REPORT ON THE CONTROL AND MONITOR OF THE IF SYSTEM OF GMRT

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1.0 INTRODUCTION

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.

2.0 DETAILS OF THE IF SYSTEM WITH EMPHASIS IN CONTROL AND MONITOR ASPECTS:

The schematic of the IF system of GMRT is enclosed as Figure 1 on page 8 and has the following features:

(a) To translate the frequency band of two RF signals provided by the FE system to a First IF signal centred at 70 MHz using the First LO signal;

(b) To translate the First IF band to Second IF bands centred at 130 and 175 MHz using the Second LO signals;

(c) To limit the bandwidth of the signals to any one of 6, 16 or 32 MHz. Choice decided by user using MCM # 9;

(d) To limit the output power to a defined value (ALC mode) or allow output power to be defined by compression of the devices used (LIN mode). Choice decided by user. **This process produces Four crucial monitor data, viz., two total power detector voltages (DETV) and two ALC feedback voltages (FBV);**

(e) To attenuate the power in 2 dB steps from 0 to 32 dB, at both the First and Second IF stages using MCM # 9. Total attenuation range is 0 to 64 dB in 2 dB steps. Two modes of Attenuator setting is provided: "User-defined" or "Auto-Optimised".

(f) To combine the two Second IF signals (along with two LO Return signals and a "Test Port" where any "Test" signal could be injected) in a Five-way combiner, limit the overall signal in a LPF to 205 MHz and give a single output of the ABR rack for feeding to OF Tx. PIU.

(g) Control data bit generation and monitor of all parameters.

3.0 IMPORTANT IMPLEMENTATION DETAILS:

3.1 Hardware distribution:

(a) Detail as in 2.0(a) above is implemented in a PIU C41 and is called "I IF CONVERSION". There will be TWO such IDENTICAL PIUs in an antenna.

(b) Detail as in 2.0(b) above is implemented in PIUs C42 and C43, which are called "130 CONVERSION" and "175 CONVERSION" respectively. There will be ONE EACH of C42 and C43 in an antenna.

(c) Detail as in 2.0(c) above is implemented in PIUs C41, C42 and C43. Selection of 32 MHz bandwidth is done in Second IF stages, when the First IF is configured as a "Through Path". Selection of 6 or 16 MHz bandwidth is done in First IF stage.

(d) Detail as in 2.0(d) is implemented in PIUs C42 and C43.

(e) Detail as in 2.0(e) above is implemented through hardware in the PIUs C42, C43 and the pair of C41 at each antenna. Modes as defined in 2.0(e) is discussed in detail later.

(f) Details as in 2.0(f) above is implemented in an "Interface Panel".

(g) Details of 2.0 (g) is the subject of this report.

The differance between catagories "C" and "D" is that the Monitor Multiplexer is absent in the former and a limited hardware for interpreting the feed-back voltages (FBV) has been installed.

3.2 Hardware Location:

The hardware of the IF system in PIUs is located in Sub-rack 4 (second sub-rack from bottom) at each antenna. Figure 2 and 3 on pages 9 and 10 give the details of screen printing done on front and rear panels of a typical IF sub-rack.

The Interface panel is located at the rear of the rack, below the panels for AC and DC power distribution.

THE FINAL OUTPUT OF THE ABR RACK IS AVAILABLE IN A TNC BULKHEAD JACK ("TO CEB") AT THE TOP OF THE RACK AS SHOWN IN FIGURE 4 on page 11.

4.0 PHILOSOPHY OF CONTROL:

4.1 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.

4.2 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 in 4.1 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.

As mentioned in 2.0(e), 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.

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 and feed-back voltages, available through MCM is proposed. Here, the frequency band of operation, the source observed, cable losses, difference in gain between antennas 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!

5.0 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 bits explained in 4.1(e) above. 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" as defined in 1.0 above 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.

