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Korea

Improving the Reliability of Vehicle Electronic Control Component Validation using MATLAB XCP Communication.

SeYoung Noh, HL MANDO

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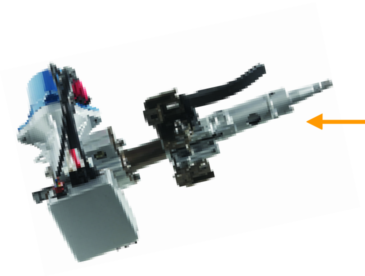
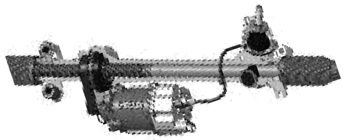
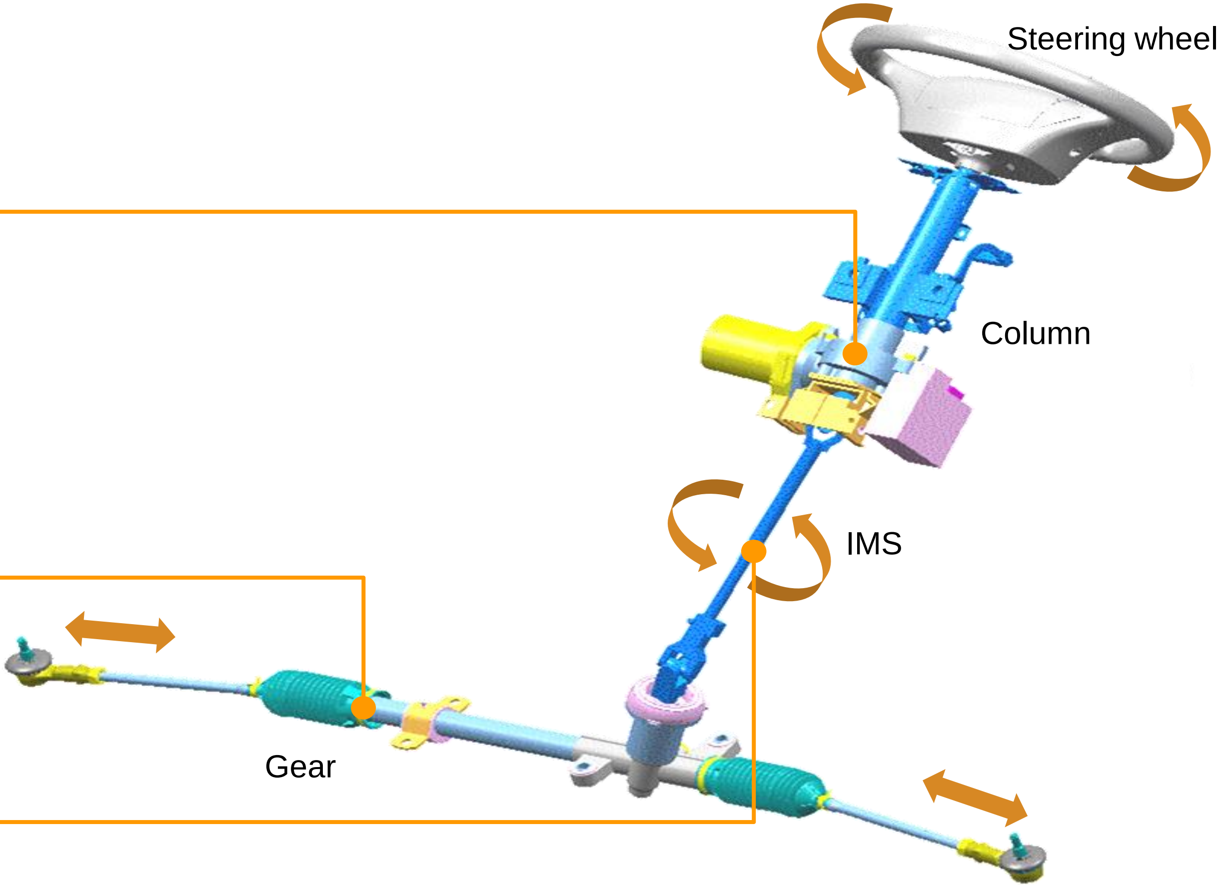
Contents

Introduction to HL MANDO Steering Products

- The presenter handles column section research and development

Section	Product	Picture
Column	✓C-EPS	
	✓SFA	
Gear	R-EPS	
	RWA	
-	IMS	



Introduction to Presenter & Rig Test

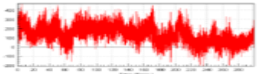
- ## Presenter

  - Senior Research Engineer / HL MANDO

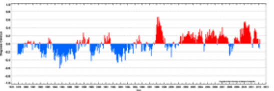
  - Rig Test Engineer / Column & IMS (2012 – Present)

- ## Testing Technology

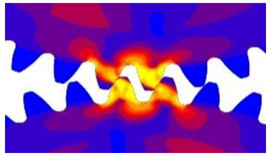
Service Load Data

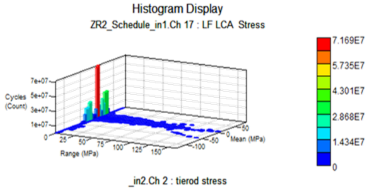


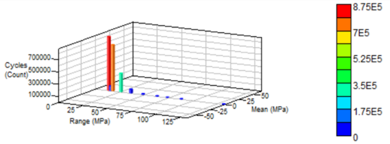
Environmental Data



Material and Geometrical Data

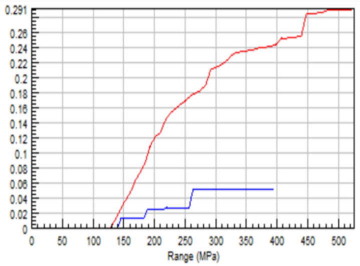


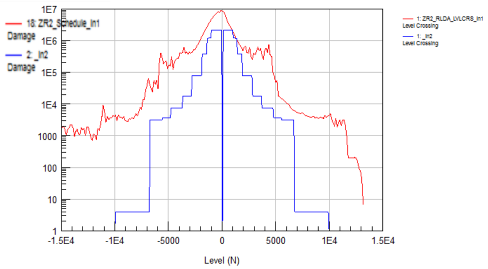




Service Stress Analysis

Fatigue Test Sequences





Real Vehicle Test Condition Analysis

Durability

Environment

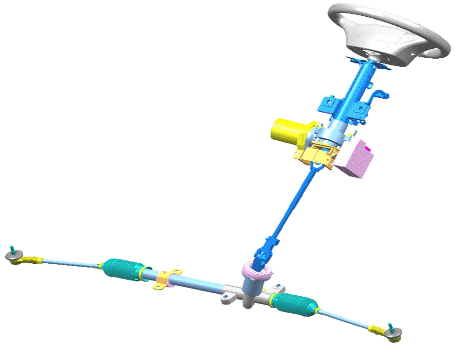
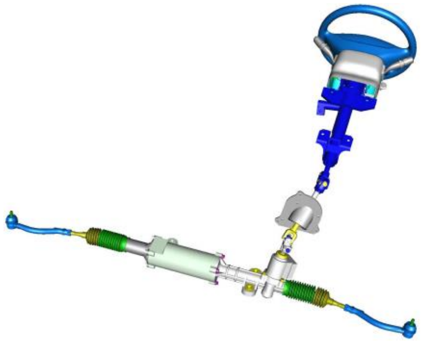
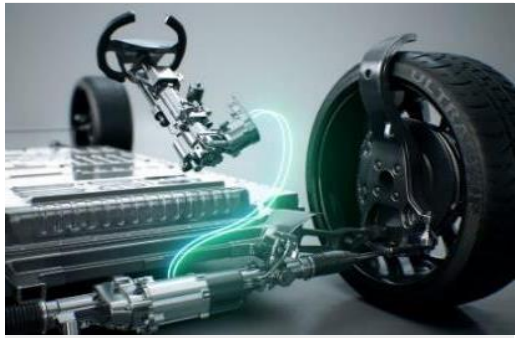
Crash

