National Centre for Radio Astrophysics
Tata Institute of Fundamental Research,
Pune University Campus, Pune INDIA

Internal Technical Report

Upgraded Baseband System
For 32 MHz GSB

Prakash Hande / Ajithkumar B.

Giant Metrewave Radio Telescope, Narayangaon, Khodad, 410504

Prakash@gmrt.ncra.tifr.res.in
Ajith@gmrt.ncra.tifr.res.in

Objective:

In receiver room, re arrange the baseband system into a new location and making a space for installing a GMRT Analog Backend system in place of exiting baseband system. So both the system can be use for observation.

Introduction:

At the GMRT, the dual polarized voltage signals from each antenna are processed through super heterodyne receivers and finally brought to a central location for further processing.

The intermediate frequency signals from each antenna are then down-converted to baseband

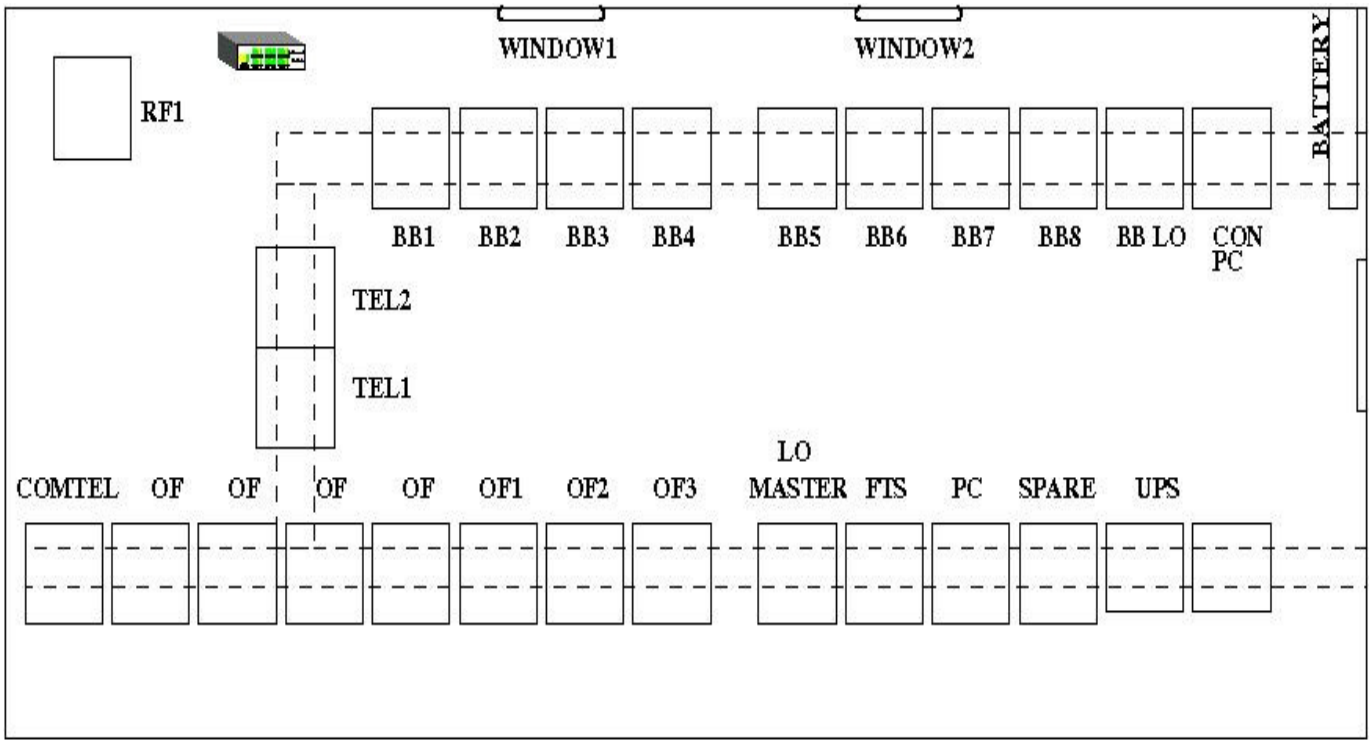
signals and fed to the digital signal processing backend. A baseband system is used for converting the IF signal to baseband signal to get a 32 MHz bandwidth from each polarization. This baseband system is currently installed in 8 racks and one rack for 4^{th} Local Oscillator, which is at present located in Receiver room.

Analog backend receiver of GMRT is being upgraded as part of the eleventh plan. These major upgrade in specification related to the analog section including complete processing of the RF signals at the central station. For installing new GMRT Analog backend System in receiver room, there is need for some space. So it has been decided that this GAB system can be installed in place of current baseband system and make a new arrangement for exiting baseband system in receiver room.

Receiver room rack configuration:

i) Before modification:

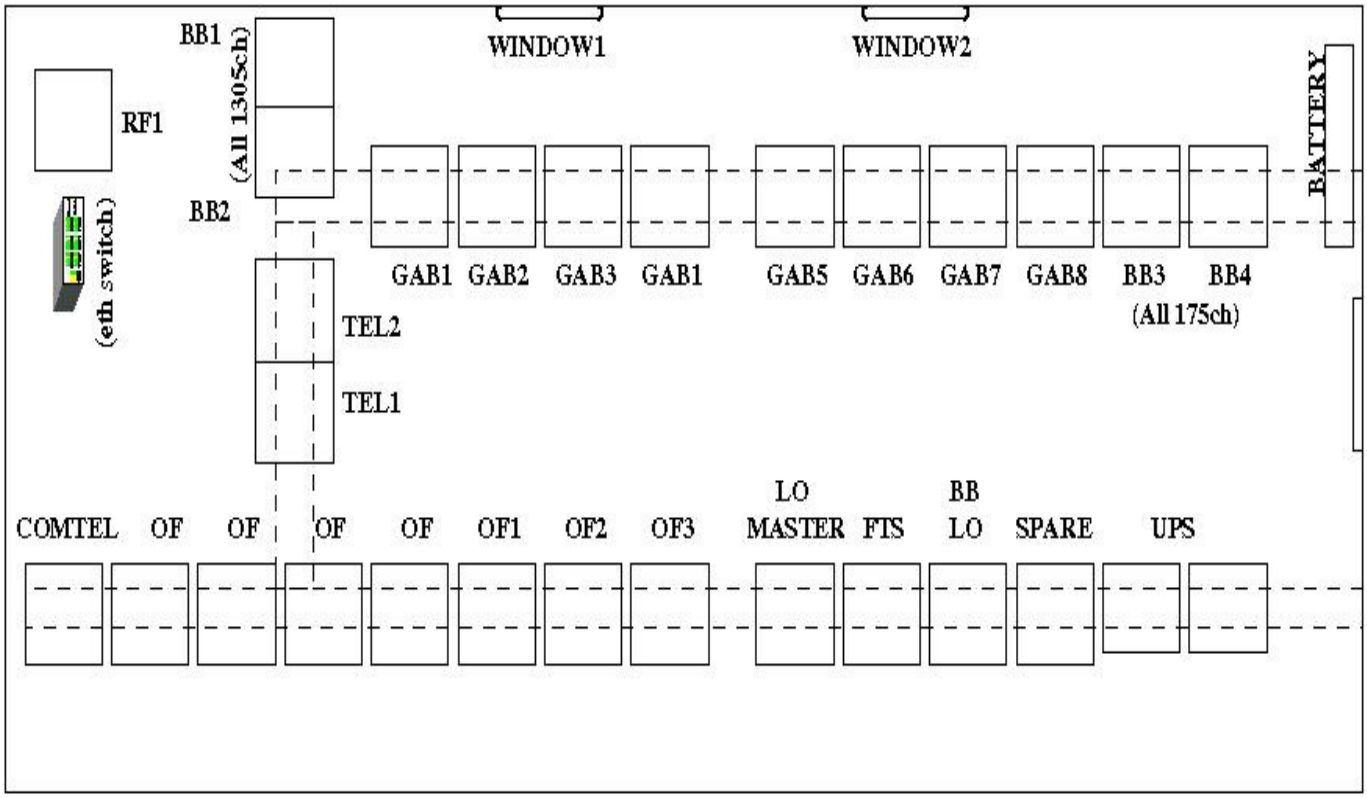
Baseband system was installed in 8 baseband Racks (BB1 to BB8 racks), where Channel 130 for all antennas were installed in BB1 to BB4 racks and channel 175 for all antennas were installed in BB5 to BB8 rack. All input cables were coming from OF rack to all this rack and output cables were going from BB rack to windows 1 &2. IV th LO system and control PC for IV th LO was installed in BBLO & CON PC racks. This is shown below.



