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FEDERAL COMMUNICATIONS COMMISSION
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REPORT

of the

**LMDS/FSS 28 GHZ BAND
NEGOTIATED RULEMAKING
COMMITTEE**

September 23, 1994

FEDERAL COMMUNICATIONS COMMISSION

WASHINGTON, D.C. 20554

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IN REPLY REFER TO:

Kathleen M. H. Wallman
Chief, Common Carrier Bureau
Federal Communications Commission
Washington, D.C.

Dear Ms. Wallman:

It is my pleasure to transmit to you the Report of the FCC Industry Advisory Committee which was charged with negotiating regulations for use by the Commission in implementing the Local Multipoint Distribution Service (LMDS) and the Fixed Satellite Service (FSS).

The Committee negotiated intensively over its eight-week chartered period, concluding at midnight of its last day in an attempt to agree means for these two services to operate together on a co-frequency basis, sharing the 27.5 - 29.5 GHz frequency spectrum. The Committee or its informal groups met almost every day and most evenings, including weekends and holidays. I can tell you that all of the Committee members and their support teams worked closely together to develop an impressive record. Although the Committee was able only to agree minor draft regulations by consensus, it was able to take advantage of the available corporate expertise of more than 100 highly talented and motivated engineers, scientists, attorneys, managers, and administrators, as well as of countless others working behind the scenes, to develop valuable analyses, conclusions, and recommendations. All of these are included in, or are appended to the Report.

Although some believe that pressing further with negotiations would have been fruitful, particularly projecting new but commercially unproven technology, it became clear during Committee discussions that **LMDS and FSS service uplinks will not be technically able at this time to reasonably share the same spectrum**. On the other hand, it is obvious from agreements reached [NRMC Document 84 (Revision 1)] that **LMDS and feeder links to non-geostationary satellites operating in the Mobile-Satellite Service are able to share the same spectrum today under certain conditions**. One derivative from these agreements is that **gateway access to the FSS (either non-geostationary or geostationary orbit) can also share with the LMDS**.

I want to recognize the FCC staff who worked so hard on this Committee, particularly Mr. Tom Tycz, the FCC representative; Ms. Susan Magnotti, the Designated Federal Officer; and Mr. Robert James, who agreed to chair one of the two major working groups. These three individuals of the Common Carrier Bureau deserve much credit for enabling this Report. Additionally, I must recognize the hard work of Mr. W. Tim Campbell and Mr. Edward F. Miller who co-chaired the other major working group. Without the sincere dedication of all these individuals, it would not have been possible for the Committee to accomplish its work.

Sincerely,



William A. Luther
Facilitator

EXECUTIVE SUMMARY

The LMDS/FSS 28 GHz Band Negotiated Rulemaking Committee (NRMC), chartered by the Federal Communications Commission, existed for 60 days for the purpose of providing recommendations to the Commission to be used in the formulation of technical rules for the Local Multipoint Distribution Service (LMDS) and/or the Fixed-Satellite Service (FSS) so as to maximize the co-frequency sharing of the 27.5 - 29.5 GHz frequency band. The scope of the activities of the Committee included assembling data, performing analyses, and providing advice to the FCC concerning technical and coordination issues presented by these services. In particular, the Committee examined the technical aspects of LMDS/FSS co-frequency sharing and of LMDS/Mobile-Satellite Service (MSS) feeder link co-frequency sharing. The Committee's work promoted the rapid exchange of technical information regarding proposed systems by bringing together a group of highly talented and motivated engineers, scientists, attorneys, managers, and administrators.

Detailed technical analyses were performed to provide information concerning the co-frequency sharing possibilities. These analyses are part of this Report as Appendix VI (Working Group 1) and Appendix VII (Working Group 2). These two Working Group reports were submitted as documents for review by the Committee and were used to develop consensus approval for twelve conclusions, four recommendations and three rule proposals for the Committee Report itself. The two Working Group reports carry full agreement within their respective group.

Actual interference-potential testing occurred during the Committee's discussions. The results of the tests by the Suite 12 Group (NRMC Document 93) and of the tests by the National Aeronautics and Space Administration Lewis Research Center (NRMC Document 94), were agreed by consensus of the Committee for inclusion within Section III of this Report.

With respect to LMDS/FSS co-frequency sharing, the Committee reached unanimous consensus on the following Conclusions:

- For FSS Earth station transmitters interfering into LMDS receivers - -
 - the Committee did not find a technical solution for co-frequency sharing;
 - sharing problems were identified as resulting from the proposed widespread distribution of both FSS Earth stations and LMDS receivers throughout the same geographic areas;
 - no proposed solutions were deemed feasible by any combination of LMDS and FSS proponents; and
 - a number of operational and interference mitigation techniques to assist sharing were identified but were not statistically and analytically assessed.

- For LMDS transmitters interfering into FSS satellite receivers - -
 - in most cases examined, interferences from hub-to-subscriber transmissions

- provided positive margins (allowed sharing);
- for the cases of subscriber-to-hub transmissions as modeled, five out of 25 cases had negative margins; in cases with negative margins, mitigating factors or techniques need to be applied;
- aggregate limits on the power spectral density of LMDS transmitters can preclude interference to satellite receivers, but agreement could not be reached on the feasibility of enforcement of regulations.

