



MISSION-CRITICAL POWER SUPPLIES



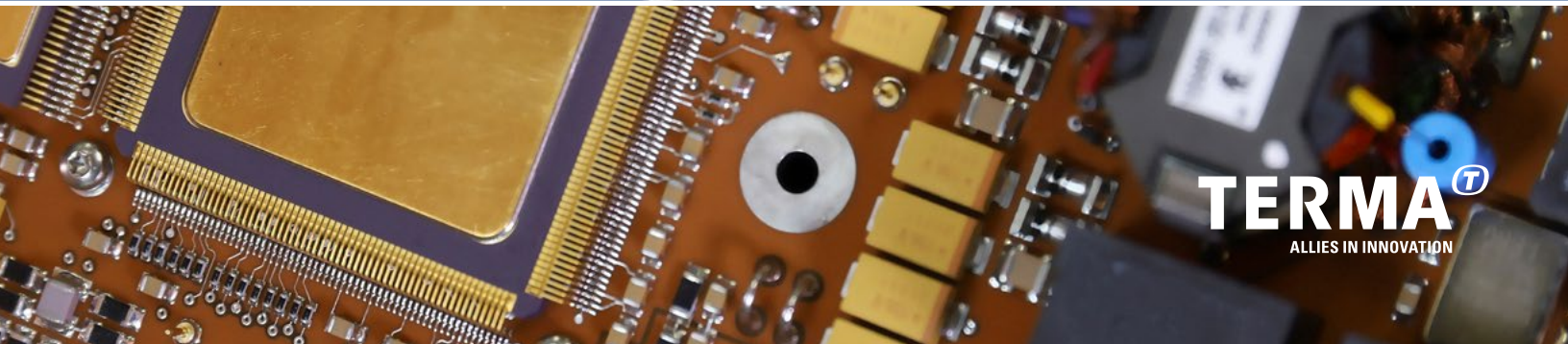
Image: ESA-C. Carreau/ATG medialab



Image: Lockheed Martin Aeronautics



Image: Ian Nightingale

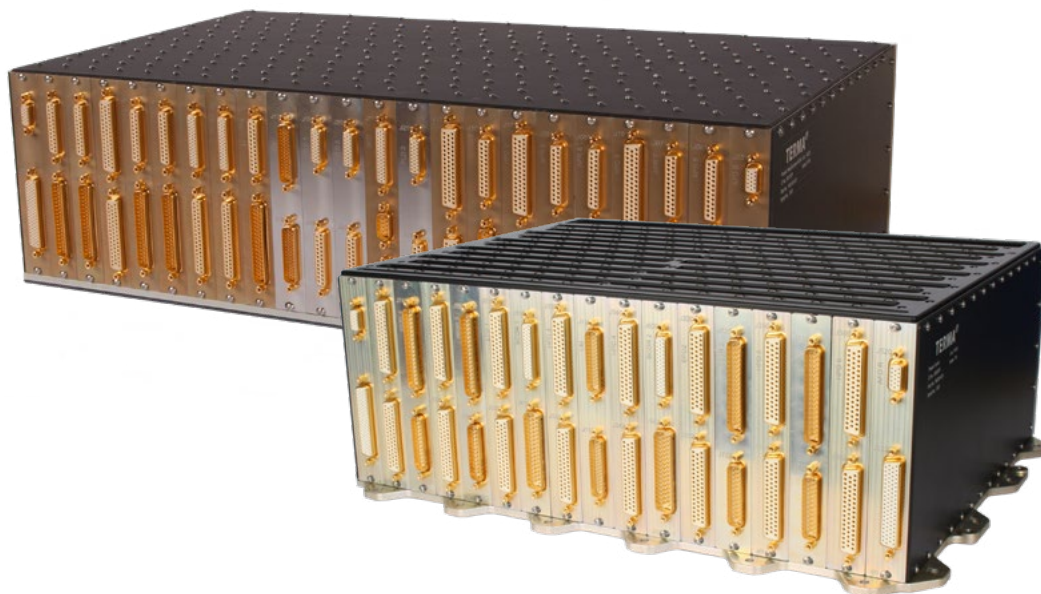


TERMA[®]
ALLIES IN INNOVATION

Powered by Terma



Image: ESA - C. Carreau/ATG media/ab



Power Supplies for All Missions

In aerospace and defense operations, a dependable power supply is essential. At Terma, we understand the requirements on power density, component efficiency, and weight. That is why we design efficient power supplies to ensure successful missions.

