CAN SYSTEM

GENERAL INFORMATION

Overview

Description

Most controllers and diagnostic interfaces of TIGGO 8 data communication system are connected via CAN Gateway Module (CGW), CAN controller and CAN transceiver are integrated into gateway module. Terminal resistors are integrated in gateway module, ICM, BCM, ECM and audio module (IHU) to form a body CAN bus with CGW and ICM as terminal resistors, a power bus with ECM and CGW as terminal resistors, IHU and CGW as infotainment CAN bus of terminal resistor, EPB and CGW as chassis CAN bus of terminal resistor. The terminal resistance is 120 Ω, and the terminal resistance of gateway module connected with diagnostic interface is 60 Ω.

Operation

CAN bus is also called vehicle bus, and full name is "Controller Area Network" which means local area network, it connects all control units together in some way to form a complete system. Each control unit collects different signals by each sensor, and transmits data among modules under the same rules. Network information can meet different real-time requirements by its priority. Data transmitted via CAN bus control unit is level model of binary format, and data transmission line transmits the voltage signal.

Composition

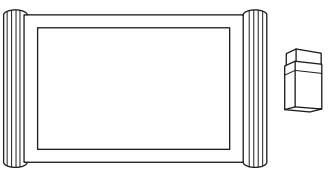
- Bus speed is: 500 Kbit/s;
- It cannot run in single line - If a CAN line of module is disconnected, CAN signal of this module cannot be transmitted;
- Drive CAN diagnosis of this vehicle is performed through diagnostic interfaces No.6 and No.14 pins.

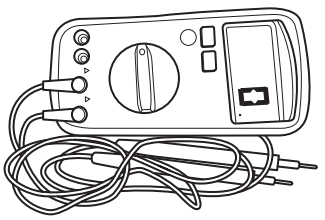
OBD: On-board Diagnostic Interface	CGW: Central Gateway Module
IHU: Audio Head Unit	TBOX Module
TCU: DCT Transmission Control Unit	ECM: Electronic Engine Injection Controller
ESP (EPB) Module	ABM: Airbag Control Module
CLM: Automatic A/C Module	APM: Center Control Integration Panel
BCM: Body Control Module	PEPS
ICM: Instrument Cluster	AVM: Panoramic Image Module
RADAR: Reversing Radar Module	PLGM: Power Back Door Module
SAM: Steering Wheel Angle Sensor	EPS: Electronic Power Steering
EPB: Electronic Parking Brake	

Tool Drawing

Tool Drawing

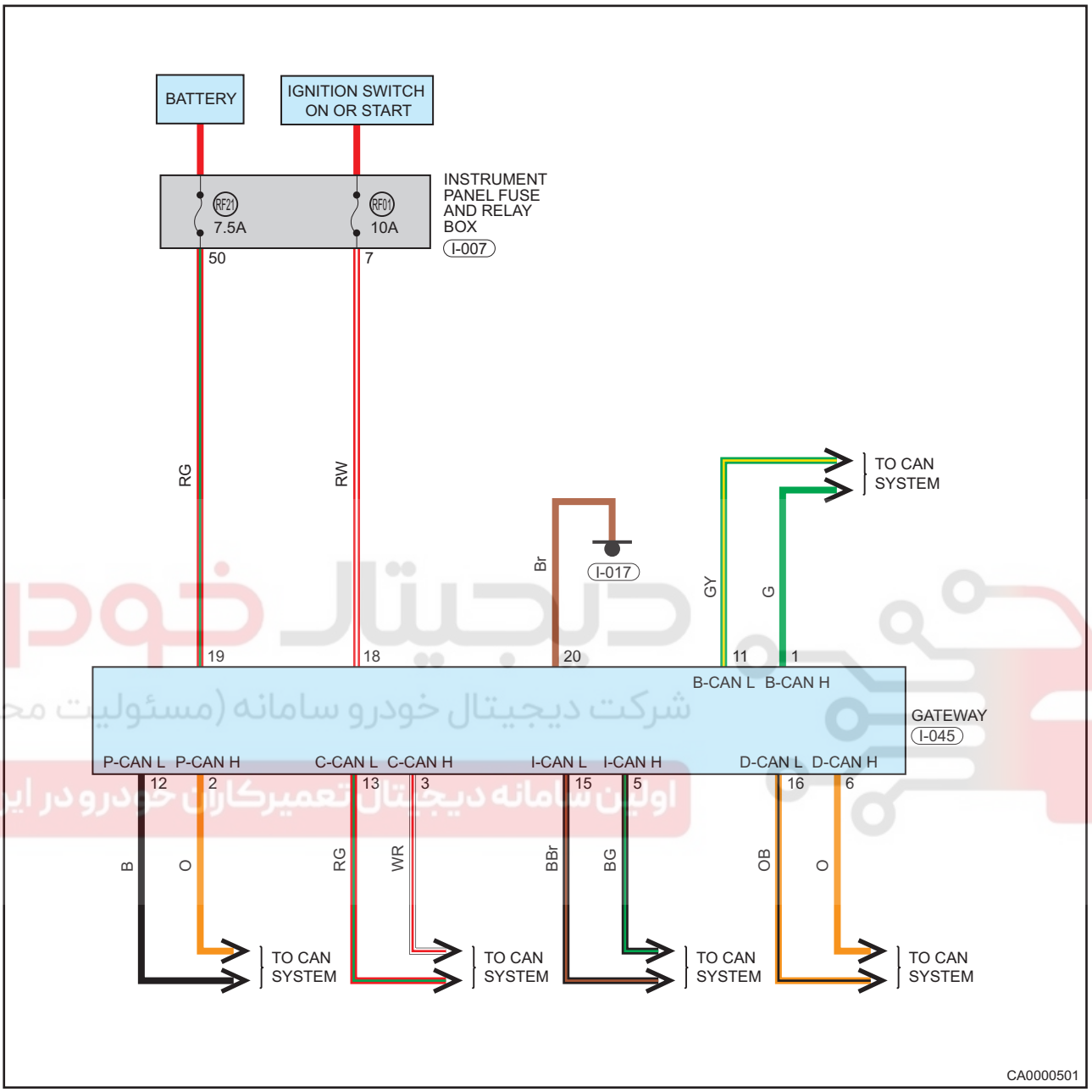
Special Tools

X-431 3G Diagnostic Tester	 001

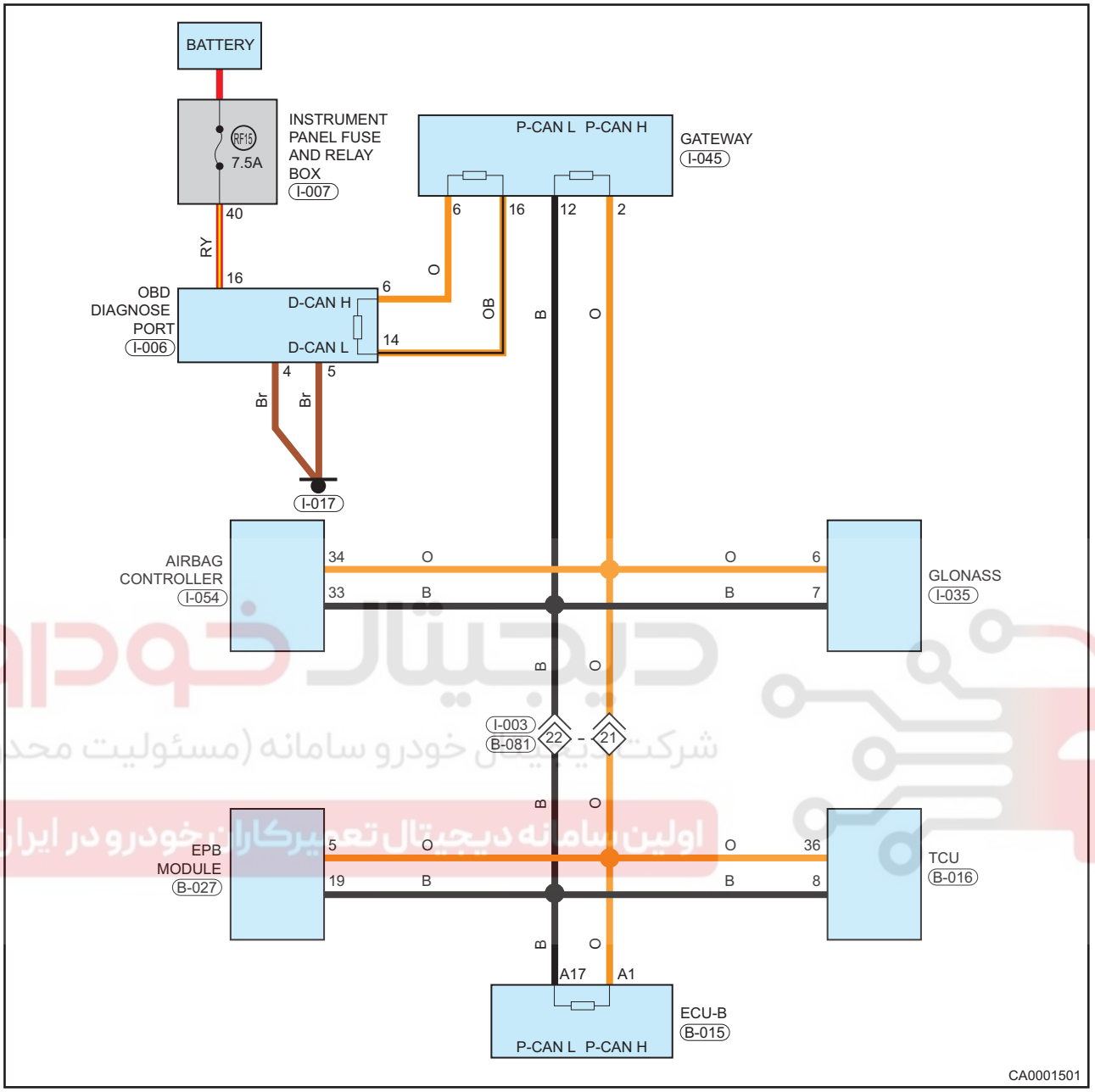
Oscilloscope	 061
Digital Multimeter	 002

