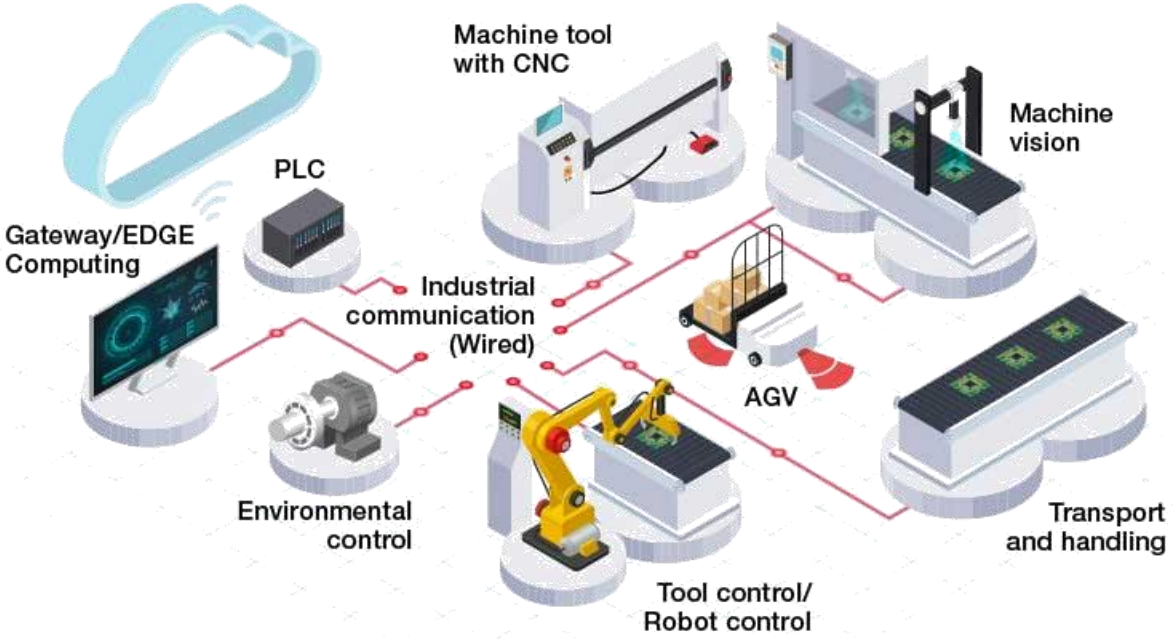
Single-pair Ethernet, the future of industrial communications

10BASE-T1L IEEE 802.3cg single-pair Ethernet PHY

By the end of this webinar, you will learn:

