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ACP SOFTWARE

USER MANUAL

FM

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CHANGE DESCRIPTION:

This is the SUM for the FM version 3.12, the change pages replace the pages in SUM version 1.6.

The calculation of temperature values for the thermo couples OH and OW has been updated. New facts due to S/W release 3.12 have been incorporated.

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1. INTRODUCTION

1.1 INTENDED READERSHIP AND SCOPE

This document is intended to be read by potential users of ACP.

1.2 CONFIGURATION CONSTRAINTS

This document is applicable to the ACP Software, version 3.12 (*April 1996*) or later.

1.3 PURPOSE

This manual refers to the Hardware and Software that constitutes the ACP instrument.

The main objectives of the ACP software are:

- to control the ACP Mechanic
- to test ACP Mechanic and all control loops
- to provide an interface to command the ACP instrument via the probe system
- to collect data and transmit them to the probe system
- to perform an automatic sequence during cruise phase
- to perform an automatic measurement during descent to Titan synchronised to the probe system

1.4 RELATED DOCUMENTS

[AD-1]	ESA EID-A,	Experiment Interface Document	Issue 1, Rev. 4, 05/95
[AD-2]	ESA EID-B,	Experiment Interface Document	Issue 2, Rev. 0, 01/95
[AD-9]	ESA PSS-05-0	Software Engineering Standard	Issue 2
[AD-11]	ACP.JR.S/W.URD.0003	ACP User Requirement Document	Issue 2, Rev. *6*, 12/95
[AD-12]	ACP.JR.S/W.SRD.0006	ACP Software Requirement Document	Issue 3, Rev. *6*, 12/95
[AD-16]	ACP.JR.S/W.SDD.0007	ACP Software Design Document	Issue 2, Rev. *6*, 12/95
[RD-13]	*ESA PSS-04-107*	*Packet Telecommand Standard*	*Issue 1*

1.5 ACRONYMS

ACP	Aerosol Collector Pyrolyser
ACPCU	ACP Control Unit
ACPDE	ACP Drive Electronic
ACPE	ACP Electronic
ACPM	ACP Mechanic
AD	Applicable Document
AGND	Analogue Ground
BCP	Broadcast Pulse
CL	Control Loop
CRC	Cyclic Redundancy Check
DDB	Data Descent Broadcast
EGSE	Electronic Ground Support Equipment
FHI	Hall sensor Filter In
FHO	Hall sensor Filter Out
FI	Filter
FIM	Filter Mechanism
FM	Filter Motor
GCMS	Gas Chromatograph and Mass Spectrometer
GM	Gate Valve Motor
GV	Gate Valve
GVHC	Hall sensor Gate Valve Closed
GVHO	Hall sensor Gate Valve Open
GVM	Gate Valve Mechanism
HSC	Hall sensor Sealing Cover
HV2	Heater for Electro-Valve V2
HP1	Heater for One-Shot-Valve P1
IAS	Institute for Applied Systems Technology
JR	Joanneum Research
LEM	Laboratory Engineering Model
ML	Monitoring Loop
ML1	Main Line 1
MLC	Memory Load Command
Mux. HK	Multiplexed Housekeeping Value
OH	Oven Heater
OPCL	Oven Pressure Control Loop
OW	Oven Wall
RD	Reference Document
RGND	Reference Ground
P1, P2, P3	One-shot valve
PL2	Power Line 2
QM	Qualification Model
SA	Service d'Aeronomie (CNRS)
SAE	Schrack-Aerospace
SC	Sealing Cover
SCH	Sealing Cover heater
SW	Status word
S/W	Software
TC	Tele Command
TCGND	Thermo Couple Ground
TCOH	Thermo Couple Oven Heater
TCOW	Thermo Couple Oven Wall
TBC	To Be Confirmed
V1, V2, Vt	Electro Valves

1.6 PROBLEM REPORTING INSTRUCTIONS

If any problems are encountered during the normal execution of the ACP S/W, please contact directly Mrs. Eveline Meitz at JR.

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1.7 GETTING STARTED

Each time ML1 is on, ACPCU is running.

2. INITIALISATION

All mechanic devices are definitely switched off within 5s after ML1 turn on (this is done by the hardware) and ACPCU is initialised. Then ACPCU waits for a DDB to start with mechanic initialisation.

Normal power on initialisation or re-initialisation of ACPM is done depending on mission phase and mission time of DDB.

☞ If ACP does not receive a valid DDB during 20s, ACP will switch actively to the other CDMU channel, independent of the status of the Processor Valid signal. If an active selection gives no positive result, ACP toggles from CDMU A to B and vice versa every 20s until a valid DDB was received.

Mission Phase of DDB	normal ACPM initialisation	ACPM re-initialisation
Descent	t < to + 1'42"	t ≥ to + 1'42"
Ground c/o Ground c/o suspended Ground c/o de-activate	no initialisation	no re-initialisation
Cruise c/o Cruise c/o suspended Cruise c/o de-activate	no initialisation	no re-initialisation

Table 1, Execution of ACPM normal initialisation or ACPM re-initialisation

☞ All devices are switched off within 5 seconds after switch on of ML1 or after a Watchdog reset by the ACPCU hardware.

☞ Normal ACPM initialisation is started not before the time for ML3 turn on (Descent: to+0'40").

Only the Gate Valve and the Filter are affected by normal initialisation:

Device	Descent
Gate Valve	locked
Filter	inside

Table 2, ACPM Normal Initialisation

This initialisation may last up to 1'00".

The duration of ACPM re-initialisation depends on the devices that have to be initialised. The component status in Table 23 lists what devices and how they are initialised after a power failure or watchdog reset.

☞ After a power failure or watchdog reset ACP is synchronised to the beginning of the next valid subsequence.

☞ During ACPCU and ACPM initialisation or re-initialisation neither PTD nor SW is generated. Furthermore all DDBs and MLCs that have been received during ACPM initialisation are cancelled.

3. SYNCHRONISATION

3.1 GENERAL

The ACP instrument works always synchronously to the Probe system. To do this the probe system provides the BCP and the DDB. Additionally ACP uses the internal TRAP (time base 4ms, interrupt).

All time dependent actions (as there are the execution of a sequence, deactivation of a device after a nominal activation time and so on) are done only if the given time matches with the internal Timecode. This Timecode is a 16 bit word with a time resolution of 125ms.

Timecode is always synchronised to the mission time of DDB, except during Engineering mode.

☞ Mission time of DDB is not incremented if mission phase is **Ground c/o suspended** or **Cruise c/o suspended**. Since all activations and deactivations of a sequence are time dependent, the sequence is halted and all mechanic devices are switched off additionally.

Each BCP increments Timecode by one. If no BCP has been received within 128ms (32*4ms), then Timecode is also incremented by one.

3.2 DDB DECODING

Only one MLC frame or one DDB frame is decoded within one 125 ms time slot. Nevertheless no information will be lost if MLC and DDB are sent within the same cut, because it will be decoded during the next cut.

☞ DDB Decoding (done only if ACP is not in Engineering Mode): The first byte and the 4 least significant bits of the second byte of DDB frame are used to identify a DDB.

Then mission time is compared with the 5 most significant bits of Timecode.

- If they match, then the three least significant bits of Timecode are set to zero.
- In case the times do not match, then the CRC of the DDB is checked. Timecode is set to mission time if no CRC error was detected, otherwise the MLC/DDB error flag in SW is set.

Afterwards the mission phase is decoded:

- If mission phase is the same as before or if the suspended flag is set then everything is OK.
- If the suspended flag is reset or if mission phase changes for example from 'Ground c/o' to 'Descent' then ACP is restarted (including ACPCU initialisation and ACPM initialisation).

All other bytes of DDB frame are not decoded.

☞ If ACP does not receive a valid DDB during 20s, ACP will switch actively to the other CDMU channel, independent of the status of the Processor Valid signal. If an active selection gives no positive result, ACP toggles from CDMU A to B and vice versa every 20s until a valid DDB was received.

4. TELEMETRY DATA

4.1 STATUSWORD AND HOUSEKEEPING DATA

4.1.1 Definition

Experiment Statusword is made up of status1 and status2, where status1 is the hi-byte.

