

INTRODUCTION TO EECS II

DIGITAL

COMMUNICATION

SYSTEMS

6.02 Fall 2010

Lecture #2

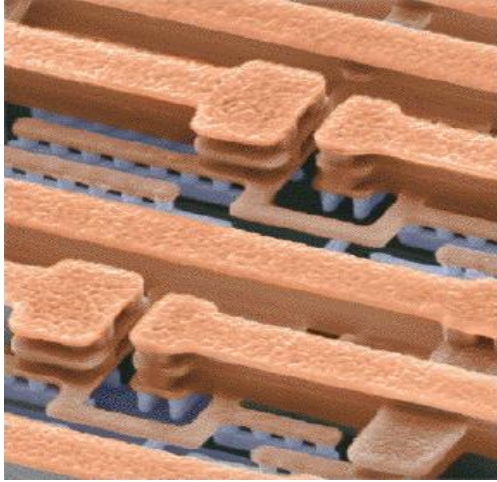
- Samples and Bits
- Real Wires
- Models
- Linearity and Superposition

6.02 Lecture 2 - Wires and Models

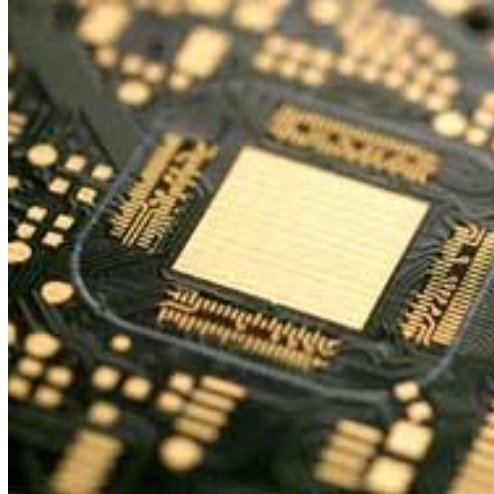
- Wires, Samples, and Bits
- Non-Ideal Transmission
 - Example wires and signal impact
 - Intersymbol Interference and Eye Diagrams
- Modeling Wires
 - Causality
 - Time-invariance
 - Linearity
- SUPERPOSITION
 - Demonstrating why it is so super

Types of Real “Wires”

IC Interconnect

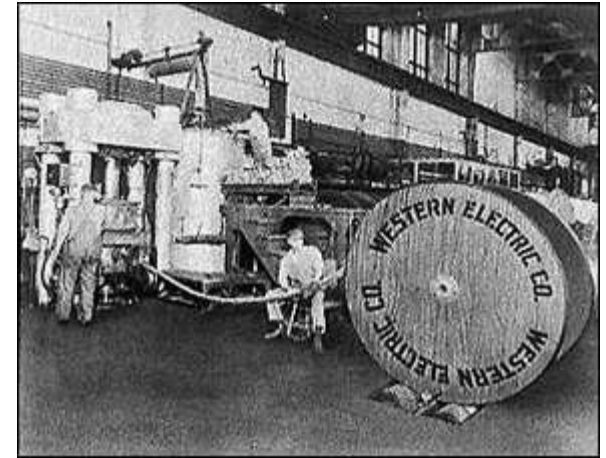


Printed Circuit Board



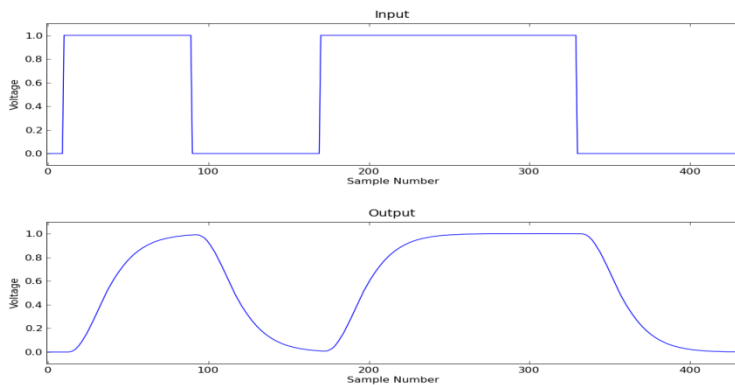
http://www.gpv-pcb.com/Files/Billeder/fabrikker/chemicalic/Chem_pcb_hdi.jpg

Transatlantic Cable

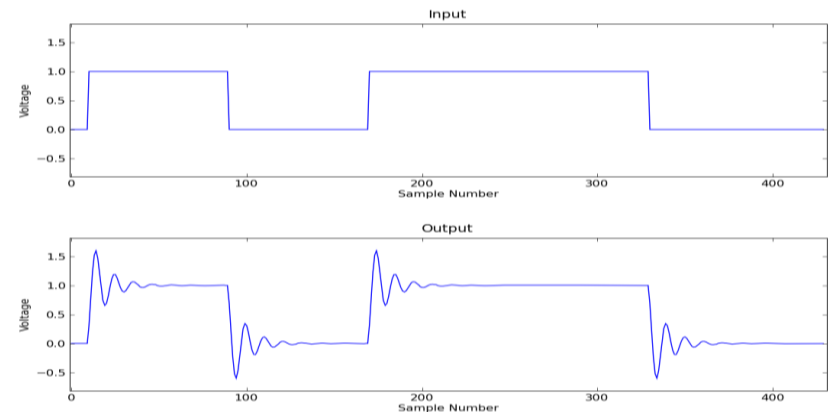


<http://www.satamerica.com/imagens/4a27897r1.jpg>

Slow Response

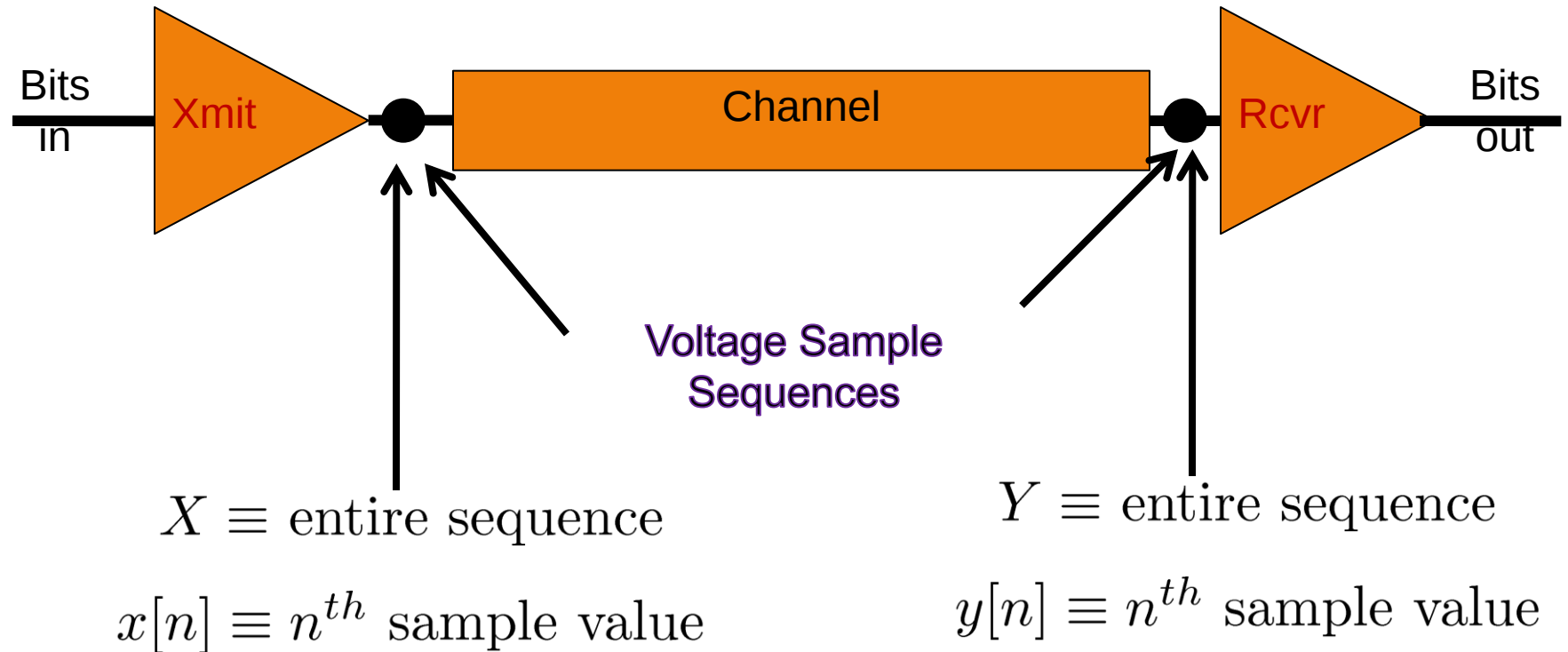


Ringing



May also have long delays (Receiver does NOT know)

Transmission Setup and Notation



Sample Rates:

- 4 million Samples/Second (IR Transceiver)
- Up to gigaSamples/Second (Fastest)

Samples, Bit Period, Bit Rate

- Our Hardware

- Updates transmitter output voltage every $\frac{1}{4}$ microsecond (4 million times a second).
- Remeasures receiver voltage every microsecond (4 million times a second).

