ISO / DIS 14230 Road Vehicles - Diagnostic Systems

Keyword Protocol 2000

Part 2: Data Link Layer

Status: Draft International Standard

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Introduction

This International Standard has been established in order to define common requirements for diagnostic systems implemented on a serial data link.
To achieve this, the standard is based on the Open System Interconnection (O.S.I.) Basic Reference Model in accordance with ISO 7498 which structures communication systems into seven layers. When mapped on this model, the services used by a diagnostic tester and an Electronic Control Unit (ECU) are broken into:

- Diagnostic services (layer 7)
- Communication services (layers 1 to 6)

See figure 1 below.

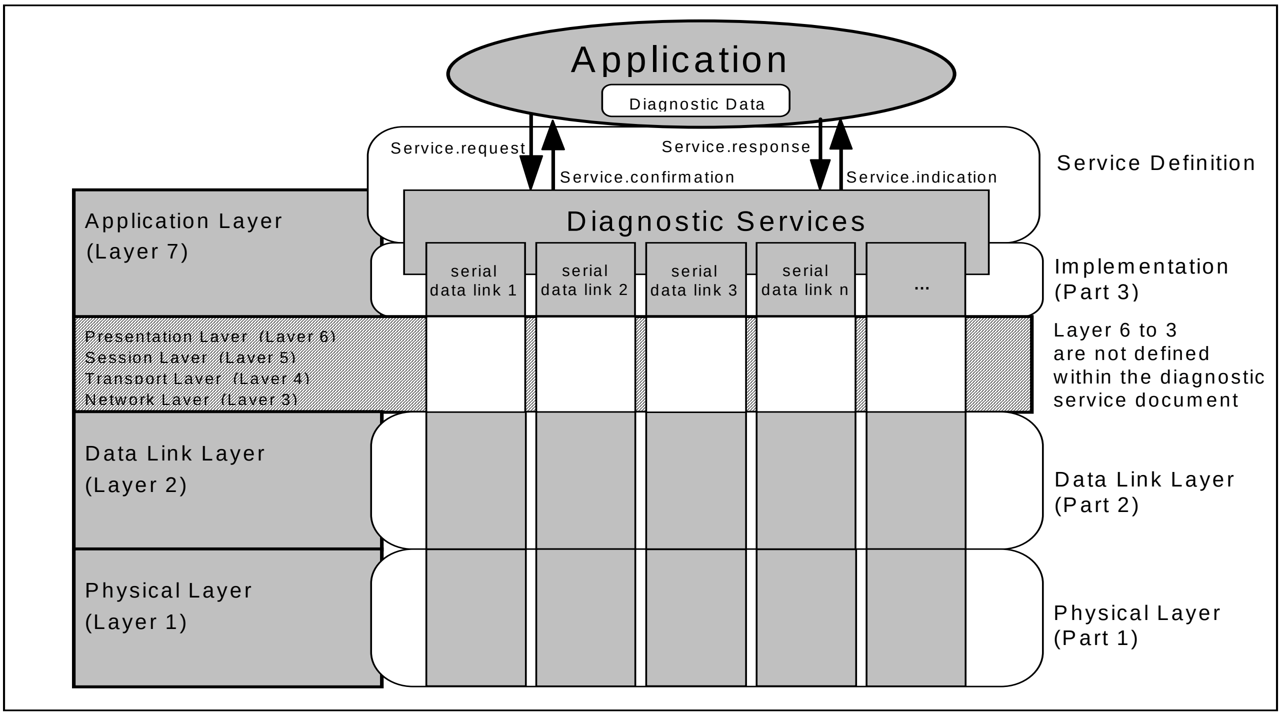


Figure 1 - Mapping of the diagnostic services on the O.S.I. Model

Example of serial data links: KWP 2000, VAN, CAN, J1850...

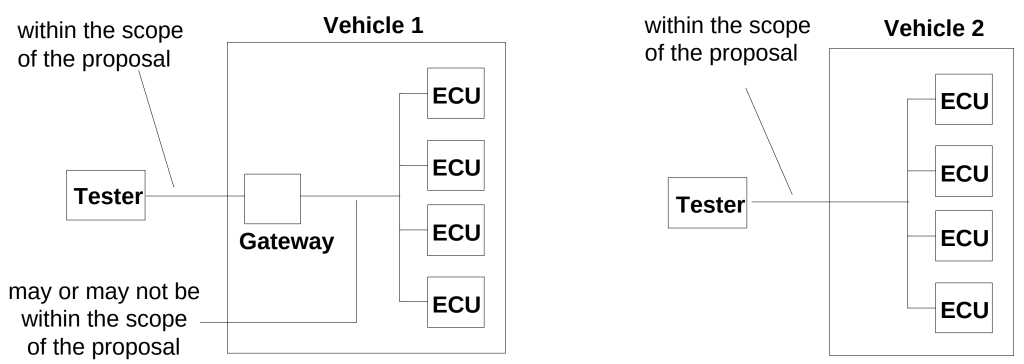
1 - Scope

This International Standard specifies common requirements of diagnostic services which allow a tester to control diagnostic functions in an on-vehicle Electronic Control Unit (e.g. Electronic Fuel Injection, Automatic Gear Box, Anti-lock Braking System, ...) connected to a serial data link embedded in a road vehicle.
It specifies only layer 2 (data link layer). Included are all definitions which are necessary to implement the services (described in "Keyword Protocol 2000 - Part 3: Implementation") on a serial link (described in "Keyword Protocol 2000 - Part 1: Physical Layer"). Also included are some communication services which are needed for communication/session management and a description of error handling.
This Standard does not specify the requirements for the implementation of diagnostic services.
The physical layer may be used as a multi-user-bus, so a kind of arbitration or bus management is necessary. There are several proposals which are not part of this document. The car manufacturers are responsible for the correct working of bus management.
Communication between ECUs are not part of this document.

The vehicle diagnostic architecture of this standard applies to:

- a single tester that may be temporarily or permanently connected to the on-vehicle diagnostic data link and
- several on-vehicle electronic control units connected directly or indirectly

See figure 2 below.



In vehicle 1, the ECUs are connected over an internal data link and indirectly connected to the diagnostic data link through a gateway. This document applies to the diagnostic communications over the diagnostic data link; the diagnostic communications over the internal data link may conform to this document or to another protocol.

In vehicle 2, the ECUs are directly connected to the diagnostic data link.

Figure 2 - Vehicle diagnostic architecture

2 - Normative Reference

The following standards contain provisions which, through reference in this text, constitute provisions of this document. All standards are subject to revision, and parties to agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of ISO maintain registers of currently valid International Standards.

ISO 7498-1:1984	Information processing systems - Open systems interconnection - Basic reference model.
ISO TR 8509:1987	Information processing systems - Open systems interconnection - Conventions of services.
ISO 4092:1988/Cor.1:1991	Road vehicles - Testers for motor vehicles - Vocabulary Technical Corrigendum 1. SAE J2012 Diagnostic Trouble Codes
ISO 9141:1989	Road vehicles - Diagnostic systems - Requirements for interchange of digital information
ISO 9141-2:1994	Road vehicles - Diagnostic systems- Part 2: CARB requirements for interchange of digital information
SAE J1979: Dec,1991	E/E Diagnostic Test Modes
SAE J2012: 1994	Recommended Format and Messages for Diagnostic Trouble Codes
SAE J2178 :June, 1993	Class B Data Communication Network Messages
ISO 14229:1996	Road Vehicles - Diagnostic systems - Diagnostic Services Specification
ISO 14230-1:1996	Road Vehicles - Diagnostic systems - Keyword Protocol 2000 - Part 1: Physical Layer
ISO 14230-3:1996	Road Vehicles - Diagnostic systems - Keyword Protocol 2000 - Part 3: Implementation
ISO 14230-4:1996	Road Vehicles - Diagnostic systems - Keyword Protocol 2000 - Part 4: Requirements For Emission Related Systems

3 - Physical topology

Keyword Protocol 2000 is a bus concept (see diagram below). Figure 3 shows the general form of this serial link.

