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| <br><b>CENTRO ASTRONOMICO DE YEBES</b> | <h1>REPORT</h1> | <b>Doc. no. : Yebes/FPSS/RP/2003-001</b><br><b>Issue : 1</b><br><b>Date : 07/02/03</b><br><b>Category : 3</b> |
| <b>HIFI-FPSS</b>  |                 | <b>Page : 1 of 11</b>   |

## PROGRESS REPORT FP S/S

### Sub-unit: Cryogenic IF Amplifier

Prepared by M. Carmen Diez

Date 07/02/03

Edited by Paul Wesselius

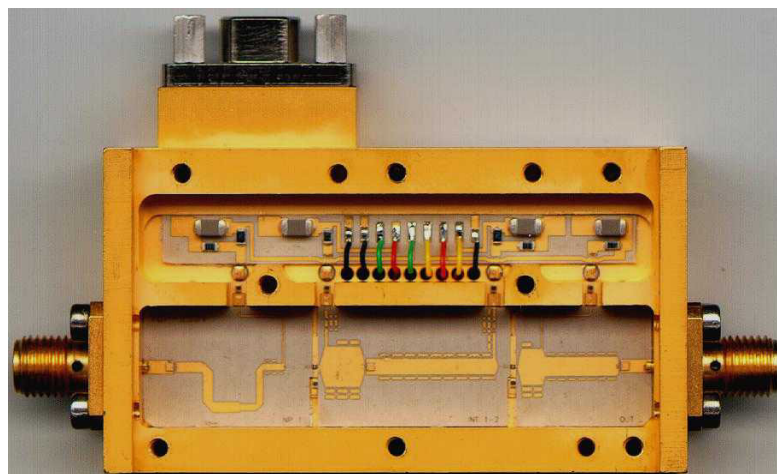
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**Reporting period: October 2002 - February 2003**

#### 1 PROGRESS DURING REPORTING PERIOD

- **DM Amplifiers**

Five amplifiers (Series YCF 6xxx) have been delivered together with the isolators and the coaxial cables that compose the complete unit to be delivered by Yebes for the DM program. Four additional amplifiers from the same series to be used by the mixer groups were also delivered. One of the prototypes is shown in Figure 1. The results of the measured prototypes were already shown in the last Progress Report and are summarize in Table 1 together with the specification.



**Figure 1.- YCF 6004 Amplifier**



CENTRO ASTRONOMICO DE  
YEBES

**HIFI-FPSS**

# REPORT

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

Issue : 1

Date : 07/02/03

Category : 3

Page : 2 of 11

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

**Table 1.- Results for amplifiers series YCF 6xxx, compared to the goal specification**

## • Isolators

- Three isolators more (CTH1365K10 A221) from the first DM batch were received at Yebes. They were measured at 15K and the results are shown in figures 2-4. Table 2 presents a comparison of the measurements obtained at 15 K with the specification at 77 K given by the manufacturer. The results were quite good although some resonances in  $S_{21}$  appears in Figure 3. These sharp resonances are real, and are even more prominent at room temperature. These resonances deteriorate  $S_{21}$ , but are not the limiting value for the worst case in the band. More information can be found in the document **Yebes/FPSS/TN/2002-003**. Once they were measured they were delivered to SRON together with three amplifiers and coaxial cables.
- Five isolators more from Pamtech were received at Yebes (CTH1365K10 A237) as the second DM batch. They have been measured at 15 K but the results (Fig. 5-9) were not satisfactory. Trying to find out if the problem was in the isolators or in the measurements set up, SRON sent back to Yebes an isolator from the first batch. It was measured again at Yebes and the results were good and similar to those got the first time. As a conclusion, the measurement set up is correct and there is a problem in the isolators of the second batch. The isolator from the first batch was sent back to SRON and three of the five isolators of the second batch were sent back to Pamtech in order to try an improvement of their performance.
- Isolators for the QM, FM and FS programs (QM:3 units, FM:10, FS:10, QA/PA:10) have been ordered. The qualification testing will be done at SRON. The electrical performance at 15K will be measured at Yebes.



