Appendix C

Measurements of Power, Modulation and Occupied Bandwidth, Spurious, Freq. Stability

Measured Test Data

The OA1900C NR NETWORK REPEATER was tested as required by 47 CFR 2.985 through 2.997, inclusive, in accordance with §2.999. The system was configured as follows:

- Two channels of CDMA (one each, Primary and Growth Enclosure),
- Reverse link Diversity,
- B-Block Diplex Filters,
- OEM handheld cellular phone and modem, required for remote network maintenance,
- Battery backup and battery charger board.

2.985 RF Power Output

Requirement

For the power levels expected, spurious signals including intermodulation distortion must meet industry and FCC requirements. The industry specification is published as ANSI J-STD-008 and ANSI J-STD-019 PCS CDMA Requirement. The FCC requirement is governed by 47 CFR 24.238.

Test Equipment

The following equipment was utilized:

1. HP E2507B Multi-format Communications Signal Simulator (MCSS), Model 60
2. HP 8563E Spectrum Analyzer, 9 kHz to 26.5 GHz
3. HP 437B Power Meter, with HP8481A sensor
4. HP 8491C Attenuator, 30 dB 'N'
5. Narda 768-30 Attenuator, 30 dB 'N' (two each)
6. Weinschel Egrg. 910-10-33 Continuously adjustable Attenuator, 1 to 10 dB

Test Method

In each direction, the repeater was driven with a two-channel CDMA test signal, to the rated output power of each channel, at mid-band frequency. In the system, the Channel 1 and Channel 2 forward outputs appear at different antenna connectors, so two traces of spectrum analyzer plots are shown on each page.

In the forward direction, the signal generator Walsh codes are set for the following signal, per industry standard:

Channel Name	Code Domain Channel Number	Relative Level, dB
Pilot	0	-7
Paging	1	-7.3
Traffic	8	-10.3
Traffic	9	-10.3
Traffic	10	-10.3
Traffic	11	-10.3
Traffic	12	-10.3
Traffic	13	-10.3
Sync	32	-13.3

In the reverse direction, the same signal is used except that Paging, Traffic, and Sync are turned off. Test frequencies are 80 MHz lower.

Spectral re-growth was checked for compliance with industry specification.

The input CDMA signal is then shifted to each of the frequency block edges. Measurement of spectral density due to IMD is measured in accordance with 47 CFR 24.238.

Test Results

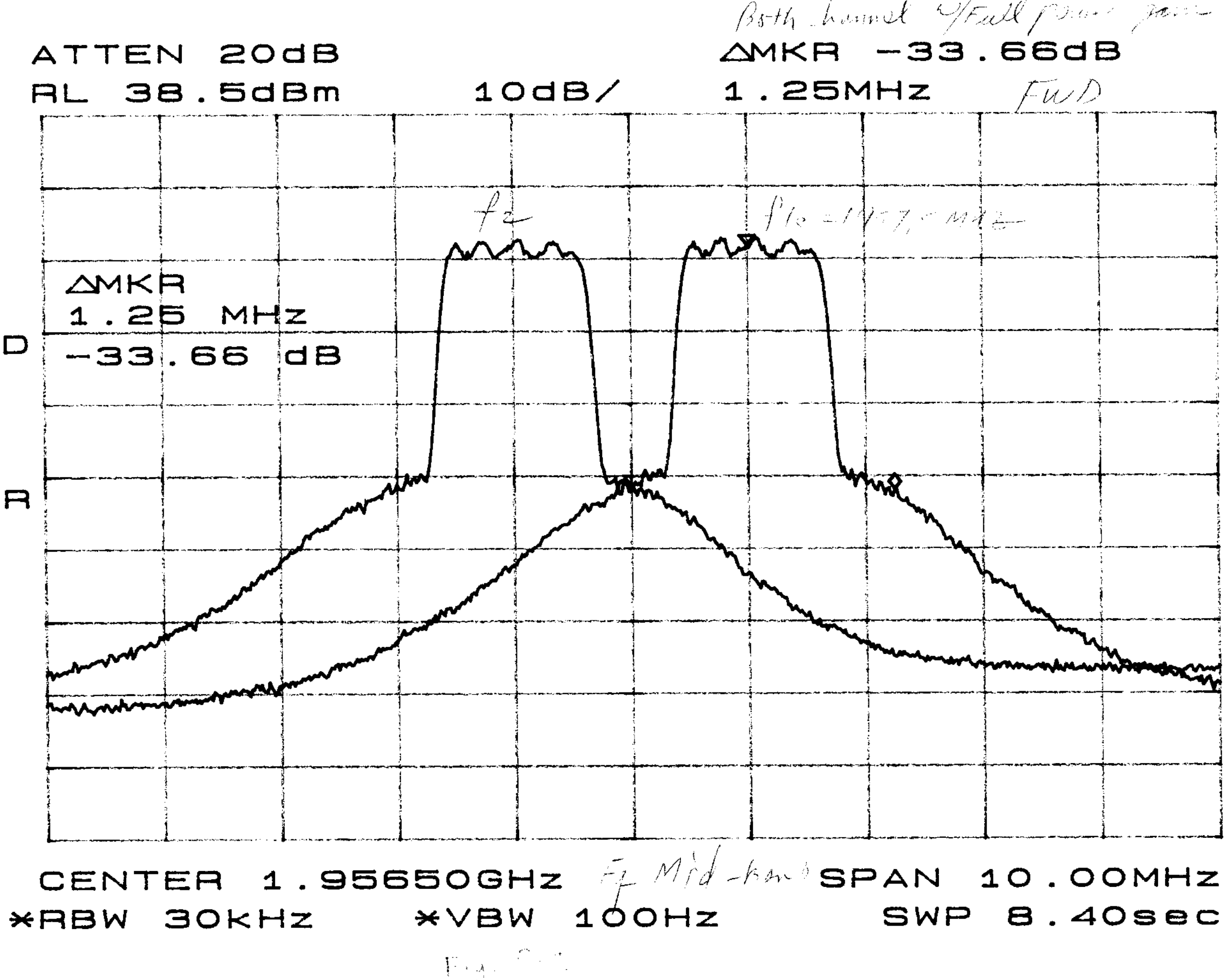
Summarized as follows:

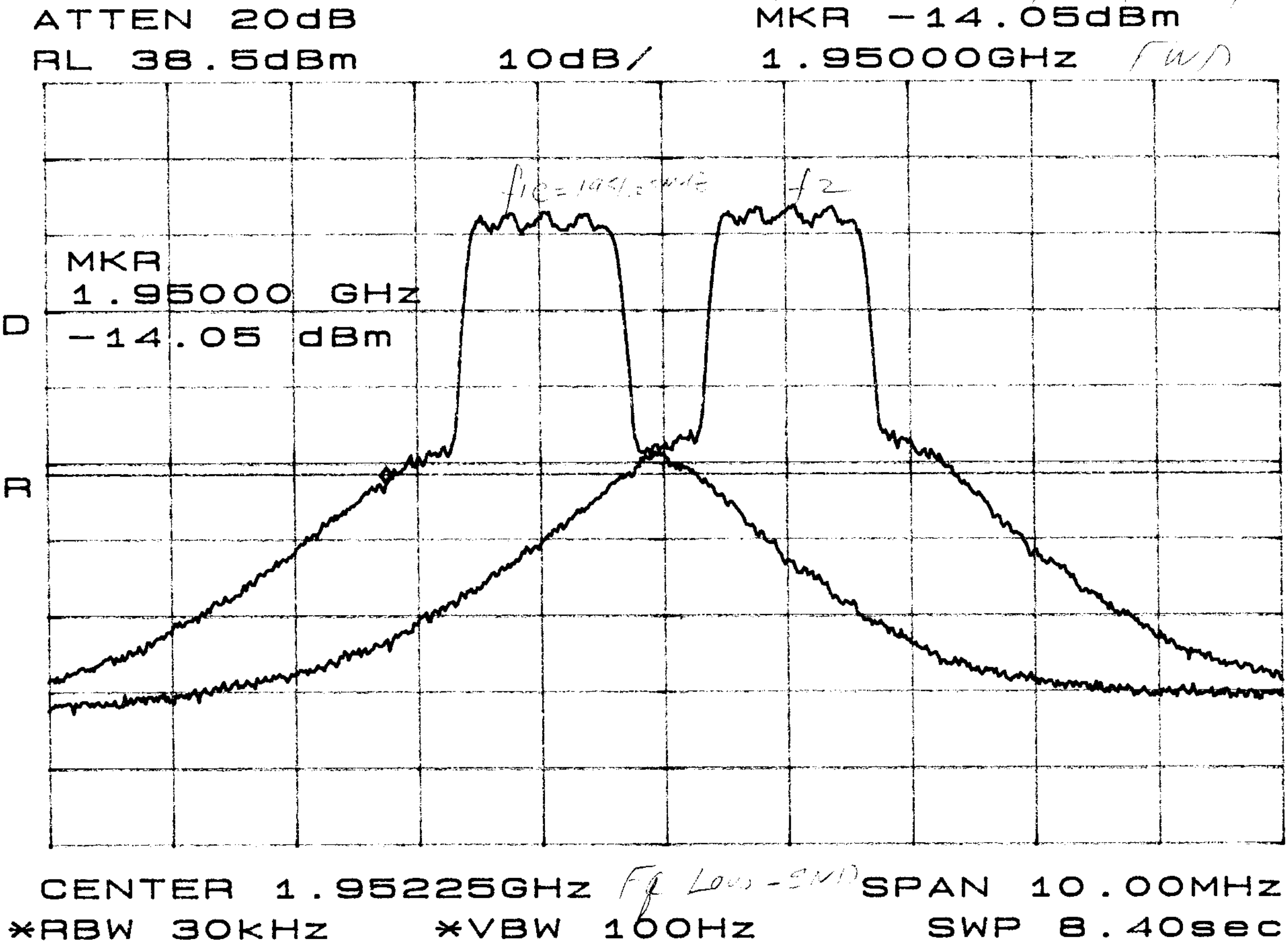
Direction	Frequency	Figure	Output Pwr., dBm	Requirement	Pass/Fail	Margin[1], dB
Forward	**mid-block**	**P-1**	**+38.5**	**ANSI J-STD-008**	**PASS (ref. only)**	**2 dB (ref. only)**
	Low-end of block	P-2	+38.5	47 CFR 24.238	PASS	-13 dBm -(-14 dBm) + 3.9 dB = 5 dB
	High end of block	P-3	+38.5	47 CFR 24.238	PASS	-13 dBm -(-14 dBm) + 3.9 dB = 5 dB
Reverse	**mid-block**	**P-4**	**+18**	**ANSI J-STD-008**	**PASS (ref. only)**	**3 dB (ref. only)**
	Low-end of block	P-5	+18	47 CFR 24.238	PASS	-13 dBm -(-36 dBm) + 3.9 dB = 27 dB
	high end of block	P-6	+18	47 CFR 24.238	PASS	-13 dBm -(-35 dBm) + 3.9 dB = 26 dB

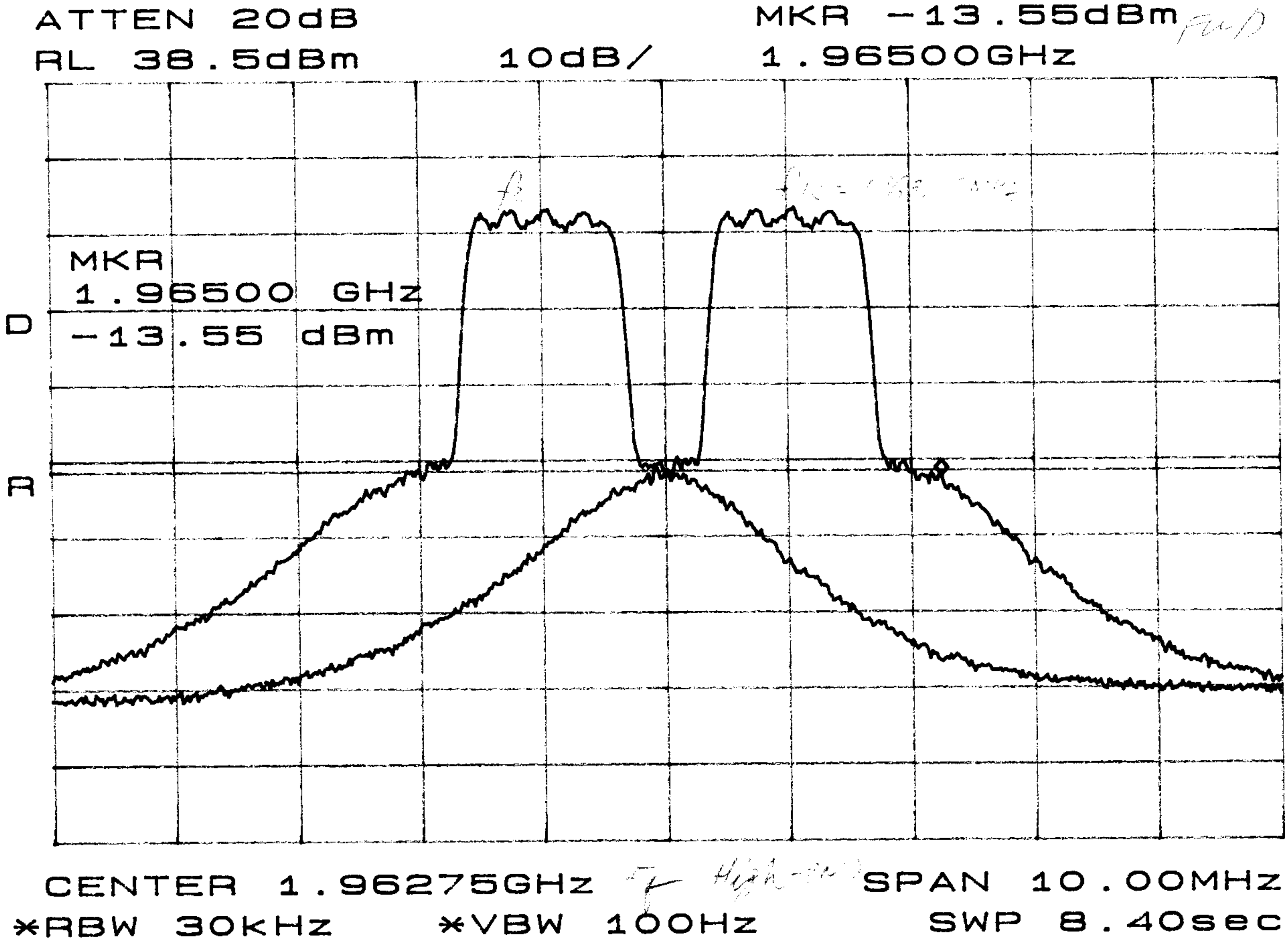
Table P- 1
Output Power and Emissions

Conclusion: The two-channel OA1900C NR meets industry and FCC specifications for emissions, when transmitting at rated output.

