Minutes of the Plan meeting of 16th March 2011

Item 1 : Signal Flow Analysis of Receiver Chain of the upgraded GMRT

Signal flow analysis results were presented and discussed for the FE, OF and BE systems. Important considerations were : input and output power levels of each system, 1 dB compression point, OIP3 point (if available), Compression Dynamic Range (CDR), Spurious Free Dynamic Range (SFDR), Headroom (this is not always the same as CDR).

The main aim is to come to a consensus such that a basic target of **SNR better than 20 dB** (i.e. less than 1% degradation of Tsys), and **headroom ~ 30 dB** can be maintained throughout the chain, while ensuring **proper matching of power levels** between the 3 systems.

FE system : Used the newly upgraded L-band FE box + common box as a case study of the problem (this does have some implications for FE system for other wave-bands). Analysis was done using the Cascaded Analysis Tool of AKB + SG, and results for 100, 200, 400 MHz BW were presented (summary of results file is attached below) :

O/p power level (w/o cable loss) : -23 to -17 dBm (for 100 to 400 MHz)
CDR : 40 to 34 dB (for 100 to 400 MHz)
Headroom : same as CDR for this system !?!
SFDR : 39 to 35 dB (for 100 to 400 MHz)

Q : what about other wave bands?

OF system : Presented revised circuits with detailed anlaysis of various sub-components and their linearity ranges. Analysis has been done with a different tool. Results were for the CWDM system. Targets : maintain 20 dB SNR throughout the chain and work out optimal operating conditions.

OF circuit has a 30 dB attenuator (with 0.5 dB step size) on i/p side at antenna base, to cater to (i) different input power levels (ii) different OF loss (analysis is for worst case loss of E06). OF system can handle **i/p power of -48 to -6 dBm for SNR > 20 dB**; lower the i/p power, better the CDR and headroom. An input power level of around -45 dBm looks like an optimal choice; for higher i/p power levels, 30 dB attenuator can take care ==> i/p power can go up to -15 dBm. With this setting, a headroom requirement of 30 dB is met (see below for preliminary version of summary sheet from OF group).

Hence, **FE to try and keep max o/p below -15 dBm and min o/p above -45 dBm** (this includes cable loss from top to bottom) e.g. -23 to -17 dBm of L-band o/p translates to -39 to -34 dBm after 16 dB cable loss at L-band.

The o/p power level ranges from -28 to +14 dBm for the i/p range of -48 to -6 dBm (it is a 20 dB gain system). **Hence, for the optimal i/p power of -45 dBm, the o/p power will be -25 dBm**.

BE system : Analysis done using the Cascaded Analysis Tool (summary chart is attached at end).

Nominal i/p power : -24 dBm
Nominal o/p power : -12 dBm
Noise Figure : ~ 20 dB
Headroom (worst case) : 27 dB

Although CDR is ~ 72 dB, headroom (worst case) is about 27 dB (due to the higher operating power levels) -- variable attn can be adjusted to get better headroom. Finally, the ADC may be the limiting factor that determines the headroom of the BE system...

Thus, it appears that to first order, the signal flow analysis appears to have produced convergence, with appropriate handshakes between the 3 main systems.

Action Item : A little more work needs to be done to cement these gains : proper reports to be completed by FE, OF and BE groups and put on the respective Plan websites (all are urged to put the present versions as preliminary drafts, within the next week); and a overarching note that combines all into a coherent unit; finer cross-checks by FE for other wave-bands.

Item 2 : Environmental Chamber

OF group has got quotations for Remi make units (similar to the one we use at present). FE group is looking at larger temperature range units. Action : OF group to go ahead with procurement of one Remi unit; FE group to continue search for better units – decision to purchase one of these can be taken when a suitable unit is found.

Item 2 : New OF links

OF group has implemented prototype version of new broadband link that uses a different optical wavelength (~ 1550 nm) for the return IF signal, instead of the original GMRT design using ~ 1310 nm. First unit was installed on W04 a few weeks ago, to test its performance vis-à-vis the normal links and check if the phase variations seen are acceptable or not. A sequence of normal GTAC observations were analysed by Manisha Samble to compare the phase behavior of W04 against other GMRT antennas (specifically nearby antennas in W-arm). A report on the results obtained had been prepared by her and this had been circulated. The results show no abnormal phase behaviour for W04 -- the phase variations seen are quite similar to the sequence seen for W02, W03, W05 and W06.

It was agreed that OF group can go ahead with installation of this new scheme in 2 more antennas – E02 + one central square antenna. Final list of 7 antennas with broadband links to be targeted by OF group is as follows : C9, C11, E02, W04, E06 + 2 antennas (one in CSQ, one in arm at intermediate distance). It was also agreed that OF group can modify C9, C11 to change the wavelength combinations, within the present MTAC period.

