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EIS Health Monitor (auto safe)

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CHANGE RECORD

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01	14/01/2005	All new	First release
02	12/07/2005	4	Corrected bit-numbering error in section 3

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Applicable References (appears in [] in the following text):

1 – EIS Science requirements: MSSL/SLB-EIS/SP007.07
2 – EIS Status: MSSL/SLB-EIS/SP017.06
3 – EIS telecommanding structure: MSSL/SLB-EIS/SP016.06
4 – Private communication with Jason Tandy on 29/7/04.
5 – Private communication with John Shea (Perdix) on 8/9/04.
6 – Health monitor limits document is to be produced by Jason Tandy.

Glossary and Convention:

ADC	Analogue to Digital Converter
BC	Block Command, Solar-B Command parameter
CAM	Camera
D	Disable
EIS	Extreme ultraviolet Imaging Spectrometer
ES	Emergency or Safe (MHC only)
HM	Health Monitor
I	Current
MHC	Mechanism and Heater controller
N	Negative
NS	Negative Slope
Reg.	Register
P	Positive
PSU	Power Supply Unit
V	Voltage
VOD	CCD Voltage Output Drain
VRD	CCD Voltage Reset Drain
QCM	Quartz Crystal Microbalance (contamination monitor).

1.0 Introduction

As Solar-B spends most of its time out of ground contact, a health monitor task is required to ensure that EIS can enter a safe mode if an error is detected (voltage, current or temperature). This was reflected in EIS Science requirements [1], instrument health section:

"Monitor the health of the instrument and enter a safe mode if an anomaly is detected"

The MHC has its own health monitor task (auto safe), however, EIS health monitor act as a back-up process to the MHC auto safe.

2.0 Health monitor parameters type

All parameters that require checking (voltages, current and temperatures) are either unsigned bytes for the PSU and CAM (range 0 to 255) or 14-bit signed MHC parameters (range 0x2000 to 0x1FFF). A summary of the parameters type is listed in the following table:

SUB-SYSTEM	TYPE	NOTES
PSU and CAM	8-bit unsigned ADC values	Some parameters have a **negative slope**. A **negative slope (NS)** means the higher the ADC output the lower the physical value [4]. Parameters that have a **negative slope** are as follows: Temperatures, -8V and +15V
MHC	14-bit signed ADC values	**Currents**: ADC output can sit near zero and move either toward 0x2000 or 0x1FFF, for over current condition; depending on the way the MHC current is measured. **Voltages**: ADC Voltage sits near the nominal value (either positive or negative). Any deviation from the nominal voltage, i.e. either an over voltage or under voltage will cause a trip. **Temperatures**: Thermistor value should always be negative 0x2000 (minimum temperature or not connected) to 0x3FFF (max temp); Limits should typically be > 0x3CD0 (ambient temp.). The health monitor treats the MHC temperatures as un-signed parameters. [5].

3.0 Health monitor (HK table) structure

Each EIS status parameter (types 1, 2 and 3) is tracked by a 32-bit health monitor table entry. The health monitor table, which is also called the **HK table** in EIS memory map, is as follows:

MEMORY TABLE ID (UPLOAD / DUMP)	SEGMENT	START ADDRESS	END ADDRESS
EF / 0F	HM TBL	0x000000	0x00027F

The health monitor table structure is as follows (in words, each word is 4 bytes):

SUB-SYSTEM	HM TABLE ALLOCATION (WORDS)	START ADDRESS (BYTES) (HEX)	END ADDRESS (BYTES) (HEX)
PSU	27	0	6B
CAM	40	6C	10B
MHC	75	10C	237
Addresses 0x238 to 0x27F are unused (128 byte alignment), as requested by the J-side			

A health Monitor entry (32-bits) consists of three fields:

Control flags Field: 4-bits field, Bits 0 to 3
Nominal voltage field: 14-bits field, bits 4 to 17 (Voltage status parameters only)
Limit field: 14-bits field, bits 18 to 31

BIT 0	BIT 1	BIT 2	BIT 3	BITS 4 TO 17	BITS 18 TO 31
NS_ES	V	I	D	Nominal voltage (applies for EIS voltages only)	Limit

The Control flags field (**TRUE = 1**) are as follows:

FLAG	SUB-SYSTEM	DESCRIPTION
NS_ES	Dual use flag	Flag meaning: PSU/CAM: Negative slope parameter Error if (parameter < limit) Positive slope parameter Error if (parameter > limit) MHC: Action taken in response to an error detection: 1: Invoke Emergency mode 0: Invoke MHC safe mode [3].