[1] 47 CFR 24.238(b) only requires 1% minimum bandwidth for this measurement. For a 1.23 MHz CDMA signal, a 12.3 kHz minimum RBW filter would be necessary. Since spectrum analyzers are commonly available with RBW filters in 1-3-10 ratio, the 30 kHz filter was used. A correction factor of 10log(30/12.3)=3.9 dB is shown.


Both channel w/Full power
ATTEN 20dB
RL 38.5dBm
10dB/
ΔMKR -33.66dB
1.25MHz
FWD
ΔMKR
1.25 MHz
-33.66 dB
D
R
CENTER 1.95650GHz
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec


ATTEN 20dB
RL 38.5dBm
10dB/
MKR -14.05dBm
1.95000GHz
MKR
1.95000 GHz
-14.05 dBm
D
R
CENTER 1.95225GHz
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec


ATTEN 20dB
RL 38.5dBm
10dB/
MKR -13.55dBm
1.96500GHz
MKR
1.96500 GHz
-13.55 dBm
D
R
CENTER 1.96275GHz
*RBW 30kHz
*VBW 100Hz
SPAN 10.00MHz
SWP 8.40sec

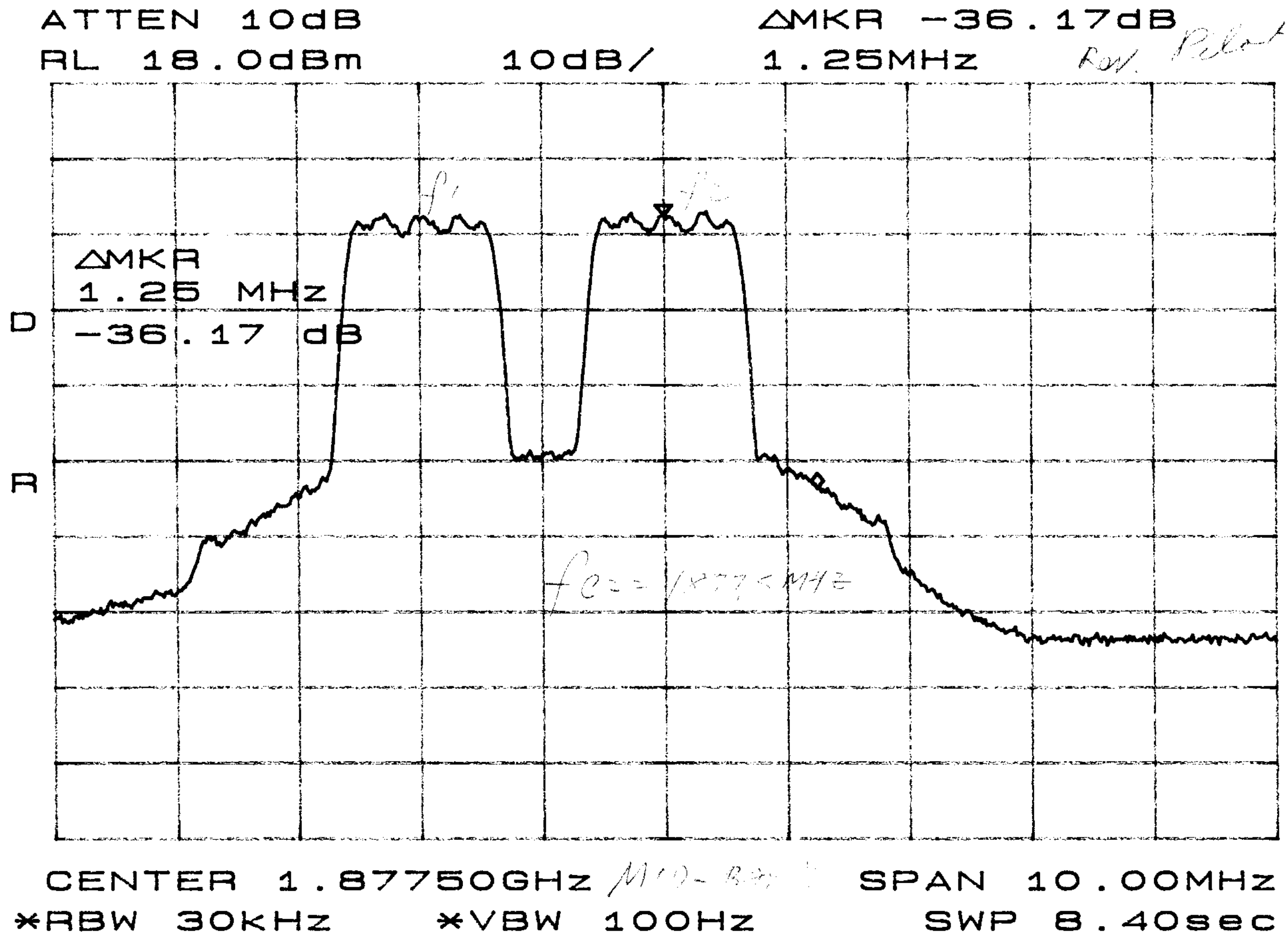

ATTEN 10dB
RL 18.0dBm
10dB/
ΔMKR -36.17dB
1.25MHz
ΔMKR
1.25 MHz
-36.17 dB
D
R
CENTER 1.87750GHz
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec

Fig. P-4

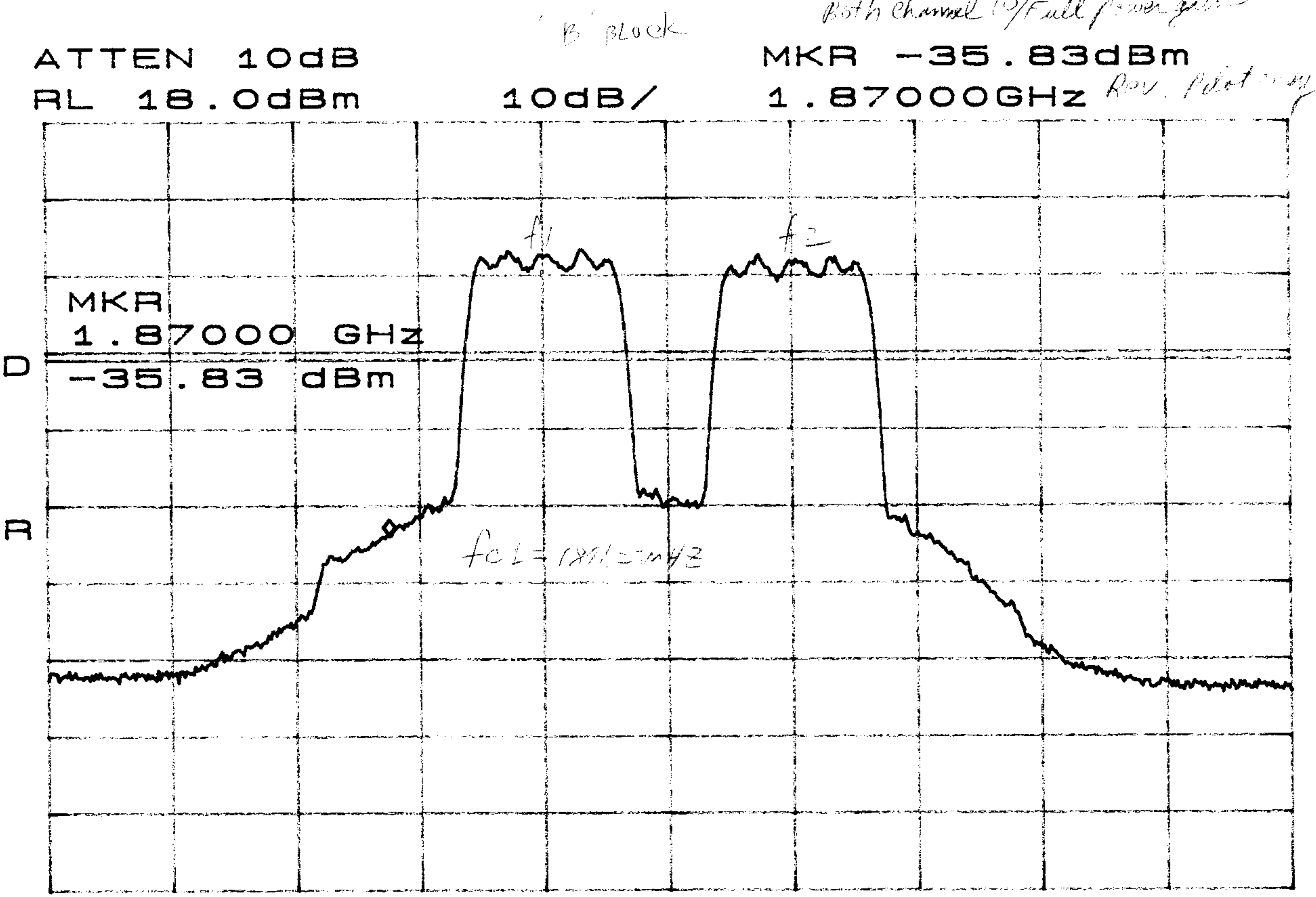
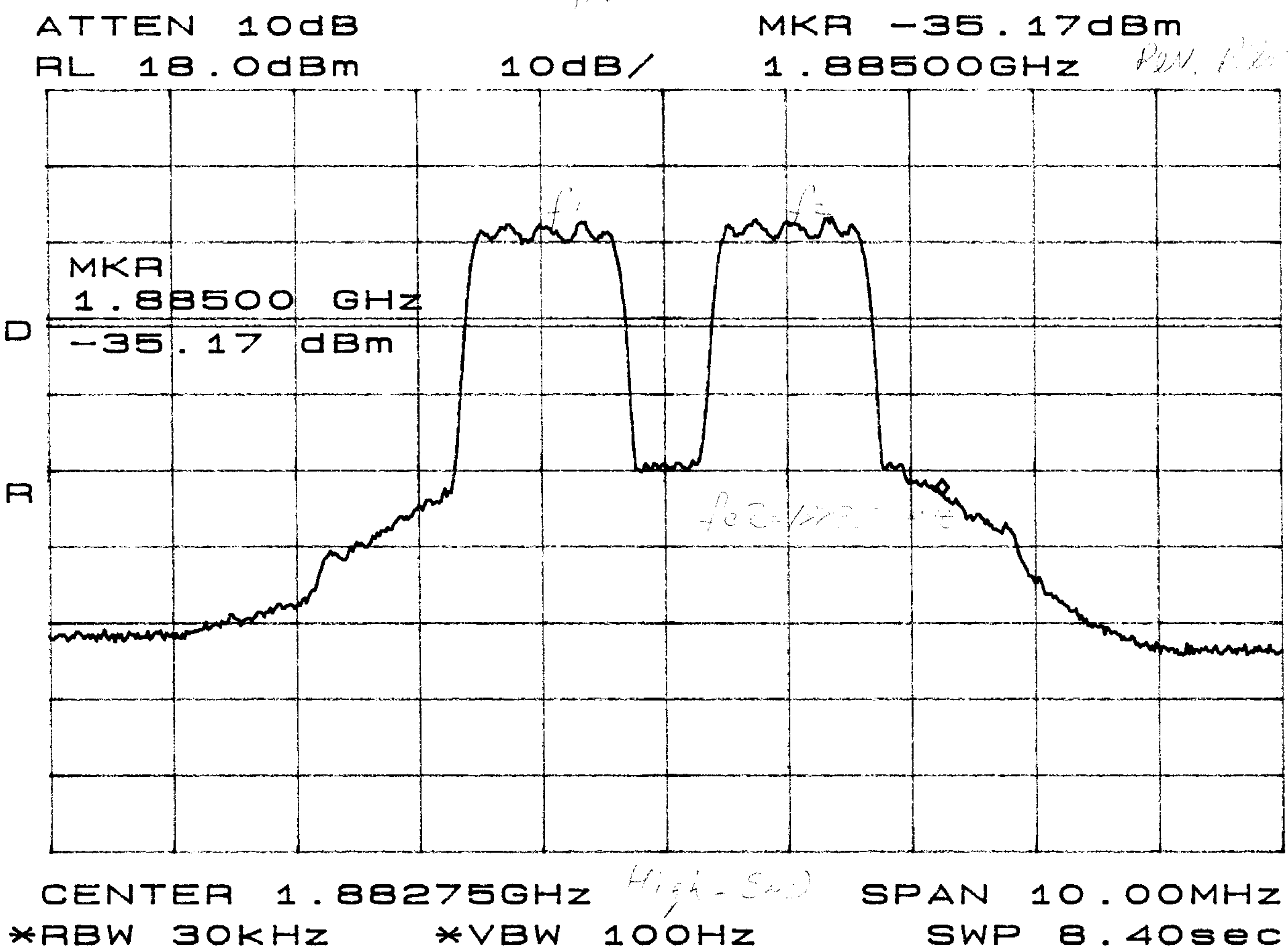

