10BASE-T1: Power & Data v104

Lennart Yseboodt, Matthias Wendt
Philips Lighting – Research
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Introduction

This presentation explores a Data/Power architecture designed to fit applications that cannot make use of star networking, but relies on a daisy-chained cable topology.

Consideration is given to both data aspects, as well as the desire to provide a modest amount of power to the devices. Being able to power devices over the communication cable allows for a small degree of power redundancy, as well as significant savings in standby power.

DALI – Digital Addressable Lighting Interface

DALI covers OSI layers from Physical to Application and is extensively used in lighting controls. See ➠wendt_10SPE_01_0916.pdf

- 1200 bit/s, two wire communication
- Manchester endoded with voltage swing up to 16V$\pm$6.5V
- Nearly any cable can be used (mains cable, twisted pair, …)
- Free topology – possible due to the extremely low data rate

> With 10BASE-T1 is is not expected that mains cabling can still be used, nor will it be possible/desired to use a completely free ca-bling topology.

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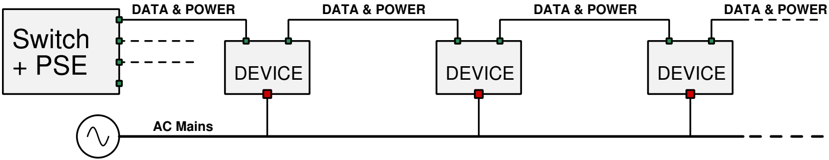
Architecture for Lighting

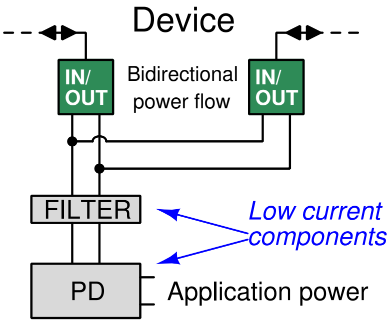


Devices (luminaires, sensors, …) are connected in passive linear topology. DALI carries a limited amount of power, and offers bus based data at very low data rate.

Requirements for 10BASE-T1:

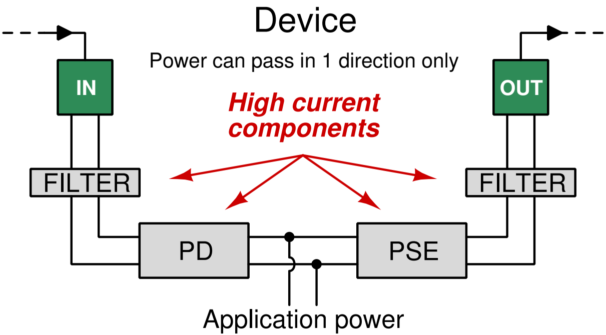
1. **Redundancy:** Device fault doesn't interrupt data & power flow
2. **Power:** Mains failure doesn't interrupt data & power flow
3. **Topology:** Linear wiring possible (active or passive)

Transferring power (DC pass)



If at DC frequency it is possible to directly connect the “in” to the “out” connector, there is no cost associated with transferring power through the device. The PD components only need to be rated for the device’s own power consumption. Power flow is bidirectional.

Transferring power (DC block)



If the device must block DC power, then a PD+PSE construction is needed, or at the very least in and output filtering. All of these components must be rated for the full output current of the source PSE, which is orders of magnitude larger than the current requirement of the application in the device. Power flow is unidirectional.

Comparison

For an example system consisting of 25 nodes (linear topology), each connected through a 4 meter cable (AWG24), with 1W of power consumption per node the following results are obtained:

DC pass

- Source delivers 0.52A at 55V= 28.7W
- Delivery efficiency 87%
- Voltage at last node: 44.8V(headroom for more nodes)

DC block

- Source delivers 0.62A at 55V= 34.3W
- Delivery efficiency 73%
- Voltage at last node: 33.9V(close to instability point)

Note: these are example numbers to illustrate the point that there is a large difference in efficiency and total possible delivered power between these two approaches.

Cost

An input stage (likely consisting of inductors), possibly a rectifier, a PD, possibly a PSE, and an output filter (again inductors), that are rated for high power (approx 100W) will be far more expensive than a filter stage and PD only rated for the application power.

Even an architecture where only an input and output filter is needed, would still require high-current magnetics for each device.

Given that the current passing through the devices in a DC block scheme is anywhere from **10x to 100x higher**, a cost uplift of a similar factor should be expected for the components in the current path.

Conclusions

- A DC pass architecture is a **far** cheaper and more efficient way to deliver power to a number of devices connected in daisy chain
- More nodes (or higher application power) is possible due to lower series resistance of the DC pass architecture
- Is there a way to implement peer-to-peer / full duplex networking and still enable DC passthrough ?
- A multidrop CSMA/CD data option seems a good match
- If passive linear is not needed for a given application, PoDL is a good match for the power delivery
- For linear topology with DC-pass applications a new powering scheme should be considered

Proposed objectives

1. Support optional power delivery over 10BASE-T1 links, using Clause 104 (PoDL)
2. Support optional power delivery over 10BASE-T1 links, using a method that allows the PD to act as a DC bus
3. Support:
   - Full duplex only links (with autonegotiation)
   - CSMA/CD multidrop links (with autonegotiation)
   - CSMA/CD multidrop links or Full duplex links (with autonegotiation)

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