PRAG 304L: Electrical Diagnostics for Farm Machinery Lab
Instructor: Dr. Pappu Kumar Yadav
Spring 2025

Lab 10: Basics of CAN Bus Communication Using InnoMakerUsb2can, Raspberry Pi and Jaltest Diagnostics system with a FENDT Tractor

1. Introduction

Modern farm machinery, such as the FENDT Vario tractor, uses the Controller Area Network (CAN) bus for communication between various electronic control units (ECUs). Understanding how to read and diagnose CAN messages is critical for farm equipment maintenance and troubleshooting. In this lab, students will learn how to set up a CAN interface, read live CAN data from a Fendt tractor, log fault codes, and visualize real-time diagnostics using a Python-based dashboard.

1.1 Understanding J1939 29-bit CAN Messages

J1939 is a communication protocol used in heavy-duty vehicles, including tractors like FENDT. It utilizes 11-bit or 29-bit extended CAN IDs where **Parameter Group Numbers (PGNs)** define specific data messages. To decode raw J1939 data, we use CAN software tools and a J1939 DBC file, but it's helpful to understand the process behind it.

Each J1939 message has a 29-bit CAN ID and a set of 8 data bytes. For example, if the CAN ID is 0x0CF00401 and the data bytes are 0xFF FF FF 68 13 FF FF FF, we first extract the **PGN (Parameter Group Number)** from the CAN ID. In this case, the PGN is 0xF004, which corresponds to **EEC1 (Electronic Engine Controller 1)**. According to the J1939 standard (J1939-71), EEC1 contains several SPNs (Suspect Parameter Numbers), such as **Engine Speed**. The data bytes hold the values of these SPNs, which can then be interpreted using scaling factors and offsets defined in the DBC file. A standard 11-bit CAN ID may look like 0x00AB. In such case PGN remains the same.

11 or 29 bit	0-64 bits
CAN ID	Data bytes

Please note: All the raw data are in hexadecimal. This lab has two experiments.

2. Materials and Methods

2.1 Materials Required

Experiment 1

- Raspberry Pi 5
- InnoMaker CAN-to-USB adapter

- Fendt Vario tractor (or simulated CAN data source)
- Python environment with installed packages (python-can, dash, plotly, sqlite3, pandas)
- Internet connection for Raspberry Pi

Experiment 2

- Jaltest diagnostic system (equipment, tablet with Jaltest software)

2.2 Methodology

2.2.1 Experiment 1

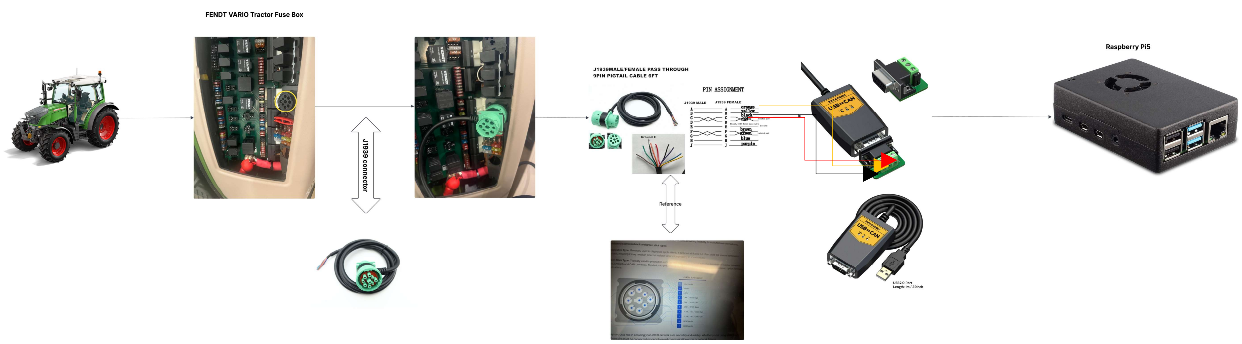
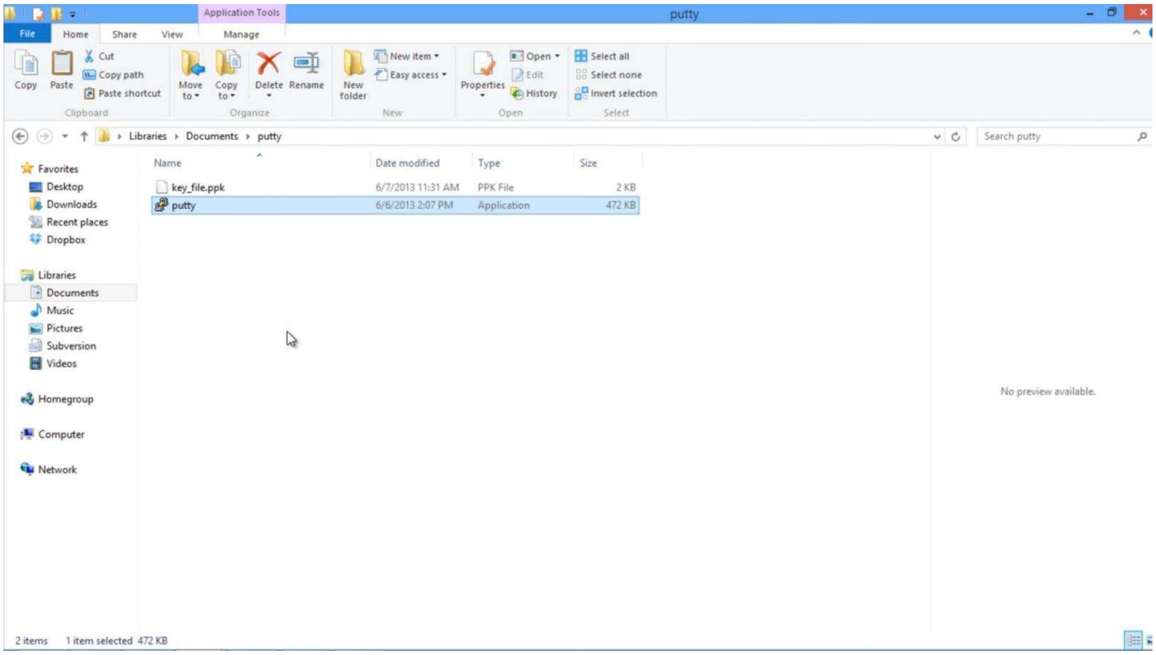
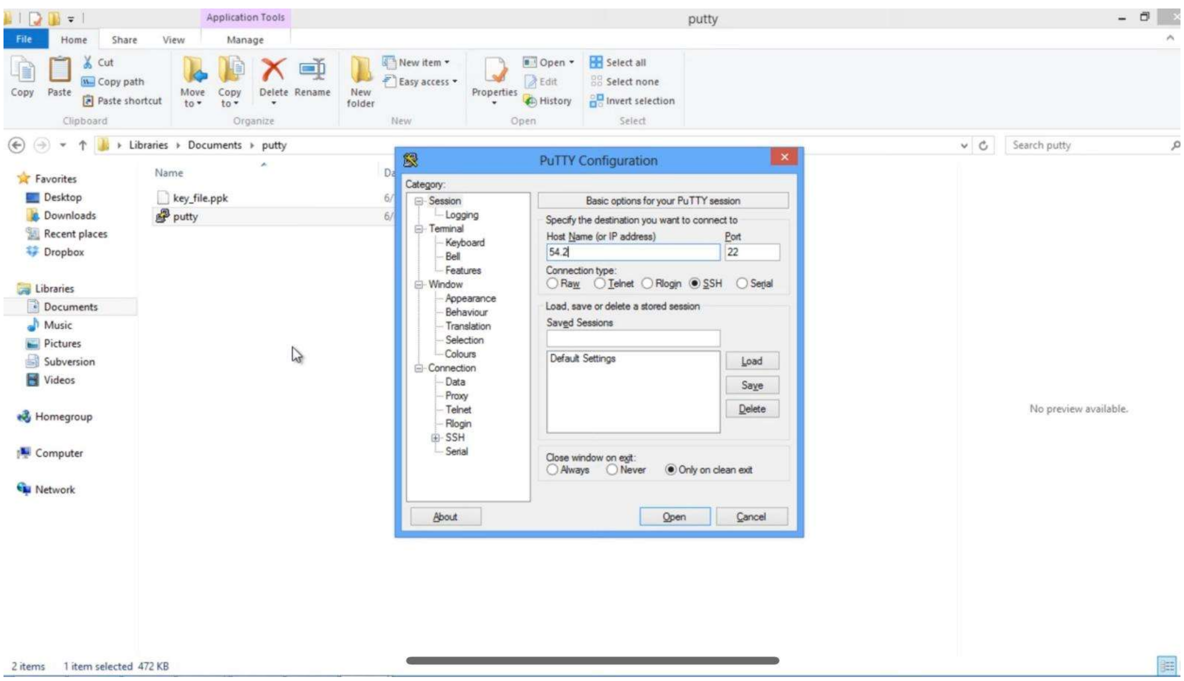
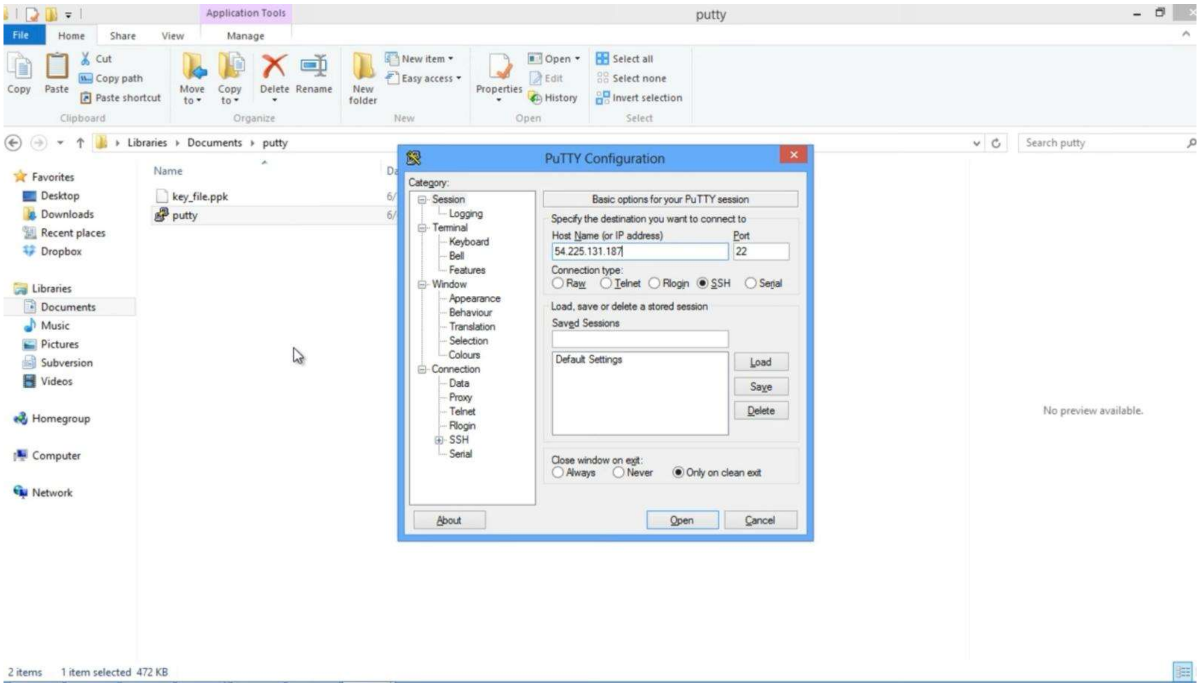


