ERASMUS+ PROGRAMME

Project Number: 618509-EPP-1-2020-1-JO-EPPKA2-CBHE-JP

ECO-CAR:
Vocational Training Diploma on Electrical and Hybrid Vehicles

WP4: Establishment of EV/HEV labs

Final Report

Al-Balqa Applied University (BAU)

10th January, 2024

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ECO-CAR Vocational Training Diploma on Electrical and Hybrid Vehicles			
WP4: Establishment of EV/HEV labs			
Project coordinator	**Prof Ahmed Al-Salaymeh, The University of Jordan (UJ)**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**The University of Jordan (UJ)** **Jordan University of Science and Technology (JUST)** **National Technical University of Athens (NTUA)**		
Author(s)	**Dr. Ma'moun Smadi and Prof. Rebhi Damseh**		
Grant's holder	**The University of Jordan (UJ)** **Queen Rania Street I Amman 11942, Jordan** **Tel: +962-6-53 55 000 Ext. 22816 I Mob: +962-777-64 4364 I Fax: +962-6-53 00 237** **Email: eco-car@ju.edu.jo**		
Project website	**http://sites.ju.edu.jo/en/ECO-CAR/Home.aspx**		
Organization Name(s)	**Al-Balqa Applied University (BAU)**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs**		
Task Number & Title	**Task 5.4: Develop Courses Content**		
Submission date	**10th Jan. 2024**	**Project month**	**36**
Number of pages			
Partners			

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1. Introduction

According to the project proposal WP4 is a part of the project development and implementation phase. It consists of two main activities; 4.1 Lab design and equipment list; 4.2 Implementation of labs and prepare manuals. The budget allocated for WP4 is 35552 Euro for staff cost and 281,000 Euro for Equipment cost.

The acquired equipment will be utilized within the project to achieve project objectives. A server will be acquired by the university of Jordan to host the project website and virtual learning platform. Smart classrooms equipped with Smart Board was established for students in each Jordanian partner university.

The lab will give the students the opportunity to develop various diagnostic strategies involving measurements on an actual EV/HEV system with real voltages under the most stringent safety conditions.

A "Hybrid and Electric Vehicles" Training system will be acquired by each university, this training system provides a safe work environment and allows students and trainees to fully focus on the task at hand. Trainees can become familiar with all the key theoretical background by means of an interactive e-learning course. Each of the theoretical sections is accompanied by practical exercises and tests of knowledge, which also help to advance vital diagnostic skills. These skills are further boosted by the built-in diagnostic system and the scrupulously selected fault scenarios. The system gives the students the opportunity to develop various diagnostic strategies involving measurements on an actual HV system with real HV voltages under the most stringent safety conditions. The system will include the following:

- CarTrain "Hybrid and Electric Vehicles" system
- Integrated WiFi measurement interface
- Experiment trolley
- Electric Service Gloves Class
- Insulation and Electrical Resistance Meter (Automotive)
- Personal Protective Equipment (PPE) for diagnostic work on high-voltage vehicles (helmet, insulating mat, Face protection screen)
- Two-pole voltage tester
- Charging Station for PEV and PHEV
- Diagnostic System include PC, software, display screen
- Emission measurement Equipment
- High precision automotive measurement units

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The students will have the chance to be trained on real vehicles during their internships at enterprises.

2. WP4 Aims and objectives:

The main aim of this work package (WP4) is to establish 8 EV/HEV labs at each partner university in jordan to support the teaching of diploma and bachelor These labs are mainly focused to set up the needed scientific labs and smart classrooms to be used by the students during their study to understand the basic concepts involved in EV/HEV systems.

The established laboratories will support the following activities:

1) Assisting teaching of ECO-CAR diploma Students;

2) Research, in collaboration with the other faculties and/or industry;

3) Vocational training for external experts

4) External services: advices for industries and final users

3. WP4 outputs and outcomes:

The output and outcome of WP4 are:

- The establishment of 8 EV/HEV labs in each Jordanian partner university
- Preparing an experiment lab manual for the received equipment.

4. WP4 Plan

Overall Plan

Number	Plan	Duration
1	WP leader will set a detailed plan for the WP.	M2
2	Prepare a list of main components in ECO-CAR centres.	M2
3	WP leader and co-leaders will set the list o needed equipment's based on WP2.	M4
4	Central Tender is published.	M10
5	Center is fully equipped and operational.	M18
6	Center establishment.	M21
7	Progress report to be provided by WP leader every 6 months based on the collected feedback from co-leaders,	

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Detailed Plan:

No	Task	Responsibility	Duration
1	WP leader will set a detailed plan for the WP.	BAU	M2
2	Prepare a list of main components in ECO-CAR centers.	BAU	M2
3	WP leader and co-leaders will set the list of needed equipment's based on WP2.	BAU, UJ, JUST, NTUA	M4
4	Central Tender published by university of Jordan.	UJ	M10
5	Tendering process in the level of officially purchasing the equipment.	UJ	M12
6	Provide each Jordanian partner with the equipment list they will receive.		M12
7	Prepare a Template to collect data for the ECO-CAR Centre/Labs that will host the equipment in each University (Jordanian Partners.	BAU, UJ	M16
8	Preparing the Lab manual, selecting experiments titles, objectives, and theoretical part	BAU, HTU, TTU	M18
9	UJ start hosting the project server.	UJ	M16
10	The equipment are purchased and delivered to the Jordanian partners	UJ and Jordanian Partners	M18
11	Prepare the practical part of the experiment manual and review it according to the course outline in cluster 9 and the received equipment	BAU, TTU and JUST	M20
12	Receive the second patch of equipment and Setup the received equipment by the Jordanian partners in center/lab in the relevant department and stick EU stickers on all equipment. Center/Lab is fully equipped and operational.	UJ and Jordanian Partners	M28
13	Prepare the final Progress report by WP leader based on the collected feedback from co-leaders and Jordanian partners.	BAU, UJ, JUST, NTUA	M36

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4.1 Lab design and equipment list

4.1.1 Lab Design

According to the detailed plan for WP4, WP leader and co-leaders prepare a template for "**Centers/Lab Design Requirements**" (Annexe 1). The template was distributed among the Jordanian partners to allocate a suitable center/Lab in the relevant department. The center/Lab must contain:

- A space for theoretical courses (Smart Classroom) in which a Smart board will be established.
- A separate space (Lab or workshop) must be allocated for the Lab equipment.

Both Locations must satisfy the following requirements:

1. The availability of sufficient free space for 15 students according to accreditation criteria.
2. The availability of sufficient lighting.
3. The availability of appropriate ventilation. (Windows in the Smart Classroom, windows and suction fan for the Lab).
4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
7. The Availability of Lab Technician.
8. The availability of basic Lab furniture (desk, chair, storage space whiteboard etc.).
9. The availability of firefighting equipment.

Centers/Lab Information:

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
Classroom Dimensions:			
Total Area:			
Number of windows:			
Area of windows:			
Number of electrical outlets:			
Type of lighting units:			
Number of lighting Units:			
Number of entries:			
Available Furniture:			

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ECO-CAR Vocational Training Diploma On Electrical and Hybrid Vehicles

Lab Information			
Lab Location:	Building	Level	Room Number
Lab Dimensions:	Length	Width	Height
Total Area:			
Number of windows:			
Area of windows:			
Number of electrical outlets:			
Type of lighting units:			
Number of lighting Units:			
Number of entries:			
Available Furniture:			
Lab Technician Information			
Name:			
Job Title (Position)			
Contact info.	Mobile	Email	

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4.1.2 Equipment List

The list of main components for ECO-CAR Lab/centers based on project proposal and WP2 requirements include the following:

- CarTrain "Hybrid and Electric Vehicles" system
- Integrated WiFi measurement interface
- Experiment trolley
- Electric Service Gloves Class
- Insulation and Electrical Resistance Meter (Automotive)
- Personal Protective Equipment (PPE) for diagnostic work on high-voltage vehicles (helmet, insulating mat, Face protection screen)
- Two-pole voltage tester
- Charging Station for PEV and PHEV
- Diagnostic System include PC, software, display screen
- Emission measurement Equipment
- High precision automotive measurement units

Based on the main list and project aims a detailed specification list was written for tendering process. The equipment list for Applied Science Private University (ASU) was modified accoding to thier reqirments. The detailed list include technical specifications, minimum requirements, quantity and pricing for each component (Annexe 2):

The tendering process was organized by the university of Jordan (UJ) in two Bids. The equipment was recieved by UJ and then distributed to the Jordanian partner universities according to the lists (Annexe 3)

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4.2 Implementation of labs and prepare manuals.

After equipment purchising starts WP4 leader and co-leaders start preparing the Lab manual by selecting experiments titles, objectives, and theoretical part according to the purchesed equipment specifications. The practical part of the experiment manual were prepared after reciving the equipment and finally the lab manuals were reviewed according to the course outline in cluster 9 and the received equipment specifications.

According to the equipment specifications, four lab manuals were prepared as showin in the table below. The detaild lab mauals are found in (Annexes 4-7).

No.	Manual	Pages	Resposibility	Annexes
1.	Gasoline-Electricity Hybrid Power System Training Bench (Toyota Corolla 1.8L).	73	BAU, TTU	Annexe 4
2.	Electric Vehicle Drive and Transmission System Training Unit.	55	BAU, TTU	Annexe 5
3.	Autel MaxiSys Pro MS908S User Manual.	50	BAU, TTU	Annexe 6
4.	Automotive Emission Analyzer.	28	JUST	Annexe 7

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LIST OF ANNEXES

Annexe 1: Centers/Lab Design Requirements.

Annexe 2: ECO-CAR Equipment List (Specification).

Annexe 3: Equipment List for Jordan University.

Annexe 4: Gasoline-Electricity Hybrid Power System Training Bench (Toyota Corolla 1.8L).

Annexe 5: Electric Vehicle Drive and Transmission System Training Unit.

Annexe 6: Autel MaxiSys Pro MS908S User Manual.

Annexe 7: Automotive Emission Analyzer.

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Annexe 1

Centers/Lab Design Requirements.

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Centers/Lab Design Requirements

Author(s)	**Prof. Tarek A. Tutunji** **Engr. Yousef Okour**		
Organization Name(s)	**HTU**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs plan**		
Task Number & Title	**Task 4.1: Lab design and equipment list**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**UJ, JUST, NTUA**		
Due date of delivery		**Project month**	
Submission date	**06.01.2022**	**Project month**	
Number of pages			

Project coordinator

Prof Ahmed Al-Salaymeh

The University of Jordan (UJ)

Queen Rania Street Amman11942, Jordan

Tel: +962-6-53 55 000 **Ext:** 22816.**Mob:** +962-777-64 4364. **Fax:** + 962-6-53 00 237

Email: ECO-CAR@ju.edu.jo

Project Website: http://sites.ju.edu.jo/en/ECO-CAR/Home.aspx

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Centers/Lab Design Requirements

The tendering process is now in the level of purchasing. The equipment will be available by January 2022. Each University from JO partner is required to allocate a suitable center/Lab in the relevant department. The center/Lab must contain:

- A space for theoretical courses (Smart Classroom) in which a Smart board will be established.
- A separate space (Lab or workshop) must be allocated for the Lab equipment.

Both Locations must satisfy the following requirements:

1. The availability of sufficient free space for 15 students according to accreditation criteria.
2. The availability of sufficient lighting.
3. The availability of appropriate ventilation. (Windows in the Smart Classroom, windows and suction fan for the Lab).
4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
7. The Availability of Lab Technician.
8. The availability of basic Lab furniture (desk, chair, storage space whiteboard etc.).
9. The availability of firefighting equipment.

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Centers/Lab Information:

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
	23 (Main Building)	2	S07
Classroom Dimensions:	Length	Width	Height
	11	6	3
Total Area:	66 m^2		
Number of windows:	4		
Area of windows:	1.6 m x 1.6 m		
Number of electrical outlets:	5		
Type of lighting units:	Neon		
Number of lighting Units:	12		
Number of entries:	1		
Available Furniture:	Tables: 15 Chairs: 30		

- Note: HTU is expanding into new buildings and therefore the lab location might change, but it will have similar area

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Lab Information			
Lab Location:	Building	Level	Room Number
	Workshop	Ground / 1st	F07
Lab Dimensions:	Length	Width	Height
	8	5	3
Total Area:	40 m^2		
Number of windows:	1		
Area of windows:	2 m x 0.5 m		
Number of electrical outlets:	12		
Type of lighting units:	LED		
Number of lighting Units:	8		
Number of entries:	2		
Available Furniture:	Benches: 9 Chairs: 18		
Lab Technician Information			
Name:	Engr. Yousef Okour		
Job Title (Position)	Workshop Supervisor		
Contact info.	Mobile	Email	
	07 8546 9983	Yousef.Okour@htu.edu.jo	

- Note: The plan is to have the lab on the 1st floor and have the cars in the ground floor

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Centers/Lab Design Requirements

Author(s)	**Dr. Ma'moun Al-Smadi**		
Organization Name(s)	**Al-Balqa Applied University (BAU)**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs plan**		
Task Number & Title	**Task 4.1: Lab design and equipment list**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**UJ, JUST, NTUA**		
Due date of delivery		**Project month**	
Submission date		**Project month**	
Number of pages	**4 pages**		

Project coordinator

Prof Ahmed Al-Salaymeh

The University of Jordan (UJ)

Queen Rania Street Amman11942, Jordan

Tel: +962-6-53 55 000 **Ext:** 22816.**Mob:** +962-777-64 4364. **Fax:** + 962-6-53 00 237

Email: ECO-CAR@ju.edu.jo

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Centers/Lab Design Requirements

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4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
7. The Availability of Lab Technician.
8. The availability of basic Lab furniture (desk, chair, storage space whiteboard etc.).
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Centers/Lab Information:

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
	Al-Bayroni	2	E203
Classroom Dimensions:	Length	Width	Height
	10m	6m	3.5
Total Area:	$60m^2$		
Number of windows:	2		
Area of windows:	$4m^2$		
Number of electrical outlets:	4		
Type of lighting units:	Florescent		
Number of lighting Units:			
Number of entries:	2		
Available Furniture:	Students Chairs Whiteboard Ceiling Fan		

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Lab Information			
Lab Location:	Building	Level	Room Number
	Workshops	Ground	1
Lab Dimensions:	Length	Width	Height
	15m	13m	4m
Total Area:	175m^2		
Number of windows:	4		
Area of windows:	8m^2		
Number of electrical outlets:	12		
Type of lighting units:	Florescent		
Number of lighting Units:			
Number of entries:	4		
Available Furniture:	Lab Tables Students Chairs Whiteboard		
Lab Technician Information			
Name:	Emad Al-odus		
Job Title (Position)	Lab Supervisor		
Contact info.	Mobile	Email	

Centers/Lab Photos:

** Please insert some photos of the center or lab where the equipment will be located.

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Centers/Lab Design Requirements

Author(s)			
Organization Name(s)	**ASU University**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs plan**		
Task Number & Title	**Task 4.1: Lab design and equipment list**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**UJ, JUST, NTUA**		
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Project coordinator

Prof Ahmed Al-Salaymeh

The University of Jordan (UJ)

Queen Rania Street Amman11942, Jordan

Tel: +962-6-53 55 000 **Ext:** 22816.**Mob:** +962-777-64 4364. **Fax:** + 962-6-53 00 237

Email: ECO-CAR@ju.edu.jo

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2. The availability of sufficient lighting.
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4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
7. The Availability of Lab Technician.
8. The availability of basic Lab furniture (desk, chair, storage space whiteboard etc.).
9. The availability of firefighting equipment.

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Centers/Lab Information: ASU University

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
	9	Basement	9005
Classroom Dimensions:	Length	Width	Height
	5.71 m	5.5 m	2.5 m
Total Area:	31.405 m^2		
Number of windows:	-		
Area of windows:	-		
Number of electrical outlets:	4		
Type of lighting units:	Squared ceiling light.		
Number of lighting Units:	54		
Number of entries:	1		
Available Furniture:	Smartboard, stools, whiteboard and tables.		

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ASU University

Lab Information			
Lab Location:	Building	Level	Room Number
	9	Basement	9005
Lab Dimensions:	Length	Width	Height
	34.051 m	12 m	4.53 m
Total Area:	408.612 m^2		
Number of windows:	10		
Area of windows:	For one window (2m × 1.5m) = 3 m^2 for ten windows total area = 30 m^2		
Number of electrical outlets:	58		
Type of lighting units:	Squared pendant light.		
Number of lighting Units:	54		
Number of entries:	2		
Available Furniture:	Stools, whiteboard, storage space, workbenches and tables.		
Lab Technician Information			
Name:	Eng. Ayham Al-Raoush		
Job Title (Position)	Technical Instructor		
Contact info.	Mobile	Email	
	0797848345	a_alrawosh@asu.edu.jo	
Name:	Eng. Waseem Shaban		
Job Title (Position)	Lab supervisor		
Contact info.	Mobile	Email	
	0799948334	w_shaban@asu.edu.jo	

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Centers/Lab Design Requirements

Author(s)	**Eman Abdelhafez**		
Organization Name(s)	**Al-Zaytoonah University of Jordan**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs plan**		
Task Number & Title	**Task 4.1: Lab design and equipment list**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**UJ, JUST, NTUA**		
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Project coordinator

Prof Ahmed Al-Salaymeh

The University of Jordan (UJ)

Queen Rania Street Amman11942, Jordan

Tel: +962-6-53 55 000 **Ext:** 22816.**Mob:** +962-777-64 4364. **Fax:** + 962-6-53 00 237

Email: ECO-CAR@ju.edu.jo

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3. The availability of appropriate ventilation. (Windows in the Smart Classroom, windows and suction fan for the Lab).
4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
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Centers/Lab Information:

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
Classroom Dimensions:	Length	Width	Height
Total Area:			
Number of windows:			
Area of windows:			
Number of electrical outlets:			
Type of lighting units:			
Number of lighting Units:			
Number of entries:			
Available Furniture:			

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Lab Information			
Lab Location:	Building	Level	Room Number
	9	-1	-
Lab Dimensions:	Length	Width	Height
	20	5	6
Total Area:	100		
Number of windows:	4		
Area of windows:	3		
Number of electrical outlets:	8		
Type of lighting units:	Fluorescent		
Number of lighting Units:	9 (in each unit 4 lights)		
Number of entries:	1		
Available Furniture:	Stool Chair: 19 Office Chair: 2 Wall Fan: 1 Cabinet: 1 First aid kit: 1 Fire Extinguisher: 1		
Lab Technician Information			
Name:	Eng. Moayad Khashan		
Job Title (Position)	Lab Supervisor		
Contact info.	Mobile	Email	
	0780194466	m.khashan@zuj.edu.jo	

Centers/Lab Photos:

** Please insert some photos of the center or lab where the equipment will be located.

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Co-funded by the Erasmus+ Programme of the European Union

Centers/Lab Design Requirements

Author(s)	**Ahmad Mostafa and Wail Adaileh**		
Organization Name(s)	**Tafila Technical University (TTU)**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs plan**		
Task Number & Title	**Task 4.1: Lab design and equipment list**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**UJ, JUST, NTUA**		
Due date of delivery	**30/04/2023**	**Project month**	
Submission date	**29/03/2023**	**Project month**	
Number of pages			

Project coordinator

Prof Ahmed Al-Salaymeh

The University of Jordan (UJ)

Queen Rania Street Amman11942, Jordan

Tel: +962-6-53 55 000 **Ext:** 22816.**Mob:** +962-777-64 4364. **Fax:** + 962-6-53 00 237

Email: ECO-CAR@ju.edu.jo

Project Website: http://sites.ju.edu.jo/en/ECO-CAR/Home.aspx

Co-funded by the Erasmus+ Programme of the European Union

Centers/Lab Design Requirements

The tendering process is now in the level of purchasing. The equipment will be available by January 2022. Each University from JO partner is required to allocate a suitable center/Lab in the relevant department. The center/Lab must contain:

- A space for theoretical courses (Smart Classroom) in which a Smart board will be established.
- A separate space (Lab or workshop) must be allocated for the Lab equipment.

Both Locations must satisfy the following requirements:

1. The availability of sufficient free space for 15 students according to accreditation criteria.
2. The availability of sufficient lighting.
3. The availability of appropriate ventilation. (Windows in the Smart Classroom, windows and suction fan for the Lab).
4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
7. The Availability of Lab Technician.
8. The availability of basic Lab furniture (desk, chair, storage space whiteboard etc.).
9. The availability of firefighting equipment.

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Centers/Lab Information:

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
	Classroom Complex	-1	ECO-CAR Centre
Classroom Dimensions:	Length	Width	Height
	7.7 m	7.5 m	4 m
Total Area:	57.75 m^2		
Number of windows:	1		
Area of windows:	2m X 1.2m		
Number of electrical outlets:	3		
Type of lighting units:	Fluorescent		
Number of lighting Units:	8		
Number of entries:	2		
Available Furniture:	20 Chair + 3 Desks+ Workstation + Whiteboard+webcam		

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Lab Information			
Lab Location:	Building	Level	Room Number
	Classroom Complex	-1	ECO-CAR Centre
Lab Dimensions:	Length	Width	Height
	11.7 m	7.5 m	4 m
Total Area:	$87.75m^2$		
Number of windows:	2		
Area of windows:	2 m X 1.2 m		
Number of electrical outlets:	6		
Type of lighting units:	Fluorescent		
Number of lighting Units:	16		
Number of entries:	2		
Available Furniture:			
Lab Technician Information			
Name:	Amer Alsharaideh		
Job Title (Position)	Lab Technician		
Contact info.	Mobile	Email	
	+962776648647		

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Centers/Lab Design Requirements

Author(s)			
Organization Name(s)	**UJ**		
WP No & Title	**Work package 4: Establishment of EV/HEV labs plan**		
Task Number & Title	**Task 4.1: Lab design and equipment list**		
WP Leader	**Al-Balqa Applied University**		
WP Co-Leaders	**UJ, JUST, NTUA**		
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Prof Ahmed Al-Salaymeh

The University of Jordan (UJ)

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Tel: +962-6-53 55 000 **Ext:** 22816.**Mob:** +962-777-64 4364. **Fax:** + 962-6-53 00 237

Email: ECO-CAR@ju.edu.jo

Project Website: http://sites.ju.edu.jo/en/ECO-CAR/Home.aspx

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Centers/Lab Design Requirements

The tendering process is now in the level of purchasing. The equipment will be available by January 2022. Each University from JO partner is required to allocate a suitable center/Lab in the relevant department. The center/Lab must contain:

- A space for theoretical courses (Smart Classroom) in which a Smart board will be established.
- A separate space (Lab or workshop) must be allocated for the Lab equipment.

Both Locations must satisfy the following requirements:

1. The availability of sufficient free space for 15 students according to accreditation criteria.
2. The availability of sufficient lighting.
3. The availability of appropriate ventilation. (Windows in the Smart Classroom, windows and suction fan for the Lab).
4. The availability of sufficient and reliable electrical outlet.
5. The availability of student seats in the smart classroom, Workbenches (Tables) and stools in the lab. (For 15 students).
6. The Lab must be in the ground Level with external wide entry and sufficient external space for car parking.
7. The Availability of Lab Technician.
8. The availability of basic Lab furniture (desk, chair, storage space whiteboard etc.).
9. The availability of firefighting equipment.

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Centers/Lab Information:

Smart Classroom information			
Classroom Location:	Building	Level	Room Number
	Engineering workshops	1st floor	-
Classroom Dimensions:	Length	Width	Height
	5.85 m	5.5 m	3 m
Total Area:	32.175 m^2		
Number of windows:	2		
Area of windows:	1.5m X 5.5m		
Number of electrical outlets:	4		
Type of lighting units:	Fluorescent		
Number of lighting Units:	9		
Number of entries:	1		
Available Furniture:	Two cabinets, two tables.		

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Lab Information			
Lab Location:	Building	Level	Room Number
	Engineering workshops	1st floor	-
Lab Dimensions:	Length	Width	Height
	5.85 m	5.5 m	3 m
Total Area:	32.175 m^2		
Number of windows:	2		
Area of windows:	1.5m X 5.5m		
Number of electrical outlets:	4		
Type of lighting units:	Fluorescent		
Number of lighting Units:	9		
Number of entries:	1, an external wide entry and sufficient external space for car parking in the ground floor is available.		
Available Furniture:	Two cabinets, two tables.		
Lab Technician Information			
Name:	Otba Aloran		
Job Title (Position)	Lab Technician		
Contact info.	Mobile	Email	
	+962791156528		

Centers/Lab Photos:

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Annexe 2

ECO-CAR Equipment List (Specification).

ERASMUS+ Programme – ECO-CAR Project number: 618509-EPP-1-2020-1-JO-EPPKA2-CBHE-JP
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ERASMUS+ PROGRAMME

Project Number: 618509-EPP-1-2020-1-JO-EPPKA2-CBHE-JP

ECO-CAR:

Vocational Training Diploma on Electrical and Hybrid Vehicles

Equipment list

Al-Balqa Applied University

7/5/2021

Table of Contents

Jordanian Partners Equipment List

#	Item	Quantity	Unit Price	Total Price
1	Hybrid and electric vehicle training unit:			
1.1	Hybrid vehicle training unit	7	22000	154000
1.2	Electric vehicle training unit	7	17000	119000
2	Electric Service Gloves	160 Pair	15	2400
3	Insulation and Electrical Resistance Meter (Automotive)	40 (28)	100	4000
4	Personal Protective Equipment (PPE) for diagnostic work on high-voltage vehicles (helmet, insulating mat, Face protection screen)			
4.1	Electrical Safety helmet	160	20	3200
4.2	Face shield	160	20	3200
4.3	Electrical insulation rubber mats	40(160)	100	4000
5	Two-pole voltage tester	40	100	4000
6	Charging Station for PEV and PHEV	8	1500	1200
7	Diagnostic System include PC, software, display screen	7	2000	14000
8	Emission measurement Equipment	8	2000	16000
9	High precision automotive measurement units	8	1000	8000
10	Personal Computer	8	800	6400
11	Smart Classroom setup for teaching the diploma courses (Smart board with data show) and personal PC's	8	2500	20000
12	Server for project website and virtual learning platform	1(8)	3000	3000

Applied Science Private University equipment List

#	Item	Quantity	Unit Price	Total Price
1	Nissan LEAF 2013 vehicle	1	6000	6000
2	Ford fusion Batteries energy Li-Ion 84 //Plug-in Vehicle with On-board Charger OBC	1	250	250
3	Nissan LEAF Li-ion	1	400	400
4	On-board Charger	1	100	100
5	Spark-Plugs Tester	1	107	107
6	Car EVAP Smoke Machine Fuel Pipe Smoke Leak Detector Emissions Tester Diagnostic	1	110	110
7	Freon Leak Detector	1	29	29
8	Cooling system test set	1	50	50
9	Tire Pressure Monitoring System (TPMS) Tools MaxiTpms ts508	1	213	213
10	Hyundai Sonata Batteries Li-Ion Polymer Type	1	142	142
11	Toyota Prius Battery 2010	2	60	120
12	Tahoe Chevrolet battery	2	180	360
13	clamp meter	1	71	71
14	Four-legged hydraulic crane (4 tons)	1	1200	1200
15	Insulation and Electrical Resistance Meter (Automotive)	1	100	100
16	Nissan LEAF 2011 vehicle cut-away	1	1800	1800

Specification of Jordanian Partners equipment list

1- Hybrid and electric vehicle training unit with the following specification:

Description: Computer-based training and experimentation system including engine, battery, inverter, generator, motor, and electronic transmission assembly. It will be used for education and training in the areas of basic and advanced Hybrid and Electric Vehicles.

1-1 Hybrid vehicle training unit with the following specification:
Description: Performable series-parallel hybrid power system (including engine, battery, inverter, generator, motor, and electronic transmission assembly), fully demonstrating the structure and working process of series-parallel hybrid power system.

Quantity: 8
Unit Price: 22000 JD
Total Price: 176000 JD

Component	Minimum Requirements
Communication:	High-speed communication bus integrated into the Electrical Vehicle system control. Communication between Electrical Vehicle charging system, battery and inverter.
Diagnostics:	diagnosis socket that enables self-diagnostic functions as fault code reading, fault code clearing and data flow reading on the electronic control systems of engine, automatic transmission, hybrid power unit and power supply.
Maintenance:	Real service maintenance plug.
Display:	LCD Display.
Interface:	RJ45 network interface and RS-232 serial port interface.
measurement interface:	4-channel oscilloscope. Multimeter.
Features:	Experiment trolley. Engine, battery, inverter, generator, motor, and electronic transmission. Detection Terminals. Fault simulation. Charge system. Operating instructions. Interactive training course.
Practical training contents:	Servicing work. Repair work. Diagnostics work.
power supply:	12 V DC supply or AC 230 V, 50 Hz
Warranty:	One years min. on site Parts and Labor.

1-2 Electric vehicle training unit with the following specification:

Description: physical Battery Electric Vehicle driving system that demonstrate the structure and working process of Electric Vehicle driving system. It will be used for education and training on battery electric vehicle driving system.

Quantity: 8
Unit Price: 17000 JD
Total Price: 136000 JD

Component	Minimum Requirements
Communication:	High-speed communication bus integrated into the Electrical Vehicle system control. Communication between Electrical Vehicle charging system, battery and inverter.
Diagnostics:	Real fault codes for electrical vehicles system, electric motor, and inverter (all diagnostics cases).
Maintenance:	Real service maintenance plug.
Display:	LCD Display.
Interface:	RJ45 network interface and RS-232 serial port interface.
measurement interface:	4-channel oscilloscope. Multimeter.
Features:	Experiment trolley. Motor-generator units with mechanical interface. multiple Measurement sockets. fault simulation. Charge system. Operating instructions. Interactive training course.
Practical training contents:	Servicing work. Repair work. Diagnostics work.
power supply:	12 V DC supply or AC 230 V, 50 Hz
Warranty:	One years min. on site Parts and Labor.

2- Electric Service Gloves

Quantity: 160 Pair
Unit Price: 15 JD each
Total Price: 2400 JD

Component	Minimum requirements
Electrical Insulating Gloves:	with dielectric and mechanical protection
insulation protection:	up to 1000 VAC and 1500 VDC

3- Insulation and Electrical Resistance Meter (Automotive)

Quantity: 40
Unit Price: 100 JD
Total Price: 4000 JD

Component	Minimum requirements
Voltage Range	50V-1000V
Resistance Measurement:	200 mA test current.
Features:	Determination of polarization index (PI) and dielectric absorption ratio (DAR). Selectable limits for successful tests, and test/external voltages. Switchable test probes for initiation of test procedures. Internal memory for 100 measurement values per measurement function True RMS voltage measurement.
Warranty:	One years min. on site Parts and Labor.

4- Personal Protective Equipment (PPE) for diagnostic work on high-voltage vehicles (helmet, insulating mat, Face protection screen)

Quantity:
160 Electrical Safety helmet,
160 Face shield,
40 Electrical insulation rubber mats
Unit Price:
Electrical Safety helmet 20 JD,
Face shield 20 JD,
Electrical insulation rubber mats 100 JD
Total Price: 3200+3200+4000= 10400 JD

Component	Minimum Requirements
• **Electrical Safety helmet**	
Chin Strap:	15 mm width and 55 cm long with buckle for adjustability.
Shell:	Hard & smoothly finished HDPE/PVC material.
• **Electrical insulation rubber mat**	
Thickness:	3 mm.
Maximum voltage:	1,000 V.
Size	Full Roll.
• **Face shield**	
Thickness:	0.5 mm with anti-scratch and Anti-fog coating.

5- Two-pole voltage tester

Quantity: 40
Unit Price: 100 JD
Total Price: 4000 JD

Component	Minimum Requirements
Voltage range:	12 - 690 V/AC/DC.
Frequency range:	40 - 400 Hz.
Features:	Audible signal, LED lights, Digital display.
Warranty:	One years min. on site Parts and Labor.

6- Charging Station for PEV and PHEV

Quantity: 8
Unit Price: 1500 JD
Total Price: 1200 JD

Component	Minimum Requirements
Charge socket:	Charge socket type 2 for Mode 3 – charging mode with actuator and safety cover.
Max. charge current:	10 A.
Inputs and outputs:	4-mm safety sockets.
Internal auxiliary voltage:	24V DC / 1A.
Voltage supply:	230V AC/50-60Hz.
Warranty:	One years min. on site Parts and Labor.

7- Diagnostic System include PC, software, display screen.

Description: Computer-based diagnosis instrument system that consists of software and vehicle interface module. It will be used for education and training purpose in the areas of basic and advanced Hybrid and Electric Vehicles

Quantity: 8
Unit Price: 2000 JD
Total Price: 16000 JD

Component	Minimum Requirements
Interfaces:	USB, Bluetooth Class 1, RS 232 (AK Protocol).
Features:	Diagnostics for all fault codes in Electric and Hybrid vehicles system.
Display	21” display screen.
Vehicle Interface:	OBD-plug (16-pin).
Vehicle Protocols:	(AU)/(E)OBD/OBDII conform protocols All vehicle manufacturers.

Software:	Automotive Data Base: All Data software with license
Power Supply:	220V AC, 50Hz.
Warranty:	One years min. on site Parts and Labor.

8- Emission measurement Equipment

Quantity: 8
Unit Price: 2000 JD
Total Price: 16000 JD

Component	Minimum Requirements
Interfaces:	USB, Bluetooth Class 1, RS 232 (AK Protocol).
Measurements:	CO, CO2, HC O2, Lamda, RPM, and temperature.
Vehicle Interface:	OBD-plug (16-pin).
Vehicle Protocols:	(AU)/(E)OBD/OBDII conform protocols All vehicle manufacturers.
Power Supply:	220V AC, 50Hz.
Warranty:	One years min. on site Parts and Labor.

9- High precision automotive measurement units

Quantity: 8
Unit Price: 1000 JD
Total Price: 8000JD

Component	Minimum Requirements
Interfaces:	USB, Bluetooth Class 1, RS 232 (AK Protocol).
Features:	complete vehicle scan. Automatic motor code identification. Real-time function and data filtering. Read and delete error codes. Service reset.
Vehicle Interface:	OBD-plug (16-pin), Diagnostics cables, Diagnostics interface
Vehicle Protocols:	(AU)/(E)OBD/OBDII conform protocols All vehicle manufacturers.
Power Supply:	220V AC, 50Hz.
Warranty:	One years min. on site Parts and Labor.

10- Personal Computer

Quantity: 8
Unit Price: 800 JD
Total Price: 6400 JD

Component	Minimum requirements
Model:	well-known Brand.
Manufacturing Requirements:	Main system unit, monitor, mouse, and keyboard must carry the same brand name.
Processor:	Intel core i7, 9th generation, Up to 4.0 GHz.
Memory:	8 GB DDR4, upgradable.
Storage:	256 GB SSD Hard Drive+1Tera SATA.
USB ports:	6 ports, including 2 USB3 ports.
Expansion slots:	1xPCIe x16.
Network interface:	Integrated 10/100/1000 Mbps LAN, UTP port.
Graphics:	Integrated Intel High Definition.
Pointing device type:	USB mouse, optical, wheel with mouse pad.
Keyboard:	USB A/L keyboard.
Monitor:	21“LED with VGA , HDMI.
CD-ROM:	Super drive DVD R/W.
PC video output:	VGA, HDMI / DP.
Audio:	High definition, integrated sound system.
Power:	220v, 50Hz AC power with MK cable.
Operating system:	Windows 10 licensed.
Drivers, Utilities & Documentation:	All drivers that support the system, Original documentation, manuals, setup utilities for installation and usage. Should be provided as sent by manufacturer.
Warranty:	One years min. on site Parts and Labor.

11- Smart Classroom setup for teaching the diploma courses (Smart board with data show) and personal PC's

Quantity: 8
Unit Price: 2500 JD
Total Price: 20000 JD

Component	Minimum requirements
Smart Board	
size:	**80”** diagonal
Touch and control:	Finger or any object
Input Method	Infrared
Electronic Free Surface:	Durable electronic free screen
Reflection & Glare	Very Low Reflection, Very Low Glare
Surface	Hard Surface
Handwriting Recognition	More than 20 languages including Arabic and English.
Object management	allow to create, move, and resize all your objects to present a changing situation.
Connectivity	USB with supplied 10m USB cable; wireless
Training	Training and Knowledge transfer on site
Short lens data show (Projector)	
Brightness:	Min. 3000 lumens.
Native resolution:	Min. WXGA 1280 × 800.
Aspect ratio:	4:3 with support for 16:9, 16:10 and 5:4 with scaling.
Display technology:	DLP® technology by Texas Instruments™, providing Brilliant Color™ performance and quality Gamma 2.2 correction with Bright Room, Dark Room, sRGB, User and SMART Presentation modes.
Lamp life:	3000 hours in Standard mode. 4000 hours in Economy mode.
Integrated loudspeaker:	15 W rms.
Contrast ratio:	10000:1
Video system compatibility:	HDTV (720p and 1080p) video system compatibility and HD Ready (HDMI technology and 720p) available, NTSC, NTSC 4:43, PAL, PAL-N, PAL-M and SECAM (480i /p and 576i /p).
Video interface compatibility:	HDCP compliant HDMI, Composite, VESA® RGB.
External management:	IR Remote, RS232 control port.
Conference Camera	
Total Zoom 8X or more.	
Full HD 1080p.	
Full duplex speakerphone and noise & Echo -cancelling microphone.	
Plug and Play USB connectivity to Windows, Mac.	
Compatibility with Skype, Google Hangouts.	

Remote control and base button control options.	
Document Camera	
Pixel count	> 3MP
Digital Zoom	> 8X
Framerate	~ 30fps
Focus	Auto, Manual
Lighting	LED Light
OS Compatibility	Microsoft Windows Vista, 7, 8, 8.1, 10, Mac OS X 10.9
Connectivity	USB
Warranty:	One Years min. on site Parts and Labor.

12- Server for project website and virtual learning platform

Description: High quality brand name USA or ECC or Japan with the following minimum specifications.

Quantity: 1
Unit Price: 3000 JD
Total Price: 3000 JD

Component	**Minimum requirements**
Processor:	Two Intel Xeon silver 4110 8 core 2.1GHz, 11MB Cache.
Memory:	64GB ECC DDR4, with memory protection expandable.
Storages:	4 X 600 G SAS HOT Plug 15Krpm RAID Controller support RAID (0,1,10 and 5) (hardware RAID) with 1 GB Cache.
Controllers:	2 x 1 GBit Ethernet Port, 2 x 10Gb/s Ethernet Port.
Expansion and I/O:	Min. 4 X USB, serial, VGA Min. 6 PCI-E Slots.
Power and cooling:	Fully used & redundant Hot-Pluggable power supplies 220-250 VAC/50Hz compatible with Jordan electricity standard. Redundant Hot pluggable cooling Fans Enough cooling to enable working continuously (24/7) without overheating.
Management:	Full Remote Management features.
Certified and/ or support:	Microsoft windows server 2012 & Microsoft windows server 2016. Microsoft Hyper-V server 2012 / VMware vSphere latest. RedHat Enterprise Linux.
Others:	All Drivers that support the system should be provided as sent by manufacturer Original server management software, for installation and configuration.
Registered Trademark:	Must be specified.
Warranty:	Three Years min. on site Parts and Labor.

Specification of Applied Science Private University equipment List

No.	Name	Specifications	No. of Units	Unit Price JOD	Total Price JOD
1	**Nissan LEAF 2013 vehicle**	S or SV model and have a HV battery with 7 Bar Capacity Max	1	6000	6000
2	**Ford fusion Batteries energy Li-Ion 84 //Plug-in Vehicle with On-board Charger OBC**	310 volts Li-ion Type with all battery pack parts like SMR SP Busbars BMS Etc.	1	250	250
3	**Nissan LEAF Li-ion**	360 volts Li-ion Type with all battery pack parts like SMR SP Busbars BMS Etc. /// **Not Working Or Low Capacity**	1	400	400
4	**On-board Charger**	FOR NISSAN LEAF 2011 3.3KW	1	100	100
5	**Spark-Plugs Tester**	The Detector could tell the good spark plugs from the bad by the strength of the spark, it is a high-voltage detector, and it has a variety of ignition speed from 1000 to 6000.	1	107	107
6	**Car EVAP Smoke Machine Fuel Pipe Smoke Leak Detector Emissions Tester Diagnostic**	smoke Leak Detector type AUTOOL SDT-106	1	110	110
7	**Freon Leak Detector**	Sensor with maximum sensitivity of 6gr/yr., the Freon leak detector detects all kinds of halogen refrigerants including but not limited to CFCs e.g. R11, R12, R13, R113, R114, R500, R502, R503 etc.	1	29	29
8	**Cooling system test set**	Sonic Equipment GmbH	1	50	50
9	**Tire Pressure Monitoring System (TPMS) Tools MaxiTpms ts508**	TPMS is an electronic system designed to monitor the air pressure inside the pneumatic tires on various types of	1	213	213

		vehicles. **The MaxiTPMS TS508** is a new generation TPMS diagnostic & service tool specially designed to activate all known TPMS sensors, read TPMS sensor status, check TPMS system health condition, program MX-sensors and conduct TPMS relearn. With Quick Mode and Advanced Mode options, the starting TPMS kit with one tool and 8 sensors.			
10	**Hyundai Sonata Batteries Li-Ion Polymer Type**	274 volts with all battery pack parts like SMR SP Busbars BMS Etc.	1	142	142
11	**Toyota Prius Battery 2010**	201.6 volts NIMH Type with all battery pack parts like SMR SP Busbars BMS Etc.	2	60	120
12	**Tahoe Chevrolet battery**	288 volts NIMH Type with all battery pack parts like SMR SP Busbars BMS Etc.	2	180	360
13	**clamp meter**	fluke	1	71	71
14	**Four-legged hydraulic crane (4 tons)**	Launch TET235SCA(U), 4-ton hydraulic crane capacity load is 450 kg, vertical	1	1200	1200
15	**Insulation and Electrical Resistance Meter (Automotive)**	To Charge socket type 2 for Mode 3 – charging mode with actuator and safety cover. **Max charge current Adjustable [8-32 A]**	1	100	100
16	**Nissan LEAF 2011 vehicle cut-away**	With all parts inside NOT WORKING	1	1800	1800

Annexe 3

Equipment List for Jordan University.

ERASMUS+ Programme – ECO-CAR Project number: 618509-EPP-1-2020-1-JO-EPPKA2-CBHE-JP
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Equipment List for Jordan University (UJ)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
1.2 *	**Electric vehicle training unit**	FXB-X04317 BEV simulator components are real parts as in the vehicle	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
7	**Diagnostic System include PC, software, display screen**	Lenovo + VCI + ALL DATA software	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Secondary Bid

Unit #	Equipment	Model	Quantity
10	**Personal Computer**		1
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1
12	**Server for project website and virtual learning platform**		1

Equipment List for Jordan University of Science and Technology (JUST)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
1.2 *	**Electric vehicle training unit**	FXB-X04317 BEV simulator components are real parts as in the vehicle	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
7	**Diagnostic System include PC, software, display screen**	Lenovo + VCI + ALL DATA software	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Secondary Bid

Unit #	Equipment	Model	Quantity
10	**Personal Computer**		1
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1

Equipment List for Al-Balqa Applied University (BAU)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
1.2 *	**Electric vehicle training unit**	FXB-X04317 BEV simulator components are real parts as in the vehicle	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
7	**Diagnostic System include PC, software, display screen**	Lenovo + VCI + ALL DATA software	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Secondary Bid

Unit #	Equipment	Model	Quantity
10	**Personal Computer**		1
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1

Equipment List for Mutah University (MU)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
1.2 *	**Electric vehicle training unit**	FXB-X04317 BEV simulator components are real parts as in the vehicle	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
7	**Diagnostic System include PC, software, display screen**	Lenovo + VCI + ALL DATA software	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Secondary Bid

Unit #	Equipment	Model	Quantity
10	**Personal Computer**		1
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1

Equipment List for Tafelah Technical University (TTU)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
1.2 *	**Electric vehicle training unit**	FXB-X04317 BEV simulator components are real parts as in the vehicle	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
7	**Diagnostic System include PC, software, display screen**	Lenovo + VCI + ALL DATA software	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Secondary Bid

Unit #	Equipment	Model	Quantity
10	**Personal Computer**		1
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1

Equipment List for Al Hussein Technical University (HTU)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
7	**Diagnostic System include PC, software, display screen**	Lenovo + VCI + ALL DATA software	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Secondary Bid

Unit #	Equipment	Model	Quantity
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1

Equipment List for Al-Zaytoonah University (ZU)

Main Bid

Unit #	Equipment	Model	Quantity
1.1 *	**Hybrid vehicle training unit**	FXB-A05004 Toyota Corolla or Toyota Prius	1
2	**Electric Service Gloves**	BAOHUA	20
3	**Insulation and Electrical Resistance Meter (Automotive)**	Grand Paw	5
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1

Equipment List for Applied Science Private University (ASU)

Main Bid

Unit #	Equipment	Model	Quantity
2	**Electric Service Gloves**	BAOHUA	20
4	**Personal Protective Equipment (PPE)**		
4.1	**Electrical Safety helmet**	Grand Paw	20
4.2	**Face shield**	Grand Paw	20
4.3	**Electrical insulation rubber mats**	BAOHUA	5
5	**Two-pole voltage tester**	Grand Paw	5
6	**Charging Station for PEV and PHEV**	FY-TECH	1
8	**Emission measurement Equipment**	Grand Paw	1
9	**High precision automotive measurement units**	Autel maxi pro 9.7 inch	1
13	**Nissan LEAF 2013 vehicle**	Nissan LEAF 2013	1
14	**Ford fusion Batteries energy Li-Ion 84 //Plug-in Vehicle with On-board Charger OBC**	Ford fusion	1
15	**Nissan LEAF Li-ion**	Nissan LEAF	1
16	**On-board Charger**	China	1
19	**Freon Leak Detector**	China	1
20	**Cooling system test set**	China	1
21	**Tire Pressure Monitoring System (TPMS) Tools MaxiTpms ts508**	Foxwell	1
22	**Hyundai Sonata Batteries Li-Ion Polymer Type**	Hyundai Sonata	1

23	**Toyota Prius Battery 2010**	Toyota Prius	1
24	**Tahoe Chevrolet battery**	Tahoe	1
25	**clamp meter**	BAOHUA	1
26	**Four-legged hydraulic crane (4 tons)**	LAUNCH	1
27	**Insulation and Electrical Resistance Meter (Automotive)**	BAOHUA	1
28	**Nissan LEAF 2011 vehicle cut-away**	Nissan LEAF 2011	1

Secondary Bid

Unit #	Equipment	Model	Quantity
11	**Smart Classroom setup for teaching the diploma courses (Smart board, Smart TV, data show, camera, microphone) and personal Laptop**		1

Annexe 4

Gasoline-Electricity Hybrid Power System Training Bench (Toyota Corolla 1.8L).

ERASMUS+ Programme – ECO-CAR Project number: 618509-EPP-1-2020-1-JO-EPPKA2-CBHE-JP
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ECO-CAR
Vocational Training Diploma on Electrical and Hybrid Vehicles

Gasoline-Electricity Hybrid Power System Training Bench

(Toyota Corolla 1.8L)

Author(s)	Dr. Ma'moun Smadi and Prof. Rebhi Damseh
Organization Name(s)	Al-Balqa Applied University (BAU)
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Task Number & Title	Task 4.3: Prepare the experiment manual according to the course outline (cluster 9) and the received equipment.
WP Leader	Al-Balqa Applied University - Jordan
Co-Leaders	The University of Jordan (UJ), Jordan University of Science and Technology (JUST) & National Technical University of Athens (NTUA)
Number of pages	**70**

Gasoline-Electricity Hybrid Power System Training Bench

(Toyota Corolla 1.8L)

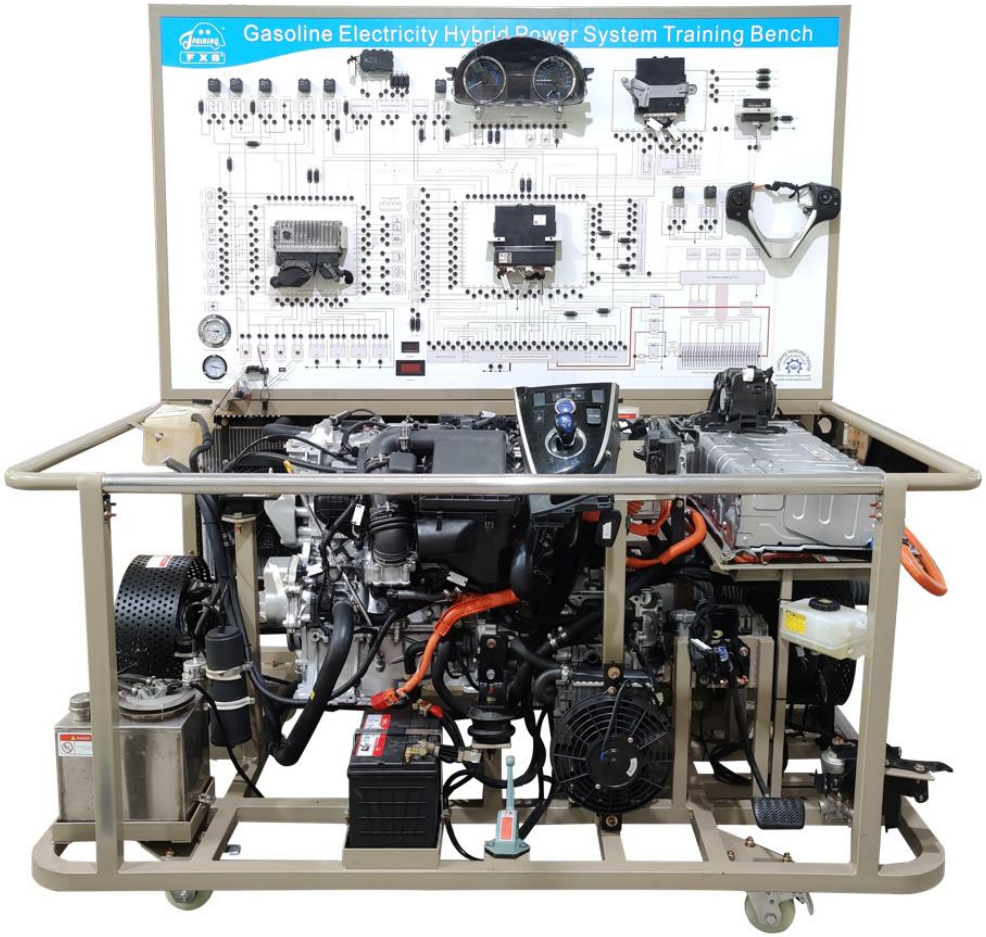


Table of Content

1. Introduction

The Training unit is based on the Toyota Corolla 1.8L's gasoline and electricity hybrid power engine to simulate engine startup, speedup, slowdown and other actions with the aim of illustrating the structure and working principle of gasoline and electricity hybrid power engine.

