



Communications Research Centre



AN EVALUATION OF THE PERFORMANCE OF 12 GHz
LOW COST TVRO TERMINALS IN NORTHWESTERN ONTARIO

by

R.W. HUCK AND E.L. PERRIER

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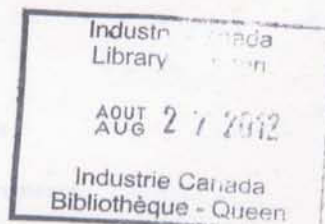
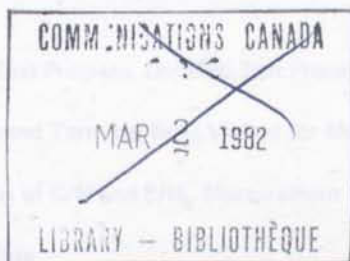
DEPARTMENT OF COMMUNICATIONS
CANADA

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(Space Technology and Applications Branch)



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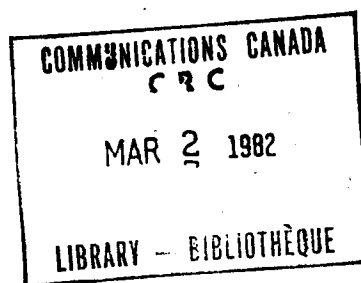
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TABLE OF CONTENTS

ABSTRACT	1
1. INTRODUCTION	1
2. THE TEST PROGRAM	3
3. OPERATIONAL CONSIDERATIONS	4
4. SUMMARY AND ANALYSIS OF TEST RESULTS	8
4.1 Polarization Angle Error	9
4.2 Antenna Pointing Errors	10
4.3 Noise Figures	13
4.4 Carrier-to-Noise Ratio and Signal-to-Noise Ratio	15
4.5 Baseband Distortions	21
4.6 IF Bandpass Response and AFC Operation	23
4.7 Remodulator Response	24
5. SUMMARY AND RECOMMENDATIONS	26
6. ACKNOWLEDGEMENT	28
APPENDIX A — LCET Evaluation Test Program, Detailed Test Procedures	29
APPENDIX B — Field Notes on Ground Terminal Sites Visited for Measurements	55
APPENDIX C — Method for Analysis of C/N and S/N _v Measurement Data	61
APPENDIX D — Condensed Field Data	67



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ABSTRACT

ANIK-B has been used since September 1979 in a Program Delivery Pilot Project to test the direct satellite transmission of TV signals to low cost TVRO terminals (LCET's) to determine the technical performance of these terminals over a long period, the ability of users to operate the terminals, and the acceptability of the signals received. 43 LCET's which have been installed in Northwestern Ontario, receive programs of the Ontario Educational Communications Authority. In October 1980, a detailed technical evaluation was made of the performance of 25 of the terminals. This report describes the procedures used to make the on-site measurements and documents the results obtained.

1. INTRODUCTION

The ANIK-B program delivery pilot project has afforded an ideal opportunity to evaluate the technical and operational performance of a Low Cost Earth Terminal (LCET) designed for reception of satellite television broadcast signals. Since the beginning of the project in September 1979, 43 LCET's have been installed in Northwestern Ontario to receive programs transmitted by the Ontario Education Communications Authority (OECA), while 36 terminals have been installed in British Columbia to receive programs provided by the Canadian Broadcasting Corporation (CBC) and British Columbia TV (BCTV). Some of the terminals have now been operating for more than one year.

A test program was established to evaluate the technical performance of 25 terminals used in the OECA project. In October 1980, a vehicle equipped with specialized test equipment was taken to each of the 25 sites where detailed performance measurements were made using both satellite signals and test signals generated using the test equipment.

The map in Figure 1 shows the contours of EIRP for the ANIK-B satellite as well as the sites where LCETs were located. The sites where the evaluation was carried out were selected to ensure that:

- (a) the evaluation included both 1.2m and 1.8m diameter terminals inside the 49.5 dBW EIRP contour and between the 46.5 and 49.5 dBW EIRP contour,
- (b) measurements of terminal performance were made across the spacecraft east-central beam pattern,
- (c) a variety of users were sampled, including private homes, cable head ends and Master Antenna TV (MATV) systems; some with reasonable alternate service and others with no or very limited alternate service, and,
- (d) the terminals were readily accessible by road.

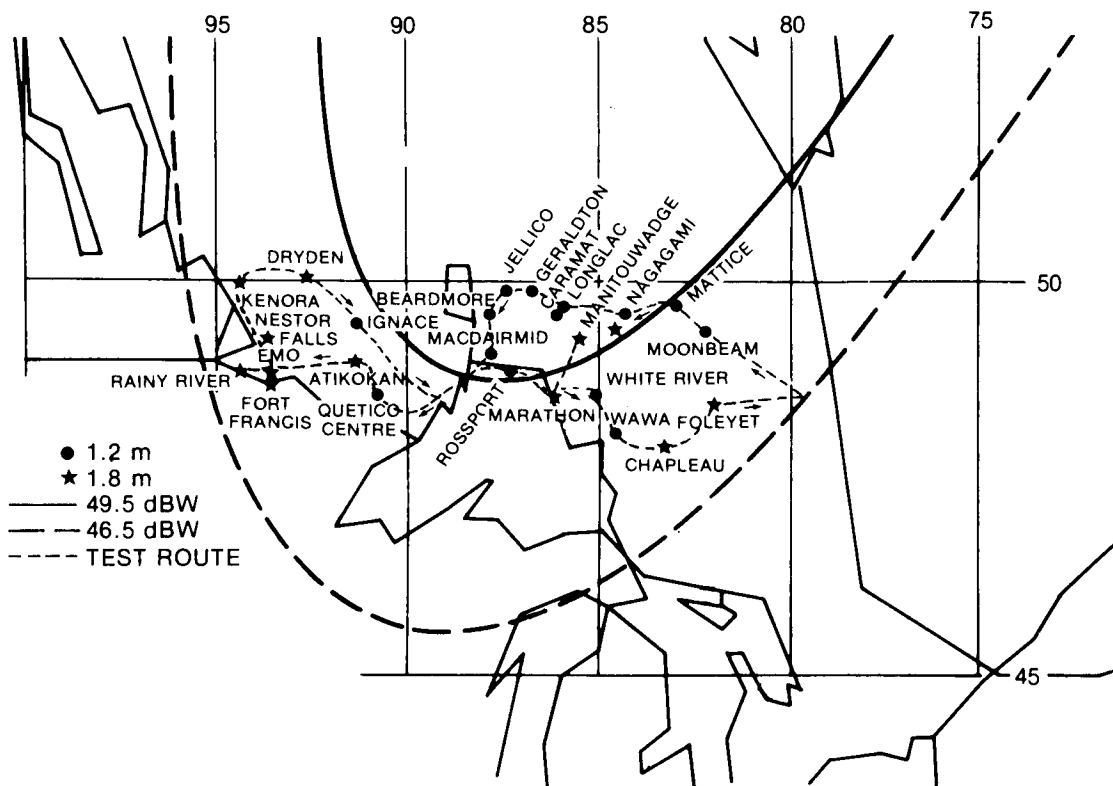


Figure 1. LCET Test Sites and Test Route

This report describes the state of the terminals upon arrival at the site, the accuracy and care of installation and alignment, the types of foundations, and the detailed performance determined from measurements of satellite signals and bench-type tests. Where possible, comparison is made with theoretical predictions, and with test results obtained at pre-delivery checks.

2. THE TEST PROGRAM

A detailed test plan (attached as Appendix A) was prepared to ensure uniformity of measurement procedures. The testing was fairly comprehensive and involved opening the indoor unit (IDU) to obtain access to the low IF circuits. The tests were divided into two sections: (a) satellite tests, and (b) bench tests. The satellite tests were used to check antenna alignment, receiver carrier-to-noise ratio (CNR) with a saturated carrier, receiver carrier-to-noise and baseband signal-to-noise ratios (SNR) for the OECA signal, and baseband distortion parameters for the OECA signal. Bench tests were then conducted to determine the system noise temperature, the SNR for video and audio as a function of CNR, pre-detection filter response, Automatic Frequency Control (AFC) lock-up performance, baseband distortion with TV test signals, and the VHF remodulator spectrum.

In some instances, satellite time was not available to provide a saturated carrier. In this case, alignment errors were determined from the OECA signal.

In general, the daily schedule for conducting the tests was to arrive at the site sufficiently early to set up the test van before satellite signals became available. This included moving the van to the new site, gaining access to the IF interfaces inside the IDU and warming up the receiver. An alternate interface cable was used between IDU and ODU to preclude a requirement to recover the cable from the user's installation.

Upon reception of the saturated satellite test signal, the CNR and alignment tests were carried out. Later, when OECA test signals were available, the remainder of the satellite related performance tests were done. The ODU was then moved inside the van and mounted in the ODU test jig to permit the bench tests to be done.

During the conduct of these tests, several difficulties were encountered in obtaining repeatable measurements from site to site. These will be referred to in the measurement analysis section (Section 4). However, one of the most common, which particularly limited the accuracy, was the difficulty of accurately measuring CNR in the RF bandwidths of the IDU. A carrier-to-noise density measurement was not sufficient due to variations in the IF filter bandpass characteristics between the IDU's. Indeed, even in a single IDU, the amplitude response of the filter changed with tuning. Some attempts were made to correct this in the measurement procedure.

A second difficulty encountered was the varying modulation level received from the OECA test signal. By later analysis, it was possible to correct for this variation by normalizing to a reference of 6.0 MHz peak deviation.

A further problem which affected some of the OECA test signal measurements, was the presence of digital Telidon Data signals on lines in the vertical interval. In itself, this was not so much of a problem except that the location of these data was often shifted around. The Marconi video test instrument was not sufficiently versatile to re-program it each time this occurred. Consequently, some data were lost.

A motor-home van equipped with a suitable set of test equipment and test jigs was used to visit the sites. It proved to be a very workable and consistent way of operating. A photograph of the van is shown in Figure 2. Figure 3 shows the equipment mounted inside. The test set-ups and a list of test equipment are provided in the test procedures contained in Appendix 1.

It should be noted that all sites visited were accessible by road and, in fact, were sufficiently close together that a different site could be reached and tested each day. Figure 1 shows the route which was followed.

3. OPERATIONAL CONSIDERATIONS

Some of the most useful and instructive results from this test program were the general observations made at each individual site. To the extent possible the types of data recorded included:

- (a) the application of the LCET, i.e., home receiver, cable head-end, Master Antenna (MATV), etc.,
- (b) the general physical condition of the LCET,
- (c) the qualitative electrical performance of the LCET,
- (d) the manner in which it was connected to user facilities, etc., TV set, distribution amplifier, etc.,
- (e) the type and construction of the foundation and the location of the installation, and
- (f) a description by the user of any operating difficulties.

Foundations for the antennas varied. In some cases, the mount was set simply on the ground and weighted down by sand or bricks; in others, it was set on a platform at the side of huts or on a wooden base, etc. For a complete record, a photograph was taken of each site and included as part of the raw data sheets (kept on file). Figures 4 to 6 show installations at Mattice (a cable head-end), Atikokan (a cable company roof-top installation) and Foleyet (a home installation). In only one known instance, Manitouadge, was the antenna actually blown over onto its face, thus damaging the cable to the ODU and bending the struts holding the ODU.

Table 1 contains a summary of the operational condition of the 25 LCET's upon arrival and upon departure. Since most of the LCET's were working reasonably well, only the more obvious malfunctions are described here.



Figure 2. LCET Test Van



Figure 3. Test Equipment Inside Test Van



Figure 4. Mattice — A Cable Head-End



Figure 5. Atikokan — A Cable Company Roof Top Installation



Figure 6. Foleyet — A Home Installation

TABLE 1

Summary of General LCET Performance

Not Working or Problems on Arrival/Repaired/ Functional on Departure	Functional	Not Functional	Functional with Problems
Moonbeam Quetico Centre Nestor Falls Ignace Foleyet Rainy River	Mattice Nagagami Geraldton Longlac MacDiarmid Atikokan Kenora Dryden Beardmore Marathon White River Chapleau Fort Frances Emo Rossport	Caramat	Jellico Manitouwadge Wawa

- (a) *Moonbeam* - Failed due to severe external physical damage to interface cable, which consequently shorted and resulted in burn-out of a series regulator resistor in the IDU power supply. This was repaired and the LCET was returned to operational status prior to testing.
- (b) *Quetico Centre* - The automatic frequency control (AFC) was malfunctioning.
- (c) *Nestor Falls* - Significant distortion and noise was visible on the Channel 3 remodulator output. By tuning input coils, Channel 3 was improved to a point where negligible distortion was visible. Channel 4 could not be improved in spite of previous operation in Channel 4.
- (d) *Ignace* - Semi-rigid cable at the ODU had been repaired but it subsequently shorted, damaging, as at Moonbeam, the series regulator resistor. The unit was repaired and made operational prior to testing.
- (e) *Foleyet* - Hum on the video signal, caused by low voltage to ODU, was repaired and the unit was tested.
- (f) *Rainy River* - The ODU was not operational and was replaced.
- (g) *Caramat* - AFC was not functional. Further investigation showed that the discriminator was not working properly. The unit could not be repaired in the field.
- (h) *Jellico* - The ODU overheated at high ambient temperatures. A cure was to wrap a cold cloth around it.
- (i) *Manitowadge* - The discriminator was not working properly.

Appendix 2 contains a description of general operating conditions and environment for each individual site.

It should be noted that some of the difficulties with terminal performance were traced, at least for the first two sites, to incorrect modulation levels at the OECA TV uplink in Toronto. At Moonbeam and Mattice considerable distortion in the video occurred due to intermodulation products which resulted from the audio subcarrier being set approximately 8 dB too high.

4. SUMMARY AND ANALYSIS OF TEST RESULTS

This Section describes and analyzes the results of the measurements made for each test as described in Appendix A. The raw data collected from the 25 sites are condensed in the Tables of Appendix D. It should be noted that considerable analysis was done on the raw data in order to attempt to remove erroneous measurements to the maximum extent and to normalize the measurements to a common reference, particularly the CNR and SNR measurements, so that a reasonable comparison of LCET performance could be made.

Although weather conditions at the sites and at the uplink terminal were recorded, their effects were not factored into the analysis since the magnitude of the effects would have had to be estimated. No significant storms occurred during the measurements in any case, and the primary variation was the degree of cloud cover.

The order of presentation of these results differs somewhat from that of the test procedures, since, in some cases, several tests are required to provide inputs for data analysis. Hence, this Section contains the results for:

- (a) Polarization angle error
- (b) Pointing errors (antenna alignment)
- (c) Noise figure
- (d) CNR and SNR for video and audio signals for both satellite tests and bench tests
- (e) Baseband distortions
- (f) IF bandpass response and AFC operation
- (g) Remodulator response

4.1 POLARIZATION ANGLE ERROR

Attached to the test procedures of Appendix A is a listing of computed polarization angles that apply to the LCET locations. The actual polarization angles were checked against these values and adjusted as required. Most of the original installations were made by DOC regional or district office staff with a brief training period. Since polarization angles are not critical, unless gross errors occur, the accuracy of initial installation was not stressed. The received signal power for a linearly polarized signal is proportional to the cosine of the angle between the incident signal and receiver feed orientation. For example, an error offset of 15° would reduce the signal power by:

$$20 \log \left(\frac{1}{\cos 15^\circ} \right) = -0.30 \text{ dB.}$$

Polarization errors will have significant impact when there is frequency re-use in the same coverage zone and polarization discrimination is used as the mechanism to provide isolation. For example, for two equal level signals transmitted on orthogonal polarizations, a polarization error of 15° would mean that the unwanted signal would be approximately 12 dB below the desired signal - an unacceptable level of interference. ANIK-B does not employ frequency re-use. However, with a satellite such as ANIK-C where frequency re-use is employed, considerable care will need to be taken in setting the polarization correctly.

Table 2 shows the errors determined at the 25 test sites. The mean error was 7.1° with a standard deviation of 5.5° . However, since little attempt was made to set this angle accurately, there is no means by which a check can be made for an error mechanism.

TABLE 2
Polarization Angle Errors

Site	Calculated Polarization Angle* (Degrees)	Actual Polarization Angle (Degrees)	Error (Degrees)	Signal Loss (dB)
1. Moonbeam	20	8	12	0.20
2. Mattice	20.3	21	-0.7	0.00
3. Nagagami	19.5	8	11.5	0.18
4. Jellico	17.2	8	9.2	0.12
5. Geraldton	17.6	12	5.6	0.04
6. Longlac	18.7	10	8.7	0.10
7. Caramat	18.7	----	-----	-----
8. MacDiarmid	17.3	18	-0.7	0.00
9. Quetico Centre	15.3	20	-4.7	0.02
10. Atikokan	14.6	11	3.6	0.02
11. Fort Frances	12.9	13	0.1	0.00
12. Emo	13	11	2.0	0.00
13. Rainy River	12.3	----	-----	-----
14. Nestor Falls	12.7	5.5	7.2	0.06
15. Kenora	11.9	27.5	-15.6	0.32
16. Dryden	13.2	9.2	4.0	0.02
17. Ignace	14.4	-1.0	15.4	0.32
18. Beardmore	18.9	20	-1.1	0.00
19. Rossport	17.8	14	3.8	0.00
20. Manitouwadge	18.9	26	-7.1	0.06
21. Marathon	18.6	19	-0.4	0.00
22. White River	19.6	36	-16.4	0.36
23. Wawa	20.3	3	17.3	0.40
24. Chapleau	18.8	28	-9.2	0.18
25. Foleyet	21.8	14	7.8	0.08

* Referenced clockwise from vertical looking towards satellite

4.2 ANTENNA POINTING ERRORS

The antenna pointing accuracy at each site was measured (using either the saturated CW carrier or the OECA signal from the satellite) by moving the antenna to peak the detected signal level and, from the change in signal level, calculating the angular error. Table 3 gives the measured pointing error for each of the sites. It should be noted that both 1.8m and 1.2m antenna sizes

are involved. The corresponding 3 dB beamwidths are 0.9° and 1.4° respectively. For reference, Figure 7 shows theoretical antenna patterns for the two sizes of reflectors. Included in Table 3 are the maximum theoretical CNR values for each terminal, based upon the measured noise figure, the location in the satellite footprint and the antenna size.

