NRSC REPORT

NATIONAL RADIO SYSTEMS COMMITTEE

NRSC-R37
FM Receiver Interference Tests - Laboratory Test Report
July 27, 1999

Part I - Report

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FOREWORD

NRSC-R37, FM Receiver Interference Tests - Laboratory Test Report, presents the results of a technical study conducted for National Public Radio, the Consumer Electronics Manufacturers Association (CEMA, precursor to CEA), and the Corporation for Public Broadcasting to document the sensitivity of consumer FM receivers to interference from other FM band signals. This report was filed with the FCC on August 2, 1999 in MM Docket No. 99-25, In the Matter of Creation of a Low Power Radio Service.

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.

FM Receiver Interference Tests

Laboratory Test Report

Test were Conducted under the Auspices of:

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RMC Technologies
North Olmsted, Ohio

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CONSUMER ELECTRONICS MANUFACTURERS ASSOCIATION
A sector of the
ELECTRONIC INDUSTRIES ALLIANCE

FM Receiver Laboratory Test Report

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Summary of FM Receiver Laboratory Tests

The purpose of these laboratory tests is to document the sensitivity of consumer FM receivers to interference from other FM band signals. The tests were divided into seven sub-tests, A through G:

A Laboratory Calibration and Receiver Certification

Laboratory Test A was divided into three categories: characterization of the sixteen consumer receivers, laboratory calibration and certification, and noise measurement methodology.

B Interference

Objective co-channel, 1st, 2nd, and 3rd adjacent interference tests were conducted in the laboratory. For these tests the undesired signal was modulation with noise and the desired signal with pilot only. Subjective recordings were made of the 2nd and 3rd adjacent tests. For the subjective recordings music was used for the program material on both the desired and undesired channels.

Two test scenarios for evaluating receiver performance with interference were conducted; the first scenario was to find the D/U at a target audio signal-to-noise, and the second scenario measured the audio S/N at a fixed D/U.

The results of the co-channel tests show that by contemporary audio quality standards significant interference was found at the FCC 20 dB D/U co-channel contour. At this D/U the average S/N measured 22 dB for the 16 receivers.

The results of the 1st adjacent test show that the average receiver S/N at the 6 dB D/U contour was 35 dB.

The results of the 2nd adjacent tests show that with a –20 db D/U the S/N averaged 45 dB for the 16 receivers and with a –40 dB D/U the S/N averaged 24 dB.

The results of the 3rd adjacent tests show that with a -30 dB D/U the S/N averaged 42 dB for the 16 receivers and with a –50 dB D/U the S/N averaged 27 dB.

Note: The above results are from those tests where the desired signal was set for –50 dBm (see Appendix B).

C Post-Detection Noise

Post detection error results in an increase in the FM receiver's baseband noise floor with first adjacent channel interference and with the desired channel audio modulated. The mixing of the first adjacent signal and desired audio signal modulation causes this noise increase. The test results show that even within 6 dB D/U first adjacent contour the baseband noise increase caused a significant increase in noise at the subcarrier frequencies.

D IF Taboo and L.O. Interference

The FCC intermediate frequency (IF) taboo protects stations from intermodulation interference caused by two stronger stations operating in the same service area with a frequency separation of 10.6 MHz or 10.8 MHz (FM receiver IF is 10.7 MHz). This interference is receiver dependent and will be heard on most FM band signals that are lower in RF level than the two undesired stations separated by 10.6 MHz or 10.8 MHz.

Local oscillator (L.O.) interference is caused by a single station operating at 10.6 MHz or 10.8 MHz above the desired signal. This interference is controlled by adhering to the IF taboo protection requirements.

The results of these tests show that the present FCC rules minimized IF intermodulation and L.O. interference.

E Reduced Undesired Modulation

The objective of this test is to evaluate restricted FM modulation scenarios for their impact on 2nd and 3rd adjacent channel interference. These tests also evaluated the quality of the audio signal using restricted modulation. The tests compared the interference caused by an FM signal using restricted modulation with a signal using standard stereo modulation. With a second adjacent interference and with a –20 dB D/U, the desired receiver's audio S/N was reduced by 4 to 13 dB and for a D/U of –40 dB (two receivers), the interference was reduced by 8 to 9 dB. It is important to note that at the –40 dB D/U two of the receivers stopped operating.

F Performance in on-air Environment

The objective of this test is to observe the FM receiver performance in a multi-station on-air environment and compare that with the laboratory test performance. The output of the receiving antenna was combined with the output of the test bed and fed directly to the receiver being tested. The test showed a noise increase with the introduction of the off-air FM band and that the average increase is dependent on the overall level of the off-air signals.

G Intermodulation with 800 kHz Channel Spacing

The mixing of two or more undesired signals in a non-linear portion of an FM receiver will generate spurious response (intermodulation). Intermodulation interference results when three evenly spaced signals are received and the desired signal is lower in level than the two undesired signals. In these laboratory tests the three signals were spaced at 800 kHz intervals.

From the results of these tests it is clear that the majority of FM receivers are sensitive to RF intermodulation interference. It is also clear that station frequency spacing and the signal level is critical for minimizing intermodulation.

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Test A
Laboratory Calibration and Receiver Characterization
(Reference Appendix A)

General

Laboratory test procedure A was divided into three categories: receiver characterization, test bed calibration, and noise measurement methodology. Procedure A.1 describes the detailed characterization process of each of the sixteen consumer receivers. Parts A.2 through A.6 detail the laboratory certification, and A.7 describes the noise measurement.

A.1 Receiver Characterization Tests

The receiver characterization is the preliminary step in the testing process that was designed to develop a thorough technical record of each receiver's performance and operating characteristics prior to the interference measurements. The tests are based on the IEEE IHF-T-200 1975 Standard Methods of Testing Frequency Modulation Broadcast Receivers and the IEC 315-1 Methods of Measurement on Radio Receivers for Various Classes of Emission. These tests measure the local oscillator frequency, set a standard audio output level, find the input overload point, measure AM rejection, measured image rejection, plot S/N vs RF level curves, and measure capture ratio, selectivity to 1st, 2nd, and 3rd adjacent interference, 10.7 MHz rejection, 10.7 MHz intermodulation (IM) and 10.7 MHz local oscillator interference. The receiver type, manufacture, model, and serial number are listed on the first page of each receiver report. Charts showing the selectivity for 30 dB and 50 dB noise floors are included. The last page of each receiver report is a chart showing the results of the IF intermodulation taboo tests and the local oscillator rejection tests.

The first form in Appendix RECEIVER is the 16-page test procedure used to conduct the receiver characterization laboratory tests. This form is also used for reporting the test data .

The results of the A.1 receiver certification tests are summarized in a table on page 3. The receivers are divided into three categories: automotive, portable, and home HiFi. The adjacent channel tests were conducted on the channels above and below the desired, and the results averaged. Because the A1 tests use tones rather than program audio or noise to simulate program audio for the undesired transmitter modulation, the results should only be used to evaluate receiver performance and not to establish protection ratios.

The adjacent tests were conducted in both mono and stereo. The sensitivity to first adjacent channel interference tests results showed that the majority of receivers were more sensitive to interference with the FM system operating in stereo. This was somewhat true for the 2nd and 3rd adjacent tests with a decreasing spread between mono and stereo signal-to-noise (S/N).

The complete results of the receiver characterization tests are in Appendix RECEIVER.

A2 through A6 Test Bed Certification

Pages 1 through 3 of Appendix A are block diagrams of the laboratory test bed calibration set up including device RF losses and measuring instrument nomenclature. Pages 4 through 12 are block diagrams of the 10 test bed setups. Page 13 is a block diagram showing the method of measuring power and the test bed losses. Page 14 shows the antenna-coupling network used for the personal portable radios. A HP 8590B spectrum analyzer was also used to monitor the output of the test bed and to calibrate the modulation monitor. Page 15 is a plot of the 75 kHz bessel null during the calibration of the AFM2 modulation monitor.

Pages 16 through 19 show the spectrum analyzer RF plots associated with the procedure used for setting up the stereo FM undesired channel transmitter modulated with clipped pink noise (CPN). The undesired transmitter is setup so the spectral characteristics when modulated with CPN are similar to the spectral characteristics of an FM station. Page 16 is a peak hold spectrum plot of a FM station in Cleveland operating at 104.1 MHz. This station's plot was used for the undesired modulation reference. Page 17 shows the spectrum of the undesired laboratory transmitter using processed clipped pink noise (CPN). Page 18 is a peak hold plot of the undesired spectrum with the laboratory transmission system modulated with rock music. Page 19 shows a spectral plot of the undesired transmitter modulated with CPN overlaid with the off-air signal.

The spectrum plots on pages 20 through 29 are the plots that were used to certify the calibration of the FM interference test bed.

A.7 Audio Noise Measurements

Weighted quasi-peak (WQP) measurements are quasi-peak detected using the CCIR 468-3 weighting filter. The CCIR filter has a spectral response similar to the human ear.

WQP S/N/ THD RMS MEASUREMENTS

The objective of this test is to compare the capability of the two methods for measuring audio interference (WQP S/N/ THD RMS).

The tables on page 30 show the results of upper second adjacent tests on two receivers (Denon TU380 and Pioneer SX201) using the two methods of measurement. Both of these receivers were used in the digital radio laboratory compatibility tests and are receivers #2 and #4 in this test series. These tests were conducted using the Audio Precision (P1PA) audio analyzer. The table shows that for the Denon TU380 receiver WQP S/N measurements 55.6 dB at a –20 dB D/U and 31.7 dB at a D/U of –50 dB. This was a change of 24 dB in audio S/N. For the same D/U change, the THD RMS value changed 0.72 %.

The WQP S/N measurement is more sensitive changes in interference than the THD RMS. The WQP measurement is weighted to simulate frequency response of the human ear.

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FM Receive st Laboratory

FM Receiver Test Laboratory Status

Tst No.	Description	Mfg. / Units	Automotive					Portable						Home HiFi				
	Updated: 7/10/99		Delco 1	Ford 5	Audivox 7	Koss 13	Ford 15	Panason 3	SonyWalk 9	Sanyo 11	SonyTR 12	Magnvox 14	RadioShk 16	Den380 2	Pioneer 4	Den680 6	SonyHiFi 8	TechHiFi 10
	Age	Years	5	5	5	1	1	5	7	1	1	1	1	5	5	4		1
	Tuning Type	Dig/VFO	Dig	Dig	Dig	Dig	Dig	VFO	Dig	Dig	Dig	VFO	VFO	Dig	Dig	Dig	Dig	Dig
	Mixer Type	Bal/Tran																
	No. IF Filters	1/2/3	3		2			1	1					2	1	3		
	Stereo Decoder Type	PLL/Walsh	Walsh	Walsh	PLL			PLL	PLL				PLL	PLL	PLL	Walsh		

Test A1 Status

1	L.O. Freq. (MHz)																	
	L.O. Freq 1	(MHz)	104.800	104.800	104.800			104.898	104.850	104.821	104.800			104.794	104.806	104.800	104.800	104.756
	L.O. Freq 2	(MHz)																
2	Std. Audio Output																	
	Lev. L	(Vrms)	2.000	1.700	1.900	0.500	1.980	1.000	0.460	0.840	0.745	1.000	0.502	0.775	0.710	0.580	0.325	0.315
	THD L	(%)	0.640	1.000	0.740	0.950	1.600	0.560	1.700	0.400	3.400	0.900	0.340	0.160	0.950	0.047	0.220	0.260
	Lev. R	(Vrms)	2.000	1.700	1.200	0.520	2.060	0.950	0.420	0.840	0.765	1.200	0.479	0.780	0.710	0.560	0.330	0.310
	THD R	(%)	0.450	1.000	0.730	0.800	1.600	0.540	1.700	0.350	3.600	0.900	0.330	0.160	0.900	0.055	0.220	0.260
3	RF Input Overload																	
		(dBm)	22.00	22.00	22.00	22.00	22.00	19.50	15.70	22.00	17.00	22.00	22.00	22.00	22.00	22.00	22.00	22.00
4	AM Rejection																	
		(dB)	0.00	0.00	0.00	0.00	0.00	-0.76	0.00	0.00	0.00	0.00	-1.50	0.00	0.00	0.00	0.00	-1.80
5	Image Rejection																	
		(dB)	-44.00	-47.00	-55.00	-46.00	-45.00	-36.00	-38.00	-20.00	-25.00	-41.00	-78.00	-53.00	-31.00	-81.32	-46.00	-44.00
7	Capture Ratio																	
		(dB)	-5.00	-3.50	-2.25	2.50	-8.50	-1.50	-3.90	-6.50	-4.00	7.50	-3.50	-0.55	-2.80	-1.15	-2.85	-1.80
8	Selectivity 1st Adj (30dB)																	
	Mono	Ave D/U	-19.13	-20.53	-18.33	-13.67	-24.00	-4.28	-1.68	-4.08	1.52	-9.90	-6.00	-9.63	-5.20	-6.87	-9.33	-5.88
	Stereo	(dB)	-18.58	-20.53	-14.73	-13.62	-24.00	-3.58	-2.18	-3.08	1.92	-9.00	-2.00	-9.48	-3.53	-6.58	-8.48	-5.88
9	Selectivity 2nd Adj (30dB)																	
	Mono	Ave D/U	-63.08	-63.08	-63.08	-63.02	-63.00	-27.23	-32.33	-26.98	-39.28	-63.00	-27.00	-63.08	-46.63	-51.58	-63.08	-63.08
	Stereo	(dB)	-63.08	-63.08	-63.08	-63.02	-63.00	-26.98	-32.33	-26.98	-38.48	-63.00	-24.50	-62.89	-46.43	-51.58	-63.08	-61.08
10	Selectivity 1st Adj (50dB)																	
	Mono	Ave D/U	5.97	-18.28	-15.13	-10.72	-23.00	-0.78	7.72	-2.28	11.47	-8.10	-2.50	-8.08	-1.68	-2.53	-7.08	-3.98
	Stereo	(dB)	7.42	-18.28	2.17	1.48	-23.00	14.67	14.22	18.42	19.92	11.00	17.50	9.42	17.02	-2.33	11.22	8.42
11	Selectivity 2nd Adj (50dB)																	
	Mono	Ave D/U	-54.58	-27.58	-58.73	-59.50	-63.00	-18.88	-28.43	-22.78	-32.08	-47.00	-20.50	-55.58	-29.58	-40.28	-30.78	-58.23
	Stereo	(dB)	-52.58	-27.58	-54.08	-41.02	-63.00	-15.58	-25.43	-15.38	-23.58	-35.00	-9.50	-48.08	-27.58	-37.88	-30.78	-46.58
12	Selectivity 3rd Adj (50dB)																	
	Mono	Ave D/U	-56.58	-31.58	-61.58	-63.02	-63.00	-30.58	-33.88	-27.43	-39.58	-55.00	-21.00	-62.99	-44.08	-37.83	-47.93	-56.23
	Stereo	(dB)	-54.58	-31.58	-54.08	-46.52	-63.00	-28.58	-33.58	-27.18	-29.83	-35.00	-19.00	-43.58	-44.08	-37.83	-47.93	-46.58
13	10.7MHz Rejection																	
		(dB)	-105.00	-77.70	-90.00	-100.50	-122.00	-68.00	-118.50	-93.40	-51.50	-72.00	-115.50	-87.70	-88.30	-128.50	-131.00	-83.50
14	10.7MHz IM Rej.																	
	10.6MHz Real World	D/U	-31.93	-31.93	-26.63	-31.93	-44.00	-20.63	-9.63	-19.63	-12.63	-17.93	-2.00	-20.63	-11.63	-31.63	-24.63	-17.63
	10.7MHz	(dB)	-31.93	-31.93	-24.63	-31.93	-39.00	-15.63	-4.63	-17.63	-9.63	-15.93	0.00	-19.63	-9.63	-31.63	-22.63	-17.63
15	10.7MHz L.O. Rej.																	
	10.6MHz Real World	D/U	-31.93	-28.93	-30.63	-21.02	-12.00	-15.63	-26.63	13.14	7.37	9.07	26.00	-31.63	-15.86	-31.63	-30.63	-14.63
	10.7MHz	(dB)	-31.93	-14.93	-30.63	-16.02	-11.00	6.37	-5.30	17.14	9.37	11.07	26.00	-18.63	-6.86	-29.63	-22.63	-10.63

FM Receiver Test Laboratory

Receiver Group

No.	Mfg / Model
1	Delco Automobile Model: 16192463 Serial: 1000499
2	Denon Home Hi Fi Model: TU-380RD Serial: 4056301149
3	Panasonic Portable Model: RX-FS430 Serial: GR3JA01184
4	Pioneer Home Hi Fi Model: SX-201 Serial: OA3965843C
5	Ford Automobile Model: F4XF-19B132-CB Serial: 9411
6	Denon Home Hi Fi (NAB) Model: TU0680NAB Serial: 2092400103
7	Audiovox Automobile Model: AV-220 Serial: 30901807N
8	Sony Home Hi Fi Model: STR-AV21 Serial: 802086
9	Sony Walkman Model: SRF-M40W Serial: 194352
10	Technics Home Hi Fi Model: SA-EX110 Serial: GY8JA38798
11	Sanyo Shelf Combo Model: MCD-S736 Serial: 8701316
12	Sony Table Model: CFD-S33 Serial: 1132161
13	Koss Automobile Model: MS-457 Serial: 3805003200
14	Phillips/Magnavox Model: AZ2700/17 Serial: KT019841120616
15	Ford Auto Radio (new) Model: XF3F Serial: WANM000067
16	Radio Shack Model: SCR-64 14-704 Serial: 12A98

Note:

Receiver numbering in subsequent showings in this report follows the above convention.

RMC Technologies
FM Receiver Laboratory
23927 Ambour Dr.
North Olmsted, OH 44070
(440) 777-3812

Equipment Inventory Date: 6/24/99

Entry No.	Qty	Manufacturer	Model No.	Serial No.	Description
1	1	RE Instruments	RE107	R01N05	RF Signal Generator
2	1	RE Instruments	RE107	R01N14	RF Signal Generator
3	1	Radiometer	BKF10a	204854	Automatic Distortion Analyzer
4	1	Radiometer	SMU401a	258509	Selective Measuring Unit
5	1	Radiometer	RE110	none	FM Carrier unit
6	1	RE Instruments	AFM2cS3	225395	Modulation Meter
7	1	Radiometer	AFM3b	248575	Modulation Meter
8	1	Radiometer	RV36c	127431	AF Millivoltmeter
9	1	Radiometer	MS27g	204207	RF Signal Generator
10	1	Tektronix	212	MOD716U	Oscilloscope
11	1	Tektronix	335	310716	Oscilloscope
12	1	RCA	WA-504	5847 L51	Audio Generator
13	1	Uniden	BC170	53010752	16 Channel Scanner
14	1	Data Precision	5740	1139	Frequency Counter
15	1	Data Precision	1450	1076	Digital Multimeter
16	1				Power Supply
17	1	RE Instruments	RE20	none	Audio Interface
18	1	Soundesign	4925BLK	16844296	CD Player
19	1	Toshiba	T2135CS	02646045-1	Computer
20					
21	1	Orban	8100	647907	Stereo generator/Processor
22	1	CRL	SG800	CBS85051112	Stereo Generator
23	1	CRL	SG800	H1112	Stereo Generator
24	1	Denon	DTR-80P	8252729	DAT Recorder
25	1	Hewlett Packard	8590B	3212A01889	Spectrum Analyzer
26	1	Audio Precision	P1PA	P1P21091	Audio Analyzer
27	1	Boonton	4220	32202BK	Power Meter
28	1	Boonton	51101	27092	Power Sensor
29	1	Kay	839	027092	Attenuator
30	1	Kay	839	026517	Attenuator
31	1	Delco	16192463	1000499	Automobile radio
32	1	Denon	TU-380RD	4056301149	Home HiFi Tuner
33	1	Panasonic	RX-FS430	GR3JA01184	Portable Radio
34	1	Pioneer	SX-201	OA3965843C	Home HiFi Receiver
35	1	Ford	F4XF-19B132-C	9411	Automobile radio
36	1	Denon	TU0680NAB	2092400103	Home HiFi Tuner
37	1	Audiovox	AV-220	30901807N	Automobile radio
38	1	Sony	STR-AV21	802086	Home HiFi Receiver
39	1	Sony	SRF-M40W	194352	Walkman Radio
40	1	Technics	SA-EX110	GY8JA38798	Home HiFi Receiver
41	1	Sanyo	MCD-S736	8701316	Portable Stereo System
42	1	Sony	CFD-S33	1132161	Portable Stereo System
43	1	Koss	MS-457	3805003200	Automobile radio
44	1	Philips/Magnavox	AZ2700/17	KT0198411206	Portable Stereo System
45	1	Ford/Visteon	XF3F-18C870-BF	WANM000067	Automobile radio
46	1	Ford/Visteon	XF3F-18C870-BF	WANM000060	Automobile radio
47	1	Ford/Visteon	XW7F-18C815-A	DE000003	Automobile radio
48	1	Ford/Visteon	XW7F-18C815-A	DE000022	Automobile radio
49	1	Radio Shack	SCR-64 14-704	12A98	Portable Radio
50					

TEST B
Interference
(Reference Appendix B)

General

Two scenarios for evaluating receiver performance were used in test B. The co-channel, 1st adjacent, and 2nd adjacent tests were first conducted by finding the D/U at target audio signal-to-noise ratio of 45 dB Weighted Quasi-Peak (WQP). For the second part of the B tests (co-channel, 1st and 2nd adjacent), the S/N was measured at fixed D/U points. The 3rd adjacent tests were conducted with three fixed D/U settings.

National Public Radio had established the 45 dB audio S/N ratio as a minimum for quality broadcasting on a previous project.

The undesired signal for all of the objective tests used the clipped pink noise (CPN) described in Test A. Subjective tests were conducted with the 2nd and 3rd adjacent channel interference. The subjective test used music for the program material for the desired and undesired channels.

Test B.1 Co-channel

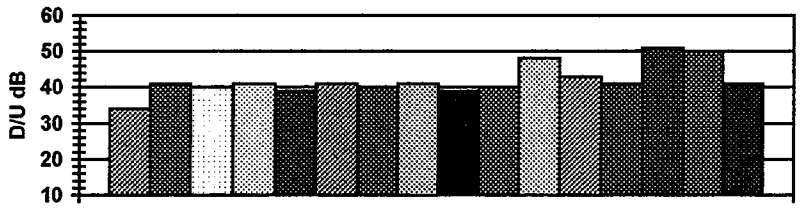
The co-channel tests were conducted with a desired signal level set at –50 dBm.

For Test B.1.3 the undesired signal was increased until a WQP audio S/N ratio of 45 dB was reached, and the D/U recorded at this point. For the 16 receivers the lowest D/U was 34 dB and the highest 51 dB, a 17 dB spread. The average D/U for the 45 dB S/N was 42dB.

Starting from the left side of Chart #1, the D/U for each of the 16 receivers is shown at the 45 dB S/N. It is clear by the values on this chart that none of the receivers came near meeting the target S/N at the FCC +20 dB protected contour. At the target S/N the average receiver needed an additional 22 dB protection.

Note: The ordering of receivers in this and subsequent charts follow the numerical sequence left to right and is listed in section A.

Chart #1 Co-Channel D/U with Audio 45 dB S/N

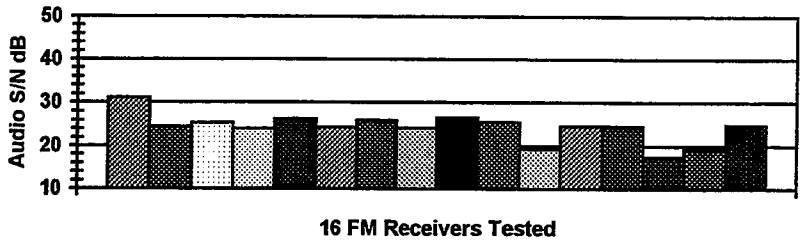


16 Radios Tested (Radio #1 extreme left, #16 right)

For the second part of test B.1.4 the WQP S/N was measured on each of the 16 receivers with the co-channel D/U set at fixed 20dB. The best receiver's audio S/N measured 31 dB and the poorest

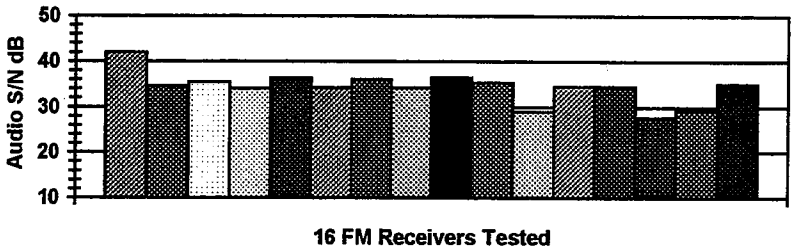
17.5 dB. With 20 dB D/U the average S/N is 24 dB. The results of these tests are illustrated in Chart #2.

Chart #2 Co-Channel Audio S/N with 20 dB D/U



For the third part of the co-channel tests the D/U was set at a fixed 30 dB. The best receiver's audio S/N was 42 dB and the poorest 27.2 dB. With a 10 dB increase in protection the noise dropped by 10 dB. The average S/N for the 30 dB D/U was 34dB (Chart #3).

Chart #3 C-Channel Audio S/N with 30 dB D/U



Conclusion

The results of the B.1 tests show that a significant increase in interference will be experienced with the addition of new stations using FCC 20 dB co-channel protection.

Test B.2 First Adjacent

The first adjacent tests were conducted with the desired signal level set at –50 dBm and –70 dBm. The tests that were conducted at –50 dBm are reviewed. The complete data for the –70 dB tests is in Appendix B.

In test B.2.3 the undesired signal was increased until a WQP audio S/N of 45 dB was measured. The D/U was recorded at this point for the 16 receivers. The average D/U was 17 dB. The results of this test are illustrated in Chart #4. There was a 32 dB D/U spread in the test results.

Chart #4 1st Adj. D/U at 45 dB Audio S/N

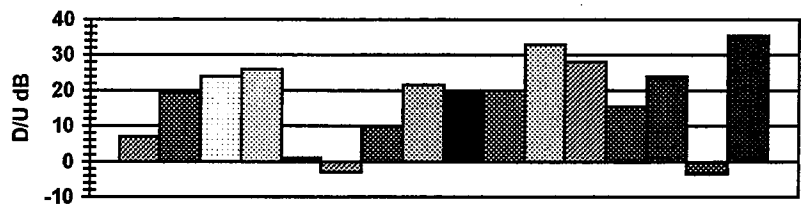
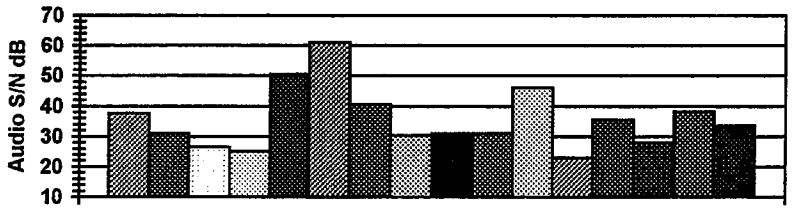


Chart #5 1st Adjacent Audio S/N at a 6 dB D/U



The 1st adjacent tests were repeated with the D/U set at the FCC 6 dB-protection level, and the S/N measured. The results of the tests are summarized in Chart #5. The S/N varied widely from a high of 61 dB to a low of 23 dB. The average S/N for the 6 dB D/U is 36 dB.

Conclusion

The establishment of a protection criteria for first adjacent interference should take into consideration the results of these tests, the post detection errors tests (subcarrier performance), and the effect the first adjacent analog signal will have on the IBOC digital sideband.

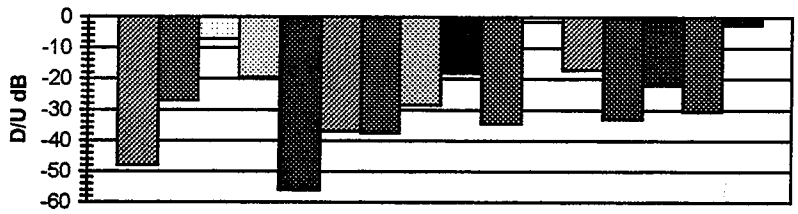
Test B.3 Second Adjacent

Second adjacent objective and subjective tests were conducted in the B.3 test series. The objective tests were conducted at two-desired signal levels –50 dBm and –70 dBm. The subjective tests were conducted at –50 dBm. Only the results of the objective tests conducted at –50 dBm are shown in the charts. The detailed data for all the B tests is in Appendix B.

B.3.3 Target S/N

For test B.3.3 the undesired signal was increased until the target WQP audio S/N of 45 dB was found. The D/U was recorded at this point. The average D/U at the 45 dB S/N was -26 dB. The D/U spread was from -7 dB to -56 dB. Chart #6 shows the test results for the 16 receivers.

Chart #6 2nd Adj D/U with 45 dB Audio S/N



B.3.4 Fixed D/U

Objective 2nd adjacent test B.3.4 was conducted using the sample 16 receivers and measuring the S/N with the D/U set at -20 dB, -30 dB, -40 dB, and –50 dB. Charts #7 through #10 illustrate the results of these tests. It can be seen that the noise increased with the undesired signal, and in some cases the receivers stopped working. The following table lists the average S/N for the four D/U scenarios and the two desired signal levels.

2nd Adjacent Average S/N at Fixed D/U				
	Desired –50 dBm		Desired –70 dBm	
Fixed D/U DB	Average S/N dB	Number of receivers with S/N below 10dB	Average S/N DB	Number of receivers with S/N below 10 dB
-20	45	0	42	0
-30	35	2	39	0
-40	28	4	29	3
-50	24	5	23	5

Note: S/N below 10 dB is considered a complete loss of channel usability.

Chart #7 2nd Adjacent Audio S/N with D/U of -20 dB

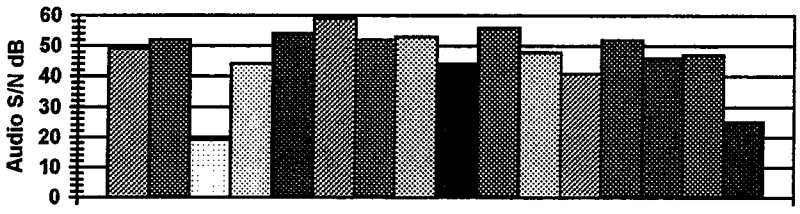


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Chart #8 2nd Adjacent Audio S/N with D/U of -30 dB

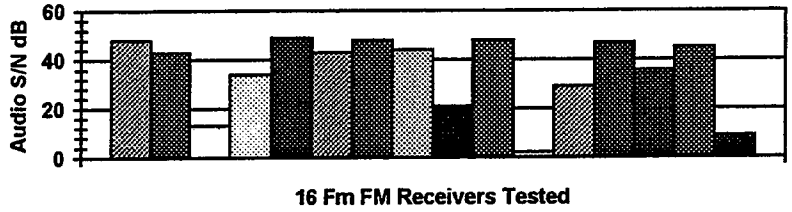


Chart #9 2nd Adjacent Audio S/N with D/U of -40 dB

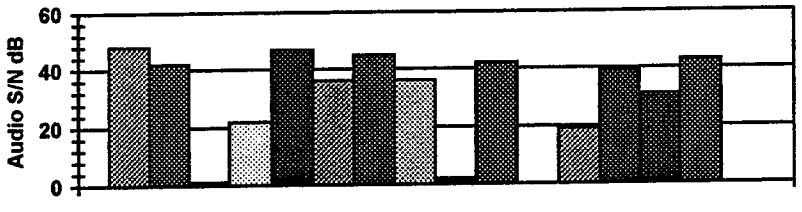
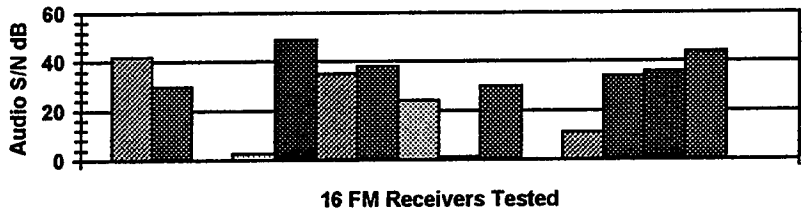


Chart #10 2nd Adjacent Audio S/N with D/U of -50 dB



Conclusion

The above tables and charts show that the 2nd adjacent interference increases significently when the D/U exceeds –20 dB.

Test B.3, 2nd and 3rd Adjacent Subjective

The results of the 2nd and 3rd adjacent subjective tests were recorded on DAT tape and transferred to CD for further assessment. The tests were conducted on receivers #1 through #14. The desired signal was set at a level of -50 dBm. For the 2nd adjacent tests, recordings were made with the undesired signal set for D/Us of -20 dB, -30 dB, -40 dB, and -50 dB, and for the 3rd adjacent the D/Us were set at -30 dB, -40 dB, and -50 dB. For all of the subjective tests the undesired signal was modulated with processed rock music and the desired signal was modulated with classical music. The test was repeated with densely modulated rock music on the desired channel. For the 3rd adjacent subjective tests the desired channel was modulated with only classical music. Each receiver test segment included a reference recording that is without interference.

These test segments clearly show that the when the desired signal is modulated with dense rock program material the interference is masked, and with low passages in the classical music the interference is apparent.

The DAT tape recording log for the 2nd and 3rd adjacent tests is part of the laboratory test data in Appendix B.

Test B.4 Third Adjacent Objective Tests

Objective 3rd adjacent test B.4 was conducted using all 16 of the receivers described in A. The tests were conducted using fixed D/U settings of -30 dB, -40 dB, and –50 dB. The WQP S/N was measured at each one of the D/U settings. All 3rd adjacent tests were conducted with the desired signal set at –50 dBm. Charts #11 through #13 illustrate the results of these tests. It can be seen that the noise increased with the undesired signal, and in some cases the receivers stopped working (no audio). The following table lists the average S/N for the three D/U test scenarios.

Average S/N At three 3rd Adjacent D/U D/U Settings		
	Desired –50 dBm	
Fixed D/U dB	Average S/N dB	S/N below 10dB
-30	42	1
-40	34	2
-50	27	4

Note: S/N below 10 dB is considered a complete loss of channel usability.

Chart #11 3rd Adjacent Audio S/N with D/U of -30 dB

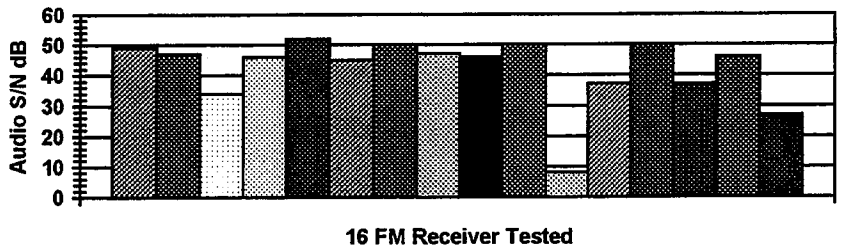


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Chart #12, 3rd Adjacent Audio S/N with D/U of -40 dB

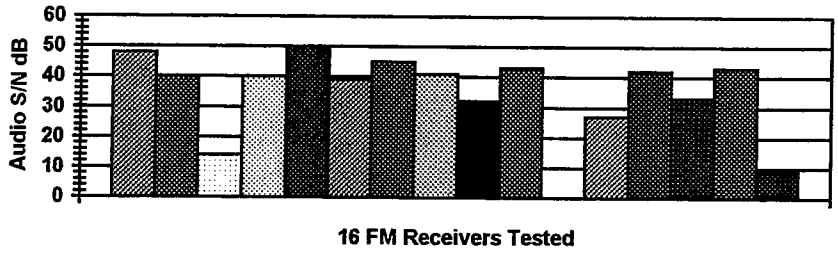
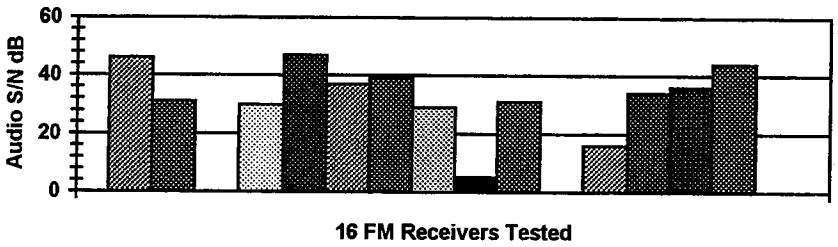


Chart #13, 3rd Adjacent Audio S/N with D/U of -50 dB



Test C Post-Detection Noise
(Reference Appendix C)

General

Post detection error results in an increase in the FM receiver's baseband noise with first adjacent channel interference and only with the desired channel modulated. Without the desired signal modulated the baseband noise increase caused by a first adjacent interference will be less. The interference effects the 38 kHz stereo difference signal and subcarrier band. The effect is greatest at the higher subcarrier frequencies. Because the interference varies with program level, masking reduces the audible effect of the interference on-program material.

C Measurements

The test was conducted using two receivers: the Denon model 380 RBDS modified for 50 ohm baseband output and the RE AFM-2 wideband demodulator (The RE AFM-2 is a laboratory modulation monitor and a precision wideband FM demodulator). The changes in baseband noise floor were observed using a spectrum analyzer.

The Test C table below summarizes the results of 14 baseband noise measurements using the two receiver's spectrum analyzer baseband plots (Appendix C). Plots 1, 2, 3, and 8 show the receiver's baseband noise level without interferers. The right column in the table shows the baseband noise increase in dB estimated from the spectrum analyzer plots at 90 kHz with an undesired 1st adjacent channel. With a 6 dB D/U the AFM2 noise floor increased by 42 dB and the Denon 380 increased by 33 dB at 90 kHz. The effect of the program audio and the 1st adjacent beating together is illustrated in plots #13 and #14. For both tests the D/U was set at 22 dB. The program audio was removed for plot #13. Without program audio the noise floor decreased 27 dB at 90 kHz.

Summary of Baseband Spectrum Plots Test C (Spectrum Analyzer Plots in Appendix C)				
Desired baseband Plot #	Receiver	Desired modultion 10% pilot +	First Adjacent D/U	Baseband noise floor increase at 90 kHz
1	RE AFM 2	1 kHz L=R	Off	0
2		1 kHz L only	Off	0
3	Signal level	1 kHz L only	Off	0
4	–20 dBm	1 kHz L only	35 dB	18 dB
5		1 kHz L only	20 dB	28 dB
6		1 kHz L only	10 dB	38 dB
7		1 kHz L only	6 dB	42 dB
8	Denon 380	1 kHz L only	Off	0 (Spurs at other frequencies)
9	Signal level	1 kHz L only	30 dB	13 dB
10	–50 dBm	1 kHz L only	20 dB	24 dB
11		1 kHz L only	10 dB	33 dB
12		1 kHz L only	6 dB	38 dB
13		Pilot only	22 dB	6 dB
14		1 Khz L only	22 dB	33 dB

Conclusion

Test C showed that even within the 6 dB first adjacent protection contour the baseband noise caused by the mixing of the first adjacent channel signal with the desired channel's program audio caused a significant noise increase at the subcarrier frequencies. The noise level is dependent on the 1st adjacent level and the desired program audio content.

TEST D
IF Taboo and L.O. Interference
(Reference Appendix D)

General

The FCC intermediate frequency (IF) taboo protects stations from intermodulation interference caused by two stronger stations operating in the same service area with a frequency separation of 10.6 MHz or 10.8 MHz (FM receiver IF is 10.7 MHz). Two stations separated by the near IF frequency can cause receiver intermodulation resulting in audible noise on the desired channels. This interference is receiver dependent and will be heard on most FM band signals that are lower in RF level than the two undesired stations separated by 10.6 MHz or 10.8 MHz.

Local oscillator (L.O.) interference is caused by a single station operating at 10.6 MHz or 10.8 MHz above the desired signal. The FCC incidentally controls this interference with the IF taboo. This interference is avoided by adhering to the IF taboo protection requirements.

D.1 IF Taboo Test

The seven receivers that measured the most sensitive to IF taboo in test A.1.14 were selected for this test.

The desired signal frequency for Test D.1 was set at 94.1 MHz. The frequency of the desired is not critical. The first undesired signal was set at 88.7 MHz and the second was at 99.3 MHz or 99.5 MHz (undesired separation of 10.6 MHz or 10.8 MHz). The two undesired signals were always at equal RF power levels. The D/U is the ratio between the desired signal RF level and the individual undesired RF level. Two target audio WQP S/N levels were used, 30 dB and 40 dB. The following table shows the average D/U for the four test modes.

The D.1 test series was conducted with two desired signal levels, –45 dBm and –60 dBm.

D.1 IM 10.6 MHz and 10.8 MHz Undesired Spacing (for seven selected receivers)			
Test	Desired Signal Level	Target WQP S/N	Average D/U
D.1.5	-45 dBm	40 dB	-12 dB
D.1.6	-45 dBm	30 dB	-17 dB
D.1.9	-60 dBm	40 dB	-20 dB
D.1.9	-60 dBm	30 dB	-25 dB

The above table lists the average test results for the seven receivers. To maintain an average 40 dB audio S/N in test D.1.5 the average D/U can be no higher than –12 dB. The desired RF level for test D.1.5 was –45 dBm. To maintain an average 40 dB audio S/N in test D.1.9 the average D/U can be no higher than –12 dB. The desired RF level for test D.1.9 was –60 dBm.

The individual values listed in the charts in Appendix D are the average target D/U values for the 10.6 MHz and 10.8 MHz spacing tests. All of the test data and additional charts are in Appendix D.

Test D.2
Local Oscillator Interference

These tests measure the interference caused by a station operating at 10.6 MHz or 10.8 MHz above the desired station. The undesired frequency is within +/- 100 kHz of the receiver's local oscillator frequency. The test used the seven receivers that measured sensitive to local oscillator inference in certification Test A.1.15. Two desired RF signal levels were used, –45 dBm and –60 dBm.

The results of local oscillator interference tests are summarized in the following table. The L.O. tests were all target audio S/N tests (fixed S/N). The interferer signal level was increased until the target audio S/N was measured at the test receiver's output. The tests were conducted with the undesired FM signal modulated with tone, and the test repeated with clipped pink noise modulating the undesired laboratory transmitter simulating a typical processed FM broadcast signal.

The L.O. interference graphs (Appendix D) illustrate the test results and the wide variation in receiver sensitivity to this interference. By limiting the assignment of stations spaced by 10.6 MHz and 10.8 MHz the FCC IF taboo has reduced the potential for local oscillator interference from occurring.

D2 Local Oscillator Interference 10.6 MHz and 10.8 MHz Above Desired Frequency (for seven selected receivers)						
Test	Frequency MHz	Desired Signal Level dBm	Target WQP S/N dB	Worst Case D/U dB	Best Case D/U dB	Undesired Modulation
B.2.4	+10.6	-45	40	+22	-22	400 Hz tone
B.2.4	+10.8	-45	40	+21	-32	400 Hz tone
B.2.5	+10.6	-45	30	+11	-32	400 Hz tone
B.2.5	+10.8	-45	30	+11	-41	400 Hz tone
B.2.6	+10.6	-45	40	18	-23	CPN
B.2.6	+10.8	-45	40	19	-33	CPN
B.2.6	+10.6	-45	30	8	-33	CPN
B.2.6	+10.8	-45	30	9	-42	CPN
B.2.7	+10.6	-60	40	8	-38	400 Hz tone
B.2.7	+10.8	-60	40	8	-49	400 Hz tone
B.2.7	+10.6	-60	30	-3	-47	400 Hz tone
B.2.7	+10.8	-60	30	-4	-58	400 Hz tone
B.2.7	+10.6	-60	40	4	-39	CPN
B.2.7	+10.8	-60	40	6	-50	CPN
B.2.7	+10.6	-60	30	-7	-48	CPN
B.2.7	+10.8	-60	30	-5	-59	CPN

Additional L.O. interference charts are located in Appendix D.

Conclusion

The results of these tests show that the 10.6 MHz and 10.8 MHz spacing specified in the FCC rules have minimized IF intermodulation and L.O. interference. The interference that will result by the elimination of the IF taboo can be estimated using the laboratory test data in Appendix D.

TEST E
Reduced Undesired Modulation
(Reference Appendix E)

General

The objective of this test is to evaluate restricted FM modulation scenarios for their impact on 2nd and 3rd adjacent channel interference. These tests also evaluated the quality of the audio signal using restricted modulation. Subjective digital recordings were made using program audio on the desire and undesired channels with 2nd and 3rd adjacent interference. The tests compare the interference from a FM signal using restricted modulation with a standard modulated signal.

Three consumer receivers were used to evaluate reductions in interference and evaluate changes in receiver performance. A representative auto, high-end home hi-fi, and competitive home hi-fi receivers were selected for these measurements.

The following table lists the seven restricted modulation scenarios used for the interference tests.

Reduced Modulation Scenarios		
Mode	Audio BW kHz	FM deviation kHz
Mono	8	75
Mono	8	37.5
Mono	15	75
Mono	15	37.5
Stereo (reference)	15	75
Stereo	15	37.5
Stereo with subcarrier (20% 67 kHz)	15	82.5
Stereo with subcarrier (20% 67 kHz)	15	41.2

Test E1 Restricted Modulation Quality

Test E.1 is designed to evaluate the performance of the FM stereo system operating with reduced deviation. The table compares the reference stereo performance with the reduced deviation stereo performance through the three receivers. The complete data for the quality test is in Appendix E.

Test E1 Restricted Modulation Quality Performance STEREO						
	75 kHz Deviation			37.5 kHz Deviation		
Receiver Type	WQP S/N	Separation	Distortion	WQP S/N	Separation	Distortion
Auto Receiver	50dB	27dB	0.5%	43dB	35dB	0.4%
High end Home Hi-Fi	61dB	38dB	0.2%	55dB	39dB	0.1%
Competitive Home Hi-Fi	61dB	28dB	0.8%	55dB	30dB	0.4%

Test E2, 2nd and 3rd Adjacent Channel Interference

These tests were conducted using the 8 transmission scenarios listed in the tables. The first two tables show the desired channel WQP audio S/N with the varying modulation scenarios on the 2nd adjacent channel with D/Us set for –20 dB and –40 dB. The desired signal level is –55 dBm.

Test E2 Second Adjacent with a D/U of –20 dB Desired Signal –55 dBm						
Mode	Audio BW in kHz	FM Deviation in kHz	Panasonic S/N in dB	Pioneer S/N in dB	Sanyo S/N in dB	Sony TR S/N in dB
No Mod		CW	46	58	40	49
Mono	8	75	23	45	22	43
Mono	8	37.5	36	55	31	47
Mono	15	75	23	45	22	43
Mono	15	37.5	36	55	31	47
Stereo	15	75	23	45	22	43
Stereo	15	37.5	36	55	31	47
Stereo	15	82.5		45		
Stereo	15	41.2		54		

Test E2 Second Adjacent with a D/U of –40 dB Desired Signal –55 dBm						
Mode	Audio BW in kHz	FM Deviation in kHz	Panasonic S/N in dB	Pioneer S/N in dB	Sanyo S/N in dB	Sony TR S/N in dB
No Mod		CW	16	40	8	36
Mono	8	75	2	25	0	20
Mono	8	37.5	2	34	0	28
Mono	15	75	2	25	0	20
Mono	15	37.5	3	34	0	28
Stereo	15	75	2	25	0	20
Stereo	15	37.5	4	34	0	28
Stereo	15	82.5		25		
Stereo	15	41.2		33		

The following table is for 3rd adjacent with the D/U set at –40 dB.