1.2. Features

Complete and original hybrid power system from Toyota Corolla vehicle, all systems work properly as in hybrid vehicle.

Never fade color circuit diagram and working principal diagram are painted on the panel. Trainees can learn and analyze the working principle of hybrid power control system by referencing the diagram and the real components.

The training bench is installed with dashboard to illustrate changes of parameters in the power transmission process, speed, fuel pressure light and electronic control system fault indicating light.

Detection terminals are installed on panel, Operators can use multimeter and oscilloscope to detect electrical signals (Such as resistance, voltage, current, frequency signals) from pins of of various sensors & actuators, engine control unit and hybrid power control unit.

The training bench is installed with OBD II diagnosis socket, which can connect to automobile decoder to read fault codes, clears fault codes, and reads data stream from the engine and hybrid power control system.

A throttle controller is installed on the bench to accelerate and slowdown.

A master power switch, coolant tank protector, flywheel protector, among other protection devices are installed on the training bench.

Lockable casters are installed to make it lockable and moveable.

Equipped with wireless fault-setting and appraisal system, teachers set faults by tablet PC then ask students to detect and find the fault. It’s helpful for teachers to know about students’ learning status, also can improve students’ skills in troubleshooting. Total 16 faults.

Experiment #1: Safety and Operational Steps

1.1 Objectives:

1. To understand safety procedures when dealing with hybrid vehicles.
2. To learn the operational steps for the hybrid-training unit.
3. To be familiar with Fault-setting Tablet.

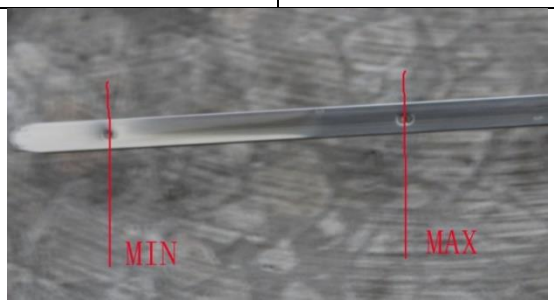
1.2 Safety

1. Operation on the engine: Work conducted on experimental bench should be carried out with good ventilation and if possible, the engine exhaust gas of the engine should be vented out of the lab through special pipe.
2. Examine for leakage of fuel tank and fuel lines before starting the engine. During the operation of the engine, trainees should keep an appropriate distance from experimental bench. Any intention of putting hands close to running component is strictly forbidden.
3. During the operation of the engine, it is forbidden to touch the high-temperature parts, such as coolant pipes or exhaust pipes (the surface temperature is high when the engine is running, beware of scalding).
4. Do not make reverse connection of positive and negative poles of battery to avoid fluid spillage from battery.
5. Do not touch the high-voltage components and high-voltage cables to prevent the risk of electric shock.
6. When removing the service plug, do not touch the connector pins with hands or tools to prevent the risk of electric shock.
7. When the fault or fault code is existed, please try to use the tablet to clear the fault, or use the diagnostic tool to clear the fault code, or turn off the main power switch for 30 seconds and then restart.
8. Before starting the engine, check whether the coolant level and oil level is within the standard range.
9. Before using the experimental bench, check whether engine oil and coolant conform to the standard range as shown in Fig 1 below.

(For safety, coolant and fuel are not added into the experimental bench in transportation process. Antifreeze and fuel shall be configured based on the specific environment at various regions.)

Engine coolant

Hybrid system coolent



Engine oil measurement

10. Don’t open cover of the coolant tank when the engine is running to avoid being scalded.
11. Don’t switch off power supply when the engine is running to avoid damage of electric components.

12. To remove the storage battery, it is necessary to disconnect power supply; remove the cathode of the battery and then the anode.
13. High-voltage (HV) battery is adopted, with voltage up to 500 V. Please be careful for safety electricity utilization.
14. To disconnect the sensor and the actuator from the harness connector, please close the ignition switch first and then disconnect the harness connector.
15. The Exhaust pie is hot when the engine is working. Don’t touch it. Otherwise, you may be scalded.
16. While the engine is under high temperature, close attention should be paid to the normal running of cooling fan. If it is not running, shut the engine off and check and maintain

relevant circuits of cooling fan. In case of scalding, do not touch the water pipe and exhaust pipe when the engine is in high temperature.

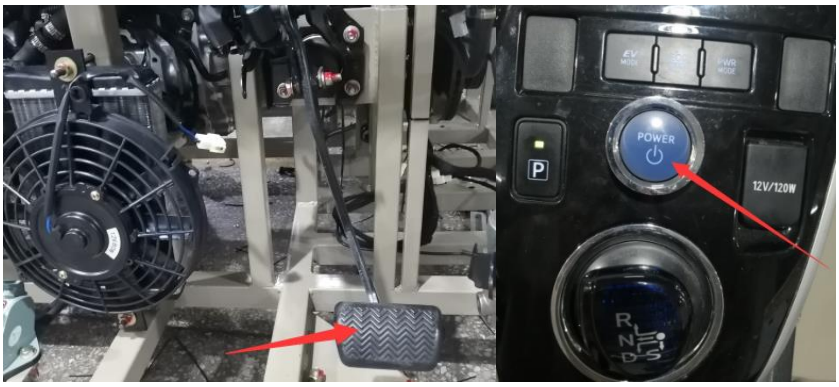
17. Pay attention to the positive and negative polarities of the accumulator while connecting and checking. Turn off the accumulator while not using the bench and keep the bench from water and dust.
18. Maintain relevant components of the engine regularly and activate the engine for at least one hour a week.

1.3 Operation Steps

1. Before experimental operation on the experimental bench, please check whether the oil level and coolant level of the engine and the oil level of automatic transmission meet standard parameters; check whether the moving parts of the engine and the automatic transmission operate with safety and liability. After confirming all the items are free from errors, battery main switch can be turned on.
2. The trainees can learn with the objects on the experimental bench in comparison with circuit diagram on the plate and try to master the operating principles of the fuel-electric hybrid power engine and the air conditioning system.
4. Turn on the main power switch. The voltmeter shows battery voltage. As shown in figure below

5. Turn on the one-button start switch to ON position, and the dashboard lights up.

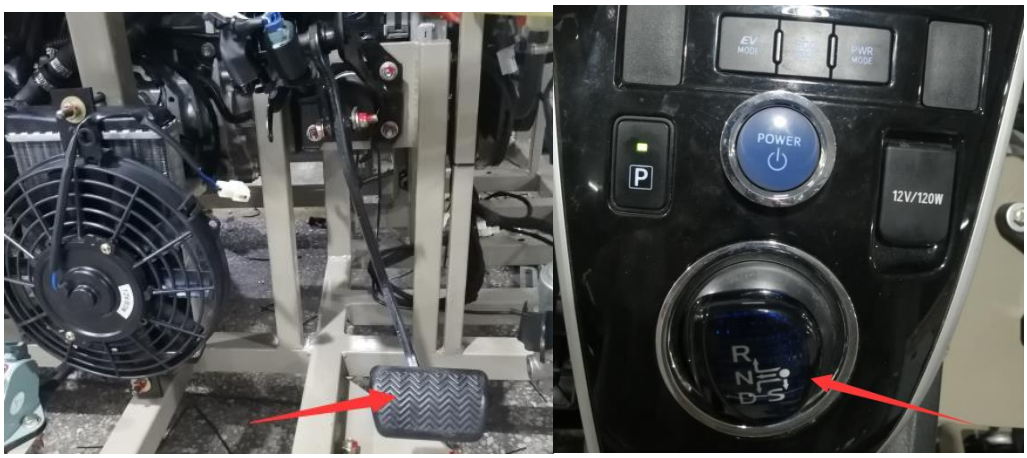
6. Press the brake pedal and press the one-button start switch again. At this time, the power system of the equipment is in the starting state, and the READY indicator is on.



7. The fault indicators of airbag, power steering, etc light up on dashboard, it's normal, because these systems are not involved in the gasoline-electric hybrid power system.

8. The vehicle will put into gear and drive only when "READY" light of the instrument is on. Press the brake pedal and shift the gear to D. The dashboard displays gear D, and it has vehicle speed display, indicating that the vehicle is in forward state.

In case of Gear D and in idling, the HV battery provides power to drive the motor to run when the electric quantity of the HV battery is sufficient, and the engine provides power to drive the motor to run when the electric quantity of the HV battery is insufficient. For accelerated running, stamp the accelerator pedal to increase the rotating speed and loads increase and at the time engine and HV battery drive the motor together to meet running of high loads. For slow-down, the engine stops and wheels drive motor to charge the HV battery; the state is called energy recycling.



9. Adjust the multi-function button and observe the dashboard, which can display the electric operation mode, hybrid operation mode and charging mode of the vehicle.

10. Press the brake pedal and shift the gear to R. The dashboard displays gear R, and it has vehicle speed display, indicating that the vehicle is in reverse state.

11. Press the brake pedal and shift the gear to N, then shift to P, and turn the one-button start switch to OFF.

12. Check various signal parameters and wave forms while running the engine: trainees may use multi-meter, oscilloscope and other equipment to detect circuit of the bench, thus learning circuit detection of automobile. Use multi-meter to detect computer terminals and circuit terminal components of motor on the bench panel, such as various sensors and actuators for voltage, current, resistance, frequency and other signal parameters, and use

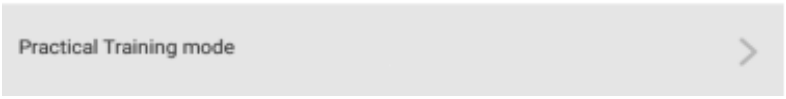
oscilloscope to measure circuit wave-forms of various sensors and actuators, and high-voltage wave form of the ignition part; thus learning engine circuit detection. Compare results with those in relevant maintenance manual to see whether those parameters and wave-forms are up to the standard.

13. Instruction of Fault-setting Tablet.

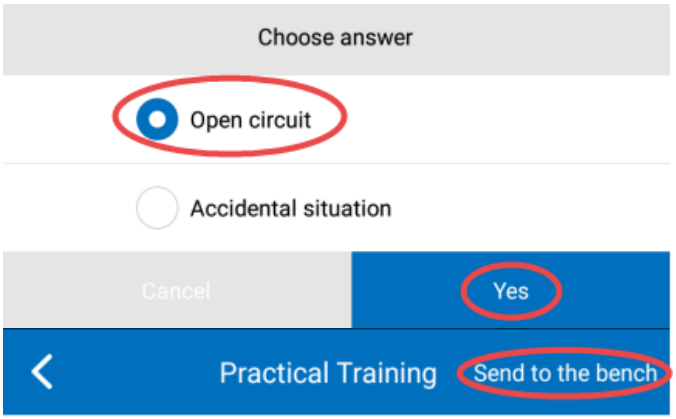
(1) Connect the tablet with equipment by WIFI, the WIFI name is "**Hybrid Bench**".

(2) Open the FXB fault-setting APP, then input IP: 10.10.100.254, Password: 123456 to login.

(3) Click "Practical training mode" to choose the fault which you want to set in the list. Total 16 faults.



(4) Choose one or more faults from the list, then choose the type "Open circuit" → "Yes" → "Send to the bench".



14. After finish normal use, fault setting and fault elimination function, please clear all faults, turn off the one-button start switch and main power switch.

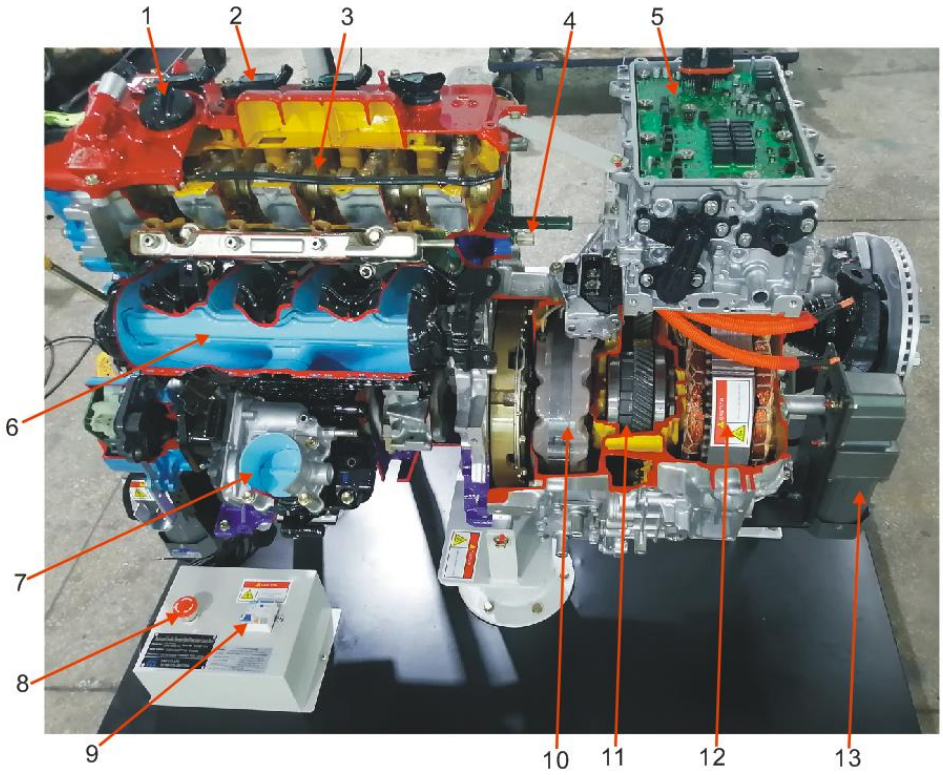
Experiment #2: Hybrid Power System Components

2.1 Objectives:

1. To get familiar with various Hybrid Power System Components
1. To get familiar with various sensors in Hybrid Power System Components

2.2 Main Components

The following pictures of cutaway components are provided to help students know the internal structure.

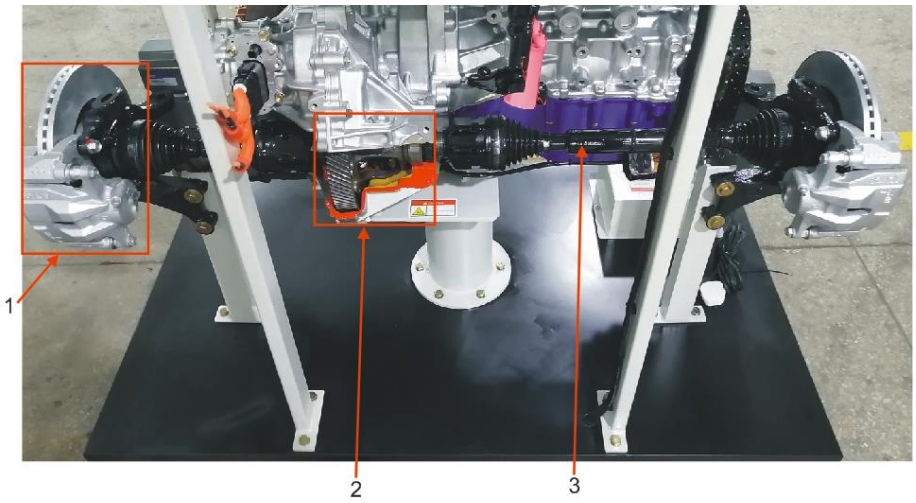


1- Oil filling port 2- Ignition coil 3- Air-intake side camshaft

4- Coolant temperature sensor 5- Inverter 6- Air-intake manifold

7- Electronic throttle 8- Emergency switch 9- Power switch

10- MG1 11- Planetary gear mechanism 12- MG2 13- Driving motor

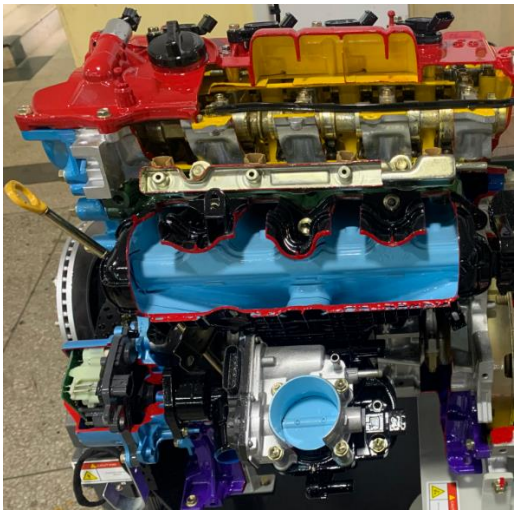


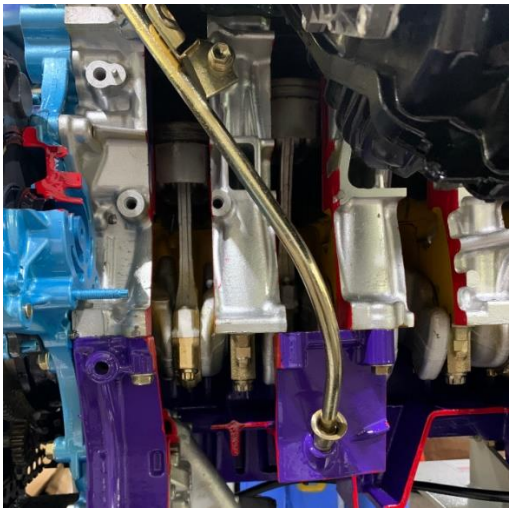
1- Disc brake 2- Main reducer and differential 3- Half shaft

2.3 Structure of Hybrid Power System

The hybrid power system is mainly composed of the following components:

1. Gasoline engine: It supplies power for the vehicle.



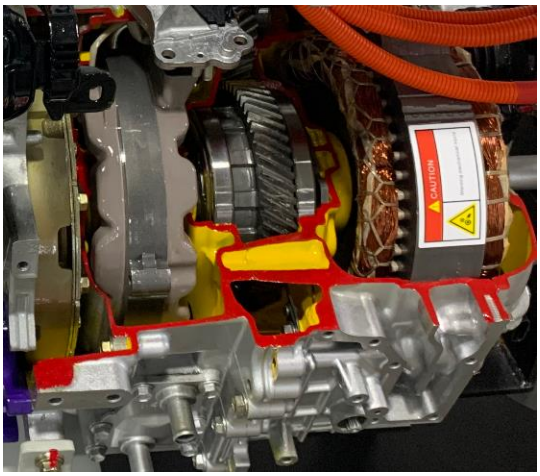


2. Hybrid power transaxle

MG1: MG1 is rotated by the engine to generate high-voltage electricity to charge the HV battery. It also effectively controls the CVT function of transaxle, and acts as starter to start the engine.

MG2: MG2 is driven by electric from MG1 or HV battery. The generated power is used to provide driving power at low speed and auxiliary power at high speed. It can also provide power assistance for engine output when necessary, to help the vehicle obtain excellent dynamic performance. During deceleration, MG2 can generate electricity to recharge the HV battery (energy recovery).

Planetary gear set: The planetary gear set is a power distribution unit. It distributes the driving force of engine in an appropriate proportion to directly drive the vehicle and generator. MG1 is connected to the sun gear, MG2 is connected to the ring gear, and the engine output shaft is connected to the planet carrier. These components are used to combine power from the engine and MG2, and can be used for energy recovery (to charge the HV battery).

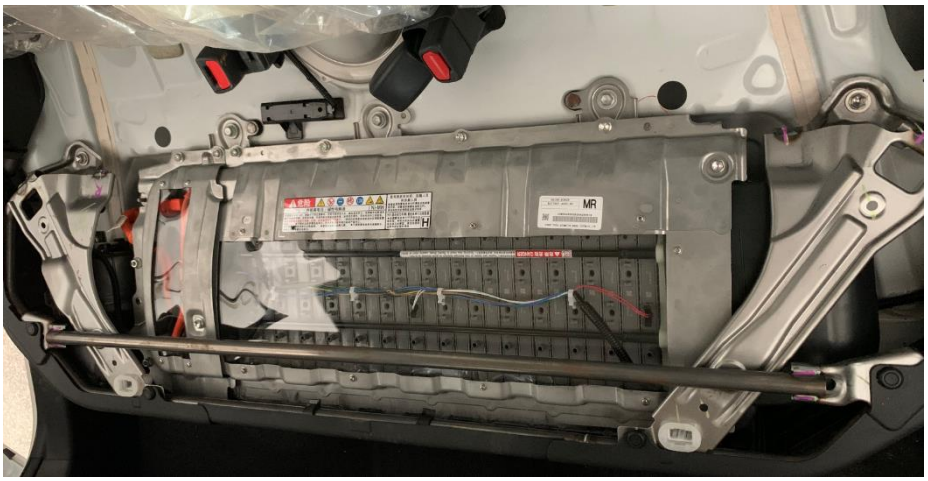


3. Inverter

The current between MG1, MG2 and HV battery is controlled by inverter. The inverter can convert high voltage DC (HV battery power) to AC (MG1 and MG2), and can rectify the high voltage AC from MG1 and MG2 to charge the HV battery.

4. HV battery

The battery stores the electric energy produced by MG2 during regenerative braking and the energy produced by MG1. The HV battery provides power to the MG2 during the vehicle's starting phase or when additional assistance is required.



5. Hybrid power ECU

It controls the power generation and electric motor driving during vehicle start, accelerate and brake.

2.4 Engine Control System

The hybrid system is equipped with Toyota 1.8L 8ZR high expansion rate cycle gasoline engine (Atkinson), using VVT-i intelligent variable valve timing control technology and ETCS-i intelligent electronic throttle control technology.

The electronic control gasoline engine is centered on the electronic control unit ECU, which uses various sensors installed on different parts of the engine to detect various operating parameters, then automatically selects the related ECU program according to these parameters, to ensure that the engine can obtain the best air-fuel ratio mixture and ignition advance angle in various operating conditions. It can realize the functions of start-up enrichment, warm-up enrichment, acceleration enrichment, deceleration dilution and automatic idle speed control, so that the engine can obtain good fuel economy and emissions.

2.5 Engine Sensors

The vehicle sensors are responsible for the collection and transmission of information. The ECU processes the information and sends commands to the actuators to implement electronic control. It can identify changes in the outside and changes in the engine system in time, and then control the work of its own system based on the changed information.

1. Coolant Temperature Sensor

The coolant temperature sensor is mainly used to detect the coolant temperature, and convert the temperature signal into an electric signal and input into the engine ECU, and the ECU corrects the fuel injection quantity and the ignition timing of the engine. The coolant temperature sensor is composed of NTC (negative temperature coefficient) thermistor. The change of coolant temperature will cause a change of the resistance value. The lower the coolant temperature, the larger the resistance value, and the higher the coolant temperature, the smaller the resistance value. The system will calculate the current coolant temperature according to the received voltage.

2. Crankshaft position sensor

The crankshaft position sensor collects the crankshaft rotation angle and engine speed signal and input them into the electronic control unit (ECU) to determine the injection sequence, injection timing, ignition sequence, ignition timing, and determine whether the engine has a fire according to the fluctuation of the crankshaft rotation angle detected by the signal.

3. Knock sensor

It mainly senses the vibration of the engine at various frequencies and converts the vibration signal into different voltage signals. When detonation occurs in the engine, the knock sensor will sense this change and generate a voltage signal with large amplitude. It detects the knock signal and inputs into the ECU as a feedback signal of the ignition advance angle to have the ignition advance angle corrected by the ECU and maintain it to be optimal, so as to achieve a closed-loop control of the ignition advance angle.

4. Oxygen sensor

The front oxygen sensor is configured to detect the oxygen content and air-fuel ratio in the exhaust pipe, convert the detection signal into an electrical signal, and feed back to the ECU. The ECU continuously corrects the injection time and quantity according to the oxygen sensor signal, maintaining the concentration of gas mixture within the desired range, enabling the engine to get the best concentration of gas mixture, thereby lowering the emission of harmful gases and reducing exhaust pollution.

The rear oxygen sensor feeds back the oxygen content behind the three-way catalytic converter to the ECU. The ECU compares the two sensor signals. Normally, the signal of the front oxygen sensor is higher than that of the rear oxygen sensor. If the signals of the two sensors are the same, it indicates that the three-way catalytic converter fails. Therefore, the rear oxygen sensor mainly detects whether the three-way catalytic converter is working properly.

5. Camshaft timing oil control valve

Through the camshaft timing oil control valve to adjust the different lift range of valve, thereby changing the intake air volume. When the intake pressure is same, the intake air volume is determined by the valve opening time.

6. Camshaft position sensor

The main purpose of the sensor is to detect the camshaft position and rotation angle to determine the compression top dead center of the No.1 cylinder piston. At the start of the engine, the engine ECU recognizes the position and stroke of piston in each cylinder and controls fuel injection sequence and ignition sequence based on the signals provided by the camshaft position sensor and the crankshaft position sensor.

Experiment #3: Working Modes of Hybrid Power System

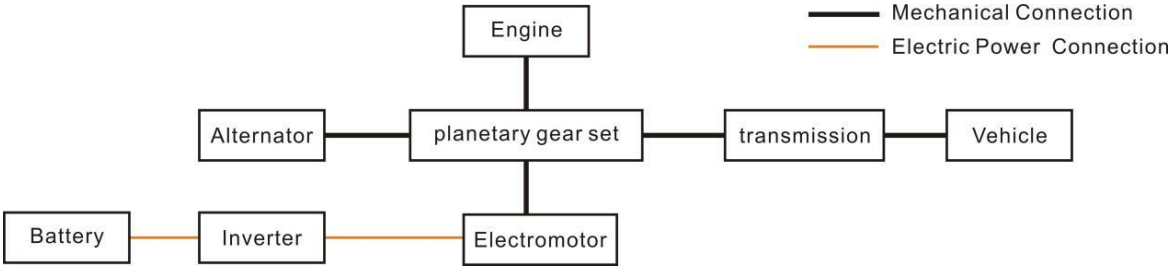
3.1 Objectives:

1. To learn the connection and control relationship in Hybrid Power System
2. To identify the different working Modes of Hybrid Power System.

3.2 Hybrid Power System

In order to achieve lower fuel consumption and emission requirements, the system only uses electric motor to drive the vehicle during start and low speed. After the vehicle is started by electric, the electric motor can provide power for the vehicle. When the vehicle is running at high speed, the engine is highly efficient. The power generated not only drives the wheels, but also drives the generator to charge the HV battery, keeping the amount of electric close to full. When decelerating and braking, the system uses the rotational force of wheels to drive the generator to generate electric, the generated electric is recycled into the HV battery. So as to achieve the purpose of energy saving and emission reduction.

The connection and control relationship of engine, transmission, electric motor (Electromotor), generator(Alternator), inverter, etc. is shown in the below picture:



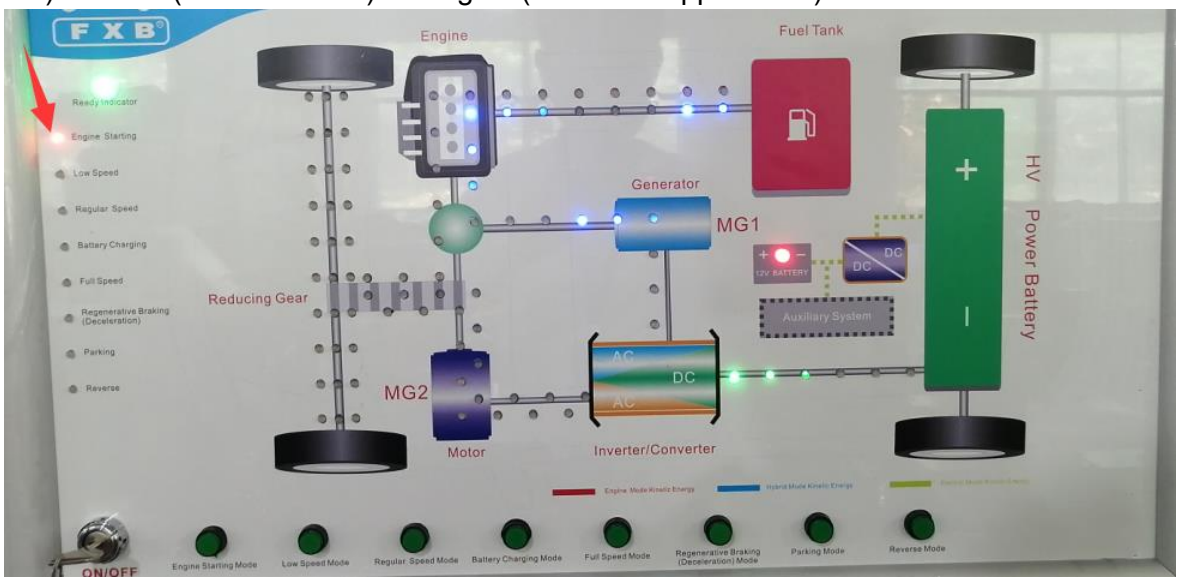
3.3 Working Modes of Hybrid Power System

The following pictures of simulated panel are provided for better explain the different working modes of hybrid power system.

1. Engine Starting Mode

Energy flow relationship:

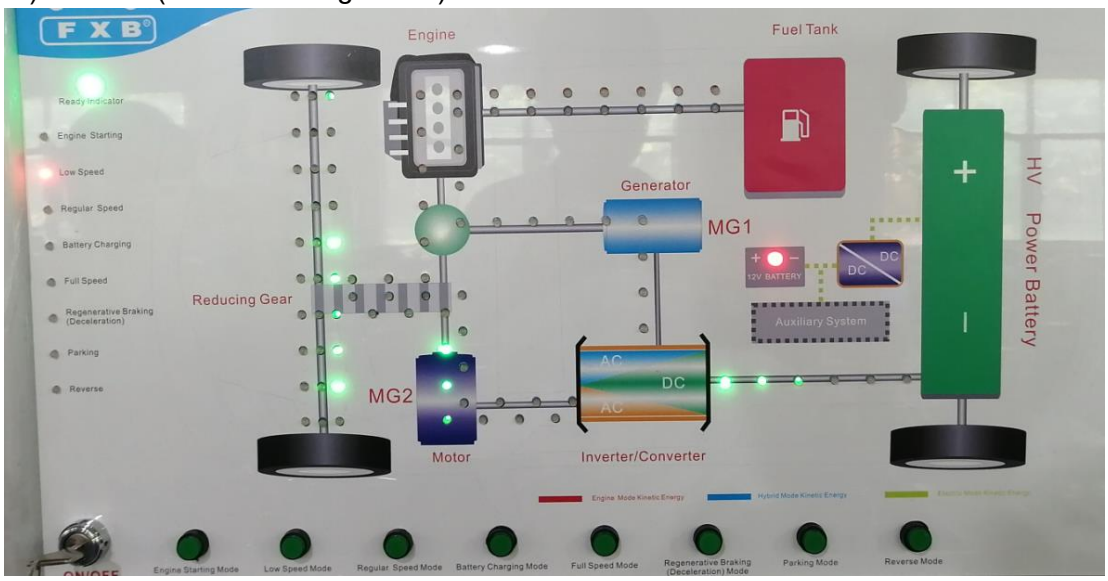
HV power battery (outputs high-voltage DC) → Inverter (converts high-voltage DC into AC) → MG1 (acts as starter) → Engine (fuel tank supplies fuel)



2. Low Speed Mode

Energy flow relationship:

HV power battery (outputs high-voltage DC) → Inverter (converts high-voltage DC into AC) → MG2 (acts as driving motor) → Main reducer / differential → wheels

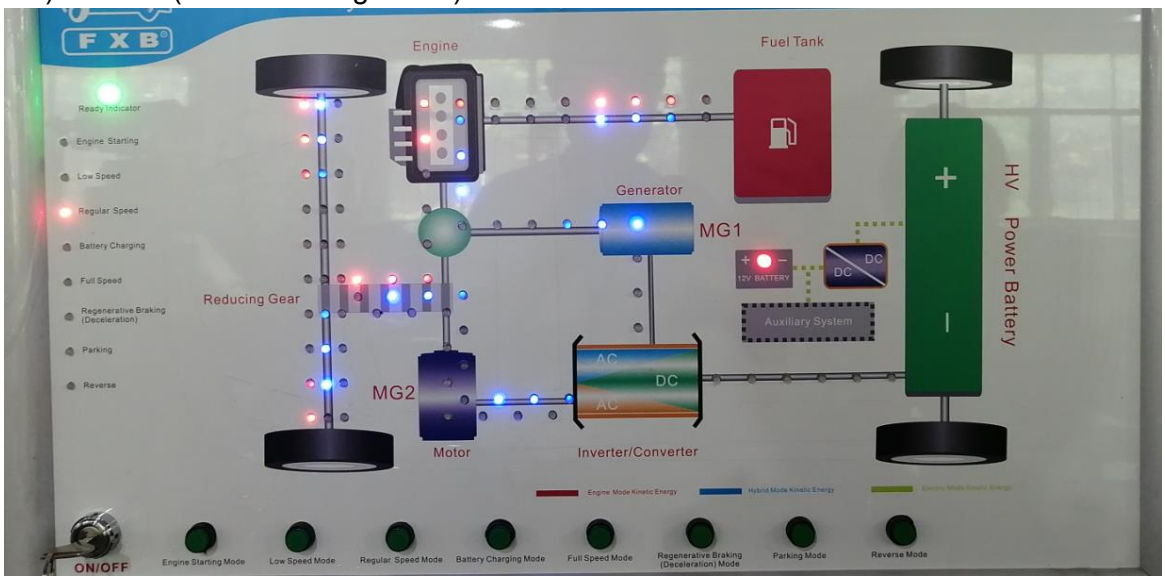


3. Regular Speed Mode

Energy flow relationship:

① Engine (fuel tank supplies fuel) → Main reducer / differential → wheels

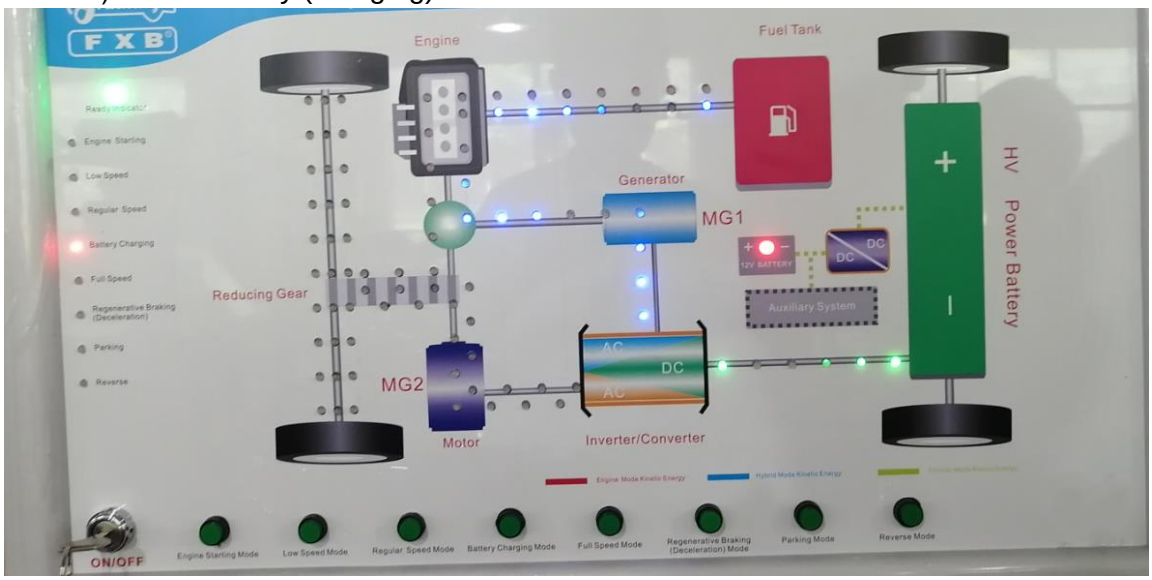
② Engine (fuel tank supplies fuel) → MG1 (acts as generator) → Inverter (converts AC) → MG2 (acts as driving motor) → Main reducer / differential → wheels



4. Battery Charging Mode

Energy flow relationship:

Engine (fuel tank supplies fuel) → MG1 (acts as generator) → Inverter (converts DC into AC) → HV battery (charging)



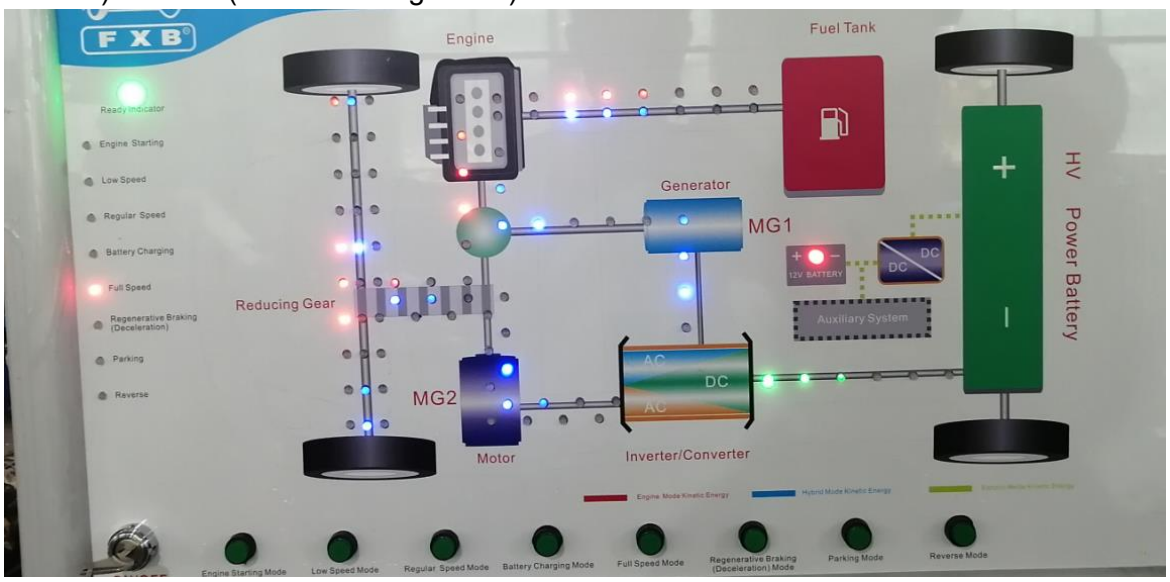
5. Full Speed Mode

Energy flow relationship:

① Engine (fuel tank supplies fuel) → Main reducer / differential → wheels

② Engine (fuel tank supplies fuel) → MG1 (acts as generator) → Inverter (converts AC) → MG2 (acts as driving motor) → Main reducer / differential → wheels

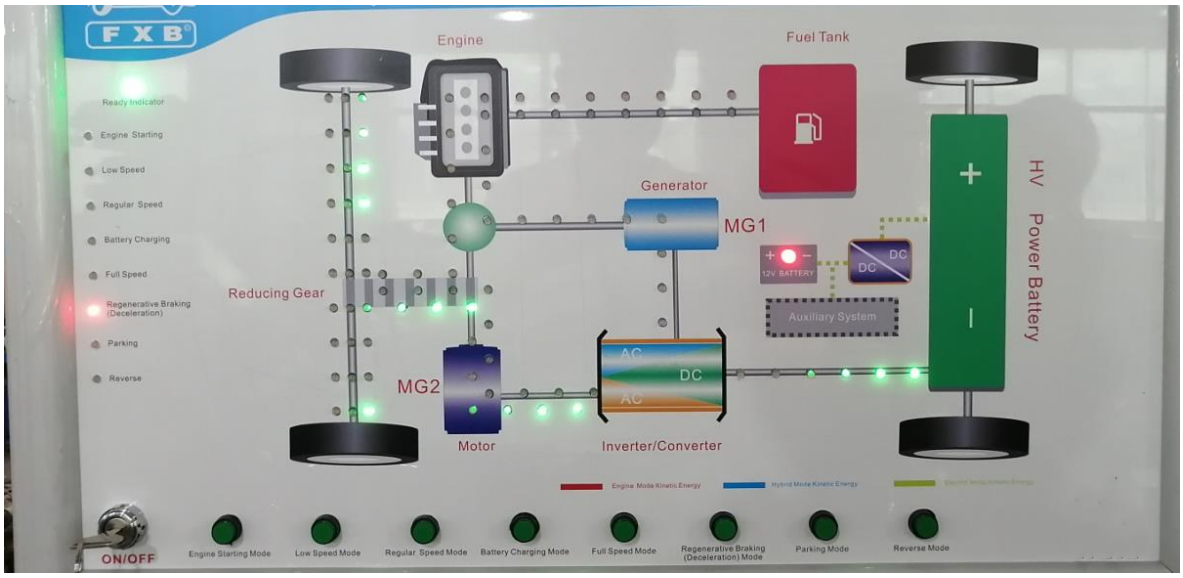
③ HV power battery (outputs high-voltage DC) → Inverter (converts high-voltage DC into AC) → MG2 (acts as driving motor) → Main reducer / differential → wheels



6. Regenerative Braking (Deceleration) Mode

Energy flow relationship:

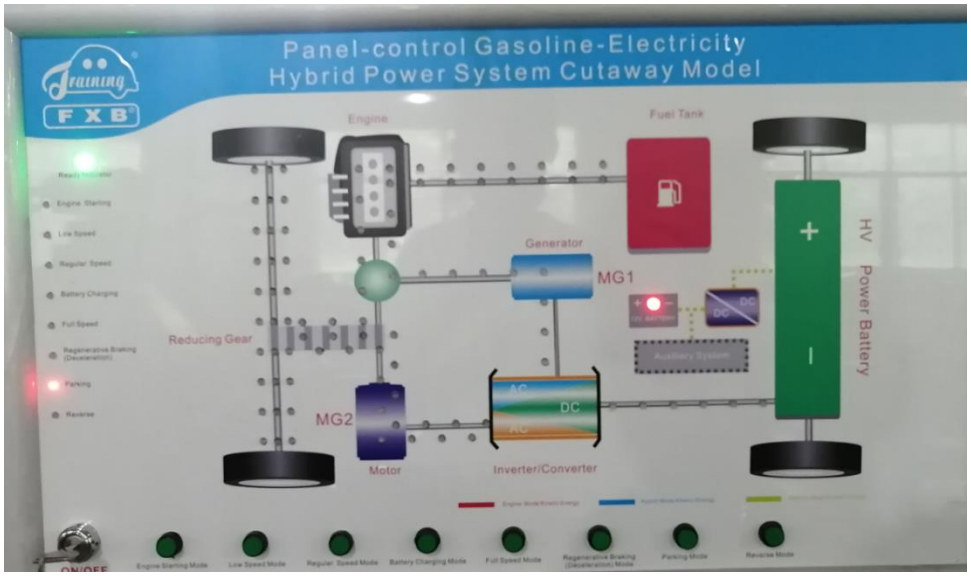
Wheels (brake force) → Main reducer / differential → MG2 (acts as generator) → Inverter (converts AC to DC) → HV power battery (charging)



7. Parking Mode

Energy flow relationship:

The vehicle in parking status, there is no energy flow.



8. Reverse Mode

Energy flow relationship:

HV power battery (outputs high-voltage DC) → Inverter (converts high-voltage DC into AC) → MG2 (acts as driving motor, the motor reverses) → Main reducer / differential → wheels


Panel-control Gasoline-Electricity
Hybrid Power System Cutaway Model
Training
F X B
Engine
Fuel Tank
Generator
MG1
Reducing Gear
MG2
Motor
Inverter/Converter
AC
DC
AC
12V BATTERY
DC
DC
Auxiliary System
HV Power Battery
+
-
Ready Indicator
Engine Starting
Low Speed
Regular Speed
Battery Charging
Full Speed
Regenerative Braking (Deceleration)
Parking
Reverse
ON/OFF
Engine Starting Mode
Low Speed Mode
Regular Speed Mode
Battery Charging Mode
Full Speed Mode
Regenerative Braking (Deceleration) Mode
Parking Mode
Reverse Mode

Experiment #4: Identification Code Box LIN Line ("ICB LIN L" in tablet)

4.1 Objectives:

1. To get familiar with the Code Box LIN Line fault in hybrid power system.
2. Analyze Code Box LIN Line faults in the hybrid power system.
3. Judge the causes of Code Box LIN Line faults.

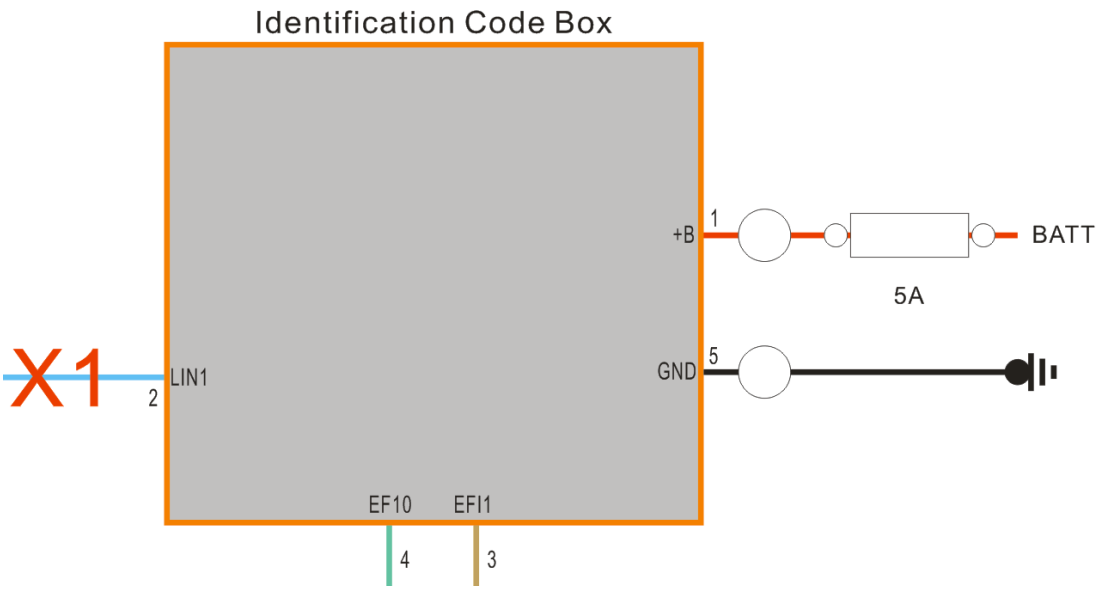
4.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting: Use tablet to set the Identification Code Box LIN Line to open circuit.

Fault Phenomenon: Use diagnostic tool to read the fault code B279A12, auxiliary battery of engine stopper system is open circuit.

4.3 Circuit Diagram:



4.4 Fault Causes:

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The identification code box has fault
2. The line has fault

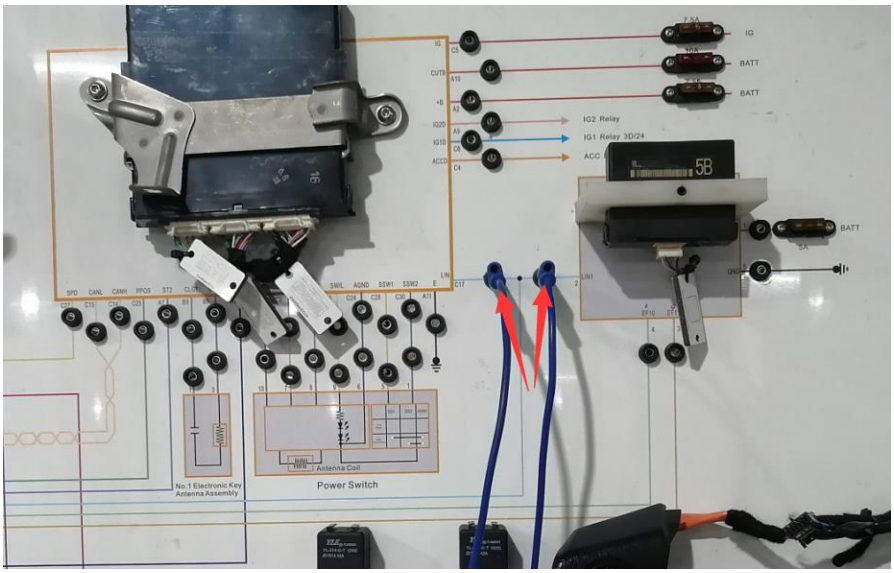
4.5 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the ground voltage of the identification code box terminal 2 V(LIN1) is about 13.0V, and the ground voltage of the smart key certified ECU terminal C17 V(LIN) is about 10.3V. The ground voltage of these two terminals is abnormal, and the normal voltage should be the same.