Bit	Byte	Function
7	status 1	"1" Oven Heater control loop ON
6	status 1	"1" Temperature in the oven over 1000 °C
5	status 1	"1" Pressure in the oven above 3 bar
4	status 1	"1" Temperature on V2 above 130 °C
3	status 1	"1" Temperature on P1 above 130 °C
2	status 1	"1" pump motor ON
1	status 1	"1" Temperature on the pump motor is above 150 °C
0	status 1	"1" Heater on SC is on or SC open, "0" Heater on SC is off and SC close
7,6	status 2	"00" FI in intermediate position, "01" FI in inner position "11" not defined, "10" FI in outer position
5,4	status 2	"00" GV in intermediate position, "01" GV locked "11" not defined, "10" GV open
3	status 2	"1" CDMU A is active, "0" CDMU B is active
2	status 2	"1" MLC or DDB is not correct or not valid
1,0	status 2	"11" Engineering Mode, "01" Descent Mode "00" Ground c/o Mode, "10" Cruise c/o Mode

Table 3, Definition of Experiment Status1 and Status2 Bits

There are four housekeeping bytes:

Bit	Byte	Function
7	HK-Info 1	"1" valve V1 open
6	HK-Info 1	"1" valve V2 open
5	HK-Info 1	"1" valve Vt open
4	HK-Info 1	"1" HP1 control loop ON
3	HK-Info 1	"1" HV2 control loop ON
2	HK-Info 1	"1" Temperature in ACPE box within range of 0 to +40 °C
1	HK-Info 1	"1" Main power 2 ON
0	HK-Info 1	"1" Main power 3 ON
7	HK-Info 2	"1" P1 open
6	HK-Info 2	"1" P2 open
5	HK-Info 2	"1" P3 open
4	HK-Info 2	"1" supply voltage +15 volts within range of +14.5 to +15.5 volts
3	HK-Info 2	"1" supply voltage -15 volts within range of -14.5 to -15.5 volts
2	HK-Info 2	"1" supply voltage +5 volts within range of +4.5 to +5.5 volts
1,0	HK-Info 2	"11" Temp. ACPE Box, "01" +15V "00" +5V, "10" -15V in HK-Info 3

Table 4, Definition of Housekeeping Info1 and Info2 Bits

The HK-Info3 value is an eight bit analogue data word with multiplexed contents. The identifier for the housekeeping value is written to HK-Info2 bit 1 & 0 (see table 4).

The HK-Info4 value is a byte counter for decoded MLCs.

4.1.2 When are the individual bits set ?

Bit	Byte	Description	
7	status 1	OH CL on	set to "1/0" whenever any oven temperature CL is switched on/off due to MLC execution or sequence processing
6	status 1	OV over temp.	computed each time a PTD header is generated (every 8s resp. 16s)
5	status 1	OV over press.	set to "1" when an over pressure interrupt occurred set to "0" after the SW has been transmitted
4	status 1	HV2 over temp.	computed each time a PTD header is generated (every 8s resp. 16s)
3	status 1	HP1 over temp.	computed each time a PTD header is generated (every 8s resp. 16s)
2	status 1	PM on	set to "1/0" whenever the PM is switched on/off due to MLC execution, sequence processing or Pump temperature ML
1	status 1	PU over temp.	set to "1" when Pump temperature CL is on and Pump temperature crosses 150 °C set to "0" when Pump temperature CL is on and Pump temperature falls below 120 °C, or if Pump is switched off due to MLC "Pump off" or sequence processing

0	status 1	SC	set to "1" when SC heater is switched on if SC heater not on, then the value is computed each time a PTD header is generated (every 8s resp. 16s): "0" if SC is closed, "1" if SC is open.
7,6	status 2	FI	computed each time a PTD header is generated (every 8s resp. 16s)
5,4	status 2	GV	computed each time a PTD header is generated (every 8s resp. 16s)
3	status 2	CDMU A	computed each time a PTD header is generated (every 8s resp. 16s)
2	status 2	MLC/DDB error	set to "1" when a wrong MLC or DDB is detected set to "0" after the SW has been transmitted
1,0	status 2	Mode	set to Engineering Mode after MLC "Engineering Mode" if Mode is not Engineering Mode then the value extracted from DDB is written to SW during DDB decoding

Table 5, Bit setting of Experiment Statusword

Bit	Byte	Description	Function
7	HK-Info 1	V1 open	set to "1/0" whenever V1 is opened/closed due to MLC execution, sequence processing or pressure CL
6	HK-Info 1	V2 open	set to "1/0" whenever V1 is opened/closed due to MLC execution or sequence processing
5	HK-Info 1	Vt open	set to "1/0" whenever V1 is opened/closed due to MLC execution, sequence processing or pressure CL
4	HK-Info 1	HP1 CL on	set to "1/0" whenever any HP1 temperature CL is switched on/off due to MLC execution or sequence processing
3	HK-Info 1	HV2 CL on	set to "1/0" whenever any HV2 temperature CL is switched on/off due to MLC execution or sequence processing
2	HK-Info 1	ACPE temp. OK	computed each time a PTD header is generated (every 8s resp. 16s)
1	HK-Info 1	PL2 on	computed each time a PTD header is generated (every 8s resp. 16s)
0	HK-Info 1	ML3 on	computed each time a PTD header is generated (every 8s resp. 16s)
7	HK-Info 2	P1 open	set to "1" after P1 heater has been switched off
6	HK-Info 2	P2 open	set to "1" after P2 heater has been switched off
5	HK-Info 2	P3 open	set to "1" after P1 heater has been switched off
4	HK-Info 2	+15V OK	computed each time a PTD header is generated (every 8s resp. 16s)
3	HK-Info 2	-15V OK	computed each time a PTD header is generated (every 8s resp. 16s)
2	HK-Info 2	+5V OK	computed each time a PTD header is generated (every 8s resp. 16s)
1,0	HK-Info 2	HK-Info3 MUX	computed each time a PTD header is generated (every 8s resp. 16s)

Table 6, Bit setting of Housekeeping Info1 and Info2

☞ Bit7 (OH CL on) of Exp_Status1, bit4 (HP1 CL on) or bit3 (HV2 CL on) of HK-Info1 set to "1" do not mean that the specific heater is on!

☞ OH and HV2 are switched off by hardware if one of the valves is open. The temperature control loops remain active and therefore the bits for OH, HP1 and HV2 do not change.

4.2 PACKET TELEMETRY DATA

4.2.1 General

There are four different PTD frames:

- PTD during Descent (and Ground c/o) Mode, sampling phase
- PTD during Descent (and Ground c/o) Mode, heating and transfer phase
- PTD during Cruise c/o Mode
- PTD during Engineering Mode

PTD frames during Cruise c/o and Engineering Mode are sent every 8th second.

During Descent, Ground c/o *and Cruise* Mode PTDs are sent every 16th second for t < 10min, and every 8th second for t ≥ 10min.
PTDs for sampling phase are sent during first and second sampling (see experiment chronogram for Descent sequence). All other times PTDs for heating and transfer phase are sent. So Time_hi and Time_lo of scientific data can tell you what frame it is.

Measurement Mode	PTD time (Time_hi, Time_lo)	PTD frame	occurrence
Descent, Ground c/o	t < to+10'00"	Descent, heating/transfer phase	16s
Descent, Ground c/o	to+10'00" ≤ t < to+23'30"	Descent, heating/transfer phase	8s
Descent, Ground c/o	to+23'30" ≤ t < to+60'00"	Descent, sampling phase	8s
Descent, Ground c/o	to+60'00" ≤ t < to+77'16,375"+Δt[1]	Descent, heating/transfer phase	8s
Descent, Ground c/o	to+77'16,375"+Δt ≤ t < to+88'30"	Descent, sampling phase	8s
Descent, Ground c/o	to+88'30" ≤ t	Descent, heating/transfer phase	8s
Cruise c/o	*t < to+10'00"*	*Cruise c/o*	*16s*
Cruise c/o	*t ≥ to+10'00"*	Cruise c/o	8s
Engineering	allways	Engineering	8s

Table 7, Occurrence of PTD frame for different modes and times

The timecode given in PTD (time_hi, time_lo) has a resolution of 250ms (LSB).

☞ PTD generation is not **synchronised to** DDB mission time but to the **BCP**. If no BCPs are sent, the S/W works with the internal time base (TRAP, 4ms). Therefore a PTD is sent every 8.162s (128ms*8*8) respectively every 16.324s if no BCPs are sent.

☞ During ACPCU and ACPM initialisation or re-initialisation no PTDs are generated.

☞ If the MLC "Engineering Mode" is sent before the time for ML3_ON then the first frame is generated depending on DDB mission phase. Nevertheless the statusword shows that ACP is in Engineering Mode. The following frames are generated in Engineering format.

---

[1]Δt = 0"...35,5" (2*7" + 4*5,375" maximum error recovery times for GM and FM) depending on activation times for GM and FM

4.2.2 Block Structure

Byte	Bit	Contents	Def.	Byte	Bit	Contents	Def.
1	7	Version number	0	2	7	Experiment packet identifier	1
1	6	Version number	0	2	6	Experiment packet identifier	0
1	5	Version number	0	2	5	Experiment packet identifier	1/0
1	4	Type	0	2	4	Experiment packet identifier	0
1	3	Data Field Header	1	2	3	Experiment packet identifier	0
1	2	Experiment packet identifier	1	2	2	Experiment packet identifier	0
1	1	Experiment packet identifier	1	2	1	Experiment packet identifier	1
1	0	Experiment packet identifier	1	2	0	Experiment packet identifier	1

Byte	Bit	Contents	Def.	Byte	Bit	Contents	Def.
3	7	Segmentation	1	4	7	Packet Counter	x
3	6	Segmentation	1	4	6	Packet Counter	x
3	5	Packet Counter	x	4	5	Packet Counter	x
3	4	Packet Counter	x	4	4	Packet Counter	x
3	3	Packet Counter	x	4	3	Packet Counter	x
3	2	Packet Counter	x	4	2	Packet Counter	x
3	1	Packet Counter	x	4	1	Packet Counter	x
3	0	Packet Counter	x	4	0	Packet Counter	x

Word	Contents
3	0077H (Packet length)
4 - 62	Scientific Data Package
63	Packet Error Control

Table 8, PTD block structure

4.2.3 Scientific Data Package

In the following the content of scientific data for the four different PTD is given. Additionally a statistic for the time intervals, when the specific values are written to the frame, is attached. Here one 'time slot' is 125ms for one frame per 8s and 250ms for one frame per 16s. All measurement values are measured in the same cut as they are written to the frame.