Fig. 1 FENDT tractor CAN Bus interface using J1939 connector and CAN to USB converter with Raspberry Pi5

i. The lab Raspberry Pi5 boards have already been set up for CAN bus interface. You will split your group members and some of you will go to High bay area and connect your Raspberry Pi5 board to the FENDT tractor's J1939 connector using the CAN to USB converter and J1939 connector as shown in Fig. 1. The remaining group member can either take lab laptop to the High Bay or remain in the lab and remotely access the Raspberry Pi5 that is connected to the tractor. Please use PUTTY on lab laptop and provide the IP address of your Raspberry Pi5 to connect it as shown below.


putty
Application Tools
File
Home
Share
View
Manage
Libraries › Documents › putty
Name
Date modified
Type
Size
key_file.ppk
6/7/2013 11:31 AM
PPK File
2 KB
putty
6/6/2013 2:07 PM
Application
472 KB
No preview available.
2 items 1 item selected 472 KB


putty
PuTTY Configuration
Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
Basic options for your PuTTY session
Specify the destination you want to connect to
Host Name (or IP address)
Port
54.2
22
Connection type:
Raw
Telnet
Rlogin
SSH
Serial
Load, save or delete a stored session
Saved Sessions
Default Settings
Load
Save
Delete
Close window on exit:
Always
Never
Only on clean exit
About
Open
Cancel
No preview available.
2 items 1 item selected 472 KB



ii. **CAN Interface Setup**

- Connect the InnoMaker CAN-to-USB adapter to the Raspberry Pi.
- Enable the CAN interface using terminal commands:

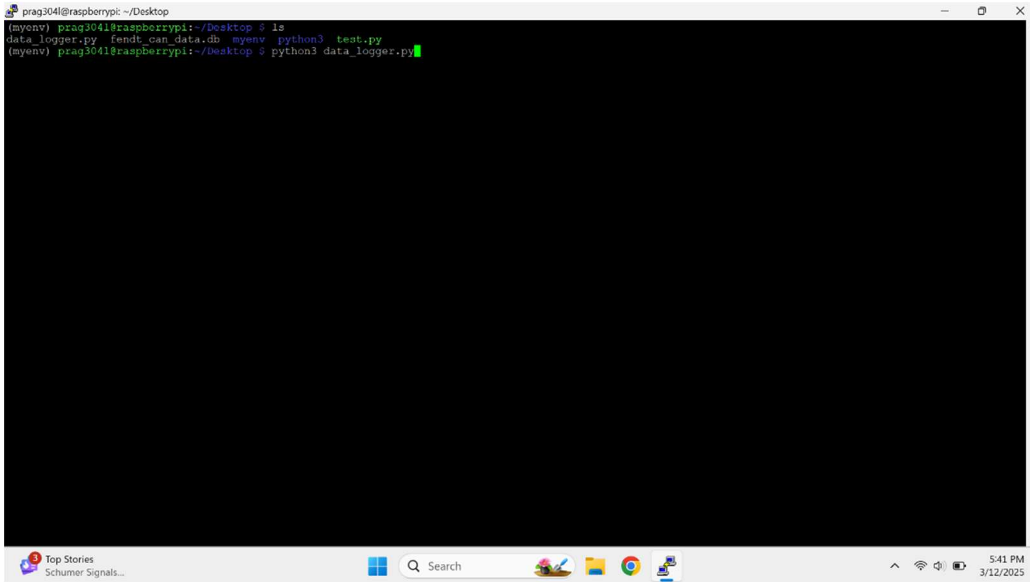
```
sudo ip link set can0 up type can bitrate 500000
```

iii. **Running the Script**

- First activate virtual environment by using the following command.

```
source myenv/bin/activate
```