Our expert engineers have over 40 years of experience, crafting cutting-edge applications for aerospace and defense systems.

Trusted by ESA and NASA, Terma is your partner in delivering efficient mission-critical power supplies.

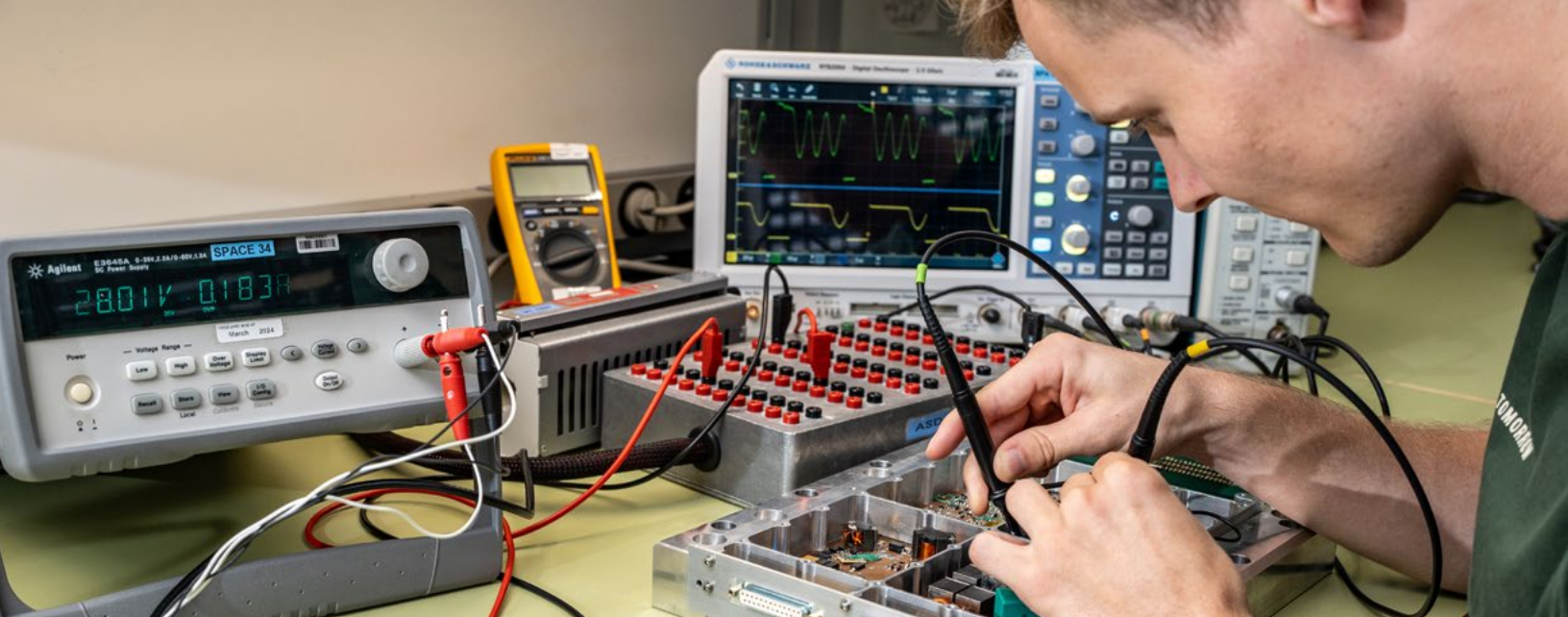
Designing for Simplicity and Effect

The mantra of all our power solutions is a “simple yet effective design”. We have expanded this mantra into nine dogmas for our power supply functions and use the guidance to ensure that all requirements are met in the design and electronic constructions.

