SURFACE VEHICLE RECOMMENDED PRACTICE

J1939™-13 AUG2024

Issued 1999-07
Revised 2024-08

Superseding J1939-13 OCT2016

Off-Board Diagnostic Connector

RATIONALE

This document has been updated to comply with the SAE Five-Year Review policy.

FOREWORD

The SAE J1939 communications network is defined using a collection of individual SAE J1939 documents based upon the layers of the open system interconnect (OSI) model for computer communications architecture. The SAE J1939-13 document defines the diagnostic connectors for off-board connection to the SAE J1939 communications network.

The SAE J1939 communications network is a high-speed ISO 11898 CAN based communications network that supports real-time closed loop control functions, simple information exchanges, and diagnostic data exchanges between electronic control units (ECUs) physically distributed throughout the vehicle.

The SAE J1939 communications network is developed for use in heavy-duty environments and suitable for horizontally integrated vehicle industries. The SAE J1939 communications network is applicable for light-duty, medium-duty, and heavy-duty vehicles used on-road or off-road and for appropriate stationary applications that use vehicle derived components (e.g., generator sets). Vehicles of interest include, but are not limited to, on-highway and off-highway trucks and their trailers, construction equipment, and agricultural equipment and implements. The physical layer aspects of SAE J1939 reflect its design goal for use in heavy-duty environments. Horizontally integrated vehicles involve the integration of different combinations of loose package components, such as engines and transmissions, that are sourced from many different component suppliers. The SAE J1939 common communication architecture strives to offer an open interconnect system that allows the ECUs associated with different component manufacturers to communicate with each other.

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

For more information on this standard, visit
https://www.sae.org/standards/content/J1939-13_202408

TABLE OF CONTENTS

1. SCOPE

SAE J1939-13 specifies the diagnostic connectors used for off-board connection to a vehicle's SAE J1939 communication links. The defined diagnostic connectors support connection to the twisted shielded pair media (refer to SAE J1939-11), the unshielded twisted pair (refer to SAE J1939-15), the twisted pair (refer to SAE J1939-14), and the twisted unshielded quad media (refer to ISO 11783-2).

2. REFERENCES

General information regarding this series of documents is found in SAE J1939.

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1708 Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications

SAE J1939-11 Physical Layer, 250 Kbps, Twisted Shielded Pair

SAE J1939-14 Physical Layer, 500 kbit/s

SAE J1939-15 Physical Layer, 250 Kbps, Un-Shielded Twisted Pair (UTP)

SAE J1939-16 Automatic Baud Rate Detection Process

SAE J2030 Heavy-Duty Electrical Connector Performance Standard

SAE J2202 Heavy-Duty Wiring Systems for On-Highway Trucks

2.1.2 ISO Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ISO 11783-2 Tractors and Machinery for Agriculture and Forestry - Serial Control and Communications Data Network - Part 2: Physical Layer

ISO 11898-1 Road Vehicles - Controller Area Network (CAN) - Part 1: Data Link Layer and Physical Signaling

3. ABBREVIATIONS

AWG American Wire Gauge

4. OFF-BOARD DIAGNOSTIC CONNECTOR

This section describes the off-board diagnostic connector used to access vehicle communication links.

4.1 General Requirements and Recommendations

4.1.1 Mounting

The connector shall be mounted inside the cab in a location that is easily accessible according to the guidelines as follows. However, applications subject to onboard diagnostics (OBD) requirements must comply with the applicable regulatory requirements.

a. For on-road heavy trucks, the connector should be mounted on the driver's side and, if possible, accessible from the ground next to the cab.

b. For buses, the connector should be located within reach of the operator's seat. For rear engine buses, an additional connector may be mounted in the engine compartment that will allow access from the ground next to the bus.

c. For construction and agricultural equipment, the connector for the tractor bus should be located behind the operator's seat or under the dash at the operator's knees. A diagnostic connector may be located elsewhere, in addition to a connector at the recommended location.

d. The cable stub length for the diagnostic connector is specified in the governing document (e.g., SAE J1939-11, SAE J1939-14, SAE J1939-15, and ISO 11783-2).

An envelope of a mated connector (see Figure 1) and the recommended cylindrical space for mating a connector (see Figure 2) are shown as recommendations to help the truck builders.