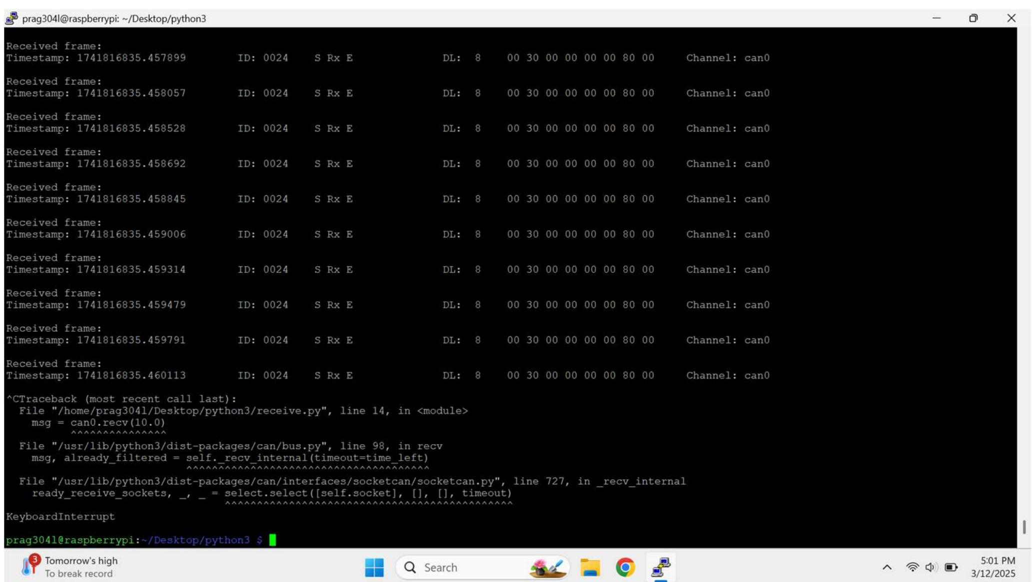
After executing this, you will see something like this.



- Execute the Python script on Raspberry Pi.

  python3 test.py (not as seen in the above image; rather run the test.py script)

  This will output raw data which might look as shown below.



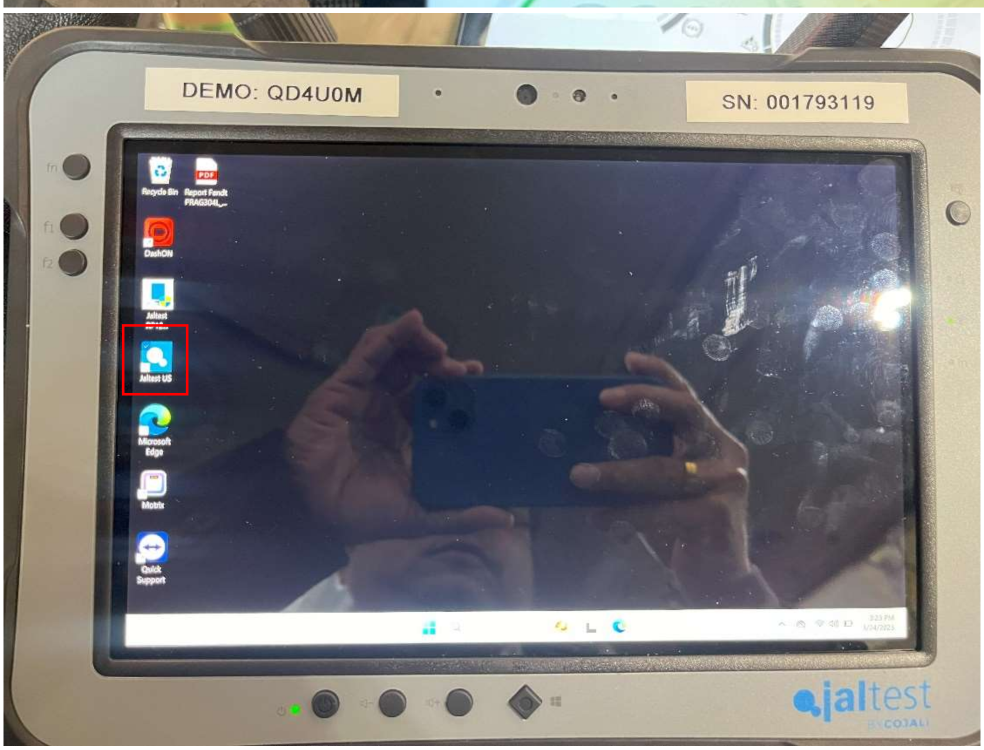
iv. From this extract the CAN ID and from that extract the PGN. Similarly extract the data bytes and convert each data byte into decimal. Make sure to show it to your lab Tas before heading for the next experiment (Experiment 2).

