RUGGED REDUNDANT AC-DC POWER SUPPLY MODULE



Model: TSQ-12V-250W-MIL-IND

General Description:

This high-reliability, conduction-cooled Isolated AC-DC power supply module is specifically engineered for mission-critical applications in the most demanding ground army environments. It integrates a 1+1 redundant architecture with active parallel load sharing, ensuring continuous, uninterrupted power delivery even in the event of a single module failure. Its design prioritizes passive thermal management through conduction cooling, eliminating the need for internal fans, which significantly enhances reliability by removing common points of failure and ingress paths for contaminants. This module is fully compliant with the rigorous electromagnetic compatibility (EMC) requirements of MIL-STD-461E/F/G (Ground Army) and the comprehensive environmental testing procedures of JSS 55555, making it an ideal solution for robust military platforms operating in harsh conditions.

2. Key Features:

- **1+1 Redundancy with Hot-Swap Capability:** Ensures maximum system availability and allows for module replacement without interrupting live operations.
- **Active Parallel Load Sharing:** Achieves balanced current distribution between modules, optimizing thermal performance, extending lifespan, and enhancing overall system efficiency.
- **Conduction Cooled Design:** Eliminates forced air cooling, leading to:
    - **High Reliability:** No moving parts (fans) for cooling, reducing points of failure.
    - **Silent Operation:** Ideal for noise-sensitive applications.
    - **Sealed Enclosure Capability:** Facilitates higher ingress protection (IP) ratings, protecting against dust, moisture, and other contaminants.

- **Wide AC Input Range (100-264VAC, 50Hz):** Versatile for global deployment and various battlefield power sources.
- **Integrated Inrush Current Limiting:** Protects upstream power infrastructure and connected equipment during power-up.
- **Precisely Regulated 12VDC Output:** Delivers stable and clean power crucial for sensitive military electronics.
- **Output Voltage Trim (+/- 5% or Better):** Allows for fine-tuning of the output voltage to meet specific system requirements.
- **High Efficiency:** Optimized design to minimize heat generation, critical for conduction cooling.
- **Comprehensive Protection Features:** Includes Over-Voltage Protection (OVP), Over-Current Protection (OCP), Short-Circuit Protection (SCP), and Over-Temperature Protection (OTP).
- **Built-in Diagnostics & Status Indicators:** Visual LEDs (Power OK, Fault, Load Share Status) and optional remote alarm signals for real-time system monitoring.

- **Designed for MIL-STD-461E/F/G Ground Army Compliance:**
  - **Conducted Emissions (CE):** Meeting CE101, CE102 limits.
  - **Radiated Emissions (RE):** Meeting RE102 limits.
  - **Conducted Susceptibility (CS):** Meeting CS101, CS106 (if applicable), CS114, CS115, CS116 limits.
  - **Radiated Susceptibility (RS):** Meeting RS103 limits.

- **Designed for JSS 55555 Compliance (Environmental Testing for Electronic and Electrical Equipment):**
  - **Temperature:** Cold, Dry Heat, Change of Temperature.
  - **Humidity:** Damp Heat (Cyclic and Steady State).
  - **Mechanical:** Vibration (Random and Sine), Shock (Mechanical, Crash Hazard, Loose Cargo), Bump.
  - **Atmospheric Pressure:** Low Air Pressure.
  - **Contaminants:** Salt Mist, Dust.

- **Ruggedized Fully Covered Enclosure:** Built with robust materials to withstand severe mechanical and climatic conditions, and sealed against environmental ingress.

3. Electrical Specifications:

- **Input:**
  - **Voltage Range:** 100-264 VAC
  - **Frequency:** 50 Hz
  - **Inrush Current:** Limited to [Specify typical value, e.g., < 20A peak at 264VAC cold start, compliant with MIL-STD-461 start up requirements]
  - **Power Factor:** > 0.95 at full load (typically active PFC for military applications)
  - **Input Protection:** Integrated fuse, over/under voltage lockout.

- **Output:**
  - **Nominal Voltage:** 12 VDC
  - **Rated Power:** 250W (per module, supporting a 250W system load with 1+1 redundancy)
  - **Current:** Approx. 20.8A at 12VDC (per module's capacity)
  - **Voltage Trim Range:** +/- 5% or better (11.4VDC to 12.6VDC or wider)
  - **Line Regulation:** +/- 0.2% max
  - **Load Regulation:** +/- 0.5% max
  - **Ripple & Noise:** < 50mVp-p (20MHz bandwidth, meeting MIL-STD-461 requirements for output noise)
  - **Efficiency:** > 90% typical at full load, 230VAC (critical for conduction cooling efficiency).

