Peripheral Sensor Interface for Automotive Applications

Substandard Airbag

1 Introduction

One significant feature of the PSI5 V2.0 is the implementation of alternative PSI5 physical and Data Link Layer parameters motivated by extended application requirements. In addition to the base standard application specific frameworks and conditions are given in corresponding substandards, where recommended operation modes and system configurations are given, as well as forbidden configurations are excluded.

Please be aware, that not every feature can be combined among one other. Hence it is in responsibility of the system vendor to evaluate which feature is necessary to fulfill the system requirements and assure that the combination of features is compatible.

This substandard is effective with the PSI5 Base standard V2.0 and is valid for all airbag components. It is in full compliance to the previous PSI5 standard PSI5 V1.3.

The document is structured similar to the PSI5 V2.0 Base Specification Standard: Chapter 2 gives recommended operation modes, whereas Chapter 3 and 4 define details of the Sensor to ECU, or the ECU to sensor communication, respectively. Chapter 5 describes Application Layer Implementations and in Chapter 6 specific system parameters and timings for airbag applications are given.

2 Recommended Operation Modes

Asynchronous Operation		
Mode	Sensor Data	Description
A8P	250/1L	min. 1 value each 250µs (incl. tolerances)
A10P	250/1L	min. 1 value each 250µs (incl. tolerances)
A16CRC	500/1L	min. 1 value each 500µs (incl. tolerances)
Synchronous Operation		
Bus Mode	Sensor Data	Description
P10P	250/1L	Single sensor 4kHz data transmission
P10P	500/2L	Two message slot parallel bus / 500µs data rate
P10P	500/3L	Three message slot parallel bus / 500µs data rate
P10P	500/4H	Four message slot parallel bus / 500µs data rate
P16CRC	500/2L	Two high resolution sensors parallel bus / 500µs data rate

3 Sensor to ECU communication

Basically the full data range as specified within the Base Specification can be applied to. Recommended Data word length is a 10 bit data word (payload) with two start bits and one Parity bit for error detection.

3.1 Scaling of Data Range

For sensors with a data word length of more than 10 bit, the data range scales as described in the PSI5 V2.0 Base Specification. Furthermore, the following definition is effective: status and initialization data words of range 2 and 3 are filled up with the value of the bit corresponding to the “D0” bit in the 10 Bit data word (possibility to check for stuck bits in the receiver).