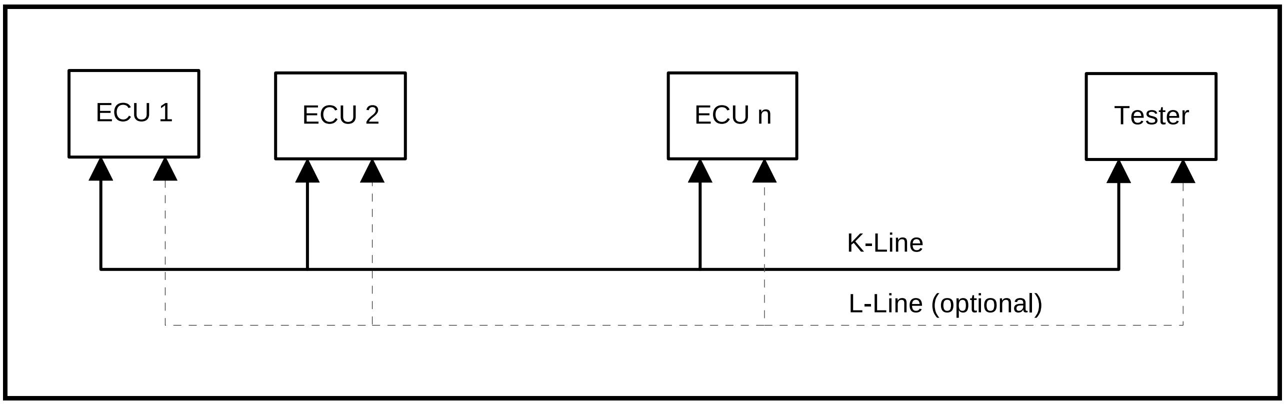


Figure 3 - Topology

“K - Line” is used for communication and initialisation, “L-Line” (optional) is used for initialisation only. Special cases are node-to-node-connection, that means only one ECU on the line which also can be a bus converter.

4 - Message structure

This section describes the structure of a message.
The message structure consists of three parts:

- header
- data bytes
- checksum

Header					**Data bytes**			**Checksum**
Fmt	Tgt1)	Src1)	Len1)	SId2)	. .	Data2)	. .	CS
max. 4 byte					max. 255 byte			1 byte

1) bytes are optional, depending on format byte
2) Service Identification, part of data bytes

The shaded area (header, checksum) are described in this part. The data bytes are described in "Keyword Protocol 2000 - Part 3: Implementation”.

Header and Checksum byte are described in this document. The area of data bytes always begins with a Service Identification. Use of the data bytes is described in "Keyword Protocol 2000 - Part 3: Implementation".

4.1 - Header

The header consists of maximal 4 bytes. A format byte includes information about the form of the message, target- and source address bytes are optional for use with multi node connections, an optional separate length byte allows message lengths up to 255 bytes.

4.1.1 - Format byte

The format byte contains 6 bit length information and 2 bit address mode information. The tester is informed about use of header bytes by the key bytes (see 5.1.5.1)

A1	A0	L5	L4	L3	L2	L1	L0

A1,A0: Define the form of the header which will be used by the message.

A1	A0	Mode
0	0	no address information
0	1	Exception mode (CARB)
1	0	with address information, physical addressing
1	1	with address information, functional addressing

L5 … L0: **Define the length of a message from the beginning of the data field (Service Identification byte included) to checksum byte (not included). A message length of 1 to 63 bytes is possible. If L0 to L5 = 0 then the additional length byte is included.**

A1, A0 = '0, 1' (CARB mode) is an exception mode. The CARB mode is not specified in this document. CARB uses format bytes $68 (0110 1000) and $48 (0100 1000). For more details refer to ISO 9141-2 and SAE J1979 documents.

4.1.2 - Target address byte

This is the target address for the message and is always used together with the source address byte. It may be a physical or a functional address. Physical addresses may be the 5 baud address byte (see ISO 9141:1989) or addresses according to SAE J2178 Part 1 (see appendix A). Functional addresses are listed in appendix B. The target address byte is optional and only necessary on multi node bus topologies. For node-to-node connections it may be omitted. For emission related (CARB) messages this byte is defined in ISO 14230 KWP 2000 Part 4: Requirements For Emission Related Systems or ISO 9141-2.

4.1.3 - Source address byte

This is the address of the transmitting device. It must be a physical address. There are the same possibilities for the values as described for physical target address bytes. Addresses for testers are listed in SAE J2178 Part 1 (see appendix B). This byte is optional (always used together with the target address byte) and only necessary on multi node bus topologies. For node-to-node connections it may be omitted.

4.1.4 - Length byte

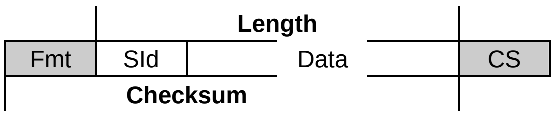
This byte is provided if the length in the header byte (L0 to L5) is set to 0. It allows the user to transmit messages with data fields longer then 63 bytes. With shorter messages it may be omitted. This byte defines the length of a message from the beginning of the data field (service identification byte included) to checksum byte (not included). A data length of 1 to 255 bytes is possible. The longest message consists of a maximum of 260 byte. For messages with data fields of less than 64 bytes there are two possibilities: Length may be included in the format byte or in the additional length byte. An ECU needs not to support both possibilities, the tester is informed about the capability of an ECU through the key bytes (see section 5.1.5.1).

Length	**Length provided in**	
	Format byte	**Length byte**
< 64	XX00 0000	present
< 64	XXLL LLLL	not present
>= 64	XX00 0000	present

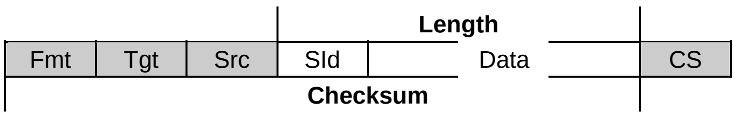
XX: **2 bit address mode information (see 4.1.1)**
LL LLLL: **6 bit length information**

4.1.5 - Use of header bytes

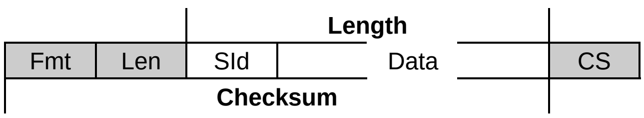
With the above definitions there are four different forms of message. These are shown diagramatically below.



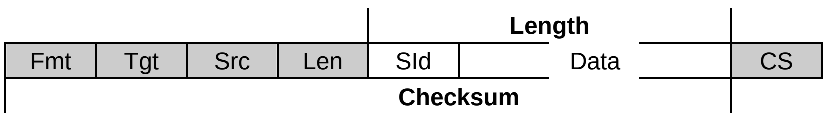
Header without address information, no additional length byte



Header with address information, no additional length byte



Header without address information, additional length byte



Header with address information, with additional length byte
(shaded area is part of this document)

Fmt	**Format byte**
Tgt	**Target address (optional)**
Src	**Source address (optional)**
Len	**additional length byte (optional)**
SId	**Service Identification Byte**
Data	**depending on service**
CS	**Checksum byte**

4.2 - Data Bytes

The data field may contain up to 63 or up to 255 bytes of information, depending on the use of length information. The first byte of the data field is the Service Identification Byte. It may be followed by parameters and data depending on the selected service. These bytes are defined in "Keyword Protocol 2000 - Part 3: - Implementation" (for diagnostic services) and in section 5 of this document (for communication services).

