Test Results of the "Feed Simulator" and the 150 MHz Front-ends

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Tech.Note : Kh/QF/2000 – 02

1 Introduction :

As described in the previous Technical Note:Kh/QF/2000 - 01, tests were carried out to ascertain the following the facts:
(i). Feasibility of the simple "Feed Simulator".
(ii). Characterisation of the 150 MHz Front–ends using this simulator.
All these tests were done at the quadripod facility, employing all the 150 MHz. Front–ends and associated settings.

2 Test Measurements :

The complete tests, which continually evolved during the course of testing are given here with figures illustrating test set ups and table of measured data.

2.1 QHDC Testing :

The 150 MHz QHDC, which is going to be utilised as the Feed Simulator was connected to the Sig.Gen. as shown in Fig.1.

Since this QHDC has four input ports H_1, H_2, V_1 and V_2 ,the RF input power can be in any one while the rest three ports are terminated by a 50 Ω- load. There is a fifth port for Noise–injection. Output ports CH1 and CH2 are connected to a Vector Voltmeter. The following table gives the measured powers at output ports:

Input Power	CH1 Power	CH2 Power
-30 dBm	-37.1 dBm	-36.9 dBm
	89.3°	90.5°

The last line indicates the phase difference between CH1 CH2 and vice versa; i.e. the CH2 leads CH1 by 90.5°. A few other observations are :

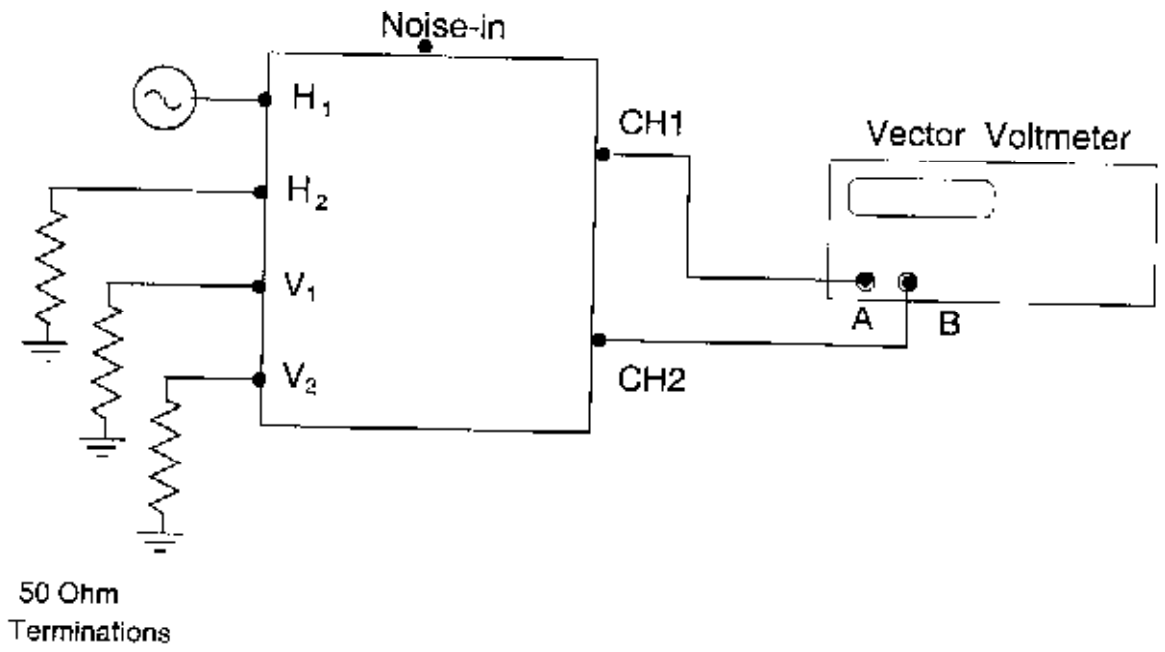

Fig.1 QHDC Testing.

- It is immaterial when the Noise–port is terminated or not
- There is no distinction between H_1 or H_2 to connect the Sig.Gen.

