Performance of the PIUs of the IF system of GMRT and a study of their Repeatability and Interchangeability

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1.0 Introduction:

This report presents the measurement plots of a set of PIUs of a type to form the IF system of GMRT and analyses the repeatabity of performance between PIUs of the same type and hence their interchangeable use between antennas.

2.0 Block Diagram:

The block diagram of the IF system is given in Fig. 1 on Page 4. Following may be noted:

(a) The PIU to convert the RF signal input to a First IF frequency of 70 MHz and processing at that frequency is numbered as C41/mmm and C41/nnn where mmm and nnn are 3 digit serial numbers starting from 101. Each ABR will have Two such identical PIUs.

(b) The PIU to convert the First IF output from C41 to the Second IF at 130 MHz and processing at that frequency is numbered as C42/xxx where xxx is a 3 digit Serial Number starting from 101. Each ABR will have One such PIU.

(c) The PIU to convert the First IF output from C41 to the Second IF at 175 MHz and processing at that frequency is numbered as C43/yyy where yyy is a 3 digit Serial Number starting from 101. Each ABR will have One such PIU.

(d) The outputs of C42 and C43 are combined (along with LO referance return signals) and then passed through a low pass filter at 205 MHz. The combiner and the filter are located in a 19" panel at the rear of the rack, called "Interface Panel".

3.0 Measurement Plots:

Plots 1 to 7 (Pages 6 to 12) give the MEASURED response of C41 PIU, with a set-up as in Fig. 2a (page 5).

Plots 8 to 10 (pages 13 to 15) give the MEASURED response of C42 PIU, together with units in the interface panel, with a set-up as in Fig. 2b (page 5).

Plots 11 to 14 (pages 16 to 19) give the MEASURED response of C43 PIU, together with units in the interface panel, with a set-up as in Fig. 2b (page 5).

Plot 15 (page 20) gives the MEASURED 2-tone intermodulation response of a typical C41 PIU. The set-up used is also included.

Plot 16 (page 21) gives the MEASURED 2-tone intermodulation response of a typical C42 PIU in ALC OFF mode. The set-up used is also included.

Plot 17 (page 22) gives the MEASURED 2-tone intermodulation response of a typical C42 PIU in ALC ON mode. The set-up used is also included.

The IMD response of C43 PIU is similar to plots 16 and 17.

4.0 Description of a typical plot for C41 (Plots 1 to 7):

All measurements are taken with a pre-attnuation of 16 dB. Each plot has Four panels. Plots are as a function of Nine RF Mid-band frequency, whose value is 50, 150, 235, 325, 610, 1060, 1170, 1280 and 1390 MHz (called as bands A, B ... H and I). Top-Left panel excludes RF band of 50 MHz. As a rule, gain decreases as RF mid-band frequency increases.

5.0 Description of typical plot for C42 and C43 (Plots 9 to 14):

All measurements are taken with a pre-attnuation of 16 dB. Plot at Top-Left panel is self-explanatory. Other Three plots are as a function of whether ALC is ON or OFF. The Detector output and ALC feedback voltages (FBV) can be logged through MCM # 9 at each antenna and analysed.

6.0 Description of IMD response plots (Plots 15 to 17):

Measurements are taken with bandwidth of 16 MHz and pre-attenuation of 16 dB for C41 PIU and given as Plot 15. For C42 PIU (Plots 16 and 17), the post-attenuation setting is 16 dB. The plots are self-explanatory.

7.0 Furthur work:

(a) Curve-Fitting to find the coefficients of a polynomial to represent each curve.

Problem has been defined to Rakesh.

(b) **Measurement of the group-delay response of the PIUs.**

Reports giving data on group delay response of individual chassis, specifically the non-linear device like the ALC is already available. Measurement of the response of an integrated PIU is being postponed and will be the subject of a future report.

8.0 Analysis of the plots:

Analysis of response plots 1 to 7 of PIU C41 indicate that the peak-to-peak gain variation between the PIUs is of the order of ± 3 dB. The cause has been identified and it should be possible to reduce the variation to ± 1 dB in future units. However, **this is not necessary** because of the plans to mathematically represent the plots by the curve-fitting exercise, the result of which can be made available as a look-up table for each PIU.

The tentative format of the look-up table is enclosed as Table 1 (pages 23 and 24). Please e-mail your suggestions to me for considering any additions/ modifications/ improvements to the table. (Note I have deliberately left some room for your suggestions!) Note that intelligent use of this table will have to be made by the On-line program to get the best performance out of the system.

Analysis of response plots 8 to 10 of C42 and 11 to 14 of C43 indicate that the ALC operating point is same for all the PIUs to with in ± 1 dB. The format for the look-up table for these PIUs is enclosed as Table 2 (pages 25 and 26).

Analysis of response plots 15 and 16 indicate that in the ALC OFF mode, if the overall system is operated to the limits of the linear mode as defined by the 1 dB compression point, **the worst case IMD performance is around -40 dBc.**

Analysis of response plots 15 and 17 indicates that in the ALC ON mode, the operation of the system with an input level corresponding to the limits as set by ALC OFF mode will result in **an IMD performance around -55 dBc.**

9.0 Important note for Field Servicing:

If the concept of intelligent use of the look-up table through the on-line program for getting the best out of the system is accepted, note that field servicing must be limited to changing a faulty PIU to a tested and released unit and updating the look-up table entries by the Service personnel.

10.0 Commissioning notes:

The following table gives the serial number of PIUs which will be installed and commissioned at C1 and C0 in the next few weeks:

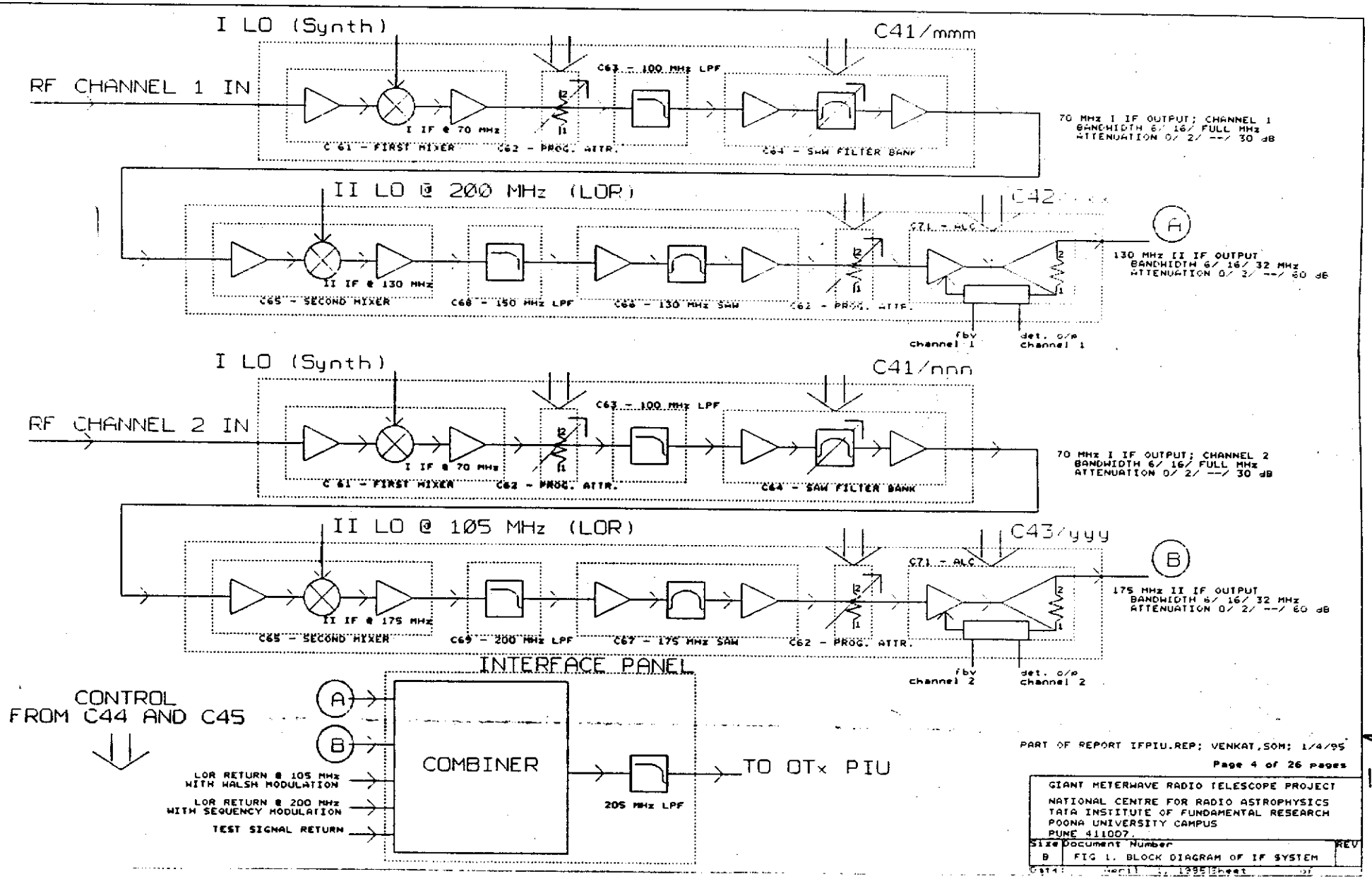
	RF Channel 1		RF Channel 2	
Antenna C1 :	C41/107	C42/114	C41/110	C43/115
Antenna C0 :	C41/101	C42/113	C41/104	C43/111

UNITS ARE AVAILABLE AT H-LAB, KHODAD OR Rx-LAB, PUNE FOR INSTALLATION AND COMMISSIONING AT C14, C11 AND W1 AT THE APPROPRIATE TIME. UNITS ALREADY INSTALLED AT C9 WILL BE BROUGHT BACK TO PUNE AT AN APPROPRIATE TIME FOR SIMILAR CHARACTERISATION.

Users may note the deliberate mixing of running numbers of PIUs has been done to bring home the point that a PIU is NOT unique to any antenna.

12.0 Acknowledgement:

The efforts of Rakesh in writing the software for standardising the presentation format of plots 1 to 14 and realising them with minimum keystrokes entry in the Unix environment is highly appreciated. Thank you, Rakesh!



PART OF REPORT IFPIU.REP; VENKAT,SOM; 1/4/95

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PUNE 411007.

Size	Document Number	REV
B	FIG 1. BLOCK DIAGRAM OF IF SYSTEM	

Sheet of

Page 4

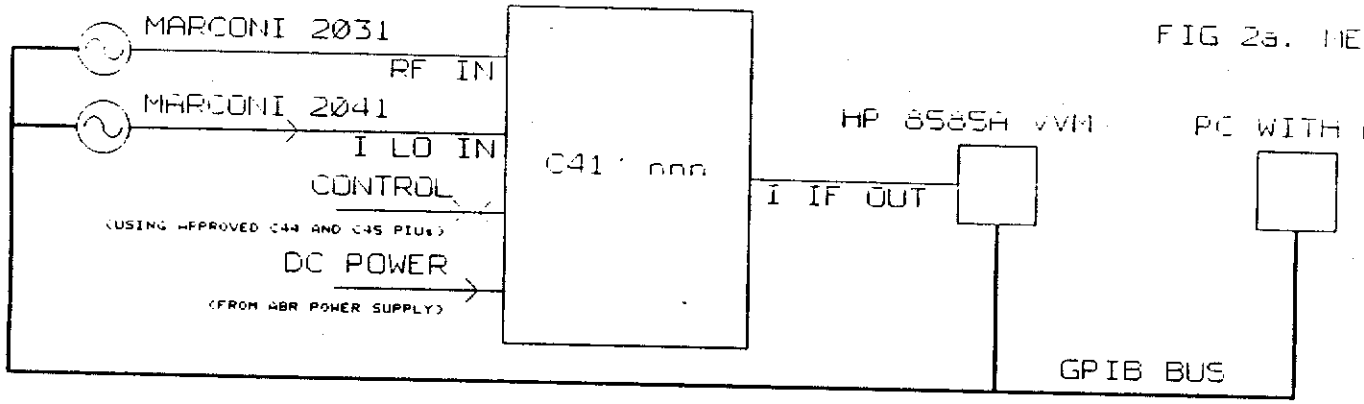

FIG 2a. MEASUREMENT SET-UP FOR C41

TO ACQUIRE DATA, RUN THE BATCH FILE ACQ.BAT IN AREA F:\HOME\VENKAT\IF\C41 OF LAN AND FOLLOW INSTRUCTIONS.
ENSURE NECESSARY SUB-DIRECTORIES ARE AVAILABLE!

FOR PLOTTING, FTP THE RAW DATA FILES TO UNIX, RUN THE PROGRAM "PLOT41" IN DIRECTORY HOME/VENKAT/IF/C41 AND FOLLOW INSTRUCTIONS

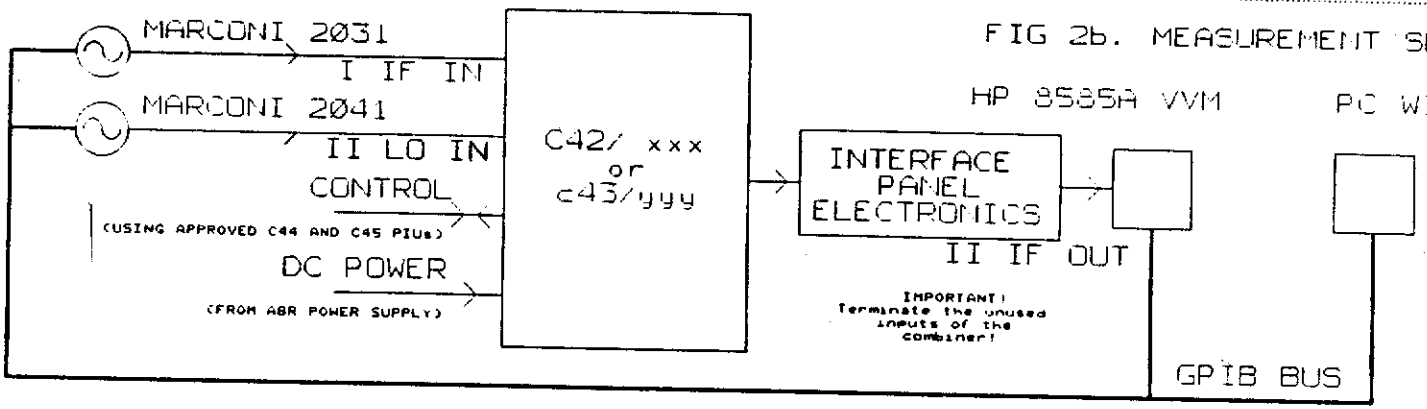

FIG 2b. MEASUREMENT SET-UP FOR C42 AND C43

TO ACQUIRE DATA FOR C42, RUN "GWBASIC C42A" IN AREA F:\HOME\VENKAT\IF\C42 AND FOLLOW THE INSTRUCTIONS.

TO ACQUIRE DATA FOR C43, RUN "GWBASIC C43A" IN AREA F:\HOME\VENKAT\IF\C43 AND FOLLOW THE INSTRUCTIONS.

FOR PLOTTING, FTP THE RAW DATA FILES TO UNIX, RUN THE PROGRAM "PLOT42" IN DIRECTORY HOME/VENKAT/IF/C42 OR "PLOT43" IN DIRECTORY HOME/VENKAT/IF/C43 AND FOLLOW INSTRUCTIONS

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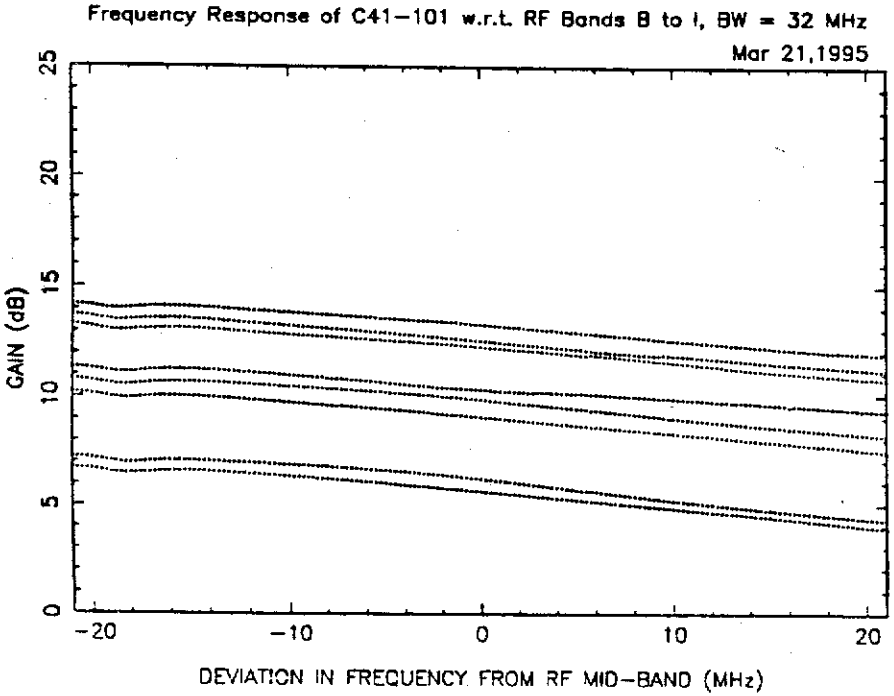
PUNE 411007.

