

# IEEE802.3da draft 3.1 power calculations - appendix



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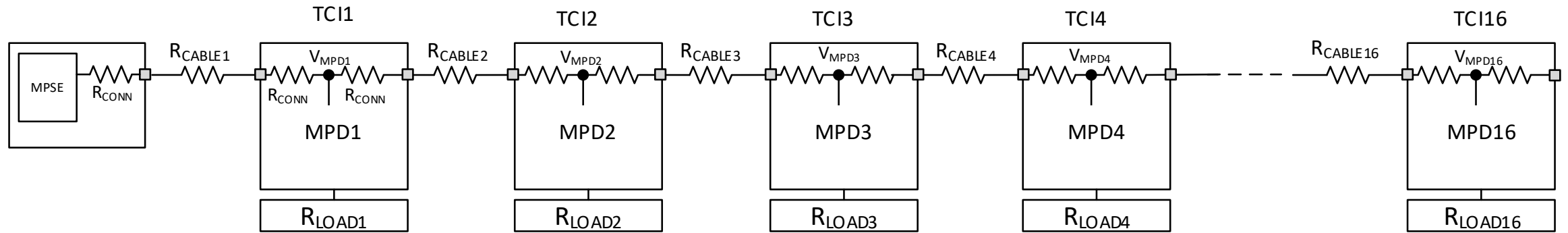
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# Goal of this appendix

- To present the calculations describing currents and voltages at each MPD of a mixing segment
- To calculate the worst-case input voltage at the last MPD (for 16 MPDs).
- To calculate the worst-case maximum current drawn from the MPSE (for 16 MPDs).
- To present calculation-matching simulations

The purpose of this presentation is to add calculations of voltage and current of each segment in a multidrop system, as an annex to the IEEE802.3da standard

# System Description



*Fig 1 – MPoE system for power, voltages and currents calculations*

# Assumptions

- All MPDs consume the maximum power allowed for their type (1.1W for Type 0, 4W for Type 1)
- All MPD loads are Power loads – mandating a constant power
- Each MPD is comprised of 2 connectors, each of which has a maximum of  $0.075\Omega$  resistance
- Overall loop-resistance is  $6.4\Omega$  consisting of  $4\Omega$  Cable resistance and  $2.4\Omega$  TCI connector resistance.
- The power consumed by the load is part of the MPD – no additional power losses included.
- Worst-case system structure is assumed to contains 16 MPDs
- Worst-case power dissipation and voltage drop occurs when the cable length between MPSE and the first MPD is the longest , and the cable length between the rest of the MPDs is reasonably short (10cm).

# MPoE System Power Calculations

For each MPD node, the following relations can be written:

$$(EQ.01) \quad V_{MPD}(n) = V_{MPD}(n+1) + i_{RCABLE}(n+1) \cdot (R_{CABLE}(n+1) + 2R_{CONN})$$

$$(EQ.02) \quad i_{MPD}(n) = \frac{P_{MPD}}{V_{MPD}(n)}$$

$$(EQ.03) \quad i_{RCABLE}(n) = i_{RCABLE}(n+1) + i_{MPD}(n)$$

- where:
- $n$ : the index of MPD (1 to 16)
- $V_{MPD}(n)$ : voltage on the  $n$ -th MPD load
- $i_{MPD}(n)$ : current flowing into the  $n$ -th MPD load
- $R_{CABLE}(n)$ : Cable resistance connecting between the  $n-1$  and  $n$ -th MPD
- $R_{CONN}$ : connection hardware resistance (connectors + wires) between input of MPoE cable and MPD load, or between MPD load and output connection to the MPoE system.  $R_{CONN} = 0.075\Omega$
- $i_{RCABLE}(n)$ : current through the cable connecting between the  $n-1$  and  $n$ -th MPD.

