

 CENTRO ASTRONOMICO DE YEBES	<h1>REPORT</h1>	Doc. no. : Yebes/FPSS/RP/2002-005 Issue : 1 Date : 13/06/02 Category : 3
HIFI-FPSS		Page : 1 of 9

PROGRESS REPORT FP S/S

Sub-unit: Cryogenic IF Amplifier

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Date 13/06/02

Edited by Paul Wesselius

Date

Reporting period: October 2001- June 2002

1 PROGRESS DURING REPORTING PERIOD

- **DM Amplifiers**

Twelve amplifier prototypes (Series YCF 6xxx) for the DM program have been designed, fabricated and measured. Two of them have been already delivered together with the isolators and the coaxial cables that compose the complete unit to be delivered by Yebes. One of the prototypes is shown in Figure 1.

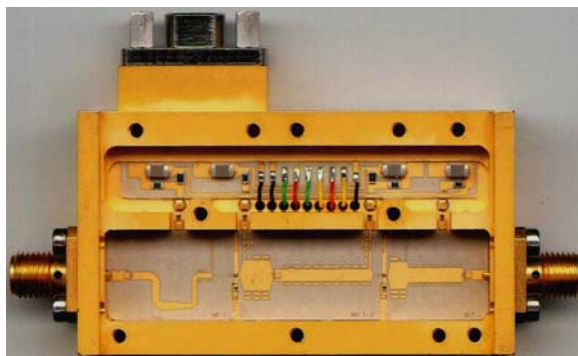


Figure 1.- YCF 6004 Amplifier

The results of five of the measured prototypes (the five ones that will be delivered for the DM Program) are shown in Figure 2. All the results got from the twelve amplifiers are summarised in Table 1 together with the specification. The gain is now around or better than 26dB and the noise lower than 4K, while the ripple, the output reflection and the gain stability are also quite good values. The bias values have been chosen in such a way that the ripple is better with penalty for the output reflection values that are higher and sometimes do not comply completely with the goal specification. A compromise between the two values needs to be reached.



CENTRO ASTRONOMICO DE YEBES

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 2 of 9

Series Number	Bias				Average Gain and ripple	Average Noise Temp.	Minimum Output Ref.	Gain Stability
	1 st stage		2 nd stage					
YCF	Vd [V]	Id [mA]	Vd [V]	Id [mA]	$G_{av} \pm \Delta G$ [dB]	T_n [K]	Γ_{out} [dB]	δG [Hz ^{-1/2} @1 Hz]
Specific.	P _D [mW]/Stage= 2mW				22 ±1.5	5	15	1.4×10 ⁻⁴
6001	0.85	3	0.5	3	27.1±1.3	3.7	14.8	1.2×10 ⁻⁴
6004	0.85	3	0.5	3	26.9±1.1	3.6	14.4	8.7×10 ⁻⁵
6005	0.85	3	0.5	3	27.3±1.0	3.4	11.2	8.9×10 ⁻⁵
6006	0.85	3	0.5	3	27.1±1.0	3.5	13.9	1.3×10 ⁻⁴
6007	0.85	3	0.5	3	25.9±1.3	4.1	14.6	1.4×10 ⁻⁴
6008	0.85	3	0.5	3	25.5±1.1	3.4	12.0	7.7×10 ⁻⁵
6009	0.85	3	0.5	3	27.4±1.1	3.5	9.7	1.0×10 ⁻⁴
6010	0.85	3	0.5	3	27.1±1.2	3.7	14.8	8.7×10 ⁻⁵
6011	0.90	3	0.45	3	25.8±1.2	4.0	12.1	1.1×10 ⁻⁴
6012	0.85	3.5	0.45	2.5	25.5±1.3	4.2	13.8	9.0×10 ⁻⁵
6013	0.85	3	0.5	3	26.1±1.3	3.9	14.9	9.3×10 ⁻⁵
6014	0.85	3	0.5	3	26.0±1.3	3.7	16.7	1.0×10 ⁻⁴

Table 1.- Results for amplifier YCF 6004, compared to the goal specifications.