RECEIVER ROOM – RACK POSITION (BEFORE MODIFICATION)

ii) After modification:

Now the new Rack rearrangement made in such a way that the baseband system installed in 4 racks (BB1,BB2,BB3, BB4) and made a space for installing 8 racks (GAB1 to GAB8 racks) to new GAB system. IV th LO rack is been shifted near FTs rack. New Receiver rack arrangement after modification is shown below.

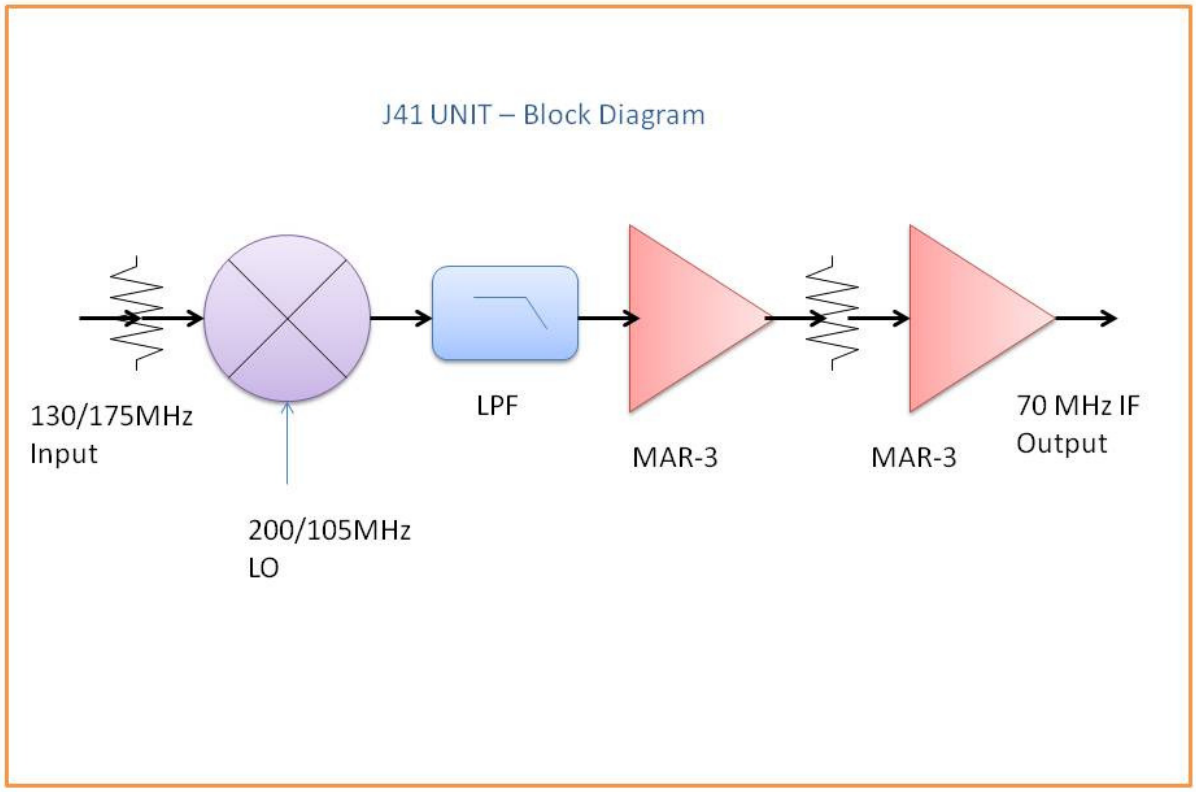


RECEIVER ROOM – RACK POSITION (AFTER MODIFICATION)

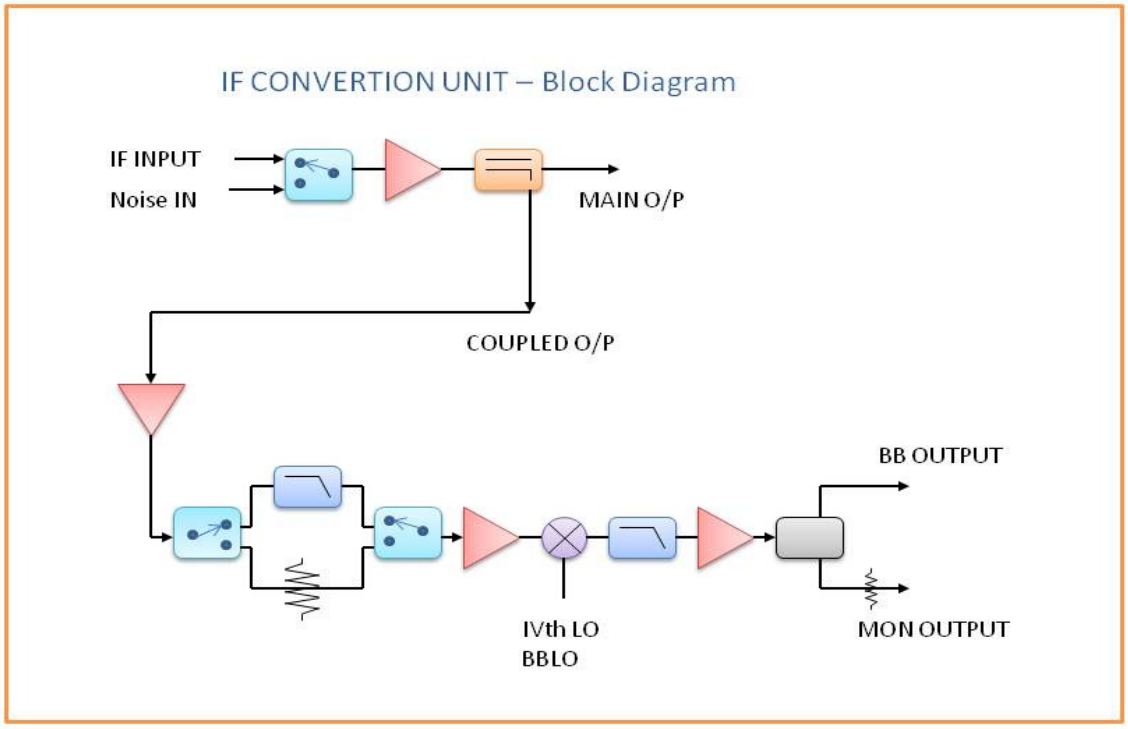
Baseband system new configuration:

The baseband system contains two units, the J41 unit and the new IF conversion unit. Both these units are housed in a metallic box. The J41 and the new IF conversion units together make up the baseband system. The units are available for a channel of 175 MHz as well as 130 MHz. These units play the key role in the down conversion of the RF signal.

