MODULUS – Ptolemy

Ptolemy GRM User Manual

Document no.: RO-LPT-OU-MA-3102
Issue: 1.0

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CHANGE RECORD

DATE	CHANGE DETAILS	ISSUE
13 June 2002	Document created	1.0

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1 Introduction

This document specifies the Ptolemy GRM High Power Simulation Test Procedure. The aim of the GRM High Power Simulation test is to operate the GRM at the highest power level expected for the Ptolemy FM.

1.1 WARNING

Under no circumstances is the GRM High Power test to be operated on the Ptolemy QM or the Ptolemy FM.

The highest-powered components on the 5V rail are the SMA heaters, which are used to actuate the helium gas tanks. The first part of this test operates the SMA heaters for 1 minute, the expected operation time for the SMA heaters. On the FM and QM these are single use items would be actuated by this test. The second part of the test operates L-valve LV7 at maximum power, this would result in loss of some the limited resource of hydrogen on QM and FM.

1.2 Overview

This document describes the procedure for running various modes on the Ptolemy GRM. In order to run a Ptolemy mode, the mode sequence must be loaded into Ptolemy EEPROM. The TCs to load the mode sequences are given in section 4 these only need to be transmitted to Ptolemy once, unless the EEPROM memory becomes corrupted. At delivery the GRM had already been loaded with sequences for the Short Form Test and the GRM High Power Simulation Test, there is no need to transmit these TCs, they have been included in this document for completeness.

Running a mode sequence consists of the following steps

1. Switch on the GRM
2. Transmit the Initialisation TCs (section 2)
3. Transmit the Run mode TCs (section 3)

Once all the TCs for a Run Mode have been transmitted then another mode can be started or the GRM can be switched off.

At any point a mode can be halted by transmitting a Safe_Mode TC or by switching off the GRM, these actions will not harm the GRM (On the FM recovery may involve some Ground Control intervention to ensure the Chemistry section is in the correct configuration).

1.3 Applicable documents

AD1 RO-LPT-RAL-TN-3403 MODULUS Ptolemy Telecommand and Telemetry Definitions
Issue 5.2 26th February 2001

AD2	RO-LPT-OU-PR-3304 Issue 1.0	Ptolemy FM Short Form Test Procedure – Air / Vacuum 22nd May 2001
AD3	R0-LPT-OU-PR-3310 Issue 1.0	Ptolemy GRM High Power Simulation Test 12th June 2002

2 Initialisation TC Sequence

The following commands are to be transmitted to Ptolemy before any of the test procedures listed in section 3.

TC number	Time (s)	TC Name	Comments
1	0	Copy Memory (1)	Coping PID constants for temperature control into RAM
2	15	Copy Memory (2)	Coping PID constants for temperature control into RAM
3	30	Check Memory(1-PID)	Checks that the Copy_Memory TCs were successful
4	45	Start_Standby	Allows GRM to accept Update_Parameter TCs
5	60	Update_Parameter (2)	Sets GRM in flexible mode
		-	Wait at least 4 minutes for GRM to send a HK packet whilst in Standby mode.
6	300	Safe_Mode	Returns GRM to Safe mode at the end of the initialisation sequence

The Copy memory commands are used to copy the temperature control constants from Ptolemy EEPROM into Ptolemy RAM

2.1 TC: Copy Memory(1)

1F3C C000 0011 10C0 0100 0001 0007 0000
0008 2364 0084 E83C

The Copy memory commands are used to copy the temperature control PID constants from Ptolemy EEPROM into Ptolemy RAM

2.2 TC: Copy Memory(2)

1F3C C001 0011 10C0 0100 0001 0007 0108
0008 246C 0084 1AD1

2.3 Check Memory(1-PID)

1F3C C002 0013 1006 0900 9802 0008 2364
0084 0008 246C 0090 B7B4

Checks that the PID constants have been successfully loaded into Ptolemy RAM. The results are returned in a check memory report within a Ptolemy Housekeeping packet The checksums in the check memory report should have the values 0000 and 090F.

