3D PLUS

DC/DC Converters Products Overview

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3D PLUS DC/DC Converter Product Offer (1/2)

THE CHALLENGE

To design and manufacture DC/DC Converters for :

- Distributed Power Architectures Systems,
- Small Satellites,
- Scientific Eexperiments....

With the following characteristics :

- High Electrical Performances,
- High Manufacturing Quality,
- ESA/CNES Qualified for Space Application(technology, design, environment),
- Cost Efficient despite the radiation guaranty,
- Available Off-the-Shelf for the European Space Industry.

THE DEVELOPMENT TEAM AND ITS RESPONSABILITIES

- GAïA CONVERTER offer State-of-the-art electrical design of DC/DC Converters for military, avionics, automotive... applications.
- 3D PLUS offer very integrated solutions with very high quality standards thanks to its 3D technology
- CNES and ESA offer technical inputs for the Product Specification and Technology and Radiation Assurance Expertise

PEB, April 2004

3D PLUS DC/DC Converter Product Offer (2/2)

THE DEVELOPMENT PHILOSOPHY :

- Use of 'selected' commercial grade components with Space Design Rules (Component Derating compliant to ESA PSS01-301 Issue 2 or MIL-STD-975)
- Topology and component technology chosen for bringing immunity to heavy ions and 20 Krads minimum :
- As a trade-off between Radiation Tolerance and Efficiency, two DC/DC converter technologies have to be evaluated :
 - A Bipolar design embedding a low power bipolar PWM driver and a bipolar Power Transistor
 - A BiCMOS design embedding a BICMOS PWM driver and a MOS Power Transistor
- Radiation Assurance activities :

TID and Heavy Ions tests will be performed at two levels :

- Individual test of the critical components
- Test at Final Product level





4 W DC/DC Converter Specification (1/2)

TECHNICAL FREATURES :

- Power : 4 W
- Input Voltage : 22V to 37V
- Output Voltage : One Adjustable Output above 3 adjustable ranges
 - 2,5V to 4V/1,2A for a 3,3V Output,
 - 3,5V to 6V/0,8A for a 5,0V Output,
 - 8,5V to 14V/0,33A for a 12,0V Output.
- Efficiency : 72 % Min
 - Protections: Primary Undervoltage lockout,
Output regulation from 0 to 100% load,
Permanent output current limitation
- Telecomand : Inhibit function
- Switching frequency : 330 KHz





4 W DC/DC Converter Specification (2/2)

TECHNOLOGY :

- 20 Krads Total Dose and Heavy Ions characterized
- Temperature range : -35°C,+85°C
- MCM-V 3-D Packaging Technology Qualified for space Application

PACKAGING :

- Dimensions : 32 * 21 * 10,5 mm
- Weight : 20 g.



4W DC/DC Converter Layout (1/2)





4W DC/DC Converter Layout (2/2)



Power Layer -

TECHNOLOGY CHARACTERISTICS :

- SMT ' selected ' Commercial Grade Components
- PLANAR Transformer Technology
- External programmation of the output voltage range
- 3D Intergation thanks to 3D PLUS Qualified Technology for Space Application (TV3)

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4W DC/DC Converter Characterization Results Summary (1/2)

ELECTRICAL TESTS (performed by GAïA CONVERTER) :

	Maquette BiCmos			Maquette Bipolaire			Cube BiCmos			Cube BiPolaire		
	3V3	5V0	12V	3V3	5V0	12V	3V3	5V0	12V	3V3	5V0	12V
Rendement (%)	72.7	77.6	80.8	69.2	71.2	75.9	69.8	75.5	78.7	64.9	67.9	72.7
Régul ligne (%)	0.02	0.01	0.02	~	~	~	0.17	0.4	0.64	0.38	0.10	0.54
Régul charge (%)	0.04	0.06	0.03	~	~	~	0.86	0.9	0.46	0.33	0.30	0.71
Régul T° (%)	0.40	0.38	0.29	~	~	~	0.44	0.2	0.73	0.17		1.21
Bruit spikes (mVpp)	60	56	80				332	190	580	400		100 0
Delta rendement (%)	ref	ref	ref	ref	ref	ref	-2.9	-2.1	-2.1	-4.3	-3.3	-3.2
Delta Pertes (mW)	ref	ref	ref	ref	ref	ref	228	178	132	382	273	231

