ALCATEL ALENIA SPACE
An Alcatel/Finmeccanica company

Alcatel Alenia Space ETCA
Status of hybrid technologies

B. Goffin, 4/5/2006

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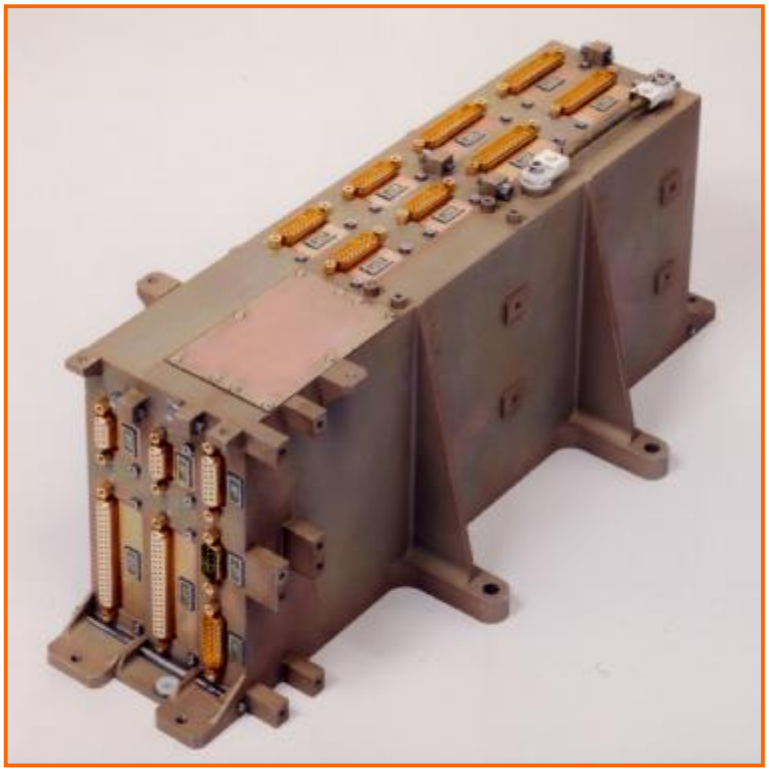
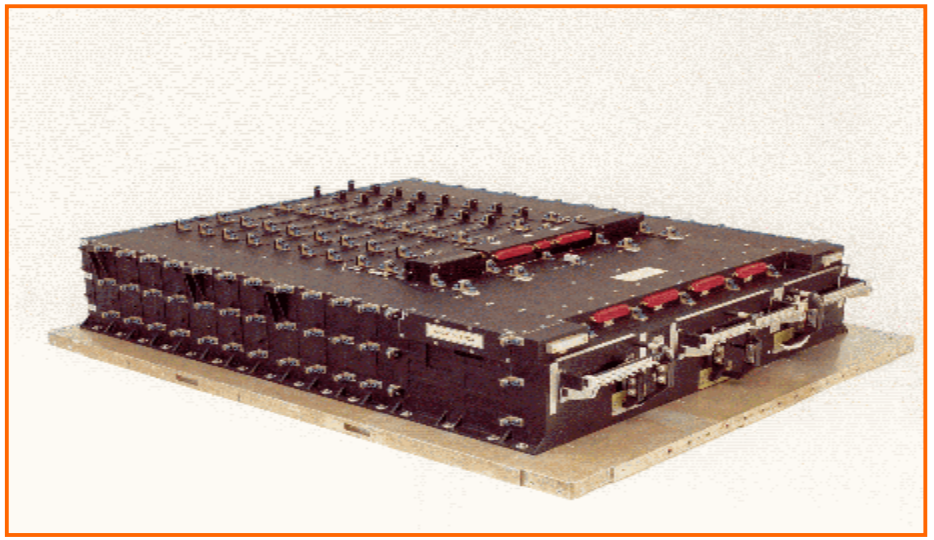
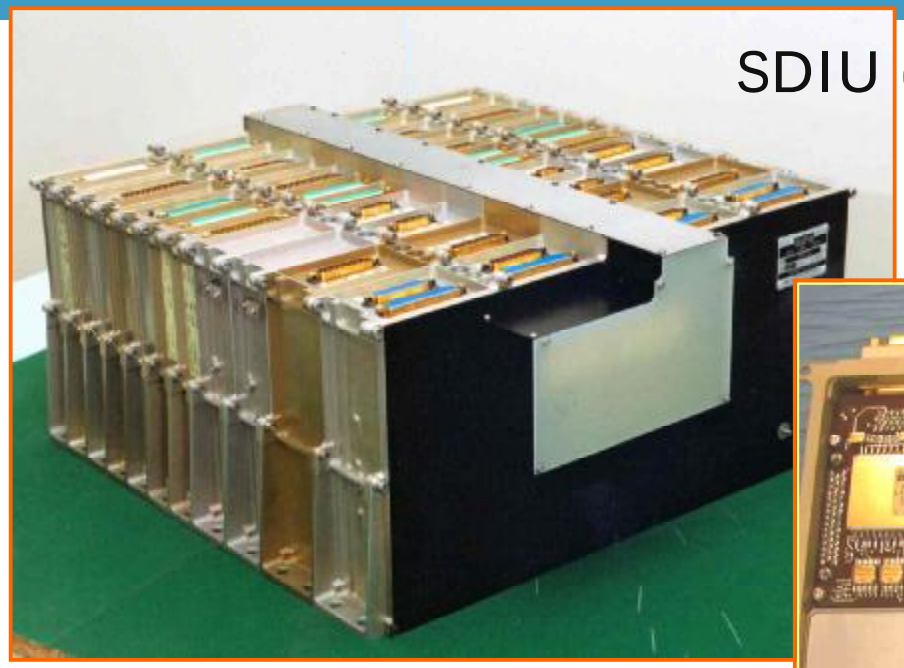
BEU: Battery electronic unit



