MODULUS – Ptolemy

Ptolemy Mode Description: PHC MS Conditioning

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CHANGE RECORD

DATE	CHANGE DETAILS	ISSUE
01 October 2013	Document created	1.0

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1.   Introduction

This document describes the command sequence and operation of Ptolemy PHC MS Conditioning.

The PHC MS Conditioning is a mode which heats the Ion Trap electrodes to 100°C for 1 hour in order to drive off trapped volatiles.

1.1   Applicable Documents

Ref	Title	Document Number	Issue	Date
AD1	Ptolemy Telecommand and Telemetry Definitions	RO-LPT-RAL-TN-3403	5.1	26 Feb 02
AD2	Ptolemy Operations plan	RO-LPT-OU-PL-3101	4.0	25 Nov 10
AD3	Ptolemy Flight Operations Plan for the First Science Sequence	RO-LPT-OU-PL-3147	1.0	24 Aug 13
AD4	Ptolemy Initialisation Description	RO-LPT-OU-PL-3112	1.0	13 Jul 04

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2.   MS Conditioning module

The MS conditioning module heats the ion trap enclosure to +100°C for 59 minutes. The temperature of the ion trap enclosure is monitored at 1 minute intervals.

2.1   Sequence outline

When Ptolemy is commanded to enter PHC MS Conditioning, it will perform the following actions:

1. Monitor temperatures of the ion trap (tION) and the AD590 reference junction (tAD590) for 10 seconds.
2. Switch on the ion trap heater at full power with a target temperature of +100°C
3. Monitor tION and tAD590 for 59 minutes at 60s intervals.
4. Set the ion trap heater off.

The detailed Ptolemy sequence is listed in section 4.

At the end of the sequence Ptolemy returns to standby mode and all subsystems are off.

2.2 Resources

Start State – All Ptolemy subsystems off
End State – All Ptolemy subsystems off

Subsystems operated:
Heaters: ION

Data Volume: Resources:

Aux Science packets	5	Helium used	none
Spectrum packets	0	Hydrogen used	none
Number of spectra	0	Oxygen used	none
		Reference gas	none
		Nano-tip use	none

Power profile Nominal:	5.2V Supply Rail		28V supply rail	
	Current (mA)	Power (W)	Current (mA)	Power (W)
Average	215	1.12	534	14.95
Maximum	215	1.12	535	14.98