To pass these dogmas, our electronic constructions are vigorously tested by our highly specialized engineers.

Terma Design Guidelines

1	Keep it simple
2	Topology is based on overall requirements and needs for security
3	Designs undergo robust control strategies
4	Only Electronical, Electronic, and Electromechanical (EEE) components of known, high quality are used
5	Circuit voltage and current waveforms are clear and undergo verification processes
6	Respect EEE parts deration
7	Designs meet EMC requirements
8	PCB layout is based on electrical and thermal design and matches physical and mechanical requirements
9	Test all operational functions, modes, and performances



Design and Development Process

Circuit Development Process

Designing electronics for aerospace and defense is complex – much more so than for standard electronics. During an electronic circuit development process, we take into consideration the harsh environment of operation, while balancing the system requirements with the costs of acquisition.

To keep costs at a minimum, we draw on previous designs and techniques when we develop unique solutions to match your specific need.

When designing power supplies for defense and aerospace, we always pay attention to:

- Switching power stage development
- Magnetics design
- Control circuit design
- Regulation loop design

To the extent possible, new designs are based on already developed building blocks for cost efficiency and to minimize risks.

Applied topologies from current solutions:

- Buck
- Super-Buck
- Boost
- Flyback
- Push-pull
- Full bridge

Laboratory Verification Process

Verification of the design is important, which is why continuous testing and proof of design is important. For circuit developments with new and complex functionalities, a laboratory bread-board is built and tested. In this connection, it is a standard discipline that all measurements are fully understood and correlate within a certain margin to the developed electrical model.

PCB Layout

DC/DC converter layout must be carried out with strong engineering expertise; electrically due to the high-rate voltage and current transitions, and thermally due to number of dissipative EEE parts.

Terma applies the Cadence Allegro and PCB Editor tools for PCB layout. For DC/DC converters, this is typically performed by an experienced Power Electronics Engineer.

