



The bridge to possible

802.3da Unit Load Concept

Simple, Flexible Network Design Guidelines

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Agenda

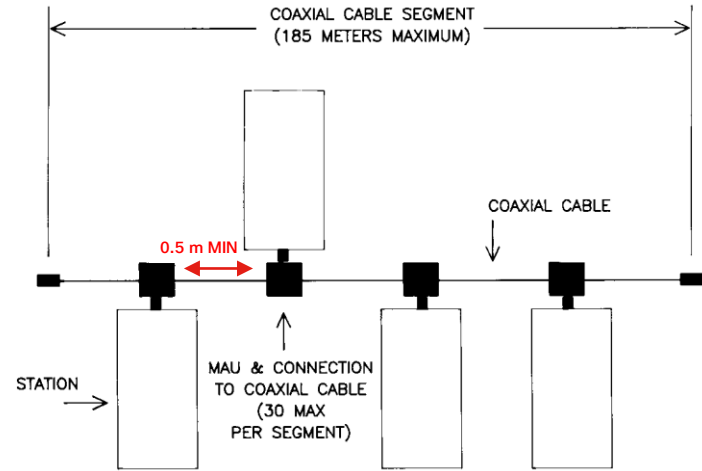
- Successfully adopted multi-drop network design guidelines from the past
- Proposal for 802.3da multi-drop network design guidelines for the future

Learn from the past...

802.3 Clause 10

10BASE2 MAU Placement

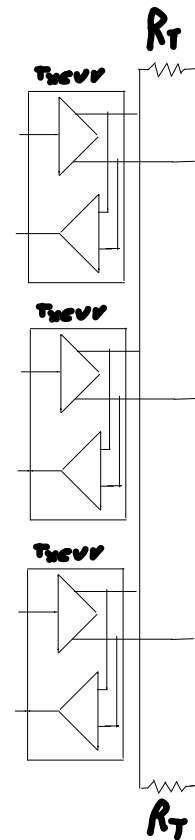
- 185 m segment length limit
- 30 stations maximum
- 0.5 m minimum spacing
- Repeaters:
 - 5-4-3 rule
 - 5 segments maximum
 - 4 repeaters maximum
 - 3 segments with stations only



IEEE 802.3-2022, Figure 10-8—The minimum system configuration

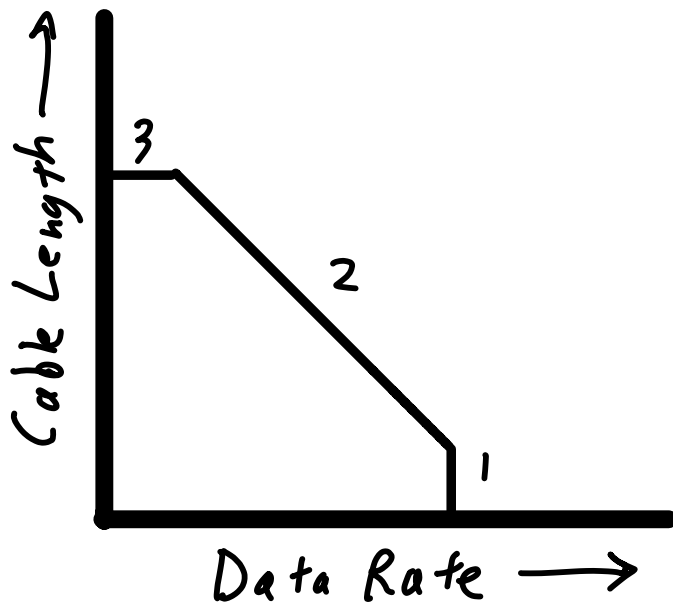
RS-485 Network Design Guidelines

- Main theme: “It depends....”
- Speed is configurable in most deployments, allowing the stations to adapt to the channel
- Node count limit is fluid, depending on loading characteristics of nodes



RS-485 Network Speed Selection

- UART BAUD rate is configurable on most equipment
 - Some standards specify a single BAUD rate
- Regions of concern on graph:
 - 1 – Driver rise time limited
 - 2 – Trade off between rate and length
 - 3 – Line loss limited
- Rule of Thumb:
 $Line\ Length\ (m) \times Data\ Rate\ (bps) < 10^7$
- In practice, users often titrate data rates post-installation to balance performance and reliability.



