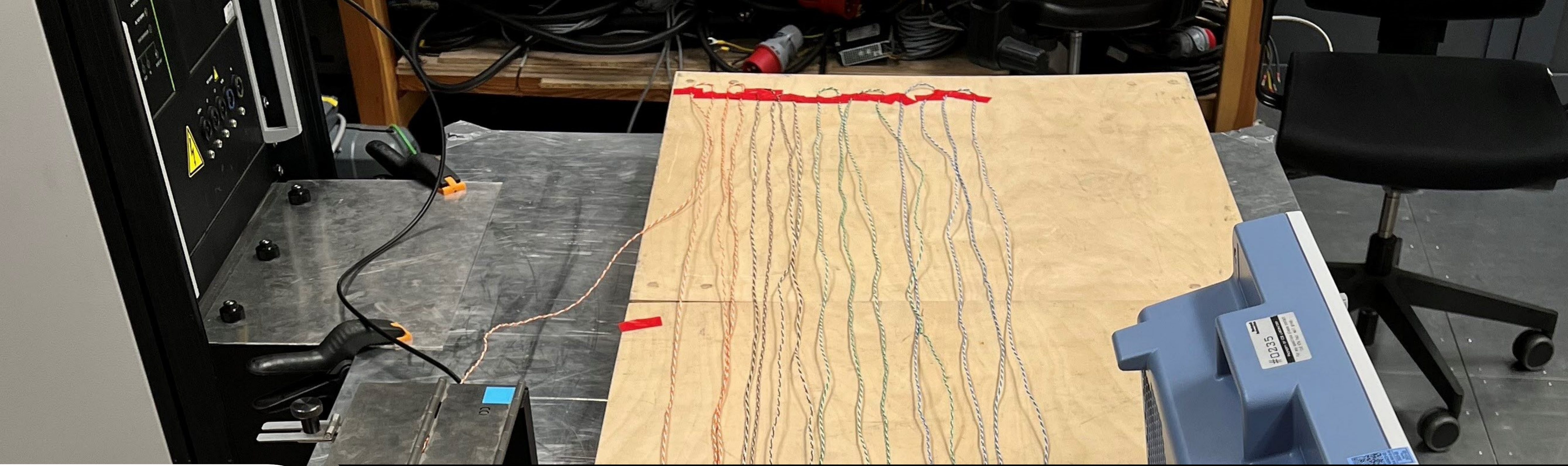

Impulse noise in multidrop link

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1 Two concepts of grounding in multidrop

2 Test setup

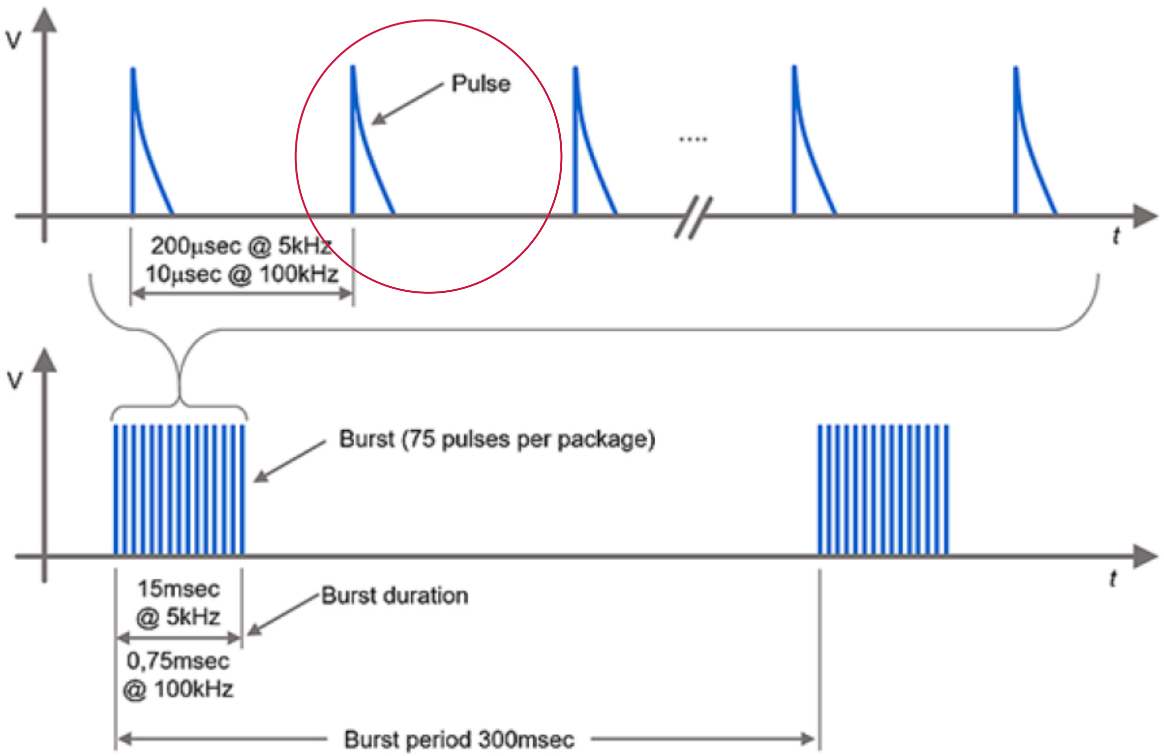
3 Noise in an industrial cable

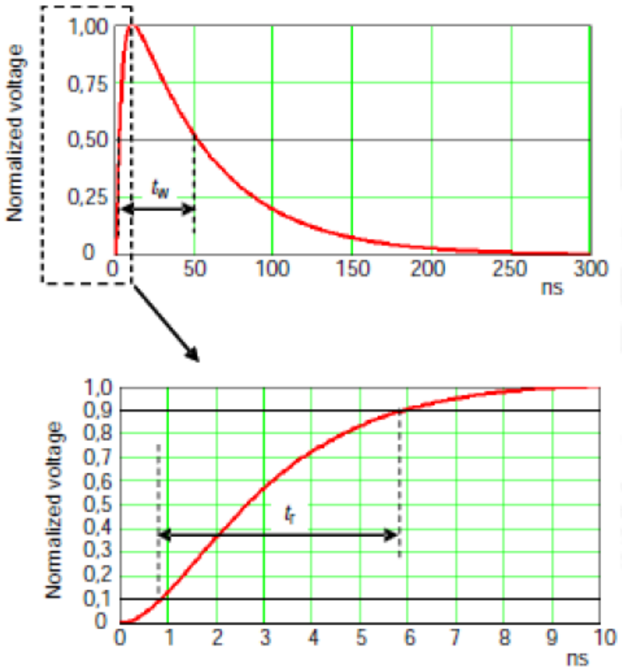
4 Noise in a twisted pair

Electrical Fast Transient (Burst Test) background

Electrical Fast Transients (burst transients) are common mode disturbances coming from an arc when mechanical contact is open due to a switching process.