4. Protection Features:

- **Over-Voltage Protection (OVP):** Latched shutdown with auto-recovery or remote reset.
- **Over-Current Protection (OCP):** Constant current limiting or hiccup mode with auto-recovery.
- **Short-Circuit Protection (SCP):** Automatic recovery upon removal of short.
- **Over-Temperature Protection (OTP):** Latched shutdown with auto-recovery or remote reset.
- **Reverse Polarity Protection (Output):** Included for enhanced system safety.
- **Failover:** These modules offer more advanced features. They actively monitor the health and load sharing of the individual power supplies. They can ensure even load distribution (Auto Current Balancing - ACB technology) among the active modules, which can extend their lifespan. They also often provide diagnostic signals (e.g., "DC OK" relay contacts, alarm LEDs) to indicate power supply status and potential issues, allowing for proactive maintenance

5. Environmental Specifications (Designed to meet JSS 55555 Categories for Ground Army):

- **Operating Temperature:** -40°C to +70°C (with appropriate derating at extreme temperatures), specific to JSS 55555 environmental categories (e.g., Cat. A, B, C for equipment usage).
- **Storage Temperature:** -55°C to +85°C.
- **Operating Humidity:** 5% to 95% RH, non-condensing (as per JSS 55555 Damp Heat requirements).
- **Vibration:** Designed to meet JSS 55555 requirements for ground vehicles (e.g., Procedure 1 for general minimum integrity, specific frequency and amplitude levels).
- **Shock:** Designed to meet JSS 55555 requirements for ground vehicles (e.g., Procedure 1 for functional shock).
- **Altitude:** Operating up to [Specify, e.g., 15,000 ft / 4500m], as per JSS 55555 atmospheric pressure tests.
- **Contaminants:** Resistance to Salt Mist, Dust ingress (achieving an appropriate IP rating for the sealed enclosure, e.g., IP67/IP68), designed as per JSS 55555 tests.
- **Cooling:** Pure Conduction Cooling (no internal fans). Heat dissipated via the baseplate/enclosure to an external heatsink or cold plate in the system.

6. Mechanical Specifications:

- **Dimensions:** 180mm (D) x 125mm (W) x 80mm (H)
- **Weight:** 2.3KG
- **Enclosure:** Robust, fully sealed, solid metal enclosure (e.g., aluminium, alloy) with integrated thermal paths for conduction cooling.
- **Connectors:** Ruggedized, military-grade connectors (e.g., MIL-DTL-38999 equivalent circular connectors for input/output).
- **Mounting:** Designed for secure chassis mounting within military platforms, often incorporating anti-vibration features and a flat, thermally conductive baseplate for efficient heat transfer.

7. Compliance & Certifications (Target Standards):

- **Electromagnetic Compatibility (EMC):**
  - **MIL-STD-461E/F/G:** Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment (Ground Army specific limits, e.g., CE101, CE102, RE102, CS101, CS114, CS115, CS116, RS103).
- **Environmental & Mechanical:**
  - **JSS 55555 (Indian Joint Services Standard):** Environmental Test Procedures for Electronic and Electrical Equipment. Compliance with relevant categories and severity levels for ground army applications (e.g., temperature, humidity, vibration, shock, altitude, salt mist, dust).
- **Safety:** IEC 62368-1 (or IEC 60950-1 if legacy), designed with consideration for safety aspects in military environments.

8. Isolation in AC-DC power supplies is primarily achieved through:

- **Transformers:** These are the primary components for galvanic isolation between the AC input and the DC output. The windings are physically separated and insulated, preventing direct electrical connection while still transferring power through magnetic induction.
- **Optocouplers (Opto-isolators):** Used for transferring control signals and feedback across the isolation barrier. They convert electrical signals into light (via an LED), transmit the light across an insulating gap, and then convert it back into an electrical signal (via a phototransistor or photodiode), ensuring complete electrical separation.
- **Physical Spacing and Creepage/Clearance Distances:** Sufficient physical separation (clearance) and distance along the surface of insulating materials (creepage) are designed into the PCB layout and component placement to prevent arcing or tracking between isolated sections under various voltage and environmental conditions.
- **Insulating Materials:** High-dielectric-strength materials are used for enclosures, component encapsulation, and PCB substrates to provide robust insulation.
- **Conformal Coating:** The entire PCB assembly might be conformal coated to provide additional protection against moisture, dust, and contaminants, and to enhance insulation.

9. Ordering Information:

- **Part Number: TSQ-12V-250W-MIL-IND**
- **Description:** Conduction-Cooled, Rugged Redundant AC-DC Power Supply Module, 12VDC, 250W, MIL-STD-461 & JSS 55555 Compliant (Ground Army).