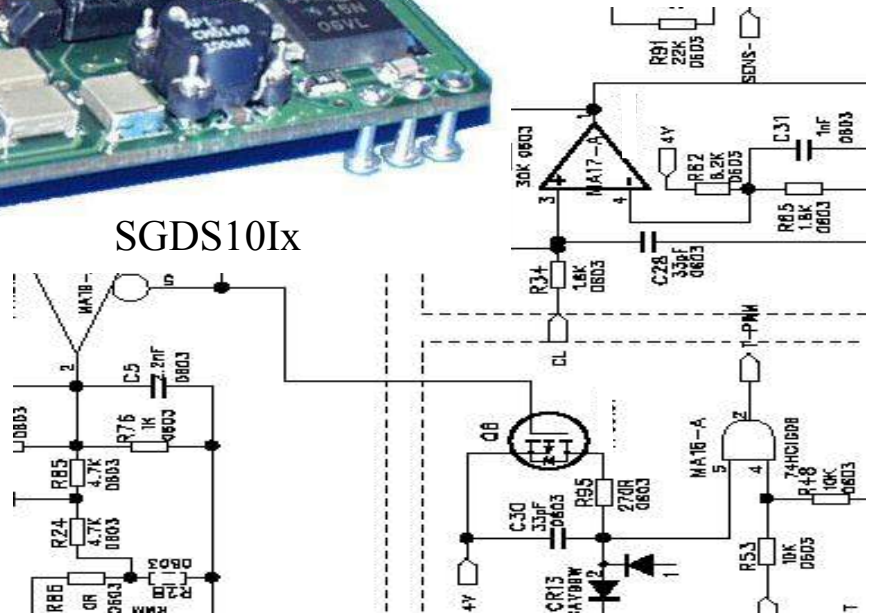
GAÏA CONVERTER

REDEFINING THE SOURCES OF POWER

An Industrial Vision for Space Use Qualified Converters

SGDS10Ix



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PRESENTATION OF GAIA CONVERTER (1/2)

LEADER IN COTS AVIONICS/MILITARY DC/DC CONVERTERS

- Product development based on the use of COTS and qualified for hirel usage
- More than 200.000 DC/DC manufactured per year

Innovative design including

- Patents on high frequency switching from 0.5 to 1.5 MHz
- Proprietary ASIC, planar transformer, ...

QUALIFIED ISO9001 V 2000

Worldwide sales and support

- USA and Canada..... : GAIA Converter Inc.
- Europe..... : GAIA Converter France
  : GAIA Converter Germany
- Worldwide..... : 21 Sales Offices

PRESENTATION OF GAIA CONVERTER (2/2)

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- Presentation of Gaïa
- COTS evaluation
- COTS qualification
- Design of space converter
  - Option 1: 3D stacking
  - Option 2 : Open frame
- Quality assurance

