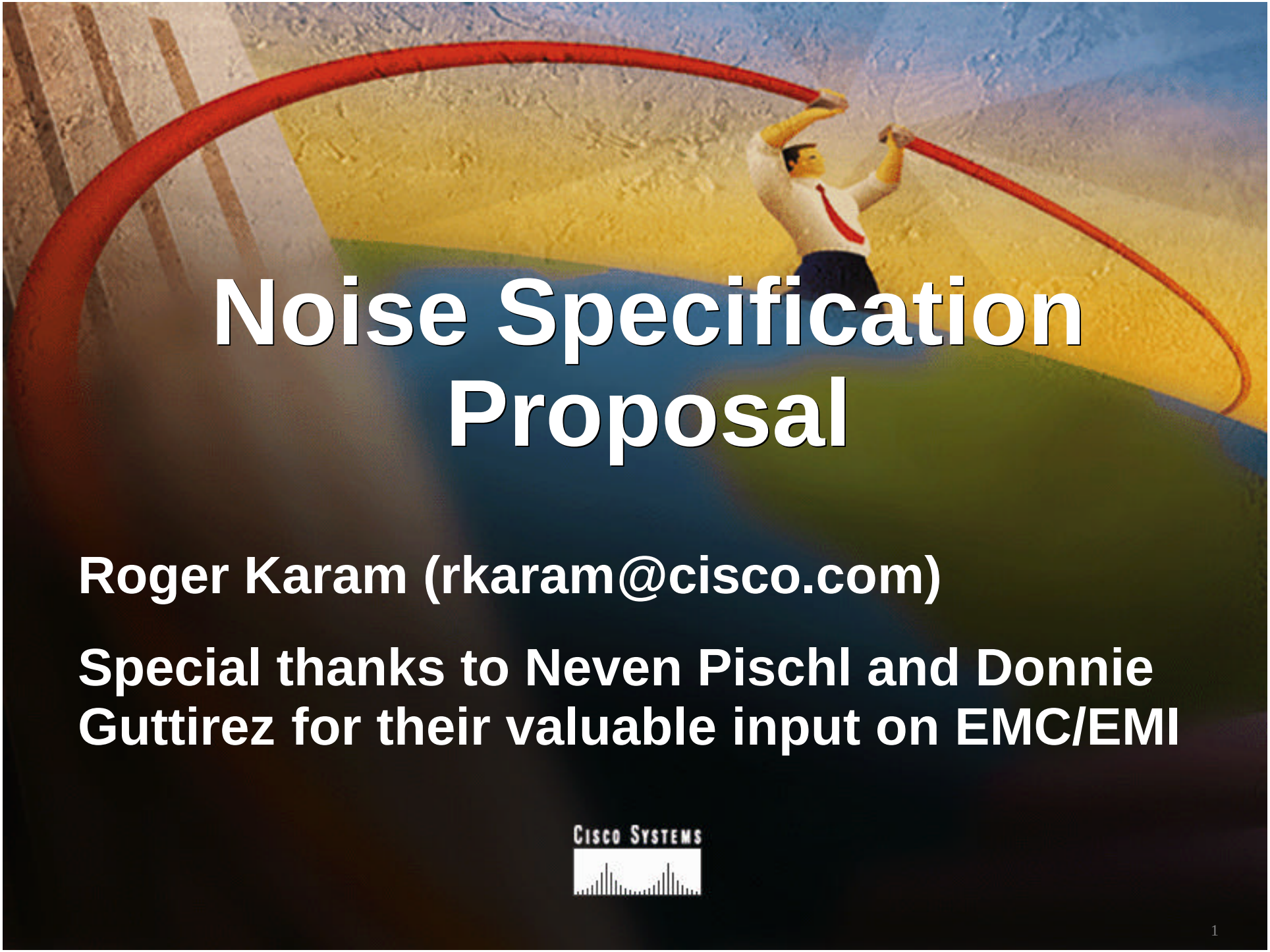

Noise Specification Proposal

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Special thanks to Neven Pischl and Donnie Guttirez for their valuable input on EMC/EMI