Vibration

Rig Test Application

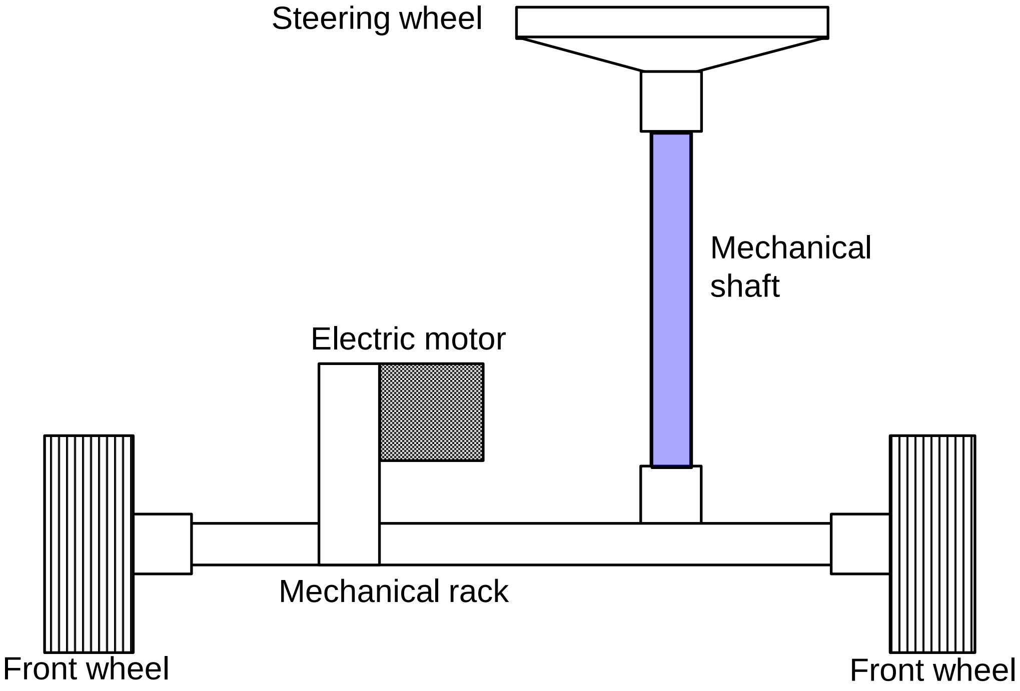
Background

- Due to advancements in automotive control technology, vehicle components are undergoing electrification and automation.

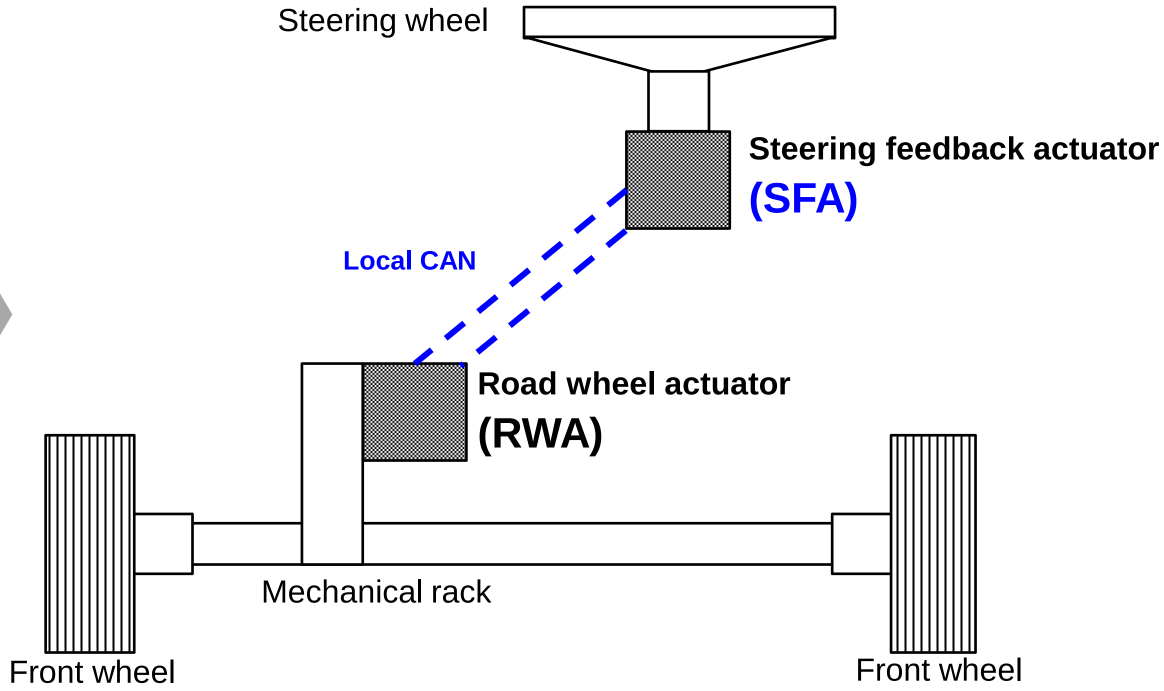
	2010	2015	2020
Vehicle			
	Conventional	Hybrid & Electric	Autonomous
Steering System			
	Colum Type Electric Power	Rack Type Electric Power	Steer-By Wire

Background

- Rack and wheel are connected by Local CAN instead of Mechanical shaft



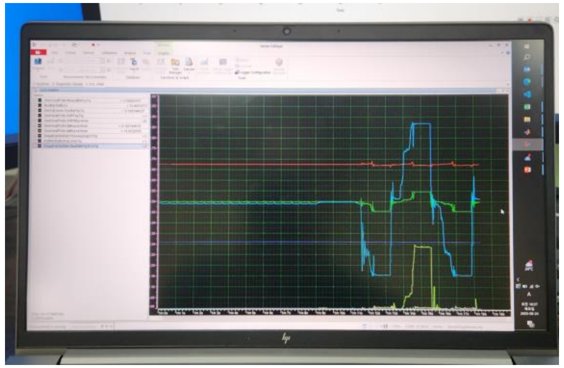
Conventional EPS system

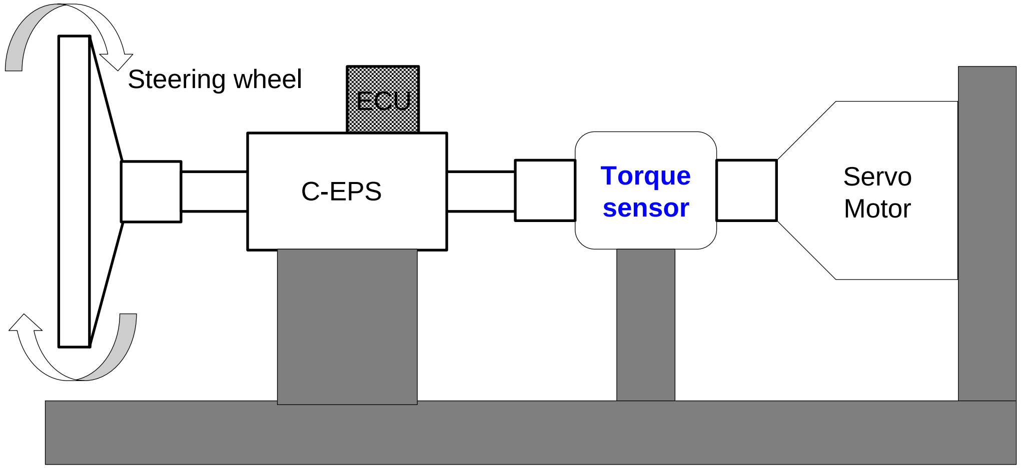


Steer-by wire System

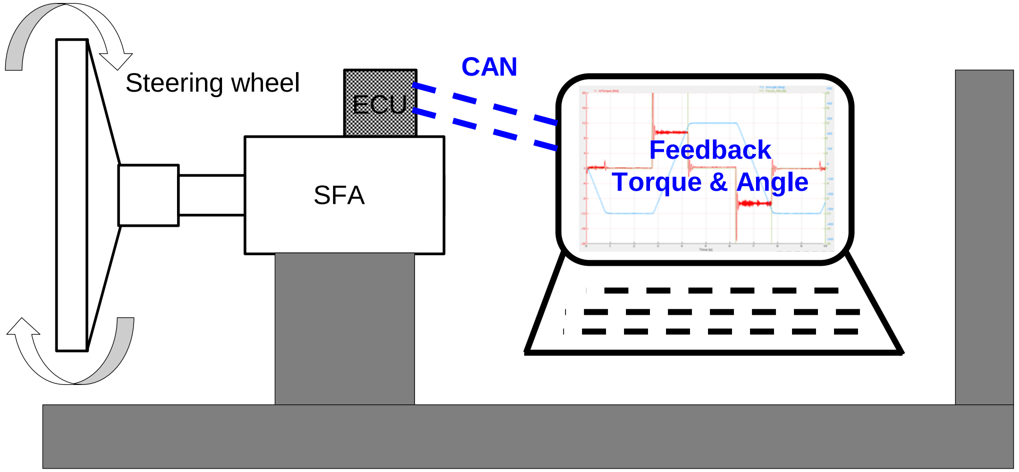
Challenges in Electronic Verification Testing

