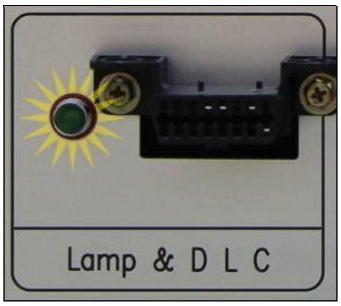
Exercise course utilizing EMS activation
1-1. Output value change of sensor and actuator control process is studied through actual operation of EMS, referring to the operation order above. 1-2. By adjusting the variable control knob of majorsensors, actuator control situation, trouble code output condition and Fail Safe function are studied, which are linked with the change of output value.

Scanner operating & measuring process

1) Turn on the 'IGNITION KEY' and activate the system.

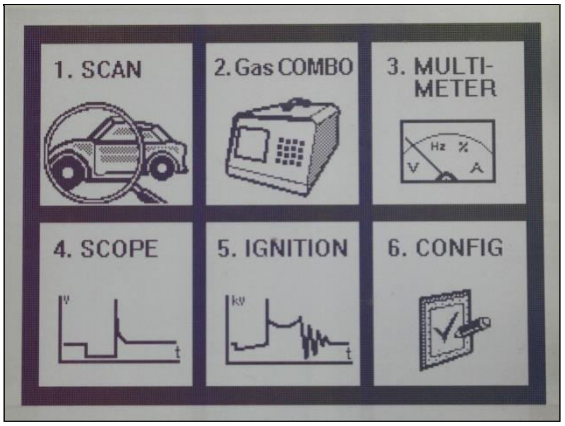


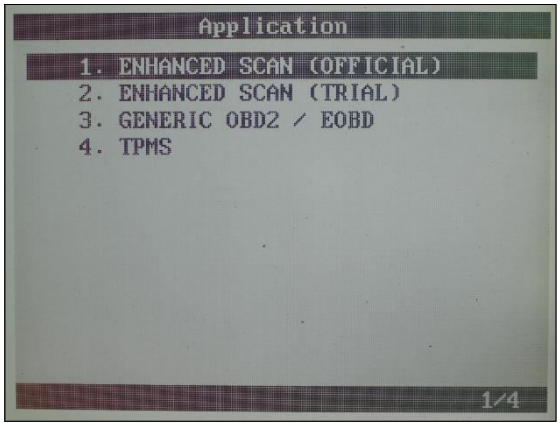
2) Locate the scanner in better place to measureand insert the connector into the D.L.C terminal.

3) When power on the scanner, the initial main screen will be displayed.

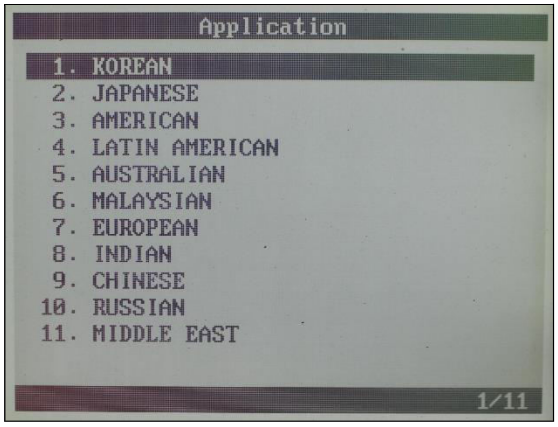
Scan-tool function

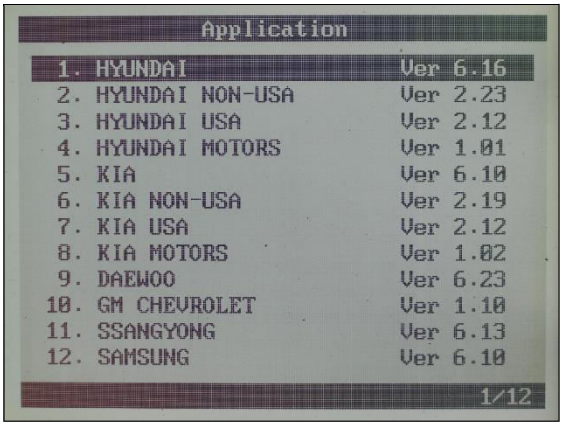
1) Select **[Scan]** on the main screen, then select **[ENHANCED SCAN]** on the selection screen.