   V(LIN1) =_____

   V(LIN) =_____

2. Use a wire to connect the two terminals of identification code box terminal 2 (LIN1) and smart key certified ECU terminal C17 (LIN). Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully. So this line has fault.



According to the above diagnosis, it can be determined that the line between the identification code box terminal 2 (LIN1) and smart key certified ECU terminal C17 (LIN) is open circuit.

Fault Conclusion: The Identification Code Box LIN Line is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the detected voltage is normal.

Experiment #5: Coolant Temperature Sensor Line 2 (“CTS L2” in tablet)

5.1 Objectives

1. To get familiar with the Coolant Temperature Sensor Line 2 fault in hybrid power system.
2. Analyze Coolant Temperature Sensor Line 2 faults in the hybrid power system.
3. Judge the causes of Coolant Temperature Sensor Line 2 faults.

5.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

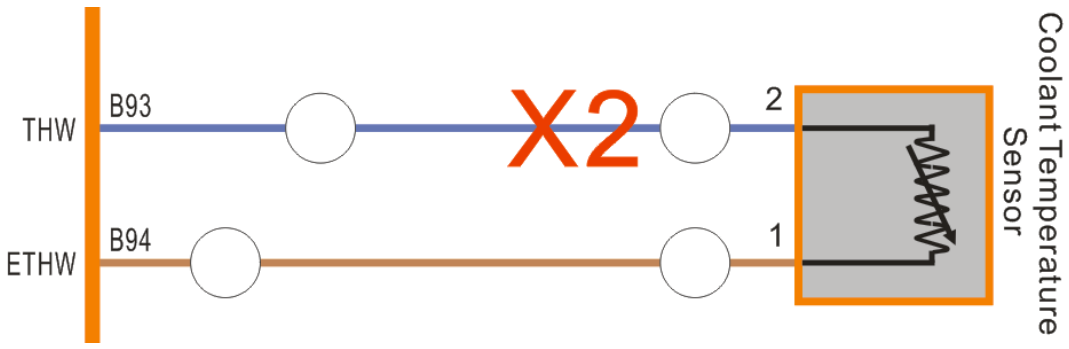
Fault Setting: Use tablet to set the Coolant Temperature Sensor Line 2 (signal line) to open circuit.

Fault Phenomenon:

1. Engine fault indicator in dashboard is on.

2. Use diagnostic tool to read the fault code P0118, the circuit of engine coolant temperature sensor has high voltage input.

5.3 Circuit Diagram:



Definition of coolant temperature sensor terminals:

Terminal 1: Coolant temperature sensor ground terminal

Terminal 2: Coolant temperature sensor signal output terminal

Fault Causes:

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The coolant temperature sensor is damaged
2. The engine control unit has fault
3. The line has fault

5.4 Operation steps

1. Turn the multimeter to the DC 20V gear to measure the line voltage of the coolant temperature sensor and engine control unit. The voltage of coolant temperature sensor terminal 1 and terminal 2 V(1-2) is 0V (The normal voltage decreases with the increase of the engine coolant temperature. When the coolant temperature is about 65°C, the measured voltage is about 1.2V).

   V(1-2)=_____

2. The voltage of engine control unit terminal B93 and terminal B94 V(B93-B94) is 5V. According to the above measurement, it is found that the measured voltage is abnormal, and the normal voltage should be the same.

   V(B93-B94)=_____

3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measure the line resistance between the coolant temperature sensor terminals and the engine control unit terminals R(1-B94), R(2-B93). (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

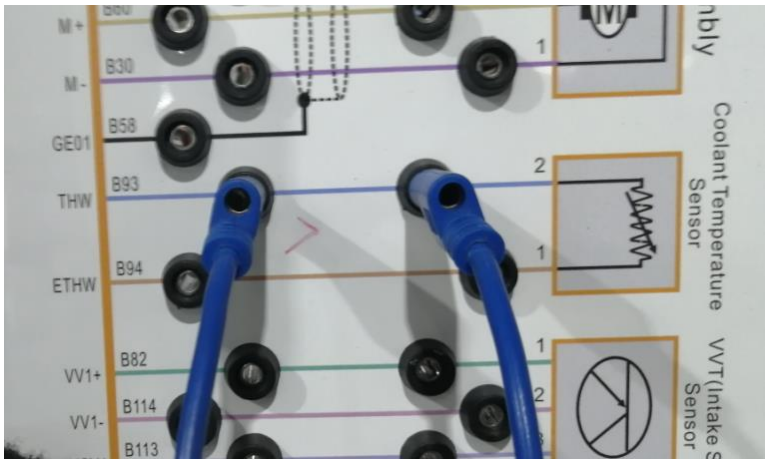
   R(1-B94)=_____

   R(2-B93)=_____

Coolant temperature sensor terminals and engine control unit terminals	Measured value (Ω)	Standard value (Ω)
1 and B94	Less than 1Ω	Less than 1Ω
2 and B93	Infinite	Less than 1Ω

After the above voltage and resistance measurement, it is found that the line between the coolant temperature sensor terminal 2 and engine control unit terminal B93 is open circuit.

4. Use a wire to connect the two terminals of coolant temperature sensor terminal 2 and engine control unit terminal B93. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.



Fault Conclusion: The Coolant Temperature Sensor Line 2 is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #6: Throttle Body Line 5 (“TBS L5” in tablet)

6.1 Objectives

1. To get familiar with the Throttle Body Line 5 fault in hybrid power system.
2. Analyze Throttle Body Line 5 faults in the hybrid power system.
3. Judge the causes of Throttle Body Line 5 faults.

6.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting: Use tablet to set the Throttle Body Assembly Line 5 (Throttle position sensor 5.0V power line) to open circuit.

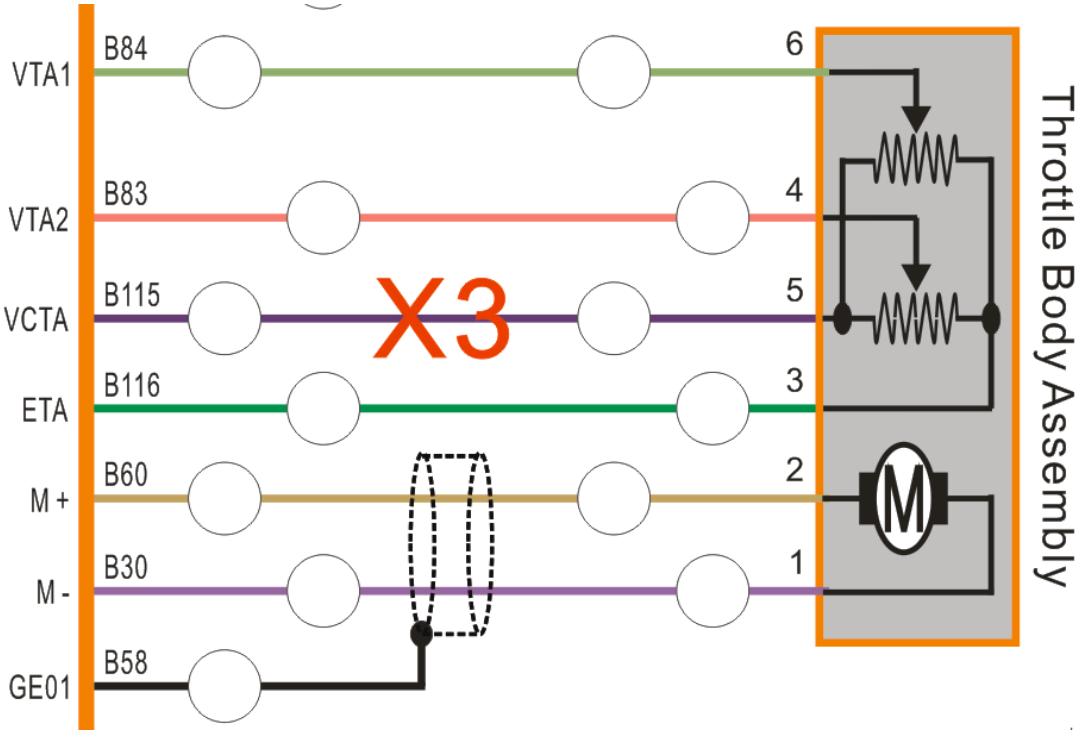
Fault Phenomenon:

1. There is no response when press the accelerator pedal.

2. The power fault indicator in dashboard is on, the engine system has fault

3. Use diagnostic tool to read the fault code P0121/P0122/P0222/P2135, throttle pedal / position sensor has fault

6.3 Circuit Diagram:



Definition of throttle body assembly terminals:

Terminals 1 and 2: Throttle motor control line

Terminal 3: Throttle position sensor ground terminal

Terminal 5: Throttle position sensor 5.0V power input terminal

Terminal 4: Throttle position sensor VTA2 signal output terminal (when the engine is stopped, the power switch is placed in the ON (IG) position and the accelerator pedal is completely released, the voltage is 2.1-3.1V)

Terminal 6: Throttle position sensor VTA1 signal output terminal (when the engine is stopped, the power switch is placed in the ON (IG) position and the accelerator pedal is completely released, the voltage is 0.6-1.1V)

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The throttle body assembly is damaged
2. The engine control unit has fault
3. The line has fault

6.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the voltage of the throttle position sensor terminal 5 and terminal 3 V(5-3) is 0V (The normal voltage is about 5.0V).

   V(5-3)=_____

2. Measured that the voltage of the engine control unit terminal B115 and terminal B116 V(B115-B116) is 5.0V (The normal voltage is about 5.0V).

   V(B115-B116)=_____

According to the above measurement, it is found that the throttle position sensor terminal 5 doesn't has 5.0V power input.

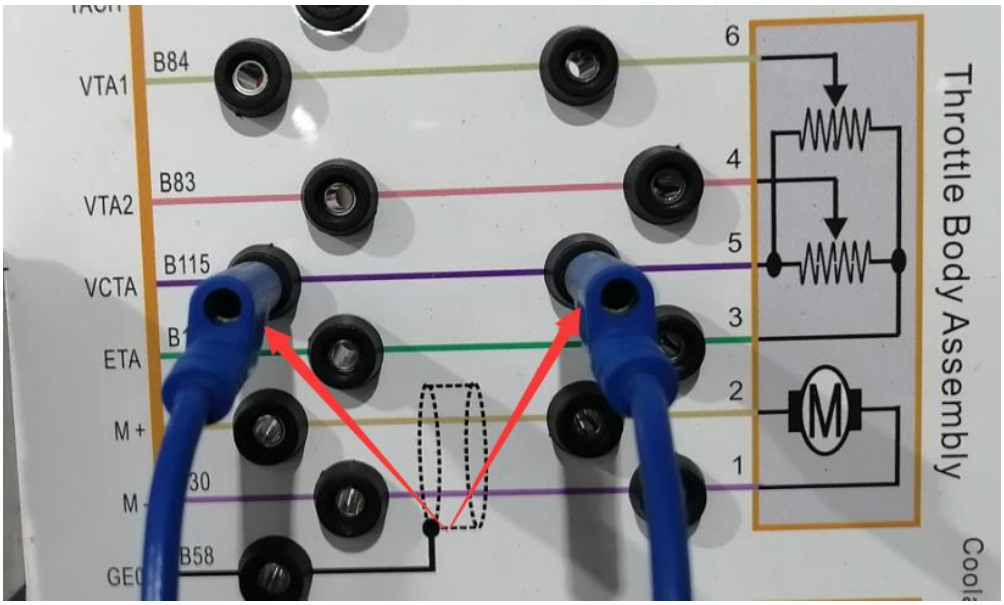
3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured the line resistance between the throttle position sensor terminal 5 and the engine control unit terminal B115 R(5-B115) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components).

   R(5-B115)=_____

After the above voltage and resistance measurement, it is found that the line between the throttle position sensor terminal 5 and the engine control unit terminal B115 is open circuit.

4. Use a wire to connect the two terminals of throttle position sensor terminal 5 and the engine control unit terminal B115. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can

be cleared successfully, and the fault indicator is off. So this line has fault.



Fault Conclusion: The Throttle Body Assembly Line 5 is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #7: VVT (Air-intake Side) Sensor Line 1 (“VVT(IS)S L1” in tablet)

7.1 Objectives

1. To get familiar with the VVT (Air-intake Side) Sensor Line 1 fault in hybrid power system.
2. Analyze VVT (Air-intake Side) Sensor Line 1 faults in the hybrid power system.
3. Judge the causes of VVT (Air-intake Side) Sensor Line 1 faults.

7.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

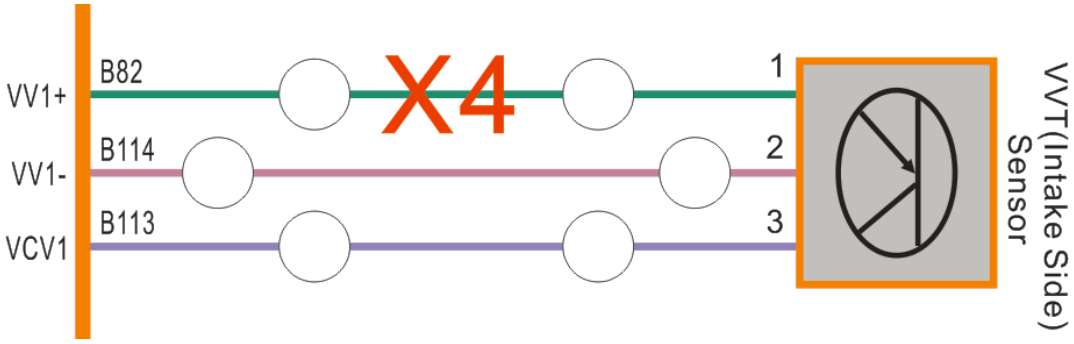
Use tablet to set the VVT (Air-intake Side) Sensor Line 1 (signal line) to open circuit.

Fault Phenomenon:

1. The engine fault indicator in dashboard is on.

2. Use diagnostic tool to read the fault code P0343, the circuit of camshaft position sensor 'A' has high voltage input.

7.3 Circuit Diagram:



Definition of VVT (Air-intake side) sensor (camshaft position sensor) terminals:

Terminal 1: VVT (Air-intake side) sensor signal line

Terminal 2: VVT (Air-intake side) sensor ground terminal

Terminal 3: VVT (Air-intake side) sensor 5.0V power input terminal

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The VVT (Air-intake side) sensor has fault
2. The engine control unit has fault
3. The line has fault

7.4 Operation steps

The following data is measured when the engine not running.

1. Turn the multimeter to the DC 20V gear, and measured that the voltage of the VVT (Air-intake side) sensor terminal 2 and terminal 3 V_{VVT}(2-3) is 5.0V (The normal voltage is about 5.0V).

   V_{VVT}(2-3) =_____

2. Measured that the voltage of the VVT (Air-intake side) sensor terminal 2 and terminal 1 V_{VVT}(2-1) is 0V (The normal voltage is about 2.4V).

   V_{VVT}(2-1) =_____

3. Measured that the voltage of the engine control unit terminal B114 and terminal B82 V(B114-B82) is 5.0V (The normal voltage is about 2.4V).

   V(B114-B82) =_____

According to the above measurement, it is found that the measured voltage is abnormal.

4. Turn off the one-button start switch, turn the multimeter to 200Ω, and measure the line resistance between the VVT (Air-intake side) sensor terminals and the engine control unit terminals R(VVT1-B82), R(VVT2-B114) and R(VVT3-B113). (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

R(VVT1-B82) =_____

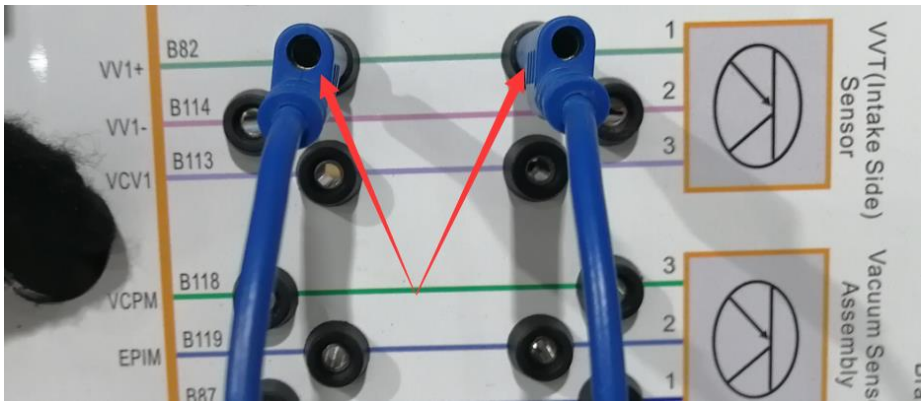
R(VVT2-B114) =_____

R(VVT3-B113) =_____

VVT (Air-intake side) sensor terminals and engine control unit terminals	Measured value (Ω)	Standard value (Ω)
1 and B82	Infinite	Less than 1Ω
2 and B114	Less than 1Ω	Less than 1Ω
3 and B113	Less than 1Ω	Less than 1Ω

After the above voltage and resistance measurement, it is found that the line between the VVT (Air-intake side) sensor terminal 1 and engine control unit terminal B82 is open circuit.

5. Use a wire to connect the two terminals of VVT (Air-intake side) sensor terminal 1 and engine control unit terminal B82. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.



Fault Conclusion: The VVT (Air-intake Side) Sensor Line 1 is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #8: No.2 Ignition Coil Line 3 (“No.2 ICA L3” in tablet)

8.1Objectives

1. To get familiar with the No.2 Ignition Coil Line 3 fault in hybrid power system.
2. Analyze No.2 Ignition Coil Line 3 faults in the hybrid power system.
3. Judge the causes of No.2 Ignition Coil Line 3 faults.

8.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

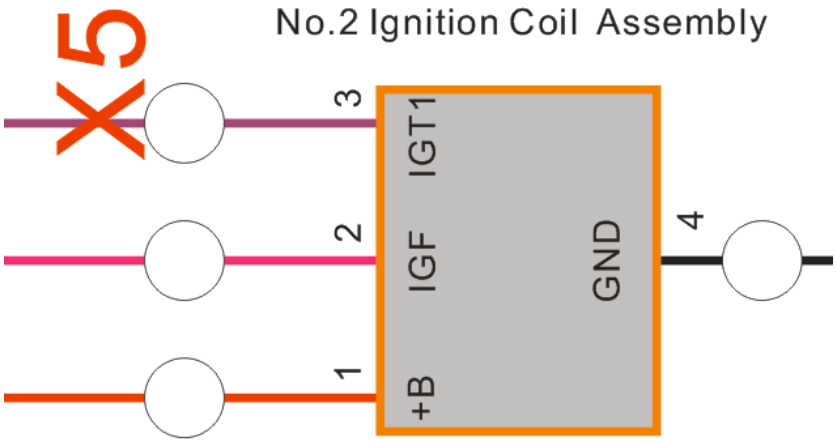
Use tablet to set the No.2 Ignition Coil Line 3 (control line) to open circuit.

Fault Phenomenon:

1. The engine shakes severely
2. The engine fault indicator in dashboard is on

3. Use diagnostic tool to read the fault code P0352, the ignition coil 'B' primary / secondary circuit.

8.3 Circuit Diagram:



Definition of ignition coil terminals:
Terminal 1: 12.0V BATT power input terminal
Terminal 2: Ignition feedback signal output terminal
Terminal 3: Ignition control terminal
Terminal 4: Ground terminal

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:
1. No.2 cylinder ignition coil has fault
2. The engine control unit has fault
3. The line has fault

8.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the voltage of the No.2 cylinder ignition coil terminal 3 and terminal 4 V(3-4) is 0V.

V(3-4) =_____

2. Measured that the voltage of the engine control unit terminal B56 and terminal B21 V(B56-21) is 0.1V.

V(B56-21) =_____

According to the above voltage measurement, it is found that the voltage difference is not large, and it is more accurate to use oscilloscope to measure.

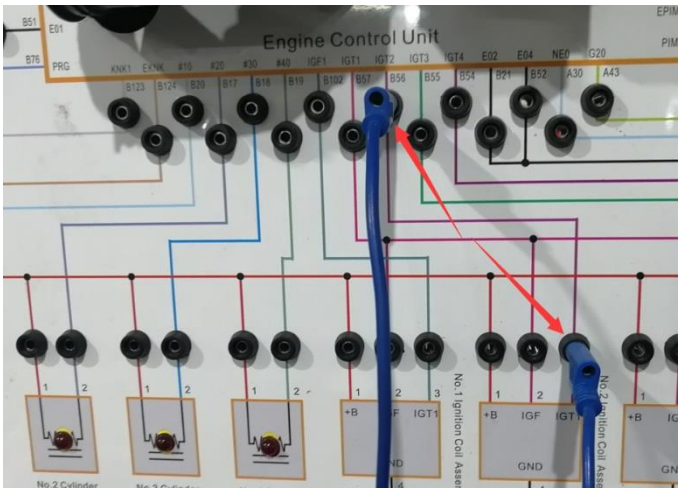
3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measure the line resistance between the No.2 cylinder ignition coil terminal 3 and engine control unit terminal B56 R(3-B56) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

R(3-B56) =_____

After the above voltage and resistance measurement, it is found that the line between the No.2 cylinder ignition coil terminal 3 and engine control unit terminal B56 is open circuit.

4. Use a wire to connect the two terminals of No.2 cylinder ignition coil terminal 3 and engine

control unit terminal B56. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.



Fault Conclusion: The No.2 Ignition Coil Line 3 is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal

Experiment #9: EFI Main Relay Control Line ("EFI MR CL" in tablet)

9.1 Objectives

1. To get familiar with the EFI Main Relay Control Line fault in hybrid power system.
2. Analyze EFI Main Relay Control Line faults in the hybrid power system.
3. Judge the causes of EFI Main Relay Control Line faults.

9.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

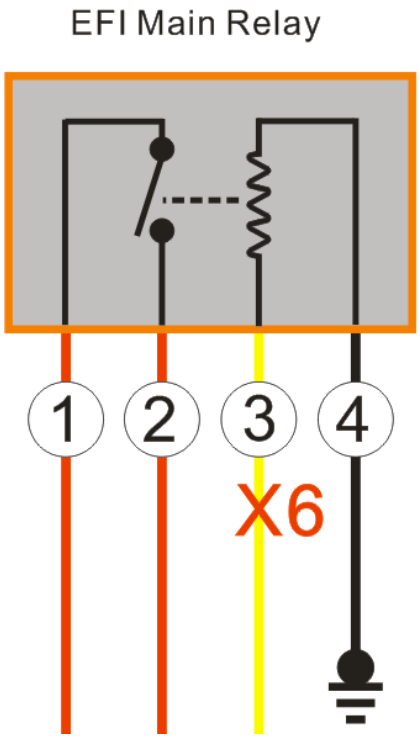
Use tablet to set the EFI Main Relay (Coil) Control Line to open circuit.

Fault Phenomenon:

1. The dashboard alarms, the coolant temperature fault indicator is on, the power fault indicator is on and indicates that the hybrid power system has fault.

2. There is no response when press the accelerator pedal.

9.3 Circuit Diagram:



Definition of EFI main relay terminals:
Terminal 1: EFI Main Relay 12.0V BATT input terminal
Terminal 2: EFI Main Relay switching power supply output terminal
Terminal 3: EFI Main Relay coil control terminal
Terminal 4: EFI Main Relay ground terminal

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:
1. The EFI main relay has fault
2. The engine control unit has fault
3. The line has fault

9.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the ground voltage of the EFI main relay terminal 3 V(EFI-GND) is 0V.

V(EFI3-GND) =_____

2. Measured that the ground voltage of the engine control unit terminal A46 V(A46-GND) is about 13.0V.

V(A46-GND) =_____

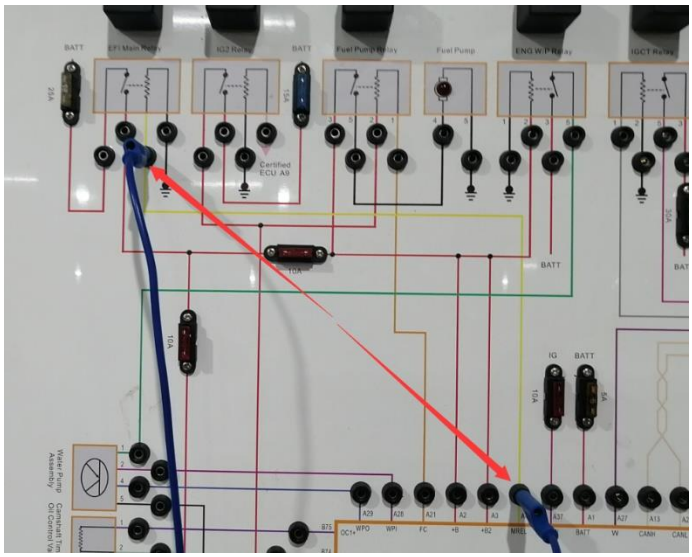
According to the above measurement, it is found that the ground voltage of the EFI main relay terminal 3 and engine control unit terminal A46 are abnormal, the normal voltage should be the same.

3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured that the line resistance between the EFI main relay terminal 3 and engine control unit terminal A46 R(EFI3-A46) is infinite. The normal value is less than 1Ω.

R(EFI3-A46) =_____

(Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

4. Use a wire to connect the two terminals of EFI main relay terminal 3 and engine control unit terminal A46. Turn off the one-button start switch and main power switch, then start again, the fault indicator in dashboard is off. So this line has fault.



Fault Conclusion: The EFI Main Relay Control Line is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, the engine works normal, and the measured voltage and resistance are normal.

Experiment #10: Fuel Pump Relay Control Line ("FPR CL" in tablet)

10.1 Objectives

1. To get familiar with the Fuel Pump Relay Control Line fault in hybrid power system.
2. Analyze Fuel Pump Relay Control Line faults in the hybrid power system.
3. Judge the causes of Fuel Pump Relay Control Line faults.

10.2 Experiment Tools

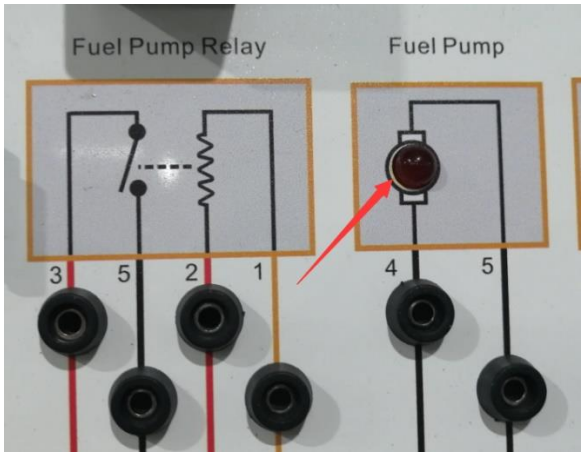
Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

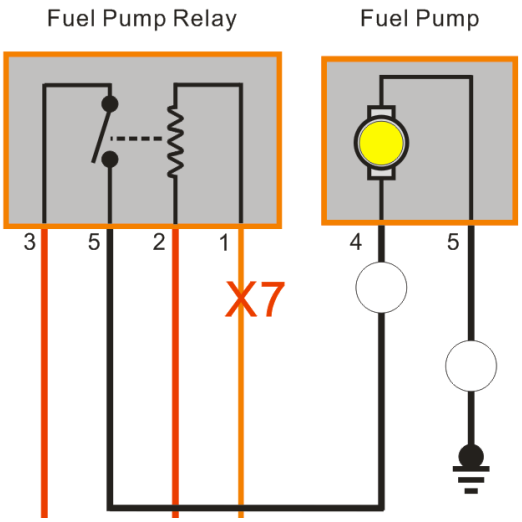
Use tablet to set the Fuel Pump Relay (Coil) Control Line to open circuit.

Fault Phenomenon:

1. The fuel pump does not work (The fuel pump indicator is off)



10.3 Circuit Diagram:



Definition of fuel pump relay terminals:
Terminal 3: Fuel pump relay 12.0V BATT input terminal
Terminal 5: Fuel pump relay switch power output terminal
Terminal 1: Fuel pump relay coil control terminal
Terminal 2: Fuel pump relay coil power input terminal

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:
1. The fuel pump has fault
2. The fuel pump relay has fault
3. The engine control unit has fault
4. The line has fault

10.4 Operation steps

1. Turn the multimeter to the DC 20V gear, press the accelerator pedal, and measured that the voltage of the fuel pump FP terminal 4 and terminal 5 V(FP4-FP5) is 0V, it means that the fuel pump doesn't has control power input.

V(FP4-FP5) =_____

2. Measured that the voltage of the fuel pump relay terminal 5 V(FPR5-GND) is 0V.

V(FPR5-GND) =_____

3. Measured that the voltage of the fuel pump relay terminal 3 V(FPR3-GND) is about 13.0V, it indicates that the relay switch has power input but no power output. The possible cause of the fault is that the relay switch is not connected or damaged.

V(FPR3-GND) =_____

4. Measured that the ground voltage of the fuel pump relay terminal 2 V(FPR2-GND) is about 13.0V.

V(FPR2-GND) =_____

5. Measured that the voltage of the fuel pump relay terminal 1 V(FPR1-GND) is about 13.0V, the voltage is abnormal.

V(FPR1-GND) =_____

6. Measured that the ground voltage of the engine control unit terminal A21 V(A21-GND) is 0V.

V(A21-GND) =_____

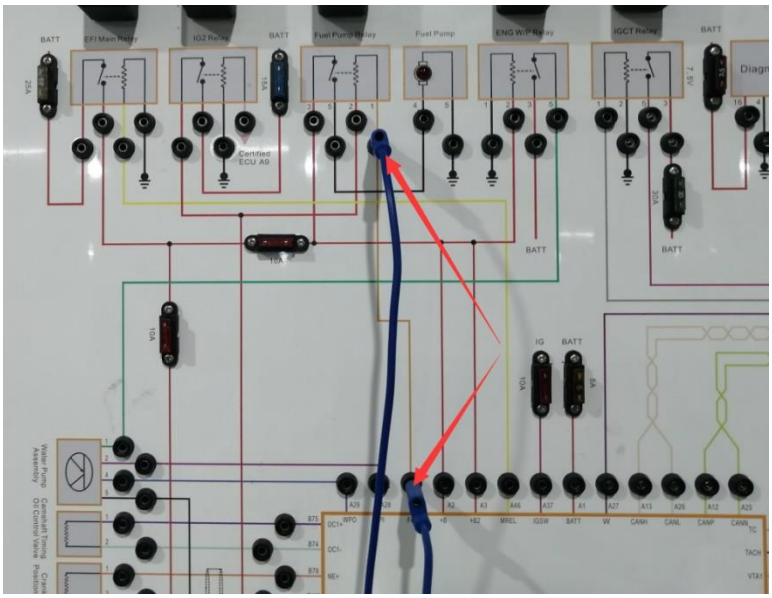
According to the above measurement, it is found that the voltage of fuel pump relay terminal 1 and engine control unit terminal A21 is abnormal.

7. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured that the line resistance between the fuel pump relay terminal 1 and engine control unit terminal A21 R(FPR1-A21) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

R(FPR1-A21) =_____

After the above voltage and resistance measurement, it is found that the line between the fuel pump relay terminal 1 and engine control unit terminal A21 is open circuit.

Use a wire to connect the two terminals of fuel pump relay terminal 1 and engine control unit terminal A21. Press the accelerator pedal, the fuel pump starts to work (The indicator is on)



Fault Conclusion: The Fuel Pump Relay Control Line is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, the fuel pump works normal (the indicator is on), and the measured voltage and resistance are normal.

Experiment #11: Interlock Switch Line 1 (“IS L1” in tablet)

11.1 Objectives

1. To get familiar with the Interlock Switch Line 1 fault in hybrid power system.
2. Analyze Interlock Switch Line 1 faults in the hybrid power system.
3. Judge the causes of Interlock Switch Line 1 faults.

11.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

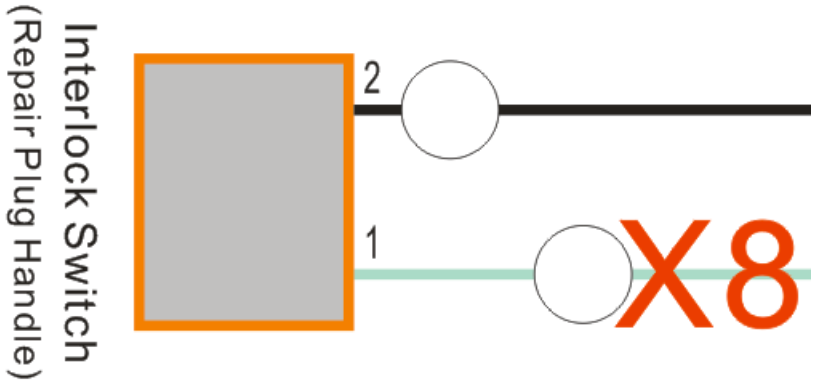
Use tablet to set the Interlock Switch Line 1 (signal line) to open circuit.

Fault Phenomenon:

1. The dashboard reports that the hybrid power system has fault, and the power fault indicator is on.

2. Use diagnostic tool to read the fault code P0A0A92, the high voltage system interlock has fault.

11.3 Circuit Diagram:



Terminal 1: Interlock switch signal output terminal (When the power switch is in the ON / IG position, and the maintenance plug handle is installed correctly, the standard voltage is 0-1.5V)

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The interlock switch (maintenance plug) is damaged
2. The hybrid power control unit has fault
3. The line has fault

11.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the ground voltage of the interlock switch terminal 1 V(1-GND) is 0V.

   V(1-GND) =_____

2. Measured that the ground voltage of the hybrid power control unit terminal B5 V(B5-GND) is about 13.0V.

   V(B5-GND) =_____

According to the above measurement, it is found that the ground voltage of interlock switch terminal 1 and hybrid power control unit terminal B5 is abnormal.

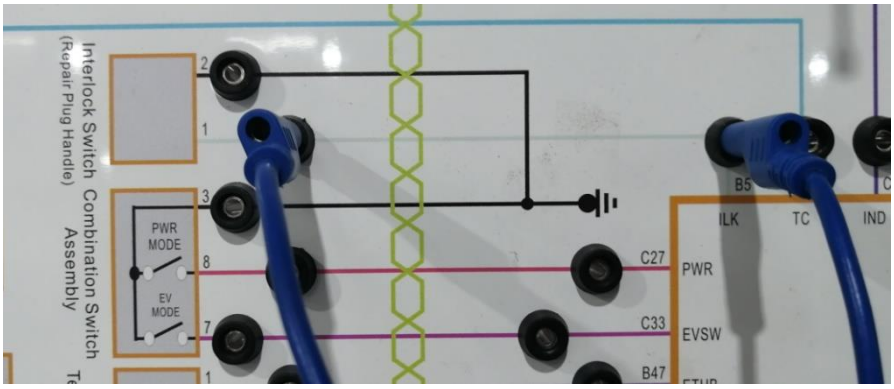
3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured that the line resistance between the interlock switch terminal 1 and hybrid power control unit terminal B5 R(1-B5) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

   R(1-B5) =_____

After the above voltage and resistance measurement, it is found that the line between the interlock switch terminal 1 and hybrid power control unit terminal B5 is open circuit.

4. Use a wire to connect the two terminals of interlock switch terminal 1 and hybrid power control unit terminal B5. Then use the diagnostic tool to clear the fault code or turn off the

one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off, the READY indicator is on. So this line has fault.



Fault Conclusion: The Interlock Switch Line 1 is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #12: HV Battery Outlet Temperature Sensor Line 2 ("HVB OTS L2" in tablet)

12.1 Objectives

1. To get familiar with the HV Battery Outlet Temperature Sensor Line 2 fault in hybrid power system.
2. Analyze HV Battery Outlet Temperature Sensor Line 2 faults in the hybrid power system.
3. Judge the causes of HV Battery Outlet Temperature Sensor Line 2 faults.

12.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

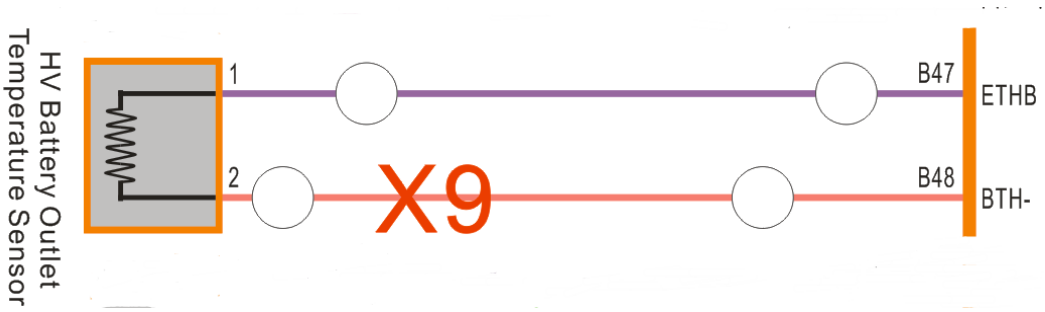
Fault Setting:

Use tablet to set the HV Battery Outlet Temperature Sensor Line 2 (signal line) to open circuit.

Fault Phenomenon:

Use diagnostic tool to read the fault code P0515, the circuit of auxiliary battery temperature sensor is short circuit or open circuit.

12.3 Circuit Diagram:



Installation location:

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The HV battery outlet temperature sensor is damaged
2. The hybrid power control unit has fault
3. The line has fault

12.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the voltage of the HV battery outlet temperature sensor terminal 1 and terminal 2 V(1-2) is 0V.

   V(1-2) = _____

2. Measured that the voltage of hybrid power control unit terminal B47 and terminal B48 V(B47-B48)is 5.0V.

   V(B47-B48) = _____

   According to the above measurement, it is found that the measured voltage is abnormal, and the normal voltage should be the same.

3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measure the line resistance between the HV battery outlet temperature sensor terminals and hybrid power control unit terminals R(1-B47) and R(2-B48) (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

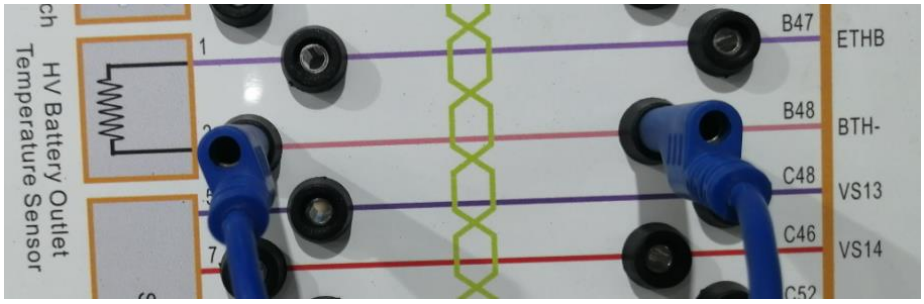
   R(1-B47) = _____

   R(2-B48) = _____

HV battery outlet temperature sensor terminal and hybrid power control unit terminal	Measured value (Ω)	Standard value (Ω)
1 and B47	Less than 1Ω	Less than 1Ω
2 and B48	Infinite	Less than 1Ω

After the above voltage and resistance measurement, it is found that the line between the HV battery outlet temperature sensor terminal 2 and hybrid power control unit terminal B48 is open circuit.

4. Use a wire to connect the two terminals of HV battery outlet temperature sensor terminal 2 and hybrid power control unit terminal B48. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully. So this line has fault.



Fault Conclusion: The HV Battery Outlet Temperature Sensor Line 2 is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #13: Crankshaft Position Sensor Signal Line ("CKPS SL" in tablet)

13.1 Objectives

1. To get familiar with the Crankshaft Position Sensor Signal Line fault in hybrid power system.
2. Analyze Crankshaft Position Sensor Signal Line faults in the hybrid power system.
3. Judge the causes of Crankshaft Position Sensor Signal Line faults.

13.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

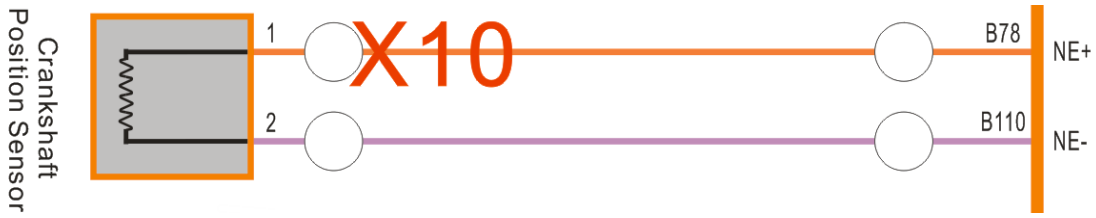
Use tablet to set the Crankshaft Position Sensor Signal Line (Line 1) to open circuit.

Fault Phenomenon:

1. The engine fault indicator in dashboard is on.

2. Use diagnostic tool to read the fault code P0335, the crankshaft position sensor 'A' circuit.

13.3 Circuit Diagram:



Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The crankshaft position sensor is damaged
2. The engine control unit has fault
3. The line has fault

13.4 Operation steps

1. Turn off the one-button start switch, turn the multimeter to 200Ω, and measure the line resistance between the crankshaft position sensor terminals and engine control unit terminals R(1-B78) and R(2-B110). (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

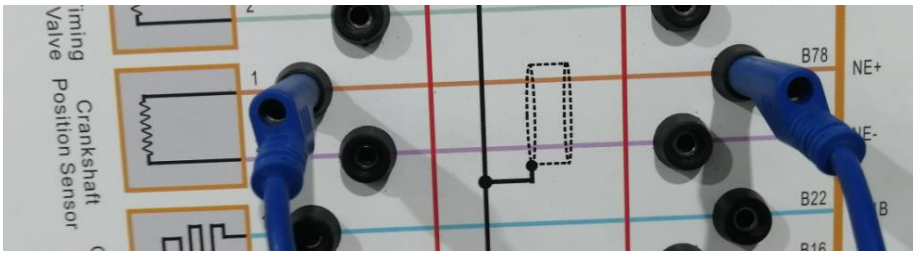
R(1-B78) = _____

R(2-B110) = _____

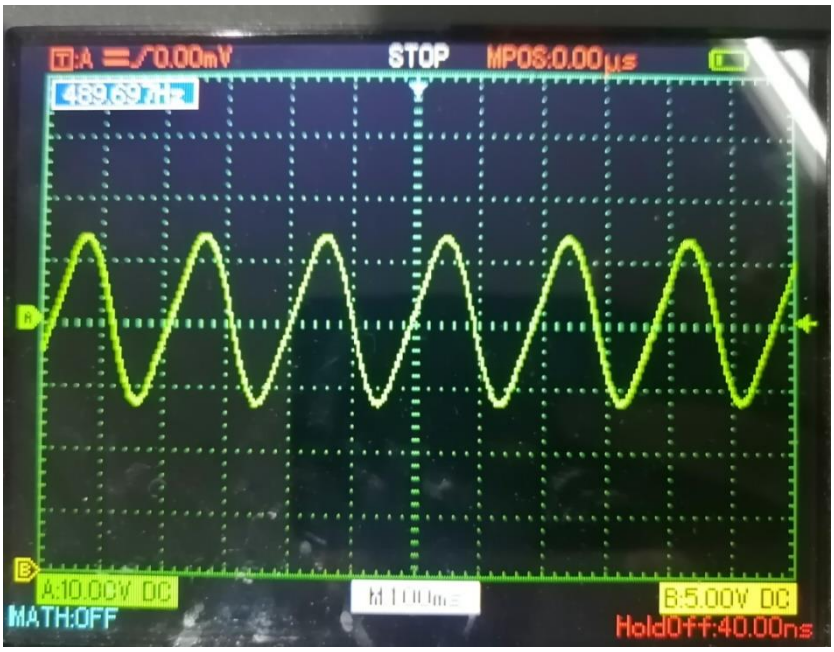
Crankshaft position sensor terminals and engine control unit terminals	Measured value (Ω)	Standard value (Ω)
1 and B78	Infinite	Less than 1Ω
2 and B110	Less than 1Ω	Less than 1Ω

After the above resistance measurement, it is found that the line between the crankshaft position sensor terminal 1 and engine control unit terminal B78 is open circuit.

2. Use a wire to connect the two terminals of crankshaft position sensor terminal 1 and engine control unit terminal B78. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.



3. Use oscilloscope to measure the waveform of crankshaft position sensor, as shown in the following picture:



Fault Conclusion: The Crankshaft Position Sensor Signal Line (Line 1) is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #14: Brake Switch Line 2 (“BS L2” in tablet)

14.1 Objectives

1. To get familiar with the Brake Switch Line 2 fault in hybrid power system.
2. Analyze Brake Switch Line 2 faults in the hybrid power system.
3. Judge the causes of Brake Switch Line 2 faults.

14.2 Experiment Tools

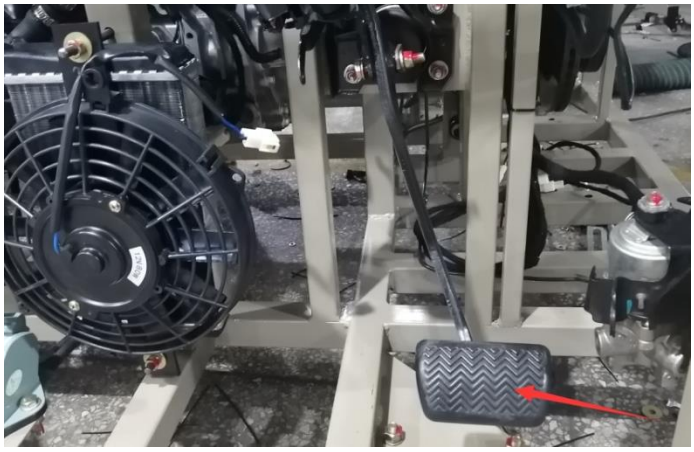
Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

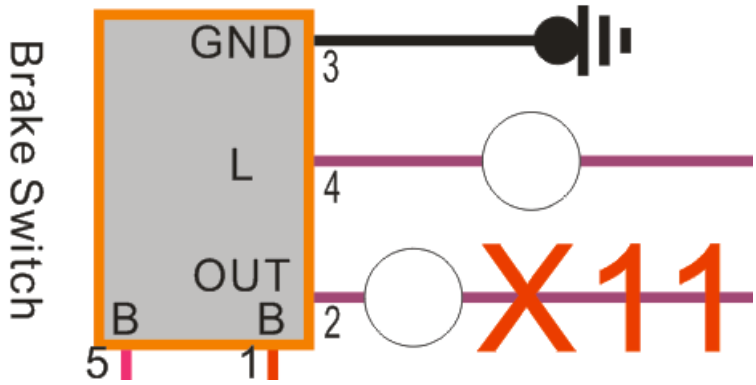
Use tablet to set the Brake Switch Line 2 to open circuit.

Fault Phenomenon:

1. Press the brake pedal, press the one-button start switch, but unable to start the vehicle.



14.3 Circuit Diagram:



Terminal 2: Brake light switch signal output (the voltage is 11-14V when press the brake pedal, the voltage is 0-1.5V when release the brake pedal)

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The brake switch is damaged
2. The hybrid power control unit has fault
3. The line has fault

14.4 Operation steps

1. Turn the multimeter to the DC 20V gear, press the brake pedal, and measured that the ground voltage of the brake switch terminal 2 V(2-GND) is about 13.0V

   V(2-GND) = _____

2. Measured that the ground voltage of the hybrid power control unit terminal A V(A-GND) is 0V.

   V(A-GND) = _____

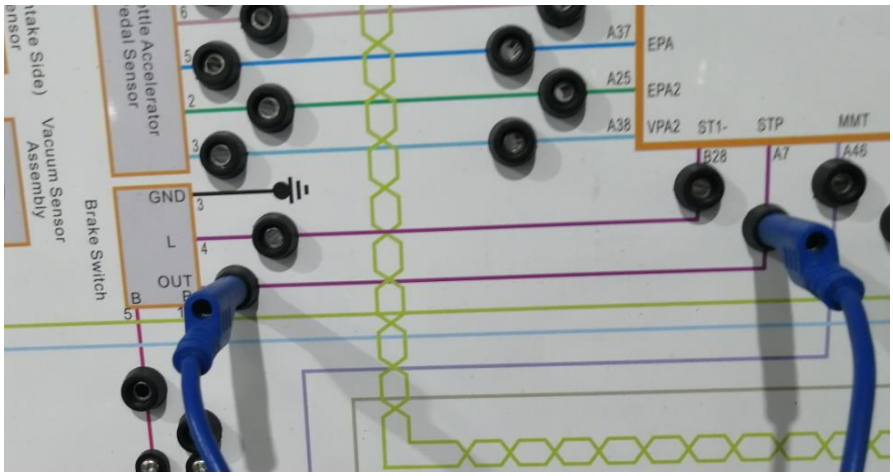
   According to the above measurement, it is found that the ground voltage of brake switch terminal 2 and hybrid power control unit terminal A is abnormal.

3. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured that the line resistance between the brake switch terminal 2 and hybrid power control unit terminal A R(2-A) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

   R(2-A) = _____

After the above voltage and resistance measurement, it is found that the line between the brake switch terminal 2 and hybrid power control unit terminal A is open circuit.

4. Use a wire to connect the two terminals of brake switch terminal 2 and hybrid power control unit terminal A. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully. So this line has fault.



Fault Conclusion: The Brake Switch Line 2 is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #15: Hybrid Control Unit Line A4 (“HCU L A4” in tablet)

15.1 Objectives

1. To get familiar with the Hybrid Control Unit Line A4 fault in hybrid power system.
2. Analyze Hybrid Control Unit Line A4 faults in the hybrid power system.
3. Judge the causes of Hybrid Control Unit Line A4 faults.

15.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

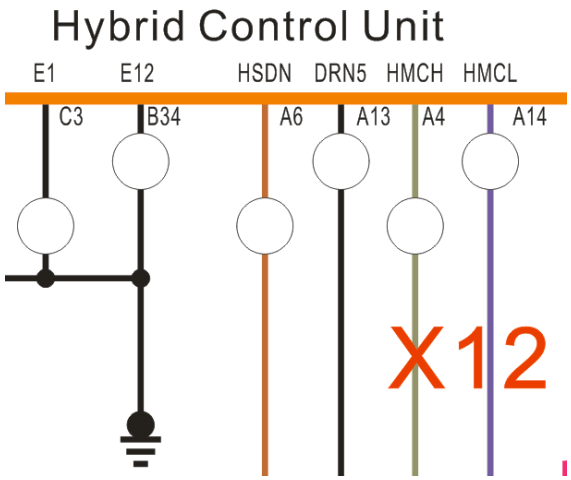
Use tablet to set the Hybrid (Power) Control Unit Line A4 to open circuit.

Fault Phenomenon:

1. The dashboard reports hybrid power fault, and the fault indicator is on.

2. Use diagnostic tool to read the fault code P312387, Communication error / lost communication from the drive motor control module to the hybrid / EV transmission system control module.

15.3 Circuit Diagram:



Definition of hybrid power control unit terminals:

Terminal A14 (HMCL): Communication signal (The power switch in the ON / IG position, it generates waveform)

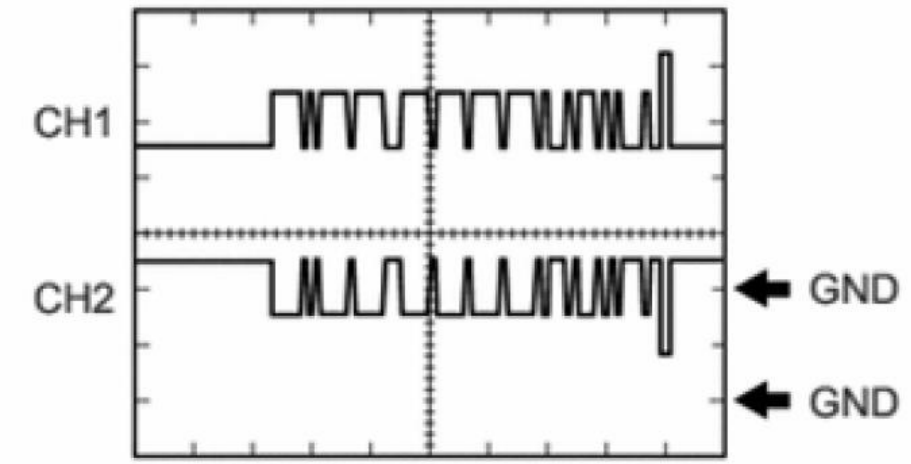
Terminal A4 (HMCH): Communication signal (The power switch in the ON / IG position, it generates waveform)

1. Communication between the hybrid power control unit, inverter and drive motor

① Definition of terminals:

Items	Content
Terminals	CH1: A4 (HMCH) and C3 (E1) CH2: A14 (HMCL) and C3 (E1)
Setup	1V/div, 50μs/div
Condition	Power switch in ON / IG

② Waveform



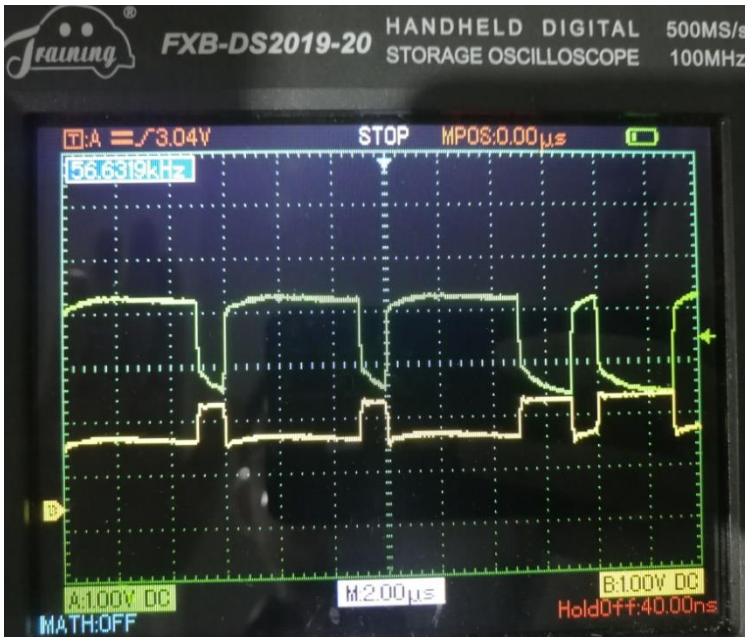
Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

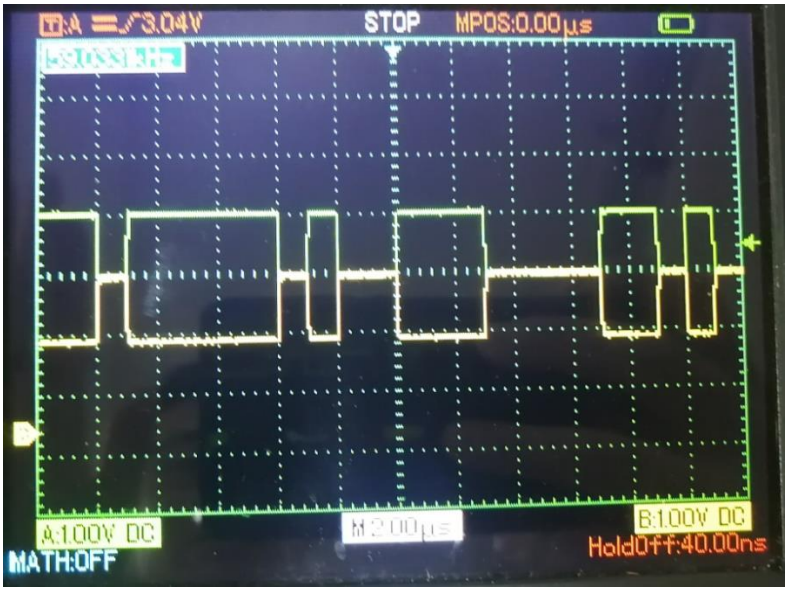
1. The inverter has fault
2. The hybrid power control unit has fault
3. The line has fault

15.4 Operation steps

1. Use oscilloscope to measure the waveform of hybrid power control unit terminals A4 (HMCH) and A14 (HMCL).



The standard waveform is shown in the picture below:



2. Turn off the one-button start switch, turn the multimeter to 200Ω, and measure the line resistance between the inverter terminals and hybrid power control unit terminals R(A20-A4) and R(A21-A14). (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

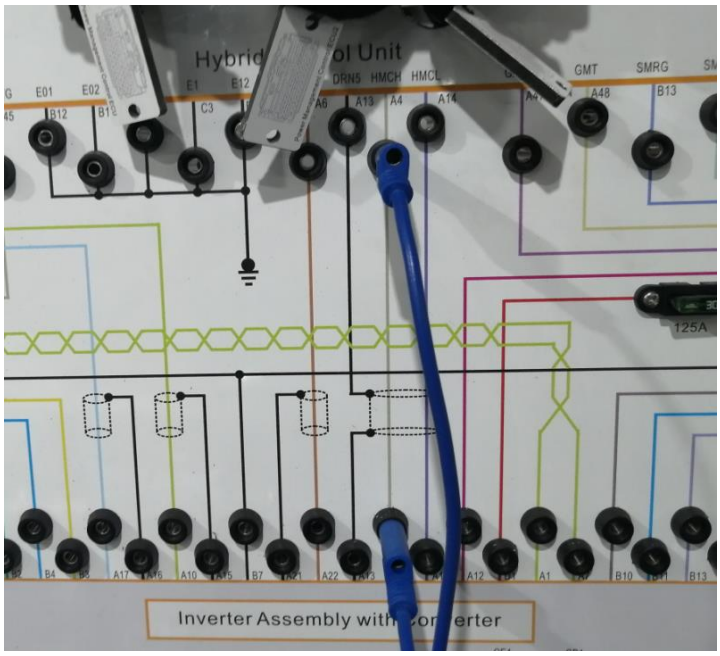
R(A20-A4) = _____

R(A21-A14) = _____

Inverter terminals and hybrid power control unit terminals	Measured value (Ω)	Standard value (Ω)
A20 and A4	Infinite	Less than 1Ω
A19 and A14	Less than 1Ω	Less than 1Ω

After the above waveform and resistance measurement, it is found that the line between the inverter terminal A20 and hybrid power control unit terminal A4 is open circuit.

3. Use a wire to connect the two terminals of inverter terminal A20 and hybrid power control unit terminal A4. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.



Fault Conclusion: The Hybrid Control Unit Line A4 is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured waveform and resistance are normal.

Experiment #16: Accelerator Pedal Position Sensor Line 6 (“TAPS L6” in tablet)

16.1 Objectives

1. To get familiar with the Accelerator Pedal Position Sensor fault in hybrid power system.
2. Analyze Accelerator Pedal Position Sensor faults in the hybrid power system.
3. Judge the causes of Accelerator Pedal Position Sensor faults.

16.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

Use tablet to set the Accelerator Pedal Position Sensor Line 6 (signal line) to open circuit.

Fault Phenomenon:

1. The engine fault indicator in dashboard is on.

2. Use diagnostic tool to read the fault code P121014/P213800, the throttle / accelerator pedal position sensor has fault.

16.3 Circuit Diagram:

Definition of accelerator pedal position sensor terminals:
Terminal 4: Accelerator pedal position sensor 5.0V power input terminal (The power switch is placed in the ON / IG position, the voltage is 4.5-5.5V).
Terminal 1: Accelerator pedal position sensor (2) 5.0V power input terminal (The power switch is placed in the ON / IG position, the voltage is 4.5-5.5V). Terminal 6: Accelerator pedal position sensor signal output terminal (The power switch is placed in the ON / IG position, the voltage is 2.6-4.5V when press the accelerator pedal, 0.4-1.4V when release the accelerator pedal).
Terminal 5: Accelerator pedal position sensor ground terminal.
Terminal 2: Accelerator pedal position sensor (2) ground terminal.
Terminal 3: Accelerator pedal position sensor (2) signal output terminal (The power switch is placed in the ON / IG position, the voltage is 3.4-5.3V when press the accelerator pedal, 1.0-2.2V when release the accelerator pedal)

Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:
1. The accelerator pedal position sensor has fault
2. The hybrid power control unit has fault
3. The line has fault

16.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the ground voltage of the accelerator pedal position sensor terminal 6 V(6-GND) is 0V, the ground voltage of the hybrid power control unit terminal A36 V(A36-GND) is 5.0V. It means that the hybrid power control unit has 5.0V power input, but the accelerator pedal position sensor terminal 6 doesn't has power input.

   V(6-GND) = _____

   V(A36-GND) = _____

2. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured that the line resistance between the accelerator pedal position sensor terminal 6 and hybrid power control unit terminal A36 R(6-A36) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

   R(6-A36) = _____

After the above voltage and resistance measurement, it is found that the line between the accelerator pedal position sensor terminal 6 and hybrid power control unit terminal A36 is open circuit.

Use a wire to connect the two terminals of accelerator pedal position sensor terminal 6 and hybrid power control unit terminal A36. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.

Fault Conclusion: The Accelerator Pedal Position Sensor Line 6 is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #17: P Gear Motor Assembly Line 9 ("PG MA L9" in tablet)

17.1 Objectives

1. To get familiar with the P Gear Motor Assembly fault in hybrid power system.
2. Analyze P Gear Motor Assembly faults in the hybrid power system.
3. Judge the causes of P Gear Motor Assembly faults.

17.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

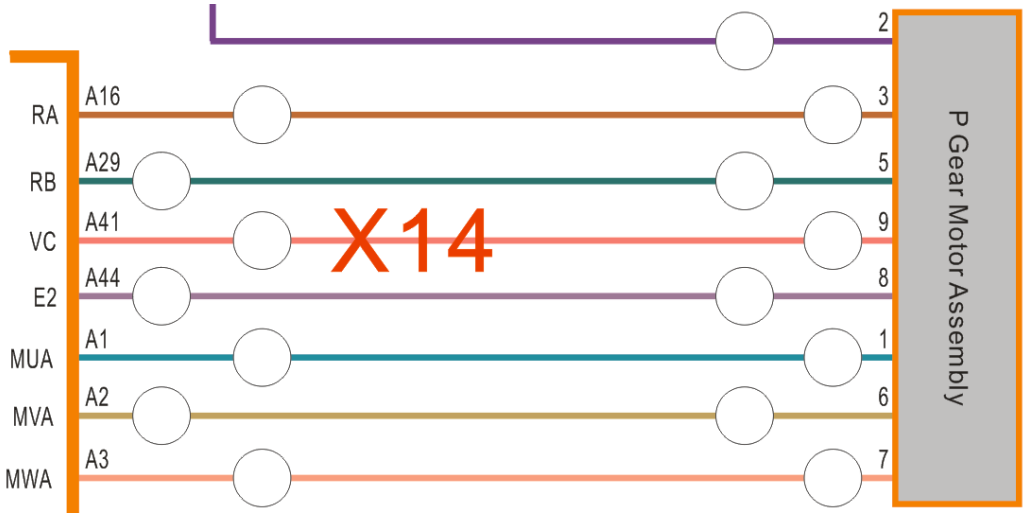
Fault Setting:

Use tablet to set the P Gear Motor Assembly Line 9 to open circuit.

Fault Phenomenon:

Use diagnostic tool to read the fault code P1C8B49, the internal electrical fault of the parking pawl motor control system (Switching control to lock / unlock).

17.3 Circuit Diagram:



Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The parking pawl motor has fault
2. The line has fault

17.4 Operation steps

1. Turn the multimeter to the DC 20V gear, and measured that the ground voltage of the accelerator pedal position sensor terminal 9 V(9-GND) is 0V, the ground voltage of the hybrid power control unit terminal A41V(A41-GND) is 5.0V. It means that the hybrid power control unit has 5.0V power input, but the accelerator pedal position sensor terminal 9 doesn't has power input.

   V(9-GND) = _____

   V(A41-GND) = _____

2. Turn off the one-button start switch, turn the multimeter to 200Ω, and measured that the line resistance between the accelerator pedal position sensor terminal 9 and hybrid power control unit terminal A41 R(9-A41) is infinite. (Note: When measuring resistance, be sure to turn off the one-button start switch to prevent burning components)

   R(9-A41) = _____

After the above voltage and resistance measurement, it is found that the line between the accelerator pedal position sensor terminal 9 and hybrid power control unit terminal A41 is open circuit.

Use a wire to connect the two terminals of accelerator pedal position sensor terminal 9 and hybrid power control unit terminal A41. Then use the diagnostic tool to clear the fault code or turn off the one-button start switch and main power switch to clear the fault code. The fault code can be cleared successfully, and the fault indicator is off. So this line has fault.

Fault Conclusion: The P Gear Motor Assembly Line 9 is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Experiment #18: Cylinder Injector Control Line ("No.1 Injector CL" in tablet)

18.1 Objectives

1. To get familiar with the Cylinder Injector Control Line fault in hybrid power system.
2. Analyze Cylinder Injector Control Line faults in the hybrid power system.
3. Judge the causes of Cylinder Injector Control Line faults.

18.2 Experiment Tools

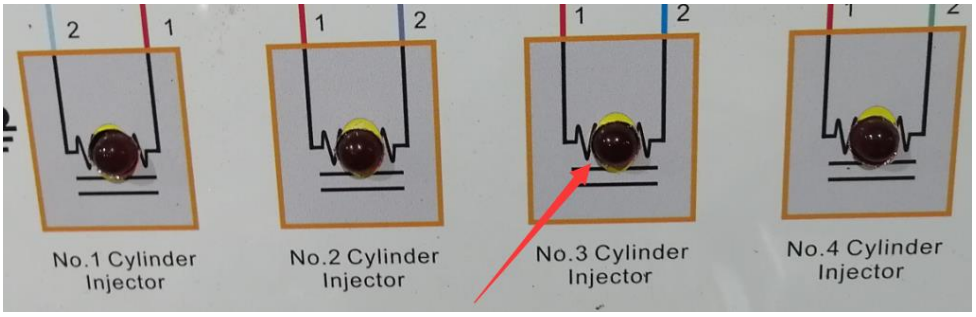
Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

Use tablet to set the No.3 Cylinder Injector Control Line to open circuit.

Fault Phenomenon:

1. The engine shakes severely, the No.3 cylinder does not inject fuel (The indicator is off)



18.3 Circuit Diagram:

Definition of No.1 cylinder injector terminals:
Terminal 1: 12.0V power input terminal
Terminal 2: Injector solenoid valve control terminal

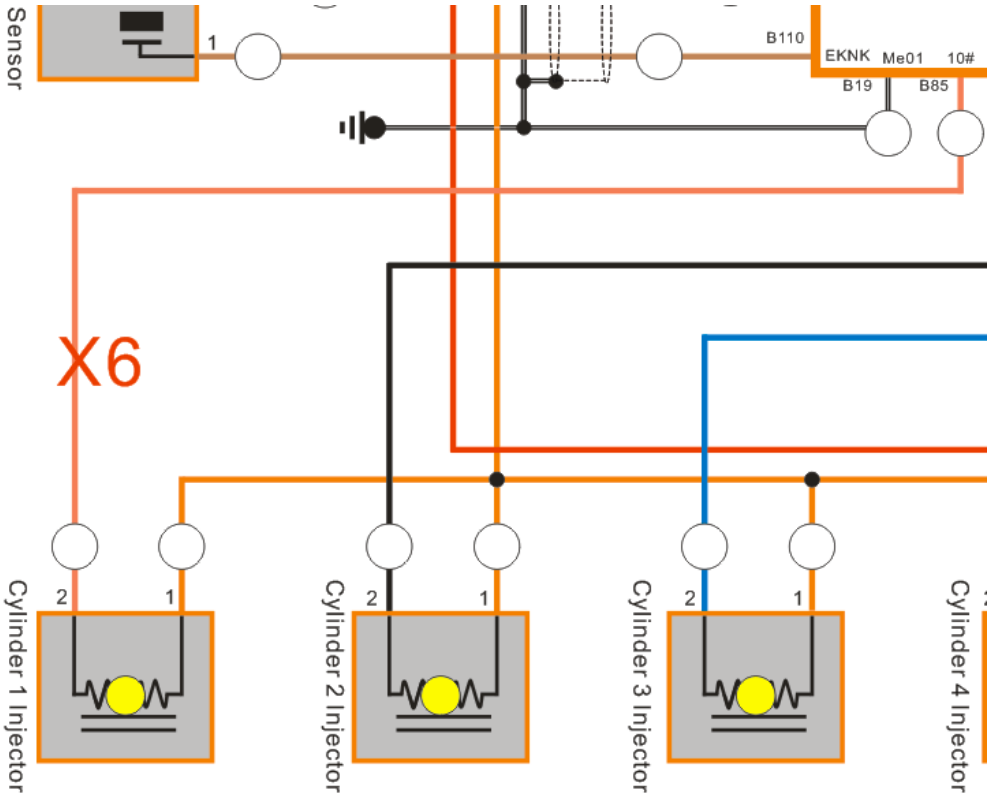
Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The No.1 cylinder injector solenoid valve has fault
2. The engine control unit has fault
3. The line has fault

18.4 Operation steps

1. Use intelligent fault setting box to set Injector 1 open circuit.



2. engine jitters.

3. Test by test lamp. Connect the test lamp to 1# and 2# terminals of the cylinder 1 injector on both ends and the test lamp does not flick (means no fuel injection signal is received); connect the test lamp to 1# terminal of cylinder 1 injector at one end and the engine control unit B85 (10#) at the other end; the test lamp flicks (fuel injection signal is sent by the engine control unit); there is failure.

4. lose the ignition switch and test by the resistance gear of the multimeter. If the resistance between 2# terminal of the 1# fuel injector and the engine control unit B85 (10#) is infinite, it can be determined that the control line of the cylinder 1 fuel injector is broken.

5. repair the line of Injector 1 with intelligent fault setting box and then the fault is eliminated.

Fault Conclusion: The No.1 Cylinder Injector Control Line is open circuit.

Fault Elimination: Clear the fault by tablet, disconnect the wire, the No.1 cylinder injector solenoid valve works normal (The indicator is on), and the measured voltage and resistance are normal.

Experiment #19: Air Flow Meter Line 5 (“AFM L5” in tablet)

19.1 Objectives

1. To get familiar with the Air Flow Meter fault in hybrid power system.
2. Analyze Air Flow Meter faults in the hybrid power system.
3. Judge the causes of Air Flow Meter faults.

19.2 Experiment Tools

Multimeter, Diagnostic tool / Scanner, Oscilloscope, Tablet

Fault Setting:

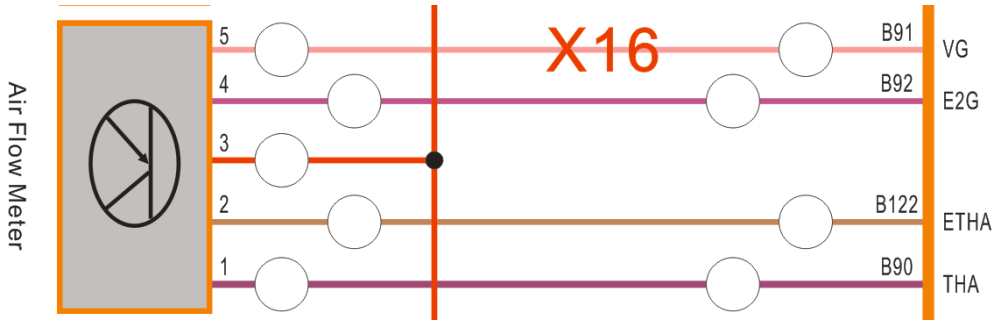
Use tablet to set the Air Flow Meter Line 5 to open circuit.

Fault Phenomenon:

1. The engine fault indicator in dashboard is on.

2. Use diagnostic tool to read the fault code P0102, the circuit voltage of air flow meter is low.

19.3 Circuit Diagram:



Definition of air flow meter terminals:

Terminal 5: Air quality sensor signal output terminal

Terminal 4: Air quality sensor negative terminal

Terminal 3: 12.0V power input terminal

Terminal 2: Intake air temperature sensor negative terminal

Terminal 1: Intake air temperature sensor signal output terminal

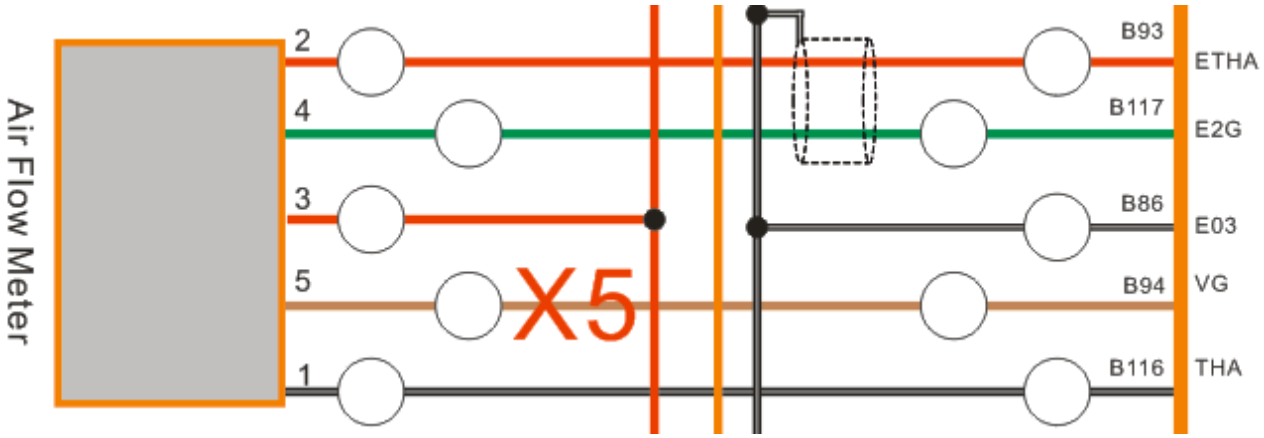
Fault Causes

According to the diagnostic results and the analysis of the circuit diagram, the possible causes of the fault are as follows:

1. The air flow meter has fault
2. The engine control unit has fault
3. The line has fault

19.4 Operation steps

1. Set the signal line of air flow meter as open circuit with intelligent fault setting box



2. Open the ignition switch, connect the decoder and read failure code P0102.

3. test by voltage gear of the multimeter; the voltage between 5# terminal and 4# terminal of the air flow meter is 0.73V (subject to actually measured value), but the voltage between B94 (VG) and B117 (E2G) is 0V; the failure may differ from different voltage value.

4. Lose the ignition switch and test by the resistance gear of the multimeter. If the resistance between 5# terminal and B94 (VG) is infinite, it can be determined that the signal line of the air flow meter is broken.

5. Repair the signal line of the air flow meter with intelligent fault setting box and then the fault is eliminated.

Fault Conclusion: The Air Flow Meter Line 5 is open circuit.
Fault Elimination: Clear the fault by tablet, disconnect the wire, use diagnostic tool and can't read fault code, and the measured voltage and resistance are normal.

Annexe 5

Electric Vehicle Drive and Transmission System Training Unit.

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ECO-CAR
Vocational Training Diploma on Electrical and Hybrid Vehicles

Electric Vehicle Drive and Transmission System Training Unit

Author(s)	Dr. Ma'moun Smadi and Prof. Rebhi Damseh
Organization Name(s)	Al-Balqa Applied University (BAU)
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Co-Leaders	The University of Jordan (UJ), Jordan University of Science and Technology (JUST) & National Technical University of Athens (NTUA)
Number of pages	**56**

Electric Vehicle Drive and Transmission System Training Unit

Table of Content

1.1 Introduction

It adopts the original parts of pure electric vehicle and customized power battery, function and control mode is exactly the same as the general pure electric vehicles, which truly presents the connection control relation, installation location and operation parameters of the core components of electric vehicle drive system.

1.2 Features

1. Complete electric vehicle drive and transmission system to illustrate the structure and working principle.
2. The main components are mounted on the bench, and the connection line is placed in the working place, and the circuit schematic diagram allows the students to master the working principle of the electric drive system.
3. The power battery information display screen displays the power battery voltage / current / temperature, relays status. The dashboard is installed for displaying the vehicle speed and battery level.
4. Pressing the accelerator pedal, the electric motor drives the gearbox and axle to rotate, observing the different parameters during different speed, master the control logic of electric vehicle running and the parameter changes of main components.
5. The brake pedal and hydraulic brake system is installed.
6. The power battery pack is covered with around 5mm transparent acrylic plate on the top, installed with the LED lightbulb lighting, for observing the battery structure.
7. The power battery pack is installed with a mechanical maintenance switch. Before opening the acrylic cover and checking the battery, pull out the mechanical maintenance switch at first to disconnect battery power for safety consideration. An emergency switch also installed.
8. A charger is provided to charge the power battery.
9. Lockable casters are installed to make it lockable and moveable.
10. Equipped with wireless fault-setting and appraisal system by tablet PC.

1.3 Technical Parameters

1. Dimension (mm): 1200*1000*1600 (length * width * height)
2. Input power: AC 220V±10% 50Hz
3. Power battery type: environmental protection type lithium iron phosphate power battery (square aluminum shell, single cell 3.2V 20AH, 16 sections in series)

   Power battery pack total capacity: 51.2V 20AH

   Total charge and discharge: 2000 times

Working temperature: - 20 °C ~ +40 °C

5. Motor controller:

Input voltage range: 40~75V DC

Rated output current: 55A

Maximum output current: 180A

Controller starting voltage: 35V DC

Communication method: CAN communication

Protection level: IP66

Insulation resistance: test insulation resistance not less than 20MΩ

Cooling method: natural air cooling

6. Driving motor:

Rated power: 2.2KW

Rated voltage: 48V

Rated current: 78A

Rated speed: 2590RPM

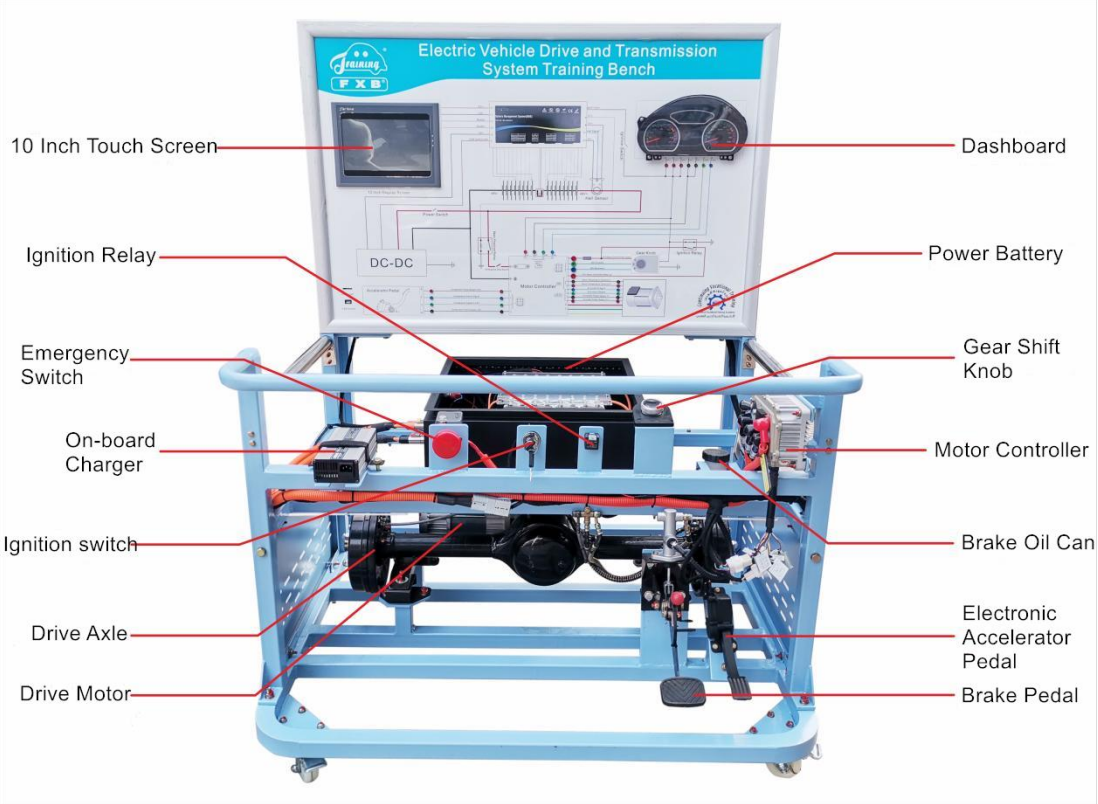
Rated torque: 11.1N.m

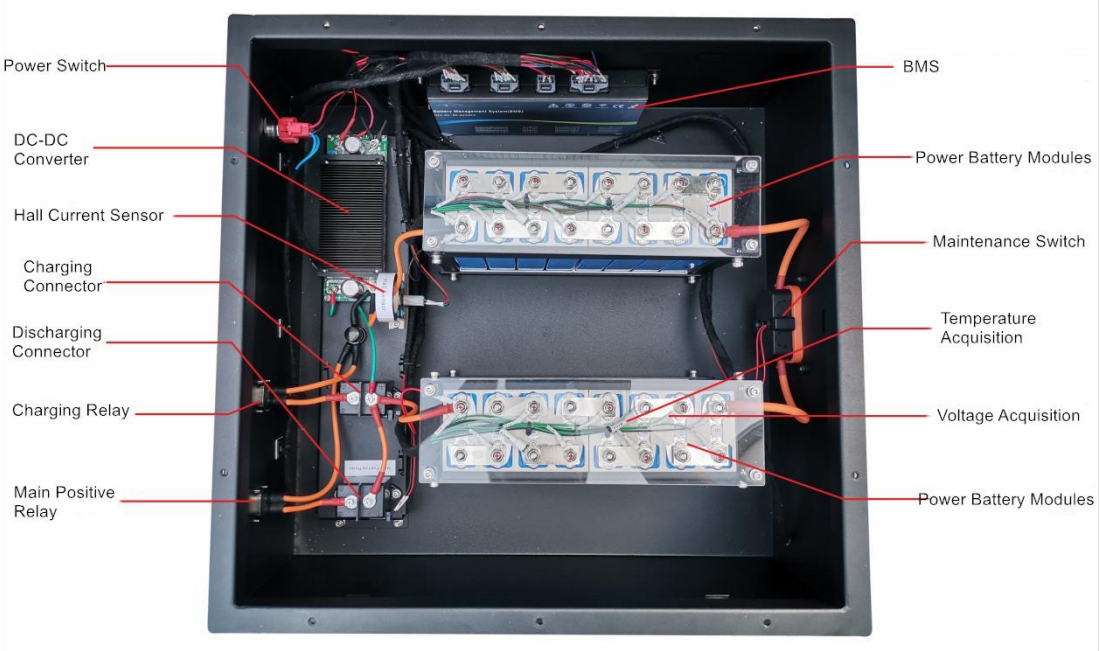
Experiment #1: Electric Vehicle system Components

1.1 Main Constituent Components

Detection and control panel (With various detection terminals and color circuit diagram), ignition switch, dashboard, power battery information display screen, lithium iron phosphate power battery with BMS, battery charger, DC-DC converter, discharging relay, charging relay, hall sensor, maintenance switch, AC controller, driving motor, motor controller, electronic accelerator pedal, gear shift lever, gearbox, brake pedal, hydraulic brake system, axle, emergency switch, wireless fault-setting program, tablet PC, movable framework (with lockable casters).

1.2 Components Location





1.3 Main Component Description

1.3.1 Power Battery & BMS

1. In this equipment, it's lithium iron phosphate power battery (square aluminum shell, single cell 3.2V 20AH, 16 sections in series). Power battery pack total capacity is 51.2V 20AH.

2. The power battery pack is an energy storage device, which is an important component that converts electrical energy into chemical energy, and chemical energy into electrical energy, and then provides energy to other electrical appliances in the vehicle.

3. At present, there are three main types of power batteries commonly used in electric vehicles: lead-acid batteries, nickel-metal hydride batteries, and lithium-ion batteries. Lithium-ion battery is a new type of battery with the best overall performance among all rechargeable batteries.

4. The whole power battery box mainly consists of 3 parts.

1) Battery & BMS: include power battery and BMS, also integrates modules such as DC/DC converter and relays.

2) Charging system: include a portable charger, which can provide a maximum charging current of 10A.

3) Connection system: the link between the above two systems, responsible for connecting the battery and the charger.

5. The functions of BMS.

1) Power battery detection: detect the single cell voltage of 0-16 modules.

2) CAN communication: it has two CAN communication interfaces to communicate with the vehicle system and the charger.

3) Voltage detection: real-time communication to collect data by connecting the collection harness to the positive electrode of the battery.

4) Temperature detection: 4 temperature sensors detect battery and ambient temperature.

5) Relay control: with 2 relay control channels.

6) SOC: real-time calculation of battery remaining capacity.

7) Prevent battery overcharge and overdischarge.

8) Balance managemen: due to the difference in capacity of batteries during production and use. When charging and discharging, some batteries will be fully discharged or fully charged first, and then continuing to charge and discharge will cause the single battery to be overcharged or overdischarged, thus affecting the service life of the battery. So the BMS is used to balance it to prolong the service life of the battery and to make the SOH higher.

1.3.2 DC-DC Converter

1. Features

Input voltage	36V / 48V / 60V / 72V / 144V / 220V
Maximum current	50A
Full load efficiency	>88%
Waterproof level	IP66
Vibration class	SAEJ1378
Ambient temperature	-20℃-50℃

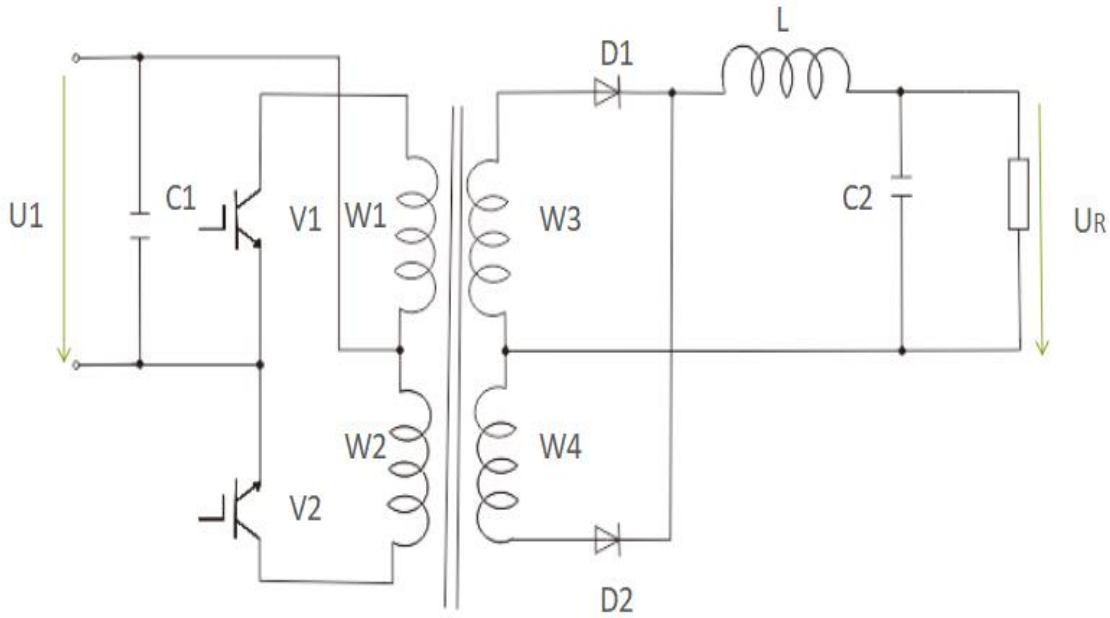
2. The DC-DC converter, also named as the low-voltage charging system, is equivalent to the generator of traditional fuel vehicle. Its function is to convert the 48V high-voltage DC power of the power battery into 12V DC power supply for low-voltage electrical appliances.

1) Reverse connection protection: when the input wire is in reversed connection, it will not start

to avoid damages.

2) Overheating protection: after overheating, the output power is automatically attenuated instead of stopping the output, so as to ensure the continuity of the power supply for the vehicle.
3) Short-circuit protection: current-limit output when the output is short-circuited, and the voltage will automatically recover after the short-circuit disappears to ensure the safety of the vehicle wiring harness.
4) Low voltage protection: when the battery voltage is too low, stop the output to avoid battery over-discharge.

3. Working principle



The DC-DC converter receives the high voltage DC signal of the power battery, converts it into high voltage AC through the two IGBTs V1 and V2, and then passes through the primary windings W1 and W2 of the transformer, outputs the AC low voltage through the secondary coils W3 and W4, and then the AC is converted into low-voltage DC through the rectifier bridge of the transformer, and finally charges the battery and supplies to low-voltage electrical equipment. At the same time, there is also a monitoring circuit in the converter to control the output voltage within the range required by the battery.

1.3.3 Hall Current Sensor

Hall current sensors can detect various types of current, from direct current to alternating current of several kilohertz, and their working principle is mainly based on the Hall effect.

1.3.4 Charger

When charging, the BMS receives the charging signal from the charging port, and the BMS detects the battery voltage, current, temperature and balance state, then analyzes and calculates the battery power according to these battery parameters. The 220V high-voltage AC is converted into high-voltage DC in the charger to charge the power battery. Please turn on the power switch to wake up the BMS, then it starts charging.

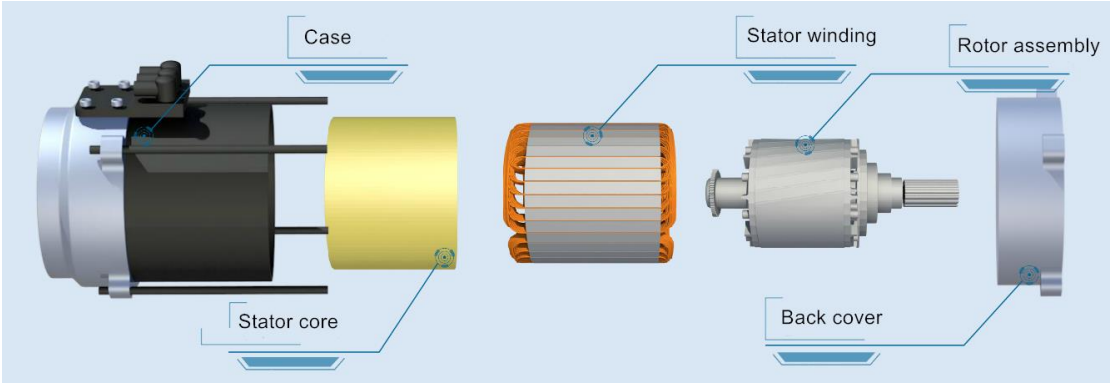
1.3.5 Driving and Transmission System

It includes driving motor, motor controller, accelerator pedal, brake pedal, gear shift knob, drive axle, differential, etc. In electric vehicles, the core of the drive system is driving motor, its performance and efficiency directly affect the performance of electric vehicles. The technology of battery, motor controller and energy management has a lot to do with safe and reliable operation. Among them, the motor control system can improve the performance of the vehicle power performance and cruising range. For example, when the vehicle runs at low speed, a large torque is required to overcome the resistance of the vehicle, constant torque is required

at the rated speed, and the kinetic energy of the motor needs to be converted into electrical energy during braking, these all require the motor controller to complete.

1. Driving motor

1) The driving motor of an electric vehicle uses the principle of electromagnetic induction to convert electrical energy into mechanical energy. It uses the energized coil (that is the stator winding) to generate a rotating magnetic field and acts on the rotor to form a magneto-electric rotational torque. The motor is mainly composed of stator and rotor.



2) The encoder sensor is installed on the back cover. When the motor is running, the encoder sensor rotor rotates with the motor rotor and provides the corresponding signal to the controller. The controller determines the speed and position signal of the motor according to the signal of the encoder sensor.

3) There are two sets of rotor position detection encoders A and B in the driving motor. When the rotor rotates one cycle, the position sensor outputs 64 pulse signals. For example, when the motor rotor rotates clockwise, the encoder A signal has 90 degrees advance to the encoder B signal.

4) There is also a set of temperature detection lines in the driving motor to detect the temperature of the motor when it is working, to prevent the motor from overheating during operation, and to cut off the power in time in case of overheating.

5) The power supply in the three main power lines U/V/W is the three-phase variable frequency AC power supplied by the motor controller to drive the motor to work.

2. Motor Controller

Input voltage range (DC/V)	30~60
Maximum output current (AC/A)	275
Rated output current (AC/A)	85
Controller startup voltage (DC/V)	35
Maximum output power (KW)	12
Working ambient temperature range	-30℃-55℃
Protection class	IP66
Efficiency	98%
Motor control method	Vector device with speed sensor
Communication method	CAN bus

1) The advanced vector control algorithm is adopted to realize the precise control of the motor torque and speed by the controller.

2) Braking or energy feedback control to improve the driving mileage of the vehicle.

3) The buzzer prompts various faults, which is convenient for maintenance.

4) Protection functions of accelerator failure, undervoltage, overvoltage, overcurrent, overheating, etc. to improve the reliability of the system.

5) CAN bus communication.

6) Its main functional modules are:

Current sensor: Detect the actual current when the driving motor is working. Voltage sensor: Detect the actual voltage supplied to the motor controller during working state.

Temperature sensor: Detect the operating temperature of the driving motor.

Encoder sensor: Detect the speed and position signals of the motor to keep the rotor synchronized with the rotating magnetic field.

Note: After setting the fault of the motor and motor controller, please do not step on the accelerator pedal for a long time, so as to avoid the short circuit caused by the motor running with high current for a long time.

3. Accelerator pedal

The electronic accelerator pedal converts the driver's driving desire into electronic signal through the electronic structure in the pedal, and transmits it to the motor controller through the signal line. After calculating according to the driver's intention, the motor controller reasonably adjusts the power to achieve the driver's driving purpose.

Operating voltage	12 V / DC
Operating temperature	-40°~85℃
Working humidity	≤95%
Signal type	Hall sensor
Output signal voltage	0~5V / DC

4. Brake pedal and hydraulic brake system

Drum brakes and hydraulic brake system are adopted. When braking, the brake pedal pushes the hydraulic oil in the brake hose to form oil pressure to open the drum brake pads. At this

time, the brake pads and the wheel drum will generate friction until the vehicle is stopped. It inhibits tire rotation by the friction force.

5. Gear shift knob

It has three gears R / N / D. According to the driver's intention, the gear position sensor detects the gear position and sends the gear signal to the motor controller. Then the motor controller controls the motor to move forward or reverse or stop.

6. Drive axle

Retarders and Differentials

1) The reducer can effectively change the transmission ratio of the whole vehicle, and realize the change of speed and torque. The main function is to reduce the speed and increase the torque of the driving motor. Electric vehicles are generally designed with a two-stage transmission, forward gear and reverse gear sharing structure, and the reverse gear is realized

by the reversal of the driving motor.

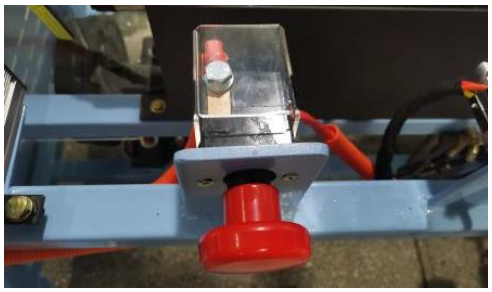
2) When the vehicle turns, the turning radius of the outer wheel is larger than the inner wheel, which requires that the rotation speed of the outer wheel is higher than the inner wheel when turning. The role of the differential is to meet the different requirements of the wheels on both sides when the vehicle turns.

Experiment # 2: Operational Steps

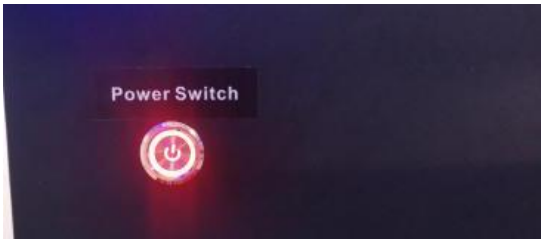
2.1 Equipment Operation

1. Check before starting the equipment: Check whether the high-voltage connection parts are fully connected, whether the low-voltage connectors are fully connected, whether the voltage of the power battery is within the specified range of 40V-50V.

2. Turn off the emergency switch: Pull the emergency switch outward to connect power



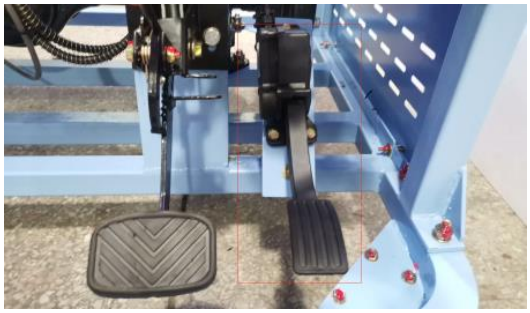
3.Turn on the power switch: Press the power switch to connect the power supply to the unit.



4. Turn on the ignition switch: Turn the ignition switch to the right (Clockwise) to turn the unit on.

5. Shift gear: Select the gear with the gear shift knob. D: forward Direction, R: reverse Direction and N: Neutral (No motion)

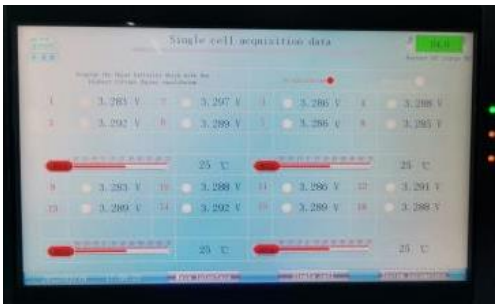
6. Accelerate: After selecting D on the gear shift knob, Press the accelerator pedal, the driving motor can run, and the speed can be checked through the dashboard.