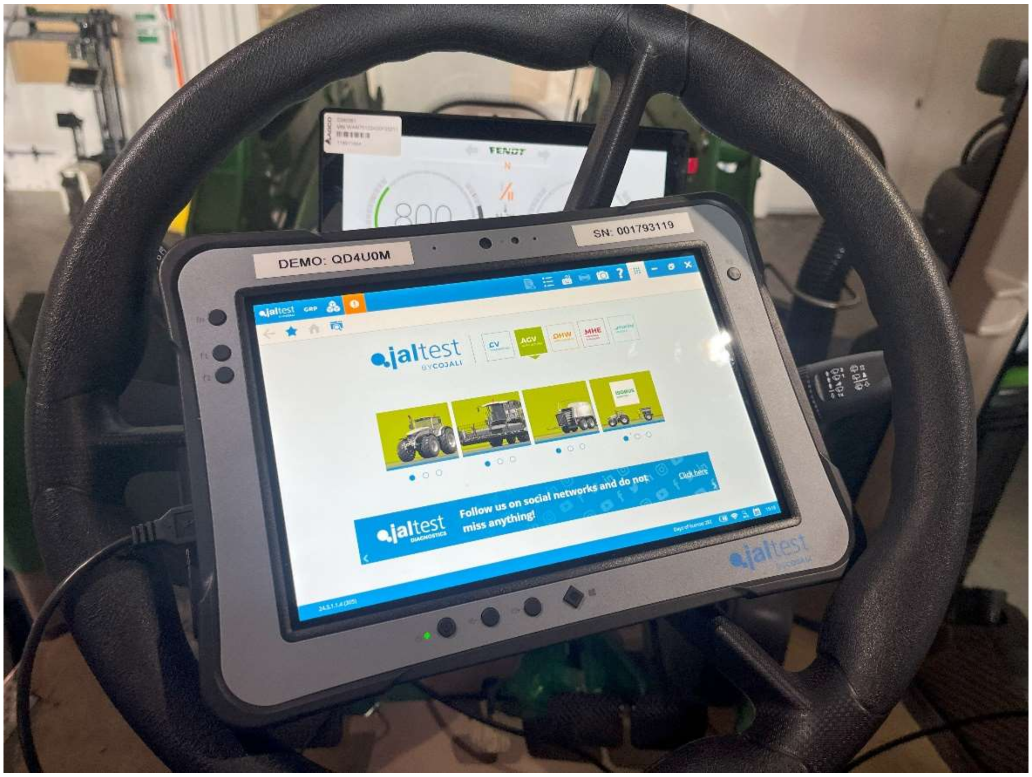
2.2.2 Experiment 2

In this experiment you will use equipment and software provided by Jaltest to monitor tractor data using the J1939 connector located at the fuse box of FENDT tractor. Jaltest will convert all the CAN bus data into a human readable format. For this experiment the whole group members need to assemble at the High Bay and one of you will need to drive the FENDT tractor (only if you know; else just turn ON the engine and leave it as it is) to monitor live data and generate diagnostics report in the end.

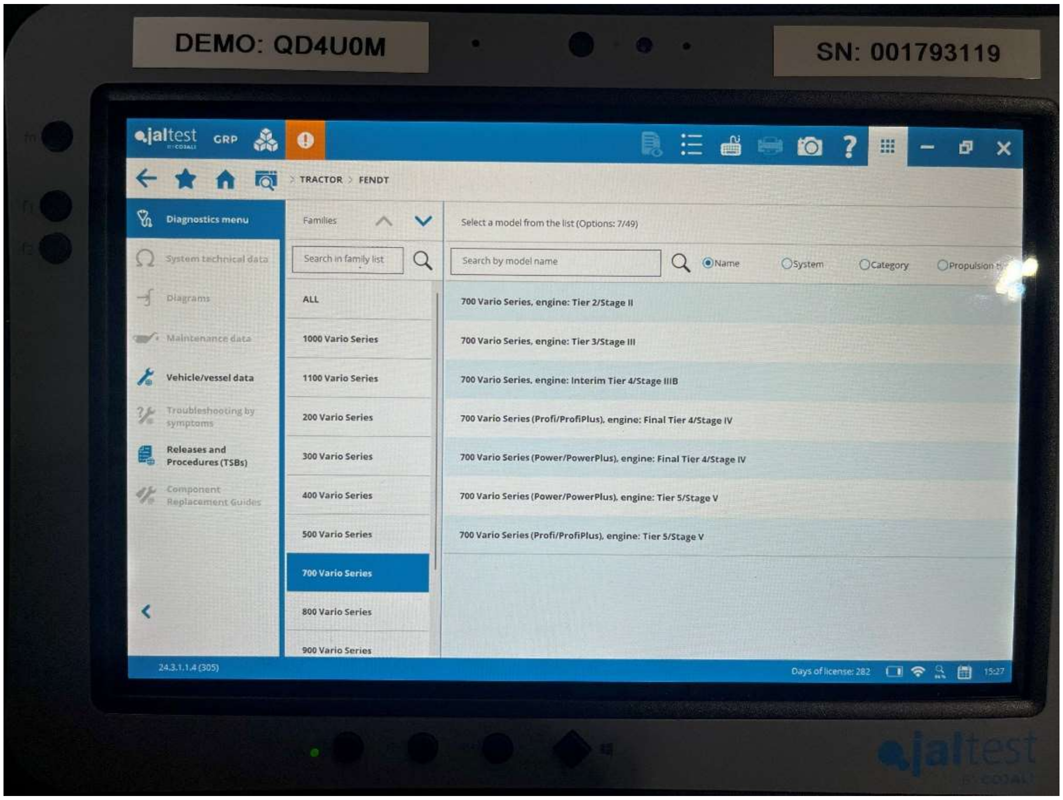
i. Please follow the lab TAs instructions at every step of the setup of the equipment.
ii. Make the necessary connections as shown below.