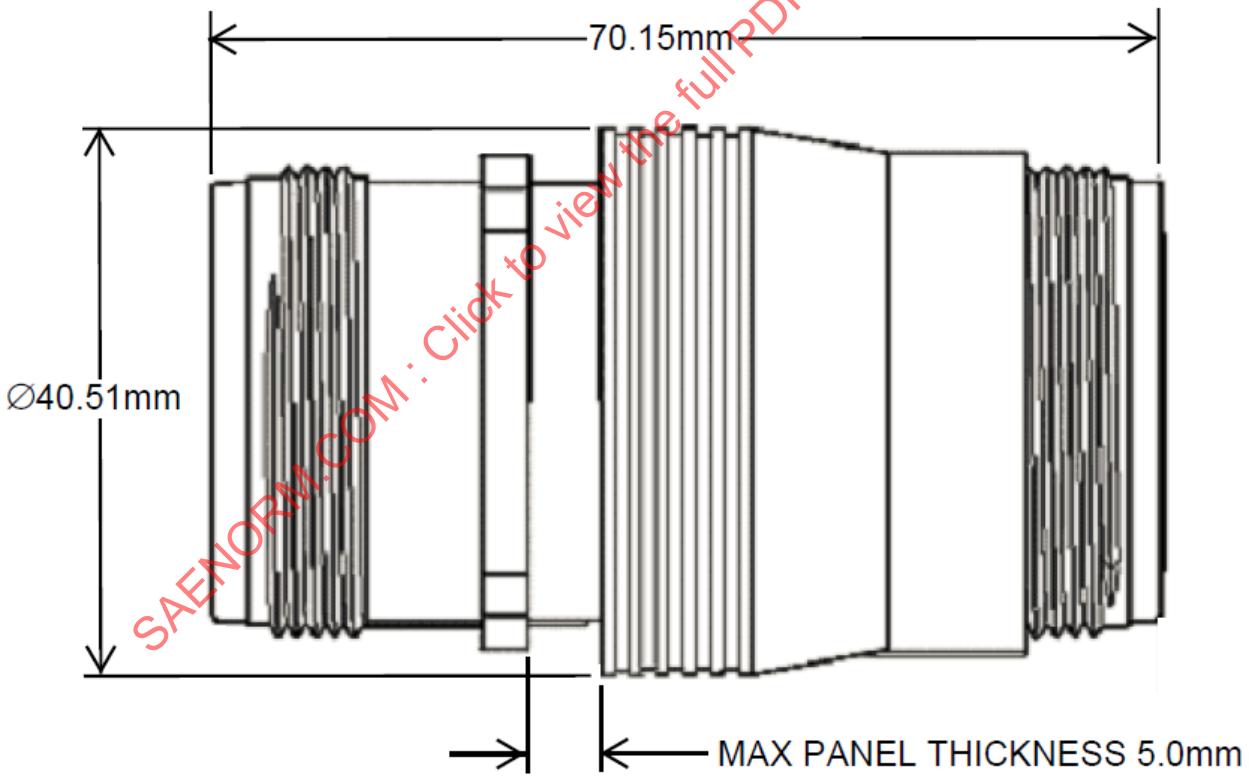

Figure 1 - Mated envelope

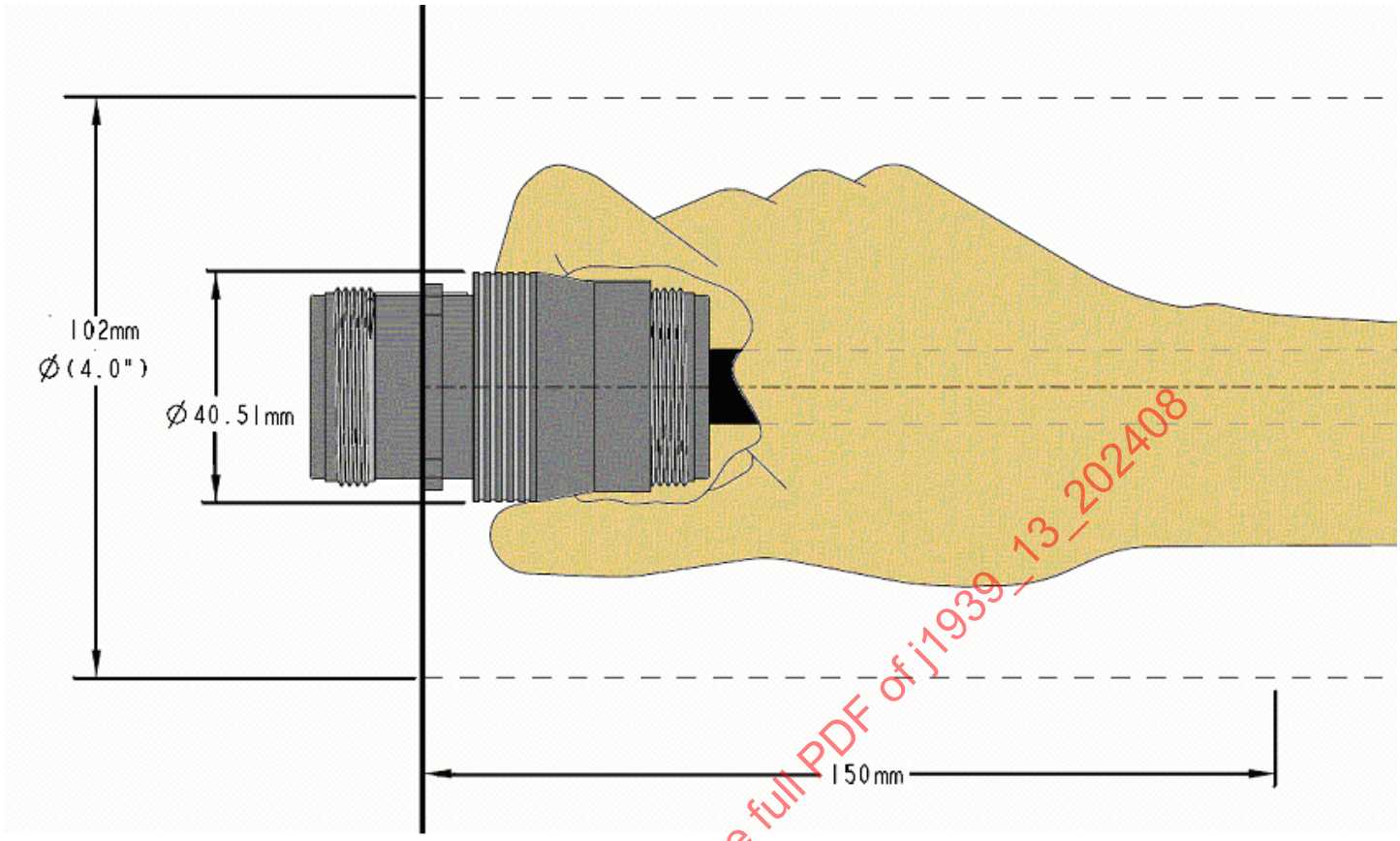

Figure 2 - Recommended cylindrical access envelope

4.1.2 Serviceability

The connector shall be serviceable allowing field replacements of contacts and seals.

