Recommended Procedure for Control and Monitor of the LO Synthesiser parameters in GMRT Receiver System through MCM #2

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1.0 Introduction:

This note summarises the procedure for controlling the Synthesised Local Oscillator frequency in the ABR system at each antenna for SYN1 through MCM #2, monitoring, logging and analysing (both on-line and off-line) the monitored data. The procedure for control and monitor of SYN2 through MCM #3 will be the subject of a subsequent note.

The details as in this note will be available from the Fifth antenna of GMRT. Note that the existing systems at C3, C12, C4 and C2 ARE NOT COMPATIBLE with the Fifth and subsequent systems to be installed. Hence, the procedures that are currently being followed for these four systems must continue to be followed (especially the RUN files for setting frequency) till the hardware is upgraded on a future date when spare plug-in-units are available.

Note that this is an advance copy circulated to colleagues, for planning related developmental activities. Chances for minor modification exists, though remote, as the Fifth system to be installed at C9 during this week can be called "The Final Prototype" and we do not have any field experience.

2.0 Features of the LO Synthesiser System:

A block diagram of the LO synthesiser and the front and rear view of the PIUs is enclosed as Annexure 1 (3 pages). The important features of the LO Synthesiser system about which users should be aware has been extracted from "LOS User Manual" (under preparation) and is being enclosed as Annexure 2 (4 pages).

3.0 Parameters that go into Controlling the frequency of a Synthesiser:

The hardware parameters of the synthesiser which are controlled by MCM are:

(a) Power supply to the oscillator, so that the unit not in use can be turned off;
(b) Step size of synthesied frequency (1 MHz or 5 MHz);
(c) RF switches, to provide a path to the selected oscillator to the final output;
(d) Setting the synchronous dividers;
(e) Mapping the various monitored points to the MCM analog inputs;
(f) Control of a fixed delay in the 1 MHz path;
(g) Setting the DAC for the YIG oscillator.

This note describes points (a) to (f) above, which are of relevance to controlling SYN1 through MCM #2.

4.0 Philosophy of monitoring:

While the MCM has the capability to monitor 64 analog channels simultaneously, the system implemented uses only 8 of them, that is, analog channels 16 to 23. Two monitor points are selected from each of the four PIUs, using a 32 to 2 multiplexer and connected to the above analog channels. This has been done to eliminate criss-crossing wires carrying low level analog signals between PIUs. Thus, it is possible to monitor 32 points in a PIU.

The hardware mapping of monitor points in a PIU to the multiplexer is as per the columns in Annexure 3 (1 page). Any row in this table can be selected (Feature 3.0(e)) through MCM Control by running one of the sixteen Monitor RUN files. See note of mine dated Nov 4, 1994 and titled "Recommended Procedure for setting Front end parameters of GMRT through MCM #2" for more details on the Monitor RUN files.

It may be noted that the MOST CRUCIAL monitor points to indicate the lock status of the system has been arranged in rows 3 and 4. Monitoring done through the other rows are for counterchecking whether a command has been properly executed at the hardware level and for isolating a fault if and when one occurs. For example, VMPAM12A and IPAM12V, when monitored and recorded through analog channel 21 by running M06 and M15 (See Annexure 3) COMPLETELY tell about the health of the power amplifier and isolation amplifier in D48 PIU (See Annexure 1; Page 1).

Additionally, facility exists to connect any "Hot Line" information in channels 24 to 30 through a D-type connector available external to the PIU. Data in these channels can be monitored and logged irrespective of the MONITOR RUN file used.

At present, the connections to these channels has not been defined. At a later date, it will include general health parameters of the ABR system like temperature at a few points in the rack, whether the doors of the shielded rack has been properly closed (An opened front/ rear door indicates to the user that some one is working on the ABR rack at that antenna), current drawn by fan trays, current drawn from Muthye power supply and similar information.

MCM #2 and MCM #3 would together provide 14 hotline points which should be adequate.

4.0 The Program for computing and setting of frequency:

A Basic program using which parameters as in 3.0 (a), (b), (c) and (d) are computed and Control RUN files produced for synthesising any frequency in DOS environment is enclosed as Annexure 4 (2 pages). Note that the relevant MONITOR command for rows 3 or 4 in Annexure 3 (as applicable) is automatically set at the end of control. Also note that this program can not be used for generating RUN files to control YIG tuned oscillator.

5.0 Procedure for implementation in Online environment:

It should be trivial to convert the Basic program in Annexure 4 for generating the RUN files in Unix environment.

The following procedure is suggested:

(a) A separate directory named LOS is created with sub-directories named as VCO1, VCO2 and VCO3.

(b) The sub-directory VCO1 will contain RUN files to synthesise frequencies from 90 MHz to 210 MHz in 1 MHz step.

(c) The sub-directory VCO2 will contain RUN files to synthesise frequencies from 190 MHz to 410 MHz in 1 MHz step.

(d) The sub-directory VCO3 will contain RUN files to synthesise frequencies from 300 MHz to 680 MHz in 5 MHz step.

(e) Rights for running any of these files is RESTRICTED to maintenance personnel ONLY.

(f) From these RUN files, MINIMUM NECESSARY FILES are chosen and copied to USER area. These files will be for LO frequencies which are to be selected as default for operating the array in the bands centered at 38, 150, 230, 325 and 610 MHz. The system will be tested in detail for guaranteed performance for these settings.

(g) A LIST OF MINIMUM FIRST LO FREQUENCIES DESIRED BY USERS IS URGENTLY SOUGHT.

(h) Choice of any other LO frequency by the user with out clearance from authorised personnel will be at their own risk.

6.0 !WARNING!WARNING!WARNING!

ANNEXURE 4 IS BEING RELEASED UNDER THE FOLLOWING CONDITIONS: USERS SHALL NOT MODIFY THE PROGRAM AND CREATE RUN FILES TO RESULT IN A BIT PATTERN AND/ OR SEQUENCE OF COMMANDS WHICH IS IN ANY WAY DIFFERENT FROM THE ONE GOT USING THE ORIGINAL BASIC PROGRAM

7.0 Control of a fixed delay in the 1 MHz path:

Users of the existing system at C4, C12 and C9 may recall occasional problems while using the system due to delay in 1 MHz path which was solved by manually adjusting the setting of the delay unit at the antenna base. A preliminary prototype circuit has been incorporated in the next system to be installed in C9, which has the following feature:

(a) A fixed delay of 2.5 nSec which could be included or excluded from the 1 MHz path by a command through the MCM.

(b) A fixed delay of 5 nSec which is included OR excluded automatically based on lock status. The state would toggle when an Out of Lock condition is sensed by the Overall Lock Indicator (OLI) to bring the system automatically into lock.

The status of (a) and (b) are monitorable (see rows 1 to 3 and column 5 of Annexure 3.