Measurement values from the PT1000, the PT500 and OV Pressure[1] value are offset corrected with the RGND value and the measurement values for +5V, +15V, -15V and RGND are corrected with the AGND value.
Only TCGND, OW temp. and OH temp. are not offset corrected. Different to all other measurement values, these values are unsigned bytes with 00h=5V and 80h=0V.
In addition all transmitted measurement values are mean-values to reduce noise:

$$Value_{CORn} = (Value_{CORn} + Value_{CORn-1})/2.$$

[1] The OV Pressure value is not corrected with the offset value calculated during in-flight calibration of the Descent Sequence.

Bytes	Contents			
1 - 4	Time_hi	Time_lo	Exp.SW 1	Exp.SW 2
5 - 8	HK-Info2	HK-Info3	Vref 1	Vref 2
9 - 12	Vref 3	TCGND	Temp. CJ	Temp. BP
13 - 16	HK-Info1	HV2 temp.	HP1 temp.	Pressure OV
17 - 20	PU temp. (1)	PU speed (1)	PU current (1)	OW temp. (1)
21 - 24	OH temp. (1)	PU temp. (2)	PU speed (2)	PU current (2)
25 - 28	PU temp. (3)	PU speed (3)	PU current (3)	PU temp. (4)
29 - 32	PU speed (4)	PU current (4)	PU temp. (5)	PU speed (5)
33 - 36	PU current (5)	PU temp. (6)	PU speed (6)	PU current (6)
37 - 40	PU temp. (7)	PU speed (7)	PU current (7)	PU temp. (8)
41 - 44	PU speed (8)	PU current (8)	PU temp. (9)	PU speed (9)
45 - 48	PU current (9)	OW temp. (2)	PU temp. (10)	PU speed (10)
49 - 52	PU current (10)	PU temp. (11)	PU speed (11)	PU current (11)
53 - 56	PU temp. (12)	PU speed (12)	PU current (12)	PU temp. (13)
57 - 60	PU speed (13)	PU current (13)	PU temp. (14)	PU speed (14)
61 - 64	PU current (14)	PU temp. (15)	PU speed (15)	PU current (15)
65 - 68	PU temp. (16)	PU speed (16)	PU current (16)	PU temp. (17)
69 - 72	PU speed (17)	PU current (17)	OW temp. (3)	OH temp. (2)
73 - 76	PU temp. (18)	PU speed (18)	PU current (18)	PU temp. (19)
77 - 80	PU speed (19)	PU current (19)	PU temp. (20)	PU speed (20)
81 - 84	PU current (20)	PU temp. (21)	PU speed (21)	PU current (21)
85 - 88	PU temp. (22)	PU speed (22)	PU current (22)	PU temp. (23)
89 - 92	PU speed (23)	PU current (23)	PU temp. (24)	PU speed (24)
93 - 96	PU current (24)	PU temp. (25)	PU speed (25)	PU current (25)
97 - 100	OW temp. (4)	PU temp. (26)	PU speed (26)	PU current (26)
101 - 104	PU temp. (27)	PU speed (27)	PU current (27)	PU temp. (28)
105 - 108	PU speed (28)	PU current (28)	PU temp. (29)	PU speed (29)
109 - 112	PU current (29)	PU temp. (30)	PU speed (30)	PU current (30)
113 - 116	PU temp. (31)	PU speed (31)	PU current (31)	PU temp. (32)
117 & 118	PU speed (32)	PU current (32)	not usable	not usable

Table 9, Scientific Data Packet during Descent Mode, sampling phase

Byte Description	#	time slot
Time_hi, Time_lo	1	0
Exp_SW 1, Exp_SW 2	1	0
HK-Info2, HK-Info3	1	0
Vref 1, Vref 2, Vref 3	1	0
TCGND	1	0
Temp. CJ	1	0
Temp. BP	1	0
HK-Info1	1	0
HV2 temp.	1	0
HP1 temp.	1	0
Pressure OV	1	0
PU temp.	32	0, 2, 4, ..
PU speed	32	0, 2, 4, ..
PU current	32	0, 2, 4, ..

OW temp.	4	0, 16, 32, 48
OH temp.	2	0, 32

Table 10, Statistic for Scientific Data Packet during Descent Mode, sampling phase

Bytes	Contents			
1 - 4	Time_hi	Time_lo	Exp.SW 1	Exp.SW 2
5 - 8	HK-Info2	HK-Info3	Vref 1	Vref 2
9 - 12	Vref 3	TCGND	Temp. CJ	Temp. BP
13 - 16	Ro	Rcal	PU temp.	Pressure (1)
17 - 20	HK-Info1 (1)	OW temp. (1)	HV2 temp. (1)	HP1 temp. (1)
21 - 24	Pressure (2)	Pressure (3)	Pressure (4)	Pressure (5)
25 - 28	HK-Info1 (2)	OH temp. (1)	Pressure (6)	Pressure (7)
29 - 32	Pressure (8)	Pressure (9)	HK-Info1 (3)	OH temp. (2)
33 - 36	Pressure (10)	Pressure (11)	Pressure (12)	Pressure (13)
37 - 40	HK-Info1 (4)	OH temp. (3)	Pressure (14)	Pressure (15)
41 - 44	Pressure (16)	Pressure (17)	HK-Info1 (5)	OH temp. (4)
45 - 48	OW temp. (2)	Pressure (18)	Pressure (19)	Pressure (20)
49 - 52	Pressure (21)	HK-Info1 (6)	OH temp. (5)	Pressure (22)
53 - 56	Pressure (23)	Pressure (24)	Pressure (25)	HK-Info1 (7)
57 - 60	OH temp. (6)	Pressure (26)	Pressure (27)	Pressure (28)
61 - 64	Pressure (29)	HK-Info1 (8)	OH temp. (7)	Pressure (30)
65 - 68	Pressure (31)	Pressure (32)	Pressure (33)	HK-Info1 (9)
69 - 72	OH temp. (8)	OW temp. (3)	HV2 temp. (2)	Hp1 temp.(2)
73 - 76	Pressure (34)	Pressure (35)	Pressure (36)	Pressure (37)
77 - 80	HK-Info1 (10)	OH temp. (9)	Pressure (38)	Pressure (39)
81 - 84	Pressure (40)	Pressure (41)	HK-Info1 (11)	OH temp. (10)
85 - 88	Pressure (42)	Pressure (43)	Pressure (44)	Pressure (45)
89 - 92	HK-Info1 (12)	OH temp. (11)	Pressure (46)	Pressure (47)
93 - 96	Pressure (48)	Pressure (49)	HK-Info1 (13)	OH temp. (12)
97 - 100	OW temp. (4)	Pressure (50)	Pressure (51)	Pressure (52)
101 - 104	Pressure (53)	HK-Info1 (14)	OH temp. (13)	Pressure (54)
105 -108	Pressure (55)	Pressure (56)	Pressure (57)	HK-Info1 (15)
109 - 112	OH temp. (14)	Pressure (58)	Pressure (59)	Pressure (60)
113 - 116	Pressure (61)	HK-Info1 (16)	OH temp. (15)	Pressure (62)
117 & 118	Pressure (63)	Pressure (64)	not usable	not usable

Table 11, Scientific Data Packet during Descent Mode, heating and transfer phase.

Byte Description	#	time slot
Time_hi, Time_lo	1	0
Exp_SW 1, Exp_SW 2	1	0
HK-Info2, HK-Info3	1	0
Vref 1, Vref 2, Vref 3	1	0
TCGND	1	0
Temp. CJ	1	0
Temp. BP	1	0
R0, Rcal	1	0
Pu temp.	1	0
Pressure OV	64	0, 1, 2, 3, ..

HK-Info1	16	0, 4, 8, ..
OH temp.	15	4, 8, 16, ..
OW temp.	4	0, 16, 32, 48
HV2 temp.	2	0, 32
HP1 temp.	2	0, 32

Table 12, Statistic for Scientific Data Packet during Descent Mode, heating and transfer phase.