Block Diagram of J41 UNIT



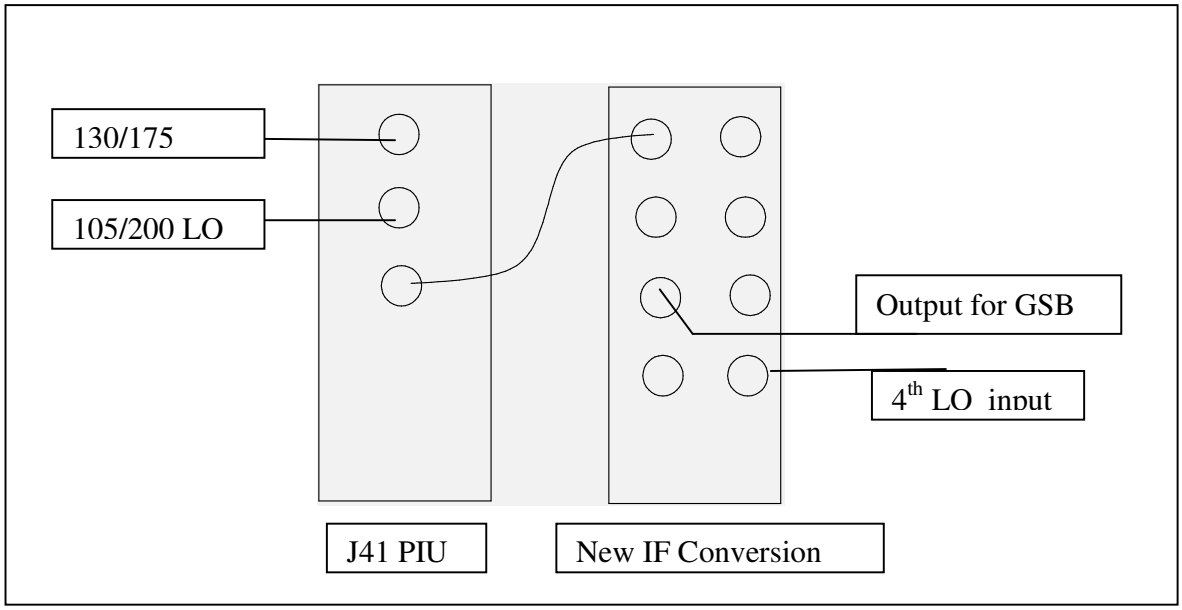
NEW IF CONVERSION UNIT:



The J41 and New IF conversion basically work on the super heterodyne principle. The RF and LO signals given to the J41 as inputs. The mixer in the J41 converts these two signals ,of frequency *f*rf and *f*lo , into the two new heterodyne frequencies *f*rf + *f*lo and *f*rf - *f*lo. The mixer may inadvertently produce additional frequencies such as third- and higher-order intermediation products. Ideally, the IF bandpass filter removes all but the desired IF signal at f_{IF}. The frequency of the local oscillator f_{LO} is set so the desired reception radio frequency f_{RF} mixes to f_{IF}. There are two choices for the local oscillator frequency because the dominant mixer products are at $f_{RF} \pm f_{LO}$. If the local oscillator frequency is less than the desired reception frequency, it is called **low side injection** ($f_{IF} = f_{RF} - f_{LO}$); if the local oscillator is higher, then it is called **high-side injection** ($f_{IF} = f_{LO} - f_{RF}$). The IF stage includes a filter and / or multiple tuned circuits in order to achieve the

desired selectivity. This filtering must therefore have a band pass equal to or less than the frequency spacing between adjacent broadcast channels. Ideally a filter would have a high attenuation to adjacent channels, but maintain a flat response across the desired signal spectrum in order to retain the quality of the received signal. Therefore a selected frequency of 70 MHz is filtered out and amplified and passed on to the new IF conversion unit. A central frequency 16 MHz signal in a 32 MHz bandwidth is the final output of the system.

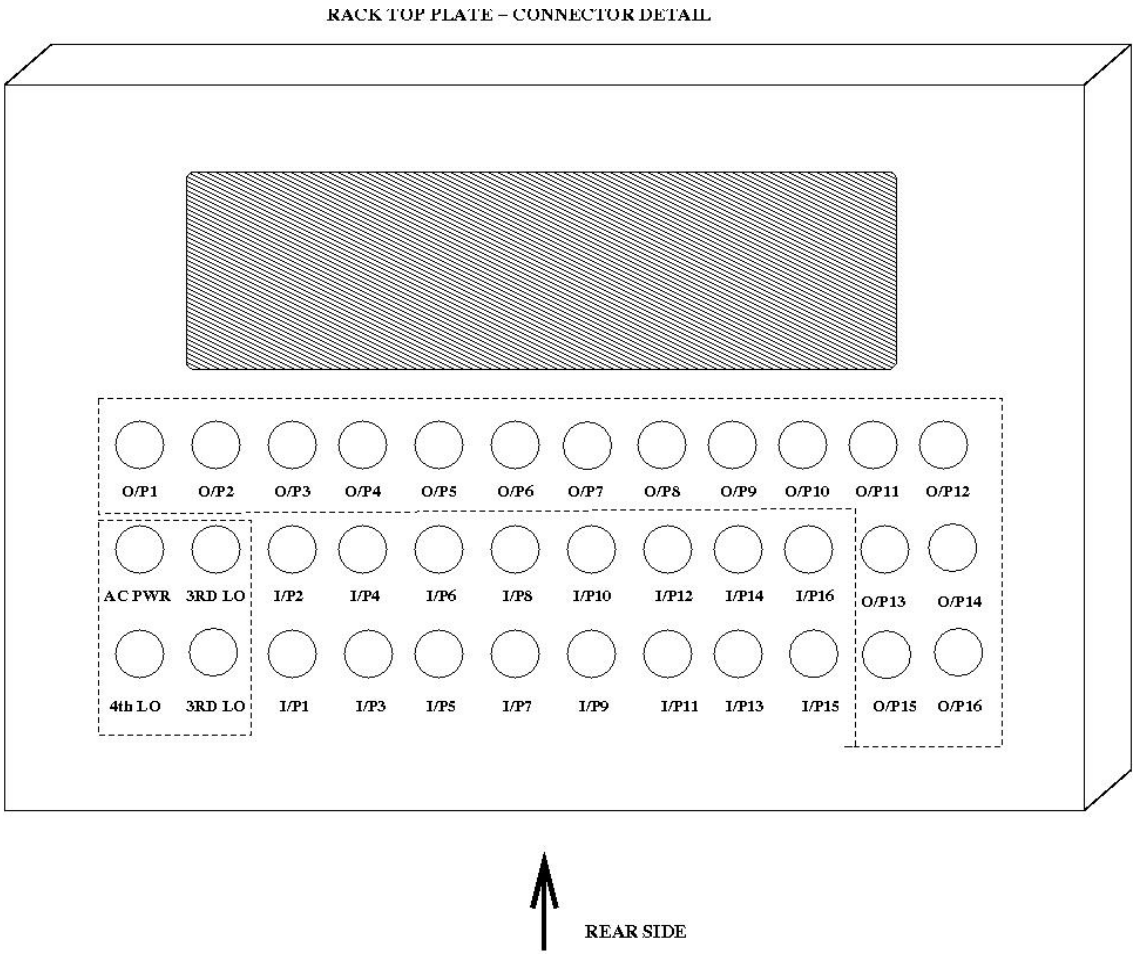
Connection between them is as per below.



