

# SOP for testing 15mtr Backend using ROACH @ NCRA, PUNE.

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The Correlator for 15 meter is a single FPGA based ( ROACH unit with one iADC ) correlator. This design accepts signals from both polarization of single antenna through iADC. The ADC samples at 200 Mhz clock giving 8bits of digitized data per pol. Two modes are supported by this design viz. Correlated output for real time analysis and raw ADC data for offline analysis.

**Real Time mode :** In real time mode 1024 point FFT is done on the digitized data. The data is intergrated for 2 Sync ( ie 5.37sec ). The final output goes to control PC through 100Mbps ethernet.

**Offline mode :** The digitized ADC data is acquired via 10Gbe, hence giving flexiblity for the user to do offline correlation/analysis. The data is sent in form of 8K bytes per packet. Each packet comprises of 64 bits of header followed by data . Each 64 bit data consist of 32 bit from Pol1 and 32 bits from Pol2.

## **I : Power ON and instrument settings :**

- (a) Power on wall socket , AC distribution board in the RACK and power supply (*verify : PC ,Optical Fibre Rx units ,Analog bin & ROACH Unit are powered ON*)
- (b) Now Switch ON the instruments and do the following settings -
- (c) Signal generator settings as CLOCK to ROACH : Freq = 800MHz , Power = 0dbm, Set “Mod to OFF and RF to ON”
- (d) 1 pps trigger for ADC : *from the PPS unit.*
- (e) Power “ON” the ROACH unit by press the switch at front panel 'ON'. To Power OFF hold down the same switch for few seconds.

## **II : Interconnections :**

### **(A) Only for testing the Digital part :**

- a. Inputs I+ & Q+ : Connect the ouput from Analog Noise source PIU to LPF of 100MHz or less. Then LPF output to 2 Way Power Divider (2WPD). Connect these two signals as inputs to I+ & Q+ ports of ROACH unit.
- b. PPS : Connect the PPS unit's output of 1Hz, Square waveform & 5Vp to Sync input of ROACH unit.
- c. Clk : Connect the 800MHz , 0dbm to clk\_i input of ROACH unit.

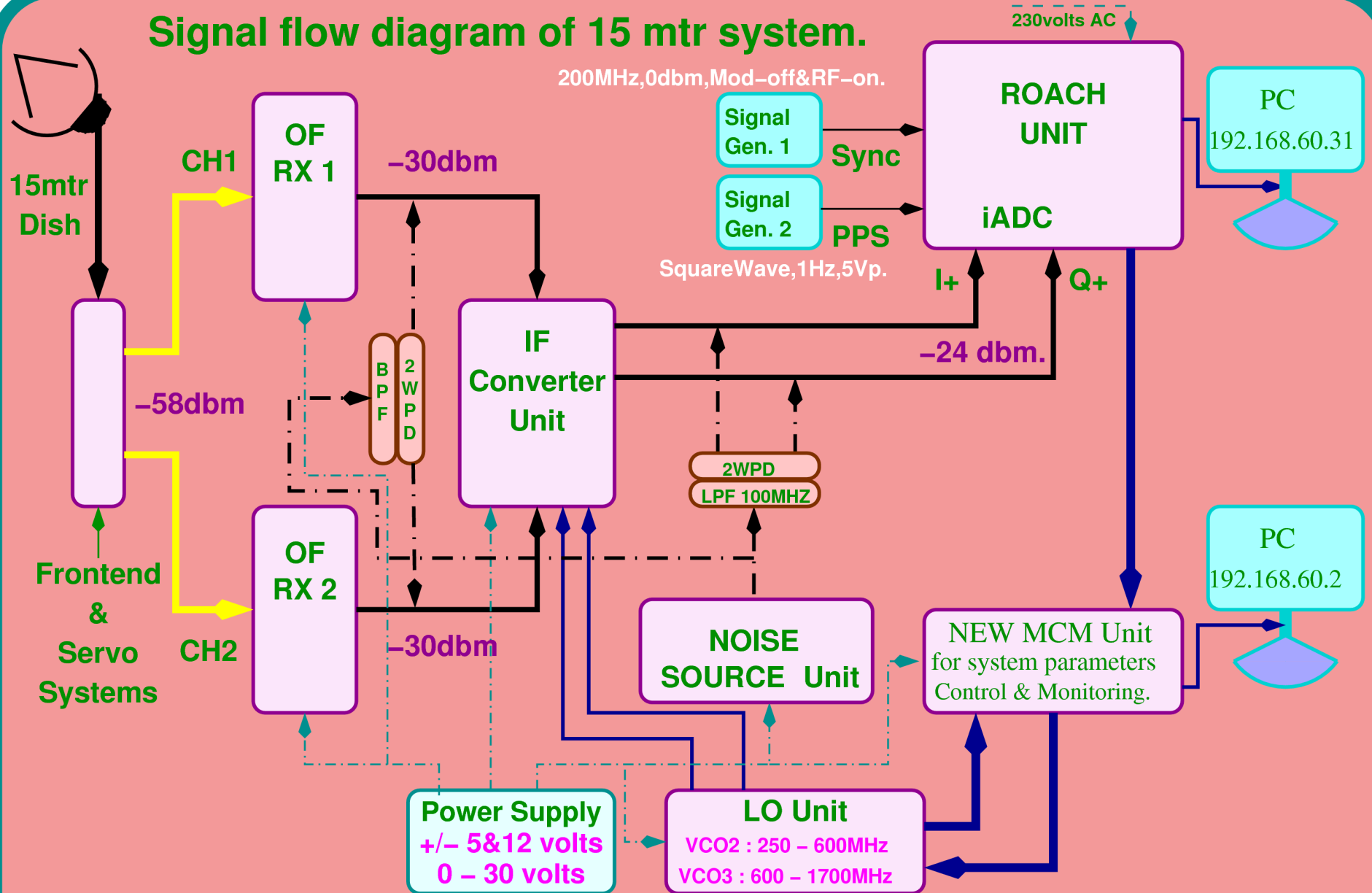
### **(B) For testing the 15mtr Analog & Digital backends :**

