DEMONSTARTION OF SWEPT FREQUENCY TECHNIQUES FOR AM ANTENNA SYSTEM MEASUREMENTS

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Network Analyzers

- Swept Frequency Reference Signal With Three Receivers
- Comparison of Relative Phase and Magnitude Between Receivers
- Computational Interface to Display Information in SWR, Return Loss, Complex Impedance (Resistance and Reactance), Response (Magnitude and Phase), S Parameters, Etc…

Types of Network Analyzers

- Two Port
  - Has directional couplers built-in
    - HP8711 – HP8712 – HP8753E and others.
- Four Port
  - Requires a test set with directional couplers
    - HP8753C – HP4395A and others
- For AM testing we need Four Port

Network Analyzers and AM

- Challenge to use in a Broadcast Environment - Operate in mV Range
  - Interference
  - Receiver overload
  - No higher power directional couplers for Medium Wave (MW 300 kHz – 3 MHz)
  - Did not care that much about bandwidth.

Network Analyzers and AM

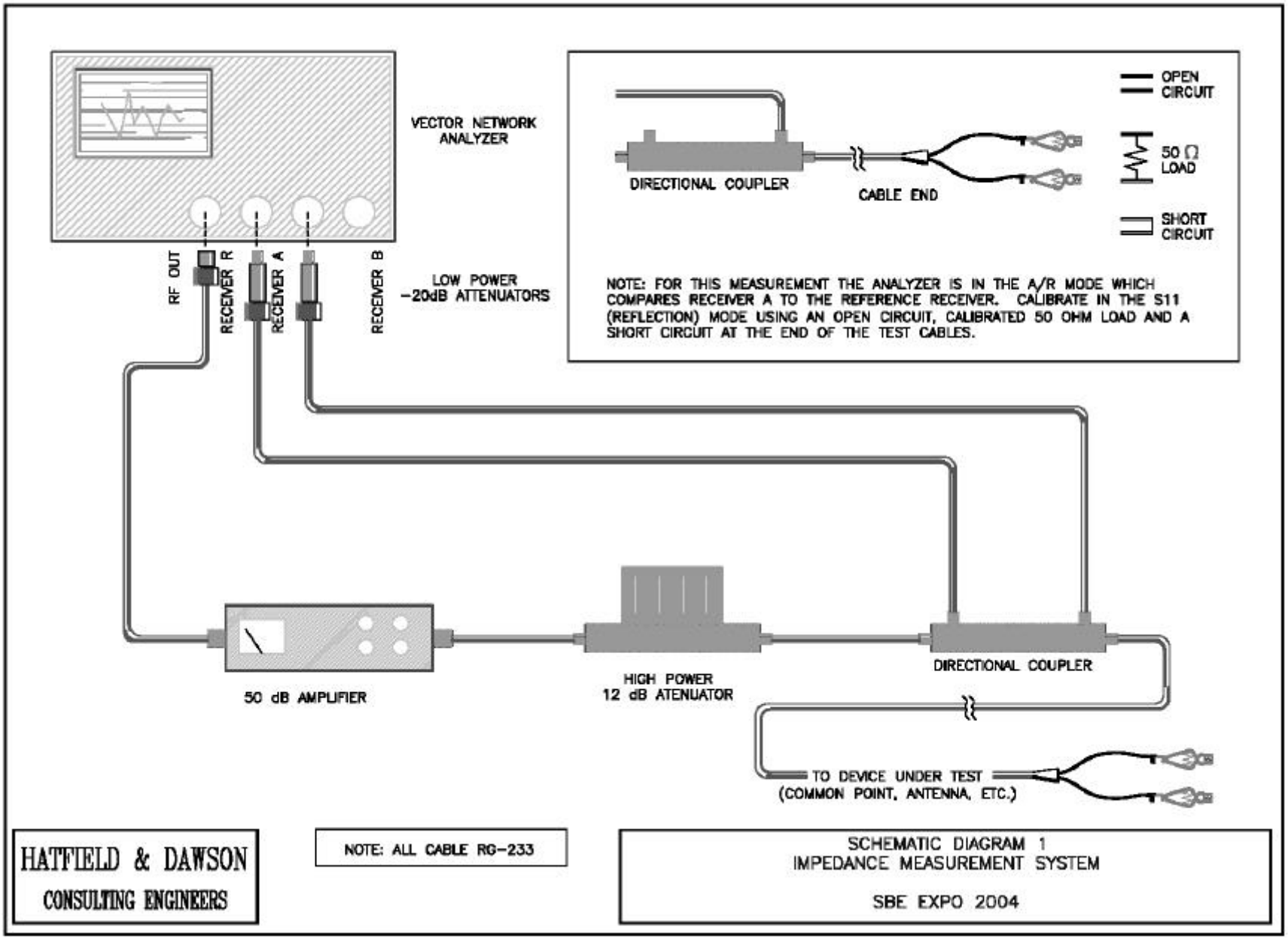
- Solutions to Working the Broadcast Environment
  - Use of Amplifier to Overcome Interference
  - Rackley's Higher Power Directional Coupler
  - Attenuators Reduces Receiver Overload
  - With IBOC We Care More About Bandwidth

