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HYSPEC MEMO NO. 11

National Radio Astronomy Observatory
Tucson, Arizona

December 12, 1986

MEMORANDUM

To: J. Payne, S. Weinreb, R. Escoffier, D. Emerson, B. Freund, A. Perfetto

From: A. Dowd

Subject: Hybrid Spectrometer Tests

The recent Hybrid Spectrometer tests have focused on two problems. First, the fast switching mode (100msec on/off) has been producing poor RMS error results on overnight runs. Therefore, an attempt was made to locate the source of this error. Secondly, the problem of "platforming" in strong lines was investigated. This error is seen when very strong lines appear in a single filter. The resulting baseline of that filter tends to fall below the neighboring filter baselines.

RMS Error

The first series of overnight runs were performed by using the standard hybrid spectrometer, but varying several observational parameters. Figure #1 shows the standard fast switching run with 4 msec dead time and 60 sec dumps. The results are typical for this mode since summer. Figures #2, 3 & 4 show the fast switching mode with the dead time between sig/ref varied. The results are not improved. Figure #5 shows a fast switching run, but with a much faster dump time. The RMS looks better, but that is because the time axis has been stretched because of the fast dumps. A stretch is by a factor of 4; consequently there is no substantial improvement in performance. Next, the dump time was varied very slightly in figures #6 & 7. Here again, performance was not improved. Finally, both dead time and dump rate were varied in Figure #8, with no change in performance. Figure #9 shows the effect of switch rate. The slower switch rate of 200 msec tends to increase performance. The fast switching rate seems to perform badly regardless of dead time or dump time.

The next sequence of overnight runs were performed with an external clock in place of the system's 100 Mhz crystal oscillator. The change in clock was made at the input to the TRW power clock amplifier. Thus the clock was affected systemwide. (One exception is the VF power conversion standard, which was not affected.) The clock was replaced with three other sources to investigate the effect of clock quality on system performance. The first series of experiments used a Wavetek model 3000 signal generator. Note, the original clock source was NOT removed from the chassis. It was still running during all of the external clock experiments.

Figure #11 thru #21 shows the results of the Wavetek model 3000 external clock experiments. In general, they showed greatly improved performance. The increased performance was substantial and not affected by slight changes in the Wavetek clock frequency. This suggests the improvement was due to improved clock characteristics and not a "beat" note problem with 60Hz.

To attempt to substantiate the link between performance and clock source, two additional sources were tried. First, a Wavetek Sweep Generator (model 2001) was setup in CW mode at 100. Mhz. The results of this configuration are in Figures 22 and 23. Finally, a Hewlett-Packard VHF signal generator model 608F was used. (It was allowed to stabilize for 36 hours.) The results are shown in Figures 24, 25 and 26.

The integrated RMS error was definitely affected by the Source of the system clock. Using available measurement methods, the only independent evaluation of the clocks was made with a HP 8555A spectrum analyzer. The Wavetek Sweep Generator was the worst in terms of general FM modulation of the signal. However its long term frequency stability was reasonable. The Hewlett-Packard model 608F had some 60 Hz sidebands during warm-up (~ 25 dB of clock). However, these improved substantially at test time.

The best performance was achieved by the Wavetek phase locked signal generator model 3000. The Wavetek model 3000 had the potential to produced the highest quality signal in terms of phase stability and FM content. The worst performance was definitely given by the worst tested clock: Wavetek 2001. Therefore, it seems reasonable to design a good quality clock source into the final system -- possibly the MITEQ model PLD-1A-5-100-15P which would be phase locked to the telescope's 5 Mhz clock standard.

External Clock Experiment Table

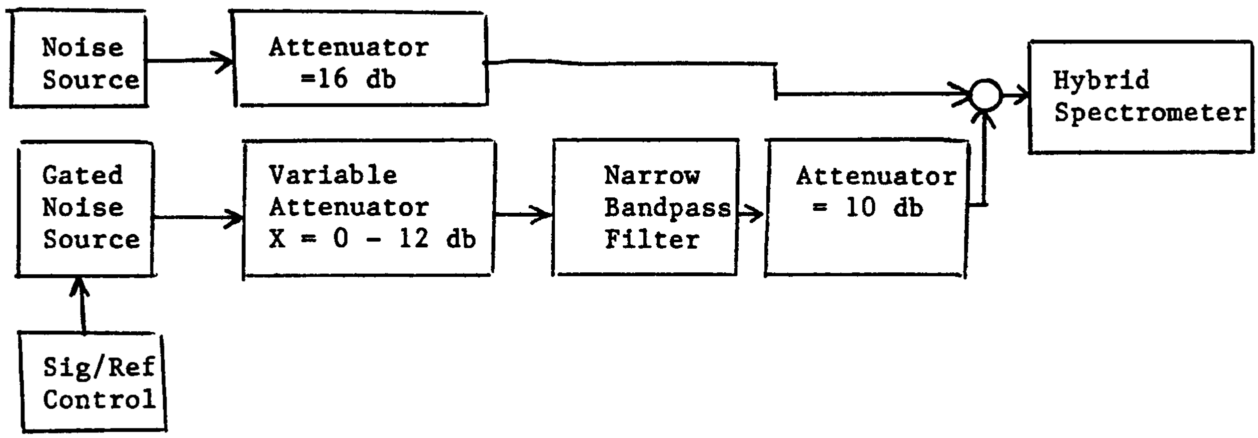
Fig#	Date	times in msec Sig	Ref	Dead	Dump	Notes
1	10/24/86	100	100	4	600e4	
2	10/17/86	100	100	0.4	600e4	
3	10/18/86	100	100	10	600e4	
4	10/27/86	100	100	0.4	600e4	
5	10/19/86	100	100	4	150e4	
6	10/21/86	100	100	4	602e4	
7	10/21/86	100	100	4	612e4	
8	10/25/86	100	100	2.8	578e4	
9	10/26/86	200	200	4	600e4	
10	10/28/86	100	100	4	600e4	Ext 1=100.001 Mhz
11	10/29/86	100	100	4	600e4	Ext 1= 99.990 Mhz
12	11/19/86	100	100	2.8	600e4	Ext 1= 99.990 Mhz
13	11/20/86	100	100	4	600e4	Ext 1= 99.990 Mhz
14	11/21/86	100	100	4	600e4	Ext 1=100.000 Mhz
15	11/22/86	100	100	4	600e4	Ext 1=100.000 Mhz
16	11/23/86	100	100	4	600e4	Ext 1=101.000 Mhz
17	11/26/86	100	100	4	600e4	Ext 1= 90.000 Mhz
18	11/26/86	100	100	4	600e4	Ext 1= 95.000 Mhz
19	12/02/86	100	100	4	600e4	Ext 1=100.000 Mhz
20	12/03/86	100	100	4	600e4	Ext 1=100.000 Mhz
21	12/04/86	100	100	4	600e4	Ext 1=100.000 Mhz
22	12/05/86	100	100	4	600e4	Ext 2=100. Mhz
23	12/26/86	100	100	4	600e4	Ext 2=100. Mhz
24	12/06/86	100	100	4	600e4	Ext 3=100. Mhz
25	12/07/86	100	100	4	600e4	Ext 3=100. Mhz
26	12/08/86	100	100	4	600e4	Ext 3=100. Mhz

NOTE

default = Connor-Winfield 100 Mhz ECL crystal
Ext 1 = Wavetek model 3000 signal generator
Ext 2 = Wavetek model 2001 sweep generator in CW mode
Ext 3 = Hewlett-Packard model 608F VHF signal generator

"Platforming"

The next set of experiment data was taken to examine the "platforming" of strong line reception. The experimental set-up was as follows:



By varying the Attenuator setting, the power in the line was changed. Figures 27-35 present the results of the experiment. The platforming was inversely related to the line power. Thus increasing the power of the line caused the baseline to be lower then expected. (The expected baseline was predicted by the neighboring filter baselines.)

These results can be predicted by a nonlinear power conversion in the filter module. The correction for this problem can be done two ways. The preferred solution is to improve the linearity of the square-law detector circuit. Alternately, the nonlinearity can be corrected in software. The main problem with the software solution is the resulting restrictions on moving filter modules. Different corrections will have to be determined for each detector, and consequently the filter modules could not be switched without changing the correction. Therefore, the hardware solution will be examined first.

External Clock Experiment Table

Fig#	Date	times in msec Sig	Ref	Dead	Dump	Notes
27	12/03/86	10	10	4	10000	X = 0dB
28	12/03/86	10	10	4	10000	X = 1dB
29	12/03/86	10	10	4	10000	X = 2dB
30	12/03/86	10	10	4	10000	X = 3dB
31	12/03/86	10	10	4	10000	X = 4dB
32	12/03/86	10	10	4	10000	X = 5dB
33	12/03/86	10	10	4	10000	X = 6dB
34	12/03/86	10	10	4	10000	X = 9dB
35	12/03/86	10	10	4	10000	X = 12dB

Conclusion

The next series of experiments will continue to examine the external clock issue. Also the double switching options will be tested.