- As the product evolves, it is necessary to measure data using CAN





Column Type Electric Power Steering



Steering Feedback Actuator

Challenges in Electronic Verification Testing

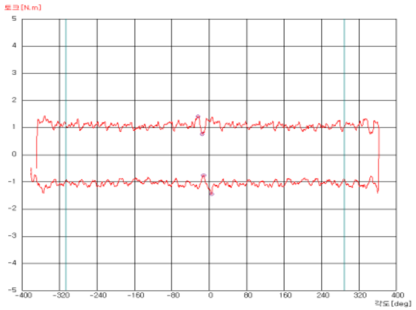
- CAN Signals measurement is required, causing problems such as difficulty and cost

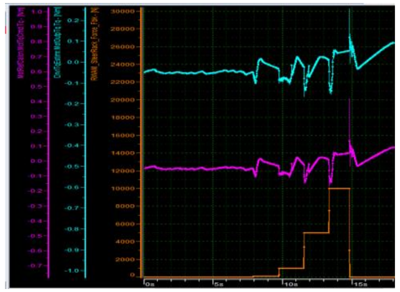
1. Measurement of CAN Signals Required

- No mechanical connection, CAN measurement required
- User Torque, Angle → Feedback Torque, Angle

2. Difficulty in Identifying Causes of Issues

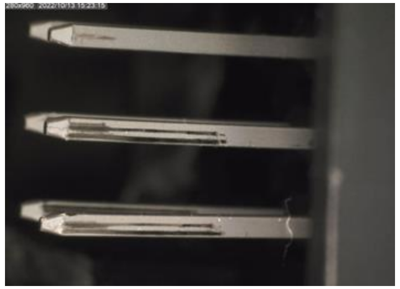
- Increased number of electronic and control devices
- Invisible control problems occur





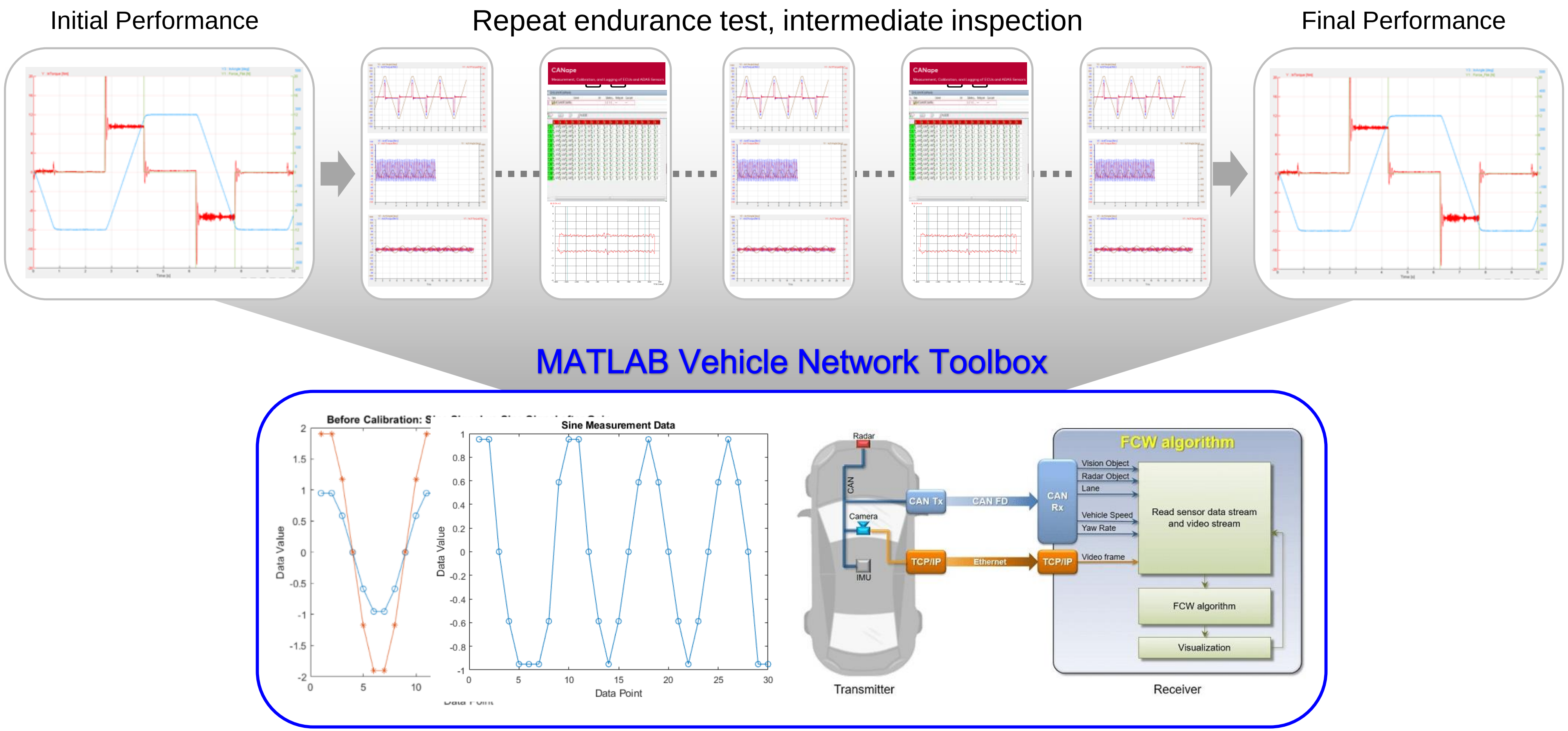
3. Increased Measurement Cost

- Requires additional CAN measurement equipment
- Software costs required for CAN measurements



Solutions and Results Through MATLAB Vehicle Network Toolbox

- Solving the waste of repetitive intermediate inspection using Vehicle Network Toolbox



Solutions and Results Through MATLAB Vehicle Network Toolbox

- Vehicle Network Toolbox

✓ CAN and CAN FD Communication

Vehicle network communication using CAN or CAN FD protocol

✓ XCP Communication over CAN or XCP or Ethernet

Vehicle network communication using XCP protocol

- J1939 Communication

Vehicle network communication using J1939 protocol

- Standard File Formats

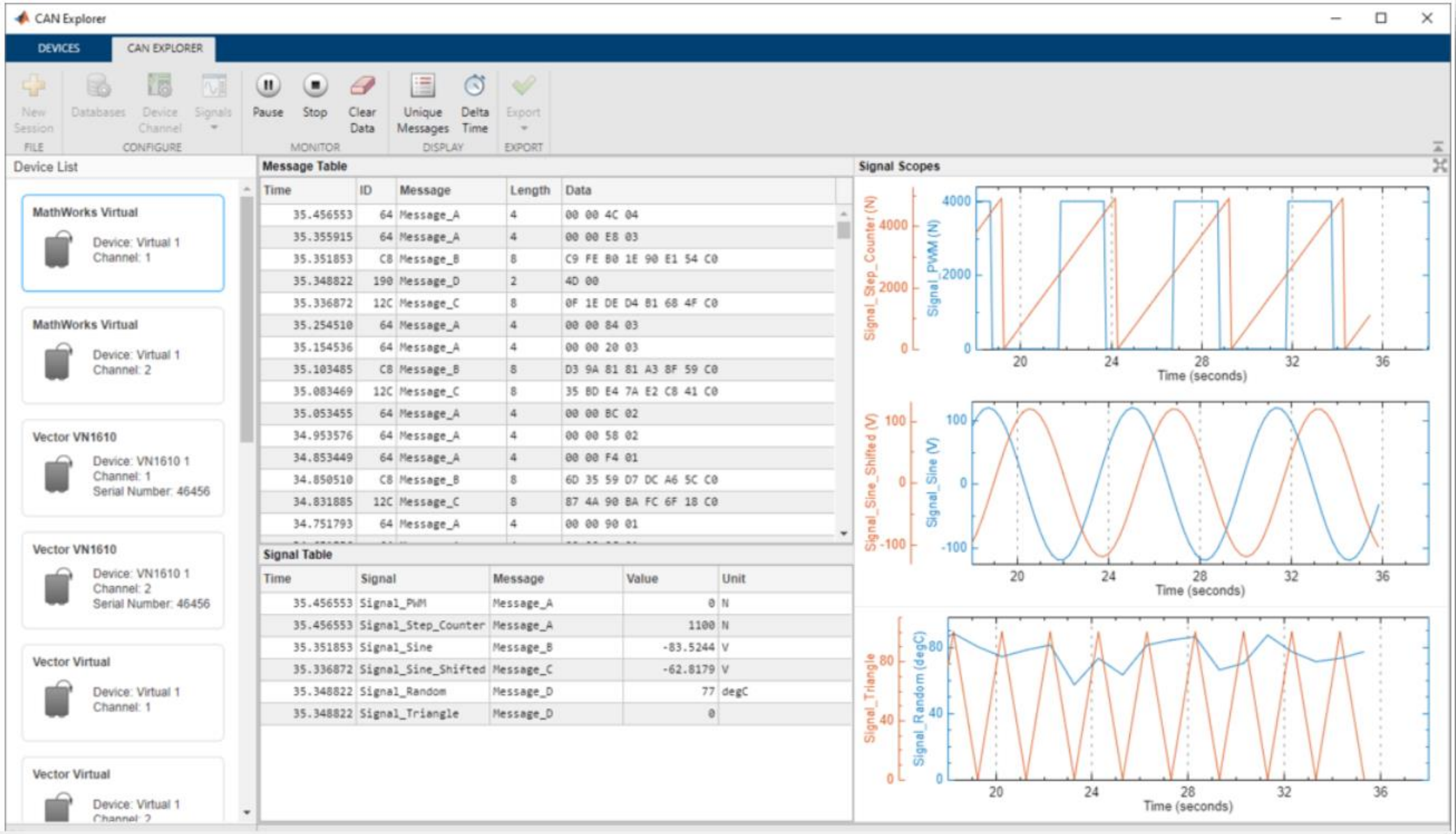
Access measurement data format (MDF), ASAM calibration data format (CDF), and binary logging format (BLF) files