Circuit Diagram

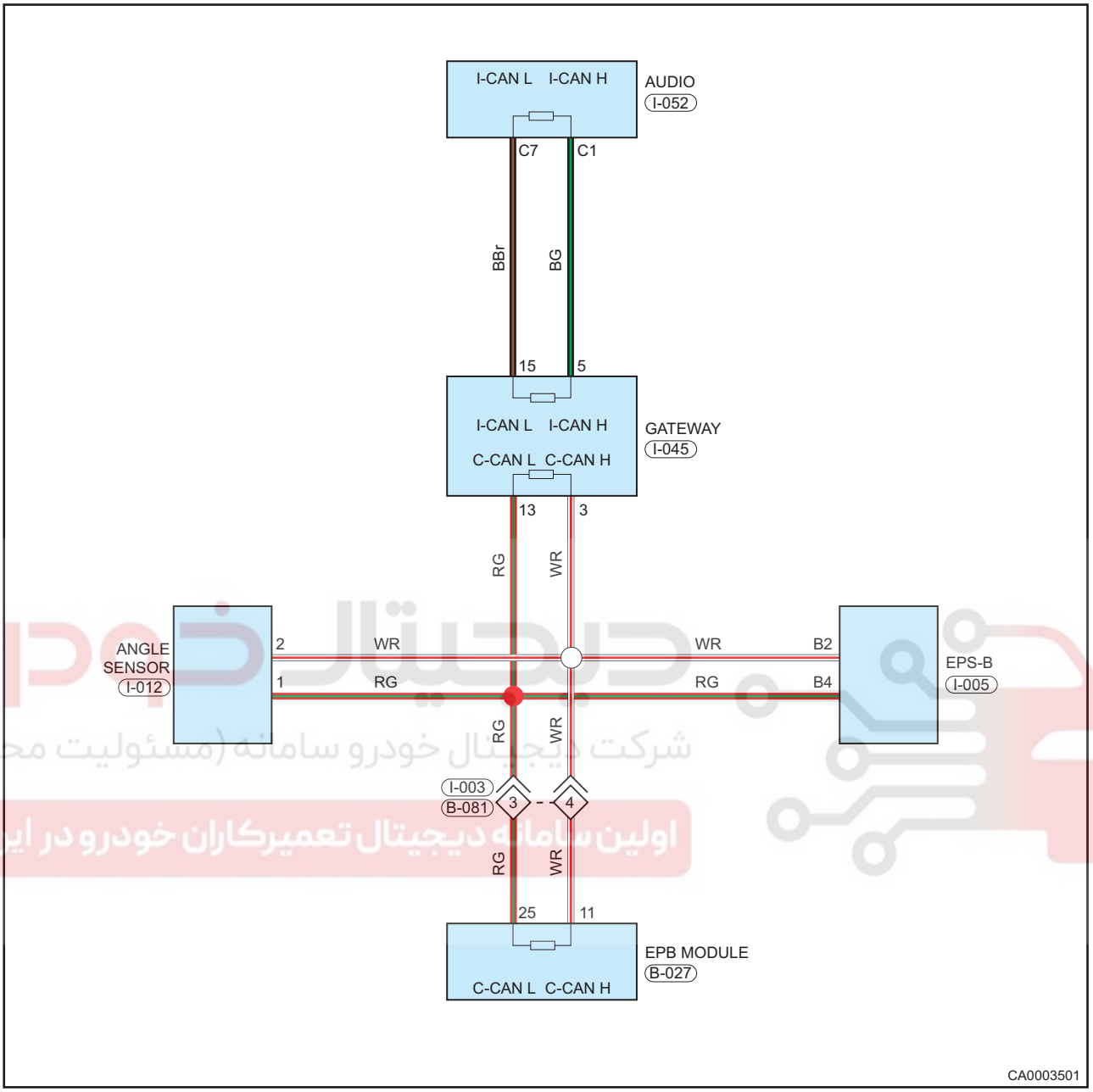
Power CAN System (Page 1 of 4)



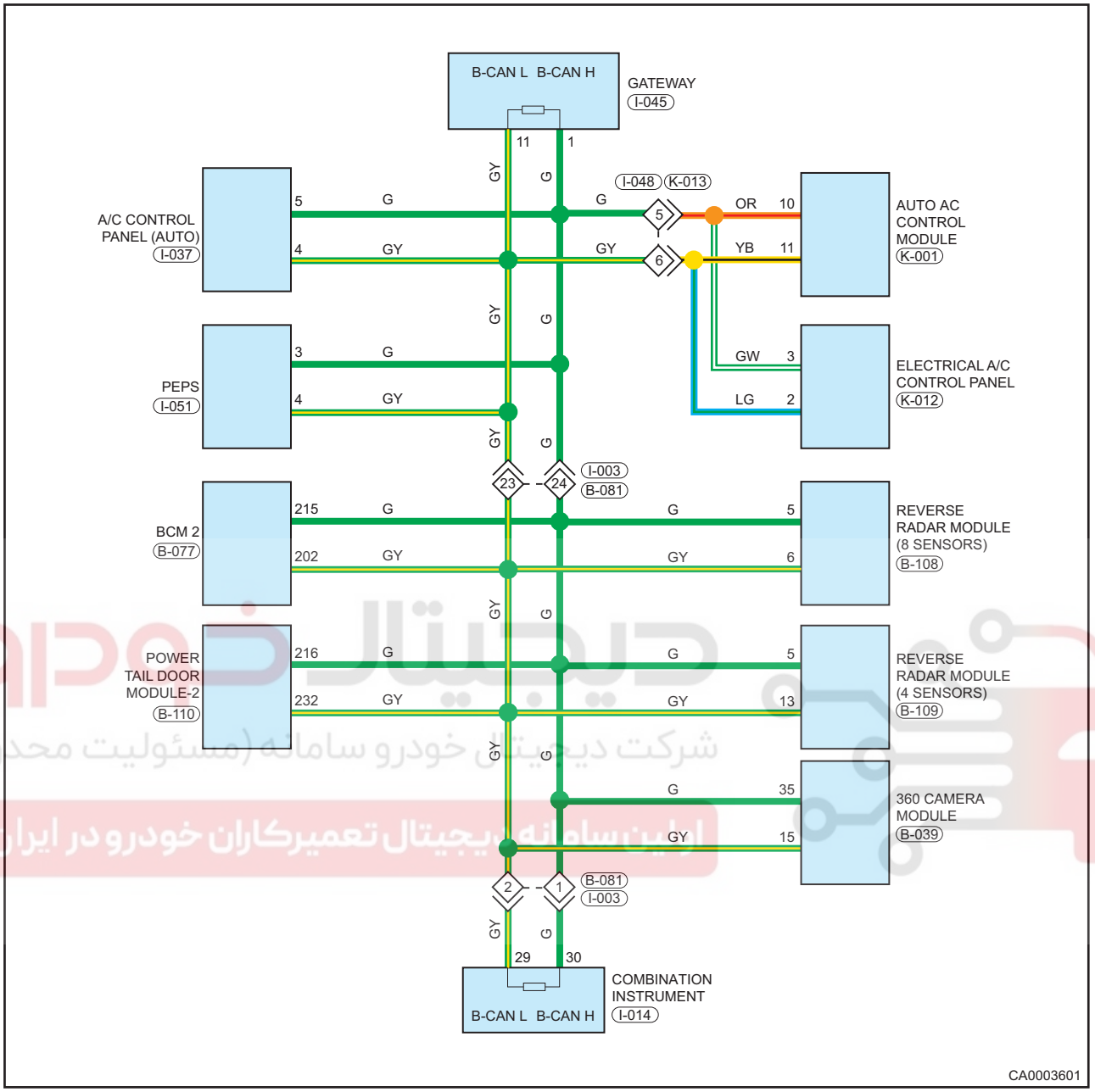
Chassis CAN System (Page 2 of 4)



Body CAN System (Page 3 of 4)



Entertainment and Diagnosis CAN System (Page 4 of 4)



DIAGNOSIS & TESTING

Diagnosis Content

Problem Symptoms Table

Hint:

Use symptoms table below to help determine cause of problem. Check each suspected area in sequence. Repair, replace or adjust faulty components as necessary.

Symptom	Suspected Area
Diagnostic interface cannot access to the system	Fuse
	CAN bus
	Gateway module
Engine control system failure	CAN bus
	Battery voltage
	Module damage
	Ground wire
Brake control system failure	Wire harness or connector
	EPB module
Airbag system failure	ECM
	Wire harness and connector
	Airbag module failure
Body electrical failure	Body Control Module (BCM) failure
	Wire harness or connector
	Instrument cluster
Transmission malfunction	Transmission Control Module (TCU) failure
	Wire harness or connector
	ECM

Diagnosis Tools

Diagnostic Tester

When connecting the diagnostic tester:

- Connect diagnostic tester (the latest software) to diagnostic interface for communication with vehicle.
- Diagnostic interface is located at driver side instrument panel crossmember.
- Diagnostic interface uses a trapezoidal design which can hold 16 terminals.

