NRSC REPORT

NATIONAL RADIO SYSTEMS COMMITTEE

NRSC-R34
High-speed Subcarrier (Digital) HSSC Field Test Report
August 7, 1997

Part II - Appendices

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Published by
CONSUMER ELECTRONICS ASSOCIATION
Technology & Standards Department
1919 S. Eads St.
Arlington, VA 22202

NATIONAL ASSOCIATION OF BROADCASTERS
Science and Technology Department
1771 N Street, NW
Washington, DC 20036

FOREWORD

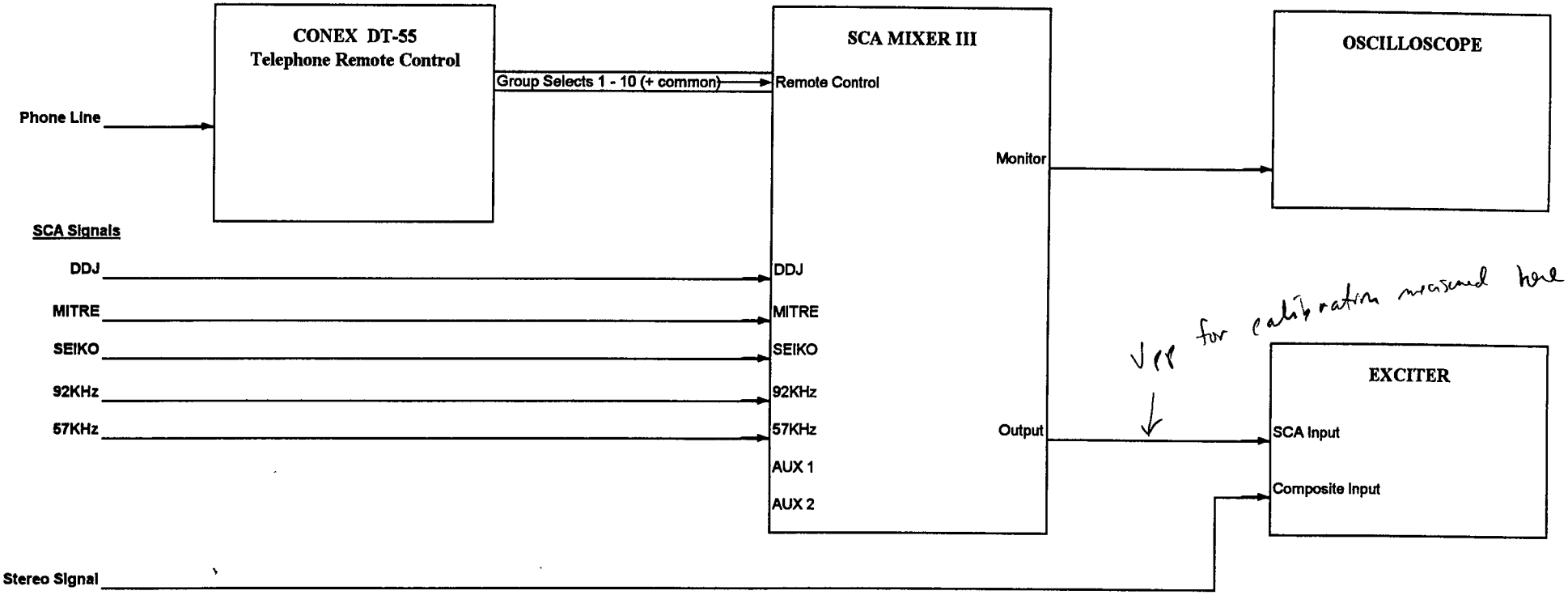
NRSC-R34, High-speed Subcarrier (Digital) HSSC Field Test Report, is the second of three test reports submitted to the NRSC's High-Speed FM Subcarrier (HSSC) Subcommittee. Three digital FM subcarrier systems were evaluated during these tests—DARC (submitted by Digital DJ, Inc.), STIC (submitted by Mitre Corporation), and HSDS (submitted by Seiko, Inc.). The co-chairmen of the HSSC Subcommittee at the time of the submission of NRSC-R34 were Michael Rau and David Kelly. The NRSC Chairman at the time of the submission of NRSC-R34 was Charles Morgan.

The NRSC is jointly sponsored by the Consumer Electronics Association and the National Association of Broadcasters. It serves as an industry-wide standards-setting body for technical aspects of terrestrial over-the-air radio broadcasting systems in the United States.

Appendix A

SCA Connection Overview

Digital Radio Test Laboratory



NRSC HSSC Field Test

SCA CONNECTION OVERVIEW

SCA MIXER III
1/97
RMc

Digital Radio Test Laboratory

EIA SCA MIXER III
Nov-96
RMc

(see updated sheet)

SCA Group Chart
Dial numbers are selected telephone numbers (DTMF tones) for use with the Conex DT 55 remote control unit
Relays in the remote control unit control the select lines of the SCA Mixer
Dial numbers correspond to Group numbers (in block dia.)
No entry (in chart) = OFF

CONEX com control

Group No.	Off	1	2	3	4	5	6	7	8	9	10	
Dial Number	###	#1	#2	#3	#4	#5	#6	#7	#8	#9	#0	
SCA Inject. (%)	0	10	10	13	10	13	20	10	13	20	NA	
AUX 1	10										ON	AUX 1
Digital DJ	~~10~~ 4 ~~10~~			ON	ON							Digital DJ
MITRE	10					ON	ON	ON				MITRE
Seiko	10								ON	ON	ON	Seiko
57KHz	3		ON		ON		ON	ON		ON	ON	ON	57KHz
92KHz	7		ON					ON			ON	ON	92KHz

Procedure;

1) Mixer must be in Remote Mode
2) Dial up remote control
3) Enter Password (EIA1)
4) Enter ### (turns all relays OFF)
5) Enter (#) + (desired group number)
   When test is complete;
6) Enter ### (turns all relays OFF)
7) At the completion of all tests;
   Enter *#* for hang up

Dial up Phone Codes;

(No.) Number only = monentary relay ON (for duration of key depression)
(#) + (No.) = Relay ON
(##) + (No.) = Relay OFF
(###) = All relays OFF
(*#*) = Unconditional Hang Up
(*) = Clear command
(***) + (No.) will return the status of the associated relay with tones

Note:
DT 55 is configured for "Interlock Mode" of operation.
Only one relay (Group) at a time is permitted to be on

SCA MIXER III
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7-14

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SCA Group Chart
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Dial numbers correspond to Group numbers (in block dia.)
No entry (in chart) = OFF

(Conex can control 10 channels)

Group No.		Off	1	2	3	4	5	6	7	8	9	10	
Dial Number		###	#1	#2	#3	#4	#5	#6	#7	#8	#9	#0	
SCA Inject. (%)		0	10	10	13	10	13	20	10	13	20	NA	
AUX 1	10											ON	**AUX 1**
Digital DJ	10			ON	ON								**Digital DJ**
MITRE	10					ON	ON	ON					**MITRE**
Seiko	10								ON	ON	ON		**Seiko**
57KHz	3		ON		ON		ON	ON		ON	ON	ON	**57KHz**
92KHz	7		ON					ON			ON	ON	**92KHz**

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3) Enter Password (EIA1)
4) Enter ### (turns all relays OFF)
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7) At the completion of all tests:
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Only one relay (Group) at a time is permitted to be on

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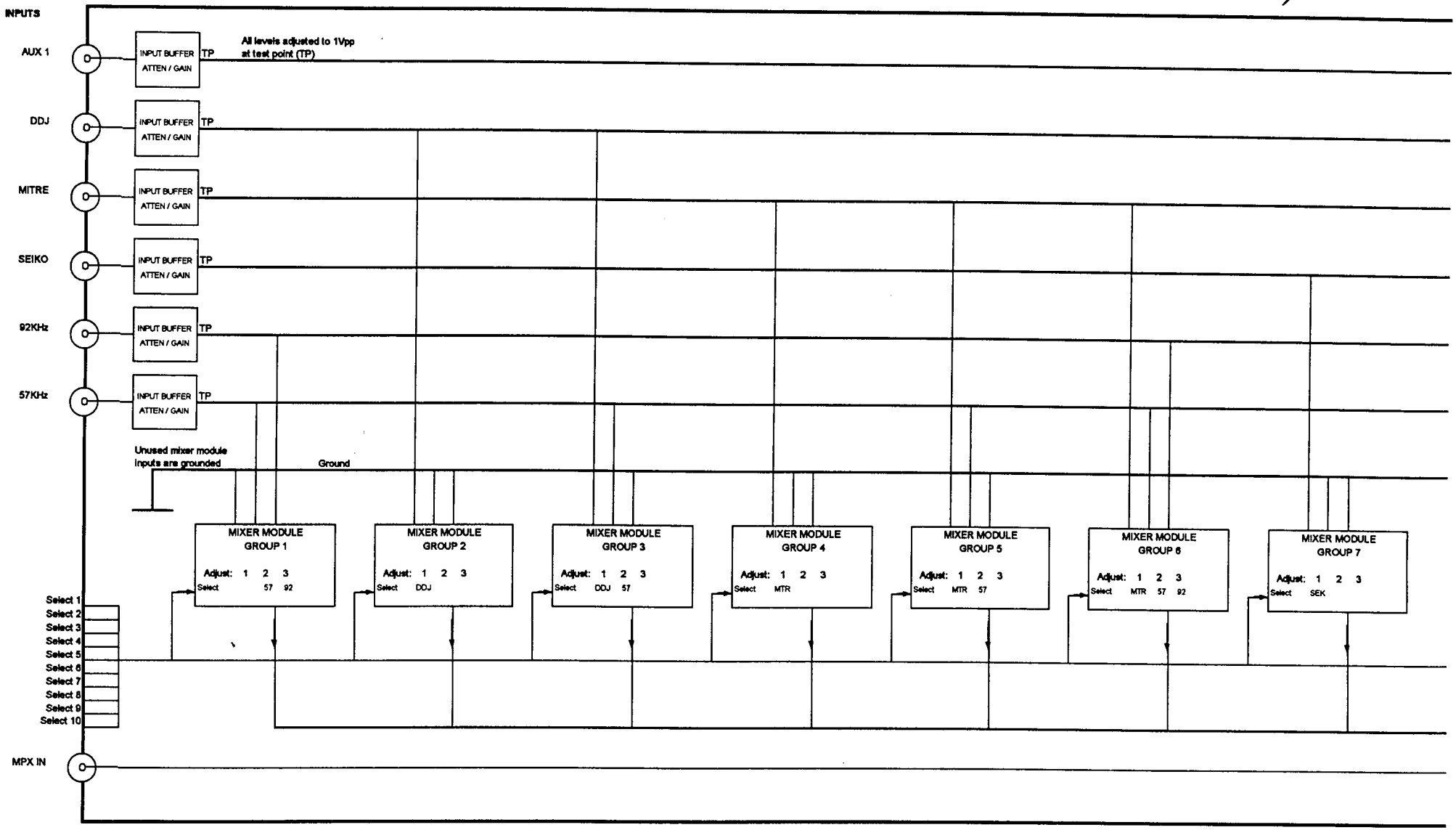
(Connects to pg. 4) →



SCA MIXER III
for
NRSC HSSC Field Tests

(Connects to pg. 4) →

SCA MIXER III
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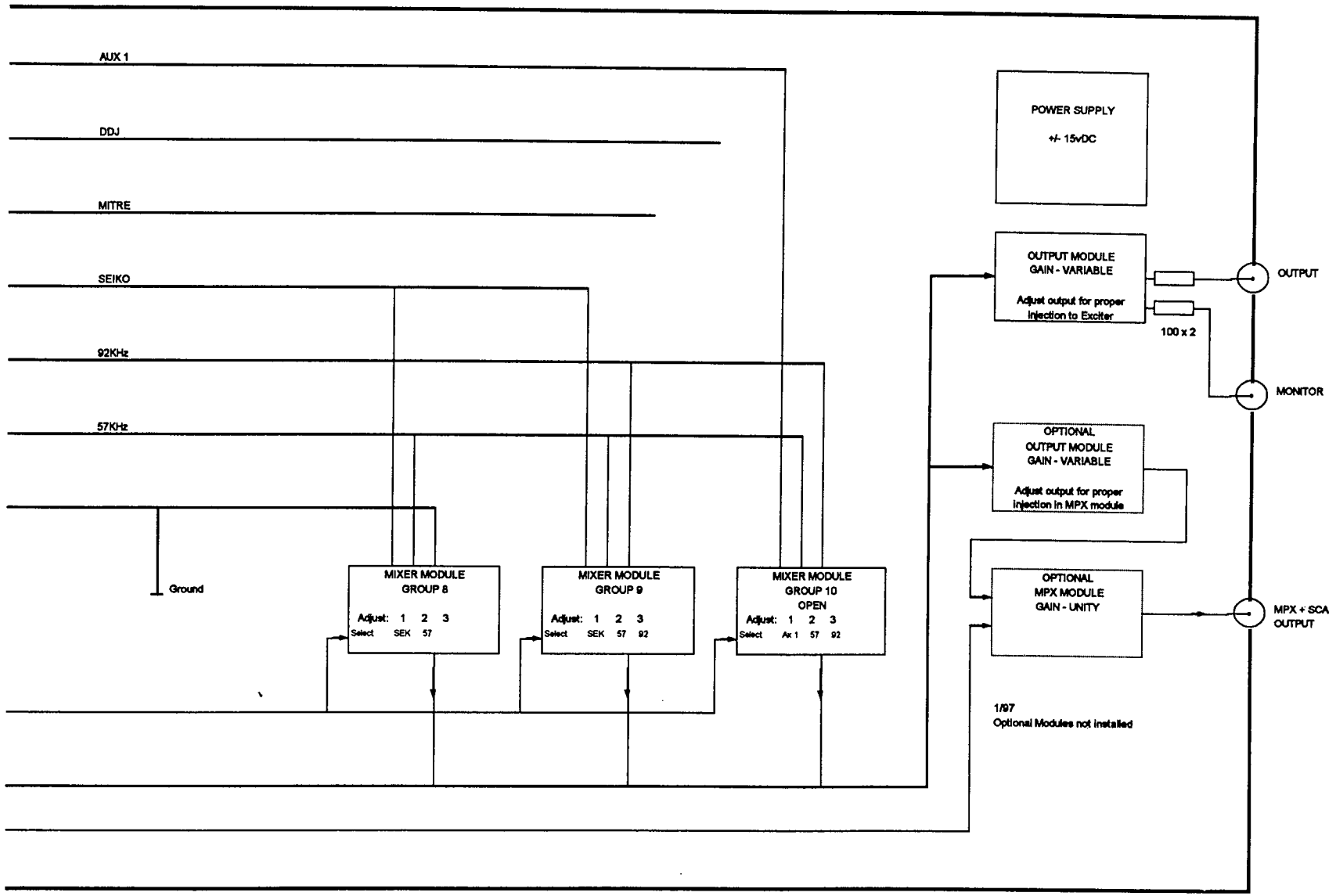
← (Connects to pg. 3)