'B' BLOCK
Both Channel w/Full power
ATTEN 10dB
RL 18.0dBm
10dB/
MKR -35.83dBm
1.87000GHz
MKR
1.87000 GHz
-35.83 dBm
D
R
f1
f2
CENTER 1.87225GHz
Low-End
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec

Fig A-5


ATTEN 10dB
RL 18.0dBm
10dB/
MKR -35.17dBm
1.88500GHz
MKR
1.88500 GHz
-35.17 dBm
D
R
CENTER 1.88275GHz
*RBW 30kHz
*VBW 100Hz
SPAN 10.00MHz
SWP 8.40sec
Fig. P-6

Paragraph 2.987 Modulation Characteristics
Paragraph 2.989 Occupied Bandwidth

Requirements

A curve or equivalent data to show that the equipment will meet the modulation requirements of the rules under which equipment is to be licensed.

Test Method

The OA1900C NR repeater does not create any modulation of its own, only amplification of input signals occurs.

The test modulation used was the two-channel CDMA modulation format.

With the test signal applied to the main mobile antenna and the base antenna ports, the corresponding outputs were observed on a spectrum analyzer.

For each measurement direction, the transmitter was set to rated output power. A comparison of output spectrum to input spectrum was made.

Test Equipment

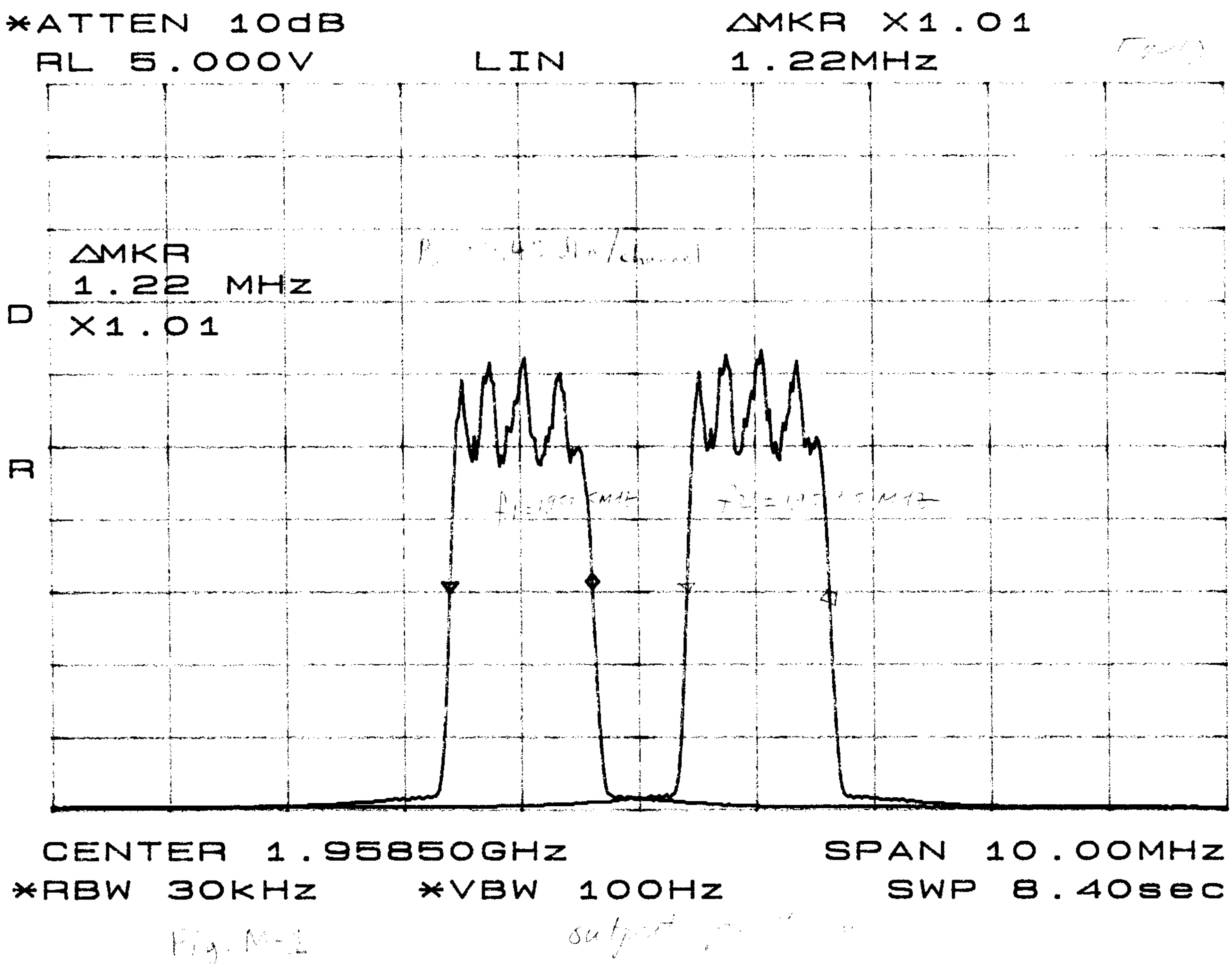
The following equipment was utilized:

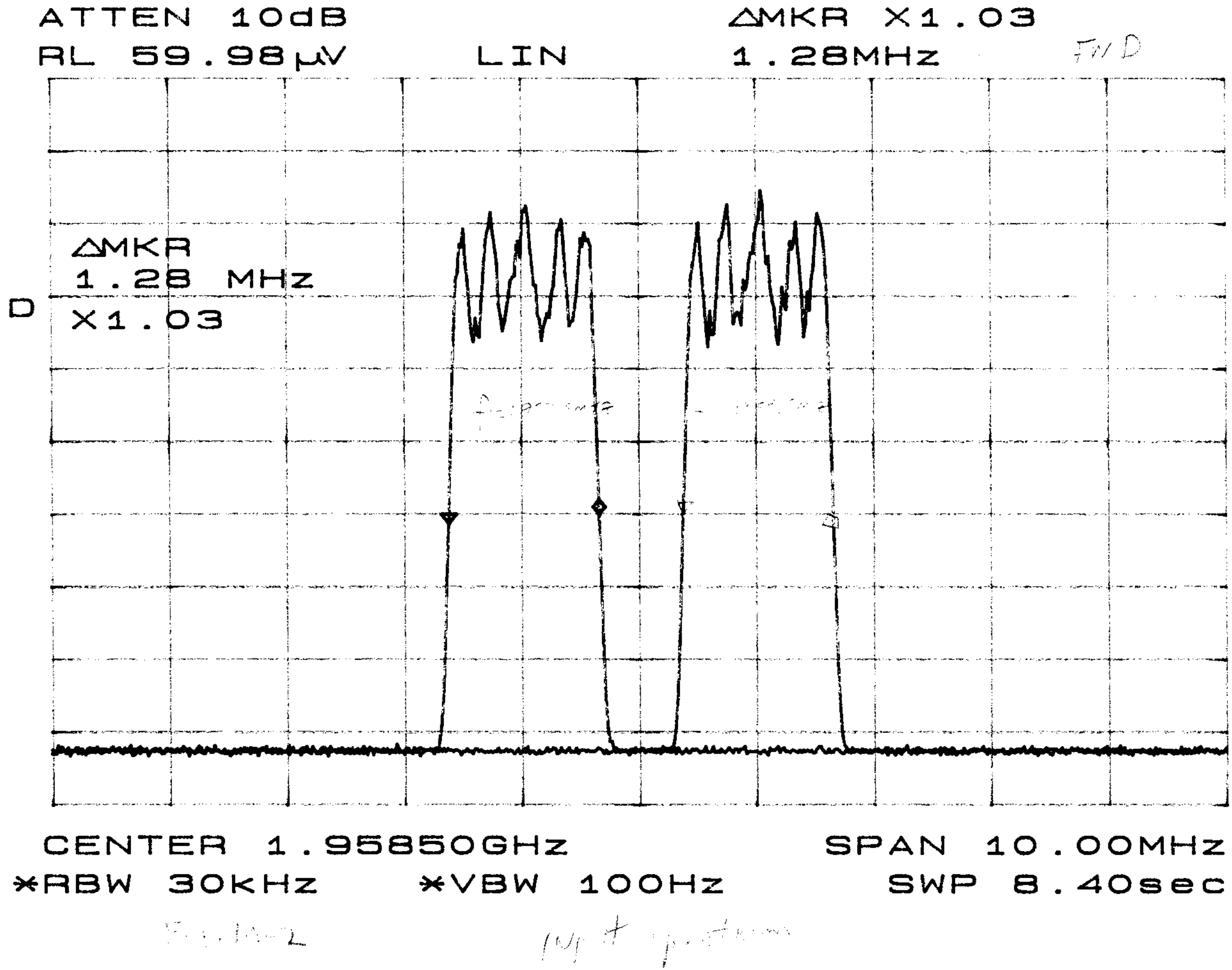
1. HP E2507B Multi-format Communications Signal Simulator (MCSS), Model 60
2. HP 8563E Spectrum Analyzer, 9 kHz to 26.5 GHz
3. HP 437B Power Meter, with HP8481A sensor
4. HP 8491C Attenuator, 30 dB 'N'
5. Narda 768-30 Attenuator, 30 dB 'N' (two each)
6. Weinschel Egrg. 910-10-33 Continuously adjustable Attenuator, 1 to 10 dB

Test Results

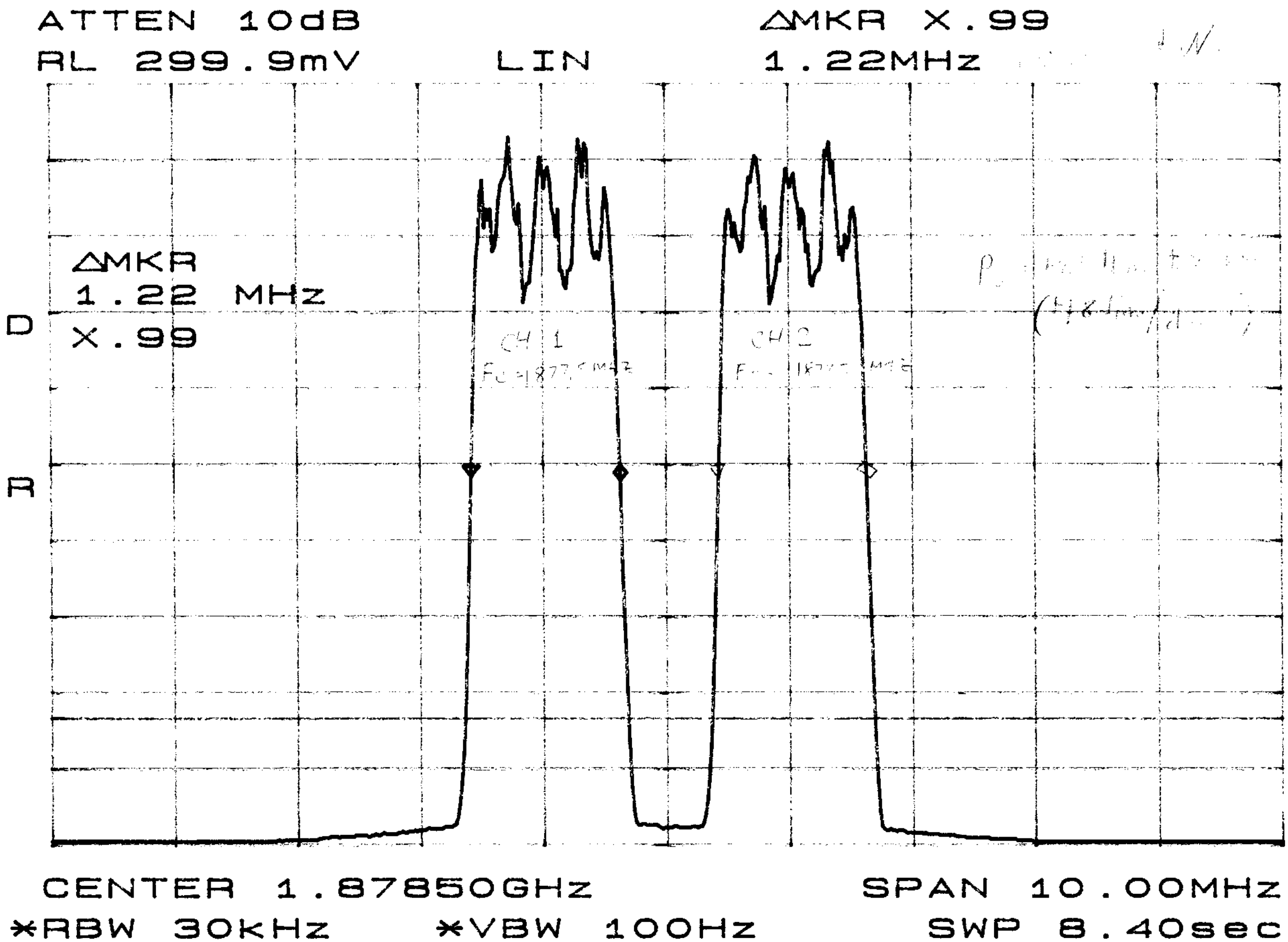
Refer to Figures M-1 and M-2 for forward direction; Figures M-3 and M-4 for reverse direction.