Digital Multimeter

When using digital multimeter:

- Troubleshoot electrical malfunctions and wire harness system.
- Look for basic malfunction.
- Measure voltage, current and resistance.

Oscilloscope

- Troubleshoot electrical malfunctions and wire harness system.
- Look for basic malfunction.
- Measure CAN network output waveform.

Diagnostic Help

1. Connect diagnostic tester (the latest software) to diagnostic interface, and make it communicate with vehicle electronic module through data network.
2. Confirm that malfunction is current, and carry out diagnostic test and repair procedures.
3. If DTC cannot be deleted, malfunction is current.
4. Only use a digital multimeter to measure voltage of electronic system.
5. Refer to any Technical Bulletin that may apply to this malfunction.

6. Visually check the related wire harness.
7. Check and clean all system grounds related to the latest DTCs.
8. If multiple trouble codes were set, use circuit diagrams and look for any common ground circuit or power supply circuit applied to DTC.

Intermittent DTC Troubleshooting

If malfunction is intermittent, perform the followings:

- Check if connector is loose.
- Check if wire harness is worn, pierced, pinched or partially broken.
- Wiggle related wire harness and connector and observe if signal in related circuit is interrupted.
- If possible, try to duplicate the conditions under which DTC was set.
- Look for data that has changed or DTC to reset during wiggling test.
- Look for broken, bent, protruded or corroded terminals.
- Inspect the mounting areas of instrument cluster, wire harness or wire harness connector and so on for damage, foreign matter, etc. that will cause incorrect signals.
- Check and clean all wire harness connectors and ground parts related to DTC.
- Remove instrument cluster from malfunctioning vehicle, then install it to a new vehicle and perform a test. If this DTC cannot be cleared, instrument cluster is malfunctioning. If DTC can be cleared, reinstall instrument cluster to original vehicle.
- If multiple trouble codes were set, refer to circuit diagrams to look for any common ground circuit or power supply circuit applied to DTC.
- Refer to any Technical Bulletin that may apply to this malfunction.

Ground Inspection

Groundings are very important to entire circuit system, which are normal or not can seriously affect the entire circuit system. Ground points are often exposed to moisture, dirt and other corrosive environments. Corrosion (rust) and oxidation may increase load resistance. This case will seriously affect normal operation of circuit. Check the ground points as follows:

1. Remove ground bolt or nut.
2. Check all contact surfaces for tarnish, dirt and rust, etc.
3. Clean as necessary to ensure that contacting is in good condition.
4. Reinstall ground bolt or nut securely.
5. Check if add-on accessories interfere with ground circuit.
6. If several wire harnesses are crimped into one ground terminal, check for proper crimps. Make sure that all wire harnesses are clean and securely fastened while providing a good ground path.

Diagnosis Procedure

Hint:

Use following procedures to troubleshoot the CAN system.

1	**Vehicle brought to workshop**

Result

Proceed to
Next

Next

2	Check battery voltage

Check if battery voltage is normal.

OK

Standard voltage: Not less than 12 V

Result

Proceed to
OK
NG

NG → Check and repair battery

OK

3	Customer problem analysis

Result

Proceed to
Next

Next

4	Check for DTCs (current DTC and history DTC)

Result

Proceed to
No DTC
Current DTC
History DTC

History DTC

5	Problem repair (no DTC), then go to step 8

Result

Proceed to
Next

Next → Go to step 8

6	Troubleshoot according to Diagnostic Trouble Code (DTC) chart, then go to step 8

Result

Proceed to
Next

Next → Go to step 8

7	Troubleshoot according to Problem Symptoms Table, then go to step 8

Result

Proceed to
Next

Next

8	Adjust, repair or replace

Result

Proceed to
Next

Next

9	Conduct test and confirm malfunction has been repaired

Result

Proceed to
Next

Next → End

Failure Analysis Method

1. Use diagnostic tester to diagnose and analyze the trouble code.

   When a module or several modules need to receive the data sent by a module to complete the corresponding function, once the data is not received, the module received the data will generate trouble codes, which could be read by diagnostic tester as: "Lost communication with XX module", "Communication with XX module is not normal"; When the bus is out of work, the trouble code will be read as CAN bus close; When there is malfunction on module CAN configuration, code will be reported as "configuration code error"

   CAN network failures consist of the following types:

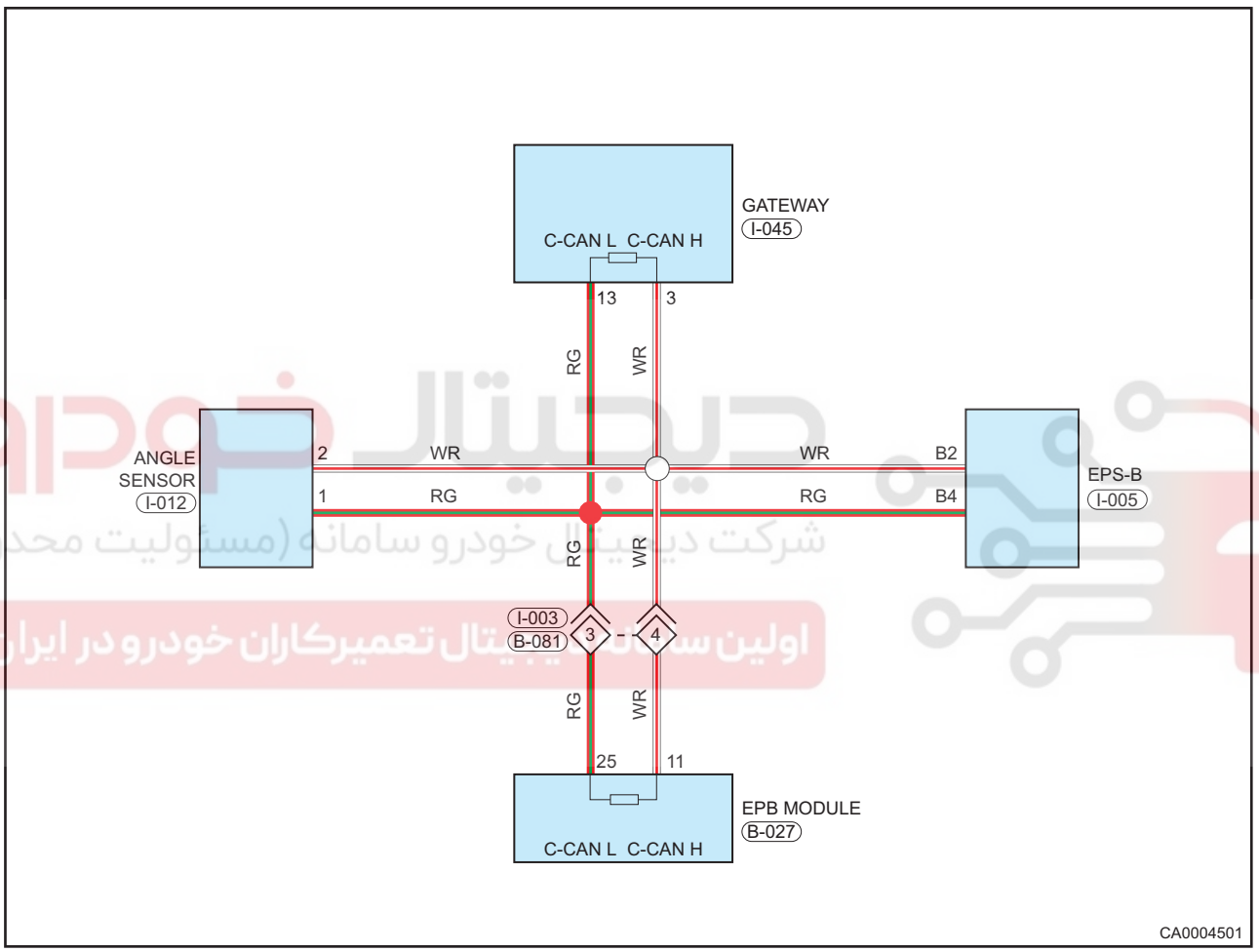
   (a) Receive continuous invalid signals: This type of fault indicates communication effective bit received by control module is "invalid" or invalid signal after processing.
   (b) Signal is below normal range: This type of fault indicates serial data bus signal is below normal range.
   (c) Signal is above normal range: This type of fault indicates serial data bus signal is above normal range.
   (d) Invalid signal: This type of fault indicates serial data bus signal does not match specified execution condition.
   (e) Lost signal: This type of fault indicates specified no specified information is received.
   (f) Bus closed: This type of fault indicates bus is out of work.
   (g) Unstable signal: This type of fault indicates a transient distortion or interruption of a bus signal.

2. Waveform analysis.
   It is main method to determine the hardware fault of CAN bus system. Check operation of high speed CAN and low speed CAN and judge most CAN network hardware faults through oscilloscope.
   For example, if bus waveform is abnormal, after sales staff can judge by "plug and unplug each joint and observe the waveform of oscilloscope at the same time". If bus waveform is normal after unplugging a joint, the fault is the module or the bus connected this module. This method is especially suitable for modules that do not have trouble code self-diagnosis.
3. Circuit diagram analysis.
   Use multimeter, oscilloscope, diagnostic tester and combine with circuit diagram to determine where is the fault.