- Bit Period and Bit Rate

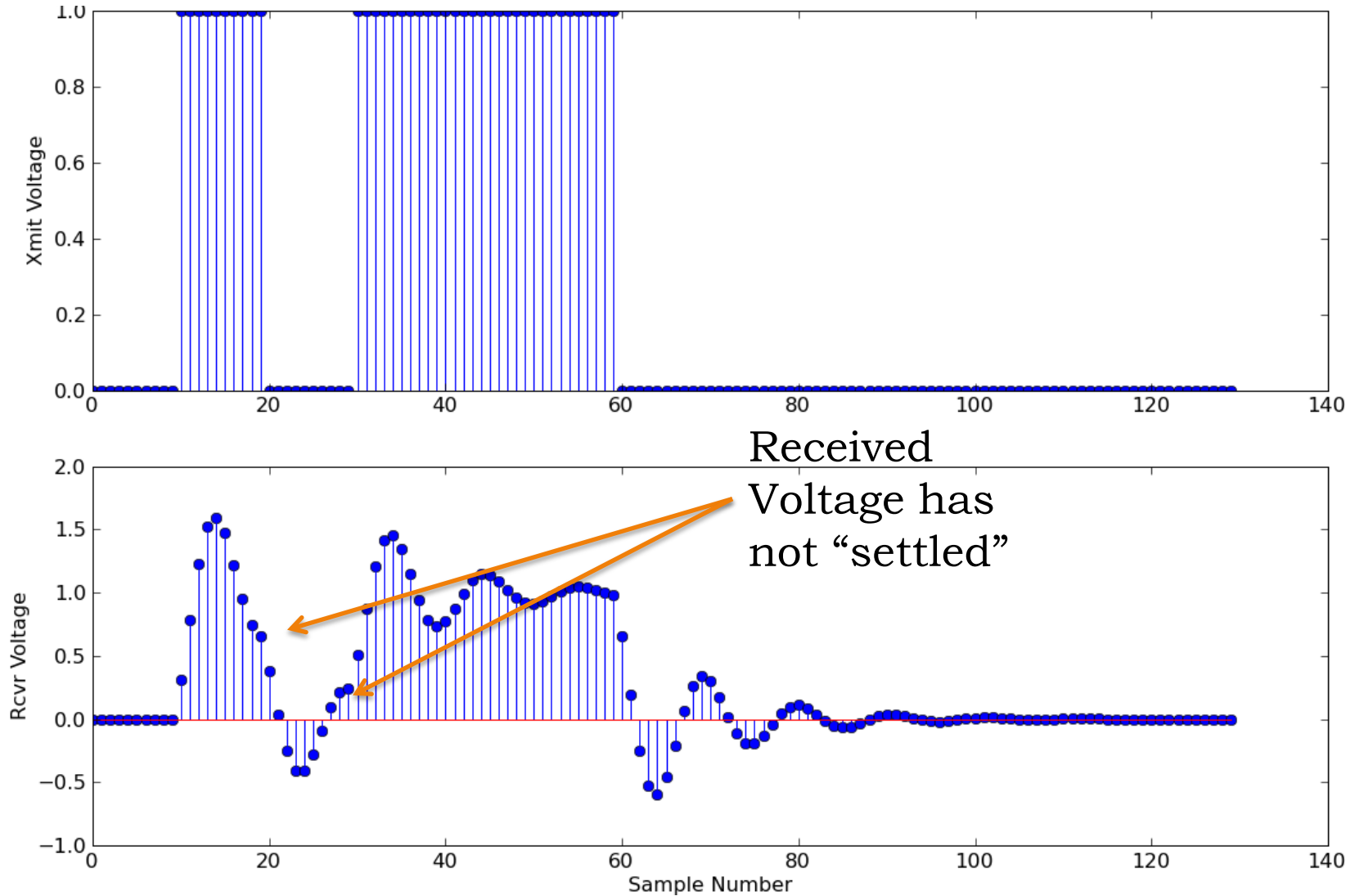
- $BP = \text{Samples/bit} * \frac{1}{4} \text{ microsecond}$
- $BR = \text{Bits transmitted per second}$
- $BR = (4 \text{ million}) / (\text{Samples/bit})$

