

Prototyping a SOC on RTAX4000D for Solar Orbiter's Low Frequency Receiver



SEFUW : Space FPGA Users Workshop

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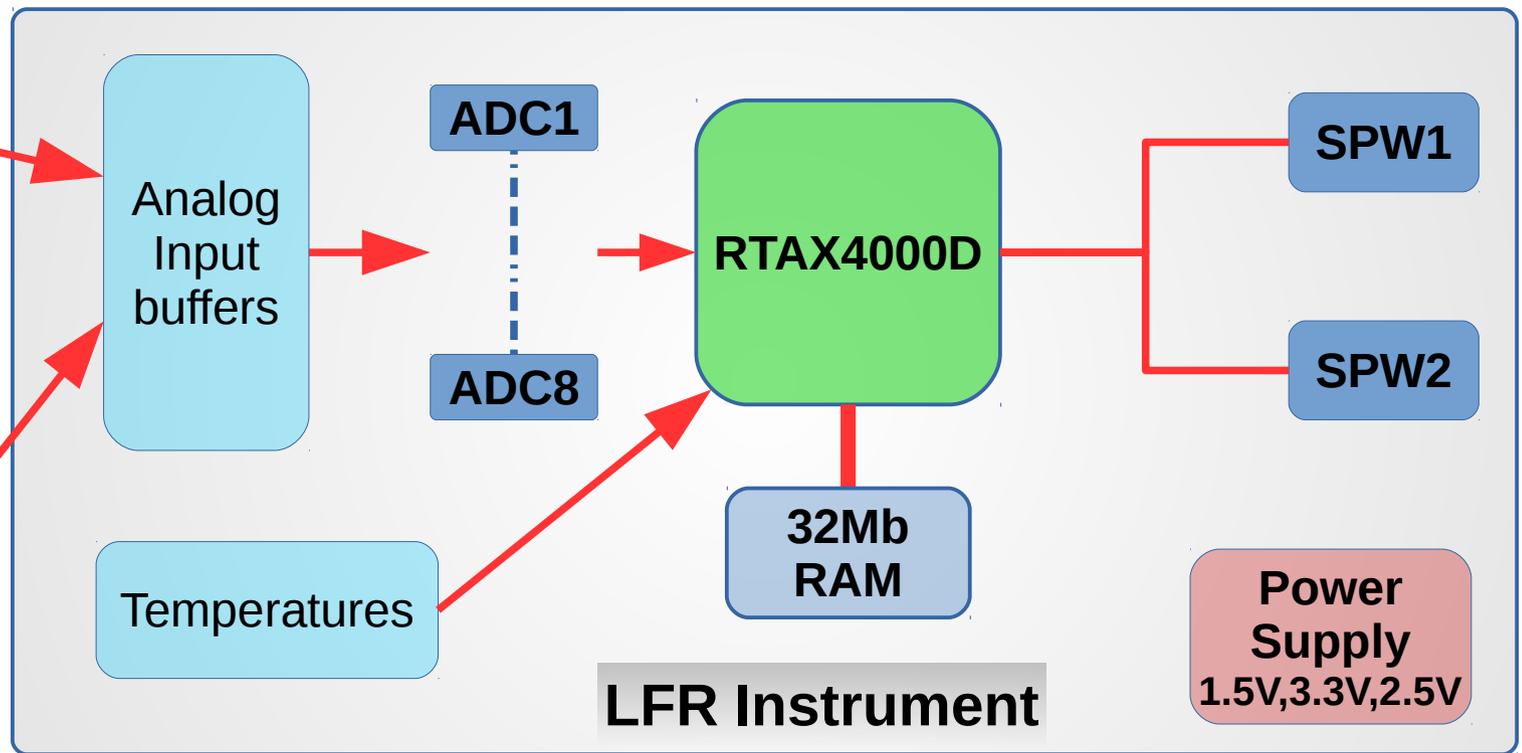
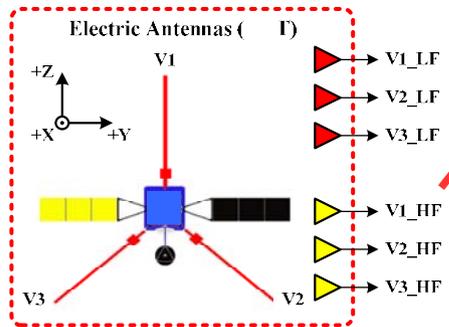
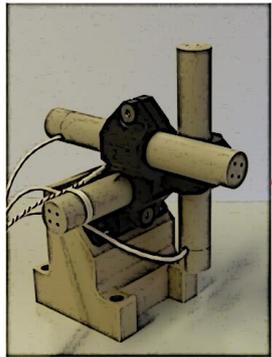
Vincent Leray