Similar disturbances could be observed from motor drivers and other load switching signals, if their cables bundled together with SPE cables.



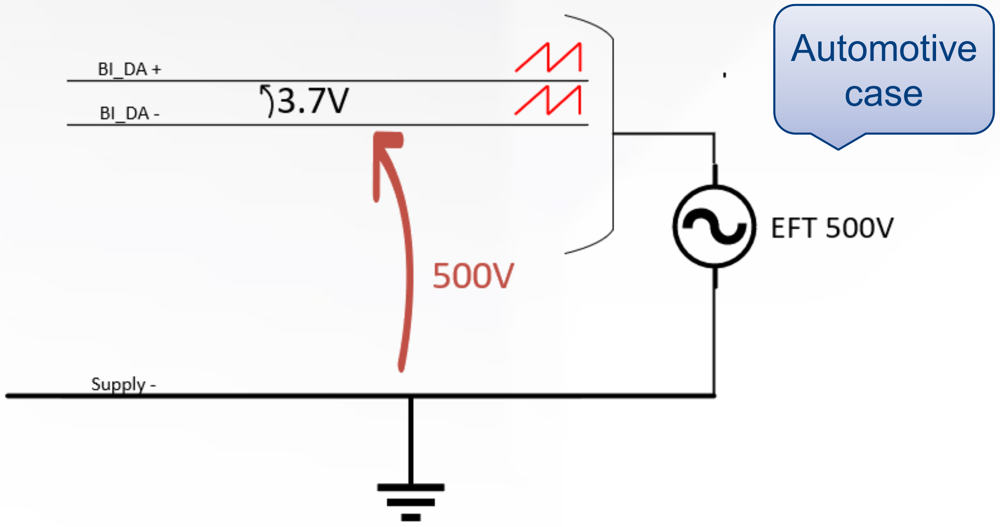


Common Mode noise immunity vs power routing

T1S PHY refers to its local GND pin. Two basic architectures with sample readouts:

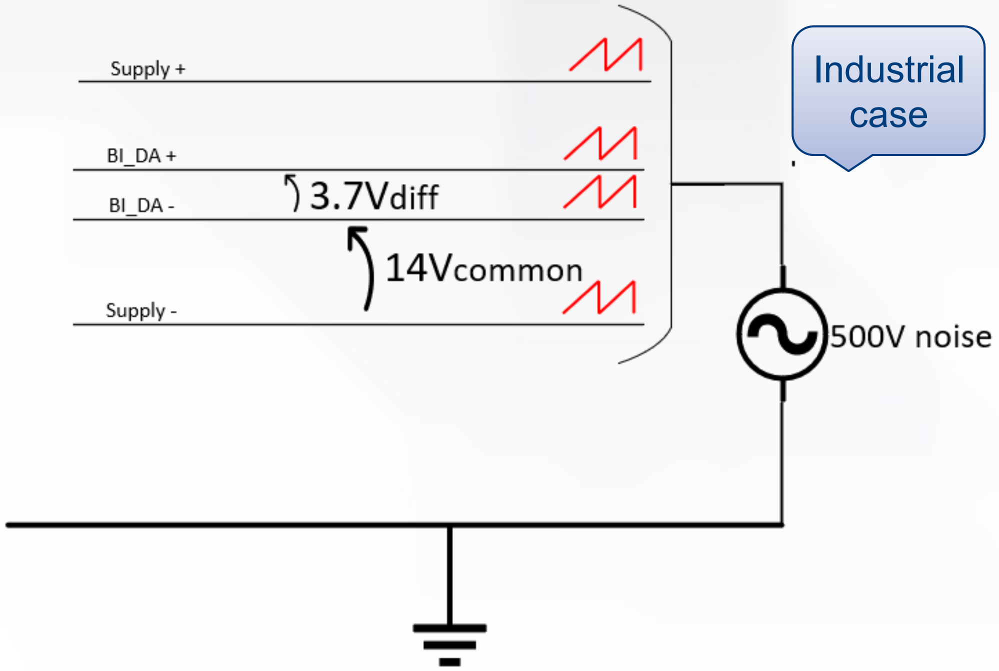
Single pair routing, separate power:

- the noise couples between PHY GND and SPE
- Large CM noise (e.g. 500Vpp)



Composite routing with power (including PoDL):