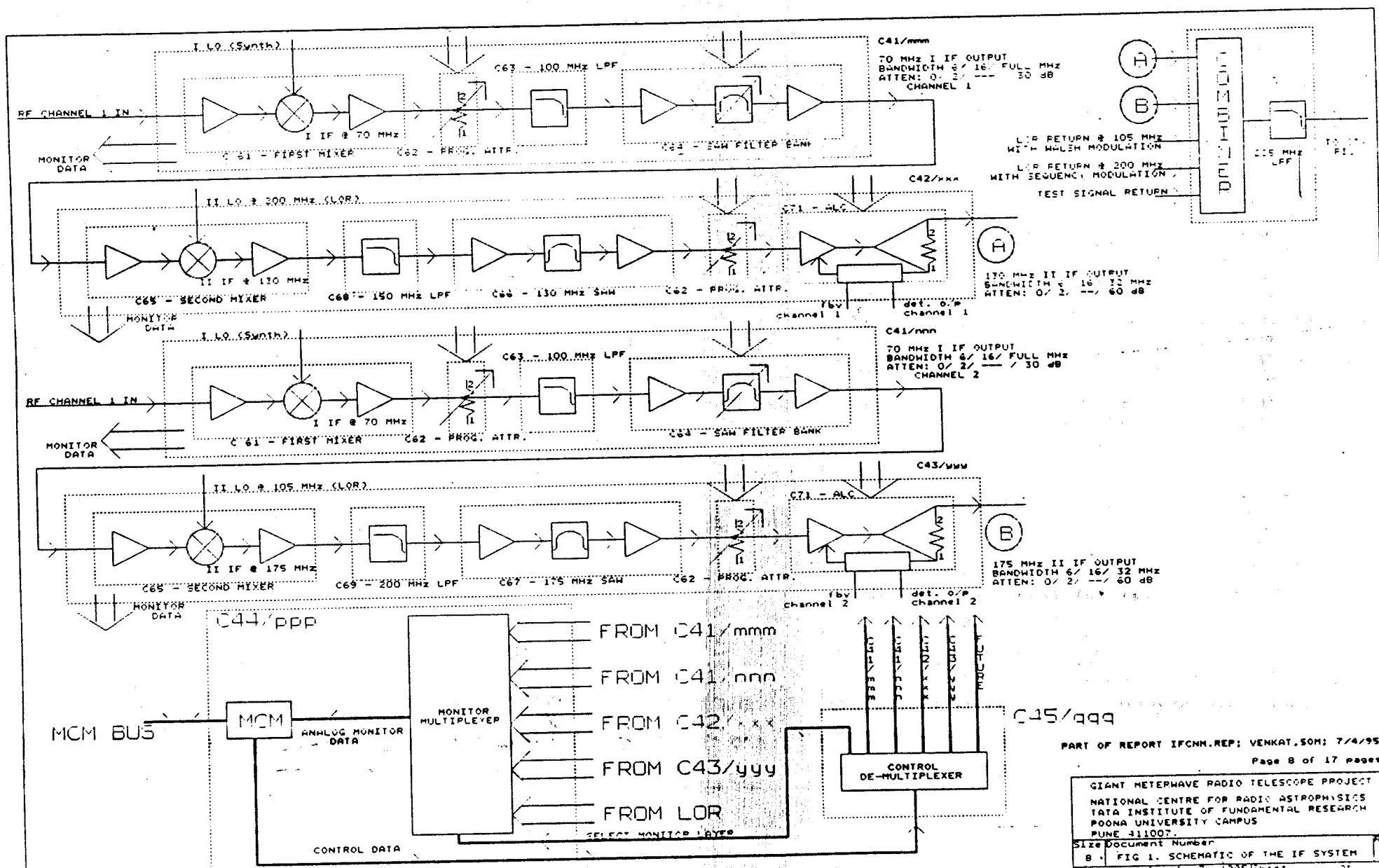
Annexure 1. 32 bit commands for setting Bandwidth and ALC mode for the two channels

****
*set bandwidth for Channel #1 at 6 MHz and Channel #2 at 6 MHz
BBC9 FBC9
****
*set bandwidth for Channel #1 at 6 MHz and Channel #2 at 16 MHz
BBD1 FBD1
****
*set bandwidth for Channel #1 at 6 MHz and Channel #2 at 32 MHz
BBE1 FBE1
****
*set bandwidth for Channel #1 at 16 MHz and Channel #2 at 6 MHz
BBCA FBCA
****
*set bandwidth for Channel #1 at 16 MHz and Channel #2 at 16 MHz
BBD2 FBD2
****
*set bandwidth for Channel #1 at 16 MHz and Channel #2 at 32 MHz
BBE2 FBE2
****
*set bandwidth for Channel #1 at 32 MHz and Channel #2 at 6 MHz
BBCC FBCC
****
*set bandwidth for Channel #1 at 32 MHz and Channel #2 at 16 MHz
BBD4 FBD4
****
*set bandwidth for Channel #1 at 32 MHz and Channel #2 at 32 MHz
BBE4 FBE4
****
*Sets ALC OFF on both channels #1 and #2
BFFF FFFF
****
*Sets ALC OFF on Channel #1 and ON on channel #2
BFFD FFFD
****
*Sets ALC ON on Channel #1 and OFF on channel #2
BFFE FFFE
****
*Sets ALC ON on both channels #1 and #2
BFCC FFCC
****

Annexure 2. GWBASIC program to create RUN file in DOS for setting the Pre- and Post-attenuators.

