Best Practices for Motion Control:
Stepper Motor and Encoder Selection

Design World

LINENGINEERING
Step Motor Specialists

US DIGITAL

Overview

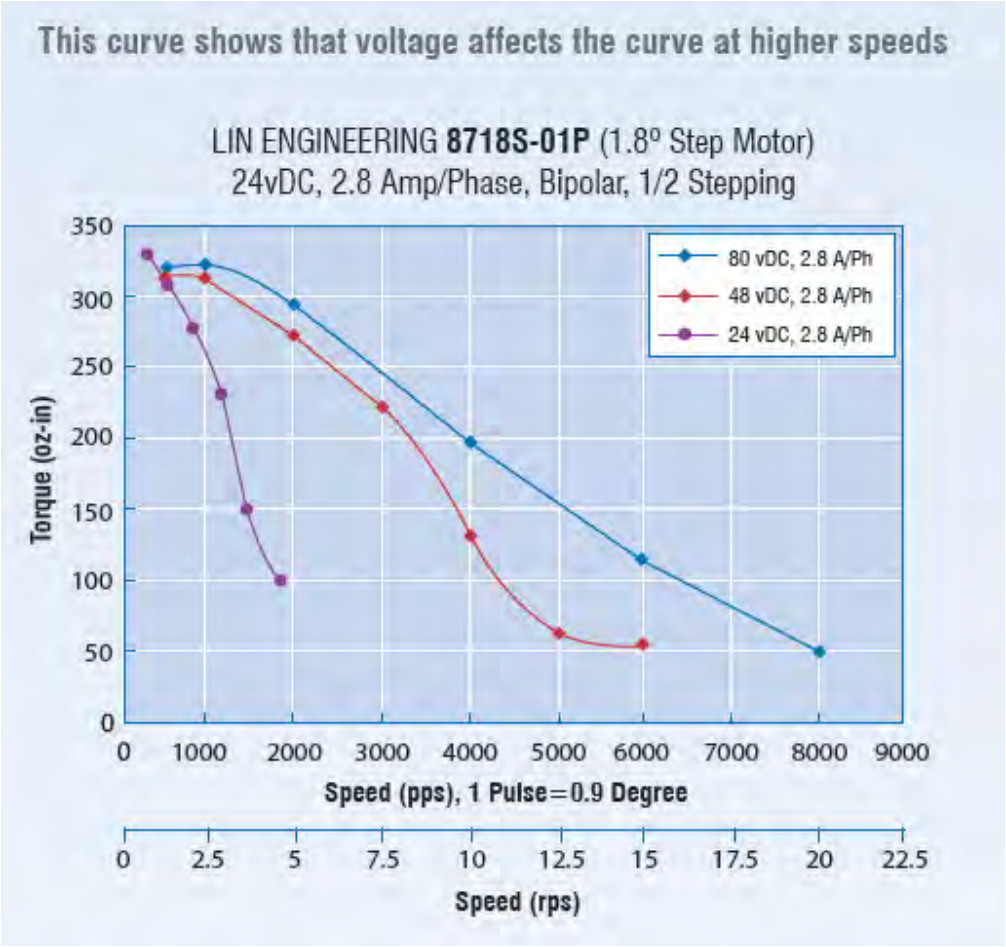
- Selecting a step motor
- Common step motor enhancements
- Case History
- Benefits of an encoder
- Encoder selection

Selecting a Stepper: What to Look for

1. **Maximum Efficiency**
   - *Torque at Speed*
2. **Power Available**
   - *Voltage & Current*
3. **Common Issues**
   - *Resonance*
   - *Accuracy*

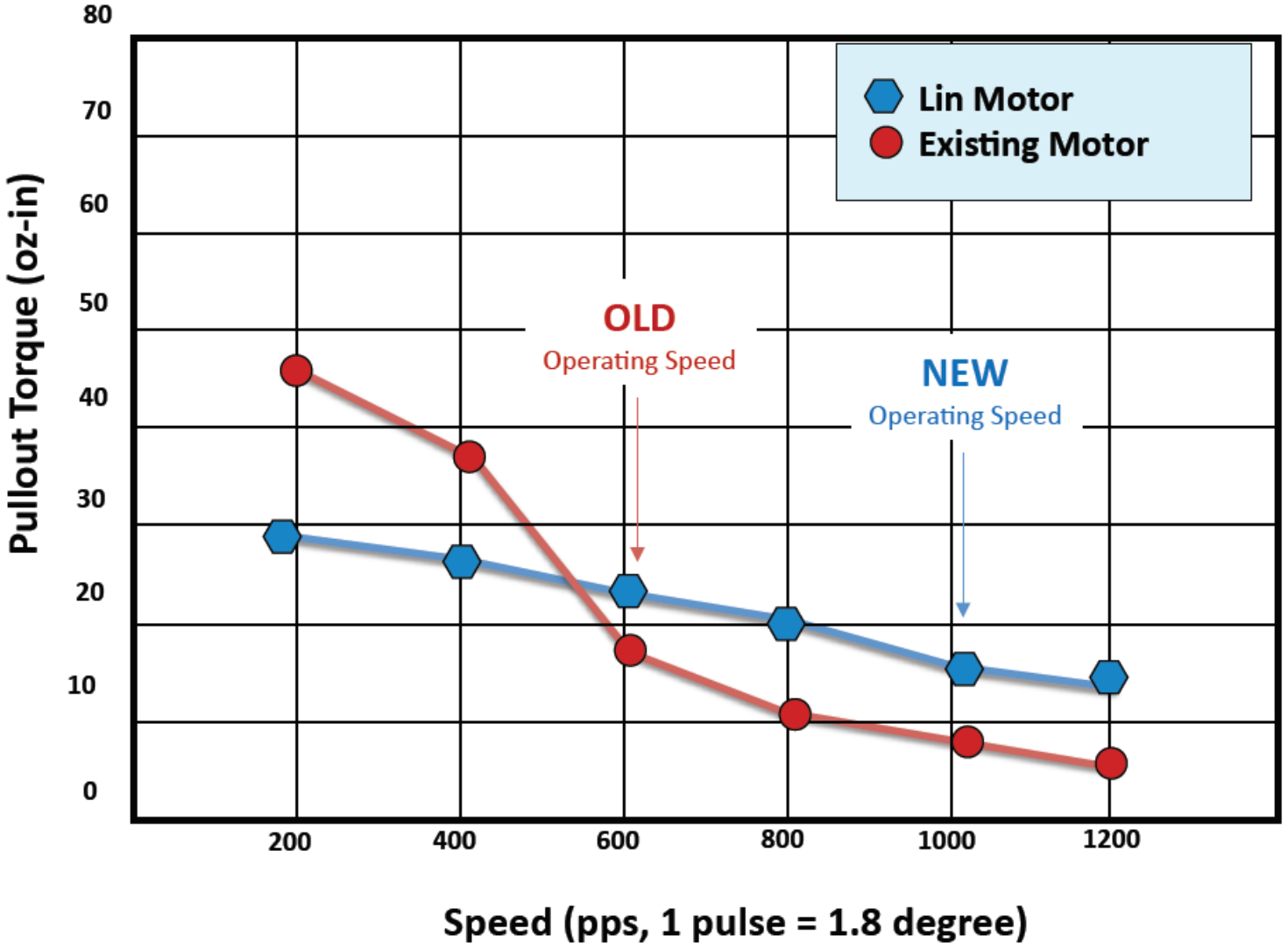
Use your step motor to measure system requirements

- Vary the *voltage* or the *current*
- Find an operating *speed*
- Motor supplier will back calculate required *torque*