AS THIS IS A NEW FEATURE, FIELD TRIALS ARE NEEDED TO CERTIFY THE PERFORMANCE.

8.0 Procedure to control the 2.5 nSec delay through MCM:

While this will not be needed when the feature as in 7.0(b) works satisfactorily, the following procedure is recommended to the user who wants to experiment. The steps outlined seem to be the simplest at this juncture and should not disturb settings of other parameters which have been already set.

a) Run monitor file M00 and record value of analog channel 20. Call as MCMCON. This value would be either around 130 or 40.

(b) Run monitor file M09 and record value of analog channels 17 and 18. Call as VCO1STAT and VCO3STAT respectively

(c) Run monitor file M10 and record value of analog channel 17. Call as VCO2STAT.

(d) Only ONE of VCO1STAT, VCO2STAT or VCO3STAT will be around 215. It should correspond to the VCO which has been selected to synthesise the frequency. The other two would be ~130

(e) Issue a 32 bit digital mask as per table below:

VCO1STAT > 170 and MCMCON > 80	Mask: 0168 8168
VCO1STAT > 170 and MCMCON < 80	Mask: 0968 8968
VCO2STAT > 170 and MCMCON > 80	Mask: 0146 8146
VCO2STAT > 170 and MCMCON < 80	Mask: 0946 8946
VCO3STAT > 170 and MCMCON > 80	Mask: 0245 8245
VCO3STAT > 170 and MCMCON < 80	Mask: 0A45 8A45

(f) Run monitor file M00 and ensure that the value read in analog channel 20 is the complement of the value read earlier.

9.0 Procedure for monitoring the current status of 5 nSec delay:

The current status of inclusion or exclusion of the 5 nSec delay in the 1 MHz path can be found as under:

(a) Run monitor file M01 and record value of analog channel 20. Call as AUTCON. This value would be either around 130 or 40.

(b) Run monitor file M02 and ensure that the value read in analog channel 20 is the complement of the value read earlier.

(c) If AUTCON < 80, then 5 nSec delay is INCLUDED.

(d) If AUTCON > 80, then 5 nSec delay is EXCLUDED.

10.0 General procedure for logging the health of the system:

The following procedure is suggested to start with:

(a) A Monitor Log file (ddmmyyss.los where dd=date; mm=month; yy=year; ss=session number on that date) is created at the start of observation.

(b) When a control command is issued where MCM2 is involved, the full details of the command issued is written into this log file.

(c) Any control involving MCM #2 is followed by running Monitor files M00 to M15 in succession and writing values of analog channels 16 to 23 in the log file. Ensure that the last monitor command issued is either M03 or M04, as appropriate.

(d) The procedure is repeated and data appended to the log file, whenever a command involving MCM #2 is issued.

(e) Shri. Suresh Sabapathi will analyse the log file off-line on a day-to-day basis, produce a summary and archive the log file for detailed study of reliability of the system.

11.0 Procedure for on-line analysis of monitored data:

The scope is restricted to analysing on-line and inferring about "Health" based on the contents of channels 16 to 23, when the files to get MOST CRUCIAL monitor data, M03 and M04 are run. Interpreting monitor data resulting when other monitor files are run on an on-line basis will be documented later based on study of performance as in 10.0(e).

(a) The most important monitor channel is 20, which has been mapped to the Overall Lock Indicator (OLI) in both M03 and M04. Expected values are around 140 or 235. Decision taking level could be set at present to 190.

This indicator is based on frequency discrimination and the EXACT matching of a Referance waveform (1 MHz or 5 MHz, depending on step size) and a Variable waveform produced by the division of the VCO frequency and fed to the Phase-frequency detector. The resolution of matching is around 4 KHz or 20 kHz, depending on the step size.

Lock is when this channel reads < 190. Unlock condition makes this channel read > 190.

(b) The next important monitor channel is Lock indication at PIU level (LKVCOn, n = 1 to 3). This indication is based on sensing the amplitude of beat signal in a comparator. The typical value for counts are 130 or 230. Decision making level could be set at present to 180.

As could be seen from Annexure 3, LKVCO1 is mapped to analog channel 17 when M03 is run; LKVCO2 to channel 17 when M04 is run and LKVCO3 to channel 19 when M04 is run.

Note that depending on the VCO used, only one of the monitor points will be meaningful and will be > 180 under lock. The channels for VCO not in use/ VCO used and out of lock would indicate counts < 180.

(c) Channels 16, 16 and 18 are mapped to indicate the voltage at which VCO1, VCO2 and VCO3 are locked (LVVCOn) and are available by running the monitor files M03, M04 and M04 respectively. The count recorded for a VCO which has not been selected will be around 130. For a selected VCO, under lock, the count could vary from 40 to 200, depending on the synthesised frequency. When the selected VCO is unlocked, the counts would be around 65 or 230. With more field experience, it should be possible to find an equation to relate count under lock and frequency. Data available at this stage is too small to venture such prediction.

THUS THERE ARE THREE INDEPENDANT WAYS TO CHECK AND CONFIRM LOCK STATUS AT AN ANTENNA AS LISTED IN (a), (b) AND (c) ABOVE.

(d) When either of M03 or M04 is run, channel 22 gives the mode selected at the site, namely Manual or Auto. The value read would be either around 130 or 215. If it is around 130, then Manual mode has been selected. If around 215, then Auto mode is selected. Decision taking value could be at present set to 170.

Note that the parameters of the LO system could be set through MCM if and only if the mode is Auto. The Manual mode is for debugging by authorised service personnel using appropriate test jigs at the site.

(e) When monitor file M03 is being run, counts in channel 21 indicate the power level of the Local oscillator signal (WARNLO). The count will be either around 140 or 250. Decision taking value could be set to around 180.

If the count read > 180, then the LO power level to IF system is proper. The count becomes < 180 when the power reduces to < ¯+5 dBm **(New feature: DO NOT COME TO HASTY CONCLUSIONS!).**

(f) When monitor file M04 is being run, counts in channel 21 indicate the temperature inside D48 PIU (WARNTEMP). **FEATURE NOT AVAILABLE IN THE C9 SYSTEM.** The count could be either around 130 or 250. Decision taking value could be set to around 200.

If the count read > 200, then the temperature inside the PIU is > 40 deg. Celsius and is a cause for worry and needs urgent attention by service personnel.

IF THE DEFAULT MONITOR RUN FILE IS (SAY) M03, THEN IT WOULD BE A GOOD PRACTICE TO RUN THE FILE M04 ONCE A MINUTE BECAUSE PARAMETERS EXPLAINED IN (e) AND (f) ABOVE ARE NOT SIMULTANEOUSLY AVAILABLE.

