BS ISO 13400-4:2016

BSI Standards Publication

Road vehicles — Diagnostic communication over Internet Protocol (DoIP)

Part 4: Ethernet-based high-speed data link connector

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National foreword

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Road vehicles — Diagnostic communication over Internet Protocol (DoIP) —

Part 4: Ethernet-based high-speed data link connector

Véhicules routiers — Communication de diagnostic sur protocole Internet (DoIP) —

Partie 4: Connecteur de lien de données haut débit fondées sur l'éthernet

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Ch. de Blandonnet 8 • CP 401
CH-1214 Vernier, Geneva, Switzerland
Tel. +41 22 749 01 11
Fax +41 22 749 09 47
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

ISO 13400 consists of the following parts, under the general title *Road vehicles — Diagnostic communication over Internet Protocol (DoIP)*:

— *Part 1: General information and use case definition*

— *Part 2: Transport protocol and network layer services*

— *Part 4: Ethernet-based high-speed data link connector*

The following parts are under preparation:

— *Part 3: Wired vehicle interface based on IEEE 802.3*

Introduction

Vehicle diagnostic communication has been developed, starting with the introduction of the first legislated emission-related diagnostics and has evolved over the years, now covering various use cases ranging from emission-related diagnostics to vehicle manufacturer specific applications like calibration or electronic component software updates.

With the introduction of new in-vehicle network communication technologies, the interface between the vehicle's electronic control units and the external test equipment has been adapted several times to address the specific characteristics of each new network communication technology requiring optimized data link layer definitions and transport protocol developments in order to make the new in-vehicle networks usable for diagnostic communication.

With increasing memory size of electronic control units and the demand to update this increasing amount of software and an increasing number of functions provided by these control units, technology of the connecting network and buses has been driven to a level of complexity and speed similar to computer networks. New applications (x-by-wire, infotainment) require high band-width and real time networks (like FlexRay, MOST), which cannot be adapted anymore to be the direct interface to a vehicle. This requires gateways to route and convert messages between the in-vehicle networks and the vehicle interface to external test equipment.

The intent of the ISO 13400 series is to describe a standardized vehicle interface which

— separates in-vehicle network technology from the external test equipment vehicle interface requirements to allow for a long-term stable external vehicle communication interface,

— utilizes existing industry standards to define a long-term stable state-of-the-art communication standard usable for legislated diagnostic communication, as well as for manufacturer specific use cases, and

— can easily be adapted to new physical and data link layers by using existing adaptation layers.

To achieve this, it is based on the Open Systems Interconnection (OSI) Basic Reference Model specified in ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the services specified by ISO 14229 series are divided into:

— unified diagnostic services (layer 7), specified in ISO 14229-1, ISO 14229-5, ISO 27145-3;

— presentation (layer 6):

  — for enhanced diagnostics, specified by the vehicle manufacturer;

  — for WWH-OBD, specified in ISO 27145-2, SAE J1930-DA, SAE J1979-DA, SAE J2012-DA;

— session layer services (layer 5), specified in ISO 14229-2;

— transport protocol (layer 4), specified in ISO 13400-2;

— network layer (layer 3) services, specified in ISO 13400-2;

— physical and data link services (layers 1 and 2), specified in ISO 13400-3

in accordance with Table 1.

Table 1 — Enhanced and legislated WWH-OBD diagnostic specifications applicable to the OSI layers

Applicability	OSI 7 layers	Vehicle manufacturer enhanced diagnostics	WWH-OBD document reference
Seven layers according to ISO/IEC 7498-1 and ISO/IEC 10731	Application (layer 7)	ISO 14229-5, ISO 14229-1	ISO 27145-3; ISO 14229-1
	Presentation (layer 6)	Vehicle manufacturer specific	ISO 27145-2, SAE J1930-DA, SAE J1979-DA, SAE J2012-DA
	Session (layer 5)	ISO 14229-2	ISO 14229-2
	Transport (layer 4)	ISO 13400-2	ISO 13400-2
	Network (layer 3)		
	Data link (layer 2)	ISO 13400-3	ISO 13400-3
	Physical (layer 1)		

The application layer services covered by ISO 14229-5 have been defined in compliance with diagnostic services established in ISO 14229-1, but are not limited to use only with them.

