NRSC REPORT

NATIONAL RADIO SYSTEMS COMMITTEE

NRSC-R58
Digital Audio Radio IBOC Laboratory Tests
Transmission Quality Failure Characterization and Analog Compatibility
August 11, 1995

Part III – Appendices F through P

NAB: 1771 N Street, N.W.
Washington, DC 20036
Tel: (202) 429-5356 Fax: (202) 775-4981

CEA: 1919 South Eads Street
Arlington, VA 22202
Tel: (703) 907-7660 Fax: (703) 907-8113

Co-sponsored by the Consumer Electronics Association and the National Association of Broadcasters
http://www.nrscstandards.org

NOTICE

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-R58, *Digital Audio Radio IBOC Laboratory Tests – Transmission Quality Failure Characterization and Analog Compatibility*, documents the first comprehensive testing of in-band/on-channel digital radio systems. This report was prepared for Working Group B and the Combined EIA DAR and NRSC DAB Subcommittees.

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.

Contents

Description	Appendix
Description of Multipath Profiles	F
Systemic Specific Tests and Procedures	G
Receiver Characterizations	H
Subcarrier Calibration	I
Ancillary Data Channel	J
IBOC Systems Modifications	K
Laboratory RF, Audio and Composite Stereo Distributions	L
RF Component Calibration	M
Bessel Null Modulation Monitor Calibration Process and Spectrum Plots	N
Peak-to-Average Power	O
Power Meter Calibration	P

APPENDIX F

Description of Multipath Profiles

SUMMARY OF:
THE FINAL REPORT OF THE
CHANNEL CHARACTERIZATION TASK GROUP;
THE DERIVATION AND RATIONAL FOR MULTIPATH SIMULATION
PARAMETERS FOR THE EIA-DAR LABORATORY TESTING

NOTE: This is a condensed version of the above titled report. It follows different section headings but with the same appendix reference as the full report. Only Appendix J is attached to this summary. The full report is available as a separate document.

MULTIPATH CHARACTERIZATION AND CHANNEL SIMULATION BACKGROUND

At the January 22, 1992 meeting of the EIA-DAR Committee, the "Digital Audio Radio Technical Performance and Service Objectives" were discussed and adopted. The requirement for multipath performance testing was set.

The candidate laboratory channel simulator could be directly programmed using time domain values; the relative attenuations, doppler frequencies (or relative phases) and time delays. Searching the literature for channel characteristics in the time domain for direct application to the simulator revealed very little information. A source of direct information on time domain parameters, the characterization test, was required.

In early 1993 the Delco channel test plan system was disclosed. The Delco system description evolves over a number of months as detailed in the series of memoranda and reports in Appendix A. The Channel Characterization data would be collected and then processed to extract the time domain parameters that would then be applied to the laboratory channel simulation. The processing plans are described in Appendix B.

The Hewlett Packard simulator, model No. 11759C was chosen for the laboratory testing. It can be programmed in the Direct mode with the individual channel parameters to simulate a multipath condition. Use of this technique to achieve a dynamic simulation at fixed steps along a path (sequential snapshots) was discussed and the direct control of the simulator based on the actual measured channel characteristics was pursued.

CHANNEL TEST NEEDS; EQUIPMENT, VENUE, ETC.

The channel test program is summarized in Appendix C. Only one city could reasonably be used for channel characteristic testing because of cost and time limits, therefore the test venue should contain many areas that represent as many "difficult" environments as possible.

By May 1993, plans were underway for conducting a channel characterization test in Charlotte, N.C. Those early tests revealed system and operational limitations in conducting such tests, detailed in the July Subcommittee meeting and in a report in Appendix D. Plans were made to revise the equipment and test at another venue.

Bonneville Broadcasting, a long time participant in the EIA-DAR test program, offered its transmitter site in Salt Lake City on Farnsworth Mountain. The site was investigated and the equipment was delivered and set up at the site with testing beginning in late September and continuing to early October of 1993.

CHANNEL TEST DATA COLLECTED; FINDINGS; ENVIRONMENTS, SPEED, DATA, VOLUME COLLECTED, PROCESSING, ETC.

In early October 1993 the actual Salt Lake City channel characterization test data was collected over approximately one week. Appendix E is a description of the measurements and the data collected. As data was collected along each path, the environment around the area was described. Four major "Environments" quickly emerged: Urban, Suburban, Rural and Terrain Obstructed. Appendix F is a March 7, 1994 memorandum discussing the data collected, its analysis and the certification of the test method.

The data extraction strategy was studied and modified from its initial frequency domain dependent version to one which selected reflections based on time domain values in order of the strongest reflections with their accompanying delay and relative phases.

By April 1994 the VHF Channel Characterization data had been analyzed, providing the overall range of reflection magnitudes verses time delay for the four significant environments in Salt Lake City as shown in Appendix G. Further analysis then extracted the individual channel reflection vs. time information on a file by file basis as explained in the memorandum report dated April 17, 1994 in Appendix H.

The measured VHF reflection time vs. magnitude information was studied to arrive at the range of data appropriate for challenging multipath Environments. Information from other sources was also compared to the measured VHF channel data so that the simulation could include the 1.4 GHz UHF channel DAR system as well. The Canadian CRC investigation relating to L-Band characterization lead to the exchange of several documents, a selection of which are included in Appendix I.

The listings of time delays and magnitudes with appropriate doppler velocities and Rayleigh file parameters for each of the three environments (four tests), as adopted by the EIA-DAR test laboratory and is indicated in the attached Appendix J.

SIMULATOR LIMITATIONS; ATTENUATOR RATE OF CHANGE & "ARTIFACTS"

The direct control method, described in the Simulator operating manual, was tested in early 1994 and limitations quickly appeared. The simulator attenuator control circuits have a significantly slow time constant which will allow only slow changes in the simulation channels, far slower than were measured. This was implemented and found to function properly.

Tests were run on the simulator using sample direct control data and observing the simulator effect in the frequency domain. Upon close observation it could be seen that artifacts were being generated. Appendix K is a memorandum and report of July 12, 1994 describing the findings. The report and attachments indicate that the frequency domain artifacts are generated by the step changes in the simulator channels.

In an attempt to resolve the Frequency Domain artifacts the data was "smoothed", as indicated in Appendix K, by limiting the rate of change of some of the parameters and approximating missing data between data files. The artifacts decreased but still remained. It was decided, not knowing the impact of the artifacts on the systems under test, that the direct control of the simulator was not possible.

IMPLEMENTING SIMULATION MODE; MAINTAINING VARIABILITY

The Simulation or "sim" mode of operation allows for two variations. The first is the "Doppler" mode, a fixed parameter mode with a fixed cyclical simulation, and the second applies a Rayleigh variation characteristic on the "Doppler" control parameters. This Rayleigh characteristic will restore some of the channel variability lost in going from the Direct to the Sim mode of channel simulation.

The Rayleigh fading characteristic is imparted on the simulator action by a control file that is generated by the HP program IQMAKE. The Rayleigh fading values are oriented about the basic channel parameters, those which were measured in Salt Lake City, not any other parameters associated with any standard Cellular or Land Mobile system. The resulting simulation has the overall characteristic of the measured control values but with the Rayleigh variation characteristics specific for the frequency and velocity of interest for the test, impressed on each of the control channels. This effect on each of the individual channels then generates a combined effect on the overall variation of the combined R.F. channel output.

DISCUSSION OF APPROPRIATENESS OF DOPPLER VS. RAYLEIGH CHARACTERISTICS

Much discussion centered about the proper use of the Doppler or Rayleigh simulation modes. Objections were raised citing the HP instruction manual with various references to the Rayleigh model defined for mobile cellular radio. Concerns were expressed relative to whether or not a Rayleigh faded channel was appropriate for the mobile environment. The use of particular sections of the Salt Lake City measured channel characteristics and then only that one venue was questioned.

Many individual experts in mobile communications reviewed the questions and concerns and have supported this simulation concept as appropriate for the laboratory testing. Appendix L contains the observations, comments and responses regarding the Rayleigh and Doppler simulations.

As a result of the questions regarding the use of Rayleigh simulation a decision was made to incorporate both Doppler and Rayleigh simulations in an expanded laboratory test.

CHANNEL TEST AND SIMULATION; LESSONS LEARNED

This channel characterization project and the channel simulation in the laboratory has again confirmed the immense variability that exists in an R.F. propagation path which can not be carried to and totally duplicated in laboratory simulation. For laboratory purposes, however, capturing all that variability would be counter-productive. For example, in an average environment, much of the time the R.F. channel may be quite benign with few if any interesting and stressful multipath conditions. The laboratory testing is meant to be a critical test of the systems. It is the relatively rare but stressful conditions that need to be reliably and rapidly repeated in the laboratory. This goal guided the extraction of "significant" multipath segments from the four environments to concentrate on those areas that generally would yield harsh tests.

Ideally, the original laboratory test would have used the actual channel parameters measured in the field, complete with their variability along the measurement path, to control the channel simulator as if driving along that same path. Hardware limitations prohibited this. The same general channel characteristics for the difficult path segments were used but with the parameter variability now supplied by the Rayleigh fading profile applied to those characteristics.

The channel simulation testing has been applied uniformly to all of the proponent systems, even to the extent of testing in both Rayleigh and Doppler modes. The systems individual relative performances will be determined by the systems themselves, not by the design of the testing. If the testing were designed so that all systems were to fail the test, or where all were to easily pass the simulation test, the results would be useless. The only valid test is one that spans the range of performance from perfect to failed for all systems under test and hence determines a threshold of actual performance. The laboratory simulation provides such a test.

APPENDIX J - DATA PROCESSING AND INTEGRATION TO SIMULATOR(S); ACTUAL SIMULATION PARAMETERS

J-1 Memo Report (L&C), "Suggested Nine Path Multipath Simulation Settings" -- 7/26/94

J-2 Letter from D. Londa, EIA, "Channel Simulator Parameters" -- 8/16/94

SUGGESTED NINE PATH MULTIPATH SIMULATION SETTINGS 7/26/94

SIMULATOR SETTINGS - DELAY IN MICROSECONDS, ATTENUATION IN dB

PATH	URBAN SLOW-FAST DELAY	URBAN SLOW-FAST ATTN.	RURAL DELAY	RURAL ATTN.	OBSTRUCTED DELAY	OBSTRUCTED ATTN.
1	0.0	2	0.0	4	0.0	10
2	0.2	0	0.3	8	1.0	4
3	0.5	3	0.5	0	2.5	2
4	0.9	4	0.9	5	3.5	3
5	1.2	2	1.2	16	5.0	4
6	1.4	0	1.9	18	8.0	5
7	2.0	3	2.1	14	12	2
8	2.4	5	2.5	20	14	8
9	3.0	10	3.0	25	16	5

URBAN - SLOW; Use Rayleigh doppler path at 1 KPH at 94.1MHz RF test frequency. NOTE; this slow speed may not allow full development of all possible Rayleigh states. Be prepared to try 2 and 4 KPH to see if there is a difference.

URBAN - FAST; Use Rayleigh doppler at 60 KPH.

RURAL (FAST); Use Rayleigh doppler at 150 KPH.

SUBURBAN/TERRAIN (FAST); Use Rayleigh doppler at 60 KPH.

NOTE: The suggested settings above are based on a comparison of the original EIA SIM A - D files and the Canadian UHF suggested 12 path urban and 8 path rural settings. A thorough review of the Salt Lake City direct control files will be made to determine the average delays and magnitudes for the four environments to extract 9 path settings to be applied to this test. Those revised settings will be coordinated with Canada. The goal is a uniform Simulation Mode test for all bands.

NOTE: 7/26/94 The EIA VHF test data has been reviewed and coordinated with Canada. The above table represents consolidated Urban and Rural environment parameters for both VHF and UHF tests. The Obstructed file is based only on the VHF measurement further analysis.

EIA DAR Test Laboratory

August 16, 1994

Mr. Robert D. Culver
Lohnes & Culver
8309 Cherry Lane
Laurel, MD 20707-4830
Phone:(301) 776-4488 Fax:(301) 776-4499

Dear Bob,

Here is the multipath characterization video tape.

The channel simulator parameters used for the Urban environment are as follow:

PATH	DELAY (us)	DOPPLER (kmh)	ATTEN (dB)
1	0.0	2 or 60	2.0
2	0.2	2 or 60	0.0
3	0.5	2 or 60	3.0
4	0.9	2 or 60	4.0
5	1.2	2 or 60	2.0
6	1.4	2 or 60	0.0
7	2.0	2 or 60	3.0
8	2.4	2 or 60	5.0
9	3.0	2 or 60	10.0

The channel simulator parameters used for the Rural environment are as follow:

PATH	DELAY (us)	DOPPLER (kmh)	ATTEN (dB)
1	0.0	150	4.0
2	0.3	150	8.0
3	0.5	150	0.0
4	0.9	150	5.0
5	1.2	150	16.0
6	1.9	150	18.0
7	2.1	150	14.0
8	2.5	150	20.0
9	3.0	150	25.0

EIA Digital Audio Radio Test Laboratory
NASA Lewis Research Center
Communications System Branch
21000 Brookpark Road, MS 54-2
Cleveland, OH 44135
Telephone (216) 433-3445
Telefax (216) 433-8705

The channel simulator parameters used for the Suburban / Terrain Obstructed environment are as follow:

PATH	DELAY (us)	DOPPLER (kmh)	ATTEN (dB)
1	0.0	60	10.0
2	1.0	60	4.0
3	2.5	60	2.0
4	3.5	60	3.0
5	5.0	60	4.0
6	8.0	60	5.0
7	12.0	60	2.0
8	14.0	60	8.0
9	16.0	60	5.0

The IQMAKE.EXE utility was used twice to create the Rayleigh fading data. The command parameters used are as follow:
IQMAKE -R 94.1E6 2 60 150 and similarly
IQMAKE -R 1.47E9 2 60 150.

These command lines then created the Rayleigh fading data files and the appropriate filename was indicated in the simulation mode menu under the Spectrum filename heading. Simulation profiles were stored with the appropriate Raleigh fading data filenames, delay and attenuation and the profiles recalled and video taped.

The first four segments on the tape (00:00-05:42) are the VHF simulations and the last five segments (05:42-12:22) include a reference of the signal unimpaired followed by the simulations in L-Band.

Call me if you have any questions.

Best regards,

Dave

David M. Londa
RF Test Manager

EIA Digital Audio Radio Test Laboratory
NASA Lewis Research Center
Communications System Branch
21000 Brookpark Road MS 54-2
Cleveland, OH 44135
Telephone (216) 433-3445
Telefax (216) 433-8705

APPENDIX G

Systemic Specific Tests and Procedures

Proposed System Specific Third Mode Test for Amati/AT&T IBOC System

May 10, 1994

The DAR test plan calls for the Amati/AT&T IBOC System to be tested in two modes. The first and primary mode uses the upper _and_ lower extremity of the FM channel mask, and the second mode uses the upper _or_ lower extremity of mask for the transmission of the DAR signal. Because of possible variations in the test receiver, limited testing of both combinations for the second mode should be conducted.

Proposal:

1. The proponent will recommend the sideband to be used for the second mode testing.

2. For the side band not used for general testing, the following tests will be conducted:

B-1 Noise for EO&C only •
B-3 Multipath and noise for EO&C only

System specific tests for the Eureka-147 DAB system

System operation in a active echo environment

A- Purpose of the tests:

These tests are to confirm the capability of the Eureka-147 DAB system, as claimed by the European system developers, to work in presence of large echoes produced by on-channel re-transmitters. These re-transmitters, operating on the same frequency, are expected to be used to fill gaps within coverage areas (gap-filler); extend the coverage of the conventional single transmitter (coverage extenders); or stretch the coverage of broadcast stations over a larger area using a network of synchronized on-channel transmitters (single frequency network - SFN). In all these three cases, the on-channel repeaters will generate, depending on where the receiver is located relative to these repeaters, active echoes that may fall either before of after the reference signal coming from the main transmitter, and the level of these active echoes could be either smaller or larger than the reference signal. The goal of this test will be to confirm the operation of the Eureka-147 system in presence of these echoes.

Further, the system developers claim that the system has improved performance in presence of echoes. More precisely, it is claimed that it makes constructive use of these echoes rather than being negatively impacted by them. In fact, the performance of the system would be related to the power addition of these echoes. The goal of these tests is also to confirm this claim and clarify the circumstances and conditions under which this happens.

B- Proposed test procedure:

<u>Test 1: Echo weighting template</u>

It is proposed to use the HP 11759C channel simulator to simulate active echoes that would be injected in the transmission channel before reception by the Eureka-147 receiver. Figure 1 depicts the setup required to conduct the tests

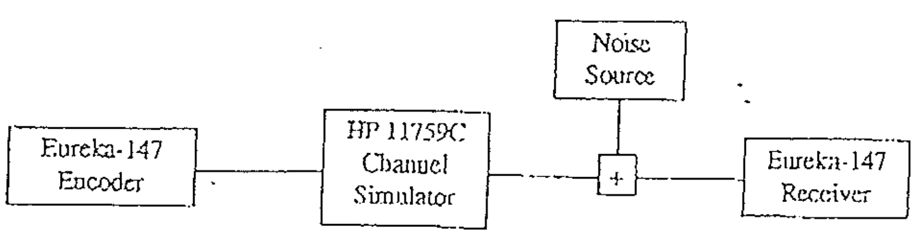


Figure 1: Block diagram of the test setup

One path of the channel simulator would be used to provide the main signal with a constant amplitude and phase. This would be the reference signal for the test. A second simulator path would carry the active echo. The phase of this path would be constantly changing (implemented in the simulator as a fixed Doppler shift). The rate of phase shift could be a minimal and a maximal amount, within the limits of the Doppler spread of the channel (i.e., simulating a vehicle displacement orthogonal to the main signal path, and parallel and orthogonal to the on-channel repeater's signal path).

It is proposed to sweep the delay of the active echo from 0 µsec to +186 µsec (limit of the channel simulator) referenced to the main path in steps of 10 µsec. At each step, the amplitude of the echo will be brought from a low level and increased until the "point of failure" (POF) is reached by listening to the audio material (measuring the BER on the data channel and identifying the echo amplitude for a BER of 10^{-4} would make this test more repeatable). The echo amplitude at the POF will be noted at each echo delay. If the POF is not reached for an echo higher that 10 dB above the reference signal, there is no need to go beyond this point. This sweep should be repeated for the case where there is no noise in the channel and also for the cases where noise levels of 15 dB and 12 dB below the level of the main path are injected in the channel.

The results of this test should be similar to the predicted template shown in Figure 2. This template can, in fact, be used to weight the effect of echoes as a function of their delay. This template should theoretically be symmetrical relative to the main path since it is claimed that pre- and post-echoes are handled the same way by the system. Although the system is to work equally well with pre-echoes, the left side of the template is not expected to be reproduceable by laboratory measurements since the synchronization algorithm is programmed to latch on to the first echo of a certain power, whether it is a pre-echo or the reference signal.

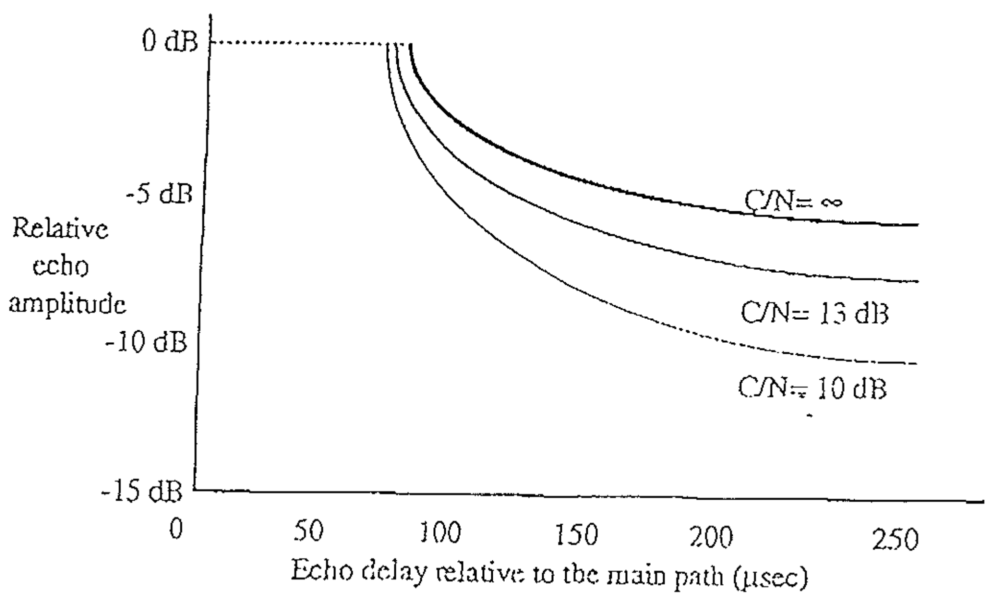


Figure 2: Typical echo weighting template

Test 2: Effect of echoes on the system's C/N performance.

Test 2.1: It is proposed to inject a calibrated level of noise in the channel path and raise this level of noise in presence of the main signal only, until the POF is reached (or BER= 10^{-4}). This value is noted.

Test 2.2: Then an echo with a varying phase as described in Test 1 above is injected at the same power as the main signal. The delay between the main signal and this echo is such that the echo falls within the range where the POF could not be reached with an increase of the echo power in Test 1 (i.e., within the system guard interval). The noise power is then increased until the POF is reached (or BER=10^{-4}). This C/N value is noted. In this case, "C" represents the added power of the two signals, thus 3 dB higher than in the preceding case. The increase in C/N value, compared to that of the previous Test 2.1. represents the impact of moving the operation of the system from a Gaussian channel to a Rayleigh channel.

Test 2.3: A second echo of the same power and varying phase should then be injected. This new echo should be within the range where the POF could not be reached as performed under Test 2.1 (i.e., within the guard interval). The noise power is then increased until the POF is reached (or BER= 10^{-4}). This new value of C/N at POF should be recorded. In this case, "C" represents the total power of the three echoes (i.e., 4.8 dB higher than in the case of the single signal). The C/N value is then compared to the case of Test 2.2 to verify that the principle of power addition of echoes applies as claimed once the system operates in a Rayleigh environment (i.e., for one echo and more). This principle can be verified further with the injection of more echoes at the same level and the identification of the C/N at POF (or BER= 10^{-4}).

Gérald Chouinard
CRC
94.05.04

EIA Digital Audio Radio Test Laboratory

Test B-1 **AT&T Amati** **Upper Side Band**	System Specific **Gaussian Noise**		Units
Glockenspiel	TOA	POF	
Attenuator	32.50	29.00	dB
Co/No	20.61	17.11	dB
EO&C TOA	Small break in recovered audio.		
EO&C POF	Excessive muting and a loud squeal.		

LSB # 18.85

16.8 on LSB

Test B-2 **AT&T Amati** **Upper Side Band**	System Specific **Co-Channel**		Units
Glockenspiel	TOA	POF	
Attenuator	20.50	18.00	dB
d/u	21.36	18.86	dB
EO&C TOA	Small warble or flutter and some static pops.		
EO&C POF	Excessive muting and fluttering.		

15.9 on LSB

LSB # 17.4

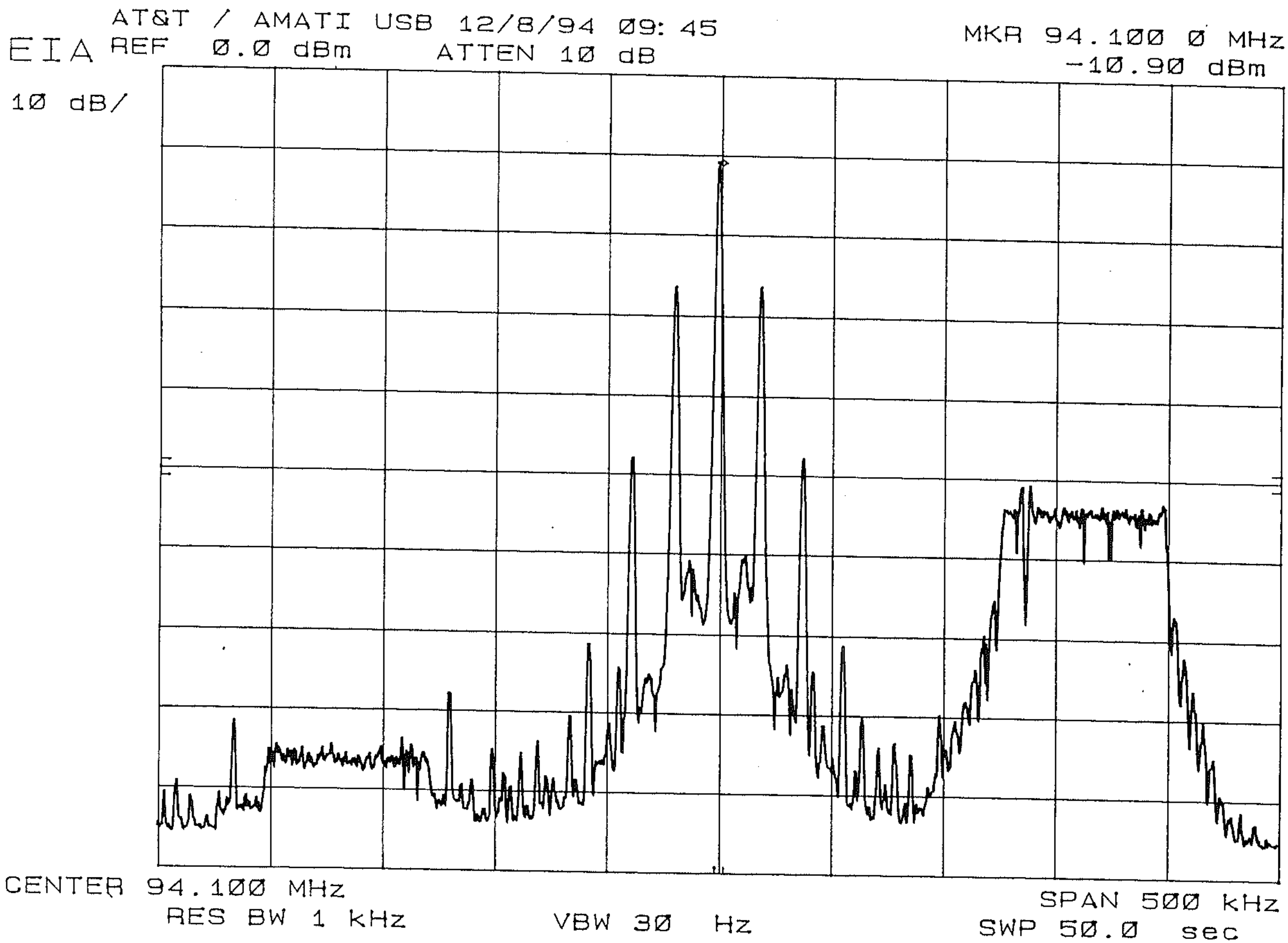
Additional Comments: In unimpaired conditions at medium signal strength the recovered audio has artifacts with glockenspiel program material. Artifacts sound like a mooroco type rattle on the first note of some glockenspiel arpeggios.

Testers: DML,RMc
Date: 8-Dec-94

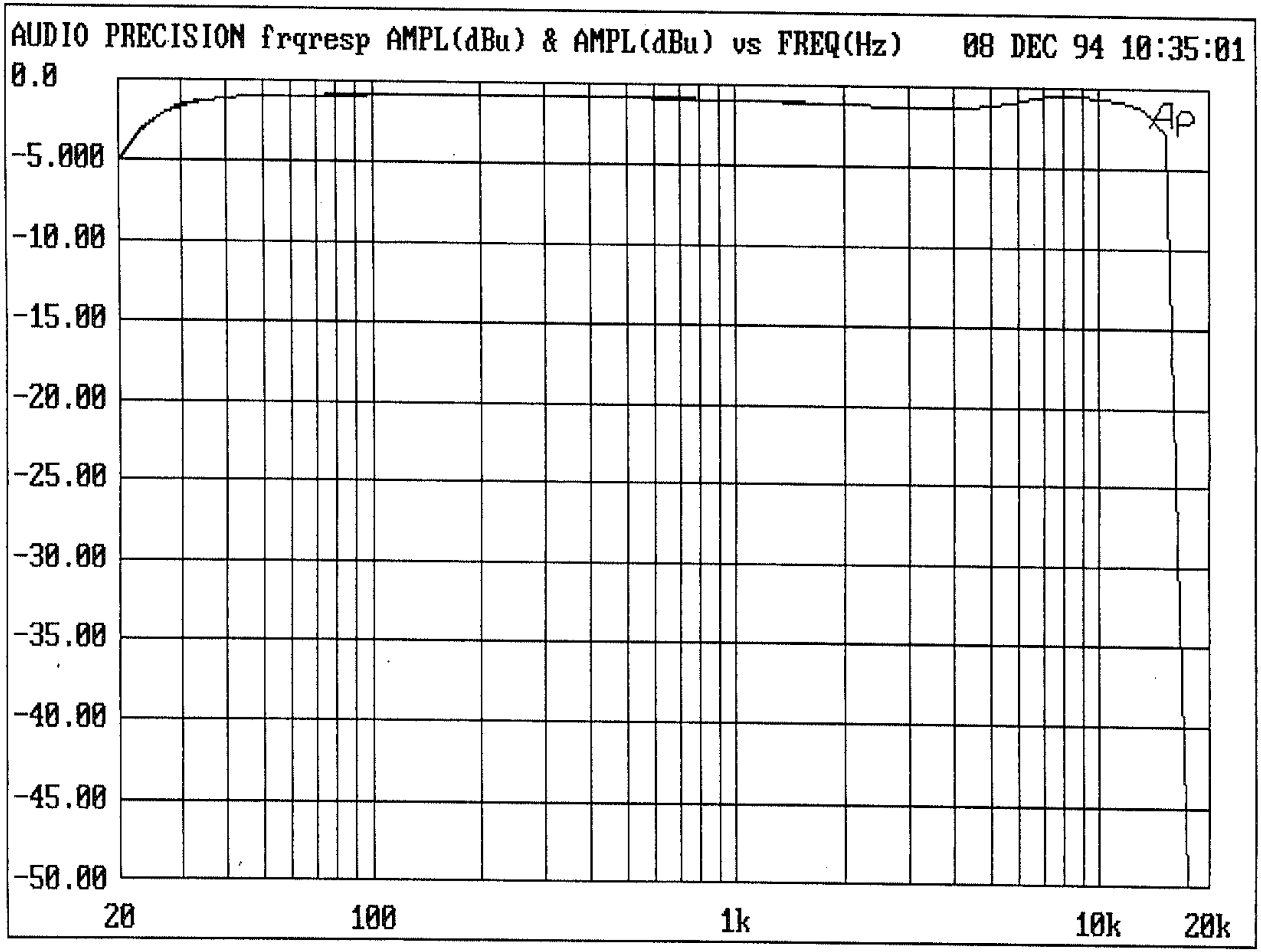
Test	B-3 System Specific Multipath (Rayleigh)				
AT&T Amati USB					
Program Material:	Glockenspiel				
Scenario	Level	Attn	Co/No	Units	EO&C
#1 Urban Slow	TOA	63.75	52.34	dB	Mutes, pops and flutters. Worse than POF.
	POF	63.75	52.34	dB	
#2 Urban Fast	TOA	63.75	52.34	dB	Flutters, pops and mutes. POF level of impairment.
	POF	63.75	52.34	dB	
#3 Rural Fast	TOA	63.75	52.34	dB	Mutes, flutters and large pops. Worse than POF.
	POF	63.75	52.34	dB	
#4 Terrain Obstructed	TOA	63.75	52.34	dB	Long duration mutes (5 sec) and pops. Worse than POF.
	POF	63.75	52.34	dB	

Test Date: 8-Dec-94
Testers: DML, RMc

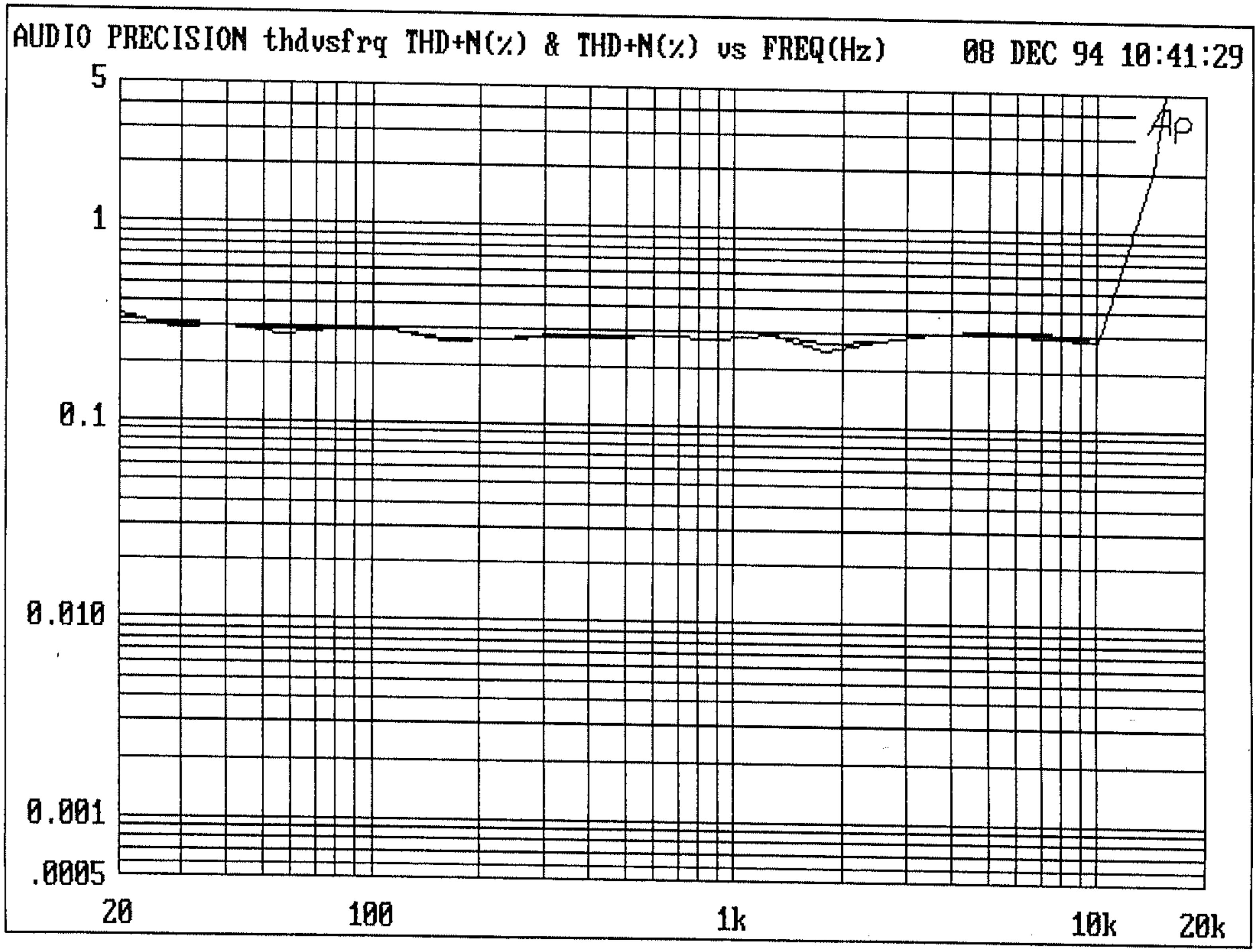
	Desired		Noise	
Signal	-31.46 dBm			
IL	40.79 dB	BW	6.45E+06 Hz	
3WIN	-72.25 dBm	0dB Ref	-41.41 dBm	



AT&T / AMATI USB 12/8/94 09: 45
EIA
REF 0.0 dBm
ATTEN 10 dB
MKR 94.100 0 MHz
-10.90 dBm
10 dB/
CENTER 94.100 MHz
RES BW 1 kHz
VBW 30 Hz
SPAN 500 kHz
SWP 50.0 sec



AT&T / AMATI - USB



AT&T / AMATI USB

30-Nov-94
E-147 System Specific
DOPPLER: 160 Km/H
PHASE: 217 Hz

CLEAR CHANNEL TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	-3.00	0.00	-2.00	-1.00	-2.00	-2.00	-3.00	-4.00	-4.00	-4.00	-4.00

C/N = 10dB TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	-0.10	0.00	-4.50	-2.30	-4.50	-3.50	-4.60	-4.30	-5.50	-5.50	-5.50	-7.30	-7.00

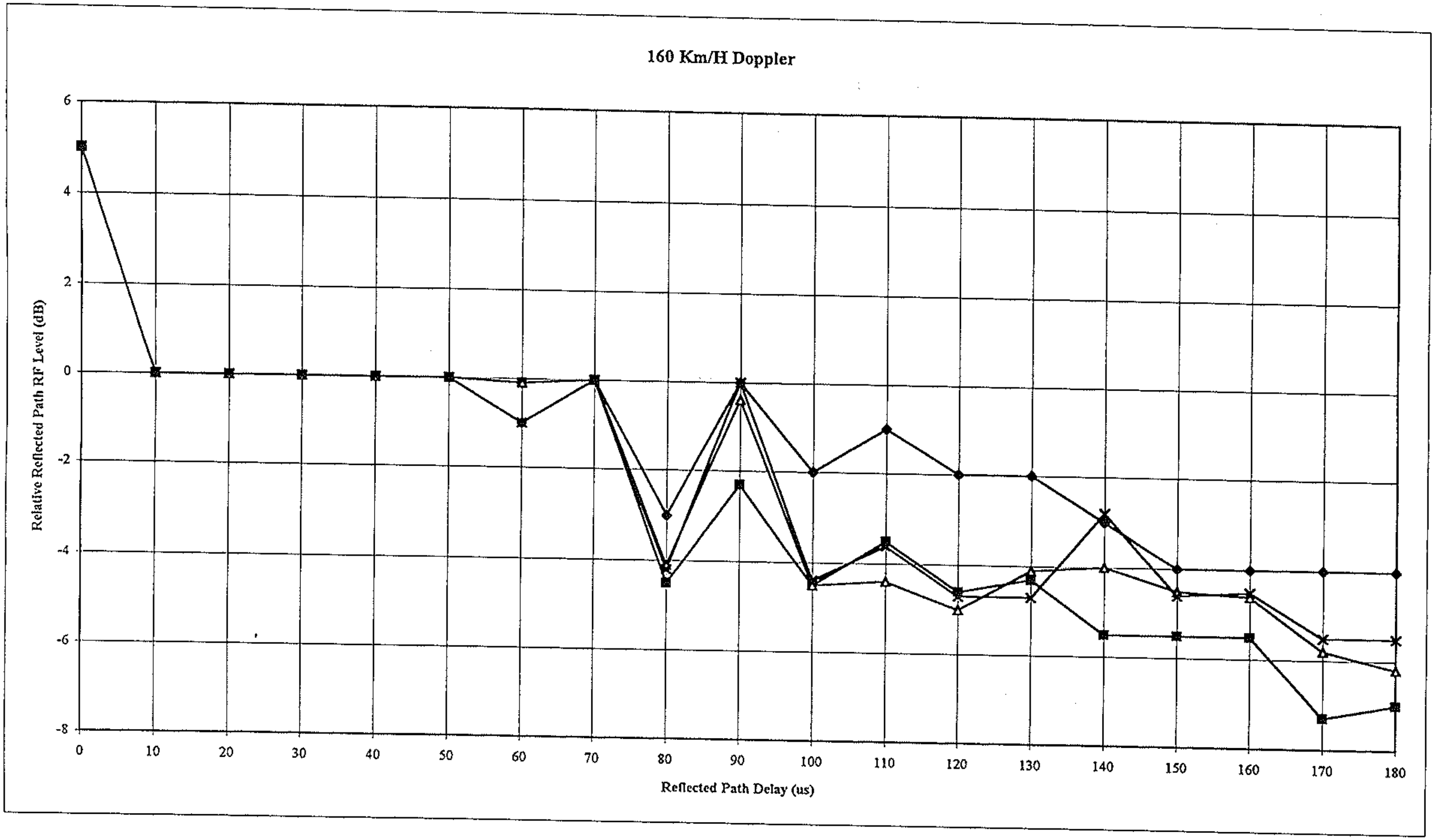
C/N = 13dB TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	-0.10	0.00	-4.10	-0.40	-4.50	-4.40	-5.00	-4.10	-4.00	-4.50	-4.60	-5.80	-6.20

Co/No = 22dB TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	-1.00	0.00	-4.20	0.00	-4.40	-3.60	-4.70	-4.70	-2.80	-4.60	-4.50	-5.50	-5.50

Notes: The values listed are the delayed or reflected path RF levels in dB relative to the non-delayed path RF level at a POF level of impairment.



File Name: E147SS.XLS UF Chart

EIA Digital Audio Radio Test Laboratory

30-Nov-94
E-147 System Specific
DOPPLER: 2 Km/H
PHASE: 2.724 Hz

worked fine | POF → | lower delayed signal by 3.5 dB to get to POF (would not work at 0)

CLEAR CHANNEL TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3.50	0.00	-2.00	-1.30	-2.00	-2.50	-3.00	-3.00	-3.50	-4.00	-4.00

"0" means both signals at same level

Co/No = 10dB TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-4.50	-2.00	-5.00	-4.40	-6.50	-6.00	-5.60	-7.50	-6.30	-6.60	-8.00

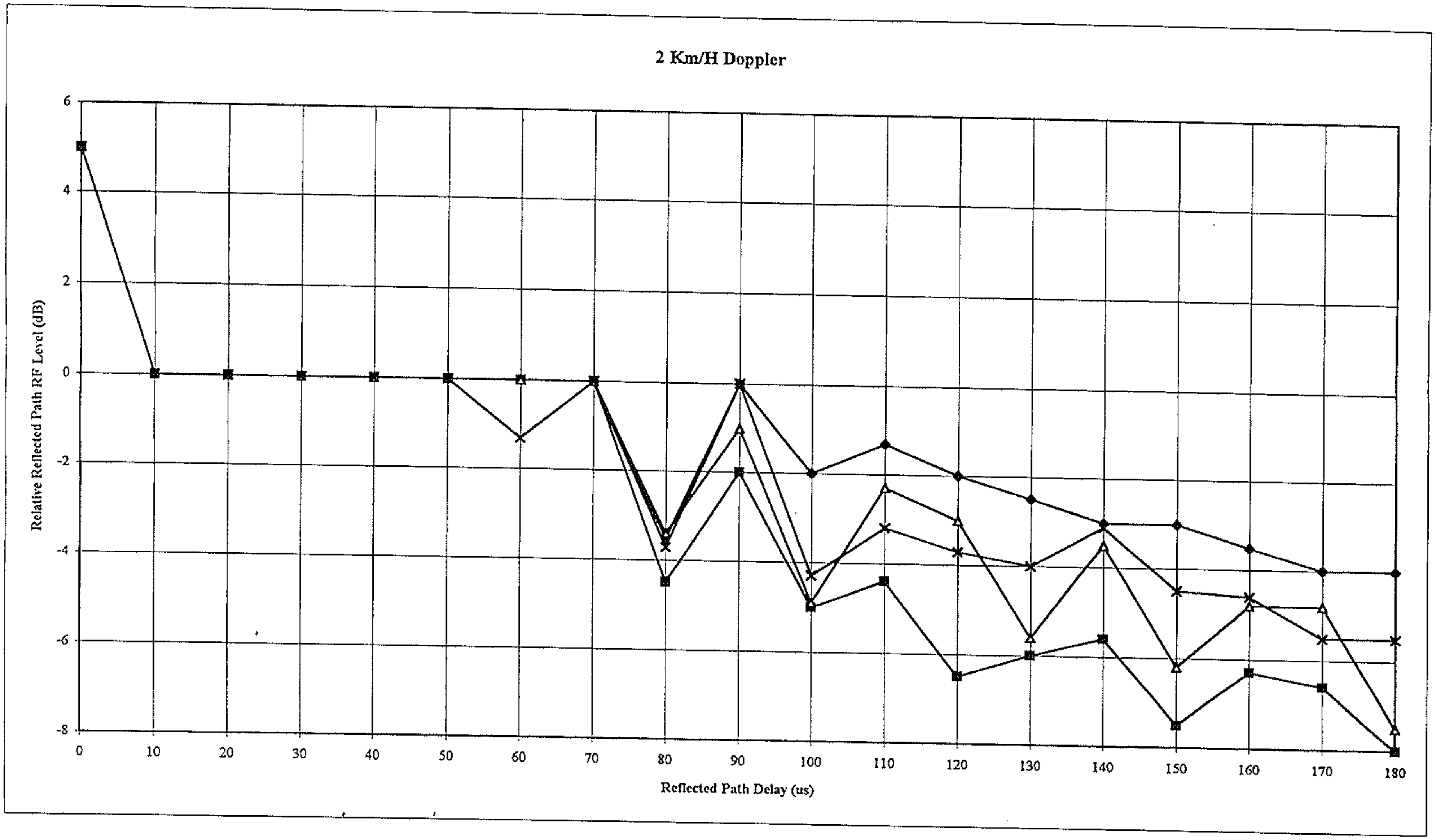
Co/No = 13dB TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-3.40	-1.00	-4.90	-2.30	-3.00	-5.60	-3.50	-6.20	-4.80	-4.80	-7.50

Co/No = 22dB TEST **DELAY (us)**

	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180
POF	5	0.00	0.00	0.00	0.00	0.00	-1.30	0.00	-3.70	0.00	-4.30	-3.20	-3.70	-4.00	-3.10	-4.50	-4.60	-5.50	-5.50

Notes: The values listed are the delayed or reflected path RF levels in dB relative to the non-delayed path RF level at a POF level of impairment.


2 Km/H Doppler
Relative Reflected Path RF Level (dB)
6
4
2
0
-2
-4
-6
-8
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Reflected Path Delay (us)

EIA Digital Audio Radio Test Laboratory

Engineers: RMc/DL
DATE: 5/24/95

TEST N

MULTIPLE SPURIOUS

This test is **IBAC** specific. In addition to co-channel and adjacent channel separations, Part 73.207 of the FCC rules also specifies the minimum distance separation requirement for FM stations operating at 10.6MHz and 10.8MHz (10.7MHz IF) above and below the operating channel. Using the interference caused by two FM stations operating at the 10.7MHz separation as the reference, Test N will compare the two FM station's reference with the interference caused by an IBAC and FM station at the same power level.

1) **Reference**
The following frequencies and procedures will be used to characterize the reference receiver.
RF GEN. 1 = 94.1MHz
Rec. Freq. = 99.95MHz
RF GEN. 2 = 104.8MHz
RF1 = The RF level required from a single generator to give 30dB S/N ratio at the receiver tuning frequency
RF2 = The RF level required from both interfering generators to give 30dB S/N ratio. (RF Level GEN 1 = RF Level GEN 2)
Result:
IF_REJ. = 20 log RF2/RF1(uV) or RF2 - RF1(dBm)
Subjective EO&C of the test receiver audio quality

2) **Test**
Using the test receiver, the proponent IBAC system will replace RF GEN. 1 (94.1MHz).
The average power of the IBAC transmitter will be set to the same level as RF GEN. 2.
Any difference in subjective interference will be noted in the EO&C.

---

used Panasonic radio since it had continuously variable tuner

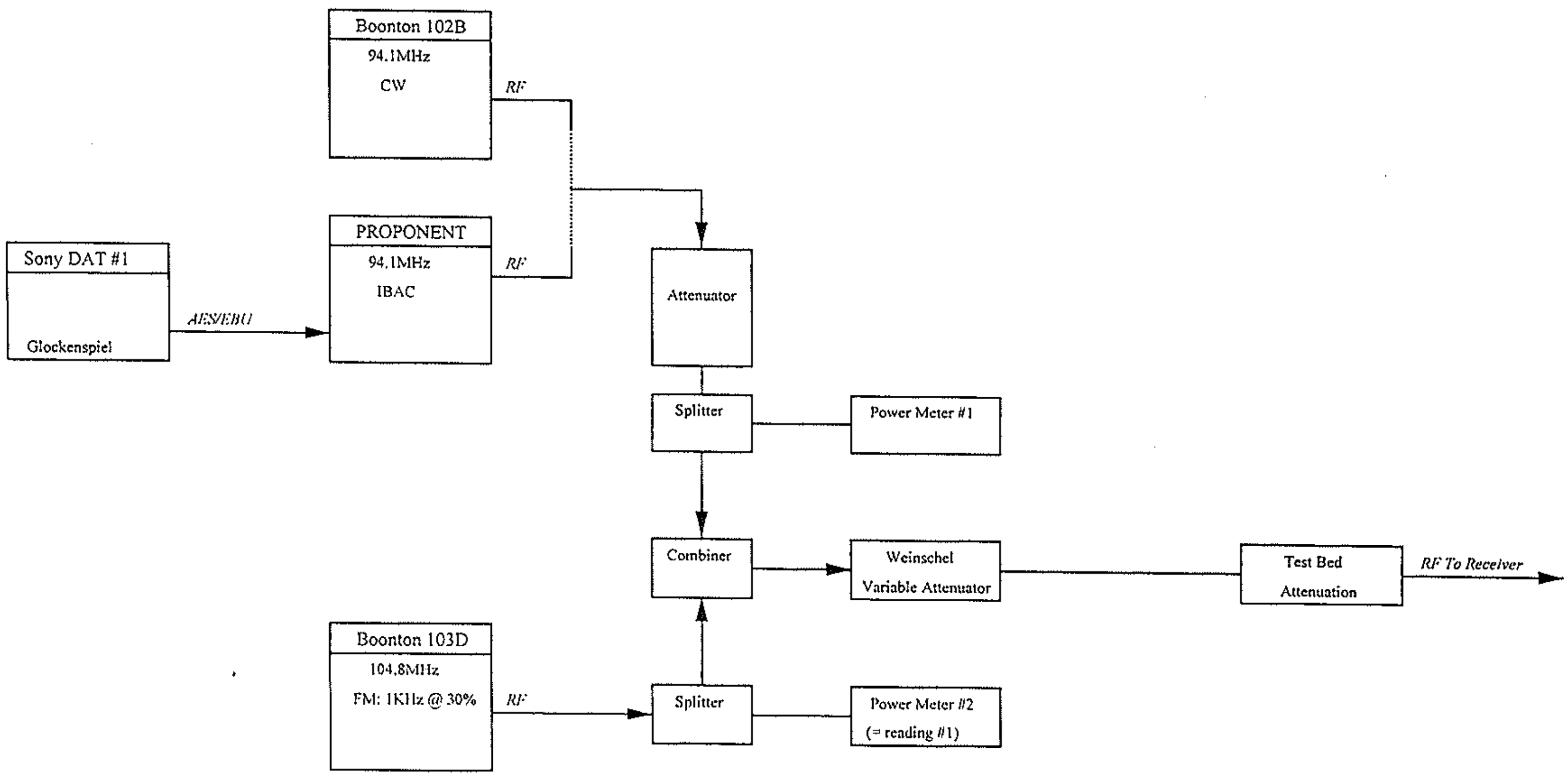
EIA Digital Audio Radio Test Laboratory

clint pinkham thinks this is better than you would expect by 20 dB

Test N Multiple Spurious Receiver #3 **PANASONIC**		RF (dBm)	EO&C Proponent Digital Audio Input = Glockenspiel	Proponent Digital Audio Input = 0	Without Digital Signal
Analog / Analog Ref.					
30dB S/N 94.1MHz	RF1	-98.2	NA	**NA**	The audio is relativly clean sounding with some background hiss typical of a 30dB S/N ratio
30dB S/N 89.25+99.95MHz	RF2	-38.95			
IF Reject.	D/U	**-59.25**			
30dB S/N 99.95MHz	RF1	-96.95			
30dB S/N 94.1+104.8MHz	RF2	-37.2			
IF Reject.	D/U	**-59.75**			
AT&T - IBAC			Sounds worse than Analog reference W/ occational low level buzzing sound	Sounds worse than Analog reference and worse than when Proponent W/Glockenspiel. Audio is torn up by a low freqency (approx 100Hz) sound	**NA**
30dB S/N 94.1+104.8MHz	RF2	-37.2			
IF Reject.	D/U	**-59.7**			

Notes:
The Boonton 103D RF generator used for S/N ratio and IF reject. tests
The Boonton 102B RF generator used as second generator in IF reject. tests (analog only)
The "Lower" generator or Proponent at 94.1MHz is not modulated (CW only)
The "Upper" generator is modulated with 1KHz at 30% (22.5KHz)
This test is an IBAC test only. Other data included as additional information only

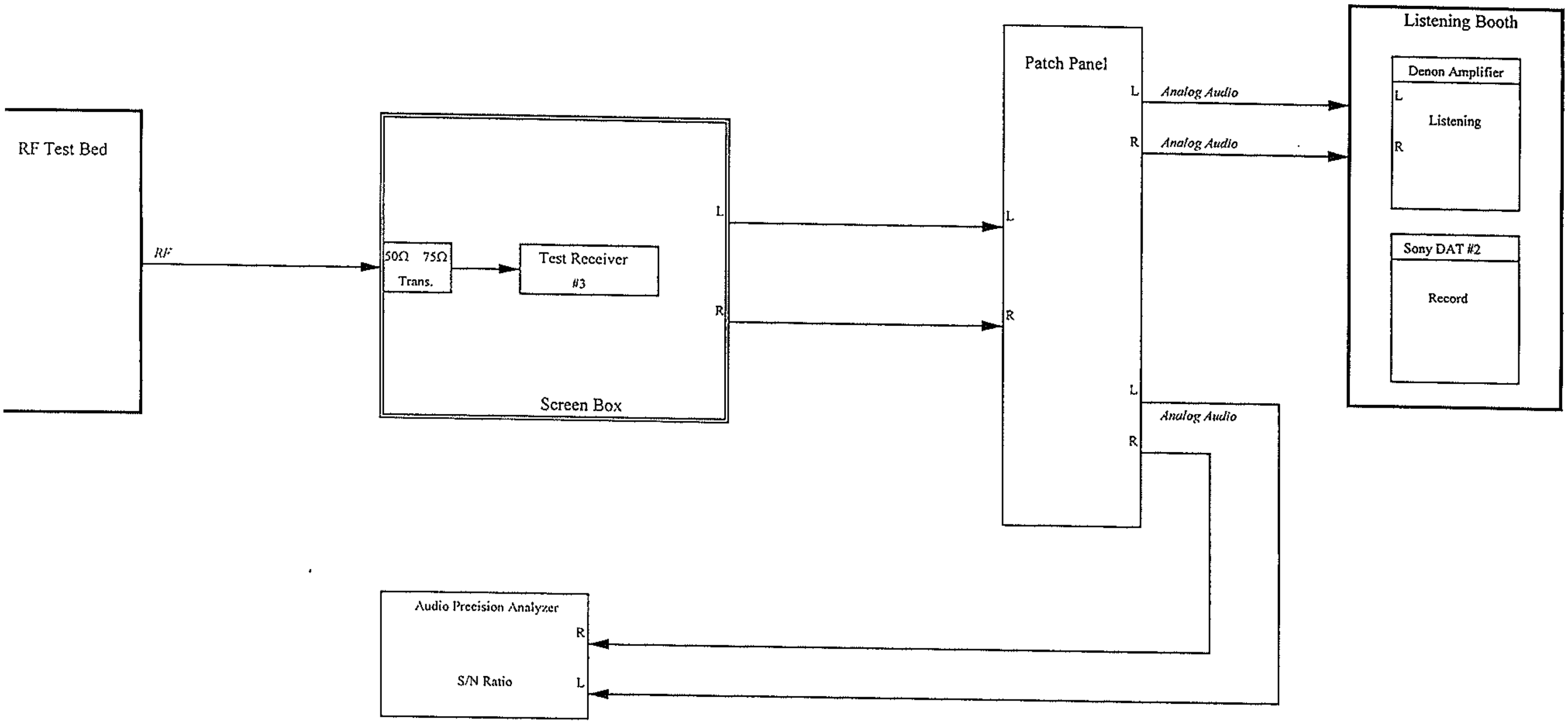
EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

N Trans Block

EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

N Rec. Block

APPENDIX H

Receiver Characterizations

APPENDIX H

Receiver Characterizations
(Consumer Analog)

Enclosure #1

Five Analog FM Receiver Characterization Reports

Enclosure #2

Additional Information of the Five FM Receivers

Enclosure #3

Three Analog AM Receiver Characterization Reports

DAR FM TEST RECEIVER DATA

Receiver Lab #1

Type Auto

Index

Page	Description
1	Laboratory FM -> FM D/U Ratios
2	Radio Characterization/Confirmation
3	Signal, Noise, & Separation VS RF Level
4	Graph of Signal & Filtered Noise VS RF Level
5	Graph of Separation VS RF Level
6	Graph of Signal, Noise, Filtered Noise, & Separation VS RF Level
7	Woodstock Engineering Receiver Test Report
8	Audio VS RF Frequency Test
9	Receiver Upper 1st Adjacent Interference/Noise
10	Receiver Lower 2nd Adjacent Interference/Noise
11	Receiver Upper 2nd Adjacent Interference/Noise

FM -> FM Laboratory Measurements for the Delco Model 16192463

Laboratory Receiver #1

Type: Auto

Measurements were made at a moderate signal level of -62 dBm.

The signal to noise ratio was set at 45 dB and this measurement was made using a 15kHz low pass and a CCIR filter with quasi-peak detection. For the second adjacent tests, 45 dB S/N was not attainable on the test bed with this receiver so 47 dB was used.

Test Results:

Co-Channel	D/U	36.17 dB
Lower First Adjacent	D/U	4.09 dB
Upper First Adjacent	D/U	5.41 dB
Lower Second Adjacent	D/U	-24.17 dB
Upper Second Adjacent	D/U	-24.17 dB

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 2/21/95

PROJ.: RADIO CHARACTERIZATION/CONFIRMATION

* Key point measurements for comparison to Grossjean data
* Additional data with regard to audio performance VS RF level

TEST SET-UP

* Delco Radio — Graphic EQ - Flat, Loudness - Off, Fader & Bal.- Centered
* Test Bed, W/Orban Stereo Gen & Harris Exciter as Signal Source
* Boonton RF Gen used for crosscheck verification
* Delco Dummy Antenna
* Audio Reference Level: 0dB = 1 Watt (2Vrms) — Load Imp. = 4Ω
* Audio measurements made with Audio Precision as rms unweighted

FM TESTS (TEST FQ. 94.1MHZ)

S/N RATIO - 1KHZ, 30% MOD

20dB S/N	-105 dBm
30dB S/N	-102 dBm
50dB S/N	-92 dBm

S/N RATIO - 1KHZ, 100% MOD

USABLE	50dB S/N	-95dBm	(Boonton Gen.)
USABLE	50dB S/N	-96dBm	(Test Bed)
MAX	59.7dB	-60dBm	(Boonton Gen.)
MAX	59.4dB	-62dBm	(Test Bed)

THD - 1KHZ, 100% MOD (-50dBm)

MONO	0.80 %	(Boonton Gen.)
MONO	0.65 %	(Test Bed)
STEREO	2.04 %	(Test Bed)

LIMITING THRESHOLD (Tracability; Grossjean/RF Generator/Test Bed)

--- Boonton RF Generator ---		Through Test Bed
98.1MHZ (Grossjean RF Freq)	94.1MHZ (lab freq.)	94.1MHZ
Audio -1dB -101 dBm	-100.4 dBm	-101 < LThresh. < -100dBm

HIGH CUT THRESHOLD — Blend circuitry test

Audio: 10KHZ, L+R, 100% Mod, Pilot off
-3dB = -85dBm
Note: Same result with Pilot On

SEPARATION @ -62dBm

Freq.	L->R	R->L	
1KHZ	36dB	32dB	(W/O Pre-Emph)
10KHZ	17dB	17dB	(W/O Pre-Emph)

SIGNAL, NOISE & SEPARATION VS RF LEVEL

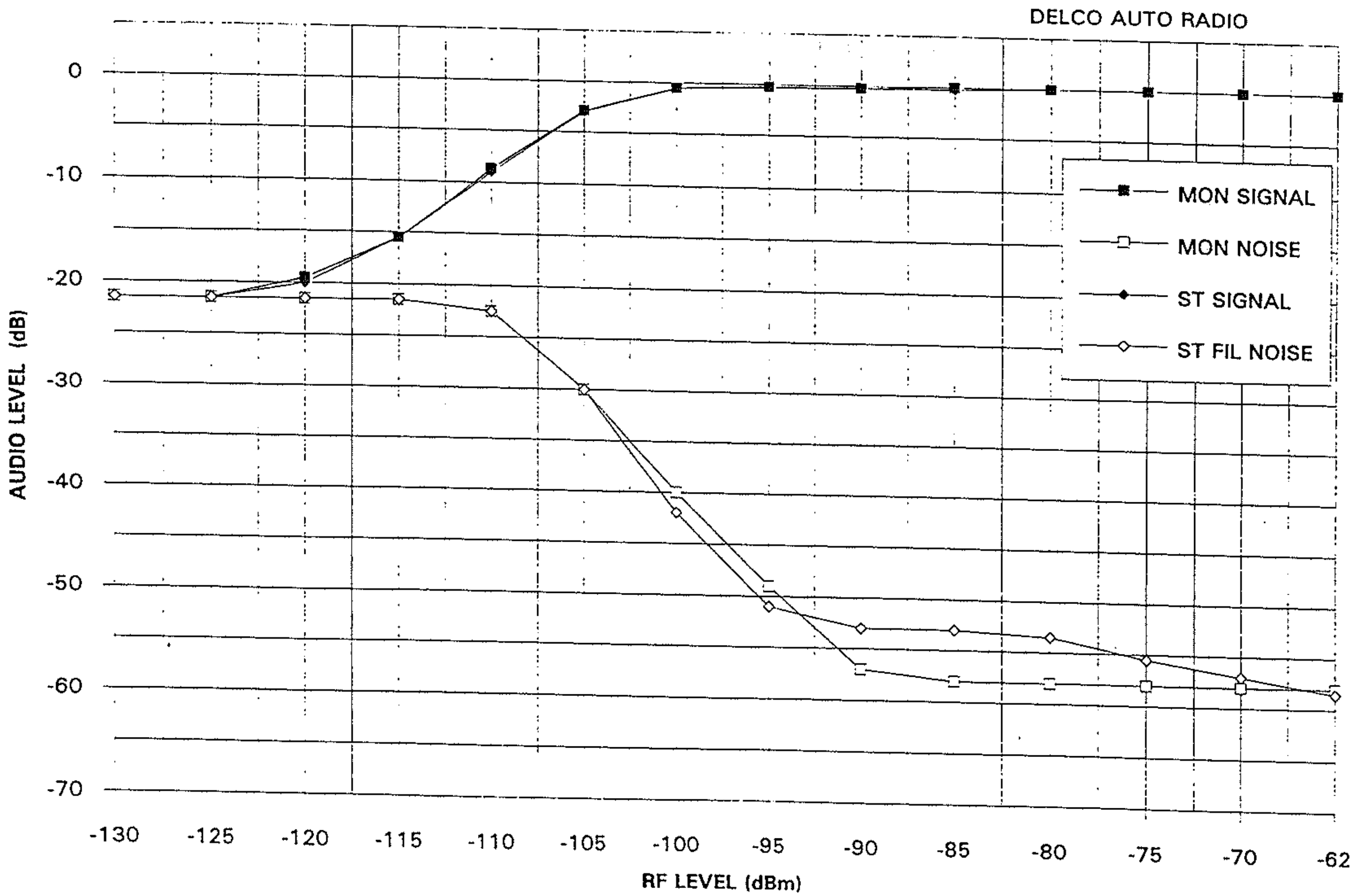
- Left channel used as the measurement channel for Signal and Noise data
- Left channel driven (L only) for separation data
- Audio test frequency = 1KHZ
- Note: There were no significant improvements in performance at RF levels above 62dBm

CURVE DATA

SIGNAL, NOISE & SEPARATION VS RF LEVEL

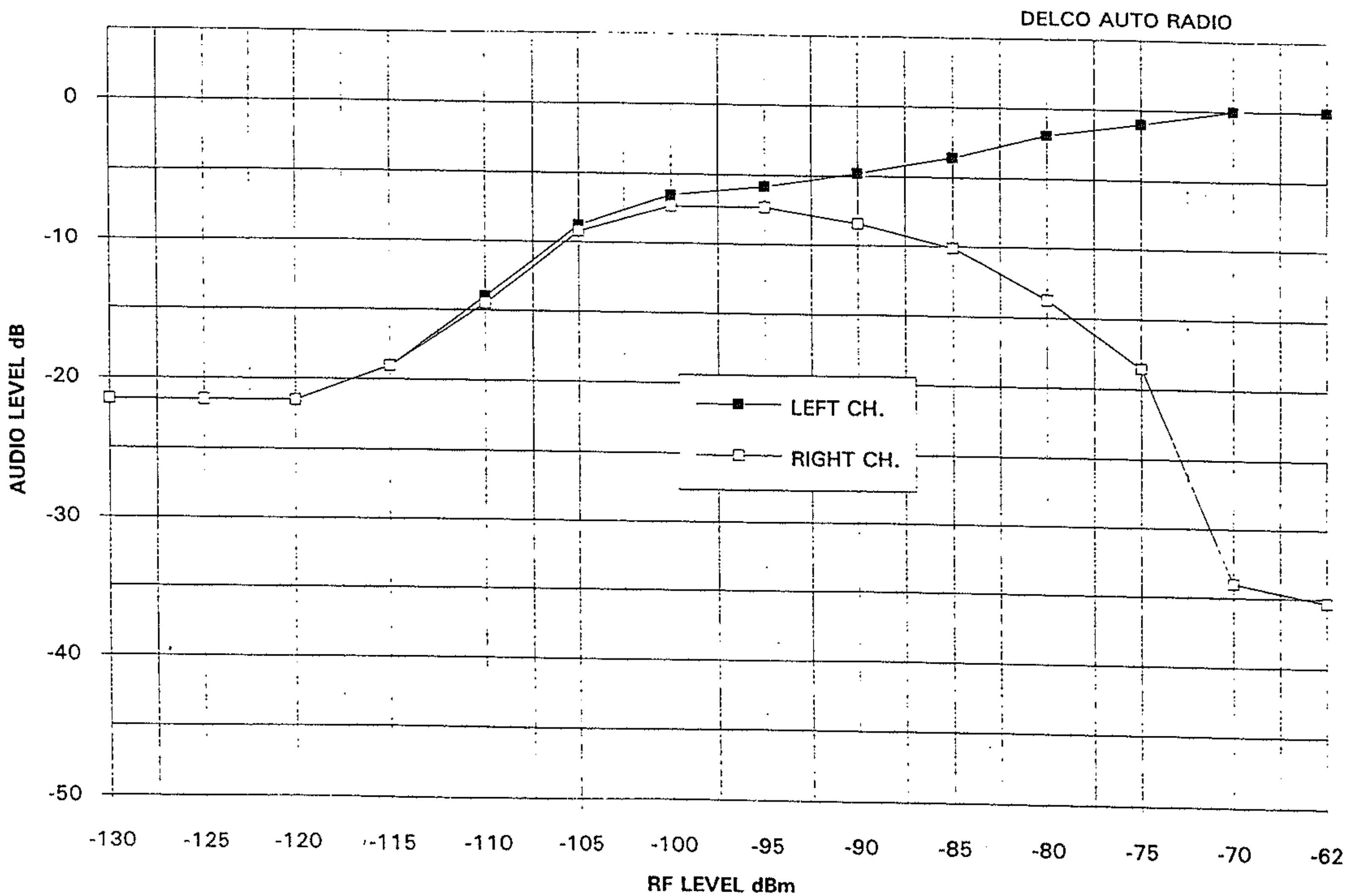
	mono (L)		Stereo (L)				Separation L->R	
RF Level	Signal	Noise	Signal	Filt. Noise	Noise	RF Level	Left	Right
dBm	dB	dB	dB	dB	dB	dBm	dB	dB
-130	-21.5	-21.5	-21.5	-21.5	-21.5	-130	-21.5	-21.5
-125	-21.5	-21.5	-21.5	-21.5	-21.5	-125	-21.5	-21.5
-120	-19.5	-21.5	-20	-21.5	-21.5	-120	-21.5	-21.5
-115	-15.5	-21.5	-15.5	-21.5	-21.5	-115	-19	-19
-110	-8.7	-22.5	-9	-22.5	-22.5	-110	-14	-14.5
-105	-2.9	-30	-3	-30	-30	-105	-8.75	-9.2
-100	-0.52	-40	-0.57	-42	-40	-100	-6.5	-7.3
-95	-0.23	-49	-0.29	-51	-48.4	-95	-5.8	-7.3
-90	-0.21	-57	-0.26	-53	-52	-90	-4.8	-8.4
-85	0	-58	-0.21	-53	-52	-85	-3.6	-10.1
-80	0	-58	0	-53.5	-52	-80	-1.92	-13.75
-75	0	-58	0	-55.5	-53	-75	-1	-18.5
-70	0	-58	0	-57	-54	-70	0	-34
-62	0	-58	0	-58.5	-54	-62	0	-35.3
-57						-57		

SIGNAL & FILTERED NOISE VS RF LEVEL

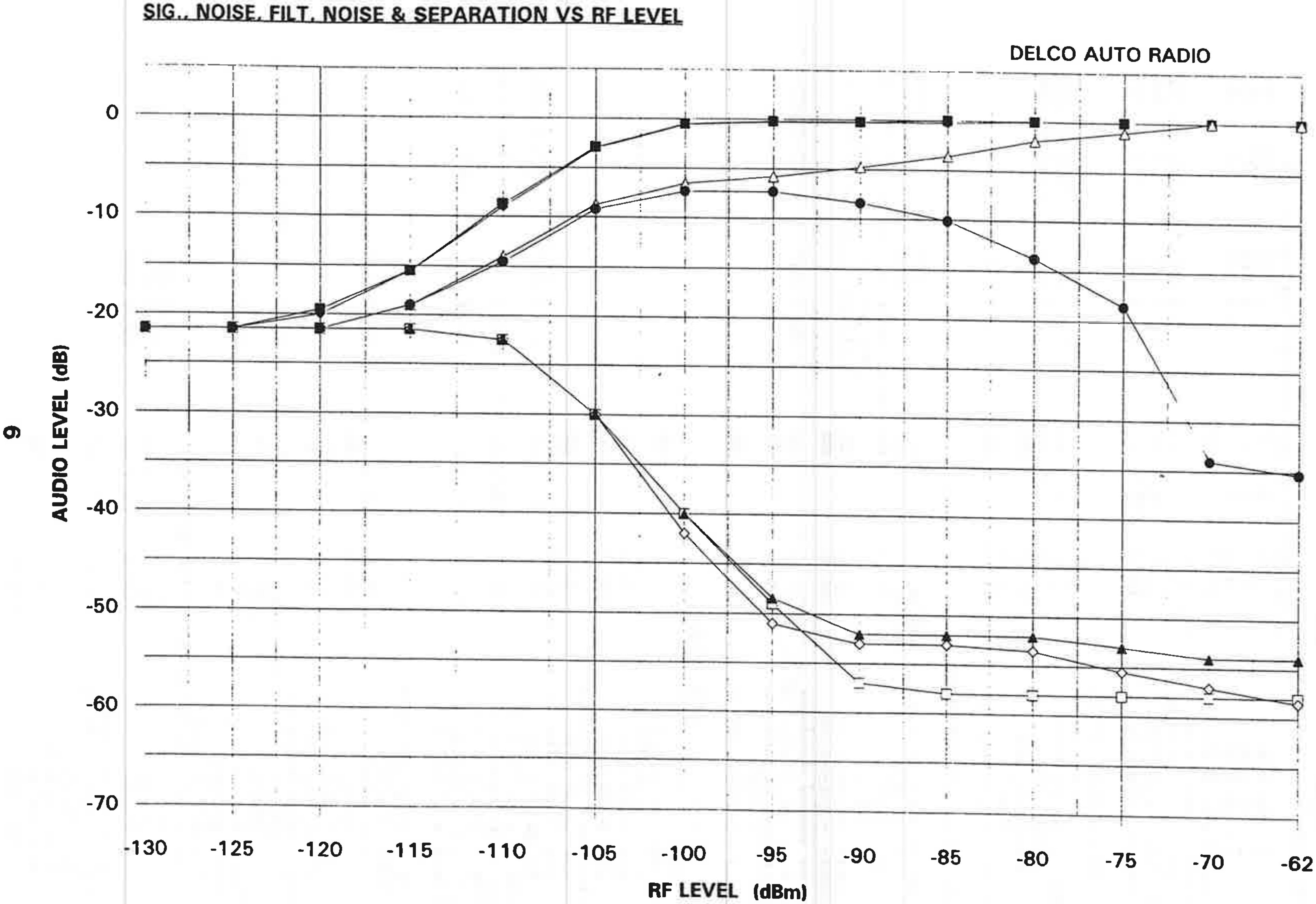


EIA DAR LAB

SEPARATION VS RF LEVEL



EIA DAR LAB



COMPOSITE OF CHARTS 1 + 2

Chart 3 of 3

TUNER TEST DATA

	GEN	RCVR		RCVR
Manufacturer:	Delco			
Model Number:	16192463			
Serial Number:	1000499			
Type:	car			

FM 30% modulation(98.1MHz)

Using IEEE/EIA 10Ω,10Ω,45Ω resistive pad

	GEN	RCVR		RCVR
20 dB S/N	1.4	0.7 μV	8.1 dBf	-110.1 dBm
30 dB S/N	1.9	1.0 μV	10.8 dBf	-107.4 dBm
50 dB S/N	4.8	2.4 μV	18.8 dBf	-99.4 dBm
Interstation Noise	-10.0	dB		
Mute start Level	very soft			
High cut at 10KHz	3.0	dB at	3.0 μV receiver input	
Fo+½IF rejection	32.0	16.0 mV	87.2 dB	-22.9 dBm
Image rejection	178.0	89.0 μV	42.1 dB	-68.0 dBm

FM 100% MODULATION MONO

Usable Sensitivity	2.0	1.0 μV	11.2 dBf	-107.0 dBm
50dB S/N	3.2	1.6 μV	15.3 dBf	-102.9 dBm
Maximum S/N	55.0	dB		
THD %	0.6			
AM Rejection at 1mV	44.8	dB		

FM 100% MODULATIONSTEREO

Usable Sensitivity	BLEND	μV	dBf	dBm
50dB S/N	BLEND	μV	dBf	dBm
Maximum S/N	65.0	dB	must be measured with volume	
THD %	1.3		set just below clipping	
1KHz separation	31.0	dB	will not handle 100% L-R	
10KHz separation	24.8	dB		
Stero Blend action:				
Separation at 25μVreceive	14.9	dB	39.2 dBf	-79.0 dBm
67KHz SCA Rejection	54.0	dB		
δF=5KHz				
19 and 38KHzproducts	-40.0	dB		

FM TWO SIGNAL TESTS(98.1 MHz)

708μV (-50dBm)				
Capture Ratio	7.5	dB		
Selectivity@ 200KHz				
for 30dB S/N	10.0	dB		
for 50dB S/N	-6.0	dB		
Selectivity@ 400KHz				
for 30dB S/N	>63	dB		
for 50dB S/N	48.0	dB		
IM Rejection	20.0	10.0 mV	91.2 dBf	-27.0 dBm
(98.9 and 99.7)				
2MHz IM rejection	100.0	50.0 mV	105.2 dBf	-13.0 dBm
(99.1 and 100.1)				
IF mix rejection	50.0	25.0 mV	99.2 dBf	-19.0 dBm
(96.4 and 107.2)				

AM 30% MODULATION MONO

DUMMY ANTENNA:				
20dB S/N	16.0	16.0 μV	-82.9 dBm	
Max S/N	49.0	dB		
THD at max S/N	0.2	%		
THD at 80% mod	0.5	%		
-3dB Audio Response				
600KHz	1680.0	Hz	2140 in AM stereo position	
1400KHz	1680.0	Hz		
±10KHz Selectivity	30.0	dB	limited by local AGC	
±20KHz Selectivity	nm	dB		
Local AGC action:				
level for -3dB 600KHz desired signal reduction				
1400KHz	100.0	70.7 mV	-10.0 dBm	
10MHz	100.0	70.7 mV	-10.0 dBm	
27MHz	100.0	70.7 mV	-10.0 dBm	
IF mix rejection				
(1400 & 945 or 950)	>100	mV		
AM stereo:				
50% modulation				
Separation	30.0	dB		
max S/N	>45.0	dB		

DAR Lab
3/15/95 DELAVRF.XLS

DELCO Channel Characteristics 94.1MHZ

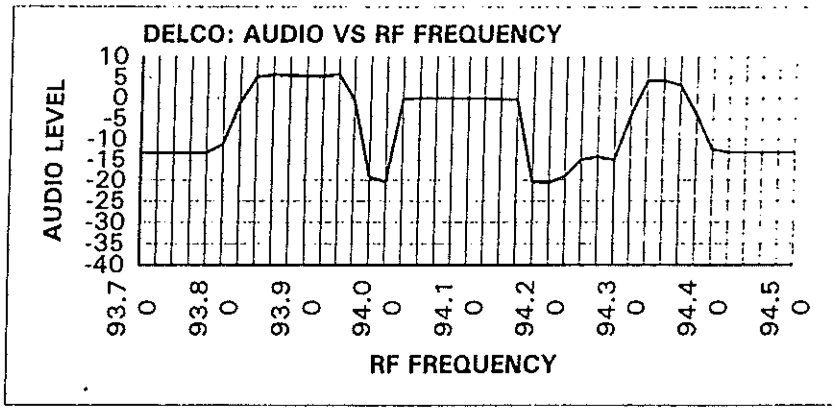
Audio VS RF Frequency

Note:

* The results here represent a chacteristic receiver input signature based on sweeping the RF signal through the desired channel
* The test signal is modulated with 1khz @ 100%
* The measurements are made using 15khz low pass and CCIR filters with quasi-peak detection
* RF level is -62dBm

RF FREQ.	AUDIO LEVEL
93.70	-13.2
93.72	-13.2
93.74	-13.2
93.76	-13.2
93.78	-13.2
93.80	-11.1
93.82	-1
93.84	5.14
93.86	5.8
93.88	5.64
93.90	5.5
93.92	5.52
93.94	5.87
93.96	-0.3
93.98	-19.1
94.00	-20.3
94.02	-0.15
94.04	0
94.06	0
94.08	0
94.10	0
94.12	0
94.14	-0.22
94.16	-0.42
94.18	-20.37
94.20	-20.57
94.22	-18.92
94.24	-14.9
94.26	-14.06
94.28	-14.97
94.30	-4.3
94.32	4.2
94.34	4.35
94.36	3.16
94.38	-3.9
94.40	-12.3
94.42	-13.1
94.44	-13.1
94.46	-13.1
94.48	-13.1
94.50	-13.1

Tuning Frequency (94.10)



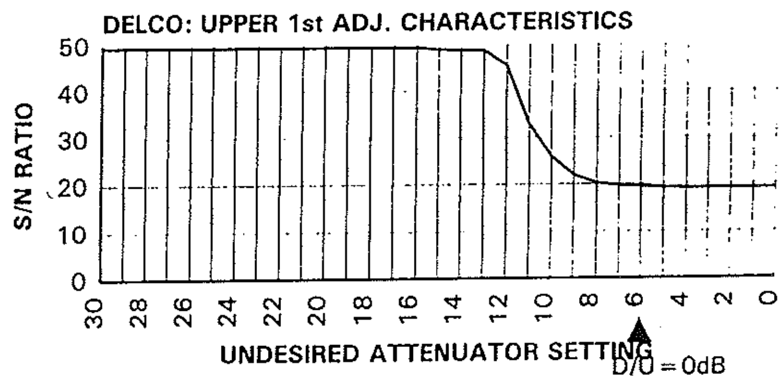
DAR Lab
Mar 8/95
RMc
Delco Adjacent Channel Characteristics

DELUP1.XLS

Upper first adj. channel 94.3mhz

Note:
* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35		
34		
33		
32		
31		
30	49.5	
29	49.5	
28	49.5	
27	49.5	
26	49.5	
25	49.5	
24	49.5	
23	49.5	
22	49.5	
21	49.5	
20	49.5	
19	49.5	
18	49.5	
17	49.5	
16	49.5	
15	49	
14	48.9	
13	48.8	
12	45.5	
11	33	
10	26	
9	22	
8	20.2	
7	19.7	
6	19.5	D/U = 0dB
5	19.3	
4	19.2	
3	19.2	
2	19.2	
1	19.2	
0	19.2	



DAR Lab
Mar 8/95

DELLOW2.XLS

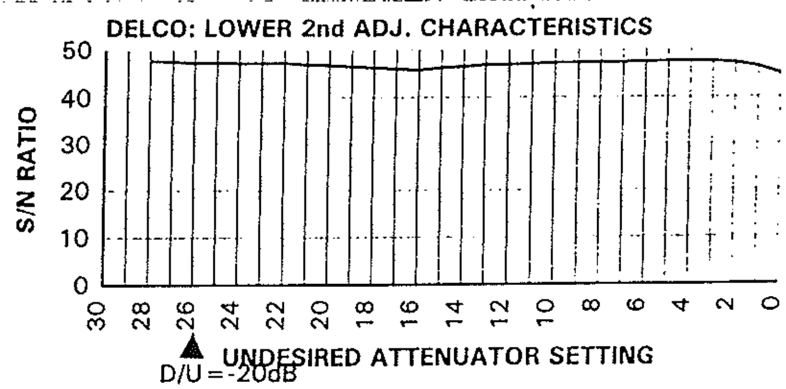
DELCO Adjacent Channel Characteristics

Lower second adj. channel 93.7mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35		
34		
33		
32		
31		
30		
29		
28	47.75	
27	47.5	
26	**47.35**	D/U=-20dB
25	47.3	
24	47.2	
23	47.2	
22	47.24	
21	46.9	
20	46.75	
19	46.5	
18	46.3	
17	46	
16	45.8	
15	46.25	
14	46.5	
13	46.8	
12	46.9	
11	47	
10	47.2	
9	47.25	
8	47.3	
7	47.3	
6	47.4	
5	47.5	
4	47.6	
3	47.5	
2	47.2	
1	46.4	
0	44.9	



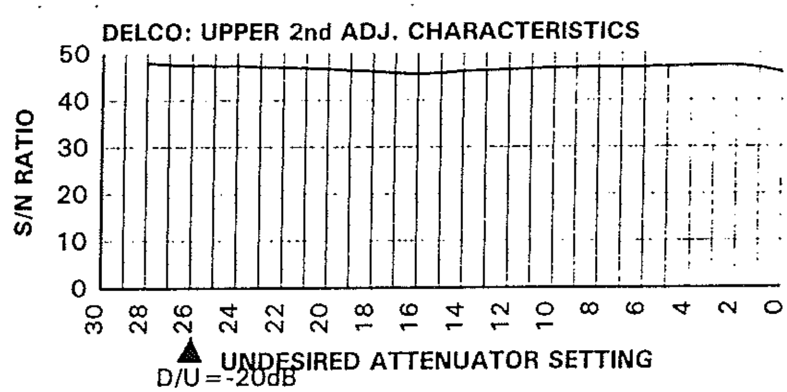
DAR Lab
Mar 13/95 DELUP2.XLS

Delco Auto Radio Adjacent Channel Characteristics

Upper second adj. channel 94.5mhz

Note:
* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35		
34		
33		
32		
31		
30		
29		
28	47.9	
27	47.6	
26	47.4	D/U=-20dB
25	47.3	
24	47.3	
23	47.1	
22	47	
21	46.8	
20	46.7	
19	46.3	
18	46.1	
17	45.8	
16	45.5	
15	45.7	
14	46.1	
13	46.3	
12	46.4	
11	46.6	
10	46.8	
9	46.9	
8	47	
7	46.9	
6	47	
5	47.1	
4	47.2	
3	47.3	
2	47.3	
1	46.8	
0	45.8	



DAR FM TEST RECEIVER DATA

Receiver Lab #2

Type High End Home Hi-Fi

Index

Page	Description
1	Laboratory FM -> FM D/U Ratios
2	Radio Characterization/Confirmation
3	Signal, Noise, & Separation VS RF Level
4	Graph of Signal & Filtered Noise VS RF Level
5	Graph of Separation VS RF Level
6	Graph of Signal, Noise, Filtered Noise, & Separation VS RF Level
7	Woodstock Engineering Receiver Test Report
8	Audio VS RF Frequency Test (no measurement made)
9	Receiver Upper 1st Adjacent Interference/Noise
10	Receiver Lower 2nd Adjacent Interference/Noise
11	Receiver Upper 2nd Adjacent Interference/Noise

FM -> FM Laboratory Measurements for the Denon Model TU-380 RD

Laboratory Receiver #2

Type: High end home Hi-Fi

Measurements were made at a moderate signal level of -62 dBm.