With respect to LMDS/MSS feeder link co-frequency sharing, the Committee reached consensus on the following conclusions, recommendations and proposed rules:

- Conclusions - -

- the FCC should designate spectrum outside of the 27.5 - 29.5 GHz band for feeder links for applicants who have not previously applied to use this band
- unrestricted sharing of the band is not possible due to the interference level anticipated from LMDS backbone and subscriber transmitters into non-geostationary orbit MSS feeder link receivers;
- a coordination procedure is required to preclude unacceptable interference from non-geostationary MSS feeder link systems to LMDS receivers;
- currently, there are no satisfactory models of the scattering effects for an urban or suburban environment;
- when the number of interfering sources exceeds five and are non-coherent, their effect on the receiver is the same as additive white Gaussian noise (AWGN);
- interference from a non-geostationary MSS feeder link Earth station into an LMDS receiver is from a single source and may not have the same effect as AWGN;
- the number of assumptions required to model the aggregate interference from LMDS subscriber transmitters is large and would make a valid model complex; no such simulation model was developed;
- it is statistically likely that no more than one high power LMDS backbone station at a time would be pointing its antenna so as to intercept a receive spot beam from a non-geostationary MSS feeder link satellite antenna; and
- among the technical and modeling parameters to be used in LMDS/MSS feeder link co-frequency sharing analyses are:
 - - A table of "Clear Air Earth-to-Space Atmospheric Loss vs. Elevation Angle;" and
 - - Satellite receiver antenna discrimination against LMDS interferences is 3 dB in the satellite main beam, where non-geostationary MSS satellite feeder link polarization is circular and the LMDS polarization is linear.

- Recommendations - -

- that the FCC identify feeder link spectrum outside of the 27.5 - 29.5 GHz band for use by non-geostationary MSS systems;
- that the FCC should encourage industry to further explore mitigation techniques and statistical modeling;
- a specific, non-exhaustive list of parameters that should be considered in interference calculation or in interference/sharing scenarios; and
- the clear sky attenuation rate given in CCIR Report 719 for different climatic zones be used in calculations.

- Proposed Rules - -

- definitions for LMDS elements
- required submission of a demonstration of compliance with technical rules that may be adopted
- consideration of the Personal Communications Service coverage area requirements when adopting LMDS rules

As part of its protocol, the Negotiated Rulemaking Committee agreed that, by definition, consensus meant unanimous agreement. The Committee agreed to include in its Report (Sections I through VI) those texts which were agreed by consensus. The Appendices are not consensus documents. The addenda were submitted after the Committee concluded its work.

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Addenda

asked for comment from satellite entities regarding the effect of this redesignation on any proposed satellite use of the band.

In the Second Notice of Proposed Rulemaking, 9 FCC Rcd 1391 (1994), the Commission modified its original proposal for use of the 28 GHz frequency band based on comments it received in response to the first NPRM and on the Report of the "MSS Above 1 GHz Negotiated Rulemaking Committee." Although the majority of commenters in this proceeding favored the Commission's redesignation proposal, satellite entities argued that they have been developing plans to use the band once the K_u and C bands are filled. In addition, the Report of the MSS Above 1 GHz Negotiated Rulemaking Committee included a statement by the Federal Aviation Administration (FAA) that the satellite entities proposing Low Earth Orbiting (LEO) systems would interfere with new navigation aids being developed by the FAA if they were permitted to place their uplink feederlinks in the 5/6 GHz frequency band. Moreover, the Second NPRM noted that other frequency bands below 15 GHz are not now available for LEO feeder link use. Accordingly, the Commission proposed to find adequate feeder link spectrum in the 28 GHz band to satisfy the needs of the MSS Above 1 GHz licensees.³

The Commission indicated that its preference in handling the competing interests for this frequency band is to accommodate all proposals. However, the Commission noted that the coordination issues involved are highly technical and that their solutions depend upon the specific system designs of the various proposals to use the band, and that expert advice and assistance from the system proponents and other interested parties would be necessary to develop such rules. Accordingly, the Commission proposed a negotiated rulemaking procedure to develop the technical rules which would permit sharing between terrestrial and satellite systems in this band.

The Commission released a Public Notice asking for comments on its proposal to implement a negotiated rulemaking procedure on the technical issues associated with sharing the 28 GHz band between terrestrial and satellite uses. The Commission identified parties which would be interested in the negotiations, found that the criteria for beginning a negotiated rulemaking process were met, and indicated the issue on which it sought expert advice from the Committee:

³ Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610 - 1626.5 / 2483.5 - 2500 MHz Frequency Bands, Notice of Proposed Rulemaking, CC Docket 92-166, 9 FCC Rcd 1094 (1994), paragraph 76.

What technical rules should be adopted for the Local Multipoint Distribution Service and/or the Fixed Satellite Service so as to maximize the sharing of the spectrum among these services?

In addition, the Commission asked that parties reaching a consensus on technical rules also address a number of economic and policy issues to show how the benefits of its proposed solution would outweigh other options for accommodating the services.

Most of the interested parties identified as such by the Commission's notice filed requests for inclusion on the committee and gave their responses to the Commission's proposals. A number of other parties also identified themselves as interested in the negotiations and responded to the proposed issues. A total of 36 parties requested inclusion on the Committee. Since the Federal Advisory Committee Act limits the number of representatives on the Committee to 25, and the Commission preferred not to exclude any party which offered to assist it in developing the necessary technical rules, the Commission requested committee applicants to combine themselves into groups of similar interests for purposes of the negotiations. Parties responded favorably and many were able to offer one representative for more than one applicant. The Commission was very appreciative of the cooperative spirit of the applicants and was pleased to offer a seat on the Committee to all proposed representatives.