Usual Troubleshooting

1. Diagnostic tester reads trouble code of CAN configuration error.
   Fault expression: CAN or configuration code error is not performed by meter or BCM, read "Software configuration error", "Configuration code error" with diagnostic tester.
   Exclusion methods and steps:
   This type of situation usually belongs to CAN system software failure. Write correct configuration code to these modules or sensors or calibrate these sensors, clear the trouble code and verify the malfunction phenomenon again;
2. Diagnostic tester cannot communicate with all modules.
   Malfunction symptom: If diagnostic tester can be used normally on other vehicle, but cannot communicate with each module on faulty vehicle, malfunction indicators or warning lights on the meter turn on.
   Malfunction reason: diagnostic interface power supply and ground malfunction, diagnostic interface CAN line open to normal CAN line, bus CAN-H short to CAN-L, CAN-H short to ground, CAN-L short to ground, CAN-H short to power supply, CAN-L short to power supply, CAN line mixed fitting, node (module) malfunction.
3. Exclusion methods and steps:
   (a) Diagnose if power supply voltage and grounding resistance are correct.
   (b) If diagnosis port power supply or ground is not repaired correctly, verify the fault phenomenon again. If it is correct, proceed to next step;
   (c) Use multimeter to detect if parallel termination resistor, meter and ECM resistance are correct.
   (d) If it is not correct, repair link between diagnostic port and two modules with termination resistance or replace module with incorrect resistance to verify the malfunction symptom again. If it is correct, proceed to next step;
   (e) Connect oscilloscope and observe waveform at the same time. Observe if waveform is normal.
   (f) If it is not normal, repair the supply and ground of these modules, verify the fault phenomenon again. If it is normal,
   (g) determine type of fault waveform, inspect and repair, then reconfirm the fault phenomenon again.
4. The diagnostic tester cannot communicate with several modules.
   Malfunction symptom: The diagnostic tester cannot communicate with several modules, but can communicate with at least one module.
   Malfunction cause: Module power supply malfunction, CAN main line open, CAN line mixed fitting, node (module) malfunction, gateway module malfunction.

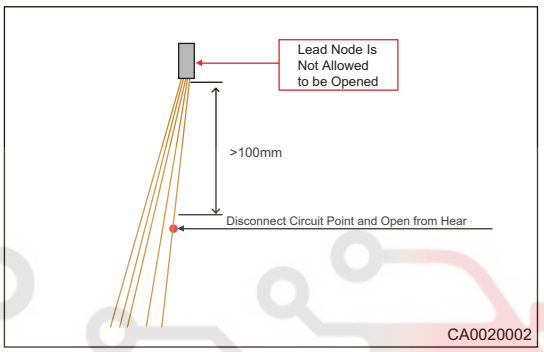
5. Power supply malfunction (power supply and ground).
   The core part of vehicle multiplex system is an electronic control unit containing a communication IC chip. The normal operating voltage of the electronic control unit is generally in the range of operating voltage: 9 V ≤ U ≤ 16 V. CAN network communication voltage range: 6 V ≤ U ≤ 16 V. If the operating voltage provided by vehicle power system is lower than this value, some electronic control units with higher requirements on operating voltage will temporarily stop working, thus making multiplex system unable to communicate. The CAN hardware controller inside ECM may not work under 6 V. Use battery tester to detect, if it does not meet the requirements, charge the battery or replace the battery (and also detect the power generated by alternator).
6. Link malfunction.



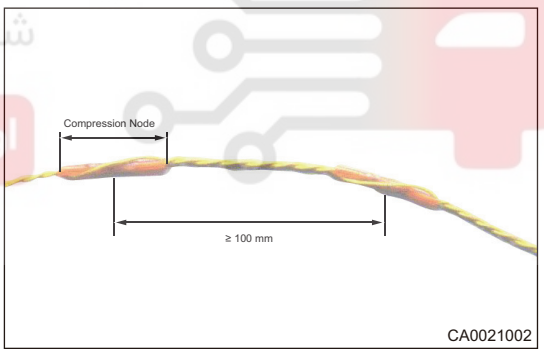
Link refers to a communication connection line between nodes. Link malfunction refers to malfunction of data communication lines, such as short circuit, open circuit and communication signal attenuation or distortion caused by changes in physical properties of the lines. These factors often cause multiple electronic control units to fail to work properly or the control system to operate improperly. To determine whether the link is malfunctioning, use an oscilloscope or a specific vehicle CAN tester to observe whether the current data communication signal matches the standard data communication signal. Maintenance methods are generally to repair shorted or open twisted-pair lines, or to eliminate the root cause of changing the physical properties of twisted-pair lines.

(a) Maintenance instructions for CAN line.
Sometimes in order to determine the malfunction, it is necessary to disconnect a control unit from the line connection point and disconnect the CAN bus connected to the control unit, or to repair wire harness after the malfunction has been determined. The data transmitted by CAN bus may even affect vehicle safety and life safety of personnel. Improper maintenance of CAN bus may cause interference or loss of signals, resulting in these data not being transmitted. Therefore, the following regulations must be observed during maintenance:

(1) During CAN bus maintenance, the disconnection point is required to be at least 100 mm away from the line node, and the line node must never be opened, maintained and updated;

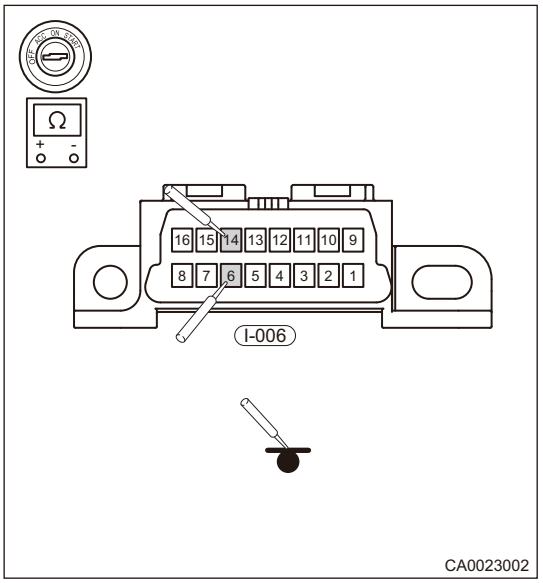


(2) If the CAN line is to be disconnected, it is only allowed to be carried out at a distance of ≥ 100 mm from the next pressure node; The twisting of CAN lines is of decisive significance to the interference effect of CAN. Only if the twisting is not damaged, the CAN can be protected from interference, so keep as little interference with the twisting as possible during maintenance.

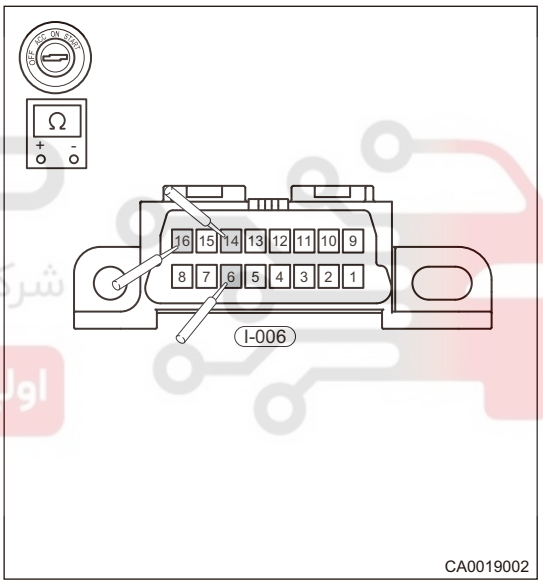


(b) Use a multimeter to measure the resistance to ground and power supply of CAN-H and CAN-L.

(1) After disconnecting T18 battery for 5 minutes, the measured resistance values to ground of diagnostic interface 6# (CAN-H) and 14# (CAN-L) are both 32 MΩ.



(2) After disconnecting T18 battery for 5 minutes, the measured resistance values to 16# of the diagnostic interface 6# (CAN-H) and 14# (CAN-L) are both 33.5 MΩ.



(c) Termination resistor.

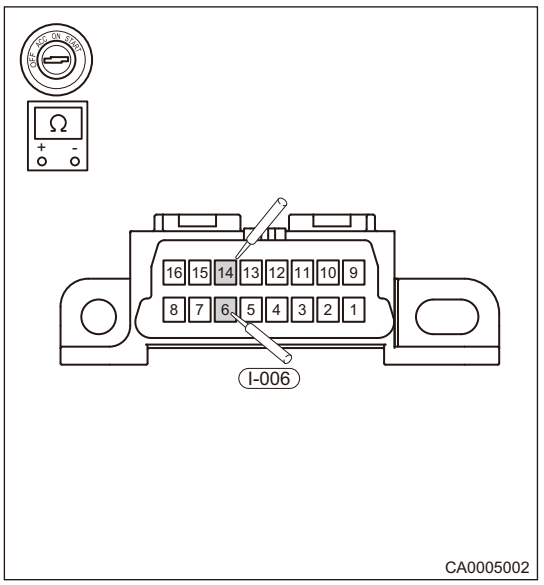
The termination resistor is installed in the system gateway module and is used to prevent CAN bus signal from reflecting the changing voltage on CAN bus. When the termination resistor fails and the square wave is transmitting, because of the reflection of line, if it is serious, the signal will be deformed and the signal of control unit will be invalid. When measuring the CAN bus signal with an oscilloscope, if the signal does not match standard signal, it is also necessary to check whether the termination resistor is damaged.

