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(57) Abstract: The invention relates to a mobile automatic test and measurement device that is capable of measuring multi-channel analog signals, suitable for wireless connection and having ultra-low power consumption.

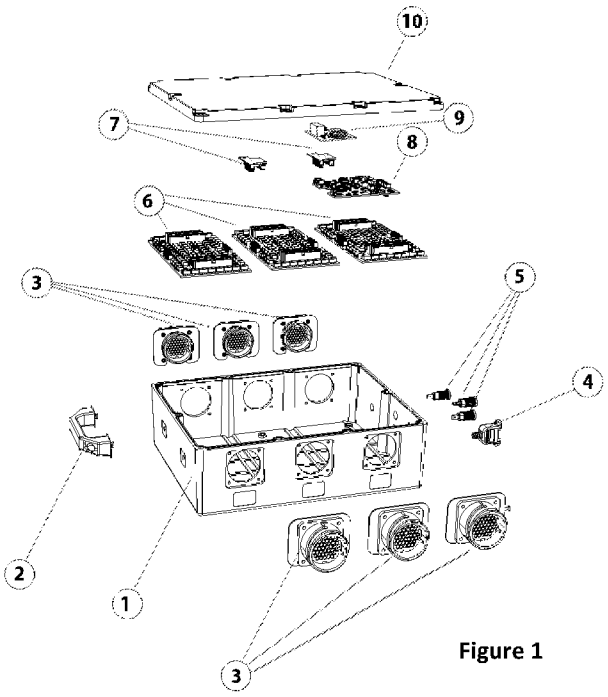

Figure 1

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AUTOMATIC MULTI-CHANNEL ELECTRONIC TEST AND MEASUREMENT DEVICE

TECHNICAL FIELD

The invention relates to a mobile automatic test, measurement and analysis device that is capable of measuring multi-channel analog signals, suitable for wireless connection and having ultra-low power consumption.

PRIOR ART

In automotive industries, manual testing instruments are used in in-vehicle cable and signal measurement. In addition to these manual testing instruments, automatic and semi-automatic systems are provided as well, however, they can carry out a measurement only in a very limited range of channels and also need an external power source (For example: mains electricity). In manual systems, signals and cables of a vehicle are individually measured by a technician and by use of a measurement device with reference to detailed schematics of the vehicle. Manual measurement instruments allow measuring by partially being connected to cable harnesses provided in the vehicle. In current automatic systems, manual testing instruments or dedicated bridging cables are still used; moreover points to be measured are manually connected by a technician and measured through a computer program with reference to connections in schematics.

The testing instruments known from the prior art are insufficient, hard to use, take too much time to be ready for use, and are quite vulnerable to human related faults, which constitutes drawbacks of both systems.

Drawbacks of the Prior Art:

- Drawbacks related to manual measurement: inaccurate values may be measured due to a non-automated measurement.
- Drawbacks related to user: Faults may occur if the user carries out incorrect matching, connects to the wrong input and uses the measurement instrument improperly.

- Connection errors: Errors occur if the user carrying out the measurement process connects the signal points to be measured, incorrectly or if physical abrasion of the connection points exists.
- Lack of reporting: Current devices are not capable of providing automated reporting and document output support. Values measured, need to be reported manually. Lack of information is therefore of concern in documentation and archiving.
- Requirement of a measurement device: It requires using an external measurement device for manual measurements. Inaccurate measurements resulting from both improper use of the measurement device and also from device calibration problems.
- Use with bad intention: Use with bad intention occurs when a technician manipulates the measurement results and tries to receive spare parts from manufacturers under warranty.
- High cost: Failure to conduct an accurate detection of a possible fault causes companies to face the problem of high cost of repair and spare parts.

Considering the products/operation methods of the systems used in the prior art;

- When a defective vehicle comes to the service, if the vehicle is giving a certain technical malfunction code, description of said malfunction code is first of all, checked through online systems or manuals. Connections to be checked for this malfunction code are again determined with online systems and manuals. Similarly, it is checked through the online systems and manuals on how to take the measurement and which tools should be used during measurement, and also a technician separately checks all connections required to be controlled for the failure related to malfunction code with manual measurement instruments. At the end of this process, a report is not generally drafted related to measurement results. The technician, who can only check one connection at a time, may need to spend a considerable amount of time for determining the problem. After completing this process, any significant problem may not be detected in any one of the connection points measured. The reason for the malfunction code may also be related to a failure in the system that generating the malfunction code. Current systems are not capable of detecting such failures.
- At the time when the defective vehicle comes to the service, the system may not have given any malfunction code. In such case, as there is no determined testing procedure, service staff measures the points that they deem suspicious of their own decisions depending on their experience. Accordingly, if any fault is not found, all the cables and

signals must be manually measured one by one. This may cause the vehicle to be kept in service for quite long periods of time.