Commenters proposed various changes to the issues proposed for the negotiated rulemaking committee. After considering the proposed changes, the Commission concluded that the Committee's work should be limited to developing technical rules for sharing, on a co-frequency basis, the 28 GHz band. The Commission determined that the Committee should not also be asked to develop an economic or policy justification for a consensus on rules for this sharing scenario. The Commission crafted a charter for the committee that specified:

The purpose of the committee is to provide recommendations to the Federal Communications Commission to be used in the formulation of technical rules which should be adopted for the Local Multipoint Distribution Service (LMDS) and/or the Fixed Satellite Service (FSS) so as to maximize the co-frequency sharing of the 27.5 - 29.5 GHz frequency band ("28 GHz band") among these services.

Accordingly, the Commission presented the proposed charter to the Office of Management and Budget and the General Services Administration, as required by the Federal Advisory Committee Act. After acquiring the necessary approvals, the Commission established the LMDS/FSS 28 GHz Negotiated Rulemaking Committee, 59 Fed. Reg. 33483 (June 29, 1994).

Training and orientation for the negotiated rulemaking process was offered to the Committee representatives and alternates on July 25, 1994. Training was provided under the auspices of the Administrative Conference of the United States (ACUS). Mr. David Pritzker, Esquire, Assistant to the Chairman of ACUS, and Mr. Chris Kirtz, Director of the Consensus and Dispute Resolution Program at the Environmental Protection Agency, offered the benefits of their expertise to the committee members.

The Committee held its first meeting on July 26, 1994, and conducted seven additional meetings thereafter. The Committee's Congressional charter expired on September 23, 1994.

II. WORKING GROUP STRUCTURE AND METHODS

A. Work Program

The Committee, by consensus, established the following work program to provide recommendations to be used in the formulation of technical rules in 47 C.F.R. Parts 21 and 25, either modifications to existing rules or new rules, so as to maximize the co-frequency sharing of the 27.5 - 29.5 GHz band between the Local Multipoint Distribution Service (LMDS) and the Fixed Satellite Service (FSS):

1. In order to determine the appropriate technical, operational and/or administrative sharing criteria that would maximize the co-frequency sharing of the band by the LMDS and the FSS, the Committee will assemble data, perform analyses and provide advice concerning the technical and coordination issues presented by these services. In this regard, the following sharing/compatibility cases should be examined:

- a) FSS Earth station uplinks accessing geostationary satellites causing potential interference into LMDS hub stations and subscriber terminals.
- b) FSS feeder uplink Earth stations accessing Low-Earth Orbit satellites providing mobile satellite services in the 1610-1626.5/2483.5-2500 MHz bands causing potential interference to LMDS hub stations and subscriber terminals.
- c) FSS Earth station uplinks accessing Low-Earth Orbit FSS satellites causing potential interference to LMDS hub stations and subscriber terminals.
- d) LMDS hub stations and subscriber terminals causing potential interference, on an individual station basis or as an aggregate of all visible terminals and hub stations, to FSS geostationary satellite receivers.
- e) LMDS hub stations and subscriber terminals causing potential interference, on an individual station basis or as an aggregate of

all visible terminals and hub stations, to FSS Low-Earth Orbit satellite receivers.

f) LMDS hub stations and subscriber terminals causing potential interference, on an individual station basis or as an aggregate of all visible terminals and hub stations, to feeder links for MSS services in the 1610-1626.5/2483.5-2500 MHz bands.

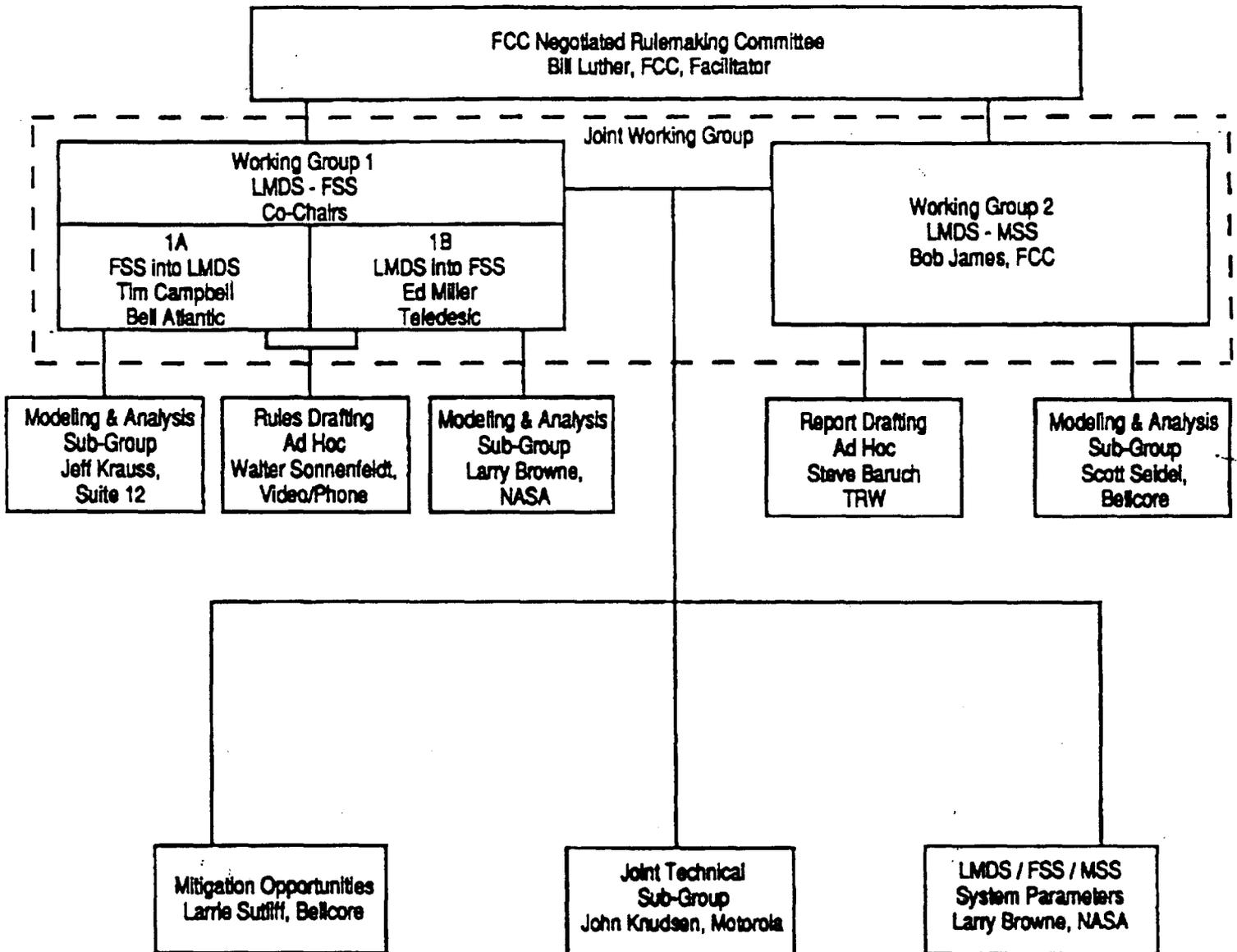
2. All recommendations or proposed rules must comply with International Telecommunication Union treaty obligations.