RF Cable Details

All input cables of 130 & 175 channel are taken from OF racks and routed to 130 & 175 racks. Output cables of all channels routed from BB130 racks to windows1 and output cables of all channels routed from BB175 racks to windows 2 for GSB system. 105 Mhz, 200 Mhz, & 4th LO cables are routed from LO rack to all BB racks. Control PC for 4th LO is presently kept near to LO rack.

RACK1 – (130CH) - CONNECTION DETAILS – RACK TOP



Input connections

Conn.	Cable	Conn.	Cable
I/P1	L01	I/P9	L09
I/P2	L02	I/P10	L10
I/P3	L03	I/P11	L11
I/P4	L04	I/P12	L12
I/P5	L05	I/P13	L13
I/P6	L06	I/P14	L14
I/P7	L07	I/P15	L15
I/P8	L08	I/P16	L16

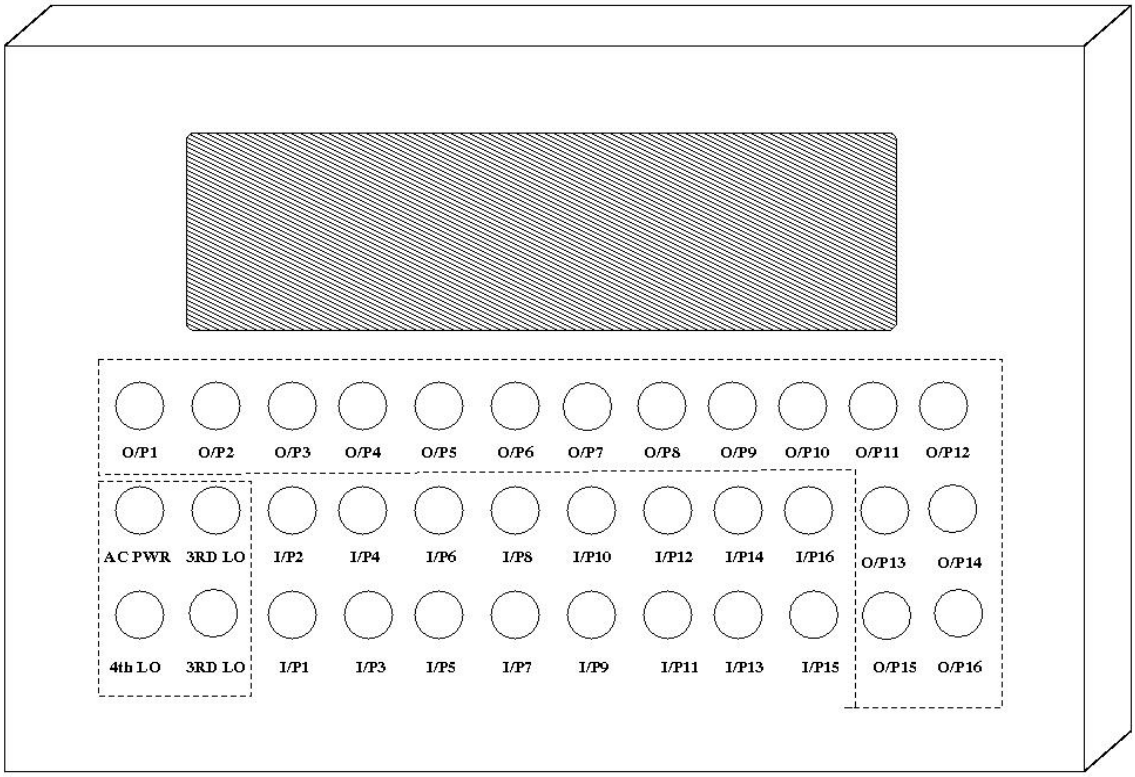
Output Connections

Conn.	Cable	Conn.	Cable
O/P1	O01	O/P9	O09
O/P2	O02	O/P10	O10
O/P3	O03	O/P11	O11
O/P4	O04	O/P12	O12
O/P5	O05	O/P13	O13
O/P6	O06	O/P14	O14
O/P7	O07	O/P15	***
O/P8	O08	O/P16	***

Conn.	Cable
3rd LO	
3rd LO	
4th LO	

RACK2 – (130CH) - CONNECTION DETAILS – RACK TOP

RACK TOP PLATE – CONNECTOR DETAIL



REAR SIDE

Input connections

Conn.	Cable	Conn.	Cable
I/P1	L17	I/P9	L25
I/P2	L18	I/P10	L26
I/P3	L19	I/P11	L27
I/P4	L20	I/P12	L28
I/P5	L21	I/P13	L29
I/P6	L22	I/P14	L30
I/P7	L23	I/P15	L31
I/P8	L24	I/P16	L32

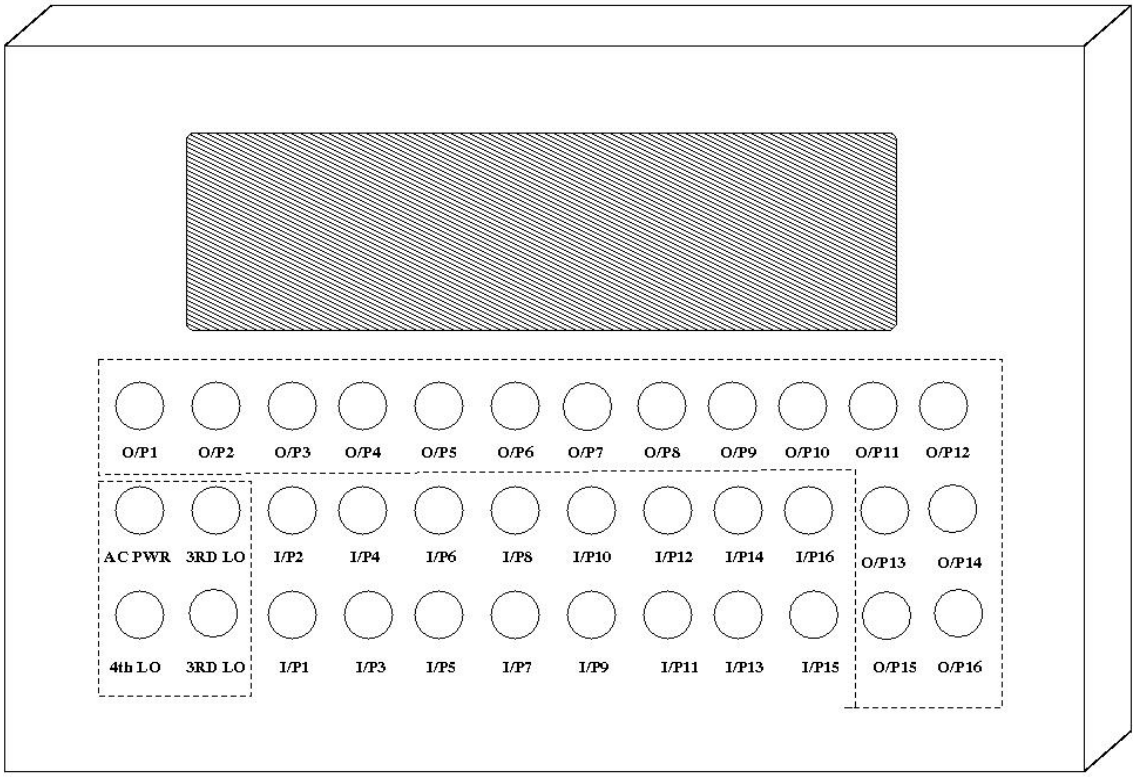
Output Connections

Conn.	Cable	Conn.	Cable
O/P1	O15	O/P9	O23
O/P2	O16	O/P10	O24
O/P3	O17	O/P11	O25
O/P4	O18	O/P12	O26
O/P5	O19	O/P13	O27
O/P6	O20	O/P14	O28
O/P7	O21	O/P15	O29
O/P8	O22	O/P16	O30