Checks for wrong data entry (ODD VALUES, NEGATIVE VALUES AND VALUES > 30) is not incorporated and has to be added in the version for the On-line program.

```
**********************************************************************
10 CLS:DIM V$(15)
20 INPUT "Specify pre-attenuation in dB for Channel 1   (0,2 ...
     30) :  ",PREATN1
30 INPUT "Specify pre-attenuation in dB for Channel 2   (0,2 ...
     30) :  ",PREATN2
40 INPUT "Specify post-attenuation in dB for Channel 1  (0,2 ...
     30) :  ",POSATN1
50 INPUT "Specify post-attenuation in dB for Channel 2  (0,2 ...
     30) :  ",POSATN2
60 PREAT1=PREATN1/2:PREAT2=PREATN2/2
70 POSAT1=POSATN1/2:POSAT2=POSATN2/2
80 V$(0)="4":V$(1)="5":V$(2)="6":V$(3)="7"
90 V$(4)="0":V$(5)="1":V$(6)="2":V$(7)="3"
100 V$(8)="C":V$(9)="D":V$(10)="E":V$(11)="F"
110 V$(12)="8":V$(13)="9":V$(14)="A":V$(15)="B"
120 A1$="B3"+V$(PREAT2)+V$(PREAT1)
130 A2$="F3"+V$(PREAT2)+V$(PREAT1)
140 A3$="B7"+V$(POSAT2)+V$(POSAT1)
150 A4$="F7"+V$(POSAT2)+V$(POSAT1)
160 NAM$="AT.DAT"
170 OPEN NAM$ FOR OUTPUT AS #1
180 PRINT
190 PRINT "* Channel 1 ::: Preatn ::: ";PREATN1;" dB; Post-Attn
     ::: ";POSATN1; "dB"
200 PRINT "* Channel 2 ::: Preatn ::: ";PREATN2;" dB; Post-Attn
     ::: ";POSATN2; "dB"
210 PRINT USING "\  \";A1$;:PRINT " ";:PRINT USING "\  \";A2$;
220 PRINT " ";:PRINT USING "\  \";A3$;:PRINT " ";:PRINT USING "\
     \";A4$
230 PRINT "q":PRINT
240 PRINT "              WRITTEN TO FILE ::: ",NAM$
250 PRINT #1, "* Channel 1 ::: Preatn ::: ";PREATN1;" dB; Post-
     Attn ::: ";POSATN1; "dB"
260 PRINT #1, "* Channel 2 ::: Preatn ::: ";PREATN2;" dB; Post-
     Attn ::: ";POSATN2; "dB"
270 PRINT #1, USING "\  \";A1$;:PRINT #1," ";:PRINT #1, USING "\
     \";A2$;
280 PRINT #1, " ";:PRINT #1, USING "\  \";A3$;:PRINT #1, "
     ";:PRINT #1, USING "\  \";A4$
290 PRINT #1,"q":CLOSE #1
300 END
```



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Size: B | Document Number: FIG 1. SCHEMATIC OF THE IF SYSTEM | REV

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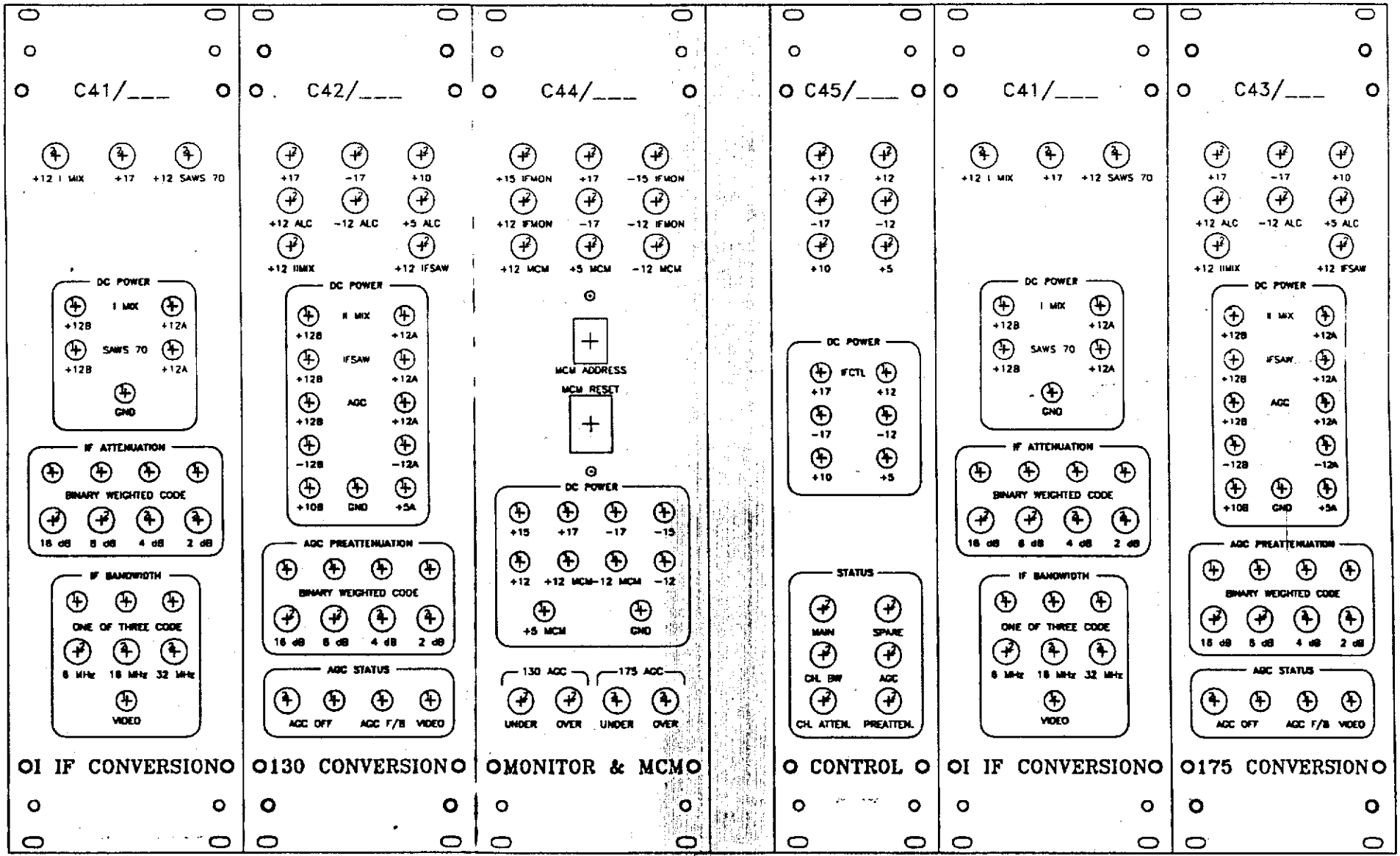