4.2 Connector Performance Requirements

4.2.1 Connect/Disconnect

a. The connector shall comply with SAE J2030 or SAE J2202 or both, except:

   1. The mating force shall be a maximum of 40 lbf (175 N).

   2. The retention force after 1000 mating cycles shall be greater than 15 lbf (65 N).

   3. The number of connect/disconnect cycles shall be a minimum of 1000.

b. The receptacle shall provide positive and friction-locking mechanism versions. It shall provide alignment before contact engagement to ensure proper engagement of the connector. The connector shall be capable of engagement with one hand.

c. The connector shall have easily identified keying arrangement by sight and touch.

4.2.2 Environmental Requirements

The connector shall be available in both sealed and unsealed versions. A dust cap shall be available. For environmental requirements, the connector shall meet the test requirements of SAE J2030, SAE J2202, or both.

4.3 Physical Requirements

a. The pins/sockets shall be sized commensurate with 2.00, 1.00, 0.80, and 0.50 mm^2 conductors (corresponding to 14, 16, 18, and 20 AWG). The size of the mating end of the contact is 16 AWG, regardless of wire size.

b. CAUTION: Conductor seals shall be applied to ensure the sealing integrity of the connector.

c. The connector shall have nine pins designated as pins A, B, C, D, E, F, G, H, and J.

d. The cable termination, including the shield, shall comply with SAE J1939-11.

4.4 Circuit Assignments and Pin Usage Requirements

This section identifies the pin locations and assignments. Pins C and D shall be utilized to satisfy the OBD requirements for the scan tool interface when OBD is a regulatory requirement. In some cases, Pin E can be utilized as well.

4.4.1 Type 1 Connector Circuit Assignments

Table 1 specifies the pin-assignment of the Type 1 connector. The designations of the individual signal wires are CAN_H and CAN_L. For SAE J1939-11, a third connection for the termination of the shield is denoted by CAN_SHLD. For SAE J1939-15 and ISO 11783-2, this same third connection is not connected. In addition to the designations of the CAN media wires, the designations of the SAE J1708 physical media wires, power, and ground are: SAE J1708 (+), SAE J1708 (-), battery (+), and battery (-). There are two pins designated for proprietary OEM use.

Table 1 - Circuit assignments for Type 1 connector

Pin	Circuit Assignment
A	Battery (-)
B	Battery (+) unswitched - with 10 A circuit protection
C	CAN_H tractor bus (250 kbit/s for both vehicle and tool)
D	CAN_L tractor bus (250 kbit/s for both vehicle and tool)
E	CAN_SHLD (for SAE J1939-11) or no connection (for ISO 11783-2 or SAE J1939-15)
F	SAE J1708 (+)
G	SAE J1708 (-)
H	Proprietary OEM use or implement bus CAN_H
J	Proprietary OEM use or implement bus CAN_L

4.4.2 Type 2 Connector Circuit Assignments

The circuit assignments for the nine pins of the Type 2 connector are listed in Table 2. The designations of the individual signal wires are CAN_H and CAN_L. For SAE J1939-11, a third connection for the termination of the shield is denoted by CAN_SHLD. For SAE J1939-15 and ISO 11783-2, this same third connection is not connected. For SAE J1939-14, this same third connection is optional. In addition to the designations of the CAN media wires, the designations of the power and ground are: battery (+) and battery (-). The vehicle side networks on pins F and G are limited to SAE J1708 and CAN 1 Mbit/s or lower.

Tool manufacturers may multiplex pins F and G if used by the tool. Multiplexing pins F and G is necessary to allow support of SAE J1708 or CAN protocol functionality on those pins.

Table 2 - Circuit assignments for Type 2 connector

Pin	Circuit Assignment
A	Battery (-)
B	Battery (+) unswitched - with 10 A circuit protection
C	CAN_H tractor bus (500 kbit/s for vehicle, 250 kbit/s / 500 kbit/s for tool with Type 1 and Type 2 support)
D	CAN_L tractor bus (500 kbit/s for vehicle, 250 kbit/s / 500 kbit/s for tool with Type 1 and Type 2 support)
E	CAN_SHLD (for SAE J1939-11) or no connection (for ISO 11783-2 or SAE J1939-15) CAN_SHLD is optional with SAE J1939-14
F	SAE J1708 (+) or CAN_H 1 Mbit/s or lower
G	SAE J1708 (-) or CAN_L 1 Mbit/s or lower
H	Proprietary OEM use or implement bus CAN_H
J	Proprietary OEM use or implement bus CAN_L

Regarding Pin C and Pin D above, when a diagnostic tool is designed to support either 250 kbit/s or 500 kbit/s vehicle networks, then the diagnostic tool or associated communications adapter shall minimize the potential for error frames when connecting to the vehicle. The connection method described by SAE J1939-16 describes means that intend to minimize error frames in ways consistent with SAE J1939 networks.

Regarding Pin F and Pin G above, tool manufacturers may multiplex pins F and G if used by the tool. Multiplexing pins F and G is necessary to allow support of SAE J1708 or CAN protocol functionality on those pins. The networks on pins F and G are limited to SAE J1708 and CAN 1 Mbit/s or lower.The vehicle side networks on pins F and G are limited to SAE J1708 and CAN 1 Mbit/s or lower.

4.4.3 Pin Usage Requirements

Tables 3 and 4 identify the circuits that are required for the connector at the tool and the receptacle connector in the vehicle. Tables 3 and 4 help to understand the required circuits at each point in the circuit from the connector on the tool, through the tool to vehicle harness, and to the connector on the vehicle. See Tables 3 and 4 for Type 1 and Type 2 pin usage descriptions.

