freq LO (Home): 14,000,000 Hz
Freq HI (End) : 14,360,000 Hz
Start Mode: Manual
Freq Step : 500 Hz
14.000.000
Esc  Menu  Fnx  CMND
```

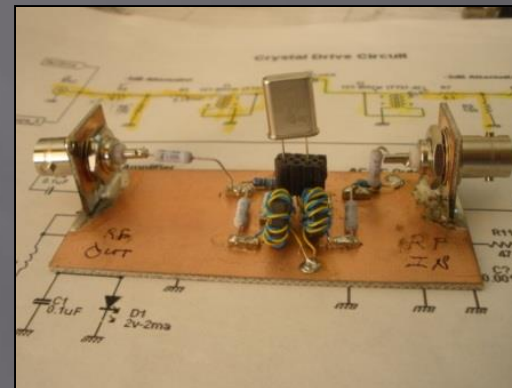
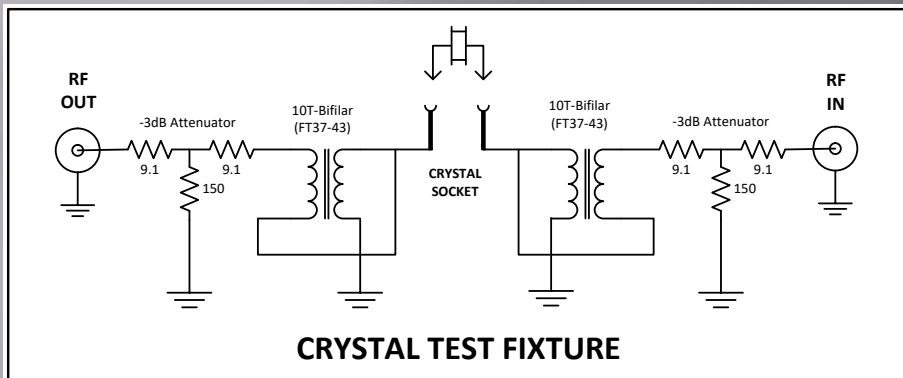




Midnight Scalar Network Analyzer

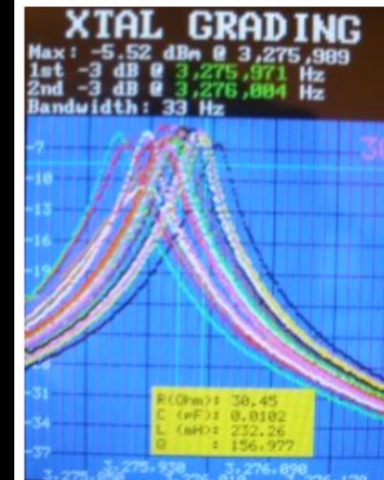
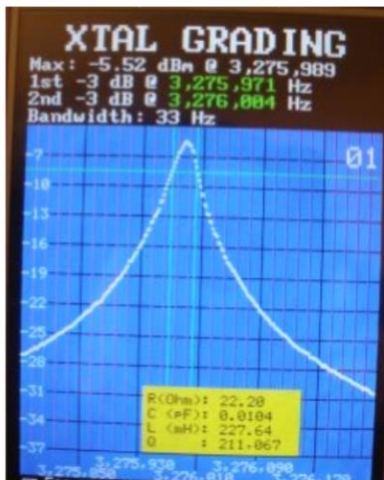


Crystal Characterization & Matching



```
Edit F3                               OUR
TITLE.....:XTAL GRADING
FILE NAME.....:X.CSU_
F LO [kHz](L2):3275.770
F HI [kHz](L3):3276.250
F ST [Hz](L4):1
ROWS      (02):401
PLX FLAG  (03):
CENTER FREQ :3276.01
CUSTOM CELL-3 :
CUSTOM CELL-2 :
CUSTOM CELL-1 :
CUSTOM CELL-0 :
```

```
Edit F3                               INS
AUTO DELAY(ns):
XTAL PREFIX...:X
...reserved...
...reserved...