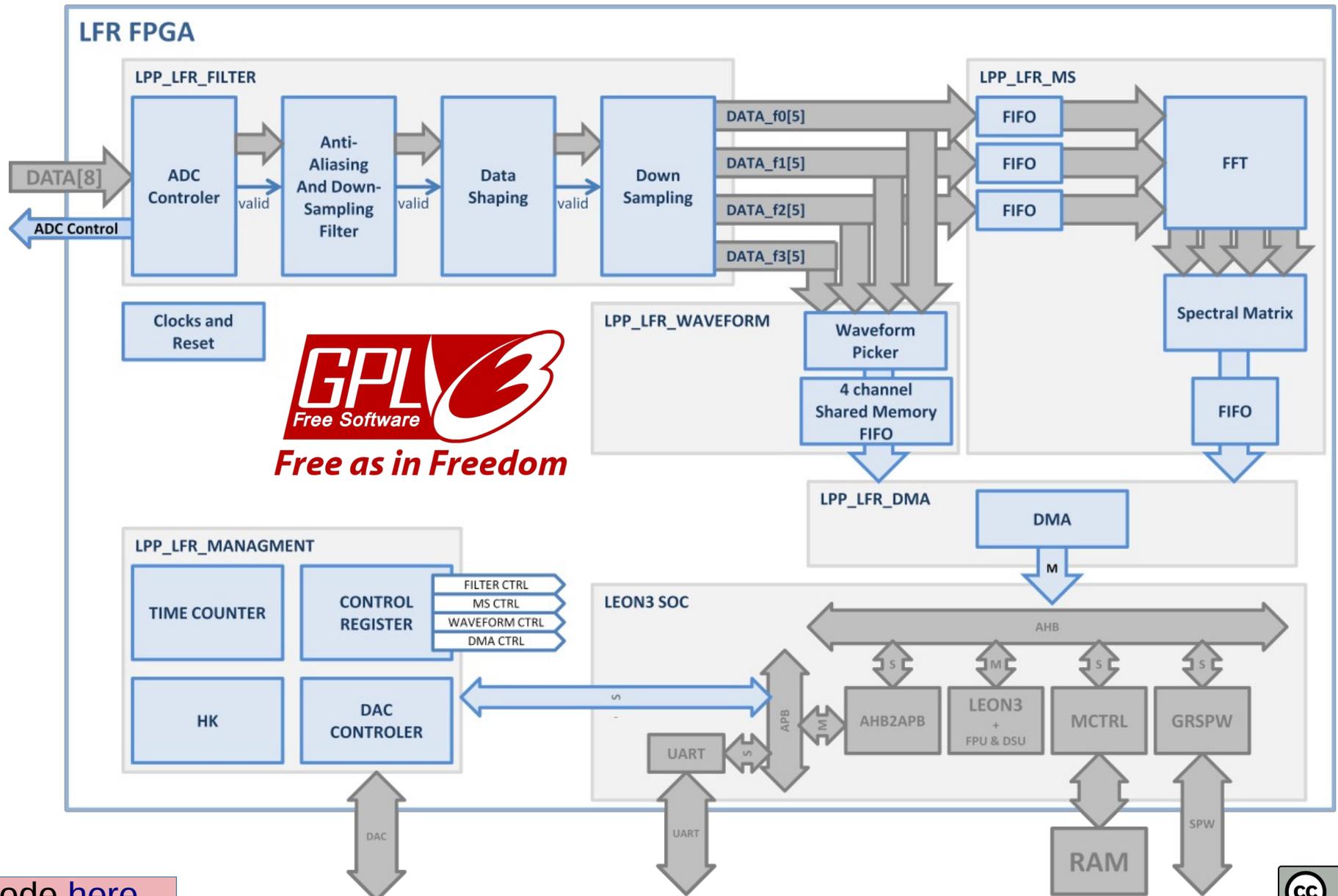
ÉCOLE
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UNIVERSITÉ PARIS-SACLAY



LFR Instrument



LFR System On Chip



Get code [here](#)

Why RTAX4000D?