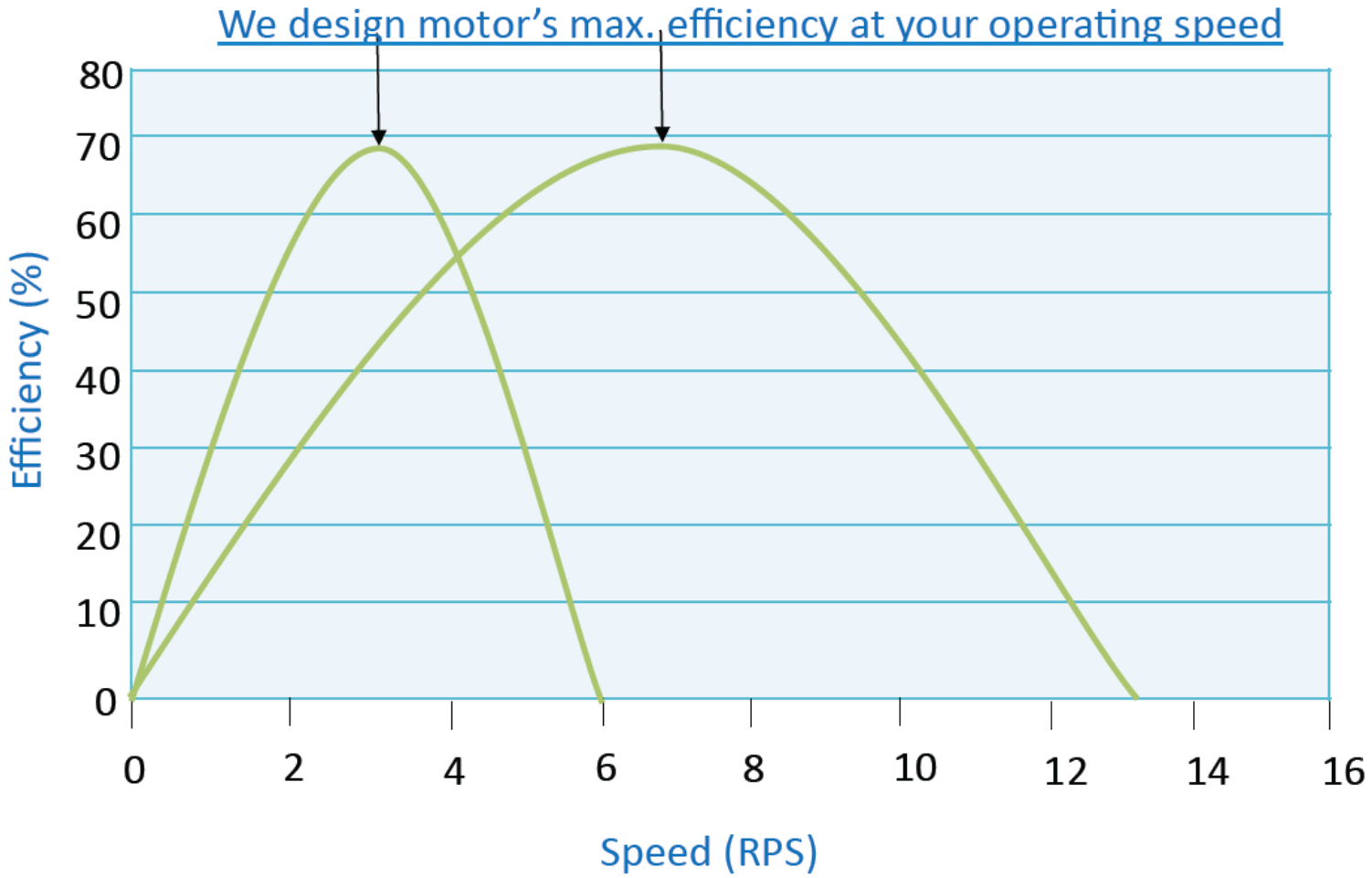
Maximizing Torque @ Operating Speed

24VDC, 2.0 Amps/Phase, Full Stepping



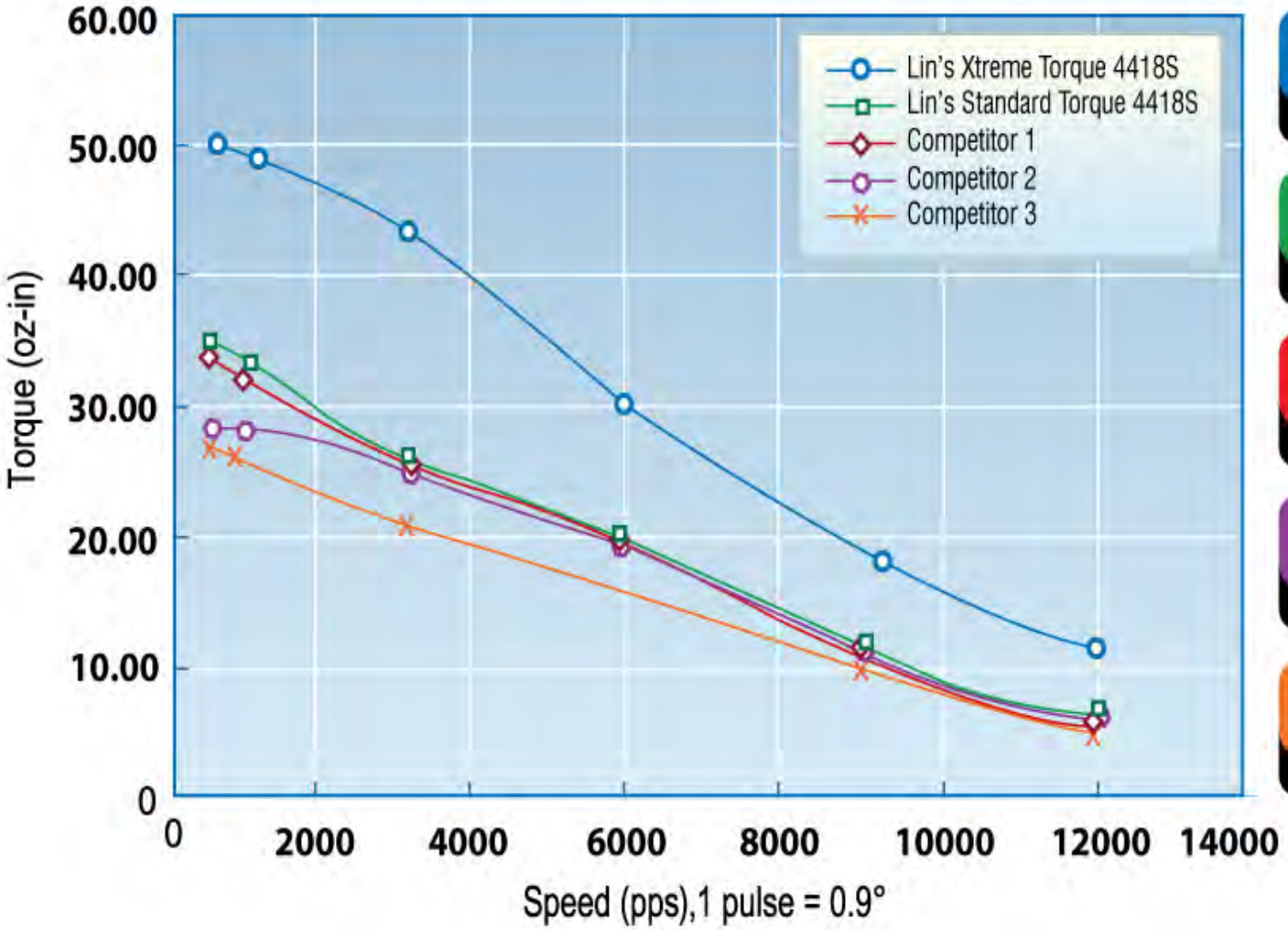
Step Motor Efficiency

(Varied by motor winding and power)



Xtreme Torque 4418S Series Comparison

1.8º Step Motor, 24vDC, Rated Current, Bipolar, 1/2 Stepping



Lin's Xtreme Torque 4418S
Motor length: 1.35"

