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400 Commonwealth Drive, Warrendale, PA 15096-0001

SURFACE VEHICLE RECOMMENDED PRACTICE

Submitted for recognition as an American National Standard

SAE REV. OCT97

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Revised
Working Draft

Physical Layer, 250K bits/sec, Twisted Shielded Pair

~~for~~ Edits from 11/3/97

Foreword—This series of SAE Recommended Practices have been developed by the Truck & Bus Control and Communications Network Subcommittee of the Truck & Bus Electrical Committee. The objectives of the subcommittee are to develop information reports, recommended practices and standards concerned with the requirements design and usage of devices which transmit electronic signals and control information among vehicle components. The usage of these recommended practices is not limited to truck and bus applications. Other applications may be accommodated with immediate support being provided for construction and agricultural equipment, and stationary power systems.

These SAE Recommended Practices are intended as a guide toward standard practice and are subject to change to keep pace with experience and technical advances

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1 Scope

These SAE Recommended Practices are intended for light- and heavy-duty vehicles on- or off-road as well as appropriate stationary applications which use vehicle derived components (e.g., generator sets). Vehicles of interest include but are not limited to: on- and off-highway trucks and their trailers; construction equipment; and agricultural equipment and implements.

The purpose of these documents is to provide an open interconnect system for electronic systems. It is the intention of these documents to allow electronic devices to communicate with each other by providing a standard architecture

2 References

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

2.1 Applicable Documents

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

2.1.1 SAE Publication
Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001

SAE J1113/13—Electromagnetic Compatibility Measurement Procedure for Vehicle Components—Part 13—Immunity to Electrostatic Discharge

2.2 Related Publication

The following publication is provided for information purposes only and is not a required part of this document.

2.2.1 ISO Publication
Available from ANSI, 11 West 42nd Street, New York, NY 10036-8002.

ISO 11898—Road vehicles—Interchange of digital information—Controller Area Network (CAN) for high speed communication.

3 Network Physical Description

3.1 Physical Layer

The physical layer is a realization of an electrical connection of a number of ECUs (Electronic Control Units) to a network. The total number of ECUs will be limited by electrical loads on the bus line. This maximum number of ECUs is fixed to 30, on a given segment, due to the definition of the electrical parameters given in the present specification.

3 5 Bus Levels During Arbitration

A dominant and recessive bit imposed on the bus lines during a given bit time by two different ECUs will result in a dominant bit.

3 6 Common Mode Bus Voltage Range

The common mode bus voltage is defined as the boundary voltage levels of CAN_H and CAN_L, measured with respect to the individual ground of each ECU, for which proper operation is guaranteed when all ECUs are connected to the bus line

3.8 Internal Resistance

The internal resistance, R_{in}, of an ECU is defined as the resistance seen between CAN_H (or CAN_L) and ground during the recessive state, with the ECU disconnected from the bus line (see Figure 3).

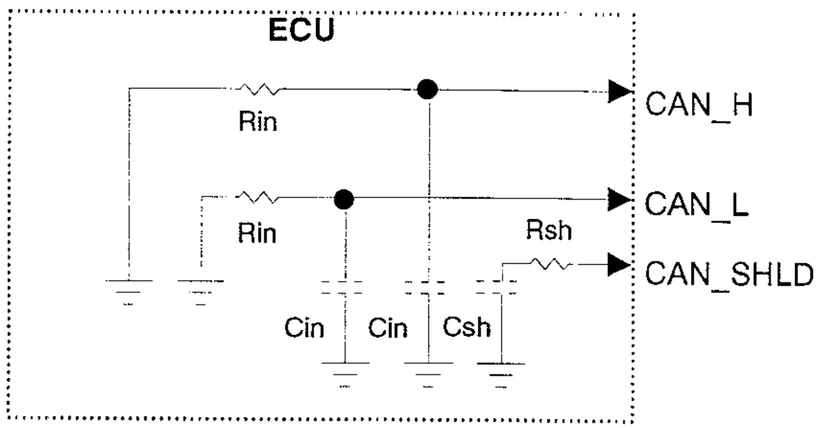


FIGURE 3—ILLUSTRATION OF INTERNAL CAPACITANCE AND RESISTANCE OF AN ECU IN THE RECESSIVE STATE

3.9 Differential Internal Resistance

The differential internal resistance, R_{diff}, is defined as the resistance seen between CAN_H and CAN_L during the recessive state, with the ECU disconnected from the bus line (see Figure 4).

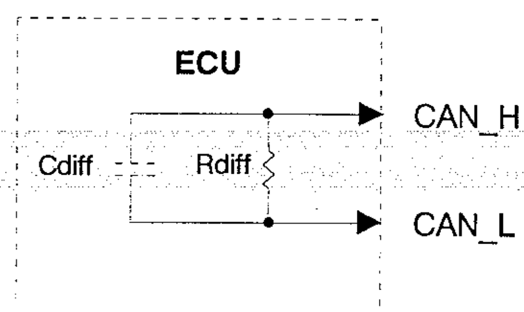


FIGURE 4—ILLUSTRATION OF DIFFERENTIAL INTERNAL CAPACITANCE AND RESISTANCE OF AN ECU IN THE RECESSIVE STATE

3.10 Internal Capacitance

The internal capacitance, C_{in}, of an ECU is defined as the capacitance seen between CAN_H (or CAN_L) and ground during the recessive state, with the ECU disconnected from the bus line (see Figure 3)

3.13 Internal Delay Time

The internal delay time of an ECU, t_{ECU}, is defined as the sum of all asynchronous delays that occur along the transmission and reception path of the individual ECUs, relative to the bit timing logic unit of the protocol IC. For more details see Figure 6.

a Synchronization—Hard Synchronization and Resynchronization are the two forms of synchronization They obey the following rules·

1 Only one Synchronization within one bit time is allowed

2 An edge will be used for Synchronization only if the value detected at the previous Sample Point (previously read bus value) differs from the bus value immediately after the edge

3 Hard Synchronization is performed during said edge whenever there is a 'recessive' to 'dominant' edge

4 All other 'recessive' to 'dominant' edges fulfilling rules 1 and 2 will be used for Resynchronization with the exception that a transmitter will not perform Resynchronization as a result of a 'recessive' to 'dominant' edge with a positive Phase Error if only 'recessive' to 'dominant' edges are used for Resynchronization

b. Synchronization Jump Width (SJW)—As a result of Synchronization PHASE_SEG1 may be lengthened or PHASE_SEG2 may be shortened The amount of lengthening or shortening of the Phase Buffer bit Segments has an upper bound given by the Synchronization Jump Width The Synchronization Jump Width is less than or equal to PHASE_SEG1

3.14 CAN Bit Timing Requirements

It is necessary to ensure that a reliable network can be constructed with components from multiple suppliers Without any bit timing restrictions, different devices may not be able to properly receive and interpret valid messages Under certain network conditions it may also be possible for a particular device to have unfair access to the network In addition, it makes network management (system diagnostics) much more difficult. CAN chip suppliers also recommend that all devices on a given network be programmed with the same bit timing values.

