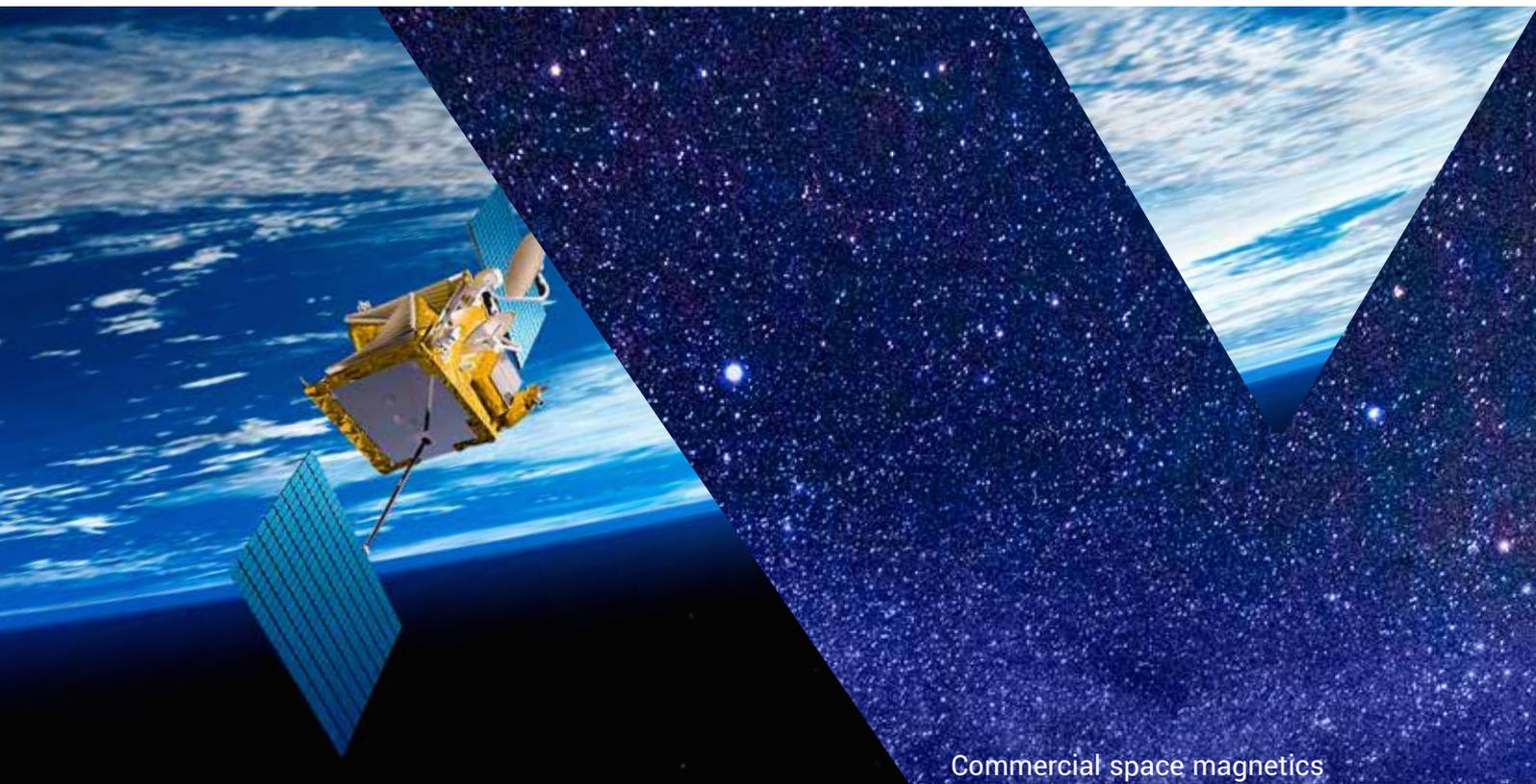




Next level
magnetics for power solutions.



Commercial space magnetics
Excellence for demanding customers



Quantity
Mission lifetime
Finance

The main implications
fostering innovative
approaches in
the supply chain

Commercial Space or New Space are both headlines describing a general disruptive trend in innovation and commercialization of the space industry. The industry was initiated by new commercial actors, paving the way for industrialization, private investment, and digitalization.

