Description of MEMS 3D-System-in-Package Spacecraft Subsystems and Packaging Technology

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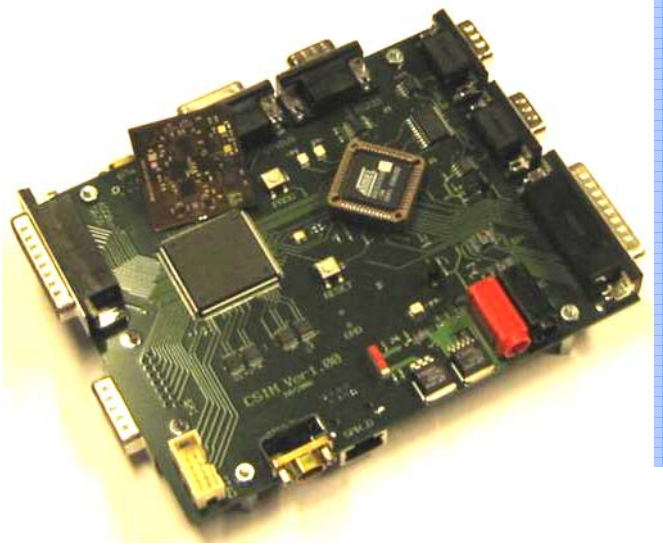
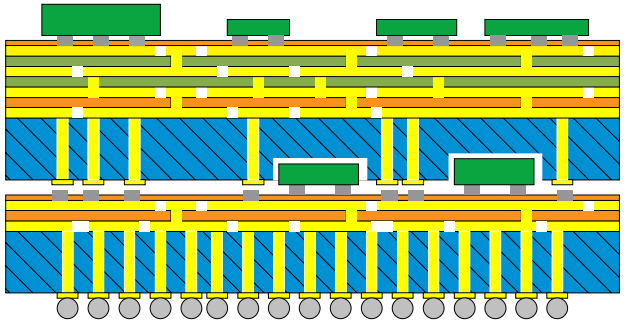
Outline

- 3D-Sytem-in-Package (3D-SiP) module
- QA Procedures
- Manufacturing Examples
- 3D-SiP Remote Terminal Unit
- 3D-SiP Magnetic Attitude Controller
- 3D-SiP Solid State Mass Memory
- Flight Schedueled July 2008
- Acknowledgement

3D-SiP Module

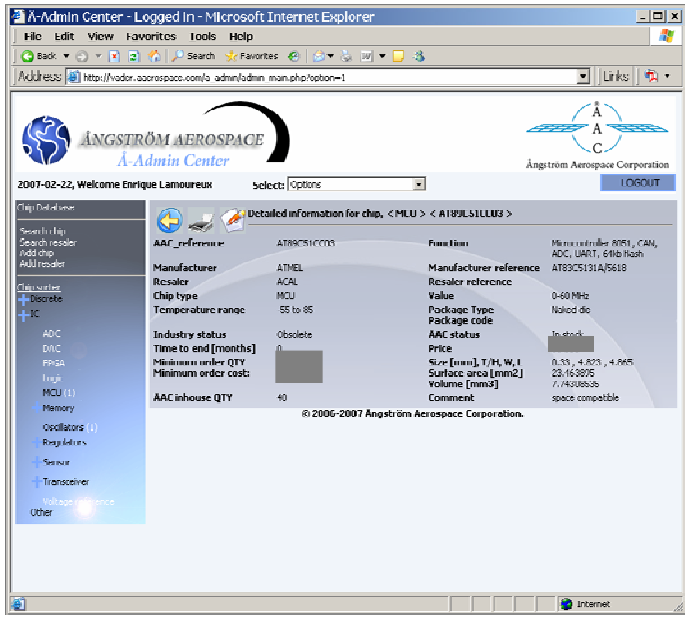
- Extreme Size and Weight Reduction
- Heat Transfer
  - -FR4 with 2metal layers k_{pe}~21W/mK, k_{ne}~0.3W/mK
  - -Silicon k=170W/mK
- Thermal Expansion Match
- Short Signal Paths
- Fine Pitch Capapilities