This test can be done either using antenna signals or Noise Source through BPF of 100MHz or less bandwidth & 2WPD.

- a. 10MHz LO Ref : connect 10MHz REF OUT from signal generator instrument's rear side to “ref in port” of the LO synth PIU in the Analog bin. (*verify : will be usually connected*)

Please refer the following “[Signal flow diagram of 15mtr.](#)” and do the interconnections using appropriate cables.

# Signal flow diagram of 15 mtr system.



Note : Signal Powers mentioned in figure are Total Power over 100MHz Bandwidth.

### III : Testing through “CONTROL PC” :

#### (A) cms15m PC Login and Settings :

- a. LOGIN in to ctrl PC as            user : cms15m            passwd : cms15m
- b. Open two Xterm windows (*one for Backend control & another for Offline plotting*)
- c. Backend control terminal            [cms15m@localhost ~]\$ cd /home/cms15m/released\_scripts/  
    Dump data in the directory        [cms15m@localhost ~]\$ cd /Data/<UrSubDir>/
- d. Offline plotting terminal           [cms15m@localhost ~]\$ cd /home/cms15m/roach\_scripts/zoom\_15m/TAX/

*NOTE : Final directory structure to be decided and modified here.*

#### (B) Initialization :

In the Backend control terminal

```
[cms15m@cms15m ~]$ cd /home/cms15m/released_scripts/
```

##### (a) help.

```
[cms15m@cms15m released_scripts]$ ./init_roach.py -h
```

```
#####
```

Usage: *init\_roach.py* <ROACH\_HOSTNAME\_or\_IP> [Options]

Options:

*-h, --help*            show this help message and exit

*-M MODE,*            *--mode=MODE*            Modes: "n" for normal & "z\*" for zoom where

*\*=2/4/8/16/32/64/128 decimation factor*

- b BOFFILE, --bof=BOFFILE Specify the bof file to load*
- A ANTA, --anta=ANTA Antenna "a" Integer Delay*
- B ANTB, --antb=ANTB Antenna "b" Integer Delay*
- S SCALE, --antab=SCALE Scaling factor*
- L LO, --lo=LO Step Number corresponding to LO frequency in Hz.  
Please refer 5. Calculations part of the " Report\_15mtr\_ver2.odt " file.*
- U BAND Select the band 1 for USB 0 for LSB*

**(b) usage :**

*# -m n for NORMAL(default) mode & z\* for zoom mode with DecimationFactor\*=2/4/8/16/32/64/128.*

*# use ./init\_roach.py -M n/z\* -A int -B int -S 74/63 -L int-Hz -U 0/1*

*#*

<i># Spec.</i>	<i>option</i>	<i>Default</i>	<i>Remarks</i>
<i># Mode</i>	<i>-M</i>	<i>normal</i>	
<i># Delay</i>	<i>-A &amp; -B</i>	<i>0</i>	<i>for channel 1 &amp; 2 resp.</i>
<i># Scaling factor</i>	<i>-S</i>	<i>74</i>	<i>This gives max. linear range for noise (63 for sine)</i>
<i># LO</i>	<i>-L</i>	<i>1</i>	<i>In Hz for zoom mode only</i>

```

# No. of FFTs for -I          normal:195312.5    This option has been hardcoded.

# 1 sec. Integration.        Zoom 2:97656.25, 4:48828.125, 8:24414.0625

#                             16:12207.03125, 32:6103.515625, 64:3051.7578125, 128:1525.87890625

# Upper/Lower Band -U        1                1 for Upper and 0 for Lower

# eg1. ./init_roach.py

# The above command sets all the default values mentioned above i.e. the design runs in normal mode with 1 sec integration time
# & 0 delay on both the channels and scaling factor of 74.

# eg2. ./init_roach.py -M z128 -L 1 -U 0

# The above command selects the zoom mode with decimation of 128, LO frequency of 0.78125MHz and lower band selected
# i.e. LO>RF