Bytes	Contents			
1 - 4	Time_hi	Time_lo	Exp.SW 1	Exp.SW 2
5 - 8	HK-Info2	HK-Info3	Vref 1	Vref 2
9 - 12	Vref 3	TCGND	Temp. CJ	Temp. BP
13 - 16	Ro	Rcal	HK-Info4	PU temp.
17 - 20	PU speed	PU current	OW temp.	Pressure (1).
21 - 24	HK-Info1 (1)	OH temp. (1)	HV2 temp. (1)	HP1 temp. (1)
25 - 28	Pressure (2)	Pressure (3)	Pressure (4)	Pressure (5)
29 - 32	HK-Info1 (2)	OH temp. (2)	Pressure (6)	Pressure (7)
33 - 36	Pressure (8)	Pressure (9)	HK-Info1 (3)	OH temp. (3)
37 - 40	Pressure (10)	Pressure (11)	Pressure (12)	Pressure (13)
41 - 44	HK-Info1 (4)	OH temp. (4)	Pressure (14)	Pressure (15)
45 - 48	Pressure (16)	Pressure (17)	HK-Info1 (5)	OH temp. (5)
49 - 52	Pressure (18)	Pressure (19)	Pressure (20)	Pressure (21)
53 - 56	HK-Info1 (6)	OH temp. (6)	Pressure (22)	Pressure (23)
57 - 60	Pressure (24)	Pressure (25)	HK-Info1 (7)	OH temp. (7)
61 - 64	Pressure (26)	Pressure (27)	Pressure (28)	Pressure (29)
65 - 68	HK-Info1 (8)	OH temp. (8)	Pressure (30)	Pressure (31)
69 - 72	Pressure (32)	Pressure (33)	HK-Info1 (9)	OH temp. (9)
73 - 76	HV2 temp. (2)	Hp1 temp.(2)	Pressure (34)	Pressure (35)
77 - 80	Pressure (36)	Pressure (37)	HK-Info1 (10)	OH temp. (10)
81 - 84	Pressure (38)	Pressure (39)	Pressure (40)	Pressure (41)
85 - 88	HK-Info1 (11)	OH temp. (11)	Pressure (42)	Pressure (43)
89 - 92	Pressure (44)	Pressure (45)	HK-Info1 (12)	OH temp. (12)
93 - 96	Pressure (46)	Pressure (47)	Pressure (48)	Pressure (49)
97 - 100	HK-Info1 (13)	OH temp. (13)	Pressure (50)	Pressure (51)
101 - 104	Pressure (52)	Pressure (53)	HK-Info1 (14)	OH temp. (14)
105 -108	Pressure (54)	Pressure (55)	Pressure (56)	Pressure (57)
109 - 112	HK-Info1 (15)	OH temp. (15)	Pressure (58)	Pressure (59)
113 - 116	Pressure (60)	Pressure (61)	HK-Info1 (16)	OH temp. (16)
117 & 118	Pressure (62)	Pressure (63)	not usable	not usable

Table 13, Scientific Data Packet during Engineering Mode

Byte Description	#	time slot
Time_hi, Time_lo	1	0
Exp_SW 1, Exp_SW 2	1	0
HK-Info2, HK-Info3	1	0
Vref 1, Vref 2, Vref 3	1	0
TCGND	1	0
Temp. CJ	1	0
Temp. BP	1	0

R0, Rcal	1	0
HK-Info4	1	0
PU temp.	1	0
PU speed	1	0
PU current	1	0
OW temp.	1	0
Pressure OV	63	0, 1, 2, 3, ..
HK-Info1	16	0, 4, 8, ..
OH temp.	16	0, 4, 8, ..
HV2 temp.	2	0, 32
HP1 temp.	2	0, 32

Table 14, Statistic for Scientific Data Packet during Engineering Mode

Bytes	Contents			
1 - 4	Time_hi	Time_lo	Exp.SW 1	Exp.SW 2
5 - 8	HK-Info2	HK-Info3	Vref 1	Vref 2
9 - 12	Vref 3	TCGND	Temp. CJ	Temp. BP
13 - 16	Ro	Rcal	HK-Info4	Pressure OV
17 - 20	HK-Info1 (1)	HK-Info1 (2)	HK-Info1 (3)	OW temp. (1)
21 - 24	OH temp. (1)	HK-Info1 (4)	PU temp. (1)	PU speed (1)
25 - 28	PU current (1)	HV2 temp. (1)	HP1 temp. (1)	HK-Info1 (5)
29 - 32	OW temp. (2)	OH temp. (2)	HK-Info1 (6)	HK-Info1 (7)
33 - 36	OW temp. (3)	OH temp. (3)	HK-Info1 (8)	PU temp. (2)
37 - 40	PU speed (2)	PU current (2)	HV2 temp. (2)	HP1 temp. (2)
41 - 44	HK-Info1 (9)	OW temp. (4)	OH temp. (4)	HK-Info1 (10)
45 - 48	HK-Info1 (11)	OW temp. (5)	OH temp. (5)	HK-Info1 (12)
49 - 52	PU temp. (3)	PU speed (3)	PU current (3)	HV2 temp. (3)
53 - 56	HP1 temp. (3)	HK-Info1 (13)	OW temp. (6)	OH temp. (6)
57 - 60	HK-Info1 (14)	HK-Info1 (15)	OW temp. (7)	OH temp. (7)
61 - 64	HK-Info1 (16)	PU temp. (4)	PU speed (4)	PU current (4)
65 - 68	HV2 temp. (4)	HP1 temp. (4)	HK-Info1 (17)	OW temp. (8)
69 - 72	OH temp. (8)	HK-Info1 (18)	HK-Info1 (19)	OW temp. (9)
73 - 76	OH temp. (9)	HK-Info1 (20)	PU temp. (5)	PU speed (5)
77 - 80	PU current (5)	HV2 temp. (5)	HP1 temp. (5)	HK-Info1 (21)
81 - 84	OW temp. (10)	OH temp. (10)	HK-Info1 (22)	HK-Info1 (23)
85 - 88	OW temp. (11)	OH temp. (11)	HK-Info1 (24)	PU temp. (6)
89 - 92	PU speed (6)	PU current (6)	HV2 temp. (6)	HP1 temp. (6)
93 - 96	HK-Info1 (25)	OW temp. (12)	OH temp. (12)	HK-Info1 (26)
97 - 100	HK-Info1 (27)	OW temp. (13)	OH temp. (13)	HK-Info1 (28)
101 - 104	PU temp. (7)	PU speed (7)	PU current (7)	HV2 temp. (7)
105 -108	HP1 temp. (7)	HK-Info1 (29)	OW temp. (14)	OH temp. (14)
109 - 112	HK-Info1 (30)	HK-Info1 (31)	OW temp. (15)	OH temp. (15)
113 - 116	HK-Info1 (32)	PU temp. (8)	PU speed (8)	PU current (8)
117 & 118	HV2 temp. (8)	HP1 temp. (8)	not usable	not usable

Table 15, Scientific Data Packet during Cruise Checkout Mode

Byte Description	#	time slot
Time_hi, Time_lo	1	0
Exp_SW 1, Exp_SW 2	1	0
HK-Info2, HK-Info3	1	0
Vref 1, Vref 2, Vref 3	1	0
TCGND	1	0
Temp. CJ	1	0
Temp. BP	1	0
R0, Rcal	1	0
HK-Info4	1	0
Pressure OV	1	0
HK-Info1	32	0, 2, 4
OW temp.	15	4, 8, 12, ..
OH temp.	15	4, 8, 12, ..
PU temp	8	6, 14, 22, ..
PU speed	8	6, 14, 22, ..
PU current	8	6, 14, 22, ..
HV2 temp.	8	6, 14, 22, ..
HP1 temp.	8	6, 14, 22, ..

Table 16, Statistic for Scientific Data Packet during Cruise Checkout Mode

4.2.4 Packet Error Control

The Error Control word for a PTD frame is computed as following:

$$Error\_Control = \sum_{i=0}^{i=123} PTD\_Byte(i)$$

4.3 CALCULATING PHYSICAL VALUES FROM VALUES GIVEN IN THE PTD

4.3.1 Voltage values

To calculate the voltage values of HP1, HV2, CJ, BP, PU, Ro, Rcal, Vref1, Vref2, Vref3, Press OV use the following formula.

if $Value[PTD] < 128$ then $Value[V] = Value[PTD] * \frac{5}{128}$

else $Value[V] = (Value[PTD] - 256) * \frac{5}{128}$

To calculate the voltage values of OH, OW and TCGND use:

$$TC\_value[V] = (TC\_value[PTD] - 128) * \frac{5}{128}$$

4.3.2 Temperature values of PT1000 and PT500

To calculate the temperature values of HV2, HP1, CJ and BP:

$$Rx = \frac{500 * PT1000[V] + 1000 * Rcal[V] - 1500 * Ro[V]}{Rcal[V] - Ro[V]}$$

$$PT1000[°C] = -2.4561*10^2 + 2.35436*10^{-1} * Rx + 1.02081*10^{-5} * Rx^2$$

To calculate the temperature of PU:

$$Rx = \left(\frac{500 * PT500[V] + 1000 * Rcal[V] - 1500 * Ro[V]}{Rcal[V] - Ro[V]} - 500\right) * 2$$

$$PT500[°C] = -2.4561*10^2 + 2.35436*10^{-1} * Rx + 1.02081*10^{-5} * Rx^2$$

4.3.3 Temperature values of Thermo Couples OH and OW

$$TC\_corr = \frac{OH[V] - TCGND[V]}{-200}$$

$$V\_corr = 2.4491*10^{-8} + 3.94124*10^{-5} * CJ[°C] + 2.60024*10^{-8} * CJ[°C]^2 - 1.05478*10^{-10} * CJ[°C]^3 + TC\_corr$$

$$TC[°C] = -0.7012147 + 2.485831*10^4 * V\_corr - 5.643959*10^3 * V\_corr^2 - 2.021945*10^6 * V\_corr^3 + 4.399447*10^7 * V\_corr^4$$

4.3.4 PU speed, PU current and Pressure values

$$PU\_speed[Hz] = 14.612 * PU\_speed[PTD]$$

$$PU\_curr[Hz] = 29.282 * PU\_curr[PTD]$$

$$Pressure[Bar] = 0.8839 * Pressure[V]$$

5. MEASUREMENT MODES

5.1 ENGINEERING MODE

5.1.1 General

Only one MLC frame or one DDB frame is decoded within one 125 ms time slot. Nevertheless no information will be lost if MLC and DDB are sent within the same cut, because it will be decoded during the next cut. One MLC frame can contain up to 116 MLCs[1].

