Integrating Motion Control with LabVIEW

TENET Technologies

John Wu

John Wu
LabVIEW CLA, PMP

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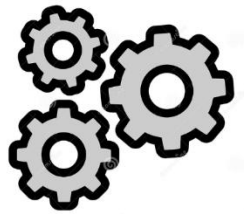
In this presentation, you'll learn:

LabVIEW™



- Benefits of integrating motion control with LabVIEW
- Motion control fundamentals
- Current motion controller options
- How to add motion control to LabVIEW in 30 minutes or less

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About me

- John Wu
  - Previous: 15 years of NI experience
    - Award-winning Motion Control System Engineer
    - Field Sales/Marketing
    - Certified LabVIEW Instructor
    - Certified LabVIEW Architect
  - Current: Founder/CEO, TENET Technologies
    - Located in Taipei, Taiwan
  - **We make motion controllers specifically for LabVIEW users**
  - Also CEO of Extend Test (www.extendtest.co)

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Benefits of motion control with LabVIEW

Why motion control with LabVIEW?

- LabVIEW is great for:
  - Data acquisition
  - Measurements and testing
  - Vision inspection
  - GUI (graphical user interface)
  - Algorithms
  - And more …
- You'll need motion control for …
  - Moving or manipulating the DUT (device under test)
  - Moving or manipulating the sensor
  - Or both

LabVIEW™

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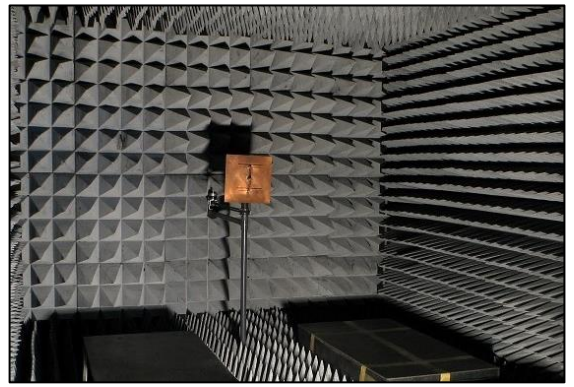
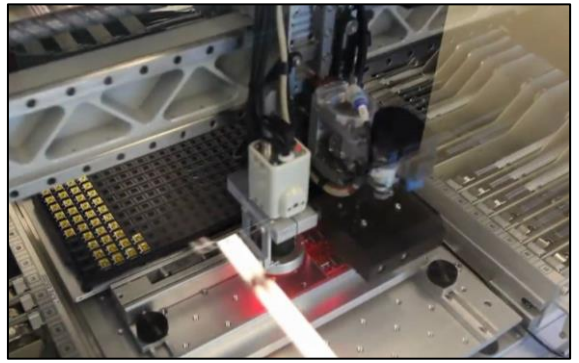
LabVIEW applications with motion control

- Antenna Testing
  - Rotating DUT in anechoic chamber while measuring RF response



- Keystroke actuation force testing
  - Moving mechanical finger in downstroke while measuring force

- Semiconductor wafer inspection
  - Sweeping camera across entire wafer while measuring and inspecting defects

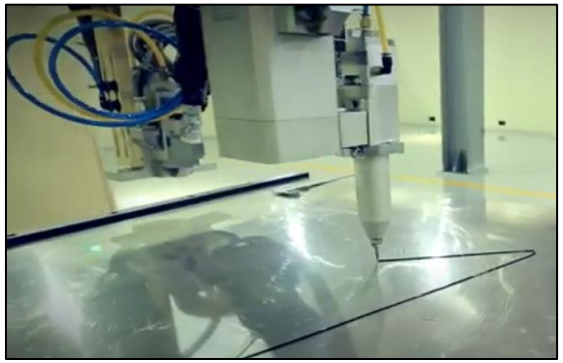


LabVIEW applications with motion control

- Flight simulator
  - Controlling 6-DOF stewart platform mechanics, while calculating inverse kinematics in LabVIEW

- Medical imaging
  - Moving sensor to sweep cross entire area, while processing data to stitch image together

- Glue dispensing for automotive parts
  - Moving nozzle in contoured profile while controlling amount of glue dispensed

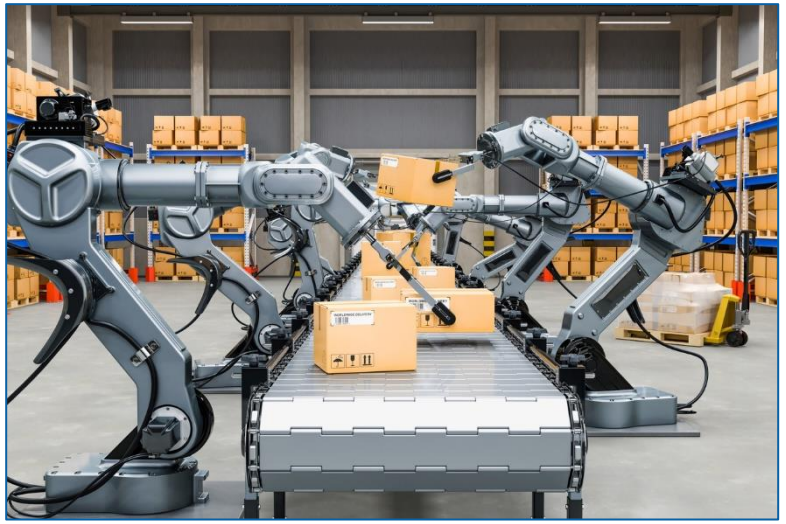


Motion control fundamentals

Goal of Motion Control

- To move an object in one or multiple dimensions while having precise control over the motion and its kinematics

- Physical elements to be controlled include:
  - Stepper motor
  - Servo motor
  - Conveyor belt
  - Gears and pulleys
  - Robot



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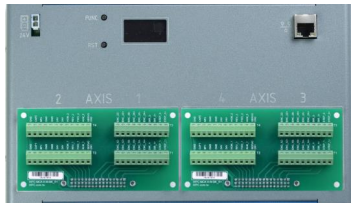
Components of a motion control system

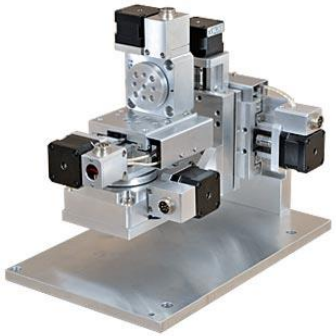
PC and application software



Motion Controller

Motor Drive or amplifier

Motor



Motor stage or assembly

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Functions of a Motion Controller

1. Generate motion trajectory
2. Send commands to motor drive based on trajectory
3. Monitor feedback from drive and I/O
4. (Optional) closed-loop control