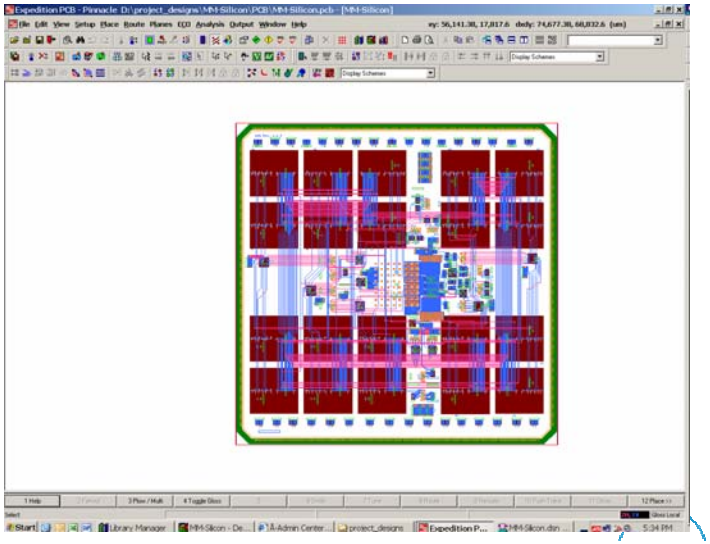




Standardized QA Procedures

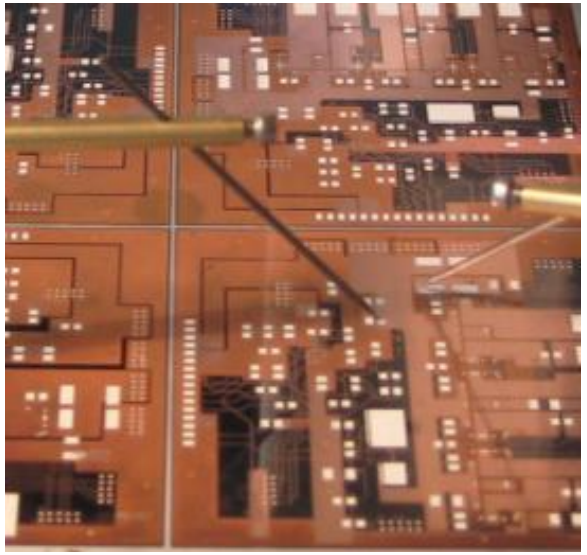
- Component and Layout Database
  - -Verified die map library
  - -Standard layout library
- Standardized Test Procedures
- Process and Test Protocols
  - -All process data recorded
  - -QA test pattern
- Recipe Database
  - -MEMS ”cookbook”