CENTRO ASTRONOMICO DE YEBES

HIFI-FPSS

# REPORT

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

Issue : 1

Date : 07/02/03

Category : 3

Page : 3 of 11

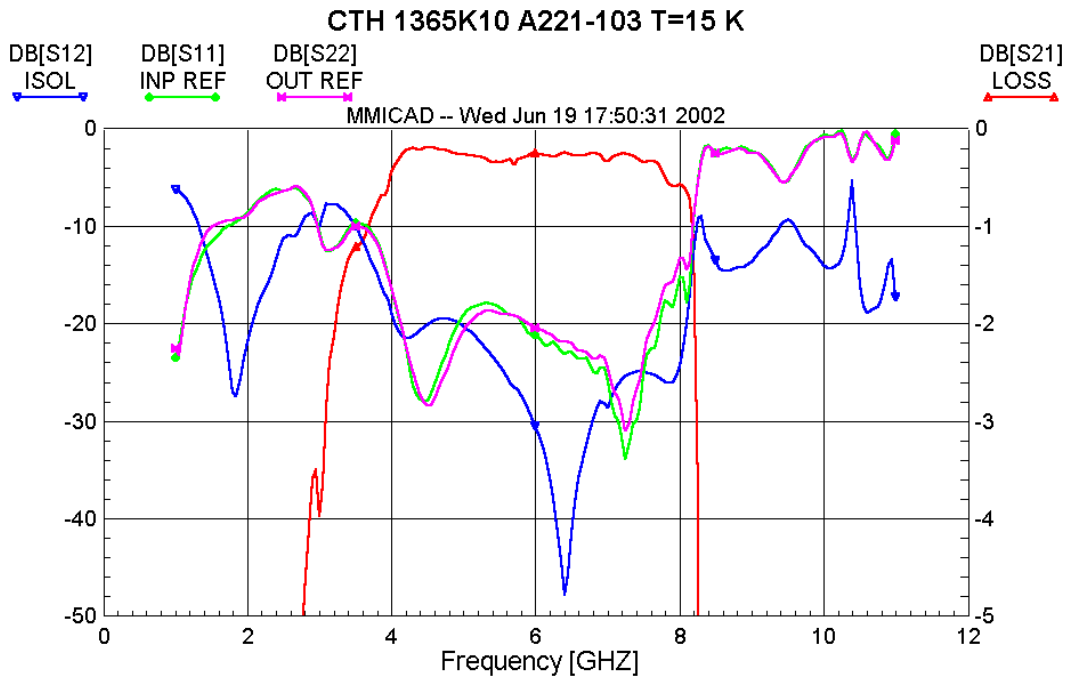


Figure 2.- Results for CTH1365K10 A221-103

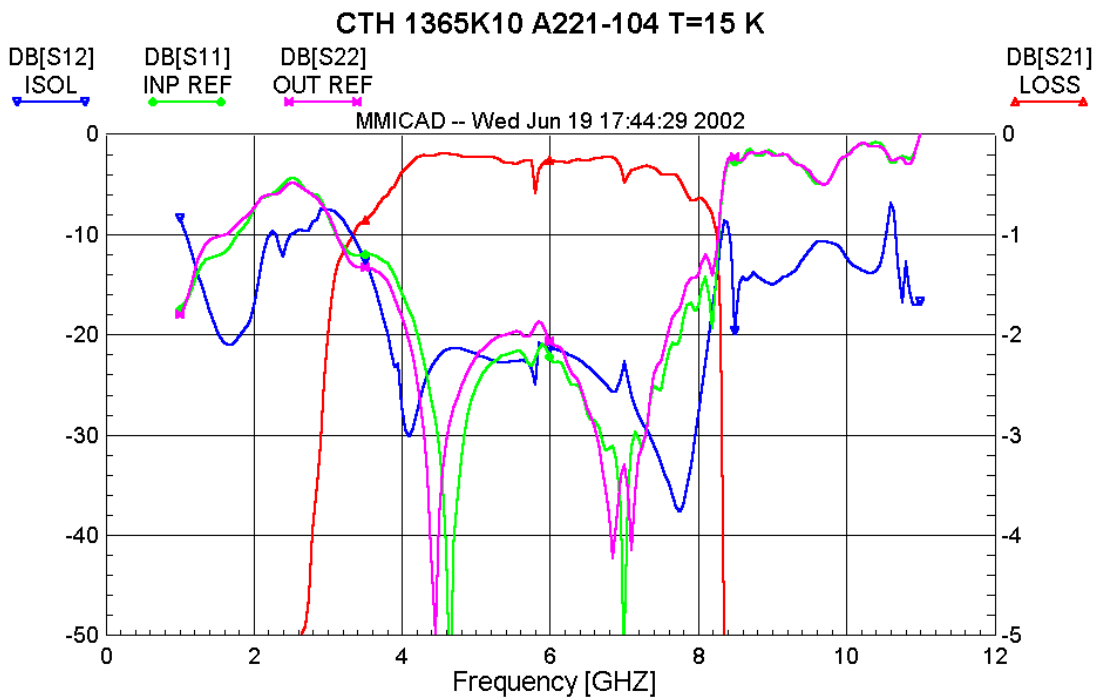


Figure 3.- Results for CTH1365K10 A221-104



CENTRO ASTRONOMICO DE  
YEBES

**HIFI-FPSS**

# REPORT

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

Issue : 1

Date : 07/02/03

Category : 3

Page : 4 of 11

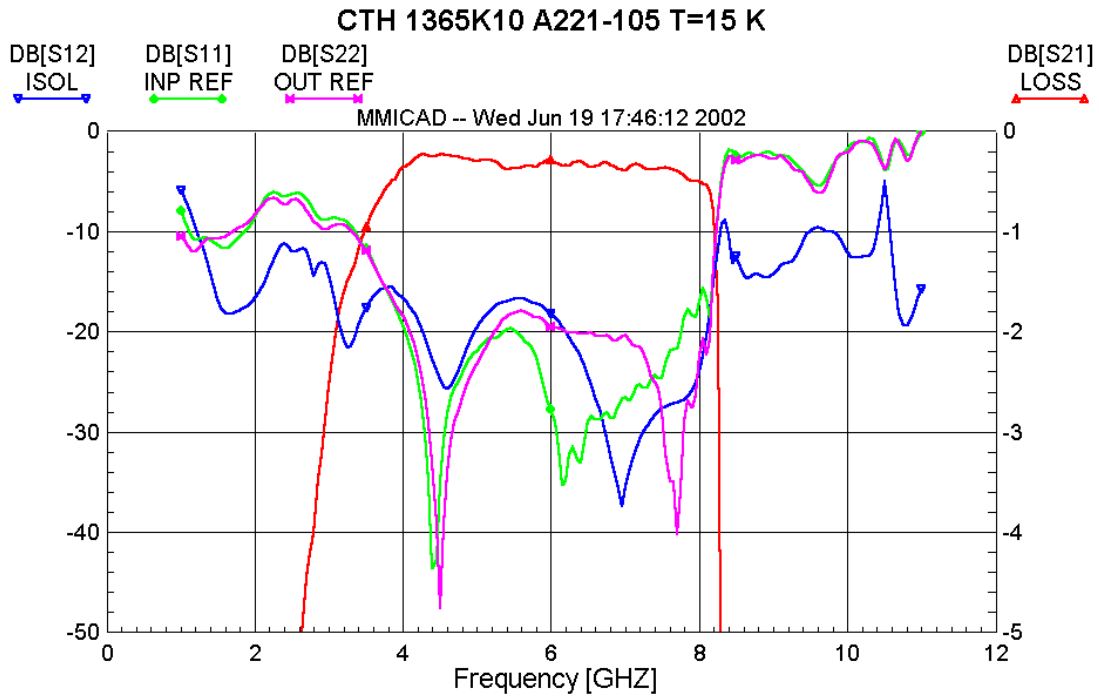


Figure 4.- Results for CTH1365K10 A221-105

| S/N   | MEASURED @ 15 K       |                       |                       |                       | PAMTECH DATA @ 77 K   |                       |                       |                       |
|-------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
|       | S <sub>11</sub> (dB)< | S <sub>12</sub> (dB)< | S <sub>21</sub> (dB)> | S <sub>22</sub> (dB)< | S <sub>11</sub> (dB)< | S <sub>12</sub> (dB)< | S <sub>21</sub> (dB)> | S <sub>22</sub> (dB)< |
| 103   | -15.1                 | -18.8                 | -0.59                 | -13.3                 | ?                     | ?                     | ?                     | ?                     |
| 104   | -15.8                 | -20.7                 | -0.66                 | -14.0                 | ?                     | ?                     | ?                     | ?                     |
| 105   | -16.9                 | -16.6                 | -0.50                 | -17.9                 | ?                     | ?                     | ?                     | ?                     |
| SPEC. |                       |                       |                       |                       | -17.7                 | -17.5                 | -0.40                 | -17.7                 |

