Pitot-Static System PSS-8/PSS-8M/PSS-8X

Interface Definition Document

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	Signature	Date
Prepared by	_____	_____
Checked by	_____	_____
Authorized for use by	_____	_____

Simtec AG (Simtec)
Gewerbestrasse 7
CH-4147 Aesch

Tel: +41 61 703 02 22

Email: info@simtec.ch

IDD PSS-8 R8

Revision Record

Revision Status	Description of Change	Date	Revision
Preliminary	Initial Issue	14.08.2012	R0
Preliminary	– Sketch of pressure ports added – Description of PCB connector pins added – Warnings added – Images updated	28.08.2012	R1
Update	– Connector PCB fixed from A to B – FIL0 and CAL3 commands removed – new 32 point filter – OAT delay updated with final value	02.12.2012	R2
Update	– New BAUD command to set the baud-rate (NMEA/maintenance-) – New OUTPUT command to enable and disable message labels (NMEA/maintenance-) – New QNH command, new QNH data message, new QNH status flag	02.08.2013	R3
Update	– Description of status label fixed and improved	15.05.2017	R4
Update	Extend Interface for PSS-8X: – Add PSS-8X specific labels for AoA and AoS – Add PSS-8X specific commands for AoA and AoS nulling – FTB-1 Connector Various: – Power consumption for PSS-8 and PSS-8X updated – WT PCB data removed	01.08.2017	R5
Update	– Company name and address updated. – Part-Numbers updated – Details on connectors updated – New data labels added: C/R, CAS-Rate and TAS-Rate – PSS-8X AoA and AoS error modes added – Details on position error – Details of maintenance interface removed	16.03.2019	R6
Update	– Fixed units for rate of CAS and rate of TAS – Added missing pin-assignments	07.05.2019	R7
Update	– FTB-1 pin assignment fixed.	16.03.2020	R8

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Contents

1 Scope

The purpose of this document is to define the interface for the Pitot-Static System PSS-8 and PSS-8X.

2 Definitions

For the purpose of this document, the following definitions apply:

0xNN	Numbers starting with 0x represent hexadecimal values.
>	The >-character represents in this document a start of header (SOH, ASCII 0x01)
¶	The ¶-character represents in this document a carriage return (CR, ASCII 0x0D)

3 Applicable Documents

The references at the end of the document form an integral part of this IDD.

4 Abbreviations

ADC	Air Data Computer
ADS	Air Data System
FCC	Flight Control Computer (with respect to this document the FCC receives pressure and air-data from the PSS)
IDD	Interface Definition Document
N/A	Not Applicable
OAT	Outside Air Temperature
PC	Personal Computer (with respect to this document the PC is used to talk on the maintenance interface with the PSS)

5 Warnings

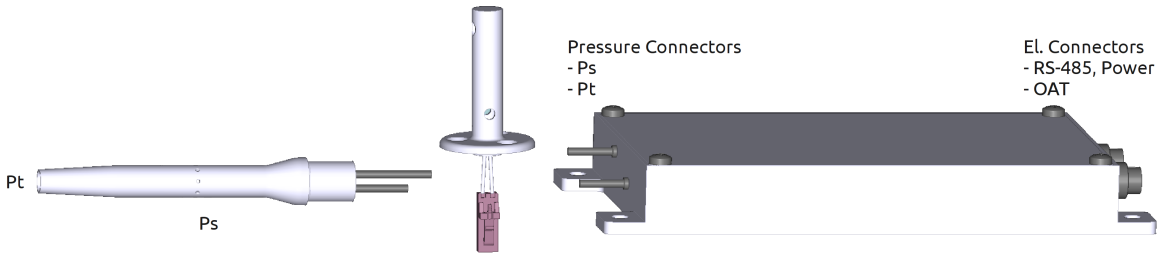
The PSS-8, PSS-8M and PSS-8X boards feature very sensitive and highly accurate pressure sensors. Do not apply differential pressure above ±80 hPa between any pressure port! Over-pressure will destroy internal pressure sensors immediately.

