Mixed Medium Ethernet Switch

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🚗 Automotive 🖥 Single Pair Ethernet

The Single Pair Ethernet (SPE) switch is designed to accommodate various ethernet standards. The PCB includes a microcontroller, a ethernet switch and various PHYs that support the different standards. Furthermore, the PCB is built up in a modular way, so that the PHYs can be swapped.

🔧 Fragmented Network Topologies

Different SPE standards are used within automotive, but they cannot communicate with each other directly. 10BASE-T1S is used for low level sensors and actuators within the car, but they need to communicate with other electronic control units (ECUs) which do not have a 10BASE-T1S interface.

🌉 Zonal Architectures

Physical layer mismatch in ethernet can be solved as this SPE switch would function as a zonal bridge, linking sensors, medium speed buses and high-bandwitch peripherals.

A mixed-medium switch can reduce the need for further, separate switches and cables running through the car.
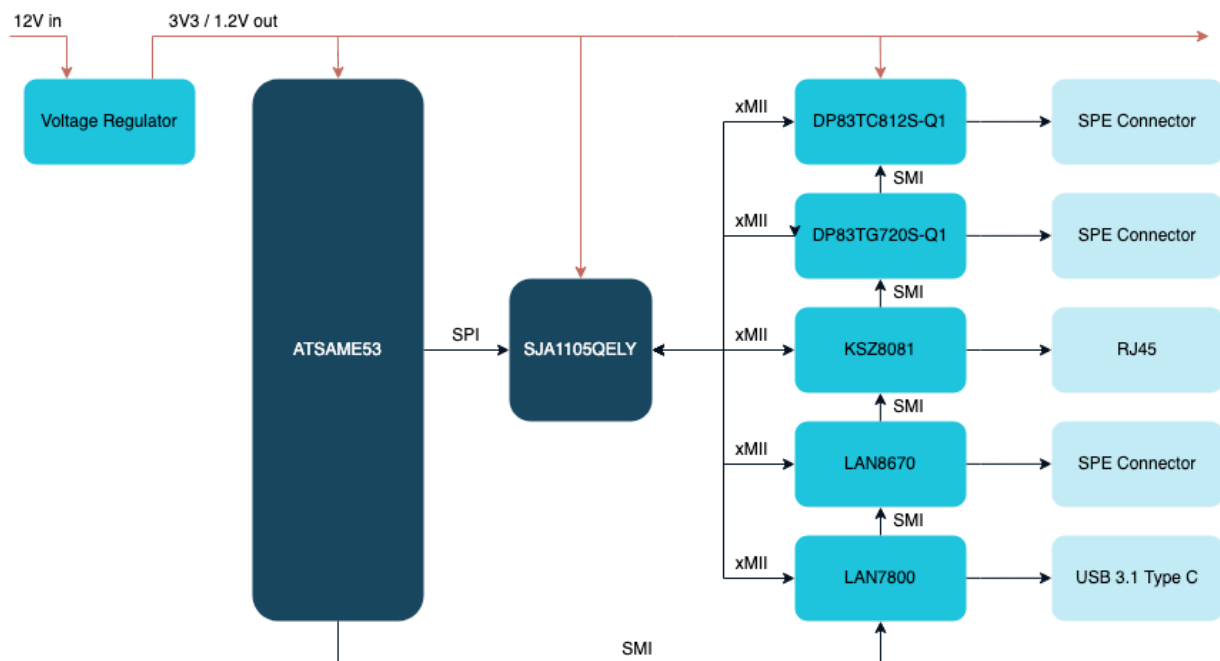
Overview

The SPE switch is designed to seamlessly integrate multiple widely used Ethernet standards into a single device. This switch accommodates 10BASE-T1S, 100BASE-T1, 1000BASE-T1, and 100BASE-TX, enabling communication across different state-of-the-art SPE networks used in automotive. At the heart of the device, a SJA1105QELY Ethernet switch is used in combination with an ATSAME53 to switch between the inputs received by the respective PHYs for each standard. Additionally, the inclusion of a USB 3.1 Type-C connector expands its functionality, to allow for an interaction within the Ethernet networks.

This switch provides an excellent bridging tool between different Ethernet standards. This makes it an essential tool for debugging and testing complex network setups, allowing engineers and developers to seamlessly translate and diagnose traffic across different Ethernet protocols.

