



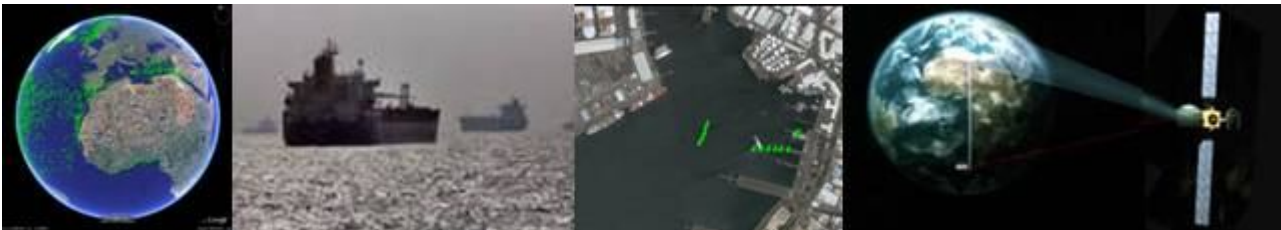
in cooperation with



Institute of
Space Systems



Flight
Operations



Technical Note TN-11-2: Receiver Software ICD

Preparatory Action for Assessment of the Capacity of Spaceborne Automatic Identification System
Receivers to Support EU Maritime Policy

Receiver Software ICD	<i>Doc. N°:</i> TN-11-2	
	<i>Issue:</i> 2	<i>Date:</i> 17.05.2010
	<i>Page:</i> 2 of 16	

<i>Doc.Type:</i> Technical Note		<i>DRD N°:</i> TN-11-2	
<i>Doc. N°:</i> TN-11-2	<i>Issue:</i> 2	<i>Date:</i> 17.05.2010	<i>Page</i> 2 of 16
<i>Title:</i> Receiver Software ICD			

	<i>Name & Function</i>	<i>Signature</i>	<i>Date</i>
<i>Prepared by:</i>	Thomas Bleckert Systems Engineer		07.04.2010
<i>Approved by:</i>	Adrian Nash Head of Systems		07.04.2010
<i>Application authorized by:</i>			
Customer / Higher Level Contractor			
<i>Accepted by:</i>			
<i>Approved by:</i>			

<i>DISTRIBUTION LIST</i>	<i>N</i>	<i>A</i>	<i>I</i>
<i>Consortium Internal</i> G Eiden (Luxspace)			
<i>External</i> Iain Shepherd (<i>DG MARE</i>) Giovanni Garofalo (<i>ESA</i>)			
<i>N=Number of copy A=Application I=Information</i>			

<i>Data Management:</i>	
..... <i>Signature</i> <i>Date</i>	<i>File:</i> 0501 PASTA MARE Technical Note TN 11-2_REV_PB.doc

DOCUMENT CHANGE RECORD

<i>ISSUE</i>	<i>DATE</i>	<i>CHANGE AUTHORITY</i>	<i>REASON FOR CHANGE AND AFFECTED SECTIONS</i>
1	07.04.2010	ComDev	First draft
2	17.05.2010	ComDev	Corrections based on ESA's comments

Applicable and Reference Documents

RD 1	Preparatory Action for Assessment of the Capacity of Spaceborne Automatic Identification System Receivers to Support EU Maritime Policy – Pasta Mare Technical Proposal Call for Tenders No MARE/2008/06
RD2	FWS/HIP/0491/001 HIP Firmware specification

Table of Contents

1. INTRODUCTION	6
1.1 ABBREVIATIONS	7
2. APPLICABLE DOCUMENTS	8
3. HARDWARE CONTROL SOFTWARE	8
3.1 SPI BUS	8
3.2 FREQUENCY SYNTHESIZER	10
3.3 ATTENUATOR AIS1 AND ATTENUATOR AIS2 [AD6]	10
4. DATA HANDLING SOFTWARE	11
4.1 CLOCK	11
4.2 ANALOG TO DIGITAL CONVERTER	11
4.3 DIGITAL DOWN CONVERSION (COM DEV EUROPE DDC)	11
4.4 GAIN CONTROL	12
4.5 DATA HANDLING	12
4.5.1 RAW DATA	12
4.5.2 TIME STAMP	12
4.5.3 SAMPLING OUTPUT FORMAT	13
5. SYSTEMS FUNCTIONS	14