Vs RTAX2000D

- Mostly memory blocks
- Then logical resources
- Timings

Vs Virtex-5QV

- Static power consumption
- Really big
- Package soldering difficult to qualify

Prototyping philosophy



EM
March 2011



RAM-Test
Aug 2014



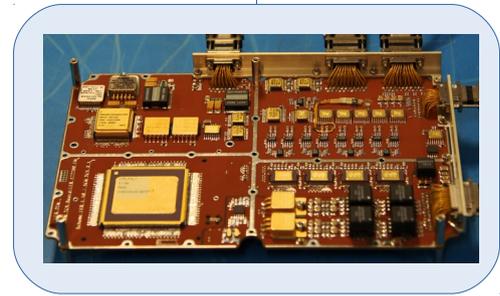
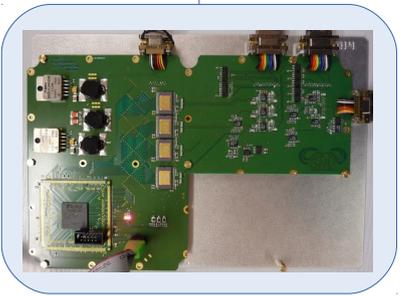
PFM
March 2016

DM
May 2010

Mini-LFR
Nov 2013

EQM
Feb 2015

SPARE
Q2 2016



A3PE for prototyping ?



- **Enough RAM blocks for our needs**
- **Less cells but enough for incremental dev**
- **Performances are close to RTAX**
- **Same tools**
- **Power consumption is the same order**
- **Package smaller**

Prototyping EM



EM
March 2011



RAM-Test
Aug 2014



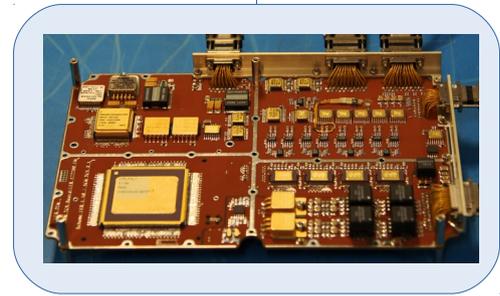
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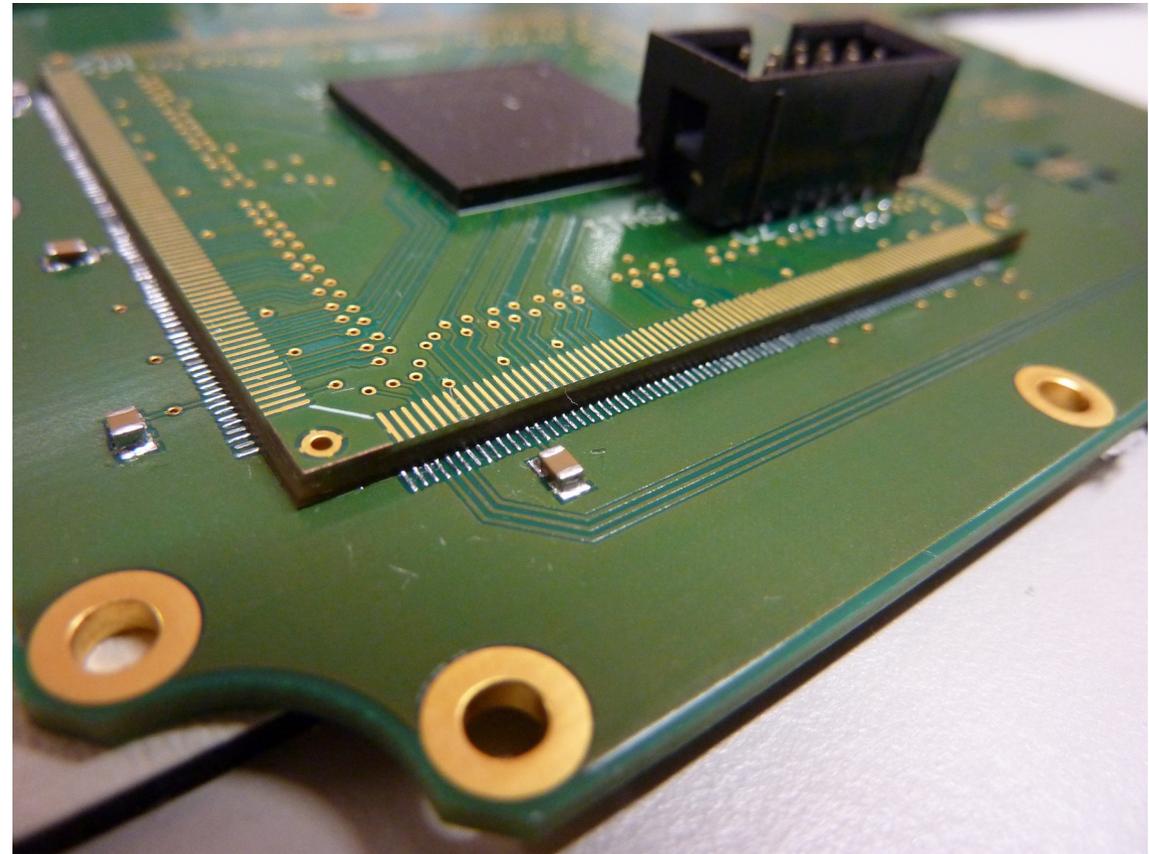
Mini-LFR
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A3PE adapter #1(EM)