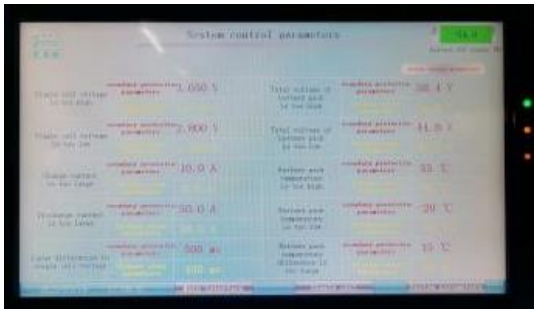
2.2 Touch Screen Operation

1. Select English interface: Select English interface, enter the main interface. You can view the total battery voltage, discharging or charging current, the highest / lowest voltage and highest / lowest temperature of the single battery, the operating status of the system, the status of relays.

2. Click on the single battery interface: you can view the voltage, temperature and balance status of each single cell in the battery.



3. Click on the system parameter interface: you can adjust the voltage of the single battery to set fault. After setting, you can press the parameter calibration OFF in the upper right corner to adjust the value back to the standard value.



2.3 Charging Operation

Safety Precautions:

1. The following operations are available after power off.
2. Pull out the corresponding connectors according to the steps, do not pull out the connectors with brute force to avoid damage.

1. Disconnect the discharging bus: Disconnect the emergency switch, push the high-voltage emergency switch inward to disconnect the discharging bus, or unplug the discharging bus at the power battery pack as shown in figure below.

2. Connect the charging bus: Connect the charging bus to the battery pack charging interface as shown in figure below.

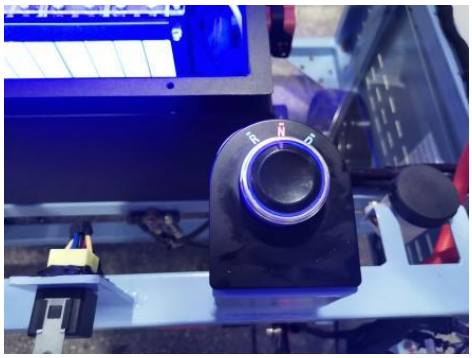
3. Connect the charger: Connect the charging bus to the charger, and then connect the charger to the power supply as shown in figure below.

4. Check before charging: Check whether the charging high and low voltage cables are properly connected.

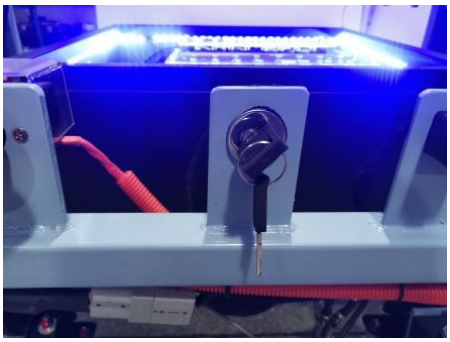
5. Turn on the 12V power switch: Turn on the power switch, then charge the battery.

2.4 Operation after Use

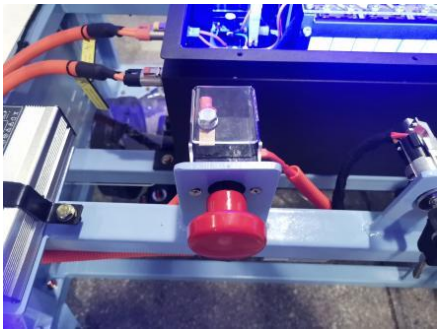
1. Shift the gear back: Adjust the gear knob to the N position.



2. Turn off the ignition switch: Turn the ignition switch to the left (counter clockwise) to OFF.



3. Turn on the emergency switch: Press the emergency switch inward to disconnect power.



4. Turn off the power switch: Turn off the power switch to disconnect power.

2.5 High-voltage Connectors

Safety Precautions:

1. The following operations are available after power off.
2. Pull out the corresponding connectors according to the steps, do not pull out the connectors with brute force to avoid damage.

- **Charging and discharging connectors**

1. Push the connecter latch forward to release the connector from the charging socket.

2. Pull out part of the connector from the charging socket.

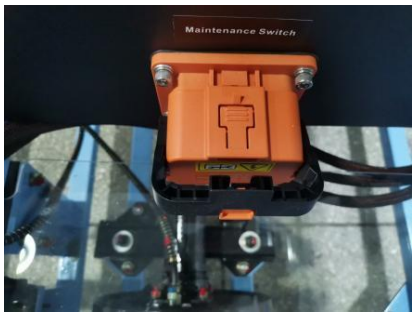
3. Release the latch after it exits the charging socket.

4. Unplug all connectors in the same way.

- **Maintenance Switch**

1. Pull the black handle tenon backward from the top of the orange maintenance switch.

2. Pull the black handle down behind the orange maintenance switch.



3. Press down the latch on the top of the orange maintenance switch to release it.

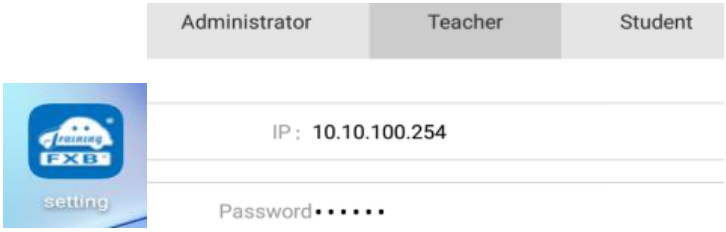
4. While pressing the latch, pull the orange maintenance switch backward to disconnect it.

2.6 Fault-setting Operation

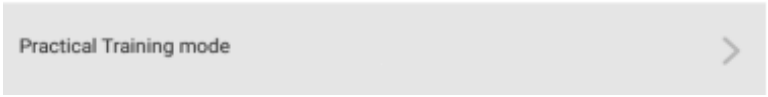
2.6.1 Fault-setting by tablet

(1) Connect the tablet with equipment by WIFI, the WIFI name is "**Electric Vehicle**".

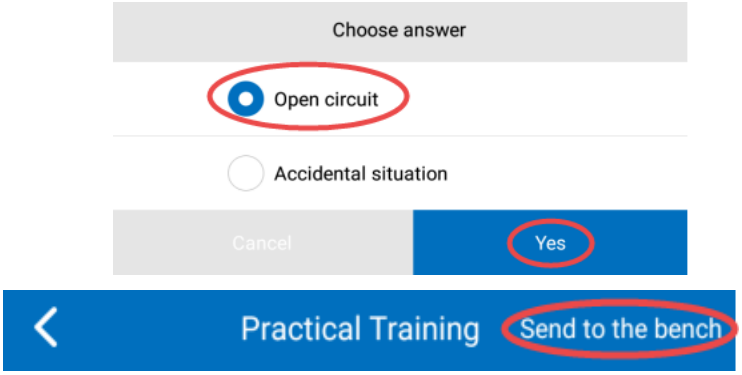
(2) Open the FXB fault-setting APP, then input **IP: 10.10.100.254**, **Password: 123456** to login.



(3) Click "Practical training mode" to choose the fault which you want to set in the list. Total 10 faults.



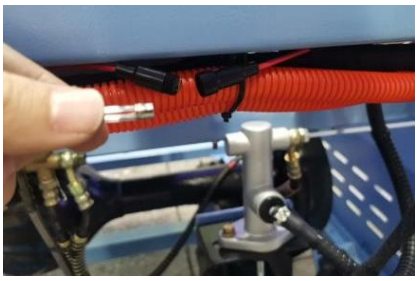
(4) Choose one or more faults from the list, then choose the type "Open circuit" → "Yes" → "Send to the bench".



2.6.2 Fault-setting by manual

Safety Precaution: When removing the fuse, please turn the ignition switch to OFF at first, to avoid the danger of touching high voltage.

Disconnect the connectors to set fault: There are some connectors for fault-setting. Disconnect the connectors and remove the fuse inside.



Start the equipment: Turn on the ignition switch, observe the changes of the display screen, operate the equipment, and find that the operation is abnormal.

Experiment #3: Motor Controller CANH / CANL Line is open circuit ("MC CANH L / MC CANL L" in tablet)

3.1 Objectives

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Motor Controller CANH / CANL Line faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Motor Controller CANH / CANL Line faults.

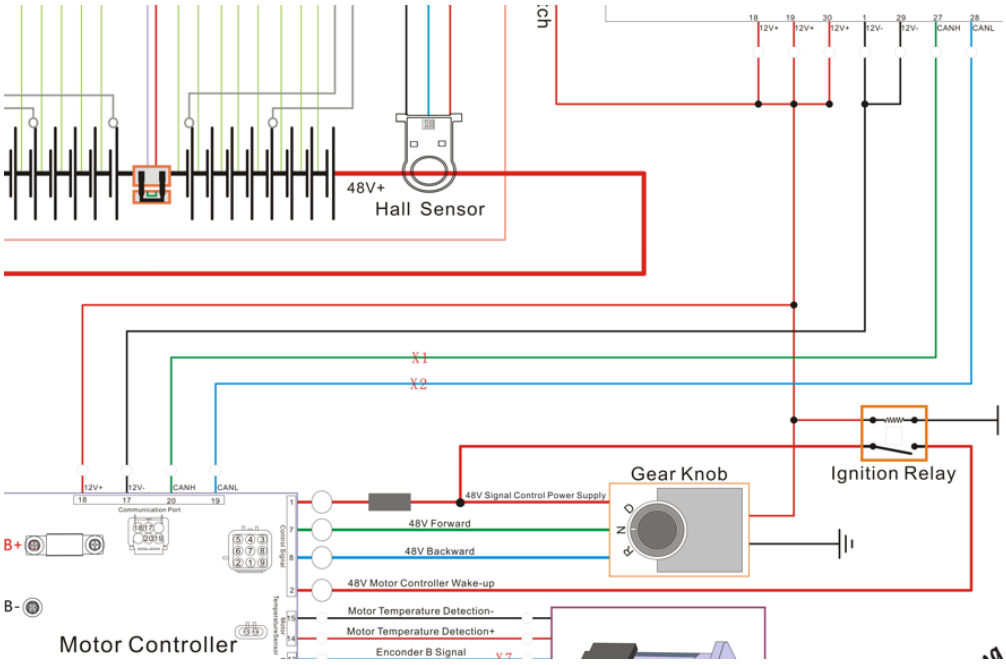
3.2 Introduction

Phenomenon: The equipment operates normally, but the dashboard does not display speed and gear information.

Fault Analysis:

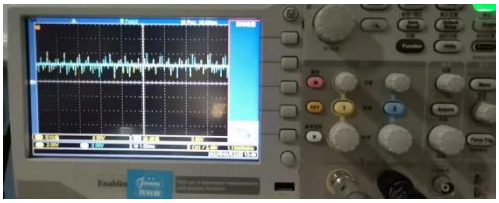
The equipment works normally, and the dashboard is on, but the speed and gear information are not displayed, it can be judged that the communication between the vehicle dashboard and the motor controller has fault.

3.3 Circuit Diagram:



3.4 Detection Procedure:

1. Measure the waveforms of CANH and CANL at the vehicle dashboard terminals by oscilloscope



2. Measure the waveforms of CANH and CANL at the motor controller terminals by oscilloscope

Through the waveforms measurement by oscilloscope at the dashboard and motor controller terminals, it can be seen that there is no waveform of CANL at dashboard terminals, it can be judged that the CANL line is open circuit. Use a wire to connect the terminals of motor control CANL and dashboard CANL, the dashboard works normal. So the line is open circuit.

Conclusion: Motor Controller CANH / CANL Line is open circuit

Experiment # 4: Accelerator Power Supply 12V+ Line is open circuit ("APS 12+L" in tablet)

4.1 Objectives:

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Accelerator Power Supply faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Accelerator Power Supply faults.

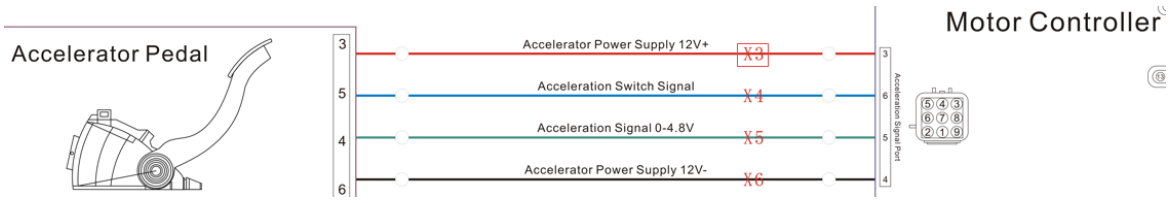
4.2 Introduction

Phenomenon：The gears of equipment can be shifted normally, the dashboard and display screen are normal, it shows that the relays are connected normally. But the motor does not work when the accelerator pedal is pressed

Fault Analysis：

1. The accelerator pedal has fault
2. The motor controller has fault
3. The line between the accelerator pedal and motor controller has fault
4. The line between the motor and motor controller has fault

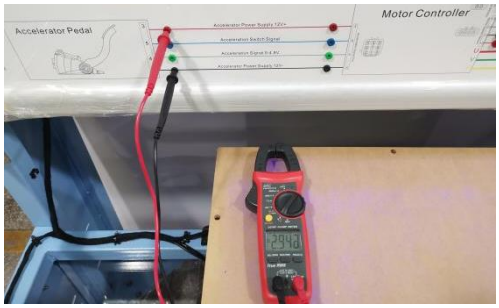
4.3 Circuit Diagram:



4.4 Detection procedure

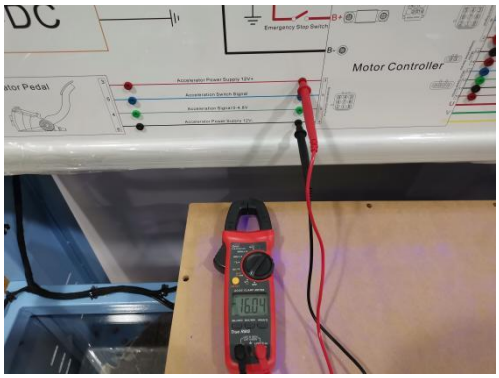
1. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 6) on the accelerator pedal side.

V(3-6)=_____



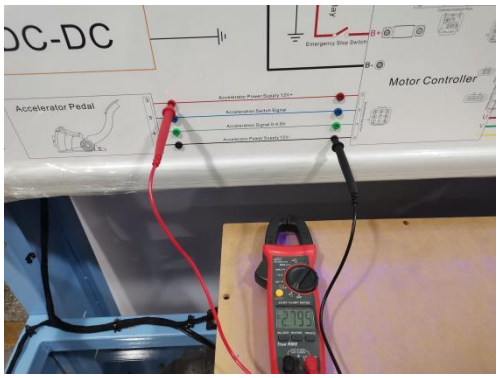
2. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 4) on the motor controller side.

V(3-4)=_____



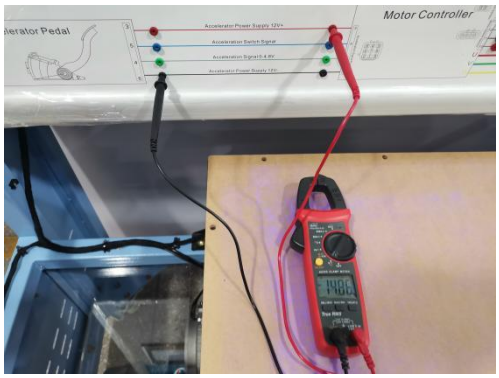
3. Measure the voltage between the accelerator power supply 12V+ (terminal 3) on the accelerator pedal side and the accelerator power supply 12V- (terminal 4) on the motor controller side.

V(3-4)=_____

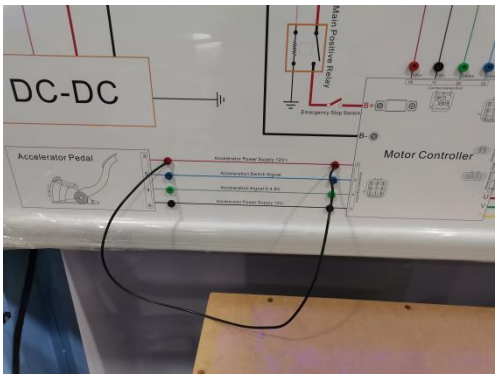


4. Measure the voltage between the accelerator power supply 12V+ (terminal 3) on the motor controller side and the accelerator power supply 12V- (terminal 6) on the accelerator pedal side.

V(3-6)=_____



Through the above voltage detection of the line between the accelerator pedal and the motor controller, it can be concluded that the line of the accelerator power supply 12V+ is open circuit. Use a wire to connect the two terminals of accelerator power supply 12V+ line, press the accelerator pedal and the equipment works normal



Conclusion：Accelerator Power Supply 12V+ Line is open circuit

Experiment # 5: Acceleration Switch Signal Line is open circuit (“AS SL” in tablet)

5.1 Objectives:

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Acceleration Switch Signal faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Acceleration Switch Signal faults.

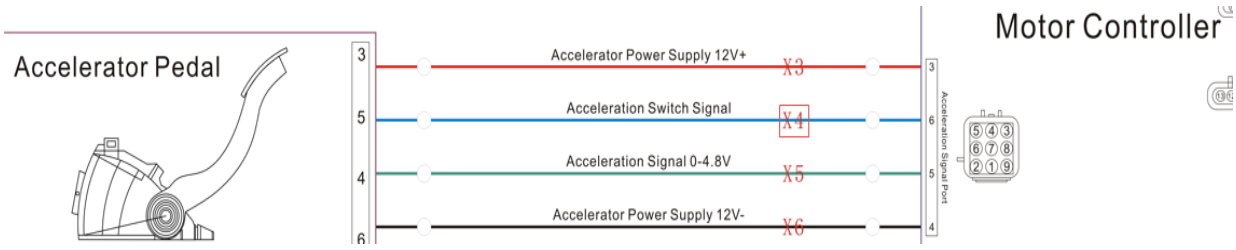
5.2 Introduction

Phenomenon : The gears of equipment can be shifted normally, the dashboard and display screen are normal, it shows that the relays are connected normally. But the motor does not work when the accelerator pedal is pressed

Fault Analysis :

1. The accelerator pedal has fault
2. The motor controller has fault
3. The line between the accelerator pedal and motor controller has fault
4. The line between the motor and motor controller has fault

5.3 Circuit Diagram:



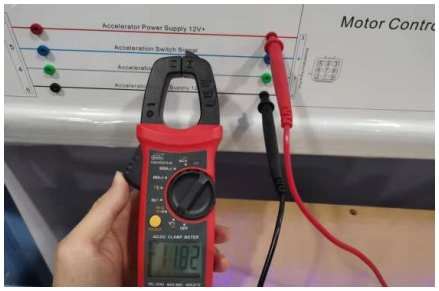
5.4 Detection Procedure:

1. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 6) on the accelerator pedal side.

V(3-6)=_____

2. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 4) on the motor controller side.

V(3-4)=_____



3. Measure the voltage between the acceleration switch signal (terminal 6) and the 12V- ground on the motor controller side.

V(6-12V-)=_____

4. Measure the voltage between the acceleration switch signal (terminal 5) and the 12V- ground on the accelerator pedal side.

V(5-12V-)=_____

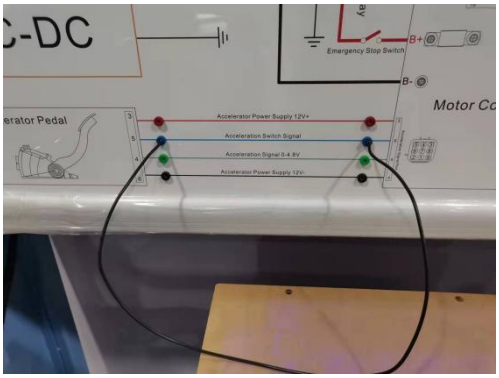
5. Measure the voltage between the acceleration switch signal (terminal 5) and the 12V-ground on the motor controller side.

V(5-12V-)=_____

6. Measure the voltage between the acceleration switch signal (terminal 4) and the 12V-ground on the accelerator pedal side.

V(4-12V-)=_____

Through the above voltage detection of the line between the accelerator pedal and the motor controller, it can be concluded that the line of the acceleration switch signal is open circuit. Use a wire to connect the two terminals of acceleration switch signal line, press the accelerator pedal and the equipment works normal



Conclusion : Acceleration Switch Signal Line is open circuit

Experiment # 6: Accelerator Pedal Signal Line 0-4.8V is open circuit ("APS L4" in tablet)

6.1 Objectives

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Accelerator Pedal Signal faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Accelerator Pedal Signal faults.

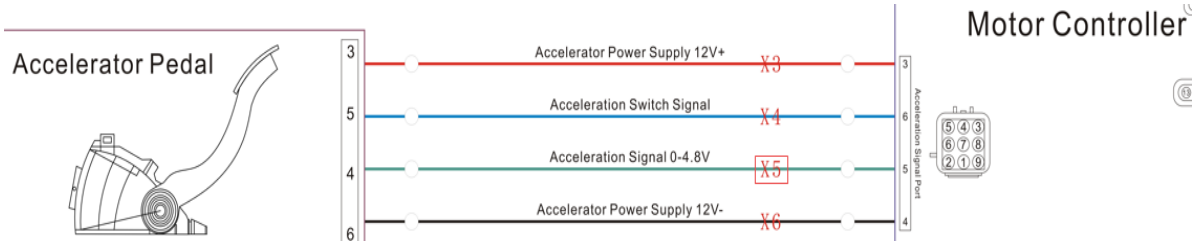
6.2 Introduction

Phenomenon: The gears of equipment can be shifted normally, the dashboard and display screen are normal, it shows that the relays are connected normally. But the motor does not work when the accelerator pedal is pressed

Fault Analysis:

1. The accelerator pedal has fault
2. The motor controller has fault
3. The line between the accelerator pedal and motor controller has fault
4. The line between the motor and motor controller has fault

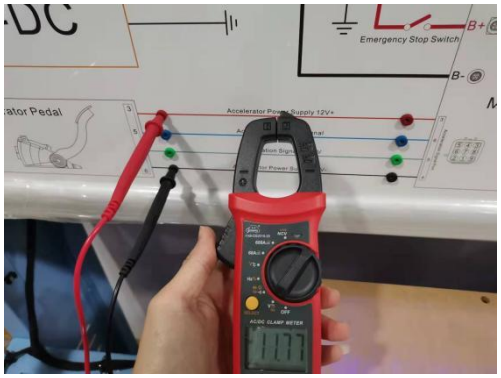
6.3 Circuit Diagram



6.4 Detection procedure

1. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 6) on the accelerator pedal side.

V(3-6)=_____



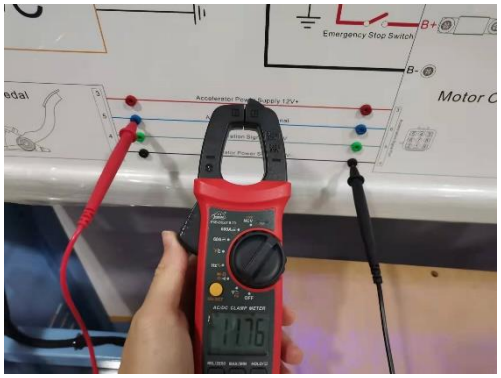
2. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 4) on the motor controller side.

V(3-4)=_____

3. Measure the voltage between the acceleration switch signal (terminal 6) and the 12V- ground on the motor controller side.

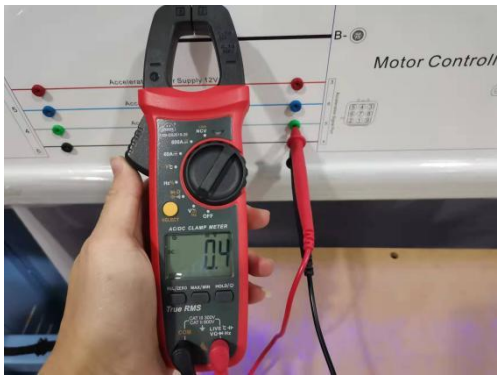
V(6-12V-)=_____

4. Measure the voltage between the acceleration switch signal (terminal 5) and the 12V- ground on the accelerator pedal side.



V(5-12V-)=_____

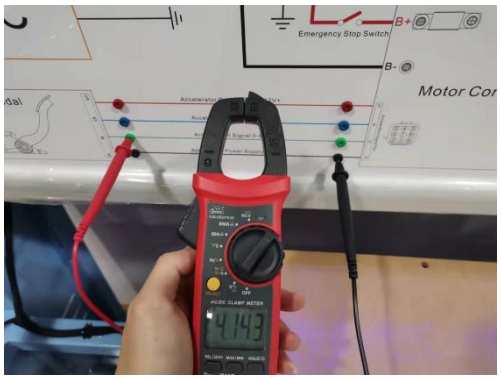
5. Measure the voltage between the acceleration signal (terminal 5) and the 12V- ground on the motor controller side.



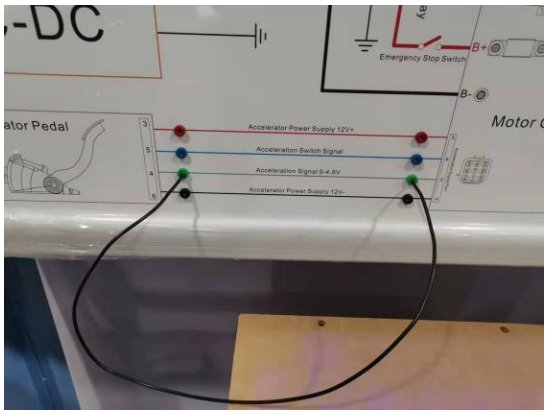
V(5-12V-)=_____

6. Measure the voltage between the acceleration signal (terminal 4) and the 12V- ground on the accelerator pedal side.

V(4-12V-)=_____



Through the above voltage detection of the line between the accelerator pedal and the motor controller, it can be concluded that the line of the accelerator pedal signal 0-4.8V is open circuit. Use a wire to connect the two terminals of accelerator pedal signal 0-4.8V line, press the accelerator pedal and the equipment works normal



Conclusion: Accelerator Pedal Signal Line 0-4.8V is open circuit

Experiment # 7: Accelerator Power Supply 12V- Line is open circuit ("APS 12-L" in tablet)

7.1 Objectives:

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Accelerator Power Supply faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Accelerator Power Supply faults.

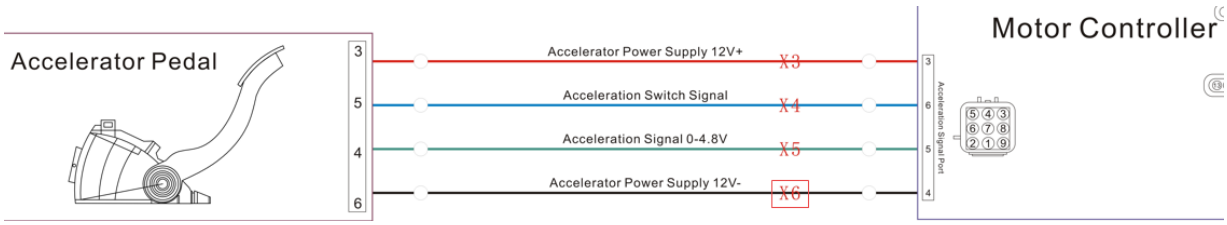
7.2 Introduction

Phenomenon: The gears of equipment can be shifted normally, the dashboard and display screen are normal, it shows that the relays are connected normally. But the motor does not work when the accelerator pedal is pressed

Fault Analysis:

1. The accelerator pedal has fault
2. The motor controller has fault
3. The line between the accelerator pedal and motor controller has fault
4. The line between the motor and motor controller has fault

7.3 Circuit Diagram:



7.4 Detection Procedure

1. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 6) on the accelerator pedal side.

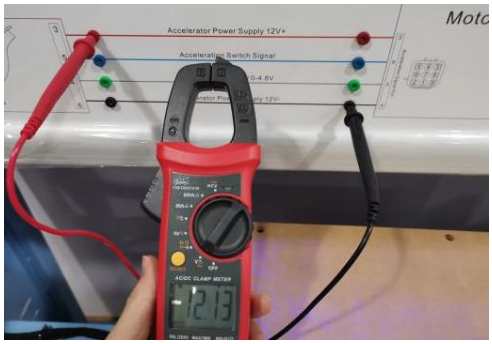
V(3-6)=_____

2. Measure the voltage between the accelerator power supply 12V+ (terminal 3) and the accelerator power supply 12V- (terminal 4) on the motor controller side.

V(3-4)=_____

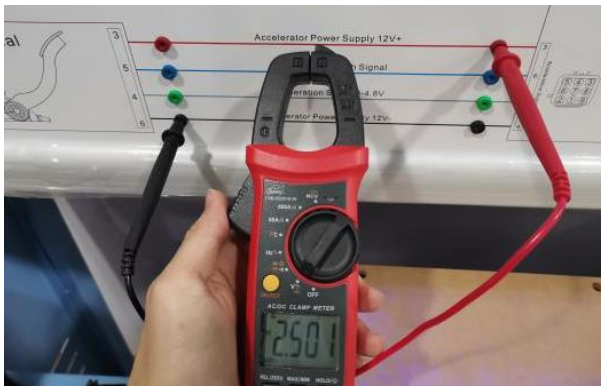
3. The voltage between the accelerator power supply 12V+ (terminal 3) on the accelerator pedal side and the accelerator power supply 12V- (terminal 4) on the motor controller side.

V(3-4)=_____

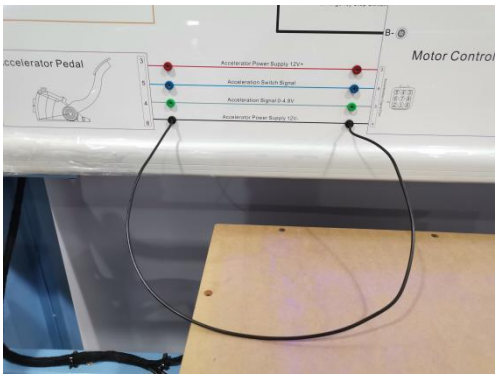


4. The voltage between the accelerator power supply 12V+ (terminal 3) on the motor controller side and the accelerator power supply 12V- (terminal 6) on the accelerator pedal side.

V(3-6)=_____



Through the above voltage detection of the line between the accelerator pedal and the motor controller, it can be concluded that the line of the accelerator power supply 12V- is open circuit. Use a wire to connect the two terminals of accelerator power supply 12V- line, press the accelerator pedal and the equipment works normal



Conclusion : Accelerator Power Supply 12V- Line is open circuit

Experiment # 8: Motor Controller Encoder B Signal Line is open circuit ("MC EB SL" in tablet)

8.1 Objectives:

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Motor Controller Encoder B Signal Line faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Motor Controller Encoder B Signal Line faults.

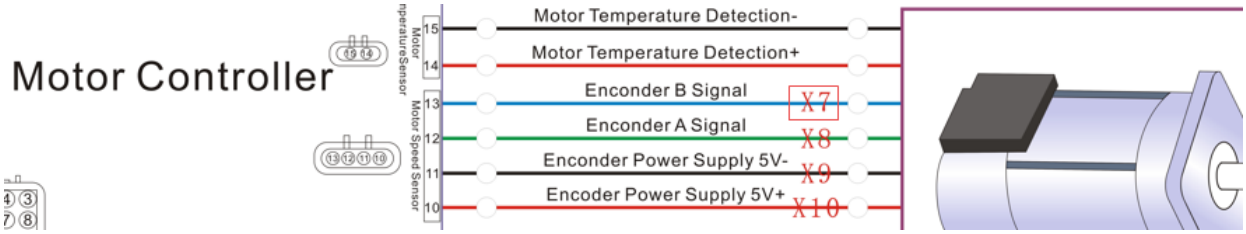
8.2 Introduction

Phenomenon: The gears of equipment can be shifted normally, the dashboard and display screen are normal, the motor runs slowly when the accelerator pedal is pressed

Fault Analysis:

1. The signal line of the accelerator pedal has fault
2. The motor controller has fault
3. The motor has fault
4. The line between the accelerator pedal and motor controller has fault
5. The line between the motor and motor controller has fault

8.3 Circuit Diagram:



8.4 Detection Procedure

1. Measure the voltage of signal lines between the accelerator pedal (AP) and motor controller (MC)

V(MC5-MC4)=_____

V(AP4-MC4)=_____

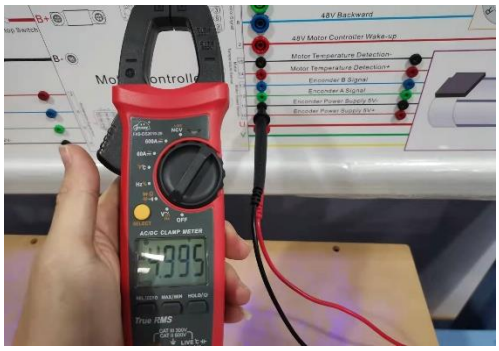
V(MC6-MC4)=_____

V(AP5-MC4)=_____

2. Measure the voltage of encoder power supply positive and negative

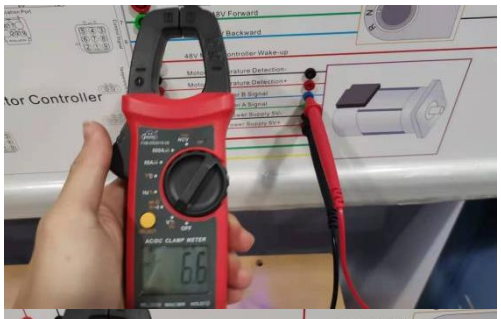
Motor Side
V(5+-5-)=_____

Motor Controller Side
V(5+-5-)=_____

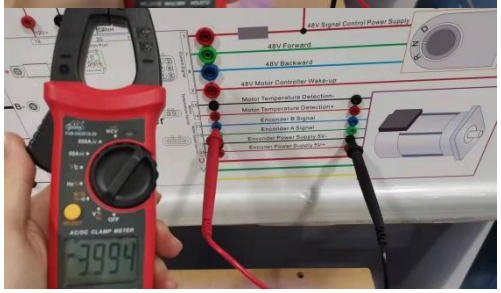


3. Measure the voltage of encoder B signal (EB)

Motor Side
V(EB-5-)=_____



Motor Controller Side
V(EB-5-)=_____

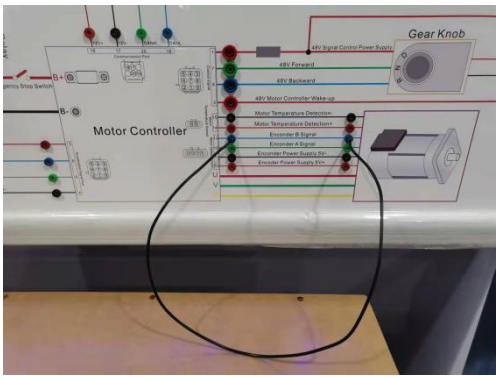


4. Measure the voltage of encoder A signal (EA)

Motor Side
V(EA-5-)=_____

Motor Controller Side
V(EA-5-)=_____

Through the above detection of the line between the accelerator pedal and the motor controller, and the detection of the line between the motor and the motor controller, it can be concluded that the signal line of the encoder B is open circuit. Use a wire to connect the two terminals of encoder B line, and the equipment works normal



Conclusion: Motor Controller Encoder B Signal Line is open circuit

Experiment # 9: Motor Controller Encoder A Signal Line is open circuit (“MC EA SL” in tablet)

9.1 Objectives

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Motor Controller Encoder A Signal Line faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Motor Controller Encoder A Signal Line faults.

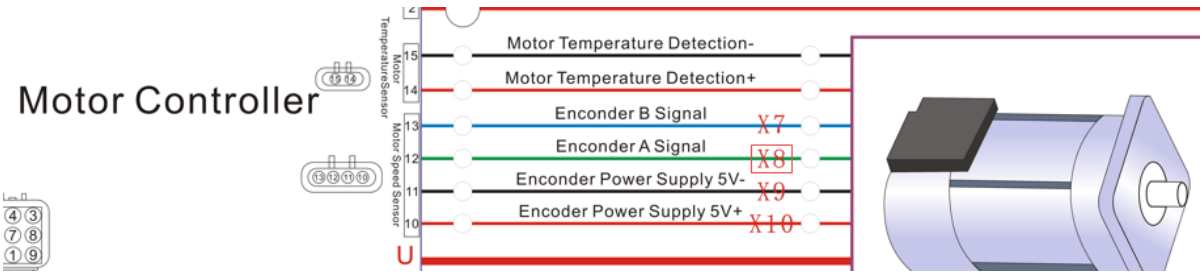
9.2 Introduction

Phenomenon: The gears of equipment can be shifted normally, the motor runs slowly when the accelerator pedal is pressed, and the positive relay is directly disconnected when the accelerator pedal is pressed for a long time, and the motor controller alarms.

Fault Analysis:

1. The signal line of the accelerator pedal has fault
2. The motor controller has fault
3. The motor has fault
4. The line between the accelerator pedal and motor controller has fault
5. The line between the motor and motor controller has fault

9.3 Circuit Diagram:



9.4 Detection Procedure

1. Measure the voltage of signal lines between the accelerator pedal (AP) and motor controller (MC)

V(MC5-MC4)=_____

V(AP4-MC4)=_____

V(MC6-MC4)=_____

V(AP5-MC4)=_____

2. Measure the voltage of encoder power supply positive and negative

Motor Side
V(5+-5-)=_____

Motor Controller Side
V(5+-5-)=_____

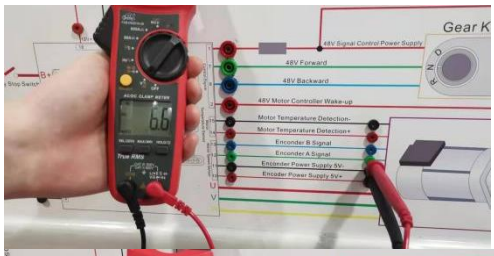
3. Measure the voltage of encoder B signal (EB)

Motor Side
V(EB-5-)=_____

Motor Controller Side
V(EB-5-)=_____

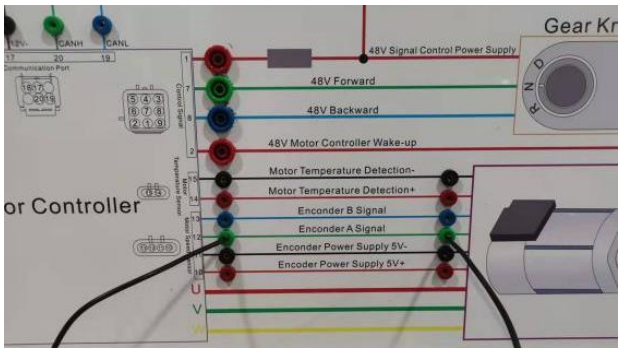
4. Measure the voltage of encoder A signal (EA)

Motor Side
V(EA-5-)=_____



Motor Controller Side
V(EpA-5-)=_____

Through the above detection of the line between the accelerator pedal and the motor controller, and the detection of the line between the motor and the motor controller, it can be concluded that the signal line of the encoder A is open circuit. Use a wire to connect the two terminals of encoder A line, and the equipment works normal



Conclusion: Motor Controller Encoder A Signal Line is open circuit

Experiment # 10: Motor Controller Encoder Power Supply 5V- Line is open circuit (“MC EPS 5V-L” in tablet)

10.1 Objectives

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Motor Controller Encoder Power Supply faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Motor Controller Encoder Power Supply faults.

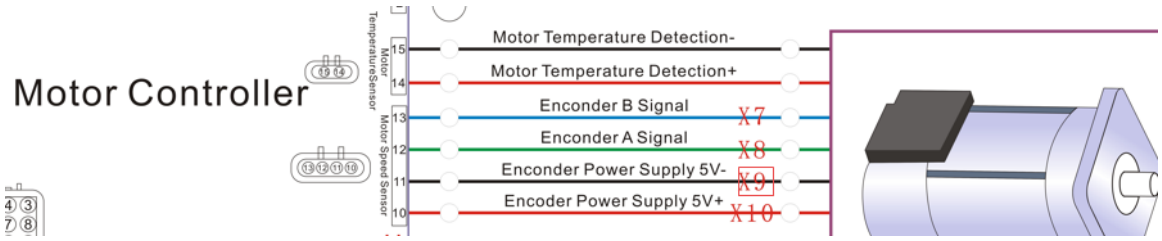
10.2 Introduction

Phenomenon: The gears of equipment can be shifted normally, the dashboard and display screen are normal, but the motor does not work when the accelerator pedal is pressed

Fault Analysis:

1. The accelerator pedal has fault
2. The motor controller has fault
3. The motor has fault
4. The line between the accelerator pedal and motor controller has fault
5. The line between the motor and motor controller has fault

10.3 Circuit Diagram:



10.4 Detection Procedure

1. Measure the voltage of lines between the accelerator pedal (AP) and motor controller (MC)

V(AP3-AP6)=_____

V(MC5-MC4)=_____

V(MC6-MC4)=_____

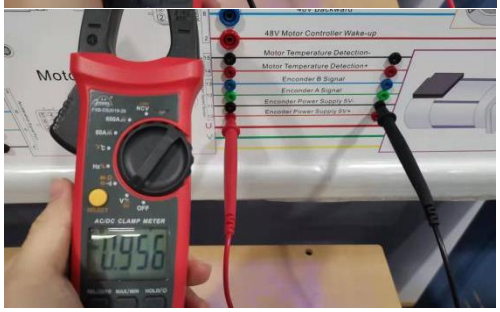
2. Measure the voltage of encoder power supply positive and negative

Motor Side
V(5+-5-)=_____

Motor Controller Side
V(5+-5-)=_____

V(5- -5+)=_____

V(5+-5-)=_____



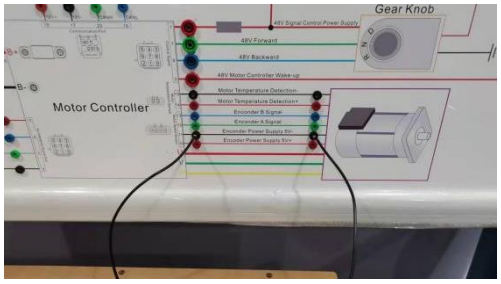
3. Measure the voltage of encoder B signal EB

Motor Side
V(EB-5-)=_____

4. Measure the voltage of encoder A signal (EA)

Motor Side
V(EA-5-)=_____

Through the above detection of the line between the accelerator pedal and the motor controller, and the detection of the line between the motor and the motor controller, it can be concluded that the line of the encoder power supply 5V- is open circuit. Use a wire to connect the two terminals of encoder power supply 5V- line, and the equipment works normal



Conclusion: Motor Controller Encoder Power Supply 5V- Line is open circuit

Experiment# 11: Motor Controller Encoder Power Supply 5V+ Line is open circuit (“MC EPS 5V+L” in tablet)

11.1 Objectives

1. To get familiar with the structure and working principle of electric vehicle drive and transmission system.

2. Analyze and judge Motor Controller Encoder Power Supply faults in the electric vehicle drive and transmission system.

3. Analyze the causes of Motor Controller Encoder Power Supply faults.

11.2 Introduction

Phenomenon: The gears of equipment can be shifted normally, the dashboard and display screen are normal, but the motor does not work when the accelerator pedal is pressed

Fault Analysis:

1. The accelerator pedal has fault

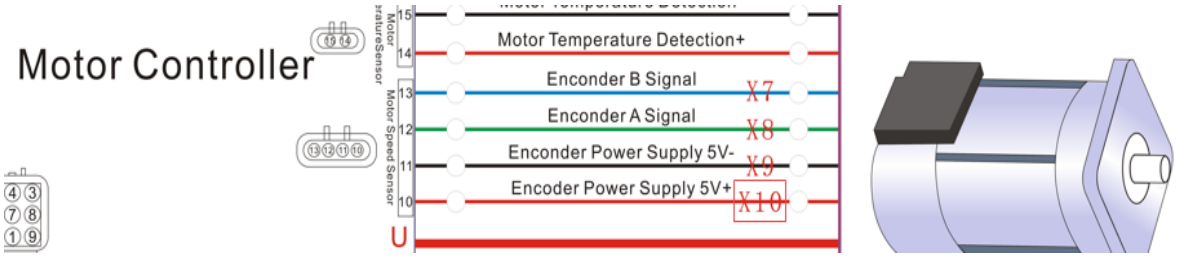
2. The motor controller has fault

3. The motor has fault

4. The line between the accelerator pedal and motor controller has fault

5. The line between the motor and motor controller has fault

11.3 Circuit Diagram:

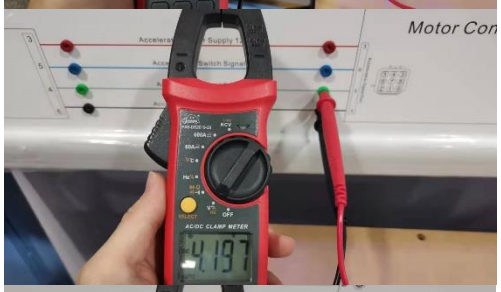


11.4 Detection Procedure

1. Measure the voltage of lines between the accelerator pedal (AP) and motor controller (MC).

V(AP3-AP6)=_____

V(MC5-MC4)=_____



V(MC6-MC4)=_____

2. Measure the voltage of encoder power supply positive and negative: From the motor controller side, measure the voltage between the encoder power supply 5V+ and the encoder power supply 5V-

Motor Controller Side
V(5+-5-)=_____

3. Measure the voltage of encoder power supply positive and negative: From the motor side, measure the voltage between the encoder power supply 5V+ and the encoder power supply 5V-.

Motor Side
V(5+-5-)=_____

4. Measure the voltage between the encoder power supply 5V+ terminals from the motor controller side, and the encoder power supply 5V- terminals from the motor side.

Both Sides
V(5+-5-)=_____

5. Measure the voltage across the encoder power supply 5V- terminals, and the voltage across the encoder power supply 5V+ terminals.

Both Sides
V(5+-5-)=_____

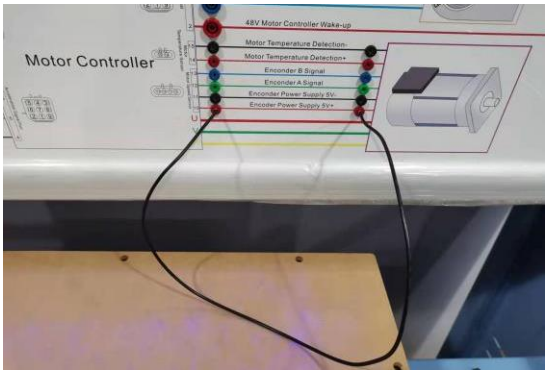
6. Measure the voltage of encoder B signal (EB): From the motor side, measure the voltage between encoder B signal and encoder power supply 5V-

Motor Sides
V(EP-5-)=_____

7. Measure the voltage of encoder A signal (EA): From the motor side, measure the voltage between encoder A signal and encoder power supply 5V-.

Motor Sides
V(EA-5-)=_____

Through the above detection of the line between the accelerator pedal and the motor controller, and the detection of the line between the motor and the motor controller, it can be concluded that the line of the encoder power supply 5V+ is open circuit. Use a wire to connect the two terminals of encoder power supply 5V+ line, and the equipment works normal



Conclusion: Motor Controller Encoder Power Supply 5V+ Line is open circuit

Annexe 6

Autel MaxiSys Pro MS908S User Manual.

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ECO-CAR
Vocational Training Diploma on Electrical and Hybrid Vehicles

Autel MaxiSys Pro MS908S User Manual

Author(s)	Dr. Ma'moun Smadi and Prof. Rebhi Damseh
Organization Name(s)	Al-Balqa Applied University (BAU)
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Task Number & Title	Task 4.3: Prepare the experiment manual according to the course outline (cluster 9) and the received equipment.
WP Leader	Al-Balqa Applied University - Jordan
Co-Leaders	The University of Jordan (UJ), Jordan University of Science and Technology (JUST) & National Technical University of Athens (NTUA)
Number of pages	**50**

Autel MaxiSys Pro MS908S

OBD2 Bi-Directional Diagnostic Scanner and J2534 VCI

Table of Content

1. Introduction

The MaxiSys MS908S Pro Diagnostic Platform is an evolutionary smart solution for specialized automotive diagnosis. Utilizing the powerful Cortex A7+A15 six-core processor, and a 9.7 inch LED capacitive touch screen, combined with the best possible coverage of OE-level diagnostics, and based on the revolutionary multitask-capable Android Operating system, the MaxiSys organizes information with test instrumentation to help you diagnose symptoms, codes, and customer complaints easily, quickly and efficiently.