- Slower Bit Rate = Longer Bit Period

- More time to propagate through channel

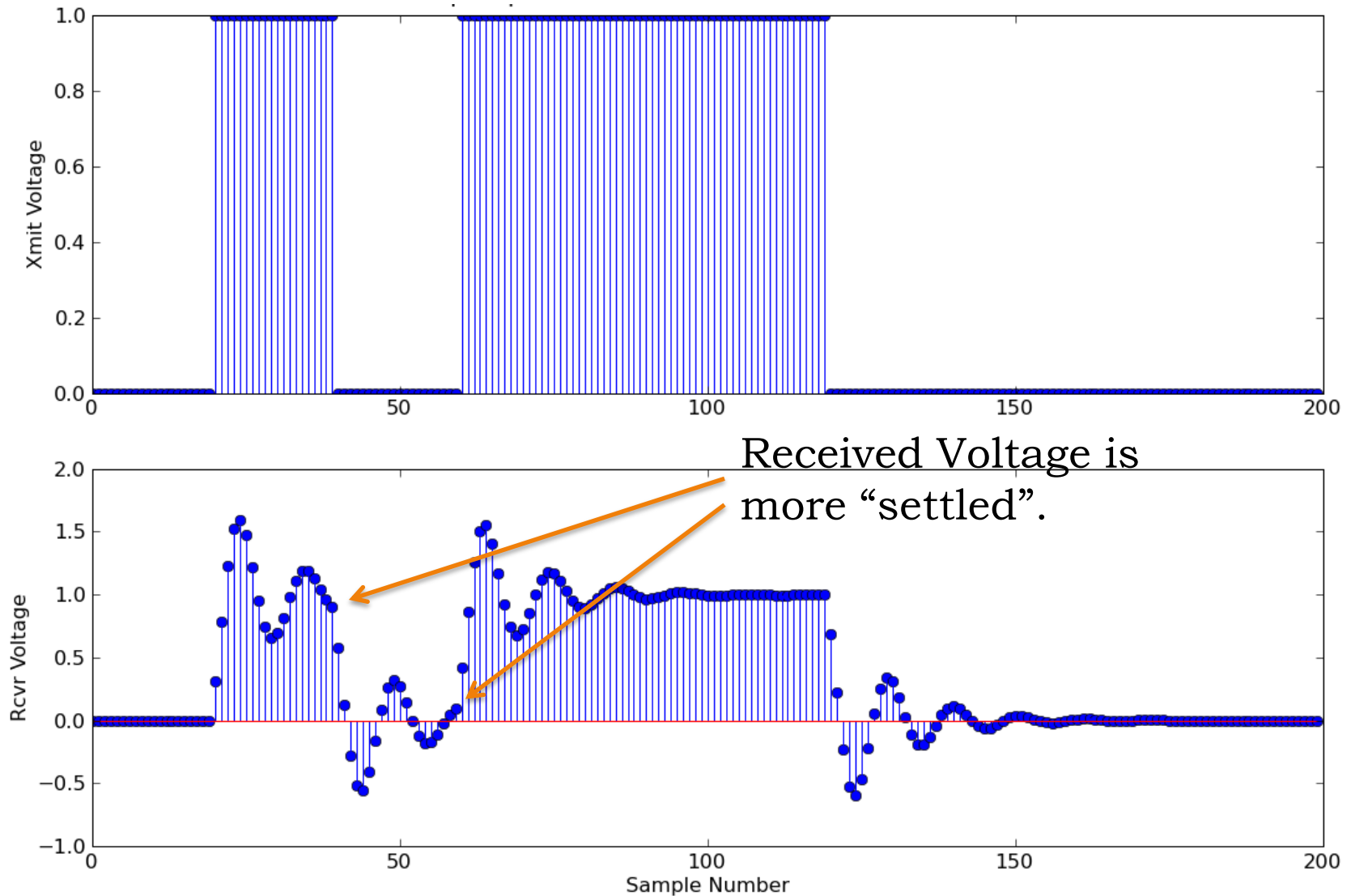
Sending 0101110, 2.5 microseconds/bit

10 samples/bit, 400,000 bits/sec



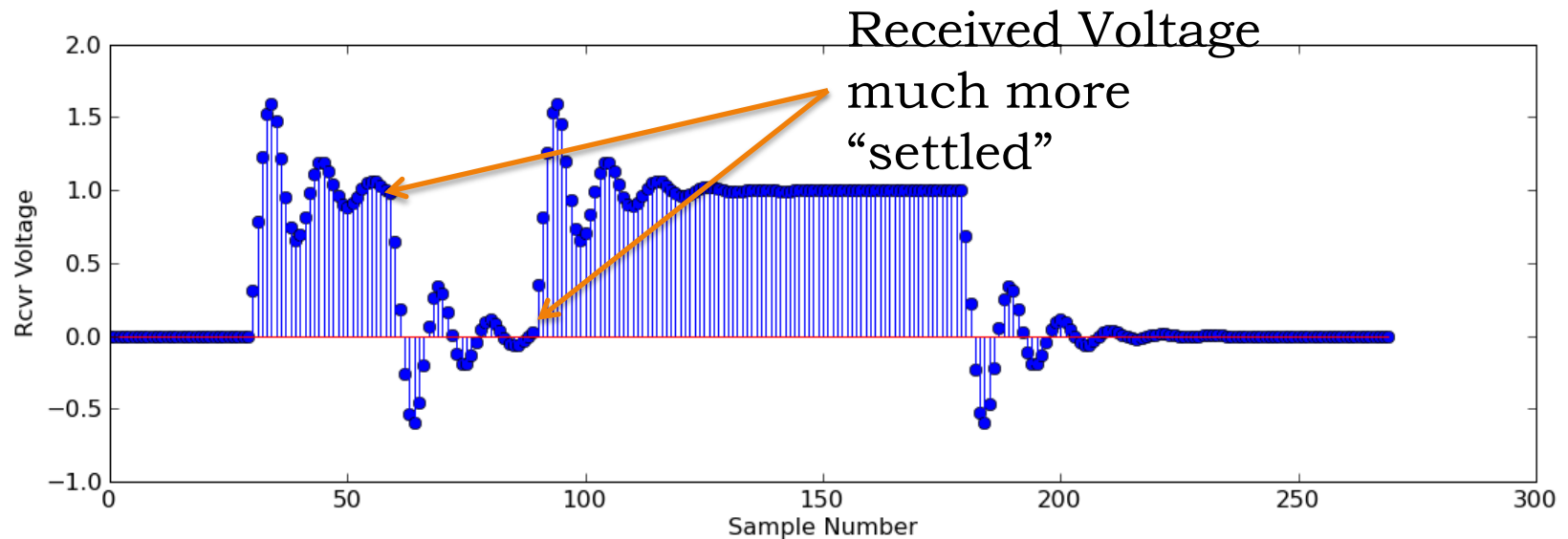
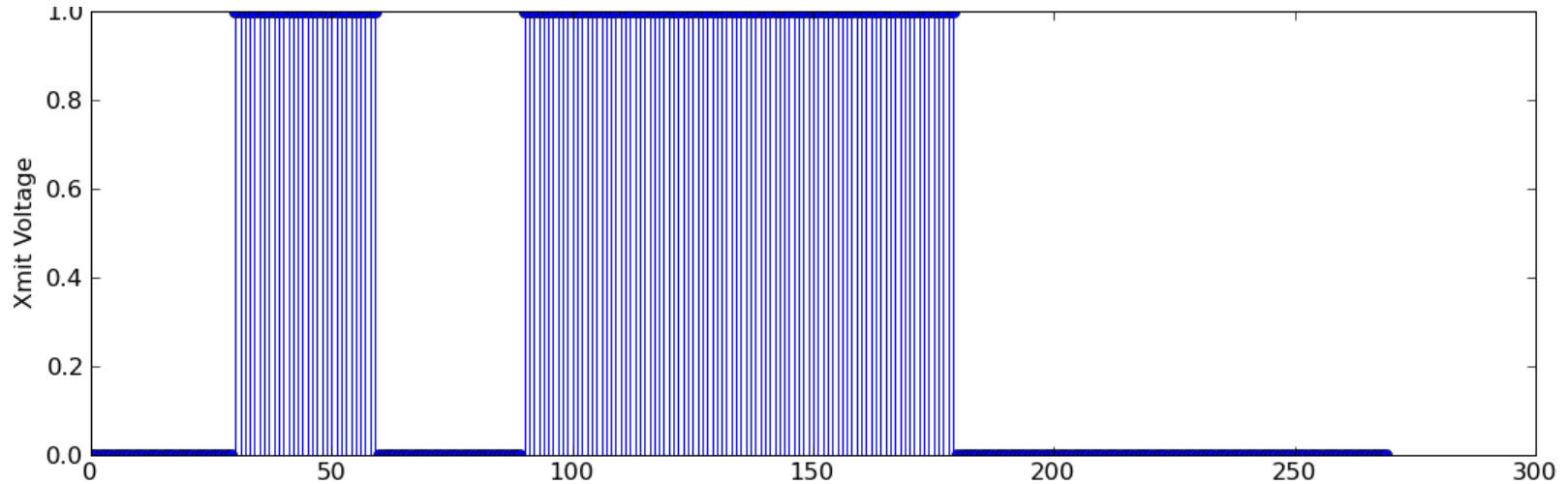
Sending 0101110, 5 microseconds/bit