Attachments :

Preliminary versions of FE, OF and BE summary tables for signal flow analysis (see below)

Summary of L-Band Front-End Cascaded Signal Flow Analysis

Date : 10 Aug 2010

UNIT Description	DEVICE Part	Freq (MHz)	Zin/Zout (ohms)	Gain (dB)	Noise Figure (dB)	Output P1 dB (dBm)	Output IP3 (dBm)	Pow @ Device O/P	Cum. Gain (dB)	Cum. NF (dB)	Head room for the I/P	I/P for Device Sat
LNA	FHX35LG	1200	50	35.00	0.45	-2	8	-59.00	35.00	0.45	57	-37
GSM-CDMA Filter		1200	50	-1.5	1.5	40	1000.00	-60.50	33.50	0.45	100.5	6.5
SPDT RF Switch	SW-338	1200	50	-0.6	0.6	30	46.00	-61.10	32.90	0.45	91.1	-2.9
Filter-bank		1200	50	-7	7	35	1000.00	-68.10	25.90	0.46	103.1	9.1
SPDT RF Switch	SW-338	1200	50	-0.6	0.6	30	46.00	-68.70	25.30	0.46	98.7	4.7
Hittite Amplifier	HMC740	1200	50	14	3.5	18	40.00	-54.70	39.30	0.47	72.7	-21.3
Phase Switch	SRA-2010MH	1200	50	-5	5	10	25.00	-59.70	34.30	0.48	69.7	-24.3
Hittite Amplifier	HMC740	1200	50	14	3.5	18	40.00	-45.70	48.30	0.48	63.7	-30.3
WBPF		1200	50	-0.5	0.5	35	1000.00	-46.20	47.80	0.48	81.2	-12.8
BSATR	SW-338,SW-239	1200	50	-2.7	2.7	30	46.00	-48.90	45.10	0.48	78.9	-15.1
SWAPSW	SW-239	1200	50	-1	1	30	46.00	-49.90	44.10	0.48	79.9	-14.1
Mini-circuit Amp	Gali-52	1200	50	20	2.5	15	32.00	-29.90	64.10	0.48	44.9	-49.1
Hittite Amplifier	HMC740	1200	50	14	3.5	18	40.00	-15.90	78.10	0.48	33.9	-60.1
Directinal Coupler	TDC-9-1W	1200	50	-1.50	1.50	20	40	-17.40	76.60	0.48	37.4	-56.6

CASCADED ANALYSIS

Instantanious BW	100	200	400	MHz
Input Power	-100.00	-97.00	-94.00	dBm
Output Power	-23.40	-20.40	-17.40	dBm
Power Gain	76.60	76.60	76.60	dB
Noise Figure	0.48	0.48	0.48	dB
1 dB Compression point Output P1 dB	16.50	16.50	16.50	dBm
O/P Third order Intercept Point OIP3	35.40	35.40	35.40	dBm
Compression Dynamic range (CDR)	39.90	36.90	33.90	dB
Spurious Free Dynamic Range (SFDR)	39.20	37.20	35.20	dB

$T_{sys} = 70^{0}K$ Gain = 76.6 dB

$kT_{sys}B = k.T_{sys}.B = 1.38 \times 10^{-23} \times 70 \times 1$

$= -210$ dBW/Hz $= -180$ dBm/Hz

Cascaded Analysis Tool :

Designed By : AKB / Sweta Gupta

Entry By : APK / VBB / APS

Oct 2010

Cascaded Performance Analysis of CWDM based Analog Fiber Optic System

Optical I/P to ORx = -5 dBm

From Front end

For SNR ≥20 dB/400 MHz

Input power level

-48 to -6 dBm

Parameters	Measured
Gain in dB	20
Noise Figure in dB	14
I/P 1 dB Compression point in dBm	-6
3rd order intercept point in dBm	4
EIN of link in dBm/Hz	-159
Compression Dynamic Range dB/Hz	147.77
Compression Dynamic Range dB/400 MHz	61.77
Estimated Spurious Free Dynamic Range $dB/Hz^{2/3}$	108.67
Estimated Spurious Free Dynamic Range $dB/400\ MHz^{2/3}$	51.32
Head room for 20 dB SNR/400MHz	42

To Back end

-28 to 14 dBm

By: SSK/AKH/PAR/MGN/SKL

CASCADED ANALYSIS	@ RF MHz	100.00
Input Power	-24	dBm
Output Power	-12.62	dBm
Power Gain	11.38	dB
Noise Figure	19.1	dB
Output P1 dB	14.9	dBm
Output IP3	27.09	dBm
CDR	72.29	dB
SFDR	56.32	dB
HeadRoom	27.52	dB
O/p Noise Density	-143.41	dBm/Hz
Noise Temp @ FE in	0.0096	K
Power Consumption	2.45	Watts