The harness from the vehicle to the tool may populate all circuits so that Type 1 and Type 2 connector support is possible.

Table 3 - Type 1 and Type 2 vehicle connector - pin usage description

Pin	Type 1 Connector		Type 2 Connector	
	Pin Function	Vehicle Requirements	Pin Function	Vehicle Requirements
A	Battery (-)	Required	Same as Type 1	Required
B	Battery (+) unswitched - with 10 A circuit protection	Required	Same as Type 1	Required
C	CAN_H tractor bus (250 kbit/s)	Only SAE J1939 250 kbit/s physical layer (SAE J1939-11 or SAE J1939-15)	CAN_H tractor bus (500 kbit/s)	Only SAE J1939 500 kbit/s physical layer (SAE J1939-14)
D	CAN_L tractor bus (250 kbit/s)	Only SAE J1939 250 kbit/s physical layer (SAE J1939-11 or SAE J1939-15)	CAN_L tractor bus (500 kbit/s)	Only SAE J1939 500 kbit/s physical layer (SAE J1939-14)
E	CAN_SHLD	Connection required for SAE J1939-11, no connection for ISO 11783-2	Same as Type 1	No connection required for SAE J1939-15 and ISO 11783-2
F	SAE J1708 (+)	As required by OEM	SAE J1708(+) or CAN_H (1 Mbit/s or lower)	As required by OEM
G	SAE J1708 (-)	As required by OEM	SAE J1708(-) or CAN_L (1 Mbit/s or lower)	As required by OEM
H	Proprietary OEM use or implement bus CAN_H	As required by OEM	Same as Type 1	As required by OEM
J	Proprietary OEM use or implement bus CAN_L	As required by OEM	Same as Type 1	As required by OEM

Table 4 - Type 1 and Type 2 tool connector - pin usage description

Pin	Type 1 Connector		Type 2 Connector	
	Pin Function	Tool Requirements	Pin Function	Tool Requirements
A	Battery (-)	Required	Same as Type 1	Required
B	Battery (+) unswitched - with 10 A circuit protection	Required	Same as Type 1	Required
C	CAN_H tractor bus (250 kbit/s)	Only SAE J1939 250 kbit/s physical layer (SAE J1939-11 or SAE J1939-15)	CAN_H tractor bus (250 kbit/s and 500 kbit/s)	Tool must be capable of supporting 250 kbit/s and 500 kbit/s physical layers (tool is responsible for using appropriate baud rate for vehicle)
D	CAN_L tractor bus (250 kbit/s)	Only SAE J1939 250 kbit/s physical layer (SAE J1939-11 or SAE J1939-15)	CAN_L tractor bus (250 kbit/s and 500 kbit/s)	Tool must be capable of supporting 250 kbit/s and 500 kbit/s physical layers (tool is responsible for using appropriate baud rate for vehicle)
E	CAN_SHLD	Connection required for SAE J1939-11, no connection for SAE J1939-15 or ISO 11783-2	Same as Type 1	No connection required for SAE J1939-15 or ISO 11783-2 CAN_SHLD is optional with SAE J1939-14
F	SAE J1708 (+)	As required by OEM	SAE J1708(+) or CAN_H (1 Mbit/s or lower)	As required by OEM
G	SAE J1708 (-)	As required by OEM	SAE J1708(-) or CAN_L (1 Mbit/s or lower)	As required by OEM
H	Proprietary OEM use or implement bus CAN_H	As required by OEM	Same as Type 1	As required by OEM
J	Proprietary OEM use or implement bus CAN_L	As required by OEM	Same as Type 1	As required by OEM

4.5 Connector Color

The Type 1 connectors shall be black or gray.

The Type 2 connectors shall be green. The color green for Type 2 connectors is recommended to be between the **RGB** range of **R**ed = 0 to 32, **G**reen = 100 to 255, and **B**lue = 0 to 32.

4.6 Connector Mechanical Requirements

The dimensional characteristics of the diagnostic connectors are shown in Figures 3 through 12. Pin designations on the connector are preferred but not required. Any pin designation applied to the connector shall conform to Figures 3 through 12.

The mating combinations of Type 1 and Type 2 connectors are shown in Figure 13.

