

Technical Specification	PSI5	I
	Peripheral Sensor Interface – Substandard Powertrain	V2.2

Peripheral Sensor Interface for Automotive Applications

Substandard Powertrain



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1 Introduction

20 The Substandard Powertrain substantiates the Base Standard document with the proposed operation modes
21 and frames formats for all sensors and transceivers used in powertrain applications.

22 Please be aware, that not every feature can be combined with every other one. Hence it is the responsibility
23 of the system vendor to evaluate which features are necessary to fulfill the system requirements and ensure
24 that the combination of features is compatible.

25 This substandard is effective with the PSI5 Base Specification standard V2.2. and all following versions of the
26 PSI5 Base Specification and is valid for all power train components.

27
28 The document is structured in a similar way to the PSI5 V2.2 Base Specification: Chapter 2 defines the
29 possible operation modes, whereas chapter 3 and 4 define details of the Sensor to ECU, or the ECU to
30 Sensor communication respectively. Chapter 5 describes Application Layer Implementations and in chapter 6
31 specific system parameters for powertrain applications are given.

2 System Setup & Operation Modes

32 Table 1 shows the possible operation modes for use in powertrain applications.

Communication Modes	
A	Asynchronous Mode
P	Synchronous Parallel Bus Mode
U	Synchronous Universal Bus Mode
V	Variable Time Triggered Synchronous Operation Mode
Error Detection	
CRC	Three Bits Cyclic Redundancy Check
Bit Rate	
L	125 kbps
Cycle time	
tttt	cycle time in μs (e.g. 500)
	or minimum allowed cycle time in μs for variable time triggered operation (e.g.. 228)

33 *Table 1 Powertrain operation modes*

34 The above selected operation modes exclude the use of synchronous daisy chain bus mode (PSI5-D) and
35 defines a 125kbps data rate.

36 A maximum of six time slots per sync period can be defined.

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3 Sensor to ECU Communication

- 37 All parts of the PSI5 Frame as defined in PSI5 Base Specification V2.2 can be applied.
- 38 An example of a payload data region for one signal transmission is given in Table 2. A 15bit payload data region, together with two start bits and three CRC bits for error detection, comprises the signal transmission.
- 39
- 40 The payload data region is composed of a 12bit Data Region A, two serial messaging bits and one status bit.

Bits	function	Number of bits
M0 ... M1	Serial messaging channel	2
E0	status	1
A0 ... A11	Sensor Data [Data region A]	12

- 41 *Table 2 Example of payload data region*

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3.1 Data Range

42 The Data Range definition is according to PSI5 Base Specification V2.2, chapter 3.3 with the following
43 definitions specifically for the powertrain application.

3.1.1 Data Region A

Value		Definition		Range	
Dec	Hex				
+511	0x1FF	Reserved (ECU internal use) *1		Status & Error Messages	2
:	:	Reserved (ECU internal use) *1			
+504	0x1F8	Reserved (ECU internal use) *1			
+503	0x1F7	Reserved (Sensor use) *2	Powertrain Substandard		
+502	0x1F6	Reserved (Sensor use) *2			
+501	0x1F5	Free to define by OEM/Supplier *4			
+500	0x1F4	PSI5: "Sensor Defect"			
+499	0x1F3	Reserved (ECU internal use) *1			
:	:	Reserved (ECU internal use) *1			
+496	0x1F0	Reserved (ECU internal use) *1			
+495	0x1EF	Reserved *4	Powertrain Substandard		
+494	0x1EE	Reserved *4			
+493	0x1ED	Temporary sensor error indication *4			
+492	0x1EC	Sensor functionality and processing error indication *4			
+491	0x1EB	Not a valid measurement value *4			
+490	0x1EA	Initialization *4			
+489	0x1E9	"Sensor in Service Mode"			
+488	0x1E8	"Sensor Busy"			
+487	0x1E7	"Sensor Ready"			
+486	0x1E6	"Sensor Ready but Unlocked" *3			
+485	0x1E5	Reserved (Sensor use) *2			
+484	0x1E4	Reserved (Sensor use) *2			
+483	0x1E3	Reserved (Sensor use) *2			
+482	0x1E2	Bidirectional Communication: RC "Error"			
+481	0x1E1	Bidirectional Communication: RC "O.K."			
+480	0x1E0	Maximum Sensor Data Value	Powertrain Substandard	Sensor Output Signal	1
:	:	:			
0	0x000	:			
:	:	:			
-480	0x220	Minimum Sensor Data Value		Block ID's and Data for Initialization	3
-481	0x21F	Status Data 1111			
:	:	:			
-496	0x210	Status Data 0000			
-497	0x20F	Block ID 16			
:	:	:			
-512	0x200	Block ID 1			