B. Working Groups

The Committee, by consensus, agreed to establish two working groups to address the primary issue before it. Working Group 1 addressed sharing between FSS and LMDS, which included items (a), (c), (d), and (e) of the work program. The co-Chairmen of the working group were Tim Campbell and Edward Miller. Working Group 2 addressed sharing between MSS feeder links and LMDS, which included items (b) and (f) of the work program. The Chairman of the working group was Robert James. Attached is a chart depicting the working group structure. Working Groups 1 and 2 describe their work programs and processes in separate reports, see Appendices 6 and 7, respectively.

LMDS/FSS 28 GHz Band Negotiated Rulemaking Committee Docket 92-297

COMMITTEE STRUCTURE



III. LMDS/FSS COMPATIBILITY ANALYSIS AND DISCUSSION

This section addresses LMDS/FSS compatibility for the sharing scenarios considered by Working Groups 1 and 2 and includes the hardware testing results that were submitted to the Committee for discussion.

III.I Analyses of LMDS/FSS Service Link Compatibility

For these sharing/interference scenarios, the analyses conducted as part of the 28 GHz band NRMC activities are described in the report of Working Group 1 (Appendix 6). Based on that work, the conclusions that received unanimous Committee consensus are contained in Section IV of this Report.

III.II Analyses of LMDS/MSS Feeder Link Compatibility

For these sharing/interference scenarios, the analyses conducted as part of the 28 GHz band NRMC activities are described in the report of Working Group 2 (Appendix 7). Based on that work, the conclusions and recommendations that received unanimous Committee consensus are contained in Section IV of this Report.

III.III Hardware Testing Results

Immediately following are NRMC Documents 93 and 94 comprising the results of testing on behalf of the Suite 12 Group and the results of testing by the National Aeronautics and Space Administration Lewis Research Center. These Documents were unanimously agreed by the Committee for inclusion in its Report.

NRMC/ 93
WGI/85

9/16/94

Preliminary Test Results of QPSK Interference on LMDS FM Video

Preface

Experiments were conducted to determine the effect of QPSK modulated signals interfering with FM video programming. These experiments were of a preliminary nature to determine a methodology and to gain some insight into probable results of a more elaborate set of experiments to be conducted under the auspices of an ad hoc group of participants of the FCC LMDS/FSS 28 GHz Band Negotiated Rule Making Committee. The Test Procedure for these more extensive tests is included in this report as Appendix A and the current tests and results reported here may be considered a subset of those. A summary of the test procedures is outlined below and the interested reader is referred to the appendix for more details. An additional test was conducted to determine the effect of burst mode QPSK as an interference signal. The procedure and test results of this experiment are included in Appendix C.

Test Setup

Interference signals of three different types were introduced into an FM video color bar test signal using the setup shown in Figure 1. The signals used were:

- (1) 64 KB/s QPSK
- (2) 1.544 Mb/s (T1) QPSK
- (3) 27.5 Mb/s QPSK

The video signal is fed into a frequency agile modulator which is set to a frequency of 270 MHz corresponding to channel 6 in the Cellular Vision frequency plan. The output FM modulated signal is combined with the interferer in a standard CV upconverter (Model CUC-1000). The output of the L band combiner is up converted again to 28 GHz and transmitted through a short distance to a standard Cellular Vision LNB and set top demodulator. The video output of the demodulator is delivered to a video monitor and a Tektronix VM700A.