```

### (C) Data dumping and offline analysis of real time data :

```
[cms15m@cms15m ~]$ cd /home/cms15m/released_scripts/
```

#### (a) Data dumping for offline analysis with tax :

```

[cms15m@cms15m released_scripts]$ ./acq_roach.py 192.168.100.40 -f /Data/<UrSubDir>/<file_name>
eg. [cms15m@cms15m released_scripts]$ ./acq_roach.py 192.168.100.40 -f /Data/11012015/normal.dat
[cms15m@cms15m released_scripts]$ ./acq_roach.py 192.168.100.40 -f /Data/11012015/z128L1.dat

```

## (b) Offline Analysis using tax :

```
[cms15m@cms15m ~]$ cd /home/cms15m/roach_scripts/zoom_15m/TAX
```

```
[cms15m@localhost TAX]$ ./xtrgsb32_15m -h
```

```
USAGE: ./xtrgsb32_15m -v visibility file -o outfile -r refant -b baselines -c chansel -t timesel -n 0/1
```

e.g. below

```
USAGE: ./xtrgsb32_15m -v raw.dat -o raw.out -r C00 -b C01,C02,W01,W05,S01,E05 -c 45,1100,1,5 -t 1,110,2,5 -n 1
```

: Chan selection format is start\_chan,stop\_chan,chan\_incr,chan\_integ

: Time selection format is start\_time,stop\_time,time\_incr,time\_integ

In the Offline Plotting terminal

(a) Plot self spectrum for Ch 1 – 1000

```
[cms15m@localhost TAX]$ ./xtrgsb32_15m -v /Data/<UrSubDir>/<file_name> -c 1,1023 -t 1,10000
```

(b) Plot cross spectrum for Ch 10 – 1000

```
[cms15m@localhost TAX]$ ./xtrgsb32_15m -v /Data/<UrSubDir>/<file_name> -c 10,1023,1 -t 1,1000,1,5 -n 1 -r C00
```

(c) Plot cross Ch – 300 over time

```
[cms15m@localhost TAX]$ ./xtrgsb32_15m -v /Data/<UrSubDir>/<file_name> -c 300 -t 1,1000000000 -n 1 -r C00
```

(d) Plot required records

```
[cms15m@localhost TAX]$ ./xtrgsb32_15m -v /Data/<UrSubDir>/<file_name> -c 10,1023,1 -t 1,1000,1,5 -n 1 -r C00
```

(keep this xterm open for Offline plotting)

### (D) Checking the 10 Gbe link for raw data dumping mode :

Connect the ROACH board to the data acquiring PC using 10gbE cable. Connect one end of 10gbE cable's CX4 connector to the CX-4 port 0 of ROACH unit and the other end to the 10gbE card on the data acquiring PC

1. Start the wireshark program : `sudo wireshark`
2. Go to “Capture” / “Interfaces”
3. Now observe the large numbers against the ethernet port corresponding to 10Gbe NIC.
4. Select “Options” against the same ethernet port. and check the box after XXX packets in “stop capture” to stop capture after XXX packets.
5. Then press start to capture XXX packets for analysis.
6. Then save the packets if required.

## IV : CONTROL & MONITORING GUI :

Make sure signals - @OFC Rx units OUTPUT : -30dbm Total power over 100MHz Band.  
@ROACH unit INPUT : -24dbm Total power over 100MHz Band.

a. start control and monitoring GUI by the following way :

- i. web-browser - <http://192.168.60.2:8080/cms-web/> user : sigcon passwd : sigcon

The GUI has the following menu bar :

HOME DASH BOARD MESSAGE CONSOLE ALARM ENGINEERING INTERFACE SETTINGS INFORMATION LINKS

ENGINEERING INTERFACE has the following submenus :

dataserver backend servo sigcon frontend sentinal

each of these displays the following informations :

Status Monitoring Parameters Raw Parameters Basic Commands Detailed Commands Trend Plot

b. Select Engineering Interface / frontend.

Basic commands / RFBAND : to set the RF band.

Bands are (MHz) : 1170 , 1280 , 1390 & 1660\*

Basic commands / RFATTN : to set the RF attenuation By default “0”.

c. Select Engineering Interface / sigcon.

Basic commands / set lo : to set the LO. Always set the LO 60MHz less than RF band selected.

Basic commands / set attn : to set the Attenuation. Default attenuation 4 dbm for both the channels.

d. Select Engineering Interface / backend.

Basic commands / INIT : to Initialize the ROACH Unit.

Feed the following information.

adcclock fftlen acqinteg fftshift stainteg sampgain channelstart channelstop channelincr sampgainctrl stokes chanavg

submit default values.

Home / CMS control / Date monitor / Plot : Spectral line display --> start : refresh time for plot is 30 seconds.

\* to set the 1660 RF band enter value as 1060.

## V : CONCLUSIONS :