- In the automatic measurement systems already known, connection to the signals to be measured is separately conducted by the technician and subsequently an automated measurement is started. However, as it can conduct a few measurements on different channels at the same time, the personnel needs to continuously change the connections of the test box in order to measure all channels. Automatic measurement systems at such a level cannot provide a detailed report, and they can only partially reduce the problems related to the technical staff and the time consumed.

As for Technical Problems;

- Insufficient technical background of the staff leads to technical problems such as erroneous connections.
- A physical abrasion on connection points causes inaccuracies in measurements and incorrect measurements thus this leads to unnecessary replacement of parts and increase in service costs.
- As there are many connection and disconnection processes that are to be conducted manually, durations of measurement and repair and also cost of manpower are increased. Therefore, customer satisfaction is decreased.
- A fault can only be detected by testing separate signals or cables individually. There is no structure that can analyze the entire system at once and this increases cost of time and human resource.
- The technician, who uses manual test boxes for on-site maintenance and repair services, needs to obtain electrical schemas and signal types of the vehicle for detecting the failure on-site.. This leads to remarkable loss of time and inaccurate detection when the technician attempts to achieve manually the correct testing procedure out of thousands of signals. As online systems are used at the stage of access and access to online systems may not be ensured everywhere, operations can only be carried out in services. Therefore, lack of mobility arises.

To highlight the problems encountered in services;

- Longer periods of time for failure detection,
- Longer periods of time and higher cost of detection and repair of breakdowns without malfunction code or with an incorrect malfunction code,
- Need for experienced technical staff for electronic parts in particular,

- Higher cost of spare parts as a result of an inaccurate detection or insufficient data,
- Difficulty of failure detection and higher possibility of obtaining inaccurate results as a result of separate and individual operation of a wide range of measurement devices,
- Difficulty of detection of inaccurate measurement occurring due to the fact that measurement devices are broken,
- Increase in service cost and decrease in service efficiency of the vehicles kept in service, for quite long periods of time,
- Lack of customer satisfaction resulting from longer repair periods and high costs of repair.

Basic needs of services are as follows;

- achieving accurate failure detection within the shortest possible time,
- reducing faults of technical staff and the cost related to these faults,
- meeting the need for trained technical staff,
- making manual measurement systems automatic and reportable,
- eliminating operational drawbacks by reducing the number of required measurement devices,
- Solving problems resulting from unnecessary replacement of spare parts at services with customers and insurance companies.

SUMMARY OF THE INVENTION

The present invention relates to a mobile automatic test, measurement and analysis device that has been developed in order to eliminate the disadvantages mentioned above and to provide novel advantages to the related art.

Structures in which the number of measurement channels can be expandable up to hundreds when required, and channels can be shorted to one another and/or routed to measurement unit separately are called multi-channel structures. The invention has channel capacity of 20 channels and above. In the preferred embodiments, the number of channels may be 100 and above.

An aim of the invention is; to produce an automatic testing box capable of carrying out multi-channel measurements and thus to eliminate the problems of the industry including measurement, failure detection, lack of technical staff, higher repair costs, cost of unnecessary spare parts, reporting and data management.

Another aim of the invention is; to alleviate the problems resulting from manual and semiautomatic measurement systems.

A further aim of the invention is; to solve problems such as incorrect detection or failure to detect fault and thereby to save companies from higher cost and loss of time.

Another further aim of the invention is; to increase service quality and thus customer satisfaction.

Another aim of the invention is; to provide an innovation to the current process by means of automation of the processes conducted by manual measurement devices.

An aim of the invention is; to reduce high cost of repairs and spare parts for the vehicles under the warranty of the manufacturing companies and to eliminate problems related to repair times and thus to maximize customer satisfaction.

Our invention is capable of eliminating all of the problems within a very short time by automatically controlling the entire system at once.

Our invention can be used in services of all vehicle brands following an adaptation process. It can be used in all vehicle maintenance, vehicle service, mobile service, ex-factory tests.

It is suitable to be used in air, land and naval vehicles in the industry. The invention is suitable to be used in maintenance and repair services of all manufacturers that manufacture heavy vehicles.

The drawbacks/problems solved by means of our invention are as follows;

- Drawbacks related to manual measurement: all drawbacks related to manual measurement are eliminated by automatic measurement.
- Drawbacks related to user: Drawbacks related to user are eliminated.
- Connection errors: Errors including improper connection or physical abrasion of the connection points are solved.
- Lack of reporting: Current instruments are not capable of providing automated reporting and output support. Values measured mostly need to be reported manually. Lack of information is therefore of concern in documentation and archiving. This brings along the problem of MIS (Management of Information System). Our invention solves this problem.
- Requirement of a measurement device: It requires using an external measurement device for manual measurements. Inaccurate measurements result from both improper use of the measurement device and also calibration problems of said device. This drawback is completely eliminated with our invention.