Figure 1

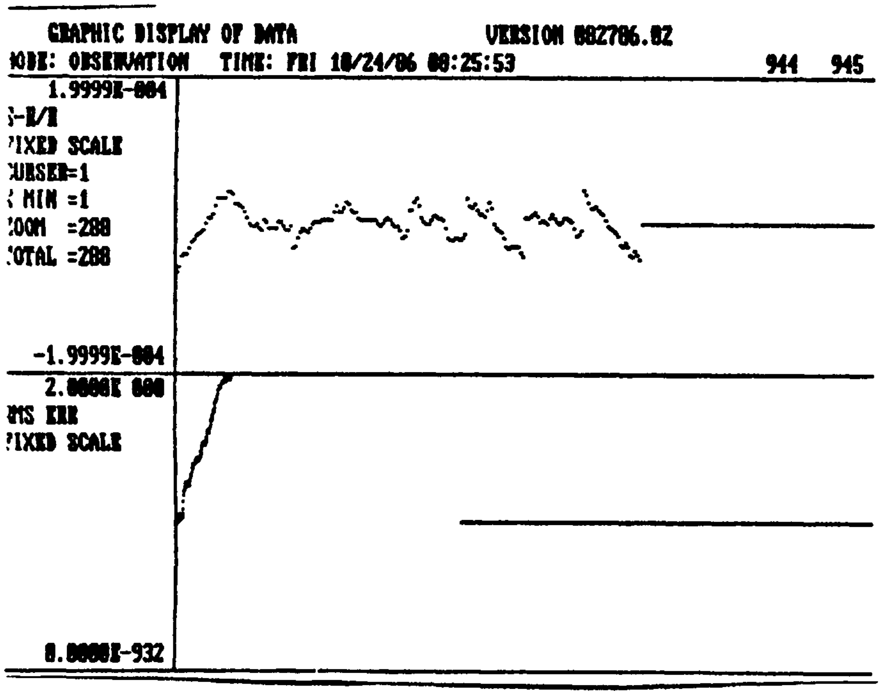


Figure 2

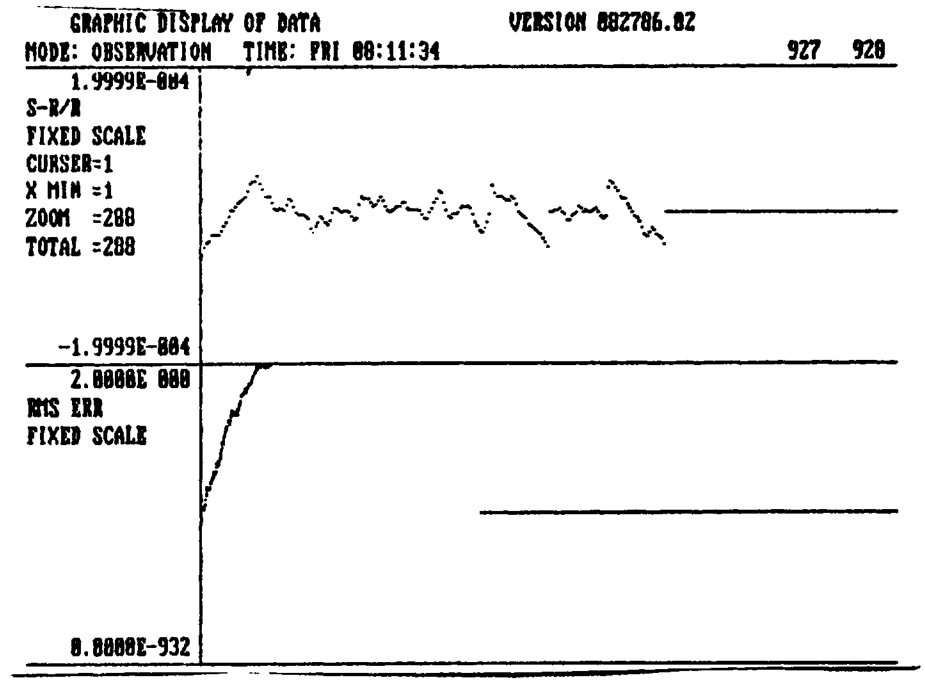
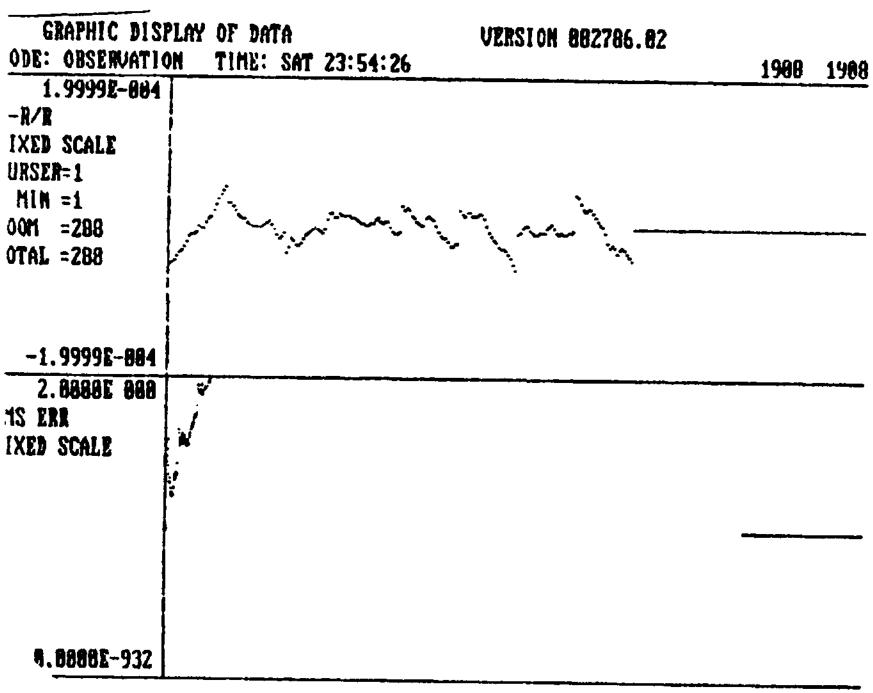


Figure 3



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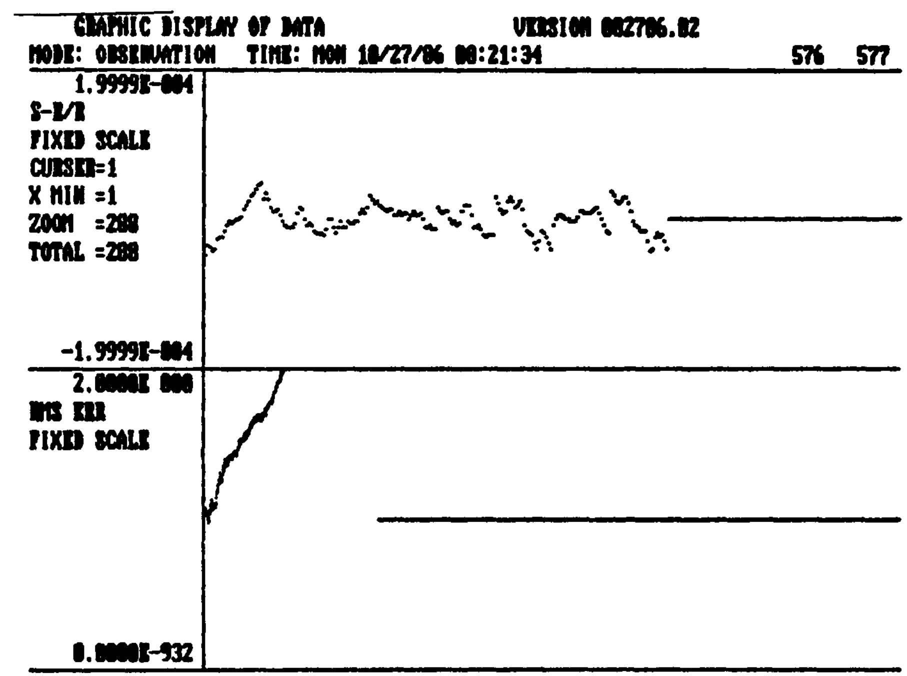

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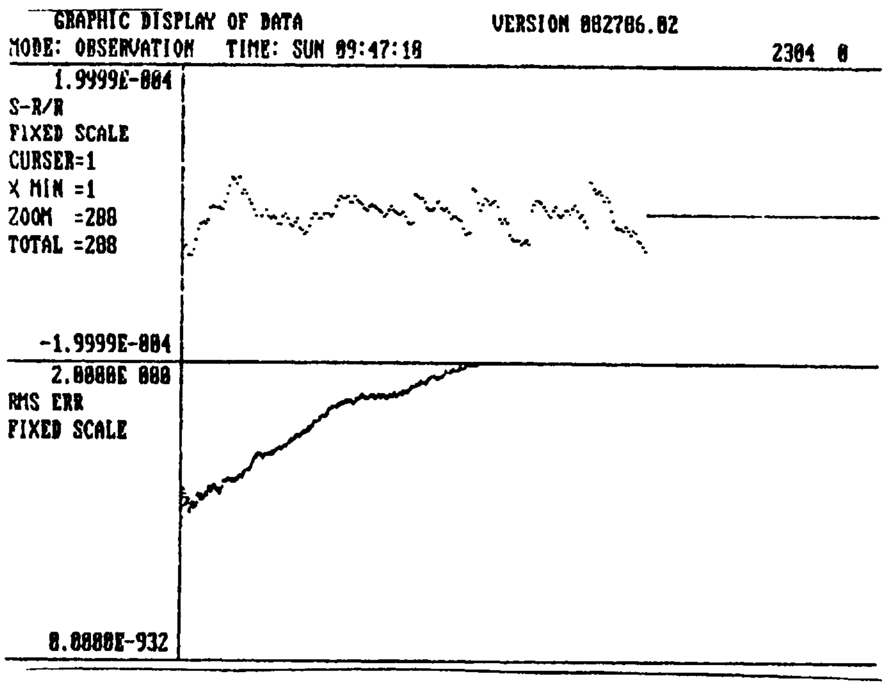
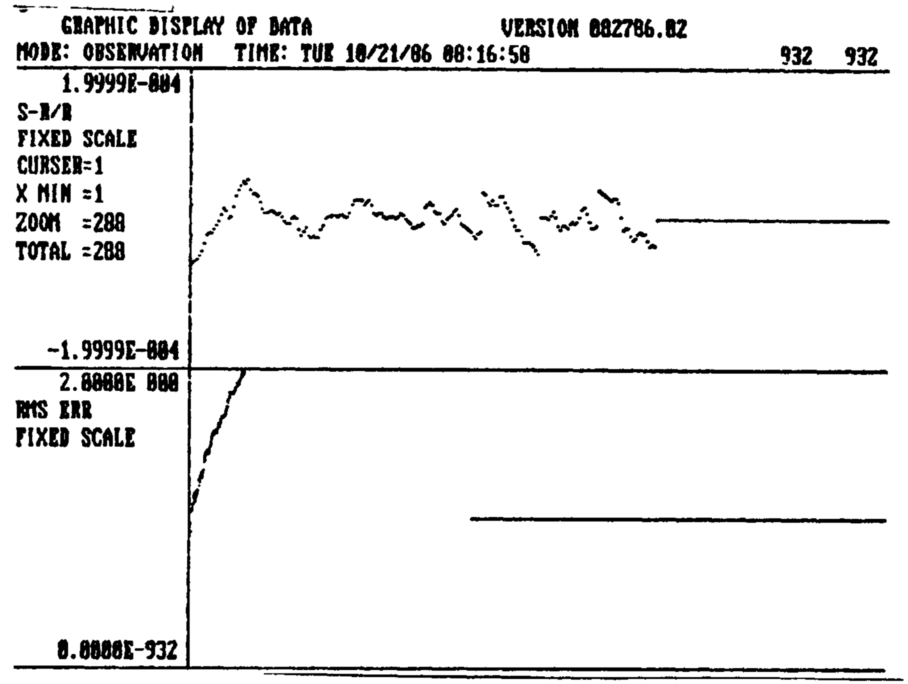


