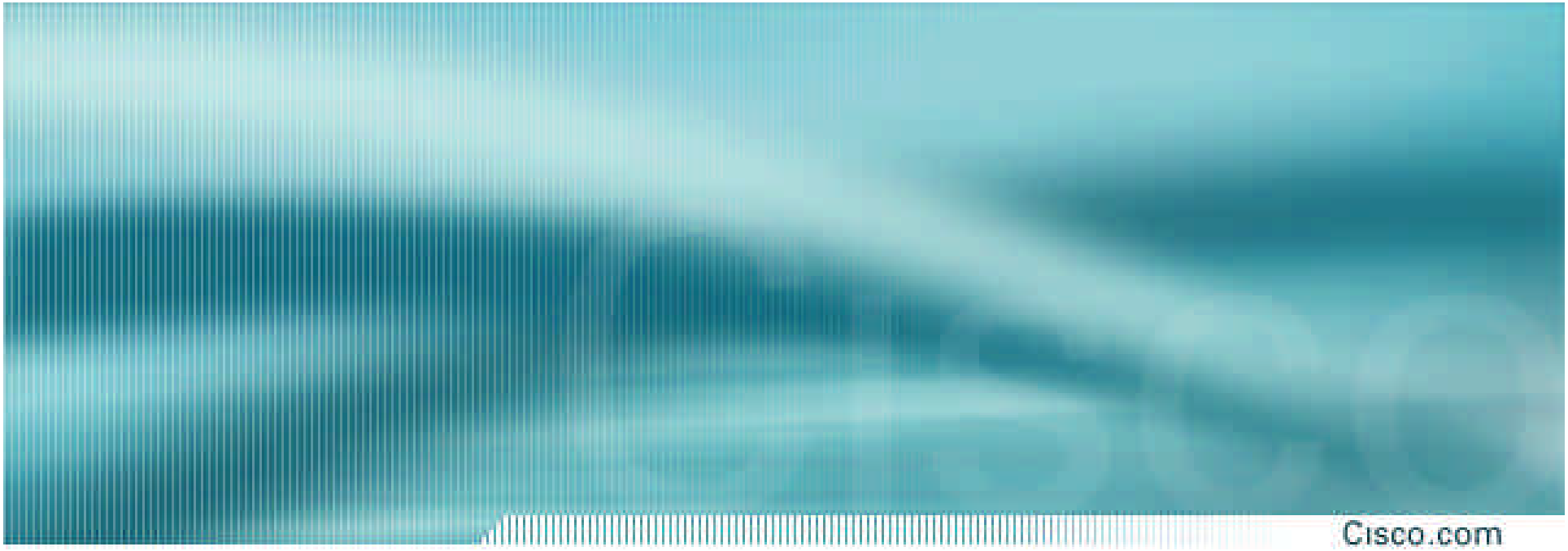


AC Disconnect & more…

Roger Karam

Las Vegas Interim

May 2002

Testing Summary

- **Tests covered AC Disconnection and DC Detection**
- **No Apparent Show Stoppers**
- **Biggest Concern is Noise Affecting Ethernet's Integrity and Interoperability**
  - **Standard does not define the AC component of the "dc detection" or Disconnection signals**
  - **Standard does not define how to test PSE or PD**
- **Recommend a More Conservative Spec. that Keeps the feel of an Ethernet port the same, (PSE Vs Legacy) and makes Interoperability testing a Low Entropy process.**

Tests conducted

Test No.

1. Economic Feasibility
   - Shared AC Vs single-port AC implementation
2. Noise Immunity
   - EFTB, Radiated, AC line coupling
   - PD (powered) tolerance to AC signal
3. Minimum PD load for AC Vs DC schemes
4. Inrush into PSE when PD powered from wall
5. Safety - SELV Requirements
6. Basic confirmation of AC Scheme
7. Interaction of signal rise-time & PD power input load
8. PSE-PSE connections
   - DC Detection Signal
   - AC Disconnection Signal

Test 1: Economical Feasibility

Concern:

- **Shared AC scheme is Economically Feasible but I have technical concerns**
- **Single-port AC implementation is technically OK but costs much more -expensive cap per port… More circuitry is need to control the AC signal…**

Recommendation:

- **More work required.**

Yes to v3.1

Test 2: Noise Immunity

Concern:

- PD analog immunity to interference
- This is NOT directly related to the AC disconnect.

Recommendation:

- Revise PSE noise spec?. Or Spec a PD's tolerance to the supply ripple that it can encounter from different Supplies out there and still have a clean analog performance, we worried about data alone so far.
- Need a way to verify compliance?
- Injecting noise from 10's of Hz into Khz a challenge when done on the power supply.

Yes to v3.1 – More work required

Noise Immunity Test Overview

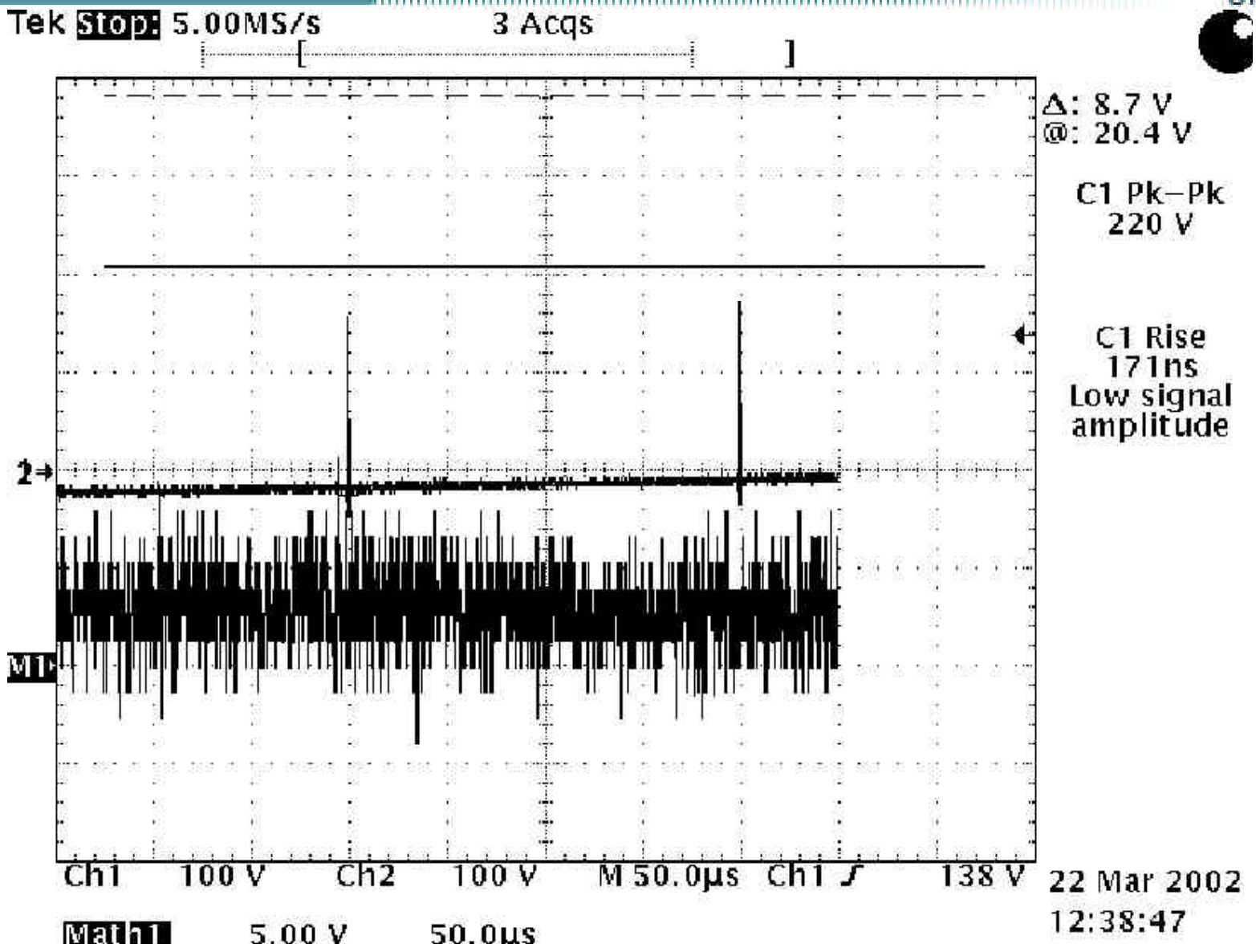
Tests

- EFTB (Electrical Fast Transient)
- Radiated Immunity (preliminary data)
- AC line power coupling (preliminary data)
- PD Noise tolerance when the PD is powered