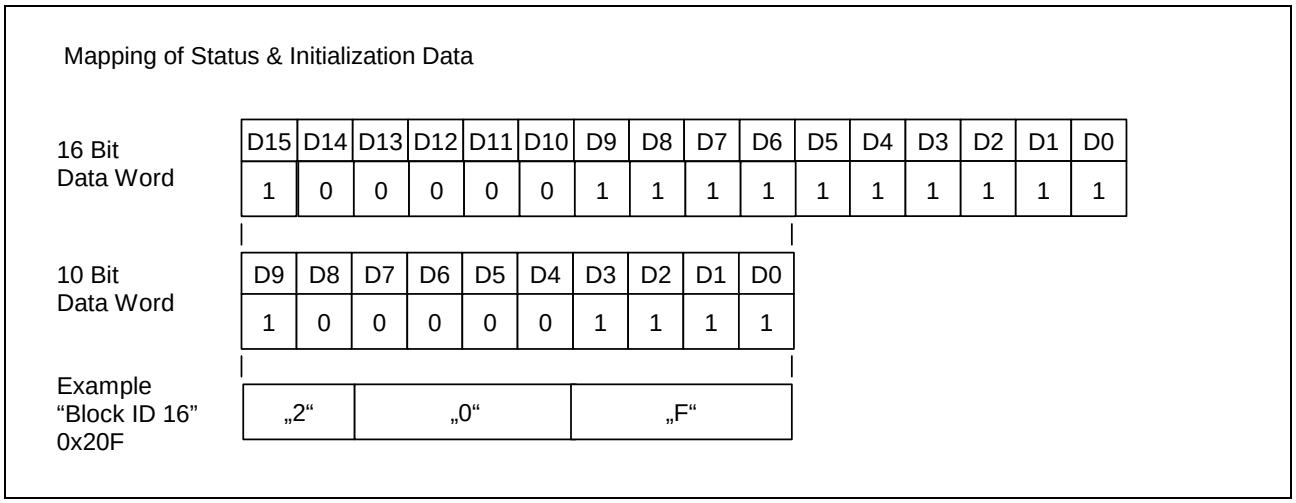

Figure 1 Mapping of status and initialization data into a data word

Dec	Hex	Signification	Range	
32767	0x7FFF	Reserved (ECU internal use)	Status & Error Messages	2
+31168	0x79FF	Sensor Ready		
:	:			
+30720	0x7800	Highest Positive Sensor Signal	Sensor Output Signal	1
:	:	:		
0	0x0000	Signal Amplitude "0"		
:	:	:		
-30720	0x8800	Highest Negative Sensor Signal		
-30784	0x87FF	Status Data 1111	Block ID's and Data for Initialisation	3
:	:	:		
-31744	0x8400	Status Data 0000		
-31808	0x83FF	Block ID 16		
:	:	:		
-32768	0x8000	Block ID 1		

Table 1 Scaling example: Data Range for a 16 Bit data frame

4 ECU to Sensor (bidirectional) communication

ECU to Sensor communication is executed in Tooth gap mode as defined in the base standard. Sensor response during bidirectional communication is carried out in Data range codes RC, RD1 and RD2.

5 Application Layer Implementations

5.1 Sensor start up an Initialization

Sensor identification data is sent via Data Range Initialization. The initialization phase is divided into three phases and the data message repetition count k typically has a value of 4.

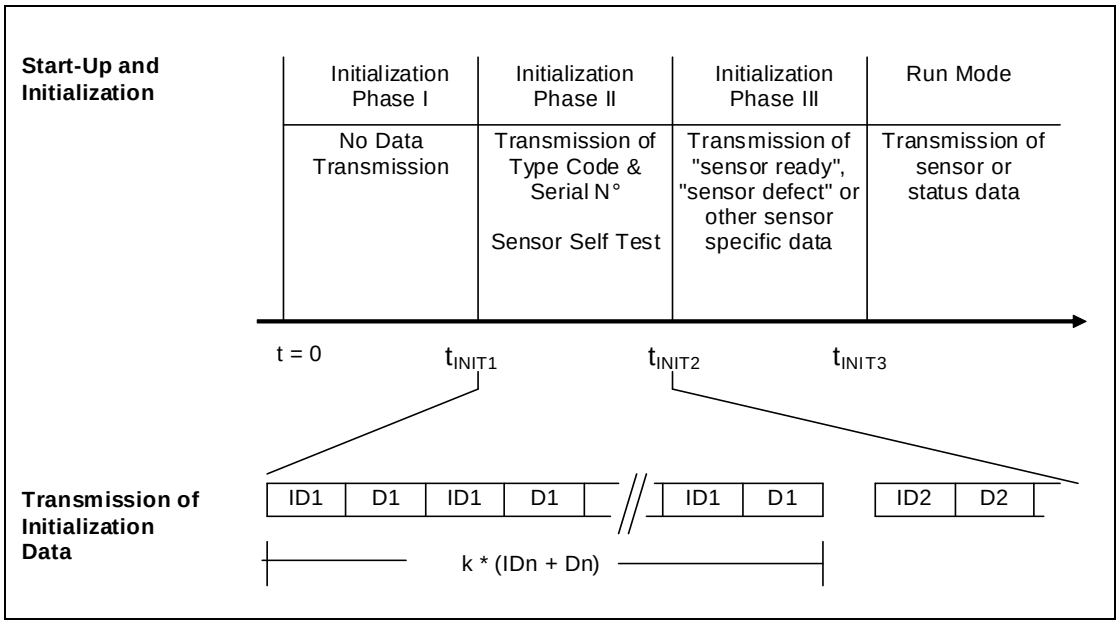

Figure 2 Initialization of the sensor

	Initialisation Phase I	Initialisation Phase III
Duration of initialization phases	t = 50…150 ms Typical: 100 ms	Minimum: 2 messages Maximum: 200 ms Typical: 10 values

Initialization Data Content:

The following definitions are made in addition to the Base Specification.

Mandatory definitions:

	Head	**Initialization**		**Vendor ID**		**Product ID**			
Data field	F1	F2		F3		F4		F5	
Data nibble	D1	D2	D3	D4	D5	D6	D7	D8	D9
	PSI5 v.	# of Datablocks		Vendor ID		Sensor type		Sensor param.	