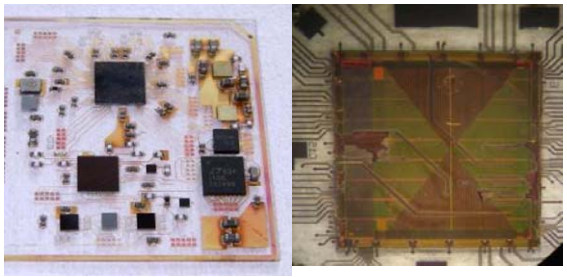




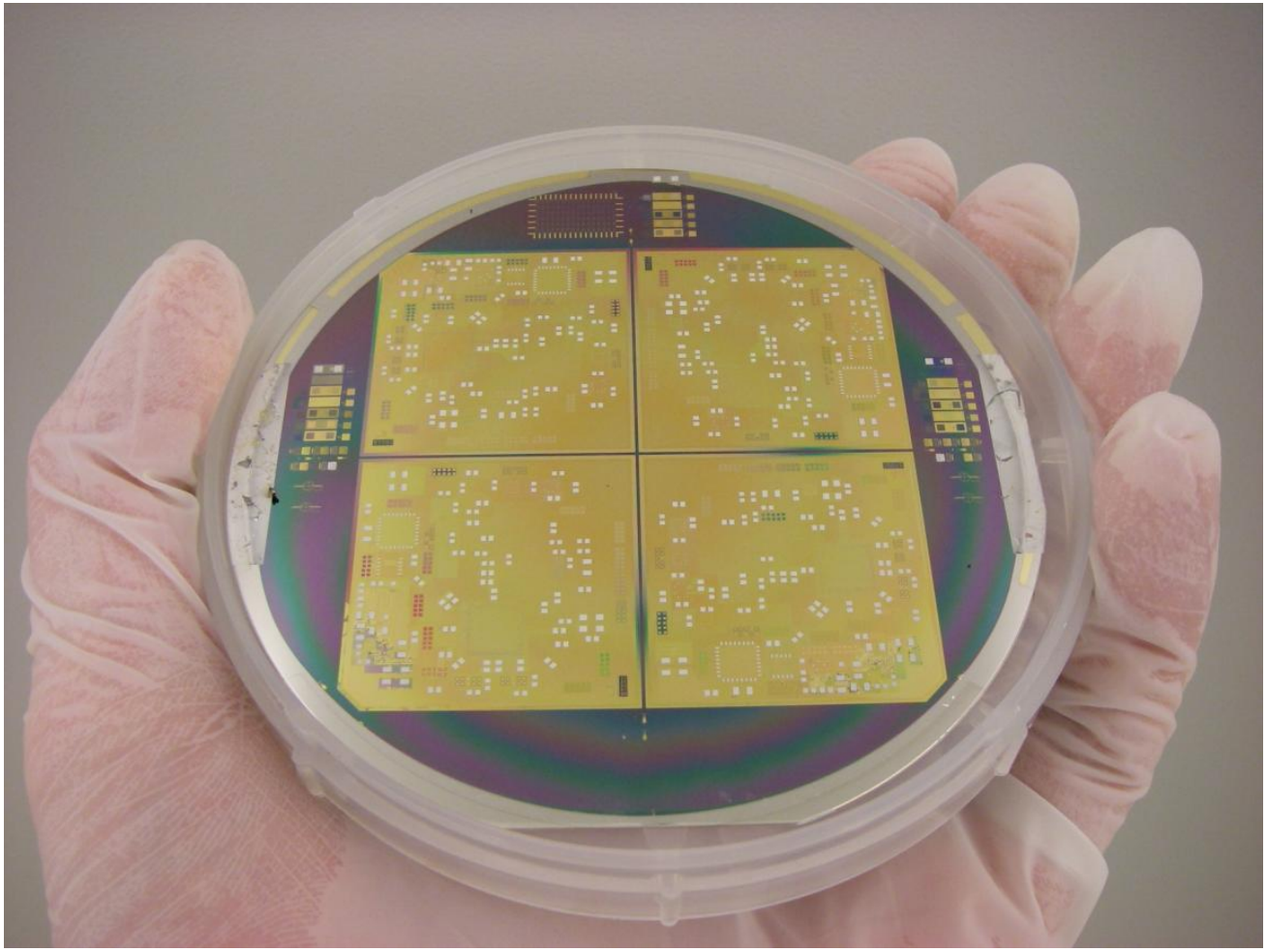
Standardized QA Procedures

- Continuous Probing During Manufacturing
  - -Standardized testprotocoll
- Temperature Cycling
- IR Inspection
- X-ray Inspection
- Glas/Pyrex Wafers
  - -Soldering verification
  - -Pad layout verification



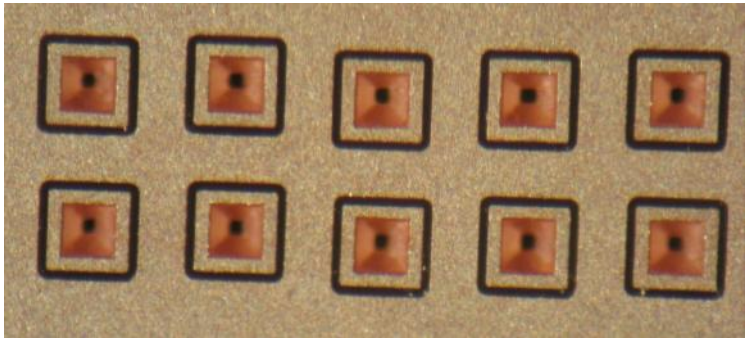


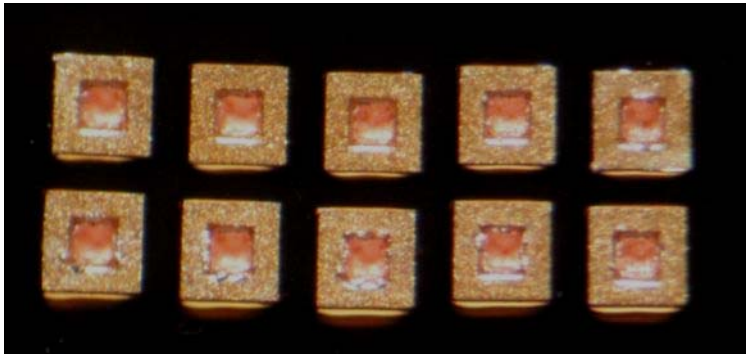
Manufacturing – 4” silicon wafers with Through Silicon Vias

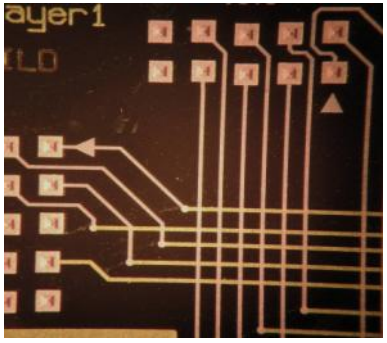


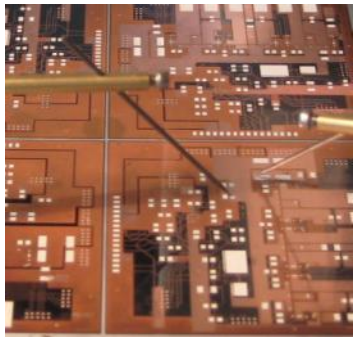
Manufacturing - Examples

- *Patent Pending* Through Silicon Vias (TSV)
  - -High yield process
  - -Variable Pitch
  - -≤20mΩ
- Metal Multilayers
  - -Various metals
  - -Choice of thickness
- ILD Multilayers
  - -Various ILD's
  - -Choice of thickness
- Open or Sealed TSV's
  - -Open: fluidic/gas and electric
  - -Closed: electric/environmental protection