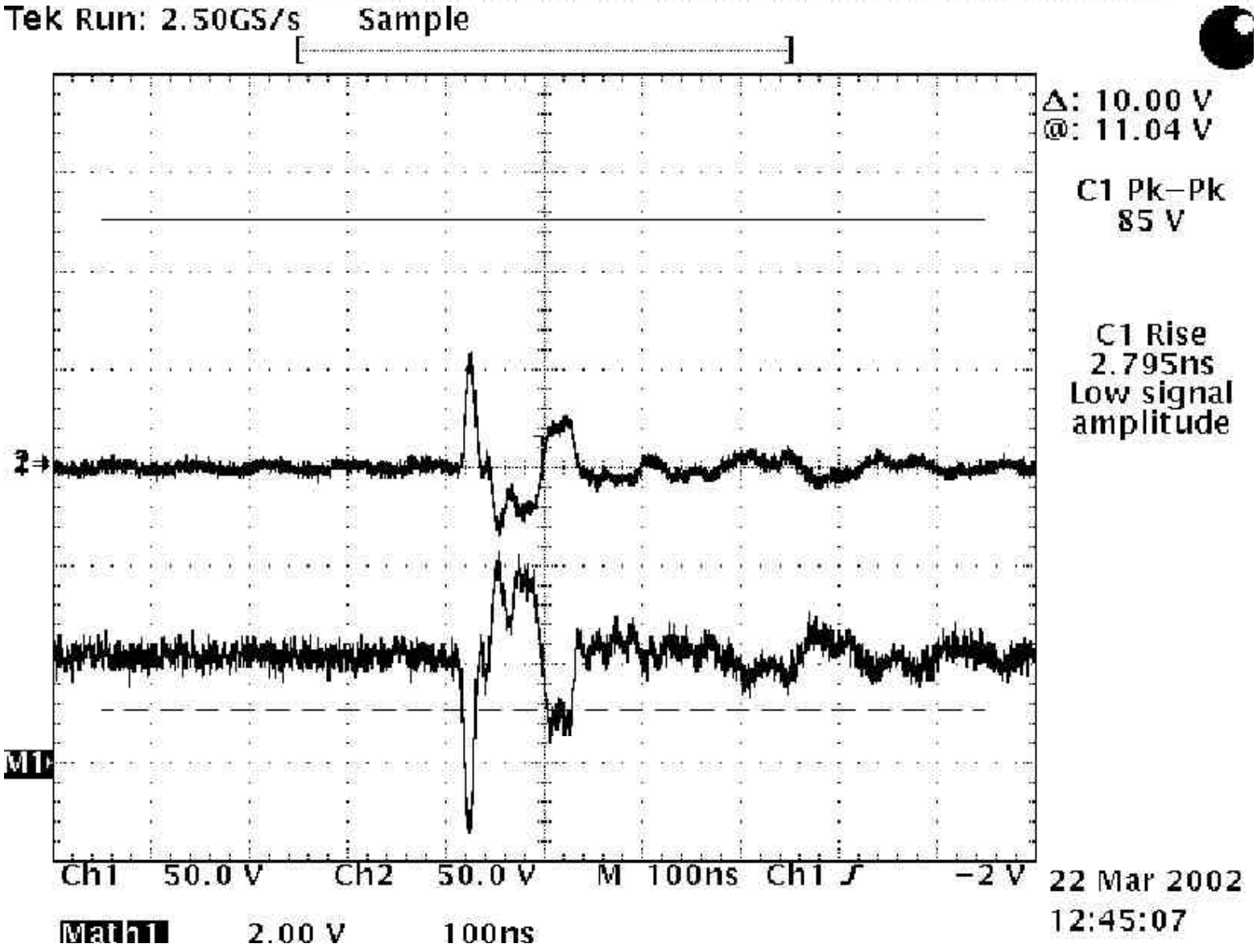
Conclusion

- AC Disconnection circuit must discriminate based on amplitude and time information

Noise Immunity
EFTB (large time scale)



Noise Immunity – EFTB Zoom-In



AC-Cord Coupling

- **Preliminary data shows that Line coupling can be as high as 3v differential, into a High impedance "power input"**
- **Used 50ft of cat-3 and a power cord.**
- **With Low impedance it can be in the high 10's of mv**
- **Again, using a good discriminator to detect the AC signal, and staying away from the line frequency will help**

Radiated Immunity

- **Preliminary results show that a “power Input “ representing a High Impedance could potentially cause a 800 mv peak-peak differential voltage in the 100mhz region**
- **Low Impedance – No diode+cap kind of input, ie standard Ethernet does not do this**
- **So again we bet on a good discriminator here**
- **We may want to spec the DC-detection to tolerate these conditions**
- **Possible alternate fix to this, is dictating a Min Capacitor in the PD (facing the wire)**

Noise Immunity - PD Noise tolerance

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PD is Powered

- **No issues related to AC Disconnection Signal**
- **Draft 3.0 Noise Spec based on Data tolerance**
  - **Need to consider analog circuitry**

- **Example: PSE meets .af D3.0 noise spec, but causes the PD grief in analog (I.e. phone audio hum)**
- **Need to determine appropriate PSE intrinsic noise specs OR spec the PD tolerance. HAS ANY ONE TESTED THIS?**

(More work required)

Test 3: Minimum PD load

Concern:

- Minimum load with DC Disc, 10 mA
- Minimum load with AC Disc, 0 mA
- This will result in different behaviors in the customer's environment

Recommendation:

- May need to spec an Min AC load facing the wire to allow the PD to behave as a minimum load under AC disconnect?

Is this an issue?

Test 4: Inrush back into PSE

Concern:

- If PD is wall powered & and wall power goes away
- PD will generate inrush back into PSE

Recommendation

- Specify that a PD must not cause damage under this condition by imposing a transient back into the PSE upon removal of a secondary power source. And
- Specify that a PD must Not Force DC Voltage on the wire. (possibly state that a current limited I<?? Voltage may be ok)

Is this covered?

Test 5: Safety

Concern:

- DC + Ripple must be below SELV

Recommendation:

- Here are the advised way to spec this
- 1. max. 4.4 Vpk-pk OR
- 2. (0.1 x Vdc) Vpk-pk, up to 5 Vpk-pk.

Yes to v3.1 with recommendation

Test 6: Basic Concept of AC Disc.

Concern:

- Under normal conditions (PSE-PD) AC Disc signal is not a concern
- Provided PD draws power – no issue

Recommendation:

- None required

Yes to v3.1

Tests conducted

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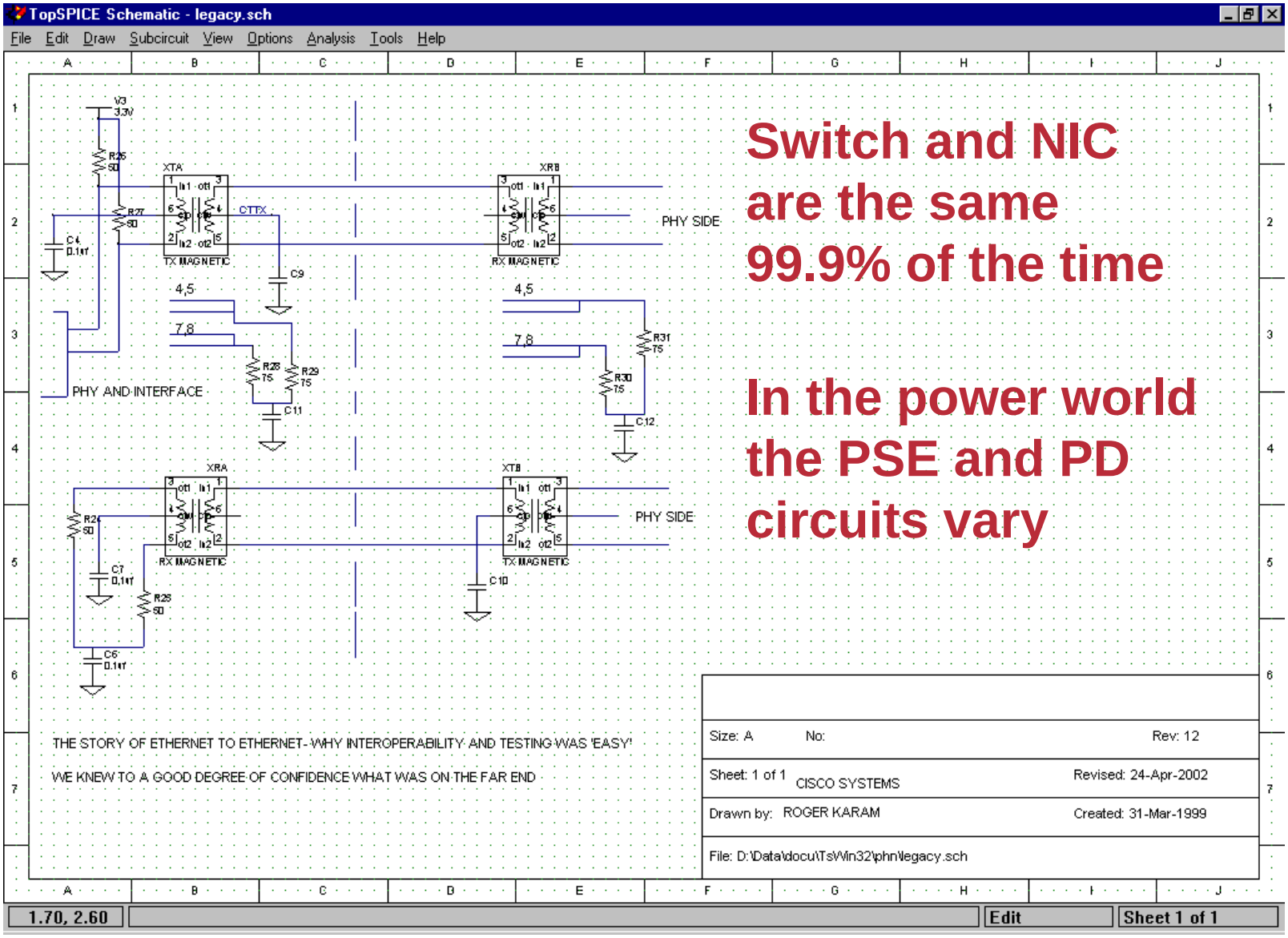
Test No.

