Application Brief

Comparing 10BASE-T1S to RS-485, CAN, and LVDS in Backplane Applications

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Introduction

A backplane (also known as a base unit) is a common bus shared by many different subsystems. Each module in the backplane communicates with other modules through the backplane bus. This is a printed circuit board (PCB) or a frame that houses multiple slots for other cards or modules to be inserted into, allowing them to interact with each other and the system as a whole. The backplane serves as the main infrastructure, providing data transfer, power supply, and control signals among them. This setup enables multiple devices to share resources, communicate with each other, and work together seamlessly. The backplane provides a standardized interface for various types of cards, which can range from simple I/O module to complex programmable logic controller (PLC) central processing units (CPUs), communication network interfaces, or graphics processors in human machine interfaces (HMI).

Figure 1 gives an example of a backplane, where multiple PCB's are connected to the backplane. They share the signal lines as shown.

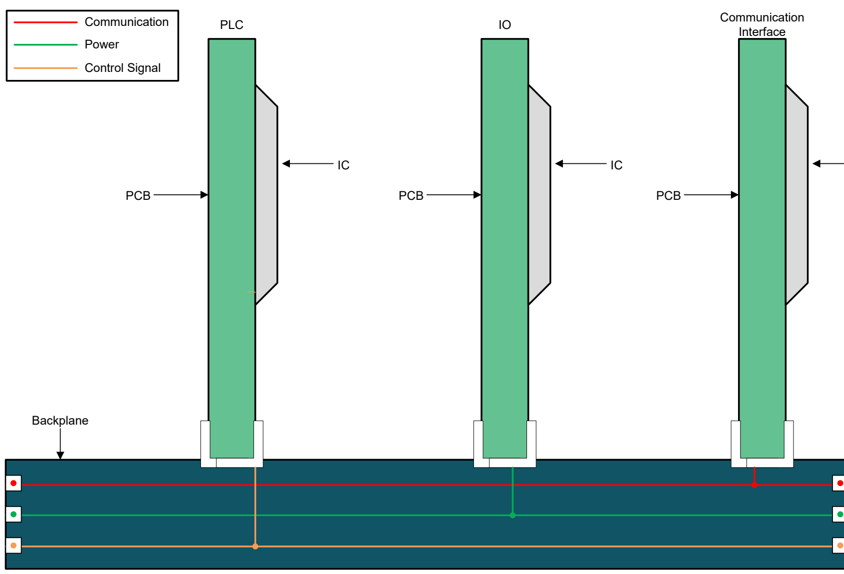

Figure 1. Backplane Example for General Purposes

10base-T1S is a new variation of Ethernet that offers a bandwidth of 10Mbit/s over a single pair cable. The specification is referred to as IEEE Std 802.3cg-2019. 10BASE-T1S for short reach applications (up to 25 meters) and 10BASE-T1L for long reach (up to 1,000 meters) applications. Traditionally Ethernet topology uses daisy chaining with two Ethernet PHY's and a 3-port MAC/switch. 10BASE-T1S uses a multidrop topology where each node connects to a single cable. This eliminates the need for a switch and results in fewer cables while each node only needs one Ethernet PHY with a simple MAC.

Each cable only uses one pair of wires, instead of the two or four pairs used in typical Ethernet cabling. The interconnection can even be implemented on a printed circuit board. The standard specifies that at least eight nodes can be connected, but depending on the Ethernet PHY, more nodes are possible. The standard also specifies a bus length of 25m, with 10cm stubs to each node. All the nodes share the 10Mbit/s bandwidth. According to the IEEE specification, these limits are actually *minimum maxima*; this makes it possible to use more than eight nodes and transmit over longer distances.

In Figure 2 a 10Base-T1S network with 10 nodes is shown.