20 samples/bit, 200,000 bits/sec

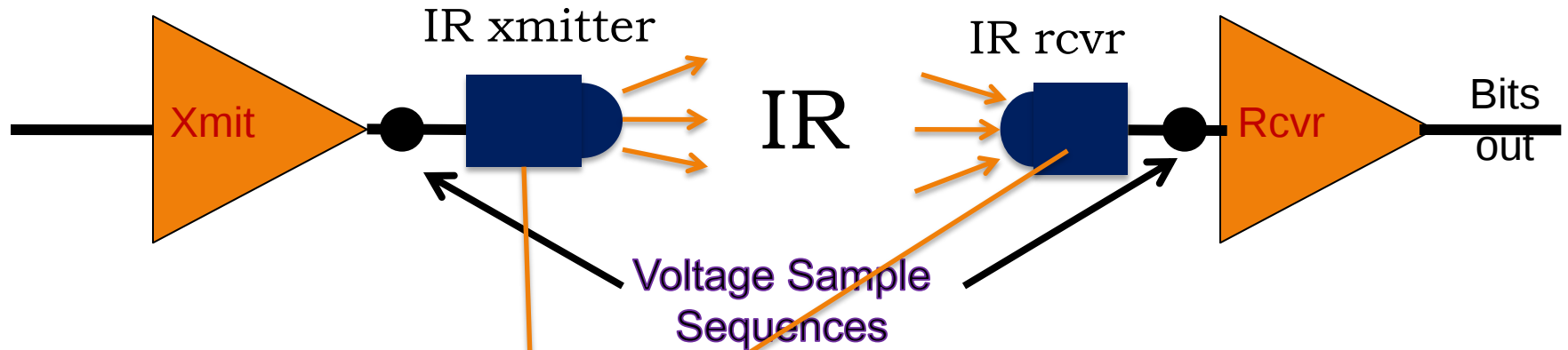


Sending 0101110, 7.5 microseconds/bit

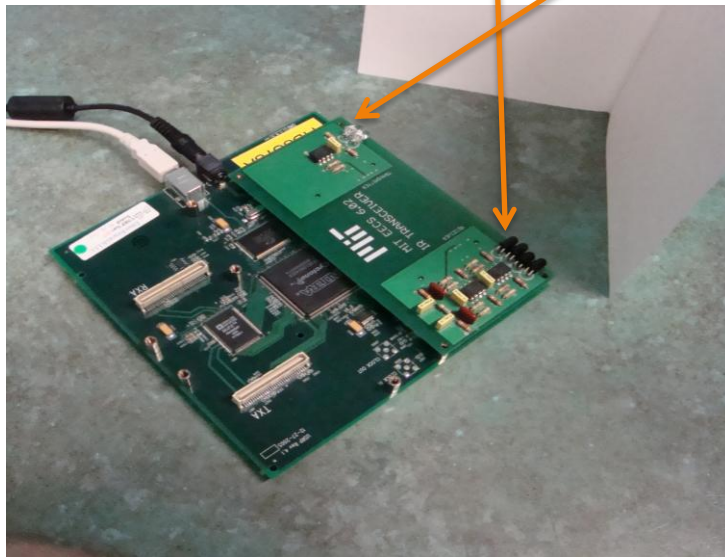
30 samples/bit, 133,333 bits/sec



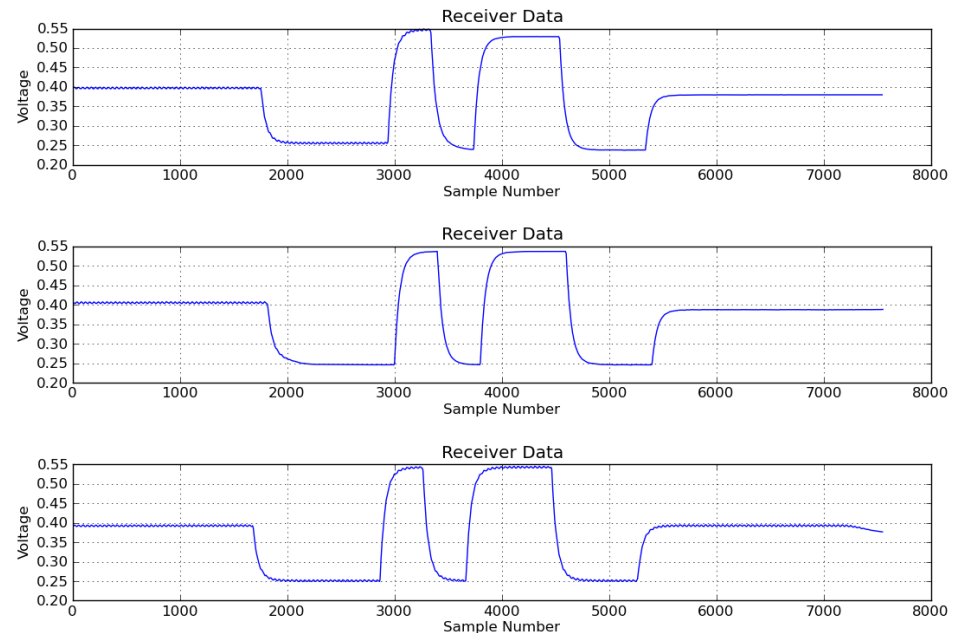
The 6.02 Infrared Transceiver



Loopback Setup

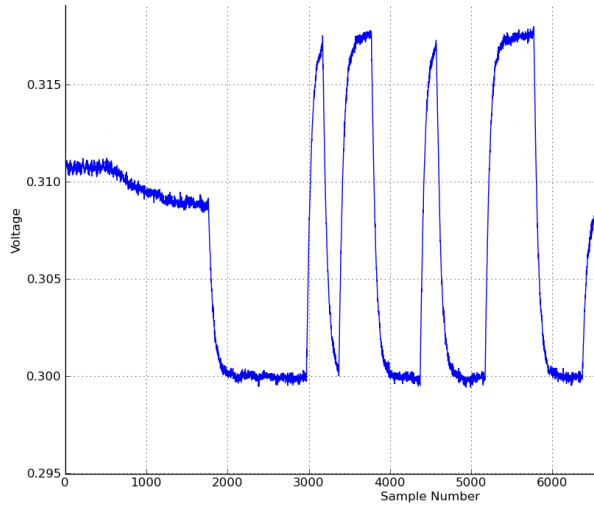


400 Samples/bit



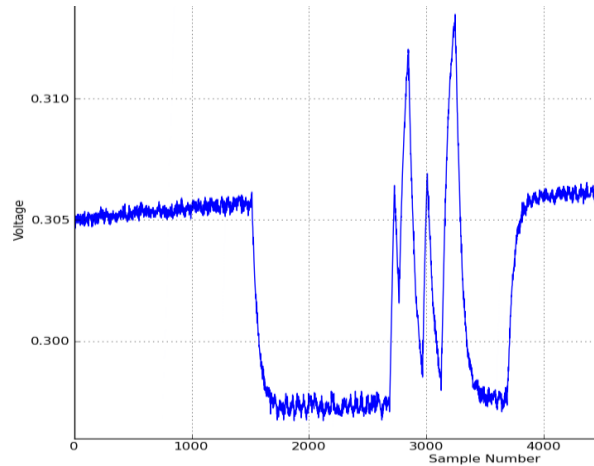
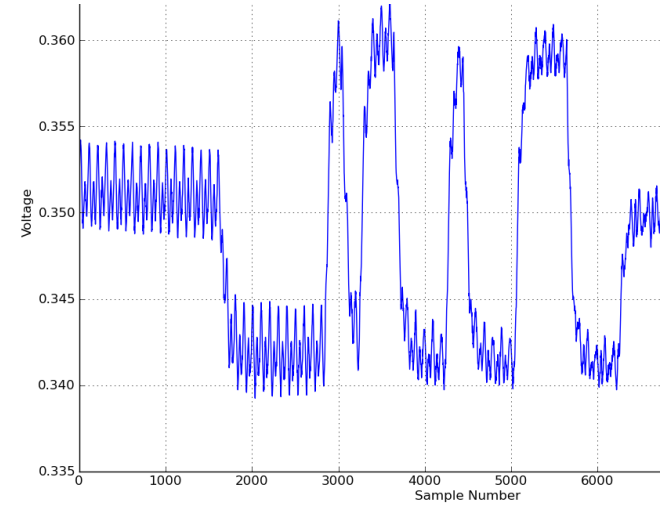
The 6.02 IR Tranceiver - Bounce off ceiling

Dark Room

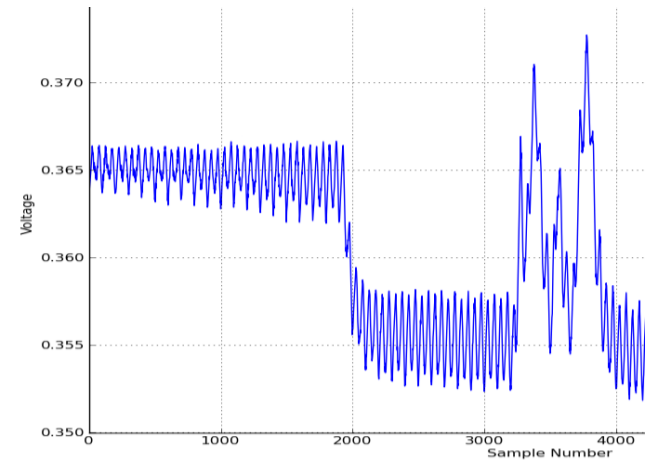


100 Samples/bit

Lights On

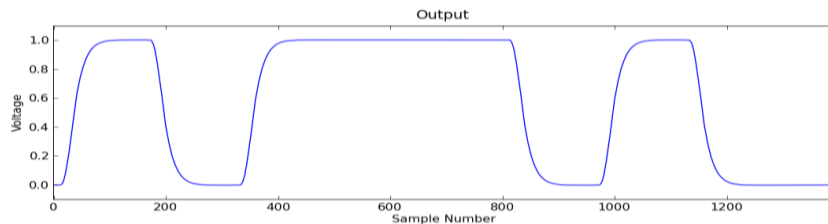
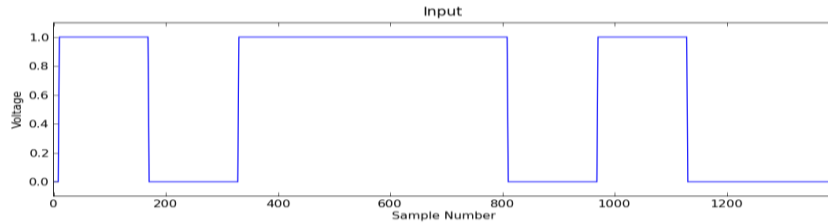
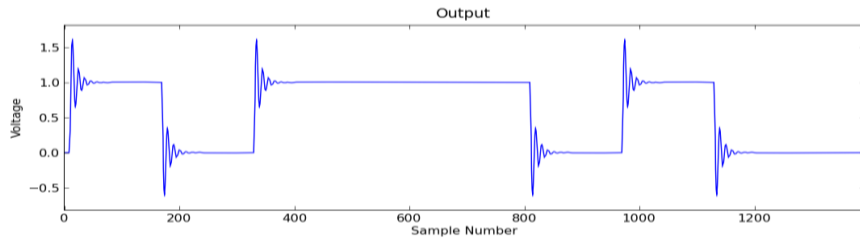
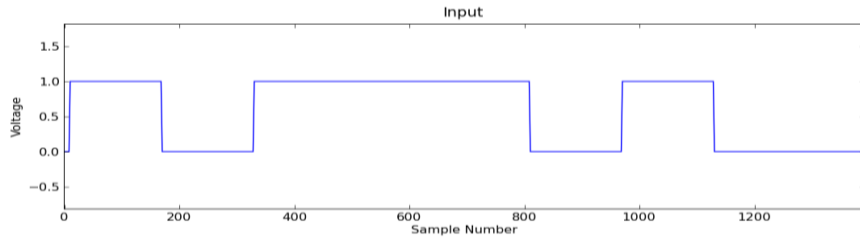