The transport and network layer services covered by ISO 13400-2 have been defined to be independent of the physical layer implemented.

For other application areas, ISO 13400-3 can be used with any Ethernet physical layer.

INTERNATIONAL STANDARD ISO 13400-4:2016(E)

Road vehicles — Diagnostic communication over Internet Protocol (DoIP) —

Part 4: Ethernet-based high-speed data link connector

1 Scope

This part of ISO 13400 specifies a minimum set of diagnostic Ethernet connector requirements which are based on ISO 15031-3. The ISO 15031-3 diagnostic connector is referenced by legislation in many countries.

The diagnostic connection specified in this part of ISO 13400 consists of two mating connectors: the vehicle connector and the external test equipment connector as specified in ISO 15031-3.

This part of ISO 13400 specifies:

— the functional requirements for the vehicle connector. These functional requirements are separated into two principal areas: connector contact allocation and electrical requirements for connector and related electrical circuits;

— the functional requirements for the external test equipment connector. These functional requirements are separated into two principal areas: connector contact allocation and electrical requirements for connector and related electrical circuits.

Two (2) different connector layouts and pin-outs are specified in this part of ISO 13400:

a) Ethernet pin assignment option 1 (see Annex A);

b) Ethernet pin assignment option 2 (see Annex B).

Historically, option 1 is specified to meet Ethernet pin assignment of road vehicles already launched onto the market and may be used to resolve conflicts with vehicle manufacturer-specific usage of discretionary pins, e.g. pins 1 and 9.

Option 2 is specified to meet the Ethernet pin assignment of road vehicles to resolve conflicts with vehicle manufacturer-specific usage of discretionary pins, e.g. pins 3 and 11.

A discovery/identification and activation method of the vehicle's Ethernet via the "Ethernet Activation Line" is specified in ISO 13400-3.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13400-1, *Road vehicles — Diagnostic communication over Internet Protocol (DoIP) — General information and use case definition*

ISO 13400-3, *Road vehicles — Diagnostic communication over Internet Protocol (DoIP) — Part 3: Wired vehicle interface based on IEEE 802.3*

ISO 15031-3, *Road vehicles — Communication between vehicle and external equipment for emissions-related diagnostics — Part 3: Diagnostic connector and related electrical circuits: specification and use*

SAE J1962-09/2015, *Diagnostic Connector*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 13400-1 and the following apply.

3.1.1
connection
two mated *connectors* (3.1.2) or *contacts* (3.1.3)

3.1.2
connector
assembly of *contact* (3.1.3) and housing, which terminates conductors for the purpose of providing *connection* (3.1.1) and disconnection to a suitable mating connector

3.1.3
contact
conductive element in a *connector* (3.1.2) (including means for cable attachment), which mates with a corresponding element to provide an electrical path

3.1.4
female contact
electrical *contact* (3.1.3) (including means for cable attachment) intended to make electrical engagement on its inner surface and to accept entry of a *male contact* (3.1.5), thus forming an electrical *connection* (3.1.1)

EXAMPLE Receptacle, sleeve.

3.1.5
male contact
electrical *contact* (3.1.3) (including means for cable attachment) intended to make electrical engagement on its outer surface and to enter a *female contact* (3.1.4), thus forming an electrical *connection* (3.1.1)

EXAMPLE Tab, pin, blade.

3.2 Abbreviated terms

100BaseTX	Fast Ethernet
CAN	Controller Area Network
CAT5	Category 5 cable (two wire-pairs cable)
DC	Direct current
GND	Ground
PHY	Physical layer
MAC	Media Access Control
Rx	Receiver
Tx	Transmitter
xMII	Cross wire media independent interface
V_{BAT}	Battery voltage
WWH-OBD	Worldwide Harmonized On-Board Diagnostics
XFRM	Ethernet transformer

4 Conventions

ISO 13400 is based on the conventions discussed in the OSI Service Conventions (see ISO/IEC 10731[1]) as they apply for diagnostic services.