All CAN ICs divide the bit time into smaller sections defined as tq (time quantum) For most CAN ICs 1tq = 250 ns (with a 16mhz clock) (determined by oscillator frequency and baud rate prescaler)

Therefore specific values for the bit timing registers need to be defined to ensure that a reliable network exists for all nodes based on the best tradeoffs between propagation delay and clock tolerance. Note that there are some differences in bit segment definition between manufacturers of CAN devices

It is recommended that a tq be selected which permits the sample point (see figure 5) to be located as close to but not later than 7/8 of a bit time (0 875x4uS=3 5uS) This provides the best tradeoff between propagation delay and clock tolerance

The following values are recommended for typical controller ICs running at standard clock frequencies At other frequencies different values may have to be selected to maintain the sample point as close as possible but not later than the preferred time.

1) Including initial tolerance, temperature, aging, etc

2) The value of t_{ECU} has to be guaranteed for a differential voltage of V_{diff} = 1.0V for a transition from recessive to dominant and of V_{diff} = 0 5V for a transition from dominant to recessive With the bit timing from the example of note 1, a CAN-Interface delay of 500 ns is possible (controller not included) with a reserve of about 300 ns. This allows slower slopes (R3 and R4 in Figures A.1 and A.2) and input filtering (R5, R6, C1, C2 in Figures A.1 and A.2) It is recommended to use this feature due to EMC

The minimal internal delay time may be zero. The maximum tolerable value is determined by the bit timing and the bus delay time

3) In addition to the internal capacitance restrictions a bus connection should also have an inductance as low as possible. The minimum values of C_{in} and C_{diff} may be 0, the maximum tolerable values are determined by the bit timing and the network topology parameters l and d (see Table 8). Proper functionality is guaranteed if occurring cable resonant waves do not suppress the dominant differential voltage level below V_{diff} = 1V and do not increase the recessive differential voltage level above V_{diff} = 0 5V at each individual ECU (see Tables 3 and 4)

4) The available time results from the bit timing unit of the protocol IC. For example, this time in most controller ICs corresponds to TSEG1. Due to missynchronization it is possible to lose the length of SJW. So the available time (t_{avail}) with one missynchronization is TSEG1-SJW ms. A tq time of 250 ns and SJW = 1 tq, TSEG1 = 13 tq, TSEG2 = 2tq results in t_{avail} = 3.00 µs

5) The load on the ECU for the purpose of this parameter should be 60 ohms between CAN_H and CAN_L in parallel with 200 pf of capacitance

4. Functional Description

As shown in Figure 2, the linear bus line is terminated with a load resistor R_L on each end These resistors suppress reflections

The bus is in the recessive state if the bus transmitters of all ECUs on the bus are switched off In this case, the mean bus voltage is generated by the passive biasing circuit in all ECUs on the bus In Figure 2 this is realized by the resistor network that defines the reference for the receive operation

A dominant bit is sent to the bus line if the bus driver circuit of at least one unit is switched on. This induces a current flow through the terminating resistors, and consequently, a differential voltage between the two wires. The dominant and recessive states are passed by a resistor network which transforms the differential voltages of the bus line to corresponding recessive and dominant voltage levels at the comparator input of the receiving circuitry for detection

5 Electrical Specification

5 1 Electrical Data

The parameter specifications in these tables must be fulfilled throughout the operating temperature range of every ECU. These parameters allow up to a maximum of 30 ECUs to be connected to a given bus segment.

5 1 1 Electronic Control Unit
The limits given in the Tables 1 to 4, apply to the CAN_H and CAN_L pins of each ECU, with the ECU disconnected from the bus line (see Section 6).

TABLE 4—DC—PARAMETERS FOR THE DOMINANT STATE OF AN ECU DISCONNECTED FROM THE BUS LINE—DOMINANT STATE

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Bus Voltage Output Behavior	V_{CAN_H}	3 0	3 5	5 0	V	1)
	V_{CAN_L}	0 0	1 5	2 0	V	
Differential Voltage Output Behavior	V_{diff_ld}	1 5	2 0	3 0	V	1)
Input Range	V_{diff}	1.0		5.0	V	1) 2)

1) The equivalent of the two terminating resistors in parallel (60 Ω) is connected between CAN_H and CAN_L.

2) Reception must be ensured within the common mode voltage range defined in Table 5 and Table 6, respectively.

TABLE 5—BUS VOLTAGE PARAMETERS FOR THE RECESSIVE STATE WITH ALL ECUs CONNECTED TO THE BUS LINE—RECESSIVE STATE

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Voltage on the bus line	V_{CAN_L}	0 1	2 5	4 5	V	measured with respect to ground of each ECU
Differential Bus Voltage[1]	V_{diff}	−400	0	12	mV	measured at each ECU connected to the bus line

1) The differential bus voltage is determined by the output behavior of all ECUs during the recessive state Therefore, V_{diff} is approximately zero (see Table 3). The minimum value is determined by the requirement that a single transmitter must be able to represent a dominant bit by a minimum value of V_{diff} = 1.2 V.

TABLE 6—BUS VOLTAGE PARAMETERS FOR THE DOMINANT STATE WITH ALL ECUs CONNECTED TO THE BUS LINE—DOMINANT STATE

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Voltage on Bus[1]	V_{CAN_H}		3 5	7 0	V	measured with respect to ground of each ECU
	V_{CAN_L}	−2 0	1 5			
Differential Bus Voltage[2]	V_{diff}	1.2	2.0	3.0	V	measured at each ECU connected to the bus line
				5.0	V	during arbitration

1) The minimum value of V_{CAN_H} is determined by the minimum value of V_{CAN_L} plus the minimum value of V_{diff} The maximum value of V_{CAN_L} is determined by the maximum value of V_{CAN_H} minus the value of V_{diff}

2) The bus load increases as ECUs are added to the network, due to R_{diff} Consequently, V_{diff} decreases. The minimum value of V_{diff} determines the number of ECUs allowed on the bus. The maximum value of V_{diff} is defined by the upper limit during arbitration This maximum value of V_{diff} for single operation must not exceed 3 V.

5 1 1.3 AC Parameters

Table 1 defines the AC Parameter requirements of the ECUs.