Lin's Standard 4118S
Motor length: 1.34"

Competitor 1
Motor length: 1.34"

Competitor 2
Motor length: 1.34"

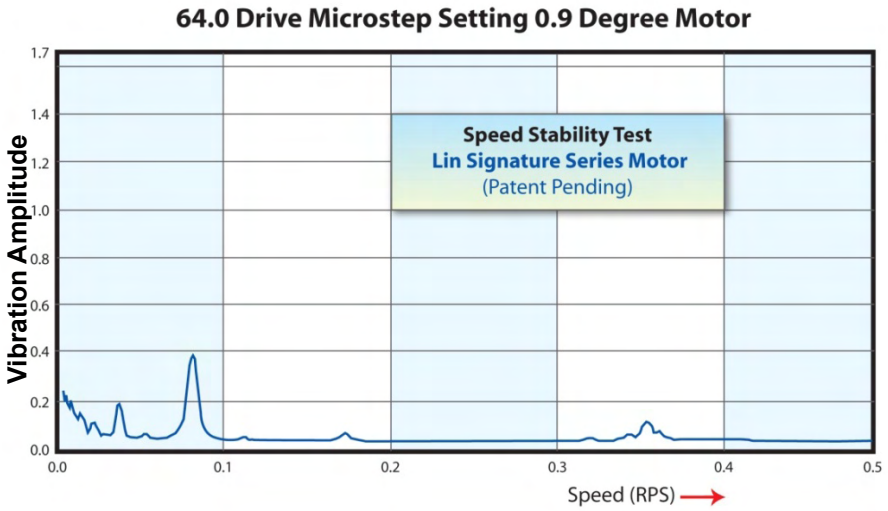
Competitor 3
Motor length: 1.30"

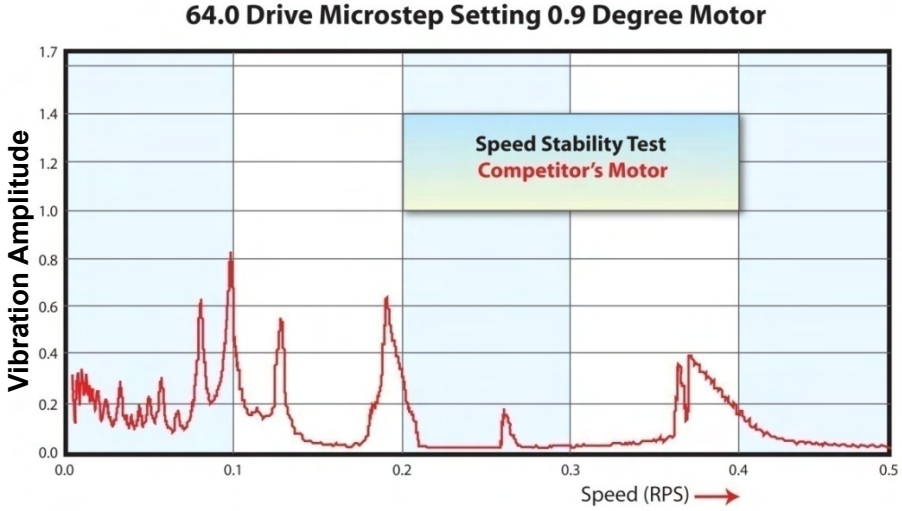
Methods of Reducing Resonance

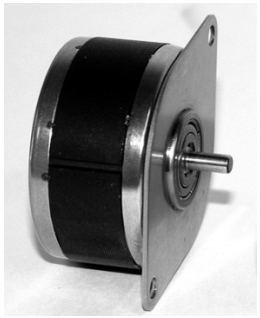
Tips to reduce resonance

- Change Voltage and Current
- Change Inertia of the load
- Change microstepping
- Change to a different motor

Product Comparison







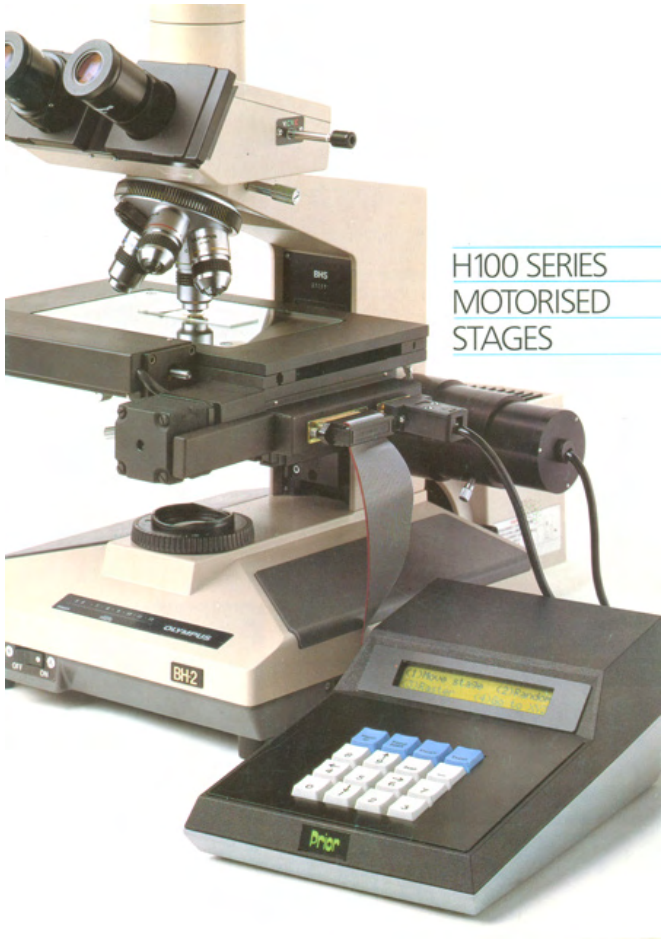
3709 vs. Standard 0.9

Signature Series PATENTED

Summary

- Vary Current or Voltage to find torque
- Every motor can be maximized for best performance for max efficiency
- Reduce resonance by changing voltage, current, microstepping or load.

Example Applications

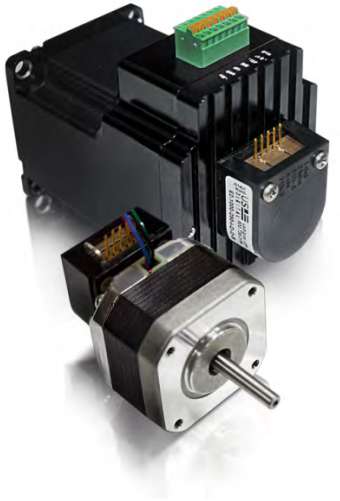


Common Enhancements

- Lower Speeds and/or Higher Torque- **Gearboxes**

- Reduce Resonance- **Dampers**

- Position Verification and Correction- **Encoders**



When is an Encoder Needed?