Digital Radio Test Laboratory



← (Connects to pg. 3)

SCA MIXER III
for
NRSC HSSC Field Tests

SCA MIXER III
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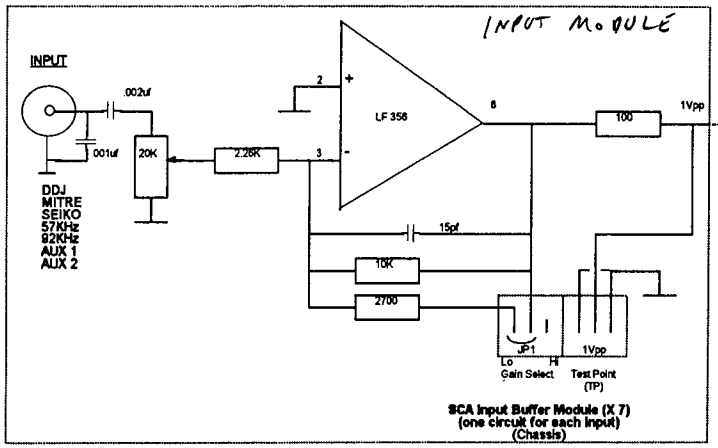
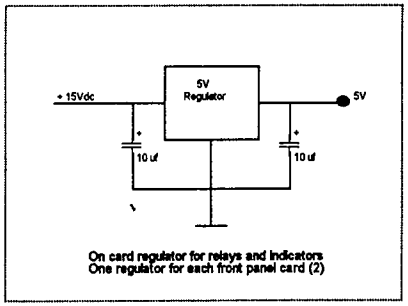
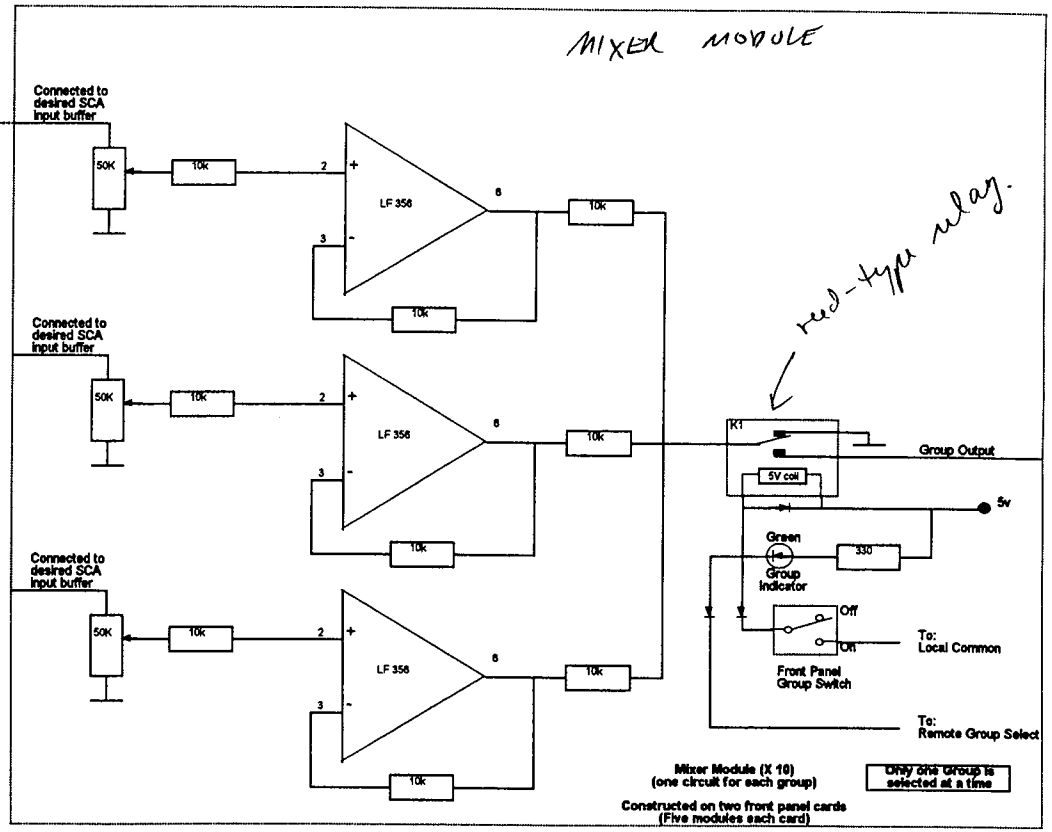


All Op Amps decoupled with 10uf at supply inputs





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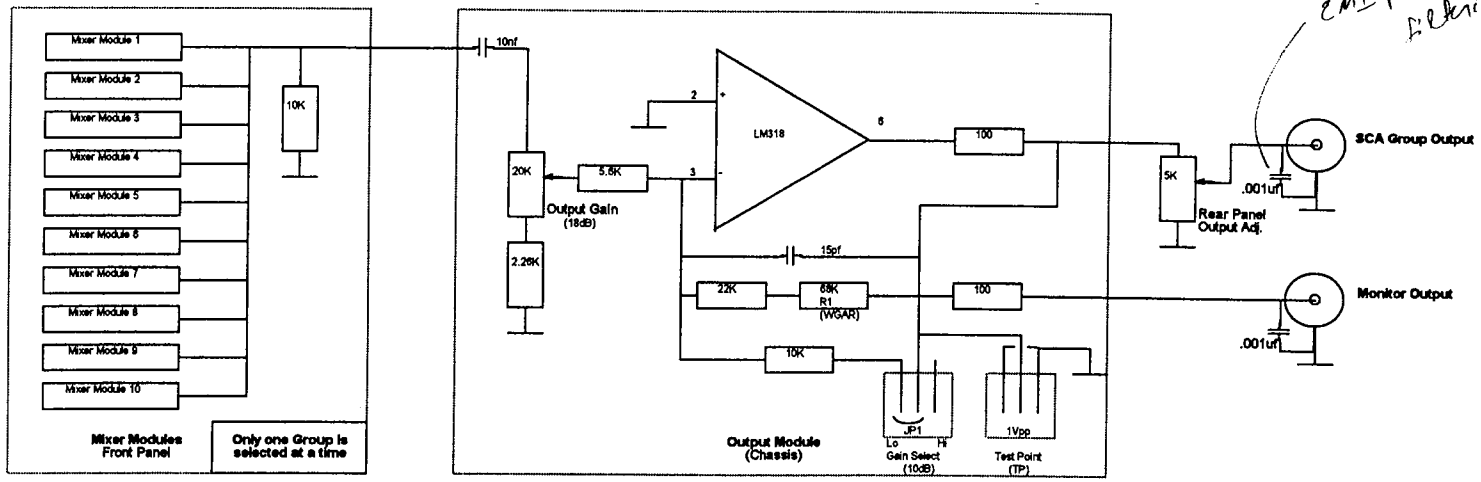
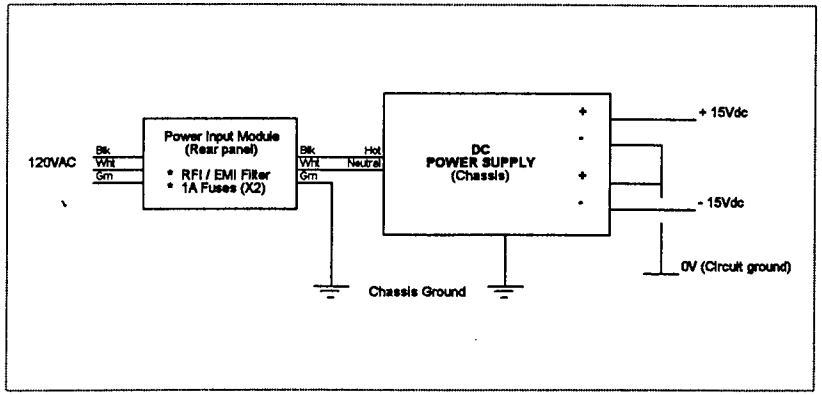
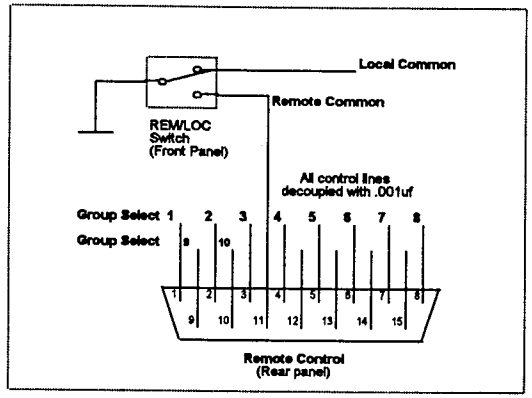
Digital Radio Test Laboratory



All Op Amps decoupled with 10uf at supply inputs

↑ high gain mode used in both.





Note: The installtion at WGAR required more output gain from the mixer to drive the exciter. Feedback resistor R1 was increased to 68K.

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1/97
RMc

Appendix B

Subcarrier Injection Measurement Accuracy

APPENDIX, B

Subcarrier Injection Measurement Accuracy

The tests were conducted using the Seiko and DDJ HSSC signal. These signals were selected because they had the highest and lowest peak to RMS measured ratios (Figure 1). Figure 2 shows the results of the injection calibration measurements using the Seiko system signal. The test compares the digital subcarrier peak-to-peak voltage measurements made with an analog oscilloscope with the voltage measured with a HP-54602B digital oscilloscope. The second set of tests compares the injection of the DDJ system through the subcarrier test mixers using both methods of measurement (Figure 3). The above measurements were made at OME

Digital Radio Test Laboratory

Time Base: 5 seconds / division
Verticle: 50 mV / division

AC Coupled

PROPONENT		Vp-p (mV)	Vrms (mV)	Crest Factor (dB)
DIGITAL DJ		285.9	93.75	0.742
		287.5	94.46	0.725
		285.9	92.83	0.827
		284.4	92.06	0.854
		285.9	94.13	0.707
	Average	**285.9**	**93.45**	**0.771**
MITRE		287.5	78.83	2.296
		287.5	78.20	2.365
		282.8	79.59	2.069
		284.4	79.70	2.106
		287.5	80.00	2.168
	Average	**285.9**	**79.26**	**2.201**
SEIKO		290.6	57.54	5.123
		279.7	56.68	4.922
		271.9	55.27	4.895
		292.2	57.82	5.129
		282.8	58.54	4.737
	Average	**283.4**	**57.17**	**4.963**

Digital Radio Test Laboratory

Injection Level Accuracy

Seiko 10 % Injection: Dual Mode Receiver: 66.5 kHz Subcarrier

Injection level set with Analog Oscilloscope and Belar Wizard

Noise Level		Error Level (%)				
C/N_0	Attn	BER	20 Byte	220 Byte	Mixer	Vp-p (mV)
77.29	10.75	0.006	0.097	1.064	Lab	300

Analog Scope Settings:
Verticle: 50 mV / Division
Horizontal: 50 us for setting Injection

Injection level set with Digital Oscilloscope

Noise Level		Error Level (%)				
C/N_0	Attn	BER	20 Byte	220 Byte	Mixer	Vp-p (mV)
77.04	10.50	0.006	0.097	1.064	Lab	281.2
						276.6
						281.2
						284.4
						282.8
						281.2

Digital Scope Settings:
Verticle: 50 mV / Division
Horizontal: 20 ms for setting Injection
5 s /division for measurement
5 50 second measurements: Average

Digital Radio Test Laboratory

Lab and Field Mixer Performance Comparison
Digital DJ 10% Injection
Injection level set same as field test

Noise Level		Error Level (%)				
C/N_0	**Attn**	**BER**	**20 Byte**	**220 Byte**	**Mixer**	**Mode**
72.04	5.50	0.030	0.170	1.333	Lab	Lab
72.29	5.75	0.018	0.073	0.533	Field	WGAR
72.04	5.50	0.072	0.341	2.400	Field	WKSU

Injection level set with digital oscilloscope

Noise Level		Error Level (%)				
C/N_0	**Attn**	**BER**	**20 Byte**	**220 Byte**	**Mixer**	**Mode**
72.04	5.50	0.050	0.195	1.333	Lab	Lab
72.04	5.50	0.010	0.097	0.533	Field	WGAR
72.04	5.50	0.022	0.146	1.067	Field	WKSU

Appendix C

WGAR Baseband Noise Investigation

APPENDIX, C

WGAR Baseband Noise

In the field test report the WGAR base band plot without audio modulation showed noise around 76 kHz. Because of the potential interference to two of the proponent systems, the baseband plots were repeated at the WGAR. Seven plots of the demodulated baseband signal were taken using an RE AFM-2 modulation analyzer for the demodulator. Test #1 was made using the test van antenna, and tests #2 through #7 used the high power transmission line tap (directional coupler).

Tests 6 and 7 show plots of the demodulated baseband of the WGAR signal with and without the main audio channel modulation. The noise that appears around 76 kHz falls into the noise floor with audio modulation (Test 6). The noise level from 60 kHz to 90 kHz increases by 5 dB to 7 dB with program modulation and is 63 dB below peak program level. Without modulation the 76 kHz noise is at least 58 dB down.

DIGITAL RADIO TEST LABORATORY

9/15/97

DML
RMc
MK WGAR

Objective: Characterize suspected audio processor noise at WGAR

Notes:

* Cutting Edge Omnia processor used as in Field Tests.