TABLE 3
Antenna Pointing Errors

Site	Change in Peak Signal (dB)	Antenna Diameter (m)	Beamwidth (Degrees)	Error (Degrees)	Max. Theoretical CNR
1. Moonbeam	1.8	1.2	1.4	0.54	11.2
2. Mattice	0.5	1.2	1.4	0.29	13.4
3. Nagagami	0.2	1.2	1.4	0.18	12.9
4. Jellico	1.2	1.2	1.4	0.44	14.4
5. Geraldton	2.0	1.2	1.4	0.57	14.1
6. Longlac	0.25	1.2	1.4	0.20	13.9
7. Caramat	-----	1.2	1.4	-----	13.5
8. MacDiarmid	-0.25	1.2	1.4	-0.20	11.3
9. Quetico Centre	0.25	1.2	1.4	0.20	11.3
10. Atikokan	2.0	1.8	0.9	0.39	15.5
11. Fort Frances	0	1.8	0.9	0.00	14.5
12. Emo	1.0	1.8	0.9	0.27	15.3
13. Rainy River	1.0	1.8	0.9	0.27	13.5
14. Nestor Falls	1.15	1.8	0.9	0.29	15.2
15. Kenora	1.0	1.8	0.9	0.27	14.0
16. Dryden	0.15	1.8	0.9	0.10	15.3
17. Ignace	0.85	1.2	1.4	0.37	13.2
18. Beardmore	0.3	1.2	1.4	0.22	11.7
19. Rossport	-0.2	1.2	1.4	-0.18	11.9
20. Manitouwadge	0.1	1.8	0.9	0.08	15.6
21. Marathon	0.1	1.8	0.9	0.08	15.9
22. White River	0.9	1.2	1.4	0.38	11.5
23. Wawa	1.15	1.2	1.4	0.43	11.8
24. Chapleau	1.65	1.8	0.9	0.34	14.6
25. Foleyet	0.25	1.2	1.4	0.20	11.2

Ten terminals were operating with pointing errors which resulted in a signal loss equal to or greater than 1.0 dB. Of these 10, only 2 terminals, Moonbeam and Wawa, did not have significant margin and indeed, were likely operating near their thresholds. Both of these terminals were installed at private homes. Of the remaining terminals, the pointing error losses were not detectable subjectively in isolation without a reference for comparison. Hence, the users did not feel a need to improve pointing. Two terminals had pointing losses equal to or greater than 2 dB, both of which were used for CATV.

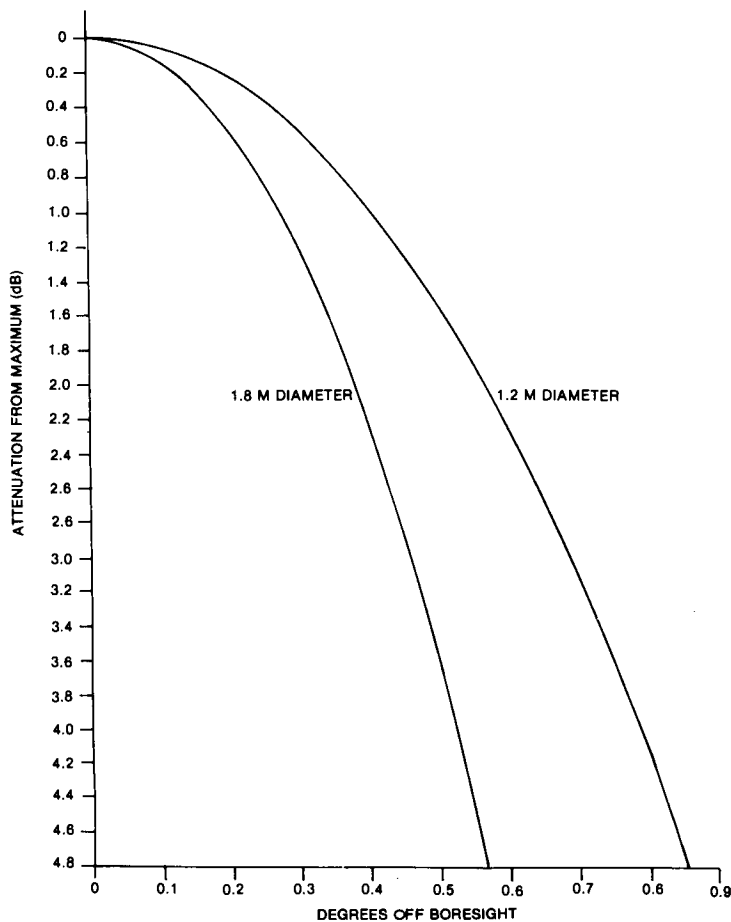


Figure 7. Theoretical Antenna Patterns for LCET Reflectors

Average pointing errors were as follows: (averaged linearly)

	Mean (dB)	Standard Deviation (dB)
1. All Terminals Combined	0.78	0.20
2. All 1.2m Terminals	0.71	0.20
3. All 1.8m Terminals*	0.88	0.21
4. All Terminals within 49.5 dBw EIRP Contour	0.51	0.22
5. All Terminals between 49.5 and 46.5 dBw EIRP Contours	0.91	0.18
6. All Terminals used for Home use	0.78	0.18
7. All Terminals used for MATV or Cable Head-Ends	0.83	0.22

* Note that except for Manitowadge, all 1.8m terminals were outside the 49.5 dBw EIRP contour.

The data in the preceding summary can be examined in several ways. Although the number of terminals involved may not be statistically significant, some general conclusions can be drawn. For example, it appears that losses associated with the 1.8m terminals are higher on the average, as one would expect. There appears to be a significantly greater pointing error outside the 49.5 dBw EIRP contour than inside. However, this is consistent with the fact that all but one of the 1.8m terminals are located outside the 49.5 dBw EIRP contour. It is also interesting to note that terminals employed for private home use are, on the average, better aligned than cable head-end and MATV terminals.

A further column in Table 3 shows the pointing error as a function of degrees rather than dB loss. The mean and standard deviation for the pointing errors expressed in degrees are as follows:

	Mean (deg.)	Standard Deviation (deg.)
1. All Terminals Combined	0.24	0.20
2. All 1.2m Terminals	0.26	0.23
3. All 1.8m Terminals	0.21	0.13

Although only a few terminals are involved, the averages indicate that 1.8m terminals are not only pointed more accurately, but that the pointing is more consistent. However, with the increased accuracy it is not sufficient to overcome the increased loss due to a narrower beam.

4.3 NOISE FIGURES

The receiver noise figure (N.F.) was measured in accordance with the test procedures given in Appendix A. Table 4 summarizes the measurement results for Channel 2, the frequency at which the OECA signal was transmitted by the spacecraft. For comparison, the factory test results are included. It should be noted, however, that the factory test results measured the noise figure for the outdoor unit only, while the field tests measured the noise figure including all contributions in a 5 MHz frequency band at the 70 MHz IF. In practice, the ODU should predominate with little contribution from the IDU. Also, it is expected that the factory measurements would be somewhat more reproducible (eg. factory tests are reproducible to approximately 0.1 dB, while field tests are reproducible to approximately 0.25 dB).

The results tabulated in Table 4 can be summarized as follows:

- (a) If one assumes the N.F. measurements in the field are accurate to better than 0.25 dB, the factory test measurements are of equal or better accuracy and that the reference noise diodes used in the field and the factory are calibrated to within ± 0.5 dB of absolute accuracy, it is likely that several of the terminals had degraded somewhat in performance. However, significant degradation, greater than 1 dB, has occurred in

only 3 out of 25 terminals. Since the field measurements include the indoor unit noise figure, it is uncertain whether the degradation was caused by the ODU or the IDU.

- (b) One parameter of interest is any degradation of the N.F..

The following differences between field tests and factory tests are evident (standard derivations are included):

	Mean	Std. Dev.
Noise Figure as Measured (dB)	0.49	0.40
Noise Temperature as Measured (Kelvin)	92	81
Noise Figure (adjusted for IDU contributions) dB	0.34	0.41
Noise Temperature (adjusted for IDU contributions) (Kelvin)	62	81

TABLE 4
Noise Figure Measurements at Approximately 11.82 GHz

	Field Tests		Factory Tests		Difference (Field-Factory)			
	NF (dB)	Ts (K)	NF (dB)	Ts (K)	dB	Adj.*	Ts	Adj.*
1. Moonbeam	5.10	648	4.45	518	0.65	0.51	130	100
2. Mattice	4.12	459	3.65	382	0.47	0.29	77	47
3. Nagagami	4.60	546	4.00	458	0.60	0.44	88	58
4. Jellico	3.80	406	3.55	367	0.25	0.06	39	9
5. Geraldton	4.00	458	4.20	473	-0.20	-0.26	-15	-45
6. Longlac	4.00	458	3.50	359	0.50	0.44	99	69
7. Caramat	4.30	491	4.20	473	0.10	-0.07	18	-12
8. MacDiarmid	5.90	838	4.70	566	1.20	1.08	272	242
9. Quetico Centre	5.00	627	4.25	482	.75	0.61	145	115
10. Atikokan	4.49	525	4.4	509	0.09	-0.08	16	-14
11. Fort Frances	4.38	505	4.15	464	0.23	0.06	41	11
12. Emo	3.96	432	3.30	330	0.60	0.48	102	72
13. Rainy River	4.87	600	4.05	447	0.82	0.67	153	123
14. Nestor Falls	4.06	449	3.85	414	0.21	0.03	35	5
15. Kenora	4.76	578	4.80	486	-0.04	-0.19	-6	-36
16. Dryden	4.60	546	3.80	406	0.8	0.64	140	110
17. Ignace	3.96	432	3.85	414	0.11	-0.07	18	-12
18. Beardmore	5.69	785	4.60	546	1.09	0.97	239	209
19. Rossport	5.36	706	4.40	509	0.96	0.83	197	167
20. Manitouwadge	5.09	646	3.90	422	1.19	1.05	224	194
21. Marathon	4.60	546	3.70	390	0.9	0.74	156	126
22. White River	5.03	633	4.85	596	0.18	0.03	37	7
23. Wawa	4.55	537	4.40	509	0.15	-0.01	28	-2
24. Chapleau	4.40	509	4.30	491	0.10	-0.06	18	-12
25. Foleyet	4.40	509	3.85	414	0.55	0.39	95	15

* 30 Kelvin, assumed for IDU, removed for comparison to factory tests.

N.F. — Noise Figure, Ts — Receiver Temperature

4.4 CARRIER-TO-NOISE RATIO AND SIGNAL-TO-NOISE RATIO

A detailed analysis was conducted on the data collected from several tests to attempt to measure the CNR and SNR performance of each terminal. Data was extracted from tests 1, 2, 3, 4, 6, and 7, where data on CNR, SNR for video and/or audio, and system noise temperature were taken. (Refer to Appendix A for the detailed test procedures.) The specific data included:

- (a) Test #1 - CNR and video and audio noise at satellite transponder saturation.
- (b) Test #2 - CNR on OECA transmission.
- (c) Test #3&7 - Signal amplitude and video noise level for OECA signal and bench test signal.
- (d) Test #4 - Noise figure for calculating expected value.
- (e) Test #6 - Signal amplitude and CNR to SNR video and audio.

Table 5 summarizes the results of the data analysis conducted for each terminal. Appendix C describes briefly how the analysis was done. In order to obtain a measure of performance relative to a standard set of conditions, several factors had to be considered:

- (a) A theoretical calculation of received CNR and SNR video (S/N_v) was done for each terminal for a saturated carrier signal transmitted by the satellite. EIRP's for the satellite for each terminal location were obtained from estimated beam patterns. The measured system noise temperature was used in the calculation (the uplink noise made a negligible contribution). The following link parameters were assumed:

Deviation sensitivity	= 6.0 MHz peak
Implementation margin	= 1.0 dB
Atmospheric attenuation	= 0.26 dB
Antenna efficiency	= 65%
System temperature	= measured value +50°K for antenna noise
Pointing loss	= 0 dB (measurement made after re-peaking)
Receiver predetection noise bandwidth	= 19 MHz

- (b) It was fairly difficult to achieve any degree of accuracy in the measurement of CNR on a satellite signal due to non-linearities of the LCET inherent in a low cost design. Hence, the true RMS voltmeter readings of S/N_v were, in most instances considered more accurate. The implied CNR (CNR^1) in the table is based upon a calculation of what the theoretical CNR would be for the measured S/N_v .

TABLE 5
Data Analysis Results for CNR and S/N_v

Site	Saturated Theoretical			Saturated Measurement		Implied CNR ¹ (dB)	OECA Measurement			Implied CNR ¹ (dB) Note 4
	EIRP (dB)	CNR (dB)	S/N_v (dB)	CNR (dB)	S/N_v (dB)		CNR (dB)	S/N_{Tek} (dB) Notes 1 and 2	S/N_{Mar} (dB) Note 3	
1. Moonbeam	48.6	11.2	40.5	12.0	42.3	13.0	13.5	44.0/43.7	—	14.4
2. Mattice	49.5	13.4	42.8	13.5	43.0	13.7	11.8	42.3/42.9	41.8	13.0
3. Nagagami	49.6	12.9	42.2	14.1	43.2	13.9	14.0	44.5/45.1	44.5	15.2
4. Jellico	50.0	14.4	43.7	—	—	—	17.1	44.7/46.3	45.4	15.4
5. Geraldton	50.0	14.1	43.4	15.8	43.0	13.7	14.6	45.8/46.2	—	16.5
6. Longlac	49.8	13.9	43.2	13.7	41.7	12.4	12.5	42.3/43.9	42.6	13.3
7. Caramat	49.8	13.5	42.8	15.7	—	—	—	—	—	—
8. MacDiarmid	49.7	11.3	40.6	14.5	43.8	14.5	12.7	45.3/44.7	—	15.4
9. Quetico Centre	48.6	11.3	40.7	13.1	40.9	11.6	13.5	43.1/43.7	41.0	11.7
10. Atikokan	48.6	15.5	44.8	17.5	44.2	14.9	17.2	47.1/47.7	—	17.8
11. Fort Frances	47.5	14.5	43.9	—	—	—	14.3	43.9/43.5	44.0	14.6
12. Emo	47.6	15.3	44.6	13.3	42.8	13.5	12.2	43.2/42.8	43.3	13.9
13. Rainy River	47.1	13.5	42.8	13.7	41.4	11.8	13.1	41.4/42.0	—	12.1
14. Nestor Falls	47.7	15.2	44.5	13.7	42.5	13.2	13.8	43.9/44.5	—	14.6
15. Kenora	47.5	14.0	43.4	13.5	41.6	12.0	13.7	42.9/43.5	—	13.3
16. Dryden	48.6	15.3	44.7	14.7	43.7	14.4	14.3	44.2/46.2	—	14.9
17. Ignace	49.0	13.2	42.5	—	—	—	13.0	41.7/41.6	—	12.3
18. Beardmore	49.9	11.7	41.1	—	—	—	13.8	44.0/45.6	—	14.7
19. Rossport	49.6	11.9	41.2	—	—	—	11.9	42.6/42.2	41.9	12.6
20. Manitouwadge	49.6	15.6	45.0	16.0	—	—	12.1	—	—	—
21. Marathon	49.2	15.9	45.2	15.5	44.5	14.9	14.3	47.6/48.1	48.1	18.3
22. White River	49.0	11.5	41.0	—	—	—	12.5	42.3/42.9	42.1	13.0
23. Wawa	48.4	11.8	41.1	13.0	41.5	11.9	12.1	42.8/43.4	42.6	13.2
24. Chapleau	47.6	14.6	44.0	13.1	42.4	12.8	13.1	44.3/44.9	44.6	15.0
25. Foleyet	47.6	11.7	40.5	12.3	42.2	12.9	12.3	44.1/42.7	—	13.4

NOTES

1. Measurement with Tektronic Test Set with weighting network.
2. Measurement with Tektronic Test Set without weighting network and adding weighting factor of 9.6 dB.
3. Measurement with Marconi Insertion Signal Analyzer.
4. Calculated from measured $(S/N)_v$ judged to be most reliable.

- (c) A complication in the analysis arose from an in-advertent oversight in the test procedures, where the bench test deviation sensitivity was set too high. This error was factored out of the measurements.
- (d) The signal transmitted by OECA was not of constant amplitude from day to day and, in fact, the transmitter deviation was adjusted at least on one occasion during the tests at Ottawa's request. The amplitude variations had to be normalized since one of the S/N_v measurement instruments measured noise relative to the bar amplitude.

Hence, in summary, all of the S/N_v given in Table 5 are corrected to give the measured and theoretical performance for a 6.0 MHz peak signal deviation for a 1 volt (140 IRE units) peak-to-peak input signal.

Examination of Table 5 indicates that after normalization of the data in the manner described in Appendix C, considerable variation still exists in the terminal performance. However, there appear to be approximately equal numbers which have CNR's greater than and less than theoretical. Only a few terminals exhibited consistent performance for all the different measurements taken. The data serves to illustrate that the measured results vary over a range of approximately 5.2 dB relative to predicted; +2.0 to -3.2 dB, where difference is theoretical - measured).

An attempt was made to determine the source of these variations. Some of the possibilities include:

- (a) the spacecraft antenna patterns may be shifted from nominal position,
- (b) the IF pre-detection filter noise bandwidths may differ significantly from the assumed 19 MHz noise bandwidth,
- (c) the non-linearities in the LCET's introduced difficulties in measuring CNR and accuracies were reduced. For example, in some cases, CNR varied with AGC level setting.

The measurement procedures were not sufficiently detailed to identify the latter two cases. The first case was examined in more detail. Figures 8 and 9 show maps of the region of interest with 49.5 dBw and 46.5 dBw EIRP contours indicated. In Figure 8, each site is given the theoretical and the best estimate for measured CNR. Figure 9 shows the difference, i.e., the theoretical less the measured values. It is difficult to conclude from this data that the beam patterns are at all different from expected.

Of some interest arising from the data analysis is the variations encountered in the settings of the deviation sensitivities within the IDU discriminator. Table 6 illustrates the measured results with the data presented in the chronological sequence in which the sites were visited. Only 5 out of 25 receivers had the sensitivities less than required, with only one of these of any significance. Five units were set greater than 1 dB too high of which 2 exceeded 3 dB high. Hence 6 units were in error by more than 1 dB.