(g) The contents of channel 23 should be around 250 when M04 is run and around 130, when files M03, M05 or M06 are run. This corresponds to MCM address 2. Note that this monitoring gives a feedback on the DIP-switch setting for selecting MCM address in the MCM pcb.

12.0 Conclusion:

(A) The topics (i) How to set the YIG tuned oscillator and (ii) How to swap SYN1 and SYN2 for interchanging the LO fed to 130 and 175 MHz IF channels will be covered in a later note.

(B) I visualise the following scenario of monitoring in the long run. There could be many other ways and suggestions are welcomed. We should have a set-up when two more systems get installed in Dec 94 to get a feed back on reliability of system.

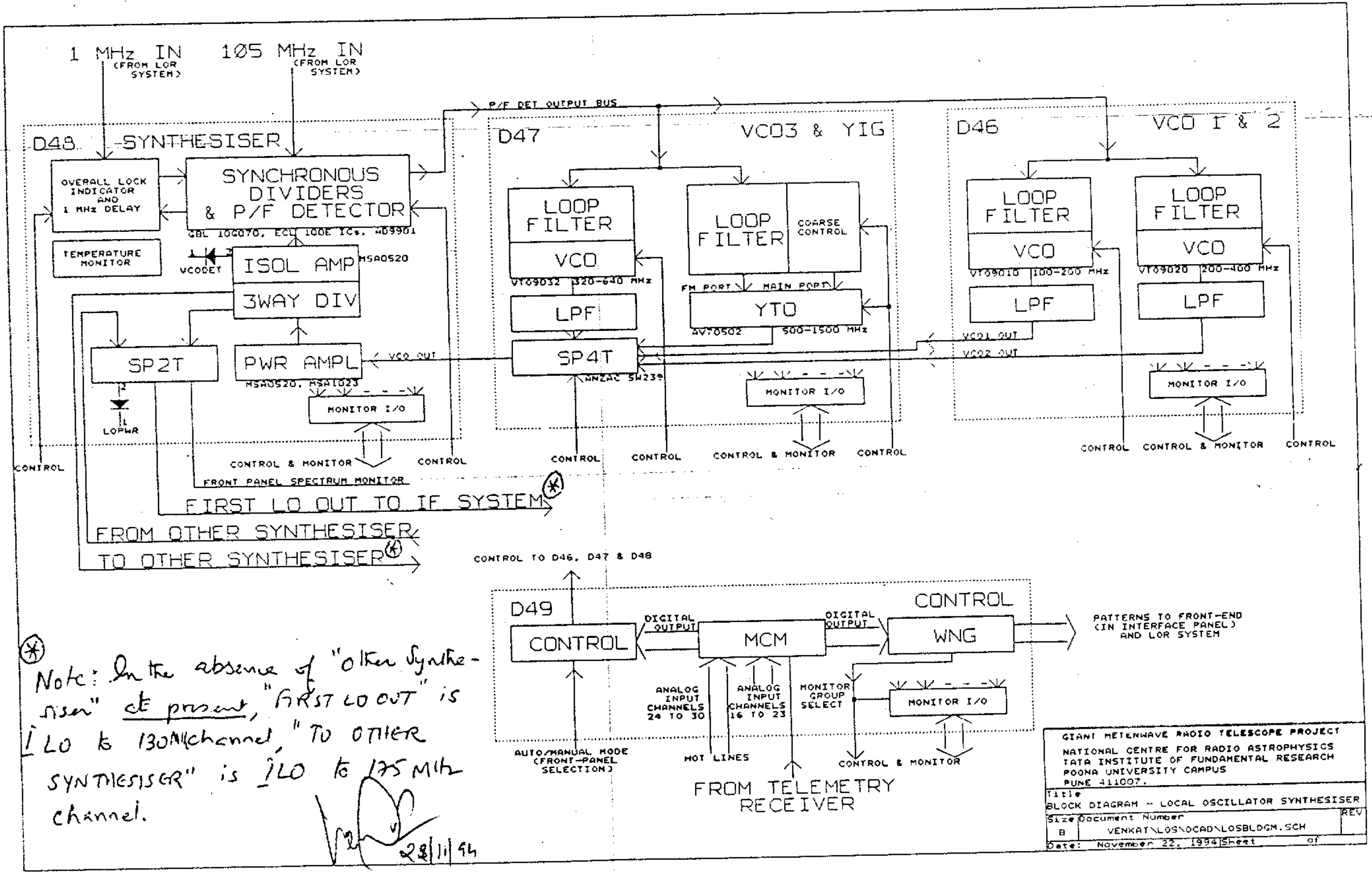
(i) While all PIUs are FUNCTIONALLY INTERCHANGEABLE, they CAN NOT BE MADE IDENTICAL. Hence a look-up table to map the running number of a type of PIU with an antenna would be needed.

(ii) Data files, one each for a particular PIU (totalling 33 systems x 2 synthesisers/ system x 4 PIUs per synthesiser = 264) which would contain (i) Number of valid states for a parameter in Annexure 3 and how they are defined; (b) The typical, maximum and minimum values of that parameter under all the valid states.

(iii) The look-up table and the data file will be updated by the service personnel when a PIU at a site is changed.