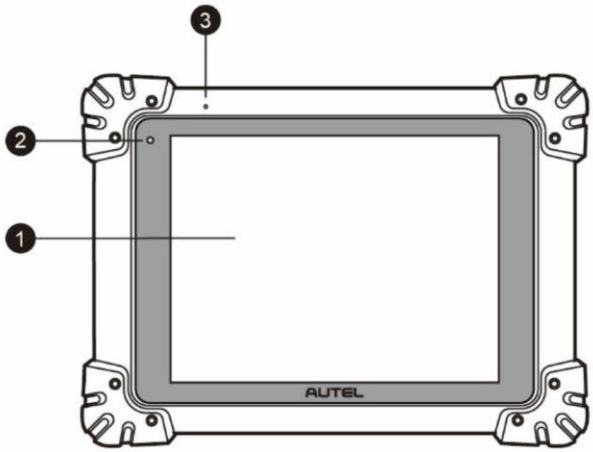
There are two main components to the MaxiSys system:

- MaxiSys Display Tablet – the central processor and monitor for the system.
- Vehicle Communication Interface (VCI) – the device for accessing vehicle data.

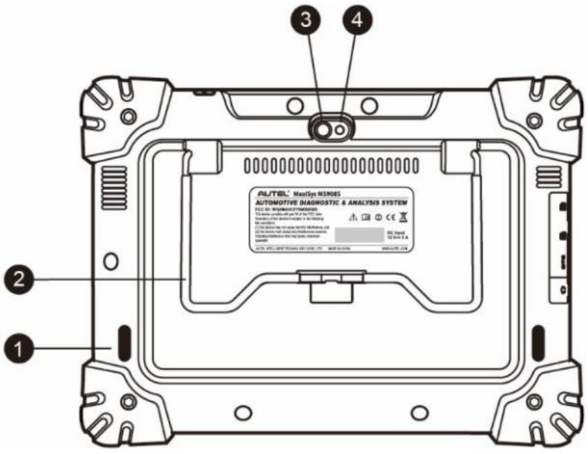
This manual describes the construction and operation of these devices and how they work together to deliver diagnostic solutions.

1.1 MaxiSys Display Tablet

1. 9.7” LED Capacitive Touch Screen
2. Ambient Light Sensor – detects ambient brightness.
3. Microphone



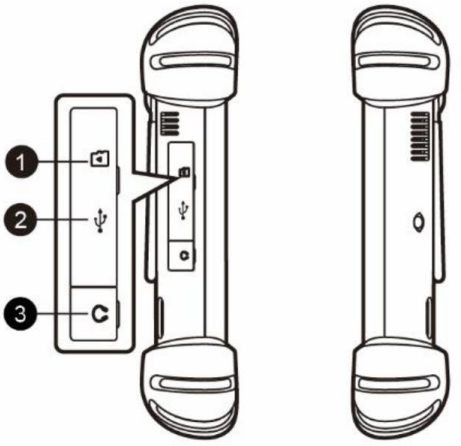
Front view



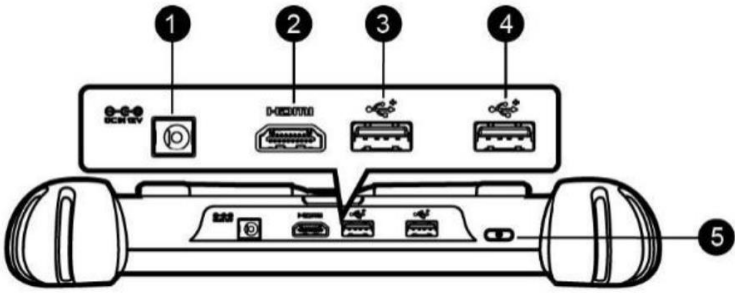
1. Audio Speaker
2. Collapsible Stand – extends from the back to allow hands-free viewing of the tablet at a 30 degree angle.
3. Camera Lens
4. Camera Flash

Back View

1. Mini SD (Secure Digital) Card Slot
2. Mini USB (Universal Serial Bus) Port (it cannot be used at the same time with the No. 4 USB Port in Top Side of the Tablet)
3. Head Phone Jack



Side view



Top View

1. DC Power Supply Input Port
2. HDMI (High-Definition Multimedia Interface) Port
3. USB Port
4. USB Port (it cannot be used at the same time with the Mini USB Port in the Left Side)
5. Lock/Power Button – long press to turn on and off MaxiSys, or short press to lock the screen.

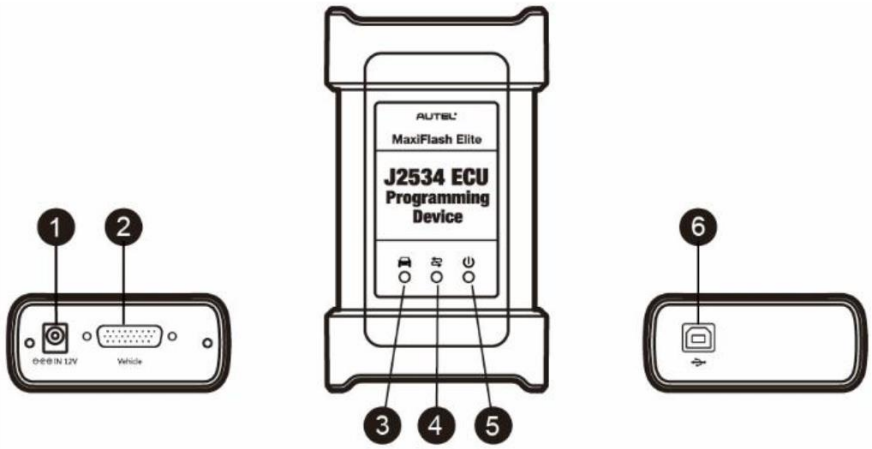
- ## Power Sources

The tablet can receive power from any of the following sources:

- **Internal Battery Pack:** The tablet can be powered with the internal rechargeable battery, which if fully charged can provide sufficient power for about 7.5 hours of continuous operation.
- **AC/DC Power Supply:** The tablet can be powered from a wall socket using the AC/DC power adapter. The AC/DC power supply also charges the internal battery pack.
- **Vehicle Power:** The tablet can be powered from the cigarette lighter or other suitable power port on the test vehicle through a direct cable connection. The vehicle power cable connects to the DC power supply port on the top side of the display unit.

1.2 VCI – J2534 ECU Programming Device

Functional Description



1. DC Power Supply Input Port
2. Vehicle Data Connector
3. Vehicle LED
   - Flashes green when the device is communicating with the vehicle's system

IMPORTANT

Do not disconnect the programming device while this status light is on! If the flash programming procedure is interrupted while the vehicle's ECU is blank or only partially programmed, the module may be unrecoverable.

4. Connection LED
   - Lights solid green when the device is properly connected with the tablet via the USB cable
   - Lights solid blue when the device is connected with the tablet via wireless (BT) connection
5. Power LED
   - Lights solid green when the device is powered on
   - Blinks red when system failure occurs
   - Lights amber automatically at power up when the device is self-testing
6. USB Port

J2534 Programming Capability

The J2534 ECU Programming Device is a SAE J2534-1 & -2 compliant Pass Through programming interface device. Using the updated OEM software, it is capable of replacing the existing software/firmware in the Electronic Control Units (ECU), programming new ECUs and fixing software-controlled drivability issues and emission issues.

Communication

The J2534 ECU programming device supports BT and USB communications. It can transmit vehicle data to the tablet with or without a physical connection. The working range of the transmitter through BT communication is 210 feet (about 70 m). A signal lost due to moving out of range automatically restores itself when the tablet unit is brought closer to the VCI unit.

- **Power Sources**

The J2534 programming device can receive power from both of the following sources:

- Vehicle Power
- AC/DC Power Supply

Vehicle Power

The J2534 programming device operates on 12-volt vehicle power, which it receives through the vehicle data connection port. The device powers on whenever it is connected to an OBD II/EOBD compliant data link connector (DLC). For non OBD II/EOBD compliant vehicles, the device can be powered from a cigarette lighter or other suitable power port on the test vehicle using the auxiliary power cable.

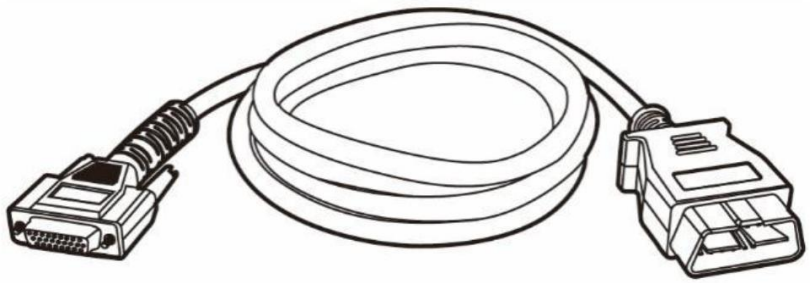
AC/DC Power Supply

The J2534 programming device can be powered from a wall socket using the AC/DC power adapter.

1.3 Accessories Kit

- **Main Cable**

The VCI device can be powered through the Main Cable when connected to an OBD II/EOBD compliant vehicle. The Main Cable is 1.5m length, it connects the VCI device to the vehicle's data link connector (DLC), through which the VCI device can transmit vehicle data to the tablet.



- **OBD I Adapters**

The OBD I adapters are for Non-OBD II vehicles. The adapter used depends on the type of vehicle being tested. The most common adapters are shown(Some adapters are optional, please contact your distributor for details).


Benz-14
(EU Only)


Chrysler-16
(America Only)


BMW-20


Kia-20


Nissan-14


GM/Daewoo-12


Honda-3


Mitsubishi/Hyund
ai-12+16


BMW Ethernet
Cable


Benz-38

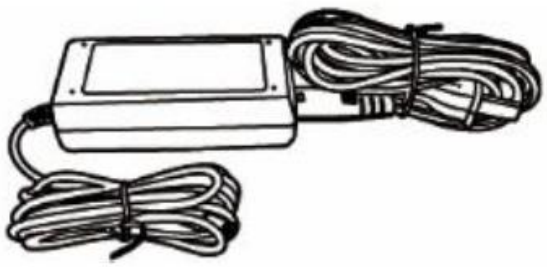

VW/Audi-2+2

1.4 Other Accessories

1. **Standard 2.0 USB Cable**
   Connects the tablet to the VCI unit.

2. **Mini USB Cable**
   Connects the tablet to the Windows-based PC.

3. **AC/DC External Power Adapter**
   Connects the tablet to the external DC power port for power supply.

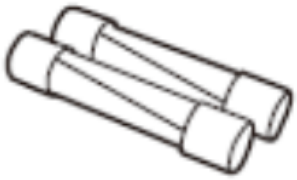


4. **Ethernet Serial Cable**
   Connects the tablet to the VCI unit.

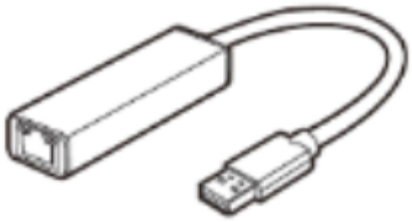
5. **Cigarette Lighter**
   Provides power to the tablet or the J2534 programming device through connection to the vehicle's cigarette lighter receptacle, as some non-OBD II vehicles cannot provide power via the DLC connection.

6. **Clipper Cable**
   Provides power to the tablet or the J2534 programming device through connection to the vehicle's battery.

7. **Lighter Fuse x2**
   A safety device for the cigarette lighter.



8. **USB Ethernet Adapter**
   Connects the device to an Ethernet network.



2. Getting Started

Before starting, make sure the tablet has sufficient power or is connected to the external power supply

2.1 Power Up

Long press the Lock/Power button on the top right side of the tablet to switch the unit on. The power LED will illuminate green. The system boots up and displays the lock screen. Press and drag the inner ring to the edge of the circle to unlock the screen; the MaxiSys Job Menu is shown.

MaxiSys Job Menu

1. Application Buttons
2. Locator and Navigation Buttons
3. Status Icons

Almost all operations on the tablet are controlled through the touch screen. The touch screen navigation is menu driven, which allows you to quickly locate the test procedure, or data that you need, through a series of choices and questions. Detailed descriptions of the menu structures are found in the section for each application.

2.2 Application Buttons

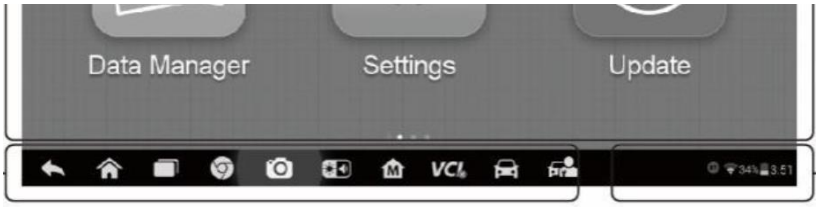
Table 1: Applications

Button	Name	description
	**Diagnostics**	Accesses the unit's diagnostics functions.
	**Service**	Accesses special functions menu.
	**MaxiFix**	Launches the MaxiFix platform that provides the most compatible and abundant repair techniques and diagnostics database.
	**Shop Manager**	Accesses Shop Manager database to store workshop, consumer information and vehicle test history.
	**Data Manager**	Accesses the organization system for saved data files.
	**Settings**	Accesses the system settings menu and general tablet menu.
	**Update**	Accesses system software update menu.
	**VCI Manager**	Accesses VCI connection menu.
	**Support**	Launches the Support platform that synchronizes Autel's online service base station with the MaxiSys tablet.
	**Academy**	Accesses technical tutorials and training articles about the device or vehicle diagnostic techniques.
	**Remote Desk**	Configures your unit to receive remote support using the TeamViewer application.

	Quick Link	Provides associated website bookmarks to allow quick access to product update, service, support and other information.
	Maxi Scope	Configures the unit to operate as an automotive oscilloscope to perform electrical and electronic circuit tests and monitor signal activities.
	Digital Inspection	Configures the unit to operate as a video scope device by connecting to an Imager head cable for close vehicle inspections.

2.3 Locator and Navigation Buttons

Operations of the Navigation buttons shown at the bottom of the screen are described in the following table:



Button	Name	Description
	Locator	Indicates the location of the screen. Swipe the screen left or right to view the previous or next screen.
	Back	Returns to the previous screen.
	Android Home	Returns to Android System's Home screen.
	Recent Apps	Displays a list of applications that are currently working. Tap an app icon to launch. To remove an app, swipe it to the right.
	Browser	Launches the Chrome Internet browser.
	Camera	Opens the camera with short press; takes and saves screenshot image with long press. The saved files are

		auto-stored in the Data Manager application for later reviews.
	**Display & Sound**	Allows you to adjust the brightness of the screen and the volume of the audio output.
	**MaxiSys Home**	Returns to MaxiSys Job Menu.
	**VCI**	Opens the VCI Manager application. The check at the bottom right corner indicates the tablet is communicating with the VCI, an X will display if the tablet is not connected to VCI.
	**MaxiSys Shortcut**	Returns to the Diagnostics screen.
	**Service**	Returns to the Service screen.

- **To use the camera:**

1. Tap the **Camera** button. The camera screen opens.

2. Focus the image to be captured in the view finder.

3. Tap the inner blue circle. The view finder now shows the captured picture and auto-saves the taken photo.

4. Tap the thumbnail image on the top right corner of the screen to view the stored image.

5. Tap the **Back** or **Home** button to exit the camera application.

Refer to Android documentation for additional information.

2.4 Power Down

1. Long press the Lock/Power Button.

2. Tap **Power off** option.

3. Tap **OK**.

2.5 Reboot System

In case of system crash, long press the Lock/Power button and tap **Reboot** to restart the system.

3. Diagnostics

The Diagnostics application can access the electronic control module of various vehicle control systems, such as engine, transmission, antilock brake system (ABS), airbag system (SRS) and more.

3.1 Establish Vehicle Communication

The Diagnostics operations require connecting the MaxiSys MS908S Pro Diagnostic Platform to the test vehicle through the VCI device using the main cable and test adapters (for non-OBD II vehicles). To establish proper vehicle communication to the tablet, you need to perform the following steps:

1. Connect the VCI device to the vehicle's DLC for both communication and power source.
2. Connect the VCI device to the tablet via BT pairing, or USB connection.
3. When the above steps are completed, check the VCI navigation button at the bottom bar on the screen, if a green check displays at the lower right corner, the MaxiSys MS908S Pro Diagnostic Platform is ready to start vehicle diagnosis.

3.2 Vehicle Connection

The method used to connect the VCI device to a vehicle's DLC depends on the vehicle's configuration as follows:

- A vehicle equipped with an On-board Diagnostics Two (OBD II) management system supplies both communication and 12-volt power through a standardized J-1962 DLC.
- A vehicle not equipped with an OBD II management system supplies communication through a DLC connection, and in some cases supplies 12-volt power through the cigarette lighter receptacle or a connection to the vehicle battery.

OBD II Vehicle Connection

This type of connection only requires the main cable without any additional adapter.

- **To Connect to an OBD II vehicle**

1. Connect the main cable's female adapter to the Vehicle Data Connector on the VCI device, and tighten the captive screws.
2. Connect the cable's 16-pin male adapter to the vehicle's DLC, which is generally located under the vehicle dash.

Non-OBD II Vehicle Connection

This type of connection requires both the main cable and a required OBD I adapter for the specific vehicle being serviced.

There are three possible conditions for Non-OBD II vehicle connection:

- DLC connection supplies both communication and power.
- DLC connection supplies communication and power is to be supplied via the cigarette lighter connection.
- DLC connection supplies communication and power is to be supplied via connection to the vehicle battery.

- **To connect to a Non-OBD II Vehicle**

1. Connect the main cable's female adapter to the Vehicle Data Connector on the VCI device, and tighten the captive screws.

2. Locate the required OBD I adapter and connect its 16-pin jack to the main cable's male adapter.

3. Connect the attached OBD I adapter to the vehicle's DLC.

- **To connect the cigarette lighter**

1. Plug the DC power connector of the cigarette lighter into the DC power supply input port on the device.

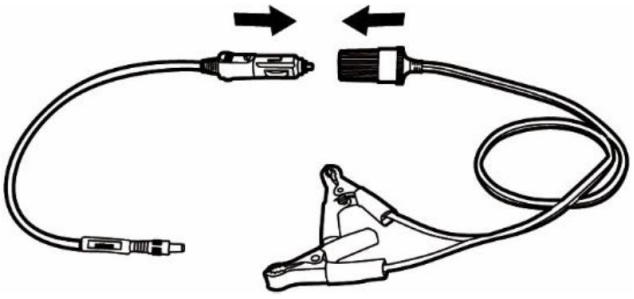
2. Connect the male connector of the cigarette lighter into the vehicle's cigarette lighter receptacle.

- **To connect the clipper cable**

1. Connect the tubular plug of the clipper cable to the male connector of the cigarette lighter.

2. Plug the DC power connector of the cigarette lighter into the DC power supply input port of the J2534 programming device.

3. Connect the clipper cable to the vehicle's battery.



After the VCI device is properly connected to the vehicle, the Power LED on the VCI device illuminates solid green light, and is ready to establish communication with the tablet.

The J2534 ECU Programming Device, which comes with the MaxiSys MS908S Pro tool kit, supports 2 communication methods with the tablet: BT, and USB.

Pairing Up via BT

Among all methods, BT pairing is recommended as the first choice for the communication between the tablet and the VCI device. The working range for BT communication is about 210 feet (70 m); this means you can perform vehicle diagnosis freely around the workshop with greater convenience.

If you use more than one VCI device to connect to the test vehicles when customers are many, you can perform vehicle diagnosis on various vehicles conveniently, by pairing the tablet separately to each of the VCI devices connected to the different test vehicles, via BT, without the need to repeat the plugging and unplugging procedure, which is unavoidable through traditional wired connection, thus saves you more time and provides more efficiency.

To pair up the tablet with the VCI device via BT

1. If not already done, power up the tablet.
2. Select the **VCI Manager** application from the MaxiSys Job Menu.
3. When the **VCI Manager** application is opened, the device automatically starts scanning for available VCI devices around for BT pairing. The found devices are listed in the Setting section on the right side of the screen.
4. Depending on the VCI type you use, the device name may display as Maxi suffixed with a serial number. Select the required device for pairing.
5. When pairing is successfully done, the connection status displayed to the right of the device name is shown as Paired.
6. Wait for a few seconds, and the VCI button on the system Navigation bar at the bottom of the screen shall display a green tick icon, indicating the tablet is connected to the VCI device, and is ready to perform vehicle diagnosis.

USB Cable Connection

The USB cable connection is a simple and quick way to establish communication between the tablet and the VCI device. After properly connecting the USB cable from the tablet to the VCI device, the VCI navigation button at the bottom bar of the screen shows a green tick icon in a few seconds, and the USB LED on the VCI device illuminates solid green light, indicating the connection between the devices is successful.

The MaxiSys diagnostic platform is now ready to perform vehicle diagnosis.

3.3 No Communication Message

A. If the tablet is not connected to the VCI device, an “Error” message displays. An “Error” message indicates the tablet is not communicating with the VCI device, and so cannot gain access to the vehicle control module. In this case, you need to do the following check-ups:

- Check if the VCI device is powered on.

- In case of wireless connection, check if the network is configured correctly, or if the right device has been paired.
- If during the diagnosis process, communication is suddenly interrupted due to the loss of signal, check if there are any objects that causes signal interruption.
- Check if the VCI device is properly positioned. It is recommended to put the VCI device with the front side up.
- Try standing closer to the VCI device to obtain more stable signals, and faster communication speed. In case of wired connection, check the cable connection between the tablet and the VCI device.
- Check if the green LED on the VCI device is illuminated for BT or USB.
- Check if the Error LED on the VCI device is on, this may indicate there is a communication error between the devices, in this case try re-establishing the connection again; if this does not work, there may be a hardware problem with the device, in this case contact for technical support.

B. If the VCI device is unable to establish a communication link, a prompt message displays with check instructions. The following conditions are the possible causes for this massage to display:

- The VCI device is unable to establish a communication link with the vehicle.
- You've selected a system for testing that the vehicle is not equipped with.
- There is a loose connection.
- There is a blown vehicle fuse.
- There is a wiring fault on the vehicle, or the data cable or adapter.
- There is a circuit fault in the data cable or adapter.
- Incorrect vehicle identification was entered.

4. Starting Diagnostics

Prior to first use of the Diagnostics application, the VCI device must be synchronized with the tablet to establish a communication link.

4.1 Vehicle Menu Layout

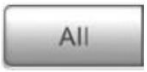
When the VCI device is properly connected to the vehicle, and paired to the tablet, the platform is ready to start vehicle diagnosis. Tap on the Diagnostics application button on the MaxiSys Job Menu, the screen then opens the Vehicle Menu.

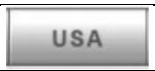
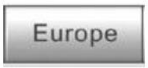
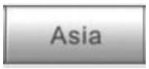
1. Top Toolbar Buttons
2. Manufacturer Buttons

- ***Top toolbar Buttons***

The operations of the Toolbar buttons at the top of the screen are listed and described in the table below:

Top Toolbar Buttons

Button	Name	Description
	**Home**	Returns to the MaxiSys Job Menu.
	**VIN Scan**	Touching this button opens a dropdown list; tap **Auto Detect** for auto VIN detection; tap **Manual Input** to enter VIN manually.
	**All**	Displays all the vehicle makes in the vehicle menu.

	**History**	Displays the stored test vehicle history records. This option provides you direct access to the previously tested vehicle recorded during previous test sessions.
	**USA**	Displays the USA vehicle menu.
	**Europe**	Displays the European vehicle menu.
	**Asia**	Displays the Asian vehicle menu.
	**Domestic**	Displays the Domestic vehicle menu.
	**Search**	Touching this button opens the virtual keyboard, allowing you to manually enter the specific vehicle make required.
	**Cancel**	Touching this button exits the search screen, or cancels an operation.

Manufacturer Buttons

The Manufacturer buttons display the various vehicle logos and the brand names. Select the required manufacturer button after the VCI device is properly connected to the test vehicle to start a diagnostic session.

The small envelop icon displays beside the vehicle brand name is tappable, touching which displays an attached PDF file, showing relevant information, such as vehicle coverage and function list etc. for the corresponding vehicle make.

4.2 Vehicle Identification

The Maxisys diagnostic system supports four methods for Vehicle Identification.

1. Auto VIN Scan
2. Manual VIN Input
3. Manual Vehicle Selection
4. OBD Direct Entry

4.2.1 Auto VIN Scan

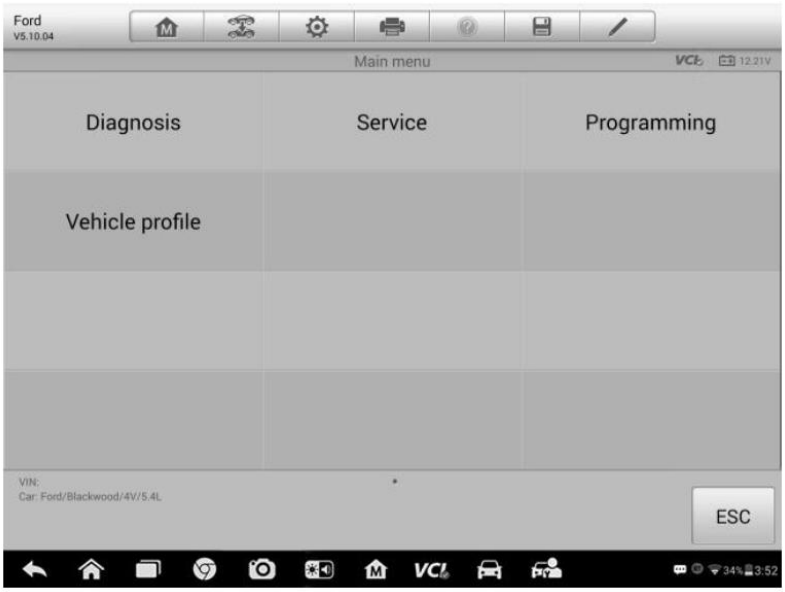
The MaxiSys diagnostic system features the latest VIN-based Auto VIN Scan function to identify CAN vehicles in just one touch, which allows the technician to quickly detect vehicles, scan all the diagnosable ECUs on every vehicle and run diagnostics on the selected system.

- **To perform Auto VIN Scan**

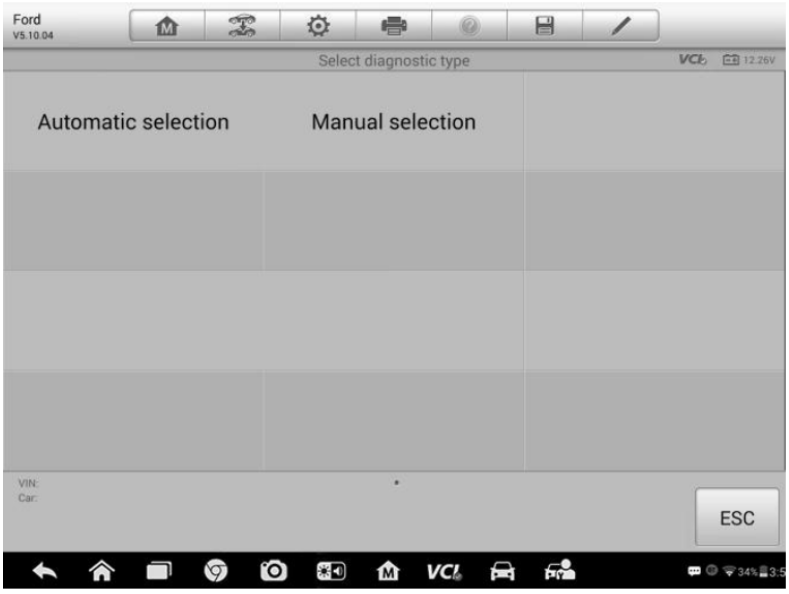
1. Tap the **Diagnostics** application button from the MaxiSys Job Menu. The Vehicle Menu displays.

2. Tap the **VIN Scan** button on the top toolbar.

3. Select **Auto Detect**. The tester starts VIN scanning on the vehicle's ECU. Once the test vehicle is successfully identified, the system will guide you to the Vehicle Diagnostics screen directly as shown in figure below.



In some cases when users have selected the vehicle brand instead of performing Auto VIN Scan in the first place, the system still provides an option for vehicle VIN scan.



Select **Automatic Selection** and the system will proceed to acquire VIN information automatically or allow users to input the VIN manually.

4.2.2. Manual VIN Input

For some vehicles that do not support the Auto VIN Scan function, the MaxiSys diagnostic system allows you to enter the vehicle VIN manually, or simply take a photo of the VIN sticker for quick vehicle identification.

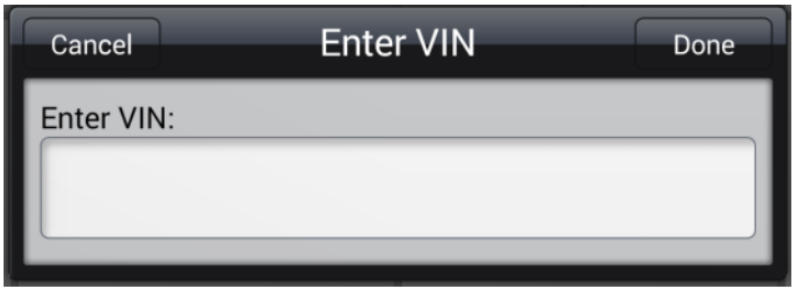
- **To perform Manual VIN Input**

1. Tap the **Diagnostics** application button from the MaxiSys Job Menu. The Vehicle Menu displays.

2. Tap the **VIN Scan** button on the top toolbar.

3. Select **Manual Input**.

4. Tap the input box and enter the correct VIN.



5. Tap **Done**. The vehicle will be identified in a few seconds, and once the matching is successful, the system will guide you to the Vehicle Diagnostics screen directly.

6. Tap **Cancel** to exit Manual Input.

4.2.3. Manual Vehicle Selection

When the vehicle's VIN is not automatically retrievable through the vehicle's ECU, or the specific VIN is unknown, you can choose to select the vehicle manually.

Step-by-step Vehicle Selection

This mode of vehicle selection is menu driven; you simply follow the screen prompts and make a series of choices. Each selection you make advances you to the next screen. A **Back** button at the lower right corner of the screen returns you to the previous screen. Exact procedures may vary somewhat by various vehicles being serviced.

Alternative Vehicle Identification

Occasionally, you may identify a test vehicle that the tester does not recognize; the database does not support, or has some unique characteristics that prevent it from communicating with the tester through the normal channels. In these instances, you are provided with the OBD direct entry, through which you can perform generic OBD II or EOBD tests.

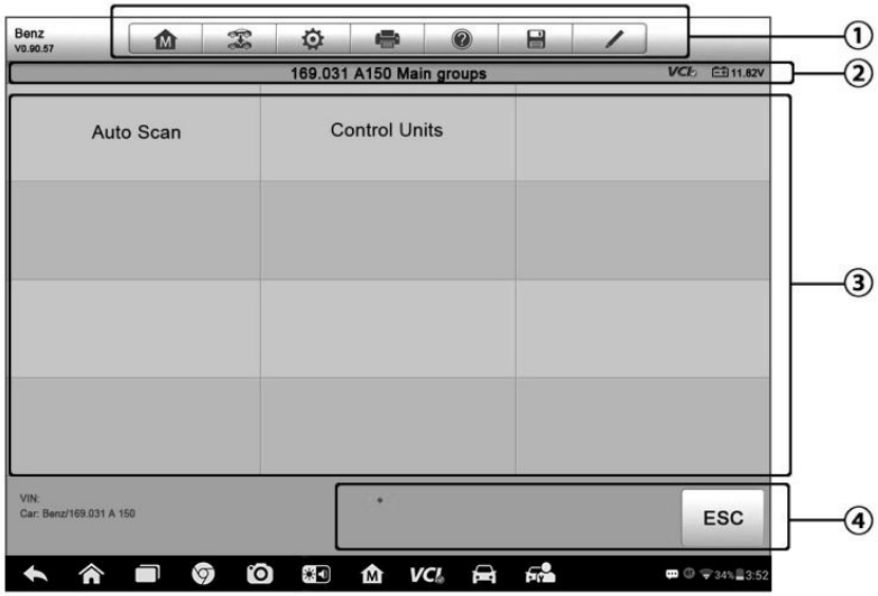
5. Navigation

This section describes how to navigate the Diagnostics interface and select test options.

5.1 Diagnostics Screen Layout

The Diagnostics screens typically include four sections.

1. Diagnostics Toolbar
2. Status Information Bar
3. Main Section
4. Functional Buttons



Diagnostics Toolbar

The Diagnostics Toolbar contains a number of buttons that allow you to print or save the displayed data and make other controls. The table below provides a brief description for the operations of the Diagnostics toolbar buttons:

Diagnostics Toolbar Buttons

Button	Name	Description
	**Home**	Returns to the MaxiSys Job Menu.
	**Vehicle Swap**	Exits the diagnostic session and returns to the vehicle menu screen to select another vehicle for testing.
	**Settings**	Opens the setting screen.
	**Print**	Saves and prints a copy of the displayed data.
	**Help**	Provides instructions or tips for operations of various diagnostic functions.

	**Save**	Taps it to open a submenu, on which there are 3 options available to save the displayed data. • Tap **Save This Page** to take a screenshot image • Tap **Save All Data** to save a PDF file (mostly used to save data that cover more than 1 page) • Tap **Start Saving** to record a video clip (only available for recording Live Data or special graph data) All saved data are stored in the Data Manager application for later reviews.
	**Data Logging**	Records the communication data and ECU information of the test vehicle. The saved data can be reported and sent to the technical center via the Internet. Go to the Support application to follow up the processing progress
	**Send**	Taps it to submit the Data Logging report to the technical center via the Internet.

- **To print data in Diagnostics**

  1. Tap the **Diagnostics** application button from the MaxiSys Job Menu. The **Print** button on the diagnostic toolbar is available throughout the whole Diagnostics operations.

  2. Tap **Print** and a drop-down menu appears.

     a) **Print This Page** – prints a screenshot copy of the current screen.

     b) **Print All Page** – prints a PDF copy of all displayed data.

  3. A temporary file will be created and sent to the computer for printing.

  4. When the file is transferred successfully, a confirmation message displays.

- **To submit Data Logging reports in Diagnostics**

  1. Tap the **Diagnostics** application button from the MaxiSys Job Menu. The **Data Logging** button on the diagnostic toolbar is available throughout the whole Diagnostics operations.

  2. Tap the **Data Logging** button. The button displays blue during the active recording process.

  3. Tap the **Data Logging** button again to finish recording. A submission form will display to let you fill in the report information.

4. Tap the **Send** button to submit the report form via the Internet, a confirmation message displays when sending is successful.

Status Information Bar

The Status Information Bar at the top of the Main Section displays the following items:

1. Menu Title – indicates the menu subject of the Main Section.

2. VCI Icon – indicates the communication status between the tablet and the VCI device.

3. Battery Icon – indicates the battery status of the vehicle.

Main Section

The Main Section of the screen varies depending on the stage of operations. The Main Section can show vehicle identification selections, the main menu, test data, messages, instructions and other diagnostic information.

Functional Buttons

The displayed Functional Buttons at this section of the screen varies depending on the stage of operations. They can be used to navigate, save or clear the diagnostic data, exit scanning as well as make other functional controls. The functions of these buttons will be introduced respectively in the following sections of the corresponding test operations.

5.2 Screen Messages

Screen messages appear when additional input is needed before proceeding. There are mainly three types of on-screen messages as to their purposes: Confirmation, Warning, and Error.

- ***Confirmation Messages***

This type of messages usually displays as an “Information” screen, which informs you when you are about to perform an action that cannot be reversed or when an action has been initiated and your confirmation is needed to continue.

When a user-response is not required to continue, the message displays briefly before automatically disappearing.

- ***Warning Messages***

This type of messages informs you when completing the selected action may result in an irreversible change or loss of data. The typical example for this is the “Erase Codes” message.

- ***Error Messages***

Error messages inform you when a system or procedural error has occurred. Examples of possible errors include a disconnected cable or communication interruption due to certain reasons.

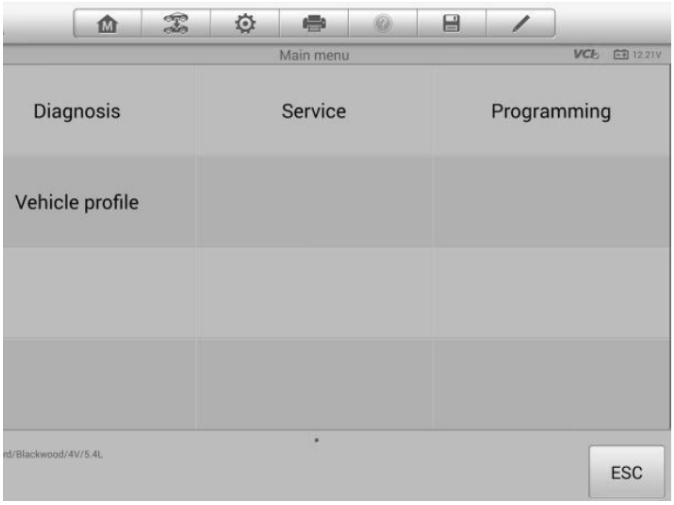
5.3 Making Selections

The Diagnostics application is a menu driven program that presents a series of choices one at a time. As you select from a menu, the next menu in the series displays. Each selection narrows the focus and leads to the desired test. Use your fingertip or the stylus pen to make menu selections.

6. Main Menu

The Diagnostics application allows you to establish a data link to the electronic control system of the test vehicle via the VCI device for vehicle diagnosis, service or programming. You can operate functional tests, retrieve vehicle diagnostic information such as trouble codes, event codes and live data, and perform ECU reprogramming, for various vehicle control systems, such as engine, transmission, ABS and more.

The Vehicle Diagnostics screen as shown in figure below has three main options:



1. Diagnosis – a comprehensive section which includes all available functions: reading, clearing, saving and printing diagnostic information, as well as performing active tests and special functions.

2. Service – a separate section designed to perform vehicle scheduled service and maintenance, such as to reset the service lights and perform calibration for various systems.

3. Programming/Coding – a separate section designed for quick access to ECU reprogramming operations.

After a section is selected and the tablet establishes communication with the vehicle via the VCI device, the corresponding function menu or selection menu displays.

7. Diagnosis

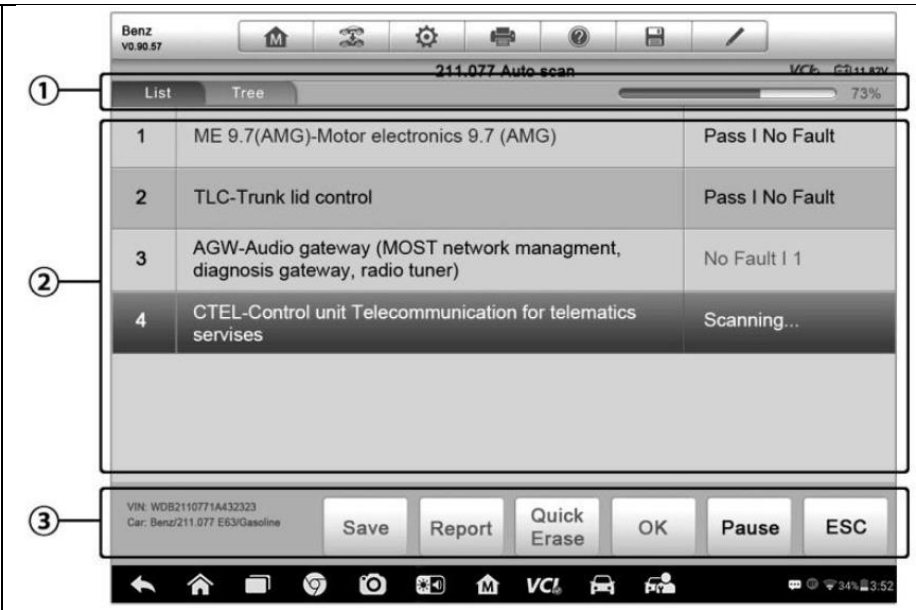
There are two options available when accessing the Diagnosis section:

1. Auto Scan – starts auto scanning for all the available systems on the vehicle

2. Control Units – displays a selection menu of all available control units of the test vehicle.

Auto Scan

The Auto Scan function performs a comprehensive scanning over all the systems on the vehicle's ECU in order to locate fault systems and retrieve DTCs. The sample operation interface of Auto Scan displays as below:

1. Navigation Bar 2. Main Section 3. Functional Buttons	

Navigation Bar

1. List Tab – displays the scanned data in list format

2. Tree Tab – display the scanned data in system distribution diagram format

3. Progress Bar – indicates the test progress

Main Section

A. List Tab

Column 1 – displays the system numbers.

Column 2 – displays the scanned systems.

Column 3 – displays the diagnostic marks indicating different conditions of the test result.

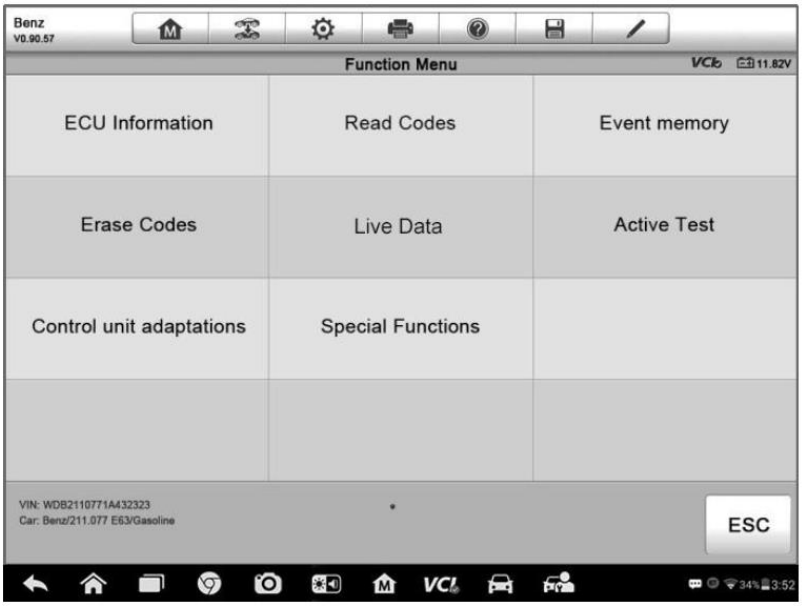
- **-!-**: Indicates that the scanned system may not support the code reading function, or there is a communication error between the tester and the control system.

- **-?-**: Indicates that the vehicle control system has been detected, but the tester cannot accurately locate it.
- **Fault |** #: Indicates there is/are detected fault code(s) present; "#" indicates the number of the detected faults.
- **Pass | No Fault**: Indicates the system has passed the scanning process and no fault has been detected.

B. Tree Tab

The tree tab screen displays a system distribution diagram of the vehicle control modules. The scanned system which has passed scanning with no fault is shown in blue font; whereas the scanned system that has been detected with fault present is shown in red font.

➢ Tab the button to the right of the system item, on which you want to perform further diagnosis and other test activities. A Function Menu screen shall then display as shown below.



7.1 Functional Buttons

The table below provides a brief description of the Functional Buttons' operations in Auto Scan:

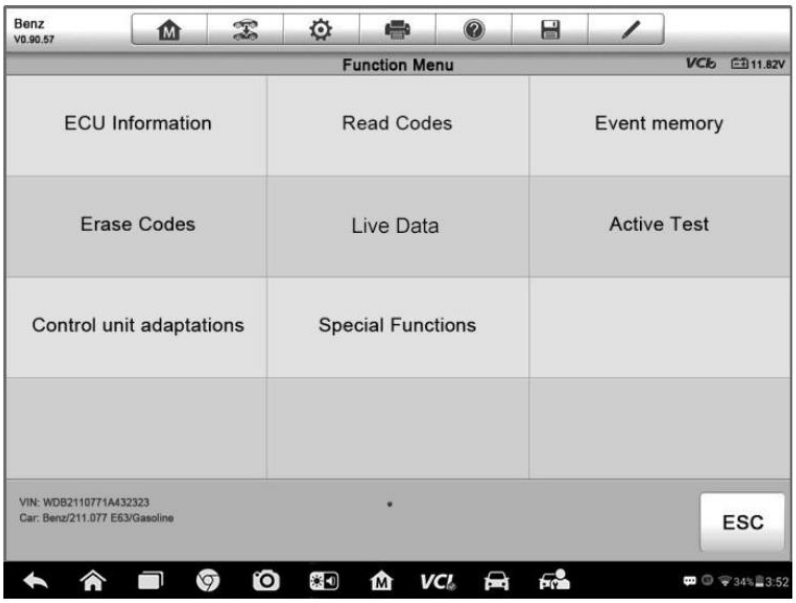
Functional Buttons in Auto Scan

Name	Description
Back	Returns to the previous screen or exit Auto Scan.
Pause	Suspends scanning and changes to show the **Continue** button.

OK	Confirms the test result, and continues to the system diagnosis after selecting the required system by tapping the item in the Main Section.
Quick Erase	Deletes codes. A warning message screen will display to inform you of possible data loss when this function is selected.
Report	Displays the diagnostic data in the report form.
Save	Saves the diagnostic session as a history record, this allows you to quickly restore access to the test systems.

Control Units

This option allows you to manually locate a required control system for testing through a series of choices. Simply follow the menu driven procedure, and make proper selection each time; the program will guide you to the diagnostic function menu after a few choices you've made.



The Function Menu options vary slightly for different vehicles. The function menu may include:

- ECU Information – provides the retrieved ECU information in detail. Selecting opens an information screen.
- Read Codes – displays detailed information of DTC records retrieved from the vehicle control module.
- Erase Codes – erases DTC records and other data from the ECM.
- Live Data – retrieves and displays live data and parameters from the vehicle's ECU.
- Active Test – provides specific subsystem and component tests. This selection may appear as *Actuators*, *Actuator Test*, or *Function Tests* and the tests options vary depending on the manufacturer and model.

- Special Functions – provides component adaptation or variant coding functions for custom configurations, and also allows you to reprogram adaptive values for certain components after making repairs. Depending on the test vehicle, this selection may sometimes appear as *Control Unit Adaptations*, *Variant Coding*, *Configuration* or something similar.

To perform a diagnostic function

1. Establish communication with the test vehicle via the VCI device.

2. Identify the test vehicle by selecting from the menu options.

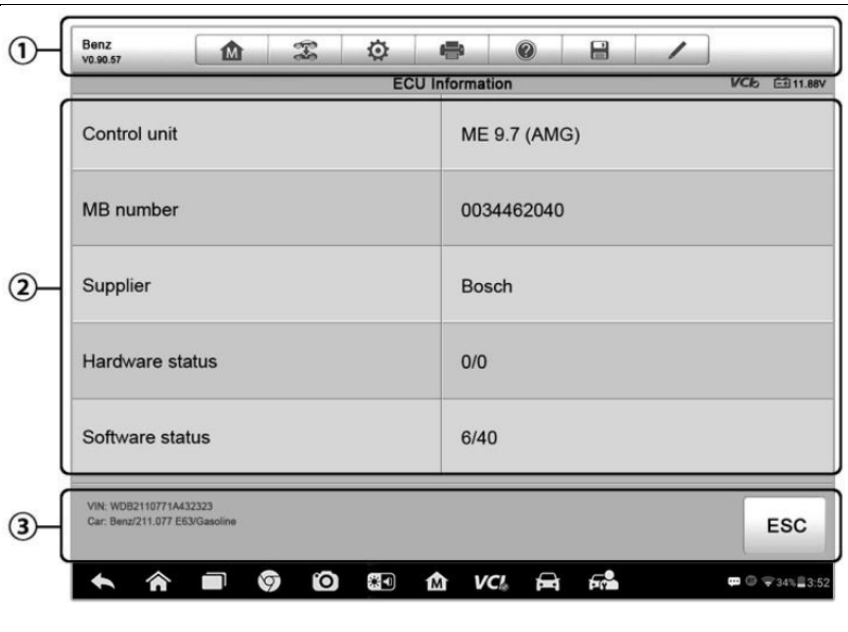
3. Select the **Diagnosis** section.

4. Locate the required system for testing by Auto Scan or through menu driven selections in Control Units.

5. Select the desired test from the Function Menu.

ECU Information

This function retrieves and displays the specific information for the tested control unit, including unit type, version numbers and other specifications. The sample ECU Information screen displays as below:

1. Diagnostics Toolbar Buttons 2. Main Section – the left column displays the item names; the right column displays the specifications or descriptions. 3. Functional Button – in this case, only a **Back** (or **ESC**) button is available; tap it to exit after viewing.	

Read Codes

This function retrieves and displays the DTCs from the vehicle's control system. The Read Codes screen varies for each vehicle being tested, on some vehicles, freezeframe data can also be retrieved for viewing. The sample Read Codes screen displays as below:

1. Diagnostics Toolbar Buttons.

2. Main Section

- Column 1 – displays the retrieved codes from the vehicle.
- Column 2 – indicates the status of the retrieved codes.
- Column 3 – detailed descriptions for the retrieved codes.

