SesKion

Peripheral Sensor Interface

for Automotive Applications

Substandard

Vehicle Dynamics Control

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 safety chassis components. Sensor components within the vehicle Dynamics Control (VDC) domain should use this substandard, which is based upon the previous airbag standard PSI5 V1.3 adding the capability for larger data words in order to allow sensor systems with higher precision.

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 VDC applications are given.

2 Recommended Operation Modes

Asynchronous Operation		
Mode	Sensor Data	Description
A20CRC	300/1L	min. 1 value each 300µs (incl. tolerances)
A20CRC	200/1H	min. 1 value each 200µs (incl. tolerances)
Synchronous Operation		
Bus Mode	Sensor Data	Description
P20CRC	500/1L	One message slot parallel bus / 500µs data rate
P20CRC	500/2L*	Two message slot parallel bus / 500µs data rate
P20CRC	500/2H	Two message slot parallel bus / 500µs data rate
P20CRC	500/3H*	Three message slot parallel bus / 500µs data rate

*) This mode requires a tighter sensor clock tolerance as typically assumed (<5%) or dependent sensors within each time slot (so that sync detection variations and clock tolerances do not add up).

3 Sensor to ECU communication

Basically the full data range as specified in the PSI5 base standard can be applied. Recommended data word length is a 20 bit data word with two start bits, three CRC bits for error detection and the following data regions:

Bits	Function	Number of bits
F[0] … F[2]	Frame control	3
E[0]	Status	1
A[0] … A[15]	Payload Data	16

Bits	function	Number of bits
B[0] … B[9]	Payload Data	10
A[0] … A[9]	Payload Data	10

4 ECU to Sensor (bidirectional) communication

ECU to Sensor communication is executed with the Tooth Gap method as defined in the base standard. Sensor response during bidirectional communication is carried out in Data range codes RC, RD1 and RD2. Optionally, for XLong Frames the FC, RAdr and Data Fields can be used otherwise than specified in the Base Standard, i.e. all existing function codes may be applied, followed by the RAdr and Data Field free to use for 16 bit data. Sensor response still has to be executed during the following three sync periods, other response codes as RC, RD1 or RD2 are allowed.

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.

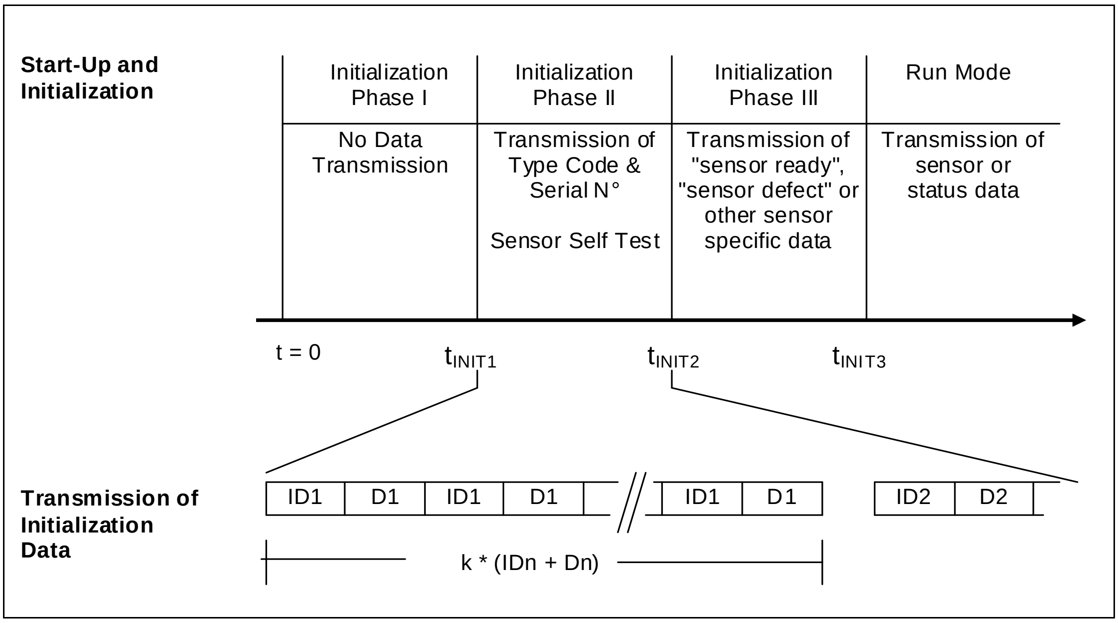

Figure 1 Initialization of the sensor

	Initialisation Phase I	Initialisation Phase III
Duration of initialization phases	t = 50…200 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

6.1 System Parameters

VDC systems are implemented in “Common Mode” as defined in the Base Specification Document with the following parameter selection.

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 $R_{E, max} = 12.5\Omega$

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 VDC applications.

6.2 Timing example for PSI5-P20CRC-500/1L 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	46,5	59	µs
3	Slot 1 end time	t^{1}_{xE}	Related to t_0	234	246,5	269	µs

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

The timings for earliest start and latest end reflect the time span for a maximum time window (“receiver view”); Sensors should be programmed with nominal start times (“sensor view”).

6.3 Timing example for PSI5-P20CRC-500/2L Mode

This example calculates the slot timings for two independent sensors within one sync period, a sensor clock tolerance of 1.8% and a time discretization of 0.5us.

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	45	56	µs
3	Slot 1 end time	$t^1{}_{xE}$	Related to t_0	240	245	259,5	µs
4	Slot 2 start time	$t^2{}_{xS}$	Related to t_0	267,5	273	288	µs
5	Slot 2 end time	$t^2{}_{xE}$	Related to t_0	464	473	492	µs

The timings also apply for universal bus mode and daisy chain bus mode.
The timings for earliest start and latest end reflect the time span for a maximum time window ("receiver view"); Sensors should be programmed with nominal start times ("sensor view").

6.4 Frame slot example for PSI5-P20CRC-500/2H Mode

This example is calculated with standard sensor clock tolerance of 5% for two independent sensors within one sync slot. Start time discretization is 0.5us.

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	46,5	59	µs
3	Slot 1 end time	$t^1{}_{xE}$	Related to t_0	169,5	179	198	µs
4	Slot 2 start time	$t^2{}_{xS}$	Related to t_0	203,5	214,5	235,5	µs
5	Slot 2 end time	$t^2{}_{xE}$	Related to t_0	329	347	374,5	µs

The timings also apply for universal bus mode and daisy chain bus mode.
The timings for earliest start and latest end reflect the time span for a maximum time window ("receiver view"); Sensors should be programmed with nominal start times ("sensor view").

6.5 Frame slot example for PSI5-P20CRC-500/3H Mode

This example is calculated with enhanced sensor clock tolerance of 1.5% with the first two time slots provided by one sensor (equal and correlated clock and sync detection tolerance). Start time discretization is 0.5us.

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	45	56	µs
3	Slot 1 end time	$t^1{}_{xE}$	Related to t_0	174,5	177,5	190,5	µs
4	Slot 2 start time	$t^2{}_{xS}$	Related to t_0	180	183,5	196,5	µs
5	Slot 2 end time	$t^2{}_{xE}$	Related to t_0	310,5	316	331	µs
6	Slot 3 start time	$t^3{}_{xS}$	Related to t_0	336	341,5	357	µs
7	Slot 3 end time	$t^3{}_{xE}$	Related to t_0	466,5	474	491,5	µs

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

The timings for earliest start and latest end reflect the time span for a maximum time window (“receiver view”); Sensors should be programmed with nominal start times (“sensor view”).

7 Document History & Modifications

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