4.3 - Checksum Byte

The checksum byte (CS) inserted at the end of the message block is defined as the simple 8-bit sum series of all bytes in the message, excluding the checksum.

If the message is **<1> <2> <3> ... <N> , <CS>**

where **<i> (1 <= i <= N)** is the numeric value of the i^{th} byte of the message,

then **<CS> = <CS>$_N$**

where **<CS>$_i$ (i = 2 to N)**

is defined as **<CS>$_i$ = { <CS> $_{i-1}$ + <i> }** Modulo 256 and **<CS>$_1$ = <1>**

Additional security may be included in the data field as defined by the manufacturer.

4.4 - Timing

During normal operation the following timing parameters are relevant:

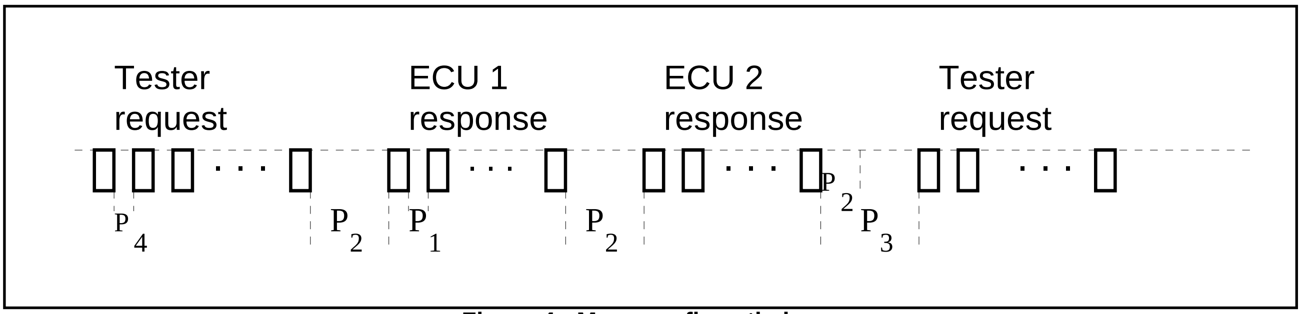


Figure 4 - Message flow, timing

Value	Description
P1	Inter byte time for ECU response
P2	Time between tester request and ECU response or two ECU responses
P3	Time between end of ECU responses and start of new tester request
P4	Inter byte time for tester request

There are two sets of default timing parameters:

- One set for normal functional and physical addressed communication. Longer timings are necessary to allow any technics of bus management.
- One set is restricted for physical addressing to allow faster communication.

The tester is informed about the capability of an ECU through the key bytes (see section 5.1.5.1). Timing parameters may be changed with the communication service "AccessTimingParameter" (see section 5.3).

Users must take care for limits listed below and the restrictions:

- P3min > P4min
- Pimin < Pimax for i=1,...,4

There may be some more restrictions, when the tester and listening ECUs detect the end of a message by time-out. In this case the following restrictions are valid:

- P2min > P4max,
- P2min > P1max

In case of functional addressing - that means that there may be more than one response to one request - some more restrictions may be added.

- It is in the designers responsibility to ensure proper communication in the case of changing the timing parameters from the default values.
- He also has to make sure that the chosen communication parameters are possible for all ECUs which participate in the session.
- The possible values depend on the capabilities of the ECU. In some cases the ECU possibly needs to leave its normal operation mode for switching over to a session with different communication parameters.

Table 1 and 2 shows the timing parameters which are used as default, the limits within which they can be changed and the resolution which may be used to set a new value (with the communication service AccessTimingParameter, see section 5.3).

Table 1 - Normal Timing Parameter Set (for functional and physical addressing) (all values in ms)

Timing	**minimum values [ms]**			**maximum values [ms]**		
Parameter	**lower limit**	**default**	**Resolution**	**default**	**upper limit**	**Resolution**
P1	0	0	---	20	20	---
P2	0	25	0.5	50	**calculation see table 3**	**see table 3**
P3	0	55	0.5	5000	∞ ($FF)	250
P4	0	5	0.5	20	20	---

Table 2 - Extended Timing Parameters Set (for physical addressing only) (all values in ms)

Timing	**minimum values [ms]**			**maximum values [ms]**		
Parameter	**lower limit**	**default**	**Resolution**	**default**	**upper limit**	**Resolution**
P1	0	0	---	20	20	---
P2	0	0	0.5	1000	**calculation see table 3**	**see table 3**
P3	0	0	0.5	5000	∞ ($FF)	250
P4	0	5	0.5	20	20	---

Table 3 - P2max Timing Parameter calculation

Timing Parameter	Hex value	Resolution	max. value in [ms]	Maximum value calculation method [ms]
P2max	01 to F0	25	25 to 6000	(hex value) ✷ (Resolution)
	F1 F2 F3 F4 F5 F6 F7 F8 F9 FA FB FC FD FE	see maximum value calculation method	6400 12800 19200 25600 32000 38400 44800 51200 57600 64000 70400 76800 83200 89600	(low nibble of hex value) ✷ 256 ✷ 25 Example of $FA: ($0A ✷ $0100) ✷ 25 = 64000
	FF	---	∞	Not Applicable

- **P2max timing parameter calculation method (values > 6000 [ms])** The P2max timing parameter calculation uses 25 [ms] resolution in the range of $01 to $F0. Beginning with $F1 a different calculation method shall be used by the server and the client in order to reach P2max timing values greater than 6000 [ms].

  Calculation Formula for P2max values > $F0

  Calculation_Of_P2max [ms] = (low nibble of P2max) ✷ 256 ✷ 25 [ms]

Note: The P2max timing parameter value shall always be a single byte value in the AccessTimingParameter service. The timing modifications shall be activated by implementation of the AccessTimingParameter service!

4.4.1 - Timing Exceptions

The extended P2 timing window is a possibility for (a) server(s) to extend the time to respond on a request message. A P2max timing exception is only allowed with the use of one or multiple negative response message(s) with response code $78 (requestCorrectlyReceived-ResponsePending) by the server(s). This response code shall only be used by a server in case it cannot send a positive or negative response message based on the client's request message within the active P2 timing window. This response code shall manipulate the P2max timing parameter value in the server and the client. The P2max timing parameter is set to the value (in ms) of the P3max timing parameter. The client shall remain in the receive mode. The server(s) shall send multiple negative response messages with the negative response code $78 if required.
As soon as the server has completed the task (routine) initiated by the request message it shall send either a positive or negative response message (negative response message with a response code other than $78) based on the last request message received. When the client has received the response message which has been preceded by the negative response message(s) with response code $78, the client and the server shall reset the P2max timing parameter to the previous timing value. The client shall not repeat the request message after the reception of a negative response message with response code $78.

5 - Communication services

Some services are necessary to establish and maintain communication. Those are not diagnostic services because they do not appear on the application layer. They are described in the same formal way and with the same conventions as the Diagnostic Services (see Keyword Protocol 2000 - Part 3: Implementation): A service table and a verbal description of the service procedure; parameters are mandatory (M), selectable (S), conditional (C) or user optional (U). A description of implementation on the physical layer of Keyword Protocol 2000 is added.