Test Setups

- Impedance Measurements
- Operating Impedance Measurements
- Sample System Measurements and Thus Pattern Bandwidth
- Network Response (phase delay)
- Filter Setup

Advantages To Bridge Measurements

- Swept Frequencies
- Speed of Measurements
- Near Real Time Measurements
- Measurements Can be Read by a Non-expert User
- Graphically See on Smith Chart as Adjustments are Made
- Nice Charts for Reports



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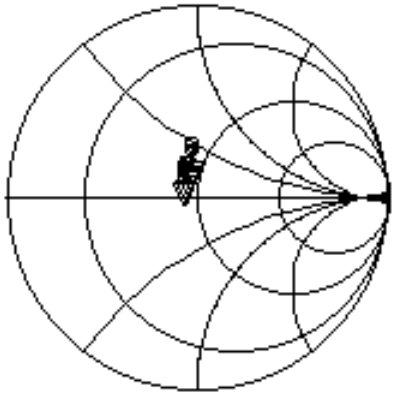
NOTE: ALL CABLE RG-233

SCHEMATIC DIAGRAM 1
IMPEDANCE MEASUREMENT SYSTEM

SBE EXPO 2004

CH1 A/R FScl 1 U 47.011 Ω 7.1316 Ω 1.41 uH

805 kHz



C?

Avg
16

↑

IF BW 1 kHz
START 805 kHz

POWER -2.6 dBm

SWP 789.9 msec
STOP 835 kHz

SELECT LETTER

SPACE

BACK SPACE

ERASE TITLE

DONE

STOR DEV [DISK]

CANCEL

N	SWP PARAM	VAL	AUX	EXTRA
0	805 kHz	47.011 Ω	7.1316 Ω	1.41 uH
1	810 kHz	47.023 Ω	5.1431 Ω	1.0106 uH
2	815 kHz	46.785 Ω	3.2423 Ω	633.16 nH
3	820 kHz	46.713 Ω	1.8994 Ω	368.66 nH
4	825 kHz	45.574 Ω	-473.86 mΩ	407.12 nF
5	830 kHz	44.48 Ω	-2.1438 Ω	89.446 nF
6	835 kHz	43.191 Ω	-3.597 Ω	52.99 nF

CH1 A/R FScl 199.4 mU 43.514 Ω -6.4745 Ω 30.537 nF

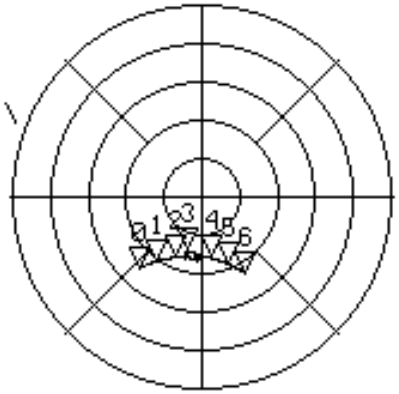
805 kHz VV.TIF

C? CURRENT DIRECTORY: \

WOSU.STA

Avg
16

WOSUDAY
.TIF



↑

IF BW 1 kHz
START 805 kHz

POWER -3 dBm

SWP 789.9 msec
STOP 835 kHz

N	SWP PARAM	VAL	AUX	EXTRA
0	805 kHz	43.514 Ω	-6.4745 Ω	30.537 nF
1	810 kHz	45.194 Ω	-6.0706 Ω	32.367 nF
2	815 kHz	46.885 Ω	-5.9247 Ω	32.961 nF
3	820 kHz	48.278 Ω	-5.2893 Ω	36.695 nF
4	825 kHz	50.527 Ω	-6.438 Ω	29.965 nF
5	830 kHz	52.339 Ω	-7.3765 Ω	25.995 nF
6	835 kHz	54.002 Ω	-8.6905 Ω	21.933 nF

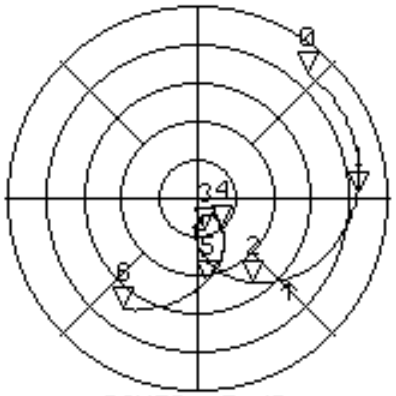
NEXT
FILES

STOR DEV
[DISK]