Duration   3550 s
Total energy   53068 J

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Calculated power profile
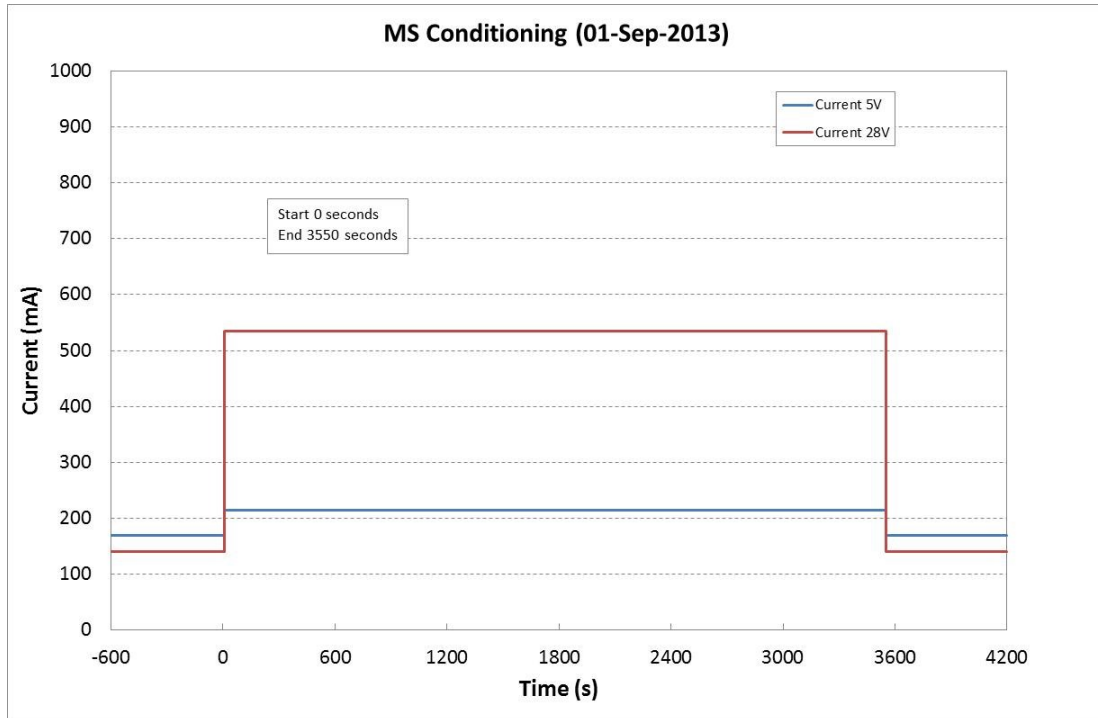
The power profile of PHC MS Conditioning on the QM under vacuum conditions is shown below. After an initial period of a few minutes drawing 420 mA from the 28 V rail, the ion trap enclosure reaches a temperature of +100°C and the power is reduced so that the heater is on ~30% of the time, depending on background temperature (colder lander = more energy required). Note the power profile only shows the first 10 minutes, once the MS is at temperature, the PWM control continues as shown until mode end.
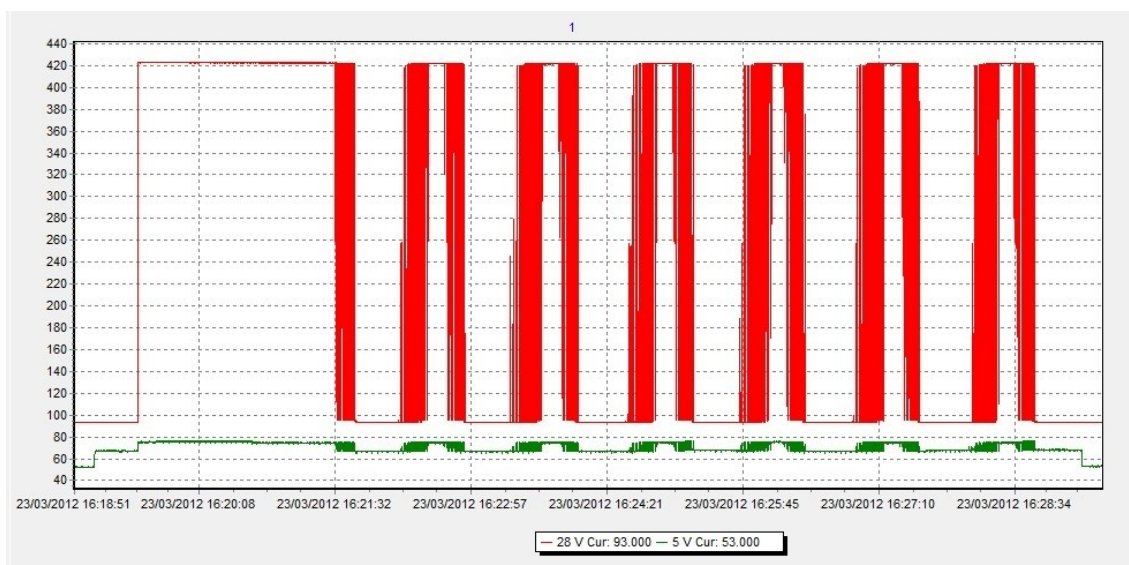
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2.3   Ptolemy Models

A summary of the use of MS conditioning module with the various Ptolemy models is given below.

Model	Use	Power Profile (c.f. FM)	Timing (c.f. FM)	Sensors
FM	Any time	-	-	-
QM	Any time	Same	Same	Same
CSS	Any time	Different	Same	Pressure sensors and heater different
GRM	Any time	Different	Same	Pressure sensors and heater different

2.3.1   Flight Model (FM)

MS conditioning does not use any limited resources and as such can be operated as many times as allowed by the power and data budget.