Measuring step of termination resistor:

(1) Turn ENGINE START STOP switch to OFF, disconnect the negative battery cable;

(2) Wait about 5 minutes until all capacitors are fully discharged;

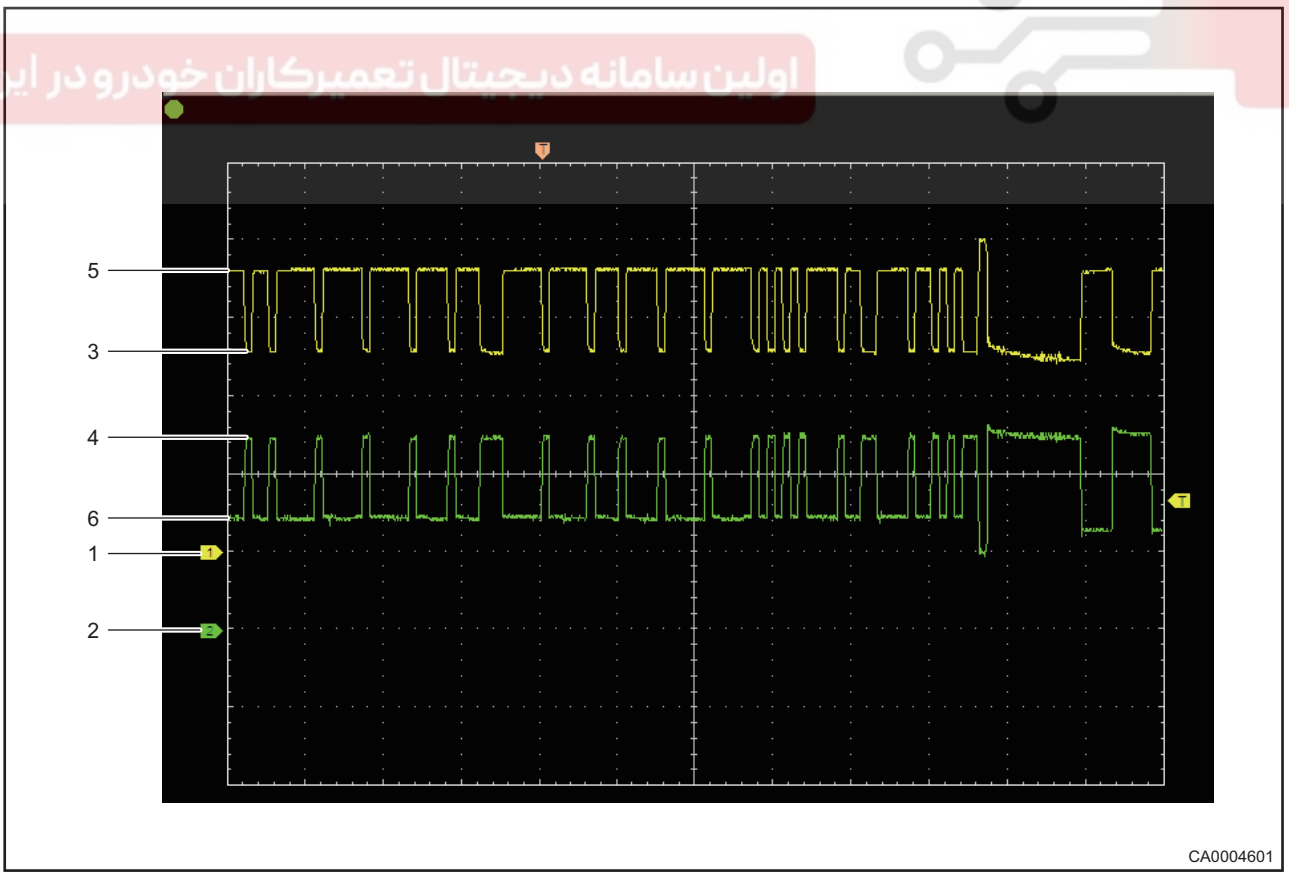
(3) Connect the measuring instrument and measure total resistance;
Using ohmmeter, measure resistance between diagnostic interfaces I-006 (6) and I-006 (14) (standard resistance is 60 Ω).



T18 measured value (for reference only): the measured resistance between diagnostic interfaces 6 # and 14 # is 58.7 Ω (the two termination resistors are connected in parallel), after the gateway module is disconnected separately, and the measured resistance between diagnostic interfaces 6 # and 14 # is ∞.

Oscilloscope analysis

1. Oscilloscope connection
CH1 (channel 1) is connected to diagnostic interface 6# (CAN-H), CH2 (channel 2) is connected to diagnostic interface14# (CAN-L), and alligator clip of the oscilloscope probe is connected to the common body ground.
(a) Normal waveform



Description:

1. Zero potential of CAN-H;
2. Zero potential of CAN-L;
3. The recessive voltage potential of CAN-H is approximately 2.6 V (logic value 1).
4. The recessive voltage potential of CAN-L is approximately 2.5 V (logic value 1).
5. The dominant voltage potential of CAN-H is approximately 3.6 V (logic value 0).
6. The dominant voltage potential of CAN-L is approximately 1.4 V (logic value 0).

Potential	CAN-H - to ground	CAN-L - to ground	Voltage difference
Dominant	3.6 V (3.5 V)	1.4 V (1.5 V)	2.2 V (2.0 V)
Recessive	2.6 V (2.5 V)	2.5 V (2.5 V)	0.1 V (0 V)

NOTE:

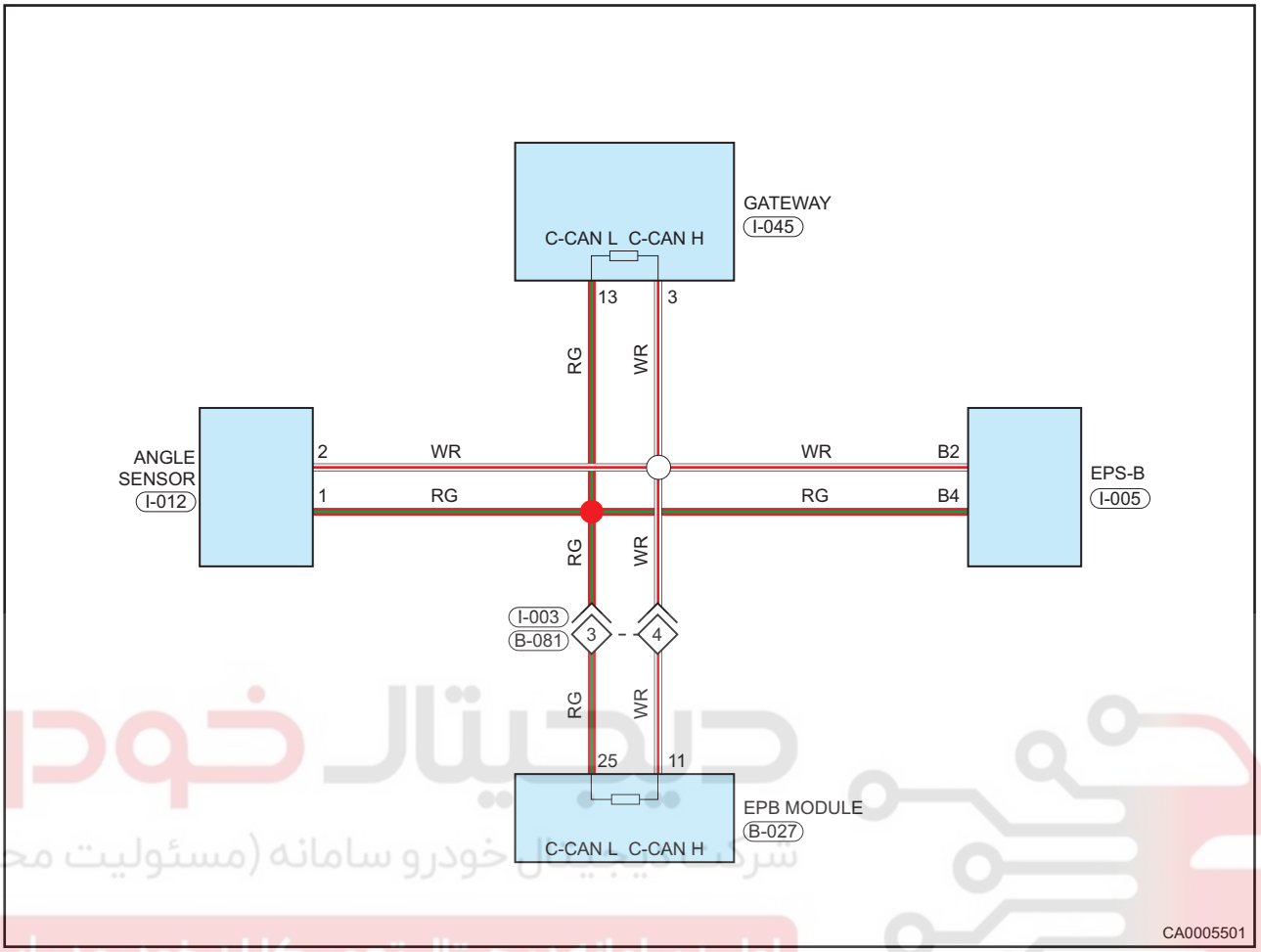
(1) Always use voltage difference between two lines to confirm data. When voltage of CAN-H rises, the voltage of CAN-L decreases accordingly. The waveform is rectangular and symmetrical.

