10 Mb/s Single Twisted Pair Ethernet
Intrinsic Safety Proposal

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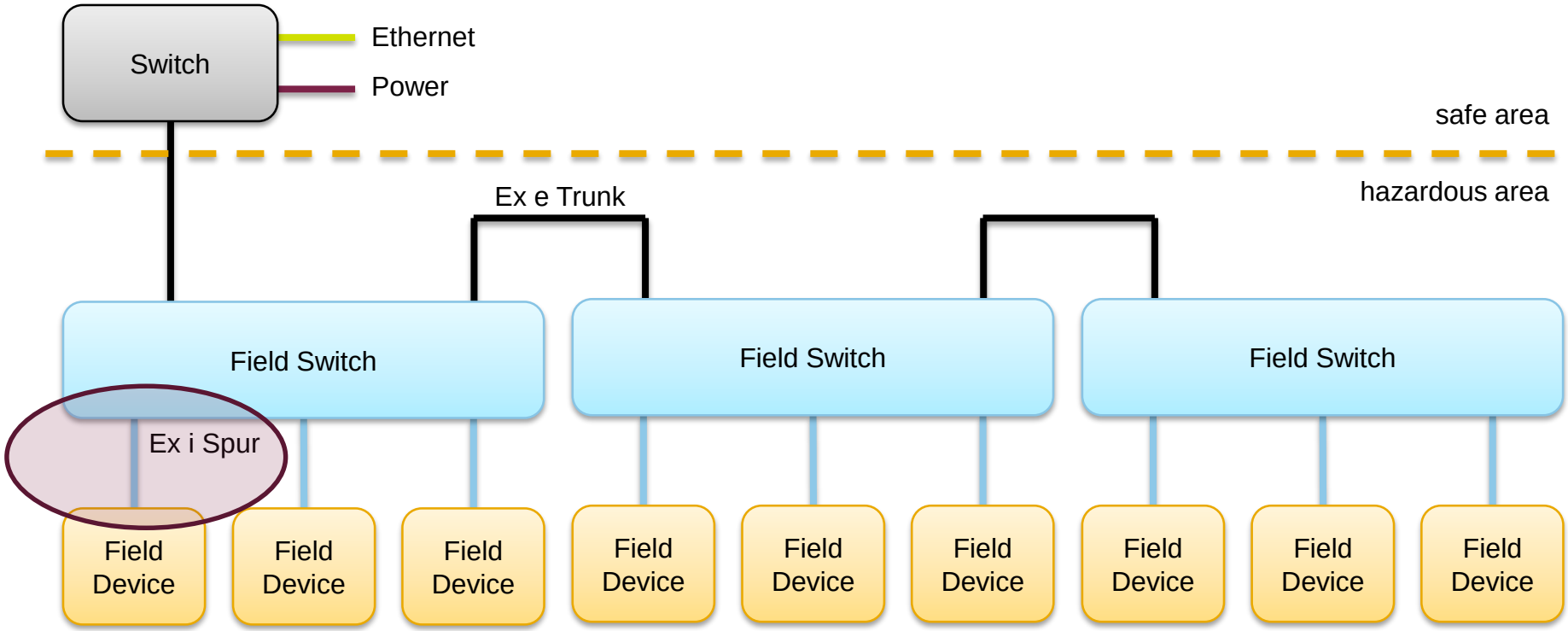
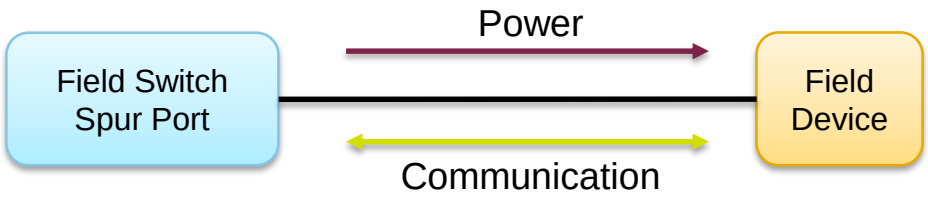
Intrinsically Safe 200 m Link Segment

- This presentation is about the powered intrinsically safe spur connections based on a 200 m link segment (see red circle in the block diagram below).
- These link segments are intended to be used with a maximum length of 200 m with a reduced modulation signal amplitude of 1 V_{pp} (-0.5 V, 0 V, +0.5 V).
- The 1000 m Ex e trunk is not part of this presentation.