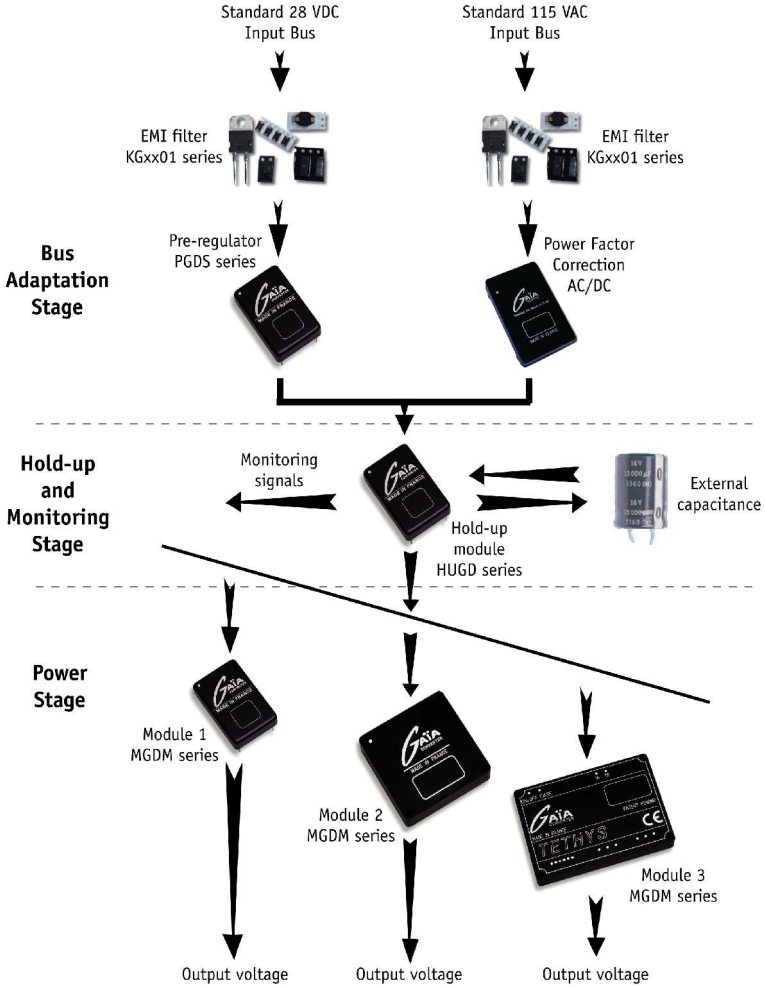
4W module

DIL24 package, 7.5mm height

150W module

58mmx 61mm package, 12.5mm height

Modular Power Architecture



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PHASE 1 : Radiation hardened products (1/2)

- Began working with CEA in **1995**
- Project : 2KW 1Mrad power supply
- In parallel, experiments were conducted to evaluate standard hirel 4W modules behaviour under radiation

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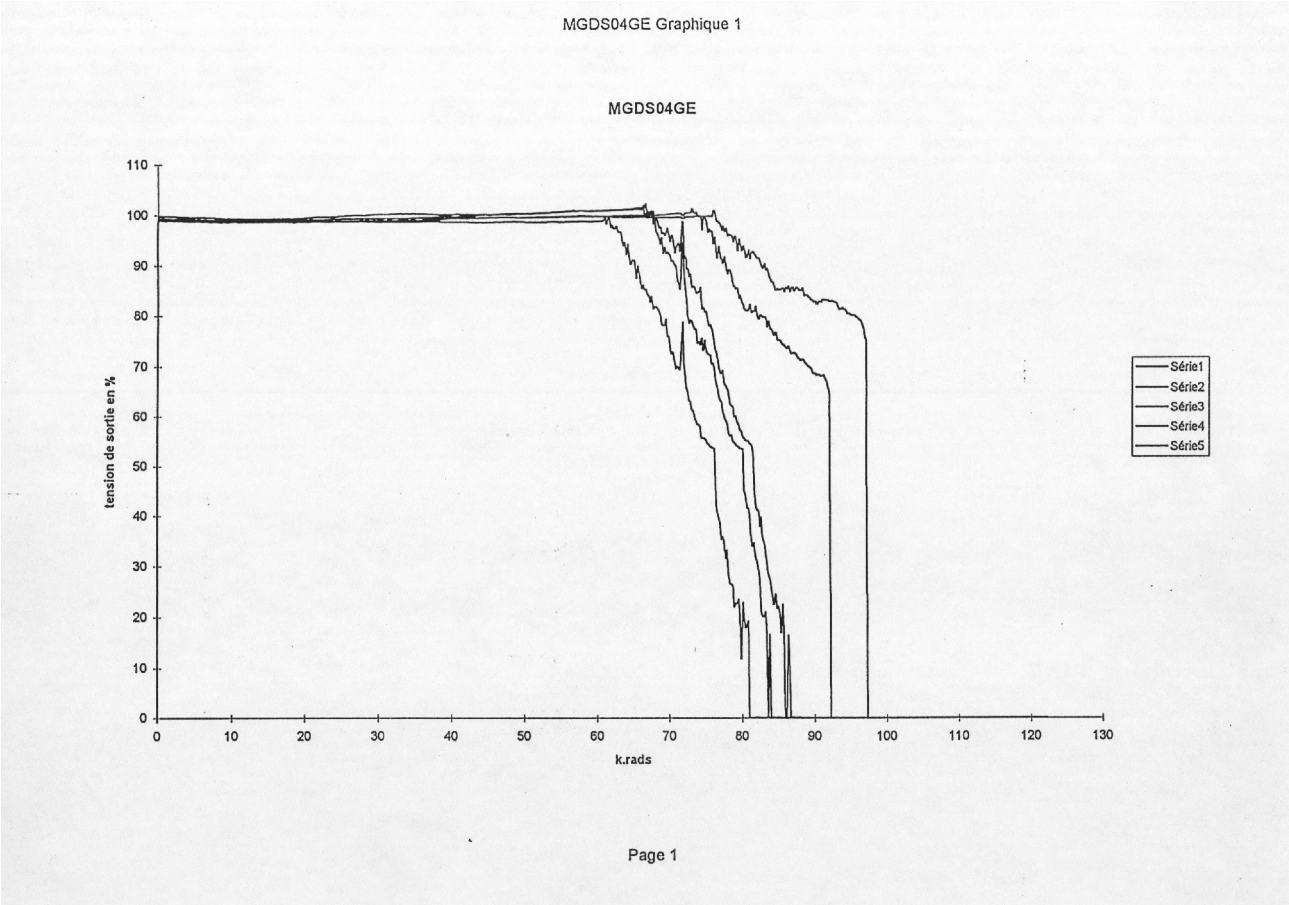
PHASE 1 : Radiation hardened products (2/2)