40 Samples/bit

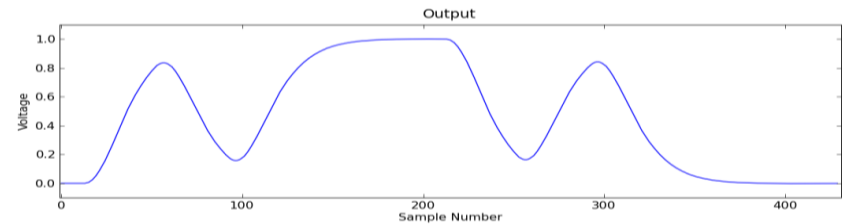
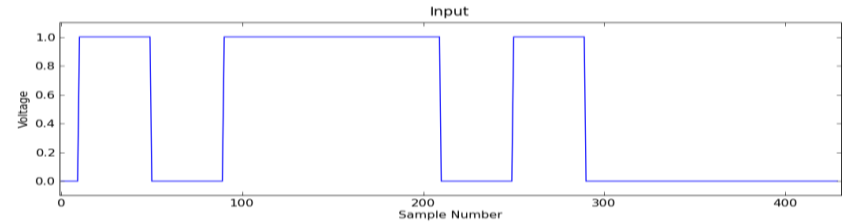
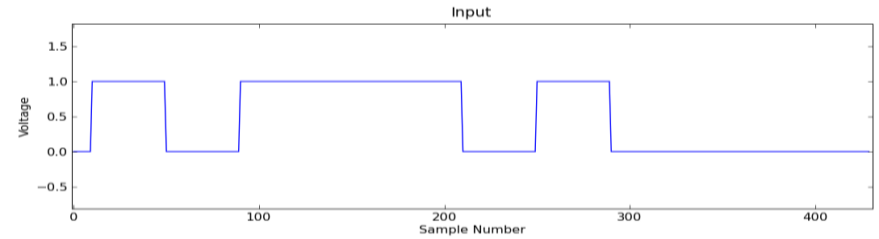


Intersymbol Interference

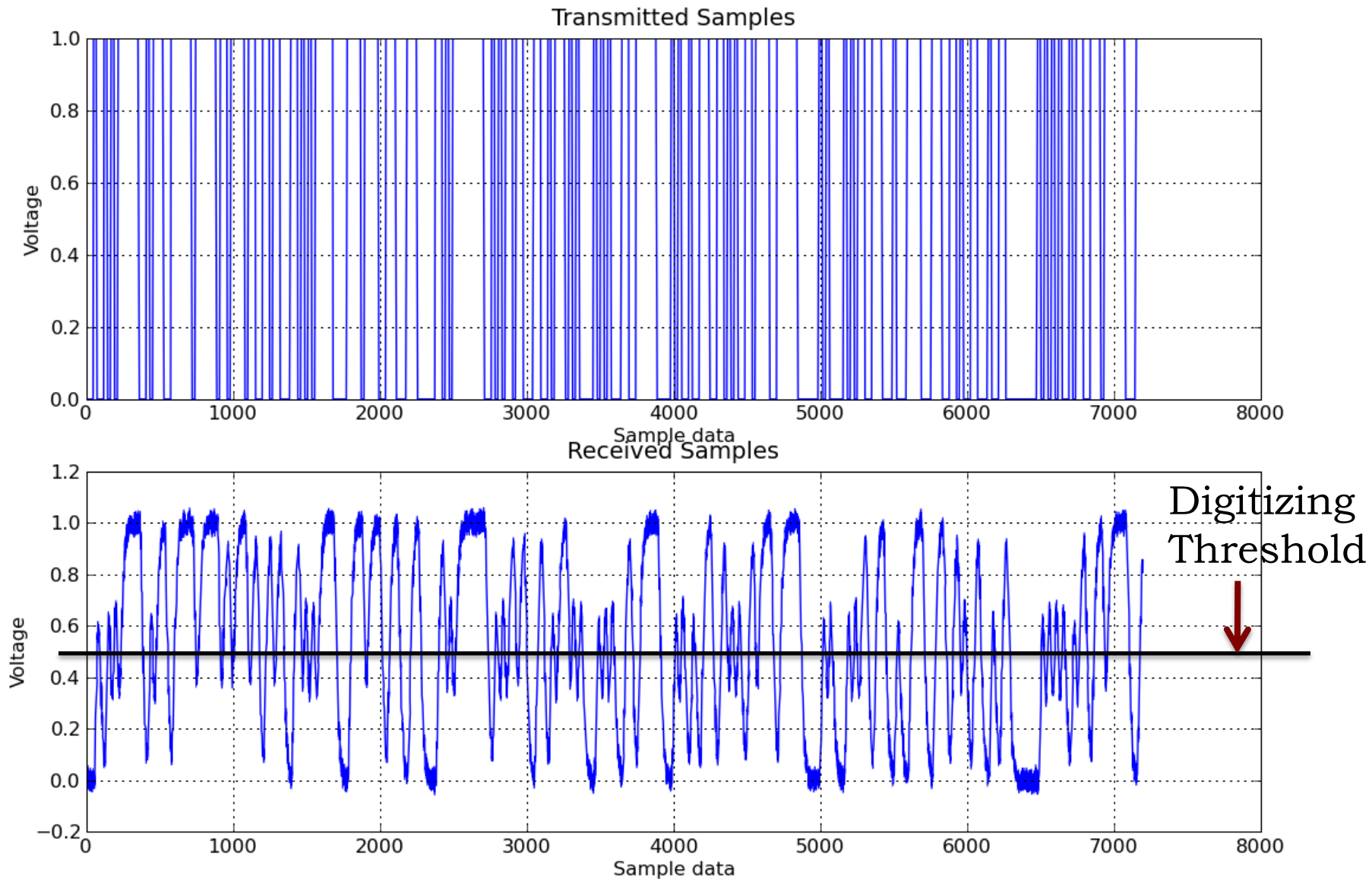
Long Bit Period (slow rate)



Short Bit Period (Fast Rate)