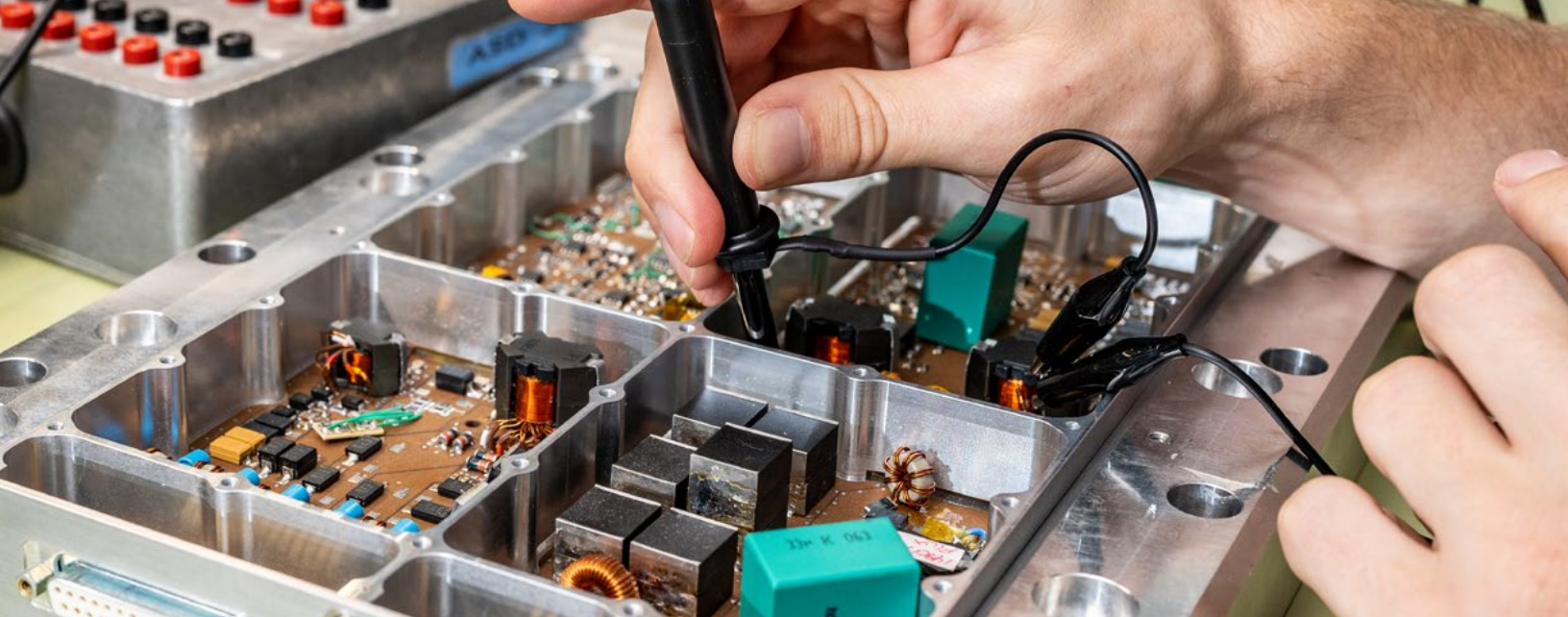
Prototyping

First manufactured item to be subject to qualification test is typically manufactured in our production facility by the same qualified operators who will later manufacture the products to be delivered to the customer.

Qualification

DC/DC converters will typically undergo a sequence of qualification tests to demonstrate their full performance and robustness to demanding environmental conditions. These tests typically include as a minimum:

- Thermal / thermal vacuum test
- Vibration and shock
- EMC test



Test and Qualification

Terma has the ability to perform testing internally when qualifying and manufacturing power supplies. The list/table illustrates the equipment and capabilities that Terma can provide.

Facilities

- X-Ray inspection equipment
 - Continuity testers - Harnesses
 - Boundary scan tester
 - Thermal chambers
 - Thermal vacuum chamber
 - Burn-in chamber
 - Conducted EMC tests
 - Component stress and inspection
 - Vibration, shock, and bump test facilities
 - Antenna measurement equipment and test range
 - Measurement and monitoring equipment
 - Altitude testing facility
-

Capabilities

- Boundary scan
 - RF testing
 - High voltage - insulation - continuity, Harnesses
 - Temperature
 - Sine and random vibration
 - Resonance search, track, dwell, and vibration
 - Classic shock
 - Shock response spectrum
 - EMI/EMC
 - Salt fog and environmental testing
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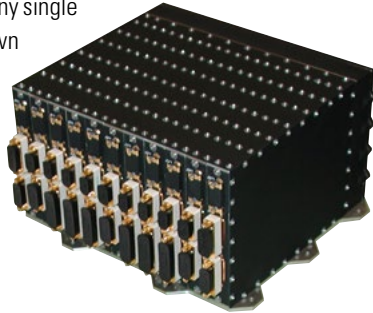
Cases

The Rosetta Power Conditioning Unit (PCU) is developed for deep space missions and comprises the following main features:

- 28V regulated bus
- Single Point Failure Free Maximum Power Point Tracking
- Fully autonomous, to fly long duration with no ground contact

As first company, Terma developed for this mission a voted maximum power point tracking function that could guarantee full solar array power extraction despite of any single failures. Three PCUs have flown

on solar system missions, with accumulated flight heritage of +40 years with no degradation or loss of redundancy.



The BepiColombo Power Conditioning and Distribution Unit (PCDU) is developed for a specific mission to Mercury, flying since 2018, and comprises the following main features:

- 100V sun regulated primary bus and 28V regulated secondary bus
- Total power capability of 15 kW
- 30 independent Maximum Power Point Trackers
- 2 kW power link for a passenger satellite
- 80 individual DC/DC converters



The Electronics Warfare Management System (EWMS) Power Supplies are developed to support specific Terma EWMS units, flying mainly on military aircraft. All supplies are designed to be compatible to MIL-STD-704 airplane power bus system.