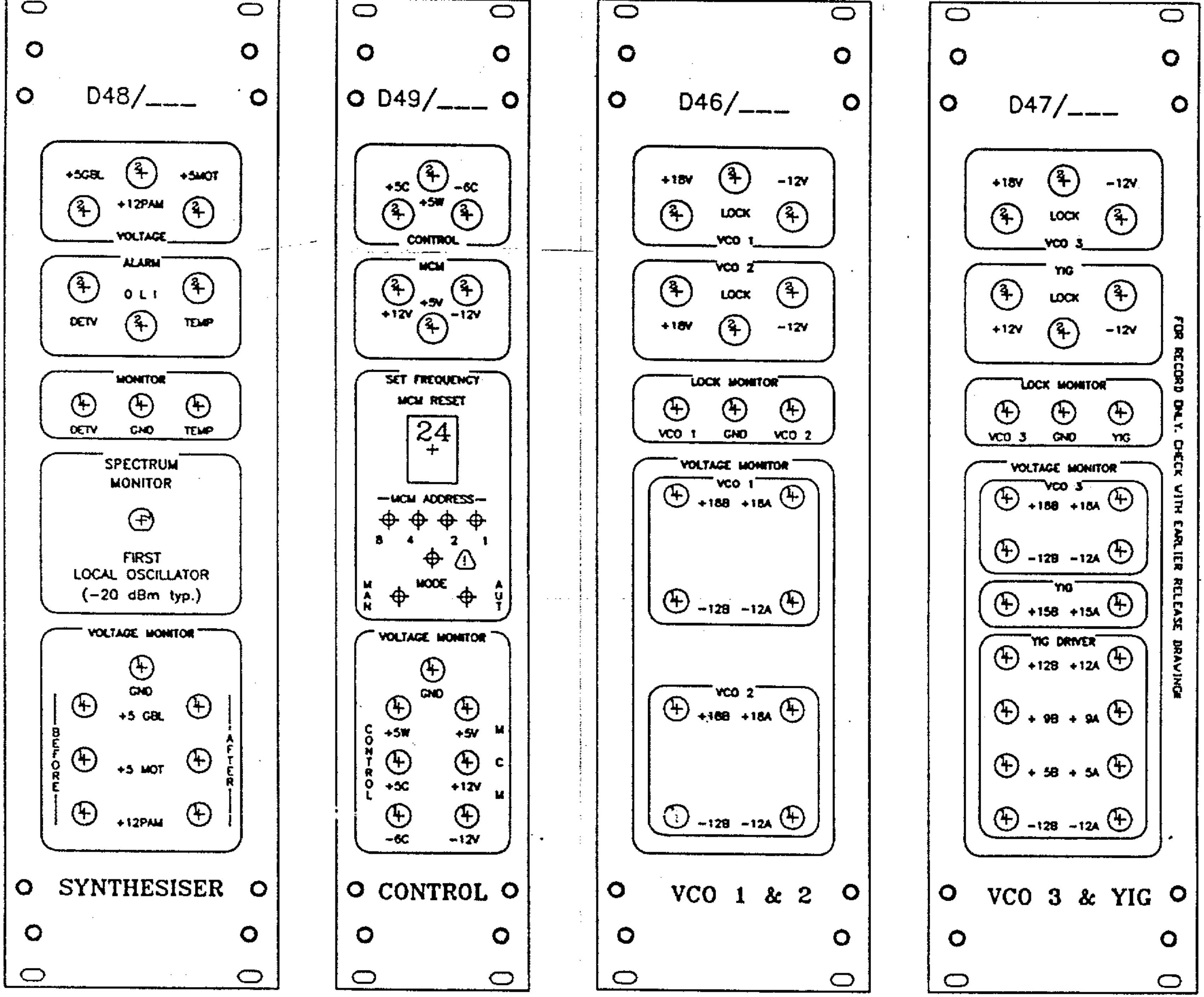
(iv) Using the above, it should be possible to infer about the health of the electronics at any antenna based on the monitor information got from that antenna, both on-line and off-line.

FIGURE 1. BLOCK DIAGRAM – LO SYNTHESISER



(*) Note: In the absence of "other Synthesiser" at present, "FIRST LO OUT" is I LO to 130MHz channel, "TO OTHER SYNTHESISER" is I LO to 175 MHz channel.

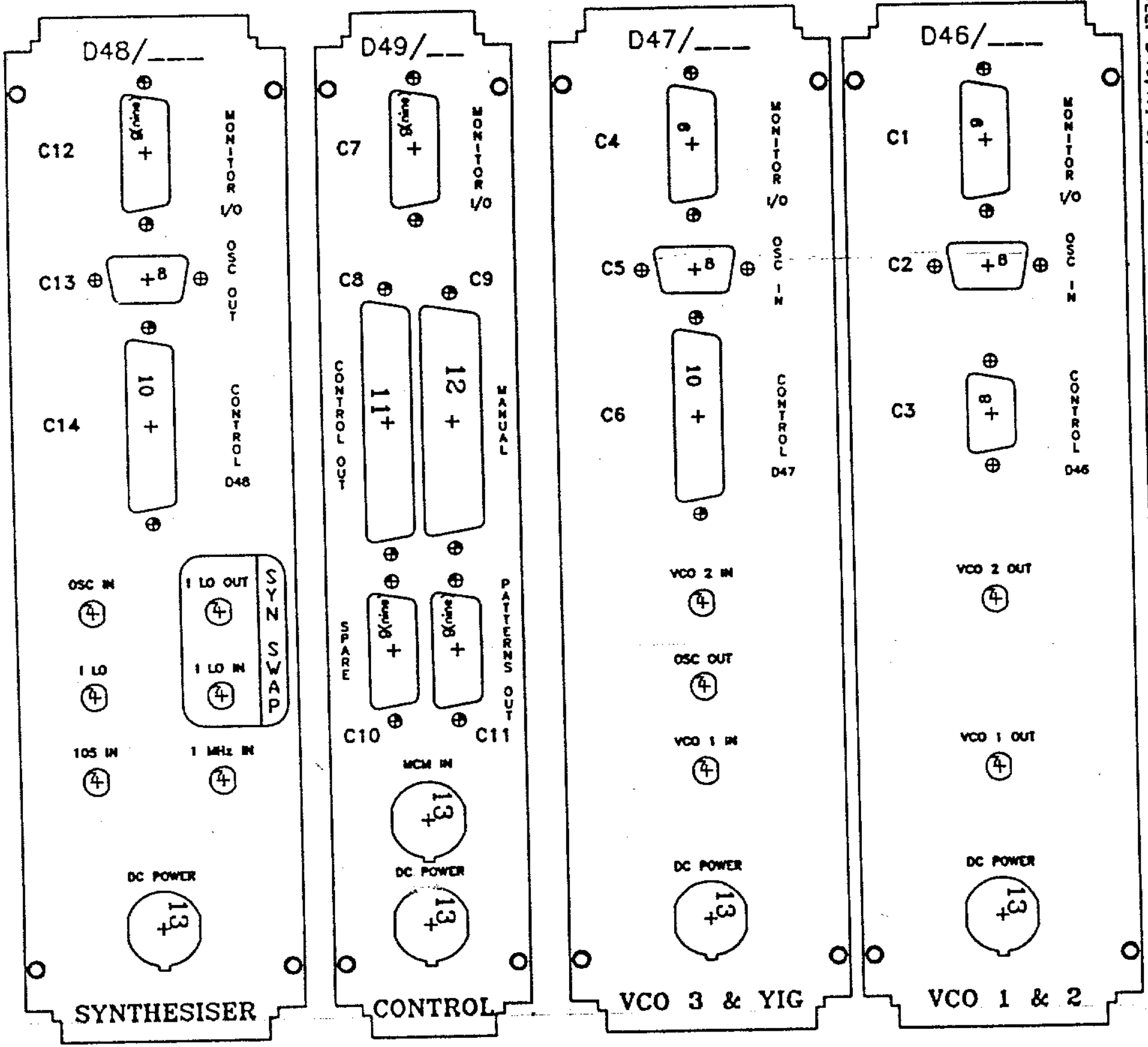
28/11/94



FOR RECORD ONLY. CHECK WITH EARLIER RELEASE DRAWINGS

GIANT METREWAVE RADIO TELESCOPE PROJECT PUNE PIU FRONT PANEL DETAILS TITLE: D46,47,48,49 DRILL DETAILS SCREEN DETAILS	D46789F.DWG DRAWING NO.: G60/LOS/___ DRAWN : TLV	DATE 22/11/94 REV R1 CHECKED:TLV	QTY.: APPD.:

FOR RECORD ONLY. CHECK WITH EARLIER RELEASE DRAWINGS!