(2) As the oscilloscope shows, CAN-Bus has only two operating states. At the recessive voltage potential, the two voltage values are very close. At the dominant voltage potential, the two voltage standard difference is 2.0 V.

(3) The difference between measured voltage value and standard value is approximately 100 mV.

(4) During communication, high-speed CAN operating voltage range: CAN-H: 2.75 V~4.5 V (dominant), 2 V~3 V (recessive); CAN_L: 0.5 V~2.25 V (dominant), 2 V~3 V (recessive); No signal transmission means that CAN bus will transmit recessive signals when it is idle, and new information will start with dominant signals.

2. Short circuit point (arrow) of CAN-H and CAN-L



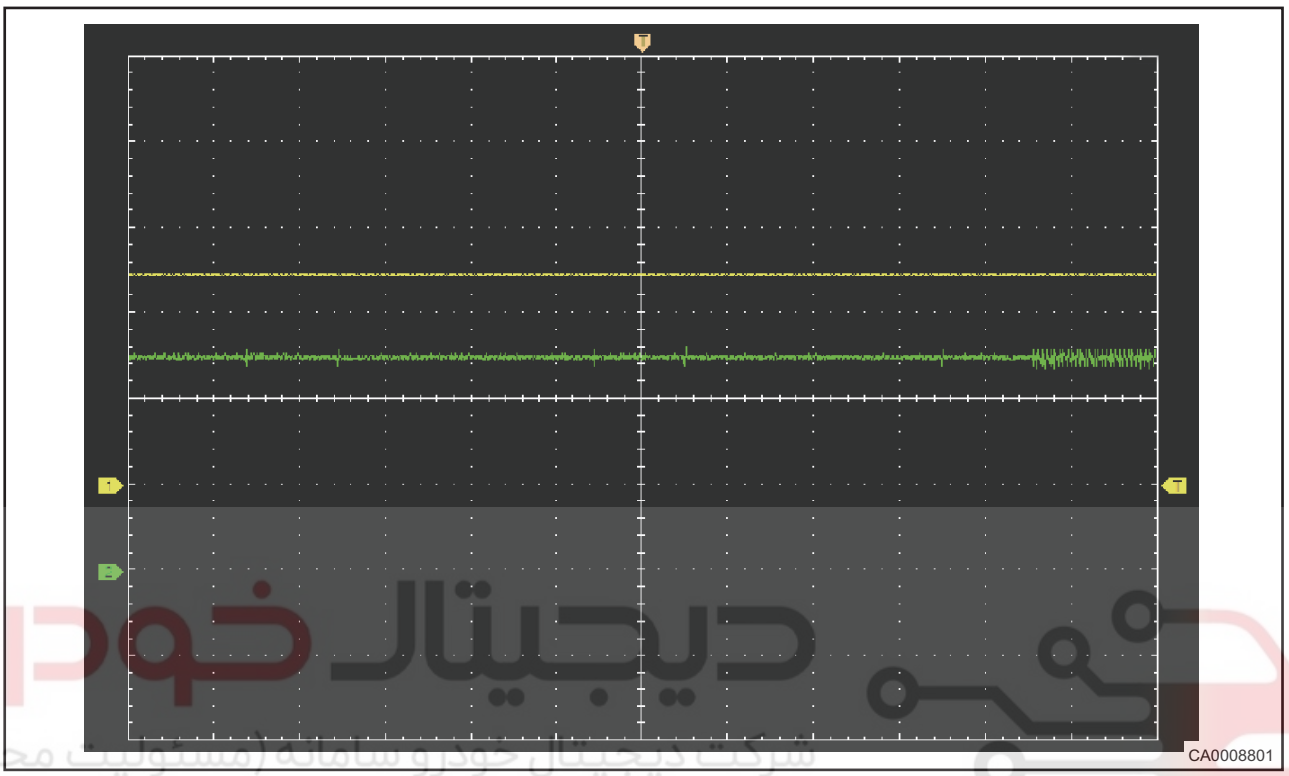
Short circuit malfunction waveform of CAN-H and CAN-L

Malfunction symptom:

- Observe with an oscilloscope, the voltage potential is at recessive voltage value (approximately 2.5 V). By moving the position of zero potential on two oscilloscope channels to make the zero potential of two channels be coincident. It can be seen that waveforms of the CAN-H and CAN-L change consistently and their potentials are consistent;

T18 actual vehicle test

- The short circuit waveforms of CAN-H and CAN-L during T18 actual vehicle test are shown in following illustration. Both waveforms are straight line with a voltage of approximately 2.5 V. Use a multimeter to test that the termination resistor is close to or equal to 0 ohms. When power CAN and body CAN, CAN-H and CAN-L are short-circuited, the vehicle cannot be started.



Troubleshooting procedure:

1. By plugging and unplugging control unit on CAN bus one by one and observing oscilloscope waveform at the same time, it can be judged whether it is a short circuit caused by the control unit or by the CAN-H and CAN-L line connection;
2. If the waveform returns to normal when unplugging the connector of a module, this module is malfunctioning;
3. For short circuit caused by short circuit of line, it is necessary to disconnect CAN wire groups (CAN-H and CAN-L) from wire harness connector or wire harness node in turn, and pay attention to waveform of oscilloscope. After disconnecting faulty wire group, waveform of oscilloscope returns to normal.
4. When there is no other measurement method, only CAN line can be disconnected from line connection point. Pay attention to maintenance instructions of CAN line.

3. CAN-H is short to power supply
   Malfunction waveform

Malfunction symptoms:

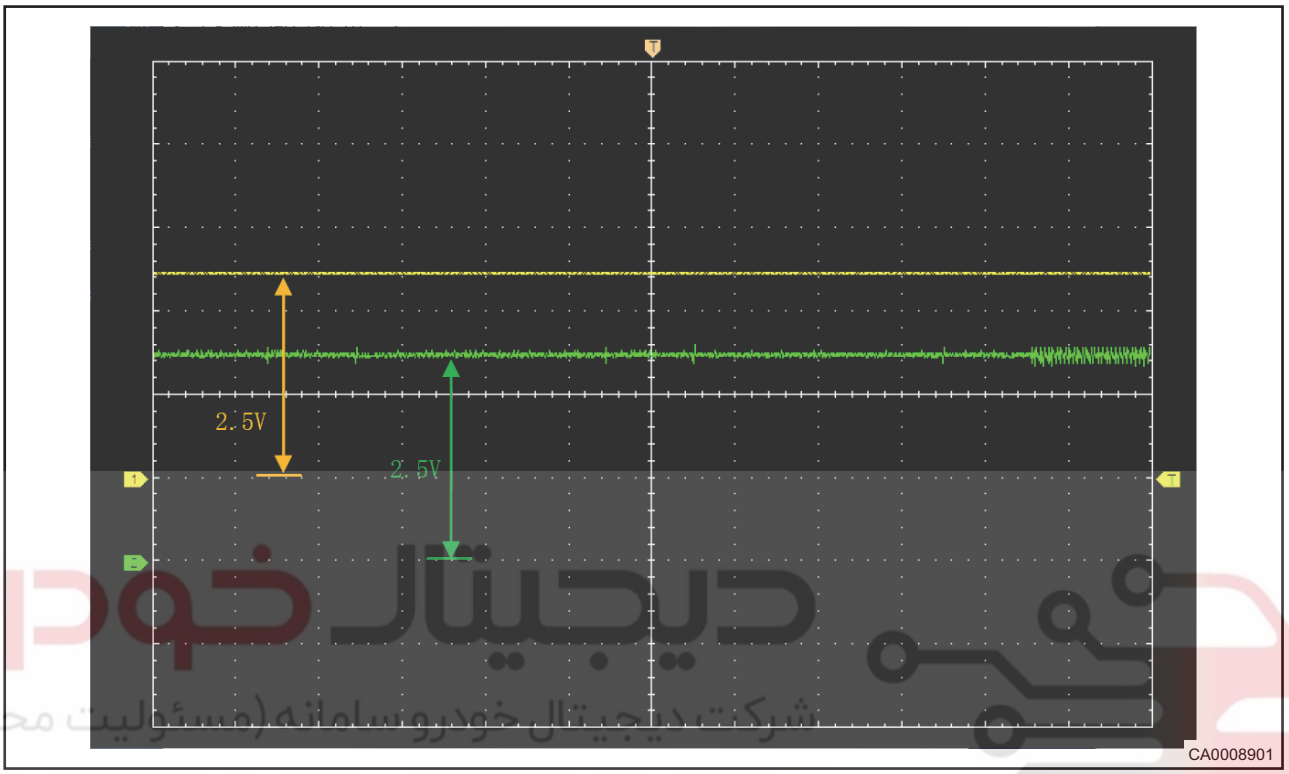
- Observe with an oscilloscope: the voltage potential of CAN-H line is placed at 12 V, the recessive voltage of CAN-L line is placed at approximately 12 V, and amplitude becomes larger due to internal connection of CAN-H and CAN-L in transceiver of control unit.