# MPoE System Power Calculations

For the last (n=16) MPD, current going to the next stage is 0, hence:

$$(EQ. 04) \quad i_{MPD}(16) = \frac{P_{MPD}}{V_{MPD}(16)}$$

$$(EQ. 05) \quad i_{RCABLE}(16) = i_{MPD}(16)$$

For n=15 MPD:

$$(EQ. 06) \quad i_{MPD}(15) = \frac{P_{MPD}}{V_{MPD}(15)}$$

$$(EQ. 07) \quad V_{MPD}(15) = V_{MPD}(16) + i_{RCABLE}(16) \cdot (R_{CABLE}(16) + 2R_{CONN})$$

Similarly, For n=1 MPD:

$$(EQ. 08) \quad i_{MPD}(1) = \frac{P_{MPD}}{V_{MPD}(1)}$$

$$(EQ. 09) \quad V_{MPD}(1) = V_{MPD}(2) + i_{RCABLE}(2) \cdot (R_{CABLE}(2) + 2R_{CONN})$$

$$(EQ. 10) \quad i_{RCABLE}(1) = i_{RCABLE}(2) + i_{MPD}(1)$$

For the first MPD and MPSE, the following equations hold:

$$(EQ. 11) \quad V_{MPSE} = V_{MPD}(1) + i_{RCABLE}(1) \cdot (R_{CABLE}(1) + 2R_{CONN})$$

$$(EQ. 12) \quad i_{TOTAL} = i_{RCABLE}(1)$$

# MPoE System Power Calculations

By using a numerical solver, setting the goal to the VMPSE required voltage, it is possible to find a numerical solution for Vmpd(n).

| IEEE802.3da Parameter    | min  | typ | max   | unit              |
|--------------------------|------|-----|-------|-------------------|
| Cable length             |      |     | 50    | m                 |
| PMPD power Type 0        |      |     | 1.1   | W                 |
| PMPD power Type 1        |      |     | 4     | W                 |
| Vsupply Type 0           | 21.6 |     | 30    | V                 |
| Vsupply Type 1           | 45   |     | 50    | V                 |
| Cable loop resistance    |      |     | 4     | $\Omega$          |
| MPI connector resistance |      |     | 0.075 | $\Omega$          |
| Number of nodes          | 1    | 16  | 16    | -                 |
| Cable Resistance         |      |     | 0.08  | $\Omega/\text{m}$ |

| Value used for Numerical Simulation |  | Value | Unit |
|-------------------------------------|--|-------|------|
| Cable length of first segment       |  | 48.5  | m    |
| Cable length of other N-1 segment   |  | 0.1   | m    |
| MPD Type                            |  | 0     | -    |
| MPD power                           |  | 1.1   | W    |
| MPSE voltage                        |  | 21.6  | V    |

| System | system # | Vsupply | cable length | Rcable         | PMPD   | 2 x RCONN     | Vmpd(n)     | i(n)      | iR(n)   |
|--------|----------|---------|--------------|----------------|--------|---------------|-------------|-----------|---------|
| MPSE   | -        | 21.60 V |              |                |        |               | 21.60 V     |           | 1.070 A |
| MPD    | 1        |         | 48.5 m       | 3.88 $\Omega$  | 1.1 W  | 0.15 $\Omega$ | 17.2881 V   | 0.06363 A | 1.070 A |
| MPD    | 2        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 17.1291 V   | 0.06422 A | 1.006 A |
| MPD    | 3        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.9803 V   | 0.06478 A | 0.942 A |
| MPD    | 4        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.8417 V   | 0.06531 A | 0.877 A |
| MPD    | 5        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.7134 V   | 0.06582 A | 0.812 A |
| MPD    | 6        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.5955 V   | 0.06628 A | 0.746 A |
| MPD    | 7        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.4880 V   | 0.06672 A | 0.680 A |
| MPD    | 8        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.3912 V   | 0.06711 A | 0.613 A |
| MPD    | 9        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.3049 V   | 0.06746 A | 0.546 A |
| MPD    | 10       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.2293 V   | 0.06778 A | 0.479 A |
| MPD    | 11       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.1643 V   | 0.06805 A | 0.411 A |
| MPD    | 12       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.1102 V   | 0.06828 A | 0.343 A |
| MPD    | 13       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0668 V   | 0.06846 A | 0.275 A |
| MPD    | 14       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0343 V   | 0.06860 A | 0.206 A |
| MPD    | 15       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0125 V   | 0.06870 A | 0.137 A |
| MPD    | 16       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0017 V   | 0.06874 A | 0.069 A |
|        |          |         | 50 m         | 4 $\Omega$     | 17.6 W | 2.4 $\Omega$  | 16.002 V    |           |         |
|        |          |         |              |                |        |               | Vmpd(final) |           |         |