Architecture

The SPE switch is based on the SJA1105QELY that supports all of the commonly used Ethernet standards in automotive. This allows for the inclusion of the lower-speed network, 10BASE-T1S, as well as the 100BASE-T1 and 1000BASE-T1 standards that are used for higher speeds. By including all of these standards, the SPE switch allows for easily switching between these standards.

Each of the Ethernet standards has their own PHY, performing the required physical layer functions for the respective Ethernet standards. The SJA1105QELY switch IC integrates all the MAC functionality for the individual PHYs. All of this is controlled by the SMI (Serial Management Interface) signals (MDIO (Management Data Input/Output) and MDC (Management Data Clock)) from the ATSAME53 microcontroller.

Key Features

- ☑ Compact form factor (120×96mm)
- ☑ 12V power supply
- ☑ Use of automotive-grade components
- ☑ Supports various SPE and conventional Ethernet standards, including 10BASE-T1S, 100/1000BASE-T1, and 100BASE-TX
- ☑ Modular design allows for the PHYs to be swapped with support for MII, RMII and RGMII
- ☑ Supports multi-drop architecture of 10BASE-T1S for easy debugging of the network

☑ Integrated termination and filter for twisted-pair signals

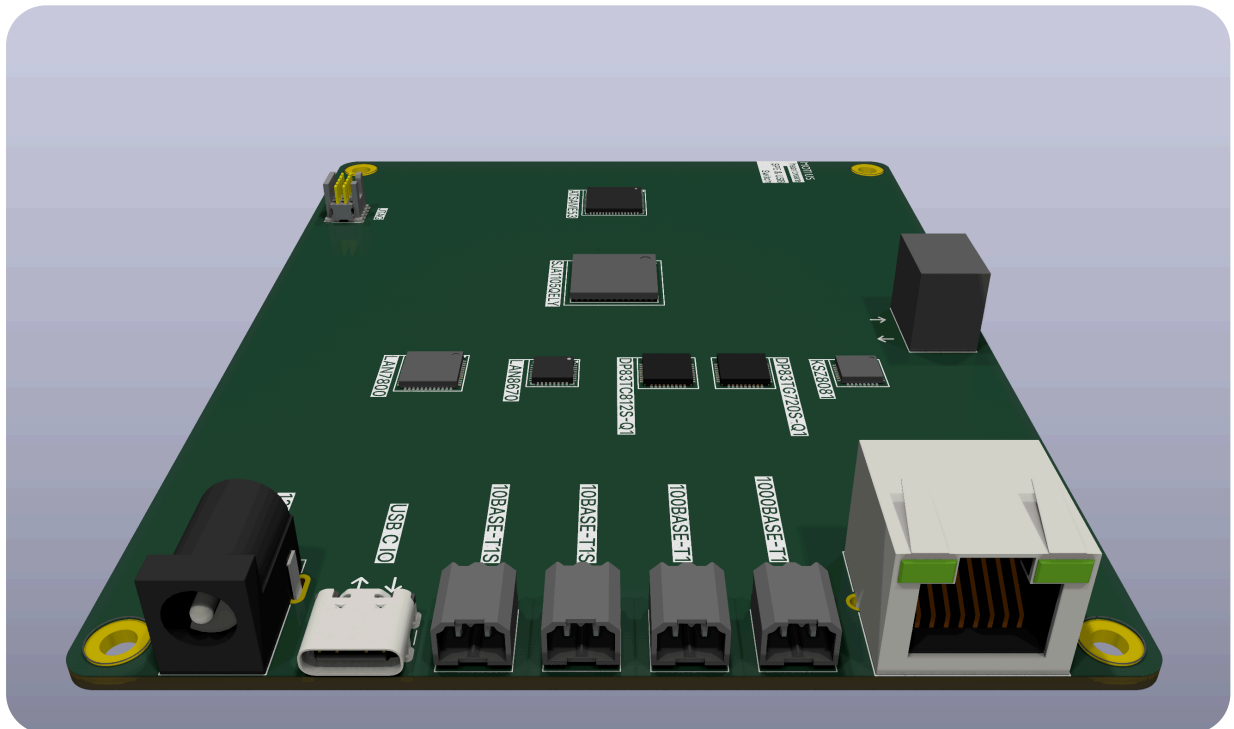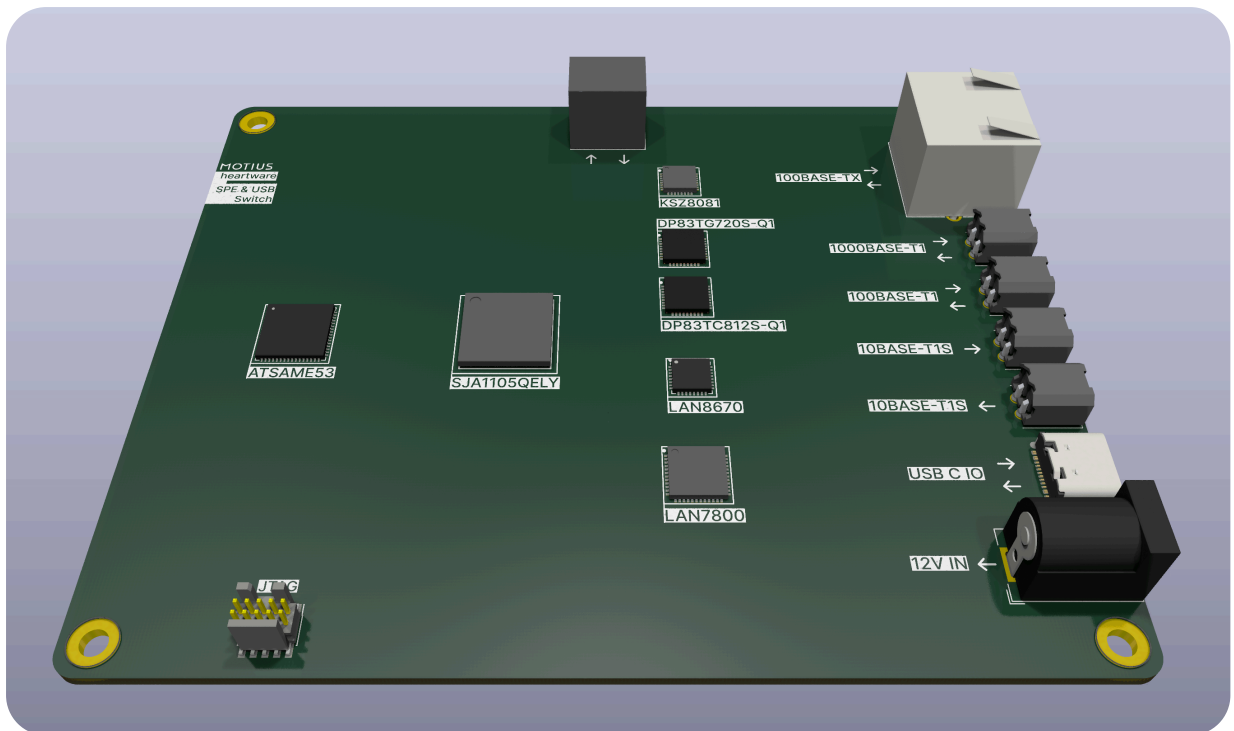☑ Traces with matched output impedance