Conn.	Cable
3rd LO	
3rd LO	
4th LO	

RACK1 – (175CH) - CONNECTION DETAILS – RACK TOP

RACK TOP PLATE – CONNECTOR DETAIL



REAR SIDE

Input connections

Conn.	Cable	Conn.	Cable
I/P1	K01	I/P9	K09
I/P2	K02	I/P10	K10
I/P3	K03	I/P11	K11
I/P4	K04	I/P12	K12
I/P5	K05	I/P13	K13
I/P6	K06	I/P14	K14
I/P7	K07	I/P15	K15
I/P8	K08	I/P16	K16

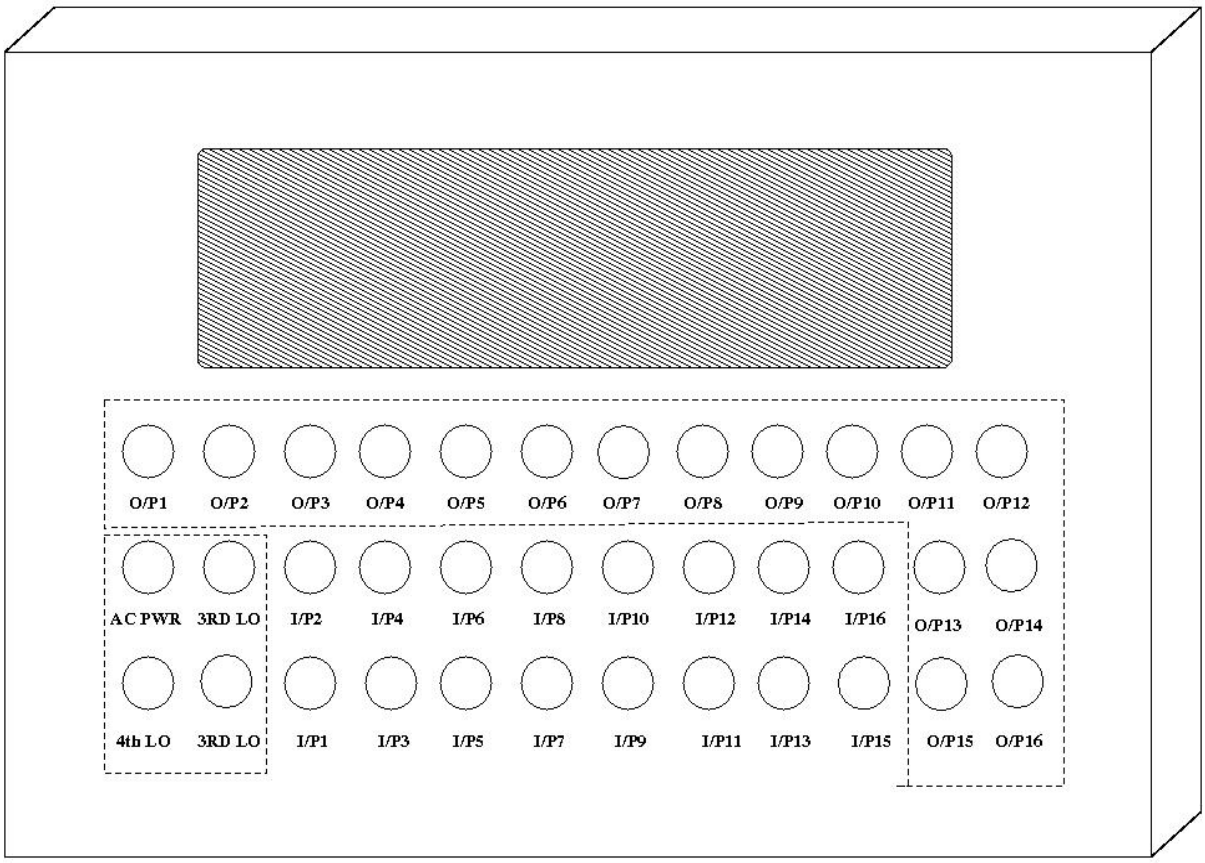
Output Connections

Conn.	Cable	Conn.	Cable
O/P1	P33	O/P9	P41
O/P2	P34	O/P10	P42
O/P3	P35	O/P11	P43
O/P4	P36	O/P12	P44
O/P5	P37	O/P13	P45
O/P6	P38	O/P14	P46
O/P7	P39	O/P15	***
O/P8	P40	O/P16	***

Conn.	Cable
3rd LO	
3rd LO	
4th LO	

RACK2 – (175CH) - CONNECTION DETAILS – RACK TOP

RACK TOP PLATE – CONNECTOR DETAIL



REAR SIDE

Input connections

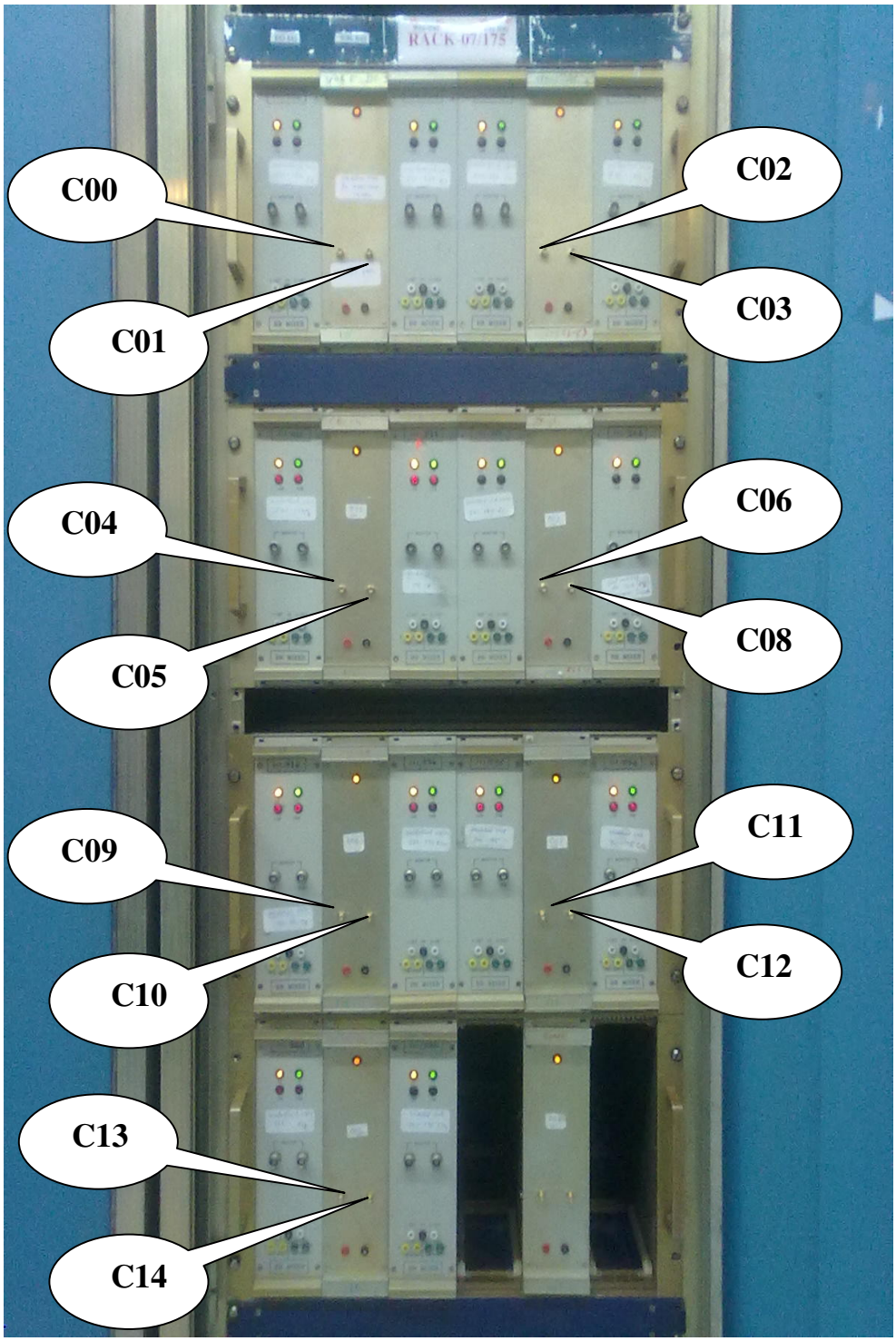
Conn.	Cable	Conn.	Cable
I/P1	K17	I/P9	K25
I/P2	K18	I/P10	K26
I/P3	K19	I/P11	K27
I/P4	K20	I/P12	K28
I/P5	K21	I/P13	K29
I/P6	K22	I/P14	K30
I/P7	K23	I/P15	K31
I/P8	K24	I/P16	K32