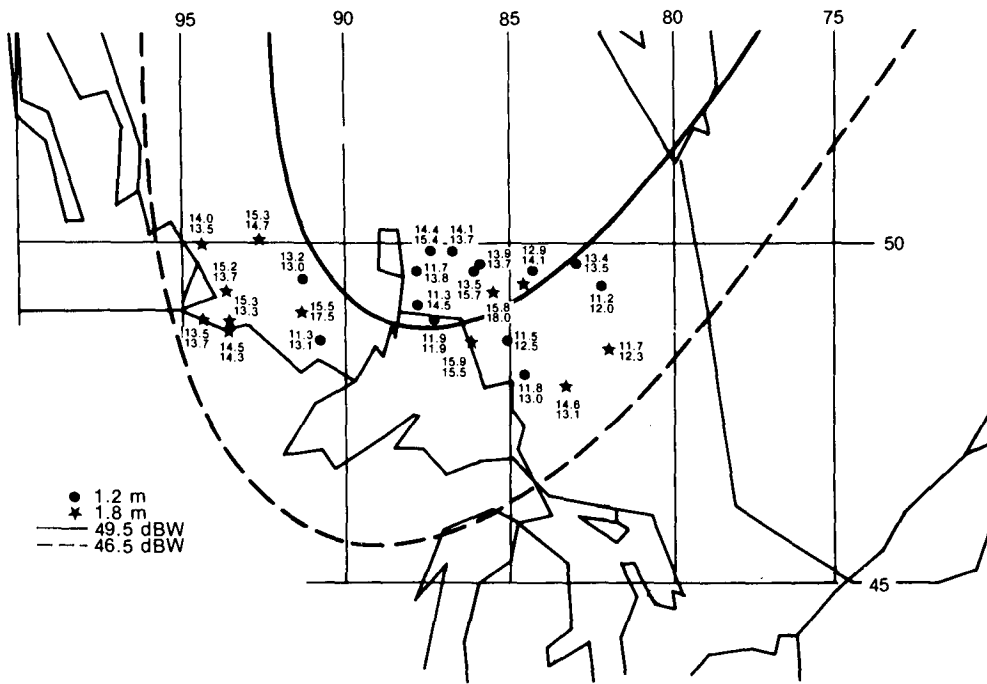


Figure 8. Theoretical and Measured
CNR at LCET Sites
CNR Theor-Top Figure
CNR Meas-Bottom Figure

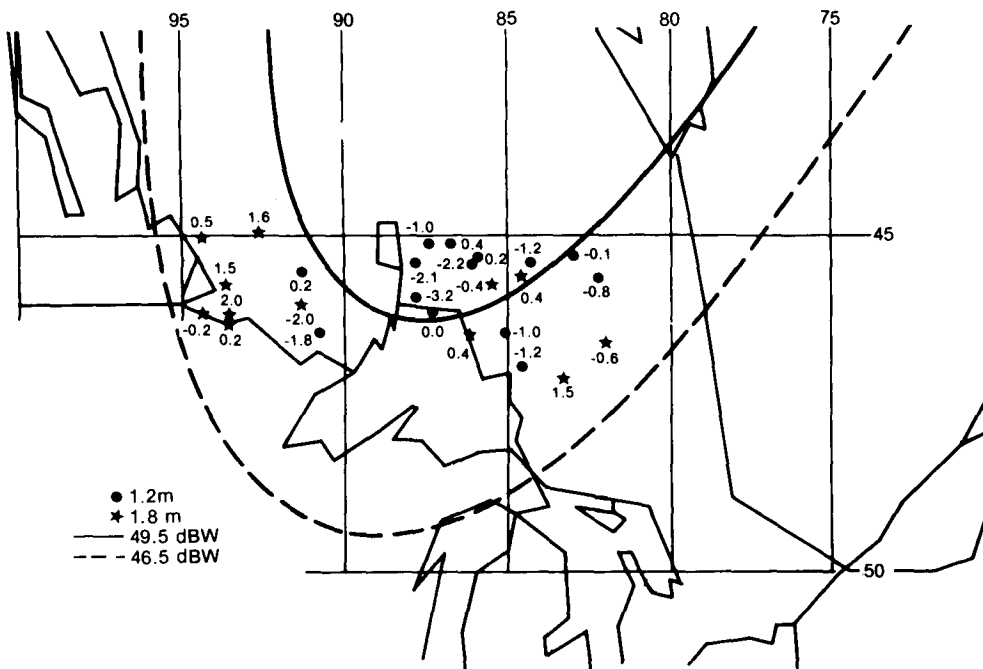


Figure 9. CNR Differences (Theoretical - Measured)

For interest, Table 6 also indicates the variations in the OECA transmit signal level encountered as the tests progressed. Part way through the test program the deviation sensitivity of the uplink terminal was increased as is evident in the Table.

TABLE 6

Deviation Sensitivity Error and Input Signal Amplitude Variation

Site	Error in Deviation Sensitivity		OECA Deviation Error (dB)	
	(+ High	- Low)	(+ High	- Low)
1. Moonbeam		+0.11		- 0.83
2. Mattice		+0.27		- 0.45
3. Nagagami		- 0.51		- 0.51
4. Jellico		+1.63		0.23
5. Geraldton		+0.21		- 0.30
6. Longlac		+0.27		- 0.96
7. Caramat		----		----
8. MacDiarmid		- 0.29		+0.80
9. Quetico Centre		+3.08		+1.68
10. Atikokan		+3.11		+0.97
11. Fort Frances		+0.93		+0.65
12. Emo		+0.15		+0.93
13. Rainy River		+1.37		+0.66
14. Nestor Falls		+0.94		+0.72
15. Kenora		- 0.11		+0.46
16. Dryden		+0.55		+0.70
17. Ignace		+0.70		+0.81
18. Beardmore		- 1.97		+0.58
19. Rosspoint		+0.58		+0.6
20. Manitouwadge		----		----
21. Marathon		- 0.45		- 0.9
22. White River		+0.29		+0.77
23. Wawa		+0.81		+0.55
24. Chapleau		+0.25		+0.58
25. Foleyet		+1.08		+0.55

Table 7 provides a summary of the measurement of the audio channel performance. Provided for each site is the theoretical CNR, the best estimate for measured CNR, the theoretical audio S/N_A and the measured S/N_A . At the start of the program, the audio subcarrier deviation on the uplink was set considerably higher than required. In 14 out of 25 cases, the measured values exceeded the theoretical predictions, where the theory was based upon specific assumptions for modulation indices. It should also be noted that the S/N_A was measured using program weighting. The theoretical calculation assumes the noise at the discriminator output to be triangular, and that a de-emphasis

circuit of 75 μ sec is used. Laboratory measurements done on other IDU,s indicate that, in fact, the noise is not triangular.

The measurements of Test #6 to determine IDU threshold, were somewhat inconclusive due to difficulties in measuring the reference CNR. However, of some interest is the relative relationship of the video and audio threshold. Although the system design is arranged to have the audio threshold occur after the video threshold is reached, for decreasing CNR, this is not evident in the IDU performance. Only 4 units out of 20 measured displayed this characteristic and then only marginally. Table 8 shows the measurement results.

TABLE 7

Audio Performance

Site	Theoretical CNR (dB)	CNR Measured (Best Estimate) (dB)	Theoretical S/N _A (dB)	Measured S/N _A
1. Moonbeam	11.2	12.0	44.9	47.2
2. Mattice	13.4	13.5	47.1	48.2
3. Nagagami	12.9	14.1	46.6	50.5
4. Jellico	14.4	15.4*	48.1	----
5. Geraldton	14.1	13.7	47.8	----
6. Longlac	13.9	13.7	47.6	49.1
7. Caramat	13.5	15.7	47.2	51.6
8. MacDiarmid	11.3	14.5	45.0	46.3
9. Quetico Centre	11.3	13.1	45.0	53.2
10. Atikokan	15.5	17.5	49.2	51.7
11. Fort Frances	14.5	14.3*	48.2	----
12. Emo	15.3	13.3	49.0	44.3
13. Rainy River	13.5	13.7	47.2	49.5
14. Nestor Falls	15.2	13.7	48.9	48.8
15. Kenora	14.0	13.5	47.7	48.6
16. Dryden	15.3	14.7	49.0	51.8
17. Ignace	13.2	13.0*	46.9	----
18. Beardmore	11.7	13.8*	45.4	----
19. Rossport	11.9	11.9*	45.6	----
20. Manitouwadge	15.6	12.1*	49.3	50.7
21. Marathon	15.9	15.5	49.6	46.1
22. White River	11.5	12.5*	45.2	----
23. Wawa	11.8	13.0	45.5	38.6
24. Chapleau	14.6	13.1	48.3	52.3
25. Foleyet	11.7	12.3	45.4	50.2

* OECA Signal

TABLE 8

Difference Between Video and Audio Threshold (dB)

Site	Difference Audio and Video Threshold* (dB)
1. Moonbeam	- 0.8
2. Mattice	3.4
3. Nagagami	3.8
4. Jellico	0.6
5. Geraldton	2.8
6. Longlac	1.0
7. Caramat	---
8. MacDiarmid	---
9. Quetico Centre	---
10. Atikokan	2.0
11. Fort Frances	0.2
12. Emo	3.2
13. Rainy River	0.9
14. Nestor Falls	1.5
15. Kenora	- 0.8
16. Dryden	- 0.3
17. Ignace	1.4
18. Beardmore	4.8
19. Rossport	1.7
20. Manitouwadge	---
21. Marathon	1.5
22. White River	3.0
23. Wawa	---
24. Chapleau	- 0.5
25. Foleyet	2.0

* Negative value indicates audio threshold is below the video threshold.

4.5 BASEBAND DISTORTIONS

In test #7, baseband video distortions were measured. The detailed measurement results are provided in Appendix D. Note that two sets of distortion measurements are provided:

- (a) The first set is given for measurements made directly at the IDU output where variations in deviation sensitivity are evident (and including the erroneous deviation of the test signal.)
- (b) A second set provides measurements where video amplitude had been adjusted to 140 IRE units peak-to-peak to provide measurements more uniformly consistent. Note, that the deviation sensitivity is still in error. However, an over-deviation of 1.6 dB should not cause significant distortion.

Table 9 contains the measurement results for differential phase ($\Delta\phi$) and gain (ΔG), and another parameter of some interest, the vertical discontinuity in the vertical retrace interval. On some units, there exists a large D.C. Shift during the vertical retrace interval indicating one of several possibilities, including:

- (a) the A.C. output coupling is insufficient or defective,
- (b) the discriminator is defective,
- (c) the clamper is defective.

In any case, the net result is that those units which display fairly large discontinuities have large distortions in the vertical retrace interval. The results are:

- (a) that vertical sync. is less precise,
- (b) any signal transmitted during the vertical interval, such as video test signals or Telidon digital data signals are severely distorted.

TABLE 9
Baseband Distortions

	Measured		Factory Tests		Vertical Interval Discontinuity (IRE Units)
	ΔG (%)	$\Delta\phi$ (Degrees)	ΔG (%)	$\Delta\phi$ (Degrees)	
1. Moonbeam	7	---	6	3.2	---
2. Mattice	7.7	2.9	4	5.2	7
3. Nagagami	4.6	2.2	14	2.7	7
4. Jellico	5.3	4.2	6	2.6	7.5
5. Geraldton	3	---	7	6.8	15
6. Longlac	3.5	2.9	14	2.7	6
7. Caramat	---	---	7	3.0	---
8. MacDiarmid	5.2	1.5	10	6.0	10
9. Quetico Centre	9.0	2.2	10	5.1	10
10. Atikokan	11.8	5.0	--	---	15
11. Fort Frances	10.6	6.8	13	5	10
12. Emo	6.4	2.0	1.5	1.1	8
13. Rainy River	6.8	5.2	15	7.2	10
14. Nestor Falls	12.1	4.1	8	8	10
15. Kenora	3.7	6.7	3	6	8
16. Dryden	6.6	4.3	6	3.2	5
17. Ignace	8.5	2.3	10	4.3	8
18. Beardmore	2.4	5.9	4	0.6	12
19. Rossport	10.1	2.5	14	5.7	5
20. Manitouwadge	--	3.2	5	2	22
21. Marathon	14.8	4.8	15	1.6	8
22. White River	3.7	4.9	9	3.7	8
23. Wawa	6.6	2.3	15	5.1	7
24. Chapleau	21.7	4.8	7	4.9	6
25. Foleyet	8.0	7.9	6	3.3	9

Figure 10 provides a photo of what was often observed. It should be noted that one would expect something in the order of less than 5 IRE units for this observation. Note that 9 terminals displayed distortions of 10 or more IRE units.

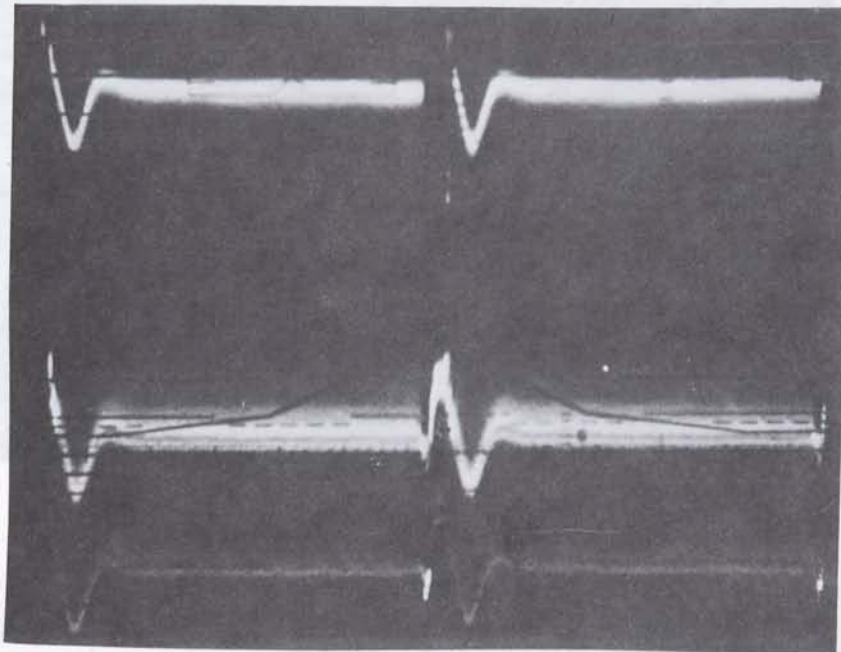


Figure 10. Two Field Display (shows vertical interval discontinuity)

Table 9 also shows, for comparison, the differential gain and phase measured at the factory before shipment. For other distortion parameters, the reader is referred to Appendix C which contains the raw measurement data.

In the data showing both field and factory tests, there is essentially no consistent agreement. This is not unexpected since large variations in differential gain and phase occur and are very much a function of the signal location in the IF passband. Any biases on the AFC manual control knob, tends to skew the signal to one side or the other, with considerable changes to differential gain and phase.

Other measurements of baseband distortion which were taken include bar and sync. amplitude, 2T pulse bar ratio, chrominance/luminance gain and delay, bar tilt, 2T K factor and field tilt. The data on these measurements are summarized in Appendix D.

4.6 IF BANDPASS RESPONSE AND AFC OPERATION

For each terminal, the IF bandpass response and the location of AFC lock-up were measured. The measurement consisted of a spectrum analyzer display of the IF bandpass amplitude characteristics and a measurement of the IF frequency with an AFC on. Figure 11 shows a typical photograph of the 70 MHz IF bandpass filter output with a CW test signal injected into the ODU via the test set.

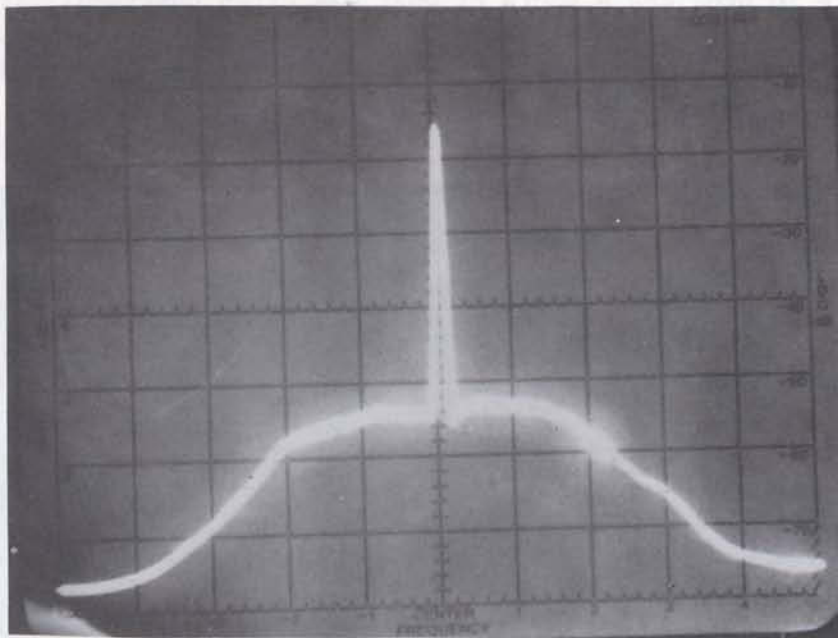


Figure 11: 70 MHz IF Bandpass Amplitude Response

It should be noted that only one terminal had a filter that appeared to be offset from 70 MHz (MacDiarmid). No noticeable degradation to the video picture was evident.

Table 10 summarizes the results of the measurement of the IF frequency. Note that 5 units are more than 1 MHz offset from 70 MHz. The majority of the units experienced difficulty with lock-up of AFC upon initial turn on. In order to acquire lock, the AFC had to be momentarily disabled.

Included in Table 10 as part of this measurement is the ratio of (carrier power) / (noise power in a 300 KHz bandwidth setting of the spectrum analyzer). The measurement was made at a constant input to the ODU, derived from the bench test set. Due to the variations in the IF filter amplitude response and bandwidth, there appears to be little relationship to CNR or measured N.F. (i.e., for constant filter bandwidths and flat amplitude response, some correlation with measured CNR and N.F. would be expected).

4.7 REMODULATOR RESPONSE

Each of the IDU's is equipped with an AM remodulator to provide a signal compatible with the RF input of consumer TV sets. Although the required modulation is vestigial sideband amplitude modulation with an FM carrier for the audio, the sideband filtering was not provided, resulting in an amplitude modulated spectrum symmetrical about the carrier. One side of the spectrum is illustrated in Figure 12 which displays the spectrum of a multiburst signal.