# MPoE System Power Calculations – Type 0

Add as Informative Annex

By using a numerical solver, setting the goal to the VMPSE voltage required, it is possible to find a numerical solution for  $V_{mpd}(n)$ .

| IEEE802.3da Parameter    | min  | typ | max   | unit       |
|--------------------------|------|-----|-------|------------|
| Cable length             |      |     | 50    | m          |
| PMPD power Type 0        |      |     | 1.1   | W          |
| PMPD power Type 1        |      |     | 4     | W          |
| Vsupply Type 0           | 21.6 |     | 30    | V          |
| Vsupply Type 1           | 45   |     | 50    | V          |
| Cable loop resistance    |      |     | 4     | $\Omega$   |
| MPI connector resistance |      |     | 0.075 | $\Omega$   |
| Number of nodes          | 1    | 16  | 16    | -          |
| Cable Resistance         |      |     | 0.08  | $\Omega/m$ |

| Value used for Numerical Simulation | Value | Unit |
|-------------------------------------|-------|------|
| Cable length of first segment       | 48.5  | m    |
| Cable length of other N-1 segment   | 0.1   | m    |
| MPD Type                            | 0     | -    |
| MPD power                           | 1.1   | W    |
| MPSE voltage                        | 21.6  | V    |

| System | system # | Vsupply | cable length | Rcable         | PMPD   | 2 x RCONN     | Vmpd(n)   | i(n)      | iR(n)   |
|--------|----------|---------|--------------|----------------|--------|---------------|-----------|-----------|---------|
| MPSE   | -        | 21.60 V |              |                |        |               | 21.60 V   |           | 1.070 A |
| MPD    | 1        |         | 48.5 m       | 3.88 $\Omega$  | 1.1 W  | 0.15 $\Omega$ | 17.2881 V | 0.06363 A | 1.070 A |
| MPD    | 2        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 17.1291 V | 0.06422 A | 1.006 A |
| MPD    | 3        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.9803 V | 0.06478 A | 0.942 A |
| MPD    | 4        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.8417 V | 0.06531 A | 0.877 A |
| MPD    | 5        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.7134 V | 0.06582 A | 0.812 A |
| MPD    | 6        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.5955 V | 0.06628 A | 0.746 A |
| MPD    | 7        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.4880 V | 0.06672 A | 0.680 A |
| MPD    | 8        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.3912 V | 0.06711 A | 0.613 A |
| MPD    | 9        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.3049 V | 0.06746 A | 0.546 A |
| MPD    | 10       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.2293 V | 0.06778 A | 0.479 A |
| MPD    | 11       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.1643 V | 0.06805 A | 0.411 A |
| MPD    | 12       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.1102 V | 0.06828 A | 0.343 A |
| MPD    | 13       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0668 V | 0.06846 A | 0.275 A |
| MPD    | 14       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0343 V | 0.06860 A | 0.206 A |
| MPD    | 15       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0125 V | 0.06870 A | 0.137 A |
| MPD    | 16       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0017 V | 0.06874 A | 0.069 A |
|        |          |         | 50 m         | 4 $\Omega$     | 17.6 W | 2.4 $\Omega$  | 16.002 V  |           |         |