5 Connector requirements

5.1 General

Vehicle manufacturers of road vehicles have the choice to implement one of two different Ethernet connector layouts and pin assignments. This is needed to meet the in-vehicle electrical architecture design.

Discovery/identification of the vehicle's Ethernet option (configuration) is a requirement for external test equipment in order to properly connect to the Ethernet without causing any damage either to the vehicles or external test equipment bus circuitry. In addition, any bus interference like bus errors shall be avoided.

The solution for external test equipment to identify the vehicle's Ethernet option is based on reading the vehicle's identification signal provided on the "Ethernet activation line" available on the diagnostic connector prior to enabling the multiplexer switches to establish an electrical Ethernet connection to the vehicle's Ethernet.

5.2 Normative references to ISO 15031-3

This part of ISO 13400 specifies additional requirements to support ISO 13400-1, ISO 13400-2, and ISO 13400-3 to be implemented when accessed through the ISO 15031-3 diagnostic connector.

5.3 Ethernet specific requirements

The Ethernet connector layout, pin assignment information, and simplified test equipment circuitry example for Ethernet option 1 is specified in Annex A.

The Ethernet connector layout, pin assignment information, and simplified test equipment circuitry example for Ethernet option 2 is specified in Annex B.

Annex A
(normative)

Ethernet pin assignment option 1

A.1 General

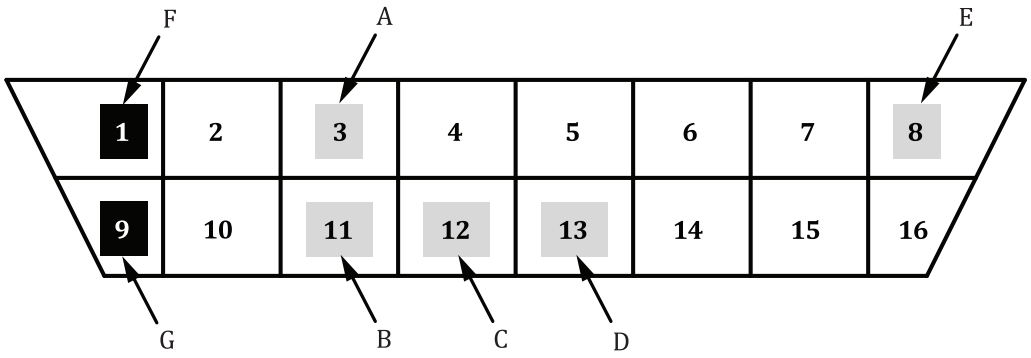
This Annex describes the usage of Ethernet 100BaseTX on the existing ISO 15031-3/SAE J1962 diagnostic connector considering IEEE 802.3 signal requirements. All definitions in this Annex are normative and aid in the usage of Ethernet for diagnostic communication in existing vehicle network architectures. This option may be used to resolve conflicts with vehicle manufacturer-specific usage of discretionary pins, e.g. pins 1 and 9.

The detailed specification for this Ethernet pin assignment configuration is specified in ISO 13400-3 (identification of pin assignment and activation of communication) and this part of ISO 13400 (Ethernet pin assignment).

A.2 Connector layout

For high frequency signal transmission, it is necessary that the pin pairs for Tx+/Tx– and Rx+/Rx– on the diagnostic connector are located as close as possible to each other. An additional pin is needed for identification of pin assignment and for activation of the Ethernet controller.

Figure A.1 shows Ethernet option 1 combined with vehicle manufacturer-specific usage of discretionary pins 1 and 9.