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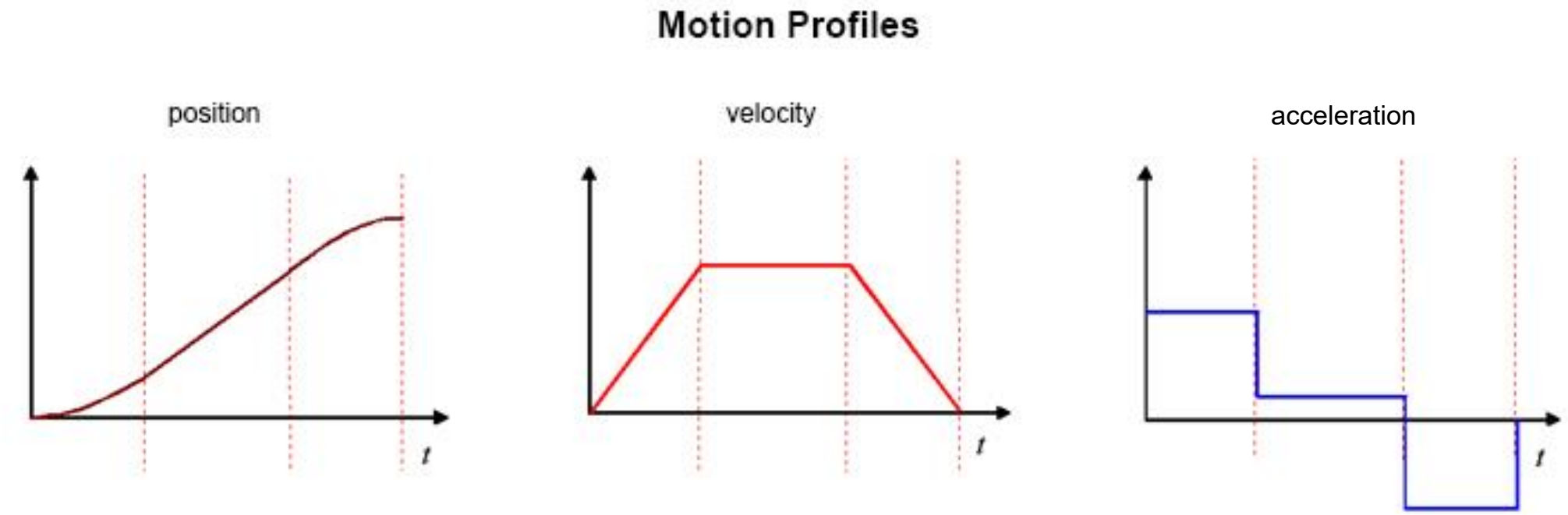
1. Generate motion trajectory

- Calculates motion profile based on user-defined position, velocity, and acceleration settings



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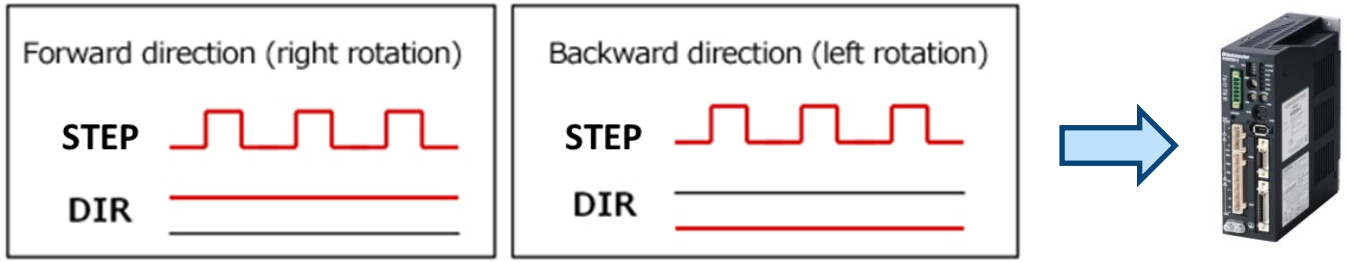
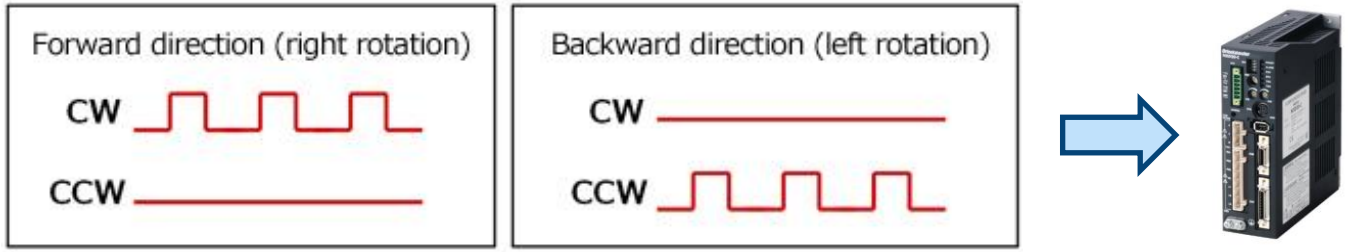
2. Send commands to motor drive

- 1-pulse output (STEP/DIR)



- 2-pulse output (CW/CCW)



- For each pulse sent, motor will turn by a specific degree
- For ex: if motor has 200 steps per revolution, each pulse = 1.8^{0}

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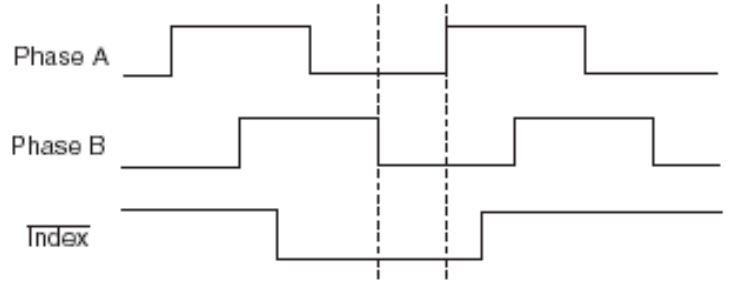
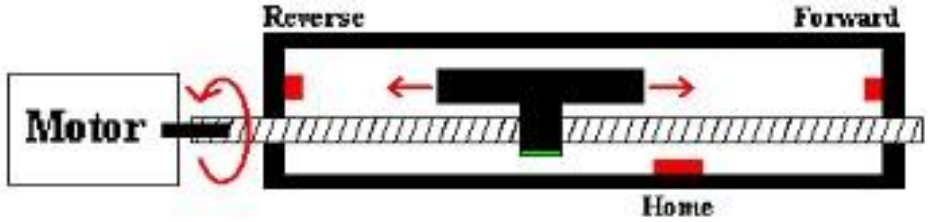
3. Monitor feedback from drive and I/O

- Position - Quadrature Encoders
  - A/B/Index (Z) pulses can be used to determine position and direction



- Home and limit switches
  - Prevent potential crashes
  - Provide reference point (home) for movements