The image shows the EWMU power supply as a typical example, with the following main features:

- 50W, 5V, +/- 14V, high power density



• Regulated Power bus	28V +/- 0.5%
- Continuous load capability	> 1000 watt
- Peak load capability	2400 watt
- Regulation technique	3-domain
• Sunlight power capability	1500 watt
- 2 sections of	750 watt
- Voted MPPT, SPFF	2
- MPP tracking accuracy	> 99.7%
- Solar array voltage	35V – 80V
- Conversion efficiency	94 to 97.3%
• Battery Interface	3 x Li-Ion, 6S
- Battery charge	3 x 9A
- Battery discharge	3 x 300 watt
• Command and monitoring	ESA TM/TC
• Idle consumption	< 15 watt
• Modules in total	11
- Format	193 x 150 x 24 mm ³
• Volume	267 x 238 x 158 mm³
• Unit mass	8.3 kg

• Primary Power bus	100V sun regulated
- Load capability	12 kW
• Sunlight power capability	14 kW
- Solar array sections	30
- 30 individual MPPTs	480 watt
- Solar array voltage	42V – 115V
• 100V LCL outputs	4 x 10A
• Transistor switch outputs	72
• Secondary power bus	28V regulated
- Load capability	700 watt
- Distribution	28 LCLs
• Power Link Distribution	60-67V, 2050W
• Pyro Activation	2 x 8 lines, 5A
• Thermal Knives Activation	2 x 14 lines, 20V
• Command and monitoring	IL-1553 bus
• Idle consumption	< 50 watt
• Modules	23
- Format	282 x 150 x 24 mm ³
• Volume	556 x 317 x 158 mm³
• Unit mass	28.1 kg

• EWMU, 2000+ items, flying on:	
- Fighters: F-16, F-111, A-10, Harrier	
- Helicopters: HH-60G Pave Hawk, CH-47D Chinook, AH-64D Apache, AS-532U2 Cougar, NH-90, EH-101 Merlin, MI-17, MI-24	
- Transports: C-160 Transall, C-130H, C-130J Hercules, Fo.27, Fo.60, P-8A Poseidon	
• EWCU, 455 items, flying on same as airplane types as above, plus:	
- IOMax AT-802U Archangel, Rayjay G550, Falcon2000, and more	
• TDU, 1300+ items, flying on:	
- Number of above-mentioned aircraft	
• PIBU, 400 items, flying on:	
- C130-J	
• ATD, 1140 items, flying on:	
- Same airplanes as EWMU, EWCU and TDU	

Electronics Manufacturing

We deliver Electronic Manufacturing Services for mission-critical equipment — where reliability is of the essence. And we have the ability to handle classified projects (ITAR). Regardless of the field you are operating in, Terma understands the quality requirements within the aerospace and defense industry.

Calibration and Quality Certifications

We are certified to ISO 9001:2015, EN 9100, and NATO AQAP 2110, NATO Quality Assurance Requirements for Design, Development and Manufacturing. We maintain an in-house calibration laboratory. Our calibration services meet the requirements in ISO 10012:2003.

All aerospace and defense customers require that we deliver electronic products that meet aerospace and defense standards for both products and production processes. As one of the only companies in Denmark, Terma is certified according to IPC's J-STD-001/IPC-A-610 standards.

Circuit Card Assembly, Box Build, and Systems Level Assembly

Highly skilled employees and 70+ years of experience in design and manufacturing of complex electronics provide our customers with an end-to-end solution, where we support their requirements on a Build to Print or Design to Specification approach. We can support our customers from the early concept and requirement phase, through design, qualification, and manufacturing — with high focus on efficiency and cost.

Advanced In-House Testing

We provide in-house testing for all applicable areas, including advanced testing of space electronics. We have experience in performing testing of mission-critical equipment in both aerospace and defense applications. Our facilities include clean rooms, optical laboratories, environmental test facilities, and more.

Core Capabilities within Electronics

We design and manufacture complex electronic solutions for our customers. Terma's core capabilities within electronics are High Efficient Power Supplies, High Frequency and Signal Processing Equipment.

Workspace Facilities and Skills

- EMC/EMI testing
- Clean Room facilities
- Autoclave bonding
- Selective soldering
- Vacuum soldering
- Perylene coating
- In-house calibration laboratory
- Environmental testing including temperature, shock vibration, and burn-in.

