A note on the optimum RF and IF(Remote) attenuator settings and calculation of the maximum signal handling capability of the receiver system.

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This note presents the signal levels at the RF-IF as well as the IF-Optical fiber interface. The calculations were performed to maximize the dynamic range of the system and to minimize the signal degradation down the link.

The calculations were performed for the optical system to determine the signal level that has to be provided at the IF output, so that the optical noise contribution is within 1%. The required signal power level was found to be -17dBm per 32MHz channel(See Fig. 1 & 5).

Calculations were then carried out for the optimum attenuator settings in the IF chain for different levels of input RF satisfying the following criteria:

- IF output power levels shall be -17dBm / 32MHz channel.
- Noise contribution from the IF shall be within 0.5% or 1.0%. (Results tabulated separately for the two cases)
- For any given level of input RF, the selected attenuator settings should provide the maximum possible instantaneous dynamic range.

The results of this optimization are presented in Fig.2(a) & 2(b).

Based on the numbers given in Fig.3 calculations were performed to obtain minimum and maximum solar attenuator settings for various input signal levels to the RF prime focus electronics. For a given incident signal level, the minimum and maximum solar attenuator settings provide an RF output which would be compatible with the IF input requirements as already listed in Fig.2. Calculations were made for the 150MHz, 233MHz, 327MHz, 610MHz and the 1420MHz RF signal chains and the results are as tabulated in Fig.4 (a) through (e).

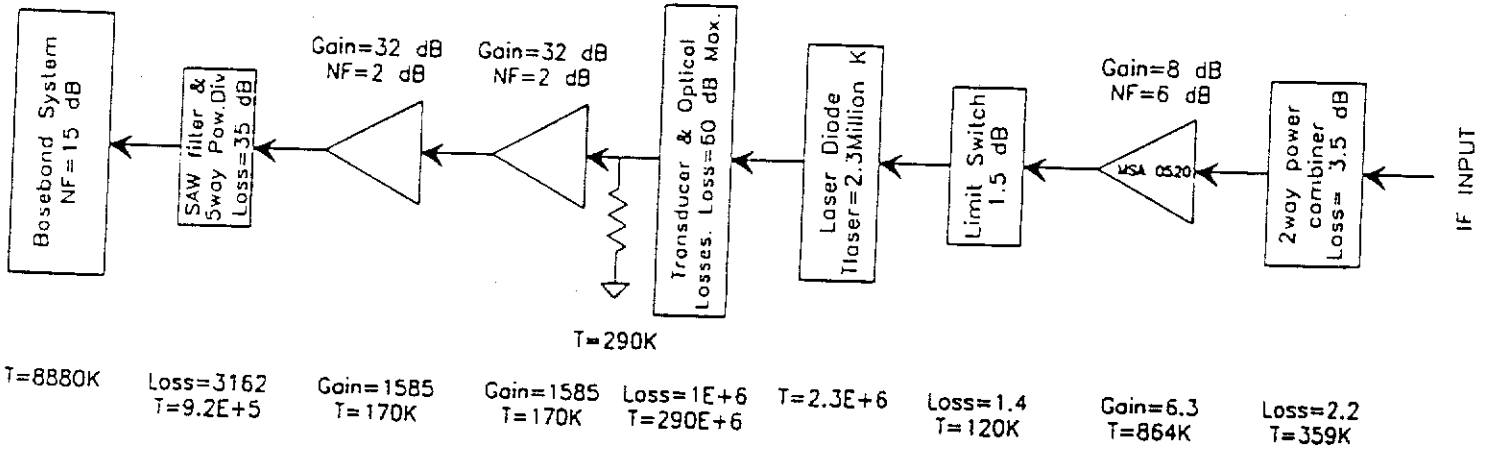
Input temperatures gave been chosen to range from T_{sys} for cold sky to T_{sys} when the power at P2 is approximately 20dB below the 1 dB compression point.

Conclusions/Comments:

☐ Instantaneous Dynamic range is limited to 14dB. However for slowly varying signals, dynamic range is 28dB with ALC-1 on.

☐ Since the dynamic range is limited by the ALC-1 amplifier, it would appear that dynamic range could improve if the IF output power level is brought down to a lower level either by inserting more gain at the IF output(after ALC-1) or at the optical fiber input. However, this is not true, since this would require reduction of the IF gain, which in turn would enhance the noise figure of the chain. As a result, for a given RF input level to the IF system, the noise contribution will exceed specified limits.