Test Procedures

During the tests the C/N of the video signal was set at 31 dB or 15 dB, the interferer signal frequency offset from the desired signal was set at a value from -10 MHz to +10 MHz and its level was adjusted in 2 dB steps from 30 dB to 0 dB. This procedure was repeated for each offset frequency and for each interferer modulation type, with the resulting data for each case, forming a matrix like table with interferer offset from the FM carrier on one axis and C/I on the other. As the interferer level was adjusted the unweighted and NTC-7 weighted SNR were recorded in the matrix along with an

carrier on one axis and C/I on the other. As the interferer level was adjusted the unweighted and NTC-7 weighted SNR were recorded in the matrix along with an observation and judgment of picture quality made by the operating engineer. The picture quality was rated on a TASO SNR/quality scale shown on page 9 of the detailed test procedure in Appendix A. It should be noted that although the tests were conducted with care and every effort was made to objectively rate the picture quality the results probably do not have the accuracy that would result from the use of expert viewers and the more elaborate procedures generally used for such tests. The tests were repeated at least twice for each case and the lower score was used in those few cases where conflicting data was obtained.

Test Results

Several general observations can be made from the data which is presented in the following six tables.

- (1) The interference depends fairly strongly on the offset of the interferer from the center of the desired signal frequency band, with center of the band and the area of +/- 4 MHz offset being particularly sensitive. SNR ranges of 10 to 12 dB are not uncommon across the frequency offset for a particular value of C/I.
- (2) The lower frequency interferers appear, subjectively, to cause slightly worse interference at given C/I than the higher frequency interferers. This is most easily seen by comparing the 0 MHz offset interference from the 64 Kb/s signal to the same offset 27.5 Mb/s interferer, where the change from a passable to a marginal quality takes place at 14 dB and 10 dB C/I respectively for 31 dB C/N.
- (3) The value of C/I for which the weighted SNR drops to 42+/-1 dB, which represents the minimum acceptable SNR for the Cellular Vision system, occurs at the levels listed below.

<u>Data Rate</u>	<u>C/I</u>	
	<u>31 dB C/N</u>	<u>15 dB C/N</u>
64Kb/s	12 dB	12 dB
1.5Mb/s	12 dB	12 dB
27.5 Mb/s	6 dB	6 dB

These values again show that the system is more tolerant of interference at the higher data rates.

- (4) Figure 2 shows three plots of C/I against the offset of the interfering signal center frequency to that of the wanted FM signal for three values of unweighted video SNR. In all cases the C/N was 31 dB. Each set of plots represents a different interfering signal ranging from 64 Kb/s to 27.5 Mb/s.