Test 2 Third Adjacent with a D/U of –40 dB Desired Signal –55 dBm						
Mode	Audio BW in kHz	FM Deviation in kHz	Panasonic S/N in dB	Pioneer S/N in dB	Sanyo S/N in dB	Sony TR S/N in dB
No Mod		CW	16	42	22	38
Mono	8	75	1	40	2	30
Mono	8	37.5	2	40	4	31
Mono	15	75	1	40	0	30
Mono	15	37.5	3	40	6	31
Stereo	15	75	1	40	0	30
Stereo	15	37.5	3	40	7	32
Stereo	15	82.5		40		
Stereo	15	41.2		40		

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Conclusions

The second adjacent –20 dB D/U tests show that the interference to the desired signal is determined by the deviation and not by the high frequency content in the signal. With the –20 dB D/U the desired receiver's audio WQP S/N was reduced by 13 dB, 10 dB, 9 dB, and 4 dB. The rate of improvement is receiver dependent. The tradeoff for this improvement is a reduction in received audio level.

The second table shows the second adjacent interference set at a D/U of –40 dB. With this D/U two receivers showed a reduction in noise with the reduced deviation (8 dB to 9 dB).

The third table shows the third adjacent tests with a D/U set at –40 dB. With this D/U almost no improvement was seen in the third adjacent interference.

For the 2nd and 3rd adjacent –40 dB D/U tests, two of the receivers stopped operating.

Recordings were made for subjective evaluation of the interference improvement. A log of the subjective test recording is in Appendix E.

TEST F
Performance in on-air Environment
(Reference Appendix F)

General

The objective of this test is to observe the FM receiver performance in a multi-station on-air environment and compare that with the laboratory test performance. A block diagram of the laboratory setup is in Appendix A, page 10. The output of the receiving antenna was combined with the output of the test bed and fed directly to the receiver being tested. Five home receivers found sensitive to intermodulation were selected from the 16 receivers characterized in Test A. For a reference the home receiver least sensitive to intermodulation and adjacent channel interference was added to the test sample. An omni-directional and a high gain directional antenna were used to receive the off-air signals.

Test F.1

The desired signal was generated by one of the laboratory signal generators, and the output mixed with the signals from the antenna. Two test frequencies that were found to have the minimum co-channel, 1st and 2nd adjacent interference were selected. The signal set at 91.7 MHz was mixed with the signals from the omni directional antenna. The signal set at 101.7 MHz mixed with the signals from the directional antenna. The directional antenna was oriented toward the Cleveland broadcast transmitter antenna farm approximately 10 miles southeast of the receiving site. The most difficult problem to overcome in selecting a clear test frequency was co-channel interference. Co-channel signals that were not obvious when observed on the spectrum analyzer reduced the received S/N performance by several dB. The omni-directional antenna was about 20 feet and the high gain directional approximately 30 feet above the ground. Spectrum analyzer plots for the resulting signal received with both antennas are in Appendix F. The plots show that the average RF level increased significantly with the directional antenna.

Reduction in S/N Performance with the Addition of the on-air Environment Desired signal level –55 dBm						
Antenna Type and Frequency	Receiver #4	Receiver #6	Receiver #9	Receuver #10	Reveiver #11	Receiver #12
Omni 91.7 MHz	5.5 dB	11.8 dB	1.1 dB	0.0 dB	3.5 dB	0.1 dB
Directional 101.7 MHz	14.6 dB	0.7 dB	15.8 dB	2.2 dB	15.2 dB	31.1 dB

The above table shows the reduction in performance for each of the receivers with the introduction of the local FM band environment. The average S/N reduction for the omni-directional is 3.7 dB and 13.2 dB for the high-gain directional antenna.

Conclusion

It is clear that the sensitivity to interference is receiver dependent. It is also interesting to note that receiver #6, the home HiFi receiver that had the best HiFi or portable performance, had the greatest S/N reduction when using the omni-directional receiving antenna. Except for receiver #6, all the other receivers encountered a reduction in S/N when using the directional antenna.

TEST G
RF Intermodulation with 800 kHz Spacing
(Reference Appendix G)

General

The mixing of two or more undesired signals in a non-linear portion of an FM receiver will generate spurious response (intermodulation). Intermodulation interference results when three evenly spaced signals are received and the desired signal is lower in level than the two undesired signals. In these laboratory tests three signals were spaced at 800 kHz intervals. All 16 receivers were tested using two interfering FM signals, 800 kHz and 1600 kHz above the desired. Other than the IF taboo tested in D, the FCC does not presently regulate the type of intermodulation measured in this test series.

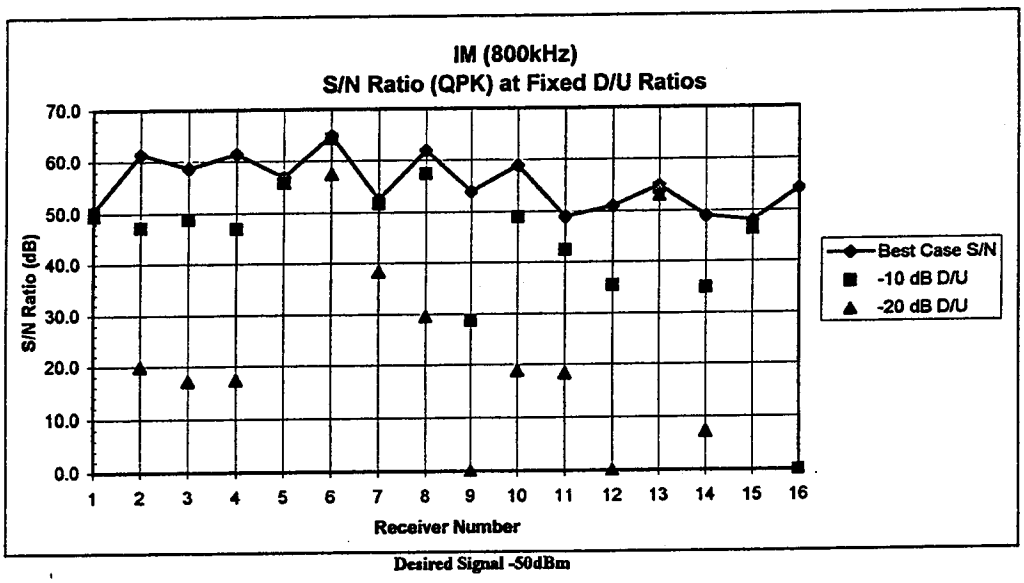
G.1 IM at 45 dB S/N

For the first part of these tests, the two undesired signals were equally increased in level until the target S/N of 45 dB was reached. The desired signal level was –50 dBm for the first and second part of Test G series. The 45 dB SNR graph in Appendix G shows that of the 16 receivers tested, only two were not sensitive to this type of intermodulation.

G.2 IM with fixed D/U

For the first part of test G.2, the desired signal level was –50 dBm with the D/U fixed at –10 dB and –20 dB. The S/N was measured at these points. For the second part of the test the desired signal was decreased to –70 dBm using two fixed D/Us of –20 dB and –30 dB. Again the S/N was measured on each of the 16 receivers for each of the D/Us.

The following graph shows the results of the G.2 test with the fixed D/U and a desired signal level of –50 dBm. In the test that produced the results shown in the graph the desired station frequency was set at 94.1 MHz, undesired station #1, 94.9 MHz and undesired station #2, 95.7 MHz. The three stations were equally spaced by 800 kHz. It can be seen on the graph that at receiving locations where the level for the 94.9 MHz and 95.7 MHz stations exceed the desired signal level by 20 dB, the S/N for 9 of the 16 receivers tuned to 94.1 MHz were below 20 dB.



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Conclusion

From the results of these tests it is clear that the majority of FM receivers are sensitive to RF intermodulation interference. It is also clear that station frequency spacing and the signal level is critical for minimizing this interference.

It should be noted that RF intermodulation interference could exist with other frequency spacing scenarios than the 800 kHz scenario tested. The 800 kHz was selected because it is the most common RF intermodualtion scenario found the United States.

Appendix A

FM Receiver Test Laboratory

RF Test Bed Calibration Data

Date: 3/29/99
Engineer: Rmc
Power Mtr Boonton 4220 W/51101 probe
AFM 2 Modulation Receiver (calibrated to Boonton)

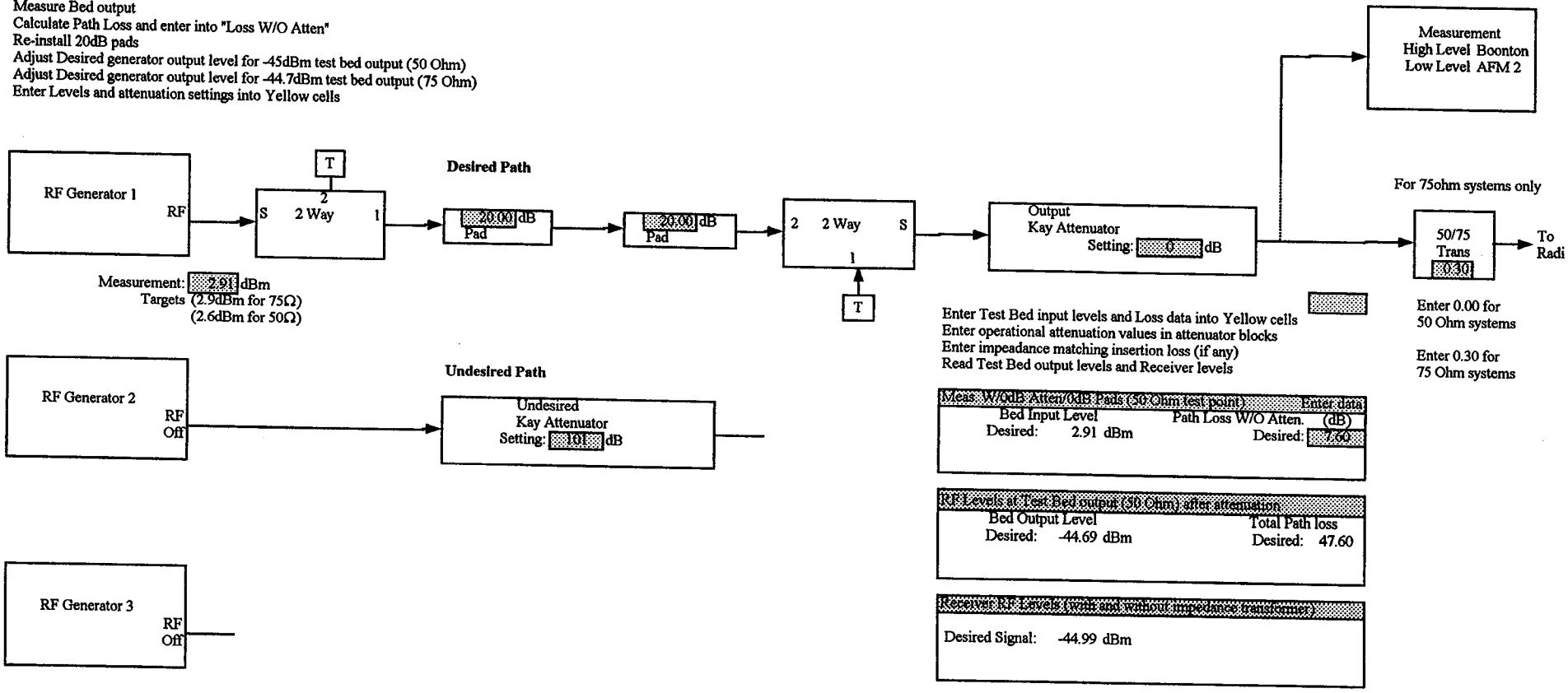
Strong Signal Test Set Up

FM Receiver Test Laboratory

RF Test Bed Calibration Data

Date: 3/29/99
Engineer: RMc
Power Mtr: Boonton 4220 W/51101 probe
AFM 2 Modulation Receiver (calibrated to Boonton)

One Tone Test Bed
Remove 20dB pads in Desired path and set Kay attenuators to 0dB
Measure Generator output
Measure Bed output
Calculate Path Loss and enter into "Loss W/O Atten"
Re-install 20dB pads
Adjust Desired generator output level for -45dBm test bed output (50 Ohm)
Adjust Desired generator output level for -44.7dBm test bed output (75 Ohm)
Enter Levels and attenuation settings into Yellow cells

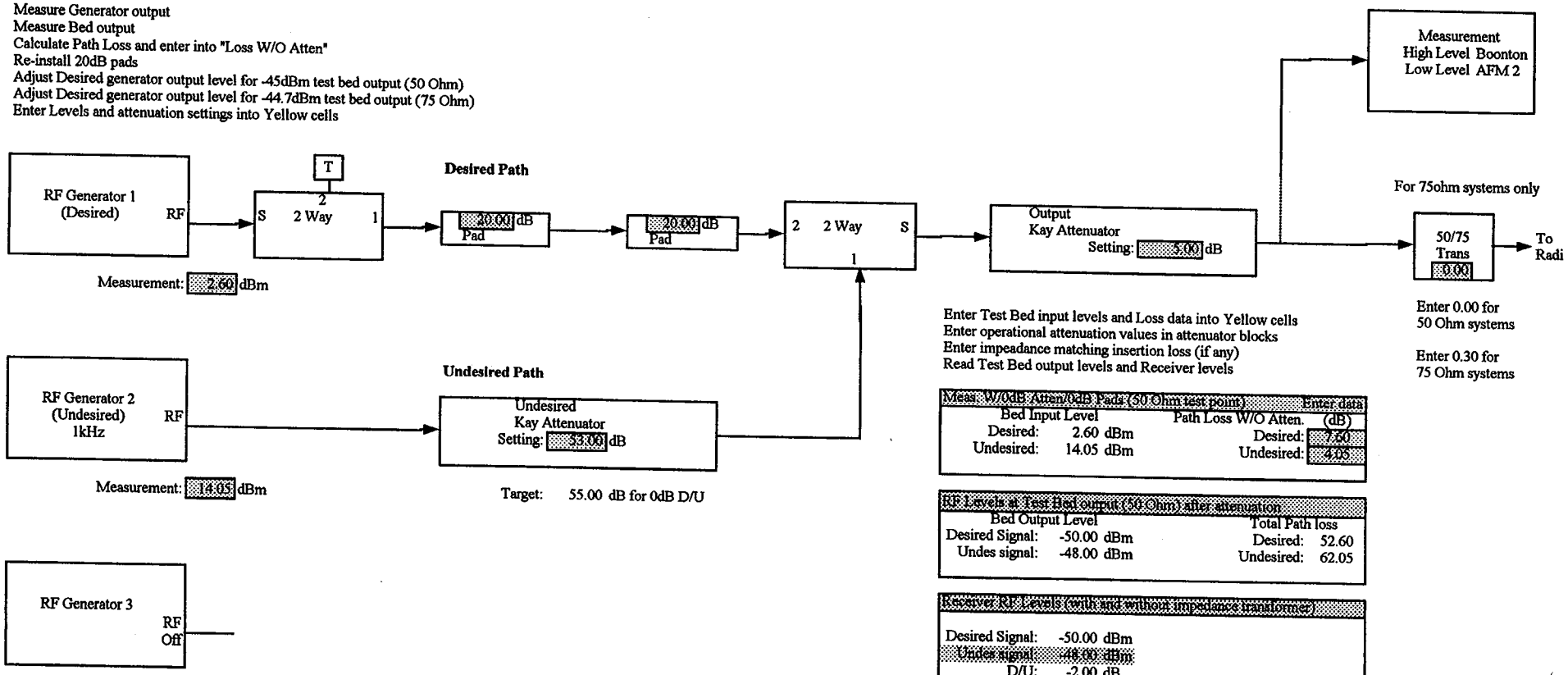


FM Receiver Test Laboratory

RF Test Bed Calibration Data

Date: 3/29/99
Engineer: RMc
Power Mtr: Boonton 4220 W/51101 probe
AFM 2 Modulation Receiver (calibrated to Boonton)

Two Tone Test Bed
Remove 20dB pads in Desired path and set Kay attenuators to 0dB
For both Paths:
Measure Generator output
Measure Bed output
Calculate Path Loss and enter into "Loss W/O Atten"
Re-install 20dB pads
Adjust Desired generator output level for -45dBm test bed output (50 Ohm)
Adjust Desired generator output level for -44.7dBm test bed output (75 Ohm)
Enter Levels and attenuation settings into Yellow cells



Enter Test Bed input levels and Loss data into Yellow cells
Enter operational attenuation values in attenuator blocks
Enter impeadance matching insertion loss (if any)
Read Test Bed output levels and Receiver levels

Meas. W/0dB Atten/0dB Pads (50 Ohm test point)			Enter data
Bed Input Level		Path Loss W/O Atten.	(dB)
Desired:	2.60 dBm	Desired:	7.60
Undesired:	14.05 dBm	Undesired:	4.05

RF Levels at Test Bed output (50 Ohm) after attenuation			
Bed Output Level		Total Path loss	
Desired Signal:	-50.00 dBm	Desired:	52.60
Undes signal:	-48.00 dBm	Undesired:	62.05

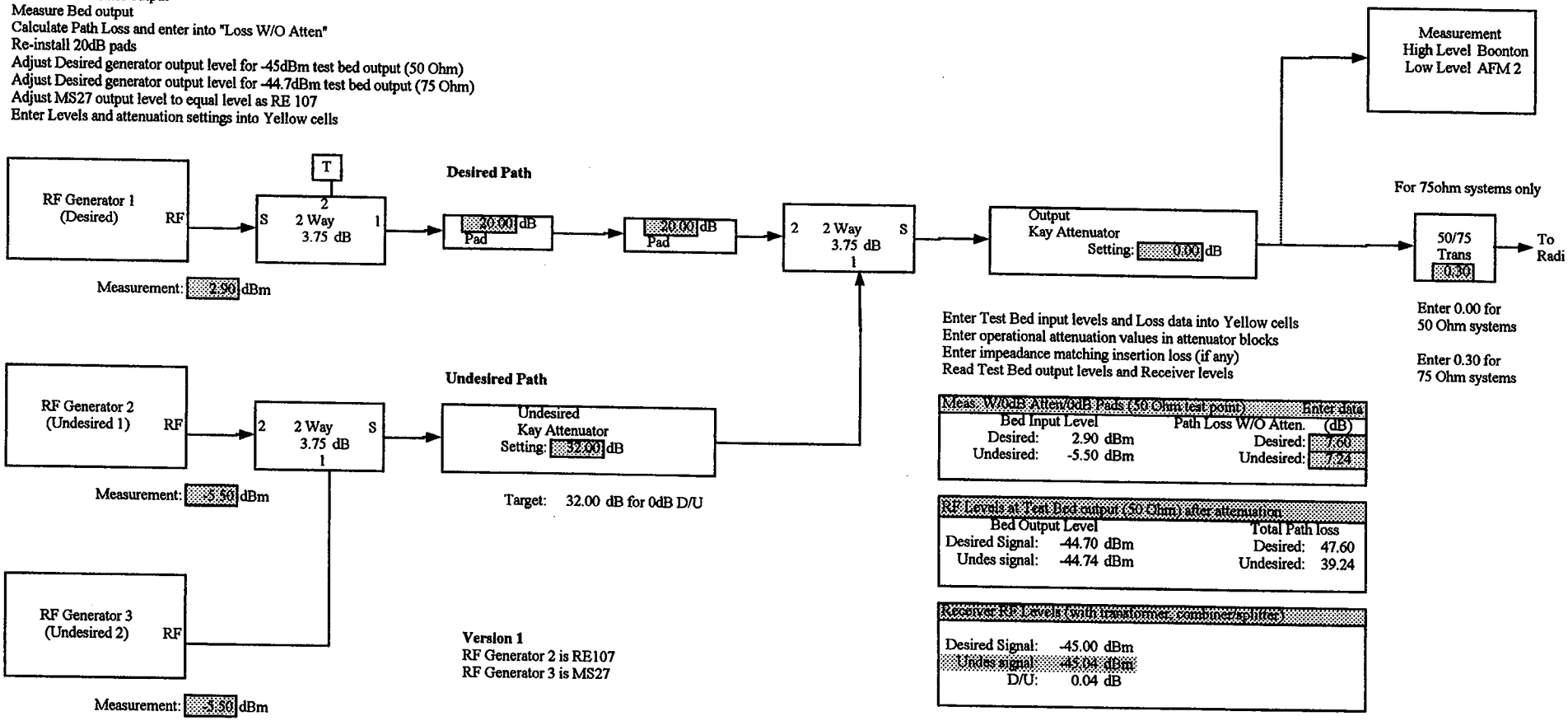
Receiver RF Levels (with and without impedance transformer)	
Desired Signal:	-50.00 dBm
Undes signal:	-48.00 dBm
D/U:	-2.00 dB

FM Receiver Test Laboratory

RF Test Bed Calibration Data

Date: 3/29/99
Engineer: Rmc
Power Mtr Boonton 4220 W/51101 probe
AFM 2 Modulation Receiver (calibrated to Boonton)

Three Tone Test Bed
Remove 20dB pads in Desired path and set Kay attenuators to 0dB
For both paths:
Measure Generator output
Measure Bed output
Calculate Path Loss and enter into "Loss W/O Atten"
Re-install 20dB pads
Adjust Desired generator output level for -45dBm test bed output (50 Ohm)
Adjust Desired generator output level for -44.7dBm test bed output (75 Ohm)
Adjust MS27 output level to equal level as RE 107
Enter Levels and attenuation settings into Yellow cells

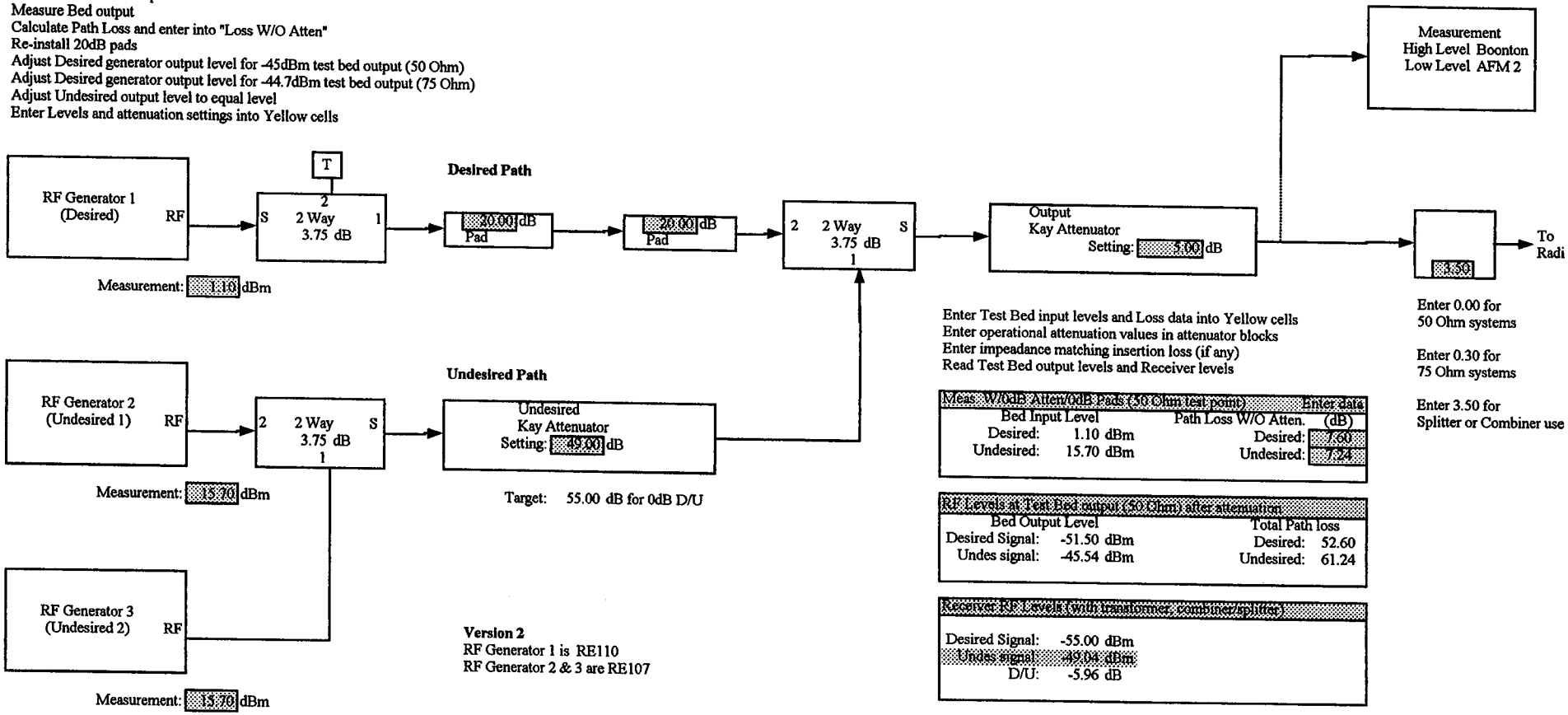


FM Receiver Test Laboratory

RF Test Bed Calibration Data

Date: 3/29/99
Engineer: Rmc
Power Mtr Boonton 4220 W/51101 probe
AFM 2 Modulation Receiver (calibrated to Boonton)

Three Tone Test Bed
Remove 20dB pads in Desired path and set Kay attenuators to 0dB
For both paths:
Measure Generator output
Measure Bed output
Calculate Path Loss and enter into "Loss W/O Atten"
Re-install 20dB pads
Adjust Desired generator output level for -45dBm test bed output (50 Ohm)
Adjust Desired generator output level for -44.7dBm test bed output (75 Ohm)
Adjust Undesired output level to equal level
Enter Levels and attenuation settings into Yellow cells



Enter Test Bed input levels and Loss data into Yellow cells
Enter operational attenuation values in attenuator blocks
Enter impeadance matching insertion loss (if any)
Read Test Bed output levels and Receiver levels

Enter 0.00 for 50 Ohm systems

Enter 0.30 for 75 Ohm systems

Enter 3.50 for Splitter or Combiner use

Meas. W/0dB Atten/0dB Pads (50 Ohm test point) Enter data

Bed Input Level		Path Loss W/O Atten. (dB)	
Desired:	1.10 dBm	Desired:	7.60
Undesired:	15.70 dBm	Undesired:	7.24

RF Levels at Test Bed output (50 Ohm) after attenuation

Bed Output Level		Total Path loss	
Desired Signal:	-51.50 dBm	Desired:	52.60
Undes signal:	-45.54 dBm	Undesired:	61.24

Receiver RF Levels (with transformer, combiner/splitter)

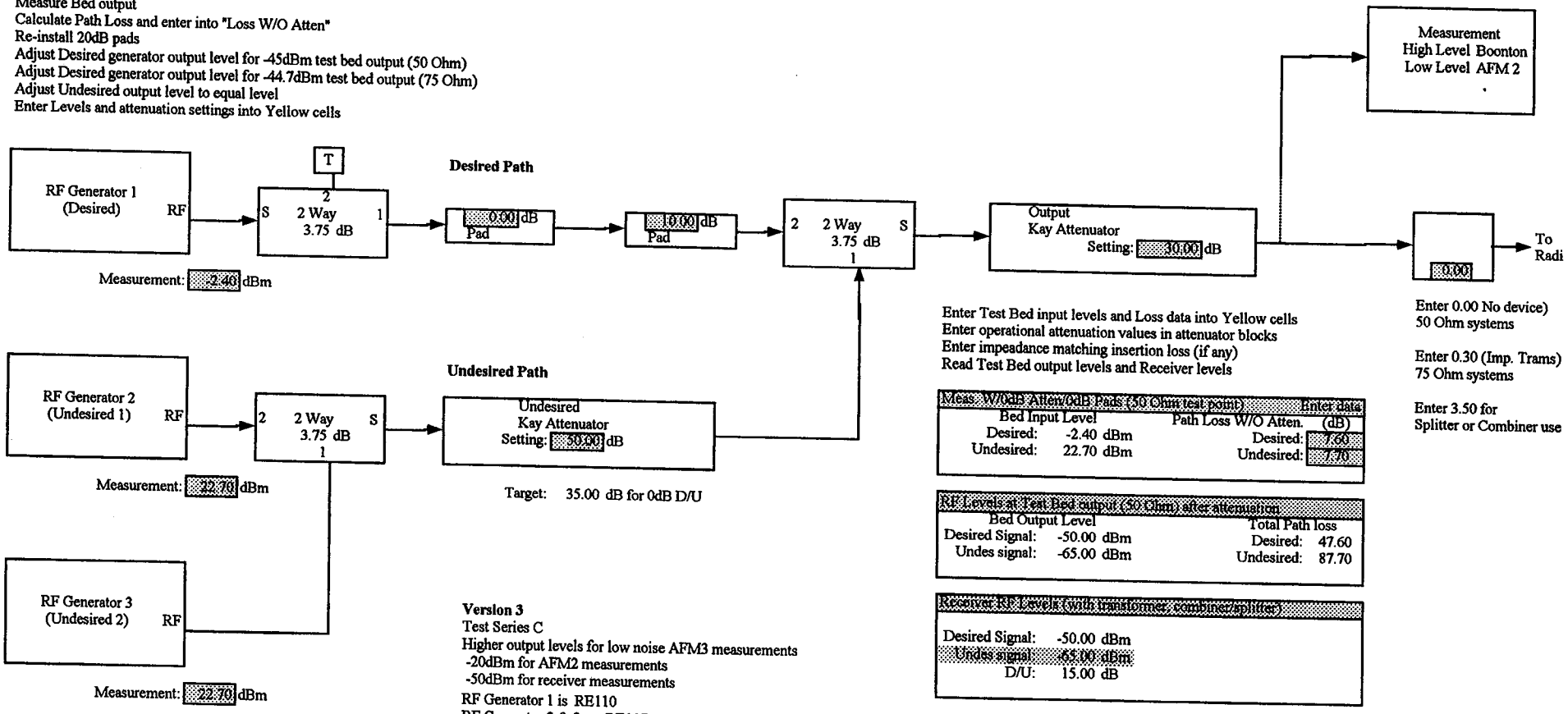
Desired Signal:	-55.00 dBm
Undes signal:	-49.04 dBm
D/U:	-5.96 dB

FM Receiver Test Laboratory

RF Test Bed Calibration Data

Date: 3/29/99
Engineer: Rmc
Power Mtr Boonton 4220 W/51101 probe
AFM 2 Modulation Receiver (calibrated to Boonton)

Three Tone Test Bed
Remove 20dB pads in Desired path and set Kay attenuators to 0dB
For both paths:
Measure Generator output
Measure Bed output
Calculate Path Loss and enter into "Loss W/O Atten"
Re-install 20dB pads
Adjust Desired generator output level for -45dBm test bed output (50 Ohm)
Adjust Desired generator output level for -44.7dBm test bed output (75 Ohm)
Adjust Undesired output level to equal level
Enter Levels and attenuation settings into Yellow cells



Enter Test Bed input levels and Loss data into Yellow cells
Enter operational attenuation values in attenuator blocks
Enter impeadance matching insertion loss (if any)
Read Test Bed output levels and Receiver levels

Enter 0.00 No device)
50 Ohm systems

Enter 0.30 (Imp. Trams)
75 Ohm systems

Enter 3.50 for
Splitter or Combiner use

Meas. W/0dB Atten/0dB Pads (50 Ohm test point) — Enter data

Bed Input Level		Path Loss W/O Atten. (dB)	
Desired:	-2.40 dBm	Desired:	7.60
Undesired:	22.70 dBm	Undesired:	7.70

RF Levels at Test Bed output (50 Ohm) after attenuation

Bed Output Level		Total Path loss	
Desired Signal:	-50.00 dBm	Desired:	47.60
Undes signal:	-65.00 dBm	Undesired:	87.70

Receiver RF Levels (with transformer, combiner/splitter)

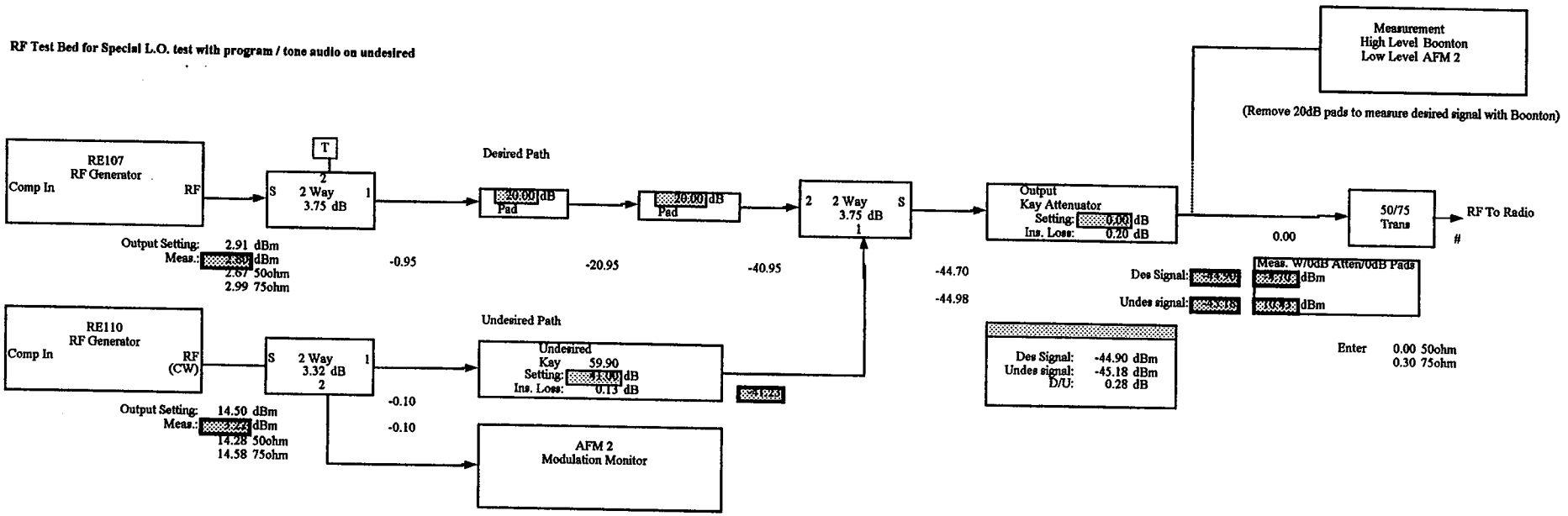
Desired Signal:	-50.00 dBm
Undes signal:	-65.00 dBm
D/U:	15.00 dB

Version 3
Test Series C
Higher output levels for low noise AFM3 measurements
-20dBm for AFM2 measurements
-50dBm for receiver measurements
RF Generator 1 is RE110
RF Generator 2 & 3 are RE107

FM Receiver Test Laboratory

RF Test Bed Calibration Data
RMc
Power Meter: Boonton
AFM 2 Modulation Receiver (calibrated to Boonton)

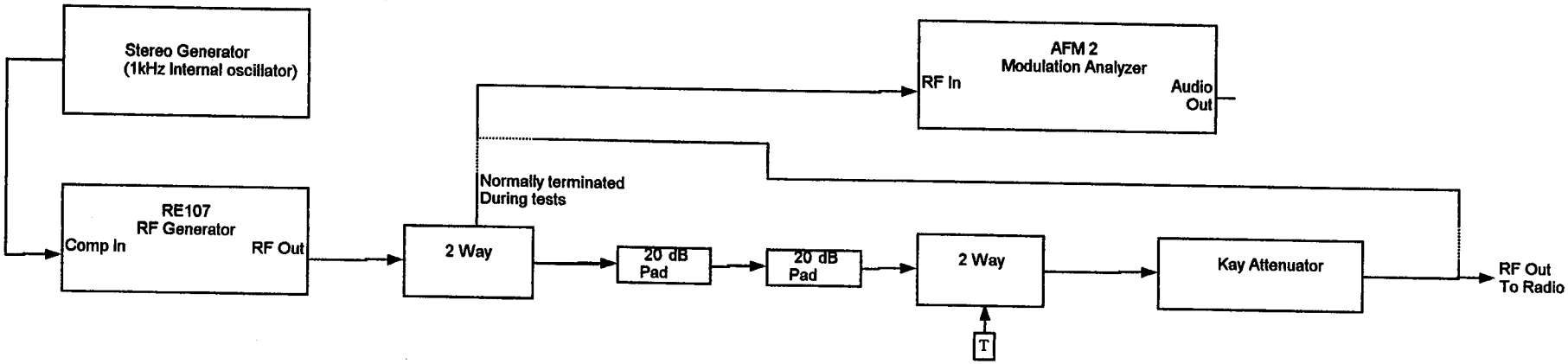
RF Test Bed for Special L.O. test with program / tone audio on undesired



FM Receiver Test Laboratory

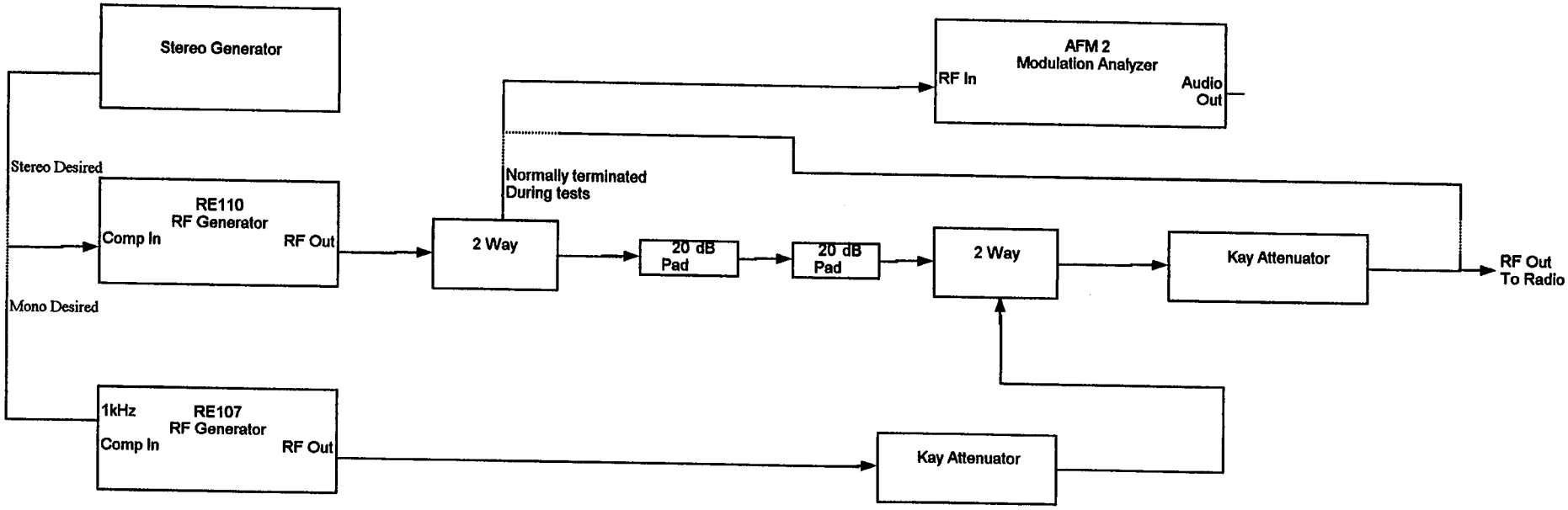
Strong Signal Test

FM Receiver Test Laboratory



Single Tone Tests

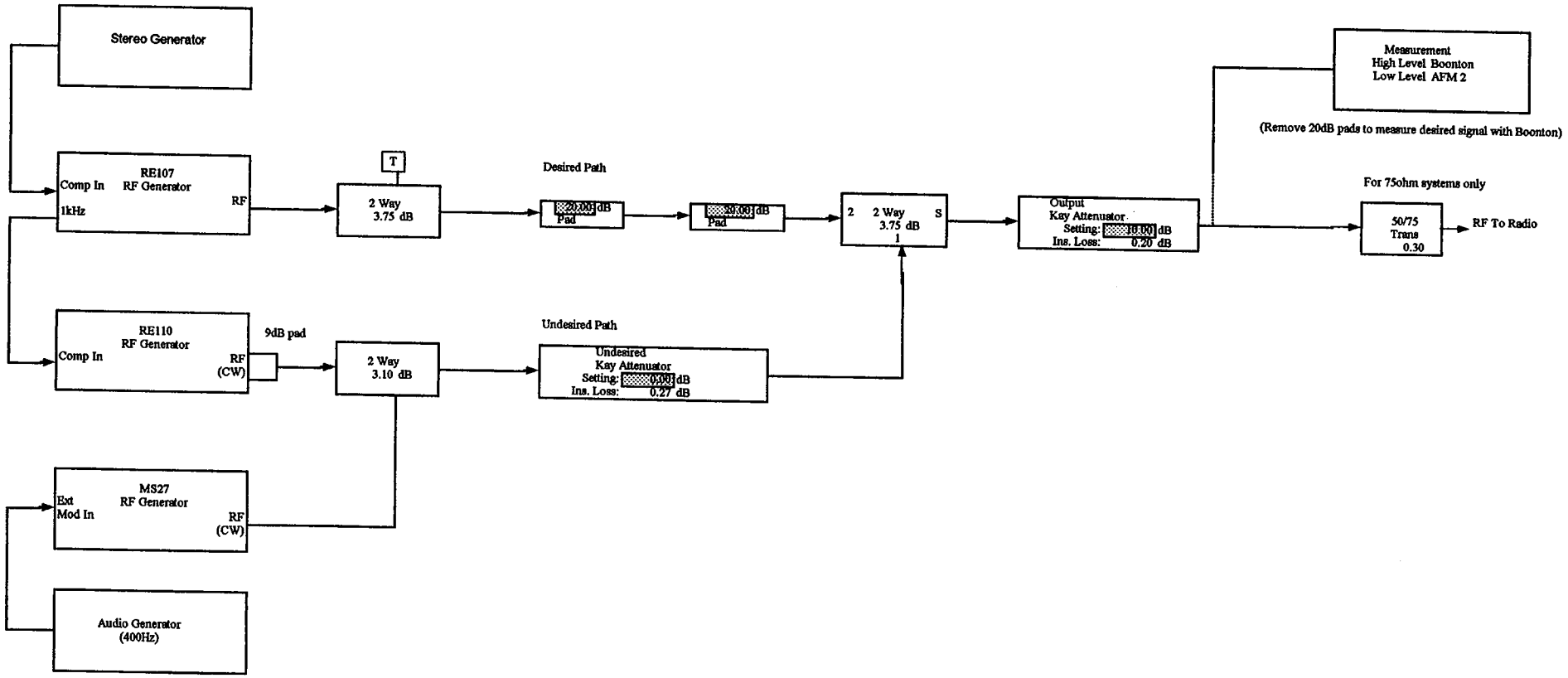
FM Receiver Test Laboratory



Two Tone Tests

FM Receiver Test Laboratory

RF Test Bed for Three RF Tone tests



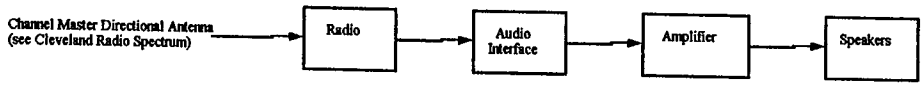
FM Receiver Test Laboratory

4/2/99
RMc
F_Exp_2a
Subjective assesment of Audio Quality in the presence of possible 10.7MHz interference (or IM) using standard test radios. See Cleveland Radio Spectrum

Freq (MHz	Level (dBm)	Type	Interference
99.5	-32	Audio Ref	None
96.5	-59	Test	107.3MHz D.L.O.
95.5	-46	Test	
94.9	-55	Test	105.6MHz D.L.O.