Fig. 2. Front Panel Layout of the IF system

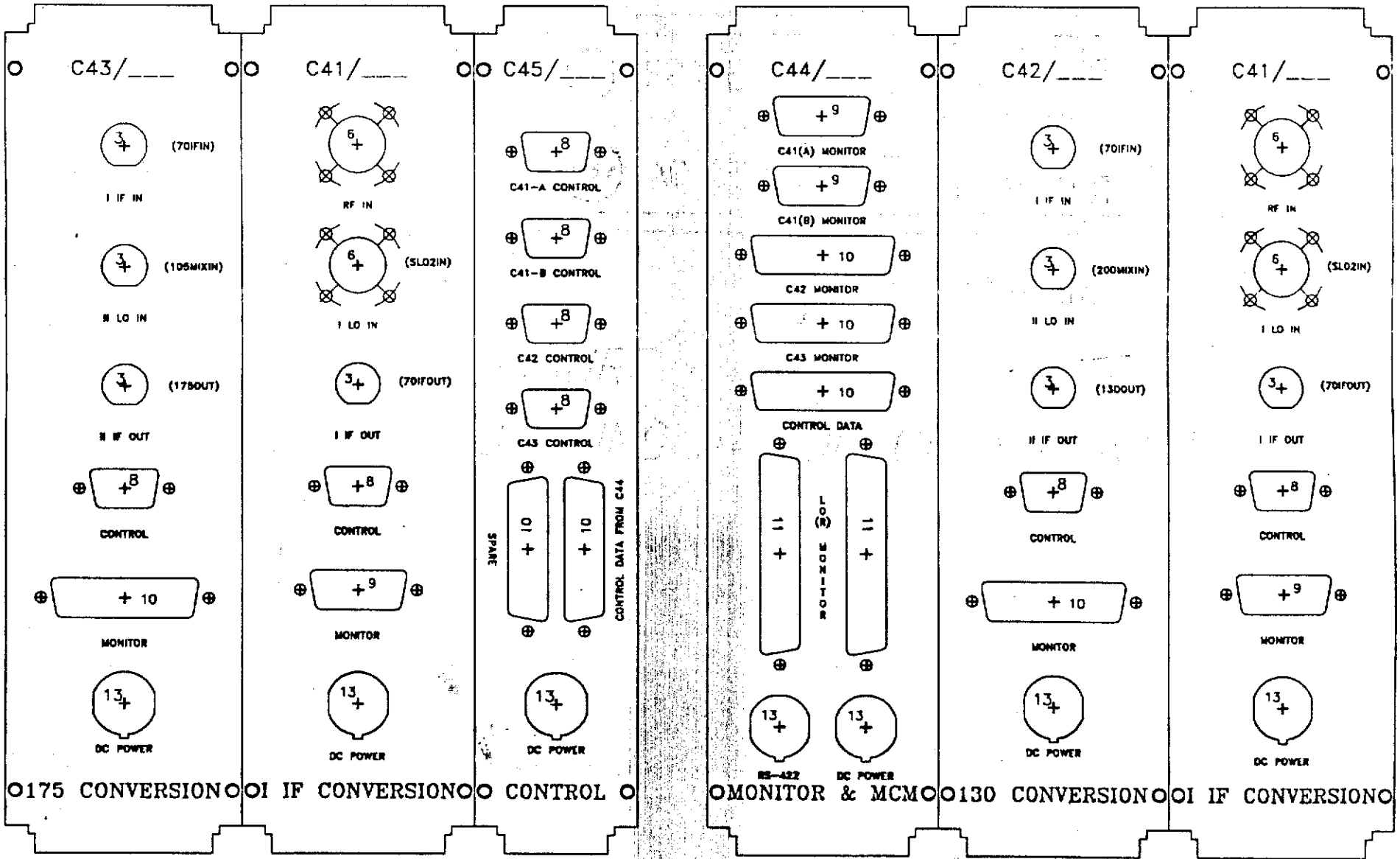
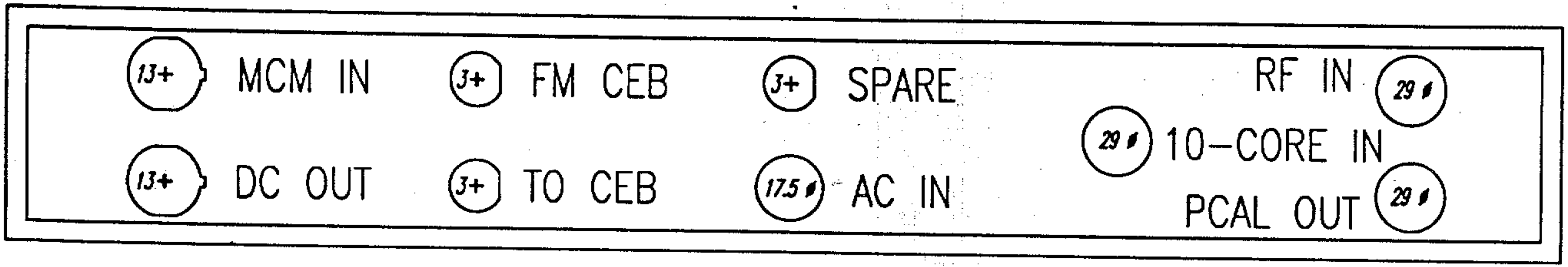