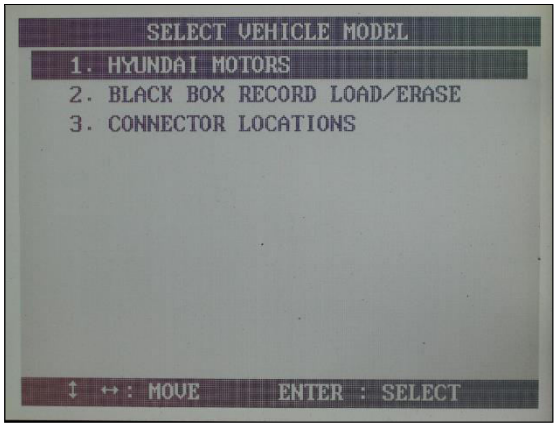


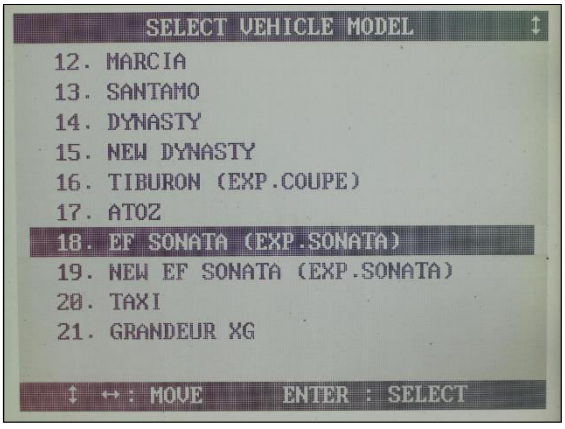
2) Select **[KOREAN]** in the country selectionscreen, then select **[HYUNDAI]** in the manufacturer selection screen.



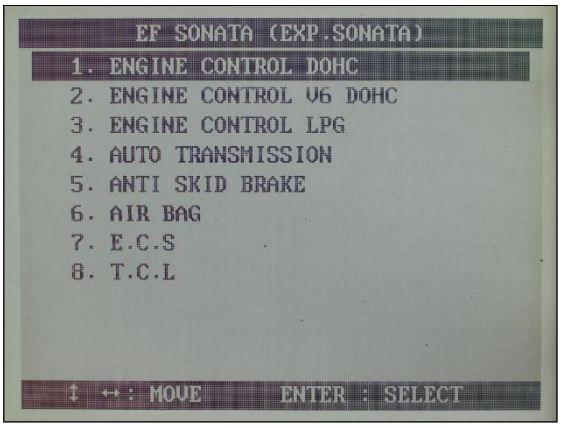


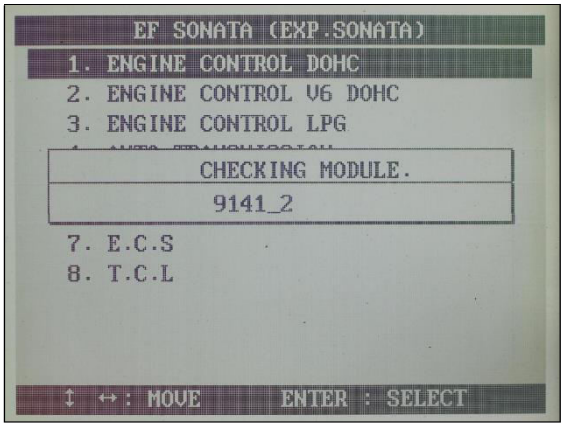
3) Select **[HYUNDAI MOTORS],** then select **[EF SONATA]** on the vehicle model selection screen.



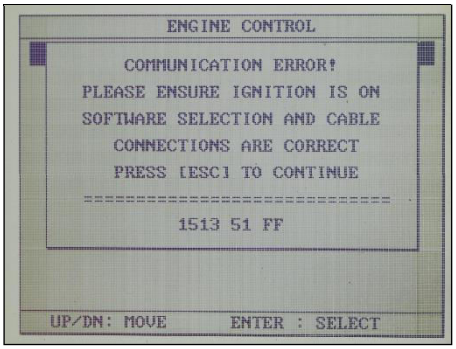


4) Select **[ENGINE CONTROL DOHC]** on the vehicle selection submenu screen. The following screen will appear if the communication with the engine ECU is successful.