☐ According to Fig.4 (a) through (e) removal of the "post amplifier" stage in 150MHz, 233MHz, and 327MHz bands will not cause any signal level problems at the RF-IF interface. The "post amplifiers" at 610MHz & 1420MHz bands should be retained as in the present configuration.



Teq of the Optical System at IF output is 3.9E+08 K

This corresponds to a power level of −37dBm in a bandwidth of 32MHz. Hence to have a 1% noise contribution, the power fed to the optical system (which is the desired IF output level), should be −17dBm.

APK/SAINI

Optimum IF attenuator settings upto 610MHz band for 0.5% noise contribution.

	Available IF Dynamic Range (dB)	IF Attenuation (dB)	AGC Preattenuation (dB)	Min RF input to IF (dBm)	IF Gain (dB)
1	14.000	30	30	-32.000	15.000
2	14.000	28	30	-34.000	17.000
3	14.000	26	30	-36.000	19.000
4	14.000	24	30	-38.000	21.000
5	14.000	22	30	-40.000	23.000
6	14.000	20	30	-42.000	25.000
7	14.000	18	30	-44.000	27.000
8	14.000	16	30	-46.000	29.000
9	14.000	14	30	-48.000	31.000
10	14.000	12	30	-50.000	33.000
11	14.000	10	30	-52.000	35.000
12	14.000	08	30	-54.000	37.000
13	14.000	06	30	-56.000	39.000
14	14.000	04	30	-58.000	41.000
15	14.000	02	30	-60.000	43.000
16	14.000	00	30	-62.000	45.000
17	14.000	00	28	-64.000	47.000
18	14.000	00	26	-66.000	49.000

Optimum IF attenuator settings upto 610MHz band for 1.0% noise contribution.

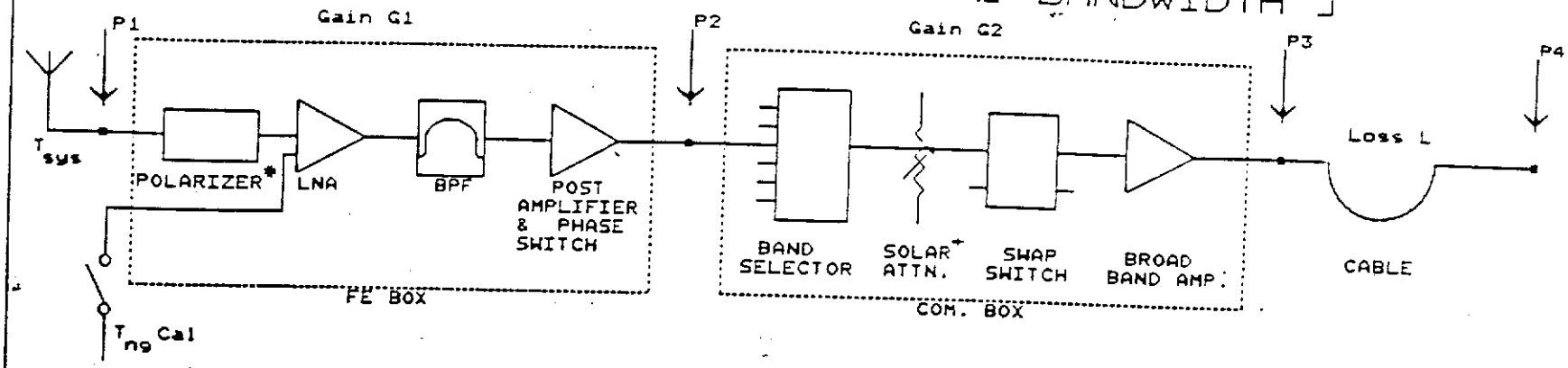
Available IF Dynamic Range (dB)	IF Attenuation (dB)	AGC Preattenuation (dB)	Min RF input to IF (dBm)	IF Gain (dB)
14.000	30	30	-32.000	15.000
14.000	28	30	-34.000	17.000
14.000	26	30	-36.000	19.000
14.000	24	30	-38.000	21.000
14.000	22	30	-40.000	23.000
14.000	20	30	-42.000	25.000
14.000	18	30	-44.000	27.000
14.000	16	30	-46.000	29.000
14.000	14	30	-48.000	31.000
14.000	12	30	-50.000	33.000
14.000	10	30	-52.000	35.000
14.000	08	30	-54.000	37.000
14.000	06	30	-56.000	39.000
14.000	04	30	-58.000	41.000
14.000	02	30	-60.000	43.000
14.000	00	30	-62.000	45.000
14.000	00	28	-64.000	47.000
14.000	00	26	-66.000	49.000
14.000	00	24	-68.000	51.000
14.000	00	22	-70.000	53.000

