Impact of Interrupted DC Current Flow on 10BASE-T1L Communications

Jason Potterf, Cisco

May 13, 2026

Power Over Ethernet (PoE) Power Coupling

PoE utilizes multi-pair cable to provider power and data on the same cable, either on separate conductors, or on the same conductors as the data

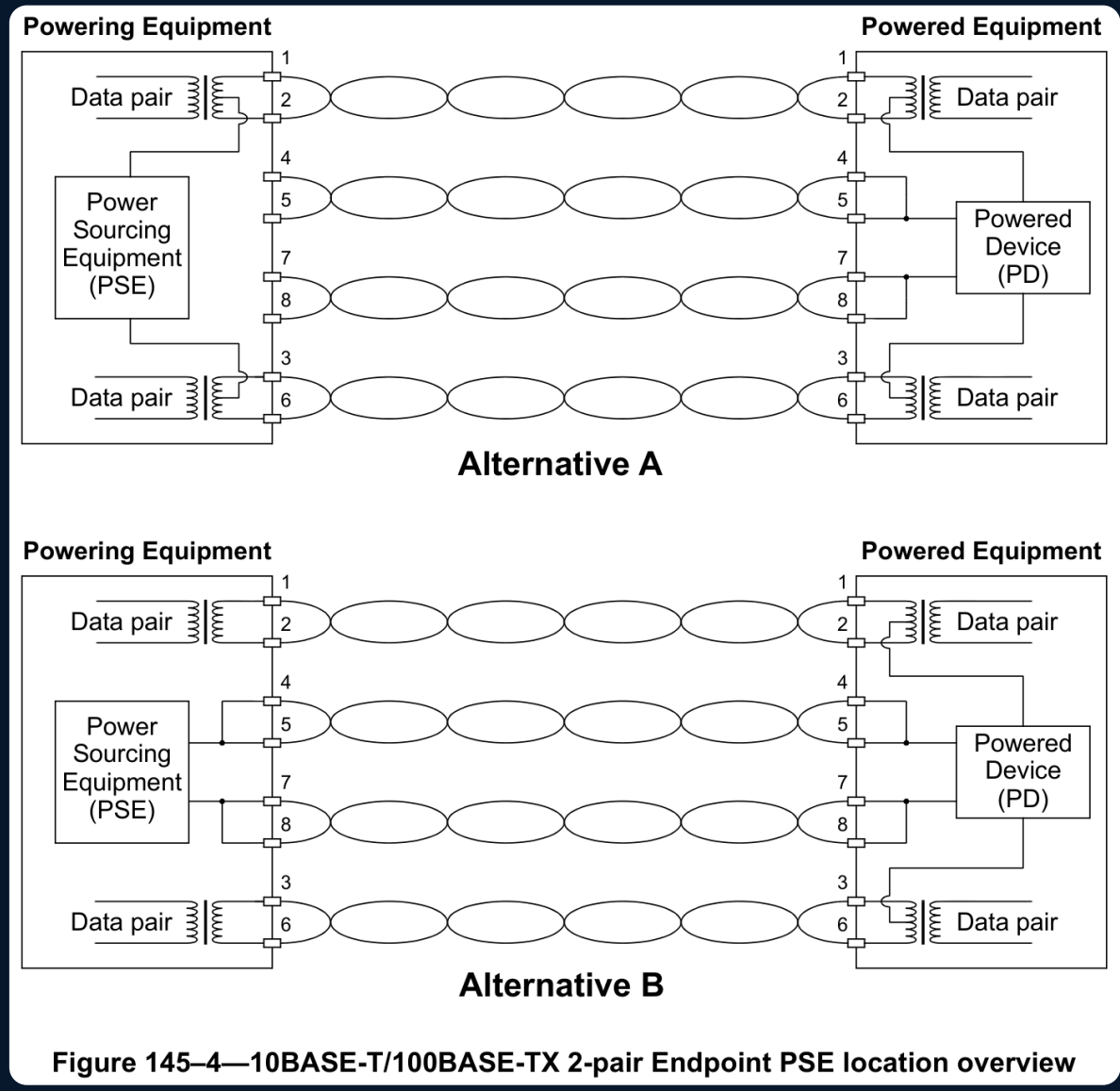
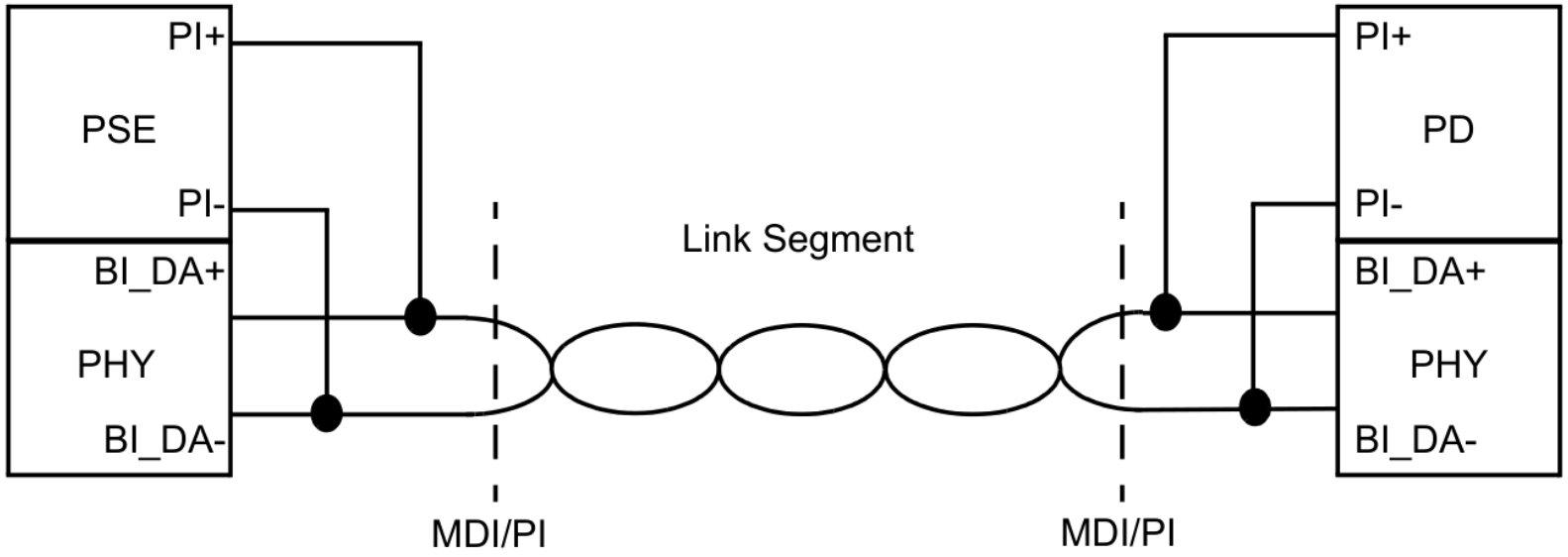