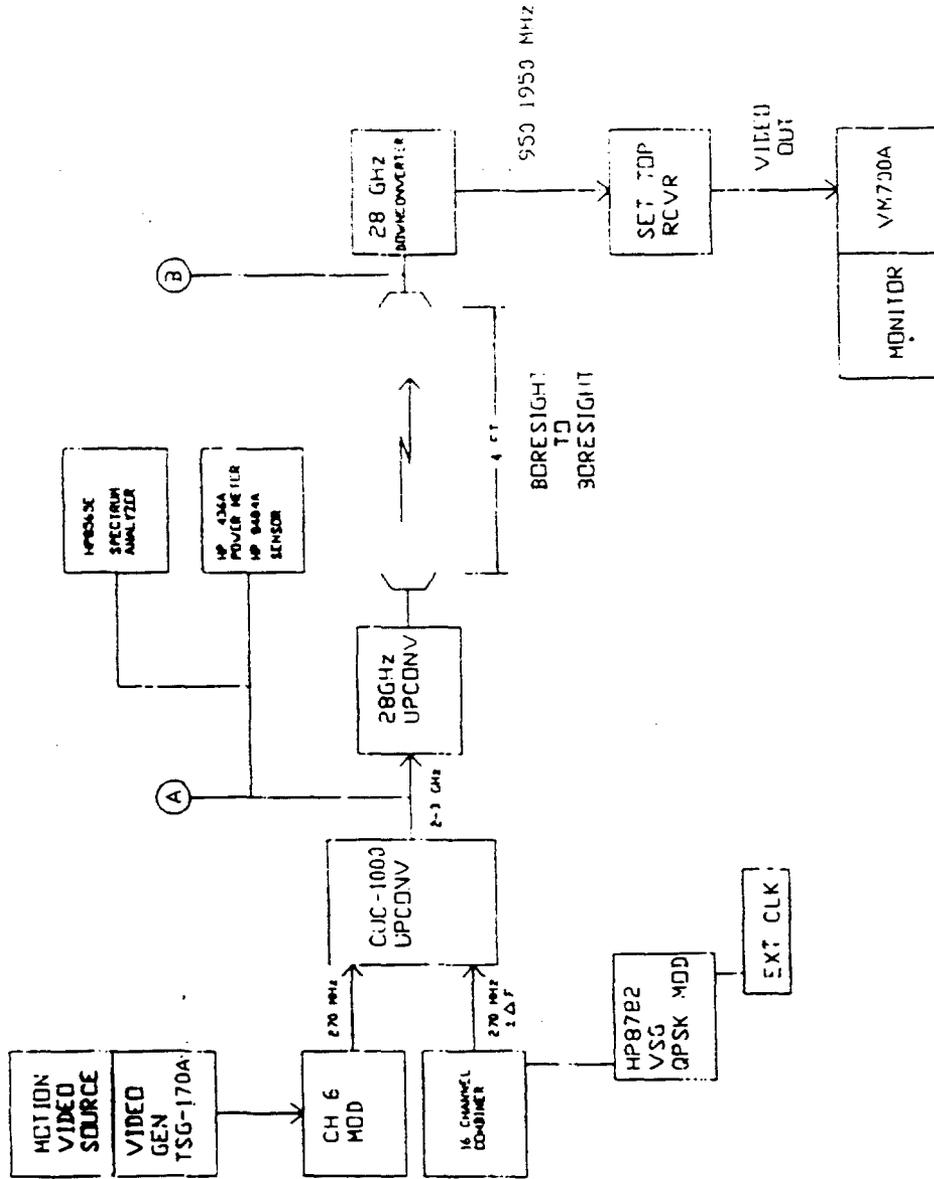
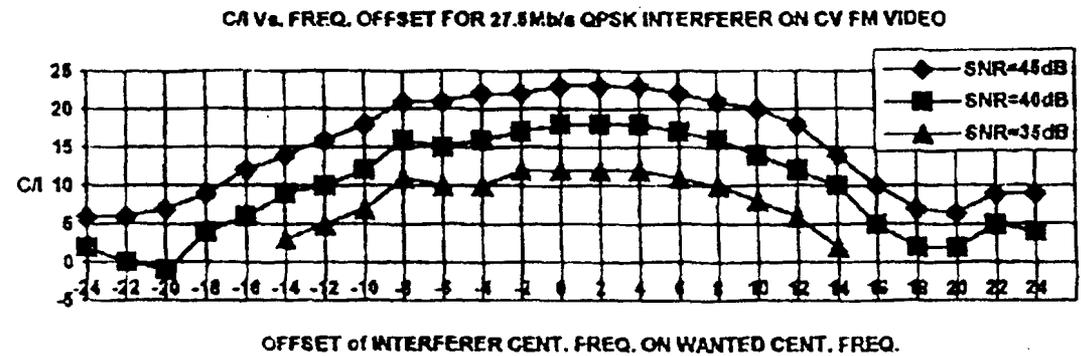
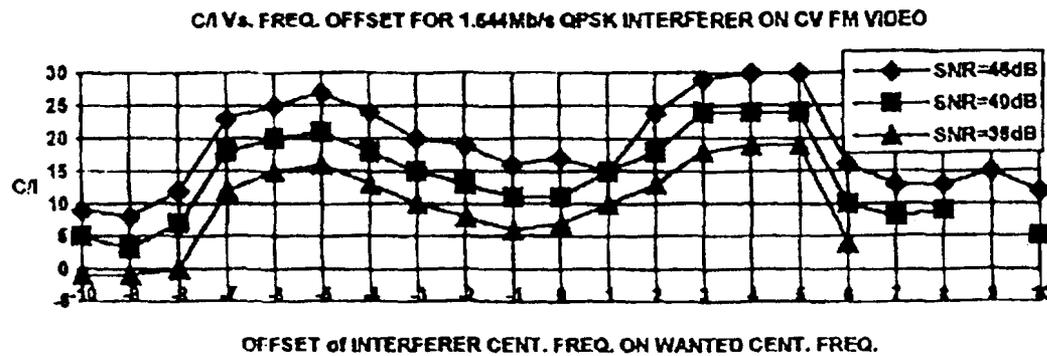
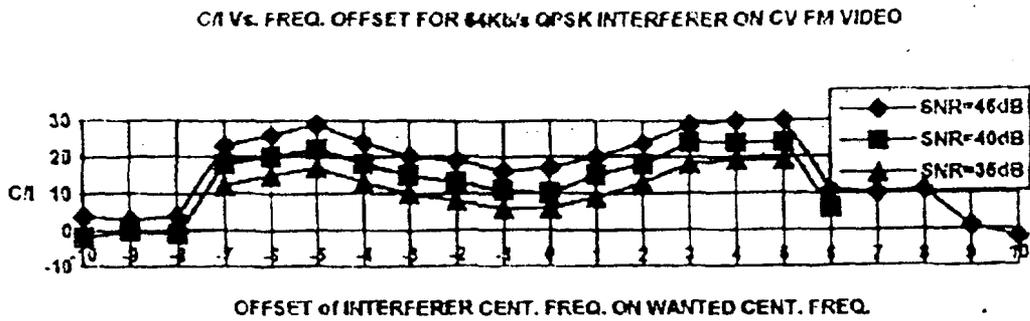


FIGURE 1: TEST SETUP

The system is designed for a fringe area reception weighted SNR of 55 dB, so the 45 dB unweighted SNR values shown in the plots of Figure 2 may also be interpreted as clear sky protection ratios.

Figure 2 C/I TO YIELD DESIRED UNWEIGHTED SNR FOR QPSK INTERFERER ON CV FM VIDEO



EFFECT OF INTERFERER SIGNAL ON FM CARRIER

INTERFERER TYPE: GFSK 64 / 64 KBIT/S

INTERFERER FREQUENCY OFFSET FROM FM CARRIER (KHZ)

	10	0	-6	-7	8	5	-4	-2	2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
-30	-	-	50	50	48	47	50	51	52	52	52	51	49	48	45	45	53	-	-	-	-
-28	-	-	52	48	47	48	49	50	51	52	52	50	49	44	44	44	53	-	-	-	-
-25	-	-	53	47	45	44	47	49	50	51	50	49	47	43	42	42	52	52	52	-	-
-24	53	53	53	48	44	42	45	48	49	50	50	48	45	40	40	40	52	53	52	-	-
+22	52	52	52	44	42	40	44	43	47	48	49	48	43	38	38	38	52	52	51	53	53
+20	53	53	52	42	40	38	42	45	48	48	48	45	42	37	36	36	51	52	51	53	53
+18	53	53	52	40	38	36	40	43	44	45	45	43	40	35	34	34	51	51	50	52	53
+16	52	52	52	38	35	34	38	42	43	45	44	41	38	33	32	32	51	50	50	48	53
+14	52	52	51	36	34	32	36	39	41	43	43	39	36	31	30	30	48	50	49	48	50
+12	51	52	50	35	32	30	34	37	39	41	41	38	34	29	28	28	46	48	48	47	47
+10	50	51	48	33	30	28	32	35	37	38	40	38	32	27	26	26	44	45	42	48	49
+8	49	49	48	31	28	26	30	33	35	38	37	33	30	24	25	24	42	43	40	48	47
+6	47	48	46	29	26	25	28	30	33	35	35	31	28	23	22	22	40	42	40	47	48
+4	46	46	45	27	24	22	26	28	30	34	33	28	26	15	24	22	39	42	42	48	48
+2	43	44	43	26	22	21	24	25	28	31	30	18	18	18	18	18	18	18	18	47	47
0	42	40	41	25	21	18	23	23	18	18	18	18	18	18	18	18	18	18	18	42	48