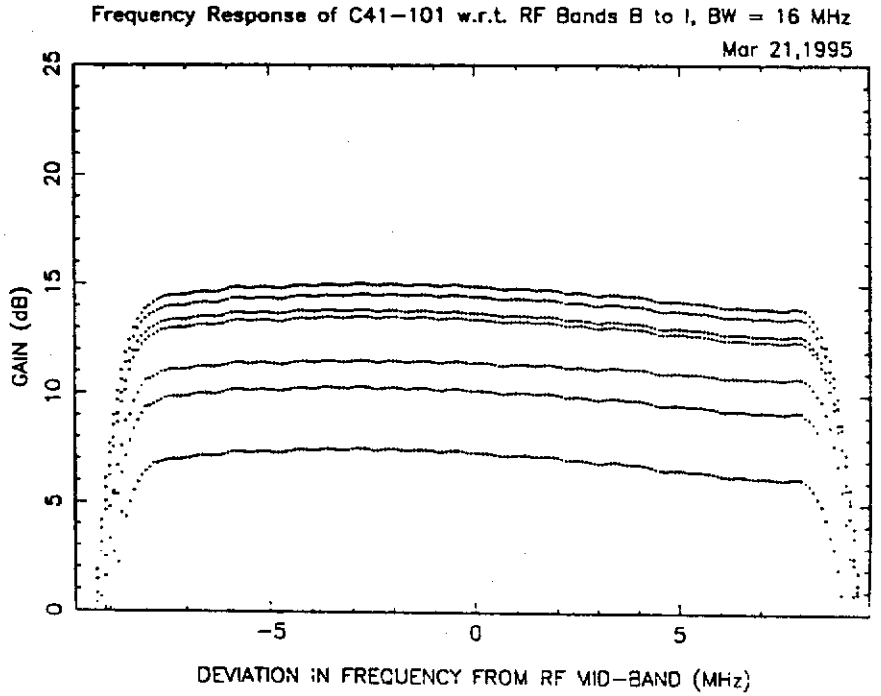
Size	Document Number	REV
B	FIG 2. MEASUREMENT SET-UP	

Date: Sheet: of Sheet

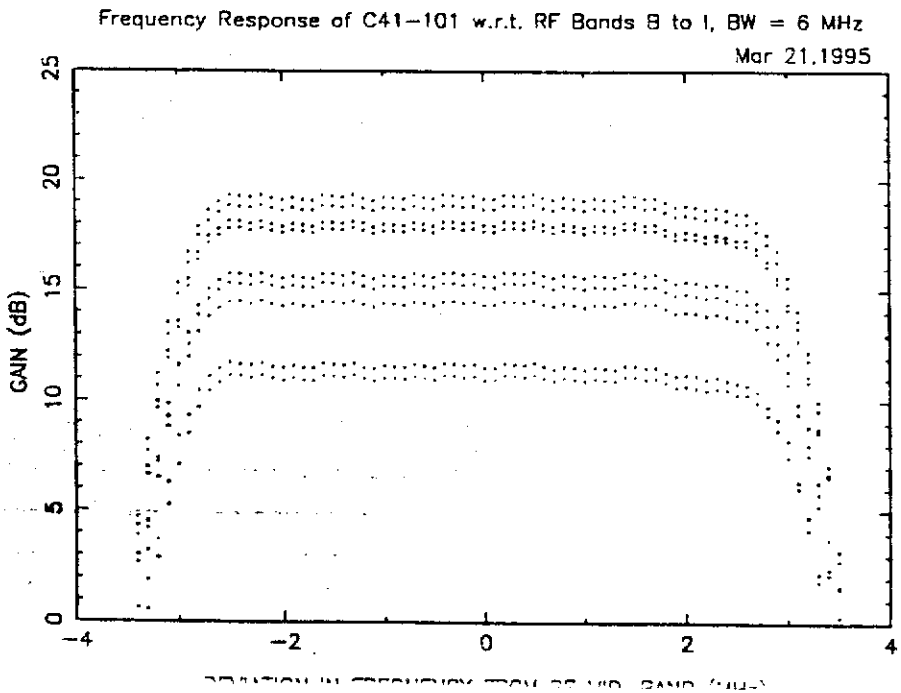
Frequency Response of C41−101 w.r.t. RF Bands B to I, BW = 32 MHz
Mar 21,1995



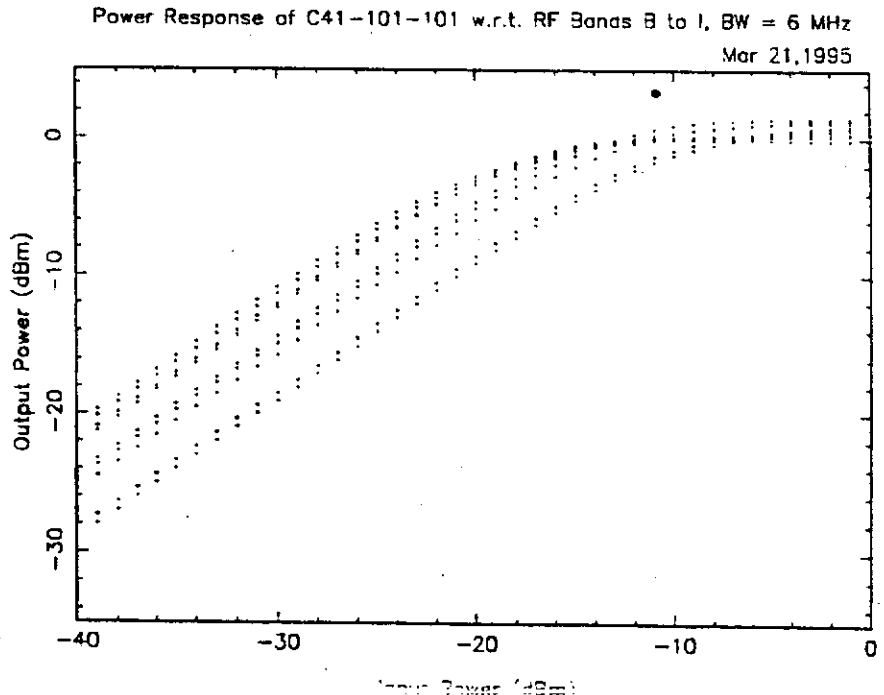
Frequency Response of C41−101 w.r.t. RF Bands B to I, BW = 16 MHz
Mar 21,1995



Frequency Response of C41−101 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995

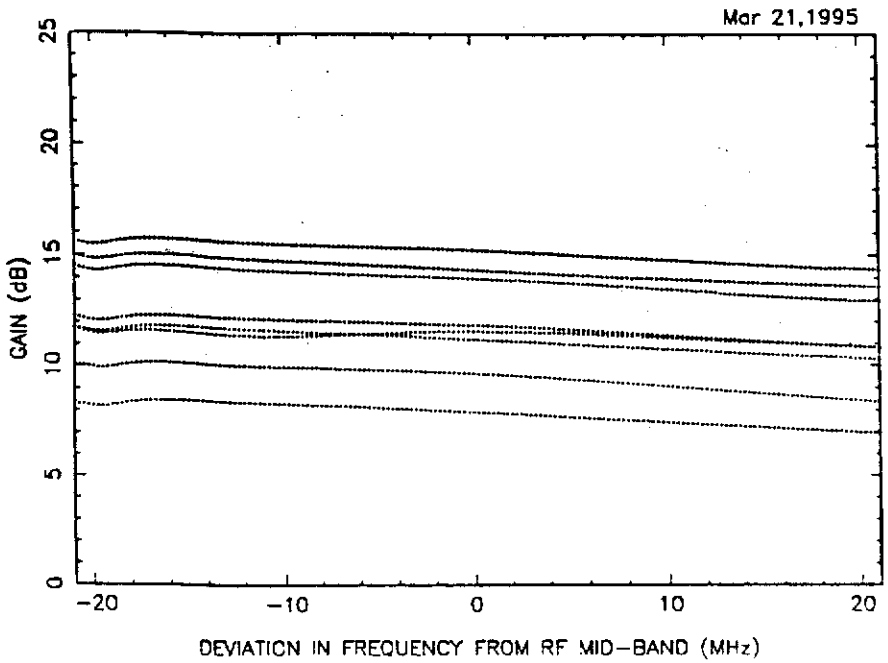


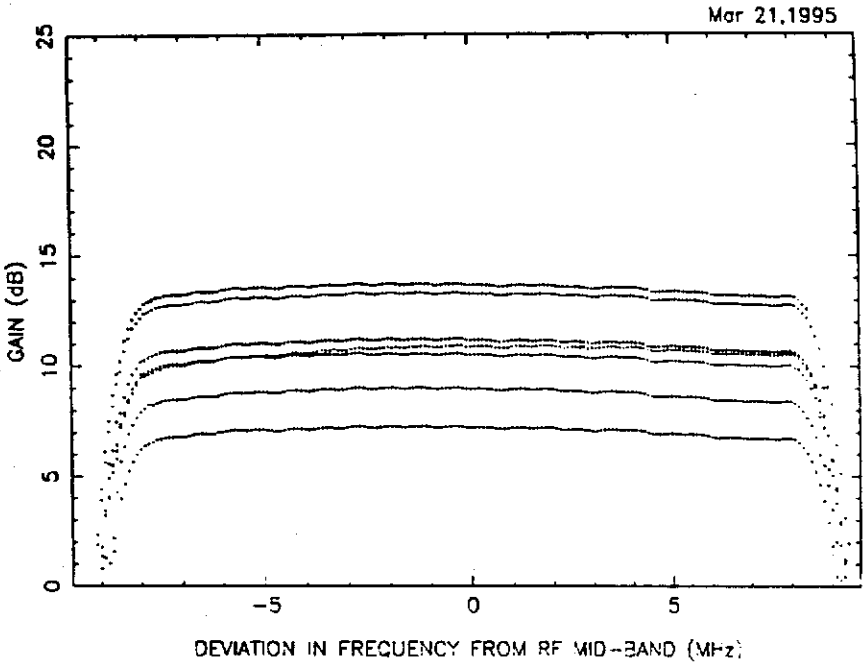
Power Response of C41−101−101 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995

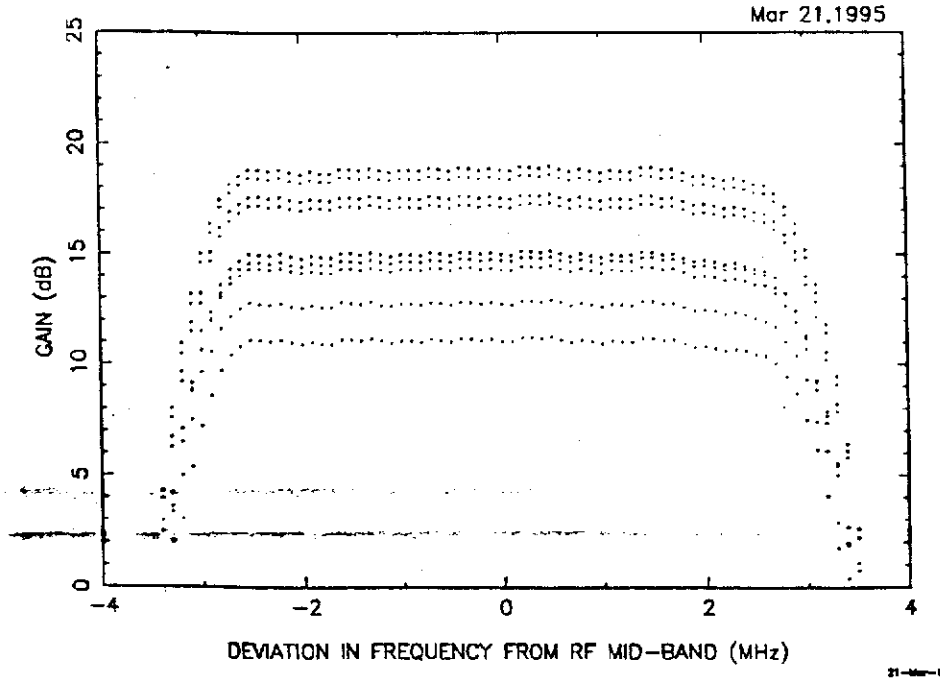


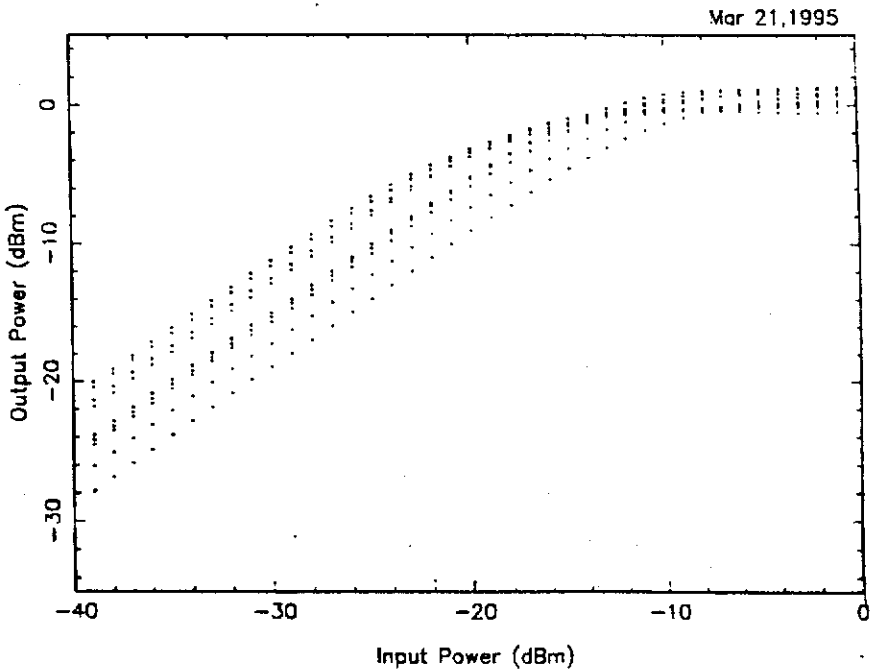
PLOT 1

Page 6


Frequency Response of C41−104 w.r.t. RF Bands B to I, BW = 32 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−20
−10
0
10
20
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

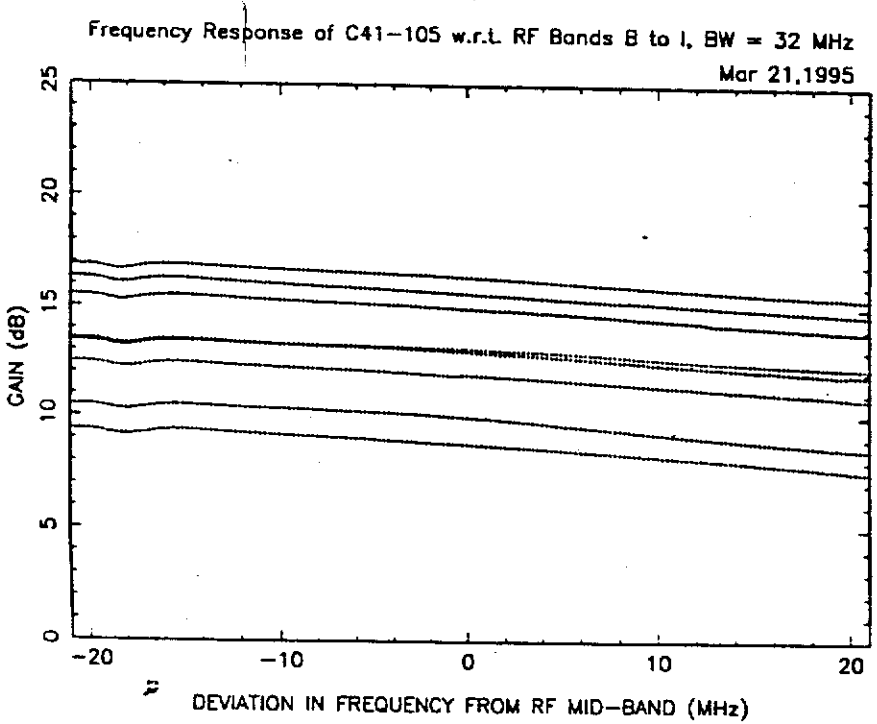

Frequency Response of C41−104 w.r.t. RF Bands B to I, BW = 16 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−5
0
5
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

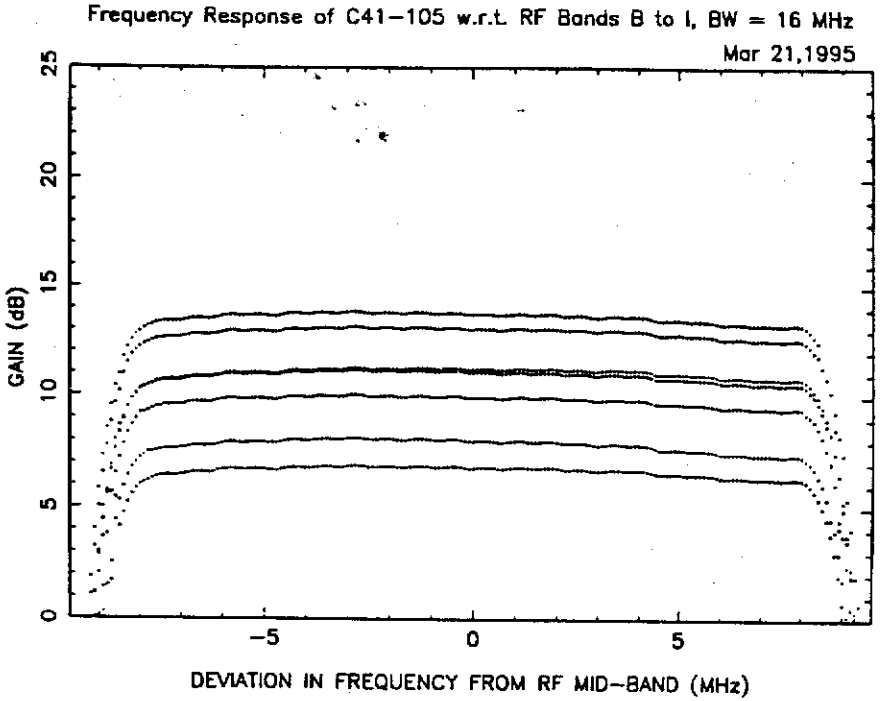

Frequency Response of C41−104 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−4
−2
0
2
4
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