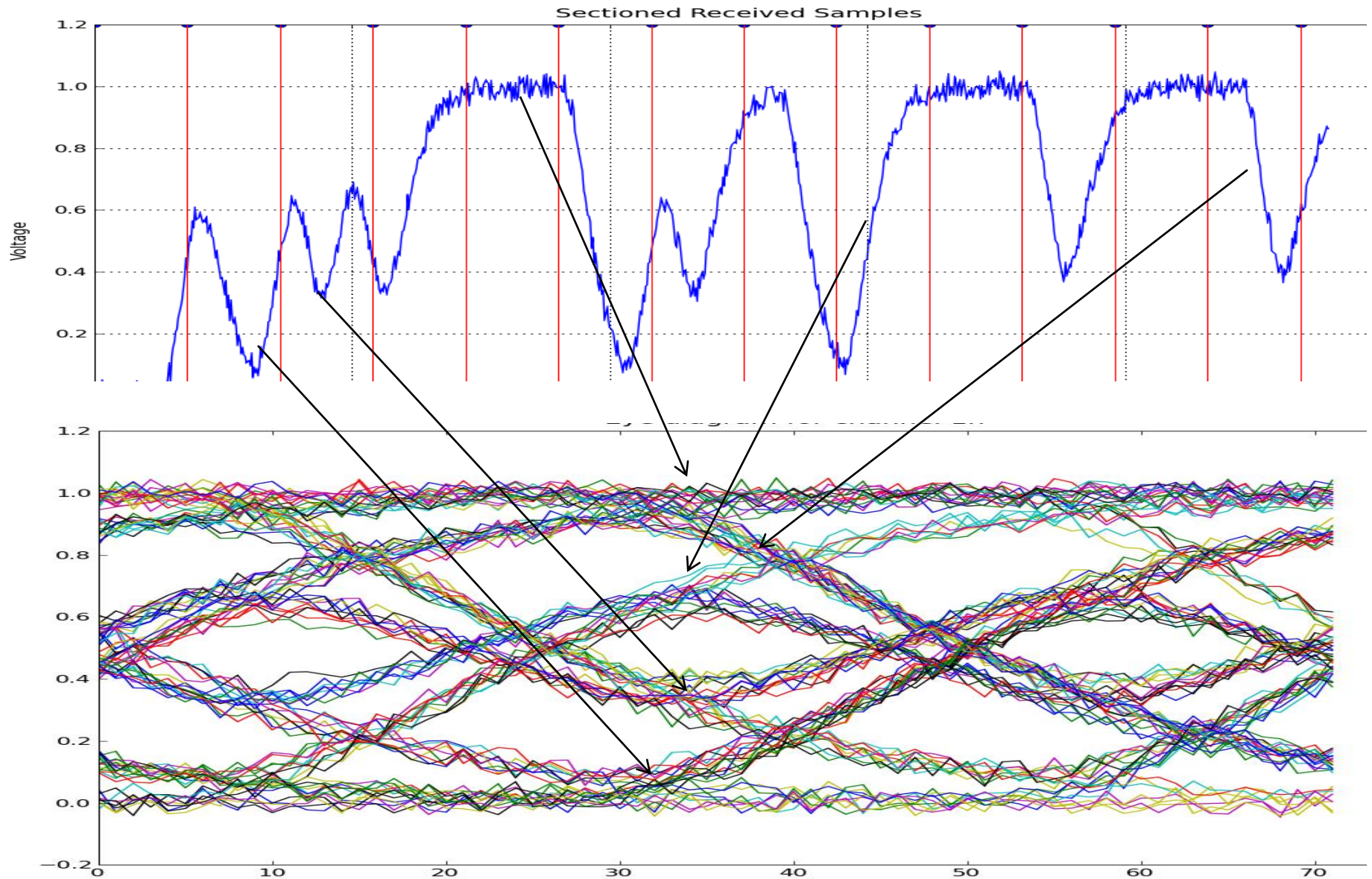


Received Data - Noisy Channel, 24 sample/bit



Any Bit Errors?

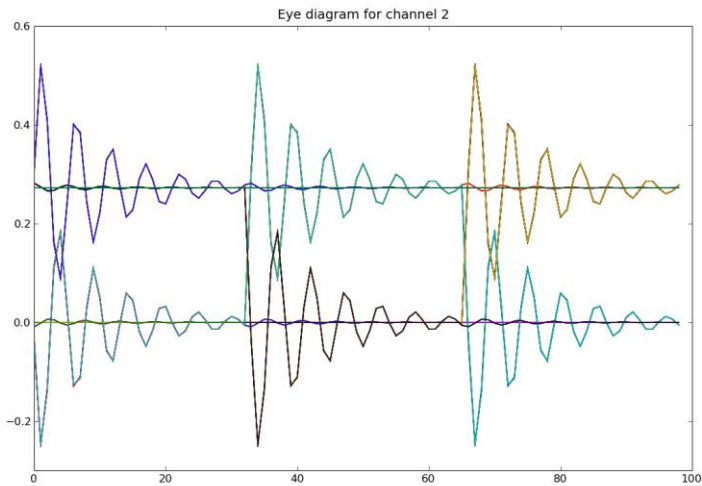
Eye Diagram-Overlay 3 Period Sections



Eye Diagram Generated with 25 samples per bit

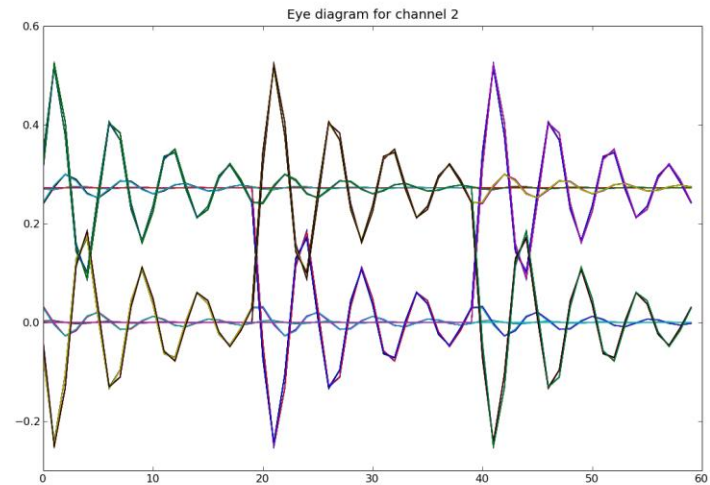
Eyes for Ringing versus Slow System

**Medium Bit
Period(33 samples)**

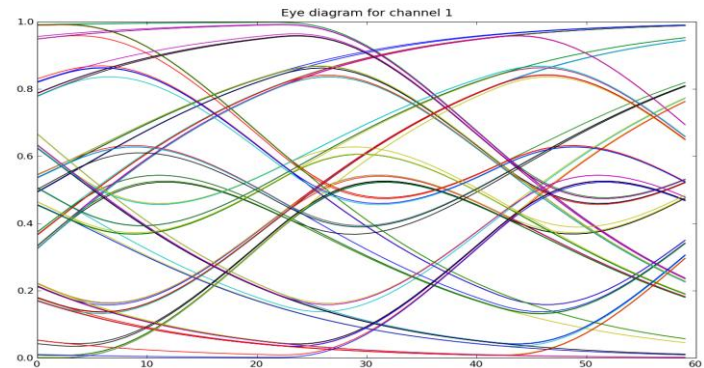
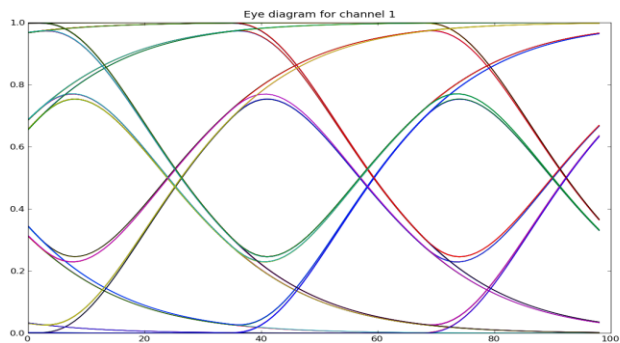


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Short Bit Period(20 samples)