Figure 145–4—10BASE-T/100BASE-TX 2-pair Endpoint PSE location overview

Power Over Data Lines (PoDL) Power Coupling

PoDL utilizes single-pair cable to provide power and data on the same conductors, utilizing a constant DC source



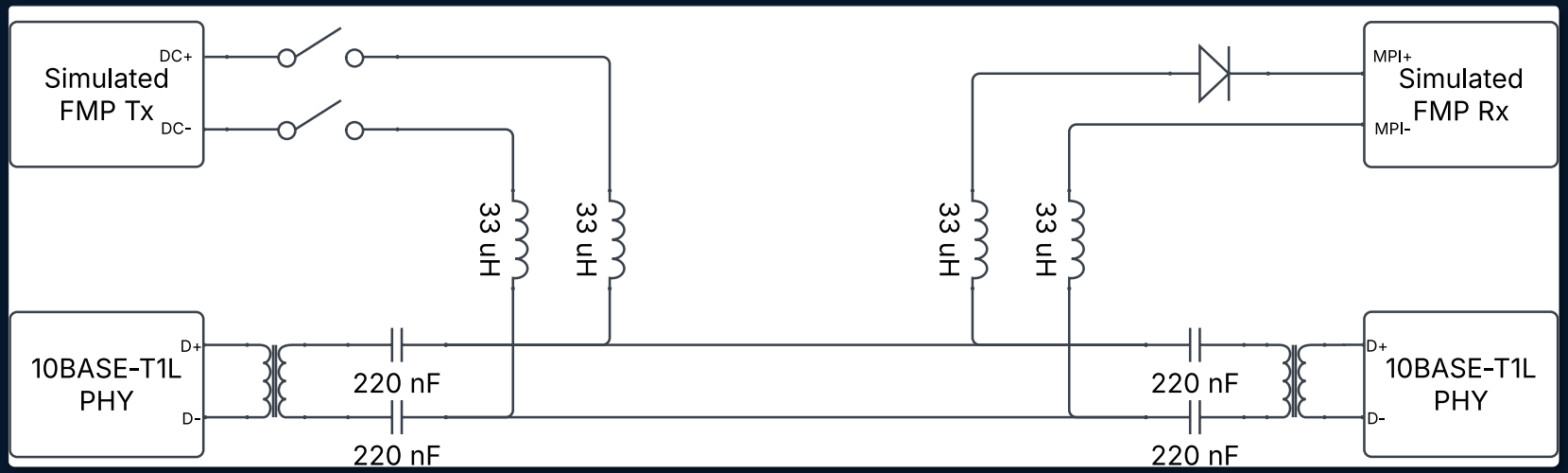
NOTE—PI elements that prevent loading of the data signal by the PSE and PD are not shown. PHY elements that block dc are not shown.