Key

A Ethernet Rx (+)
B Ethernet Rx (−)
C Ethernet Tx (+)
D Ethernet Tx (−)
E Ethernet identification of pin assignment and activation line pull-up
F vehicle manufacturer-specific usage, e.g. CAN_H line
G vehicle manufacturer-specific usage, e.g. CAN_L line

Figure A.1 — Ethernet option 1 (e.g. vehicle manufacturer-specific usage of discretionary pins 1 and 9) — Contact designation for vehicle connector mating end view

A.3 Connector pin-out information

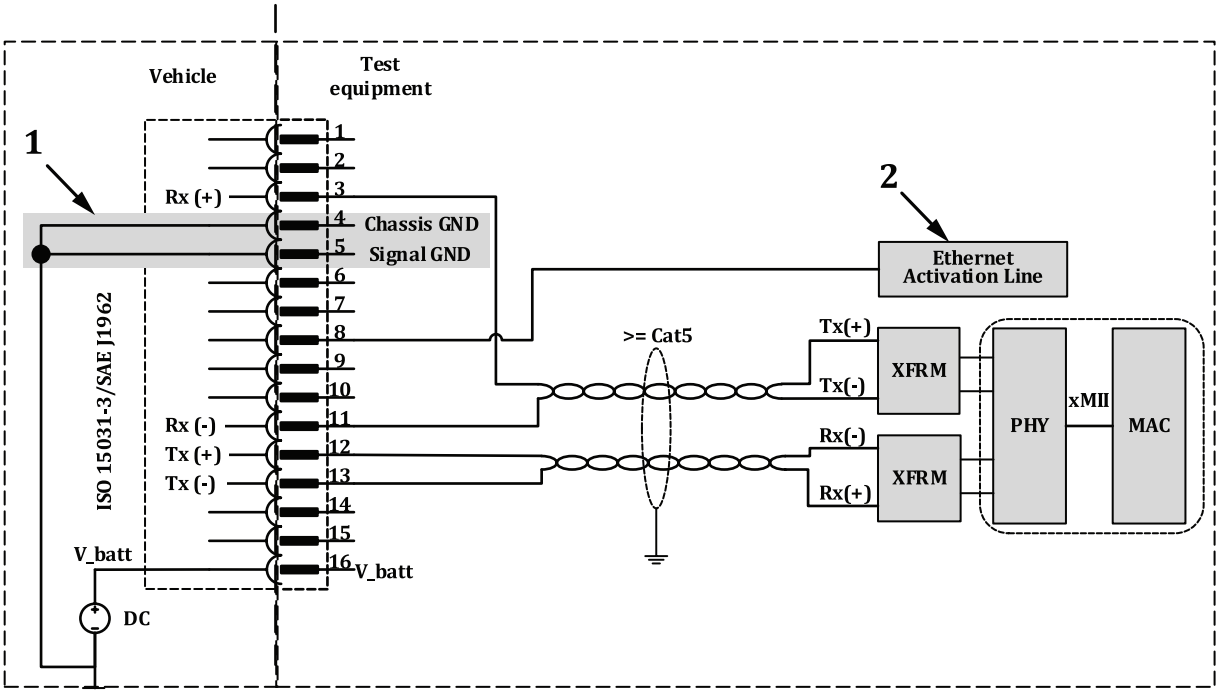
Table A.1 defines the description of Ethernet pins (option 1) on the SAE J1962 connector.

Table A.1 — Description of Ethernet pins (option 1) on the SAE J1962 connector

PIN	SAE J1962 contact assignment	Ethernet 100BaseTX usage	
		Function at the vehicle	Function at the external test equipment
1	Discretionary	Vehicle manufacturer-specific usage, e.g. CAN_H line	Vehicle manufacturer-specific usage, e.g. CAN_H line
2	Defined in SAE J1962	—	—
3	Discretionary	Ethernet Rx (+)	Ethernet Tx (+)
4	Chassis ground	—	—
5	Signal ground	—	—
6	Defined in SAE J1962	—	—
7	Defined in SAE J1962	—	—
8	Discretionary	Ethernet identification of pin assignment and activation line	Ethernet identification of pin assignment and activation line pull-up
9	Discretionary	Vehicle manufacturer-specific usage, e.g. CAN_L line	Vehicle manufacturer-specific usage, e.g. CAN_L line
10	Defined in SAE J1962	—	—
11	Discretionary	Ethernet Rx (–)	Ethernet Tx (–)
12	Discretionary	Ethernet Tx (+)	Ethernet Rx (+)
13	Discretionary	Ethernet Tx (–)	Ethernet Rx (–)
14	Defined in SAE J1962	—	—
15	Defined in SAE J1962	—	—
16	Permanent positive voltage	—	—

A.4 Simplified test equipment circuitry example — Ethernet option 1

Figure A.2 shows the simplified circuitry example of the external test equipment with Ethernet option 1 connection over the SAE J1962 diagnostic connector.