Table 2.- Results for CTH1365K10 A237 Isolators



CENTRO ASTRONOMICO DE  
YEBES

HIFI-FPSS

# REPORT

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

Issue : 1

Date : 07/02/03

Category : 3

Page : 5 of 11

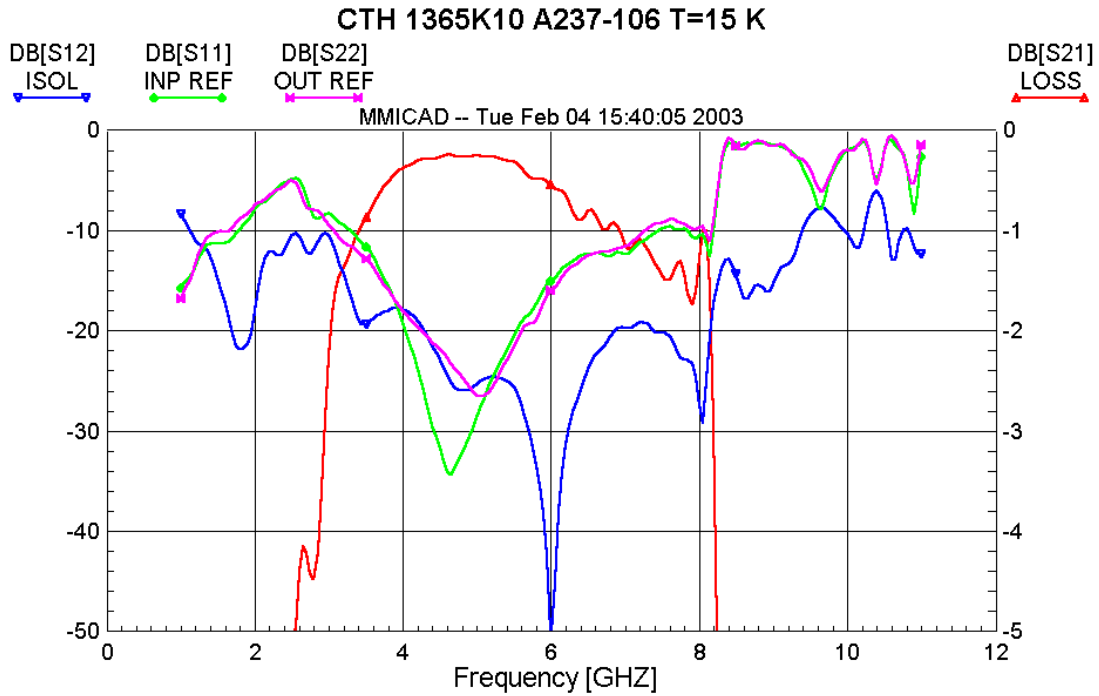


Figure 5.- Results for CTH1365K10 A237-106

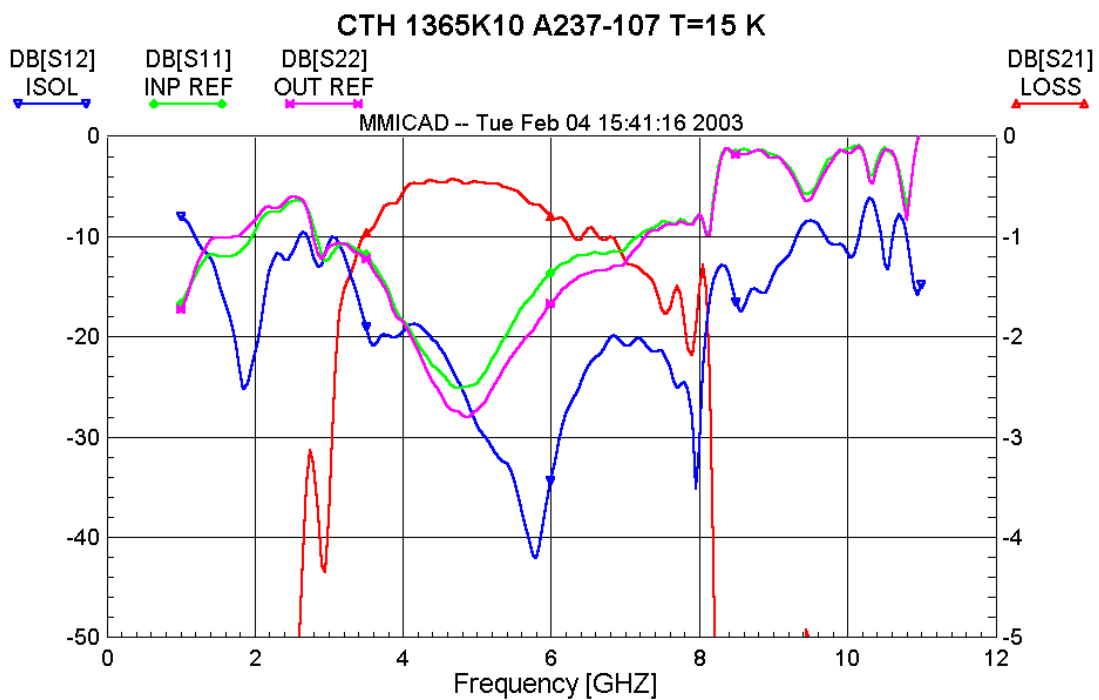


Figure 6.- Results for CTH1365K10 A237-107



CENTRO ASTRONOMICO DE YEBES

HIFI-FPSS

# REPORT

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

Issue : 1

Date : 07/02/03

Category : 3

Page : 6 of 11

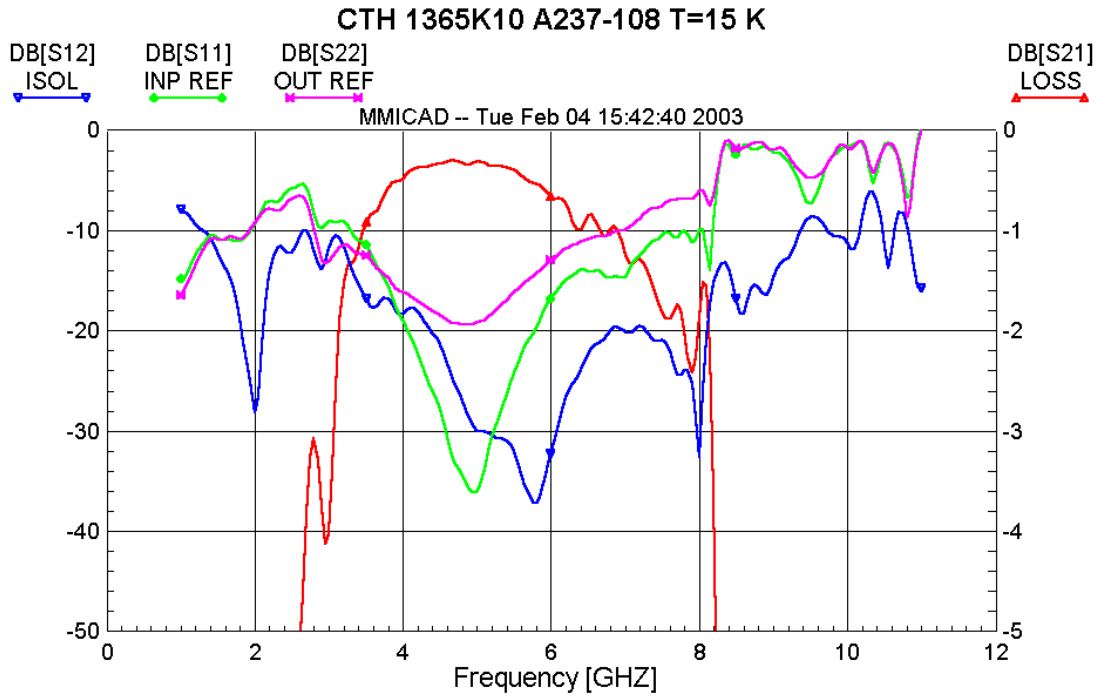


Figure 7.- Results for CTH1365K10 A237-108

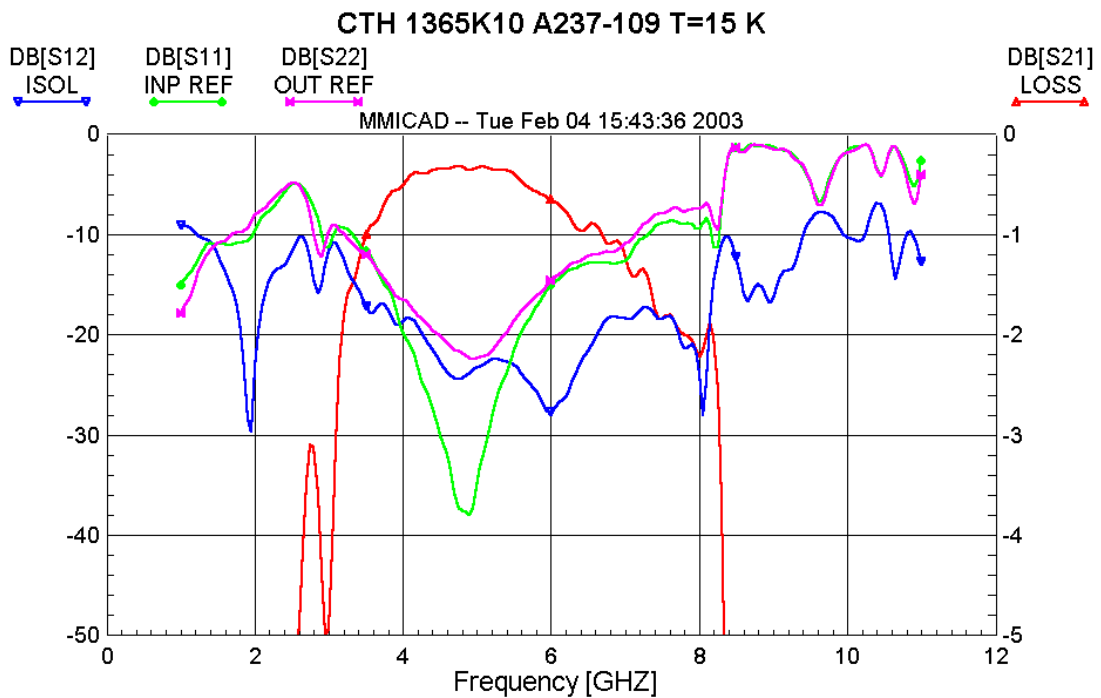


Figure 8.- Results for CTH1365K10 A237-109

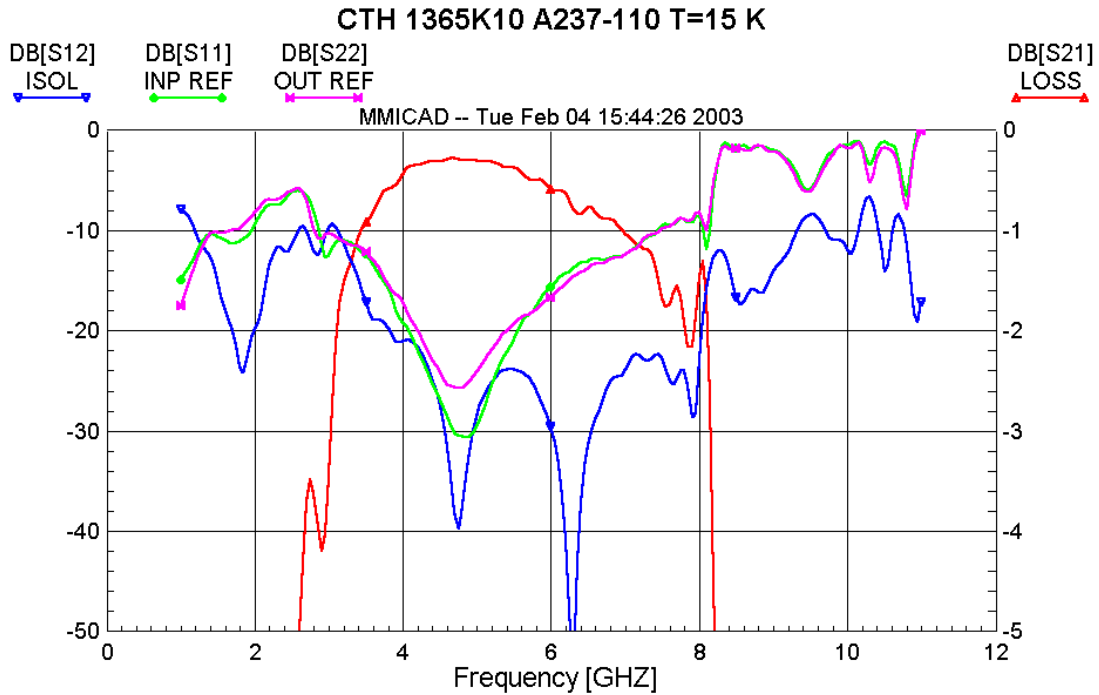


Figure 9.- Results for CTH1365K10 A237-110

• Bias Circuits

The bias circuit has been modified slightly to get the maximum EMC and ESD protection. The final version of the circuit is shown in Figure 10. This version has been approved by SRON (N. Whyborn and B. Joost)

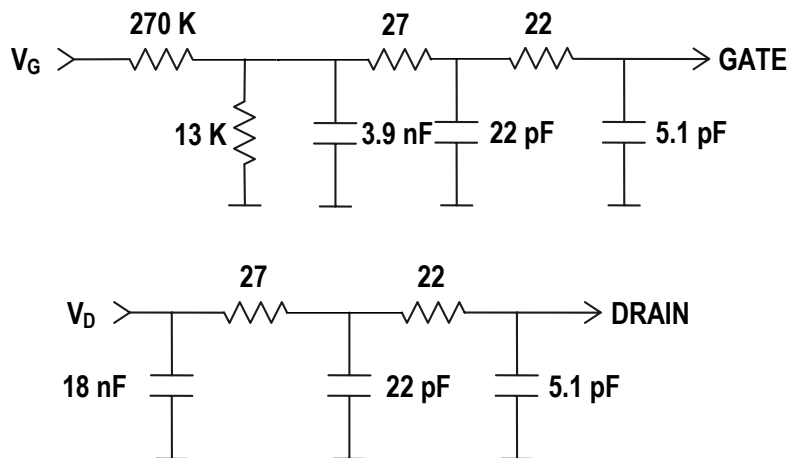


Figure 10.- IF1 Bias Circuit

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|---|----------------------|---|