* Baseband audio recovered with AFM2 Modulation Analyzer

* Observerved baseband audio: with and without programming
  With and without max hold
  With processor disconnected from exciter
  With alternate processor

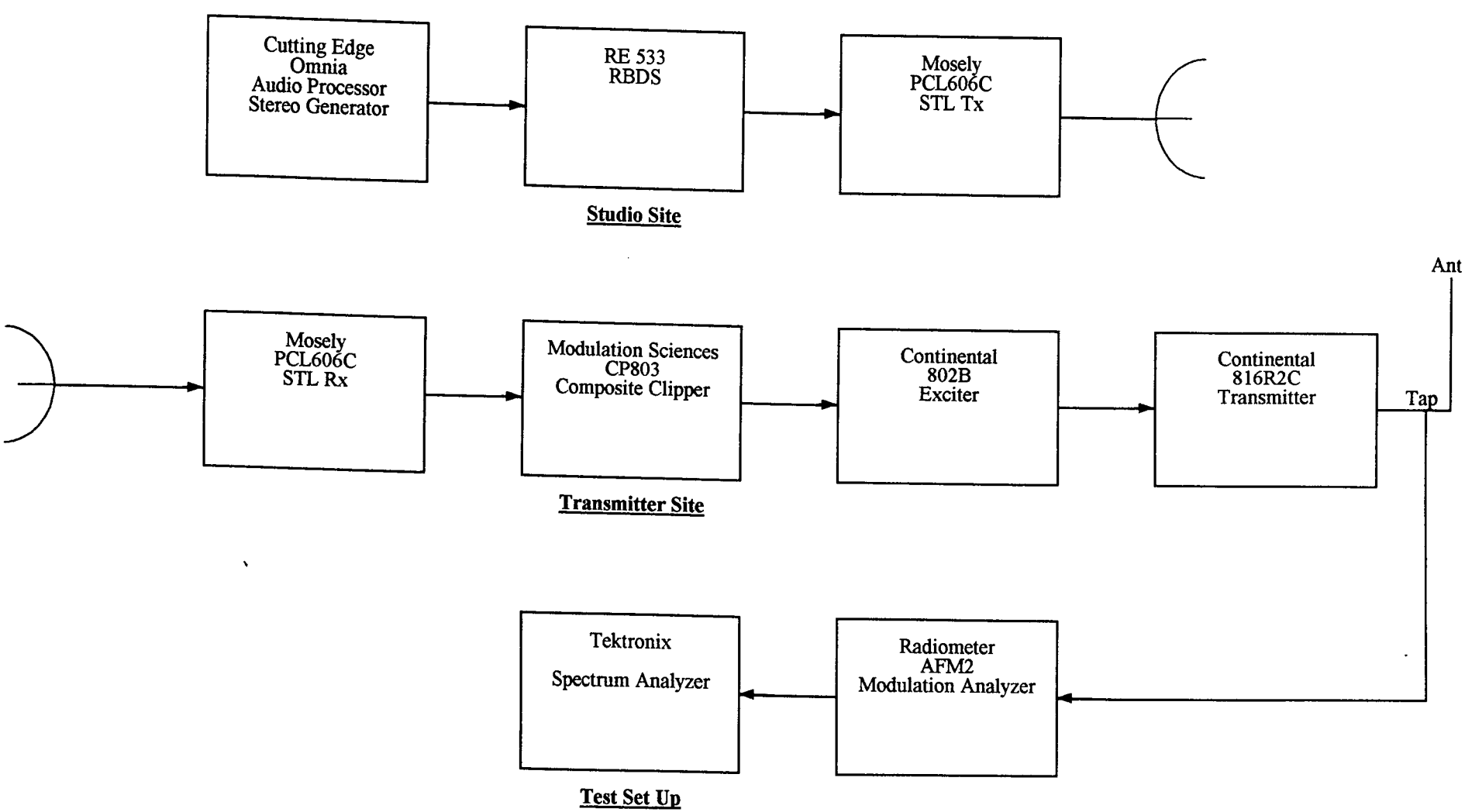
* Observed noise occurring at approximately 76kHz
  Noise is inversely modulated with audio level which is to say that the noise increases during quiet points in the program audio. Attack and decay time is fairly rapid in that the noise may be observed appearing during brief (1 sec.) quiet times in normal audio programming and immediately reducing when program audio returns.

* Disconnected the composite feed to the exciter; noise disappears

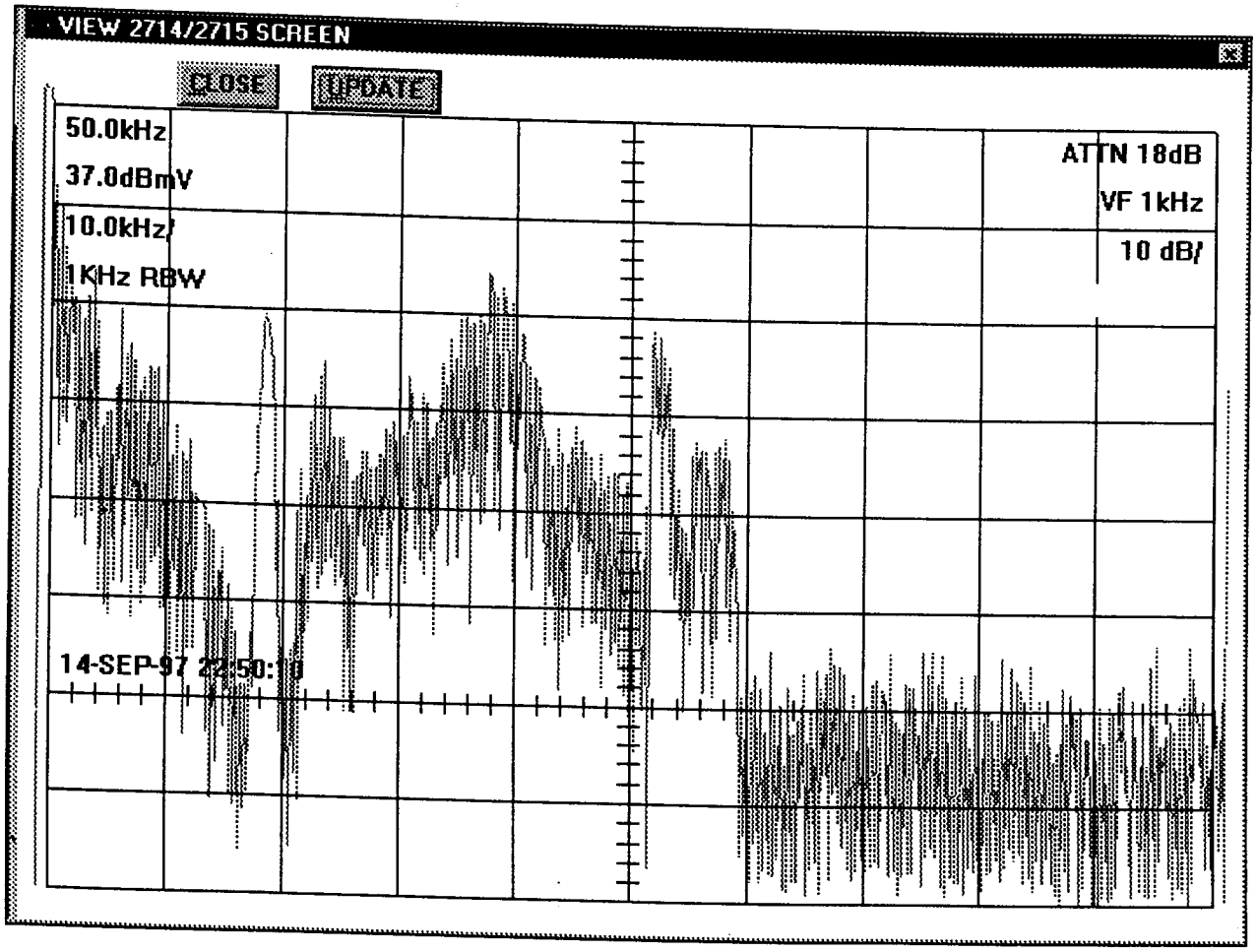
* Switched over to Orban processor for tests 6 &7 in order to determine if the noise was unique to the Cutting Edge processor. Orban processor exhibited the same results..

* Troubleshooting time limited by station management.

DIGITAL RADIO TEST LABORATORY



DIGITAL RADIO TEST LABORATORY



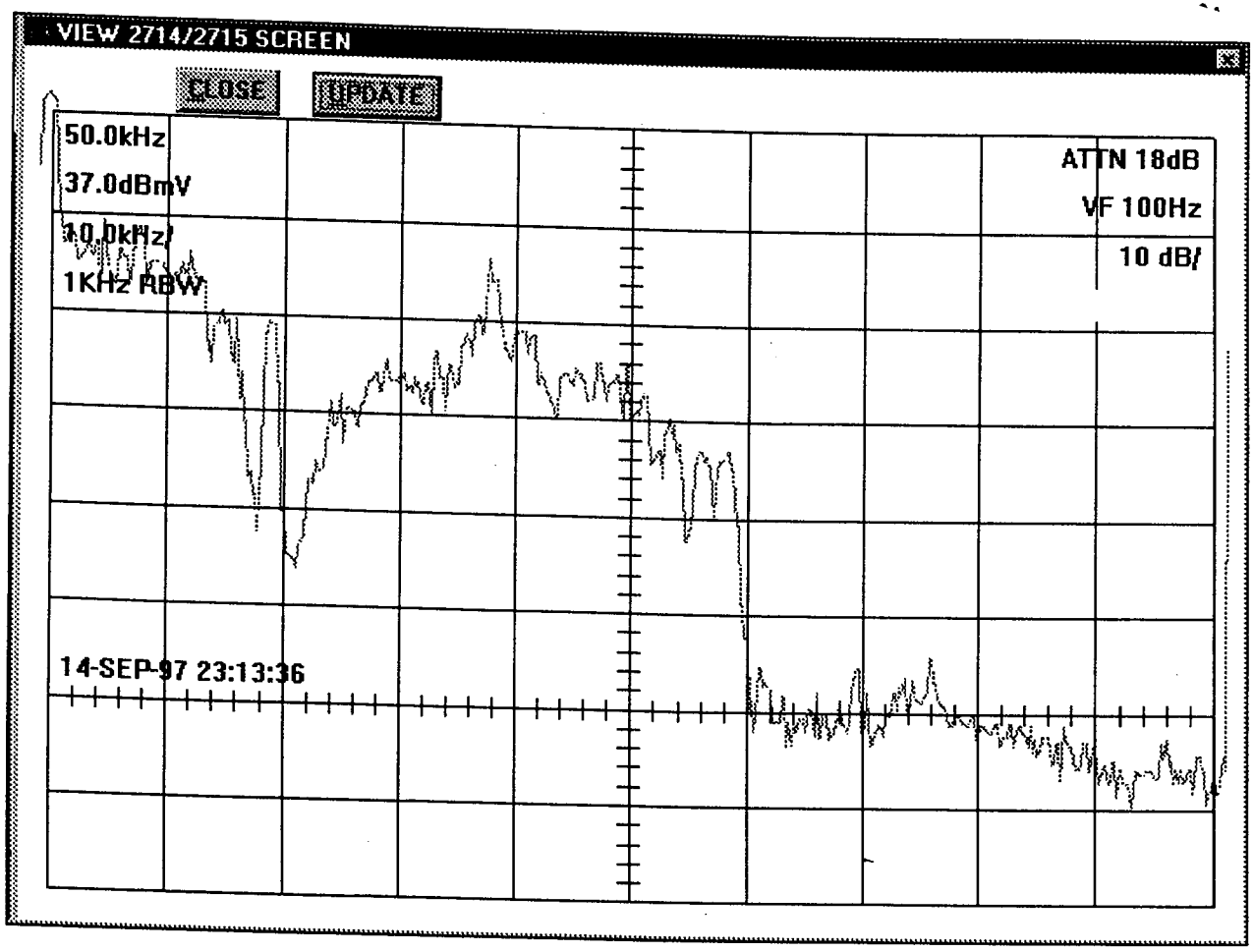
WGAR Baseband

Test 1

Program: Normal
Proc. Cutting Edge Omnia
Source: Off Air (roof antenna)