OP MODES.....:M
--- O P M O D E S ---
A(1) Automatic start
R(2) Reinitialize each plot
U(3) User plot
M(4) overWrite existing file
S(5) Signal generator mode
E(6) External SNA Controller
P(7) Power Meter Calibration
```

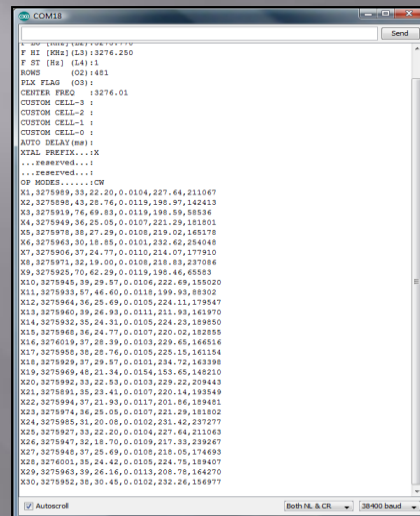




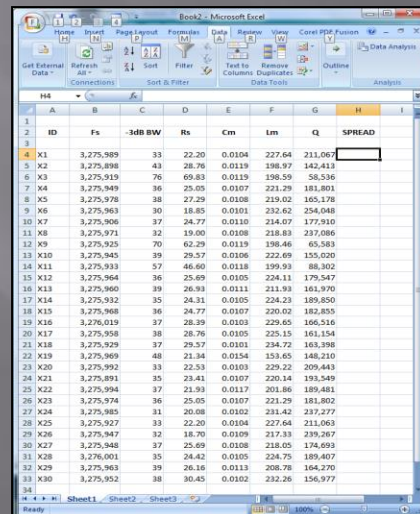
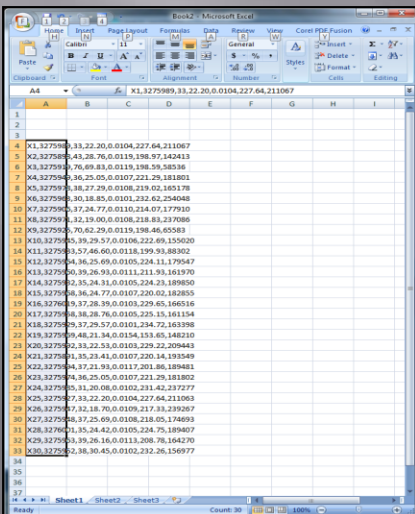
Midnight Scalar Network Analyzer



Crystal Characterization & Matching (cont.)



Book1 - Microsoft Excel									
H28									
=B33:B28									
	A	B	C	D	E	F	G	H	I
1	ID	Fs	-3dB BW	Rs	Cm	Lm	Q	SPREAD	
2	X21	3,275,891	35	23.41	0.0107	220.14	193,549	128	
3	X2	3,275,898	43	28.76	0.0119	198.97	142,413		
4	X7	3,275,906	37	24.77	0.0110	214.07	177,910		
5	X10	3,275,945	39	29.57	0.0106	222.69	155,020		
6	X28	3,276,001	35	24.42	0.0105	224.75	189,407		
