11.6.3.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end of 2KT720 oscilloscope probes to CH1 and CH2, then connect the other end of the both black banana plugs and 2 alligator clips to negative pole of battery or grounding, and connect the other end of red banana plugs and 2 banana sockets into the trigger signal line.

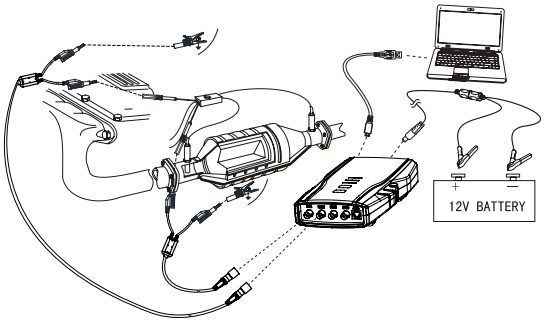


Fig. 13: Equipment connection

11.6.3.2 Measure conditions

- Start engine to heat oxygen sensor to over 315˚C, with engine in closed-loop state.
- Increase engine speed from idle.

11.6.3.3 Measure steps

1. Connect equipment according to Fig.13, switch on power supply.
2. Start engine to heat oxygen sensor to over 315˚C, with engine in closed-loop state.
3. Double click run KT720 software.
4. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
5. Click **Analyzer** --> **Sensor** --> **Dual Oxygen Sensor**;
6. Waveform will be displayed on the screen depending on measure conditions.
7. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
8. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
9. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
10. You can record a continuous waveform section by clicking “Record” button.

11.6.3.4 Waveform analysis

When testing waveform of double oxygen sensor, we can judge, through the waveform of front and rear oxygen sensors, whether the ability of three-way catalyst device to convert deleterious gas is lost. Generally speaking, the bigger the amplitude value of two waveforms is, it indicates that three-way catalyst device has perfect function; if amplitude value is basically the same, it indicates that it has lost its function. See Fig.14 for schematic diagram.

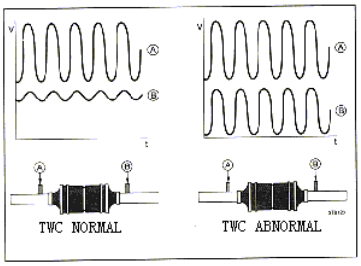


Fig. 14: Catalytic convert

11.6.4 Temperature sensor

They are mainly water temperature sensor and air intake temperature sensor, and most temperature sensors adopt negative temperature coefficient (NTC) thermistor made of semi-conducting materials. When temperature changes, its resistance is expected to experience a large change. When temperature rises, resistance decreases; when temperature decreases, resistance increases.

11.6.4.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

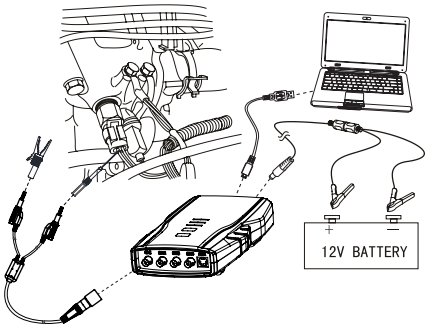


Fig. 15: Equipment connection

11.6.4.2 Measure conditions

- Switch on ignition switch, do not start engine. Securely connect temperature sensor, and measure the output voltage of temperature sensor with engine in non-running state.
- Start engine, observe voltage falling of temperature sensor when engine gets heated.
- You may also disconnect sensor and use multimeter to measure resistance value.

11.6.4.3 Measure steps

1. Connect equipment according to Fig.15, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **Temperature Sensor**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.6.4.4 Waveform analysis

You can get precise voltage range of sensor response by referring to standard manual from manufacturer. Generally, the voltage of sensor should be 3~5V (fully cold state) when engine is not started, and it should have correspondingly variable output voltage signal under different temperature conditions. When temperature sensor circuit is open, voltage increases till it reaches the peak (5V) of reference voltage; when temperature sensor is short to ground, voltage decreases till it reaches the peak of grounding voltage. As shown Fig.16 for temperature characteristics of common thermistor type coolant and air intake temperature sensor, subject to manufacturer’s manual.

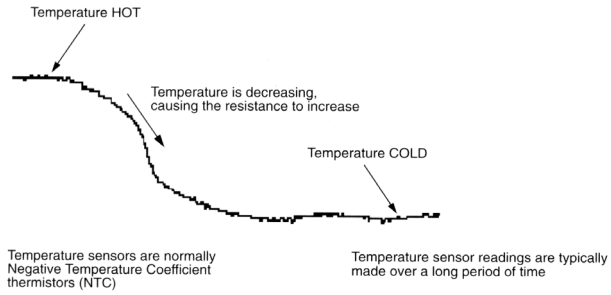


Fig. 16: Temperature characteristics

11.6.5 Throttle position sensor

Throttle position sensor (TPS) is common failure source on computer board of modern automobile. TPS informs computer of opening degree of throttle, open or closed state and open/close speed, or working conditions where engine works. When TPS resistance changes, the voltage signal it sends to computer changes consequently.

Common throttle position sensors include two types: one is potentiometer type sensor. When its shaft changes, it will cause resistance to change (potentiometer), and will provide a direct current voltage. TPS is a variable resistance fixed on throttle shaft, which provides a direct current voltage as an input signal for ECU.

The other is switch type sensor. After the signal from this kind of sensor is input to ECU, computer is informed of controlling idle (switch closed, throttle closed), or of not controlling idle (because accelerator pedal is pressed to make switch on), and ECU is informed of throttle open position when the other switch is switched on. Such linear throttle position sensor is installed on throttle shaft, with two movable contacts rotating with the same shaft. One contact is for measuring opening angle of throttle, and the other contact is for measuring closing angle of throttle. Be sure to connect circuit correctly when testing sensor.

11.6.5.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

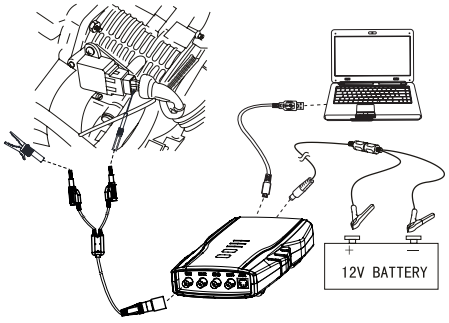


Fig. 17: Equipment connection

11.6.5.2 Measure conditions

- Switch on ignition switch, do not start engine, turn throttle to fully open position, and then turn to fully closed position, or opposition.

11.6.5.3 Measure steps

1. Connect equipment according to Fig.17, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **TPS**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button

11.6.5.4 Waveform analysis

Potentiometer type TPS is normally a variable potentiometer. Referring to repair manual from manufacturer, you can get precise voltage range of TPS. Waveform should be free from any breakpoint, cuspate peak TO GROUND or large wave break. The normally closed contact of switch type TPS constitutes idle switch. When throttle is in idle position, normally closed contact is in closed state; normally open contact indicates that throttle opens to full load. As shown Fig.18 and Fig.19 for waveform of two throttle sensors.

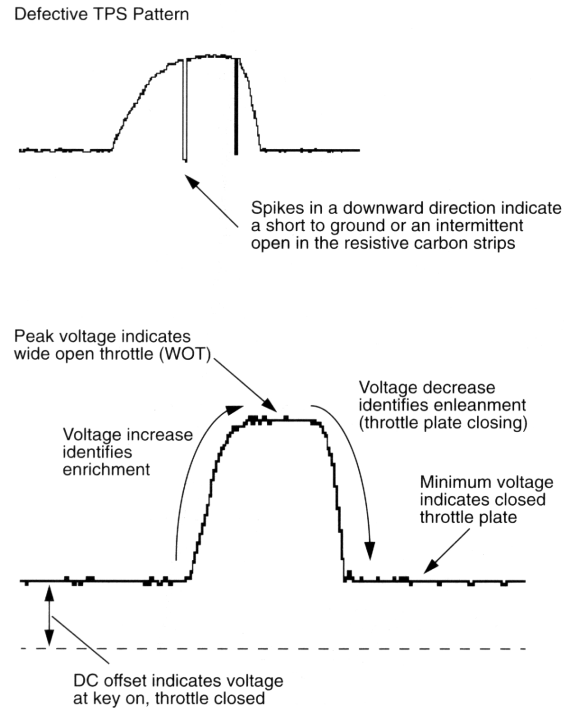


Fig. 18: Throttle position sensor (potentiometer)

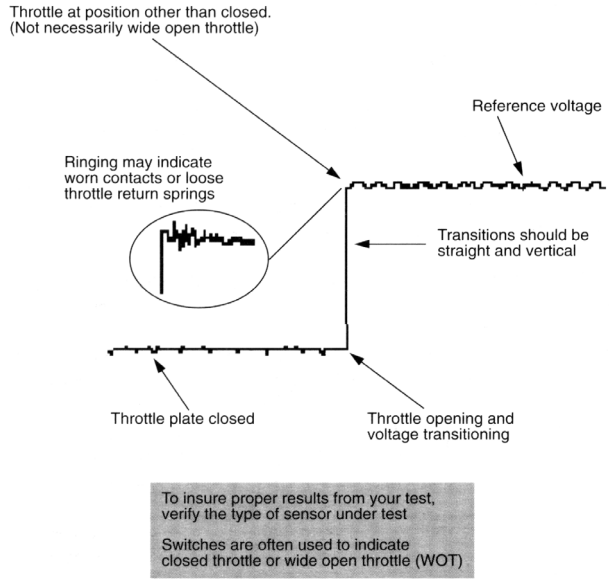


Fig. 19: Throttle position sensor- switch type

11.6.6 Crankshaft/Camshaft position sensor

It can be used to test waveform for electromagnetic sensor, Hall effect sensor and photoelectric sensor. Electromagnetic sensor (variable magnetoresistive sensor) does not need external power supply, and has two shielded lines connected to magnetostatic coil. When trigger wheel passes the magnetic field formed by coil and static magnet, small voltage signal is produced. Trigger wheel is made of steel with low magnetic resistance. Crankshaft position sensor (CPS), ABS wheel sensor and automobile speed sensor are all examples of variable magnetic resistance. Output voltage and frequency change with vehicle speed.