Cisco Systems

Agenda

- **Part I – Noise Specification Proposal**

  To ensure data integrity

  Proposal is on slides 9 & 10

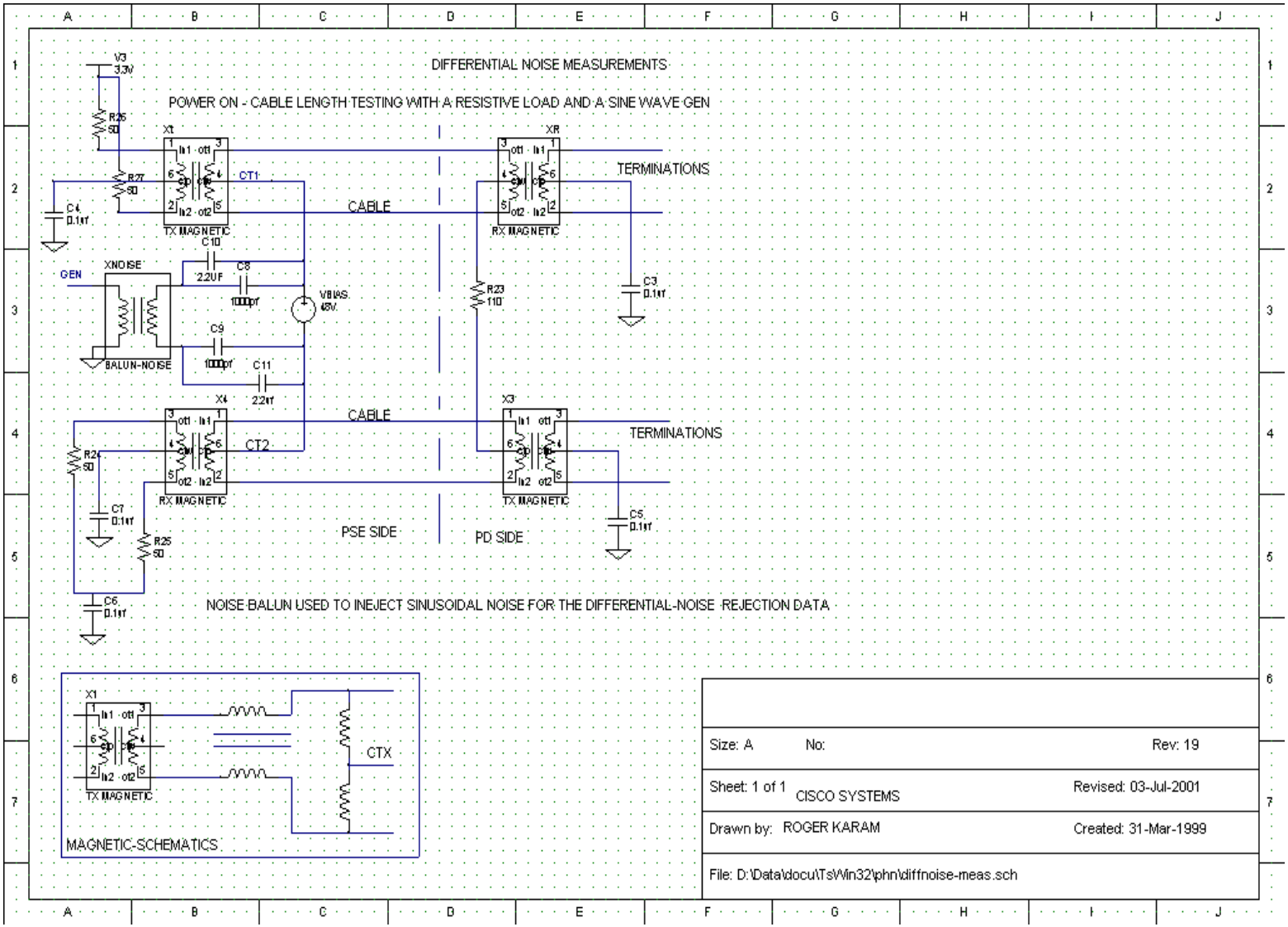
- **Part II – EMI noise limits**

  Pass EMI and everything is fine

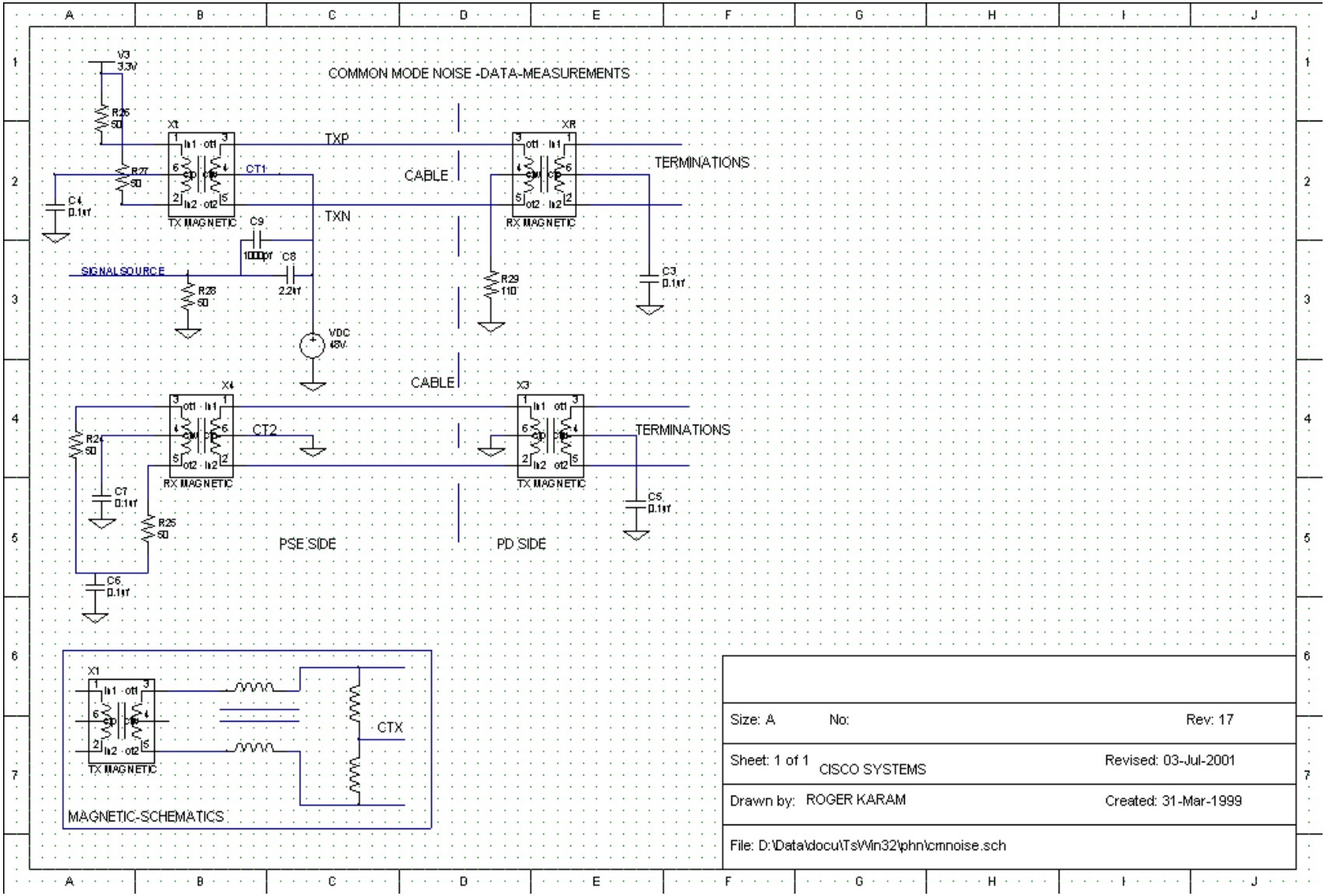
SPECIFYING NOISE Common-Mode & Differential (Pair-Pair)

- Get a baseline for the noise that impacts 10/100/1000BT Data transfer. Controlled sinusoidal injection of noise, at maximum cable reach, across some typical Phys In a differential and common-mode fashion.
- Differential noise-graphs presented in July 2000 (10/100) and January 2001 (1000BT) are presented here along with common-mode noise tolerance over freq
- 10X margin is placed to create a proposal
- Test Circuits (lab board/circuits) are shown for the controlled experiments, and the IEEE draft's here is how you test this spec, @ PSE/PD , other ways are possible.
- Last correlation of the EMI- Limited spec to Rick's measurements, of common & differential mode data that would cause EMI failures over TP cables.