Bill of Materials

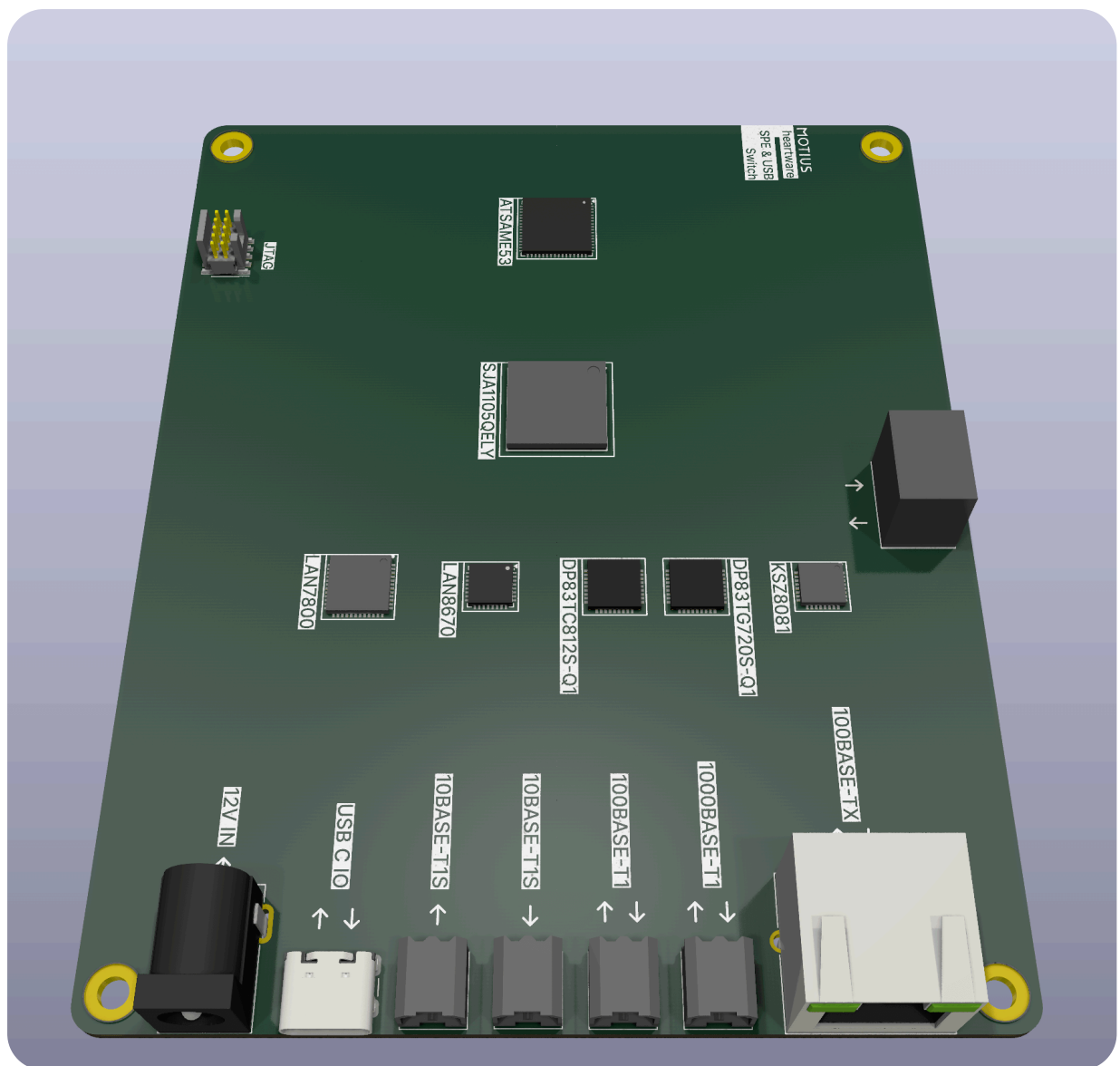| Component	Function
SJA1105QELY	Ethernet Switch
ATSAME53J20A-M	Microcontroller
KSZ8081MNXIA	100BASE-TX PHY
DP83TG720SWRHATQ1	1000BASE-T1 PHY
DP83TC812SRHATQ1	100BASE-T1 PHY
LAN8670B1	10BASE-T1S PHY
LAN7800-I_Y9X	USB 3.1 to 10/100/1000 Gigabit Ethernet bridge

Layout and Schematic

> ✏ **Schematic and Layout**
>
> These renders are only for illustration purposes (size, connectors), more details are available on request.

MOTIUS
heartware
SPE & USB
Switch

KSZ8081
DP83TG720S-Q1
DP83TC812S-Q1
LAN8670
LAN7800

ATSAME53
SJA1105QELY

JTAG

100BASE-TX
1000BASE-T1
100BASE-T1
10BASE-T1S
10BASE-T1S
USB C IO
12V IN

LAN7800
LAN8670
DP83TC812S-Q1
DP83TG720S-Q1
KSZ8081

SJA1105QELY

USB C IO
10BASE-T1S
10BASE-T1S
100BASE-T1
1000BASE-T1

Application at CustomerName

Motius can support CustomerName in the development of new E/E components, using modern embedded system development practices and technologies such as Zephyr, RISC-V, and Single Pair Ethernet.