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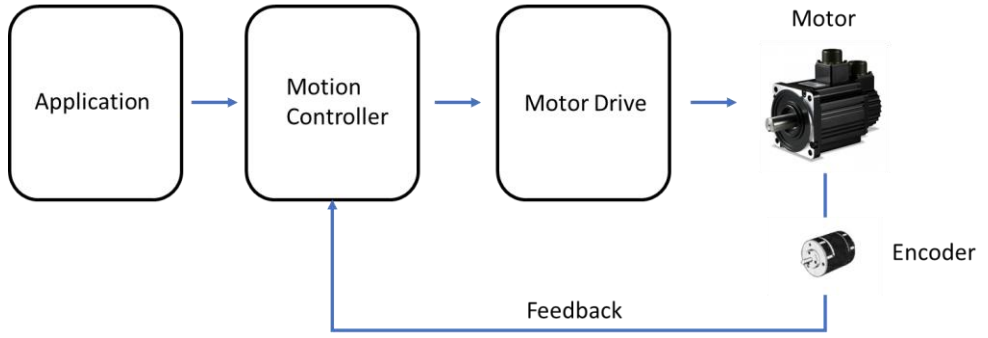
4. (optional) closed-loop control

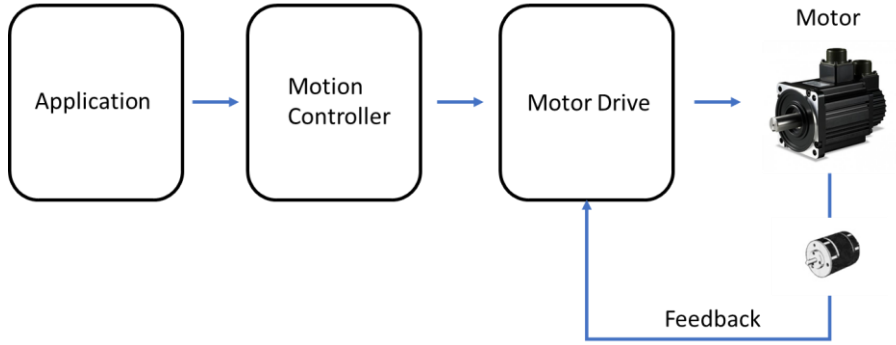
- What is closed-loop control?
  - Active compensation for deviation between target position and actual position
  - PID is popular method of control

- Note:
  - Most modern drives now have integrated closed-loop control
  - Additional compensation is not needed from motion controller
  - Feedback is passed from drive to motion controller

(PID on motion controller)



(PID on motion drive)



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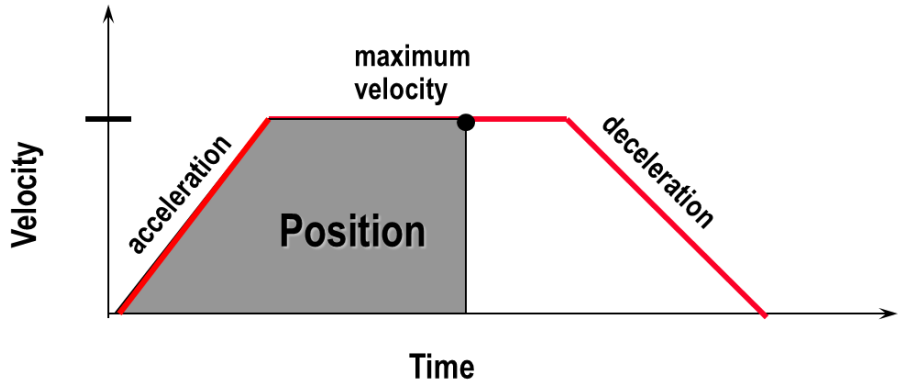
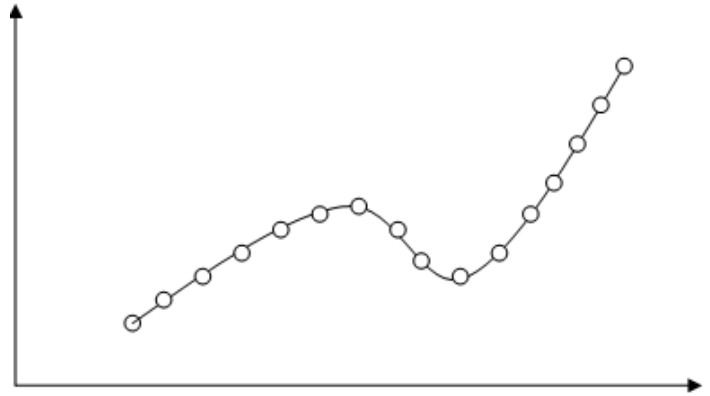
Types of moves

- Line (point-to-point)
  - Define target position, accelerate to target velocity, then decelerate
- Contour
  - Store array of pre-defined points, move through each point
- Multi-axis interpolation
  - Execute move in 2-D or 3-D coordinate systems
  - Can combine with Line move or Contour move
- Velocity move
  - No target position, only velocity





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Current motion controller options

Price vs. performance

Performance

Low-end:
- sub $100 USD
- Single-axis only
- Typically RS-232 or RS-485
- No synchronization
- Slow response

PLCs:
- Typically $300-500 USD per axis
- Some have synchronization
- Rugged
- Uses ladder logic to program

High-end laboratory:
- $800-1000 USD per axis
- Synchronization
- Typically DLL, ActiveX, or .NET driver

100 USD per axis

500 USD per axis

1000 USD per axis

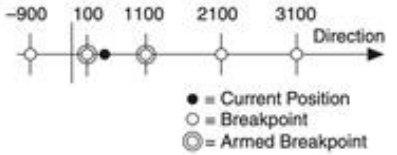
Price

However, we must keep in mind the considerations for integrating with LabVIEW…

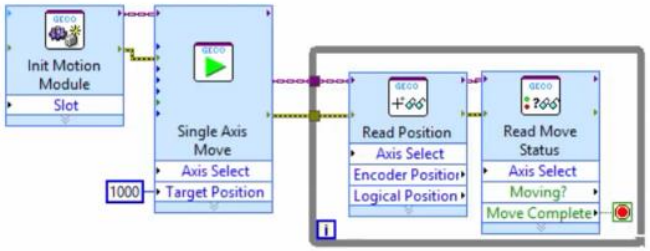
Considerations for integrating with LabVIEW

- Performance
  - Multi-axis synchronization?
  - Low latency?

- Integration
  - LabVIEW compatibility across versions?
  - Breakpoint triggers for syncing DAQ, vision, and other sensors?



- Ease of use
  - Intuitive LabVIEW driver design?
  - Friendly for both LabVIEW novices and experts?