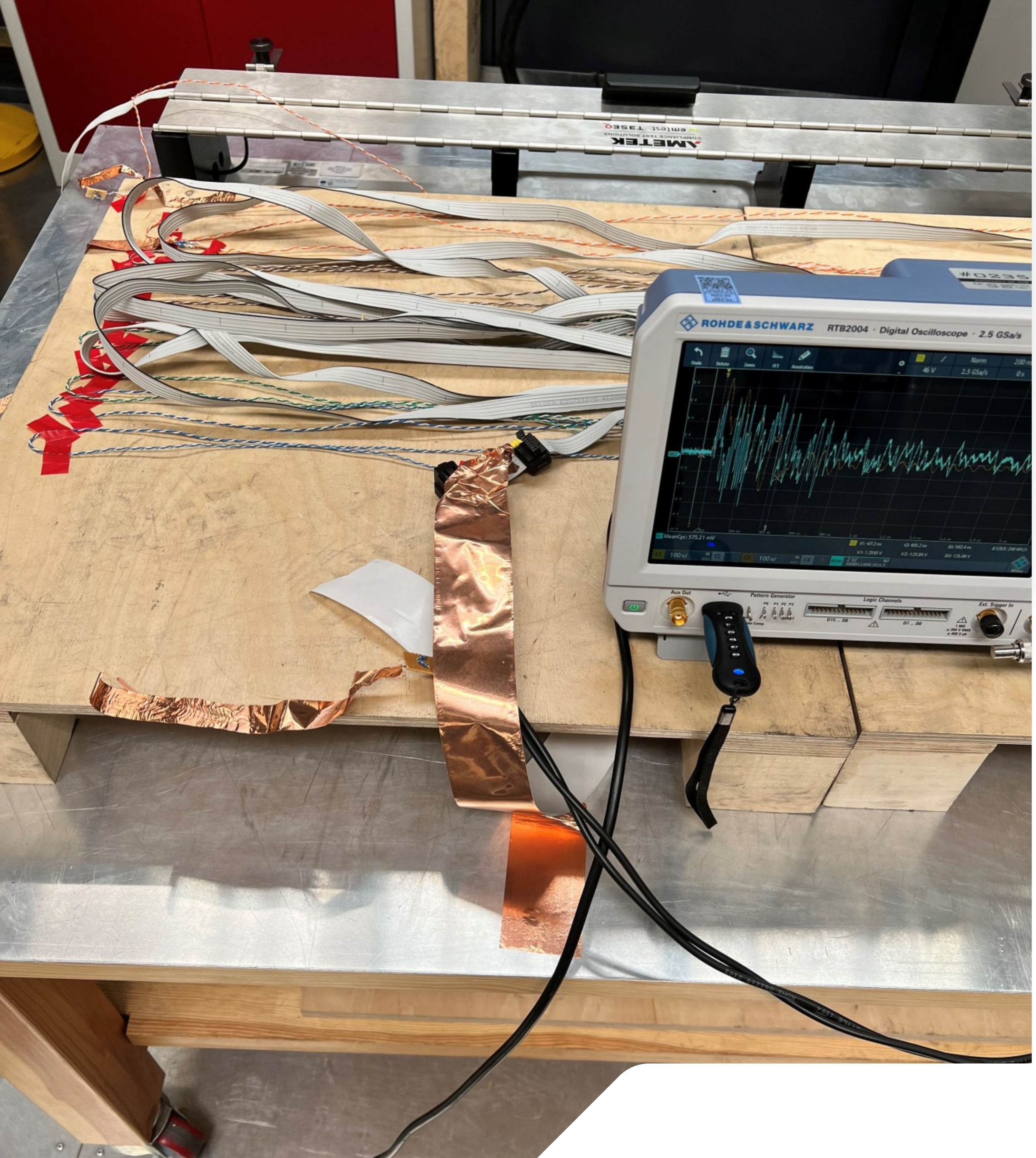
- the noise couples to both PHY GND and SPE
- the PHY sees only the difference in coupling between GND and SPE



Electrical Fast Transient (Burst) testing

Two main setups have been tested to compare noise behavior

- Industrial cable featuring composite routing with power
- Single Twisted Pair cable, with separate power routing

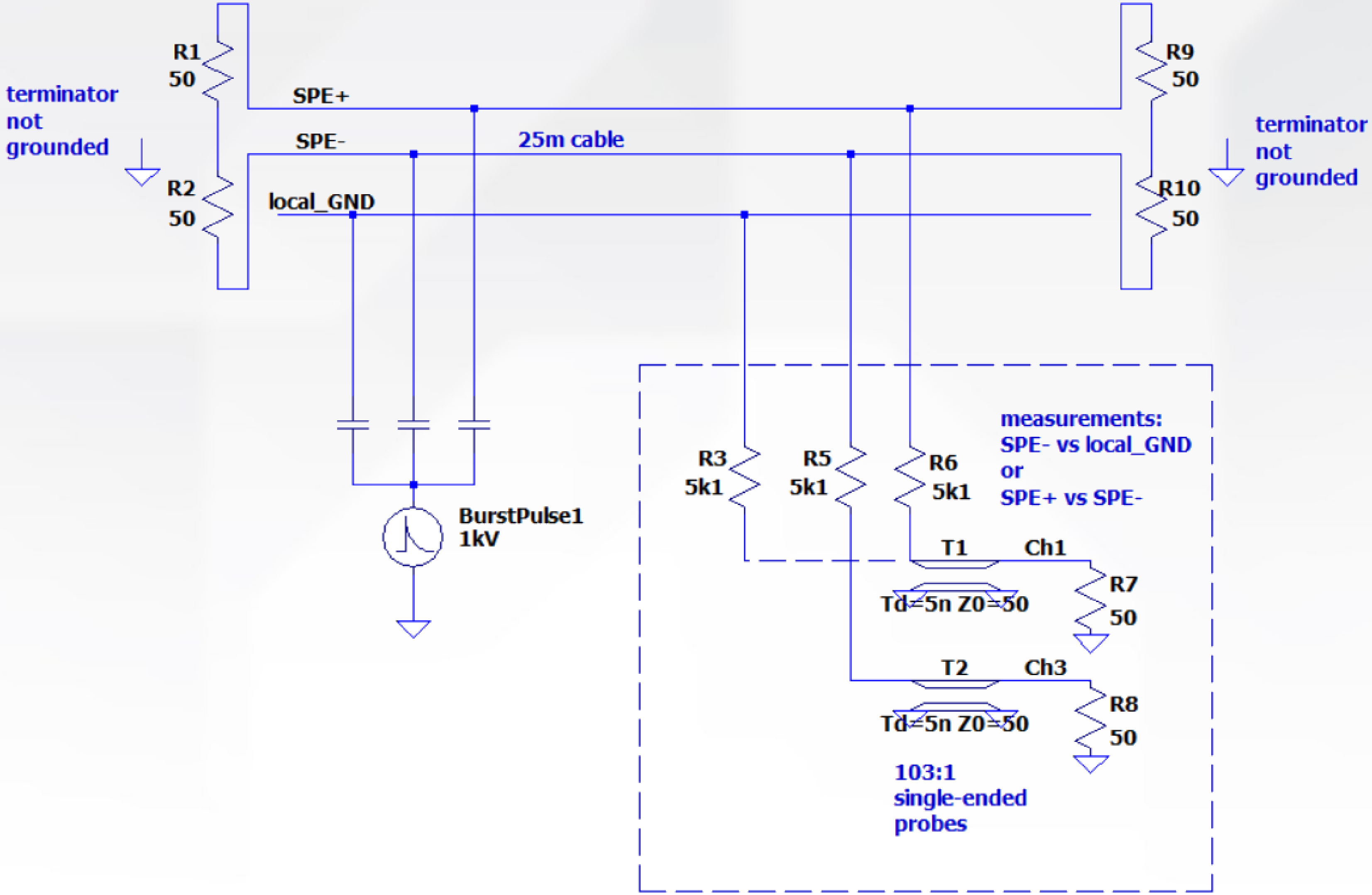


Industrial cable results

7-wire ODVA flat cable, comprising balanced 10BASE-T1S pair, power and other lines