2.2 Front -end Testing :

In the following pages, the results are presented in chronological order. Inferences from the tests and de-bugging measurements are also presented to illustrate the usefulness of this 'simulator'. Procedural steps for the system manual, given in the last section (§5) are derived from these measurements.

Fig.2 shows the test set-up; the CH1– cable of the Quadripod output cable is powered by the Sig.Gen at Hot Lab, while the CH2 cable is connected to the Spectrum Analyser. The output ports of the 'Feed Simulator'–QHDC are connected to the H1 and V1 –ports of the 150 MHz. Front end box. This is referred to as the "**Un-swapped**" condition in the Table-2.
{ **CH1** of QHDC ⇒ H1 & **CH2** of QHDC → V1 }. "**Swapped**" state is :
{ **CH1** of QHDC ⇒V1 & and so on ...}
The Common box output is connected to the CH2– cable of the Quadripod ouput, which can be switched between both the output ports of Com.box.Power in CH2–Quadr.cable is measured by the Spectrum Analyser.The Table-2 gives the result.

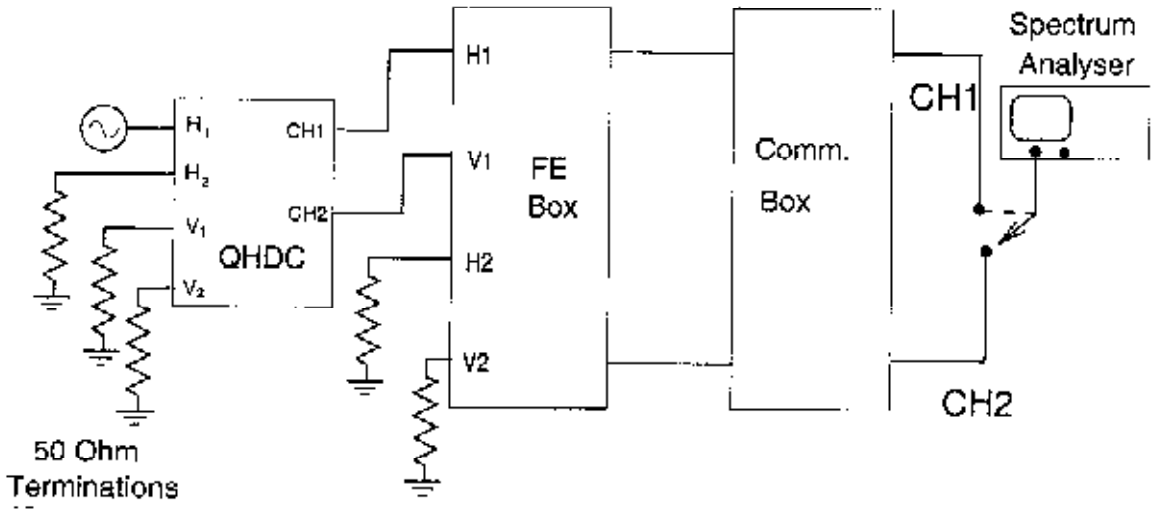

Fig.2 150-MHz. Front-end Testing.

Table-2

FE box Serial No.:# 102 ; Common box Serial No.:# 102
FE & Com.box at Quadripod.

Input Power	Un swapped		Swapped	
	CH1	**CH2**	**CH1**	**CH2**
-30	-41.2	-42.3	-50.3	-41.1
-40	-50.9	-52.2	-56.6	-51.0
-50	-60.8	-62.1	-66.8	-61.1
-60	-70.7	-72.2	-76.5	-71.2

The above table reveals the fact that
(i). CH1–CH2 isolation is **not** seen.
(ii). the Swapped /Un-swapped states has problem; if both the **CH1** and **CH2** powers get swapped, while doing the above then all sub-systems are functioning well.Hence, the problem could be either in the FE box or Common box.
To track–down the problem to the particular unit, a new set of boxes were tested at the Hot-Lab first: Measurement set-up is the same as shown in Fig.2, except for the following :

- Absence of the lengthy cables CH1,CH2 from the quadripod.
- Spectrum analyser replaced by a Vector Voltmeter.