- When *position* of motor must always be maintained
- If a motor *stall detection* and action is required

- Typical Industries:
  - Medical
  - Solar
  - Semiconductor

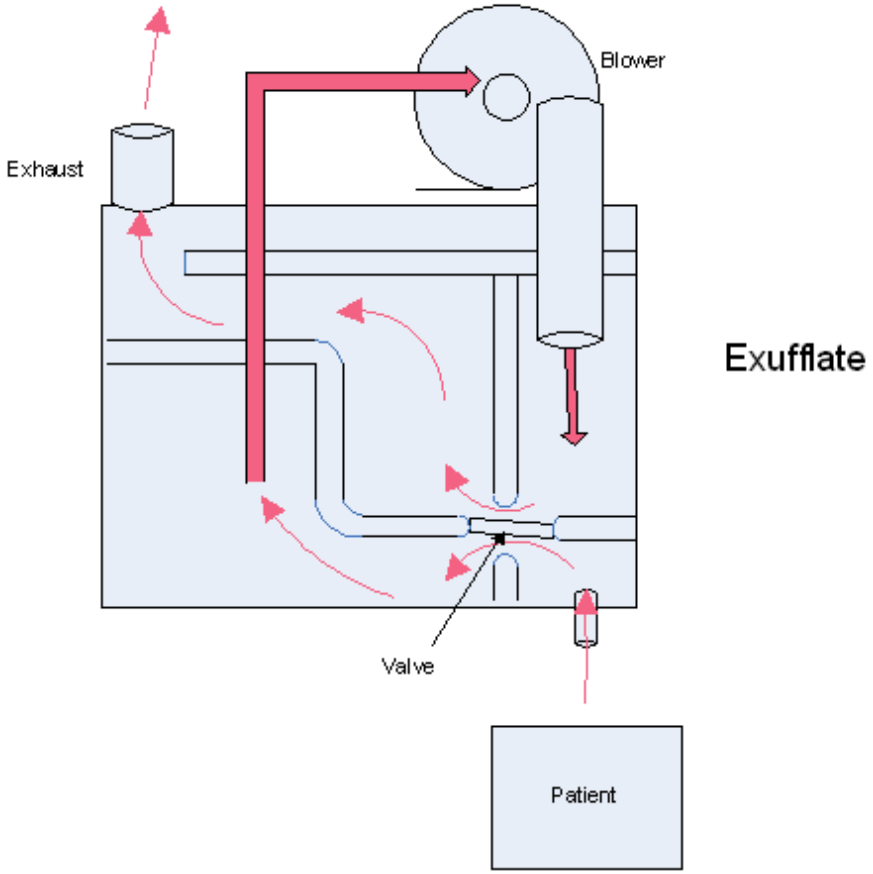
Case History

Background:

- Medical device used to remove mucus from patient airways

Requirements:

- High holding torque
- Accurate positioning
- Position feedback



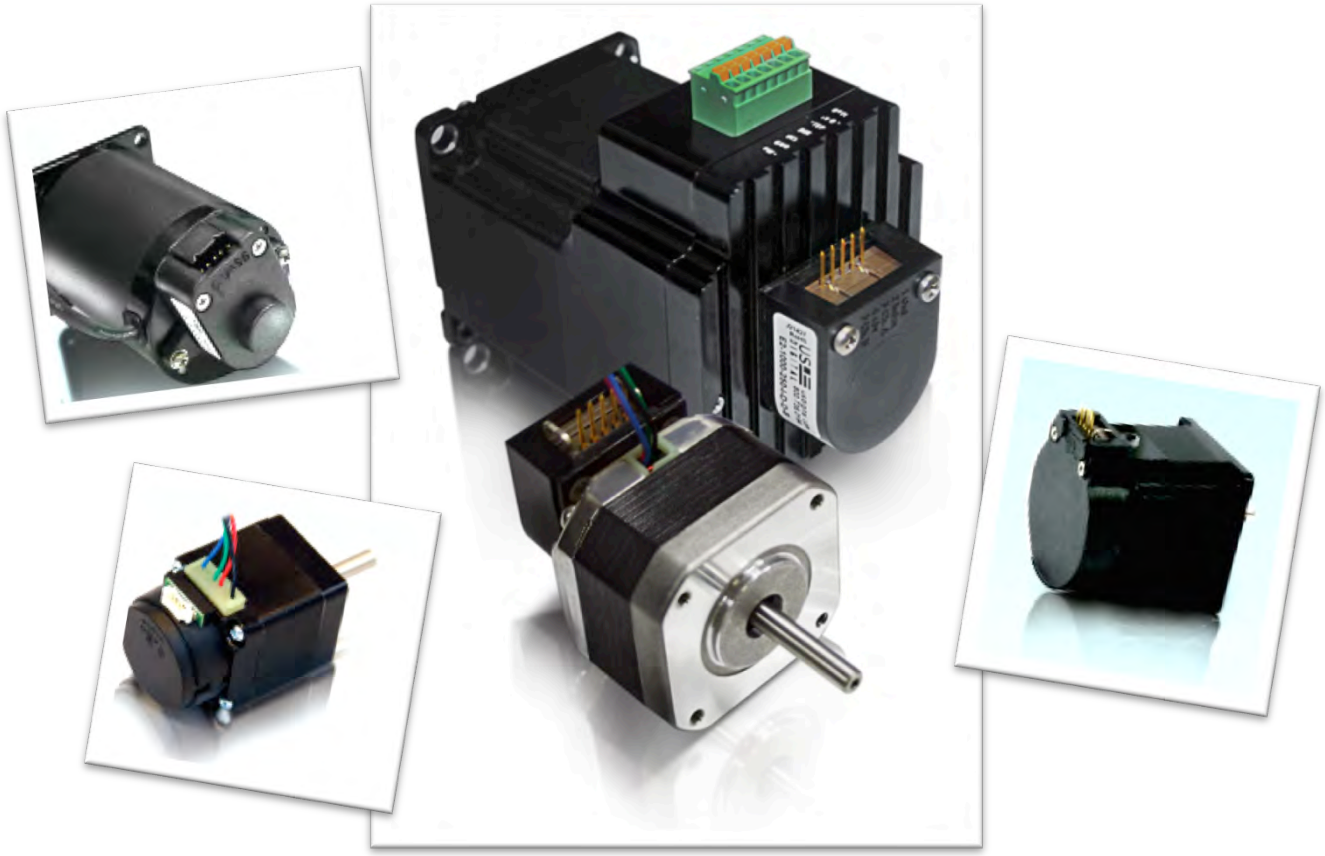
Does my specific application need an Encoder?