2.3.2   Qualification Model (QM)

MS conditioning can be used on the Ptolemy QM whilst it is in air or in Vacuum.

2.3.3   Chemistry Set Simulator (CSS)

MS Conditioning can be used on the CSS at any time. The timings should be the same as for the FM. As thermal properties of the heater simulators are different from the FM, the power profile will be different from the FM. The CSS does not simulate gas flow in the manifolds, so the pressure sensors will not give the same results as the FM.

2.3.4   Ground Reference Model (GRM)

MS Conditioning can be used on the GRM at any time. The timings should be the same as for the FM. As thermal properties of the heater simulators are different from the FM, the power profile will be different from the FM. The GRM does not simulate gas flow, so the pressure sensors will not give the same results as the FM

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3. Operation of the MS Conditioning sequence

3.1 Load Ptolemy Memory

In order to operate the MS Conditioning module, the commands have to be loaded onto Ptolemy EEPROM using the Ptolemy Load Memory TC (AD1). The TCs to upload the module only need to be transmitted once for each Ptolemy instrument, unless a check memory TC indicates that the Ptolemy EEPROM has become corrupted.

Total number of Load memory TCs 11
Number of words 229
Sequence control C100 to C10A
Memory address page 5 offset 0100 to 02CA

Load memory PHC MS Conditioning TC1 of 11
```
1F3C C100 0039 1006 0200 9701 0005 0100
0016 28C8 28CE 3000 0228 C828 CE30 0002
28C8 28CE 3000 0228 C828 CE30 0002 28C8
28CE 3000 0214 7903 8C00 FF28 C828 A9DD
```

Load memory PHC MS Conditioning TC2 of 11
```
1F3C C101 0039 1006 0200 9701 0005 012C
0016 CE30 003C 28C8 28CE 3000 3C28 C828
CE30 003C 28C8 28CE 3000 3C28 C828 CE30
003C 28C8 28CE 3000 3C28 C828 CE30 4F2B
```

Load memory PHC MS Conditioning TC3 of 11
```
1F3C C102 0039 1006 0200 9701 0005 0158
0016 003C 28C8 28CE 3000 3C28 C828 CE30
003C 28C8 28CE 3000 3C28 C828 CE30 003C
28C8 28CE 3000 3C28 C828 CE30 003C AF39
```

Load memory PHC MS Conditioning TC4 of 11
```
1F3C C103 0039 1006 0200 9701 0005 0184
0016 28C8 28CE 3000 3C28 C828 CE30 003C
28C8 28CE 3000 3C28 C828 CE30 003C 28C8
28CE 3000 3C28 C828 CE30 003C 28C8 2F71
```

Load memory PHC MS Conditioning TC5 of 11
```
1F3C C104 0039 1006 0200 9701 0005 01B0
0016 28CE 3000 3C28 C828 CE30 003C 28C8
28CE 3000 3C28 C828 CE30 003C 28C8 28CE
3000 3C28 C828 CE30 003C 28C8 28CE 1995
```

Load memory PHC MS Conditioning TC6 of 11
```
1F3C C105 0039 1006 0200 9701 0005 01DC
0016 3000 3C28 C828 CE30 003C 28C8 28CE
3000 3C28 C828 CE30 003C 28C8 28CE 3000
3C28 C828 CE30 003C 28C8 28CE 3000 6DC9
```

Load memory PHC MS Conditioning TC7 of 11
```
1F3C C106 0039 1006 0200 9701 0005 0208
0016 3C28 C828 CE30 003C 28C8 28CE 3000
3C28 C828 CE30 003C 28C8 28CE 3000 3C28
C828 CE30 003C 28C8 28CE 3000 3C28 7EFB
```