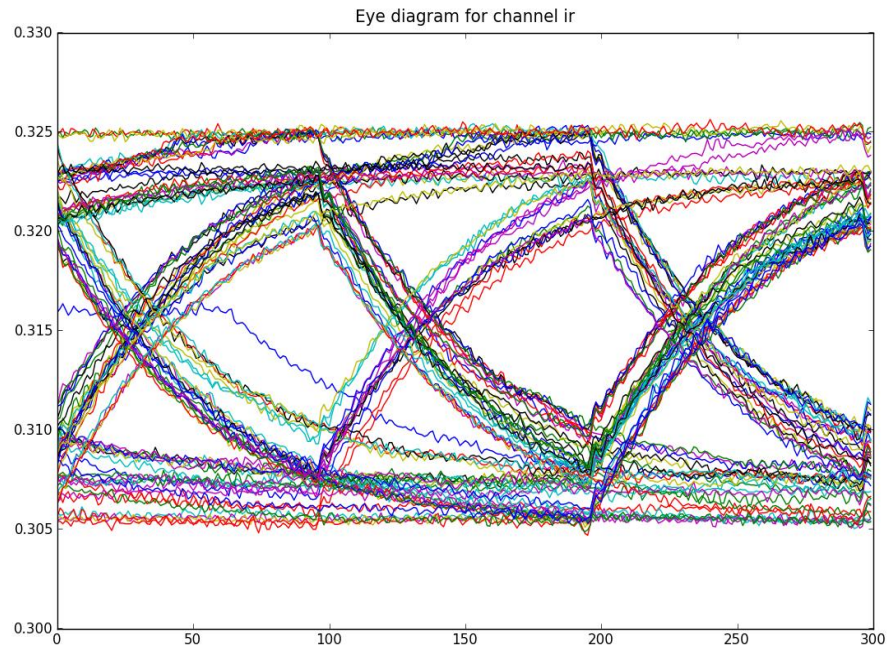


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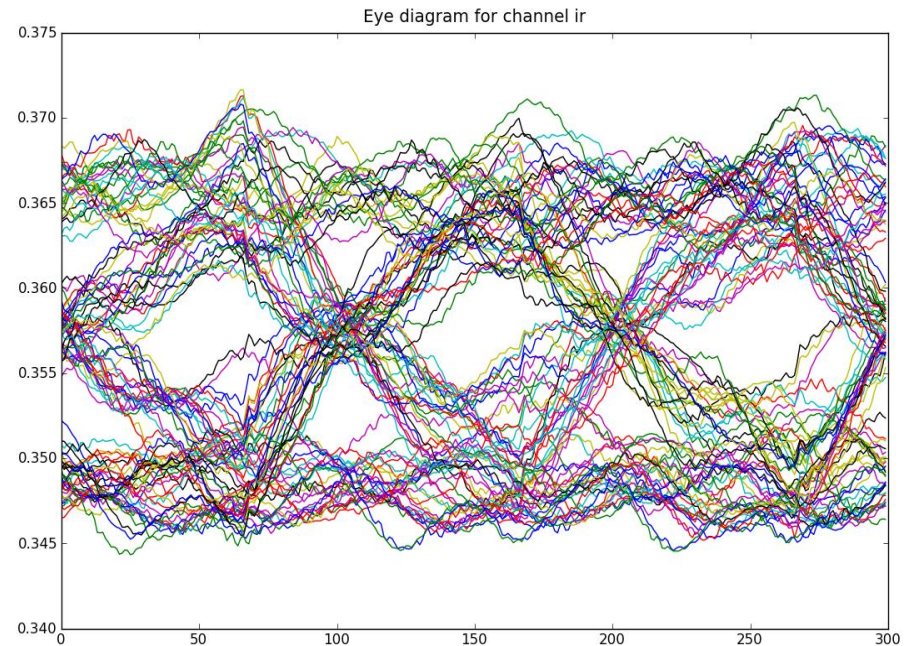


Eye Diagram for IR Detector

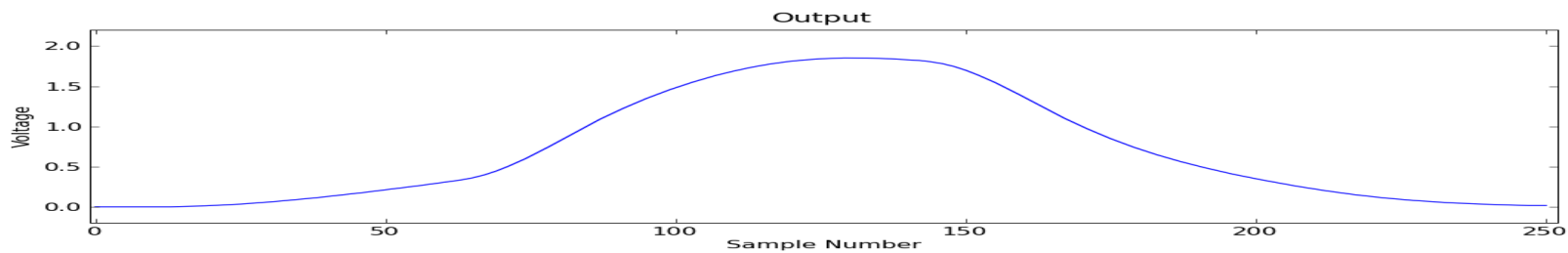
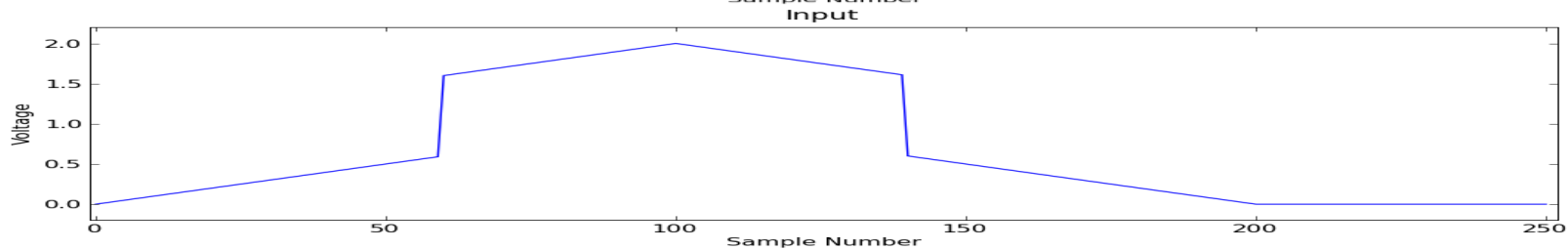
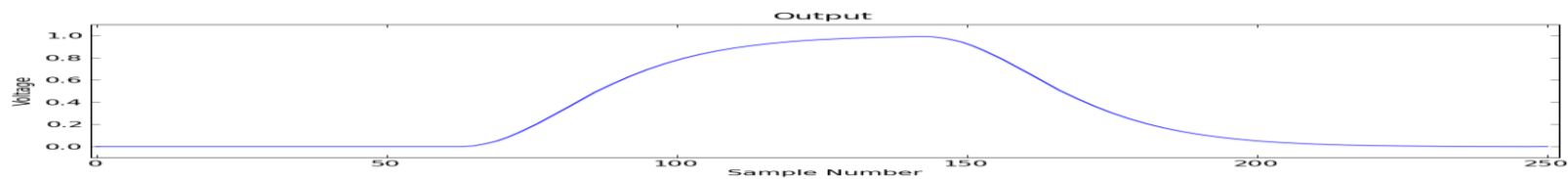
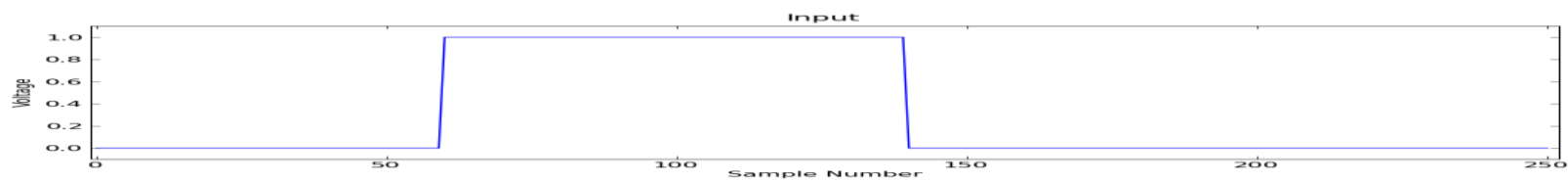
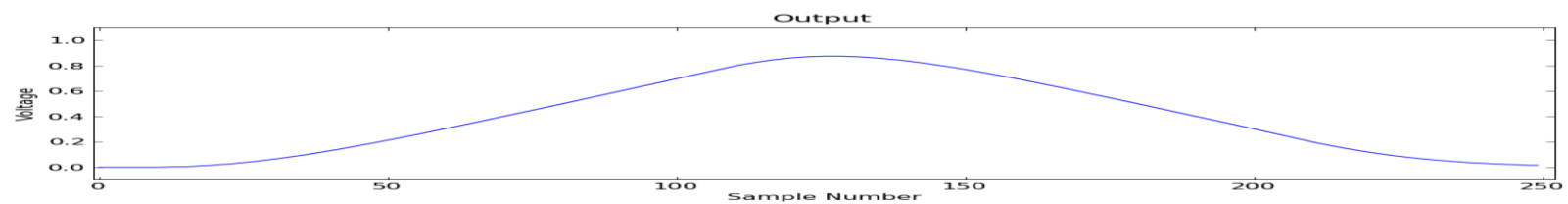
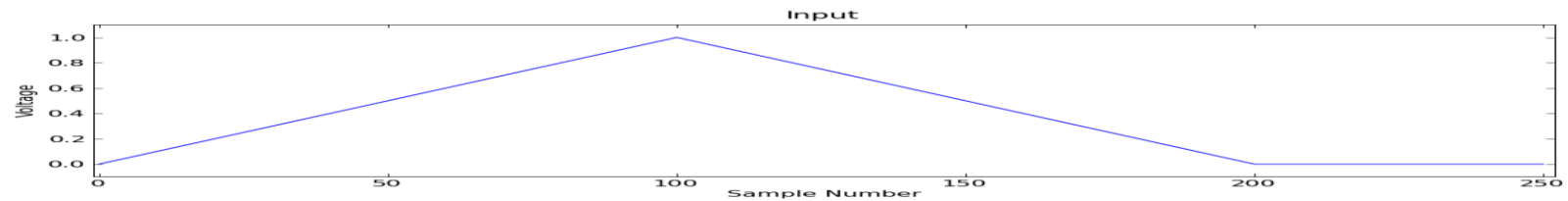
Eye Diagram 40
Samples per bit, dark
room

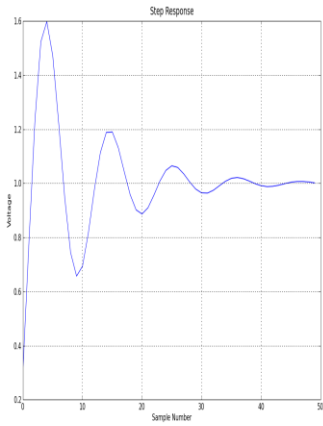


Eye Diagram 40
Samples per bit, lights
on!