Figure 6



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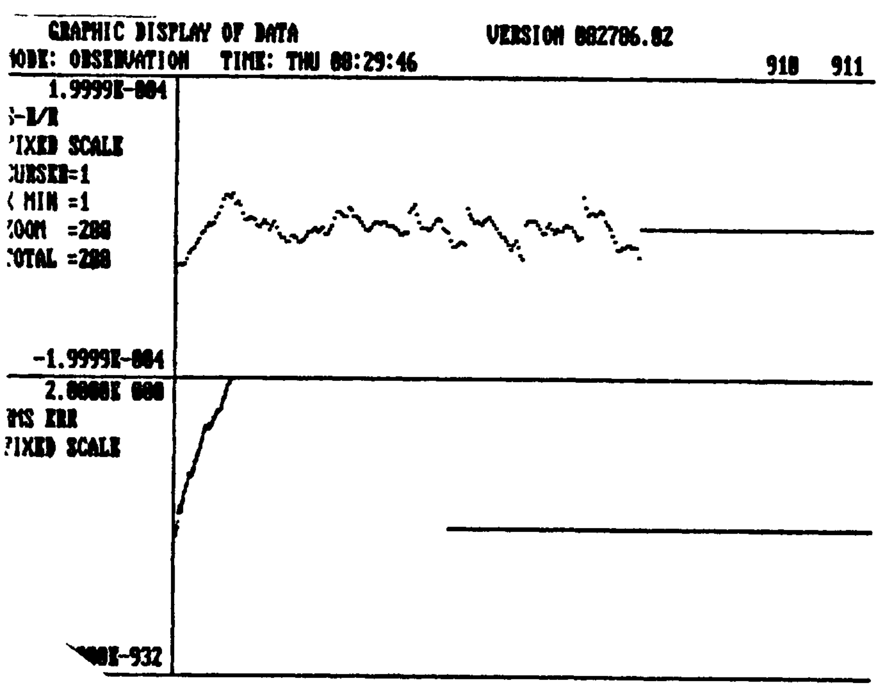
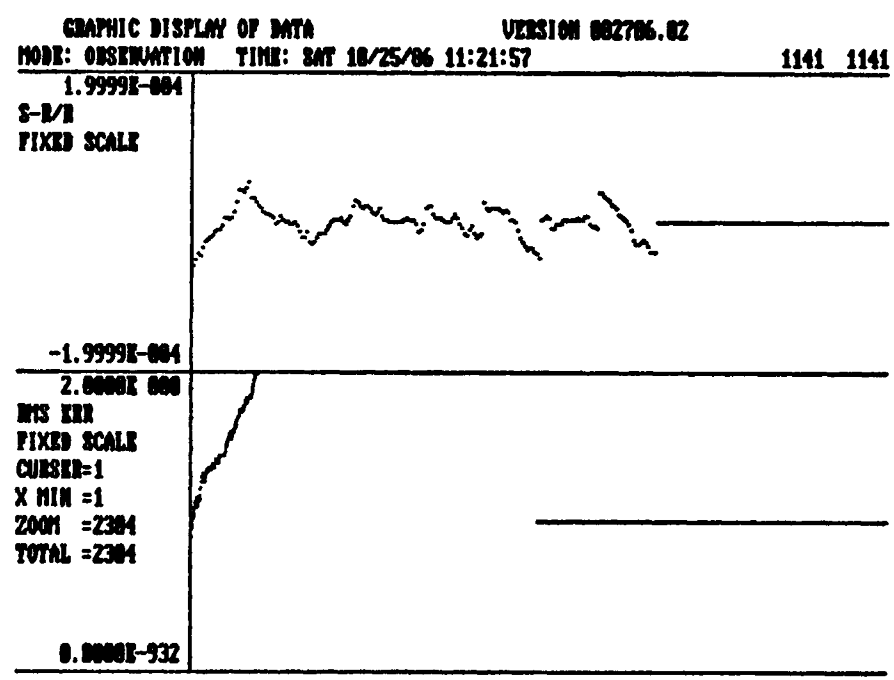


Figure 8



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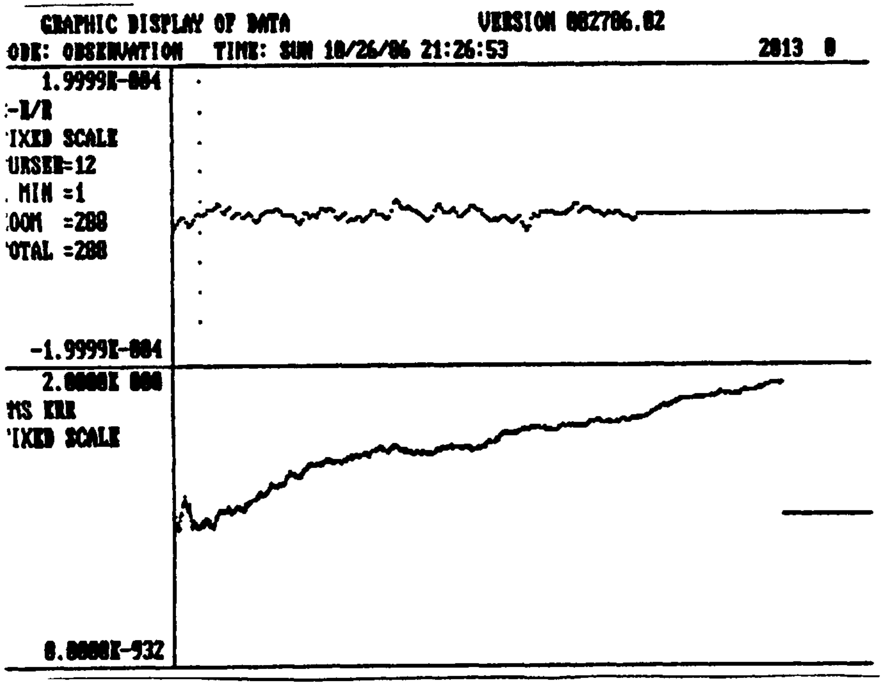

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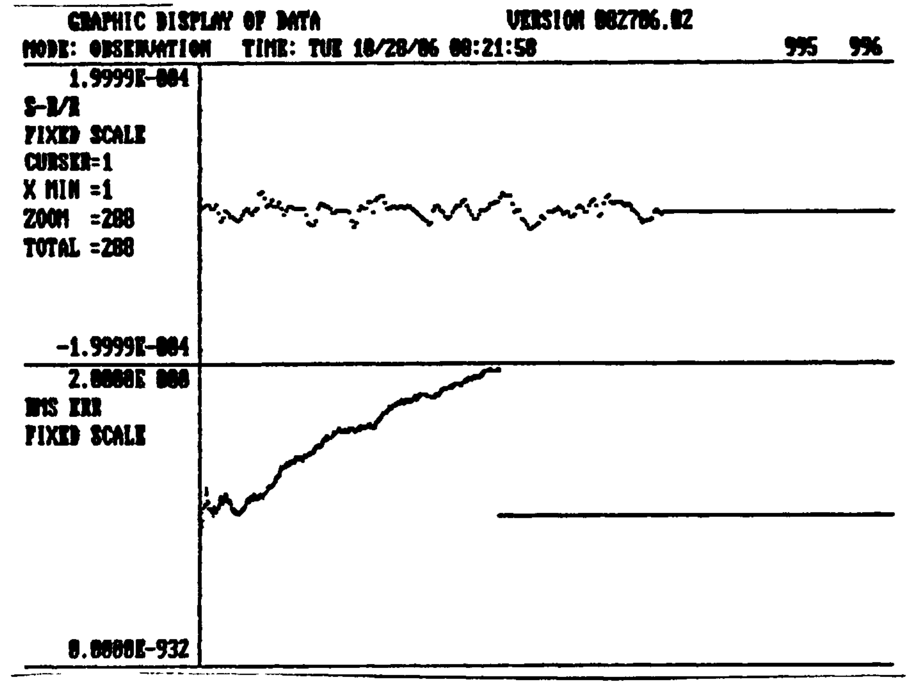