This scheme performed satisfactorily in all cases but one, where a remodulator unit was malfunctioning. Several users, however, indicated that

they experienced interference when attempting to combine the remodulated signal with antenna feeds. This interference would be eliminated, of course, had a channel filter been used to pass only the signal of interest (Channel 3 or 4) and reject all spurious and harmonics.

TABLE 10
AFC Hold Frequency and Operation

Site	IF Freq. (MHz)	C/N (300 KHz) (dB)	AFC Initial Lock	Stays Locked
1. Moonbeam	70.3	39.5	Problem	Yes
2. Mattice	71.4	39.0	Problem	Yes
3. Nagagami	70.6	39.0	No Problem Reported	Yes
4. Jellico	70.2	39.5	No Problem Reported	Yes
5. Geraldton	70.3	39.5	Problem	No
6. Longlac	70.1	40.0	No Problem Reported	Yes
7. Caramat	---	41.0	Problem	No
8. MacDiarmid	70.7	38.0	No Problem Reported	Yes
9. Quetico Centre	---	38.5	Problem	No
10. Atikokan	71.5	41.0	Problem	Yes
11. Fort Frances	71.3	39.0	Problem	Yes
12. Emo	69.3	40.0	Problem	Yes
13. Rainy River	69.3	39.0	Problem	Yes
14. Nestor Falls	70.7	39.5	No Problem Reported	Yes
15. Kenora	71.8	39.5	Generally No Problem	Yes
16. Dryden	69.9	39.0	Problem	Yes
17. Ignace	70.2	40.0	No Problem Reported	Yes
18. Beardmore	69.5	38.5	No Problem Reported	Yes
19. Rossport	69.8	38.5	—	—
20. Manitouwadge	71.4	40.0	Problem	Yes
21. Marathon	70.4	39.0	No Problem Reported	Yes
22. White River	70.2	38.0	Problem	No
23. Wawa	70.2	40.0	Problem	Yes
24. Chapleau	70.3	39.5	No Problem Reported	Yes
25. Foleyet	70.1	39.0	Problem	No

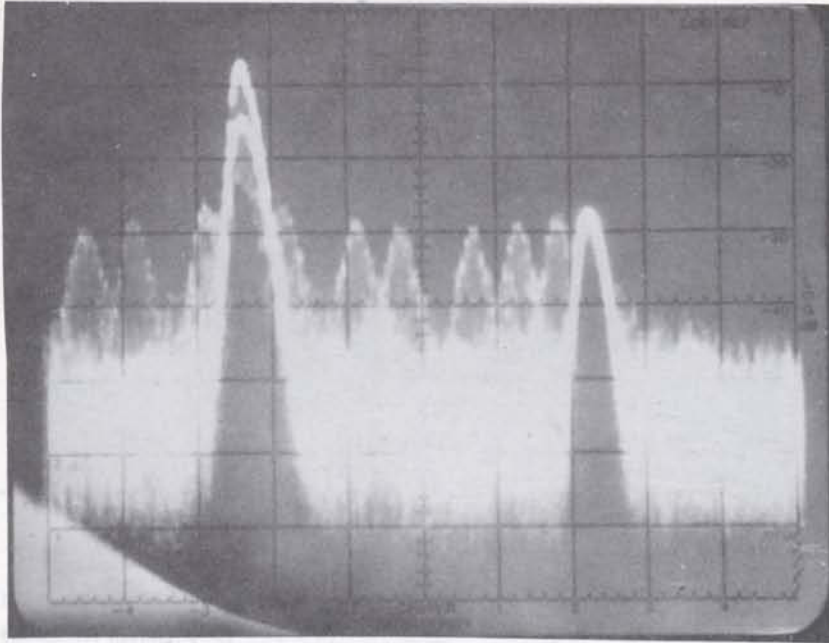


Figure 12. Remodulator Spectrum Output

5. SUMMARY AND RECOMMENDATIONS

This report describes a detailed measurement program undertaken to evaluate the performance of 25 LCET's located throughout northwestern Ontario operating under various conditions and used for applications including home reception, cable head-end, and MATV.

The operating conditions of the terminals were examined upon arrival at the site. Out of 25 terminals, 15 were functioning with no apparent degradation or malfunction, 6 were either not working or working with problems and were fixed prior to departure, one was unserviceable and 3 continued to work with some minor deficiency.

Detailed measurements indicated that fairly large polarization angle errors existed. However, in instructing the installers, this had not been emphasized. No noticeable degradation of the TV signal was apparent for any of the offsets. However, should an orthogonal polarization be used on the same frequency on a coincident downlink, severe interference would have been evident in many cases. There is no reason to believe these could not have been set more accurately had the installers been so instructed.

Antenna pointing errors, as expected, showed less angular offset but more signal attenuation due to pointing error for the 1.8m diameter reflectors. Hence, the larger antenna requires more margin for pointing errors.

The field-measured noise figures were compared to the factory final tests. Significant deterioration was evident in 3 out of 25 terminals. However, the degradation could not be separated between the IDU and the ODU. Eleven terminals were reasonably close to the factory measurement, the remainder somewhat above. An average noise temperature increase of 62 Kelvin was inferred although part of this may be attributable to differences between the noise diodes used in the factory and field measurements.

The measurement of CNR and SNR for the video and audio signals, proved to be very difficult to make in the field. Problems were encountered due to a number of factors including the non-linearities inherent in low cost designs for LCETs, the deviation sensitivity fluctuations and the input signal amplitude variations. After considerable data analysis to remove these extraneous effects, a considerable variation in CNR was still evident (over a range of 5.2 dB). Spacecraft antenna pointing was investigated as a possible source of error but insufficient data was available to draw any conclusions. Thresholds for video and audio signals were measured. Whereas the system design was to have the audio threshold at a CNR lower than the video, this was not apparent from the measurements.

The baseband distortions were examined. The LCETs were sufficiently non-linear that little correlation to previously measured data was possible. It should be noted, however, that for differential gain and phase, all terminals functioned within specification and no picture quality degradation could be traced to these parameters. Chrominance-to-luminance delay (see Appendix D for measurement results) was fairly high in some units and, while video picture quality was not adversely affected, difficulties with digital signals in the vertical interval can be foreseen. One simple "fix" for this case is to simply not filter the video baseband and to reject audio subcarriers with notch filters.

In the baseband measurements, a distortion of undetermined source in the vertical retrace interval was evident where a significant D.C. shift in voltage occurred. This phenomena would no doubt cause distortion in any signals transmitted during the vertical interval.

The IF filter amplitude response was measured and found to be adequate in all terminals. In one terminal the centre frequency was tuned below 70 MHz. In 5 units, the frequency offset was in excess of 1 MHz with the AFC on.

The remodulator response was measured and found to be adequate in all but one case.

Some general comments can be made with respect to terminal performance:

- (a) The AFC circuit was the most objectionable to users and needs to be improved. Lack of ability to lock-up to the TV signal upon commencement of transmissions from the satellite caused difficulties and annoyances to several users, particularly where unattended operation was required. Admittedly, the terminals were originally intended only for home use.
- (b) Of the terminals examined, the ODUs functioned quite well; most of the problems encountered were associated with the IDU's.

- (c) Damage to the IDU power supply subsequent to interfacility cable damage could be eliminated by fusing.
- (d) A filter should be used at the remodulator output to prevent interference into other TV signals through combining networks.

Some general comments with respect to the test program for future consideration are offered:

- (a) The tests should be kept as simple as possible and use only measurements where extraneous errors are minimized (eg., variations in uplink test signal amplitudes, etc.). The ultimate test is the satisfaction of the user and this should be emphasized more. More detailed measurements could be done in the laboratory where conditions are far more controlled and a more thorough and detailed investigation can be done. The units, by virtue of their low cost design, tend to be fairly non-linear, and because of this requires added measurements to properly characterize them.
- (b) A consistent and accurate method for determining CNR at the IF bandpass filter output is required, with the carrier remaining in the receiver. A calibrated notch filter may be appropriate. Note, however, that it was observed that the AFC moves the frequency away from 70.0 MHz to a maximum of 1.8 MHz.

6. ACKNOWLEDGEMENT

The most able and ample assistance of the DOC Regional Offices in setting up the logistics and arranging the visits at the user premises is gratefully acknowledged. The authors also wish to express their thanks to the users on whose properties the terminals were tested.

A P P E N D I X A

LCET Evaluation Test Program Detailed Test Procedures

25 September 1980

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LCET EVALUATION TEST PROCEDURES

A1. INTRODUCTION

During the month of October 1980, a test program is planned to collect technical data on the performance of LCETs which have been working in the field for up to one year. This document describes in detail the tests and procedures that will be applied to each of the sites to be visited. Included in this evaluation will be a survey of user reactions and description of set-ups.

A2. TESTS

The tests are divided into two sections: (a) Satellite tests, (b) Bench tests. The Satellite tests are dependent upon the availability of a dedicated transponder. In some instances, this will not be available. During these times, the tests have been modified to provide at least most of the data of the other sites. The satellite tests consist of the following:

- (a) Carrier-to-noise density ratio at (or near) satellite transponder saturation, and received video and audio noise levels.
- (b) Antenna alignment.
- (c) Baseband video distortion parameters such as bar and sync. amplitudes, differential phase and gain, chrominance-to-luminance gain and delay inequality, K factors, etc.

The bench tests are as follows:

- (a) System noise temperature across the 11.7 to 12.2 GHz band.
- (b) Signal-to-noise ratio for the video and audio outputs versus carrier-to-noise ratio in the 70 MHz IF and subsequent determination of threshold.
- (c) Predetection filter response and AFC lock-up point.
- (d) Baseband distortions.
- (e) Remodulator spectrum.

In addition to the above tests, it is intended to obtain as much information as possible to describe the sites, the mounts and the use of the service.

A3. TEST PREPARATION

Satellite time is scheduled such that from 10:15 - 10:45 AM, each day, excluding weekends and the period 23 - 29 October, a saturating carrier will be transmitted from Ottawa by the 9M terminal. Consequently, the satellite tests must be conducted during this time. It is suggested that the test vehicle arrive at the site at least 1 1/2 hour prior to the 10:15 AM in order to set up the test equipment, access a power source, move the IDU into the trailer, and have the LCET warmed up prior to testing.

For days where a saturating carrier is available, the testing schedule 1 attached will be used. It should be pointed out that the satellite tests are firm test periods which cannot be varied due to other schedule commitments. Hence, it is essential that testing is ready to start at 10:15 AM. Obviously, the schedule does not apply on days where a saturated carrier is not available. During these days it is only necessary to complete all applicable tests and observations. It should be noted that it will still be necessary to conduct a satellite test, however, by using the OECA program carrier. This carrier will be near but not at saturation. It will be available each day of testing except for 27 October, when testing will not be possible. At the option of the test conductors, the bench tests could be done prior to the satellite tests. If so, the operators should be careful not to adjust the IDU to improve performance until the satellite tests are done in order that a clear picture of the state of the terminal performance prior to arrival be determined. For Saturdays, OECA signals are transmitted starting at 0830.

A4. SATELLITE TESTS

Test #1: C/N, Video and Audio Noise

To be done in presence of saturating carrier transmitted from Ottawa 9M.

1. Arrange test set-ups as shown in Figure A1.
2. Set the IDU for AGC on and the AFC on.
3. Ensure that in switching AFC to "off" that signal is not lost. If so, retune with AFC "off", to bring carrier in-band, then enable AFC again. Carrier should remain in-band.
4. Set the spectrum analyzer to the following settings:

Frequency	70 MHz
BW	300 KHz
Video Filter	100 Hz

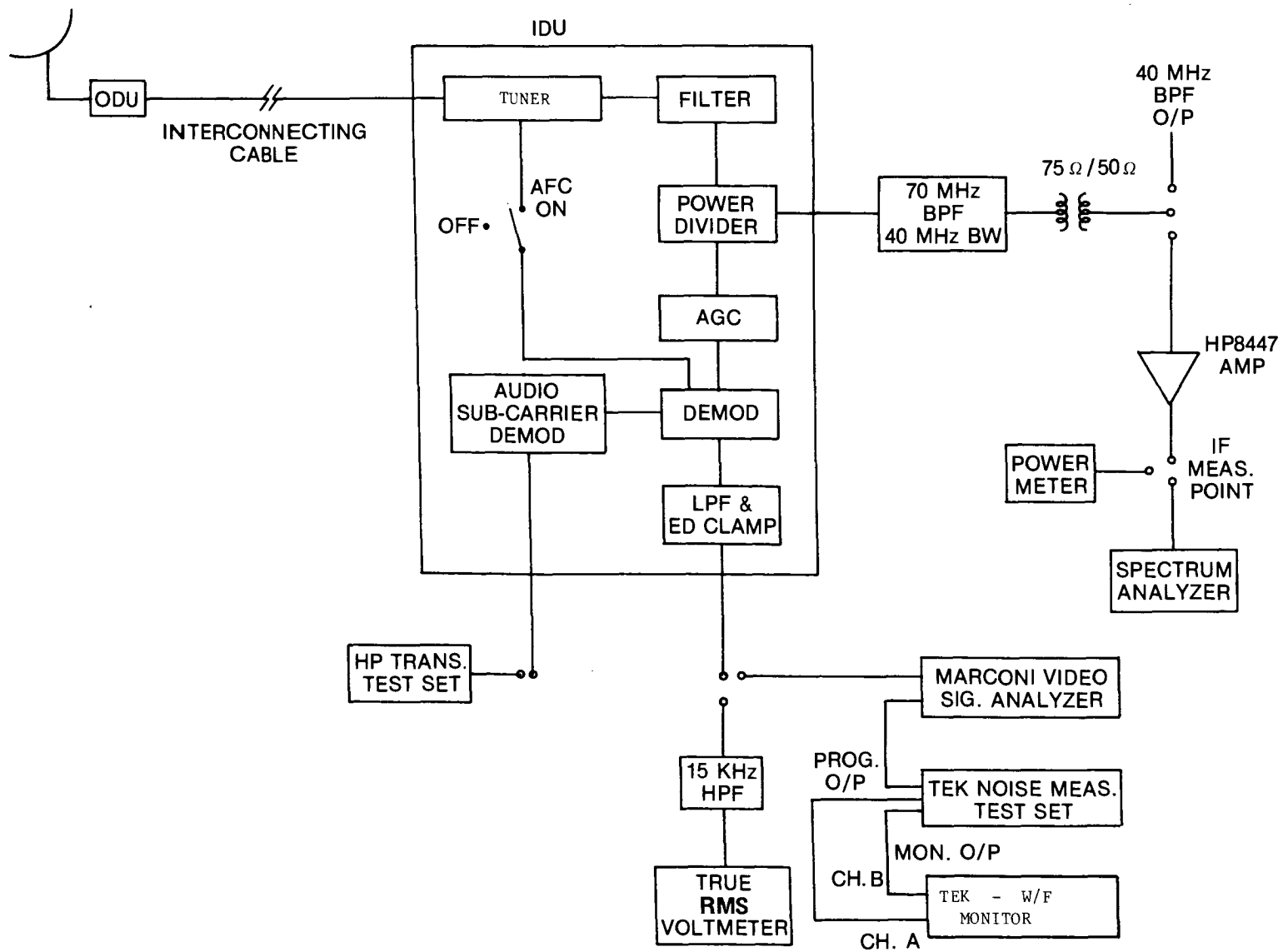


Figure A1. Satellite Test Set-Up

Scan Width	5 MHz/div.
Scan Rate	0.1 sec/div.
I/P Atten.	10 mw
IF Atten.	-20 dB
Vert. Gain	10 dB log/div.

5. Measure as accurately as possible the maximum peak of the carrier-to-average of noise and record.
6. Record video noise as measured through a 15 KHz BPF on a true RMS volt meter. Record audio noise as measured on a HP transmission test set, with the instrument controls set at received signal bridged, program weighting, message circuit noise. Ensure that the 600Ω resistor at the audio output of the LCET is in place or that o/p is terminated in 600Ω , other than in the instrument.
7. Measure carrier-to-total noise ratio directly by the following procedure:
 - (a) Set the AFC to off and ensure that carrier is at the same point as held by AFC.
 - (b) Measure C+N at the 40 MHz BPF output, with the high sensitivity head.
 - (c) Observe noise level on the spectrum analyzer as you de-tune the IDU to move the carriers out of band. Tune it just far enough above the bandpass cut-off to eliminate any large spurious or carrier residual. If noise level should move, record amount and direction. Then measure and record noise power on the power meter.
 - (d) Tune carrier back to centre and enable AFC.
8. Connect high sensitivity head of power meter in place of spectrum analyzer and note maximum received signal strength.
9. Realign antenna for maximum peak of received signal level. Record increase of carrier level as seen on power meter. Readjust polarization angle and focal distance if necessary. Comment on amount and direction of required pointing corrections and increase in signal strength.
10. Repeat steps 4 to 7.
11. Take photograph of 70 MHz spectrum using spectrum analyzer settings given in Test #5.
12. Calculate $(C+N)/N$ and C/N for both sets of data by the following:

$$\left. \frac{C}{N} \right|_{\text{dB}} = 10 \log \left\{ 10^{\left[\frac{(C+N)/N}{10} \right]} - 1 \right\}$$

Test #2: C/N, Video SNR: OECA Signal from Satellite

1. Ensure the equipment is set up as indicated in Figure 1.
2. Set the AFC off and ensure that in doing so, the signal does not change its location in the IF passband. Should it do so, adjust the tuner until no movement is evident when AFC is switched on and off.
3. Record received signal level and tuning indication on front panel meter.
4. Measure the C+N at the 40 MHz IF filter output (through the 75Ω/50Ω transformer) by a power meter.
5. If possible, observe the noise level in the passband on the spectrum analyzer as you de-tune the IDU to move the carrier out-of-band. Tune it just far enough above the BPF cut-off to eliminate any large spurious or carrier residual. If noise level should move, record direction and amount. Record noise power on the power meter.
6. Tune carrier back to centre and enable AFC.
7. Calculate (C+N)/N and C/N by

$$\left. \frac{C}{N} \right|_{\text{dB}} = 10 \log \left\{ 10^{\left[\frac{(C+N)/N}{10} \right]} - 1 \right\}$$

The following steps should be carried out if Test 1 was not conducted; otherwise, go to Test 3.

8. Set AGC to manual, AFC on and place a VM on AGC output (D.C. Output of Power Meter). Adjust AGC level for a reading near 3/4 full scale on the front panel meter at the 40 MHz BPF o/p as above. Peak antenna and record steps 4 to 7.