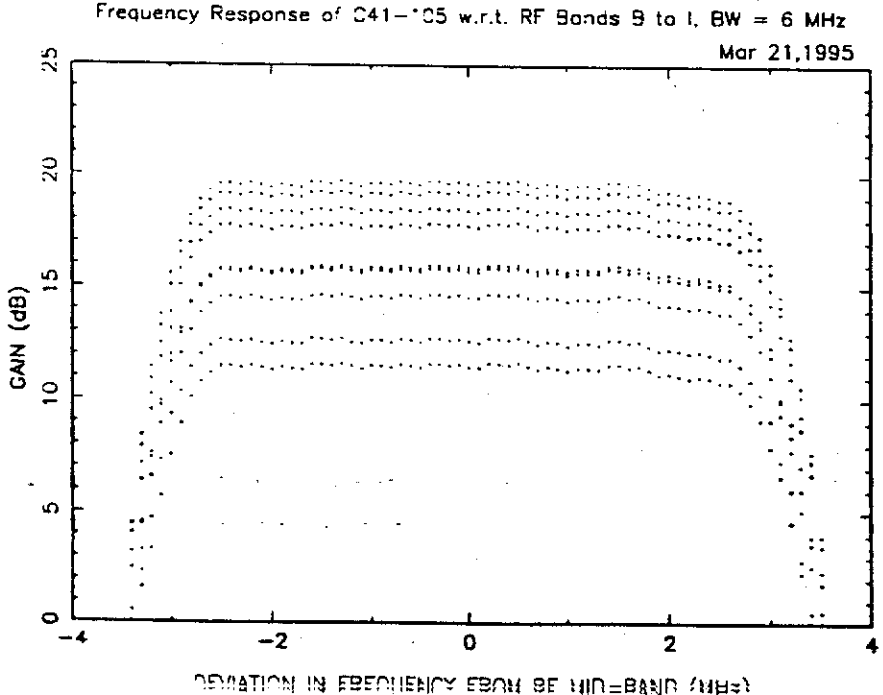

Power Response of C41−104−104 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995
Output Power (dBm)
0
−10
−20
−30
−40
−30
−20
−10
0
Input Power (dBm)

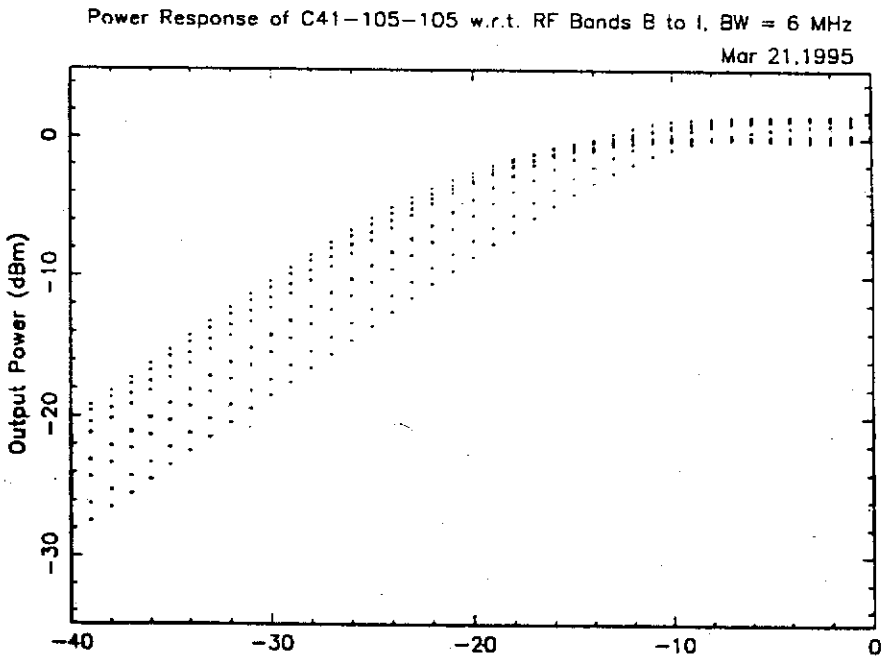
PLOT 2

Page 2


Frequency Response of C41−105 w.r.t. RF Bands B to I, BW = 32 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−20
−10
0
10
20
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

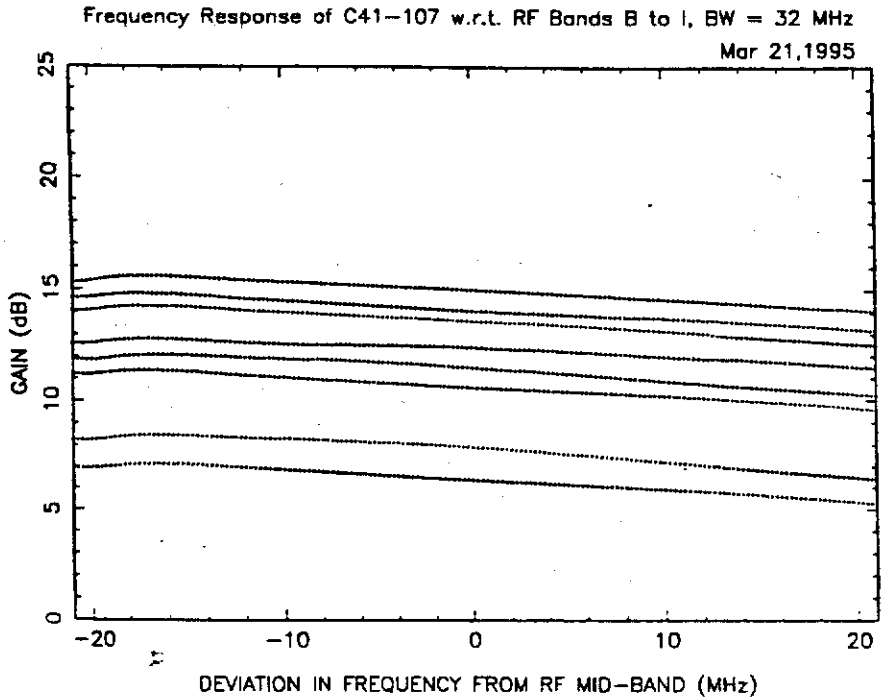

Frequency Response of C41−105 w.r.t. RF Bands B to I, BW = 16 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−5
0
5
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

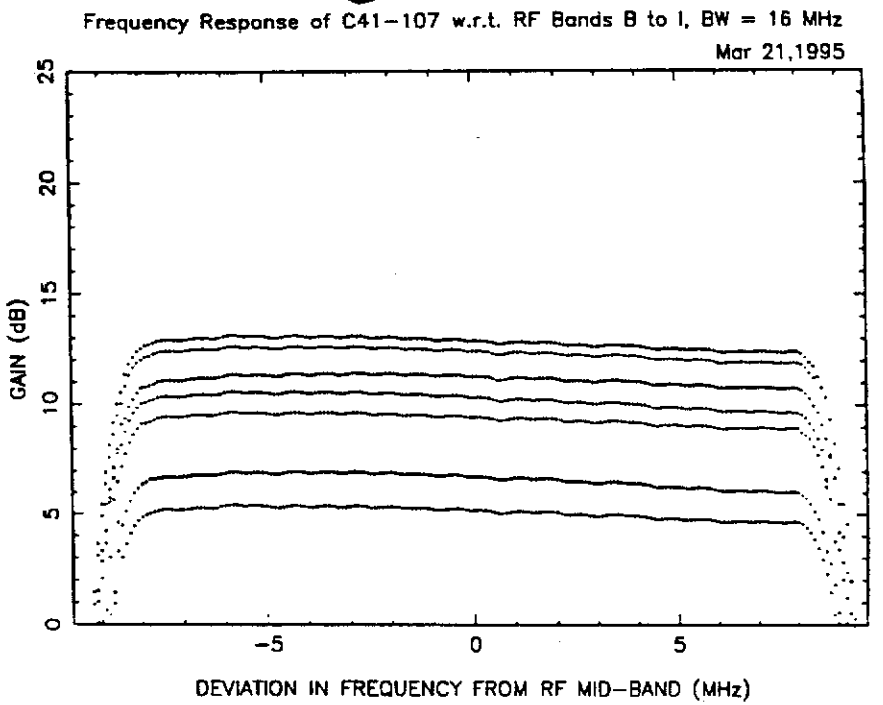

Frequency Response of C41−105 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−4
−2
0
2
4

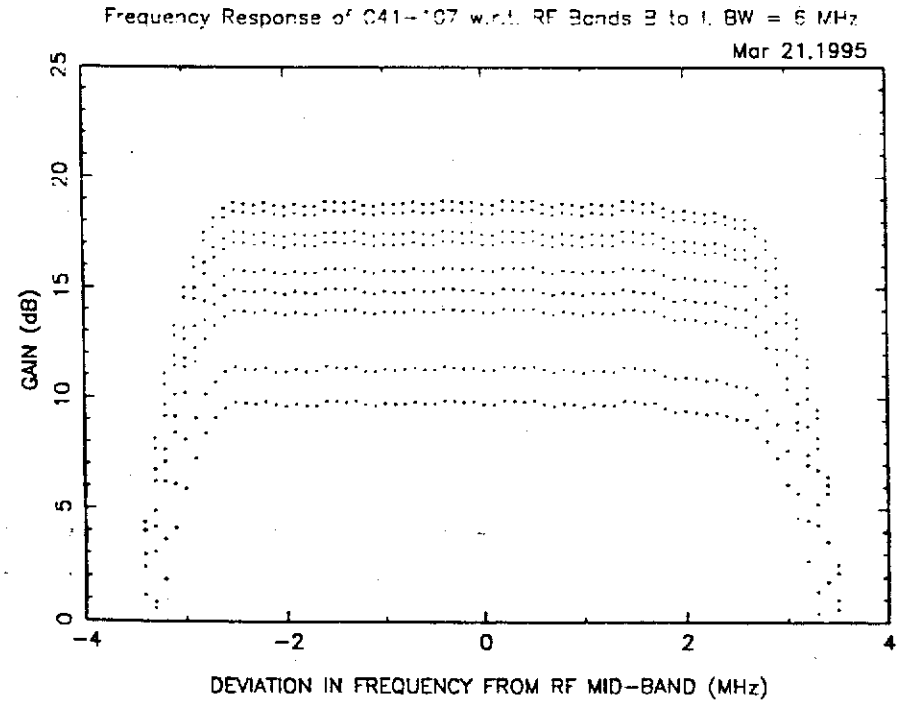

Power Response of C41−105−105 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995
Output Power (dBm)
0
−10
−20
−30
−40
−30
−20
−10
0

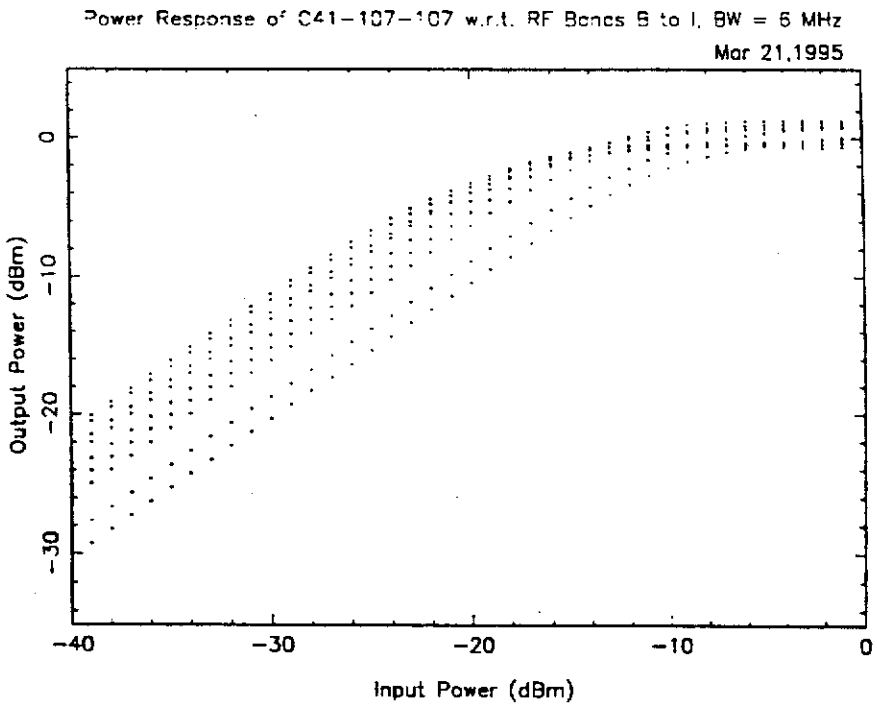
PLOT 3

(28)

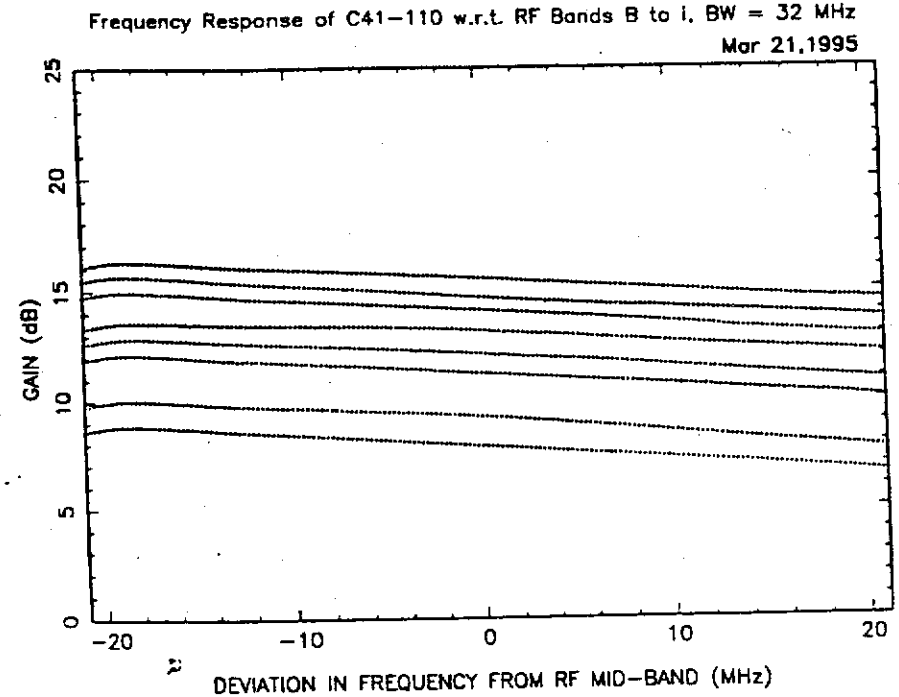

Frequency Response of C41−107 w.r.t. RF Bands B to I, BW = 32 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−20
−10
0
10
20
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

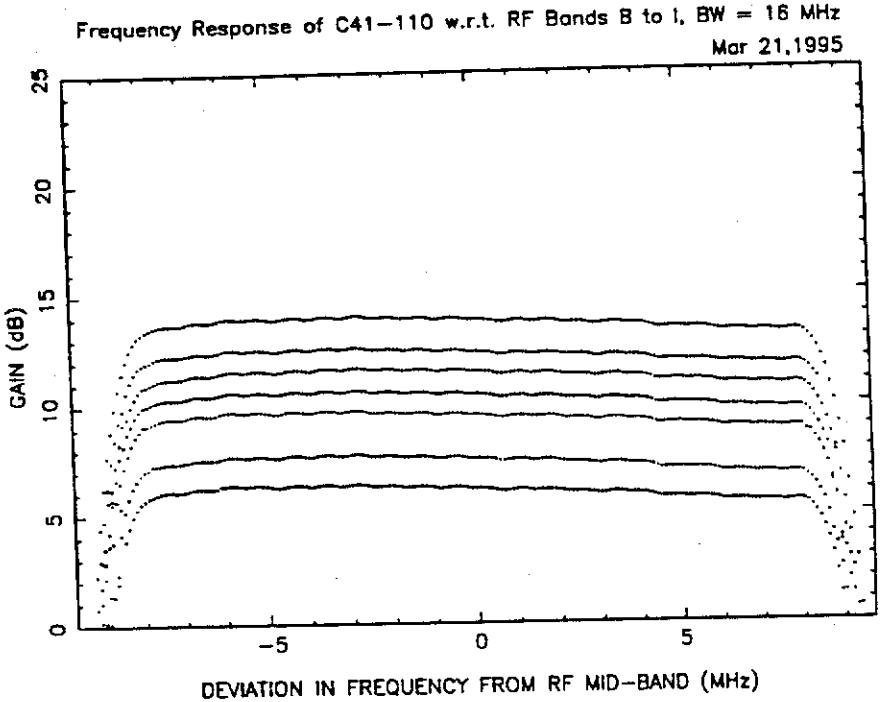

Frequency Response of C41−107 w.r.t. RF Bands B to I, BW = 16 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−5
0
5
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