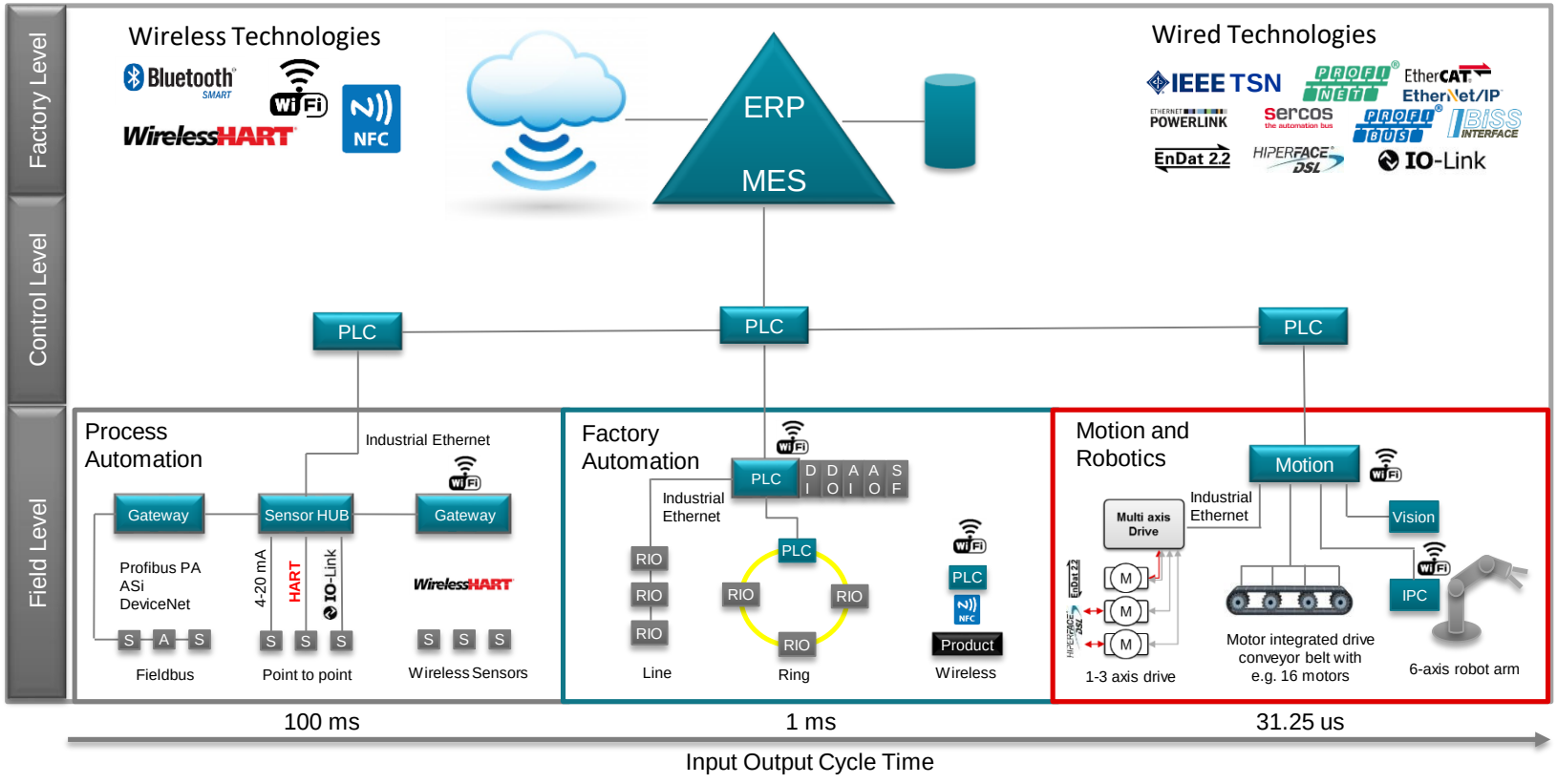
- Where **Ethernet fieldbuses** exist in industrial applications today
- What is **single-pair Ethernet** and how it compares with standard Ethernet that exists today
- How single-pair Ethernet **supports smart factories** by moving data *faster* and *farther* than ever before
- What **resources** are available to help you along your design journey

What is Ethernet?