Commercial Space can be regarded as an add-on to the existing traditional space industry as the service offerings of the two sectors are largely complementary. Commercial Mega constellations, flying in Low Earth Orbit, focus on digitalization whereas the traditional space industry typically supplies heavier space vehicles flying in Geo Stationary Orbit for Earth observations and science or deep space missions with a significantly longer lifetime.

The implications of quantity, mission lifetime, and financial aspects have fostered innovative approaches in the supply chain of these highly differentiated industries.

Flux has supplied custom-made inductive components, inductors, and transformers, to the traditional space industry since 1995, building on the heritage of the Alcatel Space principles that were founded in 1973.

**Flux is ESA Qualified
Manufacturer based on
Technology Flow
Qualification
coauthoring the ESCC
Detail Specification
ESCC3201/013**

In the early days of Commercial Space (early 2000s), Flux recognized the potential of a new ecosystem and engaged in the development of practices. A standardized practice was needed for design, material choice, and processes to provide larger quantities of components, matching the technological and financial requirements of this emerging industry.

On the path for our current space concept since 1995



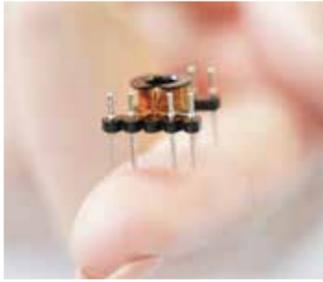
Understanding the concept of quality

As a traditional supplier of space components, it has always been Flux's philosophy to supply high-quality, flawless, and enduring components. Our concept of quality is divided into several elements which are all implemented in our manufacturing of high-quality space components:

- Electrical and mechanical design
- Choice of material
- Procurement and production processes
- Inspection criteria
- Electrical and environmental testing requirements
- Quality management
- Education and training
- Additional commercial activities

The objective has always been clear: Deliver high-quality components in all aspects at a realistic cost based on labor and material consumption.

Even in our early days, we achieved this by supplying full-grade components manufactured at our high-efficiency facility in Thailand, Flux International Ltd. Due to increased demands to low cost and acceptance of less quality control the setup has since changed. The products were inspected onsite by the traditional space production located in Denmark and were sent for a screening at the Danish Space Test Facility. Though enduring some administrative costs, we managed to maintain a high quality and a target price reduction of 50%.



Arriving at the final Commercial Space concept was closer at hand than first imagined. Flux has designed and documented space-grade products for decades based on Generic Documentation befitting the requirements of MIL-STD-981 Class B and Class S, as well as ESCC3201-ESCC3201/013. The final concept entails a declared material list consisting of space-proven materials to be used in all space designs. Flux has supplied the defence industry with HiRel products manufactured by IPC-A610 Class III certified operators and inspectors. As space-grade products, Flux's HiRel

products are serialized, tested individually, and delivered with certificates issued by our quality department based on a review of production, documentation, and test results. By combining the above-mentioned capabilities and maintaining full traceability we are able to offer AS9102 First Article Inspection and the option of full Space Grade Screening. This allowed us to achieve the ultimate target and we were able to develop space-grade designs with space-grade materials, manufactured in a HiRel production line. The solution is reliable, cost-effective, and can be supplied

from existing HiRel facilities in either Denmark or Thailand depending on the quantities needed.

Flux further offers the production of bespoke designs originating from the buying entity.

Defining the final Commercial Space concept

Design and documentation are based on MIL-STD-981 Class B, Class S, and ESCC3201 ESCC3201/013.