4. Using numerical solver to converge to MPSE voltage

3. Target voltage at MPSE

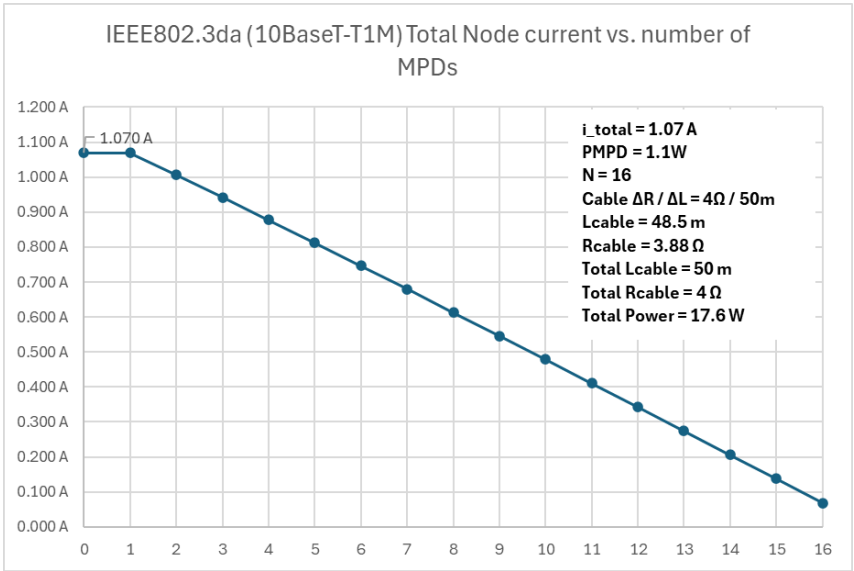
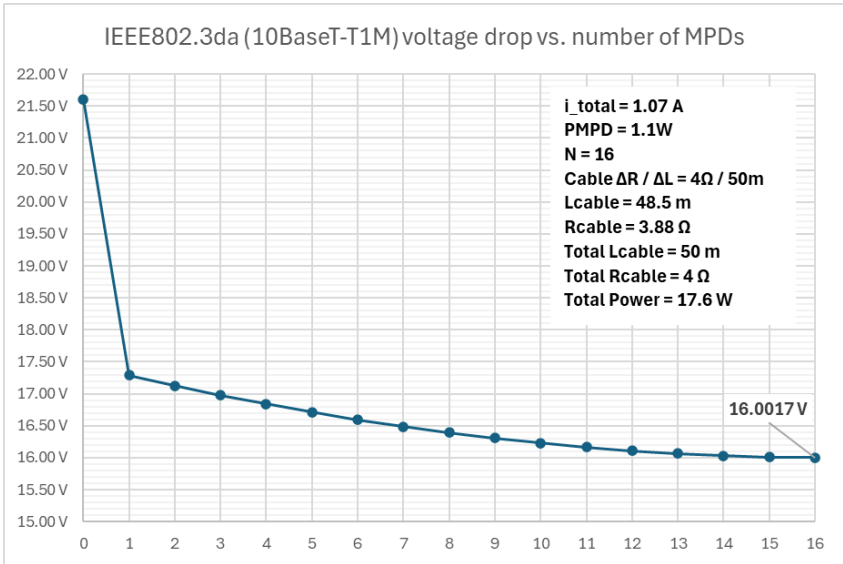
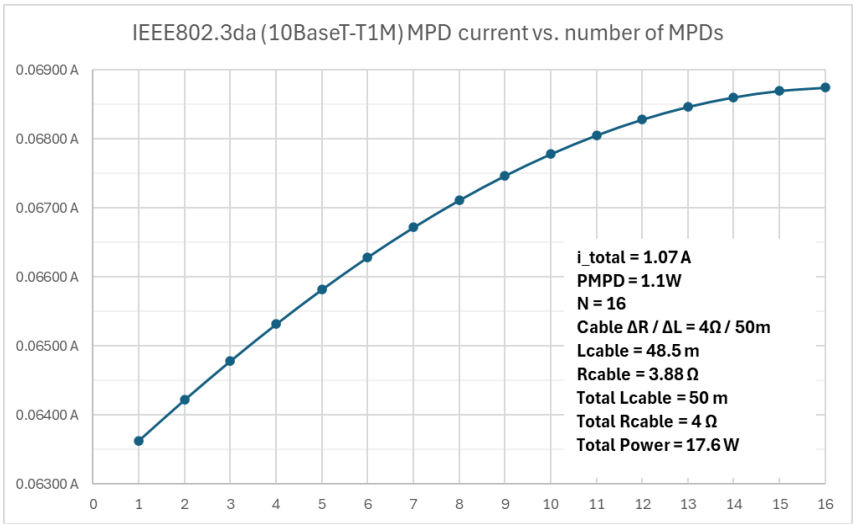
2. iterative calculation starting from  $n = 15$  used for  $V_{MPD}(n)$  calculation