- **Performance achieved : Up to 70KRad total dose**



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PHASE 2 : Standard Converters Qualification (1/3)

- Beginning of cooperation with CNES in **1998**

- Qualification of 4W and 10W converters for space use. Only potting compound was changed,
  No re-design

- Manufacturing based on the quality and industrial manufacturing structure of Gaïa – assembly of converters was done on the standard production lines

- Batch qualifications to ensure product consistency and performance

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PHASE 2 : Standard Converters Qualification (2/3)

- **Results achieved :**
  - *Life test :* 1000 hours at 85°C, ON
  - *Thermal cycling :* 300 cycles -40/+110°C, 10°C/min, 30 min dwell time
  - *Cumulated dose :* 4.4 kRad @ 200 rad/h
  - *Damp heat :* 85°C/85%RH, 500 Hours
  - *SEL SEE :* Mosfet, op-amp, pwm

- Currently, hundreds of converters delivered with units in operation on Rosetta, Deep Impact, microsat satellites like Demeter, Parasol, Essaim...

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PHASE 2 : Standard Converters Qualification (3/3)

Limitations of this solution :

- Total dose behavior is very much batch dependent (from 4KRad to 70KRad), mainly related to the use of Bi-CMOS technology for the PWM

- Thermal dissipation not optimized for space use, difficult to evacuate heat by conduction, requires special mounting brackets...

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PHASE 3 : Design of a space dedicated converter

- **2003** : Based on acquired background with CEA and CNES, it is decided to design a converter family (4W, 10W) for space use.