Load memory PHC MS Conditioning TC8 of 11
```
1F3C C107 0039 1006 0200 9701 0005 0234
0016 C828 CE30 003C 28C8 28CE 3000 3C28
C828 CE30 003C 28C8 28CE 3000 3C28 C828
CE30 003C 28C8 28CE 3000 3C28 C828 E553
```

Load memory PHC MS Conditioning TC9 of 11
```
1F3C C108 0039 1006 0200 9701 0005 0260
0016 CE30 003C 28C8 28CE 3000 3C28 C828
CE30 003C 28C8 28CE 3000 3C28 C828 CE30
003C 28C8 28CE 3000 3C28 C828 CE30 C9AF
```

Load memory PHC MS Conditioning TC10 of 11
```
1F3C C109 0039 1006 0200 9701 0005 028C
0016 003C 28C8 28CE 3000 3C28 C828 CE30
003C 28C8 28CE 3000 3C28 C828 CE30 003C
28C8 28CE 3000 3C28 C828 CE30 003C 9E3A
```

Load memory PHC MS Conditioning TC11 of 11
```
1F3C C10A 001F 1006 0200 9701 0005 02B8
0009 28C8 28CE 3000 3C28 C828 CE30 003C
1478 FFFF 7508
```

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3.2   Execution of MS Conditioning

The sequence to execute MS Conditioning in a Standalone mode is as follows:

1. Start with Ptolemy switched on and having transmitted the Ptolemy Initialisation TCs
2. Check Memory PHC MS Conditioning
3. Transmit TC to set Ptolemy into Standby mode
4. Transmit TC to enable the relevant Ptolemy subsystems
5. Transmit TC to define module start address
6. Transmit TC to Begin MS Conditioning module
7. Once the MS Conditioning module has been completed then transmit TC to set Ptolemy into Safe mode

TC: Check Memory PHC MS Conditioning
```
1F3C C008 0013 1006 0900 9702 0005 0100
0080 0005 0200 0065 5174
```

The results of the Memory check TC are returned as a Check memory report within a Housekeeping packet.

Memory Address		Number of Words	Expected Checksum
Page	Offset		
0005	0100	0080	342B
0005	0200	0065	EBBB

TC: Parameter update – define PHC MS Conditioning start address
```
1F3C C100 000D 10C3 0100 1FE2 0002 0005
0100 DA38
```

Updates parameter 0x1FE2 with two words to define the start address as EEPROM page 5 0x0100

TC: Start PHC MS Conditioning
```
1F3C D000 0007 10C1 0100 0001 52C0
```

The TCs listed below were used to execute PHC MS Conditioning on the QM on 30-Jan-2013 having initialised Ptolemy with Initialisation(3).seq (AD4)

```
Check memory      1F3C C008 0013 1006 0900 9702 0005 0100
                  0080 0005 0200 0065 5174


Start Standby     1F3C F002 000B 10C1 0000 0001 0000 0000
                  1DB7


Hazard enable     1F3C C000 000B 10C2 0100 BFFF FBFF 0060
                  4A18


Update parameter  1F3C C100 000D 10C3 0100 1FE2 0002 0005
                  0100 DA38


Start Module      1F3C D000 0007 10C1 0100 0001 52C0


Select Safe mode  1F3C F004 0005 10C1 FF00 C48F
```

4. Script PHC – MS conditioning

Script file name: PHC FM MS Conditioning, created 30/01/2013

Time (s)	Command	Comments
10	Loop, , Begin, 5, , Aux Data, tION, , , , Aux Data, AD590, , , , Time Delay, , , , 2, Loop, , End, , ,	Monitor temperatures of the ion trap (tION) and the AD590 reference junction (tAD590) for 10 seconds
10	Heater (pwm), ION, Begin, 100, 0, 255	Switch on the ion trap heater at full power with a target temperature of +100°C
3550	Loop, , Begin, 59, , Aux Data, tION, , , , Aux Data, AD590, , , , Time Delay, , , , 60, Loop, , End, , ,	Monitor tION and tAD590 for 59 minutes at 60s intervals.
3540	Heater (pwm), ION, End, , ,	Set the ion trap heater off.