VIDEO SOURCE: COLOR BAR
CARRIER-NOISE RATIO (C/N): 31 dB

EFFECT OF INTERFERER SIGNAL ON FM CARRIER

INTERFERER TYPE: GPRX-64 (64 KB/S)

INTERFERER FREQUENCY OFFSET FROM FM CARRIER (MHz)

C/N RATIO (DB)	INTERFERER FREQUENCY OFFSET FROM FM CARRIER (MHz)																				
	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
+30	-	-	-	-	41	41	41	41	41	41	41	41	41	40	41	40	-	-	-	-	-
+28	-	-	-	-	55	54	55	55	55	55	55	55	55	55	55	55	-	-	-	-	-
+26	-	-	-	-	40	40	40	40	40	41	41	41	41	40	40	40	-	-	-	-	-
+24	-	-	-	40	40	39	40	41	40	41	41	41	41	39	39	39	41	-	-	-	-
+22	-	-	41	40	39	38	39	40	40	40	40	40	40	37	37	37	41	41	41	41	41
+20	41	41	41	38	37	36	36	40	40	40	40	40	40	38	38	38	41	41	41	41	41
+18	55	55	55	54	55	51	51	52	51	49	52	52	51	50	55	55	55	55	55	54	54
+16	41	41	41	37	36	35	37	39	40	40	40	39	38	34	34	34	41	40	41	41	41
+14	55	55	55	55	55	50	50	50	50	48	51	50	50	48	54	55	54	54	54	54	54
+12	41	41	40	35	35	33	35	35	38	38	38	38	37	33	32	32	41	40	40	41	41
+10	55	55	54	54	55	48	48	48	48	47	50	49	49	47	54	54	54	54	53	52	53
+8	41	41	40	33	31	30	33	35	36	38	38	38	37	35	31	31	41	40	40	42	40
+6	55	55	54	54	54	47	47	48	48	48	49	49	47	45	54	53	53	53	52	52	53
+4	41	41	40	33	31	30	33	35	36	38	38	38	37	35	31	31	41	40	40	42	40
+2	55	55	54	54	54	48	48	48	48	47	50	49	49	47	54	54	54	54	53	52	53
0	41	41	40	33	31	30	33	35	36	38	38	38	37	35	31	31	41	40	40	42	40
	55	55	54	54	54	47	47	48	48	48	49	49	47	45	54	53	53	53	52	52	53

VIDEO SOURCE: COLOR BAR
CARRIER/NOISE RATIO (C/N): 15 dB

DATA: SNR UNWEIGHTED / SNR NTC-7 WEIGHTING / TASO SUBJECTIVE SCORE

EFFECT OF INTERFERER SIGNAL ON FM CARRIER

INTERFERER TYPE: QPSK-T1 (11.544 MB/S)

INTERFERER FREQUENCY OFFSET FROM FM CARRIER (MHz)