44 Table 3 Definition of Data Region A with 10bit
45

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- 46
- 47 (*1) Usage for ECU internal purpose possible (e.g. “No Data”, “Manchester Error” etc.)
- 48 (*2) Reserved for future extensions of this specification. These data values may not be assigned to any
49 other use
- 50 (*3) Indication for Sensor in “Production State” with powertrain application
- 51 (*4) Specific Definition of Powertrain Substandard

52 The scaling of Data Range A for data words longer than 10 bit is to be done as defined with PSI5 Base
53 Specification V2.2, chapter 3.3.2 except that the remaining unused bits are to be filled up with the value 0.

54 3.1.2 Data Region B

55 Data values in Data Region B (m bit) can be used in two different ways:

- 56 • Transparent Mode with free use of all m bits
- 57 • Measurement Data Mode with transmission of measurement data and 8 reserved values for
58 powertrain messaging (unsigned m bits)

59 In the Transparent Mode all data values from 0 to 2^m-1 are available. This mode can be used for example for
60 the transmission of rolling counter values.

61 In the Measurement Data Mode out of the m bits with values from 0 to 2^m-1 eight values are assigned to Error
62 Indicators, Specific and Initialization Messages as defined in chapter 3.1.2.1. Accordingly this mode has to be
63 defined with Data Region B with $m \geq 3$ bit, however typically a definition of $m = 8,10,12$ bit will be done for
64 reasonable transmission of sensor measurement data.

3.1.2.1 Data Region B: Reserved Values in Measurement Data Mode

65 Table 4 defines the assignment of the eight reserved addresses to Error Indicators, Specific and Initialization
66 Messages if the measurement data mode is applied for Data Region B.

	Value ($m=12\text{bit Data}$)	Definition	Comment
2^m-1	4095	Production state	Used to indicate production state of sensor (e.g. for manufacturing purposes)
2^m-2	4094	Free to define by OEM/Supplier	
2^m-3	4093	Reserved	
2^m-4	4092	Reserved	
2^m-5	4091	Temporary sensor error indication	Generic temporary error
2^m-6	4090	Sensor functionality and processing error indication	Sensor status: Signal processing and sensor functionality errors
2^m-7	4089	Not a valid measurement value	Invalid data values, not-a-number (or measurements with reduced reliability)
0	0	Initialization	The initialization message is transmitted during the sensor initialization phase until valid measurement values are available.

67 Table 4 Error Indicators / Specific Messages / Initialization Message

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3.1.3 Error Indicators, Specific and Initialization Messages in Data Region A and B

68 Table 5 shows how the powertrain application specific Error Indicators, Specific and Initialization Messages
69 are assigned to values of Data Region A and B.

Message Definition	Value	
	Data Region A	Data Region B
Production state	$2^{n-1}-26 \cdot 2^{n-10}$	2^m-1
Free to define by OEM/Supplier	$2^{n-1}-11 \cdot 2^{n-10}$	2^m-2
Reserved	$2^{n-1}-17 \cdot 2^{n-10}$	2^m-3
Reserved	$2^{n-1}-18 \cdot 2^{n-10}$	2^m-4
Temporary sensor error indication	$2^{n-1}-19 \cdot 2^{n-10}$	2^m-5
Sensor functionality and processing error indication	$2^{n-1}-20 \cdot 2^{n-10}$	2^m-6
Not a valid measurement value	$2^{n-1}-21 \cdot 2^{n-10}$	2^m-7
Initialization	$2^{n-1}-22 \cdot 2^{n-10}$	0
Reserved (Sensor use)	$2^{n-1}-9 \cdot 2^{n-10}$	-
Reserved (Sensor use)	$2^{n-1}-10 \cdot 2^{n-10}$	-

70 Table 5 Addresses of Error Indicators, Specific and Initialization Messages in Data Region A and B

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3.2 Serial Channel

71 The data content definition of the serial data frame of the serial channel is according to the definitions of SAE
72 J2716 APR2016 SENT, Appendix D.1 to D.6 with details and exceptions as described in this chapter.