GIANT METREWAVE RADIO TELESCOPE PROJECT PUNE

PIU REAR PANEL DETAILS

TITLE: D46,47,48,49 DRILL DETAILS SCREEN DETAILS

D46789R.DWG	DATE 22/11/94	QTY.:
DRAWING NO.: G60/LOS/___	REV R1	
DRAWN : TLV	CHECKED.:TLV	APPD.:

2.0 "Need to Know" facts about GMRT Local Oscillator Frequency Synthesiser

2.1 The Synthesised First Local Oscillator (LO) signal is required in the frequency range of 100 to 1500 MHz.

Explanation: The Synthesised LO is used to translate the RF signals processed by the Front-end System to an Intermediate Frequency (IF) band centred at 70 MHz. The RF signals are in the range of 30 to 1430 MHz. The PREFERRED translation equation is

$$LO = RF + IF$$

to give a better image rejection. Hence the Synthesied LO range should be in the frequency range of 100 to 1500 MHz.

Note: Equation LO = RF - IF should be used when (a) A known RFI source would appear in-band when the preferred equation is used; (b) The oscillator to be used does not peoduce the preferred frequency for the RF selected; (c) The oscillator does not lock at the preferred LO frequency.
Note that the arbitarary use of the two choices CAN lead to confusion in sign convention for source phase, unless taken care by the User.

2.2 There are two synthesisers per antenna, named as SYN 1 and SYN 2.

Explanation: This is necessitated because of the Dual frequency feed, which means that we need TWO Local oscillators LO1 and LO2, to translate RF1 and RF2 (the two RF signals selected in the common box of the Front-end) to the IF band. SYN 1 is controlled by MCM #2 and SYN 2 by MCM #3 at each antenna.

2.3 SYN 1 gives output from 100 MHz to 640 MHz and SYN 2, from 500 to 1500 MHz.

Explanation: The dual frequency mode involves RF bands of 233 and 610 MHz only. Hence the range of SYN 1 and SYN 2 as above is sufficient and adequate.

Note: The above is an austerity measure. The system CAN be upgraded to make both SYN 1 and SYN 2 cover the full range of 100 to 1500 MHz at a later date, if needed.

2.4 The synthesiser uses Three Voltage Controlled oscillators (VCOs) and a YIG tuned oscillator (YTO) as the source.

Explanation: The frequency coverage needed in the synthesiser is more than one decade wide. It is not technically possible to cover such a large range using a single oscillator. Hence we use Four devices, each catering to an octave band. The nomenclature followed is:

VCO 1	to cover LO frequencies from 100 to 200 MHz.
VCO 2	to cover LO frequencies from 200 to 400 MHz
VCO 3	to cover LO frequencies from 320 to 640 MHz
YTO	to cover LO frequencies from 500 to 1500 MHz.

Note: Looking back to Section 2.3, it will be now obvious that while SYN 1 uses VCO 1, VCO 2 and VCO 3 (and no YTO), SYN 2 uses YTO only.

2.5 The Resolution (or Step Size) of the LO signal generated using VCO 1 and VCO 2 is 1 MHz. The step size for VCO 3 and YTO is 5 MHz.

Explanation: The protected RF bands in 38, 152 and 233 MHz are less than 5 MHz wide. Hence it is preferable to define the centre of these band with a better resolution so as to avoid unwanted RFI lines appearing even when the minimum system bandwidth of 6 MHz (selected in the First IF processing) is chosen.

CAUTION: The loop parameter of each oscillator has been optimised for the step size required. Hence any experimentation at the site with the oscillator - step size combination will result in malfunctioning of the system.

Note: The program that creates the files using which the frequencies are synthesised through MCM takes care of the Oscillator - Step size combination AUTOMATICALLY.

2.6 It is not possible to synthesise ALL frequencies in the system.

Explanation: It is not possible to synthesise 330, 335, 340, 345,385, 390, 395, 440, 445 and 495 MHz using VCO 3 because of technical reasons. However, the frequencies in the above listing from 330 to 395 MHz CAN be synthesised using VCO 2.

THUS, LO FREQUENCIES 440, 445 AND 490 MHz ARE NOT SUPPORTED IN THE GMRT SYNTHESISER SYSTEM.

Note: The program that creates the files using which the frequencies are synthesised through MCM takes care of the above factor AUTOMATICALLY.

2.7 VCO 3 is preferred to VCO 2 to synthesise LO signal in multiples of 5 MHz and when the synthesised frequency lies in the range 320 to 400 MHz.

Explanation: For generating the same LO frequency (in the overlap region), VCO 3 operates at a lesser control voltage than VCO 2, which is technically preferable.

Note: The program that creates the files using which the frequencies are synthesised through MCM takes care of the above factor and chooses the appropriate oscillator AUTOMATICALLY.

2.8 It should be possible to map RF 1 and RF 2 to either of the two Second IF channels.

Explanation: There are two Second IF channels, centred at 130 (Channel 1) and 175 MHz (Channel 2). The Second IF is generated by a translation of the First IF signal (at 70 MHz), using fixed Second Local Oscillator signals at 200 and 105 MHz. The following table gives the source of I LO to be given to the IF system to meet this requirement.

CHOICE	Channel 1	Channel 2	Remarks
A	SYN 1 = RF 1 + I IF	SYN 1 = RF 1 + I IF	Single band mode; RF < 710 MHz
B	SYN 2 = RF 2 + I IF	SYN 2 = RF 2 + I IF	Single band mode; RF > 430 MHz
C	SYN 1 = RF 1 + I IF	SYN 2 = RF 2 + I IF	Dual band mode; Combination 1
D	SYN 2 = RF 2 + I IF	SYN 1 = RF 1 + I IF	Dual band mode; Combination 2

See Section 4.x for information on how these settings can be achieved by MCM commands. See Section 7.3 to understand the limitations.

2.9 Unused oscillators are always switched OFF.

Explanation: The DC supply voltages to the oscillator are given through MCM-controlled relays. Only one of the four oscillators in a synthesiser are functional at any given time. The DC power to the three oscillators not in use is turned OFF to eliminate any chance of system-produced spurious signal from affecting the performance.

2.10 The health of the system is monitored by a "Before - After" concept.

Explanation: A series resistor is inserted between the power supply and a load. The drop in the resistor (typically 100 mV) is used to assess the health of the load. The voltages "before" and "after" the resistor are bought out on the front panel of the Plug-in Units for measurement on a oscilloscope/ DMM by a servicing personnel at the site. These voltages also form the secondary monitoring points through the MCM.