Insertion Loss, IL (dB)	Measured per section 8-10.4.4, for SPE pair, at 25 m length 0.25 * (2.73 * sqrt(f) + 0.026 * f + 0.375 / sqrt(f)) $0.3 \leq f \leq 40$ where f is the frequency in MHz
Return Loss, RL (dB)	Measured per section 8-10.4.4, for SPE pair, at 25 m length $24 + 5 * \log_{10}(f/10)$, 24 max. $0.3 \leq f \leq 40$ where f is the frequency in MHz
Mode Conversion, MC (dB)	Measured per section 8-10.4.4, for SPE pair, at 25 m length TCL and TCTL: $46 – 10 * \log_{10}(f)$, 40 max. $0.3 \leq f \leq 100$ where f is the frequency in MHz

Industrial cable test setup



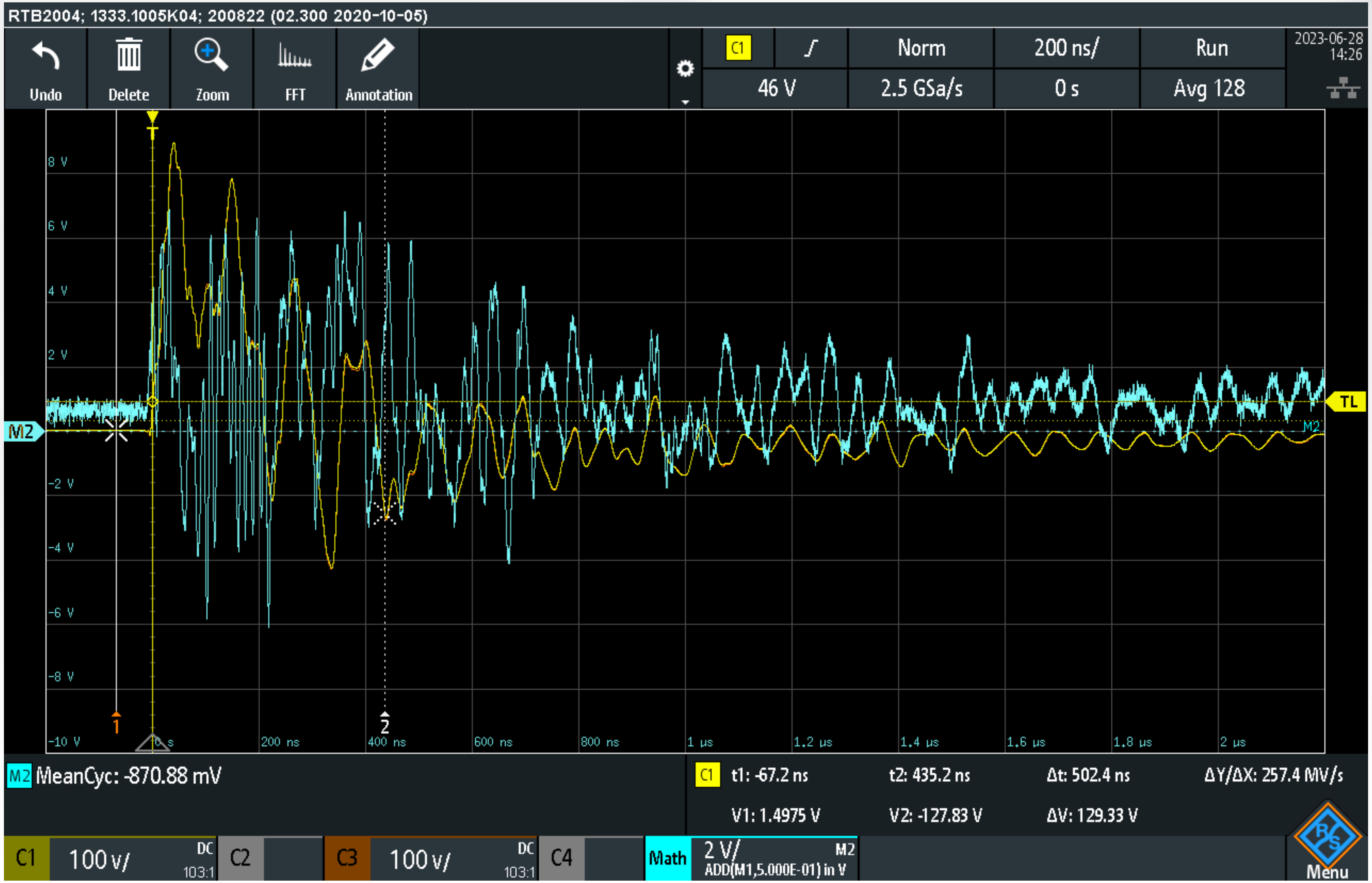
Industrial cable, no nodes, 1kV burst, SPE to table (yellow)

450V

<1000ns ringing

Industrial cable, no nodes, 1kV burst, SPE to local GND (cyan)