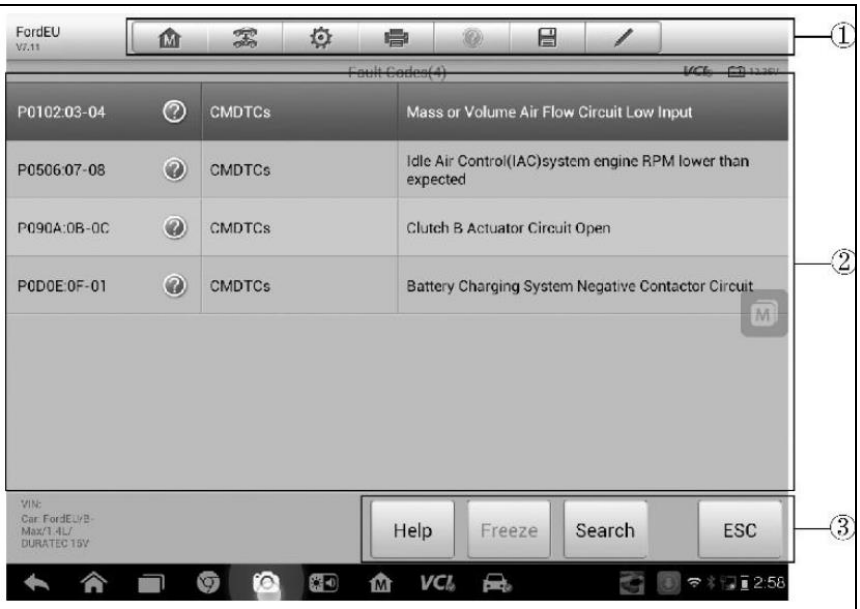
3. Functional Button

● Help – tap it to view the detailed information of the selected DTC.

● Freeze – only available when freeze frame data is available for viewing; Selecting displays a data screen, which looks very similar to the Read Codes interface, therefore same operation method may be applied.

● Search – tap it to search the selected DTC related information on the Internet.

● ESC – tap it to return to the previous screen or exit the function.



Erase Codes

After reading the retrieved codes from the vehicle and certain repairs have been carried out, you can decide to erase the codes from the vehicle using this function. Before performing this function, make sure the vehicle's ignition key is in the ON (RUN) position with the engine off.

To erase codes

1. Tap **Erase Codes** from the Function Menu.
2. A warning message displays to inform you of data loss when this function is applied.

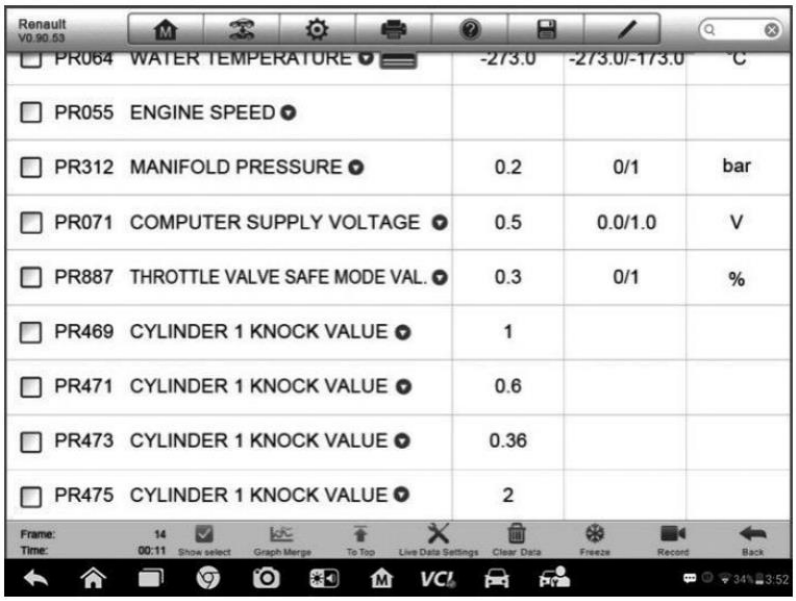
   a) Tap **Yes** to continue. A confirming screen displays when the operation is successfully done.

   b) Tap **No** to exit.
3. Tap **ESC** on the confirming screen to exit Erase Codes.
4. Check the Read Codes function again to ensure the operation is successful.

Live Data

When this function is selected, the screen displays the data list for the selected module. The data available for any control module varies from one vehicle to another. The parameters display in the order that they are transmitted by the ECM, so expect variation among vehicles.

Gesture scrolling allows you to quickly move through the data list. Touch the screen and drag your finger up or down to reposition the parameters being displayed if the data populates more than one screen. The figure below displays a typical Live Data screen:



1. Diagnostics Toolbar Buttons – tap the drop-down button at the top center of the screen displays the toolbar buttons.

2. Main Section

- Name Column – this column displays the parameter names.

a) Check Box – tap the check box at the left side of the parameter name to make selection of an item. Tap the check box again to deselect the item.

b) Drop-down Button – tap the drop-down button at the right side of the parameter name to open a submenu, which provides optional modes by which to display the data.

- Value Column – displays the values of the parameter items.
- Range Column – displays the minimum and the maximum limit value.
- Unit Column – displays the unit for the parameter values.
  - To change the Unit mode, tap the **Setting** button on the top toolbar and select a required mode..

3. Display Mode

There are four types of display modes available for data viewing, allowing you to view various types of parameters in the most suitable way for better data check-ups.

Tap the drop-down button on the right side of the parameter name opens a submenu. There are 4 buttons to configure the data display mode, plus one Help button on the right, active when additional information is available for your reference.

Each parameter item displays the selected mode independently.

- **Analog Gauge Mode** – displays the parameters in form of an analog meter graph
- **Text Mode** – the default mode that displays the parameters in texts and shows in list format.

- **Waveform Graph Mode** – displays the parameters in waveform graphs.

When displaying this mode, three control buttons will appear on the right side of the parameter item, allowing you to manipulate the display status.

  - Text Button – resumes Text Display Mode.
  - Scale Button – changes the scale values, which are displayed below the waveform graph. There are four scales available: x1, x2, x4 and x8.
  - Zoom-in Button – taps once to display the selected data graph in full screen.
- **Digital Gauge Mode** – displays the parameters in form of a digital gauge graph.
- **Full Screen Display** – this option is only available in the waveform graph mode, and mostly used in Graph Merge status for data comparison. There are three control buttons available on the top right side of the screen under this mode.
  - Edit Button – tap to open an edit window, on which you can set the waveform color and the line thickness displayed for the selected parameter item.
  - Scale Button – tap to change the scale values, which are displayed below the waveform graph. There are four scales available: x1, x2, x4 and x8.
  - Zoom-out Button – tap to exit full screen display.

To edit the waveform color and line thickness in a data graph

1. Select 1 to 3 parameter items to display in Waveform Graph mode.
2. Tap the **Zoom-in Button** on the right to display the data graph in full screen.

3. Tap the **Edit Button**, an edit window appears.
4. Select a parameter item on the left column.
5. Select a desired sample color from the second column.
6. Select a desired sample line thickness from the right column.
7. Repeat steps 4-6 to edit the waveform for each parameter item.
8. Tap **Done** to save the setting and exit, or tap **Cancel** to exit without saving.

4. Functional Buttons

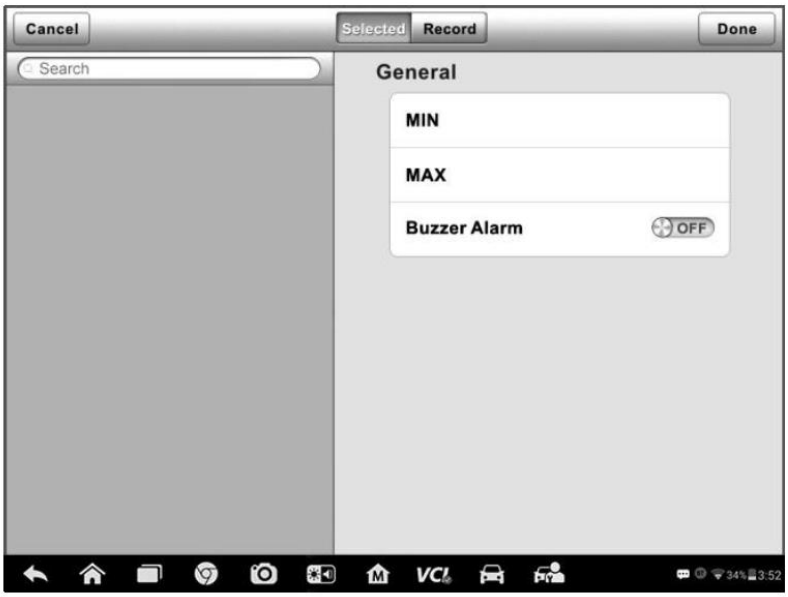
The operations of all the available functional buttons on the Live Data screen are described below:

- **Back** – returns you to the previous screen or exit the function.
- **Record** – starts recording the retrieved live data; the recorded data is then stored as a video clip in the Data Manager application for future reviews. This function could be triggered automatically at preset threshold value or manually as you choose, and the triggering mode and record duration can be configured in the Setting mode of Live Data.
- **Freeze** – displays the retrieved data in freeze mode.
    - Previous Frame – moves to the previous frame in the freeze data.
    - Next Frame – moves to the next frame in the freeze data.
- **Resume** – this button displays when the Record or Freeze function is applied. Tapping this button stops data recording, or exit freeze data mode, and resumes normal data display mode.
- **Flag** – this button displays when the Record function is applied. Tapping this button sets flags for the recorded data at points wherever you choose, when playing back the recorded video clip later in *Data Manager*, the preset flag will enable a popup to allow input of text to take notes.
- **Clear Data** – tap button to clear all previously retrieved parameter values at a cutting point whenever you choose.
- **To Top** – moves a selected data item to the top of the list.
- **Graph Merge** – tap button to merge selected data graphs (for Waveform Graph Mode only). This function is very useful when making comparison for different parameters.

To cancel Graph Merge mode, tap the drop-down button on the right side of the parameter name, and select a data display mode.

- **Show Selected/Show All** – tap button to exchange between the two options; one displays the selected parameter items, the other displays all the available items.

- **Setting** – tap button to open a setting screen, which allows you to set the trigger mode, recording duration, and various threshold values for data recording, and make other controls.



- There are four navigation buttons on top of the **Setting** mode screen.
  - **Range** – displays the configuration screen on which you can set the threshold values, an upper limit and a lower limit, for triggering the buzzer alarm. This function is only applied to the Waveform Graph display mode.

    a) MIN – tap button to open a virtual keyboard to enter the required lower limit value.

    b) MAX – tap button to open a virtual keyboard to enter the required upper limit value.

    c) Buzzer Alarm – switches the alarm on and off. The alarm function makes a beep sound as a reminder whenever the data reading reaches the preset minimum or maximum point.

- **To set threshold limits for the parameter values**

  1. Tap the **Setting** button at the bottom of the Live Data screen.
  2. Tap the **Range** navigation button.
  3. Select a parameter item on the left column, or enter the item name in the Search bar.
  4. Tap on the right side of the **MIN** button, and enter the required minimum value.
  5. Tap on the right side of the **MAX** button, and enter the required maximum value.

6. Tap the **ON/OFF** button on the right side of the Buzzer Alarm button to turn it on or off.

7. Tap **Done** to save the setting and return to the Live Data screen; or tap **Cancel** to exit without saving.

If the threshold limits are successfully set, two horizontal lines now appear on each of the data graphs (when Waveform Graph Mode is applied) to indicate the alarming point. The threshold lines are shown in different colors than the waveform of the parameters for distinction.

- **Record** – displays the configuration screen for Record Setting, on which you can set the trigger type, duration and trigger point for the data recording function.

  a) Trigger Type – sets the trigger mode for data recording, mainly of two- kinds: Manual and Auto. There are four options available:

  1) Manual – allows you to manually start and stop data recording.

  2) DTC – auto triggers data recording when any DTC is detected.

  3) DTC Check Mode – auto triggers data recording when certain pre-selected DTC types are detected.

  4) Parameter – auto triggers data recording when any parameter value reaches the preset threshold.

  b) Duration – sets the recording time (for Auto trigger mode only).

  c) Trigger Point – reserves a relative percentage of a record length before the data recording start point for reference (for Auto trigger mode only).

- **To perform setting for live data record**

  1. Tap the **Setting** functional button at the bottom of the Live Data screen.

  2. Tap the **Record** navigation button.

  3. Tap the 〉button on the right of **Trigger Type** bar and select the required trigger mode.

  4. Tap the 〉button on the right of **Duration** bar and select a length of time.

  5. Tap the 〉button on the right of **Trigger Point** bar and select a relative percentage of a record length to be reserved before the data recording start point.

  6. Tap **Done** to save the setting and return to the Live Data screen; or tap **Cancel** to cancel without saving and exit Setting.

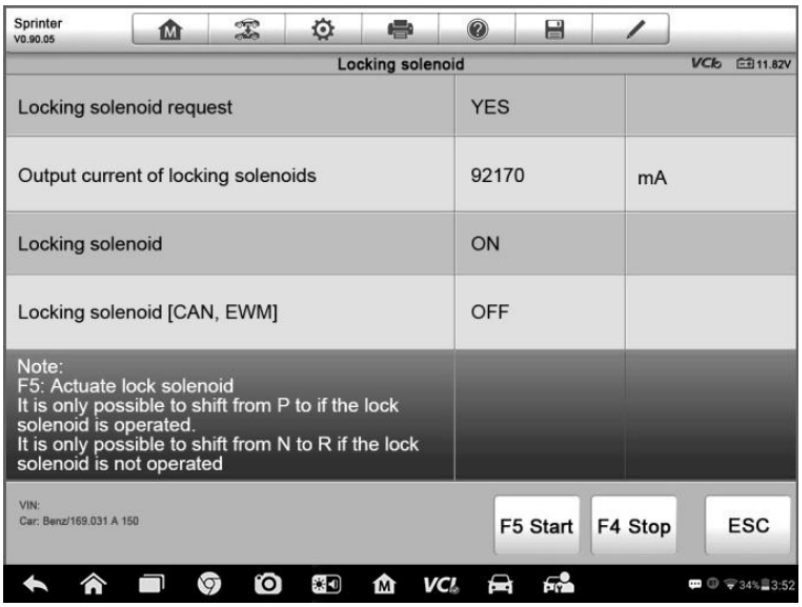
- **Done** – confirms and saves the setting, and returns you to the Live Data screen.
- **Cancel** – cancels the setting operation, and returns you to the Live Data screen.

Active Test

The Active Test function is used to access vehicle-specific subsystem and component tests. Available test vary by manufacturer, year, and model, and only the available tests display in the menu.

During an active test, the tester outputs commands to the ECU in order to drive the actuators. This test determines the integrity of the system or parts by reading ECU data, or by monitoring the operation of the actuators, such as switching a solenoid, relay, or switch, between two operating states.

Selecting Active Test opens a menu of test options that varies by make and model. Selecting a menu option activates the test. Follow all screen instructions while performing tests. How and what information is presented on the screen varies according to the type of test being performed. Some toggle and variable control tests display Active Test Controls at the top of the screen with data stream information below, or vice versa.



The functional buttons at the lower right corner of the Active Test screen manipulate the test signals. The operational instructions are displayed on the main section of the test screen. Simply follow the on-screen instructions and make appropriate selections to complete the tests. Each time when an operation is successfully executed, message such as “Command Finished”, “Activation Successful”, or something similar displays.

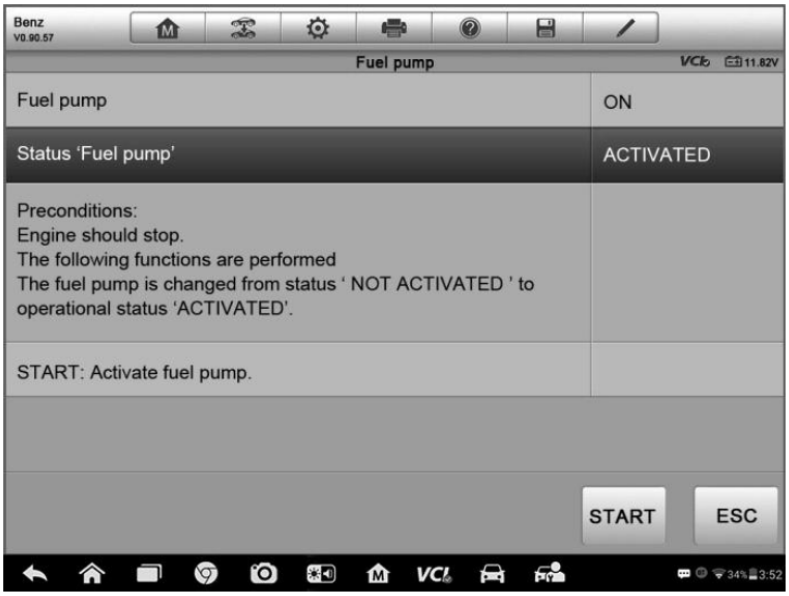
Tap the **ESC** functional button to exit the test when finished.

Special Functions

These functions perform various component adaptations, allowing you to recalibrate or configure certain components after making repairs or replacement.

The main section of the Adaptation Operation screen displays a list of operational and vehicle status information, which mainly consists of four parts:

1. The first part in the top line shows the description of the operation being performed, and the execution status is displayed on the right, such as Completed, or Activated, etc.
2. The second part shows the preconditions or requirements for executing the operation being selected.
3. The third part displays the current conditions of the vehicle control module being learned for comparison to the preconditions suggested by the second part. If the current condition of the control module is out of the suggested limit value, you must adjust the vehicle condition to meet the requirement.
4. The last part displays the instruction of how to use the functional button at the lower right corner of the screen to manipulate the teach-in operations.



Read the information carefully and check the vehicle condition accordingly, when you are sure that the vehicle is ready to perform the adaptation, simply follow the instruction provided to make appropriate selections. When the operation is done, an execution status message such as Completed, Finished or Successful, displays.

Tap the **ESC** button to exit the function.

8. Programming and Coding

Since the introduction of OBD II and leading up to modern Hybrids and EVs, computers and software in cars have been expanding at an exponential rate. In-car software is becoming one of the leading needs for service, and updating software may be the only way to fix some of these issues:

- Drivability
- Fuel Efficiency
- Power Loss
- Fault Codes
- Durability of Mechanical Parts

The Programming and Coding function is used to re-flash the vehicle control modules, it allows you to update the computer software on the vehicle to the latest version, as well as to reprogram adaptive data for certain components after making repairs or replacements.

Available programming or coding operations vary by the test vehicle, and only the available operations display in the menu.

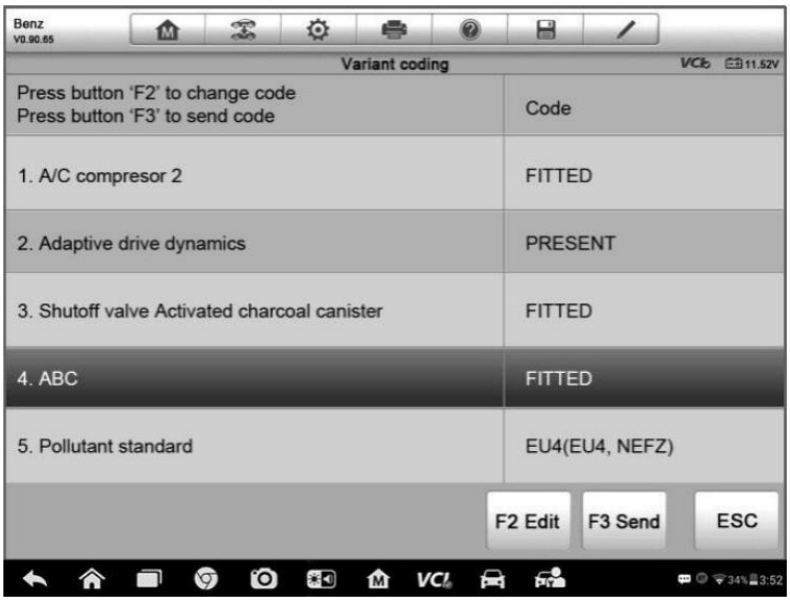
There are two general types of programming operations:

A. Coding – also known as *Teach-in Program*, *Component Adaptation* or something similar, is used to reprogram adaptive data for vehicle control modules after repairs or replacements of vehicle parts.

B. Reprogramming Operations – downloads new version of software subscription from the online server database through Internet access (this procedure is done automatically when the tablet is connected to the Internet, so there is no need to check for software subscriptions yourself), and reprograms the newest software version to the vehicle's ECU.

Selecting the Programming or Coding function opens a menu of operation options that varies by make and model. Selecting a menu option either shows a programming interface or opens another menu of additional choices. Follow all screen instructions while performing the programming or coding operations. How and what information is presented on the screen varies according to the type of operation being performed.

Variant Coding



The main section of the Variant Coding screen displays a list of vehicle components and the coding information that mainly consists of three parts:

1. The top line on the list displays the instruction of how to use the functional button at the lower right corner of the screen to manipulate the coding operations.

2. The second part under the top line of the list displays all available systems for coding on the left side, and the coding data or value on the right side.

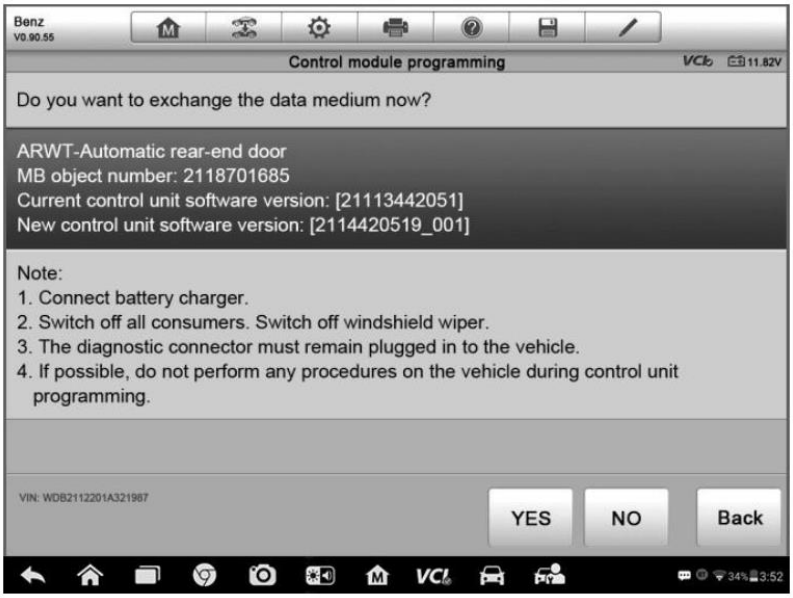
3. The bottom line of the main section displays t he functional buttons, which allows you to manipulate the operation.

Check the vehicle condition and the coding information carefully, and use the functional button to edit Codes for the corresponding components, tap **Send** when you finish edit for all the items. When the operation is done, an execution status message such as Completed, Finished or Successful, may display.

Tap the **ESC** button to exit the function.

Reprogramming Operation

Typical reprogramming operations require you to input and validate VIN number first. Tap the input box and enter the correct number, the programming interface then displays.



The main section of the reprogramming interface provides you certain hardware version, and current software versions' information, as well as the information of the newest software versions to be programmed to the control units.

Throughout the programming procedure, a series of on-screen operational instructions will display to guide you through.

Carefully read the on-screen information and follow the instruction to execute the programming procedure.

Re-flash Errors

Occasionally a flash update procedure may not complete properly. Common causes of flash errors include poor cable connections between the tablet, VCI, and vehicle, turning off the vehicle ignition switch before the flash procedure is complete, or low vehicle battery voltage.

If the process crashes, recheck all the cable connections to assure good communications and reinitialize the flash procedure. The programming procedure will automatically repeat if the previous operation does not succeed.

9. Generic OBD II Operations

A fast-access option for OBD II/EOBD vehicle diagnosis is available on the Vehicle Menu screen. This option presents a quick way to check for DTCs, isolate the cause of an illuminated malfunction indicator lamp (MIL), check monitor status prior to emissions certification testing, verify repairs, and perform a number of other services that are emissions-related. The OBD direct access option is also used for testing OBD II/EOBD compliant vehicles that are not included in the Diagnostics database. Functions of the diagnostics toolbar buttons at the top of the screen are the same as those available for specific vehicle diagnostics.

General Procedure

- **To access the OBD II/EOBD diagnostics functions**

1. Tap the **Diagnostics** application button from the MaxiSys Job Menu. The Vehicle Menu displays.

2. Tap the **EOBD** button. There are two options to establish communication with the vehicle.

  - Auto Scan – select it to establish communication using each protocol in order to determine which one the vehicle is broadcasting on.
  - Protocol – select it to open a submenu of various protocols. A communication protocol is a standardized way of data communication between an ECM and a diagnostic tool. Global OBD may use several different communication protocols.

3. Select a specific protocol if the **Protocol** option is selected. Wait for the OBD II Diagnostic Menu to appear.

4. Select a function option to continue.

  - DTC & FFD

- I/M Readiness
- Live Data
- O2 Sensor Monitor
- On-Board Monitor
- Component Test
- Vehicle Information
- Vehicle Status

Function Descriptions

This section describes the various functions of each diagnostic option:

DTC & FFD

When this function is selected, the screen displays a list of Stored Codes and Pending Codes. When the Freeze Frame data of certain DTCs are available for viewing, a snowflake button will display on the right side of the DTC item. The Erase Codes function can be applied by tapping the functional button at the lower bottom of the screen.

● **Stored Codes**

Stored codes are the current emission related DTCs from the ECM of the vehicle. OBD II/EOBD Codes have a priority according to their emission severity, with higher priority codes overwriting lower priority codes. The priority of the code determines the illumination of the Malfunction Indicator Light (MIL) and the codes erase procedure. Manufacturers rank codes differently, so expect to see differences between vehicles.

● **Pending Codes**

These are codes whose setting conditions were met during the last drive cycle, but need to be met on two or more consecutive drive cycles before the DTC actually sets. The intended use of this service is to assist the service technician after a vehicle repair and after clearing diagnostic information, by reporting test results after a single driving cycle.

a) If a test failed during the driving cycle, the DTC associated with that test is reported. If the pending fault does not occur again within 40 to 80 warm-up cycles, the fault is automatically cleared from memory.

b) Test results reported by this service do not necessarily indicate a faulty component or system. If test results indicate another failure after additional driving, then a DTC is set to indicate a faulty component or system, and the MIL is illuminated.

- **Freeze Frame**

In most cases the stored frame is the last DTC that occurred. Certain DTCs, those that have a greater impact on vehicle emission, have a higher priority. In these cases, the highest priority DTC is the one for which the freeze frame records are retained. Freeze frame data includes a “snapshot” of critical parameter values at the time the DTC is set.

- **Erase Codes**

This option is used to clear all emission related diagnostic data such as, DTCs, freeze frame data and manufacturer specific enhanced data from the vehicle’s ECM, and resets the I/M Readiness Monitor Status for all vehicle monitors to Not Ready or Not Complete status.

A confirmation screen displays when the clear codes option is selected to prevent accidental loss of data. Select **Yes** on the confirmation screen to continue, or **No** to exit.

I/M Readiness

This function is used to check the readiness of the monitoring system. It is an excellent function to use prior to having a vehicle inspected for compliance to a state emissions program. Selecting I/M Readiness opens a submenu with two choices:

- Since DTCs Cleared – displays the status of monitors since the last time the DTCs are erased.
- This Driving Cycle – displays the status of monitors since the beginning of the current drive cycle.

Live Data

This function displays the real time PID data from ECU. Displayed data includes analog inputs and outputs, digital inputs and outputs, and system status information broadcast on the vehicle data stream.

Live data can be displayed in various modes, see *Live Data section* for detailed information.

O2 Sensor Monitor

This option allows retrieval and viewing of O2 sensor monitor test results for the most recently performed tests from the vehicle's on-board computer.

The O2 Sensor Monitor test function is not supported by vehicles that communicate using a controller area network (CAN). For O2 Sensor Monitor tests results of CAN-equipped vehicles, refer to *On-Board Monitor*.

On-Board Monitor

This option allows you to view the results of On-Board Monitor tests. The tests are useful after servicing or after erasing a vehicle's control module memory.

Component Test

This service enables bi-directional control of the ECM so that the diagnostic tool is able to transmit control commands to operate the vehicle systems. This function is useful in determining how well the ECM responds to a command.

Vehicle Information

The option displays the vehicle identification number (VIN), the calibration identification, and the calibration verification number (CVN), and other information of the test vehicle.

Vehicle Status

This item is used to check the current condition of the vehicle, including communication protocols of OBD II modules, retrieved codes amount, status of the Malfunction Indicator Light (MIL), and other additional information may be displayed.

Exit Diagnostics

The Diagnostics application remains open as long as there is an active communication with the vehicle. You must exit the diagnostics operation interface to stop all communications with the vehicle before closing the Diagnostics application.

To exit the Diagnostics application

1. From an active diagnostic screen, tap the **Back** or **ESC** functional button to exit a diagnostic session step-by-step; Or

2. Tap the **Vehicle Swap** button on the diagnostics toolbar to return to the Vehicle Menu screen.

3. From the vehicle menu screen, tap the **Home** button on the top toolbar; or tap the **Back** button on the navigation bar at the bottom of the screen. Or

4. Tap the **Home** button on the diagnostics toolbar to exit the application directly to the MaxiSys Job Menu.

Now, the Diagnostics application is no longer communicating with the vehicle and it is safe to open other MaxiSys applications, or exit the MaxiSys Diagnostic System and return to the Android System's Home screen.

10. Service

The **Service** section is specially designed to provide quick access to the vehicle systems for various scheduled service and maintenance tasks. The typical service operation screen is a series of menu driven executive commands. Follow on-screen instructions to select appropriate execution options, enter correct values or data, and perform necessary actions. The application will display detailed instructions to complete selected service operations.

After entering each special function, the screen will display two application choices: **Diagnosis** and **Hot Functions**. The **Diagnosis** enables the reading and clearing of codes which is sometimes necessary after completing certain special functions. **Hot- Functions** consists of sub functions of the selected special function.

10.1 Oil Reset Service

Perform reset for the Engine Oil Life system, which calculates an optimal oil life change interval depending on the vehicle driving conditions and climate. The Oil Life Reminder must be reset each time the oil is changed, so the system can calculate when the next oil change is required.

1. Always reset the engine oil life to 100% after every oil change.
2. All required work must be carried out before the service indicators are reset. Failure to do so may result in incorrect service values and cause DTCs to be stored by the relevant control module.
3. For some vehicles, the scan tool can reset additional service lights such as maintenance cycle and service interval. On BMW vehicles for example, service resets include engine oil, spark plugs, front/rear brakes, coolant, particle filter, brake fluid, micro filter, vehicle inspection, exhaust emission inspection and vehicle checks.

10.2 Electric Parking Brake (EPB) Service

This function has a multitude of usages to maintain the electronic braking system safely and effectively. The applications include deactivating and activating the brake control system, assisting with brake fluid control, opening and closing brake pads, and setting brakes after disc or pad replacement.

- **EPB Safety**

It can be dangerous to perform Electric Parking Brake (EPB) system maintenance, so before you begin the service work, please keep these rules in mind.

- Ensure that you are fully familiar with the braking system and its operation before commencing any work.
- The EPB control system may be required to be deactivated before carrying out any maintenance/diagnostic work on the brake system. This can be done from the tool menu.
- Only perform maintenance work when the vehicle is stationary and on level ground.
- Ensure that the EPB control system is reactivated after the maintenance work has been completed.

10.3 Tire Pressure Monitoring System (TPMS) Service

This function allows you to quickly look up the tire sensor IDs from the vehicle's ECU, as well as to perform TPMS replacement and reset procedures after tire sensors are replaced.

10.4 Battery Management System (BMS) Service

The Battery Management System (BMS) allows the tool to evaluate the battery charge state, monitor the close-circuit current, register the battery replacement, activate the rest state of the vehicle, and charge the battery via the diagnostic socket.

1. This function is not supported by all vehicles.

2. The sub functions and actual test screens of the BMS may vary by vehicle, please follow the on-screen instructions to make correct option selection.

The vehicle may use either a sealed lead-acid battery or an AGM (Absorbed Glass Mat) battery. Lead acid battery contains liquid sulphuric acid and can spill when overturned. AGM battery (known as VRLA battery, valve regulated lead acid) also contains sulphuric acid, but the acid is contained in glass mats between terminal plates.

It is recommended that the replacement aftermarket battery has the same specifications, such as capacity and type, as the exiting battery. If the original battery is replaced with a different type of battery (e.g. a lead-acid battery is replaced with an AGM battery) or a battery with a different capacity (mAh), the vehicle may require reprogramming of the new battery type, in

addition to, performing the battery reset. Consult the vehicle manual for additional vehicle-specific information.

10.5 Steering Angle Sensor (SAS) Service

Steering Angle Sensor Calibration permanently stores the current steering wheel position as the straight-ahead position in the steering angle sensor EEPROM. Therefore, the front wheels and the steering wheel must be set exactly to the straight-ahead position before calibration. In addition, the vehicle identification number (VIN) is also read from the instrument cluster and stored permanently in the steering angle sensor EEPROM. On successful completion of calibration, the steering angle sensor fault memory is automatically cleared.

Calibration must always be carried out after the following operations:

- Steering wheel replacement
- Steering angle sensor replacement
- Any maintenance that involves opening the connector hub from the steering angle sensor to the column
- Any maintenance or repair work on the steering linkage, steering gear or other related mechanism
- Wheel alignment or wheel track adjustment
- Accident repairs where damage to the steering angle sensor or assembly, or any part of the steering system may have occurred

10.6 Diesel Particle Filter (DPF) Service

The Diesel Particle Filter (DPF) function manages DPF regeneration, DPF component replacement teach-in and DPF teach-in after replacing the engine control unit.

The ECM monitors driving style and selects a suitable time to employ regeneration. Cars driven a lot at idling speed and low load will attempt to regenerate earlier than cars driven more with higher load and speed. In order for regeneration to take place, a prolonged high exhaust temperature must be obtained.

In the event of the car being driven in such a way that regeneration is not possible, i.e., frequent short journeys, a diagnostic trouble code will eventually be registered in addition to the DPF light and “Check Engine” indicators displaying. A service regeneration can be requested in the workshop using the diagnostic tool.

Before performing a forced DPF regeneration using the tool, check the following items:

- The fuel light is not on.
- No DPF-relevant faults are stored in system.
- The vehicle has the specified engine oil.
- The oil for diesel is not contaminated.

10.7 Immobilizer (IMMO) Service

An immobilizer is an anti-theft mechanism that prevents an automobile's engine from starting unless the correct ignition key or other device is present. This device prevents thieves from starting the car by a method known as hot wiring. Most new vehicles have an immobilizer as standard equipment. An important advantage of this system is that it doesn't require the car owner to activate it; it operates automatically. An immobilizer is considered as providing much more effective anti -theft protection than an audible alarm alone; many auto insurance companies offer lower rates for vehicles that are equipped with an immobilizer.

As an anti-theft device, an immobilizer disables one of the systems needed to start a car's engine, usually the fuel supply or the ignition. This is accomplished by radio frequency identification between a transponder in the ignition key and a device called a radio frequency reader in the steering column. When the key is placed in the ignition, the transponder sends a signal with a unique identification code to the reader, which relays it to a receiver in the vehicle's computer control module. If the code is correct, the computer allows the fuel supply and ignition syst ems to operate and start the car. If the code is incorrect or absent, the computer disables the system, and the car will be unable to start until the correct key is placed in the ignition.

The IMMO service can disable a lost vehicle key and program the replacement key fob. One or more replacement key fobs can be programmed.

Annexe 7

Automotive Emission Analyzer.

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ECO-CAR
Vocational Training Diploma on Electrical and Hybrid Vehicles

Automotive Emission Analyzer

Author(s)	Eng.Mohammed aldaoud
Organization Name(s)	Jordan University of Science and Technology (JUST)
WP No & Title	Work package 4: Establishment of EV/HEV labs
Task Number & Title	Task 4.3: Prepare the experiment manual according to the course outline (cluster 9) and the received equipment.
WP Leader	Al-Balqa Applied University - Jordan
Co-Leaders	The University of Jordan (UJ), Jordan University of Science and Technology (JUST) & National Technical University of Athens (NTUA)
Number of pages	**28**

Automotive Emission analyzer

Contents

Introduction

NHA-406 Gas Analyzer is for measuring CO, HC and CO_2 in automotive emissions by the principle of non-dividing infrared absorption and measuring O_2 by the principle of electrochemical cell, calculating excessive air coefficient λ based on the composition of CO, CO_2, HC and O_2 measured. This instrument is equipped with gas bench with self-owned intellectual property right, microprocessor is embedded. It is an intellectual instrument with liquid crystal display and Chinese or English interface. Inductive RPM (engine-speed) measuring pliers, oil temperature sensor and printer are optional for measuring RPM and oil temperature, and printing measurement results.

This instrument complies with the requirements of International Measurement Rules OIML R99/1998 (E) made by the Organization of International Measurement Law (OIML) and the National Metrological Verification Regulations # JJG 688 for class-1 instruments. It is applicable for environmental departments, vehicle inspection stations, automotive manufacturing factories and garages.

Technical Parameters

Operation Condition	
Temperature	+5°C to +40°C
Relative humidity	5% to 95% non-condensing
Atmospheric pressure	70 kPa to 106 kPa
Power supply	
Voltage	AC220V±15%
Frequency	50Hz ±1Hz
Measurement Range	
HC (Hexane Equivalent)	$0(x10^{-6})$ ppm to $10000(x10^{-6})$ ppm
CO	$0(x10^{-2})$ % to $10(x10^{-2})$ %
CO_2	$0(x10^{-2})$ % to $18(x10^{-2})$ %
O_2	$0(x10^{-2})$ % to $25(x10^{-2})$ %
RPM	300rpm to 8000rpm
Oil Temperature	0°C to +120°C
Resolution	

HC	1($x10^{-6}$) ppm
CO	0.01($x10^{-2}$) %
CO_2	0.01($x10^{-2}$) %
O_2	0.01($x10^{-2}$) %
RPM	10rpm
Oil Temperature	1°C

Indication Error		**Absolute**	**Relative**
HC	(0 to 2000) ppm($x10^{-6}$)	±12 ($x10^{-6}$) ppm	±5%
	2001 to 10000ppm ($x10^{-6}$)	-	±10%
CO		+0.06($x10^{-2}$) %	±5%
CO_2		+0.5($x10^{-2}$) %	±5%
O_2		+0.1($x10^{-2}$) %	±5%

Others	
Warm-up Time	10 minutes
Output Interface	RS-232C
Outer Dimension	(L)450mm(W)260mm(H)180mm
Net Weight	7kg

Experiment 1: Automotive Emission Analyzer Components

Composition

As shown in Error! Reference source not found. the instrument is composed of the instrument host, short tube, pre-filter, sampling pipe, sampling probe and embedded micro printer (optional).

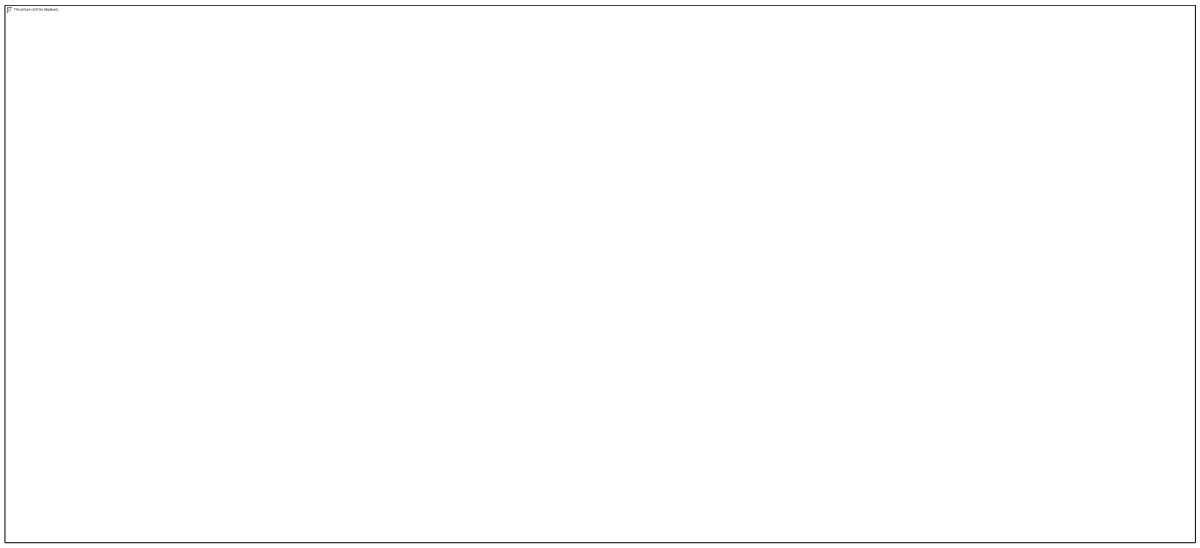


Figure Error! No text of specified style in document..1 Composition of the unit

1. Instrument host: control measurement and analyze emissions unit.
2. Embedded micro printer (optional).
3. Sampling pipe (5m): connect pre-filter and sample gas inlet.
4. Pre-filter: pre-filter sample gases.
5. Short tube: connect pre-filter and sampling probe.
6. Sampling probe: sample vehicle emissions.

Figure Error! No text of specified style in document..2

Front panel

Figure Error! No text of specified style in document..3 shows the layout of the front panel. Names and functions of all the parts on front panel:

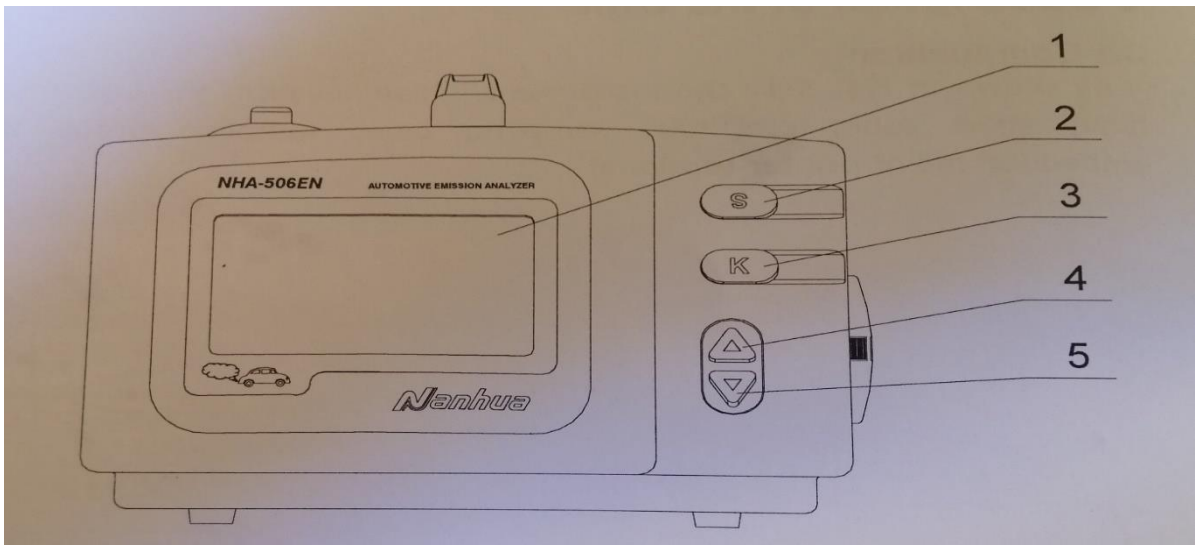


Figure Error! No text of specified style in document..3 Layout f front panel

1. Liquid crystal display: display menus and measurement data:
2. "**S**" key: corresponding to the functional sub-menu at the lower part of LCD, execute the corresponding operation:
3. "**K**" key: corresponding to the functional sub-menu at the lower part of LCD, execute the corresponding operation:
4. "▲" key: move the cursor on LCD upward and select the required item: corresponding to the functional sub-menu at the lower part of LCD, execute the corresponding operation:
5. "▼" key: move the cursor on LCD downward and select the required item: corresponding to the functional sub-menu at the lower part of LCD, execute the corresponding operation.

Rear panel

Figure Error! No text of specified style in document..4 shows the layout of the rear panel. Names and functions of all the parts on front panel:

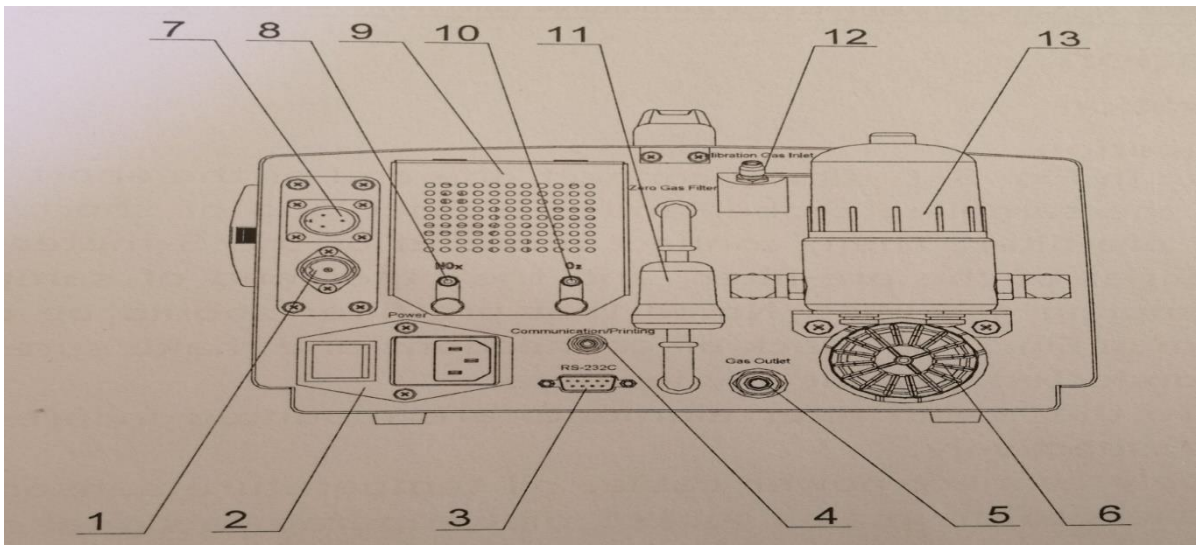


Figure Error! No text of specified style in document..4 Layout of rear panel

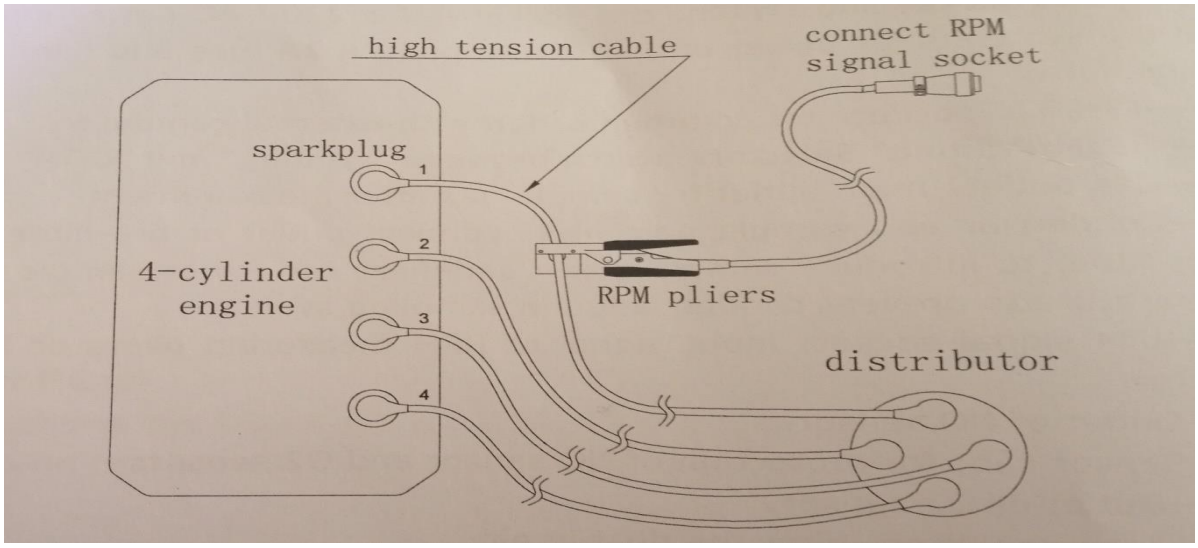
1. Oil temperature signal socket: input signal of oil temperature sensor.
2. Mains socket and switch: the socket is for 220V AC power input, and the switch is for power on/off, with built-in 1A fuse and filter for mains noise:
3. RS-232C socket: for communication with external computer:
4. "COM/Printing" Selector: switch between "Printing" and "COM".
5. Gas outlet: main outlet for sample gas after measurement:
6. Condenser and sample gas inlet: connect outlet of pre-filter via short tube, to introduce sample gas. Condenser can lower sample gas temperature to prevent condensation in sampling system:

7. RPM signal socket: input signal of RPM measuring pliers or RPM adaptor:
8. Outlet of NO sensor.
9. Sensor cap: for protection of NO sensor and O_2 sensor.
10. Outlet of O_2 sensor.
11. Zero gas filter: filter the dust in air.
12. Calibration gas inlet: used as inlet of standard gas, with pressure of approx. 0.02 MPa.
13. Water filter: separate oil, dust and water in sample gas, replace the internal big / small filter elements as required.