- Vehicle Network Toolbox Supported Hardware

Support for third-party hardware (Vector, Kvaser, NI, PEAK Systems)

Solutions and Results Through MATLAB Vehicle Network Toolbox

- CAN and CAN FD Communication



Solutions and Results Through MATLAB Vehicle Network Toolbox

- XCP Communication

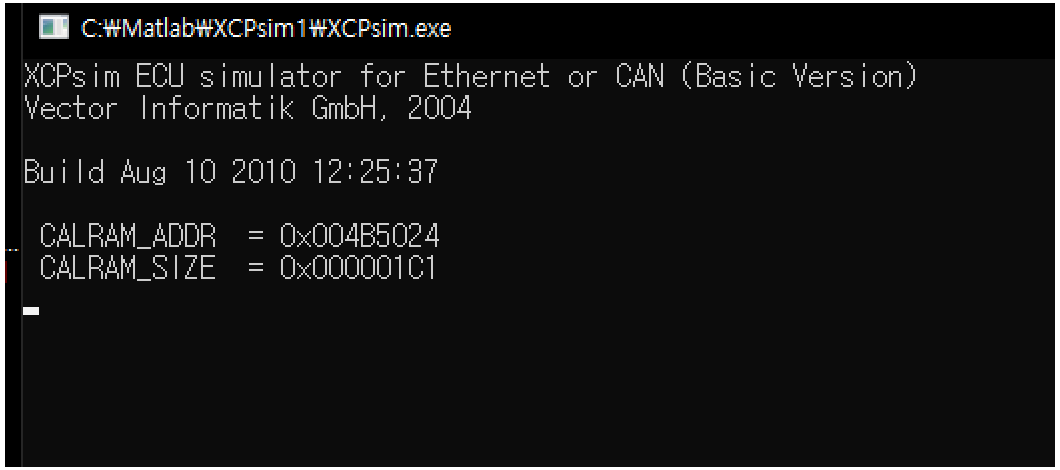
- Features
  - Measurement
  - Calibration

- Value for Vehicle Network Toolbox XCP
  - Low-cost access to calibration and measurement workflows
  - Single environment tools
  - Growing element of MBD workflow
  - Model based and actual ECU calibration

Solutions and Results Through MATLAB Vehicle Network Toolbox

- Physical & Virtual Connectivity

- Vehicle Network Toolbox(VNT) uses CAN or CAN FD in physical or virtual modes
- Physical connection to external bus via 3rd party device
- Virtual connection to build models for desktop simulation
- Virtual device developed in-house shipped in VNT (plus 3rd party)
  - Use VNT without 3rd party dependency or driver install



Solutions and Results Through MATLAB Vehicle Network Toolbox

- XCP Real Time Monitoring Program

1. XCP Signal Monitoring is Feasible

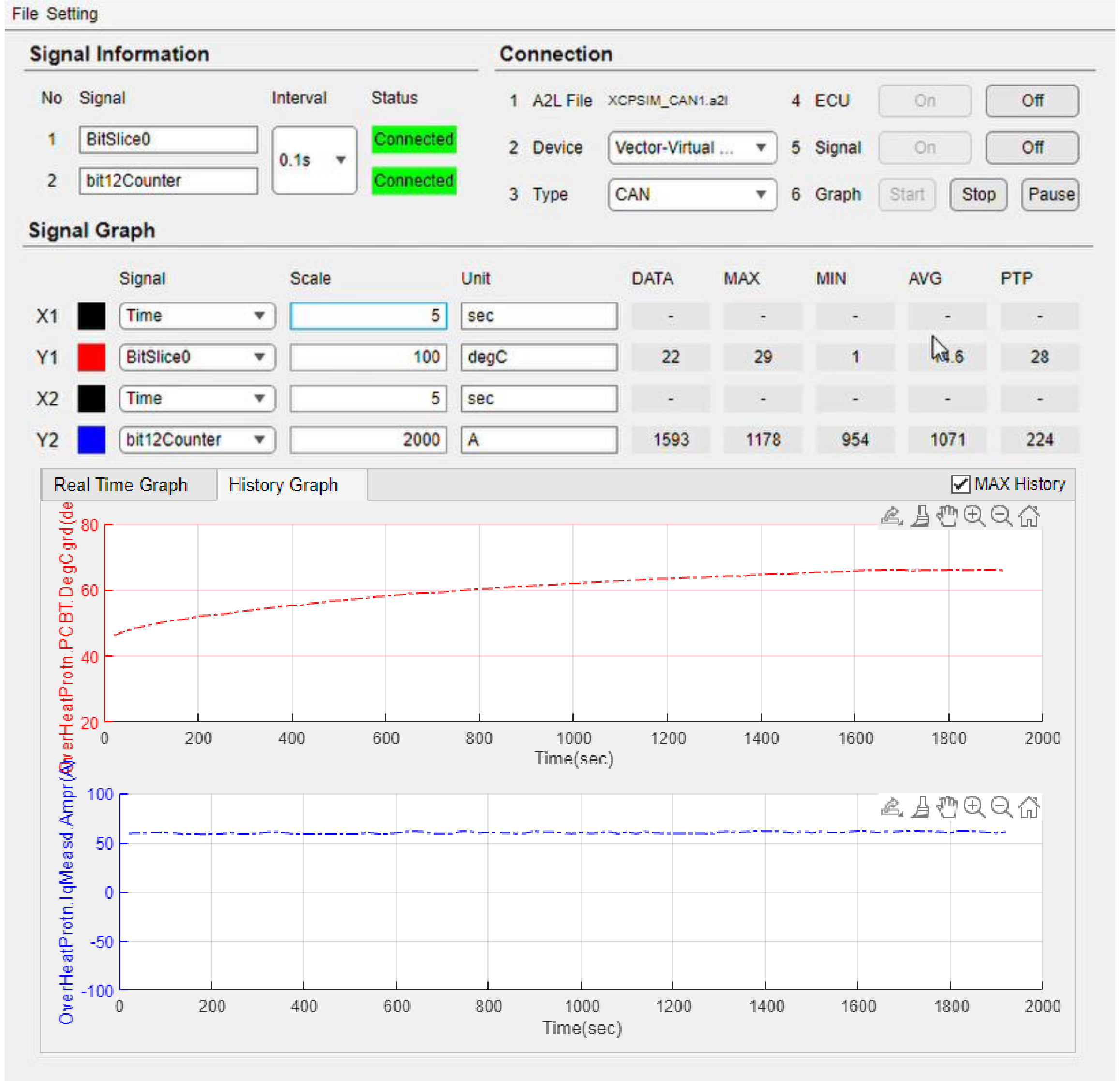
- Utilizing A2L Files for Convenient Usage
- Flexibility to Set Multiple Signals and Intervals
- Various Equipment such as CAN-FD and CAN