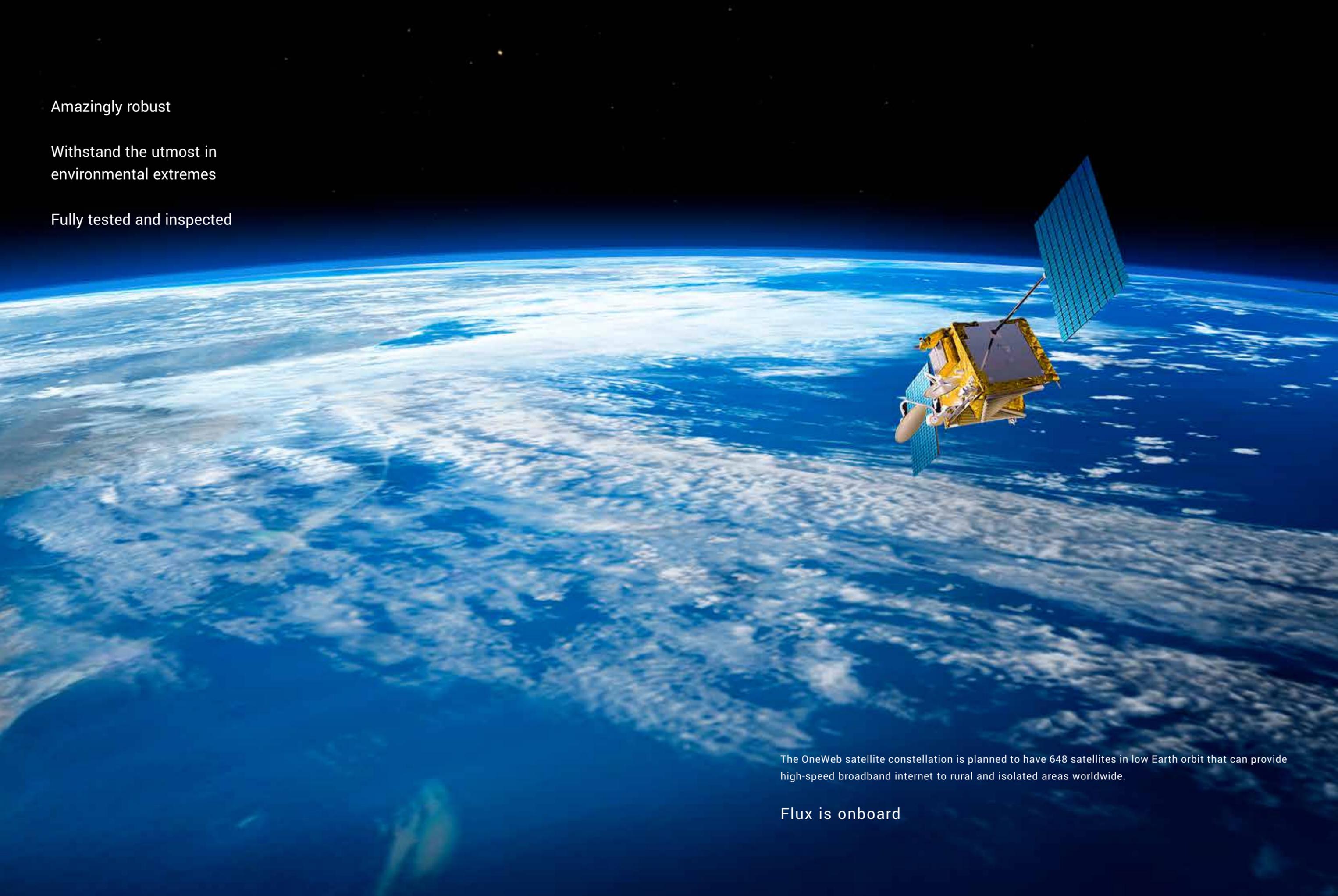
Manufactured by IPC-A610 Class III certified operators and inspectors.



Amazingly robust

Withstand the utmost in
environmental extremes

Fully tested and inspected



The OneWeb satellite constellation is planned to have 648 satellites in low Earth orbit that can provide high-speed broadband internet to rural and isolated areas worldwide.

Flux is onboard

Extensive experience in optimization of power magnetic components

At our headquarters in Asnaes, Denmark, teams of dedicated engineers are ready to work closely with our customers in designing power magnetics for your projects.

You can approach us with a finished topology and trust our expertise when it comes to optimizing materials, production design, or product layouts. You can also approach us with a series of requirements for your upcoming power solution project and leave the design process to us. Our engineering department has extensive experience in the optimization of power magnetic components – not just when it comes to the topology and the design-for-manufacturing aspects of the components, but especially in terms of the materials used. In most cases, a transformer or a choke will need to be built into a larger component such as a complete power supply and the individual components may need some type of plastic or resin encase-



ment. This, too, is part of our core expertise. Working with trusted, local, and international suppliers of raw materials, allows us to develop and produce every single part of the power magnetic components, while scaling and the shaping the production as needed.



The Iridium satellite constellation provides L-band voice and data information coverage to satellite phones, satellite messenger communication devices, and integrated transceivers, as well as a two-way satellite messaging service to support Android smartphones, over the entire surface of Earth.