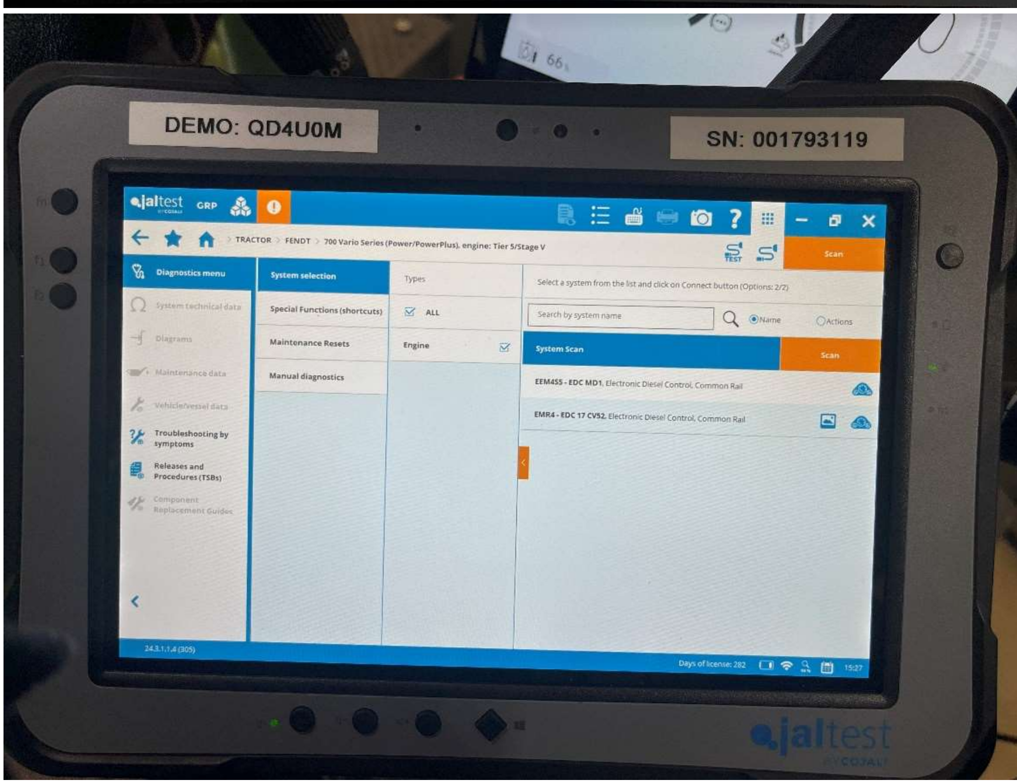

jaltest
BY COJALI
FENDT

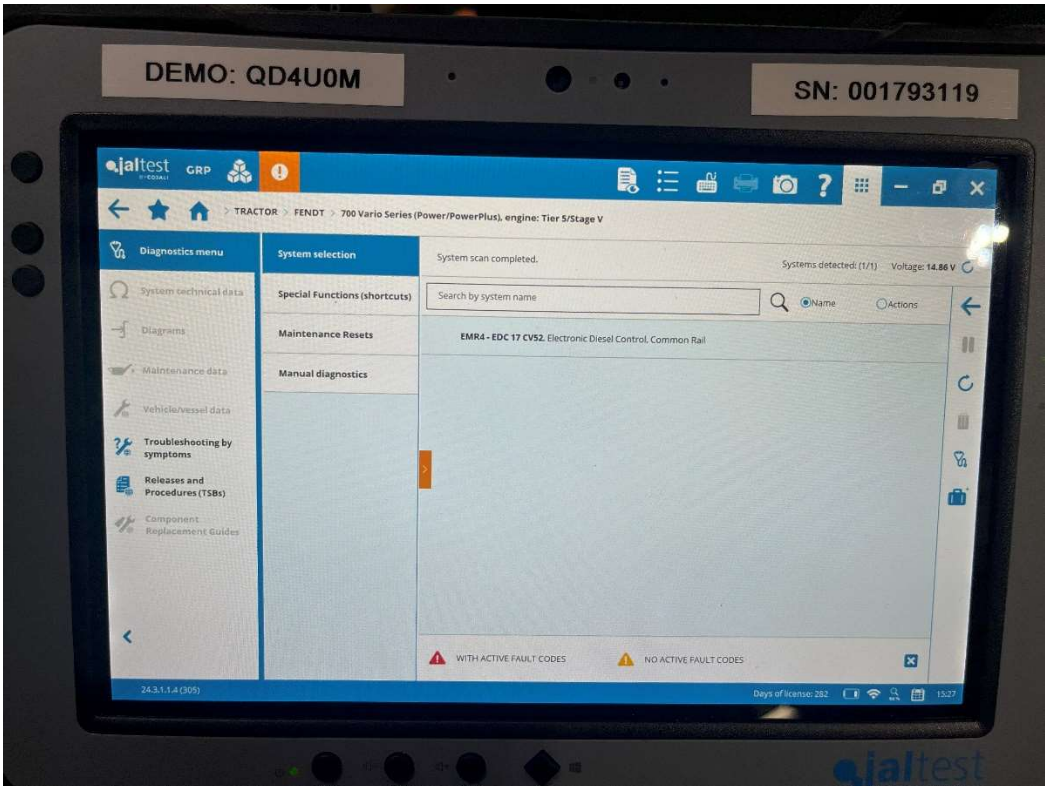

DEMO: QD4U0M
SN: 001793119
jaltest
BY COJALI

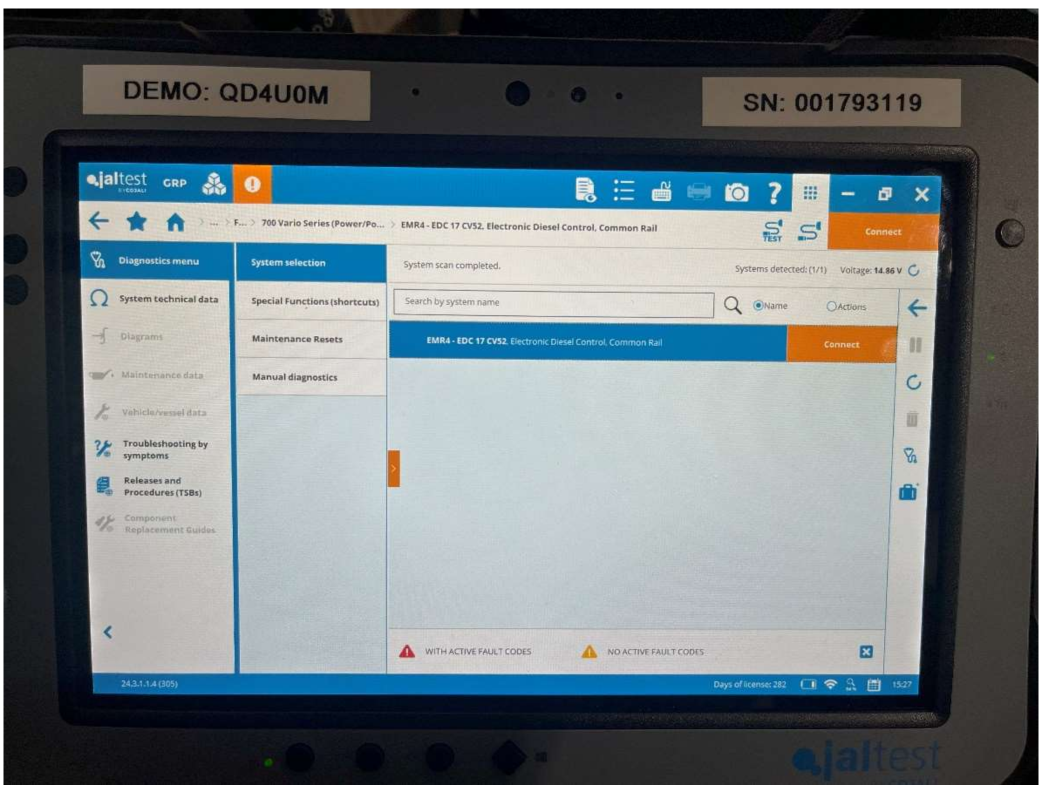


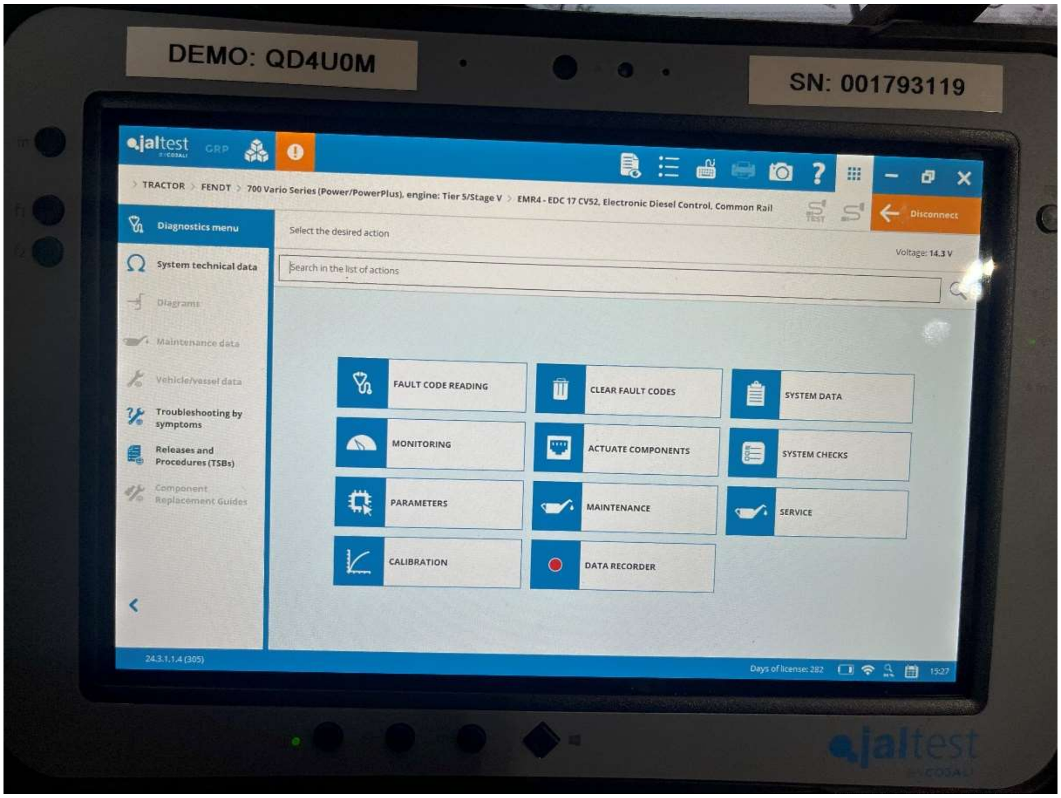
iii. Select the Make, Model and specific configurations for the FENDT tractor and follow the steps as demonstrated by the lab TAs to monitor live data of the entire tractor like engine speed, temperature, etc. as shown below.