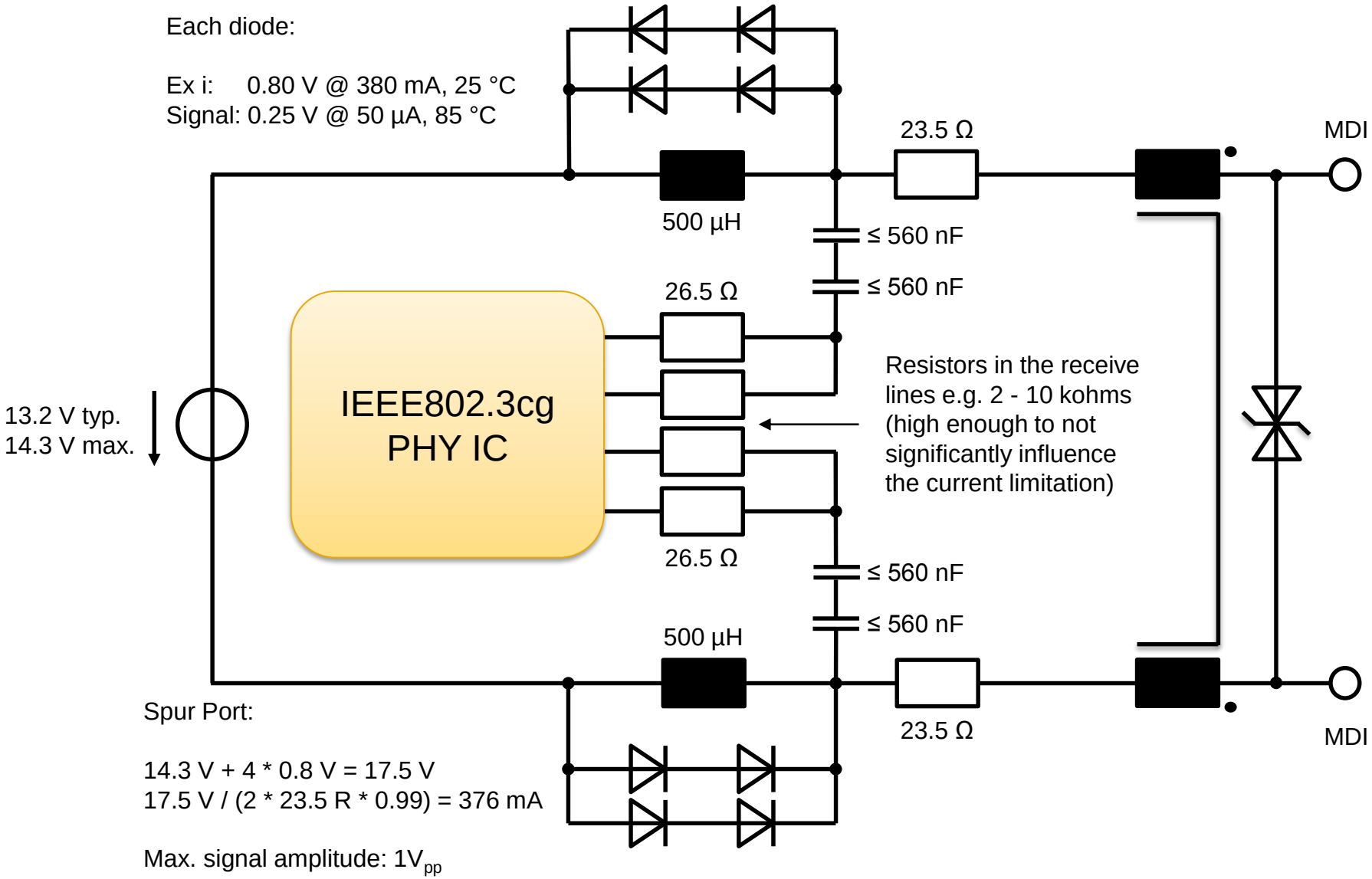


Intrinsically Safe 200 m Communication Link

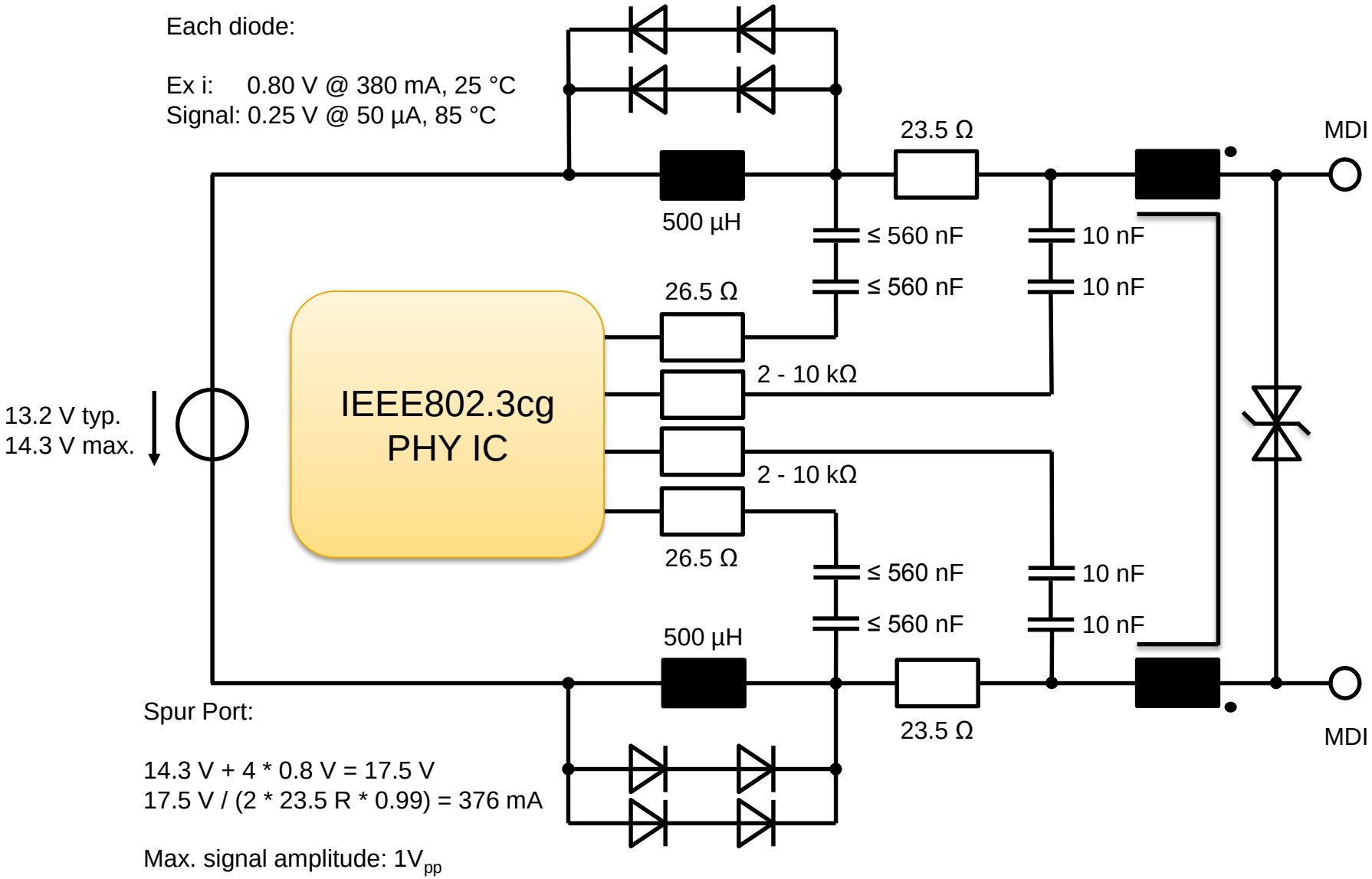
- Each communication link consists of:
  - Field switch spur port, which injects the power.
  - Field device, which receives the power.
  - Up to 200 m cable (AWG18 or AWG16).
  - Up to 4 inline connectors.
  - MDI Connectors.
- From intrinsic safety point of view it is important, that there is only one power source and that the field device can only operate as a power sink.
- Therefore for the spur port and the field device port different circuits are needed.
  - As an example two different versions for the spur port are shown.
  - One example version for the field device port is shown.