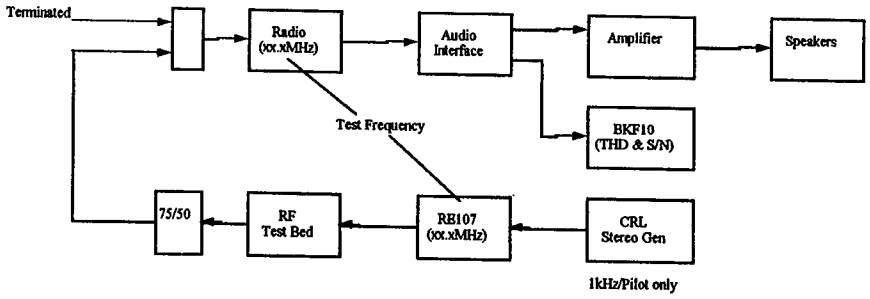
Test Set Up 5

Subjectively measure the audio quality of specific radio channels (as outlined above)

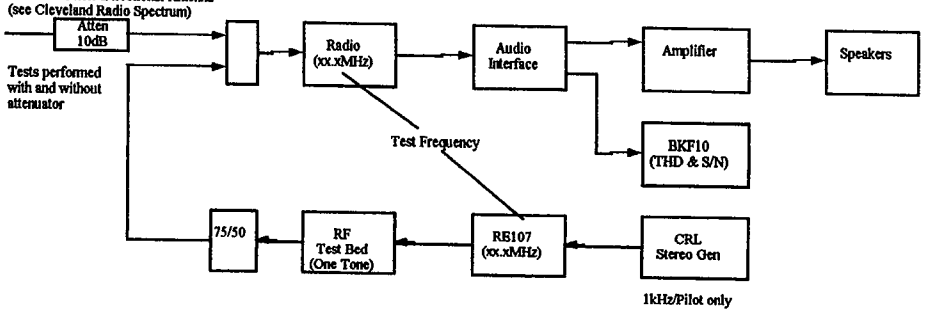


F_Exp_2b
Test Set Up 6a

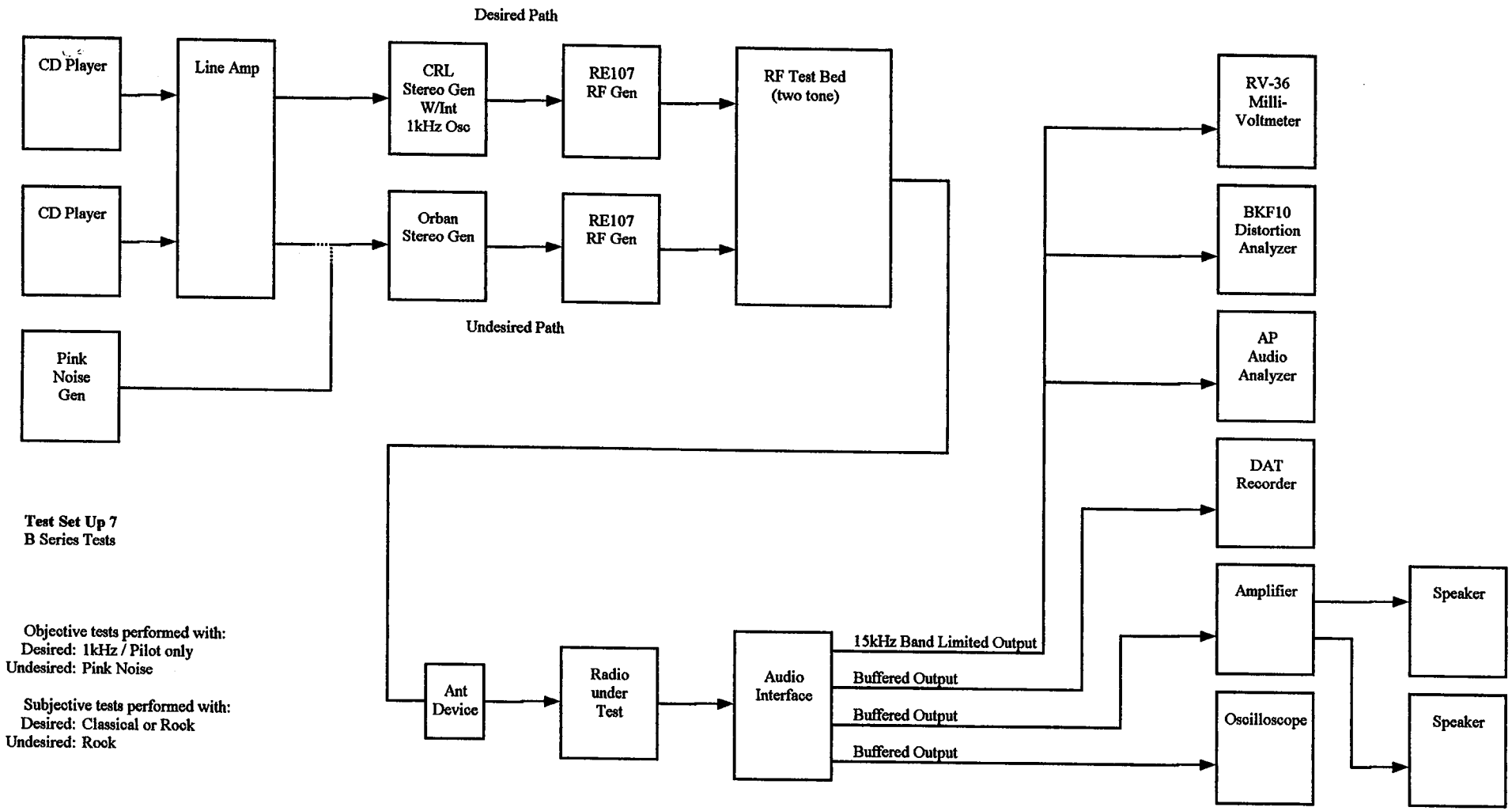
Objective measurement of test signal quality with and without interfering signals from outside antenna using standard test radios
Test frequencies are chosen to avoid co- channel and 10.6/8MHz spacing influences as much as possible
Simulates possible Low Power scenarios



Test Set Up 6b
Channel Master Directional Antenna
(see Cleveland Radio Spectrum)



FM Receiver Test Laboratory



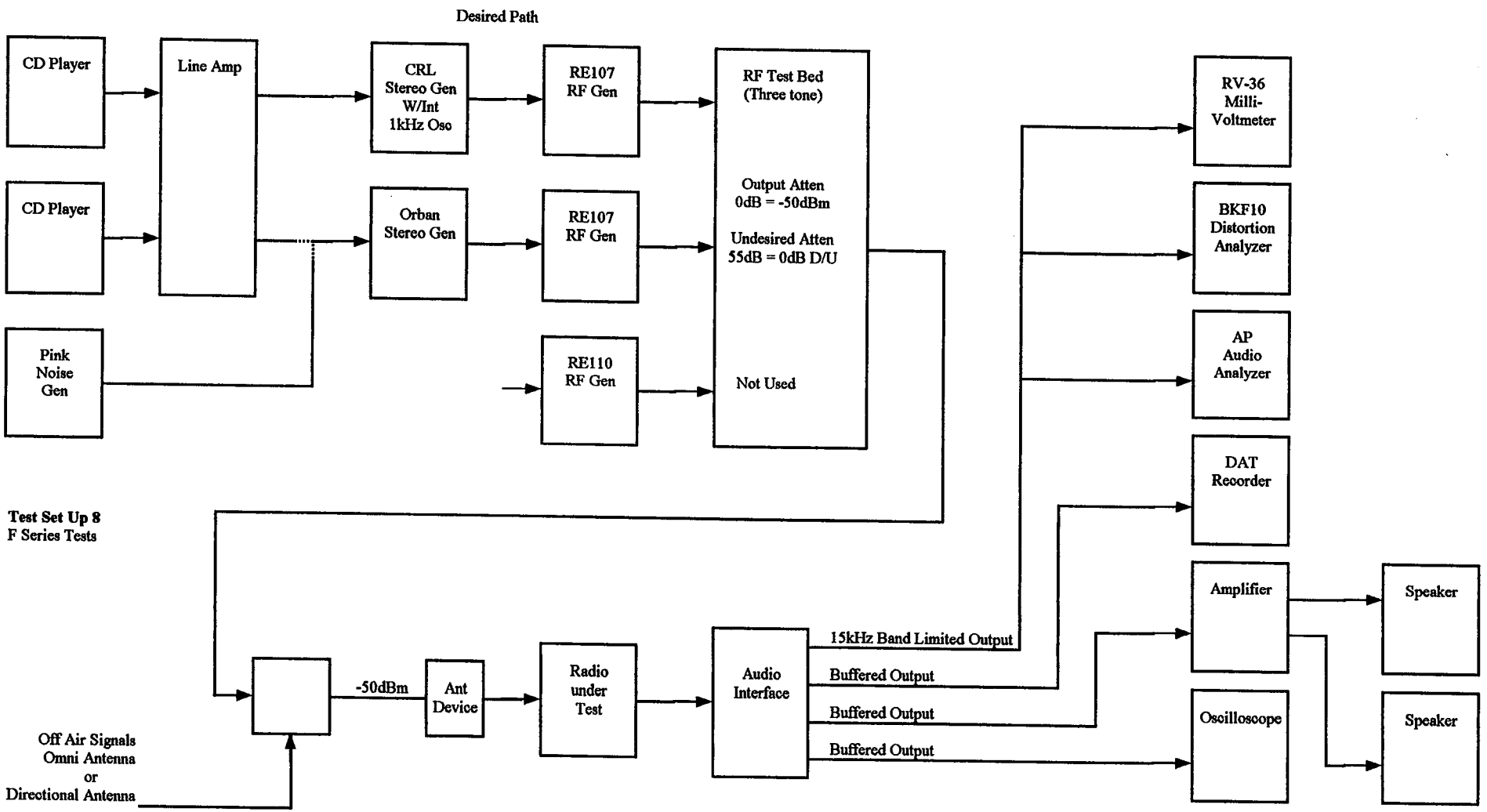
Test Set Up 7
B Series Tests

Objective tests performed with:
Desired: 1kHz / Pilot only
Undesired: Pink Noise

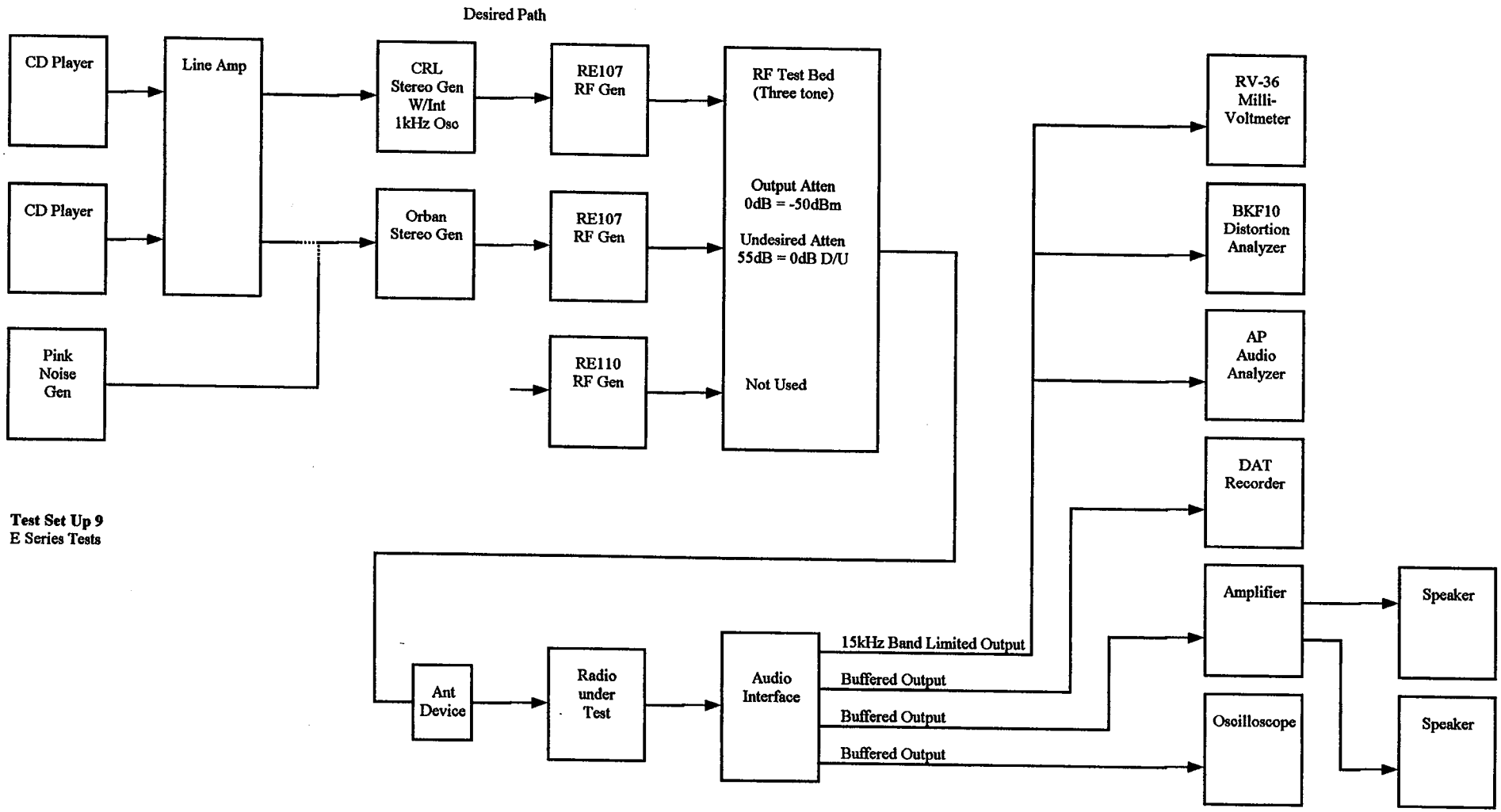
Subjective tests performed with:
Desired: Classical or Rock
Undesired: Rock

40

FM Receiver Test Laboratory

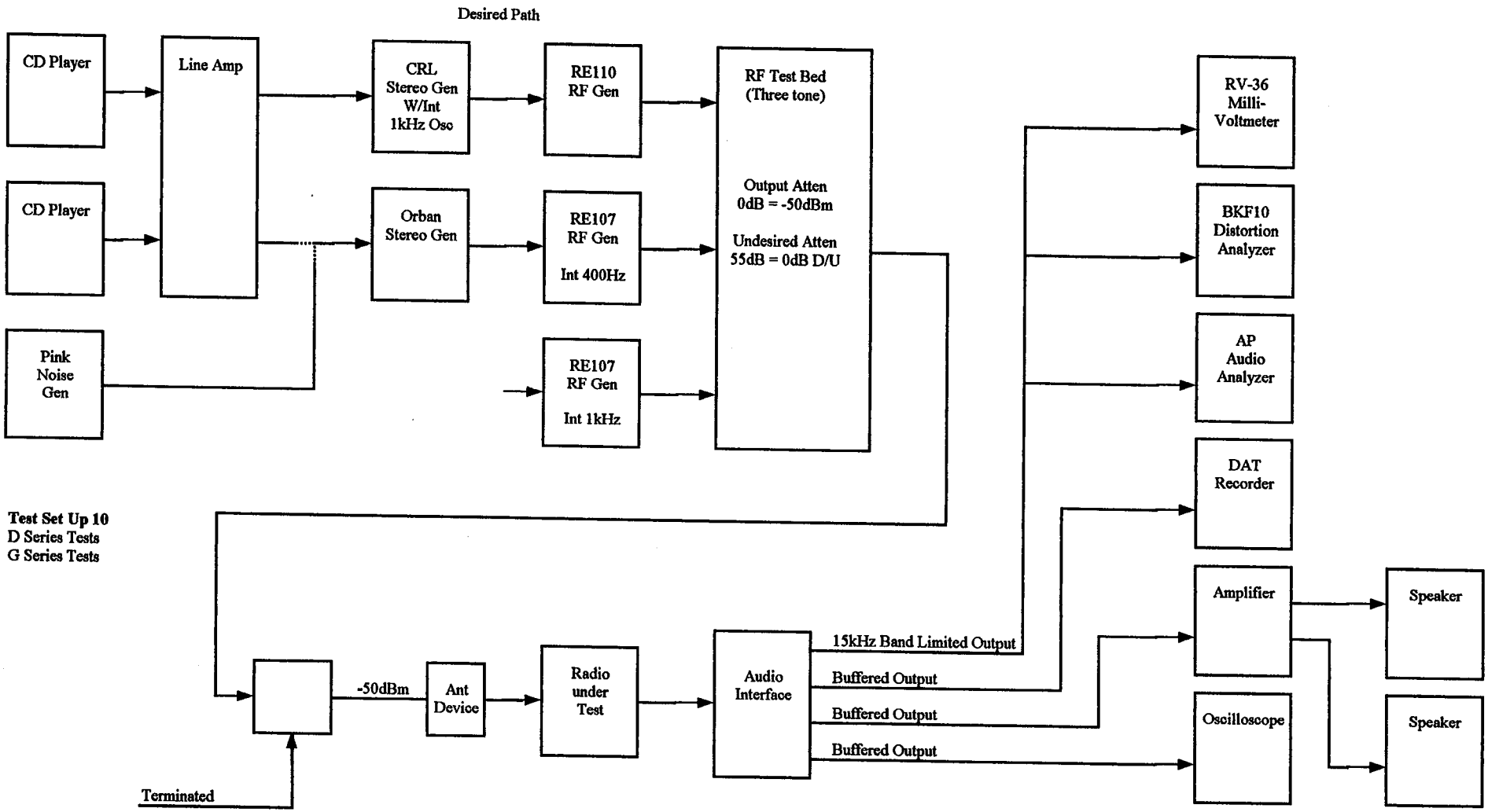


FM Receiver Test Laboratory

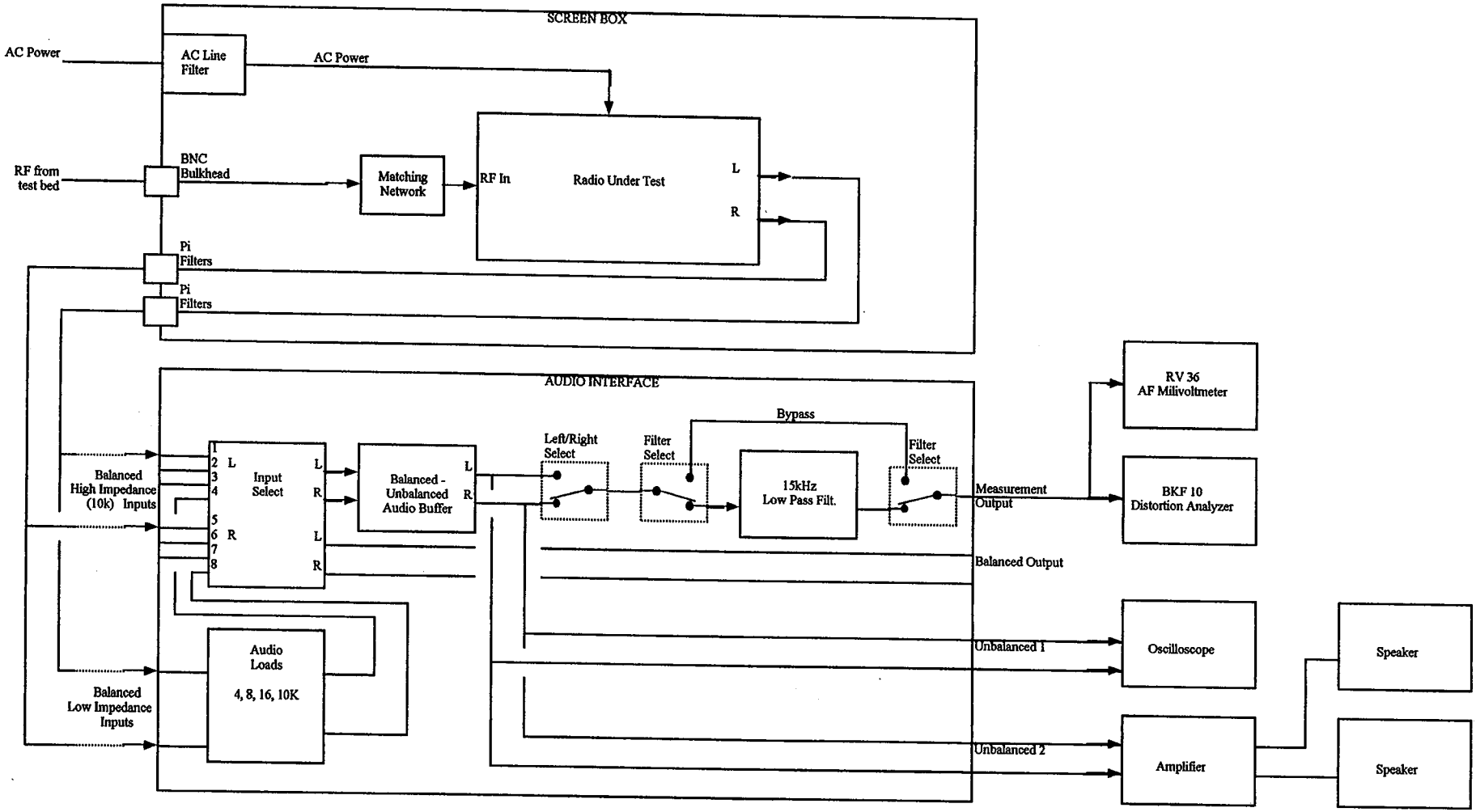


Test Set Up 9
E Series Tests

FM Receiver Test Laboratory

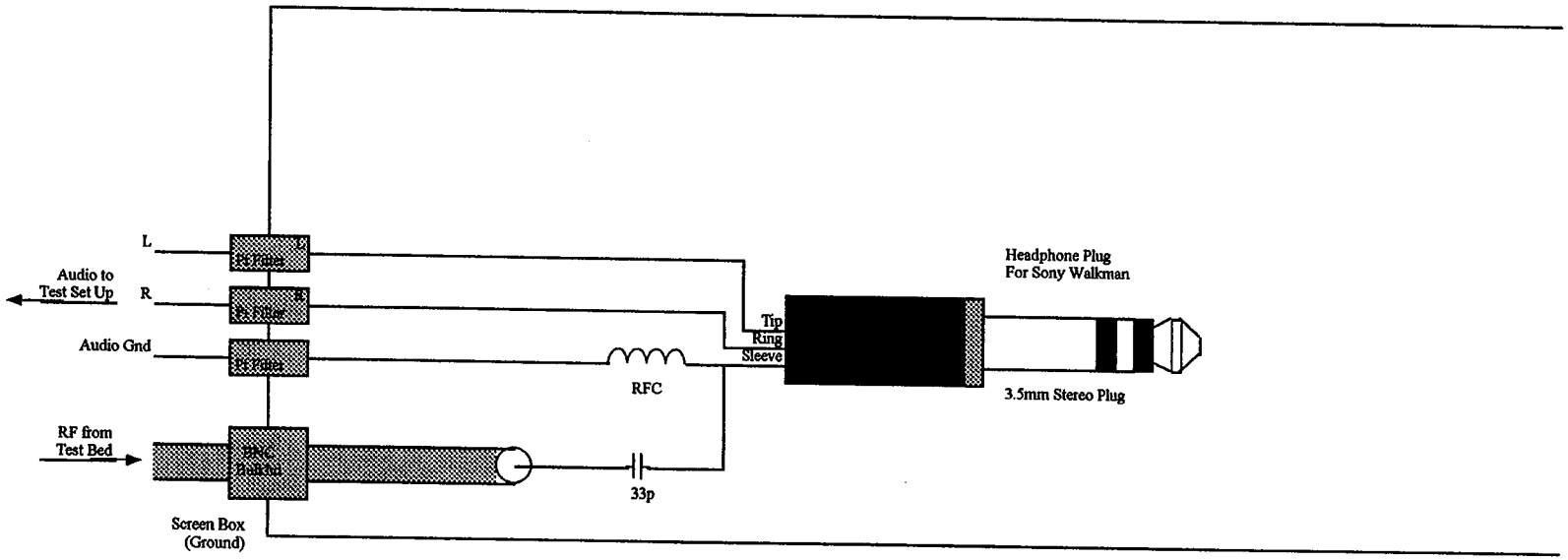


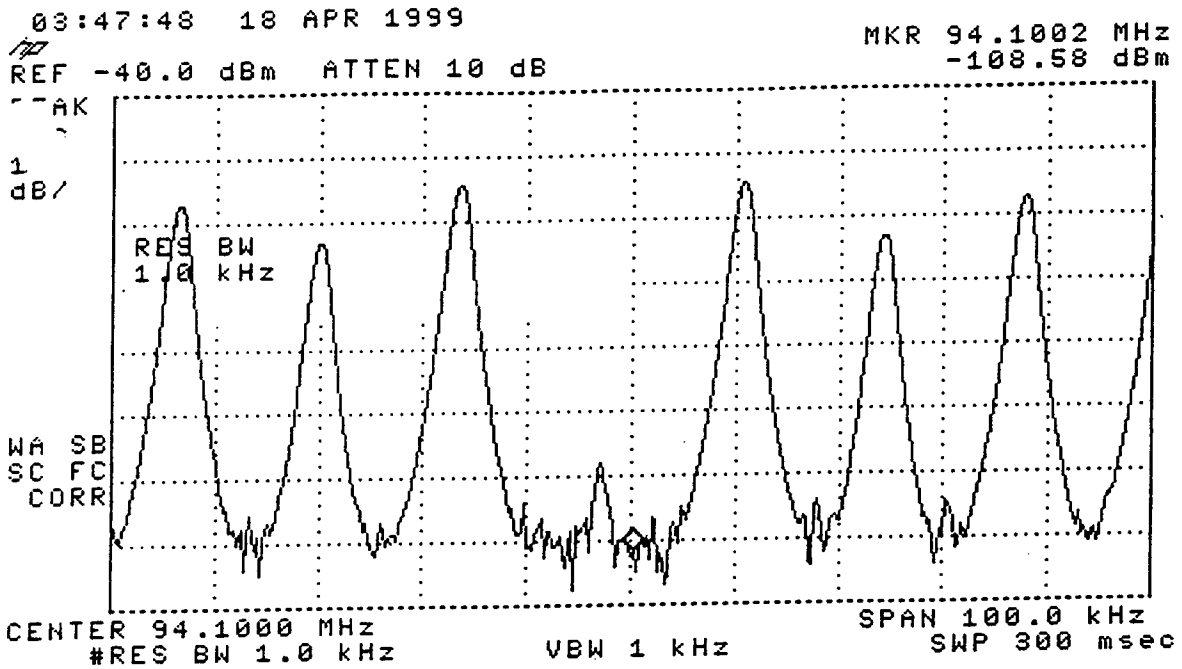
FM Receiver Test Laboratory



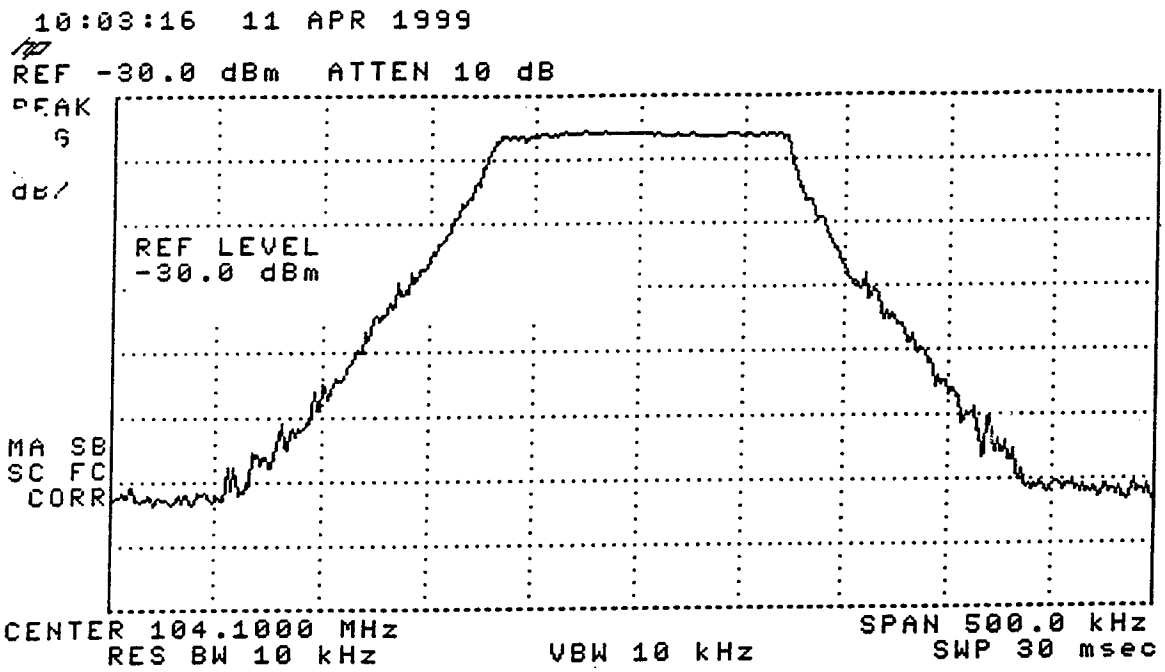
FM Receiver Test Laboratory

Antenna Network Used for Testing "Walkman" Type Receivers
3/99
RMc



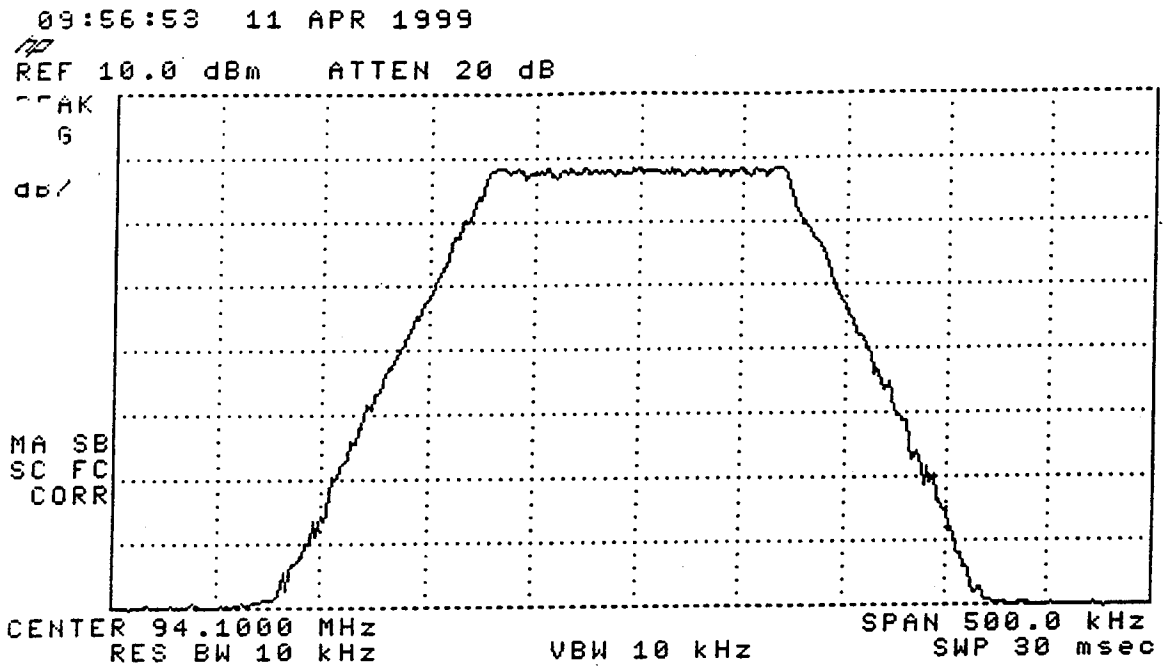


Bessel Null
AFM2 reading: 74.5kHz



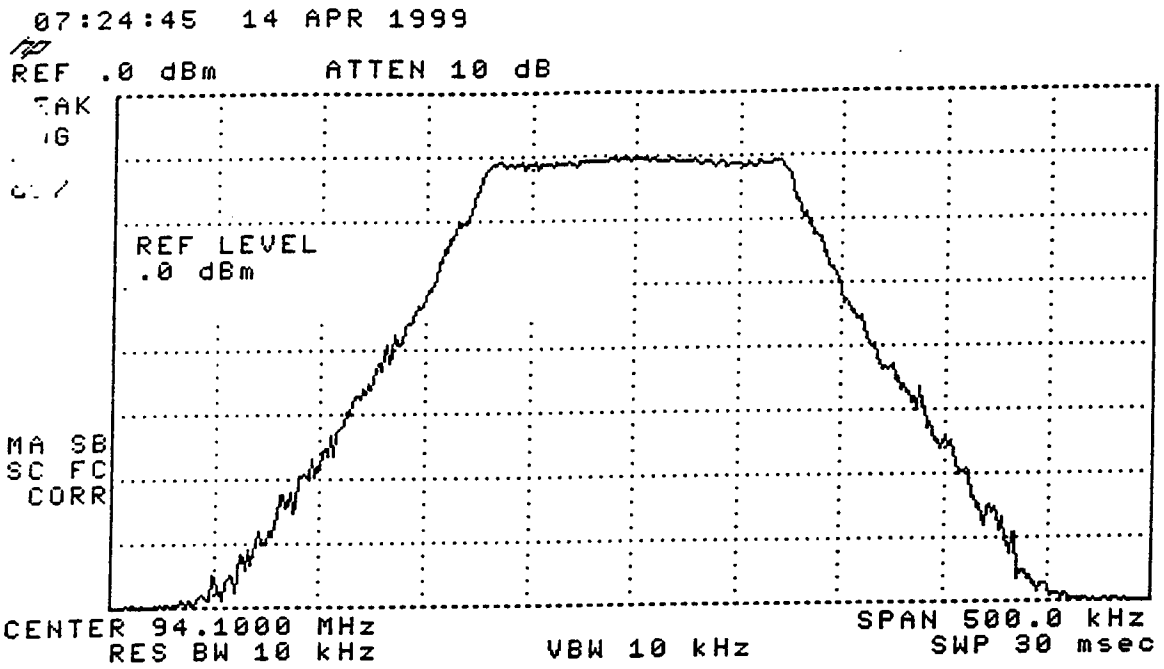
T

Off Air
104.1MHz
(Max Hold)

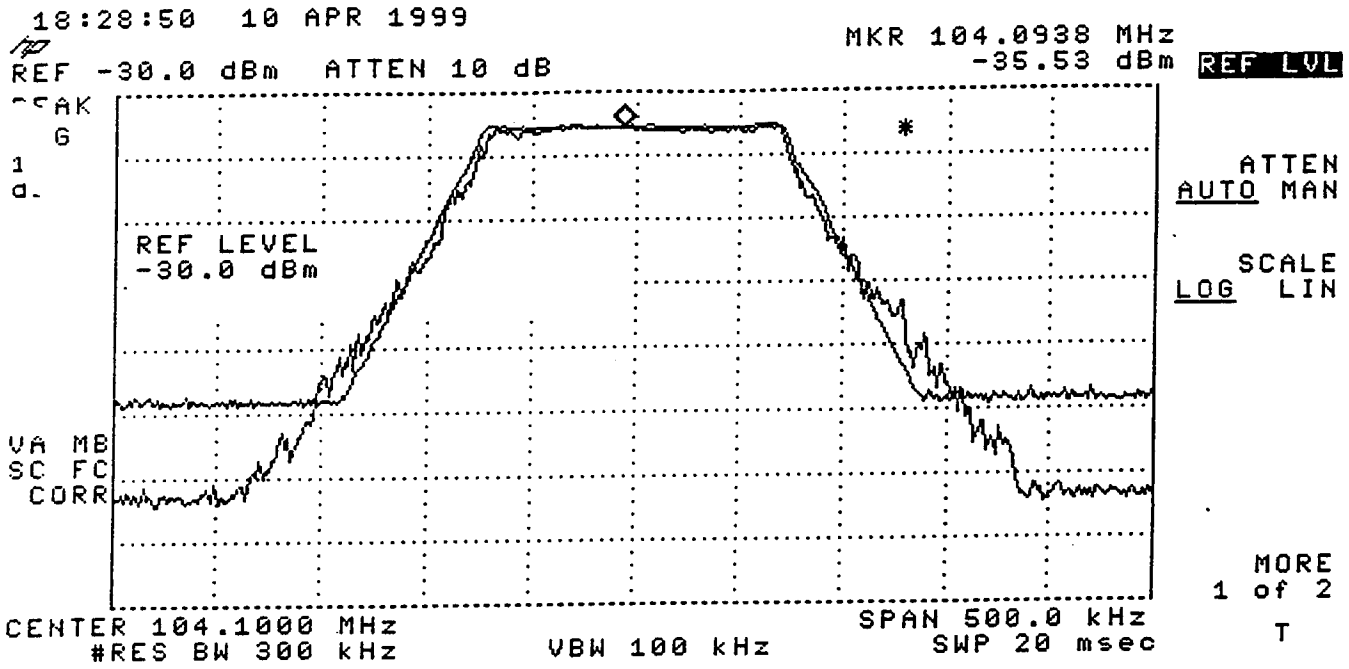


T

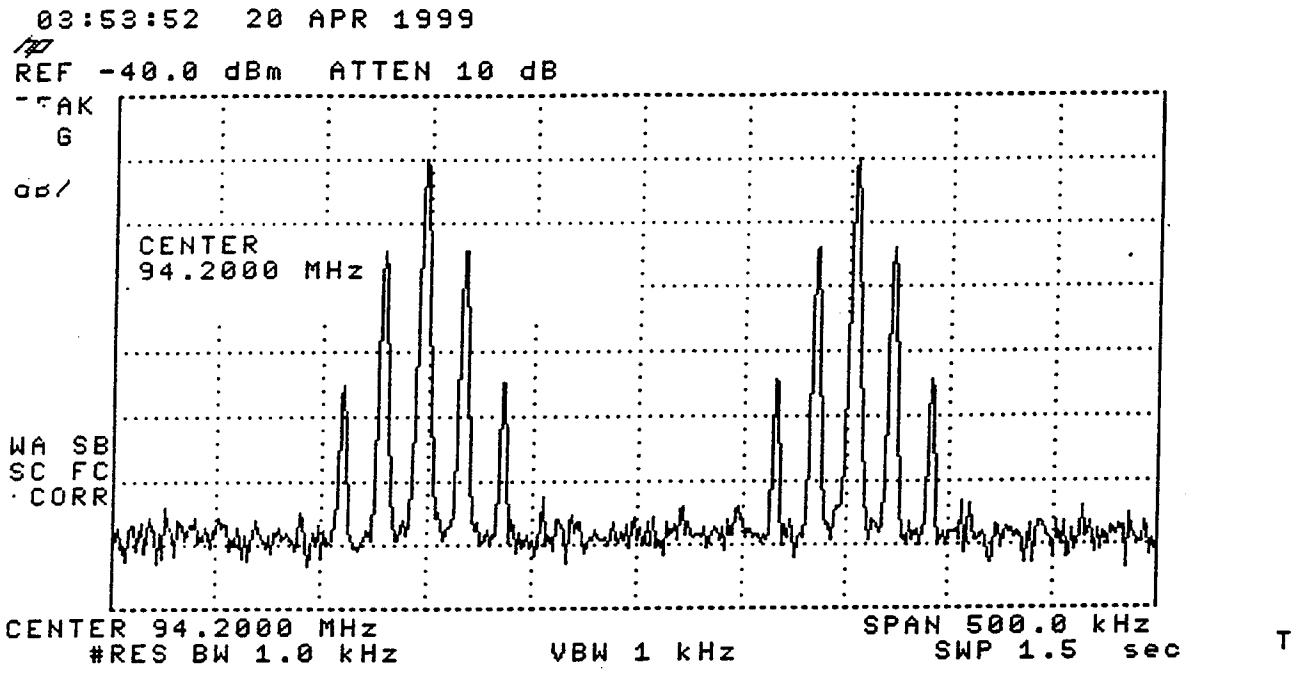
RF Domain
Clipped Pink Noise Modulation
Pink Noise - Orban - RE107 - SA



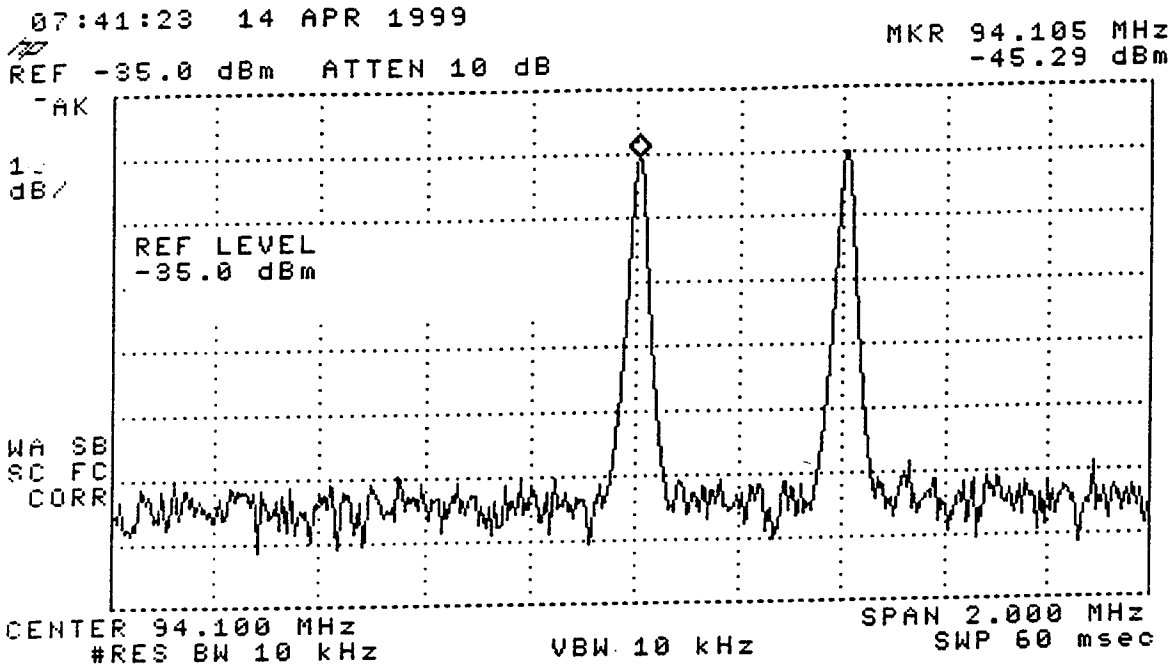
Undesired Signal
Source: "Love Shack" - Orban - RE107 - Spectrum Analyzer



104.1MHz Generator Signal (Clipped Pink Noise Modulation)
Superimposed on;
Off Air 104.1MHz (regular programming)

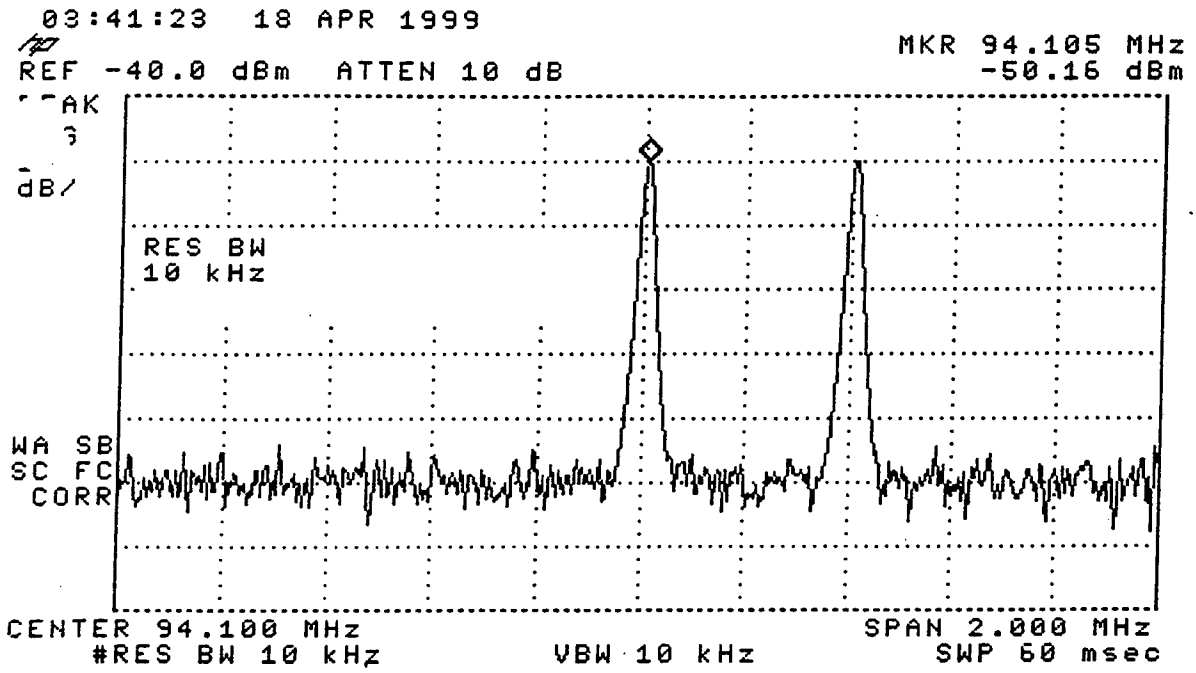


Desired Signal: 94.1MHz, Pilot only
Undesired Sigal: 94.3MHz, Pilot only

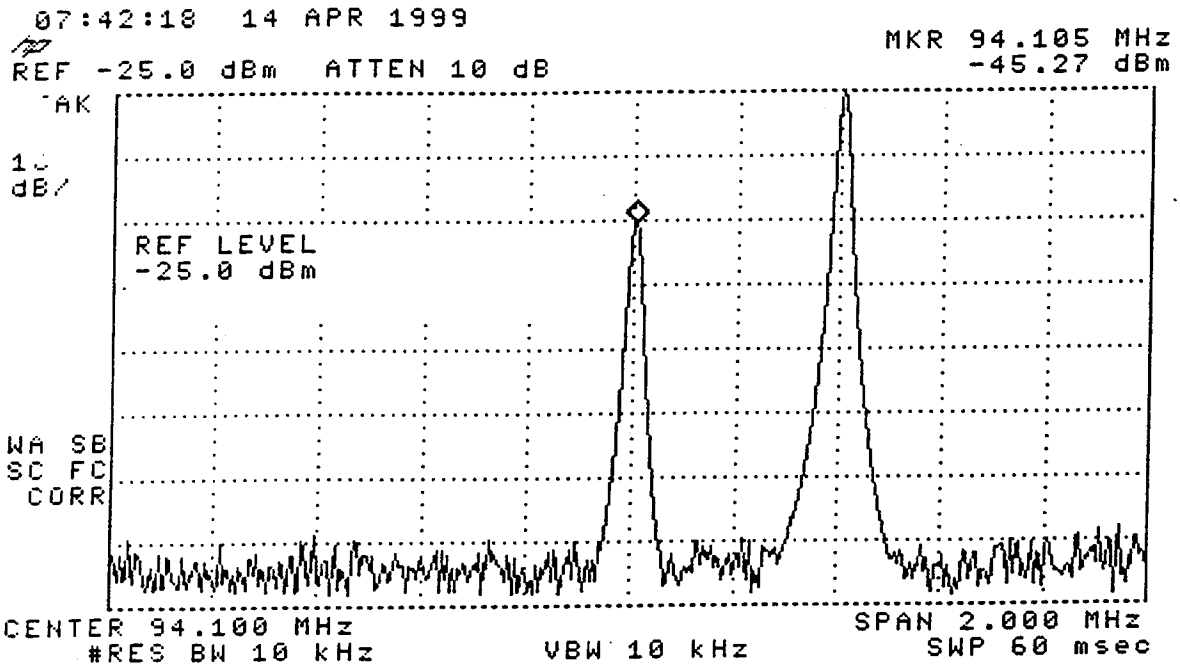


T

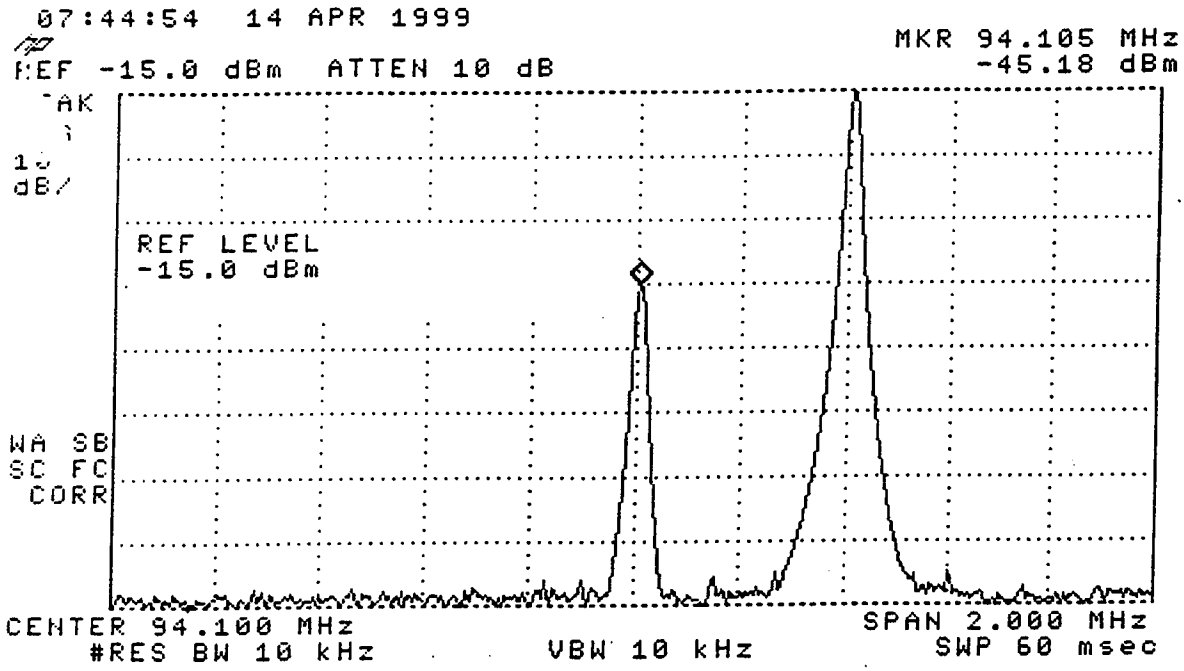
Test Set Up: Two Tone
0dB D/U
Output Atten: 0dB
Undes. Atten: 55dB
Calibrated for -45dBm Desired output (Max)