5) A communication error screen will appear if the diagnostics cable connection is faulty or if the system malfunctions. Check the related wiring and circuits and try again.



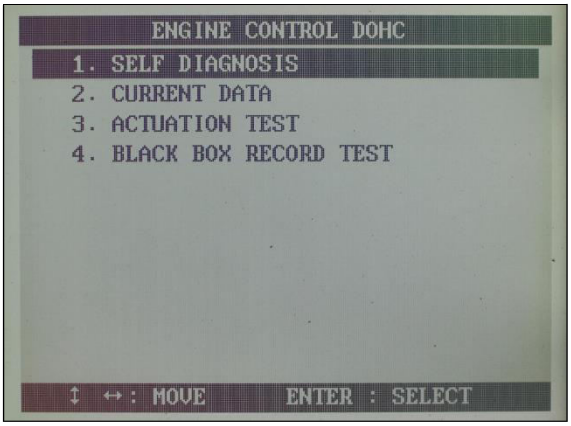
*** Checklist for addressing a communication error**

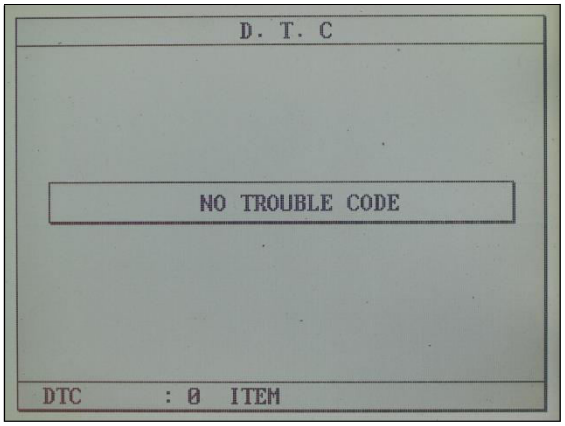
1) Check the wiring connections.

2) Verify that the vehicle type selected corresponds to the actual vehicle.

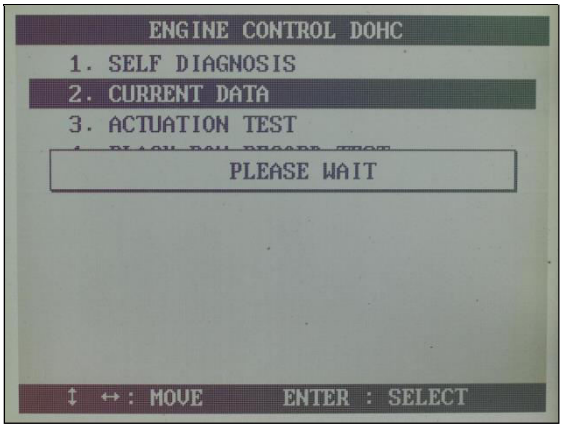
3) Check if the ignition key is in the ON position.

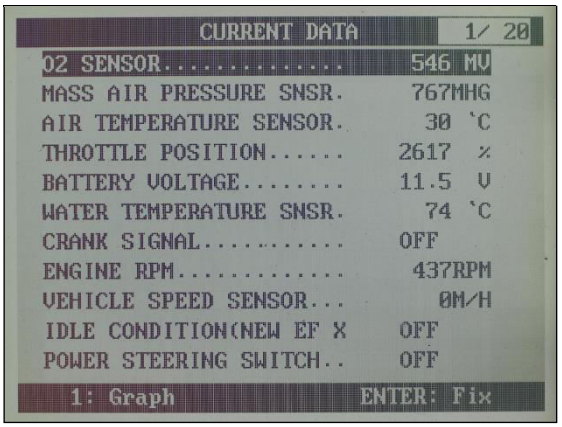
6) Click **[SELF DIAGNOSIS]** to display the trouble codes.





7) Press **[ESC]** to leave the screen, then select **[CURRENT DATA]** to check the system's service data.