1. Economic Feasibility
   - Shared AC Vs single-port AC implementation
2. Noise Immunity
   - EFTB, Radiated, AC line coupling
   - PD (powered) tolerance to AC signal
3. Minimum PD load for AC Vs DC schemes
4. Place holder – Inrush into PSE when PD powered from wall
5. SELV Requirements
6. Basic confirmation of AC Scheme

7. **Interaction of signal rise-time & PD power input load**
8. **PSE-PSE connections**
   - **DC Detection Signal**
   - **AC Disconnection Signal**

Legacy Standard Ethernet



Switch and NIC are the same 99.9% of the time

In the power world the PSE and PD circuits vary

Test 7 - Rise Time

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Concern

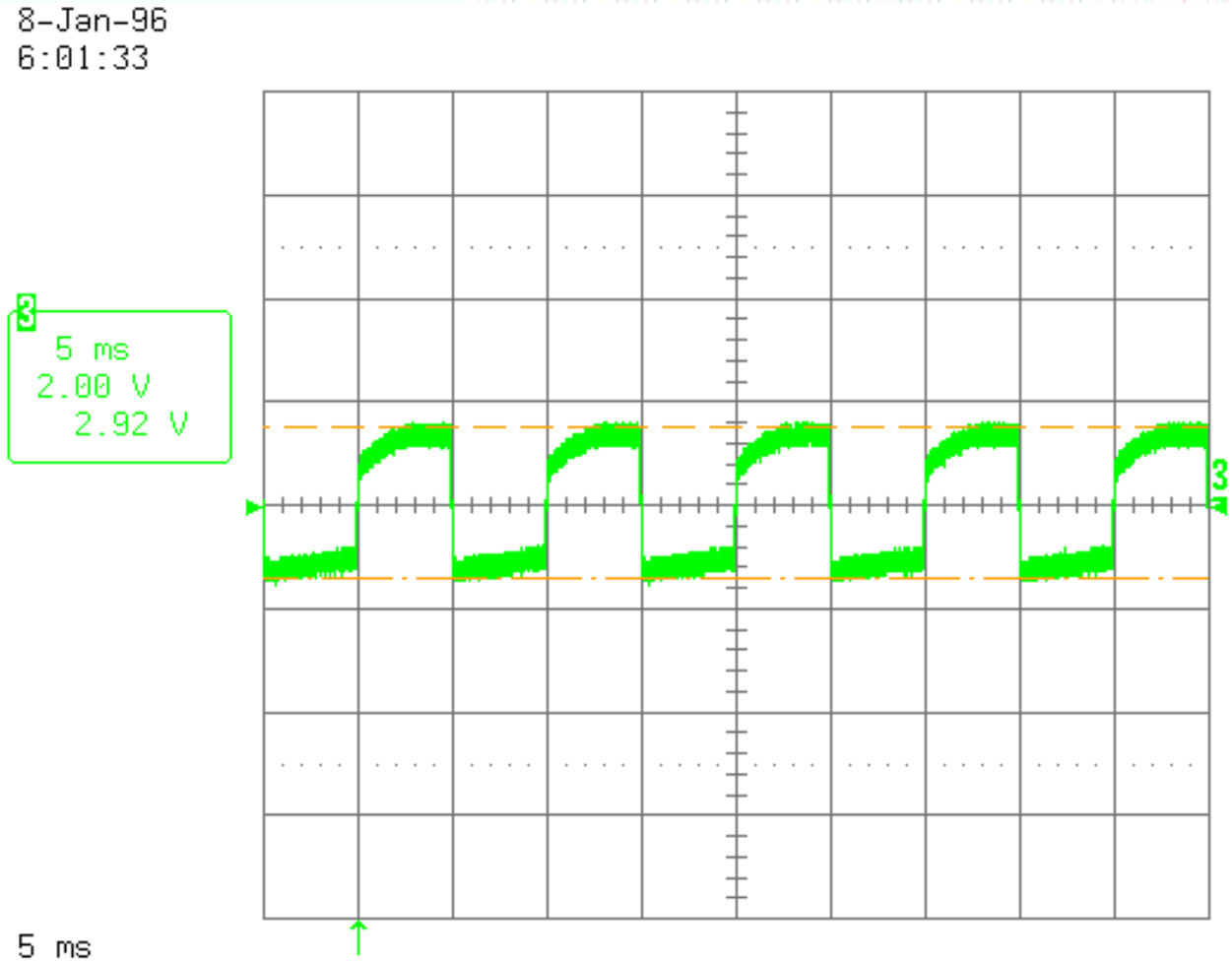
- Interaction of rise-time and PD power input load
- For rise-times of 10's uSec the EMI profile May be affected by the load
- so what load does the PSE vendor test to??

Recommendation

- slow down rise-time to mSec. As large as feasible within the 500mSec detection window