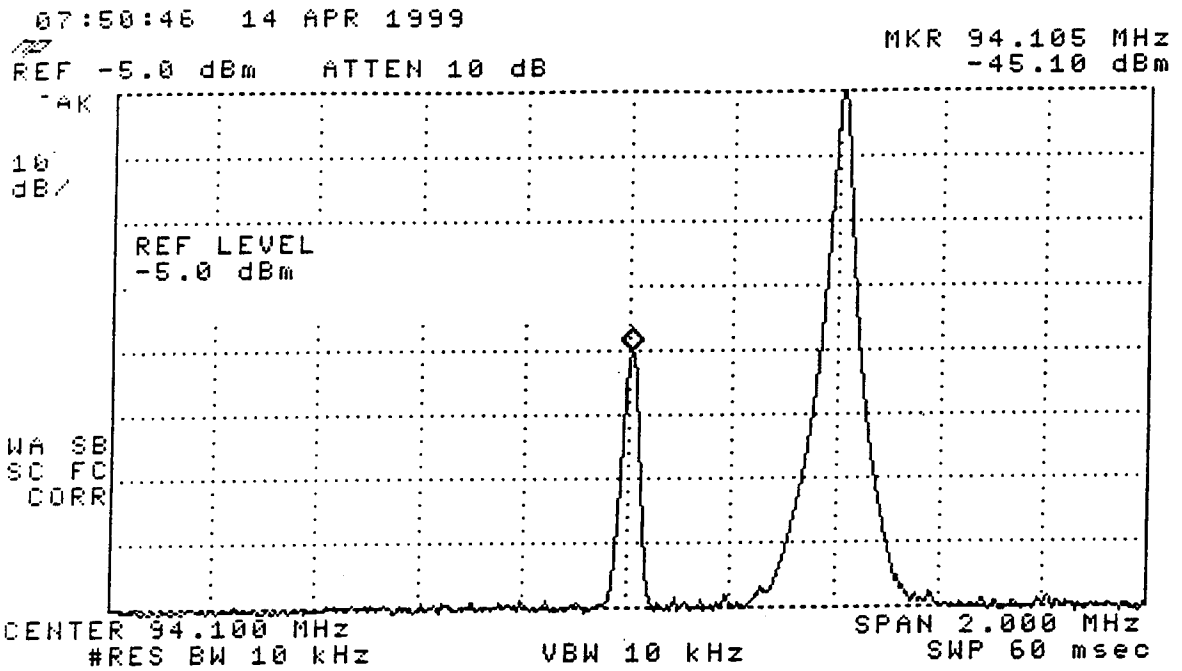
Test Set Up: Two Tone
0dB D/U
Output Atten: 0dB
Undes. Atten: 55dB
Calibrated for -50dBm Desired output (Max)
(For test set ups with antenna combiner on Test bed output)



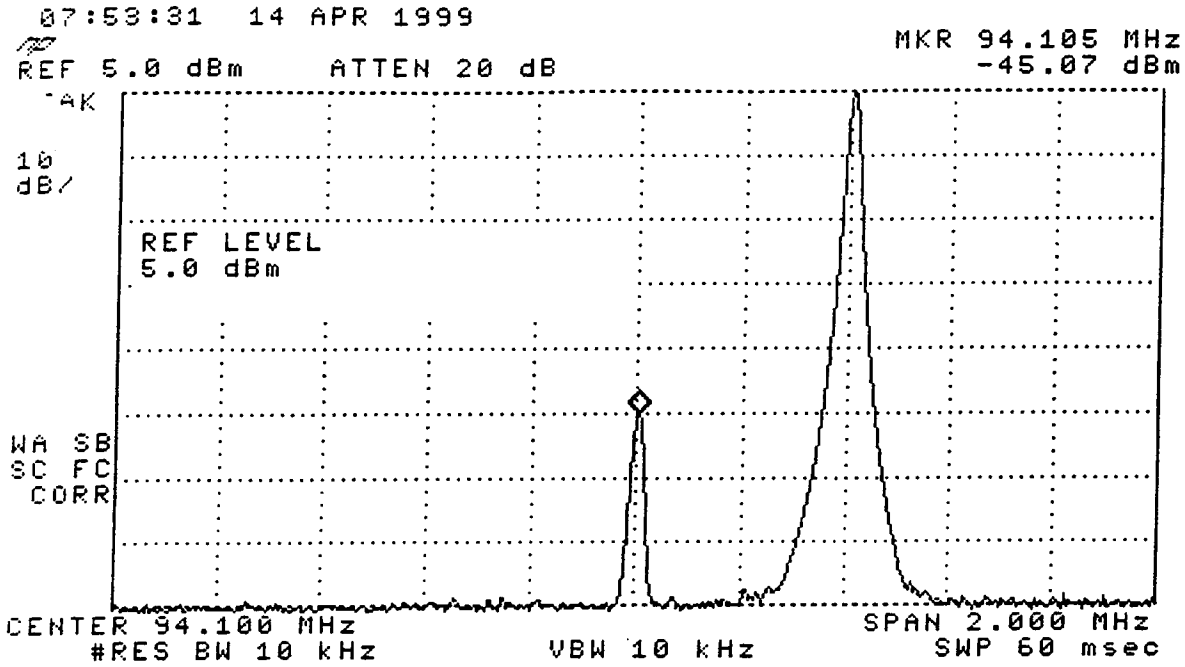
Test Set Up: Two Tone
-20dB D/U
Output Atten: 0dB
Undes. Atten: 35dB
Calibrated for -45dBm Desired output (Max)



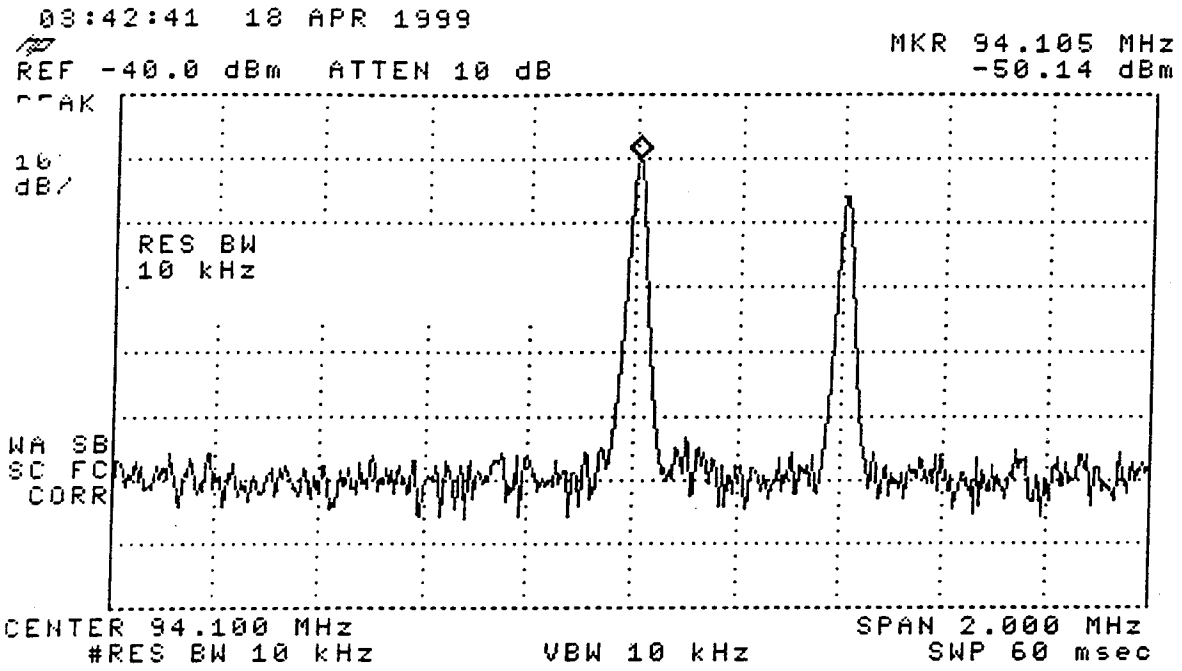
Test Set Up: Two Tone
-30dB D/U
Output Atten: 0dB
Undes. Atten: 25dB
Calibrated for -45dBm Desired output (Max)



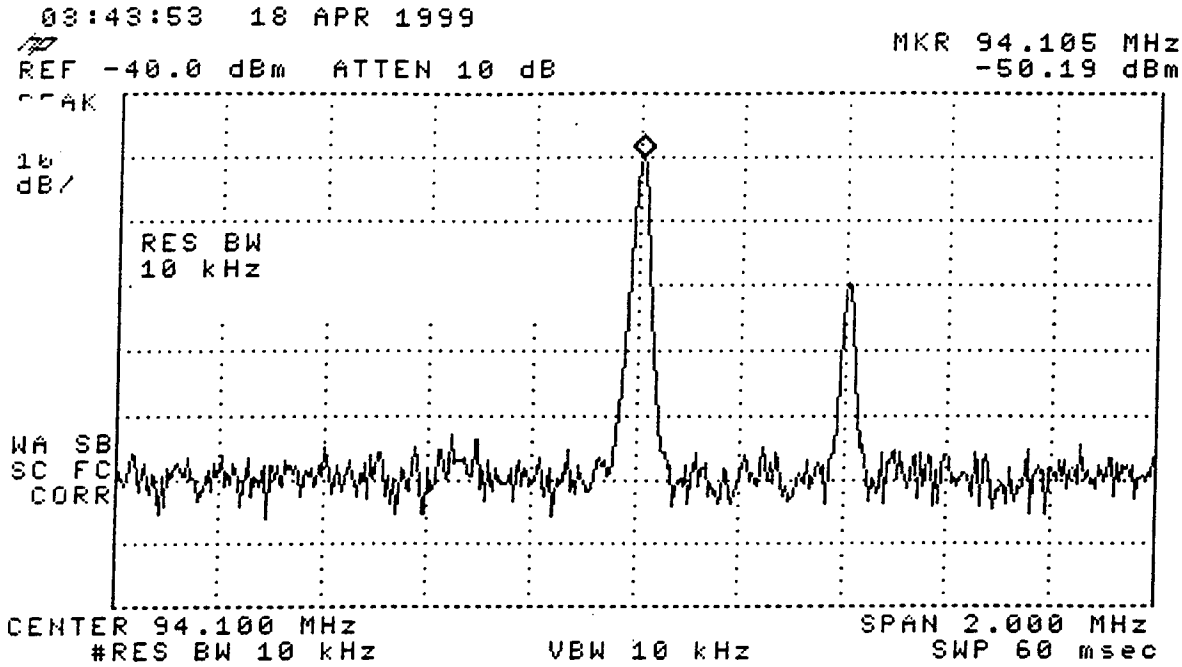
Test Set Up: Two Tone
-40dB D/U
Output Atten: 0dB
Undes. Atten: 15dB
Calibrated for -45dBm Desired output (Max)



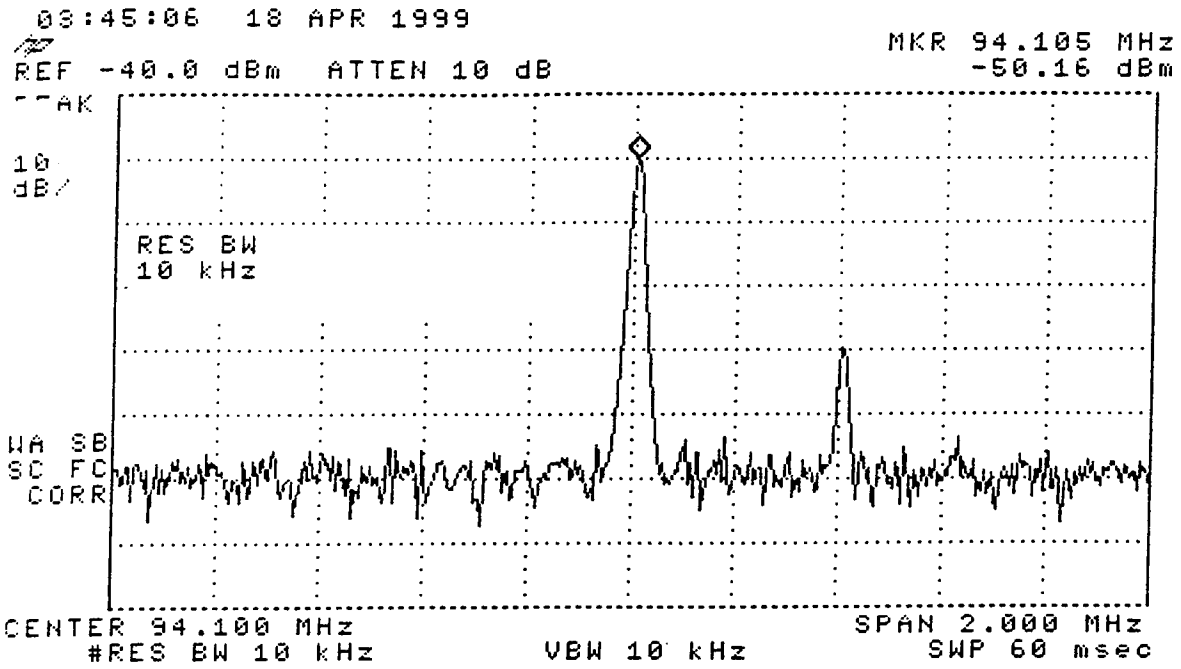
Test Set Up: Two Tone
-50dB D/U
Output Atten: 0dB
Undes. Atten: 5dB
Calibrated for -45dBm Desired output (Max)



Test Set Up: Two Tone
+6dB D/U
Output Atten: 5dB
Undes. Atten: 61dB
Calibrated for -45dBm Desired output (Max)



Test Set Up: Two Tone
+20dB D/U
Output Atten: 5dB
Undes. Atten: 75dB
Calibrated for -45dBm Desired output (Max)



T

Test Set Up: Two Tone
+30dB D/U
Output Atten: 5dB
Undes. Atten: 85dB
Calibrated for -45dBm Desired output (Max)

FM Receiver Test Laboratory

Date: 6/7/99
Engineer: RMc
Test Series: Exp
Description: SNR vs THD measurement method for measuring interference levels

Desired: 94.1MHz -50dBm

Undesired: CPN, 75kHz, Upper 2nd Adj.
Measurement: SNR vs THD AP Portable 1 RMS Unweighted WQP CCIR Weighted
D/U: Variable
-20 to -50dB

Denon TU380				
D/U (dB)	SNR RMS (dB)	SNR WQP (dB)	THD RMS (%)	THD WQP (%)
40	69.80	61.20	0.12	0.43
-20	65.00	55.60	0.13	0.46
-30	53.80	41.80	0.25	1.10
-40	52.80	43.20	0.26	1.07
-50	42.20	31.70	0.84	3.50

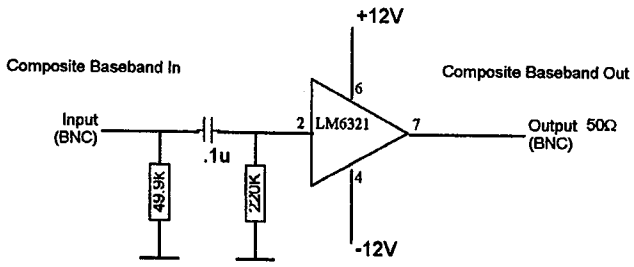
Equivilent THD (dB)	
THD RMS	THD WQP
-58.42	-47.33
-57.99	-46.74
-52.04	-39.17
-51.70	-39.41
-41.51	-29.12

Pioneer SX201				
D/U	SNR RMS	SNR WQP	THD RMS	THD WQP
40	69.20	61.30	0.81	0.98
-20	56.20	44.00	0.81	1.02
-30	43.70	33.30	0.99	3.00
-40	37.00	23.80	1.45	6.60
-50	9.30	3.20	NA	NA

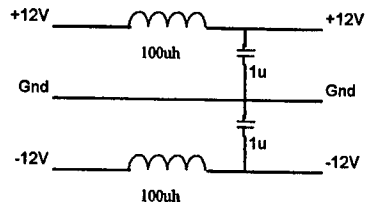
Equivilent THD (dB)	
THD RMS	THD WQP
-41.80	-40.18
-41.81	-39.83
-40.09	-30.46
-36.77	-23.61
NA	NA

5/99
RMc

Buffer Amplifier
Installed in AFM2 Osc Compartment



Regulated AFM2 Power



Note: LM6321 is specified to drive 50Ω loads.
Allows Composite Baseband Output of Modulation Analyzer to be viewed on Spectrum Analyzer.

Equipment Listing

RMC Technologies
FM Receiver Laboratory
23927 Ambour Dr.
North Olmsted, OH 44070
(440) 777-3812
Equipment Inventory

Date: 6/24/99

Entry No.	Qty	Manufacturer	Model No.	Serial No.	Description
1	1	RE Instruments	RE107	R01N05	RF Signal Generator
2	1	RE Instruments	RE107	R01N14	RF Signal Generator
3	1	Radiometer	BKF10a	204854	Automatic Distortion Analyzer
4	1	Radiometer	SMU401a	258509	Selective Measuring Unit
5	1	Radiometer	RE110	none	FM Carrier unit
6	1	RE Instruments	AFM2cS3	225395	Modulation Meter
7	1	Radiometer	AFM3b	248575	Modulation Meter
8	1	Radiometer	RV36c	127431	AF Millivoltmeter
9	1	Radiometer	MS27g	204207	RF Signal Generator
10	1	Tektronix	212	MOD716U	Oscilloscope
11	1	Tektronix	335	310716	Oscilloscope
12	1	RCA	WA-504	5847 L51	Audio Generator
13	1	Uniden	BC170	53010752	16 Channel Scanner
14	1	Data Precision	5740	1139	Frequency Counter
15	1	Data Precision	1450	1076	Digital Multimeter
16	1				Power Supply
17	1	RE Instruments	RE20	none	Audio Interface
18	1	Soundesign	4925BLK	16844296	CD Player
19	1	Toshiba	T2135CS	02646045-1	Computer
20					
21	1	Orban	8100	647907	Stereo generator/Processor
22	1	CRL	SG800	CBS85051112	Stereo Generator
23	1	CRL	SG800	H1112	Stereo Generator
24	1	Denon	DTR-80P	8252729	DAT Recorder
25	1	Hewlett Packard	8590B	3212A01889	Spectrum Analyzer
26	1	Audio Precision	P1PA	P1P21091	Audio Analyzer
27	1	Boonton	4220	32202BK	Power Meter
28	1	Boonton	51101	27092	Power Sensor
29	1	Kay	839	027092	Attenuator
30	1	Kay	839	026517	Attenuator
31	1	Delco	16192463	1000499	Automobile radio
32	1	Denon	TU-380RD	4056301149	Home HiFi Tuner
33	1	Panasonic	RX-FS430	GR3JA01184	Portable Radio
34	1	Pioneer	SX-201	OA3965843C	Home HiFi Receiver
35	1	Ford	F4XF-19B132-C	9411	Automobile radio
36	1	Denon	TU0680NAB	2092400103	Home HiFi Tuner
37	1	Audiovox	AV-220	30901807N	Automobile radio
38	1	Sony	STR-AV21	802086	Home HiFi Receiver
39	1	Sony	SRF-M40W	194352	Walkman Radio
40	1	Technics	SA-EX110	GY8JA38798	Home HiFi Receiver
41	1	Sanyo	MCD-S736	8701316	Portable Stereo System
42	1	Sony	CFD-S33	1132161	Portable Stereo System
43	1	Koss	MS-457	3805003200	Automobile radio
44	1	Philips/Magnavox	AZ2700/17	KT0198411206	Portable Stereo System
45	1	Ford/Visteon	XF3F-18C870-BF	WANM000067	Automobile radio
46	1	Ford/Visteon	XF3F-18C870-BF	WANM000060	Automobile radio
47	1	Ford/Visteon	XW7F-18C815-A	DE000003	Automobile radio
48	1	Ford/Visteon	XW7F-18C815-A	DE000022	Automobile radio
49	1	Radio Shack	SCR-64 14-704	12A98	Portable Radio
50					

FM Receiver Test Laboratory

Date: 6/7/99
Engineer: RMc
Test Series: Exp
Description: SNR vs THD measurement method for measuring interference levels

Desired: 94.1MHz -50dBm

Undesired: CPN, 75kHz, Upper 2nd Adj.
Measurement: SNR vs THD AP Portable 1 RMS Unweighted WQP CCIR Weighted
D/U: Variable
-20 to -50dB

Denon TU380				
D/U (dB)	SNR RMS (dB)	SNR WQP (dB)	THD RMS (%)	THD WQP (%)
40	69.80	61.20	0.12	0.43
-20	65.00	55.60	0.13	0.46
-30	53.80	41.80	0.25	1.10
-40	52.80	43.20	0.26	1.07
-50	42.20	31.70	0.84	3.50

Equivilent THD (dB)	
THD RMS	THD WQP
-58.42	-47.33
-57.99	-46.74
-52.04	-39.17
-51.70	-39.41
-41.51	-29.12

Pioneer SX201				
D/U	SNR RMS	SNR WQP	THD RMS	THD WQP
40	69.20	61.30	0.81	0.98
-20	56.20	44.00	0.81	1.02
-30	43.70	33.30	0.99	3.00
-40	37.00	23.80	1.45	6.60
-50	9.30	3.20	NA	NA

Equivilent THD (dB)	
THD RMS	THD WQP
-41.80	-40.18
-41.81	-39.83
-40.09	-30.46
-36.77	-23.61
NA	NA

FM Receiver Test Laboratory

Date: _____
Engineers: RMc
Project: FM Receiver Test A1

Receiver Test No.: _____
Class: _____
Radio Mfg.: _____
Model: _____
Serial: _____

Antenna Network: _____ FM
_____

Audio load: _____ Ohms

Initial Set Up: Radio under test shall have tone controls set to flat detent position, Loudness control off, Balance and Fader controls centered (set to mid position), Volume set to Standard Output
Any other control settings unique to the radio under test shall be noted in the Comments section.
Left channel shall be used for all Signal (and S/N ratio) measurements.
15kHz Low Pass filter shall be used on the output of the left channel for all measurements.
Right channel shall be used for Noise measurements - Stereo Separation test only.
All level measurements are rms

Comments: _____
_____
_____
_____

Standard RF Levels

Strong:	-45	dBm
Medium:	-55	dBm
Weak:	-65	dBm

Standard FM Test Frequencies

Low:	94.1	MHz

Standard Test Set Ups

1	Strong Signal Overload
2	Single RF Tone Tests
3	Two RF Tone Tests
4	Measurement Set up

Standard Tests

1	Local Oscillator Frequency (Tuning Error)
2	Standard Audio Output (Audio level and distortion)
3	RF Input Overload (RF level required for 5% THD)
4	AM Rejection
5	Image Rejection
6	Curve Tests (plots of RF Level Vs Signal - Mono & Stereo, Noise - Mono & Stereo, Stereo Separation
7	Capture Ratio
8	Selectivity; 1st Adjacent (30dB noise figure)
9	Selectivity; 2nd Adjacent (30dB noise figure)
10	Selectivity; 1st Adjacent (50dB noise figure)
11	Selectivity; 2nd Adjacent (50dB noise figure)
12	Selectivity; 3rd Adjacent (50dB noise figure)
13 - 15	Additional 10.7MHz Tests
16	IM (800kHz Channel Spacing)

Single RF Tone Tests

1 Local Oscillator Frequency (Tuning Error)

Set Up: Connect Spectrum Analyzer to Radio Antenna input
Adjust: Tune radio to Test Freq. 1, measure L.O. Freq 1
Tune radio to Test Freq. 2, measure L.O. Freq 2

Measurement: L.O. Freq 1 _____ MHz
L.O. Freq 2 _____ MHz

2 Standard Audio Output

Set Up: Test Set Up 2, Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio Volume to Std. Ref. Level, record Left and Right channel audio level and THD

Measurement:	Left Ch			Right Ch	
	Level _____	**Vrms**	= 0dB	**Level** _____	**Vrms**
	THD _____	**%**		**THD** _____	**%**

3 RF Input Overload

Set Up: Test Set Up 1, Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Increase RF Level until 5% THD at Radio output, record RF Level

Measurement: **RF Lev.** _____ **dBm** (@ 5% THD)

4 AM Rejection

Set Up: Test Set Up 2, Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set modulation mode to FM (75kHz), AM (30%), record THD

Measurement:					
THD _____	%	=	#NUM!	dB	(FM Only)
THD _____	%	=	#NUM!	dB	(FM + AM 30%)

AM Rejection: #NUM! dB

5 Image Rejection

Set Up: Test Set Up 2, Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Decrease RF Level until S/N Ratio = 30dB, record RF Lev1
Tune RF Gen to; Desired Freq. +/- 2 X IF Freq.
Adjust RF Level until S/N Ratio = 30dB, record RF Lev2

Measurement:		
RF Lev1 _____	dBm	(S/N Ratio = 30dB)
RF Lev2 _____	dBm	(21.4MHz + 94.1MHz = 115.5MHz)
Image Rejection: 0.00	dB	(RF Lev1 - RF Lev2)

6 Curve Tests

Set Up: Test Set Up 2, Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono/Stereo
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB) for both Mono and Stereo set ups.

Plot: Signal, Noise Vs RF Level (Mono)
Signal, Noise Vs RF Level (L+R, Stereo)
Stereo Separation Vs RF Level (L only, Stereo)
Record: Noise floor at -45dBm without Low Pass Filter as a measure of pilot rejection

CURVE DATA

SIGNAL, NOISE & SEPARATION VS RF LEVEL

RF Level dBm	Mono (L)		Stereo (L)			Separation L->R		RF Level dBm
	Signal dB	Noise dB	Signal dB	Filt. Noise dB	Noise dB	Left dB	Right dB	
-130								-130
-125								-125
-120								-120
-115								-115
-110								-110
-105								-105
-100								-100
-95								-95
-90								-90
-85								-85
-80								-80
-75								-75
-70								-70
-65								-65
-60								-60
-55								-55
-50								-50
-45								-45

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Two RF Tone Tests

7 **Capture Ratio**

Set Up: Test Set Up 3
Desired: Test Freq. 1, -55dBm, 1kHz, 22.5kHz dev, Mono
Undesired: Test Freq. 1, -130dBm, CW
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Increase Undesired signal until audio level drops 1dB, record Undesired RF level as RF Lev 1
Increase Undesired signal until audio level drops 30dB, record Undesired RF level as RF Lev 2

Measurement: RF Lev 1 _____ dBm
RF Lev 2 _____ dBm

Capture Ratio: 0.00 dB (RF Lev 1 - RF Lev 2)/2

8 **Selectivity - 1st Adjacent 30dB S/N (Upper and Lower)**

Upper 1st

Set Up: Test Set Up 3
Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 +200kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -30dB, record Undesired RF level as Undesired Upper Lev.

Lower 1st

Set Up: Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 -200kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -30dB, record Undesired RF level as Undesired Lower Lev.

	Mono 30dB		Stereo 30dB		
	dBm	D/U	dBm	D/U	
Desired Lev	-55.00		-55.00		
Undesired Upper Lev		-55.00		-55.00	
Undesired Lower Lev		-55.00		-55.00	
Selectivity, 1st Adj.:		-55.00		-55.00	(RF D/U Up + RF D/U Lo)/2

9 **Selectivity - 2nd Adjacent 30dB S/N (Upper and Lower)**

Upper 2nd

Set Up: Test Set Up 3
Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 +400kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -30dB, record Undesired RF level as Undesired Upper Lev.

Lower 2nd

Set Up: Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 -400kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -30dB, record Undesired RF level as Undesired Lower Lev.

	Mono 30dB		Stereo 30dB		
	dBm	D/U	dBm	D/U	
Desired Lev	-55.00		-55.00		
Undesired Upper Lev		-55.00		-55.00	
Undesired Lower Lev		-55.00		-55.00	
Selectivity, 2nd Adj.:		-55.00		-55.00	(RF D/U Up + RF D/U Lo)/2

10 Selectivity - 1st Adjacent 50dB S/N (Upper and Lower)

Upper 1st

Set Up: Test Set Up 3
Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 +200kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -50dB, record Undesired RF level as Undesired Upper Lev.

Lower 1st

Set Up: Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 -200kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -50dB, record Undesired RF level as Undesired Lower Lev.

	Mono 50dB		Stereo 50dB		
	dBm	D/U	dBm	D/U	
Desired Lev	-55.00		-55.00		
Undesired Upper Lev		-55.00		-55.00	
Undesired Lower Lev		-55.00		-55.00	
Selectivity, 1st Adj.:		-55.00		-55.00	(RF D/U Up + RF D/U Lo)/2

11 Selectivity - 2nd Adjacent 50dB S/N (Upper and Lower)

Upper 2nd

Set Up: Test Set Up 3
Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 +400kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -50dB, record Undesired RF level as Undesired Upper Lev.

Lower 2nd

Set Up: Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 -400kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -50dB, record Undesired RF level as Undesired Lower Lev.

	Mono 50dB		Stereo 50dB		
	dBm	D/U	dBm	D/U	
Desired Lev	-55.00		-55.00		
Undesired Upper Lev		-55.00		-55.00	
Undesired Lower Lev		-55.00		-55.00	
Selectivity, 2nd Adj.:		-55.00		-55.00	(RF D/U Up + RF D/U Lo)/2

12 Selectivity - 3rd Adjacent 50dB S/N (Upper and Lower)

Upper 3rd

Set Up: Test Set Up 3
Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 +600kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -50dB, record Undesired RF level as Undesired Upper Lev.

Lower 3rd

Set Up: Desired: Test Freq. 1, Medium, 1kHz, 75kHz Dev, Mono
Undesired: Test Freq. 1 -600kHz, -130dBm, 1kHz, 75kHz Dev, Mono
Adjust: Set Radio/Analyzer audio to Std. Ref. Level (0dB)
Set the modulation of the Desired signal to CW
Increase Undesired signal until noise floor is -50dB, record Undesired RF level as Undesired Lower Lev.

	Mono 50dB		Stereo 50dB		
	dBm	D/U	dBm	D/U	
Desired Lev	-55.00		-55.00		
Undesired Upper Lev		-55.00		-55.00	
Undesired Lower Lev		-55.00		-55.00	
Selectivity, 3rd Adj.:		-55.00		-55.00	(RF D/U Up + RF D/U Lo)/2

Additional Tests

13 10.7MHz Rejection

Using Test Set Up 1 at the desired frequency of 94.1MHz;
Set generator to 1kHz, 75kHz dev. / CW
Reduce RF level to obtain 30dB S/N ratio.
Record RF Level as RF Lev 1
Set RF generator to 10.7MHz
Adjust RF level to obtain 30dB S/N ratio
Record RF Level as RF Lev 2
Calculate the difference between the two RF levels

RF Lev 1 _____ dBm
RF Lev 2 _____ dBm EOC
D/U 0.00 dB

14 10.7 IM Test

Using the three generator set up, set generators as follows;
Set Up: Desired: 94.1MHz, -45dBm, Pilot only
Lower Undesired: 88.7MHz, 1kHz, 75kHz dev
Upper Undesired: 99.3MHz, 400Hz, 75kHz dev
Adjust: Undesired RF level to obtain -50dB noise floor, record RF lev 10.6MHz Spacing
Set upper undesired generator to 99.4MHz. Adjust RF lev for -50dB noise floor. (RF lev 10.7MHz Spacing)

10.6MHz Spacing dBm	D/U	10.7MHz Spacing dBm	D/U
-45.00		-45.00	
	-45.00		-45.00
Max RF	-45.00	Max RF	-45.00

EOC:

15 10.7MHz (10.6MHz) Local Osc Interference Test

Set Up: Desired: 94.1MHz, -45dBm, Pilot only
Set upper interferer generator to 104.7MHz (94.1MHz + 10.6MHz), 400Hz, 75kHz dev
a) Increase level of undesired signals until noise floor is -50dB (+/- 2dB). Record RF Lev for 10.6MHz Spacing
b) Re-adjust upper interfering generator to 104.8MHz (94.1MHz + 10.7MHz)
Re-adjust RF level for -50dB and record RF lev for 10.7MHz spacing

10.6MHz Spacing dBm	D/U	10.7MHz Spacing dBm	D/U
-45.00		-45.00	
	-45.00		-45.00
Max RF	-45.00	Max RF	-45.00

EOC:

16 IM (800kHz Channel Spacing)

Set Up: Desired: 94.1MHz, -45dBm, Pilot only
Undesired: U1, 94.9MHz, 400Hz/75kHz
U2, 95.7MHz, 1kHz/75kHz

Appendix B

FM Receiver Test Laboratory

Date: 4/3/99
Engineer: TBK RMc
Test Series: B
Description: Objective and Subjective measurements of interference without multipath

Desired: Tone/Pilot only - Objectives. Subjectives - see tape log
Undesired: Clipped Pink Noise, Stereo, 75kHz - Objectives. Subjectives - see tape log
Measurement: Receiver audio, 15kHz BW, rms & QP
Measurements are made with the Audio Precision Portable One Plus
WQP measurements are Quasi-Peak detected and weighted using the CCIR 468-3 Weighting Filter
High-lighted results (in bold) incate a recording is made at this setting using subjective listening program material
Test Set Up: 7 RF: Two Tone

		Best S/N	RMS	60.5	69.0	66.8	67.5	65.0	68.5	59.2	68.0	59.5	65.5	60.5	60.50	63.6	61.2	57.2	60.7	
		(Stereo)	QPK	50.5	61.5	58.7	61.5	57.0	65.0	52.6	62.0	54.0	59.0	49.0	51.0	55.0	49.0	48.2	54.3	
	Test Reference →			A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R	S
B1.3	↓		Receiver No.	Delco 1	Den380 2	Pana 3	Pioneer 4	Ford 5	Den680 6	Audivox 7	SonyHF 8	SonyWM 9	TechHF 10	Sanyo 11	SonyTR 12	Koss 13	Magna 14	Ford 15	RadShk 16	17
Co-Channel -50dB	1		RMS	26.0	30.0	30.0	30.0	28.0	30.0	29.0	30.0	30.0	30.0	33.0	30.0	30.0	36.0	34.0	30.0	
45dB S/N Target	2	D/U (dB)	WQP	34.0	41.0	40.0	41.0	39.0	41.0	40.0	41.0	39.0	40.0	48.0	43.0	41.0	51.0	50.0	41.0	
B1.4																				
-50dBm	5		RMS	38.0			34.5								35.0					
Fixed 20dB D/U	6	S/N (dB)	WQP	31.0	24.5	25.3	24.0	26.2	24.4	26.0	24.2	26.5	25.5	19.2	24.7	24.6	17.5	19.3	25.0	
	7																			
	8		RMS	48.5			44.5								45.0					
Fixed 30dB D/U	9	S/N (dB)	WQP	42.0	34.6	35.4	34.0	36.3	34.2	36.0	34.2	36.5	35.3	29.0	34.5	34.5	27.6	29.2	35.0	

FM Receiver Test Laboratory

			A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R	S
B2.3	12	Receiver	Delco	Den380	Pana	Pioneer	Ford	Den680	Audivox	SonyHF	SonyWM	TechHF	Sanyo	SonyTR	Koss	Magna	Ford	RadShk	
1st Adj.	13	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
-50dBm	14	Upper RMS	5.0			8.0								16.0					
45dB S/N Target	15	D/U (dB) QP	5.0	14.0	24.0	21.0	-8.0	-10.0	0.0	17.0	20.0	20.0	37.0	28.0	8.0	20.0	-2.0	23.0	
	16	Lower RMS	9.0			20.0								14.0					
	17	D/U (dB) WQP	9.0	24.0	24.0	31.0	10.0	4.0	20.0	26.0	20.0	20.0	29.0	28.0	23.0	28.0	-5.0	31.0	
-70dBm	19	Upper RMS	1.0	-2.0		8.0					10.0		-6.0	17.0	-4.0	5.0	-20.0		
45dB S/N	20	D/U (dB) WQP	2.0	NA	31.0	20.0	-12.0	-10.0	2.0	19.0	NA	20.0	NA	NA			NA	40.0	
Target	21	Lower RMS	7.0	13.0		20.0					12.0		-14.0	15.0	11.0	15.0	-24.0		
	22	D/U (dB) WQP	7.0	NA	31.0	31.0	-12.0	4.0	23.0	28.0	NA	20.0	NA	NA			NA	40.0	
B2.4																			
-50dBm	25	Upper RMS	60.5			43.0								34.0					
Fixed 6dB D/U	26	S/N (dB) QP	50.0	36.0	27.0	30.0	52.0	64.0	50.0	34.5	31.0	30.0	44.0	23.0	43.0	32.0	46.8	29.6	
	27	Lower RMS	42.0			31.0								36.0					
	28	S/N (dB) WQP	25.0	26.0	26.0	20.0	49.2	58.0	31.0	26.0	31.0	32.0	48.0	23.0	28.0	24.0	47.0	20.0	
-70dBm	30	Upper RMS	57.5			43.0								34.0		45.0			
Fixed 6dB D/U	31	S/N (dB) WQP	48.9	38.0	27.5	31.0	53.0	49.5	45.8	34.0	31.0	31.0	36.0	23.0	40.0		42.4	36.0	
	32	Lower RMS	50.0			30.5								36.0		39.0			
	33	S/N (dB) WQP	30.0	25.0	25.5	20.0	50.0	49.5	31.0	25.0	31.0	32.0	36.3	23.0	27.0		42.3	19.2	

FM Receiver Test Laboratory

			A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R	S
B3.3	36	Receiver	Delco	Den380	Pana	Pioneer	Ford	Den680	Audivox	SonyHF	SonyWM	TechHF	Sanyo	SonyTR	Koss	Magna	Ford	RadShk	
2nd Adj.	37	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
-50dBm	38	Upper RMS	-55.0			-27.0								-28.3					
45dB S/N Target	39	D/U (dB) WQP	-48.0	-24.0	-1.0	-18.0	-57.0	-34.0	-40.0	-29.0	-19.0	-35.0	6.0	-18.0	-35.0	-23.0	-30.0	-3.0	
	40	Lower RMS	-55.0			-31.0								-24.0					
	41	D/U (dB) WQP	-48.0	-30.0	-13.0	-21.0	-55.0	-40.0	-35.0	-28.0	-17.0	-34.0	-9.0	-16.0	-31.0	-21.0	-31.0	-2.0	
	42																		
-70dBm	43	Upper RMS	-54.0	-45.0		-32.0					-35.0		-9.0	-30.0	-44.0	-39.0	MAX		
45dB S/N Target	44	D/U (dB) WQP	-47.0	NA	3.0	-16.0	-55.0	-34.0	-33.0	-28.0	NA	-33.0	NA	NA			NA	-6.0	
	45	Lower RMS	-53.0	-44.0		-35.0					-32.0		-23.0	-28.0	-40.0	-40.0	MAX		
	46	D/U (dB) WQP	-47.0	NA	-19.0	-20.0	-53.0	-34.0	-32.0	-31.0	NA	-34.0	NA	NA			NA	3.0	
B3.4																			
-50dBm	49	Upper RMS	58.0			55.0								54.0					
Fixed -20dB D/U	50	S/N (dB) WQP	49.0	55.5	0.9	42.5	55.2	59.5	52.2	51.6	44.5	56.5	17.0	42.0	52.5	46.8	46.8	28.5	
	51	Lower RMS	57.5			58.0								50.8					
	52	S/N (dB) WQP	49.0	49.0	37.4	46.0	52.5	58.0	51.6	55.2	40.0	56.1	31.0	40.0	52.0	45.7	46.8	21.2	
-50dBm	54	Upper RMS	55.0			42.0								43.0					
Fixed -30dB D/U	55	S/N (dB) WQP	48.0	40.0	1.0	32.0	49.5	50.0	50.0	44.0	34.5	48.5	3.5	30.0	48.7	38.0	45.0	18.8	
	56	Lower RMS	56.0			46.0								39.0					
	57	S/N (dB) WQP	48.0	45.0	25.0	35.0	49.2	45.0	46.5	43.0	7.0	48.0	0.0	28.5	46.0	33.0	45.3	0.0	
-50dBm	59	Upper RMS	56.0			35.5								32.0					
Fixed -40dB D/U	60	S/N (dB) WQP	48.3	42.5	0.0	22.5	47.5	38.0	45.6	34.5	1.9	42.5	0.0	19.5	40.0	31.2	42.8	0.0	
	61	Lower RMS	56.0			34.5								29.0					
	62	S/N (dB) WQP	48.3	40.5	1.0	21.5	47.3	33.0	44.7	36.7	2.4	41.5	0.0	18.5	37.0	31.0	42.2	0.0	
-50dBm	64	Upper RMS	47.5			7.0								8.0					
Fixed -50dB D/U	65	S/N (dB) WQP	42.5	31.0	0.0	2.5	48.5	34.5	34.6	22.0	1.7	30.0	0.0	5.0	33.0	36.0	45.6	0.0	
	66	Lower RMS	48.0			7.5								16.0					
	67	S/N (dB) WQP	42.0	29.0	0.0	2.5	49.0	35.5	40.7	26.0	0.2	30.2	0.0	16.0	34.0	35.0	43.0	0.0	

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FM Receiver Test Laboratory

B3.4
2nd Adj.
-70dBm
Fixed -20dB D/U

		Receiver No.	A Delco 1	B Den380 2	C Pana 3	D Pioneer 4	E Ford 5	F Den680 6	G Audivox 7	H SonyHF 8	I SonyWM 9	J TechHF 10	K Sanyo 11	L SonyTR 12	M Koss 13	N Magna 14	P Ford 15	R RadShk 16	S 17
Upper	RMS		56.5	55.0		55.0								51.5					
S/N (dB)	WQP		48.5	45.0	26.2	42.3	56.0	49.3	46.0	47.5	44.2	48.5	35.5	40.0	42.3	34.5	42.3	32.0	
Lower	RMS		57.0	45.0		56.5								51.0					
S/N (dB)	WQP		48.5	NA	44.5	45.0	56.0	49.3	46.2	47.7	43.6	48.5	46.8	40.3	42.3	34.5	42.2	27.5	

-70dBm
Fixed -30dB D/U

Upper	RMS		54.0	54.0		46.5								44.0					
S/N (dB)	WQP		46.5	43.5	5.0	33.0	55.5	47.5	45.6	44.0	42.0	46.6	20.0	32.0	41.7	34.2	42.2	19.7	
Lower	RMS		54.0	54.0		50.0								43.0					
S/N (dB)	WQP		46.7	43.5	38.0	36.5	55.5	47.0	45.5	45.5	38.0	46.8	40.0	32.5	40.7	34.4	42.2	21.0	

-70dBm
Fixed -40dB D/U

Upper	RMS		55.0	49.0		36.0								32.0					
S/N (dB)	WQP		47.5	39.0	0.0	22.5	53.5	40.5	41.7	34.0	5.0	39.8	1.3	20.5	38.2	32.0	41.6	0.0	
Lower	RMS		55.0	48.0		39.5								28.5					
S/N (dB)	WQP		47.5	37.5	2.5	26.5	52.5	38.5	41.2	38.0	3.0	40.5	25.0	18.5	35.4	32.5	40.7	0.0	

-70dBm
Fixed -50dB D/U

Upper	RMS		47.0	42.0		25.0								12.0					
S/N (dB)	WQP		41.5	31.0	0.0	12.5	48.3	31.0	36.0	25.0	2.5	29.2	0.0	10.0	30.0	32.8	44.7	0.0	
Lower	RMS		47.0	40.0		23.0								23.0					
S/N (dB)	WQP		41.0	29.5	0.0	7.0	46.7	4.0	35.0	28.5	0.5	30.2	0.0	19.5	26.3	32.8	43.2	0.0	

B4.3
3rd Adj.
-50dBm
Fixed -30dB D/U

		Receiver No.	A Delco 1	B Den380 2	C Pana 3	D Pioneer 4	E Ford 5	F Den680 6	G Audivox 7	H SonyHF 8	I SonyWM 9	J TechHF 10	K Sanyo 11	L SonyTR 12	M Koss 13	N Magna 14	P Ford 15	R RadShk 16	S 17
Upper	RMS		57.0			57.0								50.0					
S/N (dB)	WQP		48.7	50.7	28.6	46.5	50.0	52.2	50.0	48.5	45.0	50.5	13.0	39.5	50.0	41.0	45.8	26.9	
Lower	RMS		56.7			57.0								43.7					
S/N (dB)	WQP		48.4	43.0	39.0	46.3	53.0	38.5	49.0	45.7	47.0	49.8	3.7	33.5	49.0	33.0	45.8	24.3	

-50dBm
Fixed -40dB D/U

Upper	RMS		56.2			50.5								40.0					
S/N (dB)	WQP		48.0	42.5	1.0	39.8	48.5	39.3	45.0	41.2	33.5	43.8	0.0	29.5	42.0	32.5	43.4	16.5	
Lower	RMS		56.5			50.3								35.0					
S/N (dB)	WQP		48.3	37.8	26.7	39.5	50.7	39.3	45.5	40.0	30.0	42.6	0.0	25.0	41.5	32.5	42.2	0.0	

-50dBm
Fixed -50dB D/U

Upper	RMS		52.0			40.3								23.0					
S/N (dB)	WQP		47.7	31.0	0.5	29.5	49.0	33.0	34.5	28.5	4.5	31.5	0.0	20.0	33.5	36.8	45.7	0.0	
Lower	RMS		51.0			40.0								14.0					
S/N (dB)	WQP		44.5	30.0	0.3	29.8	44.5	40.6	42.8	29.2	5.2	31.2	0.0	12.0	35.0	36.0	42.5	0.0	

FM Receiver Test Laboratory

DAT Tape Recording Log

Engineer: TBK, RMc
Test Series: B
Tape No.: 001
Set Up: Record 1kHz tone, 100% (75kHz) at -12dB (30 sec) for each individual radio for 0dB reference
All recordings at 44.1kHz
Desired Prog.: Franck: Allegretto from Symphony in D minor
Scatman John: "Scatman"
Undesired Prog.: The B-52's: "Love Shack"

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
	Sony TR						
1		4/13/99	1	0	:30	NA	Reference Tone/SonyTR (recorded at -9dB on DAT meter)
2	L-49		2	:30	1:00	-20	Classical w/ 2nd Adj interferer
3	L-54			1:00	1:30	-30	
4	L-59			1:30	2:00	-40	
5	L-64			2:00	2:30	-50	Heavy interference
6	L-49		3	2:30	3:00	-20	Scatman w/2nd interferer
7	L-54			3:00	3:30	-30	
8	L-59			3:30	4:00	-40	
9	L-64			4:00	4:30	-50	Heavy interference
10			4	4:30	5:00		Classical reference - no interferer
11	L-95			5:00	5:30	-30	Classical w/3rd Adj. interferer
12	L-100			5:30	6:00	-40	Noticible intereference
13	L-105			6:00	6:30	-50	Heavy interference
14	Pioneer	Mono					Mono
15		4/15/99	5	6:30	6:53		Reference Tone/Pioneer SX201 (recorded at -12dB on DAT meter)
16			6	7:00	7:30		Classical reference - no interferer
17	D-54		7	7:30	8:00	-30	Classical w/ 2nd Adj interferer
18	D-59			8:00	8:30	-40	
19	D-64			8:30	9:00	-50	
20	D-54		8	9:00	9:30	-30	Scatman w/2nd interferer
21	D-59			9:30	10:00	-40	
22	D-64			10:00	10:30	-50	
23	D-97		9	10:30	11:00	-30	Classical w/3rd Adj. interferer
24	D102			11:00	11:30	-40	interference is slightly reduced while Hiss is increased
25	D-107			11:30	12:00	-50	interference is reduced while Hiss is increased