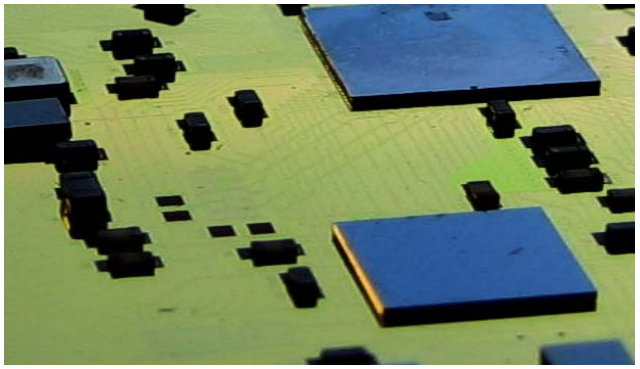


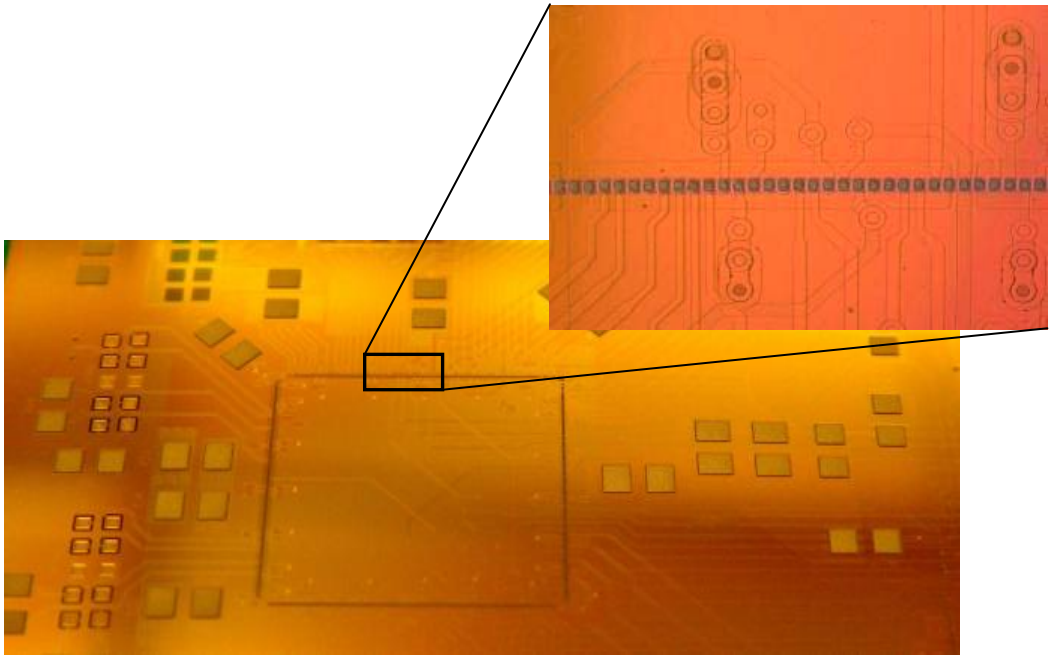


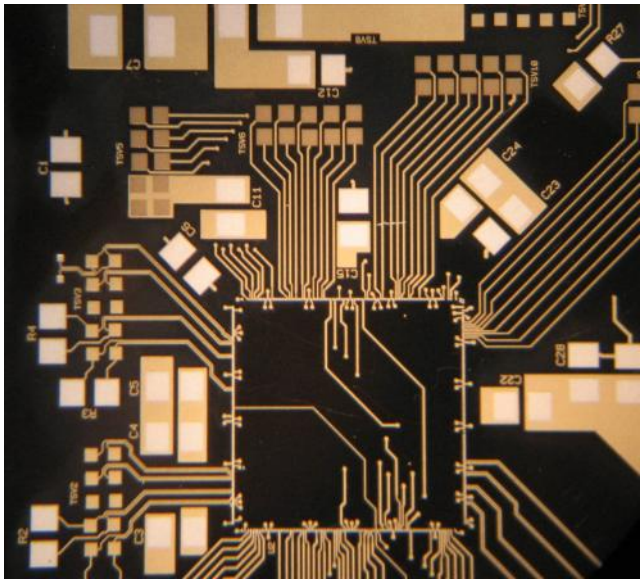


Manufacturing - Fine Pitch Chip Mounting

- Fine Pitch Capabilities
- Example
  - -FPGA 350 MHz ACTEL 1MGate ProAsic3+
  - -Pitch 57µm, pad-pad 27 µm

