Industrial Communication and Control Protection: RS-485 and Ethernet

Industry 4.0
Over 330M industrial data nodes deployed, and growing

**Worldwide Market for RS-485 and Ethernet Industrial Nodes**

<table>
<thead>
<tr>
<th>Year</th>
<th>RS-485</th>
<th>Ethernet</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>80</td>
<td>100</td>
</tr>
<tr>
<td>2016</td>
<td>90</td>
<td>130</td>
</tr>
<tr>
<td>2017</td>
<td>100</td>
<td>160</td>
</tr>
<tr>
<td>2018</td>
<td>120</td>
<td>180</td>
</tr>
<tr>
<td>2019</td>
<td>140</td>
<td>200</td>
</tr>
<tr>
<td>2020</td>
<td>160</td>
<td>220</td>
</tr>
</tbody>
</table>

Source: HMS

**Key Feature**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Industrial Ethernet</th>
<th>RS-485</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capable of driving Multiple Ports</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Noise Immunity</td>
<td>Differential pair</td>
<td>Differential pair</td>
</tr>
<tr>
<td>Common Jack</td>
<td>RJ45</td>
<td>No</td>
</tr>
<tr>
<td>Fast Speed</td>
<td>100Mbps 1Gbps</td>
<td>10Mbps Max</td>
</tr>
<tr>
<td>Network Capability</td>
<td>Yes</td>
<td>NA</td>
</tr>
<tr>
<td>Power Delivery</td>
<td>PoE (15.4 W) PoE+ (30 W)</td>
<td>NA</td>
</tr>
<tr>
<td>Long Distance Transmission</td>
<td>100 meters</td>
<td>1500 meters</td>
</tr>
</tbody>
</table>

RS-485 has been historic standard but ethernet has grown due to data transfer capabilities
Distance and data speed influence protocol selection

Increased Distance

RS-485

Remote I/O

Energy Meter

Factory Automation

Security System

Programmable Logic Controller

Test Equipment

Human Machine Interface

Wind Control

Machine Vision

Increased Data Speed

Industrial Ethernet

Human Machine Interface

Factory Automation

Security System

Machine Vision

Wind Control

Test Equipment

Programmable Logic Controller

Energy Meter

Remote I/O

RS-485
Environment impacts protection needs

- Increased lightning exposure
- Long runs increases induced surge risk
- Human touch introduces ESD risk
- Electrical fast transients can be caused by starting and stopping inductive loads

Legend:
- Outdoor connection hazards
- Intra-building connection hazards

Each port requires protection from exposure to electrical hazards for long term reliability.
Electrical threats to RS-485 and ethernet

**Lightning surges**
- Induced lightning surges can be coupled to industrial data line causing damage to sensitive ICs
- Miswiring during assembly or insulation damage can cause cables be exposed to AC line voltage

**Induced power surge**
- Lightning and power grid switching can induce power surge causing damage
- Electrical Fast Transient (EFT) can be a result of switching of inductive loads or relay contacts "bouncing"

**Electrostatic discharge**
- ESD passing through connector can cause damage to ICs
- RS-485 and Ethernet often share the same conduits with DC or AC power lines; sharp bends and tight wiring tie can gradually result cracks in the insulation and electrical faults
## Intra-building protection recommendations – RS-485

<table>
<thead>
<tr>
<th>Technology</th>
<th>Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Resettable PPTC</td>
</tr>
<tr>
<td>II*</td>
<td>TVS Diode</td>
</tr>
</tbody>
</table>

Note:
* Pulse-Guard ESD Suppressors type PGB/XGD are an alternative solution.

**Applicable Standards:**
- IEC 61000-4-2 (ESD)
- IEC 61000-4-4 (EFT)
- IEC 61000-4-5 (Lightning)
- ITU K.21 Internal Ports & YD/T 950-1998
- GR 1089 Intra-Building (Type 2)
- UL 60950-1/IEC60950-1, EN60950-1

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**Diagram:**

1. **Resettable PPTC** can increase up-time by helping to protect equipment from short circuit and power cross event.

   - **I**

2. **TVS Diode Array, SM712**, is specifically designed to help protect RS-485 applications from ESD, EFT, and lightning induced surges.

   - **II**
Resetable PPTC can increase up-time by helping to protect equipment from short circuit and power cross event.

Lightning protection utilizing a Gas Discharge Tube, GDT, with SIDACtor. When lightning occurs the SIDACtor will react first causing voltage to increase across PPTC until GDT fires. Resistance of PPTC must be selected carefully for proper coordination.

Applicable Standards:
- IEC 61000-4-2 (ESD)
- IEC 61000-4-4 (EFT)
- IEC 61000-4-5 (Surge)
- ITU K.21 Internal Ports & YD/T 950-1998
- GR 1089 Intra-Building (Type 2)
- UL 60950-1/IEC60950-1, EN60950-1
Intra-building protection for Ethernet

Port protected from ESD and EFT. Lightning is not a concern in this application. Low capacitance diode array is needed for high data transmission speeds.

Note: 1Gbps or greater will require an additional two twisted pair and the diode array solution should be replicated.

Applicable Standards:
- IEC 61000-4-2 (ESD)
- IEC 61000-4-4 (EFT)
- ITU (ESD Section)
- GR 1089 (ESD & EFT Sections)
- YD/T 950 & 1082
- UL 60950-1/IEC60950-1, EN60950-1
Outdoor and harsh environment – Ethernet

Telelink fuses can help protect power fault overcurrent. These fuses are designed specifically for high speed telecom applications. A single fuse per wire pair is sufficient.

Lightning protection utilizes GDT with diode array to meet standard requirements. Class rating and external wiring configuration will determine specific protection needed but an example would be (4kV/2kA, 1.2/50µs-8/20µs).

Note:
* PPTC Device such as T-Line (Telecom Line PPTC)

Applicable Standards:
- IEC 61000-4-2
- IEC 61000-4-4
- IEC 61000-4-5
- ITU K.20, K.21
- GR 1089
- UL 60950-1/IEC60950-1, EN60950-1
Telelink fuses can help protect power fault overcurrent. These fuses are designed specifically for high speed telecom applications.

A single TVS diode (bi-directional) across the center tap signal pair and second TVS diode across the center tap spare pair. The TVS diode can be chosen based surge requirements for 400W, 600W, 1500W or 3000W.
Key links

- General
  www.littelfuse.com
Reliability requires industrial communication protection

- RS-485 and ethernet nodes are projected to expand to 330 million by 2020
- RS-485 is generally used for longer-distance communication & control links
- Industrial Ethernet is most suitable where fast data transmission is needed
- Equipment environment and standards will determine required protection
- Lightning, ESD, EFT, inductive surges, and shorts are potential threats
- Fuses, PPTCs can be used for overcurrent protection and TVS diodes, GDTs, and SIDACtors can be used for overvoltage protection.