CH1 S11 FScl 100 mU

55.581 Ω 7.2166 Ω 1.4268 uH

805 kHz



Cor

Avg
24

IF BW 300 Hz
START 805 kHz

POWER 5 dBm

SWP 2.967 sec
STOP 835 kHz

N	SWP PARAM	VAL	AUX	EXTRA
0	805 kHz	55.581 Ω	7.2166 Ω	1.4268 uH
1	810 kHz	59.068 Ω	361.26 mΩ	70.983 nH
2	815 kHz	52.803 Ω	−4.652 Ω	41.979 nF
3	820 kHz	50.352 Ω	−1.6175 Ω	119.99 nF
4	825 kHz	51.238 Ω	−1.577 Ω	122.33 nF
5	830 kHz	50.268 Ω	−4.3506 Ω	44.075 nF
6	835 kHz	45.936 Ω	−5.3405 Ω	35.69 nF

SELECT LETTER

SPACE

BACK SPACE

ERASE TITLE

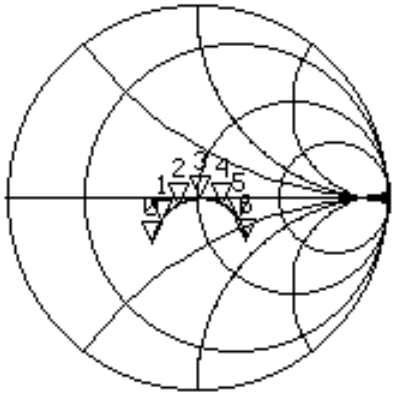
DONE

STOR DEV [DISK]

CANCEL

CH1 A/R FScl 1 U 27.762 Ω -15.27 Ω 16.676 nF

625 kHz



Cor

Avg
16

↑

IF BW 30 kHz
CENTER 640 kHz

POWER 0 dBm

SWP 72.36 msec
SPAN 30 kHz

N	SWP PARAM	VAL	AUX	EXTRA
0	625 kHz	27.762 Ω	−15.27 Ω	16.676 nF
1	630 kHz	33.056 Ω	−8.4093 Ω	30.041 nF
2	635 kHz	40.716 Ω	−2.8911 Ω	86.693 nF
3	640 kHz	51.418 Ω	−417 mΩ	596.35 nF
4	645 kHz	64.383 Ω	−4.1849 Ω	58.963 nF
5	650 kHz	74.761 Ω	−17.403 Ω	14.07 nF
6	655 kHz	73.097 Ω	−37.137 Ω	6.5429 nF