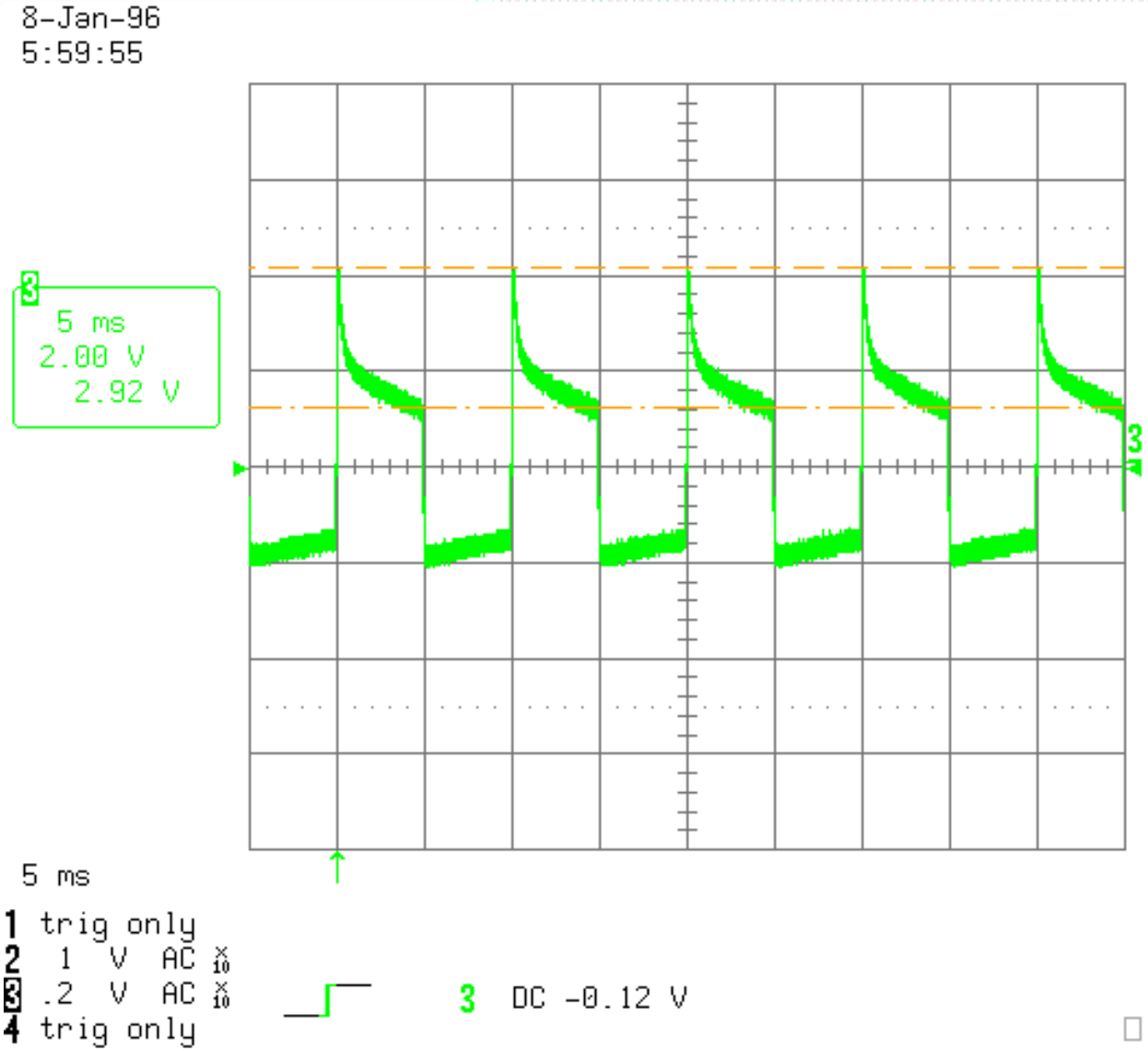
Yes to v3.1 with Recommendation

Rise-time
AC Disconnection signal with PD-1



T_rise = 150 uSec
PD no. 1 is OFF

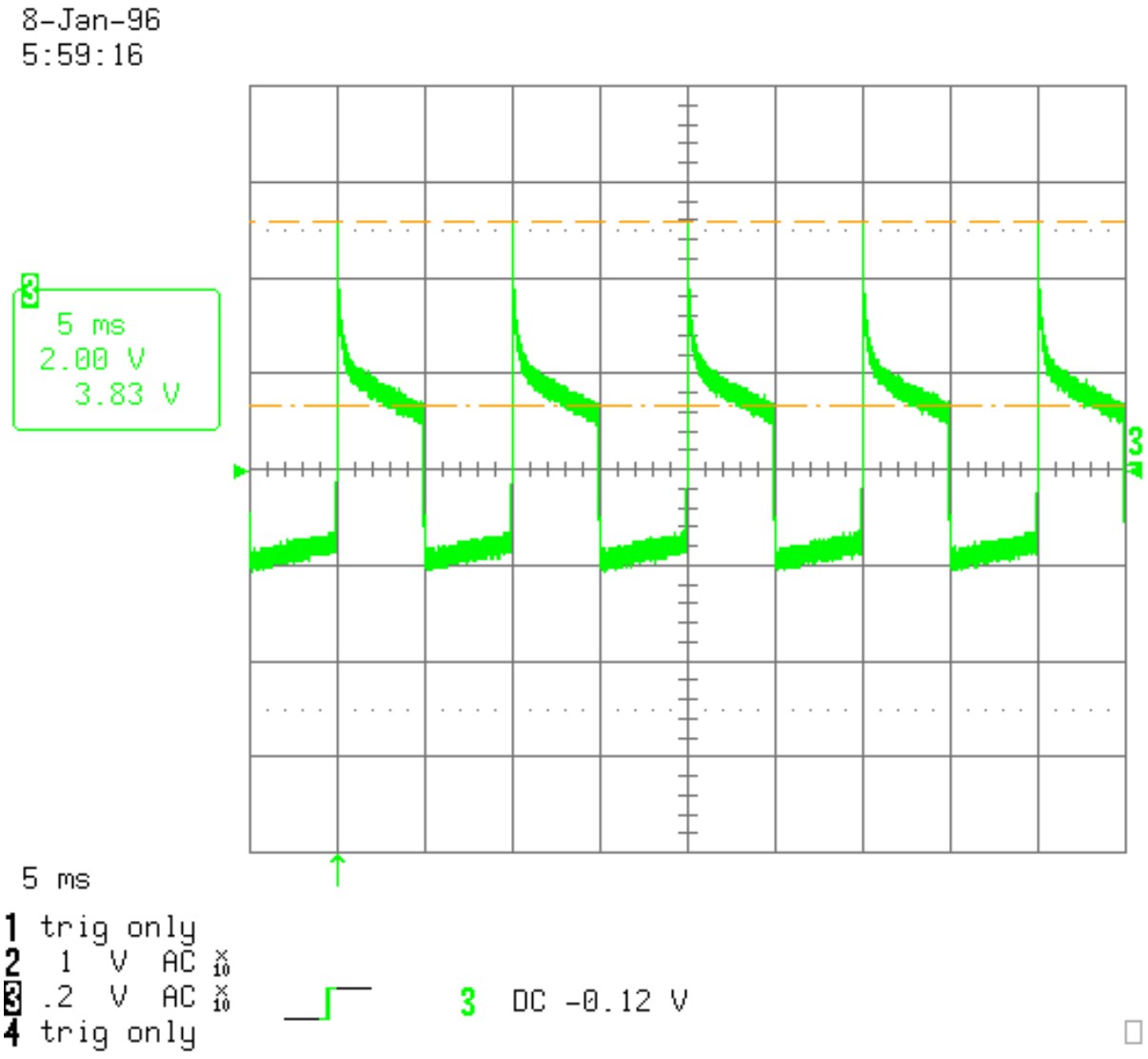
Rise-time
AC Disconnection signal with PD-2



T_rise = 150 uSec
PD no. 2 is OFF

Change in spectrum due to PD change

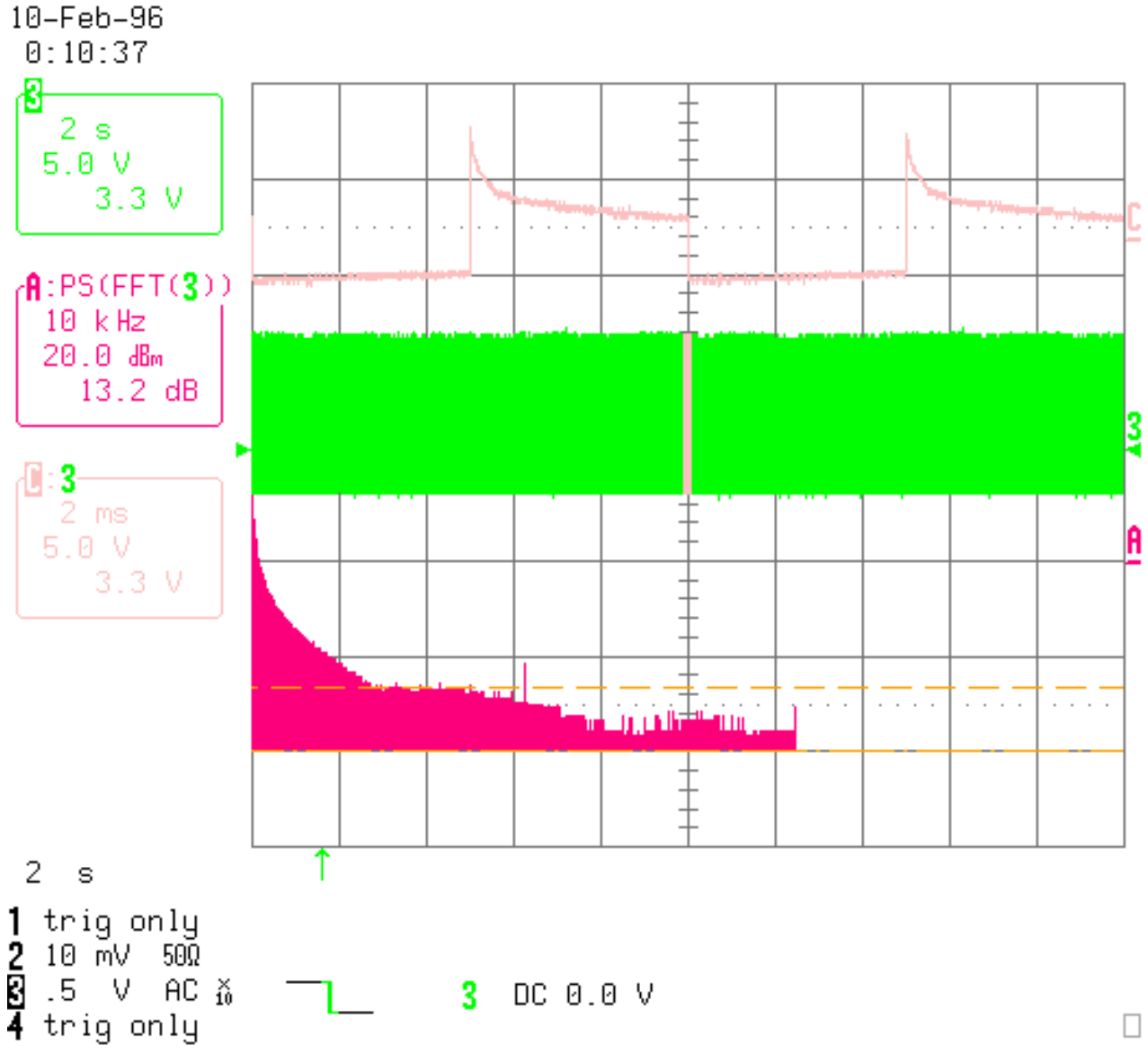
Rise-time
AC Disconnection signal with PD-2