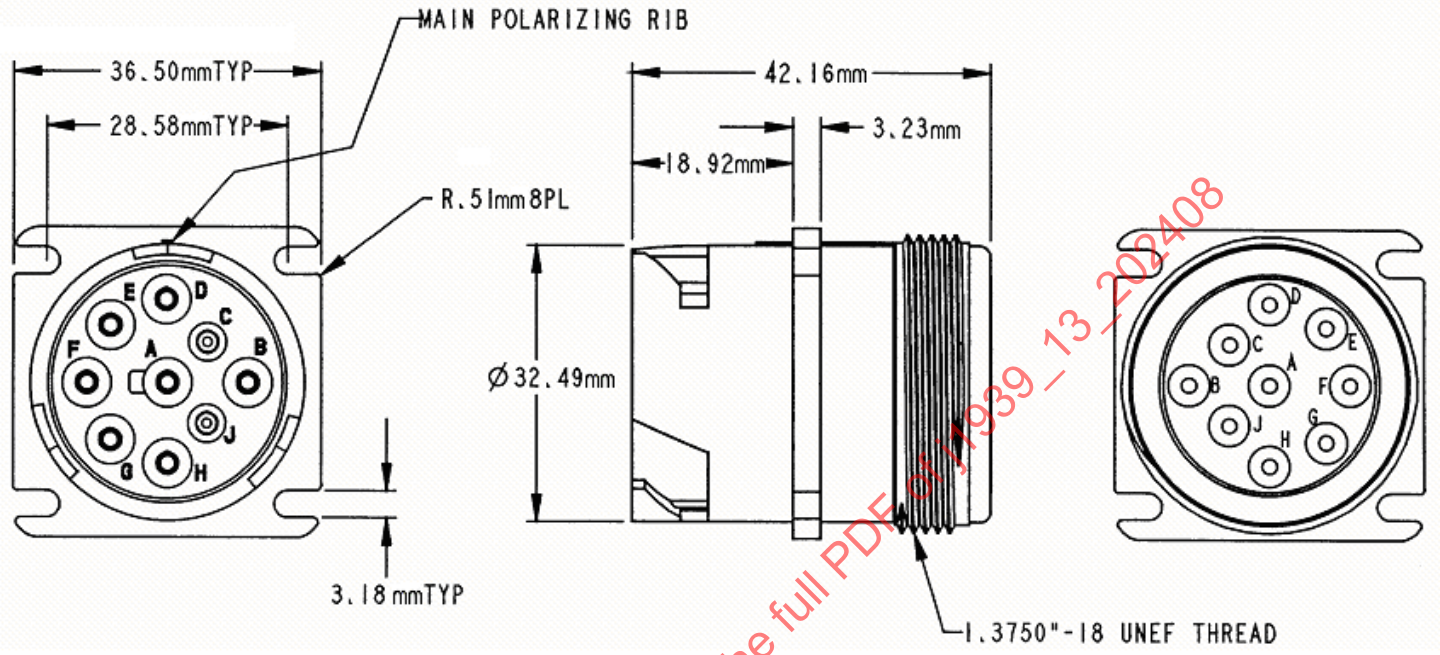

Figure 3 - Flange mount diagnostic receptacle connector Type 1 (black or gray)

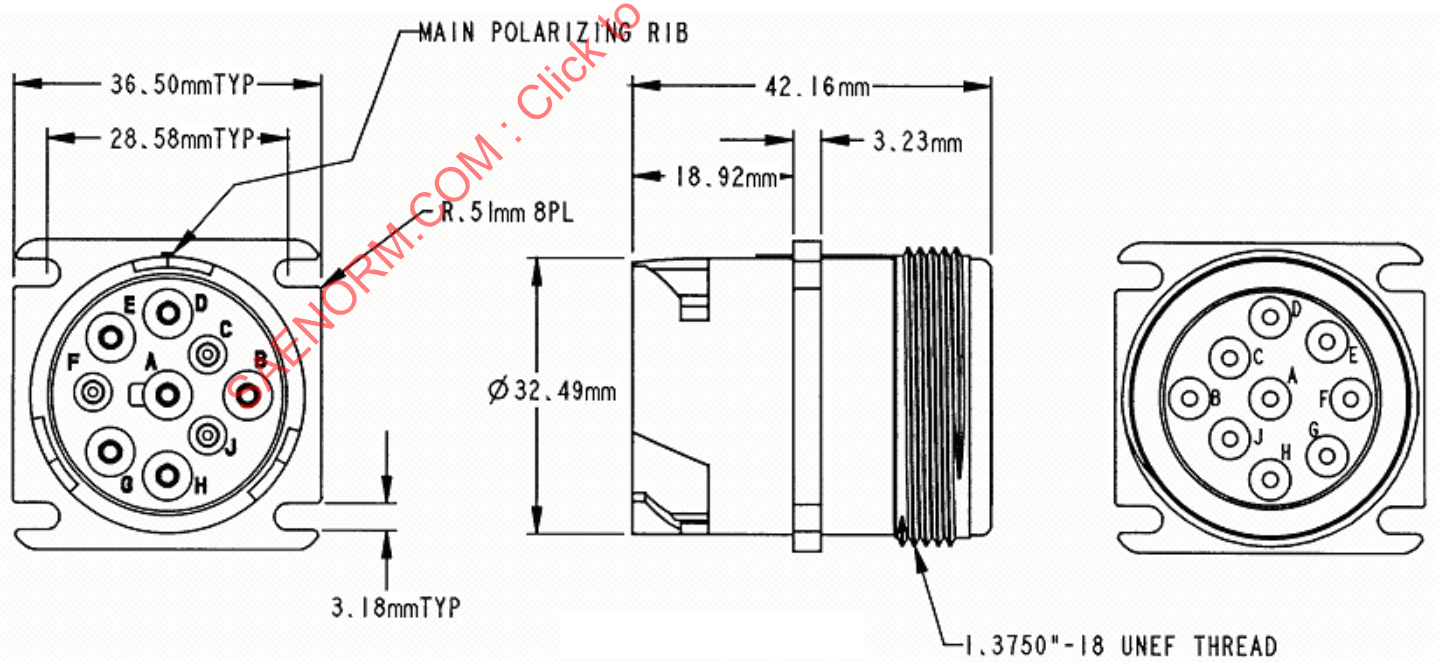

Figure 4 - Flange mount diagnostic receptacle connector Type 2 (green)