Test #3: Baseband Video Distortions - OECA Signal

1. Ensure the terminal is set-up as shown in Figure 1 with the AFC on and the AGC on.

2. Photograph line 17, field 1.
3. Using the waveform monitor as a check, select the following distortion measurements on the Marconi Signal Analyzer and record results.

Bar Amplitude	(IRE)
Sync. Amplitude	(IRE)
2 τ Pulse/Bar Ratio	(%)
Chrominance/Luminance Gain	(%)
Chrominance/Luminance Delay	(nsec)
Noise	(dB)
Bar Tilt	(IRE)
2T "K" Factor	(%)
Differential Gain	(%)
Differential Phase	(deg)
Multiburst Flag Level	(IRE)
Multiburst 1st Freq. Level	(IRE)
Multiburst 2nd Freq. Level	(IRE)
Multiburst 3rd Freq. Level	(IRE)
Multiburst 4th Freq. Level	(IRE)
Multiburst 5th Freq. Level	(IRE)
Multiburst 6th Freq. Level	(IRE)

4. Disable clamp on the waveform monitor and measure field tilt by displaying a two field display and determining the field tilt over a single field. Measure the discontinuity which occurs at the vertical interval between the two fields.
5. Repeat noise measurement by using the Tektronix video noise insertion/comparison test set along with the waveform monitor. Set the measurement set for unweighted noise. Record results. Repeat the measurement for weighted noise.
6. Observe the video signal on a picture monitor. Using the reference photographs of picture quality judge the performance level being received, and record on data sheet.

Test #4: B. Bench Tests - System Noise Temperature

1. With the IDU and ODU both located in the test trailer, set up the equipment as shown in Figure 2. Turn the AFC "off".
2. With the tuning voltage as indicated by the front panel meter the same as that required for reception of the OECA signal, measure N.F. by the Y-factor method as follows:
 - (a) With the noise source connected to the SMA port of the SMA/WR 75 adapter, and the +28 volt power supply

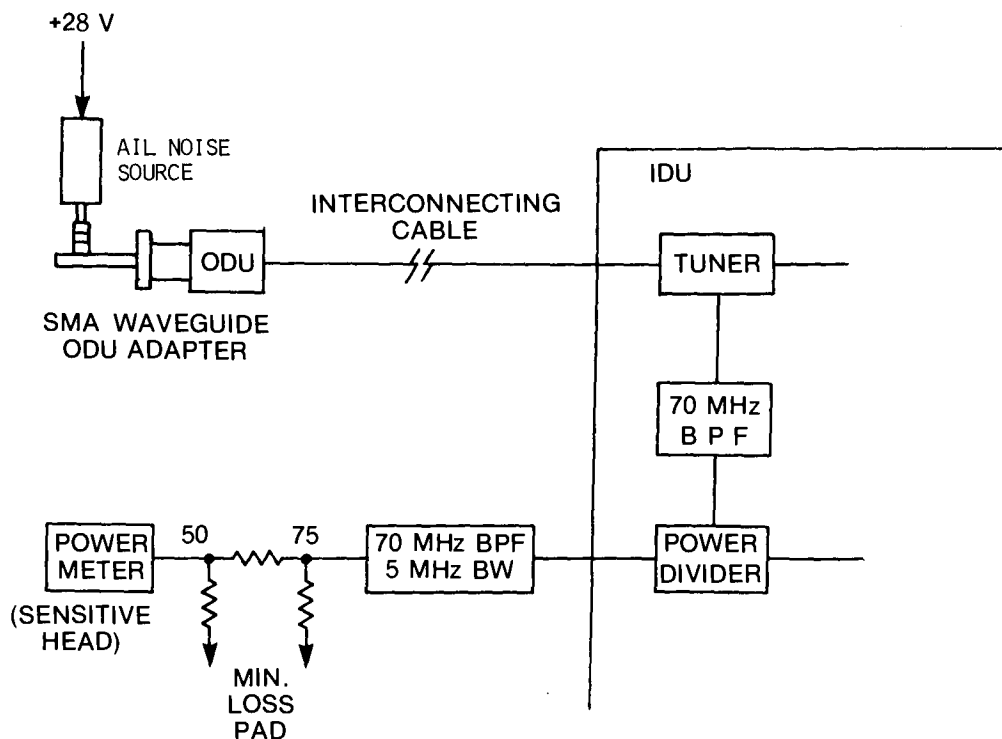


Figure A2. N.F. Measurement Test Set-Up

disconnected from the noise source, measure the power in dBm at the output of the 5 MHz BPF and the 75Ω/50Ω minimum loss pad. Note that accuracy of measurement is very important.

- (b) Apply the +28V DC supply to the noise diode and repeat noise measurement.
 - (c) Y-factor is then the difference between readings obtained in (a) and (b).
 - (d) Estimate N.F. from Nomograph provided in Figure 3, using the ENR = 15.8 dB.
3. Using the tuning indication obtained in step as a reference, X, repeat noise figure measurement for tuning indications of X-2, X+2, X+4, X+6, X+8.

Test #5: Pre-Detection Filter Response and AFC Lock-Up Position

1. Set up the equipment as indicated in Figure 4, being careful to replace the 5 MHz BPF with the 40 MHz BPF. Note that this set-up can be used for the remainder of the tests.

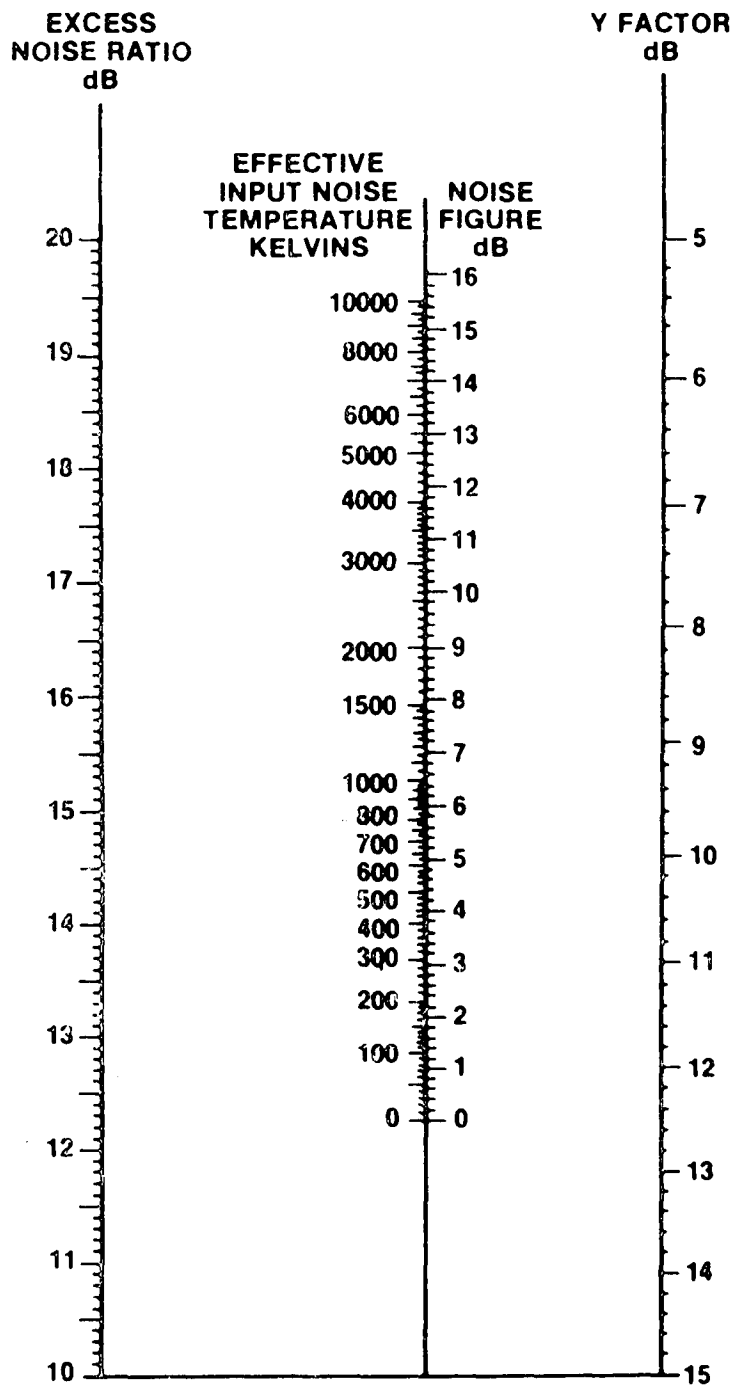


Figure A3. Nomogram for Calculation of Noise Figure

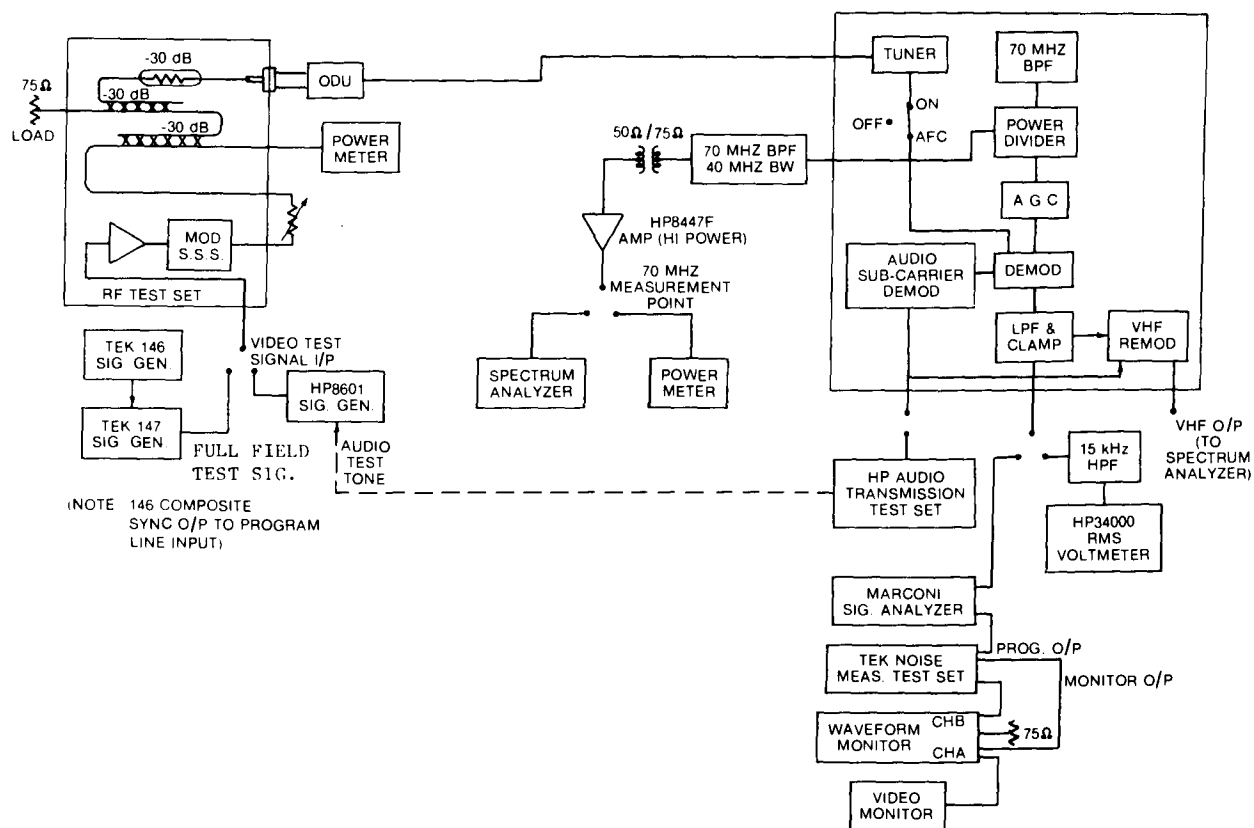


Figure A4. Bench Test Set-Up

2. Set up the following conditions:

AGC on
AFC on

RF test set attenuator to provide +10 dBm on power meter
Spectrum analyzer settings as follows, and use the store mode:

RF Freq	70 MHz
IF BW	300 KHz
Scan Width	5 MHz/div.
Video Filter	100 Hz
Scan Rate	0.1 sec/div.
RF Atten.	10 dB
RF Variable Atten.	0 dB
IF Attenuator	0 dB
Vertical Gain	10 dB log/div.

3. Tune the IDU such that the signal remains stationary in the passband when the AFC is switched off, then on again. Record the difference in dB between the carrier peak and the average of the noise (C/N_{300}).

4. With the AFC on, record tuning indication, level indication, and photograph spectrum analyzer display.
5. Measure the frequency of the IF. If >3 MHz from 70 MHz, retune the discriminator *after* completion of all tests.

Test #6: S/N_V , S/N_A , Versus C/N

1. Ensure the equipment is set up as shown in Figure 4 and that the IDU is set for AGC "on" and AFC "on".
2. Set the RF test set variable attenuator so that the RF power meter reads +10 dBm.
3. With spectrum analyzer set as follows, measure C/N_0 in 300 KHz BW setting of analyzer. Use the store mode of the spectrum analyzer.

RF	70 MHz
IF BW	300 KHz
Video Filter	100 Hz
Scan Width	2 MHz/div.
Scan Rate	0.1 sec/div.
RF i/p Atten.	10 mw
IF Attenuator	as needed
Vertical Gain	10 dB log/div.
4. Connect the high sensitivity power meter head to the 70 MHz measurement point and record power as $C+N$ (P_2). Turn off AFC. Check carrier does not move. If so, retune until carrier stationary for AFC on or off.
5. Remove RF carrier and measure noise power (P_1) alone. When removing RF carrier, observe noise floor on a 2 dB setting of the spectrum analyzer to ensure it does not change. If so, record amount and nature of change.
6. Calculate $(C+N)/N$ and consequently C/N by:

$$\frac{C+N}{N} = P_2 - P_1$$

$$\frac{C}{N} = 10 \log \left\{ 10^{\left[\frac{(C+N)/N}{10} \right]} - 1 \right\}$$

7. To calibrate video modulation index for test set, insert a 762 KHz test-tone to video input at a voltage, of 321 mv* measured into 75Ω. A zero of Bessel J₀ should be evident on the spectrum analyzer. (Third zero of J₀.)
8. To set the carrier modulation by the audio subcarrier, insert at the video i/p, a frequency of 5.14 MHz such that the level is 20.3 dB below the TV carrier.
9. From the HP transmission test set, feed a 1 KHz test-tone at an indicated level of -20.2 dBm into the Ext. FM input of the 5.14 MHz signal generator.
10. With the test set operating in this mode, record the test-tone level measured at the audio baseband output. Ensure that if the LCET has a 600Ω resistor across the o/p that the HP transmission test set is set for received signal bridged, program weighted, tone 40 Hz - 60 KHz.
11. Disable the audio test-tone. Connect the video baseband output to an RMS volt-meter through a 15 KHz HPF. Set audio receiver from tone to message circuit. The system is now ready to do a measurement of S/N_v and S/N_a versus C/N.
12. With the RF PM reading +10 dBm record video noise in dBm and audio noise in dBrn. Reduce RF power in 1 dB steps by adjusting variable attenuator, recording video and audio noise for each step. Continue until well into threshold. Calculate video and audio S/N and complete data sheet (d). Plot results on graph paper (e) and determine threshold for video and audio. (1 dB from linear)

* Note that this value was discovered later to be in error. It should have read 388 mw.

Test #7: Baseband Distortions

1. Set the RF test set back to +10 dBm on the power meter. Remove the ASC signal and insert the NTSC video test signal generator. A VITS insertion test set is used for this in order to provide signals appropriate for the Marconi signal analyzer.
2. Repeat all the steps of Test #3, recording data on the data sheet (b).

Test #8: RF Remodulator o/p

1. On the LCET IDU, feed the video baseband o/p into the RF remodulator i/p using a multiburst test waveform, photograph the spectrum at VHF with the spectrum analyzer set to the following:

RF Freq.	ch 3 = 60-66 MHz, ch 4 = 66-72 MHz
IF BW	300 KHz
Scan Width	1 MHz/div.
Video Filter	off
Scan Rate	1 msec/div.
RF i/p Atten.	10 dB
RF Variable Atten.	0 dB
IF Attenuator	-30 dB
Vertical Gain	10 dB log/div.
Scan Trigger	auto
Non-Storage Mode	

Test #9: Adjustments

1. Should any deficiencies be noted in the measured performance, they should be recorded on data sheet (f).
2. If the AFC lock up is far (>3 MHz) from the 70 MHz centre frequency, the discriminator should be adjusted to correct this. If this is done, re-photograph IF spectrum as indicated in test #3.
3. If the bar amplitude of the video test signal (composite) exceeds the limits 100 IRE) ± 5 IRE, readjust video level.
4. Unless the audio signal is a source of difficulty to the user's receiver - leave as is. Should it be a low-level receive TT and user complains of a noisy signal, the IF gain could be increased by no more than 5 dB and no higher than +10 dB. Note that this level is factory set to provide proper deviation in the RF remodulated RF spectrum and ensure it is deviating O.K. (75 KHz peak for a +10 dBm test-tone) at the RF test set i/p. Hopefully, since this test would be time consuming, it could be avoided.
5. After all testing is completed, re-install test set into service location, obtain signal and check quality, preferably by comparison with test photos. Record on data sheet (f).