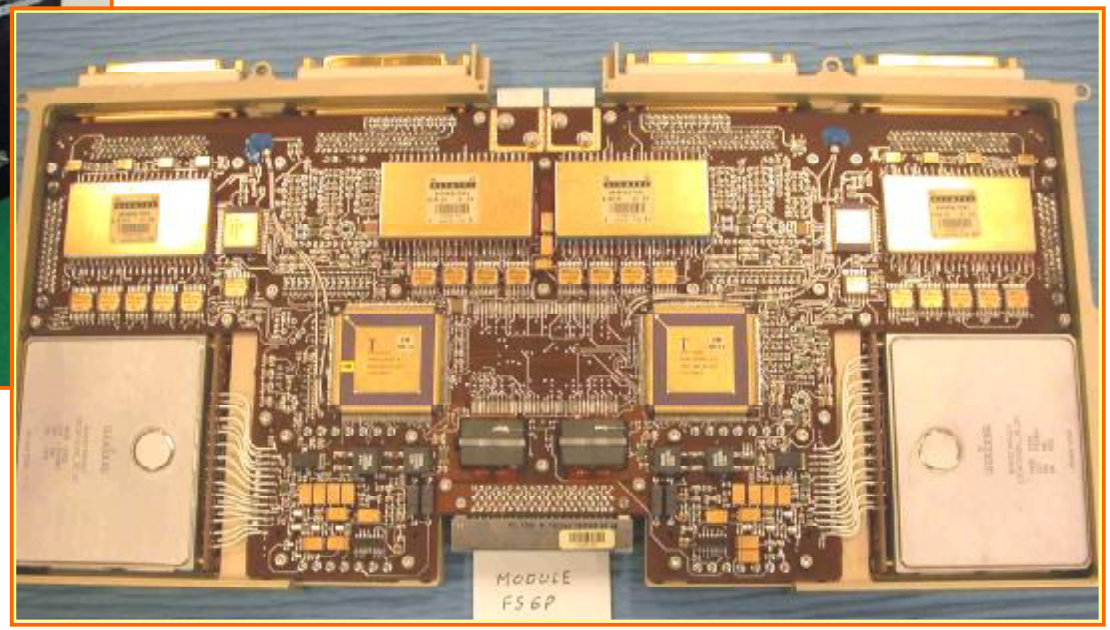


PCU: power conditioning unit

SDIU (Satellite Distribution and Interface Unit)

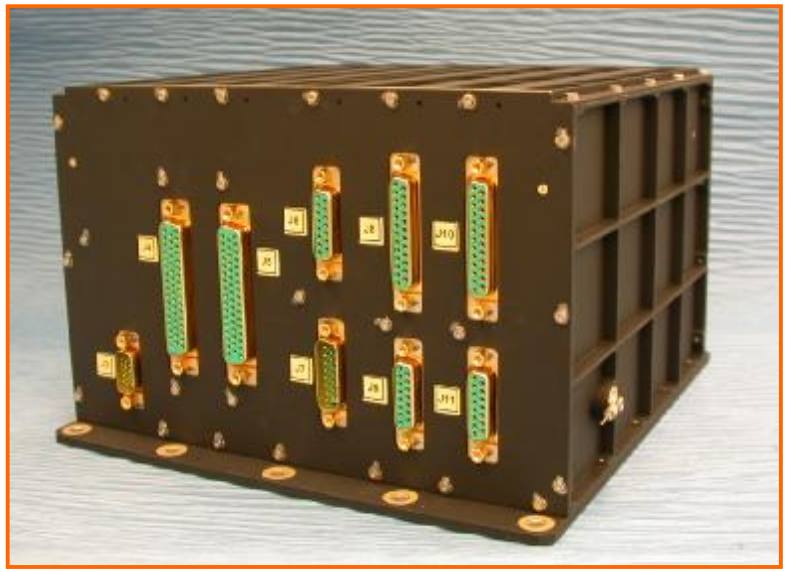


Avionics modules for SB4000 PFDIU



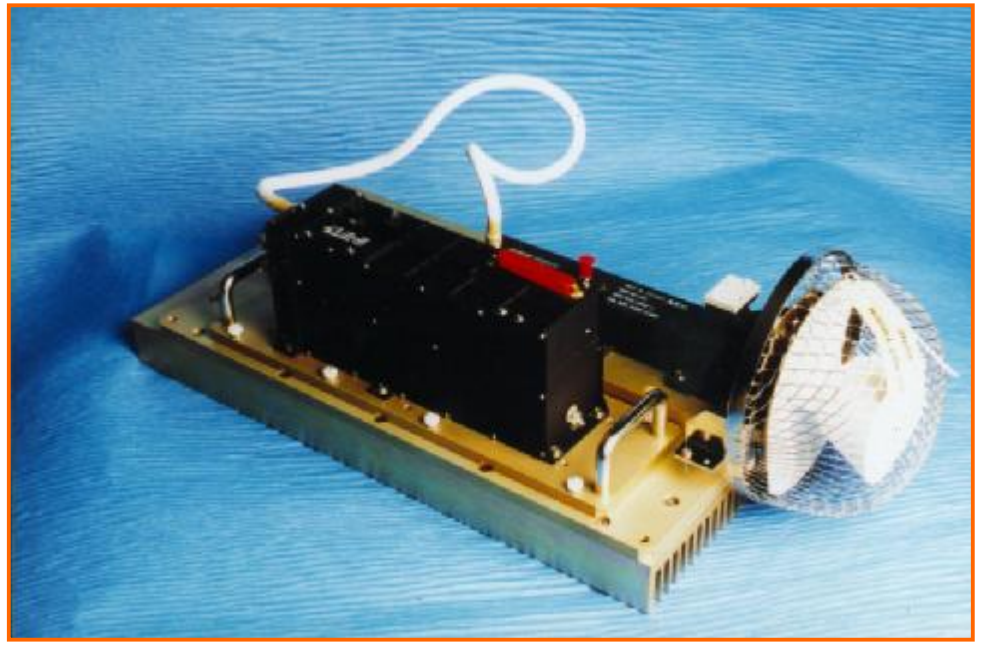
FS (Full Step Motor 6/18 axis PCB)