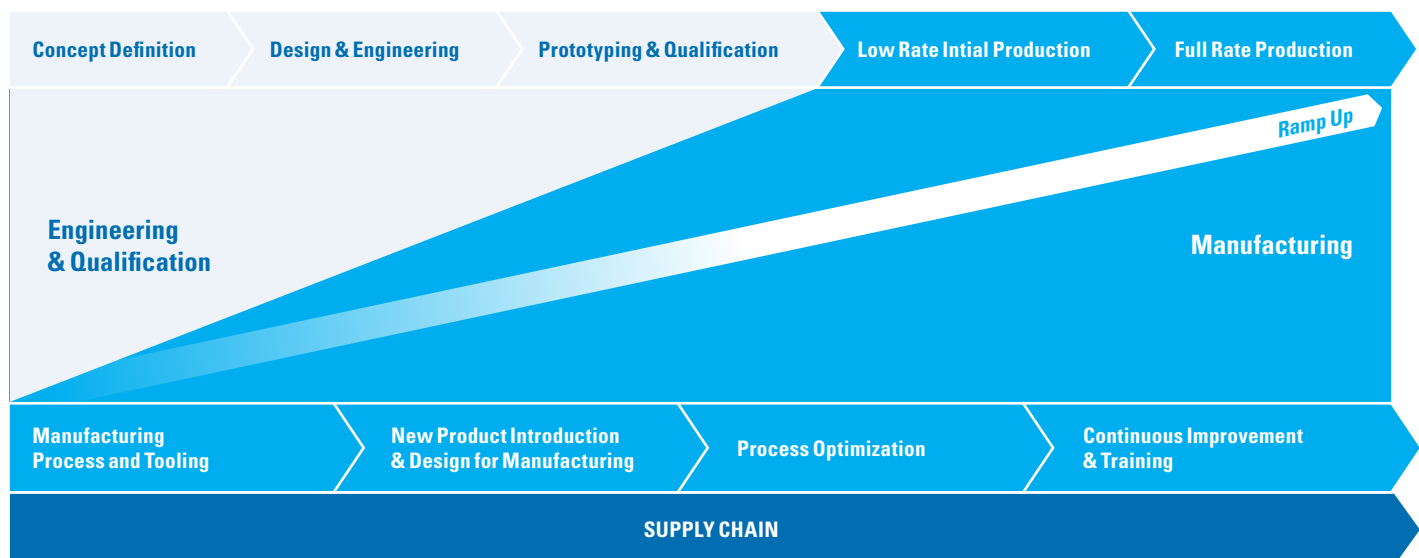
Professional Supply Chain Management

We manage all aspects of supply chain management. The aim is to realize low total costs of acquisitions while maintaining the highest possible quality and an uninterrupted flow of materials, products, and services.

A Close Partner

At the beginning of a new program, we establish Integrated Program Teams (IPT) as a cornerstone to achieve and maintain a close customer interaction. These empowered program teams represent the key functions and are responsible for the successful fulfillment of customer expectations.

End to End – Design & Manufacturing concept





Operating in the aerospace, defense, and security sector, Terma supports customers and partners all over the world. With more than 1,900 committed employees globally, we develop and manufacture mission-critical products and solutions that meet rigorous customer requirements.

At Terma, we believe in the premise that creating customer value is not just about strong engineering and manufacturing skills. It is also about being able to apply these skills in the context of our customers' specific needs. Only through close collaboration and dialog can we deliver a level of partnership and integration unmatched in the industry.

Our business activities, products, and systems include: command and control systems; radar systems; self-protection systems for ships and aircraft; space technology; and advanced aerostructures for the aircraft industry.

Terma has decades of hands-on know-how in supporting and maintaining mission-critical systems in some of the world's most hostile areas. Terma Support & Services offers through-life support of all our products to maximize operational availability, enhance platform lifetime, and ensure the best possible cost of ownership.

Headquartered in Aarhus, Denmark, Terma has subsidiaries and operations across Europe, in the Middle East, in Asia Pacific as well as a wholly-owned U.S. subsidiary, Terma Inc., with offices in Washington D.C., Georgia and Texas.