Optimum IF attenuator settings for the 1420MHz band for 0.5% noise contribution.

Available IF Dynamic Range (dB)	IF Attenuation (dB)	AGC Preattenuation (dB)	Min RF input to IF (dBm)	IF Gain (dB)
14.000	30	30	-22.000	5.000
14.000	28	30	-24.000	7.000
14.000	26	30	-26.000	9.000
14.000	24	30	-28.000	11.000
14.000	22	30	-30.000	13.000
14.000	20	30	-32.000	15.000
14.000	18	30	-34.000	17.000
14.000	16	30	-36.000	19.000
14.000	14	30	-38.000	21.000
14.000	12	30	-40.000	23.000
14.000	10	30	-42.000	25.000
14.000	08	30	-44.000	27.000
14.000	06	30	-46.000	29.000
14.000	04	30	-48.000	31.000
14.000	02	30	-50.000	33.000
14.000	00	30	-52.000	35.000
14.000	00	28	-54.000	37.000
14.000	00	26	-56.000	39.000
14.000	00	24	-58.000	41.000
14.000	00	22	-60.000	43.000
14.000	00	20	-62.000	45.000
14.000	00	18	-64.000	47.000

Optimum IF attenuator settings for the 1420MHz band for 1.0% noise contribution.

Available IF Dynamic Range (dB)	IF Attenuation (dB)	AGC Preattenuation (dB)	Min RF input to IF (dBm)	IF Gain (dB)
14.000	30	30	-22.000	5.000
14.000	28	30	-24.000	7.000
14.000	26	30	-26.000	9.000
14.000	24	30	-28.000	11.000
14.000	22	30	-30.000	13.000
14.000	20	30	-32.000	15.000
14.000	18	30	-34.000	17.000
14.000	16	30	-36.000	19.000
14.000	14	30	-38.000	21.000
14.000	12	30	-40.000	23.000
14.000	10	30	-42.000	25.000
14.000	08	30	-44.000	27.000
14.000	06	30	-46.000	29.000
14.000	04	30	-48.000	31.000
14.000	02	30	-50.000	33.000
14.000	00	30	-52.000	35.000
14.000	00	28	-54.000	37.000
14.000	00	26	-56.000	39.000
14.000	00	24	-58.000	41.000
14.000	00	22	-60.000	43.000
14.000	00	20	-62.000	45.000
14.000	00	18	-64.000	47.000
14.000	00	16	-66.000	49.000
14.000	00	14	-68.000	51.000



FREQUENCY BAND [MHz]	T_{sys} [K]	P1 [dBm]	G1 [dB]	P2 [dBm]	G2* [dB]	P3 [dBm]	L [dB]	P4 [dBm]
50	8170	-84	15	-69	29	-40	4	-44
150	580	-96	34	-62	28	-34	8	-42
233	234	-100	37	-63	27	-36	9	-45
327	108	-103	38	-65	27	-38	11	-49
610	101	-104	35	-69	26	-43	15	-58
1420	72	-105	45	-60	21	-39	23	-62

TYPICAL NOISE GENERATOR CALIBRATION LEVELS [T_{ng} Cal]

Freq. Band [MHz]	T_{ng} Cal. steps [°K]			
	Extra Hi Cal	High Cal.	Medium Cal.	Low Cal.
1390	600	150	60	15
1280	640	160	64	16
1170	720	180	72	18
1060	760	190	76	19
610	400	100	40	10
327	400	100	40	10
233	800	200	80	20
150	800	400	80	40
50	10000	5000	1000	500

'+' Solar attenuator setting: 0dB, 14dB, 30dB or 44dB.

'*' For 0 dB solar attenuator setting.

'*' The polarizer is incorporated after the LNA in the 1420 MHz receiver.