DEMO: QD4U0M
SN: 001793119
jaltest
GRP
TRACTOR > FENDT
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
Families
Search in family list
ALL
1000 Vario Series
1100 Vario Series
200 Vario Series
300 Vario Series
400 Vario Series
500 Vario Series
700 Vario Series
800 Vario Series
900 Vario Series
Select a model from the list (Options: 7/49)
Search by model name
Name
System
Category
700 Vario Series, engine: Tier 2/Stage II
700 Vario Series, engine: Tier 3/Stage III
700 Vario Series, engine: Interim Tier 4/Stage IIIB
700 Vario Series (Profi/ProfiPlus), engine: Final Tier 4/Stage IV
700 Vario Series (Power/PowerPlus), engine: Final Tier 4/Stage IV
700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V
700 Vario Series (Profi/ProfiPlus), engine: Tier 5/Stage V
24.3.1.1.4 (305)
Days of license: 282
15:27
jaltest


DEMO: QD4U0M
SN: 001793119
jaltest
GRP
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V
Scan
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
System selection
Special Functions (shortcuts)
Maintenance Resets
Manual diagnostics
Types
ALL
Engine
Select a system from the list and click on Connect button (Options: 2/2)
Search by system name
Name
Actions
System Scan
Scan
EEM4S5 - EDC MD1, Electronic Diesel Control, Common Rail
EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail
24.3.1.1.4 (305)
Days of license: 282
15:27
jaltest


DEMO: QD4U0M
SN: 001793119
jaltest
GRP
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V
Diagnostics menu
System selection
Special Functions (shortcuts)
Maintenance Resets
Manual diagnostics
System scan completed.
Systems detected: (1/1)
Voltage: 14.86 V
Search by system name
Name
Actions
EMR4 - EDC 17 CV52. Electronic Diesel Control, Common Rail
Troubleshooting by symptoms
Releases and Procedures (TSBs)
WITH ACTIVE FAULT CODES
NO ACTIVE FAULT CODES


DEMO: QD4U0M
SN: 001793119
jaltest
GRP
700 Vario Series (Power/Po... > EMR4 - EDC 17 CV52. Electronic Diesel Control, Common Rail
Connect
Diagnostics menu
System technical data
System selection
Special Functions (shortcuts)
Maintenance Resets
Manual diagnostics
System scan completed.
Systems detected: (1/1)
Voltage: 14.86 V
Search by system name
Name
Actions
EMR4 - EDC 17 CV52. Electronic Diesel Control, Common Rail
Connect
Troubleshooting by symptoms
Releases and Procedures (TSBs)
WITH ACTIVE FAULT CODES
NO ACTIVE FAULT CODES