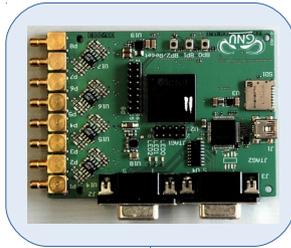


- Low cost (~35€+FPGA)
- Custom
- Hard to solder
- Weak (not tested)

Prototyping EQM



EM
March 2011



RAM-Test
Aug 2014



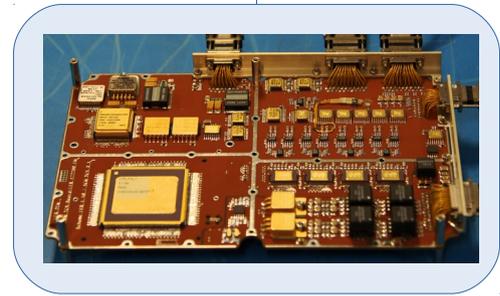
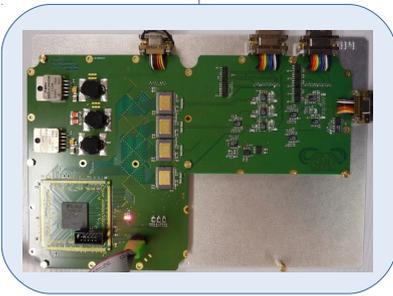
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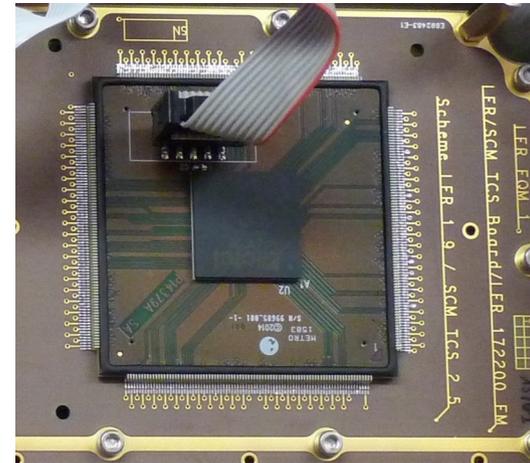
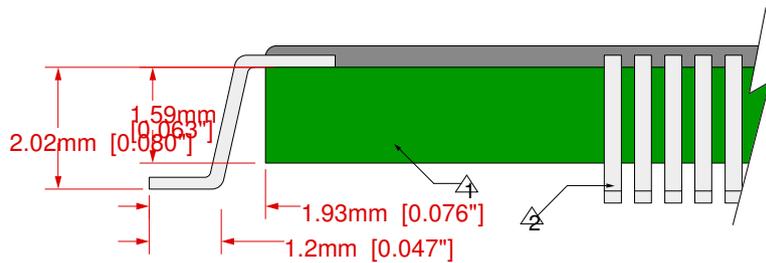
Mini-LFR
Nov 2013