Figure 104–3—PoDL system block diagram

Fault Managed Power (FMP) Power Coupling

FMP Ethernet could utilize single-pair cable to supply FMP and data on the same conductors

Most FMP transmitters are essentially an interrupted DC source



Diplexer values shown above correspond to the lab results shared later in this presentations and are known to not be optimal

10BASE-T1L PHY Transient Effects

- Presentations from IEEE P802.3dg detailed the negative impacts of similar transients on adjacent pairs of hybrid motor control cables and concluded that advanced shielding of cables was necessary for the proposed 100BASE-T1L PHY to operate with margin in this noise environment

  See: “Motor PWM coupling on 100m hybrid cables (in context of 100BASE-T1L) (rev a)”

  https://www.ieee802.org/3/dg/public/May_2024/Brychta_3dg_02a_0524.pdf

- FMP Ethernet is expected to support both same-conductor and same-cable schemes, the former of which cannot use shielding to defend against these transients
- The slides that follow provide similar characterization of the transients’ effects on 10BASE-T1L PHY communications

Test Setup Details

- A 400V lab supply was utilized to provide 400V DC
  - Supplies flow was interrupted for 2 ms every 10 ms to simulate a potential FMP power delivery scheme
- A 400V constant-current electronic load was utilized to draw 100 W and 1,000 W
  - A diode and significant capacitance was added to minimize cable discharge during off periods
- 1,000 ft of Panduit 18 AWG Shielded SPE Cable was used for this experiment
- Analog Devices ADIN1100 10BASE-T1L dev kits were used
  - A modified line coupling circuit, as shown on the previous slide, was utilized
- Oscilloscope measurements were made of voltage and current on the line side of the diplexer
- Additional oscilloscope measurements were made at the PHY
  - Measurement was made on the line side of the hybrid circuit

100 Watt Case

Line-Side Measurement

The top green trace shows voltage nominally at 400V and decaying to approximately 350V during off period.

The bottom pink trace shows current nominally 250 mA during transmission, but at zero during off period.

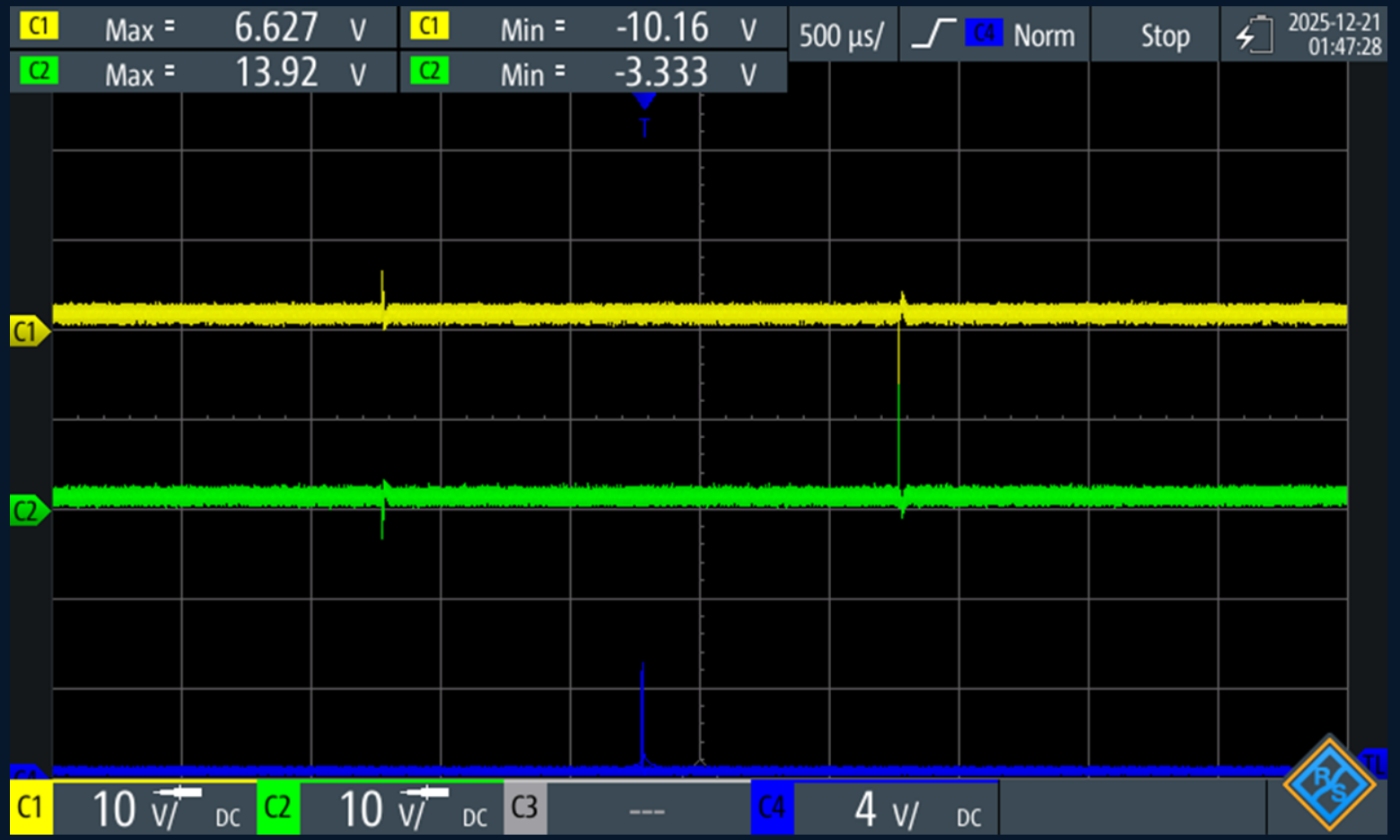
Note transients at both turn-on and turn-off times