Introducing: TENET EMotion

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EMotion 4-axis controller

Performance

High-end laboratory

PLCs

Low-end

PC-based (LabVIEW):

- Access to variety of LabVIEW libraries and toolkits
- Multi-axis synchronization
- Low latency
- Breakpoint triggering

100 USD per axis

500 USD per axis

1000 USD per axis

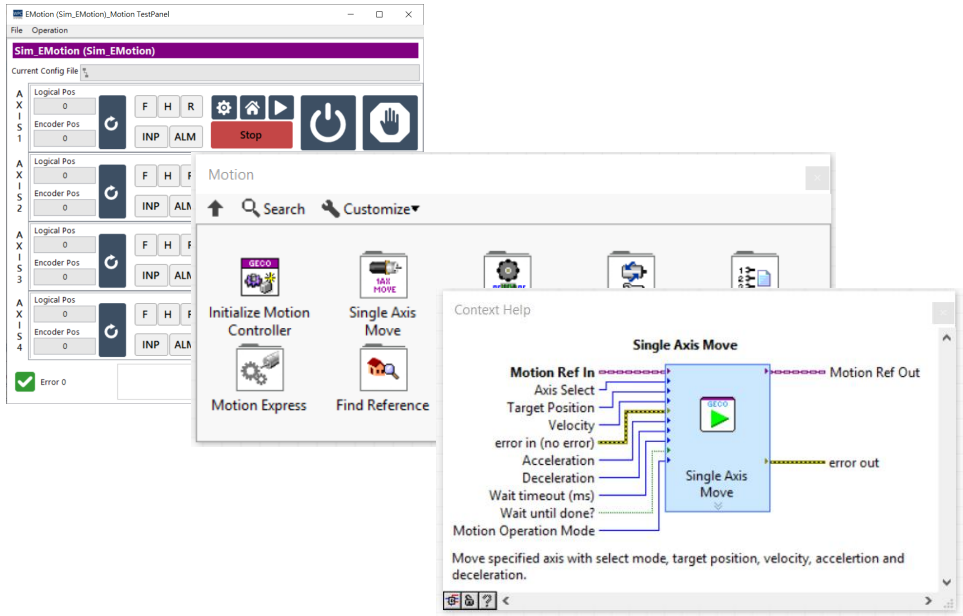
Best performance for modest price.

Enjoy the benefits and performance of PC-based LabVIEW graphical system design!

Introducing: TENET EMotion

- 4-axes ethernet motion controller
- Add motion to LabVIEW in 30min or less

- LabVIEW software features:
  - Test Panels
  - EMotion LabVIEW API
  - Example Vis
  - Exclusive! Motion Express VI
  - Compatible with LabVIEW 2015+
  - Compatible with LabVIEW Real-Time (PXI, cRIO, sbRIO)



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Using the TENET EMotion

Steps	Time
Install software	10 min.
Connect motor drive and switches	10 min.
Connect 24V power	1 min.
Configure IP address	3 min.
Connect ethernet cable	1 min.
Verify motor with test panel	5 min.
Use examples and start programming!	*Total = 30 min.

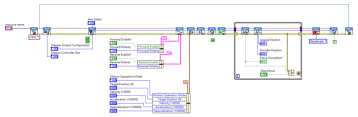
*Typical times, exact times for user may vary.

TENET offers free onboarding services to ensure swift installation.

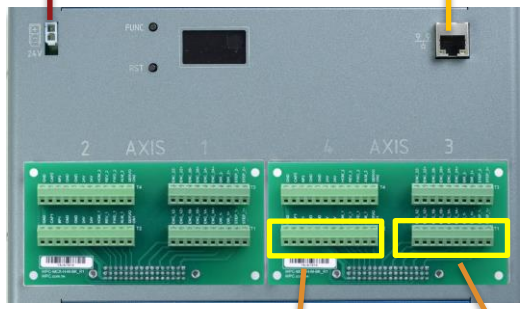
24V power supply

Ethernet cable

Host PC / Laptop



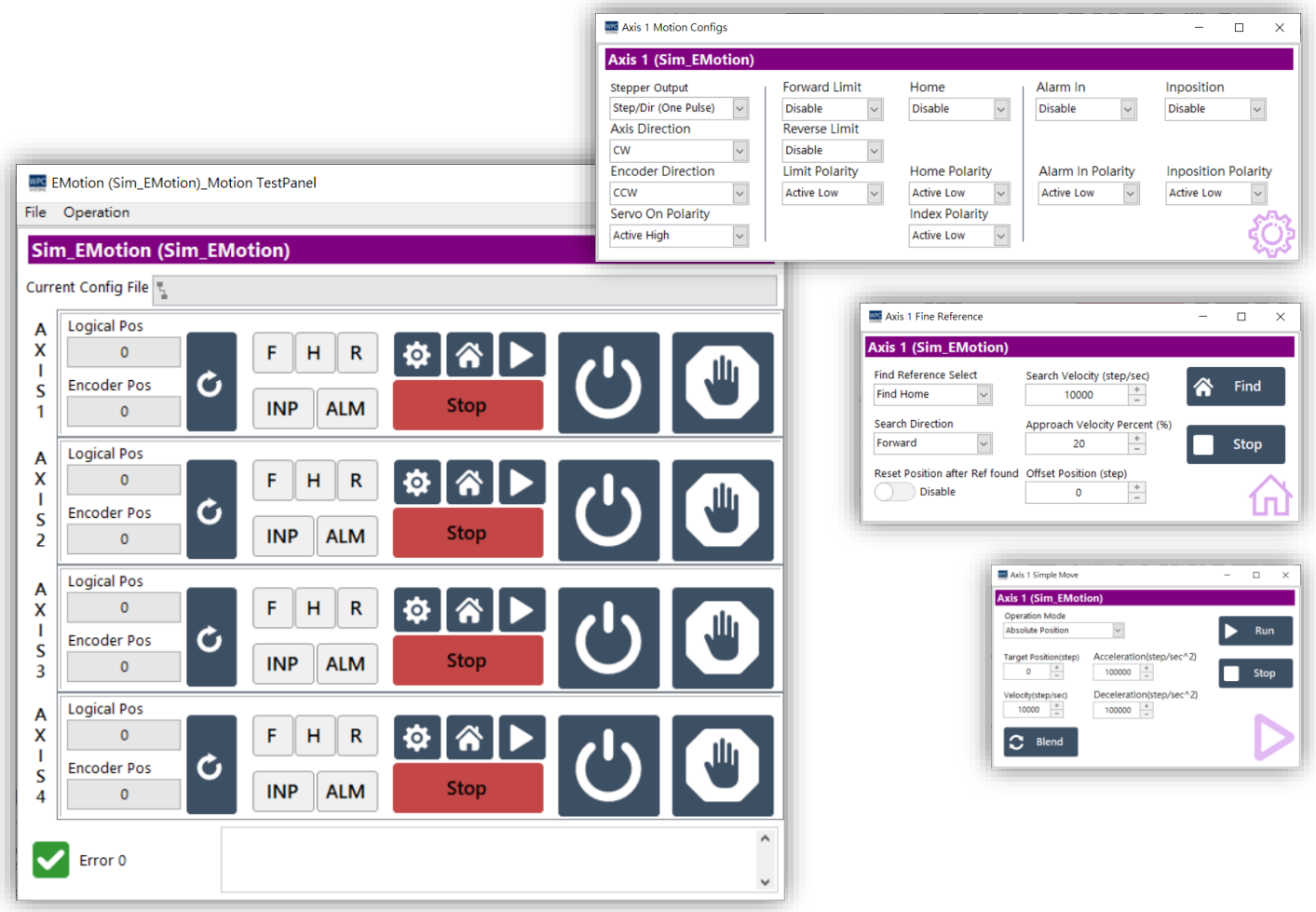
Example code



Forward/Reverse/Home
limit switches

Stepper Motors / drives
Servo Motors / drives

EMotion Test Panel



- Quickly verify if hardware is functioning
- Users can execute any command in test panel
- Go-to tool for isolating issues