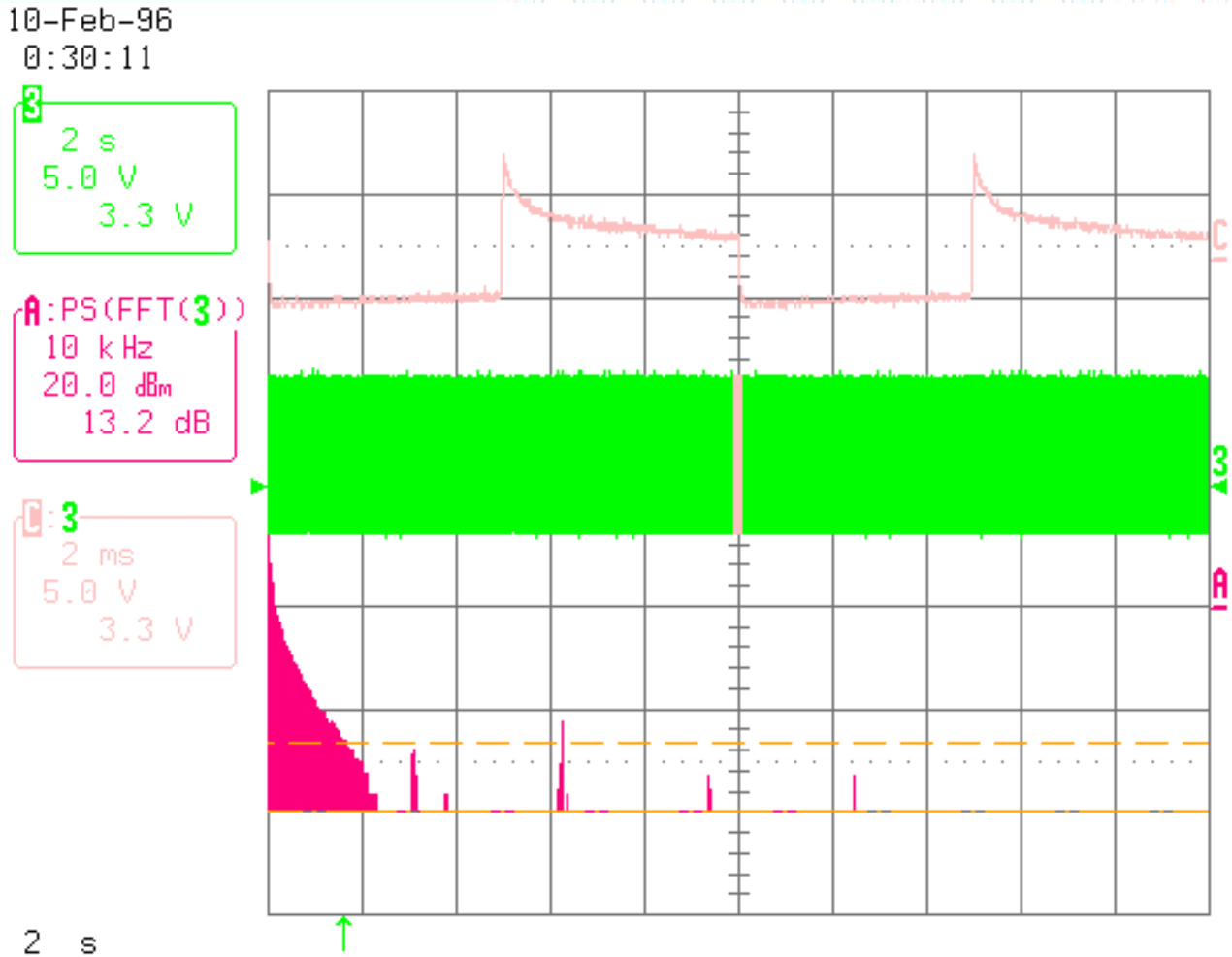
T_rise = 10 uSec
PD no. 2 is OFF

Spectrum got worse

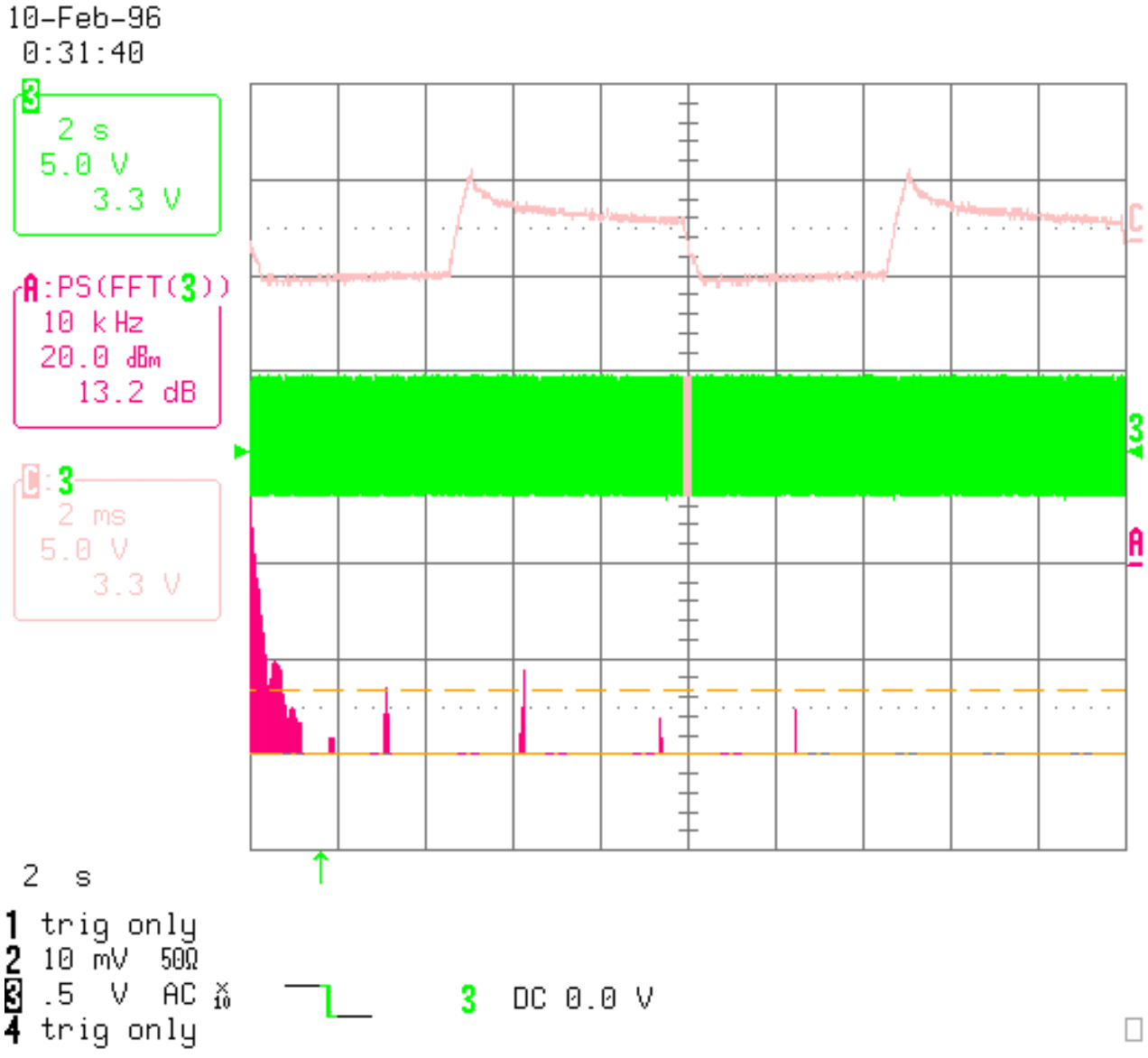
Spectrum for 10us Rise Time



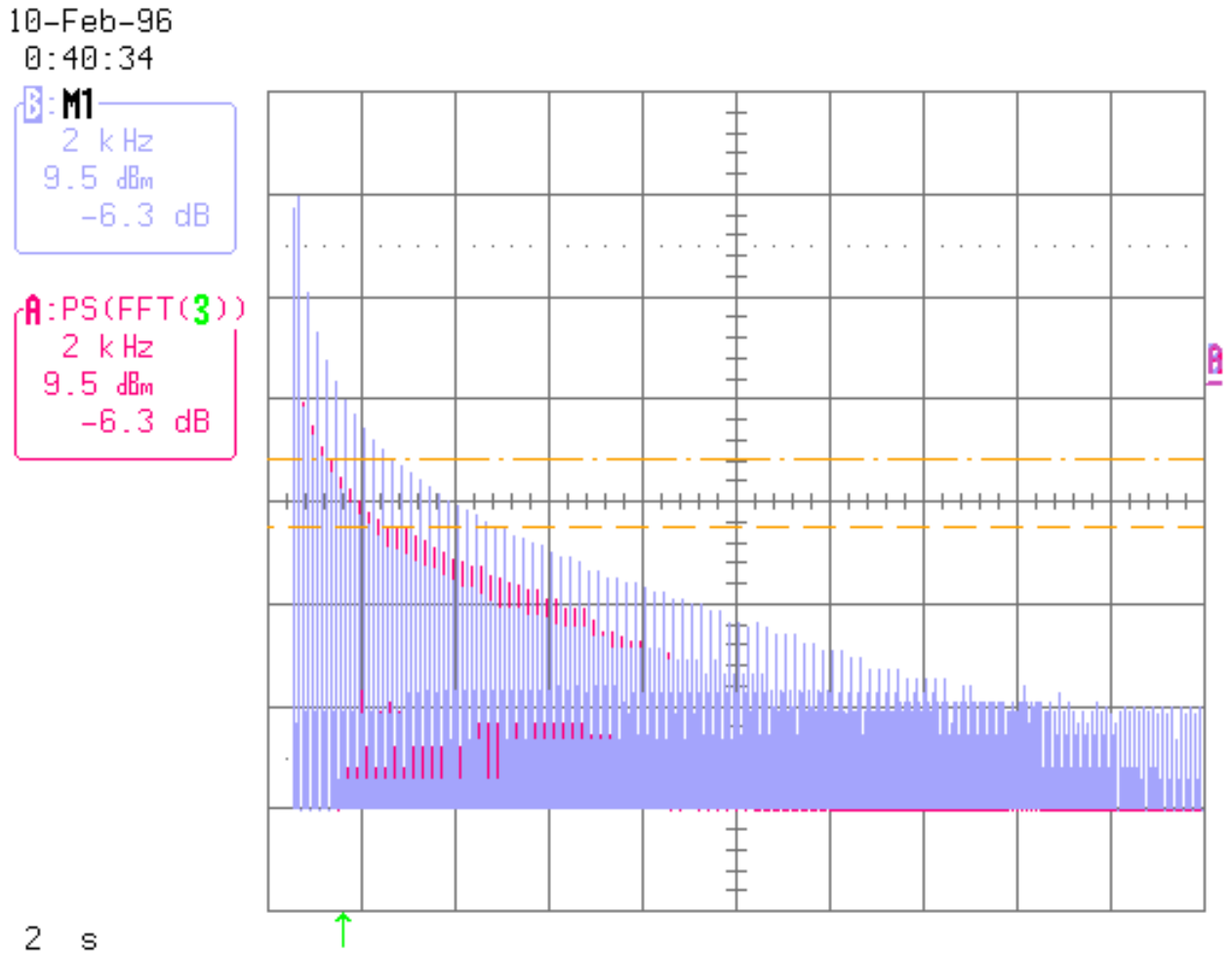
Spectrum for the 150us Rise Time



Spectrum with Trise=1msec



Compare Spectrum for Tr=40us & 150us



Rise-time testing summary

- **Draft 3.0 calls for a minimum T_rise of 10 uSec**
- **The spec should guarantee interoperability – currently it may not?**
- **Recommend: increase the rise-time to mSec but we need consensus as it affects averaging of detection measurements.**

Test 8 - PSE-PSE DC detection