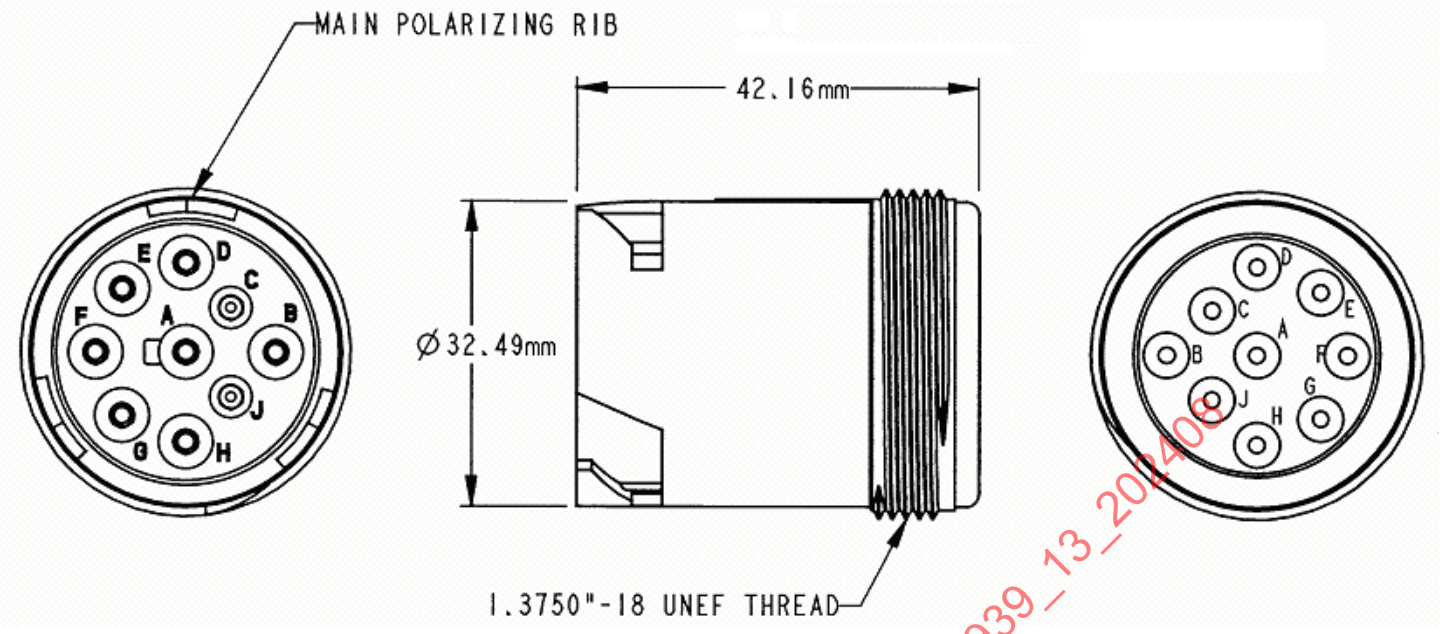

Figure 5 - In-line diagnostic receptacle connector Type 1 (black or gray)

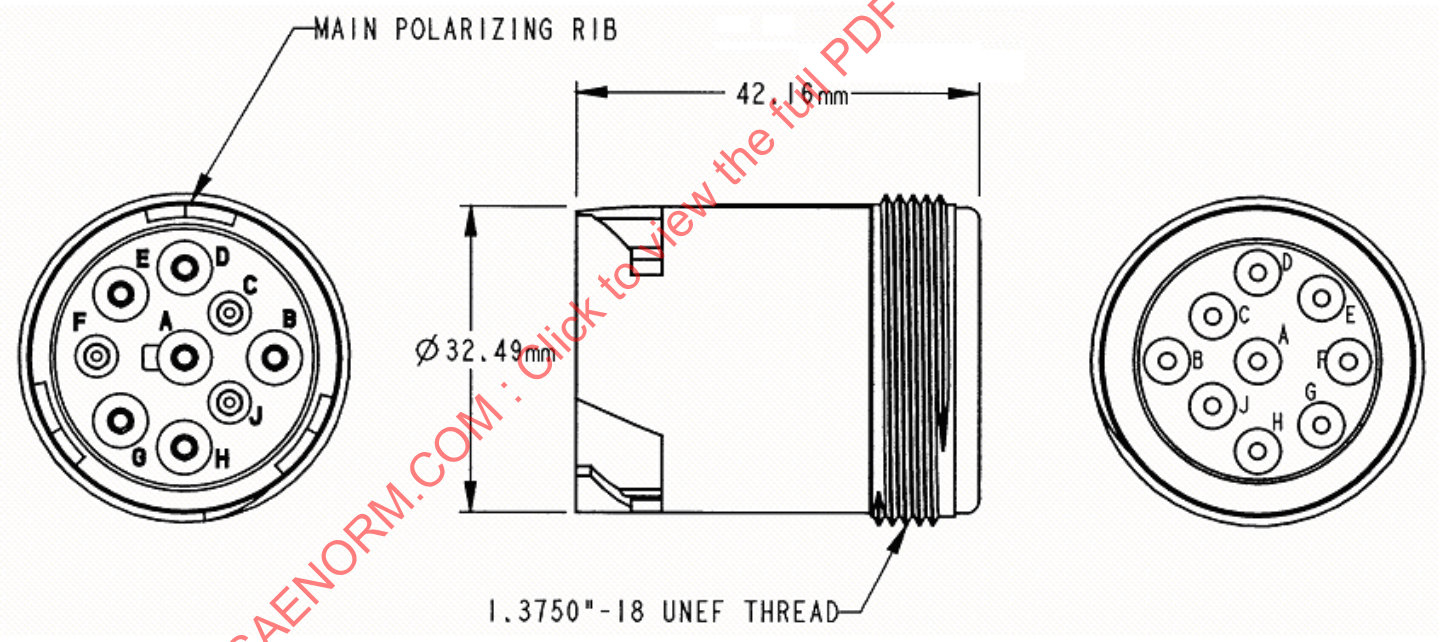

Figure 6 - In-line diagnostic receptacle connector Type 2 (green)