EQM
Feb 2015

SPARE
Q2 2016



A3PE adapter #2(EQM)



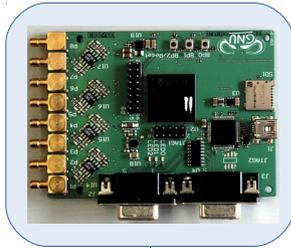
- Custom design
- More robust
- Easy to solder
- Expensive



Tests on PFM



EM
March 2011



RAM-Test
Aug 2014



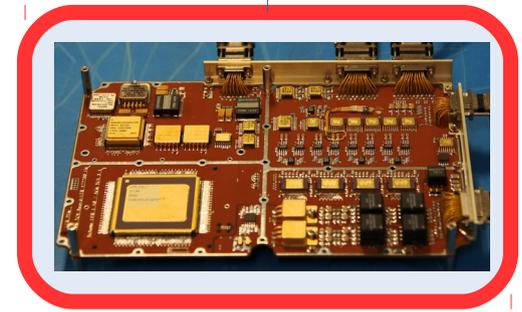
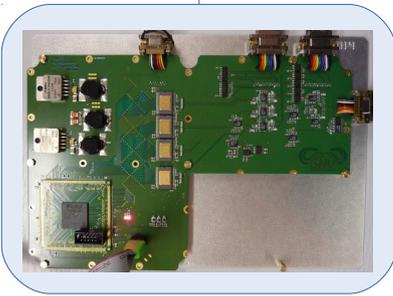
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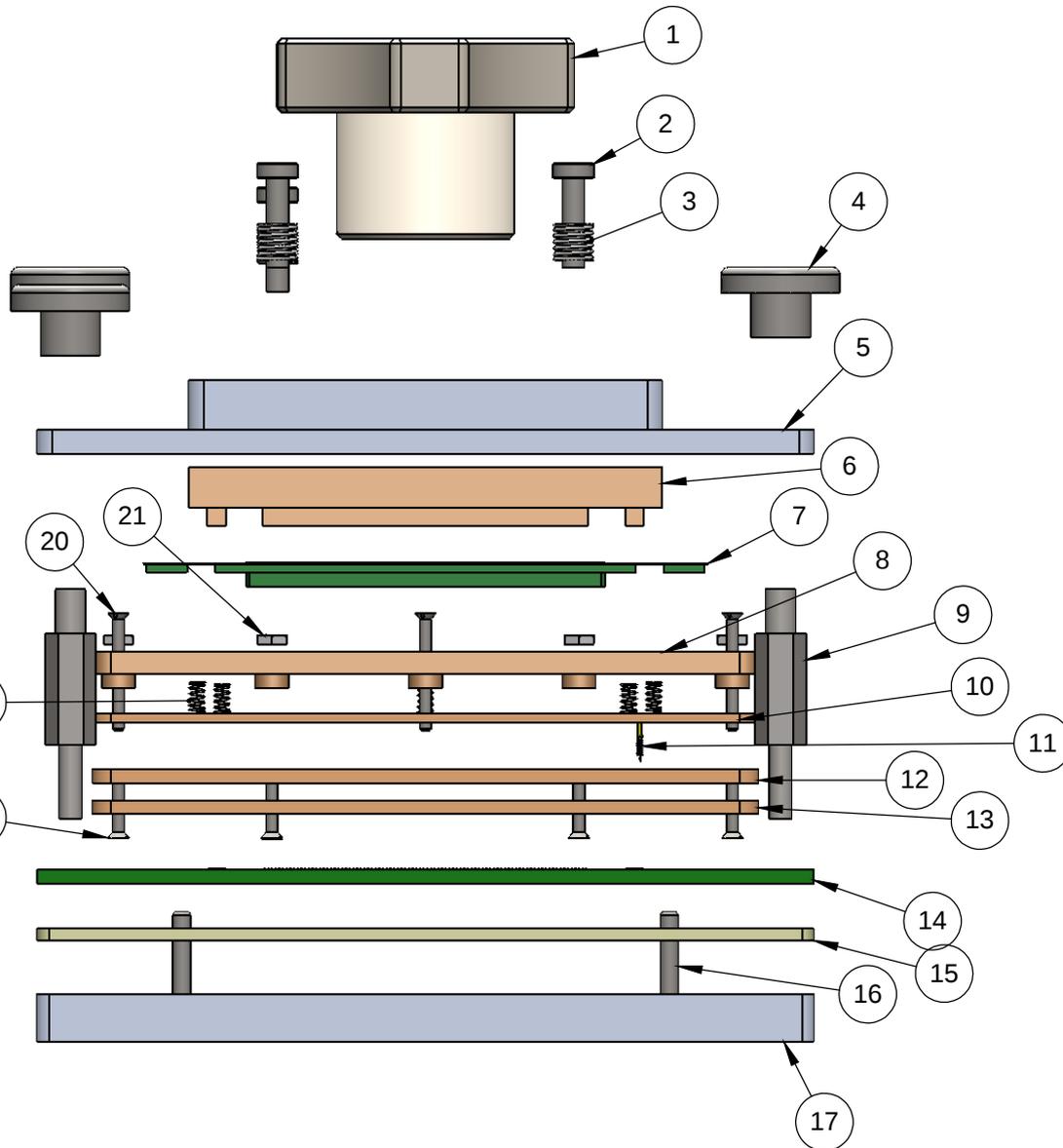