- Use with bad intention: It solves the problems of uses with bad intention that occurs when a technician manipulates the measurement results in order to obtain free products under warranty from the manufacturers.
- High cost: Failure to conduct an accurate detection of a possible fault causes firms to face the problem of high cost of repair and spare parts. Such problem of high cost is substantially alleviated by means of our invention.

To consider the solutions and advantages achieved that aim to solve technical problems that have been a matter of concern in systems/products known from the prior art, before the innovation of the present automatic multi-channel electronic test and measurement device;

- In prior art systems, fault detection can only be carried out by testing different signals or cables individually. A structure, which is capable of analyzing the entire system at once, has not been provided and this results in an increase in cost of human resources. With the help of the present invention, a multi-channel measurement is carried out, the entire system is analyzed at once and therefore the problems related to time consumption and human resources and also higher costs are completely solved.
- Technical problems are also caused when the technical staff has not been trained sufficiently or carries out incorrect connection. This leads to faulty outcomes. The invention solves this problem by minimizing the effect of the human related errors on measurement processes.
- Physical abrasions of the connection points cause faults in measurements. Inaccurate measurements lead to unnecessary replacement of parts and higher cost of service. With the present invention, the need for additional measurement devices to which a connection is carried out is eliminated and the problem thereby is solved.
- As there are several connection and disconnection processes that are to be conducted manually, time of measurement and repair and also cost of human resources are increased. Therefore, customer satisfaction is decreased. To find out a possible fault, various processes of testing may be needed, which may sometimes last for long hours while even lasting for several days. Commercial vehicles that are kept in service for a long period of time will have to face higher cost and commercial losses due to both their repair costs and also long-time absence from commercial areas. The invention eliminates this drawback with controlling the entire system at once.
- The personnel need to obtain electrical schemas and signal types of the vehicle for detecting the failure at “failure point” in manual testing instruments. It results in remarkable loss of time and inaccurate detection when the technician attempts to

achieve manually the correct testing procedure out of thousands of signals. As online systems are used at the stage of access and access to online systems may not be ensured everywhere, operations can only be carried out in services and therefore a lack of mobility arises. The invention can operate by being connected to a mobile phone or a low power supply (such as tablets, power banks etc.) with the principle of low-energy, and with its portable case design, can supply services at all points and thus the invention solves the problem of mobility. This substantially reduces the drawbacks of time consumption and cost of human resources. In military vehicle applications, these factors pose strategic importance.

The systems, which do not require to be connected to mains electricity, can obtain operational energy through mobile electronic devices and consume power of only 5 Watt and below are referred as low power systems in this document.

By means of the method of the present invention, the aforementioned drawbacks are eliminated and the needs are met. The problem can be solved with the following three steps.

1. The invention, by measuring all signals of the vehicle at once; eliminates the problems including measurement device related faults, long periods of time consumed for fault detection; higher costs related to these problems and the problems of technical staff in fault detection process.
2. Regarding the manual measurement device, lack of qualified staff is a matter of concern. Even if qualified and well-educated technical staff is ensured, there are still risks of inaccurate measurement. With the invention, all personnel, who are only capable of carrying out simple operations such as inserting a socket, will be able to carry out a measurement. Thus, the staff conducting fault detection for services can contribute to the solution of the problem of competence.
3. The duration and cost of repair is increased due to inaccurate measurements, failure to carry out a fault detection properly, incorrect applications performed by technical staff and bad intentioned use. A great number of spare parts are replaced unnecessarily, which results in quite high costs. Customer satisfaction is difficult to be ensured. The invention eliminates all these drawbacks, detects failure at the shortest time possible, reduces repair times and high costs of repair, thereby increasing customer satisfaction.

In a preferred embodiment of the invention, the device is located as a bridge between a controller and cabling of said device in a vehicle.

In another preferred embodiment of the invention, the device automatically obtains data of said vehicle (vehicle identification number, malfunction codes, etc.).

In a further preferred embodiment of the invention, the device is able to communicate via Bluetooth interface.

In another preferred embodiment of the invention, the device provides mobility by being able to use energy through any device that has USB connection.

In another preferred embodiment of the invention, the device provides electrical insulation on the USB connection.

In a preferred embodiment of the invention, the device is connected in series to a cable set of a unit of the vehicle to be tested.

In a further preferred embodiment of the invention, the device carries out fully automatic measurement.

In a preferred embodiment of the invention, the device operates without the need for an external measurement device.

In another preferred embodiment of the invention, the device is able to report all measurements and print out or digitally archive them depending on user's preferences.

In a further preferred embodiment of the invention, the channels of the device to be used in testing and measurement can be increased.

In another preferred embodiment of the invention, the device carries out inline measurement by connecting to the cable set in series.

In a further preferred embodiment of the invention, the device carries out calibration within itself before starting the measurement in order to ensure that measurement results will be accurate.