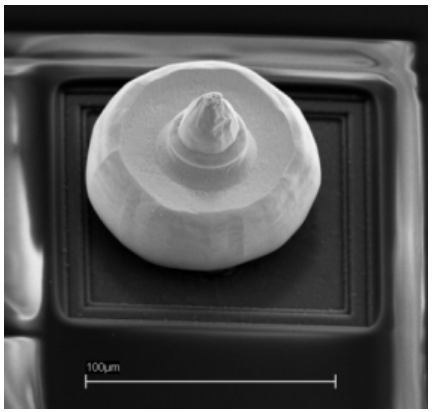


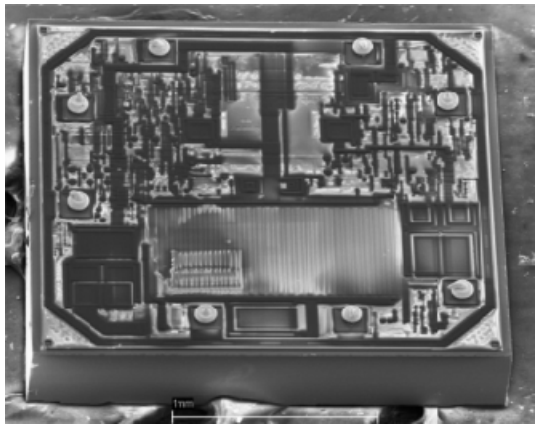


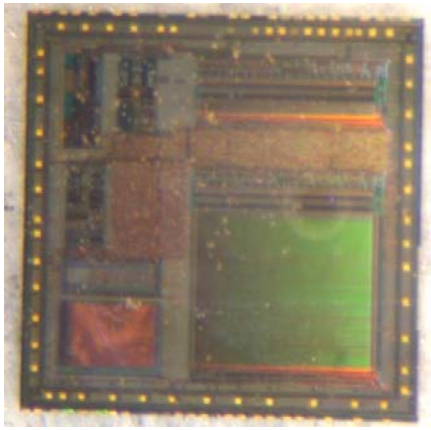


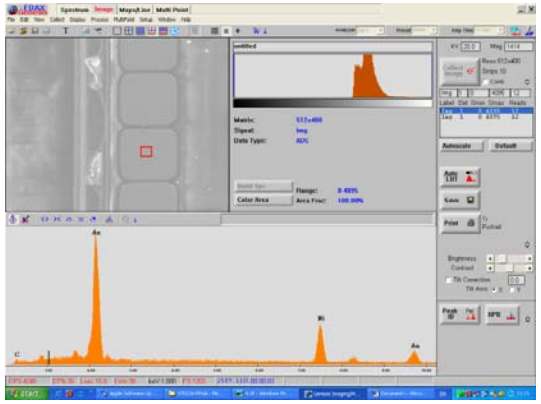
Manufacturing - Under-Bump-Metallization

- Flip Chip Technology
- Stud Bumping
- Remetallization at Chiplevel
  - -Fine pitch
- Extensive Testing
  - -SEM
  - -EDS
  - -ESCA
  - -Roughness
  - -Height