Constraints

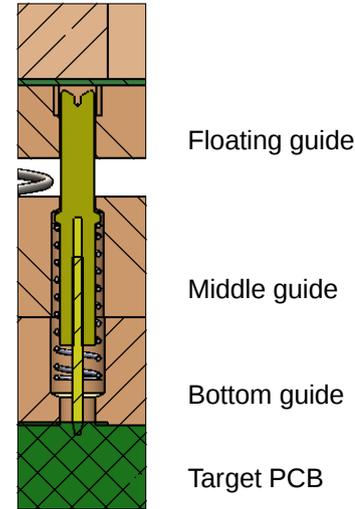


- No soldering
- Support from -30°C to $+70^{\circ}\text{C}$
- No stress for the board and parts
- Reusable

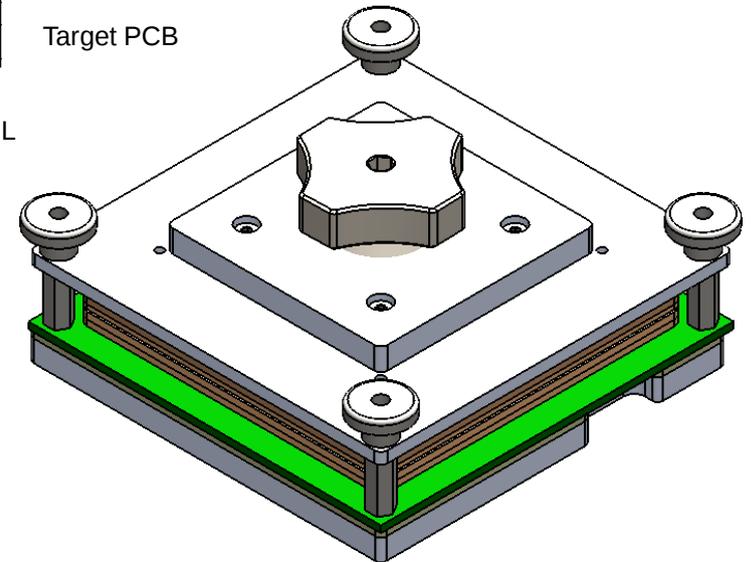
Solderless socket(1)