The signal to noise ratio was set at 45 dB and this measurement was made using a 15kHz low pass and a CCIR filter with quasi-peak detection.

Test Results:

Co-Channel	D/U	43.39 dB
Lower First Adjacent	D/U	23.61 dB
Upper First Adjacent	D/U	12.46 dB
Lower Second Adjacent	D/U	-24.67 dB
Upper Second Adjacent	D/U	-33.18 dB

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 2/21/95

PROJ.: RADIO CHARACTERIZATION/CONFIRMATION

* Key point measurements for comparison to Grossjean data
* Additional data with regard to audio performance VS RF level

TEST SET-UP

* Receiver: Denon TU-380RD
* Ant. Net: 50/75 ohm resistive pad (-7.8dB insertion loss)
* Audio Ref: 724mVrms
* Receiver in "Auto" Mode for stereo tests
* Receiver in manual mode for mono tests
* Test Bed, W/Orban Stereo Gen & Harris Exciter as Signal Source
* Audio measurements made with Audio Precision as rms unweighted

FM TESTS (TEST FQ. 94.1MHZ)

S/N RATIO - 1KHZ, 100% MOD

MAX	70dB	-62dBm	(mono)

THD - 1KHZ, 100% MOD (-50dBm)

MONO	0.17 %
STEREO	0.24 %

LIMITING THRESHOLD (Audio -1dB)

-106dBm

HIGH CUT THRESHOLD

Audio: 10KHZ, L+R, 100% Mod, Pilot off
NA due to mute

SEPARATION @ -62dBm

Freq.	L->R	R->L	
1KHZ	-38dB	-37dB	(W/O Pre-Emph)
10KHZ	-35dB	-34dB	(W/O Pre-Emph)

SIGNAL, NOISE & SEPARATION VS RF LEVEL

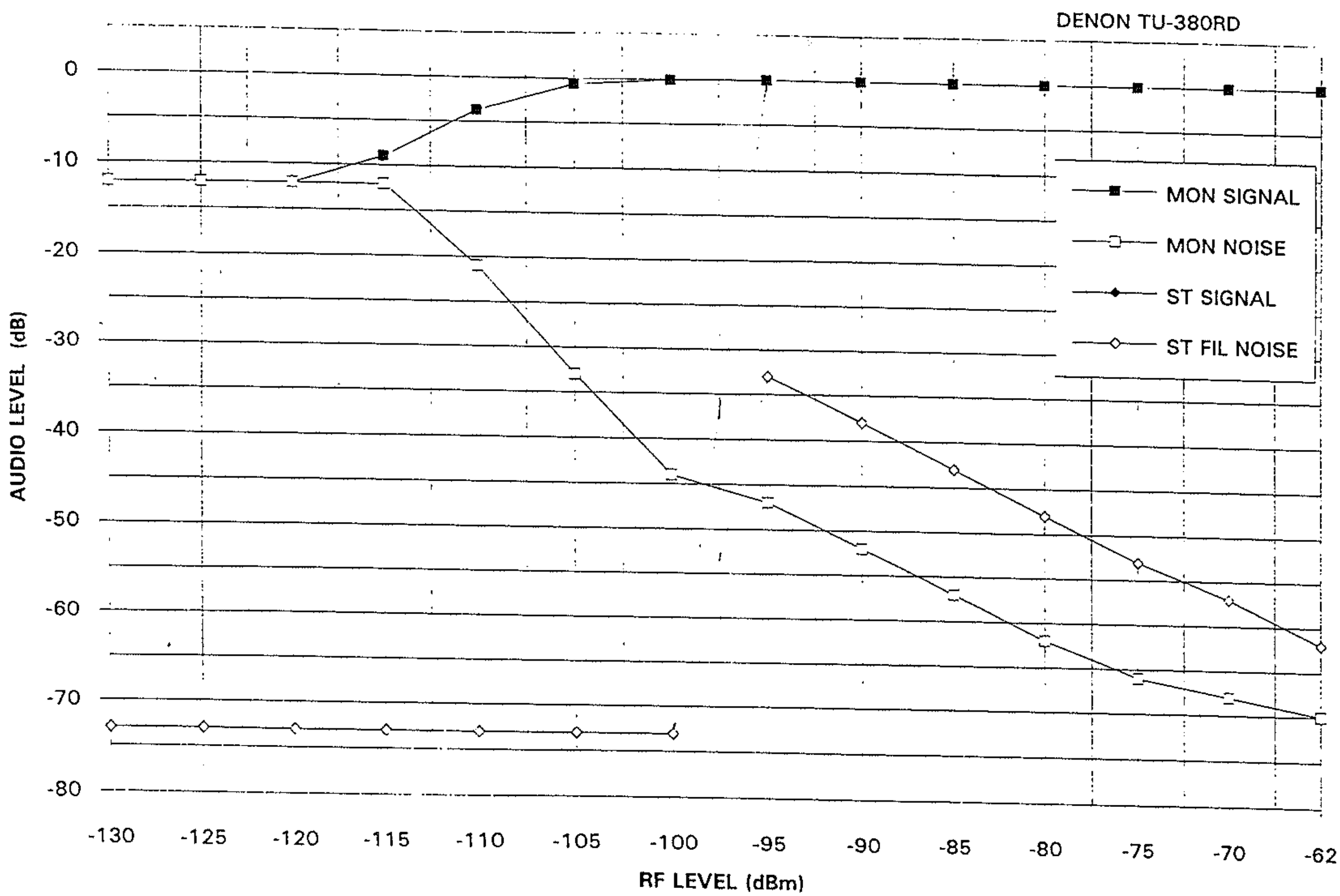
* Left channel used as the measurement channel for Signal and Noise data
* Left channel driven (L only) for separation data
* Audio test frequency = 1KHZ
* Receiver in "Manual" mode for Mono measurements, "Auto" mode for stereo measurements
* RF levels represent power into the receiver after 50/75 ohm conversion

CURVE DATA

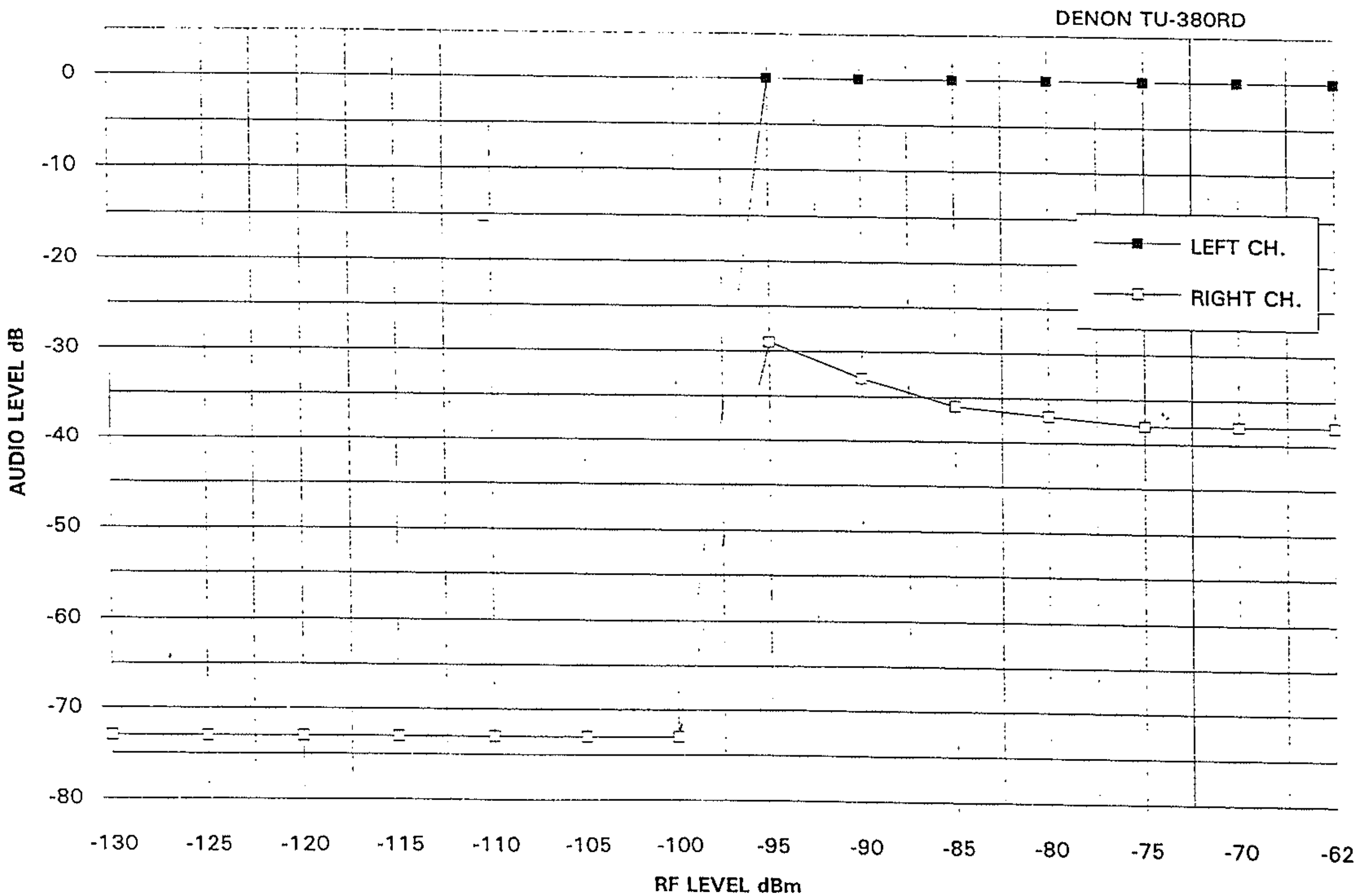
SIGNAL, NOISE & SEPARATION VS RF LEVEL

RF Level	mono (L)		Stereo (L)			RF Level	Separation L->R	
	Signal	Noise	Signal	Filt. Noise	Noise		Left	Right
dBm	dB	dB	dB	dB	dB	dBm	dB	dB
-130	-12	-12	-73	-73	-73	-130	-73	-73
-125	-12	-12	-73	-73	-73	-125	-73	-73
-120	-12	-12	-73	-73	-73	-120	-73	-73
-115	-9	-12	-73	-73	-73	-115	-73	-73
-110	-3.7	-21	-73	-73	-73	-110	-73	-73
-105	-0.6	-33	-73	-73	-73	-105	-73	-73
-100	-0.05	-44	-73	-73	-73	-100	-73	-73
-95	0	-47	0	-33	-33	-95	0	-29
-90	0	-52	0	-38	-38	-90	0	-33
-85	0	-57	0	-43	-43	-85	0	-36
-80	0	-62	0	-48	-48	-80	0	-37
-75	0	-66	0	-53	-53	-75	0	-38
-70	0	-68	0	-57	-57	-70	0	-38
-62	0	-70	0	-62	-62	-62	0	-38
-57	0	-70	0	-64	-64	-57	0	-38

SIGNAL & FILTERED NOISE VS RF LEVEL

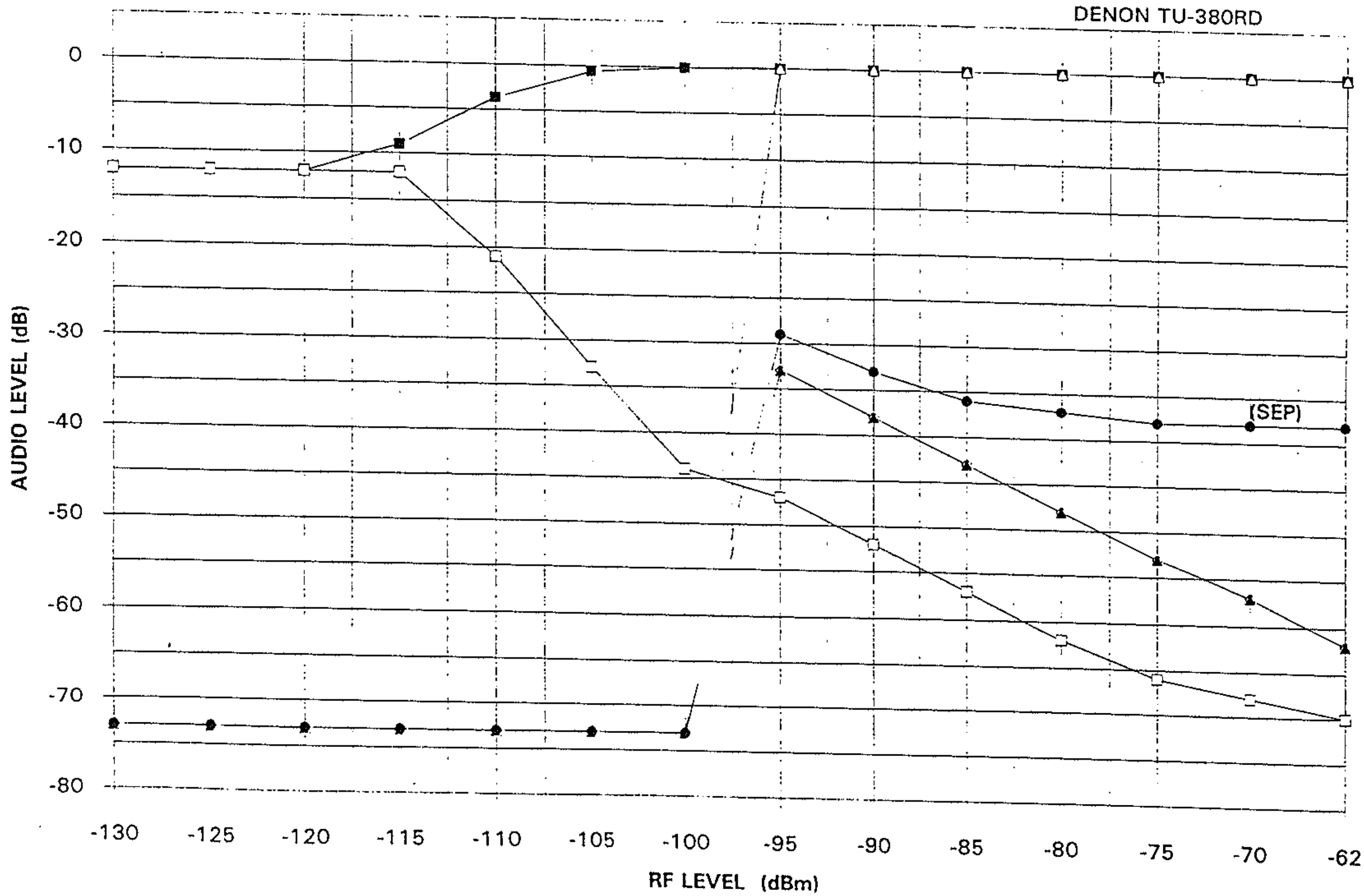


SEPARATION VS RF LEVEL



5

SIG., NOISE, FILT. NOISE & SEPARATION VS RF LEVEL



TUNER TEST DATA

Manufacturer: Denon
Model Number: TU-380RD
Serial Number: (4056301149)
Type: High End Home Hi-Fi
Using IEEE/EIA 10Ω,10Ω,45Ω matching pad

	GEN	RCVR		RCVR
FM 30% modulation(98.1MHz)				
20 dB S/N	2.2	1.1 μV	12.1 dBf	-106.2 dBm
30 dB S/N	3.2	1.6 μV	15.2 dBf	-103.0 dBm
50 dB S/N	25.2	12.6 μV	33.3 dBf	-85.0 dBm
Interstation Noise	-3.0	dB		
Mute start Level	10.0	5.0 μV	25.2 dBf	-93.0 dBm
High cut at 10KHz	none			
Fo+½IF rejection	16.0	8.0 mV	77.2 dB	-88.9 dBm
Image rejection	794.0	397.0 μV	51.1 dB	-55.0 dBm
FM 100% MODULATION MONO				
Usable Sensitivity	4.0	2.0 μV	17.3 dBf	-101.0 dBm
50dB S/N	11.0	5.5 μV	26.1 dBf	-92.2 dBm
Maximum S/N	78.0	dB		
THD %	0.2			
AM Rejection at 1mV	55.2	dB		
FM 100% MODULATION STEREO				
Usable Sensitivity	mutes			
50dB S/N	80.0	40.0 μV	43.3 dBf	-74.9 dBm
Maximum S/N	66.0	dB		
THD %	0.2			
1KHz separation	55.0	dB		
10KHz separation	37.0	dB		
Stero Blend action: none				
Separation at 25μV receiver input		dB	39.2 dBf	-73.0 dBm
67KHz SCA Rejection δF=5KHz	-66.0	dB		
19 and 38KHzproducts	-53.0	dB		
FM TWO SIGNAL TESTS(98.1 MHz) 708μV (-50dBm)				
Capture Ratio	2.3	dB		
Selectivity@ 200KHz				
for 30dB S/N	11.0	dB		
for 50dB S/N	9.5 –	dB		
Selectivity@ 400KHz				
for 30dB S/N	67.0	dB		
for 50dB S/N	46.5 –	dB		
IM Rejection (98.9 and 99.7)	3.5	1.8 mV	76.1 dBf	-42.1 dBm
2MHz IM rejection (99.1 and 100.1)	4.0	2.0 mV	77.3 dBf	-41.0 dBm
IF mix rejection (96.4 and 107.2)	4.0	2.0 mV	77.3 dBf	-41.0 dBm
AM 30% MODULATION MONO				
DUMMY ANTENNA: 50Ω generator to AM ANT terminals				
20dB S/N	3.0	3.0 μV	-97.4 dBm	
Max S/N	53.0	dB		
THD at max S/N	0.3	%		
THD at 80% mod	0.8	%		
-3dB Audio Response				
600KHz	1945.0	Hz		
1400KHz	1945.0	Hz		
±10KHz Selectivity	33.0	dB		
±20KHz Selectivity	52.0	dB		
Local AGC action: level for -3dB desired signal reduction				
600KHz				
1400KHz	none			
10MHz				
27MHz				
IF mix rejection (1400 & 945 or 950)	2.5	1.8 mV	-39.0 dBm	

DAR Lab
Mar 8/95 DENUP1.XLS
RMc

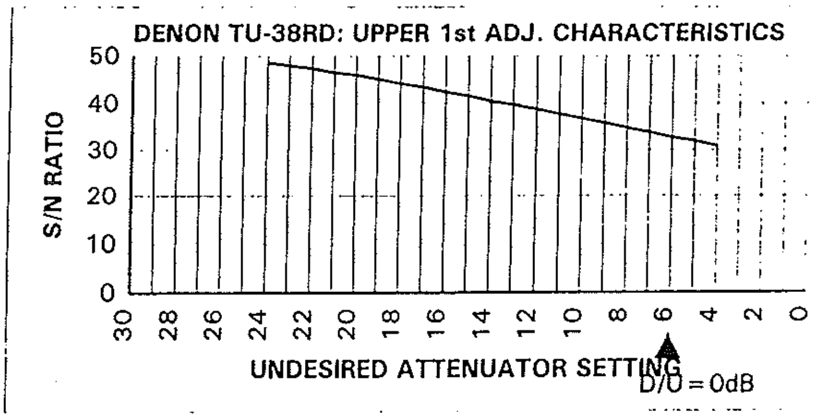
Denon TU-380RD Adjacent Channel Characteristics

Upper first adj. channel 94.3mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35		
34		
33		
32		
31		
30		
29		
28		
27		
26		
25		
24	48.6	
23	48	
22	47.4	
21	46.5	
20	46	
19	45.2	
18	44.2	
17	43.4	
16	42.5	
15	41.6	
14	40.5	
13	39.7	
12	38.8	
11	37.8	
10	36.8	
9	35.8	
8	34.8	
7	33.8	
6	32.7	D/U=0dB
5	32	
4	30.9	
3		
2		
1		
0		



DAR Lab
Mar 8/95

DENLOW2.XLS

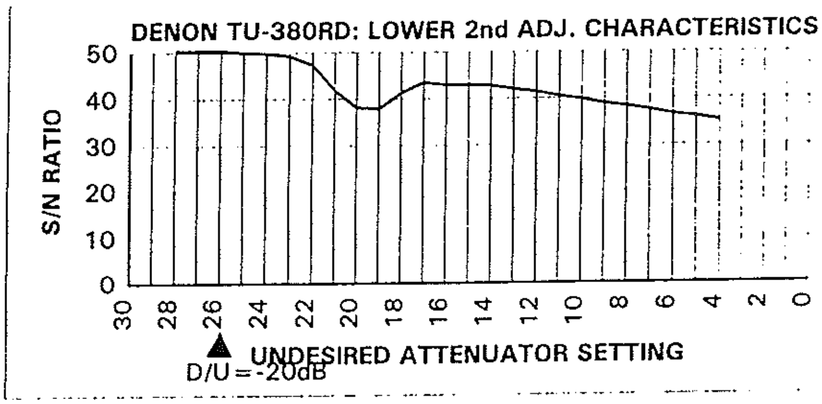
Denon Adjacent Channel Characteristics

Lower second adj. channel 93.7mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35		
34		
33		
32		
31		
30		
29		
28	50.5	
27	50.5	
26	**50.5**	**D/U=-20dB**
25	50	
24	49.8	
23	49.3	
22	47.4	
21	41.9	
20	38.2	
19	37.9	
18	41.3	
17	43.5	
16	43	
15	43	
14	42.8	
13	42	
12	41.4	
11	40.5	
10	39.8	
9	38.9	
8	38.3	
7	37.5	
6	36.6	
5	36	
4	35.2	
3		
2		
1		
0		



DAR Lab
Mar 13/95

DENUP2.XLS

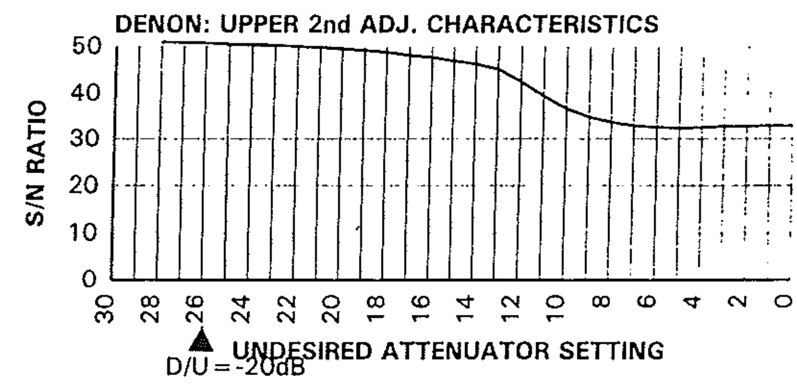
Denon TU-380RD Adjacent Channel Characteristics

Upper second adj. channel 94.5mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40	51.2	
39		
38		
37		
36		
35		
34		
33		
32		
31		
30	51.9	
29		
28	51	
27	50.9	
26	50.8	D/U=-20dB
25	50.6	
24	50.5	
23	50.3	
22	50	
21	49.8	
20	49.5	
19	49.2	
18	48.8	
17	48.2	
16	47.7	
15	47	
14	46.3	
13	45.2	
12	42.5	
11	39.4	
10	36.6	
9	34.8	
8	33.7	
7	32.9	
6	32.6	
5	32.4	
4	32.5	
3	32.8	
2	32.8	
1	32.9	
0	32.9	



DAR FM TEST RECEIVER DATA

Receiver Lab #3

Type Portable

Index

Page	Description
1	Laboratory FM -> FM D/U Ratios
2	Radio Characterization/Confirmation
3	Signal, Noise, & Separation VS RF Level
4	Graph of Signal & Filtered Noise VS RF Level
5	Graph of Separation VS RF Level
6	Graph of Signal, Noise, Filtered Noise, & Separation VS RF Level
7	Woodstock Engineering Receiver Test Report
8	Audio VS RF Frequency Test
9	Receiver Upper 1st Adjacent Interference/Noise
10	Receiver Lower 2nd Adjacent Interference/Noise
11	Receiver Upper 2nd Adjacent Interference/Noise

FM -> FM Laboratory Measurements for the Panasonic Model RX-FS430

Laboratory Receiver #3

Type: Portable (Blaster)

Measurements were made at a moderate signal level of -62 dBm.

The signal to noise ratio was set at 45 dB and this measurement was made using a 15kHz low pass and a CCIR filter with quasi-peak detection.

Test Results:

Co-Channel	D/U	40.94 dB
Lower First Adjacent	D/U	27.33 dB
Upper First Adjacent	D/U	27.19 dB
Lower Second Adjacent	D/U	-22.41 dB
Upper Second Adjacent	D/U	2.16 dB

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 2/21/95

PROJ.: RADIO CHARACTERIZATION/CONFIRMATION

* Key point measurements for comparison to Grossjean data
* Additional data with regard to audio performance VS RF level

TEST SET-UP

* Receiver: Panasonic Portable stereo
* Ant. Net: 50/75 ohm resistive pad (-7.8dB insertion loss)
* Audio Ref: 1.0Vrms
* Test Bed, W/Orban Stereo Gen & Harris Exciter as Signal Source
* Audio measurements made with Audio Precision as rms unweighted except stereo noise.

FM TESTS (TEST FQ. 94.1MHZ)

S/N RATIO - 1KHZ, 100% MOD

MAX	-61dB	-62dBm	(mono)

THD - 1KHZ, 100% MOD (-50dBm)

MONO	0.54 %	
STEREO	1.10 %	(Increase due to pilot content)

LIMITING THRESHOLD (Audio -1dB)

-96dBm

HIGH CUT THRESHOLD

Audio: 10KHZ, L+R, 100% Mod, Pilot off
NA

SEPARATION @ -62dBm

Freq.	L->R	R->L	
1KHZ	30.8dB	29dB	(W/O Pre-Emph)
10KHZ	25dB	24dB	(W/O Pre-Emph)

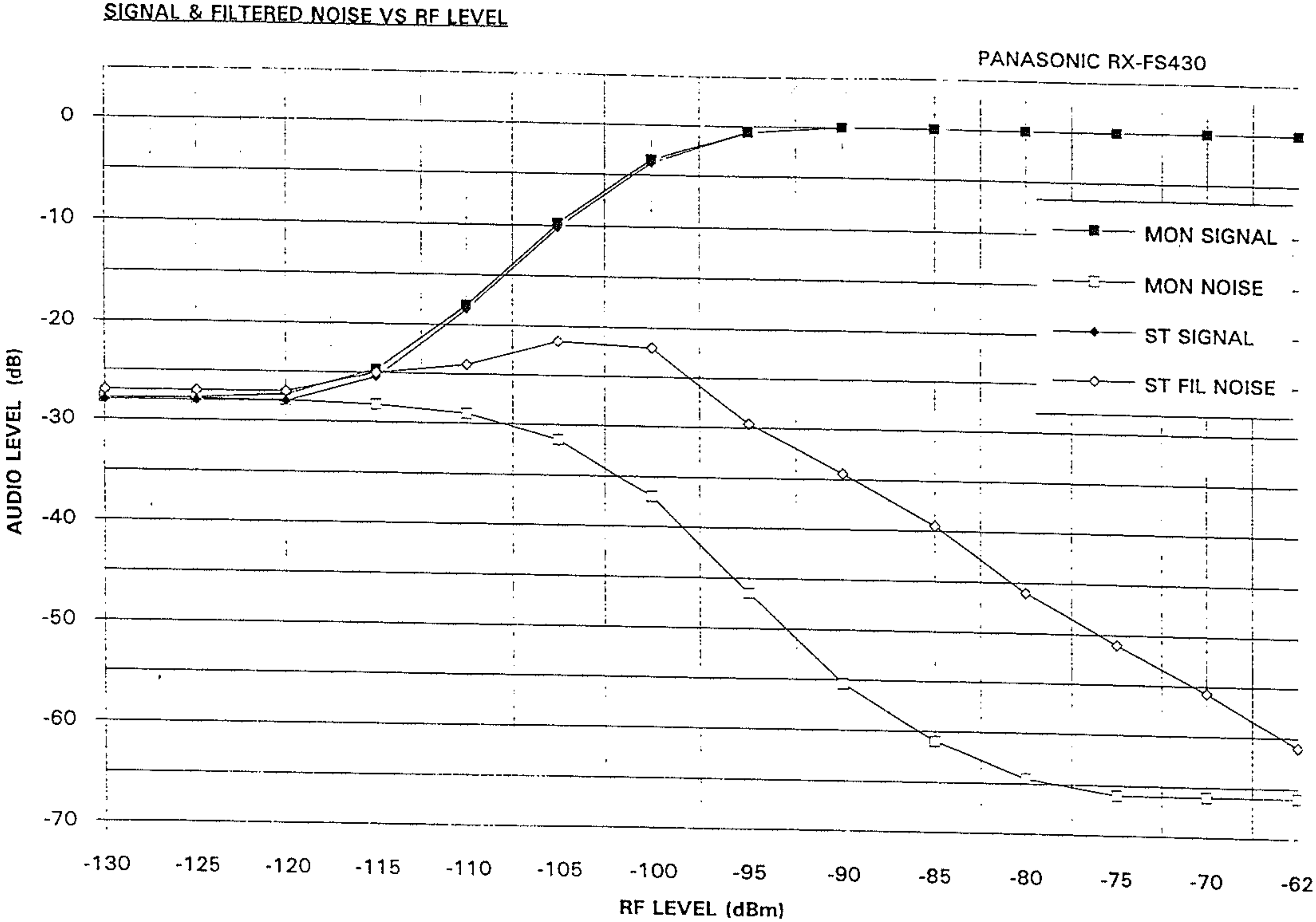
SIGNAL, NOISE & SEPARATION VS RF LEVEL

* Left channel used as the measurement channel for Signal and Noise data
* Left channel driven (L only) for separation data
* Audio test frequency = 1KHZ
* RF levels represent power into the receiver after 50/75 ohm conversion

CURVE DATA

SIGNAL, NOISE & SEPARATION VS RF LEVEL

RF Level	mono (L)		Stereo (L)			RF Level	Separation L->R	
	Signal	Noise	Signal	Filt. Noise	Noise		Left	Right
dBm	dB	dB	dB	dB	dB	dBm	dB	dB
-130	-27.8	-27.8	-28	-27	-28	-130	-27.5	-27.5
-125	-27.7	-27.8	-28	-27	-28	-125	-27.5	-27.5
-120	-27.3	-27.9	-28	-27	-28	-120	-27.5	-27.5
-115	-24.6	-28.2	-25.4	-25	-29	-115	-26.2	-26.7
-110	-18	-29	-18.4	-24	-29.7	-110	-21.5	-22
-105	-9.8	-31.5	-10.2	-21.5	-32	-105	-14.1	-14.8
-100	-3.46	-37	-3.8	-22	-28	-100	-3.2	-22
-95	-0.6	-46.5	-0.6	-29.6	-32.3	-95	-0.5	-26.3
-90	0	-55.4	0	-34.4	-36	-90	0	-28.3
-85	0	-61	0	-39.5	-38.6	-85	0	-29.4
-80	0	-64.5	0	-46	-40	-80	0	-30
-75	0	-66	0	-51	-40.5	-75	0	-30.6
-70	0	-66	0	-55.7	-40.7	-70	0	-30.7
-62	0	-66	0	-61	-40.7	-62	0	-30.8
-57						-57		

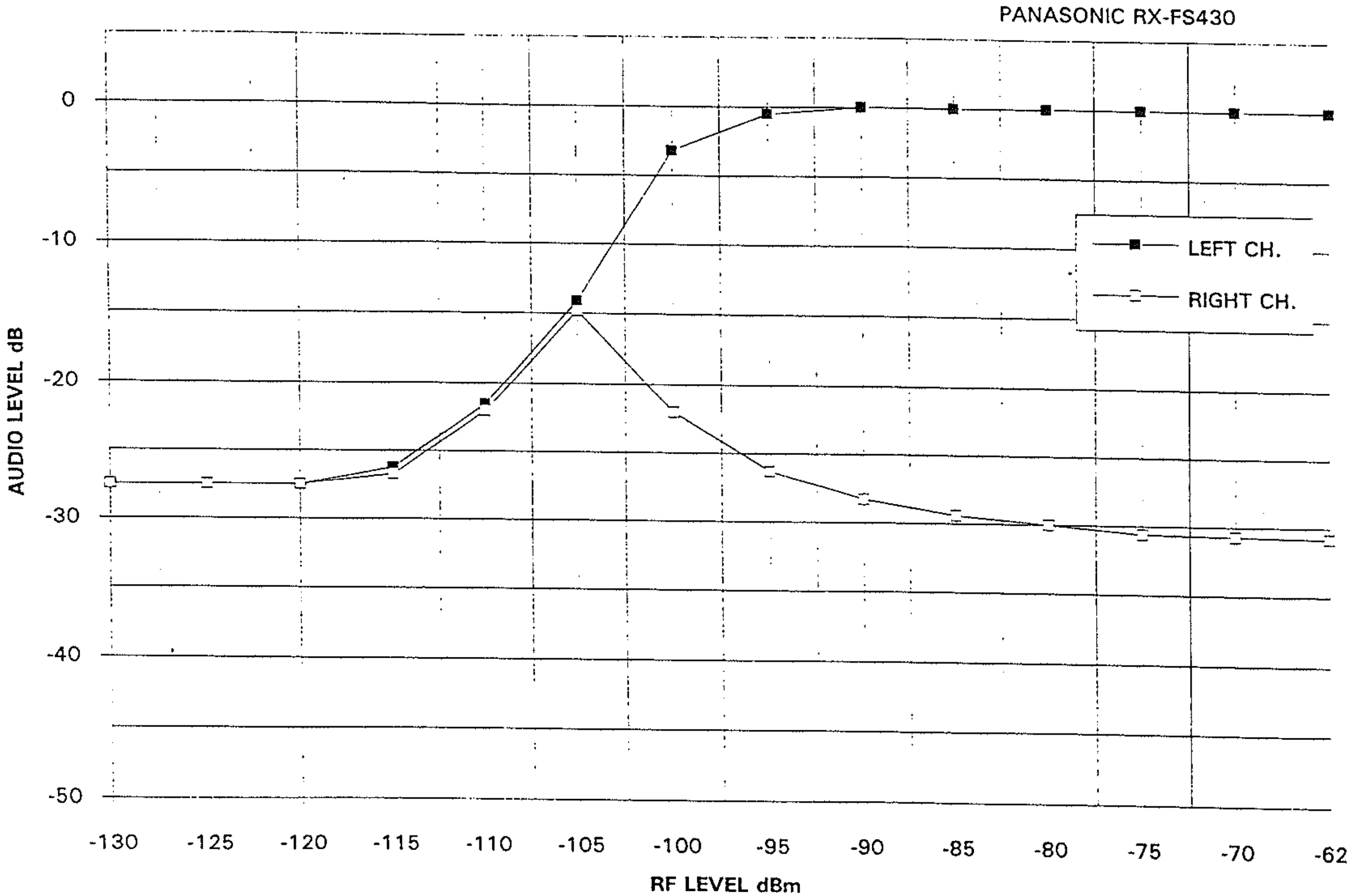

SIGNAL & FILTERED NOISE VS RF LEVEL
PANASONIC RX-FS430
MON SIGNAL
MON NOISE
ST SIGNAL
ST FIL NOISE
AUDIO LEVEL (dB)
0
-10
-20
-30
-40
-50
-60
-70
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-62
RF LEVEL (dBm)

4

Chart 1 of 3

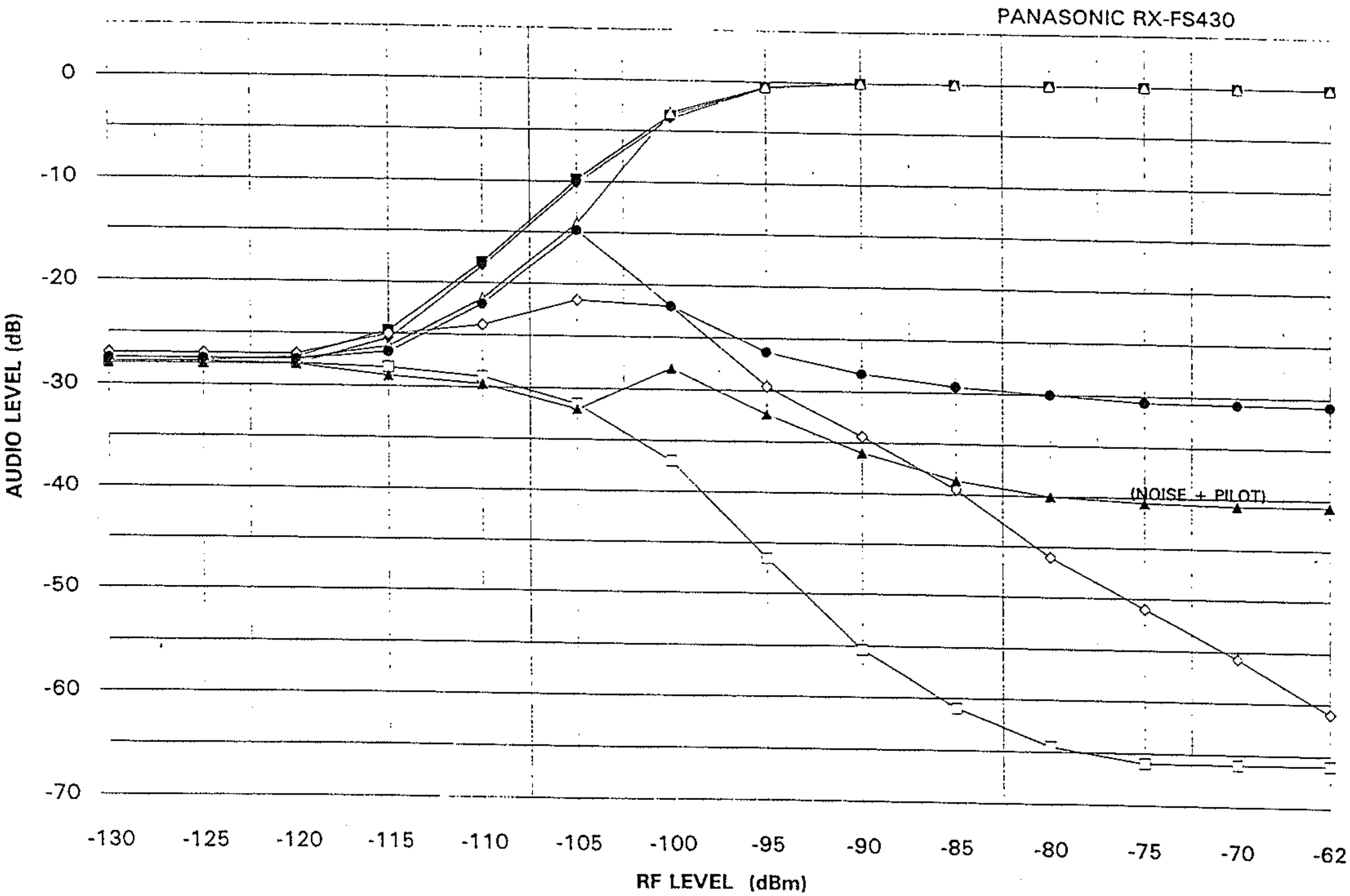
EIA DAR LAB

SEPARATION VS RF LEVEL



5

SIG., NOISE, FILT. NOISE & SEPARATION VS RF LEVEL



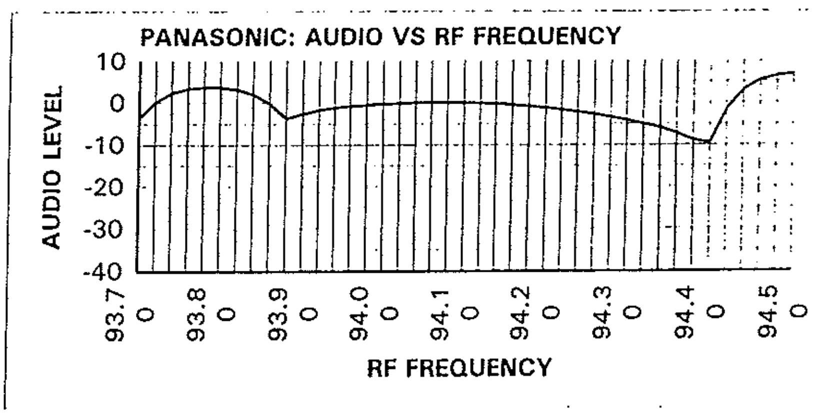
	GEN	RCVR		RCVR
FM TUNER TEST DATA				
Manufacturer:	Panasonic			
Model Number:	RX-FS430			
Serial Number:	GR3JA01184			
Type:	Personal Portable			
	using IEEE/IHF 10Ω,10Ω,45Ω resistive pad			
	external antenna disconnected			
FM 30% modulation(98.1MHz)				
20 dB S/N	4.3	2.15 μV	17.9 dBf	-100.3 dBm
30 dB S/N	6.8	3.4 μV	21.9 dBf	-96.4 dBm
50 dB S/N	80	40 μV	43.3 dBf	-74.9 dBm
Interstation Noise	-15	dB		
Mute start Level		μV	dBf	dBm
High cut at 10KHz		dB at	μV	
Fo+½IF rejection	8	4 mV	65.4 dB	
Image rejection	36	18 μV	18.5 dB	
FM 100% MODULATION MONO				
Usable Senditivity	6	3 μV	20.8 dBf	-97.4 dBm
50dB S/N	14	7 μV	28.1 dBf	-90.1 dBm
Maximum S/N	61	dB		
THD %	0.34			
AM Rejection at 1mV	48	dB		
FM 100% MODULATION STEREO				
Usable Sensitivity	9	4.5 μV	24.3 dBf	-93.9 dBm
50dB S/N	100	50 μV	45.2 dBf	-73.0 dBm
Maximum S/N	60	dB		
THD %	0.35			
1KHz separation	35	dB		
10KHz separation	38.5	dB		
Stero Blend action:	none			
Separation at 50μV		dB	39.0 dBf	-81.0 dBm
67KHz SCA Rejection δF=5KHz	54	dB		
19 and 38KHzproducts	-40	dB		
FM TWO SIGNAL TESTS(98.1 MHz)				
708μV (-50dBm)				
Capture Ratio	1.4	dB		
Selectivity@ 200KHz				
for 30dB S/N	5.5	dB		
for 50dB S/N	2	dB		
Selectivity@ 400KHz				
for 30dB S/N	29	dB		
for 50dB S/N	23.5	dB		
IM Rejection (98.9 and 99.7)	4	2 mV	77.3 dBf	-41.0 dBm
2MHz IM rejection (99.1 and 100.1)	4	2 mV	77.3 dBf	-41.0 dBm
IF mix rejection (96.4 and 107.2)	4	2 mV	77.3 dBf	-41.0 dBm
AM 30% MODULATION MONO				
DUMMY ANTENNA:	50Ω gem to 5.6μH in series with ferrite antenna			
20dB S/N	16	16 μV	-82.9 dBm	
Max S/N	51	dB		
THD at max S/N	0.7	%		
THD at 80% mod	1.1	%		
-3dB Audio Response		%		
600KHz	1570			
1400KHz	1680	Hz		
±10KHz Selectivity	14	dB		
±20KHz Selectivity	28.5	dB		
Local AGC action:		μV	dBm	
level for -3dB 600KHz desired signal reduction				
1400KHz		mV	dBm	
10MHz	141	141 mV	-4.0 dBm	
27MHz		mV	dBm	
IF mix rejection				
(1400 & 945 or 950)	NM	mV	dBm	
	local AGC prevents measurement			

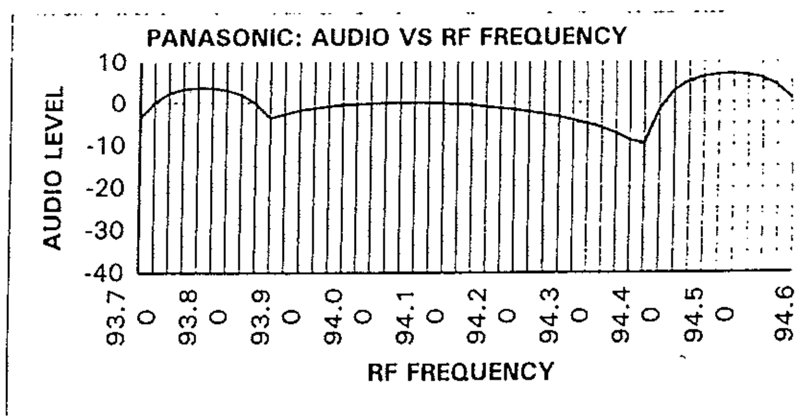
DAR Lab
Mar 15/95 PANAVRF.XLS
Panasonic Channel Characteristics 94.1MHZ

Audio VS RF Frequency

Note:
* The results here represent a chacteristic receiver input signature based on sweeping the RF signal through the desired channel
* The test signal is modulated with 1khz @ 100%
* The measurements are made using 15khz low pass and CCIR filters with quasi-peak detection
* RF level is -62dBm
* Manual tuned radio - tuned for lowest distortion for center tuning

RF FREQ.	AUDIO LEVEL	
93.70	-3.6	
93.72	0.12	
93.74	2.31	
93.76	3.36	
93.78	3.72	
93.80	3.65	
93.82	3.15	
93.84	2.03	
93.86	-0.14	
93.88	-3.67	
93.90	-2.66	
93.92	-1.77	
93.94	-1.22	
93.96	-0.83	
93.98	-0.56	
94.00	-0.34	
94.02	-0.17	
94.04	-0.03	
94.06	0.05	
94.08	0.07	
94.10	0	Tuning
94.12	-0.09	
94.14	-0.29	
94.16	-0.54	
94.18	-0.85	
94.20	-1.21	
94.22	-1.63	
94.24	-2.12	
94.26	-2.69	
94.28	-3.34	
94.30	-4.09	
94.32	-4.95	
94.34	-5.94	
94.36	-7.18	
94.38	-8.82	
94.40	-9.56	
94.42	-1.51	
94.44	3.06	
94.46	5.32	
94.48	6.36	
94.50	6.89	





DAR Lab
Mar 8/95
RMc

PANUP1.XLS

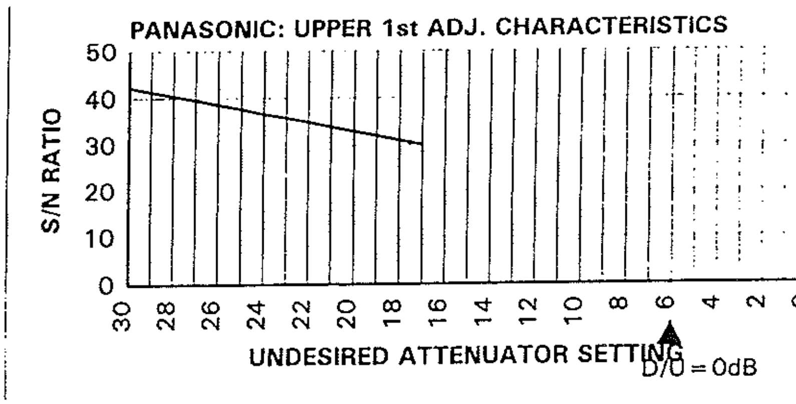
Panasonic Adjacent Channel Characteristics

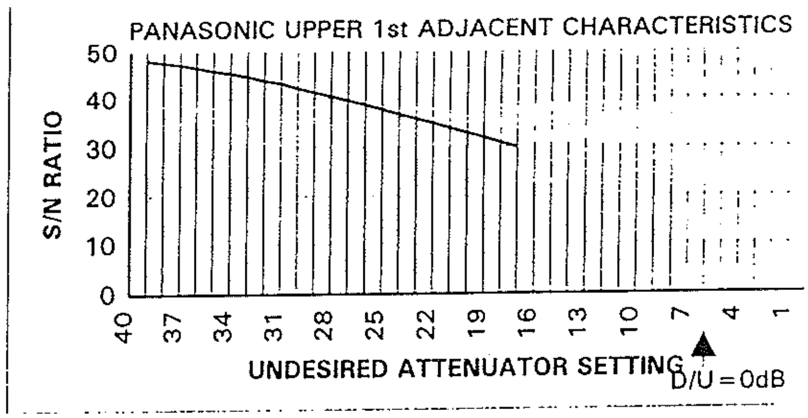
Upper first adj. channel 94.3mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)
40	
39	48.2
38	47.8
37	47.3
36	46.7
35	46
34	45.5
33	44.8
32	43.9
31	43.3
30	42.3
29	41.4
28	40.5
27	39.6
26	38.7
25	37.8
24	36.7
23	35.8
22	34.9
21	33.9
20	32.9
19	32
18	31
17	30
16	
15	
14	
13	
12	
11	
10	
9	
8	
7	
6		D/U=0dB
5	
4	
3	
2	
1	
0	





DAR Lab
Mar 8/95 PANLOW2.XLS

Panasonic Adjacent Channel Characteristics

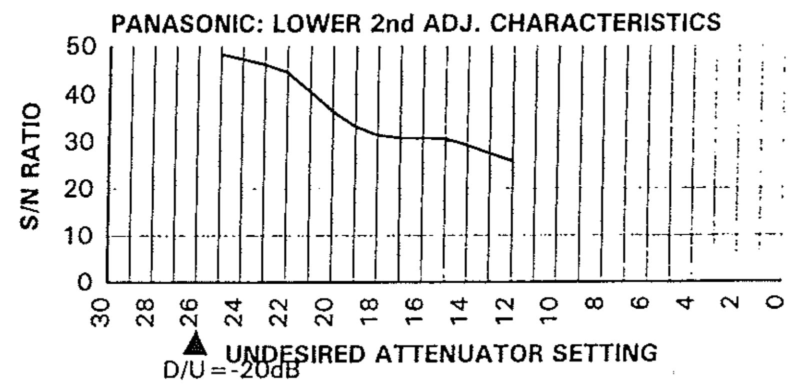
Lower second adj. channel 93.7mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)
40	
39	
38	
37	
36	
35	
34	
33	
32	
31	
30	
29	
28	
27	
26	
25	48.3
24	47.3
23	46.2
22	44.6
21	40.6
20	36.5
19	33.2
18	31.4
17	30.8
16	30.8
15	30.6
14	29.2
13	27.5
12	25.8
11	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	
0	

D/U = -20dB (at 26)



DAR Lab
Mar 13/95 PANUP2.XLS

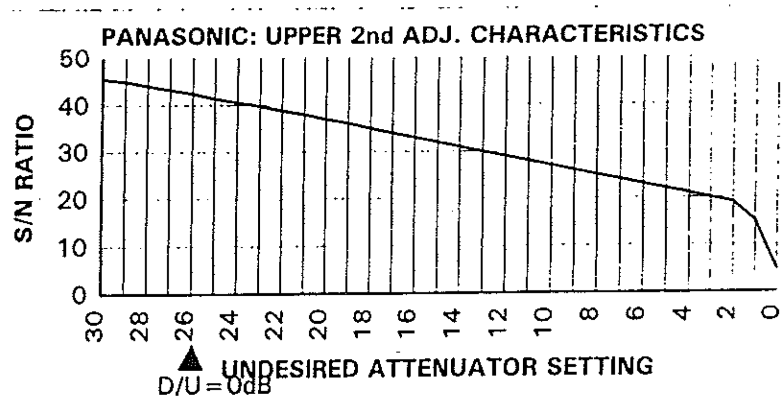
Panasonic Portable Radio Adjacent Channel Characteristics

Upper second adj. channel 94.5mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40	47.9	
39	49.7	
38	49.5	
37	48.7	
36	48.8	
35	47.5	
34	48	
33	47.5	
32	46.8	
31	46.1	
30	45.6	
29	45	
28	44.1	
27	43.3	
26	**42.5**	**D/U=0dB**
25	41.4	
24	40.6	
23	39.8	
22	38.8	
21	38	
20	37	
19	36.1	
18	35	
17	34	
16	33	
15	32	
14	31	
13	30	
12	29	
11	28	
10	27	
9	26	
8	25	
7	24	
6	23	
5	22	
4	21	
3	20	
2	19	
1	15	
0	5	



DAR FM TEST RECEIVER DATA

Receiver Lab #4

Type Home Hi-Fi

Index

Page	Description
1	Laboratory FM -> FM D/U Ratios
2	Radio Characterization/Confirmation
3	Signal, Noise, & Separation VS RF Level
4	Graph of Signal & Filtered Noise VS RF Level
5	Graph of Separation VS RF Level
6	Graph of Signal, Noise, Filtered Noise, & Separation VS RF Level
7	Woodstock Engineering Receiver Test Report
8	Audio VS RF Frequency Test
9	Receiver Upper 1st Adjacent Interference/Noise
10	Receiver Lower 2nd Adjacent Interference/Noise
11	Receiver Upper 2nd Adjacent Interference/Noise

FM -> FM Laboratory Measurements for the Pioneer Model SX-201

Laboratory Receiver #4

Type: Home Hi-Fi

Measurements were made at a moderate signal level of -62 dBm.

The signal to noise ratio was set at 45 dB and this measurement was made using a 15kHz low pass and a CCIR filter with quasi-peak detection.

Test Results:

Co-Channel	D/U	44.18 dB
Lower First Adjacent	D/U	31.87 dB
Upper First Adjacent	D/U	21.22 dB
Lower Second Adjacent	D/U	-15.16 dB
Upper Second Adjacent	D/U	-14.92 dB

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 2/21/95

PROJ.: RADIO CHARACTERIZATION/CONFIRMATION

* Key point measurements for comparison to Grossjean data
* Additional data with regard to audio performance VS RF level

TEST SET-UP

* Receiver: Pioneer SX-201
* Ant. Net: 50/75 ohm resistive pad (-7.8dB insertion loss)
* Audio Ref: 580mV
* Receiver in "Manual Tuning" Mode for all measurements
* Test Bed, W/Orban Stereo Gen & Harris Exciter as Signal Source
* Audio measurements made with Audio Precision as rms unweighted

FM TESTS (TEST FQ. 94.1MHZ)

S/N RATIO - 1KHZ, 100% MOD

MAX	-65dB	-62dBm	(mono)

THD - 1KHZ, 100% MOD (-50dBm)

MONO	0.64 %	
STEREO	1.37 %	(Increase due to pilot content)

LIMITING THRESHOLD (Audio -1dB)

-108dBm

HIGH CUT THRESHOLD

Audio: 10KHZ, L+R, 100% Mod, Pilot off
NA

SEPARATION @ -62dBm

Freq.	L->R	R->L	
1KHZ	-33.4dB	-34.5dB	(W/O Pre-Emph)
10KHZ	-23dB	-24.4dB	(W/O Pre-Emph)

SIGNAL, NOISE & SEPARATION VS RF LEVEL

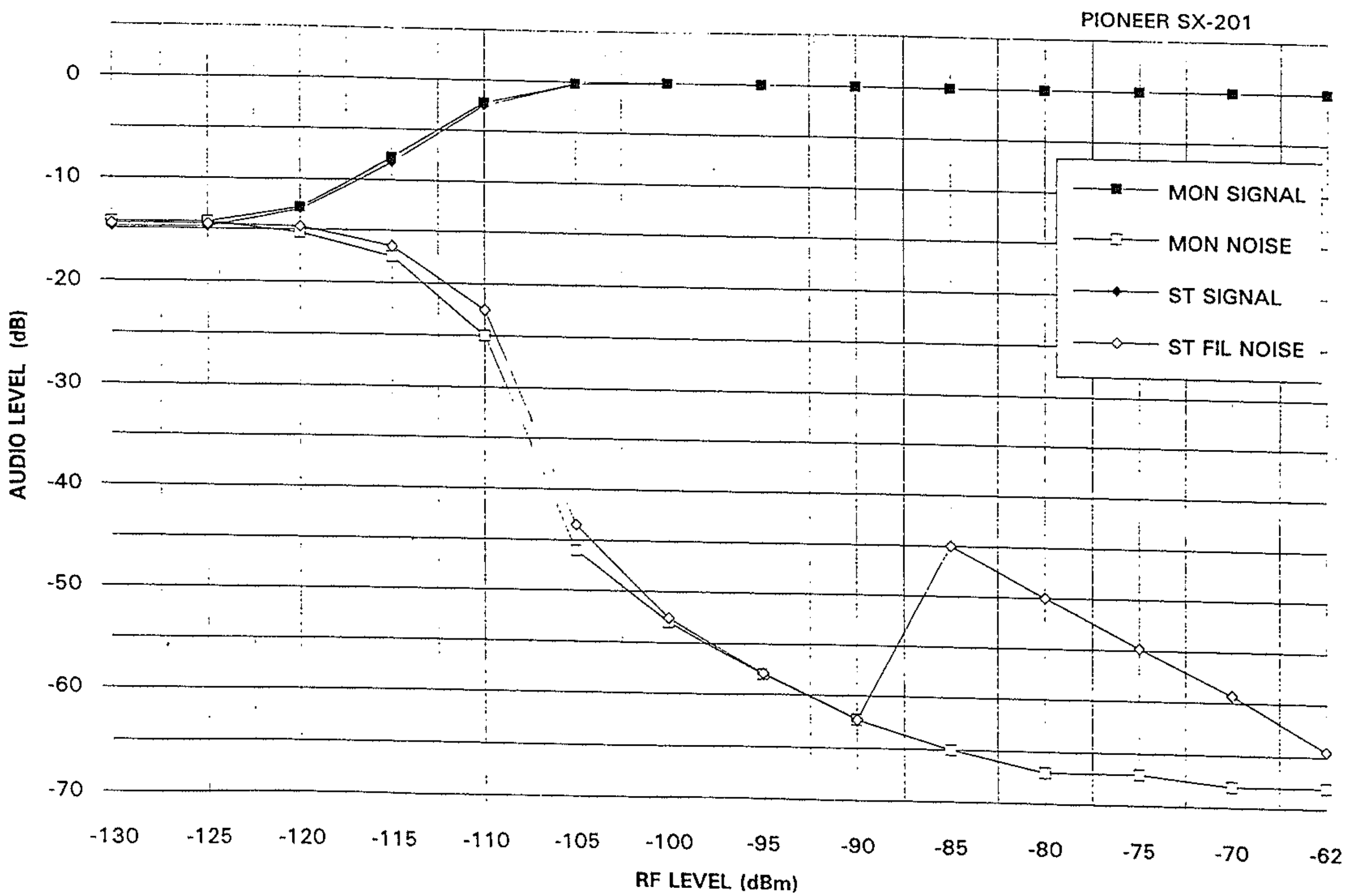
* Left channel used as the measurement channel for Signal and Noise data
* Left channel driven (L only) for separation data
* Audio test frequency = 1KHZ
* Receiver in "Manual Tuning" Mode for all measurements
* RF levels represent power into the receiver after 50/75 ohm conversion
* Filt. Noise figures represent noise measurements made with a 15khz low pass filter to reject the pilot

CURVE DATA

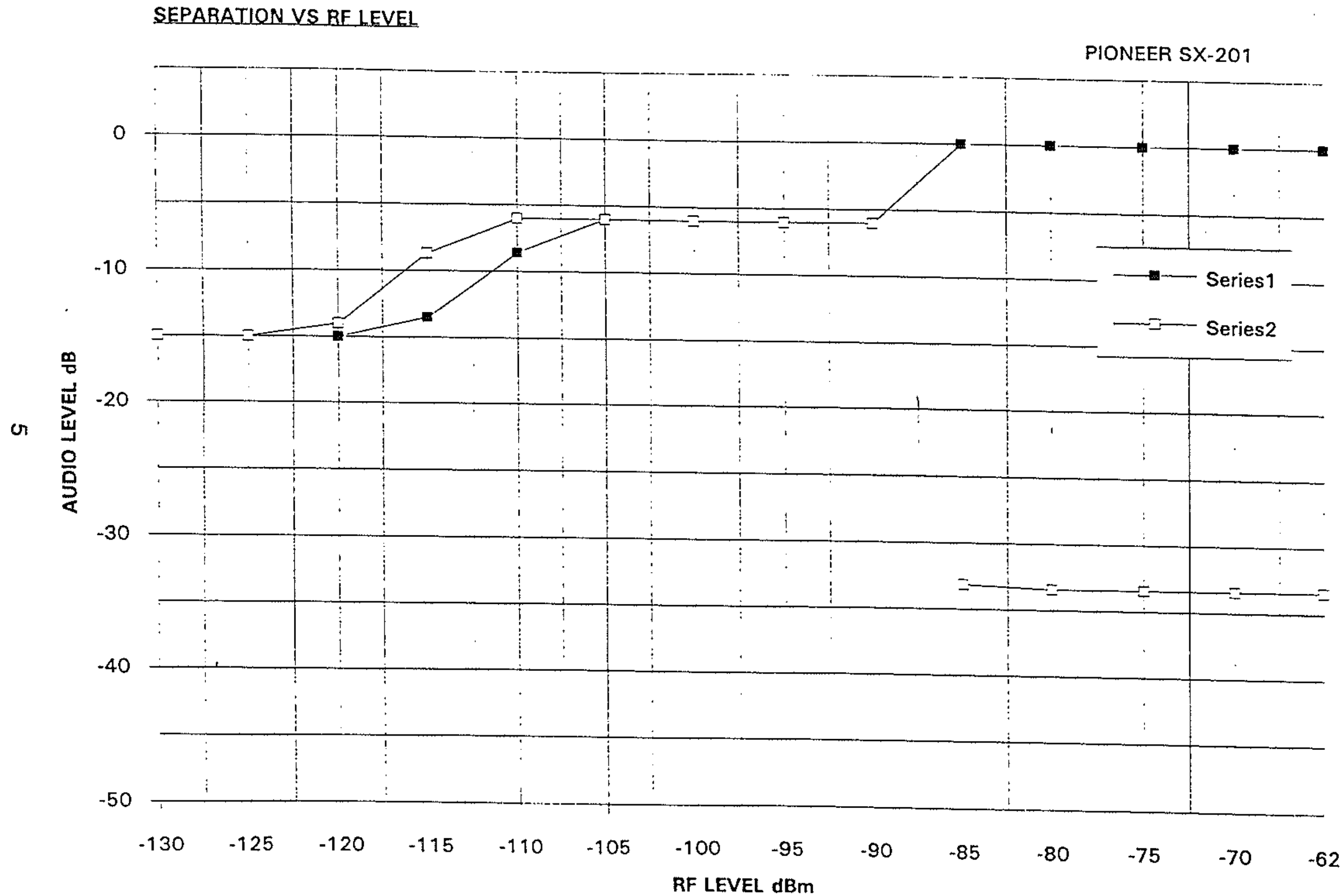
SIGNAL, NOISE & SEPARATION VS RF LEVEL

RF Level	mono (L)		Stereo (L)			RF Level	Separation L->R	
	Signal	Noise	Signal	Filt. Noise	Noise		Left	Right
dBm	dB	dB	dB	dB	dB	dBm	dB	dB
-130	-14.3	-14.3	-14.8	-14.5	-14.8	-130	-15	-15
-125	-14.3	-14.3	-14.8	-14.5	-14.8	-125	-15	-15
-120	-12.8	-15.3	-13	-14.7	-15	-120	-15	-14
-115	-7.8	-17.5	-8.3	-16.5	-17	-115	-13.5	-8.7
-110	-2.2	-25	-2.5	-22.5	-24	-110	-8.6	-6
-105	-0.2	-46	-0.23	-43.5	-40	-105	-6	-6
-100	0	-53	0	-52.6	-41.5	-100	-6	-6
-95	0	-58	0	-57.9	-42	-95	-6	-6
-90	0	-62.3	0	-62.3	-42	-90	-6	-6
-85	0	-65	0	-45	-39	-85	0	-33.1
-80	0	-67	0	-50	-39.8	-80	0	-33.4
-75	0	-67	0	-54.8	-40	-75	0	-33.4
-70	0	-68	0	-59.3	-40	-70	0	-33.4
-62	0	-68	0	-64.5	-40	-62	0	-33.4
-57						-57		

SIGNAL & FILTERED NOISE VS RF LEVEL



EIA DAR LAB



SEPARATION VS RF LEVEL
PIONEER SX-201
0
-10
-20
-30
-40
-50
AUDIO LEVEL dB
Series1
Series2
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-62
RF LEVEL dBm