Space products of ETCA

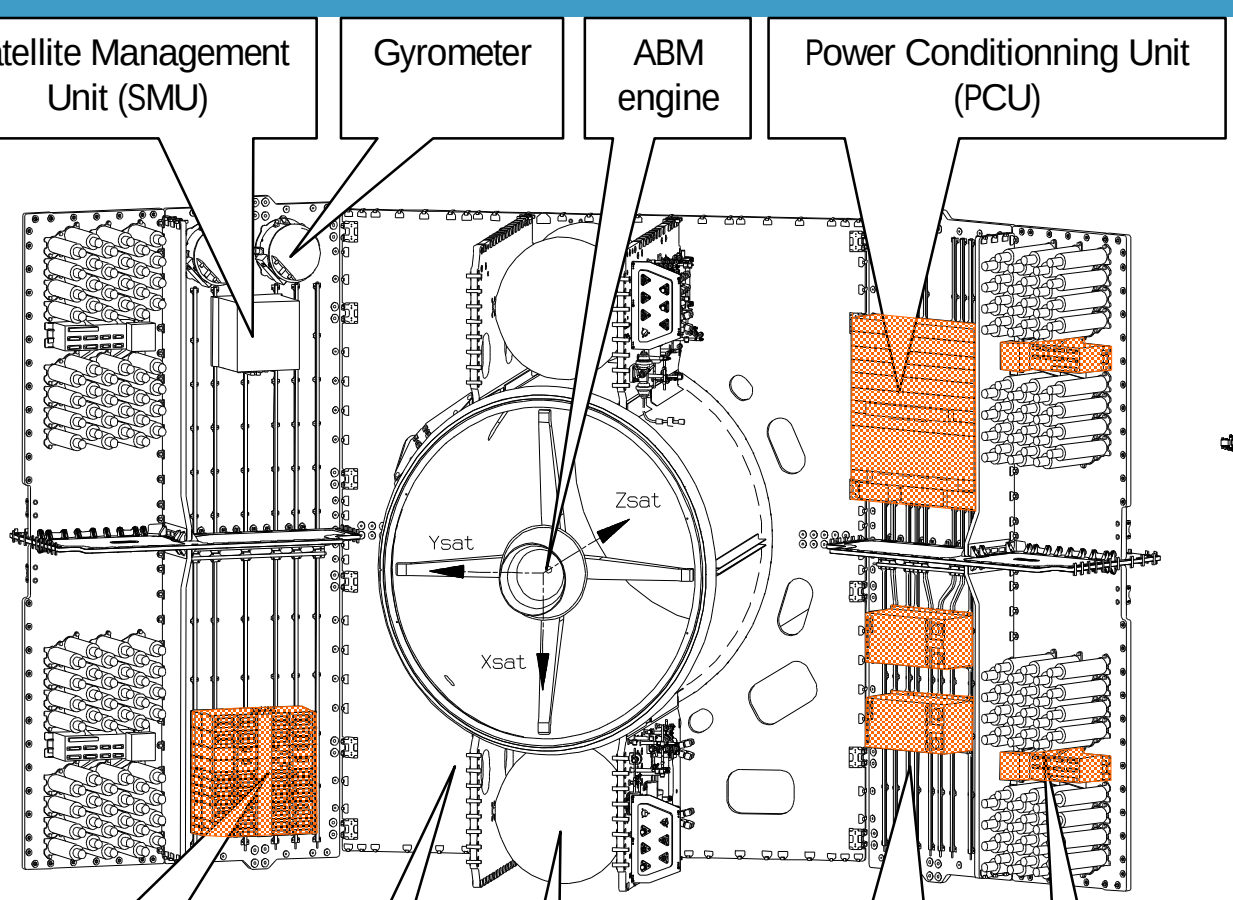


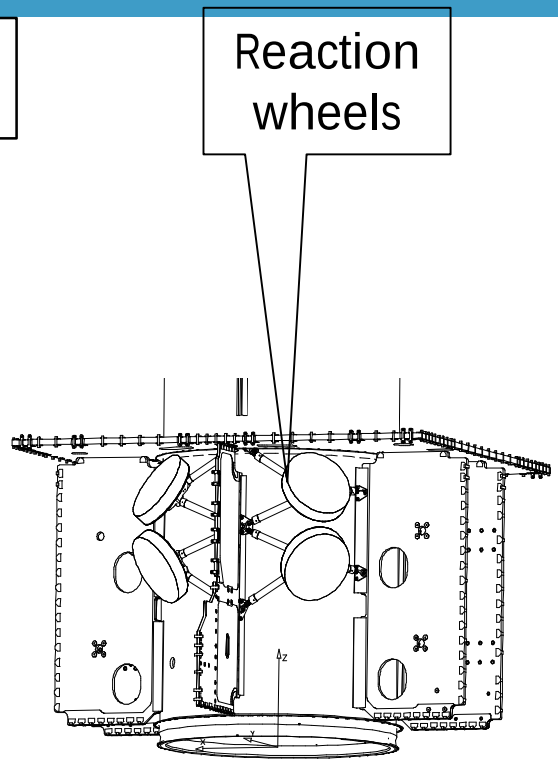
PCDU: Power Conditioning and distribution unit

EPC: electronic power controller (TWTA)



ETCA equipments on SB4000 satellite





ETCA Equipments

Service Module

Hybrid space products of ETCA

These equipments are based on building-blocks using standard, or customised, subfunctions such as:

- DC/DC converters
- LCL (latch current limiters)
- TM/TC modules
- BDR/BCR power hybrids
- S3R hybrids
- µ_controllers...

Hardware fabrication in ETCA involves various technologies and methods of productions:

- Hybrid circuits (MCMs, Power modules,...)
- Mechanical parts
- Coil & winding parts
- SMD (PWB) assembly
- Cabling and mechanical assembly

Hybrid technology processes have been conceived and qualified to:

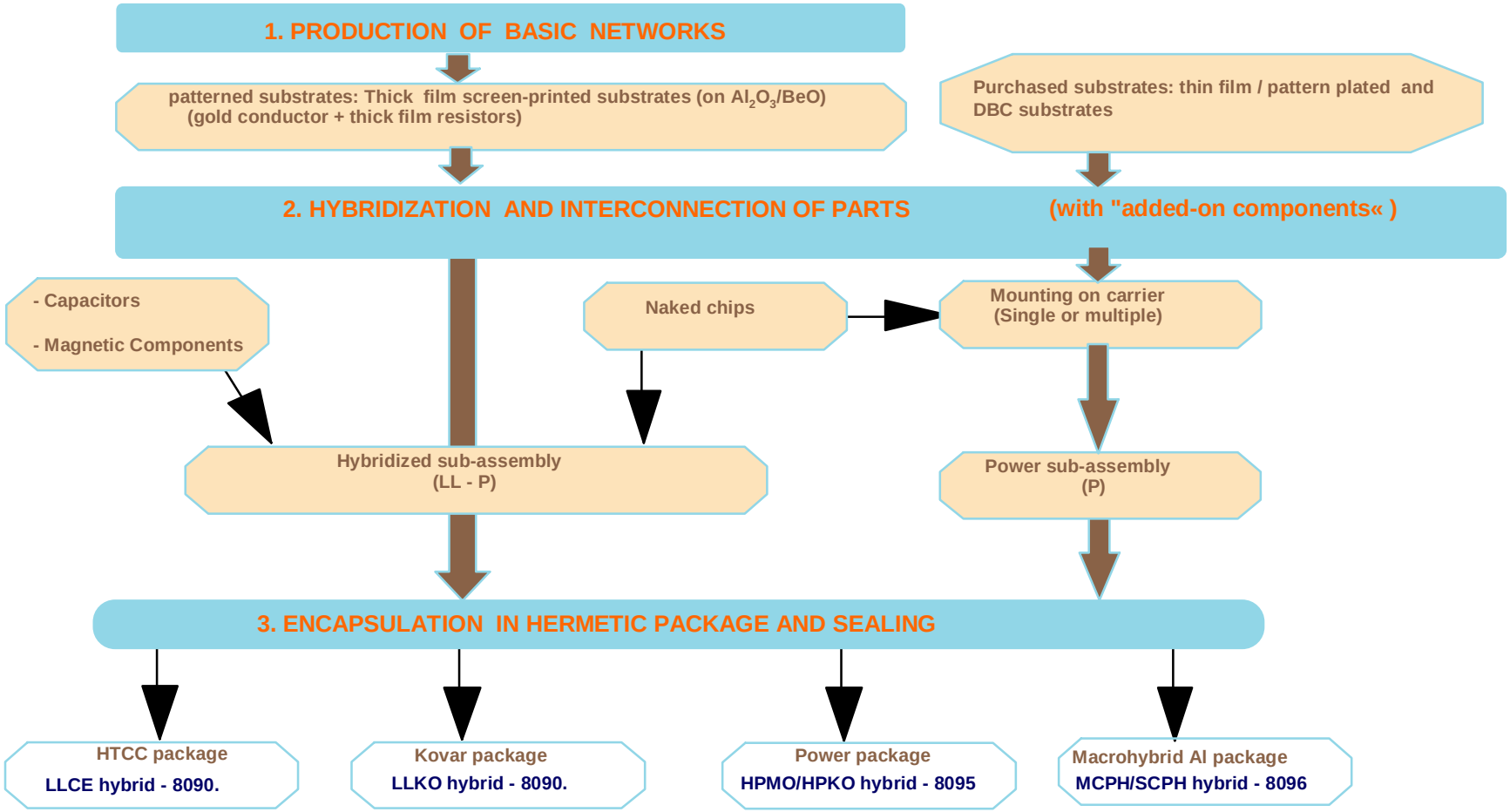
- Support applications developed in-house: DC/DC converters, BCR/BDR circuits, distribution&driver functions, TM/TC cells,...
- Assure a functional, optimised and reliable design of

