ADENEAS Newsletter #9

Power Line Communications with the Bifilar Novel Conductor Concept

Greetings! We are Eric Ropraz and Gerd Dietrich, research engineers at plc-tec AG in Switzerland. Within the ADENEAS project, we are working within Work Package 3 (WP3). WP3 focuses on topics related to Powerline Communications (PLC). PLC is a wired communication technology that uses the aircraft power distribution network for data transmission by superimposing a modulated high-frequency carrier signal over the standard power signal. One of the topics addressed in ADENEAS is applying novel conductor concepts (NCC) to improve the electromagnetic compatibility (EMC) of PLC. An evaluation of different NCCs has been performed, and the bifilar NCC has been selected for further analysis and testing, which is the topic of this newsletter.

The majority of the power distribution networks in commercial aircraft are based on a single-wire (monofilar) method, in which the metal chassis of the aircraft is used for the current return path. A single-wire power distribution has the advantage that it is a simple and cost-effective solution, providing a low resistance return path and weight savings. However, single-wire networks provide a significant disadvantage for high-frequency communications like PLC in terms of EMC with relatively strong radiated fields (egress) and little protection against radiated high-frequency fields (ingress). The bifilar NCC replaces the single wire with a twin wire. Power distribution will use the twin wire in common mode with the return path via chassis ground as in the classical scheme, but PLC uses the twin wire for communications in differential mode. Therefore, the bifilar concept provides a solution to support the single-wire power distribution architecture while providing an optimized twin-wire communication channel for PLC.

The bifilar wiring has been tested together with PLC to characterize the performance of PLC (including EMC aspects) on the bifilar wiring. Three different types of tests have been performed. For the first test, the performance of the PLC transmission has been tested using PLC modem prototypes, realizing the **P**ower **L**ine data b**US** (PLUS AVIONICS) technology provided by plc-tec. For the second test, the transmission channel has been measured using a Vector Network Analyzer. Finally, the conducted emissions from the PLC modems have been measured with a Spectrum Analyzer. The measurement campaign has also investigated the influence of different power distribution network termination impedances on the performance of PLC.

Measurements have been performed on the Aircraft Electric Wiring Interconnection System Testbench located at the Lucerne University of Applied Science and Arts (HSLU), which is an R&D partner of plc-tec. The testbench is shown in the figure below. A large conductive plane (made of copper plates) is mounted vertically on two walls. The bifilar wiring is mounted on a wooden framework (non-conductive) with a 5cm separation from the copper plane. This setup provides a standardized and reproducible configuration similar to the configuration used in EMC testing for avionics equipment, according to EUROCAE ED-14G/ RTCA DO-160G. Tests have been performed in a multi-port bifilar wiring harness provided by Fokker Elmo. It consists of a 12m long cable with several stubs of 2m length along the cable made with stub splices.

The test campaign results have shown that the PLC communication works well on the bifilar wiring harness. Conducted emission measurements are below the DO-160G/ED-14G limits and are comparable to the PLC EMC measurements performed within the ADENEAS project by NLR. Both RF transmission channel measurements and PLC performance measurements with the PLC modem prototypes show that reliable communications can be supported on the bifilar harness. It has been identified that there is a dependence on the terminating impedance of the different parts of the wiring harness. The issue does not arise on ports that will contain a PLC modem but could arise for ports that do not contain a PLC modem. This will be investigated further in a follow-up project with the Dutch National Growth Fund.

EMC measurements within the ADENEAS project have shown that PLC cannot fulfill the EMC requirements on single-wire power wiring. However, the bifilar NCC provides an alternative to provide a differential PLC transmission while maintaining the basic principle of the single-wire power distribution. In conclusion, the use of PLC on the bifilar NCC has been validated through these measurements both in terms of PLC performance and EMC. The bifilar NCC is believed to be the key enabler for the widespread usage of PLC in aircraft, according to the hybrid data network approach developed within the ADENEAS project. The recommendation is thus to use the bifilar wiring architecture with PLC deployments in future aircraft.

Figure 1: Aircraft Electric Wiring Interconnection System Testbench located at the Lucerne University of Applied Science and Arts (HSLU)

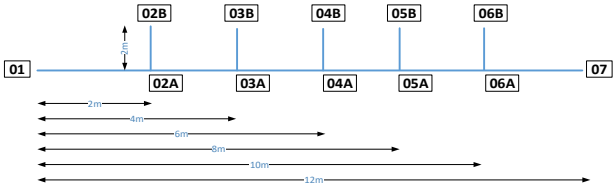

Figure 2: Bifilar Wiring Harness Prototype Architecture