If a mechanic device can not be activated (for example because it is already active), then the command is not executed, nevertheless HK_Info4 is incremented.

The commands listed in the following section are accepted only if ACP is in Engineering Mode. To set ACP to Engineering Mode, the appropriate MLC has to be sent. This command is valid during all operation modes.

Name of MLC	Code	Function
Engineering Mode	3355 H	Switch ACPCU to Engineering Mode

Table 17, General Memory Load Command

☞ The internal Timecode is normally synchronised to DDB mission time. During Engineering mode Timecode is not synchronised to DDB mission time but only to BCP. This is necessary in order to control ACPM (especially SC, P2, GV, V1, V2 and Vt) correctly also if DDB mission phase is Ground c/o suspended or Cruise c/o suspended.

[1]One MLC frame can contain up to 240 bytes. 8 bytes are used for frame header and error control. A MLC code is 2 bytes long: (240-8)/2 = 116

5.1.2 MLC Execution

All commands listed in the following table are only accepted if the ACP instrument is in Engineering Mode.

Name of MLC	Code	Function
Sealing Cover [1]	5511 H	Open Sealing Cover
P1 [1]	5512 H	Open one-shot valve P1
P2 [1]	5514 H	Open one-shot valve P2
P3 [1]	5517 H	Open one-shot valve P3
V1 OPEN	5518 H	Open electro valve V1
V1 CLOSE	55B1 H	Close electro valve V1
V2 OPEN	551B H	Open electro valve V2 (GCMS pulse 8ms in advance)
V2 CLOSE	55B2 H	Close electro valve V2
Vt OPEN	551C H	Open electro valve Vt
Vt CLOSE	55B4 H	Close electro valve Vt
Oven ON 415°C	551E H	Switch ON oven heater at 415°C
Oven ON 900°C	5521 H	Switch ON oven heater at 900°C
Oven OFF	5522 H	Switch OFF oven heater
HV2 ON 60 °C	5524 H	Switch ON heater for valve V2 at 60 °C
HV2 ON 90 °C	5527 H	Switch ON heater for valve V2 at 90 °C
HV2 ON 120 °C	5551 H	Switch ON heater for valve V2 at 120 °C
HV2 OFF	5528 H	Switch OFF heater for valve V2
HP1 ON 60 °C	552B H	Switch ON heater for valve P1 at 60 °C
HP1 ON 90 °C	552C H	Switch ON heater for valve P1 at 90 °C
HP1 ON 120 °C	5552 H	Switch ON heater for valve P1 at 120 °C
HP1 OFF	552E H	Switch OFF heater for valve P1
OPCL (VT) ON	5560 H	Activate OV pressure CL before Transfer
OPCL (V1) ON	5563 H	Activate OV pressure CL during Transfer
OPCL OFF	5569 H	Deactivate OV pressure CLs (except Safety CL)
GVM intermediate	5530 H	Bring Gate Valve to intermediate position
GVM OPEN	5533 H	Open the Gate Valve
GVM LOCK	5535 H	Close the Gate Valve
Filter IN	5536 H	Bring Filter to inner position
Filter OUT	5539 H	Bring Filter to outer position
Filter Intermediate [2]	55AAH	Bring Filter from inner to intermediate position
Pump Unit ON	553A H	Switch ON the pump
Pump Unit OFF	553C H	Switch OFF the pump
Memory Dump	5541 H	Program and temporary memory is dumped via PTD
Automatic Mode	5542 H	Finish engineering mode, switch back to DDB dependent operation
Key Sealing Cover	5544 H	Key Command for Open Sealing Cover
Key P1	5547 H	Key Command for Open one-shot valve P1
Key P2	5548 H	Key Command for Open one-shot valve P2
Key P3	554B H	Key Command for Open one-shot valve P3

Table 18, Memory Load Commands during Engineering Mode

[1] These commands are executed only, if the dedicated Key Command has been received immediately before.

2) To be sure that the filter is in intermediate position after this MLC, it is a good practice to send MLC 'Filter IN' before 'Filter Intermediate'.

☞ MLC Decoding: The first byte and the 4 least significant bits of the second byte of MLC packet header are used to identify a MLC. The number of MLCs in the frame *(MLC_count)* are derived from the packet length (3rd word of MLC frame, *MLC_count= (packet length - 1)/2*). *If the computed CRC of the frame corresponds to the CRC code in the frame* then one TC after the other is cross-checked with an internal list of valid MLCs. If it is a valid command then it is executed, otherwise the MLC/DDB error flag in SW is set.
All other bytes of *the* MLC frame are not decoded.

Specific devices are switched off before a mechanic device is activated through a MLC. The following table lists devices that are switched off by S/W. Please consider also the H/W priority management described in Table 35.

Name of MLC	SC	P1 P2 P3	GM	FM	PM	V1 V2 Vt	OP CL [1]	OH	HP1 HV2	Remark
Sealing Cover	•	•	•	•	•	•	•	•	•	executed only if MLC "Key SC" has been received immediately before and if SC heater is not active
P1	•	•	•	•	•	•	•	•	•	executed only if MLC "Key P1" has been received immediately before
P2	•	•	•	•	•	•	•	•	•	executed only if MLC "Key P2" has been received immediately before and if P2 heater is not active
P3	•	•	•	•	•	•	•	•	•	executed only if MLC "Key P3" has been received immediately before
V1 OPEN										executed only if FM, GM, SC or P2 are not active or if V1 is not open and if the 60s pause after a 50s activation is over
V1 CLOSE										
V2 OPEN										executed only if FM, GM, SC or P2 are not active or if V2 is not open and if the 60s pause after a 50s activation is over
V2 CLOSE										
Vt OPEN										executed only if FM, GM, SC or P2 are not active or if Vt is not open and if the 60s pause after a 50s activation is over
Vt CLOSE										
Oven ON 415°C	•	•	•	•	•					
Oven ON 900°C	•	•	•	•	•					
Oven OFF										
HV2 ON 60 °C	•	•	•	•	•					
HV2 ON 90 °C	•	•	•	•	•					
HV2 ON 120 °C	•	•	•	•	•					
HV2 OFF										
HP1 ON 60 °C	•	•	•	•	•					

[1] OPCL before Transfer and OPCL during Transfer; safety pressure CL not effected

HP1 ON 90 °C	•	•	•	•	•					
HP1 ON 120 °C	•	•	•	•	•					
HP1 OFF										
OPCL (VT) ON										
OPCL (V1) ON										
OPCL OFF										
GVM intermediate	•	•	•	•	•	•	•	•	•	Executed only if no GV operation is running and if GV is not in this position
GVM OPEN	•	•	•	•	•	•	•	•	•	Executed only if no GV operation is running and if GV is not in this position
GVM LOCK	•	•	•	•	•	•	•	•	•	Executed only if no GV operation is running and if GV is not in this position
Filter IN	•	•	•	•	•	•	•	•	•	Executed only if no FI operation is running and if FI is not in this position
Filter OUT	•	•	•	•	•	•	•	•	•	Executed only if no FI operation is running and if FI is not in this position
Filter Intermediate	•	•	•	•	•	•	•	•	•	Executed only if no FI operation is running and if FI is not in outer or intermediate position
Pump Unit ON	•	•	•	•	•	•	•	•	•	executed only if PM is not active
Pump Unit OFF										
Memory Dump	•	•	•	•	•	•	•	•	•	
Automatic Mode										
Key SC										
Key P1										
Key P2										
Key P3										

Table 19, Definitely switched off devices before a specific device is activated through a MLC

Most devices are activated for a certain time. The Pump motor and the pressure and temperature control loops remain active as long as they are switched off by the dedicated MLC.

The valves V1, V2 and Vt are opened for a nominal time of 50 seconds, but they can be closed by MLC before the nominal open time.