The static pressure port (Ps) and total pressure port (Pt) are interconnected. Applying high or low pressure to the static pressure port (Ps) without applying the same pressure to the total pressure port (Pt) will immediately destroy the internal pressure sensor!

6 Introduction

The PSS-8 provides calibrated and aerodynamically corrected pressure and temperature data over the RS485 interface. The PSS-8 can be configured to start in maintenance mode to update calibration values, set output frequency and other configuration settings.

The PSS-8X air data computer holds an additional connector for the FTB-1 air data boom. Calibrated angle of attack (AoA) and angle of side-slip (AoS) data is provided over the RS485 interface.



Pitot-Static Probe OAT-Sensor Air Data Computer

7 Part Numbers

SIM-74F-122	PSS-8	Pitot static system with pitot-static probe, OAT-sensor and air data computer.
SIM-89E-CCE	PSS-8 ADC	ADC box without probes.
SIM-DC7-A7B	PSS-8 OAT	OAT sensor
SIM-A77-64C	PSS-8 Probe	Pitot-static probe
SIM-FB1-382	PSS-8X	Pitot static system with pitot-static probe, OAT-sensor and air data computer and additional input for FTB-1 air data boom.
SIM-902-9F2	PSS-8M OEM	PSS-8M miniature ADC board

8 Dimensions

Dimensions of the PSS-8 are defined in Ref [4].

9 Connectors Box

Connectors on the PSS-8 box are of type Binder Series 711/712:

Name	Interface	Partnumber		Description / Contacts
FCC	RS-485 &Power	Binder 09-0097-00-05	Male, 5 Pole Series 711	Pin-1: RS-485 A / Sig+ Pin-2: RS-485 B / Sig– Pin-3: GND Pin-4: 9-32VDC Pin-5: Not Used
FTB[1]	FTB-1 AoA/AoS Potentiometer Interface	Binder 09-0097-00-04	Male, 4 Pole Series 711	Pin-1: V+ Pin-2: V– Pin-3: Signal AoA Pin-4: Signal AoS
OAT	Temperature Sensor	Binder 09-0097-00-02	Male, 2 Pole Series 711	Pin-1: T-Sensor Pin-2: T-Sensor

All PSS-8 female cable connector are of Binder Series 711 type (IP67, 360° EMI protected). The part-numbers of this connectors are:

– 99-0414-10-05 (female, 5 pole)

– 99-0402-10-02 (female, 2 pole)

All PSS-8X female cable connector are of Binder Series 711 type. The part-numbers of this connectors are:

– 99-0096-102-05 (female, 5 pole)

– 99-0080-100-04 (female, 4 pole)

– 99-0072-100-02 (female, 2 pole)

10 Connector PCB

Used on printed circuit board only.

Name	Interface	Partnumber		Description / Contacts
PSS-8[2]	RS-485 &Power	Molex SL 70553-0108	Male, 4 Pole	Pin-1: 9-32VDC Pin-2: GND Pin-3: RS-485 A / Sig+ Pin-4: RS-485 B / Sig–
PSS-8 PSS-8X	RS-485 &Power Potentiometer	Harwin M80	Male 2x5	Pin-1[3]: OAT (Pt100) Pin-2: AoS Poti-Signal Pin-3: AoA Poti-Signal Pin-4: VDC 9..32VDC Pin-5: RS-485 A Pin-6: OAT (Pt100) Pin-7: Poti-Excitation Pin-8: Poti-GND Pin-9: GND (power return) Pin-10: RS-485 B

1 PSS-8X only
2 Old PCB-boards R1, R2 and R3. As of R4 Harwin high rel. connectors are used
3 Pay attention to label on PCB