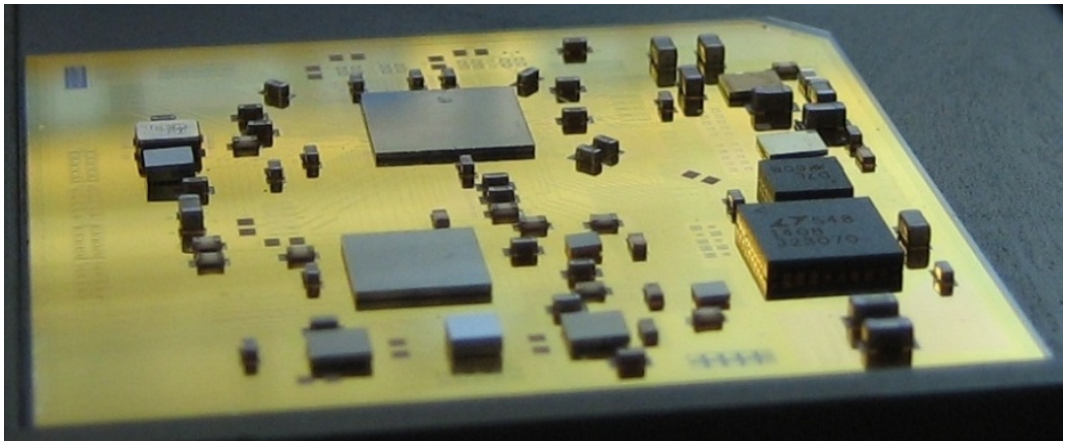






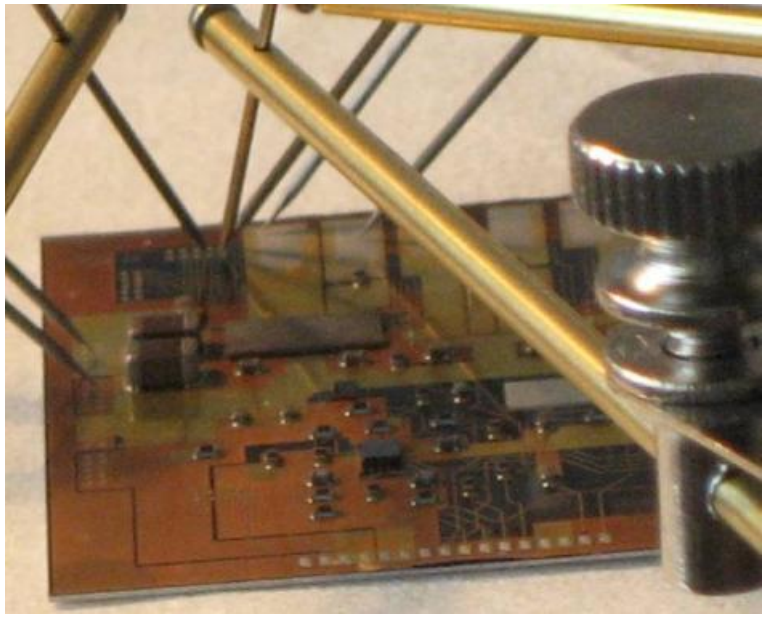
3D-SiP Examples -RTU

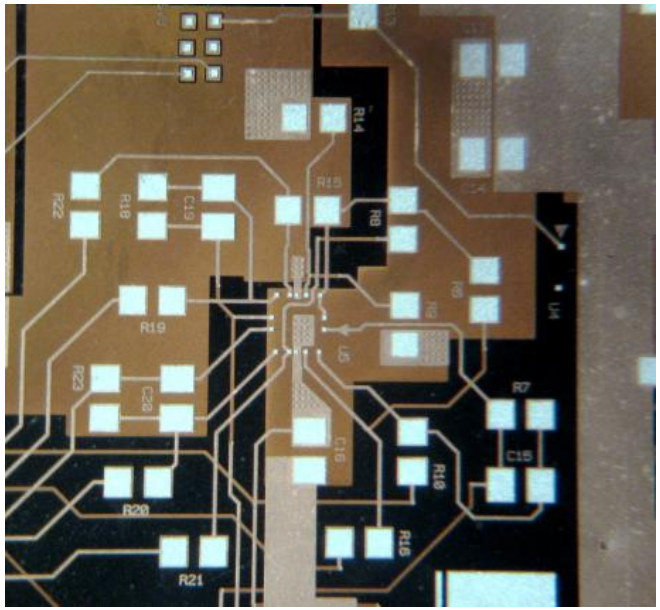
- 350 MHz ACTEL 1MGate ProAsic3+
- 60 MHz ATMEL T89C51CC03 Microcontroller
- Redundant Controller Area Network (CAN 2.0b compliant)
- Redundant high-speed LVDS drivers (SpaceWire or 1553)
- 6 x 14 bit Analog to Digital conversion user inputs (ADC)
- 4 x 12 bit Digital to Analog conversion user outputs (DAC)
- 48 bit CAN synchronizable System Elapsed time (32 bit seconds, 16 bit fractions)
- General 8-bit user I/O port (6 bit addressing and interupts)
- Dimensions: 33 x 33 x 1 (mm)
- Mass: 3 grams



3D-SiP Examples -MACS

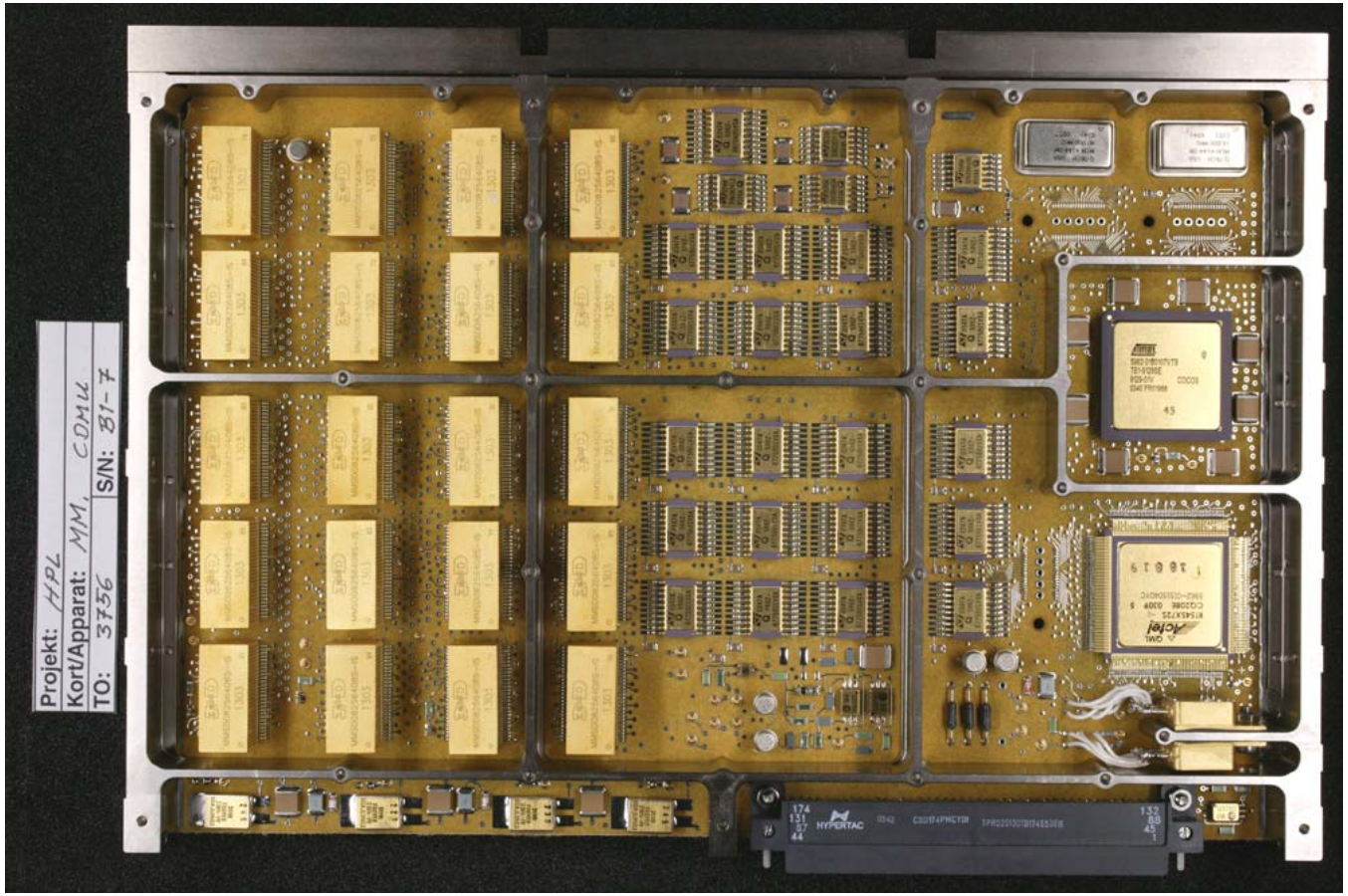
- 3 independent H-bridges 3A@12V, Max. 55V
- Filtering
- Pulse-width modulation (PWM) control
- Solderable to PCB and other substrates (optional)
- Analogue and serial magnetometer interfaces
- Dimensions: 33 x 33 x 1 (mm)
- Mass: 3 grams





