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A Physical Layer for 100 Mbits/s Ethernet over UTP CAT-5 Cable with 800m Range

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True Ethernet PHY

To be compatible with existing copper Ethernet MAC

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Target Installation Base

- PHY with up to 800 meters range can be used
  - From the fiber to the dwelling
  - Within multi-unit buildings
  - Within hospitals
  - Within Hotels
  - Inside home
- Copper is the preferred medium for mid-range data rates due to the lower cost and ease of installation and maintenance

Application Example 1 (LAX)

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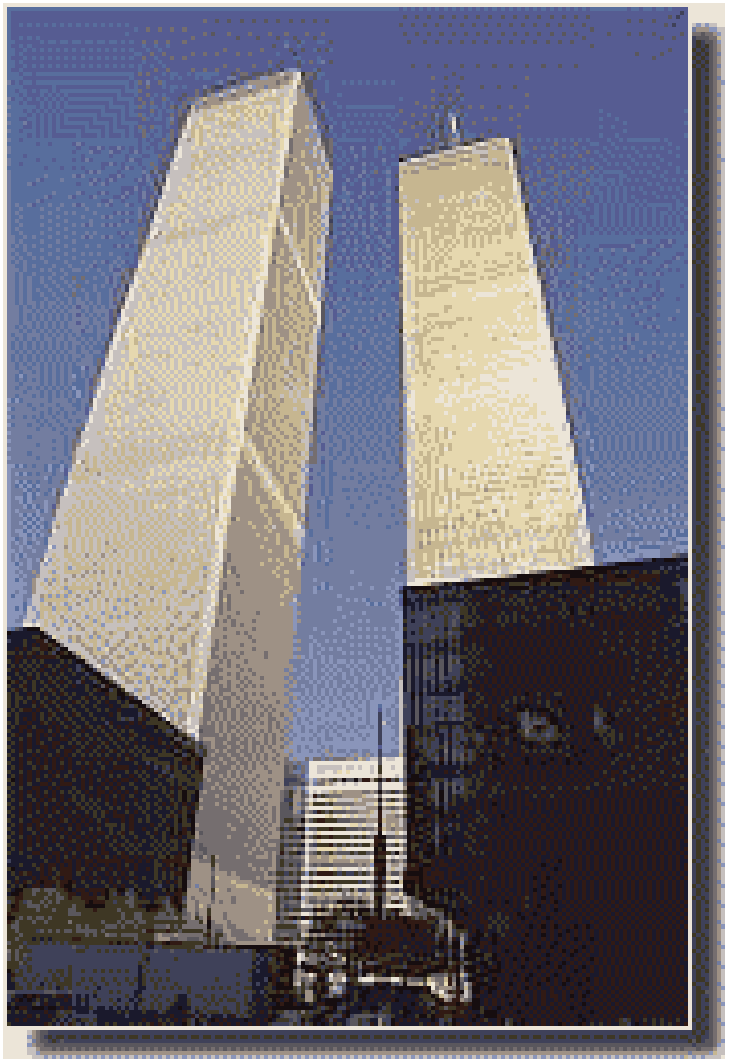
Application Example 2 (WTC-NYC)



450m

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Performance for Proposed PHYs

- 100 Mbits/s is sufficient for many applications (e.g., HDTV, SDTV, digital telephone, internet, etc.) and it is the most widely used Ethernet speed (100BASE-TX)

- Propose a 100 Mbits/s PHY over 4 pairs of CAT-5 cable for range of 800 meters (half a mile)
  - Up to 1000 meters can be demonstrated using existing components
  - Refer to this proposed PHY as 100C5

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Modulation Scheme

- Coding/modulation scheme identical to 1000BATE-T
- Throughput at 10 times lower speed
  - Clock rate of 12.5 MHz
- No major implementation problems due to speed or power
- Can be implemented using ASIC methodology
- A proven modulation scheme

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Comparison with other Copper Standards