2. Continuous 24-Hour Real-time Logging

- Ability to Determine Occurrence Time and Analysis
- Data Analysis Enables Trend Identification

3. Cost Savings and Convenience

- Cost Savings through In-House Program Coding
- Enhanced Convenience via MATLAB Integration



Solutions and Results Through MATLAB Vehicle Network Toolbox

- Introduction to Key Code for XCP Monitoring

Link to an A2L File

Link to an A2L File

Create an A2L file object.

```
a2lfile = xcpA2L('XCPSIM.a2l')
```

```
a2lfile = 

  A2L with properties:

   File Details
                 FileName: 'XCPSIM.a2l'
                 FilePath: 'c:\XCPSIM.a2l'
               ServerName: 'CPP'
                 Warnings: [0x0 string]

   Parameter Details
                   Events: {1x6 cell}
                EventInfo: [1x6 xcp.a2l.Event]
             Measurements: {1x45 cell}
          MeasurementInfo: [45x1 containers.Map]
          Characteristics: {1x16 cell}
       CharacteristicInfo: [16x1 containers.Map]
                 AxisInfo: [1x1 containers.Map]
            RecordLayouts: [41x1 containers.Map]
             CompuMethods: [15x1 containers.Map]
                CompuTabs: [0x1 containers.Map]
               CompuVTabs: [2x1 containers.Map]

   XCP Protocol Details
        ProtocolLayerInfo: [1x1 xcp.a2l.ProtocolLayer]
                  DAQInfo: [1x1 xcp.a2l.DAQ]
    TransportLayerCANInfo: [1x1 xcp.a2l.XCPonCAN]
    TransportLayerUDPInfo: [1x1 xcp.a2l.XCPonIP]
    TransportLayerTCPInfo: [0x0 xcp.a2l.XCPonIP]
```

Create an XCP Channel

Create an XCP Channel Using a CAN Server Module

Create an XCP channel using a Vector CAN module virtual channel.

Link an A2L file to your session.

```
a2l = xcpA2L("XCPSIM.a2l");
```

Create an XCP channel.

```
xcpch = xcpChannel(a2l,"CAN","Vector","Virtual 1",1)
```

```
xcpch = 

  Channel with properties:

              ServerName: 'CPP'
             A2LFileName: 'XCPSIM.a2l'
          TransportLayer: 'CAN'
    TransportLayerDevice: [1x1 struct]
              SeedKeyDLL: []
```

Create an XCP Channel for Ethernet

Create an XCP channel for TCP communication via Ethernet.

Link an A2L file to your session.

```
a2l = xcpA2L("XCPSIM.a2l");
```

Create an XCP channel.

```
xcpch = xcpChannel(a2l,"TCP","10.255.255.255",80)
```

Connect & Measurement

Connect to a Server Module

Create an XCP channel connected to a Vector CAN device on a virtual channel and connect it.

Link an A2L file to and create an XCP channel with it.

```
a2lfile = xcpA2L('XCPSIM.a2l')
xcpch = xcpChannel(a2lfile,'CAN','Vector','Virtual 1',1);
```

Connect the channel and verify that it is connected.

```
connect (xcpch)
isConnected(xcpch)
```

Read Value from XCP Channel Measurement

Read the value from an XCP channel measurement, identifying the measurement by name.

```
a2lObj = xcpA2L('myA2Lfile.a2l');
chanObj = xcpChannel(a2lObj,'CAN','Vector','Virtual 1',1);
connect(chanObj);
value = readMeasurement(chanObj,'limit')
```

```
    100
```

Alternatively, create a measurement object and read its value.

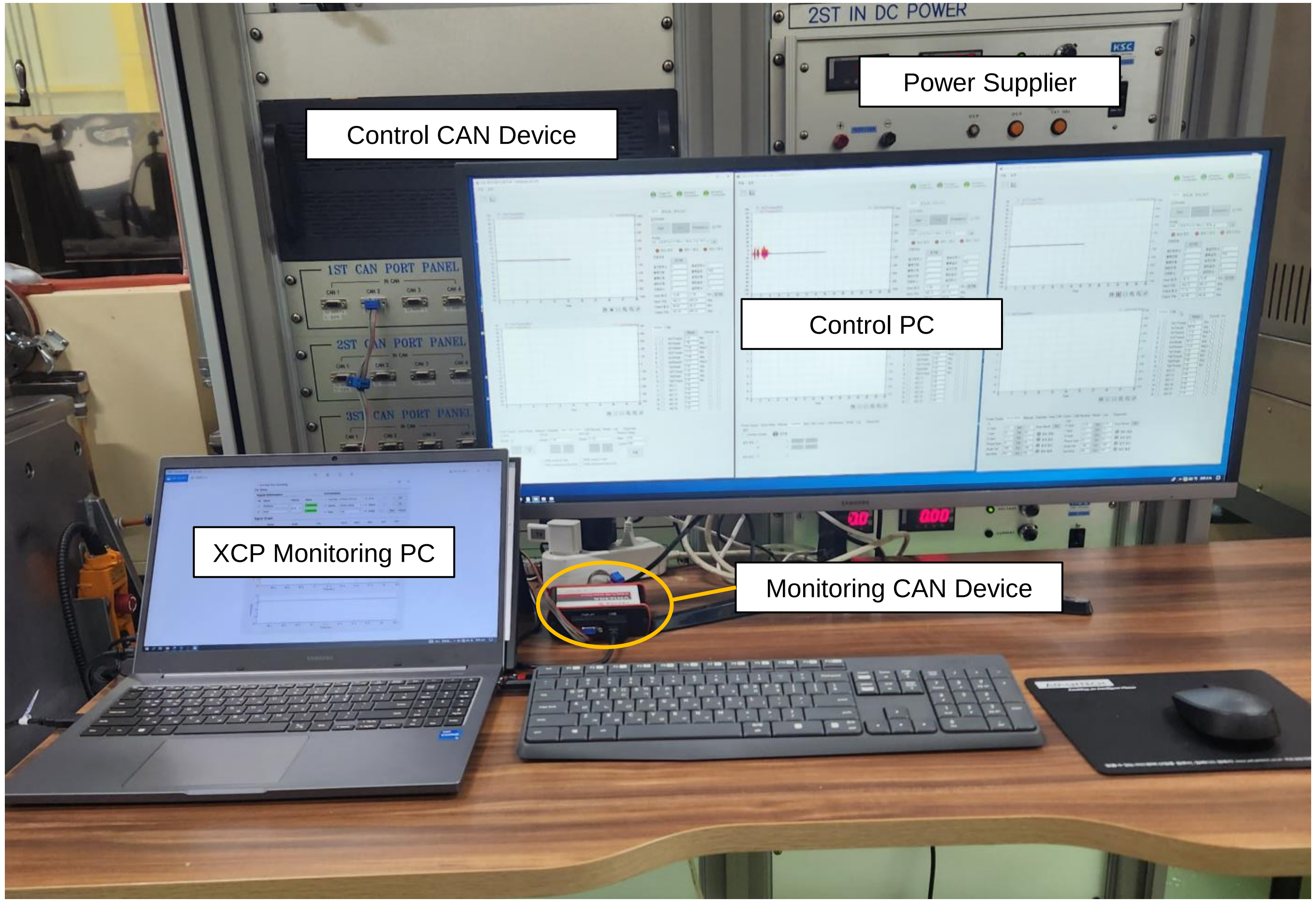
```
measObj = a2lObj.MeasurementInfo('limit');
value = readMeasurement(chanObj,measObj)
```