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Fig.4(a) Tabulation for the 150MHz band.

T_{inp} K	Equiv. Power (dBm)		Power at P2 (dBm)		Solar Attn. (dB)		Power at P4 (dBm) in 32MHz	
	BW=32MHz	BW=100MHz	BW=32MHz	BW=100MHz	Max.	Min.	Min.	Max.
580	-96	-91	-62	-57	14	0	-56	-42
10^3	-93	-88	-59	-54	14	0	-53	-39
10^4	-83	-78	-49	-44	30	14	-59	-43
10^5	-73	-68	-39	-34	44	14	-63	-33
10^6	-63	-58	-19	-24	44	30	-53	-39

Fig.4(b) Tabulation for the 233MHz band.

T_{inp} K	Equiv. Power (dBm)		Power at P2 (dBm)		Solar Attn. (dB)		Power at P4 (dBm) in 32MHz	
	BW=32MHz	BW=100MHz	BW=32MHz	BW=100MHz	Max.	Min.	Min.	Max.
250	-100	-95	-63	-58	14	0	-59	-45
10^3	-94	-89	-57	-52	30	0	-69	-39
10^4	-84	-79	-47	-42	30	14	-59	-43
10^5	-74	-69	-37	-32	44	14	-63	-33
10^6	-64	-59	-27	-22	44	30	-53	-39

Fig.4(c) Tabulation for the 327MHz band.

T_{inp} K	Equiv. Power (dBm)		Power at P2 (dBm)		Solar Attn. (dB)		Power at P4 (dBm) in 32MHz	
	BW=32MHz	BW=100MHz	BW=32MHz	BW=100MHz	Max.	Min.	Min.	Max.
100	-103	-98	-66	-61	14	0	-64	-50
10^3	-93	-88	-56	-51	30	0	-70	-40
10^4	-83	-78	-46	-41	30	14	-60	-44
10^5	-73	-68	-36	-31	44	30	-64	-50
10^6	-63	-58	-26	-21	44	30	-54	-40

Fig.4(d) Tabulation for the 610MHz band.

T_{inp} K	Equiv. Power (dBm)		Power at P2 (dBm)		Solar Attn. (dB)		Power at P4 (dBm) in 32MHz	
	BW=32MHz	BW=100MHz	BW=32MHz	BW=100MHz	Max.	Min.	Min.	Max.
100	-103	-98	-68	-63	0	0	-57	-57
10^3	-93	-88	-58	-53	14	0	-61	-47
10^4	-83	-78	-48	-43	30	0	-67	-37
10^5	-73	-68	-38	-33	30	14	-57	-41

Fig.4(e) Tabulation for the 1420MHz band.

T_{inp} K	Equiv. Power (dBm)		Power at P2 (dBm)		Solar Attn.(dB)		Power at P4 (dBm) in 32MHz	
	BW=32MHz	BW=100MHz	BW=32MHz	BW=100MHz	Max.	Min.	Min.	Max.
100	-103	-98	-63	-58	0	0	-65	-65
10^3	-93	-88	-53	-48	0	0	-55	-55
10^4	-83	-78	-43	-38	14	0	-59	-45
10^5	-73	-68	-33	-28	30	0	-65	-35
10^6	-63	-58	-23	-18	30	0	-55	-25

Note: Points P2 and P4 are as marked in Fig.3.

Quiescent RF Power Levels at IF-system and Optical system interface.

(A meeting was held to resolve the issue of Power Levels at the interface, on 10/02/1994. The following were present:)

- T.L.Venkatasubramani
- D.S.Sivaraj
- K.S.Saini

A rough sketch of the components present at the interface is given below. The RF Power levels present at various points are indicated in the diagram. The output of the 5 way combiner is the output of the Remote Receiver Rack which is fed to the Optical Rack. Currently the power level at this point is adjusted to −14dBm/IF channel. This works out at be −20dBm at the laser diode input which is less than the stipulated value of −14dBm.