Key

1 see SAE J1962 general ground practice

2 see ISO 13400-3

Figure A.2 — Ethernet option 1 — Simplified test equipment circuitry example

Annex B
(normative)

Ethernet pin assignment option 2

B.1 General

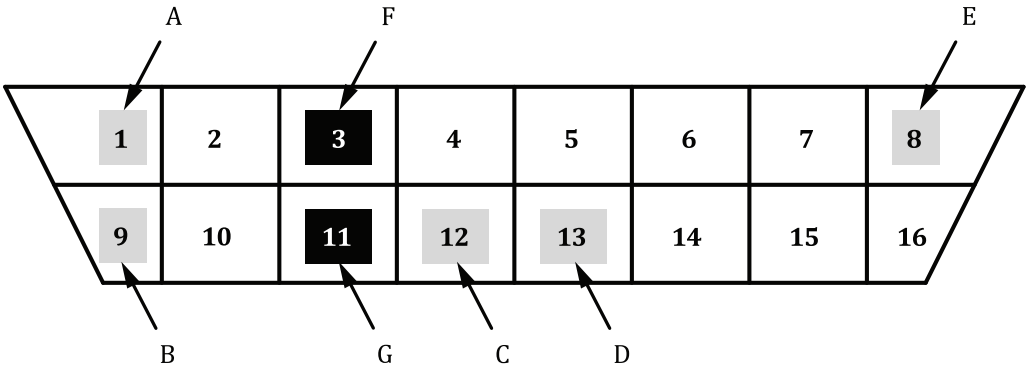
This Annex describes the usage of Ethernet 100BaseTX on the existing ISO 15031-3/SAE J1962 diagnostic connector considering IEEE 802.3 signal requirements. All definitions in this Annex are normative and aid in the usage of Ethernet diagnostic communication in existing vehicle network architectures. This option may be used to resolve conflicts with vehicle manufacturer-specific usage of discretionary pins, e.g. pins 3 and 11.

The detailed specification for this Ethernet pin assignment configuration is specified in ISO 13400-3 (identification of pin assignment and activation of communication) and this part of ISO 13400 (Ethernet pin assignment).

B.2 Connector layout

For high frequency signal transmission, it is necessary that the pin pairs for Tx+/Tx– and Rx+/Rx– on the diagnostic connector are located as close as possible to each other. An additional pin is needed for identification of pin assignment and for activation of the Ethernet controller.

Figure B.1 shows Ethernet option 2 combined with vehicle manufacturer-specific usage of discretionary pins 3 and 11.



Key

A Ethernet Rx (+)
B Ethernet Rx (−)
C Ethernet Tx (+)
D Ethernet Tx (−)
E Ethernet identification of pin assignment and activation line pull-up
F vehicle manufacturer-specific usage, e.g. CAN_H line
G vehicle manufacturer-specific usage, e.g. CAN_L line

Figure B.1 — Ethernet option 2 (e.g. combined with vehicle manufacturer-specific usage of discretionary pins 3 and 11) — Contact designation for vehicle connector mating end view