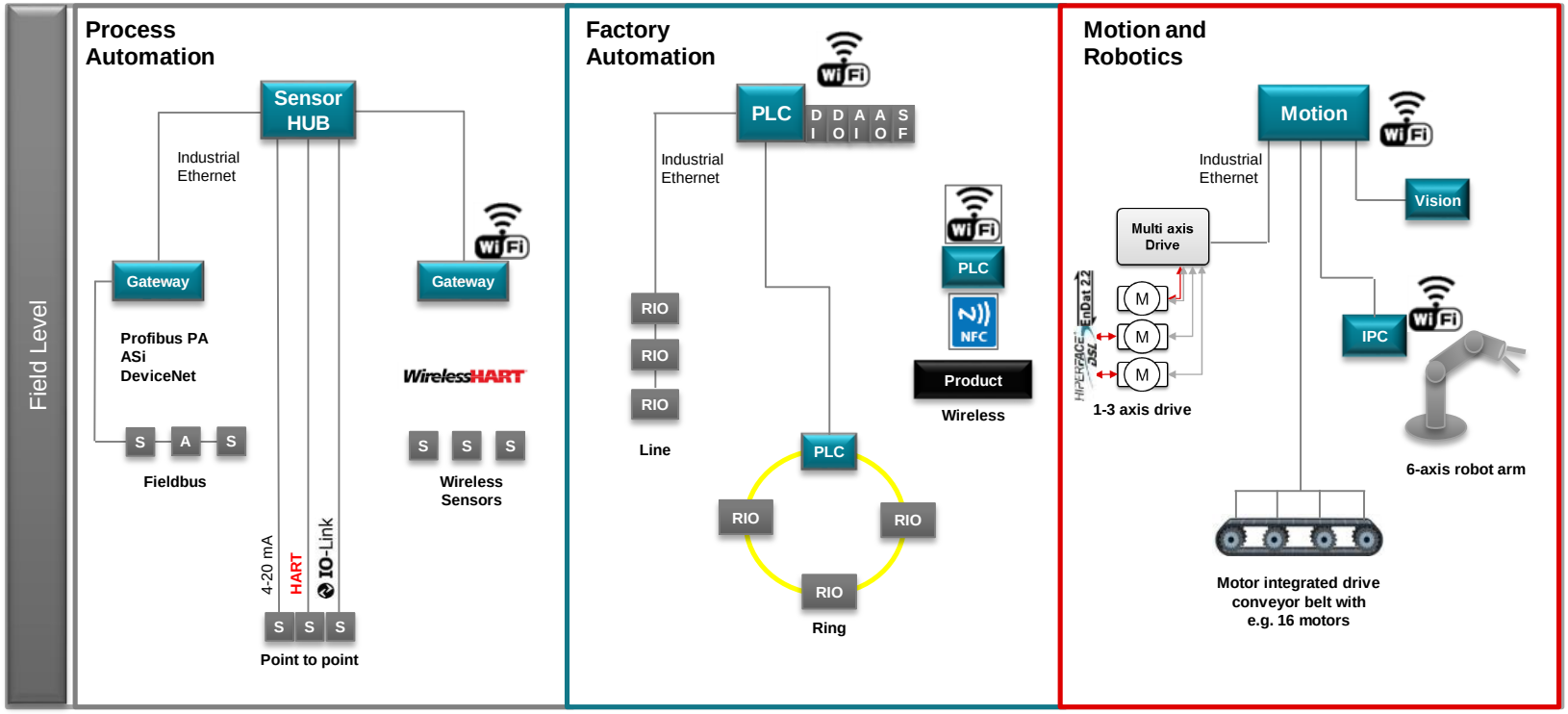


Ethernet is an **established, easy-to-use, robust, fast, price-competitive** communication protocol that enables easy connection to internet (industry 4.0), **scales** from factory floor to enterprise and beyond

Industrial and standard Ethernet in factory automation

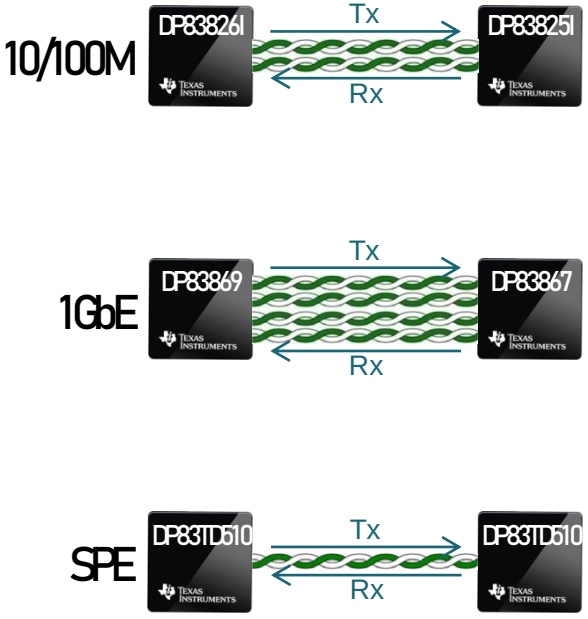


Industrial and standard Ethernet in factory automation



What is single-pair Ethernet?

Single-pair Ethernet is Ethernet, but over a *single* twisted-pair of wires.



- Industry 4.0 / IIoT driving all parts of a system to “connectedness”
- Significant systems savings in copper and potential re-use of existing wiring harnesses
- DP83TD510 supports power over data line (PoDL), APL power, and intrinsic safety

Single-pair Ethernet benefits over field buses

- Constant bandwidth with cable reach
- Low power dissipation
- Secured communication
- Reduced gateways for cloud connectivity
- Reduced cable weight & cost
- Re-use of existing two-wire cable infrastructure
- Small form-factor
- Shortened firmware development cycles
    - TCP/IP based socket programming