RS-485 Network Node Spacing

- Node spacing is determined by lumped load capacitance and media distributed capacitance
- Minimum node spacing d calculated as:

$$d > \frac{C_L}{5.25 \times C'}$$

Where C_L is the lumped load capacitance and C' is the media capacitance per unit length

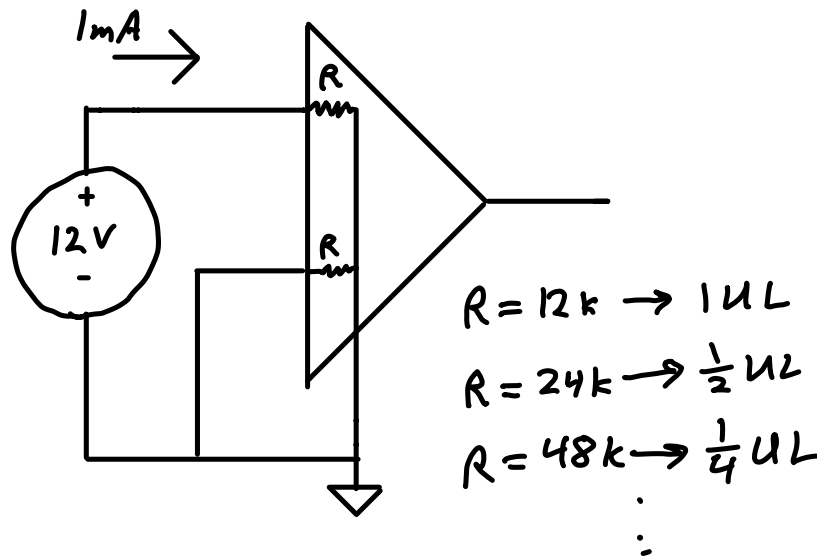
See the following document for details on this concept:

Thomas Kugelstadt, Texas Instruments, The RS-485 Design Guide, SLLA272D – FEBRUARY 2008 – REVISED MAY 2021

<https://www.ti.com/lit/pdf/slla272>

RS-485 Network Node Count

- RS-485 Networks allow 32 Unit Load
- Unit load is defined as:
 - 1 mA input current at 12V DC applied between either input terminal and ground
- Initially each transceiver was 1 UL
- Over time, transceiver technology improved, yielding fractional Unit Load devices entering the market



RS-485 Network Node Count

- Users can adopt a simple 32 node limit
 - Unaware of any >1 Unit Load devices
- Users can also calculate the number of nodes through simple sums of the fractional loads
- Fractional loads are expressed as inverse powers of two for simplicity

See the following document for more details on this concept:

Renesas Electronics TB511: The Unit Load Concept, Rev.0.00, Dec 14, 2017

<https://www.renesas.com/us/en/document/oth/tb511-unit-load-concept>

Summary of Divergent Approaches

RS-485

- Simple guidance for basic use
- Advanced design methods available to advanced users
- Speed variability allows post-cabling installation adaption
- Advances in technology allowed improvements without standard revisions

IEEE 802.3 10BASE2

- One set of rules for all
- Single speed
- Deprecated due to speed limitations and installation and reliability difficulties

Improve the future

802.3da SPMD Unit Load Proposal

- Michael Paul presented on August 30, 2023 on the significant burden on channel resistance caused by compensation networks
https://www.ieee802.org/3/da/public/083023/Paul_da_01_2023_08_30.pdf
- In the future, compensation techniques could improve
- To encourage innovation and avoid unnecessary standards work, we can adopt Mr. Paul's proposed baseline, but use the proposed limits to define a normalized Unit Load
- Total node count on the network can then scale while maintaining a constant Unit Load count

Possible Scope of Unit Load Concept for Data

Mixing Segment Node Count

- Control the number of TCIs present on a mixing segment
 - Better compensation could decrease Unit Load factor
 - Uncompensated nodes could drastically increase Unit Load factor

Cable Selection

- The allowable unit load count could vary with channel characteristics
 - This would vary with wire gauge and cable parasitics
 - We would specify this in terms of channel characteristics, though

Possible Scope of Unit Load Concept for Power

Power Allocation

- 1 Unit Load consumes 0.75W for Type 0 and 2W for Type 1
 - Fractional Unit Load units could be allocated less power to grow node count
 - Data-only nodes could be a small fractional Unit Load as they only dissipate power through their compensation network

PSE Voltage

- Different Unit Load budgets could be specified for Type 0 and Type 1 PSEs

Minimum Spacing Guidance

- Spacing requirements are not easily addressed through the Unit Load concept proposed here
- 10BASE2 may have it right here – pick a number for all cases
- In practice, this may be as easy as encouraging pre-terminated cables to be no shorter than the limit in a cabling vendor's standard product offerings and training staff on field terminated cable length guidelines
- Open to input on this topic

End Goal – Adoptability without Rigidity

- Tables illustrate vision for the level of complexity acceptable in the market to drive network design and installation guidelines
- **Numbers are placeholders and not actual proposed limits**

Note: Cable guidance outside of IEEE specification scope

| Node Unit Load | Type 0 | Type 1 |
|----------------|---------|--------|
| Powered Node | 3/8 UL | 1UL |
| Data Node | 1/16 UL | 1/8 UL |

| Max Segment Length (m) | Unit Load Budget | Minimum AWG |
|------------------------|------------------|-------------|
| 20 m | 24 UL | 24 AWG |
| 40 m | 16 UL | 24 AWG |
| 50 m | 16 UL | 23 AWG |
| 60 m | 16 UL | 22 AWG |
| 100 m | 16 UL | 20 AWG |
| 175 m | 16 UL | 18 AWG |
| 225 m | 8 UL | 18 AWG |

Questions and Discussion