Parameters: 10 ms period, 2 ms off, 250 mA CC load

PHY-Side Measurement Overview

The top yellow trace and the bottom green trace show D+ and D- voltage waveforms, respectively, with 10BASE-T1L data symbols

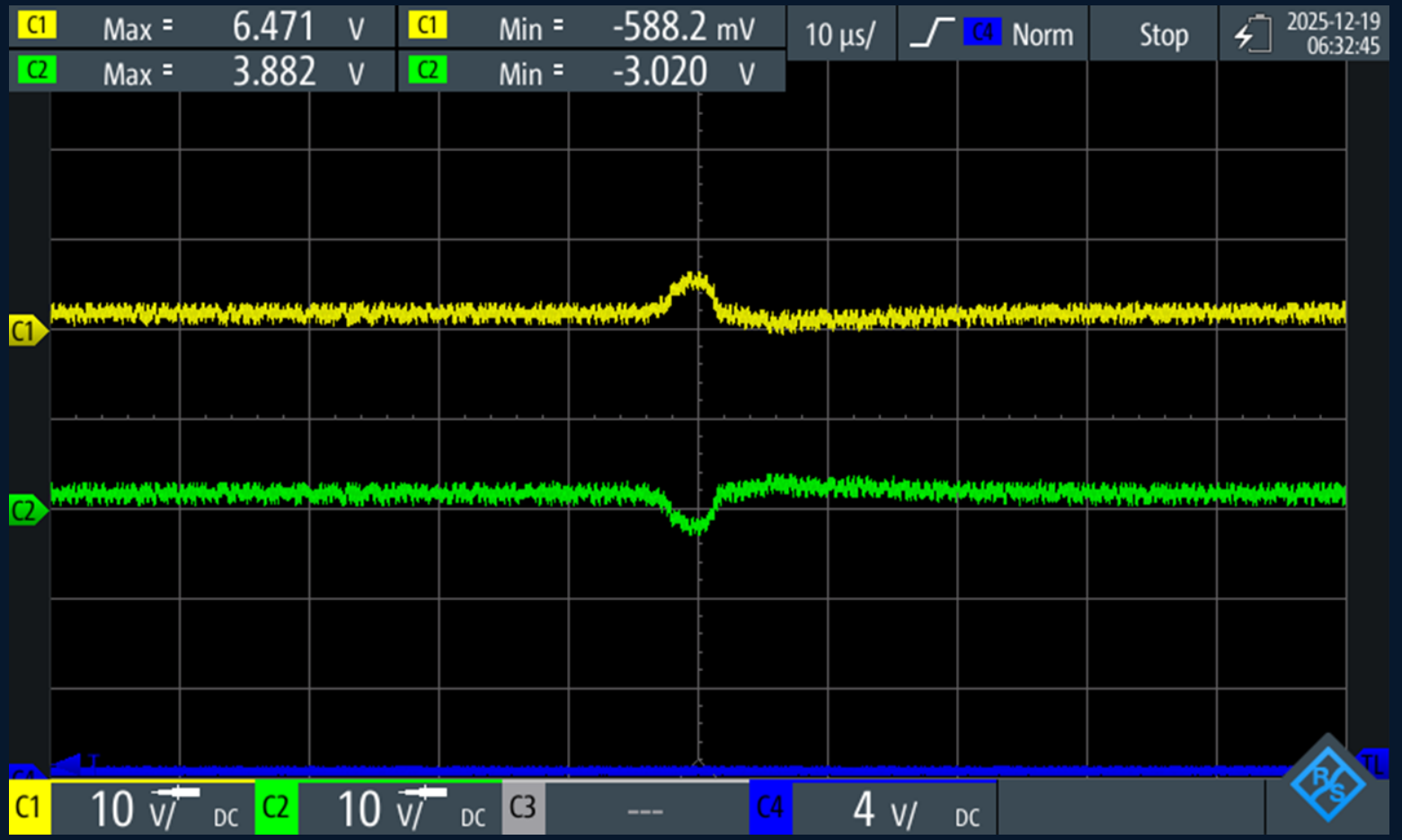
The timescale is set to show both the turn off and the turn on transients