DEMO: QD4U0M
SN: 001793119
jaltest
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V > EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail
Disconnect
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
Select the desired action
Voltage: 14.3 V
Search in the list of actions
FAULT CODE READING
CLEAR FAULT CODES
SYSTEM DATA
MONITORING
ACTUATE COMPONENTS
SYSTEM CHECKS
PARAMETERS
MAINTENANCE
SERVICE
CALIBRATION
DATA RECORDER
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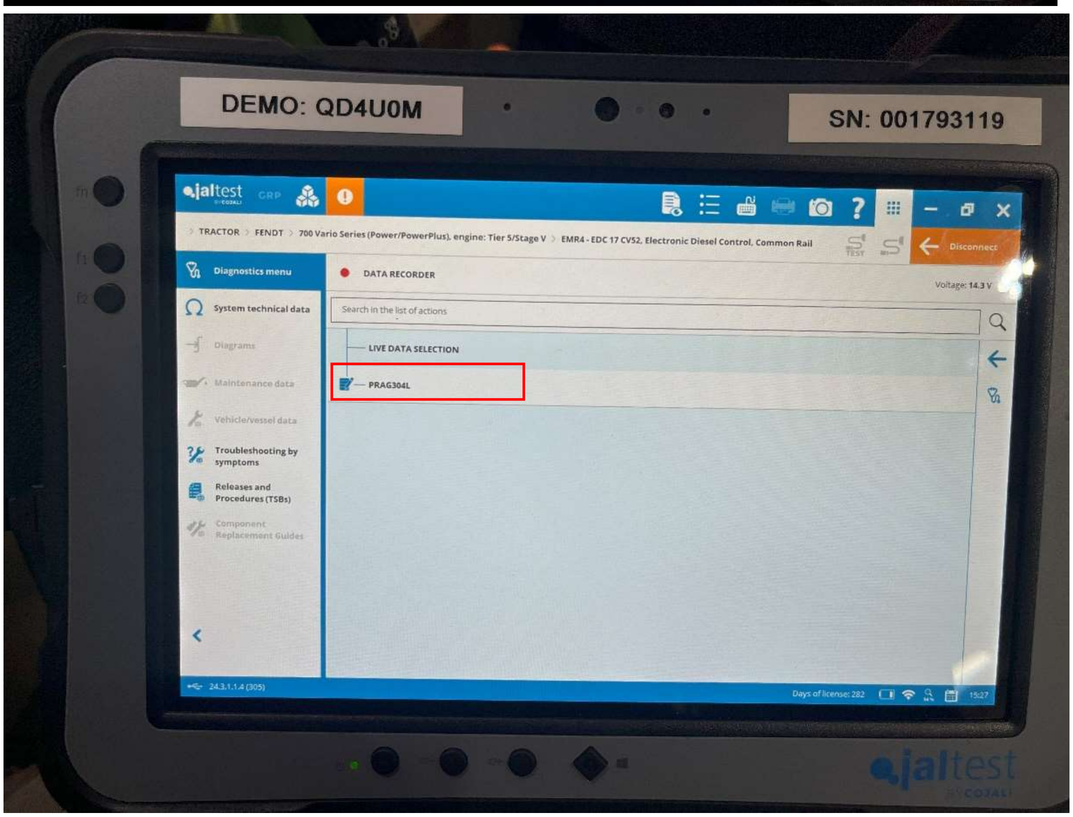
Days of license: 282
15:27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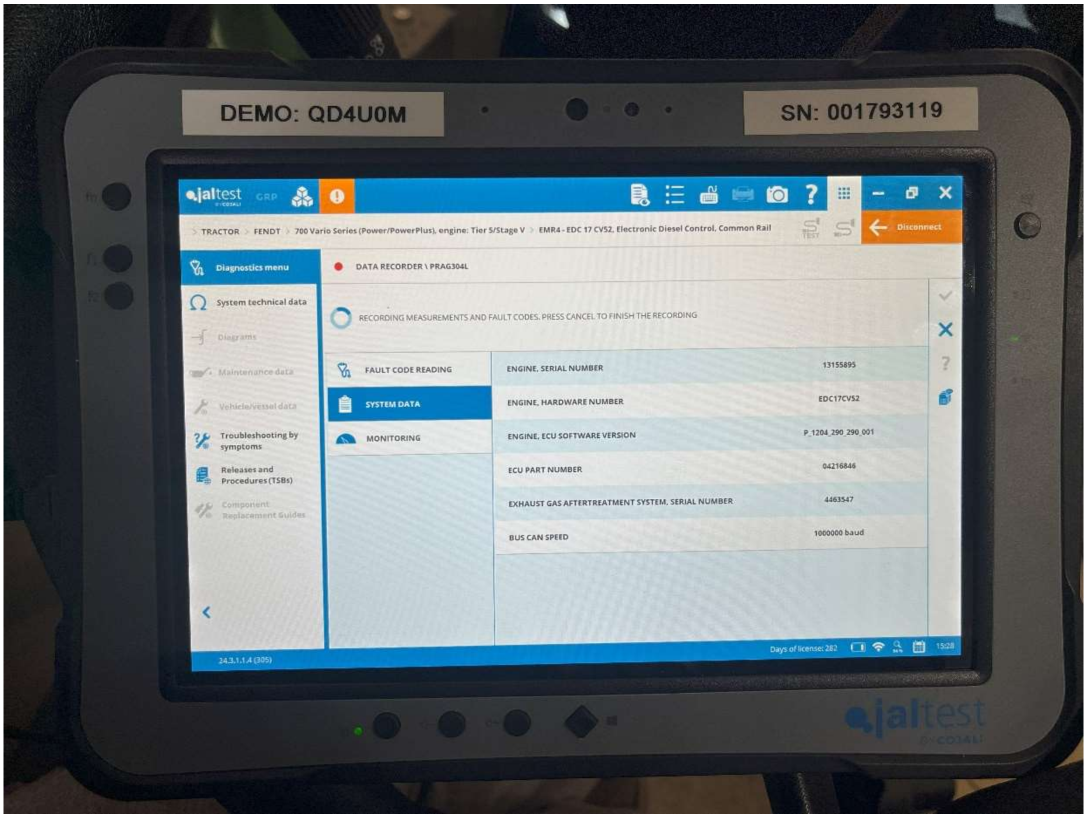
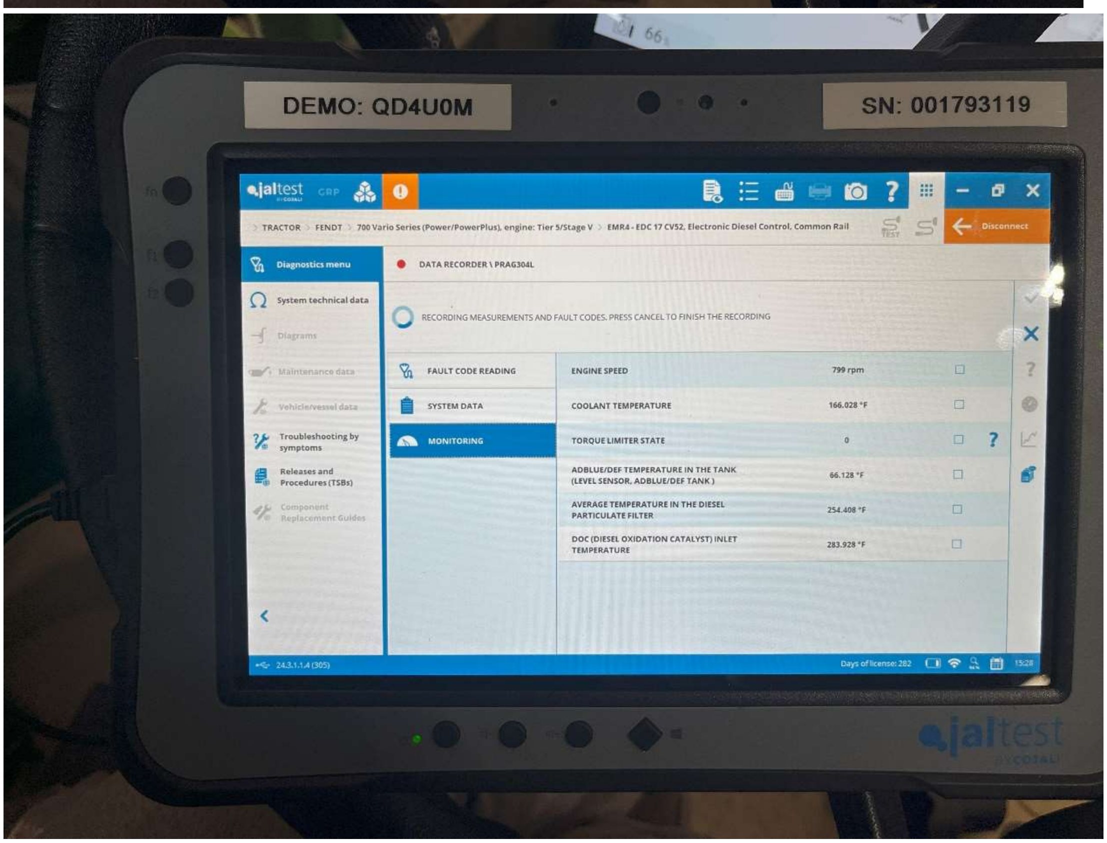
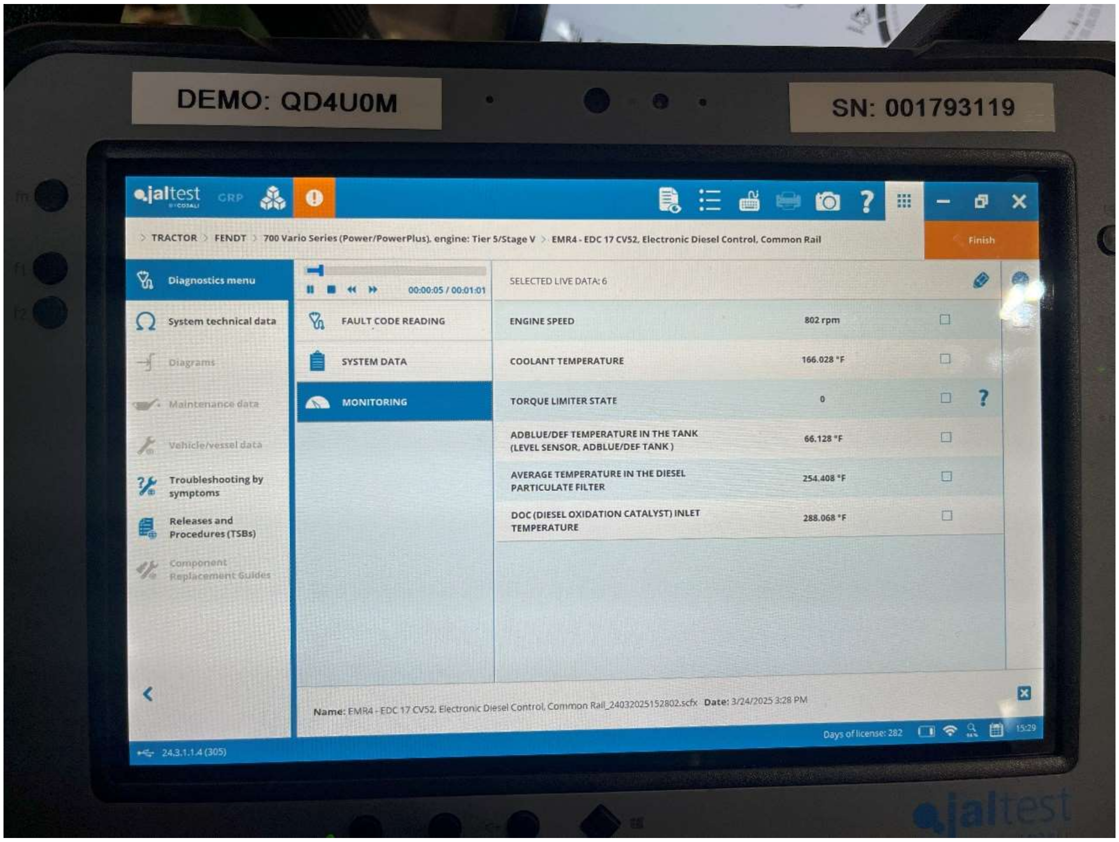
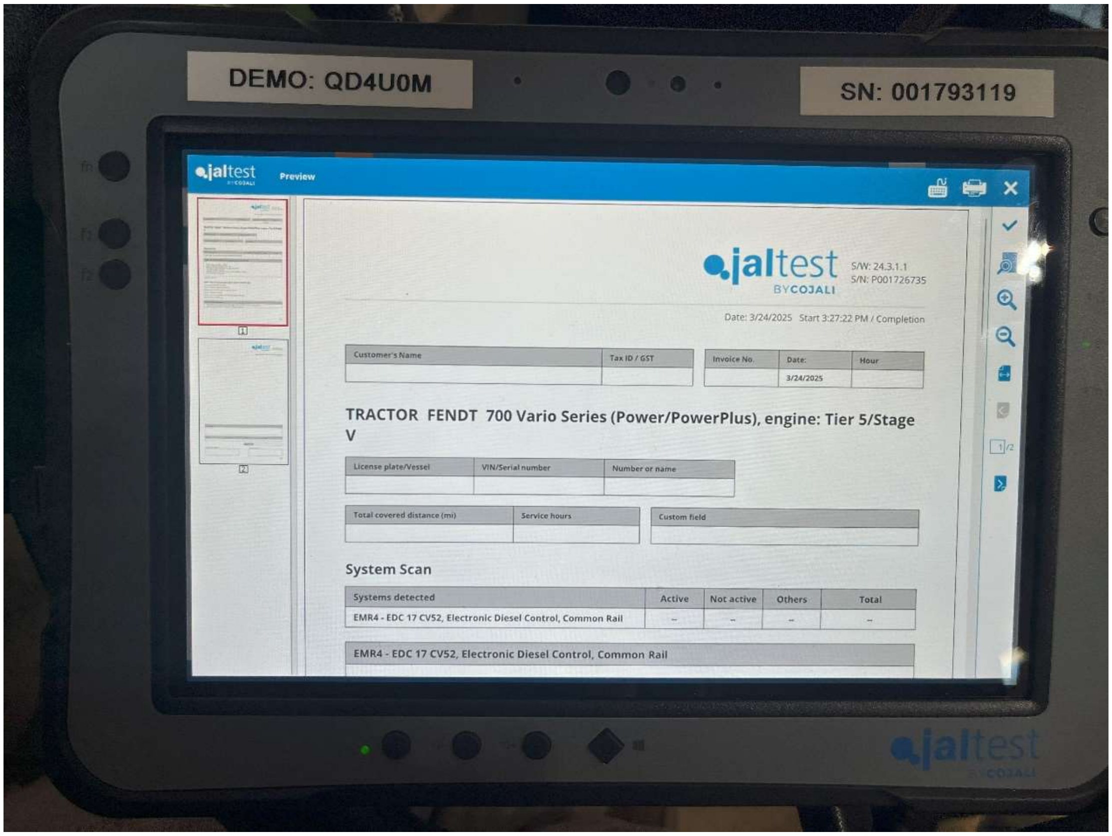
SN: 001793119
jaltest
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V > EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail
Disconnect
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
DATA RECORDER
Voltage: 14.3 V
Search in the list of actions
LIVE DATA SELECTION
PRAG304L
24.3.1.1.4 (305)
Days of license: 282
15:27