|  <p><b>CENTRO ASTRONOMICO DE<br/>YEBES</b></p> <p><b>HIFI-FPSS</b></p> | <p><b>REPORT</b></p> | <p><b>Doc. no. : Yebes/FPSS/RP/2002-005</b></p> <p><b>Issue : 1</b></p> <p><b>Date : 07/02/03</b></p> <p><b>Category : 3</b></p> <p><b>Page : 8 of 11</b></p> |
|---|----------------------|---|

- **Qualification Program**

- The Industry is now finishing the fabrication of the boards for the qualification of components, processes and materials at cryogenic temperature. They will be sent to SRON before the 15<sup>th</sup> of February. The qualification will be done at SRON although extra qualification, especially in the processes associated to the connectors, have been done at the Industry. The results are presented in the document “*Gluing and Soldering for Cryogenic Temperatures Space Applications Qualification Report*” **AEO554591**. Components for the qualification boards and the QM units have been already bought with the exception of the 18nF to be included in the final bias circuit that will be ordered by SRON.
- The “*Environmental Testing and Evaluation for the HIFI FPU IFI*” document, **FPSS-00386**, is still under discussion mainly due to the open issues in the qualification of the HEMT wafers and the transistors. However, an agreement will be probably reached in few days.
- The ATP for the components has been updated with the new capacitors needed for the final version of the bias circuit and sent to the CPPA. If no new changes are done in the bias circuit, this will be the final version of the YEBES ATP.
- ESD tests were performed on different HEMT transistors using a Human Body Model (HBM). The discharge was applied only at the gate of the transistor since this is considered to be the most sensitive part of it. The degradation was monitored by measuring the Vd/Id curves of the transistor at ambient temperature. The protection of the bias circuit of a assembled amplifier using TRW 200×0.1μm InP HEMT devices was also estimated. The ESD sensitivity level of the TRW device tested was 45V. The protection circuit adds a factor of 840, giving a theoretical ESD sensitivity level of 37.800V at the DC connector. More details can be found in the document “*ESD Tests on InP HEMT Transistors*”, **Yebes/FPSS/TN/2002-014**.
- Radiation tests to TRW devices mounted on two one stage amplifiers were carried out at KVI in Groningen. Gain and Noise values were measured before and after the tests getting similar results and concluding that the radiation had not affected the devices.
- Documentation for the CDR is being prepared. The CDR will take place once the results from the qualification boards have been obtained and the PID has been updated.