EIA DAR LAB

SIG., NOISE, FILT. NOISE & SEPARATION VS RF LEVEL

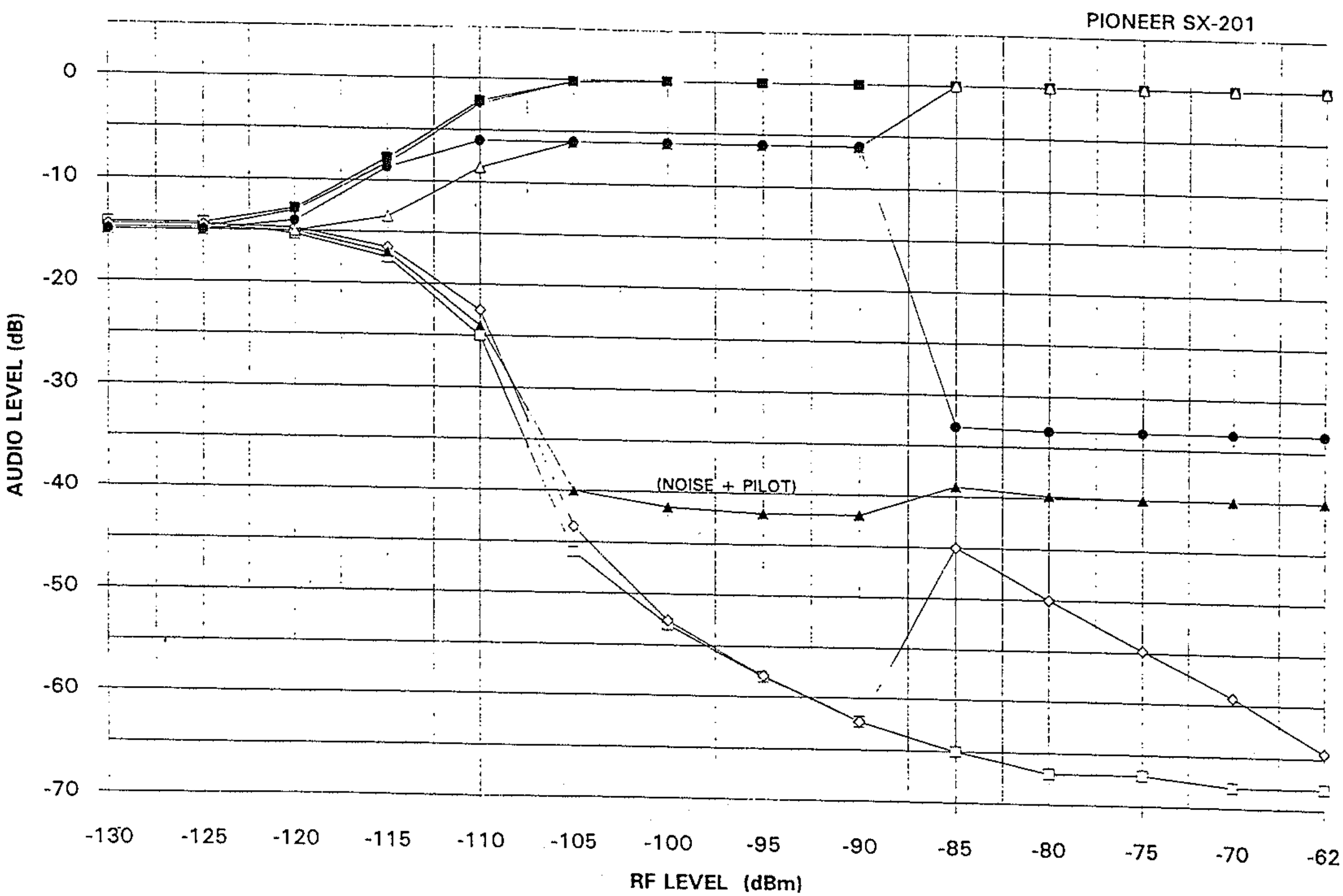


Chart 3 of 3

FM TUNER TEST DATA

Manufacturer: Pioneer
Model Number: SX-201
Serial Number: 0A3965843C
Type: Home Hi-Fi
using IEEE/IHF 10Ω,10Ω,45Ω resistive pad
and balun transformer

FM 30% modulation(98.dBm levels are 300Ω balanced output level

	GEN	RCVR 300Ω		RCVR
20 dB S/N	3	3 μV	14.8 dBf	-97.4 dBm
30 dB S/N	4.4	4.4 μV	18.1 dBf	-94.1 dBm
50 dB S/N	7	7 μV	22.1 dBf	-90.1 dBm
Interstation Noise	-2	dB		
Mute start Level		μV	dBf	dBm
High cut at 10KHz	0	dB at	μV	
Fo+½IF rejection	5	5 mV	64.4 dB	
Image rejection	224	224 μV	37.5 dB	

FM 100% MODULATION MONO

Usable Senditivity	4.4	2.2 μV	18.1 dBf	-100.1 dBm
50dB S/N	14	7 μV	28.1 dBf	-90.1 dBm
Maximum S/N	75	dB		
THD %	0.33			
AM Rejection at 1mV	56	dB		

FM 100% MODULATION STEREO

Usable Sensitivity	switches to mono		dBf	dBm
50dB S/N	70	35 μV	42.1 dBf	-76.1 dBm
Maximum S/N	66	dB		
THD %	0.8			
1KHz separation	39	dB		
10KHz separation		dB		
Stero Blend action: separation at 50μVrec	37	dB	39.2 dBf	-73.0 dBm
67KHz SCA Rejection δF=5KHz	65	dB		
19 and 38KHzproducts	-21	dB		

FM TWO SIGNAL TESTS(98.1 MHz)

Capture Ratio	1.5	dB		
Selectivity@ 200KHz				
for 30dB S/N	6	dB		
for 50dB S/N	2.5	dB		
Selectivity@ 400KHz				
for 30dB S/N	51	dB		
for 50dB S/N	46.5	dB		
IM Rejection (98.9 and 99.7)	3	3 mV	74.8 dBf	-37.4 dBm
2MHz IM rejection (96.4 and 100.1)	8	8 mV	83.3 dBf	-28.9 dBm
IF mix rejection (96.4 and 107.1)	1.4	1.4 mV	68.1 dBf	-44.1 dBm

AM 30% MODULATION MONO

DUMMY ANTENNA: 50Ω generator replacing loop

20dB S/N	15	15 μV	-83.5 dBm
Max S/N	51	dB	
THD at max S/N	0.1	%	
THD at 80% mod	0.5	%	
-3dB Audio Response		%	
600KHz	1484		
1400KHz	1484	Hz	
±10KHz Selectivity	26	dB	
±20KHz Selectivity	38	dB	
Local AGC action:		μV	dBm
level for -3dB 600KHz desired signal reduction			
1400KHz			
10MHz		mV	dBm
27MHz		mV	dBm
IF mix rejection (1400 & 945 or 950)	10	10 mV	-26.98 dBm

DAR Lab
~~Mar 8/95~~ MAR 15/95 PIONAVRF.XLS

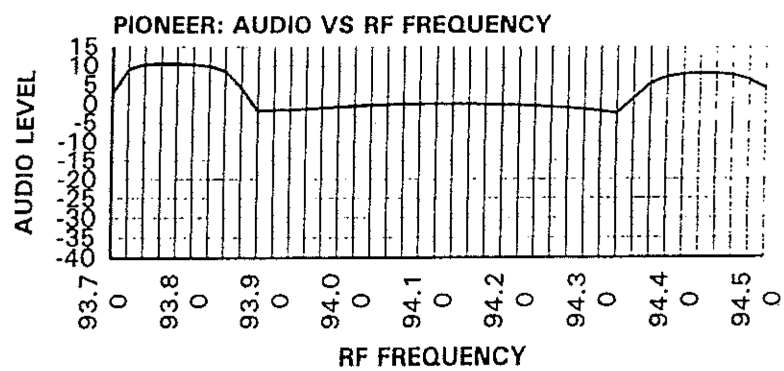
Pioneer Channel Characteristics **94.1MHZ**

Audio VS RF Frequency

Note:

* The results here represent a chacteristic receiver input signature based on sweeping the RF signal through the desired channel
* The test signal is modulated with 1khz @ 100%
* The measurements are made using 15khz low pass and CCIR filters with quasi-peak detection
* RF level is -62dBm

RF FREQ.	AUDIO LEVEL	
93.70	2.75	
93.72	9	
93.74	10.4	
93.76	10.66	
93.78	10.63	
93.80	10.4	
93.82	9.88	
93.84	8.52	
93.86	4.12	
93.88	-1.76	
93.90	-1.62	
93.92	-1.52	
93.94	-1.3	
93.96	-1.05	
93.98	-0.81	
94.00	-0.6	
94.02	-0.41	
94.04	-0.26	
94.06	0	
94.08	0	
94.10	**0**	**Tuning Frequency**
94.12	0	
94.14	0	
94.16	-0.13	
94.18	-0.24	
94.20	-0.39	
94.22	-0.57	
94.24	-0.78	
94.26	-1.07	
94.28	-1.43	
94.30	-1.88	
94.32	-2.5	
94.34	1.54	
94.36	5.32	
94.38	7	
94.40	7.7	
94.42	8	
94.44	7.9	
94.46	7.5	
94.48	6.2	
94.50	4	



DAR Lab
Mar 8/95 PIONUP1.XLS
RMc

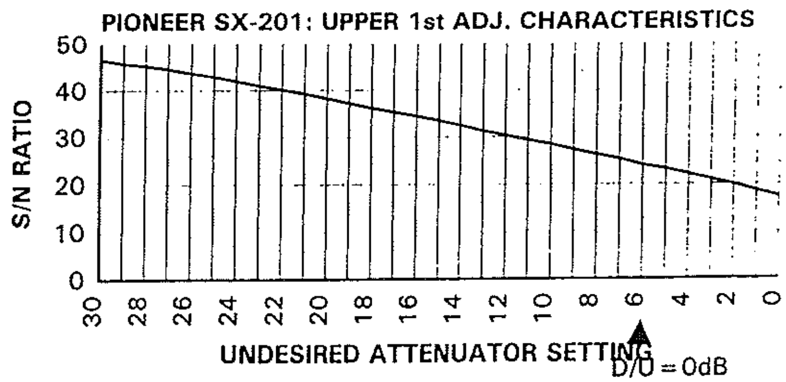
Pioneer Adjacent Channel Characteristics

Upper first adj. channel 94.3mhz

Note:

- The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
- The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
- The interfering signal is modulated with clipped pink noise
- SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35		
34		
33		
32		
31		
30	46.6	
29	45.8	
28	45.3	
27	44.6	
26	43.7	
25	43	
24	42	
23	41	
22	40.2	
21	39.3	
20	38.3	
19	37.3	
18	36.3	
17	35.4	
16	34.5	
15	33.5	
14	32.5	
13	31.3	
12	30.4	
11	29.4	
10	28.4	
9	27.3	
8	26.3	
7	25.3	
6	24	D/U=0dB
5	23.2	
4	22.1	
3	21	
2	19.9	
1	18.6	
0	17.4	



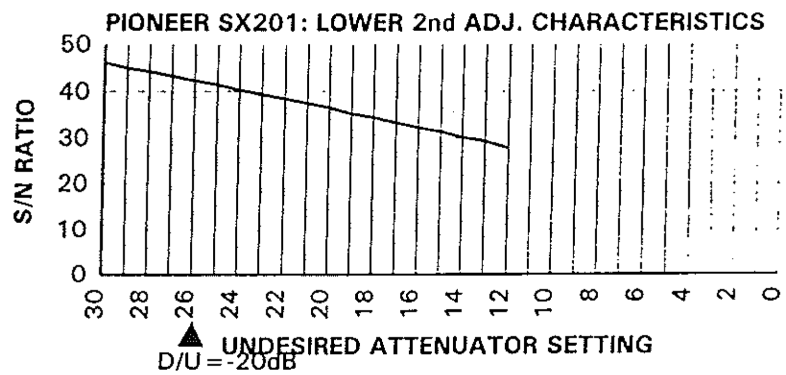
DAR Lab
Mar 8/95 PIONLOW2.XLS

Pioneer SX201 Adjacent Channel Characteristics

Lower second adj. channel 93.7mhz

Note:
* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35	49.9	
34	49.2	
33	48.5	
32	47.8	
31	47	
30	46.2	
29	45	
28	44.3	
27	43.3	
26	**42.3**	D/U=-20dB
25	41.5	
24	40.4	
23	39.4	
22	38.5	
21	37.5	
20	36.6	
19	35.3	
18	34.5	
17	33.4	
16	32.3	
15	31.4	
14	30.2	
13	29.3	
12	27.9	
11		
10		
9		
8		
7		
6		
5		
4		
3		
2		
1		
0		



DAR Lab
Mar 13/95

PIONUP2.XLS

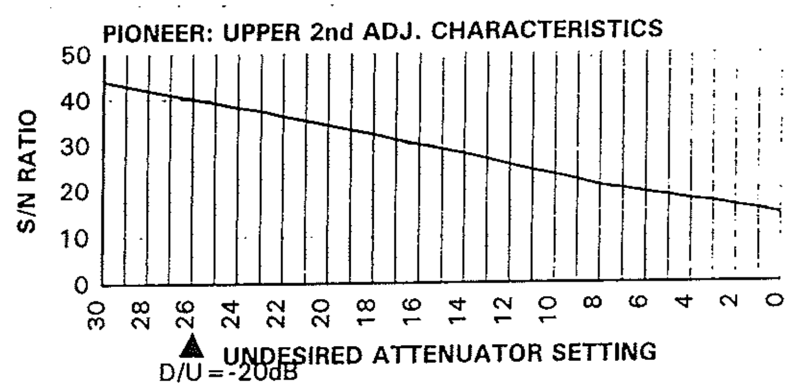
PIONEER SX-201 Adjacent Channel Characteristics

Upper second adj. channel 94.5mhz

Note:

* The results here represent a chacteristic receiver input signature based on ramping the undesired signal up in 1dB increments and recording the signal to noise ratio.
* The measurements are made using a 15khz low pass and CCIR filters with quasi-peak detection
* The interfering signal is modulated with clipped pink noise
* SCA's (group B) are employed on both the desired and the undesired signals.

UNDES. ATTEN.	RADIO S/N (dB)	
40		
39		
38		
37		
36		
35	47.5	
34	46.9	
33	46.1	
32	45.3	
31	44.6	
30	44	
29	43	
28	42	
27	41	
26	40.1	D/U=-20dB
25	39.3	
24	38.2	
23	37.5	
22	36.3	
21	35.4	
20	34.3	
19	33.3	
18	32.3	
17	31.1	
16	30	
15	29	
14	28	
13	26.8	
12	25.5	
11	24.3	
10	23.3	
9	22.2	
8	20.9	
7	20.2	
6	19.3	
5	18.6	
4	17.8	
3	17.3	
2	16.3	
1	15.6	
0	14.6	



DAR FM TEST RECEIVER DATA

Receiver Lab #5

Type Auto

Index

Page	Description
1	Laboratory FM -> FM D/U Ratios
2	Radio Characterization/Confirmation
3	Signal, Noise, & Separation VS RF Level
4	Graph of Signal & Filtered Noise VS RF Level
5	Graph of Separation VS RF Level
6	Graph of Signal, Noise, Filtered Noise, & Separation VS RF Level
7	Woodstock Engineering Receiver Test Report
8	Audio VS RF Frequency Test
9	Receiver Upper 1st Adjacent Interference/Noise
10	Receiver Lower 2nd Adjacent Interference/Noise (no measurements made)
11	Receiver Upper 2nd Adjacent Interference/Noise (no measurements made)

FM -> FM Laboratory Measurements for the Ford Model F4XF-19B132-CB

Laboratory Receiver #5

Type: Auto

Measurements were made at a moderate signal level of -62 dBm.

The signal to noise ratio was set at 45 dB and this measurement was made using a 15kHz low pass and a CCIR filter with quasi-peak detection. For the second adjacent tests 45 dB S/N was not attainable on the test bed and 48 dB was used.

Test Results:

Co-Channel	D/U	35.22 dB
Lower First Adjacent	D/U	-6.18 dB
Upper First Adjacent	D/U	-6.12 dB
Lower Second Adjacent	D/U	-44.43 dB
Upper Second Adjacent	D/U	-46.18 dB

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 2/21/95

PROJ.: RADIO CHARACTERIZATION/CONFIRMATION

* Key point measurements for comparison to Grossjean data
* Additional data with regard to audio performance VS RF level
* Unweighted rms noise measurements

TEST SET-UP

* Receiver: Ford Auto Radio
* Ant. Net: 50/75 (auto radio version)
* Audio Ref: 2.0Vrms into 4 ohms
* Test Bed, W/Orban Stereo Gen & Harris Exciter as Signal Source
* Audio measurements made as rms unweighted for singal tone tests
* Two tone tests (adjacent channel) made according to NAB Technical Report of 8/30/83

FM TESTS (TEST FQ. 94.1MHZ)

S/N RATIO - 1KHZ, 30% MOD

20dB S/N	dBm
30dB S/N	dBm
50dB S/N	dBm

S/N RATIO - 1KHZ, 100% MOD

USABLE	50dB S/N	-97dBm
MAX	66dB	-62dBm

THD - 1KHZ, 100% MOD (-50dBm)

MONO	0.90 %
STEREO	0.90 %

LIMITING THRESHOLD (Audio - 1dB)

-97dBm

HIGH CUT THRESHOLD

Audio: 10KHZ, L+R, 100% Mod, Pilot off
-3dB = -85dBm
Note: Same result with Pilot On

SEPARATION @ -62dBm

Freq.	L->R	R->L	
1KHZ			(W/O Pre-Emph)
10KHZ			(W/O Pre-Emph)

SIGNAL, NOISE & SEPARATION VS RF LEVEL

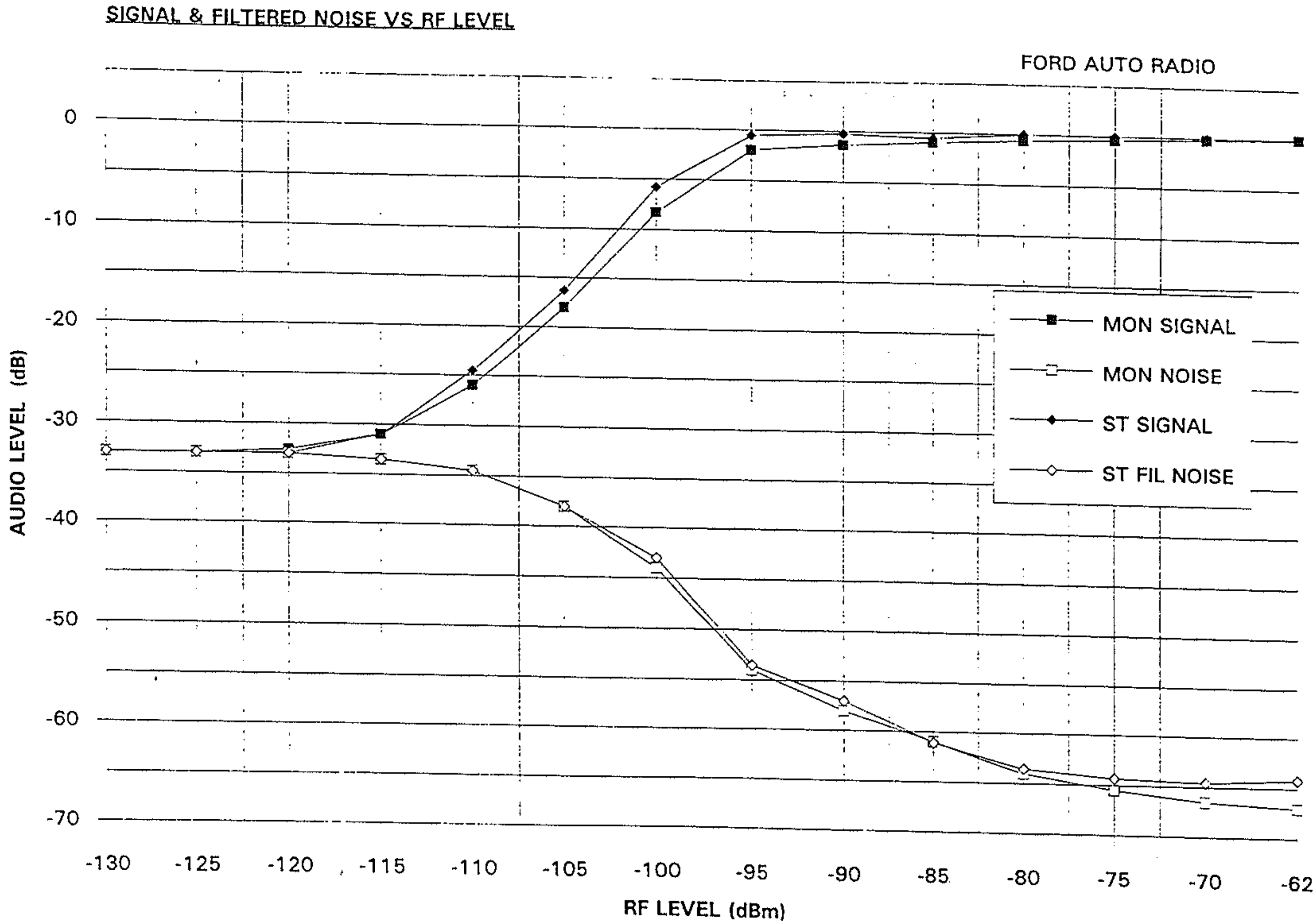
* Left channel used as the measurement channel for Signal and Noise data
* Left channel driven (L only) for separation data

* Audio test frequency = 1KHZ
* RF levels represent power into the dummy antenna

SIGNAL, NOISE & SEPARATION VS RF LEVEL

RF Level	mono (L)		Stereo (L)			RF Level	Separation L->R	
	Signal	Noise	Signal	Filt. Noise	Noise		Left	Right
dBm	dB	dB	dB	dB	dB	dBm	dB	dB
-130	-33	-33	-33	-33	-33	-130	-32	-32
-125	-33	-33	-33	-33	-33	-125	-32	-32
-120	-32.6	-33	-33	-33	-33	-120	-32	-32
-115	-31	-33.5	-31	-33.5	-33	-115	-32	-32
-110	-26	-34.5	-24.5	-34.5	-35	-110	-28	-28
-105	-18	-38	-16.3	-38	-38	-105	-22	-22
-100	-8.3	-44	-5.8	-43	-42.5	-100	-10.7	-10
-95	-2	-54	-0.51	-53.5	-50.3	-95	-7.27	-7.4
-90	-1.34	-58	-0.24	-57	-53.8	-90	-6.73	-6.8
-85	-0.94	-61	-0.52	-61.1	-56.5	-85	-6.3	-6.6
-80	-0.62	-64	0	-63.5	-58.2	-80	-6	-6.4
-75	-0.36	-65.5	0	-64.3	-58.7	-75	-5.5	-6.5
-70	-0.17	-66.5	0	-64.6	-58.8	-70	-4.9	-6.8
-62	0	-67	0	-64.2	-56	-62	-3.28	-8
-55						-55	-1.35	-10
-50						-50	-0.44	-14
-45						-45	0	-25

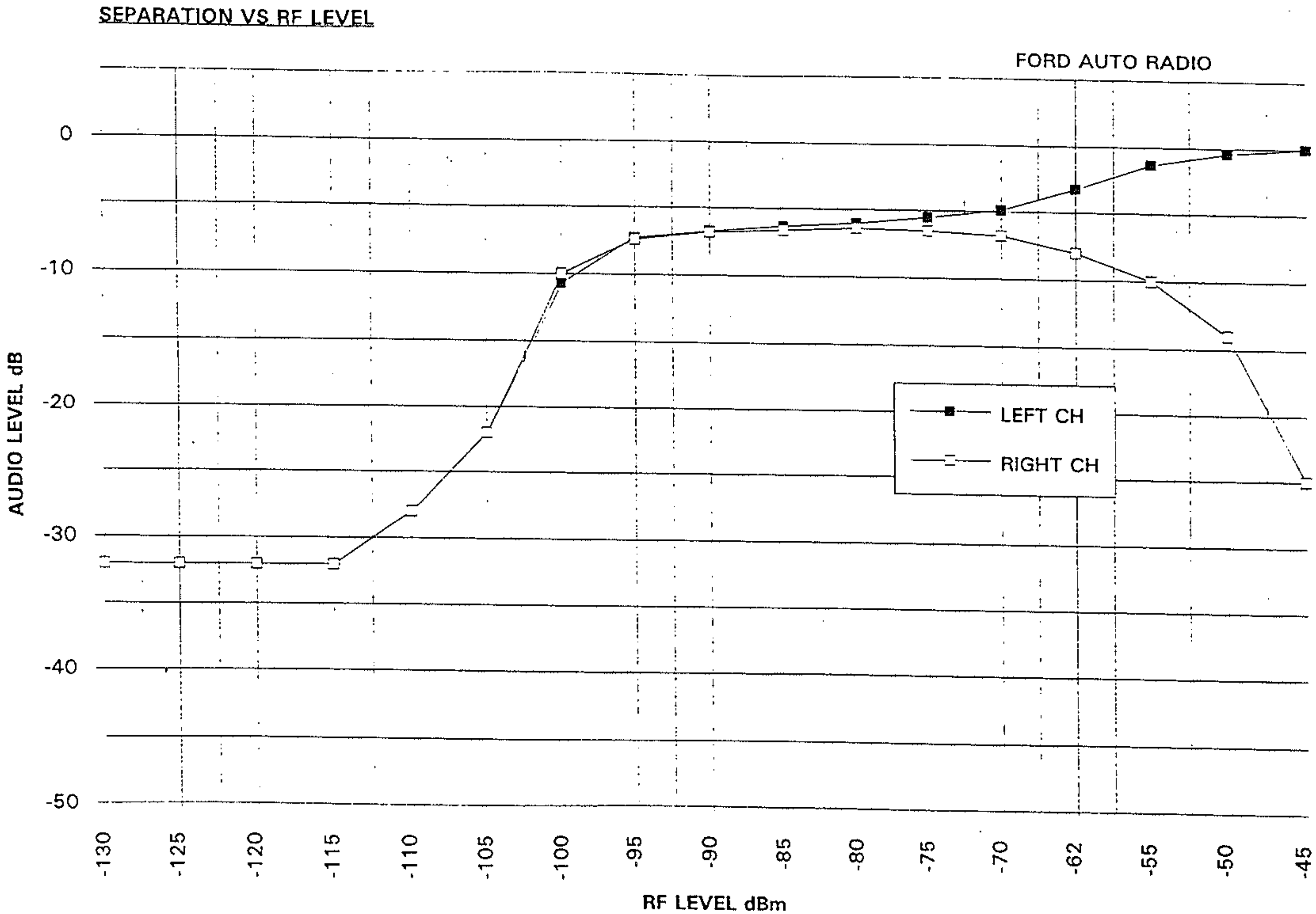
EIA DAR LAB



4

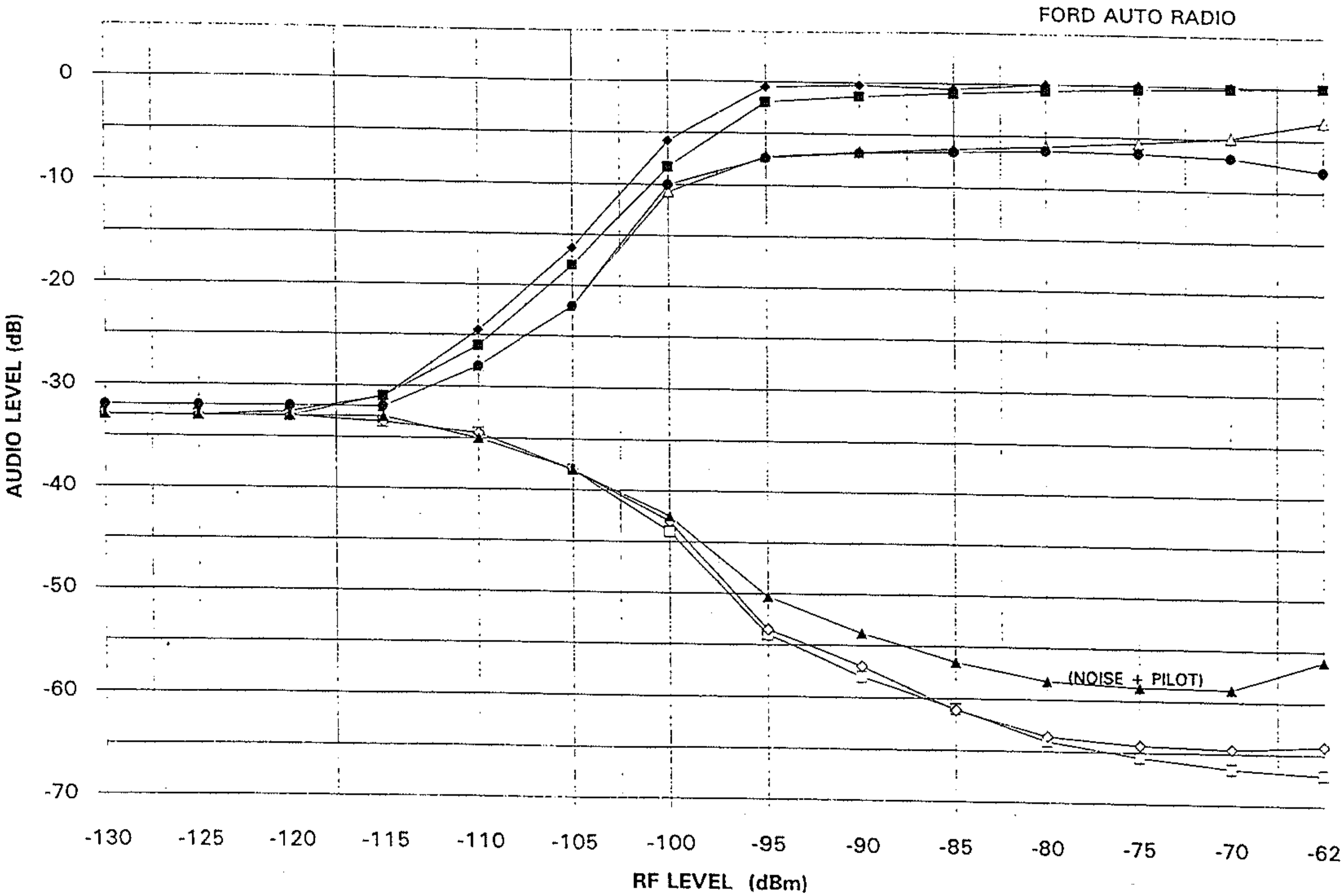
Chart 1 of 3

EIA DAR LAB


SEPARATION VS RF LEVEL
FORD AUTO RADIO
AUDIO LEVEL dB
0
-10
-20
-30
-40
-50
LEFT CH
RIGHT CH
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-62
-55
-50
-45
RF LEVEL dBm

5

SIG., NOISE, FILT. NOISE & SEPARATION VS RF LEVEL



	GEN	RCVR		RCVR
FM TUNER TEST DATA				
Manufacturer:	Ford			
Model Number:	F4XF-19B132-CB			
Serial Number:	9411			
Type:	Car Radio			
	Using IEEE/EIA 10Ω,10Ω,45Ω resistive pad			
FM 30% modulation(98.1MHz)				
20 dB S/N	1.5	0.75 μV	8.7 dBf	-109.5 dBm
30 dB S/N	2.2	1.1 μV	12.1 dBf	-106.2 dBm
50 dB S/N	13	6.5 μV	27.5 dBf	-90.7 dBm
Interstation Noise	-23	dB		
Mute start Level	2.2	1.1 μV	12.1 dBf	-106.2 dBm
High cut at 10KHz	3	dB at	6.3 μV receiver input	
Fo+½IF rejection	56.2	28.1 mV	91.5 dB	-18.0
Image rejection	447	223.5 μV	49.5 dB	-60.0
FM 100% MODULATION MONO				
Usable Sensitivity	3.98	1.99 μV	17.2 dBf	-101.0 dBm
50dB S/N	2.8	1.4 μV	14.2 dBf	-104.1 dBm
Maximum S/N	68	dB		
THD %	0.7			
AM Rejection at 1mV	57	dB		
FM 100% MODULATION STEREO				
Usable Sensitivity	BLEND	μV		
50dB S/N	BLEND	μV		
Maximum S/N	61	dB		
THD %	0.6			
1KHz separation	35.5	dB		
10KHz separation	30	dB		
Stero Blend action:	Blend starts at 1mV receiver input level			
Separation at 50μVrec	2.5	dB	45.2 dBf	-73.0 dBm
67KHz SCA Rejection δF=5KHz	61	dB		
19 and 38KHzproducts	-54	dB		
FM TWO SIGNAL TESTS(98.1 MHz)				
708μV (-50dBm)				
Capture Ratio	2.5	dB		
Selectivity@ 200KHz				
for 30dB S/N	20.9	dB		
for 50dB S/N	18.8	dB		
Selectivity@ 400KHz				
for 30dB S/N	70	dB		
for 50dB S/N	37.2	dB		
IM Rejection (98.9 and 99.7)	10	5 mV	85.2 dBf	-33.0 dBm
2MHz IM rejection (99.1 and 100.1)	12	6 mV	86.8 dBf	-31.4 dBm
IF mix rejection (96.4 and 107.2)	12	6 mV	86.8 dBf	-31.4 dBm
AM 30% MODULATION MONO				
DUMMY ANTENNA:	15/60pF			
20dB S/N	20	20 μV	-81.0 dBm	
Max S/N	50	dB		
THD at max S/N	0.4	%		
THD at 80% mod	0.5	%		
-3dB Audio Response				
600KHz	2333			
1400KHz	2333	Hz		
±10KHz Selectivity	64	dB		
±20KHz Selectivity	NM	local AGC prevents measurement .		
Local AGC action:				
level for -3dB 600KHz signal S/N reduction				
1400KHz	20	14.14 mV	-21.0 dBm	
10MHz	20	14.14 mV	-21.0 dBm	
27MHz	20	14.14 mV	-21.0 dBm	
IF mix rejection (1400 & 945 or 950)	NM	local AGC prevents measurement		

DAR Lab
Mar ~~8/95~~ 15/95

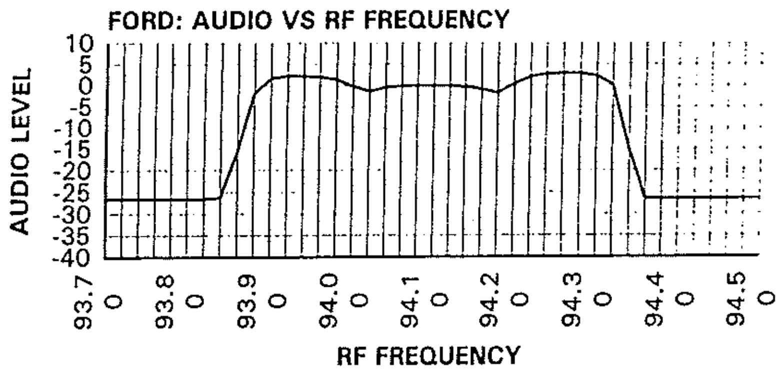
FRDAVRF.XLS

Ford Channel Characteristics **94.1MHZ**

Audio VS RF Frequency

Note:
* The results here represent a chacteristic receiver input signature based on sweeping the RF signal through the desired channel·
* The test signal is modulated with 1khz @ 100%
* The measurements are made using 15khz low pass and CCIR filters with quasi-peak detection
* RF level is -62dBm

RF FREQ.	AUDIO LEVEL	
93.70	-26.5	
93.72	-26.5	
93.74	-26.5	
93.76	-26.5	
93.78	-26.5	
93.80	-26.5	
93.82	-26.5	
93.84	-26.2	
93.86	-15.4	
93.88	-1.75	
93.90	1.7	
93.92	2.31	
93.94	2.26	
93.96	2.07	
93.98	1.42	
94.00	-0.15	
94.02	-1.31	
94.04	-0.44	
94.06	-0.12	
94.08	0	
94.10	0	**Tuning Frequency**
94.12	0	
94.14	-0.33	
94.16	-0.8	
94.18	-1.64	
94.20	0.51	
94.22	2.08	
94.24	2.63	
94.26	2.85	
94.28	2.91	
94.30	2.35	
94.32	0.2	
94.34	-14.84	
94.36	-26.4	
94.38	-26.5	
94.40	-26.5	
94.42	-26.5	
94.44	-26.5	
94.46	-26.5	
94.48	-26.5	
94.50	-26.5	



Additional Compatibility Receiver Data

DAR Lab
17-May-95 ANTDUM1.XLS
RMc

Antenna Dummy Characteristics

Delco/JFW Antenna Dummy Network

FM

Input impedance:	50 ohms
Ouptut Impedance:	50 ohms
Insersion loss:	6dB

Delco Radio

FM

Input Impedance:	50 ohms nominal

AM

Input Impedance:	Capacitive - impedance varies with frequency

Ford Antenna Dummy Network

FM

Input impedance:	50 ohms
Output Impedance:	75 ohms
Insersion loss:	4.88dB

Ford Radio

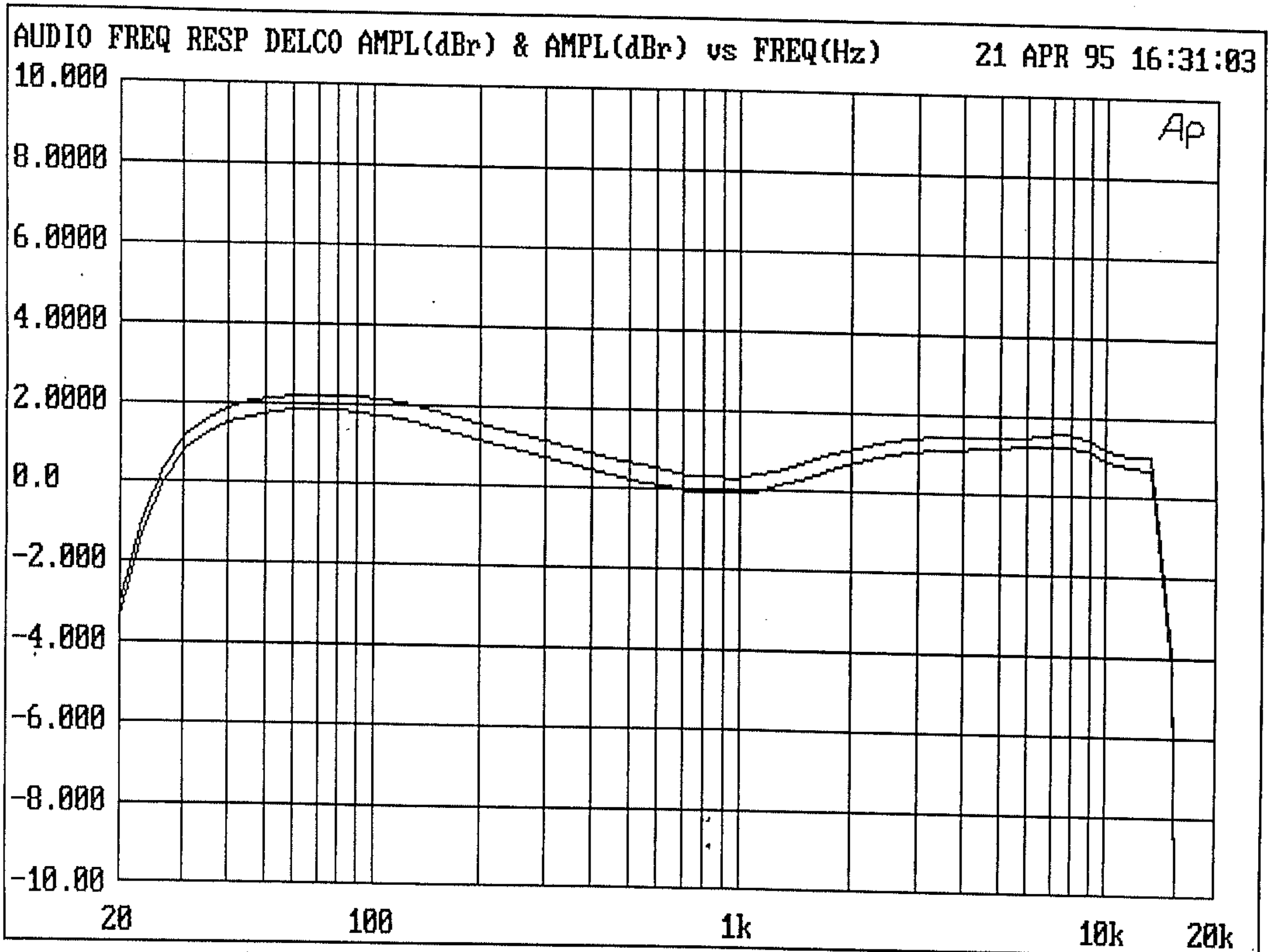
FM

Input Impedance:	100 ohms nominal

AM

Input Impedance:	Capacitive - impedance varies with frequency

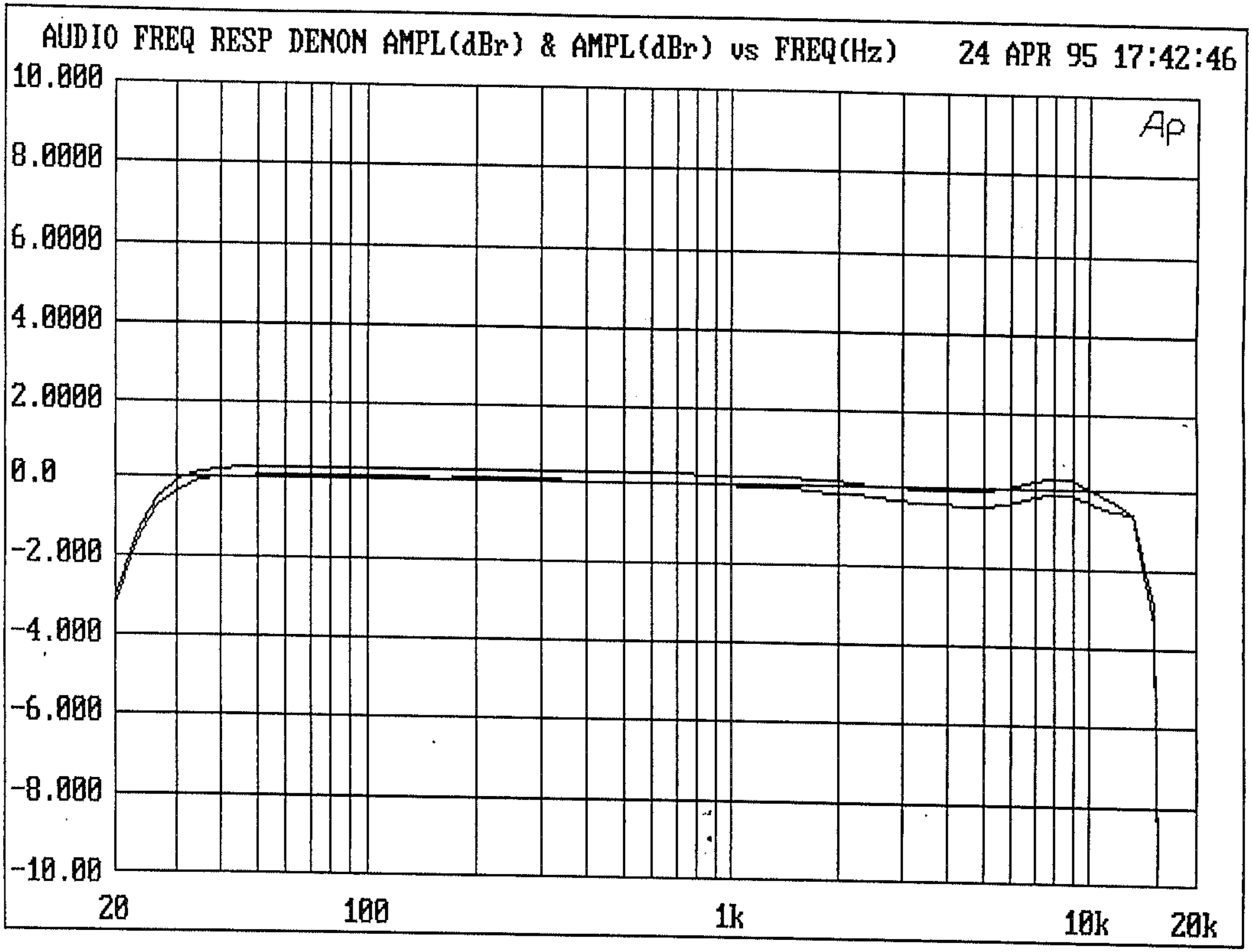
#1



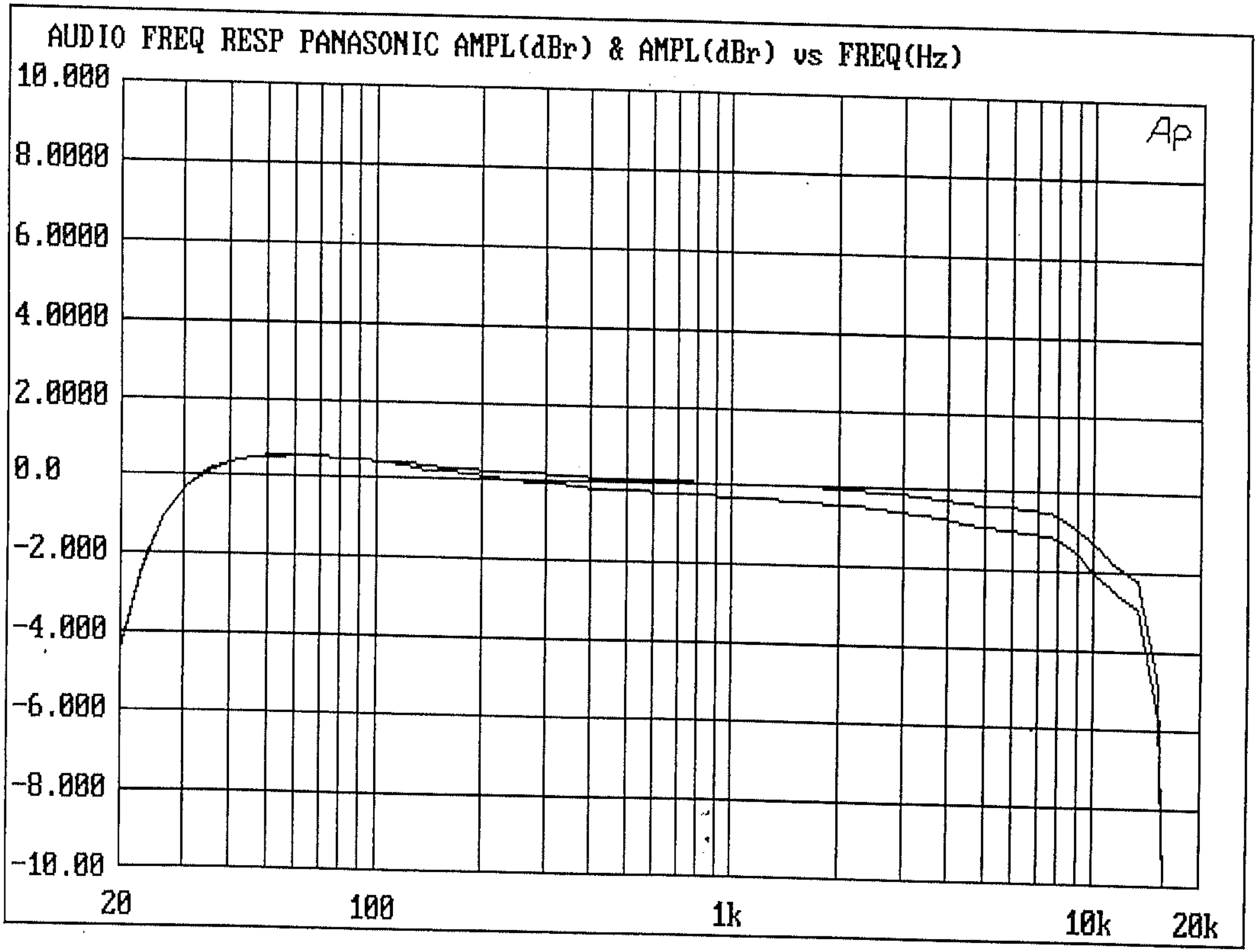
RF LEV = -62dBm
MOD = 100% @ 15 KHZ
[illegible]

0 dB = 2V/4Ω/1WATT
GRAPHIC EQ = FLAT
[illegible]

#2

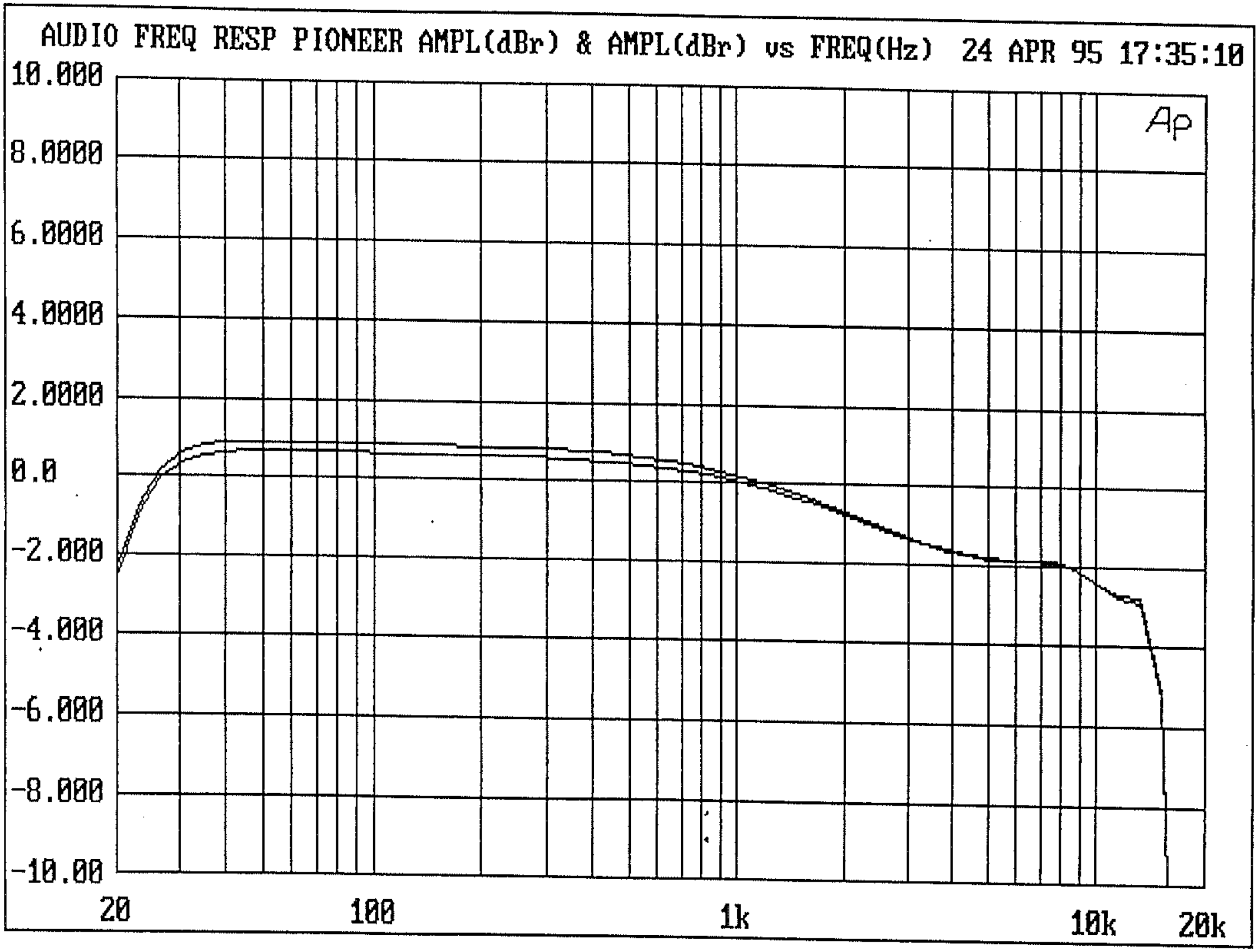

AUDIO FREQ RESP DENON AMPL(dBr) & AMPL(dBr) vs FREQ(Hz)
24 APR 95 17:42:46
Ap
10.000
8.0000
6.0000
4.0000
2.0000
0.0
-2.000
-4.000
-6.000
-8.000
-10.00
20
100
1k
10k
20k

#3

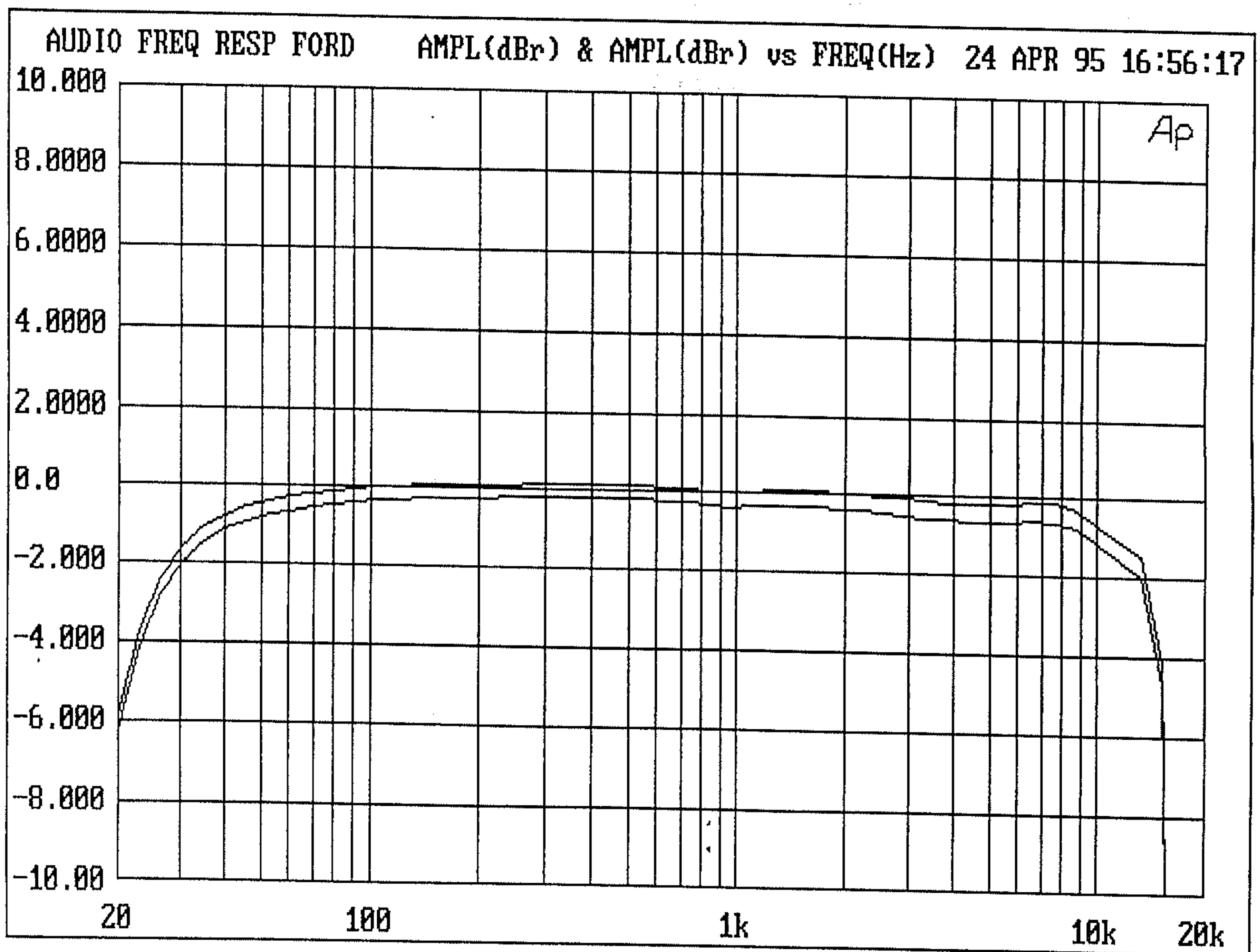


AUDIO FREQ RESP PANASONIC AMPL(dBr) & AMPL(dBr) vs FREQ(Hz)
10.000
8.0000
6.0000
4.0000
2.0000
0.0
-2.000
-4.000
-6.000
-8.000
-10.00
20
100
1k
10k
20k
Ap

#4


AUDIO FREQ RESP PIONEER AMPL(dBr) & AMPL(dBr) vs FREQ(Hz) 24 APR 95 17:35:10
10.000
8.0000
6.0000
4.0000
2.0000
0.0
-2.000
-4.000
-6.000
-8.000
-10.00
20
100
1k
10k
20k
Ap

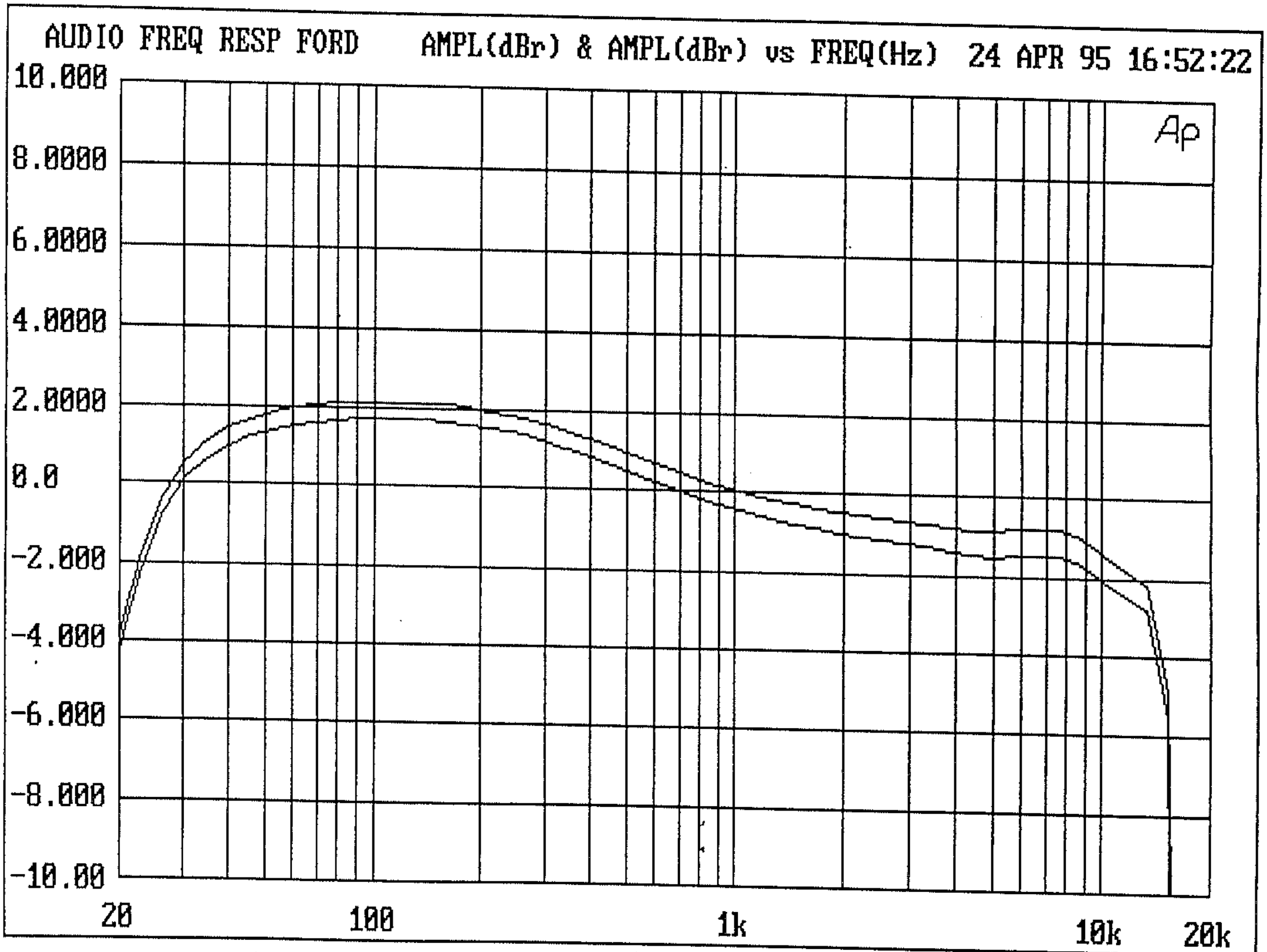
#5 A



RF LEV = -62dBm
MOD = 100% @ 15KHZ

0 dB = 423mV @ 1KHZ
BASS = DETENT
TREB = DETENT

#5 B



RF LEV = -62dBm
MOD = 100% @ 15KHZ
= 75 µsec

0 dB = 111 mV
BASS = DETENT
TREB = DETENT

EIA Digital Audio Radio Test Laboratory

Engineers: RMc/DL
Date: 6/12/95
Print Date: 8/7/95

PROJECT: RECEIVER CHARACTERIZATION

Radio Mfg.: PANASONIC
Model No.: RX-FS430
Serial No.: GR3J01184

Index

Page	Description
1	Cover
2 & 3	AM data regarding test set up and measurements including; Distortion, selectivity and signal & noise levels at various RF levels ranging from -45dBm to -130dBm
4	Plot of signal and noise VS RF level

Notes:

* All measurements made as RMS, unweighted.
* RF levels represent power at the receiver
* Tone control set full clockwise for minimum high cut
* Output set to standard output level of 1V rms

File Name: PANAM.XLS Cover

Engineers: RMc/DL
Date: 6/12/95
Print Date: 8/7/95

PROJECT: RECEIVER CHARACTERIZATION

Radio Mfg.: Panasonic
Model No.: 16192463
Serial No.: 1000499

AM TESTS (TEST FREQ. 1660KHz)

TEST SET-UP

Ant. Network: None (radio modified for 50 ohm input)
Audio Ref.: 1.0Vrms (0dB)
Rec. set up: Tone control maximum clockwise

Test Bed: Test Bed: Boonton RF generator used as signal source
2 & 3 Audio measurements made with Audio Precision as rms unweighted

THD - 400HZ, 80% MOD (-47dBm)

	4	1.20 %
STEREO		%
	5	

Selectivity (RF level = -95dBm)

+ 10KHz =	17dB	+20KHz =	30dB
- 10KHz =	14dB	-20KHz =	27dB
Average =	15.5dB	Average =	28.5dB

AUDIO VS RF LEVEL MEASUREMENTS

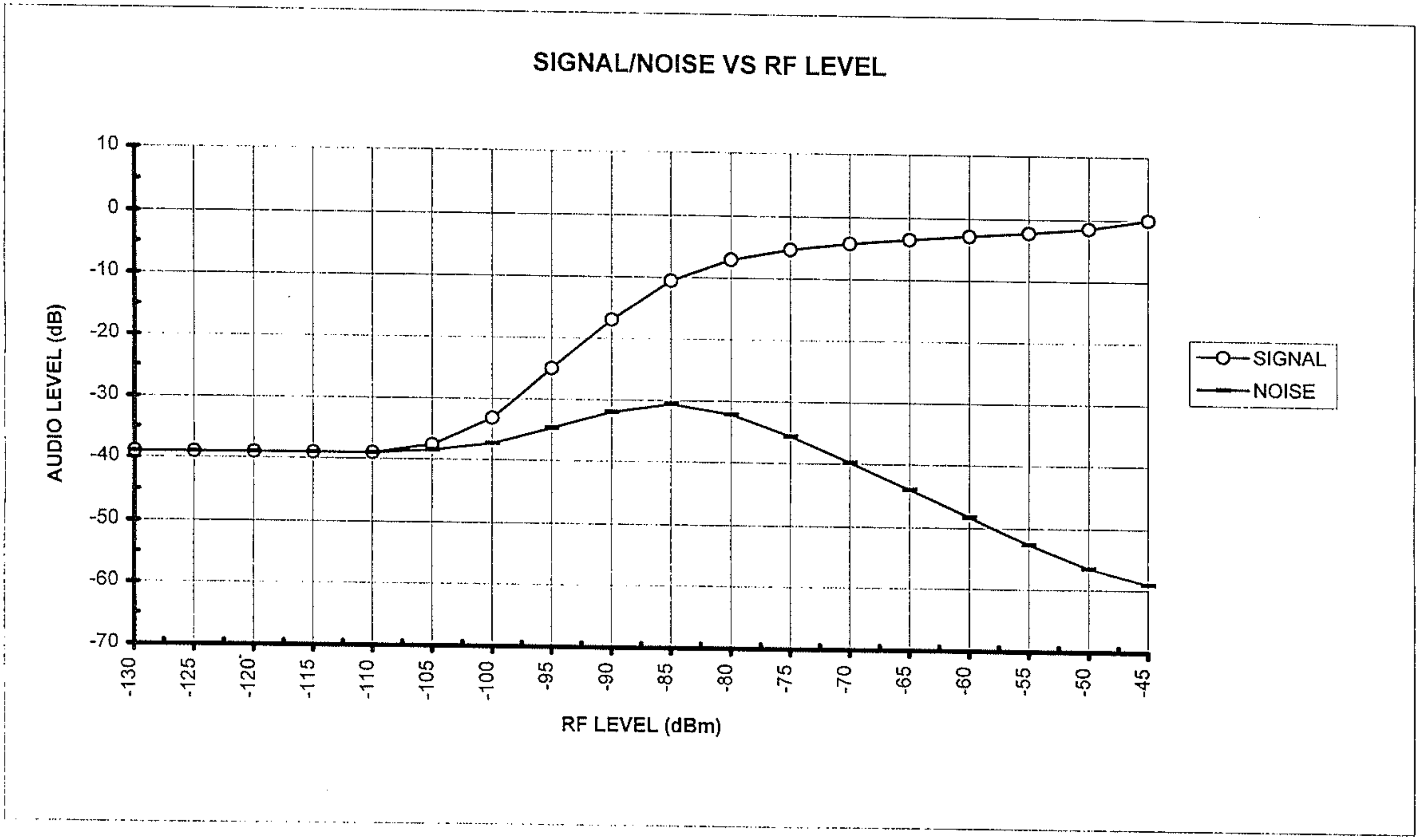
* Left channel used as the measurement channel for Signal and Noise data
* Audio test frequency = 400HZ
* "Signal" modulation level = 80%
* Audio line transformer (1:1 ratio) used to eliminate ground loop introducing RF noise into the screen box
  This receiver only was affected in this manner

CURVE DATA

Audio VS RF Level

RF Level								
	Signal	Noise	Signal	Noise	Signal	Noise	Left	Right
dBm	dB	dB	dB	dB	dB	dB	dB	dB
-130	-39	-39						
-125	-39	-39						
-120	-39	-39						
-115	-39	-39						
-110	-39	-39						
-105	-37.6	-38.5						
-100	-33.2	-37.3						
-95	-25	-34.7						
-90	-16.9	-32						
-85	-10.5	-30.6						
-80	-7	-32.2						
-75	-5.29	-35.6						
-70	-4.26	-39.8						
-65	-3.5	-44						
-60	-2.85	-48.3						
-55	-2.24	-52.6						
-50	-1.5	-56.5						
-45	0	-59						

File Name: PANAM.XLS AM_DATA


SIGNAL/NOISE VS RF LEVEL
AUDIO LEVEL (dB)
10
0
-10
-20
-30
-40
-50
-60
-70
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-65
-60
-55
-50
-45
RF LEVEL (dBm)
SIGNAL
NOISE

EIA Digital Audio Radio Test Laboratory

Engineers: RMc/DL
Date: 6/12/95
Print Date: 8/7/95

PROJECT: RECEIVER CHARACTERIZATION

Radio Mfg.: DELCO
Model No.: 16192463
Serial No.: 1000499

Index

Page	Description
1	Cover
2 &3	AM data regarding test set up and measurements including; Distortion, selectivity and signal & noise levels at various RF levels ranging from -45dBm to -130dBm
4	Plot of signal and noise VS RF level with the receiver set for "Narrow Band" operation
5	Plot of signal and noise VS RF level with the receiver set for "Wide Band" operation
6	Plot of receivers audio frequency response in both wide and narrow band modes

Notes:

* All measurements made as RMS, unweighted.
* RF levels represent power at the Dummy Antenna input
* Automobile receivers output connected to four ohm loads and set to standard reference output level of 1 Watt.
* Automobile receivers balance and fade controls set to "detent" positions. Tone controls set for "flat" operation.