1. Calculation starts by guessing  $V_{MPD}(16)$

# MPoE System Power Calculations – Type 0 results

## Type 0 MPDs (1.1W)

| System | system # | Vsupply | cable length | Rcable         | PMPD   | 2 x RCONN     | Vmpd(n)   | i(n)      | iR(n)   |
|--------|----------|---------|--------------|----------------|--------|---------------|-----------|-----------|---------|
| MPSE   | 0        | 21.60 V |              |                |        |               | 21.60 V   |           | 1.070 A |
| MPD    | 1        |         | 48.5 m       | 3.88 $\Omega$  | 1.1 W  | 0.15 $\Omega$ | 17.2881 V | 0.06363 A | 1.070 A |
| MPD    | 2        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 17.1291 V | 0.06422 A | 1.006 A |
| MPD    | 3        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.9803 V | 0.06478 A | 0.942 A |
| MPD    | 4        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.8417 V | 0.06531 A | 0.877 A |
| MPD    | 5        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.7134 V | 0.06582 A | 0.812 A |
| MPD    | 6        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.5955 V | 0.06628 A | 0.746 A |
| MPD    | 7        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.4880 V | 0.06672 A | 0.680 A |
| MPD    | 8        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.3912 V | 0.06711 A | 0.613 A |
| MPD    | 9        |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.3049 V | 0.06746 A | 0.546 A |
| MPD    | 10       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.2293 V | 0.06778 A | 0.479 A |
| MPD    | 11       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.1643 V | 0.06805 A | 0.411 A |
| MPD    | 12       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.1102 V | 0.06828 A | 0.343 A |
| MPD    | 13       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0668 V | 0.06846 A | 0.275 A |
| MPD    | 14       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0343 V | 0.06860 A | 0.206 A |
| MPD    | 15       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0125 V | 0.06870 A | 0.137 A |
| MPD    | 16       |         | 0.1 m        | 0.008 $\Omega$ | 1.1 W  | 0.15 $\Omega$ | 16.0017 V | 0.06874 A | 0.069 A |
|        |          |         | 50 m         | 4 $\Omega$     | 17.6 W | 2.4 $\Omega$  | 16.002 V  |           |         |



# MPoE System Power Calculations – Type 1

Add as Informative Annex

By using a numerical solver, setting the goal to the VMPSE voltage required (e.g. 21.6V for Type 0, 45V for Type 1), it is possible to find a numerical solution for  $V_{mpd}(n)$ .