List of Figures

Figure 1-1 Functional block diagram 6

Figure 3-1: SPI Data Timing 9

Figure 3-2: Truth Table 11

List of Tables

Table 1-1: List of Abbreviations 7

Table 2-1: List of Applicable Documents 8

Table 3-1 Mezzanine Card Output pins (JN-1) 9

Table 3-2 Mezzanine Card Input Pins (JN-1) 10

Table 4-1 16-bit words 12

Table 4-2 13

Table 4-3 Sample file recording sequence 13

Table 4-4 14

Table 5-1 15

1. INTRODUCTION

The AIS Software is designed for support the COMDEV Europe AIS receiver at the Pasta Mare project. The COMDEV AIS receiver has been designed to detect and collect AIS signals from variable platforms.

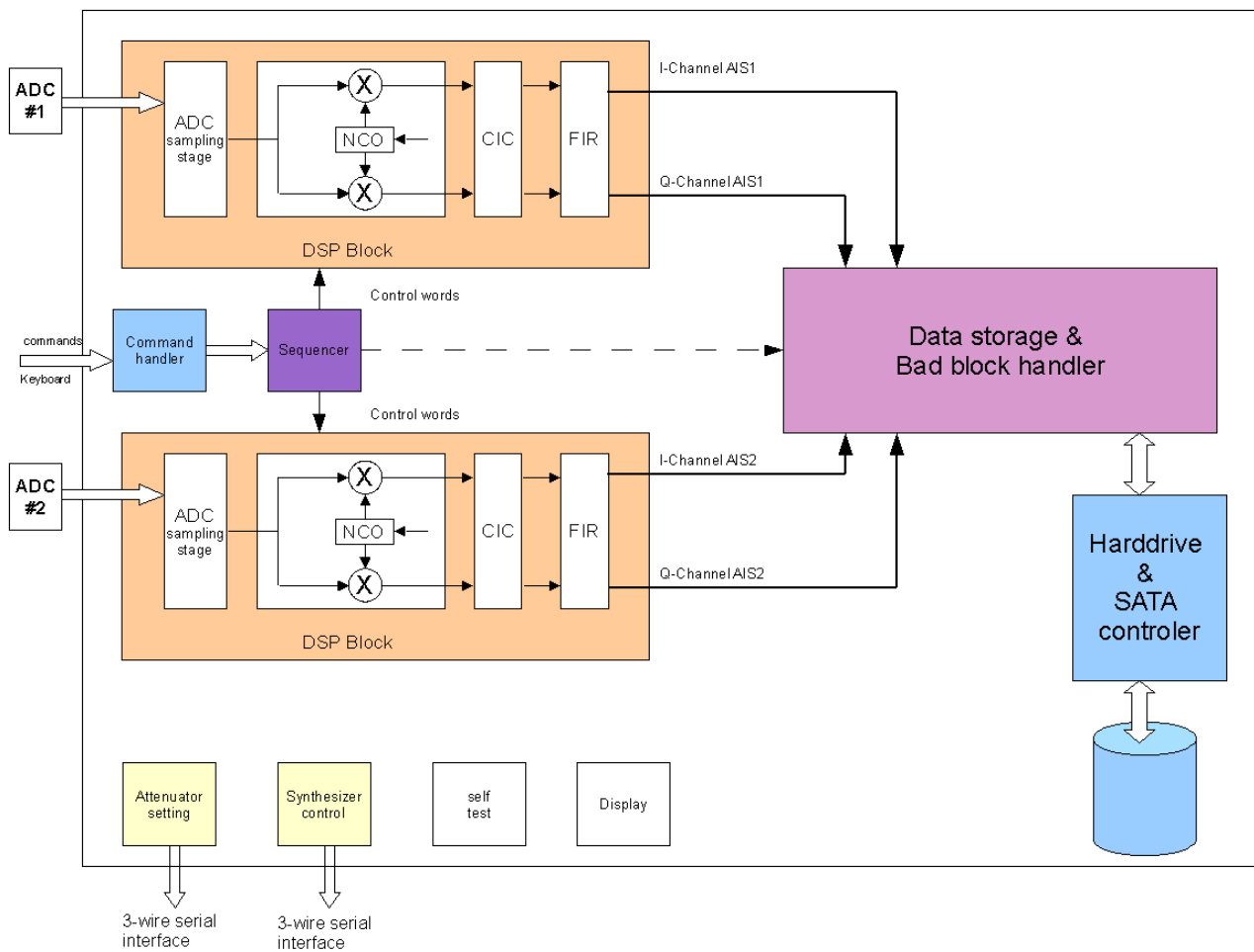


Figure 1-1 Functional block diagram

1.1 ABBREVIATIONS

The following abbreviations are used in this document.