Ethernet Scheme	Data Rate (Mbits/s) /Nyquest Frequency (MHz)	Distance Target (m)	Cabling	Coding / Modulation	Voltage Swing (V)
10BASE-T	10 / 10	≥100	2 pairs CAT-3 or better (simplex)	Manchester Coding	±2.5
100BASE-TX	100 / 62.5	≥100	2 pairs CAT-3 or better (simplex)	4B/5B PAM-3	±1
1000BASE-T	1000 / 62.5	≥100	4 pairs CAT-5 (duplex)	TCM PAM-5	±1
100C5 (CAT-5)	**100 / 6.25**	**≥800 (~1000)**	**4 pairs CAT-5 (duplex)**	**TCM PAM-5**	**±1**

8 dB lower transmission power than 10BASE-T
meets FCC radiation restrictions

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Simulation Models for CAT-5

- ANSI T1.417 CAT-5 cable transfer function model
- TIA/EIA-TSB-95 return loss (echo) model
- TIA/EIA-568-A NEXT model
- TIA/EIA-TSB-95 ELFEXT model
- ANSI T1.417 CAT-5 cable AWGN model

Simulated 1000BASE-T Eye Diagram

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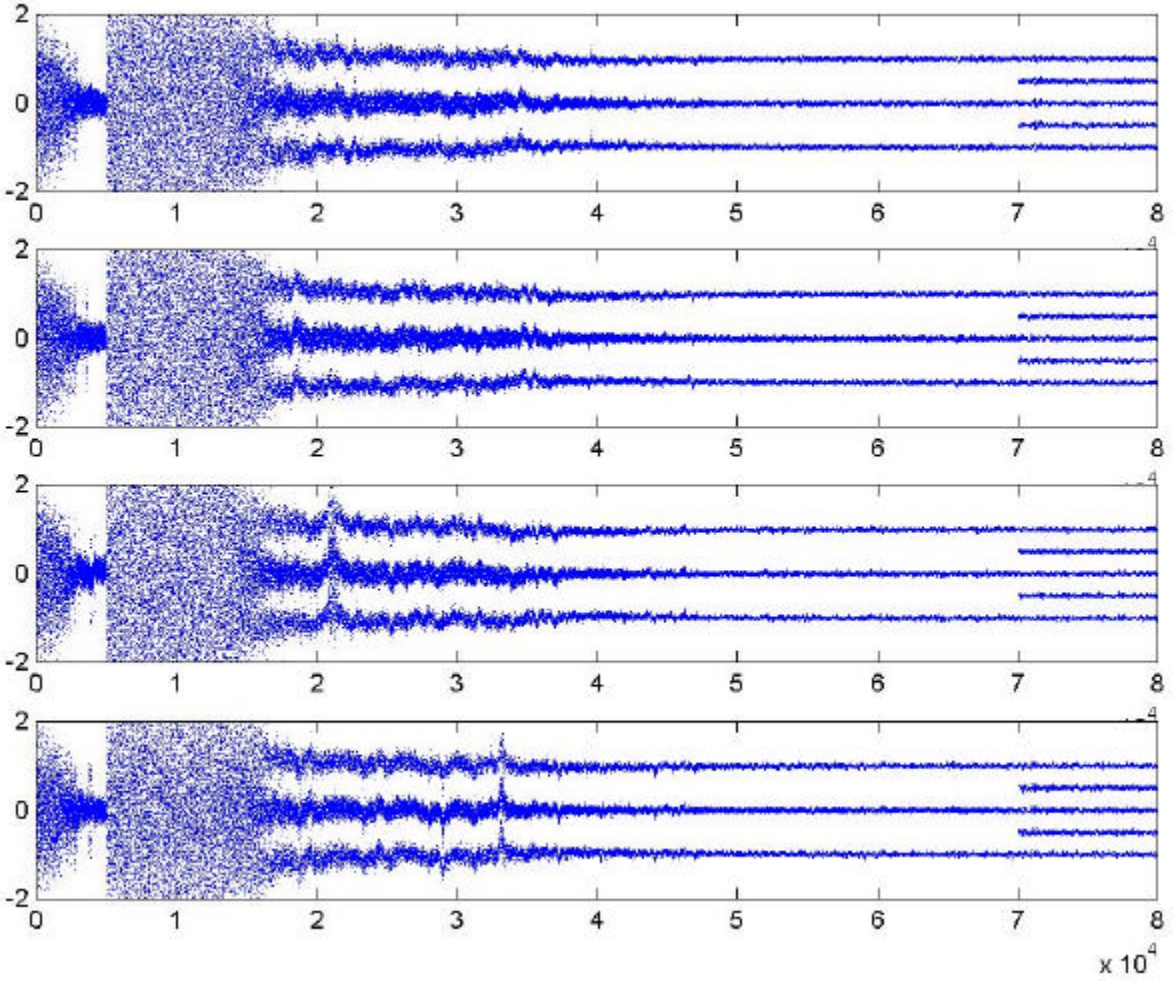
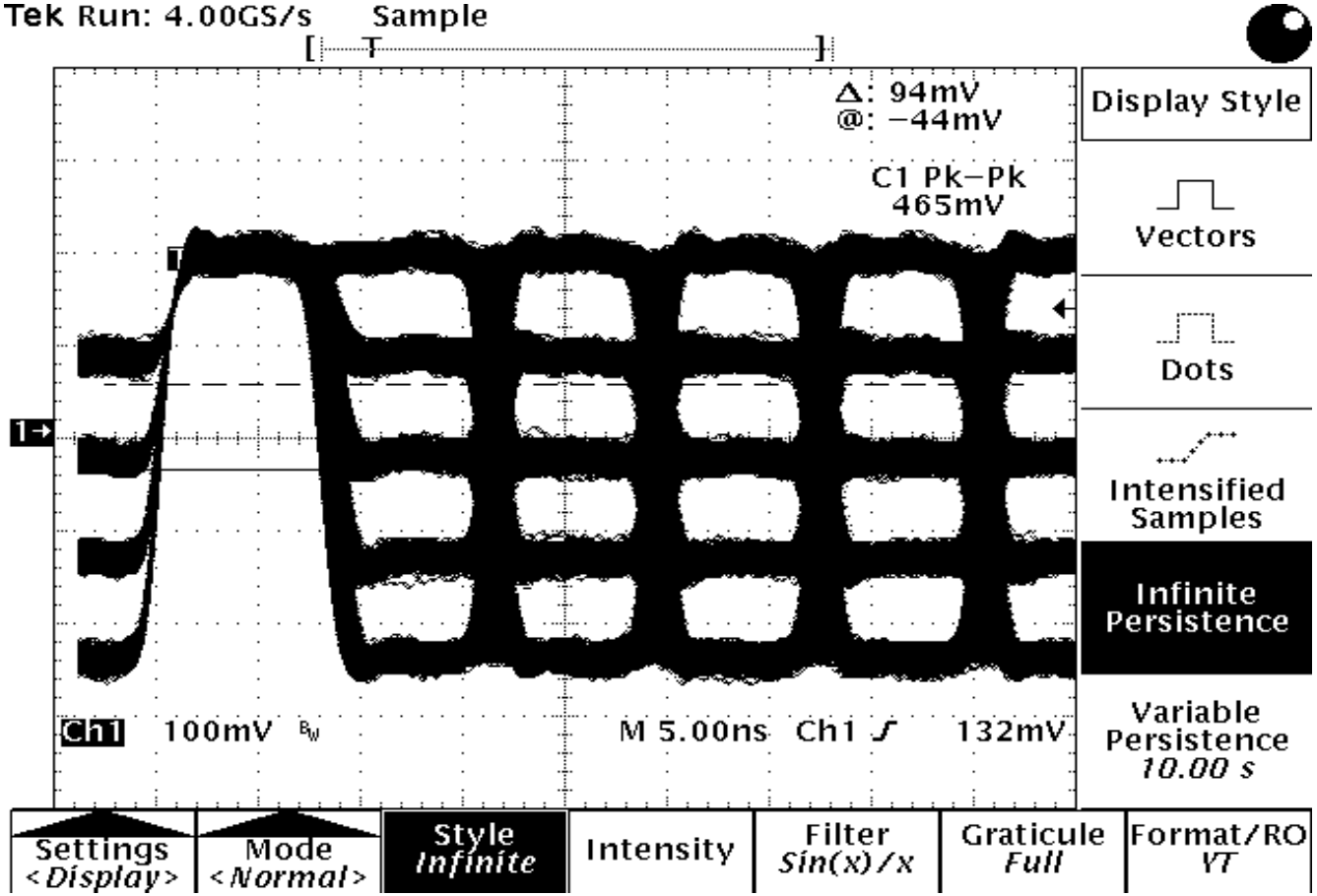
100m CAT-5 cable

