XFC – eXtreme Fast Control

IPC

I/O

Automation

Motion

Simplicity is the ultimate sophistication

Leonardo da Vinci

Introduction

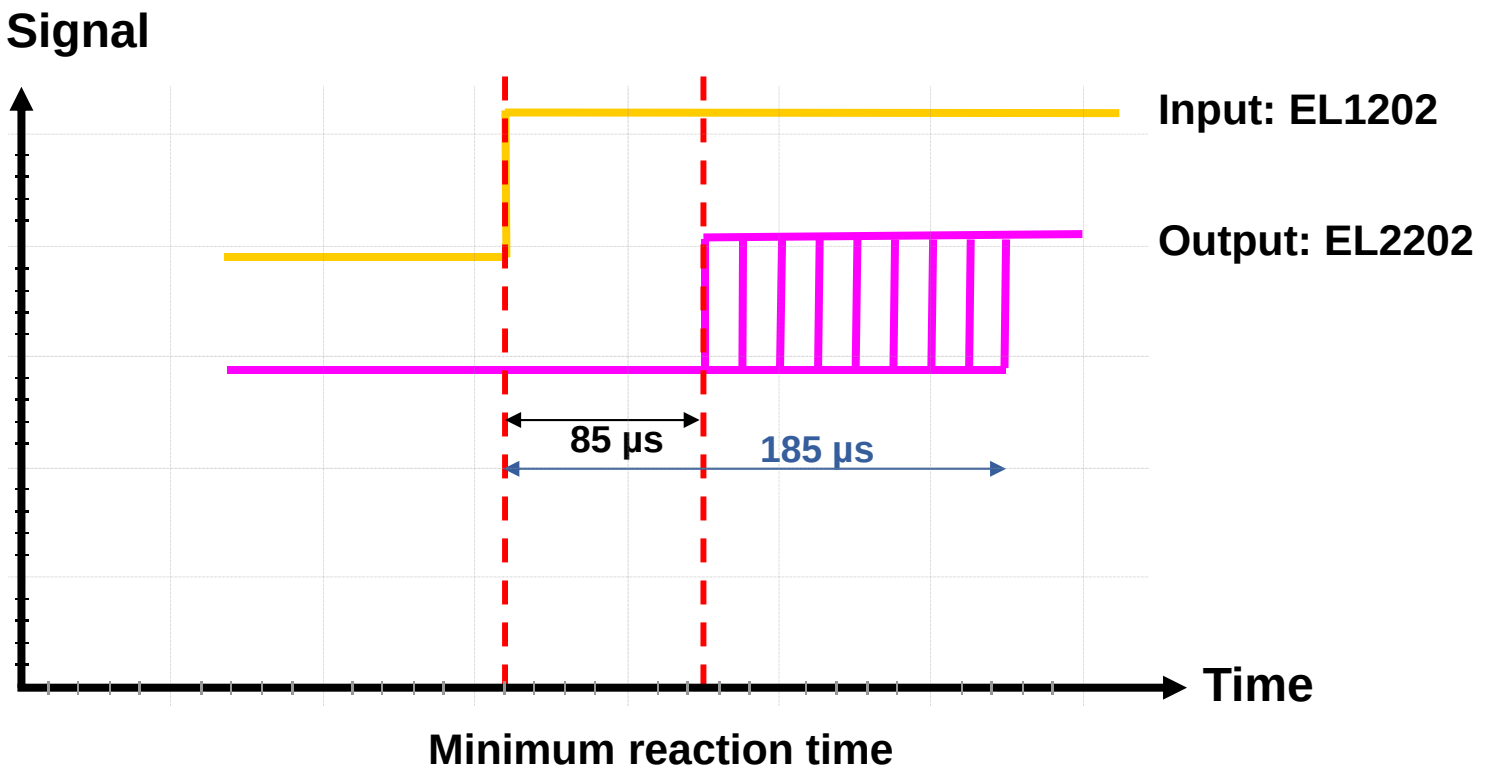
- Goal
  - The goal is to never have the control system be the weak link.
- Can we measure things and react faster than the physical world can keep up?
  - With EtherCAT the answer is YES.
- XFC is how Beckhoff uses EtherCAT in a very deterministic way – other vendors have other ways of using it and describing it.

What Components are necessary?