2.11 A comprehensive monitoring scheme has been incorporated into the system.

Explanation: Each synthesiser has about 50 digital control points and more than a 100 monitoring points.The controlling of a synthesiser is done through MCM which is checked for faithful execution AT THE LOAD END so that there is no ambiguity.The monitored voltages are grouped to result in a "Hotline set" which gives a reliable and complete indication regarding the health of the system.

2.12 The Synthesiser system plays additional role in Front-end system.

Explanation: The additional roles played by MCM #2 of the Synthesiser system are:

(a) To switch ON and OFF the MCM of the Front-end. See Section 4.y for details.

(b) To generate a Sequency pattern which is the basis for deriving the waveforms in (c) and (d) described below.

(c) To generate a Noise Switching pattern in time domain, for use by the noise generators in the Front-end. See Section 4.z for details.

(d) To generate a pair of Walsh patterns for phase-switching RF1 and RF 2 in the Front-end. See Section 4.p for details.

Note: The Sequency pattern from each antenna is transmitted to CEB by the LO Referance system at each antenna. These patterns are regenerated at CEB by the LO Referance Receiver system. These patterns are muliplexed and supplied to the Correlator system for demodulation of switchings done in the Front-end. See the Survival Guide of LOR System for details.

2.13 The phase variation of the synthesised LO is estimated for off-line correction.

Explanation: The absolute phase of the synthesised local oscillator is subject to variations because of the changes in path length of optical fibre due to temperature changes. This may be critical, especially while operating the array at 1420 MHz.

The phase variation of the synthesised local oscillator can be computed by recording the variation of phase of the LO Referance signal, as explained in Section 1.y. For more details, see the Survival Guide of LOR system. This computed value can be applied off-line to effect necessary correction to source phase.

MONITORING PLAN FOR LOS SYSTEM

BIT	D46 (as on 01/11/94) OUT1	D46 OUT2	D47 (as on 01/11/94) OUT3	D47 OUT4	D48 (as on 01/11/94) OUT5	D48 OUT6	D49 (as on 01/11/94) OUT7	D49 OUT8	REMARK
Ø			VMYIG+9A	YIGDAC6	MCMCON+	MCOUNT2		NGN-	FILE:M00
1			VMYIG+5A	YIGDAC7	AUTCON+	MCOUNT1		FECON+	FILE:M01
2			VMYIG+15A	YIGDAC8	AUTCON-			FECON-	FILE:M02
3	LVVCO1	LKVCO1	LVYIGF	LKYIG	OLI	WARNLO	MODE	ADD1	FILE:M03
4	LVVCO2	LKVCO2	LVVCO3	LKVCO3	OLI	WARNTEMP	MODE	ADD2	FILE:M04
5	VMVCO1+18A	IVCO1+18V	VMVCO3+18A	IVCO3+18V	DLYCON	TEMPMON	VMCON+5V	ADD4	FILE:M05
6	VMVCO1-12A	IVCO1-12V	VMVCO3-12A	IVCO3-12V	STEP2	VMPAM12A	VMCON-6V	ADD8	FILE:M06
7	VMVCO2+18A	IVCO2+18V	VMYIG+12A	IYIG+12V	STEP1	VMGIGA5A	VMWAL+5V	WAL1	FILE:M07
8	VMVCO2-12A	IVCO2-12V	VMYIG-12A	IYIG-12V	NCOUNT6	VMMOT05A	VMMCM+12V	WAL2	FOLE:M08
9		VCO1CON	VCO3CON	LVYIGC	NCOUNT5	D64CP1	VMMCM-12V	WAL3	FILE:M09
1Ø		VCO2CON	YIGCON	D77CP1	NCOUNT4	D64CP2	VMMCM+5V	WAL4	FILE:M10
11		22/11/94	YIGDAC1	D77CP2	MCOUNT3	LOPWRA	WP1+RF	WAL5	FILE:M11
12			YIGDAC2	D77CP3	NCOUNT2	VCODET	WP1-RF		FILE:M12
13			YIGDAC3	D77CP4	NCOUNT1	IGIGA5V	WP2+RF		FILE:M13
14			YIGDAC4	D77CP5	MCOUNT4	IMOT05V	WP2-RF		FILE:M14
15			YIGDAC5	D77CP6	NCOUNT3	IPAM12V	NGN+		FILE:M15

CONNECTION TO MCM PCB IN PIU D49, FOR SYN1 AND SYN2

MONITOR ADD.	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
CONNECTIONS FOR MCM#2 (SYN1)	OUT 1	OUT 2	OUT 3	OUT 4	OUT 5	OUT 6	OUT 7	OUT 8	ANA 9	ANA 10	ANA 11	ANA 12	ANA 13	ANA 14	ANA 15	GND
CONNECTIONS FOR MCM#3 (SYN2)	OUT 1	OUT 2	OUT 3	OUT 4	OUT 5	OUT 6	OUT 7	OUT 8	ANA 9	ANA 10	ANA 11	ANA 12	ANA 13	ANA 14	ANA 15	GND

ANA9 TO ANA15 ARE FOR MONITORING GENERAL HEALTH OF THE ABR RACK

GIANT METERWAVF RADIO TELESCOPE PROJECT
NATIONAL CENTRE FOR RADIO ASTROPHYSICS
TATA INSTITUTE OF FUNDAMENTAL RESEARCH
POONA UNIVERSITY CAMPUS
PUNE 411007.

Title 01/11/94 22:50 HRS (ALMOST FINAL)
FINAL PLAN OF MONITORING LOS SYSTEM

Size A | Document Number F:VENKAT\LOS\SCH\MONPLAN.SCH | REV

Date: November 1, 1994 | Sheet of

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ROGRAM SETFREQ.BAS venkat 22/11/94 06:00 hrs
lines to edit: 20 for VCO number;
               530 for file name;
               550 and 630 for mcm number;
               20 for Start and Stop frequency (FSTART and FSTOP).
    If VCO=1, then FSTART=90; FSTOP=190
    If VCO=2, then FSTART=190; FSTOP=410
    If VCO=3, then FSTART=300; FSTOP=680

