Application Brief

TPSI31xx EMI Mitigation for Conducted Emissions

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Noise Generated by the TPSI31xx Family

Electromagnetic Interference (EMI) is an unwanted effect between two electrical systems as a result of either electromagnetic radiation or electromagnetic conduction. EMI is the major adverse effect caused by the application of switch mode power supplies (SMPS), like the one integrated into the TPSI31xx family of devices. TPSI3100 integrates an isolated bias supply into the IC without the need for any external magnetics.

The TPSI3100 takes advantage of inductive isolation to transfer power across the isolation barrier to power both external circuits as well as the internal driver and dual isolated comparators. The switching converter inside of the TPSI3100 operates at 85MHz, and uses a 40kHz bursting window to regulate the voltage at the output. This operation can pull up to 40mA at times.

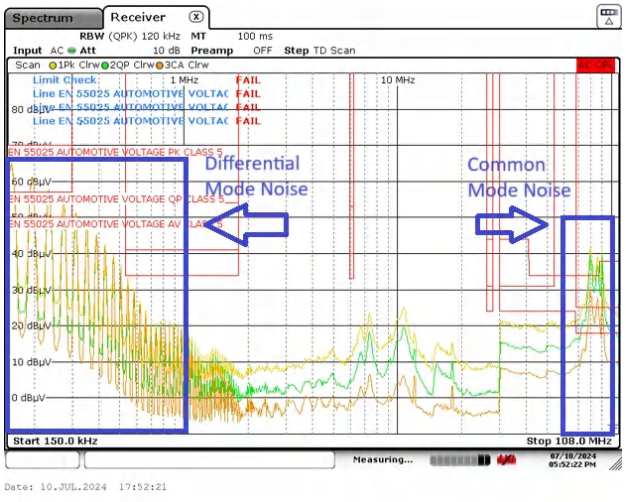

Figure 1. Noise Spectrum Without Filters

Two types of noise are created by the TPSI3100: low frequency differential mode noise below 2MHz, and high frequency common mode noise at 85MHz. Not all of the current transferred across the isolation barrier is returned back through the transformer. The stray current finds a direction back to the primary side by capacitive couple to protected earth.

Types of noise

Differential noise is the noise on a rail with reference to the ground. This type of noise is often caused by discontinuous currents flowing through the circuit. Differential noise is the typical noise that is taught in most schools and universities.

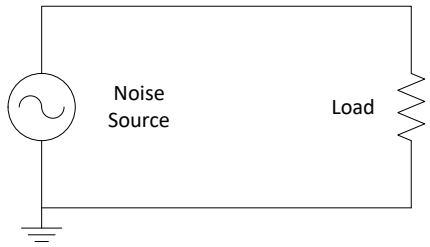

Figure 2. Differential Mode Noise Circuit

Common mode noise occurs on both power and ground, synchronously. The noise returns to the source through protected earth or chassis ground. Specifically, in the context of the CISPR 25 testing, the copper table acts as protected earth. In the context of something like a traction inverter, the case can act as a chassis ground. Current flows through capacitive coupling to the protected earth and returns to the source of the noise

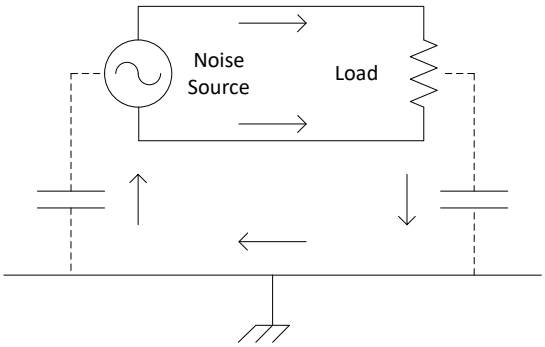

Figure 3. Common Mode Noise Circuit

Noise Mitigation

Differential mode noise can be reduced with additional capacitors. When the TPSI3100 enters a burst, the TPSI3100 can pull up to 40mA. If the device is placed far away from the power source, such as in CISPR tests, a sufficiently low impedance and high capacity input filter is required.