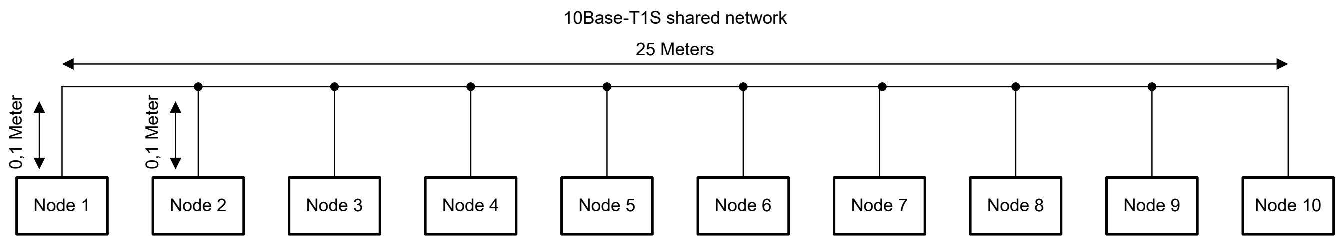

Figure 2. Base-T1S Network

T1S Comparison to Conventional Backplane Protocols

Many different technologies have been used to connect different devices. In the industrial automation world there are various field busses, RS-485, UARTs, etc. In the automotive world, CAN, FPD-Link and other networks are used, requiring complex gateway devices to communicate between domains. In Table 1 a comparison between multiple protocols is given.

Using 10BASE-T1S over a backplane leverages the standard's multidrop PHY capability to enable Ethernet communication across multiple modules.

In this configuration, the backplane acts as the shared medium, allowing peripherals to connect directly via the 10BASE-T1S transceiver. Support for PLCA (Physical Layer Collision Avoidance) makes sure that predictable latency and fair access across all devices on the multidrop segment, which is critical in control and real-time environments. By replacing legacy fieldbus or proprietary backplane buses, a 10BASE-T1S-enabled backplane consolidates communication onto a unified Ethernet-based infrastructure, while still maintaining the low complexity, low cost, and deterministic behavior required in industrial and automotive systems. From the Ethernet bus to the sensor node, there is no need to reformat the payload to a specific protocol.

Table 1. Comparison Table: Industrial Fieldbus and High-Speed Interfaces

Interface	PHY ↔ CPU Interface	Pins (typ.)	Typical Speed	Max Speed	Typical Reach	Nodes (typ./ max)	Common Protocols / Use Cases	Deterministic Real-Time Suitability
10BASE-T1S *(IEEE 802.3cg)*	MII / RMII / RGMII / SPI config	**~16**(MII) / **8**(RMII)	10Mbps	10Mbps (fixed)	15–25 m (ptp/ multidrop)	≥8 (PLCA; vendors up to ~16)	SPE Industrial Ethernet, TSN, PROFINET, OPC UA, IO-Link over SPE	**High** — deterministic via PLCA & TSN
RS-485 *(TIA/ EIA-485)*	UART TX/RX + DE/RE	**2–4**	100 kbps–1 Mbps	10Mbps (short runs)	10–100m ≥1 Mbps / up to 1200 m at 100 kbps	32 typ. / up to 256	Modbus RTU, PROFIBUS-DP, DMX512, custom serial	**Medium** — deterministic possible but SW-driven, no sync
M-LVDS *(TIA-899)*	Diff. TX± / RX±	**4**	100Mbps typ.	250Mbps	10–20 m	Up to 32 nodes	Backplane comms, clock distribution, fast ADC/DAC sampling	**High** — clocked or data-strobe schemes possible
LVDS *(TIA/EIA-644)*	Diff. TX± / RX±	**4**	155–655 Mbps typ.	1.9Gbps	Few meters at high rate / 10m de-rated	2 (point-to-point)	Camera streams, FPGA-ADC, flat-panel displays, JESD204B	**High** for sync'd clock/data schemes
CAN (Classical) *(ISO 11898-2)*	CAN_TX / CAN_RX	**2**	125–500 kbps typ.	1 Mbps	100m at 500kbps; 1 km at 50kbps	30 typ. / up to 110	CANopen, DeviceNet, SDS, simple control loops	**Medium** — bounded latency but non-deterministic arbitration
CAN-FD *(ISO 11898-1/-2)*	CAN_TX / CAN_RX	**2**	2 Mbps (data-phase)	5–8 Mbps (data-phase)	~10–30m at ≥5Mbps / ~40m at 2Mbps	Same as CAN	CAN-FD Safety, CANopen-FD, automotive/autonomous sensors	**Medium-High** — faster bursts but arbitration limits hard sync
FPD-Link III *(for example, DS90UB953)*	CSI-2 / DVP high-speed SerDes + I²C ctrl	**8–12**	1–4 Gbps	4.16 Gbps per lane	10–15m coax/STP	Point-to-point	Machine vision cameras, displays, robotics, automotive ADAS	**High** — deterministic framing, often synced with external triggers

Demo System

Figure 3 shows a design combining a T1S PHY, with a suggested MCU, and I/O expander. These are part of one board that connect to the backplane.

The MSPM0G3519 microcontroller belongs to a series of highly integrated, ultra-low-power 32-bit microcontrollers from the MSP family. These devices are based on the enhanced Arm Cortex-M0+ core platform, which operates at frequencies of up to 80 MHz.

