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A Low EMI Switched-mode Power Supply for Radio Astronomy Applications

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The recent trend of integrating high-performance digitizers into radio astronomy receiver packages is driving the requirement for power supplies with a high power density and efficiency. Linear power supplies have traditionally been used in this application due to their low EMI, but their inherent design restricts size and weight improvements, and high efficiency is difficult to achieve. The use of a switched-mode topology vastly improves these aspects, however caution is required as switched-mode supplies can produce broadband EMI well above their switching frequency. Extensive filtering and shielding is therefore required to avoid interference with astronomy observations.

The CryoPAF Receiver for the Parkes 64m Telescope is one such receiver. A combination of a phased array feed (PAF) topology and the integration of digitizers into the receiver package has driven the use of small switched-mode power supplies distributed across the PAF, located with each digitizer module.

These DC-DC converters are fed from an external 48 V DC supply and produce the low voltage supply rails for each of the receiver subsystems. The converters supply +12 V (10 A) to each digitizer, along with +6.5 V (5 A) and -6.5 V (0.3 A) to the analog and RF circuitry. A commercial isolated converter is used for the 48 V to 12 V conversion which is integrated into a custom circuit board with multi-stage filters and switching ICs to generate the ±6.5 V output rails. High-performance 10 GHz feedthrough filters are used to pass through the enclosure wall.

This design has achieved a full load efficiency of over 88% with an enclosure size of 12 x 7.5 x 3.6 cm and a total weight of only 280 g. Initial testing of the conducted EMI has shown that the multi-stage filters are effective with no features detected past 20 MHz. Testing of the radiated EMI showed emissions with the shield open, however with the shield closed, emissions fell to levels below the noise floor of the EMC receiver system, more than 20 dB below MIL-461 RE102. All remaining features detected were due to leakage into the shielded room from external sources and were present when the converter was unpowered.

This demonstrates that it is possible to design a switched-mode power supply with high efficiency and power density while still achieving low EMI emissions. These characteristics make it extremely favorable for radio astronomy applications such as PAFs that have high power requirements but also tight space and weight constraints.

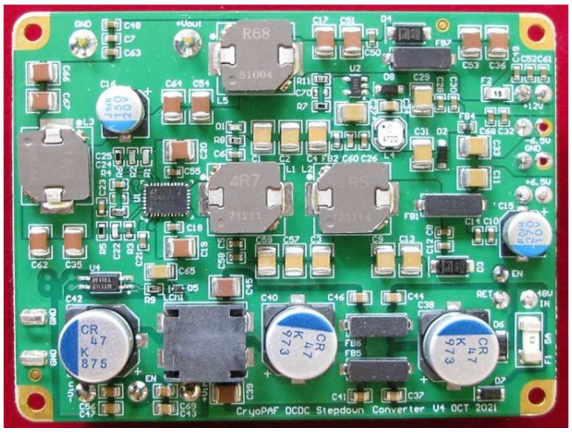

Figure 1. DC-DC converter main PCB

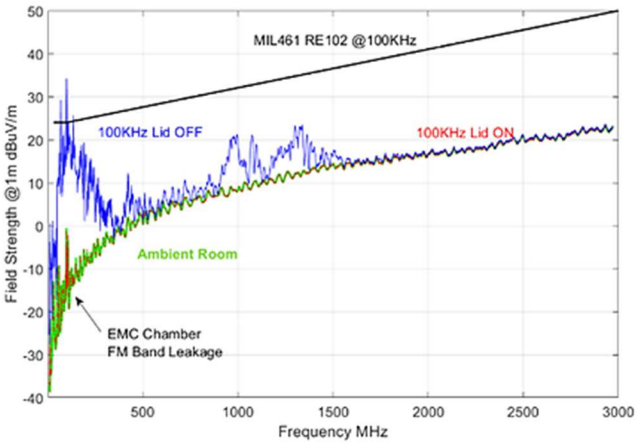

Figure 2. Radiated EMI emissions (100 kHz resolution bandwidth)