Name	Interface	Partnumber		Description / Contacts
PSS-8M	RS-485 &Power	Harwin M80	Male 2x3	Pin-1[1]: OAT (Pt100) Pin-2: VDC 9..32VDC (30mA) Pin-3: RS-485 A Pin-4: OAT (Pt100) Pin-5: GND Pin-6: RS-485 B

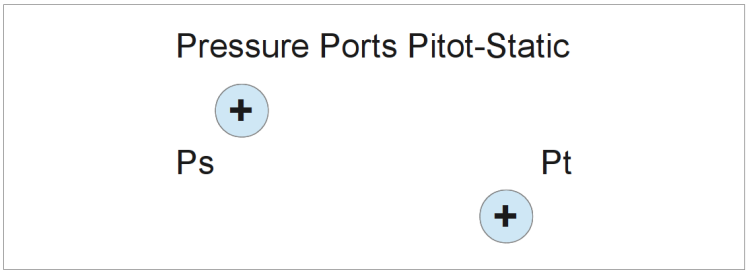
11 Connector OAT-Sensor

Name	Interface	Partnumber		Description / Contacts
OAT	Temperature Sensor	Molex SL 50-57-9402	Female, 2 Pole	Pin-1: T-Sensor Pin-2: T-Sensor

12 Pressure Ports

For a detailed layout see Ref [4].

PSS-8 PSS-8X	Pt	ø2mm Port	Total pressure
	Ps	ø2mm Port	Static pressure



13 RS-485 Data Interface

Every calibrated and correct pressure value, temperature value and air data value is sent over the data interface by a separate label.

13.1 Firmware Version

This data interface applies to PSS-8 firmware version V7.5.0

13.2 RS-485 Settings

Baud Rate	57'600 bps 115'200 bps 230'400 bps 460'800 bps	(optional, at lower data rate only) (optional, at lower data rate only) (standard) (optional)
Data Bits	8	
Parity	None	
Stop Bits	1	

1 Pay attention to label on PCB

13.3 Direction of Data Flow

The data interface transmits data and status labels and processes command labels. Data is available within 1 second after power-on.

13.4 Data Rate

Supported Data Rates	100Hz, 50Hz, 25Hz, 20Hz, 10Hz, 5Hz, 4Hz, 2Hz, 1Hz

13.5 Data Label

13.5.1 Format

The length of the data label is always 11 byte. SOH and CR are provided for easy re-synchronisation after any data loss or corruption.

Byte	Type	Description
0	SOH	Start of message
1	Header	Includes a marker bit, a flag and the ID of the label

2	Data	Encoded floating point number.
		The 8 data bits contain a representation of a floating-point value according to the IEEE 754 floating-point "single format" bit layout.
		The 32 bits of the floating-point number are converted to an integer and then encoded as a hexadecimal number.
		Example code to decode the float in Java:
		String data = "3F5BF63C";
		int i = (int) Long.parseLong(data, 16);
		float f = Float.intBitsToFloat(i);
		System.out.println(f); // prints 0.859226

3	Data	
4	Data	
5	Data	
6	Data	
7	Data	
8	Data	
9	Data	
10	CR	End of message

13.5.2 SOH, CR

ASCII	Hex Value	Notes
SOH	0x1, 0x2, 0x3	Start of header
CR	0x0D	Carriage return

13.5.3 Header

Bit	Name	Notes
7	Marker Bit	The marker bit is always set to differentiate the header from a control character.
6 5 4	Data Flag	0x0 valid data 0x1 data above valid range 0x2 data below valid range 0x3 data invalid high side 0x4 data invalid low side 0x5 data invalid
3 2 1 0	Command ID	Command ID 0x0 .. 0xE (0xF is the status message, see below)

13.5.4 Data

ASCII	Hex Value	Notes
0 .. 9 A .. F	0x30 ... 0x39 0x41 .. 0x46	Used to encod a floating point number.