CENTRO ASTRONÓMICO DE  
YEBES

**HIFI-FPSS**

# REPORT

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

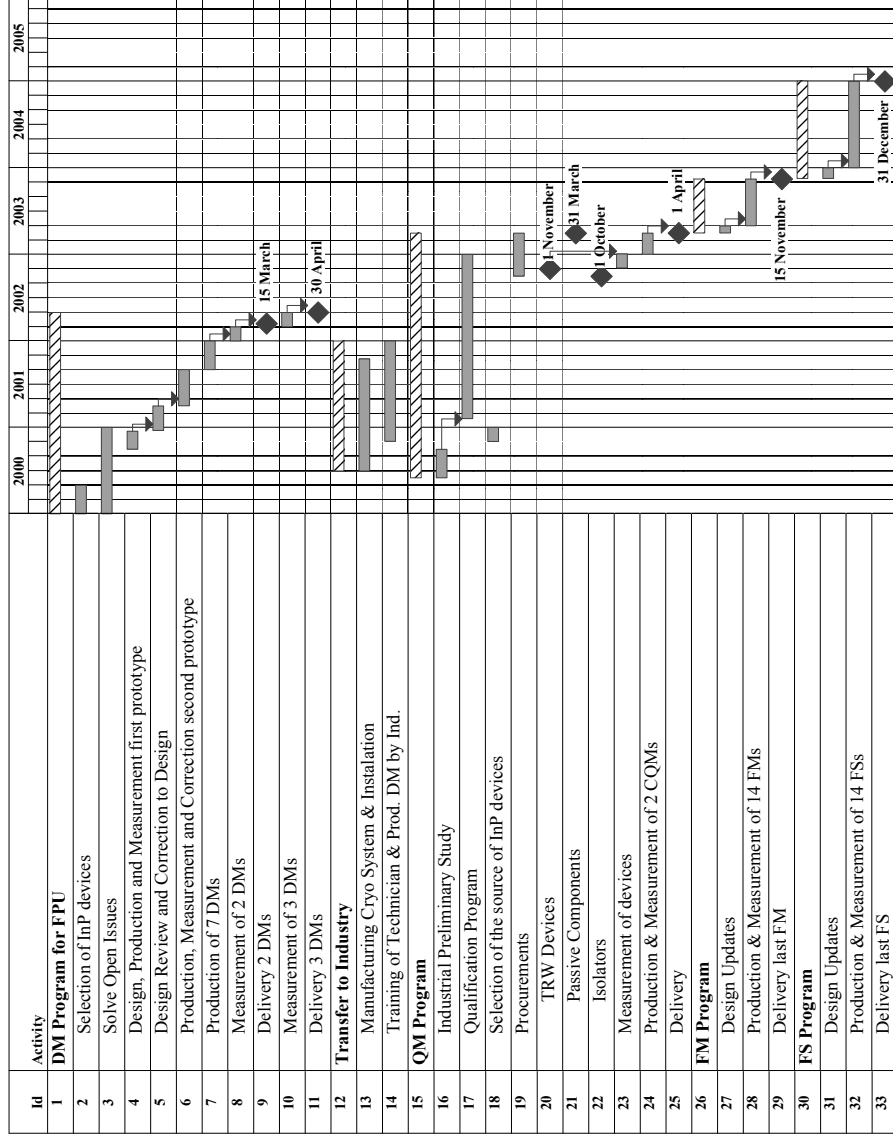
Issue : 1

Date : 07/02/03

Category : 3

Page : 9 of 11

## 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 : 07/02/03

Category : 3

Page : 10 of 11

### 3 PROGRAMMATIC/FINANCIAL CONCERNS

Problems in the bands using Hot Electron Bolometers have led to a change in the IF band. As a consequence the amplifiers for those bands need to be redesigned for the new frequencies (2.4-4.8 GHz). SRON is responsible of the design but Yebes will be responsible of the fabrication in the Industry. It is planned to have a design at the end of February and after doing the transfer of the new design to the Industry, two DMs should be ready in mid June. The total number of FM units will be the same (14) but the number of DMs and QMs will increase. Yebes has to face the challenge of fitting this into the present budget and schedule.

#### Financial Concerns

Yebes funding status is as follows:

- The current contract with Alcatel includes the production of 2 QMs for qualification, 2 QMs for acceptance and 7 FMs.
- Additional funding for year 2003 has been approved. About 1/3 of it has been delivered, but it is not enough to sign a new contract with Alcatel. Moreover, the SRON design of the second IF-1 (2.4-4.8 GHz) is not finished yet so we cannot proceed with our negotiations with Alcatel to get an estimate of costs, in particular for the conversion or new design of some parts of the amplifier (box, ...).
- The second contract with Alcatel will include the production of the second IF-1: 2 DMs of some sort and 4 FMs. We plan to include the production of 3 FM units of the first IF-1, to finish the set of 10 FMs units with 4-8 GHz band. Due to the cost increase caused by the production of the second IF-1 (2.4-4.8 GHz), it is highly unlikely that we will be able to produce any FS amplifier during 2003. A working design of the second IF-1 not too different of the first IF-1 is required in order to avoid unsurmountable technical difficulties in producing the second IF-1, and to produce it at a similar cost.