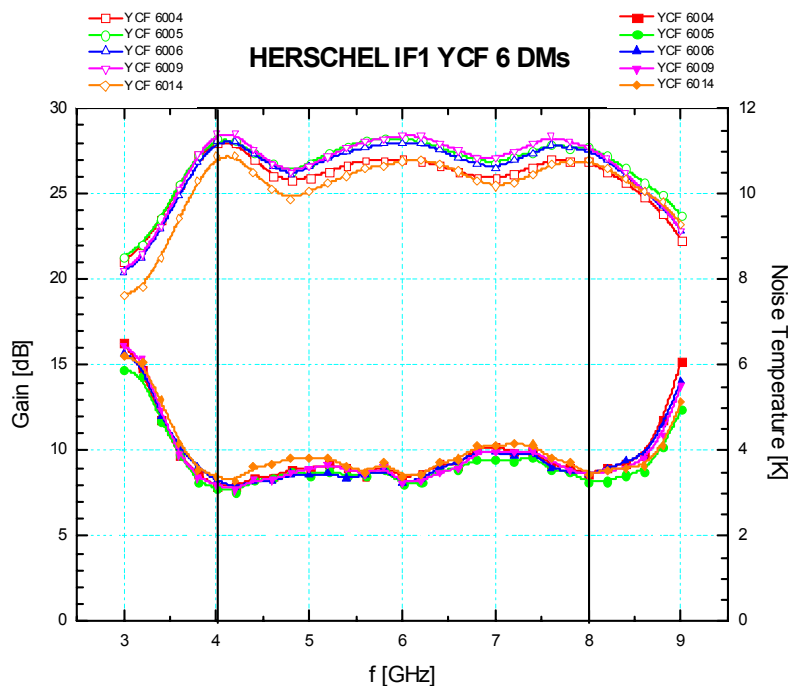


Figure 2.- Gain and noise results for YCF 6xxx Amplifiers.



CENTRO ASTRONÓMICO DE
YEBES

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 3 of 9

• Isolators

- 2 Isolators from Pamtech were received at Yebes (Figure 3). They have been measured at 15K and the results are shown in figures 4 and 5. They are compared with the specification at 77K in Table 2. Also an amplifier was measured with one of those isolators at the input and using a coaxial cable fabricated at Yebes (Figure 6). The results are shown in figure 7. Yebes would like to avoid cryogenic performance testing of the combined amplifier-isolator unit but instead measure the amplifier and isolator independently and predict the combined performance which appears to be acceptable. The two isolators were already delivered to SRON together with two amplifiers and two coaxial cables.
- Three isolators more have been received. Once they are measured at 15K they will be delivered to SRON together with three amplifiers and coaxial cables.
- Pamtech has to send Yebes 5 isolators more (DM Program) using the conventional ferrite material and centred from 3.9 GHz to 7.9 GHz at 77K.
- Pamtech promised to send Yebes 2 isolators more using a new ferrite material that could be used in future versions to improve the situation of the band shift when the isolator is cooled from 77K to 4K. The configuration will be the old one with the SMA connectors situated in line at opposite side. Yebes will test the isolators with the new material to study the feasibility of using this material for the QM/FM/FS models.
- The acceptance and qualification testing to be done by Pamtech and FPSS need to be defined. The cryogenic vibration will be done at SRON. The electrical performances can be done at Yebes at 15K but not at 10K. The electrical performances at 2K need to be done at SRON. The thermal cycling down to 10K needs to be discussed also. Some tests could be done already in the extra DM isolators.