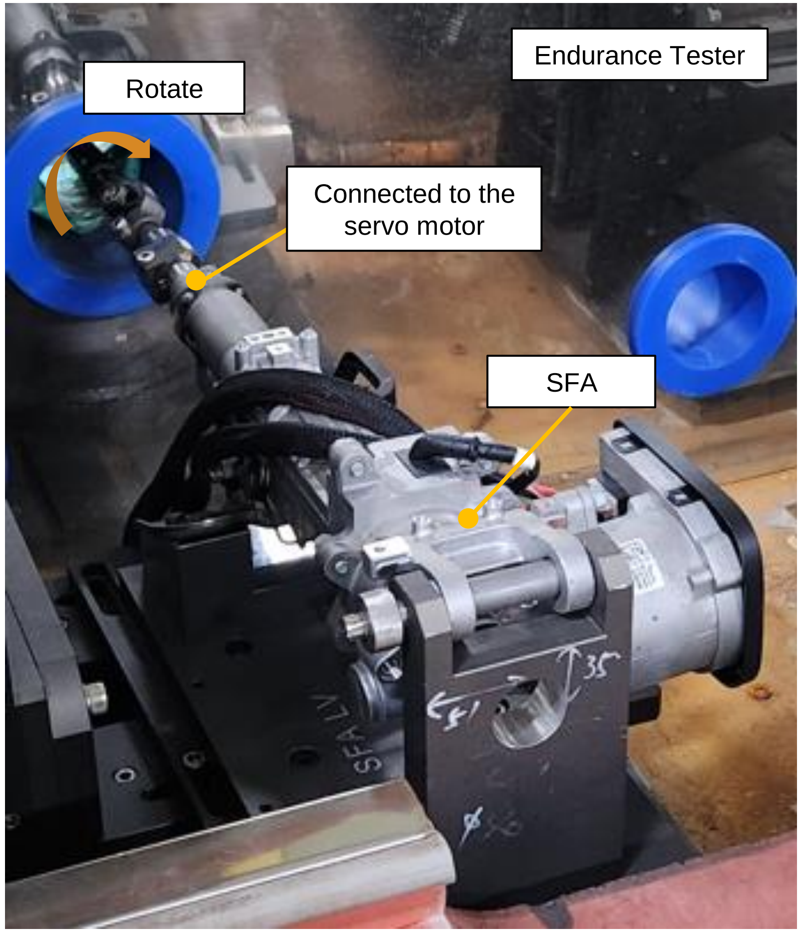
```
    100
```

Results using XCP Monitoring

- Example 1.

  - Test Equipment Setup





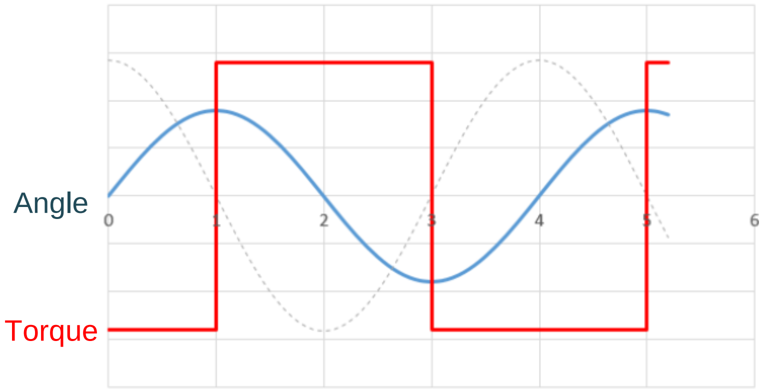
Results using XCP Monitoring

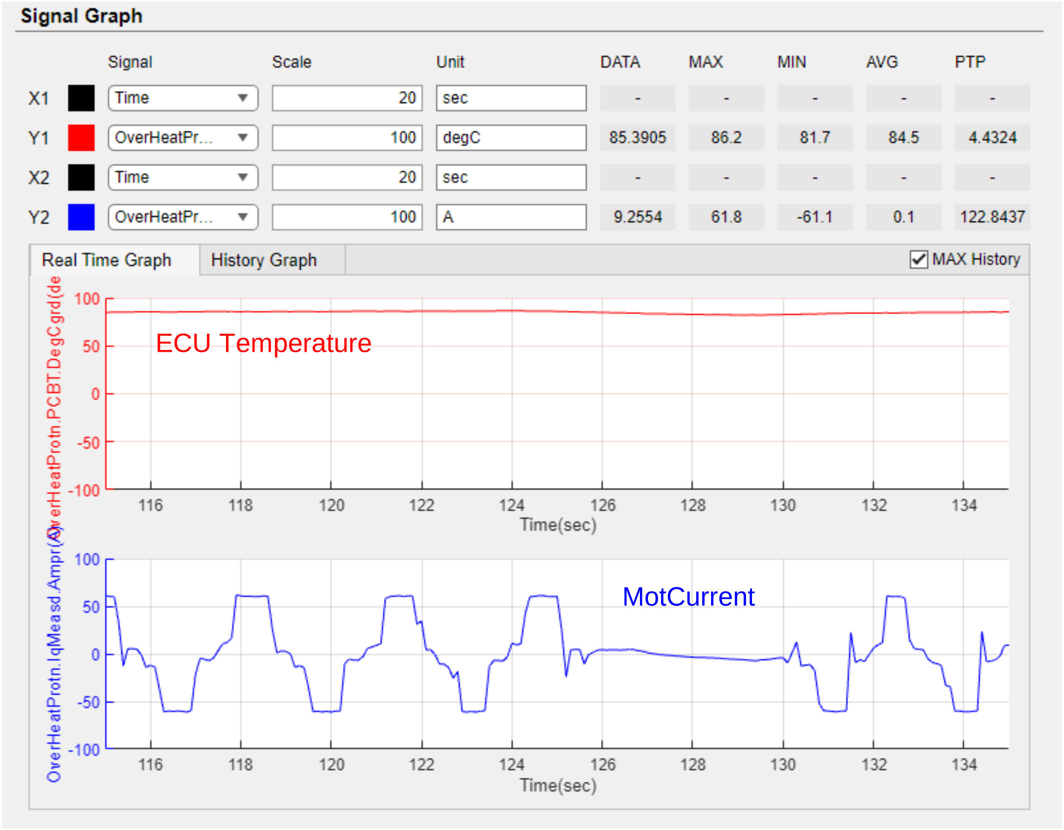
- Example 1.

- Optimal Test Interval Determination via ECU Temperature and Motor Current Monitoring

1. Test Condition

- Test Equipment : Endurance Tester
- Angle : ±180deg, Sine Wave, 360deg/sec
- Torque : SFA MAX Torque Square Wave
- Operate Cycle : 5~10 Cycle (TBD)
- Wait Time : 5~20 sec (TBD)
- Need to find the Operate Cycle and Wait time





Results using XCP Monitoring

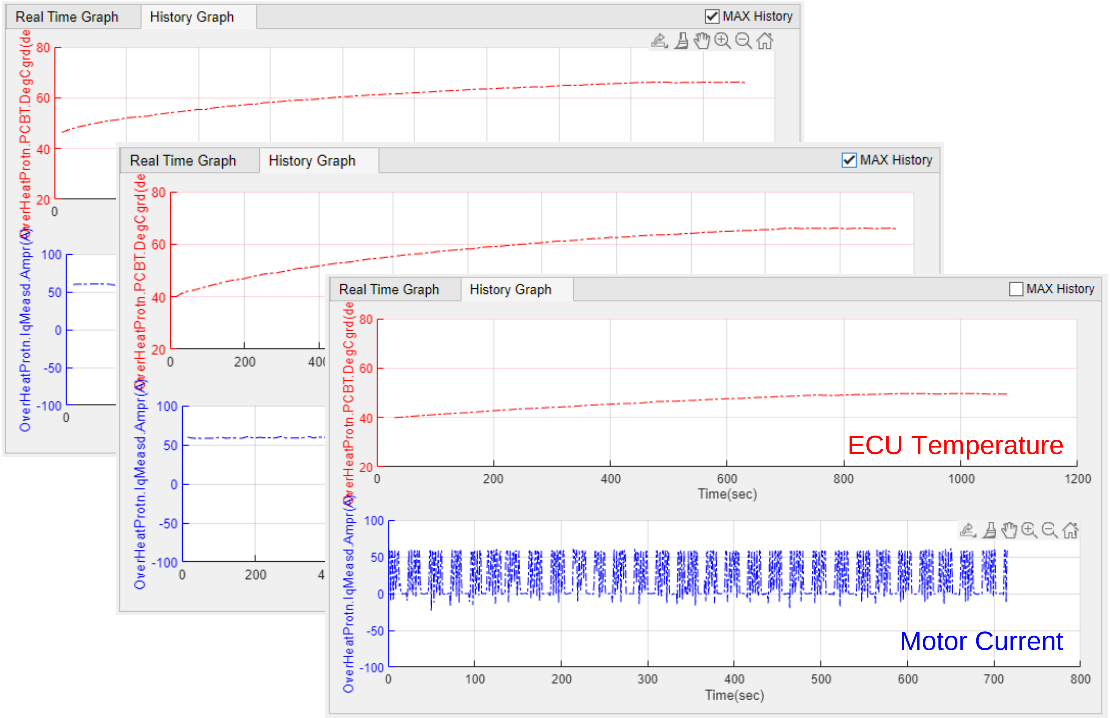
- Example 1.

- Optimal Test Interval Determination via ECU Temperature and Motor Current Monitoring

2. Test Result

- Setting the Wait Time to 20 seconds is reasonable.