The output signal spectrum as well as the input signal spectrum were recorded and compared. It was concluded that the two-channel OA1900 narrows the occupied bandwidth slightly. The output is within allowable limits.


*ATTEN 10dB
RL 5.000V
LIN
ΔMKR X1.01
1.22MHz
ΔMKR
1.22 MHz
X1.01
D
R
CENTER 1.95850GHz
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec



ATTEN 10dB
RL 59.98µV
LIN
ΔMKR X1.03
1.28MHz
FWD
ΔMKR
1.28 MHz
X1.03
D
CENTER 1.95850GHz
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec



output spectrum

Fig. M-3

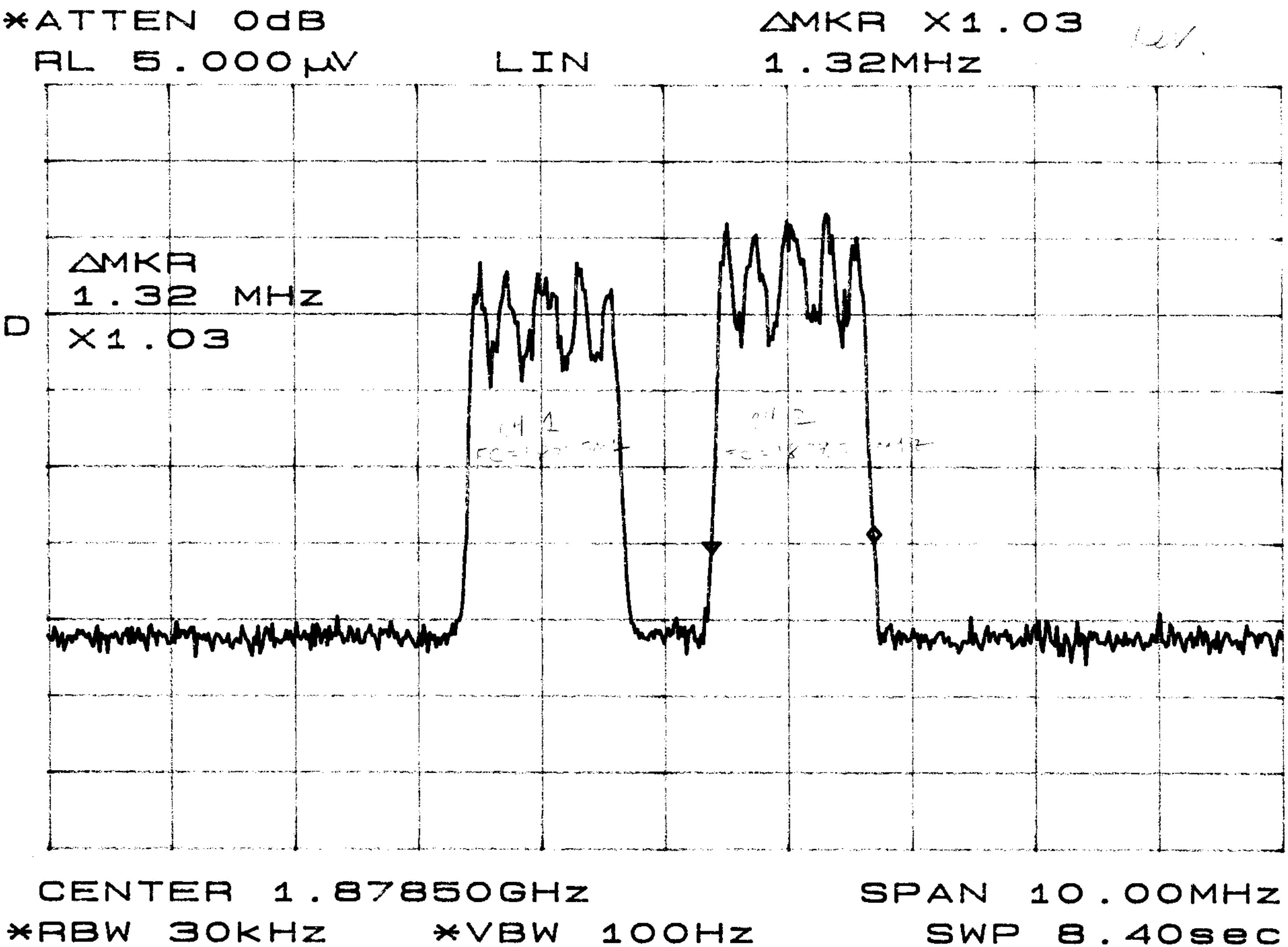

*ATTEN 0dB
RL 5.000µV
LIN
ΔMKR X1.03
1.32MHz
ΔMKR
1.32 MHz
X1.03
D
CENTER 1.87850GHz
SPAN 10.00MHz
*RBW 30kHz
*VBW 100Hz
SWP 8.40sec

Fig. M-4

Paragraph 2.991 Spurious Emissions at the Antenna Terminals

Requirements

Under §2.991, the radio frequency power generated within the equipment and appearing on a spurious frequency shall be checked at the output terminals. The frequency range of the measurement is to include harmonics.

Section 24.238 (Broadband PCS) states that the spurious signal attenuation shall be at least 43 + 10log(output power), dB. The limit is -13 dBm.

Test Method

The two-channel OA1900 repeater system was operated with three 30 dB attenuators terminating each antenna port. Thus, the transmitters were each terminated into the design load impedance of 50 Ohms.

In each direction, the repeater was driven with a 2-channel CDMA signal source to full power, confirmed by the power meter.

A microwave spectrum analyzer was used to analyze each output port. Outputs were checked for spurious and/or harmonic signals, to a frequency of ten times the fundamental transmit frequency. In the Forward direction, the spectrum analyzer's reference level offset was set to the value of the output attenuator.

Test Equipment

The following equipment was utilized:

1. HP E2507B Multi-format Communications Signal Simulator (MCSS), Model 60
2. HP 8563E Spectrum Analyzer, 9 kHz to 26.5 GHz
3. HP 435B Power Meter, with HP8481A sensor
4. HP 8491C Attenuator, 30 dB 'N'
5. Narda 768-30 Attenuator, 30 dB 'N'
6. Weinschel Egrg. 910-10-33 Continuously adjustable Attenuator, 1 to 10 dB

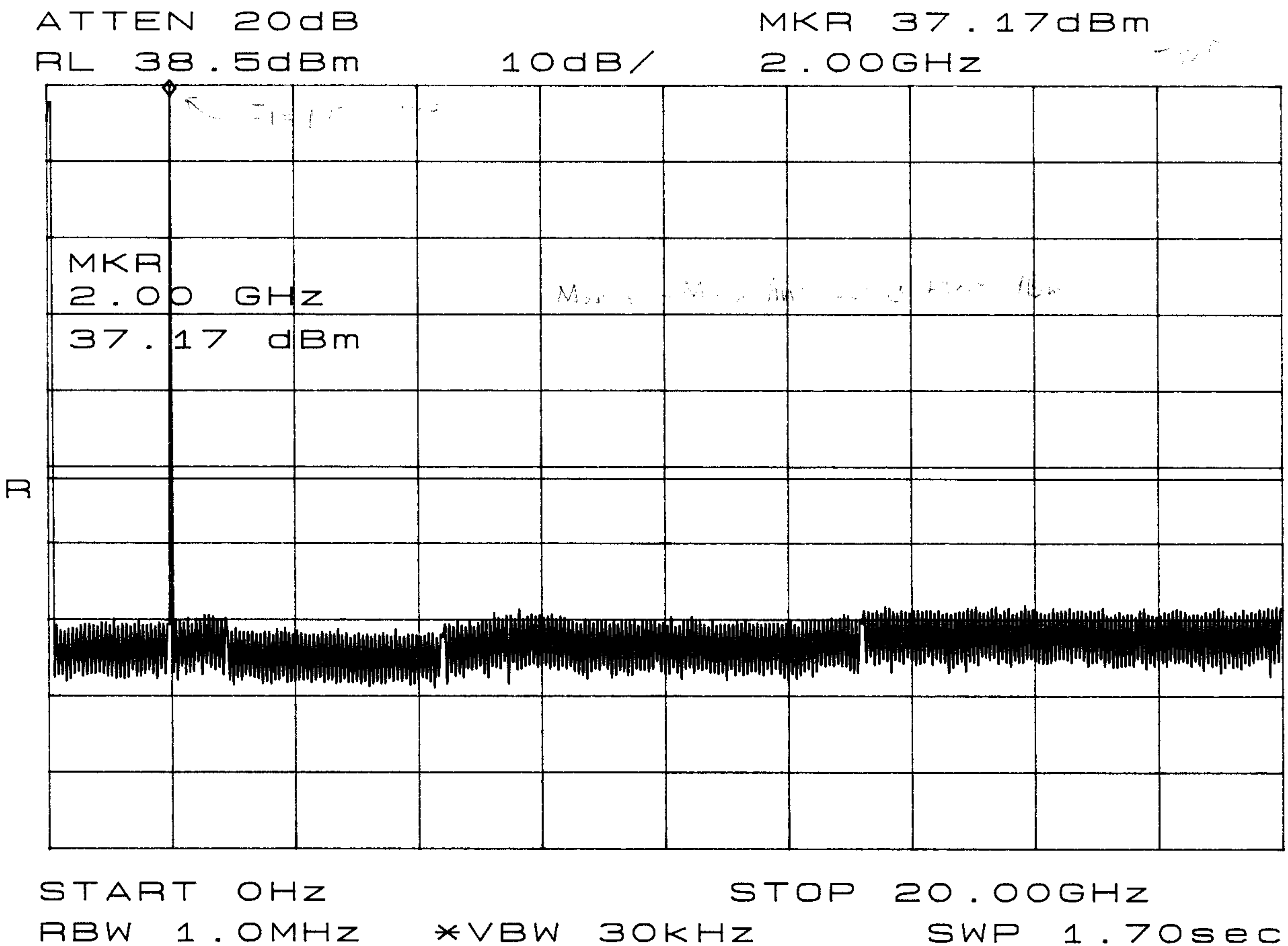
Test Results

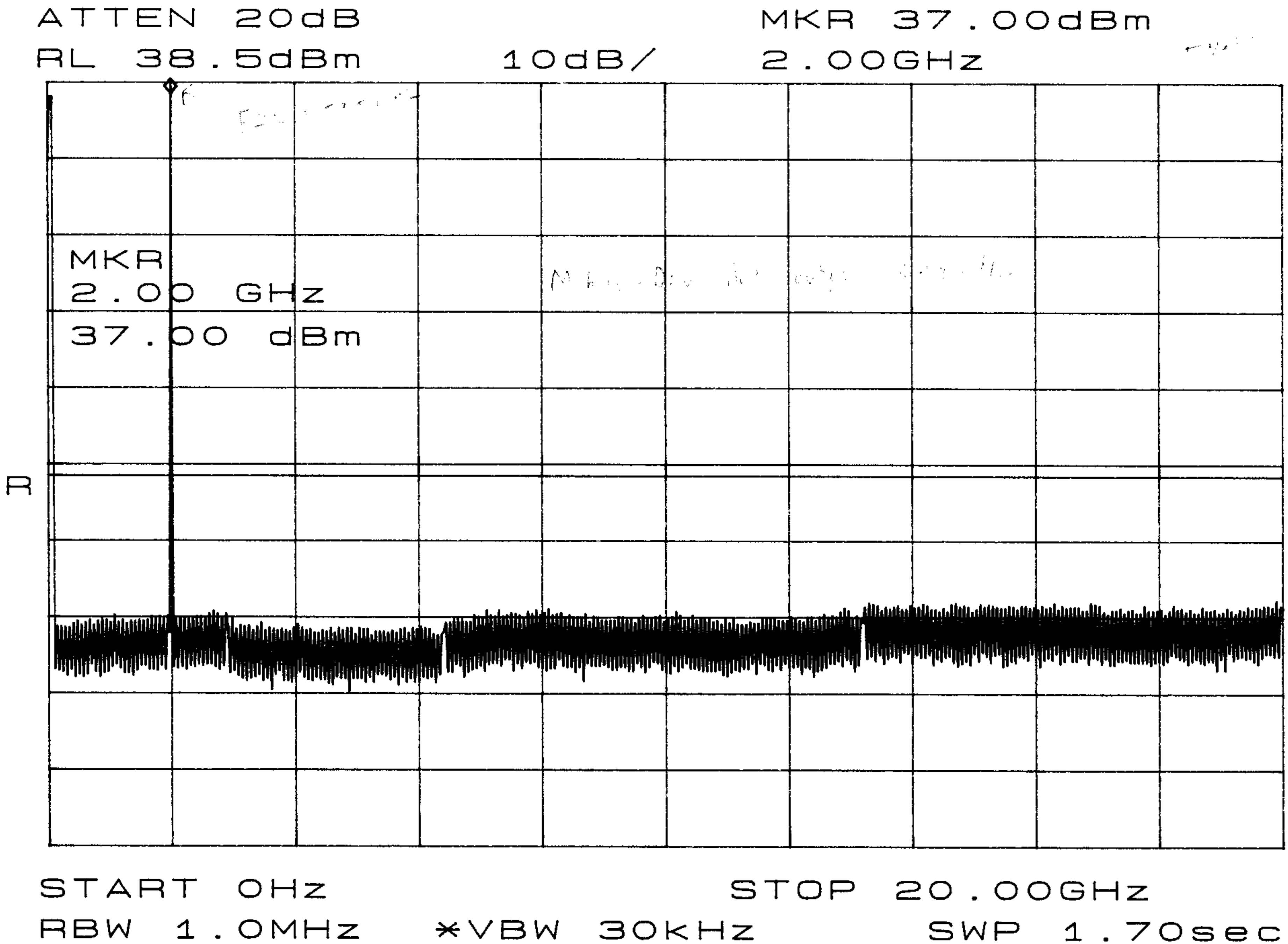
Figures CE-1 and CE-2 show the forward transmit spectrum that emanates from main and diversity mobile antenna ports, respectively.