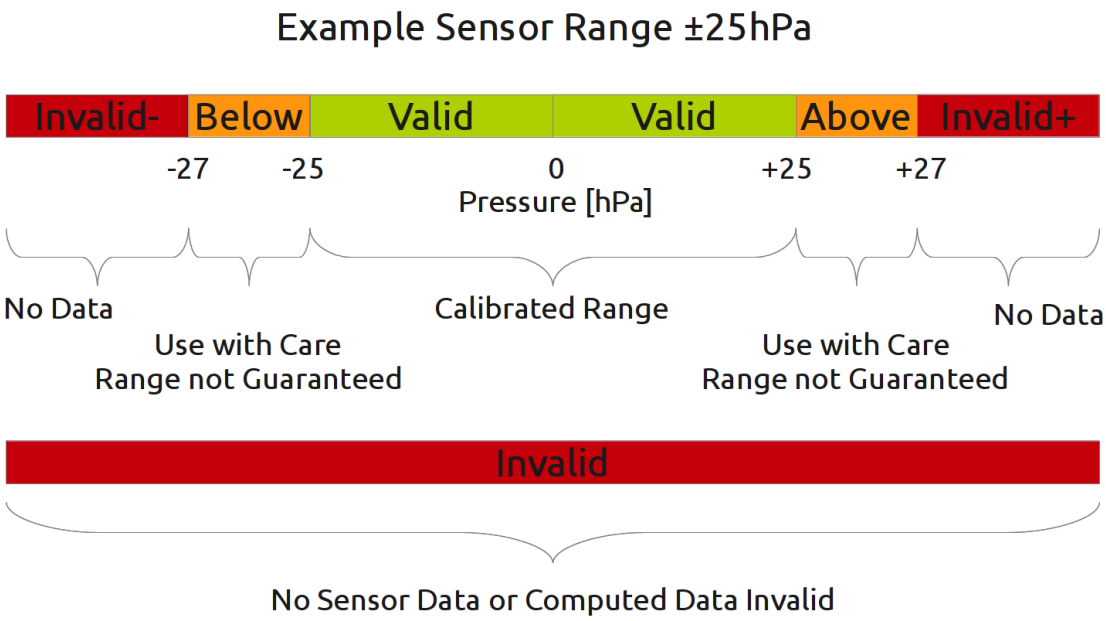
13.5.5 Command ID

SOH	ID	Name	Abbr.	Unit	Example Range
0x1	0x1	Impact Pressure	qc	Pa	0 .. 64 hPa
0x1	0x2	Static Pressure	ps	Pa	226 ... 1080 hPa
0x1	0x3[1]	Angle of Attack	AoA	°	±140°
0x1	0x4[2]	Angle of Side-Slip	AoS	°	±140°
0x1	0x5	Cal. Airspeed	CAS	m/s	0 ... 100 m/s
0x1	0x6	True Airspeed	TAS	m/s	0 ... 100 m/s
0x1	0x7	Pressure Altitude	Hp	m	-550 ... +11'000 m
0x1	0x8	Mach	Ma	-	0 ... 0.3
0x1	0x9	Static Air Temp.	SAT	°C	-60 ... +70°C
0x1	0xA	Total Air Temp.	TAT	°C	-60 ... +70°C
~~0x1~~	~~0xB[3]~~	~~Delta Pressure 1~~	~~dp1~~	~~Pa~~	~~± 64 hPa~~
~~0x1~~	~~0xC[3]~~	~~Delta Pressure 2~~	~~dp2~~	~~Pa~~	~~± 64 hPa~~
~~0x1~~	~~0xD[3]~~	~~PCB Temperature~~	~~PCB~~	~~°C~~	~~-60 ... +70°C~~
0x1	0xE[4]	QNH Setting	QNH	Pa	950 .. 1080 hPa