Recommended definitions:

	Application specific											
Data field	F6		F7			F8				F9		
Data nibble	D10	D11	D12	D13	D14	D15	D16	D17	D18	D19	**...**	D32
	Sensor manuf.		Sensor application			Sensor production date				Sensor trace inf.		

Field	Name	Parameter definition	Value
F1 (D1)	Meta Information	Protocol Description (D1) PSI5 1.x PSI5 2.0, Data Range Initialization	 0100 0110
F2 (D2, D3)	Initialization data Length Number of Data nibbles transmitted	Example: F1-F9	Example: 0010 0000
F3 (D4, D5)	Vendor ID	s. Base Specification Ch. 5.1.4	
F4 (D6, D7) F5 (D8,D9)	Sensor Type Definition of the sensor type (acceleration, pressure, temperature, torque, force, angle, etc.) Sensor Parameter Definition of sensor specific parameters e.g . measurement range.	Acceleration Sensor (High g) Information depending on the corresponding sensor type	XXXX 0001 Sensor specific definition

6 Physical Layer - Parameter Specification and timings

6.1 System Parameters

Airbag systems are implemented in “Common Mode” as defined in the Base Specification Document. In order to achieve full backward compatibility with the former PSI5 V1.3 standard, the following parameter selection is necessary.

PSI5 Common Mode

- Supply Voltage (standard mode); $V_{CE,\ min}$ = 5.5V; $V_{SS,\ min}$ = 5.0V
- Sync signal sustain voltage V_{t2} = 3.5V
- Internal ECU Resistance $R_{E,\ max}$ = 12.5Ω

With this selection the optional given system parameters N° 2, 4, 7, 9 and 12 of the “common mode” table in the PSI5 V2.0 Base Specification are excluded for airbag applications.

6.2 Timings

Please note that due to backward compatibility the values given below are adopted from PSI5 V1.3. Derivations to calculated timeslots according to Ch. 6.6 in the PSI5 V2.0 Base Standard are possible.

6.2.1 PSI5-P10P-500/3L Mode

This example is calculated with a standard sensor clock tolerance of 5%.

N°	Parameter	Symbol	Remark	min	nom	max	Unit
1	Sync signal period Maximum tolerance of sync signal period +/-1	T_{Sync}		495		505	µs
				t^{N}_{Ex}	t^{N}_{Nx}	t^{N}_{Lx}	
2	Slot 1 start time	t^{1}_{xS}	Related to t_0	44			µs
3	Slot 1 end time	t^{1}_{xE}	Related to t_0				µs
4	Slot 2 start time	t^{2}_{xS}	Related to t_0	181.3			µs
5	Slot 2 end time	t^{2}_{xE}	Related to t_0				µs
6	Slot 3 start time	t^{3}_{xS}	Related to t_0	328.9			µs
7	Slot 3 end time	t^{3}_{xE}	Related to t_0			492	µs

The timings also apply for universal bus mode and daisy chain bus mode.

6.2.2 PSI5-P10P-500/4H Mode

This example is calculated with a standard sensor clock tolerance of 5%.

N°	Parameter	Symbol	Remark	min	nom	max	Unit
1	Sync signal period Maximum tolerance of sync signal period +/-1	T_{Sync}		495		505	µs
				t^{N}_{Ex}	t^{N}_{Nx}	t^{N}_{Lx}	
2	Slot 1 start time	t^{1}_{xS}	Related to t_0	44			µs
3	Slot 1 end time	t^{1}_{xE}	Related to t_0				µs
4	Slot 2 start time	t^{2}_{xS}	Related to t_0	139.5			µs
5	Slot 2 end time	t^{2}_{xE}	Related to t_0				µs
6	Slot 3 start time	t^{3}_{xS}	Related to t_0	245.5			µs
7	Slot 3 end time	t^{3}_{xE}	Related to t_0				µs
8	Slot 4 start time	t^{4}_{xS}	Related to t_0	362.5			µs
9	Slot 4 end time	t^{4}_{xE}	Related to t_0			492	µs

The timings also apply for universal bus mode and daisy chain bus mode.

7 Document History & Modifications

Rev.N°	Chapter	Description / Changes	Date
2.0	all	First Release of Airbag Substandard; Revision Number of corresponding PSI5 Base Document adopted	01.06.2011