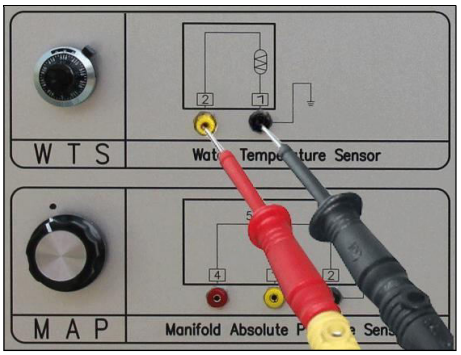
※ **Information and standard values for eachdata item.**

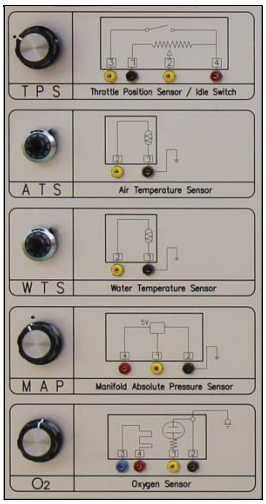
1. **MAP SENSOR** – MAP sensor indirectly detects the amount of intake air entering the engine by measuring absolute pressure in the intake manifold. During the engine operation, the sensor measures the pressure in the intake manifold, which is changed upon engine load andrpm, and converts it into the signal voltage for ECU.
   (Standard value at IDLE: 26-34KpaStandard value at 2500rpm: 2.7~29.4Kpa)
2. **INTAKE AIR TEMPERATURE SENSOR** – A kind of thermistor featuring negative resistor. By checking output voltage of IATS, ECU detects the temperature of intake air to compensate fuel amount appropriate for the air temperature, fuel amount at the ignition, ignition timing and air temperature at engine idle. **(Standard value at 20℃: 2.3~2.7V)**
3. **THROTTLE POSITION SENSOR** – Throttle Position Sensor monitors the level of openness of the throttle and converts it into output voltage for ECU.
   (Standard value at IDLE: 630 ± 300 mV Standard value at W.O.T : 5000mV)
4. **BATTERY VOLTAGE** – Battery voltage is displayed before the engine operation and generator voltage is shown during the operation. **(Standard value at : 12V~14V)**
5. **COOLANT TEMPERATURE SENSOR** – CTS transmits output voltage, which is subject to coolant temperature, to ECU. By detecting the temperature of the engine, ECU controls each actuator. **(Standard value at 20℃: 2.21~2.69㏀)**
6. **ENGINE SPEED** – It represents r.p.m. calculated by crank position sensor. **(Standard value at: 750±50RPM)**
7. **CLOSE THROTTLE POSITION SWITCH** – This represents engine idle, according to TPS signal. The ON stands for complete closure and the OFF stands for complete opening.
8. **INJECTION DURATION** – This represents duration of solenoid valve operation at the injector. That is, it represents the duration that fuel is injected. **(Standard value at IDLE : 2.5~3.5ms)**
9. **IGNITION TIMING –** IGNITION TIMIMG controls ignition timing and dwell time of ignition coil to improve fuel ratio, idle stability and drivingperformance. It also determines final ignition timing and dwell time best fitted by detecting engine operation condition through various signals from the sensors.

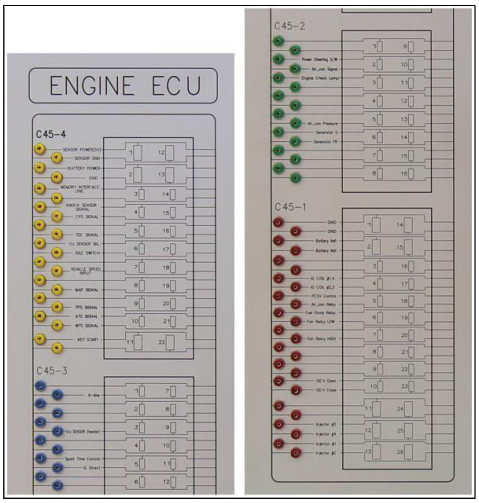
10. ISC ACTUATOR DUTY – Idle Speed Control valve, which is duty controlled by ECU, is used to compensate r.p.m. during the engine start, engine idle, electric load and gearshift load. In order to control idling speed, it calculates such input elements as TPS openness, coolant temperature, MAP values and r.p.m. to conduct various compensation control, feedback control and learning control. **(Standard value at IDLE: 30±10%)**