1. Analog circuits : from DC to several MHz
   - Low power devices : p_{max}= 0.2 W/cm²
   - Power devices: p_{max}= 6W/cm²
2. Digital circuits (MCMs) : F_{typ}= ...10...20 Mhz
3. High voltage applications : up to 750 V

Hybrid microelectronics activity

- relies on:
  - Hermetic Packaging
  - Chip& wire processes (naked dies)
  - Various technologies of substrates (Thick film, thin film, DBC,...)
- Is oriented on:
  - Design & production of Hi-Rel devices
- Is focused on a market:
  - Captive
  - External
  - Both oriented on Space and specialised applications

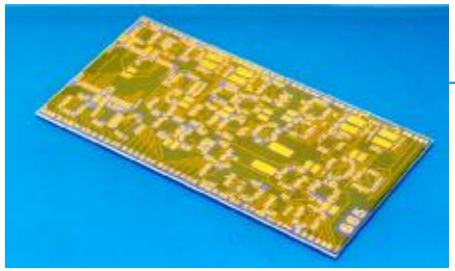
Hybrid styles qualified in ETCA



Variants of hybrids produced in ETCA

LEGEND :

: ESA : qualified ESA-PSS-01-606
LL : Low power (function)
P : Power (function)
HMPO : High power molybdenum package
MCPH : Multi-cavity power hybrid (Alu)



PRODUCTION OF BASIC NETWORKS

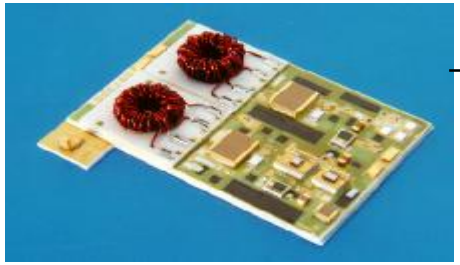
Thick film substrates (on Al_2O_3 - BeO)
(gold conductor + thick film resistors)

Pre-metallized substrates: thin film / pattern plated and DBC substrates
& Single chip carriers

HYBRIDIZATION AND INTERCONNECTION OF PARTS with "added-on components"

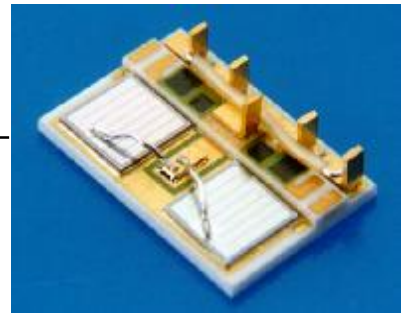
- Capacitors
- Magnetic components

Naked chips → Mounting on carrier (Single or multiple)



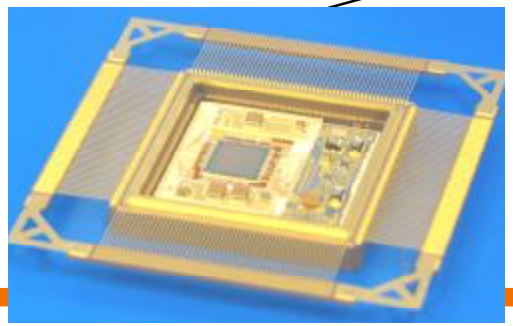
Hybridized sub-assembly
(LL - P)

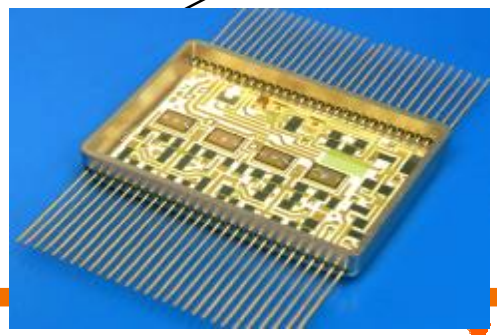
Power sub-assembly
(P)

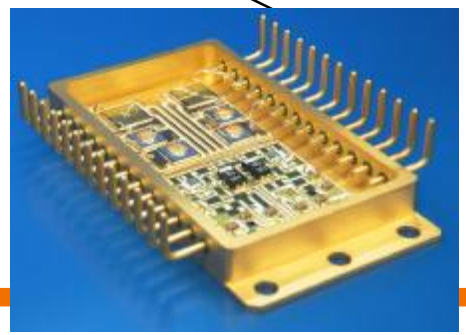


ENCAPSULATION IN HERMETIC PACKAGE AND SEALING

HTCC package	Kovar package	Power package	Macrohybrid Al package
LLCE hybrid	LLKO hybrid	HPMO - HPKO hybrid	MCPH/SCPH hybrid







Summarised domain of qualification (hybrids)

Passive networks in thick film technology

Conductors	Gold, in mono/multi-layered circuit configuration Au-Pt for land pads destined to soldering	
Resistors (screen-printed) (or added-on)	0,3Ω ... 10MΩ *Accuracy* :	0,1% from 100Ω to 1 MΩ, 1% ± 0,1Ω (for others)
Thick film shunts (screen-printed) (or added-on)	Range: *Accuracy* : *current capability*	5 mΩ ... 300 mΩ 2%, 30A
Substrates :	Alumina (As fired, or polished) Berylla (pre-scribbed as snapstrates)	

Summarised domain of qualification (hybrids)

Hybridization (authorised added-on components and related method of hybridization)

Naked chips(with/ without carriers): (on tab if required)	Mounted by:	Au/Si eutectic die bonding Conductive/non-conduct gluing Brazing
	Size range:	up to 10*10 mm²
Capacitors (ceramic, tantalium)	Mounted by	Gluing (SMT style)
	Size range:	1.2*2.0mm² to 17*19mm²
magnetic components	Mounted by	Gluing
	Size range:	up to size RM7/P12/ toroid Ø22 mm
Current sensors (on cearatab or copper tab)	Mounted by :	Gluing
	Size range:	from 5*5mm² up to 30*15mm²
	Current range:	from 0.1A to 30A max
Use of purchased substrates (Thin film, DBC, pattern plaed BeO, …)	Mounted by:	Gluing
	Size range:	max 29 cm²