Troubleshooting procedures:

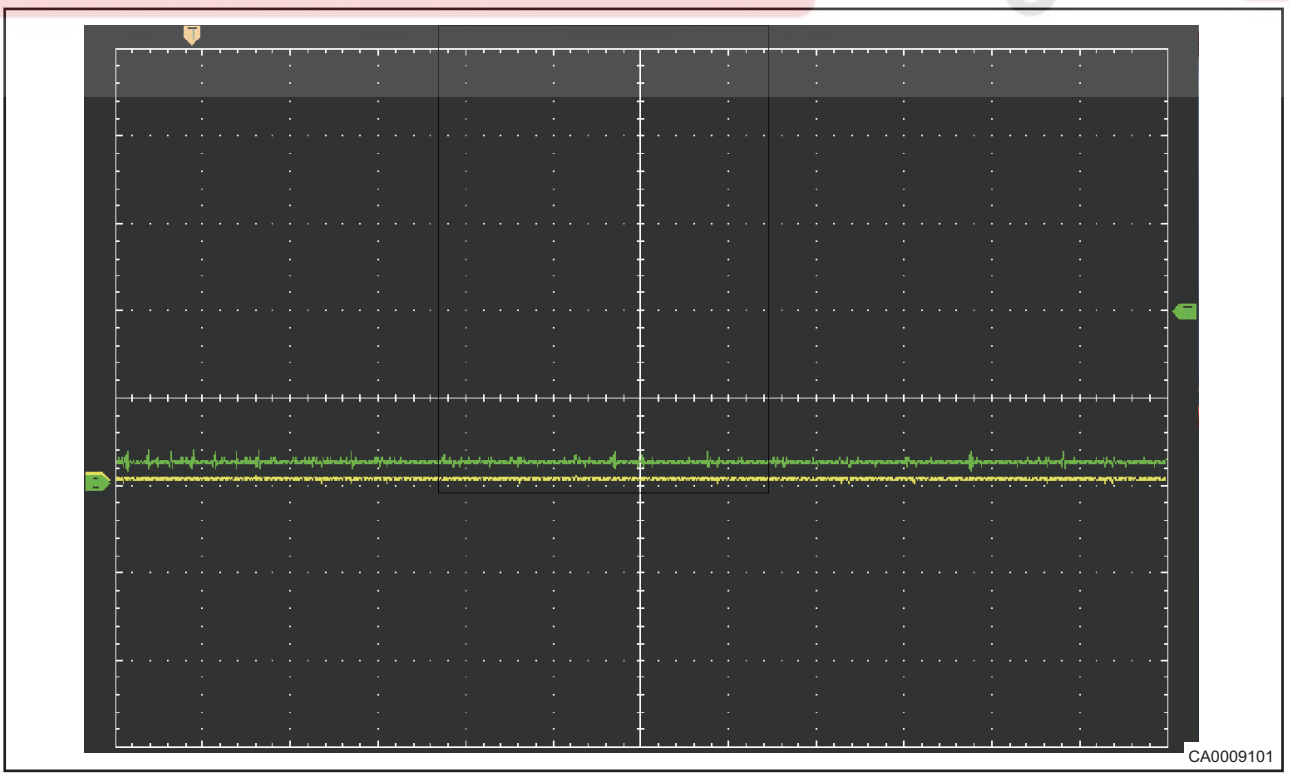
1. By plugging and unplugging control unit on CAN bus one by one and observing oscilloscope waveform at the same time, it can be judged whether it is a short circuit caused by the control unit or by the CAN-H line connection;
2. If the waveform returns to normal when unplugging the connector of a module, this module is malfunctioning;
3. When there is no other measurement method, only CAN line can be disconnected from line connection point. Pay attention to maintenance instructions of CAN line.

T18 actual vehicle test

- The short circuit waveform to positive of CAN-H during T18 actual vehicle test is shown in following illustration. The voltage potential of CAN-H line is placed at 12 V (battery voltage), and the recessive voltage of CAN-L line is placed at approximately 12V (battery voltage). The amplitude becomes larger. The diagnostic tester cannot access each module. When power CAN and body CAN, CAN-H are short to power supply, the vehicle cannot be started.



4. CAN-H is short to ground
Malfunction waveform



Malfunction symptoms:

- Observe with an oscilloscope: the voltage potential of CAN-H line is placed at 0 V, and the voltage of CAN-L line is placed at about 0.2 V (near 0 V);

Problem Cause

- Bus CAN-H is short to ground, node (module) malfunction.

Troubleshooting procedures:

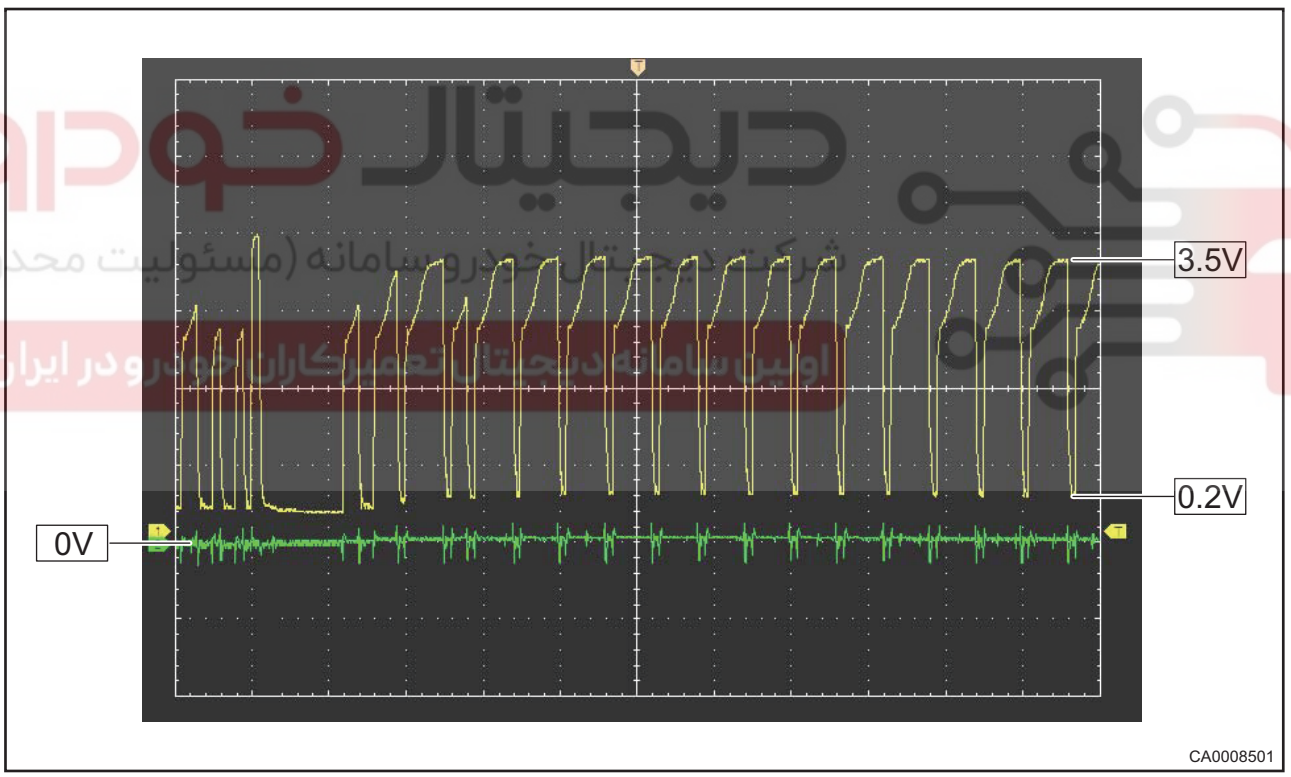
1. Plug and unplug control unit on CAN bus one by one, and observe if the oscilloscope waveform becomes normal?
2. If the waveform returns to normal when unplugging the connector of a module, this module is malfunctioning;
3. When there is no other measurement method, only CAN line can be disconnected from line connection point. Pay attention to maintenance instructions of CAN line.