Hall effect sensor has a current passing a semiconductor placed very close to a variable magnetic field. Magnetic field change occurs when crankshaft or distributor shaft rotates. Hall effect sensor is used in CPS and distributor, and the amplitude of its output voltage is constant, its frequency changes with speed.

Photoelectric sensor uses a rotary disc to separate LED light source from optical pickup unit. With a small hole in the disc, pickup unit can receive light emitted from the light source. A pulse is sent each time pickup unit receives light when the disc rotates and meets the small hole. The result of voltage change can be used as reference signal for other system, and the amplitude of its output voltage is constant, while its frequency changes with speed.

Camshaft sensor is normally installed in ignition distributor, and sensor sends electric pulse to coil module to provide data indicating camshaft and valve position.

11.6.6.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

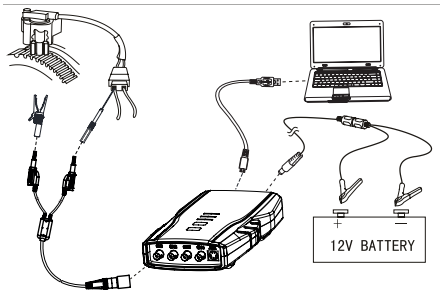


Fig. 20: Equipment connection

11.6.6.2 Measure conditions

- Check sensor for signal output. If there is no signal output, it is possible that sensor is damaged or lines are poorly connected.
- If that engine cannot be started is determined, connect the instrument according to diagram and then start engine.
- If engine can be started, connect the instrument according to diagram and then start engine; conduct test in idle and relatively high speed state.

11.6.6.3 Measure steps

1. Connect equipment according to Fig.20, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **CPS**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

9. You can record a continuous waveform section by clicking “Record” button.

11.6.6.4 Waveform analysis

2 kinds of waveform characteristics of the crankshaft/camshaft position sensor as shown in follow pictures:

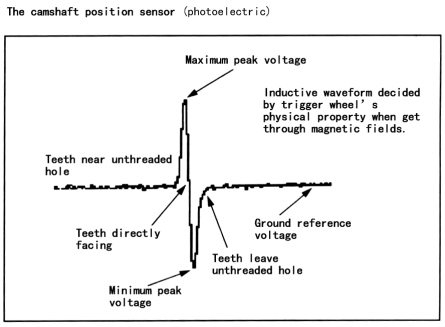


Fig. 21: Photoelectric CAM crankshaft position sensor

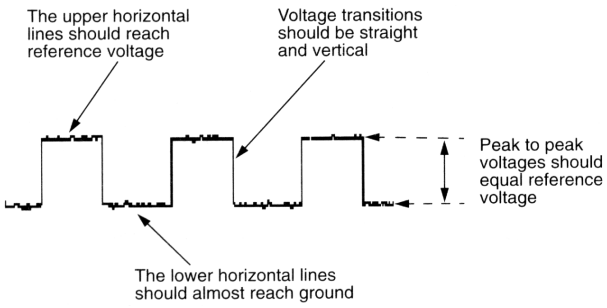


Fig. 22: Crankshaft position sensor (Hall effect)

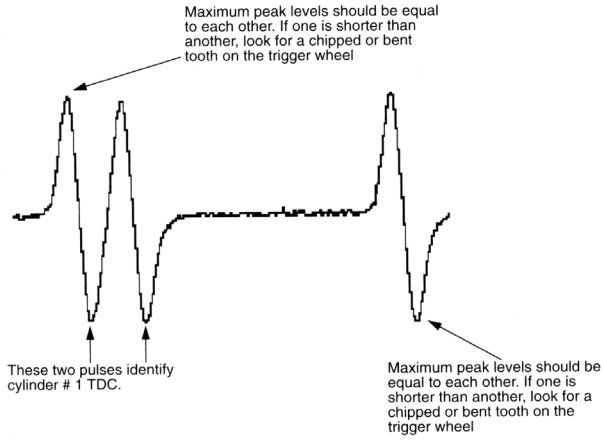


Fig. 23: Crankshaft position sensor (Magnetic)

11.6.7 Ride height (position) sensor

All kinds of position sensors produce a direct current voltage output according to the movement of variable resistance (potentiometer) shaft. Position sensor is a variable resistance connected between frame and rear axle or installed in support system. As an input signal for ECU, variable direct current voltage is used to control vehicle height. Some manufacturers use photoelectric or Hall effect sensor, corresponding sensors can be selected for test.

11.6.7.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

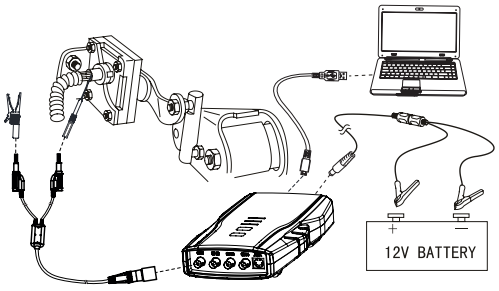


Fig. 24: Equipment connection

11.6.7.2 Measure conditions

- Switch on ignition switch, do not start engine, separate rotational shaft (fixed on the rear shaft) from sensor, and turn the shaft from stop end to the other end to measure the whole travel.
- Switch on ignition switch, do not start engine, carefully disconnect the connecting line from sensor, and then measure sensor resistance to make sure whether there is open or short circuit in the sensor.
- Re-install the rotational shaft to the rear shaft, and adjust ride height sensor according to the indexes specified in manufacturer manual.

10.6.7.3 Measure steps

1. Connect equipment according to Fig.24, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **RH(Pos) Sensor**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.6.7.4 Waveform analysis

As shown Fig.24 for waveform characteristics of ride height (position) sensor, and different vehicle models may have different indexes, subject to manufacturer’s manual.

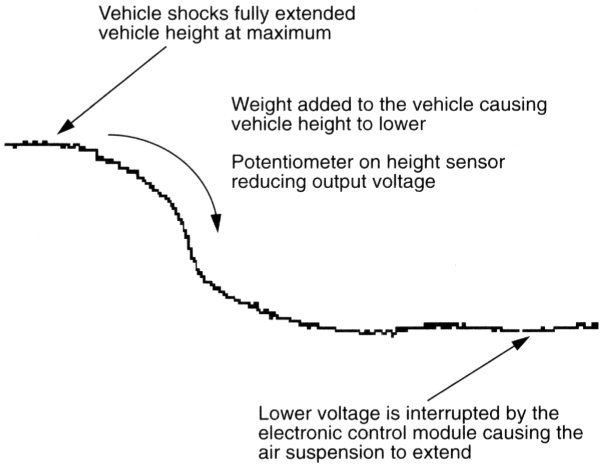


Fig. 25: Waveform characteristics

11.6.8 Anti-lock braking speed sensor

ABS control unit controls vehicle speed at braking by comparing the frequency (instead of voltage) from vehicle speed sensor, and making use of this signal. The frequency is proportional to vehicle speed and increases when vehicle speed increases.

11.6.8.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

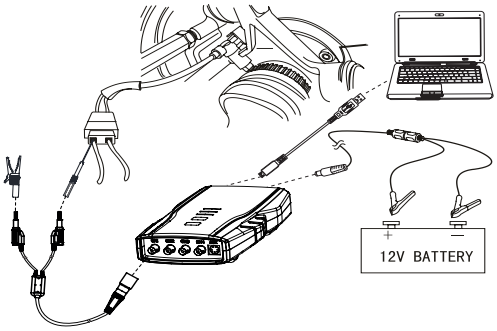


Fig. 26: Equipment connection

11.6.8.2 Measure conditions

- Lift vehicle body to make driving wheel hang in the air and be able to rotate freely.
- Switch off ignition switch, disconnect connecting line from ABS speed sensor, connect the instrument to ABS speed sensor, and then rotate wheel.
- Or start engine, pierce test probe into the back of ABS speed sensor joint, place transmission to driving gear and slowly accelerate driving; as for non-driving wheel, refer to the above mentioned method of switching off ignition switch.

11.6.8.3 Measure steps

1. Connect equipment according to Fig.26, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **ABS**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;

8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.6.8.4 Waveform analysis

As shown follow picture for waveform characteristics of ABS speed sensor.

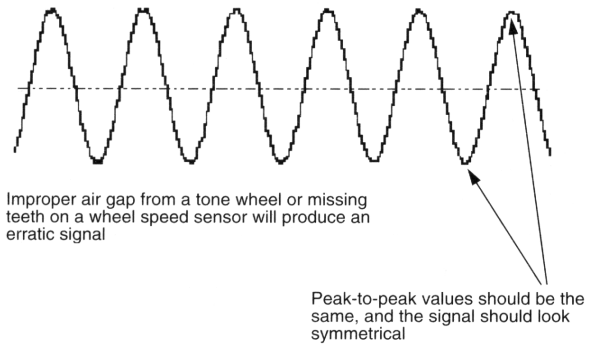


Fig. 27: Waveform characteristics

11.6.9 Vehicle speed sensor (VSS)

The output signal of vehicle speed sensor is proportional to vehicle speed. With this signal, ECU controls torque converter lockup clutch, shift point of electric control transmission and other functions. The sensors used include electromagnetic, Hall effect and photoelectric type.

11.6.9.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

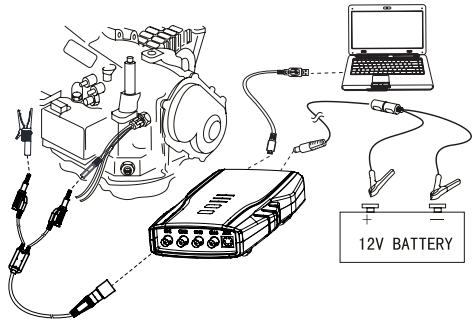


Fig. 28: Equipment connection

11.6.9.2 Measure conditions

- Lift vehicle body to make driving wheel hang in the air and be able to rotate freely.
- Connect equipment according to Fig.28, start engine and apply driving gear.
- Monitor the output signal of vehicle speed sensor at low speed and gradually increase the speed of driving wheel.