4. Using numerical solver to converge to MPSE voltage

| IEEE802.3da Parameter    | min  | typ | max   | unit       |
|--------------------------|------|-----|-------|------------|
| Cable length             |      |     | 50    | m          |
| PMPD power Type 0        |      |     | 1.1   | W          |
| PMPD power Type 1        |      |     | 4     | W          |
| Vsupply Type 0           | 21.6 |     | 30    | V          |
| Vsupply Type 1           | 45   |     | 50    | V          |
| Cable loop resistance    |      |     | 4     | $\Omega$   |
| MPI connector resistance |      |     | 0.075 | $\Omega$   |
| Number of nodes          | 1    | 16  | 16    | -          |
| Cable Resistance         |      |     | 0.08  | $\Omega/m$ |

| Value used for Numerical Simulation | Value | Unit |
|-------------------------------------|-------|------|
| Cable length of first segment       | 48.5  | m    |
| Cable length of other N-1 segment   | 0.1   | m    |
| MPD Type                            | 1     | -    |
| MPD power                           | 4     | W    |
| MPSE voltage                        | 45    | V    |

| System | system # | Vsupply | cable length | Rcable         | PMPD | 2 x RCONN     | Vmpd(n)   | i(n)      | iR(n)   |
|--------|----------|---------|--------------|----------------|------|---------------|-----------|-----------|---------|
| MPSE   | 0        | 45.00 V |              |                |      |               | 45.00 V   |           | 1.749 A |
| MPD    | 1        |         | 48.5 m       | 3.88 $\Omega$  | 4 W  | 0.15 $\Omega$ | 37.9508 V | 0.10540 A | 1.749 A |
| MPD    | 2        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.6910 V | 0.10613 A | 1.644 A |
| MPD    | 3        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.4481 V | 0.10681 A | 1.538 A |
| MPD    | 4        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.2220 V | 0.10746 A | 1.431 A |
| MPD    | 5        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.0129 V | 0.10807 A | 1.323 A |
| MPD    | 6        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.8209 V | 0.10863 A | 1.215 A |
| MPD    | 7        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.6460 V | 0.10915 A | 1.107 A |
| MPD    | 8        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.4884 V | 0.10962 A | 0.998 A |
| MPD    | 9        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.3481 V | 0.11005 A | 0.888 A |
| MPD    | 10       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.2252 V | 0.11042 A | 0.778 A |
| MPD    | 11       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.1198 V | 0.11074 A | 0.667 A |
| MPD    | 12       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.0318 V | 0.11101 A | 0.557 A |
| MPD    | 13       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.9614 V | 0.11123 A | 0.446 A |
| MPD    | 14       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.9086 V | 0.11139 A | 0.334 A |
| MPD    | 15       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.8733 V | 0.11150 A | 0.223 A |
| MPD    | 16       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.8557 V | 0.11156 A | 0.112 A |
|        |          |         | 50 m         | 4 $\Omega$     | 64 W | 2.4 $\Omega$  | 35.856 V  |           |         |