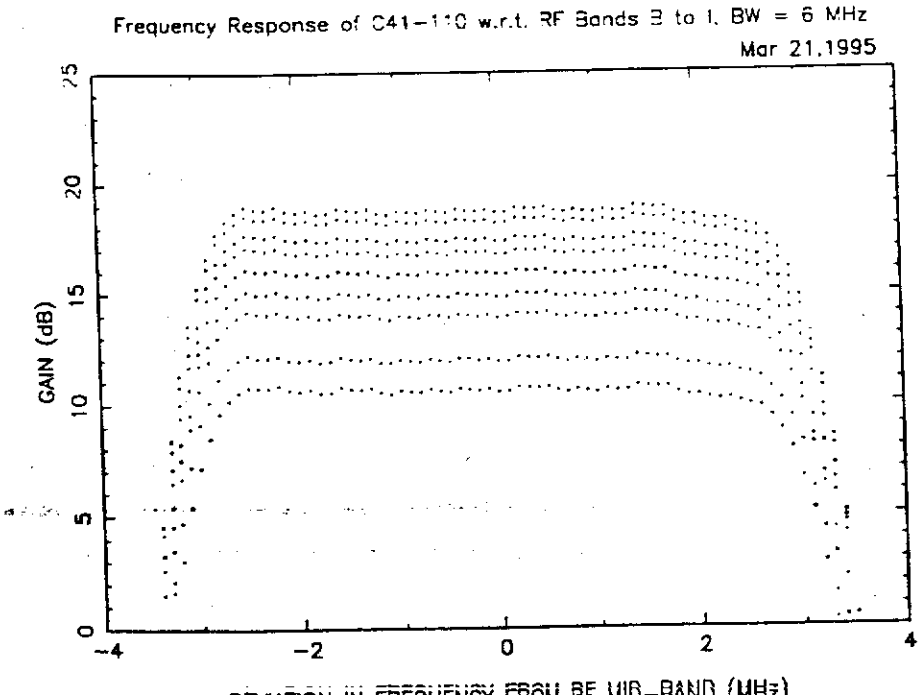

Frequency Response of C41−107 w.r.t. RF Bands B to I, BW = 8 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−4
−2
0
2
4
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

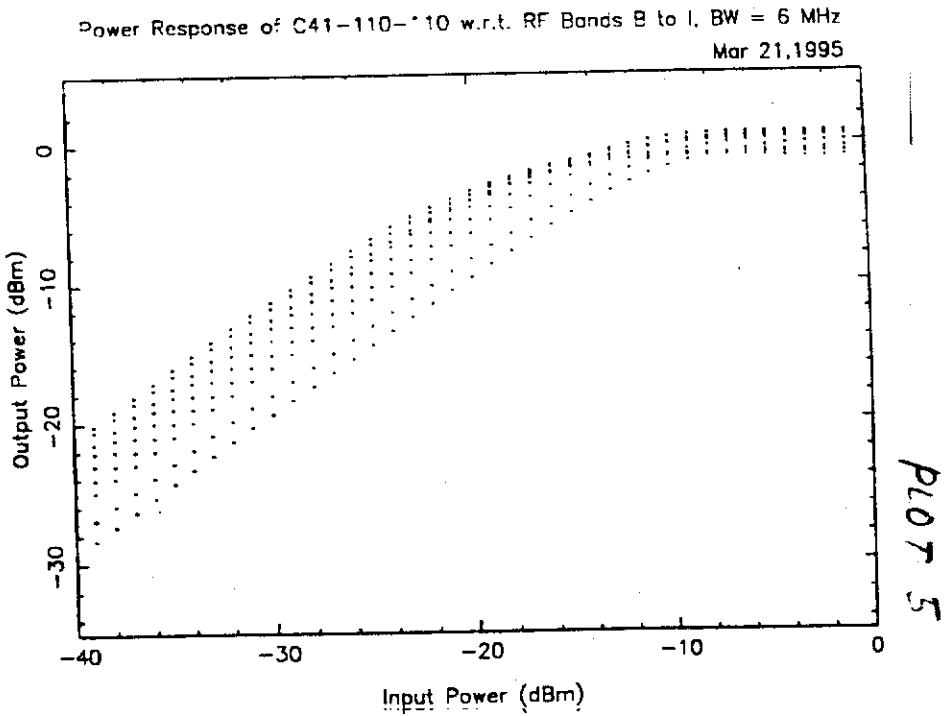

Power Response of C41−107−107 w.r.t. RF Bands B to I, BW = 8 MHz
Mar 21,1995
Output Power (dBm)
0
−10
−20
−30
−40
−30
−20
−10
0
Input Power (dBm)

Plot 4.



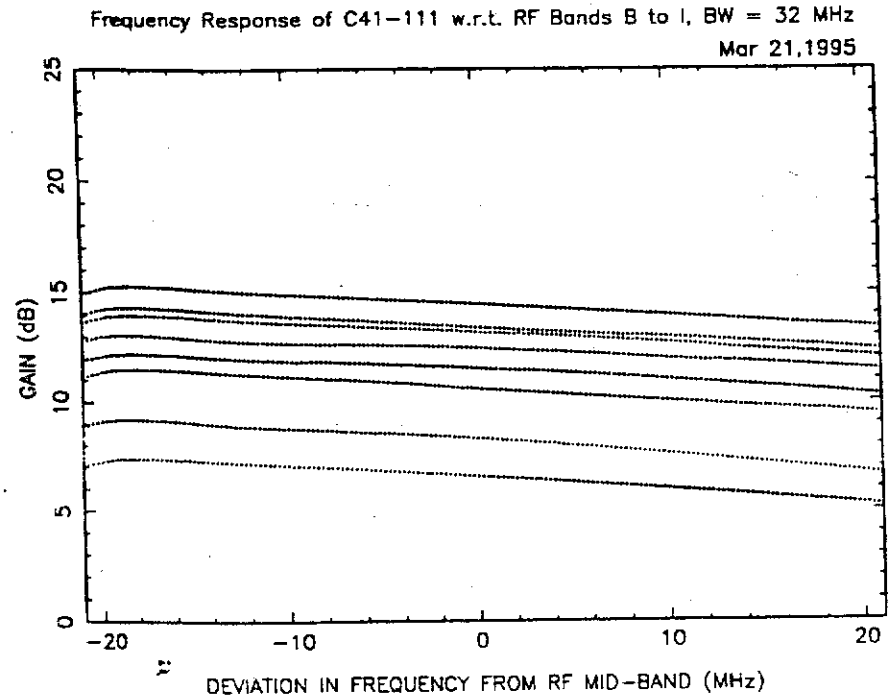


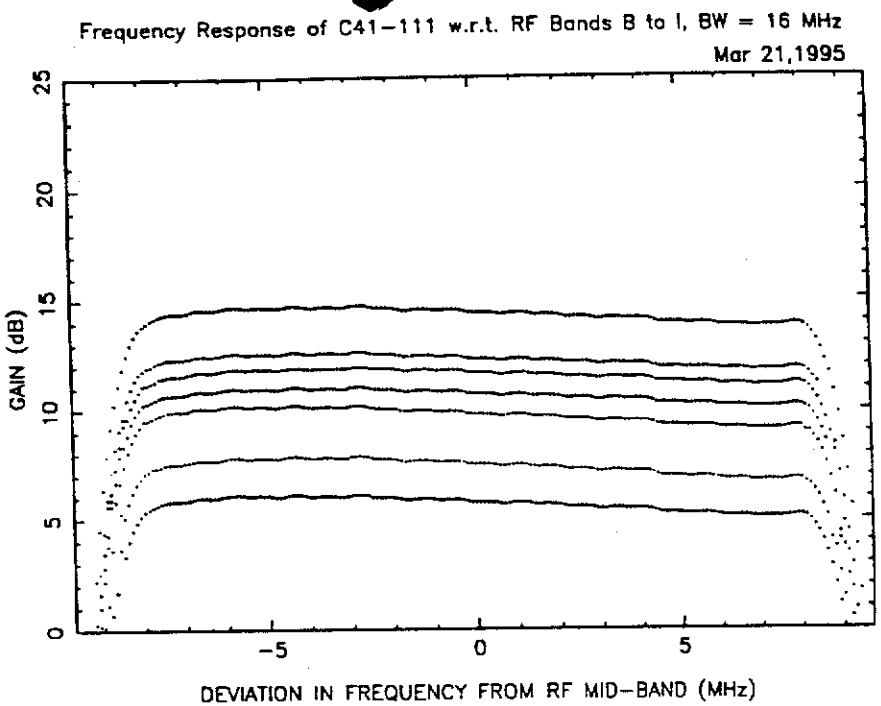


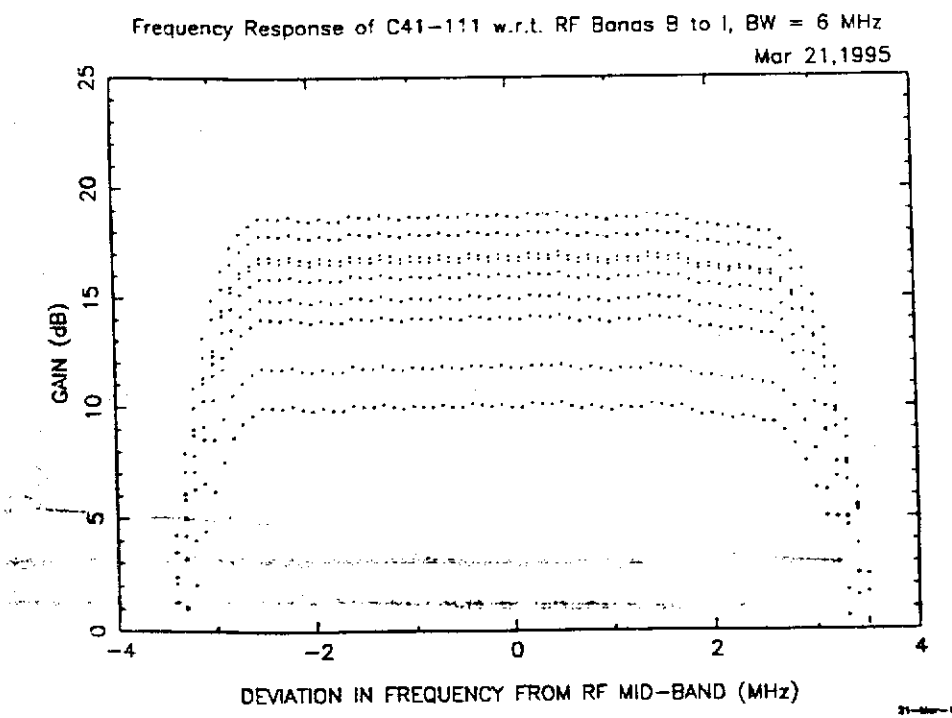


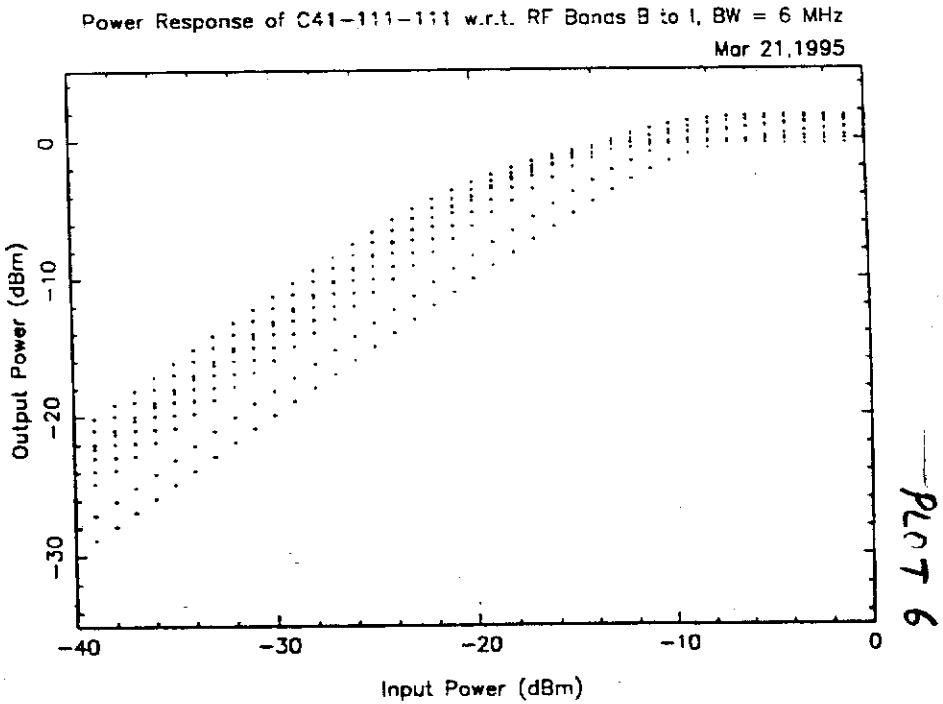
PLOT 5

Page 10

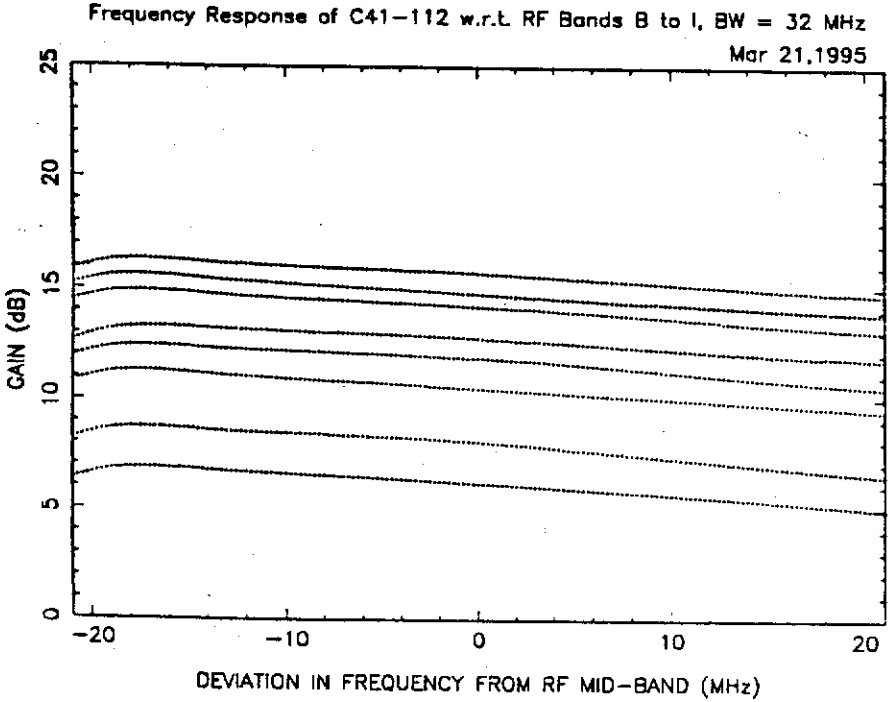

Frequency Response of C41−111 w.r.t. RF Bands B to I, BW = 32 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−20
−10
0
10
20
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

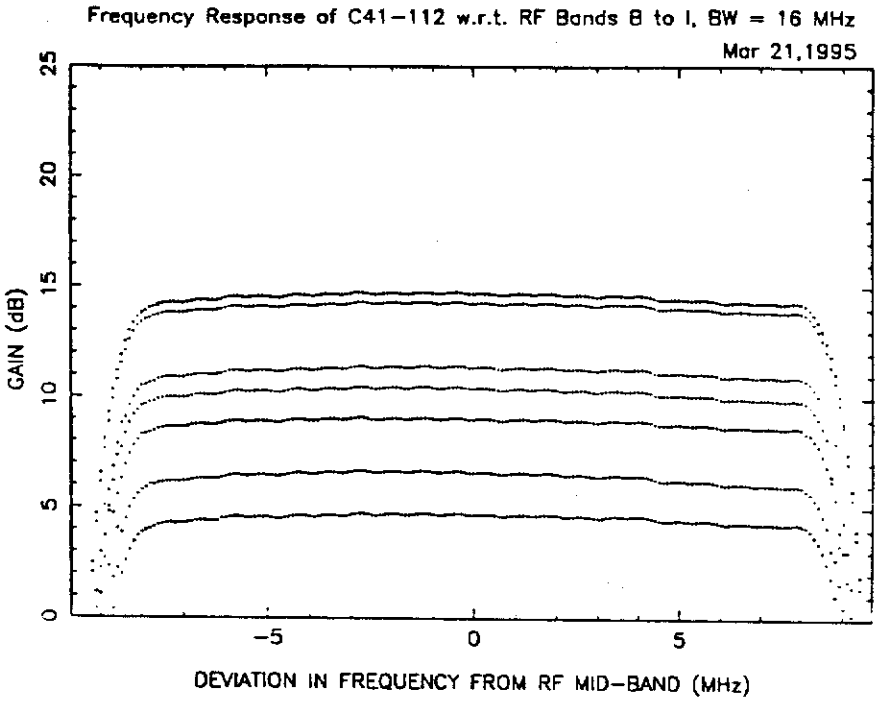

Frequency Response of C41−111 w.r.t. RF Bands B to I, BW = 16 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−5
0
5
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

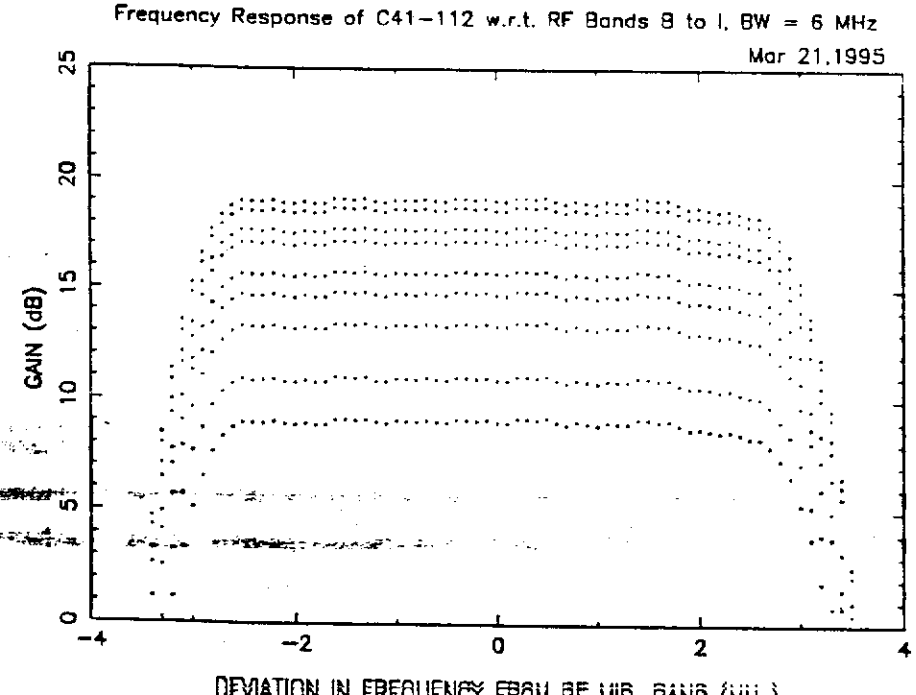

Frequency Response of C41−111 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−4
−2
0
2
4
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