		The latter will ensure that the MHC can continue EIS thermal control operations. For e.g. Mechanism over-heating. The MHC heater controller continues its operation if enabled.
V	All	Voltage parameter (upper and lower limit check) Error if **absolute** (parameter - nominal voltage) > limit
I	MHC	MHC current value Error if **absolute** (parameter) > limit
D	All	Disable parameter check. Override all flags. Other fields are "ignored". No check against limit is performed
If all these flags are set to 0, then normal check is performed, i.e. Error if parameter > limit. Note that while the MHC temperatures are signed parameters, however, their ranges are from 0x2000 to 0x3FFF (over-temperature towards 0x3FFF) hence these parameters can be treated by the Health monitor as unsigned values and setting V, I and D to "zero" shall be used for errors detection.		

For the ICU, a health monitor trip occurs if **two consecutive errors** are detected for the same parameter. This is to avoid tripping caused by "spikes". A trip will result in the ICU invoking emergency mode (PSU and CAM) and the "offending parameter" is reported in statue type 1 (bytes 60 to 63 [2]). For the MHC, an option per parameter can be set to invoke EIS emergency mode or MHC safe mode, depending on the nature of the error.

Example 1:

Set HM limit for a PSU temperature (NS parameter)

NS_ES = 1
V, I, D = 0
Limit = 0x52

The HM setting is 0x80000052

Example 2:

Set HM limit for a CAM voltage

NS_ES, I, D = 0
V = 1
Nominal voltage = 0xEA
Limit = 0x5 (+/- 5 ADC levels deviation from 0xEA)

The HM setting is 0x403A8005

Example 3:

Set HM limit for a MHC current, **Safe** MHC upon error (not emergency):

NS_ES = 0 (safe MHC upon error)
V, I, D = 0, 1, 0

Limit = 0x123

The HM setting is 0x20000123

Example 3:

Disable parameter check:

D = 1
Others = “don’t care”

The HM setting is 0x10000000

Note that the HM table addresses to set these limits are given in section 5.0.

4.0 Health monitor task commanding

4.1 ICU commanding

The health monitor operations can be globally enabled and disabled via command BC1 0x25 [3]. The Command BC2 can have one of the following values:

BC2 = 0x01 (enable health monitor)
BC2 = 0x02 (disable health monitor)

The health monitor defaults to “enabled” when the ICU operational software starts. It is not supported in Boot mode as the instrument is in a safe state anyway.

Also individual status parameters checking can be disabled via setting the D flag (see section 3).

Individual HM parameter setting is performed via memory uplink commands. Individual parameters addresses are given in section 5.0.

4.2 MHC commanding

The health monitor operation can be globally enabled and disabled via command BC1 0x5F (AUTO_SAFE_STAT) [3]. The Command BC6 and 7 can have one of the following values:

BC6 and 7 = 0x0001 (enable MHC auto safe)
BC6 and 7 = 0xFFFF (disable MHC auto safe)

The MHC auto safe is enabled from the ICU MHC initialisation EIS sequences, following the MHC power-up or reset. A minimum of one MHC parameter table update (write) must be performed before enabling the MHC auto safe. Failing to do this will result in the MHC entering auto safe due to a parameter table checksum error. The MHC initialises the parameter table checksum following each parameter table update.

5.0 Health monitor parameters setting

This section describes the setting of EIS health monitor parameters. The exact HM limits setting will be available in separate document [6]. Updating the health monitor parameters should be performed in Standby or Emergency modes, following the invocation of EIS operational software.

The status parameters (types 1, 2 and 3), when acquired are sent to the health monitor task for checking against their limits.