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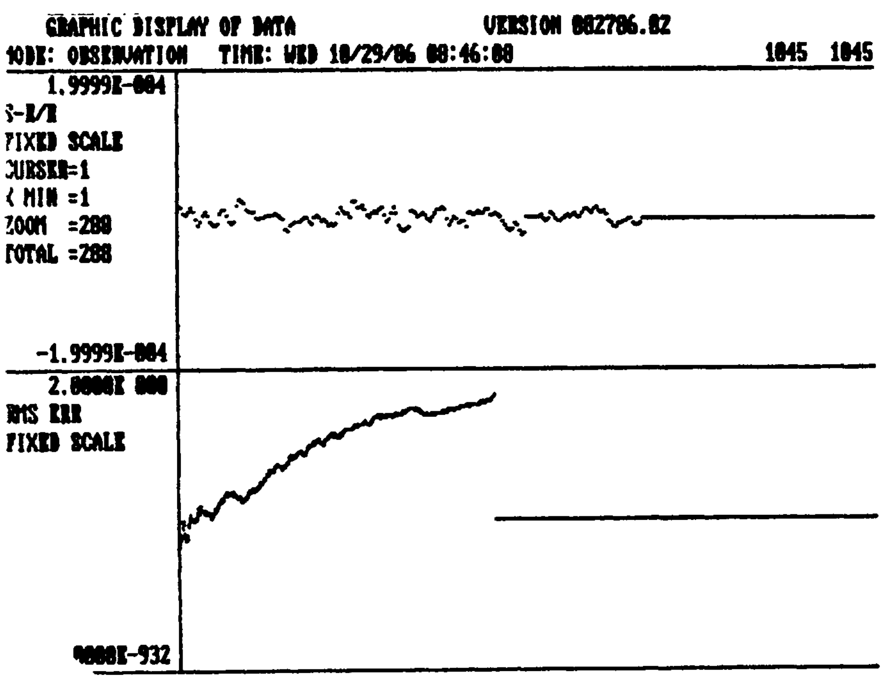

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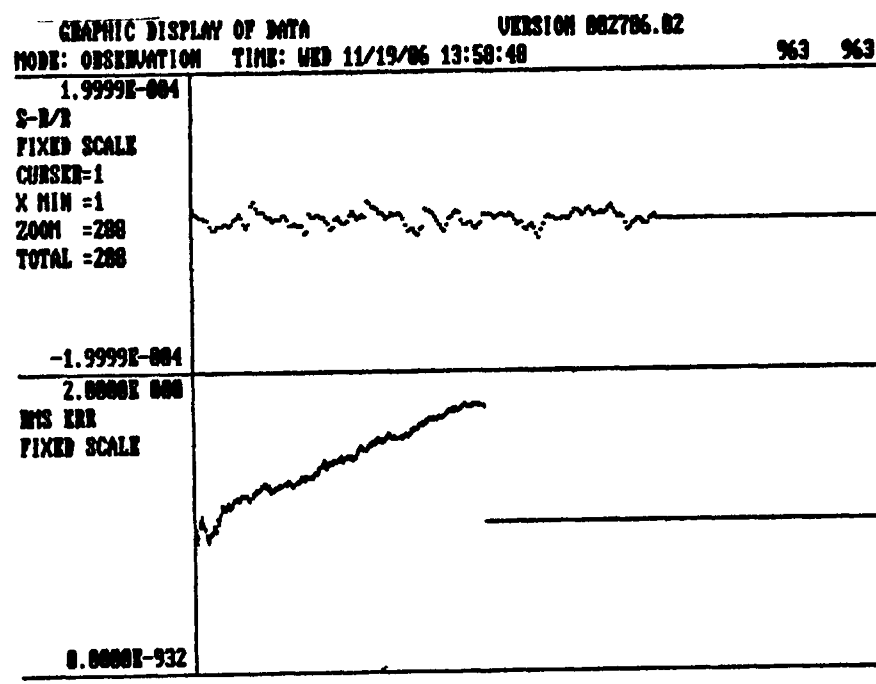
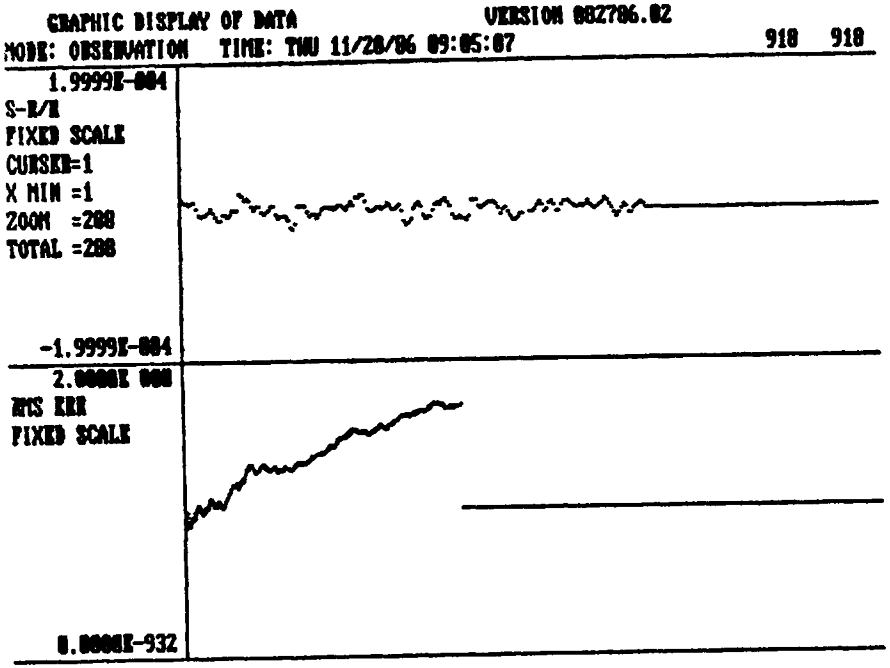


Figure 13



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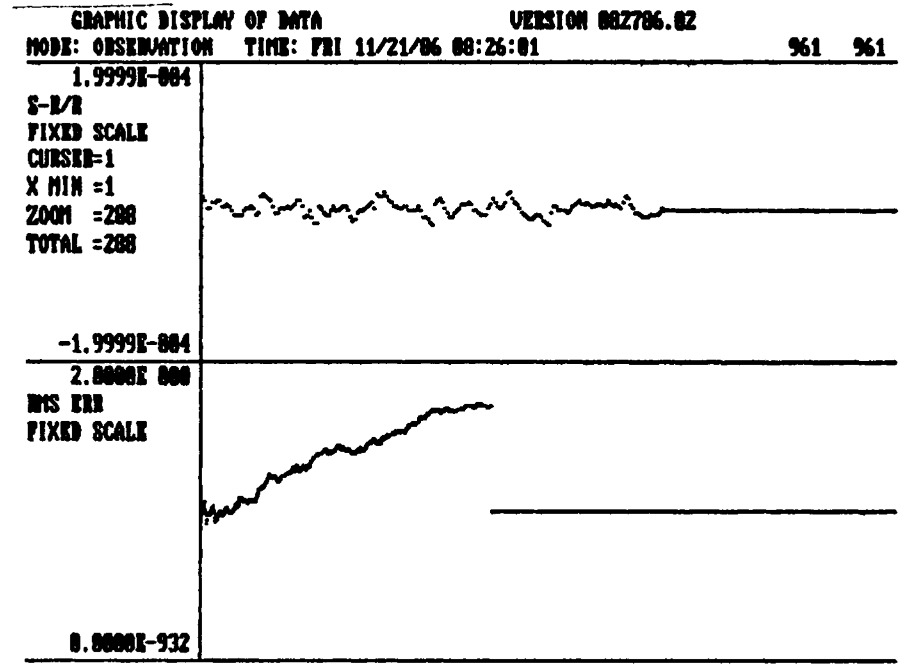

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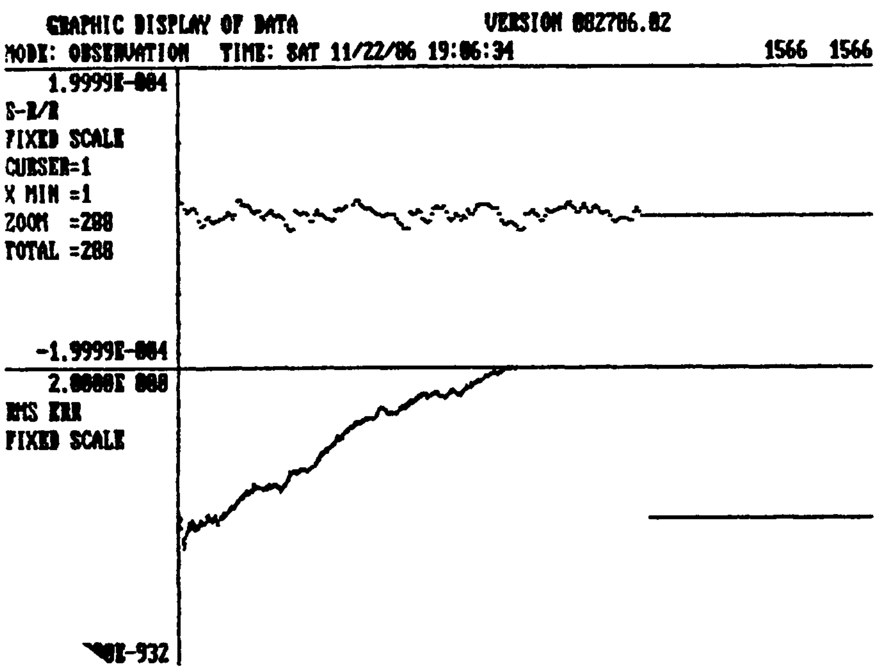