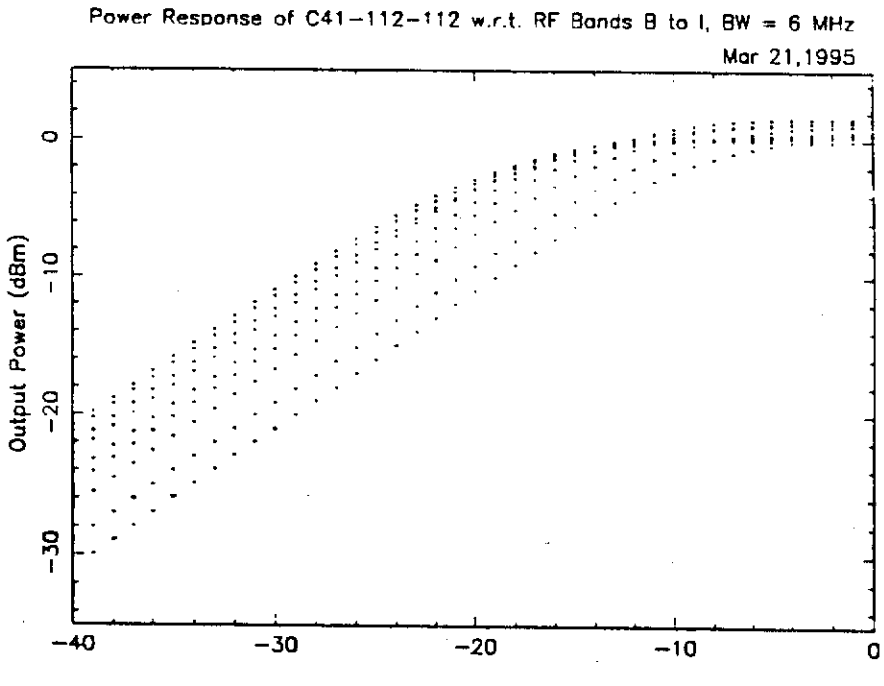

Power Response of C41−111−111 w.r.t. RF Bands B to I, BW = 6 MHz
Mar 21,1995
Output Power (dBm)
0
−10
−20
−30
−40
−30
−20
−10
0
Input Power (dBm)

Page 6 of 11


Frequency Response of C41−112 w.r.t. RF Bands 8 to 1, BW = 32 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−20
−10
0
10
20
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)


Frequency Response of C41−112 w.r.t. RF Bands 8 to 1, BW = 16 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−5
0
5
DEVIATION IN FREQUENCY FROM RF MID−BAND (MHz)

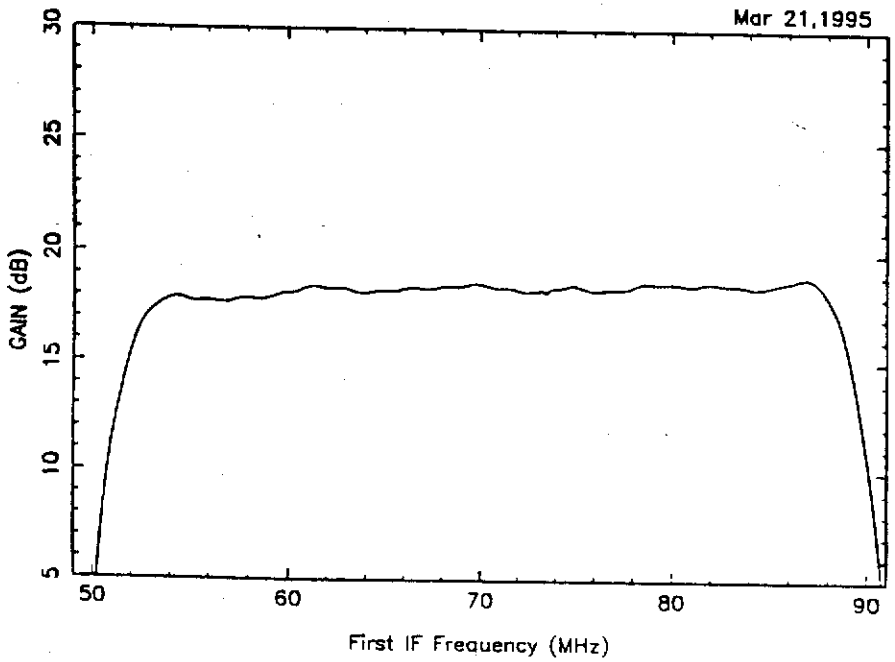

Frequency Response of C41−112 w.r.t. RF Bands 8 to 1, BW = 6 MHz
Mar 21,1995
GAIN (dB)
0
5
10
15
20
25
−4
−2
0
2
4


Power Response of C41−112−112 w.r.t. RF Bands 8 to 1, BW = 6 MHz
Mar 21,1995
Output Power (dBm)
0
−10
−20
−30
−40
−30
−20
−10
0

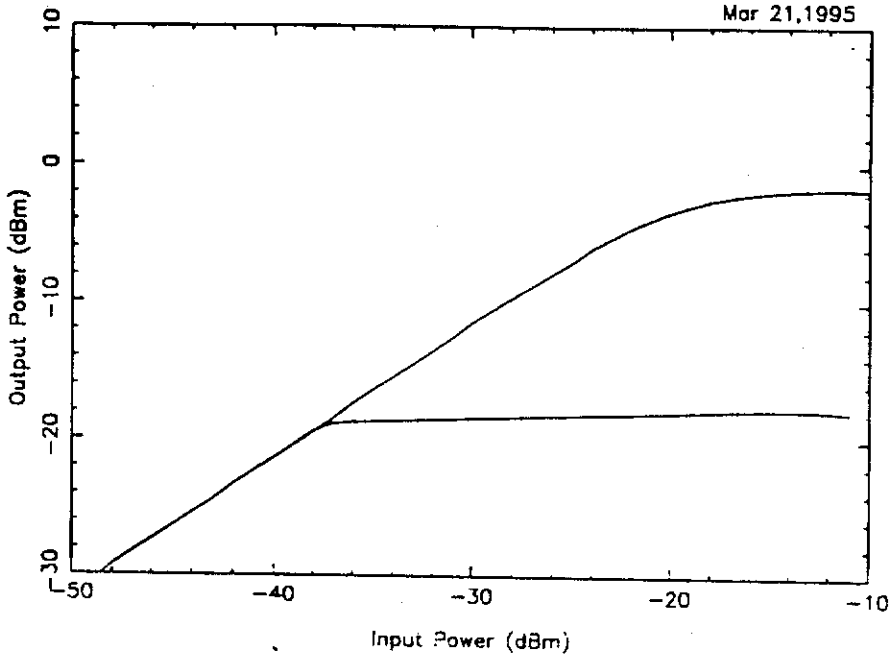
PLOT 7

Page

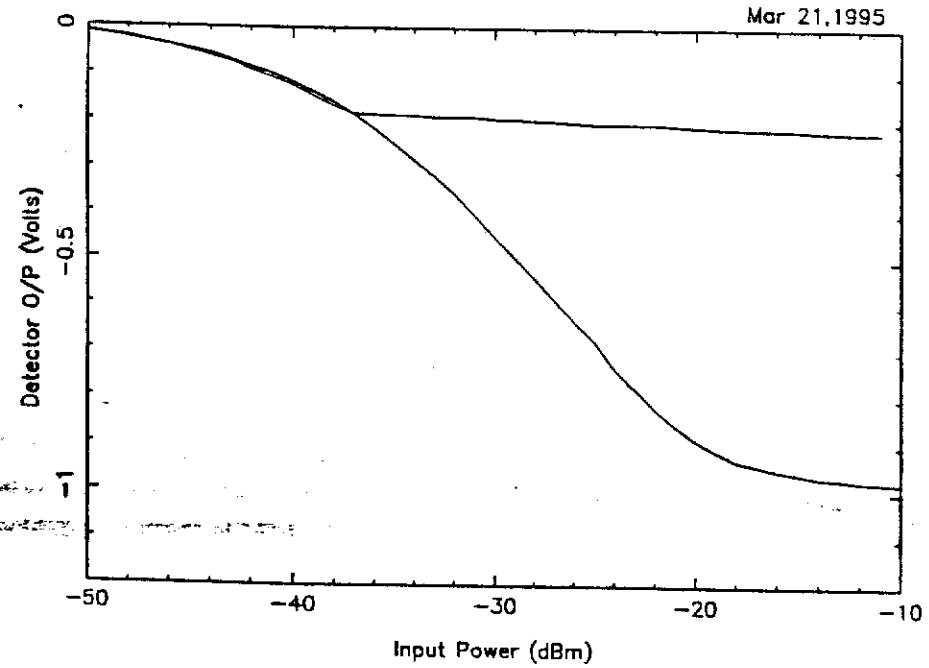
FREQUENCY RESPONSE OF C42-113 PIU



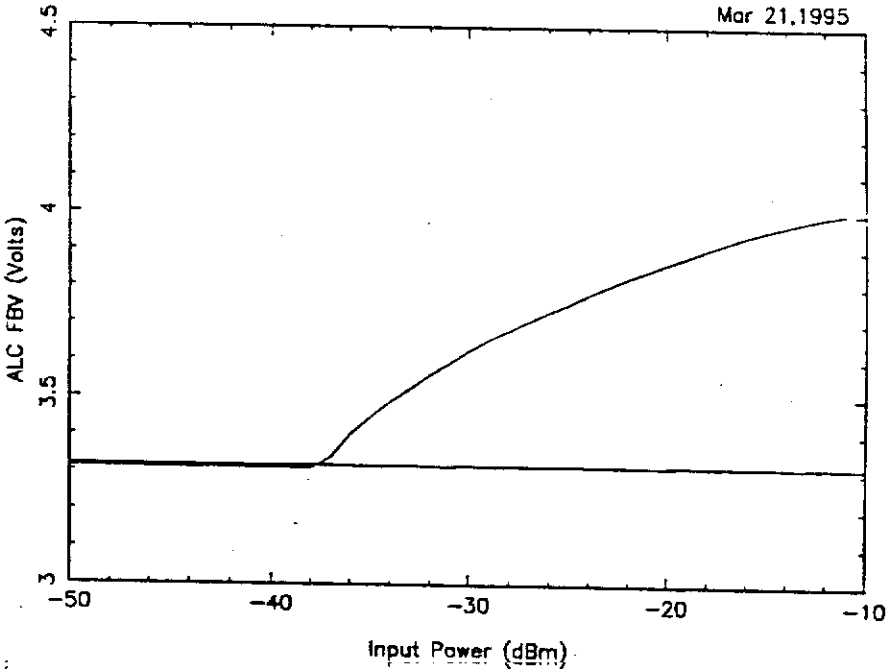
INPUT-OUTPUT POWER RESPONSE IN C42-113 PIU



TOTAL POWER DETECTOR RESPONSE IN C42-113 PIU



ALC FEEDBACK VOLTAGE RESPONSE IN C42-113 PIU



PLOT 8

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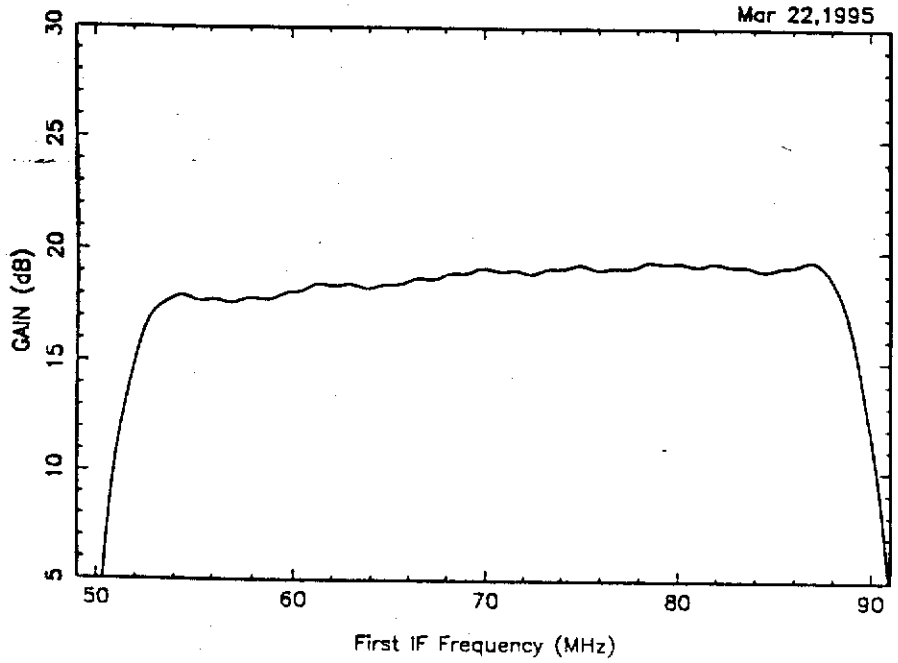
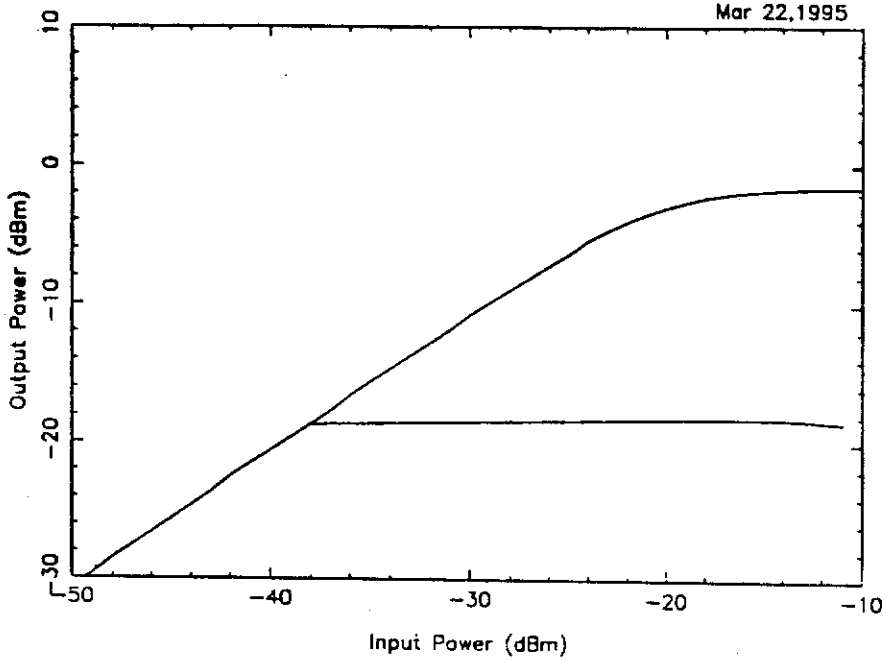
FREQUENCY RESPONSE OF C42-114 PIU



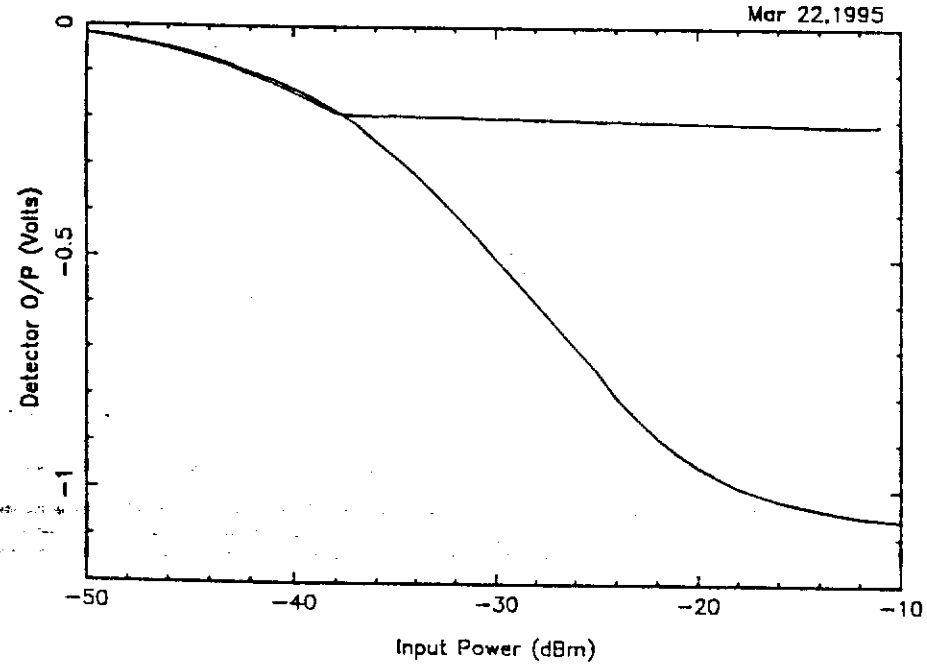
INPUT-OUTPUT POWER RESPONSE IN C42-114 PIU