Field bus	Longest reach	Highest rate
PROFIBUS DP	9.6Kb/s @ 1200m	12Mb/s @ 100m
CANopen	10Kb/s @ 5000m	1Mb/s @ 20m
Modbus RTU	100Kb/s @ 1200m	2Mb/s @ 50m
CC-Link	156Kbps @ 1.2km	10Mb/s @ 100m
HART	1200 baud @ 1524m (24AWG)	No enhanced rate
PROFIBUS PA	31.25Kb/s @ 1900m	No enhanced rate
INTERBUS	500Kb/s @ 400m	No enhanced rate
IEEE802.3cg 10BASE-T1L	10Mb/s @ 200m (1V) 10Mb/s @ 1000m (2.4V)	No enhanced rate
IEEE 802.3bw 100BASE-T1	100Mb/s @ 50m	No enhanced rate
IEEE 802.3bp 1000BASE-T1	1000Mb/s @ 15m	No enhanced rate

Industry 4.0 over existing wires

In many cases, new wire does not need to be pulled – existing cabling can be used for SPE

- Process automation
- Building automation
- Factory automation (IO-Link upgrade)

Need both long distance and short distance, single drop and multi-drop

Fieldbus	Cable Type	Cable Power
Foundation H1	FF-844 specified	Yes
HART	Various	Yes
Profibus PA	IEC 61158 Type A	Yes
4-20 mA	SP-50 instrumentation cable	Yes
CANopen	EIA-485	Yes
Modbus RTU	EIA-485	No
CC-Link	CC-Link, Ver.1.10 specified shielded, 3- & 5- core	No
DeviceNet	ODVA DeviceNet specified (5-core, various classes)	Yes
ControlNet	RG-6/U Coaxial	No
INTERBUS	3 / 6 no. twisted pairs, various	Yes
PROFIBUS DP	IEC 61158 Type A	No

Long reach Ethernet applications

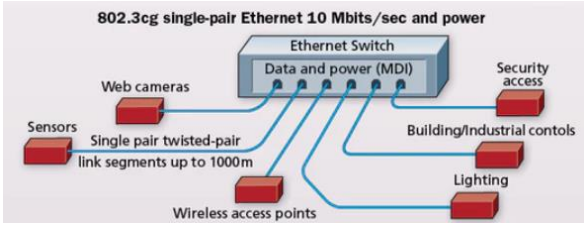
Process automation

- Field instrumentation
  - Flow sensors
  - Level sensors
  - Pressure sensors
  - Temp sensors
  - Loggers
  - Field switches

HART + Other field buses → **T1L Ethernet**

Building automation

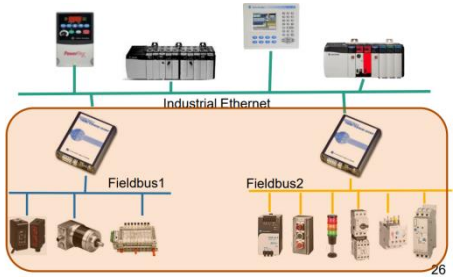
- Fire alarm control
- HVAC control
- Elevators
- Security controls



RS485 → T1L Ethernet

Factory automation

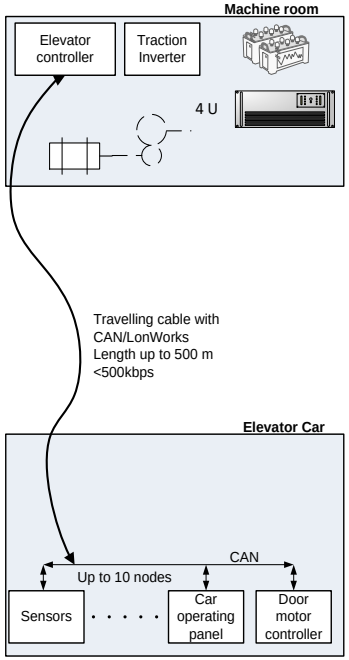
- Sensors
- Valves
- Encoders
- Motor starters
- Robotics