FM Receiver Test Laboratory

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
26	Delco						
27			10	12:00	13:00		Blank
28		4/16/99	11	13:00	13:30		Reference Tone/ Delco (recorded at -12dB on DAT meter)
29			12	13:30	14:00		Classical reference - no interferer
30	A-54		13	14:00	14:30	-30	Classical w/ 2nd Adj interferer
31	A-59			14:30	15:00	-40	
32	A-64			15:00	15:30	-50	Slight interference
33	A-97		14	15:30	16:00	-30	Classical w/3rd Adj. interferer
34	A-102			16:00	16:30	-40	
35	A-107			16:30	17:00	-50	
36	Den 380						
37		4/17/99	15	17:00	17:30		Reference Tone/ Den380 (recorded at -12dB on DAT meter)
38			16	17:30	18:00		Classical reference - no interferer
39	B-52		17	18:00	18:30	-20	Classical w/ 2nd Adj interferer Mild interference
40	B-57			18:30	19:00	-30	
41	B-62			19:00	19:30	-40	Mild interference with hiss
42	B-67			19:30	20:00	-50	Medium interference with more hiss
43	B-52		18	20:00	20:30	-20	Scatman w/2nd interferer
44	B-57			20:30	21:00	-30	
45	B-62			21:00	21:30	-40	
46	B-67			21:30	22:00	-50	
47	B-98		19	22:00	22:30	-30	Classical w/3rd Adj. interferer Mild interference
48	B-103			22:30	23:00	-40	Medium interference
49	B-108			23:00	23:30	-50	Medium interference with hiss
50	Sanyo						
51		4/17/99	20	23:30	24:00		Reference Tone/ Sanyo (recorded at -12dB on DAT meter)
52			21	24:00	24:30		Classical reference - no interferer
53			22	24:30	25:00	-20	Classical w/ 2nd Adj interferer Medium interference
54				25:00	25:30	-30	Extreme interference
55				25:30	26:00	-40	Extreme interference
56				26:00	26:30	-50	Extreme interference
57			23	26:30	27:00	-20	Scatman w/2nd interferer
58				27:00	27:30	-30	Extreme interference
59				27:30	28:00	-40	Extreme interference
60				28:00	28:30	-50	Extreme interference
61			24	28:30	29:00	-30	Heavy interference
62				29:00	29:30	-40	Extreme interference
63				29:30	30:00	-50	Extreme interference

FM Receiver Test Laboratory

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
64	Sony WM						
65		4/18/99	25	30:00	30:30		Reference Tone/ SONY Walkman (recorded at -12dB on DAT meter)
66			26	30:30	31:00		Classical reference - no interferer
67	I-50		27	31:00	31:30	-20	Classical w/ 2nd Adj interferer Mild interference
68	I-55			31:30	32:00	-30	Medium interference
69	I-60			32:00	32:30	-40	Extreme interference
70	I-65			32:30	33:00	-50	Interference causes radio to shut down - noise is very reduced
71	I-50		28	33:00	33:30	-20	Scatman w/2nd interferer
72	I-55			33:30	34:00	-30	
73	I-60			34:00	34:30	-40	Extreme interference
74	I-65			34:30	35:00	-50	Interference causes radio to shut down - noise is very reduced
75	I-96		29	35:00	35:30	-30	Classical w/3rd Adj. interferer Slight interfence
76	I-101			35:30	36:00	-40	Medium interference
77	I-106			36:00	36:30	-50	Extreme interference
78	Technics						
79		4/18/99	30	36:30	37:00		Reference Tone/ Technics (recorded at -12dB on DAT meter)
80			31	37:00	37:30		Classical reference - no interferer
81	J-50		32	37:30	38:00	-20	Classical w/ 2nd Adj interferer
82	J-55			38:00	38:30	-30	Slight interference
83	J-60			38:30	39:00	-40	Less program interference - more hiss
84	J-65			39:00	39:30	-50	Medium interference - mostly hiss
85	J-50		33	39:30	40:00	-20	Scatman w/2nd interferer
86	J-55			40:00	40:30	-30	
87	J-60			40:30	41:00	-40	
88	J-65			41:00	41:30	-50	
89	J-96		34	41:30	42:00	-30	Classical w/3rd Adj. interferer Very slight interference
90	J-101			42:00	42:30	-40	Increased hiss
91	J-106			42:30	43:00	-50	Medium to heavy interference - mostly hiss
92	Panasonic						
93		4/19/99	35	43:00	43:30		Reference Tone/ Panasonic (recorded at -12dB on DAT meter)
94			36	43:30	44:00		Classical reference - no interferer
95	C-50		37	44:00	44:30	-20	Classical w/ 2nd Adj interferer Extreme interference
96	C-55			44:30	45:00	-30	Extreme interference
97	C-60			45:00	45:30	-40	Interference causes radio to shut down - noise is reduced
98	C-65			45:30	46:00	-50	Interference causes radio to shut down - noise is reduced
99	C-50		38	46:00	46:30	-20	Scatman w/2nd interferer Extreme interference
100	C-55			46:30	47:00	-30	Extreme interference
101	C-60			47:00	47:30	-40	Interference causes radio to shut down - noise is reduced
102	C-65			47:30	48:00	-50	Interference causes radio to shut down - noise is reduced
103	C-96		39	48:00	48:30	-30	Classical w/3rd Adj. interferer Medium interference
104	C-101			48:30	49:00	-40	Extreme interference
105	C-106			49:00	49:30	-50	Extreme interference
106	Magnavox						

FM Receiver Test Laboratory

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
107		4/19/99	40	49:30	50:00		Reference Tone/ Magnavox (recorded at -12dB on DAT meter)
108			41	50:00	50:30		Classical reference - no interferer
109			42	50:30	51:00	-20	Classical w/ 2nd Adj interferer
110				51:00	51:30	-30	Mild interference
111				51:30	52:00	-40	Mild interference - prog interference is reduced- hiss is increased
112				52:00	52:30	-50	Mild interference - no prog interference- hiss takes on a different characteristic
113			43	52:30	53:00	-20	Scatman w/2nd interferer
114				53:00	53:30	-30	
115				53:30	54:00	-40	
116				54:00	54:30	-50	
117			44	54:30	55:00	-30	Classical w/3rd Adj. interferer
118				55:00	55:30	-40	Mild interference - hiss
119				55:30	56:00	-50	Mild interference - reduced hiss
120							
121							
122							
123							
124							
125							
126							
127							
128							
129							
130							

FM Receiver Test Laboratory

DAT Tape Recording Log

Engineer: TBK, RMc
Test Series: B
Tape No.: 002
Set Up: Record 1kHz tone, 100% (75kHz) at -12dB (30 sec) for each individual radio for 0dB reference
All recordings at 44.1kHz
Desired Prog.: Franck: Allegretto from Symphony in D minor
Scatman John: "Scatman"
Undesired Prog.: The B-52's: "Love Shack"

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
	Pioneer						
1		4/20/99	1	0:00	0:30		Reference Tone/Pioneer SX201 (recorded at -12dB on DAT meter)
2			2	0:30	1:00		Classical reference - no interferer
3	D-49		3	1:00	1:30	-20	Classical w/ 2nd Adj interferer Slight interference
4	D-54			1:30	2:00	-30	Medium interference
5	D-59			2:00	2:30	-40	Heavy interference
6	D-64			2:30	3:00	-50	Severe interference
7	D-54		4	3:00	3:30	-20	Scatman w/2nd interferer
8	D-49			3:30	4:00	-30	
9	D-59			4:00	4:30	-40	
10	D-64			4:30	5:00	-50	Severe interference
11	D-97		5	5:00	5:30	-30	Classical w/3rd Adj. interferer Mild interference
12	D102			5:30	6:00	-40	Mild interference - mostly hiss
13	D-107			6:00	6:30	-50	Medium interference - hiss
14	Ford						
15		4/20/99	6	6:30	7:00		Reference Tone/Ford Auto (recorded at -12dB on DAT meter)
16			7	7:00	7:30		Classical reference - no interferer
17	E-50		8	7:30	8:00	-20	Classical w/ 2nd Adj interferer very slight interference
18	E-55			8:00	8:30	-30	slight interference
19	E-60			8:30	9:00	-40	
20	E-65			9:00	9:30	-50	Slight interference - some hiss
21	E-50		9	9:30	10:00	-20	Scatman w/2nd interferer
22	E-55			10:00	10:30	-30	
23	E-60			10:30	11:00	-40	
24	E-65			11:00	11:30	-50	
25	E-96		10	11:30	12:00	-30	Classical w/3rd Adj. interferer Slight interference
26	E-101			12:00	12:30	-40	Slight interference
27	E-106			12:30	13:00	-50	Some increase in hiss level

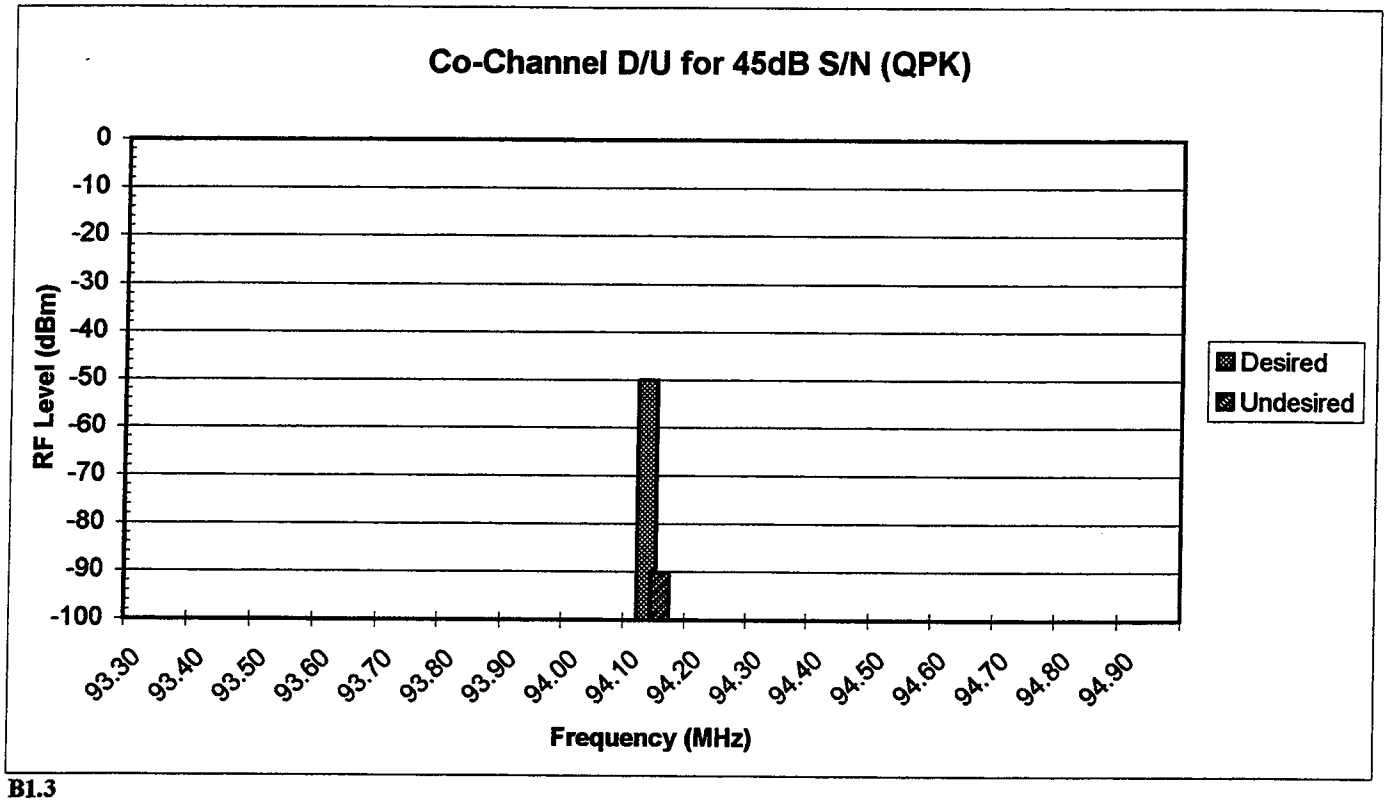
FM Receiver Test Laboratory

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
28	Den680						
29		4/20/99	11	13:00	13:30		Reference Tone/Denon 680 (recorded at -12dB on DAT meter)
30			12	13:30	14:00		Classical reference - no interferer
31	F-52		13	14:00	14:30	-20	Classical w/ 2nd Adj interferer
32	F-57			14:30	15:00	-30	Slight interference
33	F-62			15:00	15:30	-40	Medium interference
34	F-67			15:30	16:00	-50	Medium interference
35	F-52		14	16:00	16:30	-20	Scatman w/2nd interferer
36	F-57			16:30	17:00	-30	
37	F-62			17:00	17:30	-40	
38	F-67			17:30	18:00	-50	
39	F-98		15	18:00	18:30	-30	Classical w/3rd Adj. interferer
40	F-103			18:30	19:00	-40	Medium interference
41	F-108			19:00	19:30	-50	Mild interference - mostly hiss Mild interference - both prog & hiss
42	Audiovox						
43		4/21/99	16	19:30	20:00		Reference Tone/Audiovox Auto (recorded at -12dB on DAT meter)
44			17	20:00	20:30		Classical reference - no interferer
45	G-52		18	20:30	21:00	-20	Classical w/ 2nd Adj interferer
46	G-57			21:00	21:30	-30	
47	G-62			21:30	22:00	-40	
48	G-67			22:00	22:30	-50	
49	G-52		19	22:30	23:00	-20	Scatman w/2nd interferer
50	G-57			23:00	23:30	-30	
51	G-62			23:30	24:00	-40	
52	G-67			24:00	24:30	-50	
53	G-96		20	24:30	25:00	-30	Classical w/3rd Adj. interferer
54	G101			25:00	25:30	-40	
55	G-106			25:30	26:00	-50	
56	Koss						
57		4/21/99	21	26:00	26:30		Reference Tone/Koss Auto (recorded at -12dB on DAT meter)
58			22	26:30	27:00		Classical reference - no interferer
59	M-52		23	27:00	27:30	-20	Classical w/ 2nd Adj interferer
60	M-57			27:30	28:00	-30	
61	M-62			28:00	28:30	-40	
62	M-67			28:30	29:00	-50	
63	M-52		24	29:00	29:30	-20	Scatman w/2nd interferer
64	M-57			29:30	30:00	-30	
65	M-62			30:00	30:30	-40	
66	M-67			30:30	31:00	-50	
67	M-96		25	31:00	31:30	-30	Classical w/3rd Adj. interferer
68	M101			31:30	32:00	-40	
69	M-106			32:00	32:30	-50	
70	SonyHP						

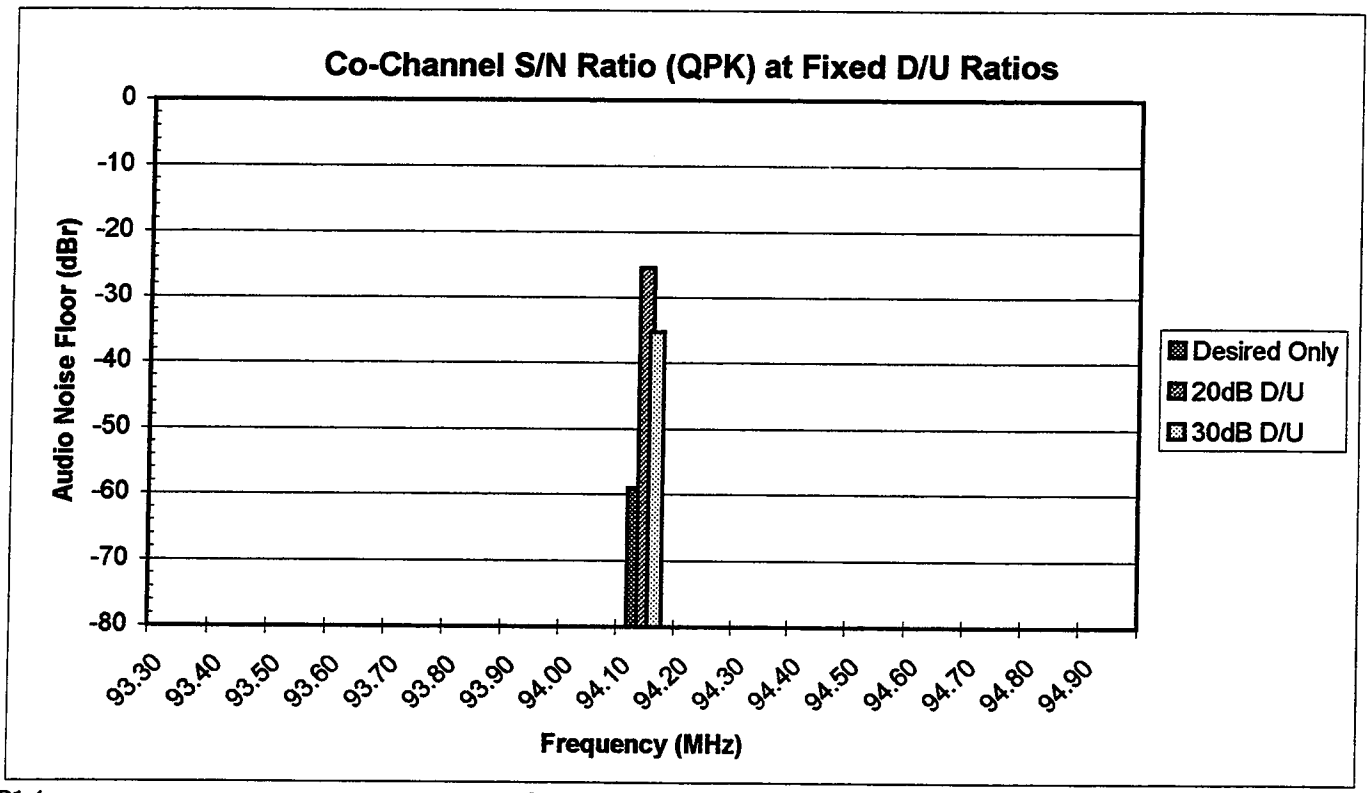
FM Receiver Test Laboratory

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments
71		4/22/99	26	32:30	33:00		Reference Tone/SonyHF (recorded at -12dB on DAT meter)
72			27	33:00	33:30		Classical reference - no interferer
73	H-50		28	33:30	34:00	-20	Classical w/ 2nd Adj interferer
74	H-55			34:00	34:30	-30	
75	H-60			34:30	35:00	-40	
76	H-65			35:00	35:30	-50	
77	H-50		29	35:30	36:00	-20	Scatman w/2nd interferer
78	H-55			36:00	36:30	-30	
79	H-60			36:30	37:00	-40	
80	H-65			37:00	37:30	-50	
81	H-98		30	37:30	38:00	-30	Classical w/3rd Adj. interferer
82	H-103			38:00	38:30	-40	
83	H-108			38:30	39:00	-50	
84							
85							
86							
87							
88							
89							
90							
91							
92							
93							
94							
95							

FM Receiver Test Laboratory



B1.3

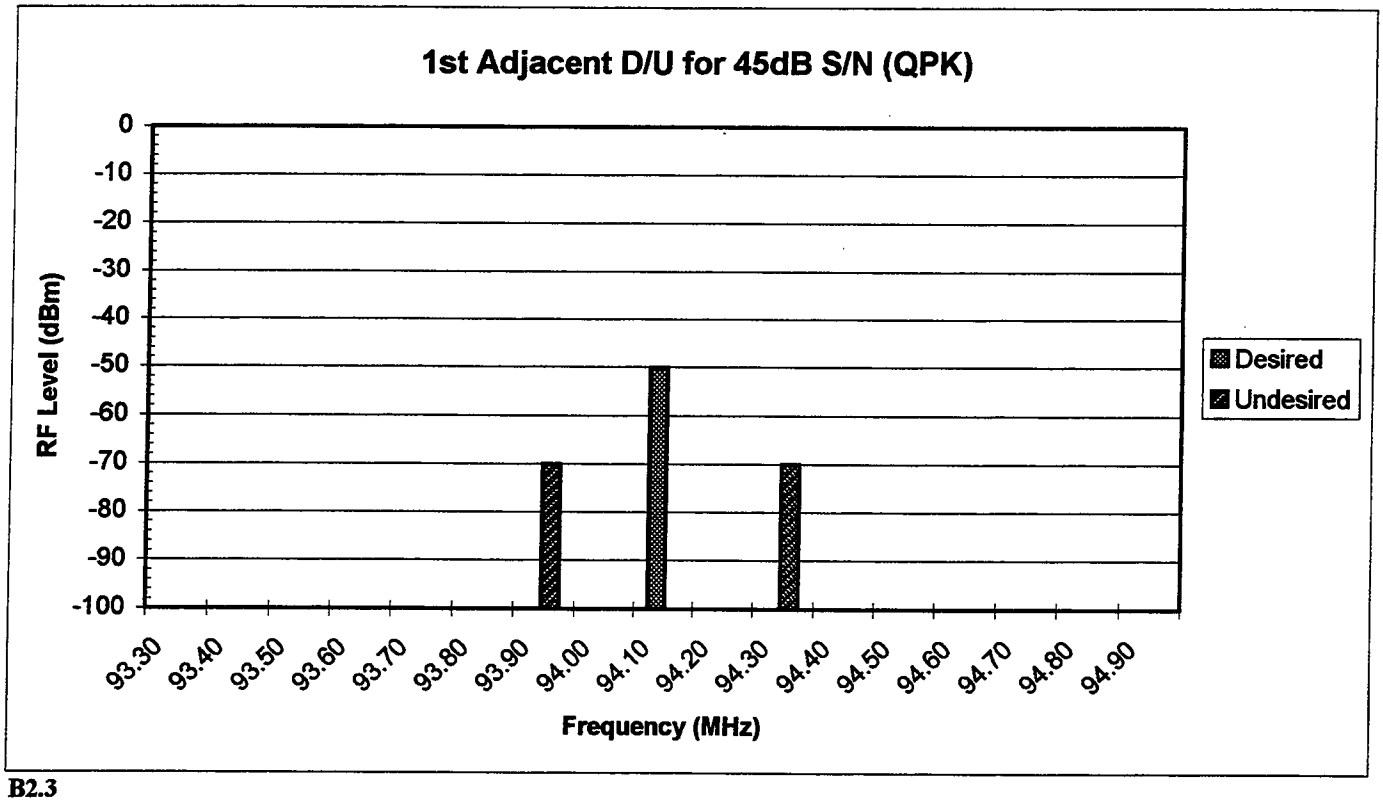


B1.4

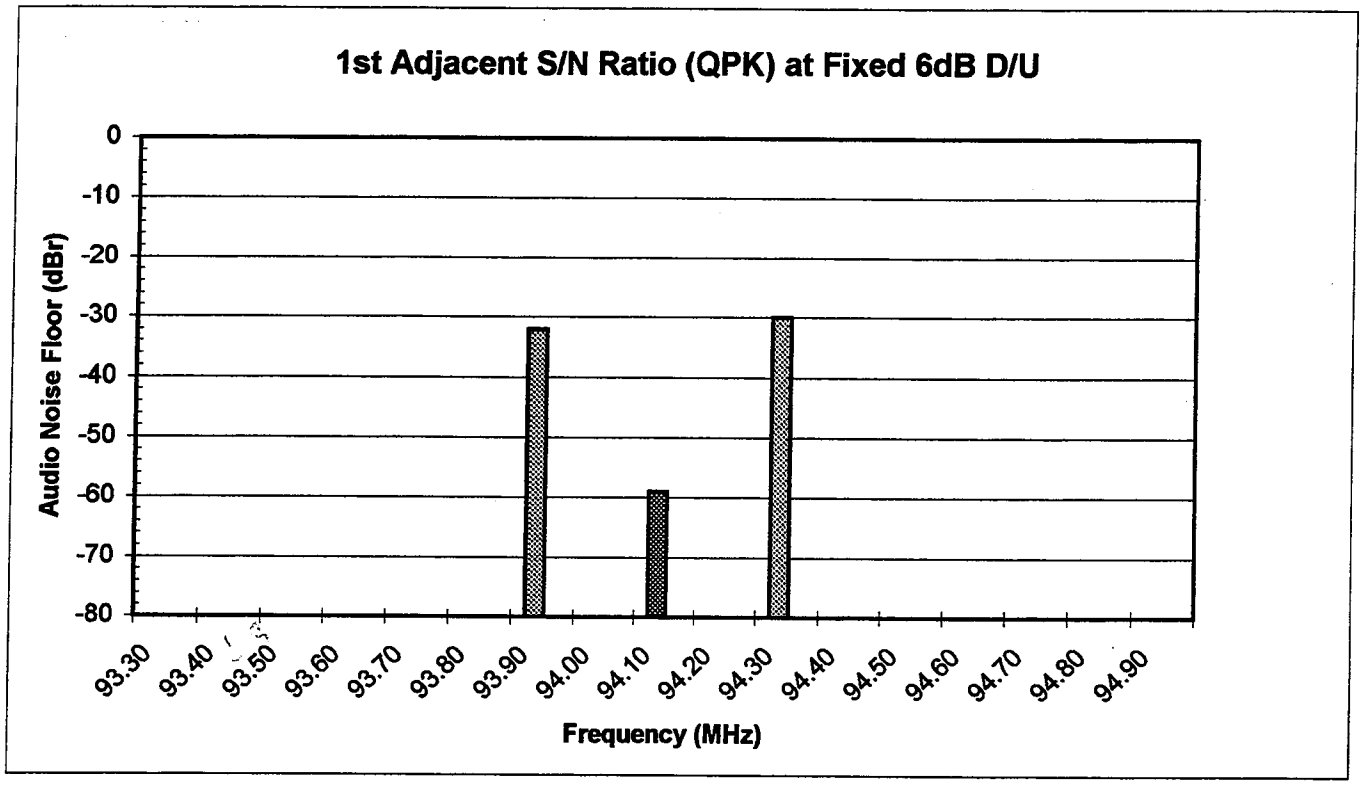
Co-Channel Characteristics

RX No.: 10 TechHF

FM Receiver Test Laboratory



B2.3

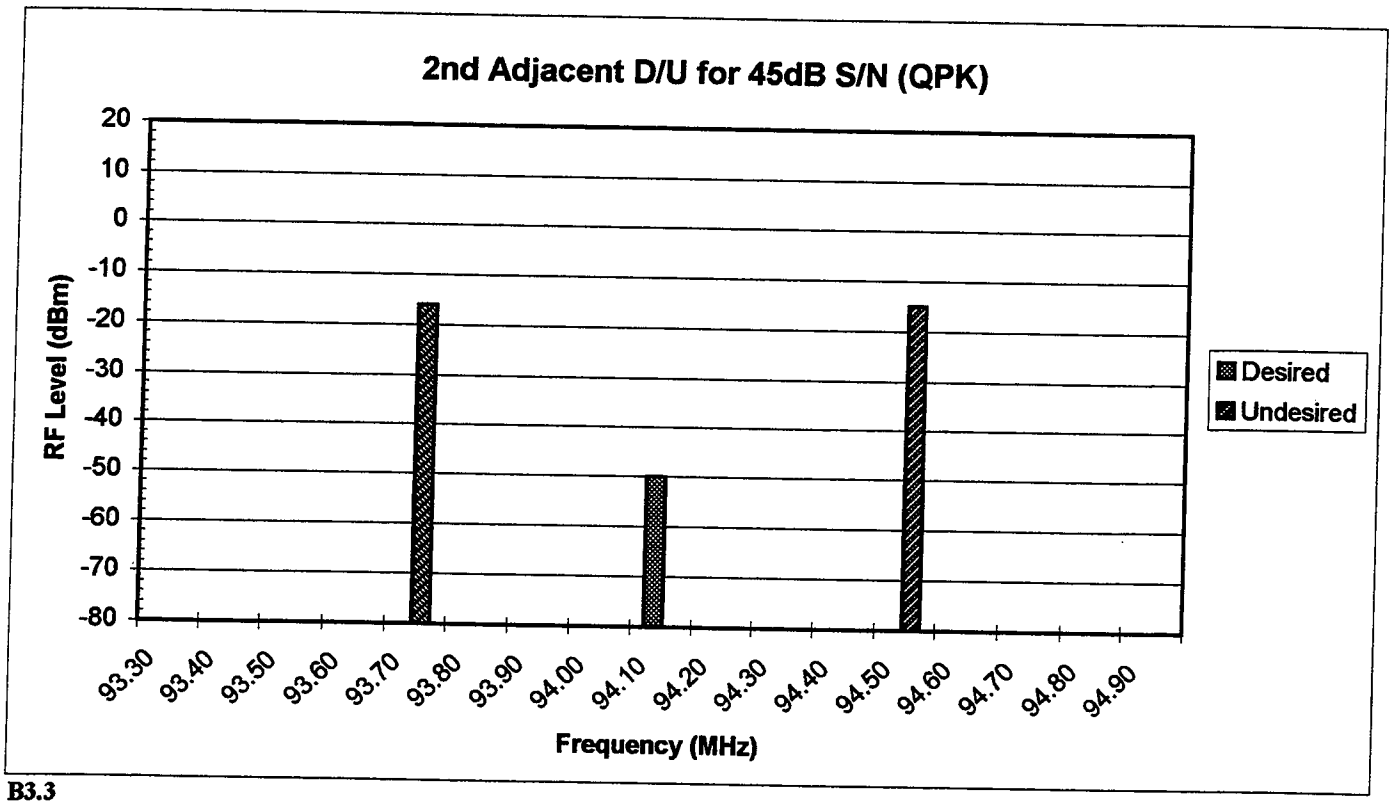


B2.4

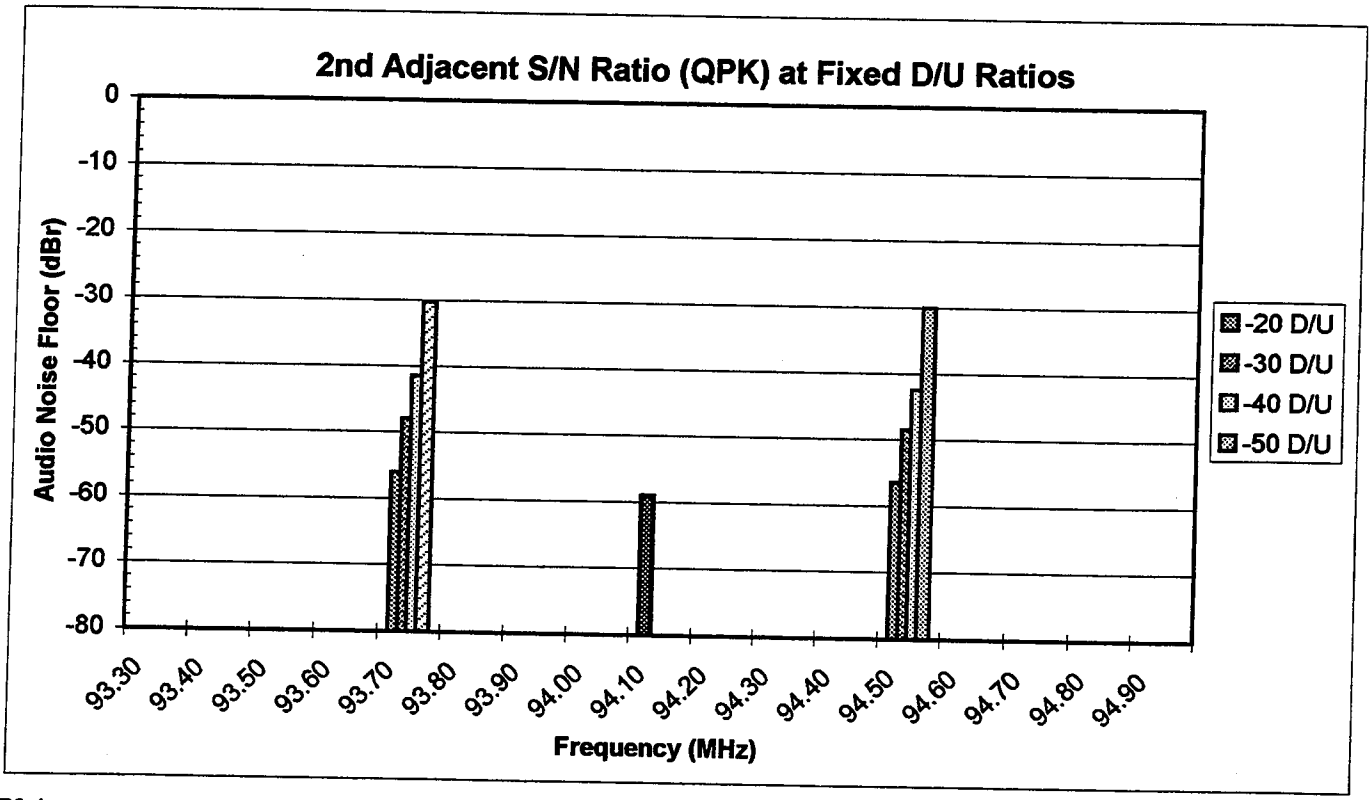
1st Adjacent Characteristics

RX No.: 10 TechHF

FM Receiver Test Laboratory



B3.3



B3.4

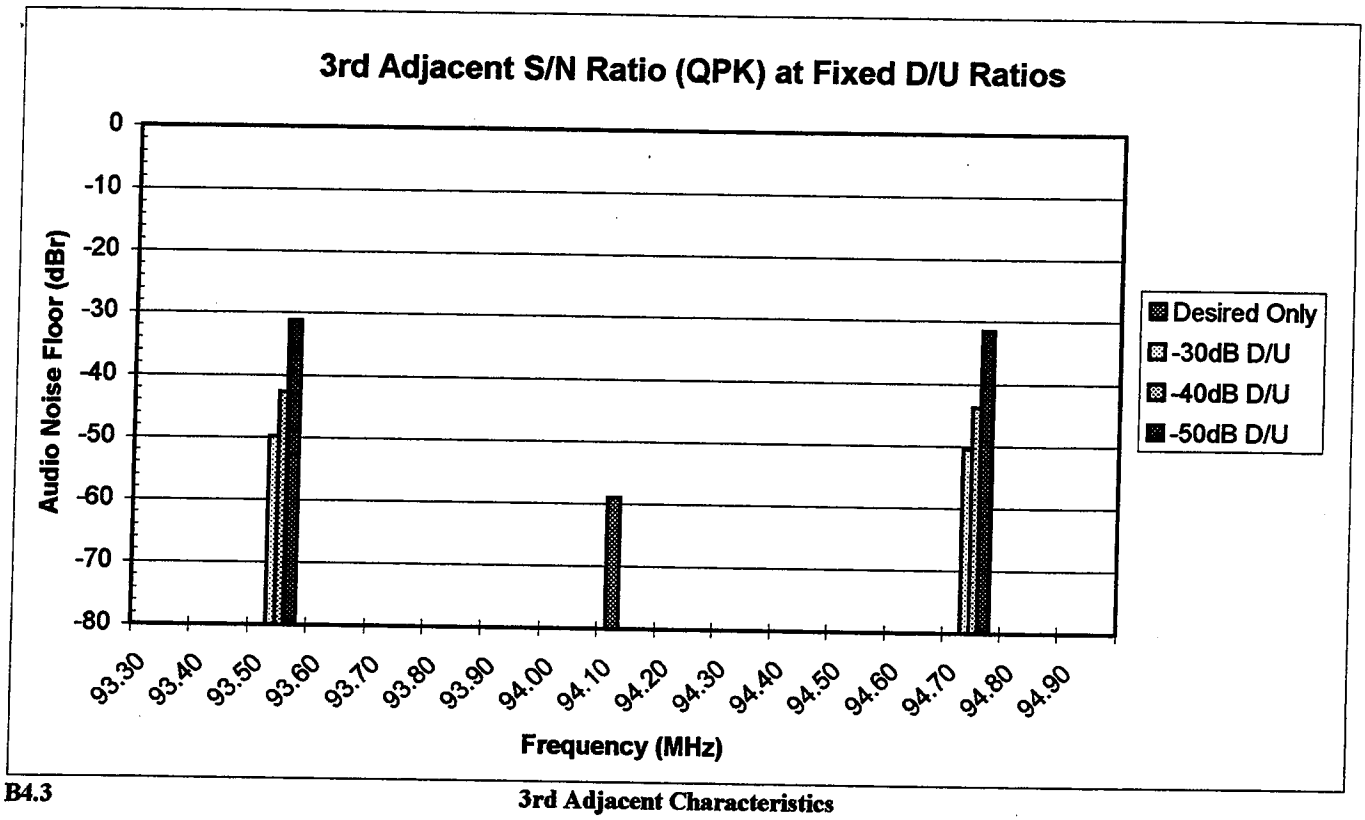
2nd Adjacent Characteristics
RX No.: 10 TechHF

B5

File Name: B_test

2nd Adj Chart

FM Receiver Test Laboratory

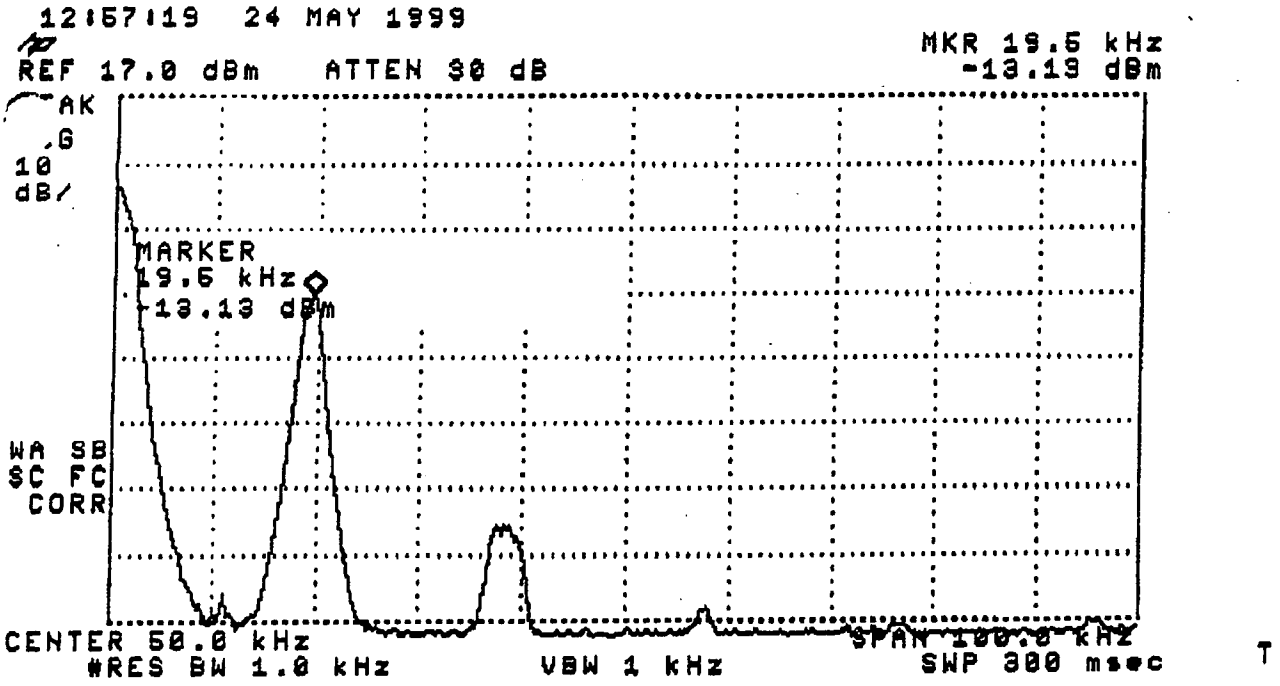


B4.3

3rd Adjacent Characteristics

RX No.: 10 TechHF

Appendix C



Baseband Calibration

94.1 MHz,

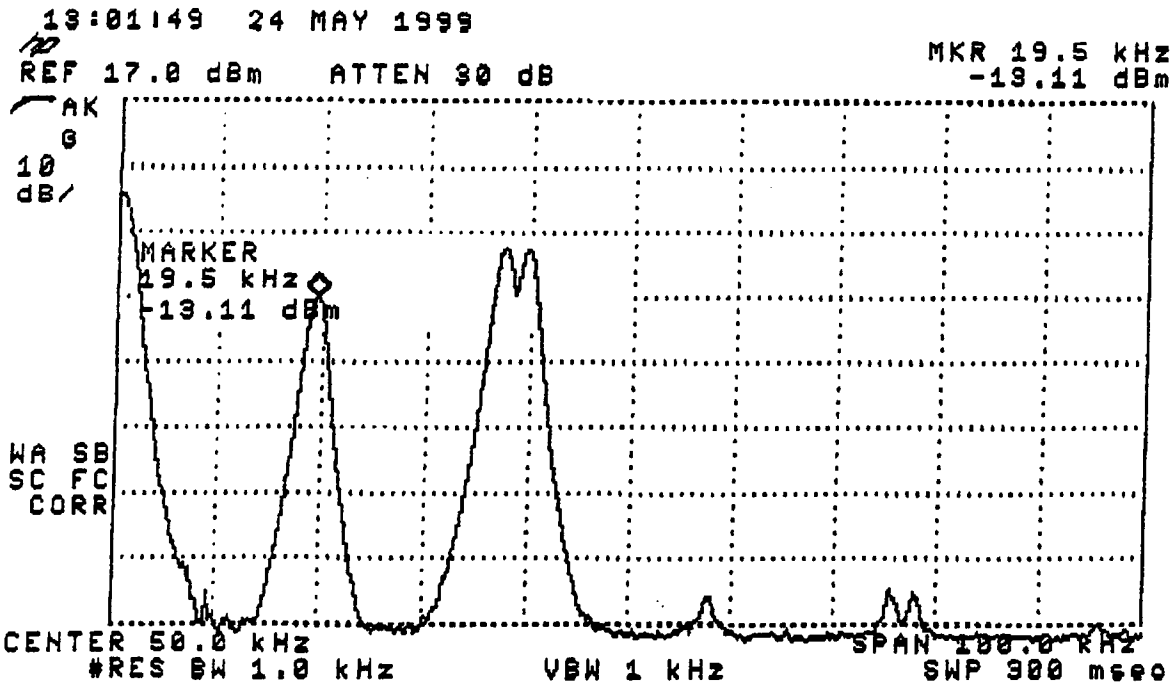
AFM2 composite output -> buffer amplifier -> spectrum analyzer

1 kHz, L=R, Pilot 10%

AMF2 Reading: 75%

-20 dBm

Plot 1



Baseband Calibration

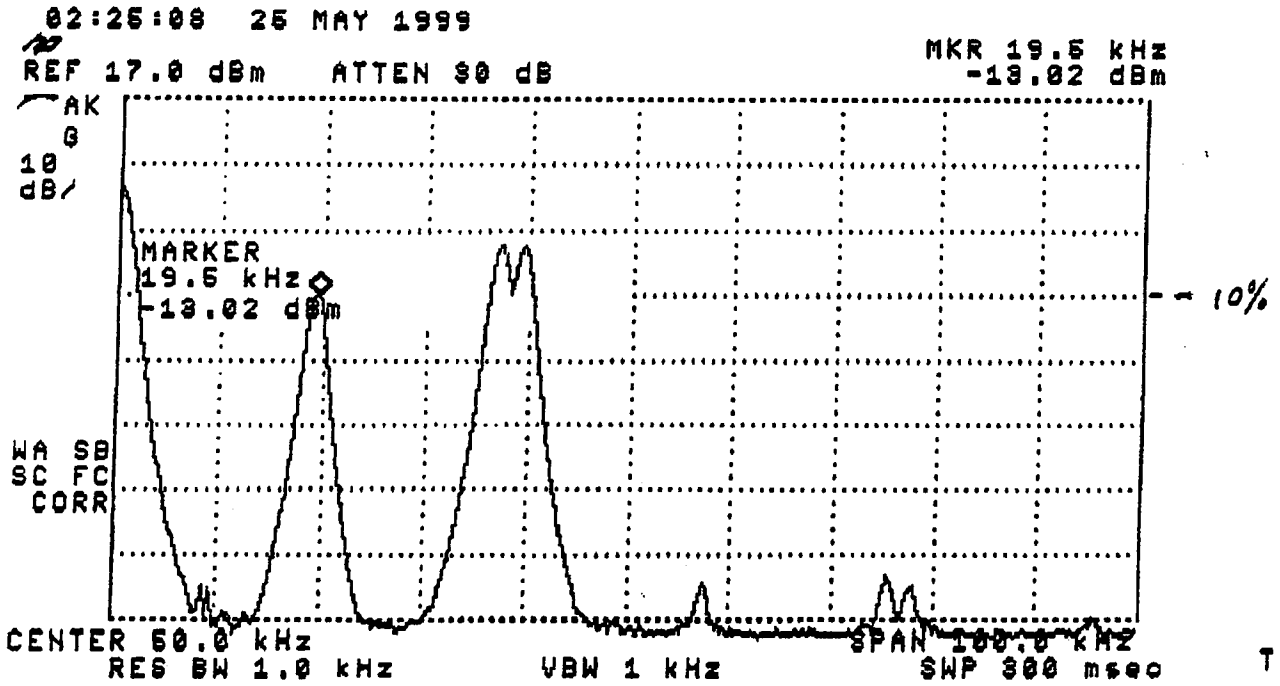
94.1 MHz,

AFM2 composite output -> buffer amplifier -> spectrum analyzer

1 kHz, L only, pilot 10%

-20 dBm

Plot 2

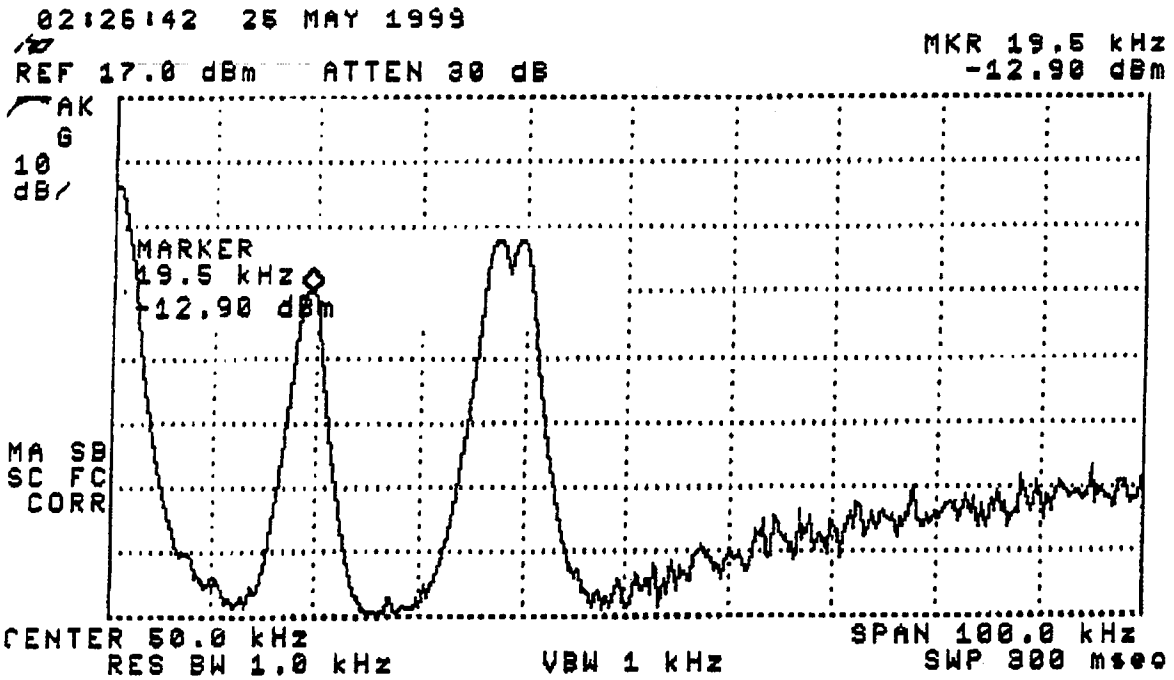


AFM2 Composite output

Unimpaired

-20 dBm

Plot 3



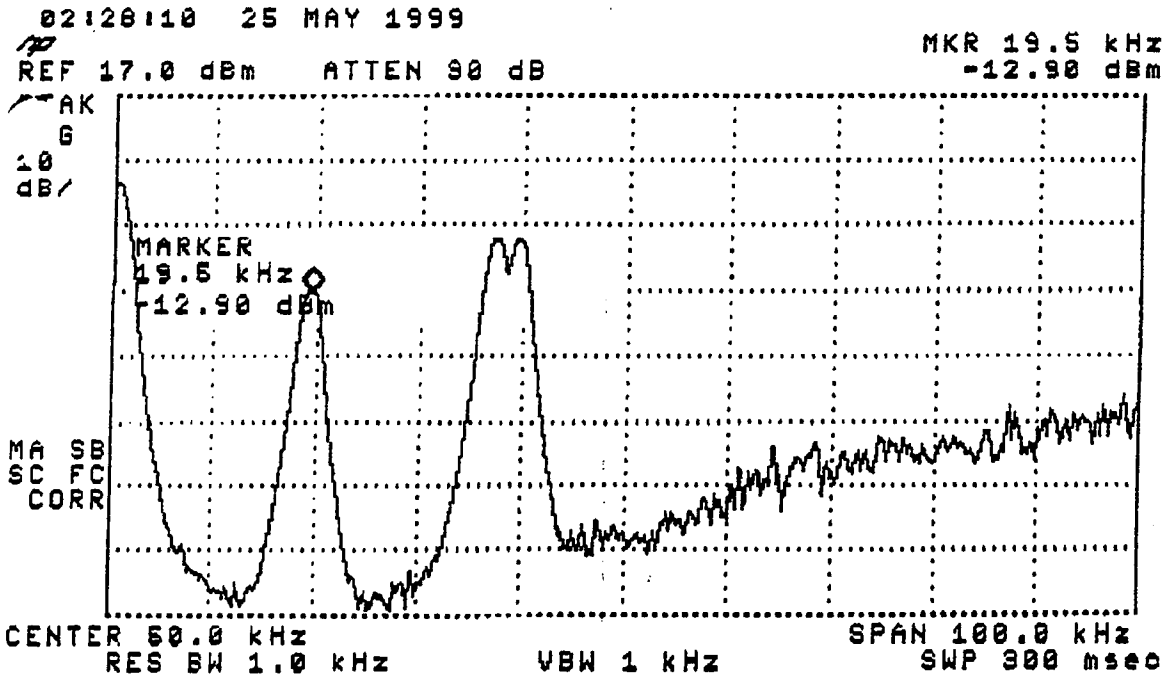
AFM2 Composite output

1st adjacent (CPN)