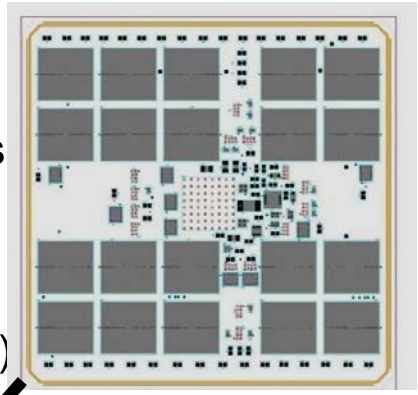
3D-SiP Examples - ÅAC / SAAB Space SSMM

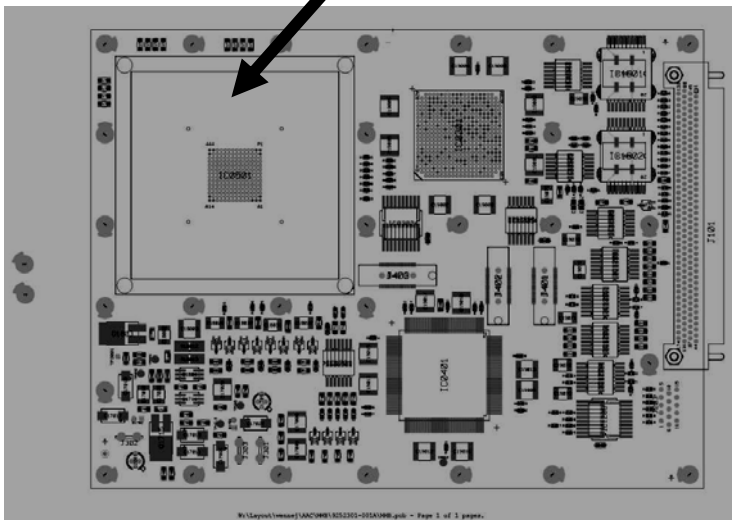
- Solid State Mass Memory (SAAB Space, ESA Herschel Plank)