Decision Criteria

- Mechanical
- Resolution
- Index
- Differential vs. Single Ended Output

Mechanical

Steppers + Encoders



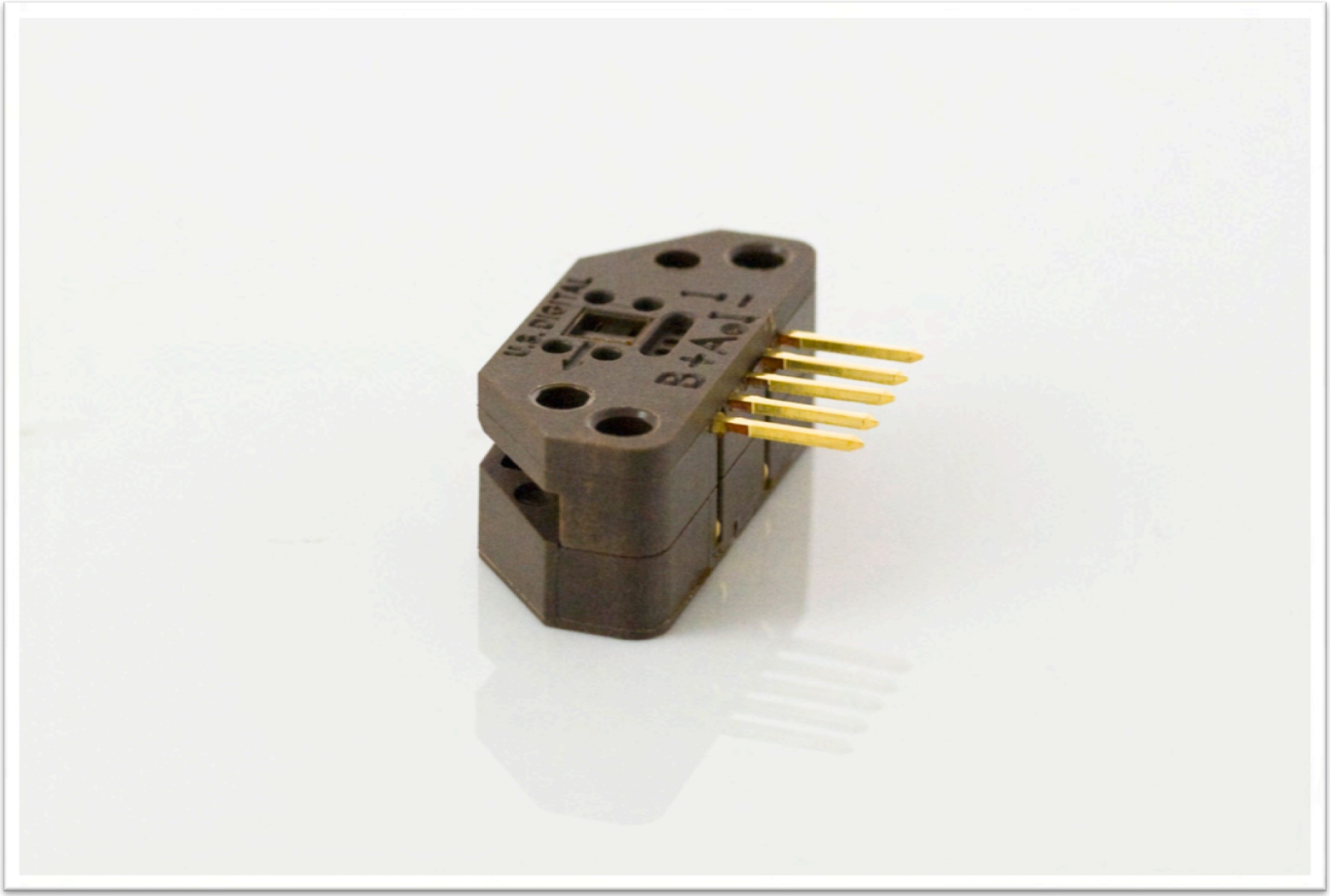
Mechanical Details

- Frame Size
- Shaft Diameter
- Mounting Bolt Circle
- Environmental Considerations