Engineers: RMc/DL
Date: 6/12/95
Print Date: 8/7/95

PROJECT: RECEIVER CHARACTERIZATION

Mfg.: Delco
Model No.: 16192463
Serial No.: 1000499

AM TESTS (TEST FREQ. 1660KHz)

TEST SET-UP

Ant. Network: JFW composite antenna dummy
Audio Ref.: 2.0Vrms Load Imp = 4 ohms
Rec. set up: Loudness off, graphic EQ flat, balance & fade centered

Test Bed: Test Bed: Boonton RF generator used as signal source
Meas.: Audio measurements made with Audio Precision as rms unweighted

THD - 400HZ, 80% MOD (-47dBm)

MONO	1.30 %
STEREO	%

Selectivity (RF level = -105dBm)

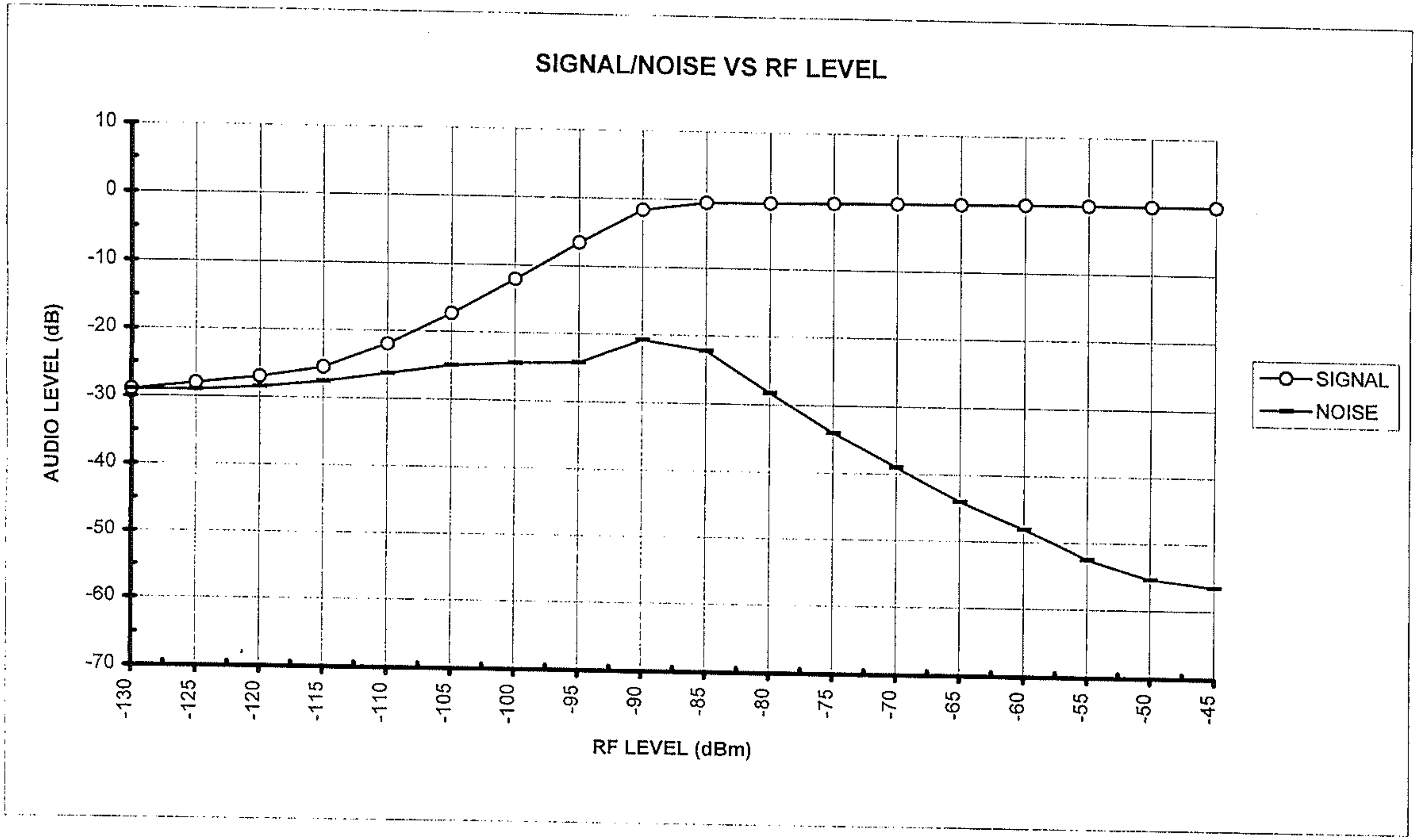
Narrow		Wide		Narrow		Wide	
+ 10KHz =	33dB	+ 10KHz =	22dB	+20KHz =	NA	+20KHz =	NA
- 10KHz =	35dB	- 10KHz =	11.5dB	-20KHz =		-20KHz =	
Average =	34dB	Average =	16.75dB	Average =		Average =	

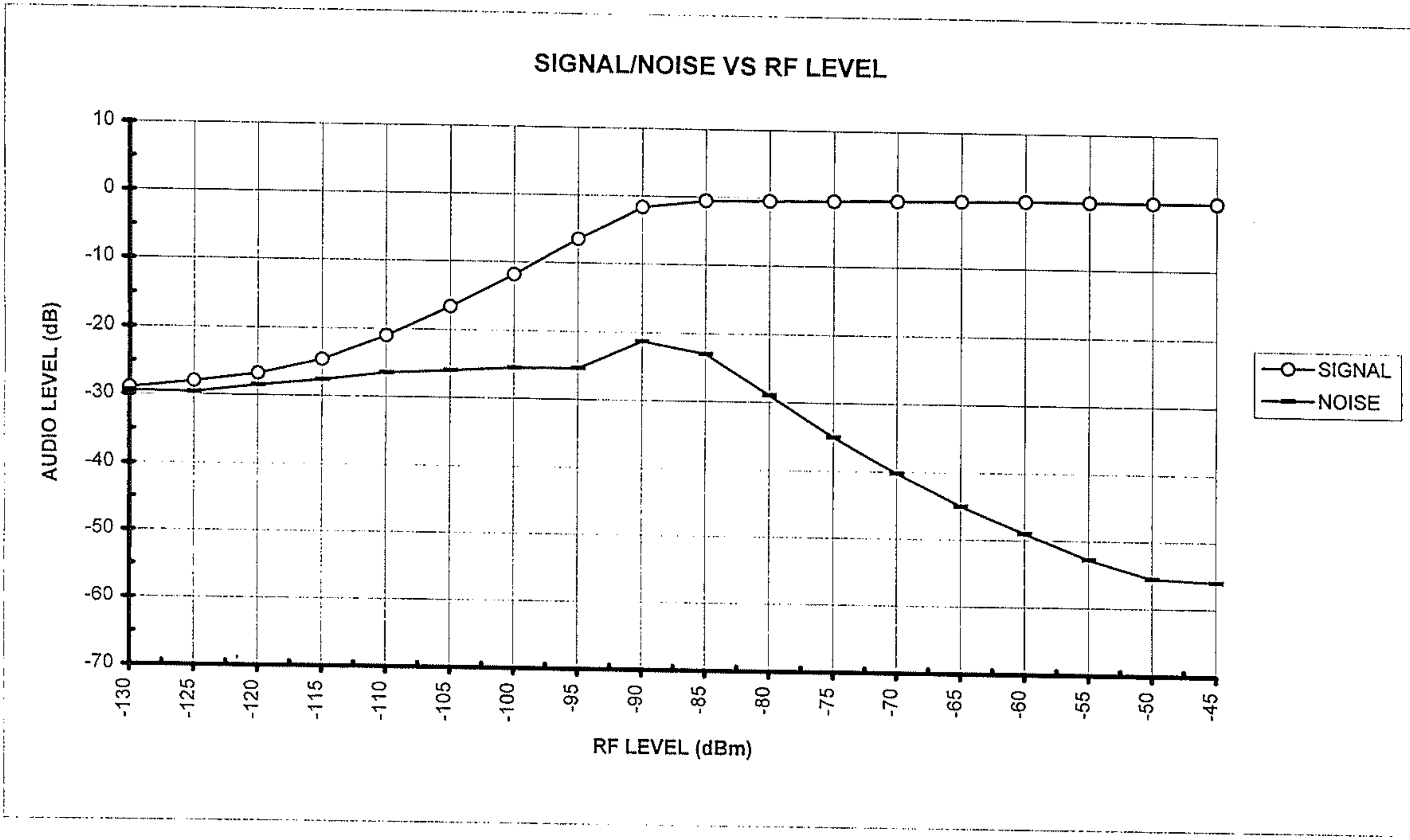
* Left channel used as the measurement channel for Signal and Noise data
* Audio test frequency = 400HZ
* "Signal" modul 35.3dB
* "Wide Band" refers to "Am-St" selected
* "Narrow Band" refers to "Am-St" off

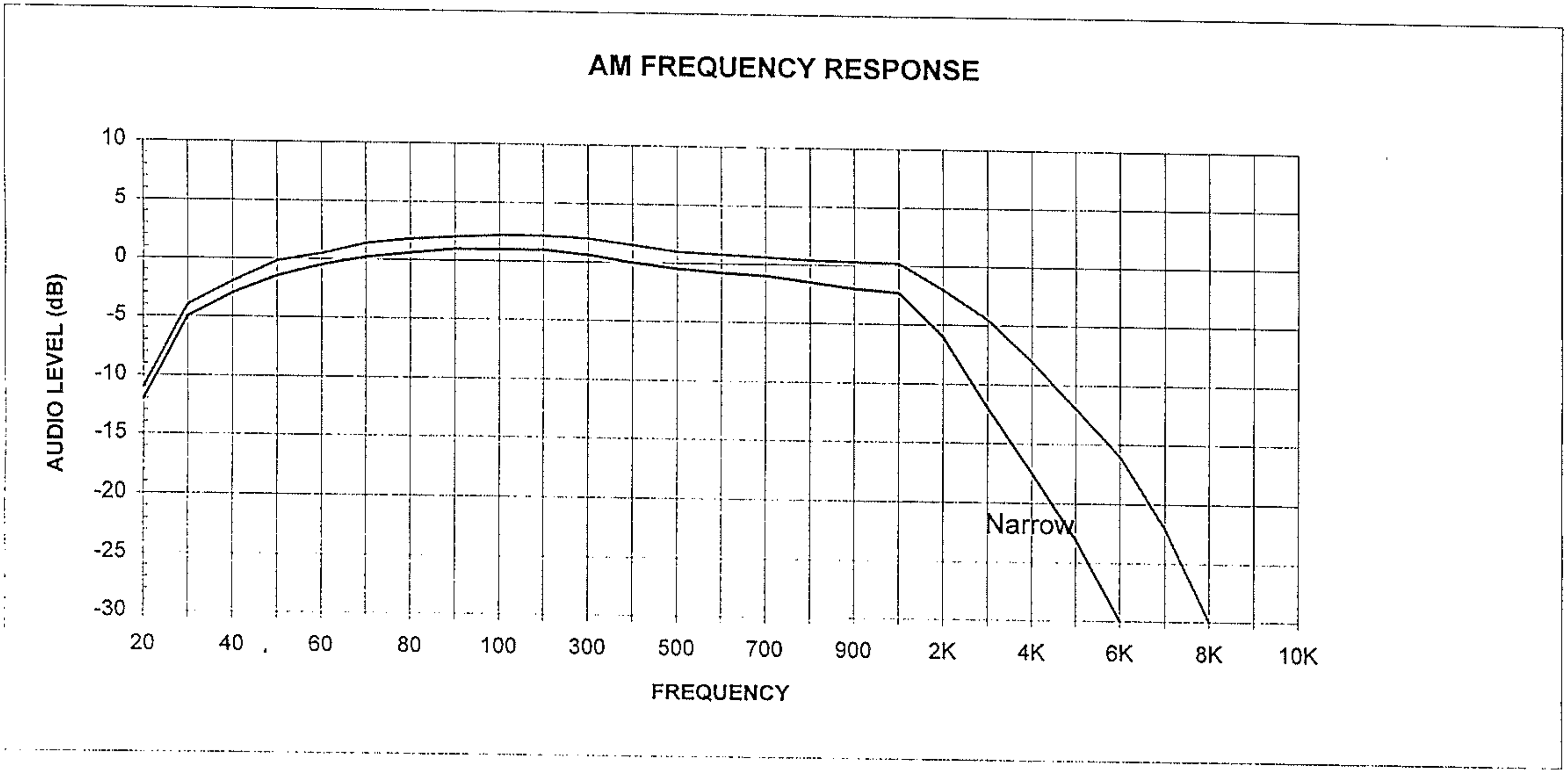
CURVE DATA

Audio VS RF Level

RF Level	Wide Band		Narrow Band					
	Signal	Noise	Signal	Noise	Signal	Noise	Left	Right
ent power into th	dB	dB	dB	dB	dB	dB	dB	dB
-130	-29	-29	-29	-29.5				
-125	-28	-29	-28	-29.6				
-120	-27	-28.5	-26.8	-28.5				
-115	-25.5	-27.6	-24.6	-27.6				
-110	-22	-26.3	-21	-26.5				
-105	-17.3	-25	-16.6	-26				
-100	-12.1	-24.5	-11.8	-25.5				
-95	-6.6	-24.3	-6.5	-25.4				
-90	-1.65	-20.8	-1.6	-21.3				
-85	-0.44	-22.3	-0.5	-23				
-80	-0.38	-28.3	-0.45	-29				
-75	-0.27	-34	-0.32	-35				
-70	-0.15	-39	-0.2	-40.2				
-65	-0.1	-44	-0.1	-45				
-60	0	-48	0	-49				
-55	0	-52.5	0	-52.8				
-50	0	-55.3	0	-55.5				
-45	0	-56.5	0	-56				


SIGNAL/NOISE VS RF LEVEL
AUDIO LEVEL (dB)
10
0
-10
-20
-30
-40
-50
-60
-70
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-65
-60
-55
-50
-45
RF LEVEL (dBm)
SIGNAL
NOISE


SIGNAL/NOISE VS RF LEVEL
AUDIO LEVEL (dB)
10
0
-10
-20
-30
-40
-50
-60
-70
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-65
-60
-55
-50
-45
RF LEVEL (dBm)
SIGNAL
NOISE


AM FREQUENCY RESPONSE
AUDIO LEVEL (dB)
10
5
0
-5
-10
-15
-20
-25
-30
20
40
60
80
100
300
500
700
900
2K
4K
6K
8K
10K
FREQUENCY
Narrow

EIA Digital Audio Radio Test Laboratory

Engineers: RMc/DL

PROJECT: RECEIVER CHARACTERIZATION

Radio Mfg.: Denon
Model No.: TU-680NAB
Serial No.: 2092400103

Index

Page	Description
1	Cover
2 & 3	AM data regarding test set up and measurements including; Distortion, selectivity and signal & noise levels at various RF levels ranging from -45dBm to -130dBm
4	Plot of AM signal and noise VS RF level with the receiver set for "Narrow Band" operation
5	Plot of AM signal and noise VS RF level with the receiver set for "Wide Band" operation
6	Plot of AM audio frequency response in both wide and narrow band modes

Notes:

* All measurements made as RMS, unweighted.
* RF levels represent power at the receiver after 50/75 ohm conversion

File Name: D680AM.XLS Cover
Print Date:8/7/95

Engineers: RMc/DL

PROJECT: RECEIVER CHARACTERIZATION

Radio Mfg.: Denon
Model No.: TU-680NAB
Serial No.: 2092400103

AM TESTS (TEST FREQ. 1660KHz)

TEST SET-UP

Ant. input: 75 ohms
Audio Ref.: 672mVrms (0dB)
Rec. set up: "Bandwidth" wide or narrow selected for specific tests

Test Bed: Test Bed: Boonton RF generator used as signal source
Meas.: Audio measurements made with Audio Precision as rms unweighted

THD - 400HZ, 80% MOD (-47dBm)

MONO	3.50 %
STEREO	%

Selectivity (RF level = -95dBm)

Narrow		Wide		Narrow		Wide	
+ 10KHz =	10.5dB	+ 10KHz =	10.5dB	+20KHz =	65dB	+20KHz =	64dB
- 10KHz =	7dB	- 10KHz =	7dB	-20KHz =	51dB	-20KHz =	51dB
Average =	8.75dB	Average =	8.75dB	Average =	58dB	Average =	57.5dB

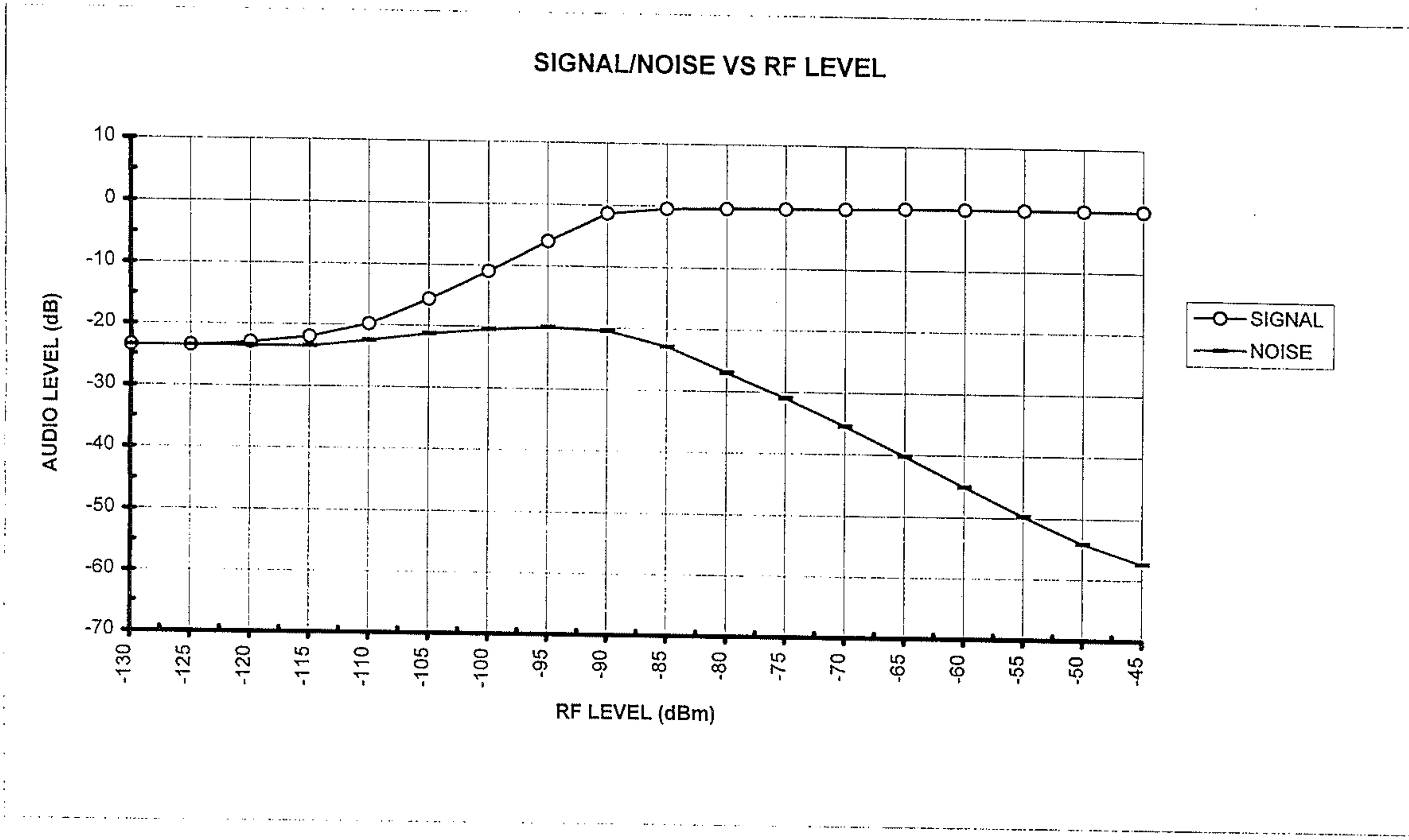
AUDIO VS RF LEVEL MEASUREMENTS

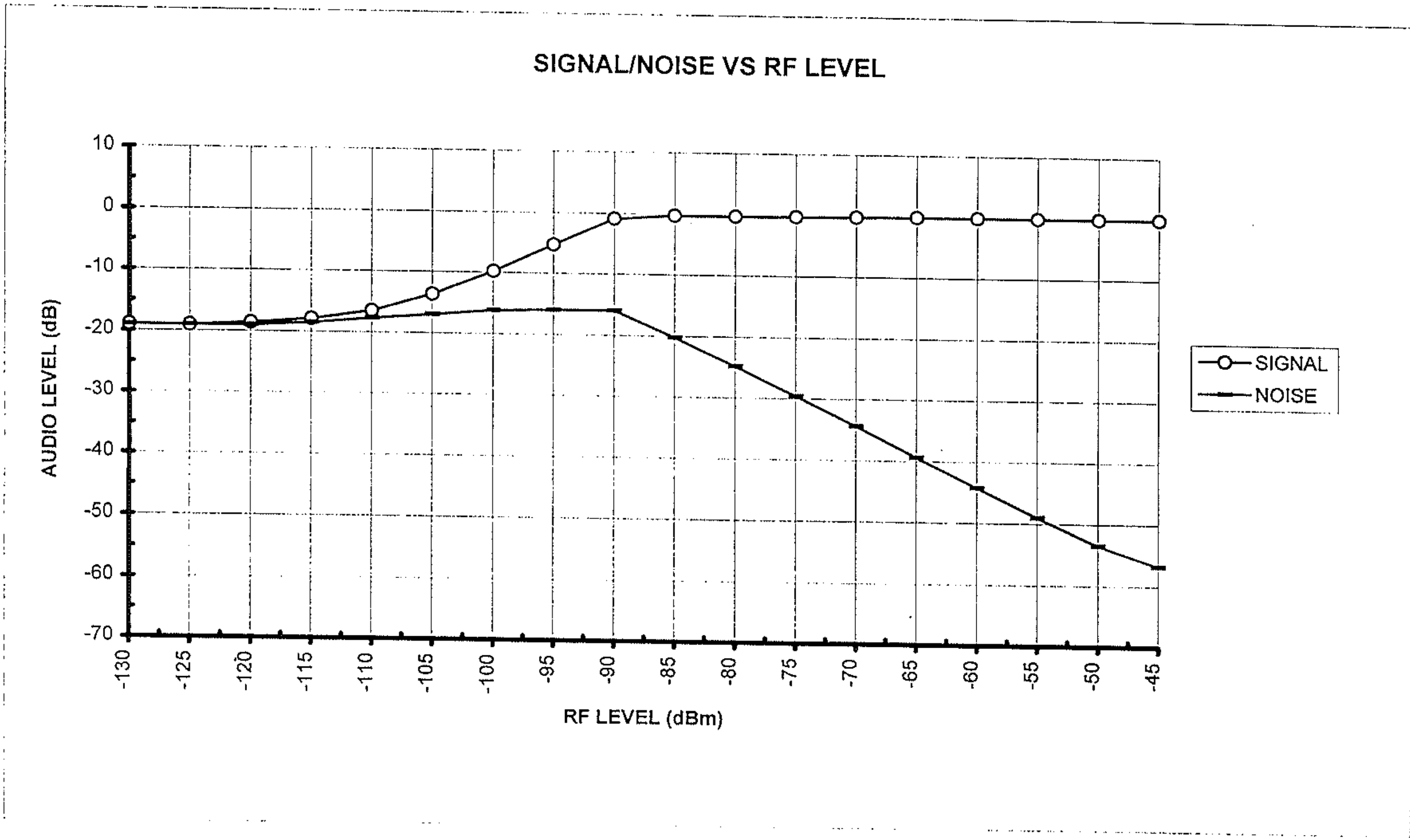
* Left channel used as the measurement channel for Signal and Noise data
* Audio test frequency = 400HZ
* Signal modulation level = 80%

CURVE DATA

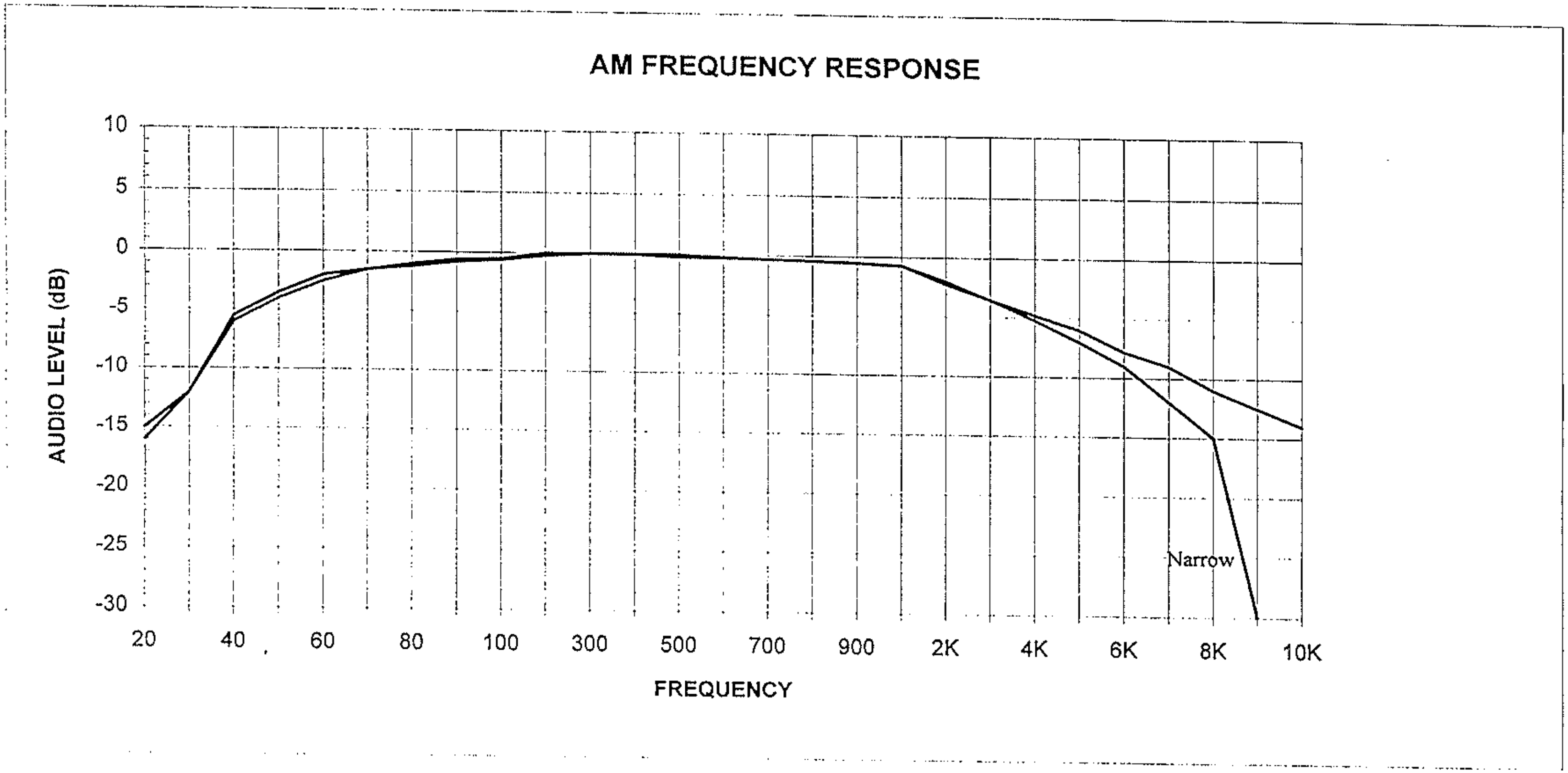
Audio VS RF Level

RF Level	Wide Band		Narrow Band					
	Signal	Noise	Signal	Noise	Signal	Noise	Left	Right
dBm	dB	dB	dB	dB	dB	dB	dB	dB
-130	-19	-19	-23.5	-23.5				
-125	-19	-19	-23.5	-23.5				
-120	-18.6	-19	-23	-23.5				
-115	-17.9	-18.5	-22	-23.5				
-110	-16.5	-17.7	-19.8	-22.5				
-105	-13.7	-17	-15.6	-21.3				
-100	-9.8	-16.2	-11	-20.5				
-95	-5.3	-16	-6	-20				
-90	-0.85	-16	-1.35	-20.5				
-85	-0.2	-20.2	-0.42	-22.9				
-80	-0.18	-24.8	-0.32	-27				
-75	-0.13	-29.6	-0.25	-31				
-70	-0.08	-34.4	-0.14	-35.5				
-65	0	-39.4	0	-40.2				
-60	0	-44.3	0	-45				
-55	0	-49	0	-49.7				
-50	0	-53.4	0	-54.1				
-45	0	-56.7	0	-57.3				


SIGNAL/NOISE VS RF LEVEL
AUDIO LEVEL (dB)
10
0
-10
-20
-30
-40
-50
-60
-70
-130
-125
-120
-115
-110
-105
-100
-95
-90
-85
-80
-75
-70
-65
-60
-55
-50
-45
RF LEVEL (dBm)
SIGNAL
NOISE



File Name: D680AM.XLS AM SN VS RF (WIDE)


AM FREQUENCY RESPONSE
AUDIO LEVEL (dB)
10
5
0
-5
-10
-15
-20
-25
-30
20
40
60
80
100
300
500
700
900
2K
4K
6K
8K
10K
FREQUENCY
Narrow

APPENDIX I

Subcarrier Calibration

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 5/12/95

SCA CALIBRATION

Measurements made with Belar Wizard Modulation Monitor
Typical measurements reflect numbers that one should see on this monitor
The Monitor indicates 1% at CW and 101% at 100% (with reference to Besel null method)
All individual SCA's were cross checked on Seiko RPA Spectrum Analyzer
Seiko RPA Spectrum Analyzer calibration checked with HP8566B Spectrum Analyzer
Group output from SCA Mixer box used for both group and individual SCA's
Individual SCA levels set in SCA Mixer box
Cutting Edge stereo gennerator used

GROUP A

FREQ.	INJ. LEV.	MEAS.	SOURCE	TYPE	COMMENTS
57khz	3.00%	4.00%	RE533	RDS	Phase locked to pilot sync port
66.5khz	8.50%	11.00%	SEIKO	HS Data	Phase locked to pilot sync port Injection level accurately set with RPA utility
92khz	8.50%	9.00%	CRL	Analog	
TOTAL	20.00%	21.00%			

GROUP B

FREQ.	INJ. LEV.	MEAS.	SOURCE	TYPE	COMMENTS
57khz	10.00%	11.00%	RE533	RDS	Phase locked to pilot sync port
67khz	10.00%	11.00%	CRL	Analog	
TOTAL	20.00%	21.00%			

GROUP C

FREQ.	INJ. LEV.	MEAS.	SOURCE	TYPE	COMMENTS
67khz	10.00%	11.00%	CRL	Analog	
92khz	10.00%	11.00%	CRL	Analog	
TOTAL	20.00%	21.00%			

GROUP D

FREQ.	INJ. LEV.	MEAS.	SOURCE	TYPE	COMMENTS
92khz	10.00%	11.00%	Mainstream	Data	
TOTAL	10.00%	11.00%			

ELECTRONIC INDUSTRIES ASSOCIATION
Digital Audio Radio Laboratory
Engineers: RMc/DL
DATE: 5/12/95

SCA GROUP / ANALOG CALIBRATION

EQUIPMENT:
CUTTING EDGE STEREO GENERATOR
BELAR WIZARD MODULATION MONITOR

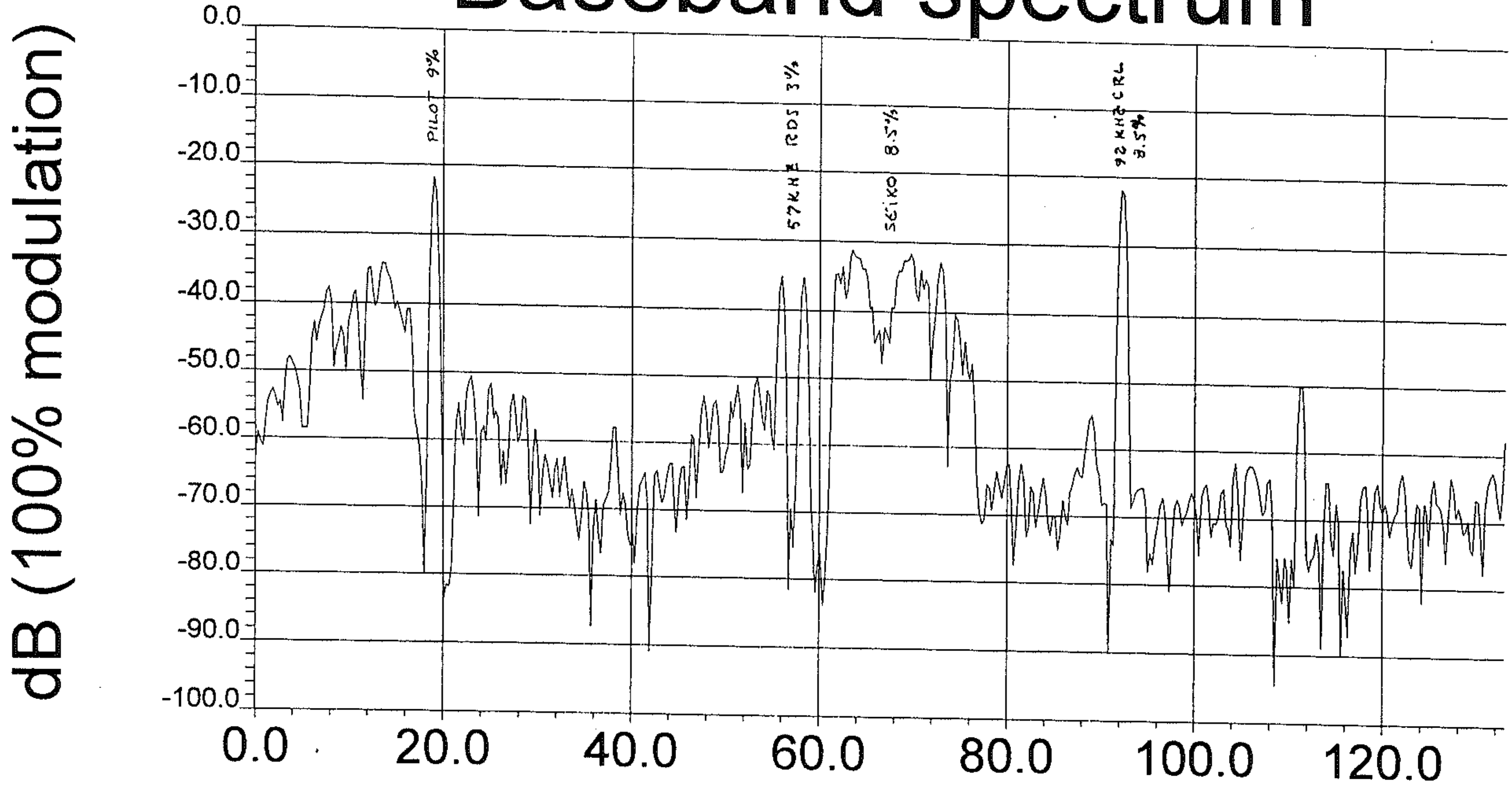
SET-UP GUIDE

CUTTING EDGE:	PROCESSORS SET FOR CLIPPED PINK NOISE SETTINGS	
(C.E.)	STEREO MODE	: ON
	PILOT	: ON
	PILOT LEVEL ATTENUATOR:	82
	OUTPUT LEV ATTENUATOR:	SEE CHART

CALIBRATION

SIGNAL	C.E. Output Level Setting	BELAR % Measurement
CW (PILOT OFF)	47	4
PILOT ONLY	47	13
PILOT+SCA GRP A	42	30
PILOT+SCA GRP B	42	30
PILOT+SCA GRP D	47	23
PILOT +PINK NOISE	47	100
PINK NOISE+GRP A	42	110
PINK NOISE+GRP B	42	110
PINK NOISE+GRP D	47	110

Baseband spectrum



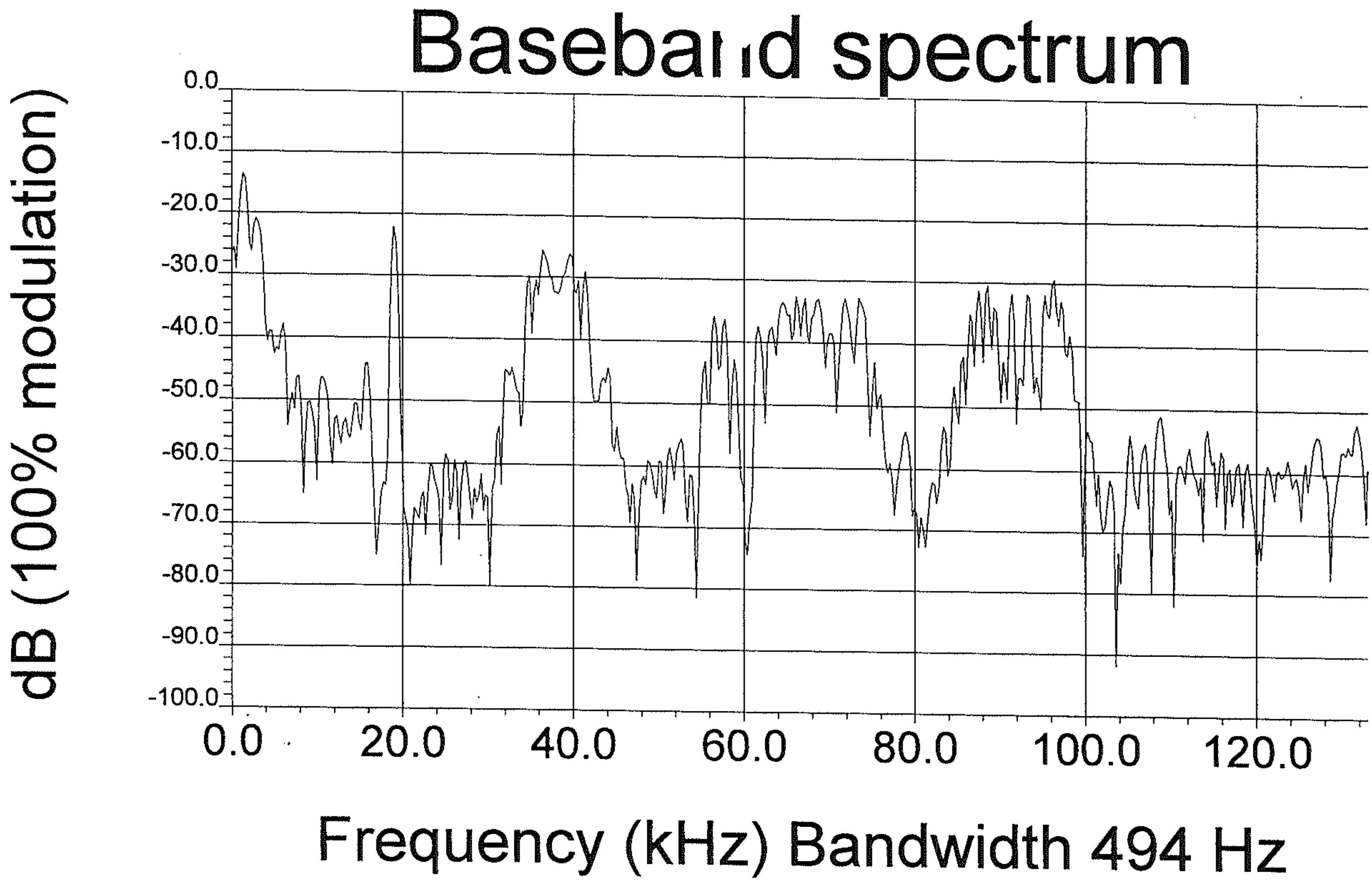
Frequency (kHz) Bandwidth 494 Hz

RF input
-32.6 dBm

5/11/95 RMS/DL
CUTTING EDGE
PILOT + GROUP A SCA'S

Frequency
94.1 WEIA

Attenuator
0 dB



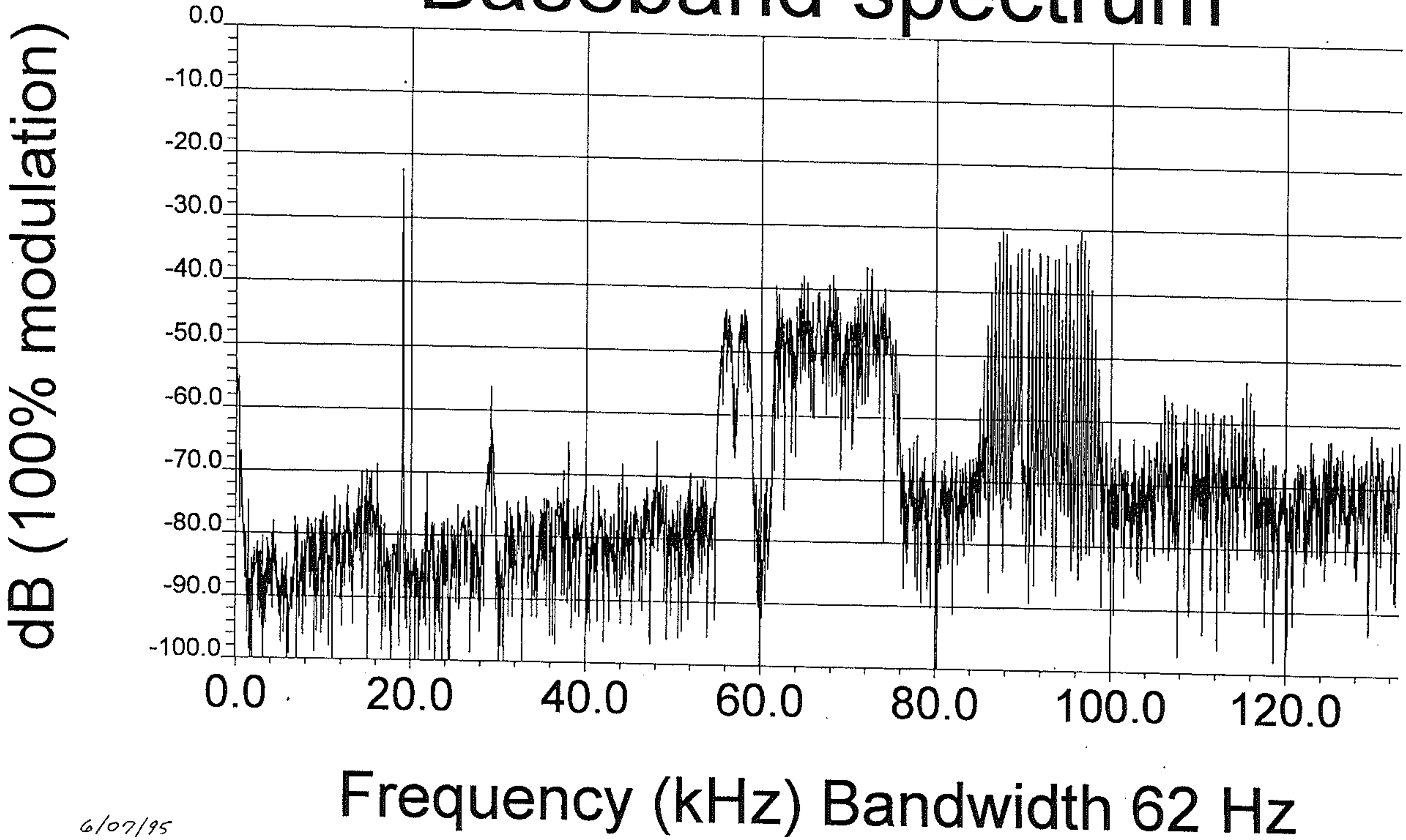
L 2
FM REF
SCA GRP A

RF input
-47.0 dBm

Frequency
94.1 WEIA

Attenuator
0 dB

Baseband spectrum



6/07/95

SCA GROUP A   57KHZ RDS, 66.5KHZ SEIKO, 92KHZ (MODULATED)

RF input
-47.7 dBm

Frequency
94.1 WEIA

Attenuator
0 dB

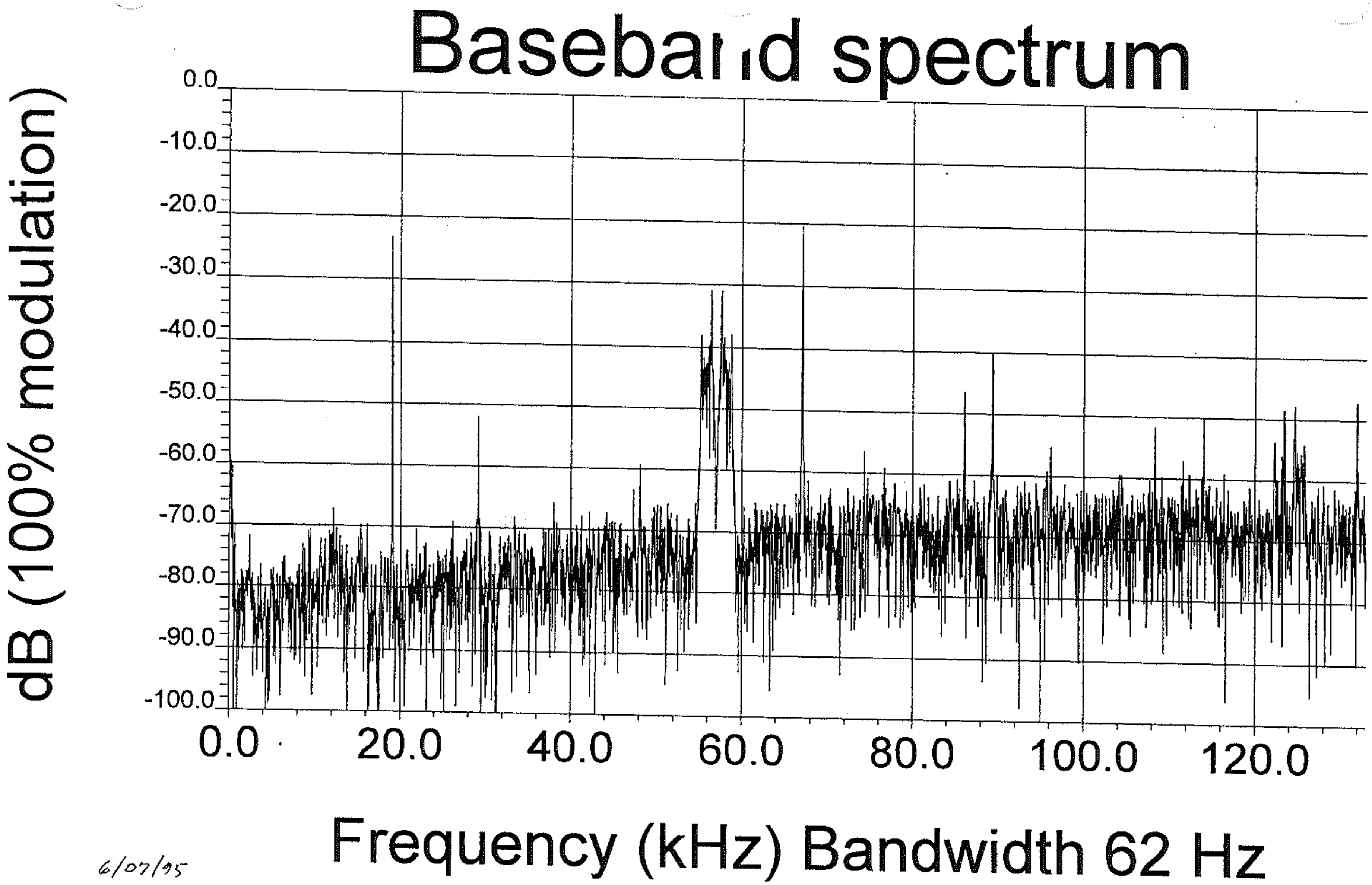
Pilot phase: 62.1 (SEIKO)

Pilot Injection: 8.9%

Pilot Frequency: 18999.1

Subcarrier Injection: 8.5% (SEIKO)

RF input -32.6 dBm	Frequency 94.1 WEIA	Attenuator 0 dB



6/07/95

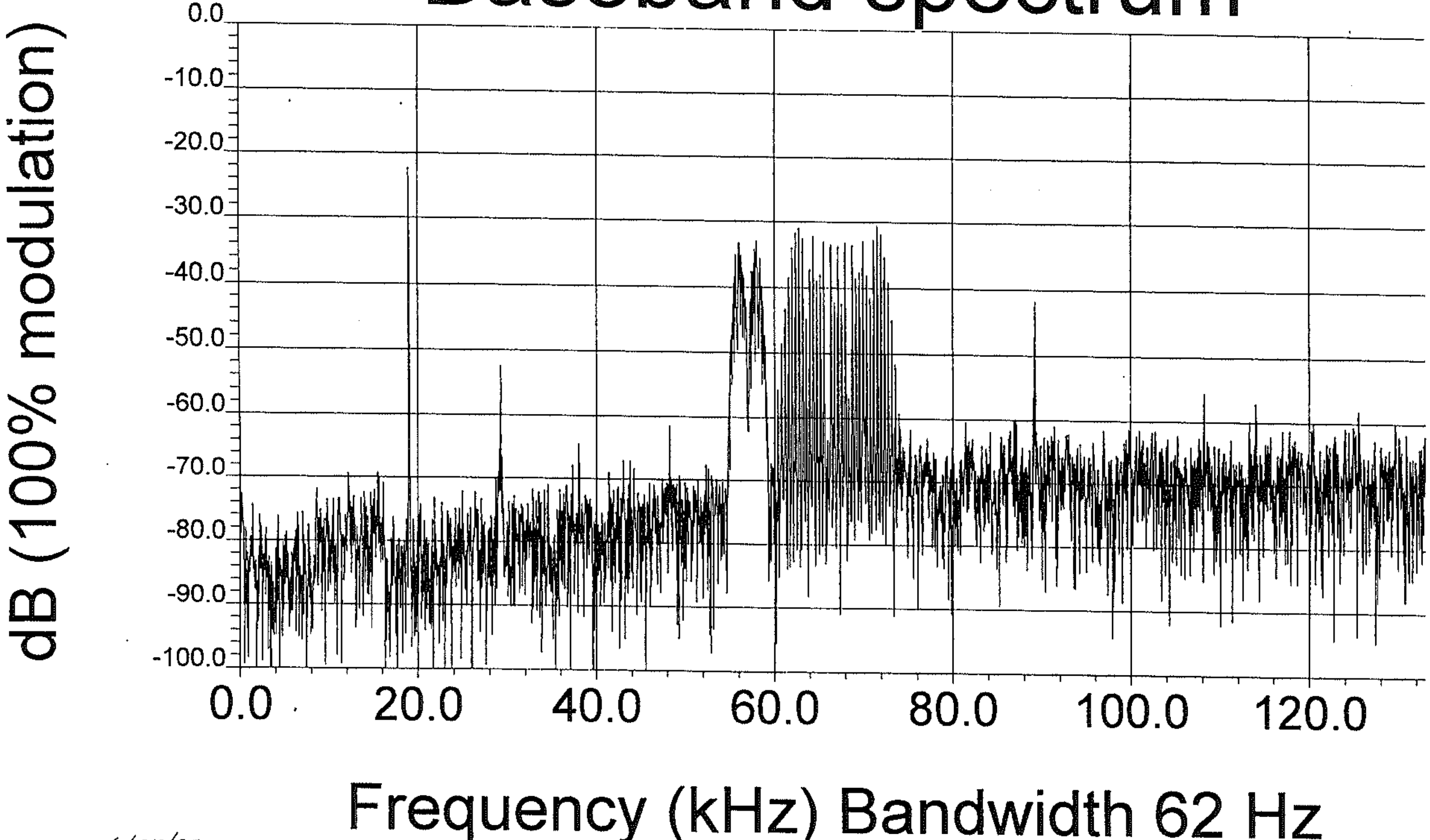
SCA GROUP B 57KHZ RDS & 67KHZ (UNMODULATED)

RF input
-53.0 dBm

Frequency
94.1 WEIA

Attenuator
0 dB

Baseband spectrum



6/07/95

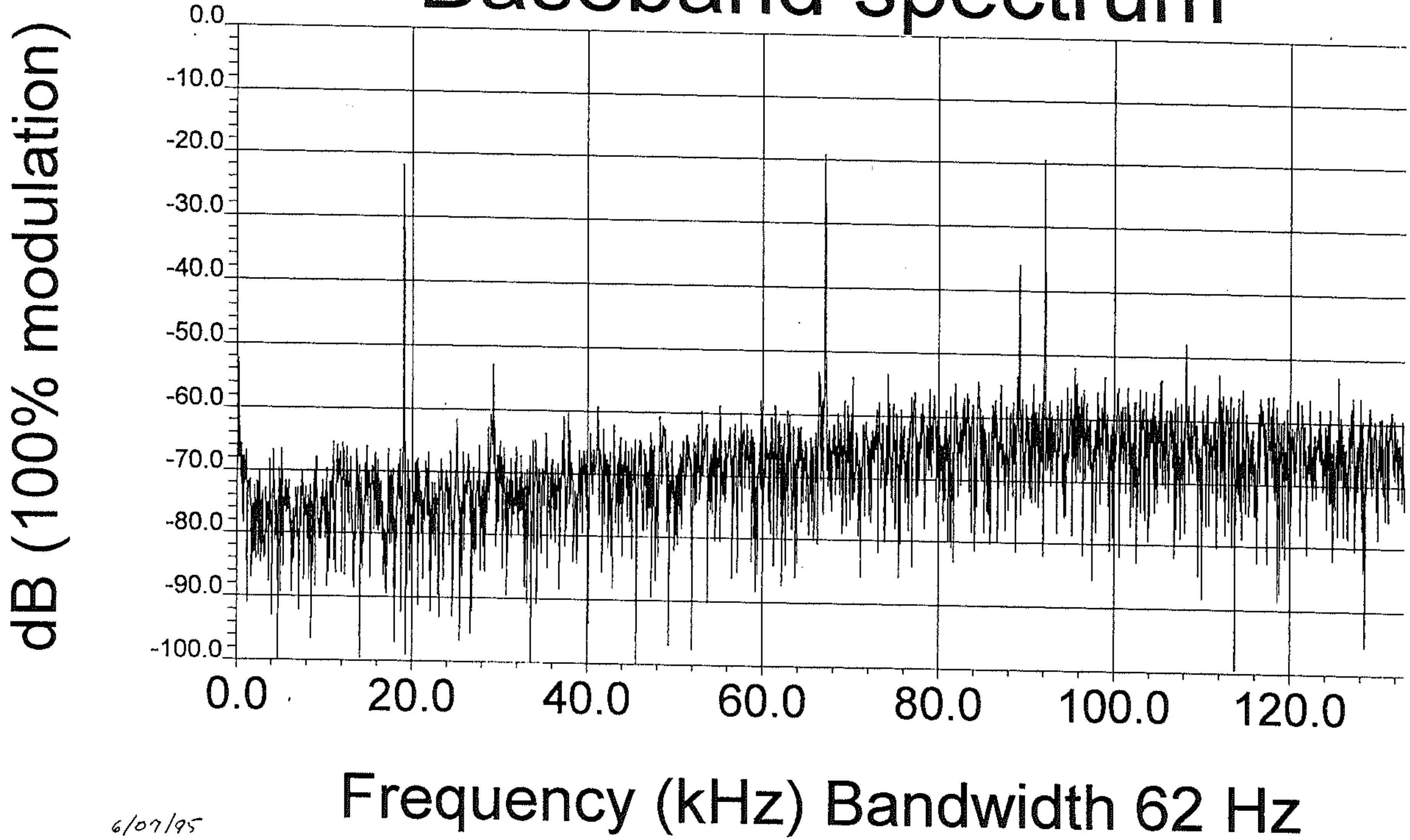
SCA GROUP B 57KHZ RDS & 67KHZ (MODULATED)

RF input
-50.4 dBm

Frequency
94.1 WEIA

Attenuator
0 dB

Baseband spectrum



6/07/95

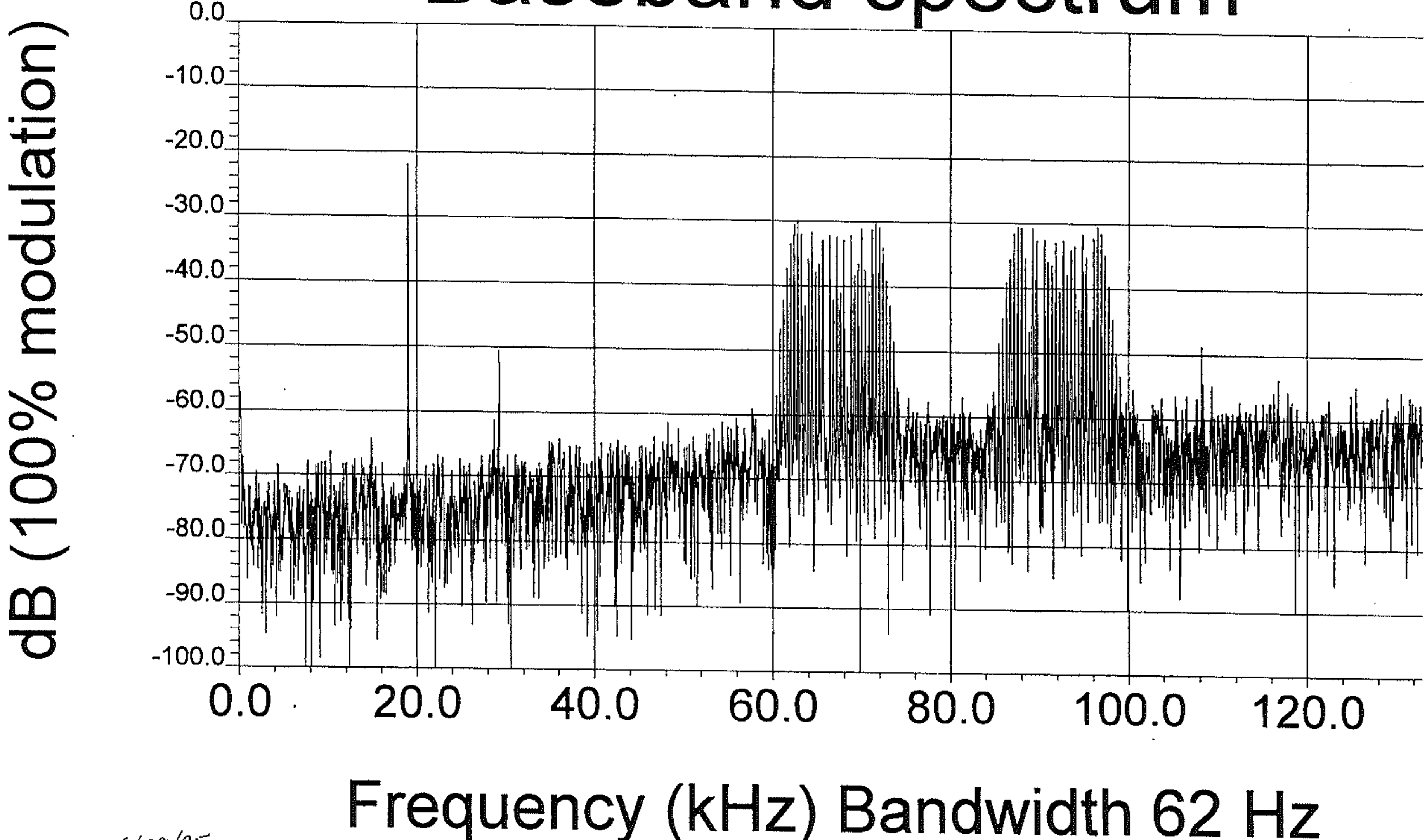
SCA GROUP C (67KHZ & 92KHZ) UNMODULATED

RF input
-56.2 dBm

Frequency
94.1 WEIA

Attenuator
0 dB

Baseband spectrum



6/07/95

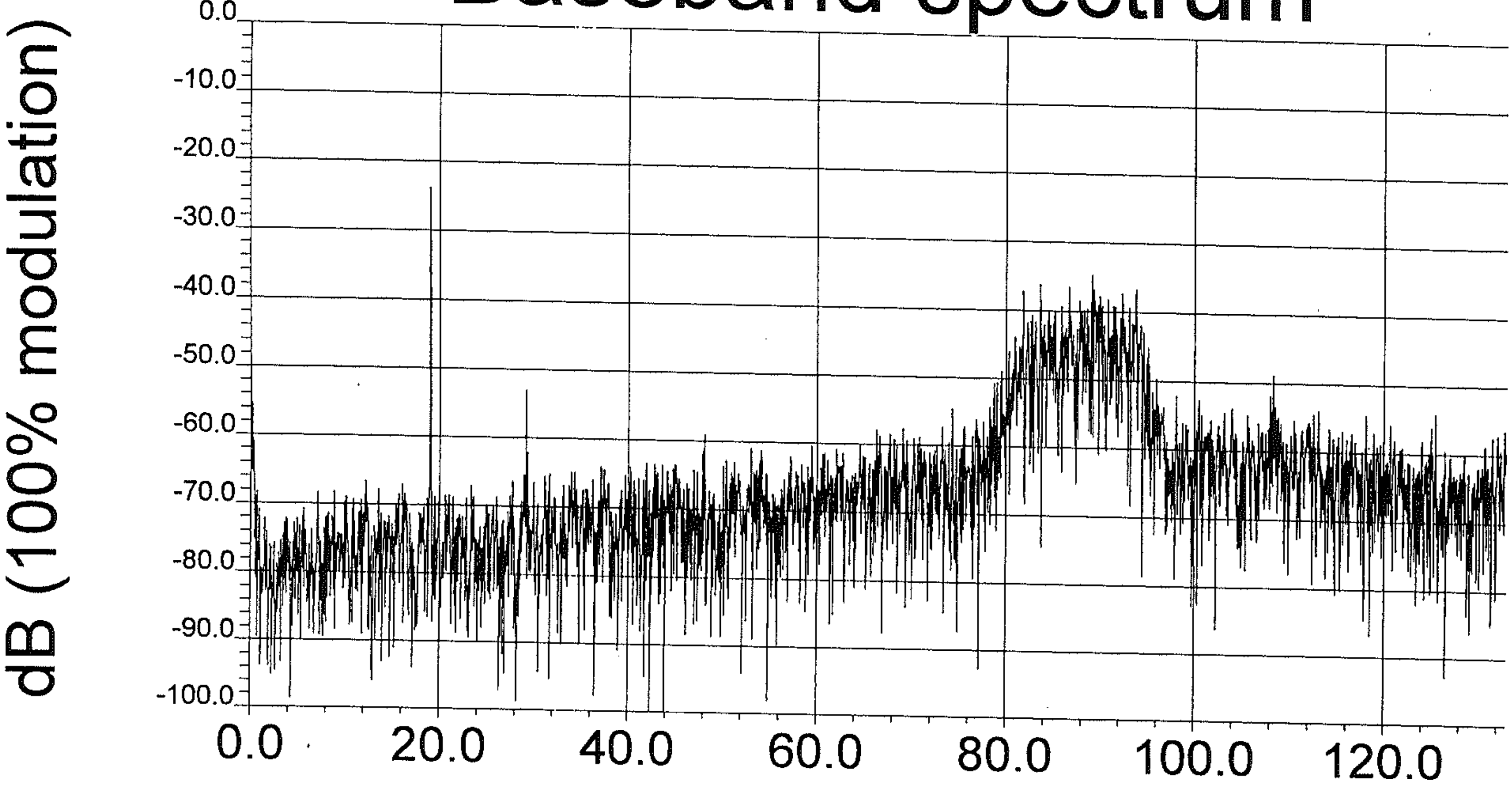
SCA GROUP C (67KHZ & 92KHZ) MODULATED

RF input
-56.3 dBm

Frequency
94.1 WEIA

Attenuator
0 dB

Baseband spectrum



Frequency (kHz) Bandwidth 62 Hz

6/07/95

SCA GROUP D 92KHZ MAINSTREAM DATA

RF input	Frequency	Attenuator
-56.5 dBm	94.1 WEIA	0 dB

June 14, 1995

Mr. Robert McCutcheon,
EIA DAR Testing Lab
NASA Lewis Research Center

Dear Mr. McCutcheon,

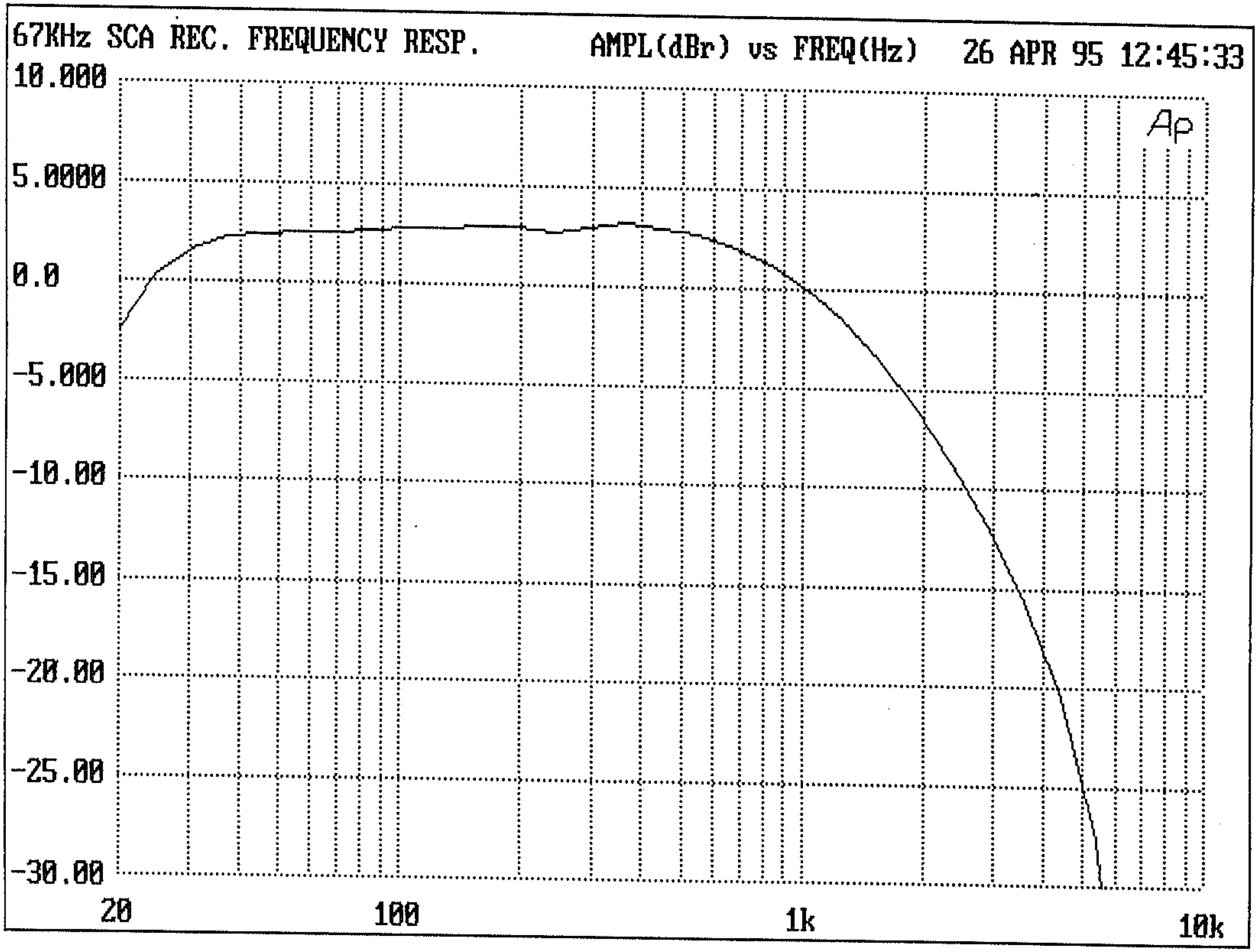
Thank you for hosting me at the DAR testing facility on June 7th. During the visit I was able to determine that the Mainstream Data FM subcarrier equipment had been installed correctly, and was operating at 10% injection. Upon addition of RF noise the signal degradation initially produced "first-level" error correction activity as expected, and with additional signal degradation the "second-level" error correction also became active, as expected.

As we discussed during the visit there is a threshold of errors above which we deem the performance unacceptable. Admittedly, this is not a sharp line, given that some customers are more sensitive to errors than others. Our installers attempt to orient the customer antenna to eliminate ANY error correction activity during the several minutes they would be allotted to stay and watch the LCD display. This is achievable in most cases. If the antenna cannot be adjusted to bring the error rate below five to ten first-level error corrections per minute then the site is deemed a non-FM site and other arrangements are made to deliver the data to the customer by other more costly means. Rapid first-level error events, while they may all be corrected over any short observation period, indicate that there is not enough performance margin left to trust the site performance over a variey of weather and other anomalous conditions.

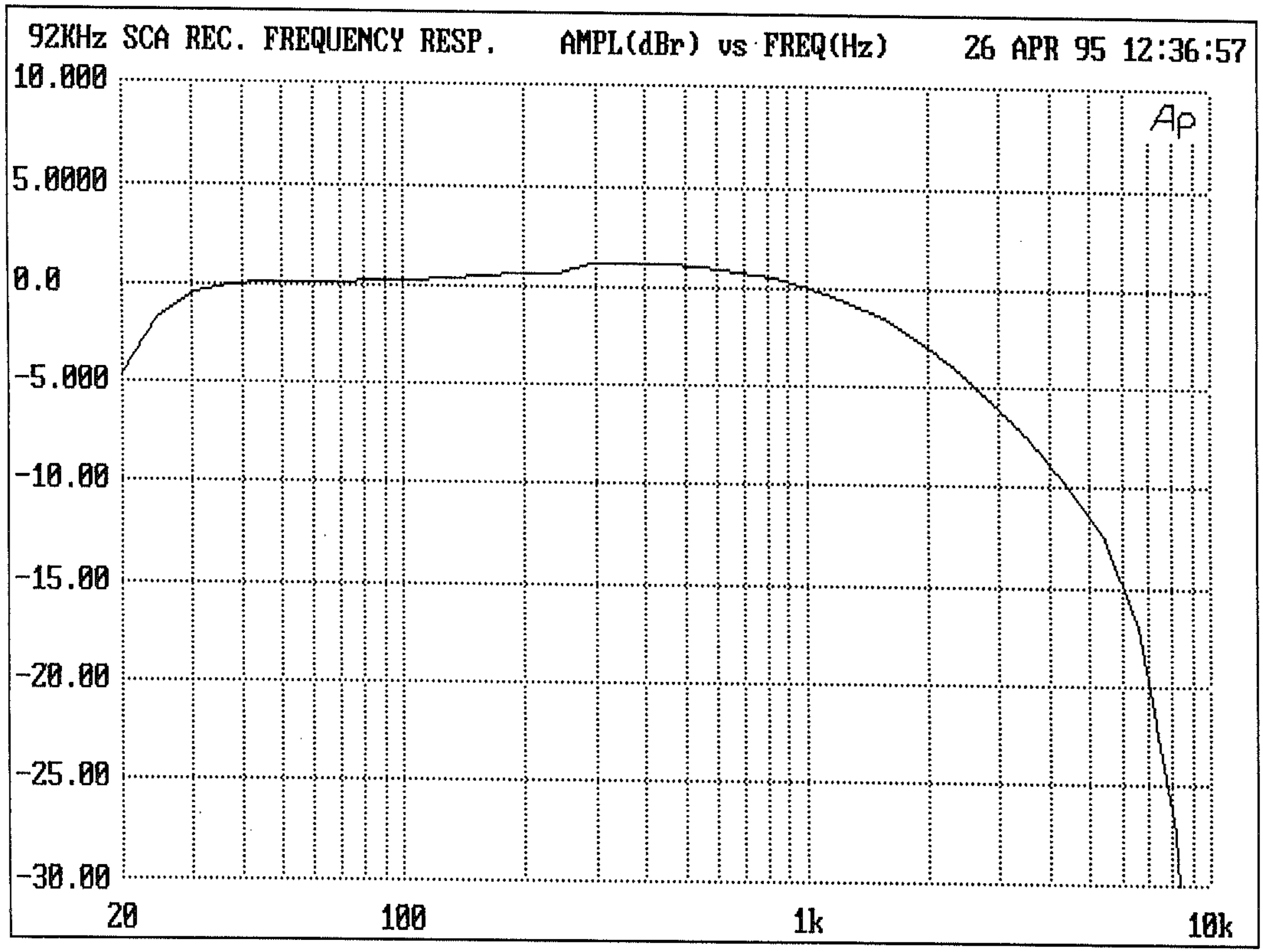
Sincerely,

Bruce Rothaar

Bruce Rothaar
V.P. Engineering
Mainstream Data
(801) 584-2800



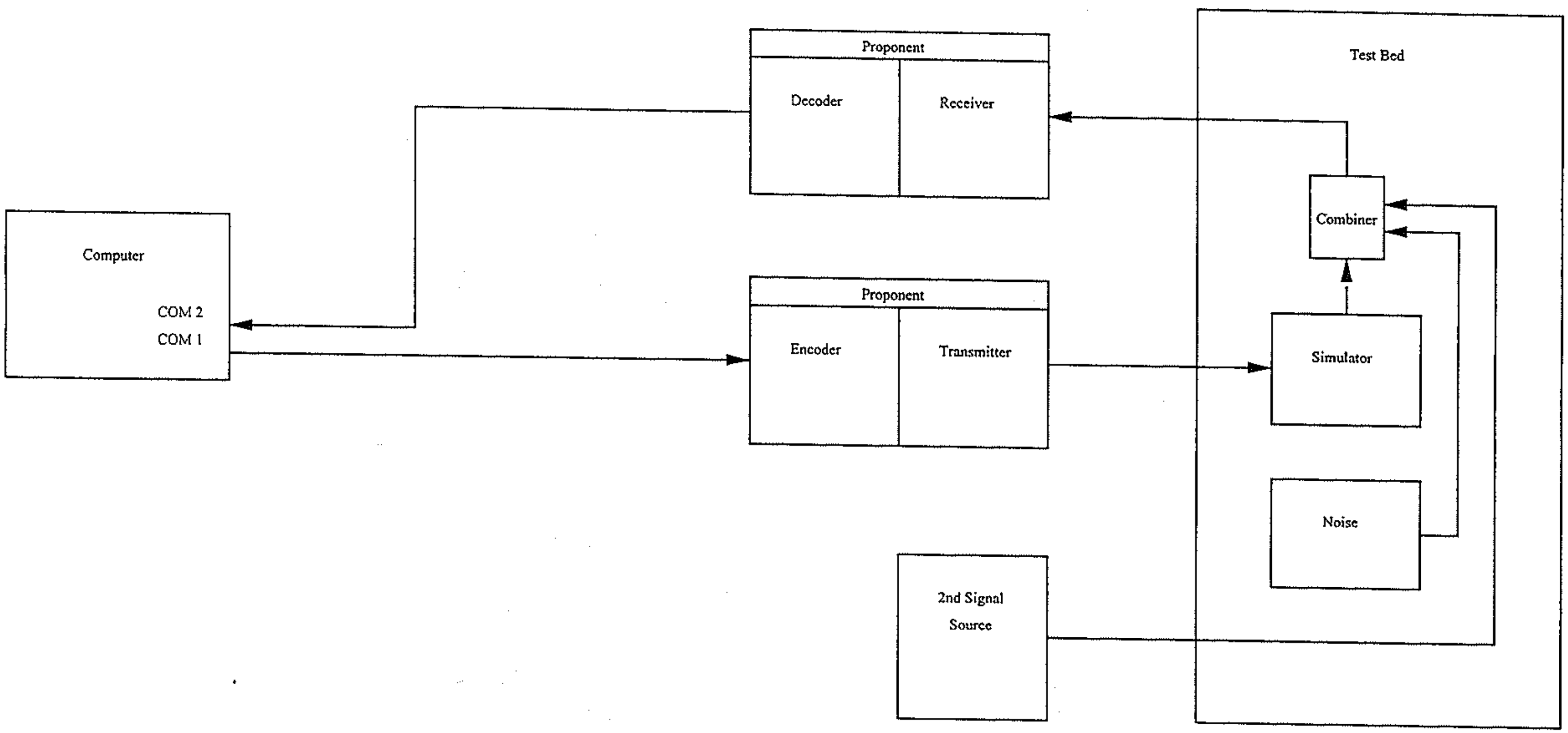
67KHz SCA REC. FREQUENCY RESP.
AMPL(dBr) vs FREQ(Hz)
26 APR 95 12:45:33
10.000
5.0000
0.0
-5.000
-10.00
-15.00
-20.00
-25.00
-30.00
20
100
1k
10k
Ap


92KHz SCA REC. FREQUENCY RESP.
AMPL(dBr) vs FREQ(Hz)
26 APR 95 12:36:57
Ap
10.000
5.0000
0.0
-5.000
-10.00
-15.00
-20.00
-25.00
-30.00
20
100
1k
10k

APPENDIX J

Ancillary Data Channel

EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

BER Test

Testing DAR ancillary data channels

Proponent ancillary and auxillary data channels must conform to PC-compatible COM1, COM2 port electrical and mechanical specifications. Electrical specifications follow RS-232 conventions. Mechanical specification are that it is a male DB-9 connector with signals as follows:

pin	signal	sense	function
2	RxD	in	input data
3	TxD	out	output data
5	GND		
7	RTS-	out	input flow control
8	CTS-	in	output flow control

The test platform ("EIA Test PC") is an IBM-compatible 486DX PC running DOS 5.0 or higher with COM1 and COM2 ports and VGA display. In addition, two "Null Modem" cables are required to connect the test PC to the proponent transmitter and receiver. Test PC COM1 connects to the proponent transmitter, and Test PC COM2 connects to proponent receiver. Figure 1 shows the connections for each of the proponents that uses the PAC codec. A "Null Modem" cable has connections as follows:

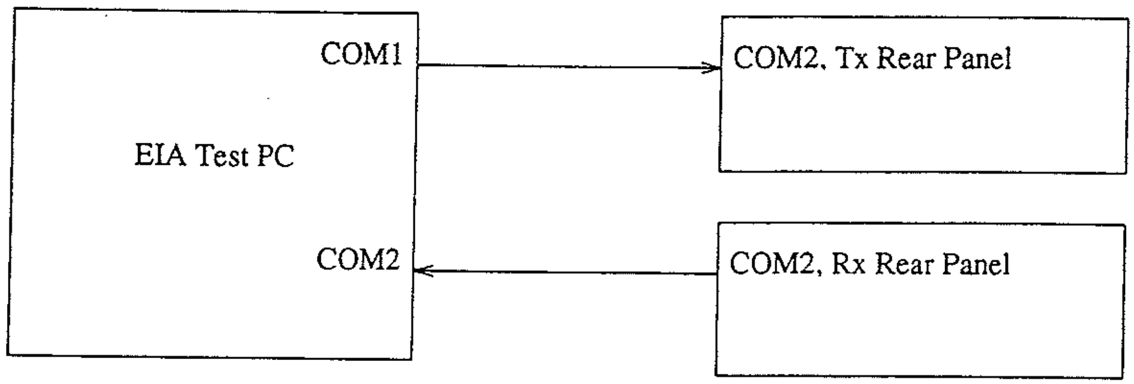
from pin	to pin
2	3
3	2
5	5
7	8
8	7

The Test PC runs the supplied C-language program *ck_data.c* that transmits a known sequence of 8-bit bytes out the Test PC's COM1 port and checks that the Test PC receives them on its COM2 port. Currently the sequence is the 8-bit values 0, 1, 2, ... 255, 0, 1, ... although this can be easily changed in the test program source code. This C-language test program requires the following commercial software:

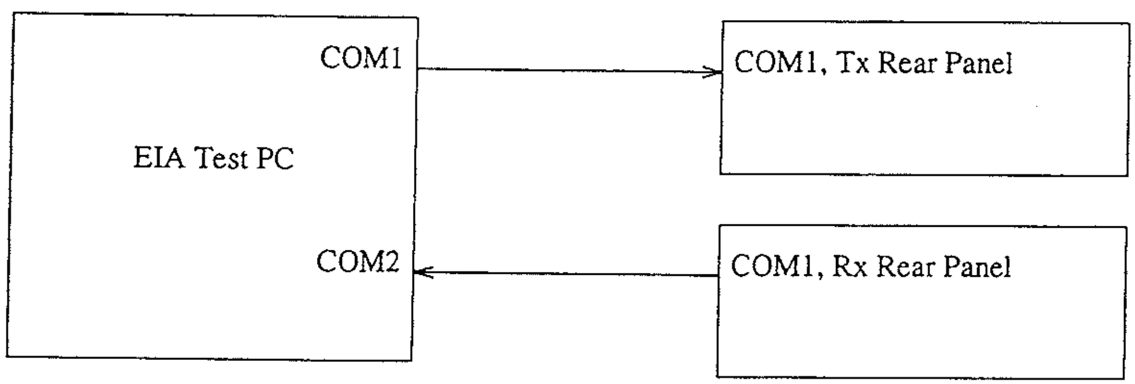
Microsoft C/C++ compiler version 7.0 (also called "Visual C++").
Greenleaf Commlib level 2, version 4.0 or higher Greenleaf Software, Inc. (214) 248-2561

On executing the data check program *ck_data.exe* the Test PC will display several statistics, all referenced to when the test began or to when the test counts were reset. They are: the current elapsed time for the test, the data rate over the channel under test, expressed in bits per second (bps), the total number of bytes received, and the number of errored bytes received.