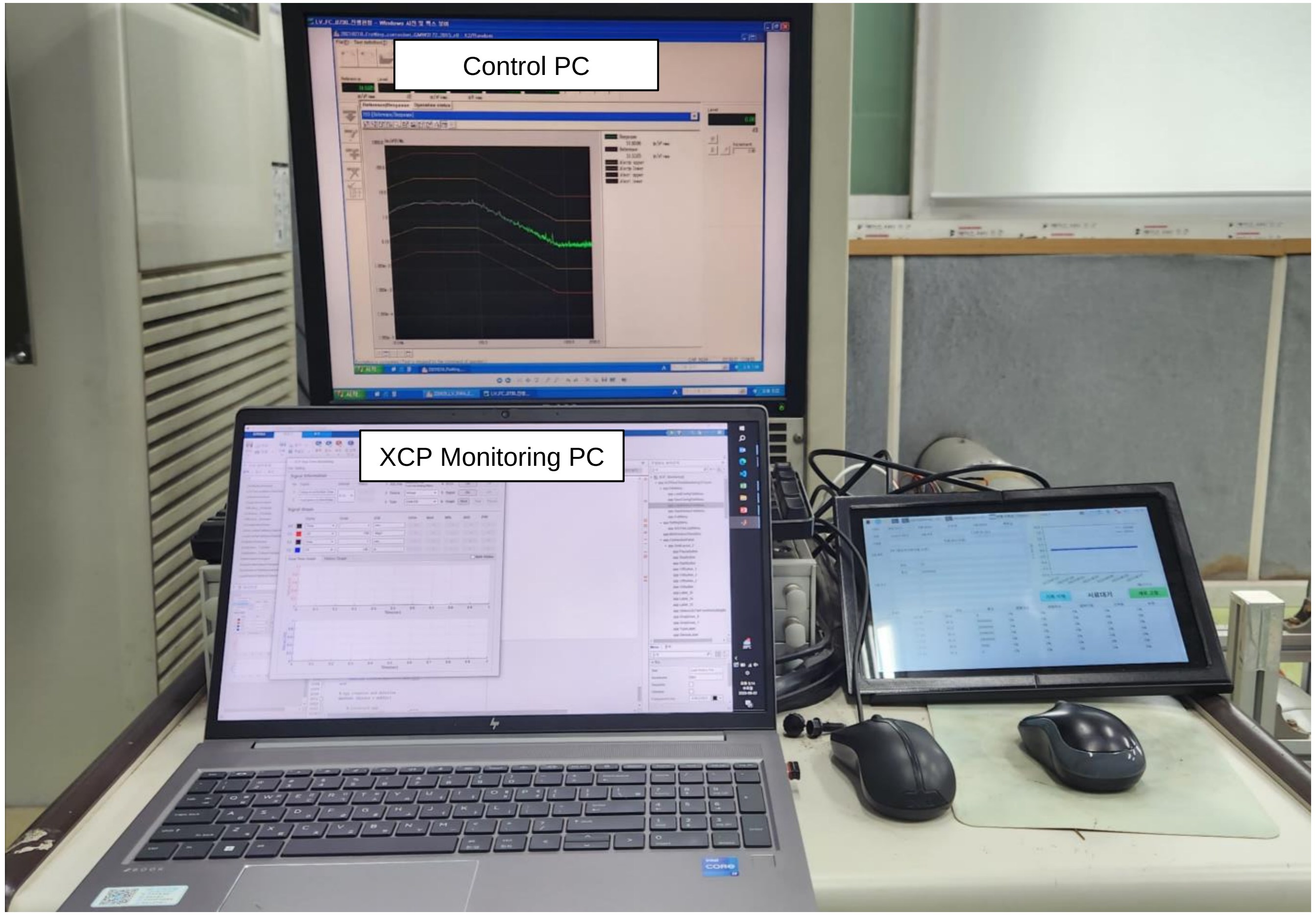
Operate (Cycle)	Wait Time (sec)	MAX Temp (˚C)	Result
Criteria	TBD	MAX 55	
5	5	66	Over Temp
5	10	65	Over Temp
5	20	50	Acceptable
10	5	72	Over Temp
10	10	68	Over Temp
10	20	62	Over Temp

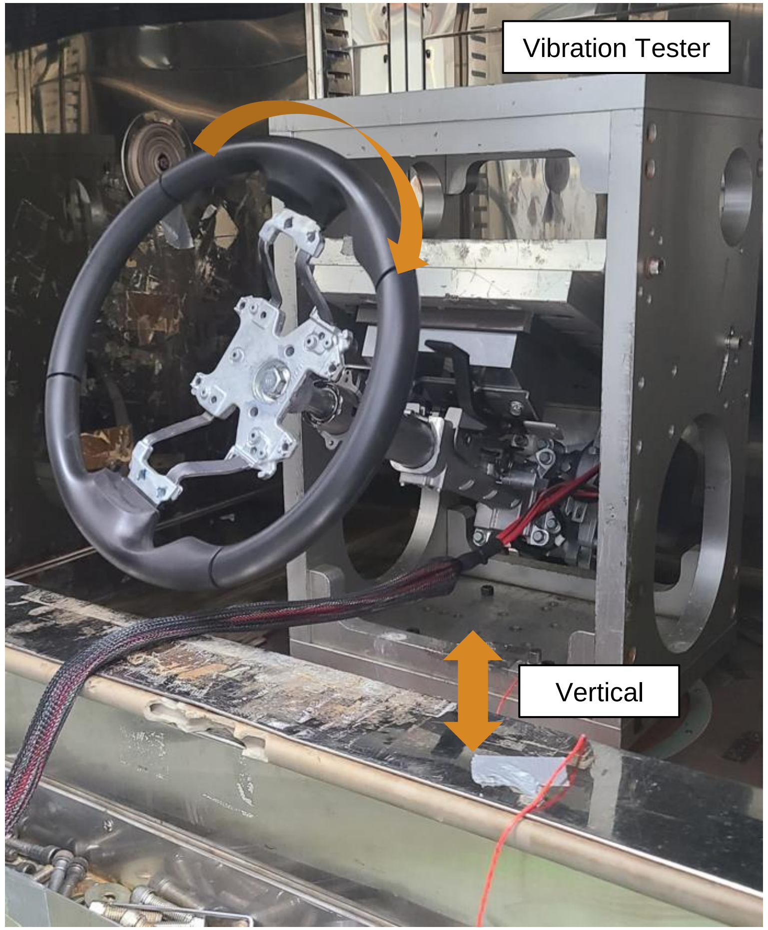


Results using XCP Monitoring

- Example 2.