11.6.9.3 Measure steps

1. Connect equipment according to Fig.28, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **VSS**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.6.9.4 Waveform analysis

Generally, if the amplitude of waveform of electromagnetic vehicle speed sensor is too low, check whether the air gap between trigger wheel and pickup unit is too big; if waveform is not steady, check whether trigger wheel or shaft deforms; if there is one twisted waveform, check whether certain tooth of the trigger wheel deforms or is damaged. It is basically the same case with Hall effect sensor which produces square wave. As shown Fig.29 and Fig.30 for waveform characteristics of electromagnetic and photoelectric vehicle speed sensor.

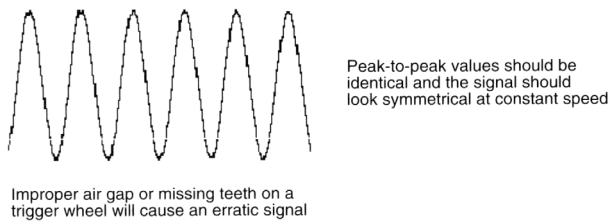


Fig. 29: Vehicle speed sensor (Magnetic)

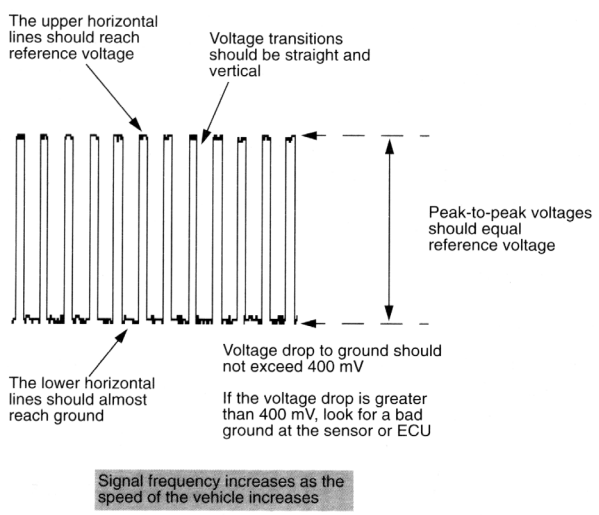


Fig. 30: Vehicle speed sensor (Optical)

11.6.10 Air flow sensor

Analog air flow sensor: This kind of air flow sensor uses a preheated thin metal element to measure the air flow into the air intake manifold. This element is heated to 77˚C and its temperature will decrease and consequently its resistance will decrease when air passes it, which causes current to increase and voltage to decrease. This signal is regarded by computer as a change of voltage reduction (increment of air flow causes voltage reduction), and also as an indication of air flow.

Digital air flow sensor: This kind of air flow sensor takes 5V sent by computer as reference and sends back frequency signal equivalent to air amount of engine. Output signal is a square wave, its amplitude is fixed at 0-5V, and signal frequency changes between 30-150Hz. Low frequency represents small amount of air flow while high frequency indicates large amount of air flow.

11.6.10.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

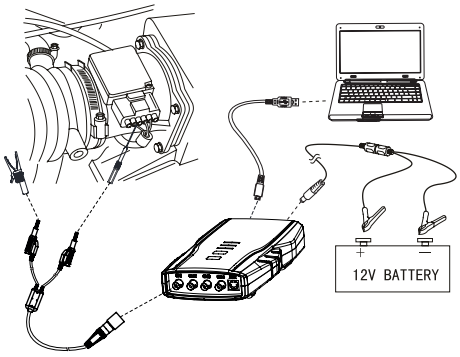


Fig. 31: Equipment connection

11.6.10.2 Measure conditions

- Connect equipment, start engine and run it at idle, slowly accelerate and observe display result.
- Use screwdriver handle to tap the sensor when testing and temporary delay and unsteady acceleration will be caused if the connecting line inside the sensor is loose.

11.6.10.3 Measure steps

1. Connect equipment according to Fig.31, switch on power supply.
2. Double click run KT720 software.

3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **Air Flow Sensor**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.6.10.4 Waveform analysis

As shown Fig.32 and Fig.33 for waveform characteristics of two air flow sensors.

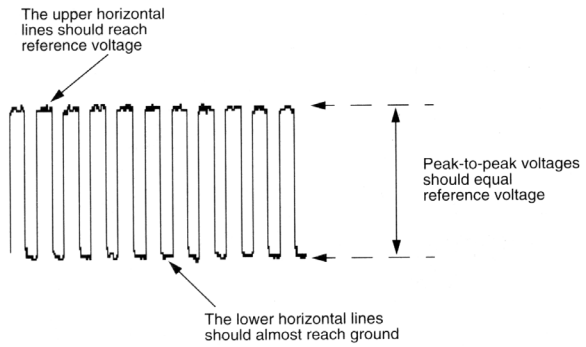


Fig. 32: Mass air flow meter (Digital)

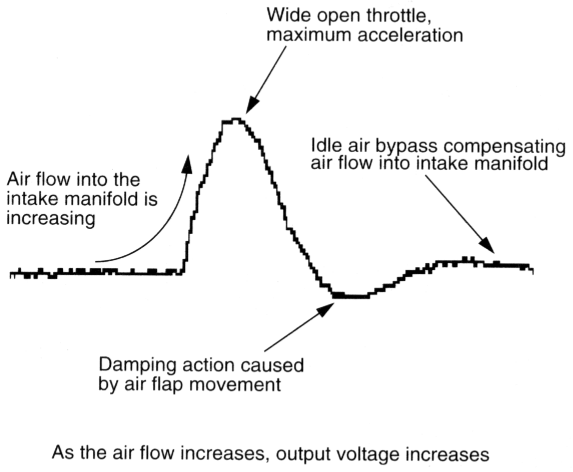


Fig. 33: Mass air flow meter (Analog)

11.6.11 Knock sensor-piezoelectric crystal

In order to achieve optimal performance and fuel economy for engine, ignition time should be adjusted properly to make combustion occur when crankshaft rotates to a particular angle, and start at the top dead center (TDC) of working stroke. If ignition occurs late, the power of the cylinder decreases, if ignition occurs early, knock occurs. Most knock sensor is made of piezoelectric crystal, and bolted to engine body. It is a kind of very special crystal which produces voltage when it is under mechanic stress. The voltage signal differs a lot due to knock conditions. The voltage, after being processed by ECU, is used to adjust ignition timing to achieve optimal engine performance.

11.6.11.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

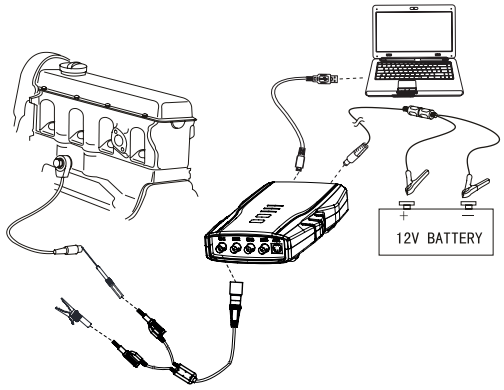


Fig. 34: Equipment connection

11.6.11.2 Measure conditions

Offline test of knock sensor (sensor disconnected)

- Disconnect knock sensor, and connect instrument to sensor.
- Use mallet strike cylinder body near sensor to make sensor produce signal.

Online test of knock sensor (delayed ignition test)

- Conduct advance time test according to chapter 11.7.6.
- Use mallet strike cylinder body near sensor to make sensor produce signal.
- Observe ignition time to confirm that ignition delays when knock signal is received by ECU.

11.6.11.3 Measure steps

1. Connect equipment according to Fig.34, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Sensor** --> **Knock sensor**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.6.11.4 Waveform analysis

The waveform of knock sensor has direct relation with knock degree and reason, so each waveform looks a little different. Knock sensor mainly checks whether there is signal. For most vehicles, when ECU receives signal from knock sensor, it will delay ignition till knock disappears. As shown Fig.35 for characteristic waveform of ordinary knock.

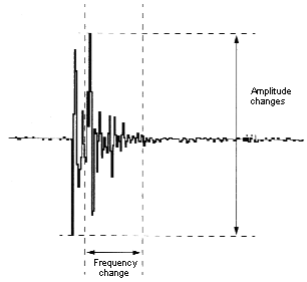
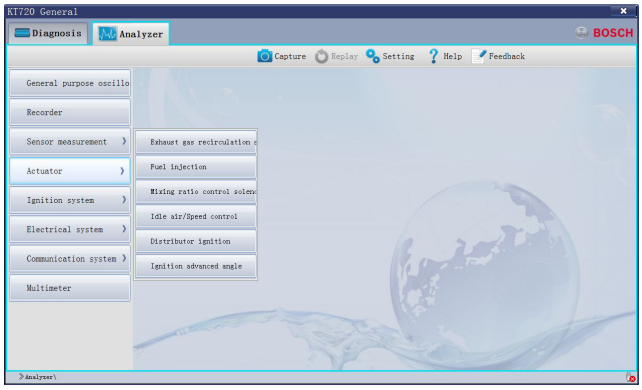


Fig. 35: Waveform characteristic

11.7 Actuator measure

Measured the waveform of actuator.



11.7.1 Exhaust gas recirculation

EGR valve position sensor is a variable resistance connected to EGR valve. EGR valve position sensor provides a direct current voltage which changes with the movement of knob on the variable resistance (potentiometer). Variable direct current voltage is used as input signal by computer to indicate working conditions of EGR.

When engine has excessive combustion temperature and air-fuel ratio is lean, EGR system dilutes air fuel ratio and limits formation of NOx. Gasoline engine EGR should work at middle acceleration and cruise speed between 50-120Km/h. Computer makes use of method of providing power supply or cutting off solenoid coil, or uses pulse width modulated solenoid, to switch on or switch off solenoid coil to achieve the goal of controlling vacuum.

11.7.1.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the trigger signal line.

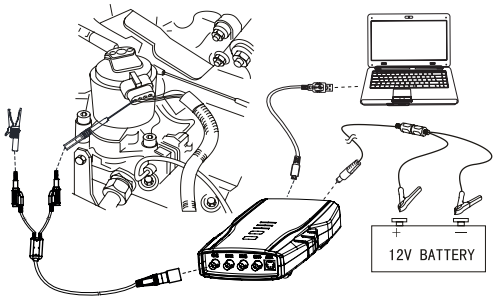


Fig. 36: Equipment connection

11.7.1.2 Measure conditions

- Start engine, connect KT720 to EGR valve, and slowly increase engine speed to cruise speed.