DEMO: QD4U0M
SN: 001793119
jaltest
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V > EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail
Disconnect
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
DATA RECORDER \ PRAG304L
RECORDING MEASUREMENTS AND FAULT CODES. PRESS CANCEL TO FINISH THE RECORDING
FAULT CODE READING
SYSTEM DATA
MONITORING
ENGINE, SERIAL NUMBER 13155895
ENGINE, HARDWARE NUMBER EDC17CV52
ENGINE, ECU SOFTWARE VERSION P_1204_290_290_001
ECU PART NUMBER 04216846
EXHAUST GAS AFTERTREATMENT SYSTEM, SERIAL NUMBER 4463547
BUS CAN SPEED 1000000 baud
24.3.1.1.4 (305)
Days of license: 282
15:28


DEMO: QD4U0M
SN: 001793119
jaltest
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V > EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail
Disconnect
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
DATA RECORDER \ PRAG304L
RECORDING MEASUREMENTS AND FAULT CODES. PRESS CANCEL TO FINISH THE RECORDING
FAULT CODE READING
SYSTEM DATA
MONITORING
ENGINE SPEED 799 rpm
COOLANT TEMPERATURE 166.028 °F
TORQUE LIMITER STATE 0
ADBLUE/DEF TEMPERATURE IN THE TANK (LEVEL SENSOR, ADBLUE/DEF TANK) 66.128 °F
AVERAGE TEMPERATURE IN THE DIESEL PARTICULATE FILTER 254.408 °F
DOC (DIESEL OXIDATION CATALYST) INLET TEMPERATURE 283.928 °F
24.3.1.1.4 (305)
Days of license: 282
15:28


DEMO: QD4U0M
SN: 001793119
jaltest
GRP
TRACTOR > FENDT > 700 Vario Series (Power/PowerPlus), engine: Tier 5/Stage V > EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail
Finish
Diagnostics menu
System technical data
Diagrams
Maintenance data
Vehicle/vessel data
Troubleshooting by symptoms
Releases and Procedures (TSBs)
Component Replacement Guides
00:00:05 / 00:01:01
FAULT CODE READING
SYSTEM DATA
MONITORING
SELECTED LIVE DATA: 6
ENGINE SPEED 802 rpm
COOLANT TEMPERATURE 166.028 °F
TORQUE LIMITER STATE 0
ADBLUE/DEF TEMPERATURE IN THE TANK (LEVEL SENSOR, ADBLUE/DEF TANK) 66.128 °F
AVERAGE TEMPERATURE IN THE DIESEL PARTICULATE FILTER 254.408 °F
DOC (DIESEL OXIDATION CATALYST) INLET TEMPERATURE 288.068 °F
Name: EMR4 - EDC 17 CV52, Electronic Diesel Control, Common Rail_24032025152802.scfx Date: 3/24/2025 3:28 PM
Days of license: 282
15:29
24.3.1.1.4 (305)



iv. Save and transfer the PDF copy of diagnostic report generated in the end to your Flash drive and submit it along with your lab report.

3. **Discussion**

In the lab report discuss what you learnt from both the experiments along with screenshot of live data as well as diagnostic report.