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**HIFI Critical Items**

**Status and Approach of Critical Items**

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Issue 2

SRON-U/HIFI/PR/1999-008; Listing and control of Critical Items. <http://www.sron.nl/hifi/>

**Generic:**

There are many items open, or items partly visible but with not sufficient visible or documented information that allows implementation in a Critical Items List.

**Reference or base line for observations:**

PDR presentation on critical items on April 27, 2001

All EEE components procured through the CPPA are for the purpose of the critical items control not considered as critical items.

**FMECA**

**FMECA status:** SRON-U/HIFI/RP/2000-001 iss.1.1 (30-03-2001)

**FMECA related items:**

- Chopper: Containes pivots,
- Calibration source: PID for assembly is beeing developed.
- Diplexer mechanism: Containes pivots.
- Local Oscilator Source Unit: The LSU has been redesigned, impact on the FMECA is unknown.

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**Reliability or Qualification Status Items, self manufactured or self procured**

**Focal Plane Unit:**

**Mixers:**

A review has been performed recently to assess the PID status and the PID qualification status of the mixer designs, with the exception of mixer band 6L that will be reviewed later.

For all the mixer units prequalification items concerning parts, materials and processes has been identified. For some mixer groups controls has to be implemented as required by the PA plan.

The PID status varied largely from group to group.

Some items such as the evaluation and application of components and interconnection technology versus substrate and clamping approach will be coordinated by the Focal plane S.S.

**Pivots:** See also above. No procurement spec., procurement source and evaluation program visible, but alternative sources are being reviewed.

**Calibration source:** See also above.

- PID under development, semiconductor temperature sensor will be evaluated also for radiation and PAD for temp. sensor to be issued.

**Isolator/circulator PAMTECH:** PAD/PID under development.

**Intermediate Frequency Amplifier 1:**

- InP HEMT transistors from TRW: No formal status available concerning evaluation and qualification. Verbal information (JPL) has been provided that TRW has performed qualification on a wafer lot for a user outside HIFI, but no procurement spec. and qualification base line visible.
- The combination substrate/components/interconnection technology to be defined and evaluated/qualified, also versus the substrate clamping technology.
- PAD for passive components to be applied outside their qual. temperature range has been issued, see further the interconnection technology evaluation.

**Intermediate Frequency Amplifier 2:**

- Design status is open.
- PAD for GaAs transistor has been rejected (power consumption).

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**Local Oscillator unit:**

- Varactor dice: Applied in frequency multipliers assembled, either by JPL or RPG. JPL PID under final development and qualification approach is visible.
- Varactor, discrete: Applied by MILLITECH for a frequency multiplier. Screening and qualification approach is visible. PAD to be issued.
- Frequency Multipliers: Assembled by JPL, PID under development and qualification approach is visible.
- Frequency Multipliers: Assembled by RPG, no visible PID and qualification approach.
- Frequency Multiplier: Assembled by MILLITECH. PID under development and qualification approach is visible
- High Frequency Amplifiers: Manufactured by TRW. Procurement specification, including qualification approach and PID base line from JPL, is visible.
- Isolators, designed by JPL/MILLITECH and manufactured by MILLITECH, presently under development.
- Isolator designed and manufactured by MILLITECH, presently under development, awaiting PDR documentation confirming also PID status.

**Local Oscillator Source Unit:**

- The unit contains mainly electronic components and some of them are not available from qualified sources but have a successful application history. Some components require further development. Further development of the component list will be undertaken. At present a preliminary list is available. A number of components will be procured through the project CPPA, the remainder will be self procured by COMDEV. PAD have been requested

### Wide Band Spectrometer:

- Bragg cell: Procurement specification and qualification approach is visible.
- CCD: PAD covering procurement evaluation, assembly PID and qualification is visible. Sensitivity to radiation is high, 2 KRad Si, and requires further confirmation and requires evaluation of shielding.
- Solid State Laser: PAD covering screening and qualification is visible.
- ASIC, digital, CMOS: PAD is under development. Open items concerning qualification to be closed and implemented.
- Intermediate Frequency Modules: The PAD summarising the acceptance approach for the components is under development. The PID for the module assembly is being developed.
- Power supply modules (hybrids): The WBE procurement approach is at present open but procurement through the CPPA is being considered. PAD has been requested by HIFI to cover the procurement approach.