Intrinsically Safe Spur Port, Version I



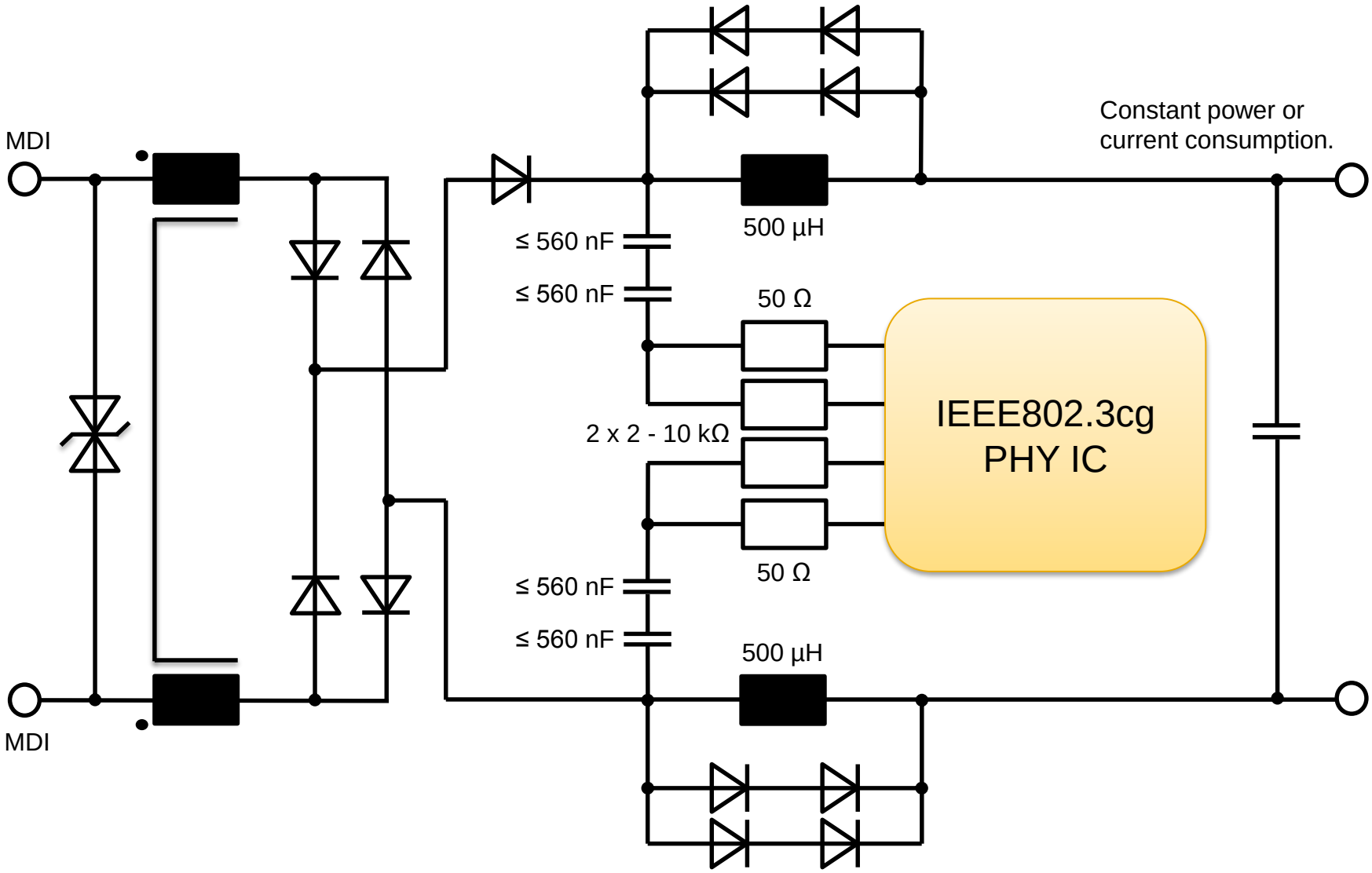
Intrinsically Safe Spur Port, Version II