SELECT LETTER

SPACE

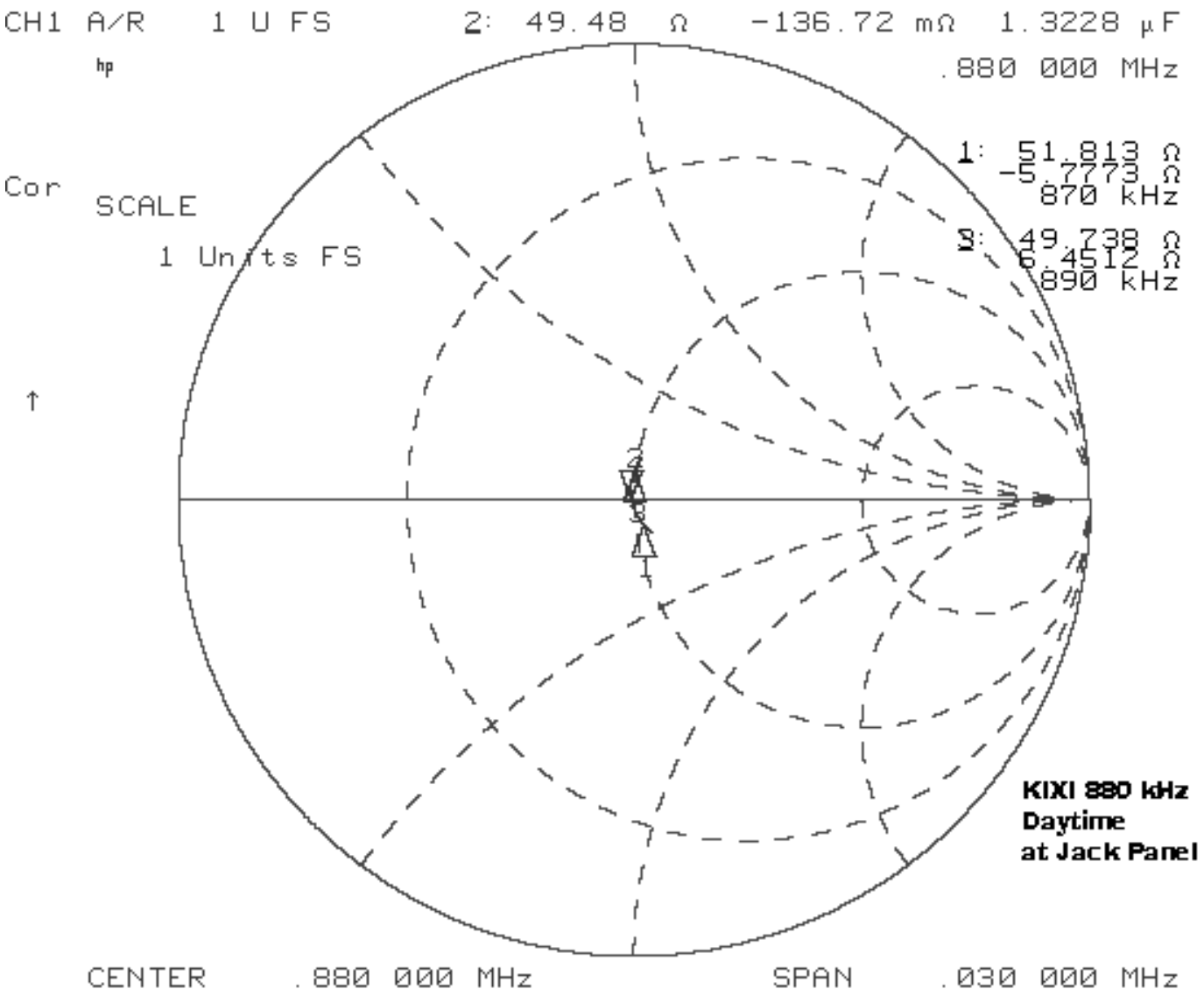
BACK SPACE

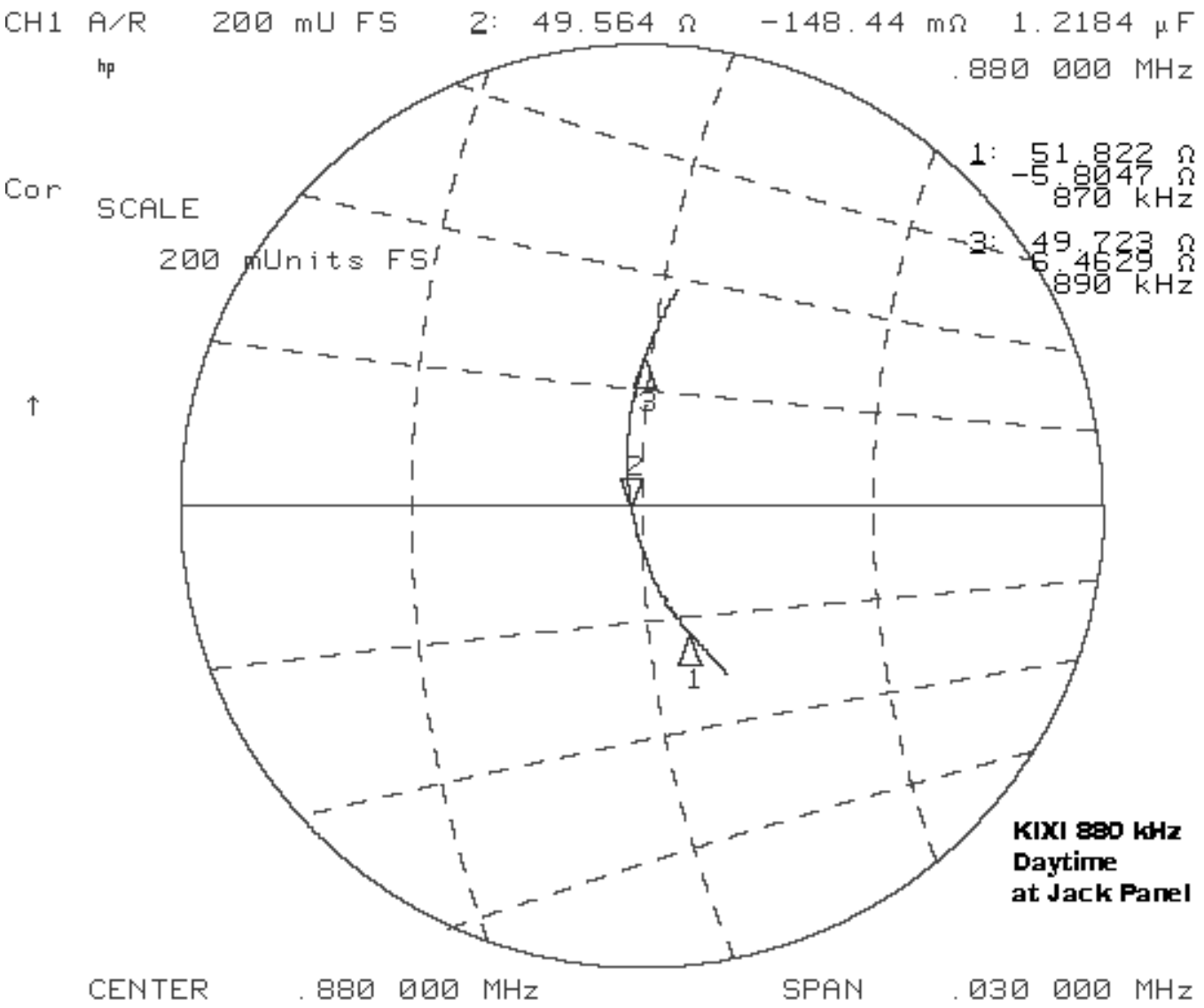
ERASE TITLE

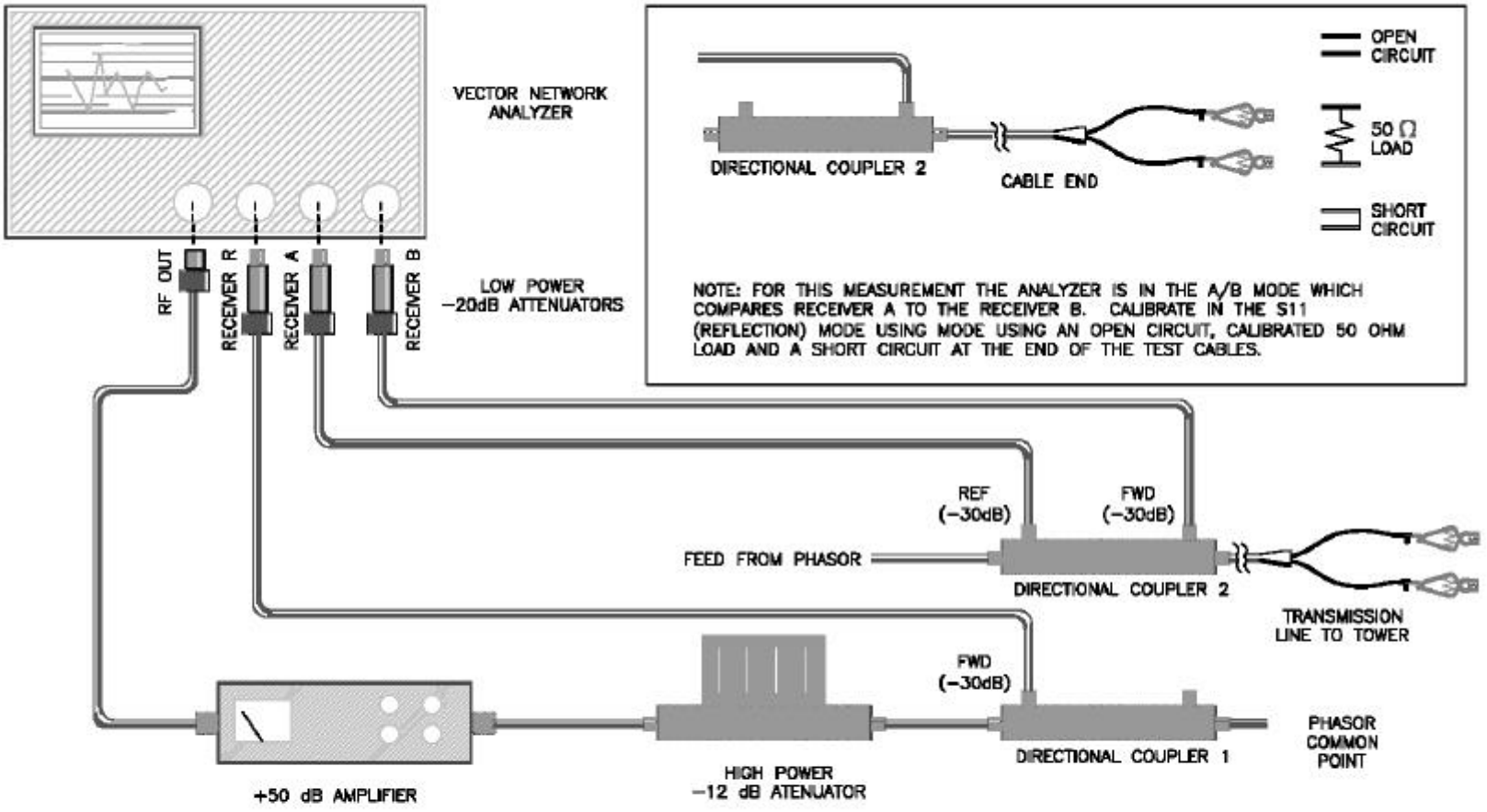
DONE

STOR DEV [DISK]

CANCEL


CH1 A/R 1 U FS
2: 49.48 Ω -136.72 mΩ 1.3228 µF
.880 000 MHz
Cor
SCALE
1 Units FS
1: 51.813 Ω
-5.773 Ω
870 kHz
3: 49.738 Ω
6.4512 Ω
890 kHz
KIXI 880 kHz
Daytime
at Jack Panel
CENTER .880 000 MHz
SPAN .030 000 MHz


CH1 A/R 200 mU FS 2: 49.564 Ω -148.44 mΩ 1.2184 µF
hp
.880 000 MHz
1: 51.822 Ω
-5.8047 Ω
870 kHz
3: 49.723 Ω
-6.4629 Ω
890 kHz
Cor
SCALE
200 mUnits FS
KIXI 880 kHz
Daytime
at Jack Panel
CENTER .880 000 MHz
SPAN .030 000 MHz