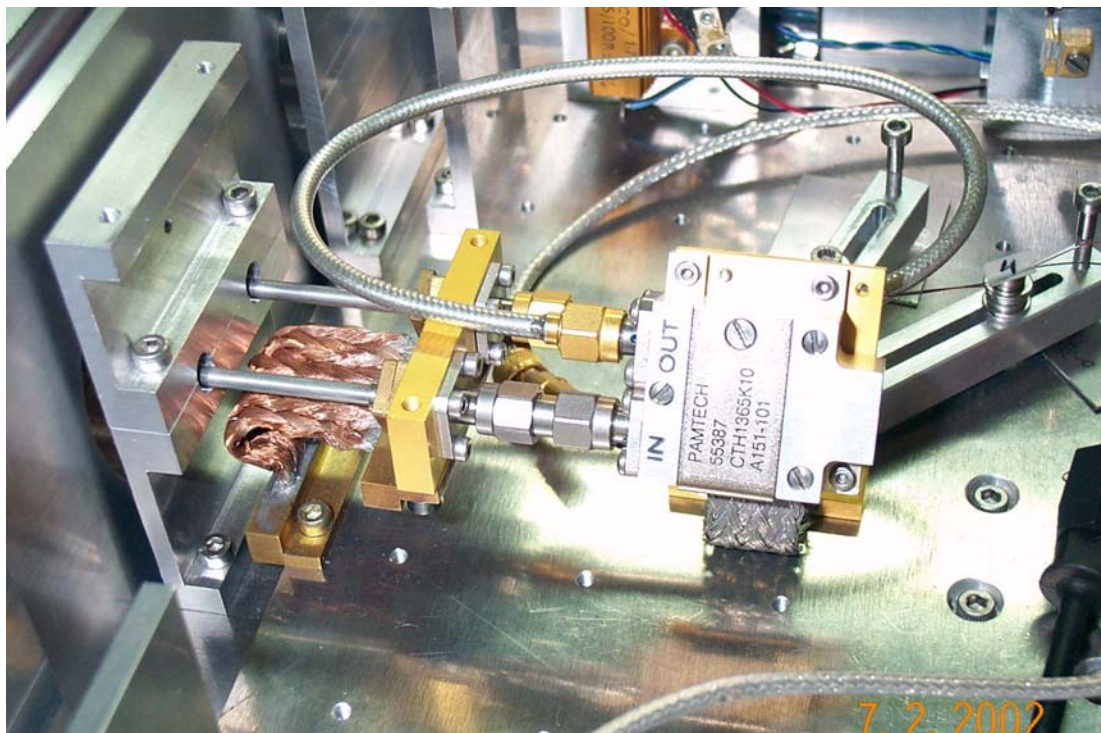


Figure 3.- Pamtech Isolator CTH1365K10 A151-101



CENTRO ASTRONOMICO DE YEBES

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 4 of 9

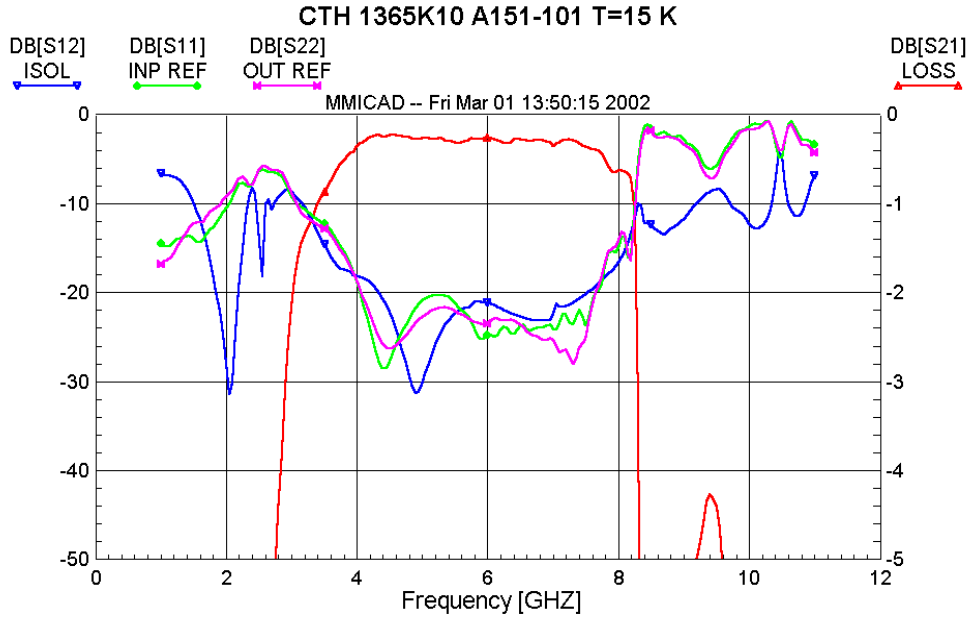


Figure 4.- Results for CTH1365K10 A151-101

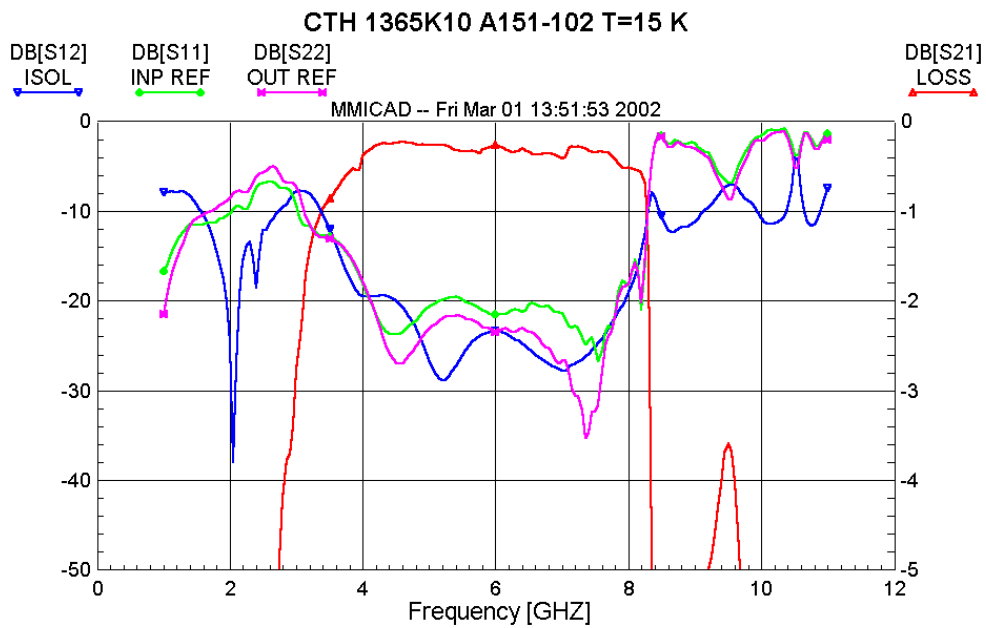


Figure 5.- Results for CTH1365K10 A151-102

S/N	MEASURED @ 15 K				PAMTECH DATA @ 77 K			
	S_{11} (dB)<	S_{12} (dB)<	S_{21} (dB)>	S_{22} (dB)<	S_{11} (dB)<	S_{12} (dB)<	S_{21} (dB)>	S_{22} (dB)<
101	-15.0	-16.5	-0.63	-14.0	-18.5	-16.5	-0.28	-18.8
102	-18.0	-19.0	-0.50	-17.7	-19.1	-16.3	-0.28	-19.1
SPEC.					-18.2	-16.0	-0.30	-18.2