ANIK-B Site Information (Ontario)

Name	Lat.	Long.	Az.	EI.	Pol.
Ottawa Building 14	45.35	75.9	222 25	28.4	28.3
Geraldton	49.8	86.9	207.9	29.1	17.6
Marathon	48.8	86.4	208.9	29.1	18.6
Owen Sound	44.5	80.9	217.2	31.6	25.5
Manitouwadge	49.1	85.7	209.6	29.4	18.9
Toronto	43.7	79.4	219.4	31.5	27.3
Thunder Bay	48.4	89.3	205.6	31.2	16.6
Sault Ste. Marie	46.5	84.0	212.7	31.2	21.8
Dryden	49.9	92.9	200.7	31.1	13.2
Hornepayne	49.2	84.8	210.7	28.9	19.5
Atikokan	48.8	91.6	202.6	31.5	14.6
London	43.0	81.5	217.3	33.2	26.3
Orient Bay	49.3	88.1	206.7	30.0	17.0
Rosspport	48.8	87.5	207.6	30.3	17.8
MacDiarmid	49.0	88.0	206.9	30.2	17.3
Beardmore	49.5	88.0	210.0	29.0	18.9
Mattice	49.6	83.2	212.4	28.0	20.3
White River	48.5	85.3	210.3	29.8	19.6
Red Lake	51.1	93.8	199.2	29.7	11.5
Ear Falls	50.6	93.2	200.1	30.1	12.6
Ignace	49.4	91.5	202.5	30.9	14.4
Sioux Lookout	50.1	91.9	201.8	30.3	13.8
Savant Lake	50.2	90.7	203.3	29.9	14.7
Pickle Lake	51.4	90.2	203.5	28.6	14.4
Nestor Falls	49.1	93.9	199.6	31.8	12.7
Emo	48.6	93.8	200.0	32.3	13.0
Moosonee	51.3	80.6	214.7	25.5	20.8
Frazer Dale	49.7	81.6	214.2	27.3	21.3
Sultan	47.6	82.8	213.7	29.7	21.9

ANIK-B Site Information (Ontario)

Name	Lat.	Long.	Az.	EI.	Pol.
Opasatika	49.5	82.9	212.8	28.0	20.6
Foleyet	48.25	82.3	214.0	28.9	21.8
Wawa	48.0	84.8	211.0	30.1	20.3
Oba	49.1	84.1	211.5	28.8	20.0
Franz	48.5	84.4	211.4	29.5	20.2
Jellico	49.8	87.5	207.3	29.3	17.2
Aroland	50.2	86.9	207.8	28.7	17.4
Pagwa River	50.0	85.2	209.9	28.4	18.7
Caramat	49.6	86.1	209.0	29.1	18.7
Nakina	50.2	86.7	208.1	28.7	17.5
Armstrong	50.3	89.0	205.3	29.3	15.8
Rainy River	48.7	94.6	198.9	32.4	12.3
Montreal	47.2	84.6	211.7	30.7	20.9
Iroquois Falls	48.8	80.7	215.6	27.7	22.5
South Bay Mines	51.5	92.0	201.4	28.9	13.1
Fort Frances	48.7	93.8	199.9	32.2	12.9
Kenora	49.2	94.5	198.7	31.2	11.9
Huntsville	45.3	79.3	218.7	30.1	26.1
Chapleau	51.6	83.6	211.2	26.3	18.8
Gore Bay	45.9	82.5	214.8	31.1	23.4
Kitchener	43.4	80.5	218.3	32.3	26.7
Dubreuilville	48.3	84.5	211.4	29.7	20.3
Quetico	48.5	91.0	203.4	31.7	15.3
Mine Center	48.8	92.6	201.4	31.8	13.9
Slate Falls	51.1	91.1	202.5	29.1	13.9
Summer Beaver	52.8	89.8	203.6	27.1	14.0
Monteith	48.65	80.7	215.6	27.8	22.0
Parry Sound	45.4	80.0	217.9	28.9	25.5

General Site Data

Date: _____ Test Conductors: _____

Location: _____

User's name and use: _____

LCET Serial #s IDU _____ ODU _____

Sat. Signal Available _____

Size of Antenna: _____

Polarization Angle Setting: Actual _____ Calculated _____ Readjusted* _____

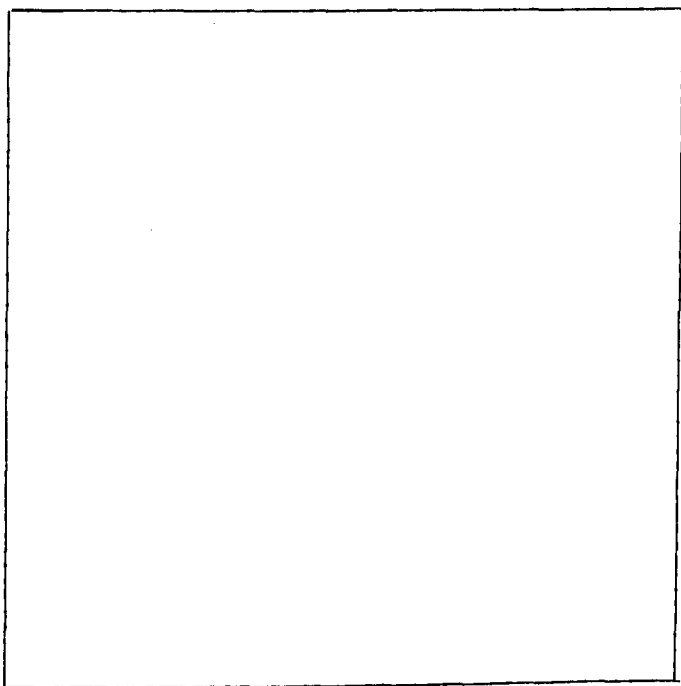
Axial Distance from Dish Surface to Tip of Circular w/o on feed

1.8M = 27", 1.2M = 19" Actual _____ Required _____ Readjusted _____

Type of Foundation: (e.g. wood, earth, roof, cement, pavement, etc.)

describe: _____

Terminal Photo



Local Weather (check as appropriate)

Clear: _____

Light Moderate Heavy

Cloud: _____

Rain: _____

Fog: _____

Snow: _____

Freezing

Rain: _____

Ottawa weather _____

(Ops at 9m to record each day during tests)

Toronto weather _____

(Ops to call Toronto (OECA) for data each day of test)

Approximate temp: _____

Wet snow in dish? _____

Comments of Users on quality and reliability of service: (if possible)

* To be readjusted only if error $> 3^\circ$.

*Data***Test #1 — Procedure 1 — Sat. Carrier C/N and Antenna Alignment.**

LCET # IDU	_____	ODU	_____
AFC on?	_____	AGC on?	_____
	Before Alignment		After Alignment
Tuning indication or meter	_____ <i>va</i>	_____	_____ <i>va</i>
Level indication on meter	_____ <i>va</i>	_____	_____ <i>va</i>
C/N (per 300 KHz BW)	_____ dB	_____	_____ dB
Video noise	_____ dBm	_____	_____ dBm
Audio noise	_____ dBm	_____	_____ dBm
C + N	_____ dBm	_____	_____ dBm
N	_____ dBm	_____	_____ dBm
N Noise floor shift	_____ dBm	_____	_____ dBm
(C+N)/N Noise floor shift	_____ dB	_____	_____ dB
C/N *(see procedure)	_____ dB	_____	_____ dB
Increase in maximum peak signal received after re-alignment of dish	_____	_____	_____ dB
Comments:	_____		

Test #2 — C/N OCEA Signal

	Before Alignment*		After Alignment
Level Indication on Meter	_____ <i>va</i>		
Tuning Indication on Meter	_____ <i>va</i>	_____	_____ <i>va</i>
C + N	_____ dBm	_____	_____ dBm
N	_____ dBm	_____	_____ dBm
Noise Floor Shift	_____ dB	_____	_____ dB
C+N/N Noise floor shift	_____ dB	_____	_____ dB
C/N	_____ dB	_____	_____ dB
If antenna realigned, record P.M. increase in max. received signal	_____	_____	_____ dB
Comments:	_____		

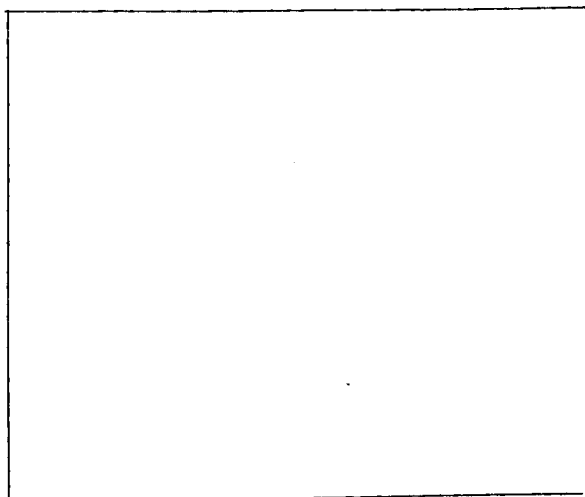
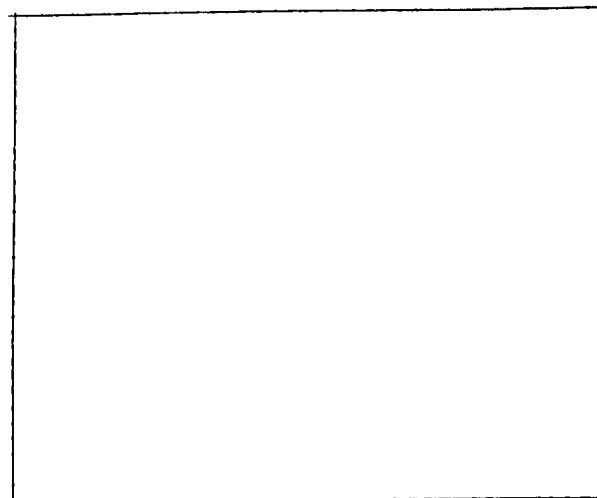
* This column need be completed only if Test #1 was not done.

Data

LCET serial # = IDU _____ ODU _____

Tests 3 & 7 Baseband Distortion Parameters:

	OECA Signal	Bench Test Signal
Bar Amplitude (IRE)	_____	_____
Sync Amplitude (IRE)	_____	_____
2τ Pulse/Bar ratio (%)	_____	_____
Chrominance/Luminance gain (%)	_____	_____
Chrominance/Luminance delay (nsec)	_____	_____
Noise (dB)	_____	_____
Bar tilt (IRE)	_____	_____
2τ "K" factor (%)	_____	_____
Differential gain (%)	_____	_____
Differential phase (deg)	_____	_____
Multiburst Flag level (IRE)	_____	_____
Multiburst 1st freq. level (IRE)	_____	_____
Multiburst 2nd freq. level (IRE)	_____	_____
Multiburst 3rd freq. level (IRE)	_____	_____
Multiburst 4th freq. level (IRE)	_____	_____
Multiburst 5th freq. level (IRE)	_____	_____
Multiburst 6th freq. level (IRE)	_____	_____
Field Tilt (IRE)	_____	_____
Vert. Interval discontinuity (IRE)	_____	_____
Subjective Video Quality	_____	_____
SNR (Tek. test Set) (unweighted) dB	_____	_____
SNR (Tek. test Set — weighted) dB	_____	_____

Line 17 OECA Signal**Line 17 Bench Test Signal**

Data

LCET Serial # IDU _____ ODU _____

Test # 4 – System Noise Temperature

	Tuning indication	P₂ (dBm)	P₁ (dBm)	Y (dB)	N.F. (dB)
(OECA) x	_____	_____	_____	_____	_____
x-2	_____	_____	_____	_____	_____
x+2	_____	_____	_____	_____	_____
x+4	_____	_____	_____	_____	_____
x+6	_____	_____	_____	_____	_____
x+8	_____	_____	_____	_____	_____

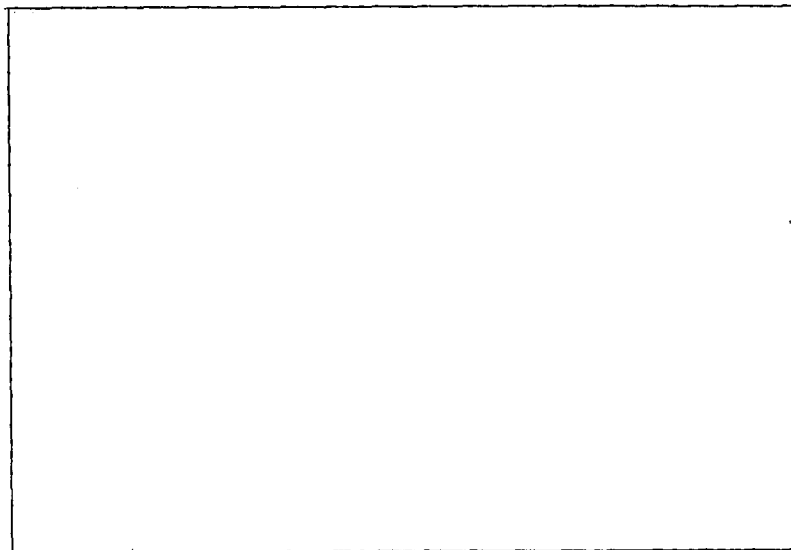
Test # 5 – If BPF Response and AFC Lock-up

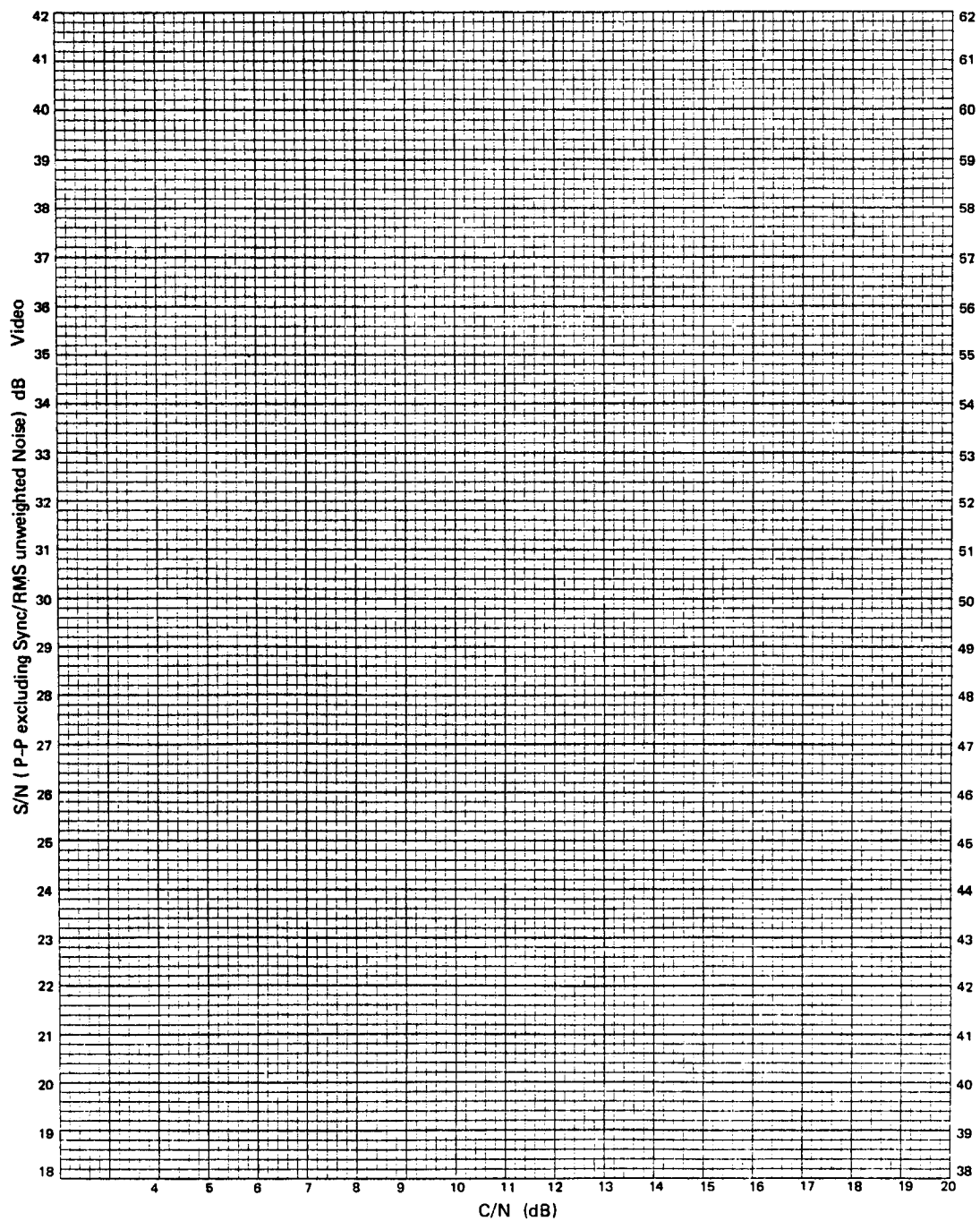
Tuning Level Indication _____

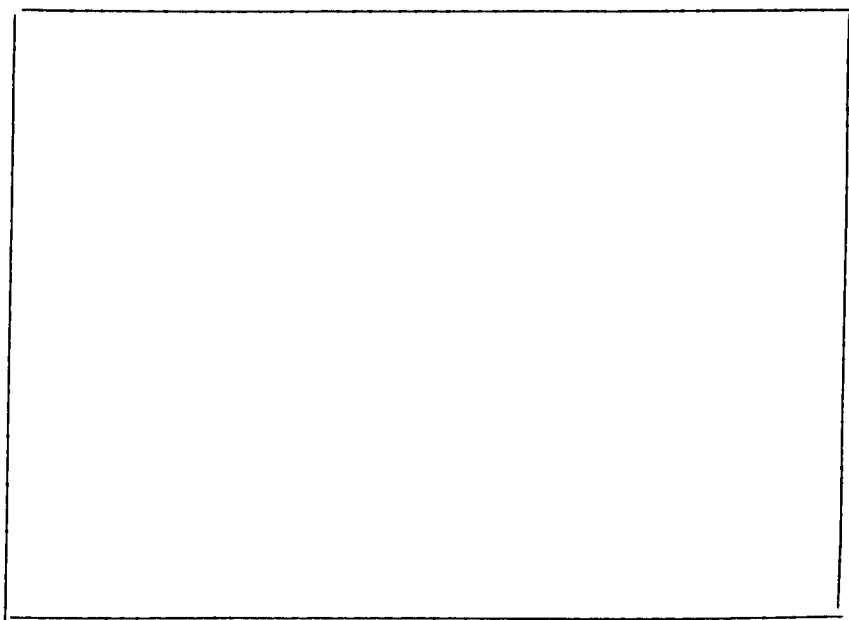
Received Signal Indication _____

If frequency _____ MHz.