Fig. 3. Back panel layout of the IF system



37.6 cm x 5.7 cm

FIGURE 4

TYPICAL CONNECTOR MAPPING AT TOP OF ABR RACK

MONITORING PLAN FOR IF AND LOR SYSTEM

BIT	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	REMARK
0	ALC_U #1	ALC_O #1	FBV #1	DETV #1	ALC_U #2	ALC_O #2	FBV #2	DETV #2	LOR-OLI	1 MHz CV	105 MHz CV	200 MHz CV	1 MHz LK	105 MHz LK	200 MHz LK	FILE:M00
1	PRA_16 #1	PRA_08 #1	PRA_04 #1	PRA_02 #1	PRA_16 #2	PRA_08 #2	PRA_04 #2	PRA_02 #2								FILE:M01
2	POA_16 #1	POA_08 #1	POA_04 #1	POA_02 #1	POA_16 #2	POA_08 #2	POA_04 #2	POA_02 #2								FILE:M02
3	BW_32 #1	BW_16 #1	BW_06 #1	ALCST #1	BW_32 #2	BW_16 #2	BW_06 #2	ALCST #2								FILE:M03
4	FUC41 #1	FUC42			FUC41 #2	FUC43										FILE:M04
5	MONBIT4	MONBIT3	MONBIT2	MONBIT1	FUC44			SPRMON1								FILE:M05
6	SPMON9	SPMON8	SPMON7	SPMON6	SPMON5	SPMON4	SPMON3	SPMON2								FILE:M06
7	IMIX12B #1	IMIX12A #1	SAW7012B#1	SAW7012A#1	IMIX12B #2	IMIX12A #2	SAW7012B#2	SAW7012A#2								FILE:M07
8	IIMIX12B#1	IIMIX12A#1	IFSAW12B#1	IFSAW12A#1	IIMIX12B#2	IIMIX12A#2	IFSAW12B#2	IFSAW12A#2								FILE:M08
9	ALC12B #1	ALC12A #1	ALC-12B#1	ALC-12A#1	ALC12B #2	ALC12A #2	ALC-12B#2	ALC-12A#2								FILE:M09
10	ALC $B #1	ALC $A #1			ALC $B #2	ALC $A #2										FILE:M10
11																FILE:M11
12																FILE:M12
13																FILE:M13
14																FILE:M14
15																FILE:M15

Notes:

Channel 31 is also monitored and is connected to System GROUND.

Pnemonics used in the table:

#1: 130 MHz channel; #2: 175 MHz channel

FBV: Analog ALC feed-back voltage; DETV: Analog total power Detector voltage

ALC_U and ALC_O: Under and Over range digital assertion of ALC analog voltage

PRA_xx: Pre-attenuator of xx dB; POS_yy: Post attenuator of yy dB (digital levels)

BW_zz: Bandwidth selection of zz MHz (digital levels); SPMONi to 9: Spare bits for future.

ALCST: Status of ALC - ON or OFF (digital);

MONBITn: Monitor Multiplexer bit n.

FUC41, FUC42, FUC43 and FUC44: Provision for monitoring future control in these PIUs.

CV: Control voltage to VCXO (analog); LK: Lock condition of VCXO (digital)

LOR-OLI: Hardware AND of all Cvs and LIs

Bit 0: Critical Parameters, Level 1; Bits 1 to 6: Important parameters, Level 2;

Bits 7 to 15: Health parameters, Level 3

LOR does not have any Level 2 monitoring at present.

Level 3 monitoring of LOR (bits 7 to 15) will be defined later.