Concern:

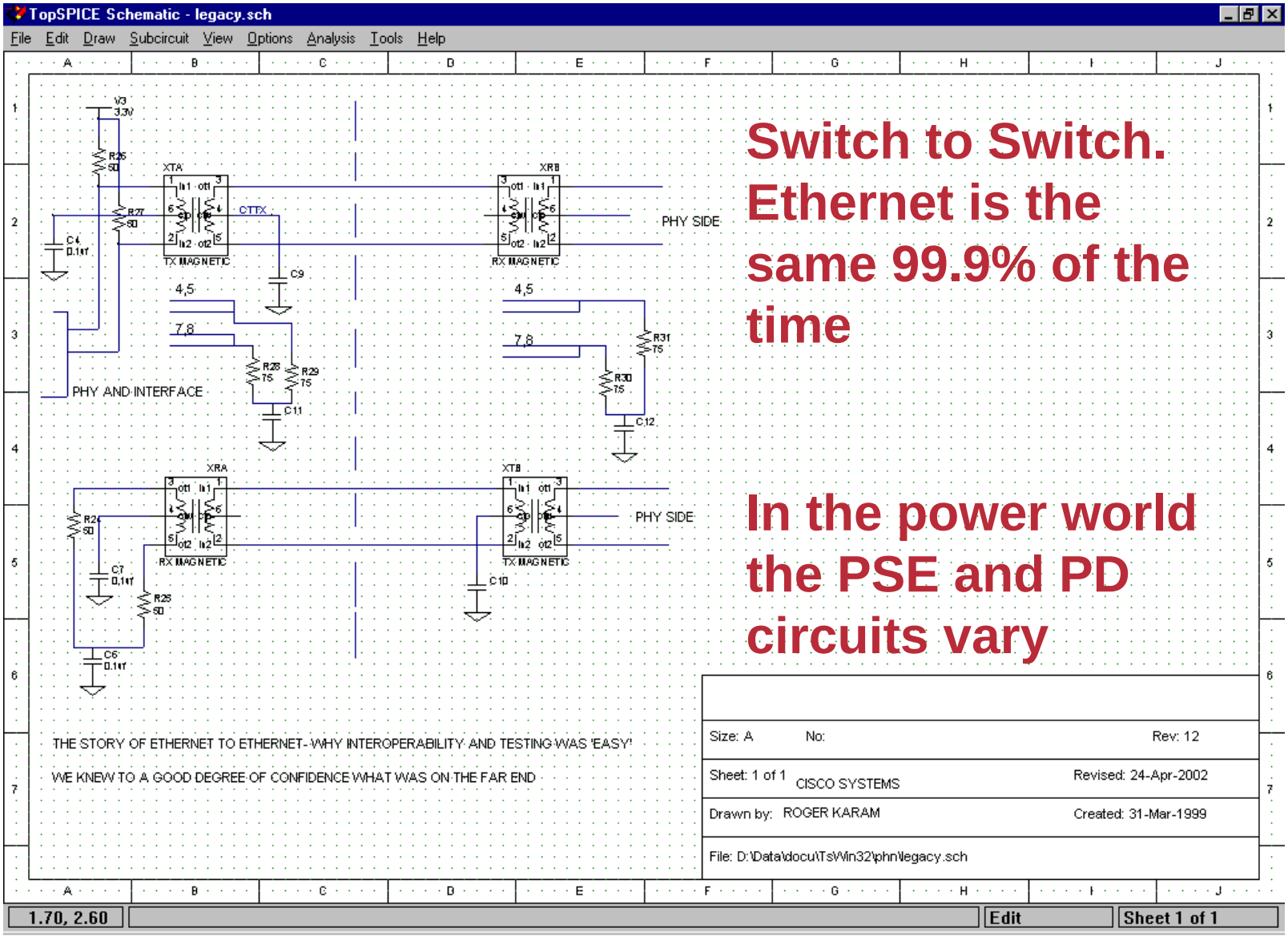
- Is this really a DC detection scheme. It turns out that many implementations are switching rapidly between the two probing voltages (AC) at an unspecified frequency and duty-cycle with aggressive rise-times
- Ethernet interoperability

Recommendation:

- Should not go to 2nd probe voltage until a possible PD is discovered at the 1st probe voltage (preferred solution – real DC)
- Specify the switching rate (not clean)

Yes to v3.1 with Recommendation

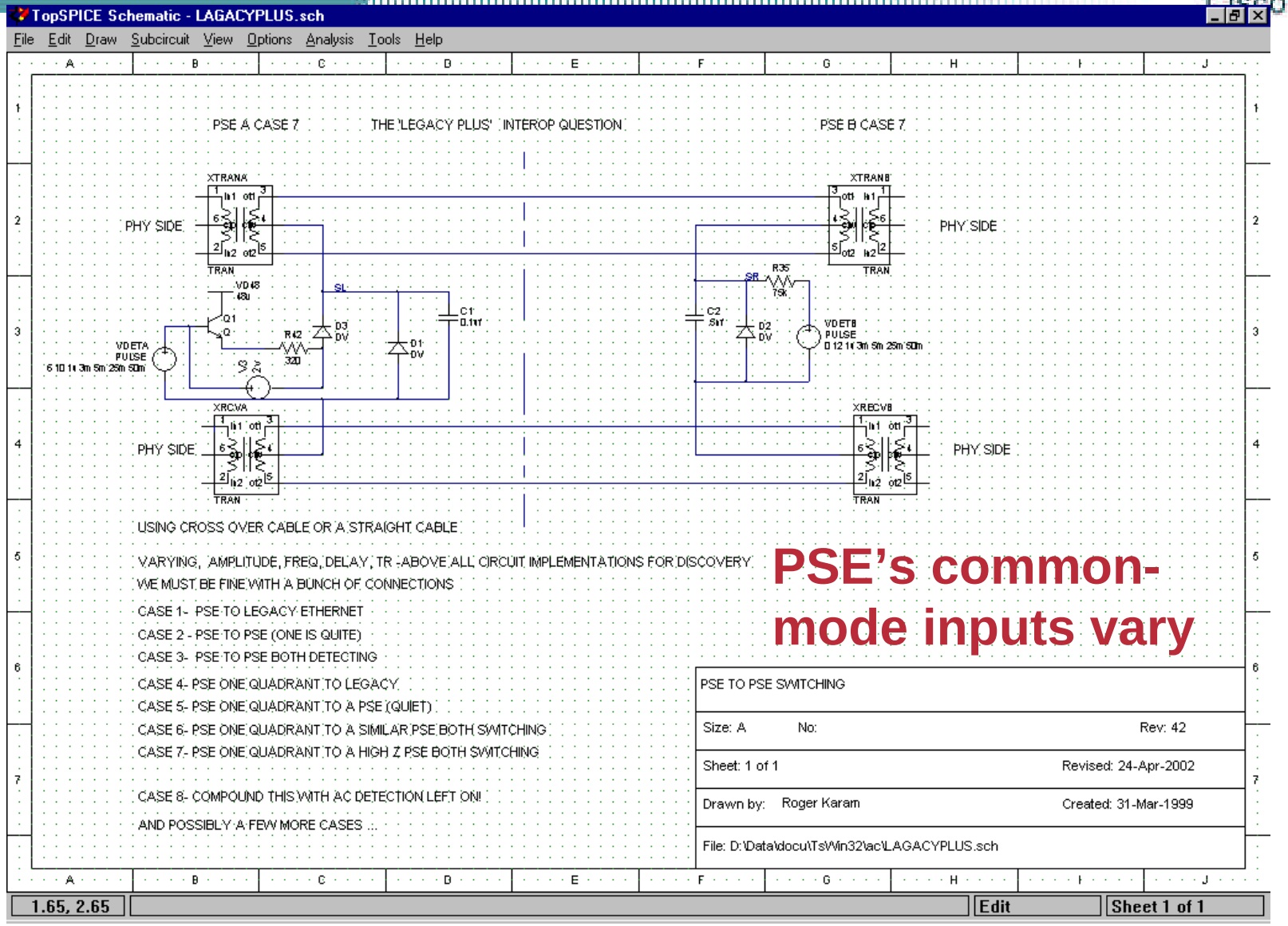
PSE – PSE connections
Legacy Standard Ethernet