Oscilloscope function

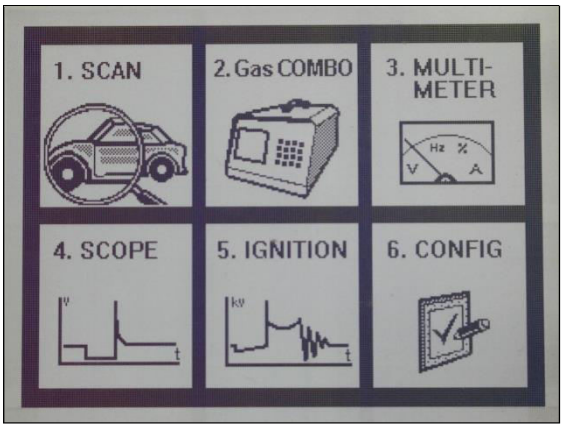
1) After connecting the scan-tool with a scope probe, insert the probe into a check terminal wishto be measuring. (Be sure to connect the grounding cable).

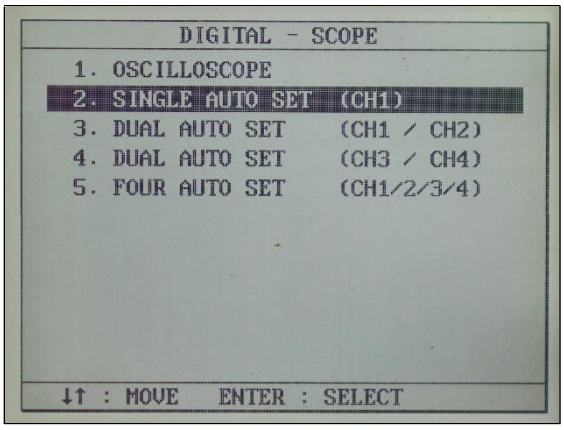




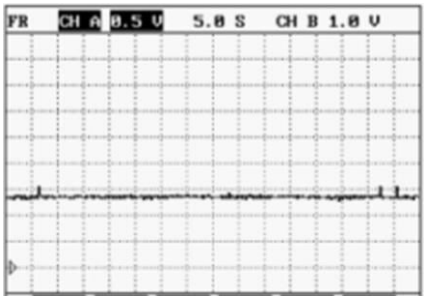


2) On the initial main screen, enter **[SCOPE]** andselect **[SINGLE AUTO SET (CH1)].**

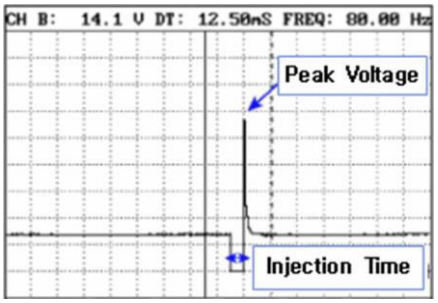




3) The wave form is measured according to the adjustment of time axis and voltage axis.



<IATS>

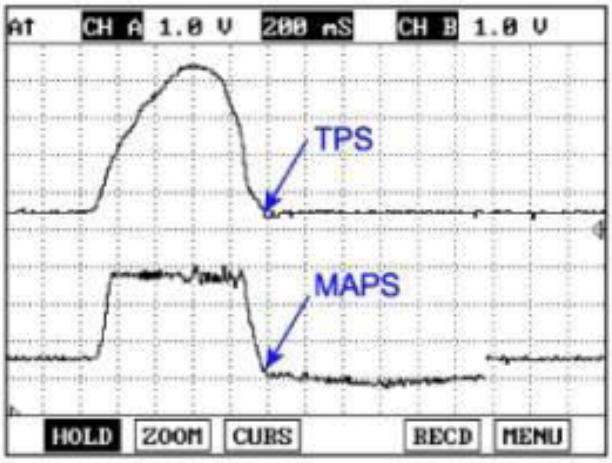


<INJ>

*** Wave-form analysis**

1. IATS- Signal that detects the temperature of intake air. Normal output value is 1.29V. The temperature is in inverse proportion to the output voltage.