C/N 300 _____ dB

*Note: If other spectrum analyzer settings are used please indicate here:*



Test # 8 — Remodulator response

Subjective video quality on user's set _____

(compared with photos)

Equipment

1 of 2

- | | |
|---------------------------------|----------------|
| 1) Spectrum Analyzer | |
| H.P. 141T Display A/N 14374 | S/N 1502A09201 |
| 8555A R.F. Section A/N 08624 | S/N 1203A0190 |
| 8555B I.F. Section A/N 10977 | S/N 1431A06988 |
| 2) Random Noise Measurement Set | |
| TEK 1430 A/N 18292 | S/N B080581 |
| 3) NTSC Test Generator | |
| TEK R146 A/N 15419 | S/N B010198 |
| 4) NTSC Test Generator | |
| TEK R147 A/N 09207 | S/N B010228 |
| 5) Generator/Sweeper | |
| H.P. 8601 | S/N 945—01052 |
| 6) Waveform Monitor | |
| TEK 1480C A/N 11442 | S/N B020528 |
| 7) Counter | |
| H.P. 5303B A/N 09948 | S/N 1240A00884 |
| 8) Measurement System | |
| H.P. 5300A A/N 09949 | S/N 1320A08265 |
| 9) Transmission Test Set | |
| H.P. 3551A A/N 12202 | S/N 1115A00778 |
| 10) Power Meter | |
| H.P. 435A A/N — | S/N 1415A01734 |
| 11) Power Meter | |
| H.P. 435A A/N — | S/N 1748V02914 |
| 12) Voltmeter | |
| H.P. 3400A | S/N 528—05756 |
| 13) Camera | |
| H.P. 197A A/N | S/N 610—00386 |
| 14) Video Monitor | |
| Sony CVM1710 A/N 17194 | S/N 200288 |
| 15) DVM | |
| Fluke 8020A A/N 17816 | S/N N2271759 |
| 16) Calculator | |
| H.P. 45 | S/N 1349A34692 |
| 17) Space R.F. Section | |
| H.P. 8555 | S/N 1043A00212 |

- 18) Scope
Teleequipment D32 A/N 12987 S/N E609811
- 19) Amplifier
H.P. 8447F A/N 16291 S/N 1726A00692
- 20) Intercom
Archer A/N 18775
- 21) AVOMETER
Model 8 S/N 69142—C—1257
- 22) Insertion Signal Analyzer
Marconi TF 2914

A P P E N D I X B

Field Notes on Ground Terminal Sites Visited For Measurements

1. *Moonbeam* - 1.2M - Home use; installed on ground weighted down by concrete blocks; interface cable damaged with repair attempted by user - resulted in shorted ODU power supply; repointed once by user by use of a spirit level to regain initially installed conditions; significant distortion on video was apparent - caused by audio subcarrier intermods; connected to 75 Ω splitter to combine with an off-air antenna feed. IDU had to be turned off when viewing off-air signals to prevent interference. AFC lock-up not functioning upon initial turn-on; antenna repeaked twice by DOC.
2. *Mattice* - 1.2M - Cable head-end; installed on a platform fastened half way up a wall of a small hut but simply resting on the earth, i.e., no foundation; unit left on at all times but daily curtailment of transmissions requires AFC on-off switch to be exercised to regain AFC lock (done by automatic momentary relay switch on a 27 minute timer); severe herringbone distortion present, eventually traced to over-deviation of the audio subcarriers on the uplink; antenna re-aligned twice by DOC, once by user.
3. *Nagagami* - 1.2M - MATV distribution to 5-6 locations; antenna mounted on solid wooden platform base; LCET left on continuously; antenna repointed twice by DOC.
4. *Jellicoe* - 1.2M - Home use; antenna installed on wooden platform resting on earth and weighted down by concrete blocks; some hum was noted on video, eliminated by slightly increasing voltage to ODU; ODU malfunctioned above 90°F ambient, solved by use of ice packs placed on ODU by user; IDU output feeds a 75 Ω splitter feeding two homes; antenna repeaked once by DOC.
5. *Geraldton* - 1.2M - Cable head-end; antenna mounted on top of concrete blocks, then weighted down with more blocks; antenna repeaked once by user; experience AFC lock-up problems when transmissions begin.
6. *Longlac* - 1.2M - Home use; installed on base made of laminated 2 x 10 inch planks, bolted to planks; two 300 ohm baluns hooked in parallel to conventional TV set; TV set is tuned to channel 8 to pick up OECA because of interference from a local Channel 4 when tuned to Channel 3; LCET remodulator puts out same signal on Channel 8, about 10 dB down from proper signal on Channel 3; DOC repeaked the antenna twice.
7. *Caramat* - 1.2M - Home use; 2 planks on earth, concrete block weighting; user had changed houses and dish and ODU were sitting in back yard; we set up and aligned antennna but found that IDU was not functioning properly and had to be replaced.

8. *MacDiarmid* - 1.2M - Home use; sitting on earth with rock weighting; antenna had not been peaked since original installation.
9. *Quetico Centre* - 1.2M - MATV distributed to about 7 points within 1 kilometer; mounted on carport with bolts and a few concrete blocks; converted from Channel 3 to Channel 13 to prevent interference on local Channels 2 and 4; AFC not functioning on unit that was here, another unit was left and it had to be tuned daily when signal came on.
10. *Atikokan* - 1.8M - Cable company; roof installation, concrete block weighting; after signal goes through cable system it is degraded substantially by the cable system; requires daily tuning when OECA first comes on.
11. *Fort Frances* - 1.8M - Cable company; installed on 2 wooden planks, concrete patio-stone weighting; peaked once by DOC and once by user with no problem; children have been seen climbing on dish and there was no apparent damage.
12. *Emo* - 1.8M - Home use; installed on small boards, concrete block weighting; signal from LCET is summed a couple of times with other signals, consequently, it is very noisy on user's TV set.
13. *Rainy River* - 1.8M - Home use; 2 x 4 inch boards on earth, concrete block weighting; unit never needs tuning if left on.
14. *Nestor Falls* - 1.8M - Home use; wooden beams on earth, bolted to beams; remodulator changed from Channel 3 to Channel 4 and there was substantial improvement.
15. *Kenora* - 1.8M - Cable company; large 8 x 10 inch timbers on sidewalk, weighted down with another beam; no tuning required if unit left on.
16. *Dryden* - 1.8M - Cable head end; sits on three large cable spools with rock weighting; needs tuning every day but note that IDU was in an unheated hut.
17. *Ignace* - 1.2M - MATV; distributed to twelve apartments; sitting on earth with long nails holding it in ground; semi-rigid cable had been broken at ODU and user attempted a repair resulting in a shorted cable and burned, but still usable connector, on ODU.
18. *Beardmore* - Cable company; roof installation, concrete block weighting; never repeaked since installation.
19. *Rosspport* - 1.2M - Home use; boards on earth with brick weighting; hum noticeable during tests but not on user's set.

- 20. *Manitowadge* - 1.8M - Cable company; roof mounted, concrete block weighting; IDU not working properly, has to be replaced; this antenna has blown over, breaking the semi-rigid coax. and bending the struts.
- 21. *Marathon* - 1.8M - Cable company; roof mounted, concrete block weighting LCET left on at all times.
- 22. *White River* - 1.2M - Cable company; installed on roof of small shed; sand bag weighting; daily tuning required.
- 23. *Wawa* - 1.2M - Home use; sitting on concrete window well, no weighting; audio was very bad on arrival at site, with some adjustments it improved but there is still something wrong with the audio.
- 24. *Chapleau* - 1.8M - Cable company; roof installation, bolted down; when connected to cable system it was very noisy until we realized that the user was attenuating OECA Channel 3 from the remodulator to prevent interference with other channels. By removing some attenuation OECA can be made acceptable and still not interfere with other channels.
- 25. *Foleyet* - 1.2M - Home use; earth with concrete block weighting; unit is turned off when not in use because it interferes with other channels; antenna peaked once by user while observing TV set.

A P P E N D I X C

Method for Analysis of C/N and S/N_v Measurement Data

C1. THEORETICAL PREDICTION OF C/N

C1.1 ASSUMPTIONS

Deviation	= 6.0 MHz peak
Implementation Margin	= 1.0 dB
Atmospheric Attenuation	= 0.26 dB
Antenna Efficiency	= 65%
System Temperature	= measured Ts + 50K
Pointing Loss	= 0 dB
Received Predetection Bandwidth	= 19 MHz
Audio Bandwidth	= 10 KHz
Audio Demod. Implementation Loss	= 2 dB
Audio Subcarrier Deviation	= 60 KHz peak
Carrier Deviation by Audio Subcarrier	= 0.99 MHz peak
Uplink CNR - Was large and assumed infinite for these calculations	

The received C/N was calculated from:

$$\frac{C}{N} = \text{EIRP} - \text{FSL} - \text{Atm Atten} + \frac{G}{T} - K - B$$

where	EIRP	= effective isotropic radiated power from satellite
	FSL	= free space loss
	Atm Atten	= atmospheric attenuation
	G/T	= receive station figure of merit
	K	= Boltzman's constant
	B	= IF filter bandwidth

C2. THEORETICAL PREDICTION OF S/N_V AND S/N_A

The following two equations were used:

$$S/N_V = 10 \log 3/2 + 20 \log \left\{ 2\sqrt{2} \frac{100}{140} \right\} + \text{WP} - \text{IM}$$

$$+ 20 \log \frac{\Delta f_V}{f_V} - 10 \log f_V + \frac{C}{N} + 10 \log \text{BW.}$$

where: WP = weighting and pre-emphasis = 12.8 dB
 Δf_v = 6.0 MHz
 f_v = 4.2 MHz
 BW = 19 MHz
 IM = 1.0 dB

For the parameters used in the pilot project, this equation reduces to:

$$S/N_v = C/N + 29.3 \text{ dB.}$$

$$S/N_A = 10\log 3/4 + WP - IM + 20\log \Delta f_c + 20\log \Delta f_a \\ - 30\log f_a - 20\log f_{sc} + \frac{C}{N} + 10\log BW$$

where: WP = weighting and pr-emphasis = 9.6 dB
 IM = implementation margin = 1.0 dB
 Δf_c = 0.99 MHz peak
 Δf_a = 60 KHz peak
 f_a = 10 KHz
 f_{sc} = 5.14 MHz
 BW = 19 MHz

C3. CALCULATION OF MEASURED SATURATED S/N_v FOR SATELLITE TEST (TEST #1)

$$S/N_v = -6.8 \text{ dBm} + 6.1 \text{ dB} - (\text{Noise power}) + \Delta \text{ Deviation}$$

-6.8 dBm = 1.0 volt peak-to-peak test signal.

6.1 dB = conversion from peak-to-peak to blank-to-white level is required by CCIR definition

Δ Deviation was added to account for the deviation sensitivity the terminal was set to.

An additional error was accounted for by an erroneous setting of the test signal deviation. The deviation was in error by:

$$20\log\left(\frac{388 \text{ mv}}{321 \text{ mw}}\right) = 1.63 \text{ dB}$$

Hence Δ Deviation was derived as:

$$20\log\left(\frac{\text{Total IRE}}{140}\right) - 1.63 \text{ dB.}$$

C4. INSTRUMENT READING ADJUSTMENT FOR OVER DEVIATION AND INCORRECT INPUT SIGNAL AMPLITUDE

The signal-to-noise ratio was measured by several instruments, including a Tektronix model # 1430 and a Marconi model # TF 2914. The Tektronix instrument provides a reading relative to a blank-to-white signal amplitude. Hence, for an incorrect deviation sensitivity setting, the measurement is normalized to 6.0 MHz peak by:

$$S/N = \text{Tek. reading} + 20\log\left(\frac{\Delta \text{ Deviation (measure)}}{\Delta \text{ Deviation 1 volt p-p}}\right)$$

The deviation sensitivity offset from 6.0 MHz peak of the IDU can be found from:

$$\Delta \text{ Dev} = 20\log \frac{\text{IRE units}}{140} - 1.63 \text{ dB.}$$

The level of the OECA signal blank-to-white level can then be found by:

$$\Delta \text{ Amplitude} = 20\log \frac{100 + 10^{(\Delta \text{ Dev}/20)}}{\text{Bar Amplitude}} .$$

For the Marconi instrument, which measures bar amplitude to noise level, the $\Delta \text{ Amplitude}$ needs to be added to the S/N to normalize for a 1 volt peak-to-peak input signal.

A P P E N D I X D
Condensed Field Test Data

Installation Date	Location	Ant. Size (m)	Use	Serial Number		Pol. Angle Error	Weather		
				IDU	ODU		Site	Ottawa	Toronto
Feb 80	1. Moonbeam	1.2	Home	3-101468	056	12°	Heavy Cloud		
Oct 79	2. Mattice	1.2	CATV	3-101405	027	0.7°	Mod Cloud Light Snow	Light Rain	Light, Mod Rain, Cloud
Jan 80	3. Nagagami	1.2	MATV	3-101412	071	11.5°	Mod Cloud Light Snow	Light Winds	Light Cloud
Nov 79	4. Jellicoe	1.2	Home	3-101426	082	9.2°	Mod Cloud		
Nov 79	5. Geraldton	1.2	CATV	3-101453	051	5.6°	Mod Cloud	Light Cloud Light Winds	Mod Cloud Light Winds
Jan 80	6. Longlac	1.2	Home	3-101421	077	7.6°	Clear	Light Cloud Light Winds	Light Winds
Jan 80	7. Caramat	1.2	Home	3-10443	063		Light Cloud	Light Cloud Mod Winds	Light Cloud Light Winds
Sept 79	8. MacDiarmid	1.2	Home	9-060423	009	0.7°	Light Cloud	Light Winds	Light Winds
Dec 79	9. Quetico Centre	1.2	MATV	3-101420	008	4.7°	Clear	Light Cloud Light Wind	Heavy Cloud Light Rain Light Winds
Sept 79	10. Atikokan	1.8	CATV	9-060403	012	3.6°	Mod Cloud	Mod Clouds Light Winds	Light Cloud Light Wind
Jan 80	11. Fort Frances	1.8	CATV	3-101429	072	0.3°	Clear		
Feb 80	12. Emo	1.8	Home	3-101407	074	2.0°	Mod Cloud	Light Clouds Mod Winds	Mod Cloud Light Winds
Feb 80	13. Rainy River	1.8	Home	3-101439	026		Mod Cloud	Mod Cloud Light Winds	Mod Clouds Light Rain Light Wind
Feb 80	14. Nestor Falls	1.8	Home	3-101442	040	7.2°	Light Cloud	Mod Cloud	Mod Cloud Light Winds
Dec 79	15. Kenora	1.8	CATV	9-060427	005	15.6°	Heavy Cloud Light Snow	Light Cloud	Light Winds
Oct 79	16. Dryden	1.8	CATV	3-101470	019	4.0°	Heavy Cloud Light Snow	Light Winds	Light Winds
Dec 79	17. Ignace	1.2	MATV	3-101428	065	15.4°	Mod Cloud Light Snow		
Nov 79	18. Beardmore	1.2	CATV	3-101406	058	1.1°	Mod Cloud Light Snow		
Jan 80	19. Rossport	1.2	Home	3-101447	085	3.8°	Clear		

Installation Date	Location	Ant. Size (m)	Use	Serial Number		Pol. Angle Error	Weather		
				IDU	ODU		Site	Ottawa	Toronto
Nov 79	20. Manitouwadge	1.8	CATV	3-101397	031	7.1°	Heavy Cloud Light Snow	Mod Cloud Light Winds	Light Winds
Sept 79	21. Marathon	1.8	CATV	3-101403	021	0.4°	Mod Cloud	Light Cloud Mod Wind	Heavy Winds
Feb 80	22. White River	1.2	CATV	3-101404	048	16.4°	Light Cloud		
Feb 80	23. Wawa	1.2	Home	3-101475	062	17.3°	Mod Cloud	Mod Cloud Light Winds	Mod Cloud Light Winds
Mar 80	24. Chapleau	1.8	CATV	3-101471	097	9.2°	Mod Cloud	Heavy Cloud Light Rain	Mod Cloud Light Winds
Feb 80	25. Foleyet	1.2	Home	3-101465	090	7.8°	Light Cloud	Mod Cloud Mod Winds	Mod Cloud Mod Winds

Site	Test #1 Sat. Carrier		Test #2 OECA Sig.		Test #4 Noise Figure (OECA) (dB)					
	C/N After Align. (dB)	Change in Peak Sig. (dB)	C/N After Align. (dB)	Change in Peak Sig. (dB)	x = Tuning Voltage for Chan 2					
					x-2	x	x+2	x+4	x+6	x+8
1	12.0	1.8	13.5	1.2	4.6	5.1	5.3	5.6	5.3	5.0
2	13.5	0.5	11.8		3.8	4.12	4.6	5.1	5.4	5.1
3	14.14	0.2	14.0		4.44	4.6	4.38	4.76	5.25	5.2
4			17.1		2.7	3.8	2.3	3.8	4.4	4.4
5	15.8	2.0	14.55		3.85	4.0	4.28	5.25	4.98	4.60
6	13.7	0.25	12.35		4.12	4.0	4.12	4.9	4.6	4.6
7	15.7				3.7	4.3	4.1	4.3	4.7	4.4
8	14.5	-0.25	12.7	0.0	5.8	5.9	5.3	7.2	6.6	7.8
9	13.1	0.25	13.5		5.36	5.0	5.69	5.64	5.20	5.47
10	17.5	2.1	17.2		4.49	4.49	4.60	4.92	5.25	5.09
11			13.25		4.76	4.38	4.71	5.25	4.92	4.82
12	13.25	1.0	12.2		4.28	3.96	3.65	4.01	3.96	4.12
13	13.7	1.0	13.1		4.65	4.87	4.44	5.14	5.42	4.92
14	13.7	1.15	13.8		3.90	4.06	5.36	5.58	4.71	4.38
15	13.5	1.0	13.7	0.85	4.44	4.76	4.92	5.47	4.87	4.55
16	14.7	0.15	14.25		4.06	4.60	4.55	4.55	5.80	5.53
17			13.0		4.01	3.96	4.06	4.87	5.09	4.92
18			13.8		6.25	5.69	5.80	6.1	4.82	4.49
19			11.9		5.25	5.36	5.53	6.4	6.4	6.65
20	16.0	0.1	12.14		4.38	5.09	5.20	5.42	5.7	5.31
21	15.5	0.1	14.3		4.55	4.60	5.14	5.14	5.25	5.20
22			12.5	0.9	4.82	5.03	4.82	5.14	5.03	5.53
23	13.0	1.15	12.14		4.06	4.55	4.49	5.75	5.80	4.92
24	13.1	1.65	13.1		4.0	4.4	4.6	5.25	4.8	4.4
25	12.3	0.25	12.3		4.1	4.4	4.4	5.5	6.1	5.8