Most EGR valves only start when engine is at load state. Therefore, it is possible to use road test or make use of horsepower tester to assist test.

Only conduct the following tests when engine is at cold state to avoid burn.

- Ignition switch is at switch-on position, engine stops, insert probe into position sensor on the top of EGR valve, and carefully (cold engine) lift EGR from chassis. If EGR diaphragm has obstacle or is not easily accessible, it is possible to move EGR valve when vehicle is at load state.
- Switch off ignition switch, disconnect sensor, and then carefully lift EGR valve from chassis. Some position sensors can be disconnected from EGR valve so as to make sensor terminal accessible;
- Apply potentiometer test function of common sensors when testing position sensor.

11.7.1.3 Measure steps

1. Connect equipment according to Fig.36, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Actuator** --> **EGT**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison.
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

10.7.1.4 Waveform analysis

Most vehicles start exhaust gas recirculation control when they travel or accelerate. EGR system does not work when engine runs at idle and decelerates since control signal is cut off. Peak height of waveform reduces when failure occurs, which indicates that vacuum solenoid coil of EGR is short; if no control signal is found, it indicates that failure occurs to PCM or EGR control conditions for PCM does not meet, or there is something wrong with the circuit of EGR system.

11.7.2 Fuel Injection(FI)

Electronically-controlled fuel injection is controlled by computer and also affected by many working factors, including water temperature, engine load and oxygen sensor signal in closed-loop work.
Fuel injection time can be expressed in pulse width in ms, representing the amount of fuel injected into the cylinder. Wide pulse indicates more fuel injected under the same injection pressure. ECU provides a path for nozzle through a driving triode. When triode is through, current passes from nozzle and triode to ground, which makes nozzle open There are three kinds of fuel injection system currently, and each has its own fuel injection control method. All nozzles have a method of limiting current, because large current will damage nozzle.

Peak value keeping type: In nozzle circuit, nozzle is actually powered by two different circuits. When two circuits work for nozzle at the same time, nozzle is supplied with high starting current and opens quickly; after nozzle opens, one of the circuits is cut off, and the other circuit continues to work to keep the nozzle open till the end of injection time. In the circuit, one resistance is used to reduce the current passing through nozzle. When the second circuit is cut off, nozzle closes, and fuel injection ends. The method for measuring opening time is to locate the falling edge of opening pulse and the rising edge representing the second circuit is cut off.

Throttle injection system: is designed to take the place of carburetor, and pulse width represents working or opening time of nozzle. ECU controls pulse width according to engine working and driving conditions.

The triode of traditional (saturated switch type): nozzle provides nozzle with fixed current. Some nozzles use resistance to control current, and other nozzles have high internal impedance, with only one injection pulse.

Nozzles of pulse width: modulation type have high starting current to quickly open nozzle. After nozzle opens, pulse switch-on begins at grounding end to cut current off to extend opening time of nozzle, and limit the current passing through nozzle at the same time.

11.7.2.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end of 1 cylinder signal to CH3 of KT720,use signal clip to clip high voltage line of one cylinder of engine. Please check that there is “This side faces to spark plug” on the signal clip, do not clip reversely. Connect BNC end of mulriple end ofKT720 differential probes to CH4, connect the other end of mulriple end to assistant channel. Then connect the other end of the black banana plug ofKT720 differential probes and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the signal line. Multi-point fuel injection connection method as shown fig. 37, single-point fuel injection connection methods as shown fig. 38.

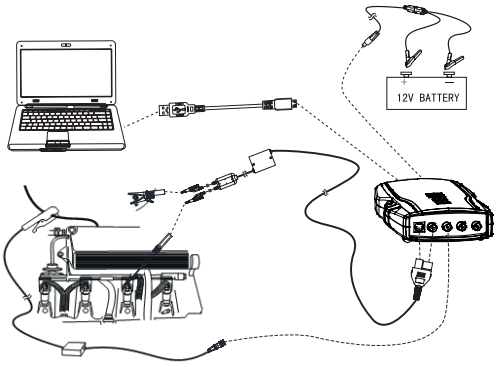


Fig. 37: Connecting diagram of multi-point fuel injection

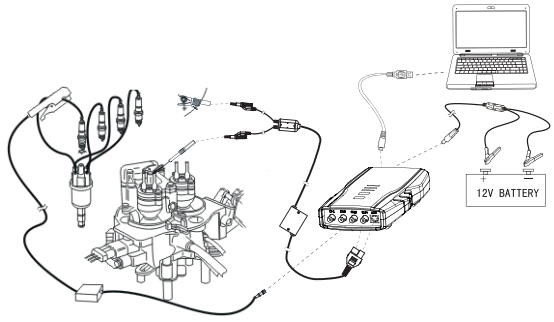


Fig. 38: Connecting diagram of single point fuel injection

! Inductive pickup measures speed signal of engine. If engine speed is not displayed inKT720 , re-clip the high voltage line after turning it 180˚C.

11.7.2.2 Measure conditions

- Start engine after connecting equipment. Start test from idle, slowly increase engine speed and observe nozzle signal at the same time.
- Change output signal of MAP sensor or oxygen sensor to increase engine load.
- Another method is to disconnect oxygen sensor, which will decrease the voltage signal sent to ECU, and ECU will increase injection pulse width, but this method may lead to occurrence of DTC.
- Connect signal end of oxygen sensor to positive (+) of battery to increase the voltage signal sent to ECU, and ECU will decrease injection pulse width.

11.7.2.3 Measure steps

1. Connect equipment according to Fig.37 or Fig.38, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Actuator** --> **FI**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.7.2.4 Waveform analysis

As shown Fig.39, 40 and 41 for waveform characteristics of all nozzles.

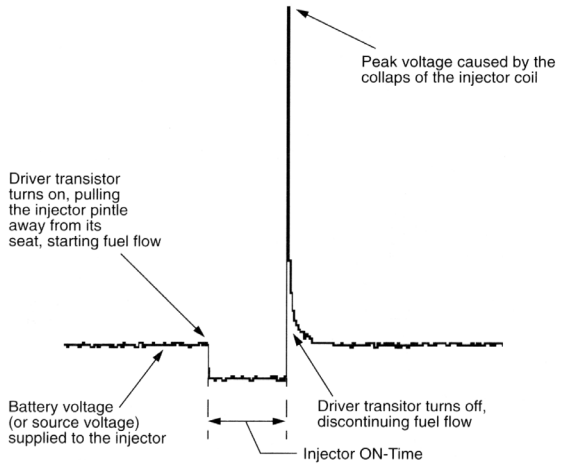


Fig. 39: Conventional (Saturated switch driver) fuel injector

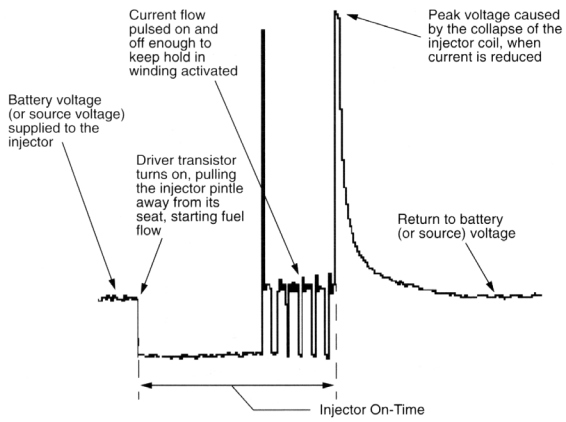


Fig. 40: Pulse-sidth modulated fuel injector

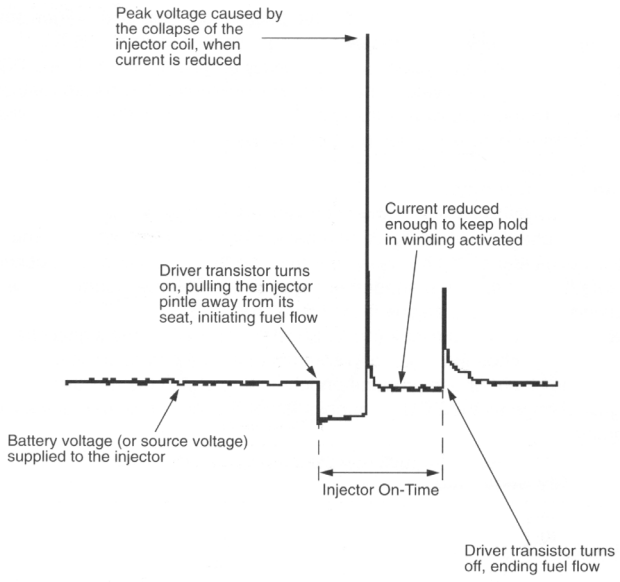


Fig. 41: Current-controlled (Peak and hold) fuel injector (Throttle body and port fuel injection systems)

11.7.3 Coil and diode test

When the energy of electromagnetic control unit disappears, change of magnetic field can induce burr of voltage. Clamping diode (or suppression diode) is used to filter these burrs, horn, relay, fan motor, clutch of air conditioning compressor and some fuel injection equipment are all examples.

A faulty diode produces noises that can be heard normally in sound system of vehicle. The waveform of these noise burrs will contain big burr when one level changes to another. These burrs can also affect sensitive sensors or control system in the vehicle.

11.7.3.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into into the power supply of solenoid coil.

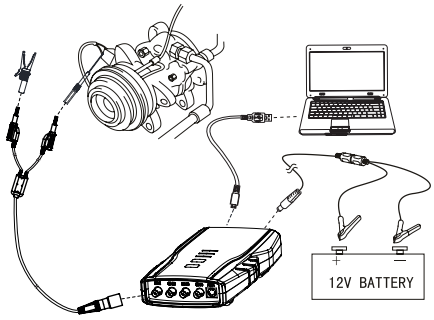


Fig. 42: Equipment connection

11.7.3.2 Measure conditions

- Excite tested equipment, and then observe display of KT720 .