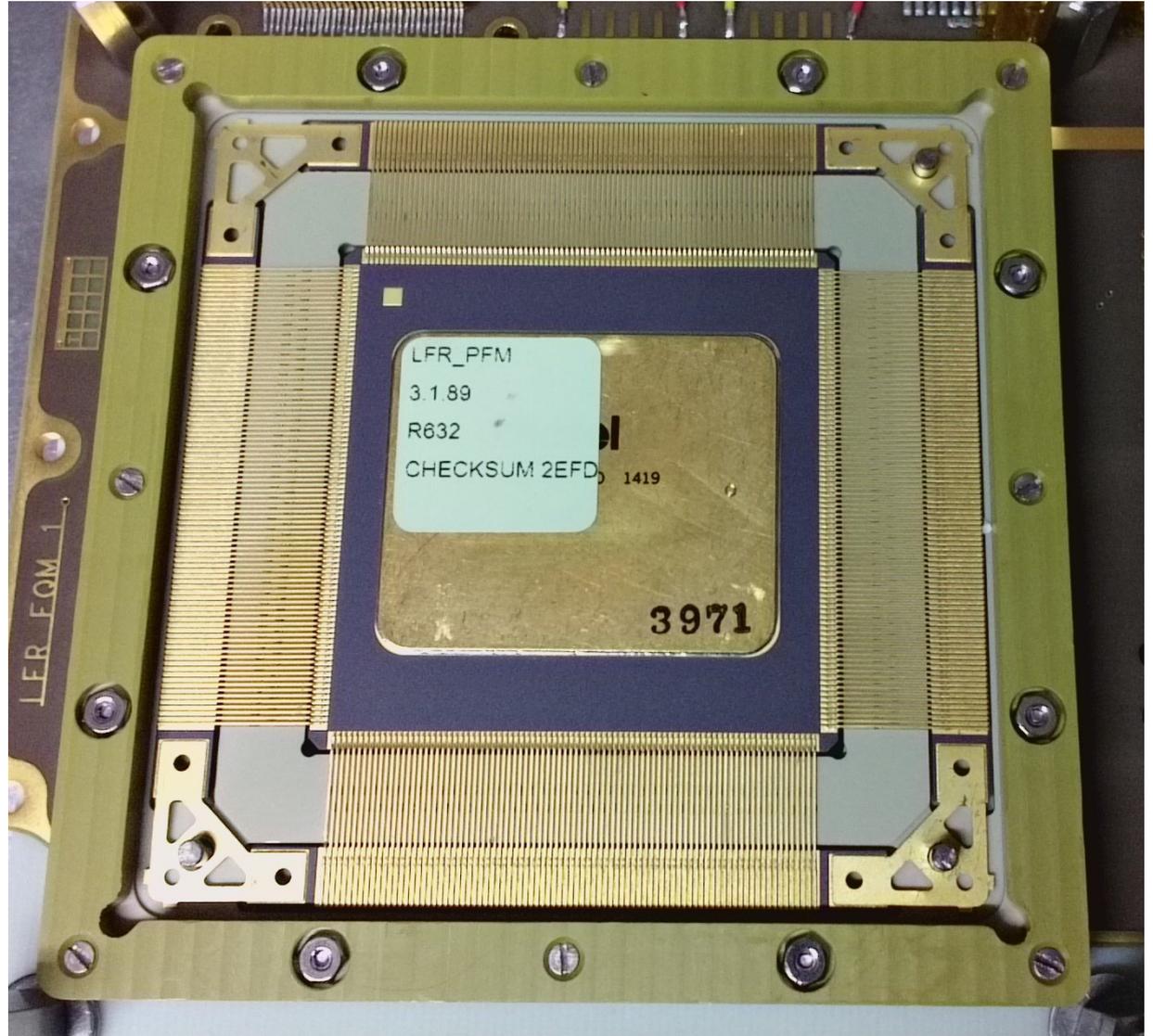
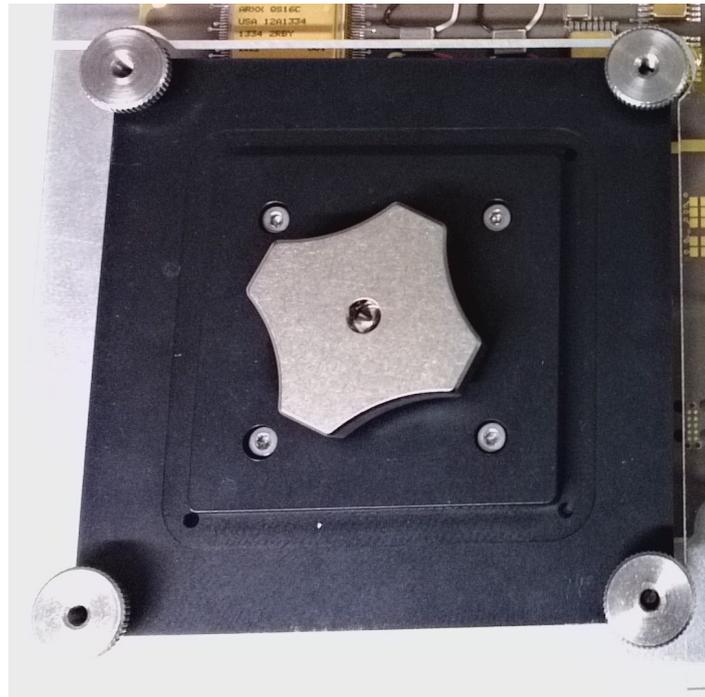
Compression plate