Site	Test #5				Test #6					Comments
	Tune Level Ind.	Rec. Sig. Ind.	I.F. Freq. MHz	C/N 300 (dB)	C/N (dB)	S/N _v (dB)	S/N _a (dB)	Threshold Vid. (dB)	Threshold Aud. (dB)	
1	6.5	21	70.3	39.5	18.5	38.7	52.2	9.2		Unit not working — Cable cut and repaired.
2	8.5	30	71.4	39.0	18.3	38.1	53.2	8.0	11.4	Must be tuned daily.
3	6.5	42	70.6	39.0	17.8	38.15	52.5	8.0	11.8	
4	6.5	48	70.2	39.5	19.2	38.2	51.8	8.8	9.4	ODU needs cooling cloths above 90°F.
5	6.5	27	70.3	39.5	18.2	38.5	50.8	7.2	10.0	
6	7.0	37	70.1	40.0	17.9	38.6	52.1	6.8	7.8	
7	7.0	25		41.0						IDU unit U/S — not aligned before arrival.
8	4.0	31	70.7	38.0	16.8	37.95	48.3	8.0		
9	8.0	48		38.5	18.0	36.2	51.2	7.1		No AFC — IDU changed after tests.
10	5.0	45	71.5	41.0	19.7	38.4	51.7	8.8	10.8	Very poor after cable system.
11	7.0	42	71.3	39.0	17.5	37.7	51.3	7.8	8.2	
12	7.5	40	69.3	40.0	18.5	40.04	51.3	7.7	10.9	User had too many splitters in system.
13	7.0	46	69.3	39.0	17.9	37.2	52.5	6.8	7.7	ODU installed on site.
14	7.0	28	70.7	39.5	18.3	39.25	51.8	7.1		Would not work in Chan 4.
15	6.0	17	71.8	39.5	17.4	37.5	51.6	9.1	8.4	Extra run done with snow in dish.
16	6.0	28	69.9	39.0	17.8	39.25	51.8	7.0	6.9	Voltage regulator required for Spectrum Analyzer and LCET
17	6.0	28	70.2	40.0	19.35	37.85	50.4	8.4	9.8	Cable to ODU broken and repaired.
18	8.0	22	69.5	38.5	18.4	36.95	50.7	7.0	11.8	
19	7.0	18	69.8	38.5	16.8	37.4	50.3	6.2	7.85	
20	8.5	19	71.4	40.0	18.3	48.5	49.7			Unit not working properly.
21	7.0	42	70.4	39.0	15.7	37.6	46.1	5.3		C/N is probably wrong due to oscillation.
22	8.0	28	70.2	38.0	17.5	38.55	51.0	7.0	10.0	SMA loose on ODU and cable would not come off.
23	7.0	33	70.2	40.0	18.2	39.15		7.7		Audio discriminator not working properly.
24	7.0	48	70.3	39.5	18.3	39.5	54.3	9.3		
25	7.0	0	70.1	39.0	18.0	39.75	51.2	6.0	8.0	

Site	Test #3																		
	OECA Video Parameters																		
	Bar (IRE)	Sync (IRE)	2T P/B (%)	C/L Gain (%)	C/L Del (nSec)	Noise ₁ (dB)	Bar Tilt (IRE)	2T 'K' Fact (%)	Diff Gain (%)	Diff Phase (Degrees)	MB ₂ IRE 1	* MB IRE 2	MB IRE 3	MB IRE 4	MB IRE 5	MB IRE 6	Field Tilt	Vert Int Disc ₃ (IRE)	Sub Video Qual ₄ (dB)
1	92	38	90	92	150		2.0				50	45	40	40	40	35	0	38	Above Thres.
2	98	41.5	95	87.5	170	31.9	-0.3	5.5	12.4	4.5	45.5	44.6	41.6	39.0	41.8	41.0	0	4	Above Thres.
3	88.9	37.9	93.2	90.1	105	34.4	+1.1	4.2	3.0	2.3	46.0	44.5	41.8	40.5	43.0	42.3	0	5	+2
4	117.5	51.0	95.4	96.0	117.2	35.5	+2.3	+3.8	3.8	6.2	45.8	50.2	44.8	45.1	44.2	44.3	0	10	+2
5	99.0	39.0	92.0	90.0	100.0		2.0		0		50.0	47.0	40.0	40.0	42.0	43.0	0	15	+4
6	92.4	41.3	80.1	85.0	160.1	32.0	3.9	10.6	8.0	2.5	46.9	46.5	42.2	40.4	43.3	41.1	0	+5	+3
7																			
8	106	43	82	84	150		0										0	10	+3
9	173.0	67.6	86.1	92.4	130	33.0	2.2	5.0	7.5	8.4	47.9	48.0	44.4	40.9	45.0	43.4	0	20	+3
10	160	57	87	88	150		0		10		90	80	80	80	80	80	-3	20	+2
11	120	52	94	94	96	35	0.6	3.6	10.0	8.0	43.5		41.5	40.9	44.0	43.0	0	10	+2
12	113.2	47.3	90.0	81.5	77.8	34.6	0.6	4.0	6.3	2.9	41.6	41.4	36.0	35.0	37.9	34.1	0	10	+3
13	126.4	54.2	86.5	85.7	108		2.3	4.6	5.1	7.5	42.6	43.0	39.9	38.7	31.9	31.4	0	15	+4
14	121	52	90.7	84.1	71.0		0.2	3.6	12.1	7.7	43.6	42.8	38.1	38.1	41.2	38.0	0	11	+3
15	104.1	46.3	91.2	90.6	120.0		0.5	4.3	5.3	6.3	44.2	44.0	40.6	37.6	42.6	37.5	0	10	+4
16	115.5	49.8	86.4	88.0	122		1.0	4.1	4.7	8.0	42.5		39.5	43.4	41.4	35.9	0	5	+4
17	119.0	50.0	93.0	96	84		-0.5	4.2	6.0	3.0	43.5		42.7	41.0	45.5	37.0	0	8	+4
18	85.2	36.3	95	94.4	120.0		1.2	3.7	2.5	3.3	43.8	44.7	39.4	41.2	44.1	41.9	0	10	+4
19	114.5	49.0	84	84.3	76.4	32.9	-0.6	4.8	6.5	6.2	41.8	40.4		41.8	40.6	36.1	0	5	+2
20	98.3	45.3	80	75	113.7		1.7	13.0	78.6	52.4			43.5				0	20	+4
21	85.7	38.4	98.9	100.4	93.1	37.6	0.2	2.8	13.8	6.6	44.5		42.2	45.1	48.8	46.8	0	8	+4
22	113	48	93	90.5	83.1	33.3	1.4	4.4	3.8	2.0	43.2		37	38.9	42.5	40.8	0	10	+2
23	117	50.5	88.0	85.9	82.4	33.5	0.5	4.2	4.5	3.3	41.8	41.0	41.0	37	41.9	36.7	0	5	+3
24	110	46.3	90.2	82.7	61.1	35.5	0.4	3.6	13.5	6.7	51.4	46.1	41.0	41.9	43.8	44.5	0	5	+4
25	120.7	52.2	90.1	87.3	93.7		1.2	4.0	11.2	8.1	42.9	42.4	39.5	37.8	41.4	38.7	0	10	+2

Site	Test #3 OECA		Test #7 Bench Tests Video													
	SNR TEK Unweighted (dB)	SNR TEK Weighted (dB)	Bar (IRE)	Sync (IRE)	2T P/B (%)	C/L Gain (%)	C/L Del (n sec)	Noise (dB)	Bar Tilt (IRE)	2T 'K' Fact (%)	Diff Gain (%)	Diff Phase (Degrees)	Field Tilt (IRE)	Vert Int Disc ₃ (IRE)	SNR TEK Unweighted (dB)	SNR TEK Weighted (dB)
1	34	44	126	45	82	90	<50		5.0		7		0	40	39	48
2	33	42	125.1	49.2	95.5	90.9	120		3.0	5.1	6	4.2	0	7	39	48
3	36	45	114.1	45.2	94.4	93.1	101.9	41.0	4.0	2.3	5.8	2.8	0	7	39	48
4	35	43	147.2	57.7	94.7	90.8	157.1	40.8	5.0	4.6	3.5	5.0	0	12	37	46
5	36	46	128.0	45	94	94	160		4.0		3		0	15	40	49.5
6	34	42	125	49.3	71	86	159	41.3	7.0	7.8	4.7	3.0	0	7	39	49.5
7																
8	36	45	117.5	45.8	85.5	74.1	49	42.2	3.3	2.5	6.8	3.0	0	10	40	50
9	31	40	173.3	67.6	87.2	85.2	147.3	40.0	4.9	4.0	9.3	3.7	0	20	33	42
10	35	44	173.7	67.9	91.0	81.5	52.8	41.7	3.2	2.7	17.6	8.5	0	25	38	47
11	33	43	134	54	94.0	94.1	92.6	40.8	4.7	2.8	13.0	8.1	0	12	37	46
12	33	43	123.7	48.2	92	85.5	90.0	42.1	2.8	3.2	5.7	6.8	0	8	40	50
13	31	40	142	55.7	86.4	83.6	103	40.3	5.0	2.7	8.2	6.4	0	15	38	48
14	34	43	136	52.2	90.8	83.7	61.8	42.5	3.4	3.0	18.0	9.5	0	12	39	49
15	34	43	118.2	48.6	91.6	93.3	113.8	39.5	3.5	2.6	3.1	6.4	0	10	37	47
16	36	44	129.6	50.4	85.5	85.9	130.2	41.8	4.3	3.0	8.4	6.8	0	10	39	48
17	32	41	132	51	94.5	99.2	90.0	41.2	2.6	2.4	10.0	3.1	0	10	38	49
18	38	46	95.6	39.0	95.4	92.5	134	39.5	4.0	2.7	5.1	4.0	0	13	39	48
19	32	42	130.2	50.3	85	82.7	79.9	40.5	1.9	3.8	9.2	5.6	0	8	38	47
20																
21	39	48	113.5	46.8	98.7	97.9	98.8	40.8	3.7	2.3	10.0	6.9	0	10	40	49
22	33	42	126.9	47.8	93.7	91.3	92.2	39.9	4.2	4.1	5.5	3.7	0	8	40	49
23	33	42	133.2	52.2	90.0	86.6	86.7	42.0	3.7	3.1	7.5	4.9	0	10	39	48
24	35	44	125.4	48.5	91.3	79.9	61.5	43.0	3.6	3.5	17.4	6.8	0	6	43	51
25	32	43	134.1	52.2	91.0	85.1	86.4	42.2	4.1	3.6	12.2	8.3	0	11	40	48

Site	Test #7 Bench Tests Video (After Video Level was Adjusted)														Test #8	
	Bar (IRE)	Sync (IRE)	2T P/B (%)	C/L Gain (%)	C/L Del (n Sec)	Noise ₁ (dB)	Bar Tilt (IRE)	2T 'K' Fact (%)	Diff Gain (%)	Diff Phase (Degrees)	Field Tilt (IRE)	Vert Int Disc (IRE)	SNR TEK Unweighted (dB)	SNR TEK Weighted (dB)	Remod Carriers to Bursts (dB)	Subj Vid Quality on User's Set (dB)
1	100	38	91	97	< 50		2.0		7				41	50	22	Above Thres.
2	100.5	38.4	93.1	87.0	90.0	41.6	2.9	4.9	7.7	2.9	0	7	41	51	20	Above Thres.
3	102.4	40.5	94.7	92.7	100.9	40.9	4.2	2.2	4.6	2.2	0	7	40	48	20	+2
4	101.3	40.2	94.4	89.8	153.5	40.6	5.0	4.6	5.3	4.2	0	7.5	40	49	20	+2
5	100.0	38.0	96	96	150		2.0		3		0	15	41	51	21	+4
6	100.0	39.5	71.0	86	156	41.2	7.3	7.8	3.5	2.9	0	6	42	49.5	24	+1
7																
8	100.0	38.8	84.0	73	51	41.8	3.4	2.5	5.2	1.5	0	10	41	51	22	+2
9	102.1	41.7	88.5	86.4	116.3	40.0	5.5	2.9	9.0	2.2	0	10	38	49	22	+3
10	99.7	39.9	92.0	82.0	46.8	42.4	3.1	2.8	11.8	5.0	0	15	42	51	21	0
11	101	41	94	93	90	40.6	4.1	2.7	10.6	6.8	0	10	41	50	22	+2
12	100.1	39.2	90.3	85.5	84.2	42.7	3.5	2.7	6.4	2.0	0	8	42	51	21	-2
13	100.7	41.1	87.2	83.5	97.4	40.6	5.5	2.7	6.8	5.2	0	10	40	49	20	+4
14	100.5	38.9	90.0	83.0	69.3	42.4	3.3	3.3	12.1	5.1	0	10	43	52	21	+3
15	100.6	40.7	92.1	91.9	123.9	40.3	3.6	2.5	3.7	6.7	0	8	41	50	22	+4
16	100.0	39.1	87.4	89.2	124.8	41.7	3.4	3.1	6.6	4.3	0	5	41	50	22	+4
17	101.0	39.4	94.5	98.6	84.7	41.0	3.1	2.4	8.5	2.3	0	8	41	50	22	
18	100.4	39.0	92.6	90.0	116	40.1	4.1	2.5	2.4	5.9	0	12	40	49	21	
19	100.2	38.3	82.6	82.4	90.0	40.2	1.5	3.7	10.1	2.5	0	5	40	50	21	+1
20	100.0	40	80	72			2.6	1.3		3.2	0	22	49	57	24	
21	102.1	41.7	99.4	99.2	86.6	41.9	3.5	2.3	14.8	4.8	0	8	40	50	21	+2
22	99.8	37.8	94.0	90.3	85.0	40.1	3.9	4.2	3.7	4.9	0	8	40	49	20	+1
23	101.9	39.7	89.8	86.8	84.7	41.6	3.8	3.7	6.6	2.3	0	7	42	52	21	+1
24	100.4	39.1	90.7	80.6	54.4	43.0	2.7	3.4	21.7	4.8	0	6	43	51	22	+2
25	101.3	39.1	91.1	87.3	90.8	41.9	3.5	4.1	8.0	7.4	0	9	42	51	22	+1

Manufacturer's Test Data													
Site	Serial Number		Noise Figure (dB)						Diff		S/N _V (dB)	S/N _A (dB)	Threshold (dB)
	IDU	ODU	11.7 GHz	11.8 GHz	11.9 GHz	12.0 GHz	12.1 GHz	12.2 GHz	Phase (Degrees)	Gain (%)			
1. Moonbeam	3-101468	056	4.45	4.45	4.75	4.45	4.65	4.85	3.2	6	40.0	44.3	9.5
2. Mattice	3-101405	027	3.50	3.65	3.85	4.05	3.70	4.20	5.2	4.0	41.4	49.5	9.4
3. Nagagami	3-101412	071	4.65	4.00	4.10	4.15	3.80	4.05	2.7	14	41.3	48.8	9.5
4. Jellico	3-101426	082	3.45	3.55	3.45	3.25	3.40	3.45	2.6	6	41.5	49.0	9.5
5. Geraldton	3-101453	051	4.00	4.20	3.90	4.00	3.90	4.20	6.8	7	41.0	48.1	9.5
6. Longlac	3-101421	077	3.90	3.50	3.60	3.45	3.35	3.55	2.7	14	41.5	48.6	9.5
7. Caramat	3-101443	063	4.25	4.20	3.85	3.85	3.90	4.35	3.0	7	41.3	47.5	9.5
8. MacDiarmid	9-060423	009	4.7	4.7	4.5	4.5	4.3	4.8	6.0	10	41.2	45.6	9.5
9. Quetico Centre	3-101420	008	4.70	4.25	4.40	4.25	4.10	4.50	5.1	10	41.7	49.7	9.4
10. Atikokan	9-060403	012	4.7	4.4	4.8	4.7	4.5	4.6					
11. Fort Frances	3-101429	072	4.25	4.15	4.55	4.00	3.95	4.00	5	13	40.6	48.3	9.5
12. Emo	3-101407	074	3.90	3.30	3.55	3.30	3.30	3.55	1.1	1.5	42.0	48.2	9.5
13. Rainy River	3-101439	026	4.90	4.05	4.35	4.25	3.70	3.75	7.2	15	41.0	48.3	9.3
14. Nestor Falls	3-101442	040	4.45	3.85	4.00	3.65	3.40	3.50	3	8	41.7	47.4	9.4
15. Kenora	9-060427	005	4.5	4.8	4.0	4.1	4.1	4.2	6	3	41.6	48.2	9.5
16. Dryden	3-101470	019	4.0	3.8	4.0	3.7	3.4	3.6	3.2	6	40.6	48.7	9.5
17. Ignace	3-101428	065	4.45	3.85	4.10	3.90	3.80	4.05	4.3	10	41.0	47.6	9.5
18. Beardmore	3-101406	058	4.80	4.60	3.95	3.85	3.90	4.00	0.6	4	41.3	49.2	9.3
19. Rossport	3-101447	085	4.65	4.40	4.85	4.30	4.35	4.30	5.7	14	41.8	48.3	9.4
20. Manitouswadge	3-101397	031	4.25	3.90	4.40	4.00	3.75	4.00	2	5	41.0	48.2	9.5
21. Marathon	3-101403	021	3.8	3.7	3.8	3.6	3.5	3.5	1.6	15	40.6	48.8	9.3
22. White River	3-101404	048	4.85	4.85	4.80	4.45	4.40	4.40	3.7	9	41.7	50.5	9.3
23. Wawa	3-101475	062	4.40	4.40	4.85	4.40	4.70	4.60	5.1	15	40.0	47.5	9.5
24. Chapleau	3-101471	097	4.20	4.30	4.20	4.00	4.10	4.20	4.9	7	41.0	47.7	9.5
25. Foleyet	3-101465	090	4.50	3.85	4.45	4.00	4.15	4.25	3.3	6	41.1	47.1	9.5

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5. AUTHOR(s): R.W. Huck and E.L. Perrier

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17 Navigation, Communications, Detection, and Countermeasures

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8. ABSTRACT: ANIK-B has been used since September 1979 in a Program Delivery Pilot Project to test the direct satellite transmission of TV signals to low cost TVRO terminals (LCET's) to determine the technical performance of these terminals over a long period, the ability of users to operate the terminals, and the acceptability of the signals received. 43 LCET's which have been installed in Northwestern Ontario, receive programs of the Ontario Educational Communications Authority. In October 1980, a detailed technical evaluation was made of the performance of 25 of the terminals. This report describes the procedures used to make the on-site measurements and documents the results obtained.

9. CITATION: _____

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