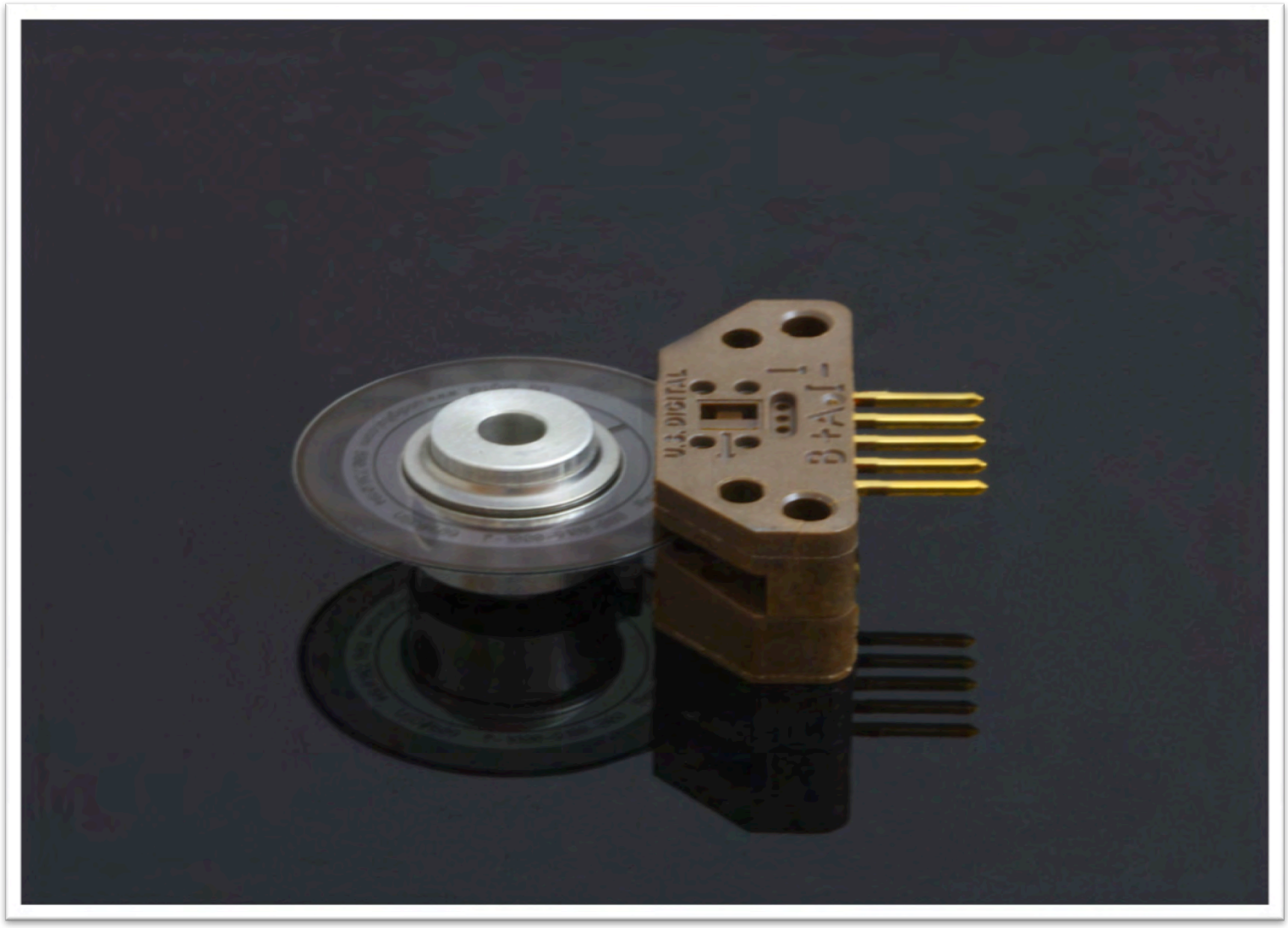
Resolution

Typical Optical Encoder Disk

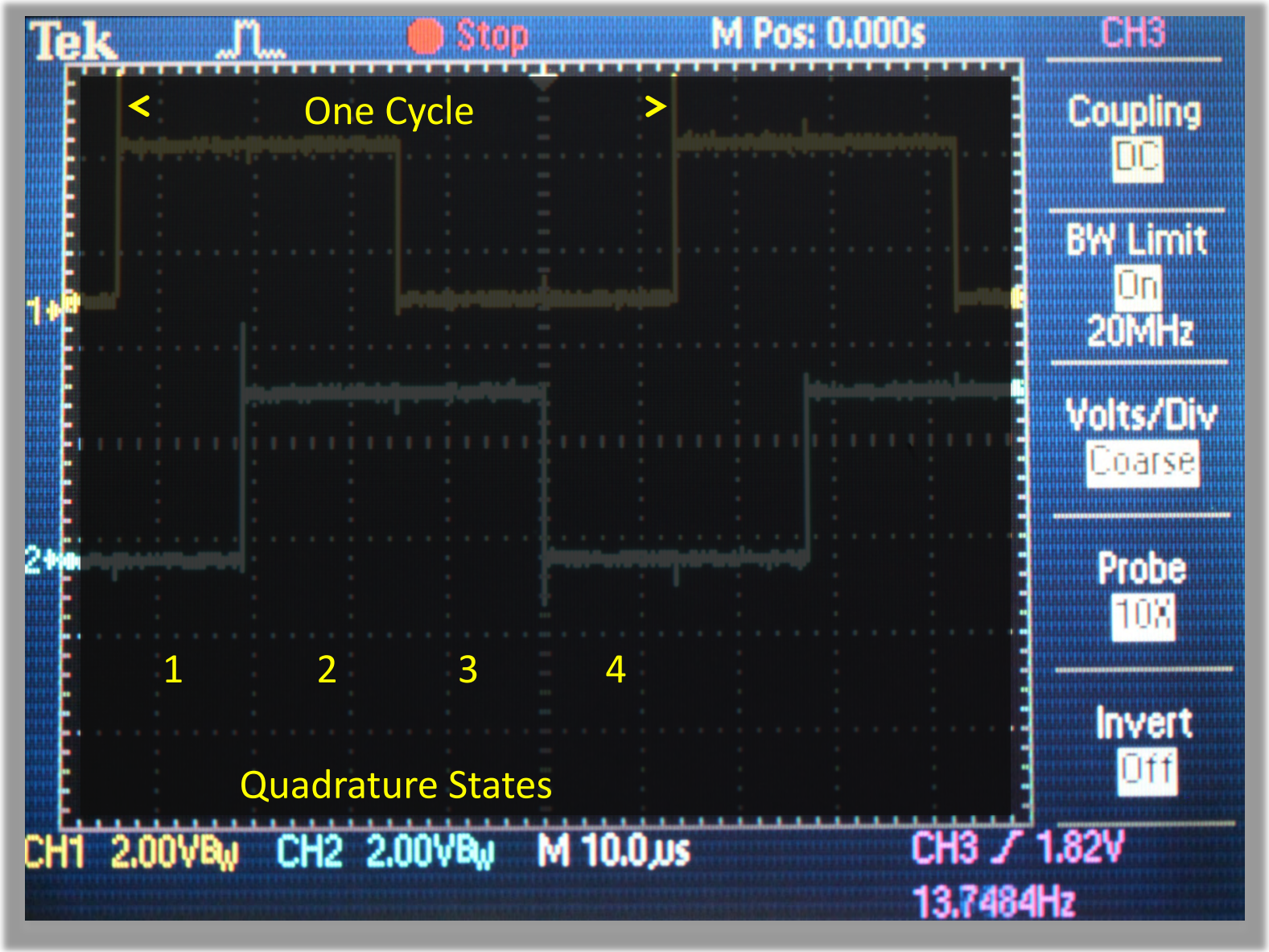
Optical Encoder Read Head



Encoder Module With Disk Assembly



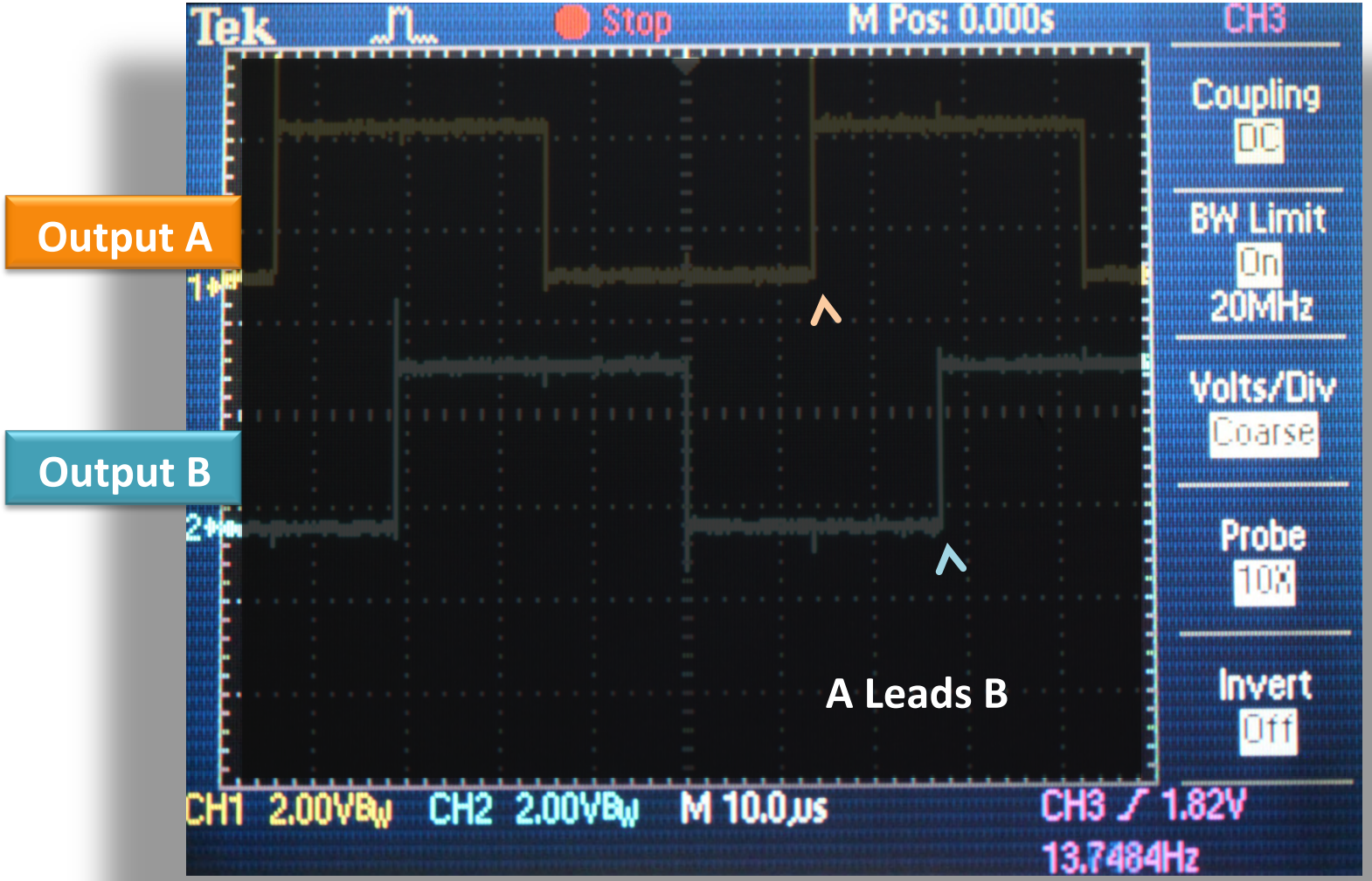
Quadrature States



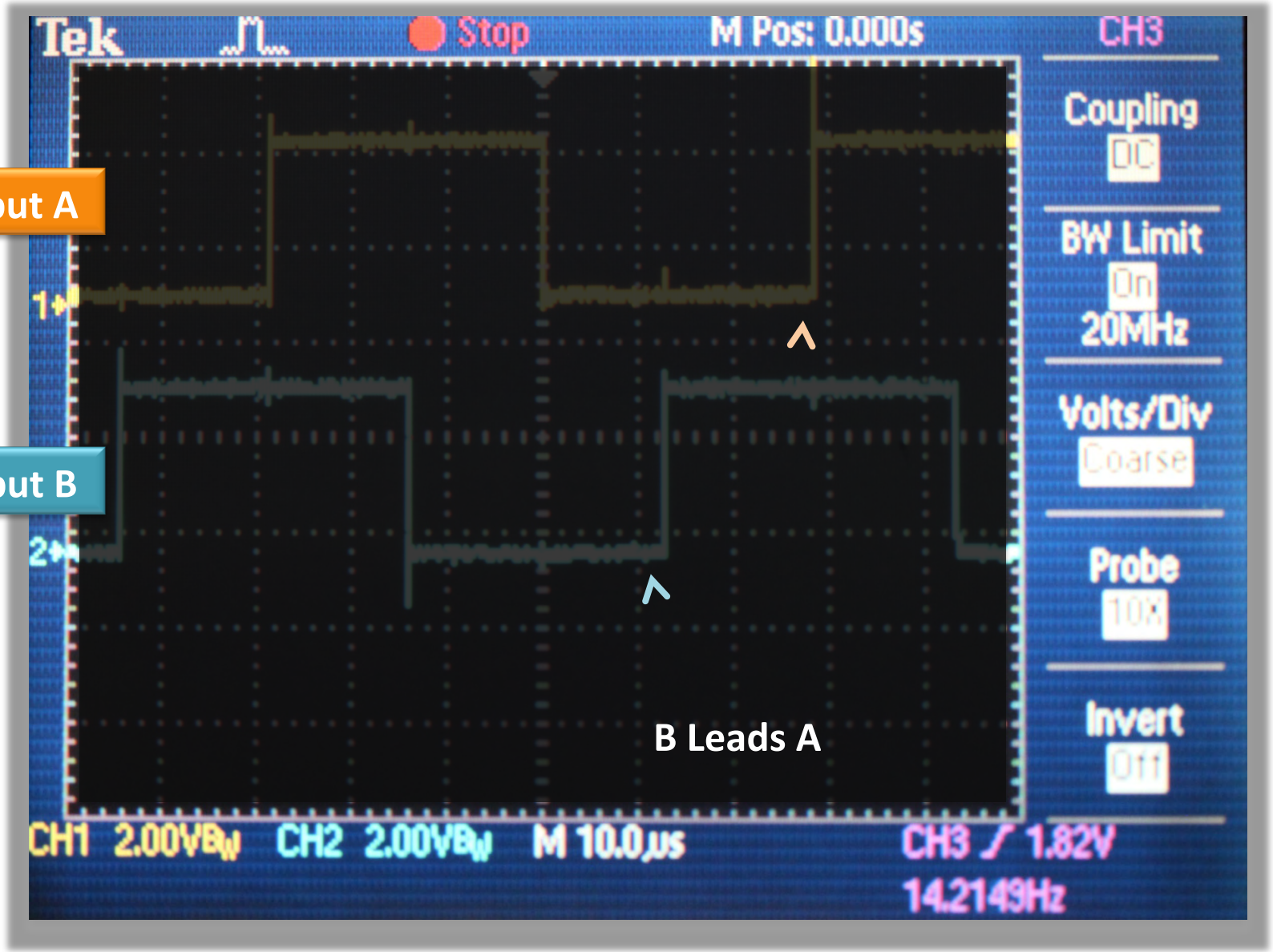
CPR vs. PPR

- CPR - Cycles Per Revolution