In general services are not mandatory, only StartCommunication service must be implemented.
The StartCommunication service and the AccessTimingParameter service are used for starting a diagnostic communication. In order to perform any diagnostic service, communication must be initialised and the communication parameters need to be appropriate to the desired diagnostic mode. A chart describing this is shown in figure 5.

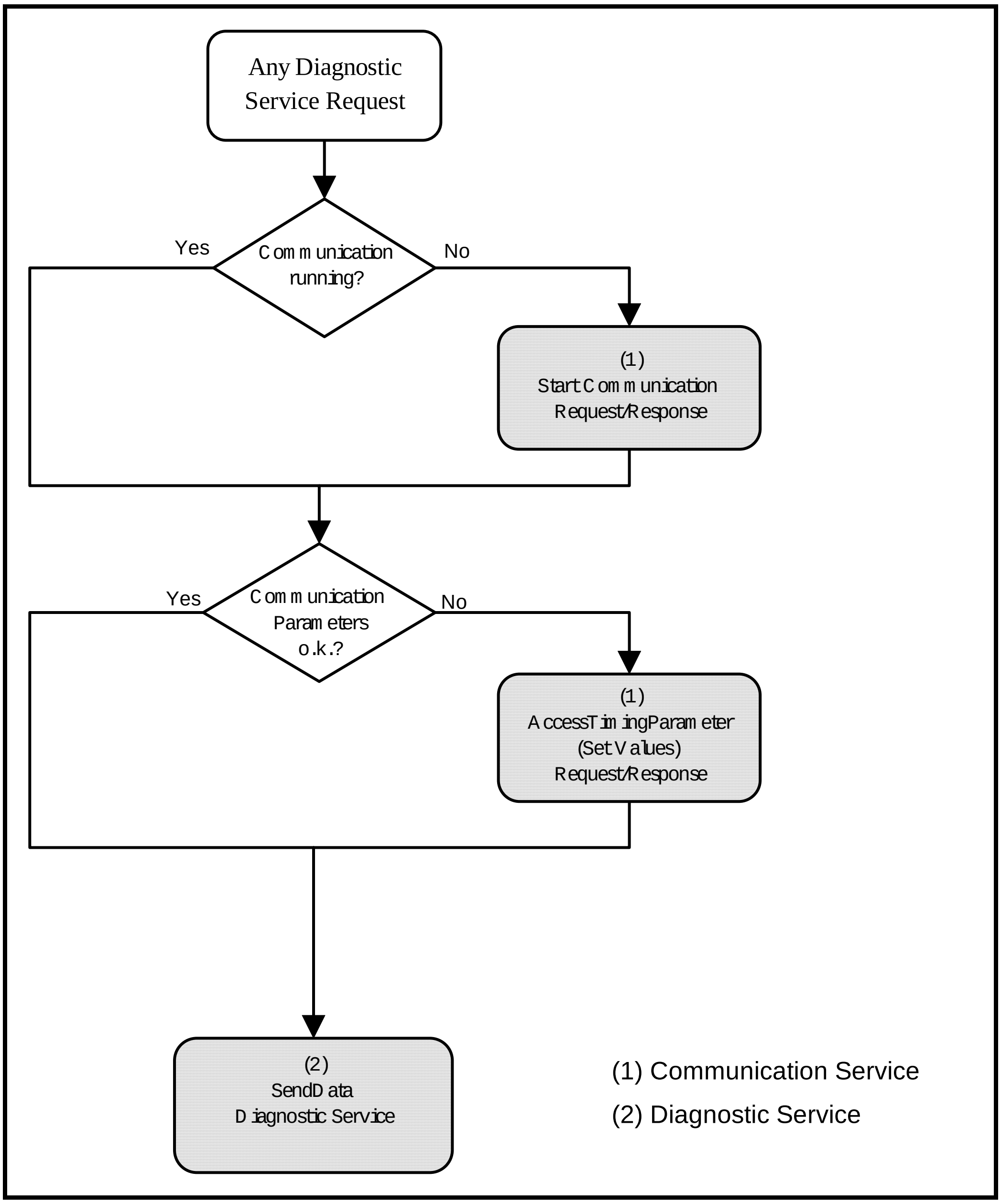


Figure 5 - Use of communication services

5.1 - StartCommunication Service

5.1.1 - Service Definition

5.1.2 - Service Purpose

The purpose of this KWP 2000 communication layer service is to initialise the communication link for the exchange of diagnostic data.

5.1.3 - Service Table

Table 3 - StartCommunication Service

StartCommunication Request	M
Initialisation Mode Identifier	M
Target Initialisation Address	M
Source Initialisation Address	C
StartCommunication Positive Response	M
Key bytes	M

C: Source initialisation address is added if Initialisation Mode Identifier = Fast Initialisation

Application Note: The way of initialisation is determined by the Initialisation Mode Identifier, the value of this parameter may be CARB-initialisation, 5-Baud initialisation or Fast initialisation.

5.1.4 - Service Procedure

Upon receiving a StartCommunication indication primitive, the ECU shall check if the requested communication link can be initialised under the present conditions. Valid conditions for the initialisation of a diagnostic communication link are described in section 5.1.5 "Implementation" of this document.
Then the ECU shall perform all actions necessary to initialise the communication link and send a StartCommunication response primitive with the positive response parameters selected.

If the communication link cannot be initialised by any reason, the ECU shall maintain its normal operation (see section 6, Error handling).

5.1.5 - Implementation

The StartCommunication Service is used to initialise a communication on the "K-line". There are different possibilities to initialise:

Initialisation mode identifier	
1	CARB initialisation
2	5 Baud initialisation
3	Fast initialisation

Figure 6 shows the three possibilities and the ECU status after each kind of initialisation.
After finishing the initialisation the ECUs are in the same status, regardless of the initialisation mode:

- all communication parameters are set to default values according to the key bytes.
- ECU is waiting for the first request of the tester for a time period of P3.
- ECU is in the default diagnostic mode (= has a well defined functionality).