Hardware for LOR-OLI is not implemented as of date.

Level 2 and 3 monitoring of IF and LOR are not implemented as of date.

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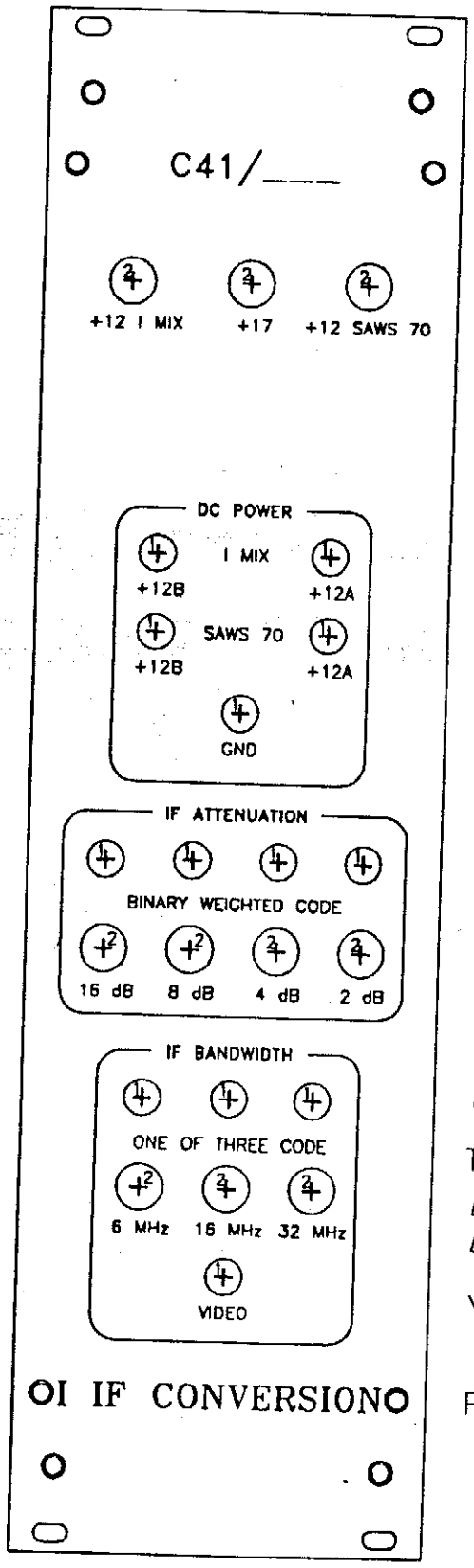


PIU CODE AND SERIAL NUMBER

VISUAL INDICATION OF DC POWER
All LEDS should glow

DMM/ OSCILLOSCOPE MONITOR:

Typical voltage WRT GND are:
IMIX +12B: 12 VOLTS;
IMIX +12A: 11.1 VOLTS;
SAWS70 +12B : 12 VOLTS;
SAWS70 +12A: NO CONNECTION

Pre-Attenuator Monitor:
Value set is the sum of values of ALL LEDs which are glowing.

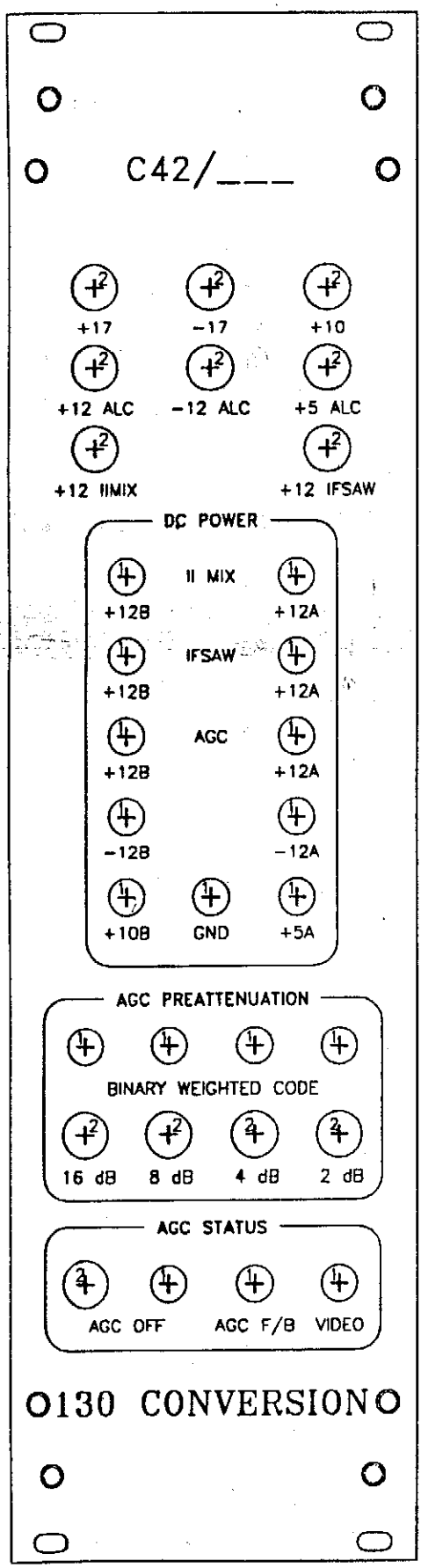
Typical voltage WRT GND are:
LED ON : 3.4V / 200 mV / 3.4V / 3.4V
LED OFF:200mV / 3.4V / 200mV / 200mV

Bandwidth Monitor:
Value set corresponds to that of GLOWING LED.