T18 actual vehicle test

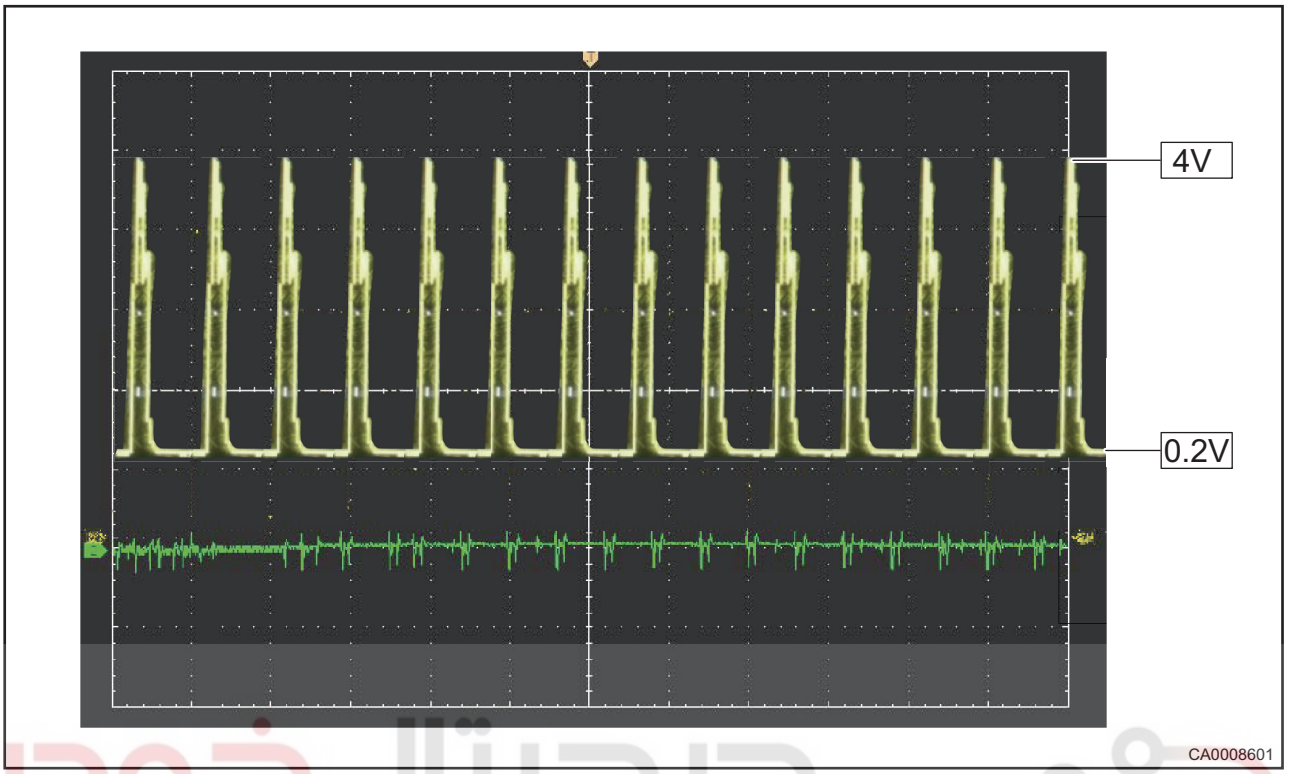
- In the short circuit waveform to ground of CAN-H during T18 actual vehicle test, the voltage potential of CAN-H line is placed at 0 V, and the recessive voltage of CAN-L line is placed at approximately 0.2 V. When power CAN and body CAN, CAN-H are short to ground, the vehicle cannot be started.

5. CAN-L is short to ground

Malfunction waveform



CAN malfunction waveform



Malfunction symptoms:

- Observe with an oscilloscope: The voltage of CAN-L is approximately 0 V, and the recessive voltage of CAN-H line is also reduced to 0.2 V (near 0 V).

Malfunction cause: Bus CAN-L is short to ground, node (module) malfunction.

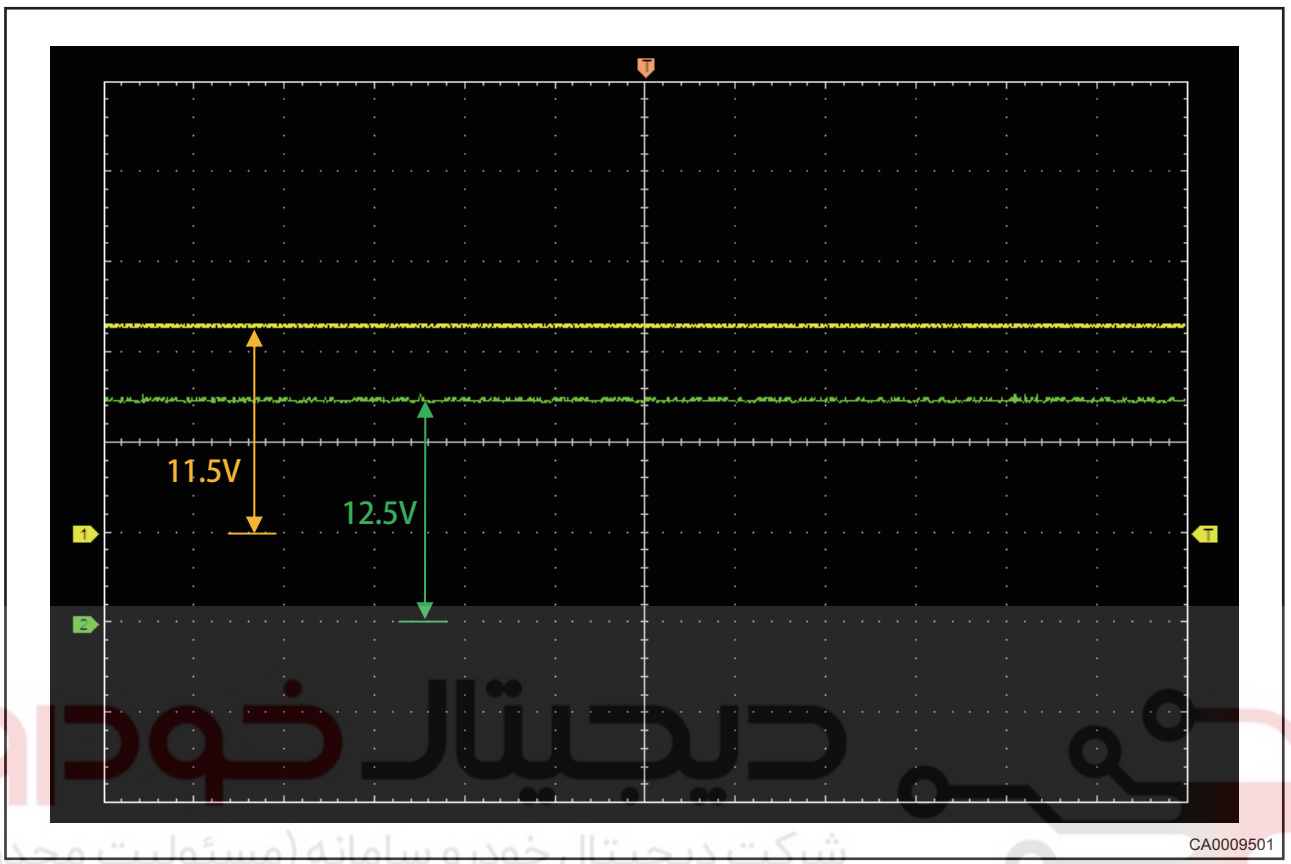
Troubleshooting procedures:

1. By plugging and unplugging control unit on CAN bus one by one and observing oscilloscope waveform at the same time, it can be judged whether it is a short circuit caused by the control unit or by the CAN-L line ground;
2. If the waveform returns to normal when unplugging the connector of a module, this module is malfunctioning;
3. When there is no other measurement method, only CAN line can be disconnected from line connection point. Pay attention to maintenance instructions of CAN line.

T18 actual vehicle test

- In the short circuit waveform to ground of CAN-L during T18 actual vehicle test, the voltage potential of CAN-L line is placed at 0 V. When power CAN and body CAN, CAN-L are short to ground, the vehicle cannot be started.

6. CAN-L short to power supply
Malfunction waveform



Malfunction symptoms:
- Observe with an oscilloscope: Both bus voltages are approximately 12 V, and waveforms are straight lines.

Malfunction cause: Bus CAN-L is short to power supply, node (module) malfunction.
Troubleshooting procedures:
1. By plugging and unplugging control unit on CAN bus one by one and observing oscilloscope waveform at the same time, it can be judged whether it is a short circuit caused by the control unit or by the CAN-L line short to power supply;
2. If the waveform returns to normal when unplugging the connector of a module, this module is malfunctioning;
3. When there is no other measurement method, only CAN line can be disconnected from line connection point. Pay attention to maintenance instructions of CAN line.

T18 actual vehicle test
- After power CAN and body CAN, CAN-L are shorted to power supply, the vehicle cannot be started.

ON-VEHICLE SERVICE

Gateway Module (CGW)

Removal

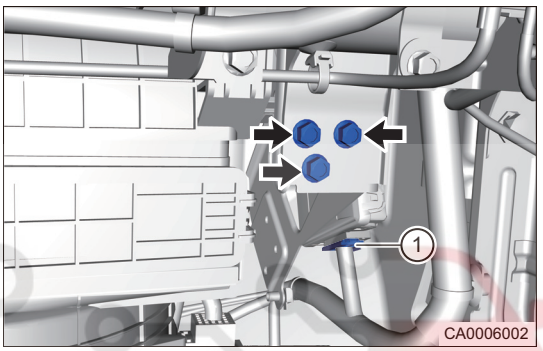
Warning/Caution/Hint

Caution:

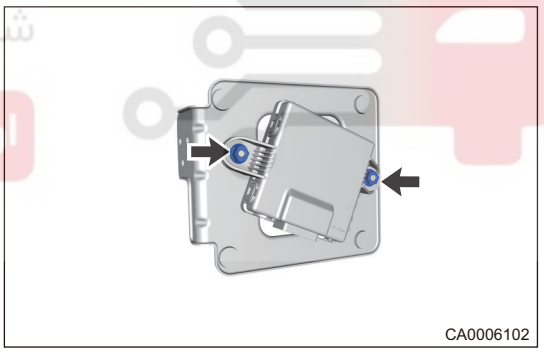
- Before removal of gateway module, read and record CGW module configuration code with diagnostic tester.
- Try to prevent interior and body paint surface from being scratched, when removing gateway module.

1. Turn ENGINE START STOP switch to OFF.
2. Disconnect the negative battery cable.
3. Remove the glove box assembly.
4. Remove the gateway module.

(a) Remove 3 fixing bolts (arrow) from gateway bracket and disconnect connector (1) from gateway module.



(b) Remove 2 fixing nuts (arrow) between gateway module and gateway bracket.



(c) Remove the gateway module.

Installation

1. Installation is in the reverse order of removal.
2. After installation is completed, write in configuration code with diagnostic tester and check if module operates normally.

- MEMO -