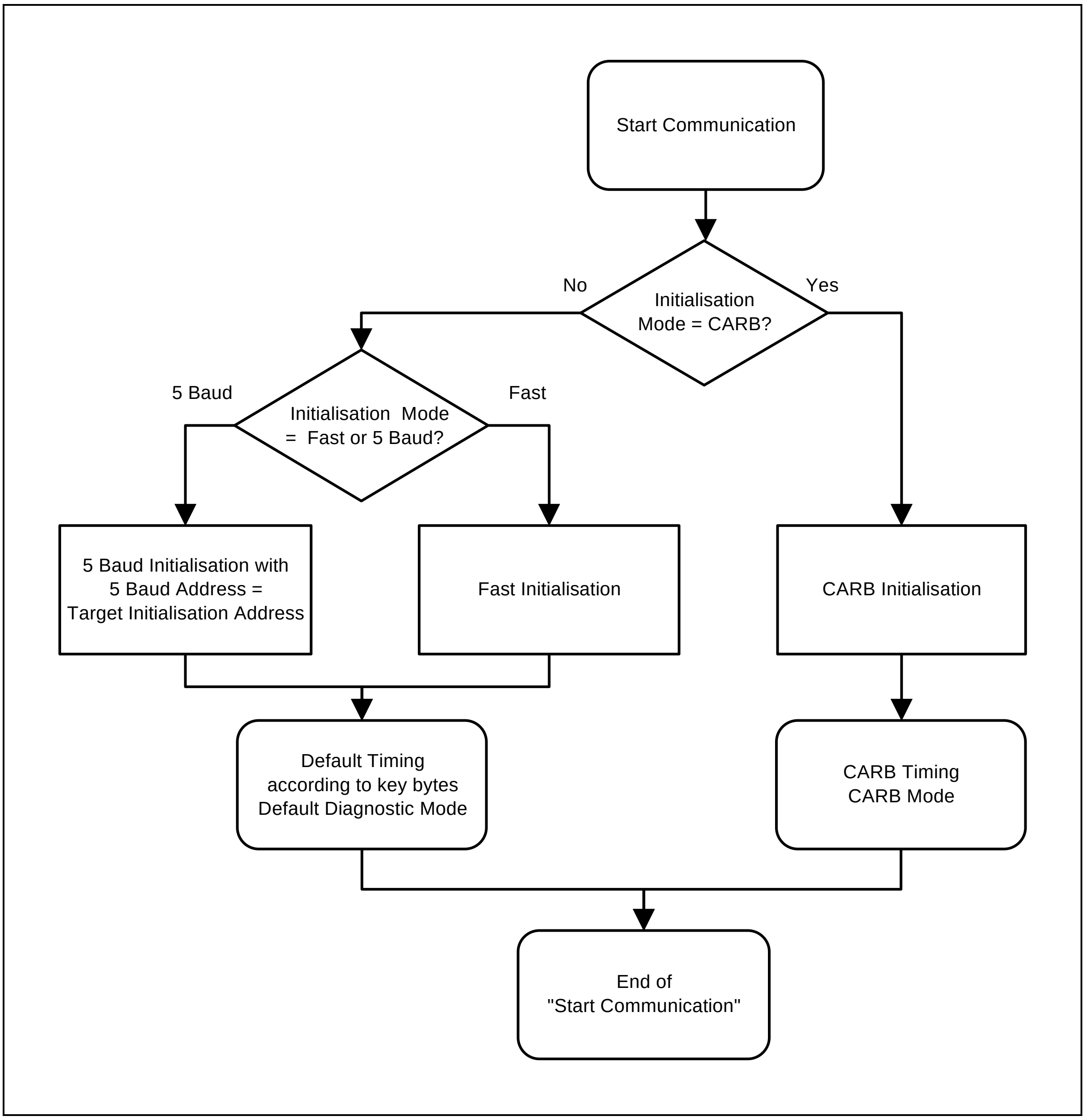


Figure 6 - Initialisation modes

There are general facts that are common to all modes of initialisation:

- Prior to any activity there shall be a bus-idle time.
- Then the tester sends an initialisation pattern.
- All information which is necessary to establish communication is contained in the response of the ECU.

5.1.5.1 - Key bytes

With these bytes an ECU informs the tester about the supported header, timing and length information. So an ECU not necessarily has to support all possibilities. The decoding of the key bytes is defined in ISO 9141:1989. KB1 = Low Byte, KB2 = High Byte, 7 bit, odd parity.

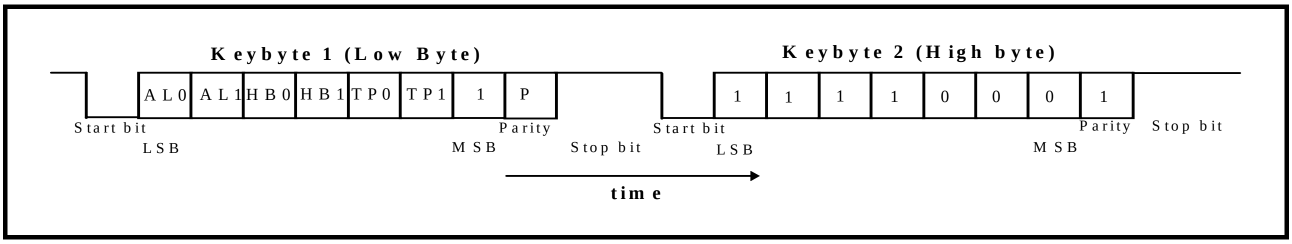


Figure 7 - Key bytes

Table 4 - Key bytes

	= 0	= 1
AL0	length information in format byte not supported	length information in format byte supported
AL1	additional length byte not supported	additional length byte supported
HB0	1 byte header not supported	1 byte header supported
HB1	Target/Source address in header not supported	Target/Source address in header supported
TP0*)	normal timing parameter set	extended timing parameter set
TP1*)	extended timing parameter set	normal timing parameter set

***) only TP0,TP1 = 0,1 and 1,0 allowed**

The following table lists all key bytes specified by this document:

Table 5 - Possible values of key bytes

<table>
<tr><th colspan="4">Key bytes</th><th colspan="2">Supported</th><th rowspan="2"></th></tr>
<tr><th>Binary
KB2 KB1</th><th></th><th>Hex</th><th>Dec.*)</th><th>Length information</th><th>Type of header</th></tr>
<tr><td>1000 1111</td><td>1101 0000</td><td>$8FD0</td><td>2000</td><td colspan="3">see Note</td></tr>
<tr><td>1000 1111</td><td>1101 0101</td><td>$8FD5</td><td>2005</td><td>format byte</td><td rowspan="3">1 byte header</td><td rowspan="9">extended timing</td></tr>
<tr><td>1000 1111</td><td>1101 0110</td><td>$8FD6</td><td>2006</td><td>additional length byte</td></tr>
<tr><td>1000 1111</td><td>0101 0111</td><td>$8F57</td><td>2007</td><td>both modes possible</td></tr>
<tr><td>1000 1111</td><td>1101 1001</td><td>$8FD9</td><td>2009</td><td>format byte</td><td rowspan="3">Header with target and source address information</td></tr>
<tr><td>1000 1111</td><td>1101 1010</td><td>$8FDA</td><td>2010</td><td>additional length byte</td></tr>
<tr><td>1000 1111</td><td>0101 1011</td><td>$8F5B</td><td>2011</td><td>both modes possible</td></tr>
<tr><td>1000 1111</td><td>0101 1101</td><td>$8F5D</td><td>2013</td><td>format byte</td><td rowspan="3">Both types of header supported</td></tr>
<tr><td>1000 1111</td><td>0101 1110</td><td>$8F5E</td><td>2014</td><td>additional length byte</td></tr>
<tr><td>1000 1111</td><td>1101 1111</td><td>$8FDF</td><td>2015</td><td>both modes possible</td></tr>
<tr><td>1000 1111</td><td>1110 0101</td><td>$8FE5</td><td>2021</td><td>format byte</td><td rowspan="3">1 byte header</td><td rowspan="9">normal timing</td></tr>
<tr><td>1000 1111</td><td>1110 0110</td><td>$8FE6</td><td>2022</td><td>additional length byte</td></tr>
<tr><td>1000 1111</td><td>0110 0111</td><td>$8F67</td><td>2023</td><td>both modes possible</td></tr>
<tr><td>1000 1111</td><td>1110 1001</td><td>$8FE9</td><td>2025</td><td>format byte</td><td rowspan="3">Header with target and source address information</td></tr>
<tr><td>1000 1111</td><td>1110 1010</td><td>$8FEA</td><td>2026</td><td>additional length byte</td></tr>
<tr><td>1000 1111</td><td>0110 1011</td><td>$8F6B</td><td>2027</td><td>both modes possible</td></tr>
<tr><td>1000 1111</td><td>0110 1101</td><td>$8F6D</td><td>2029</td><td>format byte</td><td rowspan="3">Both types of header supported</td></tr>
<tr><td>1000 1111</td><td>0110 1110</td><td>$8F6E</td><td>2030</td><td>additional length byte</td></tr>
<tr><td>1000 1111</td><td>1110 1111</td><td>$8FEF</td><td>2031</td><td>both modes possible</td></tr>
</table>

***): Calculation of decimal value: clear the parity bit of both key bytes, multiply key byte 2 by 2^7 and add key byte 1.**

Note: With value 2000D, the ECU does not give information about which options of the standard are supported. These options concern use of normal or extended timing, additional length byte, header with or without address information. In case of 5 baud initialisation the tester should know what options are implemented. In case of fast initialisation the use of header and length byte will be the same as in the StartCommunication service positive response of the ECU.