73 The composition of a serial message with a serial data frame out of the messaging bits is according to PSI5
74 Base Specification V2.2, chapter 3.4.

75 The PSI5 Base Specification V2.2, chapter 3.4 follows SAE J2716 APR2016 SENT, chapter 5.2.4.2
76 Enhanced Serial Message Format and ch. 5.2.4.3 Enhanced Serial Message Format CRC.

77 All channel definition in SAE J2716 APR2016 SENT with Channel 1 refers to Data Region A and Channel 2
78 refers to Data Region B of PSI5 Frame Format.

3.2.1 8bit Serial ID

79 The list of valid 8bit serial IDs is described in SAE J2716 APR2016 SENT, Appendix D.1.

80 With the message ID 0x05 the Vendor ID is transmitted in the 12bit data field with assignments given in PSI5
81 Base Specification V2.2, chapter 5.1.4. The assigned 8 bit values of the Vendor ID are mapped into 12 bit
82 data field of the serial data frame starting LSB first with 4 MSB filled up with the value 0.

83 With the 8 bit Message ID 0x06 the protocol standard revision is transmitted with 12 bit data field definition
84 given in chapter 3.2.2.

3.2.2 Protocol Standard Revision

85 With the message ID 0x06 the protocol standard revision is transmitted in the 12 bit data field of the serial
86 data frame. The list of 12 bit codes is given hereafter in Table 6.

12 bit Code	Definition	Comment
0x000	not specified	
0x001 – 0x0FF	reserved for SENT Protocol Standard Revisions	
0x100	PSI5 2.0	
0x101	PSI5 2.1	
0x102	PSI5 2.2	
x103 - 0xFFE	reserved	
0xFFF	not specified	

87 *Table 6 List of 12bit codes for Protocol standard revision*

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4 ECU to Sensor Communication

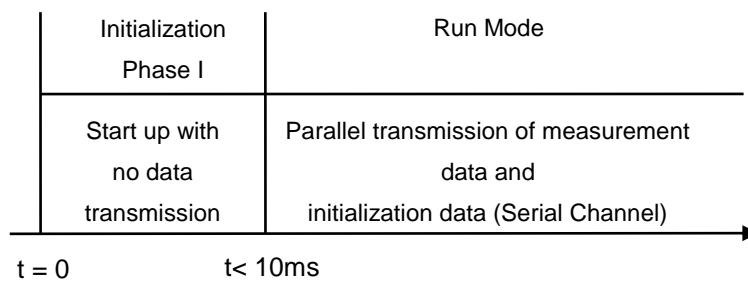
- 88 The optional ECU to Sensor Communication is realized using the “Pulse Width” method as specified in PSI5
89 Base Specification V2.2, chapter 4.1.2.
- 90 The Frame format for the ECU to sensor communication is Frame 4 "XXLong" with configuration bit [0]
91 according to PSI5 Base Specification V2.2, chapter 4.2..
- 92 Synchronization pulses with a pulse width beyond the specified range (sync signal sustain time <16µs or
93 >62µs) are ignored by the sensor.

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5 Application Layer Implementations

5.1 Sensor Initialization / Identification

94 Sensor Initialization and Identification is executed in Serial Channel Method according to PSI5 Base
 95 Specification V2.2, chapter 5.1.
 96 After power up of the system the Initialization Phase I follows where no data is transmitted and the ECU can
 97 perform a connectivity test or sensor self tests can be executed.



98 *Figure 1 Initialization of the Bus*

99 With application of the Serial Channel Method some constraints and requirements as defined with SAE
 100 J2716 APR2016 SENT, Appendix D.7 have to be considered.