3. Target voltage at MPSE

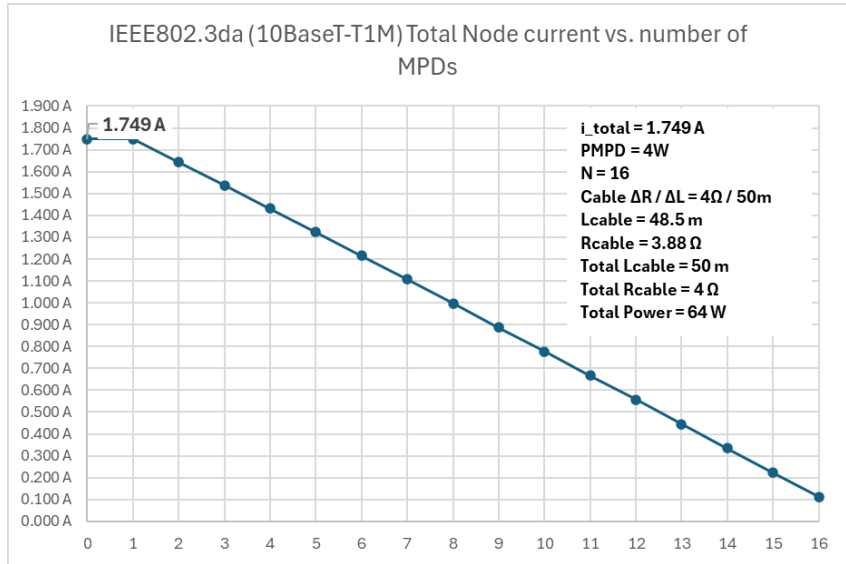
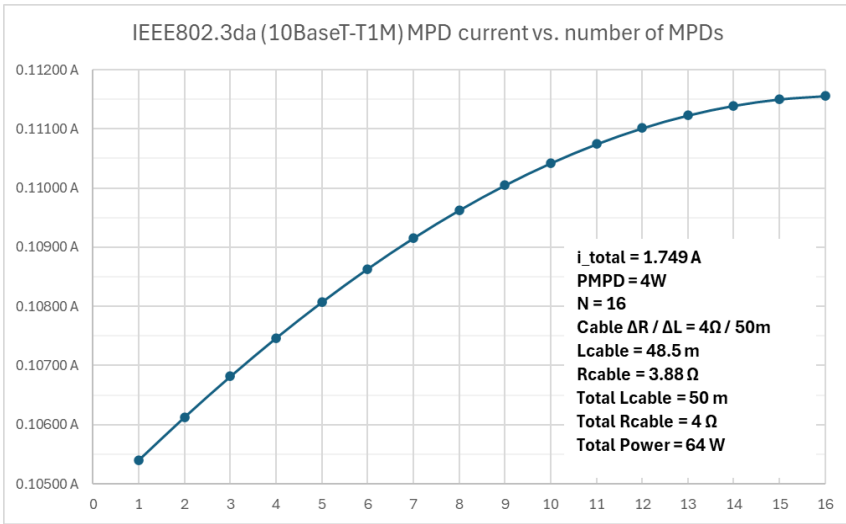
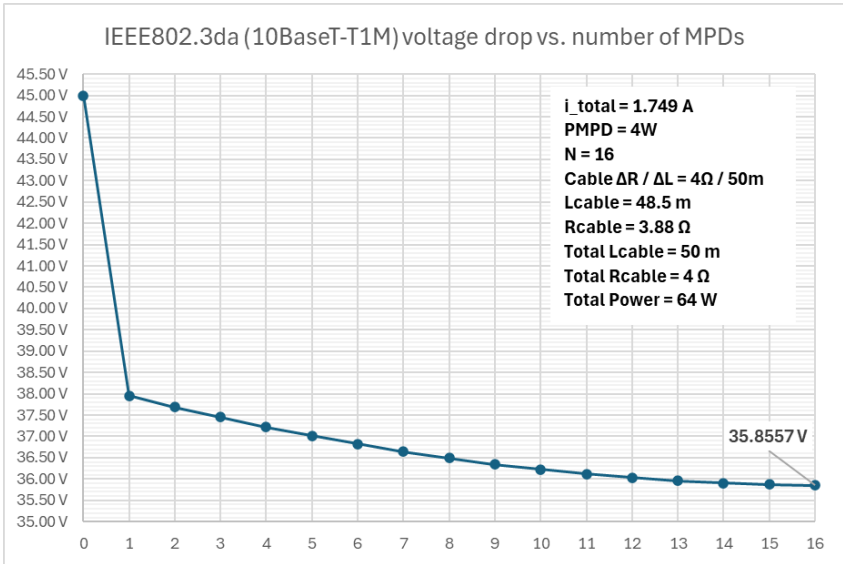
2. iterative calculation starting from n = 15 used for  $V_{MPD}(n)$  calculation