CLS
VCO=1:FSTART=90:FSTOP=210
IF ((VCO=1) OR (VCO=2)) THEN ST=1      ' ST=STEP SIZE
IF ((VCO=3) OR (VCO=4)) THEN ST=5
'
'GROUP 5 BIT PATTERN: SELECT MONITORING ROW FOR THE VCO UNDER USE
'
IF ((VCO=1) OR (VCO=4)) THEN V9$="6005":V10$="E015"
IF ((VCO=2) OR (VCO=3)) THEN V9$="6002":V10$="E012"
'
F=FSTART-ST:CHECK=1
WHILE CHECK
 '
 ' COMPUTE THE SYNCHRONOUS DIVIDER BIT PATTERN: WEED OUT FREQUENCIES
 ' NOT POSSIBLE TO BE GENERATED
 '
 F=F+ST
00 IF (F >= FSTOP) THEN CHECK=0 ELSE CHECK=1
10 F1=F/ST
20 MDEC=F1-10*INT(F1/10) : MNUM=15-MDEC
30 NDEC=(INT(F1/10))    : NNUM=255-NDEC+1            'TECHNICALLY NOT ALLOWED
40 IF (MDEC >= NDEC) THEN GOTO 770
50 PRINT "FREQUENCY :: ";F;" MHz; STEP :: ";ST;" MHz;   VCO No. :: ";VCO
60 '
70 'COMPUTATION OF GROUP 1 BIT PATTERN FOR THE SNCHRONOUS DIVIDER
80 '
90 BX=NNUM*16
00 ACUM=BX+MNUM
10 V1$="4"+HEX$(ACUM)
   V2$="C"+HEX$(ACUM)
   '
240 'ASSIGNMENT TO GROUP 2 BIT PATTERN FOR YIG DAC : NOT USED IN SYN 1
250 '
260 DACSET=255:SPARE=15
270 BX=DACSET*16
280 ACUM=BX+SPARE
290 V3$="2"+HEX$(ACUM)
300 V4$="A"+HEX$(ACUM)
310 '
320 'ASSIGNMENT TO GROUP 3 BIT PATTERN : RF SWITCHES, STEP SIZE AND DLYCON
330 '
340 IF VCO=1 THEN V5$="0168":V6$="8168"
350 IF VCO=2 THEN V5$="0146":V6$="8146"
360 IF VCO=3 THEN V5$="0245":V6$="8245"
370 IF VCO=4 THEN V5$="0258":V6$="8258"
380 '
390 'ASSIGNMENT TO GROUP 4 BIT PATTERN : DC SUPPLY
400 '
410 IF VCO=1 THEN V7$="1001":V8$="9001"
420 IF VCO=2 THEN V7$="1002":V8$="9002"
430 IF VCO=3 THEN V7$="1004":V8$="9004"
440 IF VCO=4 THEN V7$="1008":V8$="9008"
```

.TOMATICALLY CHOOSE FILE NAME FOR WRITING