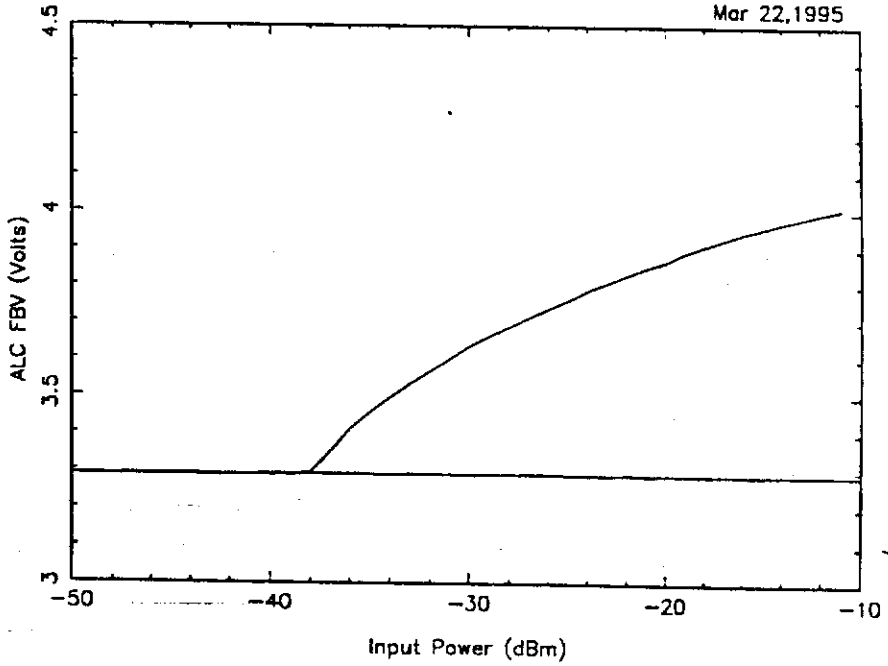
C1

C65 3.20

TOTAL POWER DETECTOR RESPONSE IN C42-114 PIU



ALC FEEDBACK VOLTAGE RESPONSE IN C42-114 PIU



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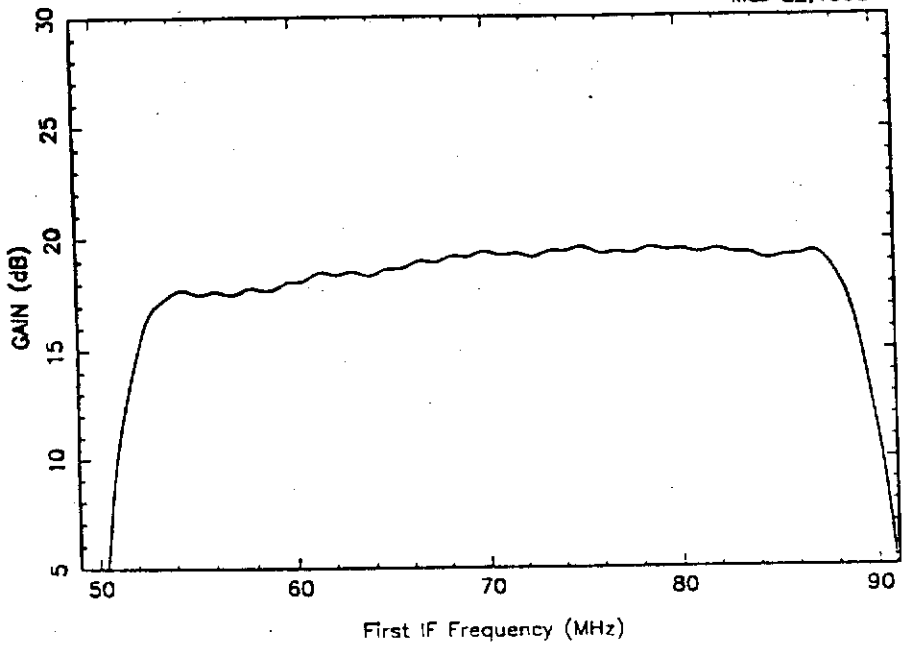
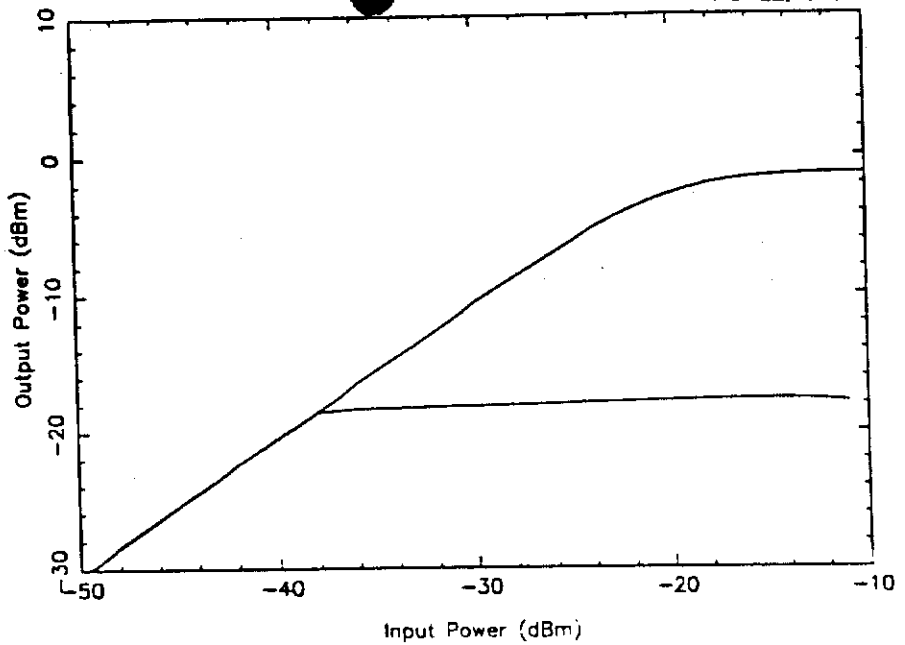
FREQUENCY RESPONSE OF C42-115 PIU

Mar 22,1995

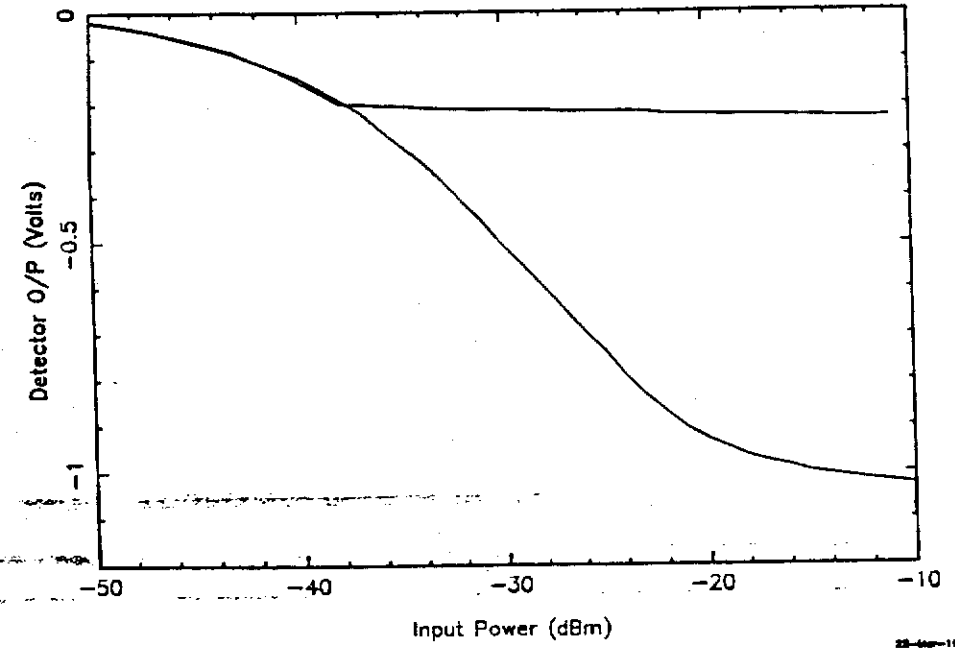


Mar 22,1995



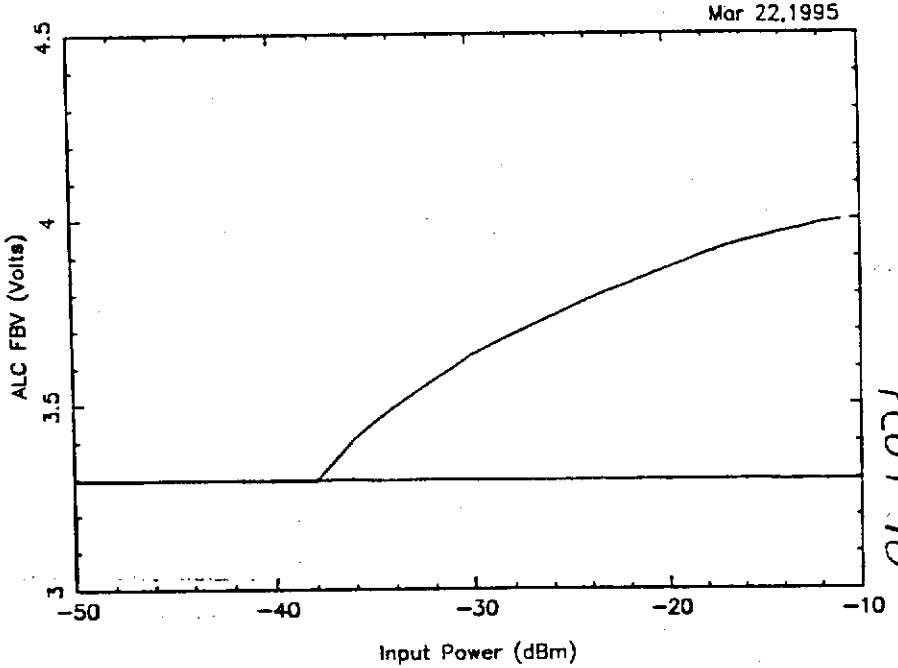
TOTAL POWER DETECTOR RESPONSE IN C42-115 PIU

Mar 22,1995



ALC FEEDBACK VOLTAGE RESPONSE IN C42-115 PIU

Mar 22,1995



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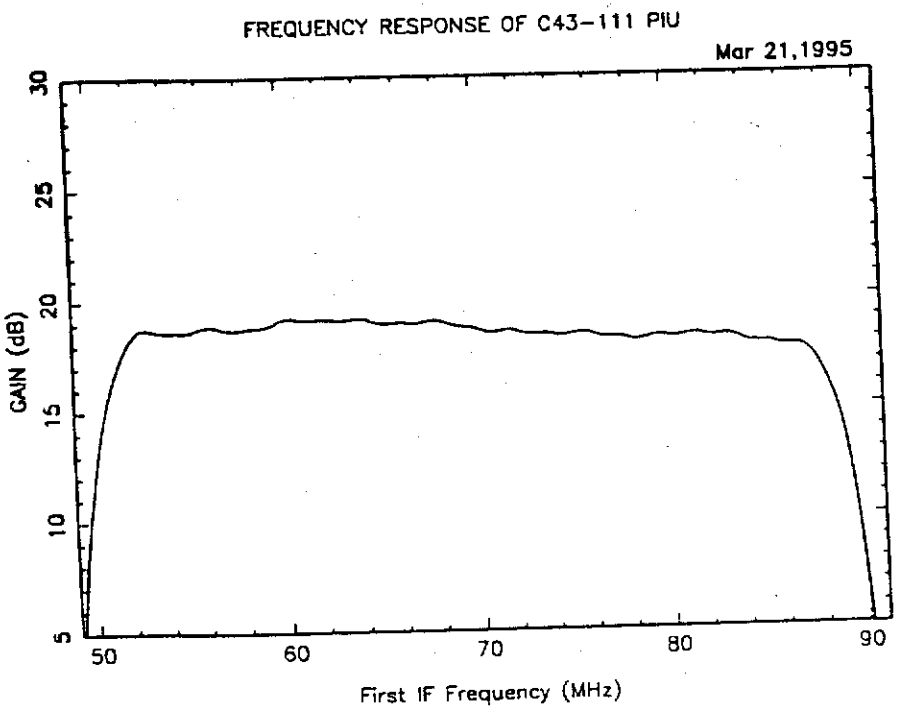