Output Connections

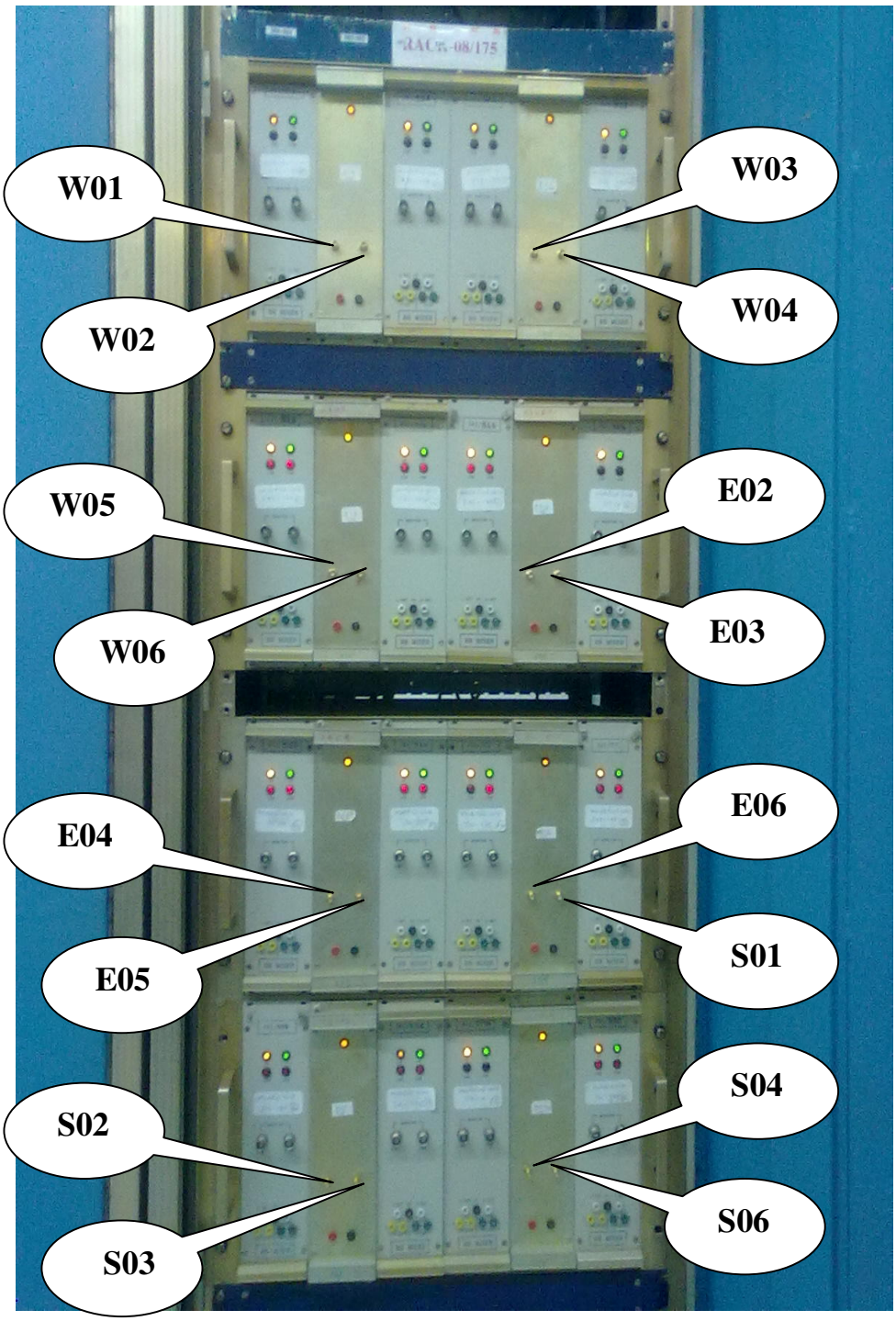
Conn.	Cable	Conn.	Cable
O/P1	P47	O/P9	P55
O/P2	P48	O/P10	P56
O/P3	P49	O/P11	P57
O/P4	P50	O/P12	P58
O/P5	P51	O/P13	P59
O/P6	P52	O/P14	P60
O/P7	P53	O/P15	P61
O/P8	P54	O/P16	P62