- PPR - Pulses Per Revolution
- **Example - 100 CPR = 400 PPR**

Quadrature Waveform



Reverse Rotation Quadrature Waveform

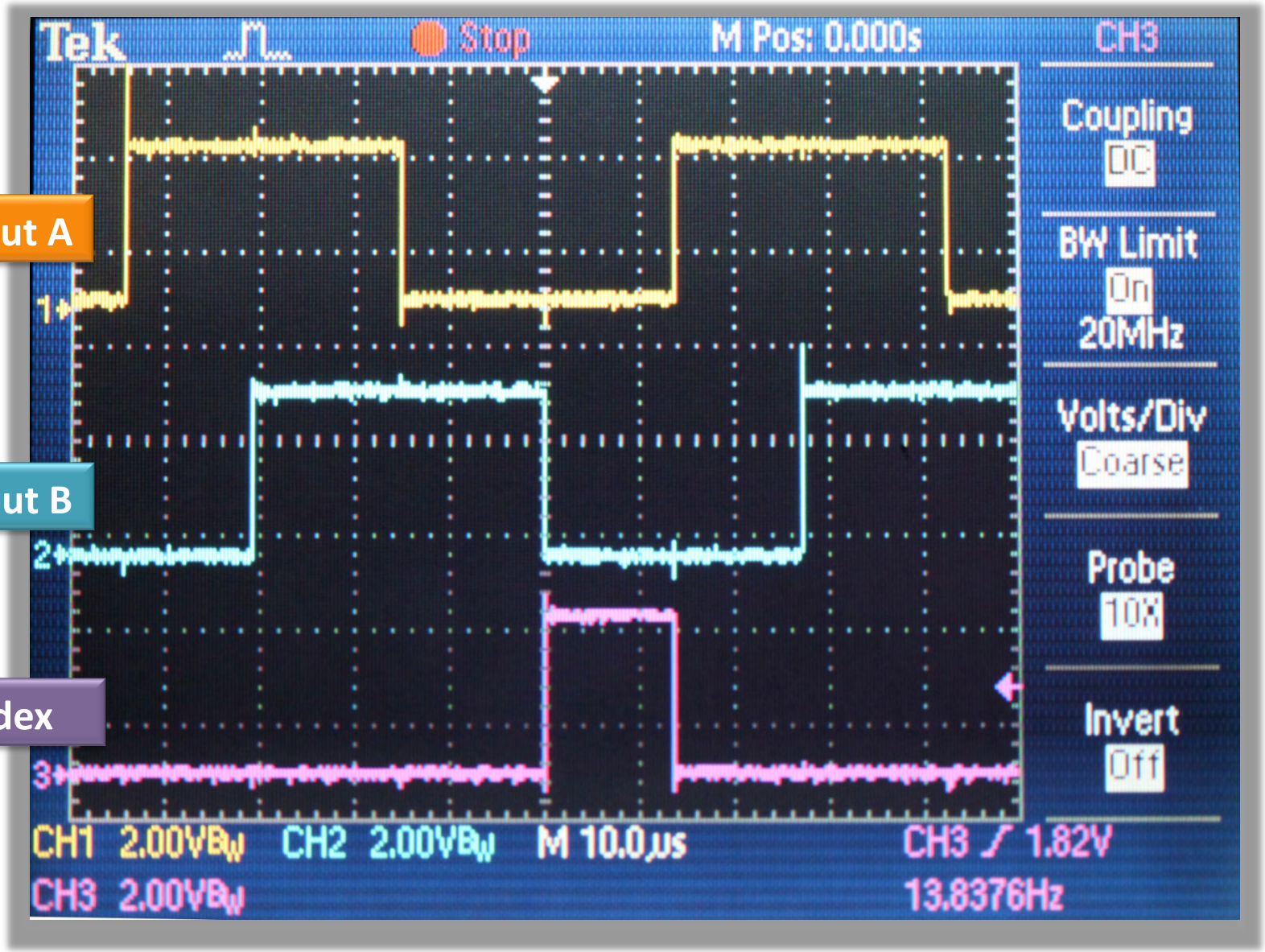


Quadrature Encoder Signals

- Provide Direction of Shaft Rotation Information
- Enable 4x Resolution Increase Over Disk CPR
- Standard Signals Regardless of Encoder Mechanical Package