Summarised domain of qualification (hybrids)

Interconnections

Gold wire:	Thermosonic ball bonding: ∅ from 17 µm to 50 µm Ultrasonic bonding: ∅ 50 µm
Aluminium wire:	Ultrasonic bonding: ∅ from 25 µm to 635 µm Opposite electrodes welding: ∅ from 300 µm to 890 µm
Gold wire: (Heavy w.& ribbon)	Opposite electrodes and parallel gap welding: ribbon 5*20 mil² Opposite electrodes welding and parallel gap welding: ∅ 200 µm
SnPb soldering:	Copper wires in magnetic components - ∅ 0.2mm…0.8mm

Summarised domain of qualification (hybrids)

Packaging

Thick film sub-assemblies can be encapsulated in following styles of housing :

- LL (low power):flat pack or plug-in packages
  Typical power dissipation : 0.2 W/cm²
  - LLCE : low power in HTCC package (CQFP, Plug in)
  - LLKO: low power in Kovar package (Plug in, FP)

- HPMO :High Power Molybdenum packages
  Typical power dissipation : 6 W/cm²
  A sub-variant exists with HPKO (footprint in Kovar, p_{max}: 3W/cm²)

- MCPH/SCPH :Multi or Single Cavity Power Hybrid packages
  Case machined in Aluminium,
  2 variants exist: *Gold finish with brazed feed-thrus
  *conversion coating, with laser welded hermetic connectors
  Typical power dissipation : 3 W/cm²

Summarised domain of qualification (hybrids)

Sealing of cavities in dry atmosphere

Thick film sub-assemblies can be encapsulated in following styles of housing :

- Seam welding for LL, HPMO packages
- Laser welding for MCPH/SCPH packages

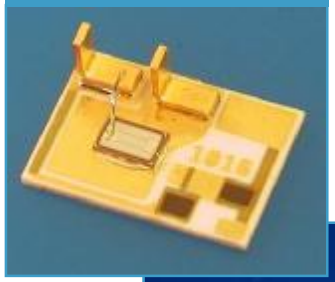
Quality level

- In accordance with ESA_PSS_01_608 (generic specification for procurement of hybrids), to be soon converted into ECSS-Q-60-05
- Manufacturing processes qualified according to ESA_PSS_01_606

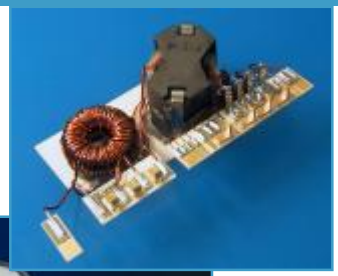
Example 1 (hybrid module, MCPH): DC/DC converter