Conn.	Cable
3^{rd} LO	
3^{rd} LO	
4^{th} LO	

Antenna Configuration : 130 RACK 1 & 175 RACK 1



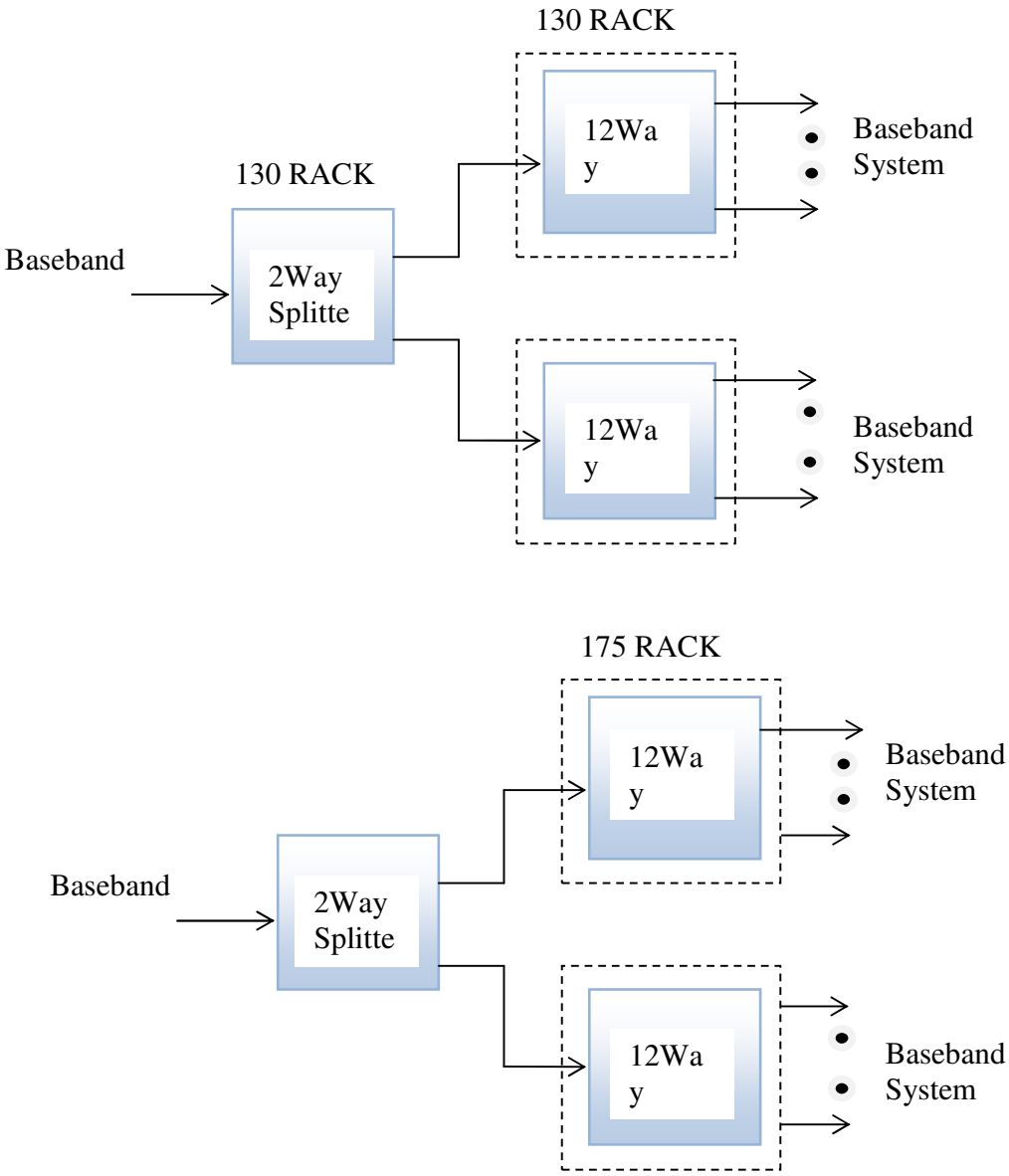
130 RACK 2 & 175 RACH 2

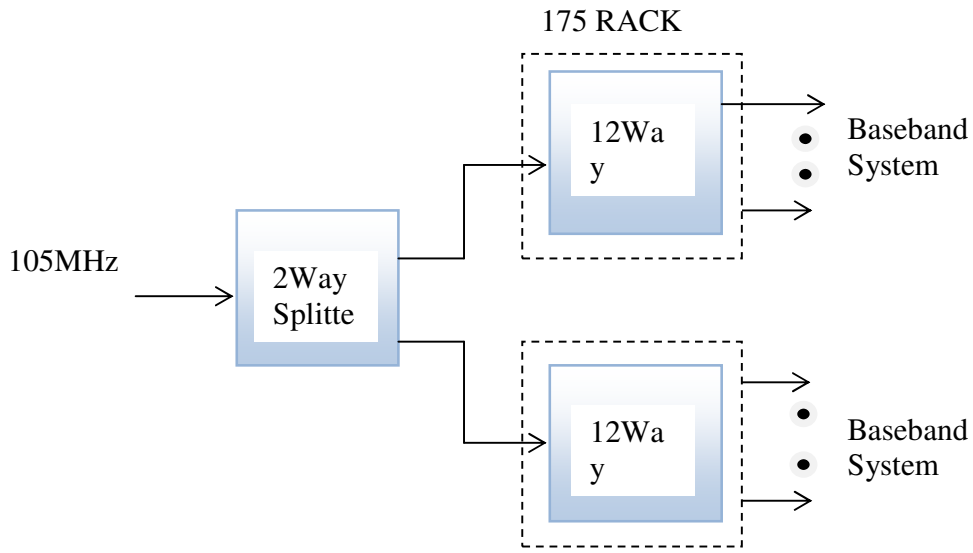


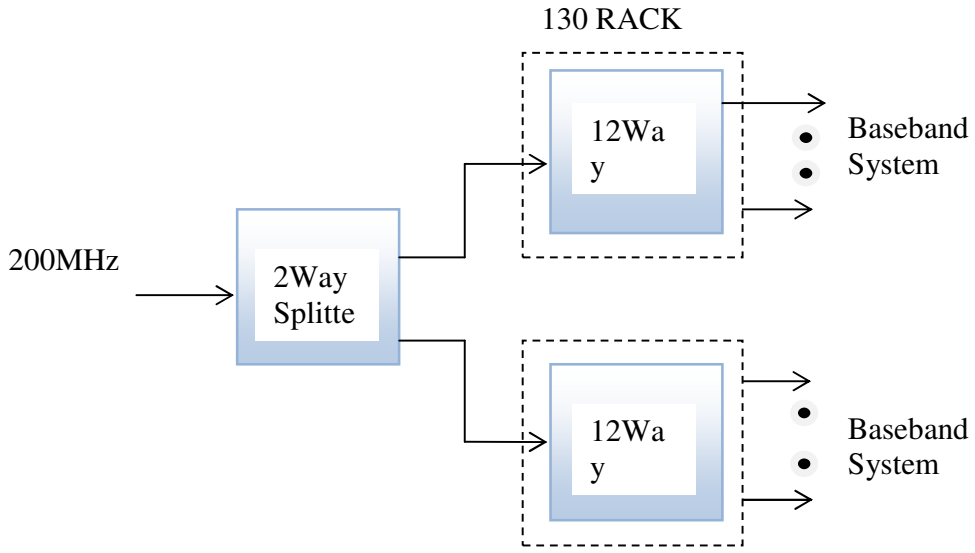
4th LOCAL OSCILLATOR :