10.7.3.3 Measure steps

1. Connect equipment according to Fig.42 switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Actuator** --> **MC**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.7.3.4 Waveform analysis

As shown Fig.43 for characteristic waveform of clamping diode.

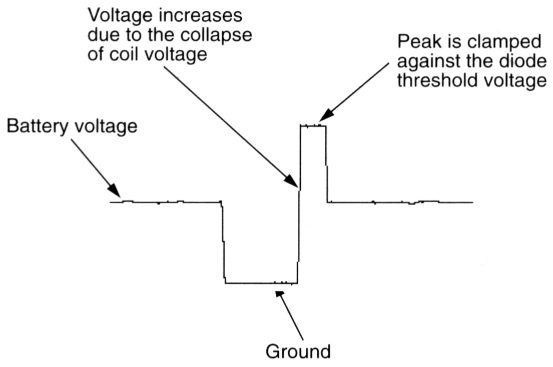


Fig. 43: Waveform characteristic

11.7.4 Idle air/speed control (IAC/ISC)

Idle air controller (IAC) of engine control unit adjusts engine idle and prevents stop. Some idle control system adopts step motor to control the air flow into bypass of throttle; other idle control systems use bypass control valve controlled by square wave signal sent by ECU. Due to impedance of coil, the square wave signals may be slightly different in shape.

11.7.4.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the single line.

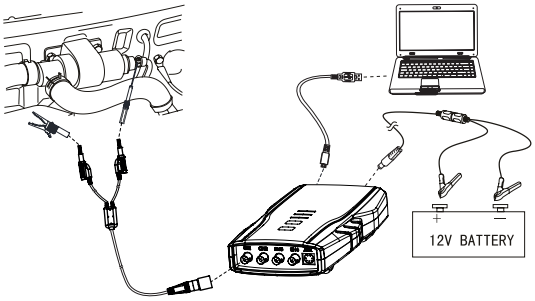


Fig. 44: Equipment connection

11.7.4.2 Measure conditions

- Start engine after connecting instrument to air control valve, and monitor conditions in cold, warm and hot engine state.
- Intentionally cause small vacuum leak and pay attention to the signal from engine control unit how to adjust opening of valve.

11.7.4.3 Measure steps

1. Connect equipment according to Fig.44, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Actuator** --> **IAC/ISC**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.7.4.4 Waveform analysis

When switches for accessorial appliances (air conditioning, etc.) switch on or off and transmission apply or does not apply, engine control unit will change idle by controlling IAC/ISC to open/close throttle bypass. If idle remains unchanged, it is the most possible reason that IAC/ISC is damaged or throttle bypass is blocked. As shown Fig.45 for characteristic waveform of common IAC/ISC, and refer to manufacturer's manual for possible special shapes.

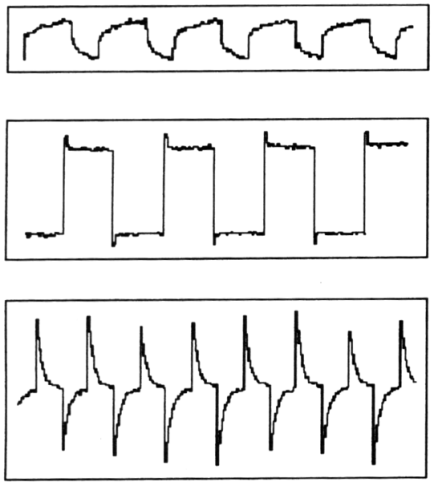


Fig. 45: Waveform characteristic

11.7.5 Distributor trigger

Electromagnetic distributor trigger: the electromagnetic sensor used for distributor trigger consists of a permanent magnet and a magnetic core. Filament wrapped on the core functions as pickup coil. Non-magnetic trigger wheel is installed on distributor shaft and has the same number of teeth as cylinder number. When one tooth of trigger wheel passes magnetic field (formed by pickup coil), a signal is produced. Magnetic sensor or variable magnetoresistive sensor usually has two conducting wires and produces its own signal.

Hall effect distributor trigger: Hall effect switch has a fixed sensor and a trigger wheel, and requires a small input voltage to produce output voltage. When rotary vane passes through between magnet and Hall element, output voltage changes. This signal is sent, in square waveform, to ignition module to trigger ignition coil.

Photoelectric distributor trigger: photoelectric signal generator produces voltage signal by using light produced by LED to trigger photoelectric triode. Trigger wheel is a piece of disc with small hole, which rotates in the clearance between LED and photoelectric triode.

11.7.5.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into the single line.

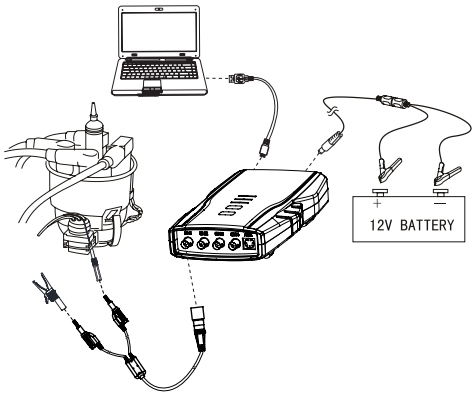


Fig. 46: Equipment connection

11.7.5.2 Measure conditions

- If you are diagnosing "Cannot start" failure, connect wires as connection note, and then start engine. Check whether there is signal. If there is, problem is not here; if there is no signal or signal is too weak, check whether sensor fails or lines have problem.
- If engine can be started, connect wires as connection note. Start engine, and check engine in various working conditions.

11.7.5.3 Measure steps

1. Connect equipment according to Fig.46, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Actuator** --> **DIST Trig**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;

8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.7.5.4 Waveform analysis

As shown Fig.47, 48 and 49 for characteristic waveform triggered by three kinds of distributors.

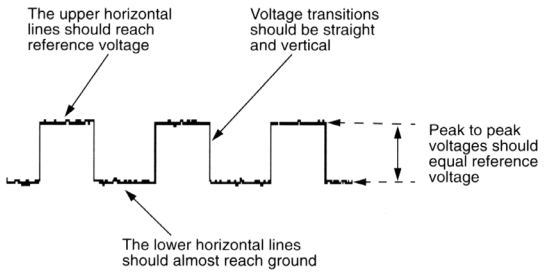


Fig. 47: Primary distributor triggering (Hall effect)

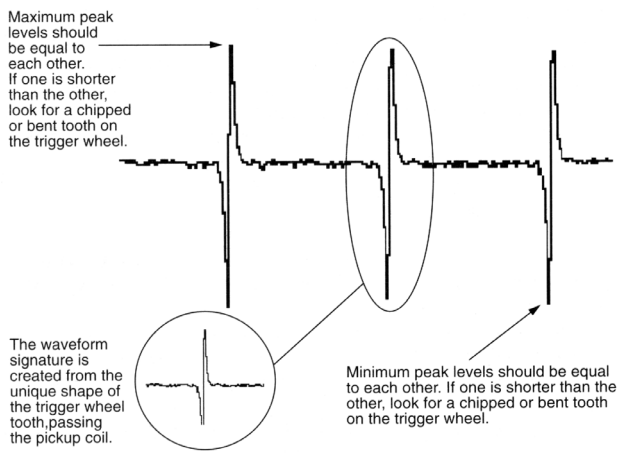


Fig. 48: Primary distributor triggering (Magnetic)

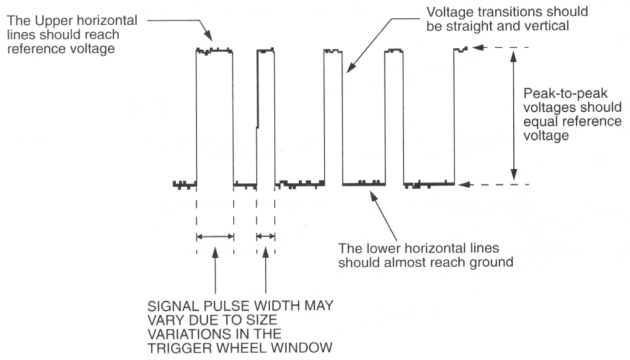


Fig. 49: Primary distributor triggering (Optical)

11.7.6 Advance time

Two channels of KT720 can determine ignition advance time of the ignition system. Connect CH1 to the first cylinder or primary of ignition coil (ignition module), and CH2 to TDC signal.

11.7.6.1 Equipment connection

When connecting KT720 to power extension cable for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery clip power cable as example. Connect BNC end of 2KT720 oscilloscope probes to CH1 and CH2, and connect BNC end of 1 cylinder signal to CH3, then connect the other end of the both black banana plugs and 2 alligator clips to negative pole of battery or grounding, and connect the other end of red banana plugs and 2 banana sockets into the “-“ connector of ignition coil and signal line of crankshaft position sensor.

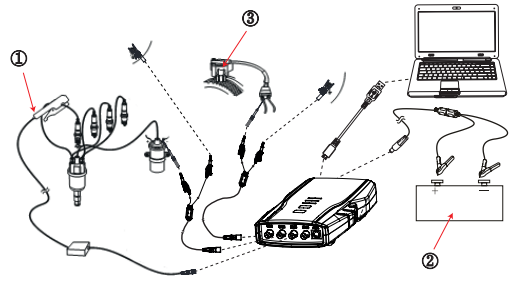


Fig. 50: Equipment connection

1 1 Cylinder Signal
2 Battery
3 Capacitive Pickup

11.7.6.2 Measure conditions

- ConnectKT720 , and the test line on Channel CH2 cannot be grounded.
- Start engine and let it run at idle, slowly accelerate it and observe result displayed on the screen.
- When electronic and mechanic (if found) advances begin to function, the increment of ignition advance can be observed.

11.7.6.3 Measure steps

1. Connect equipment according to Fig.50, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Actuator** --> **Adv Time**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;

8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.7.6.4 Waveform analysis

As shown Fig.51 for characteristic waveform.