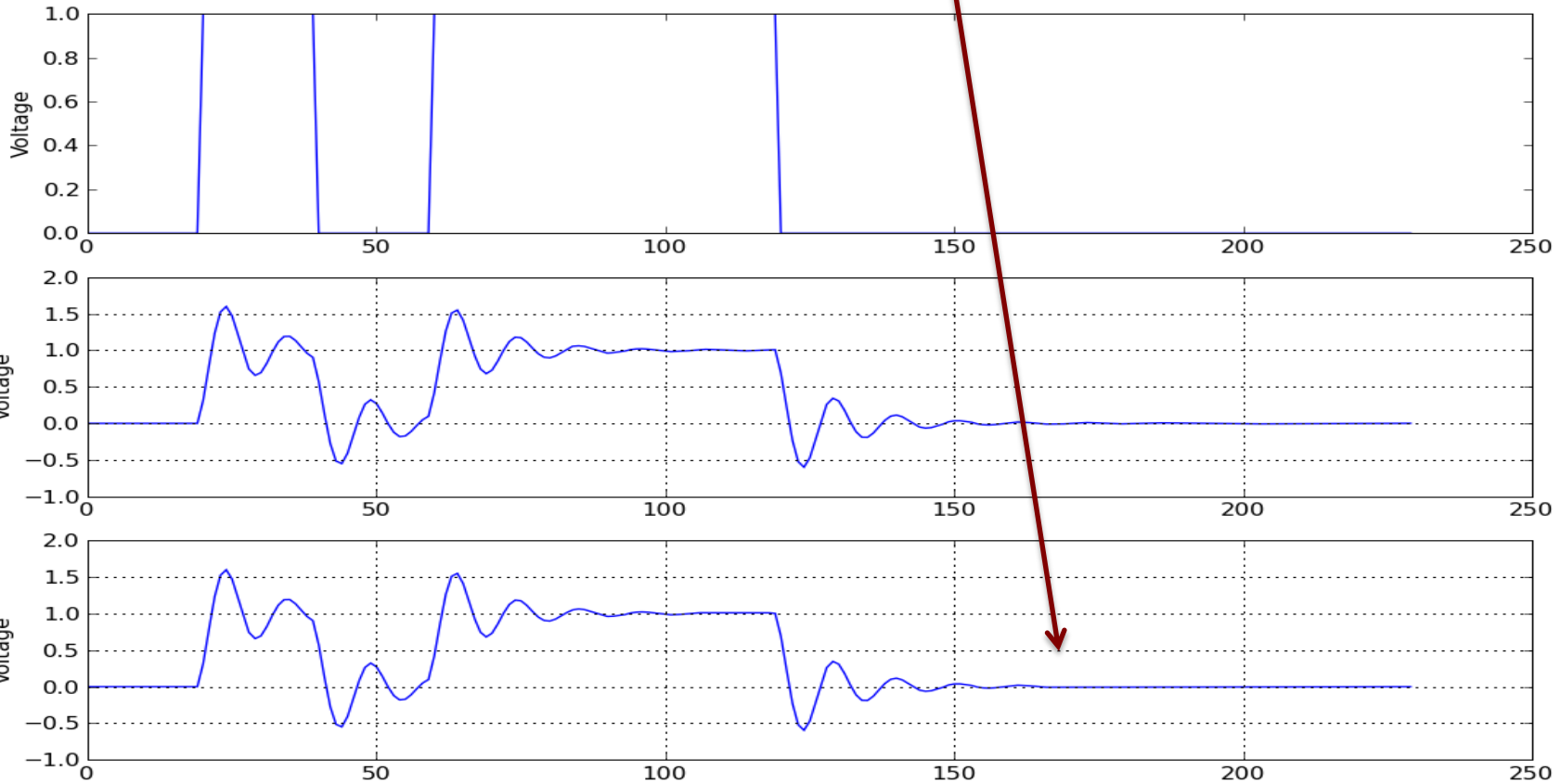


Superposition

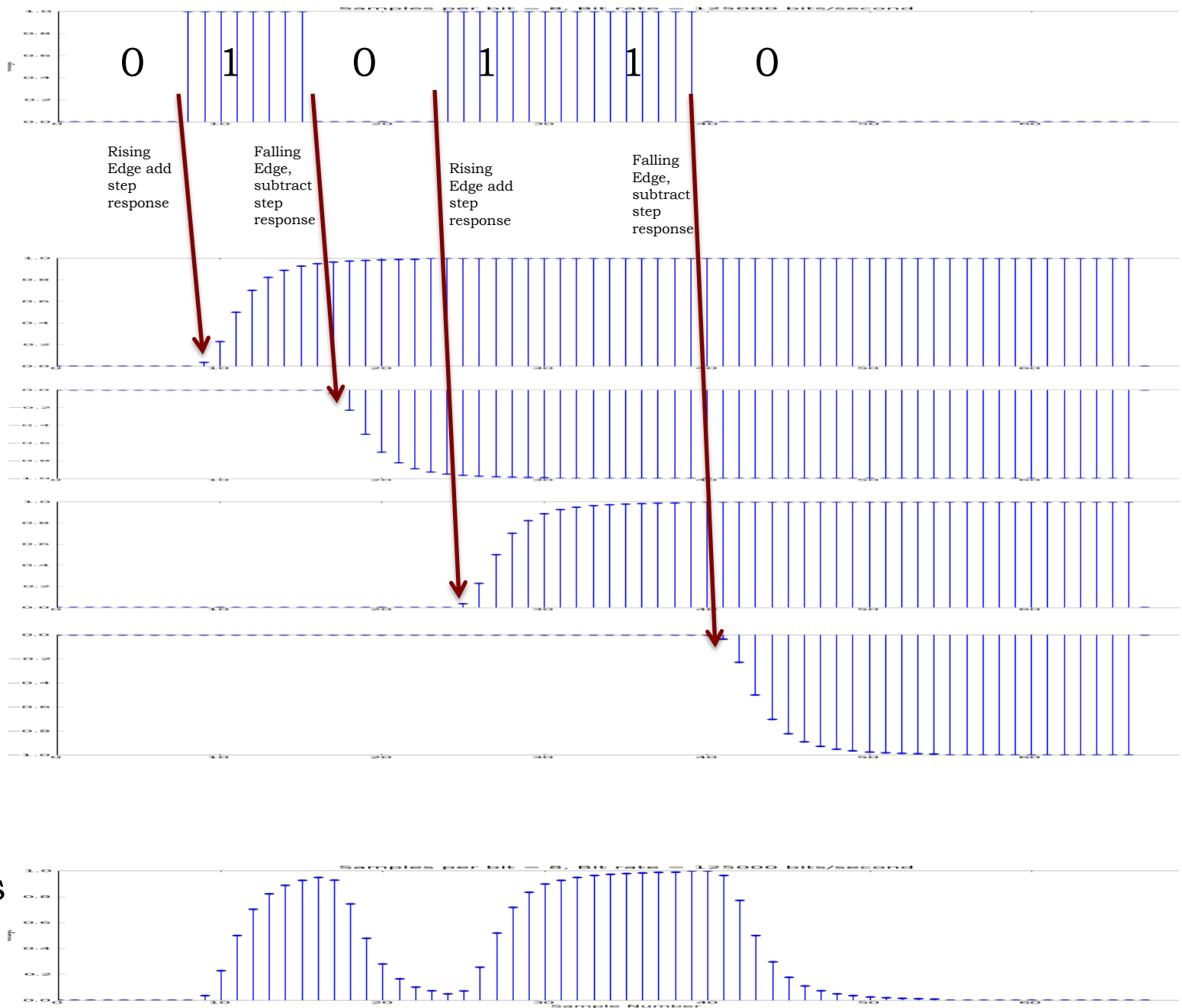




Step Response and
results from
superposition



Xmit
Data



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