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6 Physical Layer - Parameter Specification

6.1 System Parameters

101 The PSI5 interface implementation can be made with the following selected parameters by either applying the
 102 “Common Mode” (Table 7) or the “Low Power Mode” (Table 8) as specified in PSI5 Base Specification V2.2,
 103 chapter 6.1.2.

104 Common Mode

N°	Parameter	Symbol	Min	Typ	Max	Unit
2	Supply Voltage (low voltage)	V_{SS}	4.0		11.0	V
6	Sink current ΔI_s	$\Delta I_s = I_{s,High} - I_{s,Low}$	22.0	26.0	30.0	mA
7	Sync signal sustain voltage, referenced to $V_{SS, BASE}$	V_{I2}	2.5			V
9	Internal ECU resistance	R_E	5		9.5	Ω

105 *Table 7 Selected System Parameters for Common Mode implementation*

106 Due to standard sensor sink signal current in combination with low supply voltage, special attention needs to
 107 be paid concerning sensor power dissipation and supply voltage ripples.

108 Low Power Mode

N°	Parameter	Symbol	Min	Typ	Max	Unit
2	Supply Voltage (low voltage)	V_{SS}	4.0		11.0	V
6	Sink current ΔI_s	$\Delta I_s = I_{s,High} - I_{s,Low}$	11.0	13.0	15.0	mA
7	Sync signal sustain voltage, referenced to $V_{SS, BASE}$	V_{I2}	2.5			V
9	Internal ECU resistance	R_E	5		9.5	Ω

109 *Table 8 Selected System Parameters for Low Power Mode implementation*

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6.2 Sensor Power-on Characteristics

110 To ensure a proper startup of the system in powertrain applications the parameters and definitions for Sensor
 111 Bus Configuration of PSI5 Base Specification V2.2, chapter 6.2.1 shall be applied.
 112 An Extended Settling Time t_{SET2} as defined in PSI5 Base Specification V2.2, chapter 6.2.2 is not allowed.

6.3 Undervoltage Reset and Microcut Rejection

113 For powertrain sensors, an undervoltage reset is optional and should be defined component specific, if
 114 implemented.
 115 If sensor supply voltage drops below $V_{SS,min}$ no reset of the sensor is allowed between $V_{SS} = 4.0V$ and $V_{SS} =$
 116 $3,8V$.
 117 The functional performance within this sensor supply voltage range is defined as follows:
 118

- Sensor can interrupt data transmission but must not restart internal initialization.
- If the sensor continues sending data it must be within the sensor specification or clearly marked as corrupt.
- Sensor must continue data transmission when voltage returns to normal operation within the next transmission period.

 121
 122

6.4 Data Transmission Parameters

N°	Parameter	Symbol/Remark	Min	Typ	Max	Unit
3*	Sensor clock deviation during data frame	Option 1			1	%

123 *Table 9 Data transmission parameters for powertrain applications*
 124 3*) @ maximum temperature gradient and maximum frame length; the overall transmitter clock
 125 tolerance must not be exceeded.

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7 Document History & Modifications

Rev.N°	Chapter	Description / Changes	Date
2.0	all	First Release of Powertrain Substandard; Revision Number of corresponding PSI5 Base Document adopted	01.06.2011
2.1	all	Editorial changes	05.10.2012
	3.1	Chapter added: Data Range	
	3.2	Chapter added: Serial Channel	
	5.1	– Mandatory transmission of Meta Header during initialization removed – Link to SAE J2716 JAN2010 SENT added	
	6	– Optional definition of sensor undervoltage reset added – Supply voltage range added where no sensor reset is allowed	
	6.3	– Chapter added: Data Transmission Parameters	
2.2 draft	all	Editorial changes	18.05.2016
	div.	Reference to PSI5 Base Specification changed from V2.1 to new version V2.2	
	div.	Reference to SAE J2716 SENT changed from JAN2010 to new released version APR2016	
	3.2.2	12 bit code for Protocol Standard Revision PSI5 V2.2 added	
	6.1	Table 7 and Table 8 added to replace System Parameter definitions within text body	
	6.2	Chapter added: Sensor Power-on Characteristics	
	6.4	Table 9 update due do change in Base Standard including Footnote	

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