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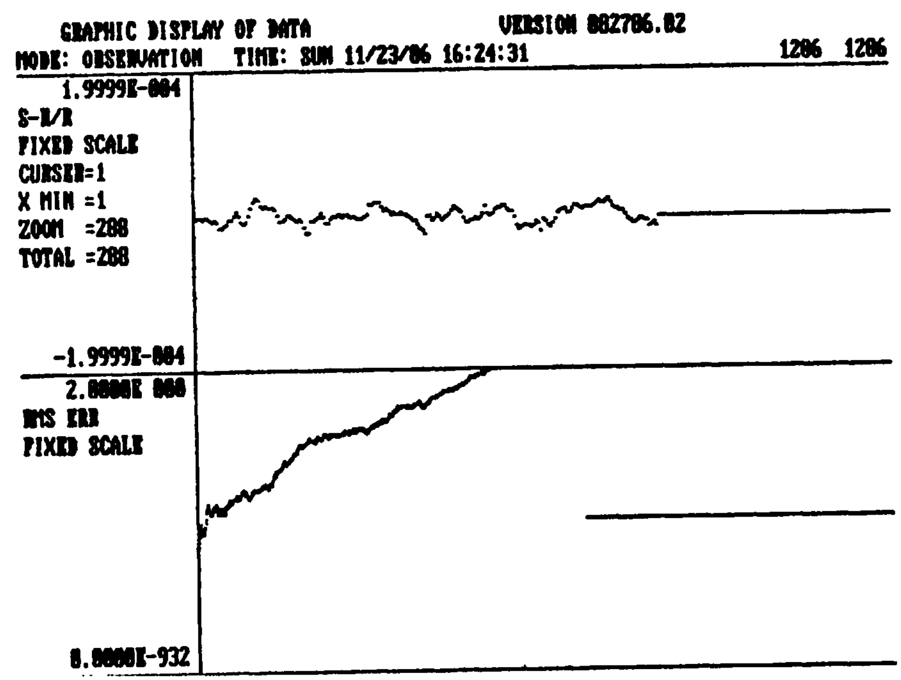

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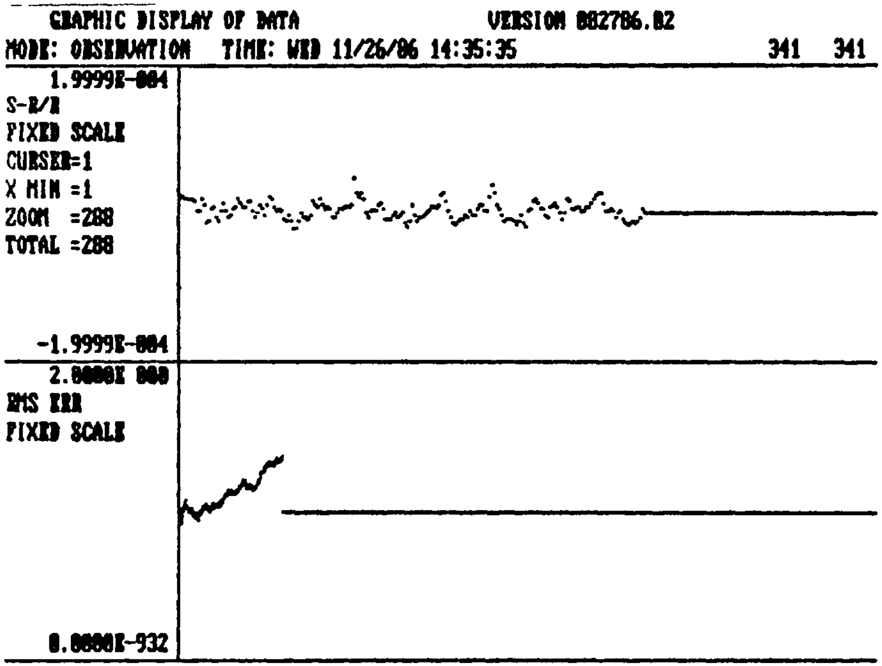

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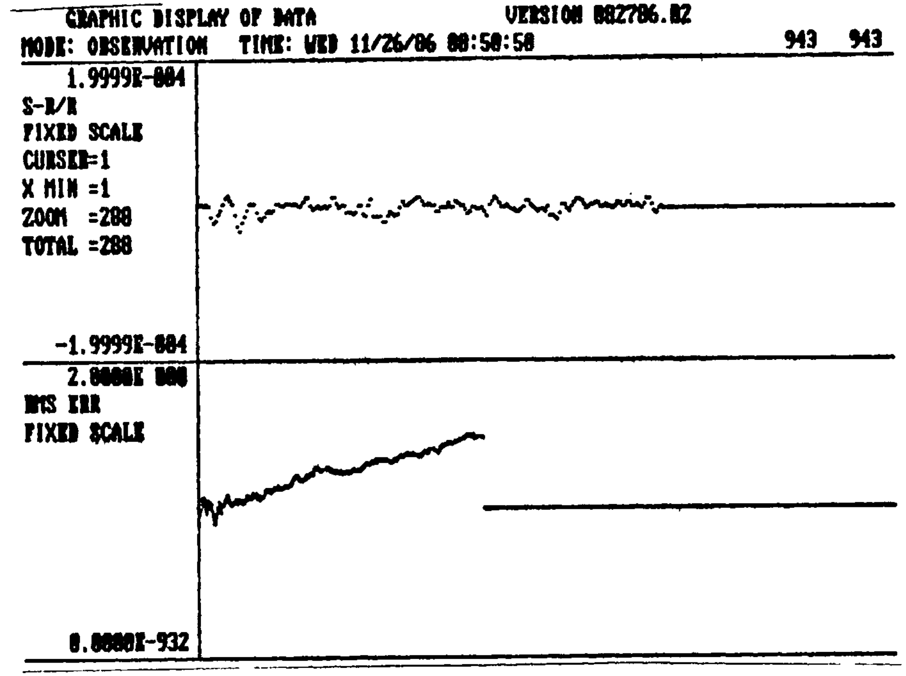

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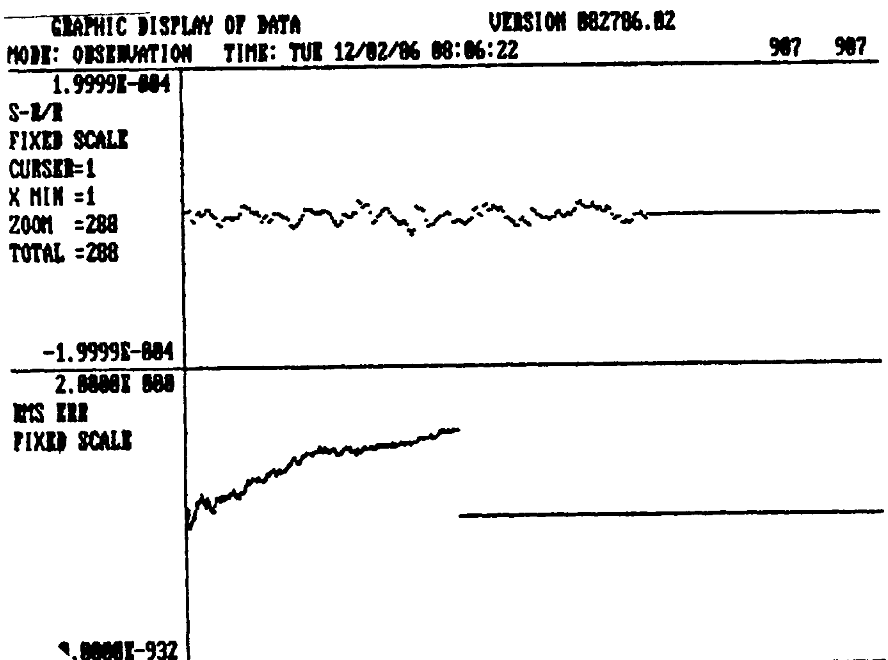
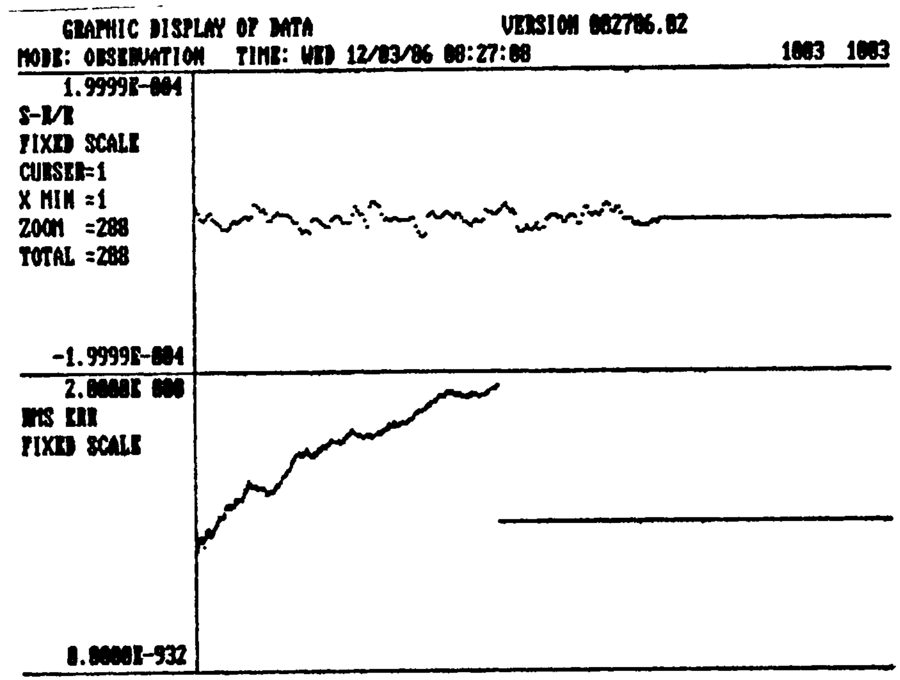