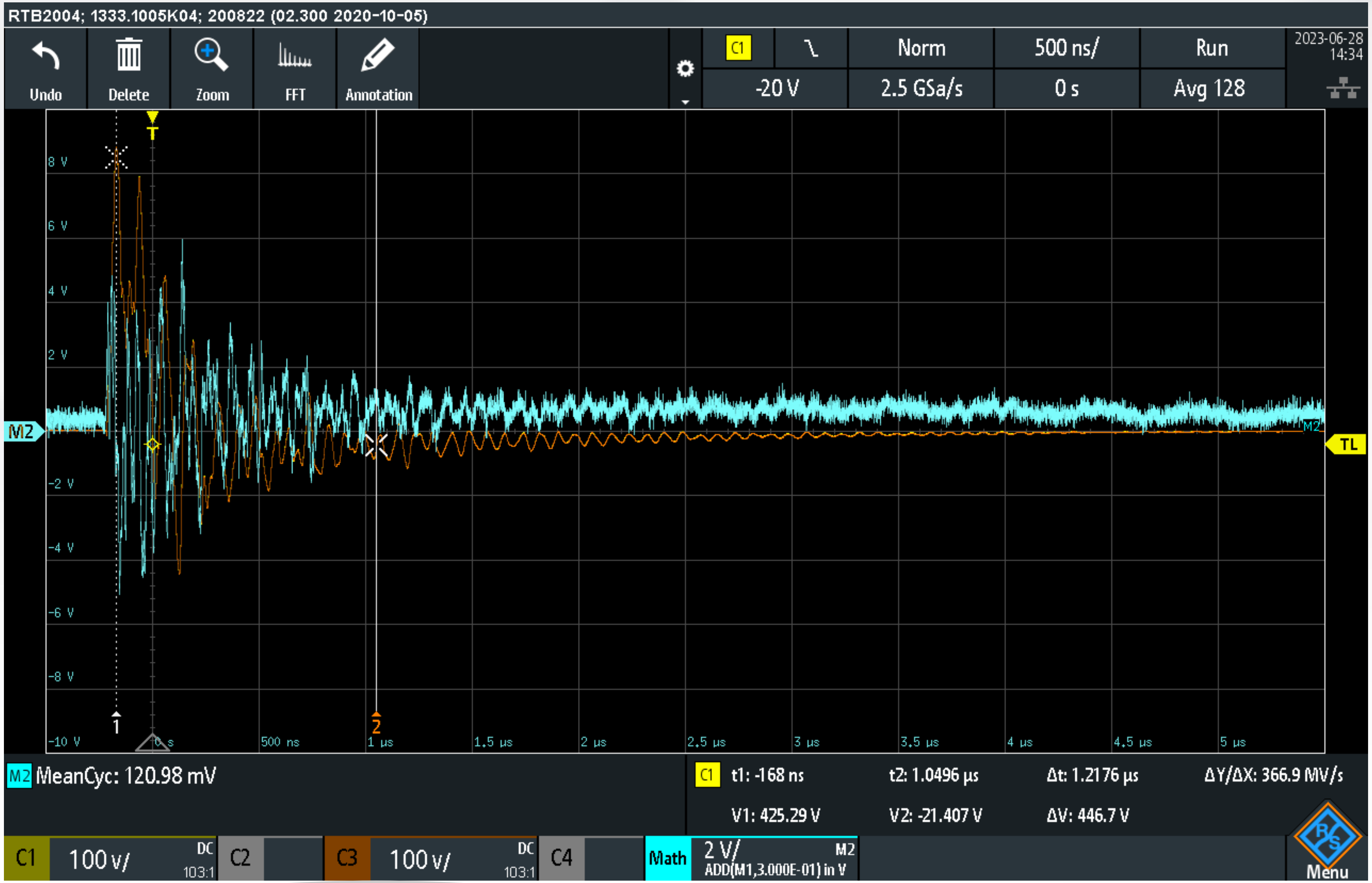
7V



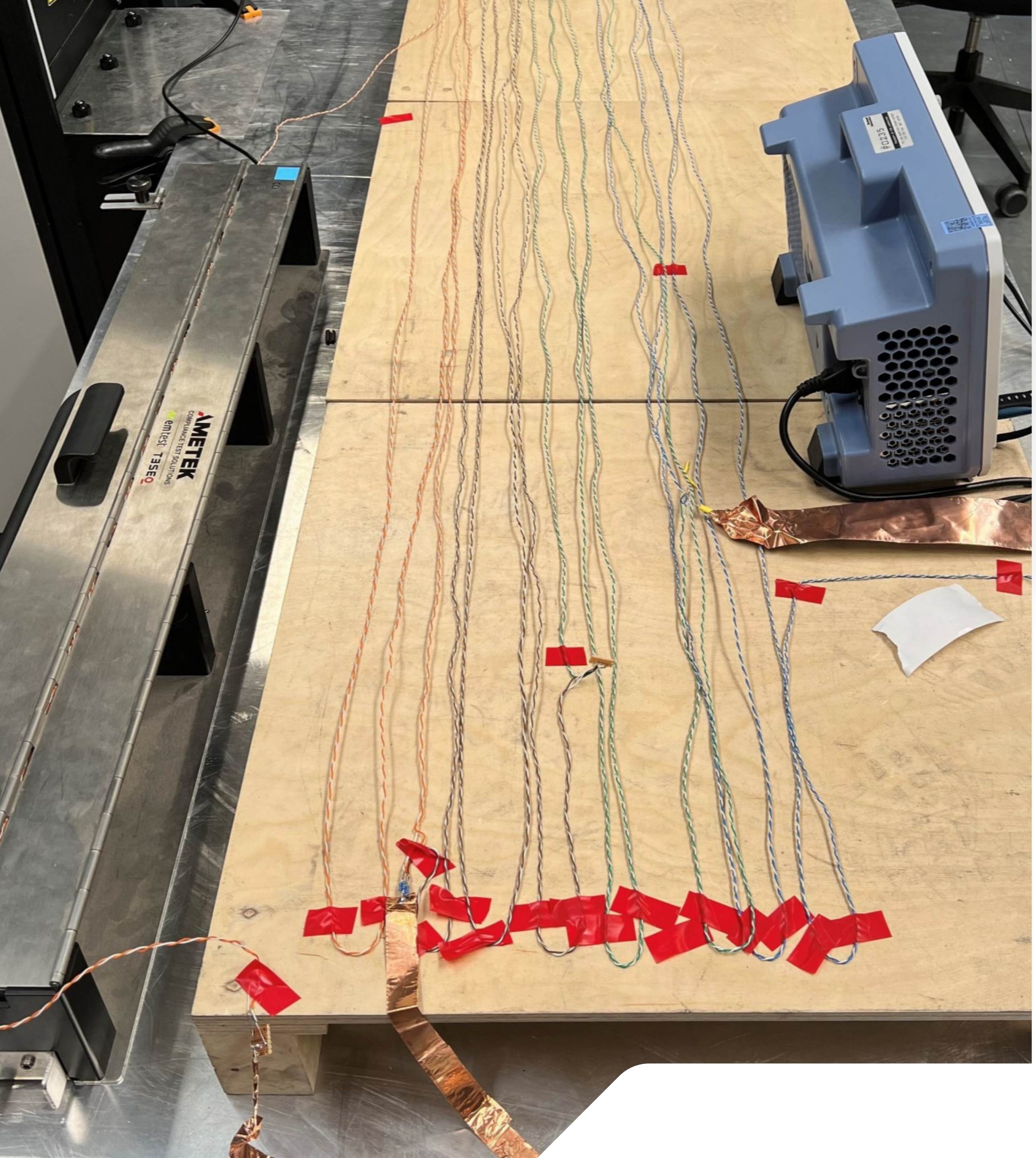
in supported DC range

Industrial cable, no nodes, 1kV burst, SPE+ vs SPE- (cyan)