Switch to Switch. Ethernet is the same 99.9% of the time

In the power world the PSE and PD circuits vary

PSE – PSE connections
Legacy Ethernet + power

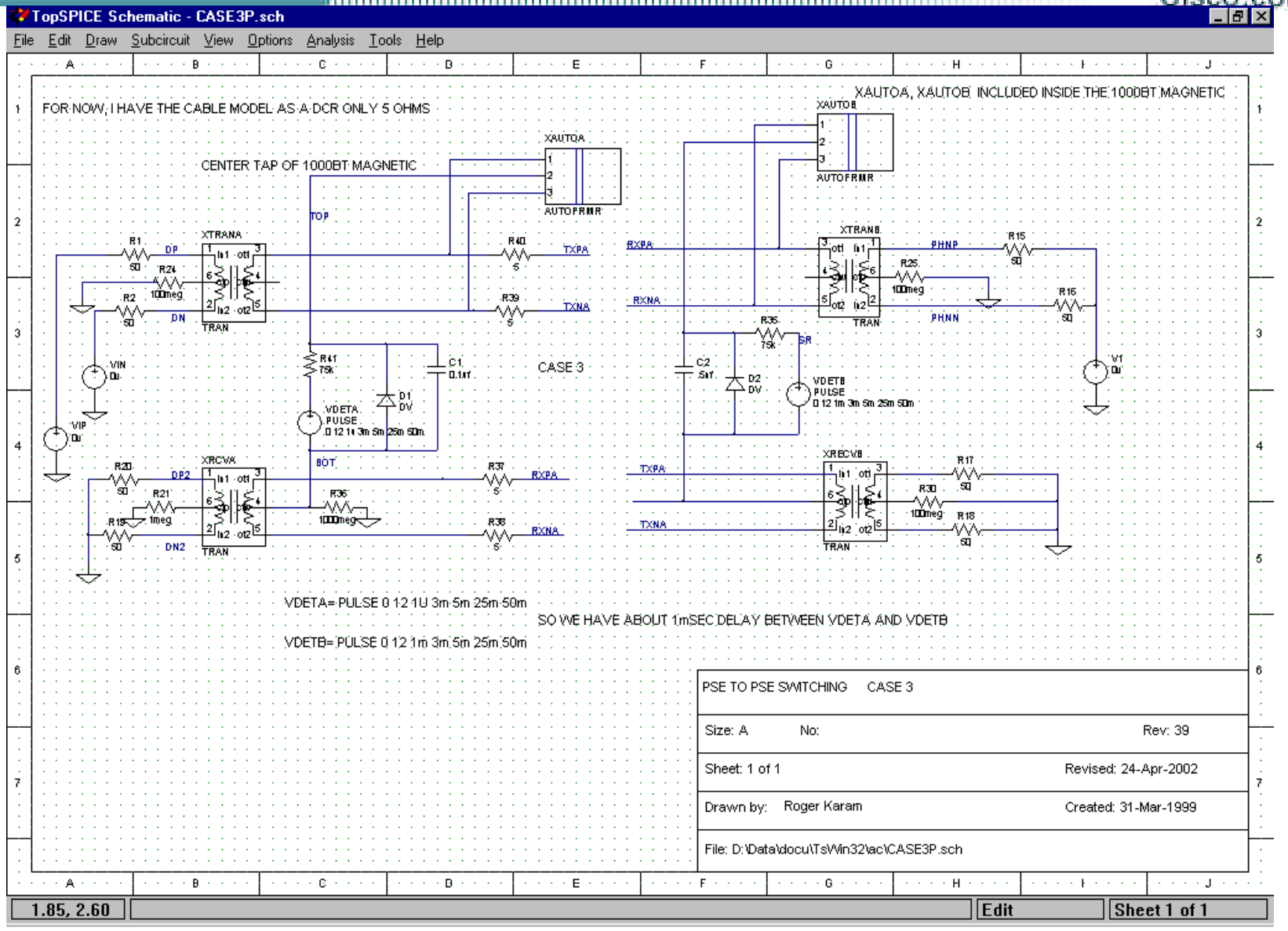


PSE – PSE Test Overview

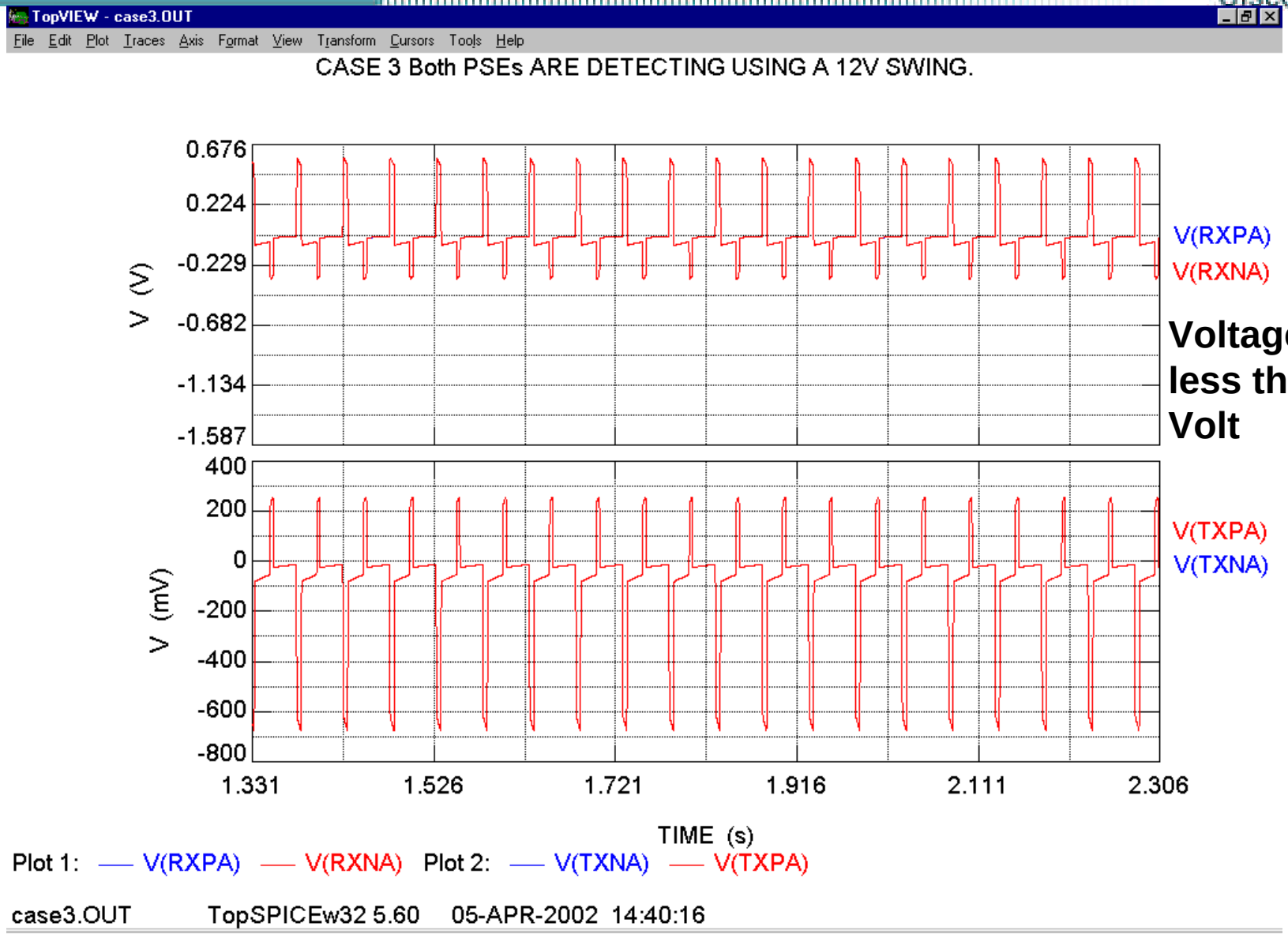
DC detection is actually AC

- **Pick 1 case, two high impendence PSEs**
- **Set frequency and rise-time to mSec (setup 1)**
- **Plotted results (OK)**
- **Changed frequency and rise-time (setup 2)**
- **Plotted results (Big Difference)**