Various field buses →T1L Ethernet

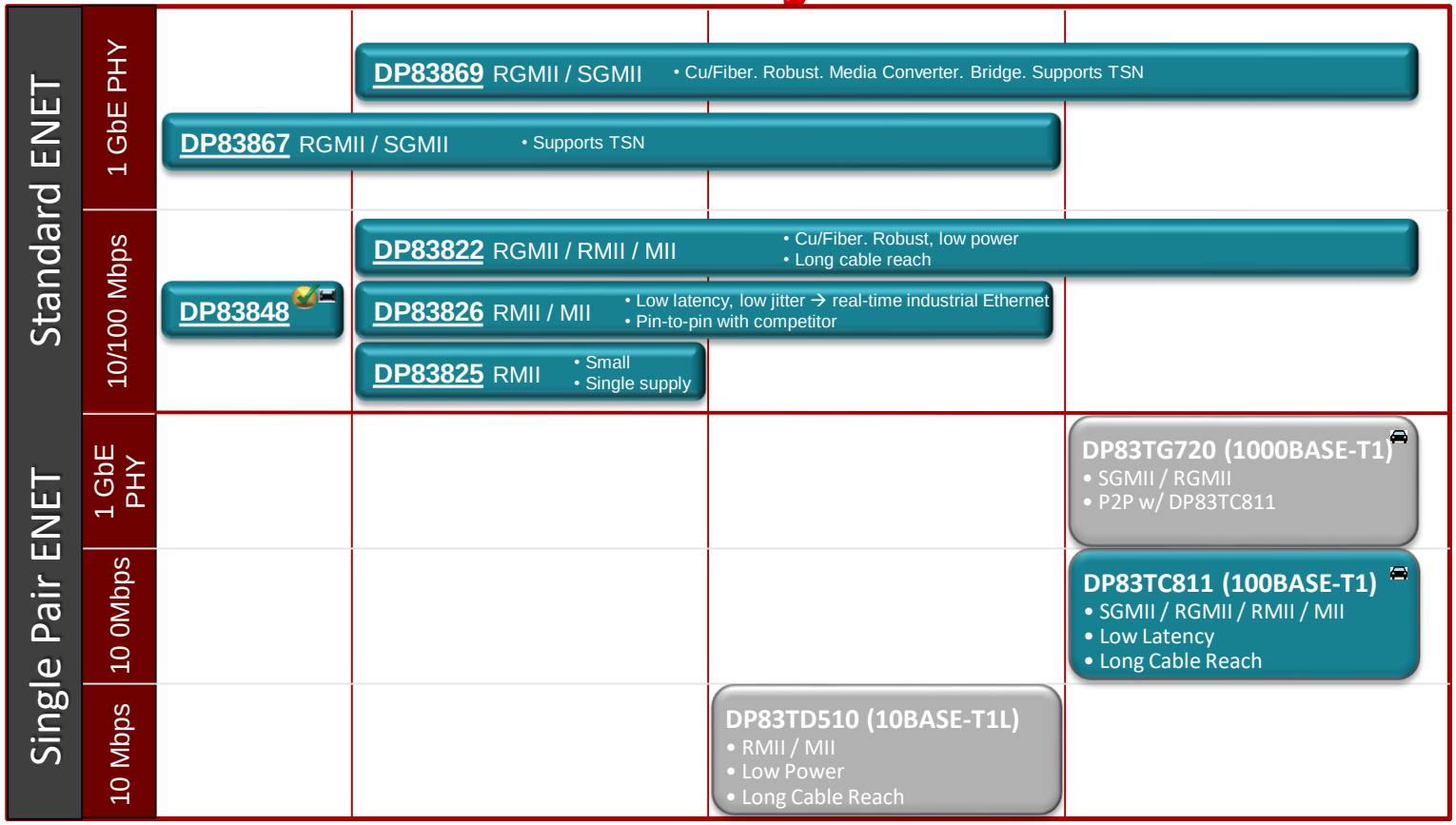
Application example | Elevator communications

- Elevators require traveling cable for communications
- Both length and bandwidth limited
- New features pushing requirements
- SPE enables retrofitting, and future architectures



Existing infrastructure

TI's Ethernet PHY key devices



DP83TD510 IEEE 802.3cg – low power, long reach

Single twisted-pair Ethernet PHY (10BASE-T1L)

Features

- Very **Low Power** consumption (45mW)

- **Cable reach** : 1000 meter, 200 meter. Strap configurable modes
  - Cable Reach Extender Support, >1000 meters Cable Reach
  - MDI Amplitude Level : 2.4v p2p (1000 meter) or 1v p2p (200 meter)

- **Robust**
  - 8 kV HBM ESD Protection on MDI lines
  - Industrial Temperature Range support : -40 to 105C
- MDC/MDIO Interface