- 2 converters options were investigated from the technical and the industrial point of vue :

  - Option 1 : 3D-stacking
  - Option 2 : Open frame with optimal thermal design

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Option 1 : 3D Stacking

- Prototypes of 4W converters have been designed, with the following conclusions :

Advantages :

- Space qualified technology
- Space qualified production lines
- Ease of mounting, SMD package

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Option 1 : 3D Stacking

Disadvantages and limitations :

- Commutation noise due to proximity effects (400mV spikes)
- Weight around 20gr for a 4W converter
- Thermal dissipation : only possible through board pins, hot spots can not be cooled efficiently. Due to this restriction**, it is not possible to design high power converters.**
- Potting causes important parameters variations – for example, inductance changes due to constraints
- Production line is not included in a large scale industrial production scheme that would generate cost savings, therefore it is **expensive compared to COTS solutions**

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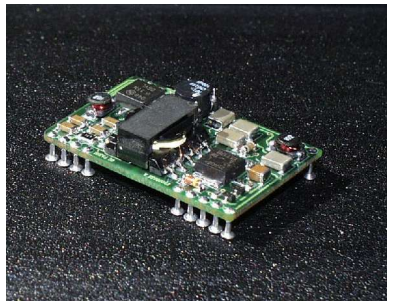
Option 2 : Open frame with optimal thermal design

This approach was **totally industry driven**, using the **same technologies that Gaia is using** for its new standard product ranges :



- Designed according to **ESA-PSS-01-301** derating guidelines
- Open frame converter, **no potting**
- Optimized thermal design, **buried thermal drain in the PCB**, heat dissipation possible by conduction through chassis mounting
- Bipolar technology
- Manufacturable on Gaïa standard production lines

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Option 2 : Open frame with optimal thermal design

SGDS04 and SGDS10 families Designed for space applications :

Components derating ESA-PSS-01-301
Dump input
Undervoltage lockout
Inhibition function
Synchronisation function
Adjustable output
Output regulation 0 to 100% load
Permanent output current limitation
Parallel operation (master slave)

Weight 8gr (4W), 10gr (10W)

Operating temperature range -40°c to +85°c

Heavy ions and ionising dose 20Krad characterised

Galvanic insulation 500 VDC
Integrated LC filter
EMI MIL-STD-461C with recommended external filter

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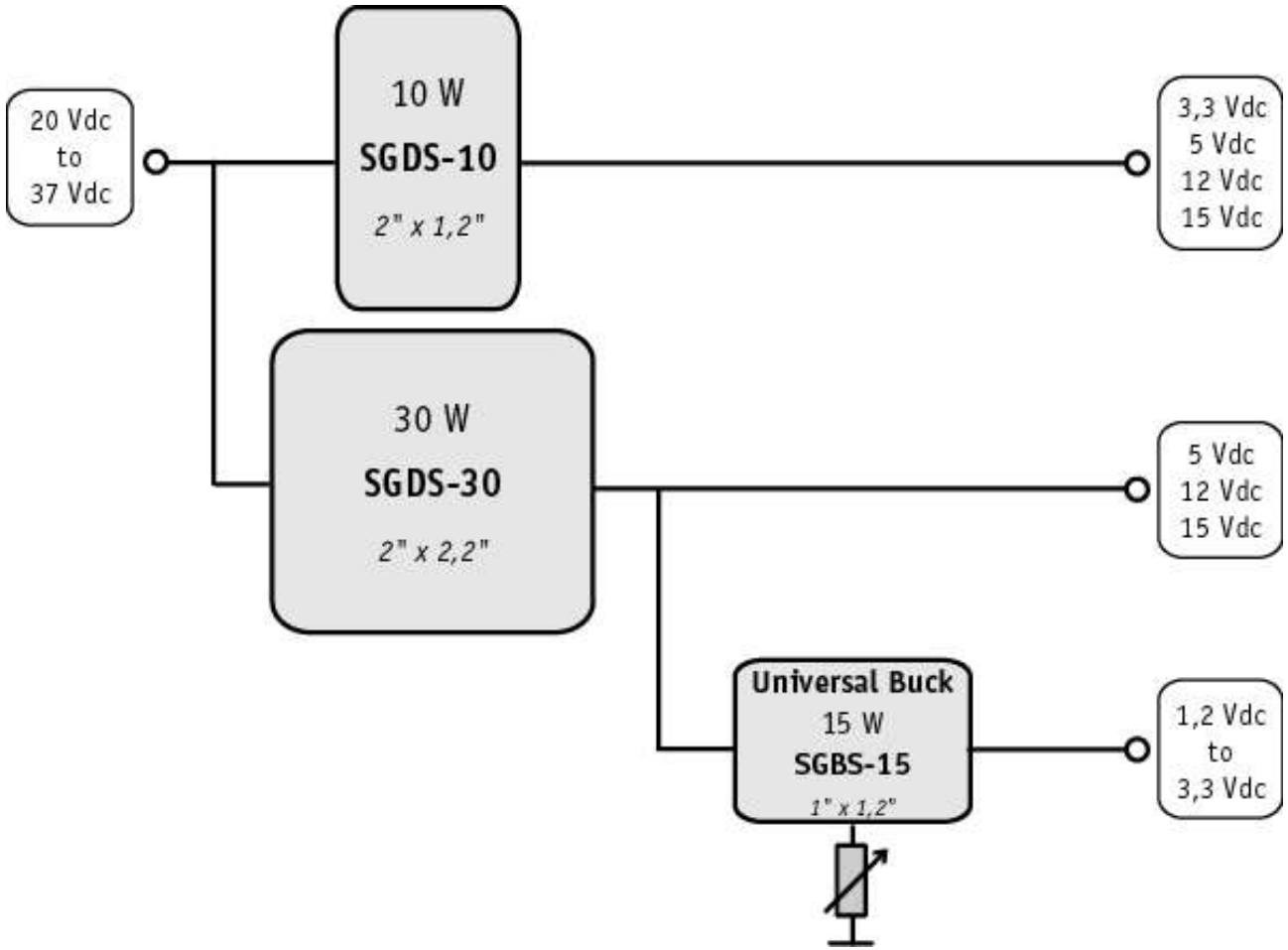
Option 2 : Open frame with optimal thermal design