Parameters: 10 ms period, 2 ms off, 250 mA CC load

PHY-Side Measurement Turn-Off

The same measurements from the previous slide are shown with a 10 us timescale to better depict the turn-off transients

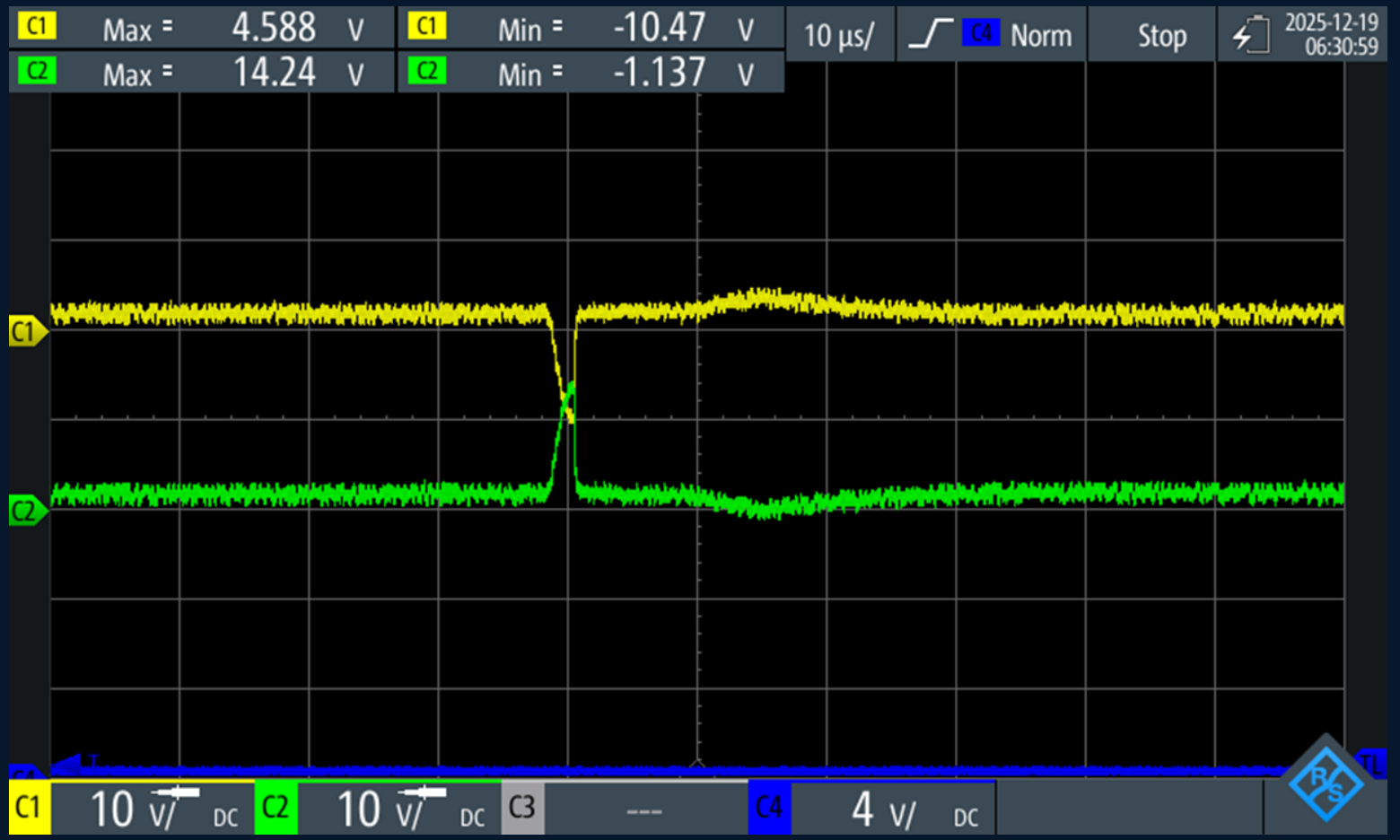


Parameters: 10 ms period, 2 ms off, 250 mA CC load

Disturbance duration: Approximately 23 µs

PHY-Side Measurement Turn-On

The same measurements from the previous slide are shown with a 10 us timescale to better depict the turn-on transient



Parameters: 10 ms period, 2 ms off, 250 mA CC load

Disturbance duration: Approximately 30 µs

But we didn’t come here to supply 100 Watts...