HM table Address In bytes (HEX)	Byte No. (STATUS)	Name	Description	Default
PSU (type 1)				
0	40, 41	PSU_FLAGS	D	0x10000000
4	42	PSU_CCD_A_TEMP	NS	0x80000052 (TBC)
8	43	PSU_CCD_B_TEMP	NS	0x80000052 (TBC)
C	44	PSU_PROC_TEMP	NS	TBD
10	45	Unused	D: Discarded sun sensor	0x10000000
14	46	PSU_ICU_P2.5V	V	TBD
18	47	PSU_ICU_P5V	V	TBD
1C	48	PSU_ICU_P15V	V	TBD
20	49	PSU_ICU_N15V	V	TBD
24	50	PSU_ICU_P2.5I	None	TBD
28	51	PSU_ICU_P5I	None	TBD
2C	52	PSU_ICU_P15I	NS	TBD
30	53	PSU_ICU_N15I	NS	TBD
34	54	PSU_MBUS_28V	V	TBD
38	55	PSU_MBUS_28I	None	TBD
3C	X	Unused	D: Discarded sun sensor	0x10000000
40	X	Unused	D: Discarded sun sensor	0x10000000
The following **PSU** HK parameters appear in **status type 2**				
44	40	PSU_CAM_P39V	V	TBD
48	41	PSU_CAM_P39VI	None. **Reset to 0 if CAM is OFF**	TBD
4C	42	PSU_CAM_P7V	V	TBD
50	43	PSU_CAM_N8V	V	TBD
54	44	PSU_CAM_P8V	Set V flag only (NS parameter) As only deviation from nominal is needed	TBD
58	45	PSU_CAM_P13V	V	TBD
5C	46	PSU_CAM_P7VI	None. **Reset to 0 if CAM is OFF**	TBD

HM table Address In bytes (HEX)	Byte No. (STATUS)	Name	Description	Default
60	47	PSU_CAM_N8VI	None. **Reset to 0 if CAM is OFF**	TBD
64	48	PSU_CAM_P8VI	None. **Reset to 0 if CAM is OFF**	TBD
68	49	PSU_CAM_P13VI	None. **Reset to 0 if CAM is OFF**	TBD
CAM (status type 2)				
6C	0	CAM_P5V1_DIG	V	TBD
70	1	CAM_P2V5_DIG	V	TBD
74	2	CAM_P5V_AN_A	V	TBD
78	3	CAM_P5V_AN_B	V	TBD
7C	4	CAM_N5V_AN_A	Set V flag only (NS parameter) as a deviation from nominal is only needed	TBD
80	5	CAM_N5V_AN_B	Set V flag only (NS parameter) as a deviation from nominal is only nedded	TBD
84	6	CAM_P36V_A	V	TBD
88	7	CAM_P36V_B	V	TBD
8C	8	CAM_P12V_A	V	TBD
90	9	CAM_P12V_B	V	TBD
94	10	CAM_VOD_A	V	TBD
98	11	CAM_VRD_A	V	TBD
9C	12	CAM_VSS_A	V	TBD
A0	13	CAM_VOD_B	V	TBD
A4	14	CAM_VRD_B	V	TBD
A8	15	CAM_VSS_B	V	TBD
AC	16	CAM_P5VI_DIG	None	TBD
B0	17	CAM_P2V5I_DIG	None	TBD
B4	18	CAM_P5VI_AN_A	None	TBD
B8	19	CAM_P5VI_AN_B	None	TBD
BC	20	CAM_N5VI_AN_A	None	TBD
C0	21	CAM_N5VI_AN_B	None	TBD
C4	22	CAM_P36VI_A	None	TBD
C8	23	CAM_P36VI_B	None	TBD
CC	24	CAM_P12VI_A	None	TBD
D0	25	CAM_P12VI_B	None	TBD
D4	26	CAM_UP_T	NS	TBD
D8	27	CAM_LO_T	NS	TBD
DC	28	CAM_N10V_A	V	TBD
E0	29	CAM_N10V_B	V	TBD
E4	30	Spare	D	0x10000000
E8	31	Spare	D	0x10000000
EC	32	CAM_VOD	D. CCDA and B VOD commanded value	0x10000000
F0	33	CAM_VRD	D. CCDA and B VRD commanded value	0x10000000
F4	34	CAM_VSS	D. CCDA and B VSS commanded value	0x10000000
F8	35	CAM_CONTROL_REG_1	D	0x10000000
FC	36	CAM_CONTROL_REG_2	D	0x10000000
100	37	Spare	D	0x10000000
104	38	Spare	D	0x10000000

HM table Address In bytes (HEX)	Byte No. (STATUS)	Name	Description	Default
108	39	CAM_SEU_COUNTER	D	0x10000000

HM table Address (HEX)	Parameter Number	Name	Description	Default
MHC (status type 3) **Note: All the MHC parameters are 16 bits long. These parameters are numbered 1 to 75. Parameter 1 appears in status type 3 bytes 0 to 1 and so forth.**				
10C	1	MHC_SG_OP	D	0x10000000
110	2	MHC_P5VD	V	TBD
114	3	MHC_P15V_A	V	TBD
118	4	MHC_N15V_A	V	TBD
11C	5	MHC_P15V_M	V	TBD
120	6	MHC_GRA_POS_AN	D	0x10000000
124	7	MHC_SS_POS_STEPS	D	0x10000000
128	8	MHC_P120V_PZT	V	TBD
12C	9	MHC_SGV_REF	D	0x10000000
130	10	MHC_P5V_D_I	I	TBD
134	11	MHC_P15V_A_I	I	TBD
138	12	MHC_N15V_A_I	I	TBD
13C	13	MHC_CMIR_POS_STEPS	D	0x10000000
140	14	MHC_GND_I_REF	D	0x10000000
144	15	MHC_RDC_I	I	TBD
148	16	MHC_DB_T0	T	TBD
14C	17	MHC_BOX_T1	T	TBD
150	18	MHC_PB_T2	T	TBD
154	19	MHC_PB_T3	T	TBD
158	20	MHC_SLA_T4	T	TBD
15C	21	MHC_SLA_T5	T	TBD
160	22	MHC_HARNSS_T6	T	TBD
164	23	MHC_MIR_BASE_T7	T	TBD
168	24	MHC_MIR_PZT_T8	T	TBD
16C	25	MHC_MIR_MOTOR_T9	T	TBD
170	26	MHC_GRA_MOTOR_T10	T	TBD
174	27	MHC_GRA_ASM_T1	T	TBD
178	28	MHC_PB_D4_T12	T	TBD
17C	29	MHC_REF_THER_0	D	0x10000000
180	30	MHC_CAL_THER_0	T	TBD
184	31	MHC_HZ_T0	T	TBD
188	32	MHC_HZ_T1	T	TBD
18C	33	MHC_HZ_T2	T	TBD
190	34	MHC_HZ_T3	T	TBD
194	35	MHC_HZ_T4	T	TBD
198	36	MHC_HZ_T5	T	TBD
19C	37	MHC_HZ_T6	T	TBD
1A0	38	MHC_HZ_T7	T	TBD
1A4	39	MHC_HZ_T8	T	TBD
1A8	40	MHC_HZ_T9	T	TBD
1AC	41	MHC_HZ_T10	T	TBD
1B0	42	MHC_HZ_T11	T	TBD
1B4	43	MHC_HZ_T12	T	TBD
10C	44	MHC_HZ_T13	T	TBD
110	45	MHC_HZ_T14	T	TBD
114	46	MHC_HZ_T15	T	TBD
118	47	MHC_GND_F_REF	D	0x10000000
11C	48	MHC_CMIR_POS	D	0x10000000

HM table Address (HEX)	Parameter Number	Name	Description	Default
120	49	MHC_SS_POS	D	0x10000000
124	50	MHC_MOTOR_OPT_EC	D	0x10000000
128	51	MHC_ACT_OPT_ENC	D	0x10000000
12C	52	MHC_GRA_SW_POS	D	0x10000000
130	53	MHC_EXP_T1	D	0x10000000
134	54	MHC_EXP_T2	D	0x10000000
138	55	MHC_PZT_DRIVE	D	0x10000000
13C	56	MHC_ACT_STAT	D	0x10000000
140	57	MHC_CAL_SRC_STAT	D	0x10000000
144	58	MHC_HTR_STAT	D	0x10000000
148	59	MHC_QCM_MSW	D	0x10000000
14C	60	MHC_QCM_LSW	D	0x10000000
150	61	MHC_C_MON1_T	T	TBD
154	62	MHC_C_MON2_T	T	TBD
158	63	MHC_QCM_INT_CLOCK	D	0x10000000
15C	64	MHC_CMD_REC	D	0x10000000
160	65	MHC_CMD_ACK	D	0x10000000
164	66	MHC_CMD_NACK	D	0x10000000
168	67	MHC_CMD_ID	D	0x10000000
16C	68	MHC_SEC_MSW	D	0x10000000
170	69	MHC_SEC_LSW	D	0x10000000
174	70	MHC_TIME_MSW	D	0x10000000
178	71	MHC_TIME_LSW	D	0x10000000
17C	72	MHC_SYS_STAT	D	0x10000000
180	73	MHC_VAC_GAUGE	D	0x10000000
184	74	MHC_PERFORM_INDEX	D	0x10000000
188	75	MHC_PERFORM_PARM	D	0x10000000