In another preferred embodiment of the invention, the device has sensors that enable to detect not only if the device has fallen down, but also, the angle at which it has fallen down and the parts that has been damaged by means of a security unit used therein.

In another preferred embodiment of the invention, said security unit comprises its own battery system that enables the device to continue operating even without being connected to another power unit.

In a further preferred embodiment of the invention, bridging channels and signal measuring channels are dedicated to be screened within printed circuits.

In a preferred embodiment of the invention, the device has a structure that is capable of testing the entire system at once by a multi-channel measurement.

In another preferred embodiment of the invention, the device has a structure that comprises an integrated system capable of operating via an automatic channel routing, multi-channel connection and an USB interface.

In a different preferred embodiment of the invention, the device has a portable design.

In a further preferable embodiment of the invention, the device comprises an internal battery system and an internal charging system instead of an external power supply.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1: An automatic multi-channel electronic test, measurement and analysis device is shown.

REFERENCE NUMBERS

1 Case
2 Handle
3 Cabling Connectors
4 USB Input Port
5 Manual Signal Outputs
6 Analog Forwarding Unit
7 Analog Expansion Unit
8 Main Processing Unit
9 Insulation Unit or Protection Unit
    9a. Insulation Unit
    9b. Protection Unit
10 Lid

DETAILED DESCRIPTION OF THE INVENTION

In this detailed description, the novelty subject to the present invention has been described by illustrations that are not limiting but that have been disclosed only to provide a better understanding of the subject matter.

The present invention is a mobile automatic test, measurement and analysis device that is capable of measuring multi-channel analog signals, suitable for wireless connection and having ultra-low power consumption.

General Operation Principle:

The invention analogously measures signals defined in a vehicle, compares them with reference values and then reports the results thereof. It keeps the report document within a database so as to be used later optionally. It then measures all signals within a cabling of the vehicle at one scenario and reports the results thereof. It determines faults and the points likely to have fault.

When an operating principle in a preferable embodiment of the invention is considered; The device is connected to a computer, a tablet, a smartphone or an external power supply through an USB interface. The system attains all power it needs to be able to operate preferably through the USB interface. Energy is introduced to an Insulator Card, and subsequently a Main Processing Unit in the device. All power and reference voltages required to enable the device to operate are formed on the Main Processing Unit and then the device switches to a standby mode. Once the device is assured that the power signals required are generated, it waits for a communication through the USB and a Bluetooth interface in standby mode. By means of interface software, the model, type and/or unit of connection of the vehicle desired to measured, is selected. The device requires a vehicle identification number and the other necessary information to be inputted before launching a test. If desired, these data can be automatically obtained from the vehicle to be measured.

Afterwards, the automatic or manual measurement scenario intended to be carried out is selected. And, then, depending on the measurement scenario selected, a user guidance panel is reflected on the screen. On this panel, it is shown graphically and in writing to the user which cable is set is to be connected to which point of connection bundle of the measurement device.

Once the connection is ensured, the conditions required by the scenario (idle, ignition on, ignition off etc.) are reported. Measurement is launched by the user performing the requirements. During measurement, the user is directed once or more than once and the necessary conditions for every measurement group are ensured to be performed by the user. In a manual test scenario, all steps of test of the vehicle or unit to be measured are listed and a measurement scenario is started over the test steps the user has selected. As in the automatic measurement scenario, the user is routed for the necessary measurement needs and a measurement is carried out. After the measurement is completed, a reporting module is activated and a report of the measurement is formed and presented in PDF format If desired, it can be added to database and thereby measurement history of former records can be kept.

Basic functions of the system

Said components of the device are shown in Figure 1.

The system basically consists of 3 electronic components. These are; an Analog Forwarding Unit (6) that enables the desired channels out of a cable harness to be routed to main processing unit, a Main Processing Unit (8) that is a unit managing the entire system, and an Insulation Unit (9a) that provides an electrical insulation. In a preferable embodiment of the invention, when the Analog Forwarding Units are more than one, it comprises an Analog Expansion Unit (7) that is a unit allowing the number of channels to be increased by connecting the Analog Forwarding Units (6) to one another.

Analog Forwarding Units (6): It is the unit that performs the function of routing signals. It is preferably defined as an electronic board. It routes the channel in which a measurement is to be performed to measurement ports through the relays it comprises therein within the instructions from the main processing unit. It gets the power and the control signals it needs to operate from an expansion interface or main processing unit Then, it transfers the power and control signal lines through its internal layout to the output expansion port of the board. It momentarily repeats this process with updates obtained from the processing unit
Said unit is able to be adapted to different types of vehicles and units and cable sets thereof through cabling input connectors it has on the board. When switched to a new type of cable set, the unit is enabled to be adapted to the new system without a need for any change on the analog forwarding unit board. The Analog Forwarding Unit provides two functions in one. These are; the function of signal bridging and the function of channel routing.