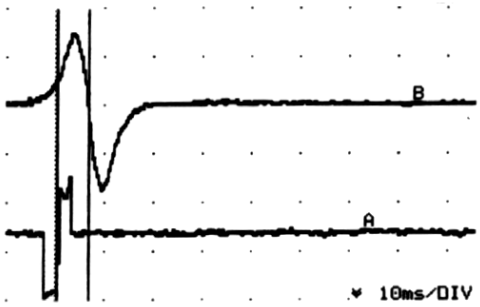
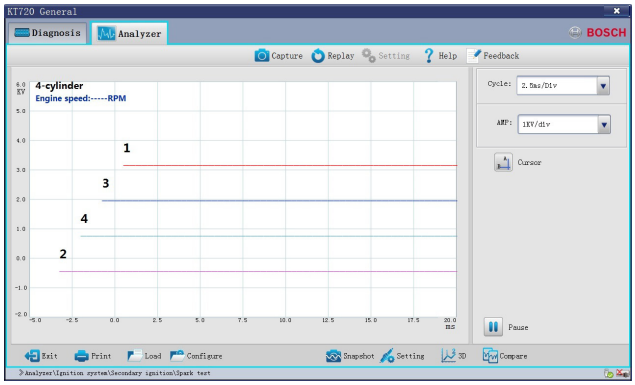


Fig. 51: Waveform characteristic

11.8 Ignition system

Measured the waveform of secondary and primary ignition.



If the ignition cylinder is greater than 4, you need to used 2 capacitive pickup to measured.

11.8.1 Secondary ignition

We can effectively check traveling performance of vehicle and reason for emission problem through analysis of ignition secondary waveform. Generally, the waveform is mainly used to check whether high voltage line of spark plug is short or open, and whether spark plug misfires due to carbon deposit. Secondary waveform of ignition is also affected by different engine, fuel supply system, air intake system and ignition condition, so we can effectively test the failure in mechanic parts of engine, fuel supply system parts and ignition system parts in accordance with secondary waveform of ignition.

When testing, we generally divide into three kinds according to ignition system: traditional ignition, direct ignition and double end ignition. Traditional ignition generally refers to distributor ignition, which is usually adopted by domestic vehicles of old model; direct ignition generally refers to ignition mode in which one cylinder corresponds to one ignition coil, which is normally used in high grade car; double end ignition means one ignition coil ignites two cylinders at the same time, which is common currently in Era Superman, JETTA GT, Fukang and Audi V6 engine.

11.8.1.1 Equipment connection

Since ignition mode and ignition system of the engines to be tested differ in connection, connecting method is also different. Please confirm ignition mode of engine to be tested before testing secondary ignition waveform. We will illuminate the test and connecting method of three common ignition modes in the following.

When connecting KT720 to extension line for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery as example.

Traditional ignition / Direct ignition: Connect BNC end of 1 cylinder signal to CH3 ofKT720 , use signal clip to clip high voltage line of one cylinder of engine. Please check that there is “This side faces to spark plug” on the signal clip, do not clip reversely; connect BNC end of capacitive pickup to CH1, and then use capacitive pickup to clip high voltage line of each cylinder. As shown Fig.52 for connecting method.

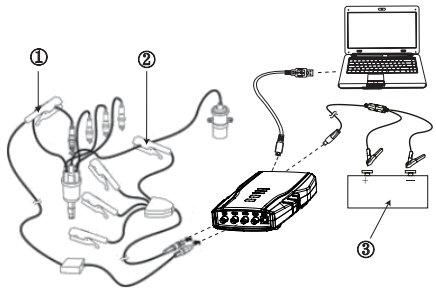


Fig. 52: Equipment connection of traditional ignition

1 1 Cylinder Signal
2 Capacitive Pickup
3 Battery

Double end ignition: Connect BNC end of 1 cylinder signal to CH3 ofKT720 , used for synchronization of cylinder signal, use signal clip to clip high voltage line of one cylinder of engine. Please check that there is “This side faces to spark plug” on the signal clip, do not clip reversely. Connect BNC end of one capacitive pickup to CH1, then connect the other end to positive of high voltage cylinder line. Connect BNC end of the other capacitive pickup to CH2, then connect the other end to negative of high voltage cylinder line. As shown Fig.53 for connecting method.

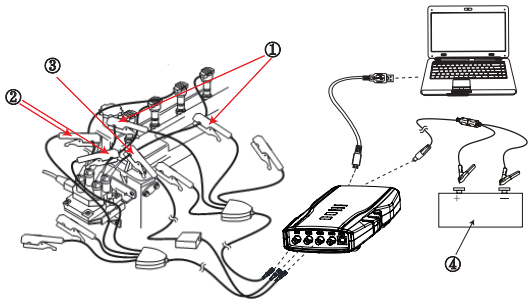


Fig. 53: Equipment connection of double end ignition

1 Capacitive Pickup
2 Capacitive Pickup
3 1 Cylinder Signal
4 Battery

11.8.1.2 Measure conditions

- Start engine, and test the performance of testing elements at different load and speed. Spark plug, ignition connector and the elements of other secondary circuit may function abnormally at high load. Conduct these tests (on power tester or road test) at load state to precisely locate failure position in the system.

11.8.1.3 Measure steps

1. Connect equipment according to Fig.52 or Fig. 53, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Ignition SYS** --> **Secondary IGN** --> **Spark Test**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. Depending on the parameters of engine to set IGN settings, include ignition mode, sensation,number of cylinder and ignition order.
7. You can adjust to cycle, amplitude, and cursor.
8. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, snapshot current waveform, display mode of waveform and waveform comparison;
9. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.8.1.4 Waveform analysis

Secondary waveform of ignition is divided three parts: closed part, ignition part and middle part.

Closed part: This period of time is the time when triode is on or platinum contact is connected, and falling edge of waveform should be kept consistent, indicating that each cylinder has the same dwell angle and ignition timing is correct.

Ignition part: including an ignition line and a spark line (combustion line). Ignition line is a vertical line, representing breakdown voltage; spark line is an approximate horizontal line, representing a voltage needed to keep current pass clearance of spark plug.

Middle part: it displays that ignition coil consumes surplus energy through primary and secondary oscillation, normally 2 oscillatory wave at least. As shown Fig.54 for characteristic waveform of traditional secondary ignition.2

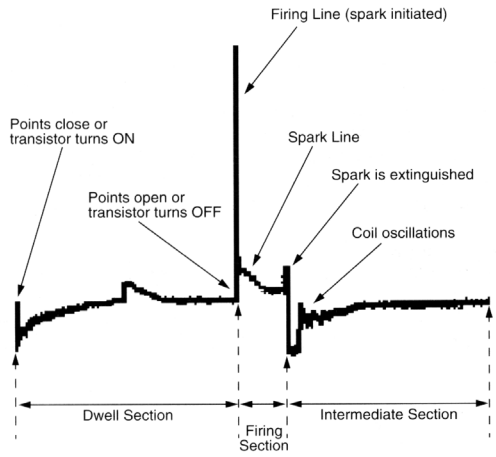


Fig. 54: Waveform characteristic

11.8.2 Primary ignition

The display of primary ignition dwell angle brings convenience for diagnosis of traditional ignition. The advent of electronic ignition control system removes the need to adjust dwell angle since ignition dwell angle is controlled by ECU. Due to mutual inductance of primary and secondary coil of ignition, spark that occurs at secondary circuit will be fed back to primary circuit, therefore, primary ignition is also very important.

Primary Ignition have 2 modes: multi-cylinder and single -cylinder.

11.8.2.1 Equipment connection

When connecting KT720 to extension line for power supply, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery as example.

Connect one end of 1 cylinder signal to CH3 ofKT720 , use signal clip to clip high voltage line of one cylinder of engine. Please check that there is “This side faces to spark plug” on the signal clip, do not clip reversely. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket into “IG-“ signal line of ignition coil, as shown Fig.55.

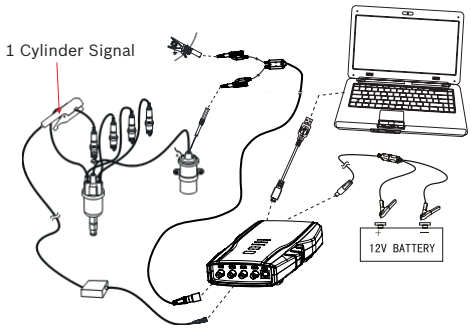


Fig. 55: Equipment connection

Primary ignition single-cylinder mode connection method 1: When the trigger channel is CH3, connect one end of 1 cylinder signal to CH3 of Kt720, use signal clip to clip high voltage line of one cylinder of engine. Please check that there is "This side faces to spark plug" on the signal clip, do not clip reversely. Connect BNC end of VMI differential probe composite joint to CH4 port, the other port connect to auxiliary port. Then connect the other end of the black banana plug of VMI differential probe and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug of VMI differential probe and red banana socket into "IG-"signal line of ignition coil.

11.8.2.2 Measure conditions

- Start engine, and test ignition system at different load to test the performance of elements. Primary ignition module may not work properly at high load and high temperature.

11.8.2.3 Measure steps

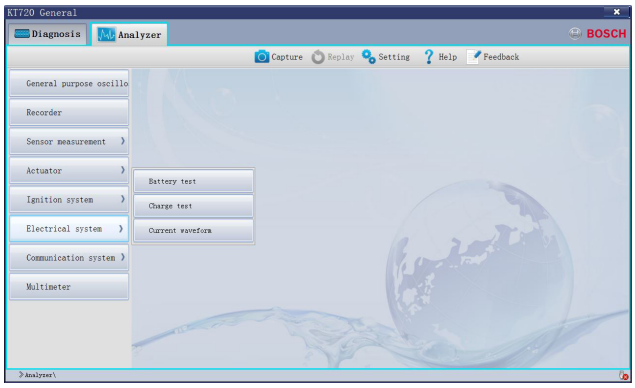
1. Connect equipment according to Fig.55, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Ignition SYS** --> **Primary IGN** --> **Multi-Cylinder mode** or **Single-Cylinder mode**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. Depending on the parameters of engine to set IGN settings, include ignition mode, sensation,number of cylinder and ignition order.
7. You can adjust to cycle, amplitude, and cursor.
8. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, snapshot current waveform, display mode of waveform and waveform comparison;
9. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.8.2.4 Waveform analysis

Observe whether the height of ignition breakdown peak voltage of each cylinder is relatively consistent, and change of dwell angle when engine load and speed change.

11.9 Electrical system

Measured the waveform of electrical system.