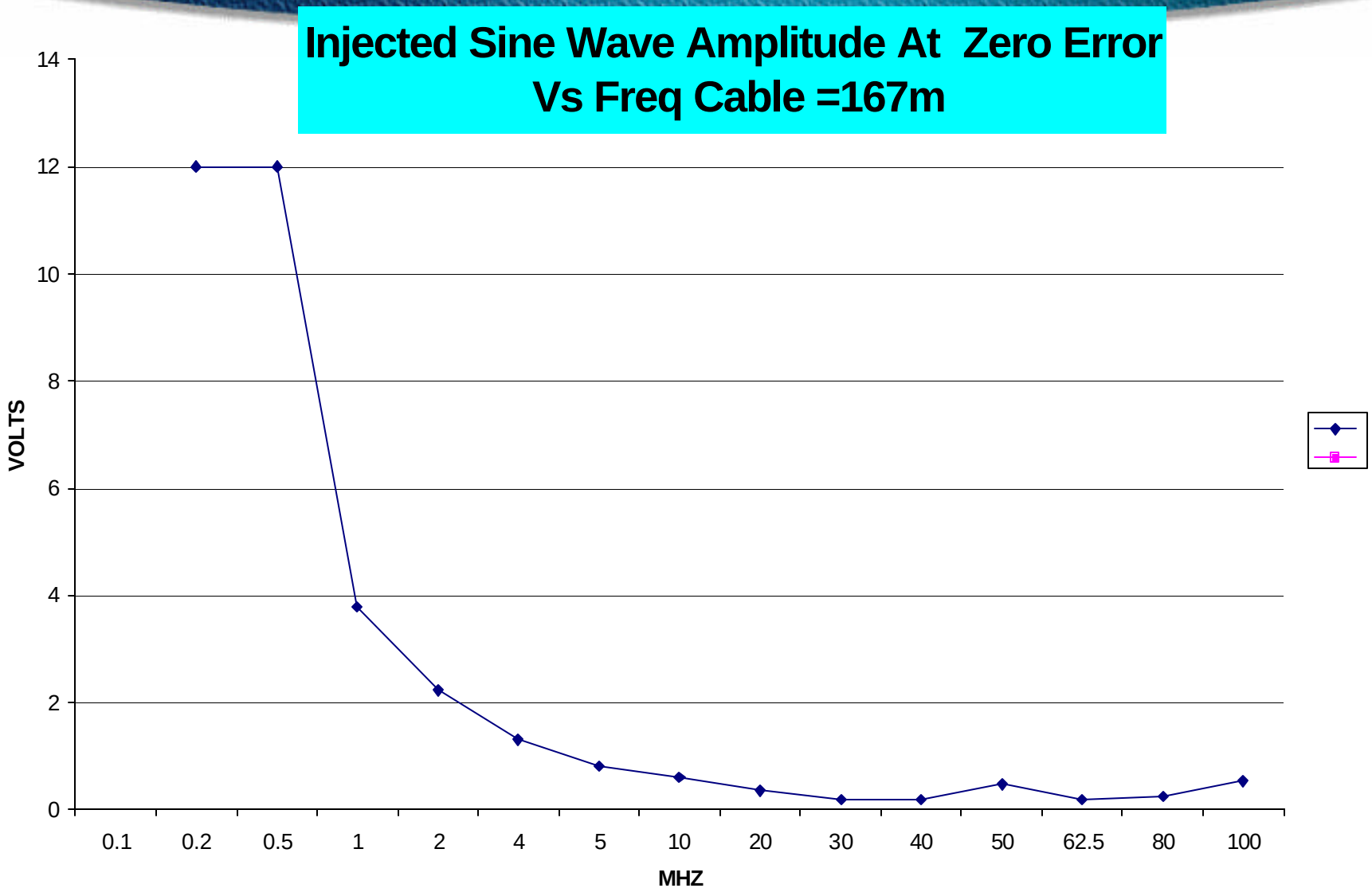
Differential Noise Test Circuit



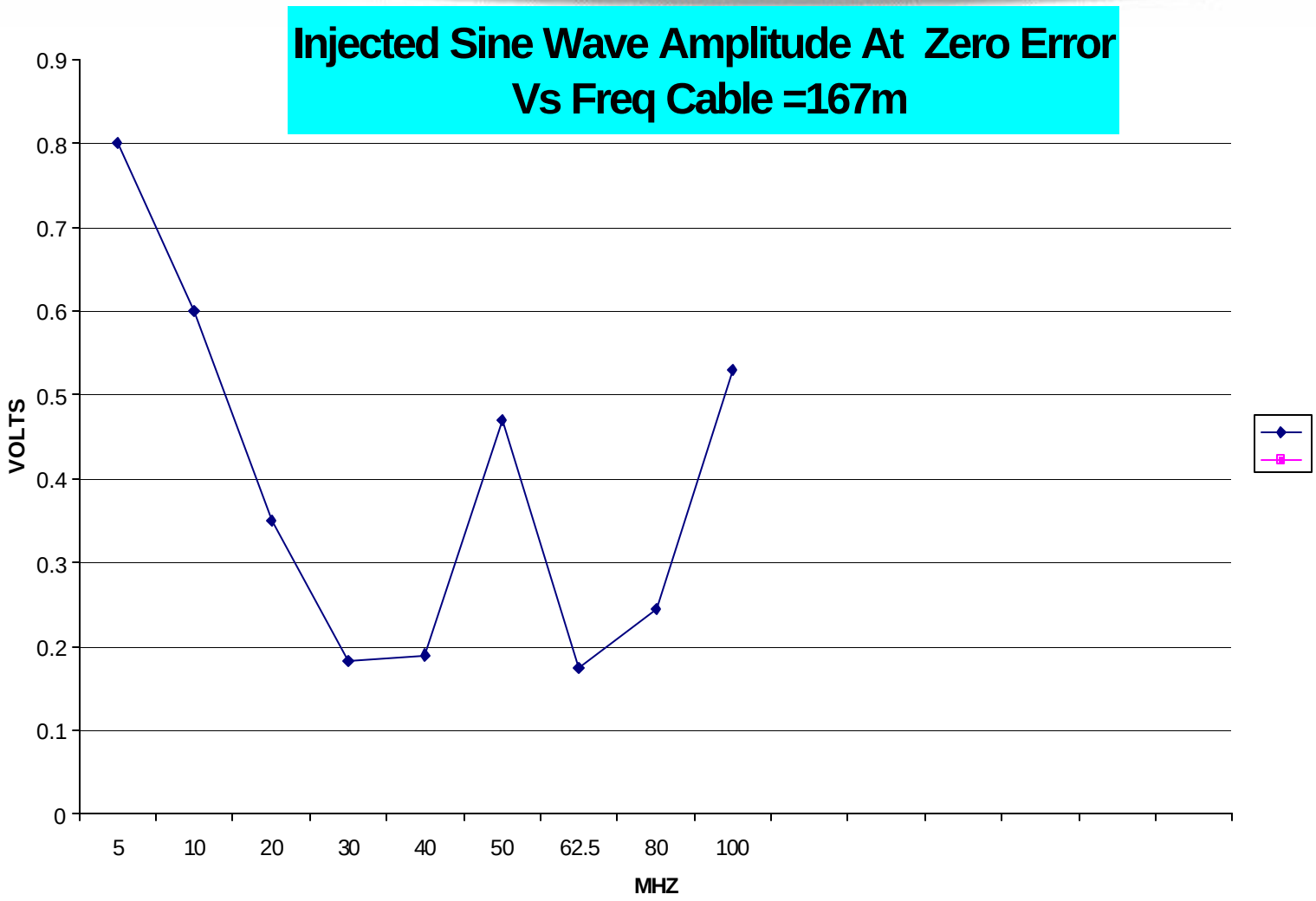
Common-mode Data Collection



1000BT Differential Noise Data

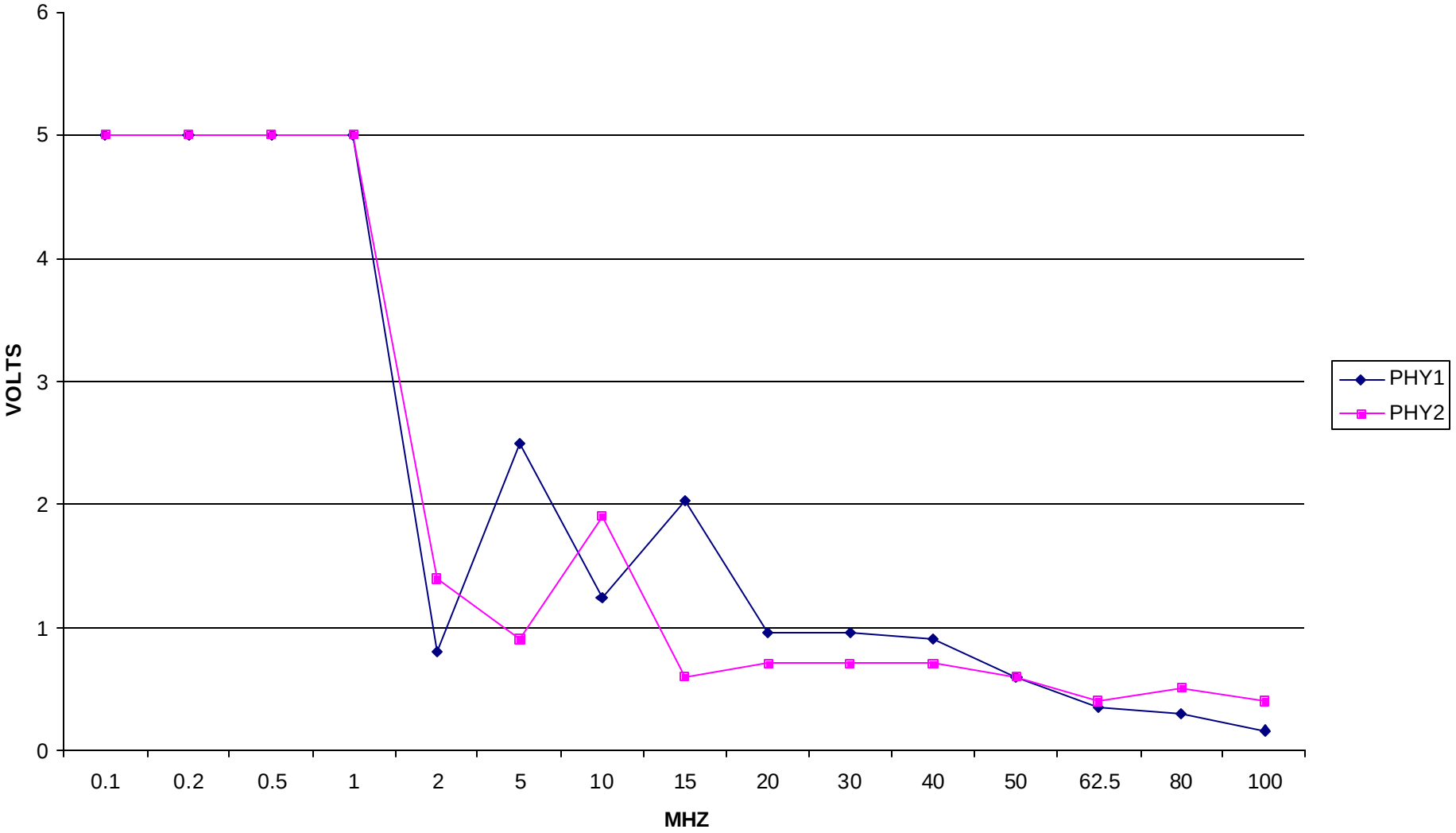


1000BT > 5MHz Zoom In



100 TX Differential Noise Data

Injected Sine Wave Amplitude At Zero Error Vs Freq 100MBIT



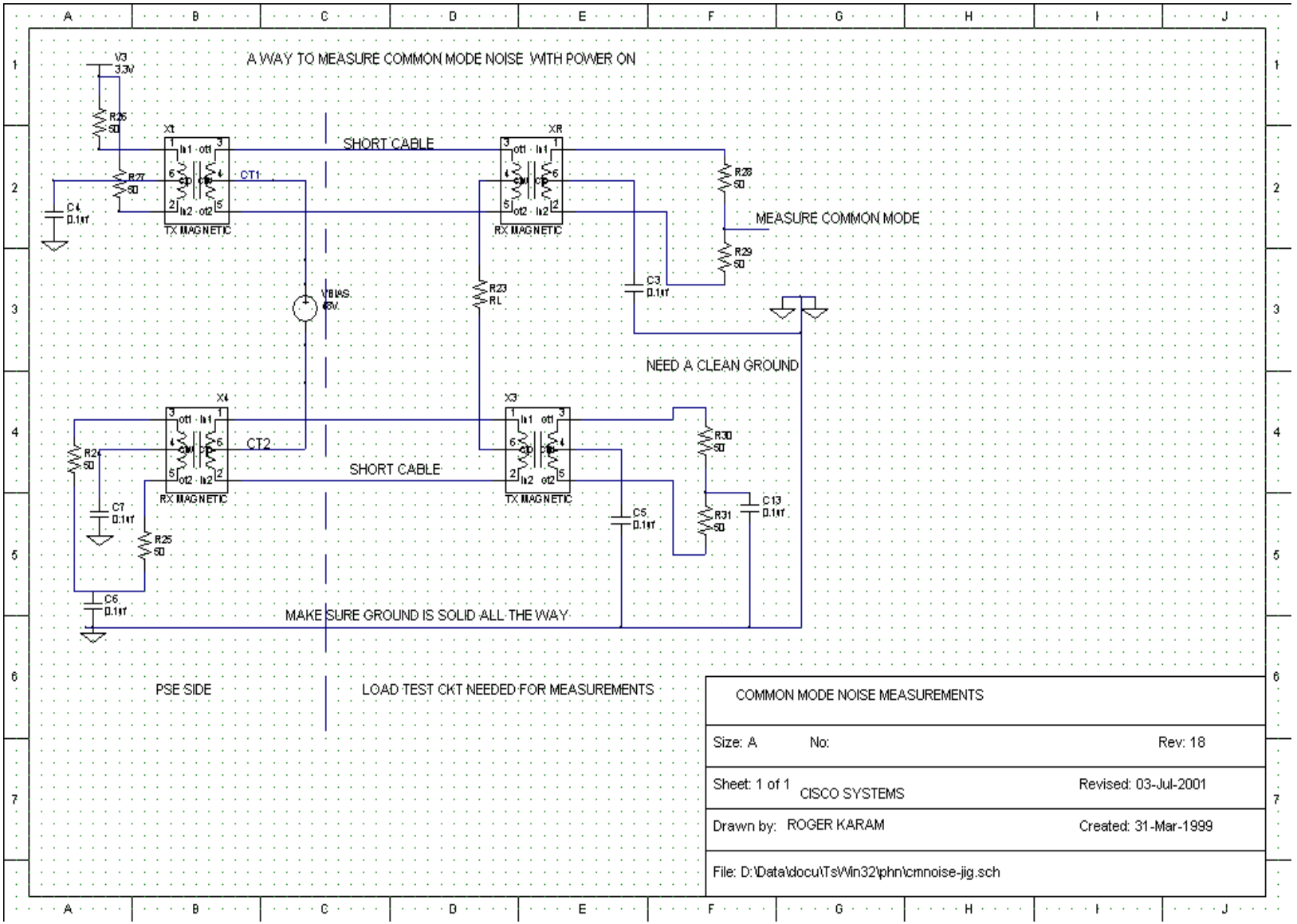
Common-mode Noise Data

	Tests				Proposed Specification	
Freq Range	10/100		1000BT		10/100/1000 with 10X margin	
	Phy A to A	Phy A to B	Phy A To A		Freq Range	Maximum Noise
30k-300k	1.9v	1.8v	1.9v		<300khz	200mv
300k-3M	1.8v	1.8v	1.68v		300k-3M	150mv
3M-30M	922m	500m	400m		3M-30M	30mv
30M-50M	519m	389m	380m		30M-100Mhz	15mv
					> 100Mhz	15mv