Name of MLC	Nominal time [s]	Remark
Sealing Cover	180 - 240	
P1	0.150	deactivation synchron with TRAP
P2	120 - 279	
P3	0.150	deactivation synchron with TRAP
V1 OPEN	50	after a 50s activation a reactivation is possible only after a pause of 60s
V2 OPEN	50	after a 50s activation a reactivation is possible only after a pause of 60s
Vt OPEN	50	after a 50s activation a reactivation is possible only after a pause of 60s
Oven ON 415°C	-	Oven switched off after MLC Oven OFF
Oven ON 900°C	-	Oven switched off after MLC Oven OFF
HV2 ON 60 °C	-	HV2 switched off after MLC HV2 OFF
HV2 ON 90 °C	-	HV2 switched off after MLC HV2 OFF
HV2 ON 120 °C	-	HV2 switched off after MLC HV2 OFF
HP1 ON 60 °C	-	HP1 switched off after MLC HP1 OFF
HP1 ON 90 °C	-	HP1 switched off after MLC HP1 OFF
HP1 ON 120 °C	-	HP1 switched off after MLC HP1 OFF
OPCL (VT) ON	-	pressure CL switched off after MLC OPCL OFF
OPCL (V1) ON	-	pressure CL switched off after MLC OPCL OFF
GVM intermediate	1	depending on sensors: lock→interm or open→interm
GVM OPEN	4.5 or 7	depending on sensors: interm→open or lock→open
GVM LOCK	4.5 or 7	depending on sensors: interm→lock or open→lock
Filter IN	0.600 or 5.256	depending on sensors: interm→in or out→in, activation and deactivation synchron with TRAP
Filter OUT	5.256	function in→out, activation and deactivation synchron with TRAP
Filter Intermediate	0.600	function in→interm, activation and deactivation synchron with TRAP
Pump Unit ON	-	PM switched off after MLC Pump Unit OFF

Table 20, Nominal activation times for devices

For detailed information of mechanic device activation, including recovery actions, see [AD-11]. GM and FM activation is detailed also in chapter 6 of this document.

☞ P1, P3 and Filter activation times are based on the TRAP (4ms). All other device activation times are based on the internal Timecode (LSB 125ms).

5.2. CRUISE C/O MODE

5.2.1 General

The Cruise c/o sequence was designed mainly to perform an automatic functional test of ACP instrument during cruise phase. ACP will be turned on approximately once in a half year during cruise phase.

Since there are life-time restrictions for certain mechanic devices (that is FM, GM, PM) and because actions as P2 opening and GV locking have to be executed only at specific times during cruise phase, the Cruise c/o sequence has several branches. There are six MLCs, dedicated for Cruise c/o phase only, that determine that particular branches have to be executed.

5.2.2 Sequence Table

The sequence for the first turn on consists of only one subsequence called "Synchro pulses". The sequence for the second turn on is divided into 9 subsequences, based at the experiment chronogram. They are listed in the following table.

Sub-Sequence[1]	Time 1	Component Status	MLC to branch
Initial Venting	to + 141'42"	00 00 00 00	
Outgassing or GV unlocking	to + 142'10"	00 00 00 00	GV unlock
Sampling	to + 143'00"	00 00 00 00	Sampling
Outgassing, Hot outgassing or P2 opening	to + 144'00"	00 00 00 00	Hot outgassing or P2 opening
OH, HV2, HP1	to + 148'50"	00 00 00 00	
Wait or GV locking	to + 149'20"	00 00 00 00	GV locking
Outgassing	to + 149'40"	00 00 00 00	

Table 21, Sequence Table for Cruise c/o Mode, second turn on

☞ After a power failure or watchdog reset ACP is synchronised to the beginning of the next valid subsequence.

☞ ACP does not distinguish between the DDB mission phases 'Flight c/o' and 'Flight c/o deactivate'.

[1] If there is more than one sub-sequence mentioned for one time entry, then the first named sub-sequence is executed for default. The other sub-sequence is executed only if the MLC listed in the last column has been transmitted before. For the contents of each sub-sequence see [AD-12] chapter 3.4.

5.2.3 MLCs during Cruise c/o Mode

The following commands are dedicated to be used during Cruise c/o mode.

Name of MLC	Code	Function
GV locking	CA81 H	Do the "GV Locking" branch
Key P2	CA48 H	Key command for Open one-shot valve P2
P2 Opening[1]	CA9C H	Do the "P2 Opening" branch
Hot Outgassing	CA0F H	Do the "Hot Outgassing" branch
GV unlock	CAC0 H	Don't skip the "GV Unlocking" sub-sequence
Sampling	CAF6 H	Don't skip the "Sampling" sub-sequence

Table 22, Memory Load Commands during Cruise c/o Mode

☞ These MLCs must not be sent within 5 seconds after power on (ACPCU initialisation) *and* not after to+142'09" (for first possible branch at to+142'10").

Only one MLC frame or one DDB frame is decoded within one 125 ms time slot. Nevertheless no information will be lost if MLC and DDB are sent within the same cut, because it will be decoded during the next cut. One MLC frame can contain up to 116 MLCs[2].

☞ MLC Decoding: The first byte and the 4 least significant bits of the second byte of MLC packet header are used to identify a MLC. The number of MLCs in the frame *(MLC_count)* are derived from the packet length (3rd word of MLC frame, *MLC_count= (packet length - 1)/2). If the computed CRC of the frame corresponds to the CRC code in the frame*) then one TC after the other is cross-checked with an internal list of valid MLCs. If it is a valid command then it is executed, otherwise the MLC/DDB error flag in SW is set.
All other bytes of *the* MLC frame are not decoded.

5.3 DESCENT MODE

5.3.1 General

The Descent mode was designed to perform a synchronised and automatic measurement during the descent phase at Titan.

[1]This command is valid only, if "Key P2" has been received immediately before.
[2]One MLC frame can contain up to 240 bytes. 8 bytes are used for frame header and error control. A MLC code is 2 bytes long: (240-8)/2 = 116

5.3.2 Sequence Table

The Descent sequence is divided into the following sub-sequences based at the experiment chronogramme.

Sub-sequence[1]	Time 1[2]	Time 2[3]	Component Status
Initial Venting and SC Ejection	1'42"	-	00 00 00 01
Preparation for Sampling	6'30"	77'04"	10 00 00 01
Sampling	23'30"	77'16.375"	00 00 00 11
Filter retraction and oven closing	60'00"	88'30"	01 00 00 11
Preparation to Ambiant Temperature	62'30"	97'30"	00 00 00 01
Transfer + Venting	65'00.25"	99'00.25"	00 01 00 01
Background analysis + Venting	65'43.125"	99'43.125"	00 01 00 01
Preparation for 250 °C	66'05"	100'05"	00 01 00 01
Transfer + Venting	68'00.25"	102'00.25"	00 10 00 01
Background analysis + Venting	68'43.125"	102'43.125"	00 10 00 01
Preparation for 660 °C	69'05"	103'05"	00 10 00 01
Transfer + Venting	73'00.25"	107'00.25"	00 11 00 01
Background analysis + Venting	73'43.125"	107'43.125"	00 11 00 01
Oven and Transfer Lines Cleaning	75'06"	108'05"	00 11 00 01

Table 23, Sequence Table for Descent Phase

The Component Status describes the status of the mechanic before the beginning of a subsequence. These mechanic devices are re-initialised to that status after a power failure or a watchdog reset.

The Component Status is described as follows:
- bit7=1: SC open
- bit6=1: PM on;
- bit 5,4= 00: OH, HV2, HP1 off
- bit 5,4= 01: OH off, HV2 and HP1 heated on 60°C (CL)
- bit 5,4= 10: OH heated on 415°C, HV2 and HP1 heated on 90°C (CL)
- bit 5,4= 11: OH heated on 900°C, HV2 and HP1 heated on 90°C (CL).
- (Bit 3,2 = 00)
- bit 1,0 = 00: GV intermediate position, FI inner position
- bit 1,0 = 01: GV locked, FI inner position
- bit 1,0 = 10: GV opened, FI intermediate position
- bit 1,0 = 11: GV opened, FI outer position

☞ After a power failure or watchdog reset ACP is synchronised to the beginning of the next valid subsequence.

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[1]For the contents of each sub-sequence see [AD-12] chapter 3.4.
[2]The times given in this column correspond to the times of the first measurement.
[3]The times given in this column correspond to the times of the second measurement.

5.4 GROUND C/O MODE

5.4.1 General

The Ground c/o mode was designed for integration and test purposes. This mode is similar to Descent Mode but with some constraints for mechanic activation.

☞ ACP does not distinguish between the DDB mission phases 'Ground c/o' and 'Ground c/o deactivate'. There is only one Ground c/o Mode in ACP.

5.4.2 Sequence Table

Ground c/o mode uses the same sequence table as Descent mode (see Table 23). Only the sub-sequences of rows 7 and 8 respectively 10 and 11 (Transfer and Background Transfer) are overwritten with the subsequences 'Ground Transfer' and 'Ground Background analysis'. These Transfers do not activate any valves. The component status is not valid since there is no mechanic re-initialisation during Ground c/o mode.