1 PSS-8X only
2 PSS-8X only
3 Deprecated, used on old devices only
4 The same data format is used to set the QNH value.

SOH	ID	Name	Abbr.	Unit	Example Range
0x2	0x1	Climb-Rate	CR	m/s	±50m/s
0x2	0x5	CAS-Rate	CAS-R	m/s^2	$±50m/s^2$
0x2	0x6	TAS-Rate	TAS-R	m/s^2	$±50m/s^2$
0x3	0x1[5]	Uncorr. Impact Pressure	Qcu	Pa	0 .. 64 hPa
0x3	0x2[6]	Uncorr. Static Pressure	Psu	Pa	226 ... 1080 hPa

Sensor data is marked valid, invalid or out of range according to the following rule:



13.6 Status Label

The status message has a length of 7 byte. SOH and CR are provided for easy re-synchronisation after any data loss or corruption.

13.6.1 Format

Byte	Type	Description
0	SOH	Start of Message
1	Header (0x8F)	Includes a marker bit, a flag and the ID of the label. The flags is never set in the status message. The ID of the label has the value 0xF.
2-5	Status Bits	Encoded status code in hexadecimal unsigned 16bit format (0x0000 .. 0xFFFF)
6	CR	End of message

5 PSS-8X only
6 PSS-8X only

13.6.2 Header

See section “Data Label”.

13.6.3 Status

Each bit of the status data has a special meaning:

Bit Nr.	Name	Notes
15	Not Used	Spare flag
14	Not Used	Spare flag
13	Sensor Zeroed	Indicates that a sensor zeroing command has been issued since the last power-up.
12	QNH	Indicates that the QNH has been set.
11	Watchdog Reset	Watchdog was active since last power-up.
10	BOD Reset	This flag is set when the reset controller detects a reset initiated by the watchdog, due to brown-out detection, a CPU error, etc. This flag is cleared during a reset only.
9	CPU Reset	
8	Other Reset	As long as the PSS-8 sends valid sensor data this bit can be neglected by the FCC. If the bit is set during multiple flight over and over again some further investigation should be initiated.
7	I/O Error	Input or output error detected.
6	Memory Error	Flash memory error detected.
5	CRC Error	Configuration data error detected during start-up.
4	SPI Error	SPI-communication detected.
3	Sensor Error	Sensor data unreliable. This flag is set as soon as one of the sensors is out of range or does not work properly. The flag is cleared as soon as sensor is in range again or the communication is established again.
2	Serial Error	Serial interface error detected.
1 0	Mode	0: Normal Data Mode 1: Maintenance Mode 2: Calibration Mode 3: Not Used

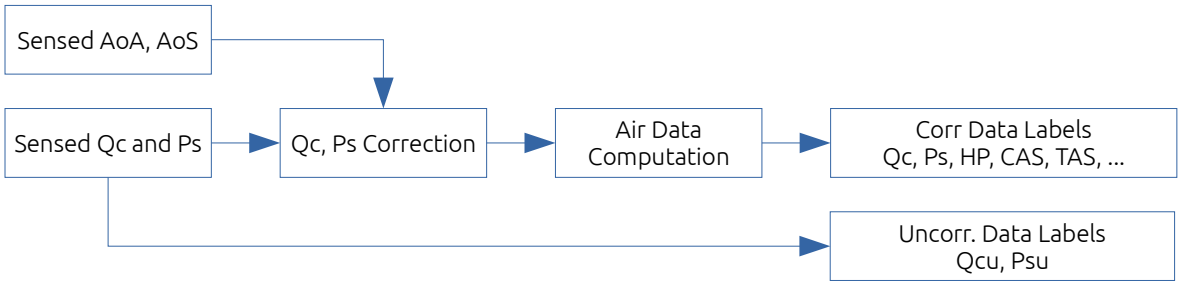
A status message with all bits cleared has the ASCII value '0000', a status message with all bits set has the value 'FFFF'.