Figure CE-3 shows the transmit spectrum that gets transmitted to the base.

The noise floor of the spectrum analyzer and its automatic internal band changing are visible. The only spur visible is on the reverse direction plot, about 23 dB below the FCC threshold.

The OA1900C NR complies with FCC rules and regulations for conducted spurious emissions.


ATTEN 20dB
RL 38.5dBm
10dB/
MKR 37.17dBm
2.00GHz
MKR
2.00 GHz
37.17 dBm
R
START 0Hz
STOP 20.00GHz
RBW 1.0MHz
*VBW 30kHz
SWP 1.70sec


ATTEN 20dB
RL 38.5dBm
10dB/
MKR 37.00dBm
2.00GHz
MKR
2.00 GHz
37.00 dBm
R
START 0Hz
STOP 20.00GHz
RBW 1.0MHz
*VBW 30kHz
SWP 1.70sec

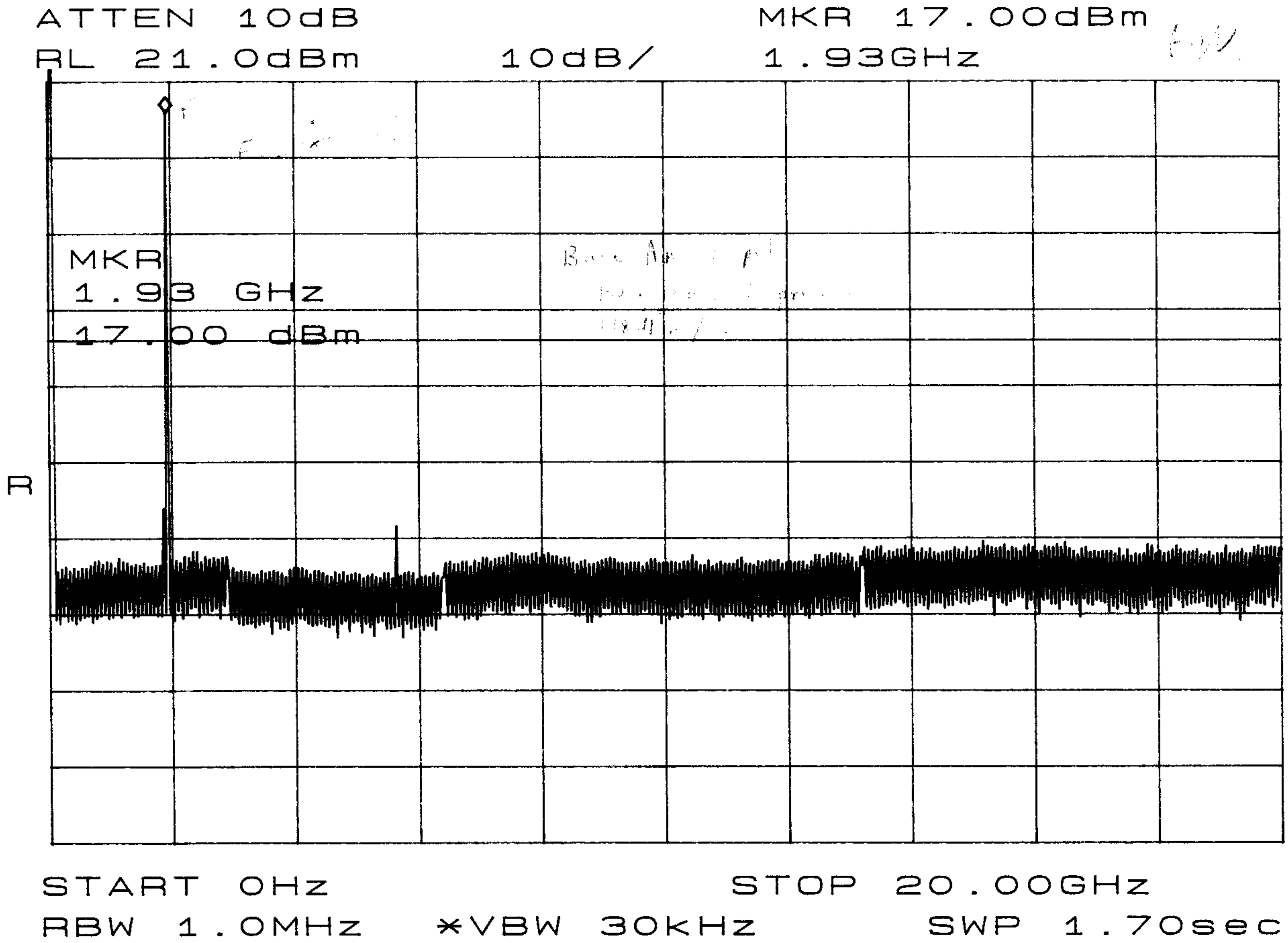

ATTEN 10dB
RL 21.0dBm
10dB/
MKR 17.00dBm
1.93GHz
MKR
1.93 GHz
17.00 dBm
R
START 0Hz
RBW 1.0MHz
*VBW 30kHz
STOP 20.00GHz
SWP 1.70sec

Fig. CE-3

Paragraph 2.993: Field Strength of Spurious Emissions

Requirements

The OA1900C NR is to be measured for spurious emissions, to a frequency of at least 10 times the rated output frequency. All spurious and harmonic signals are to be less than that which would be received by a -13 dBm transmitter into a ½ wave dipole, at the same distance as the DUT.

Test Method

The test location was a sheltered outdoor area between the building and the parking lot. The OA1900C NR REPEATER was operated with 2-channel forward traffic at 7 Watts/channel, and 2-channel reverse traffic at +18 dBm/channel, both directions simultaneously. RF Attenuators (30 dB) were connected to all three antenna ports.

A spectrum analyzer with suitable antennas was used as the test receiver. The antennas are listed below. Transmission line loss, between the measurement antenna and test receiver (spectrum analyzer), was entered into the spectrum analyzer as a reference level offset.

A sweep generator was used as a –13dBd signal source. A trace of the spectrum analyzer was used to record the amplitude of the substitution source across the frequency band. This result can be seen on the graphs as the wavy line above the measurement, roughly corresponding to the display line level. The display line is set to a calculated level, based on –13dBd minus path loss + RxAntennaGain – TransmissionLineLoss.

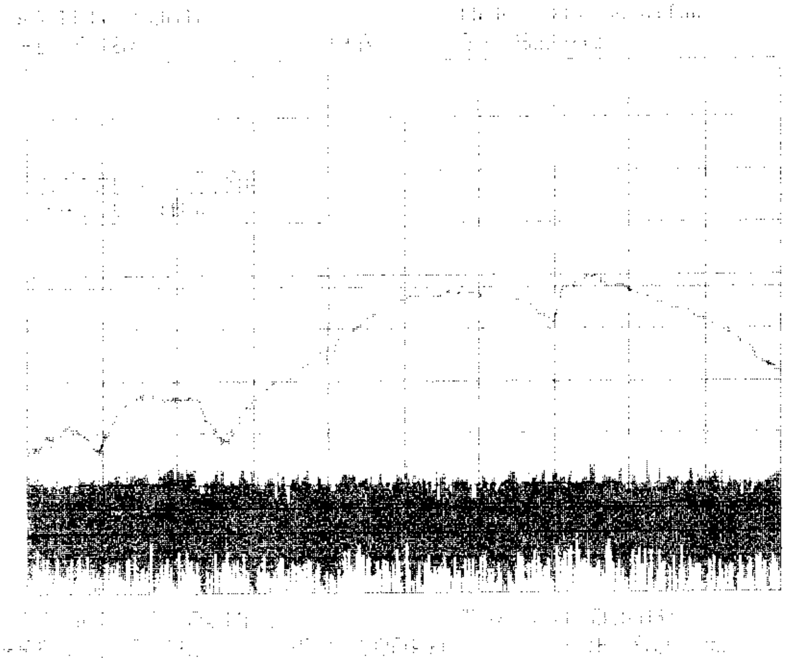
The test antenna was manually positioned with respect to DUT azimuth, elevation, and polarization, to maximize any spurious signals into the test receiver.

The following frequencies were used:

Forward direction: 1952.0 and 1954.0

Reverse direction: 1872.0 and 1874.0

Freq. Band		Calculation method, based on path loss									Substitution method				
Figure number	Freq range	Freq for calc of path loss, MHz	Base power level into dipole, dBm	Dist., DUT to Rx antenna, m	Free Space path loss, dBi	Measurement Antenna	Rx antenna gain, dBi	Transmission line, measurement antenna to measurement receiver	Cable loss (Spec. Analyzer Ref Level offset), dB	Max Allowed Rx level, dBm (Display line setting)	Base power level into dipole, dBm	Substitution antenna type	Gain of substitution antenna, dBd	Cable loss driving substitution antenna, dB	*Tx Power into substitution antenna, dBm (sweeper out. Level)*
RE-1	8 to 10 GHz	9000	-13	1	51.5	Electro-Metrics Horn, Double-ridged, RGA-60	12	6' RG-142	4	-52.5	-13	Coax to waveguide transition	4	0	-17
RE-2	5.5 to 8 GHz	7000	-13	1	49.4	Electro-Metrics Horn, Double-ridged, RGA-60	10.9	6' RG-142	3.5	-51.5	-13	Coax to waveguide transition	4	0	-17
RE-3	4 to 5.5 GHz	5500	-13	1	47.3	Electro-Metrics Horn, Double-ridged, RGA-60	10.5	6' RG-142	3	-49.8	-13	Coax to waveguide transition	4	0	-17
RE-4	3 to 4 GHz	4000	-13	1	44.5	Electro-Metrics Horn, Double-ridged, RGA-60	9.4	6' RG-142	2.5	-48.1	-13	Watkins-Johnson Log-periodic	6	0	-19
RE-5	1 to 3 GHz	2000	-13	1	38.5	Electro-Metrics Horn, Double-ridged, RGA-60	7.5	6' RG-142	2	-44.0	-13	Watkins-Johnson Log-periodic	7	0	-20
RE-6	0.5 to 1.0 GHz	900	-13	1	31.5	Watkins-Johnson Log-periodic	5	6' RG-142	1	-39.5	-13	1/4 wave gnd plane cut to 0.8 GHz	0	0	-13
RE-7	250 to 500 MHz	400	-13	3	34	Discone, with low-freq. extension whip, Diamond D-130	4	5' RG-58	1	-43.0	-13	1/4 wave Larsen gnd plane cut to 350 MHz	0	2	-11
RE-8	60 to 250 MHz	200	-13	3	38.5	Discone, with low-freq. extension whip, Diamond D-130	2	5' RG-58	0.5	-49.5	-13	1/4 wave Larsen gnd plane cut to 120 MHz	0	1	-12
RE-9	25 to 60 MHz	38	-13	3	24	Discone, with low-freq. extension whip, Diamond D-130	-5	5' RG-58	0	-42.0	-13	Lakeview Co. Inc. model 9106, 1/4 wave gnd plane	-2	1	-10