TABLE 7—PHYSICAL MEDIA PARAMETERS FOR TWISTED SHIELDED CABLE

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Impedance	Z	108	120	132	Ω	Three meter sample length measured at 1 Mhz between the two sig wires, with shield grounded, using open/short method
Specific Resistance	r_b	0	25	50	mΩ/m	1) measured at 20°c.
Specific Line Delay	t_p		5 0		ns/m	2) 67% V_p
Specific Capacitance	c_b	0	40	75	pF/m	Between conductors
	c_s	0	70	110	pF/m	Conductor to shield
Cable size						3)
0.5mm² Conductor (20 AWG)	a_c	0 508			mm²	4) (includes drain wire)
Wire insul dia	d_{ci}	2.23		3.05	mm	
Cable diameter	d_c	6 0		8 5	mm	
0.8mm² Conductor (18 AWG)	a_c	0 760			mm²	4) (includes drain wire)
Wire insul dia.	d_{ci}	2 5		3 5	mm	
Cable diameter	d_c	8 5		11 0	mm	
Shield Effectiveness			200	225	mΩ/m	surface transfer impedance up to 1 MHz Test method per MIL-C-85485
Temperature Range	C	-40		+125	deg C	5) Heat aging: 3000 hours per ISO 6722, Test with a mandrel 4-5x diameter of cable.
Cable Bend Radius	r	4xdia of cable			mm	90 degree bend radius without cable performance or physical degradation

1) The differential voltage on the bus line seen by a receiving ECU depends on the line resistance between it and the transmitting ECU Therefore, the total resistance of the signal wires is limited by the bus level parameters of each ECU
2) The minimum delay time between two points of the bus line may be zero The maximum value is determined by the bit time and the delay times of the transmitting and receiving circuitry.
3) Other conductor sizes available Component insulation dimensions may be larger than those specified in SAE J1128 Design engineers should ensure compatibility between cables, connectors and contacts
4) Meet performance requirements of SAE J1128 for types GXL or SXL (includes drain wire)
5) 125°C or per OEM specification

5.2.1 Bus Line

5 2 3 Terminating Resistor

Each end of the main 'backbone' of the linear bus must be terminated with an appropriate resistance to provide correct termination of the CAN_H and CAN_L conductors. This termination resistance should be connected between the CAN_H and CAN_L conductors. The termination resistance should meet the characteristics specified in Table 9.

TABLE 9—TERMINATING RESISTOR PARAMETERS

Parameter	Symbol	Min	Nom	Max	Unit	Conditions
Resistance	R_L	110	120	130	Ω	minimum power dissipation 400 mW [1]
Inductance				1	μh	

[1] Assumes a short of 16V to V_{CAN_H}

5.2.4 Shield Termination

The shield should be terminated by a wire conductor and directly grounded at only one point.

General guidelines (in order of importance) for direct termination of the shield are:

1. Connect to the point of least electrical noise
2. Use the lowest impedance connection possible
3. The closest connection to the center of the network should be used.

It is the responsibility of the vehicle manufacturer to identify the shield termination implementation

Each node on the bus should also provide a shield ground; however, this connection of the CAN_SHLD conductor should be by a series resistor and capacitor to the best ground connection within the node. Recommended values are R=1 Ω and C=0 68 μF. (See Figures A.1 and A.2)

5.3 Connector Specifications add (Appendix C)

Two types of connectors are shown that are capable of implementing all aspects of the network. An ECU may be connected with either a hard splice or connector. If a connector is to be used to connect an ECU to the 'backbone' of the network it is called the Stub Connector and is designated "A" in Figure 8. The 'backbone' connector is shown in Figure 9. The connector used to connect the termination resistor to the ends of the 'backbone' cable or to pass through structural boundaries, such as cab bulkheads, or to extend the ends of the 'backbone' is called the 'Through Connector' and is designated "B" in Figure 8. The 'Through Connector' is shown in Figure 10.

These two connectors are very similar in design, with different keying structures to eliminate the possibility of connecting the network in a method that would be detrimental to proper communications. The connectors shall provide for the electrical connections of CAN_H, CAN_L and drain wire CAN_SHLD.

An example of the use of this connector concept is shown in Figure 8

5 3 2 Connector Mechanical Requirements

these

~~Connectors should be used at all points where two or more cables terminate. These~~ connectors should have locking, polarizing, and retention devices that meet the requirements of the specific application. These connectors should also incorporate environmental protection appropriate for the application. The dimensional characteristics of the Stub and Through connectors are shown in Figures 9 and 10, respectively.

If connectors are used

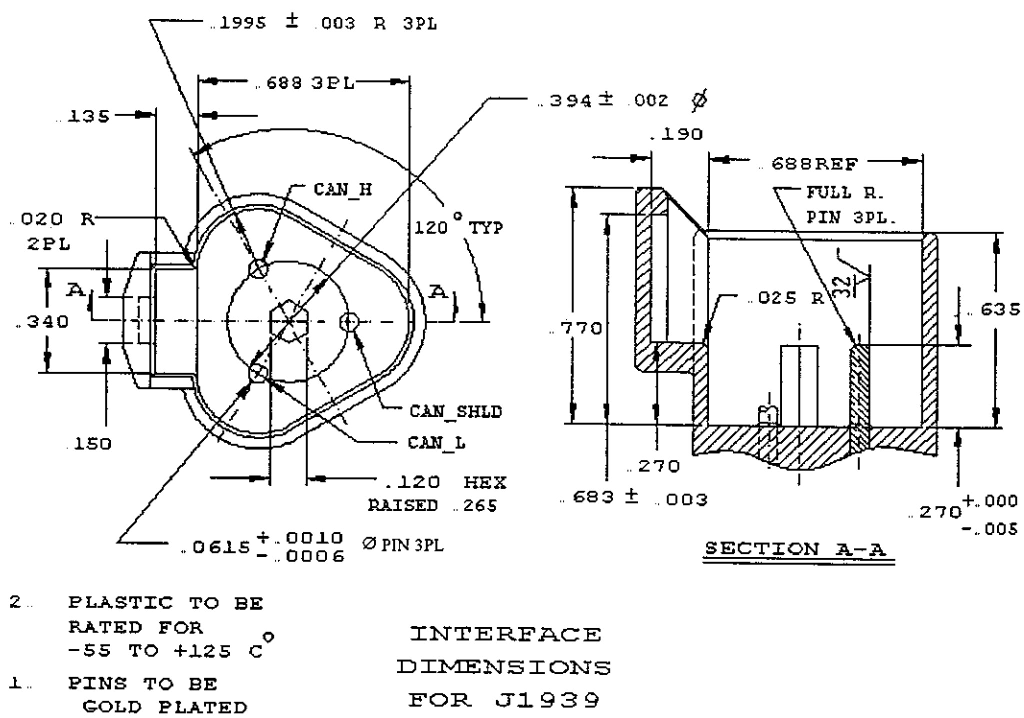


FIGURE 9—STUB CONNECTOR (WITH MALE KEY) DIMENSIONAL REQUIREMENTS (A)

V_{CAN_H} and V_{CAN_L} are measured unloaded while the bus is idle V_{diff} is then determined by

$$V_{diff} = V_{CAN\_H} - V_{CAN\_L} \quad \text{(Eq 2)}$$

Table 3 defines the limits during the recessive state

NOTE—V_{CAN_H} and V_{CAN_L} is measured with no load such that the worst case would be observed for the maximum recessive condition

6 2 Internal Resistance of CAN_H and CAN_L

The internal resistance, R_{in}, of CAN_H and CAN_L can be measured as shown in Figure 12.