6V



<1000ns ringing

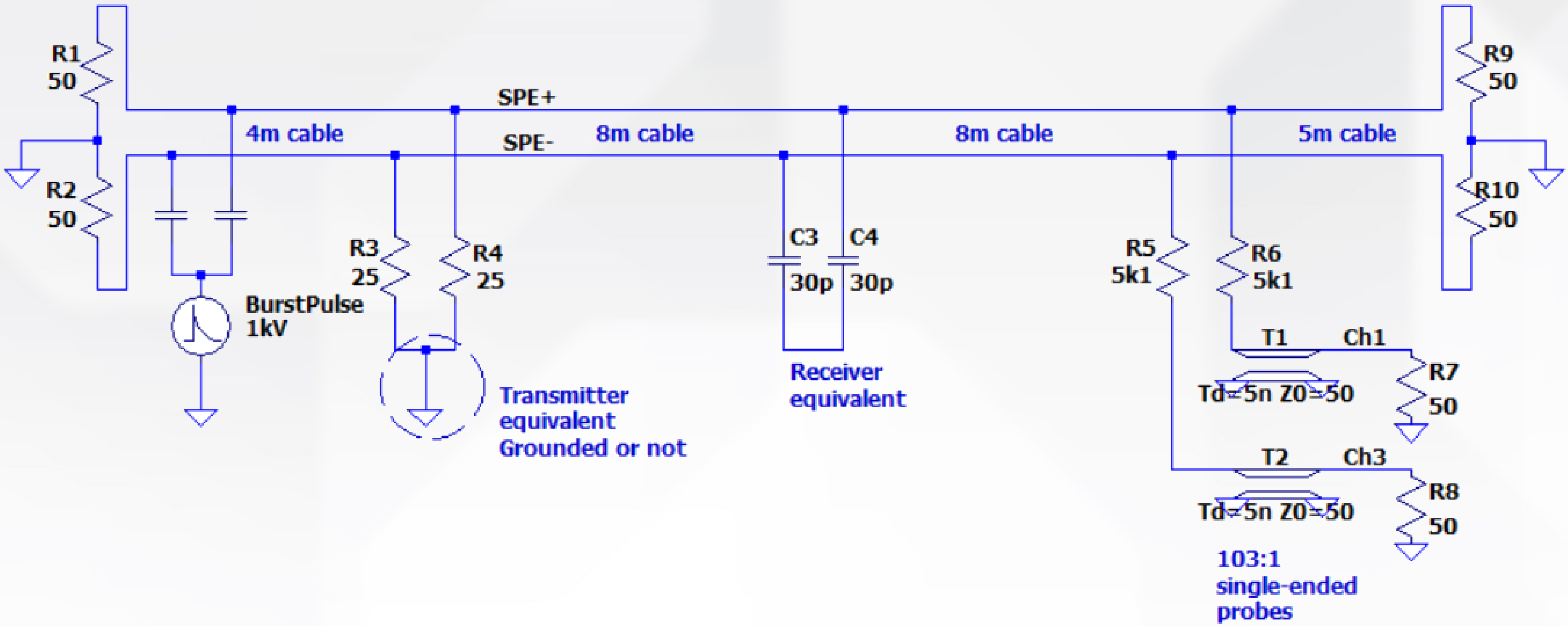


UTP CAT6 –based cable results

Concatenated pairs from CAT6 cable, 26m total

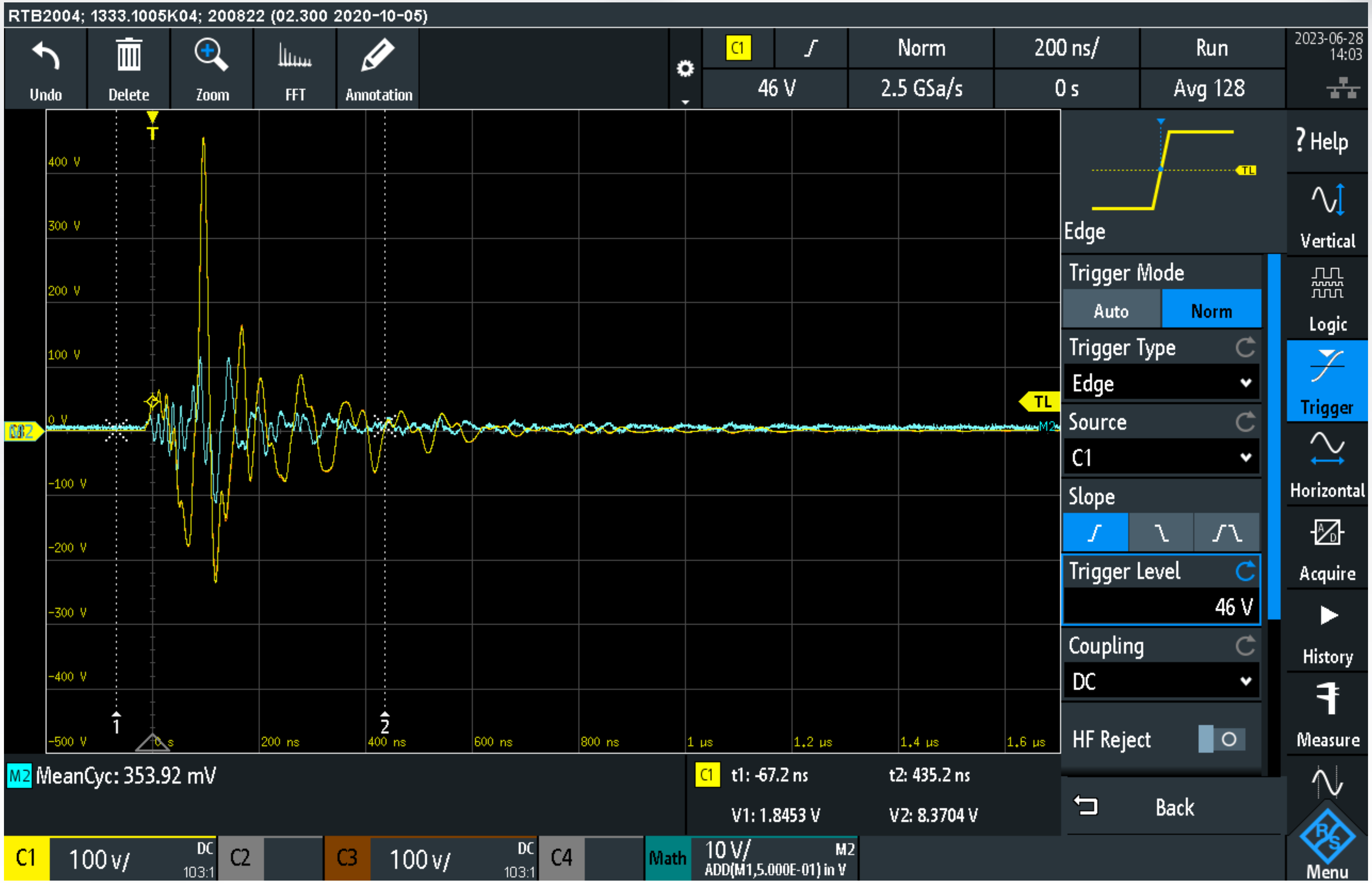
UTP cable test setup

~26m of single pair cable, artificial TX & RX nodes to assess their grounding effect