Typical voltage WRT GND are:
LED ON : +7.5V / +7.5V / +10V
LED OFF: -10V / -10V / -10V

VIDEO Monitor: No Connection

PIU NAME



PIU CODE AND SERIAL NUMBER

VISUAL INDICATION OF DC POWER
All LEDS should glow

DMM/ OSCILLOSCOPE MONITOR:

Typical voltage WRT GND are:

IIMIX +12B:	*12V*	*IIMIX +12A:*	*11.1V*
IFSAW +12B:	*12V*	*IFSAW +12A:*	*10.8V*
AGC +12B:	*12V*	*AGC +12A:*	*11.1V*
AGC -12B:	*-12V*	*AGC -12A:*	*-11.7V*
AGC +10B:	*5.1V*	*AGC +5A:*	*4.9V*

Post-Attenuator Monitor:
Value set is the sum of values of ALL LEDs which are glowing.

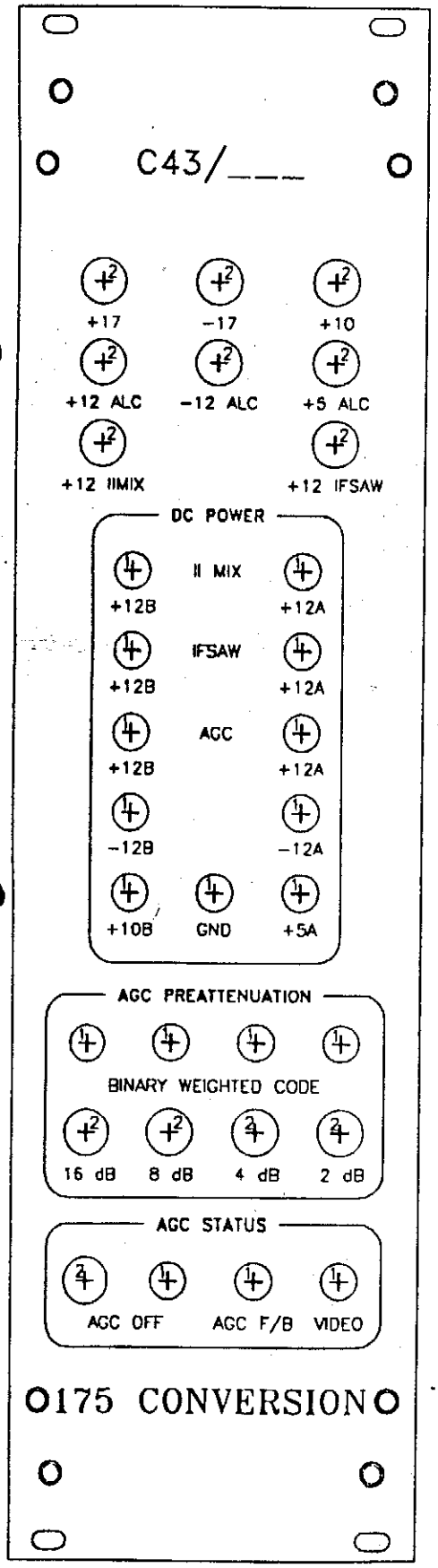
Typical voltage WRT GND are:
LED ON : 3.4V / 200 mV / 3.4V / 3.4V
LED OFF:200mV / 3.4V / 200mV / 200mV

ALC and Total Power Monitor:
LED glows when ALC is OFF

Typical voltage WRT GND are:
ALC ON : 200 mV; ALC OFF: 3.5V

ALC F/B and VIDEO: DC voltage depends on i/p power and ALC mode

PIU NAME



PIU CODE AND SERIAL NUMBER

VISUAL INDICATION OF DC POWER
All LEDS should glow

DMM/ OSCILLOSCOPE MONITOR:

Typical voltage WRT GND are:

IIMIX +12B:	*12V*	*IIMIX +12A:*	*11.1V*
IFSAW +12B:	*12V*	*IFSAW +12A:*	*10.8V*
AGC +12B:	*12V*	*AGC +12A:*	*11.1V*
AGC -12B:	*-12V*	*AGC -12A:*	*-11.7V*
AGC +10B:	*5.1V*	*AGC +5A:*	*4.9V*

Post-Attenuator Monitor:
Value set is the sum of values of ALL LEDs which are glowing.