B.3 Connector pin-out information

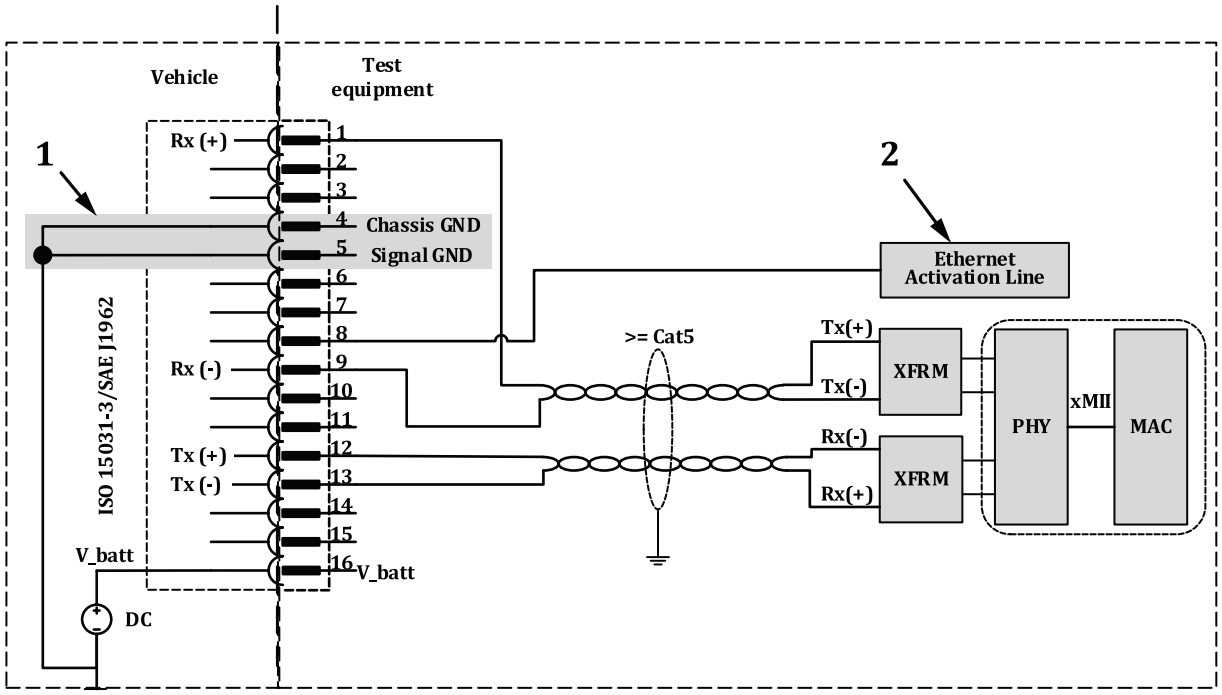
Table A.1 defines the description of Ethernet pins (option 2) on the SAE J1962 connector.

Table B.1 — Description of Ethernet pins (option 2) on the SAE J1962 connector

PIN	SAE J1962 contact assignment	Ethernet 100BaseTX usage	
		Function at the vehicle	Function at the external test equipment
1	Defined in SAE J1962	Ethernet Rx (+)	Ethernet Tx (+)
2	Defined in SAE J1962	—	—
3	Discretionary	Vehicle manufacturer-specific usage, e.g. CAN_H line	Vehicle manufacturer-specific usage, e.g. CAN_H line
4	Chassis ground	—	—
5	Signal ground	—	—
6	Defined in SAE J1962	—	—
7	Defined in SAE J1962	—	—
8	Discretionary	Ethernet identification of pin assignment and activation line	Ethernet identification of pin assignment and activation line pull-up
9	Defined in SAE J1962	Ethernet Rx (–)	Ethernet Tx (–)
10	Defined in SAE J1962	—	—
11	Discretionary	Vehicle manufacturer-specific usage, e.g. CAN_L line	Vehicle manufacturer-specific usage, e.g. CAN_L line
12	Discretionary	Ethernet Tx (+)	Ethernet Rx (+)
13	Discretionary	Ethernet Tx (–)	Ethernet Rx (–)
14	Defined in SAE J1962	—	—
15	Defined in SAE J1962	—	—
16	Permanent positive voltage	—	—

B.4 Simplified test equipment circuitry example — Ethernet option 2

Figure B.2 shows the simplified circuitry example of the test equipment with Ethernet option 2 connection over the SAE J1962 diagnostic connector.



Key

1 see SAE J1962 general ground practice

2 see ISO 13400-3

Figure B.2 — Ethernet option 2 — Simplified test equipment circuitry example

Bibliography

[1] ISO/IEC 10731, *Information technology — Open Systems Interconnection — Basic Reference Model — Conventions for the definition of OSI services*

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