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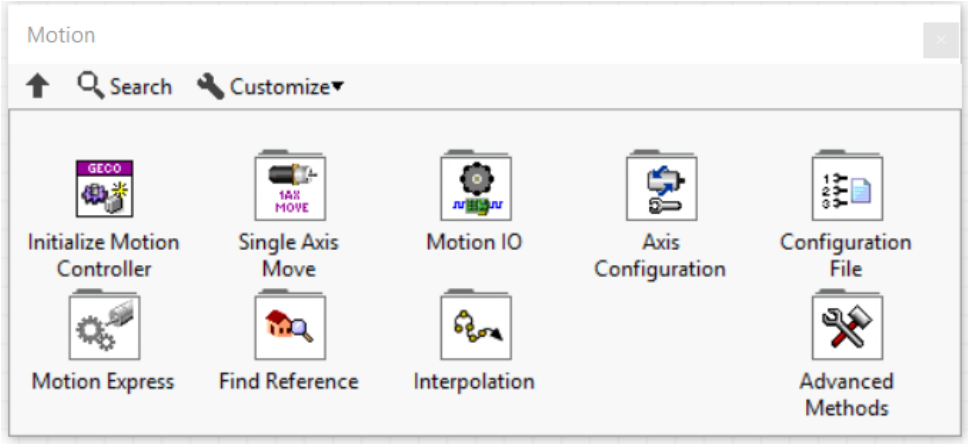
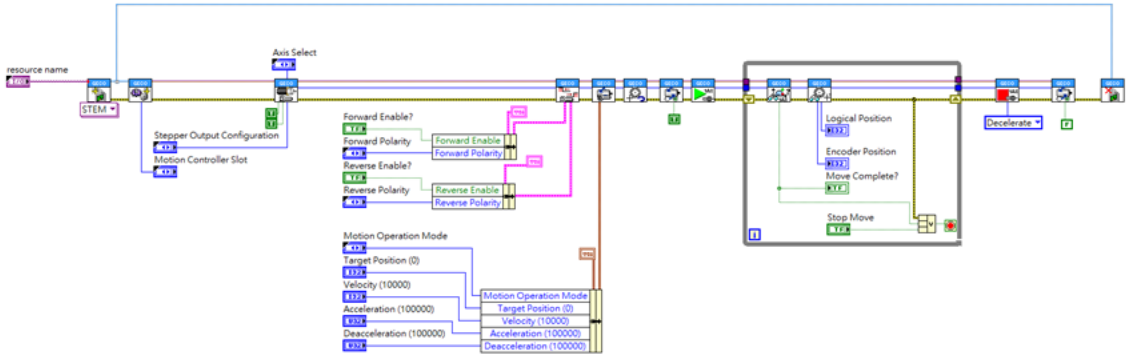
EMotion LabVIEW driver

- Inspired by NI-Motion driver API
  - (now discontinued)
- Designed by certified LabVIEW engineers
- Follows dataflow paradigm and LabVIEW best practices





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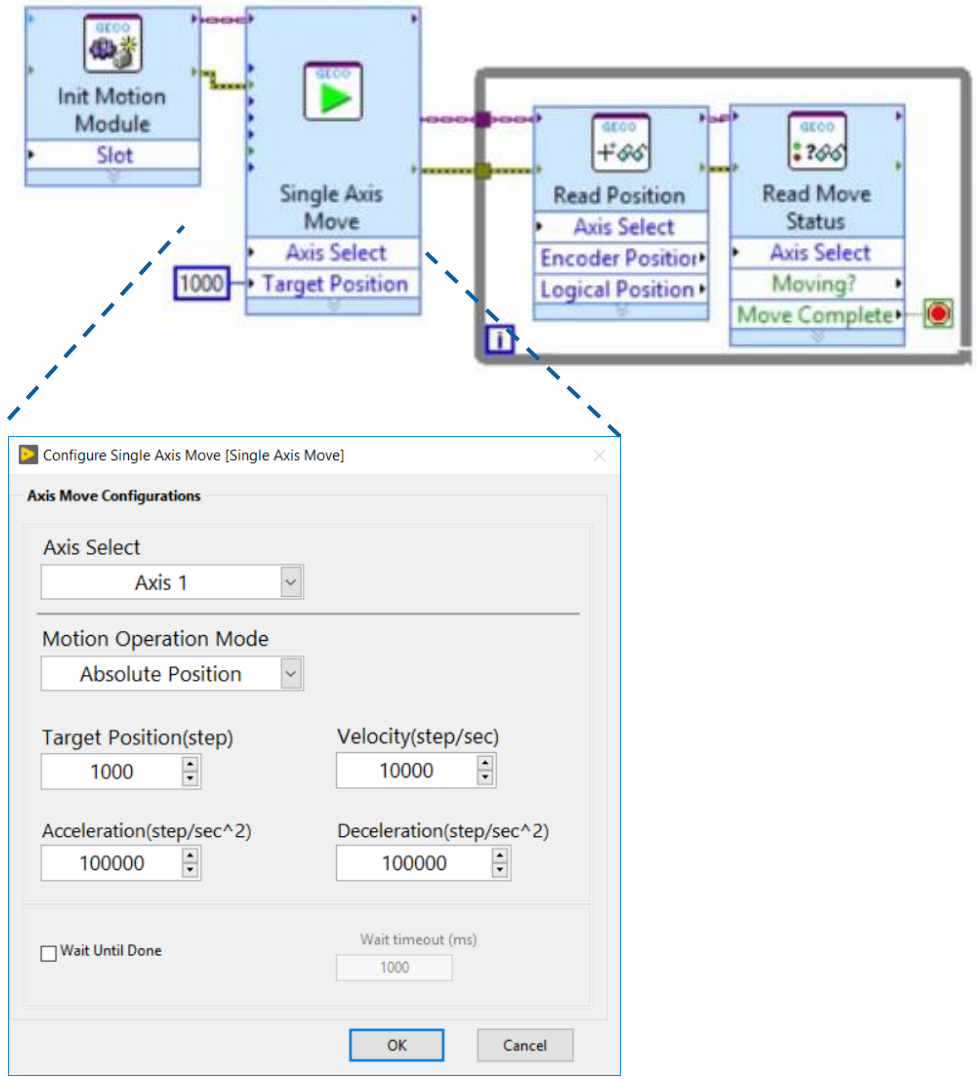
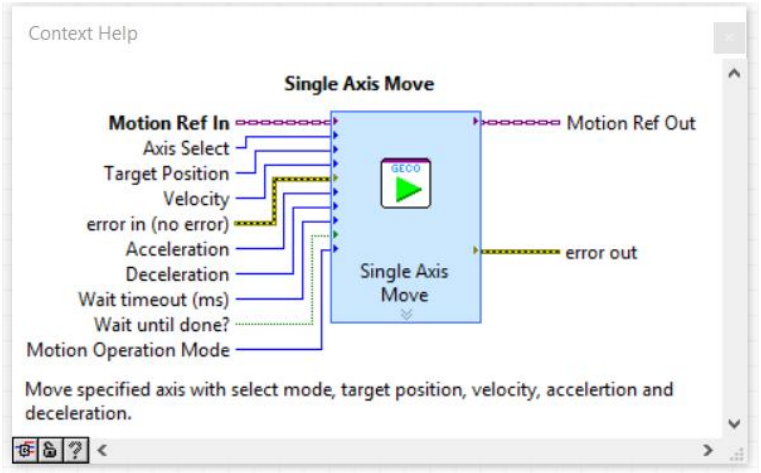
Exclusive! Motion Express VI