Table 2.- Results for CTH1365K10 A151 Isolators



CENTRO ASTRONOMICO DE
YEBES

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 5 of 9

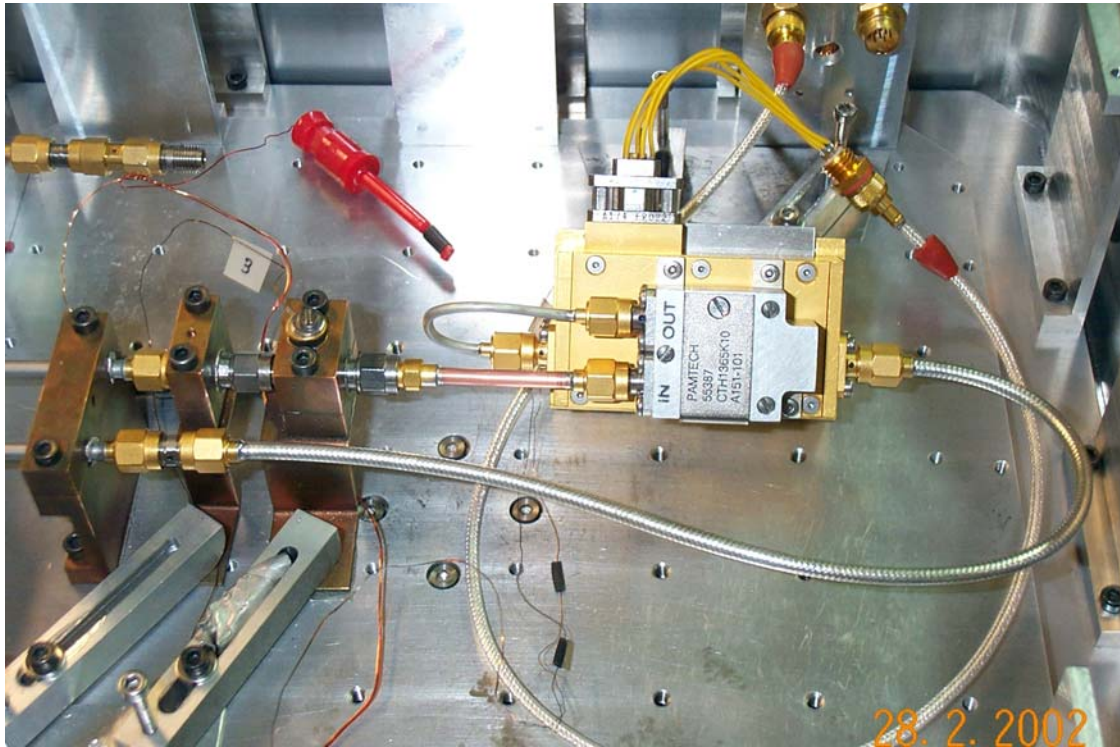


Figure 6.- Isolator-Cable-Amplifier Unit

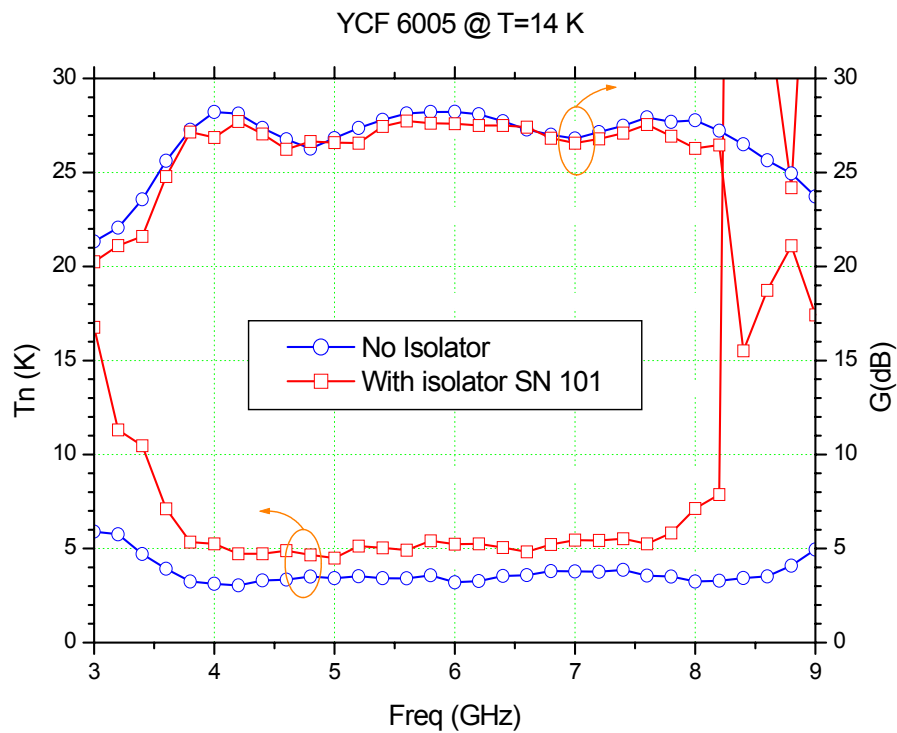


Figure 7.- Results Isolator-Cable-Amplifier Unit



CENTRO ASTRONÓMICO DE
YEBES

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 6 of 9

- **Transfer to Industry (QM and FM Programs)**

A first prototype has been fabricated and measured by Industry. A photo is shown in figure 8. The results compared with one of the YCF 6xxx amplifiers are shown in figure 9.

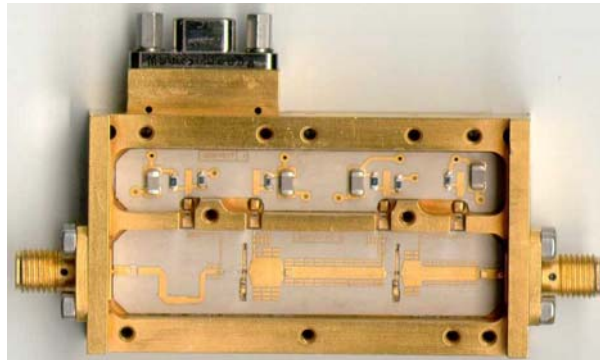


Figure 8.- First Industry Prototype