TESTING AT&T ANCILLARY DATA CHANNEL



TESTING AT&T AUXILLARY DATA CHANNEL



TESTING AT&T/AMATI OR JPL ANCILLARY DATA CHANNEL

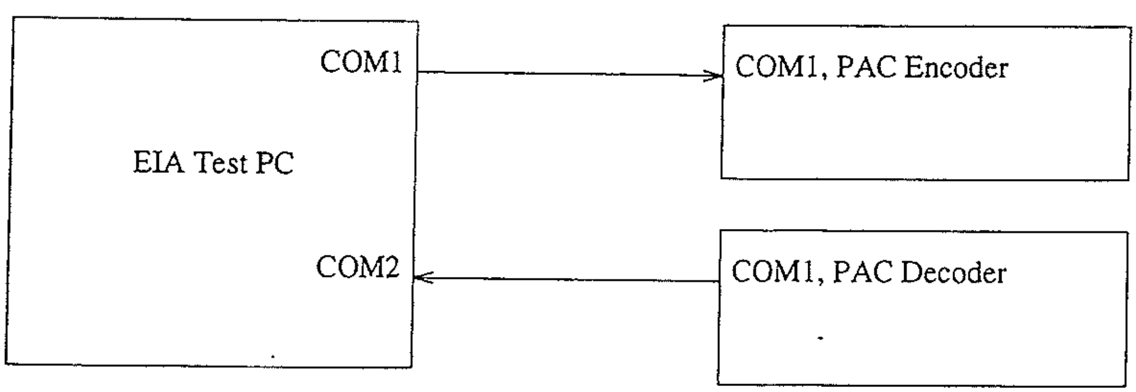


Figure 1. Block Diagram for Testing DAR Data Channels

```
 * program to test ancillary data channels
 *
 * COM1 transmits data test pattern
 * COM2 receives data test pattern
 * COM1 and COM2 run with hardware flow control (CTS-/RTS-)
 *       at 19200 baud.
 * the output test pattern is byte sequence of i%255 for i=0,1,2... or
 *       0,1,2,...255,0,1...
 * any desired output sequence can be generated by modifying
 *       function "next_byte()"
 * the input data is flagged as "illegal" until SYNCLIM correct bytes
 *       are received, after which the consecutive correct bytes
 *       are counted and the received bits per second (bps) are computed,
 *       with each received byte counted as 8 bits. Elapsed time is displayed.
 * from keyboard:
 *       "ESC" key quits program
 *       "R" key resets counts
 */
#define DEBUG   1

#include <stdio.h>
#include <stdlib.h>
#include <graph.h>
#include <time.h>
#include <string.h>
#include <math.h>
#include "commlib.h"
#include "asciidef.h"
#include "ibmkeys.h"
#include <io.h>

#define TITLE   "EIA DAR Ancillary Data Channel Test"
#define BAUD    19200L
#define SYNCLIM 32
#define T_ROW   1                     /* title */
#define C_ROW   5                     /* com port status */
#define L_COL   0                     /* left margin */
#define M_COL   60                    /* middle tab stop */

PORT    *port[2];
int     com_port[2], com_char, com_ref;
long    com_bytes, com_sync, com_err;
char    buffer[80];
double  interval;

extern  void main(int argc,char **argv );
extern  void open_com(int i);
extern  void put_port_char(int i);
extern  void get_port_char(int i);
extern  int next_byte(int *i);
extern  void show_port_stat(void);
extern  void clr_com_stats(void);
extern  int time_int(int mode,double *interval,int step);
extern  void show_time(double interval);

void
main(argc, argv)
int argc;
char **argv;
```

```
	int c, i, j;

	/* set defaults */
	com_port[0] = COM1;
	com_port[1] = COM2;
	com_char = 0;

	if (DEBUG) {
		printf("sending on COM1 at %ld baud\n", BAUD);
		printf("receiving on COM2 at %ld baud\n", BAUD);
		printf("%s, %s\n\n",
			"ESC to quit",
			"'R' to reset counts");
		printf("CR to proceed\n");
		getchar();
	}

	/* open ports */
	open_com(0);
	open_com(1);

	clr_com_stats();
	time_int(0, &interval, 1);

	while (1) {
		if ( gfkbhit() ) {
			c = getkey();
			if ( c == ESC )  {
				PortClose( port[0] );
				PortClose( port[1] );
				_settextposition(23, 0);
				exit( 0 );
			}
			else if ( c == 'R' ) {
				clr_com_stats();
				time_int(0, &interval, 1);
			}
		}

		put_port_char(0);
		get_port_char(1);

		if (time_int(1, &interval, 1)) {
			show_time(interval);
			show_port_stat();
		}
	}
}

void
open_com(i)
int i;
{
	port[i] = PortOpenGreenleaf( com_port[i], BAUD, 'N',  8, 1 );
	if ( port[i]->status < ASSUCCESS ) {
		printf( "Failed to open COM1 port. Status = %d\n",
			port[i]->status );
		exit( 1 );
	}
	UseRtsCts( port[i], 1 );
}

void
put_port_char(i)
int i;
```

```
        int j;
        if (WriteChar( port[i], com_char ) == ASSUCCESS) {
                next_byte(&com_char);
        }
}

void
get_port_char(i)
int i;
{
        int c, match;
        c = ReadChar( port[i] );

        if ( c < ASSUCCESS ) return;

        match = (next_byte(&com_ref) == c) ? 1 : 0;
        com_bytes++;

        if (com_sync++ < SYNCLIM) {
                if (!match) {
                        com_sync = 0;
                        com_ref = c;
                }
        }
        else {
                if (!match)  {
                        com_err++;
                        com_sync = 0;
                        com_ref = c;
                        return;
                }
                else {
                        com_sync = SYNCLIM;
                }
        }
}

int
next_byte(int *p)
{
        int i = ((*p)+1) & 0xff;
        return(*p = i);
}

void
show_port_stat()
{
        long rate;

        rate = 8.0*(double)com_bytes/interval;

        sprintf(buffer,
                "Received: %6ld bps at %6ld baud", rate, BAUD);
        _settextposition(C_ROW, L_COL);
        _outtext(buffer);

        if (com_sync == SYNCLIM) {
                sprintf(buffer, "%12ld %12s %12ld bytes",
                        com_err, "errors in", com_bytes);
        }
        else {
                sprintf(buffer, "%12ld %12s %12ld bytes",
                        com_sync, "invalid data", com_bytes);
        }
        _settextposition(C_ROW+1, L_COL);
```

```
}

void
clr_com_stats()
{
        _clearscreen( _GCLEARSCREEN);
        sprintf(buffer, "%s", TITLE);
        _settextposition(T_ROW, L_COL);
        _outtext(buffer);
        com_bytes = 0;
        com_sync = 0;
        com_err = 0;
}


int
time_int(mode, interval, step)
int mode;
double *interval;
int step;
{
        long now;
        static long start, prev;

        if (mode == 0) {
                start = ElapsedTime()/1000;
                prev = start;
                return 0;
        }
        else {
                now = ElapsedTime()/1000;
                if (now < (prev + step)) {
                        return 0;
                }
                else {
                        *interval = (double)(now - start);
                        prev = now;
                        return 1;
                }
        }
}

void
show_time(interval)
double interval;
{
        long s = (long)interval;
        sprintf(buffer, "TIME: %3dh %2dm %2ds",
                (int)(s/(60*60)),
                (int)(s%(60*60))/60,
                (int)(s%60));
        _settextposition(T_ROW, M_COL);
        _outtext(buffer);
}
```

APPENDIX K

IBOC Systems Modifications

AT&T
Bell Laboratories

600 Mountain Avenue
P.O. Box 636
Murray Hill, NJ 07974-0636
908-582-3000

TO: TOM KELLER, EIA WG B
cc: Dave Londa, DAR Test Lab Manager
John Bingham, Amati Communications Corp.

FROM: Edward Y. Chen, AT&T

DATE: Friday March 17, 1995

SUBJECT: AT&T/AMATI EQUIPMENT MODIFICATIONS

1. On January 27, the following changes were made in the AT&T/Amati IBOC transmitters,

   a. In the primary transmitter, resistor R25 (1 K) was bypassed with a wire.
   b. In the secondary transmitter, an external 2K resistor was replaced by a 750 ohm resistor.
   c. The changes resulted in an increase in digital power level for both transmitters. Prior to the changes, the digital power was measured to be -28.43 dBm with the composite power (analog + digital) at -7.10 dBm. After the changes, the digital power was increased by 8 dB to -20.44 dBm with the composite power at -7.31 dBm.

2. On February 3, 1995, permission was given to allow the Amati analog FM signal to be disabled and substituted by an FM signal generated by a Harris THE -1 FM exciter. The Harris FM signal was combined with the Amati digital signal through an external 10 dB directional coupler. The final power levels were adjusted to be identical to what they were previously with Amati's original FM. The final composite power was -7.16 dBm with analog FM at -7.56 dBm and digital power at -20.46 dBm.

3. On March 15, 1995, a front end box was installed and became part of the AT&T/Amati IBOC receiver. This additional box functioned as a broadband attenuator which protected the receiver from being overdriven. Its insertion loss was 2.24 dB.

4. The 3 dB bandwidth of the Amati DAB signal is 73.3 Khz per sidelobe, or 146.6 Khz total.

Sincerely,

Edward Y. Chen

Edward Y. Chen

usa DIGITAL RADIO

March 6, 1995

Tom Keller
Consultant and Chairman
Working Group B
Digital Audio Radio Subcommittee
Electronic Industries Association
6721 Clelia Ct
Springfield, Virginia 22152-3033

Dear Mr. Keller:

The following changes were made by USADR to its FM-1 IBOC-DAB receiver system, returned today to Cleveland.

1. **Receiver Equalizer**: One field programmable gate array (FPGA) was replaced and demodulator software was upgraded to increase equalizer speed. Software upgrades have been supplied on a microdiskette in a set of DOS files in a directory named "RXCODE5." Software which drives the Transmitter, found in a subdirectory named "TXCODE2," has not been changed.

2. **Source Decoding**: The software upgrade (PROM change) to correct the design error causing unintentional time delay in music decoding was not made. However, a PROM change was made to the error correction decoder. This change is addressed in the attached letter.

3. **RF Front End**. Two changes were made. The first change was the removal and replacement of a rotary encoder switch used for tuning the FM frequency. Before this repair, the FM-1 receiver front end would either tune in one direction only or not tune at all. This repair allows the FM-1 receiver front end to tune, in frequency, up and down as well as wrap around.

   The second change to the receiver RF front end was the removal of a notch filter assembly, which was never used (system was always operated with this filter assembly bypassed), from an internal compartment labeled "Notch Filters." The notch filter assembly was replaced, in this compartment, with an FMIF bandpass filter, TTE # KC6 10.7 MHz BPF, 500 kHz BW. This bandpass filter improves IF selectivity to a limited degree.

   A 6 dB attenuator was added in line between the RF front end and the demodulator to make up for the reduced insertion loss of the bandpass filter installed compared to the notch filter assembly removed.

332 South Michigan Avenue . Suite 605 . Chicago, Illinois 60604
Phone. 312 . 987 . 4449 Fax. 312 . 427 . 9851 1-800-33-USADR

I certify that no other changes were made to the FM-1 RF front end, demodulator or error correction decoder. I certify that no changes at all were made to the CDQ 2001 *MUSICAM* decoder. Please refer to the attached letter regarding the changes to the error correction decoder.

Sincerely,

A.J. Vigil
Engineering Manager

cc: Ralph Justus
Electronic Industries Association
Consumer Electronics Group
2500 Wilson Blvd
Arlington, VA 22201-3834

cc: Dave Londa
EIA/DAR Test Laboratory
NASA-Lewis Research Center
21000 Brookpark Road
MS 54-2
Cleveland, OH 44135

usa DIGITAL RADIO

March 6, 1995

Tom Keller
Consultant and Chairman
Working Group B
Digital Audio Radio Subcommittee
Electronic Industries Association
6721 Clelia Ct
Springfield, Virginia 22152-3033

Dear Mr. Keller:

USA Digital Radio thanks the EIA for this system modification and lab retest opportunity.

In the process of executing various system changes which are described in the attached letter, USADR also found it necessary to modify its FM-1 interleaver and deinterleaver.

USADR has executed changes in Chicago to its FM-1 error correction decoder as well as changes in Cleveland, today, to its error correction encoder.

In detail, the following changes were made:

1. **Error Correction Decoder**: Removal and replacement of 3 28-pin PROMS, those PROMS labelled U6, U26 and U46.

2. **Error Correction Encoder**: Removal and replacement of 3 28-pin PROMS, those PROMS labelled U6, U26 and U46.

Although these changes were not previously allowed, USADR respectfully requests the EIA to accept these changes. USADR believes the following reasons justify allowing these changes.

332 South Michigan Avenue . Suite 605 . Chicago, Illinois 60604
Phone. 312 . 987 . 4449 Fax. 312 . 427 . 9851 1-800-33-USADR

1. The modulation waveform remains unchanged, significantly simplifying retesting.
2. Unimpaired audio codec performance is unaltered, significantly simplifying retesting.
3. A previous proponent system change was requested which did not impact unimpaired audio codec performance. This proponent change was accepted for similar reasons.
4. Retesting, for which USADR has already agreed to pay, has already been scheduled and does not need to be altered.

I certify that no changes were made to the USADR FM-1 system other than those described here and those described in the attached letter documenting previously allowed changes.

Sincerely,

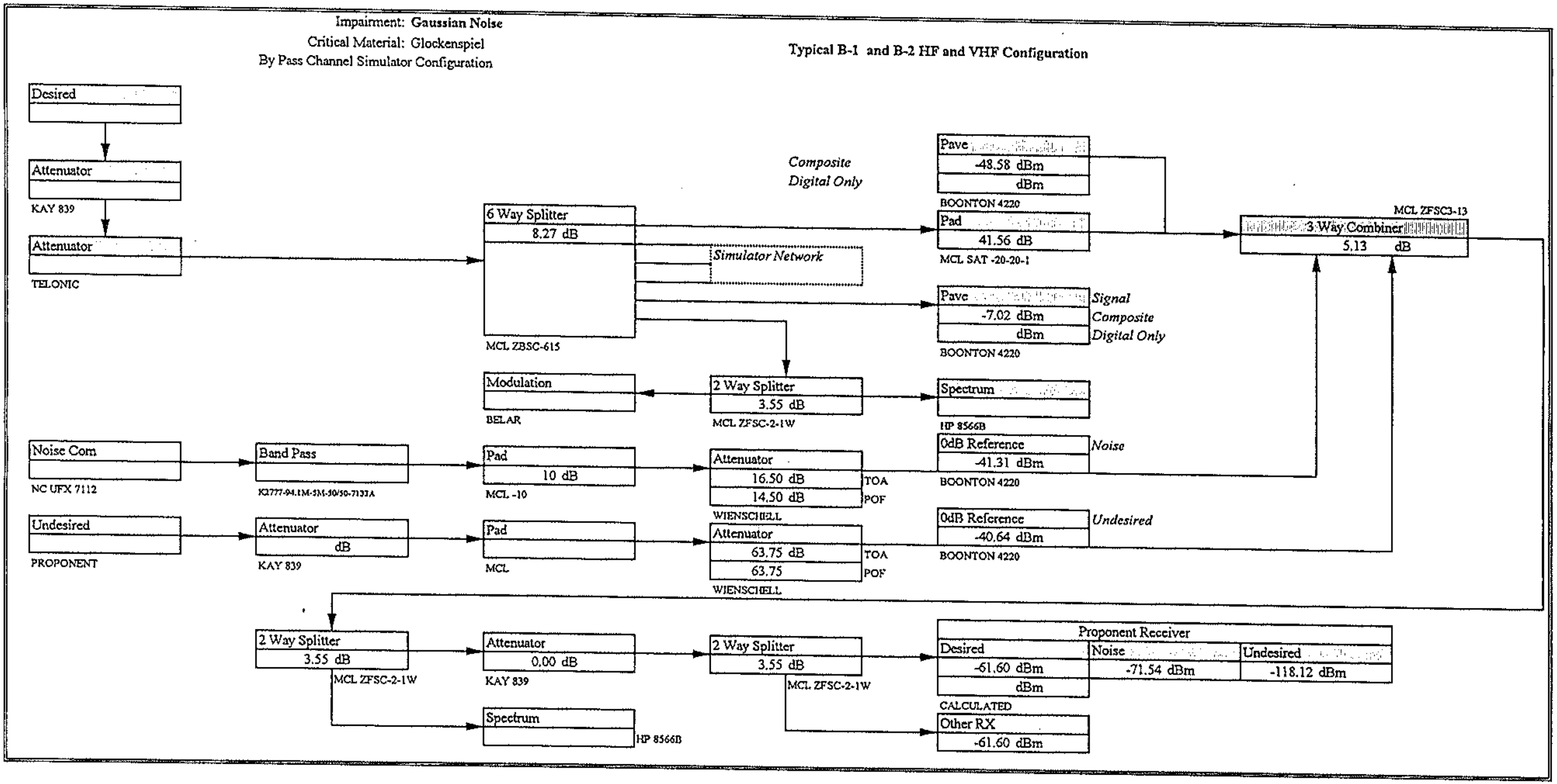
A.J. Vigil
Engineering Manager

cc: Ralph Justus
Electronic Industries Association
Consumer Electronics Group
2500 Wilson Blvd
Arlington, VA 22201-3834

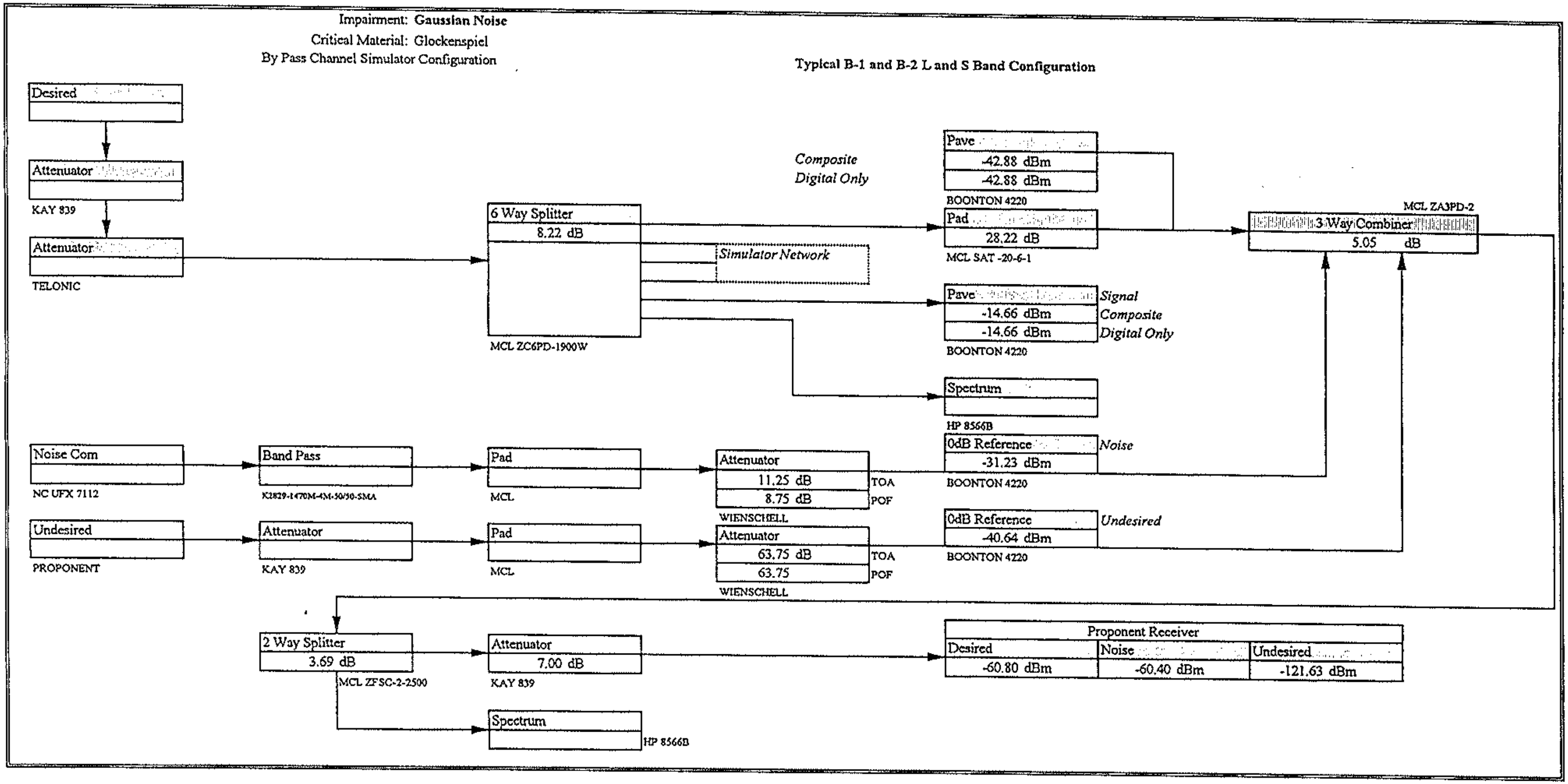
cc: Dave Londa
EIA/DAR Test Laboratory
NASA-Lewis Research Center
21000 Brookpark Road
MS 54-2
Cleveland, OH 44135

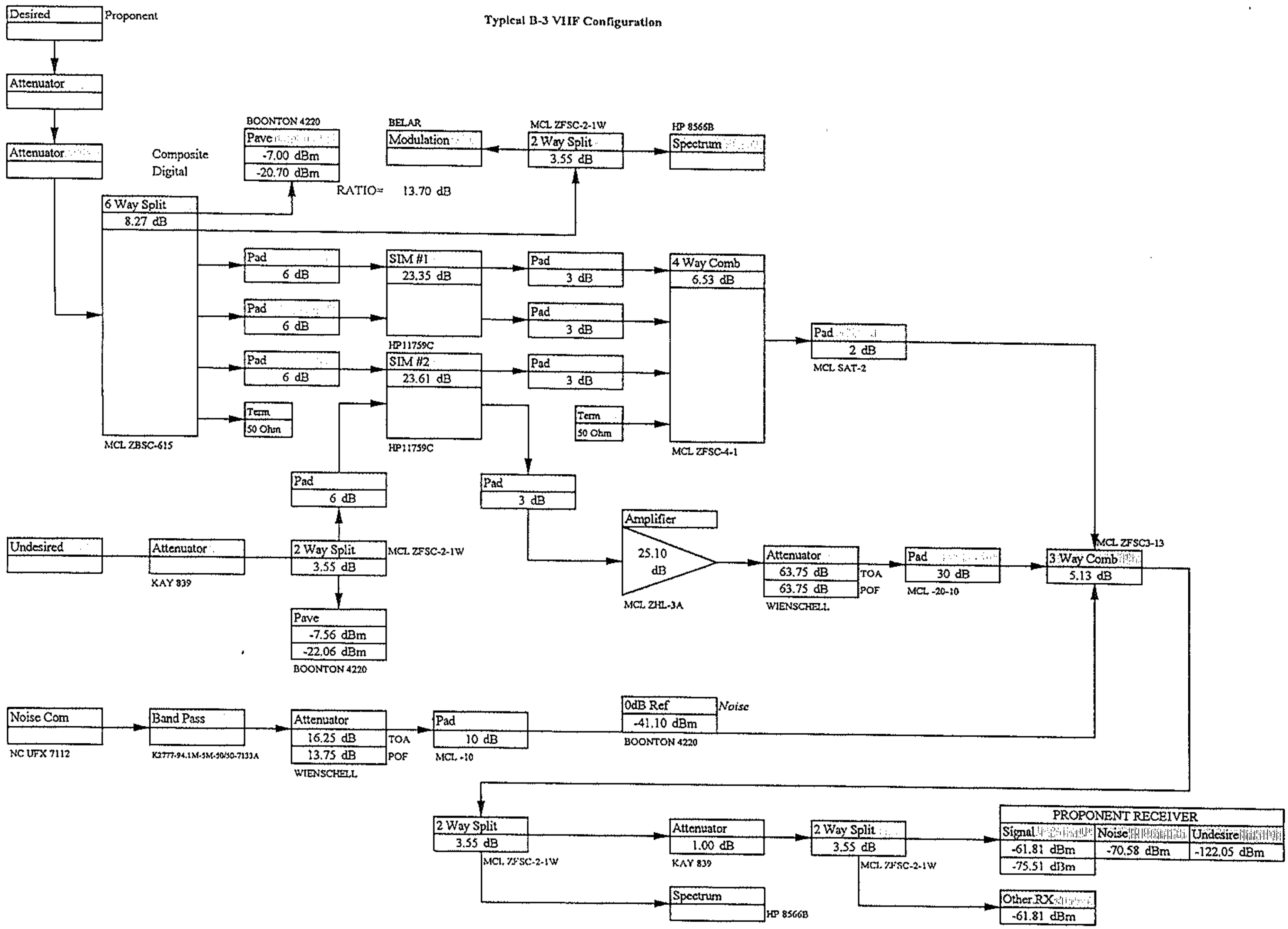
APPENDIX L

Laboratory RF, Audio and Composite Stereo Distributions

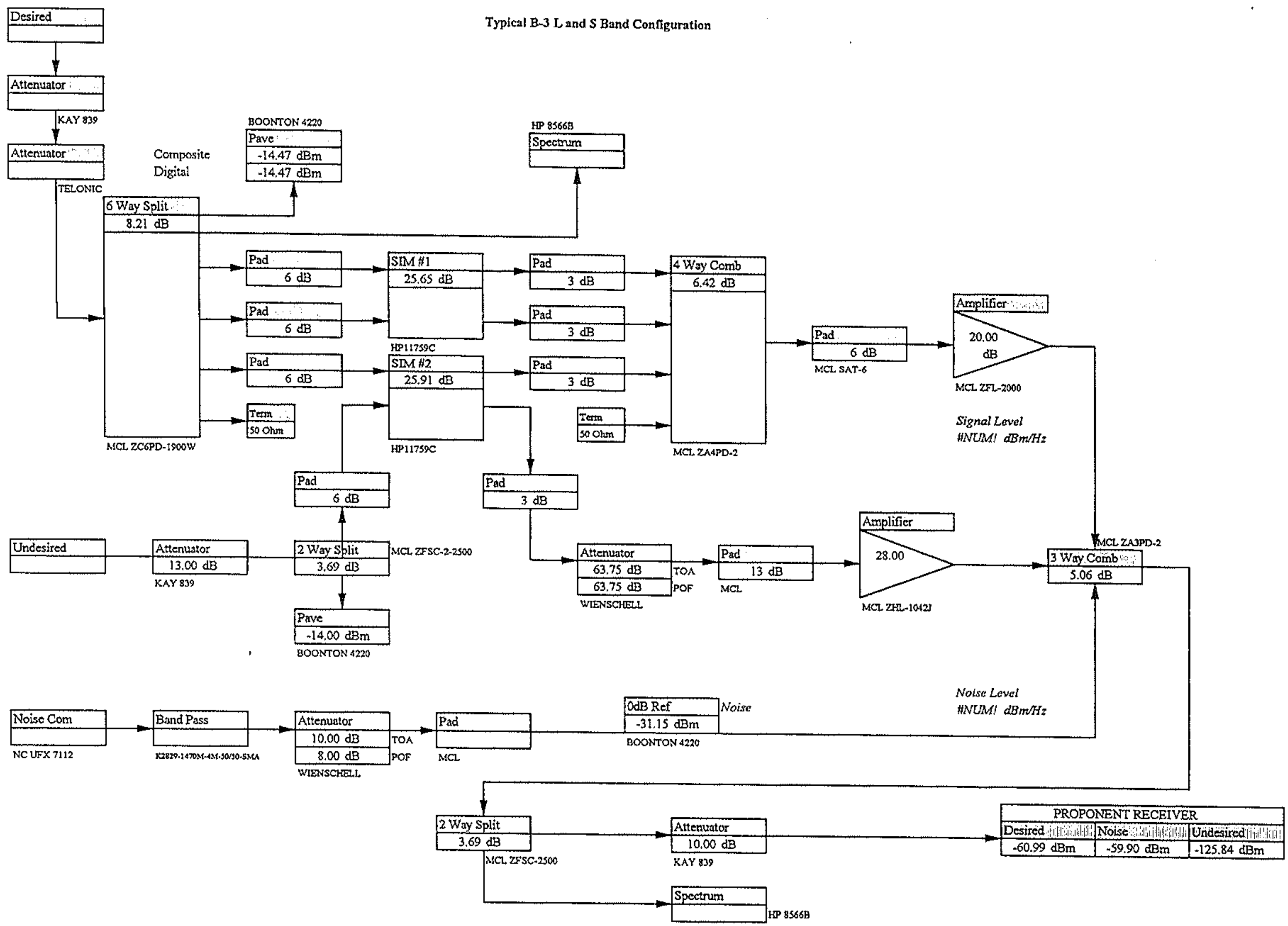

Impairment: Gaussian Noise
Critical Material: Glockenspiel
By Pass Channel Simulator Configuration
Typical B-1 and B-2 HF and VHF Configuration
Desired
Attenuator
KAY 839
Attenuator
TELONIC
6 Way Splitter
8.27 dB
MCL ZBSC-615
Simulator Network
Composite
Digital Only
Pave
-48.58 dBm
dBm
BOONTON 4220
Pad
41.56 dB
MCL SAT -20-20-1
MCL ZFSC3-13
3 Way Combiner
5.13 dB
Pave
-7.02 dBm
dBm
Signal
Composite
Digital Only
BOONTON 4220
Modulation
BELAR
2 Way Splitter
3.55 dB
MCL ZFSC-2-1W
Spectrum
HP 8566B
Noise Com
NC UFX 7112
Band Pass
K2777-94.1M-5M-50/50-7133A
Pad
10 dB
MCL -10
Attenuator
16.50 dB
14.50 dB
TOA
POF
WIENSCHELL
0dB Reference
-41.31 dBm
Noise
BOONTON 4220
Undesired
PROPONENT
Attenuator
dB
KAY 839
Pad
MCL
Attenuator
63.75 dB
63.75
TOA
POF
WIENSCHELL
0dB Reference
-40.64 dBm
Undesired
BOONTON 4220
2 Way Splitter
3.55 dB
MCL ZFSC-2-1W
Attenuator
0.00 dB
KAY 839
2 Way Splitter
3.55 dB
MCL ZFSC-2-1W
Proponent Receiver
Desired
-61.60 dBm
dBm
Noise
-71.54 dBm
Undesired
-118.12 dBm
CALCULATED
Other RX
-61.60 dBm
Spectrum
HP 8566B

EIA Digital Audio Radio Test Laboratory





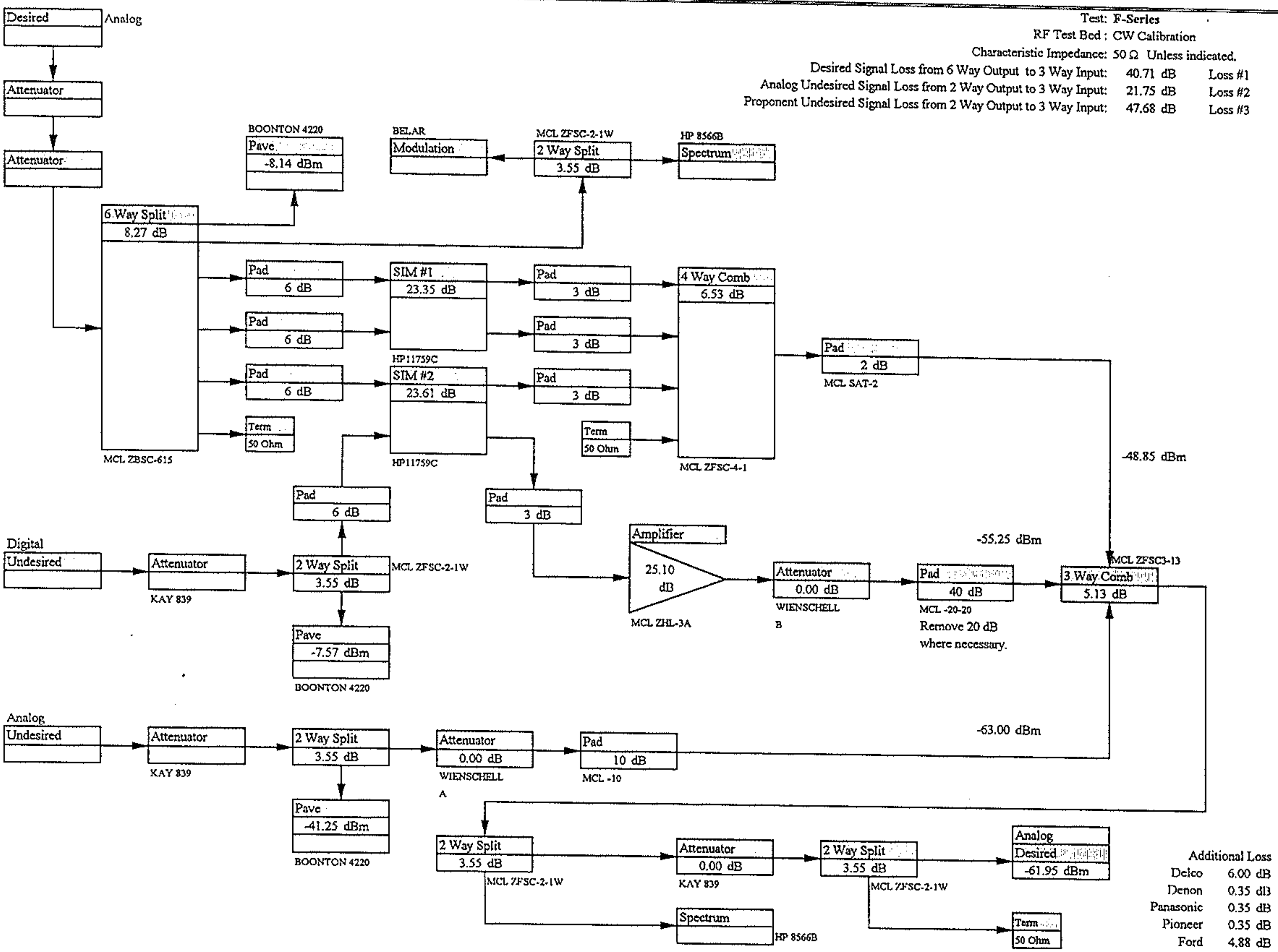
Typical B-3 VHF Configuration
Desired
Proponent
Attenuator
Attenuator
Composite
Digital
BOONTON 4220
Pave
-7.00 dBm
-20.70 dBm
RATIO= 13.70 dB
BELAR
Modulation
MCL ZFSC-2-1W
2 Way Split
3.55 dB
HP 8566B
Spectrum
6 Way Split
8.27 dB
MCL ZBSC-615
Pad
6 dB
Pad
6 dB
Pad
6 dB
Term
50 Ohm
SIM #1
23.35 dB
HP11759C
SIM #2
23.61 dB
HP11759C
Pad
3 dB
Pad
3 dB
Pad
3 dB
Term
50 Ohm
4 Way Comb
6.53 dB
MCL ZFSC-4-1
Pad
2 dB
MCL SAT-2
Pad
6 dB
Pad
3 dB
Undesired
Attenuator
KAY 839
2 Way Split
3.55 dB
MCL ZFSC-2-1W
Pave
-7.56 dBm
-22.06 dBm
BOONTON 4220
Amplifier
25.10
dB
MCL ZHL-3A
Attenuator
63.75 dB
63.75 dB
TOA
POF
WIENSCHELL
Pad
30 dB
MCL -20-10
MCL ZFSC3-13
3 Way Comb
5.13 dB
Noise Com
NC UFX 7112
Band Pass
K2777-94.1M-5M-50/50-7133A
Attenuator
16.25 dB
13.75 dB
TOA
POF
WIENSCHELL
Pad
10 dB
MCL -10
0dB Ref
-41.10 dBm
Noise
BOONTON 4220
2 Way Split
3.55 dB
MCL ZFSC-2-1W
Attenuator
1.00 dB
KAY 839
2 Way Split
3.55 dB
MCL ZFSC-2-1W
PROPONENT RECEIVER
Signal
-61.81 dBm
-75.51 dBm
Noise
-70.58 dBm
Undesire
-122.05 dBm
Spectrum
HP 8566B
Other RX
-61.81 dBm


Typical B-3 L and S Band Configuration
Desired
Attenuator
KAY 839
Attenuator
TELONIC
Composite
Digital
BOONTON 4220
Pave
-14.47 dBm
-14.47 dBm
HP 8566B
Spectrum
6 Way Split
8.21 dB
Pad
6 dB
Pad
6 dB
Pad
6 dB
Term
50 Ohm
MCL ZC6PD-1900W
SIM #1
25.65 dB
HP11759C
SIM #2
25.91 dB
HP11759C
Pad
3 dB
Pad
3 dB
Pad
3 dB
Term
50 Ohm
4 Way Comb
6.42 dB
MCL ZA4PD-2
Pad
6 dB
MCL SAT-6
Amplifier
20.00
dB
MCL ZFL-2000
Signal Level
#NUM! dBm/Hz
Pad
6 dB
Pad
3 dB
Undesired
Attenuator
13.00 dB
KAY 839
2 Way Split
3.69 dB
MCL ZFSC-2-2500
Pave
-14.00 dBm
BOONTON 4220
Attenuator
63.75 dB
63.75 dB
TOA
POF
WIENSCHELL
Pad
13 dB
MCL
Amplifier
28.00
MCL ZHL-1042J
MCL ZA3PD-2
3 Way Comb
5.06 dB
Noise Level
#NUM! dBm/Hz
Noise Com
NC UFX 7112
Band Pass
K2829-1470M-4M-50/50-SMA
Attenuator
10.00 dB
8.00 dB
TOA
POF
WIENSCHELL
Pad
MCL
0dB Ref
-31.15 dBm
Noise
BOONTON 4220
2 Way Split
3.69 dB
MCL ZFSC-2500
Attenuator
10.00 dB
KAY 839
Spectrum
HP 8566B
PROPONENT RECEIVER
Desired
-60.99 dBm
Noise
-59.90 dBm
Undesired
-125.84 dBm

EIA Digital Audio Radio Test Laboratory

Test: F-Series
RF Test Bed : CW Calibration
Characteristic Impedance: 50 Ω Unless indicated.

Desired Signal Loss from 6 Way Output to 3 Way Input:	40.71 dB	Loss #1
Analog Undesired Signal Loss from 2 Way Output to 3 Way Input:	21.75 dB	Loss #2
Proponent Undesired Signal Loss from 2 Way Output to 3 Way Input:	47.68 dB	Loss #3

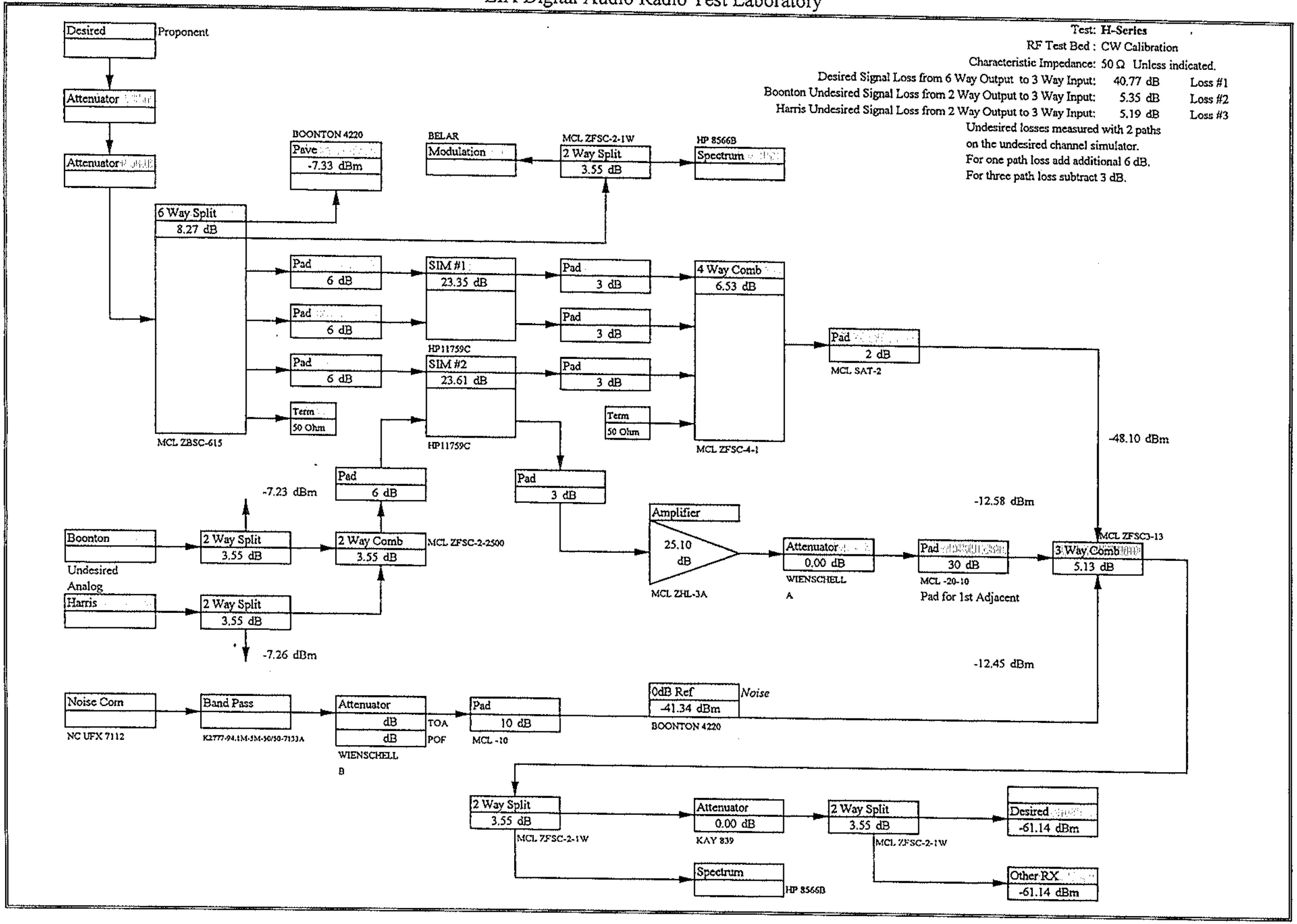


Additional Loss

Delco	6.00 dB
Denon	0.35 dB
Panasonic	0.35 dB
Pioneer	0.35 dB
Ford	4.88 dB

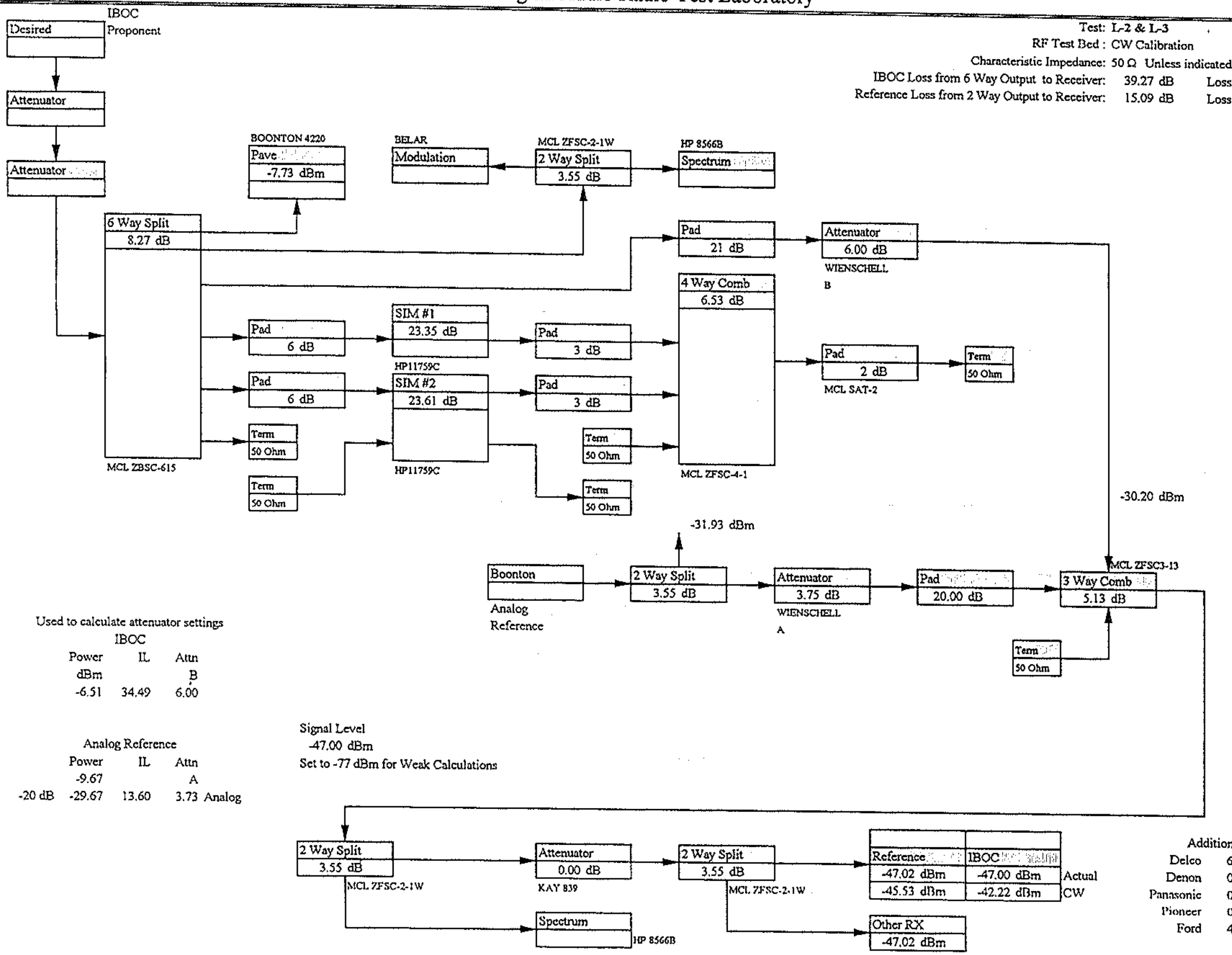
File Name:RFSETUP.XLS Levels F-Series

EIA Digital Audio Radio Test Laboratory



EIA Digital Audio Radio Test Laboratory

Test: L-2 & L-3
RF Test Bed : CW Calibration
Characteristic Impedance: 50 Ω Unless indicated.
IBOC Loss from 6 Way Output to Receiver: 39.27 dB Loss #1
Reference Loss from 2 Way Output to Receiver: 15.09 dB Loss #2



Used to calculate attenuator settings

	IBOC		
	Power	IL	Attn
	dBm		B
	-6.51	34.49	6.00

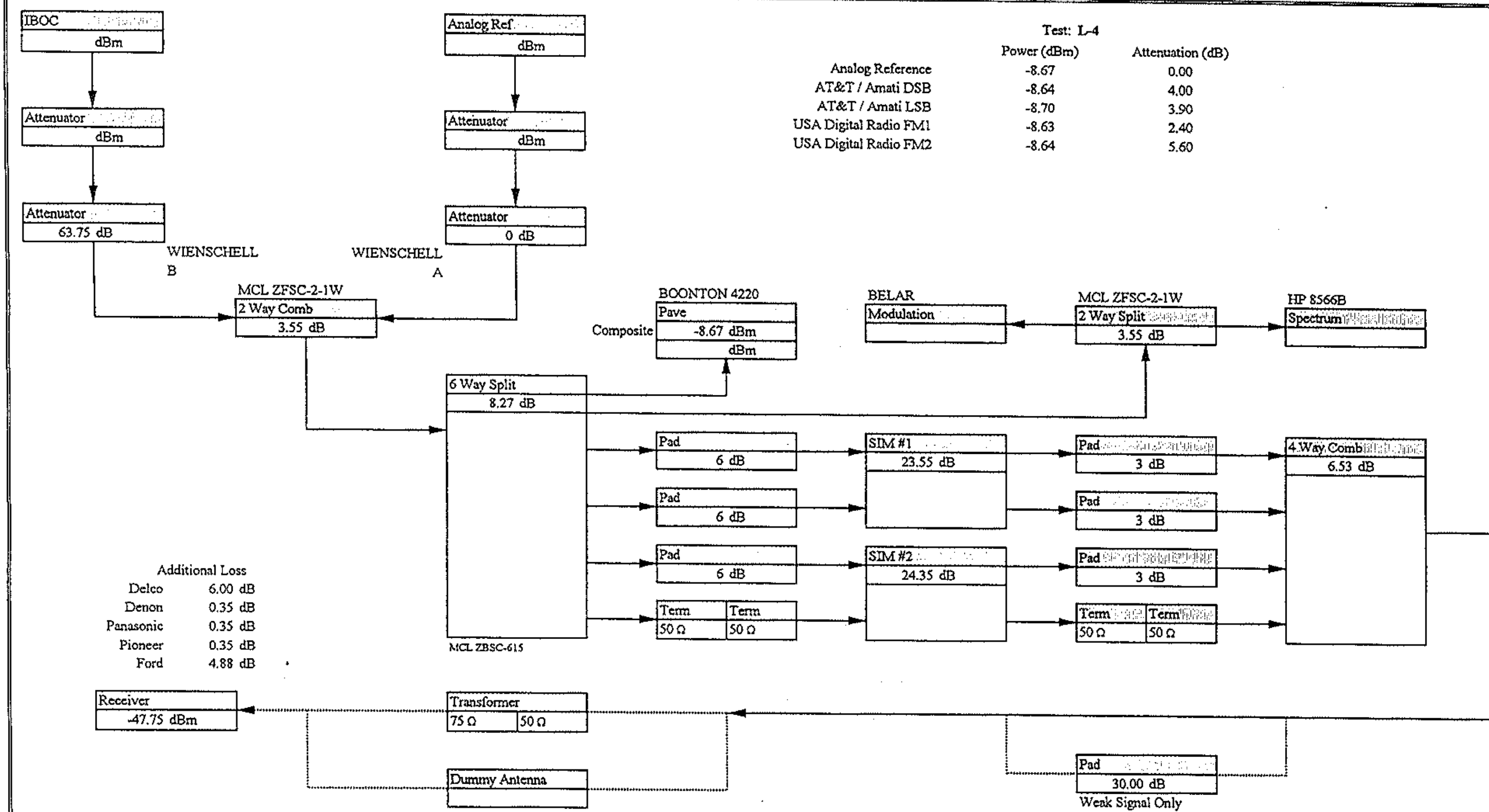
	Analog Reference			
	Power	IL	Attn	
	-9.67		A	
-20 dB	-29.67	13.60	3.73	Analog

Signal Level
-47.00 dBm
Set to -77 dBm for Weak Calculations

Additional Loss

Delco	6.00 dB
Denon	0.35 dB
Panasonic	0.35 dB
Pioneer	0.35 dB
Ford	4.88 dB

EIA Digital Audio Radio Test Laboratory

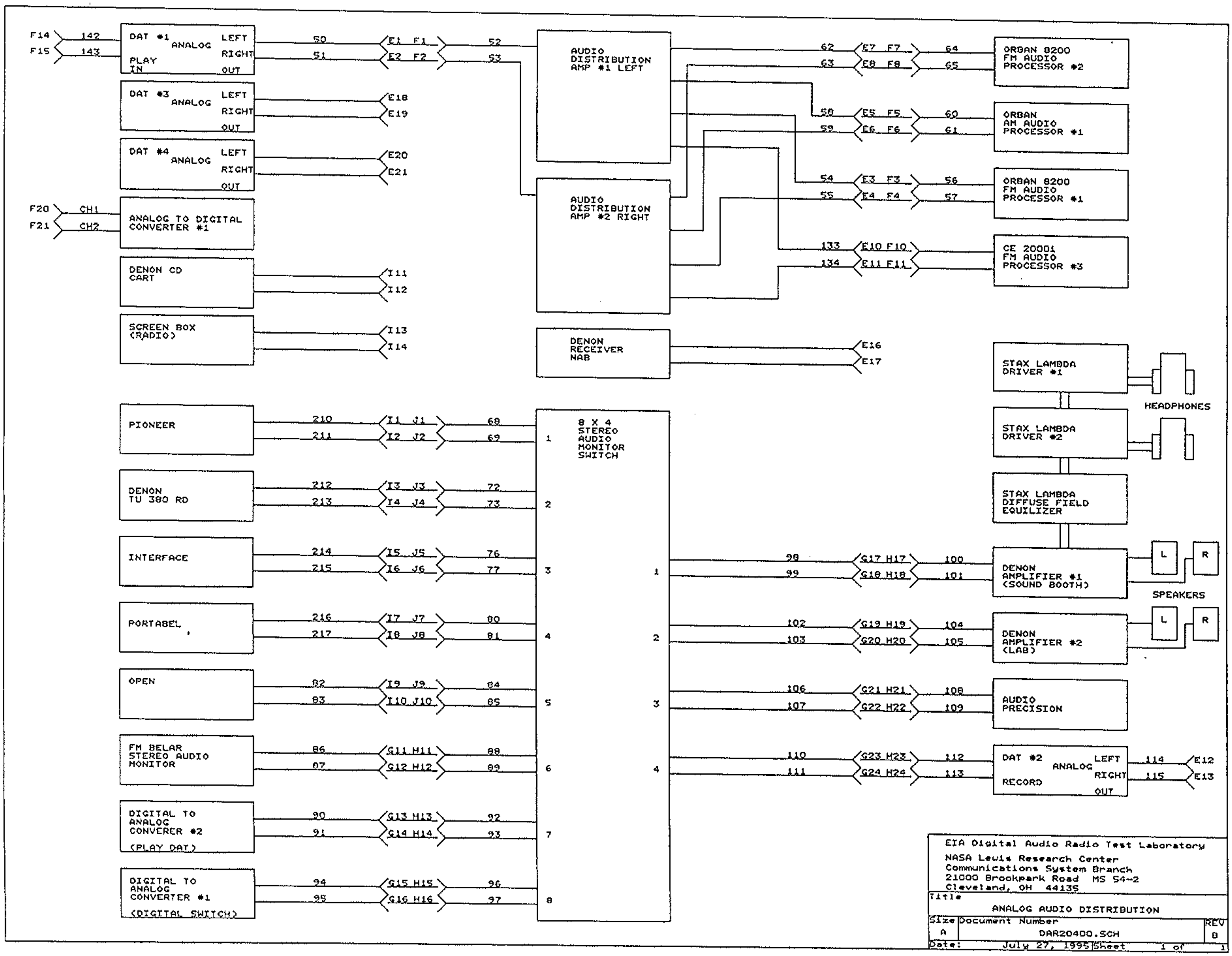


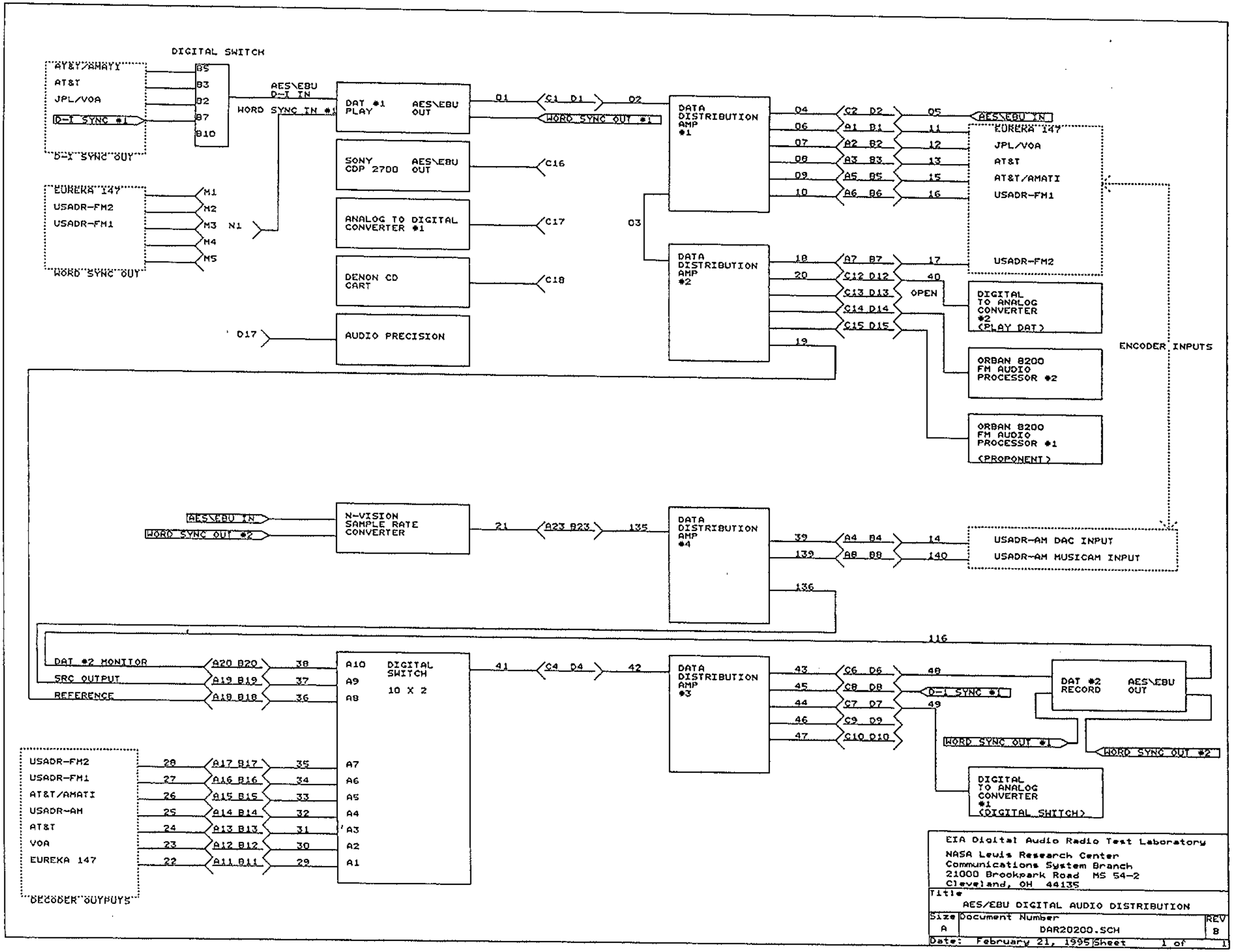
Test: L-4

	Power (dBm)	Attenuation (dB)
Analog Reference	-8.67	0.00
AT&T / Amati DSB	-8.64	4.00
AT&T / Amati LSB	-8.70	3.90
USA Digital Radio FM1	-8.63	2.40
USA Digital Radio FM2	-8.64	5.60

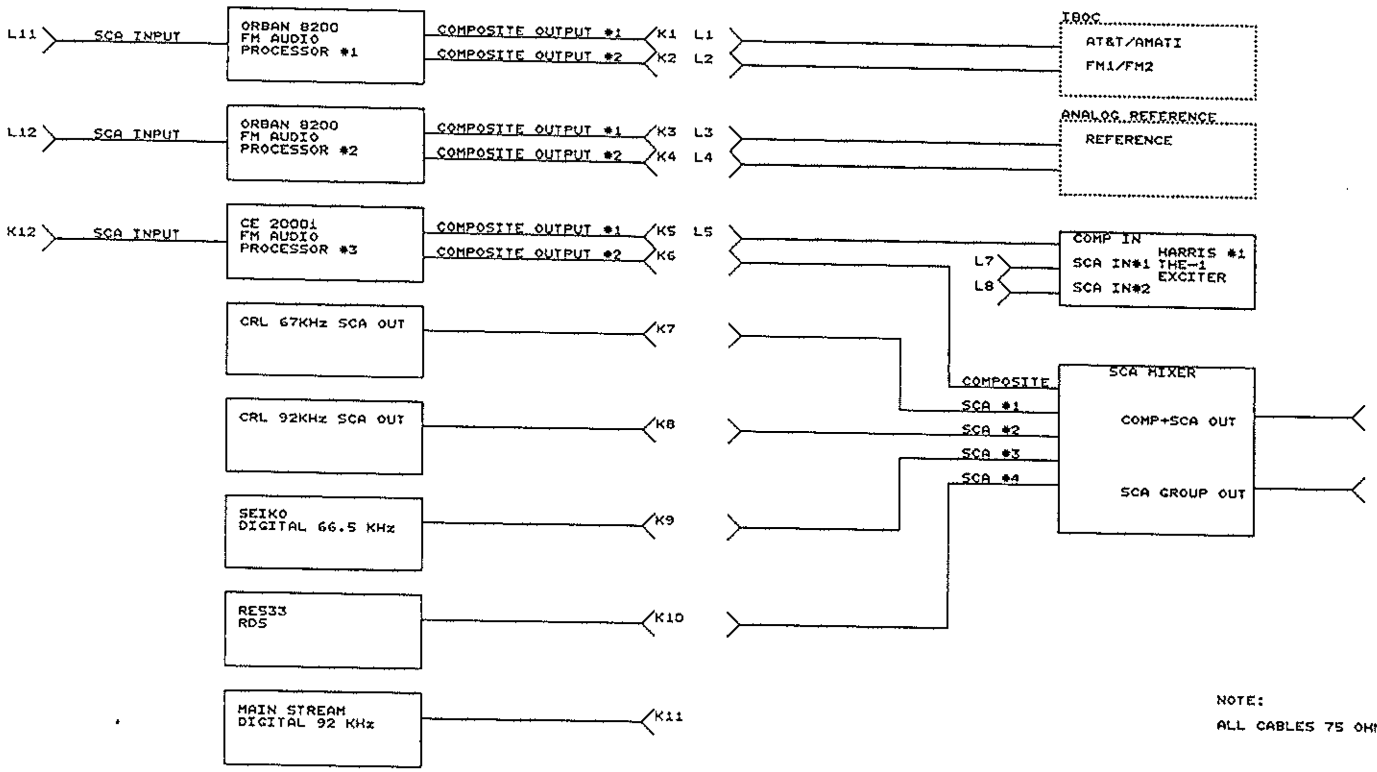
Additional Loss

Delco	6.00 dB
Denon	0.35 dB
Panasonic	0.35 dB
Pioneer	0.35 dB
Ford	4.88 dB


DAT #1 ANALOG PLAY IN LEFT RIGHT OUT
DAT #3 ANALOG LEFT RIGHT OUT
DAT #4 ANALOG LEFT RIGHT OUT
ANALOG TO DIGITAL CONVERTER #1
DENON CD CART
SCREEN BOX (RADIO)
PIONEER
DENON TU 380 RD
INTERFACE
PORTABEL
OPEN
FM BELAR STEREO AUDIO MONITOR
DIGITAL TO ANALOG CONVERER #2 (PLAY DAT)
DIGITAL TO ANALOG CONVERTER #1 (DIGITAL SWITCH)
AUDIO DISTRIBUTION AMP #1 LEFT
AUDIO DISTRIBUTION AMP #2 RIGHT
DENON RECEIVER NAB
8 X 4 STEREO AUDIO MONITOR SWITCH
ORBAN 8200 FM AUDIO PROCESSOR #2
ORBAN AM AUDIO PROCESSOR #1
ORBAN 8200 FM AUDIO PROCESSOR #1
CE 20001 FM AUDIO PROCESSOR #3
STAX LAMBDA DRIVER #1
STAX LAMBDA DRIVER #2
HEADPHONES
STAX LAMBDA DIFFUSE FIELD EQUILIZER
DENON AMPLIFIER #1 (SOUND BOOTH)
SPEAKERS
DENON AMPLIFIER #2 (LAB)
AUDIO PRECISION
DAT #2 ANALOG RECORD LEFT RIGHT OUT
EIA Digital Audio Radio Test Laboratory
NASA Lewis Research Center
Communications System Branch
21000 Brookpark Road MS 54-2
Cleveland, OH 44135
Title
ANALOG AUDIO DISTRIBUTION
Size A
Document Number DAR20400.SCH
REV B
Date: July 27, 1995
Sheet 1 of 1



DIGITAL SWITCH
AT&T/AMATI
AT&T
JPL/VOA
D-I SYNC #1
D-I SYNC OUT
EUREKA 147
USADR-FM2
USADR-FM1
WORD SYNC OUT
AES\EBU D-I IN
WORD SYNC IN #1
DAT #1 PLAY AES\EBU OUT
SONY CDP 2700 AES\EBU OUT
ANALOG TO DIGITAL CONVERTER #1
DENON CD CART
AUDIO PRECISION
DATA DISTRIBUTION AMP #1
DATA DISTRIBUTION AMP #2
WORD SYNC OUT #1
AES\EBU IN
EUREKA 147
JPL/VOA
AT&T
AT&T/AMATI
USADR-FM1
USADR-FM2
OPEN
DIGITAL TO ANALOG CONVERTER #2 (PLAY DAT)
ORBAN 8200 FM AUDIO PROCESSOR #2
ORBAN 8200 FM AUDIO PROCESSOR #1 (PROPONENT)
ENCODER INPUTS
AES\EBU IN
WORD SYNC OUT #2
N-VISION SAMPLE RATE CONVERTER
DATA DISTRIBUTION AMP #4
USADR-AM DAC INPUT
USADR-AM MUSICAM INPUT
DAT #2 MONITOR
SRC OUTPUT
REFERENCE
DIGITAL SWITCH 10 X 2
DATA DISTRIBUTION AMP #3
DAT #2 RECORD AES\EBU OUT
D-I SYNC #1
WORD SYNC OUT #1
WORD SYNC OUT #2
DIGITAL TO ANALOG CONVERTER #1 (DIGITAL SWITCH)
USADR-FM2
USADR-FM1
AT&T/AMATI
USADR-AM
AT&T
VOA
EUREKA 147
DECODER OUTPUTS
EIA Digital Audio Radio Test Laboratory
NASA Lewis Research Center
Communications System Branch
21000 Brookpark Road MS 54-2
Cleveland, OH 44135
Title
AES/EBU DIGITAL AUDIO DISTRIBUTION
Size A
Document Number DAR20200.SCH
REV B
Date: February 21, 1995
Sheet 1 of 1



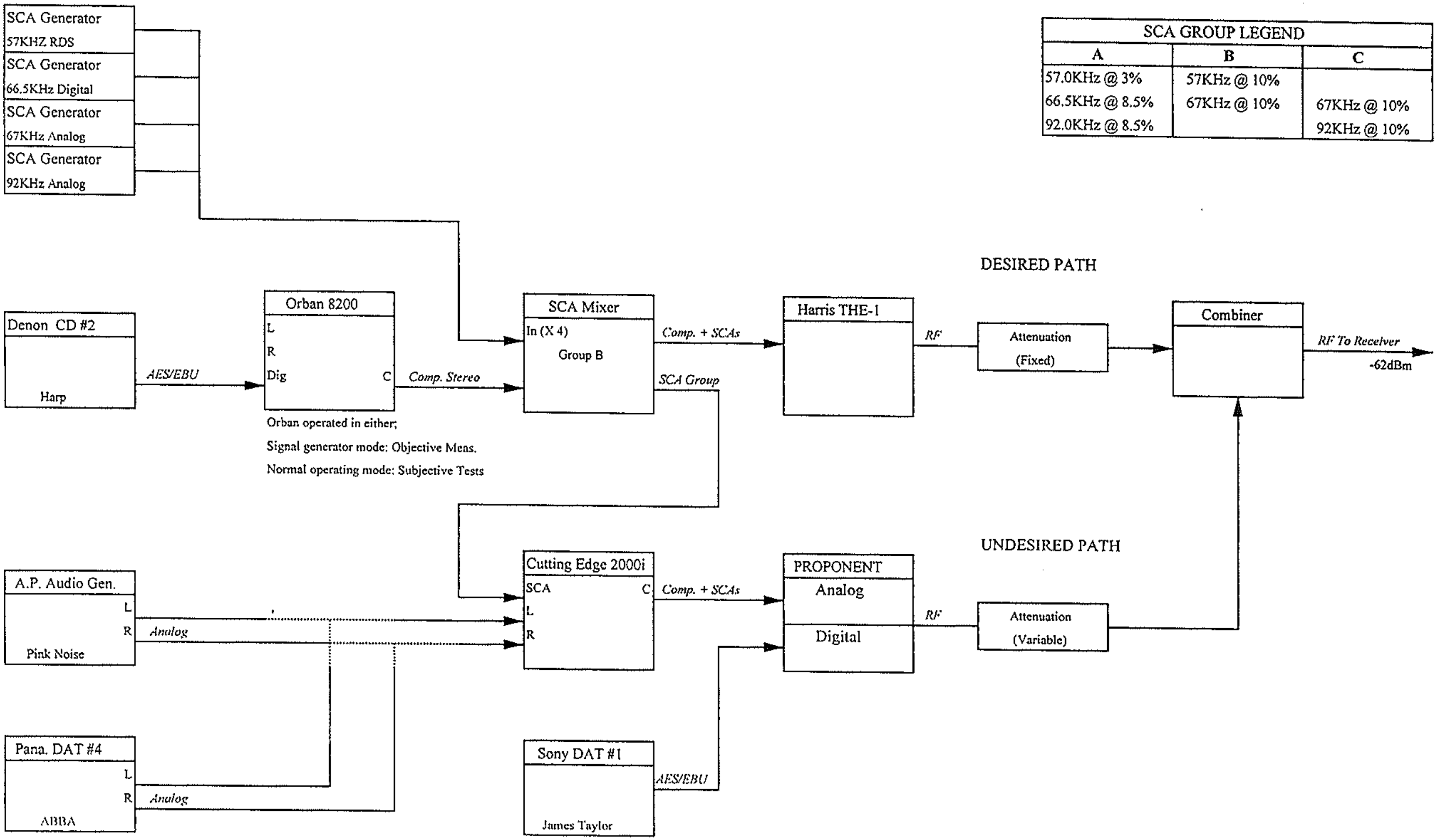
NOTE:

ALL CABLES 75 OHM UNLESS INDICATED.