- Define motion via dialog window
- Generates LabVIEW code in background
- Easier for novice LabVIEW users





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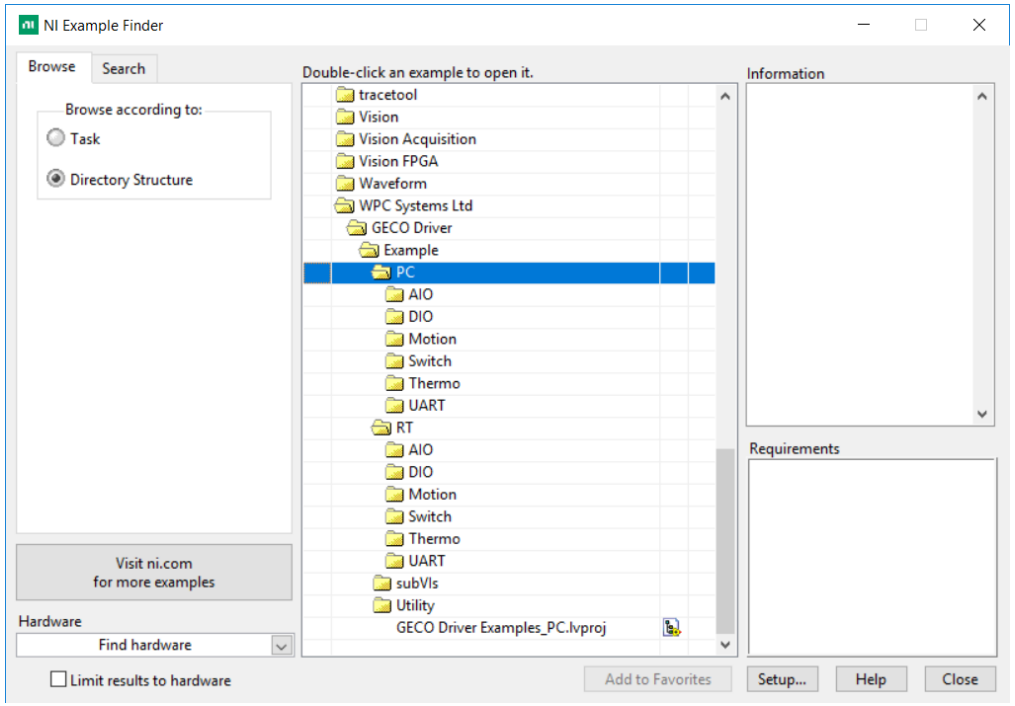
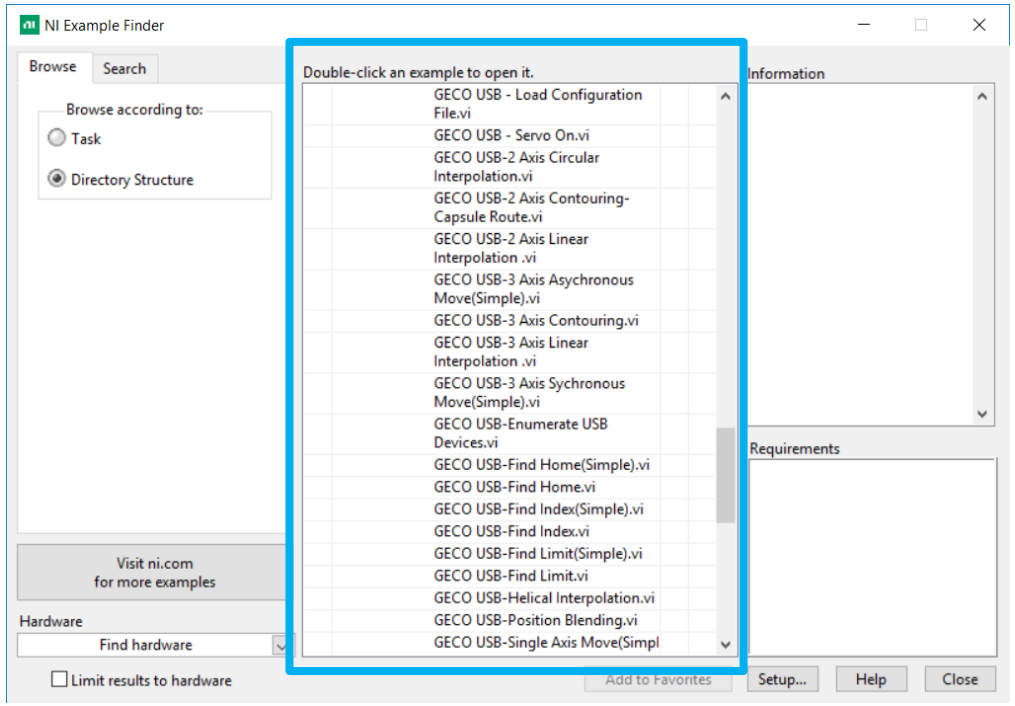
LabVIEW Examples

- Searchable in LabVIEW Example Finder
- There’s an example for each available hardware function
- No need to start from scratch





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Demo Video

https://docs.tenet-tech.co/emotion-getting-started-guide

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TENET EMotion additional benefits