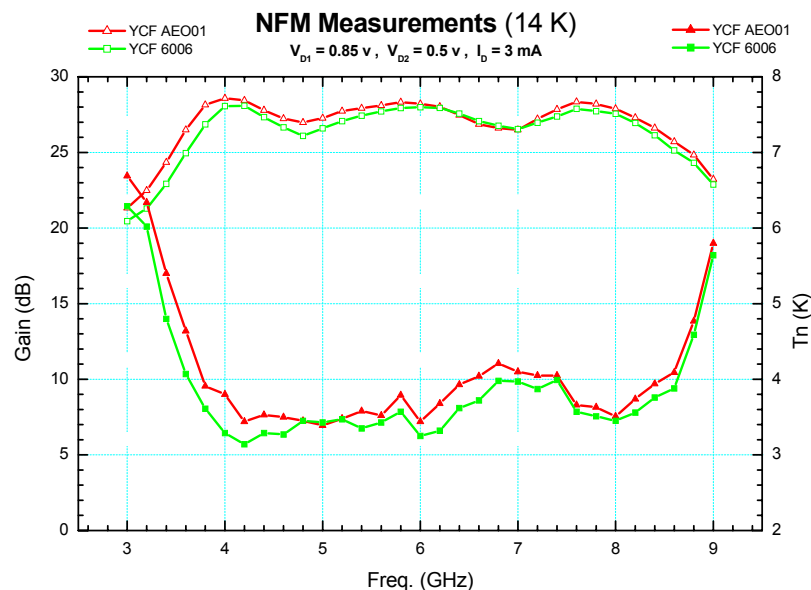


Figure 9.- Results first Industry prototype

The results comply with the specification and compare well with those got at Yebes.

- **Qualification Program**

- The Industry is building qualification boards for the qualification of components, processes and materials at cryogenic temperature. The qualification will be done at SRON although extra qualification, especially in the processes associated to the connectors, will be done at the Industry. Component procurement for these tests is complicated by the fact that two surface mount techniques (solder or epoxy) will be tested requiring different terminations on the chip components.