Intrinsically Safe Spur Port

- Both versions are very similar and behave at the MDI connector in the same way.
- Nevertheless for the IEEE802.3cg PHY IC hybrid the two circuits make a significant difference.
- Version I has the receiver inputs being connected by external resistors at the same point as the transmitter, which allows a simpler and smaller external circuit.
  - Some less capacitors are needed and the layout including creepage and clearance distances gets simpler.
  - At the receive side there is a voltage divider between the 23.5 Ω and 26.5 Ω resistors.
  - The hybrid must be able to adopt to this voltage divider to be able to cancel out the echo.
  - Depending on the Ex concept there is also the possibility that the resistor values change (keeping a total termination resistance of 100 Ω).
- Version II has the receiver inputs being connected using additional capacitors at the down side of the current limiting resistors.
  - Additional capacitors are needed.
  - The voltage at the receive side is independent from the resistance ratio.
  - The hybrid does not need to adopt to different implementation scenarios, which allows an easier implementation.
- Both versions have the need to be able to separately connect the transmitter and receiver pins.
- Leakage inductance of the current compensated choke is expected to be less than 1 µH (typ. 500 nH).
- Capacitance of the suppressor diode is expected to be in the range of less than 200 pF (typ. 100 pF, e.g. by adding a bridge rectifier in series to the suppressor diode to reduce the capacitance).

Intrinsically Safe Device Port



Intrinsically Safe Device Port

- Each device has a constant power or constant current consumption.
  - Constant power consumption is preferred, because it allows a higher device efficiency.
  - Constant current consumption will also be a possible operation mode, which allows easier implementation for low power devices.
- Connection of the device is polarity independent (bridge rectifier).
  - Each device must be able to operate with both polarities.
  - Eases installation, prevents miswiring of the device.
- Internal capacitors and other energy storage devices are decoupled from the supply/communication lines using a redundant diode assembly.
  - Device only acts as a power sink, no power sourcing is possible.
  - Prevents the energy stored in internal capacitors of the device from flowing to the link segment.
  - Only one source on a spur port, no multi sources.
- Depending on the protection method of the field device (e.g. when using Ex q or Ex d for the field device itself), it could also be an option to have integrated termination resistors within the IEEE802.3cg PHY IC.
- Leakage inductance of the current compensated choke is expected to be less than 1 µH (typ. 500 nH).
- Capacitance of the suppressor diode is expected to be in the range of less than 200 pF (typ. 100 pF, e.g. by adding a bridge rectifier in series to the suppressor diode to reduce the capacitance).

Intrinsic Safety Objective

- The objective „Do not preclude working within an Intrinsically Safe device and system as defined in IEC 60079“ only demands, that the standard allows building a PHY, which is able to be used in intrinsically safe environments.
- This is not requiring, that each PHY according to this standard allows the connection of external resistors.
- Nevertheless without the possibility to use external termination resistors, it will not be possible to use this PHY in several intrinsically safe applications, which will limit the usage of such a PHY IC in process automation applications.
- Therefore one possibility could be to have integrated 50 Ω resistors within the IEEE802.3cg PHY IC to allow a simple usage within standard applications, but additionally to have the option to have external access to the transmit and receive lines, so that it will be possible to add external resistors.
- Alternatively, it can make sense to be able to configure also the hybrid, but there are also possibilities to have the hybrid fixed by slightly increasing the external circuit effort.

PHY Term for Intrinsically Safe Circuits

- As long as the PHY is typically being defined to comprise the PHY IC, the transformer and also the MDI connector, how can this formally be handled thinking about standard PHYs and intrinsically safe PHYs?
- This gets even more complicated, as for the intrinsically safe PHYs it needs to be distinguished between the PHYs which are connected to a power sourcing port and these PHYs being connected to a power sinking port.
- Additionally, as described, depending on the energy limiting concept in the future there will also be different resistor combinations possible.

- As we cannot specify several different PHYs, there needs to be a methodology, how to describe a PHY within this project in such a common way, that the number of resulting PHYs can be limited.
  - Should be independent form the resistor ratio.
  - Perhaps we need to distinguish between standard PHYs and intrinsically safe PHYs.
  - We should try not to distinguish between PHYs being connected to a power sourcing port and a power sinking port.

- There are several possible options, how to use an IEEE802.3cg PHY IC within a PHY.
- A common matrix showing all relevant use cases for standard and intrinsically safe usage scenarios could make sense to get a detailed overview and to support the ongoing discussions.

Thank You