One of the key benefits of these MCUs is their ability to balance cost optimization with design flexibility. This makes them suitable for a wide range of applications that require varying amounts of flash memory, from 256KB to 512KB. They can also be packaged in small form factors or feature higher pin counts, up to 100 pins. They include cybersecurity enablers that help protect against various types of threats and attacks. In addition to their digital capabilities, these MCUs also offer high-performance integrated analog sections. This allows developers to create devices that can accurately measure and process analog signals with low power consumption. These microcontrollers also demonstrate excellent low-power performance across a wide operating temperature range. This makes them suitable for use in applications where energy efficiency is crucial, such as in industrial control systems or Internet of Things (IoT) devices.

The DP83TD555 is a multidrop 10Base-T1S Ethernet SPI MAC-PHY. This is an IEEE 802.3cg compliant device, which means it supports multidrop 10BASE-T1S (10 Mbps half-duplex) Ethernet. It has a mixing segment that can reach up to 25 meters and support up to 16 nodes, or a point-to-point half-duplex connection with up to 15 meters reach. The device also supports IEEE 802.1AS time stamping, synchronized CLKOUT, and event trigger/capture, making it TSN-ready. It has an integrated Physical Layer Control Architecture (PLCA) that can operate in normal mode, burst mode, or precedence mode. Other features include remote PHY control with microcontroller reset through protocol layer 2 and selective node standby state.

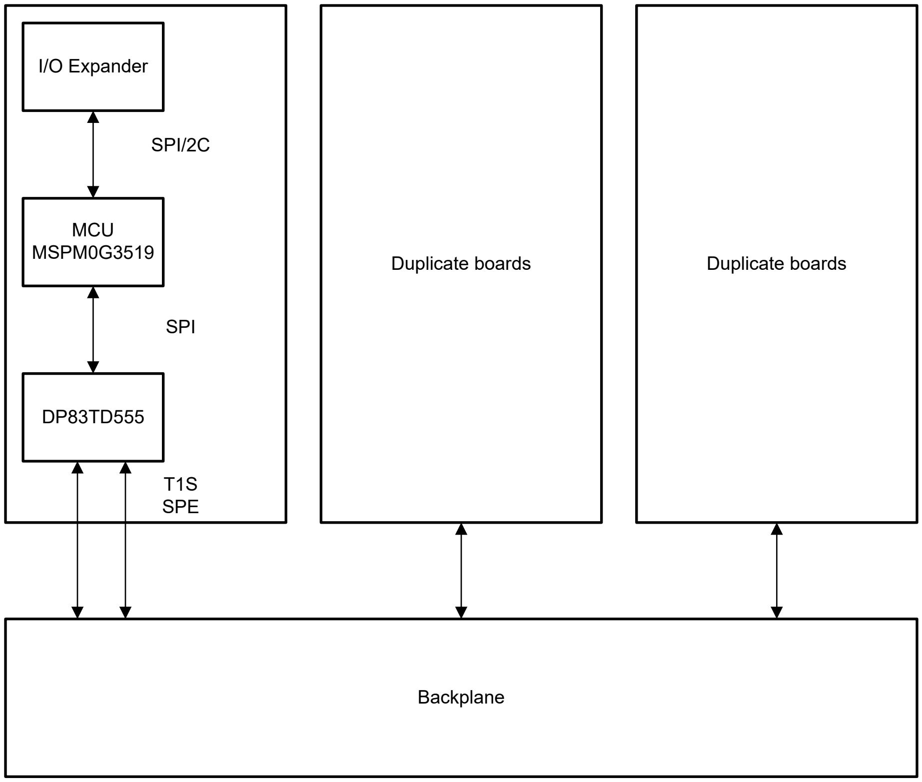

Figure 3. Block Diagram

Conclusion

Integrating 10BASE-T1S with a backplane provides a practical way to simplify connectivity and reduce system costs in applications such as automotive electronics, industrial control, and modular embedded systems. Because 10BASE-T1S enables multiple devices to share a single communication line, it minimizes cabling and connector requirements, which lowers material and assembly expenses. Applied to a backplane, this allows modules and sensor boards to be connected seamlessly without the need for additional switches or complex wiring. The result is a more scalable and flexible architecture that supports standardized Ethernet communication, enabling easier integration with higher-speed networks and paving the way for future system upgrades while maintaining a compact and cost-efficient design.

Trademarks

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