There remain an open issue regarding the procurement of certain EEE parts: The 10nF capacitor Mil-spec version is not available in the small format (1206) although this format is available in commercial grade.



**CENTRO ASTRONOMICO DE
YEBES**

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 7 of 9

- Amplifiers qualification and acceptance test flow have been accepted by FPSS and Industry.
- Isolators qualification and acceptance test flow need to be defined.
- The ATP for the components was sent CPPA. After some discussion there are still problems to get Mil-specs. components with the sizes and termination materials needed for the amplifier design.
- ESD tests to TRW devices will be done at Yebes in few weeks.
- Radiation tests will be carried out to the devices at KVI in Groningen.
- Documentation for the CDR is being prepared.



**CENTRO ASTRONOMICO DE
YEBES**

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 8 of 9

2 PRESENT PLANNING TIED TO FPU NEED DATES



**CENTRO ASTRONOMICO DE
YEBES**

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 9 of 9



CENTRO ASTRONOMICO DE
YEBES

HIFI-FPSS

REPORT

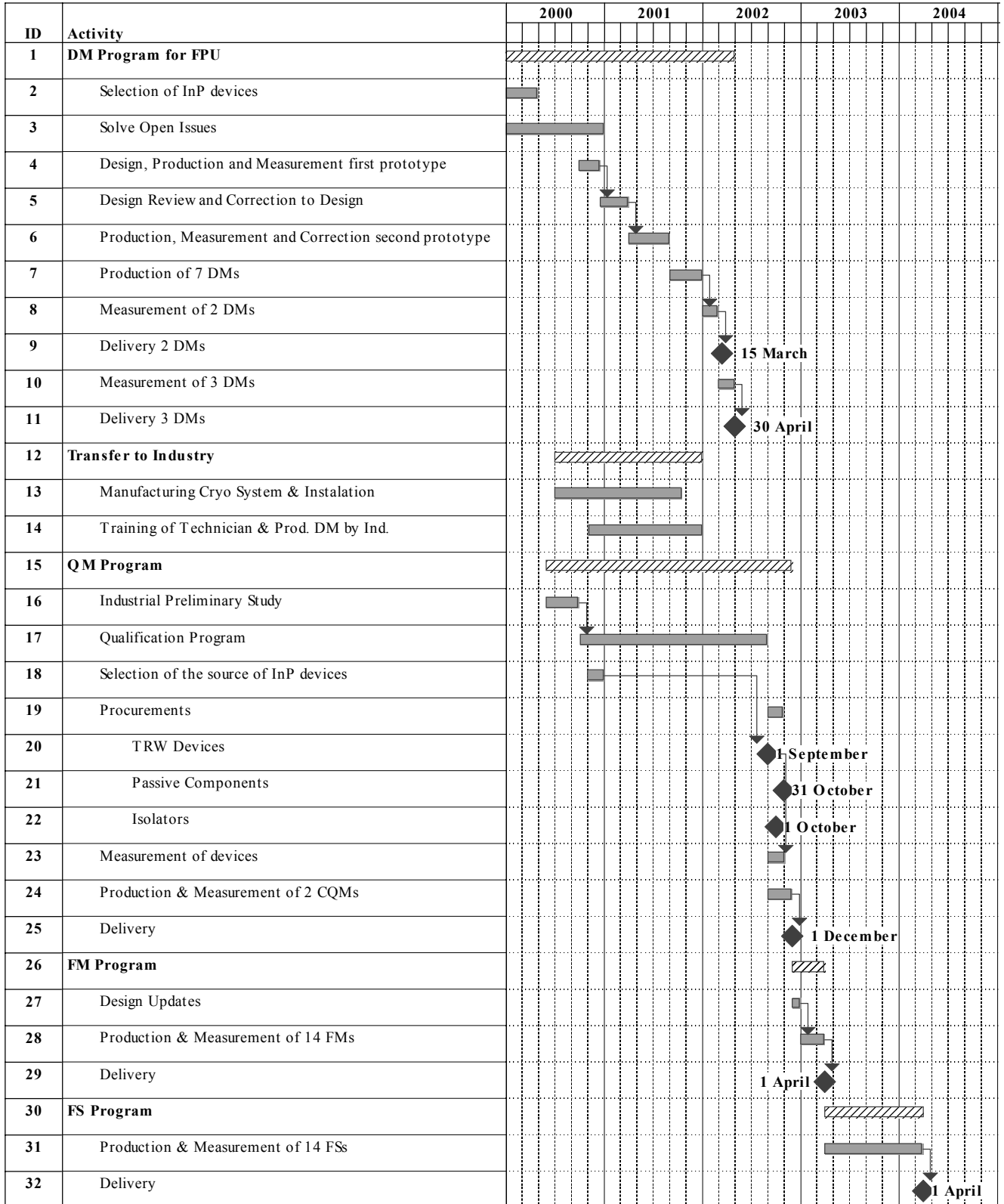
Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 10 of 9





