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Dynamic Range of GMRT Fiber Optic System

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1.1 *Introduction:*

The Dynamic Range of the fiber optic system needs a clear study and understanding to effectively use the available dynamic range of the system. This report attempts to high light the above and suggests methods for effective use of the system.

It is to be noted that the fiber optic system goes to saturation stage by stage. The first limiting factor is the post amplifier of the fiber optic receiver which goes to saturation earlier (at –18dBm RF). This forces us to operate the fiber optic transmitter at –14dBm. It is also to be understood that this operating level is for zero kilometer distance between the fiber optic transmitter and the receiver. As the fiber optic link distance increases the saturation point of the system also moves far–away. This is because the power input to the post amplifier keeps reducing as the fiber length increases. Thus we could operate at greater power levels, greater than –14 dBm with increase in fiber distance and still be in linear range.

In the near–by antenna an excess gain exists and kept attenuated in the receiver units at CEB. The RF input level to the fiber optic transmitter can be reduced and the same can be compensated using the excess gain at CEB to meet output specification. A scheme is worked here for making use of the above excess gain and reduce the RF input level to the fiber optic system.

1.2 *Near–by antenna (< 2 Km distance from CEB):*

The central square antennas have extra gain available in the fiber optic receivers. This is because all systems were designed for a link distance of 20 Km distance. The excess gain (~15 dB) are attenuated in every receiver of the central square antenna links. This extra gain can be used to reduce the operating point for the IF system i.e. the RF input power level to the fiber optic transmitter can be reduced and compensated using the available gain. At present the IF input power fed to the fiber optic transmitter is –20 dBm per channel. The total IF power for two channel will be –17dBm. Using the excess gain of 15 dB the IF power can be reduced to –30 dBm per channel and leaving further gain of 5 dB for system margin . This 5 dB system margin is equivalent to 2.5 dB optical loss which can be used when the link loss increases due to bad connectors or additional splices during cable breakage. This modification can be done just by releasing the excess gain in the Fiber optic receiver at CEB. Thus only the attenuator in the receiver has to be reduced. The worked out specification is found suitable for the following 15 antennas:

S.No.	Antenna	Fiber distance to CEB in Km	Optical loss in dB	Available excess gain at CEB receiver in dB
1.	C00	1.364	0.96	> 15
2.	C01	0.909	0.98	> 15
3.	C02	0.631	1.28	> 15
4.	C03	0.711	1.57	> 15
5.	C04	0.972	0.80	> 15
6.	C05	0.975	1.79	> 15
7.	C06	1.167	1.07	> 15
8.	C08	1.334	1.65	> 15
9.	C09	0.862	1.20	> 15
10.	C10	1.334	1.57	> 15
11.	C11	1.227	0.75	> 15
12.	C12	1.730	0.94	> 15
13.	C13	1.939	1.06	> 15
14.	C14	1.321	0.84	> 15
15.	W1	1.937	1.57	> 15

Releasing 10 dB of the available 15 dB gain remains 5 dB equivalent to 2.5 dB optical margin. Thus the system will continue to remain reliable as usual. With the 2.5 dB all the above antennas will have an optical budget of 4.5 dB. From the above table it is clear that the optical loss at every antenna is not greater than 2 dB and hence an optical budget of 4.5 dB is sufficient for reliable operation of the antennas.

1.3 *Far–away antenna (< 12 Km distance from CEB):*

In the far–awayantennas for a distance greater than 2 Km and less than 12 Km (Y array ant.) the RF input to the fiber optic receiver reduces due to fiber loss and hence the system is well below the saturation of the post amplifier and hence they can be operated at still higher input levels linearly. But the IF system has to operate at higher output levels and very near to its own saturation, which is not desired. But this extra dynamic range will be helpful when IF systems operate with ALC Off and the IF power raises to zero dBm.

The far–awayantennas when looked in another angle, an extra amplifier at the fiber optic transmitter may help in reducing the operating the level of the IF and boost the same with the extra amplifier gain at the transmitter unit. This scheme is already done for far–most antennas like W05 and W06. Thus by providing an extra amplifier in the return link we could reduce the operating power level of IF from –20dB/ channel to –30dB/ channel. The worked out specification is found suitable for the following antennas :

S. No.	Antenna No.	Fiber Distance Antenna to CEB in Km	Optical Loss in dB in dB	Available excess gain at CEB in dB
16.	W02	4.185	2.27	> 8 dB
17.	W03	7.594	3.45	> 8 dB
18.	W04	11.45	4.40	> 8 dB
19.	E02	3.657	2.59	> 8 dB
20.	E03	6.309	2.83	> 8 dB
21.	E04	10.44	4.63	> 8 dB
22.	S01	4.782	2.31	> 8 dB
23.	S02	7.312	3.30	> 8 dB
24.	S03	10.45	4.63	> 8 dB

Presently the return fiber optic link of the above antennas having less than 12 Km consumes an optical budget of 5 dB maximum , leaving an excess gain of 10 dB at these antennas links. By providing an 8 dB amplifier (MSA 0520 , output 1 dB compression Point is at 23 dB) at the transmitter unit will have a gain of 18 dB in the return link. Now to reduce the IF power level from –20dBm to –30dBm , 10 dB out of 18 dB gain will be used and 8 dB will be leftout as excess gain. This 8 dB gives an optical margin of 4 dB to meet future degradation in the link. With this scheme the antennas will have an optical budget of 9 dB. Some of the near by antennas of the above can support the IF power reduction without the extra amplifier. But for a reliable operation it may be necessary.

1.4 *Far most antenna:*

The far most antennas like 5th and 6th antenna of the Y array needs an PIN–FET receiver to provide the good signal to noise ratio and dynamic range. Due to the cost of the receiver it can be implemented only in the far most antennas. It will be interesting if we attempt to build a transimpedance amplifier for the existing PIN diode receivers which is also proposed under microwave photonics project. This may work out low in cost and will give a incomparable performance for the GMRT system. This modification can help in reducing the IF power required to the system. It is also to be understood that these antennas can be operated at high input powers since the saturation point of the Post amplifier has moved faraway due to reduced input to it from preamplifier. This is because the optical loss at these antennas are high and hence the RF power output at the preamplifier is less. Thus to make use of the available dynamic range the IF power fed to the system should be increased and still have the same dynamic range and signal to noise ratio. An amplifier with larger gain and high 1 dB compression point may be helpful at the transmitter input. This helps in providing the required signal level at the receiver output with reduced IF signal. This may require further study with these far most antennas greater than 12 Km distance from CEB.

1.5 *Conclusion:*

Thus from the above analysis and discussion it is clear that it is possible to reduce the IF power input to the fiber optic system and one can exploit the available dynamic range of GMRT Fiber optic system.

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