Abbreviation	Full
DDC	Digital Down Converter
AIS	Automatic Identification System
ADC	Analog to Digital Converter
GPS	Global Positioning System
IF	Intermediate Frequency
LNA	Low Noise Amplifier
PLL	Phase Locked Loop
RF	Radio Frequency
SPI	Serial Peripheral Interface Bus
TBC	To Be Confirmed
TBD	To Be Defined
VHF	Very High Frequency
FIR	Finite Impulse Response
CIC	Cascaded Integrator-Comb
ksp/s	kilo samples per second
NMEA	National Marine Electronic Association

Table 1-1: List of Abbreviations

2. APPLICABLE DOCUMENTS

Document	Description
[AD-1]	6039 PASTA MARE Technical Note TN 09 actual document
[AD-2]	Receiver Hardware ICD TN-11-1 actual document
[AD-3]	System specification TN-11-8 actual document
[AD-4]	Data sheet Clock generator ADF4001
[AD-5]	Data sheet RF PLL Frequency Synthesizer ADF411x
[AD-6]	Data sheet Attenuator HRF-AT4521
[AD-7]	Documentation E-Instrument PC
[AD-8]	Documentation X5-400
[AD-9]	Documentation X3-Timing
[AD-10]	NMEA 0183 Standard

Table 2-1: List of Applicable Documents

3. HARDWARE CONTROL SOFTWARE

3.1 SPI BUS

SW-REQ-3.1.1.1 The Synthesizers and the attenuators shall be composed of three lines: Data, Clock and Chip select (SPI Bus).

SW-REQ-3.1.1.2 The SPI Bus shall have following timing.

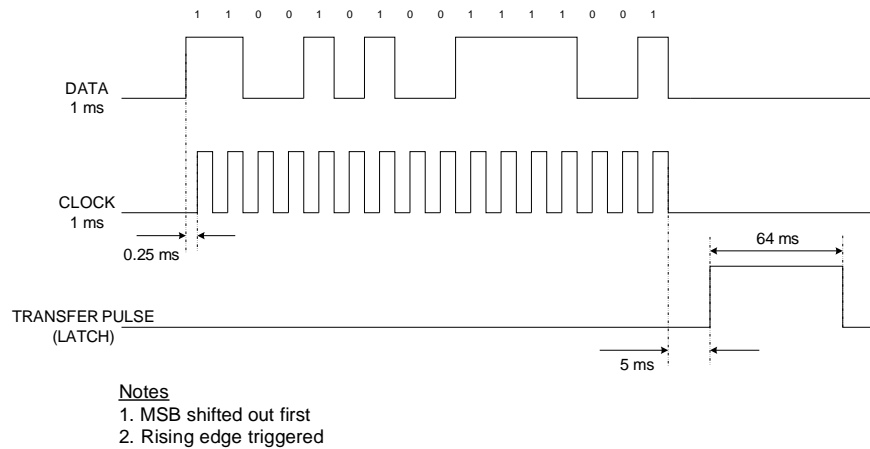


Figure 3-1: SPI Data Timing

SW-REQ-3.1.1.3 The serial clock rate shall be 100kHz.

SW-REQ-3.1.1.4 The output ports at JN1 Mezzanine Card from the elnstrument PC related to following SPI Bus Signals.

Pin	Signal	Notes
5	FDIO0	SPI-PLL-DATA
6	FDIO1	SPI-ATTN-DATA
7	FDIO2	SPI-PLL-CLK
8	FDIO3	SPI-ATTN-CLK
9	FDIO4	SPI-RX1-ATTN-CS
10	FDIO5	SPI-RX2-ATTN-CS
11	FDIO6	SPI-RX1-LO1-CS
12	FDIO7	SPI-RX2-LO1-CS
13	FDIO8	SPI-LO2-CS

Table 3-1 Mezzanine Card Output pins (JN-1)

SW-REQ-3.1.1.5 The software shall be designed for signalling alarms (out of lock state) from all Phase Locked Loops at the Radio Interface.