Space Architecture Modules



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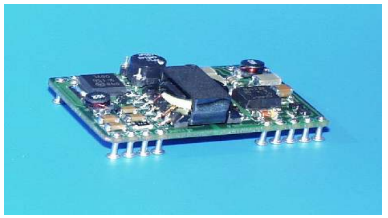
Option 2 : Open frame with optimal thermal design



Advantages :

- Low output noise (60mV ripple + spikes)
- Due to bipolar technology, total dose caracterised to 20KRad
- No potting brings **lightweight, higher reliability and higher consistency** in production
- **Simple assembly process**, no mezzanine boards
- Possibility to design higher output power versions – no limitation due to the technology
- Manufactured on standard production lines used for other Gaia products leads to **huge costs savings**

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Option 2 : Open frame with optimal thermal design

Disadvantages/limitations :

- Production line not yet qualified for space production, discussions have been initiated with ESA and CNES.

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Industrial approach : The assurance of space grade quality

- Design according to the ESA design rules
- Initial design validation :
  - electrical, thermal, mechanical
  - reliability (life-test, thermal cycling)
  - radiations (heavy ions, total dose)
- Components procurement in consistent batches for a 3 year production
  - approved suppliers
  - radiation batch qualification
  - drying of plastic case components and packing in dry-pack
  - nitrogen storage

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Industrial approach : The assurance of space grade quality

- Purchasing of PCBs to approved suppliers (i.e. SYSTRONIC)
- Manufacturing of consistent batches :
  - consistency of assembly through the use of automated assembly lines
  - consistency of consumeables (solder pastes, glues...)
- Assembly by a qualified sub-contractor with periodic audits :
  - Detailed flowcharts under control of Gaïa
  - Re-inforced and monitored controls
  - traceability and recording of all manufacturing operations

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Industrial approach : The assurance of space grade quality

- Electrical tests with recording of results at -40/+85/+25°C
- Batch qualifications :
  - life test 2000 h
  - Thermal cycling : 500 cycles -40/+85°C
  - DPA (RX and visual inspections, micro-sections)
- Nitrogen storage of converters