**High Resolution Spectrometer:**

- Recent redesign or descoping, impact on components list.
- Intermediate frequency Modules: No formal, confirmed approach visible.
- ACS: PAD sheets of a GaAs ASI and a CMOS ASIC has been made available and are being processed.
- There is no visibility on the procurement approach of the power supplies.



## Definition of Critical Items

**On HIFI consortium level, a start has been made with the identification and tracing or follow-up of critical items.**

**In order to control the identification of critical items and in order to enable prioritising the related initial efforts, a more formal definition has been established.**

**All this is in support of the effort, to have components and subassembly designs evaluated and qualified prior to application in qualification and flight equipment.**

**Table 1: Summary of critical items and documentation approach**

Ref.	Critical item definition	Summary of proposed control documentation
1	New or unique technology items and electrical or mechanical components designed and manufactured in the HIFI consortium	<ul style="list-style-type: none"> <li>- Design specification</li> <li>- Development and qualification plan</li> <li>- Process Identification Document</li> <li>- Facility review</li> </ul>
2	EEE components from non qualified sources	<ul style="list-style-type: none"> <li>- Request for approval (PAD sheet), component and manufacturer evaluation plan</li> <li>- Procurement specification dedicated to actual procurement approach and actual manufacturer, including Lot Acceptance Test plan</li> <li>- Process Identification Document to be established at the manufacturer.</li> </ul>
3	EEE components and mechanical components used outside their qualification limits	Request for approval (PAD sheet), component evaluation plan, Lot Acceptance Test plan for the specific application
4	Materials and processes applied outside qualification limits	Request for Approval, evaluation and qualification plan
5	Items/components identified through FMECA as single point failures	Development plan(for new or unique technology item), qualification plan; system, subsystem or assembly design description and evaluation of alternatives
6	Long lead items with a lead time in excess of 12 month or items that will have to be ordered prior to the Preliminary Design Review	All activities as applicable (see critical item definition references 1-5) shall be started and results and documentation shall be accepted prior to ordering or starting flight hardware. Relevant dates or milestones shall be identified in the subsystem, supplier or subcontractors planning.

(SRON-U/HIFI/PR/1999-008; Listing and control of Critical Items.)

**Criticality classification:**

**A: Reliability**

**B. Performance**

**C: Single point failure**

**D: Manufacturing, reproducibility**

**E: Procurement, availability**

**F: Handling and storage and/or ESD sensitive**

**G: Organizational/programmatic critical/availability**

(SRON-U/HIFI/PR/1999-008; Listing and control of Critical Items.)

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## Indication of critical items

**Formally, critical items are considered to be identified from:**

- **Block and circuit diagrams: Detection of Single point failures and evaluating redundancy considerations\***
- **Components, materials and processes lists: Evaluation of reliability and qualification status**

**However, real life is different.**

**Most of the critical items are already visible from the very beginning of the project and a lot of work has already been done to define and document design approach, hardware approach and the qualification or evaluation approach. In addition, a lot of information has emerged as a result of the recently held Sub System Preliminary Design Reviews.**

\*In support of this, a FMECA has been performed and is maintained on HIFI System level reference: Failure Mode, Effect and Criticality Analysis at system level, SRON-U/HIFI/RP/2000-001

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## Critical Items list

**An effort has to be made to provide an overview of the status of already known critical items and to provide a baseline for indicating other critical items that are less obvious or may not be recognised as such at a local level.**

**In order to trace the status of the definition and the status of acceptance of design or selection, a list will be established and maintained by HIFI System. The list will show the documented approach for the critical items, subsequently it will show the status of the design, hardware control and evaluation or qualification results.**

**The Critical Item approach will be subject of discussion between the sub systems and the HIFI System, also based on quality requirements as established for the project and taking established redundancy considerations into account.**

**Based on the acceptance or positive outcome of the respective steps, the criticality may be closed.**

### Balanced approach

**As identified earlier, most of the critical items do require additional effort early in the program to insure that programmatic, performance and quality requirements are met at a later stage in the program.**

**In the end, a balanced approach with respect to reliability has to emerge, with respect to items considered critical and items considered non-critical.**