In the technologies known already, connection is made manually to a system in which an analog measurement is desired to be carried out. Such connection is carried out through particular connections of connectors called sockets. There is a need for a signal carrier cable compatible with these sockets in order to carry out a measurement on these sockets. Additionally, if it is needed to take a measurement when the system operates, a need for making an additional bridging cable or printed circuit board arises. If it is not desired to make an additional cabling, it is needed to connect to signals on the socket through an alligator, a clamp or similar apparatus.

In an attempt to measure the signals in an internal cabling of a car, an "N"-channeled measurement device needs a bridging cable which is capable of routing the signals within the vehicle to the measurement device or a perforated analog bridging box to which the channels in the vehicle cable set can be connected to the measurement device by specialized connection ports. In these systems, length of the cables in the connections that used to carry signals to the measurement device, which is called as "stub", can be up to a few meters. This causes deviations in the characteristics of the signal measured and also in inductance, capacitance and resistance values of the channel in which the signal is to be measured. Said deviations are known as stub effect. Such a cabling needs to be made for every one of the signals intended to be respectively or automatically measured. This approach may also result in deteriorations in signals by creating a stub effect on channels that are not enabled to be measured at this moment, in other words, it may have an effect on the signals waiting for their turns to be measured. Particularly, this deterioration/effect is greater in high-frequency signals.

In the present invention, architecture of signal bridging and architecture of channel routing are on the same board in the Analog Forwarding Unit. As it can route the signals to be measured within itself, its signal route extending to a measurement channel is quite short (at the level of cm's) and this effect is only applicable on the signal to be measured. The stub effect is at a negligible level in the signals waiting for their measurement turns. In other systems, the stub effect is started as of the moment when a physical socket connection is made, which is not possible to be blocked. The invention restrains the stub effect onto the signal measured only and has an enhanced quality and reliability of measurement due to its quite short stub length, which constitutes the main difference and advantage of the invention. The stub provided in the Analog Forwarding Unit (6) has a maximum length of 15 cm. In addition, this unit is capable of operating with ultra-low power.

As to another advantage of the present invention, in current measurement systems of the prior art, as the signal is transmitted to the measurement device through its outdoor measurement cables exposed to external effects, it will be also exposed to environmental

electromagnetic effects and noises and undesired noises may occur in the signal. Additionally, in other systems, longer cables are used in these measurements, which results in distortions, noises and inaccurate measurements on the signal during measuring. On the contrary, as for our system subject to the present invention, as the bridging channels and signal measurement channels are dedicatedly screened within the printed circuits, it is much stronger against such distortions and noises.

The number of channels is limited in the current systems and this limitation is results from configuration, limitations for addressing of data bus or power limitations. In our system, by means of a modular structure of channel expansion, an unlimited number of analog routing cards are connected to one another and thus the number of channels can be increased. The only limitation of the number of channels is the amount of energy they would consume.

Analog Expansion Unit (7): It is used for transferring analog and digital lines between Analog Forwarding Units which can be preferably defined as electronic board. The unit basically acts as a bridge in transferring the signals. Its main function is to form an electrical connection between the Analog Forwarding Units in an attempt to enhance channel capacity, to supply energy to the Analog Forwarding Units and to enable digital routing signals to be transferred to the Analog Forwarding Units.

Main Processing Unit (8): It is the processing unit that manages the entire system. It can be preferably defined as a electronic board. It functions as a unit that performs the processes of measurement, control, communication, calibration, signal scaling, analog signal measurement, power distribution control, control of Analog Forwarding Units. Internal units that may be contained in the Main Processing Unit are listed below.

Power Distribution Unit: It is the portion that supplies the energy and electrical values that the modules in the Main Processing Unit need. It is capable of supplying energy and of blocking the energy supply to the related units at any time desired while being controlled by a microprocessor included in the board.

Primary Signal Routing Unit: Its main function is to transmit the information of the signals to be routed for measurement to the Analog Forwarding Units and to launch a routing process. After the function of primary signal routing is completed, the signals selected are introduced to measurement inputs of the Main Processing Unit through the Analog Expansion Units.

Internal Signal Routing Unit: The selected signals that are obtained from the Primary Signal Routing Unit are introduced to the input of this unit. A second internal routing process is started on the Main Processing Unit depending on the type of measurement or analysis to be performed. In such an internal routing process, the signals; may be routed to one of the units including a Digital Communication Unit, off-case external output connectors or an Analog Scaling and Calibration Unit.

Analog Scaling and Calibration Unit: Its main function is to perform a calibration in an attempt to enhance accuracy of the measurement circuit before a measurement or any time desired, and to ensure that the analog signals obtained from the Internal Signal Routing Unit and routed for an analog measurement are scaled in accordance with the one to be measured out of the components of voltage, resistance or current.

Analog Measurement Unit: It measures the scaled signal obtained from the analog scaling and calibration unit. The microprocessor matches the data obtained from the analog scaling and calibration unit with the data obtained from the analog measurement unit and generates a final measurement result.