CENTRO ASTRONÓMICO DE
YEBES

HIFI-FPSS

REPORT

Doc. no. : Yebes/FPSS/RP/2002-005

Issue : 1

Date : 13/06/02

Category : 3

Page : 11 of 9

3 TECHNICAL DIFFICULTIES

- **EMC and ESD filtering:** Filters for EMC and ESD are not defined yet. The EMC tests indicate the present DM IF-1 bias filtering is very good within the 4 – 8 GHz IF band and fulfils our needs. However, there is still a problem concerning amplifier bias noise rejection in the ~ 300 MHz to 1.5 GHz region. The EMC tests performed on DM hardware indicate that the filter performance in this frequency region has to be improved to allow us to meet the present (provisional) radiated susceptibility E-field rejection limit of 0.1 V/m. The drain filter should be redesigned to give a minimum rejection of 20 dB over the range ~10 MHz to 4 GHz with a goal of 30 dB.

The performance of the bias circuit for the DM amplifiers with an increment of the gate bias potential divider ratio from 10:1 to ~20:1 was simulated and the rejection between 10 MHz and 4 GHz was higher than 30 dB. Two test fixtures, where the drain and gate bias circuit will be implemented, are being fabricated in order to measure their response.

A discussion on ESD protection clamp diodes is needed. An Alpha Industry device – DMK-2308-000 – was suggested. The clamp device must be no more difficult than the HEMT to handle and must be bondable. Noted that the actual ESD limits and maximum ratings of the TRW HEMT's are unknown.

It is important to note that such filtering may require marginally increased dissipation in the amplifier. On the other hand, the use of the “filter” cavity on the underside of the IF-1 box for extra EMC/ESD filtering is barely possible and should be avoided since the space is occupied by the bias connector wiring and implementing a filter here would complicate assembly considerably.

- **Isolators:** Delivery of the DM amplifiers has been delayed due to problems in the fabrication and delivery of the Pamtech isolators.

Qualification and acceptance programs need to be defined.

- **Qualification:** Levels of qualification (Vibration, ...) for the IF1 amplifiers are being defined.

4 PROGRAMMATIC/FINANCIAL CONCERNS

The planning described in paragraph 2 is not realistic due to funding problems and Industry delays.

The money for **2001** is going to be paid in few days. Contract with Industry for the fabrication of the QMs and few FMs could be signed at the end of September. The Industry has given us an estimation for the fabrication, measure and qualification or acceptance tests of the amplifiers. The time schedule, once the substrates, structures and components are prepared, is as follows:

- 2 QMs with qualification tests: 5 months
- 2 QMs with acceptance tests: 2'5 months
- 14 FMs with acceptance tests: 10 months

This time schedule has not been accepted by the FPU. A meeting to optimise the schedule with Industry is going to take place on the 18th of June.