30 dB D/U

-20 dBm

Plot #4



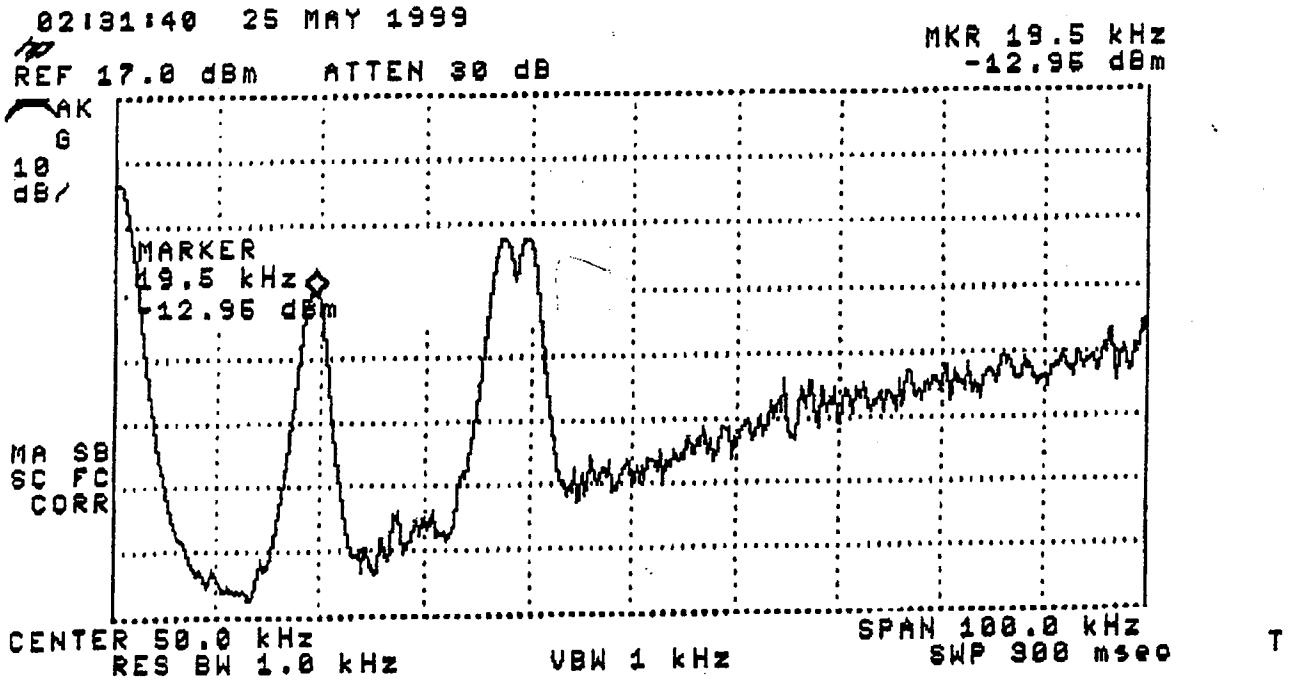
AFM2 Composite output

1st adjacent (CPN)

20 dB D/U

-20 dBm

Plot #5



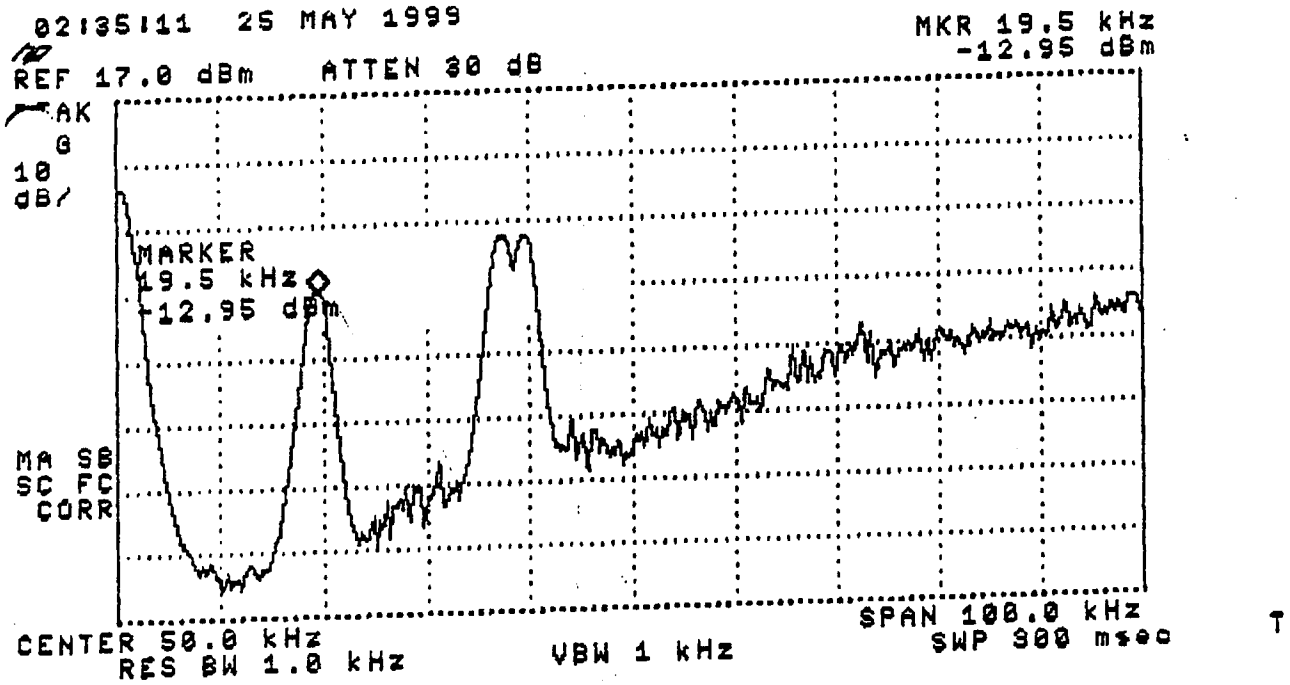
AFM2 Composite output

1st adjacent (CPN)

10 dB D/U

-20 dBm

Plot #6



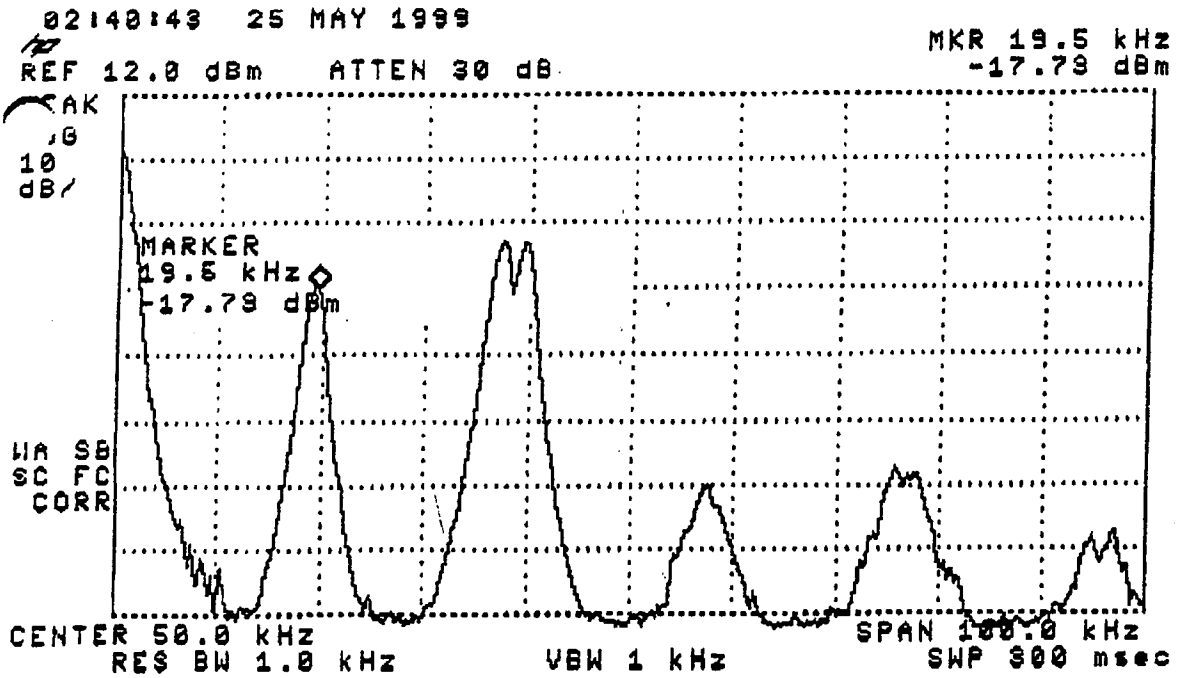
AFM2 Composite output

1st adjacent (CPN)

6 dB D/U

-20 dBm

Plot #7



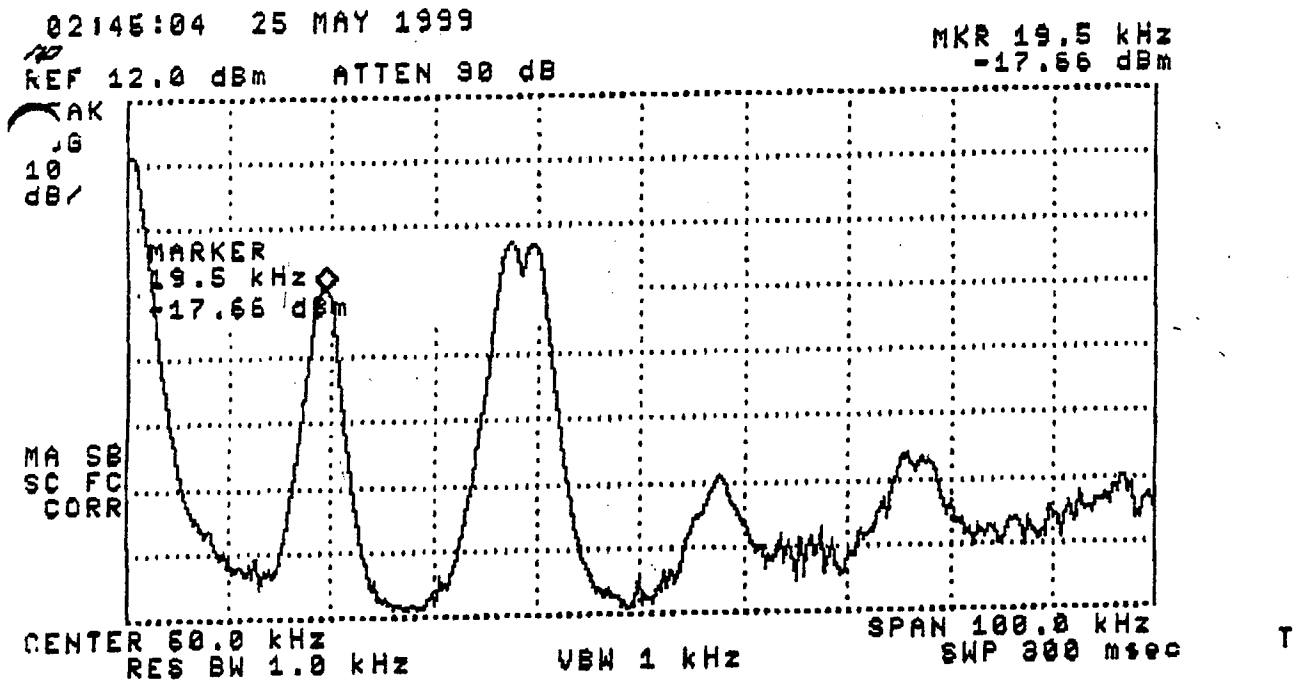
Denon 380 composite output

Unimpaired

-50 dBm

-20 dBm

Plot #8



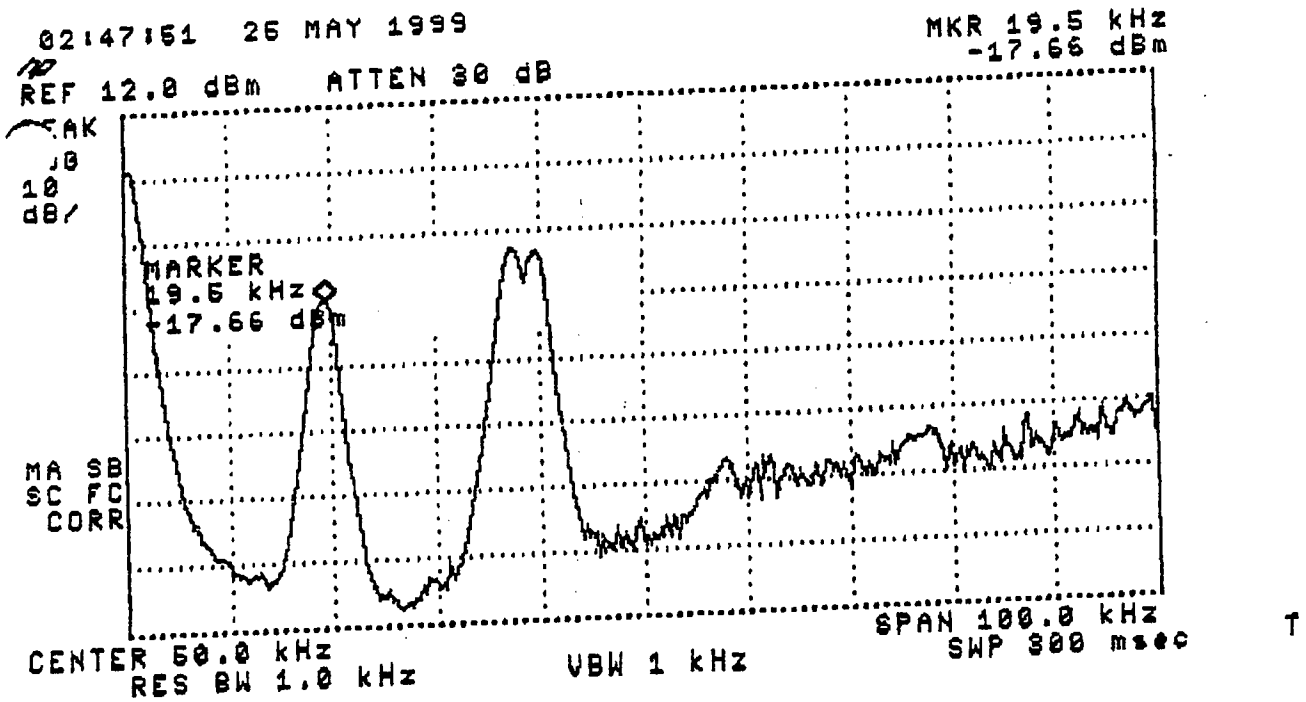
Denon 380 composite output

Lower 1st adjacent

30 dB D/U

-50 dBm

Plot #9



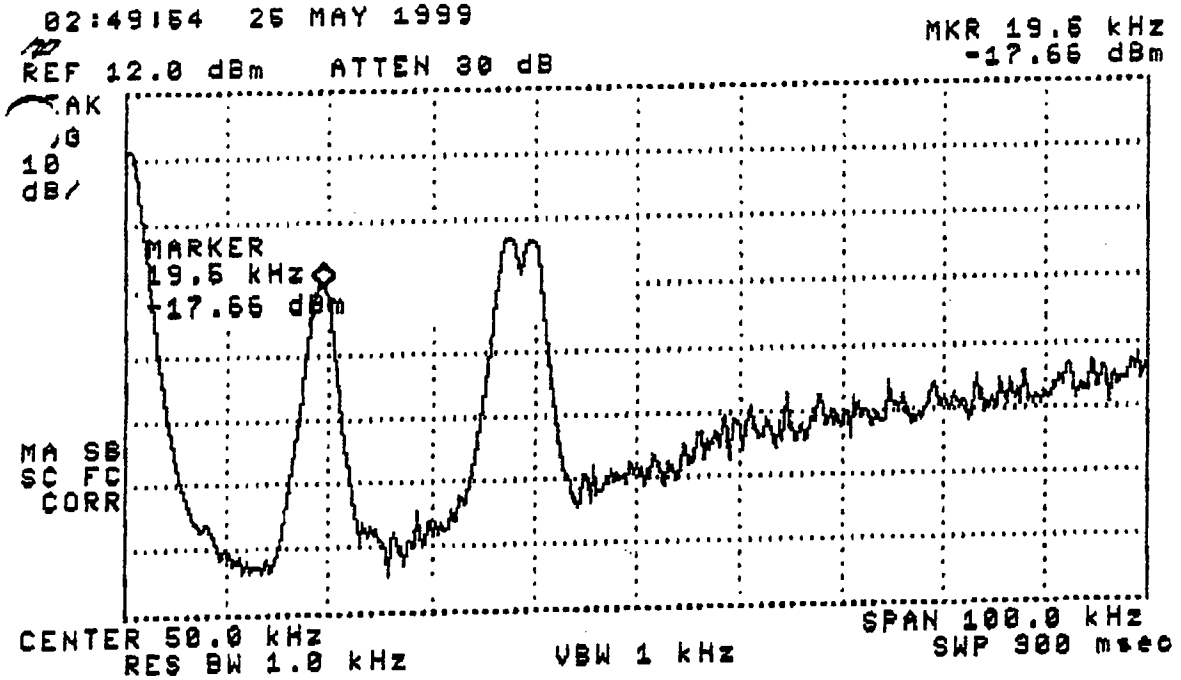
Denon 380 composit output

Lower 1st adjacent

20 dB D/U

-50 dBm

Plot #10



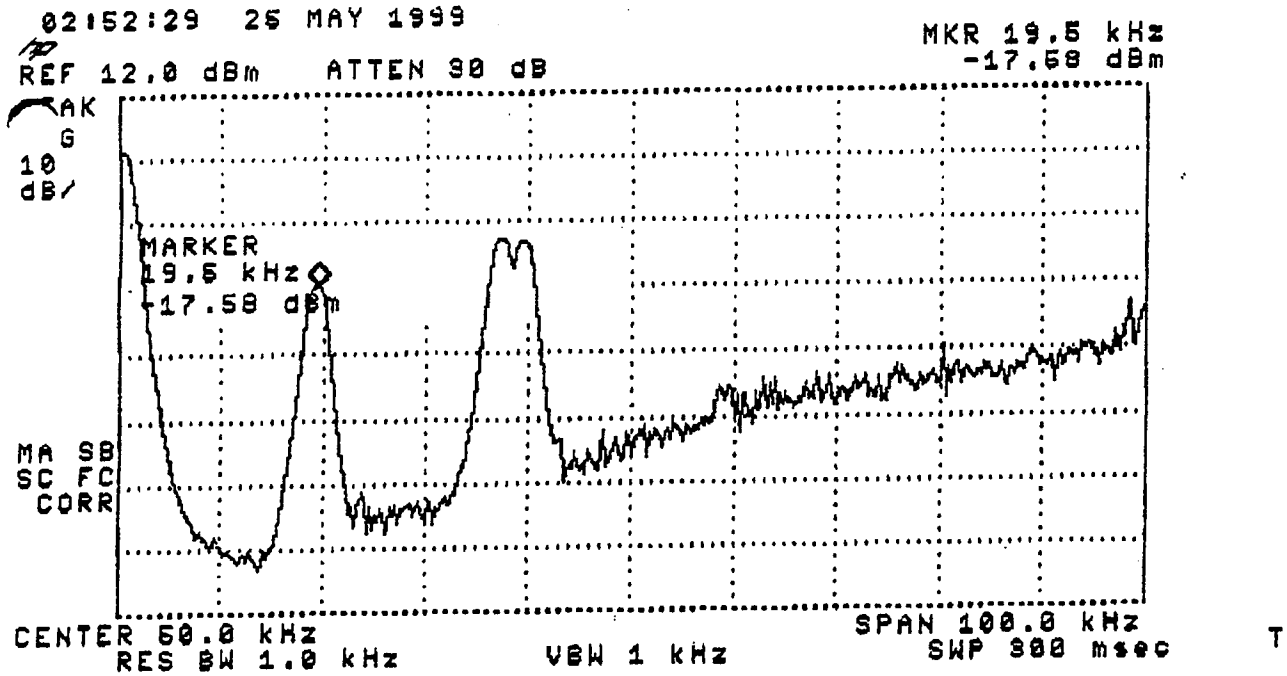
Denon 380 composite output

Lower 1st adjacent

10 dB D/U

-50 dBm

Plot #11



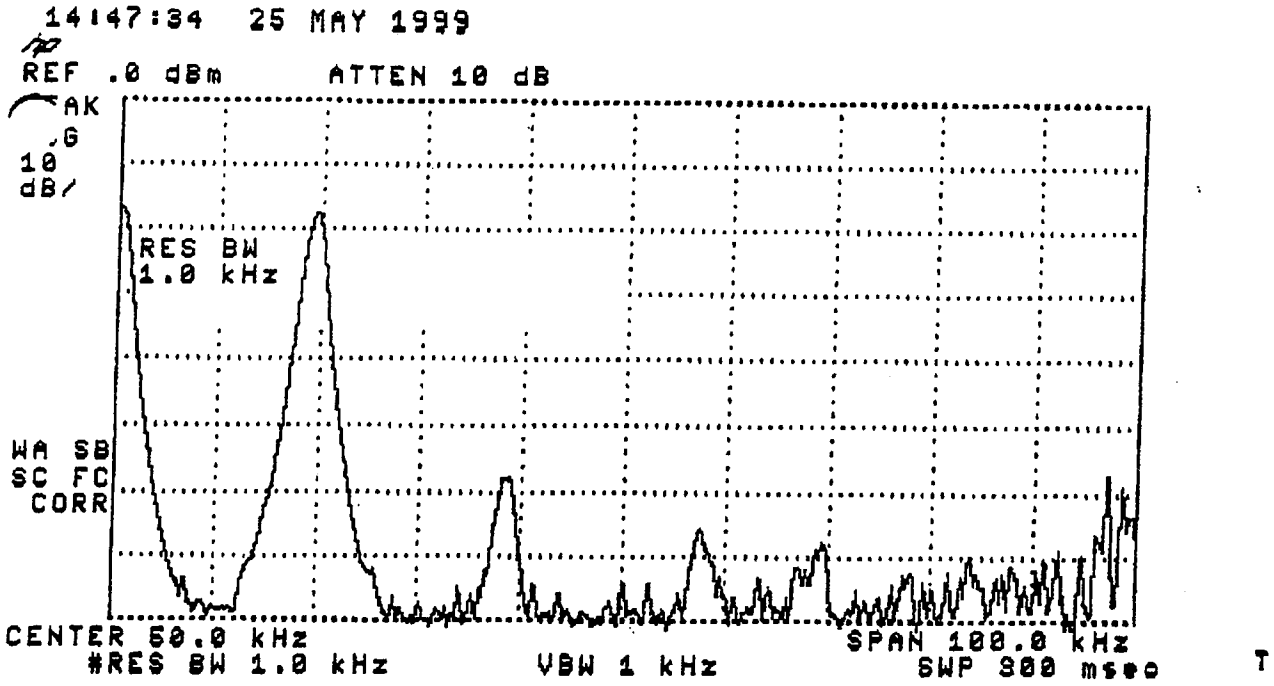
Denon 380 composite output

Lower 1st adjacent

6 dB D/U

-50 dBm

Plot #12



Denon 380 composite output

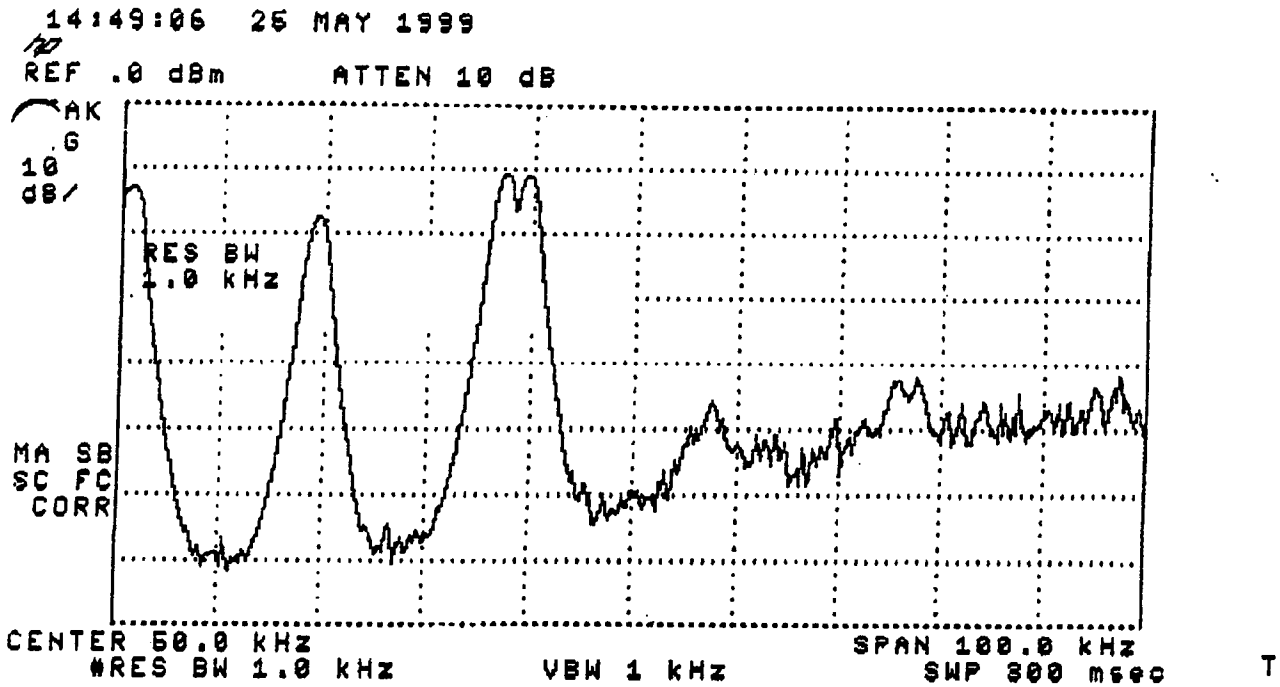
Lower 1st adjacent

22 dB D/U

Pilot only modulation

-50 dBm

Plot #13



Denon 380 composite output

Lower 1st adjacent

L only modulation

-50 dBm

Plot #14

Appendix D

FM Receiver Test Laboratory

Date: 4/23/99
Engineer: TBK RMc
Test Series: D
Description: 10.6/8MHz IM and 10.6/8MHz LO interference tests

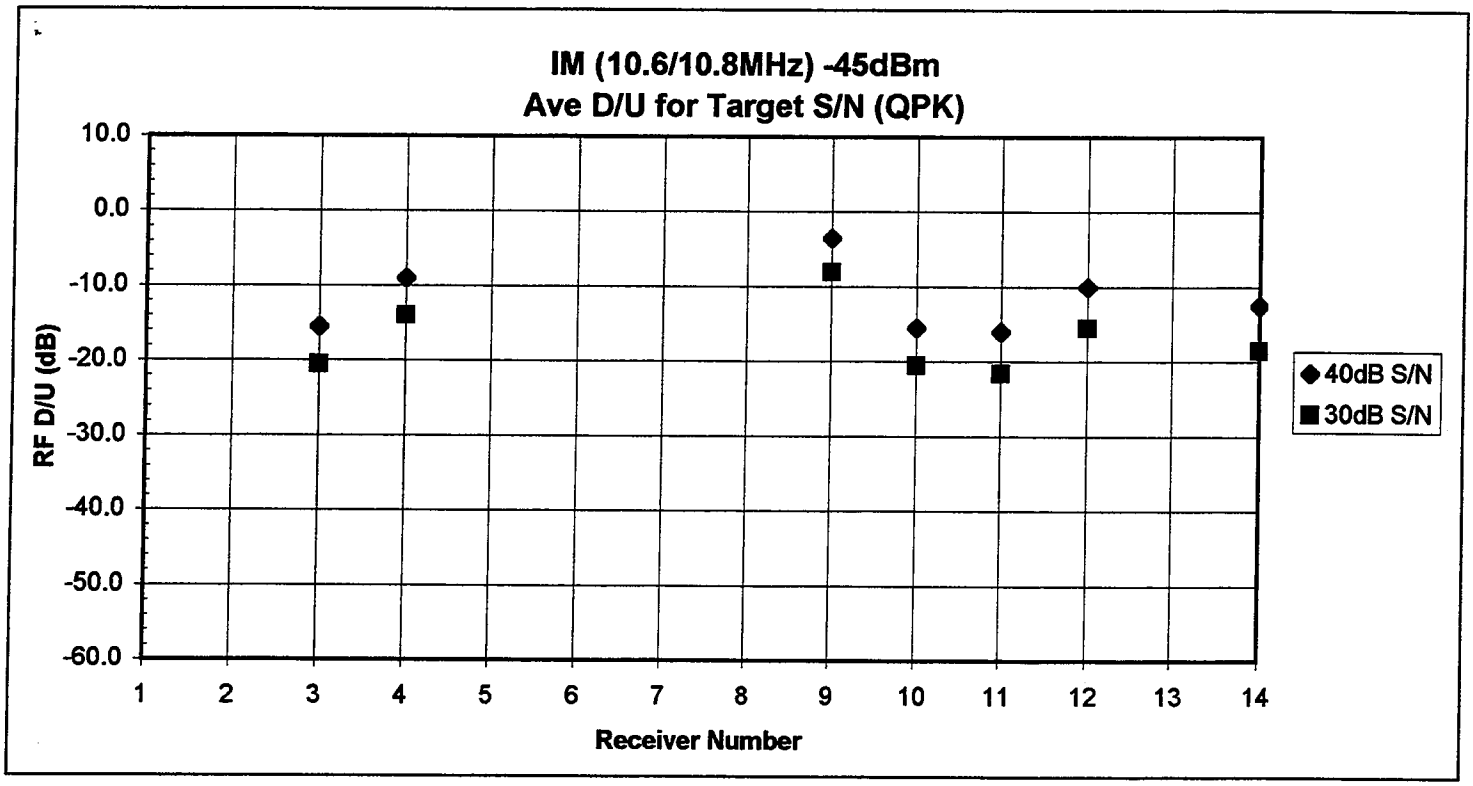
Desired: 94.1MHz, Tone/Pilot only
Undesired: Clipped Pink Noise (CPN) or Tone, 75kHz
Upper: 99.3MHz or 99.5MHz, 1000Hz, 75kHz
Lower: 88.7MHz, 400Hz, 75kHz
Measurement: Receiver audio, 15kHz BW, WQP (weighted CCIR, Quasi-Peak detected)
Measurements are made with the Audio Precision Portable One Plus
WQP measurements are Weighted Quasi-Peak using the CCIR 468-3 Weighting Filter
Test Set Up: 10 RF: Three Tone

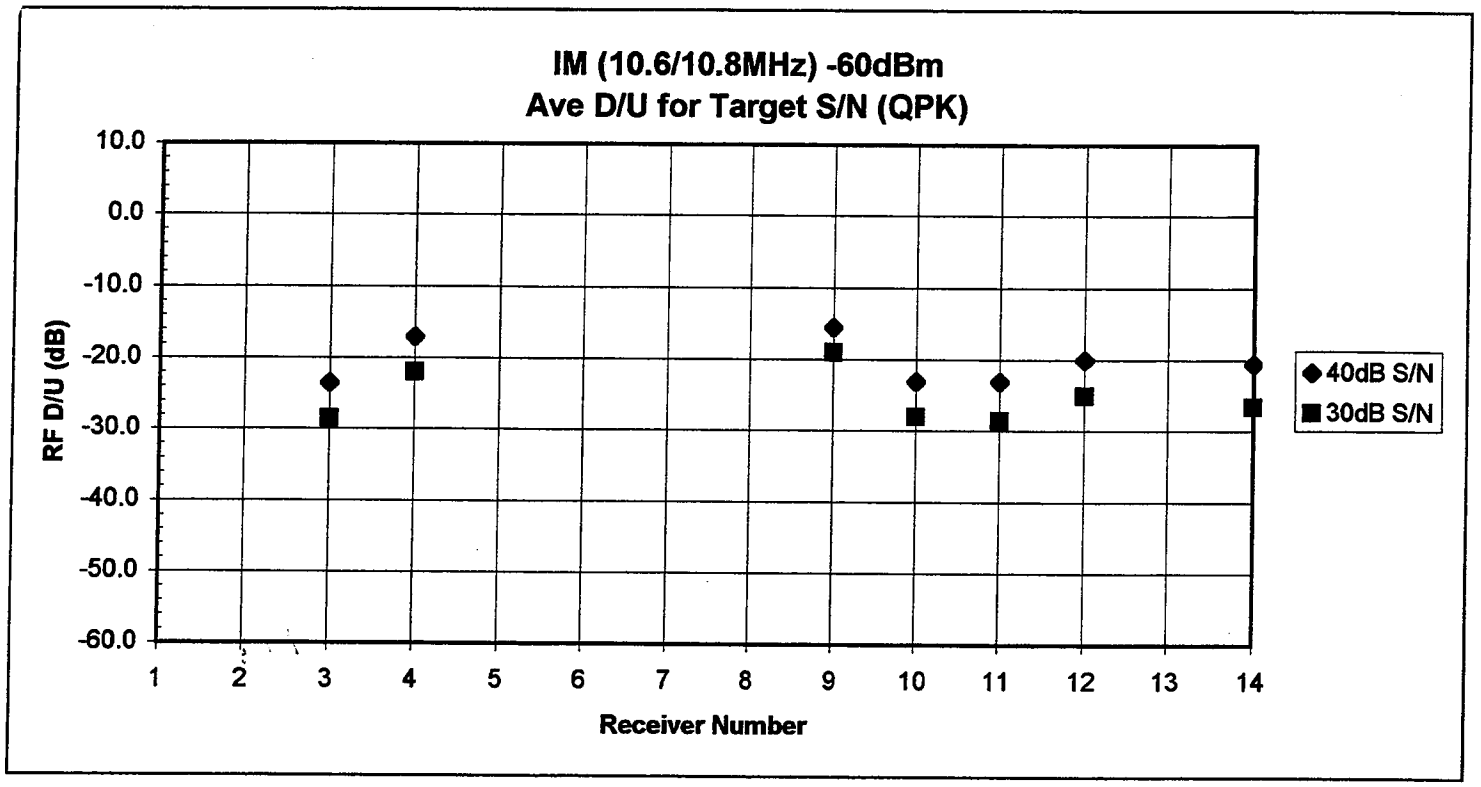
			Best S/N	RMS	60.5	69.0	66.8	67.5	65.0	68.5	59.2	68.0	59.5	65.5	60.5	60.50	63.6	61.2
			(Stereo)	QPK	50.5	61.5	58.7	61.5	57.0	65.0	52.6	62.0	54.0	59.0	49.0	51.0	55.0	49.0
		Test Reference →			A	B	C	D	E	F	G	H	I	J	K	L	M	N
		↓	Undesired	Receiver No.	Delco 1	Den380 2	Pana 3	Pioneer 4	Ford 5	Den680 6	Audivox 7	SonyHF 8	SonyWM 9	TechHF 10	Sanyo 11	SonyTR 12	Koss 13	Magna 14
D1	**10.6/8MHz IM**																	
D1.5	-45dBm	1	10.6MHz	D/U			-16.0	-9.0					-6.0	-15.0	-16.0	-11.0		-13.0
	40dB S/N Target	2	10.8MHz	D/U			-15.0	-9.0					-1.0	-16.0	-16.0	-9.0		-12.0
			Ave D/U	-11.74			-15.5	-9.0					-3.5	-15.5	-16.0	-10.0		-12.5
D1.6	30dB S/N Target	4	10.6MHz	D/U			-21.0	-14.0					-11.0	-20.0	-22.0	-16.0		-19.0
		5	10.8MHz	D/U			-20.0	-14.0					-5.0	-21.0	-21.0	-15.0		-18.0
			Ave D/U	-16.95			-20.5	-14.0					-8.0	-20.5	-21.5	-15.5		-18.5
D1.9	-60dBm	7	10.6MHz	D/U			-24.0	-17.0					-18.0	-22.0	-23.0	-20.0		-20.0
	40dB S/N Target	8	10.8MHz	D/U			-23.0	-17.0					-13.0	-24.0	-23.0	-20.0		-21.0
			Ave D/U	-20.38			-23.5	-17.0					-15.5	-23.0	-23.0	-20.0		-20.5
	30dB S/N Target	10	10.6MHz	D/U			-29.0	-22.0					-21.0	-27.0	-29.0	-25.0		-26.0
		11	10.8MHz	D/U			-28.0	-22.0					-17.0	-29.0	-28.0	-25.0		-27.0
			Ave D/U	-25.38			-28.5	-22.0					-19.0	-28.0	-28.5	-25.0		-26.5

FM Receiver Test Laboratory

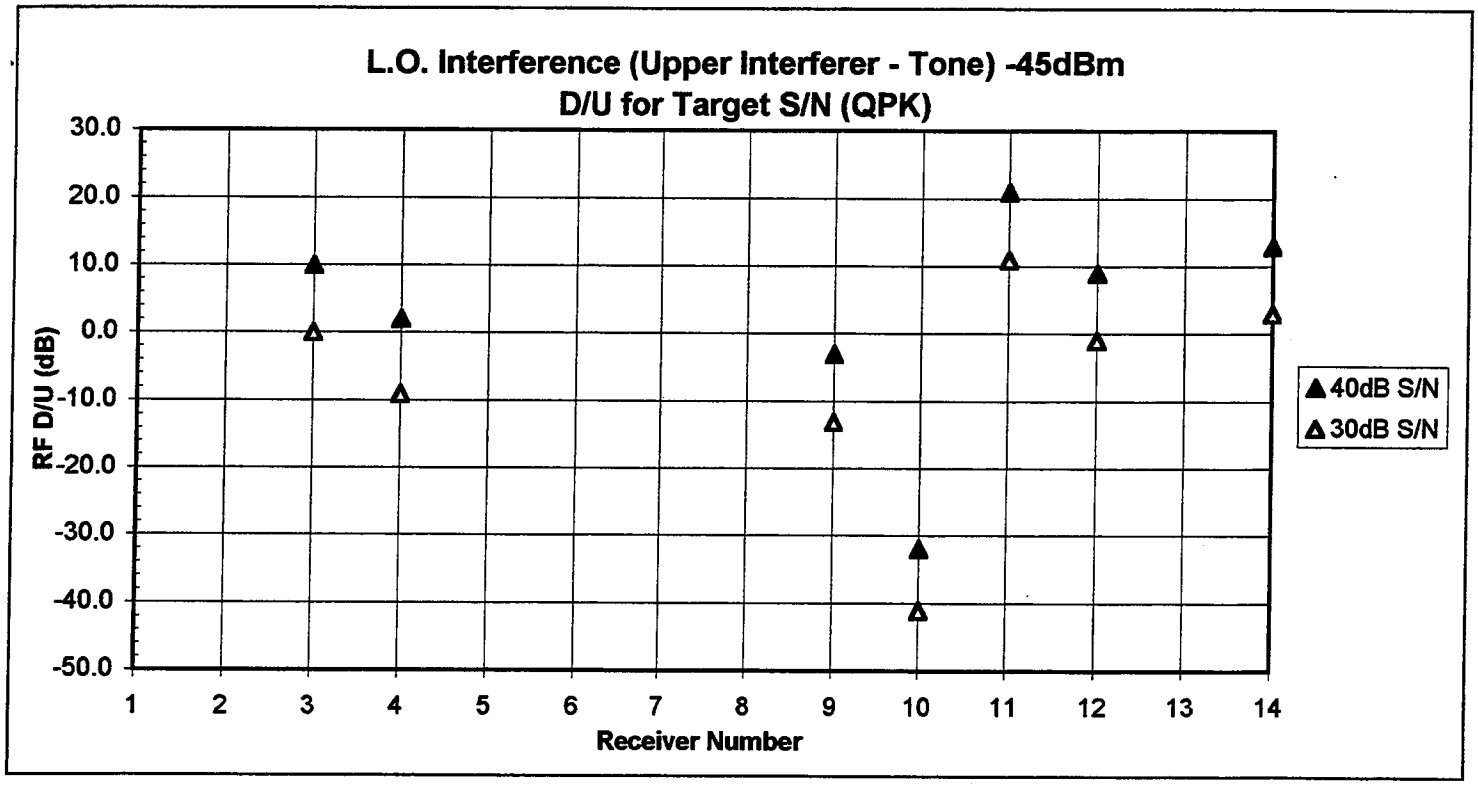
+ L.O. Interference

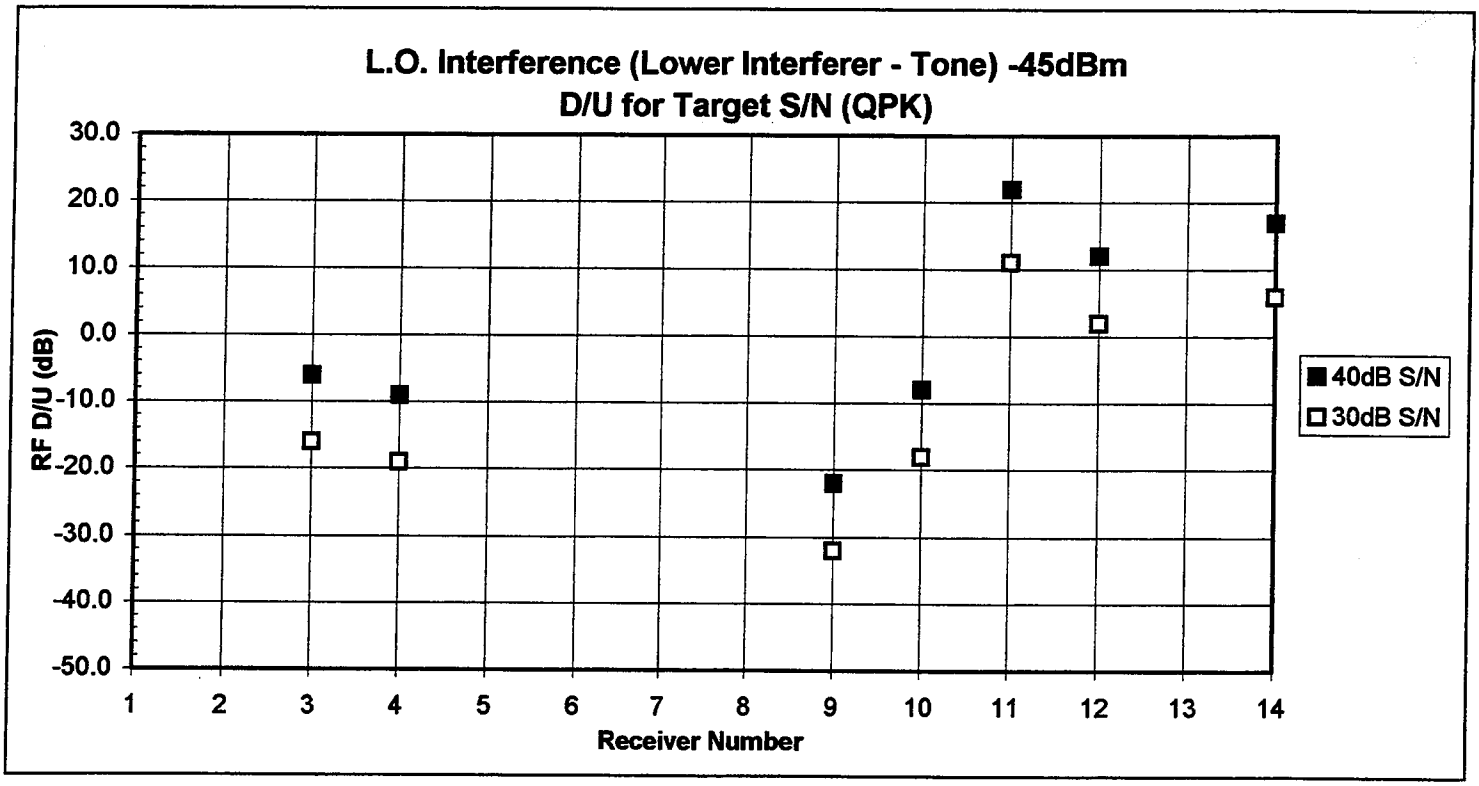
			Receiver	A	B	C	D	E	F	G	H	I	J	K	L	M	N
		14		Delco	Den380	Pana	Pioneer	Ford	Den680	Audivox	SonyHF	SonyWM	TechHF	Sanyo	SonyTR	Koss	Magna
		15	Undesired	No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
D2.4	-45dBm	16	104.7MHz	D/U			-6.0	-9.0					-22.0	-8.0	22.0	12.0		17.0
	(Undesired: 400Hz)	17	104.9MHz	D/U			10.0	2.0					-3.0	-32.0	21.0	9.0		13.0
	40dB S/N Target																	
D2.5	30dB S/N Target	19	104.7MHz	D/U			-16.0	-19.0					-32.0	-18.0	11.0	2.0		6.0
		20	104.9MHz	D/U			0.0	-9.0					-13.0	-41.0	11.0	-1.0		3.0
D2.6	-45dBm	22	104.7MHz	D/U			-16.0	-12.0					-23.0	-8.0	18.0	10.0		15.0
	(Undesired: CPN)	23	104.9MHz	D/U			11.0	0.0					-3.0	-33.0	19.0	9.0		5.0
	40dB S/N Target																	
	30dB S/N Target	25	104.7MHz	D/U			-23.0	-22.0					-33.0	-18.0	8.0	1.0		4.0
		26	104.9MHz	D/U			1.0	-10.0					-13.0	-42.0	9.0	-1.0		-5.0
D2.7	-60dBm	29	104.7MHz	D/U			-22.0	-23.0					-38.0	-25.0	8.0	-3.0		3.0
	(Undesired: 400Hz)	30	104.9MHz	D/U			-5.0	-12.0					-18.0	-49.0	8.0	-6.0		-1.0
	40dB S/N Target																	
	30dB S/N Target	32	104.7MHz	D/U			-31.0	-33.0					-47.0	-35.0	-3.0	-14.0		-9.0
		33	104.9MHz	D/U			-15.0	-23.0					-28.0	-58.0	-4.0	-16.0		-12.0
	(Undesired: CPN)																	
	-60dBm	35	104.7MHz	D/U			-29.0	-26.0					-39.0	-25.0	4.0	-4.0		0.0
	40dB S/N Target	36	104.9MHz	D/U			-4.0	-14.0					-18.0	-50.0	6.0	-6.0		-10.0
	30dB S/N Target	38	104.7MHz	D/U			-37.0	-36.0					-48.0	-35.0	-7.0	-15.0		-12.0
		39	104.9MHz	D/U			-14.0	-24.0					-28.0	-59.0	-5.0	-16.0		-22.0