EIA Digital Audio Radio Test Laboratory
NASA Lewis Research Center
Communications System Branch
21000 Brookpark Road MS 54-2
Cleveland, OH 44135

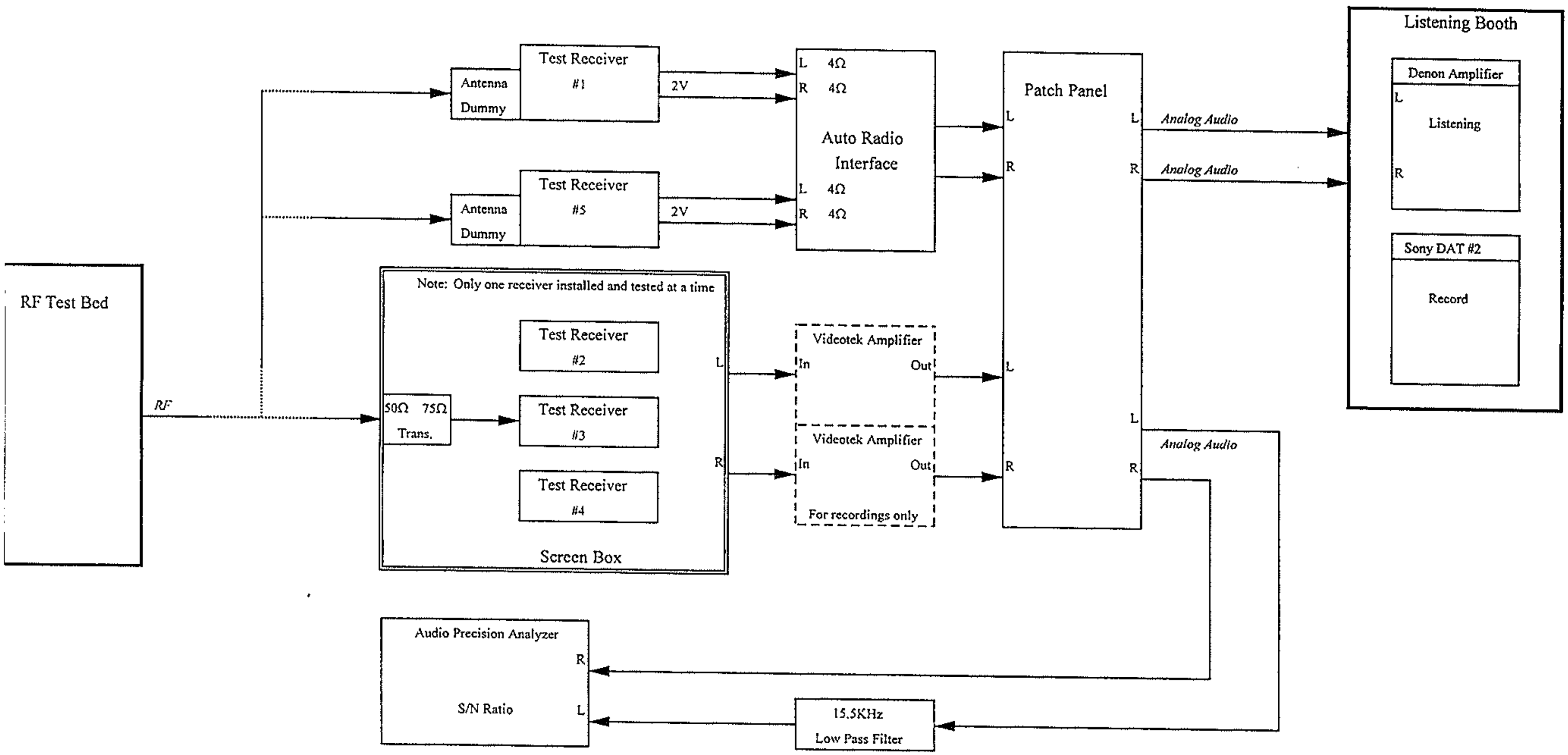
Title		
COMPOSITE STEREO AND SCA DISTRIBUTION		
Size: A	Document Number: DAR20500.SCH	REV: A
Date: July 27, 1995	Sheet 1 of 1	

EIA Digital Audio Radio Test Laboratory



SCA GROUP LEGEND		
A	B	C
57.0KHz @ 3%	57KHz @ 10%	
66.5KHz @ 8.5%	67KHz @ 10%	67KHz @ 10%
92.0KHz @ 8.5%		92KHz @ 10%

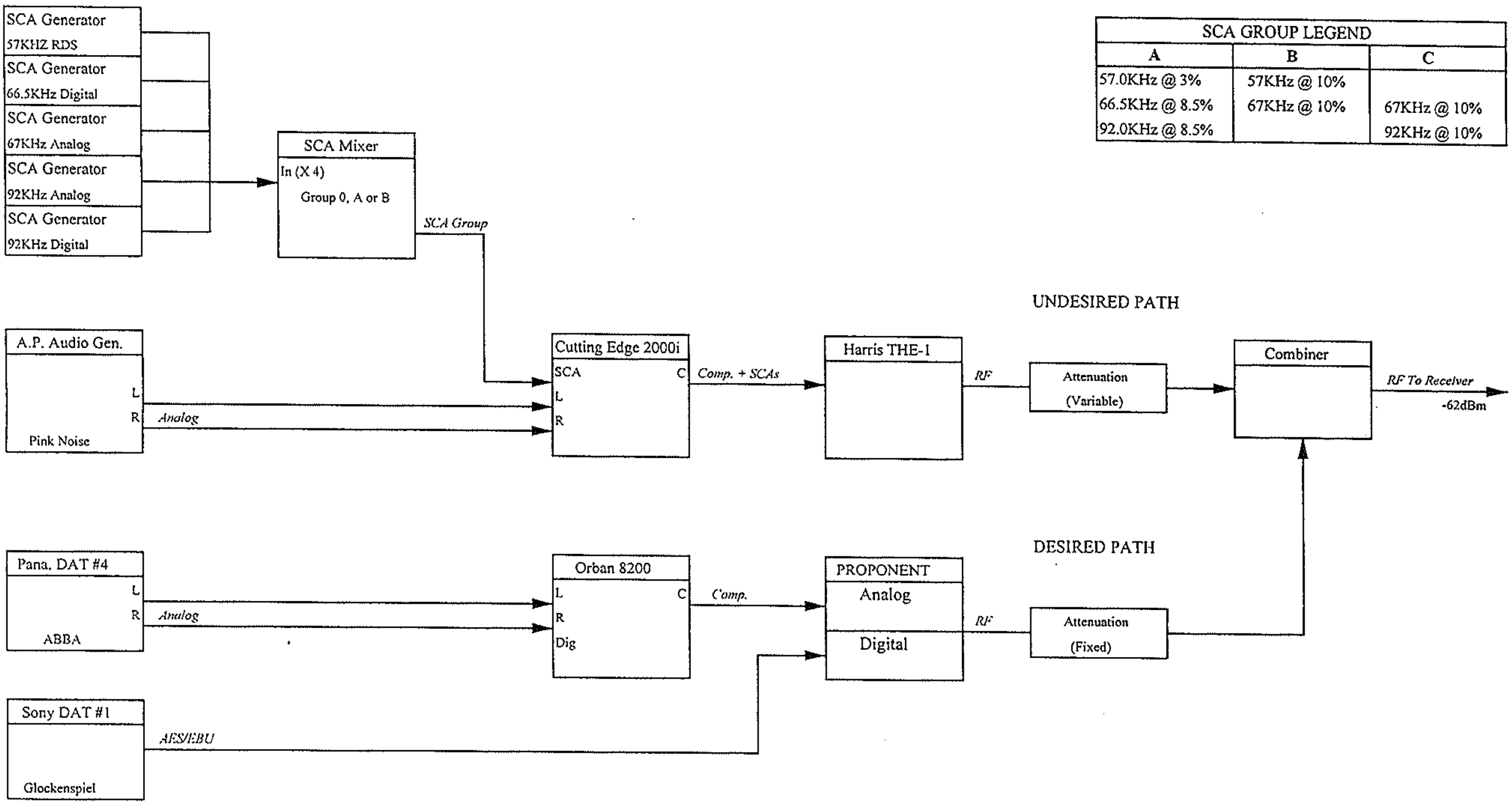
EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

F & G Rec. Block

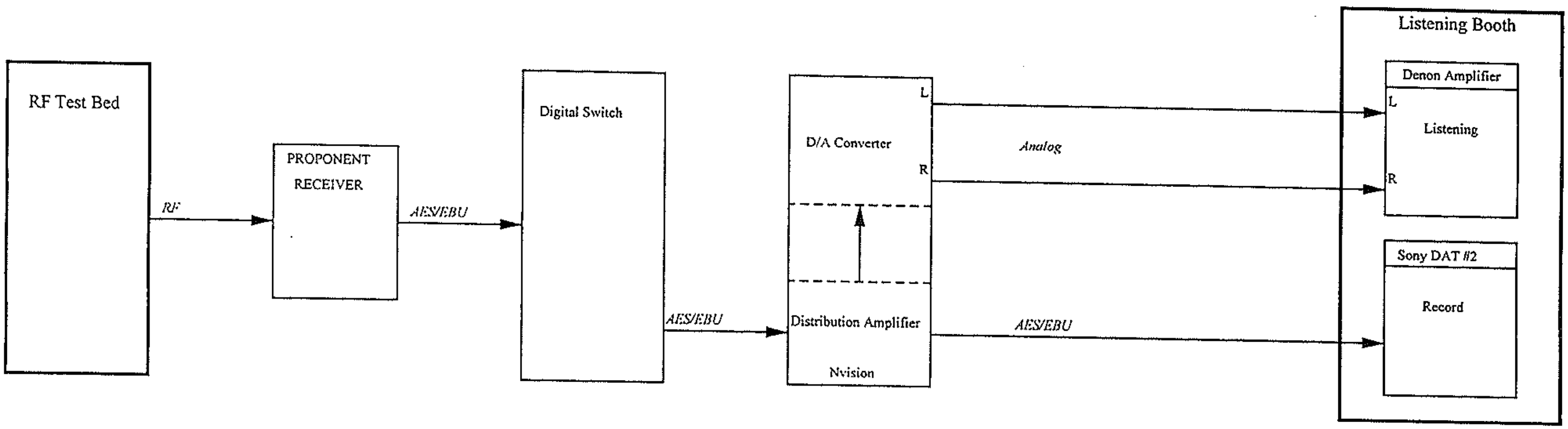
EIA Digital Audio Radio Test Laboratory



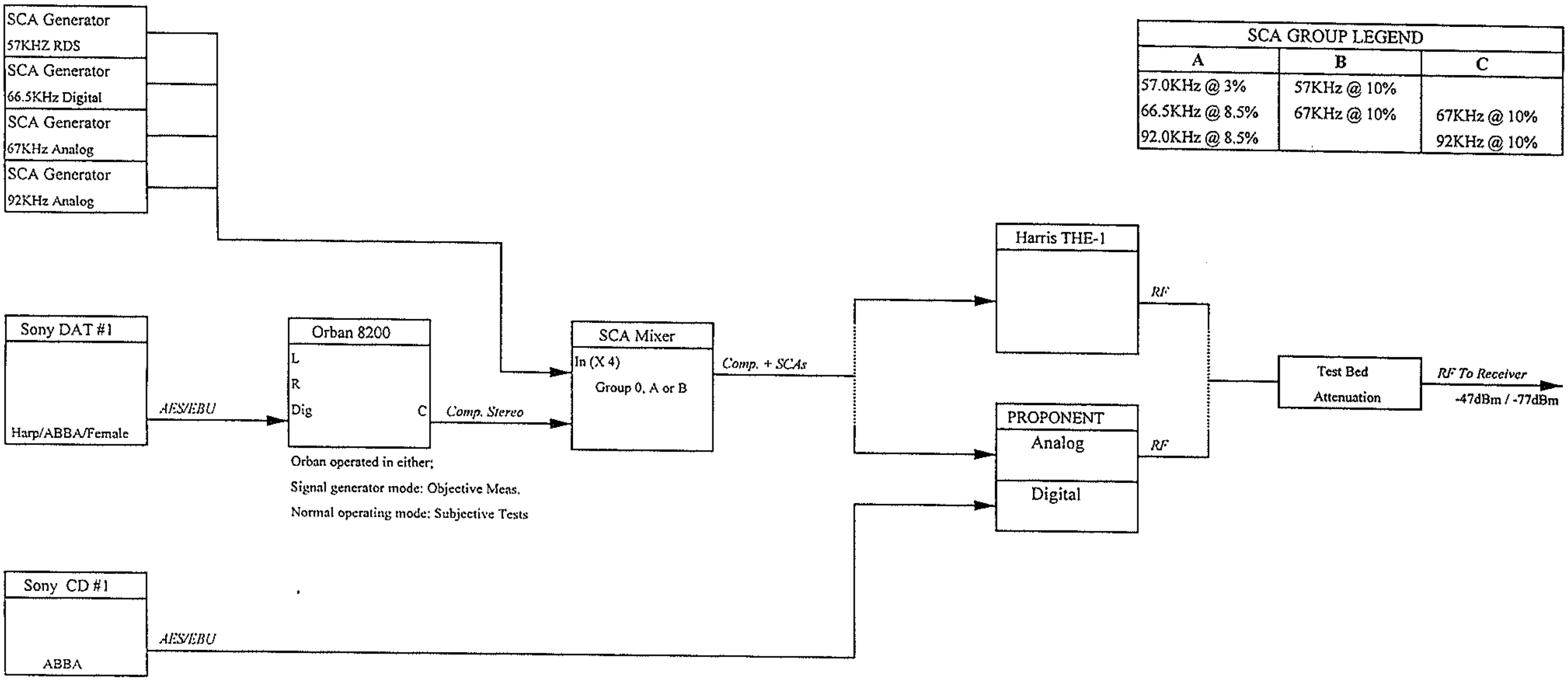
SCA GROUP LEGEND

A	B	C
57.0KHz @ 3%	57KHz @ 10%	
66.5KHz @ 8.5%	67KHz @ 10%	67KHz @ 10%
92.0KHz @ 8.5%		92KHz @ 10%

EIA Digital Audio Radio Test Laboratory

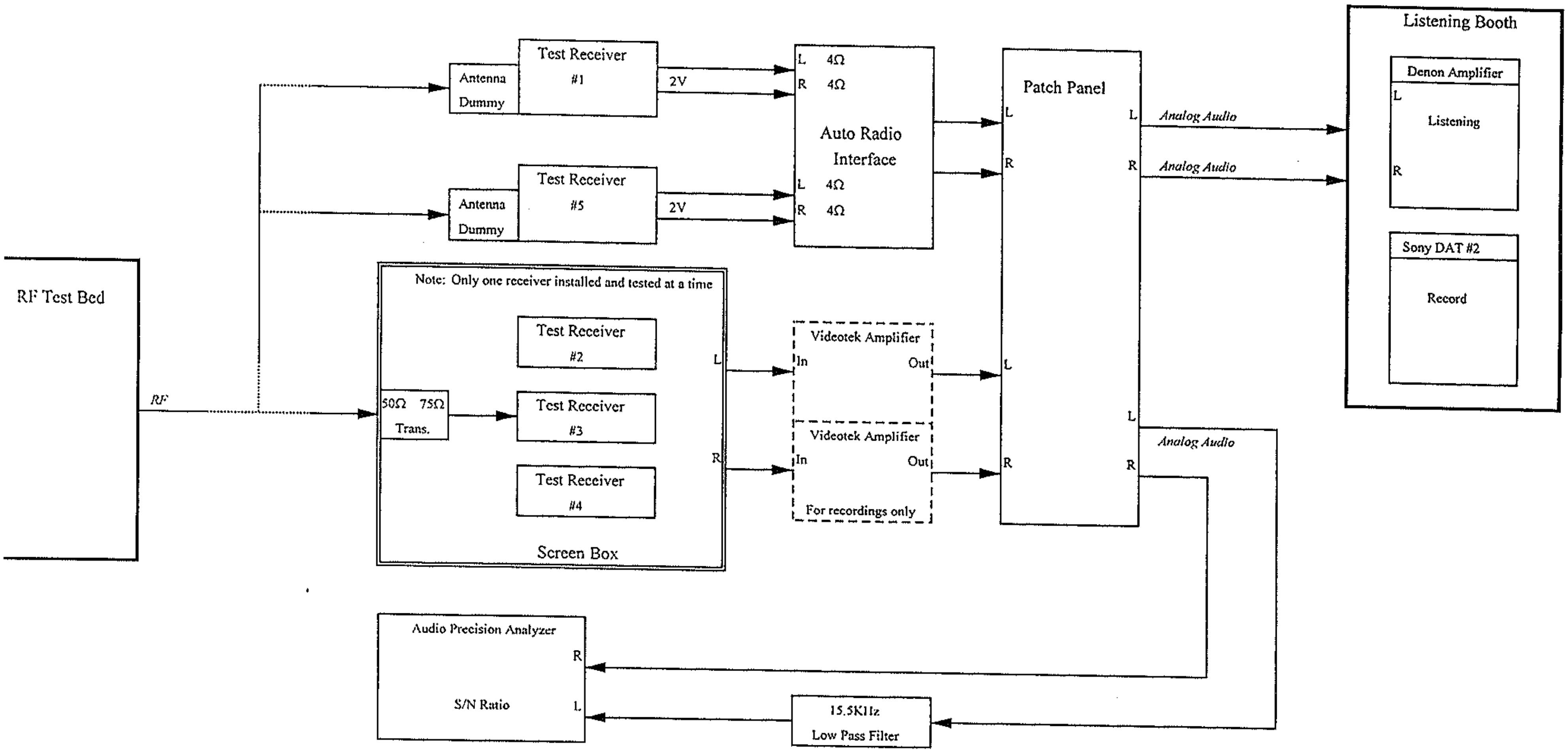


EIA Digital Audio Radio Test Laboratory



SCA GROUP LEGEND		
A	B	C
57.0KHz @ 3%	57KHz @ 10%	
66.5KHz @ 8.5%	67KHz @ 10%	67KHz @ 10%
92.0KHz @ 8.5%		92KHz @ 10%

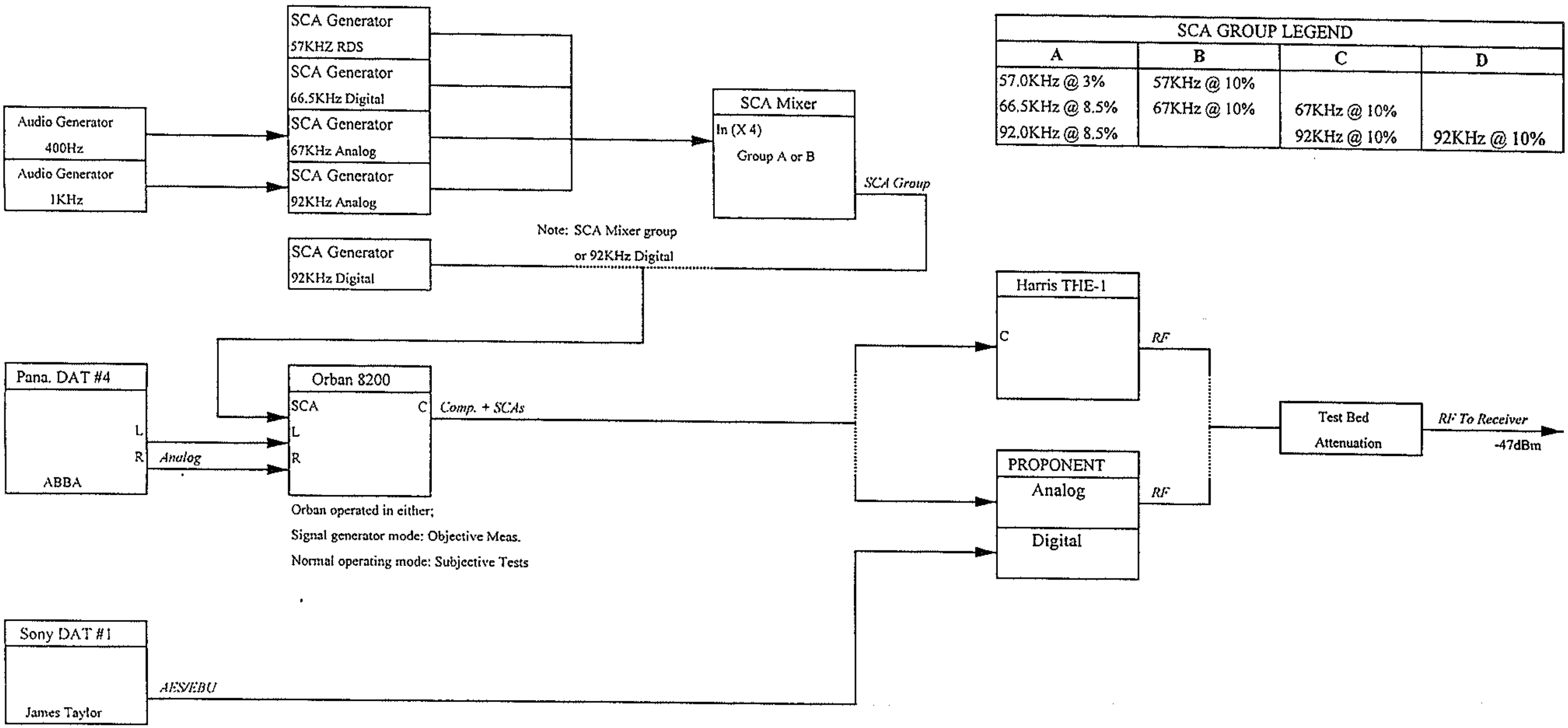
EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

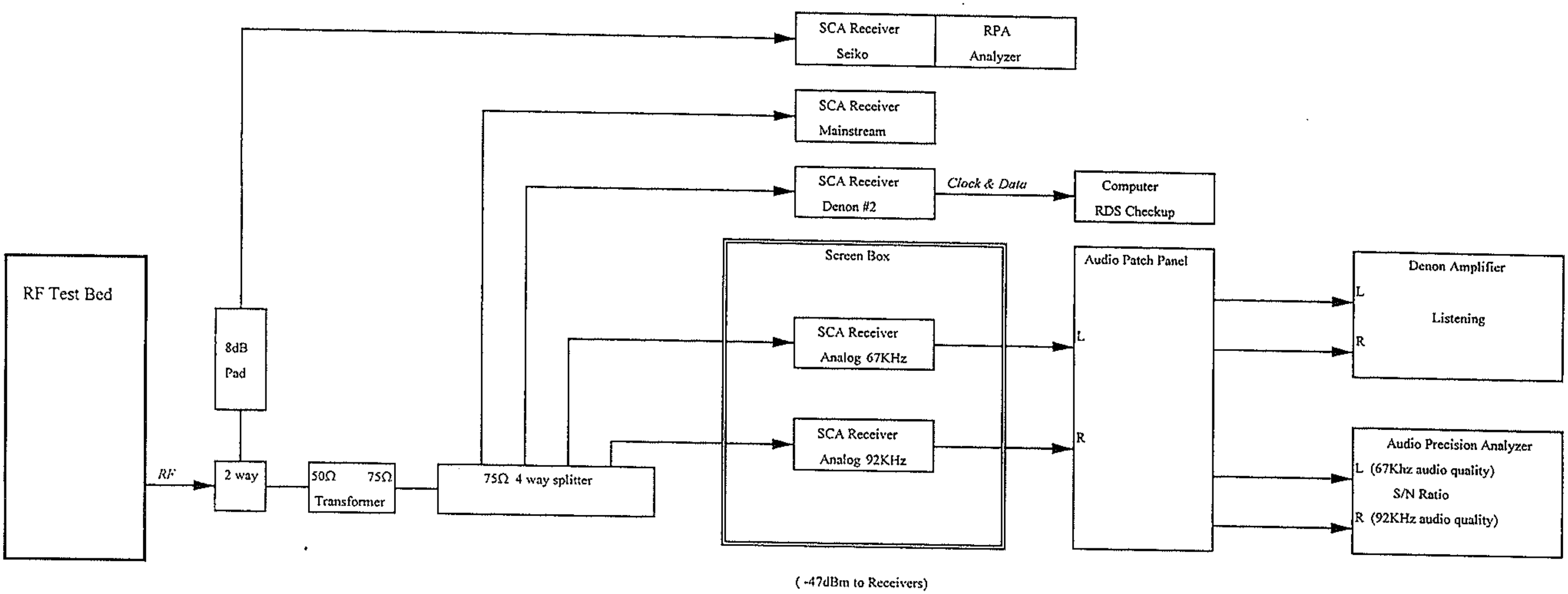
L Rec. Block

EIA Digital Audio Radio Test Laboratory



SCA GROUP LEGEND			
A	B	C	D
57.0KHz @ 3%	57KHz @ 10%		
66.5KHz @ 8.5%	67KHz @ 10%	67KHz @ 10%	
92.0KHz @ 8.5%		92KHz @ 10%	92KHz @ 10%

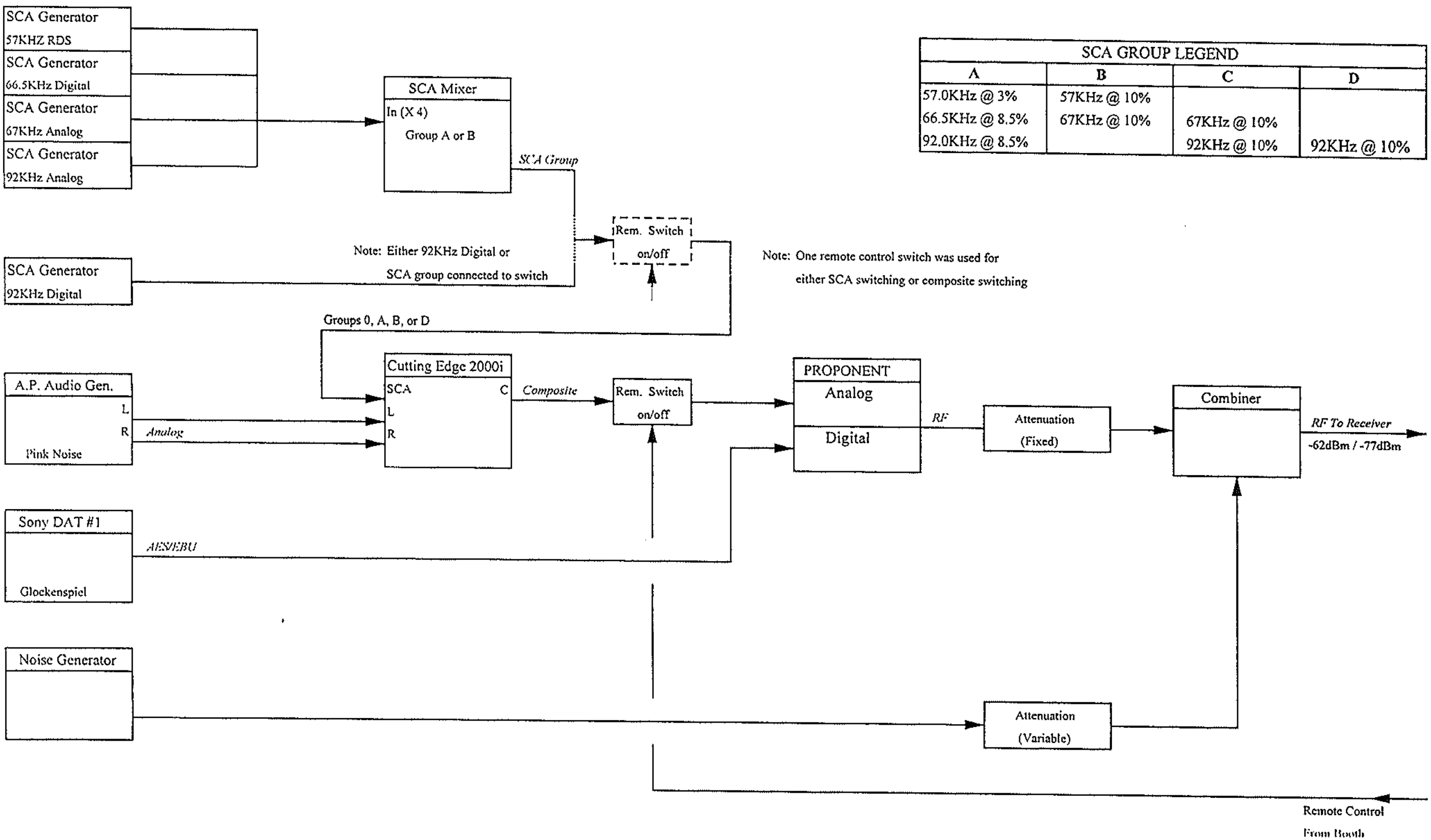
EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

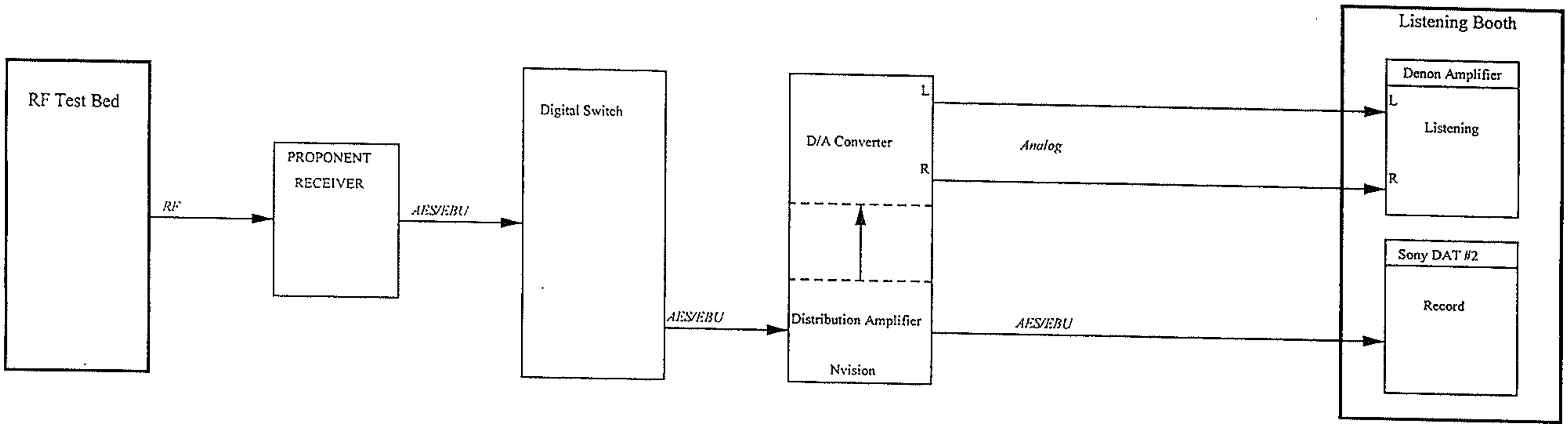
L (SCAs) Rec. Block

EIA Digital Audio Radio Test Laboratory



SCA GROUP LEGEND			
A	B	C	D
57.0KHz @ 3%	57KHz @ 10%		
66.5KHz @ 8.5%	67KHz @ 10%	67KHz @ 10%	
92.0KHz @ 8.5%		92KHz @ 10%	92KHz @ 10%

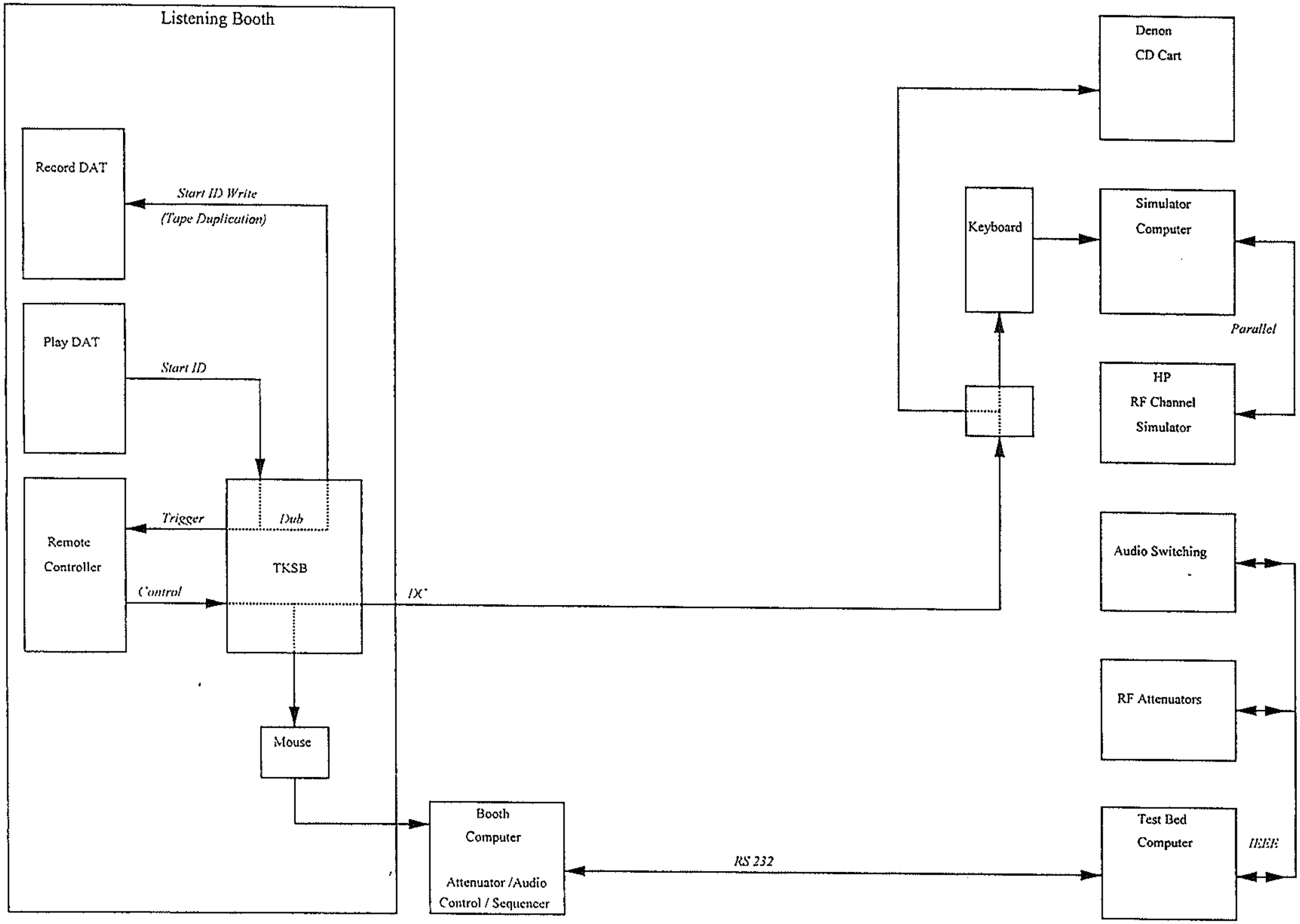
EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

M Rec Block

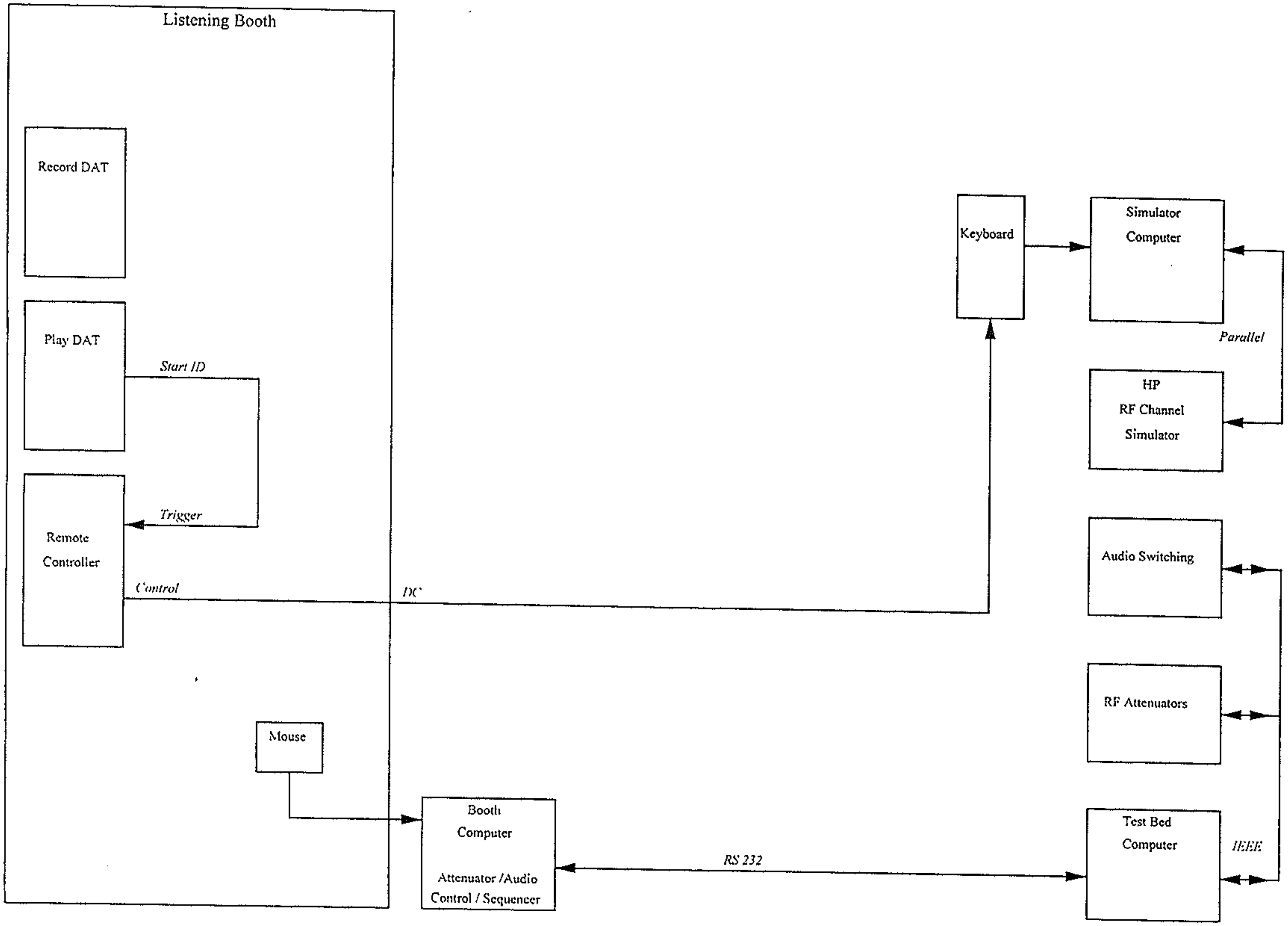
EIA Digital Audio Radio Test Laboratory



File Name:BLOCKDIA.XLS

Rem. Cont. G & L

EIA Digital Audio Radio Test Laboratory



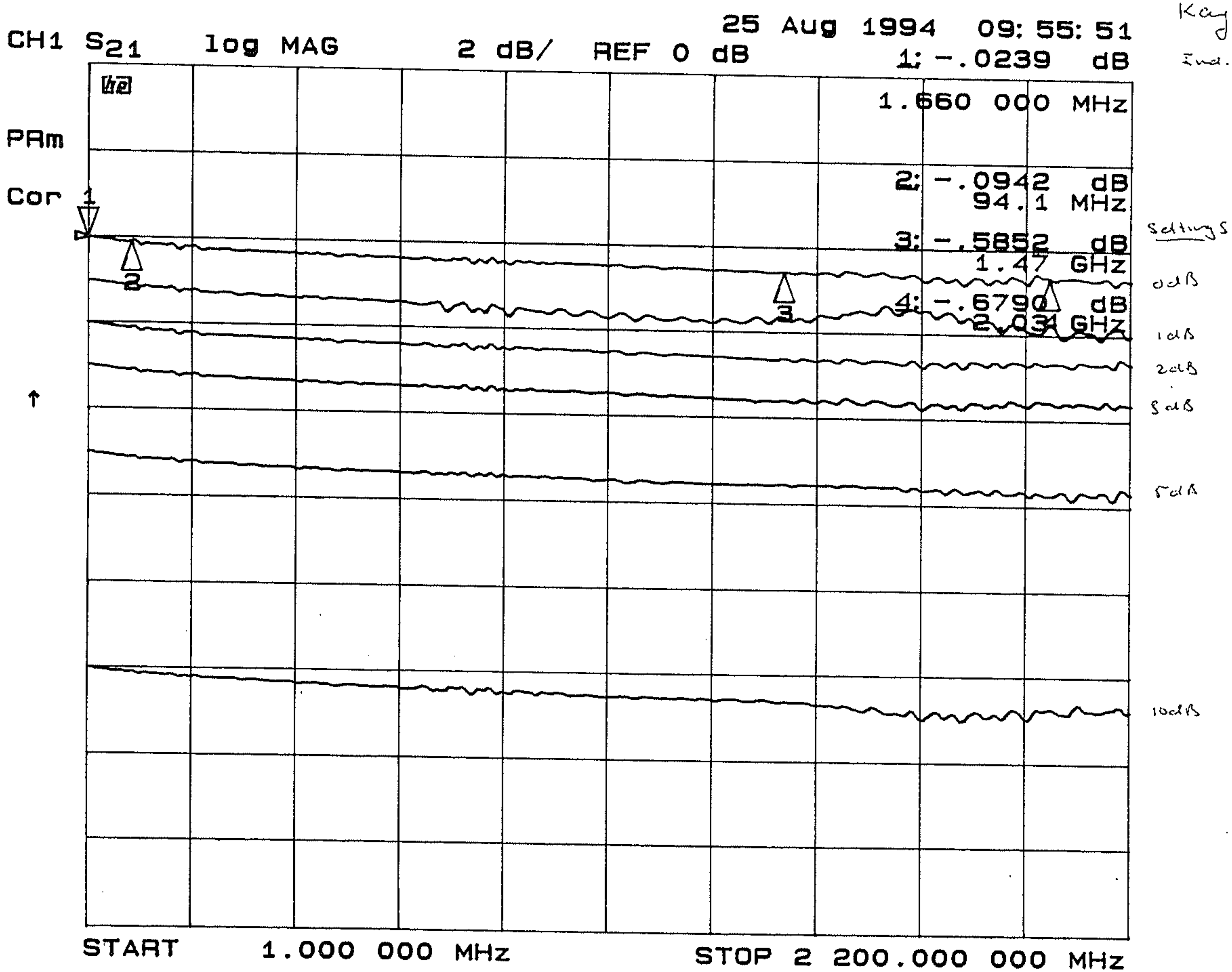
File Name:BLOCKDIA.XLS

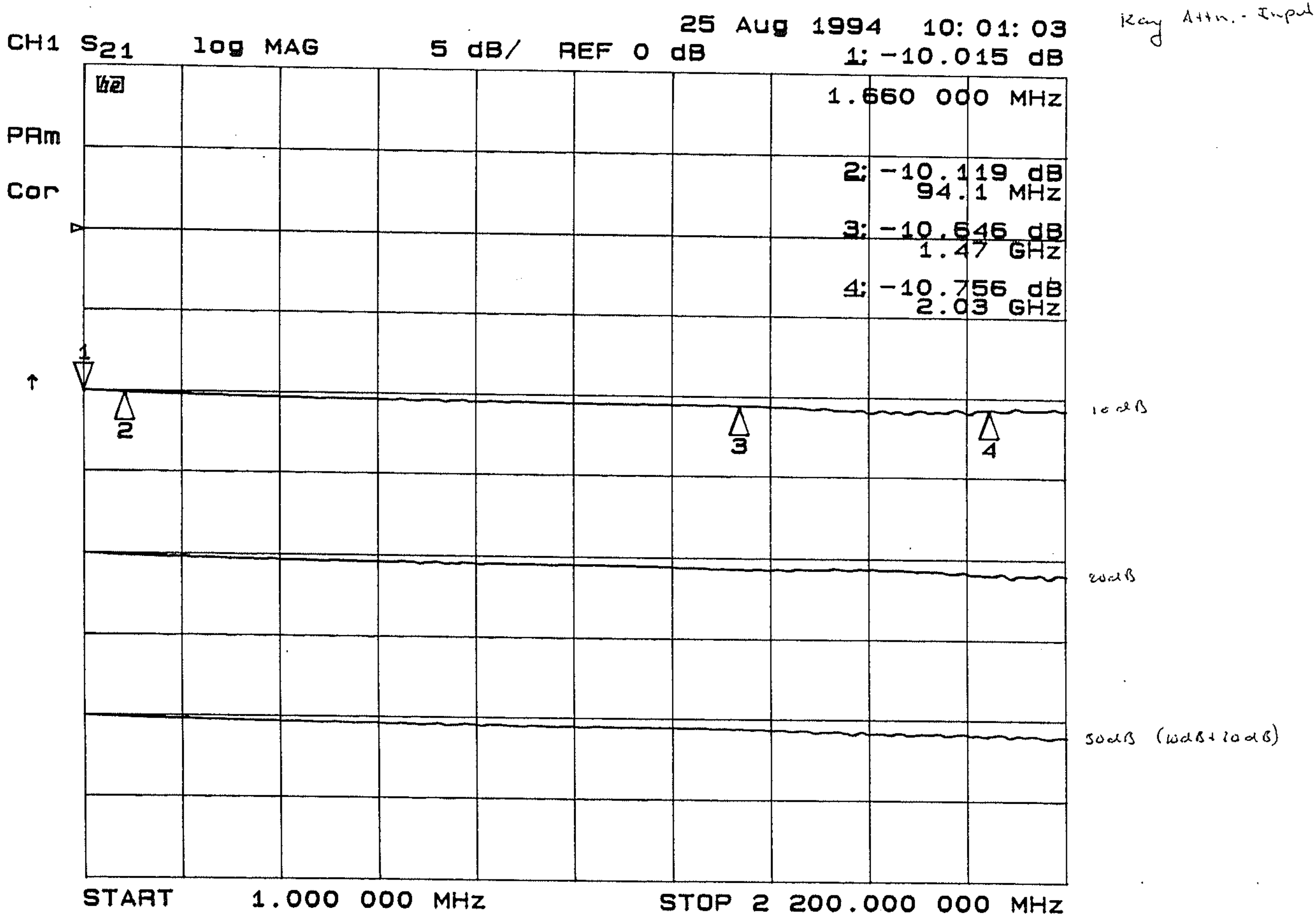
Rem. Cont. B. E. I & M

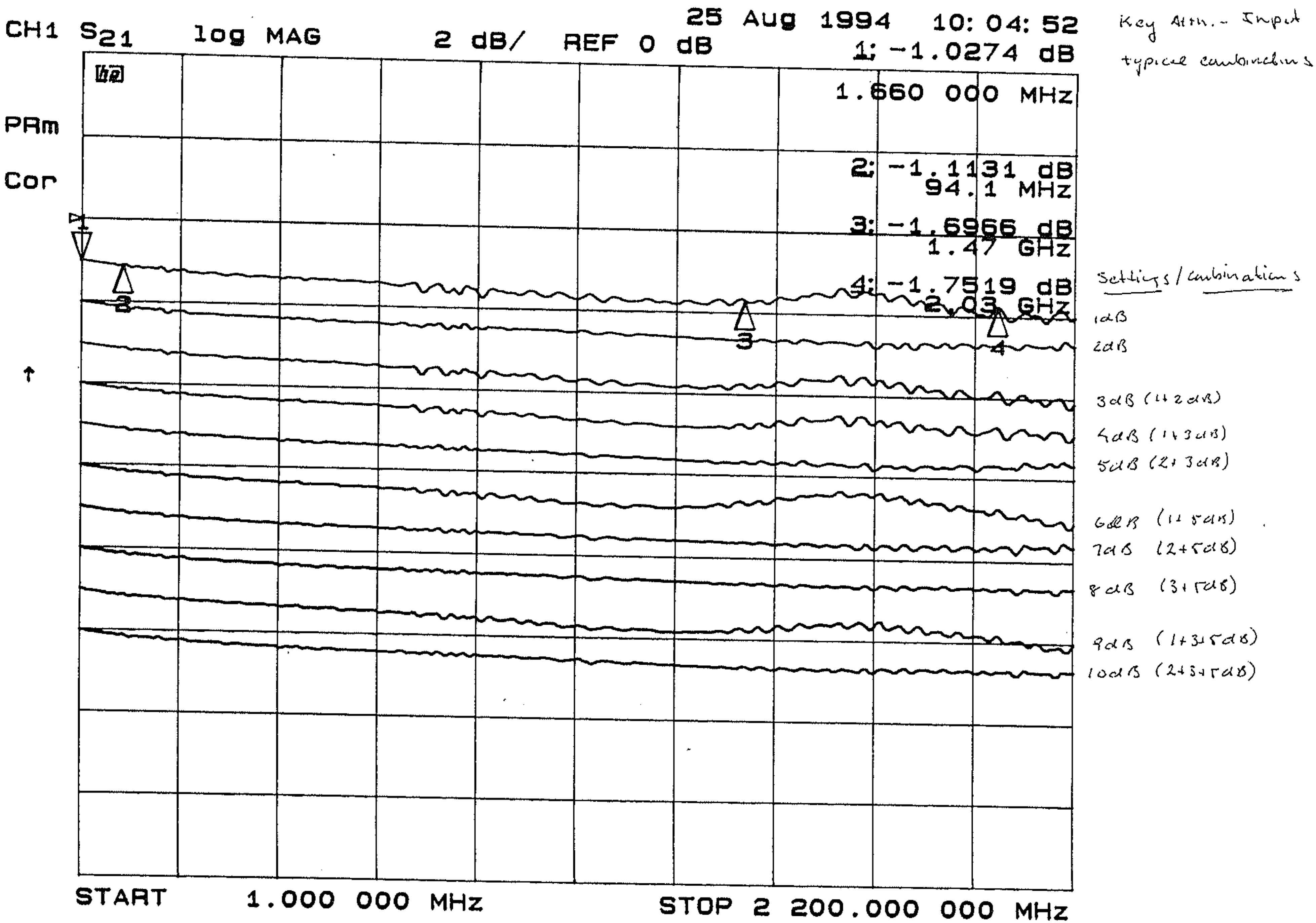
APPENDIX M

RF Component Calibration

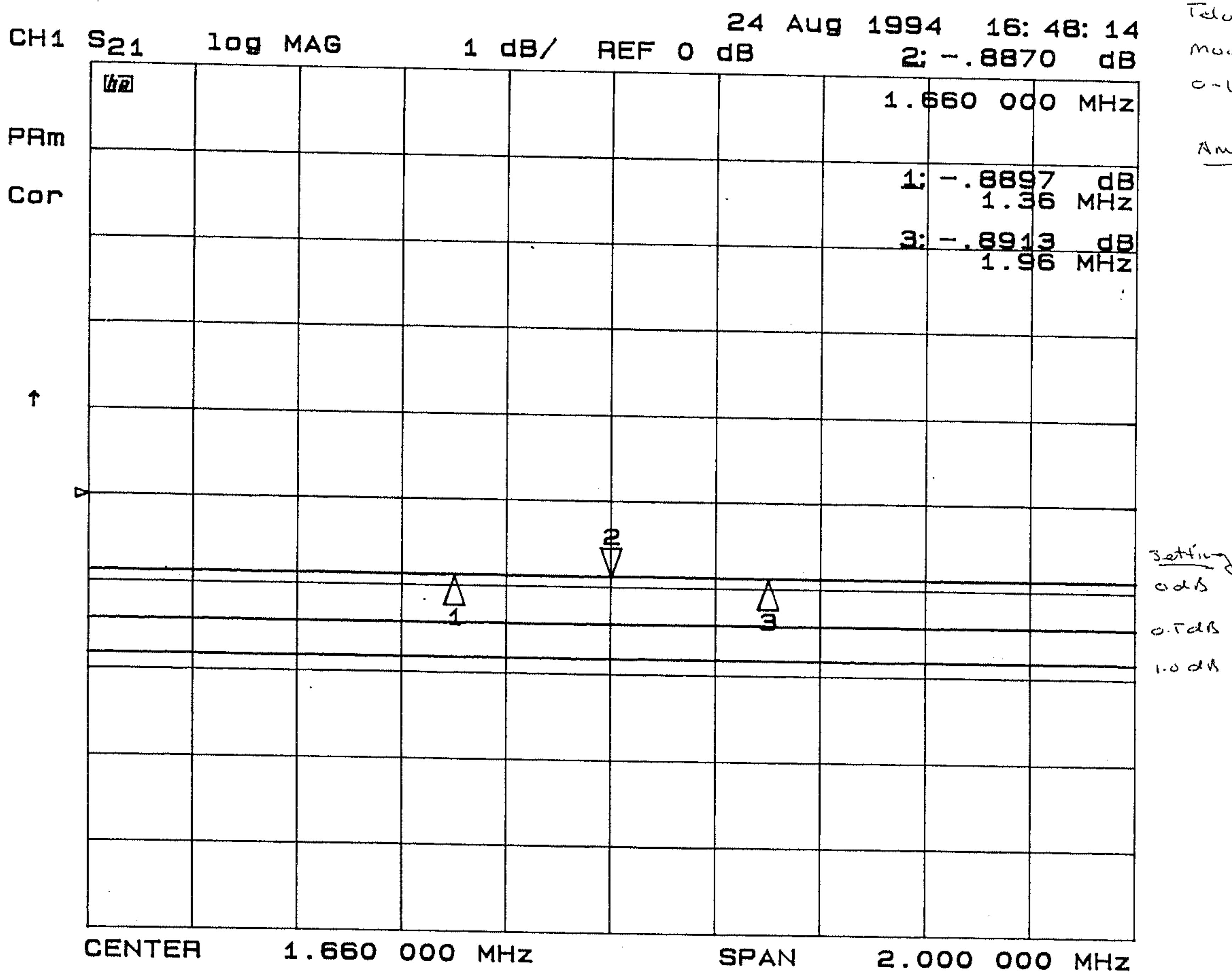
Kay Attn. - Input
Ind. switch settings




CH1 S21 log MAG 5 dB/ REF 0 dB
25 Aug 1994 10: 01: 03
1: -10.015 dB
1.660 000 MHz
2: -10.119 dB
94.1 MHz
3: -10.646 dB
1.47 GHz
4: -10.756 dB
2.03 GHz
PRm
Cor
START 1.000 000 MHz
STOP 2 200.000 000 MHz
Ray Attn. - Input
10dB
20dB
30dB (20dB+10dB)

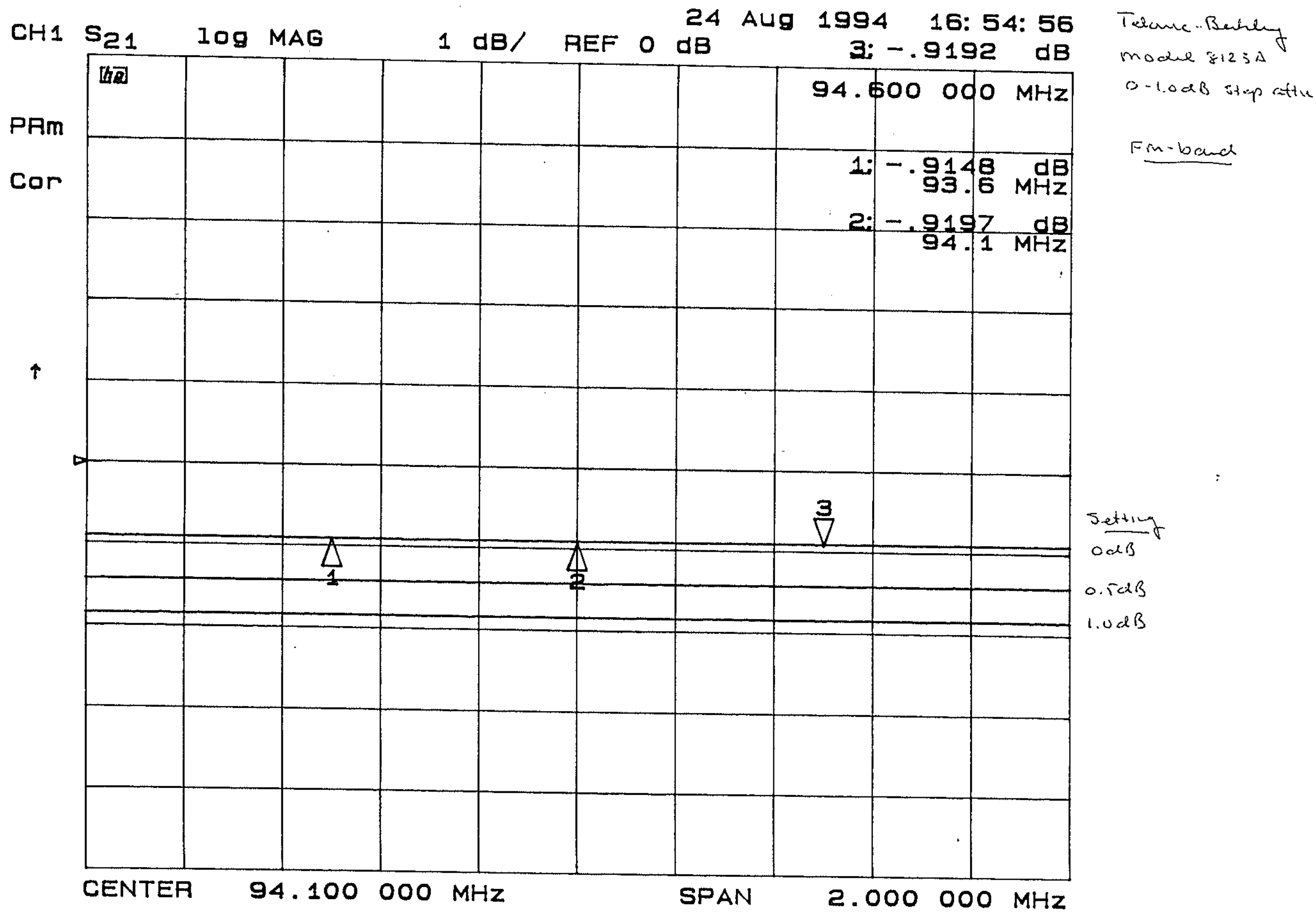


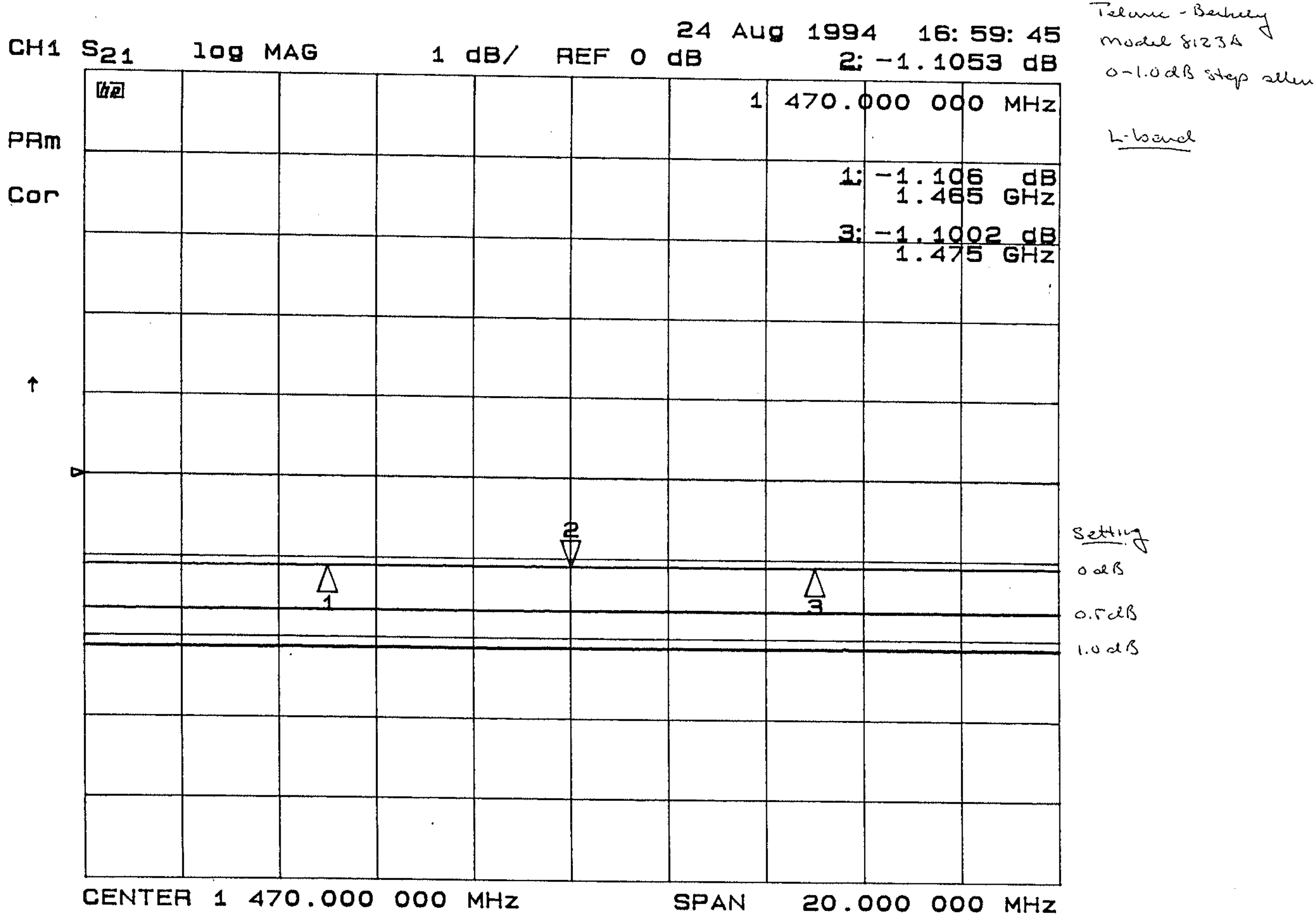
CH1 S21 log MAG 2 dB/ REF 0 dB
25 Aug 1994 10: 04: 52
1: -1.0274 dB
1.660 000 MHz
2: -1.1131 dB
94.1 MHz
3: -1.6966 dB
1.47 GHz
4: -1.7519 dB
2.03 GHz
PRm
Cor
START 1.000 000 MHz
STOP 2 200.000 000 MHz
Key Attn. - Input
typical combinations
Settings / combinations
1dB
2dB
3dB (1+2dB)
4dB (1+3dB)
5dB (2+3dB)
6dB (1+5dB)
7dB (2+5dB)
8dB (3+5dB)
9dB (1+3+5dB)
10dB (2+3+5dB)

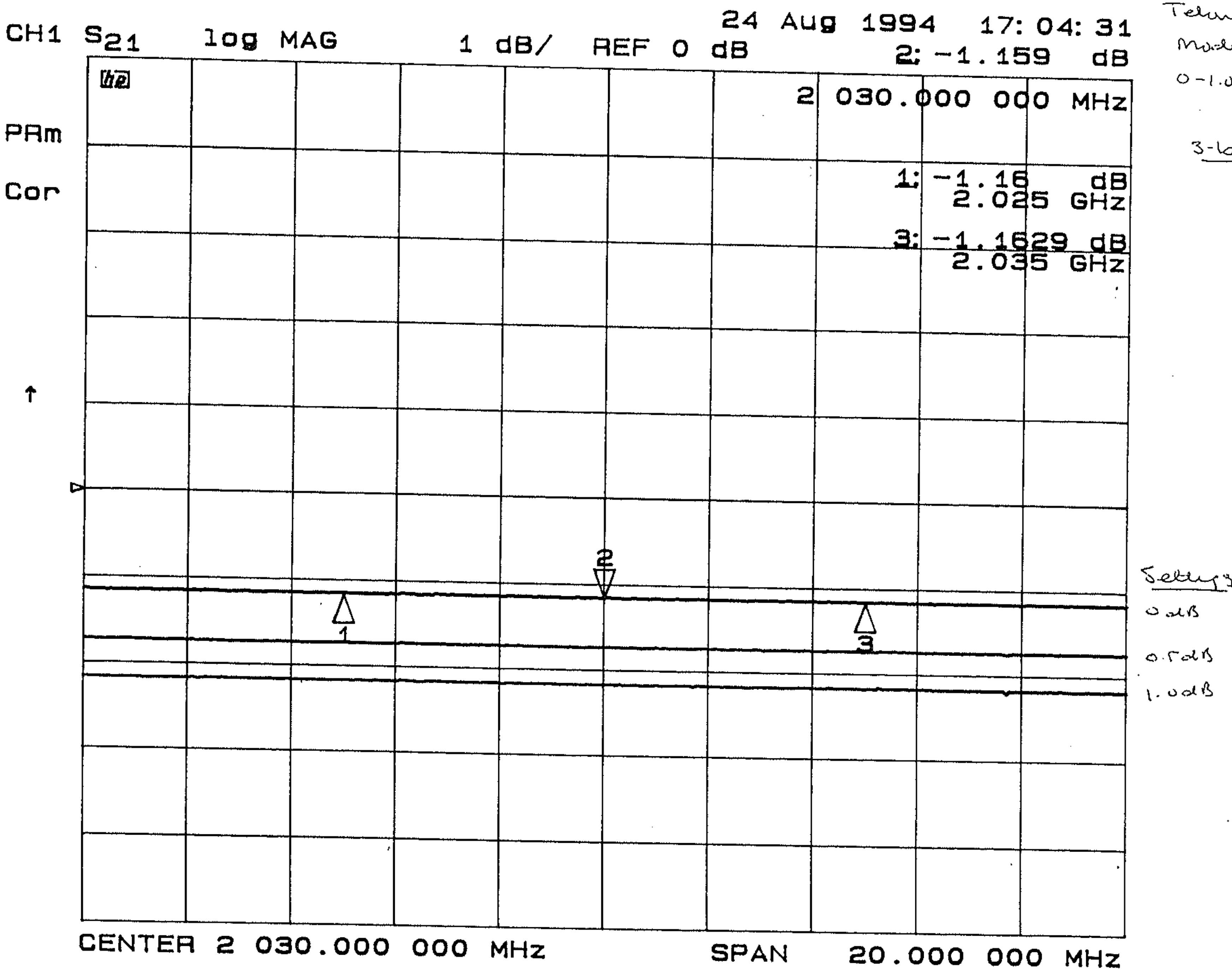


Telonic-Berkeley
model 8123A
0-1.0dB step att.

AM band

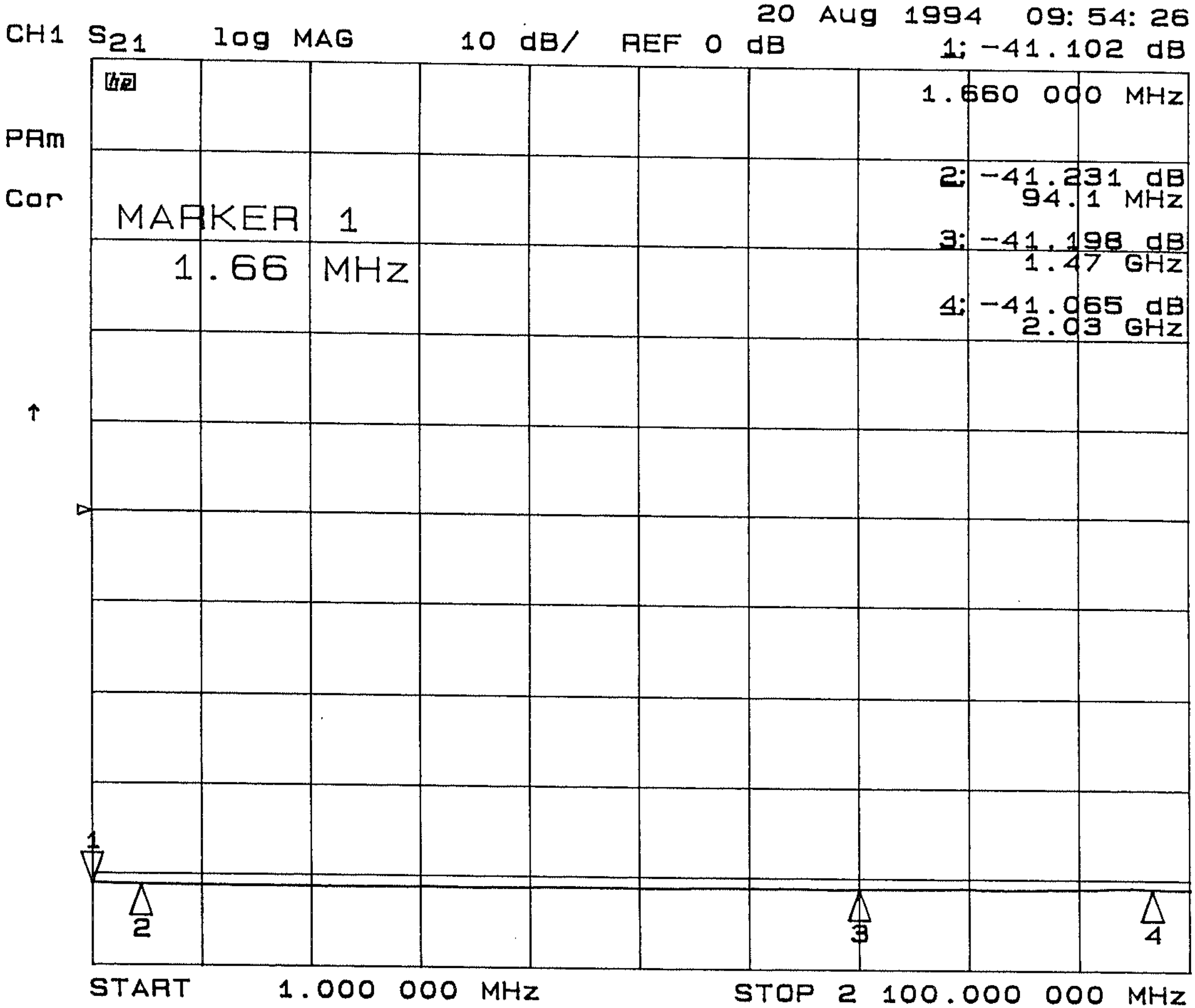

24 Aug 1994 16: 54: 56
CH1 S21 log MAG 1 dB/ REF 0 dB
3: -.9192 dB
94.600 000 MHz
PRm
Cor
1: -.9148 dB
93.6 MHz
2: -.9197 dB
94.1 MHz
1
2
3
CENTER 94.100 000 MHz
SPAN 2.000 000 MHz
Telonic-Berkeley
model 8123A
0-1.0dB step attn.
FM-band
Setting
0dB
0.5dB
1.0dB


24 Aug 1994 16: 59: 45
CH1 S21 log MAG 1 dB/ REF 0 dB 2: -1.1053 dB
1 470.000 000 MHz
PRm
Cor
1: -1.106 dB
1.465 GHz
3: -1.1002 dB
1.475 GHz
CENTER 1 470.000 000 MHz
SPAN 20.000 000 MHz
Telonic - Berkeley
model 8123A
0-1.0 dB step atten
L-band
Setting
0 dB
0.5 dB
1.0 dB

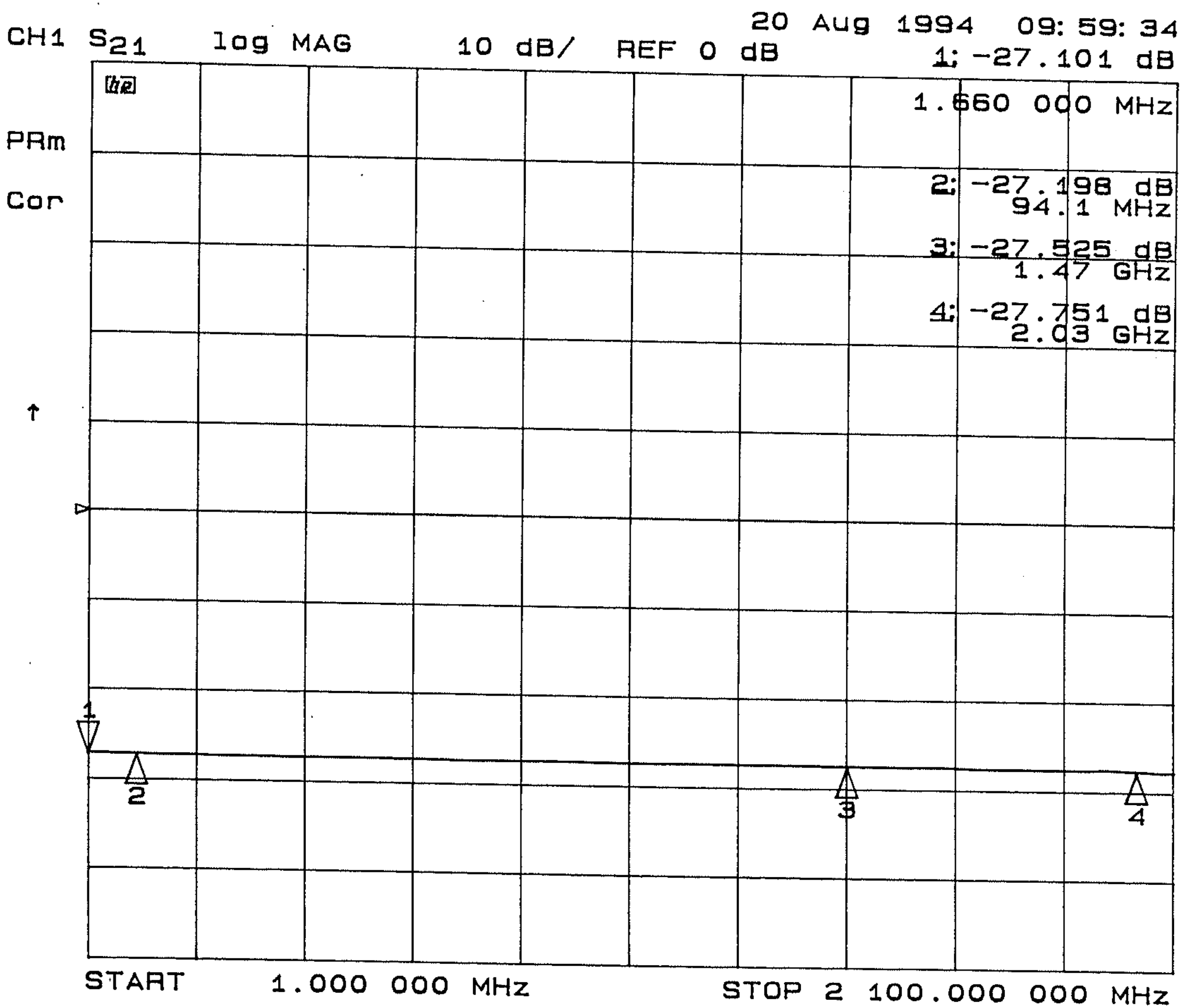


Telonic Berkeley
Model 8123A
0-1.0 dB step atten

3-band



AM/PM
Bypass attenuator crosscheck (MCL attenuators)



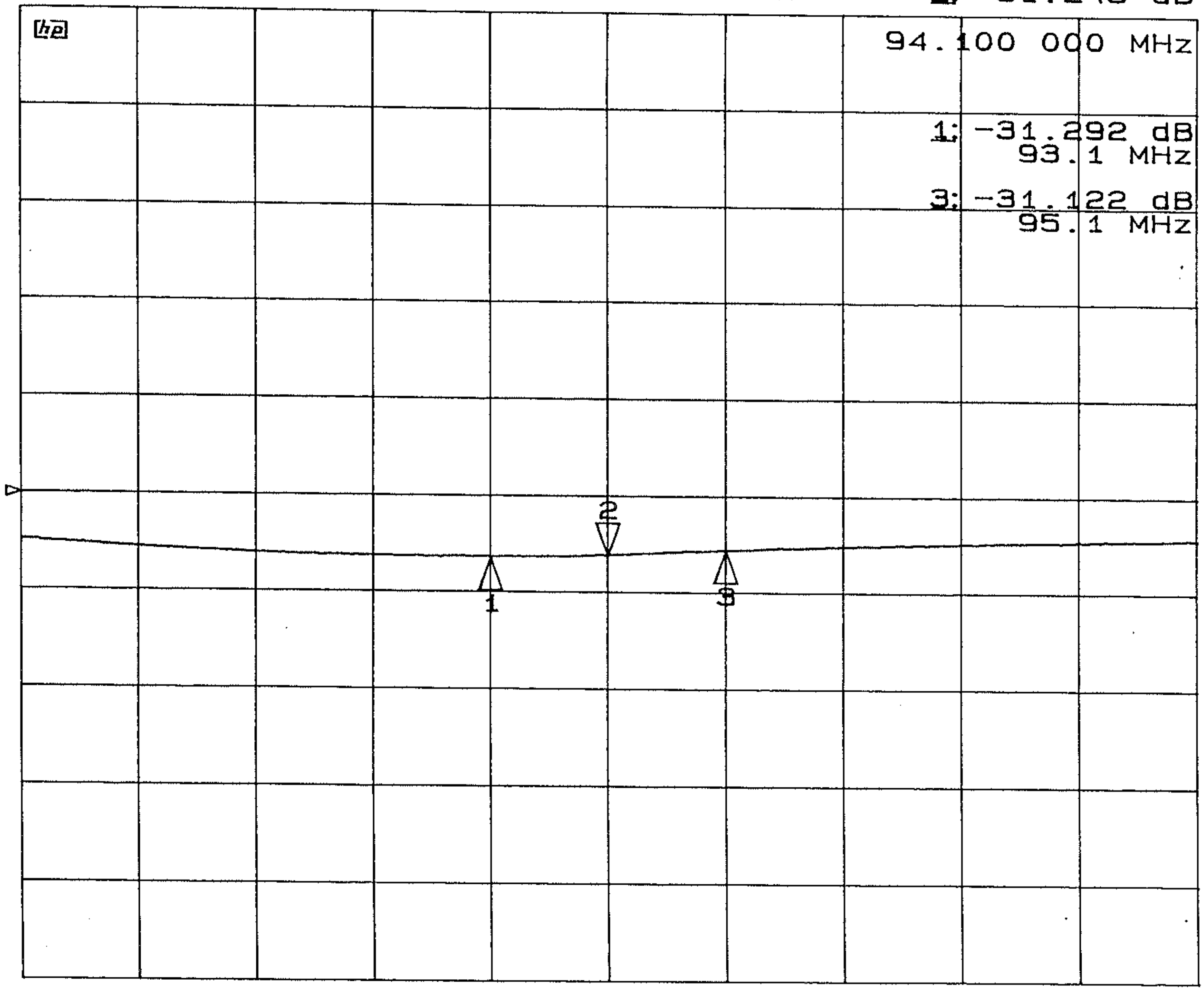
L+S band bypass attenuator cascade (MCL attenuators)

19 Aug 1994 18: 19: 31

CH1 S_{21} log MAG 2 dB/ REF -30 dB 2: -31.243 dB

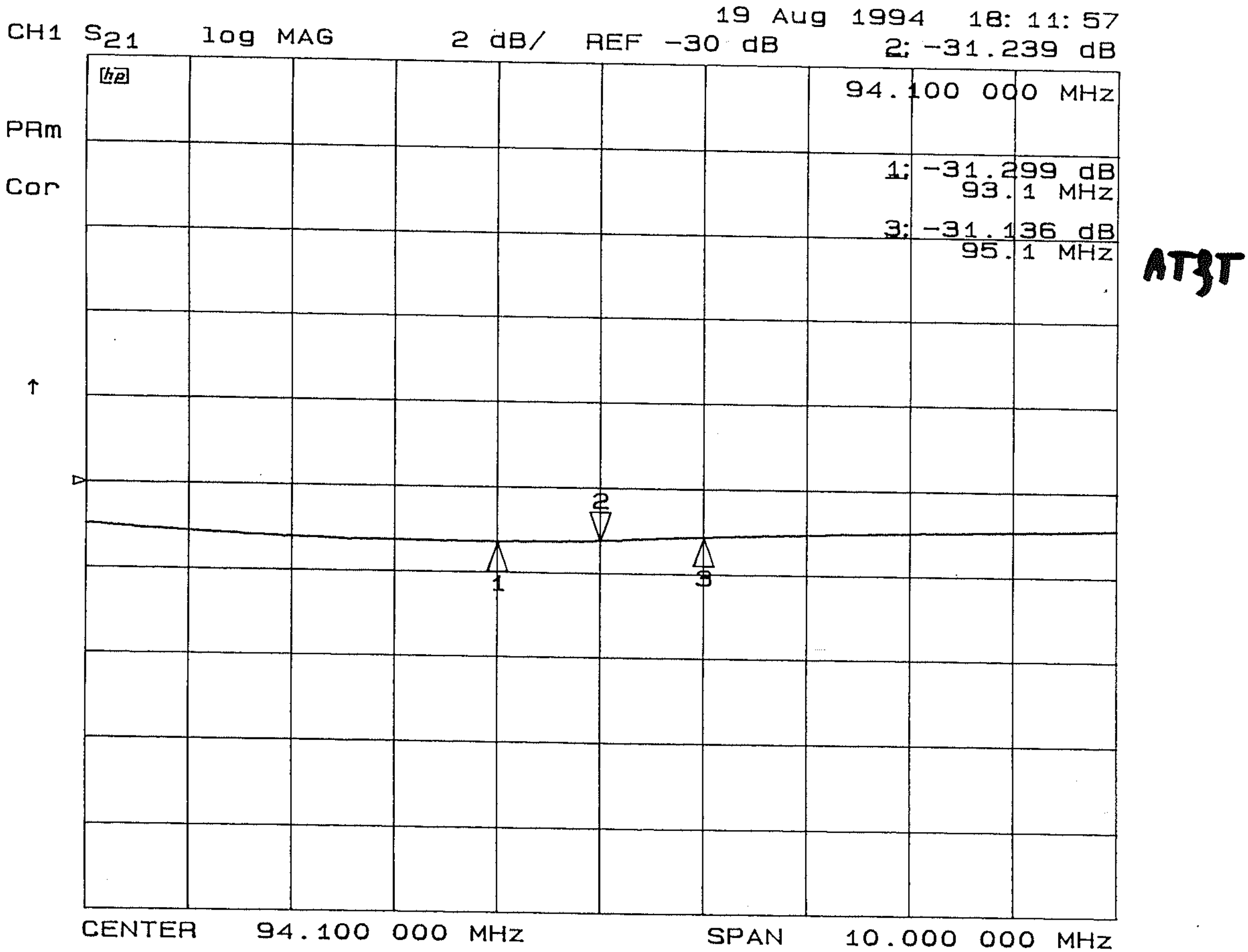
PRm

Cor



AMATI

CENTER 94.100 000 MHz SPAN 10.000 000 MHz

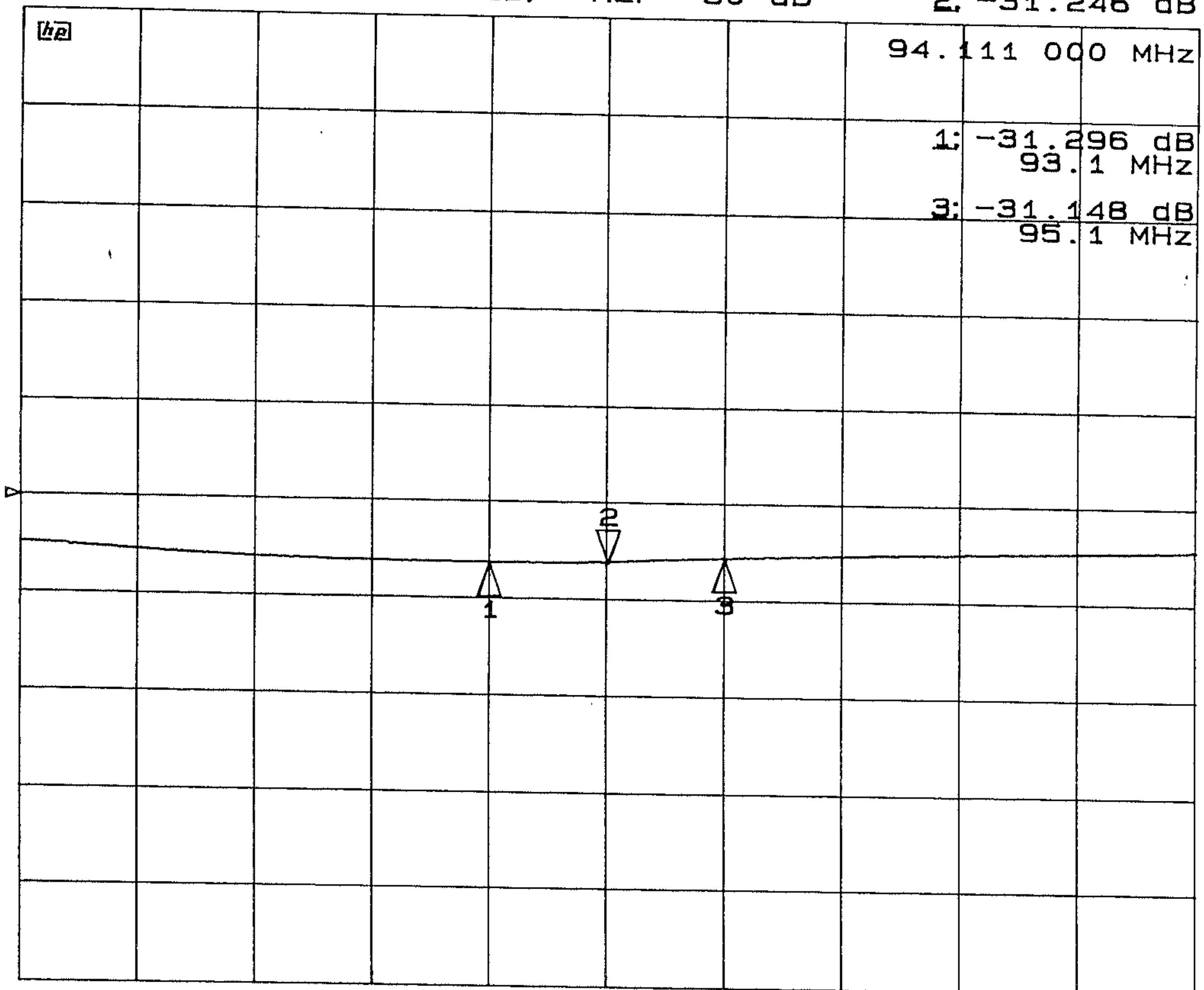

19 Aug 1994 18: 11: 57
CH1 S21 log MAG 2 dB/ REF -30 dB
2: -31.239 dB
94.100 000 MHz
PRm
Cor
1: -31.299 dB
93.1 MHz
3: -31.136 dB
95.1 MHz
AT3T
CENTER 94.100 000 MHz
SPAN 10.000 000 MHz