Index

Quadrature With Index Waveform



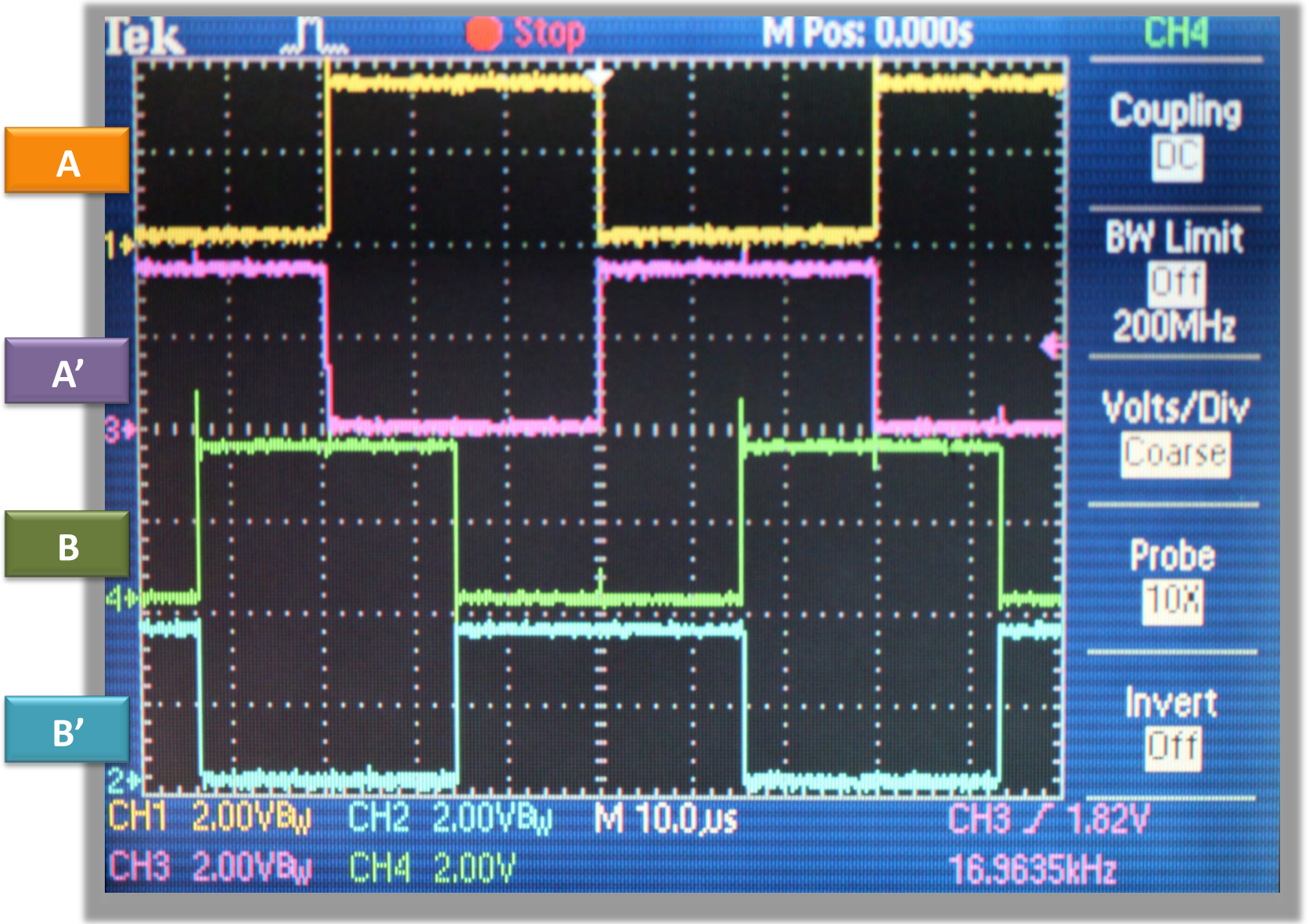
Index Pattern on Optical Encoder Disk

Encoder Third Channel Index

- Once per 360 Degree Rotation
- Gives a Single Absolute Location
- Typically Used for Home or Zero Location

Differential vs. Single Ended Output

Differential A and B Quadrature Output

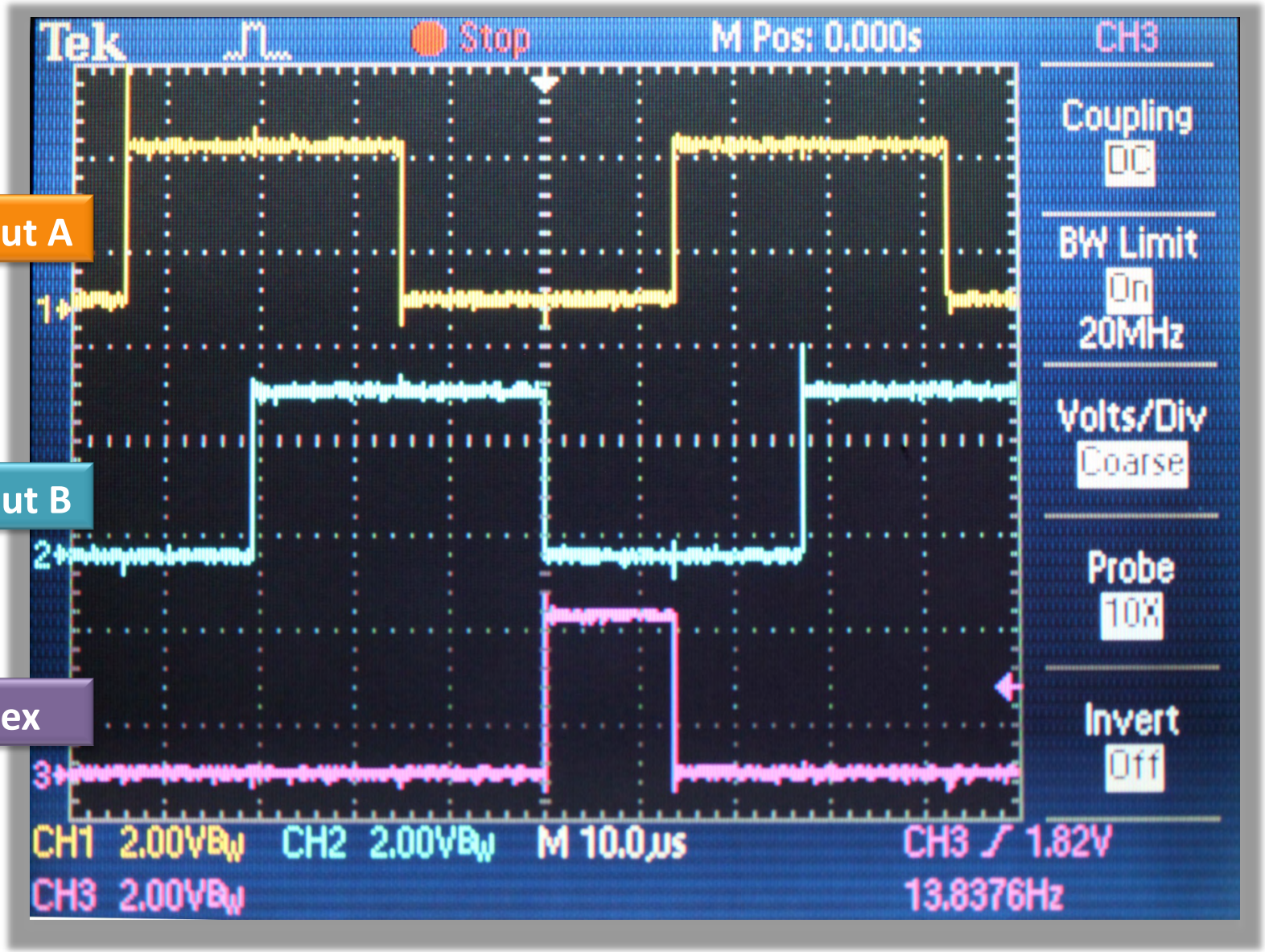


Differential A with Index

Differential Encoder Signals

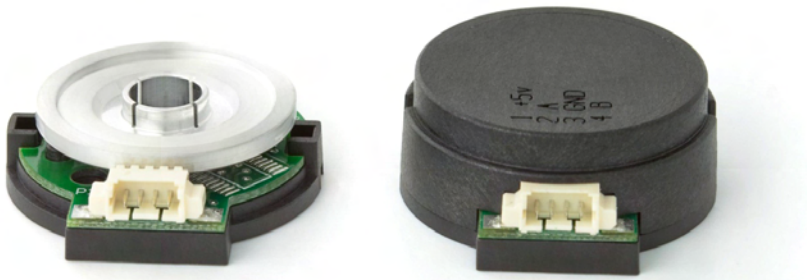
- High Electrical Noise Immunity
- Transmitting Encoder Signals Over a Long Distance
- Requires Differential Receiver

Single Ended Quadrature Waveform



Single Ended Encoder Signals

- Simple Interface Requirements
- Most Common Form of Encoder Output
- Short Distance Signal Transmission



Encoder Decision Summary

- Mechanical
- Resolution
- Index
- Differential vs. Single Ended Output
- Final Step - Decision

Flexibility and Customization

Custom Encoder

Custom Mounting Encoder

Custom Pinion Gear Encoder

LIN Engineering & US Digital Value Proposition

- Short Lead Times
- Personal Customer Service
- Great Value
- Reliability
- Custom Motion Control Solutions

Questions?

Design World

Thank you for attending!

Design World