SW-REQ-3.1.1.6 When an Alarm is indicated, the software shall reprogram the PLL 3 times. If this action failed the software shown information on the screen.

SW-REQ-3.1.1.7 The programming action shall be recorded in a log file.

SW-REQ-3.1.1.8 The input ports at JN1 Mezzanine Card of the eInstrument PC relate to the following Pins.

Pin	Signal	Notes
14	FDIO9	RX1-LO1-ALM
15	FDIO10	RX2-LO1-ALM
16	FDIO11	LO2-ALM

Table 3-2 Mezzanine Card Input Pins (JN-1)

3.2 FREQUENCY SYNTHESIZER

SW-REQ-3.2.1.1 The Charge Pump Current shall be pre-programmed for 5 mA.

SW-REQ-3.2.1.2 The MUXOUT of the Synthesizer shall be programmed for Lock detects.

SW-REQ-3.2.1.3 The Local oscillator (RX1 LO1) [AD5] for AIS1 Channel shall by define for initial output frequency 183.375MHz (AIS1+21.4 MHz).

SW-REQ-3.2.1.4 The Local oscillator (RX2 LO1) [AD5] for AIS2 Channel shall by define for initial output frequency 183.425 MHz (AIS2+21.4 MHz).

SW-REQ-3.2.1.5 The frequency step size (LO1) shall be designed for 12.5 kHz

SW-REQ-3.2.1.6 The tuning range (LO1) shall be defined ± 50 kHz.

SW-REQ-3.2.1.7 The Local oscillator LO2 [AD4] shall by define for output frequency 20.95 MHz.

3.3 ATTENUATOR AIS1 AND ATTENUATOR AIS2 [AD6]

SW-REQ-3.3.1.1 The attenuator shall be initial set to max. Attenuation (31dB)

SW-REQ-3.3.1.2 The attenuation values following the truth table as a 5-bit word

S4	S3	S2	S1	S0	Output
0	0	0	0	0	Reference Input
0	0	0	0	1	1 dB
0	0	0	1	0	2 dB
0	0	1	0	0	4 dB
0	1	0	0	0	8 dB
1	0	0	0	0	16 dB
1	1	1	1	1	31 dB

Figure 3-2: Truth Table

4. DATA HANDLING SOFTWARE

4.1 CLOCK

SW-REQ-4.1.1.1 The system clock shall be provided to all devices, including the receiver.

SW-REQ-4.1.1.2 The system clock has an option to use a flexible clock source (eInstrument PC or AIS Receiver).

4.2 ANALOG TO DIGITAL CONVERTER

SW-REQ-4.2.1.1 The data clock for the ADC 's has to be sync on system clock.

SW-REQ-4.2.1.2 The sample clock shall be 1.8000 MHz.

SW-REQ-4.2.1.3 The precision of the ADC shall be 14 bits.

4.3 DIGITAL DOWN CONVERSION (COM DEV EUROPE DDC)

SW-REQ-4.3.1.1 There shall be two Digital Down Converters (DDC), one for each AIS channel. Both DDC 's shall employ $F_s/4$ (1.8MHz/4) for the down converting the signal.

SW-REQ-4.3.1.2 A CIC filter and FIR filter should be designed for decimate and filtering the signal to a 25kHz Channel

SW-REQ-4.3.1.3 The output of the DDC is a serial 12-bit I/Q Data stream.

SW-REQ-4.3.1.4 The output sample rate is designed for 28.125 kbps.

4.4 GAIN CONTROL

SW-REQ-4.4.1.1 The gain is designed for control the input level for each AIS channel Page: 12

The attenuator is set up manually by the operator for obtaining the best results.

SW-REQ-4.4.1.2 The software creates the control data for each Attenuator separately The control data is stored with a time stamp, separate for each channel (every 10 sec).

4.5 DATA HANDLING

4.5.1 RAW DATA

SW-REQ-4.5.1.1 The raw data (12-bit) stored as a 16-bit word unsigned integer with following structure.

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B0	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	x	x	x	x

Table 4-1 16-bit words

SW-REQ-4.5.1.2 The first word is the I-Channel sample. The second word is the Q-Channel sample.

4.5.2 TIME STAMP

SW-REQ-4.5.2.1 The GPS should be used as NMEA Standard 0183 protocol [AD10].