1,000 Watt Case

Line-Side Measurement

The top green trace shows voltage nominally at 400V and decaying to approximately 280V during off period.

The bottom pink trace shows current nominally 2.5 A during transmission, but at zero during off period.

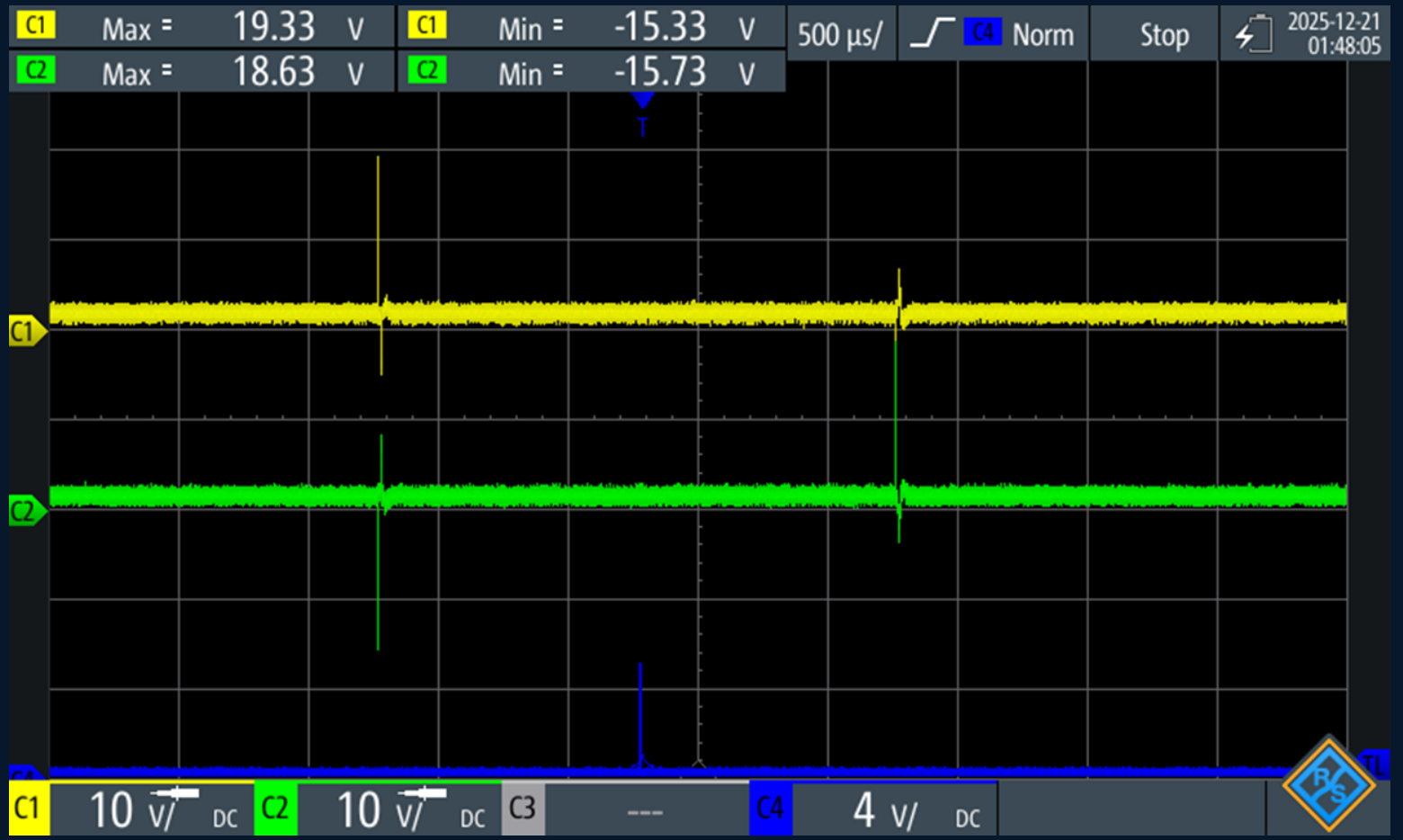
Note larger transients at both turn-on and turn-off times