Video Filter: 100Hz
Max Hold: Off
Aquisition Time: NA

DIGITAL RADIO TEST LABORATORY



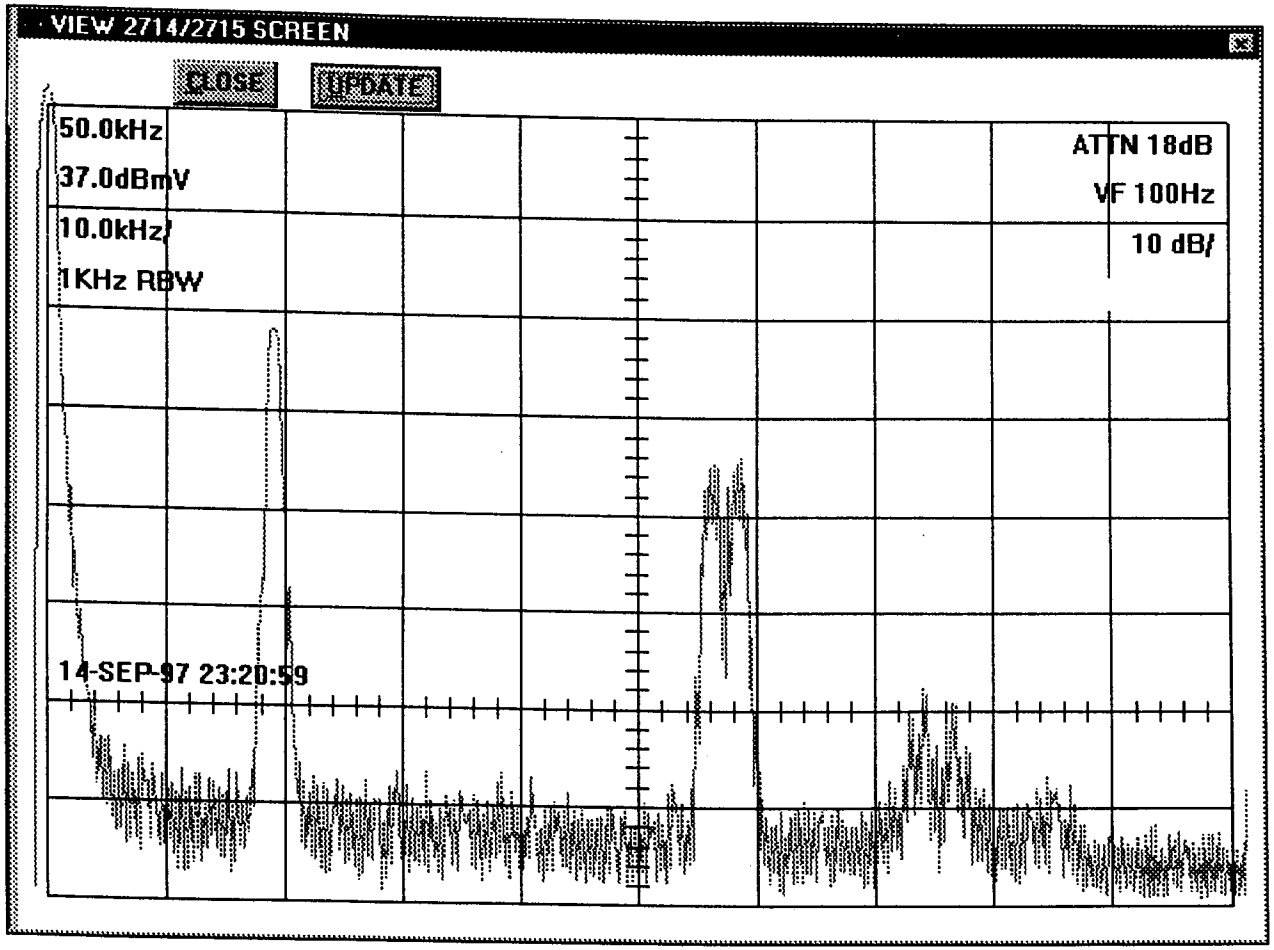
WGAR Baseband

Test 2

Program: Normal
Proc. Cutting Edge Omnia
Source: RF Tap

Video Filter: 100Hz
Max Hold: On
Aquisition Time: 5 min

DIGITAL RADIO TEST LABORATORY



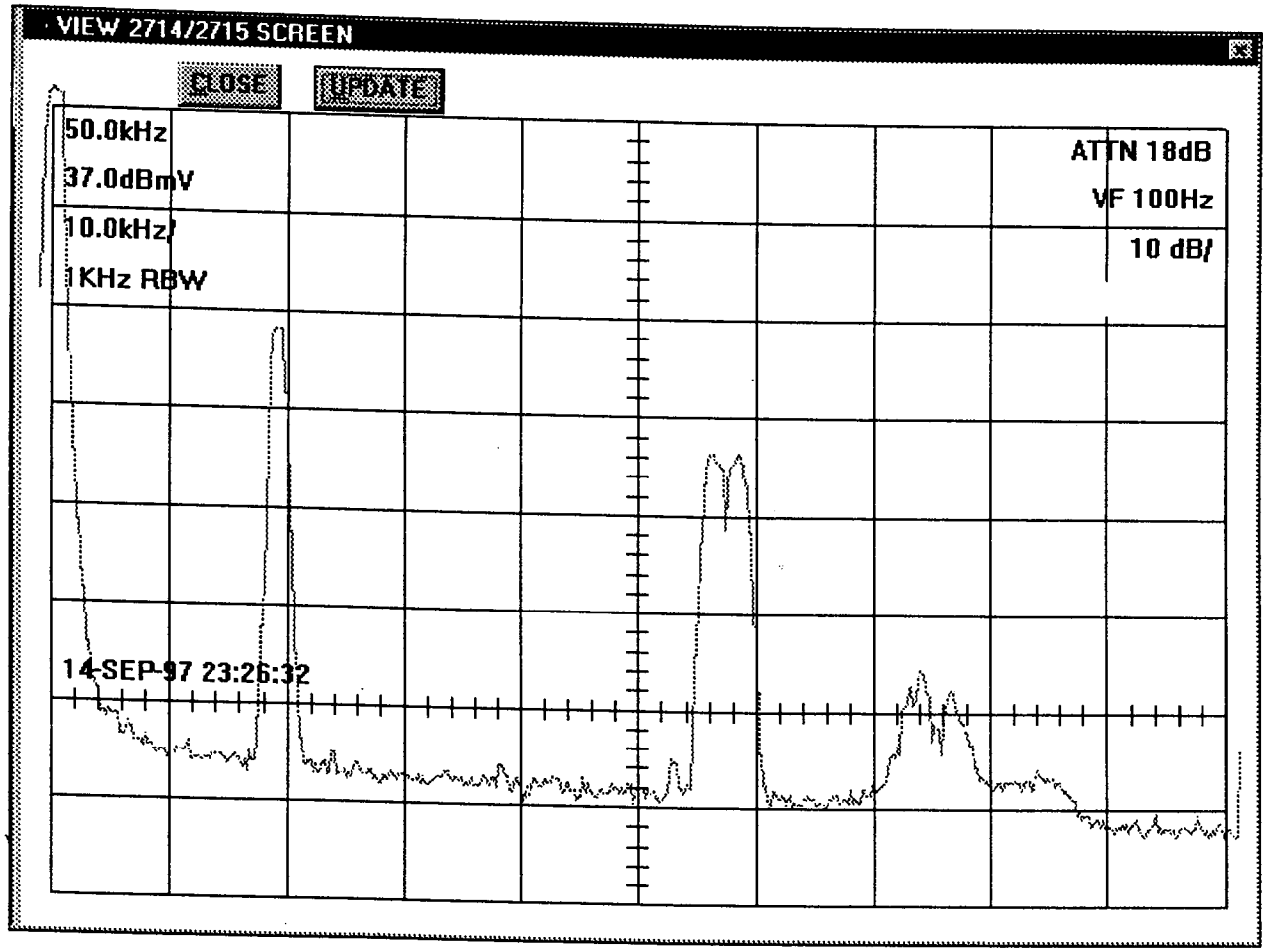
WGAR Baseband

Test 3

Program: Off
Proc. Cutting Edge Omnia
Source: RF Tap

Video Filter: 100Hz
Max Hold: Off
Aquisition Time: NA

DIGITAL RADIO TEST LABORATORY



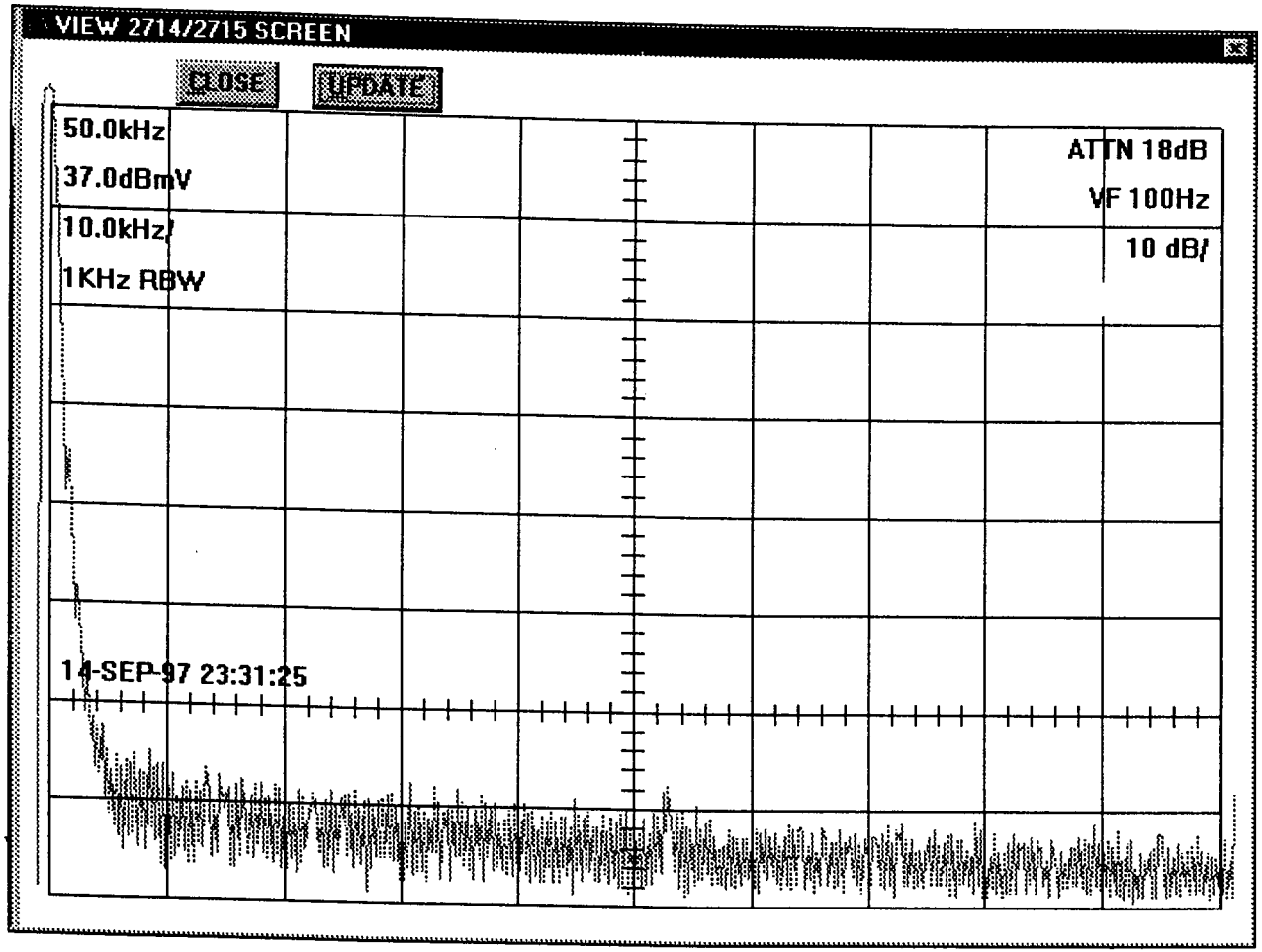
WGAR Baseband

Test 4

Program: Off
Proc. Cutting Edge Omnia
Source: RF Tap

Video Filter: 100Hz
Max Hold: On
Aquisition Time: 5 min

DIGITAL RADIO TEST LABORATORY

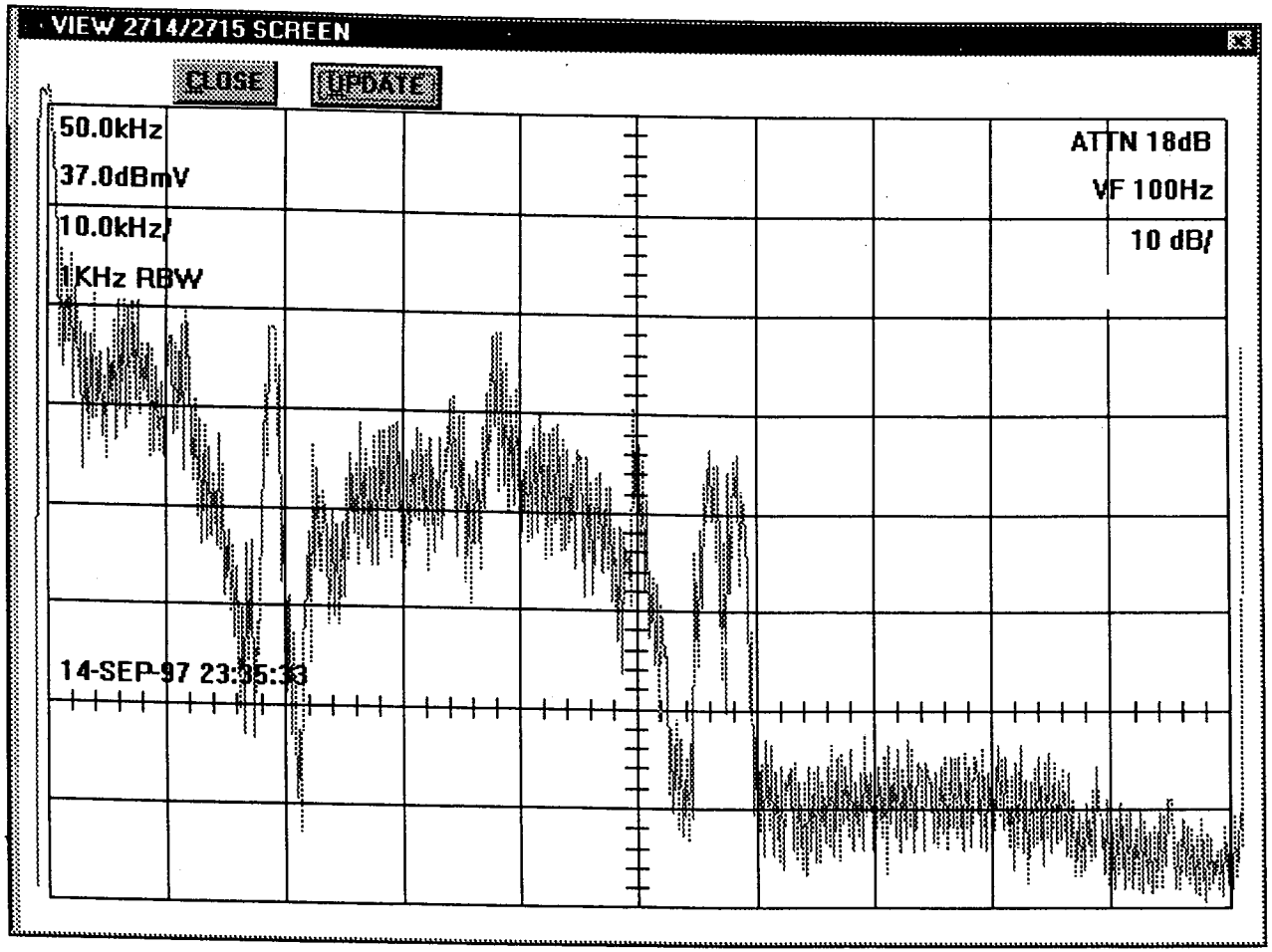


WGAR Baseband

Test 5

Program: Off
Proc. Disconnected
Source: RF Tap

Video Filter: 100Hz
Max Hold: Off
Aquisition Time: NA



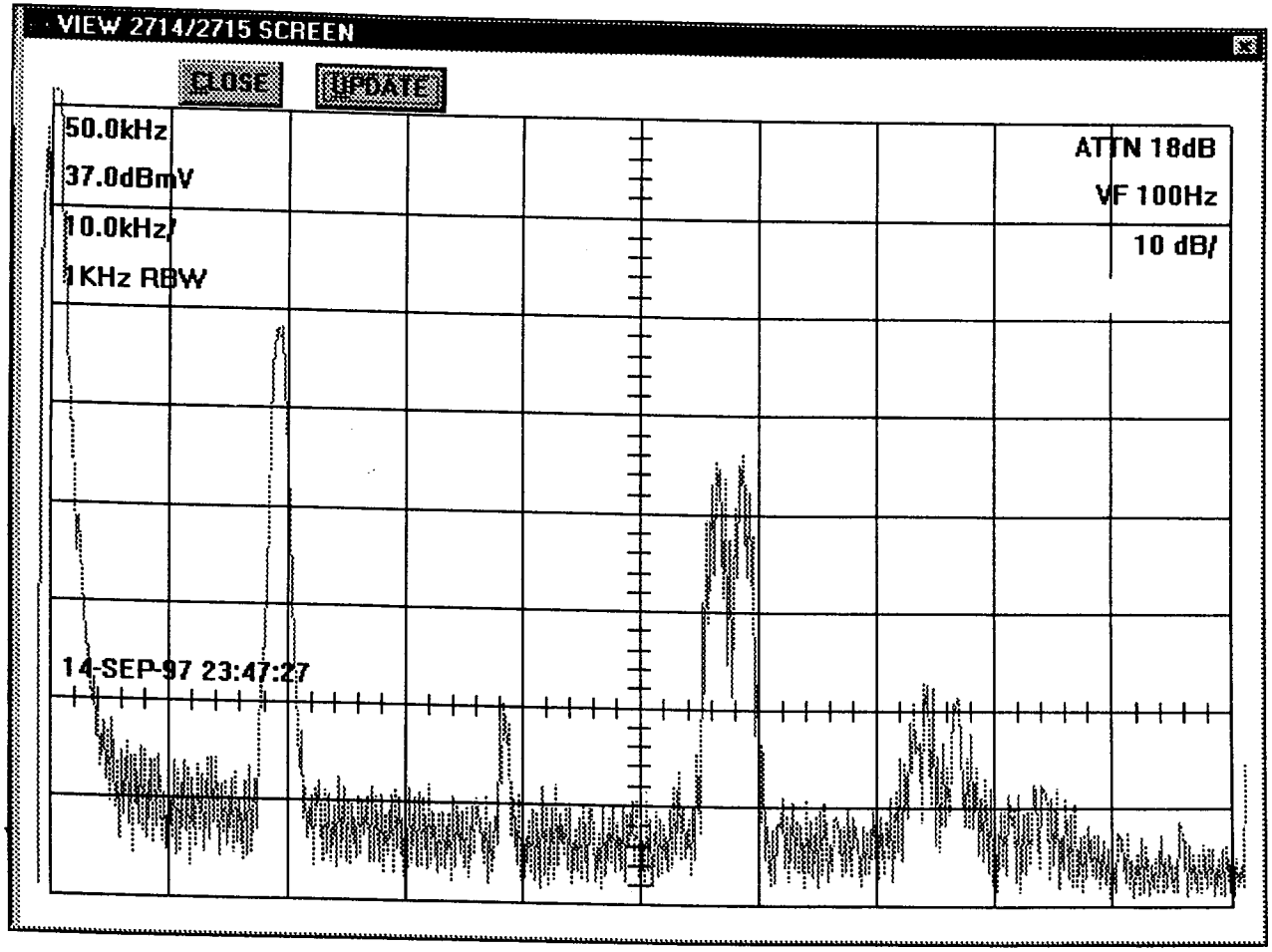
WGAR Baseband

Test 6

Program: On
Proc. 8100A
Source: RF Tap

Video Filter: 100Hz
Max Hold: Off
Aquisition Time: NA

DIGITAL RADIO TEST LABORATORY



WGAR Baseband

Test 7

Program: Off
Proc. 8100A
Source: RF Tap

Video Filter: 100Hz
Max Hold: Off
Aquisition Time: NA

Appendix D

Quality of Recovered WGAR Pilot

APPENDIX, D

Quality of Recovered WGAR Pilot

For the WKSU field tests the 19 kHz pilot originated from the stereo generator in the DDS Harris exciter at the transmitter. For the WGAR test the only source of pilot at the transmitter site was the regenerated signal from the Belar demodulator. A test to measure possible effects of the regenerated pilot for the DDJ system was conducted. To simulate possible instability problems, a noisy off air signal was used in the laboratory. A Belar demodulator, the same type equipment used at WGAR field test, was used for the laboratory pilot recovery test. The laboratory tests compared the DDJ noise OME performance using the Orban 8200 pilot, with the DDJ system operating with the off-air Belar recovered pilot. The DDJ OME was the same for both sources of pilot. The Co/No was 4.31 dB. A 0.25 dB attenuator was used for this test.