Name of Sub-system	Analog Backend System		
Input Power Level	-24	dBm	
Signal Bandwidth	400	MHz	
Analysis @ Freq		MHz	
Impedance	50	Ohm	
Gain in Prev Stages	64	dB	

CASCADED ANALYSIS	@ RF	1000.00
Input Power	-24	dBm
Output Power	-12.75	dBm
Power Gain	11.25	dB
Noise Figure	19.91	dB
Output P1 dB	14.9	dBm
Output IP3	29.6	dBm
CDR	71.59	dB
SFDR	57.53	dB
HeadRoom	27.65	dB
O/p Noise Density	-142.71	dBm/Hz
Noise Temp @ FE in	0.0116	K
Power Consumption	2.45	Watts

CASCADED ANALYSIS	@ RF	1500.00
Input Power	-24	dBm
Output Power	-12.93	dBm
Power Gain	11.07	dB
Noise Figure	20.31	dB
Output P1 dB	14.9	dBm
Output IP3	30.06	dBm
CDR	71.37	dB
SFDR	57.69	dB
HeadRoom	27.83	dB
O/p Noise Density	-142.49	dBm/Hz
Noise Temp @ FE in	0.0127	K
Power Consumption	2.45	Watts

List of topics for Plan meet of 6th April 2011:

Operations related :

1.1 Updates on Rabbit card testing with (i) serial port and (ii) ethernet system
1.2 RFI shielding of Rabbit card
1.3 Development of new MCM card
1.4 Status of software development for new MCM card
1.5 Rugged PC for Ant Com at antenna base : follow-up with Dynalog, Comint etc.
1.6 Updates about completed documents put up on Plan web-page by the Ops group.

Any other items:

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Minutes from previous Plan meet of 23 / 03 / 2011 :

Item 0 : Comments on previous minutes : none so far ; quick discussion of follow-up action items : RF, OF and BE groups to update the documents and also put them on the Plan website.

Item 1.1 : Updates on performance tests of prototype 250-500 MHz feed : New round of tests done in March : RF deflection at antenna base and also deflection as measured by GSB -- problem with power levels due to 14 dB change or drop in power across the 250 MHz range ==> repeat the tests with proper power equalisation at each stage and also include beam shapes at different frequencies. ACTION : JNC to coordinate the above and update new results. Timescale : asap.
FE group opined that new LNA with flat response can take care of 14 dB drop ==> FE group to try for that and see if 2nd FE box can be made ready before the next test.

Item 1.2 : Status of Cone dipole feed prototype unit : Cone dipole feed ready and coming from W'shop within a day or so; to put 3 sleeve dipole in it, test in lab, add new FE box and do sky test; then try on turret behind the lab for rough phase centre test; then put on antenna for full test.
ACTION : APK to corodinate the above with GSS and Hanumanth Rao. Time scale : within the next 2 weeks.

Item 1.3 : CSIRO feed over last month or two : last part of step Xmer had fallen out and has been repaired; 7.3 vs 5.7 dB deflection in the two pols and changing with BW setting.
ACTIONS : ANR to circulate doc compiling current set of results; detailed discussions in the lab; follow-up couple of weeks from now.
Also, mechanical structure for strenghtening of weight reduced units OK -- modified drawing cleared by Tapde.
ACTION : this aspect can be closed.

Item 1.4 : Testing of Eleven feed : oscillatory behaviour in pseudo differential
mode; balun from existing 610 feed used to make it a single ended system ==> no oscillations. To try with lossy wideband Balun? To try with 150 MHz LNAs?
Different options discussed (e.g. VBB unit):
ACTION : to try test with 2 types of 150 LNAs & do a sky test to see how it works.

Item 1.6 : Noise injection with probes : boxing ring option at Bonn was discussed; question asked how well does/can it work for crossed dipole feeds? ACTION : DMitra to check for cross-dipole feed at Arecibo and send a response; Meanwhile, to try for our 150 MHz boxing ring system. Use simulation techniques to (i) design an appropriate radiating element (ii) check for the effect on the response of the main feed, of introducing this radiating element.
ACTION : APK to coordinate the effort of FE group for the above.

Item 1.5 : Reports from FE group :

1. L-band system -- done ; check if available on Plan web-page
2. 300-500 MHz system -- done ; check if available on Plan web-page
3. Hanumanth on simulation vs measurements : draft version can be put up
4. GSS on edge taper mismatch to cross-polar performance : final version can be put up on Plan web-page
5. HR/GSS on comparison of different configurations of cone-dipole feed : material collected , first draft to be made in next week to ten days
6. GSS short note on direct vs reflected path and sensitivity of test range : draft version available, can be put up on Plan web-page
7. FE team : detailed comparison of various feed designs options for 250-500 MHz range ??
8. Final version of noise report (Aarti Sandikar version) to be put up on Plan web-page
9. 50 MHz feed reports : can be put up on Plan web-page

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