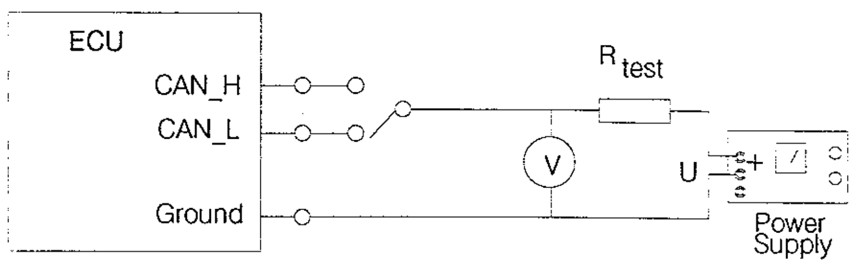


FIGURE 12—MEASUREMENT OF R_{IN} WHILE THE ECU PROTOCOL IC IS SET TO BUS IDLE

R_{in} of CAN_H and CAN_L is determined for U = 0 V and U = 5 V, respectively, with R_{test} = 5 kΩ. R_{in} of CAN_H and CAN_L is then calculated by

$$R_{in} = R_{test}\frac{V_{CAN\_H,L} - V}{V - U} \quad \text{(Eq 3)}$$

where:

V_{CAN_H} and V_{CAN_L} are the open circuit voltages according to Figure ~~2~~ 11 R_{in} is defined for the recessive state by Table 3 and Note 4 for DC - Parameters.

Current I is adjusted to a value which develops 0 5 V (the upper limit for detecting a recessive bit during the recessive state) across R_{test} with R_{test} = 60 Ω (Bus Line Load Equivalent Resistance) In addition, U is set to two suitable values that produce V = –2 V and V = 6 V during bus idle Under these conditions the ECU must not stop transmitting. This indicates that every transmitted recessive bit is still detected as recessive by the protocol IC of the ECU The level of the dominant bits is nearly independent of U

NOTE—The 6 V value is used instead of 7 V since the maximum threshold for receiving a recessive bit is 0 5 V per Table 2

6 5 Dominant Output of an ECU

The dominant output of an ECU can be measured as shown in Figure 15

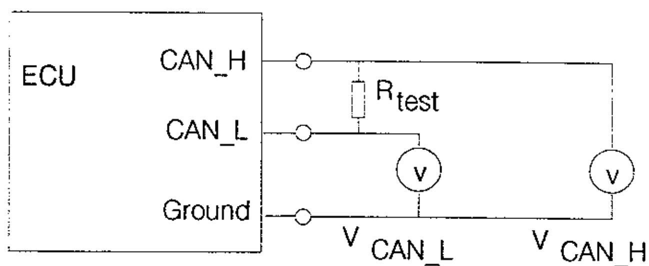


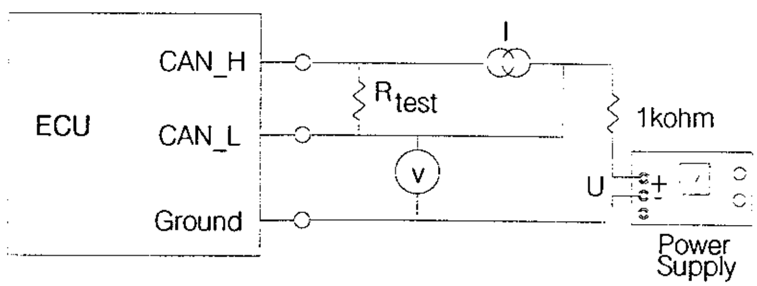
FIGURE 15—MEASUREMENT OF V_{CAN_H} AND V_{CAN_L} WHILE THE ECU SENDS A DOMINANT BIT

V_{CAN_H} and V_{CAN_L} are measured during a dominant bit transmission R_{test} is set to 60 Ω The corresponding value of V_{diff} is given by

$$V_{diff} = V_{CAN\_H} - V_{CAN\_L} \qquad \text{(Eq.5)}$$

6 6 Dominant Input Threshold of an ECU

The dominant input threshold of an ECU can be verified over the common mode range as shown in Figure 16



The dominant and recessive voltage levels are set by the test unit to the corresponding threshold voltages for reception This means that the dominant overwriting level is 1 V, and the recessive level is 0 5 V This ensures a uniquely defined relationship between voltage levels and internal delay time

7 Discussion of Bus Faults

Possible Failures—During normal operation, several bus failures can occur that may influence operation These failures and the resulting network behavior are specified subsequently

7 1 Loss of Connection to Network

If a node becomes disconnected from the network, the remaining nodes shall continue communication

7 2 Node Power or Ground Loss

If a node loses power, or if it is in a low voltage condition, the network is not loaded down, and the remaining nodes shall continue communication.

If a node loses ground, the network shall not be biased up. The remaining nodes shall continue communication.

7 3 Unconnected Shield

In case the shield loses connection at one node, communication is possible but electromagnetic interference increases. Common mode voltages can be induced between the shield and the wires.