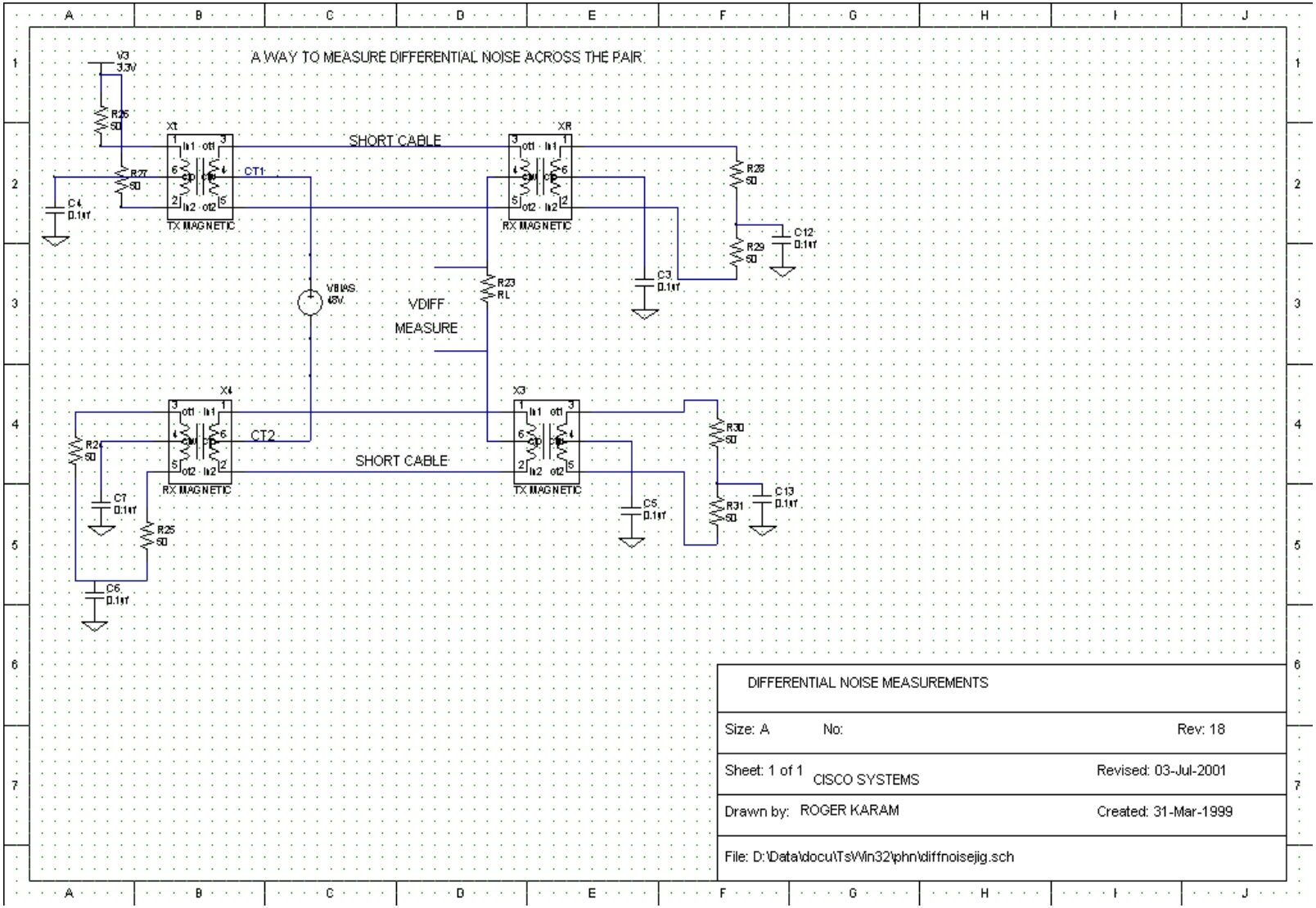
Differential Noise Spec

	Differential Noise See Graphs				Proposed Specification	
Freq Range	10/100		1000BT		10/100/1000 with 10X margin	
					Freq Range	Maximum Noise
< 1MHz	500m		500m		< 1MHz	500m
5-10M	40m		100m		5-10M	40m
>10MHZ	20m		20m		> 10MHZ	20m

Common-mode Noise Test Circuit



Differential-mode Noise Test Circuit



Summary

- EMI will be the limiting factor
- Data assumes proper receiver design for common mode rejection
- These levels are very likely to cause emi failure, but that we have data for, and will not spec here.
- Measuring “uv” for emi and constraining data for emi is not our Goal.
- So we must state that emi /immunity specs may dominate and make this Spec A minimum.
- It is the responsibility of the PD/PSE designer to insure that adding power does not degrade the BER.
- Next we include a correlation to RICK’s EMI measurements.

60HZ Specification

- We could get better spec for 60HZ at a cost
- it would cost no less than $2k, and a couple of days
- Resorted to the Bellcore specification to Interpolate.

trying to do some measurements if i can... tough to setup...

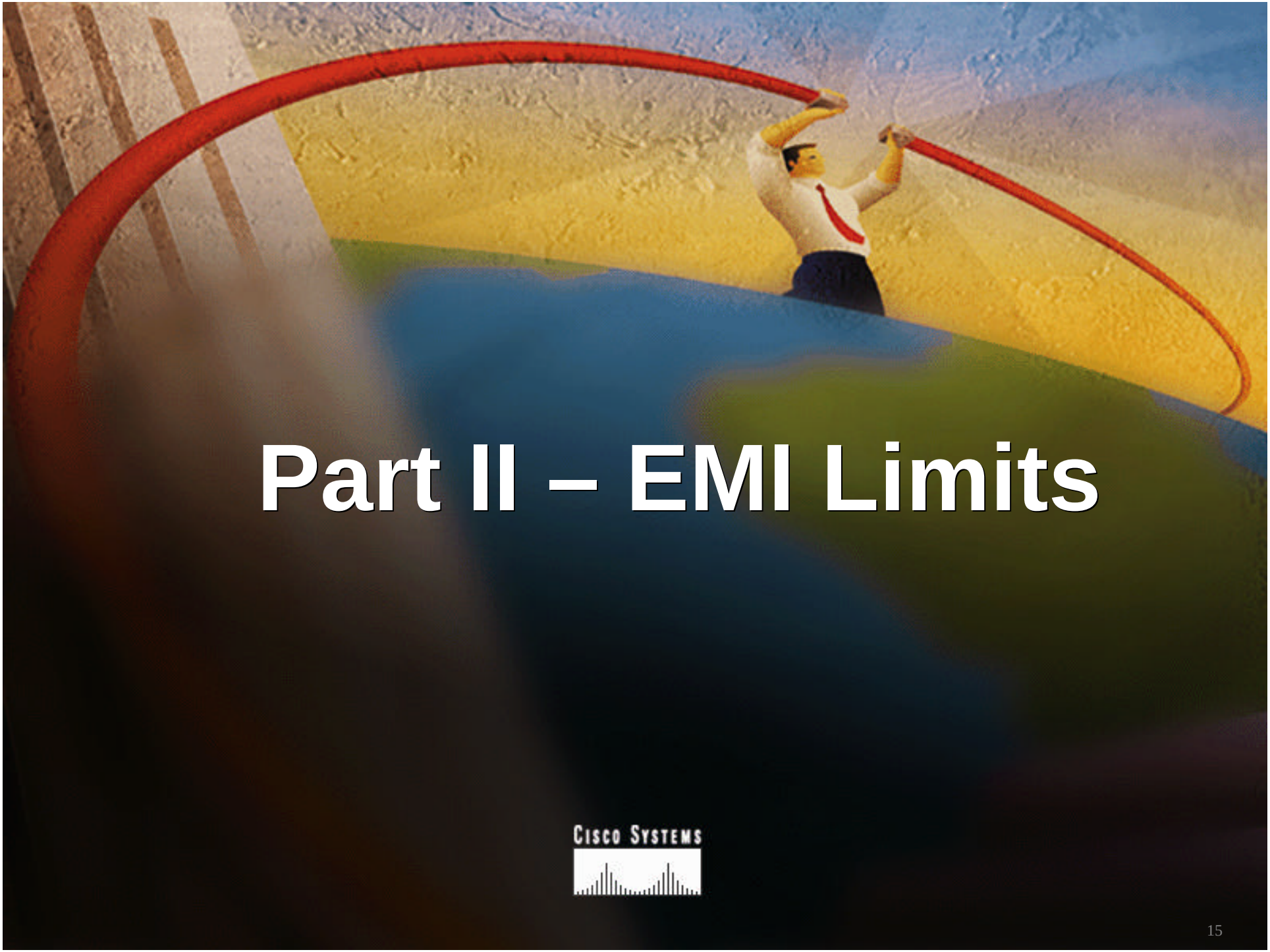
out of the Bellcore spec, for a 20kft run we could see 50vrms into 600ohms. per pair

so say we could have 400ft in ethernet.

and the spec should be (400/20000) * 50v rms = 1vrms

I don’t have More data on this, any Volunteers?

There is a good chance 500mv-1v is all we need.