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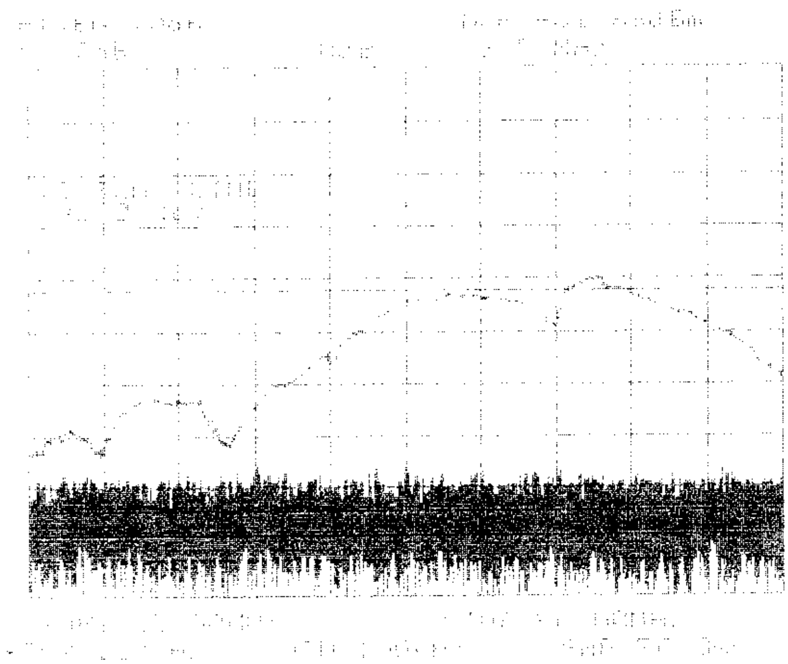
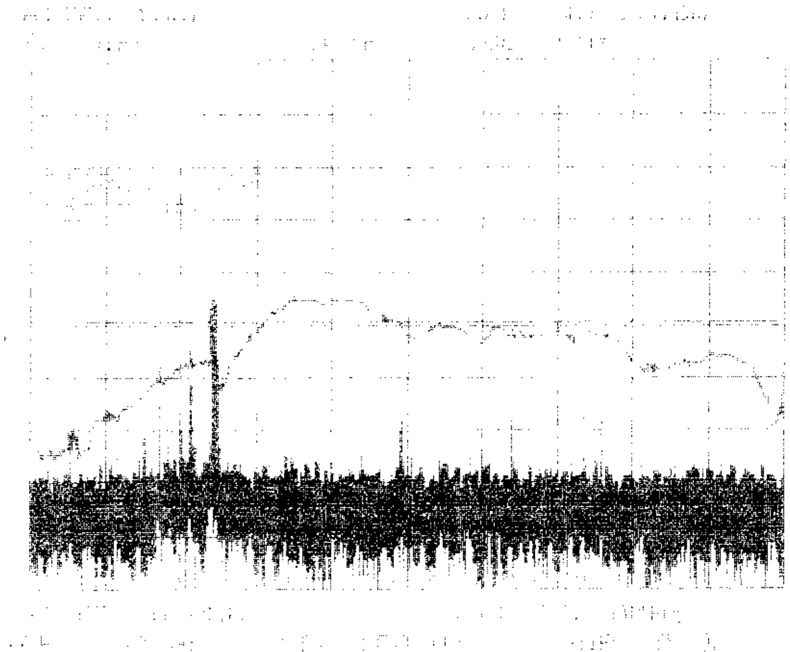
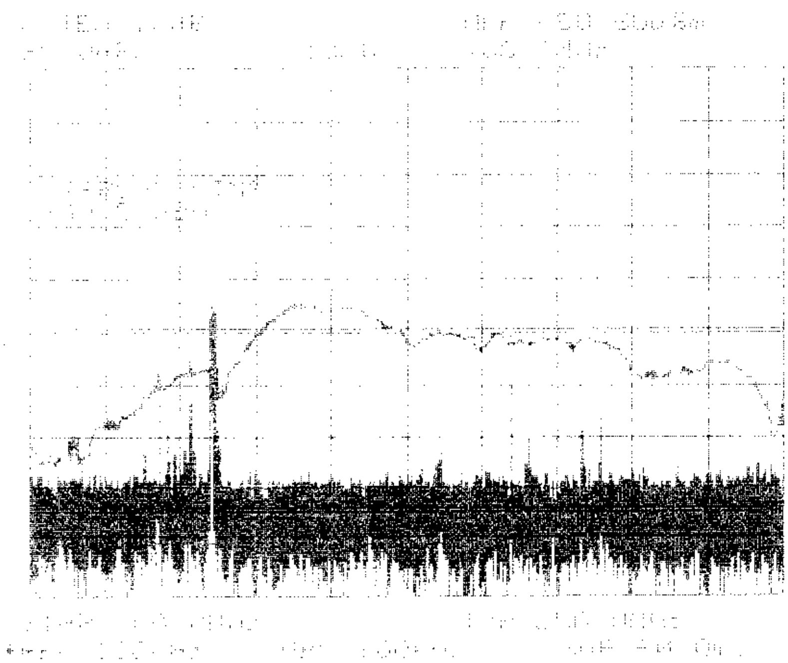


Flt. OFF

Fig RE-9

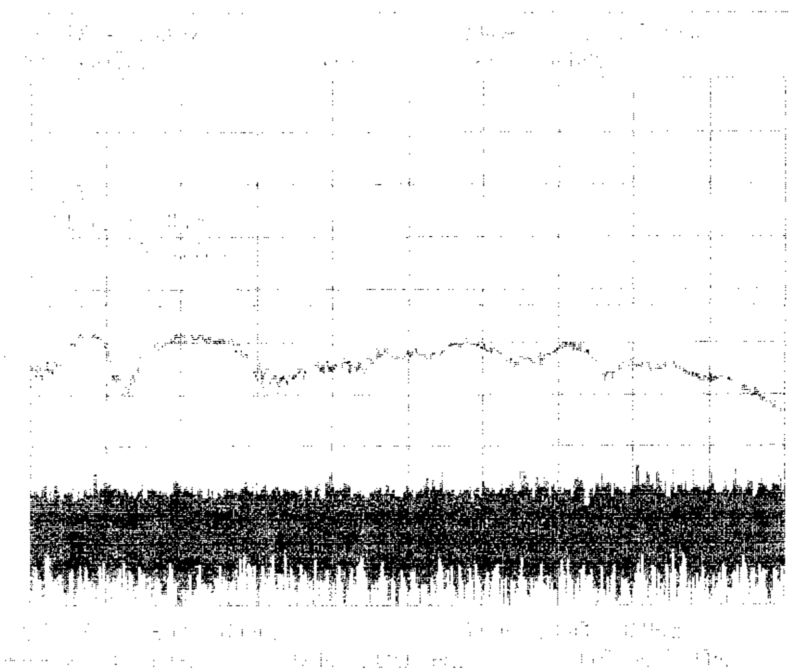


Rf - ON



Rf - OFF

Fig. 8



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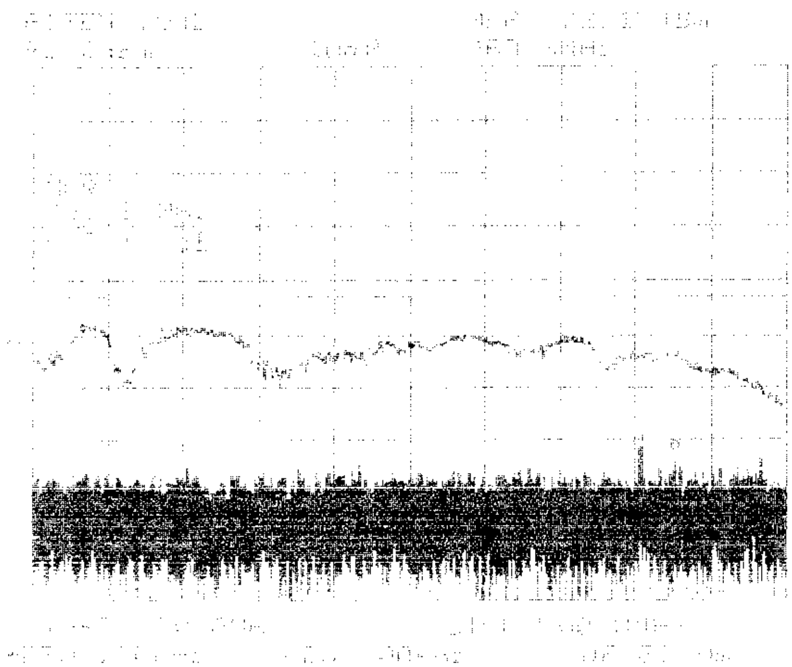
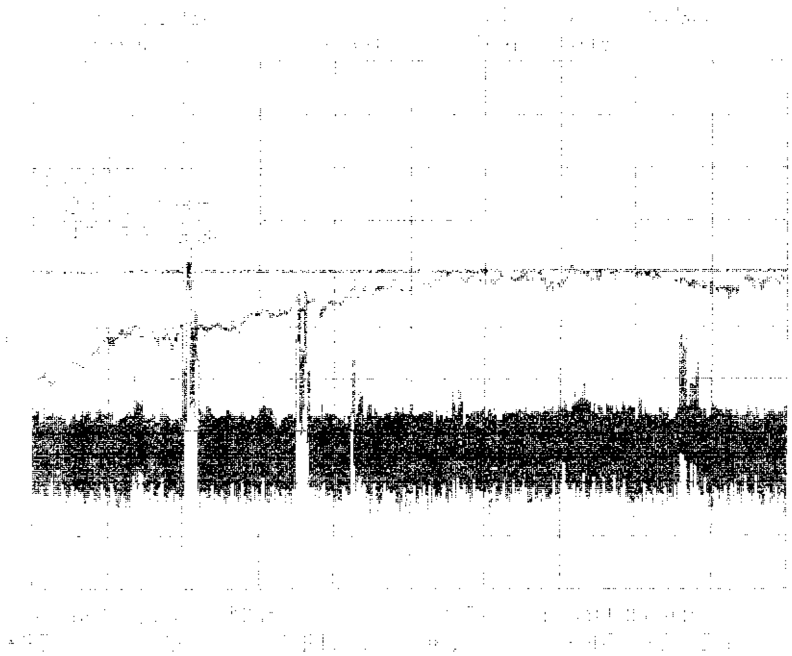
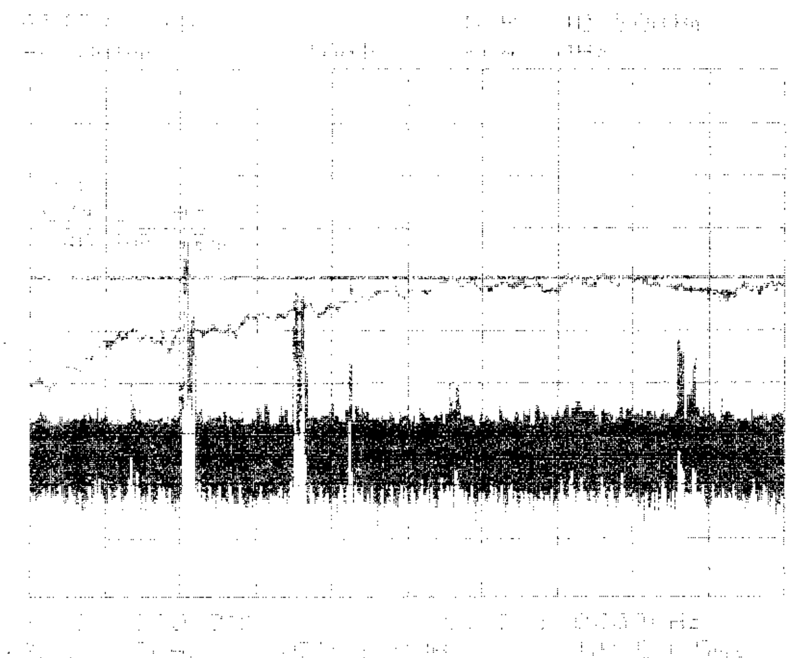