Parameters: 10 ms period, 2 ms off, 2.5 A CC load

PHY-Side Measurement Overview

The top yellow trace and the bottom green trace show D+ and D- voltage waveforms, respectively, with 10BASE-T1L data symbols

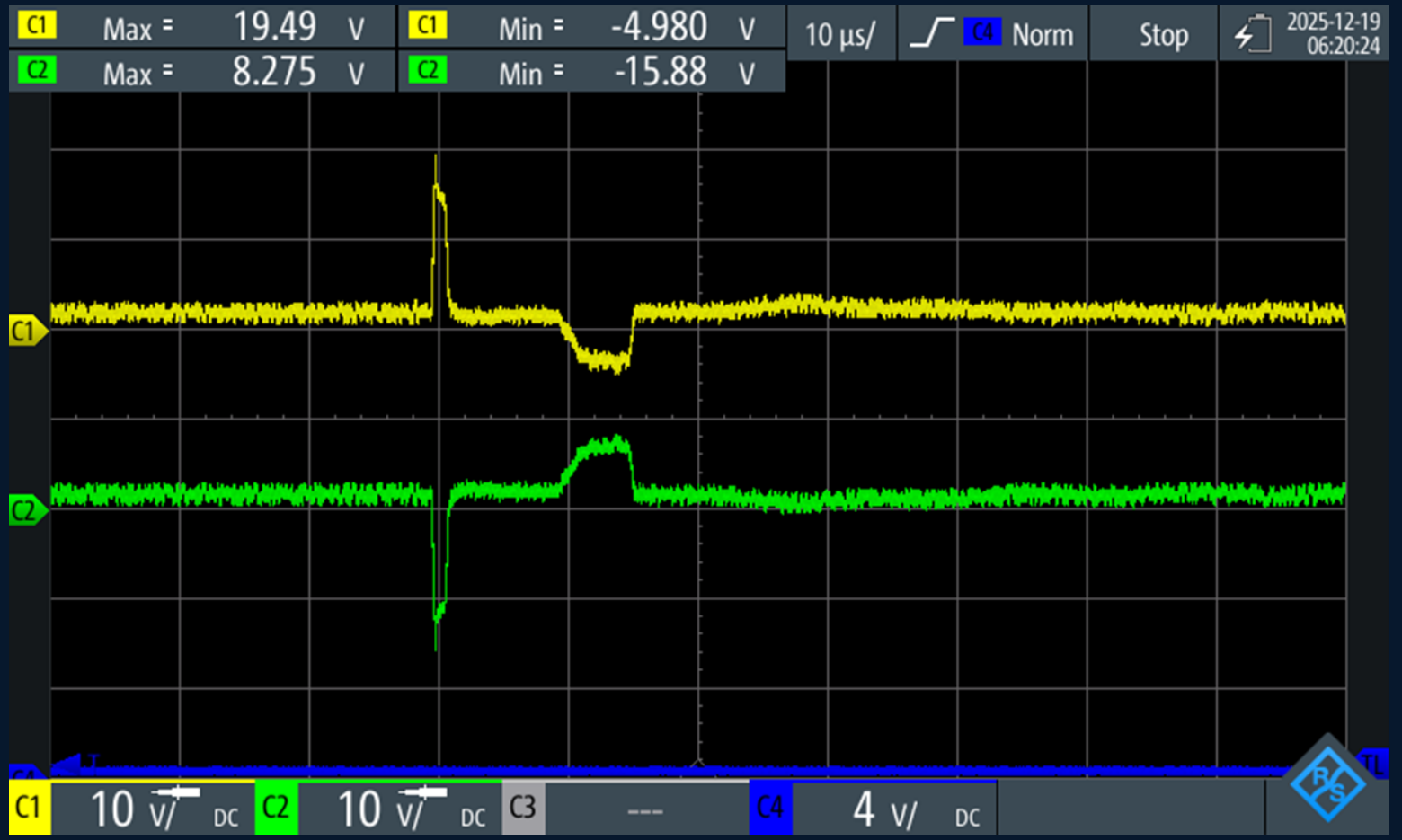
The timescale is set to show both the turn off and the turn on transients



Parameters: 10 ms period, 2 ms off, 2.5 A CC load

PHY-Side Measurement Turn-Off

The same measurements from the previous slide are shown with a 10 us timescale to better depict the turn-off transient