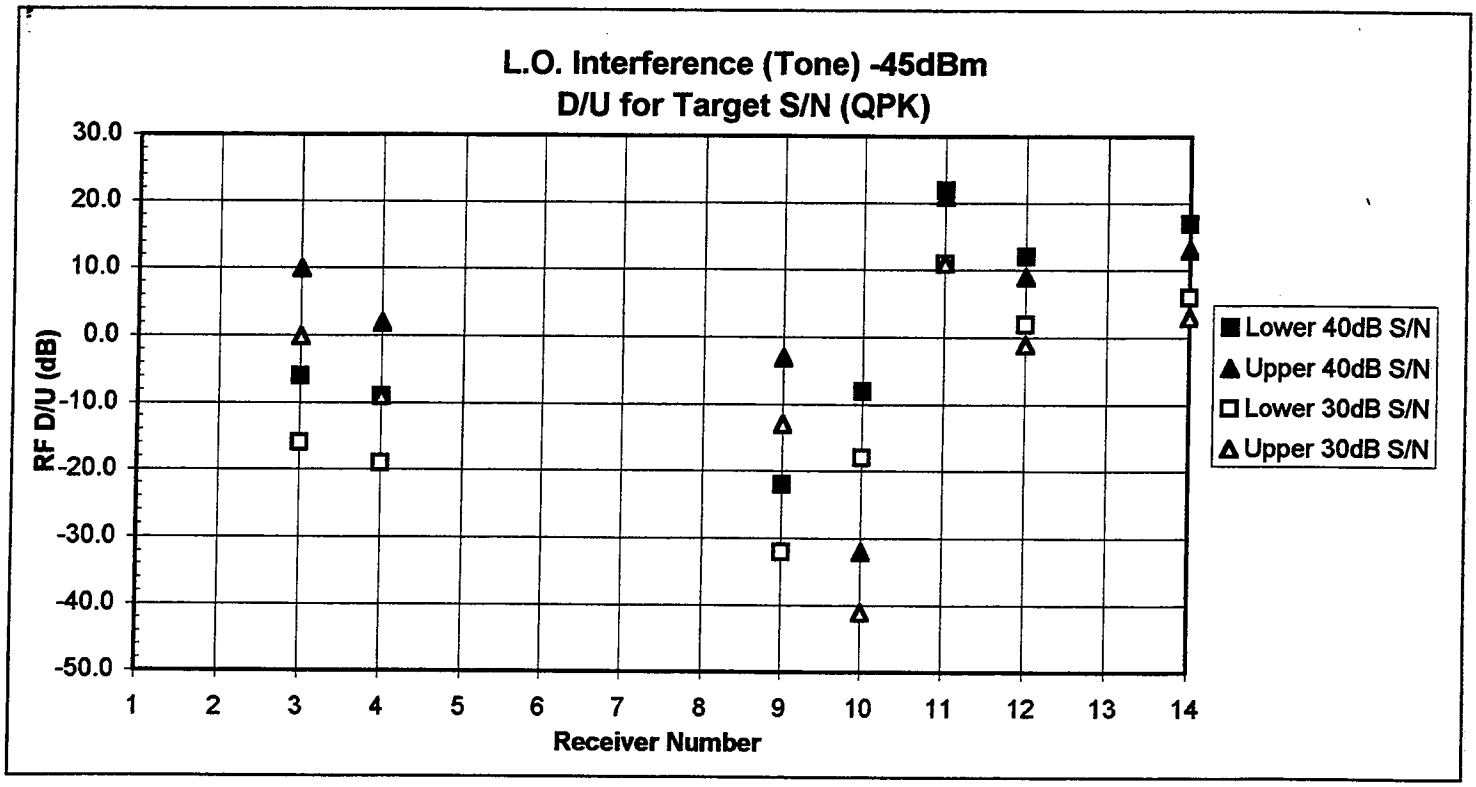

IM (10.6/10.8MHz) -45dBm
Ave D/U for Target S/N (QPK)
RF D/U (dB)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Receiver Number
40dB S/N
30dB S/N


IM (10.6/10.8MHz) -60dBm
Ave D/U for Target S/N (QPK)
RF D/U (dB)
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
-60.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Receiver Number
40dB S/N
30dB S/N

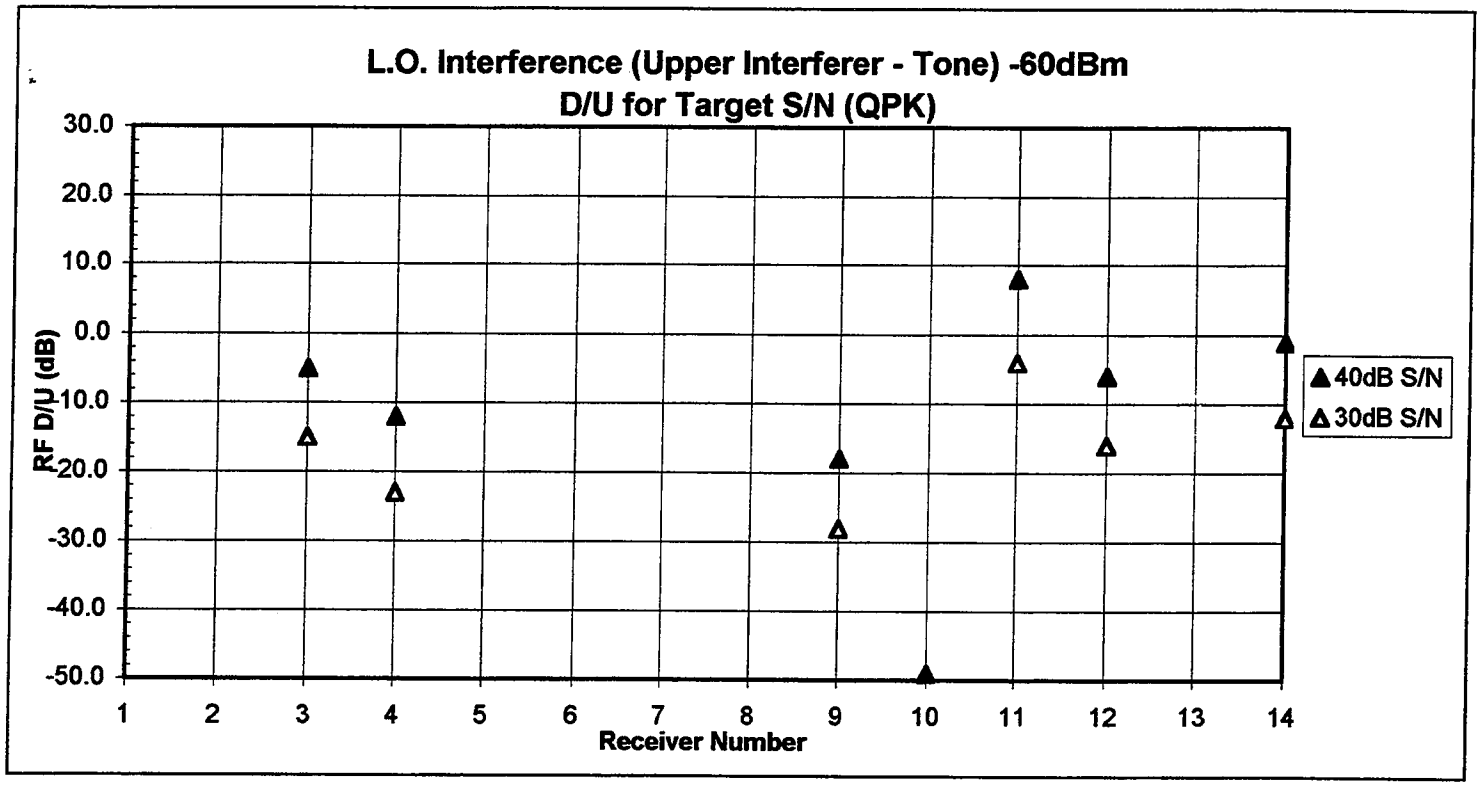
FM Receiver Test Laboratory

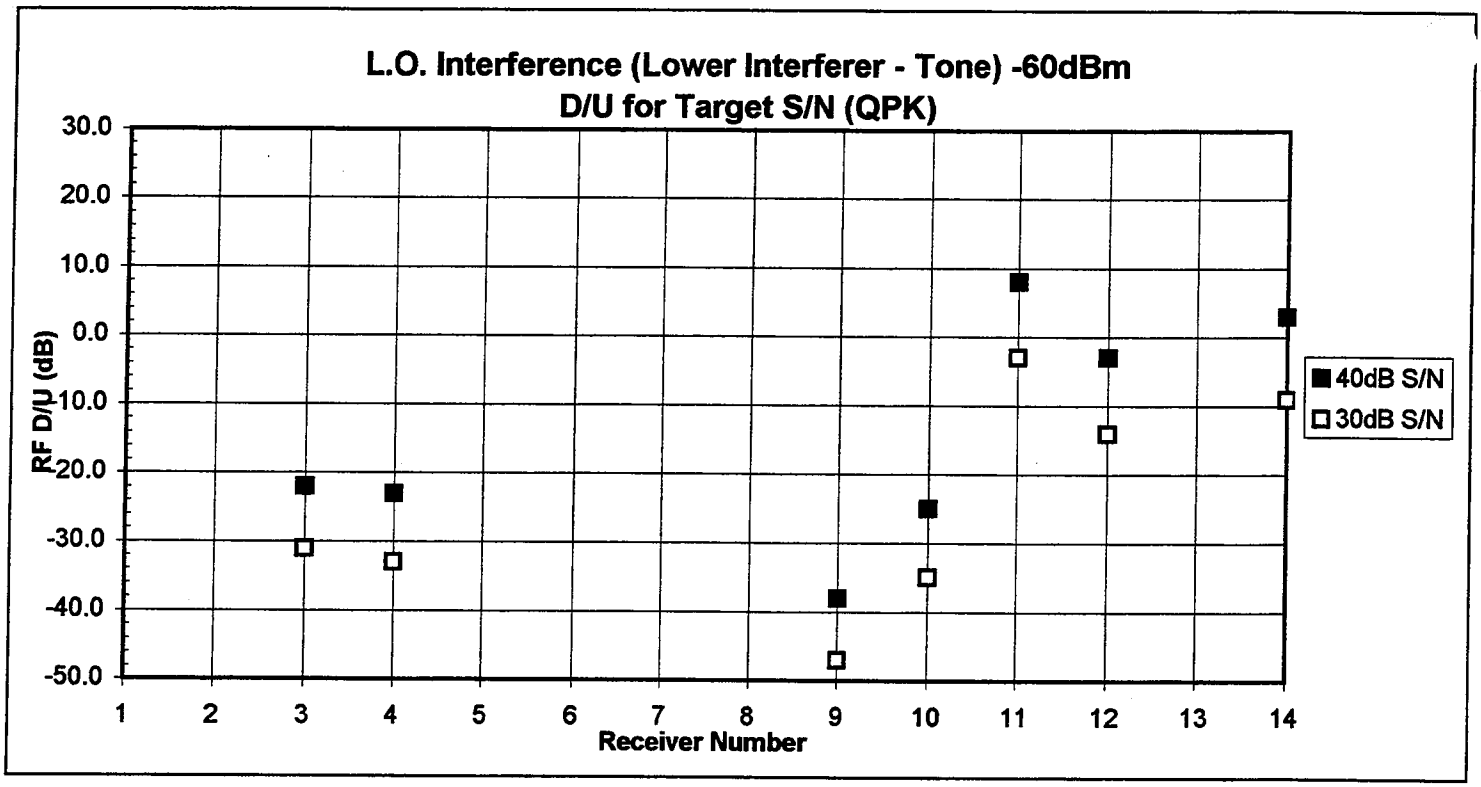





L.O. Interference (Tone) -45dBm
D/U for Target S/N (QPK)
RF D/U (dB)
30.0
20.0
10.0
0.0
-10.0
-20.0
-30.0
-40.0
-50.0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
Receiver Number
Lower 40dB S/N
Upper 40dB S/N
Lower 30dB S/N
Upper 30dB S/N

FM Receiver Test Laboratory

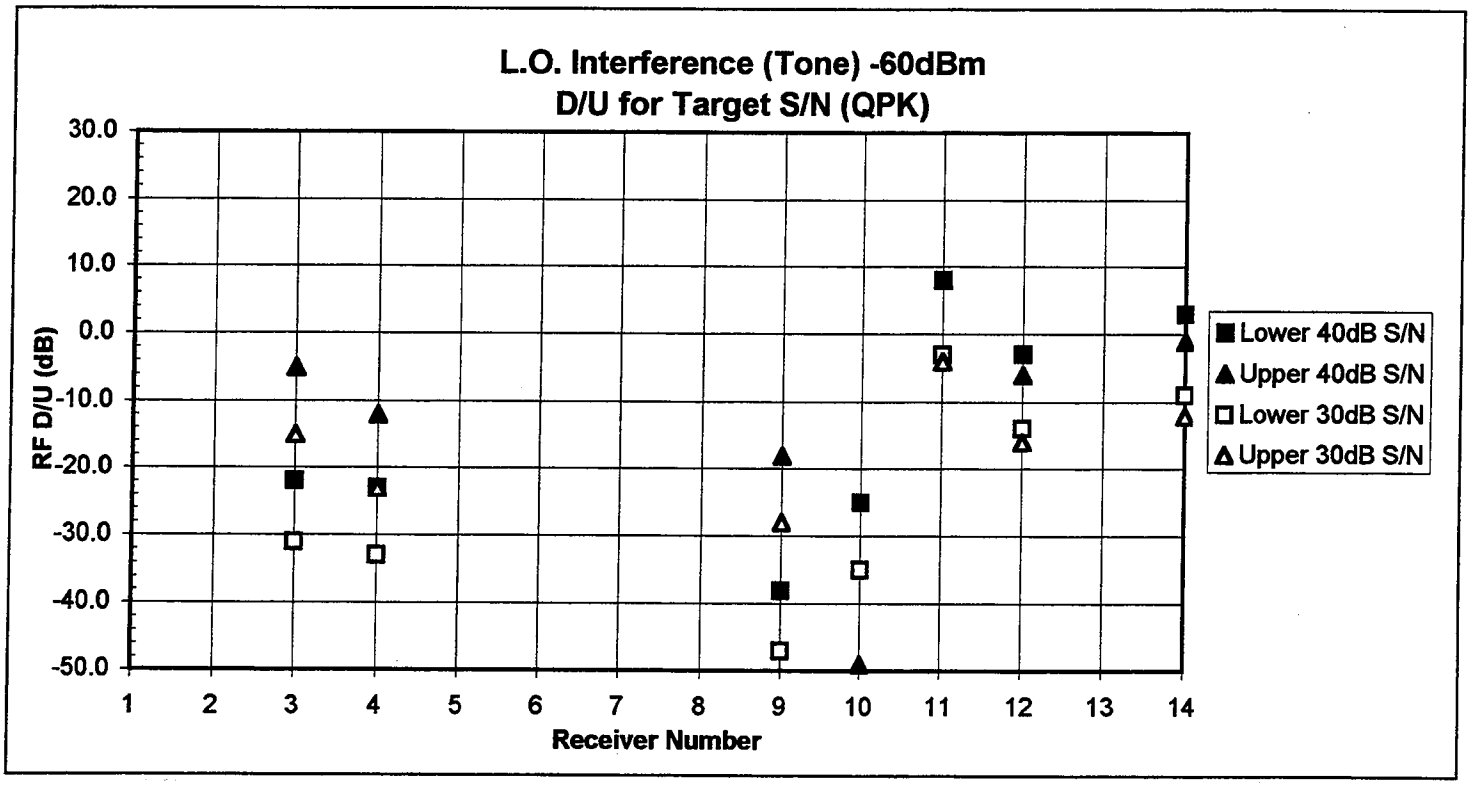




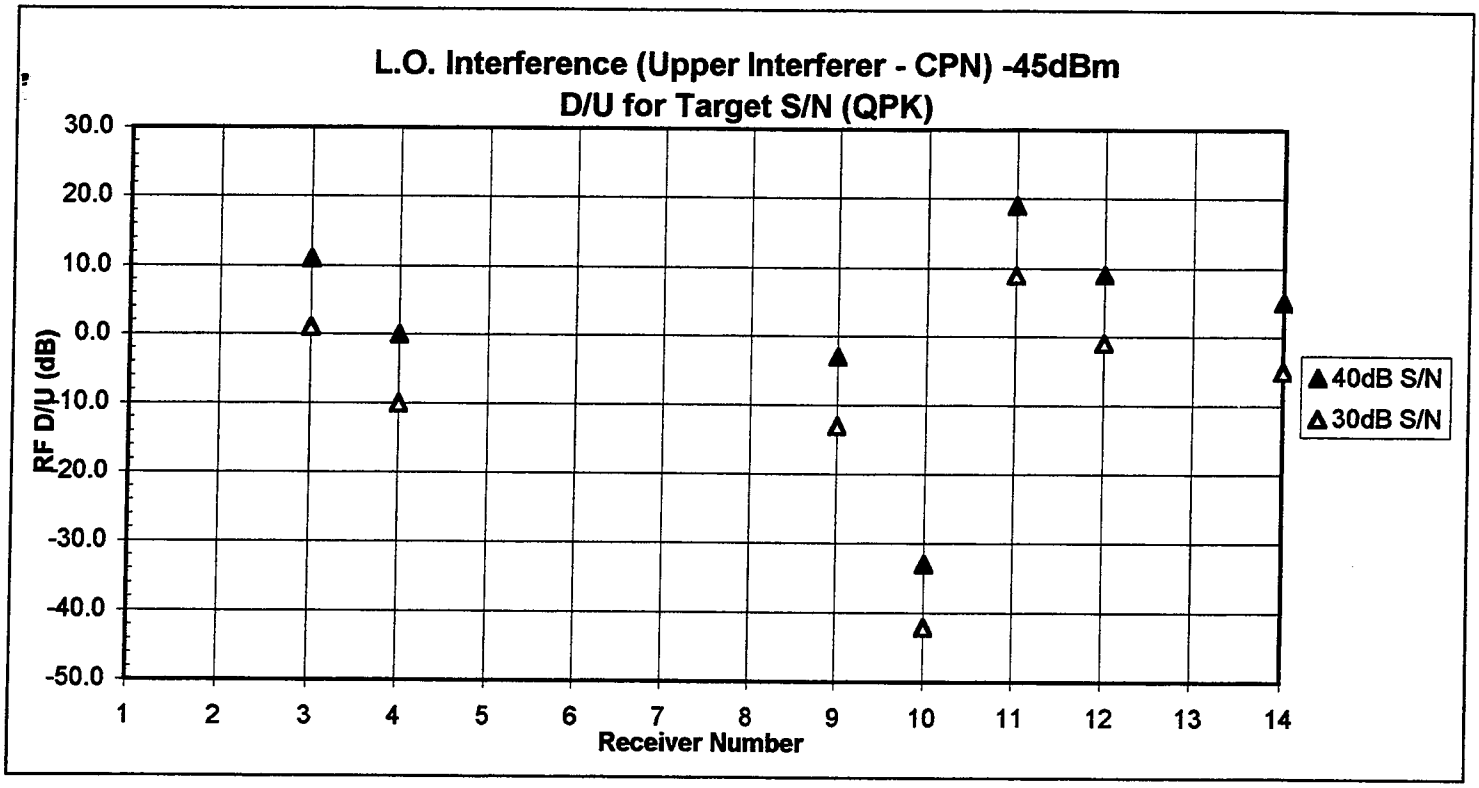
File Name: D_test

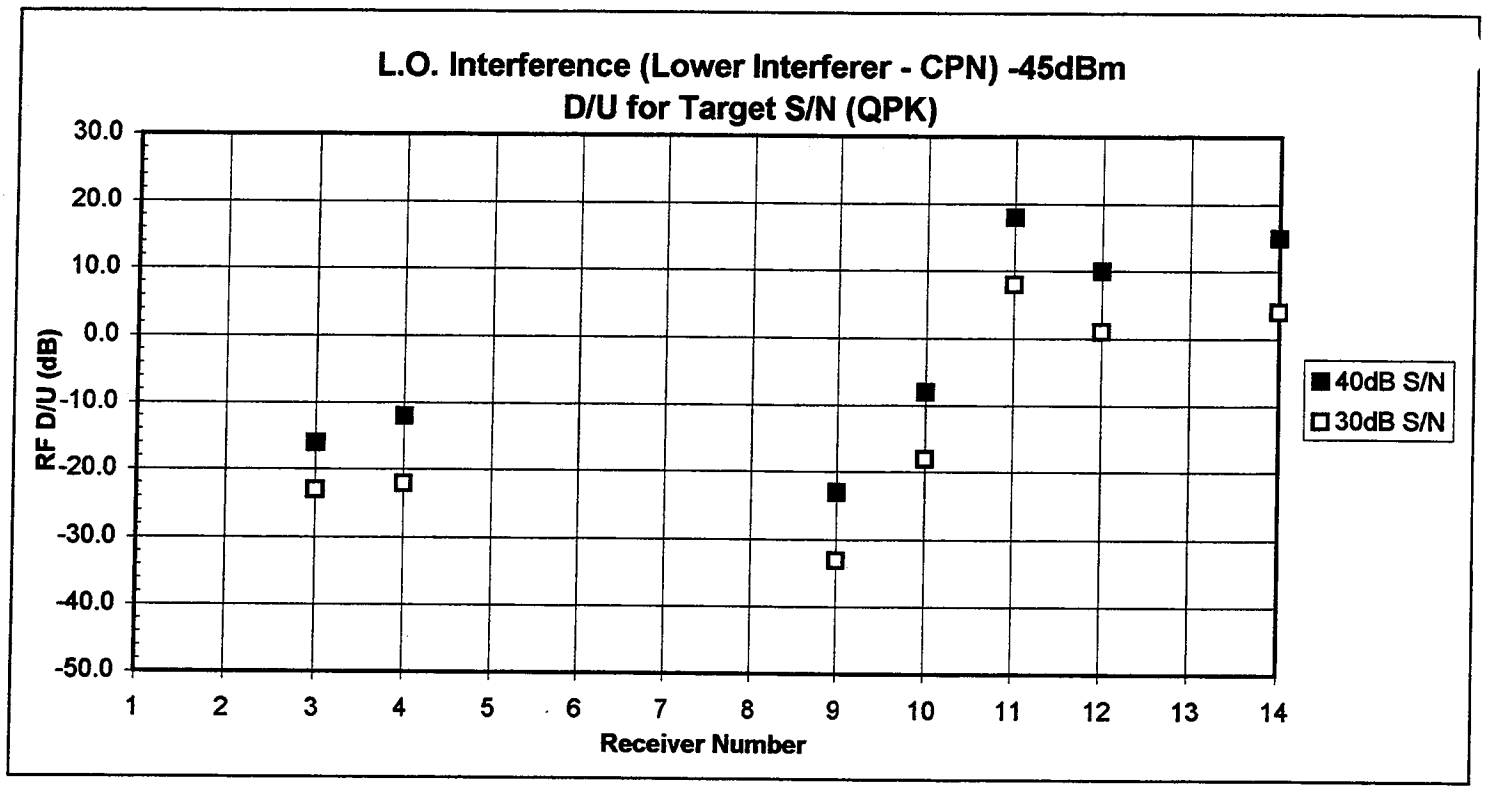
D2 (-60dBm, Tone) SNR Plot

FM Receiver Test Laboratory



FM Receiver Test Laboratory

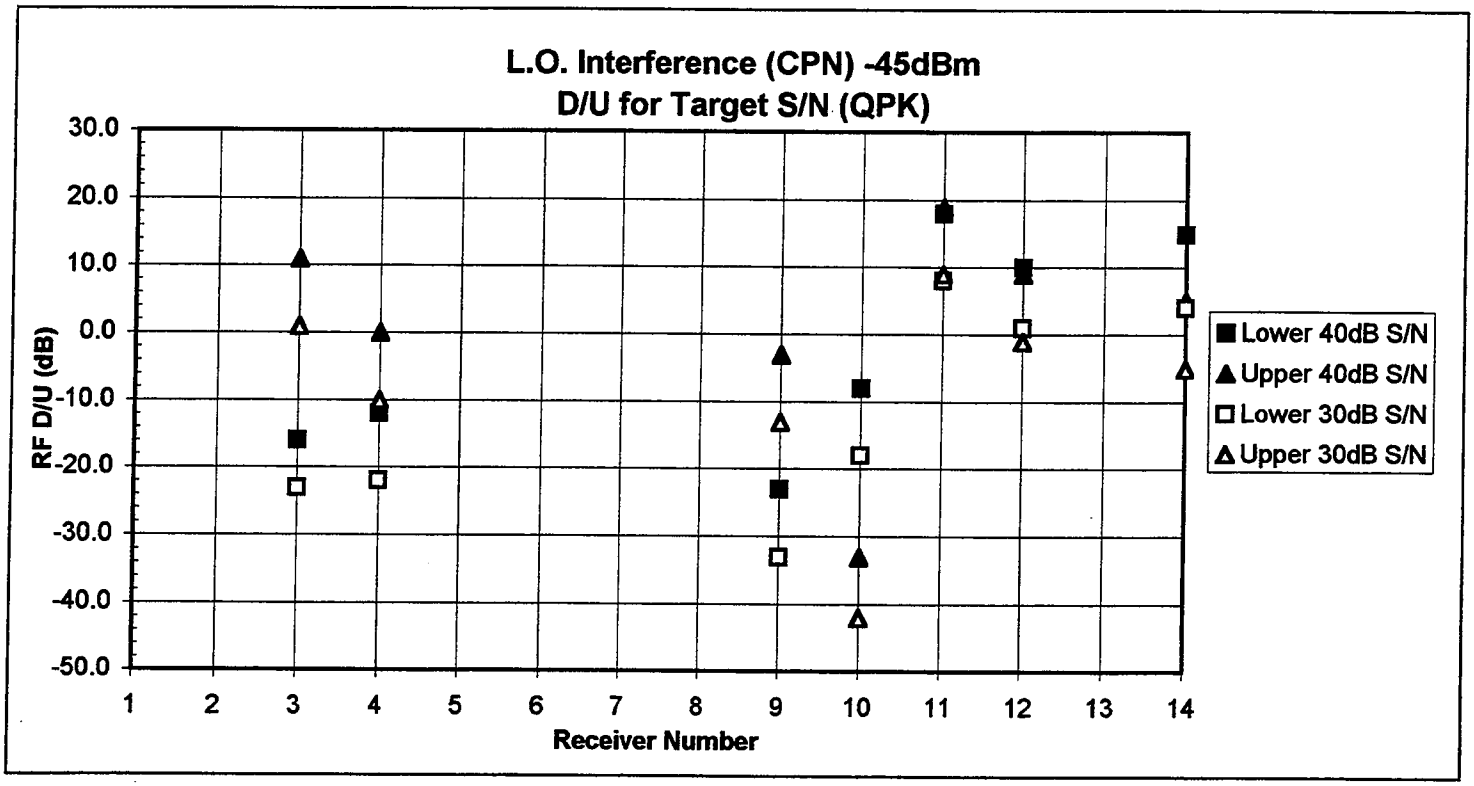




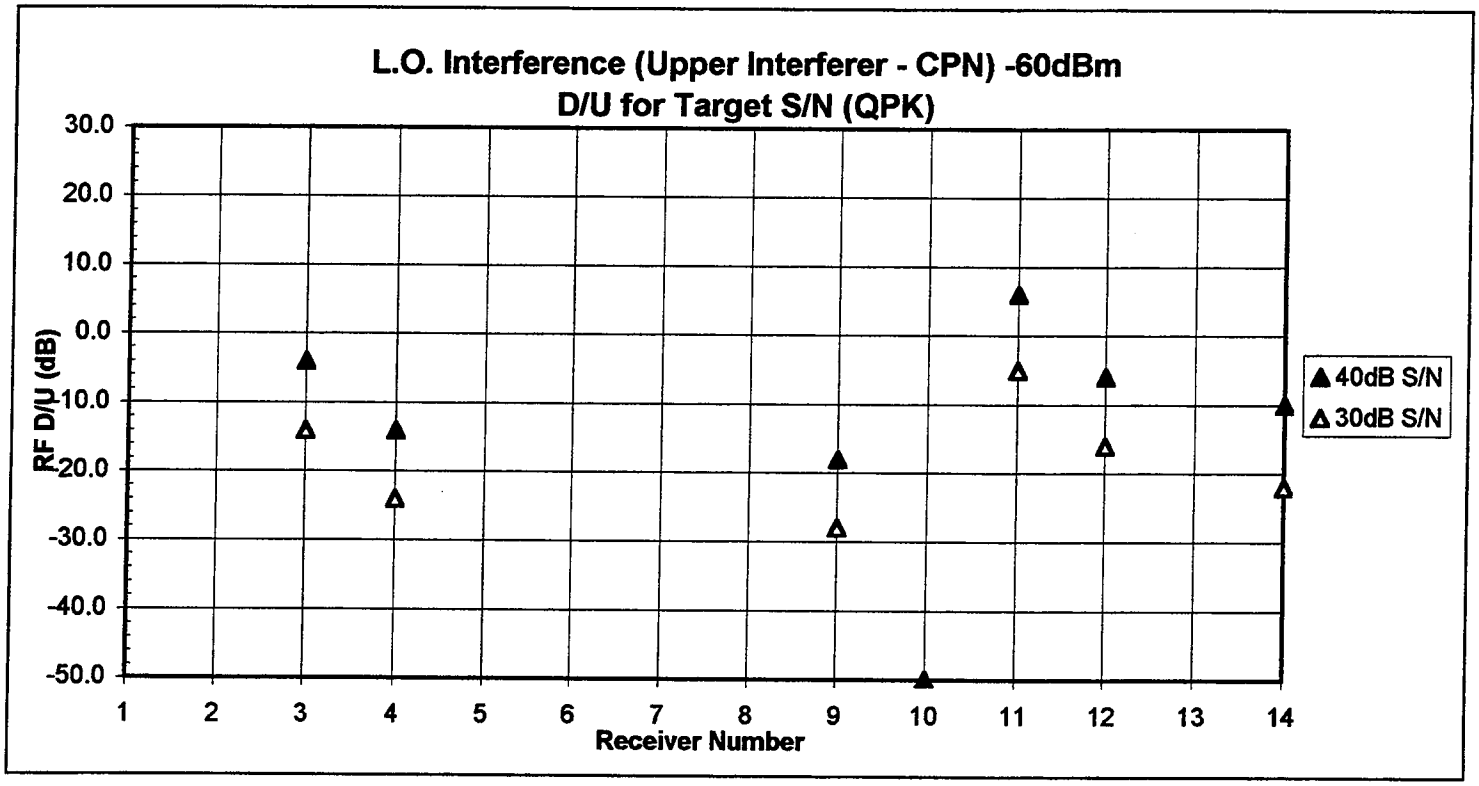
File Name: D_test

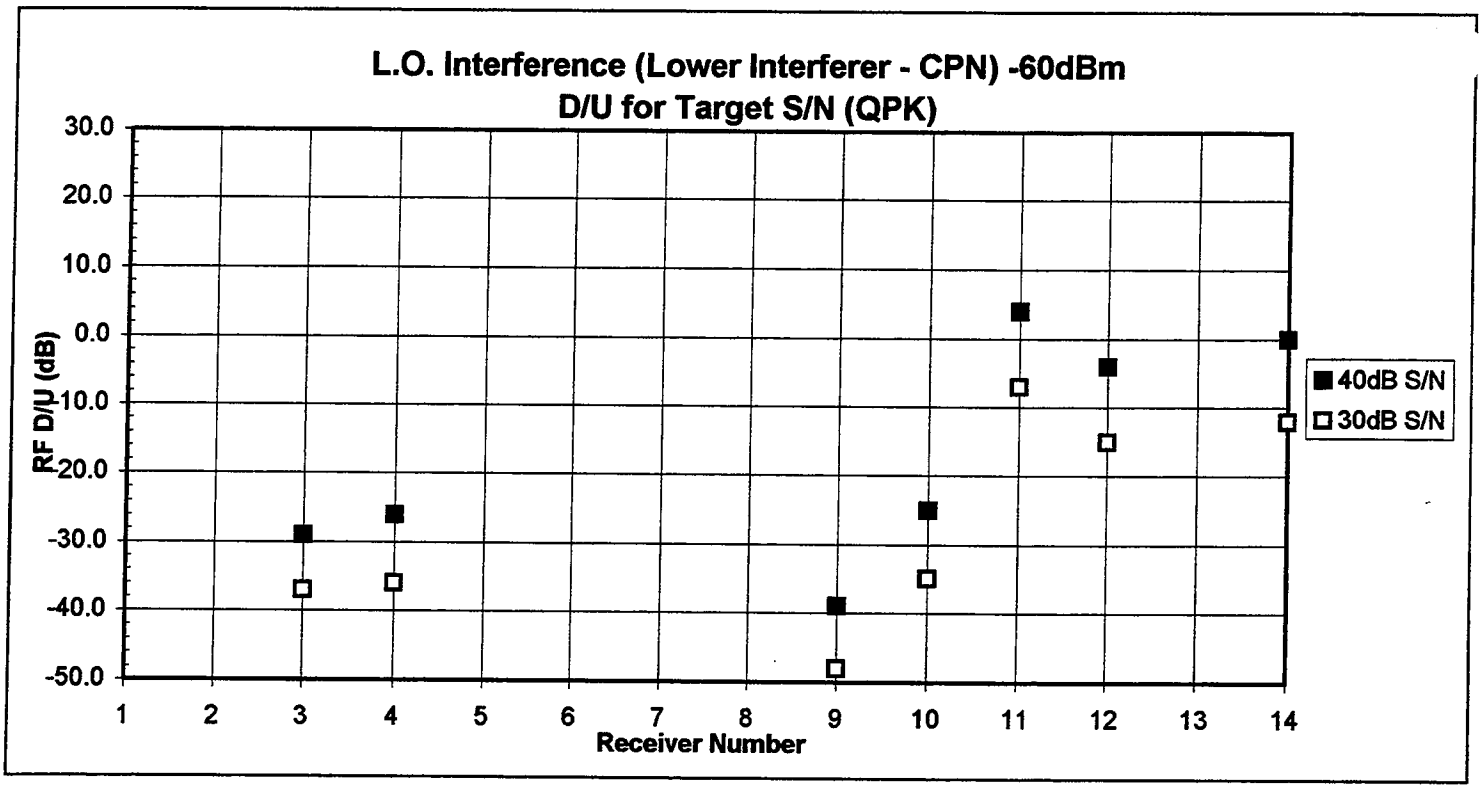
D2 (-45dBm, CPN) SNR Plot

FM Receiver Test Laboratory



FM Receiver Test Laboratory

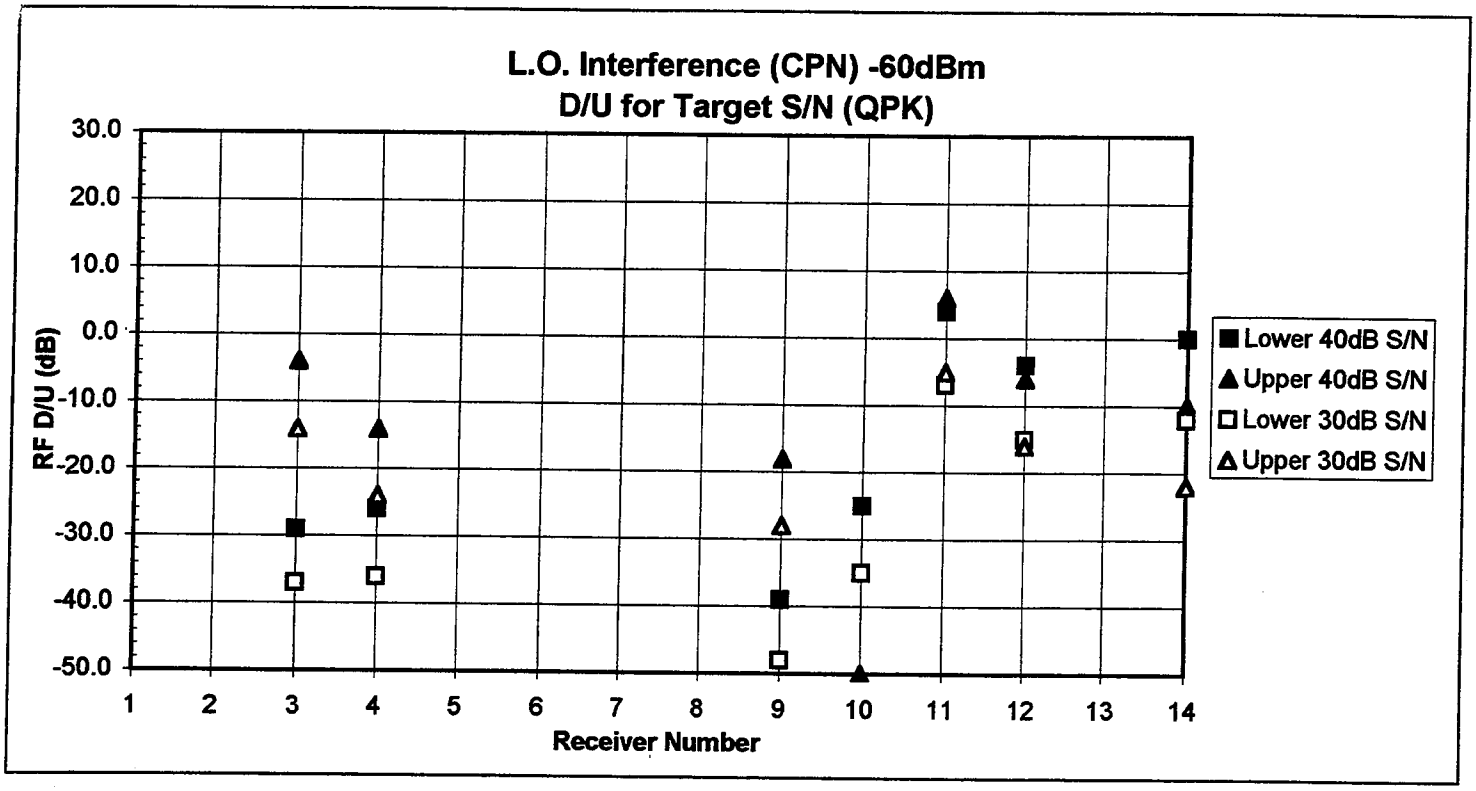




File Name: D_test

D2 (-60dBm, CPN) SNR Plot

FM Receiver Test Laboratory



Appendix E

FM Receiver Test Laboratory

Date: 5/6/99
Engineer: TBK RMc
Test Series: E
Description: Reduced Modulation Tests

Desired: 94.1MHz, Tone/Pilot only - Objectives.
Subjectives: Classical
Undesired: Clipped Pink Noise (CPN) or Tone, Stereo, 75kHz - Objectives.
Subjectives: Rock
Measurement: Receiver audio, 15kHz BW, WQP (weighted CCIR, Quasi-Peak detected)
Measurements are made with the Audio Precision Portable One Plus
Test Set Up: 7 RF: Three Tone

				Best S/N	RMS	60.5	69.0	66.8	67.5	65.0	68.5	59.2	68.0	59.5	65.5	60.5	60.50	63.6	61.2
				(Stereo)	QPK	50.5	61.5	58.7	61.5	57.0	65.0	52.6	62.0	54.0	59.0	49.0	51.0	55.0	49.0
Test Reference						A	B	C	D	E	F	G	H	I	J	K	L	M	N
		E	Desired Mod.		Receiver No.	Delco 1	Den380 2	Pana 3	Pioneer 4	Ford 5	Den680 6	Audivox 7	SonyHF 8	SonyWM 9	TechHF 10	Sanyo 11	SonyTR 12	Koss 13	Magna 14
E1	1																		
Restricted Mod.	2	1.1	Mono 8/75kHz		S/N	50.8	69.2		65.2										
Quality	3	1.2	Mono 8/37.5kHz		S/N	44.6	63.2		59.0										
	4	1.3	Mono 15/75kHz		S/N	50.8	69.2		65.2										
Desired	5	1.4	Mono 15/37.5kHz		S/N	44.6	63.2		59.0										
Signal level	6																		
-50dBm	7	1.5	Stereo 15/75kHz		S/N	50.3	61.0		61.3										
	8				Sep	26.7	38.4		27.8										
	9				THD	0.50	0.16		0.76										
	10																		
	11	1.6	Stereo 15/37.5kHz		S/N	43.0	55.0		54.6										
	12				Sep	34.5	38.6		30.0										
	13				THD	0.35	0.11		0.38										
	14																		
	15	1.7	Stereo 15/75kHz		S/N														
	16		20% 67kHz SC		Sep														
	17		110% / 82.5kHz		THD														
	18																		
	19	1.8	Stereo 15/37.5kHz		S/N														
	20		20% 67kHz SC		Sep														
	21		110% / 41.25kHz		THD														
	22																		

FM Receiver Test Laboratory

E2
2nd Adjacent
(Upper)
D/U -20dB
Desired signal:
Standard Modulation
Desired
Signal level
-55dBm

E	Undesired Modulation		A Delco 1	B Den380 2	C Pana 3	D Pioneer 4	E Ford 5	F Den680 6	G Audivox 7	H SonyHF 8	I SonyWM 9	J TechHF 10	K Sanyo 11	L SonyTR 12	M Koss 13	N Magna 14
2.2	No Modulation	S/N			45.8	57.5							40.0	49.4		
	Mod Set Up 1.1	S/N			22.6	44.8							22.0	43.0		
	Mod Set Up 1.2	S/N			35.6	54.5							31.0	47.3		
	Mod Set Up 1.3	S/N			22.7	44.8							22.0	43.0		
	Mod Set Up 1.4	S/N			35.7	54.5							31.0	47.3		
	Mod Set Up 1.5	S/N			22.6	44.8							22.0	43.0		
	Mod Set Up 1.6	S/N			35.7	54.5							31.0	47.3		
	Mod Set Up 1.7	S/N				45.0										
	Mod Set Up 1.8	S/N				53.5										

D/U -40dB

E	Undesired Modulation															
2.2	No Modulation	S/N			16.3	39.5							7.8	35.5		
	Mod Set Up 1.1	S/N			1.7	24.8							0.0	19.5		
	Mod Set Up 1.2	S/N			2.2	34.1							0.0	27.6		
	Mod Set Up 1.3	S/N			2.0	24.8							0.0	19.9		
	Mod Set Up 1.4	S/N			3.0	34.2							0.0	27.6		
	Mod Set Up 1.5	S/N			2.0	25.0							0.0	20.2		
	Mod Set Up 1.6	S/N			4.0	34.2							0.0	27.5		
	Mod Set Up 1.7	S/N				24.8										
	Mod Set Up 1.8	S/N				33.2										

3rd Adjacent
D/U -40dB

Desired signal:
Standard Modulation

E	Undesired Modulation															
2.3	No Modulation	S/N			16.0	41.6							22.4	38.1		
	Mod Set Up 1.1	S/N			1.0	39.8							1.5	30.2		
	Mod Set Up 1.2	S/N			2.0	40.3							4.4	31.2		
	Mod Set Up 1.3	S/N			1.0	39.9							0.0	30.2		
	Mod Set Up 1.4	S/N			2.6	40.3							6.0	31.4		
	Mod Set Up 1.5	S/N			1.2	40.0							0.0	30.2		
	Mod Set Up 1.6	S/N			3.0	40.4							7.0	32.1		
	Mod Set Up 1.7	S/N				39.8										
	Mod Set Up 1.8	S/N				40.0										

Notes: Set ups 1.7 and 1.8 were only used to determine the effect of SCAs on adjacent channel interference, not for restricted modulation quality on the main channel of the desired signal.