- **Control Hardware**
  - Beckhoff IPC‘s
- **Software**
  - TwinCAT
- **Communications**
  - EtherCAT
- **I/O**
  - On PLC cycle
    - Regular Inputs and Outputs acting on cycles
    - Fast Inputs and Outputs
  - Inbetween PLC cycle
    - Timestamped Inputs and Outputs
    - Oversampled

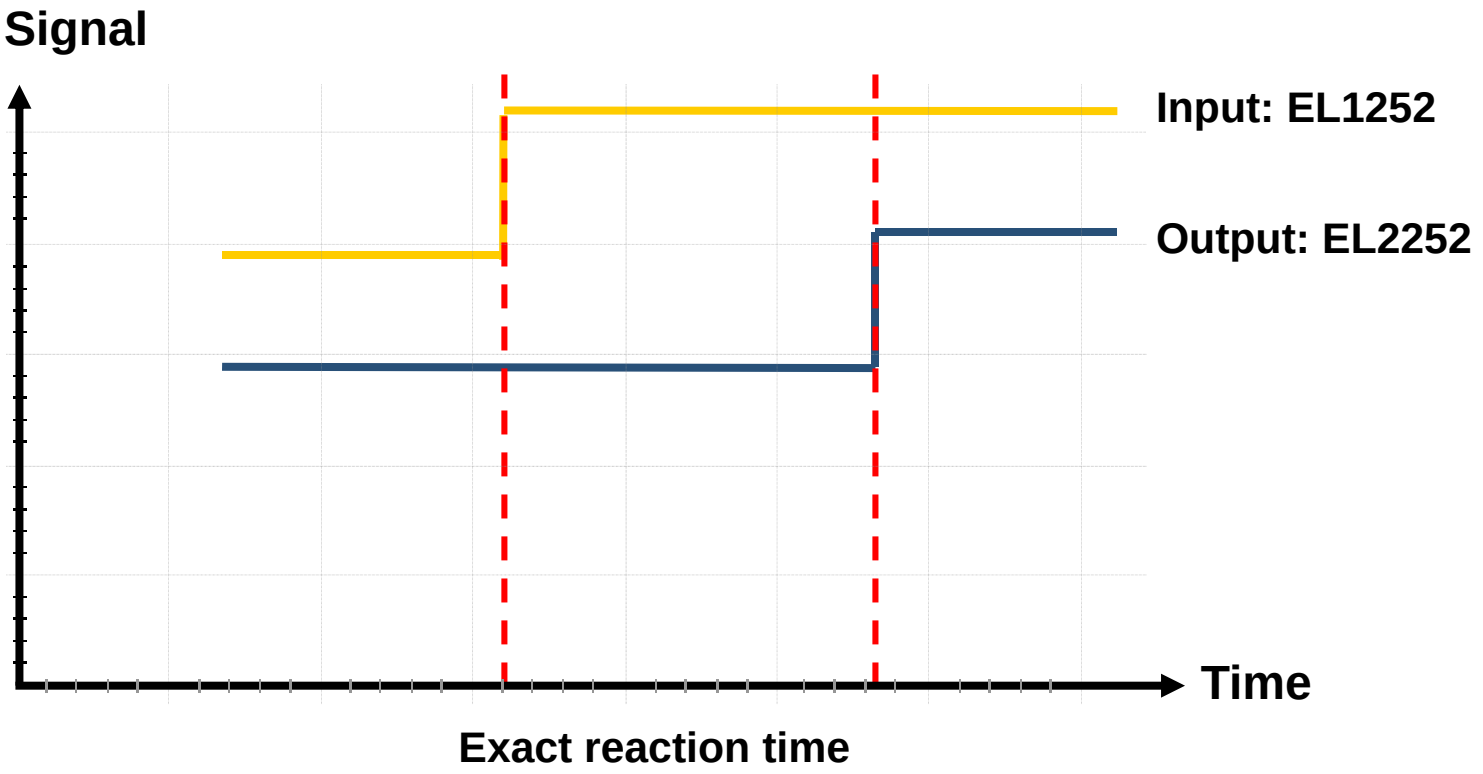
Fast I/O terminals