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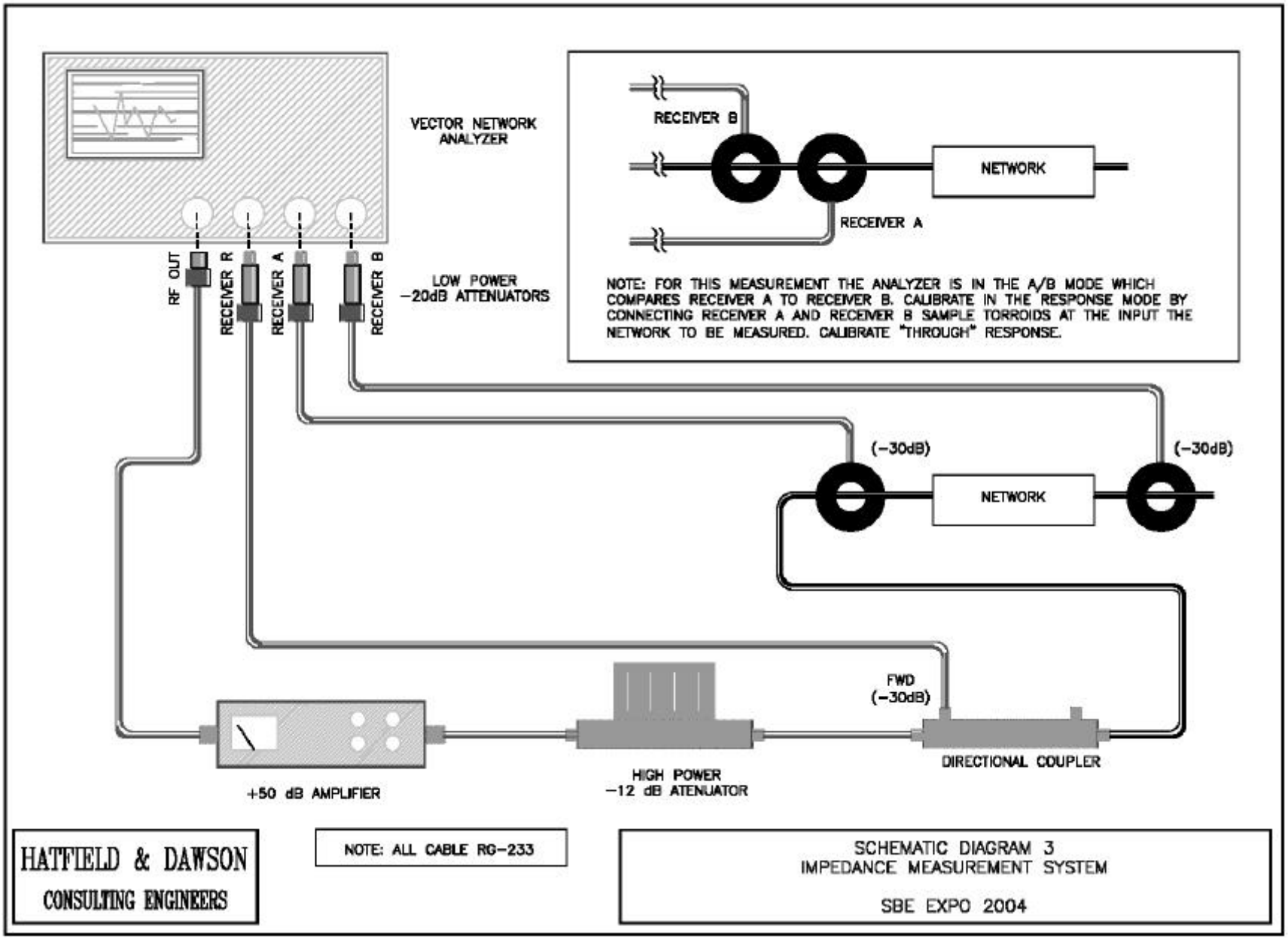
SCHEMATIC DIAGRAM 2
IMPEDANCE MEASUREMENT SYSTEM