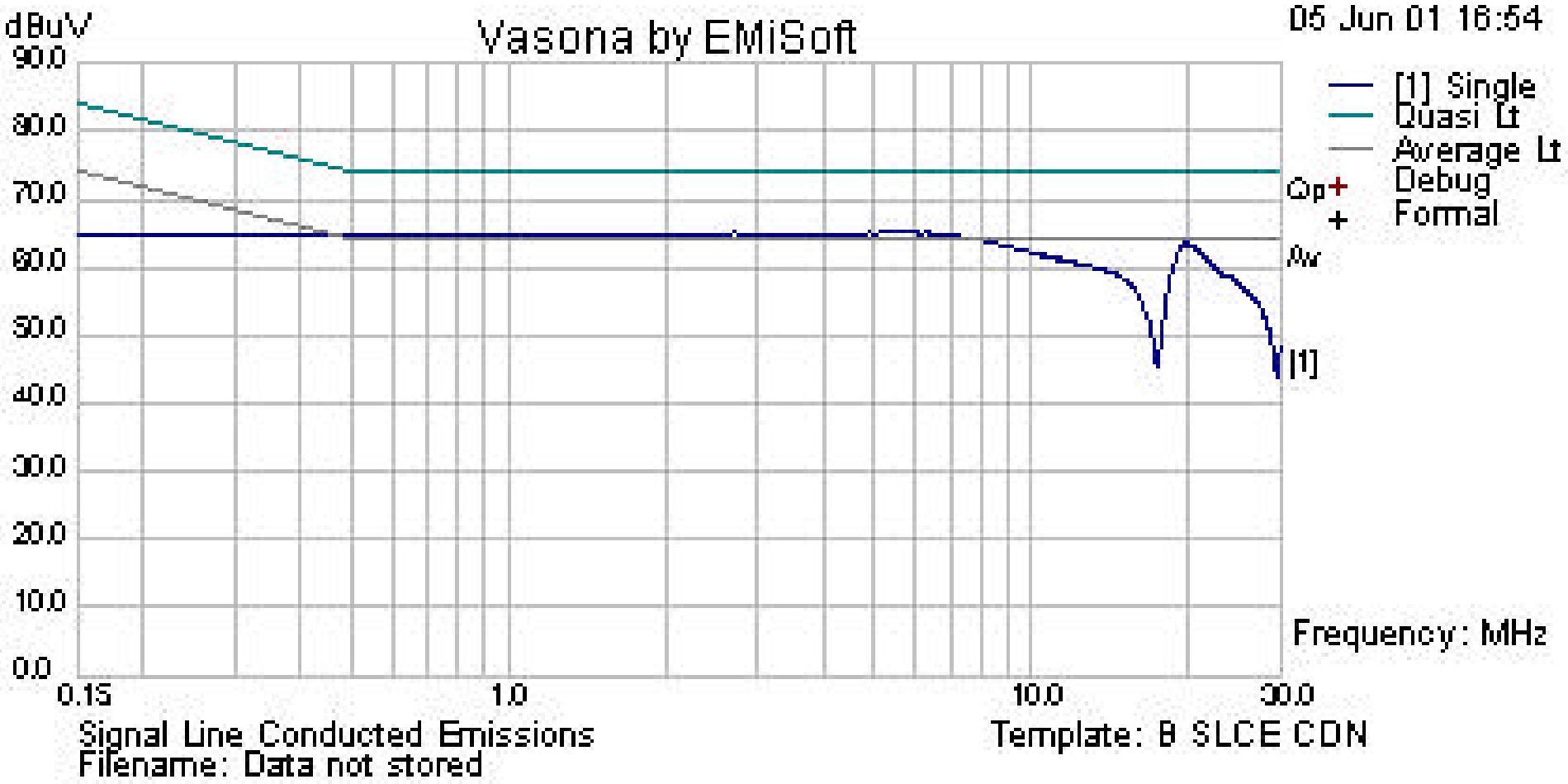
Part II – EMI Limits

EMI Limitation on Noise Spec

- Did Both Common Mode and Pair-Pair Measurements
- Did Both Conducted and Radiated
- This was meant to correlate with Rick's Measurement in some case we agree in some we don't
- The story does not end here, on a Multi-Port switch these numbers will change and we prefer not to start specing Mico Volts, if anything this points the challenges are really in EMI as pointed back in San Diego ….
- The good news is that the noise in the DC/DC area's (100's of Khz) can be easier to deal with (EMI allows few 100's of mv)- with reasonnable filtering IF kept Differential...

Conducted Common Mode (single Pair)

75dBuV from 8591EM tracking generator.

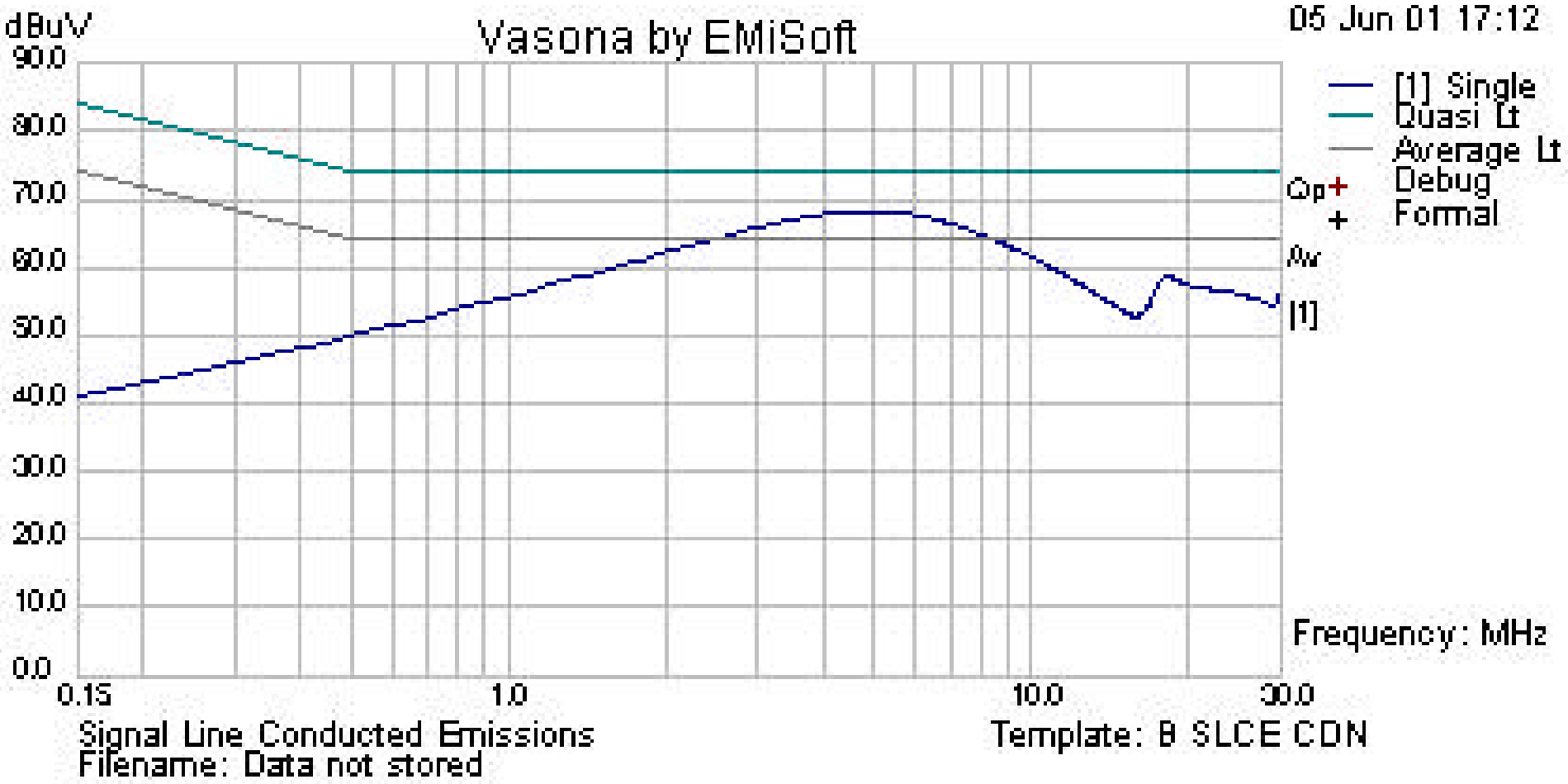


Conducted Common-mode Correlation

Freq	*COMMON MODE*	Rick's #	Comments
20-20K	Not Done		
20k-150K	<5.6mv	<500mv	This is with no margin for a single port we need to check again
150k-1Mhz	<1mv	<1mv	fine with this
1M-30Mhz	<0.3mv	<0.3mv	fine with this if we margin up here…

Conducted Differential (Pair-Pair)

100dBuV from 8591EM tracking generator.