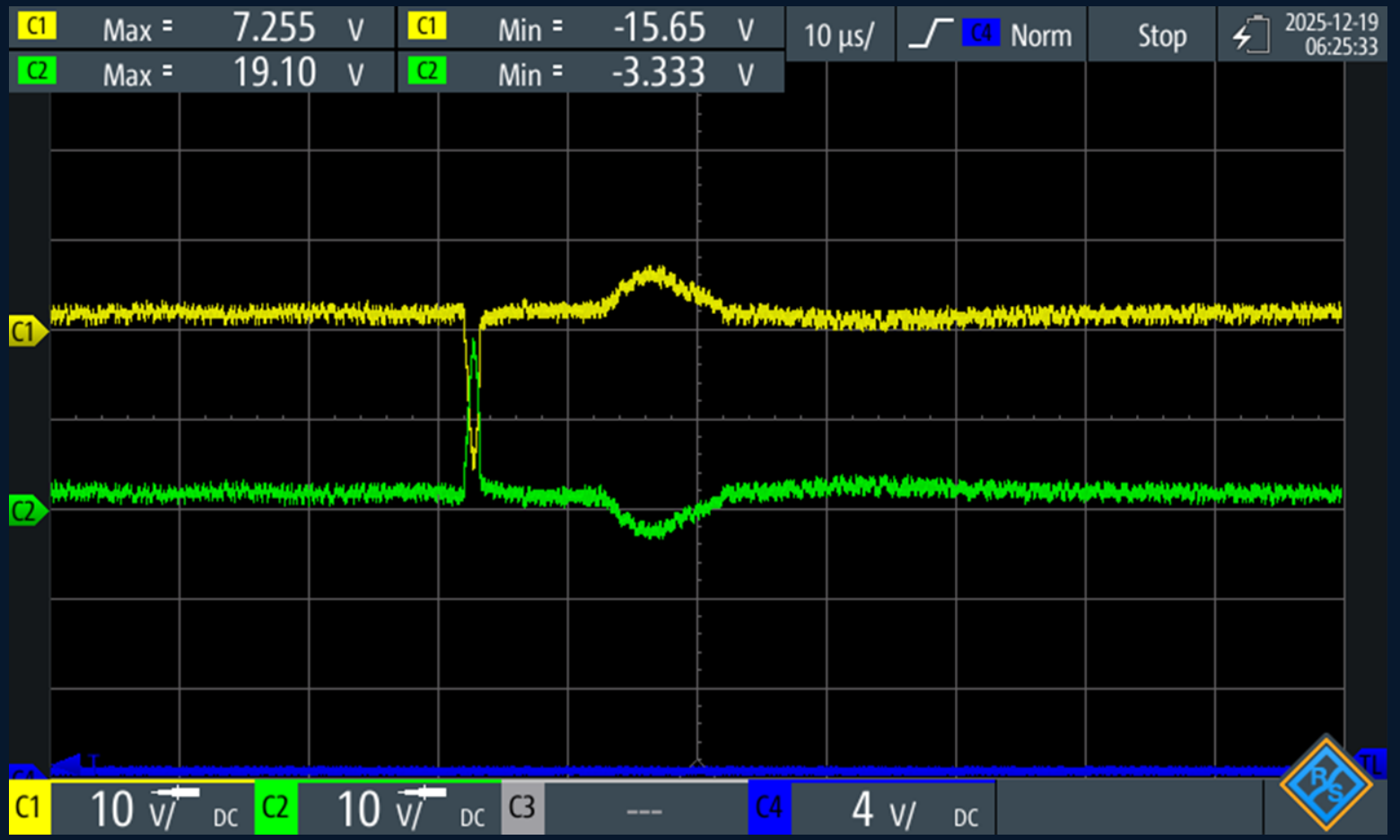


Parameters: 10 ms period, 2 ms off, 2.5 A CC load

Disturbance duration: Approximately 40 µs

PHY-Side Measurement Turn-On

The same measurements from the previous slide are shown with a 10 us timescale to better depict the turn-on transient



Parameters: 10 ms period, 2 ms off, 2.5 A CC load

Disturbance duration: Approximately 28 µs

Key Timing Observations

- 10BASE-T1L requires:
  - 67 µs to transmit a minimum-length frame
  - 1,234 µs to transmit a maximum-length frame
- Data presented indicates approximate transient durations of:
  - 23 µs – 30 µs for 250 mA interrupted DC current
  - 28 µs – 40 µs for 2.5 A interrupted DC current
  - Higher currents likely will result in longer transients
- Transient durations are on the order of a single frame for 10BASE-T1L
- Transient durations are on the order of multiple frames for 100BASE-T1L
- The transients are caused by the FMP Transmitter and can be specified more narrowly than the broad limits of the UL1400-1 safety standard to enable FMP Ethernet
- To do so, we must specify FMP interoperability parameters in IEEE 802.3

Suggested FMPE Objective to Address Transients

Specify modifications of at least one 802.3 electrical physical layer to operate in the presence of transients caused by FMP operating on conductors that are the same or separate from the data conductors.

Questions?