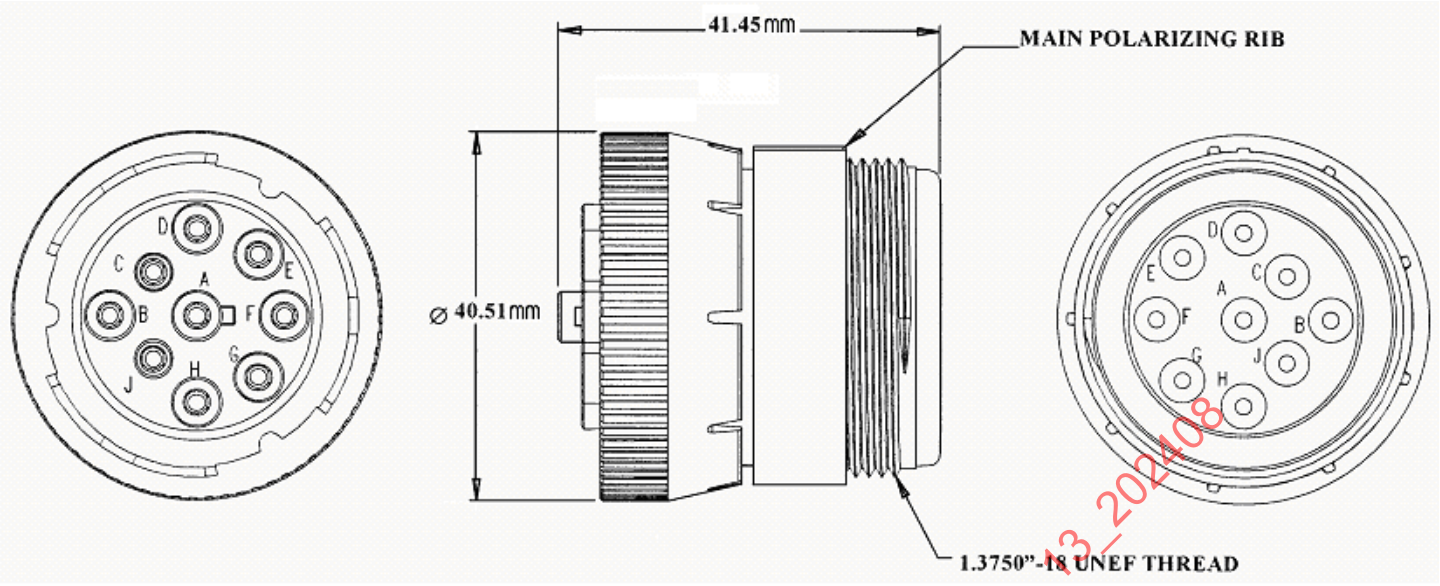

Figure 7 - Diagnostic plug connector Type 1 (black or gray)

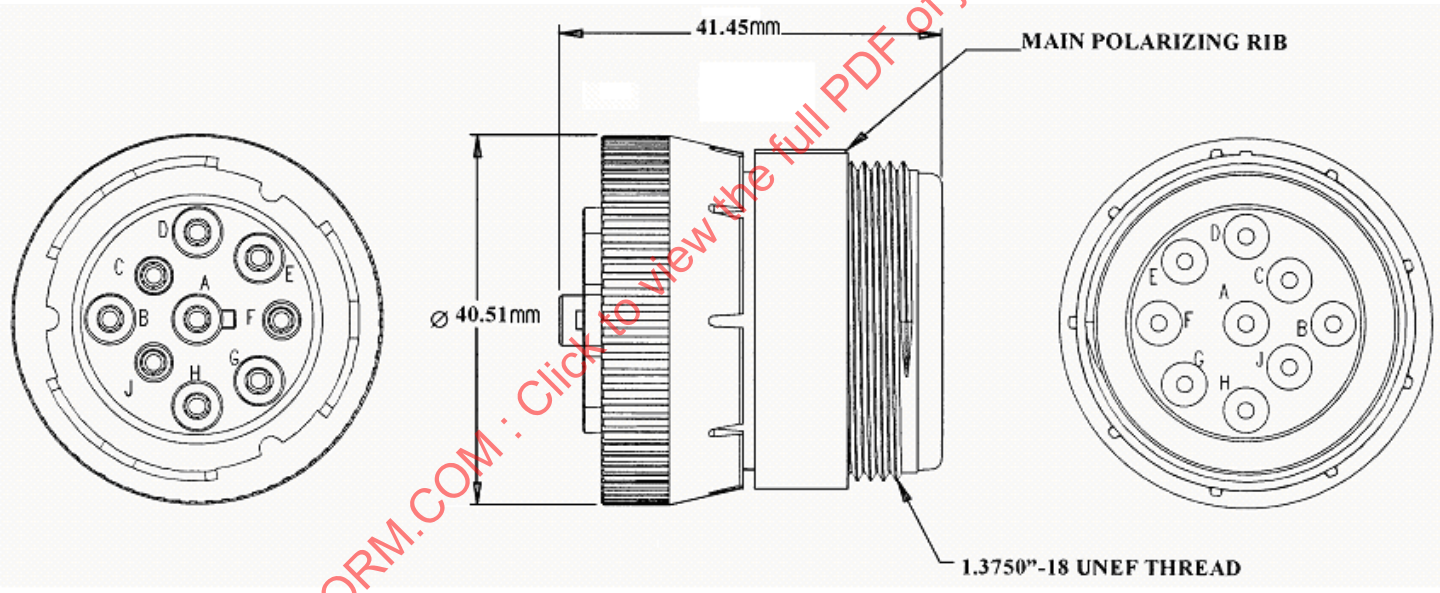

Figure 8 - Diagnostic plug connector Type 2 (green)