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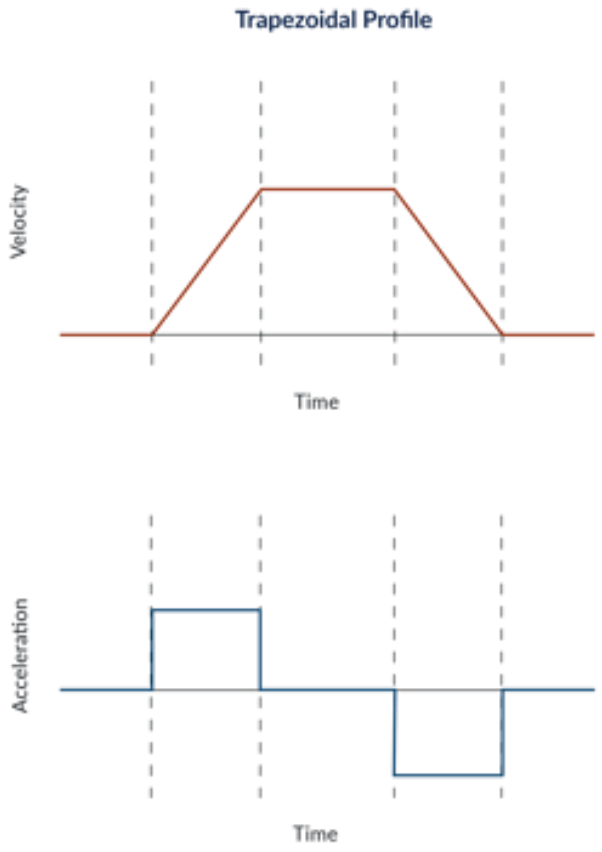
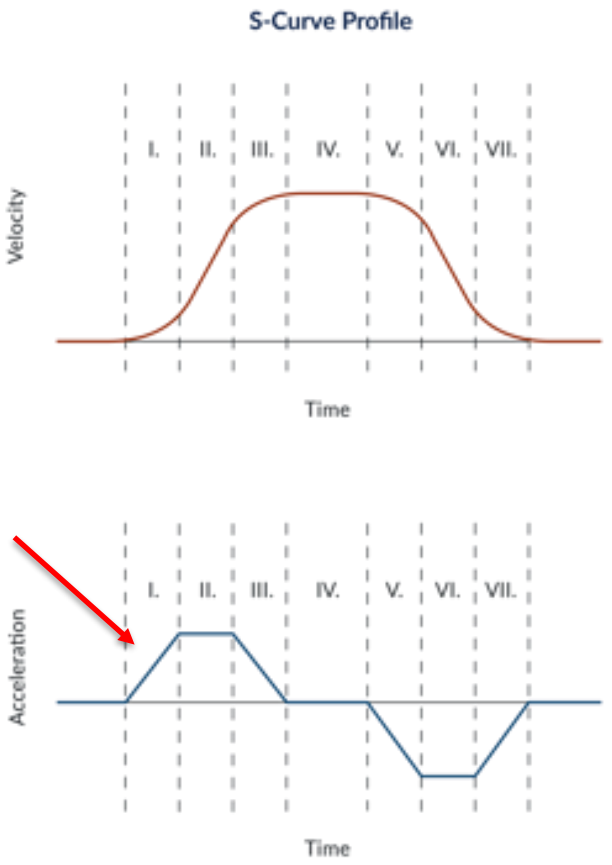
S-curve velocity profiles available

- Trapezoidal velocity profile (typical)



- S-curve velocity profile (advanced)

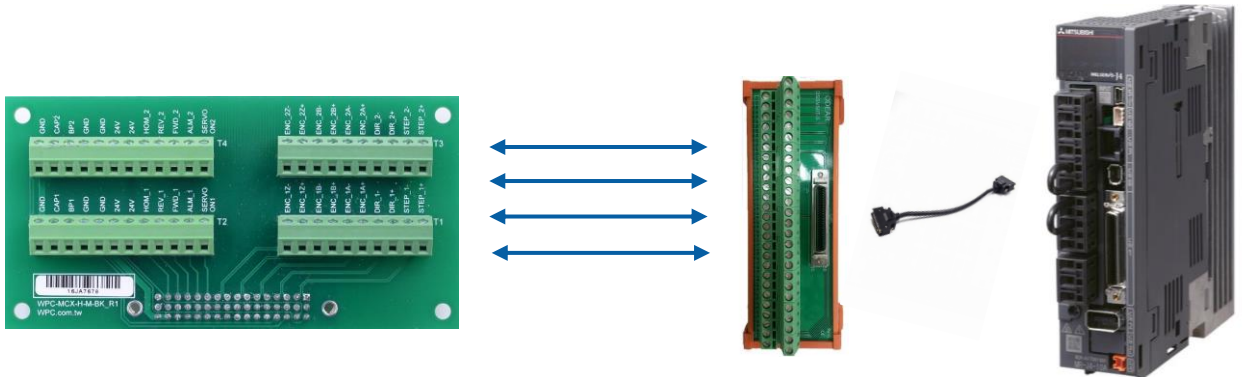


da/dt = “jerk”

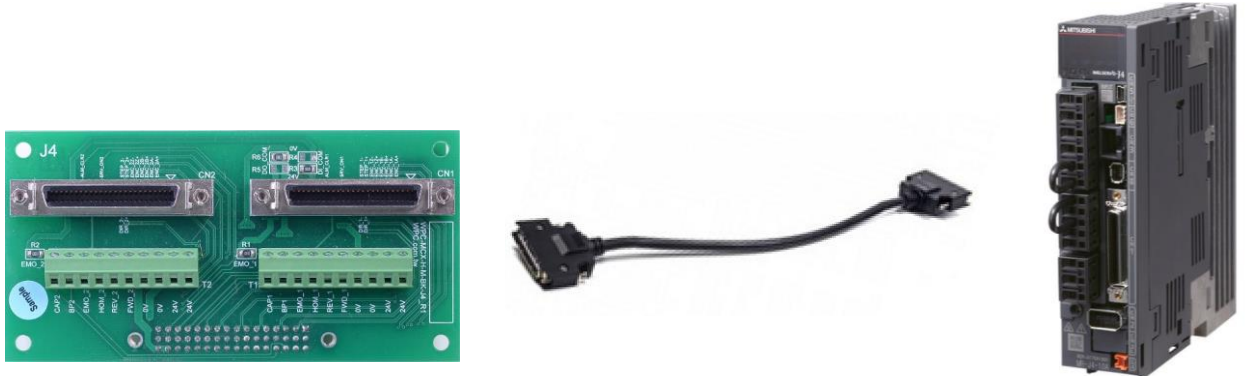
Rate of change of acceleration (jerk) can be defined, which allows for smoother velocity curve.

Direct connectivity to popular motion drives

- Simplifies cable complexity and eliminates noise issues
- Models supported:
  - Delta ASDA-A2, B2
  - Yaskawa SGDV/SGD7 (Sigma-7)
  - Panasonic Minas A4/A5/A6
  - Mitsubishi MR-J4/JE/J2S