Examples in Hex-Format:

All status-bits cleared	01-8F-*30-30-30-30*-0D (7 bytes in hex-format) Convert status bits from Hex to ASCII: 0x30 › 48 › '0' 0x30 › 48 › '0' 0x30 › 48 › '0' 0x30 › 48 › '0' So the final ASCII is '0x0000' meaning all bits are cleared
QNH status bit set	01-8F-*31-30-30-30*-0D (7 bytes in hex-format) Convert status bits from Hex to ASCII: 0x31 › 49 › '1' 0x30 › 48 › '0' 0x30 › 48 › '0' 0x30 › 48 › '0' So the final ASCII is '0x1000' which is binary '0001 0000 0000 0000' which means bit 12 is set (QNH is set)

13.7 PSS-8X

The PSS-8X air data computer corrects measured Qc and Ps pressure values of the FTB-1 pitot-static probe according to the actual AoA and AoS vane position up to flow-angles of ±30°. If uncorrected values are required as for example for calibration the vanes can be set to the zero position or the labels Qcu and Psu can be used. Airspeed, altitude and other data that is derived from the sensed Qc and Ps pressure is always computed from corrected pressure data.



As of firmware version V7.5.0 the following applies:

AoA, AoS	Ps/Qc Correction	AoA/AoS Flag	Ps/Qc Flag	Description
within ±30°	applied	valid	valid	Full accuracy, PS and QC data fully corrected for high flow angles, derived data like CAS, TAS, etc are corrected and fully valid as well.
above ±30° but within ±140°	correction of 30° is applied	valid	above	Reduced air data accuracy above ±30° flow angles.
above ±140° or invalid vane data	no correction applied	invalid	above	As no data from the vanes is available no pitot-static correction is applied. The raw pressure data (Qcu, Psu) is used internally for the computration. Air data like CAS, TAS, etc. is computed from uncorrected pressure data. The data has a reduced accuracy.

Note that if the vane sensor fails during high angle of attack or at large side-slip operation a sudden jump in pressure, altitude, airspeed etc can occur as the air data computer switches from corrected to uncorrected data.

13.8 QNH

As of firmware V1.2.0 the PSS-8 accepts and processes a QNH command. The user can send a QNH command to set the QNH of the system. On success the system acknowledges the command with a QNH message. The same data format is used to send and receive the QNH value (see page 9). If the QNH is set the QNH-flag in the status message is also set.

The QNH value is not stored in flash. After a power-up or reset the system starts with the standard value of 1'013.25hPa.

As the RS-485 interface is half-duplex sending and receiving data at the same time is not possible.

13.9 Sensor Zeroing

The command label has a length of 7 byte. SOH and CR are provided for easy re-synchronisation after any data loss or corruption.

Command Label Format:

Byte	Type	Description
0	SOH	Start of message (0x1, 0x4)
1	Header	Includes a marker bit, a flag and the ID of the label. The flags is never set in the command message.
2-5	Command	Encoded command code in hexadecimal unsigned 16bit format (0x0000 .. 0xFFFF)
6	CR	End of message

Header Format:

Bit	Name	Notes
7	Marker Bit	The marker bit is always set to differentiate the header from a control character.
6	Data Flag	Always set to 0x0
5		
4		
3	Command ID	Command ID 0x0 .. 0xF
2		
1		
0		

Commands:

SOH	ID	Name	Details
0x4	0x2	QC-Sensor Zeroing Command	Has always the signature 0xF0F0
0x4	0x3	AoA Zeroing Command	Has always the signature 0xF0F0
0x4	0x4	AoS Zeroing Command	Has always the signature 0xF0F0

The sensor zeroing commands are used to zero the Qc, AoA and AoS sensor. The commands have to be issued twice in a row within 1 second to be effective. To get accurate zero values the probe has to operated for a couple of minutes in a very calm place. The zeroing command is issued only if the airspeed is close to zero. The new offsets are stored in flash and the sensor zeroing flag is set. Alternatively the zero offsets can also be set via the maintenance interface.