1. Calculation starts by guessing  $V_{MPD}(16)$

# MPoE System Power Calculations – Type 1 results

## Type 1 MPDs (4W)

| System | system # | Vsupply | cable length | Rcable         | PMPD | 2 x RCONN     | Vmpd(n)   | i(n)      | iR(n)   |
|--------|----------|---------|--------------|----------------|------|---------------|-----------|-----------|---------|
| MPSE   | 0        | 45.00 V |              |                |      |               | 45.00 V   |           | 1.749 A |
| MPD    | 1        |         | 48.5 m       | 3.88 $\Omega$  | 4 W  | 0.15 $\Omega$ | 37.9508 V | 0.10540 A | 1.749 A |
| MPD    | 2        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.6910 V | 0.10613 A | 1.644 A |
| MPD    | 3        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.4481 V | 0.10681 A | 1.538 A |
| MPD    | 4        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.2220 V | 0.10746 A | 1.431 A |
| MPD    | 5        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.0129 V | 0.10807 A | 1.323 A |
| MPD    | 6        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.8209 V | 0.10863 A | 1.215 A |
| MPD    | 7        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.6460 V | 0.10915 A | 1.107 A |
| MPD    | 8        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.4884 V | 0.10962 A | 0.998 A |
| MPD    | 9        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.3481 V | 0.11005 A | 0.888 A |
| MPD    | 10       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.2252 V | 0.11042 A | 0.778 A |
| MPD    | 11       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.1198 V | 0.11074 A | 0.667 A |
| MPD    | 12       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.0318 V | 0.11101 A | 0.557 A |
| MPD    | 13       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.9614 V | 0.11123 A | 0.446 A |
| MPD    | 14       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.9086 V | 0.11139 A | 0.334 A |
| MPD    | 15       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.8733 V | 0.11150 A | 0.223 A |
| MPD    | 16       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.8557 V | 0.11156 A | 0.112 A |
|        |          |         | 50 m         | 4 $\Omega$     | 64 W | 2.4 $\Omega$  | 35.856 V  |           |         |



# MPoE System Power Calculations – simulation results

| System | system # | Vsupply | cable length | Rcable         | PMPD | 2 x RCONN     | Vmpd(n)   | i(n)      | iR(n)   |
|--------|----------|---------|--------------|----------------|------|---------------|-----------|-----------|---------|
| MPSE   | 0        | 45.00 V |              |                |      |               | 45.00 V   |           | 1.749 A |
| MPD    | 1        |         | 48.5 m       | 3.88 $\Omega$  | 4 W  | 0.15 $\Omega$ | 37.9508 V | 0.10540 A | 1.749 A |
| MPD    | 2        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.6910 V | 0.10613 A | 1.644 A |
| MPD    | 3        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.4481 V | 0.10681 A | 1.538 A |
| MPD    | 4        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.2220 V | 0.10746 A | 1.431 A |
| MPD    | 5        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 37.0129 V | 0.10807 A | 1.323 A |
| MPD    | 6        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.8209 V | 0.10863 A | 1.215 A |
| MPD    | 7        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.6460 V | 0.10915 A | 1.107 A |
| MPD    | 8        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.4884 V | 0.10962 A | 0.998 A |
| MPD    | 9        |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.3481 V | 0.11005 A | 0.888 A |
| MPD    | 10       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.2252 V | 0.11042 A | 0.778 A |
| MPD    | 11       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.1198 V | 0.11074 A | 0.667 A |
| MPD    | 12       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 36.0318 V | 0.11101 A | 0.557 A |
| MPD    | 13       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.9614 V | 0.11123 A | 0.446 A |
| MPD    | 14       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.9086 V | 0.11139 A | 0.334 A |
| MPD    | 15       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.8733 V | 0.11150 A | 0.223 A |
| MPD    | 16       |         | 0.1 m        | 0.008 $\Omega$ | 4 W  | 0.15 $\Omega$ | 35.8557 V | 0.11156 A | 0.112 A |
|        |          |         | 50 m         | 4 $\Omega$     | 64 W | 2.4 $\Omega$  | 35.856 V  |           |         |

Type 1 MPDs (4W)