UTP cable, floating nodes, 1kV burst, SPE pair to table (yellow)

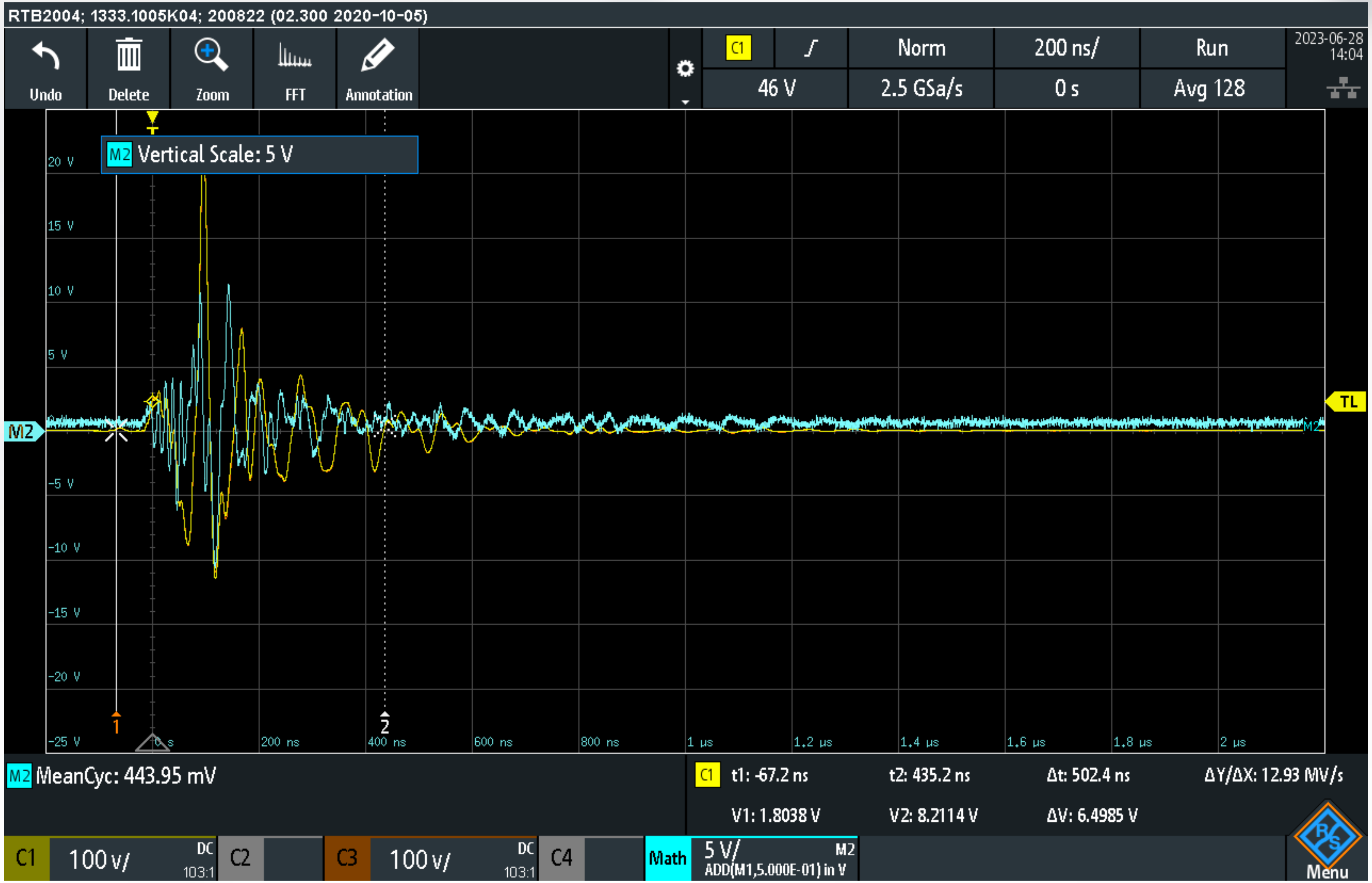
400V



<800ns ringing

UTP cable, floating nodes, 1kV burst, SPE+ to SPE- (cyan)