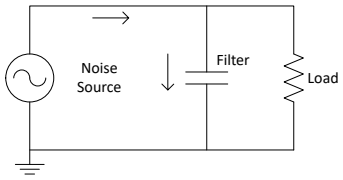

Figure 4. Differential Mode Noise Filter

As common mode currents return, the currents must flow through both power and ground circuits. By placing a large impedance in the path of the noise, we can reduce the flow of current, reducing the noise power; this is done with a set of ferrite beads. Using a set of ferrite beads, the configuration has the added benefit of reducing high frequency differential mode noise.

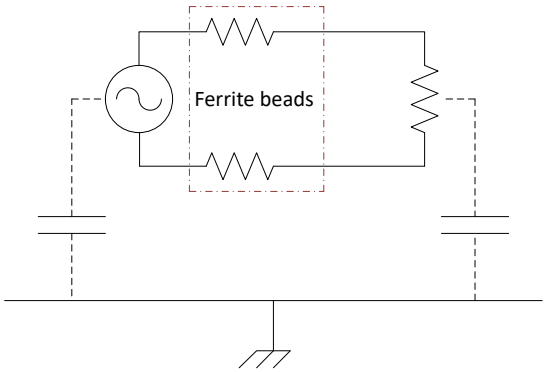

Figure 5. Common Mode Noise Filter

Hardware Design

In previous prototype designs and documentation, 1.1uF was used. This was sufficent to pass CISPR 32, but insufficient to pass CISPR 25 Class 5 conducted emissions, even at minimum power transfer. Using 2 sets of 2.5K impedance ferrite beads and 3 ceramic input caps (10uF, 1uF, 0.1uF), the TPSI3100 can pass CISPR25 Class 5 conducted emissions at maximum power transfer. This represents an improvement of 15dBuV or more across the entire spectrum, which can be seen in Figure 6.

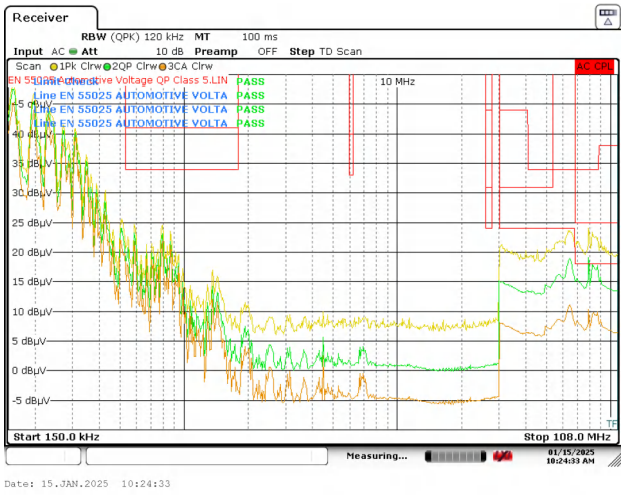

Figure 6. Noise Spectrum with the External Filters

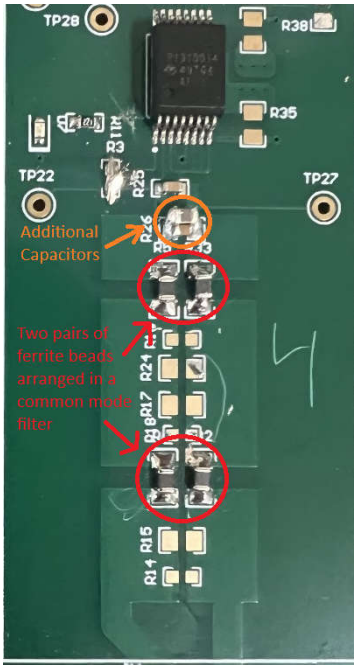

Figure 7. Installed EMI Filter

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