19 Aug 1994 18: 32: 17

CH1 S_{21} log MAG 2 dB/ REF -30 dB 2: -31.246 dB

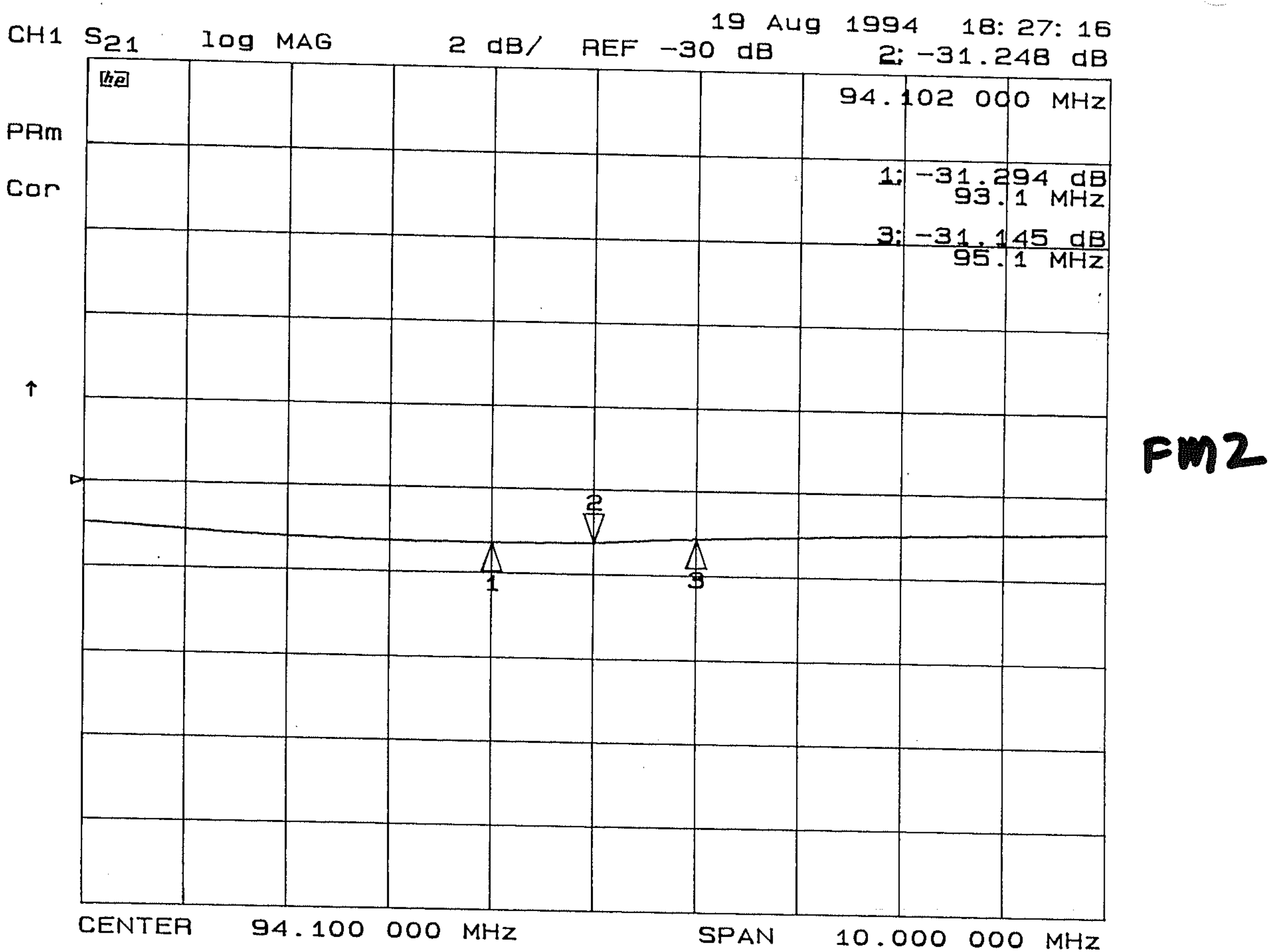
PRm

Cor

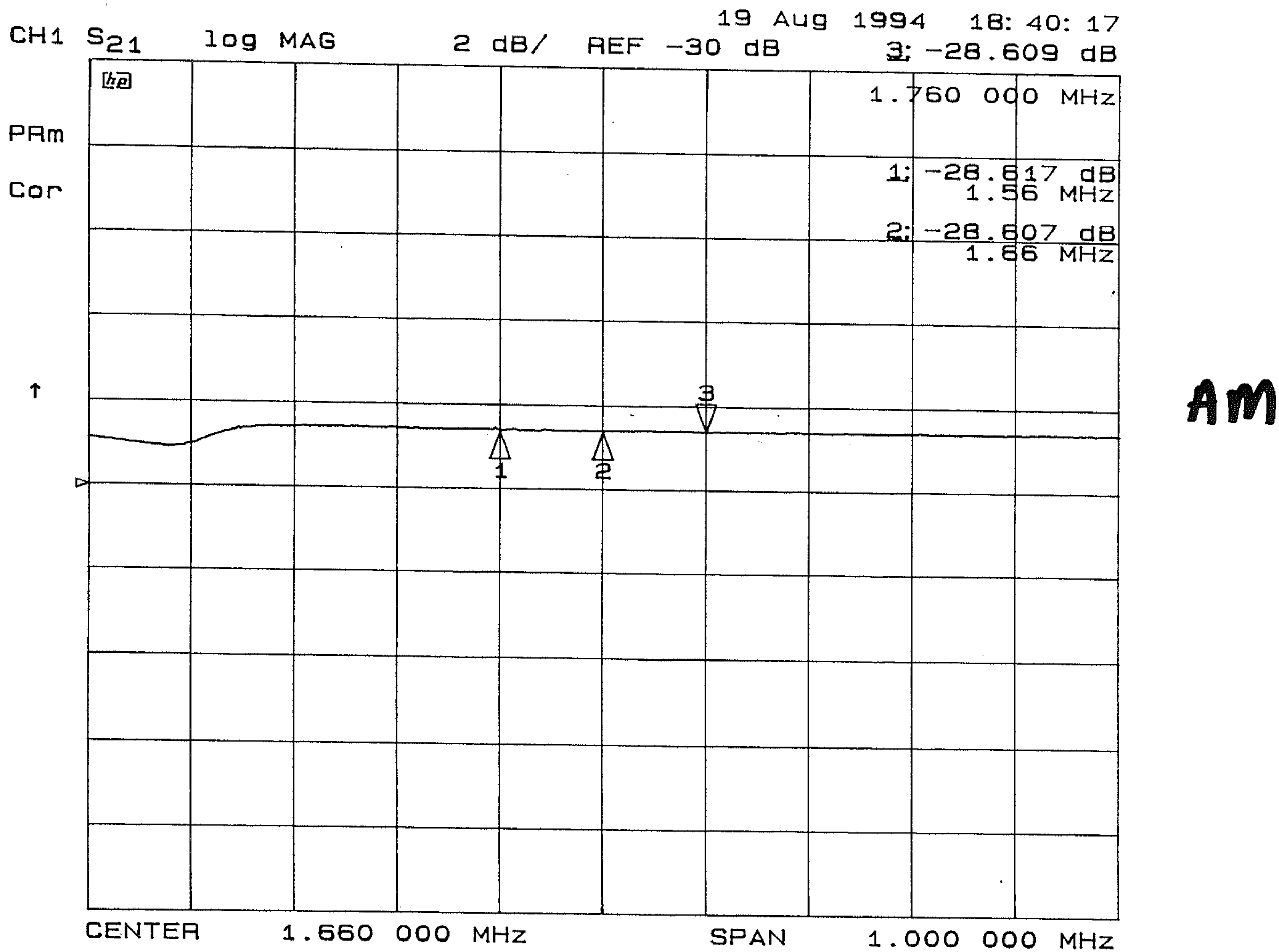


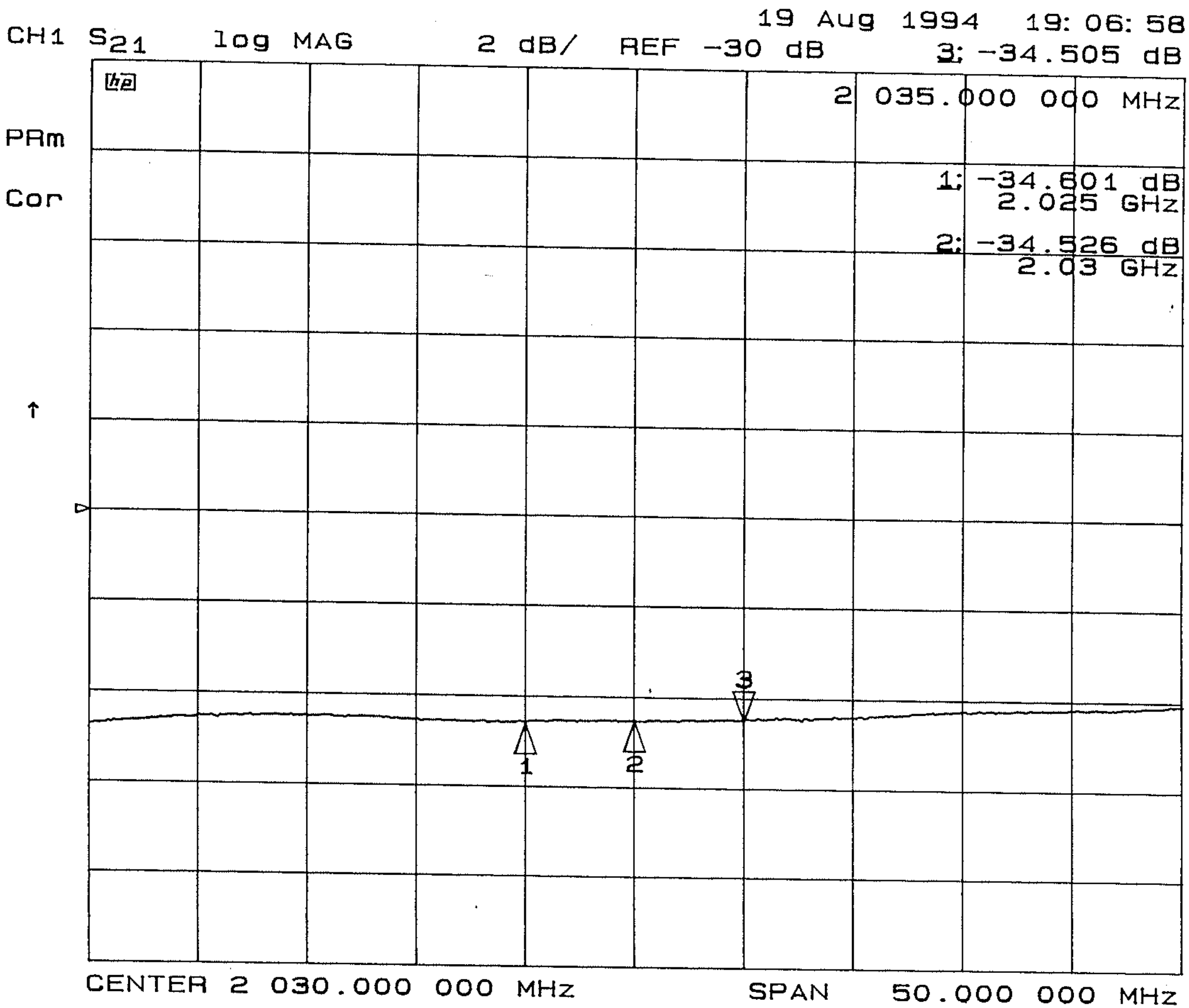
CENTER 94.100 000 MHz SPAN 10.000 000 MHz

FM1

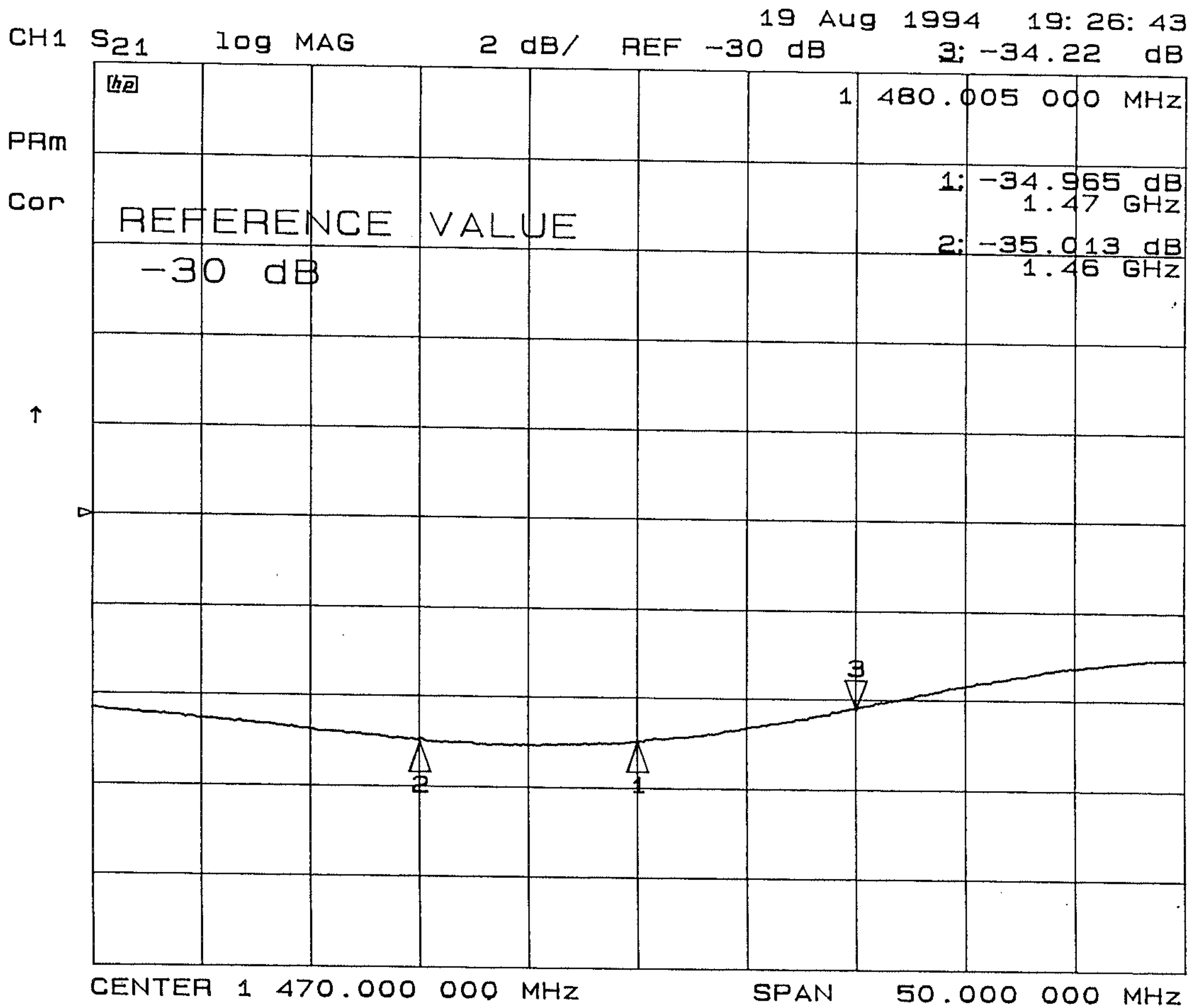


CH1 S21 log MAG 2 dB/ REF -30 dB
19 Aug 1994 18: 27: 16
2: -31.248 dB
94.102 000 MHz
PRm
Cor
1: -31.294 dB
93.1 MHz
3: -31.145 dB
95.1 MHz
CENTER 94.100 000 MHz
SPAN 10.000 000 MHz
FM2


19 Aug 1994 18:40:17
CH1 S21 log MAG 2 dB/ REF -30 dB
3: -28.609 dB
1.760 000 MHz
PRm
Cor
1: -28.617 dB
1.56 MHz
2: -28.607 dB
1.66 MHz
1
2
3
AM
CENTER 1.660 000 MHz
SPAN 1.000 000 MHz

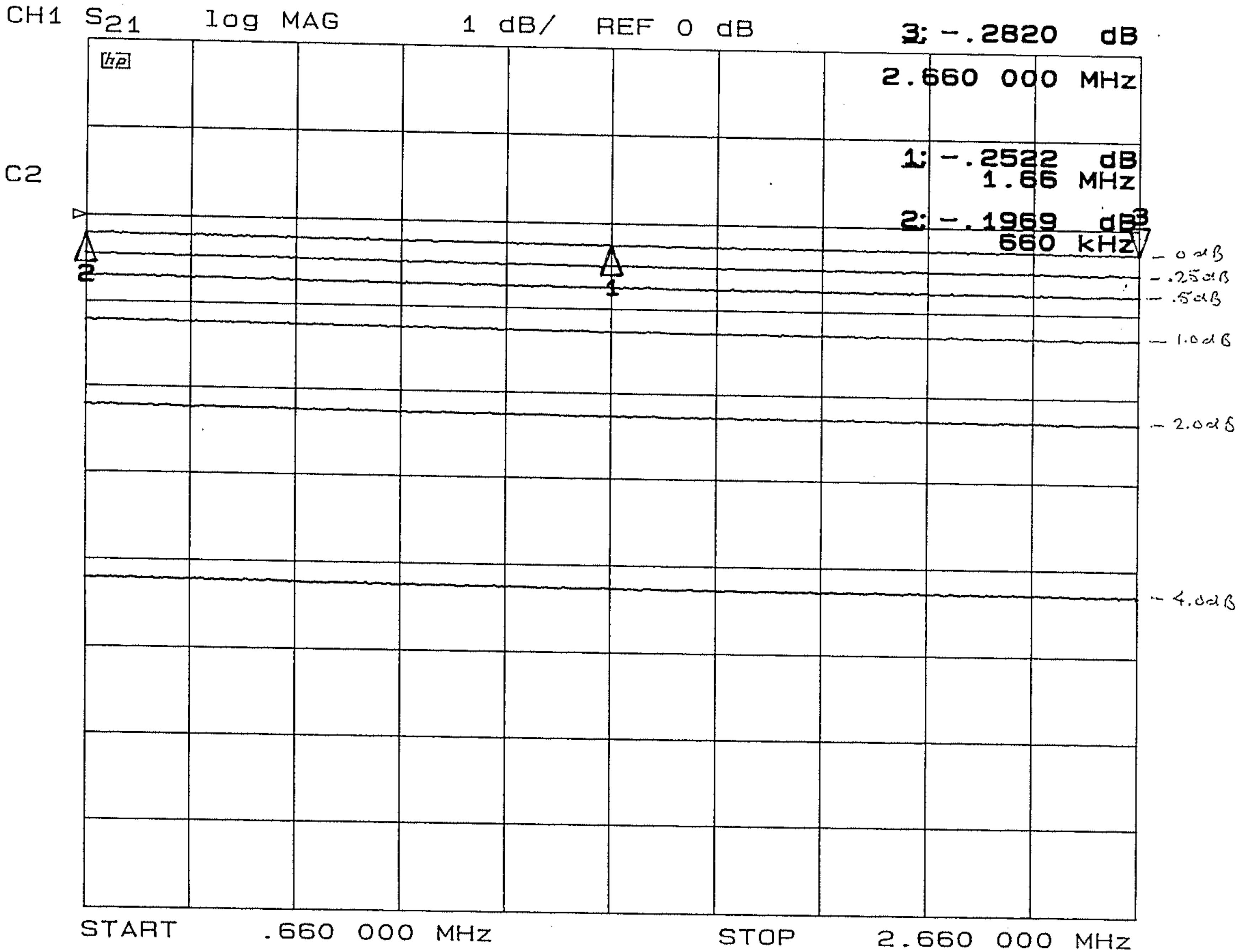

19 Aug 1994 19: 06: 58
CH1 S21 log MAG 2 dB/ REF -30 dB 3: -34.505 dB
2 035.000 000 MHz
PRm
Cor
1: -34.601 dB
2.025 GHz
2: -34.526 dB
2.03 GHz
1
2
3
CENTER 2 030.000 000 MHz SPAN 50.000 000 MHz

JPL


19 Aug 1994 19: 26: 43
CH1 S21 log MAG 2 dB/ REF -30 dB 3: -34.22 dB
1 480.005 000 MHz
PRm
Cor
1: -34.965 dB
1.47 GHz
2: -35.013 dB
1.46 GHz
REFERENCE VALUE
-30 dB
CENTER 1 470.000 000 MHz
SPAN 50.000 000 MHz

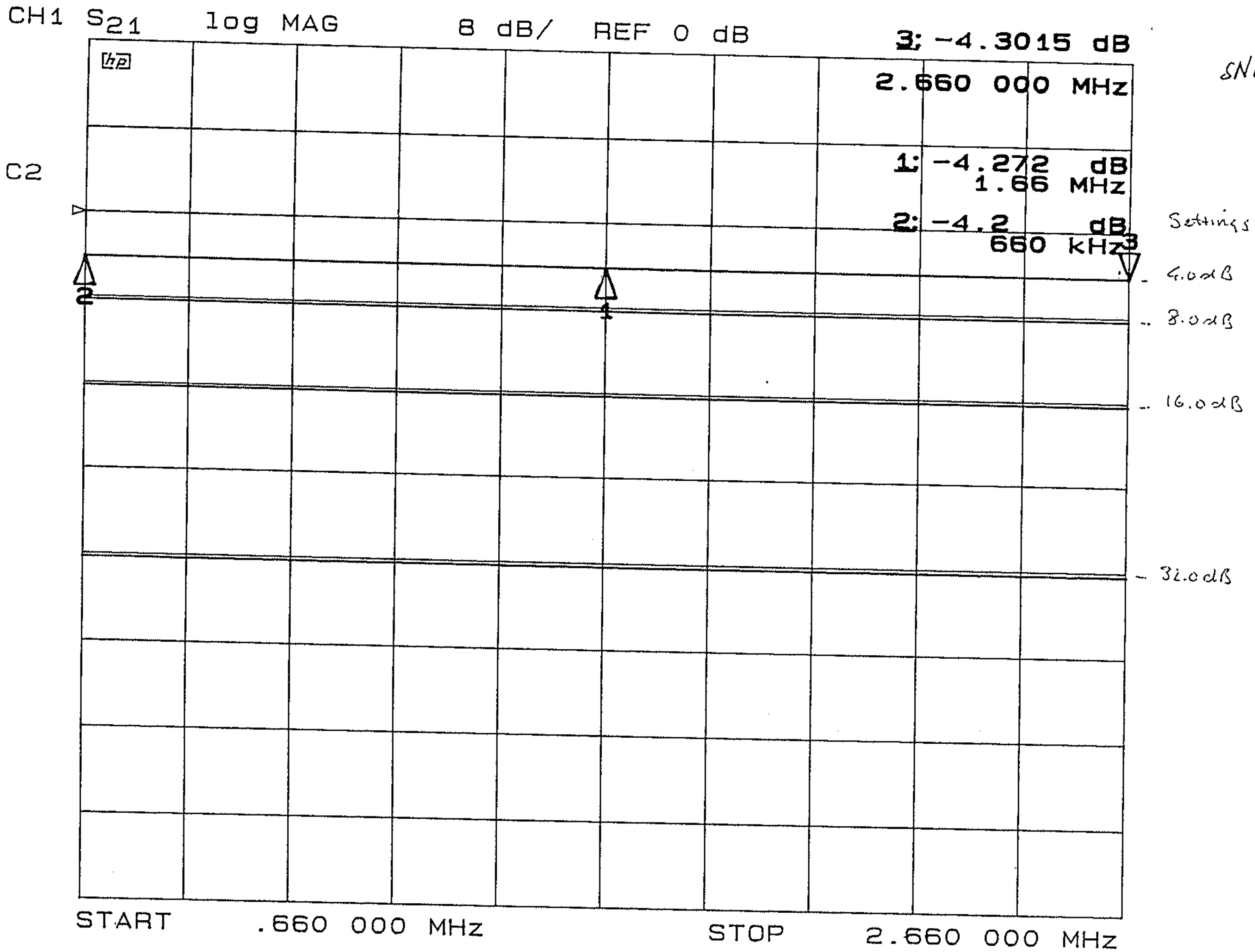
E-147

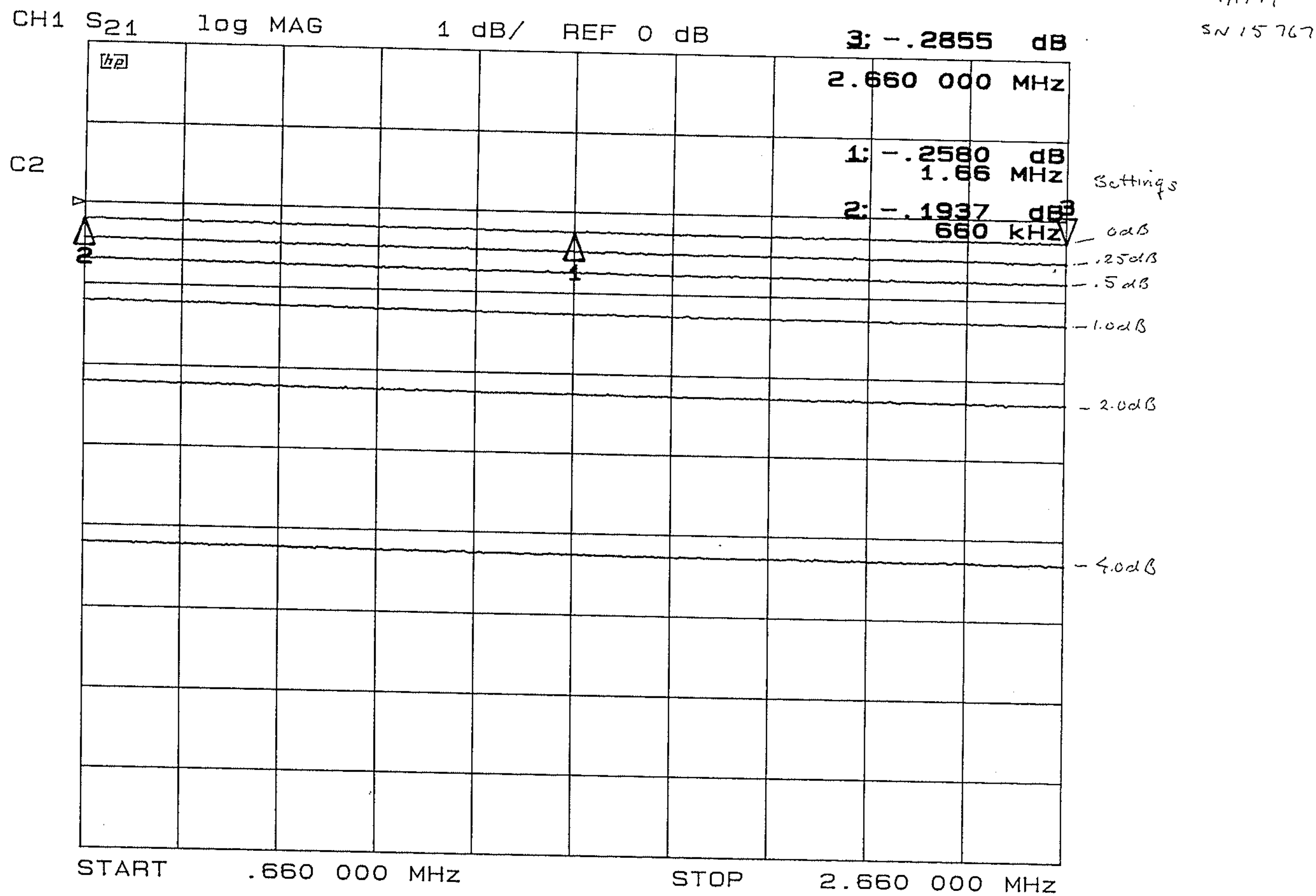
SN15766 7/11/99



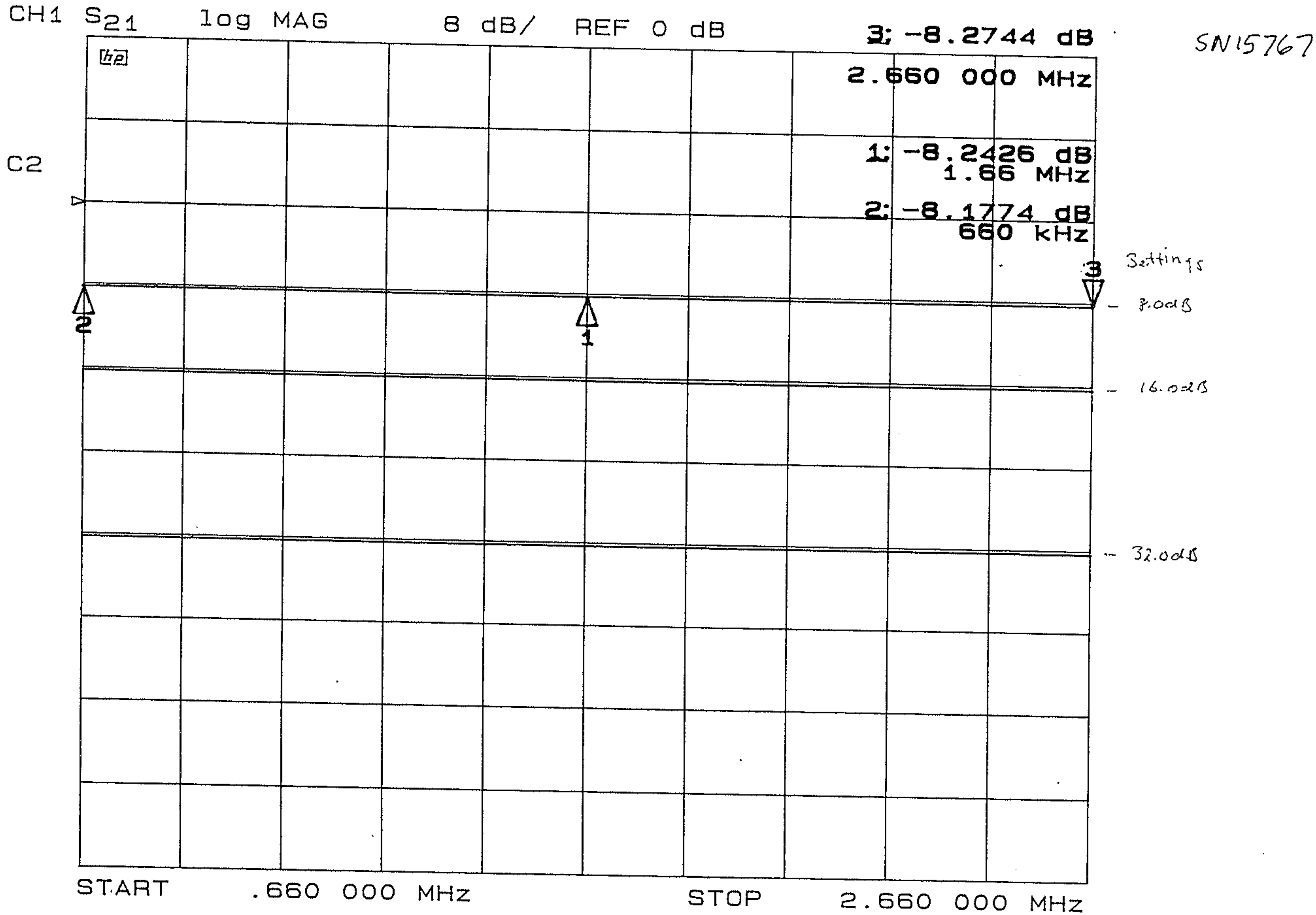
SN15766

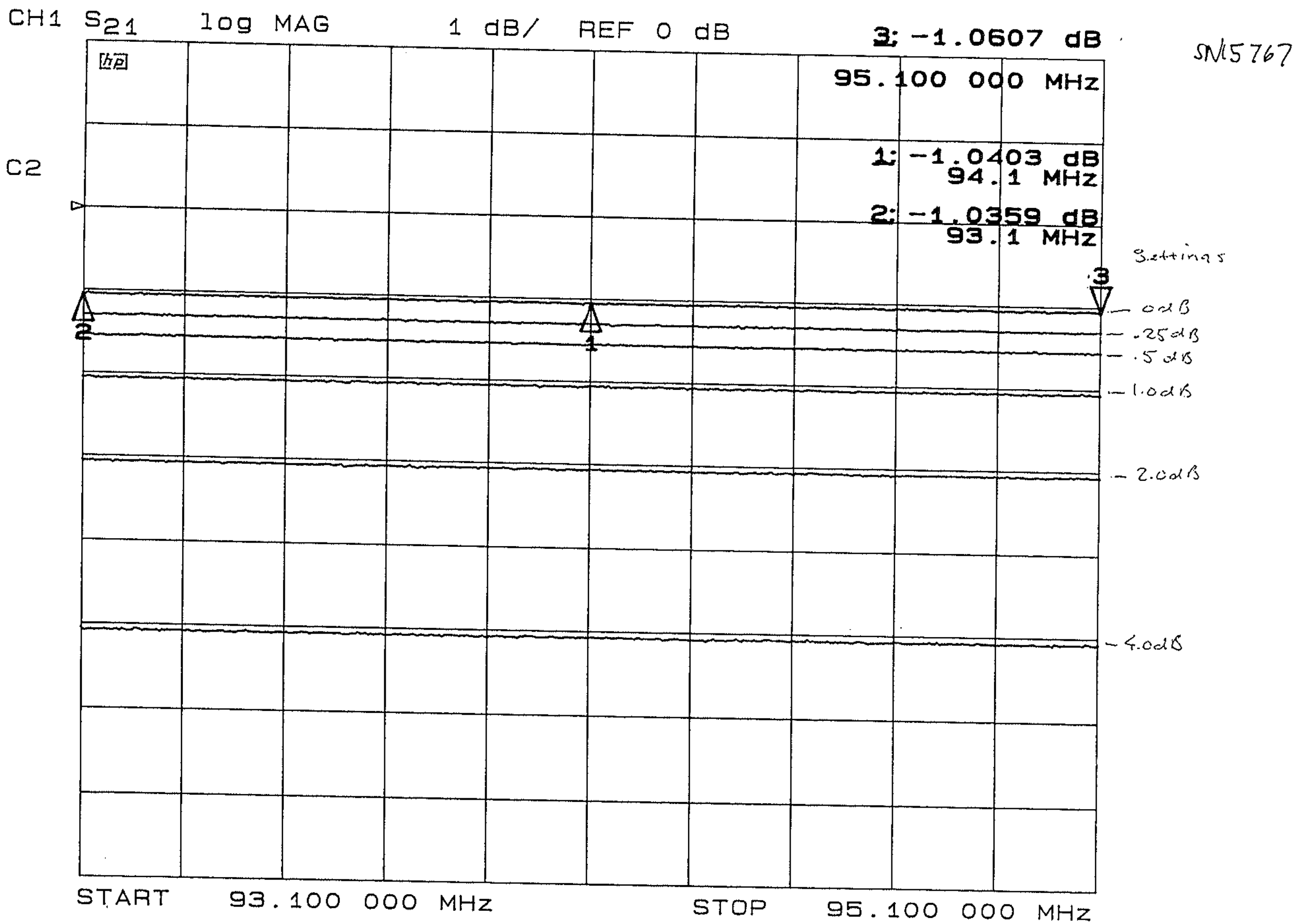
SN15766 4/1/94




4/1/94
SN 15767
CH1 S21 log MAG 1 dB/ REF 0 dB
3: -.2855 dB
2.660 000 MHz
C2
1: -.2580 dB
1.66 MHz
2: -.1937 dB
660 kHz
Settings
0dB
.25dB
.5dB
1.0dB
2.0dB
4.0dB
START .660 000 MHz
STOP 2.660 000 MHz

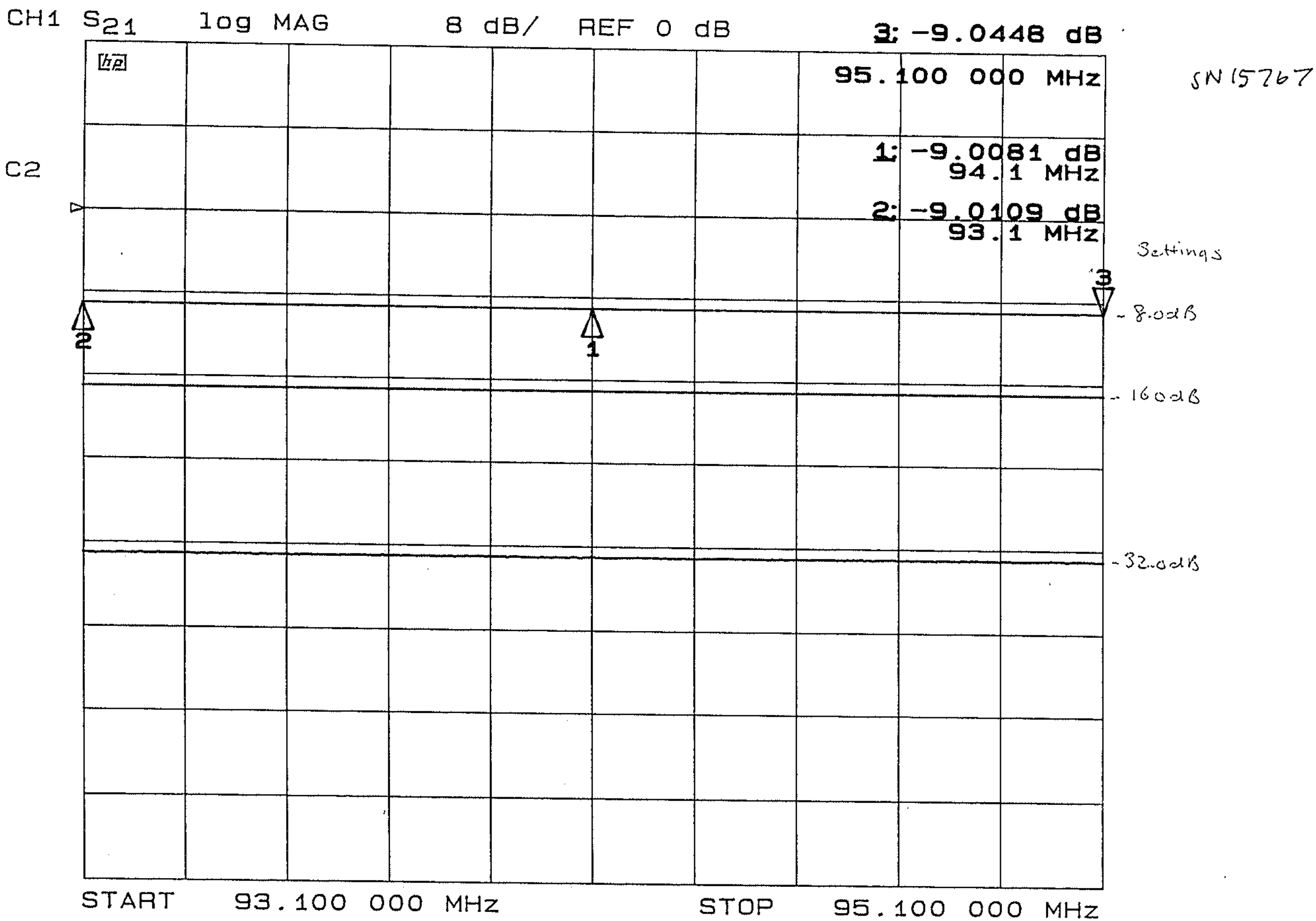
SN 15767 4/1/99



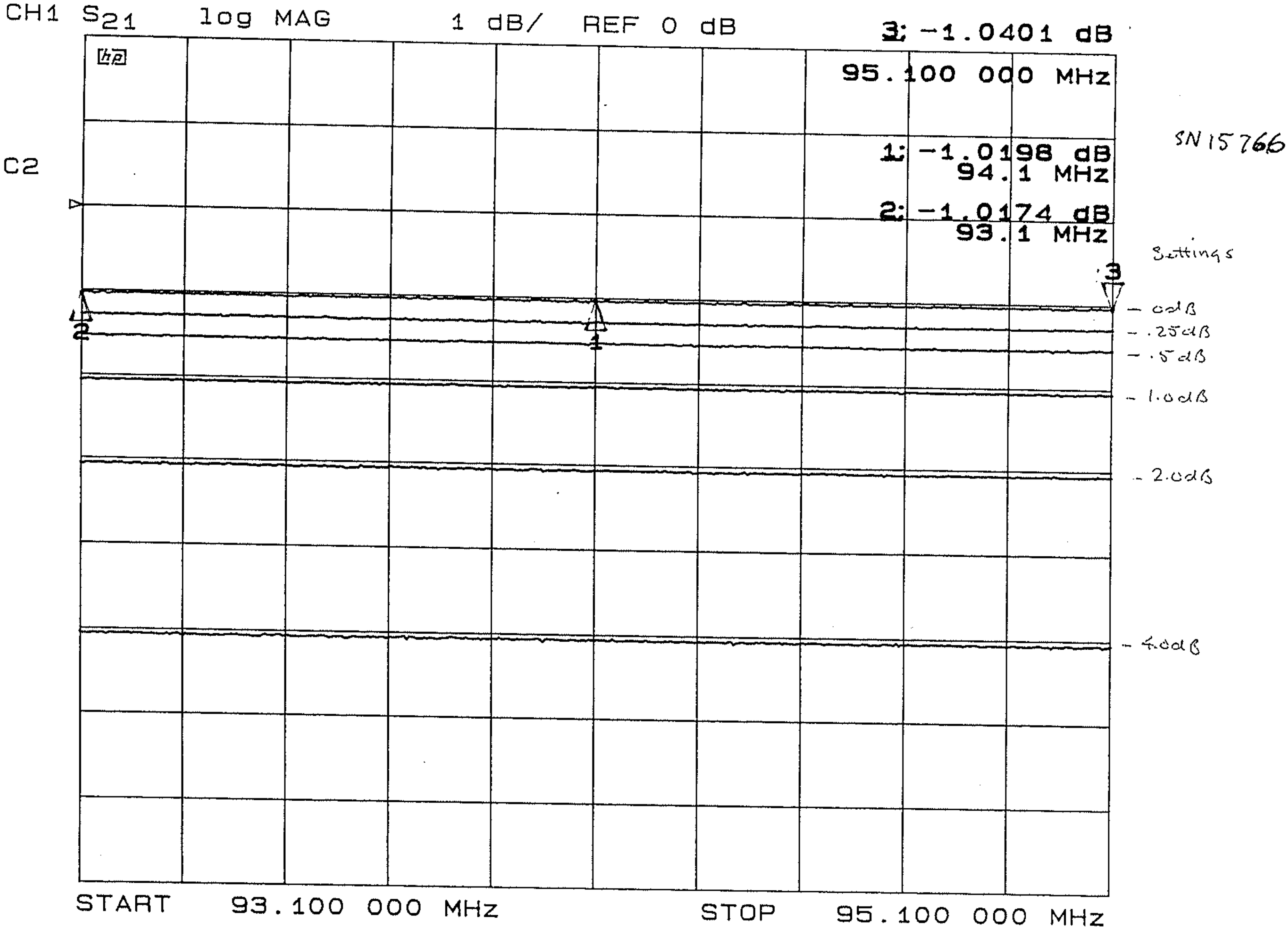


CH1 S21 log MAG 1 dB/ REF 0 dB
3: -1.0607 dB
95.100 000 MHz
C2
1: -1.0403 dB
94.1 MHz
2: -1.0359 dB
93.1 MHz
SN5767
Settings
0dB
.25dB
.5dB
1.0dB
2.0dB
4.0dB
START 93.100 000 MHz
STOP 95.100 000 MHz

SN 15767 4/1/94

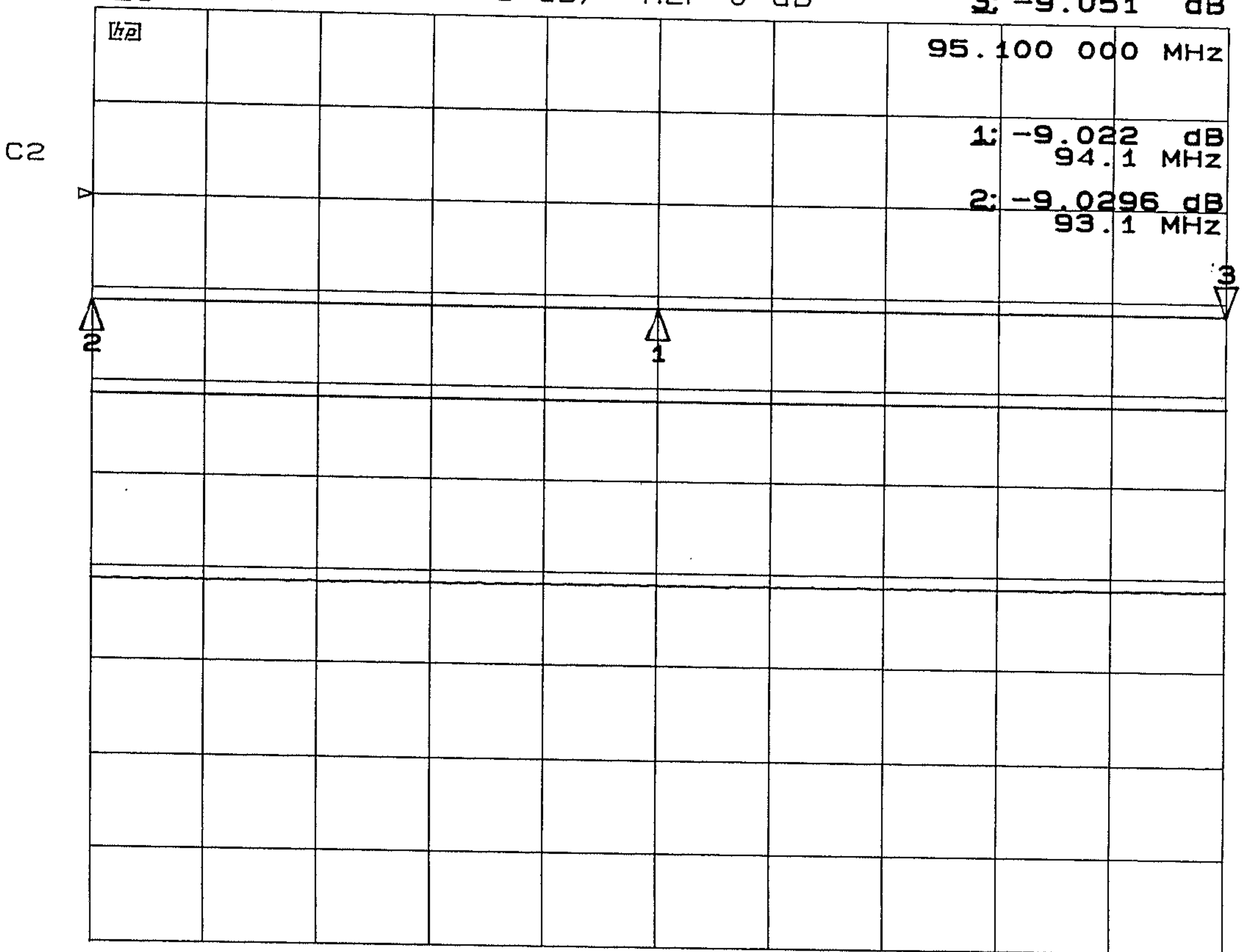


SN15766


CH1 S21 log MAG 1 dB/ REF 0 dB
3: -1.0401 dB
95.100 000 MHz
C2
1: -1.0198 dB
94.1 MHz
2: -1.0174 dB
93.1 MHz
Settings
- 0dB
- .25dB
- .5dB
- 1.0dB
- 2.0dB
- 4.0dB
START 93.100 000 MHz
STOP 95.100 000 MHz
SN15766

SN15766 4/1/94

CH1 S_{21} log MAG 8 dB/ REF 0 dB

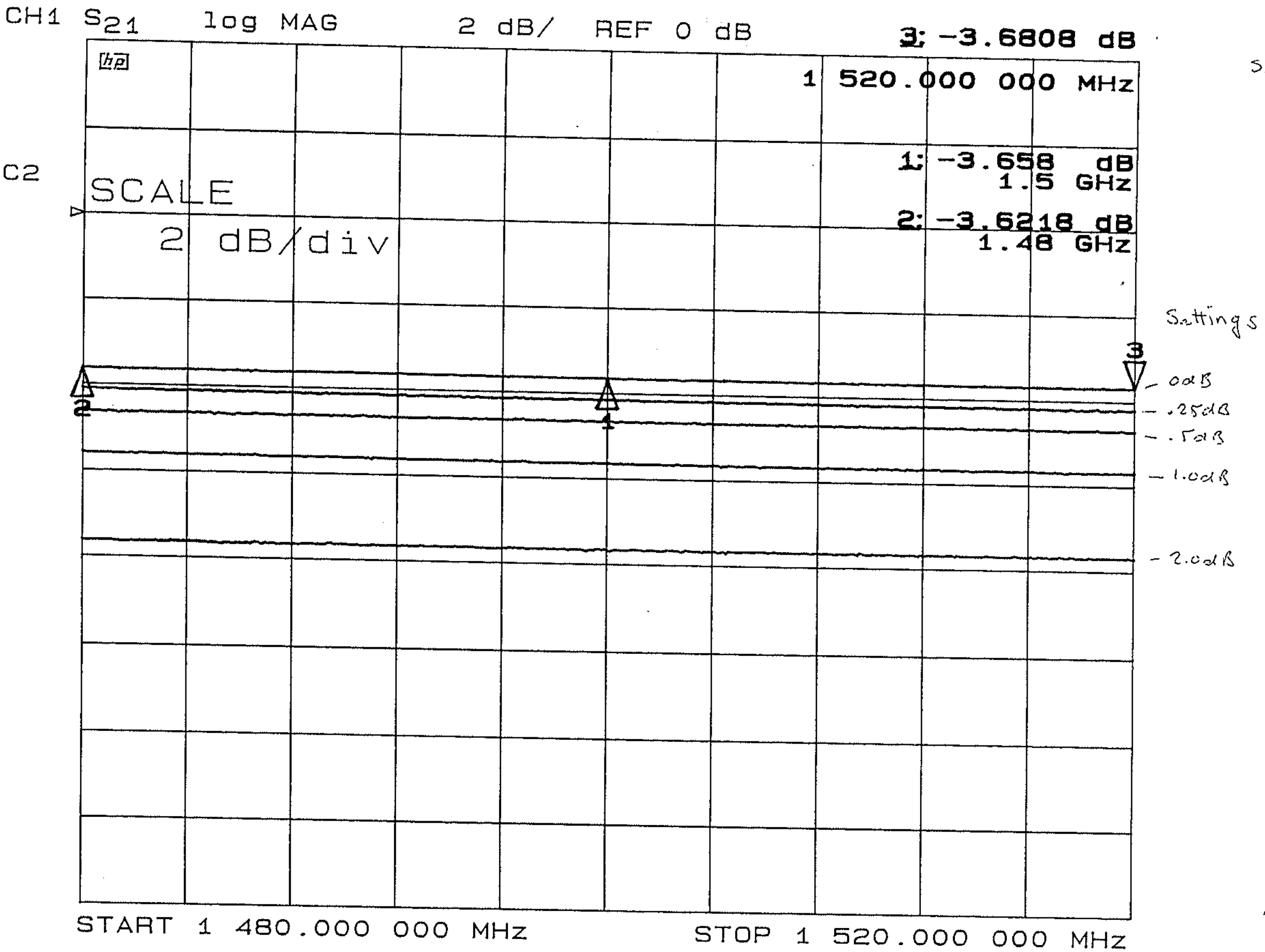


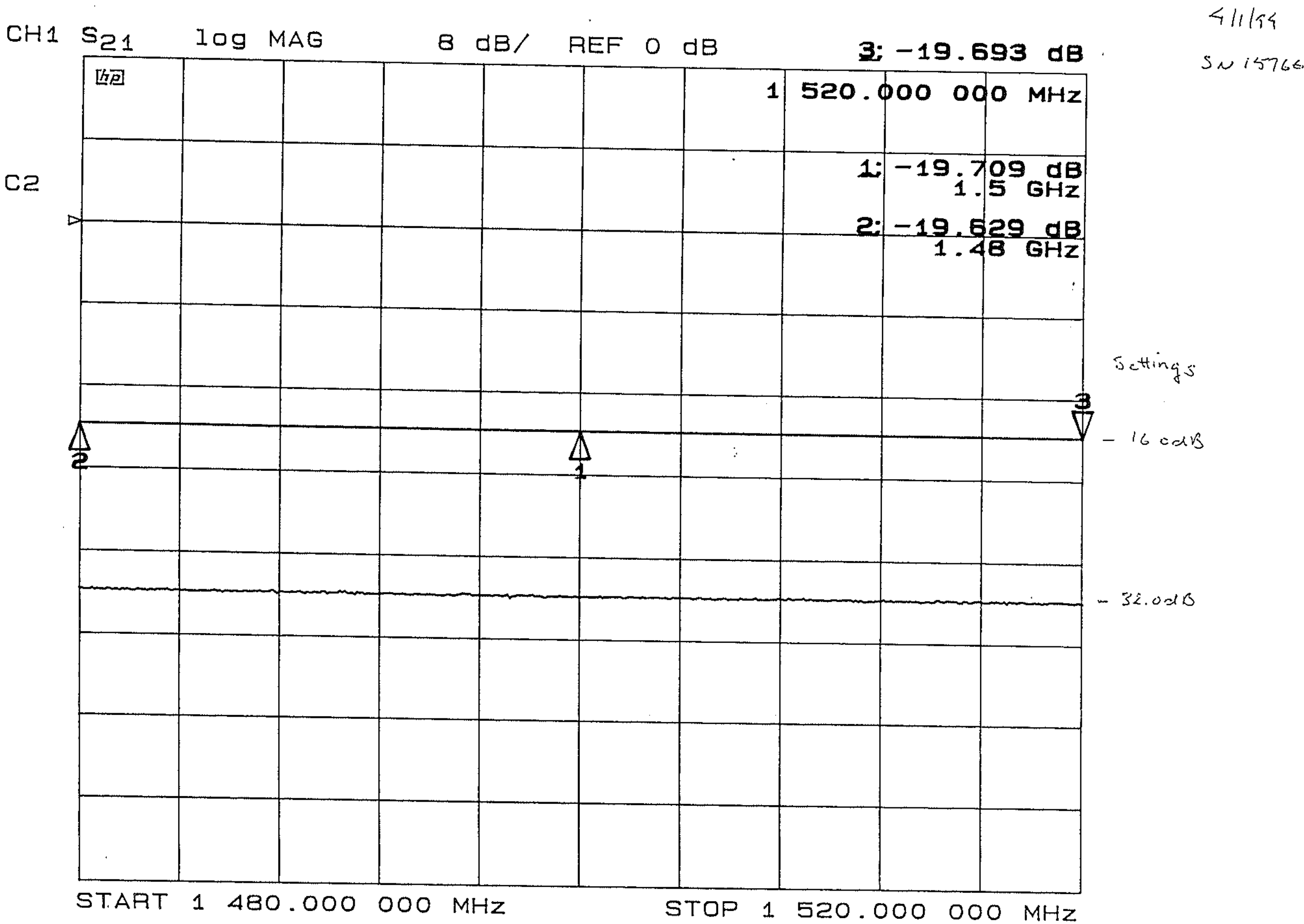
SN15766

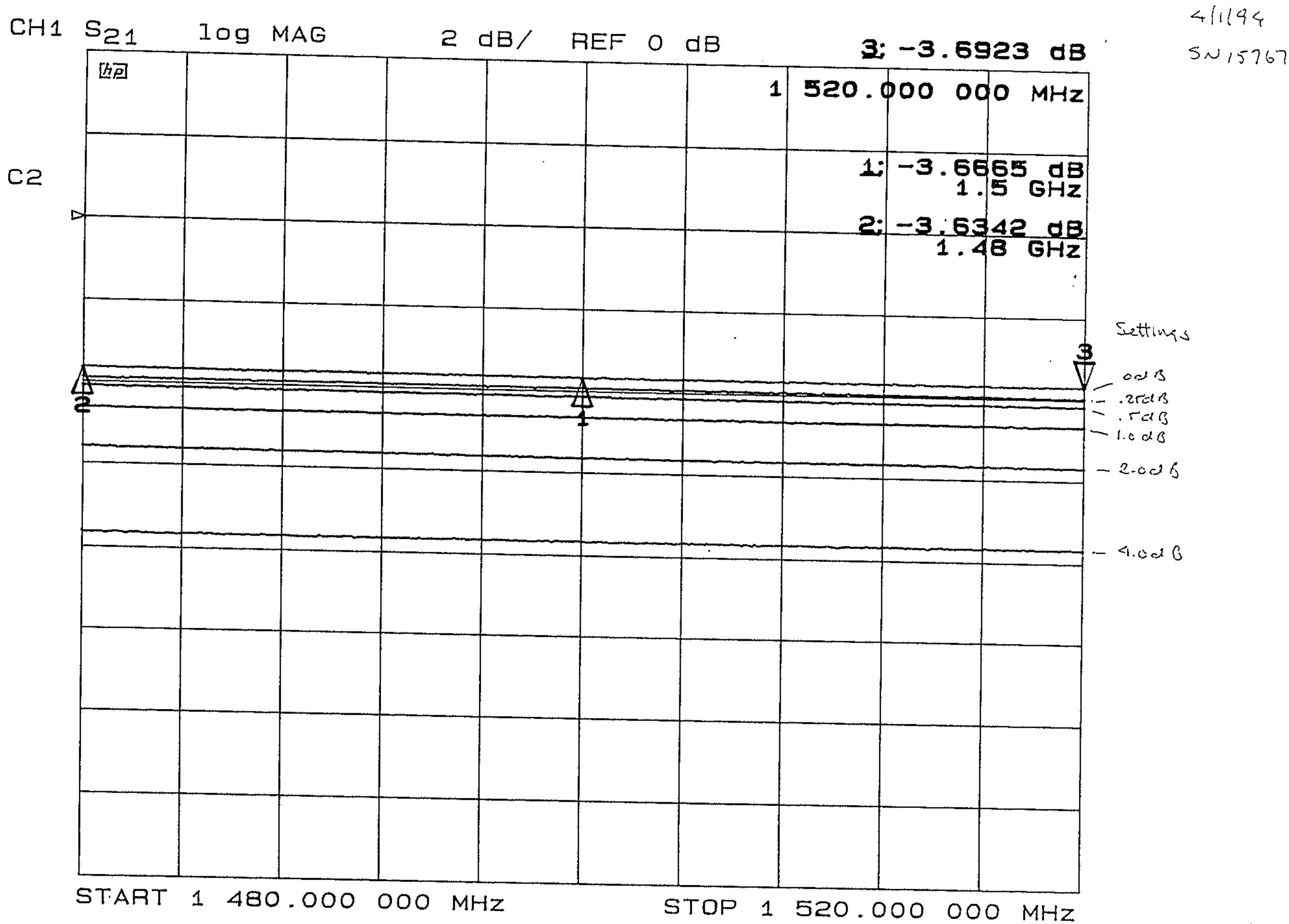
Settings
8.0 dB
16.0 dB
32.0 dB

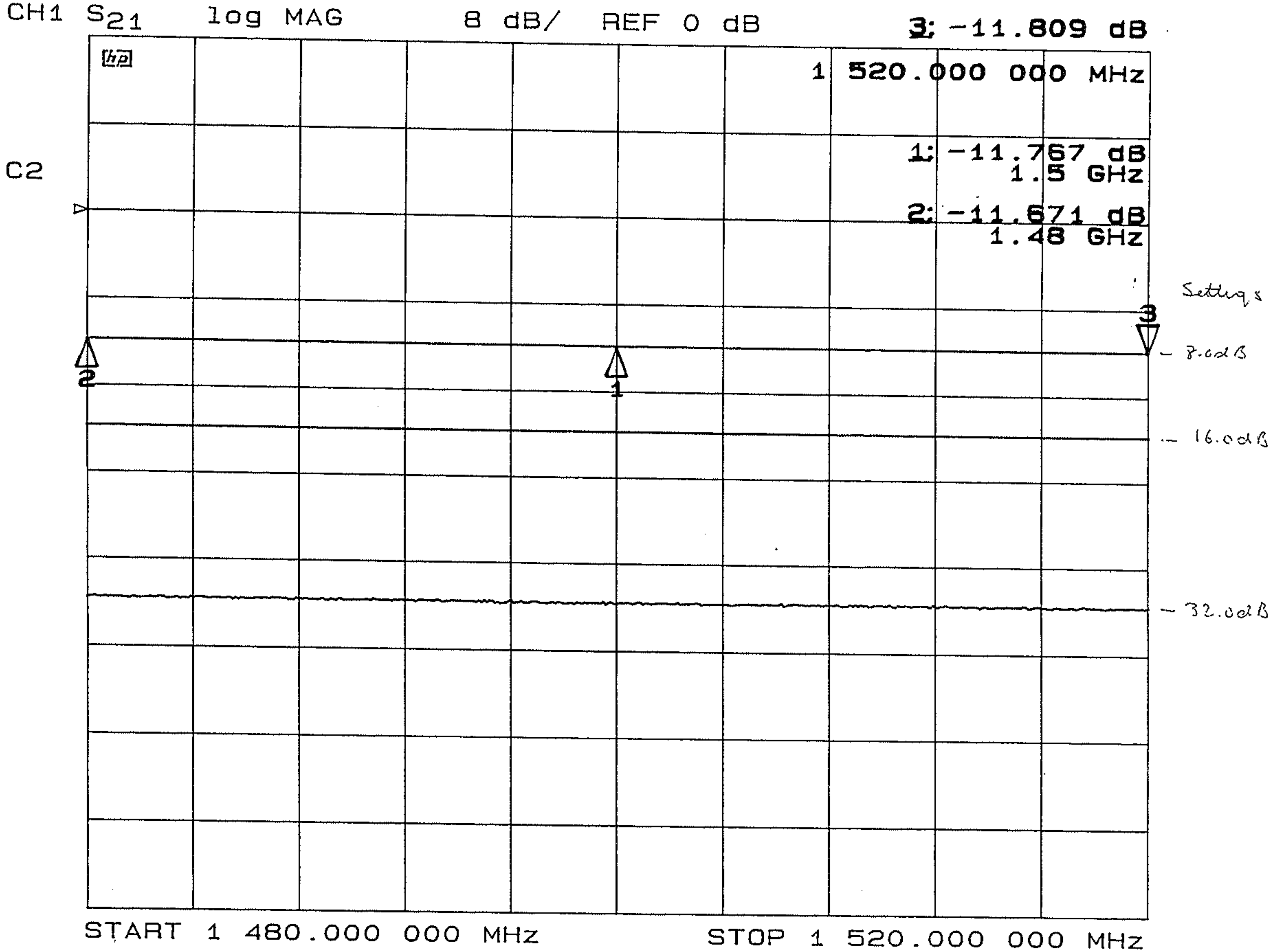
START 93.100 000 MHz STOP 95.100 000 MHz

4/1/99
SN 15766

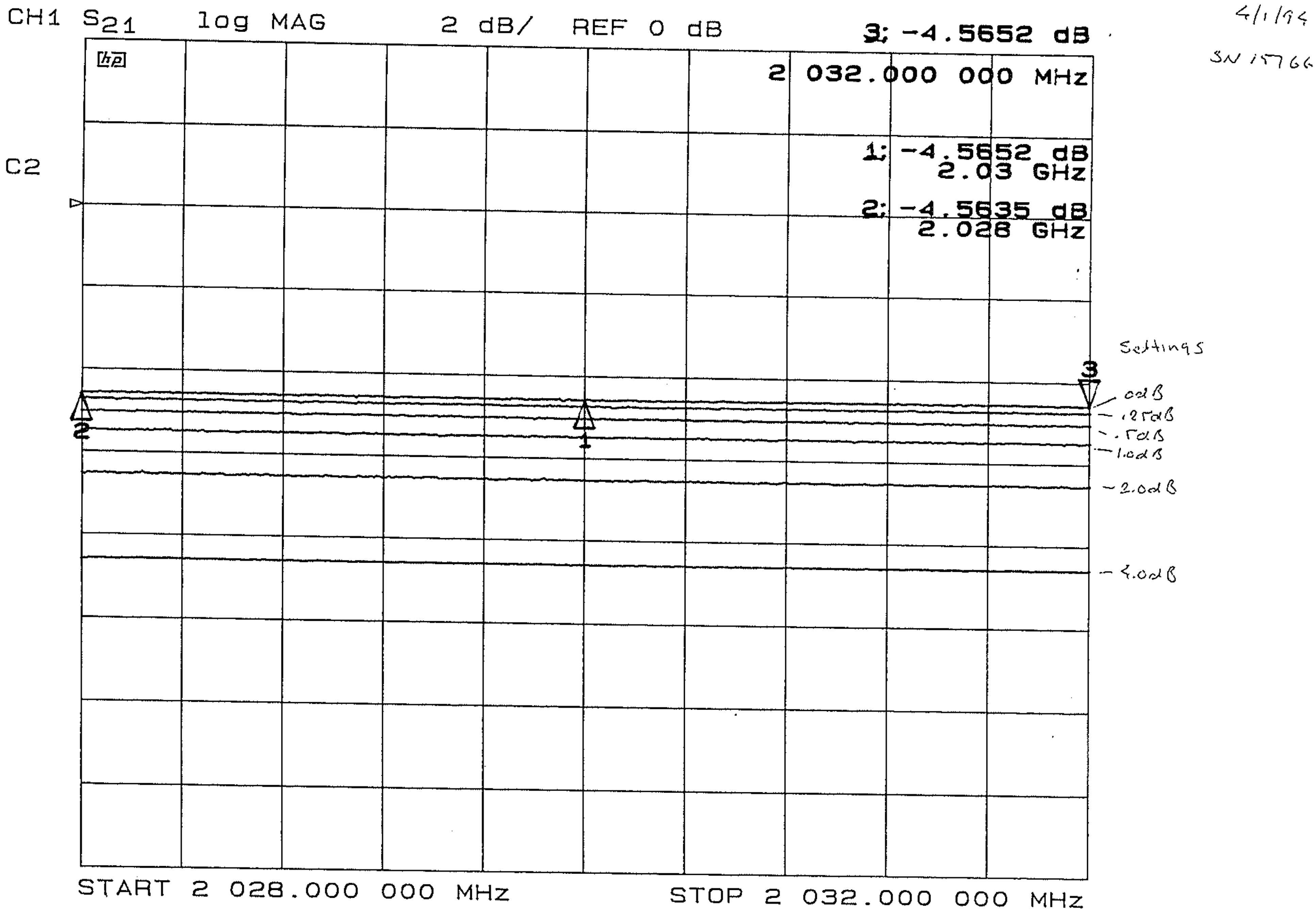



4/1/99
SN 15766
CH1 S21 log MAG 8 dB/ REF 0 dB
3: -19.693 dB
1 520.000 000 MHz
C2
1: -19.709 dB
1.5 GHz
2: -19.629 dB
1.48 GHz
Settings
- 16.0dB
- 32.0dB
START 1 480.000 000 MHz
STOP 1 520.000 000 MHz


CH1 S21 log MAG 2 dB/ REF 0 dB
3: -3.6923 dB
1 520.000 000 MHz
C2
1: -3.6665 dB
1.5 GHz
2: -3.6342 dB
1.48 GHz
START 1 480.000 000 MHz
STOP 1 520.000 000 MHz
4/11/94
SN 15767
Settings
.0 dB
.25 dB
.5 dB
1.0 dB
2.0 dB
4.0 dB



4/11/94
SN15767

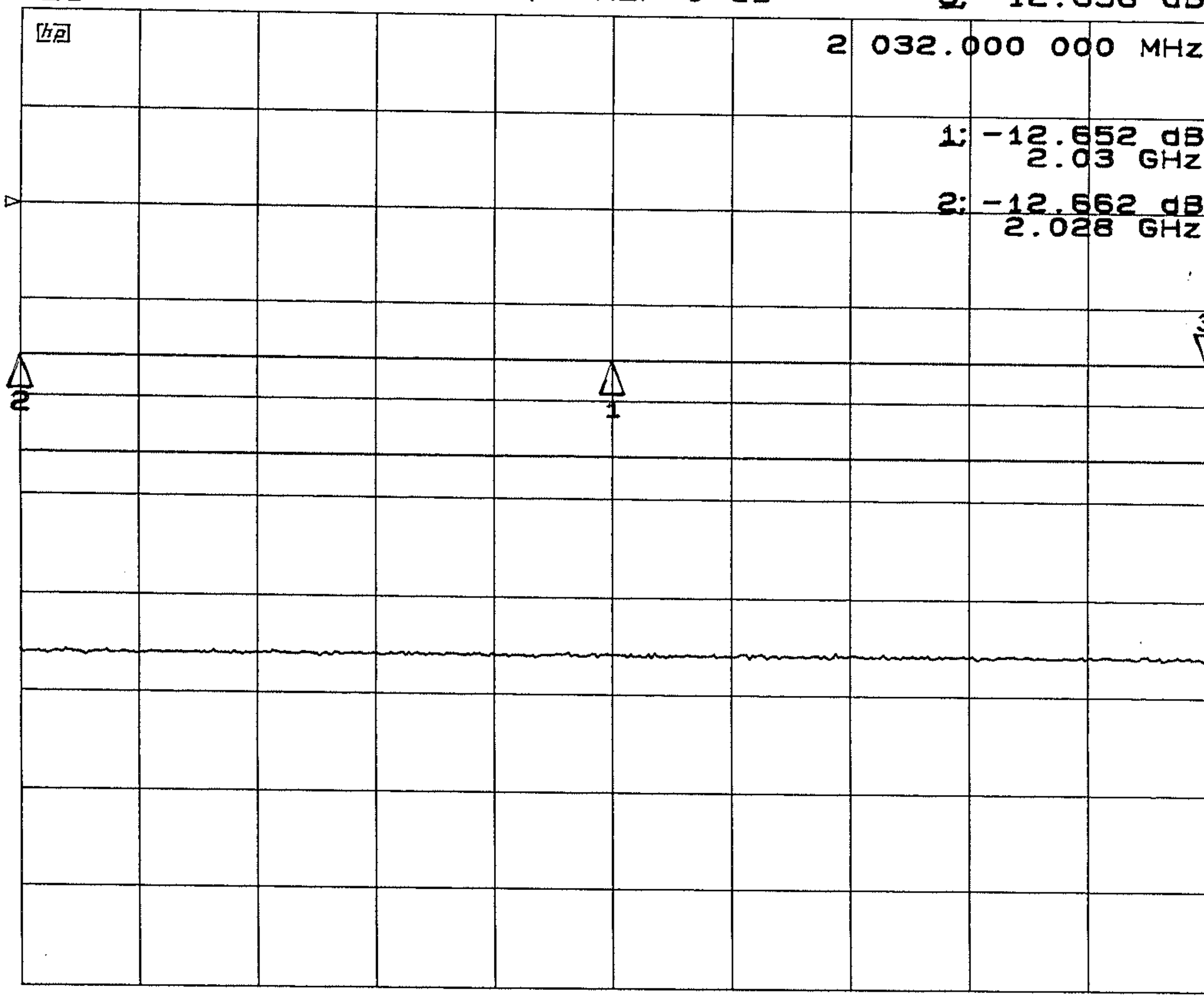

CH1 S21 log MAG 2 dB/ REF 0 dB
3; -4.5652 dB
2 032.000 000 MHz
1; -4.5652 dB
2.03 GHz
2; -4.5635 dB
2.028 GHz
C2
START 2 028.000 000 MHz
STOP 2 032.000 000 MHz
4/1/94
SN 15766
Settings
0dB
.125dB
.5dB
1.0dB
2.0dB
4.0dB