SBE EXPO 2004


VECTOR NETWORK ANALYZER
RF OUT
RECEIVER R
RECEIVER A
RECEIVER B
LOW POWER
−20dB ATTENUATORS
RECEIVER B
NETWORK
RECEIVER A
NOTE: FOR THIS MEASUREMENT THE ANALYZER IS IN THE A/B MODE WHICH COMPARES RECEIVER A TO RECEIVER B. CALIBRATE IN THE RESPONSE MODE BY CONNECTING RECEIVER A AND RECEIVER B SAMPLE TORROIDS AT THE INPUT THE NETWORK TO BE MEASURED. CALIBRATE "THROUGH" RESPONSE.
(−30dB)
NETWORK
(−30dB)
FWD
(−30dB)
+50 dB AMPLIFIER
HIGH POWER
−12 dB ATENUATOR
DIRECTIONAL COUPLER
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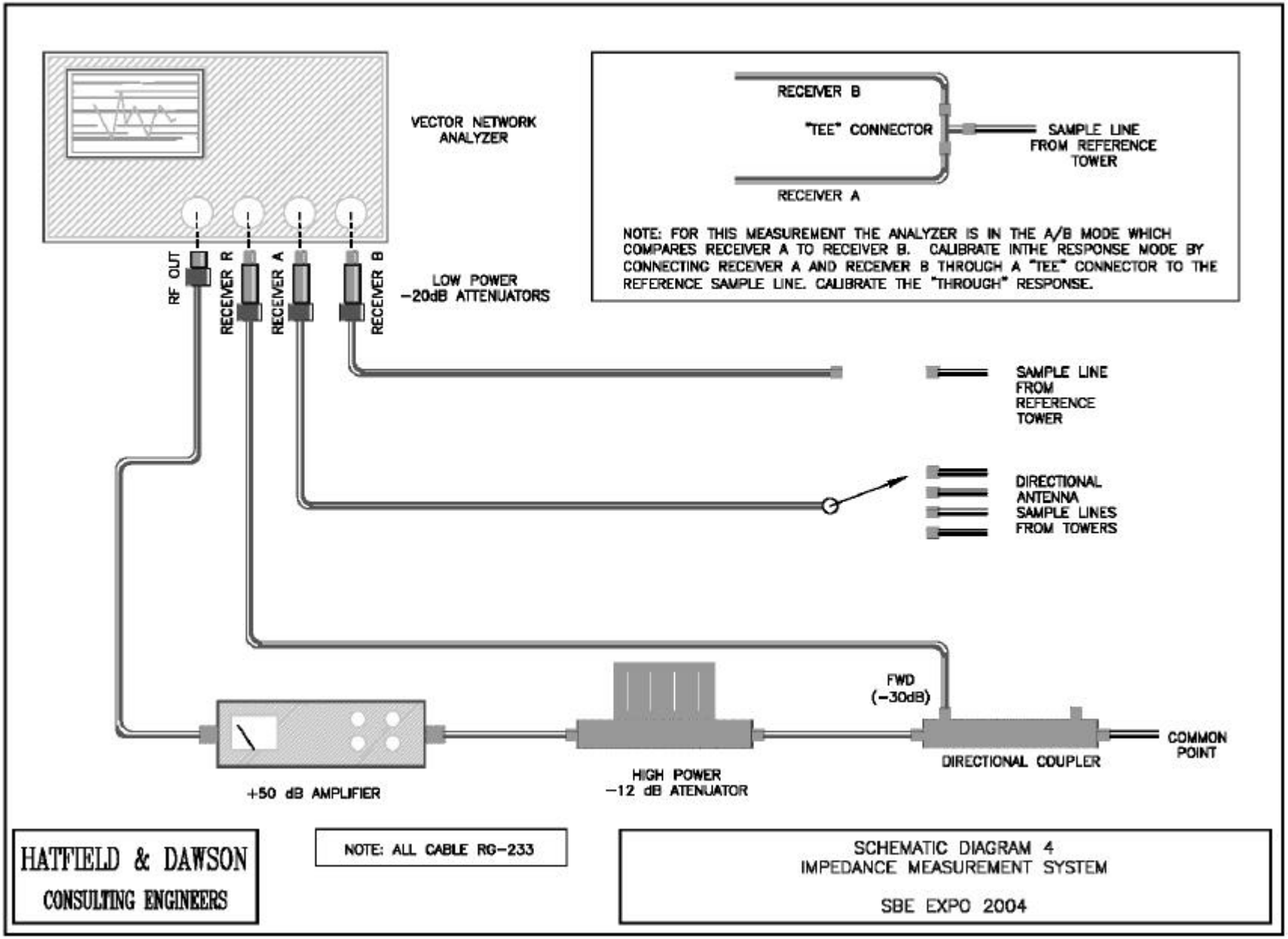
NOTE: ALL CABLE RG−233
SCHEMATIC DIAGRAM 3
IMPEDANCE MEASUREMENT SYSTEM
SBE EXPO 2004