Diode de buck

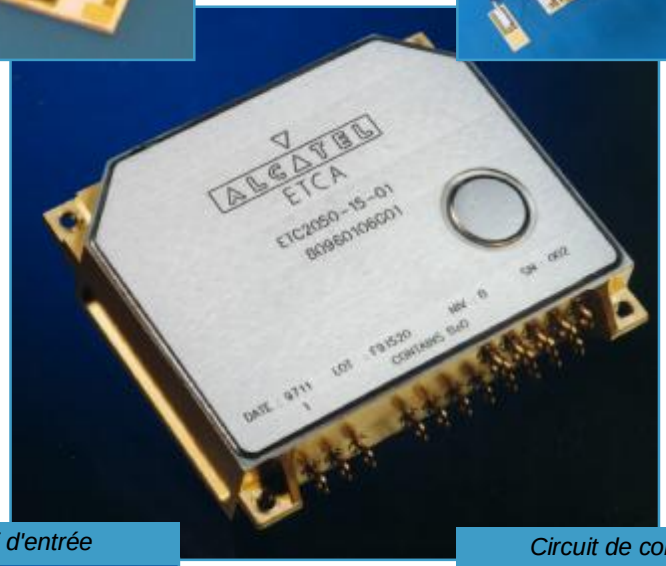
Transistor de buck



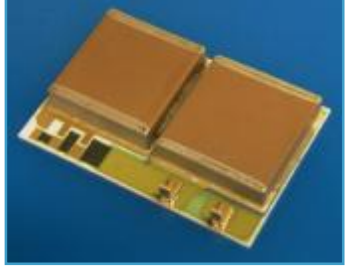
Transformateur et selfs de buck



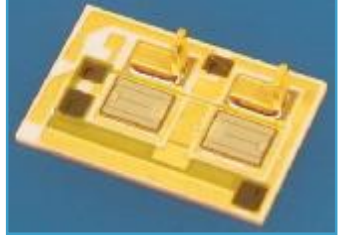
Etage de sortie



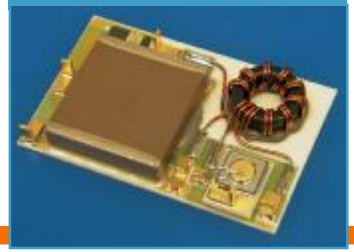
Capacités d'entrée



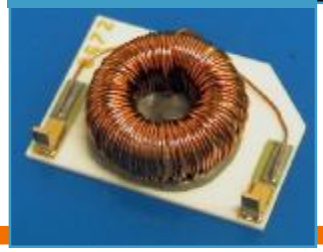
Cellule de découpe



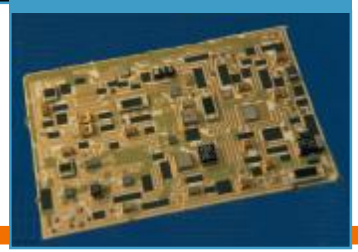
Filtre d'entrée



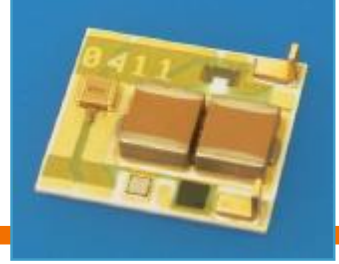
Self d'entrée



Circuit de contrôle



Mesure de courant

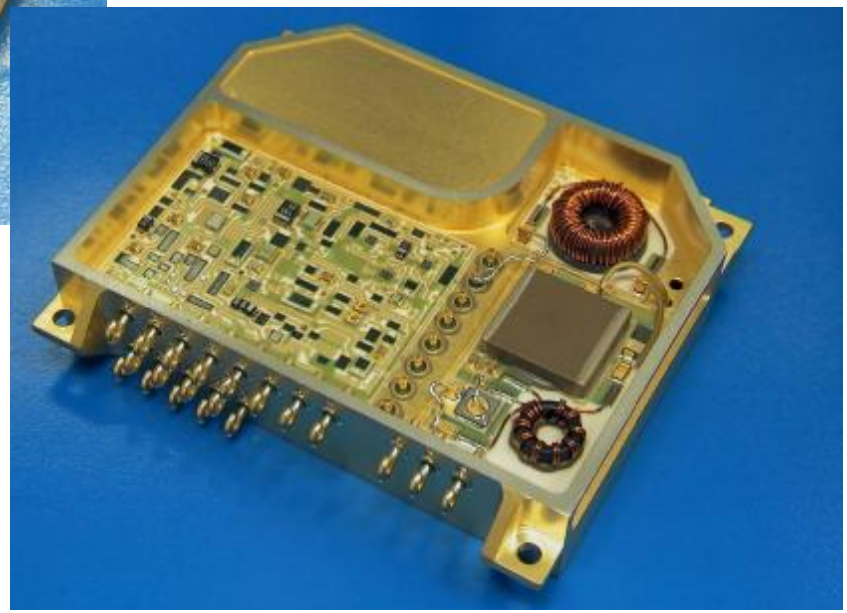


Example 1 (hybrid module, MCPH): DC/DC converter

DC/DC converter

P= 30W, Vin= 20…50V

Vout: 4 floating DC output voltages, with protections (overcurrent, overvoltage,.)



FM hybrid in MCPH technology,

with embedded filters and tfos,

with parylen protection, and hermetically sealed

Mass= 165g, vol= 85*65*19 mm³

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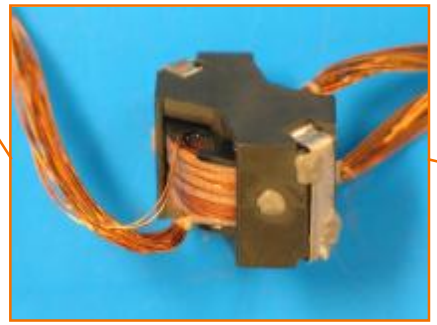
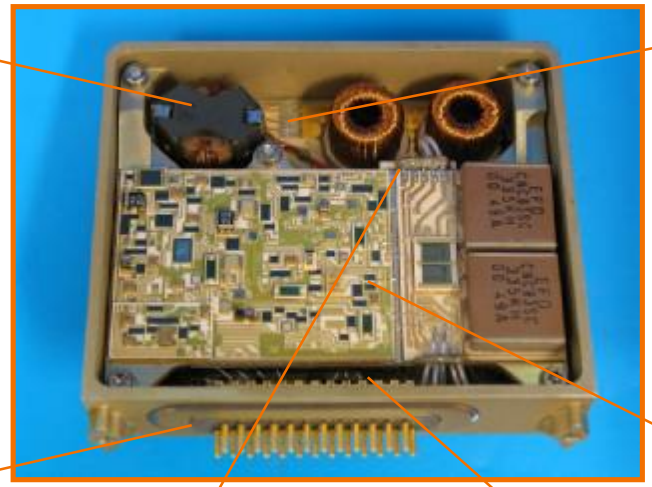
Example 2 (SCPH module): DC/DC converter

Hyb. bobin

Hybrid tfo

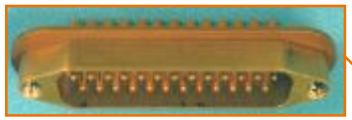


DC/DC converter P= 40W
In MCPH var#2
Mass: 200 g, V=85*78*20 mm³

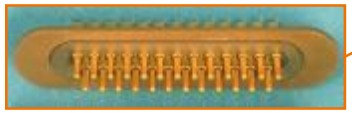


Coils module &
config. output stage

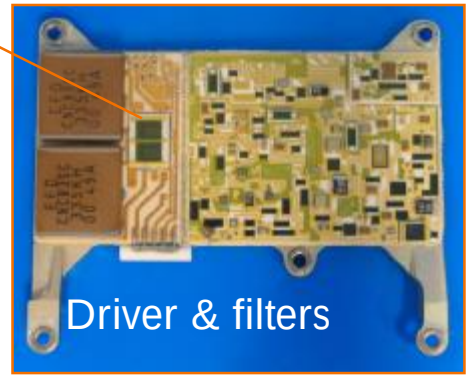
Hermetic conn.



Config. Package



Hermetic MFP



Driver & filters

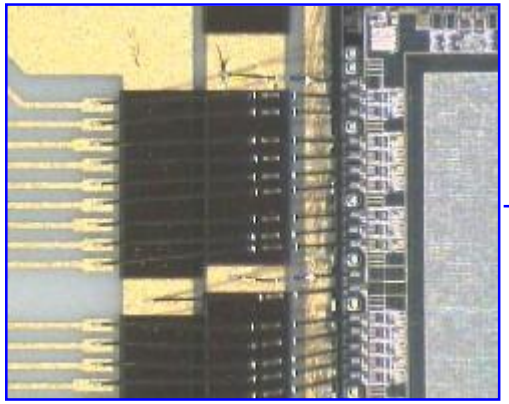
Example 2 (SCPH module): DC/DC converter

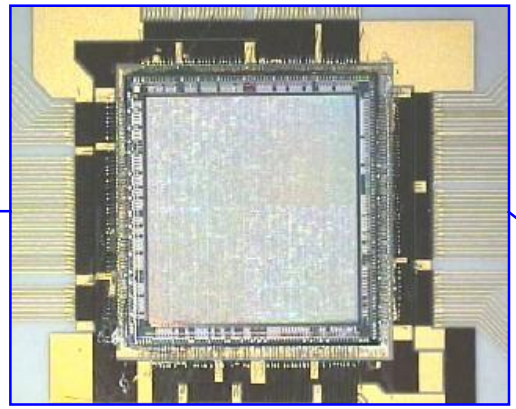
Type		V_{IN} range	P_{OUT}	Outputs	Size	Remark
20 to 50V Series	ETC 2050-15	20 - 50 V_{DC}	15 W	DC and/or AC	A	
	ETC 2050-30		30 W	DC and/or AC	A	
	ETC 2050-40		40 W	Single DC output	A	Ext. settability ±5%
50 to 100V Series	ETC 50100-15	50 - 100 VDC	15 W	DC and/or AC	A	
	ETC 50100-30		30 W	DC and/or AC	A	
Other series	ETC 4050-40	40-50 V_{DC}	40 W	DC and/or AC	A	
	ETC 25100-10	25-100V_{DC}	10 W	DC and/or AC	A	