7	X16	3,276,019	37	28.39	0.0103	229.65	166,516		
8	X23	3,275,974	36	25.05	0.0107	221.29	181,802		
9	X5	3,275,978	38	27.29	0.0108	219.02	165,178		
10	X24	3,275,985	31	20.08	0.0102	231.42	237,277		
11	X1	3,275,989	33	22.20	0.0104	227.64	211,067		
12	X20	3,275,992	33	22.53	0.0103	229.22	209,443		
13	X22	3,275,994	37	21.93	0.0117	201.86	189,481		
14	X3	3,275,919	76	69.83	0.0119	198.59	58,536		
15	X9	3,275,925	70	62.29	0.0119	198.46	65,583		
16	X25	3,275,927	33	22.20	0.0104	227.64	211,063		
17	X18	3,275,929	37	29.57	0.0101	234.72	163,398		
18	X14	3,275,932	35	24.31	0.0105	224.23	189,850		
19	X11	3,275,933	57	46.60	0.0118	199.93	88,302		
20	X26	3,275,947	32	18.70	0.0109	217.33	239,267		
21	X27	3,275,948	37	25.69	0.0108	218.05	174,693		
22	X4	3,275,949	36	25.05	0.0107	221.29	181,801		
23	X30	3,275,952	38	30.45	0.0102	232.26	156,977		