13.10 Bus Capacity

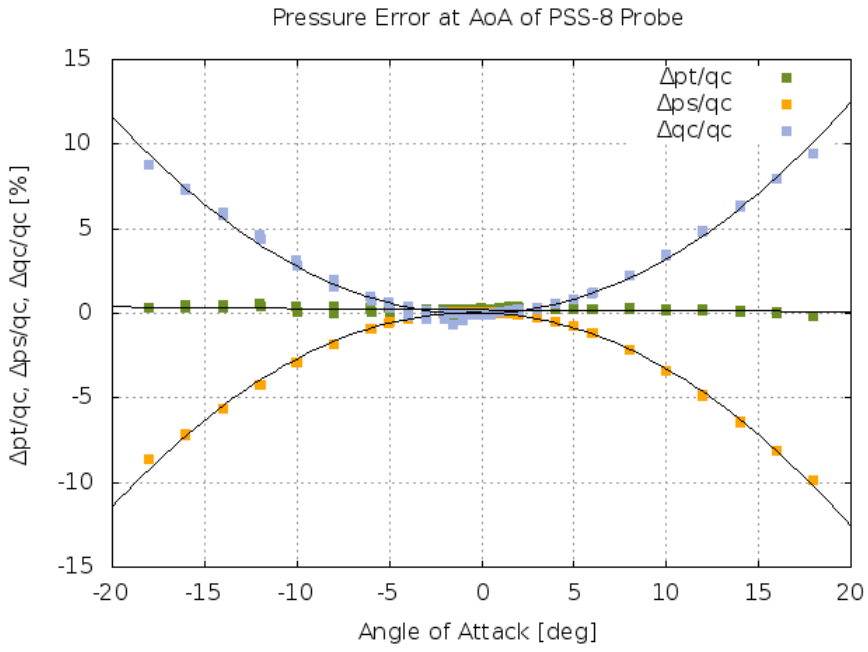
At 100 Hz the capacity of the data-bus is 230'400baud / 100Hz = 2'304 bytes/cycle. On the RS-485 data-bus each byte needs 10 bits. Each data label occupies 110 bits, the status label another 70 bits.

Assuming the user activates 10 data labels at 100 Hz then about 51 % of the bus capacity is used.

13.11 Order of Labels

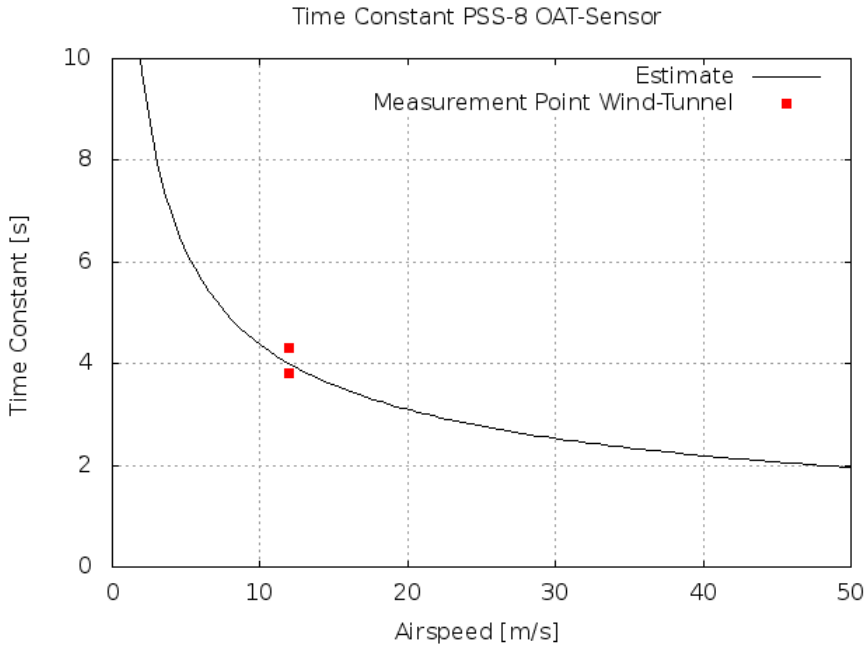
Data messages are sent first, followed by the status message. The order is according to the table given in section 13.5.5 Command ID.