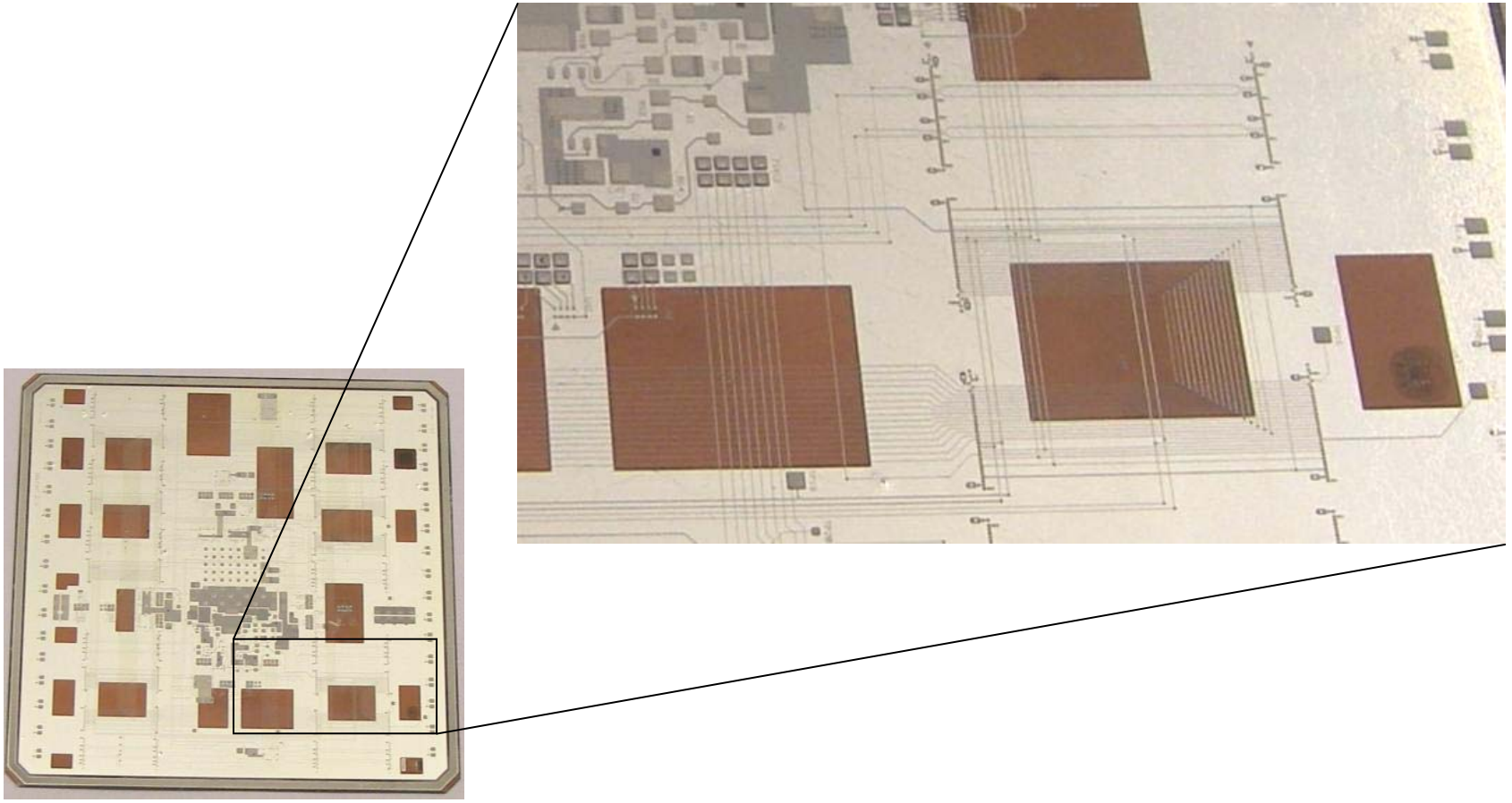
3D-SiP Examples - ÅAC / SAAB Space SSMM

- 32 Gbit (40 Gbit incl. EDAC) SDRAM Solid state MASS MEMORY
- 10 Gbit (incl. EDAC) / silicon wafer. Up to 4 stacked wafers
- Through Silicon Via (TSV) Technology
- Built in SEL protection in the silicon, response time ~ 100 ns
- All buffers built in the silicon
- Dimensions: 68 x 68 x 1(mm) , 8Gbit
- Only external part is memory controller (SAAB COCOS/NUT)





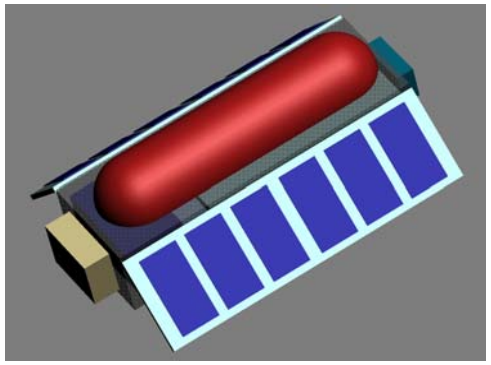
3D-SiP Examples - ÅAC / SAAB Space SSMM



NanoRubin (Prime OHB System)

FLIGHT DATA

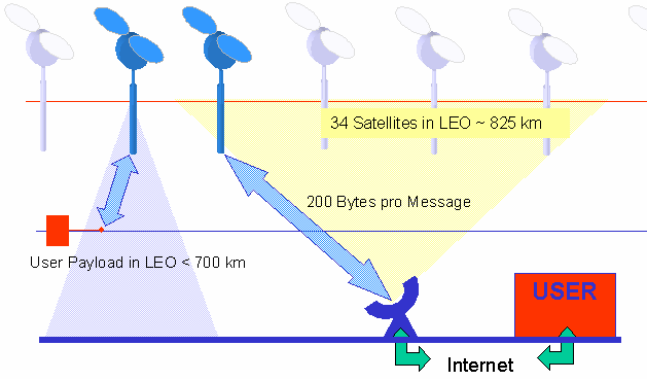
- NanoRubin-1
- Customer: SNSB
- Integrator: OHB System AG (Bremen)
- Launch vehicle: Russian COSMOS-3M rocket
- Launch: July 2008
- Satellite mission: Dedicated Technology Demonstrator Satellite
- Operation: Operation from ÅACs facilities in Uppsala for 1 year



NanoRubin MNT internal (I1) and external (E1 & E2) payload accommodation

ÅAC Contributions

- Prototypes of MACS
- Prototype of Mass memory with SAAB Space
- Prototypes of RTU
- Flight software validation



Communication with NanoRubin is performed via the ORBCOM network

Acknowledgement

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