24	X13	3,275,958	38	28.76	0.0105	225.15	161,154		
25	X17	3,275,960	39	26.93	0.0111	211.93	161,970		
26	X6	3,275,963	30	18.85	0.0101	232.62	254,048		
27	X29	3,275,963	39	26.16	0.0113	208.78	164,270		
28	X12	3,275,964	36	25.69	0.0105	224.11	179,547		
29	X15	3,275,968	36	24.77	0.0107	220.02	182,855		
30	X19	3,275,969	48	21.34	0.0154	153.65	148,210		
31	X8	3,275,971	32	19.00	0.0108	218.83	237,086		

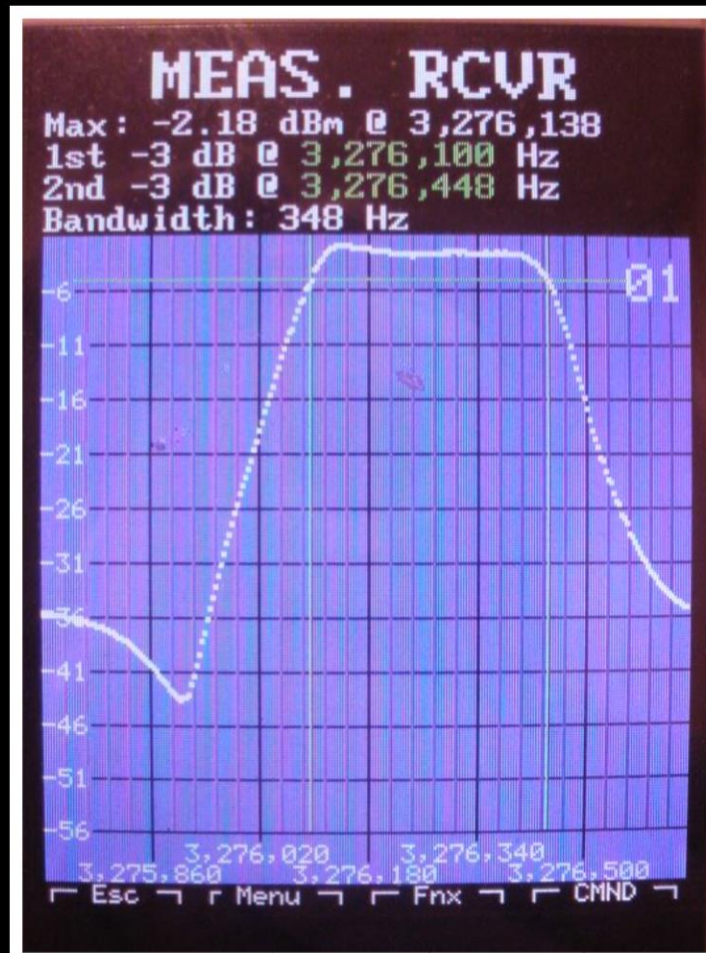
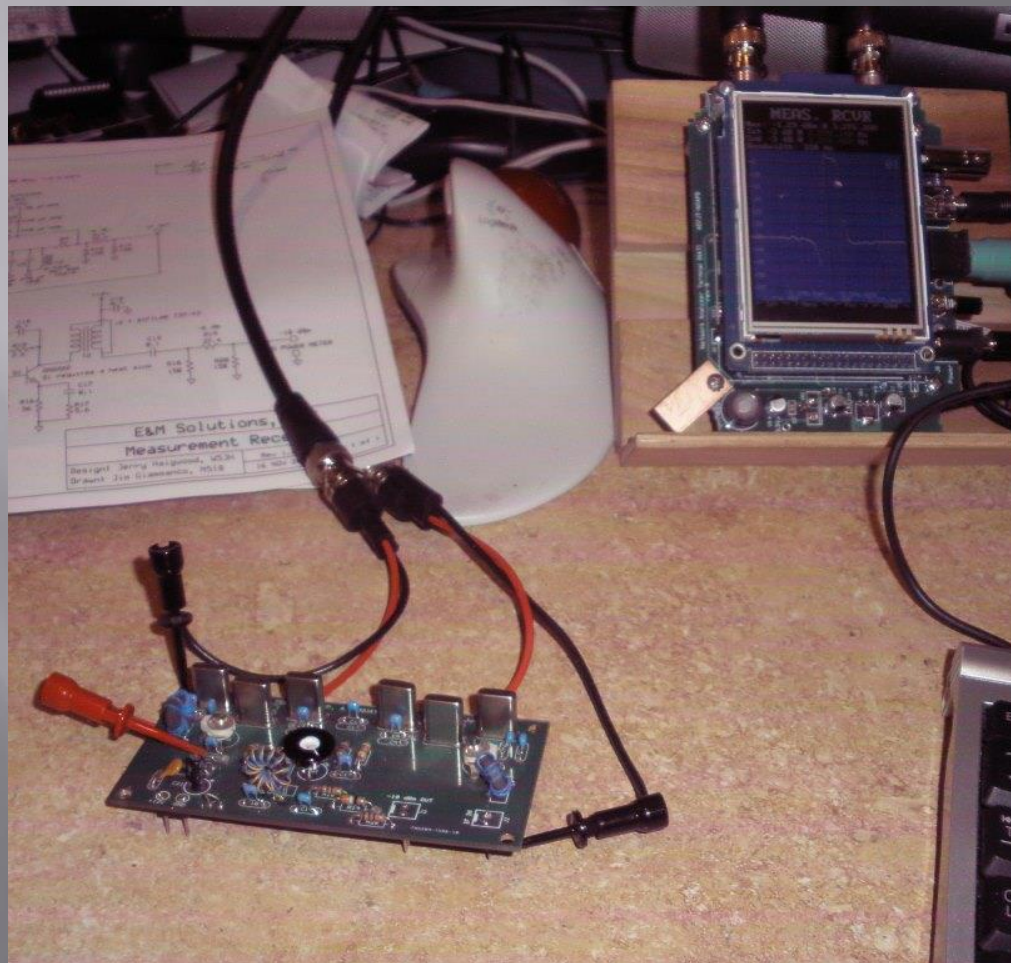




Midnight Scalar Network Analyzer



Crystal Characterization & Matching (cont.)



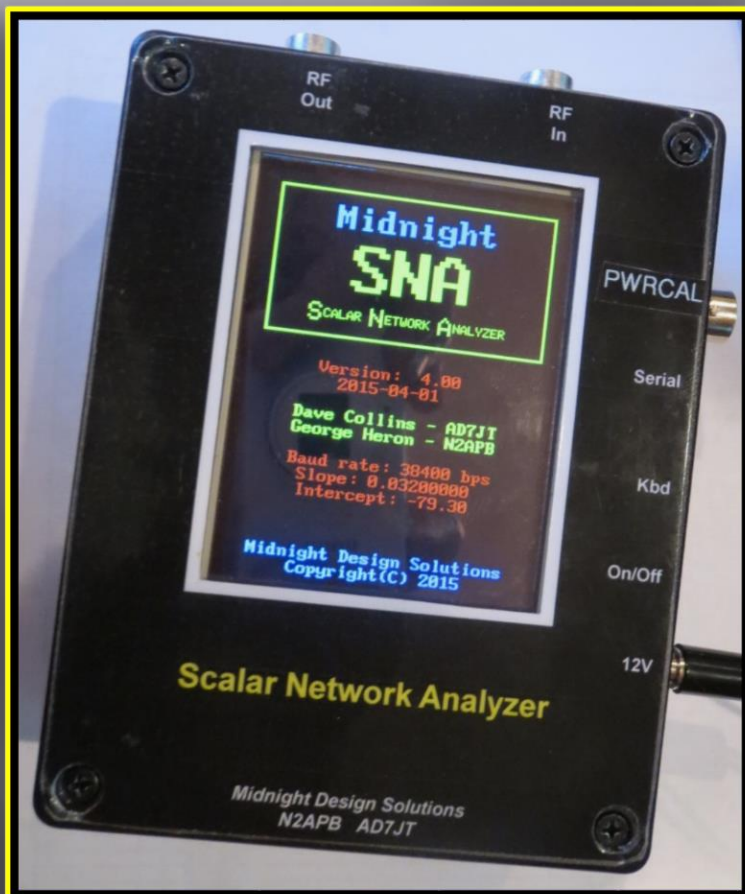


Midnight Scalar Network Analyzer



Feature Summary

- Handheld instrument for making “scalar measurements”
... incident, reflected & transmitted signal magnitudes are measured to determining results.