Conducted Pair-Pair Correlation

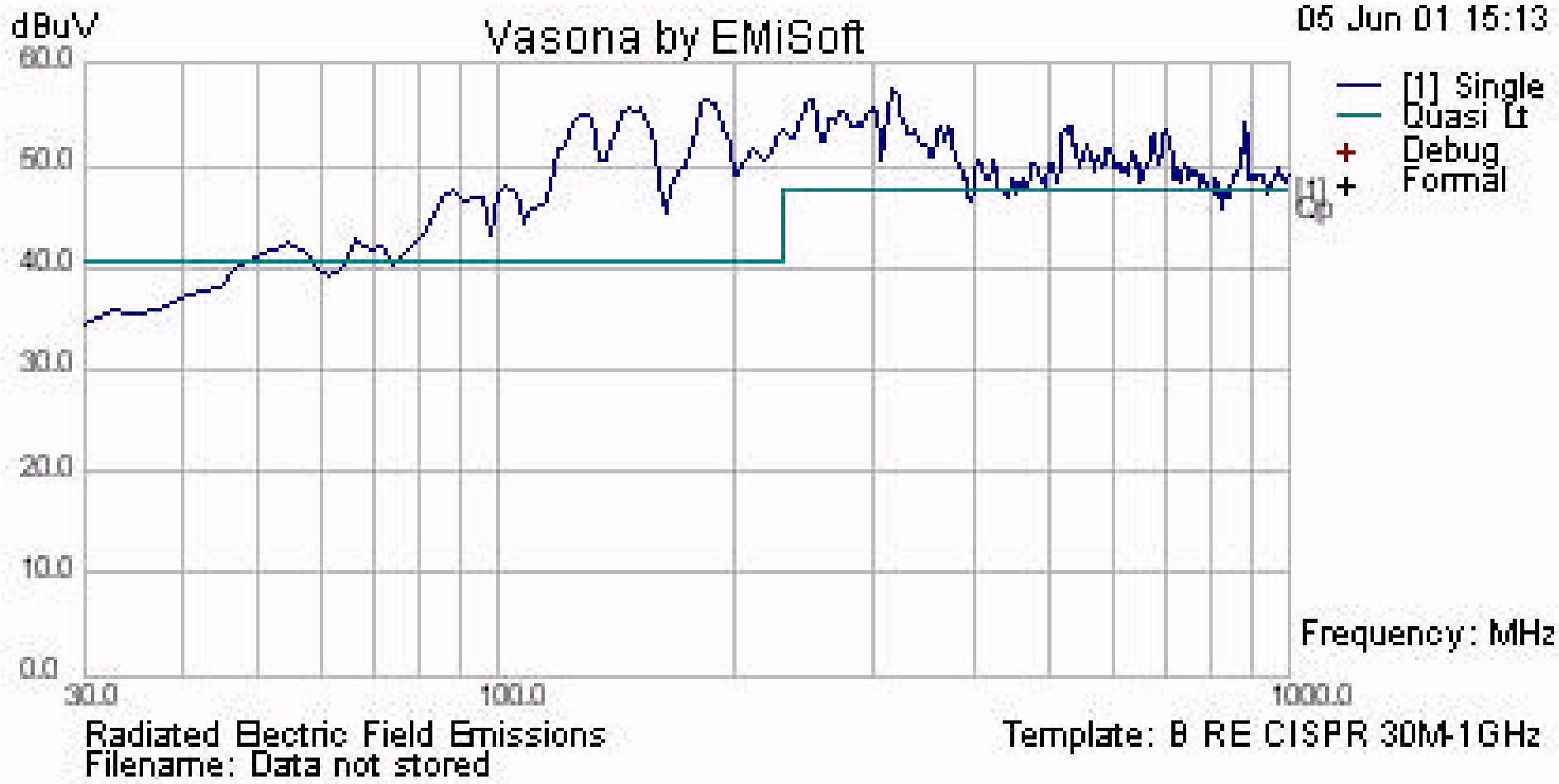
Freq	Pair To Pair	Rick's #	Agree with Rick
20-20K	Not Done		
20k-150K	< 500mv	<500mv	Yes
150k-1Mhz	<200mv	<100mv	No/Looser
1M-30Mhz	<20mv	<3mv	No/looser

Conducted Pair-Pair Correlation

Freq	Pair To Pair	Rick's #	Comments
20-20K	Not Done		
20k-150K	< 500mv	<500mv	basically this is strictly Ethernet signal limited
150k-1Mhz	<200mv	<100mv	Worst case is a total of 100dbuv+15dbuv to be at the limit around 1MHZ (sloping upward) This leaves us with 0.5v to the limit for a single port. Data that we do not suffer from Ethernet Link Degradation
1M-30Mhz	<20mv	<3mv	Here we are at the spec between 2-9Mhz for a 100dbuv we are left with about 95dbuv this put us at 56m, allow for 6db margin 20mv would be enough.?? This is for Multiports and all other factors (meas Errors)…

Graph C – Radiated Differential

80dBuV from 8591EM tracking generator.