13.12 Total, Static and Dynamic Pressure Error



14 Time Constant of OAT-Sensor

The time constant τ represents the time it takes the OAT sensor on a step response to reach approx. 63.2% of its final temperature value.



15 Recovery Factor of OAT-Sensor

The recovery factor of the OAT-Sensor is 0.9 as measured in the wind-tunnel. The recovery factor is used to compute SAT from TAT in the air data computer.

16 Position Error

The maintenance error provides two factors k_{ps} and k_{qc} to correct for position errors. Both values are set to null at factory but can be adjusted by the user via the maintenance interface.

The correction is applied as follows:

$$ps_{corr} = ps_{sensed} - (k_{ps}\ qc_{sensed})$$
$$qc_{corr} = qc_{sensed} - (k_{qc}\ qc_{sensed})$$

17 RS-485 Maintenance Interface

The maintenance interface is activated only if it is initiated at start-up of the PSS-8 by sending the $MAINT-command continuously to the PSS-8.

If the PSS-8 does not receive the maintenance command at start-up within 2 seconds the PSS-8 initiates normal operation and the maintenance interface cannot be activated any more. If the maintenance mode is enabled the data interface is deactivated. Real-time operation is not guaranteed. Each power-off disables the maintenance interface automatically.

User of the PSS-8 will not need to implement the maintenance interface. Simtec provides PC-software that implements all important functions.

17.1 Direction of Data Flow

The direction of data flow is bi-directional as long as the maintenance interface is active. Sensing and receiving data at the same time is not supported (half-duplex operation).

17.2 NMEA Like Data Interface

The PSS-8 uses a data interface for communication that is similar to the NMEA 0183 data interface. The interface allows to easily make configuration changes by sending text-type commands to the PSS-8.

The generic build-up of a proprietary PSS-8 sentences is as follows:

1. Each message starts with a dollar sign
2. The next five characters identify the proprietary PSS-8 sentence (PSS8)
3. All data fields that follow are comma-delimited.
4. The next field is the name of the command
5. The first character that immediately follows the last data field character is an asterisk.
6. The asterisk is immediately followed by a two-digit checksum representing a hex number. The checksum is the exclusive OR of all characters between the '$' and '*'. According to the official specification, the checksum is optional for most data sentences.
7. <CR><LF> ends the message.

As an example, the following command sets the output frequency to 10Hz:

```
$PSS8,FREQ,10*<CR><LF>
```

Details are available on request. It is recommended to use the maintenance software provided by Simtec AG to access the maintenance interface. The software can be downloaded from https://www.swiss-airdata.com.

18 Power Supply (PWR)

Input Voltage	9 ... 32 VDC (28 VDC)

Max. measured power consumption at start-up is about 33mA at 28VDC (0.9 Watt) with the RS-485 interface. Typical power consumption as measured at the PWR input is:

	Current Nom.	Current Max. at Start-Up
9 VDC	70 mA (75 mA)[1]	76 mA
12 VDC	54 mA (61 mA)	64 mA
28 VDC (Nominal)	27 mA (30 mA)	33 mA
32 VDC	24 mA (27 mA)	28 mA

The power consumption of the PSS-8M board is slightly lower.

19 References

[1]	NMEA_0183 http://en.wikipedia.org/wiki/NMEA_0183	2009
[2]	Binder Connectors, Subminiature circular connectors series 711 http://www.binder-connector.de/	2009
[3]	Binder Connectors, Subminiature circular connectors series 712 http://www.binder-connector.de/	2009
[4]	Assembly Transfer Document, PSS-8	2012

1 Values in brackets are for the PSS-8X with FTB-1 connected.