```
 JSC$=CHR$(VCO+48)
 HUN=INT (F/100)
0 BAL=F-100*HUN
30 TEN=INT (BAL/10)
)0 UNI=BAL-10*TEN
)0 HU$=CHR$(HUN+48)
.0 TE$=CHR$(TEN+48)
0 UN$=CHR$(UNI+48)
0 NAM$="a:\m2\V1\N"+HU$+TE$+UN$
0 OPEN NAM$ FOR OUTPUT AS #1
0 PRINT ":2"
0 PRINT USING "\  \";V1$;:PRINT " ";:PRINT USING "\  \";V2$;
0 PRINT " ";:PRINT USING "\  \";V3$;:PRINT " ";:PRINT USING "\  \"
0 PRINT USING "\  \";V5$;:PRINT " ";:PRINT USING "\  \";V6$;
0 PRINT " ";:PRINT USING "\  \";V7$;:PRINT " ";:PRINT USING "\  \"
0 PRINT USING "\  \";V9$;:PRINT " ";:PRINT USING "\  \";V10$
0 PRINT "q"
5 PRINT "                  WRITTEN TO FILE ::: ",NAM$
0 PRINT #1,"* FREQUENCY :: ";F;" MHz; STEP :: ";ST;" MHz;  VCO No.
0 PRINT #1,":2"
0 PRINT #1,USING "\  \";V1$;:PRINT #1," ";:PRINT #1, USING "\  \";
) PRINT #1," ";:PRINT #1,USING "\  \";V3$;:PRINT #1," ";:PRINT #1,
) PRINT #1,USING "\  \";V5$;:PRINT #1," ";:PRINT #1,USING "\  \";V
) PRINT #1," ";:PRINT #1,USING "\  \";V7$;:PRINT #1," ";:PRINT #1,
) PRINT #1,USING "\  \";V9$;:PRINT #1," ";:PRINT #1,USING "\  \";V
) PRINT #1,"q"
) 'PRINT #1,":1"
) 'PRINT #1,"0000 0000"
) 'PRINT #1,"q"
) 'PRINT #1,":1"
) 'PRINT #1,"0000 0000"
) 'PRINT #1,"q"
 CLOSE #1
 WEND
 END
```

Fm: venkat, Som

A note titled "REPORT ON THE CONTROL AND MONITOR OF THE IF SYSTEM OF GMRT" by Venkat & Som, dated 7/4/95 is released and is available at Pune and Khodad Library for the interested user. Important excerpts from this report and a few additional points are given below:

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This report summarises the scheme of control and monitoring of the IF system. The function is achieved through MCM #9. Note that monitoring of the health of LOR system at each antenna will be ALSO done using the same MCM.

IMPORTANT NOTE: THE SYSTEMS INSTALLED AND COMMISSIONED CAN BE DIVIDED INTO FOUR CATAGORIES:

(A) OLD SYSTEM WITH ONLY CONTROL OF IF SYSTEM (AND NO MONITORING) USING MCM # 4 FOR C3, C12, C4 AND C2. SEE PAGE 24 OF SAINI'S "USERS' GUIDE" AND THE VARIOUS RUN FILES BEING USED FOR DETAILS.

(B) INTERMEDIATE SYSTEM WITH FULL CONTROL AND "CRUCIAL POINTS" MONITOR OF IF SYSTEM, INSTALLED AND COMMISSIONED AT C9. SEE PAGES 24 AND 25 OF SAINI'S "USERS' GUIDE" (AND A RECENT ERRATA BY VENKAT) AND SAINI'S "OPERATING INSTRUCTIONS FOR THE NEW IF(R) SYSTEM" FOR DETAILS.

(C) PRE-FINAL SYSTEM WITH FULL CONTROL AND "CRUCIAL POINTS" MONITOR OF IF AND LOR SYSTEM USING MCM # 9 FROM C1 ONWARDS.

(D) FINAL SYSTEM WITH FULL CONTROL OF IF SYSTEM AND COMPREHENSIVE MONITORING OF IF AND LOR SYSTEMS.

THIS REPORT DEALS WITH CONTROL AND MONITOR OF CATAGORIES "C" AND "D". NOTE CATAGORY "D" WILL BE A SUPER-SET OF "C". THE RF HARDWARE AND CONTROL COMMAND STRUCTURE OF CATAGORIES "B", "C" AND "D" ARE SIMILAR. UNIFICATION OF ALL THE CATAGORIES WILL BE DONE IN THE NEAR FUTURE.

The schematic of the IF system of GMRT (with emphasis on control and monitor aspects) is enclosed as Figure 1 on page 8.

PHILOSOPHY OF CONTROL:

HARDWARE OF CONTROL DE-MULTIPLEXER:

The IF system at an antenna needs a minimum of 29 control bits for Channels 1 and 2:

(a) 3 * 2 bits for setting the bandwidth and
(b) 1 * 2 bits for setting the ALC mode.
(c) 4 * 2 bits for setting the pre-attenuation;
(d) 4 * 2 bits for setting the post-attenuation;
(e) 4 bits for deciding the group of monitor points in the Monitor Multiplexer (yet to be designed).

The design of the Multiplexer ensures that the control of groups (a) to (e) defined above are mutually exclusive and apriori information on status of other four groups is not required to control any group.

To take care of any future requirements, ONE spare control bit is available in PIUs C42, C43, C44 and the pair of C41. Additionally, 9 spare control bits are available at the rear of C45 PIU to cater to the needs of second phase of the IF system.

CONTROL SOFTWARE:

It is recommended that the control of (bandwidth + ALC mode) is de-linked from setting the attenuator value.

Annexure 1 on page 6 gives the structure of 32 bit commands in DOS for controlling groups a and b as defined above. It should be trivial to create a program in Unix which asks the user to specify the bandwidth and ALC mode for channels 1 and 2 and compose the RUN file for executing the command.

It is recommeded that a single 64 bit command is composed, combining both bandwidth and ALC mode and executed as a single instruction.

Two modes of Attenuator setting is envisaged: "User-defined" or "Auto-Optimised". Annexure 2 on page 7 gives a GWBASIC program for controlling groups c and d in User-defined mode. Here, the user inputs the values desired and a DOS RUN file named AT.DAT is automatically created which can be executed using command 20 of MCMPRN program. It should be trivial to rewrite this program in C for On-line environment and create the a-la-carte RUN file for setting the attenuators. This mode is restricted to users who know what they are doing and have a full understanding of the RF hardware.

The "Auto-Optimised" option can be achieved in various ways. A recent report by Rakesh and Swarup ["Recommended IF Attenuation Settings for various sources", dated 23/3/95] discusses default setting by a look-up table based on a-priori information of source, Tsys, bandwidth and overall gain of the system as a function of frequency band of operation.

An alternative scheme, which may be called "Minimum Iteration guess of the Four Attenuator Settings" (MIgFAs, with a silent s and g and hence pronounced MIFA), which depends on the detector (DETV) and feed-back (FBV) voltages, available through MCM is proposed. Here, the frequency band of operation, t source observed, cable losses, difference in gain between ante and other factors are not relevant.

In this scheme, the first order setting of the attenuators is done based on a look-up table and the values of FBV and DETV are monitored when ALC is ON and OFF. If this setting has resulted in the operation of the system at the "Knee", the DETV readings for the cases when ALC was OFF and ON should be same. The deviation decides direction for the next guess of the attenuator settings. The process is repeated till the settings to establish the knee is obtained. If it is not possible to zero on to the knee, the algorithm switches in solar attenuator, till the target is achieved.

The algorithm also ensures minimum contribution to Tsys by the IF system and includes a parameter to decide on the FINAL setting, based on how deep the user should go beyond the knee.

MIgFAs can be invoked any time and as many times as desired during an observation schedule. The optimised setting remains till the User decides to run MIgFAs again. MIgFAs may be invoked by default after any control command to the turret rotation, LOS, FE or IF systems.

Needless to say, the optimisation scheme has to evolve with time. Perhaps, we may end up in more than the two schemes briefly described above and the User may be asked choose any scheme he wishes to use. Perhaps, the different schemes may give differant answers for the attenuator settings!

MONITORING SCHEME FOR IF AND LOR SYSTEMS:

The concept of monitoring, as perfected and implemented in the LOS system is planned to be extended. The salient features are:

(a) Only 16 of the 64 monitor channels in the MCM, namely, 16 to 31 is used. Channels 16 to 23 are for IF system and 24 to 30 are for LOR. Channel 31 is connected to GROUND and could be used to study ground pick-ups etc.

(b) There would be a "depth" in monitoring of 16 layers, which will be defined by controlling the four monitor bits. The list giving the mapping of parameters is enclosed as a table on page 12.

(c) The Monitor parameters are divided into 3 groups:

CRUCIAL or LEVEL 1: These parameters (of both LOR and IF) will be monitored every second and will be mapped to one of the 16 layers. This layer will be selected by default.

IMPORTANT or LEVEL 2: There will be monitored whenever a control command, to change the parameters explained in 4.1 (a) to (d) is issued. There will be four or five layers for these parameters. Monitoring these parameters ensures that that the control command has been successfully executed at the destination.

HEALTH or LEVEL 3: These will be monitored at the start of the observation schedule (or whenever an User suspects some mal-functioning). The parameters include the power supply voltages, current drawn by various units etc.

(d) The LOR system does not have any control as of date and hence does not have any Level 2 parameters to monitor.

(e) The important differance in Catagories "C" and "D" is that Level 1 monitoring has been implemented in Catagory "C", as per Table 1 on page 11 AND IS AVAILABLE AS A STANDARD FEATURE FROM ANTENNA C1 UPWARDS.

(f) Inclusion of Levels 2 and 3 in the scheme and taking the system to Catagory D would involve design, procurement of components, prototyping and mass-production of a PCB. Activity will start in June/ July 95 and the feature is likely to be available as a retrofit in the systems already commissioned, by Dec 95.

6.0 PREVENTIVE SITE MAINTENANCE:

The PIUs have adequate visual and Multimeter/ Oscilloscope monitor points on the front panel for use by service personnel. A brief description of what a service personnel should see/ measure to conclude on general health of the system has been included in this report on pages 13 to 17.

AS THE DENSITY OF CONNECTIONS IN THE REAR OF THE SUB-RACK IS QUITE HIGH, WHICH CAN (AND HAS) RESULTED IN LOOSE/ WRONG CONNECTIONS, HANDLING OF THESE CONNECTIONS MUST BE STRICTLY RESTRICTED TO QUALIFIED AND CERTIFIED SERVICE PERSONNEL.

THE MOBILE ABT ("ANTENNA BASE TESTER") IS TO BE USED FOR ANY MEASUREMENTS OF THE COMPLETE RF+IF+LO SYSTEMS IN A TOTAL POWER MODE AT THE ANTENNA BASE BY ANY USER. THE INPUT TO THE ABT WILL BE THE OVERALL OUTPUT AT THE TOP OF THE ABR RACK, AVIILABLE AS A TNC BULKHEAD JACK MARKED "TO CEB" (REFER PAGE 11). THE ABT IS UNDER THE FINAL STAGES OF INTEGRATION AND CHARACTERISATION AND WILL BE RELEASED SHORTLY.

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venkat 15/4/95; 05:44