Experiment 2: Preparing Automotive Emission Analyzer

Installation

1. Firstly, connect one end of the short tube with the end of the sampling probe, and the other end of short tube with inlet of the pre-filter. Then, connect one end of the 5-meter sampling pipe with outlet of the pre-filter, and the other end of sampling pipe with the sampling gas inlet. Noted that pre-filter should be connected as per shown in Fig. 3-1, check all connections and make sure that they are firmly connected without any leakage.
2. Make sure that clean filter elements are mounted in pre-filter and water filter respectively.
3. Respectively connect power cable, oil temperature sensor and RPM measuring pliers to the mains socket, oil temperature signal socket and RPM signal socket.
4. Insert the oil temperature sensor into the hole of engine oil dipstick, clamp the RPM measuring pliers on the high tension cable of spark plug of 1st cylinder (Fig. 4-1-1).


high tension cable
connect RPM
signal socket
sparkplug
1
2
3
4
4-cylinder
engine
RPM pliers
distributor

Warm-up

Insert power cable into 220V AC mains socket, power on and warm up the instrument. "Warming Up!" and "Please Wait for xxx seconds" appear. "xxx seconds" is the warm-up time remained by count-down. The total warm-up time is 600 seconds (10 min.). User should follow the prompt to remove the sealing of the sampling probe so as to ensure correct sampling. See Figure Error! No text of specified style in document..5.

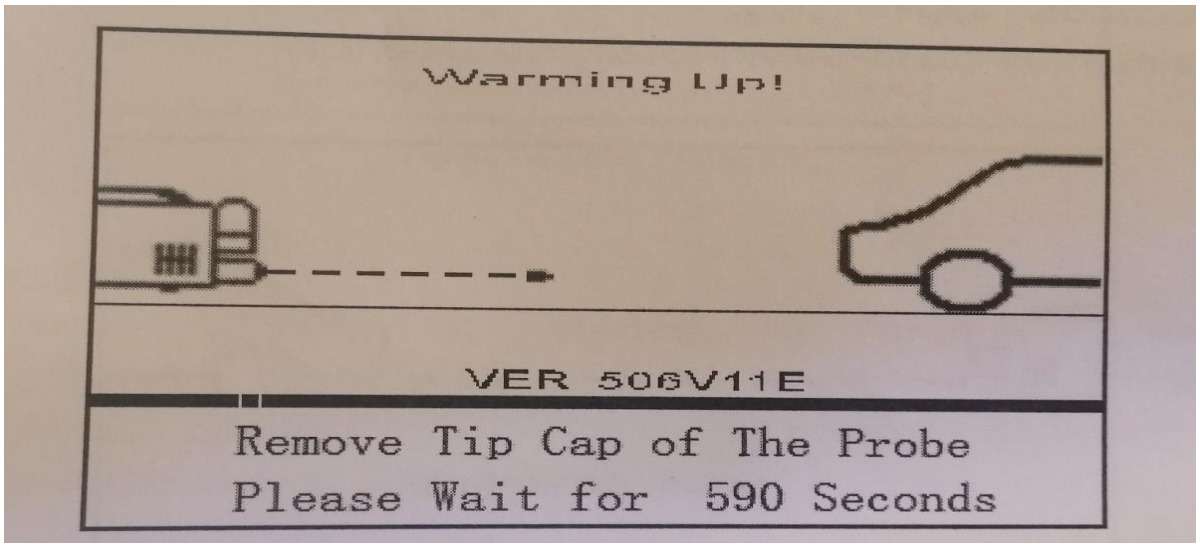


Figure Error! No text of specified style in document..5. Warm-up after power on

Warm-up time of 600 seconds is only for the case when the instrument is operated at ambient temperature of approx. 20°C. If ambient temperature is much higher than 20°C, the warm-up time may be shorter. If ambient temperature is much lower than 20°C, the warm-up time will be longer. The warm-up will be automatically ended as long as the technical requirements are reached. User should follow the prompt to remove the sealing of the sampling probe so as to ensure correct sampling, the sampling pipe should not be blocked, otherwise leakage will be caused and leak check will fail.

Leak Check

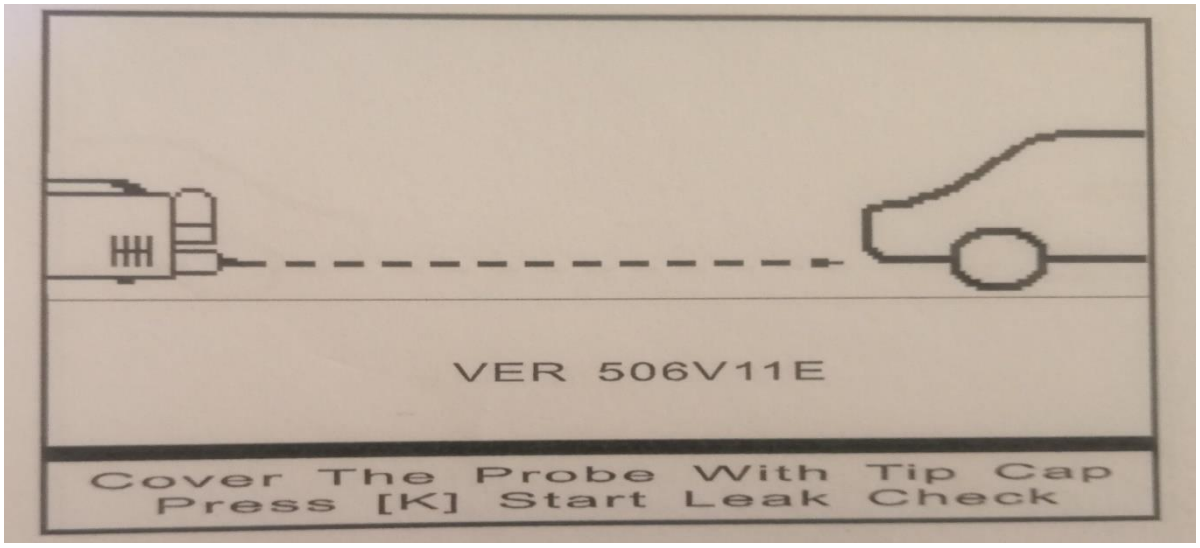


Figure Error! No text of specified style in document..6 Waiting for leak check

The instrument automatically enters the interface of Leak Check after warm-up, to check the sampling system for leakage. At this time, a prompt appears on the upper part of the display as "Cover The Probe with Tip Cap" and "Start Leak Check" appears at the lower part of the display (see Figure Error! No text of specified style in document..6). User shall operate as per the prompts, press [K] to start leak check. Then, "Leak Checking." and "Please Wait for xx seconds" appear (Figure Error! No text of specified style in document..7). "XX sec." is the leak checking time remained (by count-down, totally 10 seconds).

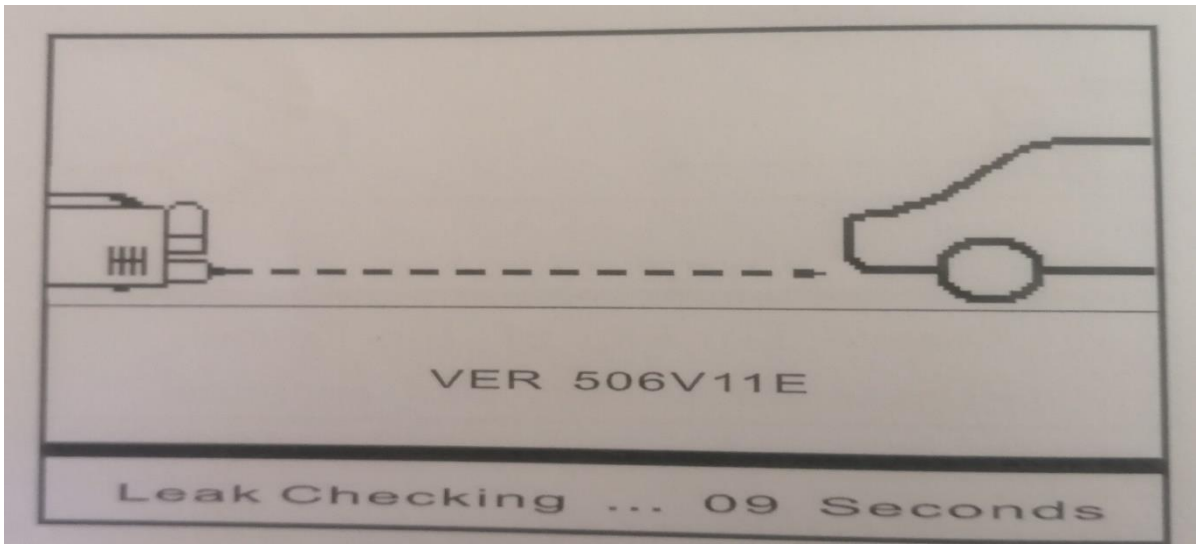


Figure Error! No text of specified style in document..7 leak checking

After leak check, if leakage is detected, a prompt appears as "Leakage, Please Check....." and "**K** start Leak Check Again" (Figure Error! **No text of specified style in document.**.8). User shall check the sampling system carefully and eliminate any leakage. If no leakage is detected, "Leak Checking.....OK!" appears (Figure Error! No text of specified style in document..9), and zeroing will be started automatically.

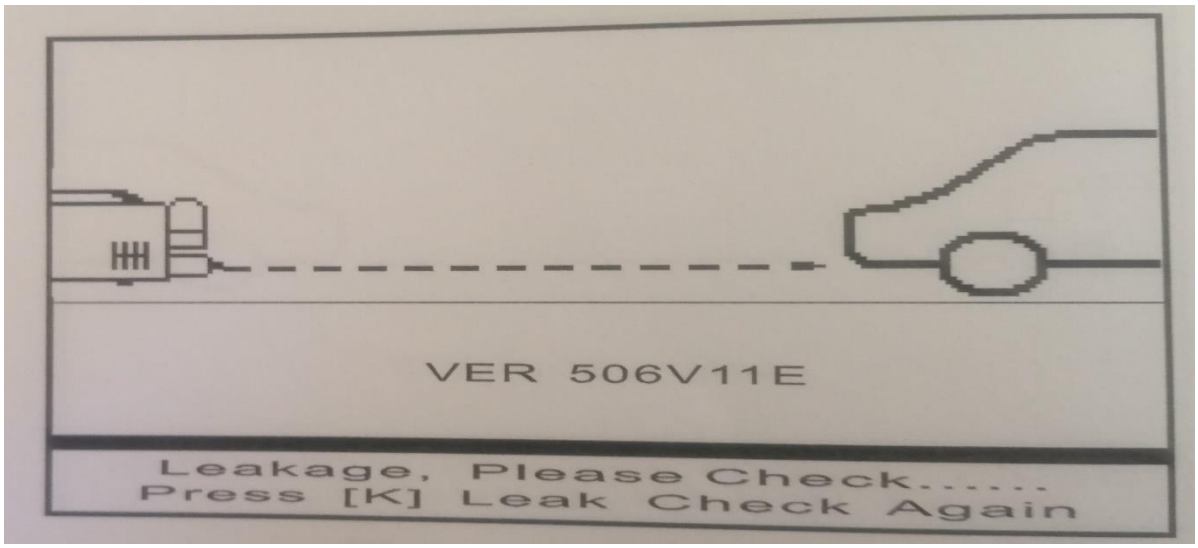


Figure Error! No text of specified style in document..8 leak check fails

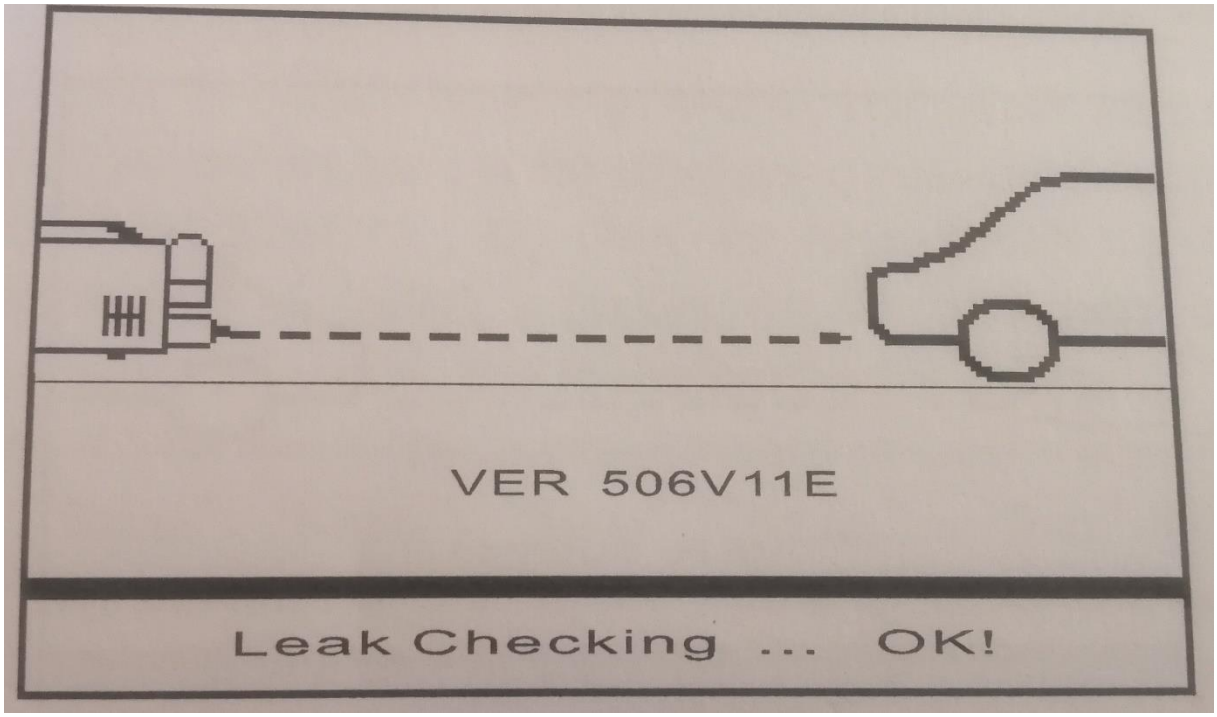


Figure Error! No text of specified style in document..9 leak check ok

Auto Zeroing

When auto zeroing is started, a prompt appears as "Zeroing...Please Wait!" (Figure Error! No text of specified style in document..10). When zeroing is completed, "Zeroing OK!" appears (Figure Error! No text of specified style in document..11). The prompts disappear and the main menu is displayed in several seconds.

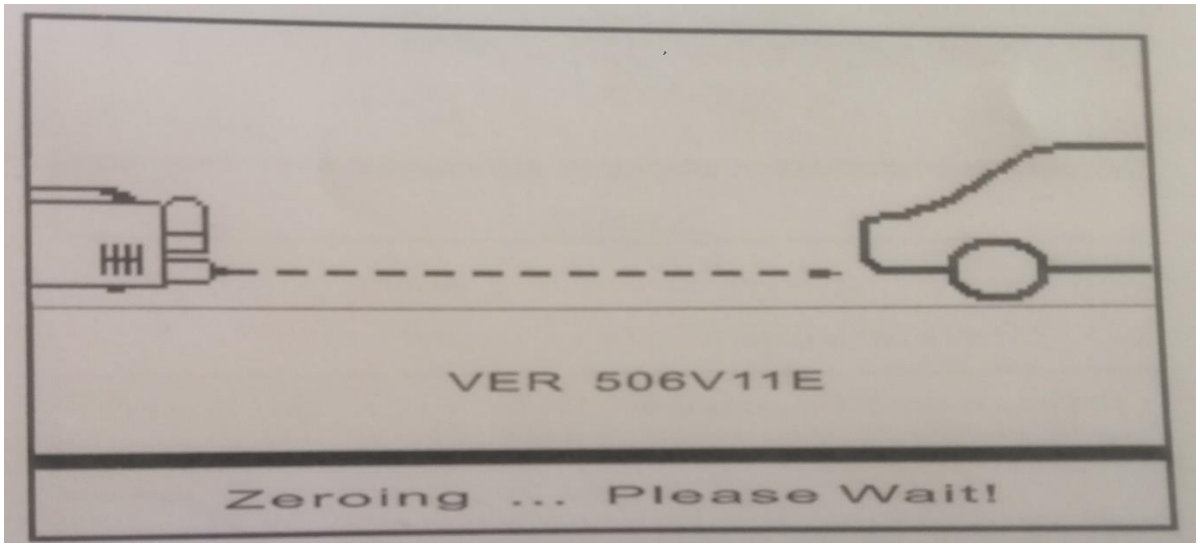


Figure Error! No text of specified style in document..10 Zeroing

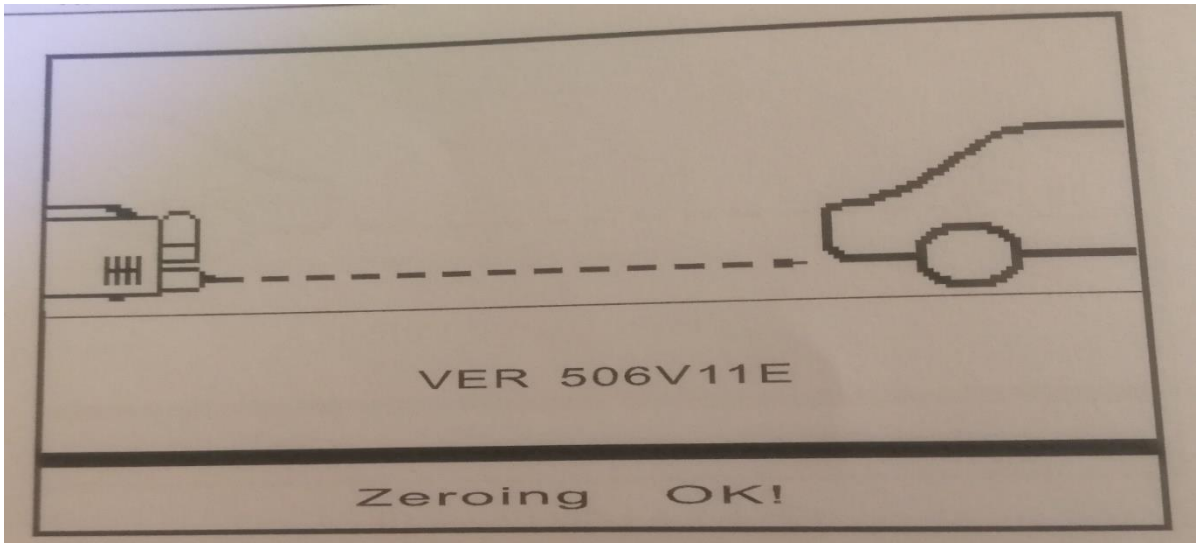


Figure Error! No text of specified style in document..11 Zeroing ok

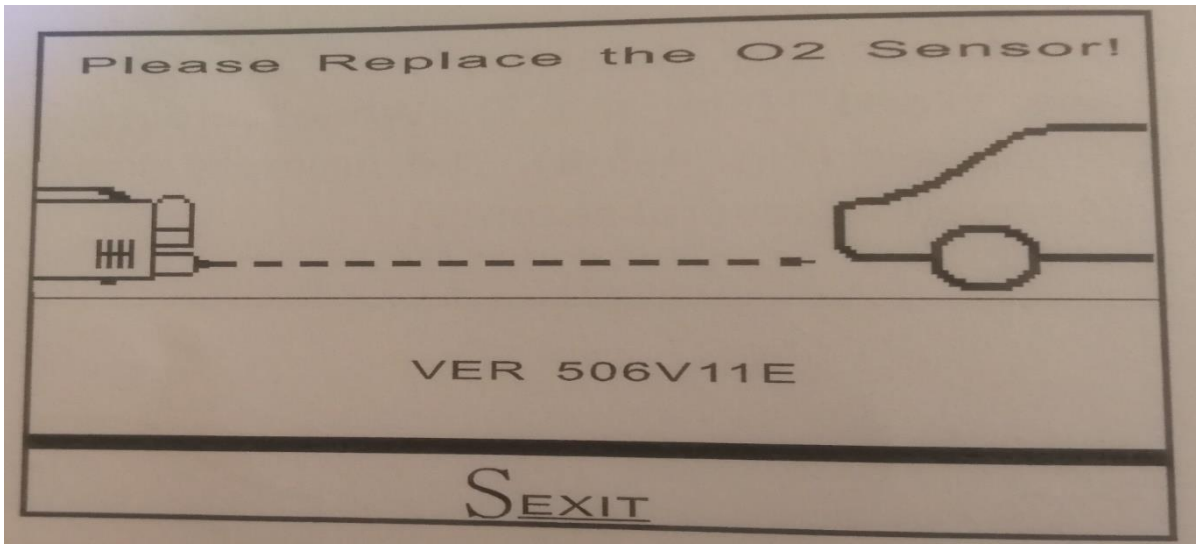


Figure Error! No text of specified style in document..12 O_2 Sensor s ageing

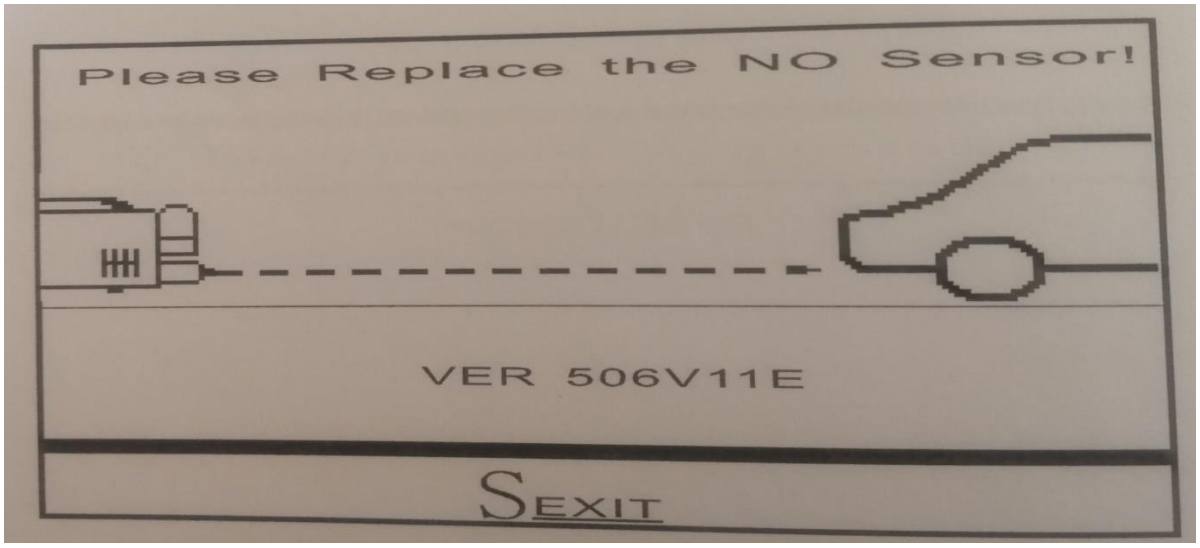


Figure Error! No text of specified style in document..13 NO Sensor is ageing

If the life time of NO sensor or O_2 sensors is exceeded, there are prompts to remind user to replace sensor in time after auto zeroing, see Figure Error! No text of specified style in document..12 and Figure Error! No text of specified style in document..13. After NO sensor is replaced, operate as per instruction for "New NO Sensor" and re-calibrate it.

Experiment 3: Calibration with Gas

The instrument may drift and the sensors may become ageing during service. Therefore, it is necessary to calibrate span after a period of service (generally 3-6 months). The O_2 sensor and NO sensor shall be replaced after service of approx. 1 year due to ageing. After NO is replaced, operate as per instruction for "New NO Sensor" and re-calibrate the channel before being used. (Note: O_2 is not for NHA-206EN, NO is not for NHA-406EN/206EN)

During calibration, if the deviation of data is very serious due to wrong operation and re-calibration is impossible, use option "Reset Default Cal. Values" to reset the default values. (Note: calibration values for HC, CO CO_2 channels can be reset, but not for O_2 channel and NO channel.

Select Standard Gas

One-component and three-component standard gases are required for span calibration, the components are as follows,

1. Three-component standard gas
1. CO approx. 3.5 (x 10^{-2}) % vol:

2. C_3H_8 (Propane): approx. 2000 (x10^{-6}) ppm (0.2 (10^{-2}) \%) vol:

- CO_2: approx. 14 (x 10^{-2}) \% vol

1. N_2 (Nitrogen): residual value

2. One-component standard gas (not for NHA-406EN/206EN)
3. NO: approx. 1000 (x10^{-6}) ppm (0.1 (x 10^{-2}) \%) vol:

4. N_2 (Nitrogen) residual value

During calibration, the actual calibration values shall be subjected to the values on the tag on the standard gas cylinder, without exceeding 15\% of the above values.

NO calibration gas is excluded in accessories due to cylinder and validity problem. Please contact us for need of NO calibration gas.

Span Calibration for HC, CO and CO_2 Channels

Calibration steps are as follows:

1. Zeroing: calibrate zero as per 4.3 before calibration.
2. In the main menu (Fig. 4-2-1), press [▲] or [V] to locate at "KGAS CAL", press [K] to enter the interface as shown in Figure Error! No text of specified style in document..14.

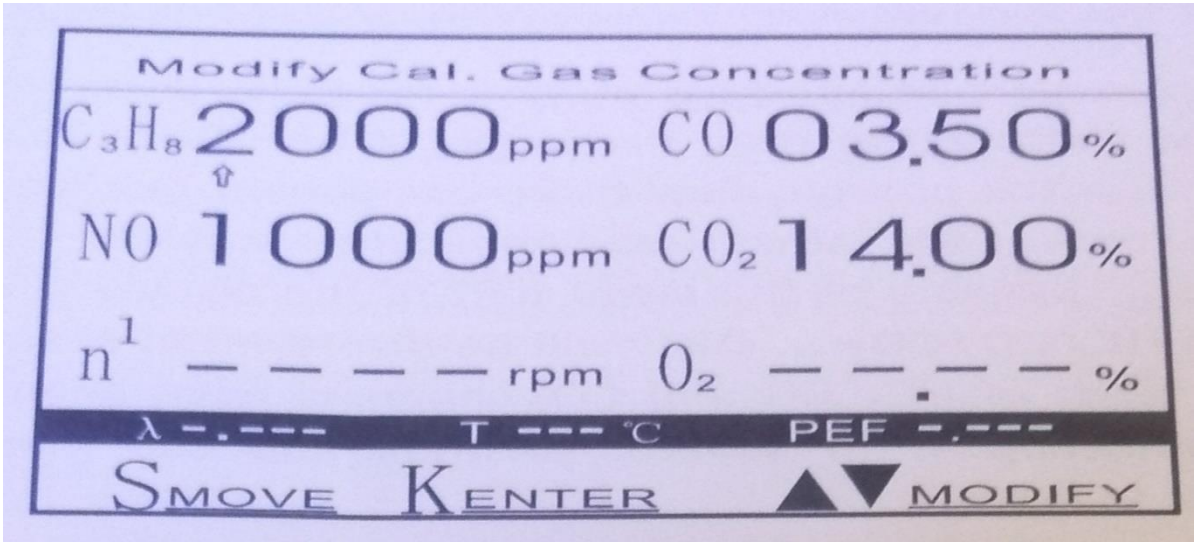


Figure Error! No text of specified style in document..14 Modify Concentration of calibration gas

3. Modify Cal. Gas Concentration" is displayed on the upper part of the LCD; set values of calibration gas components, which were used during the previous calibration, are displayed in the middle part. If these values do not match the nominal values used for this calibration, user can make modification as follows,

1. **s** key-move to make it locate at any figure of the 4 channels; ▲ or key-modify the value located by. the value is ranged 0~9;

2. **K** key-confirm the modification and enter the interface as shown in Figure Error! No text of specified style in document..15.

3. If the set values for HC. CO and CO_2 match the nominal values on the three-component gas cylinder used for this calibration, or the set values are modified, press [K] in the interface as shown in Figure Error! No text of specified style in document..14 to enter the interface as shown in Figure Error! No text of specified style in document..15. During calibration with three-component gas, the set value for NO channel can be ignored.

Figure Error! No text of specified style in document..15 Wait for calibration

4. In the upper part of interface of Wait for Calibration Figure Error! No text of specified style in document..15, "Please Flow Calibration Gas, Press [K] When Data Is Stable." is displayed. Follow the prompt, flow three-component gas via calibration gas inlet. Press [K] after readings are stable. "Calibrating HC/CO/CO_2..." appears at the lower part of the display Figure Error! No text of specified style in document..16, "Calibrating HC/CO/CO_2 OK!" will be displayed in several seconds Figure Error! No text of specified style in document..17. span of HC, CO and CO2 channels have been calibrated. The prompts disappear in several seconds and the main menu is returned.

5. If [K] is pressed without flowing standard gas to the instrument or the calibration values are out of range, "Calibrating HC/CO/CO_2... Fails!" will be displayed at the lower part of the LCD. The prompt disappears in several seconds and the main menu is returned, the calibration is invalid.

Figure Error! No text of specified style in document..16 Calibrating

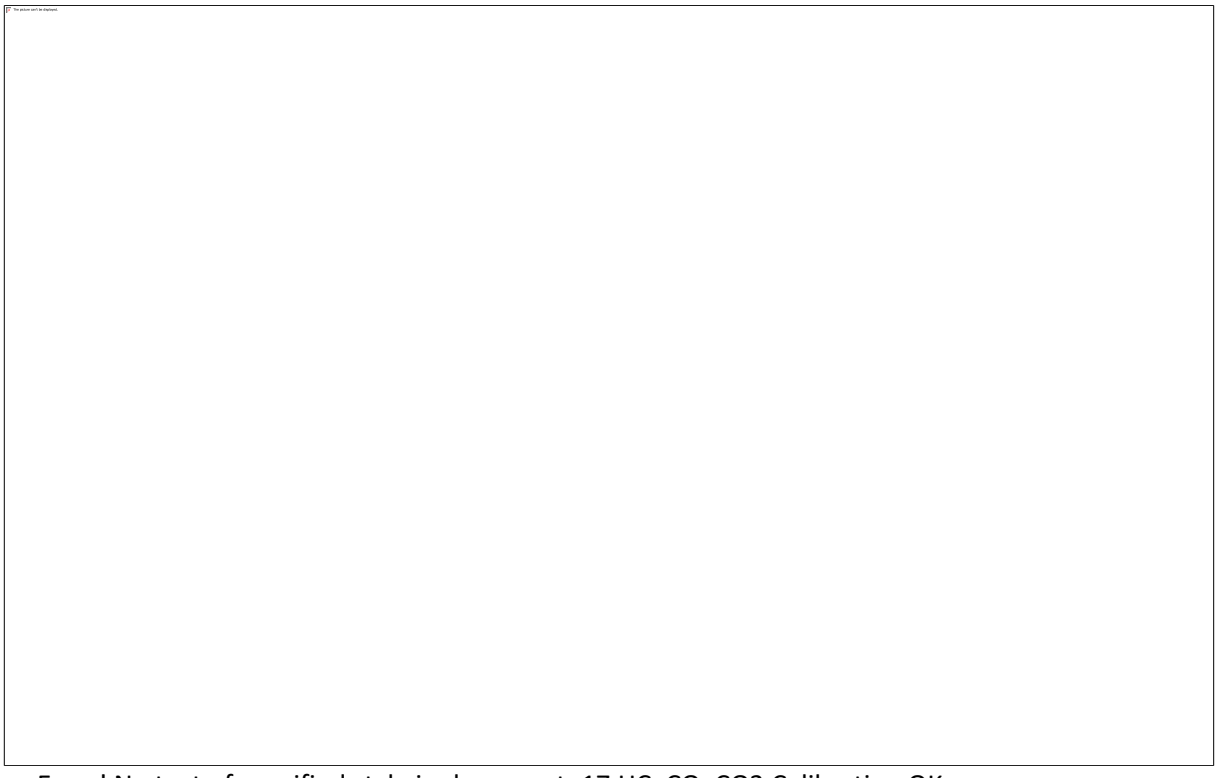


Figure Error! No text of specified style in document..17 HC, CO, CO2 Calibration OK

6. In the interface of Wait for Calibration Figure Error! No text of specified style in document..15, if calibration is not required any more, press [S] to return to the main menu directly.

7. After calibration, remove the gas cylinder before other operations.

Note: A check valve is assembled at the calibration gas inlet on the instrument. When flowing calibration gas into the instrument, aim the nozzle of the calibration gas cylinder at the calibration gas inlet on the instrument, slightly force it downward to open the valve, and the calibration gas will enter the instrument.

when using any calibration gas cylinder other than the one supplied by us, if the nozzle of the gas cylinder is inapplicable for this instrument, and the check valve cannot be opened, use the adapter in the accessories. To use it, fasten it on the inlet of calibration gas, the check valve will be opened.

Calibrate NO Channel (not for NHA-406EN/206EN)

a) Zeroing: calibrate zero as per 4.3 before span calibration.
b) In the main menu, press [▲] or [] to locate at KGAS CAL press [K] to enter the interface of Calibration Figure Error! No text of specified style in document..14.

c) "Modify Cal. Gas Concentration" appears at the upper part of the display; the set values of the calibration gas components, which were used for the previous calibration, are displayed in the middle part. If these values do not match the nominal values used for this calibration, user can make modification as follows,

1. S key-move to make it locate at any figure of the 4 channels;

2. ▲ or ▼ key-modify the value located by. the value is ranged 0 9;

3. K key-confirm the modification and enter the interface as shown in Figure Error! No text of specified style in document..15.

d) If the set value for NO channel matches the nominal value on the gas cylinder used for this calibration, or the set value has been modified, press [K] in the interface as shown in Fig. 4-4-1 to enter the interface as shown in Figure Error! No text of specified style in document..15. During calibration with one-component gas, the set values for the other three channels can be ignored.

Figure Error! No text of specified style in document..18 Calibrating

Figure Error! No text of specified style in document..19 NO Calibrating OK

e) "Please Flow Calibration Gas, Press [K] When Data Is Stable." appears at the upper part of the interface of Wait for Calibration Figure Error! No text of specified style in document..15. Follow the prompt, flow NO calibration gas via the sample gas inlet (Figure Error! No text of specified style in document..4, item 6) with pressure of approx. 0.02 MPa. Press [K] after readings are stable. "Calibrating NO..." appears at the lower part of the display Figure Error! No text of specified style in document..18.The prompt changes to be "Calibrating NO... OK!" in a few seconds Figure Error! No text of specified style in document..19. The span of NO channel has been calibrated. The prompt disappears in a few seconds and the main menu is returned.

f) If [K] is pressed without flowing standard gas into the instrument or the calibration value is out of range, "Calibrating NO ... Fails!" appears at the lower part of the display. The prompt disappears in several seconds and the main menu is returned, the calibration is invalid.

g) In the interface of Wait for Calibration Figure Error! No text of specified style in document..15, if calibration is not required any more, press [S] to return to the main menu directly.

h) After calibration, remove the gas cylinder before other operations.

Flow NO standard gas via the sample gas inlet on the instrument, the flow should be within 5-61/min. Do not calibrate it without flowing NO standard gas

Oil Temperature Calibration

Calibrate oil temperature when it is deemed as necessary. The steps are as follows,

1. Insert oil temperature sensor, wait for 5 min. or above.
2. b) In the main menu. press [A] or [▼] to locate at "KICAL". press [K] to enter the interface of Oil Temperature Calibration Figure Error! No text of specified style in document..20.
3. If oil temperature sensor is not inserted, a prompt "Install Oil Temp. Probe!" appears. The prompt disappears in a few seconds and the main menu is returned. This calibration is invalid.

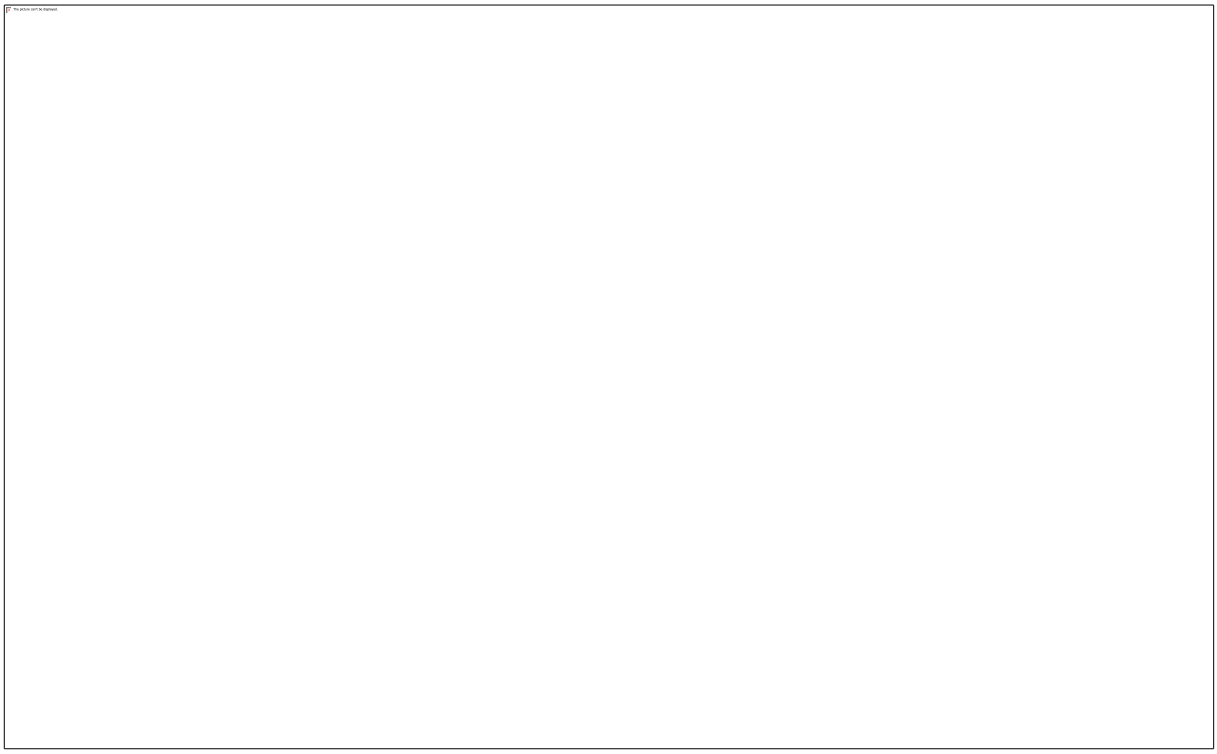


Figure Error! No text of specified style in document..20 Setting Calibration Values at Ambient Temperature

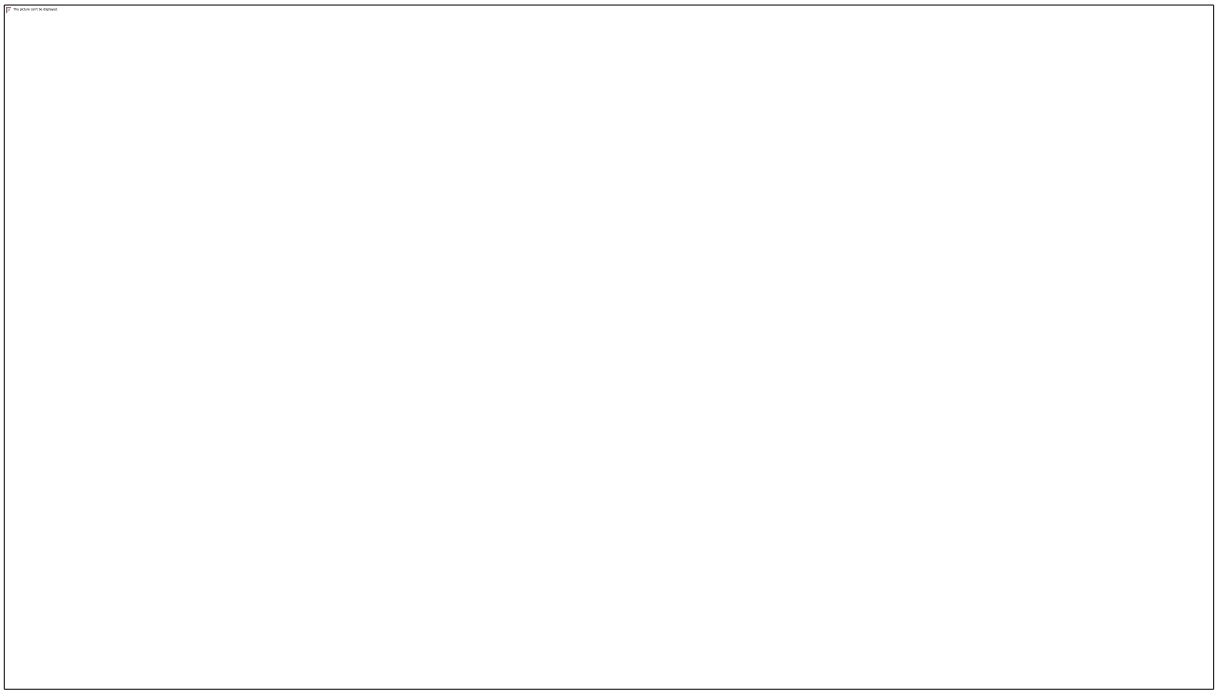


Figure Error! No text of specified style in document..21 Wait for Calibration at Ambient Temperature

d) Figure Error! **No text of specified style in document.**.20 shows settings calibration values at ambient temperature. press [▲] or [▼] to modify the current setting at ambient temperature (subject to the current reading of the temperature measuring device). After modification, press [K] for the next operation Figure Error! No text of specified style in document..21. If oil temperature calibration is not required any more, press [S] to exit and return to the main menu.

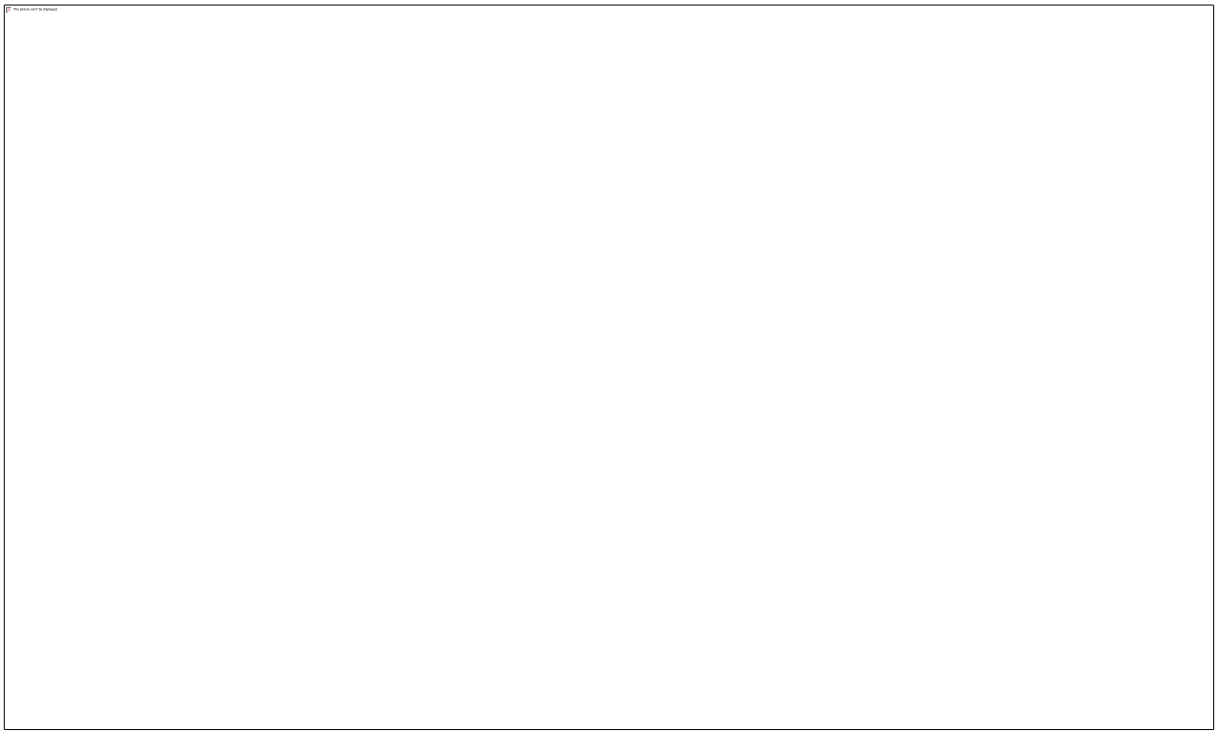


Figure Error! No text of specified style in document..22 Calibration at Ambient Temperature

e) In the interface of Wait for Calibration at Ambient Temperature Figure Error! No text of specified style in document..21, follow the prompt. place the oil temperature sensor in ambient air, press [K] when the reading is stable, and start calibration at ambient temperature Figure Error! No text of specified style in document..22. If such calibration is not required, press [S] to skip it and enter the interface of Setting Calibration Values at High Temperature Point Figure Error! No text of specified style in document..23.

f) After calibration at ambient temperature is completed, "Calibrating...OK!" appears at the lower part of the displayed Figure Error! No text of specified style in document..23. In several seconds, the interface of Setting Calibration Values at High Temperature Point is entered Figure Error! No text of specified style in document..24. If oil temperature sensor is not inserted or the set values are out of range, "Cal. Value Out of Range, Calibration Fails!" appears at the lower part of the display. The prompt disappears in a few seconds and the main menu is entered, this calibration is invalid.

Figure Error! No text of specified style in document..23 Calibration at Ambient Temperature Completed

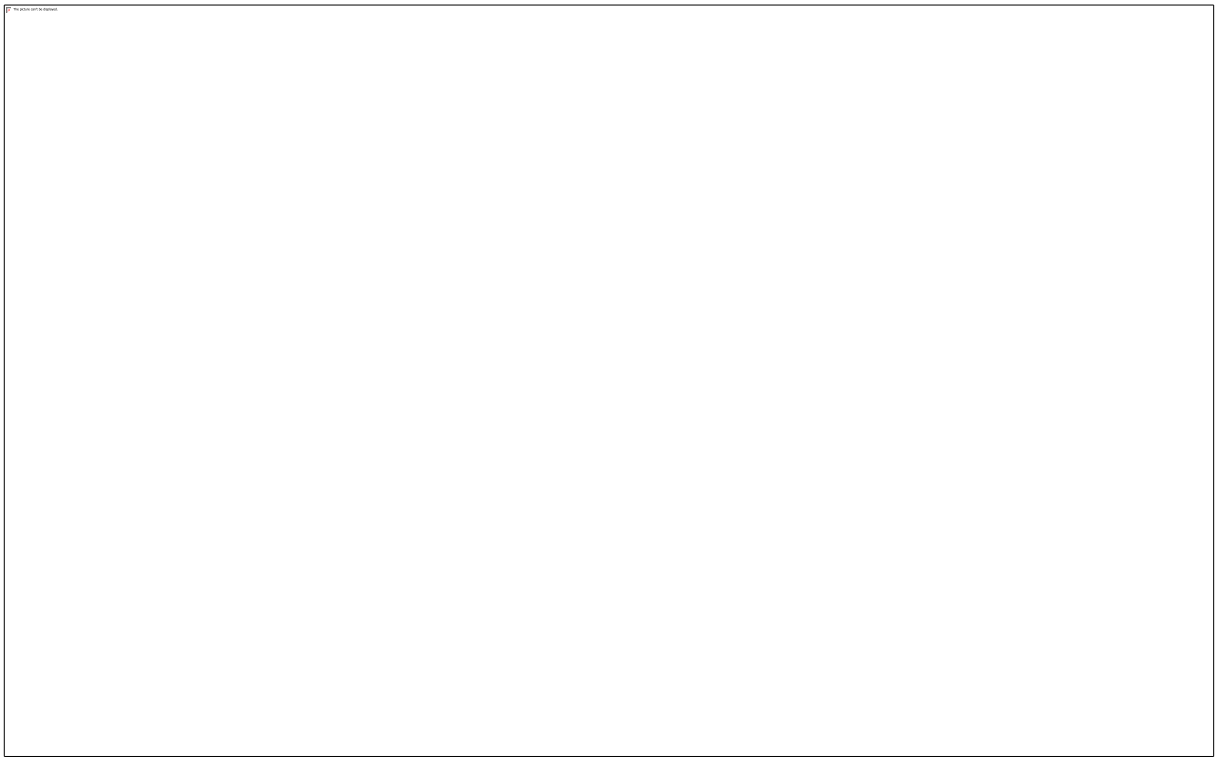


Figure Error! No text of specified style in document..24 Setting Calibration Values at High Temperature Point

g) Figure Error! No text of specified style in document..24 shows the calibration values at high temperature point. press [▲] or [▼] to modify the set values at high-temperature environment (100°C boiled water or other high-temperature device with known temperature). After modification, press [K] for the next operation. If high-temperature calibration is not required any more, press [S] to exit and return to the main menu.

Figure Error! No text of specified style in document..25 Wait Calibration Values at High Temperature Point

h) In the interface of Wait for Calibration at High-Temperature Point Figure Error! No text of specified style in document..25, follow the prompt. place the oil temperature sensor in 100 boiled water or other high-temperature device with stable temperature, press [K] when the reading is stable, start calibration at high-temperature point. If such calibration is not required, press [S] to exit and enter the main menu.

i) After calibration at high-temperature point is completed, "Calibrating...OK!" appears at the lower part of the display and the main menu is returned. If oil temperature sensor is not inserted or the set values are out of range, "Cal. Value Out of Range, Calibration Fails!" appears at the lower part of the display. The prompt disappears in a few seconds and the main menu is entered, this calibration is invalid.