Figure 20



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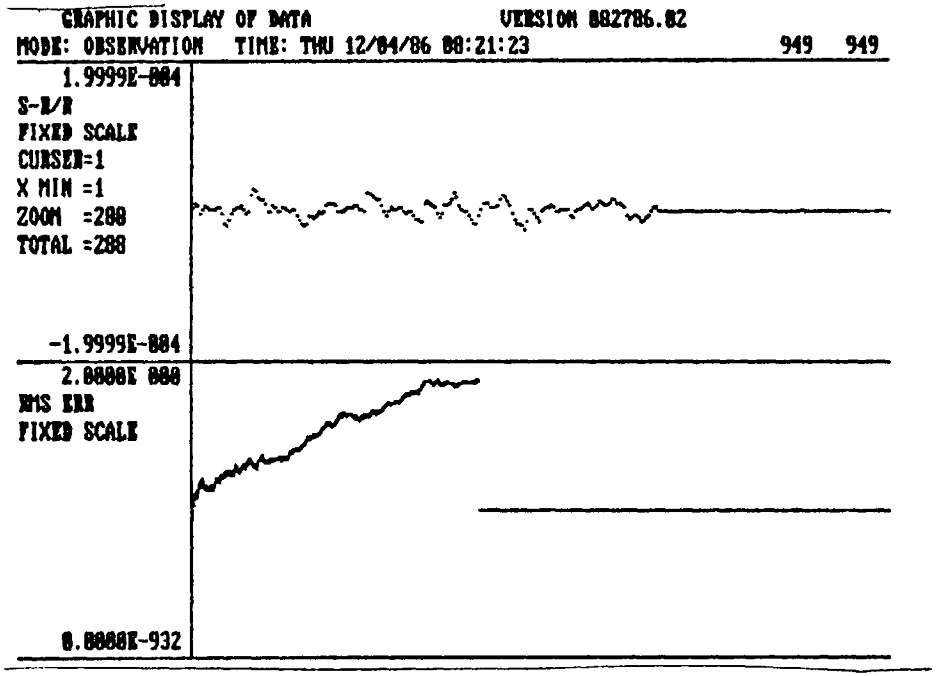

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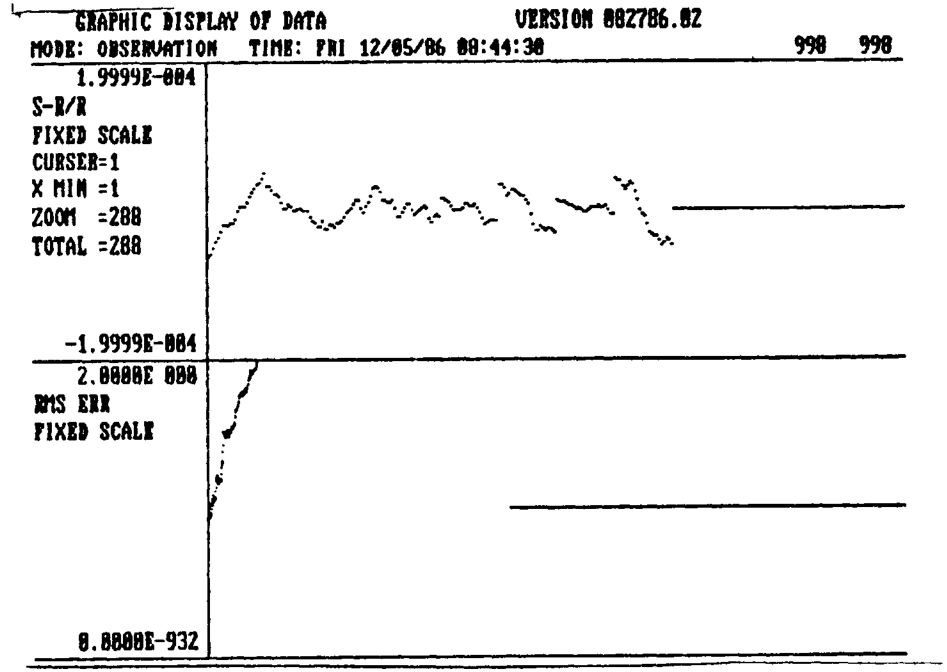

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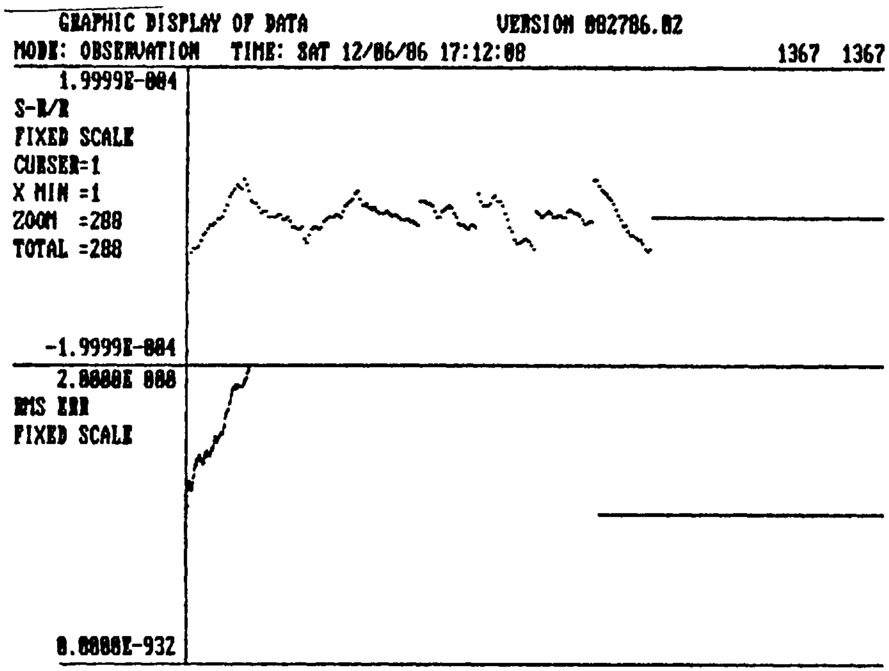
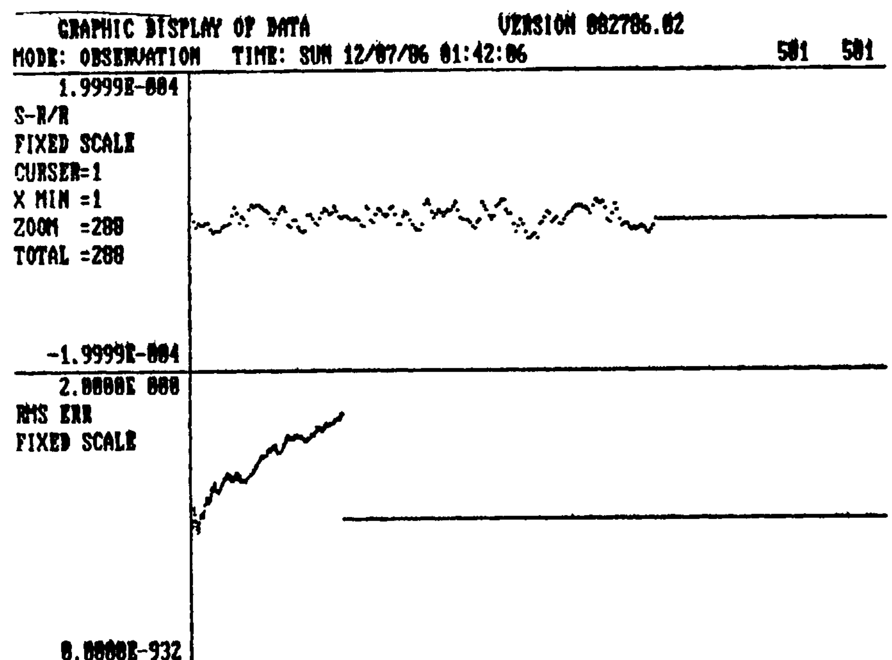