Rf: OFF

FIG. 7

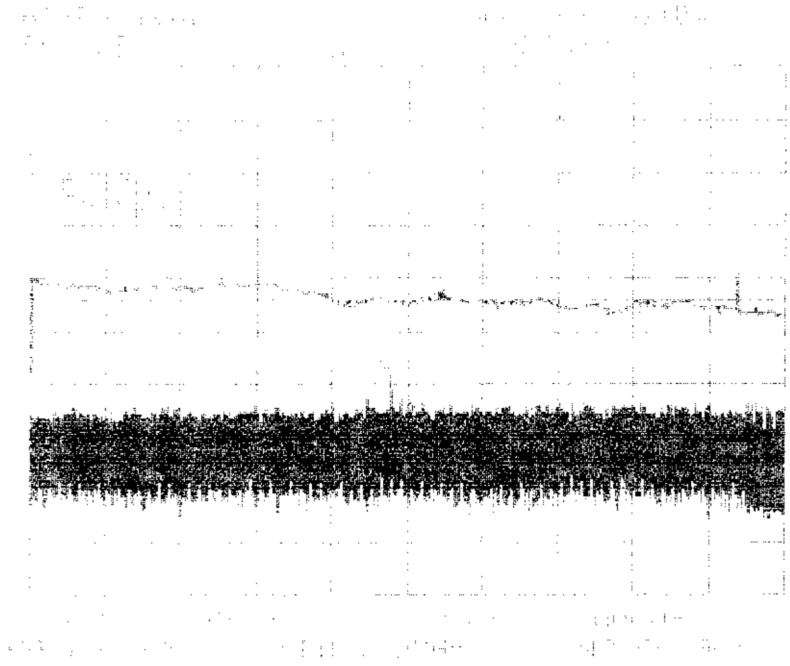


Rpt ON

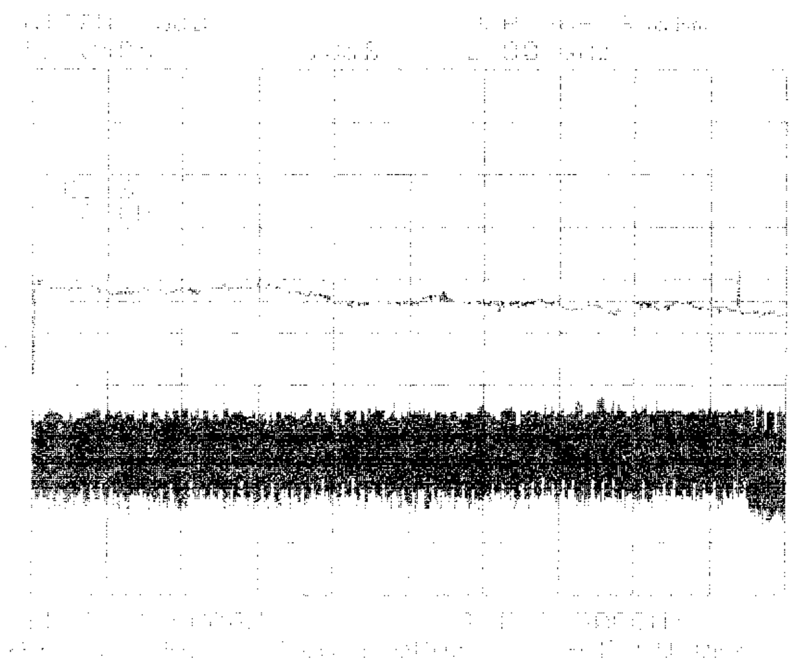


Rpt OFF

Figure 6

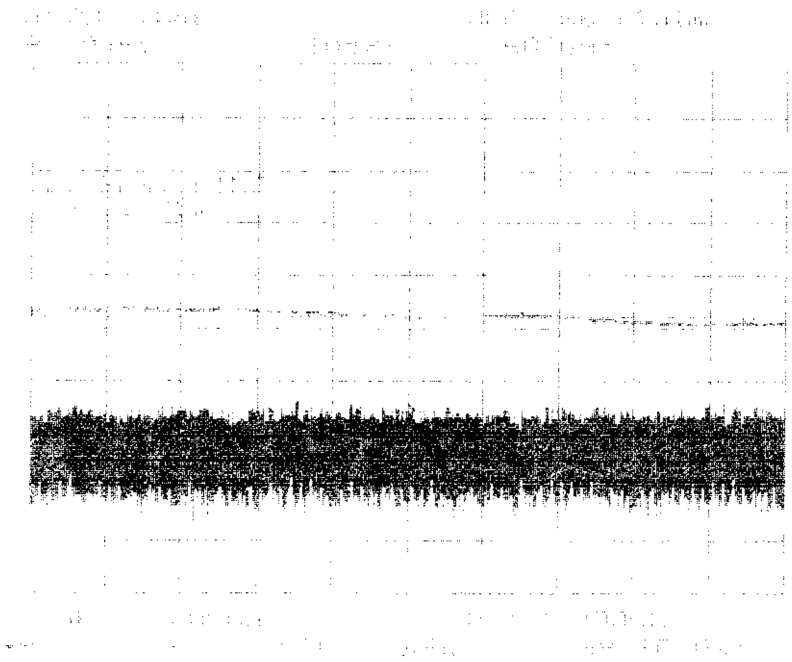


Rpt. ON



Rpt. OFF

F... 5



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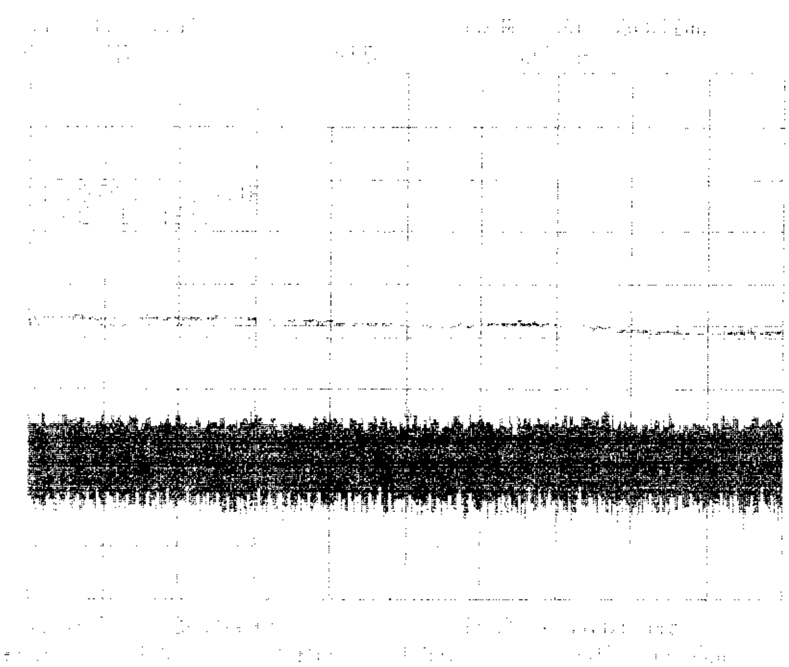
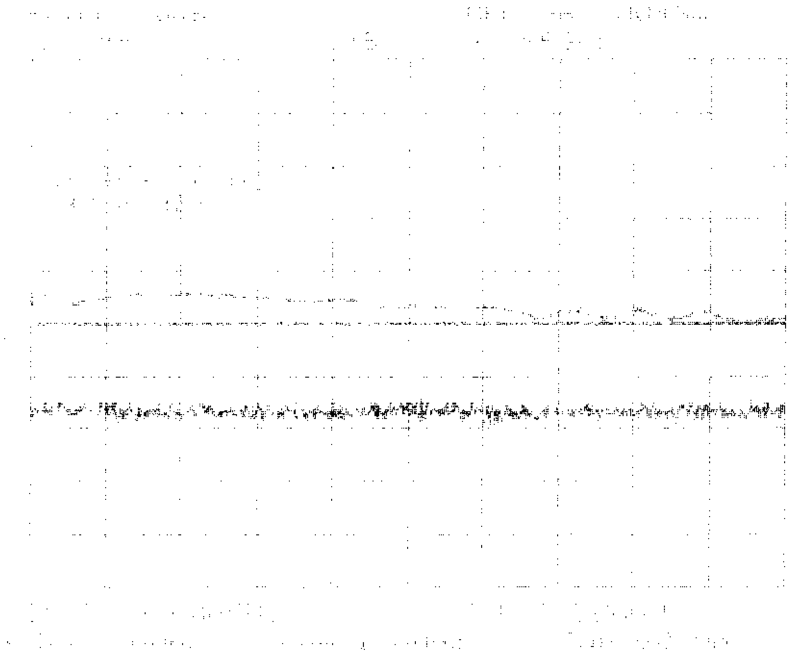
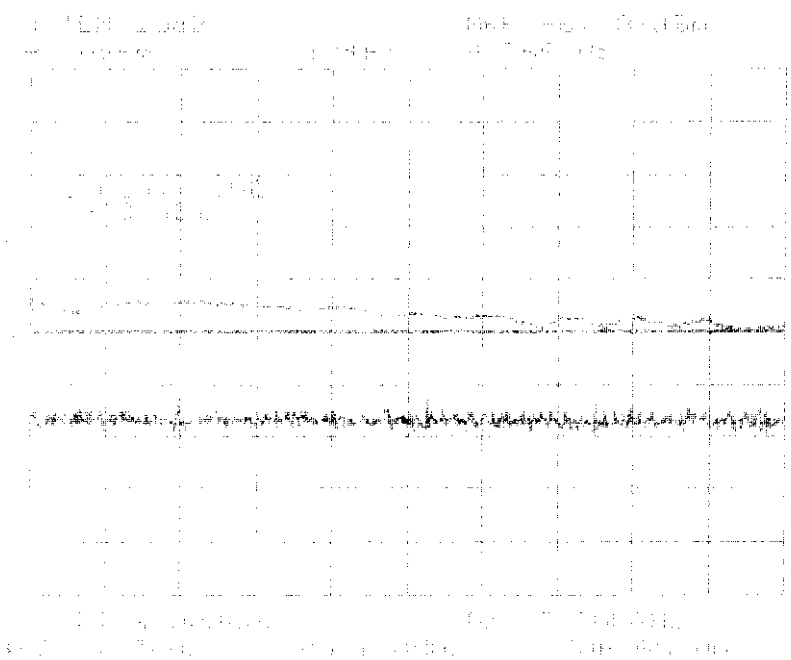