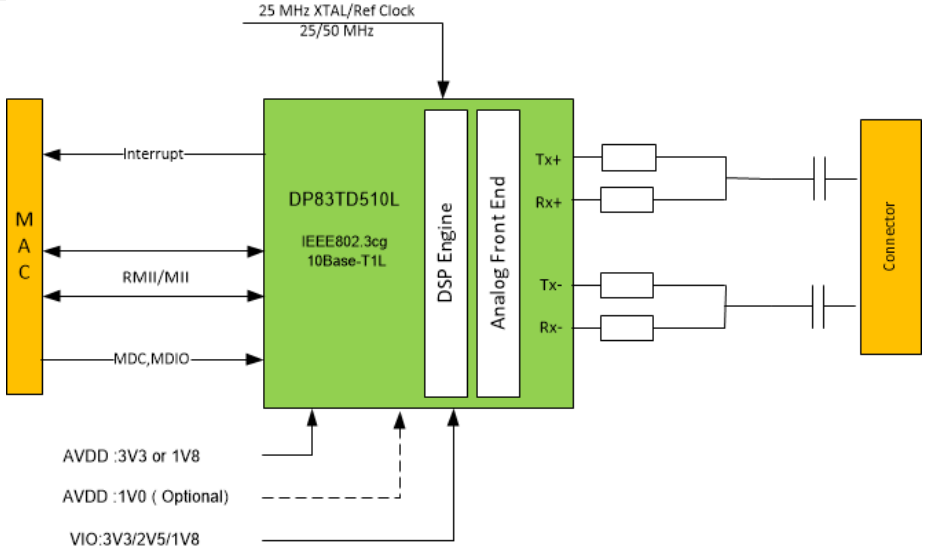
- **Diagnostics** :
  - Active Link Cable Diagnostics
  - TDR Based Open and Short
  - Built In Packet Generator
  - IEEE Test Mode Support

Applications

- **Factory Automation :** PLC and IO Communication modules
- **Process Automation :** Sensor Nodes, Field Switches, Transmitters
- **Building Automation :** HVAC Controls, Fire Safety, Escalators

Benefits

- Supports Ethernet-APL intrinsic safety implementation
- Flexible cable lengths, reduced cabling costs or cable reuse
- Assures performance in harsh environments
- Simplifies maintenance & lowers costs



DP83TD510 IEEE 802.3cg – low power, long reach

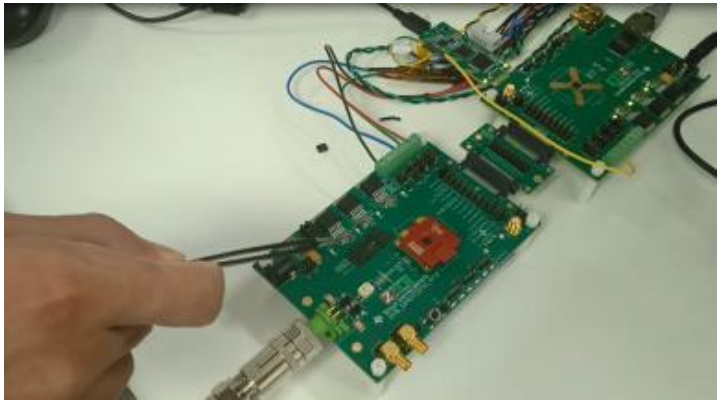
Single twisted-pair Ethernet PHY (10BASE-T1L)

- Power consumption results

Specification	Config. 1		Config. 2		Config. 3	
Feature	1V p2p, 200 meters		1V p2p, 200 meters		2.4V p2p, 1000 meters 1V p2p, 200 meters	
AVDD	1.8V		1.8V, 1V		3.3V	
VDDIO	1.8V		1.8V		1.8V	
Status	**Target**	**Measured**	**Target**	**Measured**	**Target**	**Measured**
Typical Power Dissipation (25C)	70mW	**52 mW**	65mW	**45mW**	110mW (2.4V p2p) 100mW (1V p2p)	**100mW (2.4V p2p)** **87 mW (1V p2p)**

DP83TD510 IEEE 802.3cg – low power, long reach

Single twisted-pair Ethernet PHY (10BASE-T1L)