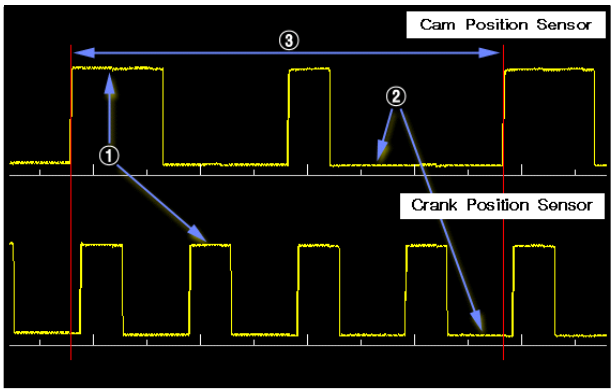
2. INJ – Signal that is generated during injector control. The power supply voltage is about 14V, the grounding voltage is below 0.8V, and the surge voltage is about 70V. It checks the power supply and the grounding when the wave form is tilted.



*** Wave-form analysis**

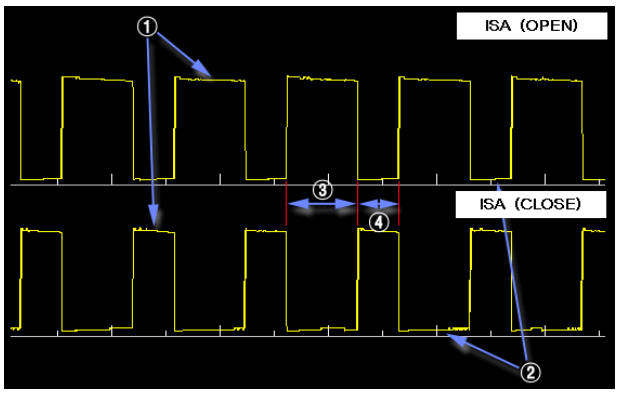
3. MAPS – Signal that shows the movement of intake manifold pressure. The voltage increases when throttle valve is completely opened, while it decreases when the valve is closed. This wave form is that of sudden acceleration.

4. TPS – Signal that shows the movement of throttle valve. The voltage increases when throttle valve is completely opened (4.5~4.8V), while it decreases when the valve is closed (0.3~0.5V). This wave form is that of sudden acceleration.



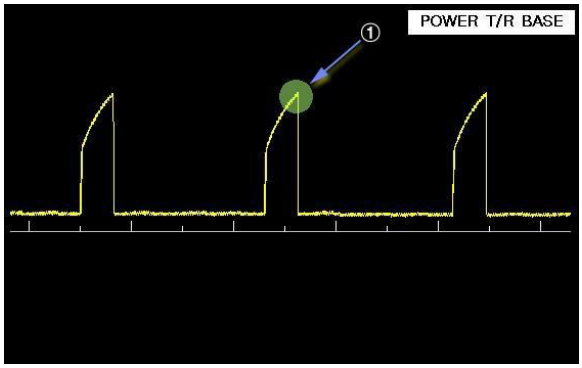
*** Wave-form analysis**

5. CMPS, CKPS - Differentiates the No. 1 and No. 4 cylinders using cam shaft and crank shaft changes, with the wider wave representing the No. 1 cylinder. The student can observe reductions in pulses, the presence of noise and the regularity of the signal during acceleration and declaration. Zone ③ represents a single cycle of the engine (2 revolutions of the crank shaft), differentiating between the cylinder and the crank shaft positions.Zone ① represents the sensor voltage, approximately 5V, with zone ② representing the sensor ground, at around 0V.



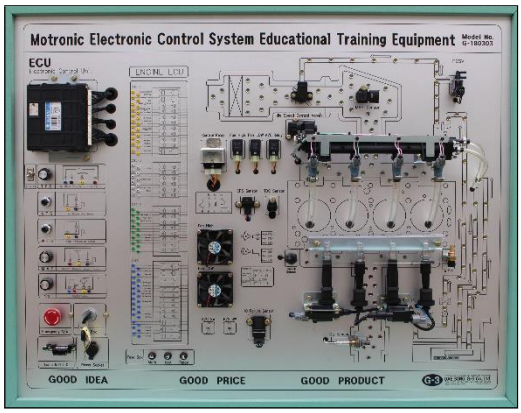
*** Wave-form analysis**

6. ISA – Intake air is brought in through the idle airbypass as the throttle valve is completely closed during idling. The ISA is installed along the bypass intake pathway to control the airflow through duty loads. Zone ① represents the voltage when the intake is closed (OFF) at 12-14.7V, with zone ② representing open voltage at less than 0.8V, and zones ③ representing the closed duty ratio and ④ indicating the open duty ratio (30-32% at idle).