The sub-sequences have to observe the following constraints for device activations during Ground c/o.

Device	Constraints
Sealing Cover	definitely not activated
P1, P2, P3	definitely not activated
V1 (pressure control loop during transfer) [1]	set 2 bar level for control loop to 3 bar (so V1 is open whenever the control loop is active)
V2,Vt [1]	no constraints
Gate Valve Mechanism	definitely not activated
Filter Mechanism	definitely not activated
Pump Unit	definitely not activated
Oven Heater	activation limited to 5s for each activation
Heater HV2	activation limited to 5s for each activation
Heater HP1	activation limited to 5s for each activation
Synchro pulses	no constraints

Table 24, Constraints during Cruise c/o

[1]Concerning transfers: only the 660°C Transfer is done as in Descent mode. During all other transfers the valves are not activated.

6. FILTER AND GATE VALVE ACTIVATION

How to read the following tables:

- Whenever status '1' is specified for Hall Effect Sensors, this will mean that the sensor sees the magnet, whereas the '0' value will signify that the sensor does not see the magnet.
- For the 'nominal Activation' the sensor status is not checked.
- After the 'nominal Activation', the sensor status is checked. Select column '1. Recovery Activation' and the row with the proper sensor status to see what is done for recovery. A '-' mean that the driver routine is finished. If there are no more columns, the driver routine is also finished.
- If there are more columns, read these columns the same way as the second one.

6.1 ACTIVATION OF THE FILTER MOTOR

Activation time is given in [ms]. The direction of Filter movement is indicated by 'in' and 'out'.

6.1.1 Inner position to outer position

FHI, FHO	nominal Activation	1. recovery Activation	2. recovery Activation
0,1	5256 out	-	-
0,0 1,0 1,1	5256 out	5256 in, 5256 out	5256 in, 5256 out

Table 25, FIM: Inner position to outer position

6.1.2 Outer position to inner position

FHI, FHO	nominal Activation	1. recovery Activation	2. recovery Activation
1,0	5256 in	-	-
0,0 0,1 1,1	5256 in	5256 out, 5256 in	5256 out, 5256 in

Table 26, FIM: Outer position to inner position

6.1.3 Inner position to intermediate position

FHI, FHO	nominal Activation
0,0 0,1 1,0 1,1	600 out

Table 27, FIM: Inner position to intermediate position

Since there is no recovery action, the status of the hall sensors will not be checked.

6.1.4 Intermediate position to inner position

FHI, FHO	nominal Activation	1. recovery Activation	2. recovery Activation	3. recovery Activation
1,0	600 in	-	-	-
0,0 0,1 1,1	600 in	5256 in	5256 in	5256 in

Table 28, FIM: Intermediate position to inner position

6.2 ACTIVATION OF THE GATE VALVE MOTOR

Activation time is given in [s]. The direction of Gate valve movement is indicated by 'open' and 'close'.

6.2.1 Locked to open position

GVHC,GVHO	nominal Activation	1. recovery Activation	2. recovery Activation
0,1	7 open	-	-
0,0 1,0 1,1	7 open	7 open	7 open

Table 29, GVM: Locked position to open position

6.2.2 Open to locked position

GVHC,GVHO	nominal Activation	1. recovery Activation	2. recovery Activation
1,0	7 close	-	-
0,0 0,1 1,1	7 close	7 close	7 close

Table 30, GVM: Open position to locked position

6.2.3 Locked position to intermediate position

GVHC,GVHO	nominal Activation	1. recovery Activation
0,0	1 open	-
0,1 1,0 1,1	1 open	1 open

Table 31, GVM: Locked position to intermediate position

6.2.4 Intermediate position to locked position

GVHC,GVHO	nominal Activation	1. recovery Activation	2. recovery Activation
1,0	4.5 close	-	-
0,0 0,1 1,1	4.5 close	7 close	7 close

Table 32, GVM: Intermediate position to locked position

6.2.5 Open position to intermediate position

GVHC,GVHO	nominal Activation	1. recovery Activation
0,0	1 close	-
0,1 1,0 1,1	1 close	1 close

Table 33, GVM: Open position to intermediate position

6.2.6 Intermediate position to open position

GVHC,GVHO	nominal Activation	1. recovery Activation	2. recovery Activation
0,1	4.5 open	-	-
0,0 1,0 1,1	4.5 open	7 open	7 open

Table 34, GVM: Intermediate position to open position

7. SIMULTANEOUS ACTIVATIONS OF MECHANIC DEVICES

7.1 HARDWARE PRIORITY MANAGEMENT

The following table lists the devices that are switched off by H/W when a specific device is active.

OFF / ON	SC	P1 P2 P3	GM	FM	PM	V1 V2 Vt	OH	HP1	HV2	Remark
SC										
P1, P2, P3										
GM										
FM										
PM										
V1, V2, Vt					•		•		•	PM ,OH and HV2 are reactivated (if necessary) after electro-valves are switched off

Table 35, H/W priority management

7.2 SOFTWARE PRIORITY MANAGEMENT

The design of the sequences for the different modes guaranties that no devices are activated simultaneously if they should not.

If one of the heaters control loops is activated then the S/W (module HEATER_CONTROL, called once in 125ms) guarantees that OH has higher priority than the external heaters. The external heaters are only switched on if OH has not to be activated.

During Engineering Mode, all devices can be activated in any order and at (nearly) any time. But before a specific device or control loop is activated, some other devices are switched off. Table 19 gives an overview what devices are switched off by S/W, when a certain MLC is executed. This secures that no impossible simultaneous activation occurs (in order not to cross the maximum current).

8. CHANGES TO PREVIOUS S/W VERSIONS

8.1 VERSION 3.0 → VERSION 3.1, 14. FEBRUARY 1995

- The nominal temperature for the high temperature oven heater control is reduced from 960°C to 900°C.
  Affected module: acpvect: constant OH_660C
  Ref: ACP.SRI.CR.027

- The time for pressurisation before injection has been reduced from 1.0s to 0.625s. The time distance between two injections has not been changed.
  Affected modules: SEQ_D_TRANS, SEQ_G_TRANS, acpvect: DESCENT_TABLE
  Ref: ACP.SRI.CR.027

- Correct PTD generation after MLC 'Memory Dump'
  Affected module: COMMAND_EXECUTE
  Ref: ACP.JR.NCR.0070

- The RAM area for variables is set to 0 before the PROMS are switched off.
  Affected module: ACP_START
  Ref: ACP.JR.NCR.0069

- Check of Checksum during PROM copying cancelled
  Affected module: ACP_START
  Ref: ACP.JR.NCR.0083

8.2 VERSION 3.1 → VERSION 3.2, 17. FEBRUARY 1995

- Check of Checksum during PROM copying added
  Affected module: ACP_START
  Ref: -

8.3 VERSION 3.2 → VERSION 3.3 DRAFT, 15. MAY 1995

- The problems with wrong measurement values, when a pressure CL is on, has been solved.
  Affected modules: AD_MEASUREMENT, AD_12_CONVERSION
  Ref: ACP.JR.S/W.TN.0093, chapter 1

- Module MLC_DECODING is called at the end of the main loop, thus each DDB is decoded in the same cut as it is transmitted (>24ms after BCP). Now no timing problems during transfer will occur.
  Affected module: ACP_START
  Ref: ACP.JR.S/W.TN.0093, chapter 2

8.4 VERSION 3.3 DRAFT → VERSION 3.4, 30. JUNE 1995

- OH errorbit in S/W is now set correctly.
  Affected module: UPDATE_SW_HK
  Ref: ACP.JR.NCR.0094, ACP.JR.S/W.TN.0093, chapter 3

- HP1 and HV2 errorbits in SW are set if the corresponding temperature is above 130°C.
  Affected module: UPDATE_SW_HK
  Ref: ACP.JR.S/W.TN.0093, chapter 4

- Module GEN_PTD_FRAME is called after module AD_MEASUREMENT in main loop. Now the measurement values are written to the PTD frame in the same cut as they are measured. This is more consistent because the SW and the housekeeping bytes in the PTD do also correspond to the cut when they are written to the PTD.
  Affected module: ACP_START
  Ref: -

- The heaters OH, HV2 and HP1 are no longer activated via the counters implemented in the ACTEL but the lines are switched directly (heater priority management has been shifted to the S/W). The heaters can now be activated continuously.
  (For continuos activation with the counters it was necessary to set the counters each 125ms to the maximum counter value. During the setting of the counters (~100µs) all heater lines were switched off, so no real continuous activation was possible.)
  Affected modules: HEATER_CONTROL, HEATER_DEACTIVATE, SWITCH_OFF_MECHANIC, MECHANIC_OFF
  Ref: -

- In case of re-initialisation during Descent or Ground c/o mode with DDB-time (to+23'30" ≤ t < to+60'00") or (to+77'16,375" ≤ t < to+88'30") PTDs with format Descent, sampling phase are generated.
  Affected modules: SET_MEASMDEP_VAR
  Ref: -