Digital Radio Test Laboratory

Signal

No Main Channel Modulation on the Harris THE-1.

DDJ Pilot input from Orban (normal) or from WGAR decoded pilot from Belar (off air).

Noise Level		Error Level (%)			
C_0/N_0	Attn	BER	20 Byte	220 Byte	Pilot Input
4.31	5.50	0.030	0.170	1.333	Locked to Orban
4.56	5.75	0.005	0.049	0.267	
4.56	5.75	0.023	0.122	0.800	Locked to Belar Decoded Pilot from WGAR off Air
4.31	5.50	0.066	0.292	2.400	

Appendix E

Field Test Subcarrier Mixer Tests

APPENDIX, E

Field Test Subcarrier Mixer Tests

Two subcarrier mixers were custom built for the HSSC tests: laboratory and field. Because the WGAR exciter required a higher input voltage than that used at the WKSU transmitter, the subcarrier mixer output level had to be increased for the WGAR tests. The method used for increasing the output level resulted in additional amplitude slope across the baseband . The frequency response of the laboratory unit was flat.

Figure 1 shows the frequency response of the field test mixer in the WKSU gain mode and Figure 3 in the WGAR gain mode. Tables 1 and 2 show the occupied bandwidths and slope for each system.

Table 1. Subcarrier Mixer Frequency Slope Across System Channel - WKSU Mode

System	Slope (dB)	Occupied BW (kHz)
DDJ	0.7	24.0
MITRE	0.4	15.2
Seiko	0.3	16.0

Table 2. Subcarrier Mixer Frequency Slope Across System Channel - WGAR Mode

System	Slope (dB)	Occupied BW (kHz)
DDJ	1.5	24.0
MITRE	1.0	15.2
Seiko	0.7	16.0

To quantify the effects of the slope on the DDJ system, two additional laboratory tests were conducted: test B-1 noise and B-3 multipath. The tests compared the system performance through the laboratory mixer with a flat frequency response (Figure 5) against the field test mixer in both modes. Using a digital oscilloscope (HP-54602B) to calibrate injection, there were no changes in the C/No for any of the three mixer modes. Using an analog oscilloscope to set subcarrier injection, the DDJ OME C/No performance increased in the WGAR mode by 0.25 dB.

The multipath tests were conducted without main channel audio and with clipped pink noise. The Urban Fast scenario was used for this test. Because the DDJ system exhibited errors, no noise was added to the signal. The message error rates observed using the lab and field test (WGAR mode) mixers are close, indicating very similar performance.

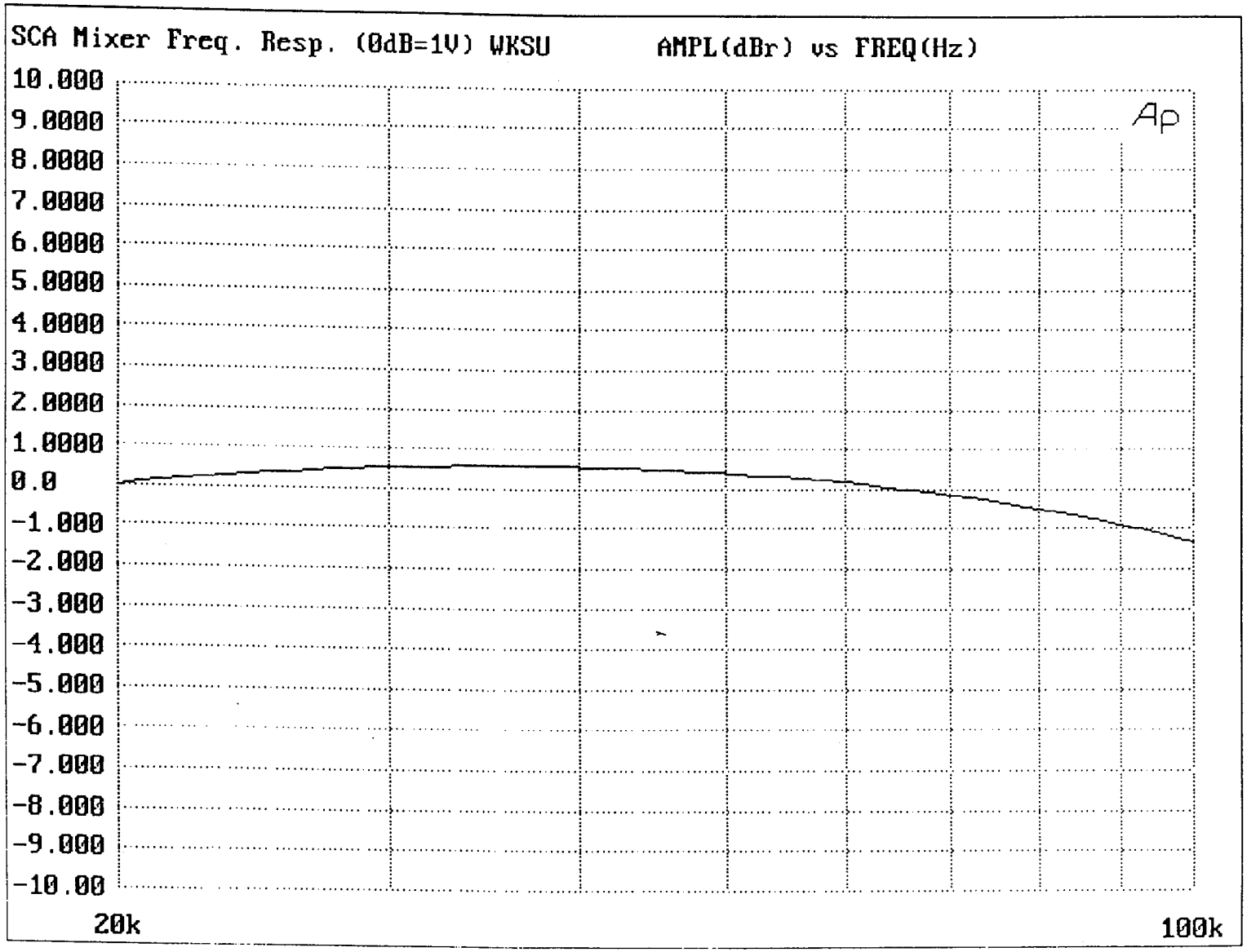
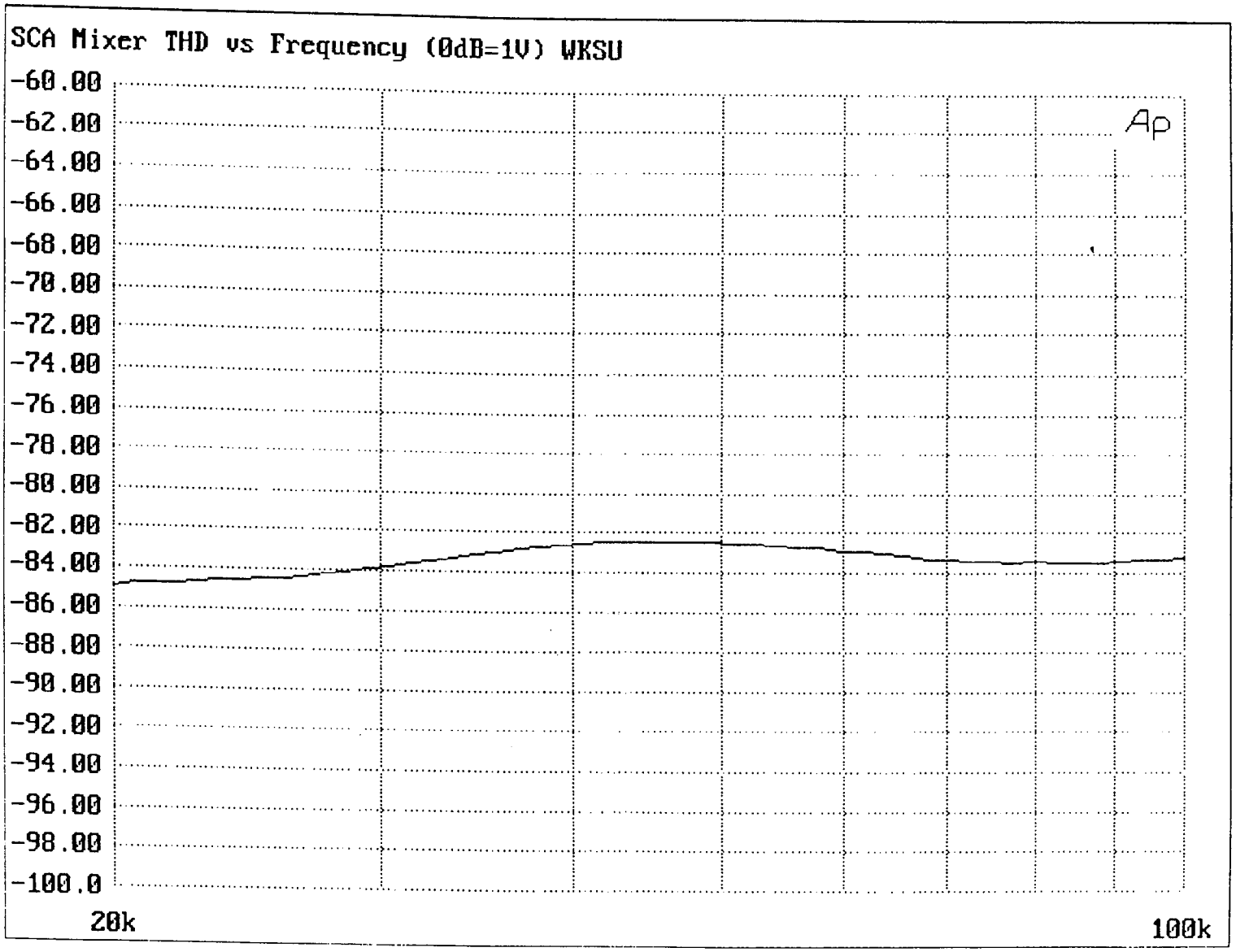

SCA Mixer Freq. Resp. (0dB=1V) WKSU
AMPL(dBr) vs FREQ(Hz)
Ap
10.000
9.0000
8.0000
7.0000
6.0000
5.0000
4.0000
3.0000
2.0000
1.0000
0.0
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000
-9.000
-10.00
20k
100k

Figure 1


SCA Mixer THD vs Frequency (0dB=1V) WKSU
-60.00
-62.00
-64.00
-66.00
-68.00
-70.00
-72.00
-74.00
-76.00
-78.00
-80.00
-82.00
-84.00
-86.00
-88.00
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-94.00
-96.00
-98.00
-100.0
20k
100k
Ap

Figure 2

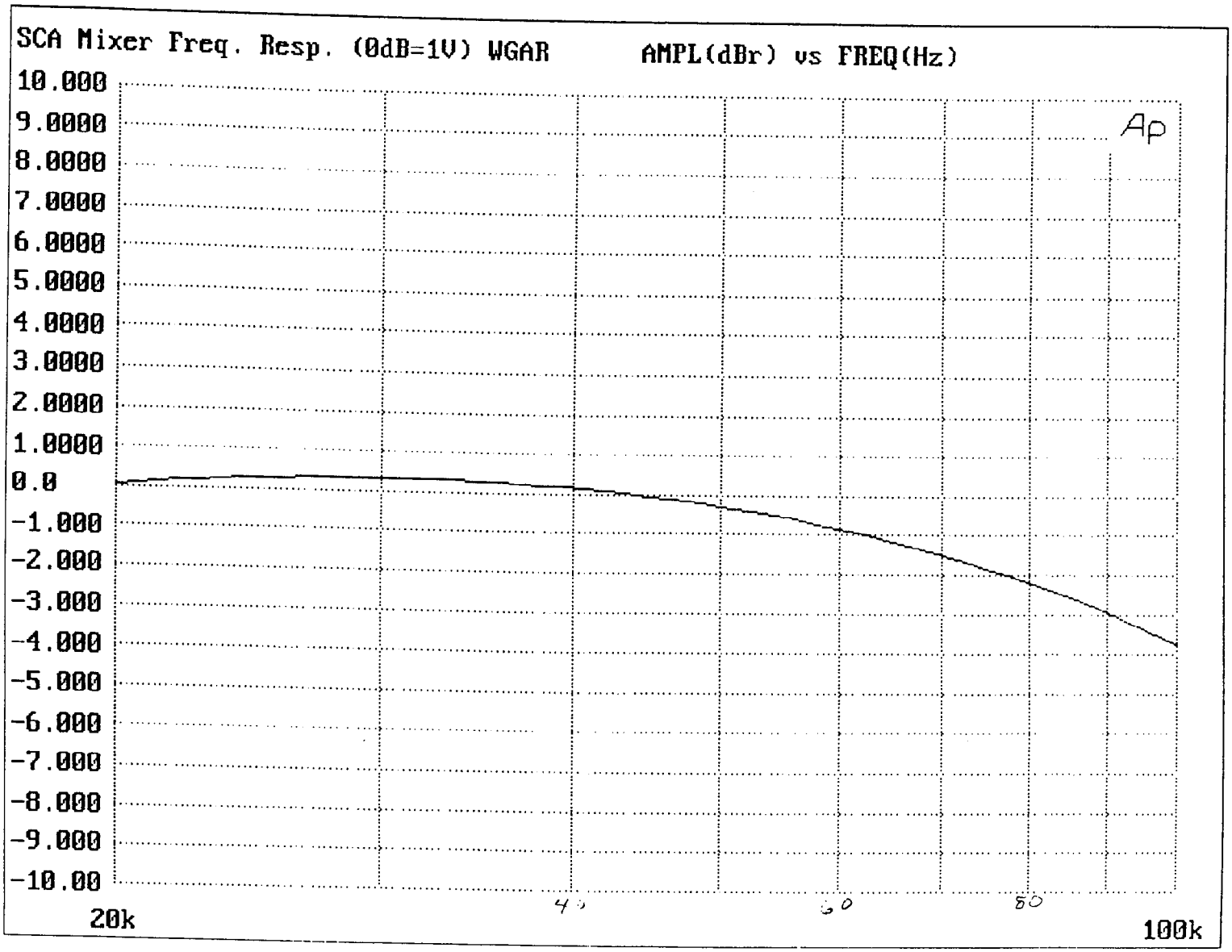

SCA Mixer Freq. Resp. (0dB=1V) WGAR
AMPL(dBr) vs FREQ(Hz)
10.000
9.0000
8.0000
7.0000
6.0000
5.0000
4.0000
3.0000
2.0000
1.0000
0.0
-1.000
-2.000
-3.000
-4.000
-5.000
-6.000
-7.000
-8.000
-9.000
-10.00
20k
40
60
80
100k
Ap