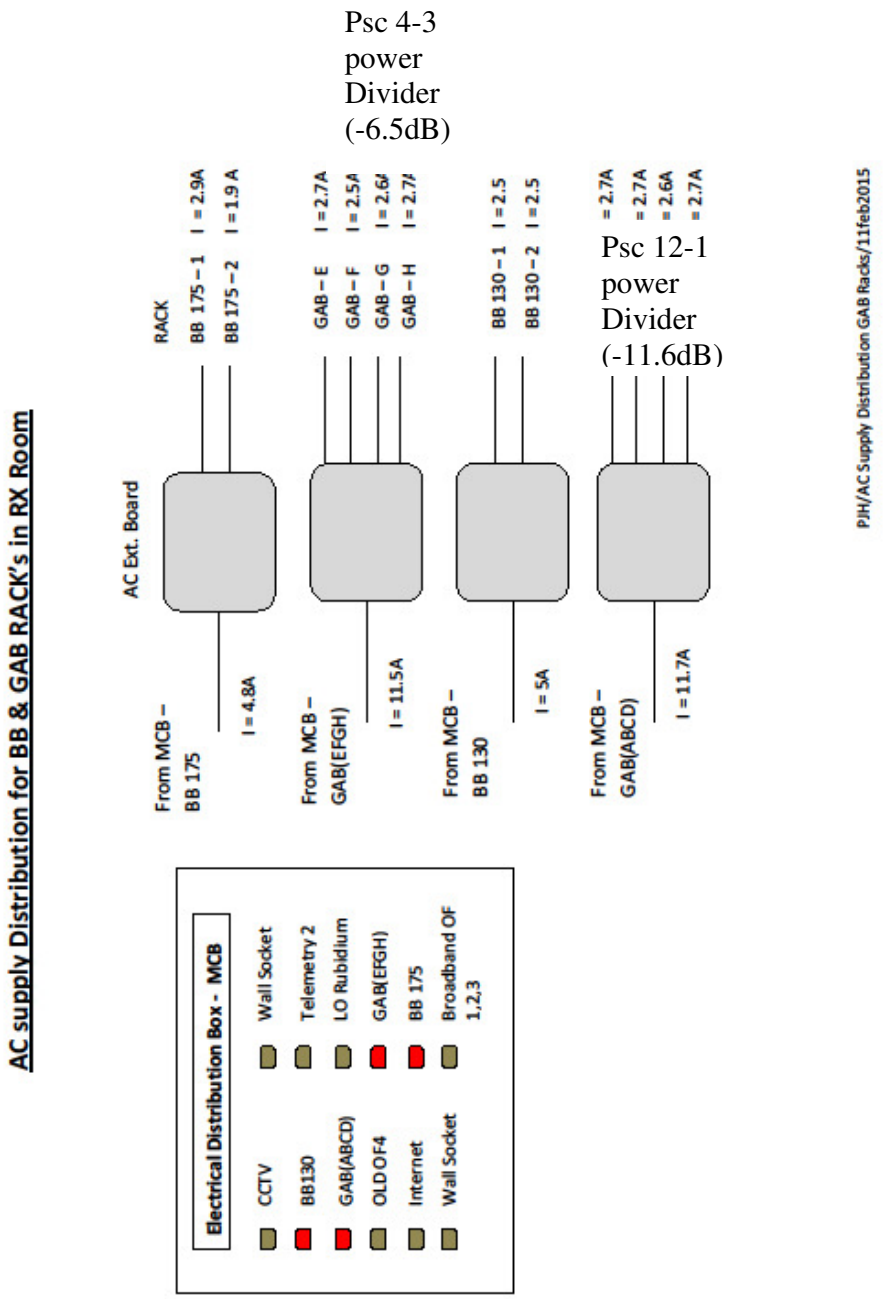
4Th Local Oscillator system

LO Distribution:



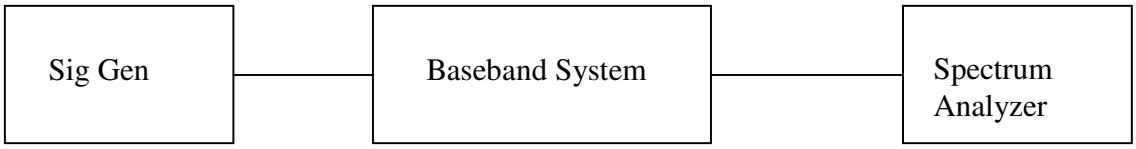

175 RACK
12Wa
y
Baseband
System
105MHz
2Way
Splitte
12Wa
y
Baseband
System


130 RACK
12Wa
y
Baseband
System
200MHz
2Way
Splitte
12Wa
y
Baseband
System


AC supply Distribution for BB & GAB RACK's in RX Room
Psc 4-3 power Divider (-6.5dB)
Psc 12-1 power Divider (-11.6dB)
AC Ext. Board
RACK
BB 175 – 1 I = 2.9A
BB 175 – 2 I = 1.9 A
From MCB – BB 175
I = 4.8A
GAB – E I = 2.7A
GAB – F I = 2.5A
GAB – G I = 2.6A
GAB – H I = 2.7A
From MCB – GAB(EFGH)
I = 11.5A
BB 130 – 1 I = 2.5
BB 130 – 2 I = 2.5
From MCB – BB 130
I = 5A
= 2.7A
= 2.7A
= 2.6A
= 2.7A
From MCB – GAB(ABCD)
I = 11.7A
PJH/AC Supply Distribution GAB Racks/11feb2015
Electrical Distribution Box - MCB
CCTV
BB130
GAB(ABCD)
OLDOF4
Internet
Wall Socket
Wall Socket
Telemetry 2
LO Rubidium
GAB(EFGH)
BB 175
Broadband OF 1,2,3

Baseband System Testing after Modification:

Test Set Up :



Procedure:

For measuring 130 CH.

1. Connect Sig. Gen to 130Ch input of baseband system at Optic Fiber End of selected Ant.
2. Set Sig. Gen – Center Frequency: 130Mhz, Amplitude: -47dBm
3. Connect Spectrum Analyzer to output of baseband system of selected Ant. at Corr. Window end.
4. Setting of Spectrum Analyzer : Center Freq. 19Mhz Span : 10 Mhz, RBW: 300 Khz, VBW:3Khz
5. Set Baseband LO : 51MHz
6. Note Down the Peak Marker Value @19Mhz on Spectrum Analyzer.
7. Repeat the procedure for Antenna of 130Channel.

For measuring 175 CH.

1. Connect Sig. Gen to 175Ch input of baseband system at Optic Fiber End of selected Ant.
2. Set Sig. Gen – Center Frequency: 175Mhz, Amplitude: -47dBm
3. Connect Spectrum Analyzer to output of baseband system of selected Ant. at Corr. Window end.
4. Setting of Spectrum Analyzer : Center Freq. 19Mhz Span : 10 Mhz, RBW: 300 Khz, VBW:3Khz
5. Set Baseband LO : 51MHz
6. Note Down the Peak Marker Value @19Mhz on Spectrum Analyzer.
7. Repeat the procedure for Antenna of 175Channel.

Input Power@OF End : -47dBm

Antenna.	130 Ch. Power@BB o/p(in dBm)	175 Ch. Power@BB o/p(in dBm)
C0	-16.8	-15.9
C1	-16.5	-14.8
C2	-18.0	-17.6
C3	-16.2	-16.3
C4	-16.1	-13.5
C5	-18.3	-20.1
C6	-18.6	-14.7
C8	-17.7	-15.4
C9	-17.0	-18.3
C10	-15.7	-16.2
C11	-18.3	-16.2
C12	-16.0	-17.2
C13	-16.3	-15.3
C14	-14.0	-15.0
W01	-17.0	-15.0
W02	-16.5	-14.0
W03	-17.3	-17.7
W04	-16.2	-16.4
W05	-17.0	-15.3
W06	-17.0	-17.9
E02	-17.2	-15.0
E03	-16.4	-16.2
E04	-15.8	-18.7
E05	-14.1	-15.3
E06	-22.4	-16.8
S01	-14.5	-15.4
S02	-11.0	-18.0
S03	-13.0	-16.0
S04	-16.7	-16.0
S06	-14.6	-16.5

Baseband system Power Response

Input Power (in dBm)	Output Power (in dBm)
-66	-36
-64	-34.5
-62	-32.5
-60	-30.4
-58	-28.5
-56	-26.3
-54	-24.4
-52	-22.5
-50	-20.5
-48	-18.3
-46	-16.3
-44	-14.2
-42	-12.1
-40	-10.3
-38	-8.4
-36	-6.3
-34	-4.3
-32	-2.3
-30	-0.4

Baseband system Power Response