7.4 Open and Short Failures

In principle, failures are detectable if there is a significant message destruction rate, as interpreted by the electronic control units. Some external events that may cause failures are shown in Figure 18 and are discussed as follows:

a. Case 1: CAN_H is Interrupted—Data communication between nodes on opposite sides of an interruption is not possible. Data communication between nodes on the same side of an interruption may be possible, but with reduced signal-to-noise ratio

b Case 2: CAN_L is Interrupted—Data communication between nodes on opposite sides of an interruption is not possible. Data communication between nodes on the same side of an interruption may be possible, but with reduced signal-to-noise ratio

c. Case 3: CAN_H is Shorted to VBat—Data communication is not possible if VBat is greater than the maximum allowed common mode bus voltage

d Case 4: CAN_L is Shorted to GND—Data communication is possible, because the bus voltages are within the allowed common mode voltage range. Signal-to-noise ratio is reduced and radiation is increased. The electromagnetic immunity is decreased

e Case 5: CAN_H is Shorted to GND—Data communication is not possible

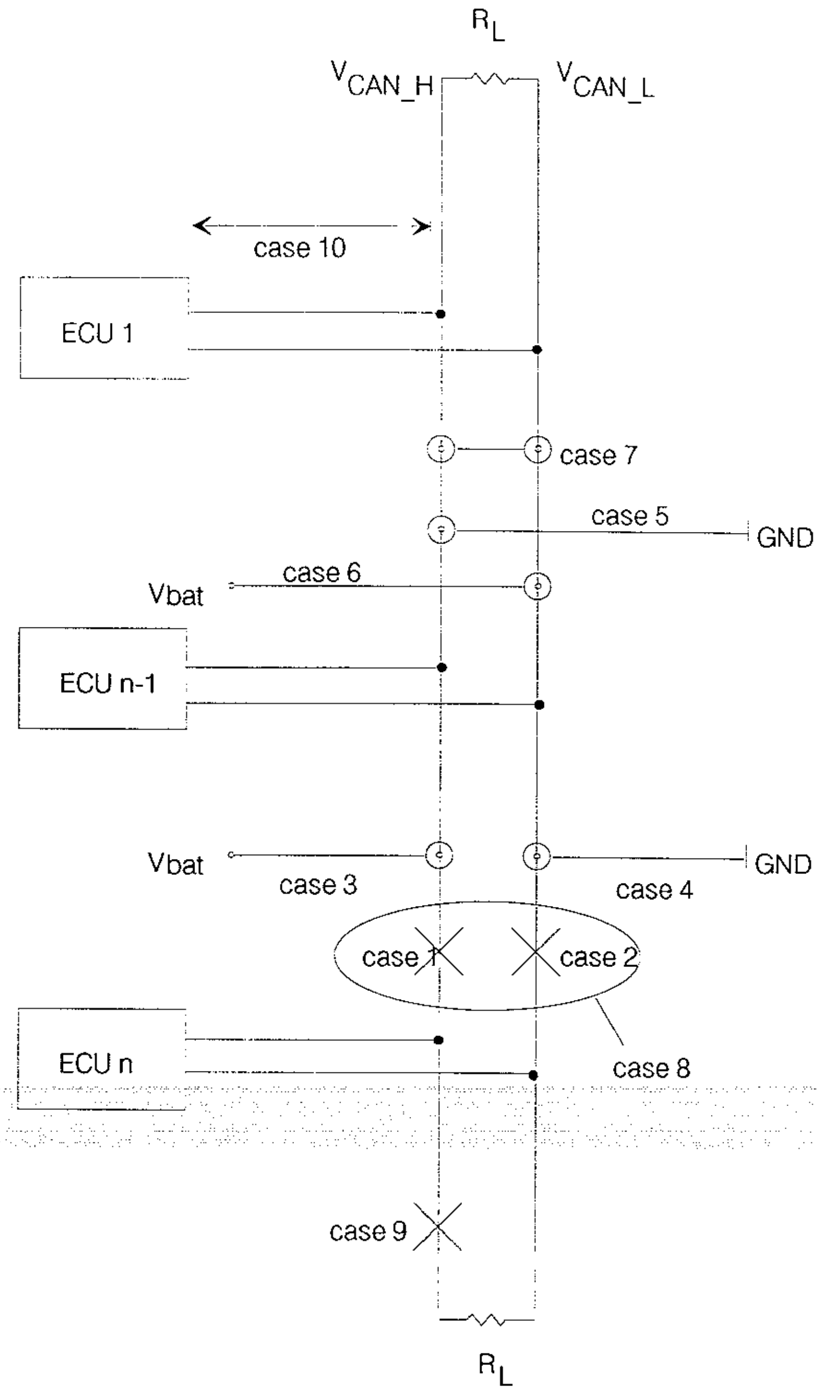


FIGURE 18—
POSSIBLE FAILURES DUE TO EXTERNAL EVENTS

The circuit has a special short-circuit protection for the CAN_L path Therefore it uses only low power components but withstands voltages up to +50 V on the bus lines (e.g , load dump) R7, R8, R9, R10 form the biasing network for the recessive state; R5, R6, C1, C2 together with the biasing network form an input filter with a corner frequency of about 1 2 MHz. R3, R4, R15, and R16 provide the drive impedance for Q1, Q2; they should be chosen so that the switching waveforms of CAN_H and CAN_L are symmetrical during transitions R1 and R2, together with the on-resistance of Q1 and Q2, set the output impedance of the link for the dominant state; D1 and D2 are used for common mode decoupling R12, R13, D3, Z1, and Q3 switch Q2 off if voltage levels at CAN_L exceed +10V (Q1 is decoupled by D1 in this case) D3 isolates the capacitance of Z1 from the bus line L1 is used to reduce the amount of high-frequency microprocessor switching noise on the bus