Digital Communication Unit:This unit is used for extracting data including identification number, malfunction codes and similar data of the vehicle by connecting to digital data buses of the vehicle to which the connection is made. It supports eight communication protocols. These are; the protocols of SAE J1850 VPW, SAE J1850 PWM, ISO 9141-2, ISO 14230 KWP2000, ISO15765-4/SAE J2480, SAE J1587, SAE J1708 and SAE J1939.

Bluetooth Communication Unit: It is an alternative used as a control interface of the measurement device. If there is a great distance between the measurement device and the user performing the measurement, it provides the user with an extra mobility due to its wireless communication infrastructure. Furthermore, as the controlling unit has no physical connection with the measurement device, it enables the signal distortions resulting from the noises introduced through the communication interface to be eliminated. When the Bluetooth interface is activated, the device is enabled to be fed through the external power supplies.

Security Unit: It is responsible for ensuring security of the system itself. It detects when the device is disassembled by technical stuff, vehicle manufacturer or out of warranty, and records such cases. In addition to this, it also detects if the device has fallen down or exposed to any

kind of shock, and records such cases. The security unit has its own battery system therein and continues operating even if it is not connected to another power unit. By means of the sensors (accelerometer etc.) that the unit comprises, it is capable of detecting not only if the device has fallen down, but also, at which angle it has fallen down and from which parts it has been damaged. Therefore, it acts in detecting the user faults and in increasing service quality.

Protection Unit (9b): It is the unit that protects the device against electrical problems likely to result from the battery when the device is operated with an internal battery. In addition to that, it also therein contains the charger circuits that enable the internal battery to be charged.

Insulation Unit (9a): It is preferably used for insulating the electrical connections between the measurement device and the device supplying power when a feeding through the USB is a case. This unit can be an insulation card as well as it can be placed on other cards in the system. Electrical power and data are thus separated and thereby both systems are prevented from affecting and damaging each other. Furthermore, the noise coming from the power supply is blocked, which eliminates any accuracy loss likely to occur in the measurement device due to such noise.

As for the other components;

These are the components including the Case (1) that allows movement and protection, the Handle (2) that allows handling, the Cabling Connectors (3) that are needed for receiving signals from the external devices and can be optionally alternated and adapted to different structures, the USB Input Port (4) that is used for data bus communication and power connections, the Manual Signal Outputs (5) that enable the signals within the cable harness to be also externally measured, and the Lid (10) that is the cover of the case.

When reviewing some of the similar and different intended uses of our device subject to the present invention compared to those of the systems known from the prior art;

- **Inline Measurement**, carries out an inline measurement by being connected to the cable set in series.
- The device has **ultra-low energy** consumption. Accordingly, in a preferable embodiment of the device, it can supply energy via USB connection. Thus, it has operation potential in all devices supported with USB connection. Other systems need to be connected to mains electricity or alternative external power supplies.

- **Multi-Channel Measurement,** while other alternative devices can conduct a synchronous measurement, their number of measurement channels is limited. (Approximately in the range of 1 to 10) In our invention, the number of channels can be extended and increased up to hundreds of channels.
- **Reporting Support,** it can report, print out or digitally archive all measurements according to the user's preference. Other measurement devices fail to provide such support or provide it partially.
- **Automatic measurement,** other devices can only perform manual or semiautomatic measurements. Our invention is capable of performing fully automatic measurements including automatic channel routing.
- **Requirement for a Measurement Instrument,** current manual or conventional systems need an external measurement instrument. In our invention, any external measurement device is not needed.
- **Bluetooth,** the measurement device allows a Bluetooth connection and thus the measurement device and the interface of a mobile phone or a computer can be placed at different locations. Particularly, when testing scenarios are performed, the user both needs to be at the wheel and to follow the instructions. Such a feature has not been provided in other current devices.
- **Mobility,** other systems need to be connected to mains electricity or alternative external power supplies. Our invention, due to its characteristic of ultra-low energy consumption, in a preferable embodiment, supplies energy from any device with USB connection such as a mobile phone, and thus provides mobility. Additionally, when a Bluetooth module is used, mobility is enhanced more.
- **Support to Mobile Platforms,** our invention can operate in line with mobile platforms and be used with gadgets like mobile phones and tablets.

When looking at the embodiment of the invention;

The device is connected in series to the cable set of the unit of the vehicle intended to be tested. A computer or mobile software of the device guides the user and explains the steps required to start a measurement process. The user proceeds to carry out the steps one by one and thus enables the measurement process to be performed. A report of the measurement is sent to a computer or a mobile device, and if desired, the user can print out or digitally save the report.

With reference to the aforementioned description, some general characteristics of the present invention are presented below.