Table.3 shows the results.

Table-3

FE box Serial No.:# 132 ; Common box Serial No.:# 102

FE & Com.boxes at Hot-Lab

Input Power	FE-box output		Com.box output	
	CH1	CH2	CH1	CH2
-40	-40.1	-11.6	-17.3	-17.8
-50	-49.8	-21.5	-17.0	-16.7
-60	-60.2	-31.7	-14.4	-14.3

One can infer that the Common box #102 has been problematic, from the above table: FE box outputs are as expected (isolation seen between both channels) yet similar isolation is not seen in the Com.box outputs. Hence the Com.box 102 was replaced by #113 and tested at Hot-Lab. Table-4 gives the results:

Table-4

FE box Serial No.:# 132 ; Common box Serial No.:# 113

FE & Com.boxes at Hot-Lab

Input Power	FE-box output		Com.box output	
	CH1	CH2	CH1	CH2
-40	-40.8	-12.1	-18.8	+ 3.4
-50	-50.2	-21.9	-27.9	- 5.3
-60	-61.0	-32.3	-38.7	-15.2

Here the isolation is seen between CH1 and CH2; *Moreover it can be concluded that if the* **Feed simulator** *were connected to the one of the H- and V- ports (either H_1, V_1 or H_2, V_2) of the FE & Com.box units, for a perfectly-working unit and in Un-swapped condition* the CH1 power will be always less than CH2.

This also can be proved by network theory as illustrated in Appendix:A

To complete the Lab.tests, measurements were done after swapping of H1 and V1 ports-connecting cables. Results are furnished below in Table-5.

Table-5

FE box Serial No.:# 132 ; Common box Serial No.:# 113

Both FE & Com.box at Hot-Lab Common box output powers alone are shown here.

Input Power	Un-swapped		Swapped	
	CH1	CH2	CH1	CH2
-50	-27.7	- 5.0	- 5.1	-27.6
-40	-18.9	+ 3.2	+ 3.2	-18.8

Reverting back to the first stage, tests were done after installing the Common box # 113 at the Quadripod:

Table-6

FE box Serial No.:# 102 ; Common box Serial No.:# 113
Both FE & Com.box at Quadripod

Input	Un-swapped		Swapped	
Power	CH1	CH2	CH1	CH2
-60	-40.4	-15.3	-15.2	-38.7
-50	-30.2	- 5.3	- 5.4	-28.9
-40	-20.2	+ 3.5	+ 3.5	-18.8
-30	-10.3	+ 5.0	+ 5.1	- 9.7
-50	- 5.4	-28.9	-28.3	- 5.2

The last line of the above Table-6 refers to a software swap done through the interface computer and the code: mcmprnn.
It can be concluded that the FE box # 102 and Com.box # 113 are functionally okay on all respects. Based on these measurements the procedures for checking the Feed and the Front-ends could be formulated, which is given as a 'System manual' for the Feed simulator.(vide Sec.§5)

3 Antenna Testing :

As a final step towards the practical feasibility of this testing method a trial run was done on one of the central square antenna,viz., C5. Using the Cherry-Picker the four dipoles cables were removed first, and the Feed simulator was connected. The Sig.Gen was kept at the antenna shell and 50 m. long RG-223 cable carried the RF to the CP-basket and connected to the H_1 port of the simulator. Output powers were measured at antenna base at CH1 and CH2 cables, after dis-connecting them from the LO-rack. Tests proved the correct the polarization status as well as the good health of the 150 MHz FE system.Table.7 presents the data:

Table-7

FE Testing at Antenna : C05
FE box Serial No.:# 132 ; Common box Serial No.:# 121

Input Power	H1,V1 ports		H2, V2 ports	
	CH1	**CH2**	**CH1**	**CH2**
-50	-39.3	-15.4	-42.2	-15.5
-40	-29.2	- 5.5	-32.1	- 5.4
-30	-19.3	+ 2.3	-21.2	+ 2.3
-30	—	—	+ 2.7	-19.8
-40	—	—	- 4.8	-30.7

The last two rows are for Cable (Simulator to FE box) swapped condition.
Since the isolation seen as well as the CH1 power being low when compared to CH2, the FE system is checked okay; the sense of polarization in this antenna is correct as per design.(under un-swapped settings for the FE parameters, through MCM-05.)