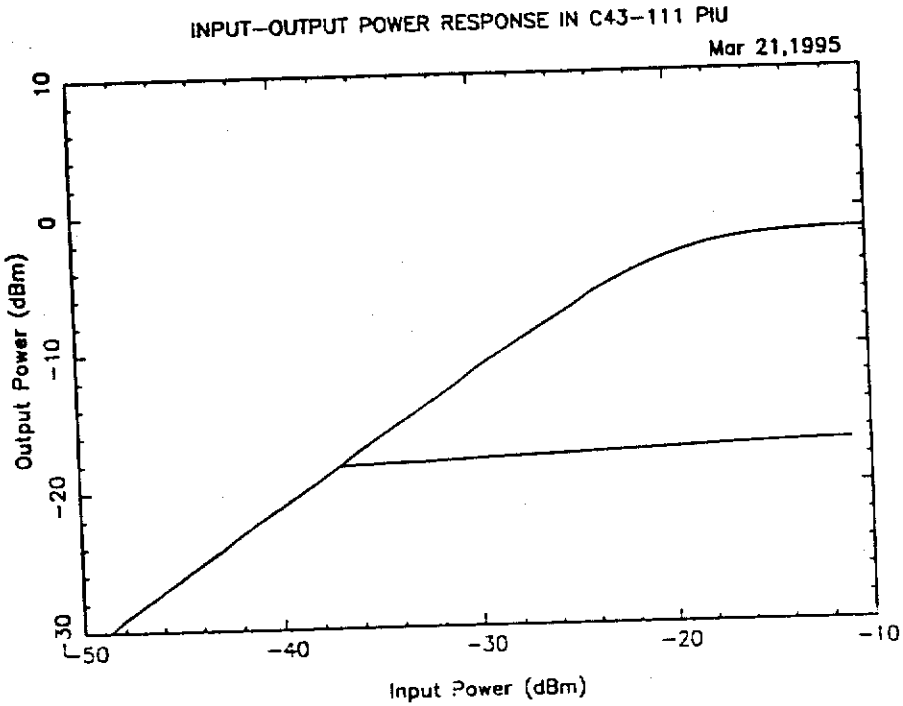

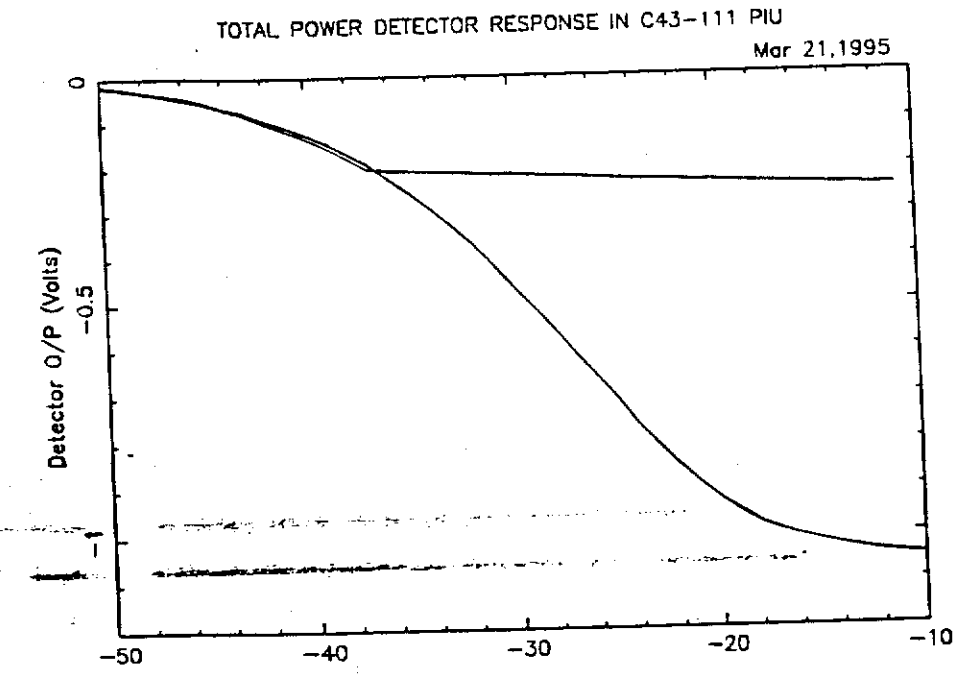

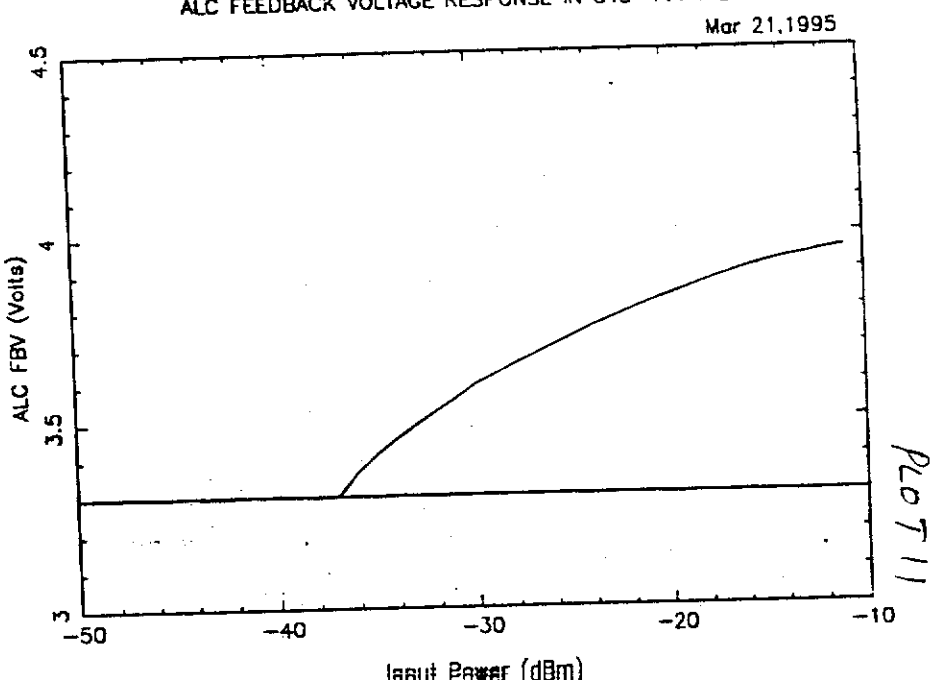

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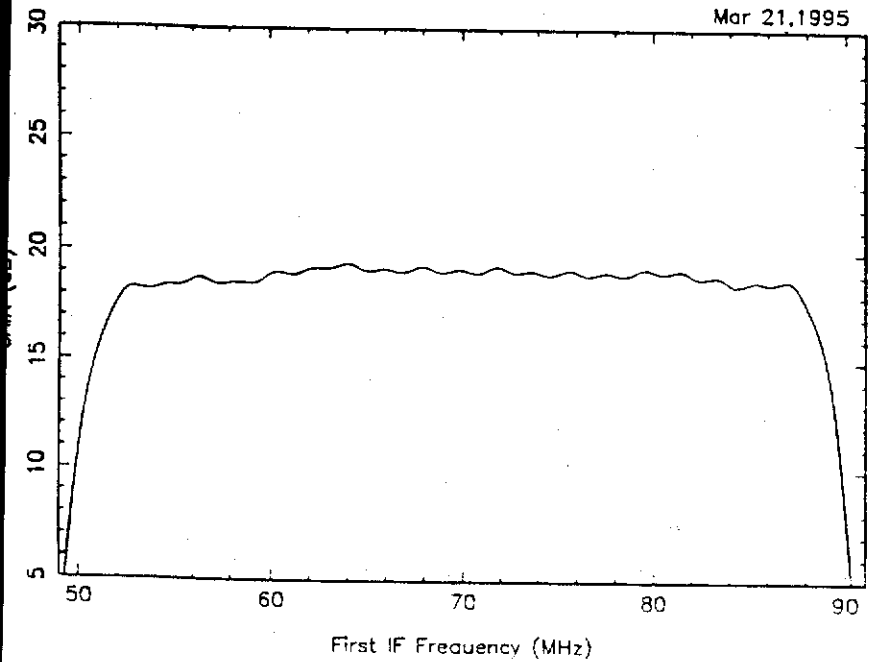
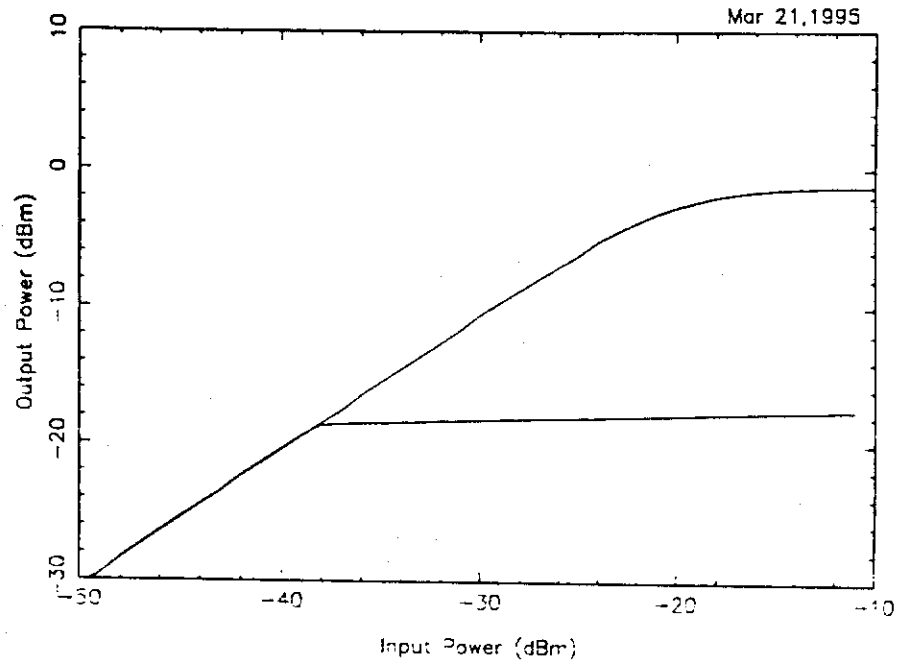
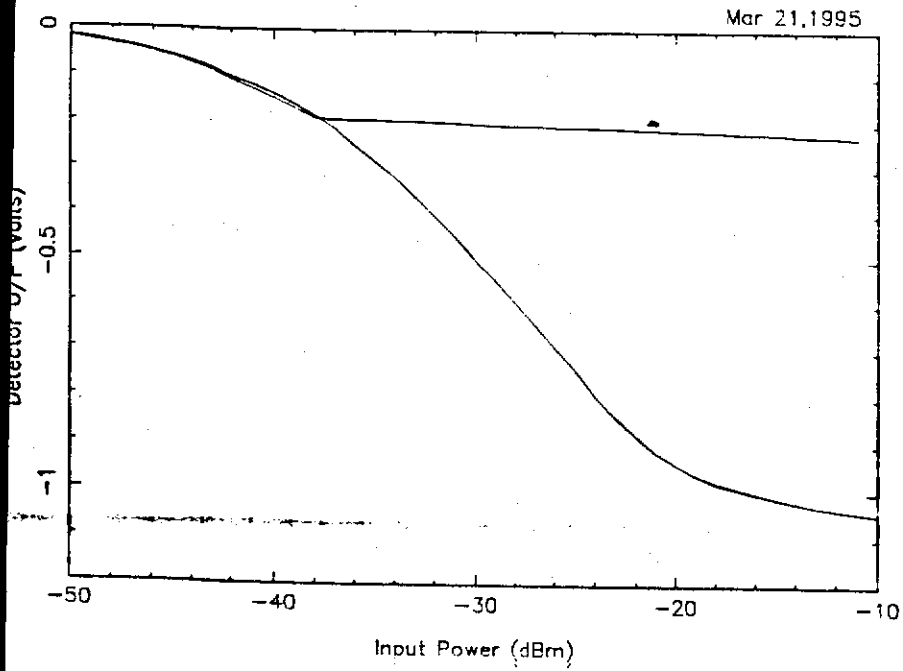
FREQUENCY RESPONSE OF C43-112 PIU



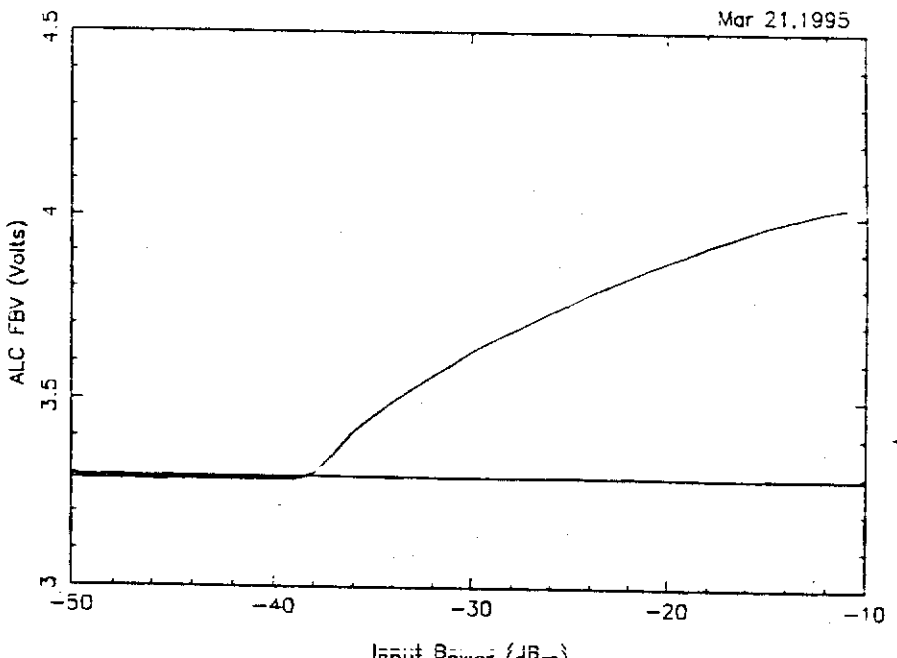
INPUT-OUTPUT POWER RESPONSE IN C43-112 PIU



TOTAL POWER DETECTOR RESPONSE IN C43-112 PIU

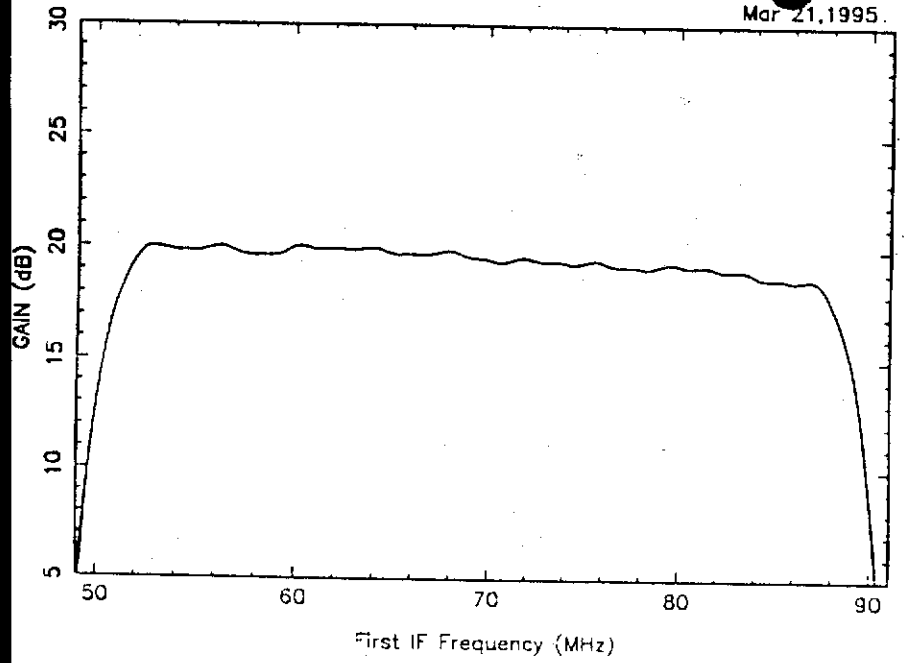


ALC FEEDBACK VOLTAGE RESPONSE IN C43-112 PIU



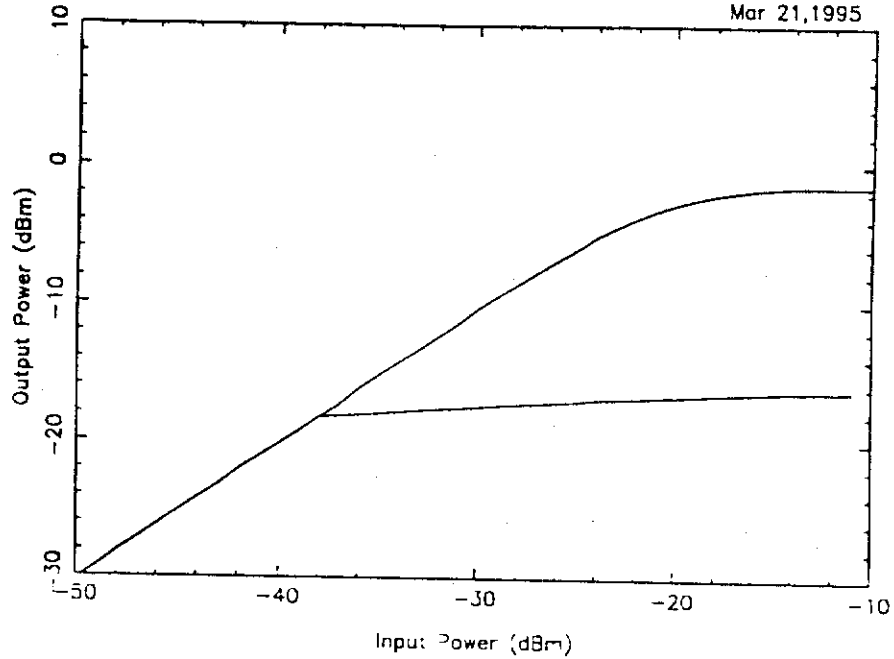
FREQUENCY RESPONSE OF C43-114 PIU

Mar 21,1995



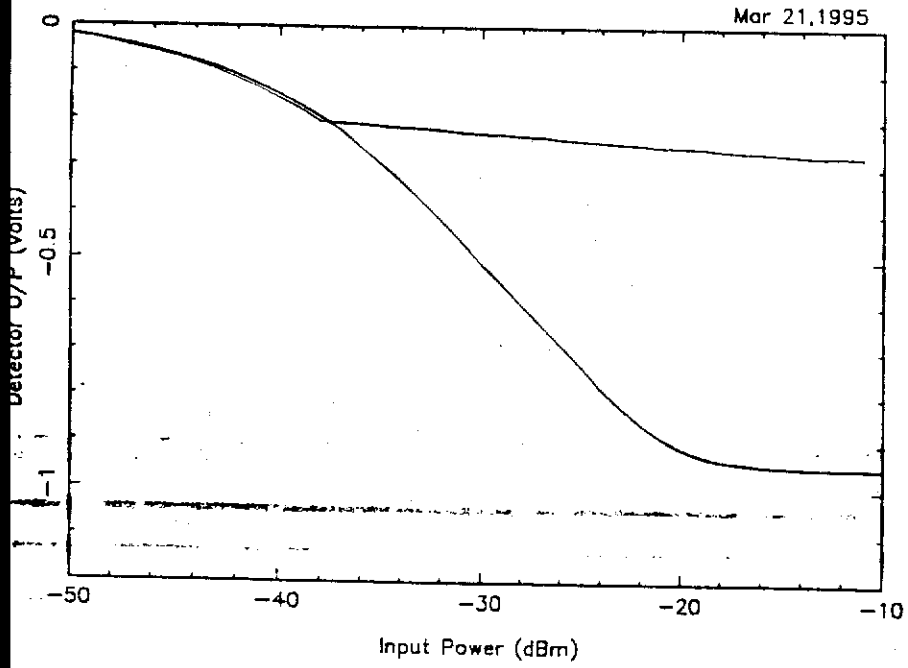
INPUT-OUTPUT P[illegible]ER RESPONSE IN C43-114 PIU

Mar 21,1995



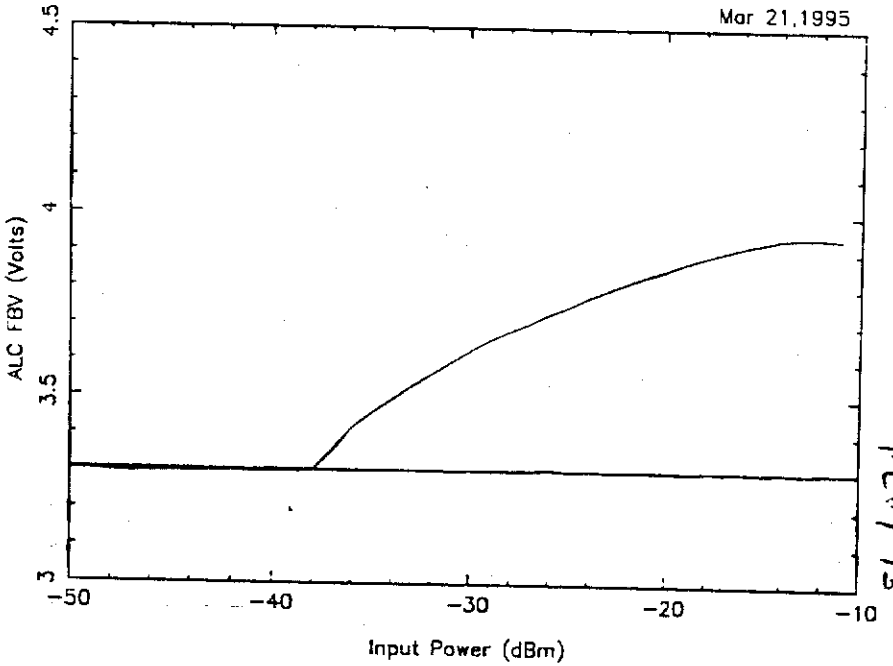
TOTAL POWER DETECTOR RESPONSE IN C43-114 PIU