*** Wave-form analysis**

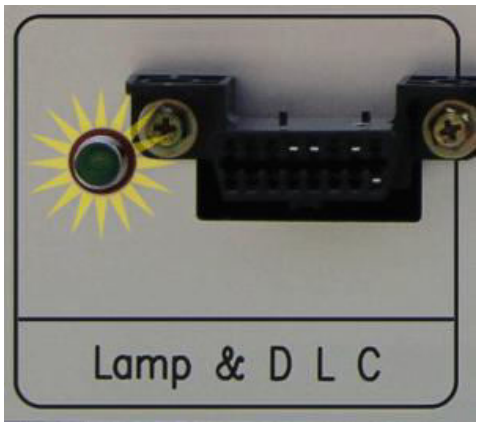
7. Power T/R BASE – The TR base voltage can be observed when checking the ignition system to determine whether the signal from the ECU is missing, or whether there is a signal being emitted by a problem with the ignition coils. Zone ① is the TR "OFF" position, with an output of approximately 4.75V.

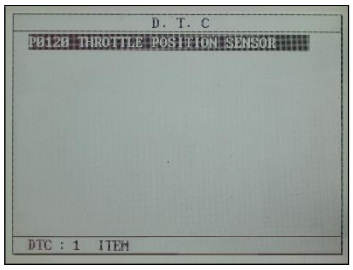
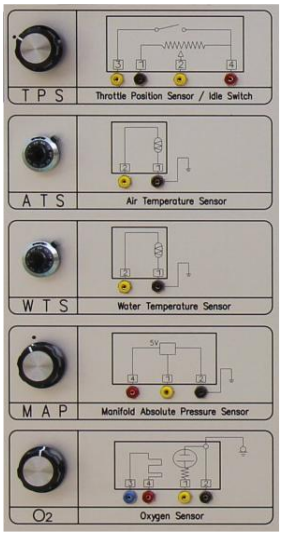
Instruction of engine control process	
	1. Engine system on the instructional engine panel is studied. 2. Related information and circuit diagram in the theory manual are referred to.

When EMS Operate Abnormally

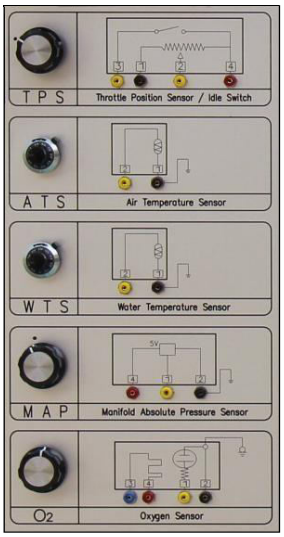
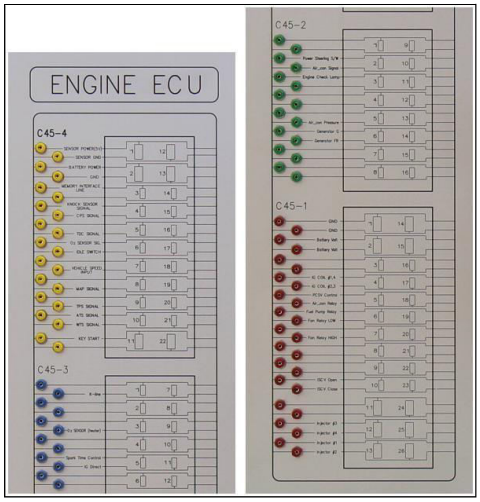
1) When there is any trouble in the system, the ECU senses it, lighting the warning lamp.

2) ECU changes the mode of troubled sensors andactuators into Fail Safe to control them, when engine warning lamps light up.



Actions to be done when alarm lamp lights		
1) When the engine warning lamp continuously lights up, solve the problem by using the scanner. When they are not erased, set the variable control knob for major sensors to normal value, and erase them again. 2) When the engine alarm lamp keeps lighting upand in an emergency condition without scanner, push the emergency stop switch and turn it on after 15 seconds to clear the memory		
		

Exercise course utilizing check terminal

4-1. Check terminal is connected to sensors,actuators of EMS control circuit.

4-2. Trainee exercises test of voltage, currency, and resistance of each check terminal of EMS with multi-tester.