APPENDIX B

RECOMMENDED CABLE TERMINATION PROCEDURE

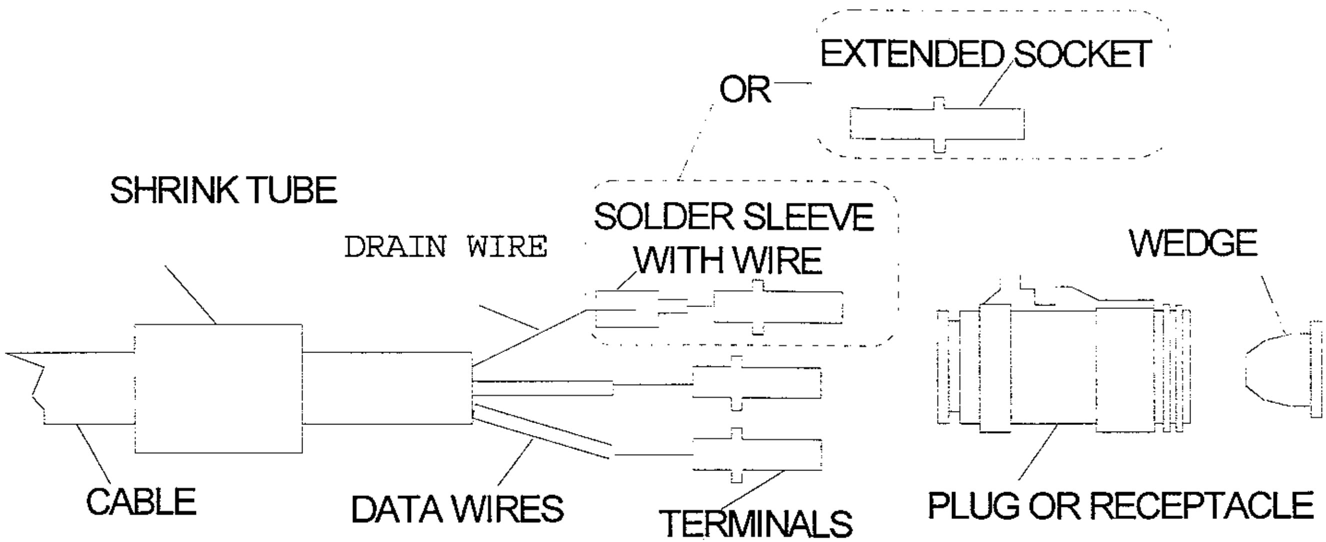


FIGURE B1—CABLE TERMINATION

1. Remove cable outer jacket approximately 40-100 mm.
2. Remove foil shield from exposed wires to within 2 mm of cable jacket.
3. Strip insulation from data wires 7 mm ± 0 8 mm
4. Attach adhesive filled solder sleeve and wire to drain wire per manufacturer's recommendation **OR** attach extended wire barrel socket contact to the drain wire.
5. For the solder sleeve option cut wire on solder sleeve to a length of 25 mm and strip the insulation on that wire 7 mm ± 0.8 mm.
6. Crimp the appropriate terminal on each data wire and the solder sleeve wire **OR** extended socket per manufacturers recommendation
7. Slide adhesive filled shrink tube over cable end.
8. Install terminals into connector body per manufacturer's instructions Isopropyl alcohol may be used to aid in assembly
9. Install wedge in front of connector body per manufacturer's instructions.
10. For outer jacket removal greater than 40 mm, apply the replacement EMC shielding material per the manufacturer's recommendation.
11. Apply shrink tube to end of connector body per manufacturer's recommendation

APPENDIX C

RECOMMENDED CABLE SPLICE PROCEDURE

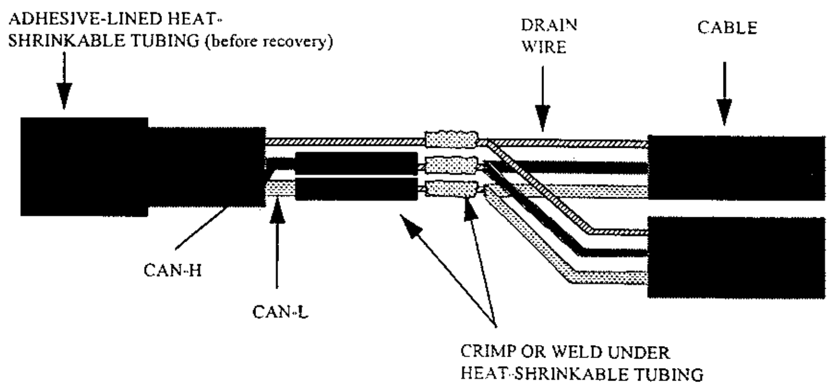
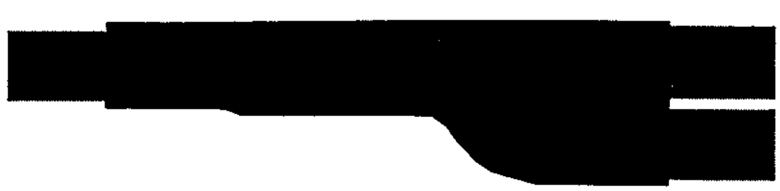


FIGURE C1 - CABLE SPLICE[1]

40-100 mm

1. Cut the end of the cable cleanly. Measure back 50 mm and mark the cable jacket. Remove this section of cable jacket and foil shield.
2. Measure back 6,3 mm on the drain wire and cut it. ≈ 6 mm
3. Remove 6,3 mm of insulation on the data wire CAN-H.
4. Measure back 21 mm on data wire CAN-L and cut it. Remove 6,3 mm of insulation on this wire. approx ≈ 6mm
5. Repeat steps 1 through 4 for the other two cables that will be spliced but **REVERSE** the order of steps 3 and 4 for CAN-H and CAN-L[2].
6. Slide the two pieces of insulating heat-shrinkable tubing over the CAN-H and CAN-L data wires.
7. Slide the one piece of adhesive-lined heat-shrinkable tubing onto the cable
8. Install crimp (or weld) the three drain wires together, the three CAN-H data wires together, and the three CAN-L data wires together.
9. Solder the connections if desired.
10. Center the insulating heat-shrinkable tubing over the two crimped or welded data wire splices and install the tubing per the manufacturer's recommendation.
11. Apply the replacement EMC shielding material per the manufacturer's recommendation.
12. Center the adhesive-lined heat-shrinkable tubing over the assembly and apply per manufacturer's recommendation.



[1] Shielding material not shown.
[2] The overall length of the assembly is minimized by offsetting the crimps.

FIGURE D2 - CABLE SPLICE-FINISHED ASSEMBLY

WORKING DRAFT Date: October 30, 1997

J1939/13
OFF-BOARD DIAGNOSTIC CONNECTOR

FOREWORD

This series of SAE Recommended Practices have been developed by the Truck & Bus Control and Communications Network Subcommittee of the Truck & Bus Electrical Committee The objectives of the subcommittee are to develop information reports, recommended practices and standards concerned with the requirements design and usage of devices which transmit electronic signals and control information among vehicle components. The usage of these recommended practices is not limited to truck and bus applications. Other applications may be accommodated with immediate support being provided for construction and agricultural equipment, and stationary power systems

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2. REFERENCES:

General information regarding this series of recommended practices is found in SAE J1939

2.1 Applicable References

ISO 11898 Road Vehicles -- Interchange of digital information -- Controller Area Network (CAN) for high speed communication.

SAEJ2030
SAEJ1939/11
SAEJ1939/12
SAEJ1708

2.2 Other Related Publications

3. Off-Board Diagnostic Connector

This section describes the Off-Board Diagnostic connector used on the vehicle to get access to the vehicle communication links

The diagnostic connector defined supports both the twisted shielded pair media (J1939/11) as well as the twisted unshielded quad media (J1939/12) The designations of the individual signal wires are CAN_H and CAN_L For /11, a third connection for the termination of the shield is denoted by CAN__SHLD. For /12, this same third connection is not connected

In addition to the designations of the CAN media wires, the designations of the J1708 physical media wires, power and ground are: J1708 (+), J1708 (-), Battery (+) and Battery (-). There are two pins designated for proprietary vehicle OEM use

3.1 General Requirements

3.1.1 Mounting

The connector shall be mounted inside the cab in a location that is easily accessible according to the guidelines below.