The present invention,

- is a multi-channel elecktronic test, measurement and analysis device that has been particularly developed for military and commercial heavy tonnage land vehicles.
- is used in in-vehicle cabling and sensor tests,
- allows measuring the signals and sensors within the cable harness at once.
- allows automatic measurement parameters for different types of vehicles and electronic control units to be defined through the interface control software.
- is modular and have an expandable number of analog channels as desired.
- has the ability of single and multiple automatic measurement.
- has the ability of manual measurement with channel routing.
- has adaptable cable connections.
- is capable of producing an automatic report of test results.
- is capable of performing voltage, resistance, current, frequency, impedance, capacitance, inductance measurements.
- can adjust a range of automatic measurements.
- can perform vehicle model detection with the interface it comprises.
- can directly connect to a CAN bus of the vehicle.
- has a number of channels that can be increased up to 500.
- has a modular channel structure.
- has ultra-low energy consumption.
- reduces energy consumption by automatically closing the components that are not used for multiple channels in multiple cards.
- always provides the accurate result by carrying out automatic calibration.
- is Bluetooth-assisted and runs wireless measurements and tests.
- electrically insulates computer/tablet/mobile phones as well as the measurement device due to the insulation circuit it comprises.
- has a multilingual interface.
- allows the user to individually or collectively carry out a test and measurement on a channel or any channels desired.
- has the ability of channel routing.
- has a semi/fully automatic vehicle recognition system.
- has mobility.
- can detect a fault and thus determine if such a fault results from the mechanism of the vehicle or sensors.

In the present invention, the number of channels intended to be used for a measurement can be increased depending on user's preference, which ensures flawless testing and measuring processes. By means of such an advantage, the invention is simply adaptable to various systems. It analyzes measurement results, determines the structures/units likely to have the potential of generating a fault later on, and reports them. As the measurements are carried out on integrated circuits, they provide the results with high accuracy and precision. The signals that are selected, when desired, through signal routing mechanisms provided on the device can be routed to the external measurement connectors provided on the device case. During a measurement process, as the cabling distances of the present invention are quite shorter compared to those of the current systems already known, results can be obtained with higher accuracy.

CLAIMS

1. An automatic multi-channel electronic measurement device for cables and/or signals of a land vehicle, **characterized by** comprising;
   - an insulation or protection unit (9) that provides insulation or protection of electrical connections between the measurement device and a power supply,
   - a main processor unit (8),
   - at least one Analog Forwarding Unit (6) that allows routing of at least a channel out of cable harness intended to be measured to a measurement unit provided in the main processor unit (8), and that provides the function of signal bridging and/or the function of channel routing.
2. The measurement device according to Claim 1, characterized by comprising an insulation unit (9a) that allows insulation of electrical connections between the measurement device and the power supply when an external power supply is used.
3. The measurement device according to Claim 1, characterized by comprising a protection unit (9b) that enables the device to be protected against electrical problems likely to result from the internal battery when an internal power supply is used.
4. The measurement device according to Claim 1, characterized in that the stub provided in the Analog Forwarding Unit (6) has a maximum length of 15 cm.
5. The measurement device according to Claim 1, characterized by further comprising Manual Signal Outputs (5) that enable the signals within the cable harness to be measured externally.
6. The measurement device according to Claim 1, characterized by comprising a plurality of Analog Forwarding Units (6).
7. The measurement device according to Claim 6, characterized by comprising at least one Analog Expansion Unit (7) that enables the number of channels to be increased by connecting the Analog Forwarding Units (6) to one another, which forms electrical connections between the Analog Forwarding Units, and allows Analog Forwarding Units to be provided with power and digital control signals .
8. The measurement device according to Claim 1, characterized by said main processor unit (8) comprising a Power Distribution Unit that provides the modules included therein with the energy and the electrical values they require.
9. The measurement device according to Claim 1, characterized by said main processor unit (8) comprising a primary signal routing unit that sends and routes the information of the signals to be routed for measurement to the Analog Forwarding Unit.

10. The measurement device according to Claim 9, characterized by said main processor unit (8) comprising an internal signal routing unit that routes the selected signals introduced from the primary Signal Routing unit to a related unit depending on the type of the measurement or analysis to be carried out.

11. The measurement device according to Claim 10, characterized by said main processor unit (8) comprising an analog scaling and calibration unit that performs calibration in an attempt to enhance accuracy of the measurement circuit before a measurement process or at any time desired, and enables the analog signals obtained from the Internal Signal Routing Unit and routed for an analog measurement to be scaled in accordance with the one to be measured components of voltage, resistance or current.

12. The measurement device according to Claim 11, characterized by said main processor unit (8) comprising an Analog Measurement Unit that measures the scaled signal obtained from the Analog scaling and calibration unit.

13. The measurement device according to Claim 1, characterized by said main processor unit (8) comprising a digital communication unit that attains data of the device by being connected to the digital data busses of the device under measurement.