Outputs	#	Size A :≤ 4	Customisable, DC and/or AC
Size	A	85 x 77 x 20 mm³	195 grs

- More than 40 different variants exist today -

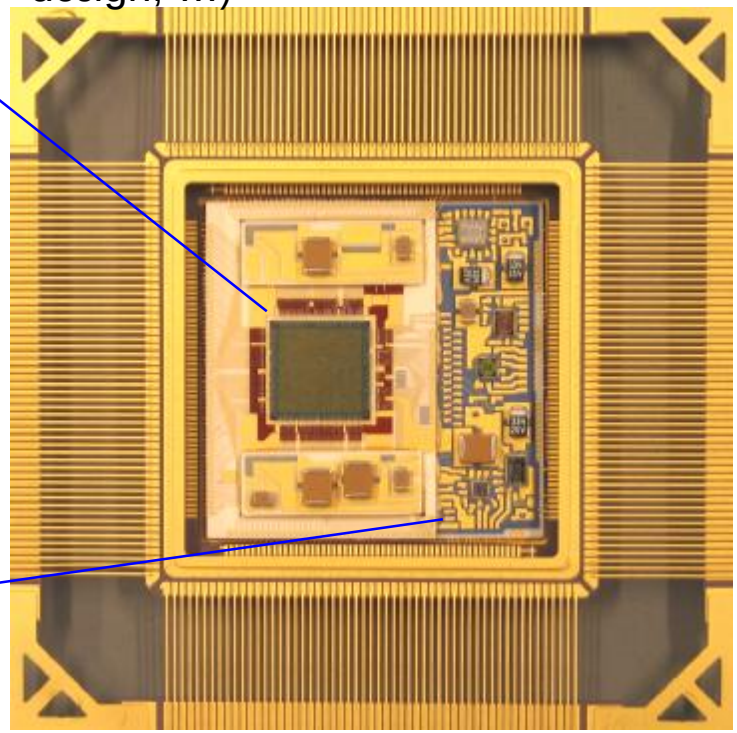
Example 3 (LLCE MCM) : µ ST function

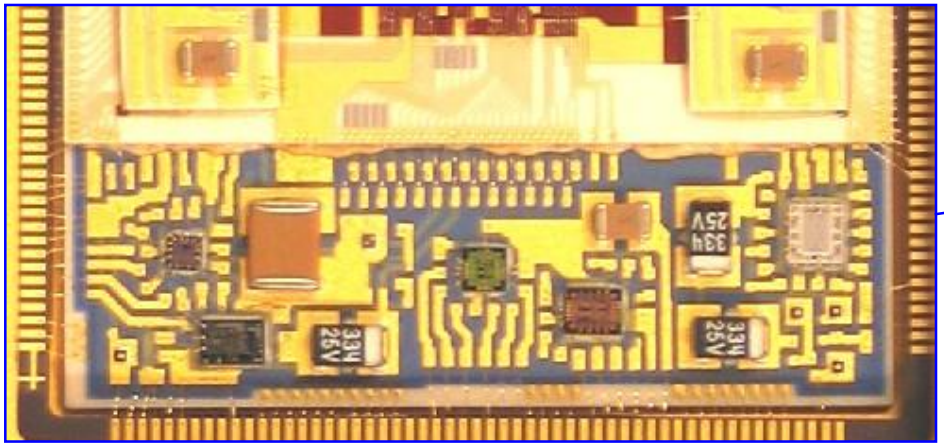




Pitch: 110 µm (pad width: 80µm)

MCM in HTCC_CQFP 220 package
With: ASIC, multi sub. Technology design, …)





µ_ST- Remote terminal for TM/TC

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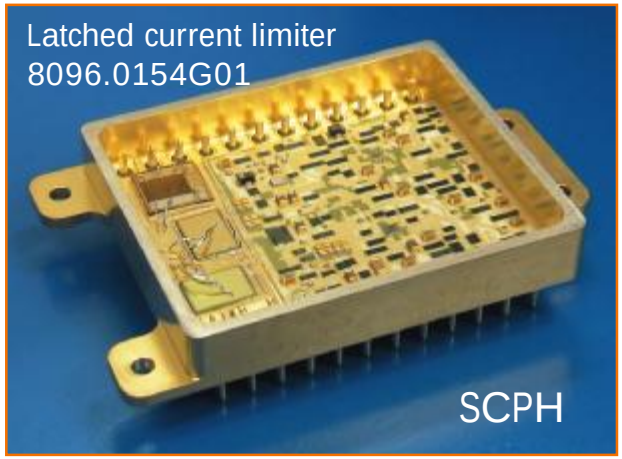
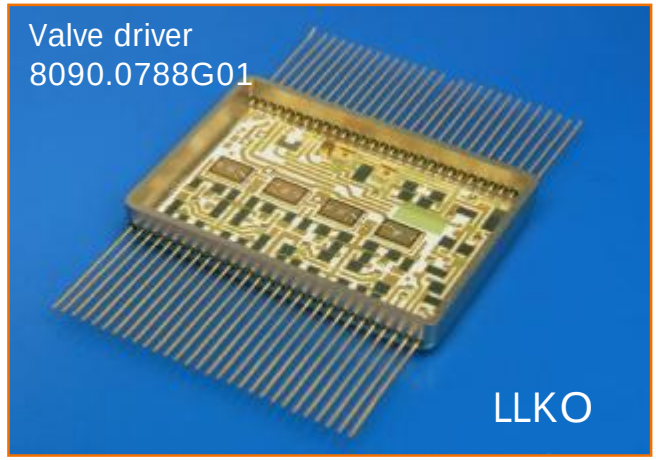
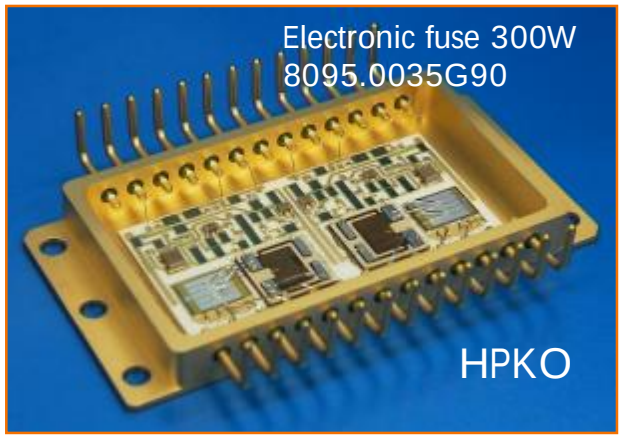
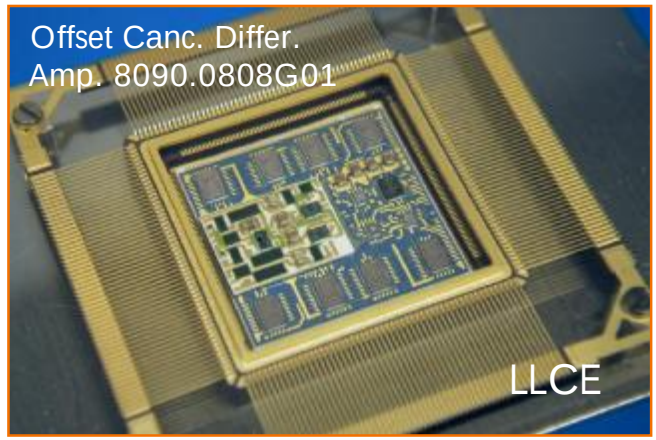
Qualified packaging styles