Flux is on board



The Magnetorquer Rod. A Collaboration between Space Inventor and Flux



Background

In response to the need for precise momentum control in Low Earth Orbit (LEO) satellites, Space Inventor contracted Flux to take up the task of precise windings and coating of the magnetorquer, essentially enhancing performance and reliability of the overall magnetorquer product.

Partnership Overview

Space Inventor, a satellite manufacturer, and Flux, a space solutions provider, recognized the industry's demand for an advanced and reliable magnetorquer rod. In light of their complementary expertise, Space Inventor contracted Flux to participate in developing the highly reliable magnetorquer rod, aiming to deliver superior performance, reliability, and integration efficiency.

The Magnetorquer Rod

The magnetorquer is an integrated solution designed and manufactured by Space Inventor tailored for precise momentum control and dumping of LEO satellites.

Key features include

Optimized Core Material: Utilizing annealed Alloy 79, the core ensures reliable and precise momentum control.

Enameled Copper Winding: The enameled copper winding maximizes magnetic performance while minimizing power consumption.

Low Power Consumption: Designed for minimal power usage, aligning with satellite power constraints.

Built-in Control Electronics: Streamlines integration with integrated control electronics.

Redundancy for Reliability: Incorporates redundancy for heightened reliability, including diode-connected input supplies, dual copper windings, and driver electronics.

Adjustable Mounting Brackets: Mounting brackets can be adjusted to accommodate various satellite bus features, simplifying installation.

Manufacturing by Flux

Flux played a pivotal role in winding and coating of the magnetorquer rods thus ensuring top-quality production standards aligned with the overall standards demanded by the industry.

Benefits of the Joint Partnership/Product

The collaboration between Space Inventor and Flux yields several advantages:

Enhanced Performance: The workmanship in terms of windings and coating by Flux enhance satellite magnetic control, improving longevity and performance.

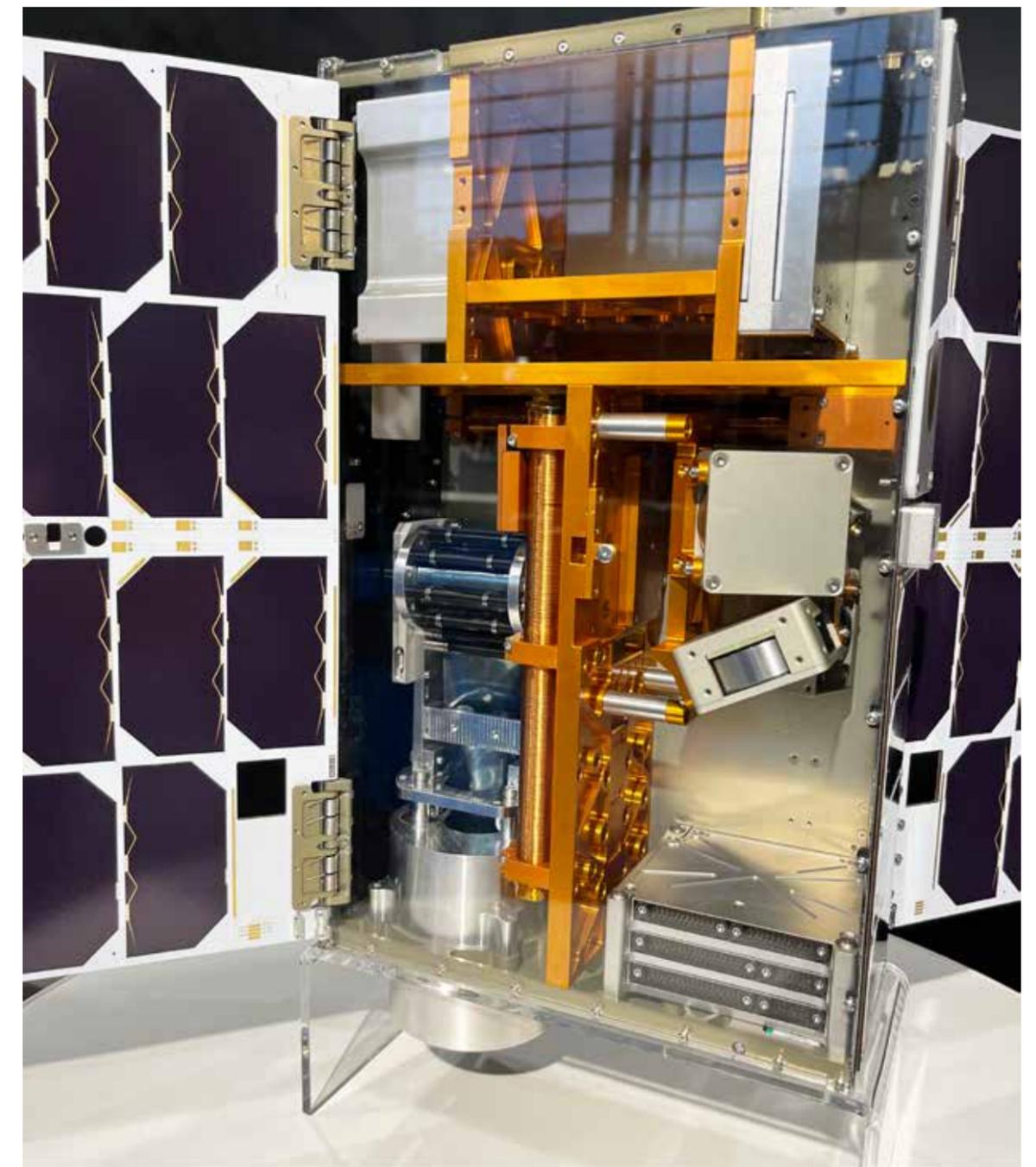
Reliability: Full Redundancy ensures unwavering reliability, reducing mission failure risks.