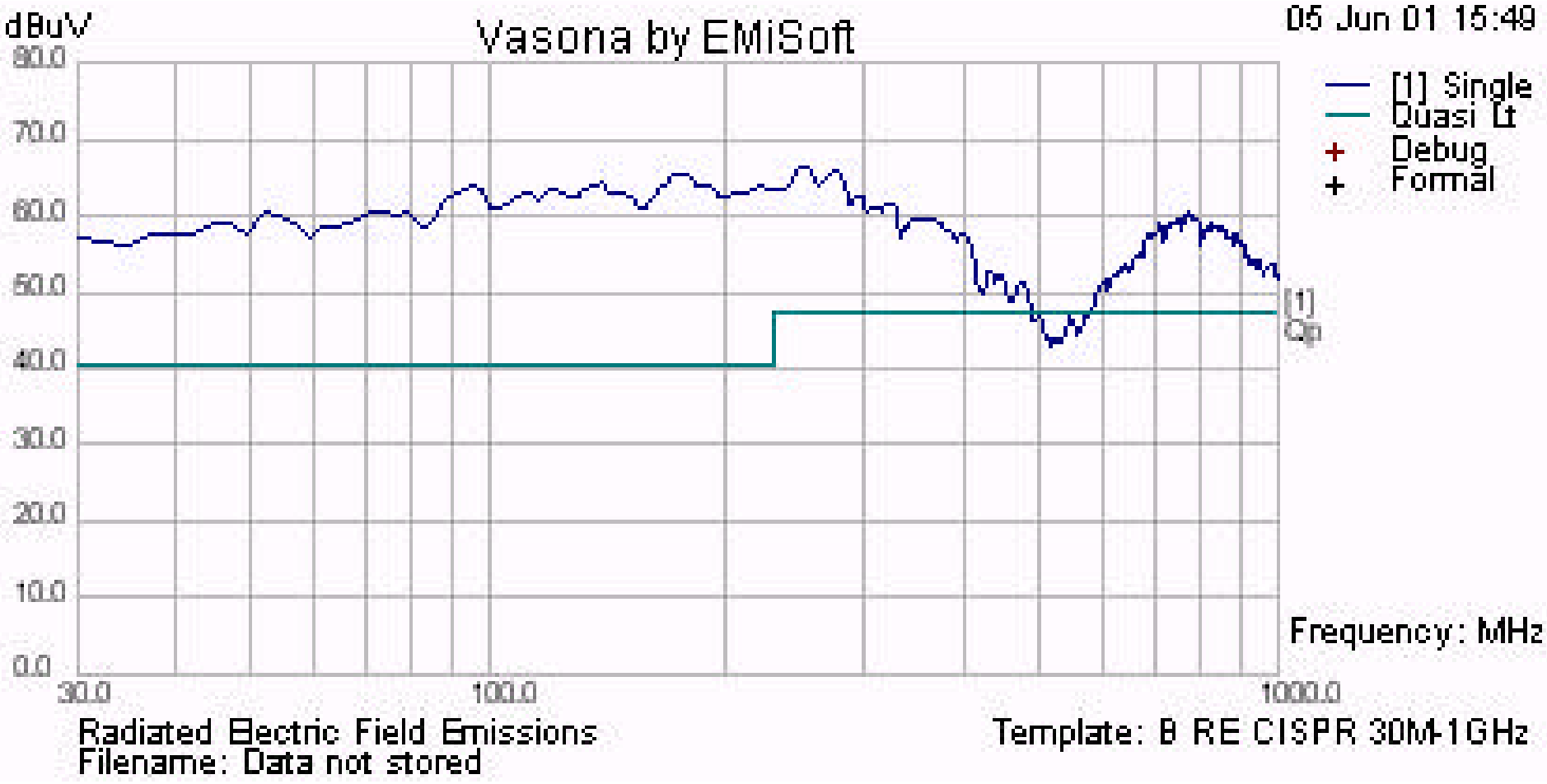


Differential Radiated Limits

Freq	*COMMON MODE*	Rick's #	Comments
30M-1GHZ	<10uv	<0.3mv	Here we are at 80dbuv-60dbuv =20dbuv (right at the limit). this puts us at 10uv. Yuck. How do we measure 10UV (smiling of course)and we have not factored any margin (error in measurements- Multiport)

Graph D – Radiated Common-mode

80dBuV from 8591EM tracking generator.

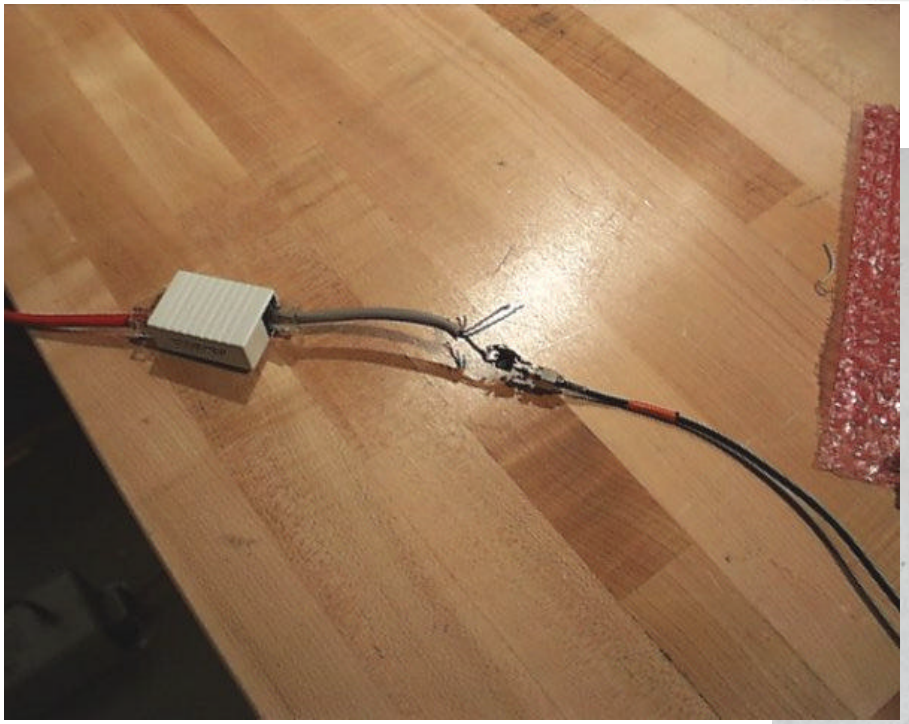


Common-mode radiated limits

Next For Radiated (30M-1Ghz Use Graph D= WORST CASE below)

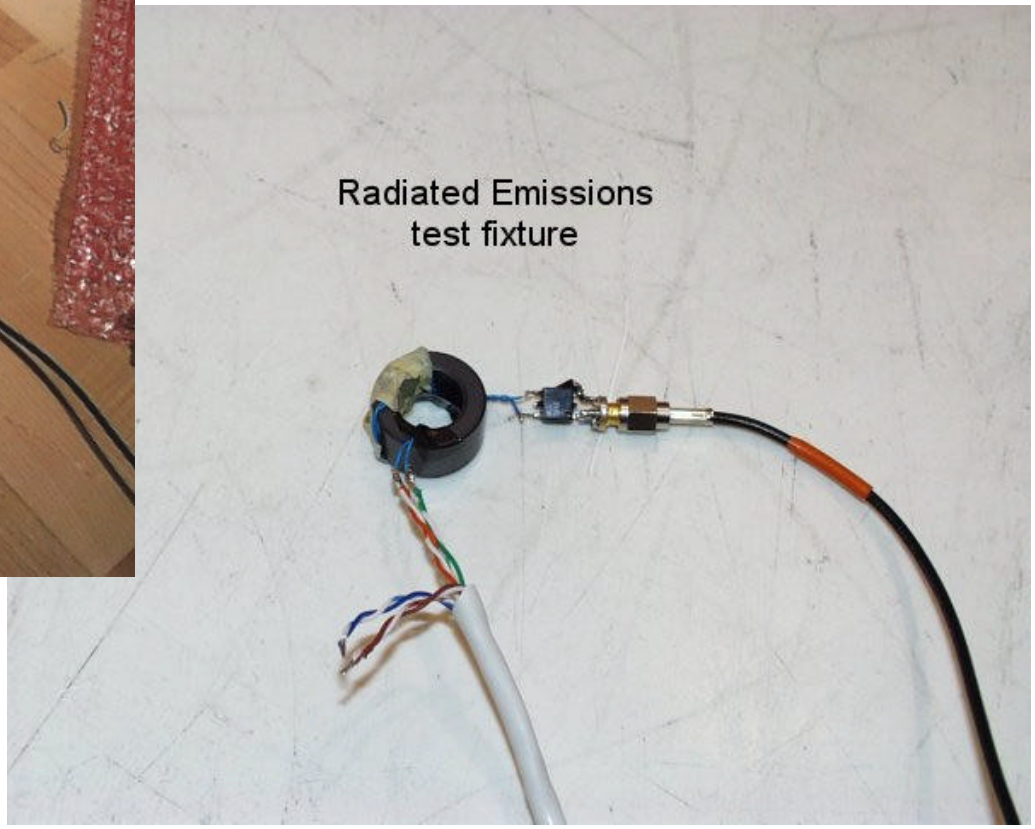
Freq	*COMMON MODE*	Rick's #	Comments
30M-1GHZ	<10uv	<0.3mv	Here we are at 80dbuv-60dbuv =20dbuv (right at the limit). this puts us at 10uv. Yuck. How do we measure 10UV (smiling of course)and we have not factored any margin (error in measurements- Multiport)

EMI-Data on TP cable Common-mode & Pair-Pair



Common mode test

Differential with Choke



EMI-Based Results Summary

- The Radiated limits are at about 30uv for both Pair-Pair and common-mode measurements
- Conducted limits are in the few mv for common mode
- but can be up in the 100’s of mv if kept differential.
- We may want to spec the level of noise affecting the data per this proposal and leave the EMI spec in an annex, please note that these measurements were for a single-port.