Main features of hybrid technology in ETCA

Main interesting features:

- High power integration capability (I_{max}= 30A/pin and p_{max}=6W/cm²), involving DBC substrates, heavy wirebonding, HC pins.
- « High density » and « high pin count » LF integration capability with « thin film »substrate.
- Capability approval covering a large panel of technologies: LLCE, LLKO, HPMO, MCPH.
- Possibility to mix « power » & « low power » functions
- « Piggy substrate mounting »
- Sleeved cabling in aluminium
- Parylen coating (for protection against propagation of failures)
- Modularity in Macro-hybrid construction
- Hybridisation of magnetics

Main features of hybrid technology in ETCA

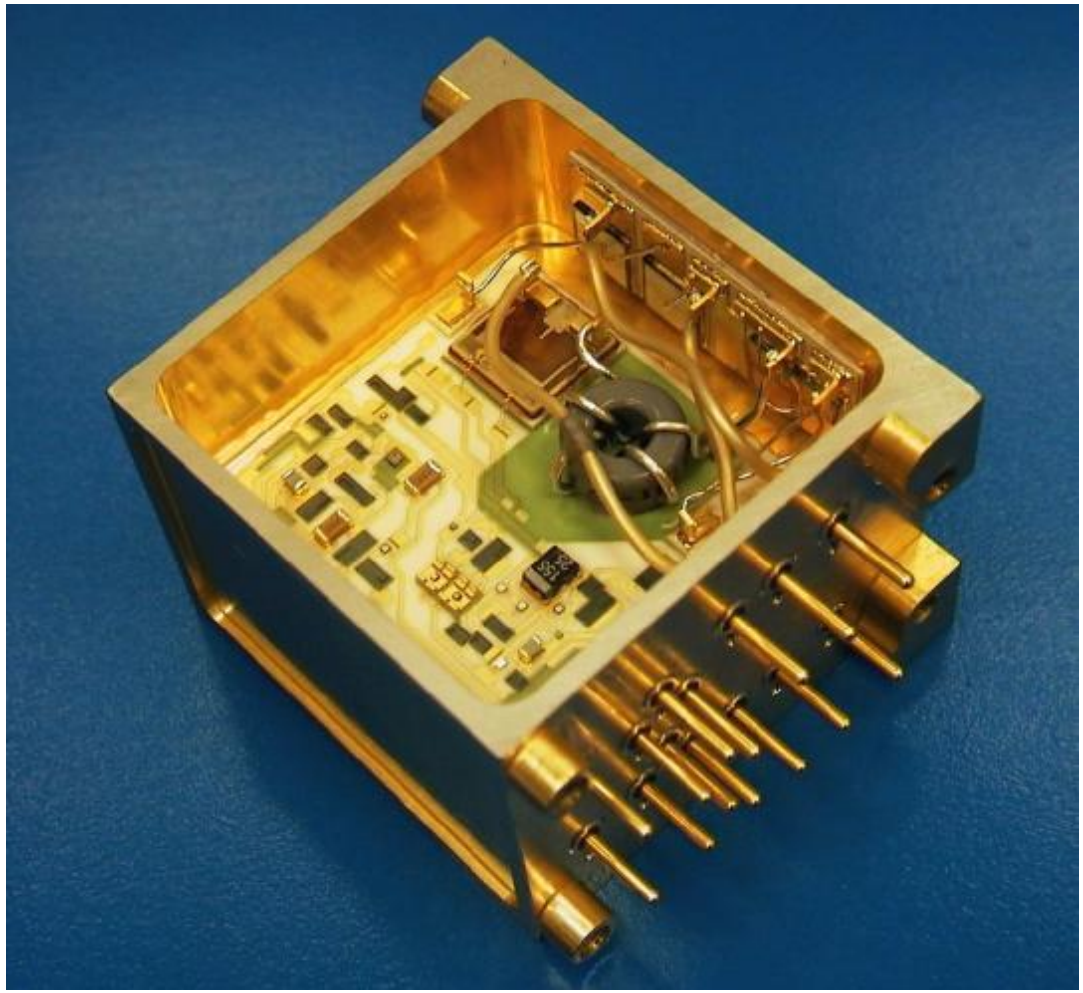
Main interesting features (follow) :

- Hybridisation of magnetics (with « class H » enamelled copper winding, or Al)
- Mounting of chips on « auxilliar carriers » qualified (allowing pre-characterisation of die prior to hybridisation, if neccessary)
- Buried resistors , with low tolerance
- Deep access integration and bonding, allowing 3D integration

Example 4: µ_controller function

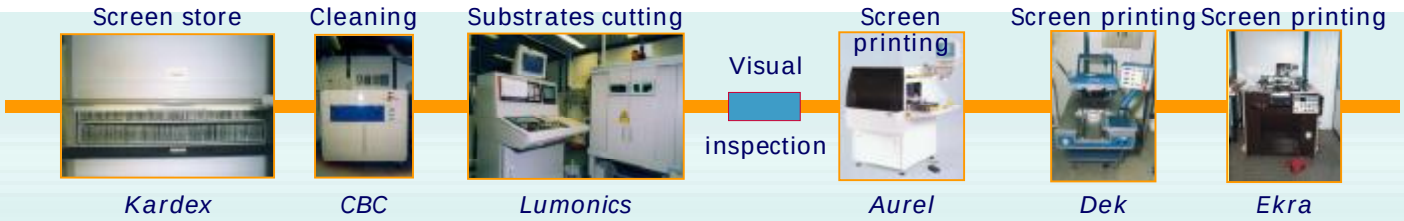
Exemple of 3D integration in MCPH package – S3R hybrid

- Double cavity package
- Hybridisation on perpendicular planes
- Interconnexion with 35mil Al heavy wire (including winding of inductance)



Productions means

Screen printing



Hybridisation

Productions means

Interconnection

Manual wire bonding

Kulicke & Soffa

Automatical wire bonding

Hugges / Palomar

Manual heavy wire bonding

Orthodyne

Automatic heavy wire bonding

Orthodyne

Electric welding

Unitek Equipment Inc.

Semi automatic Al wirebonding

Palomar

Visual inspection

Quality control test

Bond strength testing

Dage

Visual inspection

Leica + Volpi + Sony

X-ray inspection

Balteau S.A.

Scanning electron microscope

Leica

Particle impact noise detection

PTI

Productions means

Screening

leak detection

Veeco

Constant acceleration

Trio-Tech

Schock test

Avex

Thermal shocks

Heraeus

Thermal shocks

Heraeus

Burn-in

Thermotron

Electrical test

Hybrid test bench

Alcatel

Thermal test system

Temptronic

Sealing

Parylene coating

Novatran

Seam sealing

Pyramid

Laser sealing

GSI Lumonics

leak detection

Veeco

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