5.1.5.2 - Initialisation with 5 Baud address word

5.1.5.2.1 - CARB initialisation

For CARB purposes 5 baud initialisation is used only. It is a functional initialisation. Description see ISO 14230 KWP 2000 Part 4: Requirements For Emission Related Systems or ISO 9141-2. Messages are send to all emission related ECUs.

5.1.5.2.2 - 5 Baud Initialisation

The general form of a 5 baud initialisation is shown in figure 8. A 5 Baud address byte is transferred from the tester on the "K-Line" and on the "L-Line". After sending the 5 baud address byte the tester will maintain the "L-Line" on high level.
After receiving the 5 baud address byte the ECU will transmit the synchronisation pattern "$55" and the two key bytes with the actual communication baud rate. The tester transmits key byte 2 (inverse), then the ECU transmits the address byte (inverse).
In the case of physical initialisation the ECU has to answer according to figure 8.
Using functional initialisation (that means that more than one ECU is initialised) the vehicle manufacturer has to take care, that all ECUs use the same option of the protocol. Only one ECU has to perform the sequence of initialisation (figure 8).

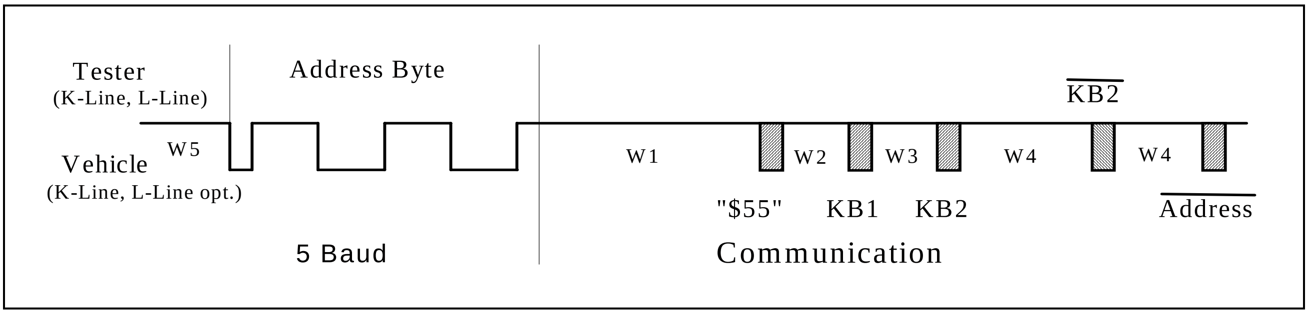


Figure 8 - 5 Baud initialisation

Table 6 - Timing values for 5 Baud initialisation

Timing Para-meter	Values in ms min.	max.	Description
W1	60	300	Time from end of the address byte to start of synchronisation pattern
W2	5	20	Time from end of the synchronisation pattern to the start of key byte 1
W3	0	20	Time between key byte 1 and key byte 2
W4	25	50	Time between key byte 2 (from the ECU) and its inversion from the tester. Also the time from the inverted key byte 2 from the tester and the inverted address from the ECU
W5	300	-	Time before the tester starts to transmit the address byte

These are fixed values. They cannot be changed by the AccessTimingParameter service.
Key bytes as defined above. Baud rates from 1200 to 10400 Baud are allowed for communication.
The tester will recognise the baud rate from the synchronisation byte ($55).

5.1.5.2.3 - Functional initialisation

With this procedure a group of ECUs is initialised. Address bytes which define a functional group of ECUs are listed in Appendix A.
Other manufacturer defined functional address bytes according to ISO 9141:1989 (i.e. odd parity) are possible.
Functional addressing is only possible, if all ECUs of a functional group use equal baud rates.
CARB initialisation is a special case of functional addressing.

5.1.5.2.4 - Physical initialisation

With this procedure only a single ECU is initialised.
5 Baud initialisation address is according to ISO 9141:1989. Odd Parity is used. Address bytes are manufacturer controlled.

5.1.5.3 - Fast Initialisation

All ECUs which are initialised must use a baud rate of 10400 baud for initialisation and communication.
The tester transmits a Wake up Pattern (WuP) on "K- and L-Line" synchronously. The pattern begins after an idle time on "K-line" with a low time of T_{iniL}. The tester transmits the first bit of the StartCommunication service after a time of t_{WuP} following the first falling edge.

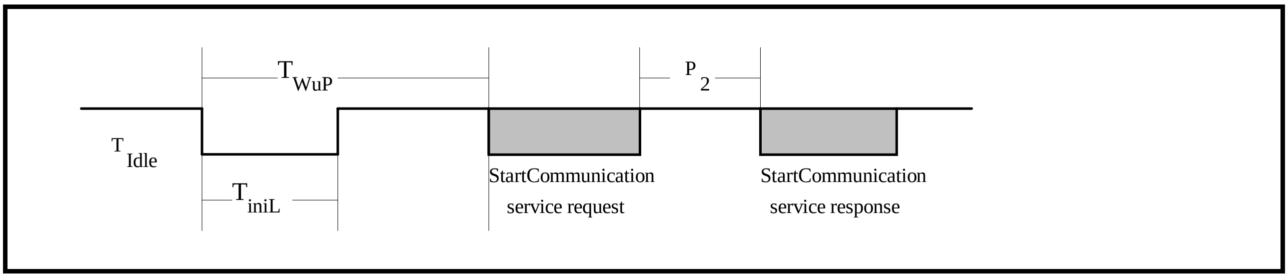


Figure 9 - Fast initialisation

Values of T_{WuP} and T_{inil} are defined in table 7:

Table 7 - Timing values for fast initialisation

		min	max
T_{iniL}	25 +/- 1 ms	24 ms	26 ms
T_{WuP}	50 +/- 1 ms	49 ms	51 ms

There are different possibilities for the idle time T_{Idle}:

- First transmission after power on: $T_{Idle} = W_5$
- After completion of StopCommunication service: $T_{Idle} = P_{3min}$
- After stopping communication by time-out P_{3max}: $T_{Idle} = 0$

The transfer of a Wake up Pattern as described above is followed by a StartCommunication Request from the tester and a response from the ECU. The first message of a fast initialisation always uses a header with target and source address and without additional length byte. An ECU may answer back with or without address information and length byte and tells its supported modes within the key bytes.

StartCommunication Request Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte physical addressing functional addressing	M	xx=[81 C1]	FMT
2	Target address byte	M	xx	TGT
3	Source address byte	M	xx	SRC
4	**startCommunication Request Service Id**	**M**	**81**	**STC**
5	Checksum	M	xx	CS

StartCommunication Positive Response Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**startCommunication Positive Response Service Id**	**S**	**C1**	**STCPR**
6	Key byte 1 (see 5.1.5.1 for use of key bytes) Key byte 2	M M	xx xx	KB1 KB2
7	Checksum	M	xx	CS

C1: Format byte is 10xx xxxx or 11xx xxxx; C2: Format byte is xx00 0000.

5.2 - StopCommunication Service

5.2.1 - Service Definition

5.2.1.1 - Service Purpose

The purpose of this KWP 2000 communication layer service is to terminate a diagnostic communication.