A. For on road heavy trucks the connector should be mounted on the driver side and if possible accessible from the ground next to the cab.

B. For busses the connector should be mounted on the front passenger door side and if possible accessible from the ground next to the bus.

C. For construction and agricultural equipment, it is recommended that the connector for the tractor bus be located behind the operator's seat or under the dash at the operator's knees. This connector must be labeled as the diagnostic connector. A diagnostic connector may be located elsewhere, in addition to a connector at the recommended location.

D. The cable tail length for the diagnostic connector is 0.66m maximum for the vehicle and 0.33m maximum for the off-board diagnostic tool

3.1.2 Serviceability

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

3.2 Connector Performance Requirements

3.2.1 Connect/ Disconnect

A. The connector shall comply with SAE J2030 except the number of connect/disconnect cycles shall be 1000

B. The receptacle shall support/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

3.2.2 Environmental Requirements

The connector shall be available in both sealed and unsealed versions. A dust cap shall be available

3.3 Physical Requirements

3.3.1 Pin Designation

A. The pins/sockets shall be sized commensurate with 2, 1, 0 8 and 0 5 mm2 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: Appropriate conductor seals are necessary to ensure the sealing integrity of the connector.

C The connector shall have nine pins designated as follows:

Pin A	Battery (-)	
Pin B	Battery (+)	Unswitched - with Unconditioned 10 Amp Fuse
Pin C	CAN_H	Tractor Bus
Pin D	CAN_L	Tractor Bus
Pin E	CAN_SHLD **(for J1939/11)** or No Connection **(for J1939/12)**	
Pin F	J1708 (+)	
Pin G	J1708 (-)	
Pin H	Proprietary OEM Use or Implement Bus CAN_H (for J1939/02)	
Pin J	Proprietary OEM Use or Implement Bus CAN_L (for J1939/02)	

3.3.2 Connector Mechanical Requirements

The dimensional characteristics of the diagnostic connectors are shown in Fig 3.1 through 3.4. Pin designations on the connector are preferred but not required. Any pin designation applied to the connector must conform to Figures 3.1, 3.2, 3.3, and 3.4.

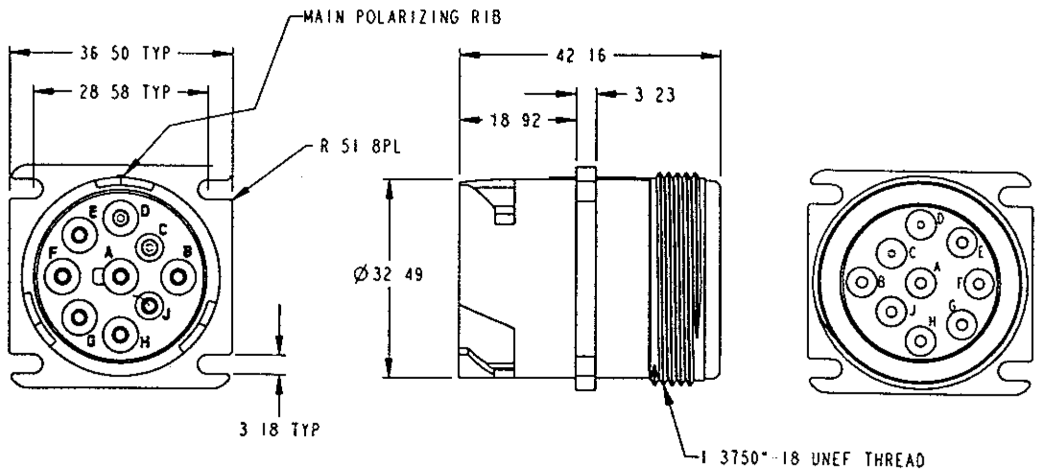

Figure 3.1 Flange Mount Diagnostic Receptacle Connector

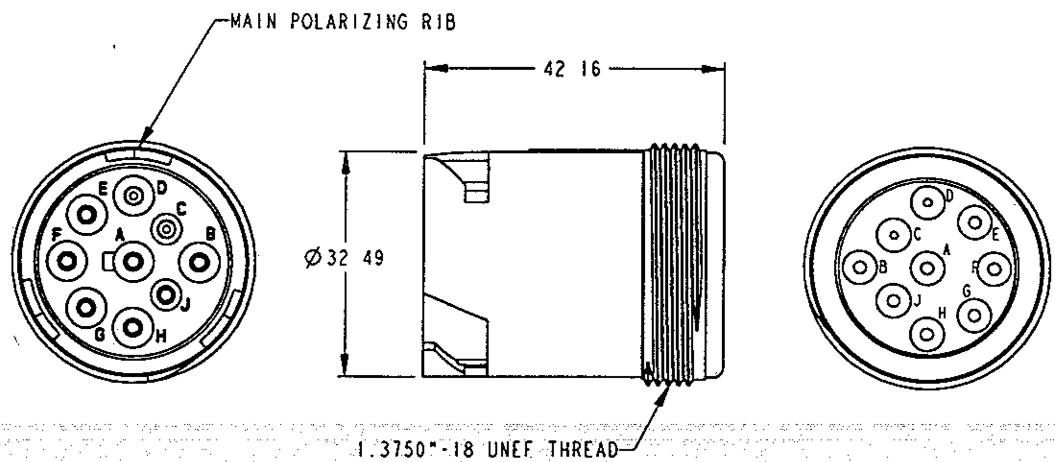

Figure 3.2 In-Line Diagnostic Receptacle Connector

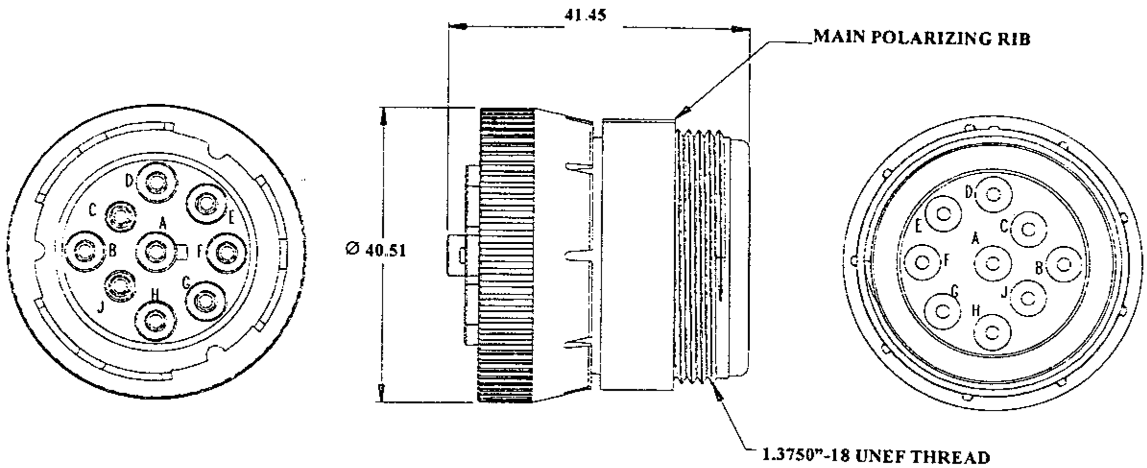

Figure 3.3 Diagnostic Plug Connector

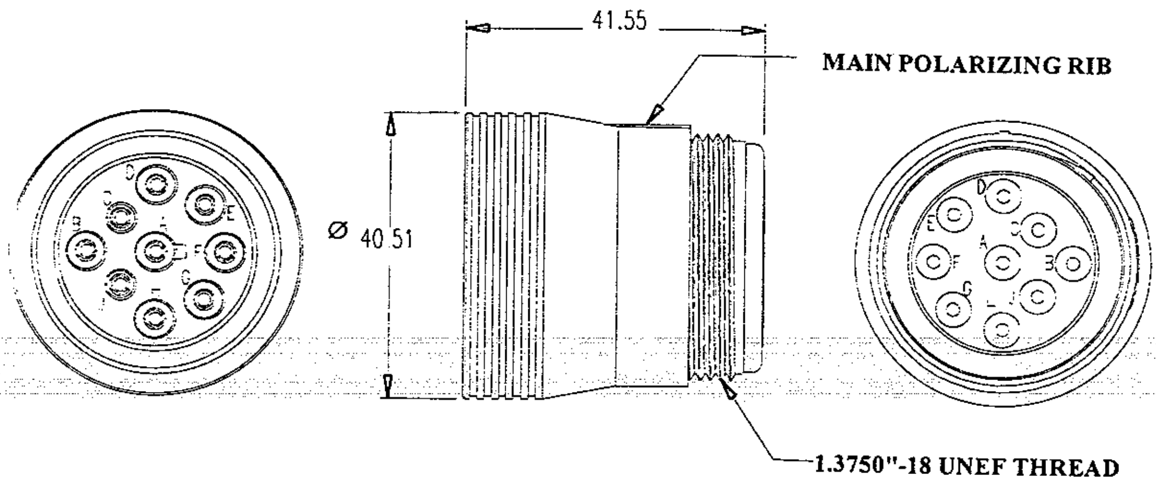

Figure 3.4 Friction Locking Plug Connector

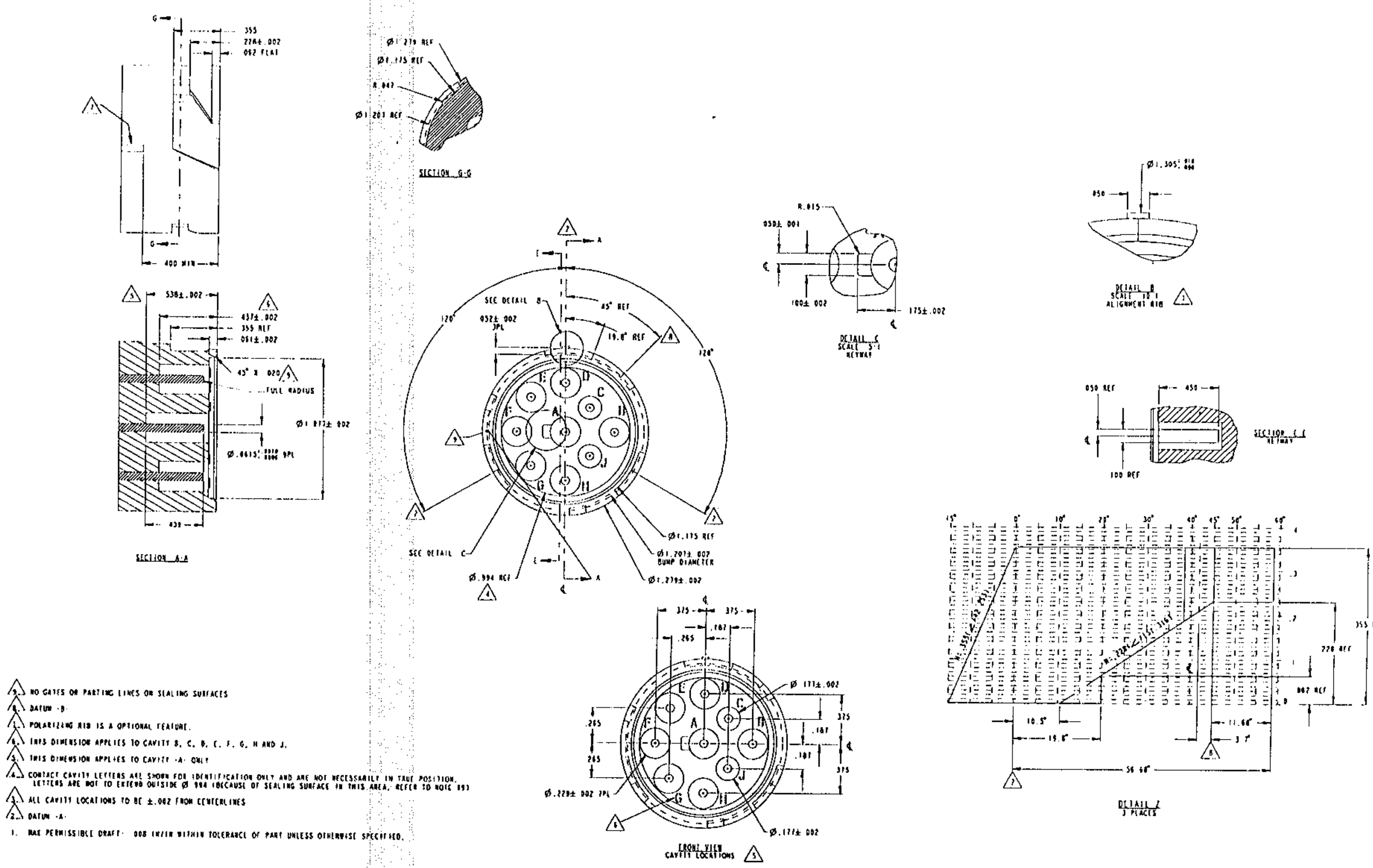

Figure 3.5 Interface Details