PIN DETAIL



Solderless socket(2)



Solderless socket(3)



- Use RTAX with tie bar
 - No solder
- High temperature range(-55 to +180)
 - Up to 4A per pin(16mOhms)
 - Excellent signal integrity at high frequencies(>14GHz)
- No more NRE (QFE352SC)(~2k€)
 - Quite big
- Not so expensive(900€ wo NRE) and reusable(125K cycles)

Well suited for Burn-in and others tests

Design tools



- Libero 9.1.5.1 with default Synplify gives 85 % cell usage + 85 % delay as cell → total **170 %** cell usage and **12MHz**.
- Libero Version 9.1.5.1 with **Synplify E-2012-03A-SP1-2** gives correct results :

R-CELL=90,99 %

C-CELL=84,05 %

DSP=4,16 %

~26MHz

RTAX4000D



- Compared to A3PE IO delays are different
- As usual add timing constraints to each IO.
- Only 8 global networks with 4 breakable.
 - Ones should promote most loaded signals to those networks (in VHDL with actel macro).
- Use of multi-pass layout.(50 passes~22 to 26MHz)
- With GRSPW, follow the doc, add constraints and for the best layout pass move and fix the clock recovery gates. (Xor close to input and Flop with long data path to delay data from strobe).
- Poor usage of DSP blocks by GRLIB's IPs...

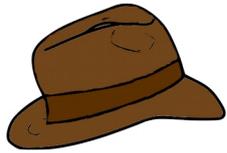
Conclusions



- Close to RTAX2000 flow
- No AX4000 for prototyping
- Design running at 25MHz, tested between -30°C and +70°C
- Whole board power consumption between 1.7W and 1.9W (Primary)

Caveats:

- Don't wait to compile for RTAX
- CQ352 thickness
- Libero version matters
- RTAX4000D pinout != RTAX2000 !
- High programming failure rate (~30%)



SocExplorer



- Ergonomic tool for SOC debug and tests
- Free (GPLv2)
- Written in C++
- Portable thanks to Qt api
- Scriptable with Python
- Extensible with plugins
- Scalable to user needs
- Used for the whole LFR validation from VHDL test and debug to calibration.



SocExplorer(2)



The screenshot displays the SocExplorer application interface with several key components:

- Plugin Manager:** Shows loaded plugins including SpwPlugin0, AMBA_PLUGIN0, and GenericRWplugin0.
- Device List:** Lists detected devices such as LEON3, GRSPW, and MCTRL, with details on their sizes and addresses.
- Register explorer:** Displays the register map for DSU3 @0x90000000, listing registers like Control, Time tag counter, and Break and Single St.
- Generic memory editor:** Provides a hex editor for memory at address 0x40000000, with options to read or write memory.
- Plugin List:** Lists available plugins like AMBA_PLUGIN, dsu3plugin, and MemController.
- Plugin description:** Shows details for the GenericRWplugin, including its name, root, child status, and author information.
- Python console:** A terminal window for running Python scripts.
- Parameter Configuration:** A panel for configuring various parameters such as COMMON_PAR, NORMAL_PAR, BURST_PAR, SBM1_PAR, SBM2_PAR, and DUMP.

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- Thanks for your attention
- Questions ?