Figure 3

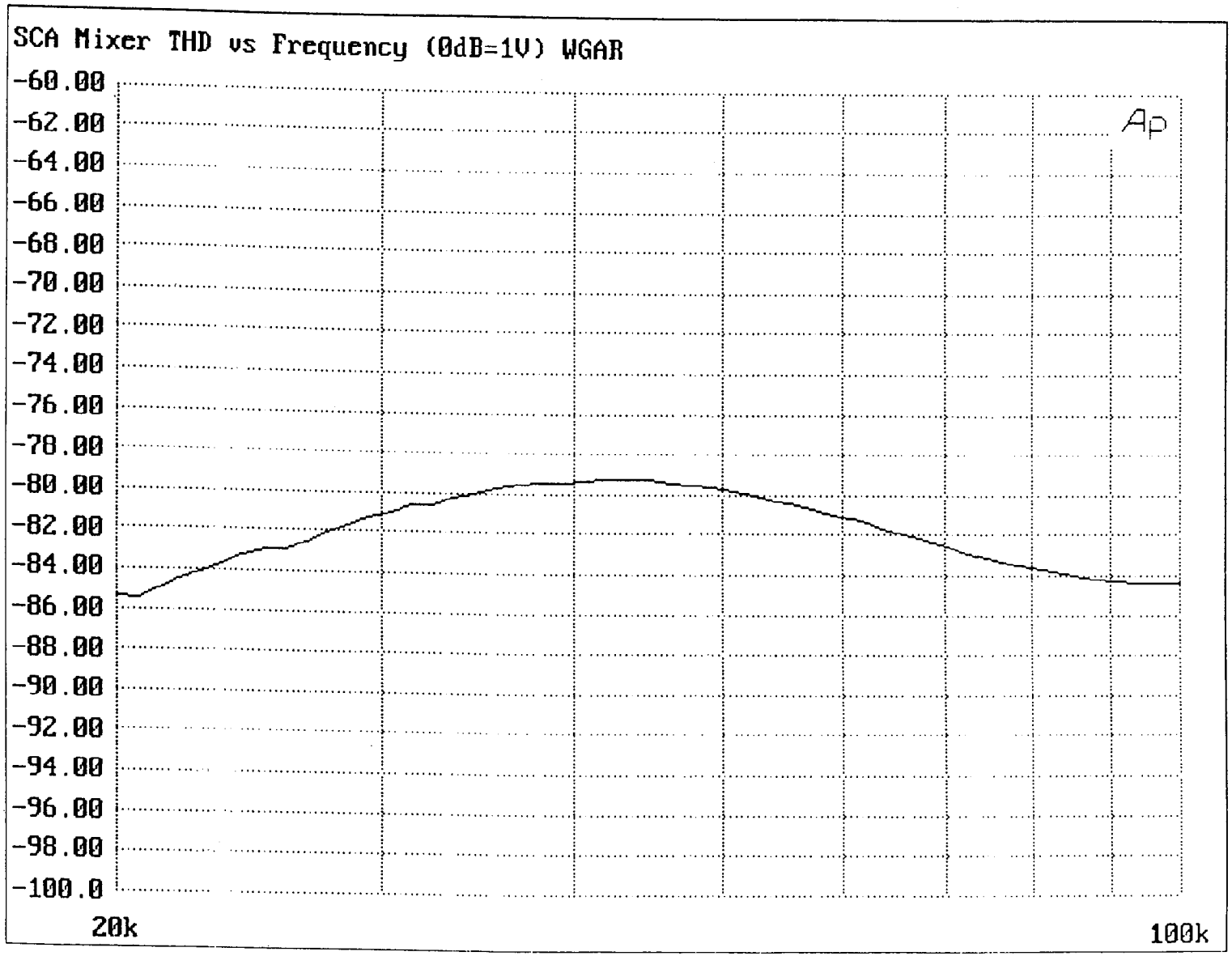

SCA Mixer THD vs Frequency (0dB=1V) WGAR
-60.00
-62.00
-64.00
-66.00
-68.00
-70.00
-72.00
-74.00
-76.00
-78.00
-80.00
-82.00
-84.00
-86.00
-88.00
-90.00
-92.00
-94.00
-96.00
-98.00
-100.0
20k
100k
AP

Figure 4

S/N RATIO: [illegible] (0dB = 1V)

THD @ 50kHz -[illegible] dB

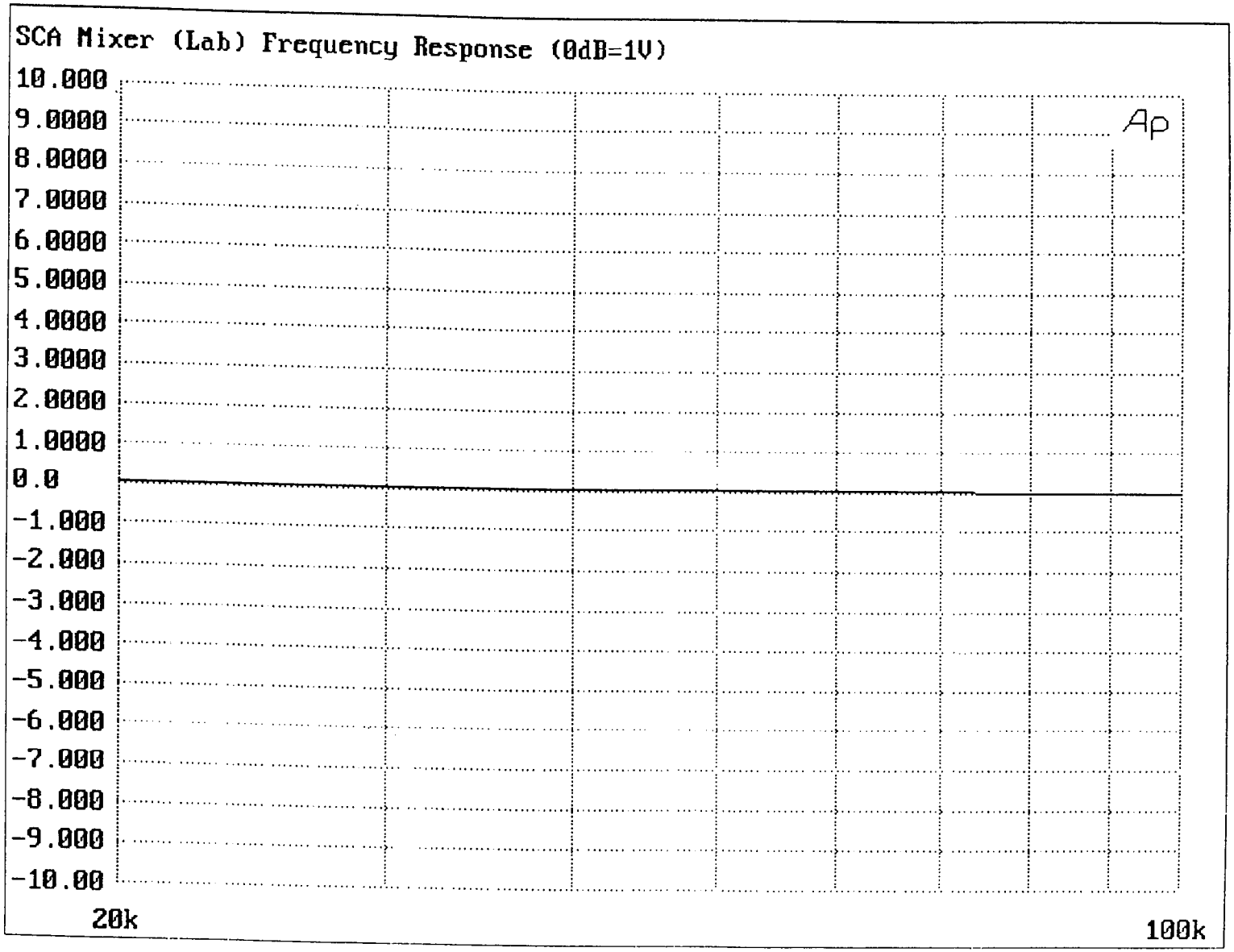


Figure 5

E-1

Digital Radio Test Laboratory

Lab and Field Mixer Performance Comparison
Digital DJ 10% Injection
Injection level set same as field test

Noise Level		Error Level (%)				
C/N_0	**Attn**	**BER**	**20 Byte**	**220 Byte**	**Mixer**	**Mode**
72.04	5.50	0.030	0.170	1.333	Lab	Lab
72.29	5.75	0.018	0.073	0.533	Field	WGAR
72.04	5.50	0.072	0.341	2.400	Field	WKSU

Injection level set with digital oscilloscope

Noise Level		Error Level (%)				
C/N_0	**Attn**	**BER**	**20 Byte**	**220 Byte**	**Mixer**	**Mode**
72.04	5.50	0.050	0.195	1.333	Lab	Lab
72.04	5.50	0.010	0.097	0.533	Field	WGAR
72.04	5.50	0.022	0.146	1.067	Field	WKSU

Digital Radio Test Laboratory

Lab and Field Mixer Performance Comparison with Multipath
Error Level (%)

Multipath	BER	20 Byte	220 Byte	Program	Mixer	Mode
Urban Fast	0.031	0.195	1.600	Pilot Only	Lab	Lab
Urban Fast	0.043	0.170	1.333	Pilot Only	Field	WGAR

Multipath	BER	20 Byte	220 Byte	Program	Mixer	Mode
Urban Fast	1.326	6.569	36.00	CPN	Lab	Lab
Urban Fast	1.217	6.764	33.60	CPN	Field	WGAR

DDJ 10% Injection

Appendix F

Ford Motor Co. Antenna Tests (cover sheet only)

DAB FIELD TEST PROJECT ANTENNA CHARACTERIZATION REPORT

submitted to:

NRSC/EIA/NAB Field Test Task Force

July 9, 1996

prepared by:
Ford Motor Company
Audio Subsystems Engineering
Michael Chrysochoos (313) 594-3684 mchrysoc@e-mail.com
Richard Zerod (313) 323-2526

(For additional info contact NAB Science & Technology at 202-429-5346)

Table of Contents

(Attachment 2)

Appendix G

Crest Factor Measurements

Digital Radio Test Laboratory

Time Base: 5 seconds / division
Verticle: 50 mV / division

AC Coupled

PROPONENT	Vp-p (mV)	Vrms (mV)	Crest Factor (dB)	
DIGITAL DJ	285.9	93.75	0.742	
	287.5	94.46	0.725	
	285.9	92.83	0.827	
	284.4	92.06	0.854	
	285.9	94.13	0.707	
Average	**285.9**	**93.45**	**0.771**	3,69
MITRE (88.5 kHz system)	287.5	78.83	2.296	
	287.5	78.20	2.365	
	282.8	79.59	2.069	
	284.4	79.70	2.106	
	287.5	80.00	2.168	
Average	**285.9**	**79.26**	**2.201**	5,12
SEIKO (88.5 kHz system)	290.6	57.54	5.123	
	279.7	56.68	4.922	
	271.9	55.27	4.895	
	292.2	57.82	5.129	
	282.8	58.54	4.737	
Average	**283.4**	**57.17**	**4.963**	7,38

(Data presented at 11/19/98 meeting - attachment 18)
(SEE pg. B-3 - same as that)

12/9,17/1997
Project(s): NRSC HSSC
Test(s): Crest Factor Measurements
Engr(s): DML, TK

Description: Crest factor measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: HP 54615B oscilloscope for peak to peak voltage measurements.
HP34401A multimeter for true rms voltage measurements.
Belar FMMA-1 Digital Modulation Analyzer for injection level measurements.
Injection levels observed to vary from 10.3 to 10.7 % during measurements.
Audio Precision System One for high accuracy sine wave generation and audio analysis.