4/1/94

SN 15766

CH1 S_{21} log MAG 8 dB/ REF 0 dB

C2



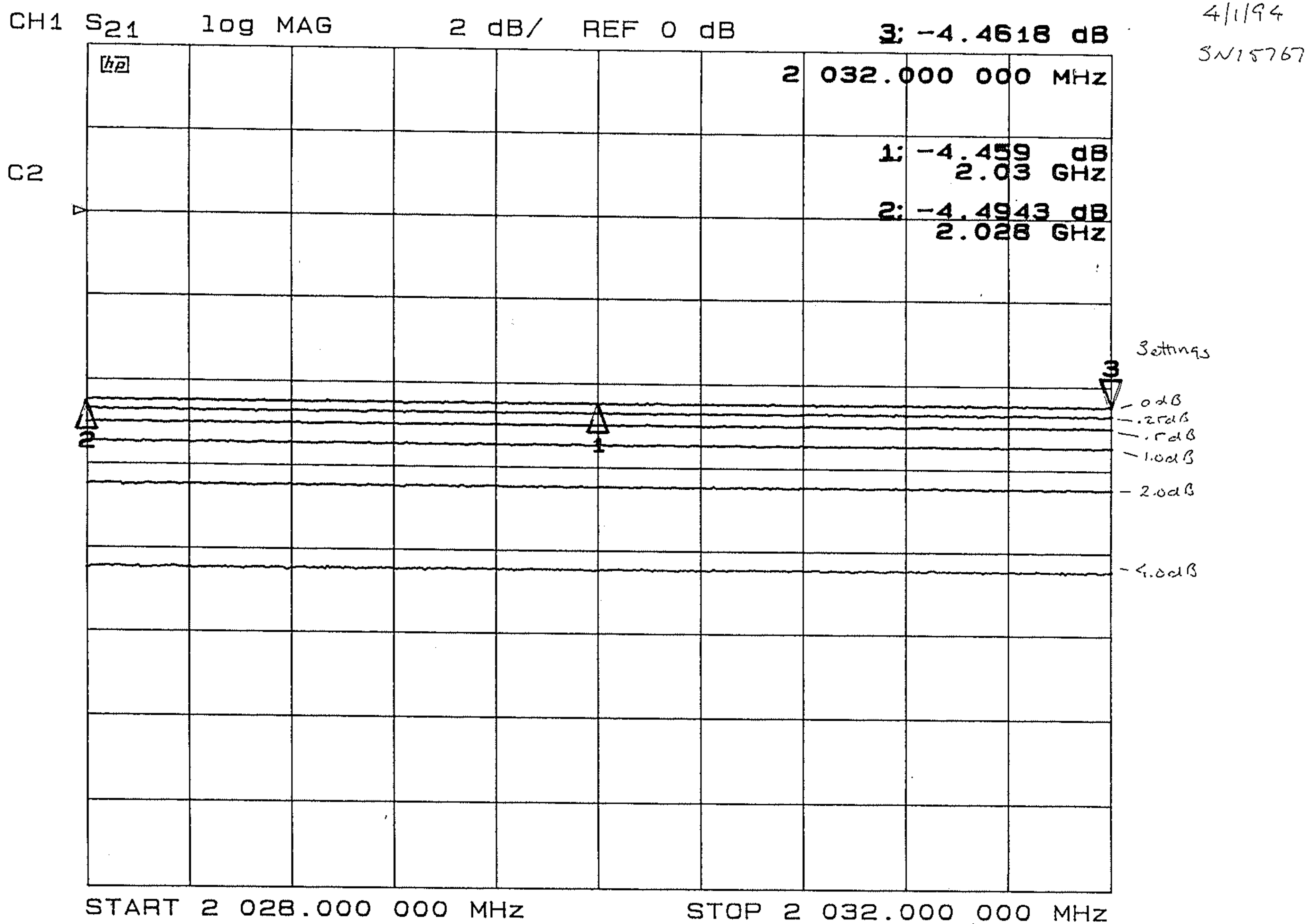
Settings

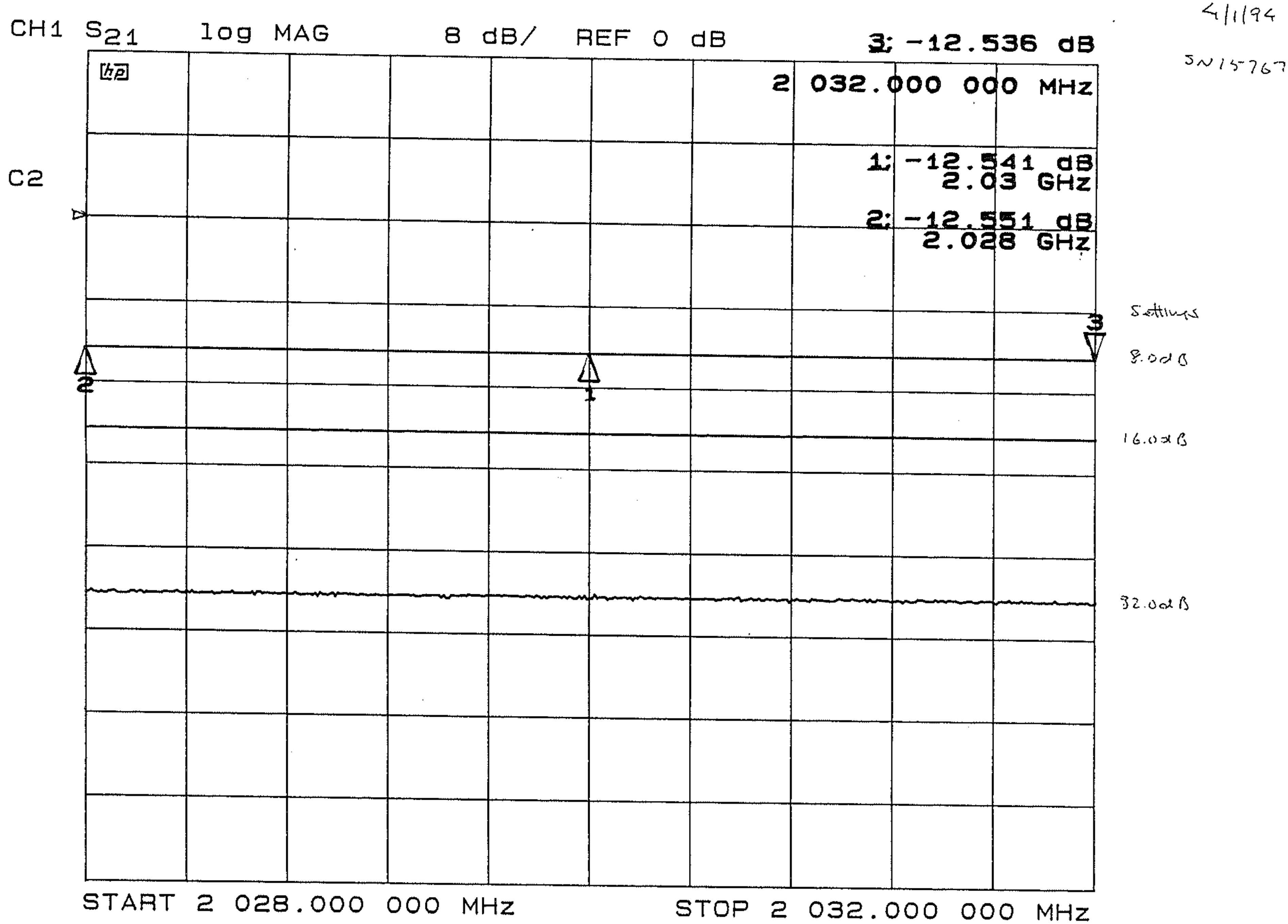
- 8.0dB

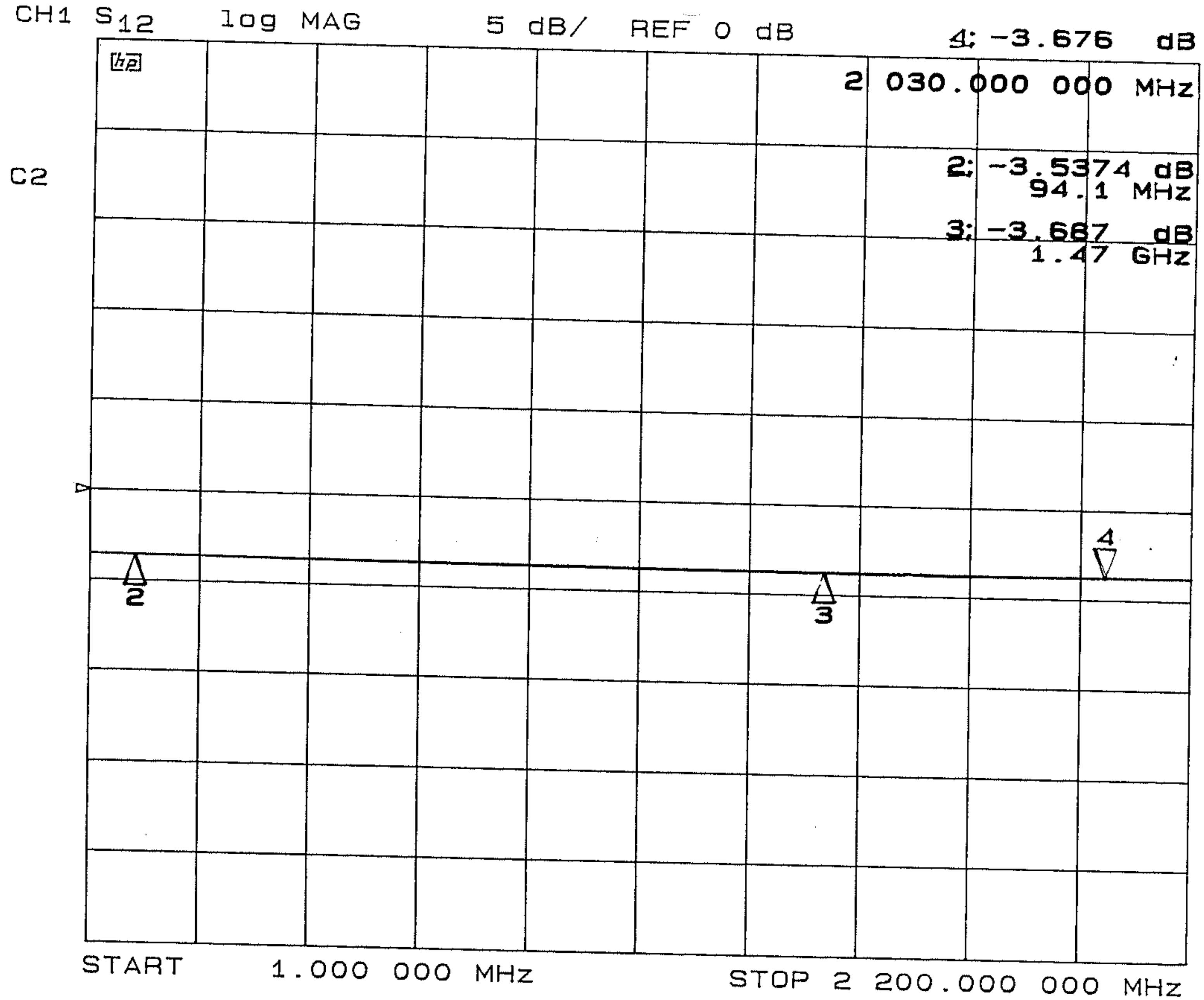
- 16.0dB

- 32.0dB

START 2 028.000 000 MHz STOP 2 032.000 000 MHz

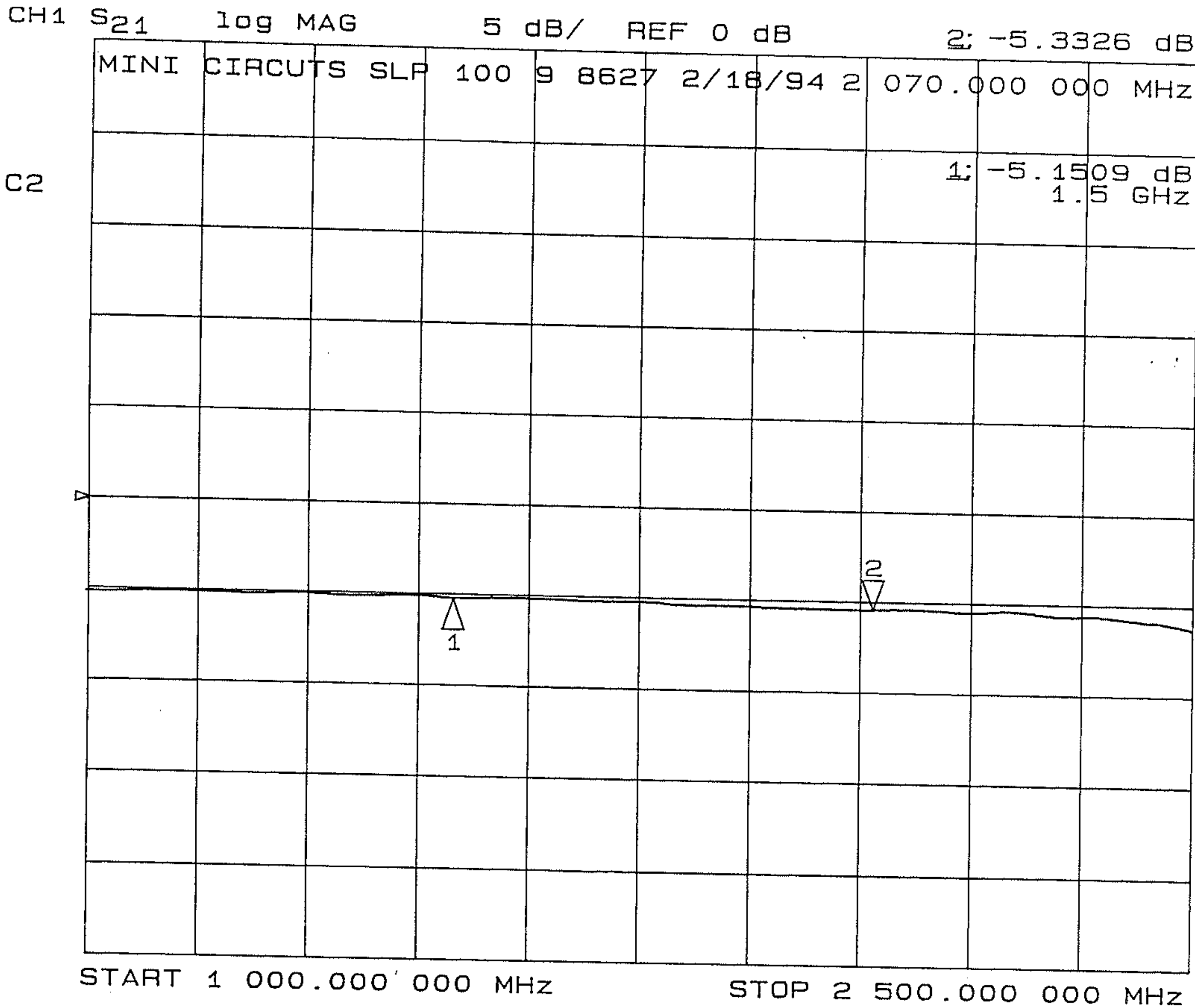

CH1 S21 log MAG 2 dB/ REF 0 dB
3: -4.4618 dB
2 032.000 000 MHz
C2
1: -4.459 dB
2.03 GHz
2: -4.4943 dB
2.028 GHz
Settings
- 0 dB
- .25 dB
- .5 dB
- 1.0 dB
- 2.0 dB
- 4.0 dB
START 2 028.000 000 MHz
STOP 2 032.000 000 MHz
4/1/94
SN15767


CH1 S21 log MAG 8 dB/ REF 0 dB
3: -12.536 dB
2 032.000 000 MHz
1: -12.541 dB
2.03 GHz
2: -12.551 dB
2.028 GHz
C2
START 2 028.000 000 MHz
STOP 2 032.000 000 MHz
4/1/94
Settings
8.0dB
16.0dB
32.0dB



4/26/94

ZFSC-2-2500
mcL 2way
splitter
Thru loss
ports to 1+2
(overlay)



2-18-94

L Band Combiner

Port # 1

Port S output

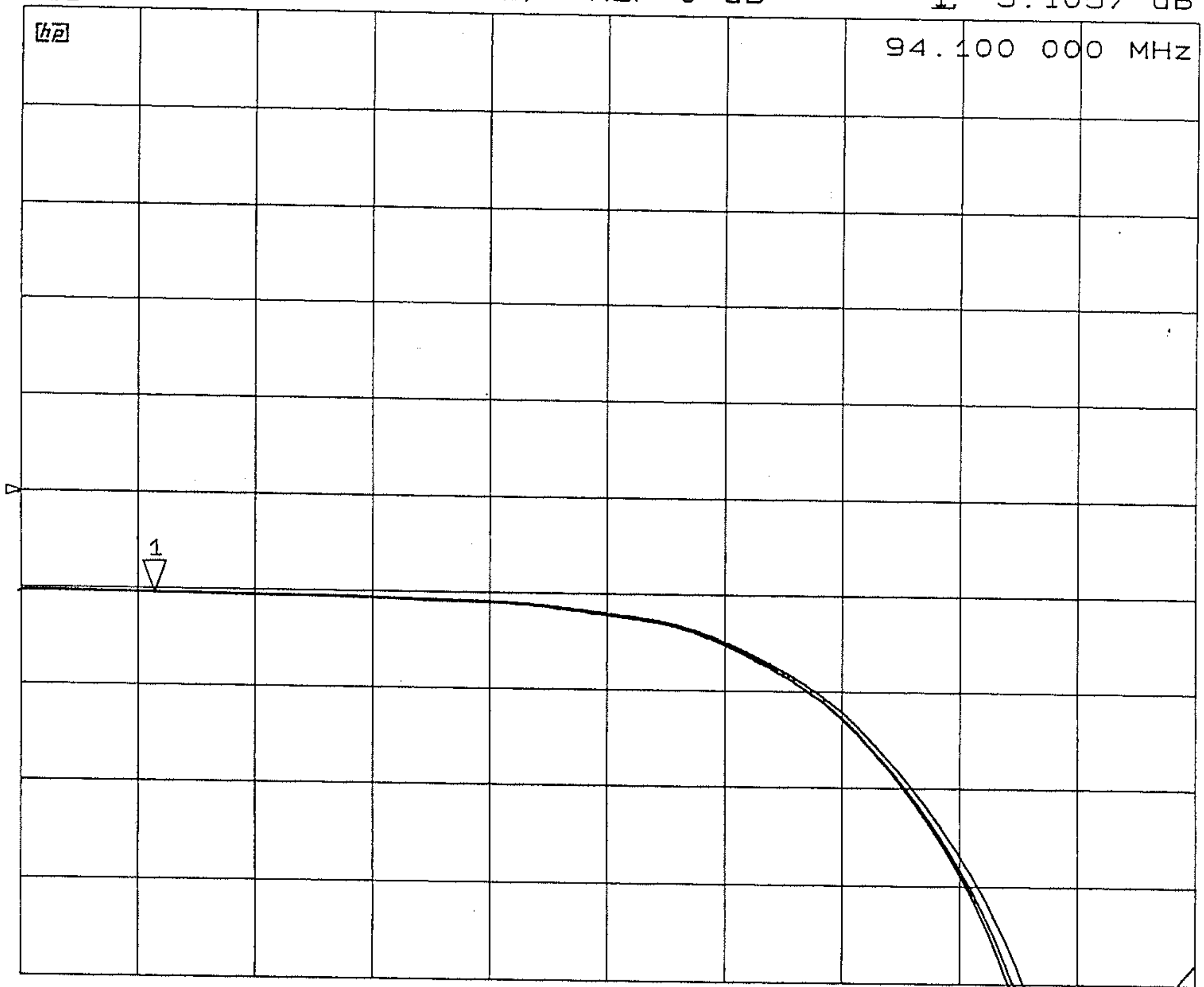
ZA3PD-2.

MEASURED from Panel.

ZA3PD-2

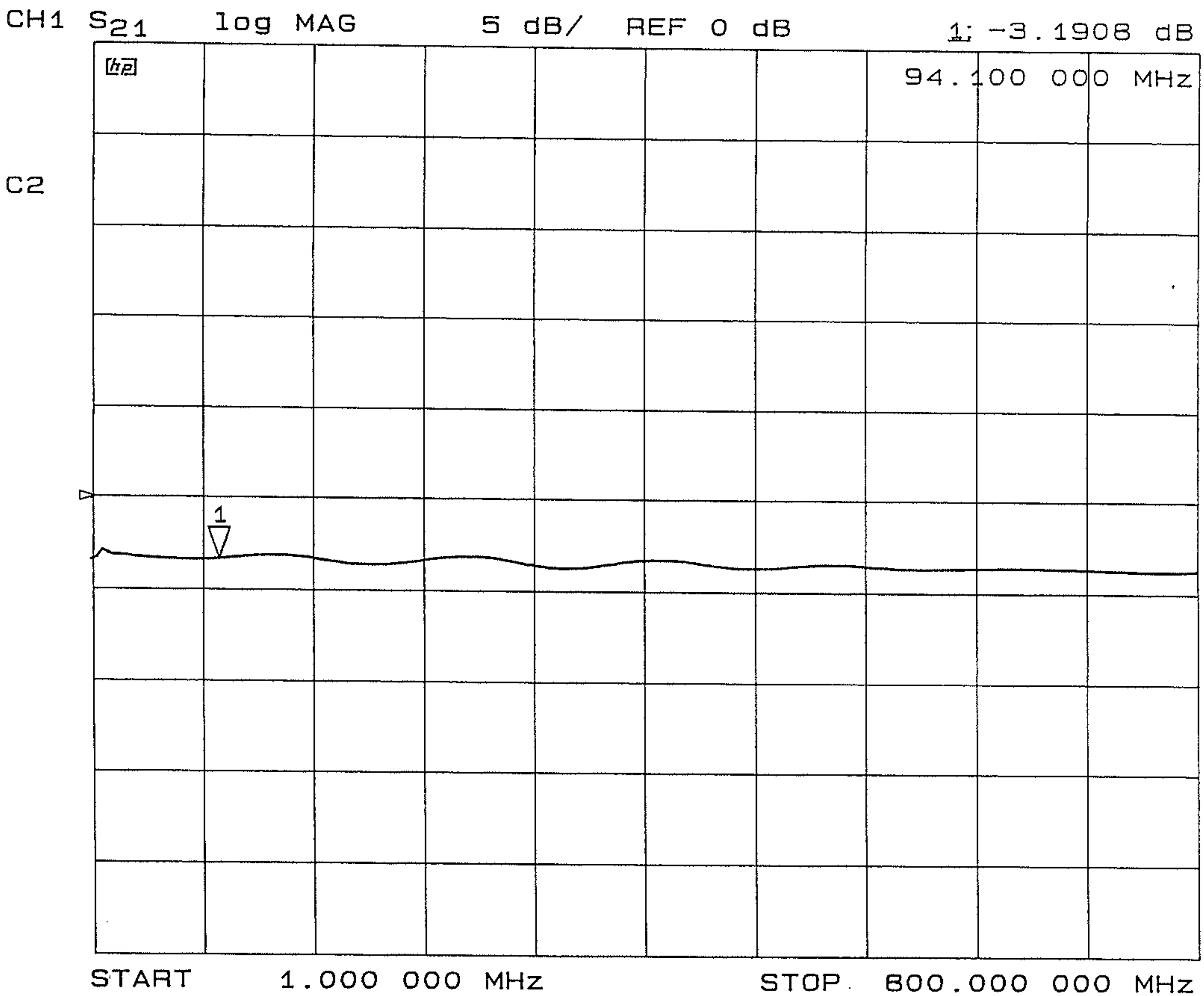
CH1 S_{21} log MAG 5 dB/ REF 0 dB 1; -5.1057 dB

C2

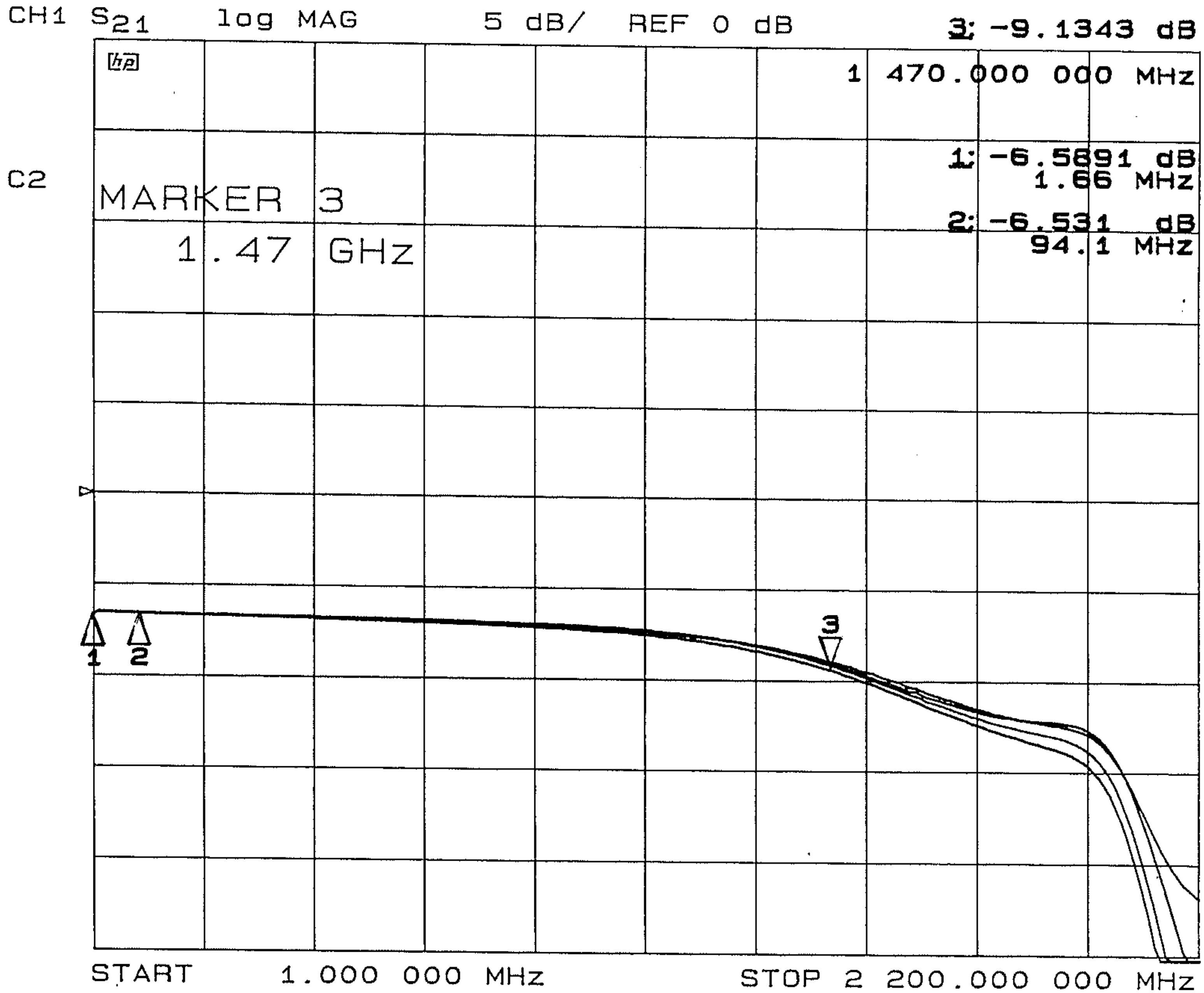


START 1.000 000 MHz STOP 800.000 000 MHz

5/19/99
ZFSC-3-13
$|S_{21}|$
all ports in one plot

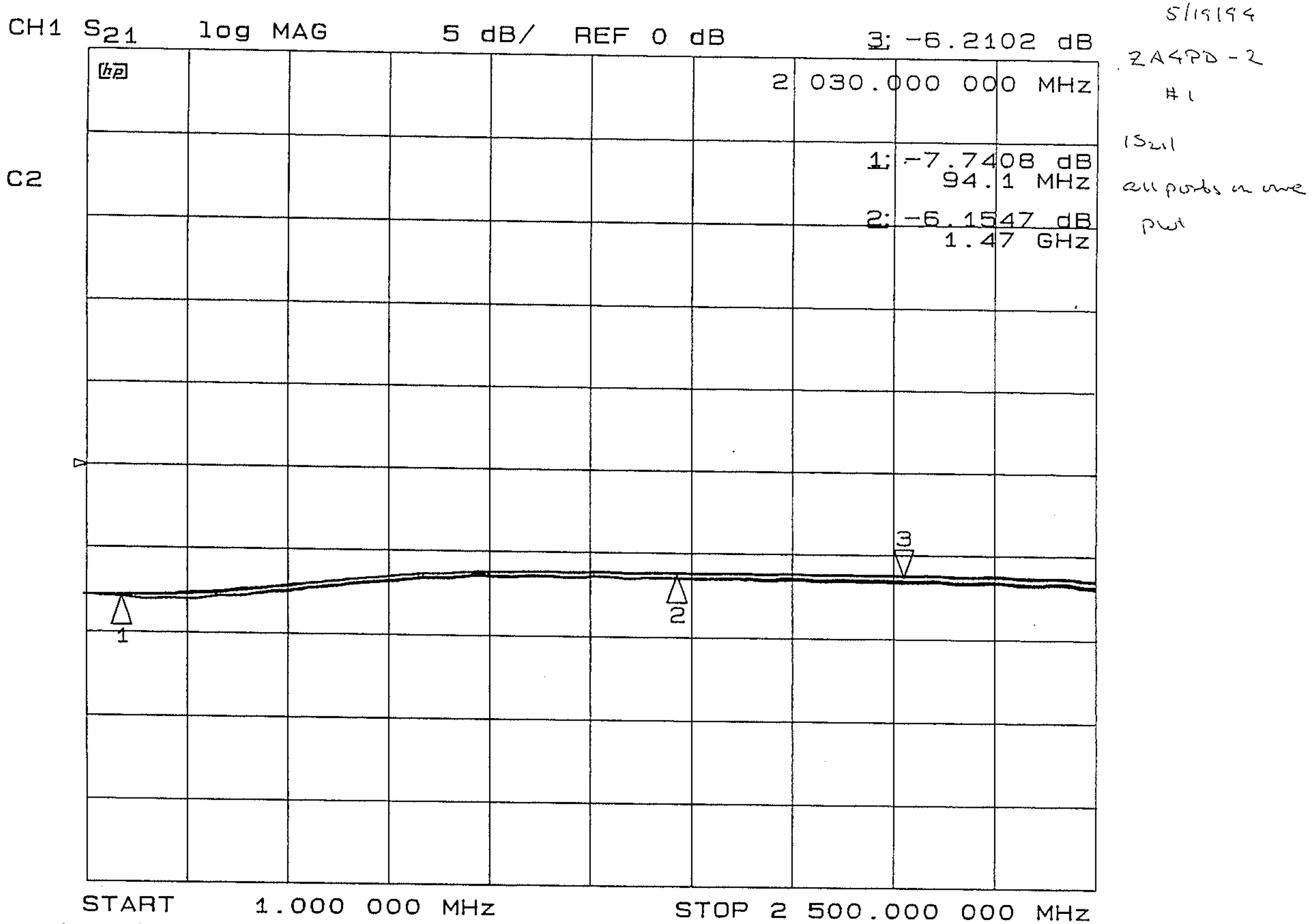


5/19/94
2FSC-2-1W
#2
$|S_{21}|$
both plots in one plot

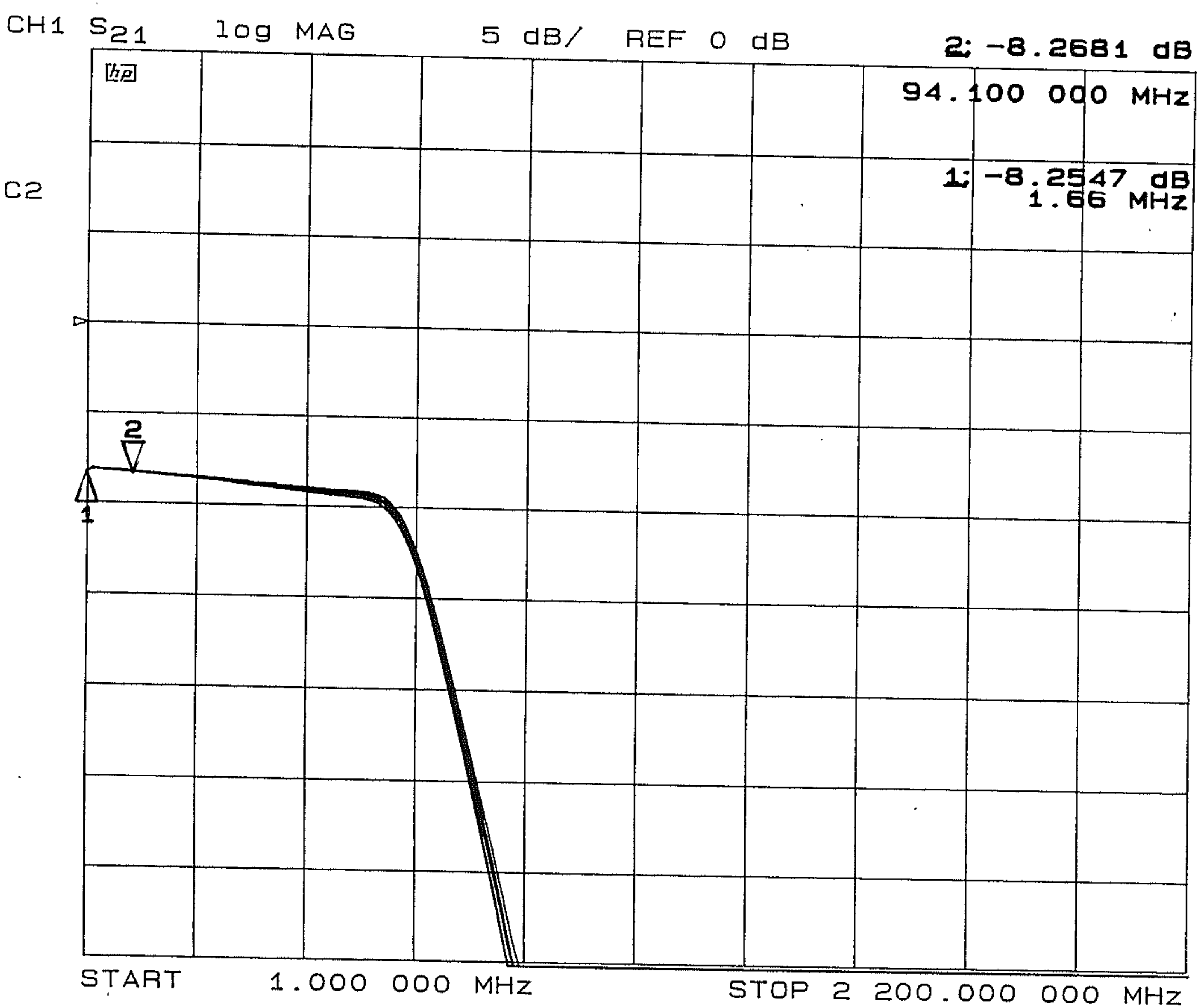


4/26/94

MCL ZFSC-4-1
4 way splitter
Thru loss
port S input
others terminated



CH1 S21 log MAG 5 dB/ REF 0 dB 3: -6.2102 dB
2 030.000 000 MHz
C2
1: -7.7408 dB
94.1 MHz
2: -6.1547 dB
1.47 GHz
1
2
3
START 1.000 000 MHz STOP 2 500.000 000 MHz
5/19/94
ZA4PD-2
#1
|S21|
all ports on one pwt



4/26/99

ZBSC-615
6-way splitter
ports to rest
(overlay)
unused ports
terminated

5/19/94

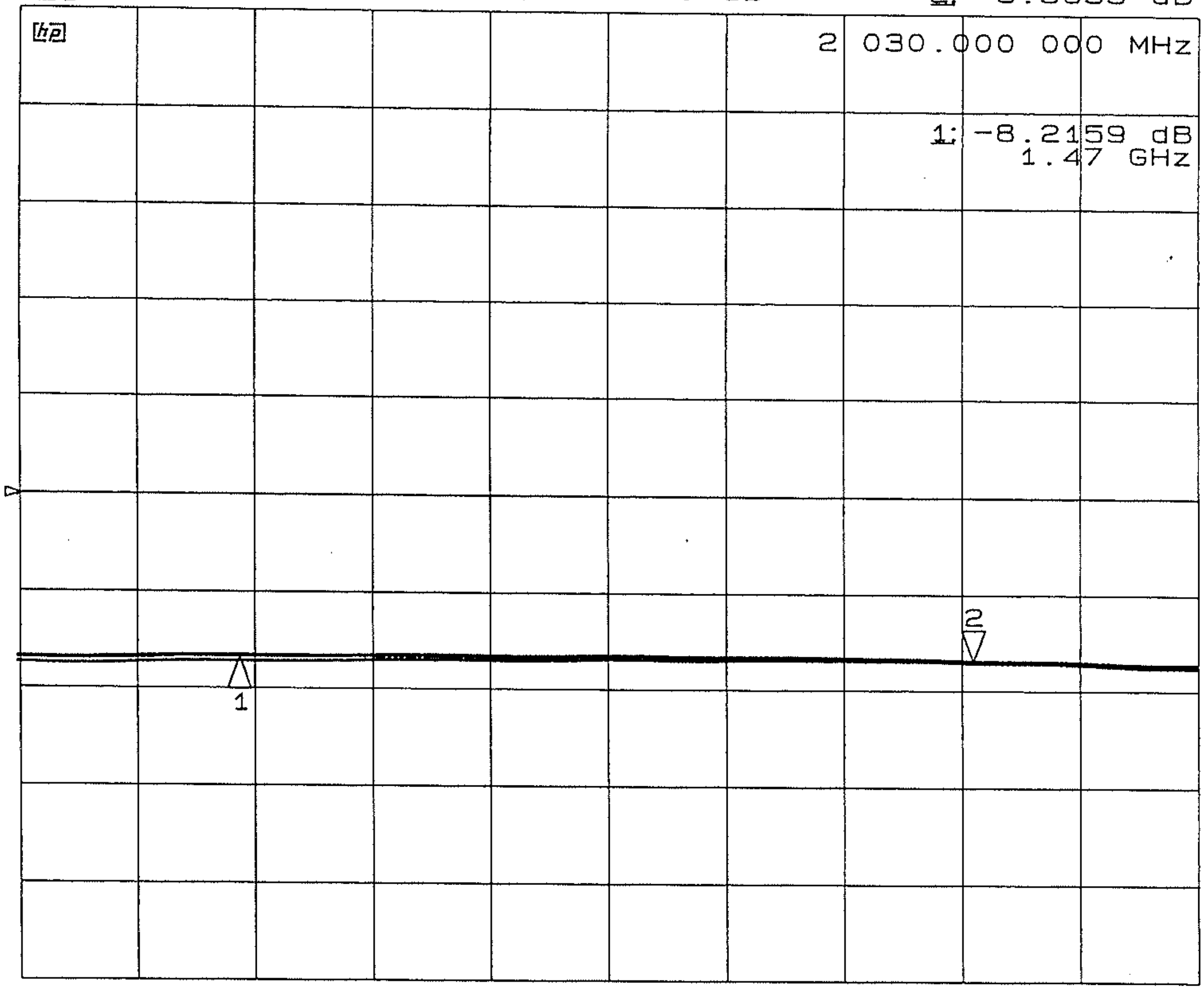
CH1 S_{21} log MAG 5 dB/ REF 0 dB 2: -8.3633 dB

2C6PD -1900W

$|S_{21}|$

all ports on one plot

C2



START 1 300.000 000 MHz STOP 2 200.000 000 MHz

APPENDIX N

Bessel Null Modulation Monitor Calibration Process and Spectrum Plots

Frequency Deviation Using the Bessel Null Method

The most accurate way to determine frequency deviation is to use the *Bessel null method*. This method is usually used to calibrate a station's modulation meter while the station is not in service. The Bessel null method relies on the fact that the Bessel functions which determine the amplitude of the FM signal components are zero for certain values of the modulation index.

The FM carrier is proportional to $J_0(M)$ and each harmonic is proportional to $J_n(M)$, where n is the harmonic number and M is the modulation index. The modulation index is the peak frequency deviation divided by the modulating frequency. To make the carrier or a sideband disappear from the FM signal spectrum, choose a modulating frequency that corresponds to one of the modulation indices in Table 1.

Table 1. Bessel function nulls.

Null No.	Carrier Signal $J_0(M)$	Modulating Signal Harmonics: Second $J_1(M)$	Third $J_2(M)$	Fourth $J_3(M)$
1	2.4048	3.8317	5.1356	6.3802
2	5.5201	7.0156	8.4172	9.7610
3	8.6531	10.1735	11.6198	13.0152
4	11.7915	13.3237	14.7960	16.2235
	Modulation indices at which Bessel functions are zero			

To establish the 100% modulation point when the peak deviation frequency is ± 75 kHz, follow this procedure:

1. Decide which signal component you will null. To calculate the required frequency, divide 75 kHz by the corresponding modulation index from Table 1. For instance, the first two carrier null frequencies are 31.188 kHz (75 kHz/2.4048) and 13.586 kHz (75kHz/5.5201).
2. The audio pass band of most stations will not transmit 31 kHz, so select the second null value of 13.586 kHz instead.
3. Connect an audio sine wave generator to the modulator input and set its frequency to 13.586 kHz. Use a frequency counter to measure the frequency. The accuracy of the Bessel null method is governed by the accuracy of the modulating signal.
4. Set the amplitude of the audio signal to zero. Connect your spectrum analyzer to an RF test point or directional coupler at the transmitter output.
5. If your deviation meter is already approximately correct, increase the signal generator output level until the meter reads about 100% and then vary the signal level slightly until the analyzer shows a null.
6. If your meter is totally uncalibrated, increase the signal generator output level until a null is reached. Continue increasing the output level until a second null is achieved.

A representative display of the resulting spectrum is shown in Figure 27. The null-carrier condition represents exactly 100% modulation. The modulation meter should now be adjusted to show 100%.

The Bessel null method can be used for any percent deviation by multiplying the frequency required for 100% deviation by the alternate percentage. For instance, in the example above, the second carrier null using a frequency of 6.793 kHz (half of 13.586 kHz) represents 50% deviation.

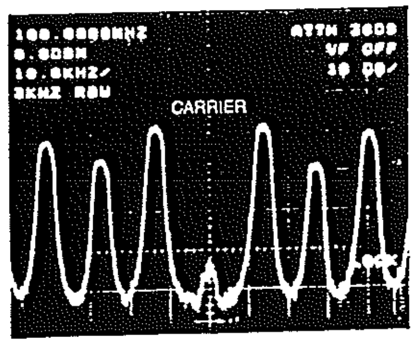
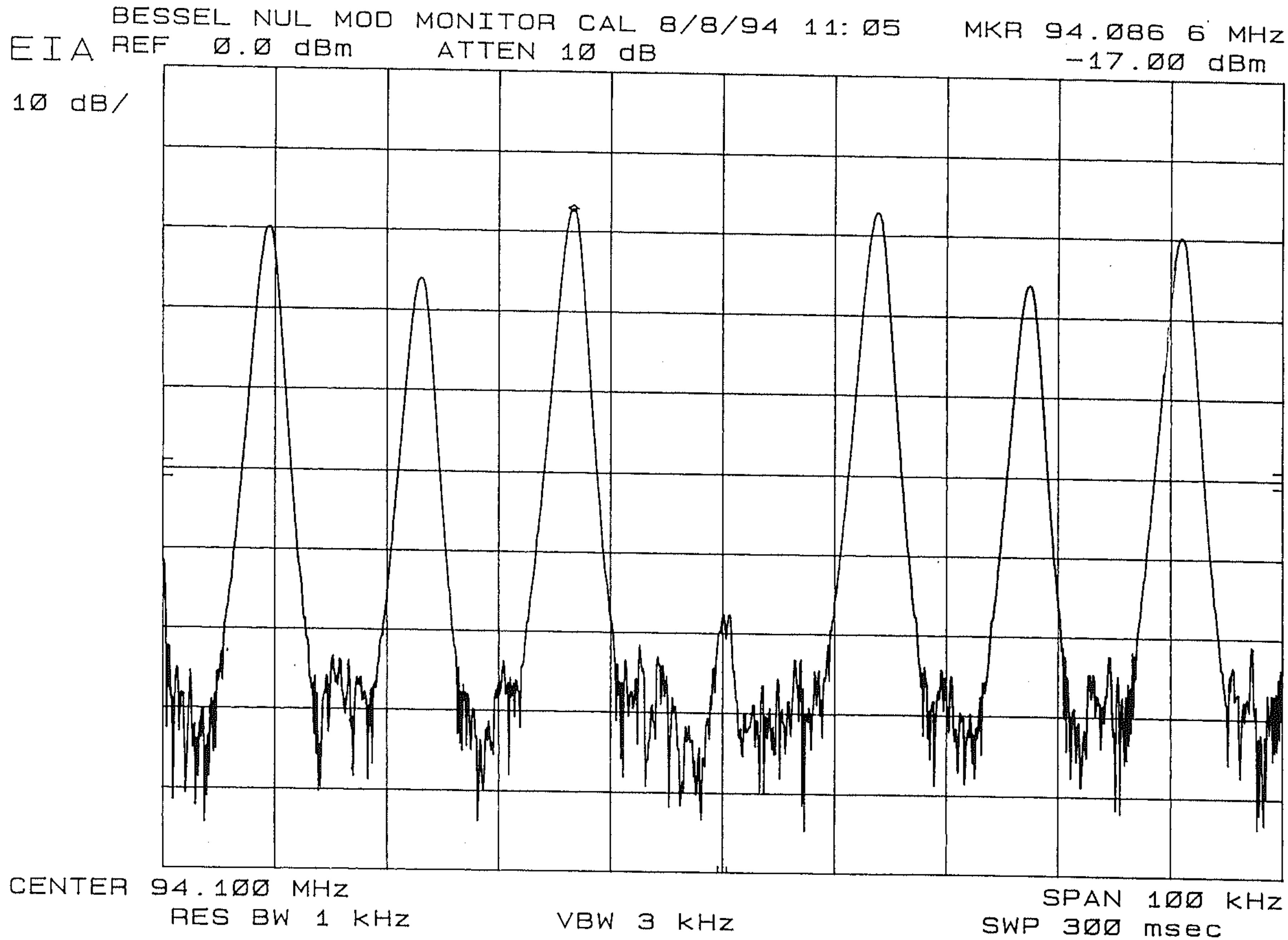
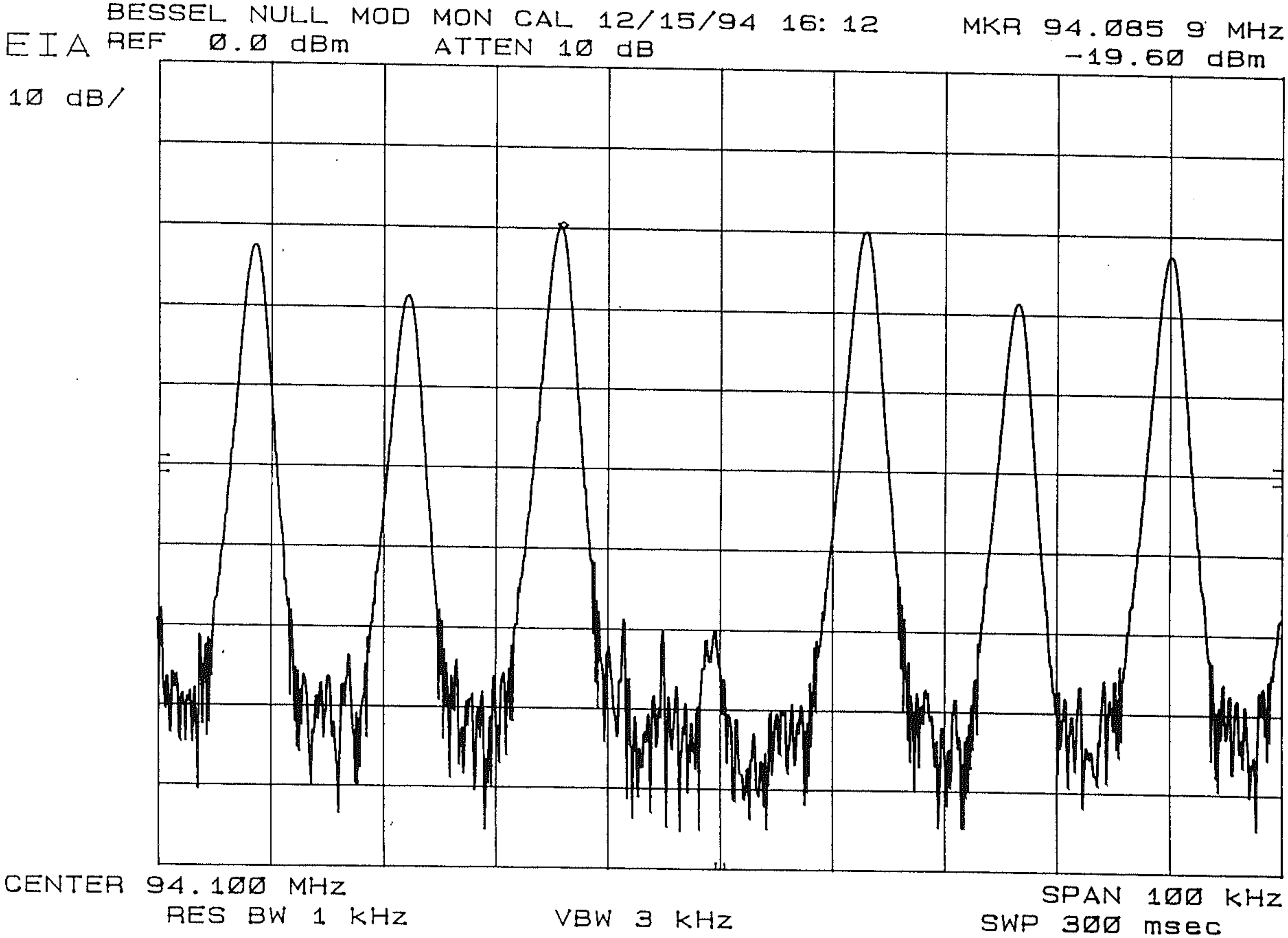


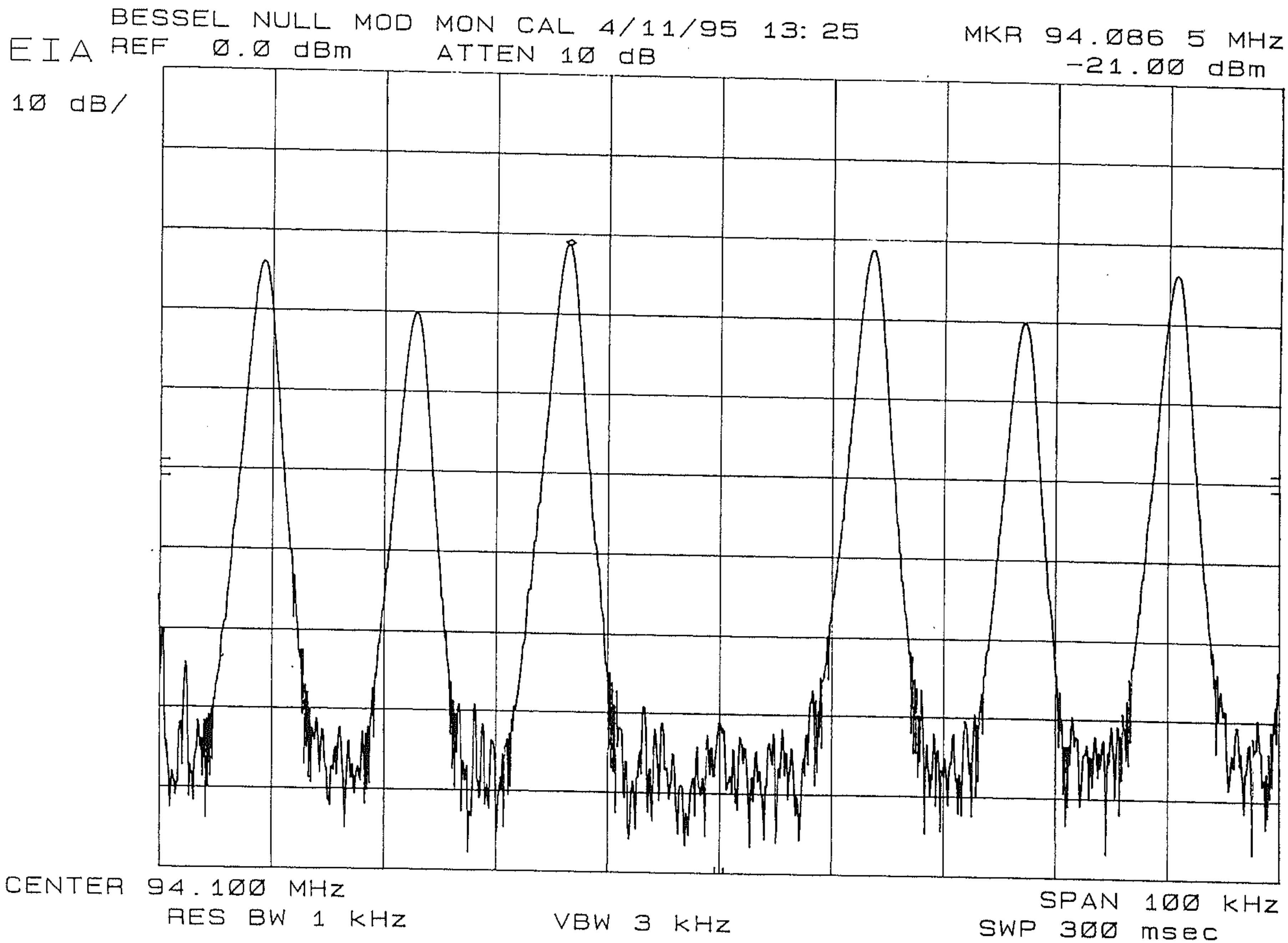
Figure 27. Second Bessel carrier null.

Tracking Generator—(with Spectrum Analyzer for Swept Measurements)

A *tracking generator* is a signal generator whose output frequency is synchronized to, or tracks with (hence "tracking generator"), the frequency being analyzed by the spectrum analyzer at any point in time. When used with a spectrum analyzer, a tracking generator allows the frequency response of filters, amplifiers, couplers, etc. to be measured over a very wide dynamic range. The measurements are performed by connecting the output of the tracking generator to the input of the device being tested, and monitoring the output of the

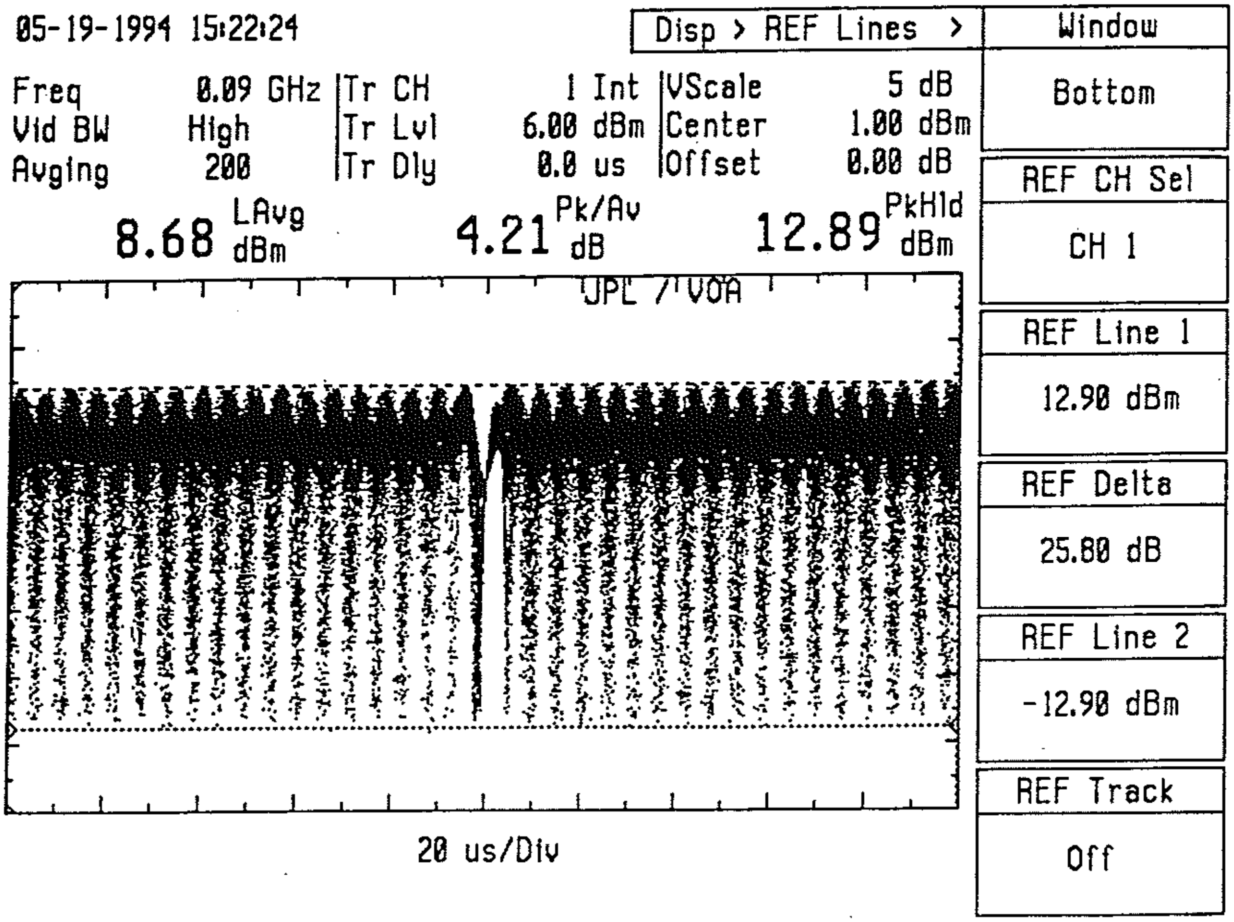

BESSEL NUL MOD MONITOR CAL 8/8/94 11:05
EIA
REF 0.0 dBm
ATTEN 10 dB
MKR 94.086 6 MHz
-17.00 dBm
10 dB/
CENTER 94.100 MHz
RES BW 1 kHz
VBW 3 kHz
SPAN 100 kHz
SWP 300 msec


EIA
BESSEL NULL MOD MON CAL 12/15/94 16: 12
REF 0.0 dBm
ATTEN 10 dB
MKR 94.085 9 MHz
-19.60 dBm
10 dB/
CENTER 94.100 MHz
RES BW 1 kHz
VBW 3 kHz
SPAN 100 kHz
SWP 300 msec


BESSEL NULL MOD MON CAL 4/11/95 13: 25
EIA
REF 0.0 dBm
ATTEN 10 dB
MKR 94.086 5 MHz
-21.00 dBm
10 dB/
CENTER 94.100 MHz
RES BW 1 kHz
VBW 3 kHz
SPAN 100 kHz
SWP 300 msec

APPENDIX O

Peak-to-Average Power

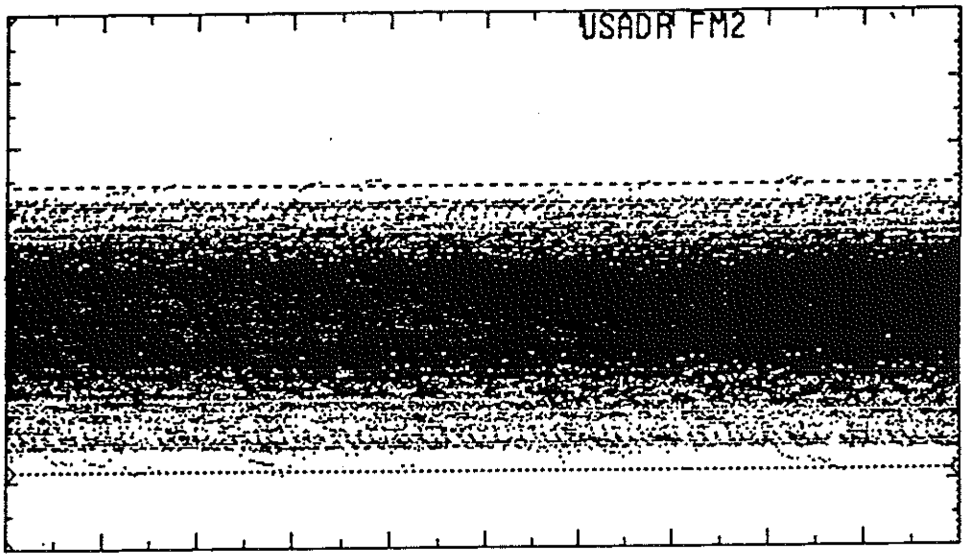

05-19-1994 15:22:24
Disp > REF Lines >
Window
Bottom
Freq 0.09 GHz
Vid BW High
Avging 200
Tr CH 1 Int
Tr Lvl 6.00 dBm
Tr Dly 0.0 us
VScale 5 dB
Center 1.00 dBm
Offset 0.00 dB
8.68 LAvg dBm
4.21 Pk/Av dB
12.89 PkHld dBm
JPL / VOA
20 us/Div
REF CH Sel
CH 1
REF Line 1
12.90 dBm
REF Delta
25.80 dB
REF Line 2
-12.90 dBm
REF Track
Off

05-19-1994 15:02:27

Disp > REF Lines >

Freq	0.09 GHz	Tr CH	2 Ext	VScale	1 dB
Vid BW	High	Tr Lvl	2.03 V	Center	5.00 dBm
Avging	200	Tr Dly	0.0 us	Offset	0.00 dB

4.48 LAvg dBm   2.05 Pk/Av dB   6.53 PkHld dBm



20 us/Div

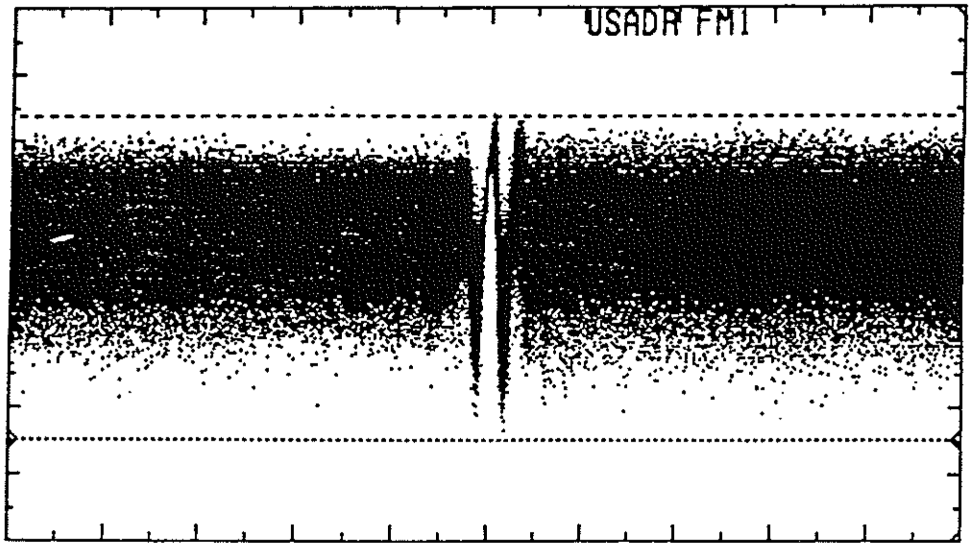
Window	Bottom
REF CH Sel	CH 1
REF Line 1	6.40 dBm
REF Delta	4.25 dB
REF Line 2	2.15 dBm
REF Track	Off

05-19-1994 14:36:51

Disp > REF Lines >

Freq	0.09 GHz	Tr CH	1 Int	VScale	2 dB
Vid BW	High	Tr Lvl	3.00 dBm	Center	0.00 dBm
Avging	200	Tr Dly	0.0 us	Offset	0.00 dB

1.35 LAvg dBm   3.51 Pk/Av dB   4.86 PkHld dBm



20 us/Div

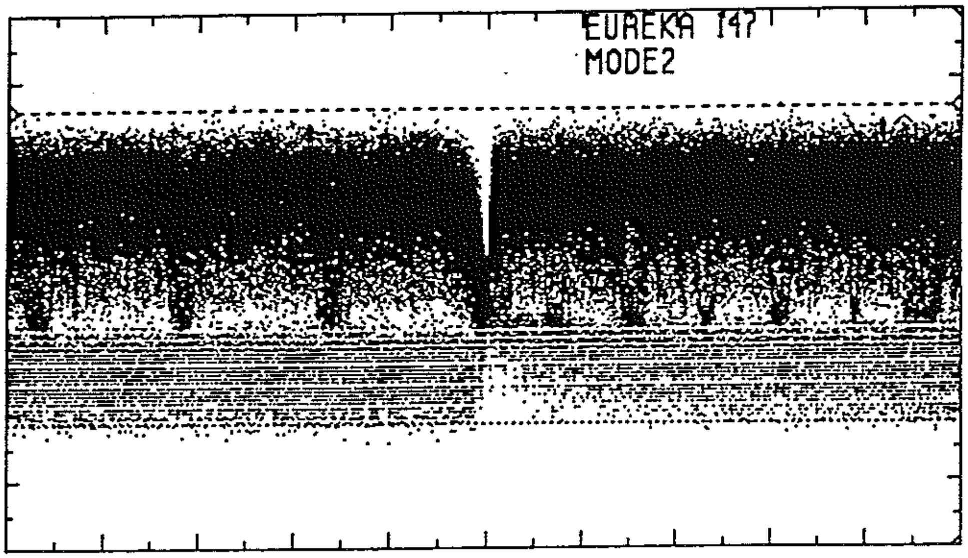
Window
Bottom
REF CH Sel
CH 1
REF Line 1
4.76 dBm
REF Delta
9.76 dB
REF Line 2
-5.00 dBm
REF Track
Off

05-19-1994 11:36:29

Disp > REF Lines >

Freq	1.47 GHz	Tr CH	1 Int	VScale	10 dB
Vid BW	High	Tr Lvl	-16.00 dBm	Center	-10.00 dBm
Avging	250	Tr Dly	0.0 us	Offset	0.00 dB

4.07 LAvg dBm   12.17 Pk/Av dB   16.24 PkHld dBm



10 us/Div

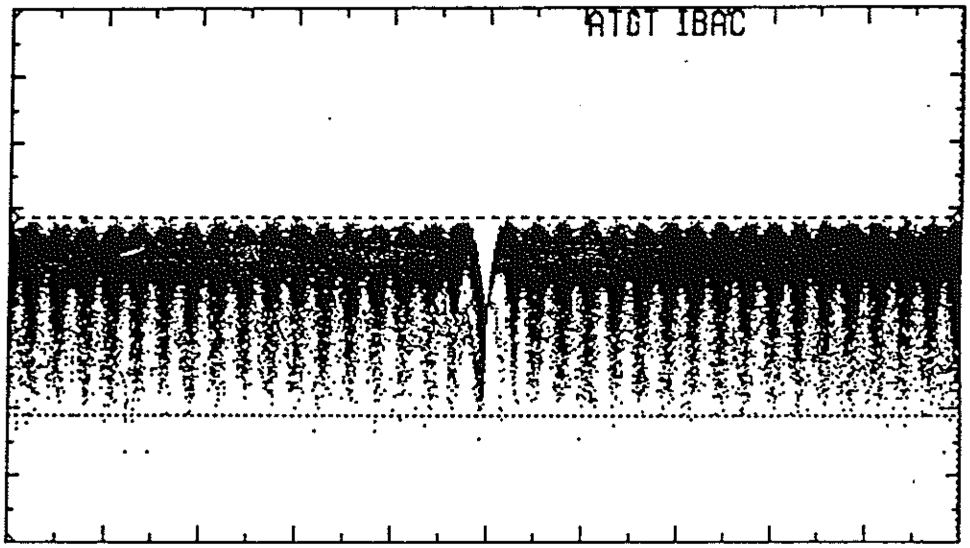
Window	Bottom
REF CH Sel	CH 1
REF Line 1	15.80 dBm
REF Delta	47.34 dB
REF Line 2	-31.54 dBm
REF Track	Off

05-19-1994 15:13:19

Disp > REF Lines >

Freq	0.09 GHz	Tr CH	1 Int	VScale	10 dB
Vid BW	High	Tr Lvl	0.00 dBm	Center	5.00 dBm
Avging	200	Tr Dly	0.0 us	Offset	0.00 dB

7.58 LAvg dBm   6.03 Pk/Av dB   13.61 PkHld dBm



20 us/Div

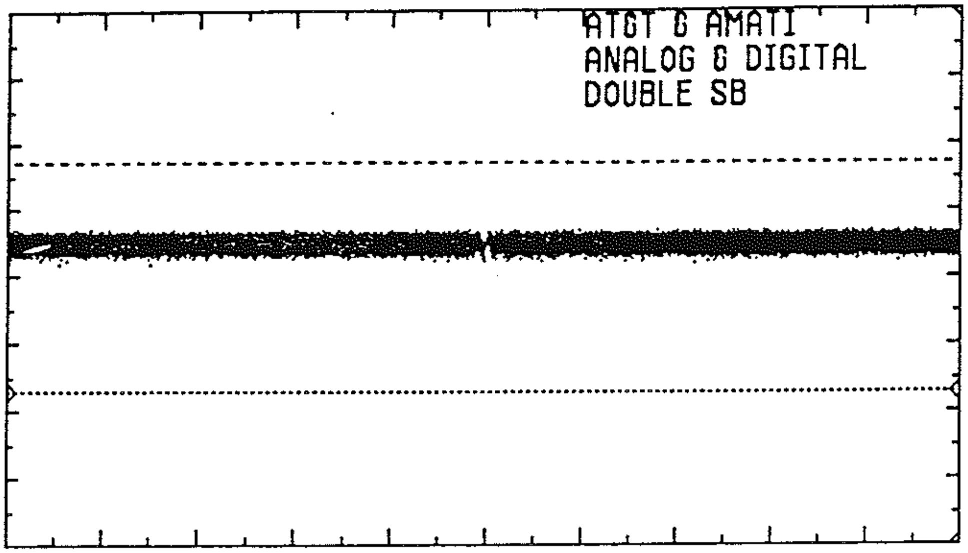
Window
Bottom
REF CH Sel
CH 1
REF Line 1
13.60 dBm
REF Delta
29.60 dB
REF Line 2
-16.00 dBm
REF Track
Off

05-19-1994 14:26:27

Util > Plotter >

Freq	0.09 GHz	Tr CH	1 Int	VScale	10 dB
Vid BW	High	Tr Lvl	5.00 dBm	Center	0.00 dBm
Avging	200	Tr Dly	0 us	Offset	0.00 dB

4.95 LAvg dBm   2.06 Pk/Av dB   7.01 PkHld dBm



50 us/Div

Device
Printer
Device Type
LaserJet
Output Port
Disk
Plot Label
Off On
Graph & Text
Off On
Select
02

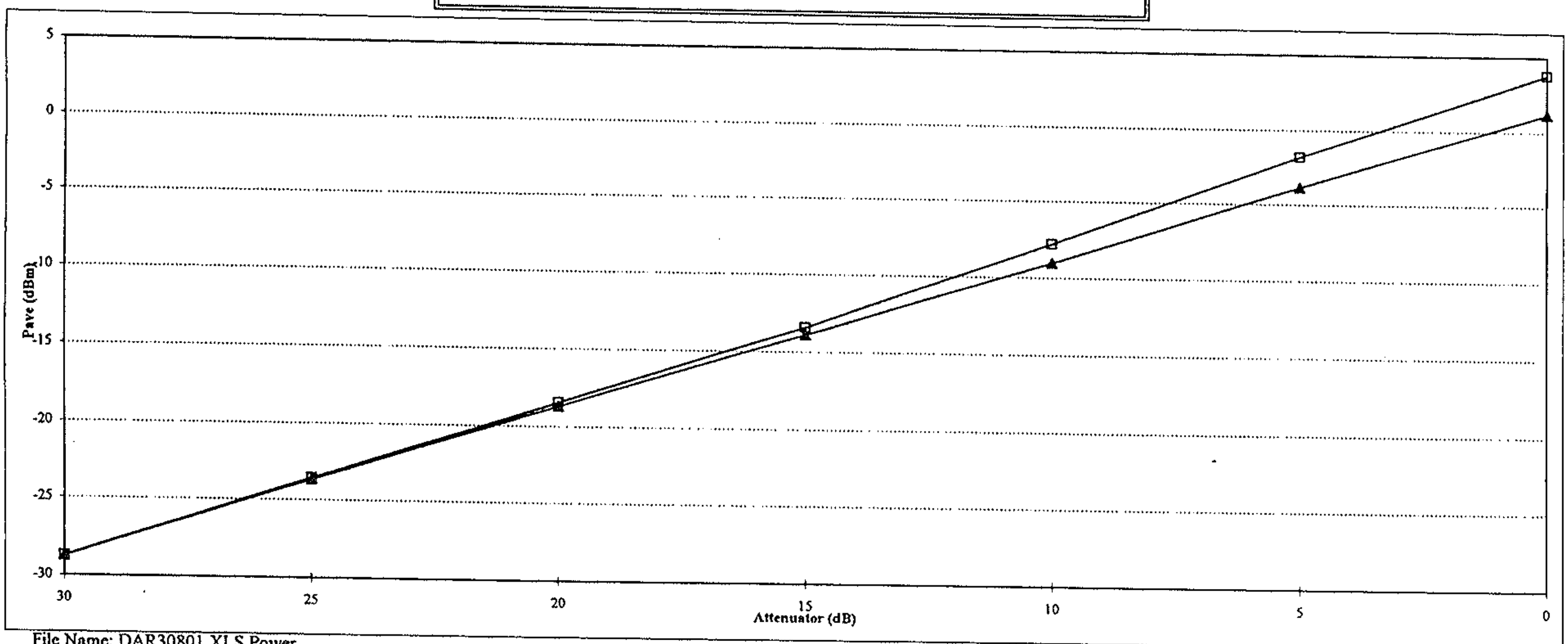
APPENDIX P

Power Meter Calibration

EIA Digital Audio Radio Test Laboratory

Power Meter Calibration

Attenuator	CW (dBm) 1470 MHz	E-147 (dBm)	Δ
40	-38.82	-38.82	0.00
35	-33.67	-33.67	0.00
30	-28.75	-28.72	-0.03
25	-23.69	-23.59	-0.10
20	-18.70	-18.45	-0.25
15	-13.90	-13.41	-0.49
10	-9.02	-7.80	-1.22
5	-3.85	-1.83	-2.02
0	1.15	3.80	-2.65
7	-5.89	-4.22	-1.67
8.3	-7.19	-5.54	-1.65



File Name: DAR30801.XLS Power

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:
SUBMITTER'S NAME: COMPANY:	TEL: FAX: EMAIL:
ADDRESS:	
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:

SIGNATURE:	DATE:

FOR NRSC USE ONLY

Date forwarded to NAB Technology: ______________________________________

Responsible Committee: ______________________________________

Co-chairmen: ______________________________________

Date forwarded to co-chairmen: ______________________________________

CEA®
Consumer Electronics Association

NAB™
NATIONAL ASSOCIATION OF BROADCASTERS