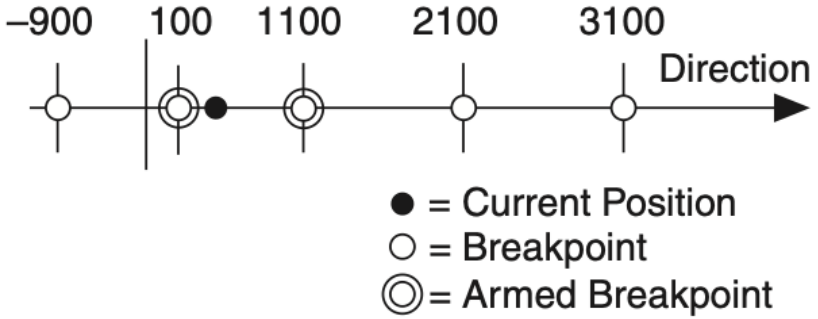
Generic breakout board and wiring

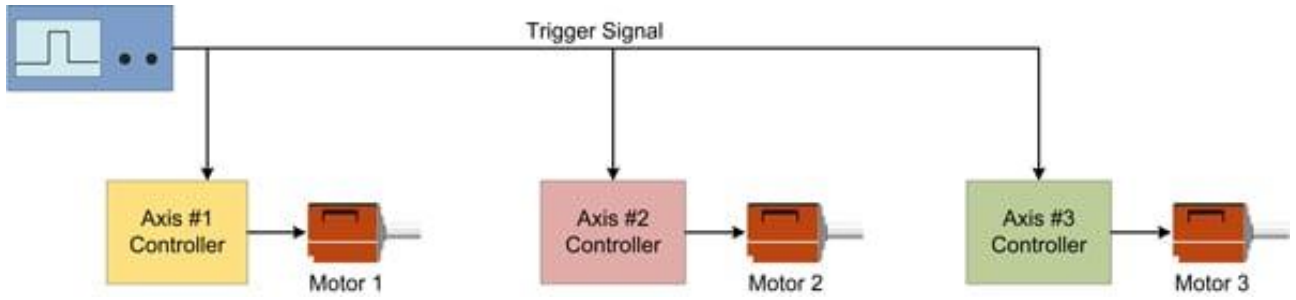


Vendor specific breakout board, single cable solution

Breakpoints (position triggers)

- Used to synchronize other sub-systems with motion
- When motor reaches a pre-defined position, a breakpoint (pulse) is triggered
- Trigger pulses are used to clock other systems, such as DAQ or other axes
- Very useful for move with varying speeds
  - Can’t always assume velocity is constant





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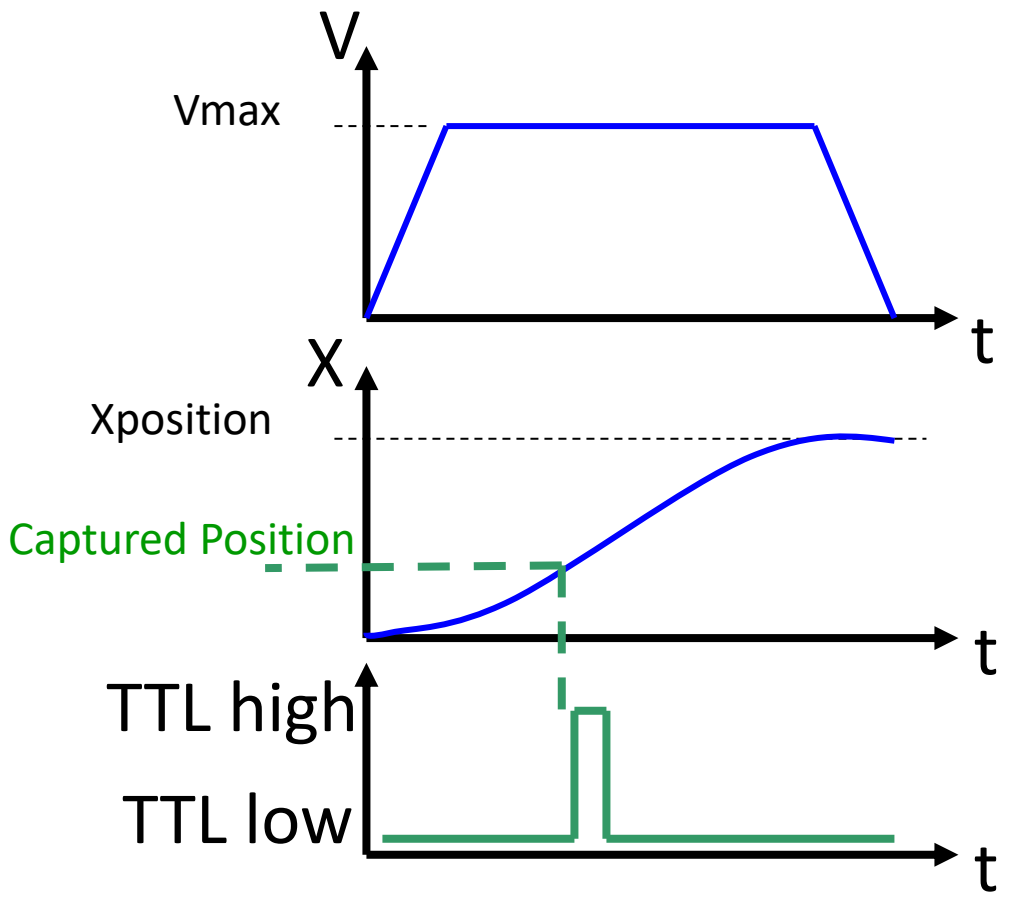
High-speed position capture

- Immediately capture an event occurrence position and store it in memory
- Useful if you have an external trigger and want to know the position at which the trigger occurs



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About TENET Technologies, Inc.

- Global sales channel of WPC Systems Ltd., an NI Alliance Partner
  - Over 15+ years of LabVIEW and NI product knowledge
  - Over 15+ years of system integration experience
  - Custom embedded systems
  - Product design and manufacturing
  - Based in Taipei, Taiwan
  - Founding team with over 20+ years of NI experience

TENET + WPC SYSTEMS

Contact Info

Add motion control to LabVIEW in 30 minutes or less, guranteed.

Follow me on LinkedIn!

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- For more TENET EMotion, visit: geco-lv.com/emotion.html

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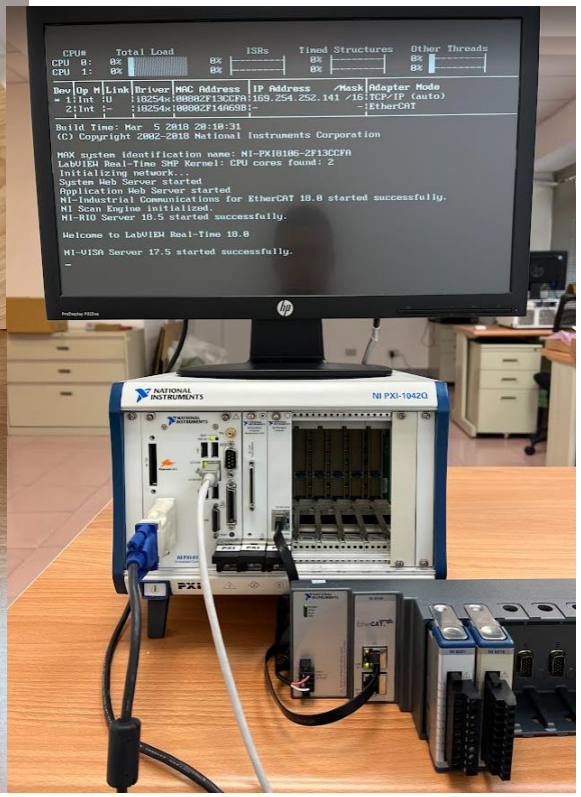
BUT WAIT! There's more…

EXTEND TEST
Pre-owned | Surplus | Discontinued

- My other business: www.extendtest.co
  - Buy and sell legacy NI hardware



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- For discontinued NI hardware, visit: www.extendtest.co

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