- 1 µs TON/TOFF



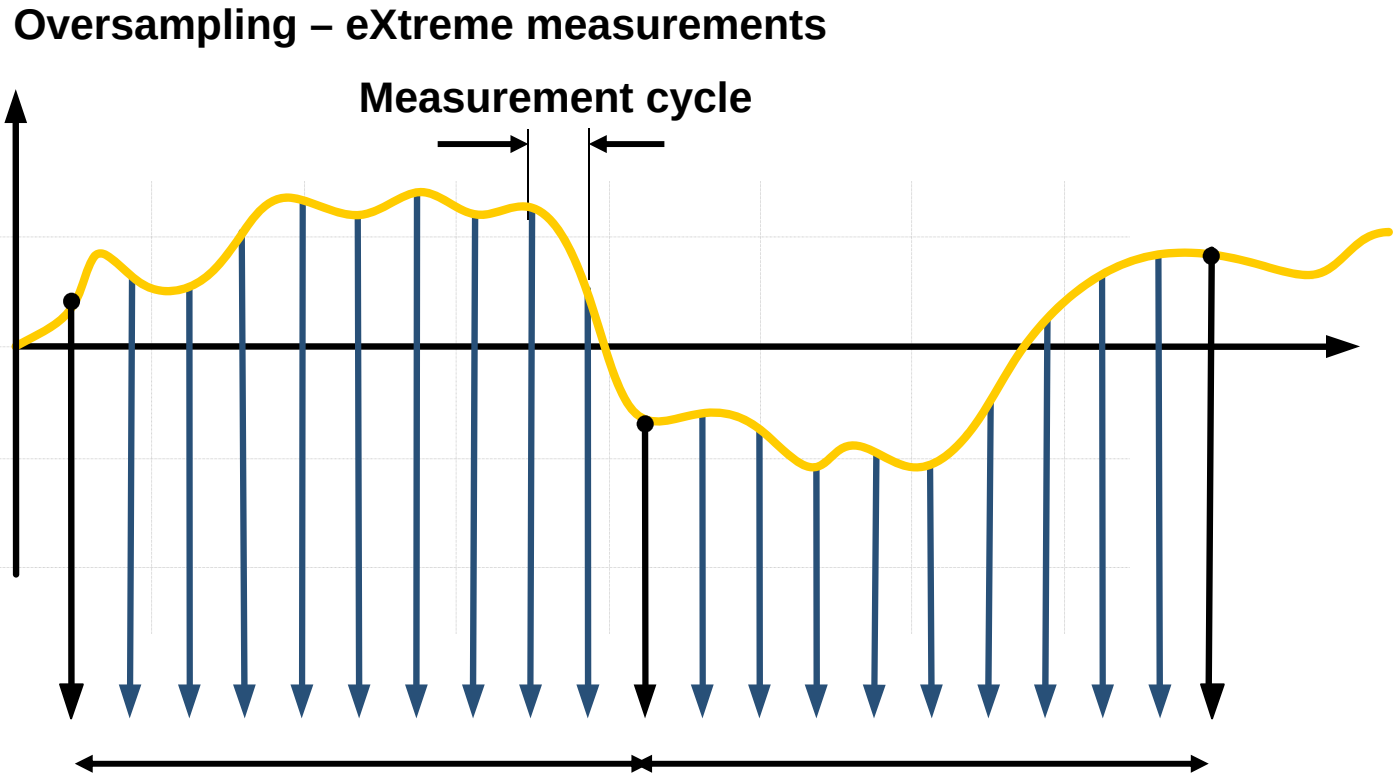
Timestamping

- Exact time resolution
- Syncronized responses



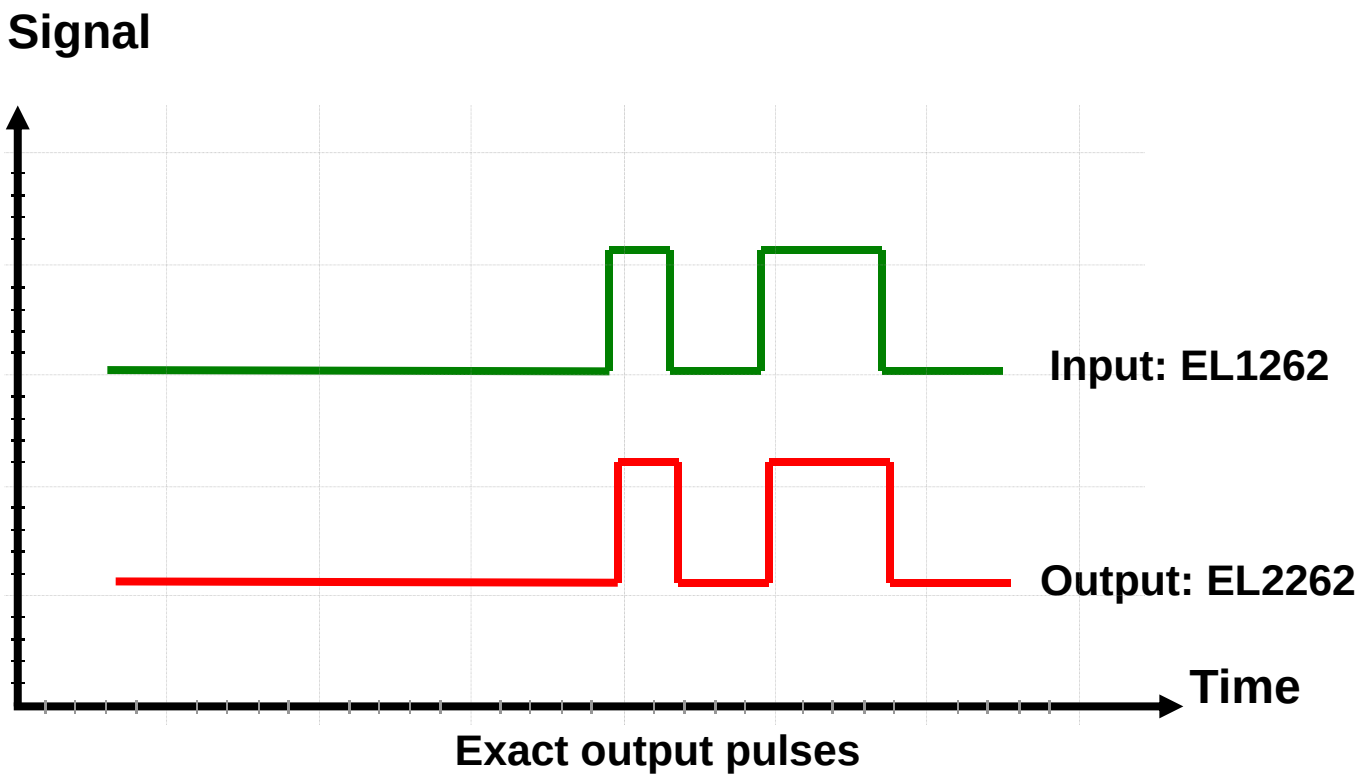
Oversampling

- Fast signal sampling
- Analog value recording



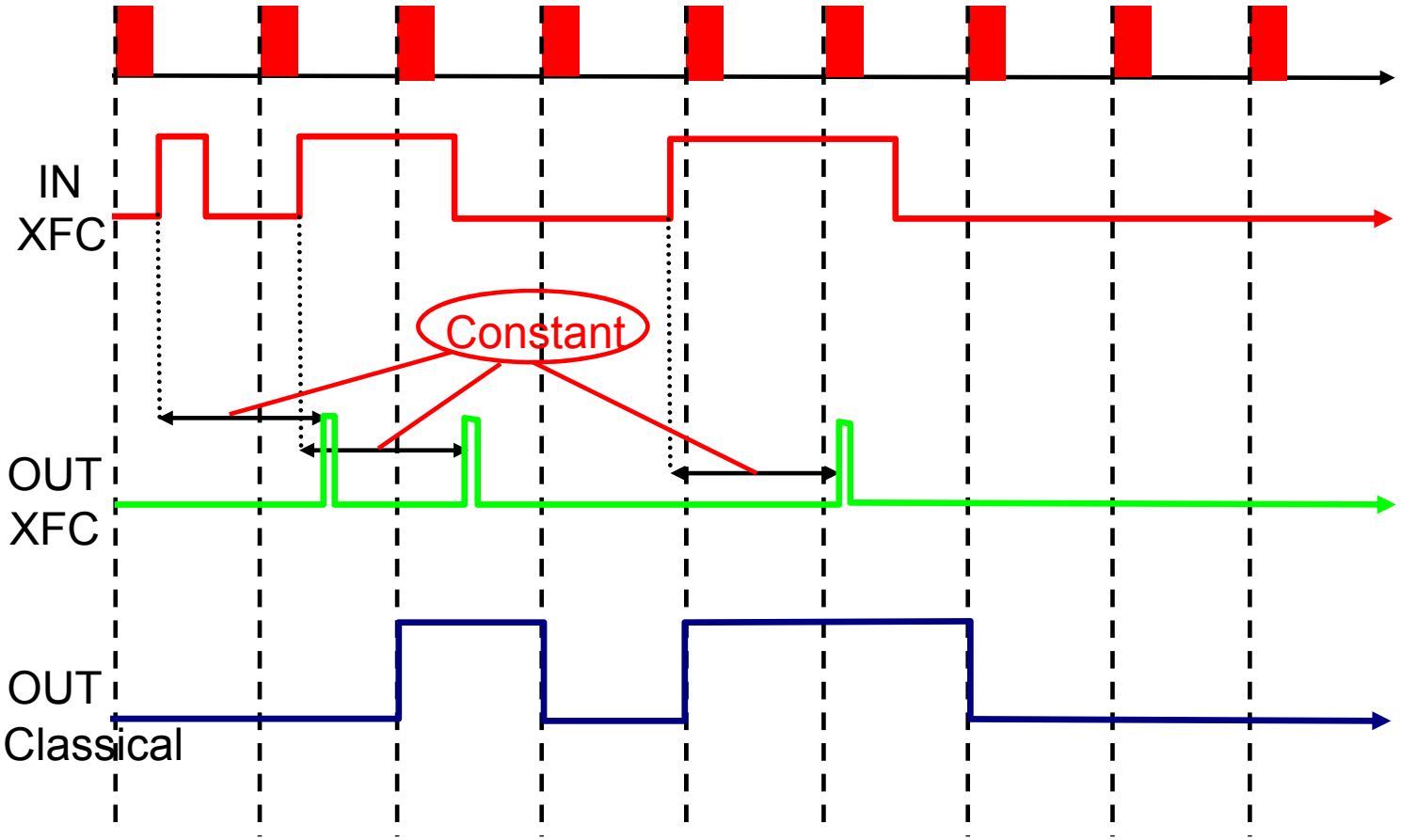
Oversampling

- Fast digital signal sampling
- Output of short pulses