#### Planning

The planning described in section 2 agrees completely with the FPU need dates but it is not realistic due to Industry delays. Alcatel schedule for the fabrication, measurement, qualification and acceptance tests of 4 QMs and the first 7 FMs (contract already signed) is shown in Figure 11. Iterations with Alcatel are taking place in order to optimise the total delay. Note that a second contract will be running parallel to this one once the second contract is signed, leading to new delays in the delivery dates specially if the design of the second IF1 (2.4-4.8 GHz) is very different from the 4-8 GHz one.



CENTRO ASTRONÓMICO DE YEBES

HIFI-FPSS

# REPORT

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

Issue : 1

Date : 07/02/03

Category : 3

Page : 11 of 11

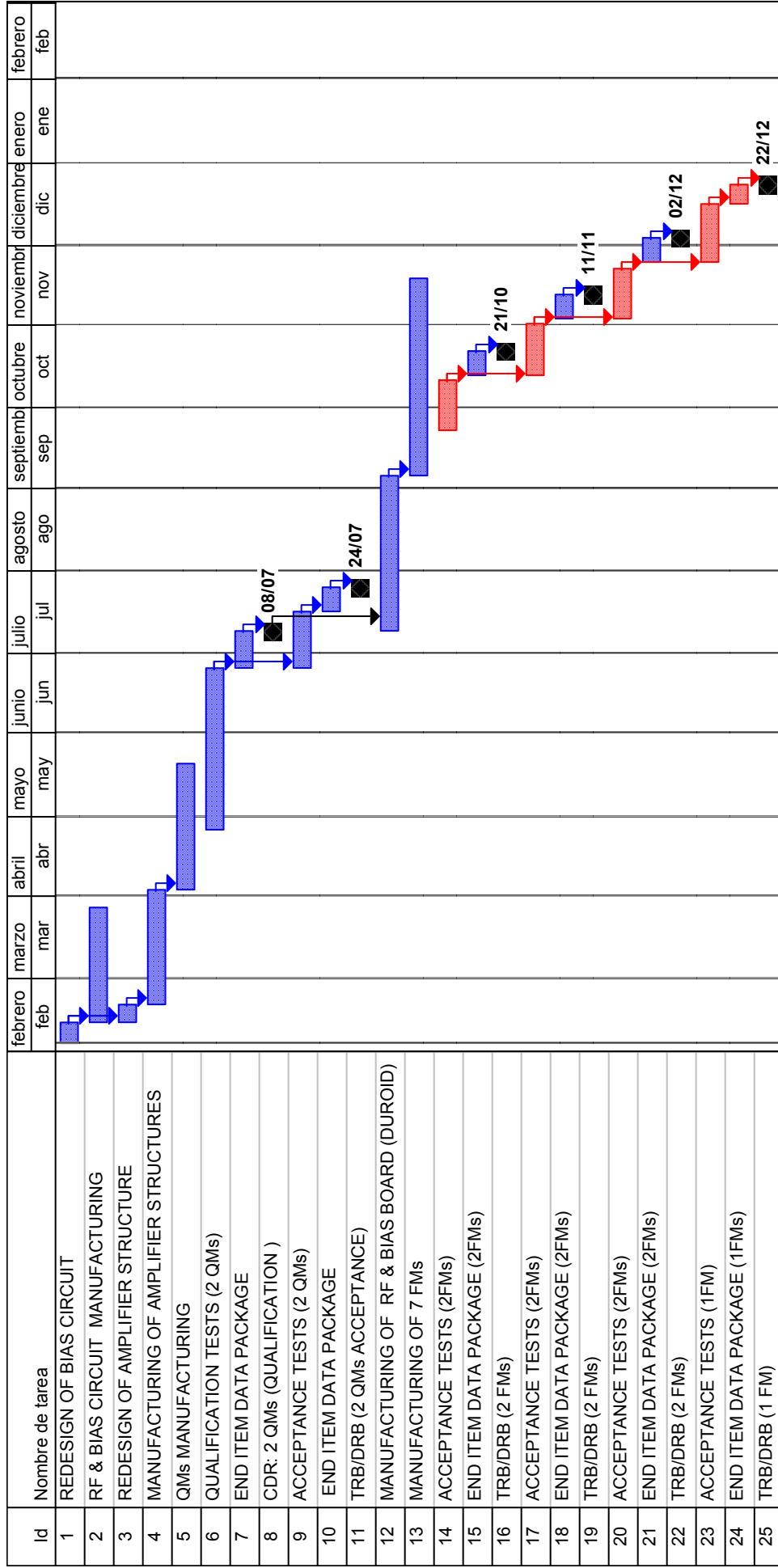


Figure 11.- Alcatel Schedule for the contract already signed