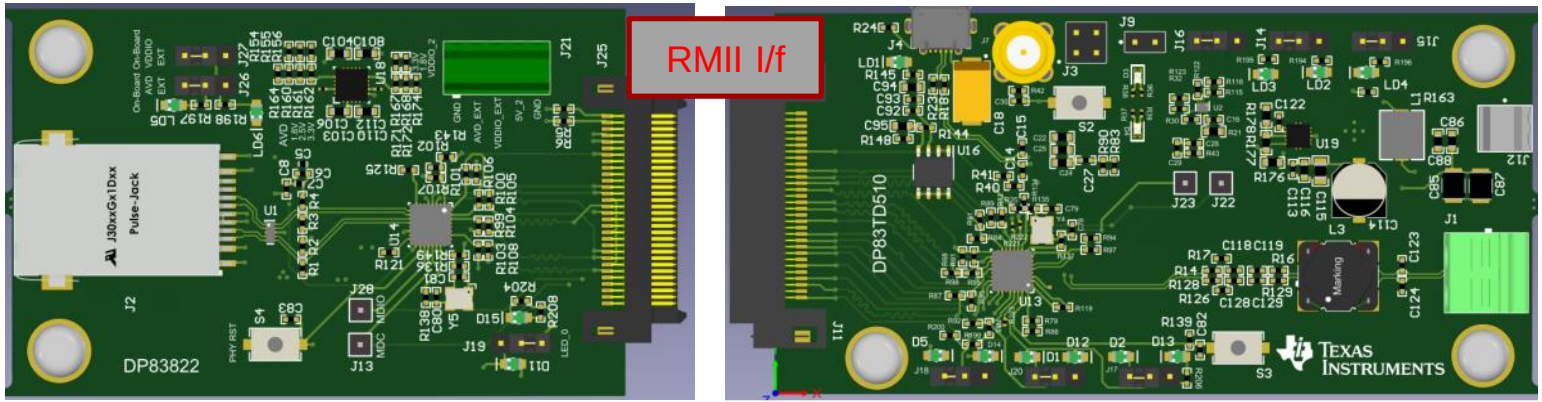
	1V p2p		2.4V p2p	
Cable	Auto-Neg	Force Mode	Auto-Neg	Force Mode
#1	1.2 km	1.7km	1.2 km	1.7 km
#2	300 meters	550 meters	300 meters	550 meters

Tested across temperature

Summary

- DP83TD510E 10BASE-T1L IEEE 802.3cg PHY:
  - Exceeds standards' specifications, enabling data to travel faster and farther
  - Eases upgrade by supporting reuse of existing cabling where possible, and migration to more economical copper where fibre has been used before
  - Mitigates the need for protocol conversion by gateways

DP83TD510E EVM rev 2.0



Key features:

1. Media Convertor
2. Option to use on board LDO or external Power Rails
3. MDI : Terminations and CMC on the board.
4. RGMII/MII/RMII interface on the connector
5. Jumpers for strapping

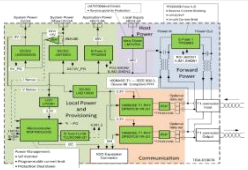
Single-pair Ethernet tools

IEEE 802.3cg / 10BASE-T1L:
- **Product Folders / Datasheets** DP83TD510 **EVM** DP83TD510E-EVM

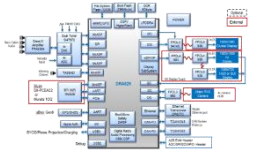
IEEE 802.3bw / 100BASE-T1:
- **Product Folders / Datasheets** DP83TC811R DP83TC811S **EVM** DP83TC811EVM

IEEE 802.3bp / 1000BASE-T1:
- **Product Folders / Datasheets** DP83TG720SS **EVM** DP83TG720EVM

Additional resources
Single-pair Ethernet
- Low-power operation
- Diagnostic toolkit
- Systems and reference schematics for configurable MAC interfaces
- Compliance & debug
- How 10Base-TI single-pair Ethernet PHYs help bring more data farther in long-distance applications technical article
- Extend network reach with IEEE 802.3cg 10BASET1L Ethernet PHY application report
- Previous new product webinar: Industrial Ethernet

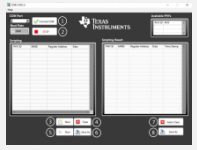


TIDA-010076: Daisy-chained power and data over single-pair Ethernet (T1)



TIDA-01020: Automotive domain controller for gateway, assisted & automated driving systems

Development Support



EVM GUI

Linux drivers

Ethernet schematic checklists

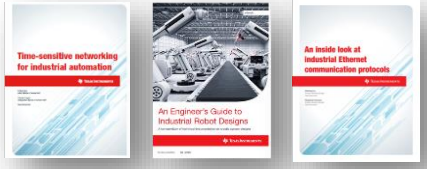
E2E™ support forums ›

Technical articles › Industrial

Learning Tools

TI training and videos

Engineering thought leadership



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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265