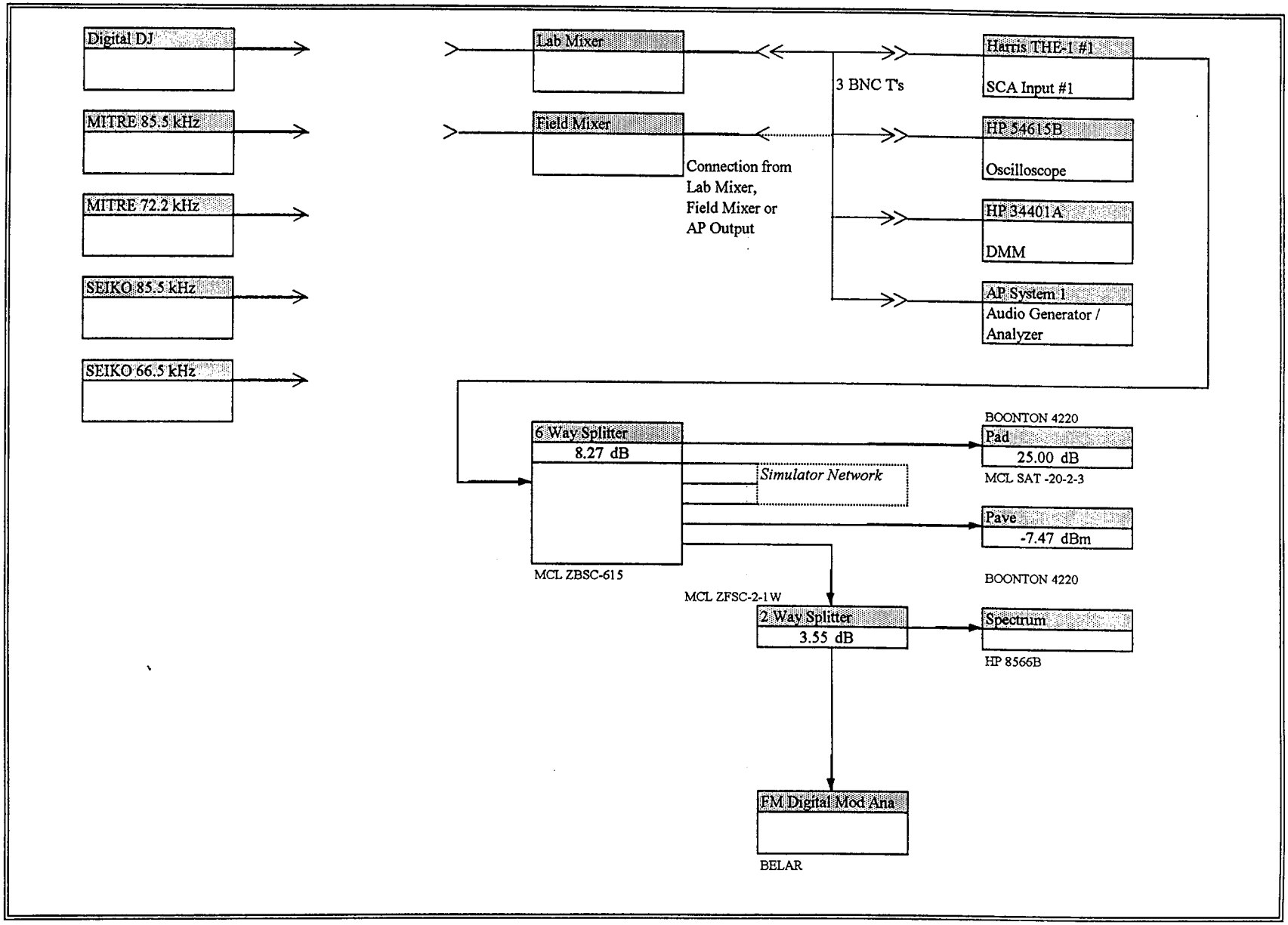
HP 54615B Settings

50 mV	Verticle Divisions
2 ms	Horizontal Divisions
AC	Coupling
Pk Detect or Normal	Display Mode
On or Off	Vectors

Timebase set for relatively stable peak to peak voltage readings.

HP 34401A Settings
power up defaults

AC Volts	Function
100 mV	Range


Digital DJ
MITRE 85.5 kHz
MITRE 72.2 kHz
SEIKO 85.5 kHz
SEIKO 66.5 kHz
Lab Mixer
Field Mixer
Connection from
Lab Mixer,
Field Mixer or
AP Output
3 BNC T's
Harris THE-1 #1
SCA Input #1
HP 54615B
Oscilloscope
HP 34401A
DMM
AP System 1
Audio Generator /
Analyzer
6 Way Splitter
8.27 dB
MCL ZBSC-615
Simulator Network
BOONTON 4220
Pad
25.00 dB
MCL SAT -20-2-3
Pave
-7.47 dBm
BOONTON 4220
MCL ZFSC-2-1W
2 Way Splitter
3.55 dB
Spectrum
HP 8566B
FM Digital Mod Ana
BELAR

December, 17 1997

Project(s): NRSC HSSC

Test(s): Crest Factor Measurements

Engr(s): DML, TK

Description: Crest factor measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: HP 54615B oscilloscope for peak to peak voltage measurements (Normal Display Mode).
HP34401A multimeter for true rms voltage measurements.
Belar FMMA-1 Digital Modulation Analyzer for injection level measurements.
Audio Precision for high accuracy sine wave generation and true rms voltage measurements.
Tektronics 485 Analog Oscilloscope

Sine Wave Calibration

66.5 kHz			85.5 kHz		
AP (mVrms)	HP34401A (mVrms)	HP54615B (mVp-p)	AP (mVrms)	HP34401A (mVrms)	HP54615B (mVp-p)
70.0	70.0	210	69.7	69.7	207

December, 18 1997

Project(s): NRSC HSSC

Test(s): Crest Factor Measurements

Engr(s): DML

Description: Crest factor measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Measurement Summary

	CREST FACTORS (dB)									
	DDJ		MITRE 72.2kHz		SEIKO 66.5kHz		MITRE 85.5kHz		SEIKO 85.5kHz	
HP 54615B Display Mode	Lab	Field	Lab	Field	Lab	Field	Lab	Field	Lab	Field
Peak Detect	0.793	0.810	1.877	1.880	3.971	3.939	2.268	2.229	5.200	5.220
Normal	0.617	0.680	1.556		3.430		1.997		4.665	

	Peak Detect			Normal		
	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**	**Vp-p (mV)**	**Vrms (mV)**	**Crest Factor (dB)**
Field Mixer	292.2			298.1		
	290.6			295.3		
	290.6			290.6		
	290.6			287.5		
	292.2			289.1		
Average	**291.2**	**93.8**	**0.810**	**292.1**	**95.5**	**0.680**

	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**	**Vp-p (mV)**	**Vrms (mV)**	**Crest Factor (dB)**
Lab Mixer	295.3			290.6		
	295.3			290.6		
	293.8			289.1		
	293.8			289.1		
	295.3			292.2		
Average	**294.7**	**95.1**	**0.793**	**290.3**	**95.6**	**0.617**

	Peak Detect			Normal		
	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**			
Field Mixer	292.2					
	290.6					
	292.2					
	293.8					
	292.2					
Average	**292.2**	**83.2**	**1.880**			

	Peak Detect			Normal		
	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**	**Vp-p (mV)**	**Vrms (mV)**	**Crest Factor (dB)**
Lab Mixer	293.8			275.0		
	293.8			273.4		
	292.2			275.0		
	293.8			271.9		
	293.8			275.0		
Average	**293.5**	**83.6**	**1.877**	**274.1**	**81.0**	**1.556**

	Peak Detect			Normal		
	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**			
Field Mixer	296.9					
	296.9					
	293.8					
	289.1					
	292.2					
Average	**293.8**	**66.0**	**3.939**			

	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**	**Vp-p (mV)**	**Vrms (mV)**	**Crest Factor (dB)**
Lab Mixer	290.6			270.3		
	296.9			273.4		
	293.8			271.9		
	289.1			275.3		
	290.6			273.4		
Average	**292.2**	**65.4**	**3.971**	**272.9**	**65.0**	**3.430**

	Peak Detect			Normal		
	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**			
Field Mixer	293.8					
	293.8					
	296.9					
	293.8					
	296.9					
Average	**295.0**	**80.7**	**2.229**			

	Vp-p (mV)	**Vrms (mV)**	**Crest Factor (dB)**	**Vp-p (mV)**	**Vrms (mV)**	**Crest Factor (dB)**
Lab Mixer	301.6			287.0		
	298.4			289.0		
	298.4			292.2		
	295.4			285.9		
	295.3			287.5		
Average	**297.8**	**81.1**	**2.268**	**288.3**	**81.0**	**1.997**

	Peak Detect			Normal		
	Vp-p (mV)	Vrms (mV)	Crest Factor (dB)			
Field Mixer	298.4					
	292.2					
	292.2					
	296.9					
	290.6					
Average	**294.1**	**57.0**	**5.220**			

	Vp-p (mV)	Vrms (mV)	Crest Factor (dB)	Vp-p (mV)	Vrms (mV)	Crest Factor (dB)
Lab Mixer	300.0			279.7		
	296.9			284.4		
	295.3			282.8		
	296.9			275.0		
	298.4			271.9		
Average	**297.5**	**57.8**	**5.200**	**278.8**	**57.6**	**4.665**

(Attachment 1)

Appendix H

Additional Laboratory HSSC Tests
(to address concerns of DDJ)

ADDITIONAL LABORATORY HSSC TESTS
DDJ only

Rev 3

Number	System	Name	Description
1	DDJ (field tests)	Effect of Mixer Slope on Injection Calibration	At the November 19th subcommittee meeting, the committee members recommended that a laboratory test be conducted to determine if the WGAR mixer frequency response slope caused an increase in the crest factor for the Digital DJ signal. With the injection level measured at the output of the mixer, an increase in crest factor would result in a reduced injection RMS level setting. If a change in crest factor of 0.2 dB or less is measured, no other test will be conducted.
2	DDJ (field tests)	Pilot Regeneration	A Digital DJ 78 kHz carrier locked to recovered pilot test will be conducted to assure that the Digital DJ system is locked to the WGAR pilot during the off-air test. The stability of the lock indicator on the Digital DJ equipment will be observed during the test.
3	DDJ (field tests)	Effect of Lower Injection	To document the effect of the lower injection voltage (3.40 V / 3.50 V), the Digital DJ system will be tested in the laboratory using a digital oscilloscope. Using tests B-1 and B-3, the system performance will be measured through the WGAR mixer at the two injection voltage settings. Belar monitor injection levels will be recorded for the two levels.
4	DDJ (field tests)	WGAR Spurious & Composite	A test to simulate the WGAR transmitter configuration and reproduce the effect of 78 kHz noise on the Digital DJ signal will be conducted. The 78 kHz noise signal will be set at a level equal to the level shown on the WGAR base band plot on page #27 of the field test report. This injection level for the 78 kHz noise (not dispersed program audio modulation) will be a worst case condition. To simulate the field test transmission environment at the WGAR transmitter site on the Digital DJ system, a laboratory test will be conducted that includes combined impairment: a. WGAR spurious signal at 78 kHz b. Low Digital DJ system injection c. WGAR mixer frequency response roll off The test will compare Digital DJ system performance without the above impairments (HSSC signal directly to exciter) to the Digital DJ system performance with the above impairments. A test to measure headroom for the 78 kHz impairment will also be conducted. Additionally, off air observations of the WGAR signal during normal programming will be made at the laboratory. Plots of visible noise at 78 kHz will be recorded.

December, 15 1997

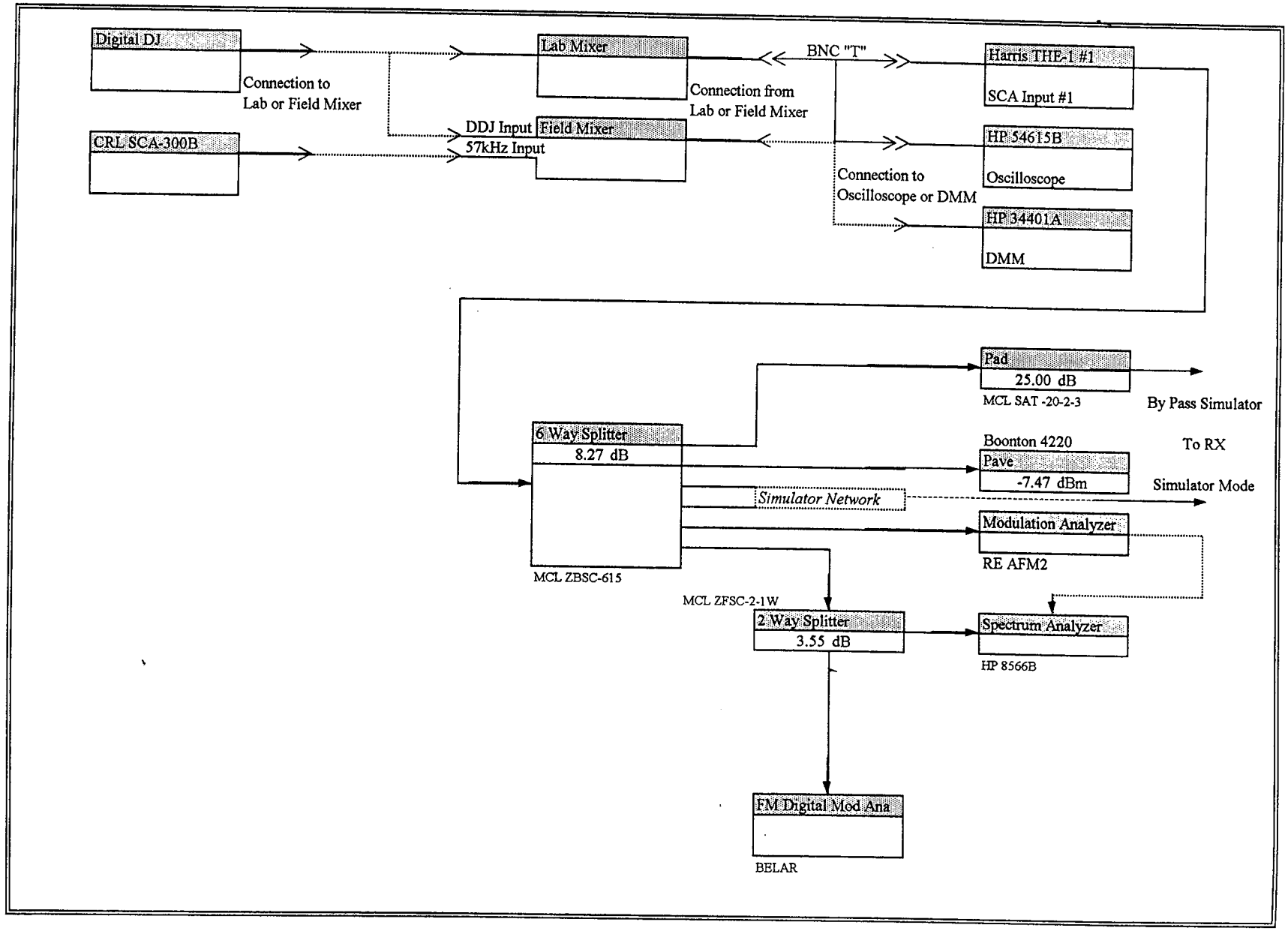
Project(s): NRSC HSSC

Test(s): Digital DJ tests to examine effects of field test equipment settings.

Engr(s): TK, DML

Description: Observations and measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: See Block Diagram


Digital DJ
Connection to
Lab or Field Mixer
CRL SCA-300B
Lab Mixer
DDJ Input
57kHz Input
Field Mixer
Connection from
Lab or Field Mixer
BNC "T"
Harris THE-1 #1
SCA Input #1
HP 54615B
Oscilloscope
Connection to
Oscilloscope or DMM
HP 34401A
DMM
Pad
25.00 dB
MCL SAT -20-2-3
By Pass Simulator
6 Way Splitter
8.27 dB
MCL ZBSC-615
Boonton 4220
Pave
-7.47 dBm
To RX
Simulator Mode
Simulator Network
Modulation Analyzer
RE AFM2
MCL ZFSC-2-1W
2 Way Splitter
3.55 dB
Spectrum Analyzer
HP 8566B
FM Digital Mod Ana
BELAR

December, 9 1997

Project(s): NRSC HSSC

Test(s): Compare DDJ Crest Factor measurements through lab and field mixers.

