Development of Planar transformers for Space power converters with multiple outputs

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Flux has been driven a study project on planar transformers for the Space industry.

Using PCBs as windings in magnetic components is a well known and proven technology when it comes to the standard industry. Here some of the first transformers were build in the late 80'es, but it has never been qualified for space applications. The general space qualified standards for PCB layout and assembly makes it impossible to create a good transformer with reasonable parameters, and space converter Engineers are requesting planar technology more and more.

The project was therefore initiated with its purpose of highlighting the frame of design and production methods along with simulation prediction contra the final test measurements. As well as durability and life test.

High reliability transformers are produced according to military standards both for NASA and ESA, where PCB design in both cases are pointing at IPC standards if not superseded by ESA's own standard system ECCS.

The baseline for the project is:

- Definition of design rules
- Material Process Selection
- Comparison of Planar vs. Traditional
- Qualification Strategy
- Design & Characterisation
- Prototype Manufacturing
- Test plan and Procedures

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ESA Qualification

MIL-PRF-27F
General specification for Power Transformers and Inductors

IPC -2221

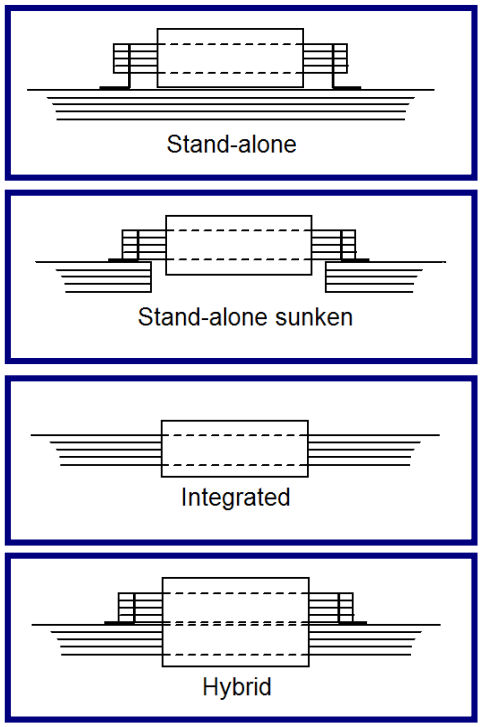
Generic Standard on Printed Board Design

ECSS

Space product assurance

Manual Soldering of High-reliability electrical connections

Stand-alone Component vs integration.



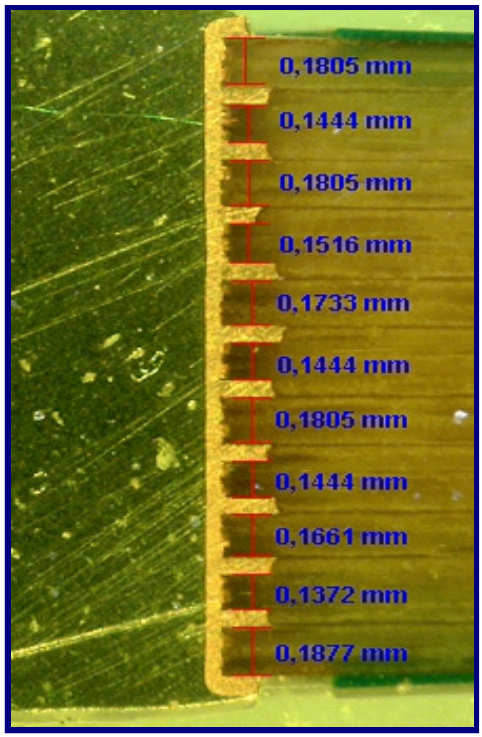
Since the standard usage of SMPS transformers in space application are build with multiple outputs, and often as combined magnetics, several layers in the PCB are needed. The standard industrial 4 or 6 layers PCB's, and building technique, used for the SMPS converters are not sufficient, so pioneering thinking is needed.

Integrating the model could be a great solution, but flexibility of trimming the transformer during prototype testing demands for at total PCB change of the converter which also requires mounting new components all over.

Flux A/S is a custom component manufacturer, so the natural choice is to build the planar transformers as stand-alone components. By this approach Flux A/S can also combine several standardised PCB's and stack them together as the designers request different output or inputs, or adjust by changing a single PBC to trim the performance.

The initial layout cost and production setup for copper etching is highly expensive when it comes to low quantity, which is normal for Space. 10, 20 or max 30 units are standard lot sizes, so it is also very important to have the possibility for standardised component building blocks, to keep production prices low by reuse.

Layouts can also be reused and adapted into integration or hybrid constructions in later converter models, in order to optimise the graphic design time.



Layer buildup

When designing planar transformers for power, the real battle is with the general tolerances of final produced laminate and copper thickness. But also the PCB building methods, are important to know, when designing with buried and blind vias for power application.

The micro-section measurements, to the right, shows laminate variants from 144 to 180µm on a PCB that is specified to be 200µm in all layers. All according to the IPC tolerances, which is also used when the prepreg is filled with resin content at the laminate manufacturing process.

The outcome

Running this project will in the end provide Flux A/S with the needed theoretical knowledge and practical experience in such deep details and with a wide perspective within SMPS transformers, that we are able to guide the power converter designers, and produce state of the art planar transformers. With detailed knowledge of parasitic values, Flux A/S are able to make calculated models to predict the thermal limits, and efficiency of the component before expensive prototypes are build.

- And this is of course also applicable for standard High-grade and Industrial components.

If you like to hear more about how planar technology can improve the quality of your product. Please contact:

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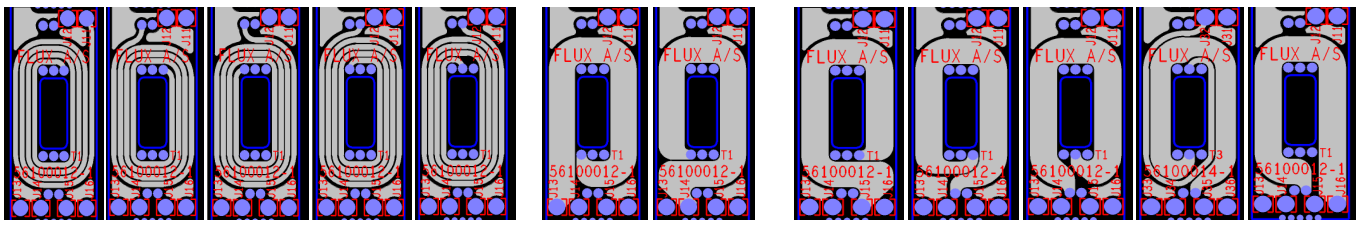

The project was initiated by ESA's technology center ESTEC in Holland