Integration Efficiency: Integrated control electronics and versatile mounting options simplify satellite integration.

Energy Efficiency: Low power consumption contributes to extended mission lifetimes.

Conclusion

The MT magnetorquer rod exemplifies the successful collaboration between Space Inventor and Flux. This joint venture highlights the potential for industry leaders to combine their strengths in advancing space technology.



DC/DC converter for RF applications used in the OneWeb Satellite constellation - meeting cost and performance targets for NewSpace

For Micross – being a trusted supplier of space-grade DC/DC converters for decades – it has always been second nature to supply the highest possible quality and reliability based on proven methodologies, careful selection of materials, reliable processes, and extensive testing.

Partnership Overview

For the OneWeb satellite constellation, Micross was chosen to develop and produce 2,000 isolated DC/DC converters for power RF circuitry. With a challenging specification requiring five outputs, high power efficiency and a price point order of magnitude below that of classical space power electronics, without sacrificing performance and reliability, called for strategic partnering with suppliers of the cost driving components.

Performance requirements

For space grade DC/DC converters, the magnetic components are key cost drivers since manual craftsmanship at highest level as-well-as comprehensive test and screening is required. Custom designs are needed to meet the electrical performance requirements and although the selected topology, a flyback converter, theoretically only needs one magnetic component, the need for high efficiency led to use of synchronous rectification with associated gate drive transformers, as well as a current transformer instead of a sense resistor for the converter PWM control scheme (cycle-by-cycle current mode control).