Figure 24



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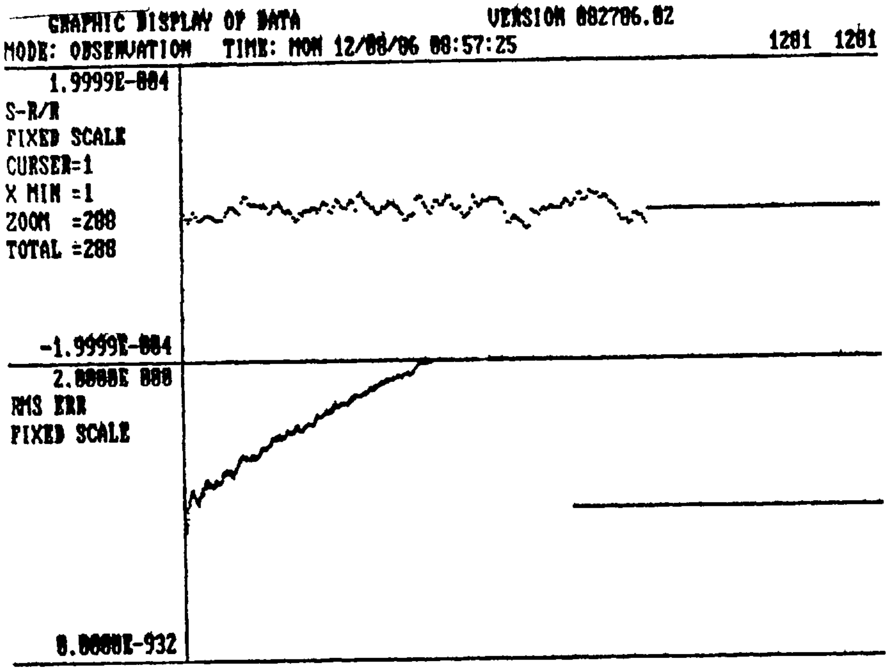


Figure 26

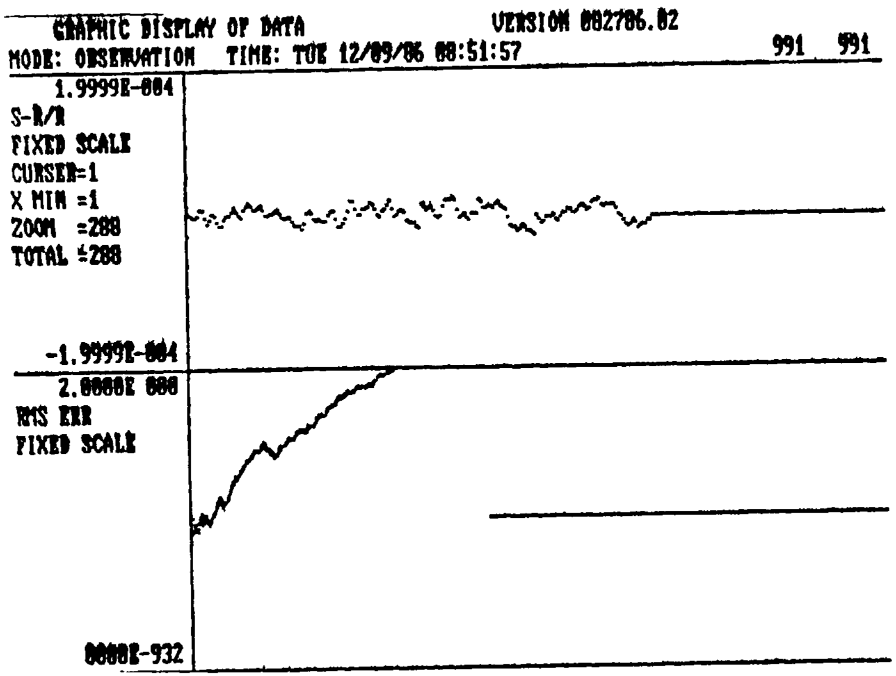
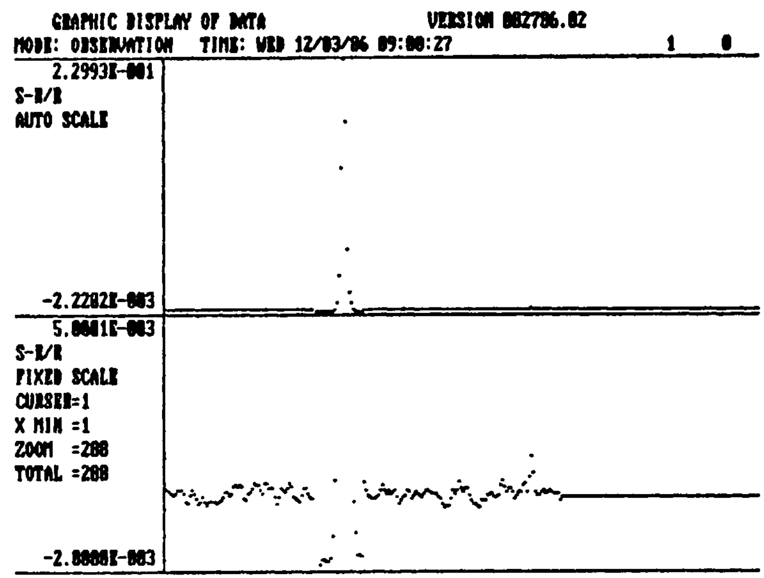


Figure 27 (10dB)

X = 0 dB
(total = 10dB)



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00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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01C85964
1)F4
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00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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1)

Figure 28 (11dB)

x= 1 db
(total= 11db)

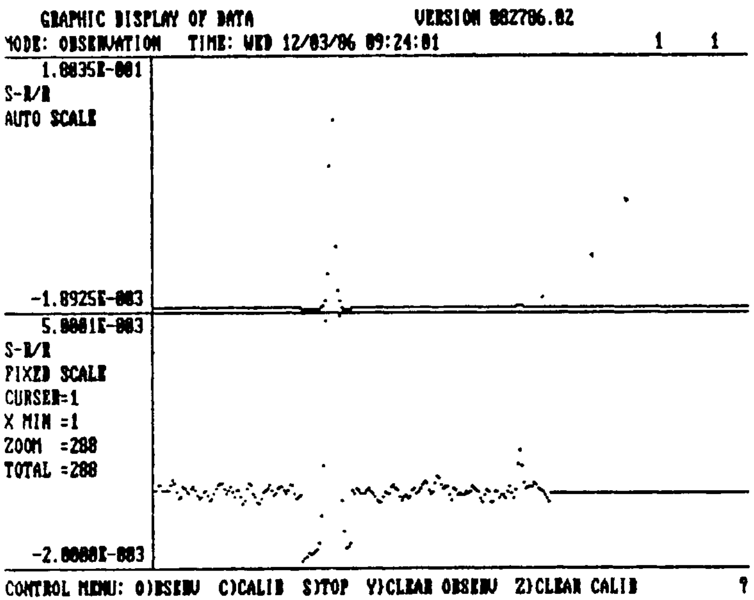

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Figure 29 (12dB)

(total = 12db)
x= 2 db

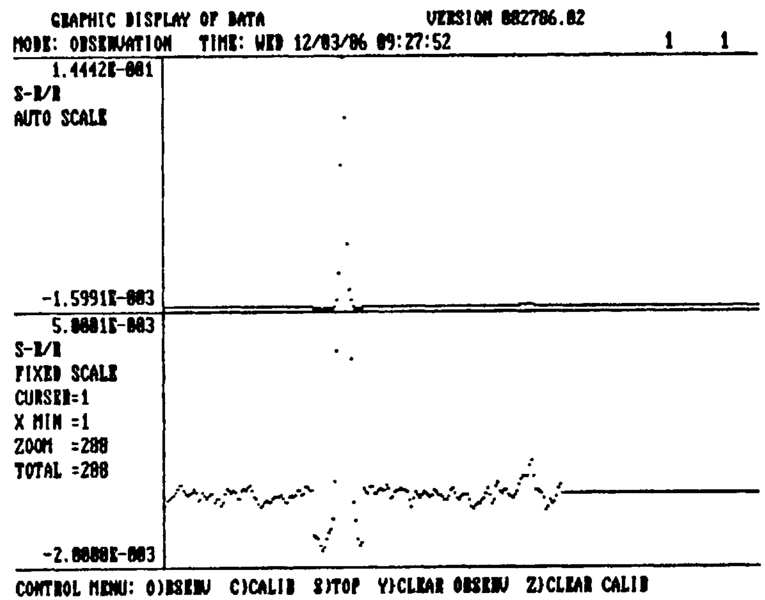

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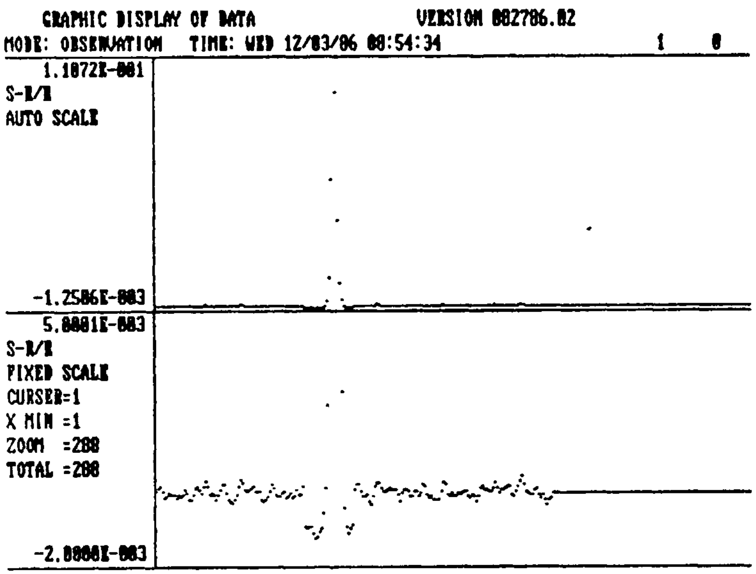
Figure 30 (13dB)

X= 3dB
(Total = 13 dB)