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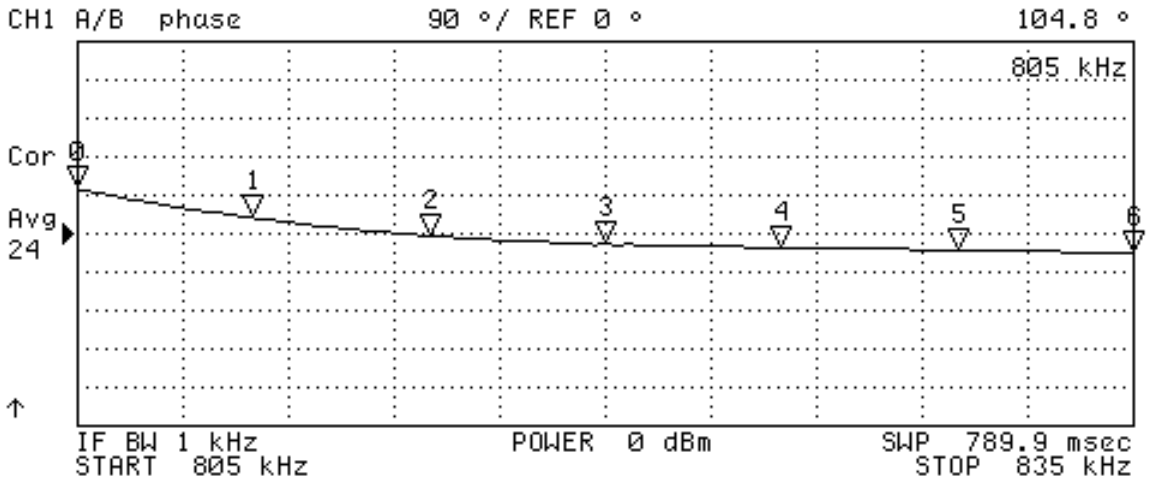
NOTE: ALL CABLE RG-233

SCHEMATIC DIAGRAM 4
IMPEDANCE MEASUREMENT SYSTEM

SBE EXPO 2004



SELECT LETTER

SPACE

BACK SPACE

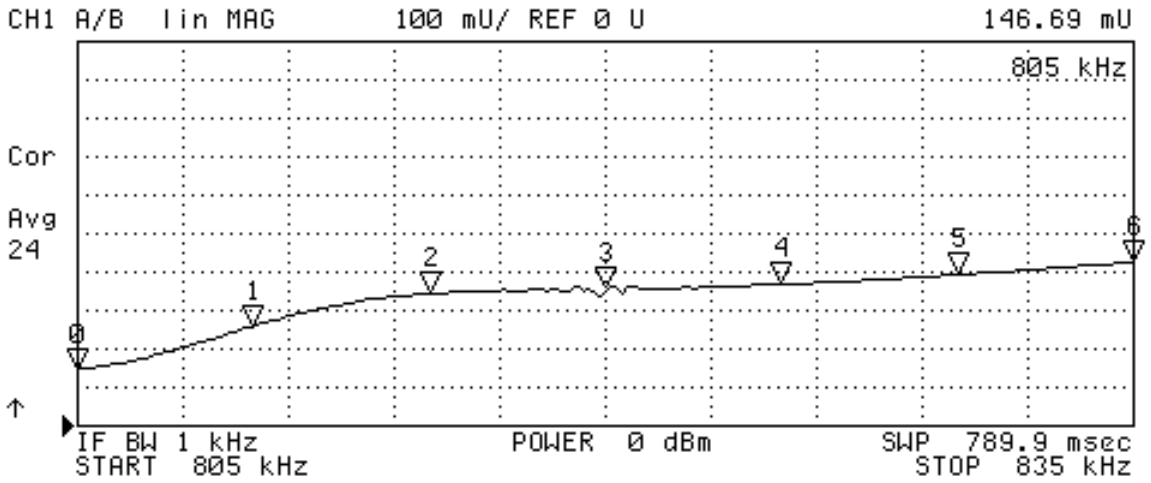
ERASE TITLE

N	SWP PARAM	VAL
0	805 kHz	104.8 °
1	810 kHz	37.203 °
2	815 kHz	-4.232 °
3	820 kHz	-24.943 °
4	825 kHz	-32.181 °
5	830 kHz	-38.319 °
6	835 kHz	-45.274 °

DONE

STOR DEV [DISK]

CANCEL



SELECT LETTER

SPACE

BACK SPACE

ERASE TITLE

N	SWP PARAM	VAL
0	805 kHz	146.69 mU
1	810 kHz	258.27 mU
2	815 kHz	344.71 mU
3	820 kHz	355.55 mU
4	825 kHz	368.39 mU
5	830 kHz	393.92 mU
6	835 kHz	425.08 mU

DONE

STOR DEV [DISK]

CANCEL

Resources

- *Swept Frequency Techniques for Evaluation AM Antenna System Bandwidth* – Ronald D. Rackely, P.E. NAB Broadcast Engineering Proceedings 2003
- *Evaluation and Improvement of AM Antenna Characteristics for Optimal Digital Performance* – Ronald D. Rackely, P.E. NAB Broadcast Engineering Proceedings 2003
- *Exploring the Architectures of Network Analyzers* – Agilent AN 1287-2 Application Note
- *Applying Error Correction to Network Analyzer Measurements* – Agilent AN 1287-3
- *Using a Network Analyzer to Characterize High-Power Components* – Agilent AN 1287-6
- *Electronic Applications of the Smith Chart* – Phillip H. Smith

Hands On Time…
Questions ?