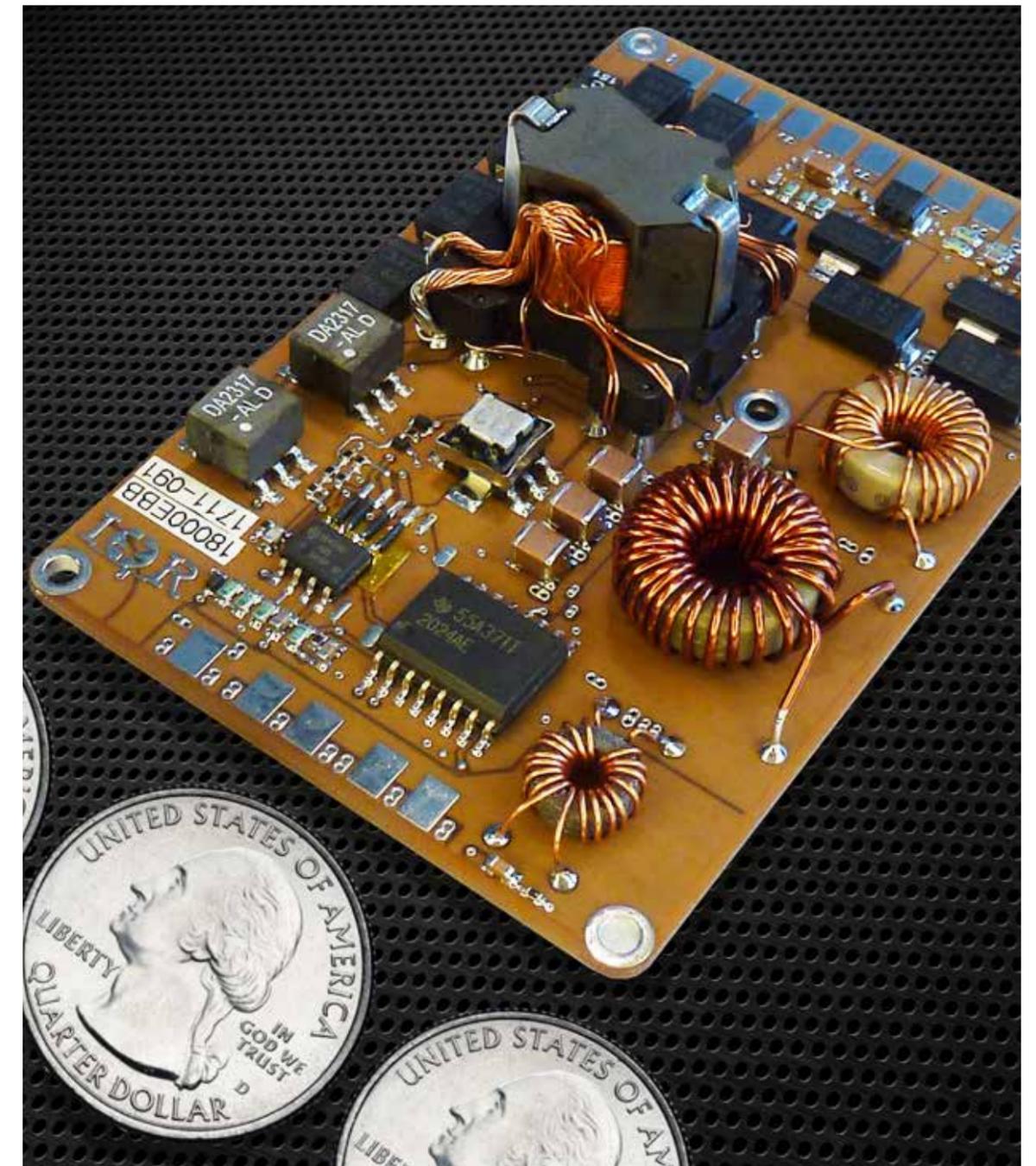
Micross' well-known PCB-based isolated space-grade DC/DC converters for classical space, typical-

ly use full-custom magnetic design for best-in-class performance based on in-house innovative designs and partnership with FLUX for manufacturing, test, and screening to the highest standards. The product assurance concept used for the OneWeb DC/DC converter applies the same rigorous and well-known design methodology, derating criteria and finite element modeling as known from classical space. This ensures performance predictability and reliability. To meet the cost target, a combination of COTS magnetic and custom magnetic design is used. COTS can be used for the non-performance setting elements like signal transformers and output chokes, while custom magnetic designs are required for the performance setting fly-back transformer. The key parameters for the fly-back transformer includes minimum cross regulation between the five outputs, low power loss, and low cost.

Manufacturability and cost

Use of custom bobbins and cores is standard in Micross' line of classical space DC/DC converters, but due to cost this is not an option for the OneWeb program. Together with FLUX the selection amongst COTS bobbins, wires, and cores were made to facilitate the design and performance, as well as manufacturability and cost. The widespread commercially available bobbins do not offer the same degree of freedom in the design, leading to reduced thermal performance. This challenge was solved in corporation with FLUX by a specially designed heatsink winding.

More than 1,800 units of the final DC/DC design were produced - using more than 9,000 magnetic components. The design has proven excellent EMI performance which is key for a DC/DC converter used in RF applications. Meeting the EMI requirements is facilitated by the close cooperation with FLUX to design the custom magnetic components.





When small
components
make a
big difference



Next level
magnetics for power solutions.



Flux A/S - part of discoverIE Group plc

Industrivangen 5
4550 Asnaes
Denmark
Phone +45 5965 0089
E-mail flux@flux.dk

Defence and Space inquiries

www.flux.dk
Email: space@flux.dk

Flux International Ltd.

BLK C 5, 41/27 Bangna-Trad KM. 16.5
Bangchalong, Bangplee
Thailand

Phone +662 (02) 337 0201
E-mail flux@flux.dk

Flux.dk