**EEE components processed through the co-ordinated procurement.**

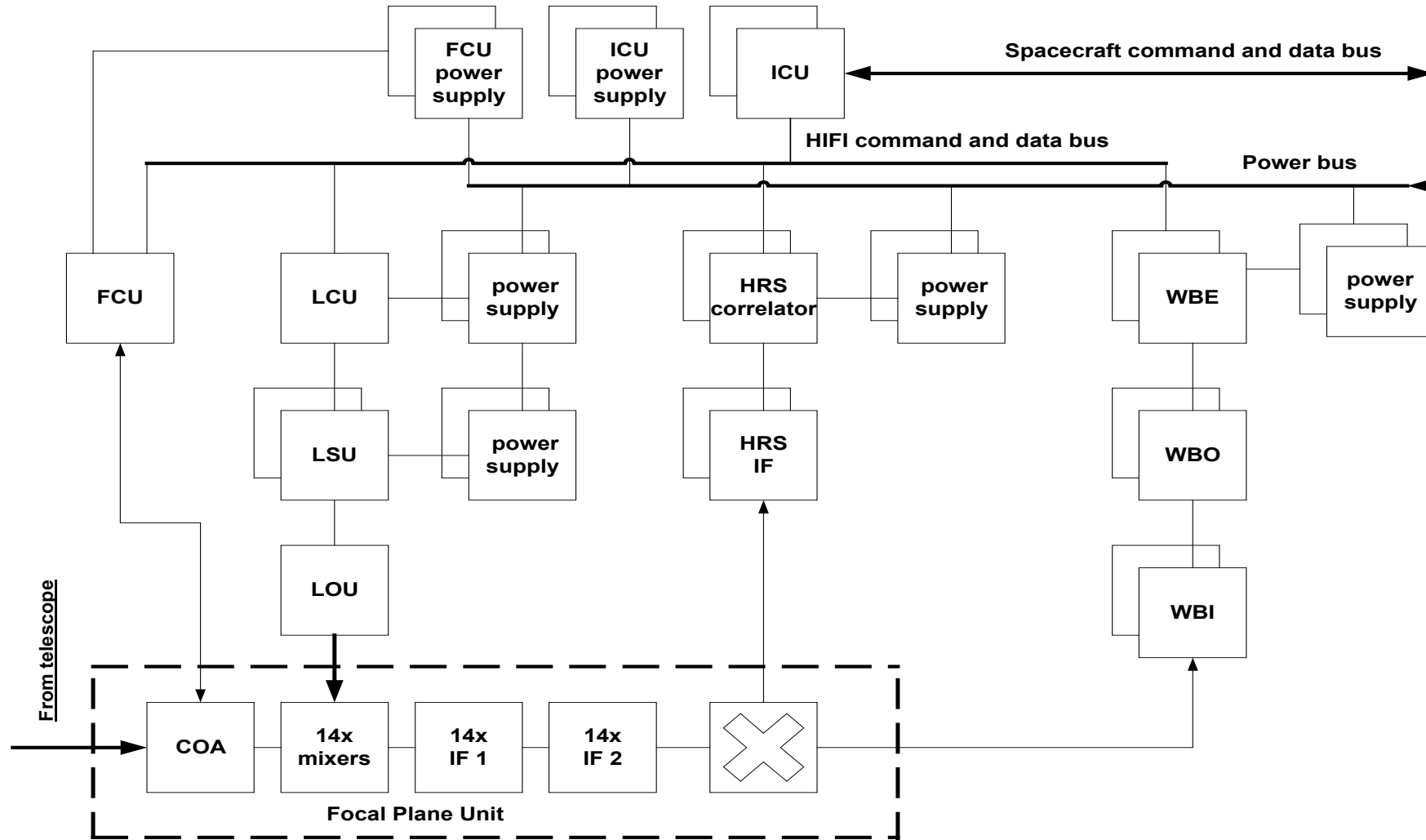
**For obvious reasons EEE components, based on the presented criticality definition, might be defined as critical items, will not be considered as such when they are processed through the co-ordinated procurement. (FPCB and ESA controlled procurement Agent)**

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**Where are the critical items located within HIFI**



## Simplified block diagram of HIFI



### FMECA related items

The Focal Plane Unit is the only unit that does contain realistic “Criticality Index 1 and 2 Failure mode” items.