Typical voltage WRT GND are:

LED ON : 3.4V / 200 mV / 3.4V / 3.4V

LED OFF:200mV / 3.4V / 200mV / 200mV

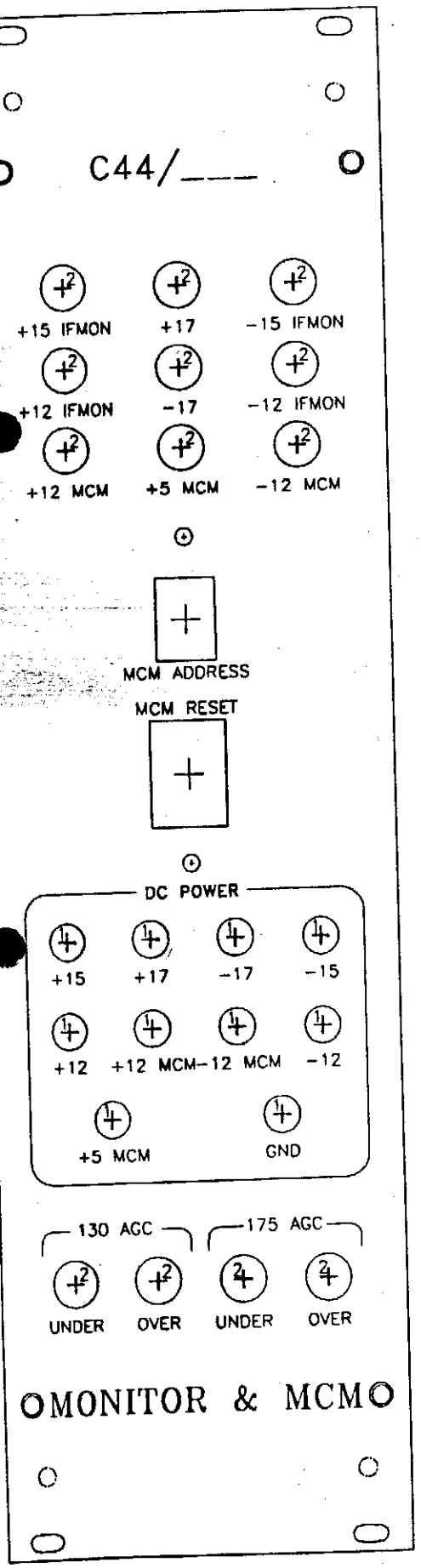
ALC and Total Power Monitor:
LED glows when ALC is OFF

Typical voltage WRT GND are:

ALC ON : 200 mV; ALC OFF: 3.5V

ALC F/B and VIDEO: DC voltage depends on i/p power and ALC mode

PIU NAME



PIU CODE AND SERIAL NUMBER

VISUAL INDICATION OF DC POWER
All LEDS should glow

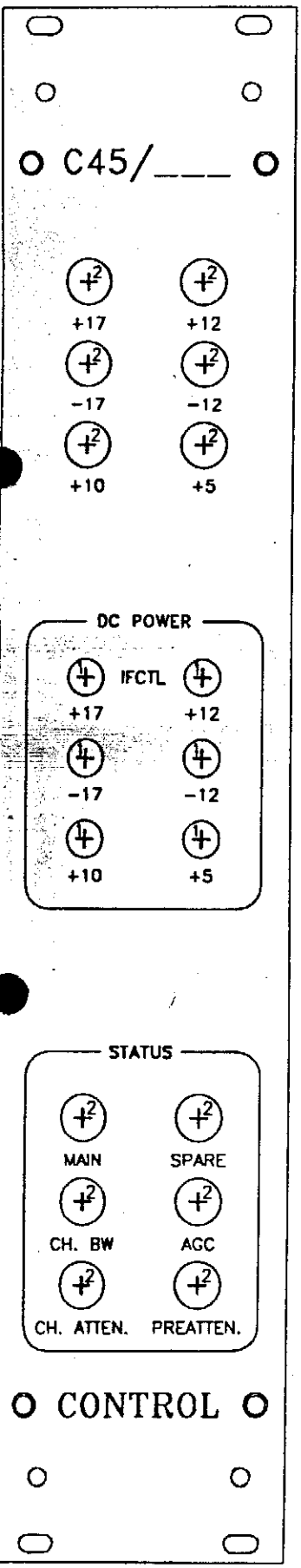
Visual indication of MCM address
LED in RESET switch blinks when
ABC communicates.

DMM/ OSCILLOSCOPE MONITOR:

Typical voltages WRT ground are
as screen-printed to within ± 2%

Visual Indication of ALC operation:
When ALC mode is selected, BOTH the UNDER and OVER LEDs MUST NOT GLOW for the correct range of input total power.

PIU NAME



PIU CODE AND SERIAL NUMBER

VISUAL INDICATION OF DC POWER
All LEDS should glow

DMM/ OSCILLOSCOPE MONITOR:

Typical voltages WRT ground are as screen-printed to within ± 2%

Visual Indication of Control action:

SPARE LED blinks momentarily when a MONITOR command is issued.

When any IF parameter Control Commnad is issued, LED corresponding to that parameter and the MAIN LED blink momentarily.

PIU NAME