5.2.1.2 - Service Table

Table 8 - StopCommunication Service

StopCommunication Request	M
StopCommunication Positive Response	S
StopCommunication Negative Response Response Code	S M

5.2.1.3 - Service Procedure

Upon receiving a StopCommunication indication primitive, the ECU shall check if the current conditions allow to terminate this communication. In this case the server shall perform all actions necessary to terminate this communication.
If it is possible to terminate the communication, the ECU shall issue a StopCommunication response primitive with the positive response parameters selected, before the communication is terminated. If the communication cannot be terminated by any reason, the server shall issue a StopCommunication response primitive with the negative response parameter selected.

5.2.2 - Implementation

StopCommunication Request Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**stopCommunication Request Service Id**	**M**	**82**	**SPC**
6	Checksum	M	xx	CS

StopCommunication Positive Response Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**stopCommunication Positive Response Service Id**	**S**	**C2**	**SPCPR**
6	Checksum	M	xx	CS

StopCommunication Negative Response Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**negative Response Service Id**	**S**	**7F**	**SPCNR**
6	stopCommunication Request Service Identification	S	82	STC
7	ResponseCode*) = generalReject	M	xx = 10	RC
8	Checksum	M	xx	CS

***) Other response codes possible, see Keyword Protocol 2000 - Part 3: Implementation**
C1: Format byte is 10xx xxxx or 11xx xxxx
C2: Format byte is xx00 0000.

5.3 - AccessTimingParameter Service

5.3.1 - Service Definition

5.3.1.1 - Service Purpose

The purpose of this KWP 2000 communication layer service is to read and change the default timing parameters of a communication link for the duration this communication link is active.
Warning:
Use of this service is complex; it depends on ECU capability and physical topology. The user of this service is responsible for the functionality.

5.3.1.2 - Service Table

Table 9 - AccessTimingParameter Service

AccessTimingParameter Request	
Timing Parameter Identifier (TPI)	M
P2min	C1
P2max	C1
P3min	C1
P3max	C1
P4min	C1
AccessTimingParameter Positive Response	**S**
Timing Parameter Identifier (TPI)	M
P2min	C2
P2max	C2
P3min	C2
P3max	C2
P4min	C2
AccessTimingParameter Negative Response	**S**
Response Code	M
Timing Parameter Identifier (TPI)	M

C1: Condition is TPI = Set values
C2: Condition is TPI = Read limits, read current values

5.3.1.3 - Service Procedure

This procedure has four different modes:

- read limits of possible timing parameters
- set timing parameters to default values
- read currently active timing parameters
- set timing parameters to given values

Upon receiving an AccessTimingParameter indication primitive with TPI = 00, the ECU shall read the timing parameter limits, that is the values that the ECU is capable of supporting.
If the read access to the timing parameter is successful, the ECU shall send an AccessTimingParameter response primitive with the positive response parameters.
If the read access to the timing parameters is not successful, the ECU shall send an AccessTimingParameter response primitive with the negative response parameters.

Upon receiving an AccessTimingParameter indication primitive with TPI = 01, the server shall change all timing parameters to the default values and send an AccessTimingParameter response primitive with the positive response parameters before the default timing parameters become active.
If the timing parameters cannot be changed to default values for any reason, the ECU shall maintain the communication link and send an AccessTimingParameter response primitive with the negative response parameters.

Upon receiving an accessTimingParameter indication primitive with TPI = 10, the ECU shall read the currently used timing parameters.
If the read access to the timing parameters is successful, the ECU shall send an AccessTimingParameter response primitive with the positive response parameters.
If the read access to the currently used timing parameters is impossible for any reason, the ECU shall send an AccessTimingParameter response primitive with the negative response parameters.

Upon receiving an AccessTimingParameter indication primitive with TPI = 11, the ECU shall check if the timing parameters can be changed under the present conditions.
If the conditions are valid, the ECU shall perform all actions necessary to change the timing parameters and send an AccessTimingParameter response primitive with the positive response parameters before the new timing parameter limits become active.
If the timing parameters cannot be changed by any reason, the ECU shall maintain the communication link and send an AccessTimingParameter response primitive with the negative response parameters.

5.3.2 - Implementation

Selection of mode (read/write/current/limits) is by the Timing Parameter Identifier (TPI):

Read	**limits**	**0000 0000B**	**C4**
Set	**parameters to default values**	**0000 0001B**	**-**
Read	**current values**	**0000 0010B**	**C4**
Set	**values**	**0000 0011B**	**C3**

AccessTimingParameter Request Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**AccessTimingParameter Request Service Id**	**S**	**83**	**ATP**
6	Timing Parameter Identifier =[read limits of possible values, set parameter to default, read active parameters, set parameters]	M	xx=[00, 01, 02, 03]	TPI
7 8 9 10 11	P2min P2max P3min P3max P4min	C3 C3 C3 C3 C3	xx : : : xx	P2MIN P2MAX P3MIN P3MAX P4MIN
12	Checksum	M	xx	CS

AccessTimingParameter Positive Response Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**AccessTimingParameter Positive Response Service Id**	**M**	**C3**	**ATPPR**
6	Timing Parameter Identifier =[read limits of possible values, set parameter to default, read active parameters, set parameters]	M	xx=[00, 01, 02, 03]	TPI
7 8 9 10 11	P2min P2max P3min P3max P4min	C4 C4 C4 C4 C4	xx : : : xx	P2MIN P2MAX P3MIN P3MAX P4MIN
12	Checksum	M	xx	CS

AccessTimingParameter Negative Response Message

Byte	Parameter Name	CVT	Hex Value	Mnemonic
1	Format byte	M	xx	FMT
2	Target address byte	C1	xx	TGT
3	Source address byte	C1	xx	SRC
4	Additional length byte	C2	xx	LEN
5	**negative Response Service Id**	**S**	**7F**	**ATPNR**
6	AccessTimingParameter Request Service Id	S	83	ATP
7	ResponseCode*) = generalReject	M	xx = 10	RC
8	Checksum	M	xx	CS

***) Other response codes possible, see Keyword Protocol 2000 - Part 3: Implementation**
C1: Format byte is ‘10xx xxxx’ or ‘11xx xxxx’
C2: Format byte is ‘xx00 0000’.

5.4 - SendData Service

5.4.1 - Service Definition

5.4.1.1 - Service Purpose

The purpose of this KWP2000 communication layer service is to transmit the data from the service request over a KWP2000 communication link.

5.4.1.2 - Service Table

Table 10 - SendData Service

SendData Request	**M**
Service Data	M
SendData Positive Response	**S**
SendData Negative Response	**S**
Response Code	M

5.4.1.3 - Service Procedure

Upon a SendData request from the application layer, the respective data link layer entity of the message transmitter will perform all actions necessary to transmit the parameters of the request by a KWP 2000 message. This includes the determination of the message header (incl. the format byte), the concatenation of the message data, the checksum calculation, idle recognition, the transmission of message bytes and the timing surveillance (arbitration).

Upon receiving a message over a KWP 2000 communication link, the respective data link layer entity of the message receiver will perform all actions necessary to provide the received information to the respective application layer. This includes the recognition of a message start, the timing surveillance, the reception of message bytes, a checksum check, segmenting of the message data based on the format information and delivery of the message data to the application layer with a SendData indication primitive.

If the service was successfully completed (i.e. the message was transmitted), a SendData response primitive with the positive response parameter selected is delivered from the data link layer entity of the transmitting device to the respective application layer entity.