- Useful for:
 - Testing and evaluating filters
 - Measuring crystal parameters
 - Return Loss Measurement
 - VSWR and antenna tuning
 - Measuring QRP transmit power
- Provides 0 dBm signal reference output
- QRP Power Meter functions
 - Current power
 - Peak power
 - Average power
- User calibration achieved with just a DVM
- Continuous/repeated operation options
- 3.2", 240 x 320, 16-bit color graphic LCD display
- Touch panel & Keyboard as input devices
- Field upgradable firmware
- Serial port connection to other devices
- EEPROM for storing settings & options
- SD Card storage up to 1 GB provides:
 - Data spooling and playback
 - Calibration data storage and reloading
 - Direct data exchange with Windows and Linux apps
- DOS-like commands to manage and playback data files





Midnight Scalar Network Analyzer



References:

- <http://www.midnightdesignsolutions.com/nat>
- <https://groups.yahoo.com/neo/groups/NAT-SNA/info>
- <https://groups.yahoo.com/neo/groups/PHSNA/info>

Contacts:

- Dave - ad7jt@dnbrealty.com
- George - n2apb@midnightdesignsolutions.com

QUESTIONS?

COMMENTS?

CRITIQUES?



Midnight Scalar Network Analyzer



□ Time for a little math

- Gain ratio = P_{out}/P_{in}
- Gain (dB) = $10 \log(P_{out}/P_{in})$
- Gain (dBm) = $10 \log(P_{out}/.001) = 10 \log(P_{out} \times 1000)$
 $= 10 (\log(P_{out}) + \log(1000)) = 10 \log(P_{out}) + 30$
- Short circuit gain = $10 \log(P_{in}/P_{in}) = 10 \log(1) = 0$
for any P_{in}
- Gain (dBm) = $10 \log(P_{in}) - d$
where:
 P_{in} = power meter reading in mw
 d = short circuit gain reading in mw
- DDS output level varies with frequency (due to $\sin(x)/x$ sampling effect) therefore d is a function of frequency: $d(f)$

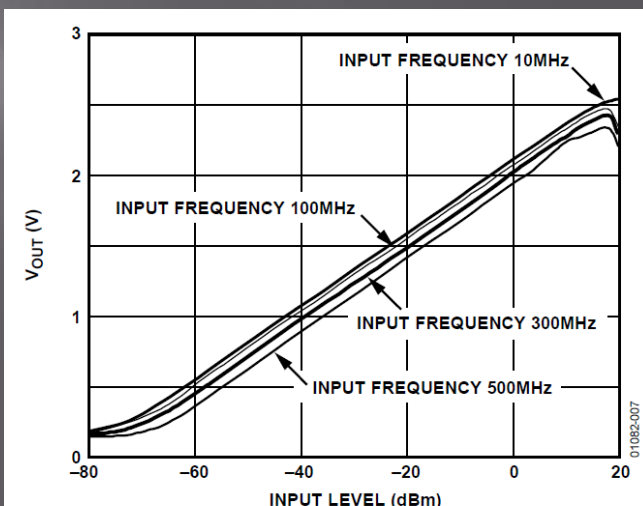


Figure 7. V_{OUT} vs. Input Level (dBm) at Various Frequencies