SW-REQ-4.5.2.2 The first part of the time stamp is defined as [GPGGA](#) field with a fixed length of 574 bits.

SW-REQ-4.5.2.3 The second part of the time stamp is the value for the attenuator AIS1 and attenuator AIS2.

SW-REQ-4.5.2.4 The format for each attenuator is a [5 –bit word](#).

SW-REQ-4.5.2.5 Structure of the time stamp

GPGG A	AIS 1 ATT	AIS 2 ATT
574 bit	5 bit	5 bit

Table 4-2

4.5.3 SAMPLING OUTPUT FORMAT

SW-REQ-4.5.3.1 As a reference, the GPS position and the set for both attenuators are recorded every 10 s as a Time stamp.

SW-REQ-4.5.3.2 The sampling file recording sequence should be as following

Time stamp	1. AIS1 I-Word	1. AIS1 Q-Word	2. AIS2 I-Word	2. AIS1 Q-Word	...	281250. AIS2 Q-Word	Time stamp	1. AIS1 I-Word
	10 second							

Table 4-3 Sample file recording sequence

SW-REQ-4.5.3.3 The sampling file shall have a length of approximately 3 minutes.

SW-REQ-4.5.3.4 The sampling file shall end with the last AIS2 Q-Word from a 10 second period (before the next time stamp).

Time stamp	1. AIS1 I-Word	...	281250. AIS2 Q-Word	Time stamp	1. AIS1 I-Word	...	281250. AIS2 Q-Word
Sample file n				Sample file n+1			

Table 4-4

SW-REQ-4.5.3.5 Sampling file names for data called yyyyymmdd-hhmmss.bin, where the indicated time is the UTC time. The file recorded at the beginning of the UTC second.

SW-REQ-4.5.3.6 The maximum time synchronizations error is 5ms with respect to the UTC second reference.

5. SYSTEMS FUNCTIONS

SW-REQ-5.1.1.1 The receiver system shall operate autonomously after power up/boot sequence execution.

SW-REQ-5.1.1.2 The operator shall be able to monitor the estimated remaining battery life.

SW-REQ-5.1.1.3 The alarms from the PLL shall be displayed.

SW-REQ-5.1.1.4 The operator shall be able to monitor the correct output file,

SW-REQ-5.1.1.5 The operator shall be able to monitor Input power level

SW-REQ-5.1.1.6 The GPS Information shall be displayed

Annex

NMEA Data words

The maximal lengths for all data sentence are 82 ASCII characters include line feed and carriage return.

The data is contained within this single line with data items separated by commas. There is a provision for a checksum at the end of each sentence. The checksum field consists of a '*' and two hex digits representing an 8 bit exclusive OR of all characters between, but not including, the '\$' and '*'.

GP GGA - Global Positioning System Fix Data, Time, Position and fix related data for a GPS receiver.

Example for a data set:

\$GPGGA,191410,4735.5634,N,00739.3538,E,1,04,4.4,351.5,M,48.0,M,,*45

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
\$GPGGA	hhmmss.ss	llll.lll	a	yyyyy.yyy	a	xx	x.x	xxxxx.x	x.x	M	xx.x	M		x.x
\$GPGGA	191410	4735.5634	N	00739.3538	E	1	04	4.4	351.5	M	48.0	M		*45

Table 5-1

Field Number:

- 1) Universal Time Coordinated (UTC)
- 2) Latitude
- 3) N or S (North or South)
- 4) Longitude
- 5) E or W (East or West)
- 6) GPS Quality Indicator,
 - 0 - fix not available,
 - 1 - GPS fix,
 - 2 - Differential GPS fix
- 7) Number of satellites in view, 00 - 12
- 8) Horizontal Dilution of precision
- 9) Antenna Altitude above/below mean-sea-level (geoid)
- 10) Units of antenna altitude, meters
- 11) Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean-sea-level (geoid), "-" means mean-sea-level below ellipsoid
- 12) Units of geoidal separation, meters
- 13) Age of differential GPS data, time in seconds since last SC104 type 1 or 9 update, null field when DGPS is not used

Receiver Software ICD

Doc. N°: **TN-11-2**

Issue: **2** *Date:* **17.05.2010**

Page: **16** of **16**

14) Differential reference station ID, 0000-1023

15) Checksum