FM Receiver Test Laboratory

Engineer: TBK, RMc
Test Series: E
Tape No.: 004
Set Up: Record 1kHz tone, 100% at -12dB (30 sec) for each individual radio for 0dB reference
All recordings at 44.1kHz
Desired Prog.: Franck: Allegretto from Symphony in D minor

Undesired Prog.: The B-52's: "Love Shack"

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments	Subjective Grade
	Pioneer							
1	NA	5/7/99	1	0:00	0:30	NA	1kHz reference tone	
2	NA		2	0:30	1:00	NA	Classical reference	
3	D27		3	1:00	1:30	-20	Upper 2nd Adjacent without modulation	
4	D28		4	1:30	2:00	-20	2nd Adj - set up 1.1 (Mono, 8, 75)	
5	D29		5	2:00	2:30	-20	2nd Adj - set up 1.2 (Mono, 8, 37.5)	
6	D30		6	2:30	3:00	-20	2nd Adj - set up 1.3 (Mono 15, 75)	
7	D31		7	3:00	3:30	-20	2nd Adj - set up 1.4 (Mono 15, 37.5)	
8	D32		8	3:30	4:00	-20	2nd Adj - set up 1.5 (Stereo 15, 75)	
9	D33		9	4:00	4:30	-20	2nd Adj - set up 1.6 (Stereo 15, 37.5)	
10								
11	D38		10	4:30	5:00	-40	Upper 2nd Adjacent without modulation	
12	D39		11	5:00	5:30	-40	2nd Adj - set up 1.1 (Mono, 8, 75)	
13	D40		12	5:30	6:00	-40	2nd Adj - set up 1.2 (Mono, 8, 37.5)	
14	D41		13	6:00	6:30	-40	2nd Adj - set up 1.3 (Mono 15, 75)	
15	D42		14	6:30	7:00	-40	2nd Adj - set up 1.4 (Mono 15, 37.5)	
16	D43		15	7:00	7:30	-40	2nd Adj - set up 1.5 (Stereo 15, 75)	
17	D44		16	7:30	8:00	-40	2nd Adj - set up 1.6 (Stereo 15, 37.5)	

FM Receiver Test Laboratory

Log Entry	Test Reference	Date (M/D/Y)	Index ID	Start m:s	End m:s	D/U	EO&C Comments	Subjective Grade
18	SonyTR							
19	NA	5/7/99	17	8:00	8:30	NA	1kHz reference tone	
20	NA		18	8:30	9:00	NA	Classical reference	
21	L27		19	9:00	9:30	-20	Upper 2nd Adjacent without modulation	
22	L28		20	9:30	10:00	-20	2nd Adj - set up 1.1 (Mono, 8, 75)	
23	L29		21	10:00	10:30	-20	2nd Adj - set up 1.2 (Mono, 8, 37.5)	
24	L30		22	10:30	11:00	-20	2nd Adj - set up 1.3 (Mono 15, 75)	
25	L31		23	11:00	11:30	-20	2nd Adj - set up 1.4 (Mono 15, 37.5)	
26	L32		24	11:30	12:00	-20	2nd Adj - set up 1.5 (Stereo 15, 75)	
27	L33		25	12:00	12:30	-20	2nd Adj - set up 1.6 (Stereo 15, 37.5)	
28								
29	L38	5/7/99	26	12:30	13:00	-40	Upper 2nd Adjacent without modulation	
30	L39		27	13:00	13:30	-40	2nd Adj - set up 1.1 (Mono, 8, 75)	
31	L40		28	13:30	14:00	-40	2nd Adj - set up 1.2 (Mono, 8, 37.5)	
32	L41		29	14:00	14:30	-40	2nd Adj - set up 1.3 (Mono 15, 75)	
33	L42		30	14:30	15:00	-40	2nd Adj - set up 1.4 (Mono 15, 37.5)	
34	L43		31	15:00	15:30	-40	2nd Adj - set up 1.5 (Stereo 15, 75)	
35	L44		32	15:30	16:00	-40	2nd Adj - set up 1.6 (Stereo 15, 37.5)	
36	Sanyo							
37	NA	5/7/99	33	16:00	16:30	NA	1kHz reference tone	
38	NA		34	16:30	17:00	NA	Classical reference	
39	K27		35	17:00	17:30	-20	Upper 2nd Adjacent without modulation	
40	K28		36	17:30	18:00	-20	2nd Adj - set up 1.1 (Mono, 8, 75)	
41	K29		37	18:00	18:30	-20	2nd Adj - set up 1.2 (Mono, 8, 37.5)	
42	K30		38	18:30	19:00	-20	2nd Adj - set up 1.3 (Mono 15, 75)	
43	K31		39	19:00	19:30	-20	2nd Adj - set up 1.4 (Mono 15, 37.5)	
44	K32		40	19:30	20:00	-20	2nd Adj - set up 1.5 (Stereo 15, 75)	
45	K33		41	20:00	20:30	-20	2nd Adj - set up 1.6 (Stereo 15, 37.5)	
46	Panasonic							
47	NA	5/7/99	42	20:30	21:00	NA	1kHz reference tone	
48	NA		43	21:00	21:30	NA	Classical reference	
49	C27		44	21:30	22:00	-20	Upper 2nd Adjacent without modulation	
50	C28		45	22:00	22:30	-20	2nd Adj - set up 1.1 (Mono, 8, 75)	
51	C29		46	22:30	23:00	-20	2nd Adj - set up 1.2 (Mono, 8, 37.5)	
52	C30		47	23:00	23:30	-20	2nd Adj - set up 1.3 (Mono 15, 75)	
53	C31		48	23:30	24:00	-20	2nd Adj - set up 1.4 (Mono 15, 37.5)	
54	C32		49	24:00	24:30	-20	2nd Adj - set up 1.5 (Stereo 15, 75)	
55	C33		50	24:30	25:00	-20	2nd Adj - set up 1.6 (Stereo 15, 37.5)	
56								
57								

Appendix F

FM Receiver Test Laboratory

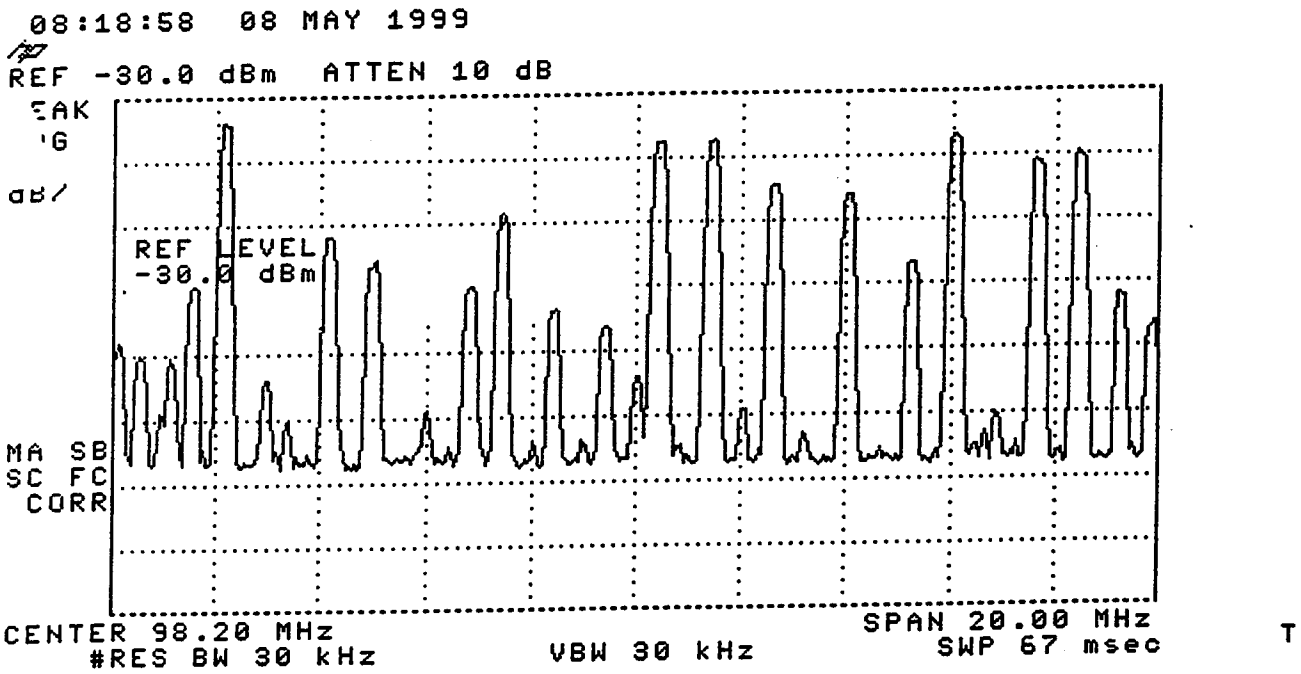
Date: 5/8/99
Engineer: TBK RMc
Test Series: F tests
Description: Receiver Performance in an on-air multi station environment
Desired: IM test; 91.7 (W/Omni interferer)
IM test; 101.7 (W/Directional interferer)

Undesired: Omni Antenna
Directional Antenna

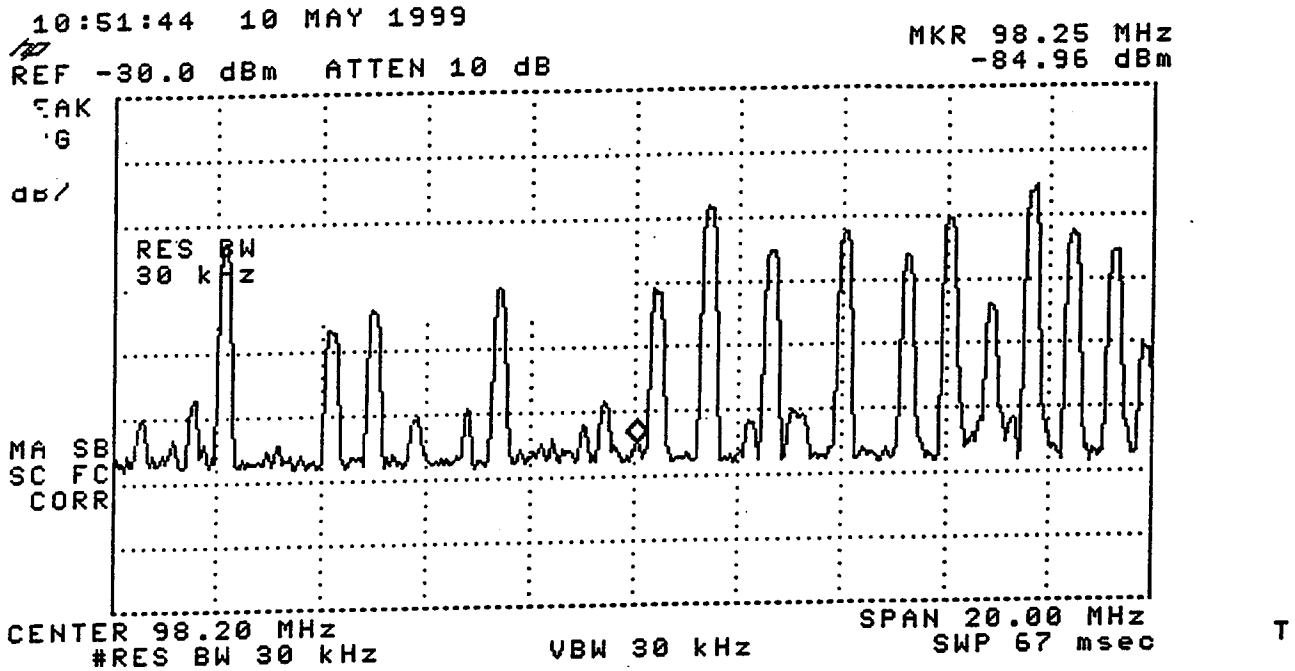
Test Set Up: 8 RF: Three Tone Receiver audio measurements, 15kHz BW, WQP (weighted CCIR, Quasi-Peak detected)

		Best S/N	RMS	60.5	69.0	66.8	67.5	65.0	68.5	59.2	68.0	59.5	65.5	60.5	60.50	63.6	61.2
		(Stereo)	QPK	50.5	61.5	58.7	61.5	57.0	65.0	52.6	62.0	54.0	59.0	49.0	51.0	55.0	49.0
		Test Reference →		A	B	C	D	E	F	G	H	I	J	K	L	M	N
F1	In Band	↓	Receiver No.	Delco 1	Den380 2	Pana 3	Pioneer 4	Ford 5	Den680 6	Audivox 7	SonyHF 8	SonyWM 9	TechHF 10	Sanyo 11	SonyTR 12	Koss 13	Magna 14
F1.2	91.7MHz, -55dBm	1	Gen Only S/N				59.7		62.8			53.3	58.4	48.0	50.0		
F1.3	91.7MHz +	2	W/ Omni An S/N				54.0		51.0			52.2	58.4	44.5	49.9		
F1.4a	101.7MHz	3	Gen Only S/N				59.6		63.0			52.3	58.7	48.5	50.6		
F1.4	101.7MHz +	4	/ Direct An S/N				45.0		62.3			36.5	56.5	33.2	19.5		
F1.4	Ant Sig. reduced	5	-10dB S/N												32.2		
							Tested 5/10/99		Tested 5/10/99			Tested 5/10/99		Tested 5/10/99			

120



F_Tests
Directional Antenna



F_Tests
Omni Antenna
(Afternoon)

Appendix G

FM Receiver Test Laboratory

Date: 5/11/99
Engineer: RMc
Test Series: G Series
Description: Three Tone Receiver Performance with IM signals, 800kHz Spacing

Desired: 94.1MHz, Tone/Pilot
-50dBm and -70dBm
Undesired: U1; 94.9MHz, 400Hz; 75kHz
U2; 95.7MHz, 1kHz; 75kHz

Test Set Up: 10 RF: Three Tone Receiver audio measurements, 15kHz BW, WQP (weighted CCIR, Quasi-Peak detected)

-45dBm		Best S/N	RMS	60.5	69.0	66.8	67.5	65.0	68.5	59.2	68.0	59.5	65.5	60.5	60.50	63.6	61.2	57.2	60.7	
		(Stereo)	QPK	50.5	61.5	58.7	61.5	57.0	65.0	52.6	62.0	54.0	59.0	49.0	51.0	55.0	49.0	48.2	54.3	
	Test Reference →			A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R	S
IM - 800kHz			Receiver No.	Delco 1	Den380 2	Pana 3	Pioneer 4	Ford 5	Den680 6	Audivox 7	SonyHF 8	SonyWM 9	TechHF 10	Sanyo 11	SonyTR 12	Koss 13	Magna 14	Ford 15	RadShk 16	17
-50dBm																				
45dB Target	1		D/U	-52.0	-11.0	-12.0	-11.0	-55.0	-24.0	-17.0	-9.0	-4.0	-11.0	-9.0	-6.0	-26.0	-6.0	-27.0	7.0	
	2																			
Fixed -10dB D/U	3		S/N	50.1	47.3	48.9	47.0	56.7	64.4	51.7	57.5	28.8	49.0	42.5	35.5	54.3	35.0	47.0	0.0	
Fixed -20dB D/U	4		S/N	49.6	20.0	17.2	17.4	56.0	57.5	38.4	29.6	0.0	18.9	18.4	0.0	53.1	7.4	46.5	0.0	
	5											FAIL			FAIL				FAIL	
-70dBm	6																			
Desired Only	7		S/N	48.5	45.5	46.0	48.6	56.1	50.0	46.5	48.6	42.2	48.5	36.6	42.9	42.8	34.7	41.8	45.0	
Fixed -20dB D/U	8		S/N	48.5	45.2	45.6	48.0	55.9	49.7	46.3	46.6	38.5	48.3	35.9	40.5	42.8	33.8	41.8	0.0	
Fixed -30dB D/U	9		S/N	47.5	29.0	26.2	27.0	55.8	48.3	34.5	20.5	11.0	28.9	23.0	14.7	42.1	15.1	41.6	0.0	
																			FAIL	

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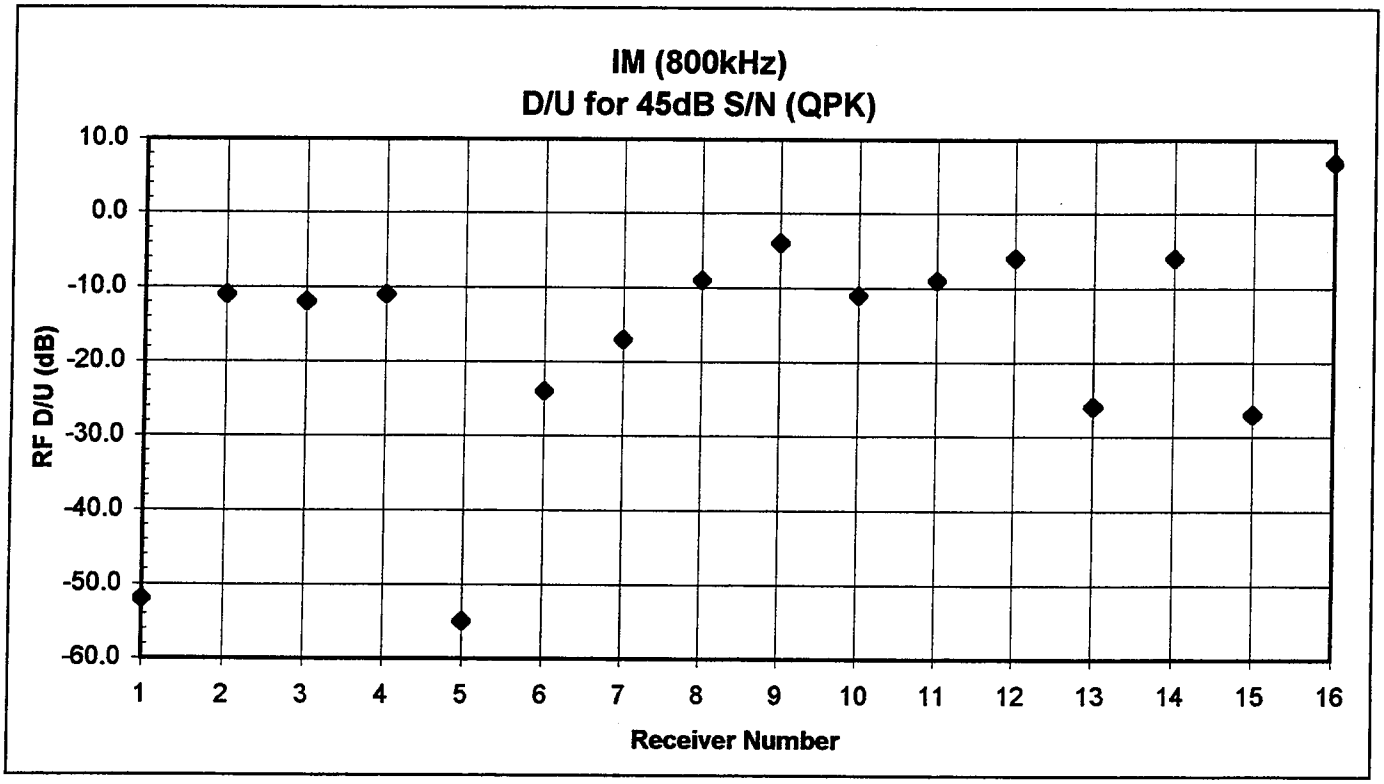
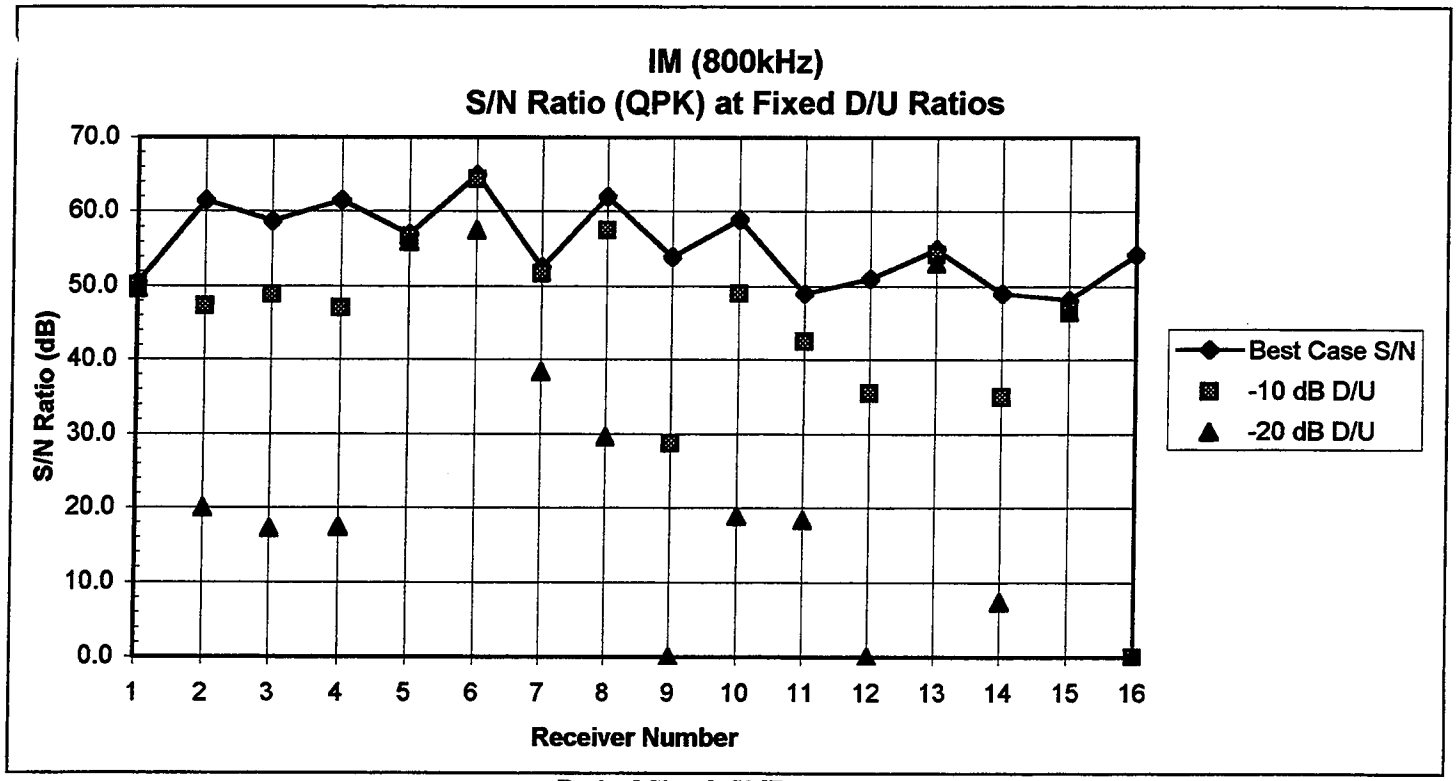
FM Receiver Test Laboratory



File Name: G_test

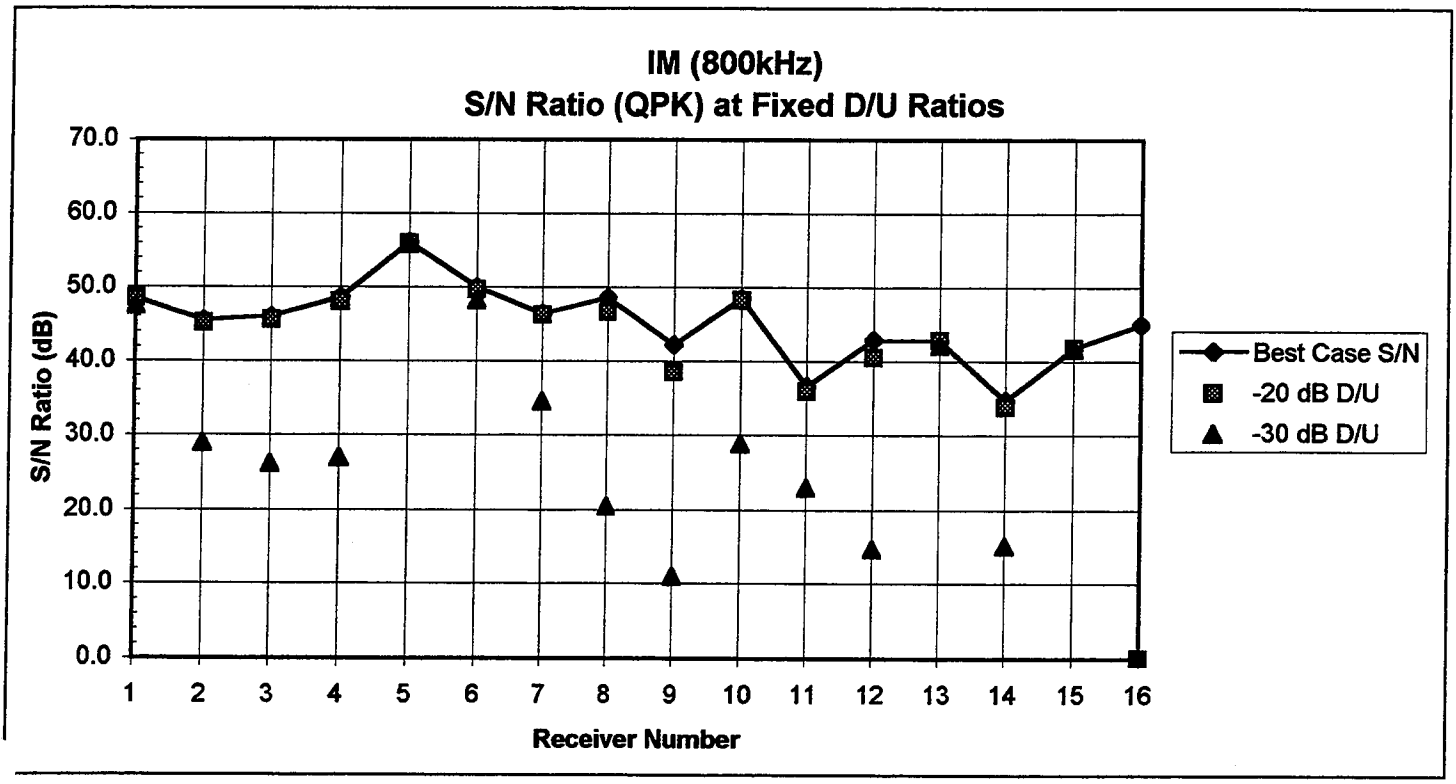
45dB SNR Plot

FM Receiver Test Laboratory



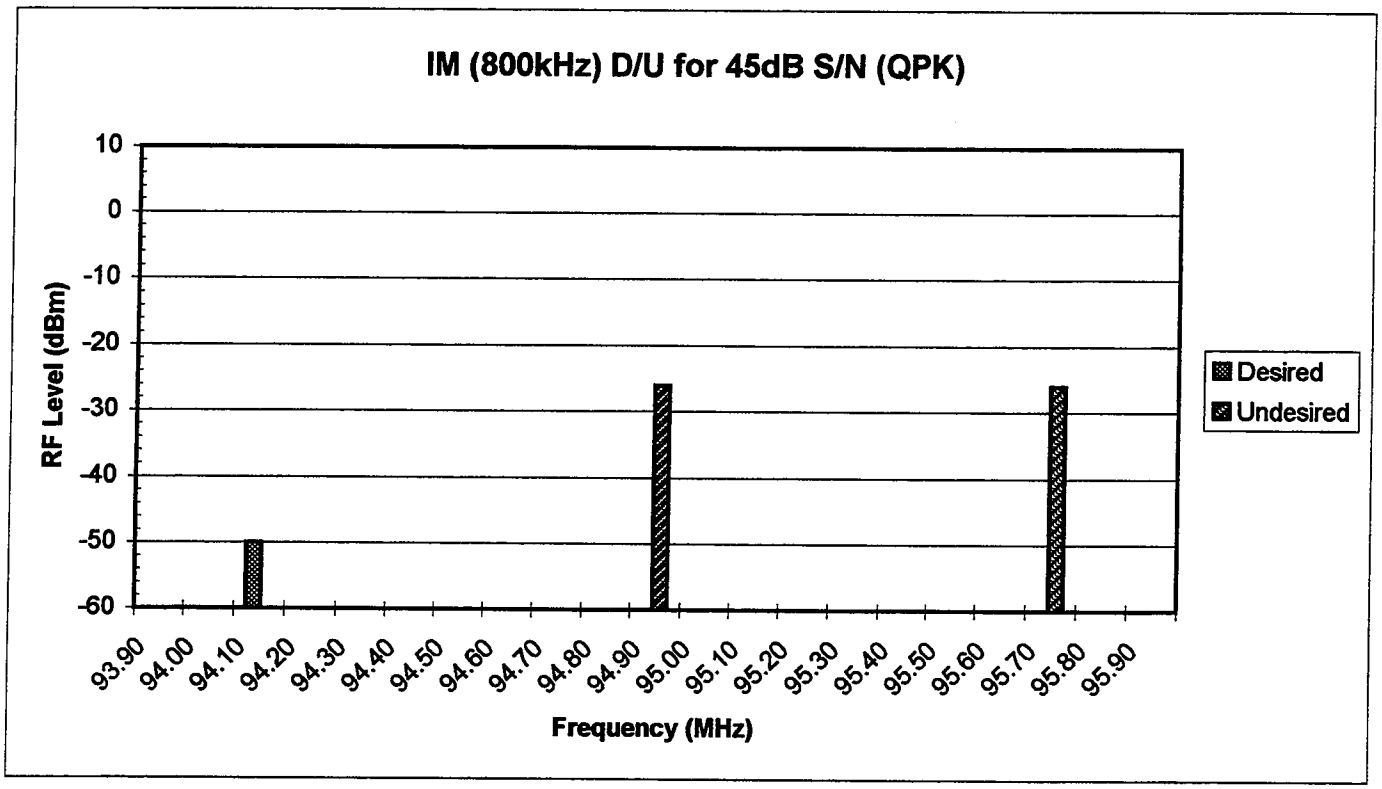
Desired Signal -50dBm

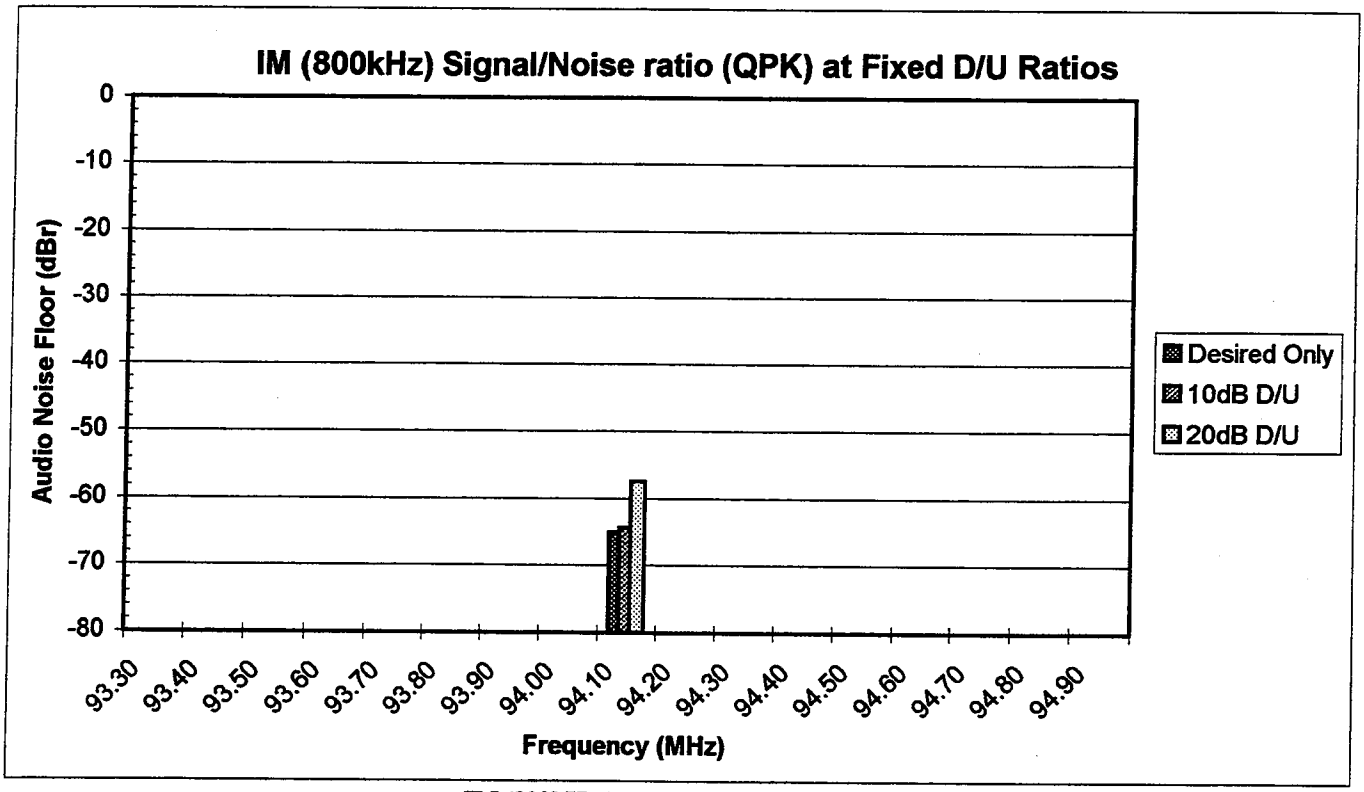
Note: Interconnection line for the Reference S/N data points denotes only the data series as a best case visual reference line. It does not imply a relationship between the data points.



Desired Signal -70dBm

FM Receiver Test Laboratory





IM (800kHz Spacing) Characteristics

RX No.: 6 Den680

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Appendix H

FM Receiver Test Outline

June 10, 1999

A. Laboratory calibration and receiver characterization

B. Interference

C. Post-detection noise

D. IF taboo and LO

E. Interference with restricted undesired station modulation

F. Performance in on air environment

G. IM with 800 kHz station spacing

June 10, 1999
Rev #9

FM RECEIVER LABORATORY TEST PROCEDURES

Test Group	Test & Impairment	TEST DESCRIPTION	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
A **Laboratory Calibration and receiver characterization**	1. Receiver characterization tests	1. Local oscillator frequency (tuning error) 2. Standard audio output (@ strong signal level) 3. RF input overload (@ 5% THD) 4. AM Rejection FM only and FM+30% (THD) 5. Image rejection 6. Curve tests, signal/ noise vs RF level and separation 7. Capture ratio 8. Selectivity – 1st adjacent 30 dB S/N 9. Selectivity – 2nd adjacent 30 dB S/N 10. Selectivity –1st adjacent 50 dB S/N 11. Sensitivity –2nd adjacent 50 dB S/N 12. Sensitivity –3rd adjacent 50 dB S/N 13. 10.7 MHz rejection 14. 10.7 MHz IM 15. 10.7 MHz L.O. interference	Objective	Varying	Receiver operating parameters
	2. Test transmitter proof of performance (before and after test or as needed)	1. Stereo proofs will be conducted on both the desired and undesired test transmitters. 2. The tests will be conducted for each desired operating frequency. 3. A high quality wideband demodulator will be used for the tests. 4. The tests will be conducted from the input of the stereo generator to the output of the precision stereo demodulator.	Objective	NA	Transmitter performance parameters
	3. Test transmitter power.	1. The desired and undesired transmitter power will be certified using a separate laboratory power meter.	Objective	NA	NA
	4. Modulation monitor calibration	1. The FM monitor will be calibrated weekly. Bessel null calibration method will be used.	Objective	NA	Record of calibration results
	5. Spectrum	1. A spectrum analyzer plot of the desired and undesired transmitter signal will be taken. Two plots taken, the first with pilot only and the second with pilot and clipped pink noise. 2. The recommended spectrum analyzer settings are: RES BW 1 kHz, VBW 30 Hz, and sweep span of 1 MHz.	Objective	-50 dBm	Spectrum plot
	6. Test bed calibration	1. All critical components in the test bed, including the multipath simulator, attenuators, combiners, filters, generators, and measuring instruments, should be checked for calibration on a monthly schedule.	Objective	NA	Data in lab test record
	7. Audio noise measurements	1. RMS 2. Audio noise measurements made using quasi-peak detection and CCIR weighting filter (WQP)	Objective	Na	NA

Test Group	Test & Impairment	TEST DESCRIPTION Notes: 1. These tests will be conducted on all 16 of the representative consumer FM stereo receivers. 2. Adjacent channel tests will be conducted individually on the upper and lower adjacent channel. 3. Receiver audio S/N measurements will be conducted using a pilot filter.	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
B **Interference without multipath**	1. Co-channel	1. The desired signal will be modulated with stereo pilot. 2. The undesired transmitter will be modulated with stereo clipped pink noise. 3. The undesired signal will be increased until a WQP and RMS audio S/N of 45 dB is measured. The D/Us will be recorded at this point. 4. WQP S/N tests will be conducted on each receiver with the D/U set at 20 and 30 dB.	Objective	-50 dBm	D/U with 45 dB S/N Audio S/N at the two D/U settings
	2. First adjacent	1. The desired signal will be modulated with stereo pilot. 2. The undesired signal transmitter will be modulated with stereo clipped pink noise. 3. The undesired signal will be increased until a WQP audio S/N of 45 dB is measured. RMS S/N will be measured on three selected receivers. The D/U will be recorded at this point. 4. WQP S/N tests will be conducted on each receiver with the D/U set at 6 dB. 5. RMS S/N will be measured on three selected receivers in steps 3 and 4.	Objective	-50 dBm and –70 dBm	D/U with 45 dB S/N Audio S/N at a D/U of 6 dB
	3. Second adjacent	1. The desired signal will be modulated with stereo pilot. 2. The undesired transmitter will be modulated with clipped pink noise. 3. The undesired signal will be increased until a WQP S/N of 45 dB is measured. The D/U will be recorded at this point. 4. The tests will be conducted measuring the WQP audio S/N with the D/U set at –20, 5. -30, –40, and –50 dB. 6. With the desired signal set at –50 dBm and the D/U set at –20 dB, -30 dB, -40 dB, and –50 dB, a DAT audio recording will be made of the desired signal for further subjective assessment. For these recordings undesired transmitter will be modulated with aggressively processed rock music and the desired with moderately processed classical music. The test will be repeated with the desired channel modulated with heavily modulated rock music. 7. While making the recordings, the laboratory specialist will make EO&C comments for each segment. 8. RMS S/N will be measured for steps 3 and 4 on three selected receivers.	Objective EO&C and Subjective	-50 dBm and -70 dBm	D/U at the 45 dB audio S/N at the four D/U settings
	4. Third adjacent	1. The desired signal will be modulated with stereo pilot. 2. The undesired transmitter will be modulated with clipped pink noise. 3. The tests will be conducted measuring the RMS and WQP audio S/N with the D/U set at –30, –40, and –50 dB. 4. Using the same program modulation used for the DAT recordings in the second adjacent tests (B.3), the test will be repeated using the –30 dB, -40 dB, and –50 dB D/U settings and the –50 dBm desired signal level. 5. RMS S/N will be measured for step 3 on three selected receivers.	Objective EO&C and Subjective	-50 dBm	S/N at the three D/U settings

June 10, 1999 REV #9	FM RECEIVER LABORATORY TEST PROCEDURES				
Test Group	Test & Impairment	TEST DESCRIPTION Notes: This test will be conducted using two receivers: the Denon model 380 RBDS tuner modified for 50 ohm baseband output and the RE AFM-2 wideband demodulator. The RE AFM-2 is a laboratory modulation monitor and a precision wideband FM demodulator.	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
C **Post-detection noise**	1. First adjacent	1. The desired signal will be modulated with pilot and a 1 kHz tone. 2. The undesired transmitter will be modulated with clipped pink noise. 3. The results of spectrum analyzer 1 kHz to 100 kHz baseband plots will be recorded with the first adjacent D/U set at 35 dB, 20 dB, 10 dB, and 6 dB for both test receivers. 4. Noise floor increase on the spectrum analyzer plots will be noted at the 90 kHz subcarrier frequency. 5. To determine if the noise floor change is caused by the beat between the program audio and the undesired first adjacent signal, a test will be conducted with and without program audio. The test will be conducted using the consumer receiver, a moderate D/U of 22 dB, and the noise floor compared with the program audio switched on and off.	Objective	-20 dBm AFM-2 -50 dBm Denon	Spectrum analyzer plots of the receiver baseband will be made. S/N at baseband subcarrier frequencies.

June 10, 1999 REV #9	FM RECEIVER LABORATORY TEST PROCEDURES				
Test Group	Test & Impairment	TEST DESCRIPTION Notes: Tests D.1 will be conducted using receivers that measured sensitive to 10.7 MHz (10.6 or 10.7 MHz) intermodulation interference in the receiver certification tests A.1.14. Tests D.2 will be conducted using receivers sensitive to local oscillator inference in certification tests A.1.15.	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
D **IF taboo**	1. IM with 10.6 MHz 10.8 MHz station spacing	1. Receivers sensitive to IM will be used for this test series. 2. A desired frequency will be selected between 94.1 MHz and 101.9 MHz. The desired transmitter will be modulated with pilot. 3. The undesired signals will transmit on a frequency 5.4 MHz below and 5.2 MHz above the desired signal (10.6 MHz separation). The –5.4 MHz signal will be deviated 75 kHz with a 400 Hz tone, and the +5.2 MHz deviated 75 kHz with at 1 kHz tone. 4. The desired signal level will be –45 dBm at the receiver input. 5. The undesired transmitter output levels will be combined equally and then mixed with the desired signal. The undesired signals will be equally increased to the point where the audio WQP S/N is 40 dB. The undesired signal levels and the D/U will be recorded. 6. The undesired RF signals will then be increased to produce a 30 dB WQP S/N (the maximum undesired RF level will be –20 dBm). 7. To verify that the combination of both transmitters is causing the IM, the undesired signals will be turned off one at a time. 8. The test will be repeated with the upper undesired signal set at 5.4 MHz (10.8 MHz separation). 9. The test will be repeated with the desired signal level set at –60 dBm.	Objective	-45 dBm and -60 dBm	D/U at 30 & 40 dB WQP audio S/N on all receivers in all test modes.
	2.. Local oscillator interference	1. Receivers sensitive to signals at the LO frequency will be used for this test series. 2. The undesired signal will be set at 10.6 MHz above the desired signal and modulated with 400 Hz tone at 75 kHz deviation. 3. The desired signal will be modulated with pilot and the RF level into the receiver set at –45 dBm. 4. The undesired signal will be increased until a WQP S/N of 40 dB is measured. The D/U will be recorded at this point. 5. The undesired RF signals will then be increased to produce a 30 dB WQP S/N. 6. The test will be repeated with the undesired signal modulated with clipped pink noise. 7. The test will be repeated with the desired signal level set at –60 dBm. 8. The test will be repeated with the undesired signal set at 10.8 MHz above the desired.	Objective	-45 dBm and -60 dBm	D/U at 30 & 40 dB WQP audio S/N on all receivers in all test modes.

FM RECEIVER LABORATORY TEST PROCEDURES

Test Group	Test & Impairment	TEST DESCRIPTION Notes: 1. The receivers used for E.1 will be Delco auto radio, Pioneer home hi-fi, and Denon 380. 2. The receivers used for E.2 will be the four receivers that measured most sensitive to interference in test B.3 and B.4 (second and third adjacent).	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
E **Reduced undesired Modulation**	1. Restricted modulation quality	1. Monophonic 8 kHz audio with 75 kHz total deviation. 2. Monophonic 8 kHz audio at with 37.5 kHz total deviation. 3. Monophonic 15 kHz audio with 75 kHz total deviation (**mono reference**). 4. Monophonic 15 kHz audio with 37.5 kHz total deviation. 5. Stereo 15 kHz audio with 75 kHz total deviation (**stereo reference**). 6. Stereo 15 kHz audio with 37.5 kHz total deviation. 7. Stereo 15 kHz audio with 15 kHz subcarrier deviation, total deviation 82.5 kHz deviation . 8. Stereo 15 kHz audio with 15 kHz subcarrier deviation, total deviation of 41.2 kHz deviation. 9. Spectrum analyzer plots will be taken of each of the above 8 transmission modes using clipped pink noise for the audio source. 10. For those transmission modes that reduced interference in test D.2, audio distortion, frequency response, and stereo separation tests will be conducted for each receiver. 11. Using each transmission mode for each receiver, audio program material will be transmitted through the system and digitally recorded for future subjective assessment.	Objective Subjective EO&C	SA plots –50 dBm	FM channel spectrum analyzer plots for the 8 transmission modes Audio quality tests for all 8 modes on each of four receivers Subjective recordings
	2.. 2nd and 3rd adjacent tests	1. Using the four receivers that measured the most sensitive to second and third adjacent interference in test series B.3, additional second adjacent tests will be conducted with the undesired transmitter modulated with clipped pink noise and operating in the transmission modes listed in E.1 (reference no undesired modualtion). 2. With the undesired second adjacent signal set for D/Us of –20dB and –40dB, the WQP audio S/N will be measured. 3. With the undesired third adjacent signal set for a –40dB D/U, the WQP audio S/N will be measured. 4. Using the transmission modes that reduced interference in steps 2 and 3, audio program materials will be transmitted through the systems and digitally recorded for further subjective assessment.	Objective	-55 dBm	Quantify interference for each reduced modulation modes Subjective recordings

June 10, 1999 REV #9		FM RECEIVER LABORATORY TEST PROCEDURES			
Test Group	Test & Impairment	TEST DESCRIPTION Notes: 1. The objective of these tests are to re-measure receiver performance in an on-air multi-station environment. 2. These tests will be conducted in a suburban environment (in the west Cleveland, Ohio area) using an omni-directional and a high-gain directional antenna to receive the local FM band. The desired signal will be generated in the test-bed and mixed with the off-air signals. 3. This test will be conducted in the laboratory using the four receivers that measured the most susceptible to adjacent channel interference in tests B, C, and D. The test will be repeated with one auto and one home hi-fi receiver that tested the least susceptible to adjacent channel interference. 4. To minimize interference the desired signal level will be at least 35 dB above any co and first adjacent signals, and the desired no lower than the 15 dB below the second and third adjacent.	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
F. **Simulated in-band tests**	1. Performance in FM band	1. The desired signal will be modulated with stereo pilot and tested at 91.7 MHz. 2. The WQP S/N will be first measurement through the test receiver without the off-air signals added. 3. Using the omni-directional antenna the off-air signals will be added, and the test in step #2 repeated. 4. Using the high-gain directional antenna (oriented toward the transmitter) the off-air signals will be added, and the test in step #2 repeated with the desired signal operating on 101.7 MHz.	Objective	-55 dBm	Measured changes in receiver noise with the addition of the on-air band Spectrum plots

June 10, 1999 REV #9		FM RECEIVER LABORATORY TEST PROCEDURES			
Test Group	Test & Impairment	TEST DESCRIPTION Notes: This test will be conducted using all of the 14 compatibility receivers.	Type of Evaluation	Desired Signal Level	Test Results Data to be Recorded
G. **IM with 800 kHz station spacing**	1. IM at 45 dB S/N	1. The desired signal will be operated at 94.1 MHz and modulated with stereo pilot. 2. Undesired signal U1 will operate at 94.9 MHz and be modulated with a 400 Hz tone. 3. Undesired signal U2 will operate at 95.7 MHz and be modulated with a 1 kHz tone. 4. The undesired transmitter outputs will be equally combined and then mixed with the desired signal. The desired signals will be equally increased in level to the point where the target audio WQP S/N is 45 dB. The D/U will be recorded at this point. 5.	Objective	-50 dBm	D/U at 45 dB WQP S/N
	2. IM with fixed D/Us	1. The desired signal will be operated at 94.1 MHz and modulated with stereo pilot. 2. Undesired signal U1 will operate at 94.9 MHz and be modulated with a 400 Hz tone. 3. Undesired signal U2 will operate at 95.7 MHz and be modulated with a 1 kHz tone. 4. The D/U will be set at –20 dB and –30 dB and WQP S/N measurements made. 5. The test will be made with the desired level set at –50 dBm and –70 dBm	Objective	-50 dBm and -70 dBm	S/N with D/Us of –20 dB and –30 db

NRSC Document Improvement Proposal

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