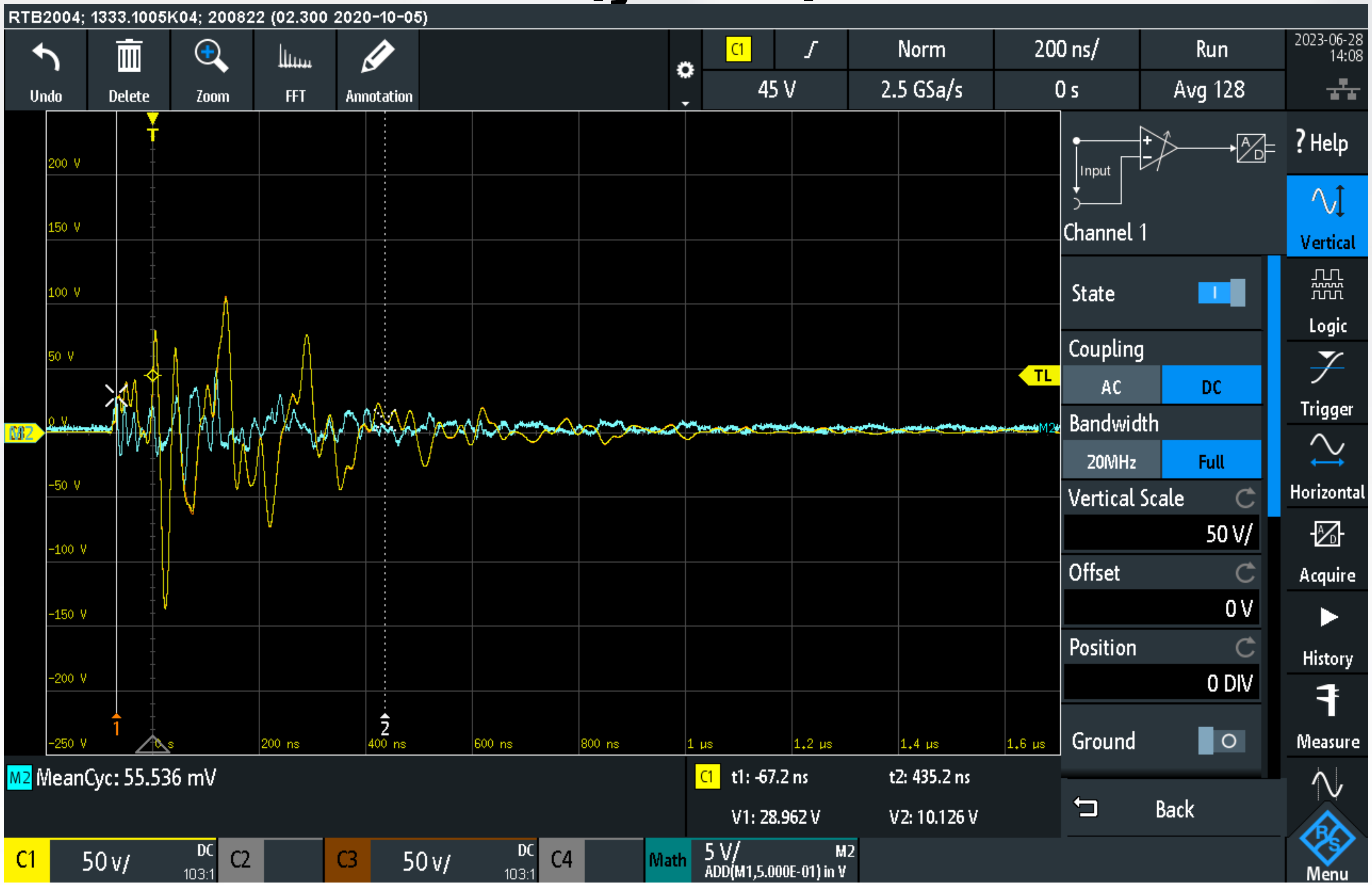
12V



<800ns ringing

UTP cable, transmitter grounded, 1kV burst, SPE pair to table (yellow)

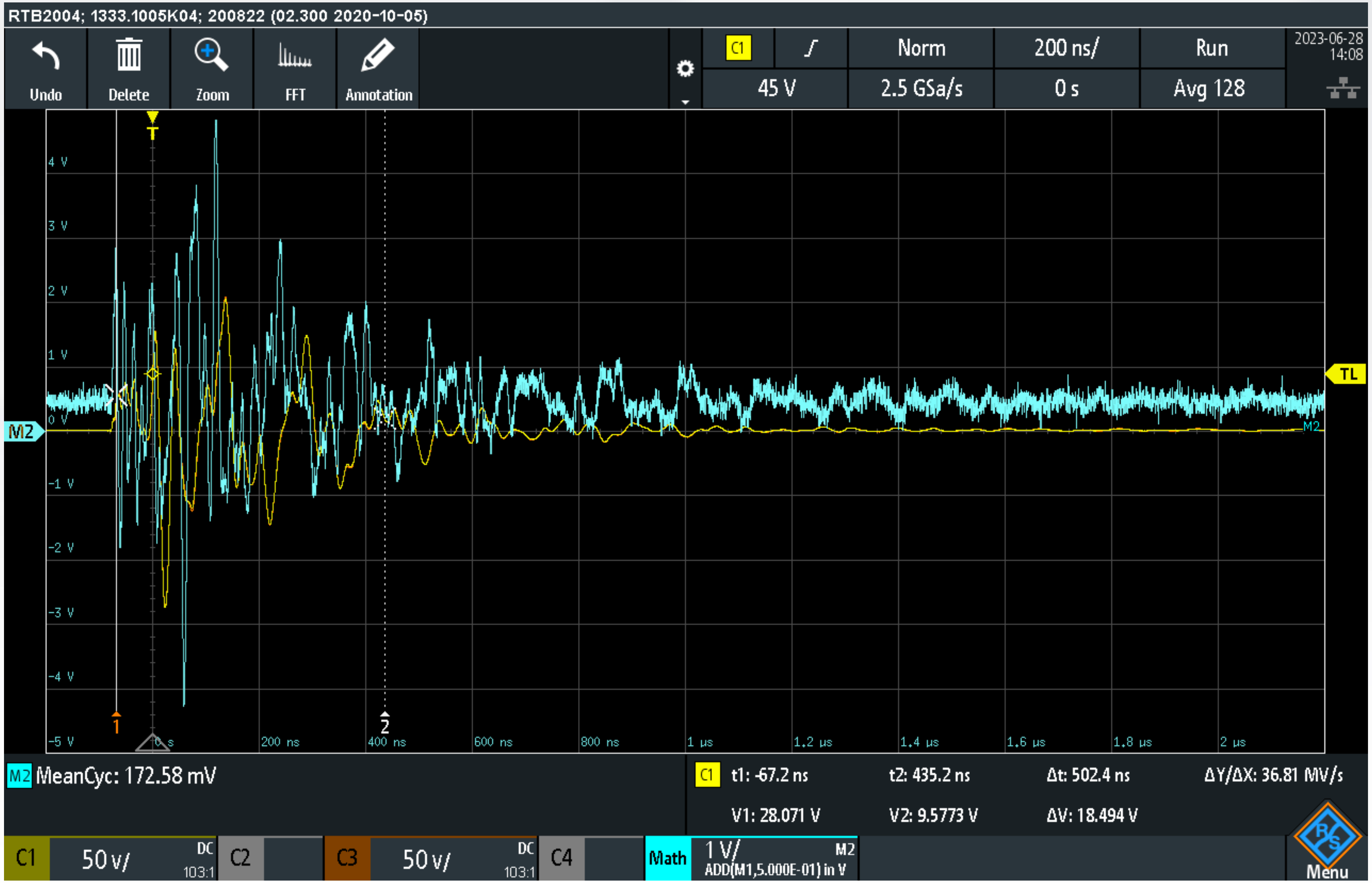
110V



<500ns ringing

UTP cable, transmitter grounded, 1kV burst, SPE+ to SPE- (cyan)

5V



<1000ns ringing

Conclusions

- As expected, the noise amplitudes as seen by the PHYs are vastly different depending on the power routing scheme
- The UTP link noise behavior strongly depends on the common mode termination points on the link (not just terminators)

- **The cable ringing period is similar, regardless of cable type (500-1000ns)**
- **Therefore, the erasure lengths can be expected to be similar in both cable types**
- **So a common FEC/retransmission solution should be possible**
- Actual ringing period can be shorter due to clamping in nodes (480ns observed for industrial real test)

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