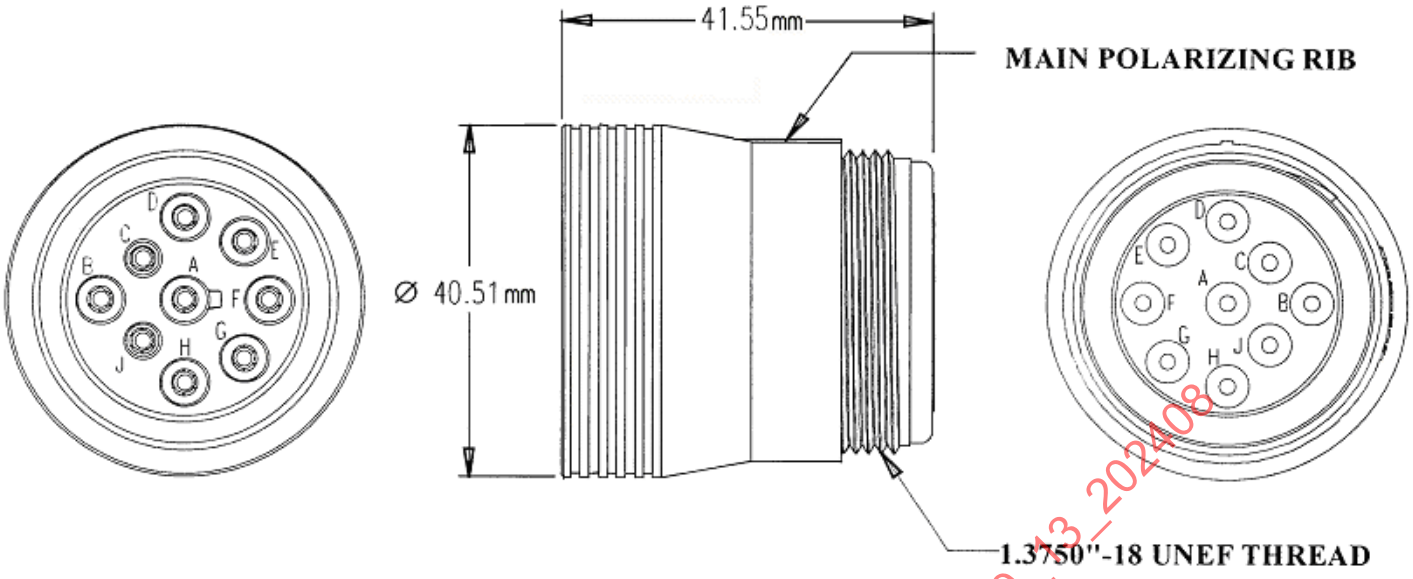

Figure 9 - Friction-locking plug connector Type 1 (black or gray)

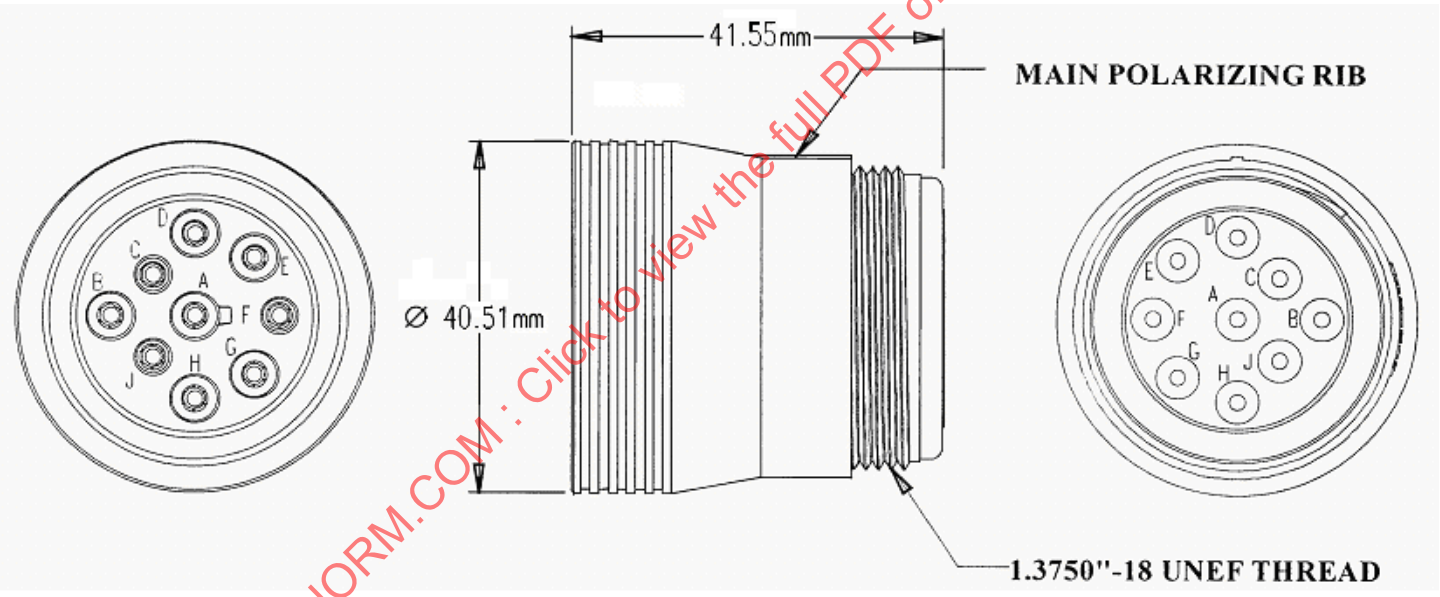

Figure 10 - Friction-locking plug connector Type 2 (green)