- Nominal activation time for GV activation from locked to intermediate or from open to intermediate position has been changed to 1s.
  Affected module: GV_MOVE_CNTRL
  Ref: ACP.CNRS.SYS.ECR.0071

- Nominal activation time for SC has been set to 180s, the new recovery activation time is 60s. During Descent Mode SC heater is activated at 2'05", GV is activated at 6'30".
  Affected module: SC_OPEN_CNTRL, SEQ_D_IVENT; DESCENT_TABLE in acpvect.AS
  Ref: ACP.CNRS.SYS.ECR.0072

8.5 VERSION 3.4 → VERSION 3.5, 17. AUGUST 1995

- Also negative voltage values from the pressure sensor are handled correctly. Negative values from the pressure sensor correspond to negative pressure values. An offset of the pressure sensor is not taken into account.
  Affected modules: GET_PSOUT_VALUE, P2_OPEN_CNTRL; pressure values in acpvect.AS
  Ref: ACP.JR.NCR.0097

- The 1.2 bar value for the pressure control loops has been changed to 1.7 bar, the 2.0 bar value has been changed to 2.5 bar.
  Affected module: pressure values in acpvect.AS
  Ref: -

8.6 VERSION 3.5 → VERSION 3.6, 8. SEPTEMBER 1995

- An offset calibration for the pressure sensor has been added at the end of the Initial Venting subsequence of the Descent Sequence. The maximum offset is ± 0.4 bar. Pressure values used for the pressure control loop are offset corrected - in contrast to those written to the PTD.
  Affected modules: CALCULATE_PRESS_OFFSET, GET_PSOUT_VALUE; acpvect.AS
  Ref: ACP.CNRS.ECR.0073

- The 1.7 bar value for the pressure control loops has been changed to 2.0 bar, the 2.5 bar value has been changed to 2.7 bar.
  Affected module: pressure values in acpvect.AS
  Ref: ACP.CNRS.ECR.0074

- Changes to the Cruise c/o Sequence have been implemented.
  Affected modules: SEQ_C_OUTG1, SEQ_C_HOTOUTG; Cruise2_Table, Tab1_C_Outg1, Tab2_C_Outg3, Tab1_C_Hotoutg in acpvect.AS
  Ref: ACP.CNRS.ECR.0078

- Over Pressure flag is checked at beginning of mechanic initialisation and the AGND value in RAW_VALUES is set to an initial value of 80h (=0V). Thus also an over pressure at the time of ACP switch ON is handled correctly (→ VT on).
  Affected modules: ACPCU_INIT, ACPM_INIT
  Ref: ACP.JR.NCR.0098

- The over pressure interrupt flip-flop in the ACTEL is enabled after the pressure reached the 2.7 bar.
  Affected modules: OVP_IRQ, TRAP_IRQ
  Ref: -

8.7 VERSION 3.6 → VERSION 3.7, 31. OCTOBER 1995

- If the ACPE receives no valid DDB within 20 sec after switch ON, ACP selects CDMU B independently from the status of the Processor Valid signal. If an active selection gives no positive result, ACP toggles from A to B and vice versa every 20 seconds until a valid DDB was received.
  If ACP receives no valid DDBs within 20 seconds, ACP changes to the other CDMU channel as described above.
  Once ACP actively toggled the CDMU channel, the processor valid signal is no longer considered.
  Affected modules: ACP_START, ACPCU_INIT, WAIT_DDB, DDB_DECODING, TRAP_IRQ, BCP_IRQ
  New module: CHECK_CDMU_CHANNEL
  New variables and constants in acpvect.AS: Time_since_last_DDB, CDMU_Channel,

CDMU_Channel_Base_Addr, CDMU_A, CDMU_B
Ref: ACP.SRI.CR.036

- The last VT opening time during the Initial Venting subsequence of Decent sequence has been increased from 6 to 30 seconds. VT will close at to +2'47".
  Affected modules: TAB1_D_IVENT in acpvect.AS
  Ref: ACP.SRI.CR.038

- The openings and closings of V1 during second Cruise sequence are done by activating and deactivating the V1 pressure control loop (PCL; levels: 2.0bar, 2.7bar). After activating the PCL V1 is opened. V1 will be closed by the PCL if the pressure is above 2.7 bar.
  Affected modules: SEQ_C_VENTING, VALVES_OPEN, VALVES_CLOSE
  Ref: ACP.CNRS.FAX.05.0130

- P2 opening time depends on initial pressure value.
  Affected modules: P2_Press_Value in acpvect.AS
  Ref: ACP.JR.S/W.RFW.0101

8.8 VERSION 3.7 → VERSION 3.8, 03. NOVEMBER 1995

- The ACPM initialisation during the 2nd turn on of Cruise mode has been cancelled.
  Affected modules: ACPM_INIT
  Ref: ACP.CNRS.FAX.05.0130

- The old MLC command for Cruise mode "GV and FI moving" is replaced by the new MLC "GV intermediate". If this command is sent during Cruise mode before to+142'10", then the GV will be moved from locked to intermediate position at 142'10". This replaces the former 8b subsequence of the cruise chronogram. In addition the 10b subsequence of the Cruise c/o sequence has been cancelled.
  Affected modules: SEQ_C_PREP, SEQ_C_FROC, CRUISE2_TABLE in acpvect.AS
  Ref: ACP.CNRS.FAX.05.0130

- The pressure sensor offset calibration is kept up also after switching from Descent to Engineering mode and back to automatic mode.
  Affected modules: COMMAND_EXECUTE (part Automatic Mode)
  Ref: -

8.9 VERSION 3.8 → VERSION 3.9, 09. NOVEMBER 1995

- The 2.0 bar value for the pressure control loops has been changed to 1.9 bar, the 2.7 bar value has been changed to 2.5 bar.
  Affected module: pressure values in acpvect.AS
  Ref: -

8.10 VERSION 3.9 → VERSION 3.10, 14. NOVEMBER 1995

- Previous S/W versions have assigned the PValid status to the CDMU bit of the Statusword. Since ACP now can actively switch CDMU channels, independent of the PValid line, the CDMU bit of the Statusword reflects the CDMU channel that is used by ACP to retrieve DDBs and MLCs.
  Affected modules: UPDATE_SW_HK, CHECK_CDMU_CHANNEL
  New flag in acpvect.AS: CDMU_Source_Intern
  Ref: -

- The pressure values used for calculations for P2 opening are taken directly from the Meas_Values field, therefore 0 bar correspond to 00h. Negative values from the pressure sensor will not be handled correctly, in that case P2 will be heated for the maximum activation time of 279s, independent of pressure. (All changes made on S/W version 3.4 at module P2_OPEN_CNTRL have been undone.)
  Affected modules: P2_OPEN_CNTRL
  Ref: ACP.JR.NCR.0103

- The variable Time_since_last_DDB is reset in DDB_DECODING also if Meas_Mode is Engineering Mode. In that case ACP will not actively switch CDMU channels while in Engineering Mode. (No DDBs are decoded during Engineering Mode.)
  Affected modules: DDB_DECODING
  Ref: ACP.JR.NCR.0104

8.11 VERSION 3.10 → VERSION 3.11, 30. NOVEMBER 1995

- Due to a S/W failure in S/W versions 3.7 and following, ACP was not able to run on internal time-base (128ms) in case of a failure on the BCP <u>and</u> DDB lines. This bug has been removed.
  Affected modules: TRAP_IRQ
  Ref: ACP.JR.NCR.0107

8.12 *VERSION 3.11 → VERSION 3.12, 16. APRIL 1996*

- *The variable MLC_count (used to calculate the number of MLCs in a TC frame) is set according to the packet length definition in [RD-13]: MLC_count = (packet length-1)/2.*
  Affected modules: MLC_DECODING
  Ref: ACP.JR.NCR.0121, HUY-NC-520-5075

- *The CRC of the TC frame is checked before the MLCs in the packet are decoded.*
  Affected modules: MLC_DECODING, DDB_DECODING, CRC_CHECK
  Ref: -

- *During Cruise c/o mode for mission time < to+10' one PTD frame is generated each 16th second, for mission time > to+10' one PTD frame is generated each 8th second.*
  Affected modules: SEQ_C_SYNCHRO, SEQ_C_PTDSWITCH, SET_MEASMDEP_VAR, SET_TABLE_POINTER; CRUISE1_TABLE in acpvect.AS
  Ref:HUY-NC-520-3252, HUY-NC-520-5071 (packet count error)

- *Wait 200μs instead of 100μs for checking if DMA is active.*
  Affected modules: COPY_PTD_FRAME
  Ref: -

- *During Memory Dump the Status word is generated, too. (Up to now during Memory Dump no SW was generated therefore the SW read by the probe was FFFFh.)*
  Affected modules: COMMAND_EXECUTE
  Ref: HUY-NC-520-5070

- *Packet_counter is decremented only if BCP_counter ≠ FFh and BCP_counter is set to FFh in order to start with a new PTD frame after restart.*
  Affected modules: RESTART
  Ref: