ANNEX 13

ACS USER'S MANUAL

CENTRE NATIONAL D'ETUDES SPATIALES

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Integral Anticoincidence System (ACS)

ACS Operations Manual

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CONTENTS

1 Scope

This document shall describe the operational aspects of the INTEGRAL-ACS which are not explicitly mentioned in the chapter of the reference documents.
The operational aspects are divided in two main parts namely the commanding rules/debugging hints/constraints and the scientific aspects.
For the commanding aspects mainly the VCU SW Specification is applicable /RD22/.
The Analogue HK Transfer Functions are given as well as the Analogue HK Limits.

2 Applicable/Reference documents

AD/RD No.	Doc. Ident.	Document Title	Issue	Rev
/1/	SPI-ST-0-91-CNES	Instrument System Specification	3	1
/2/	SPI-SG-0-82-CNES	Mechanical Design Specification	1	4
/3/				
/4/	SPI-SG-0-80-CNES	General Electrical Requirements	1	3
/5/	SPI-SG-0-84-CNES	Electromagnetic General Specification	1	2
/6/				
/7/	SPI-DV-0-30-CNES	Development Plan	2	1
/8/	SPI-ST-1-1041-CNES	ACS Subassembly Requirements	1	5
/9/	SPI-MPE-SP-12-2	Spec. of ACS Electronics Requirements	1	4
/10/				
/11/	SPI-SI-0-1324-CNES 0	SPI Interfaces Specification		3

Contractual-Reference Documents

/12/	ACS-GR-0000.002	SPI Phase B Final Report	1	
/13/	AS-GR-4400.011	Phase B Breadboard Investigation	1	
/14/	SPI-SM-0-90-CSCI	SPI Instrument Mission Specification	4	1
/15/	SPI-DD-0-1088-CNES	Instrument Design Report	0	1
/16/				
/17/	SPI-MPE-TN-12-1	Description of ACS Electronics	2	-
/18/	DA-PS-002	Description of Required Data		1

Other Reference Documents

/19/	LI-ACS-0000DS/05	List of Acronyms and Abbreviations	1	0
/20/	TN-ACS-1200DS/05	Main Structure, Detector S/S Mechanical Analysis		
/21/	SPI-AQ-0-60107-CNES	Radiation Dose Calculation for the SPI	1	0

/22/	RS-ACS-4500DS/02	VCU Software Specification	5	0
/23/	IS-ACS-4100DS/04	Internal Electrical ICD (IICD)	2	0
/24/	IS-ACS-4100DS/05	External Electrical ICD (EICD)	2	0
/25/	DA-ACS-PS-001	Product Assurance & Safety Requirements	2	-
/26/	RS-ACS-4100DS/07	VCU Unit-Tester Requirements Spec.	1	
/27/	RS-ACS-4100DS/10	VCU Verification Matrix	1	0
/28/	TN-ACS-4300DJ/03	FEE Command Description	2	0
/29/	TN-ACS-5100DS/14	Analog Housekeeping Transfer Functions of the FM Integral-ACS	1	0

3 List of Abbreviations

See Ref. /19/

4 ACS Operations

4.1 Commanding Aspects

The commanding aspects which are not mentioned in /RD22/ are sorted into sub-chapters to ease the search.

4.1.1 FEE Commanding

4.1.1.1 FEE Operations; FEE Watchdog arming

In order to observe anomalies or non-working PMTs, HV and others it is strongly recommended to arm the FEEs' watchdogs during measurements.

4.1.1.2 FEE Operations; FEE Watchdog alerts

FEE Watchdog alerts indicate (if enabled) that

- Within a period of 32.7 msec no veto event was observed (thus the watchdog retriggered) from the analogue acquisition circuit (mainly CSA) or
- The asynchronous logic of the FPGA was blocked and thus no further veto was acquired. After 32.7 msec the watchdog awake.

In addition to the watchdog alert after the a.m. events the watchdog resets the FPGA's asynchronous logic and thus allows further proper veto acquisition.
This functionality allows a quasi online observation of the HV-PMT-CSA chain and indicates malfunctions or wrong setting of parameters (if watchdog alert is generated continuously).
Remark:
The alert information is read every 32 seconds by the VCU from each FEE (see /RD 22/). The FEEs accumulate the alert information within this period and resets these bits with the readout.
The alert information also is accumulated by the VCU until the next readout of the DPE.

4.1.1.3 FEE Operations; FEE test pulse generator

It is recommended not to use event threshold smaller than 10_{dec} (A_{hex} respectively) when operating with the test pulse generator.

4.1.1.4 FEE Operations; FEE High Voltage

If the high voltage intentionally will be switched off it is recommended to command „HV off" at least 5 sec before the VCU and thus the FEE are powered down.

4.1.1.5 FEE Operations; FEE Configuration

The min. wait time after last configuration command until configuration is set in FEEs is 8sec.
This status is reflected in "Configuration Status Table"-bit in the most significant Byte (MSB) of ACS Status (HK0).

Additionally to this delay it has to be taken into account that the high voltage rise time is approx. 5 seconds until the commanded value is reached.

4.1.2 VCU Commanding/Constraints

4.1.2.1 VCU(ACS) Operations; VCU Watchdog

Disabled VCU watchdog after power on. After switched on in configuration mode it can not be disabled by command again as long as VCU is powered.

4.1.2.2 VCU(ACS) Operations; SW patches (SW maintenance)

VCU S/W patches in maintenance mode can only be performed successfully with inactive watchdog, i.e. after power on.

4.1.2.3 VCU(ACS) Operations; Veto pulse length

The following table shows the allowed/not allowed veto pulse length settings in VCU command "acsSetCfgVetoMask& PulseWidth". Other settings may effect corrupt pulse patterns because of the signal path in the delay lines.

Setting	Nom. Delay
00:	154 ns (default)
08:	172 ns
09:	187 ns
12:	202 ns
13:	217 ns
1C:	247 ns
1D:	280 ns
2E:	**not allowed !!**

4.1.2.4 VCU(ACS) Operations; Processing cycles

According /RD 22/ the following table has to be taken into account to estimate any reaction of the ACS system:

Fee command	Cmd Code	Period [sec]	FEE Processing Cycle (32 seconds)	No. of Requests	
			|01234567|89012345|67890123|45678901|		
read rate meter	12(C)	8	|xxx-----|xxx-----|xxx-----|xxx-----|	3	
set start rate meter	5	8	|xxx-----|xxx-----|xxx-----|xxx-----|	1	
set event trigger threshold	7	16	|---x----|--------|---x----|--------|	1	
set energy discr. threshold	8	16	|--------|---x----|--------|---x----|	1	
set veto propagation delay	6	16	|--------|----x---|--------|----x---|	1	
set high voltage [1)]	9	16	|--------|-----x--|--------|-----x--|	1	
set system service	3	32	|--------|--------|----x---|--------|	1	
set veto signal configuration	4	32	|--------|--------|-----x--|--------|	1	
read analog status	10(A)	32	|----xxxx|--------|--------|--------|	5	
read alert status [3)]	13(D)	32	|--------|--------|--------|------x-|	1	
read label [2)]	14(E)	32	|--------|------xx|--------|--------|	2	
read revision number	15(F)	32	|--------|------xx|--------|--------|	1	
read digital status	11(B)	32	|--------|--------|------x-|--------|	1	
set VCU configuration	-	32	|--------|--------|-------x|--------|	1	
spare			|--------|--------|--------|-------x|		

1),2) The service set-high-voltage configures high voltage1. For the PSAC the service read-label will be used to configure the high voltage 2. The label will not be read from the PSAC.
3) The alert status will not be read from the PSAC.

4.1.2.5 VCU(ACS) Operations; Not allowed commands

The VCU software handles incoming commands (column 1) dependent on the actual ACS modes (Standby, Configuration, Operational and Diagnostic).
The behaviour is shown in the following table (according /RD22/):

Command	Standby	Config.	Operat.	Diag.
Mode command START	-	X	-	-
Mode command CONF	X	-	X	X
Mode command DIAG	-	X	-	-
Mode command STANDBY	-	X	X	X
OBT Sync command	X	X	X	X
HK acquisition commands	X	X	X	X
Configuration commands	-	X	-	-
ACS Calibration command	-	-	-	X
Load commands	-	X	-	-
Dump command	-	X	-	X

Legend: - command not allowed, failure flag 'Not allowed command' will be set in response
X command is allowed, response will be Ack

Table: ACS Modes/Commands Matrix

4.1.2.6 VCU(ACS) Operations; Gamma Burst Measurement

After starting the gamma ray measurement (reception of acsGetGammaBurstStartTime), the first 161 samples (compete Toggle Buffer A and the first sample of Toggle Buffer B) contain 0 and must be discarded.

4.1.2.7 VCU(ACS) Operations; HK Buffer

After power on, the VCU SW starts with the acquiring of the HK data from all 92 FEEs and storing the data in the HK buffer. This initial filling of the HK buffer can not be dropped. So the HK buffer may contain error information (after at least 32 seconds all HK data will be acquired).
If the ACS is in configuration mode, the ISB communication can be switched off for single FEEs.
With the reading of the HK buffer, it will be cleared for the next acquisition cycle.

4.2 Scientific Aspects

4.2.1.1

5 Analog HK-Acquisition Transfer Function

(This chapter is a direct copy of /RD29/)
Remark: The high number of significant digits serves for correct calculation only and do not indicate any accuracy information.

5.1 Temperature HK Transfer Functions (AD590 sensors)

T[°K] = (-cnts[12bit] * 0.048828) + 400°K
T[°C] = (-cnts[12bit] * 0.048828) + 126.8°C

T[°K] = (-cnts[8bit] * 0.78125) + 400°K
T[°C] = (-cnts[8bit] * 0.78125) + 126.8°C

$\Delta \pm 1° \cong \Delta \pm$ 14hex cnts $\Delta \pm 0.5° \cong \Delta \pm$ 0Ahex cnts (for 12bit)

$\Delta \pm 0.0488° \cong \Delta \pm 1$ cnt (for 12bit)
$\Delta \pm 0.78125° \cong \Delta \pm 1$ cnt (for 8bit)

5.2 Data structure of the "acsGetHkTemperatures" command (AD590 sensors)

8 bit HK-Temperature acquisition with **acsGetHkTemperatures** command:

acsGetHkTemperatures (Byte Position)		
1	80 hex	User's Acknowledgement
2	18 hex	Hk acq. Identifier = **18** hex
	8 Bit Values	
3		Temperature 0 (UCR 0)
4		Temperature 1 (UCR 1)
5		Temperature 2 (UCR 2)
6		Temperature 3 (LCR 0)
7		Temperature 4 (LCR 1)
8		Temperature 5 (LCR 2)
9		Temperature 6 (SSA 0)
10		Temperature 7 (SSA 1)
11		Temperature 8 (SSA 2)
12		Temperature 9 (LVS 0)
13		Temperature 10 (LVS 1)
14		Temperature 11 (LVS 2)
15		Temperature 12 (VCU intern, HK board)
16		Temperature 13 (PSAC 0)
17		Temperature 14 (PSAC 1)
18		Temperature 15 (PSAC 2)
19		00
20		CS

5.3 Data structure of the "acsGetDiag1" command (AD590 sensors)

12 bit HK-Temperature acquisition with **acsGetDiag1** command:

acsGetDiag1 (Byte Position)		
1	80 hex	User's Acknowledgement
2	80 hex	Hk acq. Identifier = **80** hex
	12 Bit Values	
3..4		Temperature Thermistor 0 → UCR 0 (12 bit) Byte 3: 0000.xxxx (4 most significant bits) Byte 4: xxxx.xxxx (8 least significant bits)
5..6		Temperature Thermistor 1 → UCR 1 (12 bit)
7..8		Temperature Thermistor 2 → UCR 2 (12 bit)
9..10		Temperature Thermistor 3 → LCR 0 (12 bit)
11..12		Temperature Thermistor 4 → LCR 1 (12 bit)
13..14		Temperature Thermistor 5 → LCR 2 (12 bit)
15..16		Temperature Thermistor 6 → SSA 0 (12 bit)
17..18		Temperature Thermistor 7 → SSA 1 (12 bit)
19..20		Temperature Thermistor 8 → SSA 2 (12 bit)
21..22		Temperature Thermistor 9 → LVS 0 (12 bit)
23..24		Temperature Thermistor 10 → LVS 1 (12 bit)
25..26		Temperature Thermistor 11 → LVS 2 (12 bit)
27..28		Temperature Thermistor 12 → VCU internal (HK-Board) (12 bit)
29..30		Temperature Thermistor 13 → PSAC 0 (12 bit)
31..32		Temperature Thermistor 14 → PSAC 1 (12 bit)
33..34		Temperature Thermistor 15 → PSAC 2 (12 bit)
35		Spare
36		CS

5.4 Voltage resp. Current HK Transfer Functions

For the VCU **FM** the following transfer functions for voltage/current HKs apply:

HK_IAC:

I_{AC}[A] = cnts [12bit] *2.44A/4096 = cnts * 0.0005957
I_{AC}[A] = cnts [8bit] *2.44A/256 = cnts * 0.00953

HK_VAC:

V_{AC}[A] = cnts [12bit] *35V/4096 = cnts * 0.008545
V_{AC}[A] = cnts [8bit] *35V/256 = cnts * 0.1367

2.5V Ref and GND:

U_{ref} = cnts (12bit) * 1.22mV
GND = cnts (12bit) * 1.22mV

+15V:

U_{+15V} = cnts (12bit) * 7.3242mV

-15V:

U_{-15V} = (cnts (12bit) * 4.069mV) - 23.333V

+5V (same for VCU-EM and FM):

U_{+5V} = cnts (8bit) * 0.0391V
U_{+5V} = cnts (12bit) * 2.442mV

5.5 Data structure of the "acsGetHkVoltage&Current" command

8 bit analogue HK acquisition with **acsGetHkVoltage&Current** command:

acsGetHkVoltage&Current (Byte Position)		
	Nom	Remarks
1	**80** hex	User's Acknowledgement
2	**17** hex	Hk acq. Identifier = **17** hex
	8 Bit Values	
3		VCU AC current,
4		VCU AC voltage (28V)
5		VCU +5 V supply voltage
6		CS

5.6 Data structure of the "acsGetDiag2" command

12 bit analogue HK acquisition with **acsGetDiag2** command:

AcsGetDiag2 (Byte Position)		
	Nom	Remarks
1	**80** hex	User's Acknowledgement
2	**81** hex	Hk acq. Identifier = **81** hex
	12 Bit Values	
3..4		VCU AC current, 12 bit
5..6		VCU AC voltage (28V) 12 bit
7..8		VCU 2.5 V Ref. (12 bit)
9..10		VCU +15 V Supply (12 bit)
11..12		VCU -15 V Supply (12 bit)
13..14		VCU +5 V Supply (12 bit)
15..16		VCU Ground Ref. (12 bit)
17..35		Further digital information
36		CS

5.7 Analog channel to DPE in RTU

Remark: The high number of significant digits serves for correct calculation only and do not indicate any accuracy information.

AC voltage [V AC] = DPE input voltage * 7.38 * V AC + 0.67 V AC

or

AC voltage [V AC] = HKreading * 0.1482 * V AC + 0.67 V AC

HKreading represents the digital value of the DPE acquisition, taking into account the email from Pierre Koutsikidis, CNES, August 11th 2000. (5.12 V/ 255)

6 Analogue Housekeeping Operational Limits

The limits given in the following chapter are calculated that within these there are covered all modes and adjustments.
Basis for the limit philosophy are the emails from Nadine Geraud-Liria, CNES,
March 27th 2000, 10:07 “RE: HK alert definition” and
April 4th 2000, 17:47 “Default value, min,max ...”

According this definition in the following there are given “**Warning Values**” as well as “**Alarm Values**”.

The definition of “lower” and “upper” is due to the physical values (temperature, voltage, current).

Due to the small tolerances for the temperature data acquisition there is no additional margin considered.

For calculation the following EXCEL-spreadsheet can be used:

Transfer_Functions_AHK.xls

6.1 Limits of the "acsGetHkTemperatures" command (AD590 sensors)

8 bit HK-Temperature acquisition with **acsGetHkTemperatures** command:

Warning Values

acsGetHkTemperatures (Byte Position)	Lower Limit * [hex]	Lower Limit * [°C]	Nominal Value @25°C [hex]	Nominal Value [°C]	Upper Limit * [hex]	Upper Limit * [°C]	Channel Designation
3	B8	-17	82	25°C	6F	+ 40	Temperature 0 (UCR 0)
4	B8	-17	82	25°C	6F	+ 40	Temperature 1 (UCR 1)
5	B8	-17	82	25°C	6F	+ 40	Temperature 2 (UCR 2)
6	B8	-17	82	25°C	6F	+ 40	Temperature 3 (LCR 0)
7	B8	-17	82	25°C	6F	+ 40	Temperature 4 (LCR 1)
8	B8	-17	82	25°C	6F	+ 40	Temperature 5 (LCR 2)
9	B8	-17	82	25°C	6F	+ 40	Temperature 6 (SSA 0)
10	B8	-17	82	25°C	6F	+ 40	Temperature 7 (SSA 1)
11	B8	-17	82	25°C	6F	+ 40	Temperature 8 (SSA 2)
12	B8	-17	82	25°C	6F	+ 40	Temperature 9 (LVS 0)
13	B8	-17	82	25°C	6F	+ 40	Temperature 10 (LVS 1)
14	B8	-17	82	25°C	6F	+ 40	Temperature 11 (LVS 2)
15	B8	-17	82...68 **	25...45°C	55	+ 60**	Temperature 12 (VCU int.)
16	B8	-17	82	25°C	6F	+ 40	Temperature 13 (PSAC 0)
17	B8	-17	82	25°C	6F	+ 40	Temperature 14 (PSAC 1)
18	B8	-17	82	25°C	6F	+ 40	Temperature 15 (PSAC 2)

* Limits according latest temperature prediction
**Due to internal hot spot this measurement point may show up to 20°C higher temperatures than the current ambient temperature.

Alarm Values

acsGetHkTemperatures (Byte Position)	Lower Limit * [hex]	Lower Limit * [°C]	Nominal Value @25°C [hex]	Nominal Value [°C]	Upper Limit * [hex]	Upper Limit * [°C]	Channel Designation
3	CF	- 35	82	25	6F	+ 40	Temperature 0 (UCR 0)
4	CF	- 35	82	25	6F	+ 40	Temperature 1 (UCR 1)
5	CF	- 35	82	25	6F	+ 40	Temperature 2 (UCR 2)
6	CF	- 35	82	25	6F	+ 40	Temperature 3 (LCR 0)
7	CF	- 35	82	25	6F	+ 40	Temperature 4 (LCR 1)
8	CF	- 35	82	25	6F	+ 40	Temperature 5 (LCR 2)
9	CF	- 35	82	25	6F	+ 40	Temperature 6 (SSA 0)
10	CF	- 35	82	25	6F	+ 40	Temperature 7 (SSA 1)
11	CF	- 35	82	25	6F	+ 40	Temperature 8 (SSA 2)
12	CF	- 35	82	25	6F	+ 40	Temperature 9 (LVS 0)
13	CF	- 35	82	25	6F	+ 40	Temperature 10 (LVS 1)
14	CF	- 35	82	25	6F	+ 40	Temperature 11 (LVS 2)
15	CF	- 35	82...68 **	25...45	55	+ 60**	Temperature 12 (VCU int.)
16	CF	- 35	82	25	6F	+ 40	Temperature 13 (PSAC 0)
17	CF	- 35	82	25	6F	+ 40	Temperature 14 (PSAC 1)
18	CF	- 35	82	25	6F	+ 40	Temperature 15 (PSAC 2)

* Limits according defined HW survival temperature and the predicted upper temperature level.
**Due to internal hot spot this measurement point may show up to 20°C higher temperatures than the current ambient temperature.

6.2 Limits of the "acsGetDiag1" command (AD590 sensors)

12 bit HK-Temperature acquisition with **acsGetDiag1** command:

Warning Values

acsGetDiag1 (Byte Position)	Lower Limit * [hex]	Lower Limit * [°C]	Nominal Value @25°C [hex]	Nominal Value [°C]	Upper Limit * [hex]	Upper Limit * [°C]	Channel Designation
3..4	B81	-17	824	25°C	6F1	+ 40	Temperature 0 (UCR 0)
5..6	B81	-17	824	25°C	6F1	+ 40	Temperature 1 (UCR 1)
7..8	B81	-17	824	25°C	6F1	+ 40	Temperature 2 (UCR 2)
9..10	B81	-17	824	25°C	6F1	+ 40	Temperature 3 (LCR 0)
11..12	B81	-17	824	25°C	6F1	+ 40	Temperature 4 (LCR 1)
13..14	B81	-17	824	25°C	6F1	+ 40	Temperature 5 (LCR 2)
15..16	B81	-17	824	25°C	6F1	+ 40	Temperature 6 (SSA 0)
17..18	B81	-17	824	25°C	6F1	+ 40	Temperature 7 (SSA 1)
19..20	B81	-17	824	25°C	6F1	+ 40	Temperature 8 (SSA 2)
21..22	B81	-17	824	25°C	6F1	+ 40	Temperature 9 (LVS 0)
23..24	B81	-17	824	25°C	6F1	+ 40	Temperature 10 (LVS 1)
25..26	B81	-17	824	25°C	6F1	+ 40	Temperature 11 (LVS 2)
27..28	B81	-17	824...68B **	25...45°C	558	+ 60**	Temperature 12 (VCU int.)
29..30	B81	-17	824	25°C	6F1	+ 40	Temperature 13 (PSAC 0)
31..32	B81	-17	824	25°C	6F1	+ 40	Temperature 14 (PSAC 1)
33..34	B81	-17	824	25°C	6F1	+ 40	Temperature 15 (PSAC 2)

* Limits according latest temperature prediction
**Due to internal hot spot this measurement point may show up to 15°C higher temperatures than the current ambient temperature.

12 bit HK-Temperature acquisition with **acsGetDiag1** command:

Alarm Values

acsGetDiag1 (Byte Position)	Lower Limit * [hex]	Lower Limit * [°C]	Nominal Value @25°C [hex]	Nominal Value [°C]	Upper Limit * [hex]	Upper Limit * [°C]	Channel Designation
3..4	CF	- 35	824	25	6F1	+ 40	Temperature 0 (UCR 0)
5..6	CF	- 35	824	25	6F1	+ 40	Temperature 1 (UCR 1)
7..8	CF	- 35	824	25	6F1	+ 40	Temperature 2 (UCR 2)
9..10	CF	- 35	824	25	6F1	+ 40	Temperature 3 (LCR 0)
11..12	CF	- 35	824	25	6F1	+ 40	Temperature 4 (LCR 1)
13..14	CF	- 35	824	25	6F1	+ 40	Temperature 5 (LCR 2)
15..16	CF	- 35	824	25	6F1	+ 40	Temperature 6 (SSA 0)
17..18	CF	- 35	824	25	6F1	+ 40	Temperature 7 (SSA 1)
19..20	CF	- 35	824	25	6F1	+ 40	Temperature 8 (SSA 2)
21..22	CF	- 35	824	25	6F1	+ 40	Temperature 9 (LVS 0)
23..24	CF	- 35	824	25	6F1	+ 40	Temperature 10 (LVS 1)
25..26	CF	- 35	824	25	6F1	+ 40	Temperature 11 (LVS 2)
27..28	CF	- 35	824...68B **	25...45	558	+ 60**	Temperature 12 (VCU int.)
29..30	CF	- 35	824	25	6F1	+ 40	Temperature 13 (PSAC 0)
31..32	CF	- 35	824	25	6F1	+ 40	Temperature 14 (PSAC 1)
33..34	CF	- 35	824	25	6F1	+ 40	Temperature 15 (PSAC 2)

* Limits according defined HW survival temperature and the predicted upper temperature level.
**Due to internal hot spot this measurement point may show up to 15°C higher temperatures than the current ambient temperature.

6.3 Limits of the "acsGetHkVoltage&Current" command

8 bit analogue HK acquisition with **acsGetHkVoltage&Current** command:

Warning Values

acsGetHkVoltage&Current (Byte Position)	Lower Limit [hex]	Lower Limit *	Nominal Value @ Operation [hex]	Nominal Value @ Operation	Upper Limit * [hex]	Upper Limit *	Channel Designation
3	4E	0.75 A	9D	1.5 A	FF	2.43 A	VCU AC current,
4	B6	25V	C6	27.1 V	DB	30 V	VCU AC voltage (28V)
5	7A	4.8 V	7F	5 V	8A	5.4 V	VCU +5 V supply voltage

* Limits also cover the tolerances/failures, as estimated, of the measurement itself. The limits are calculated with the nominal transfer function.

8 bit analogue HK acquisition with **acsGetHkVoltage&Current** command:

Alarm Values

acsGetHkVoltage&Current (Byte Position)	Lower Limit [hex]	Lower Limit *	Nominal Value @ Operation [hex]	Nominal Value @ Operation	Upper Limit * [hex]	Upper Limit *	Channel Designation
3	4E	0.75 A	9D	1.5 A	FF	2.43 A	VCU AC current,
4	B3	24.5 V	C6	27.1 V	E2	31 V	VCU AC voltage (28V)
5	73	4.5 V	7F	5 V	8F	5.6 V	VCU +5 V supply voltage

* Limits also cover the tolerances/failures, as estimated, of the measurement itself. The limits are calculated with the nominal transfer function.

6.4 Limits of the "acsGetDiag2" command

12 bit analogue HK acquisition with acsGetDiag2 command:

Warning Values

AcsGetDiag2 (Byte Position)	Lower Limit [hex]	Lower Limit *	Nominal Value @ Operation [hex]	Nominal Value @ Operation	Upper Limit * [hex]	Upper Limit *	Channel Designation
3..4	4EB	0.75 A	9D6	1.5 A	FFF	2.44 A	VCU AC current, 12 bit
5..6	B6D	25 V	C63	27.1 V	DB6	30 V	VCU AC voltage (28V) 12 bit
7..8	7AF	2.4 V	801	2.5 V	853	2.6V	VCU 2.5 V Ref. (12 bit)
9..10	7AE	14.4 V	800	15 V	851	15.6 V	VCU +15 V Supply (12 bit)
11..12	893	-14.4 V	7FF	-15 V	76C	-15.6 V	VCU -15 V Supply (12 bit)
13..14	7AD	4.8 V	7FF	5 V	8A3	5.4 V	VCU +5 V Supply (12 bit)
15..16	000	0 V	000	0 V	004	6m V	VCU Ground Ref. (12 bit)

* Limits also cover the tolerances/failures, as estimated, of the measurement itself. The limits are calculated with the nominal transfer function.

12 bit analogue HK acquisition with acsGetDiag2 command:

Alarm Values

AcsGetDiag2 (Byte Position)	Lower Limit [hex]	Lower Limit *	Nominal Value @ Operation [hex]	Nominal Value @ Operation	Upper Limit * [hex]	Upper Limit *	Channel Designation
3..4	4EB	0.75 A	9D6	1.5 A	FFF	2.44 A	VCU AC current, 12 bit
5..6	B33	24.5 V	C63	27.1 V	E2B	31 V	VCU AC voltage (28V) 12 bit
7..8	786	2.35 V	801	2.5 V	87C	2.65V	VCU 2.5 V Ref. (12 bit)
9..10	777	14.0 V	800	15 V	888	16.0 V	VCU +15 V Supply (12 bit)
11..12	8F5	-14.0 V	7FF	-15 V	70A	-16.0 V	VCU -15 V Supply (12 bit)
13..14	732	4.5 V	7FF	5 V	8F5	5.6 V	VCU +5 V Supply (12 bit)
15..16	000	0 V	000	0 V	008	10m V	VCU Ground Ref. (12 bit)

* Limits also cover the tolerances/failures, as estimated, of the measurement itself. The limits are calculated with the nominal transfer function.

6.5 Limits of the RTU AC-Bus voltage measurement

According the AC-Bus voltages limits as described in the previous chapters the following limits for the RTU channel should be used.

Warning Values

RTU channel	Lower Limit VCU output [V]	Lower Limit physical value [VAC]	Nominal value VCU output [V]	Nominal value [VAC]	Upper Limit VCU output [V]	Upper Limit physical value [VAC]	Remarks
AC-Bus voltage	AA	25.9 V	B8	28 V	CB	30.9 V	Values compared to VCU measurement 0.9 V lower

Alarm Values

RTU channel	Lower Limit VCU output [V]	Lower Limit physical value [VAC]	Nominal value VCU output [V]	Nominal value [VAC]	Upper Limit VCU output [V]	Upper Limit physical value [VAC]	Remarks
AC-Bus voltage	A6	25.4 V	B8	28 V	D2	31.9 V	Values compared to VCU measurement 0.9 V lower