Benefits of XFCvs Classical Control

- Measure and react inside PLC cycles



XFC – eXtreme Fast Control
Performance

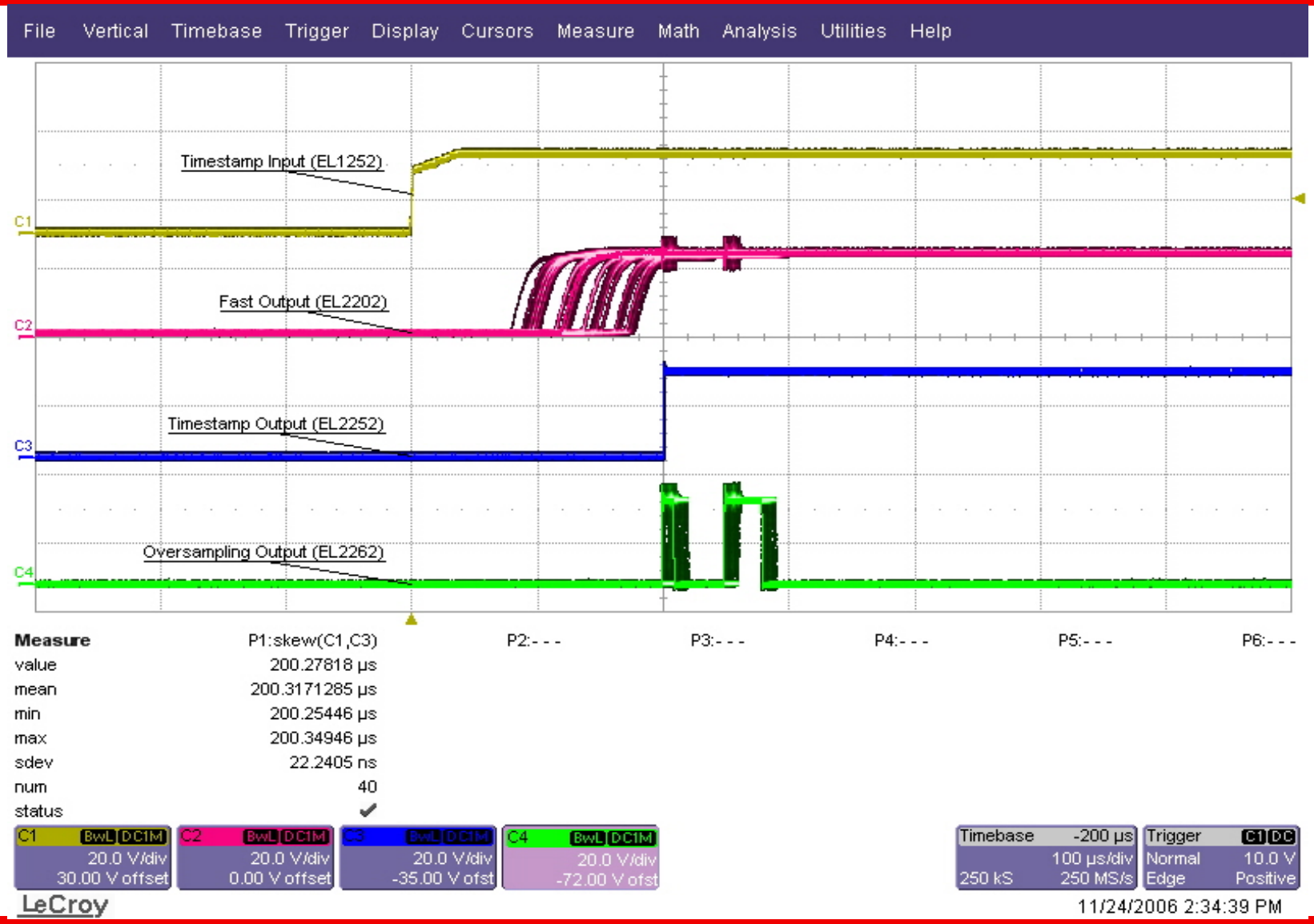
- System Performance
  - Cycle time 100 µs (min. 50 µs)
  - I/O response time 85 µs (185µs)
- Distributed Clocks
  - Resolution 10ns
  - Accuracy < 100ns
- Timestamping resolution
  - Resolution 10ns
  - Accuracy < 100ns
- Oversampling
  - Sample rate 1MHz
  - Time Resolution 1µs
  - Accuracy < 100ns

XFC – eXtreme Fast Control
Performance

- XFC numbers in perspective
  - Speed of light 300,000km/s
  - Light travels 3m in 10ns
- We have entered the era of Control Relativity
  - The speed of light becomes a design consideration for extreme applications.

XFC – eXtreme Fast Control

XFC Verified



XFC – eXtreme Fast Control
Application

Husky HyPAC Injection Molding Machine

XFC – eXtreme Fast Control
Application

Challenge – make thinner wall and save plastic

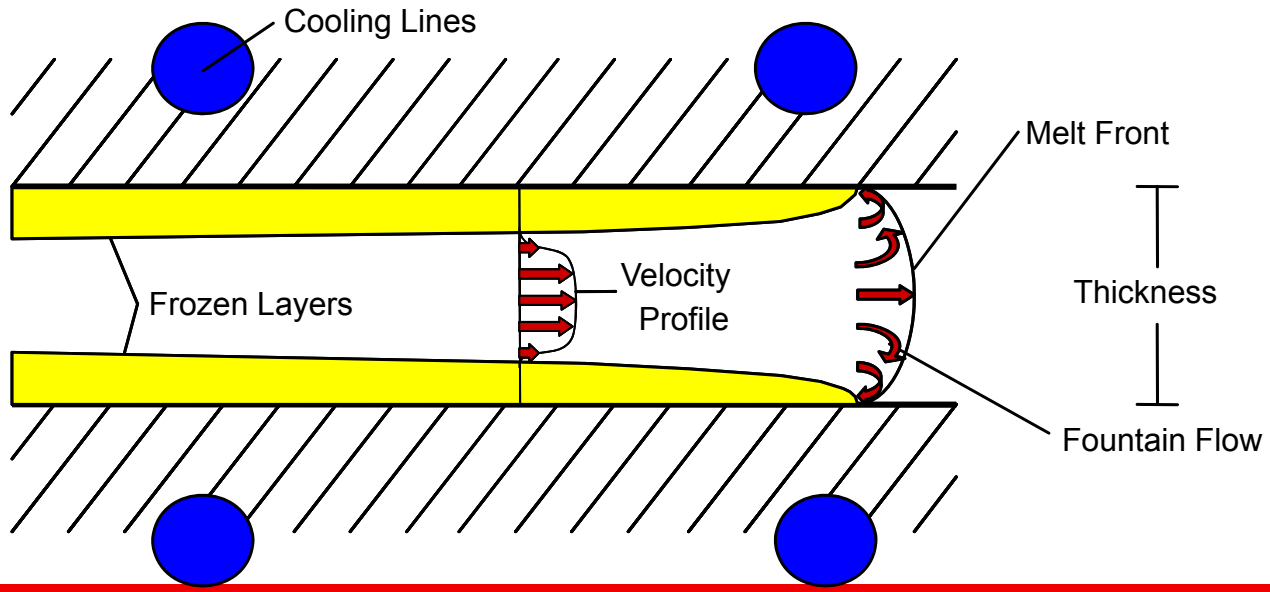
Thinner Wall Thickness

↓

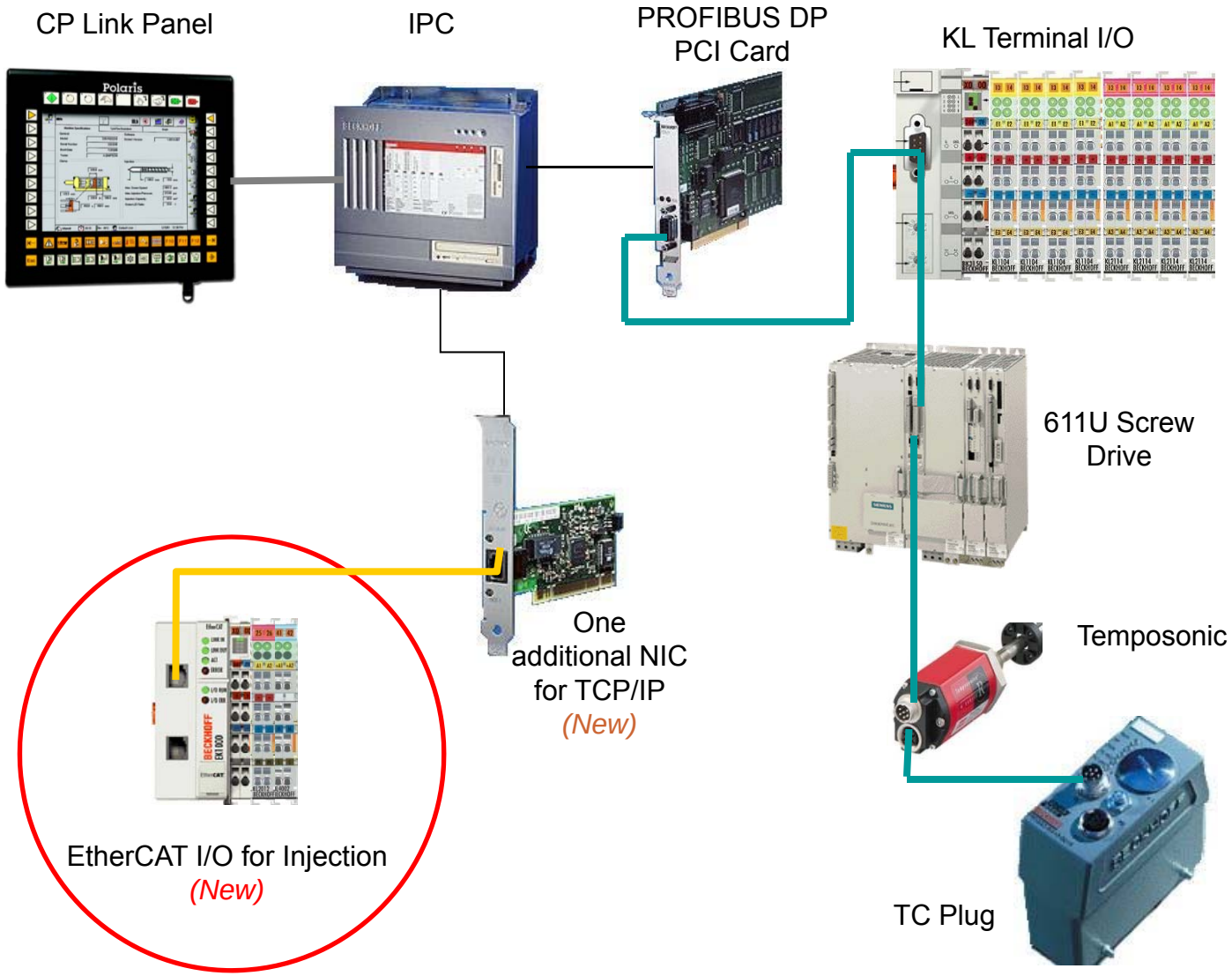
Less Material

↓

Lower Cost

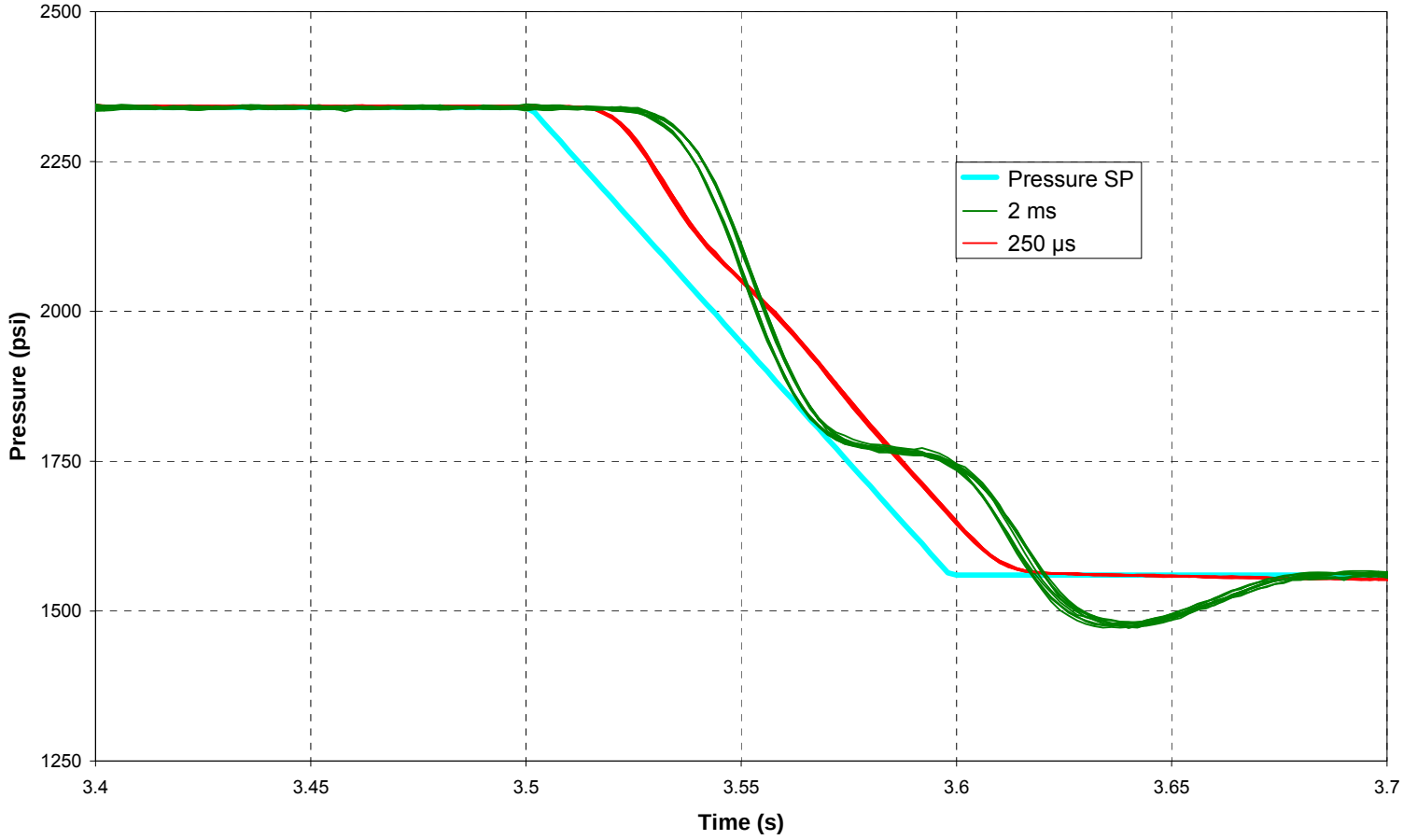