Mar 21,1995



ALC FEEDBACK VOLTAGE RESPONSE IN C43-114 PIU

Mar 21,1995



PLOT 13

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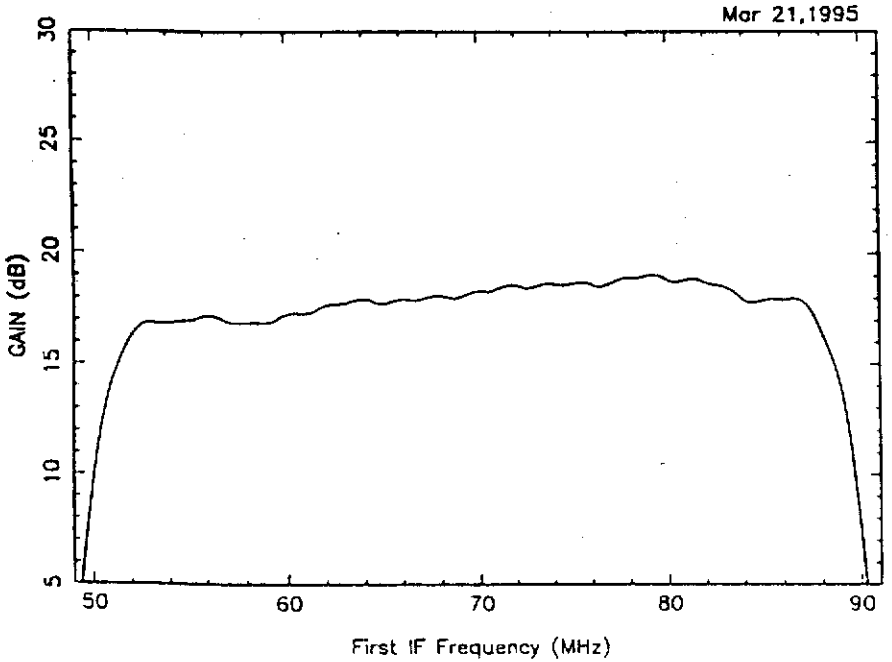
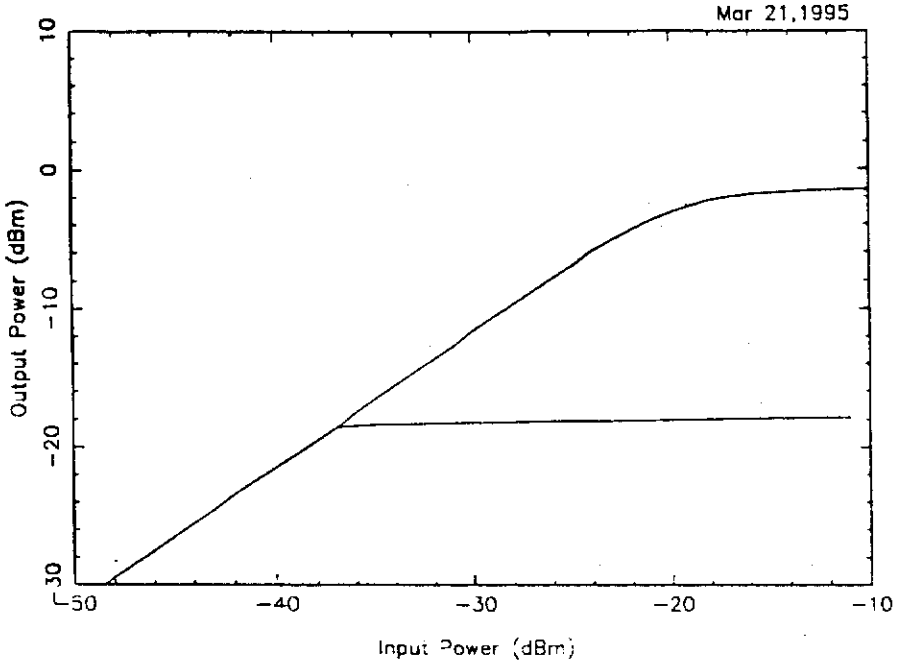
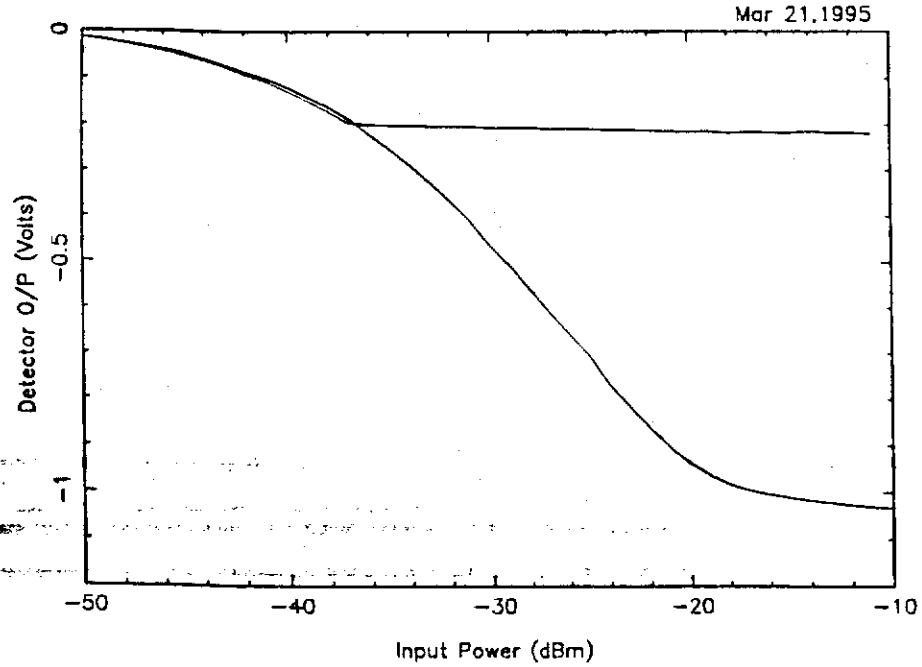
FREQUENCY RESPONSE OF C43-115 PIU



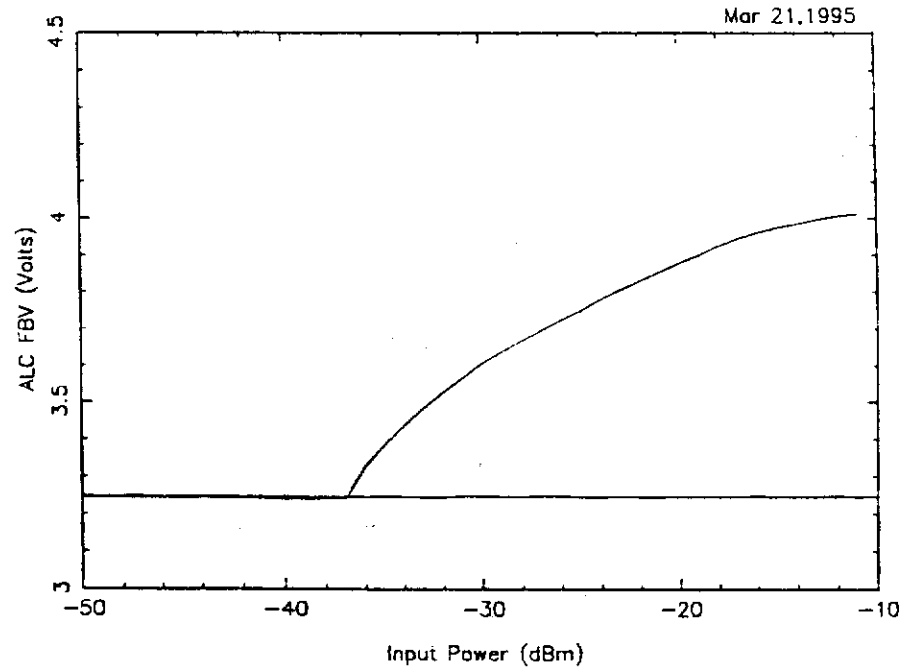
INPUT-OUTPUT POWER RESPONSE IN C43-115 PIU



TOTAL POWER DETECTOR RESPONSE IN C43-115 PIU



ALC FEEDBACK VOLTAGE RESPONSE IN C43-115 PIU



C1

PLOT 14

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INTERMODULATION RESPONSE OF C41-[redacted]4 March 29 1995

Plot 15

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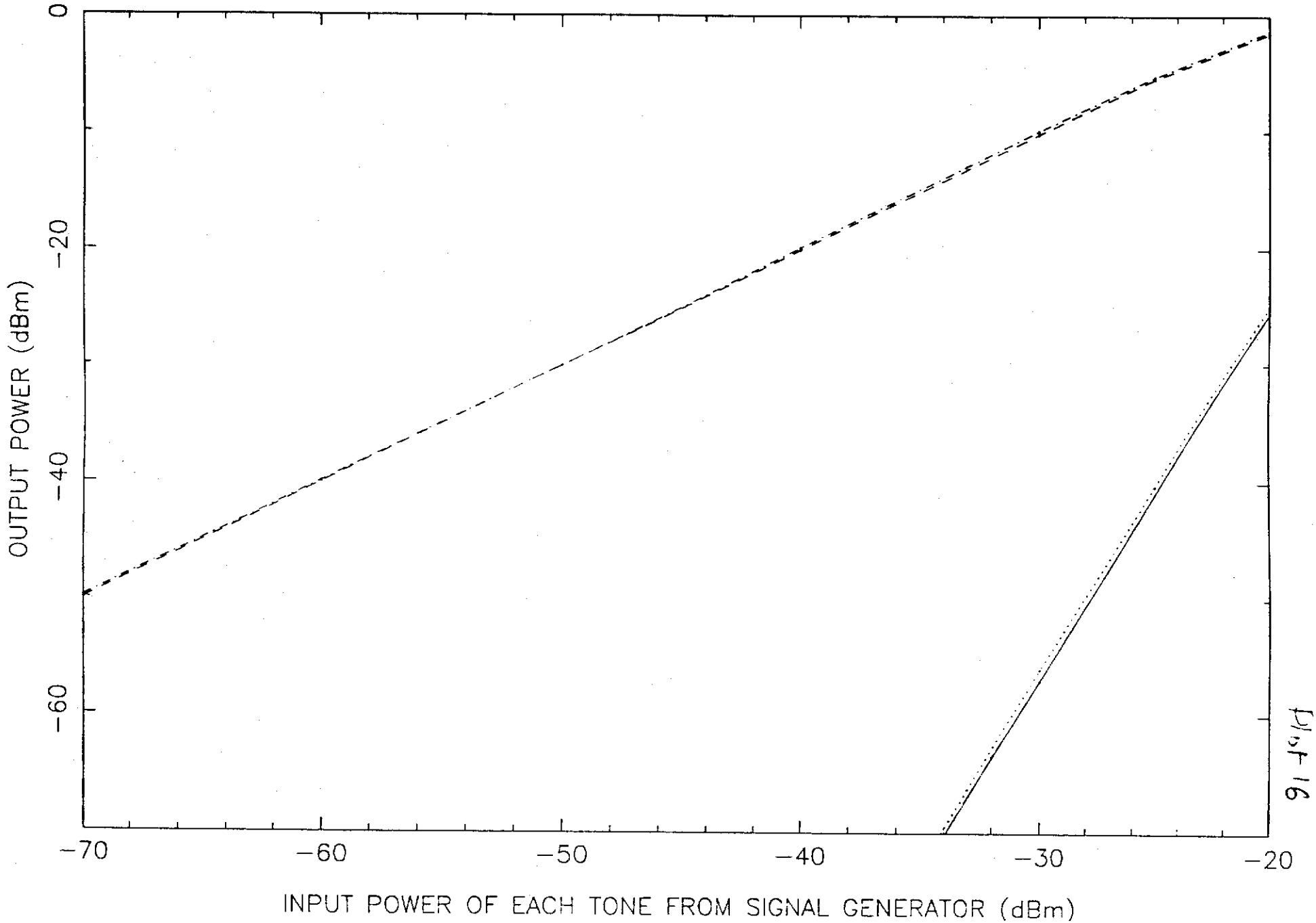
TWO-TONE INTERMODULATION RESPONSE OF C42-113 ALC OFF March 29 1995



TWO–TONE INTERMODULATION RESPONSE OF C42–113 ALC ON March 29 1995

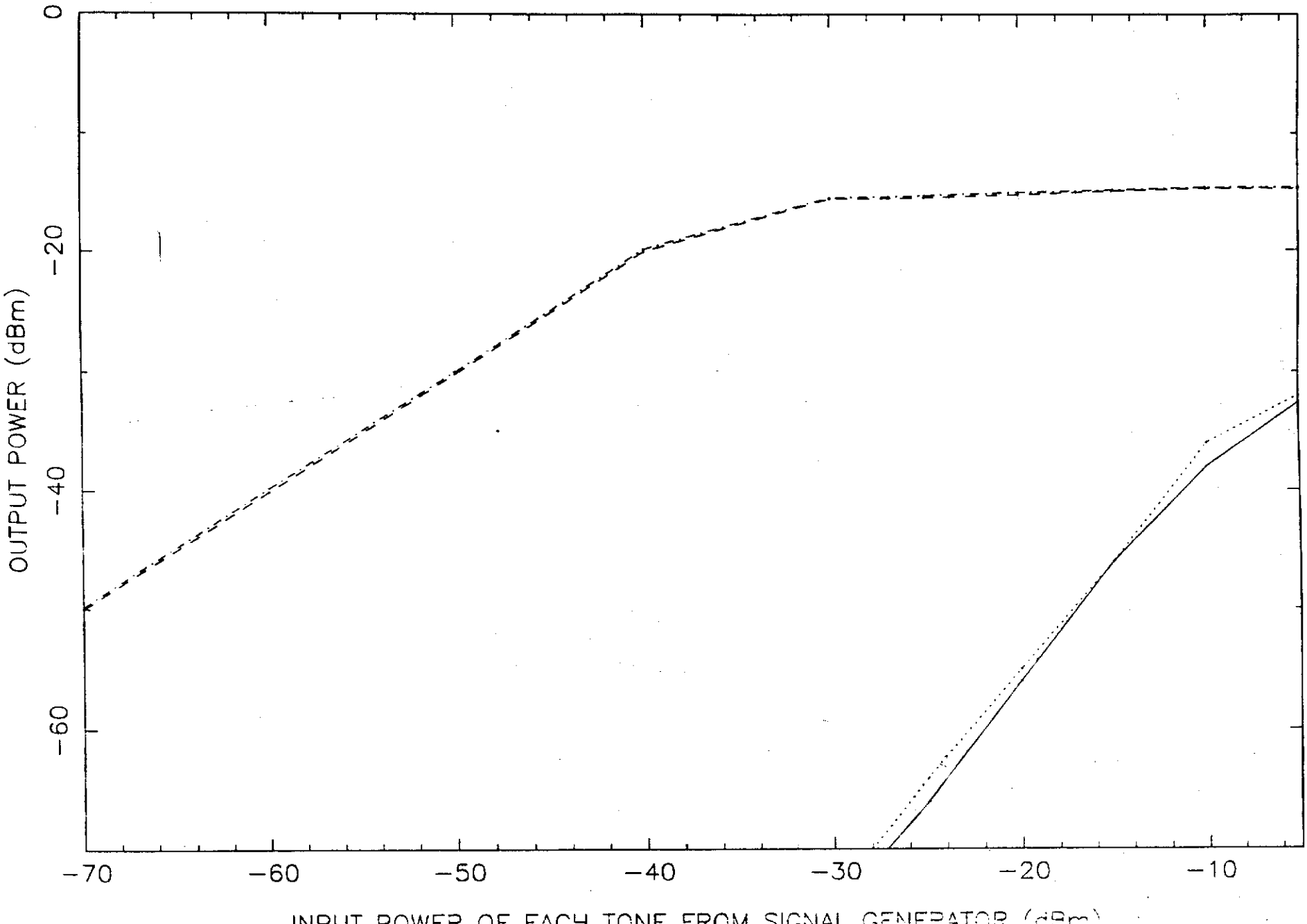


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TABLE 1. PRELIMINARY FORMAT FOR LOOK-UP TABLE FOR C41 PIU

The look-up will be in two stages: Stage A to generate an ASCII file for mapping the PIU serial number to an antenna and stage B, giving details for the individual PIU.

Stage A. Tentative format:

Antenna	RF Channel 1	RF channel 2
C0	101	104
C1	107	110
C2		
||		
C14		
W1		
||		
W6		
E1		
||		
E6		
S1		
||		
S6		

Stage B: Tentative format for PIU C41/nnn:

Data on **stop-band characterestics**, computed using the raw data which resulted in the top-right and bottom-left panels of plots 1 to 7:

Nominal IF bandwidth in MHz	Actual Bandwidth in MHz			
	1 dB	3 dB	10 dB	15 dB
6				
16				

Data on the coefficients of a polynomial y = a + b*x + c*x**2 + d*x**3 + --- to represent the ripple, slope in the band and other **pass-band characterestics**, computed using the raw data which resulted in the top-left, top-right and bottom-left panels of plots 1 to 7. Coefficients for the other Eight RF Mid-bands namely 50, 150, 235, 610, 1060, 1170, 1280 and 1390 MHz are similarly computed.

RF mid-band in MHz	IF bandwidth in MHz	Band limit for computing	Coefficients computed a	b	c	d
325	6	± 2				
325	6	± 4				
325	6	± 6				
325	16	± 4				
325	16	± 8				
325	16	± 16				
325	32	± 8				
325	32	± 16				
325	32	± 32				

Data on the coefficients of a polynomial y = a + b*x + c*x**2 + d*x**3 + --- to represent the **power response** and hence estimate linearity limits, computed using the raw data which resulted in the bottom-right panel of plots 1 to 7.

RF mid-band in MHz	Coefficients computed a	b	c	d
50				
150				
235				
325				
610				
1060				
1170				
1280				
1390				

TABLE 2. PRELIMINARY FORMAT FOR LOOK-UP TABLE FOR C42 & C43 FIUs

The look-up will be in two stages: Stage A to generate an ASCII file for mapping the PIU serial number to an antenna and stage B, giving details for the individual PIU.

Stage A. Tentative format:

Antenna	C42/nnn	C43/nnn
C0	113	111
C1	114	115
C2		
||		
C14		
W1		
||		
W6		
E1		
||		
E6		
S1		
||		
S6		

Stage B: Tentative format for PIU C42/nnn and C43/nnn:

Data on **stop-band characterestics**, computed using the raw data which resulted in the top-left panel of plots 8 to 14:

Nominal IF bandwidth in MHz	Actual Bandwidth in MHz		
	1 dB	3 dB	10 dB
32			

Data on the coefficients of a polynomial y = a + b*x + c*x**2 + d*x**3 + --- to represent the ripple, slope in the band and other **pass-band characterestics**, computed using the raw data which resulted in the top-left panel of plots 8 to 14.

IF bandwidth in MHz	Band limit for computing	Coefficients computed			
		a	b	c	d
32	± 8				
32	± 16				
32	± 32				

Data on the coefficients of a polynomial y = a + b*x + c*x**2 + d*x**3 + --- to represent **the power response, detector law and feed-back voltage law in ALC OFF and ALC ON modes** and hence help in estimating proper operating point of the system. Computed using the raw data which resulted in the top-right, bottom-left and bottom-right panels of plots 8 to 14.

Parameter characterised	ALC mode	Coefficients computed a	b	c	d
Power response	ON				
Power response	OFF				
Detector response	ON				
Detector response	OFF				
FBV response	ON				
FBV response	OFF				