If the service cannot be performed by the data link layer entity of the transmission device, a SendData response primitive with the negative response parameters selected is delivered to the respective application layer entity.

6 - Error Handling

6.1 - Start Communication service

If the tester detects an error during the "StartCommunication Service" either by timing or by the bit stream, then the tester will wait for a period of W_5 before beginning the process again (starting with the wake up pattern). If an ECU detects an error in the sequence from the tester then it shall be immediately prepared to recognise another "StartCommunication Service".
Both tester and ECU are required to recognise failure to comply with maximum timing values. Minimum timing value transgressions need not be detected but are likely to cause bit stream errors.

6.2 - Mainstream Communications

It is allowed but not required that the tester and ECU(s) may monitor their own messages. This creates four areas where error handling can be defined. Each is discussed separately below and diagramatically represented in figure 10.

6.3 - ECU detected Tester transmission error

The ECU shall check each message by its checksum and number of bytes received before P_2max elapses. If either is in error then the ECU shall send no response and will internally ignore the whole message. The ECU is not required to check for other timing transgressions but may do so. Again no response should be given.
The ECU may detect other errors in the format or content of messages, but which satisfy the checksum and length requirements. In these cases, in order that the tester be aware that there is not a simple communications problem, the ECU should respond with the appropriate negative response message at least.

6.4 - Tester detected error in vehicle response

A single request may result in a single response from a single ECU or in multiple responses from several modules. The tester should check that all responses are correct both in terms of length and checksum as above. In case of an error or no response during P_{2max} it should retransmit the original message twice (i.e. three transmissions in total) before considering more severe error recovery processes. The application shall be informed of errors on the communication link. This will allow the application to make the appropriate action.

6.5 - ECU detected error in ECU response

The ECU may detect a difference between what it transmitted and what was detected on the "K - Line”. In this case it may either do nothing or retry the transmission within a period of P_2 after bus activity ceasing. This allows various bus management methods to be adopted.

6.6 - Tester detected error in tester transmission.

The tester may detect a difference between what it transmitted and what it detected on the "K - Line”. In this case it shall transmit the whole message and give an error report to the application. After the time P2max the tester may retransmit the request.

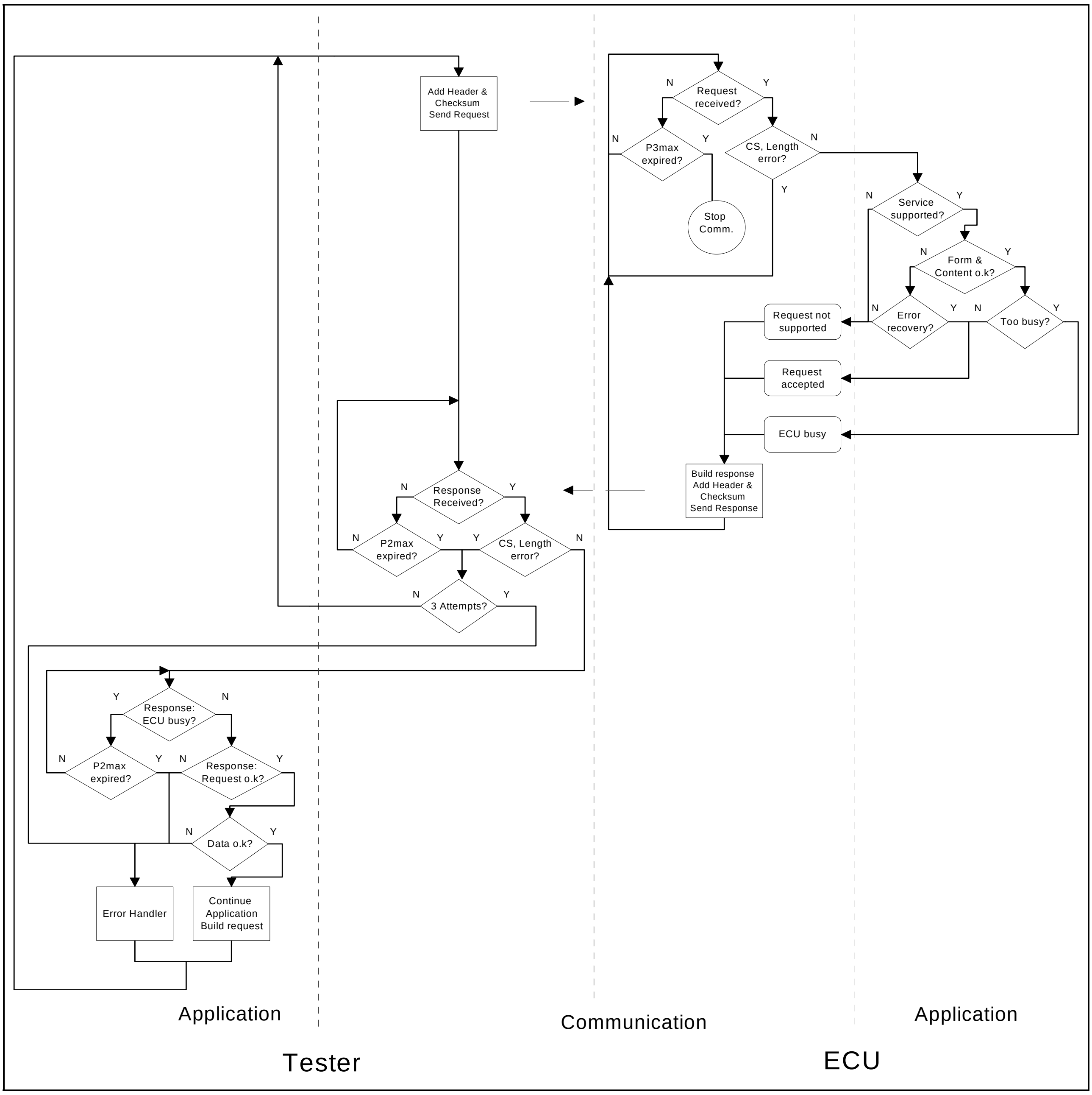


Figure 10 - Error Handling

Appendix A - ECU/Tester Addresses for 5 Baud Initialisation

This section is part of the International Standard.

Physical Addresses

According to ISO 9141:1989
Address byte consists of 1 start bit, 7 bit address, 1 parity bit (odd parity), at least 1 stop bit.
Addresses are controlled by car manufacturers.

Functional Addresses

Addresses with values < $80 are reserved for future standardisation.
Addresses with values > $80 are manufacturer specific.

Appendix B - ECU/Tester Addresses for fast initialisation

This section is for information only.
Addresses may be the same as used for 5 Baud initialisation (see Appendix A) or according to SAE J2178 Part 1.

Powertrain Controllers	**Hex**
Integration/Manufacturer Expansion	00 - 0F
Engine Controllers	10 - 17
Transmission Controllers	18 - 1F
Chassis Controllers	
Integration/Manufacturer Expansion	20 - 27
Brake Controllers	28 - 2F
Steering Controllers	30 - 37
Suspension Controllers	38 - 3F
Body Controllers	
Integration/Manufacturer Expansion	40 - 57
Restraints	58 - 5F
Driver Information/Displays	60 - 6F
Lightning	70 - 7F
Entertainment/Audio	80 - 8F
Personal Communication	90 - 97
Climate Control (HVAC)	98 - 9F
Convenience (Doors,Seats,Windows,etc)	A0 - BF
Security	C0 - C7
Future Expansion:	C8 - CF
Manufacturer Specific	D0 - EF
Off-Board Tester/Diagnostic Tools:	F0 - FD
All Nodes	FE
Null Nodes	FF