SPACE DC/DC CONVERTERS

MARKET ANALYSIS AND TRENDS

1. Overview

- US hybrid DC/DC converters are “popular” in scientific space programs as “standard” DC/DC
- US hybrid DC/DC are considered as low cost, Off-the-shelf products
- But US space DC/DC are subjected to export restrictions
- But lack of design justification and quality issues have been observed for US space DC/DC
- So, part of the European Components Initiative,

  The development and qualification of a European DC/DC converter has been identified as necessary

2. Space DC/DC Market Segmentation

Three market segments have been identified:

1. Standard DC/DC:
   - Based on modular design
   - No or little non-recurring effort
   - Short lead time, low cost
2. Custom DC/DC:
   - Meets special requirements, e.g. scientific instruments, optics, radar, laser, RF equipments
3. EPC:
   - Electronic Power Conditioners for Solid State Power Amplifiers (SSPAs for communication & navigation)

3. Space European DC/DC Market Analysis

- **US hybrid DC/DC converters are used in the 2 first market segments:**
  - **- Standard DC/DC for 80%**
  - **- Custom DC/DC for 20%**
- **The annual turnover of space US hybrid DC/DC in Europe converter is around 1.5M€**
- **Interpoint and International rectifier dominate this market with Class K and Class H products (Interpoint only) at low recurring prices:**
  - **- 6 to 10k€ for Class K**
  - **- 2 to 4k€ for Class H**

A low business volume split in a large number of different items with low recurring prices

Why are US hybrid DC/DC used?

- **Advantages:**

  - No or very low NRE if catalogue product

  - Low recurring price compared to custom solution

  - Possible selection in a "family"

  - Low mass

- **Drawbacks:**

  - External input filter often necessary and I/Fs (ON/OFF, sync…) imposed by the DC/DC

  - Limited electrical performances (efficiency, cross-regulation, load range…)

  - Limited access to information (schematics, analysis…) when existing

  - Export restrictions (ITAR when rad-hard)

US hybrid DC/DC converters are used for cost reasons

4. Experience using Off-the-shelf DC/DC

- **2 attempts in the last 10 years compared to more than 50 custom DC/DC converters or EPC developments**

  - One ITAR rad-hard mono-secondary DC/DC (Class K) for a very simple function – satisfactory results

  - One non rad-hard DC/DC (Class H) for LEO OBC mission
  Failure in latch-up of the DC/DC in heavy ion test
  Development of the custom DC/DC in a hurry!

- **Lessons learnt:**

  - Very few opportunities for Off-the-shelf DC/DC converters

  - It is necessary to procure radiation guaranteed DC/DC converter (total dose and SEE) to be able to use them on a space program

  - Parts have always to be added around such DC/DC to adapt to application (inrush current limiter, UVD, OVD…)

  - It is difficult to provide design justification to customers since these DC/DC are not specially designed for space

5. European DC/DC technical requirements

- **Key Success Factors**

  - ITAR-free

  - International Rectifier Mosfets free – Use of STM mosfets currently in development

  - "Space" designed and qualified versus ESA rules

  - Adaptable to specific user requirements (one family?)

  - Competitive solution (NRE and recurring cost)

Due to potential low volume of each dedicated DC/DC, the qualification of this DC/DC must be achieved for the whole series of DC/DC to minimize NRE.

PFM approach possible at equipment level for limited complementary qualification

5. European DC/DC technical requirements

- **Needed functions**

  - Input filter included

  - External synchronisation possibility

  - Adjustable primary UVD

  - Output overvoltage protection

  - Overcurrent protection

- **Environment**

  - Operational temperature: -40°C to 85°C (derating included)

  - Total dose: 50krads (up to 100krads depending on new rad-hard European parts availability)

  - SEE: immune up to 40MeV + latch-up free up to 82MeV

  - Shocks: 2000g (3kHz to 10kHz)

5. European DC/DC technical requirements

- **Electrical performances**

  - Primary input voltage: 22V-37V (50V if possible) for LEO, scientific and perhaps some GEO missions)

  - 100V bus excluded since a product has already been identified for @bus (EADS-Astrium answers the relevant ITT)

  - Secondary power: up to 40W

  - Number of secondaries: up to 4 with +/-5% accuracy
  *** one very low voltage (2.5V – 1.8V) / 10A**
  *** 3 other rails (range of products)**

  - Possibility to operate under no load configuration

  - Efficiency > 85% at full load

  - Mass and dimensions optimised – reduced height

Electrical performances as good as US DC/DC necessary

5. European DC/DC technical requirements

- **In order to provide European industry with a competitive and non-US dependant DC/DC converter, are needed:**

  - As first priority, European Mosfets as good as International Rectifier ones

  It appears to be necessary to support STM in its current development with User experience in electrical and hardening fields

  - European parts like Mosfet drivers, PWM in addition to the Mosfets developed by STM

  - Technological developments to reduce size of the DC/DC (magnetics, substrates, parts report)