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00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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00000000 00000000 00000000 00000000 005A6D73 005AEA0C 005C8598 005AFC7A
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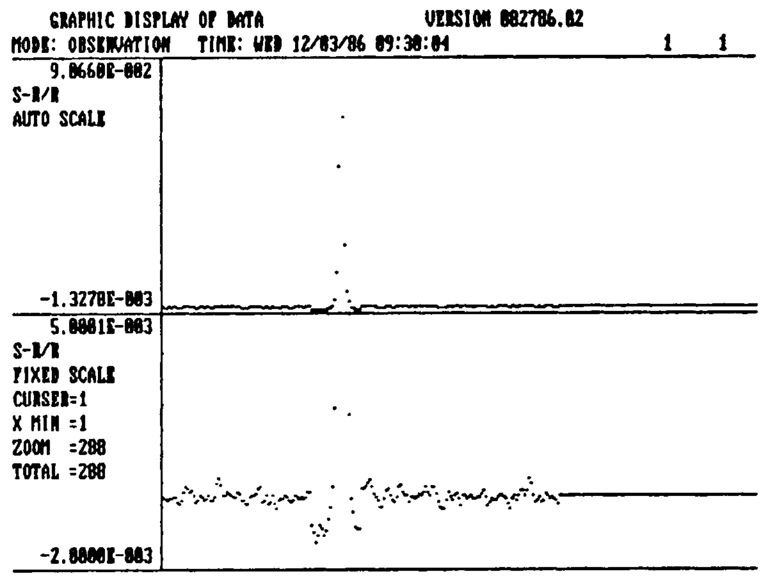
Figure 31 (14dB)

X= 4db
(Total= 14 db)



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00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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Figure 32 (15dB)

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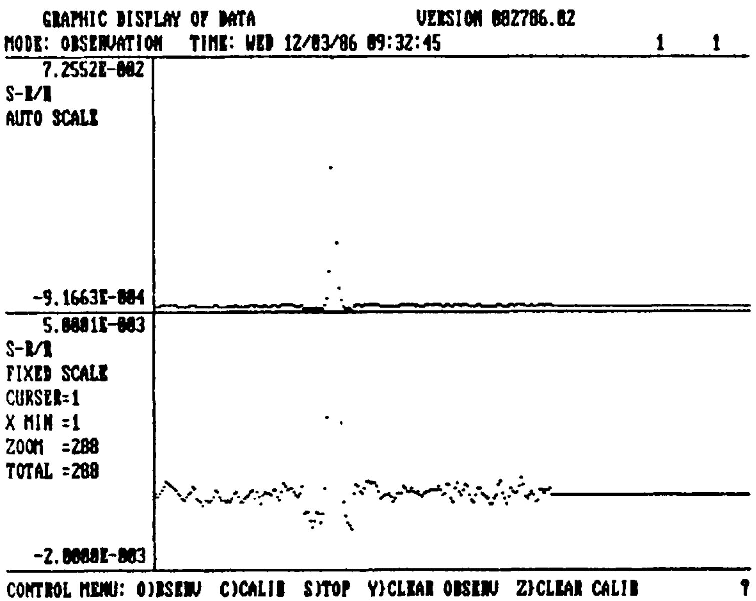


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00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
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00000000 00000000 00000000 00000000 005AAC05 005B9D4A 005B9DA3 005AFA68
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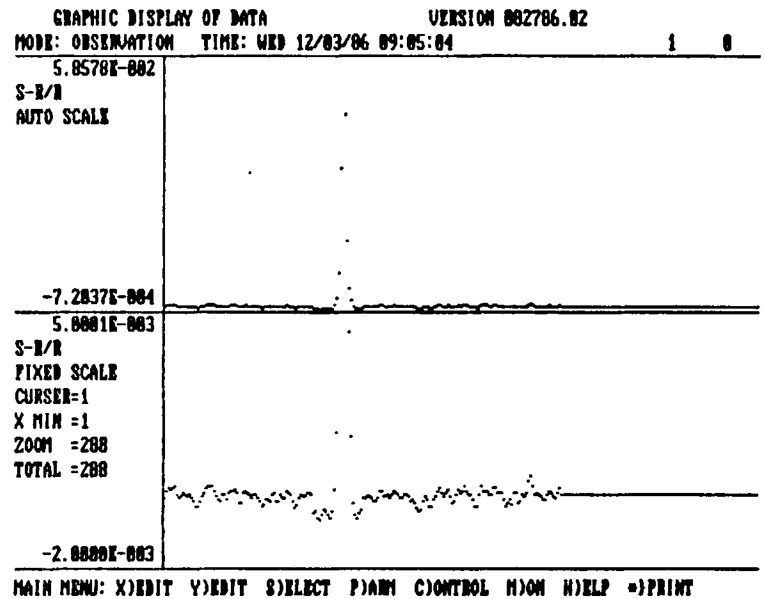
Figure 33 (16dB)

X= 6dB
(total= 16dB)

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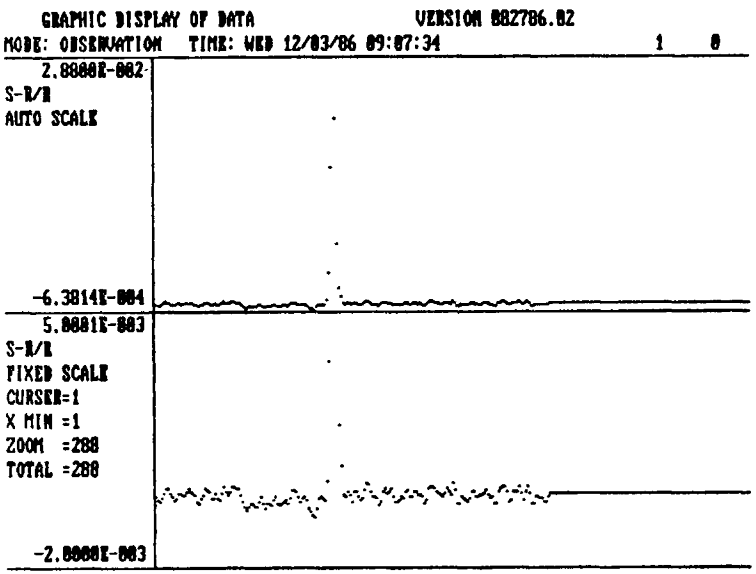
ANALOGB DATA:  SEGMENT= 456C   OFFSET= 01C4

1)V
2C3514D0 00000000 00000000 00000000 2C3514D0 00000000 00000000 00000000
1)F0
005AFD1A 005B2F33 00599F4A 005AC50B 005B86A9 005B3F23 005B3CDD 005B073C
00000221 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00599F4A 005B3CD6 005AC50D 005B073C
01C85965
1)F4
005AFC08 005B2CF0 00599C97 005B56B0 005B847A 005B3B7B 005B3BA6 005B05C7
00000246 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00599C9C 005B3BA8 005B56B3 005B05D1
01C852A0
1)
```

Figure 34 (19dB)

X= 9 dB
(total = 19 dB)



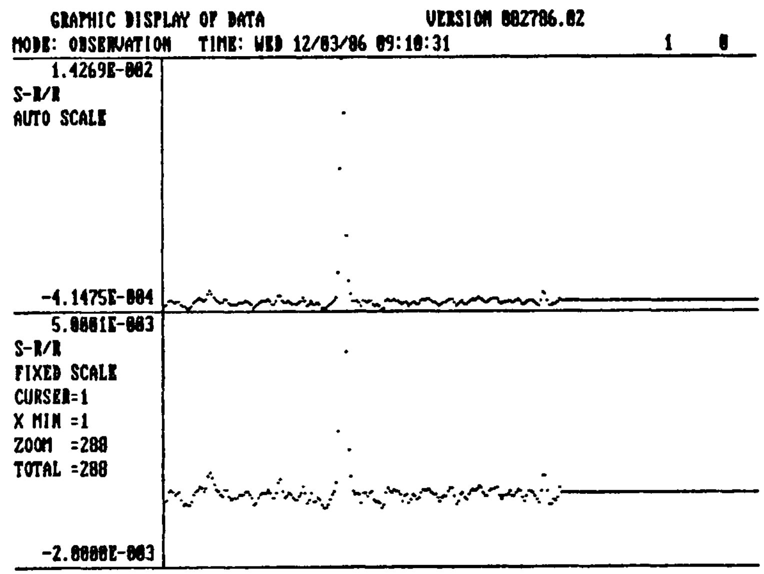
MAIN MENU: X)EDIT Y)EDIT S)ELECT P)ARM C)ONTROL M)ON H)ELP *)PRINT

@
ANALOGS DATA: SEGMENT= 456C OFFSET= 01C4

1)V
2C3514D0 00000000 00000000 00000000 2C3514D0 00000000 00000000 00000000
1)F0
005AF507 005B244C 005A7208 005B6361 005AE1F5 005B350B 005B78B8 005AFFB4
0000020C 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 005A720A 005B78B8 005B6362 005AFFB7
01C85972
1)F4
005AF246 005B2173 005A6C6E 005BA8D5 005AE050 005B338F 005B767F 005AFDC0
000001E0 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 005A6C7F 005B767F 005BA8D4 005AFDC3
01C852A8
1)

Figure 35 (22dB)

X= 12dB
(total = 22db)



MAIN MENU: X)EDIT Y)EDIT S)ELECT P)ARM C)ONTROL M)ON H)ELP *)PRINT

@
ANALOGS DATA: SEGMENT= 456C OFFSET= 01C4

1)V
2C3514D0 00000000 00000000 00000000 2C3514D0 00000000 00000000 00000000
1)F0
005AF8CA 005AA089 005A78E1 005B6967 005AE793 005AA93B 005B3A53 005B0577
0000020B 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 005A78E6 005B3A52 005B696B 005B0579
01C85956
1)F4
005AF7A1 005A9EE4 005A7707 005B8AF8 005AE458 005AA6B7 005B3988 005B0378
00000224 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 00000000 00000000 00000000 00000000
00000000 00000000 00000000 00000000 005A7703 005B398B 005B8B00 005B037B
01C85299
1)