	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
+30	-	-	53	51	48	47	50	51	52	52	52	51	48	48	45	45	52	-	-	-	-
	-	-	54	54	54	52	51	52	51	51	51	51	50	53	54	54	54	-	-	-	-
	-	-	E	E	F	F	F	E	E	E	E	E	F	F	F	F	E	-	-	-	-
+28	-	-	52	48	47	48	48	50	51	52	52	50	48	44	44	44	52	-	-	-	-
	-	-	54	54	54	51	50	50	53	53	50	50	53	53	53	54	54	-	-	-	-
	-	-	E	F	F	F	F	F	E	E	E	F	F	F	F	F	E	-	-	-	-
+26	-	-	52	47	46	44	47	48	50	51	50	48	47	43	42	42	51	52	52	-	-
	-	-	54	54	53	53	53	53	53	53	53	53	53	53	53	54	54	54	54	-	-
	-	-	E	F	F	F	F	F	F	F	F	F	F	F	F	F	E	E	E	-	-
+24	53	53	51	48	44	42	45	48	49	50	50	48	46	40	40	50	52	52	-	-	-
	54	54	54	54	53	53	53	53	53	53	53	53	53	54	54	54	54	54	-	-	-
	E	E	E	F	F	F	F	F	F	F	F	F	F	P	P	F	F	E	E	-	-
+22	52	52	51	44	42	41	44	48	47	43	43	44	43	39	38	38	48	51	51	52	52
	54	54	54	53	53	53	53	53	53	54	54	54	54	53	53	53	53	53	53	53	54
	E	E	E	F	F	F	F	F	F	F	F	F	F	P	P	P	F	E	E	E	E
+20	52	52	51	42	40	39	42	45	46	48	48	45	42	37	36	36	48	50	51	51	52
	54	54	54	53	52	52	53	54	53	53	54	54	53	51	51	52	51	52	53	53	54
	E	E	E	F	F	P	P	F	F	P	P	F	F	P	P	F	F	F	F	E	E
+18	52	51	48	40	38	37	40	43	44	48	48	43	40	35	34	34	47	48	50	50	51
	54	54	53	52	51	51	52	52	51	51	53	52	51	48	48	50	51	50	51	52	53
	E	E	F	P	F	P	P	P	F	P	P	P	F	P	P	P	F	F	F	F	E
C/N RATIO (DB)	+16	51	50	48	38	38	35	38	41	43	45	44	41	38	33	32	32	45	47	48	49
		53	53	53	51	50	51	49	48	48	51	50	48	47	43	43	43	50	50	50	52
		E	F	F	P	P	P	P	P	P	P	P	P	M	P	P	P	F	P	F	F
	+14	50	50	47	38	34	33	36	38	41	42	43	39	36	31	30	31	43	47	48	48
		53	53	52	51	51	49	48	48	47	49	48	47	45	57	57	57	57	57	57	57
		F	F	P	P	P	M	P	M	M	M	P	P	M	M	M	P	P	P	P	F
	+12	48	48	48	38	32	31	34	37	32	41	41	37	34	28	28	42	44	43	43	45
		51	52	51	53	57	47	46	47	45	46	47	48	45	43	55	54	54	53	53	55
		F	F	P	M	P	M	M	P	P	M	M	P	P	M	M	P	P	P	P	F
	+10	47	47	43	33	30	28	32	35	37	38	38	35	32	27	26	27	40	42	41	43
		50	51	50	58	55	46	44	46	43	43	44	43	41	53	52	51	52	50	52	54
		F	F	P	M	P	M	M	P	M	M	P	M	M	I	I	M	P	P	F	F
	+8	44	46	42	31	28	27	30	33	35	37	37	33	30	24	26	26	38	40	38	42
		52	55	55	56	54	43	42	43	41	41	43	42	41	38	51	48	48	48	48	51
		P	P	P	M	M	M	I	M	P	M	I	M	M	I	I	I	M	M	M	P
	+6	42	44	39	29	28	25	28	30	33	35	34	31	27	23	23	33	38	38	38	41
		48	57	58	53	52	41	40	41	38	38	41	40	38	36	48	43	44	47	47	50
		P	P	M	I	M	M	I	M	M	I	I	M	M	I	I	I	M	M	M	P
	+4	39	41	37	27	24	23	26	28	30	33	32	28	25	15	23	23	35	37	38	41
		45	53	53	51	50	38	38	38	37	37	38	38	38	15	47	42	43	46	46	53
		P	P	M	I	M	I	I	M	I	I	I	I	I	LS	I	I	I	I	I	M
	+2	38	38	36	25	23	21	24	26	28	31	LS	41								
		43	48	49	47	47	37	38	38	35	35	LS	52								
		M	M	I	I	I	I	I	I	I	I	LS	M								
	0	38	38	35	24	21	19	23	23	LS											
		41	45	48	43	44	35	34	34	LS											
		M	M	I	I	I	I	I	I	LS											

VIDEO SOURCE: COLOR BAR
CARRIER/NOISE RATIO (C/N): 31 dB

DATA: SNR UNWEIGHTED / SNR NTC-7 WEIGHTING / TASA SUBJECTIVE SCORE

EFFECT OF INTERFERER SIGNAL ON FM CARRIER

INTERFERER TYPE: OPEX-T1 (1.544 MHz)

INTERFERER FREQUENCY OFFSET FROM FM CARRIER (MHz)

	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	+1	+2	+3	+4	+5	+6	+7	+8	+9	+10
+30	-	-	-	-	41	41	41	41	41	41	41	41	41	40	41	40	-	-	-	-	-
+28	-	-	-	-	55	55	55	55	55	55	55	55	55	54	55	55	-	-	-	-	-
+26	-	-	-	41	40	39	40	41	40	41	41	41	41	39	39	38	41	-	-	-	-
+24	-	-	-	55	55	53	53	54	54	54	54	54	54	53	55	55	55	-	-	-	-
+22	-	-	-	41	38	38	38	40	40	41	41	40	40	38	38	38	41	-	-	-	-
+20	41	41	41	39	37	36	33	40	40	40	40	40	38	36	36	41	41	41	41	41	41
+18	55	55	55	55	55	52	51	52	51	48	52	52	51	50	55	55	55	55	55	55	55
+16	41	41	41	38	36	33	38	38	38	38	38	38	37	33	32	32	40	40	40	41	41
+14	41	41	40	35	33	32	34	37	38	38	38	37	36	31	31	31	38	40	40	41	40
+12	41	40	40	33	31	30	33	35	38	38	38	36	33	28	28	28	38	40	40	41	41
+10	40	40	38	31	28	28	31	34	35	37	37	34	32	28	27	27	38	38	38	41	41
+8	40	38	38	30	27	28	28	32	34	36	36	33	30	28	28	28	36	37	38	41	42
+6	38	33	37	28	26	24	27	30	32	34	34	31	28	24	24	24	36	38	37	41	41
+4	38	37	36	28	24	22	25	27	29	32	32	28	28	23	23	23	34	36	37	40	42
+2	38	38	33	26	22	20	23	25	28	30	30	28	26	23	23	23	34	36	40	41	41
0	35	34	24	24	LS	37															

VIDEO SOURCE: COLOR BAR
CARRIER/NOISE RATIO (C/N): 16 dB

DATA: SNR UNWEIGHTED / SNR NTC-7 WEIGHTING / TASSO SUBJECTIVE SCORE