4 Conclusion:

The Feed simulator can be effectively used to check the 150 MHz Front-ends either at Lab./ Quadripod / Antenna base. As pointed out in the prev. note (Kh/QF/2000 – 01), any faulty feed can be identified by inspection connectors (at the focal region of the antenna) and subsequent testing after removal and replacement. As described above if the CH1 and CH2 powers exhibit the desired pattern the swap–status for the chosen antenna is correct. Any deviant pattern calls for steps to restore it.

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5 System Manual

Procedures to check the Polarization swap status
for the chosen antenna

1. Disconnect all the dipoles from the Front-end box.

2. Connect the PC to control the FE settings. Make sure the Noise is OFF, Solar attenuator OFF and RF is ON.

3. Connect the **CH1 & CH2** output ports of the Feed simulator to H1 & V1 ports of the FE box.

4. Terminate the H2 & V2 ports (of the FE) by 50 Ω load.

5. Feed simulator, i.e. the 150 MHz QHDC's input ports – Connect the Signal Generator to H_1 while all the remaining three (viz.H_2 , V_1 , V_2) should be terminated.

6. Set 150 MHz as the frequency and Power level of -60 to -40 dBm.

7. Monitor the power at the Common box outputs CH1,CH2.

5.1 Diagnostics:

* If CH1-power is less than CH2 power by $\sim$ 22 dB, then **all systems are okay** and the CH1 is left-circular polarized.

One can set the software polarization swap here and check it too.

* If the results do not occur, monitor the FE box outputs first; Connect the FE box to the Spectrum analyser or VVM; Here too the CH1–power should be less than CH2 by $\sim$ 28 dB. If this condition is satisfied then FE box is okay and Com.box is defective.

* Subsequently one can repeat the tests for the other pair of input-ports of the FE box (viz. H_2, V_2 ports).

* If no output power is seen check the RF settings at the PC; re–do the settings and check again.

* If the problem persists, FE box too needs replacement.

Dipoles can be spot checked by VVM and dual-directional coupler to measure the return-loss 150 MHz, which should be less than -22 dB (or SWR $\leq$ 1.2). All four dipoles could be tested this way.

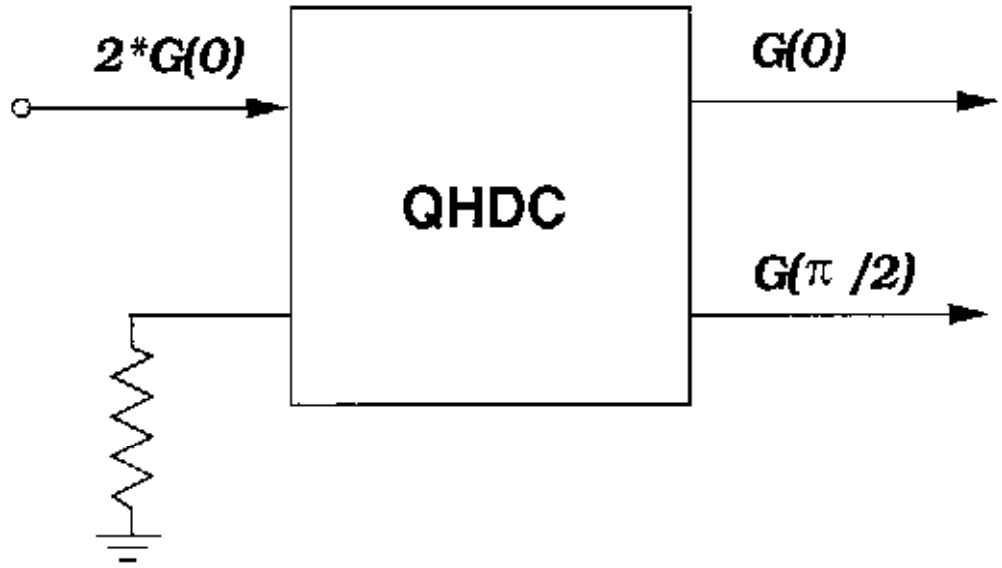

Fig. A1

6 Appendix: A

It can be proved by simple Network theory that the CH2 power of the FE output (Com.box) will be greater than CH1 , when the Feed simulator – QIIDC is connected at the input of FE box as shown in Fig.1.

First considering the QIIDC alone, as shown here in Fig.A1, if the input to one of the port is $2G(0)$, while other (input) port is terminated, the outputs are :
$G(0)$ and $G(\pi/2)$ respectively.

When these outputs of the QHDC are coupled to the 150 MHz. Front-ends, the following power division occurs:

The FE box of 150 MHz. contains first a pair of power–combiners; When one of the inputs to these combiners is terminated, as shown in Fig.A2 (since we connect the Feed simulator to H_1, V_1 and H_2, V_2 are terminated), the power levels at the input ports of the *QHDC inside the FE box* are:
$G(0)$ and $G(\pi/2)$ respectively.

Assuming unity gains throughout the FE–chain of amplifiers,the *QHDC inside the FE box* will further split this input powers and so the **CH1** and **CH2** signal will be:

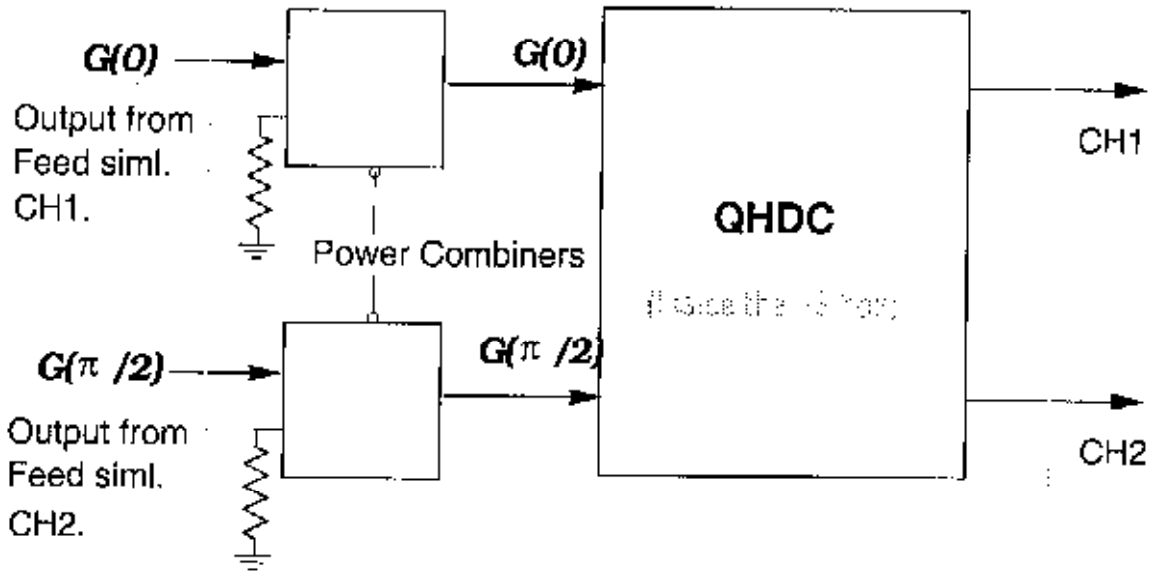
G(0)
Output from
Feed siml.
CH1.
G(0)
Power Combiners
QHDC
CH1
G(π /2)
Output from
Feed siml.
CH2.
G(π /2)
CH2

Fig. A2

$$
\begin{aligned}
\texttt{CH1}Power &= \frac{G}{2}(0) + \frac{G}{2}(\pi) \\
&= 0 \\
\texttt{CH2}Power &= \frac{G}{2}(\frac{\pi}{2}) + \frac{G}{2}(\frac{\pi}{2}) \\
&= G(\frac{\pi}{2})
\end{aligned}
$$

– Hence, for the configuration shown in Fig.A2 (as well as Fig.1), the CH1 power **will be less than** CH2 power.

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