Engr(s): DML

Description: Measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: DDJ
Compliment of Lab Test Bed
Field Test Mixer
HP 54615B Oscilloscope
HP 34401A DMM

Test conducted through both lab and field mixer.

HP 54615B Settings

50	mV	per verticle division
2	ms	per horizontal division
AC	Coupling	
Pk Detect	Display mode	

Vectors Off
Timebase set for relatively stable peak to peak voltage readings.

HP 34401A DMM Settings
power up defaults
Function AC Volts

	Vp-p (mV)	Vrms (mV)	Crest Factor (dB)
Field Mixer	292.2		
	290.6		
	290.6		
	290.6		
	292.2		
Average	**291.2**	**93.8**	**0.810**

	Vp-p (mV)	Vrms (mV)	Crest Factor (dB)
Lab Mixer	295.3		
	295.3		
	293.8		
	293.8		
	295.3		
Average	**294.7**	**95.1**	**0.793**

December, 12 1997

Project(s): NRSC HSSC

Test(s): Observe recovered pilot and DDJ pilot lock stability.

Engr(s): DML, TK

Description: Observations as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: DDJ
Compliment of Lab Test Bed
Tektronix 485 Oscilloscope

Digital DJ and the Belar decoded WGAR off air pilot were connected to oscilloscope traces 1 and 2 respectively. Trace 2 was used to trigger the scope. With DDJ equipment in the external sync mode and the Belar decoded pilot connected to DDJ's pilot input the traces were observed to be in sync. While in this mode the lock light on DDJ's equipment was observed to be stable (lock indicator no flickering).

Switching DDJ into the internal sync mode caused the traces to loose synchronization as observed on the oscilloscope.

December, 10 1997

Project(s): NRSC HSSC

Test(s): Compare DDJ OME performance at injection levels relating to 3.4 or 3.5 V p-p at WGAR.

Engr(s): DML

Description: Performance measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: DDJ
Compliment of Lab Test Bed
Field Test Mixer
HP 54615B Oscilloscope

Test conducted through both lab and field mixer.
Field mixer results reported.
Lab mixer results showed 0.25 dB performance difference.

December, 10 1997

AWGN

WGAR Level (V p-p)	Target (mV p-p)	Lab Level (mV p-p)	Belar (%)	C/No (dB Hz)	Attn (dB)	BER	20 Byte	220 Byte
				76.38	5.75	0.000	0.000	0.000
3.40	286.6	285.9	10.1	76.63	5.50	0.005	0.049	0.267
				76.63	5.50	0.000	0.000	0.000
3.50		295.0	10.5	76.88	5.25	0.009	0.049	0.533
2.86%		3.07%						

Signal Conditions

Main Channel:	Off	Noise	Signal Reference	
Noise Attenuator:	7.50 dB	0 dB Ref	3W in	6W out
		-31.70 dBm	-32.66 dBm	-7.44 dBm
	C/No			
	74.63 dB Hz			

December, 12 1997

Project(s): NRSC HSSC
Test(s): DDJ Spurious and Composite performance test.
Engr(s): TK, DML

Description: Performance measurements as a result of NRSC HSSC subcommittee meeting on November 19, 1997.

Equipment: DDJ
Compliment of Lab Test Bed
Field Test Mixer

A 78kHz analog subcarrier modulated with clipped pink noise is used here to simulate the noise observed at WGAR June 20, 1997.

This signal is put into the field test mixer on the 57 kHz input.

The baseband spectrum analyzer settings were followed from the field test settings and the 78 kHz subcarrier injection level set according to the June 20, 1997 observation.

December, 12 1997

Field Mixer + 78 kHz Baseband Noise

AWGN	Belar (%)	C/No (dB Hz)	Noise Attn (dB)	BER(%)	20 Byte	220 Byte	(% MER)	
- Field mixer, - 78 kHz baseband noise - AWGN		76.41	5.75	0.000	0.000	0.000	No MCM	(Main channel modulation)
	10.2	76.66	5.50	1.058	3.333%	5.600		
(Control) Lab mixer, no 78 kHz baseband noise		76.66	5.50	0.000	0.000	0.000	No MCM	
	10.5	76.91	5.25	0.072	0.316 %	2.133		
Multipath - Field mixer - 78 kHz baseband noise - Main channel modulation	10.2			0.738	2.798 %	8.000 %		Urban Slow
	10.2			1.465	5.547 %	17.600 %		Urban Fast
	10.2			0.366	1.922 %	12.533 %		Rural Fast

No gaussian noise added on the multipath tests.

Signal Conditions

		Noise	Signal Reference	
Main Channel:	CPN 91%			
Noise Attenuator:	7.50 dB	0 dB Ref	3W in	6W out
		-31.66 dBm	-32.59 dBm	-7.44 dBm

C/No
74.66 dB Hz

December, 12 1997 No Mixer no 78 kHz Baseband Noise

AWGN	Belar (%)	C/No (dB Hz)	Attn (dB)	BER (%)	20 Byte	220 Byte	
Multipath (reference data no impairments, with main channel modulation)	10.5			0.743 (%)	2.701 %	7.467 %	Urban Slow
	10.5			0.399	2.238 %	13.067 %	Urban Fast
	10.5			0.345	1.825 %	11.200 %	Rural Fast

No gaussian noise added on the multipath tests.
(Multipath Test Reference)

Signal Conditions

Main Channel:	CPN 91%	Noise	Signal Reference	
Noise Attenuator:	7.50 dB	0 dB Ref	3W in	6W out
		-31.66 dBm	-32.59 dBm	-7.44 dBm
	C/No			
	74.66 dB Hz			

December, 12 1997 Threshold

AWGN

Belar (%)	C/No (dB Hz)	Attn (dB)	BER	20 Byte	220 Byte
10.5	72.91	5.75	0.142	0.803	5.600

AWGN added to produce level 0.25 dB before OME and simulated baseband noise level increased till an effect could be measured.

Signal Conditions

Main Channel:	Off	Noise	Signal Reference	
Noise Attenuator:	5.75 dB	0 dB Ref	3W in	6W out
		-31.66 dBm	-32.59 dBm	-7.44 dBm
	C/No			
	72.91 dB Hz			

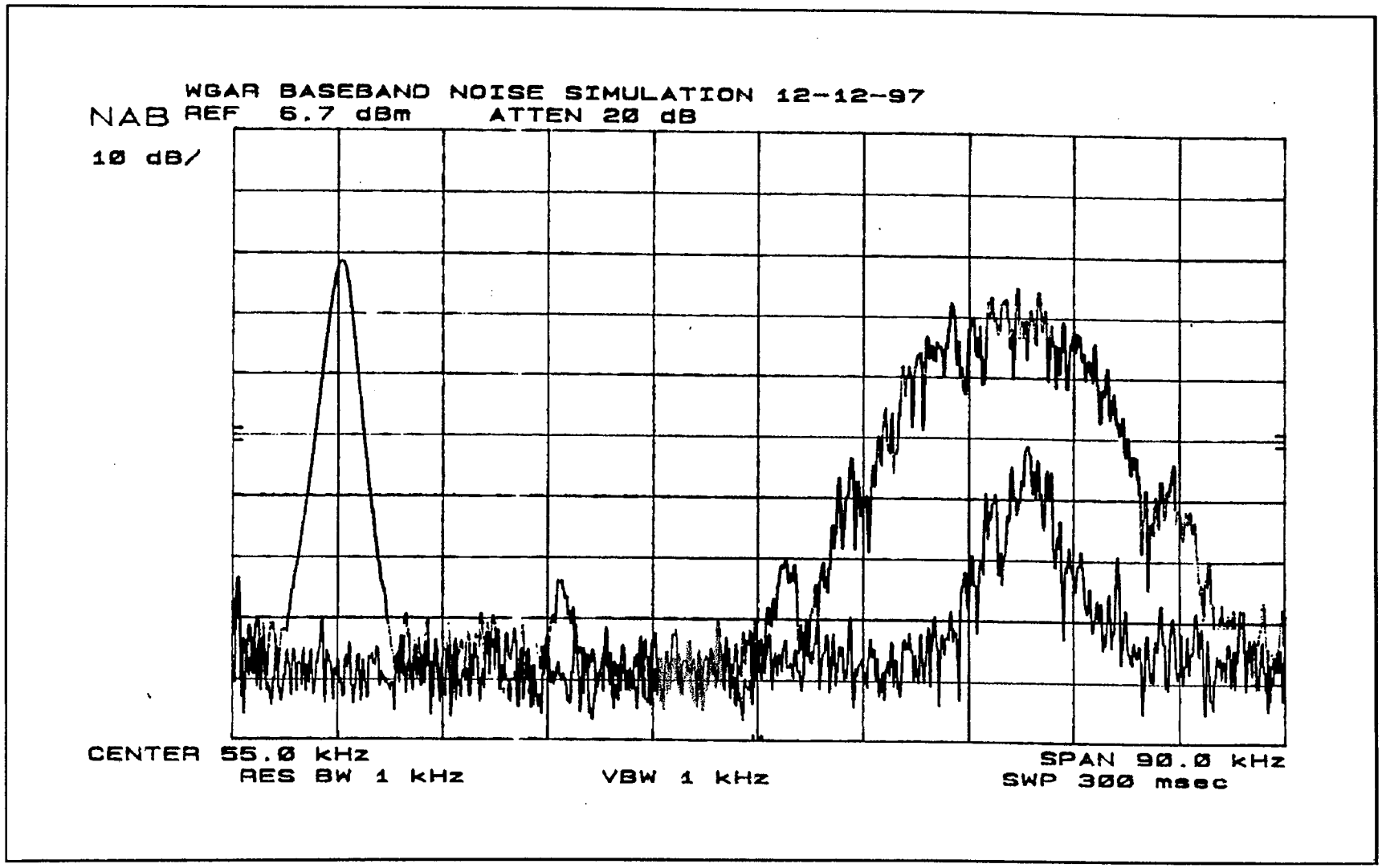


Figure 1: Digital DJ and simulated noise at WGAR level.

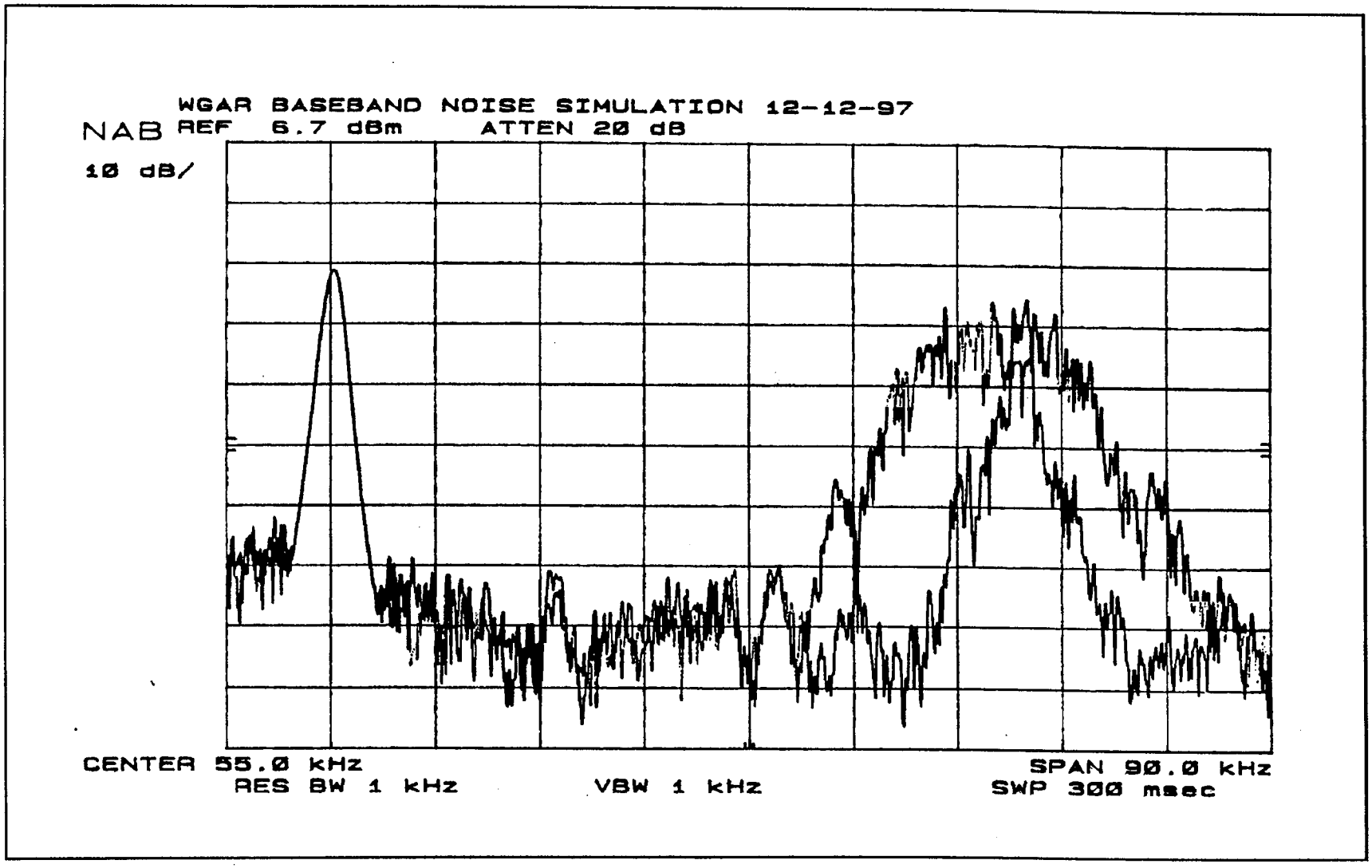


Figure 2: Digital DJ and simulated noise at threshold level.

NRSC Document Improvement Proposal

If in the review or use of this document a potential change appears needed for safety, health or technical reasons, please fill in the appropriate information below and email, mail or fax to:

National Radio Systems Committee
c/o Consumer Electronics Association
Technology & Standards Department
1919 S. Eads St.
Arlington, VA 22202
FAX: 703-907-4190
Email: standards@ce.org

DOCUMENT NO.	DOCUMENT TITLE:
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URGENCY OF CHANGE: _____ Immediate _____ At next revision	
PROBLEM AREA (ATTACH ADDITIONAL SHEETS IF NECESSARY): a. Clause Number and/or Drawing: b. Recommended Changes: c. Reason/Rationale for Recommendation:	
ADDITIONAL REMARKS:	
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CEA
Consumer Electronics Association


NAB
NATIONAL ASSOCIATION OF BROADCASTERS