14. The measurement device according to Claim 1, characterized by said digital communication unit comprising the protocol supports of SAE J1850 VPW, SAE J1850 PWM, ISO 9141-2, ISO 14230 KWP2000, ISO15765-4/SAE J2480, SAE J1587, SAE J1708 and SAE J1939.

15. The measurement device according to Claim 1, characterized by said main processor unit (8) comprising a Bluetooth communication unit.

16. The measurement device according to Claim 1, characterized by said main processor unit (8) comprising a security unit that detects if the device is being operated by out of warranty, or by another person rather than the technical staff, the manufacturer and records such cases.

17. The measurement device according to Claim 1, characterized by comprising a USB interface that enables the energy to be supplied by a power supply.

18. The measurement device according to Claim 1, characterized by comprising user interface software that controls the device, manages testing and measurement scenarios, and supports the mobile and desktop platforms guiding the user.

19. The measurement device according to Claim 18, characterized by having the ability of analyzing measurement results of the said software and thereby determining the structures/units that are likely to have the potential of creating a problem later on.

20. The measurement device according to Claim 1, characterized by being operated with energy of 5 Watt and below.

21. The measurement device according to Claim 1, characterized by having a capacity of 20 channels and above, preferably 100 channels and above.

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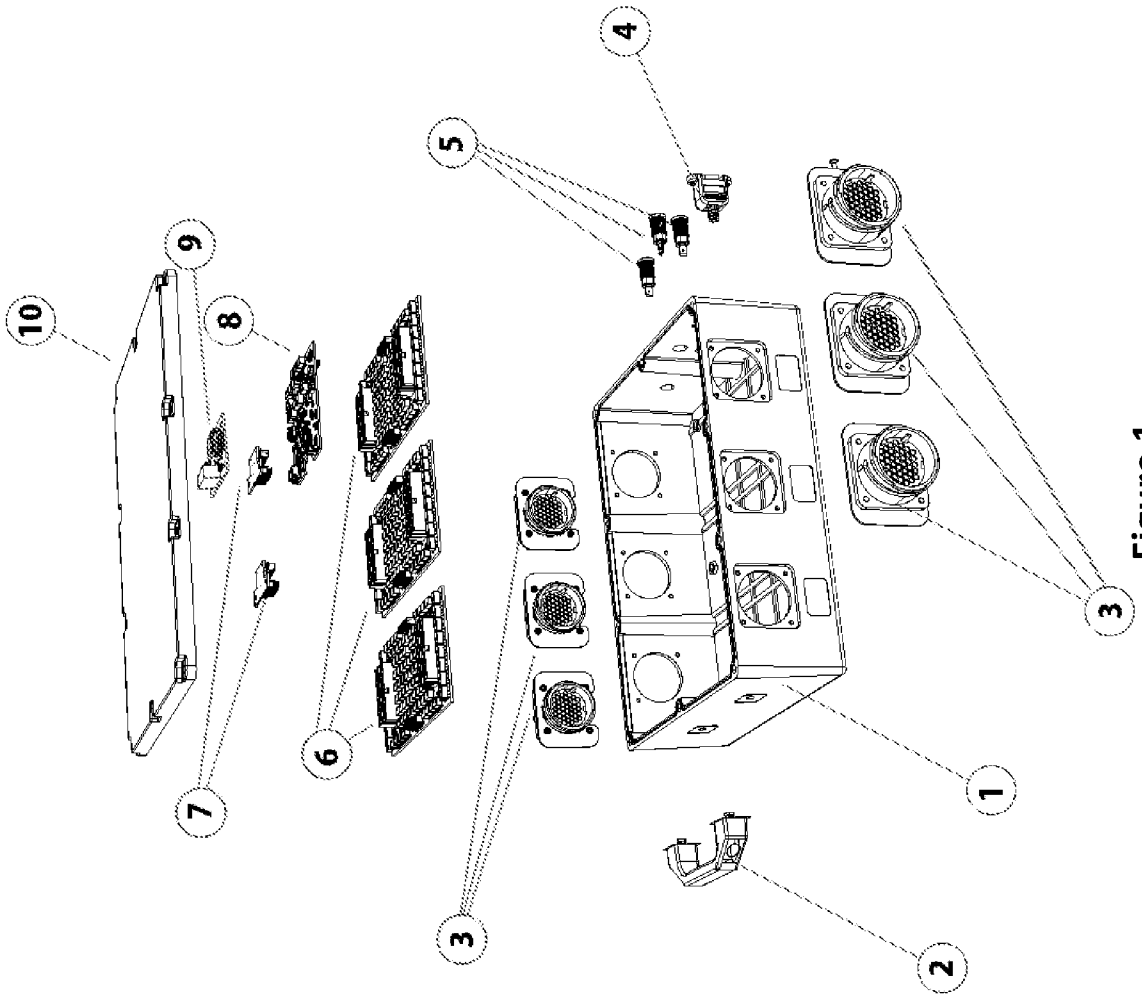

Figure 1