- ⇒ Efficiency of 3D DC/DC Converter between 78,7 % for the BICMOS 12,0 V and 64,9 % for the BIPOLAR 3,3 V
- ⇒ Some Efficiency loss may be due to 3D Module plating thickness and output voltage range programming possibility (impedance mismatch and loss in the planar transformer)

4W DC/DC Converter Characterization Results Summary (2/2)

RADIATION TESTS (performed by CNES) :

DC/DC Reference	Parametric TID Level (Krads)	Functional TID Level (Krads)
Bipolar 3,3V	50	-
Bipolar 12,0V	50	-
BICMOS 3,3V	24	40
BICMOS 12,0V	15	24

- ⇒ Radiation Tolerance of 3D DC/DC Converter between 15 Krads for the BICMOS 12,0 V and 50 Krads for the BIPOLAR 3,3 V and 12,0 V
- ⇒ Radiation Performance of the 3D Module significantly better than the individual components (example : The BICMOS PWM driver was out of the range at 5 Krads)
- ⇒ Heavy Ion tests will be completed on 3T2004.
- ⇒ DESIGN FEASIBILITY PROVEN
- ⇒ GLOBAL SATISFACTORY RESULTS AND LAUNCH OF THE 10 W DC/DC CONVERTER IN 2003 UNDER ESA CONTRACT.

10 W DC/DC Converter Design Philosophy

• Use of 'selected' commercial grade components with Space design rules (Component Derating compliant to ESA PSS01-301 Issue 2 or MIL-STD-975)

Minimum change will be introduced compare to the 4W DC/DC converter Part list

• Topology and component technology chosen for bringing immunity to heavy ions and 20 Krads TID

Based on 4W Study, only Bipolar technology will be implemented

• Topology design for 5V and evolution to 3,3V, 10V, 12V and 15 V with Minor Modifications.

• Radiation Assurance activities :

TID and Heavy Ions tests will be performed at two levels :

- Individual test of the critical components
- Test at Final Product level



10 W DC/DC Converter Specification (1/2)

TECHNICAL FEATURES :

- **Power** : 10 W
- Input Voltage : 22V to 37V
- Output Voltage : One Adjustable Output 5,0V/2A
- Output Ripple : 50 mVpp
- Set Point Accuracy : +/- 2%
- Line Regulation : +/- 0,6 %
- Load Regulation : +/- 0,6 %
- Efficiency : > 75 % Full Load
- Protections : Primary Under Voltage Off/On threshold 18V/20V,
 - Output regulation from 0 to 100% load (Permanent),
 - Permanent Output Current limitation
- On/Off Telecomand
- Master/Slave parallelization possibility for high Power requirements (Synchronization)
- Input Filter (differential mode)
- EMI (MIL-STD-416C) with external filter
- Isolation 100 MOhm @ 500 V



10 W DC/DC Converter Specification (2/2)

TECHNOLOGY :

- Radiations
 : TID > 20 Krads
 Heavy Ions protections
- Temperature Range : -40°C/+85°C
- Survival Temperature Range : -55°C /+125°C
- Use of 3D PLUS Qualified Technology for Space Applications

PACKAGING :

- Dimensions : 40 * 26 * 12 mm
- Weight : 45 g.



10 W DC/DC Converter 3D Layout (1/2)





POWER LAYER

CONTROL LAYER

MEASURE LAYER



10 W DC/DC Converter 3D Layout (2/2)





10 W DC/DC Converter Development Progress Status

Main Achievements :

- PDR and CDR completed in 2003
- **BB fully Compliant to specification**
- **3D DC/DC Converter design completed and prototypes under manufacturing**

Planned activities :

- 3D Modules will be tested in September 2004
- TID test will be performed in November 2004
- Heavy Ions test on stand alone components are planned for September 2004
- Heavy Ions test on DC/DC Converter are planned for January 2005



3D PLUS DC/DC Converter Product Range Summary and Road Map



Product Available Off-the-Shelf with EM and FM quality grade

- Product Under Development
- Product to be developed with Minor topology changes