XFC – eXtreme Fast Control
Application



XFC – eXtreme Fast Control
Application

- Transition Pressure Control



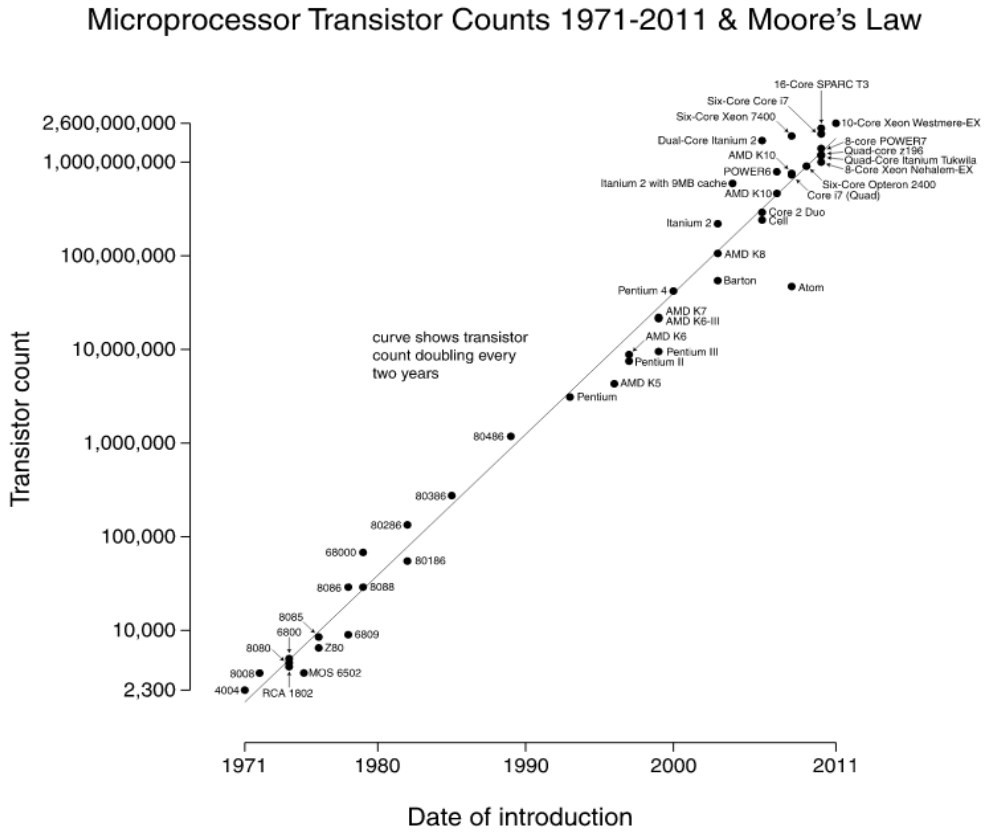
Application

- Benefit
  - Reduces part weight

Part weight today (g)	**22**
Part weight target (g)	**20**
Part per Mold	**8**
Parts / Year	**54,568,421**
Annual savings (kg)	**125,507**
Annual savings ($US)	**$182,651**

XFC – eXtreme Fast Control
The Future

- Beckhoff IPC‘s use Intel processors
  - Massive Intel R&D
  - Moore‘s law remains valid



The Future

- EtherCAT + XFC + lots of computation bandwidth
  - What is possible when you imagine highly deterministic communication to I/O and multiple, many cores of computation?

The Future

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