Rf t. OFF

F[illegible] 2-4

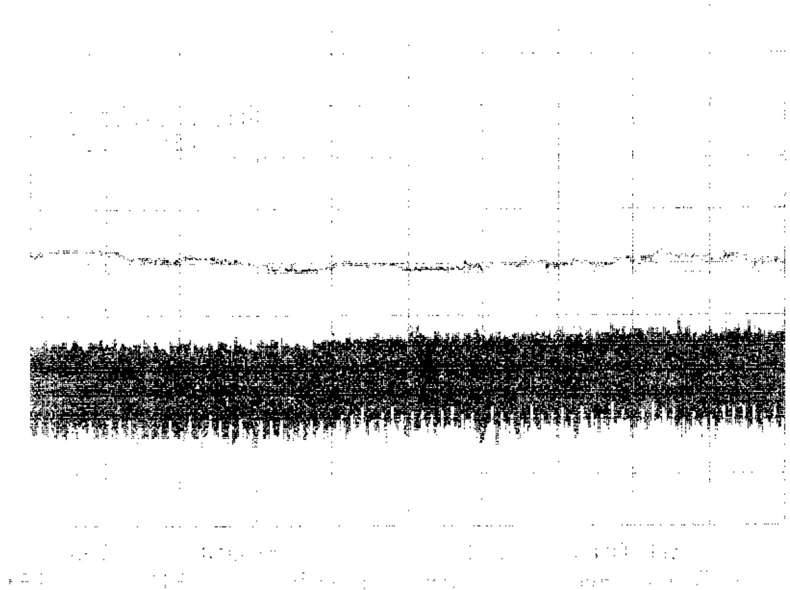


R_p = ON

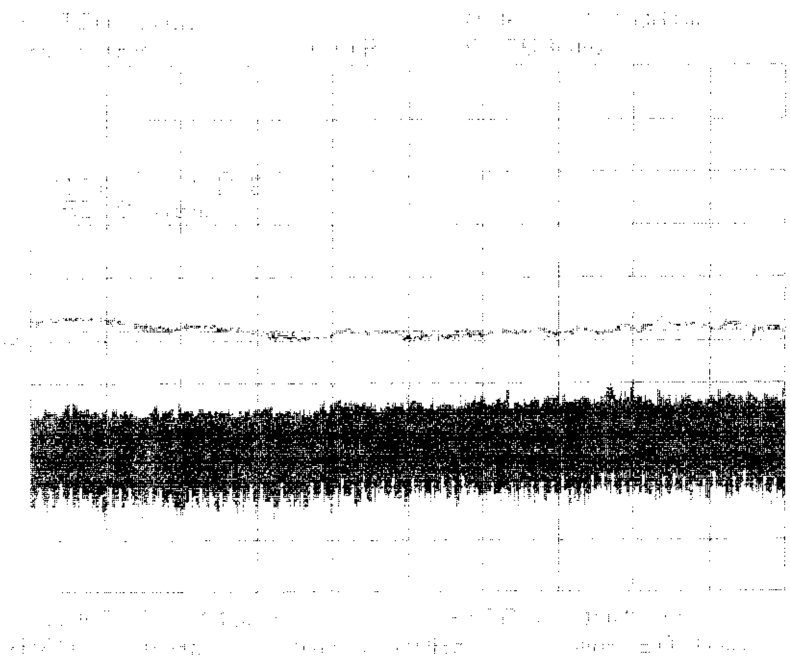


R_p = OFF

F[illegible] – 4

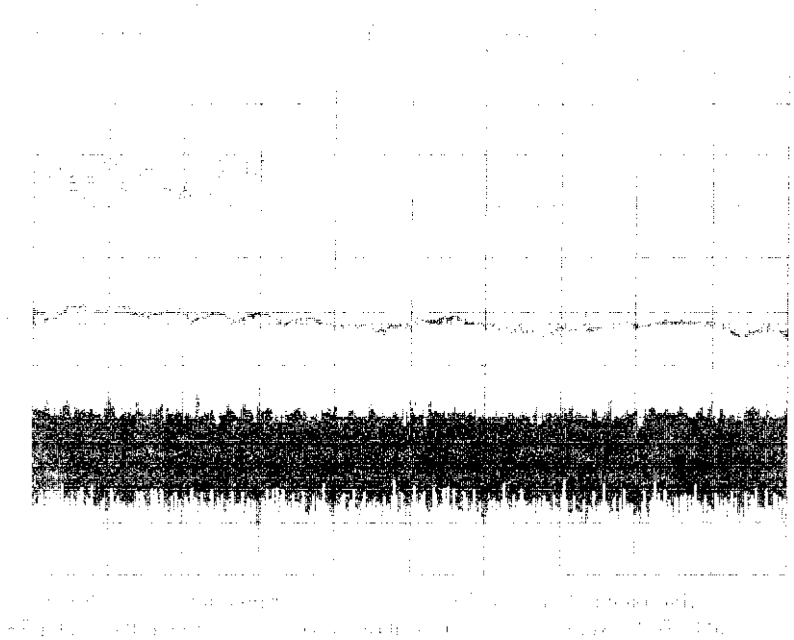


Rpt. ON

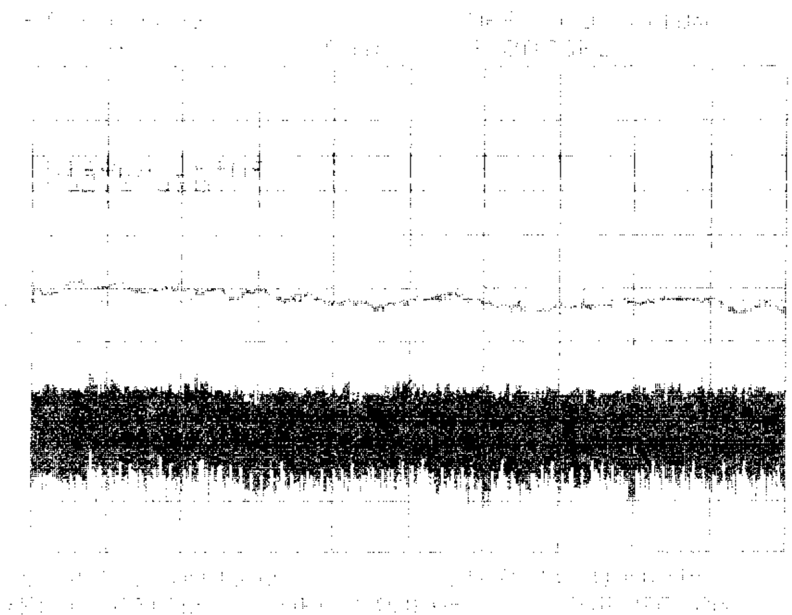


Rpt. OFF

Figure 2



Rc+ ON



Rp+ OFF

Paragraph 2.995 Frequency Stability

Requirements

The output frequencies of the OA1900C NR repeater system are to be measured vs. primary power supply voltage and variations in temperature. The primary power supply voltage is varied over 85 to 115 % of nominal. The temperature is varied from -30 degree C to +50 degree C.

Section 24.235 states that the freq. stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

Test method

The repeater system under test was put in a temperature chamber and a variable power source was used to power the DUT. Input signal was from the signal generator, whose 10 MHz reference input was supplied by the high stability timebase of the counter. Over the temperature and line voltage ranges of interest, frequency error was calculated from input and output frequency measurements of the second channel Growth Enclosure. Both forward and reverse measurements were made.

Because the OA1900C NR Off-Air repeater is a linear amplifying device, exactly zero Hertz freq. error is expected. This is always true because the same Local Oscillator that mixes input down to IF is used to mix IF back up to output frequency.

Test Equipment

Signal Generator:	HP 83620A
Frequency Counter:	HP 53131A
Attenuators:	MaCom 30 dB and Narda 766-30
Variable AC power source:	B&K Precision 1655 AC Power Supply
AC Voltmeter	Fluke 8060A multimeter with true rms
Temperature Chamber	Thermotron S-32

Test Signals

For the forward test, a CW signal of 1,877.500 000 MHz was used. For the reverse test, a CW signal of 1,957.500 000 MHz was used.

Test Results

Refer to Table FS-1 for test results.

The OA1900C NR Repeater exhibits zero Hz. freq. error and meets FCC requirement.

Test Equipment

Item	Description	Usage
HP 83620A	Synthesized Sweep Signal Generator, 10 MHz to 20 GHz	Substitution signal source
HP 8563E	Spectrum Analyzer, 9 kHz to 26.5 GHz	Measurement receiver
Narda 768-30	Attenuator, 30 dB, 20 Watt	2 ea., use to terminate each port and inject signals
HP 437B and HP 8481A	Power meter and power sensor	Use to set power levels
HP E2507B, Model 60	Multi-format Communications Signal Simulator (MCSS)	Generate forward traffic signals
HP 8935	CDMA Base Station Test Set	Use to generate one channel reverse traffic
Anritsu MG3670B	Digital Modulation Signal Generator	Use to generate one channel reverse traffic
Antennas	See table	Various receive and substitute transmitter antennas

Test Results

Measurements were taken with the repeater DUT turned on, and then off, for comparison.

Each of the RE-1 through RE-9 graphs shows three curves:

1. a display line at the power calculated to correspond with FCC limit of –13 dBd,
2. a stored trace that represents the substitution signal generator's received level,
3. the actual measurement from the DUT.

In all graphs, the actual measurement from the DUT is well below either of the thresholds. Therefore, radiated spurious emissions are FCC compliant.

Ambient Temp.	Line Voltage, Vrms					
	95	100	110	117	125	135
-30	0	0	0	0	0	0
-20	0	0	0	0	0	0
-10	0	0	0	0	0	0
0	0	0	0	0	0	0
10	0	0	0	0	0	0
20	0	0	0	0	0	0
30	0	0	0	0	0	0
40	0	0	0	0	0	0
50	0	0	0	0	0	0
55	0	0	0	0	0	0

Table FS - 1

Freq. error, Hertz,
vs.
Line voltage and Ambient Temperature

I.C. RSS-131-1 (6.4)

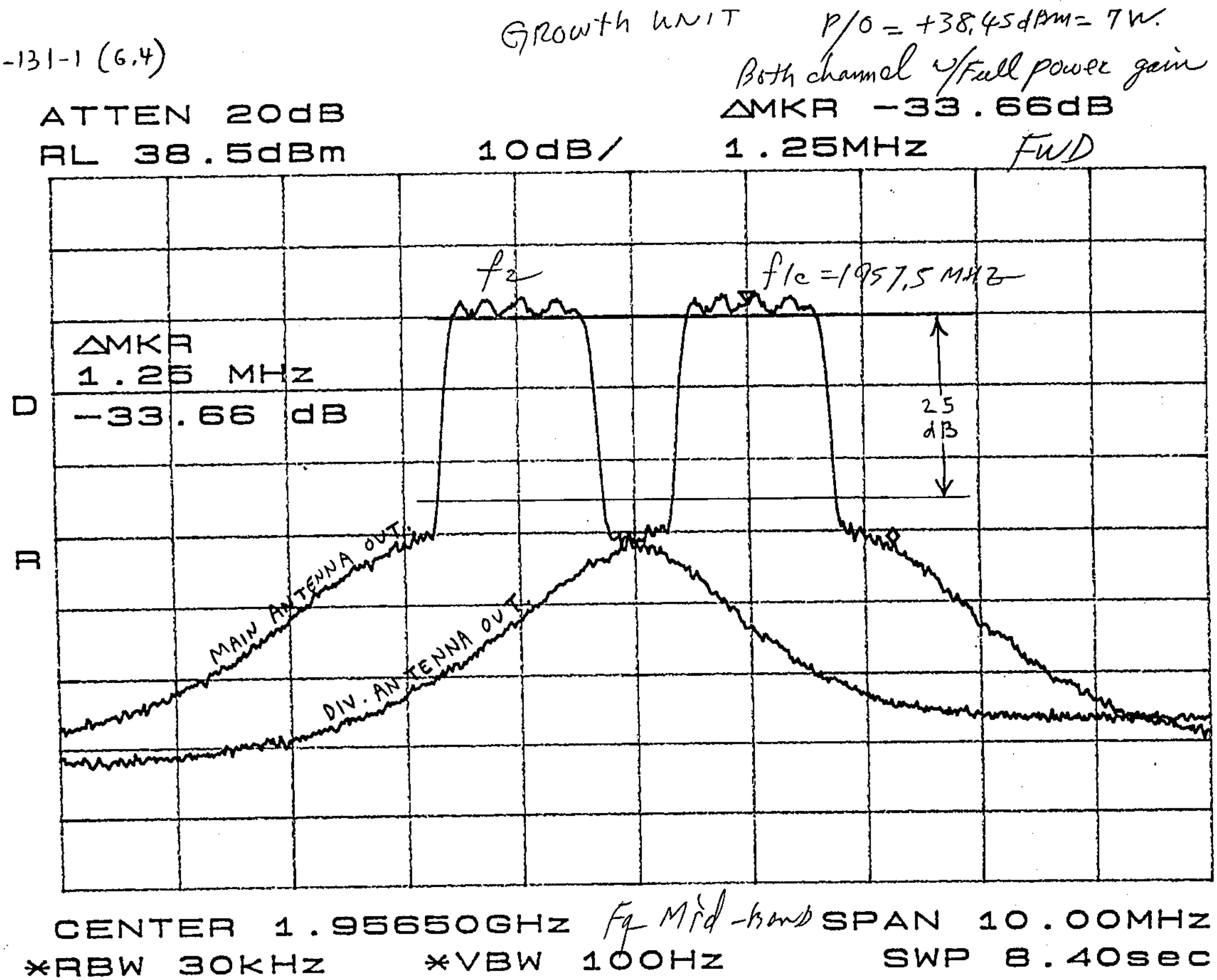


Fig. P-1

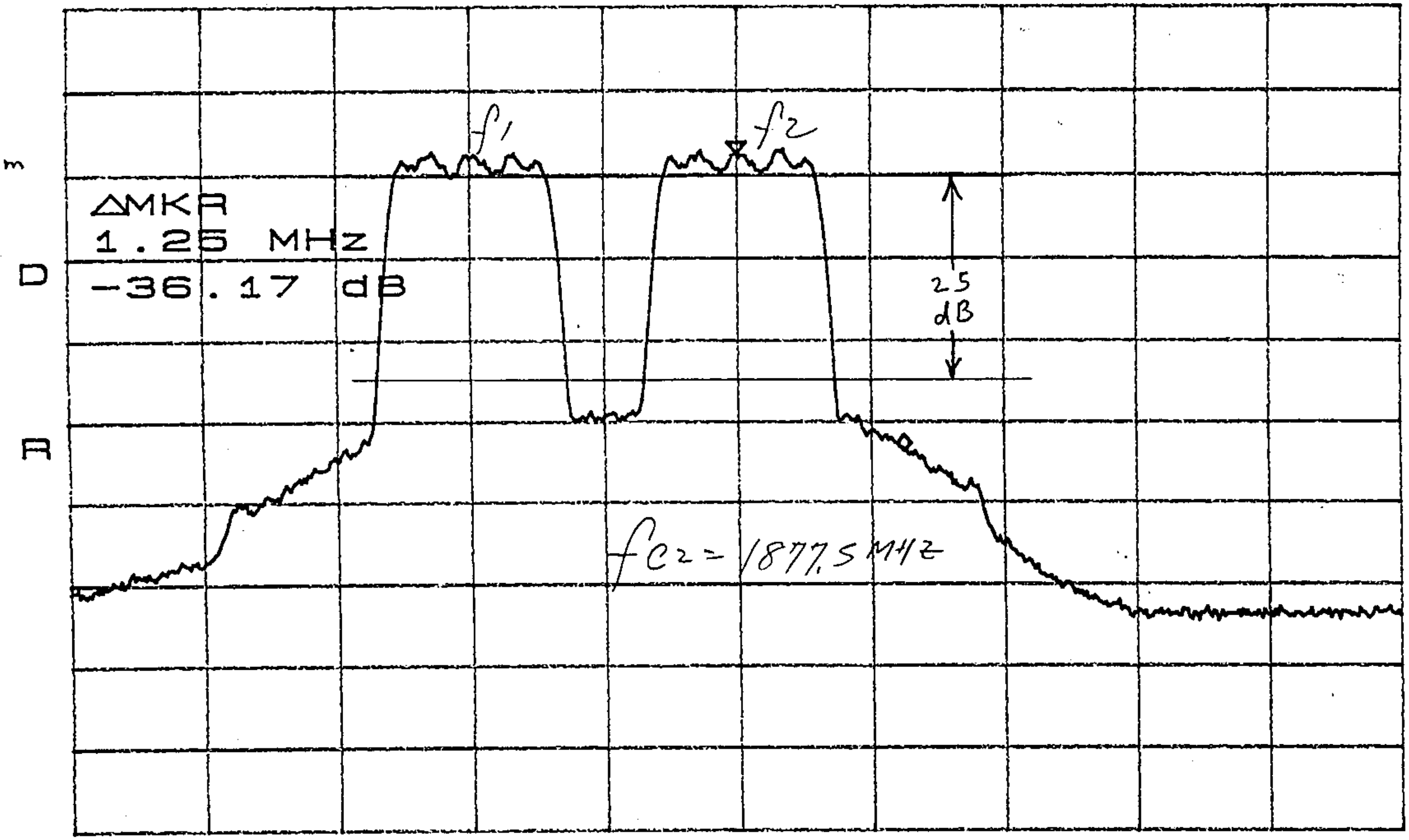
I.C, RSS-131-1 (6.4)

GROWTH UNIT
" " B BLOCK

P/o = +21 dBm = 125.1 mW TOTAL PWR,
Both channel w/Full power gain

ATTEN 10dB　　　　　　　　　　ΔMKR -36.17dB
RL 18.0dBm　　10dB/　　1.25MHz　Rov. Pilot only

Power per
channel = +18 dBm



CENTER 1.87750GHz MID-BAND　SPAN 10.00MHz
*RBW 30kHz　*VBW 100Hz　SWP 8.40sec

Fig. P-4