PSE – PSE
Both High-Z Test Setup 1

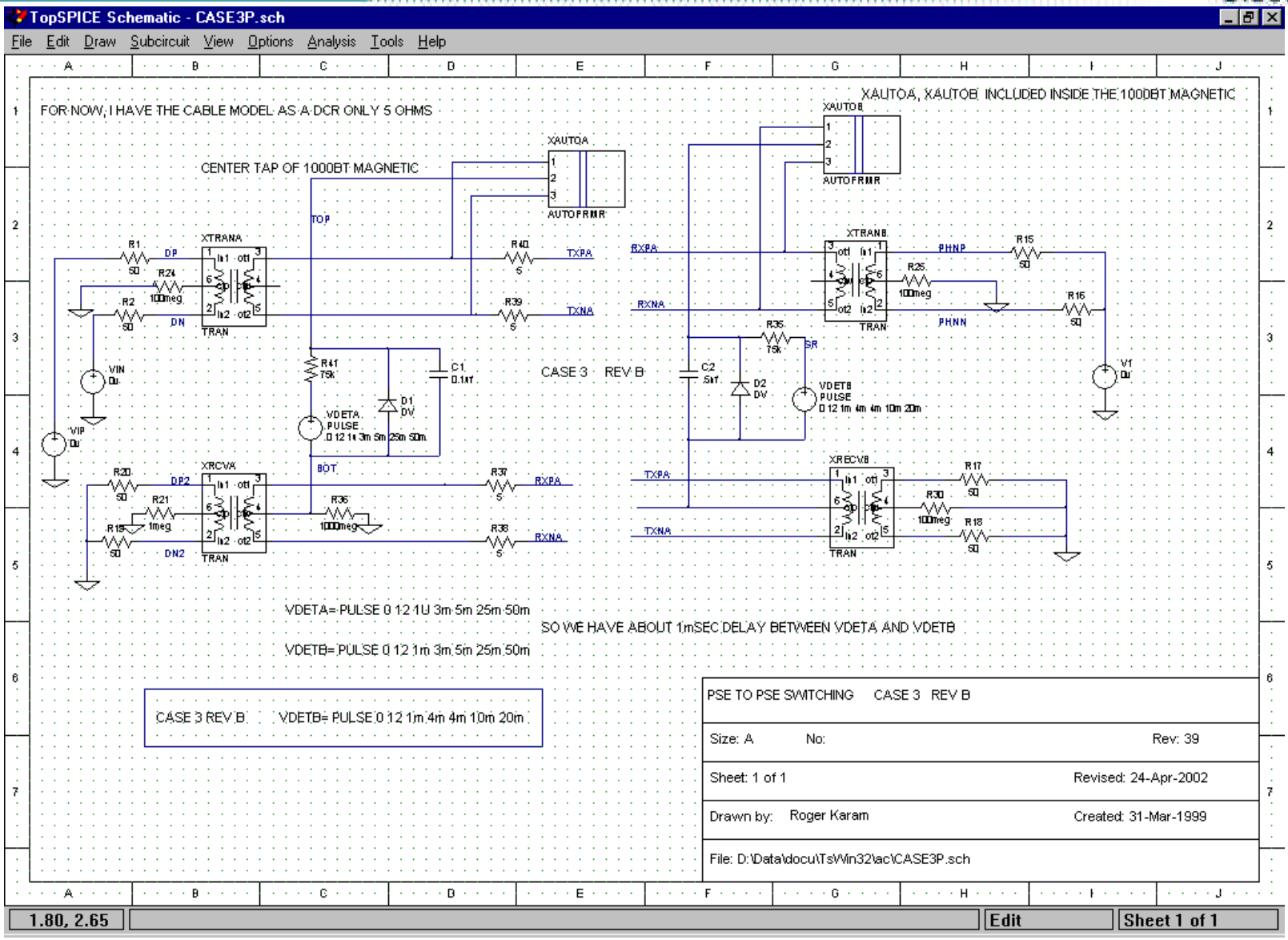


PSE – PSE
Setup 1 Test Results

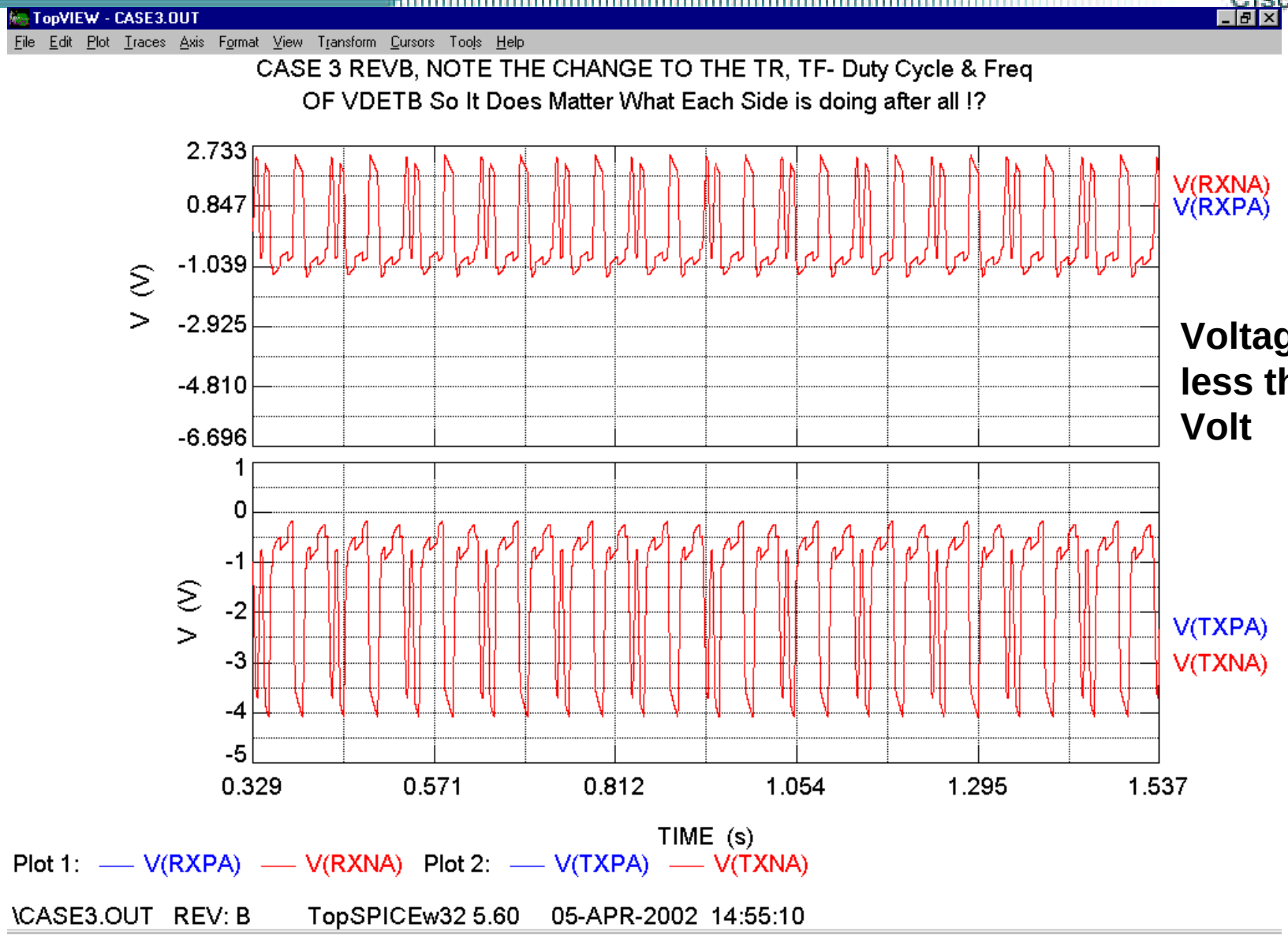


Voltage is less than 1 Volt

PSE – PSE
Setup 2 (change signal- VDETB)



PSE – PSE
Setup 2 Test Results



Voltage is less than 5 Volt

PSE – PSE SUMMARY…

- Same Issue exists for AC Disconnect Signal
- Can this impact the data?
- Ethernet Interoperability – what do I test to?
- What happens on a bundle of cables as the DC is switched up to 30V
- The pair-to-pair DCR mismatch may be a factor in the 1 quadrant detection (up to 5 mA discovery current)
- AGAIN, we used reasonable rise-times in simulations (mSec)

Daddy did you break Ethernet in Vegas?

PSE – PSE SUMMARY

- **Do we need to be "aggressive" ?**
- **Recommend a Conservative Approach**
- **Don't shift to 2nd probe voltage until a trigger at 1st voltage has taken place - This ensures Ethernet 'feels' the same. Interoperability friendly**
- **Turn off AC signal when no power is applied**

PSE-PSE AC Disconnection signal

Concern:

- Same issues as the AC switching of the DC detection signal.
- When no PD is connected a PSE sending the AC signal may interfere with PSE-PSE data transfer

Recommendation:

- Do not send AC signal when a PD is removed (or not powered)

Yes to v3.1 with recommendation

Classification Using Forced Current

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Concerns

- Lab work shows that this has the potential to oscillate.
- Thus this can be an inter-operability nightmare.
- Some vendors claim this will add cost (to integrate this on a PD chip) …

Recommendation:

- We have enough things to worry about
- Disallow Current Based Classification

Change Summary

- Amplitude to 4.4V max.
- AC Signal rise-time slowed to mSec
- AC signal off when not powering
- DC detection should be, well, DC
- Specify a Min AC load
- Classification using forced-Current Removed
- Specify test PSE and PD, with test profile

The risk is Ethernet interoperability