- Chopper, mainly because of the pivots (FMECA cat.2 failure)
- Calibration source, (FMECA cat. 2 failure)
- Diplexer mechanisms, mainly because of the pivots.(FMECA cat. 2 failure)
- Thermal straps.(FMECA cat. 1 and 2 failure)

The Local Oscillator Source Unit has a Criticality Index 2 Failure Mode\* in the coupler/splitter at the end connection of the 2 redundant synthesisers

\* Failure Mode, Effect and Criticality Analysis at system level, SRON-U/HIFI/RP/2000-001

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## Criticality Index of the assumed failure mode

(Failure Mode, Effect and Criticality Analysis at system level, SRON-U/HIFI/RP/2000-001)

**1= Failure propagation towards on board equipment outside the HIFI instrument**

**2= Full loss of HIFI functions**

**3= Sensible degradation of HIFI functions**

**4= No degradation of HIFI functions**

### With Criticality Index Suffix:

**SP= no redundant function available**

**R = redundant function available**

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## Reliability or Qualifications Status related Items

The Focal Plane Unit does contain mainly new or unique technology items both mechanical and electronic. In addition, EEE components (standard passive components) are applied that are used outside their qualification limits. Depending on the application location (organisational) also materials and processes have to be considered critical that do require a further qualification effort, in particular with respect to the extreme low temperature application and associated cycling.

Main new or unique technology items:

- Mixers from several sources.
- IF amplifiers (4-8 GHz) from YEBES and ETH, containing InP HEMT.
- InP HEMT discrete transistors from YEBES and TRW.
- Isolators/circulators (4-8 GHz) by PAMTECH.
- Chopper; (FMECA cat.2 failure), also containing pivots.
- Calibration source; (FMECA cat. 2 failure).
- Duplexers; (FMECA cat. 2 failure), containing pivots.

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**Reliability or Qualifications Status related Items, continued:**

**The Local Oscillator unit contains also mainly special designed, special manufactured, new technology items that are considered as critical items:**

- **Multipliers, based on varactor diodes manufactured by JPL and assembled/ tested by JPL or RPG: design, manufacturing and reliability critical.**
- **Multiplier, manufactured, tested and qualified by MILLITECH.**
- **Isolators, manufactured, tested and qualified by MILLITECH.**
- **EHF power amplifiers also containing GaAs MMIC, designed by JPL/TRW and manufactured, tested, and qualified by TRW: design, manufacturing and reliability critical.**

**In addition a number of process and materials items as applied in the LOU do need further attention.**

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**Reliability or Qualifications Status related Items, continued:**

**It is expected that the Local Oscillator Source Unit is mainly made-up of EEE components, available on the market.**

**However, formal qualified high frequency EEE components are rare, but components with a successful application history are certainly available from several sources. This makes the LSU EEE components reliability/procurement critical.**

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Reliability or Qualifications Status related Items, continued:

**From a management point of view, the Control Units (ICU, FCU, LCU) should not contain critical hardware items. This is confirmed at review of the EEE components lists and is largely due to the co-ordinated component selection and procurement effort on Spacecraft level.**

**The Wide Band Spectrometer contains the following items considered critical:**

- **The Bragg cell: procurement critical, special production and single source.**
- **The 4 lines CCD: special new design, evaluation required, reliability and procurement critical.**
- **The Solid state Laser: only available as commercial product from a single source, in-house up screening, reliability critical also because of the intrinsic limited life time under power (2 lasers are foreseen in cold redundancy).**
- **The 14 bit ADC, 800 KSPS: reliability and procurement critical, not available through the co-ordinated procurement at this moment.**
- **ASIC, Digital, CMOS, reliability and procurement critical.**

**Further EEE components as required may be available through the CPPA.**

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**Reliability or Qualifications Status related Items, continued:**

**The Intermediate Frequency unit (IF) and the correlator (ACS) of the High Resolution Spectrometer are solely made up of EEE components.**

**A number of components for the IF and ACS is available through the CPPA. In the ACS, 3 ASIC designs are being applied:**

- **ASIC, Digital, CMOS, reliability and procurement critical**
- **ASIC, Digital, GaAs, reliability and procurement critical**
- **ASIC, Analogue, GaAs, non complex, reliability and procurement critical**
- **ASIC of respective designs, assembled in multi chip modules, also critical because of power consumption and critical heat flow/thermal design. Manufacturing/reliability critical.**

**The IF unit contains high frequency components that are not available through the co-ordinated procurement, among them custom VCO designs, multi chip modules and special packaging: procurement and reliability critical.**



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Reliability or Qualifications Status related Items, continued:

### Power supplies

As will be observed from the HIFI hardware block diagram, power supplies are being applied in all HIFI sub systems. They require special attention, in particular when hybrid modules are being applied.

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**Page for notes and remarks:**