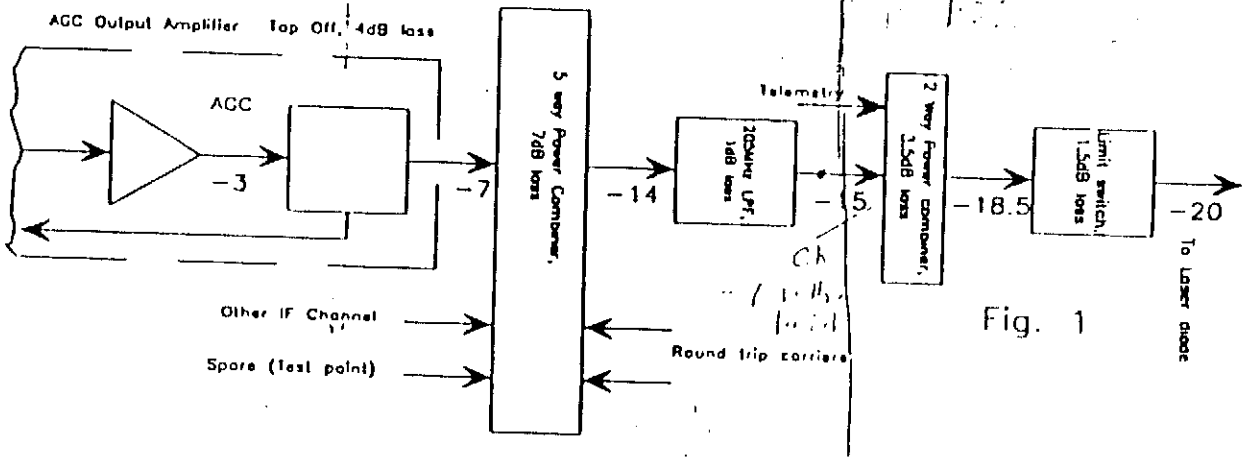

Fig. 1

With the current operating levels, the final output amplifier of the AGC in the IF system is operating at a level of −3dBm, which corresponds to an IMD performance of −46dBc. If IMD performance is not to be sacrificed, then the deficit of power at the laser diode cannot be made up by shifting the output level of the AGC by 6dB. It was therefore decided to add an 8dB modular amplifier MSA0520 of AVANTEK make (whose compression point is sufficiently high), and reduce the IF gain and the AGC operating level by 2dB. This gives the required operating levels as shown below:

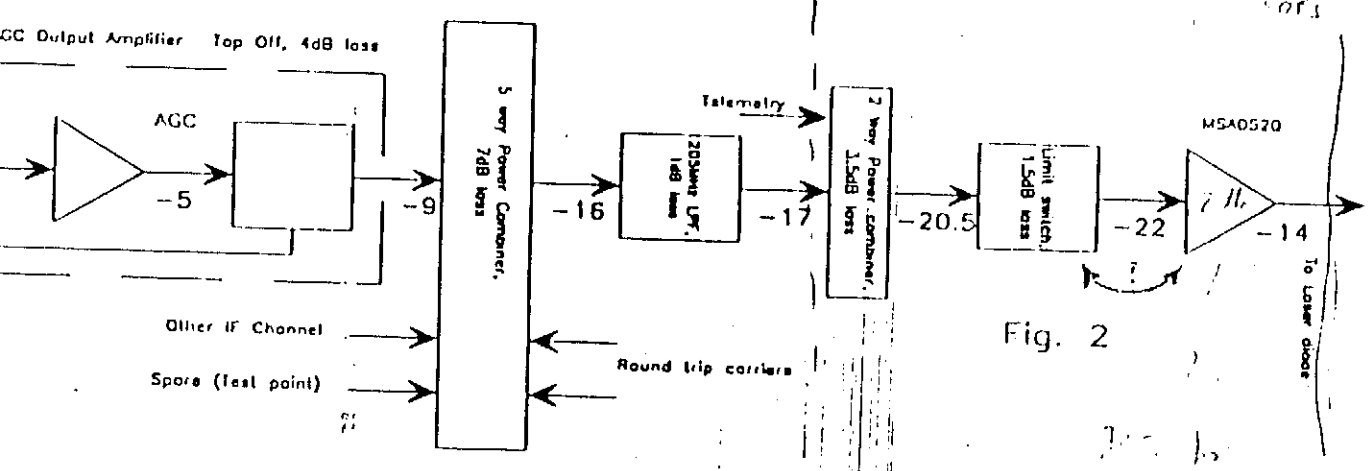

Fig. 2

Minuted by K.S.Saini

FIGURE - 5