  - Test Equipment Setup





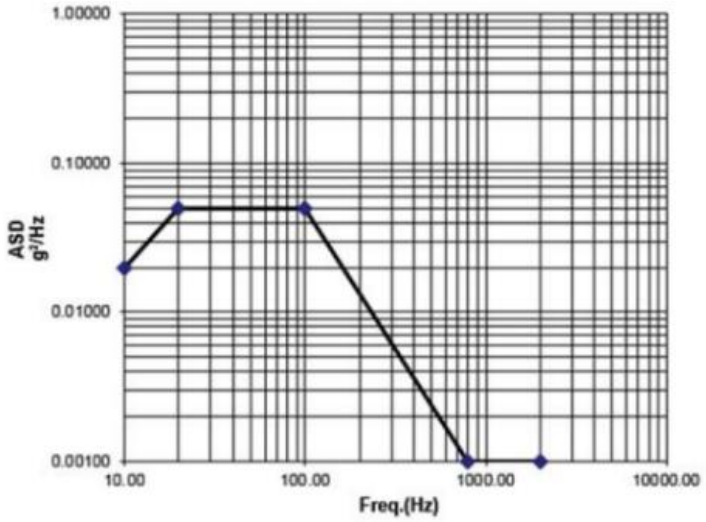
Results using XCP Monitoring

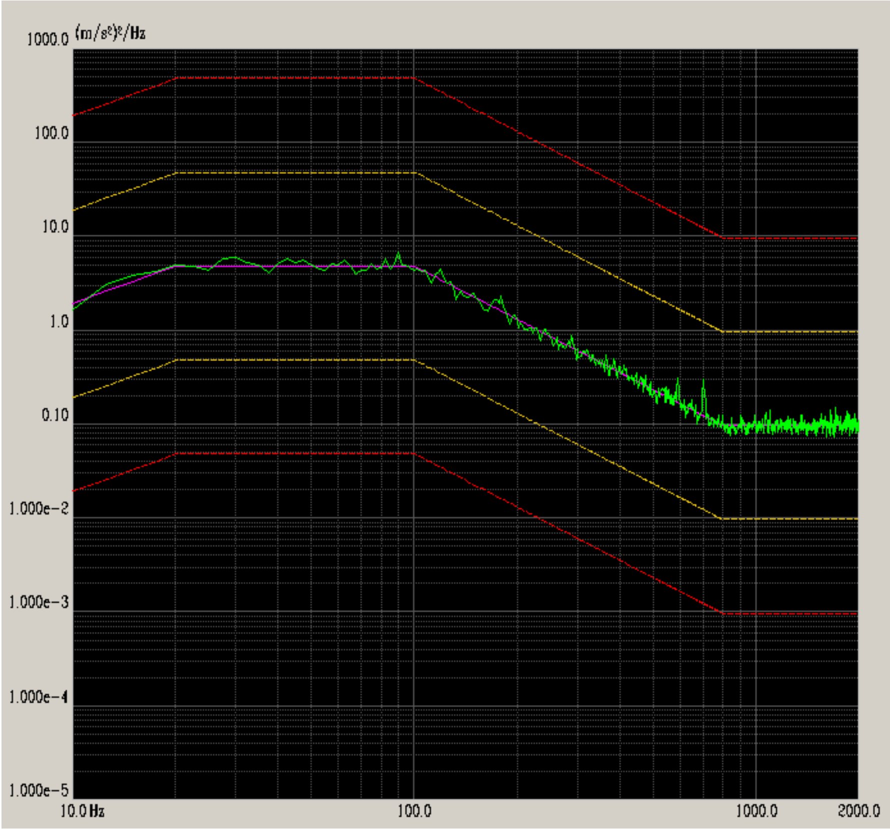
- Example 2.

- Validation of Sensor Error During Complex Environmental Vibration Test

1. Test Condition

- Test Equipment : Vibration Tester
- Chamber Temperature : -40 ~ 85˚C (12hr, Cycle)
- Frequency : Refer to below the graph
- No abnormalities in torque signal expected





Results using XCP Monitoring

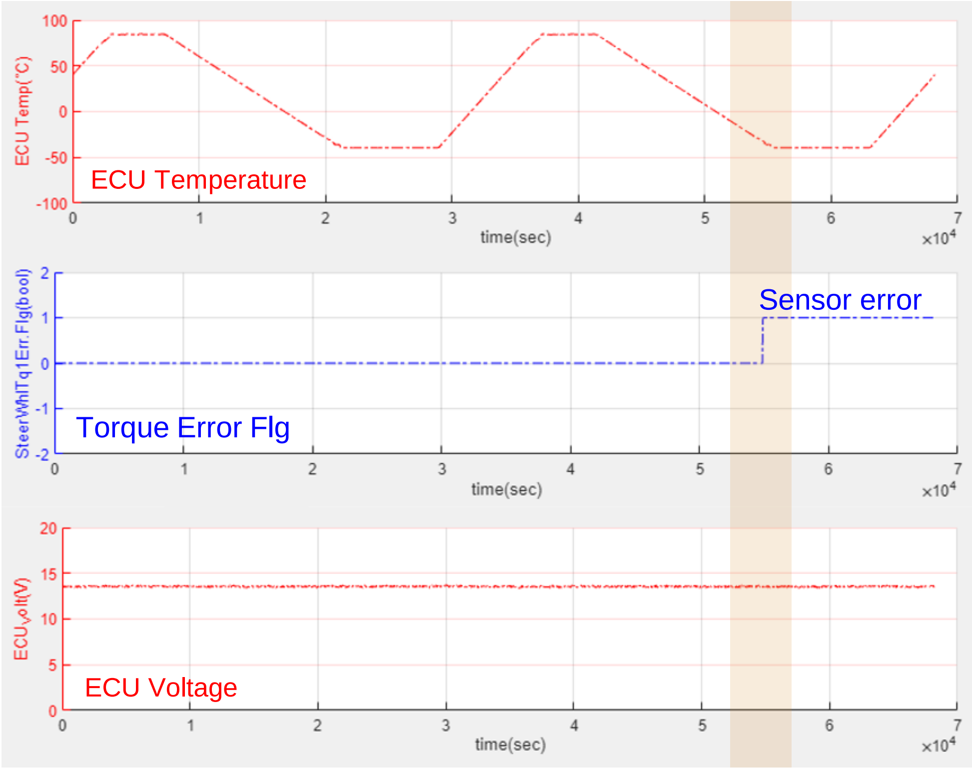
- Example 2.

- Validation of Sensor Error During Complex Environmental Vibration Test

2. Test Result

- Confirmed torque sensor error at low temperature

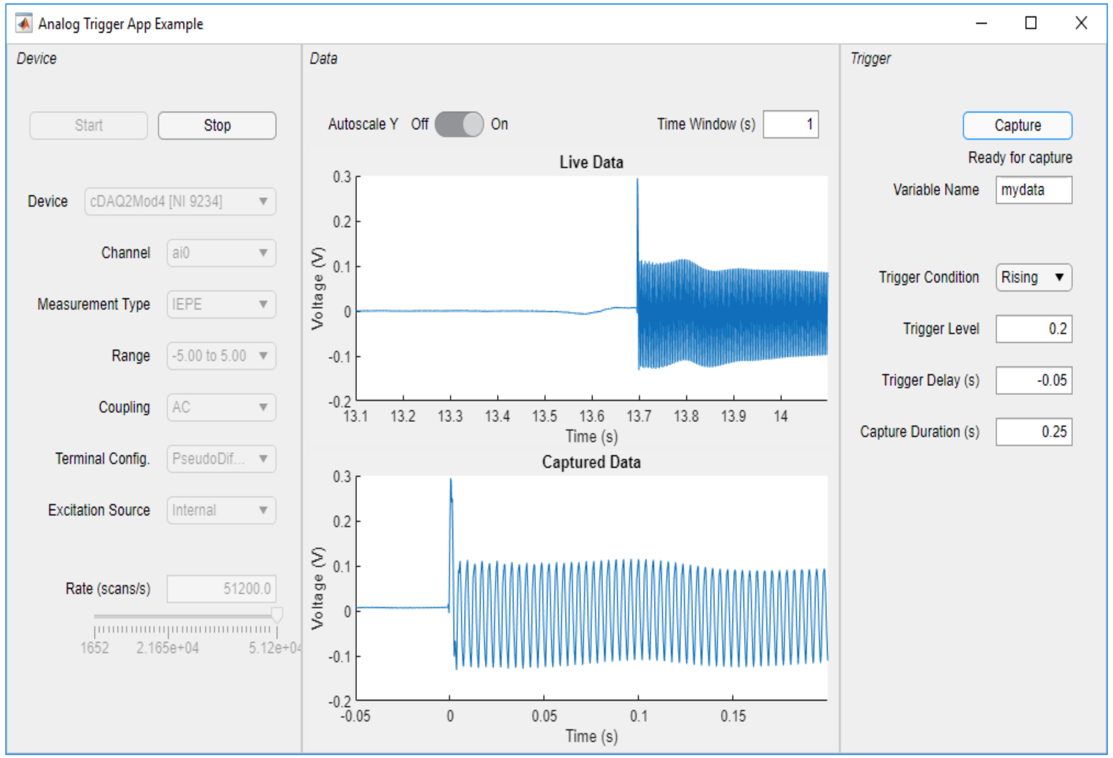
Sample No.	ECU Voltage (V)	Sensor error (Boolean)	Result
Criteria	12~15	0	-
#1	13.4	0	OK
#2	13.7	0	OK
#3	13.5	0	OK
#4	13.5	1	NG
#5	13.6	0	OK
#6	13.5	0	OK



Further Details on Solutions Adopted

- Data Acquisition Toolbox + Vehicle Network Toolbox

  - Monitoring DAQ, Trigger, and XCP signals for analyzing Analog and XCP data



Data Acquisition Toolbox

NI DAQ Board

Conclusion

- Challenges

  - Challenges in Test and Verification Due to Electrification of Mechanical Products Complexity, Reliability, and Cost Issues

- Solutions

  - Utilizing XCP Communication for Monitoring CAN Signals in Products
  - Analyzing Occurrence Time and Causes through Continuous 24-Hour Real-time Logging
  - Cost-effective Solution with In-House Program Coding and Enhanced Convenience through MATLAB Integration

- Results

  - Monitoring ECU via XCP for Temperature, Torque, Angle, and Current facilitated issue resolution and prevention

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