11.9.1 Battery test

The problem of charging system is usually from vehicle owner who complains about “Cannot start”, battery cannot provide electric energy at this time, while starting motor cannot drive engine. The first step usually is to test battery, and charge battery first if necessary.

When measuring system voltage, surface charge of the battery can be released several minutes after turning on headlight, and then turn off headlight and measure the voltage between two terminals of the battery. If possible, use gravimeter to measure specific gravity of each separate cell of the battery. Battery load test should be conducted to check battery performance at load state. Because only charging state is displayed in voltage test, not in battery conditions.

11.9.1.1 Equipment connection

When connecting KT720 to power extension cable, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket to positive of battery.

11.9.1.2 Measure conditions

Let headlight on for about 3 minutes to remove the surface charge in the battery.

11.9.1.3 Measure steps

1. Connect equipment, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Electrical SYS** --> **Battery Test**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.9.1.4 Waveform analysis

Generally, amplitude value of battery voltage is displayed as a line on the oscillograph.

11.9.2 Charge test

Charging output test: new electric regulator can maintain charging voltage between 13-15V, and charging system must provide sufficient output to maintain battery charging and need of vehicle.

Test rectifying diode: three-phase alternator uses three pairs of diodes to rectify output current. These diodes are usually installed on a insulating radiating seat or in rectifying bridge. Diode allows current to pass through in only one direction but not in the other. If diode is short, current can pass through in both directions; if open, current can pass through in neither direction.

The way of testing open or short diode is to connect one end of testing line of KT720 to one end of the diode, and to connect the other testing line to radiating seat or generator housing. And then test again in reverse direction. It should be displayed on KT720 that one direction is on while the other direction is off. If the testing result is on in both directions, the diode is short. If it is off in both directions, the diode is open.

11.9.2.1 Equipment connection

When connecting KT720 to power extension cable, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery as example. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to the negative of battery or grounding. For different function test, the test location ofKT720 oscilloscope probe is also different. Refer to testing conditions for details.

11.9.2.2 Measure conditions

- Connect KT720 to the generator on the vehicle, as shown in Fig.56.
- Start engine, and conduct test at idle and load state, slowly increase engine speed.
- Turn on the electric appliances on the vehicle to make charging system loaded, such as headlight, water tank fan motor and wiper, etc.

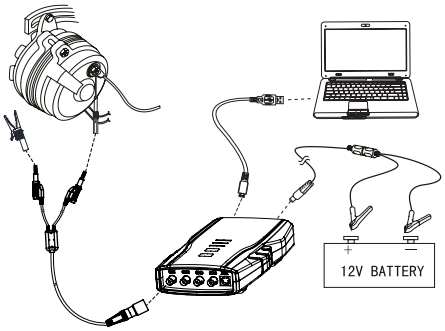


Fig. 56: Equipment connection

11.9.2.3 Measure steps

1. Connect equipment, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Electrical SYS** --> **Charge Test**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.
9. You can record a continuous waveform section by clicking “Record” button.

11.9.2.4 Waveform analysis

The waveform of charging voltage is a steady line.

11.9.3 Current waveform

Current waveform is be used to measure paramenter trends at work of vehicle electrical lines.

Current waveform must be connected current clamp to measured.

11.9.3.1 Equipment connection

When connecting KT720 to power extension cable, choose power supply according to the battery position of vehicle mode tested. All connecting diagrams in this users manual take power supply by battery as example. Connect BNC end ofKT720 oscilloscope probe to CH3, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket to positive of battery.

DC 1000A current clamp should be reverse connected to positive of battery, and the other end connected to CH4.

Fig. 57: Current clamp connection

11.9.3.2 Measure conditions

- Turn off before connected cables.
- Turn on after connected cables, then automatically measured.

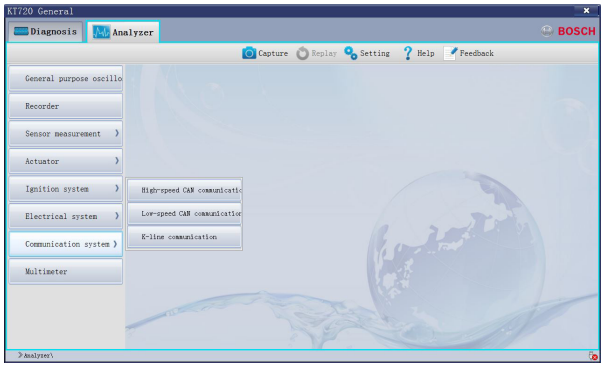
11.9.3.3 Measure steps

1. Connect equipment, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Electrical SYS** --> **Current Waveform**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and waveform comparison;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

9. You can record a continuous waveform section by clicking “Record” button.

11.10 Communication system

Measure waveform of the vehicle’s communication system.



11.10.1 High-speed CAN communication

As for high-speed CANBUS test, the waveform data of CAN bus can be acquired by the user.

11.10.1.1 Equipment connection

Connect KT720 and extension line of power supply, choose power supply mode according to battery location of the vehicle to be tested. Connect BNC end of OSC detector to CH1; then connect the alligator clip of the probe to the vehicle ground or battery negative pole, and connect the other end of the probe to CAN_H and CAN_L of CAN network.

11.10.1.2 Measure conditions

- Turn the key to position ON.
- If diagnostic data needs to be viewed, a diagnostic analysis shall be conducted on ECU during measurement.

11.10.1.3 Measure steps

1. Connect equipment, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Communication SYS** --> **High-Speed CAN**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and single change between simulation model and digtal model;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.10.2 Low-speed CAN communication

As for low-speed CANBUS test, the waveform data of CAN bus can be acquired by the user.

11.10.2.1 Equipment connection

Connect KT720 and extension line of power supply, choose power supply mode according to battery location of the vehicle to be tested. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket to CAN_H and CAN_L of CAN network.

11.10.2.2 Measure conditions

- Turn the key to position ON.
- If diagnostic data needs to be viewed, a diagnostic analysis shall be conducted on ECU during measurement.

11.10.2.3 Measure steps

1. Connect equipment, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Communication SYS** --> **Low-Speed CAN**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and single change between simulation model and digtal model;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.10.3 K-line communication

The waveform data of K-line can be acquired by the user.

11.10.3.1 Equipment connection

Connect KT720 and extension line of power supply, choose power supply mode according to battery location of the vehicle to be tested. Connect BNC end ofKT720 oscilloscope probe to CH1, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding, and connect the other end of red banana plug and red banana socket to K-line network.

11.10.3.2 Measure conditions

- Turn the key to position ON.
- If diagnostic data needs to be viewed, a diagnostic analysis shall be conducted on ECU during measurement.

10.10.3.3 Measure steps

1. Connect equipment, switch on power supply.
2. Double click run KT720 software.
3. Select communication mode: USB communication or wireless communication, the KT720 and the computer are successfully communicated.
4. Click **Analyzer** --> **Communication SYS** --> **K-Line**.
5. Waveform will be displayed on the screen depending on measure conditions.
6. You can adjust to cycle, amplitude, coupling, reversed-phase, and cursor. If the cycle locates at high-frequency section, the triggering channel and triggering modes can be adjusted.
7. You can print measured data, load snapshot data and reference waveform data, save current configuration or acquire old configuration, automatically adjust the amplitude, snapshot current waveform and single change between simulation model and digtal model;
8. You can check the details of current waveform by clicking “Pause” button. After click, the button turns to “Start”, click it again to carry forward measurement.

11.11 Multimeter

It is used to measure values of DC voltage, AC voltage, switch, resistance and diode. Value of DC voltage can be measured through CH1, CH2, CH3 and CH4, and values of AC voltage, switch and resistance and diode can be measured through CH4 only.

Judge channel by the color displayed. Red indicates CH1, Blue indicates CH2, Green indicates CH3, Yellow indicates CH4.

Display modes of measured values: including display by panel, display by column, display by waveform, and display by digital. You can select a proper mode according to the actual requirement.

Click the correct channel display frame, and select the check box at the top right corner of each display frame. The maximum and minimum value: the maximum and minimum value during the measurement will be recorded automatically for each channel.

Maximize the display frame of channel: Click the maximization button locating at right corner of each display frame to maximize the frame. After maximization, clikc the restoration button locating at right corner to restored the frame.

11.11.1 DC voltage

Measure DC voltage of vehicle components.

11.11.1.1 Equipment connection

Connect KT720 and extension line of power supply, choose power supply mode according to battery location of the vehicle to be tested. All connection schema-

tic diagrams therein are based on connection of battery clip. Connect BNC end of KT720 oscilloscope probe to CH4, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding. Different tests on functions. Connect the other end of red banana plug and red banana socket to DC signal to be measured.

DC voltage on 4 vehicle components can be measured simultaneously by KT720 .

11.11.1.2 Measure conditions
Start the automotive generator.

11.11.1.3 Measure steps
1. Connect the equipment; switch on power supply ofKT720 .
2. Double click to run KT720 application.
3. Select communication mode: USB communication or wireless communication, the KT720 and computer are successfully connected.
4. Click **Analyzer** --> **Multimeter**.
5. Since measured value of CH1 is set as default, please remove the CH1 and then select CH4.
6. Click “DC Voltage” button on the right to display the value of DC voltage measured through CH4.
7. You can select display mode of measured values and decide whether the display frame to be maximized or not.
8. You can print the measured data.
9. Click “Pause” button to hold off the measurement. Meanwhile, the button turns to “Start” and click it again to carry forward the measurement.

11.11.2 AC voltage
Measure AC voltage of vehicle components.

11.11.2.1 Equipment connection
Connect KT720 and extension line of power supply, choose power supply mode according to battery location of the vehicle to be tested. All connection schematic diagrams therein are based on connection of battery clip. Connect BNC end ofKT720 oscilloscope probe to CH4, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding. Different tests on functions. Connect the other end of red banana plug and red banana socket to AC signal to be measured.

11.11.2.2 Measure conditions
Start the automotive generator.

11.11.2.3 Measure steps
1. Connect the equipment; switch on power supply ofKT720 .
2. Double click to run KT720 application.
3. Select communication mode: USB communication or wireless communication, the KT720 and computer are successfully connected.
4. Click **Analyzer** --> **Multimeter**.
5. Since measured value of CH1 is set as default, please remove the CH1 and then select CH4.
6. Click “DC Voltage” button on the right to display the value of DC voltage measured through CH4.
7. You can select display mode of measured values and decide whether the display frame to be maximized or not.
8. You can print the measured data.
9. Click “Pause” button to hold off the measurement. Meanwhile, the button turns to “Start” and click it again to carry forward the measurement.