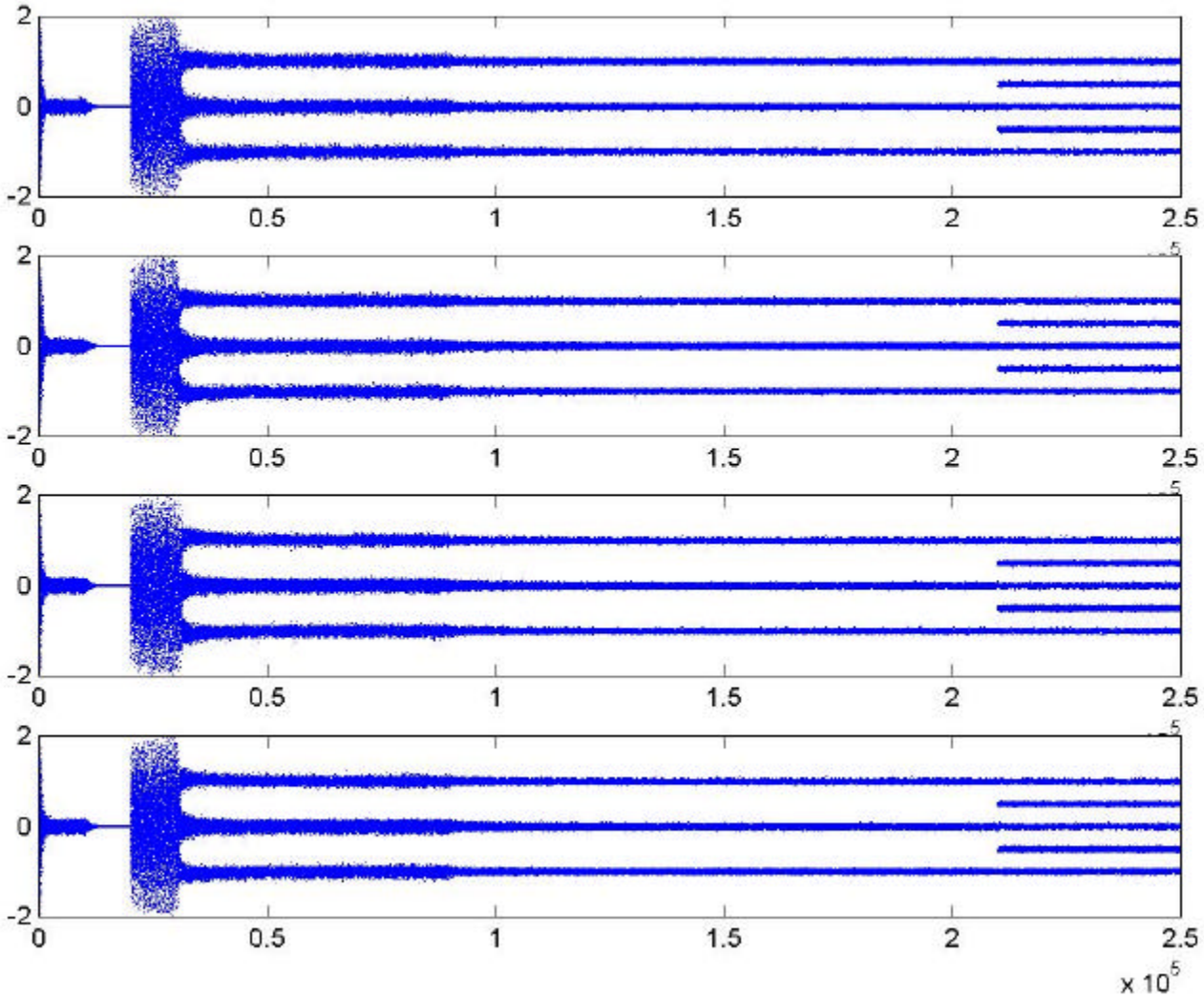


Measured 1000BASE-T Eye Diagram

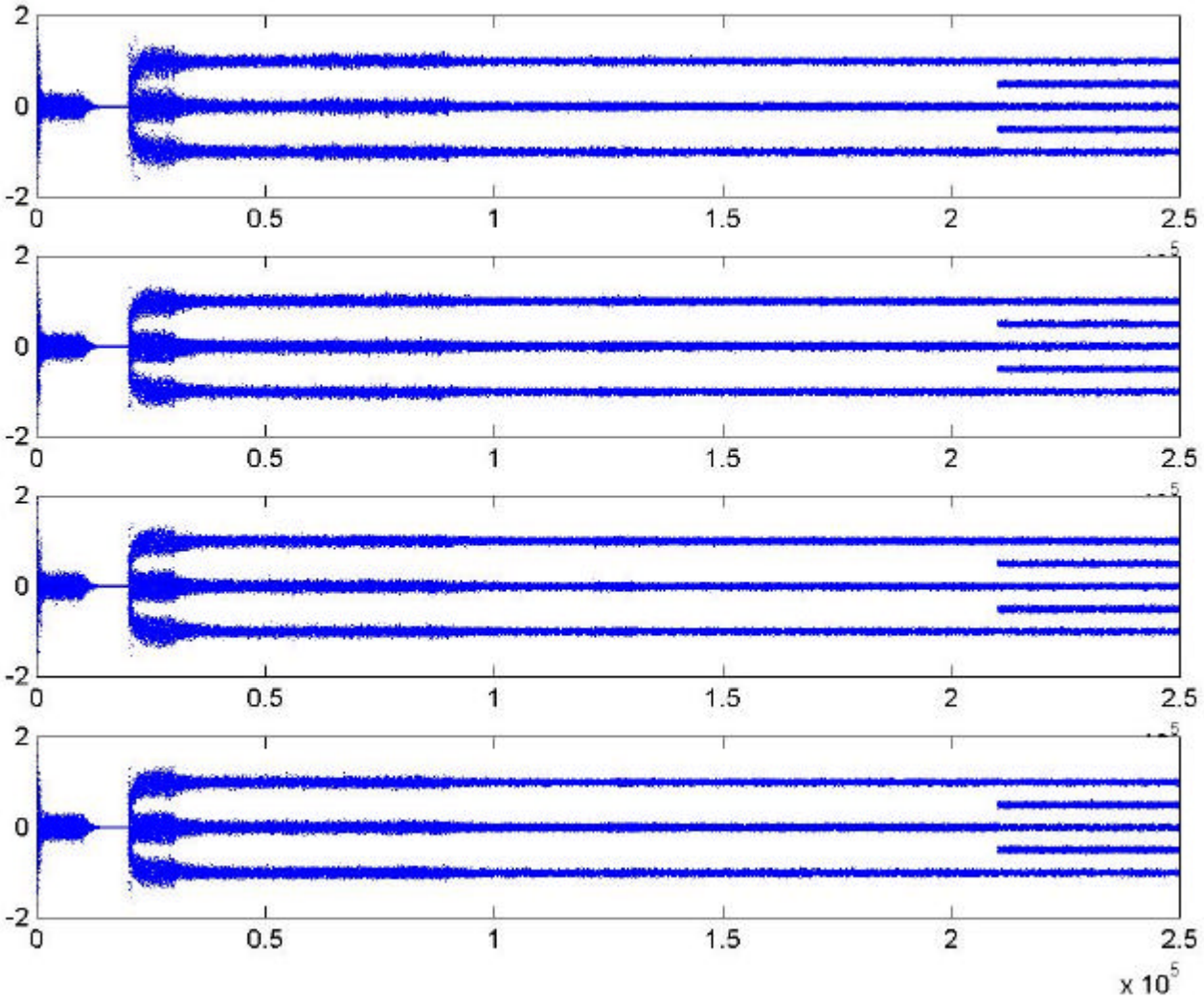
100 m CAT-5 cable



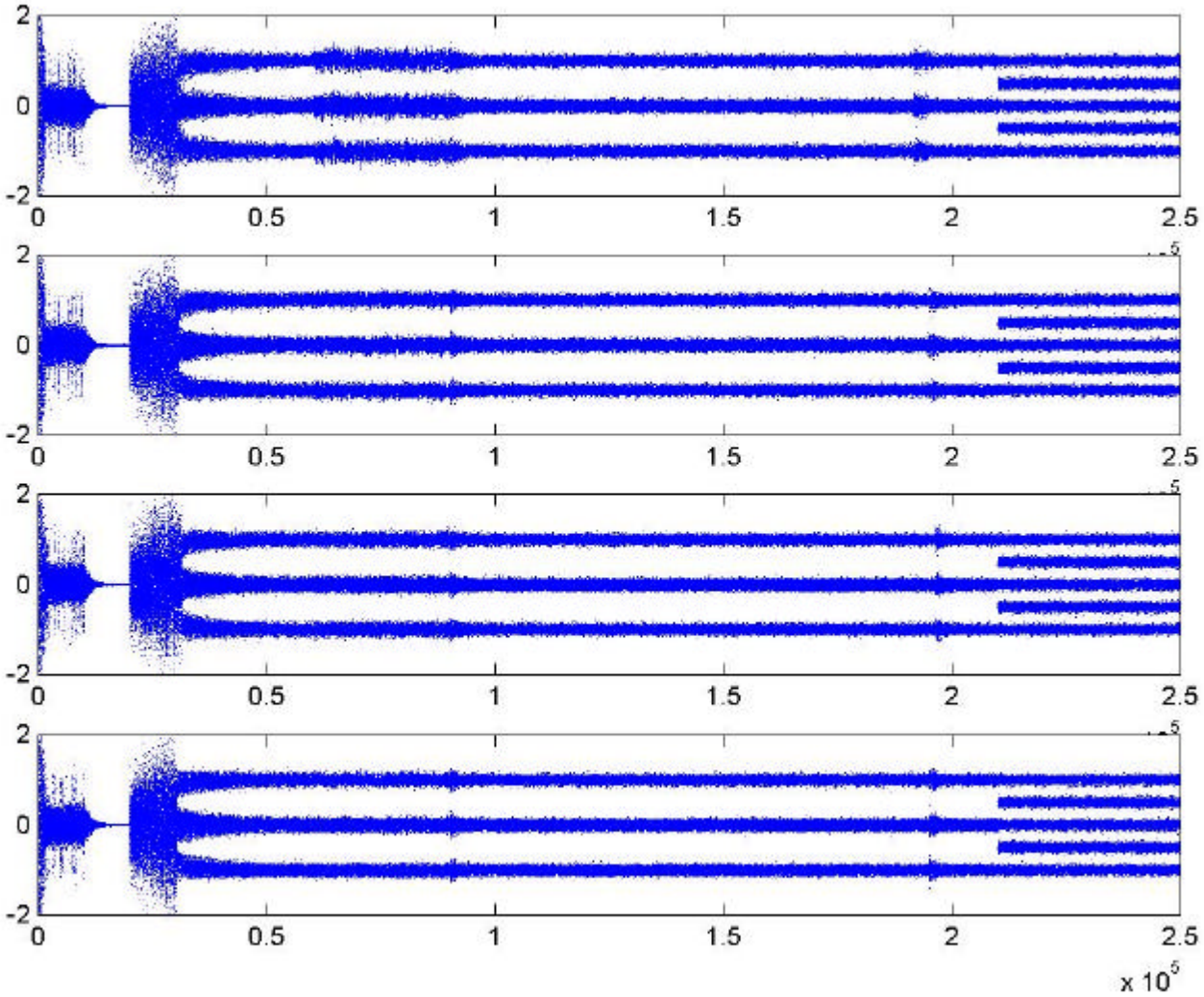
Eye Diagram of 100C5 over 600m CAT-5



Eye Diagram of 100C5 over 800m CAT-5



Eye Diagram of 100C5 over 1km CAT-5



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Easy Migration from 1000BASE-T to 100C5

- Same CAT-5 cable
- Same TCM scheme (rate 8/9)
- Same transmit power (± 1V)
- Same receiver architecture
- Same duplex mode
- Ethernet MAC @ 100Mb/s

- Lower data rate (100Mbits/s)
  - Lower circuit speed, better performance
  - Higher ADC resolution (10+ bits)
- Longer transmission distance (≥ 800m, ~1km)
- Lower FEXT
- Lower radiation than 100BASE-TX

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Summary of 100C5 Proposal

- Feasibility of 100 Mbit/s over UTP CAT-5 verified by simulation using standardized models
- No change to Ethernet MAC
- Very similar to existing 802.3ab standard
  - Much lower speed (10 times)
  - Low cost and power
- Data rate that supports speed critical applications