11.11.3 Switch
Measure the conduction ability of vehicle components.

11.11.3.1 Equipment connection
Connect BNC end ofKT720 oscilloscope probe to CH4, then connect the other end of the black banana plug and black alligator clip. Then connect the other end of red banana plug and red banana socket to switchl to be measured.

10.11.3.2 Measure conditions
Switch off the vehicle power.

11.11.3.3 Measure steps
1. Connect the equipment; switch on power supply ofKT720 .
2. Double click to run KT720 application.
3. Select communication mode: USB communication or wireless communication, the KT720 and computer are successfully connected.
4. Click **Analyzer** --> **Multimeter**.
5. Since measured value of CH1 is set as default, please remove the CH1 and then select CH4.
6. Click “DC Voltage” button on the right to display the value of DC voltage measured through CH4.
7. You can select display mode of measured values and decide whether the display frame to be maximized or not.
8. You can print the measured data.
9. Click “Pause” button to hold off the measurement. Meanwhile, the button turns to “Start” and click it again to carry forward the measurement.

When measuring, if resistance <= 60 ohm, the buzzer will ring.

11.11.4 Resistance

Measure resistance value of vehicle components.

11.11.4.1 Equipment connection

Connect BNC end ofKT720 oscilloscope probe to CH4, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding. Then connect the other end of red banana plug and red banana socket to resistance to be measured.

11.11.4.2 Measure conditions

Switch off the vehicle power.

11.11.4.3 Measure steps

1. Connect the equipment; switch on power supply ofKT720 .
2. Double click to run KT720 application.
3. Select communication mode: USB communication or wireless communication, the KT720 and computer are successfully connected.
4. Click **Analyzer** --> **Multimeter**.
5. Since measured value of CH1 is set as default, please remove the CH1 and then select CH4.
6. Click “DC Voltage” button on the right to display the value of DC voltage measured through CH4.
7. You can select display mode of measured values and decide whether the display frame to be maximized or not.
8. You can print the measured data.
9. Click “Pause” button to hold off the measurement. Meanwhile, the button turns to “Start” and click it again to carry forward the measurement.

11.11.5 Diode test

Measure diode value of vehicle components.

11.11.5.1 Equipment connection

Connect BNC end ofKT720 oscilloscope probe to CH4, then connect the other end of the black banana plug and black alligator clip to negative pole of battery or grounding. Then connect the other end of red banana plug and red banana socket to diode to be measured.

11.11.5.2 Measure conditions

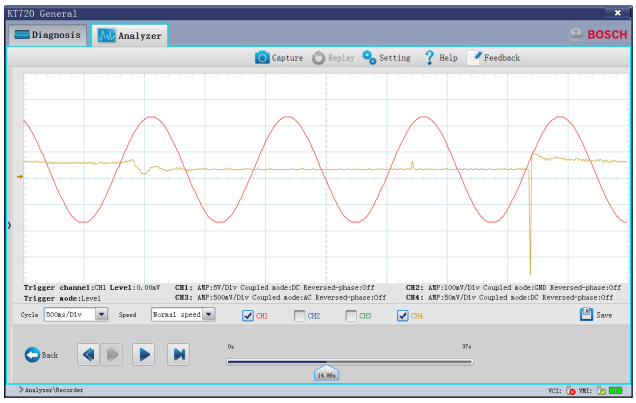
Test the rectifier bridge after the generator is disconnected.
Diagnose the faulted generator according to methods suggested by the manufacturer.

11.11.5.3 Measure steps

1. Connect the equipment; switch on power supply ofKT720 .
2. Double click to run KT720 application.
3. Select communication mode: USB communication or wireless communication, the KT720 and computer are successfully connected.
4. Click **Analyzer** --> **Multimeter**.
5. Since measured value of CH1 is set as default, please remove the CH1 and then select CH4.
6. Click “DC Voltage” button on the right to display the value of DC voltage measured through CH4.
7. You can select display mode of measured values and decide whether the display frame to be maximized or not.
8. You can print the measured data.
9. Click “Pause” button to hold off the measurement. Meanwhile, the button turns to “Start” and click it again to carry forward the measurement.

11.12 Record and playback functions

KT720 can playback the data acquired, but this could be realized only in the measuring course.



3 Kinds of files including KT720 file, freeze file and record file can be played back by KT720 .

File: waveform files saved in SD card in measuring course.
Freeze File: waveform files saved by clicking “Frozen” button.
Record File: waveform files saved by clicking “Record” button in recorder interface.

Button	Function and description
	Playback button

	Play Forward button, default play mode
	Play button, click this button to replay waveform
	Pause button, click this button to hang replay
	Fast Forward button
Back	Back button, back to current interface
Save	Save button, save waveform data

Cycle: waveform data can be replayed by means of compression and compression cycle must be greater than **the replay cycle:** Waveform data could be compressed to one-fifth. For instance, when the cycle of the waveform to be replayed is 5ms/Div, the waveform could be compressed to 10ms/Div. This waveform could be compressed to 250ms/Div where it reaches the highest compression level.

Play Speed: speed when playing back the waveform includes normal speed, speed after slowed down by 1 time, speed after slowed down by 2 times, speed after accelerated by 1 time, speed after accelerated by 2 times.

Progress Bar: monitor playback progress, in percentage.

If multi-channel data are acquired, you can select the waveform displaying channel according to your preference.

Waveform parameter can be displayed during playback.

12. Auxiliary Function

12.1 Screen shot

Catch the current window information, the system will save it to your selected path with format of .JPG, you just need to enter a available name of this file.

Operate Method:

1. Click "Screen Shot" 抓屏 button in system function area, the system will save the file automatically; a window pops up to display the file's save path and name.
2. Click "OK" button to exit Screen Shot.

12.2 Help

This function is KT720's online help function, which help you to know how to operate KT720, how to diagnose or measure; and this interface is individual.

Operate Method:

1. Click "help" 帮助 button in system function area to enter the help interface.
2. 2.You can figure out what you want to know according to the left navigation column.
3. 3.You can ask for help by searching key words through "find" button.

You can put some contents that you usually view in favorites, which will convenient for you to quick search; you could print the current page.

12.3 Feedbacks

KT720 provides online feedback function to help you to feedback any questions you meet. However, your computer must connect to Internet.

Operate Method:

1. Click "feedback" 反馈 button in system function area to enter the feedback interface;
2. The system will check test path automatically, please write vehicle and fault information correctly so that the feedbacks can be figured out quickly and exactly.
3. All contents attached red "*" must be filled.
4. Click "submit" to submit your feedback.

13. Maintenance Help

This function is vehicle maintenance information offered by Bosch for repairman reference.

14. Service and maintenance

14.1 Cleaning

It is not recommended to clean the KT720 host with the corrosive detergent or any coarse cloth; only the soft cloth and neutral detergent can be used.

14.2 Maintenance

- Place the KT720 in the flat and dry place with moderate temperature and less dust when the KT720 is not used.
- Don't place the KT720 in the place with direct sunlight or close to the heating device.
- Don't place the KT720 near the stove or in the place where will be easily subjected to smoke erosion, water entry, and oil splashing.
- Don't disassemble the host without permission.
- If the vehicle test is not performed for a long time, please periodically run the KT720 host to avoid being affected with damp.

14.3 Battery maintenance

- The battery shall be charged when the power is used up; the battery shall not be charged too long, 5 hours generally.
- It is prohibited to put the instrument in the vehicle with high temperature when using.
- Be sure to used battery of Bosch supply.
- Do not heat the battery or drop it in the fire.
- The battery shall be kept away from water. Keep the anode and cathode of the battery dry.
- Do not distort, dismantle or refit the battery.
- Do not attempt to peel or cut off the battery housing.
- Do not drop or knock the battery, or collide the battery in other ways.
- Do not put the battery at extremely warm or humid place.
- If the battery duration is obviously shortened after correct charging, it means that the effective life time of the battery is over, replace it.

15. Warranty

- Warranty period of the KT720 is twelve (12) months dating from the day of user's registration. Warranty period of accessories is six (6) months dating from the day of registration.
- If the KT720 breaks down within the warranty period under normal operation, the Company will provide maintenance service free of charge.

If the KT720 breaks down in any of the following cases, the Company will charge the material costs or other expenses as appropriate:

  - Breakdown caused by misuse or accident.
  - Breakdown caused by dismantling or repairing without authorization.
  - The accessories damage or get worn naturally;
  - Breakdown caused by natural disasters and force majeure.
- Warranty service is limited to the equipment; the Company is not liable to damages go beyond the equipment.

16. Device parameters

16.1 Device parameters

Item	Index
Size	227*134*44(mm)
Weight	Approximately 760g
POWER	≤30W
WORKING TEMPERATURE	-10~45°C
STORAGE TEMPERATURE	-15~50°C

Item	Index
RELATIVE HUMIDITY	10%~95%
INPUT VOLTAGE	DC 7~32V
USB	USB2.0 FULL SPEED
KEY	RECORDER KEY
LED	3 LED INDICATOR LAMPS INDICATING THE WORKING STATUS
WLAN	COMPATIBILITY IEEE 802.11B/G/N
PROTECTION GRADE	IP30
BATTERY(OPTIONAL)	2200MAH
SD CARD	≤32GB
HOOK	LOADING CAPACITY: 5KG

16.2 Oscillograph parameters

Item	Index
Sampling channels	4 channels
Bandwidth	DC~2MHz
Sampling rate	40MS/s
Memory depth	64Kbyte/CH
*Vertical scope	20mVDIV~20V/DIV
Level of collection	1uSec~50Sec/Div
Electric level reference	With hardware adjustable(0~100%)

**) You can only measured 100VDC or ±50VAC singles when you connectedKT720 differential probes.*

16.3 Multimeter parameters

Item	Index
AC voltage	30VAC
DC voltage	60VDC
Diodes	0~2.0V
Resistance	0~60MΩ
Switching	0~60Ω

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