2.4 TC: Start_Standby

1F3C C003 000B 10C1 0000 0001 0000 0000 03EC

2.5 TC: Update Parameter(2)

1F3C C005 000B 10C3 0100 85DC 0001 0000 BBBA

This sets the GRM into “flexible” mode. At startup the GRM is in “fixed” mode. In “fixed” mode any information reports are transmitted in only the second quarter of a HK packet, only one report may be in a HK packet. In “flexible” mode a Ptolemy Housekeeping packet information packets can be transmitted in the second, third or forth quarters of a HK packet, thus increasing the speed of transmitting information reports by a factor of 3.

2.6 TC: Safe Mode

1F3C C008 0005 10C1 FF00 D038

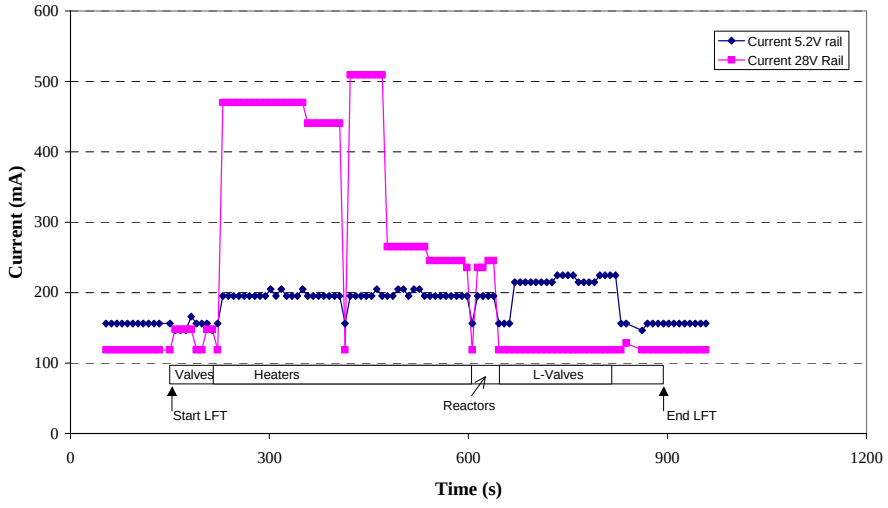
3 Running GRM modes

3.1 Running the Short Form Test (SFT)

The Short Form Test (loaded into the "Ground Test" mode area of GRM EEPROM) is run by entering the following commands:

TC number	Time (s)	TC Name	Comments
1	0	Check_Memory(SFT)	
1	15	Start_Standby	
2	30	Update_Parameter (1)	
3	45	Update_Parameter (3)	
4	60	Hazard_Enable (SFT)	
5	75	Select_Ground_Test	
	105	-	1st Science packet returned
	120	-	2nd Science packet returned
	155	-	3rd Science packet returned
	235	-	4th Science packet returned
	425	-	5th Science packet returned
	610	-	6th Science packet returned
	705	-	7th Science packet returned
	790	-	8th Science packet returned
	915	-	End of SFT, wait at least another 4 minutes for a HK packet with the GRM in Standby mode
6	1200	Safe Mode	

Power profile during the SFT



3.1.1 Check_Memory (SFT)

Checks that the Limited functional test is correctly stored in EEPROM.

1F3C C200 000D 1006 0900 9701 0005 0000 01CC 8B91

Limited functional test is stored in EEPROM page 5 and consists of 01CCh words in address 0000h to 0397h. A correct result returns the value C486 in a check memory report within a Housekeeping packet.

3.1.2 Update_Parameter (1)

This command sets the default value used for the mass spectrometer RF frequency stored at address 284Eh to 0900h. This corresponds to an RF of about 554 kHz.

1F3C C004 000B 10C3 0100 284E 0001 0900 8923

3.1.3 Update_Parameter (3)

This assigns the address for the short form test to EEPROM page 5, offset 0000. (This command is not necessary, but other tests later may require this TC).

1F3C C010 000D 10C3 0100 1FE2 0002 0005 0000 0FA7

3.1.4 Hazard_Enable (SFT)

Hazardous Function Enable of all valves, all heaters and all reactors.

1F3C C006 000B 10C2 0100 7FFF FBFF 0000 17E5

3.1.5 Select_Ground_Test

1F3C C007 0007 10C1 0100 0001 77FD

3.1.6 Select_Safe_Mode

1F3C C008 0005 10C1 FF00 D038

3.2 Running the GRM High Power Simulation Test

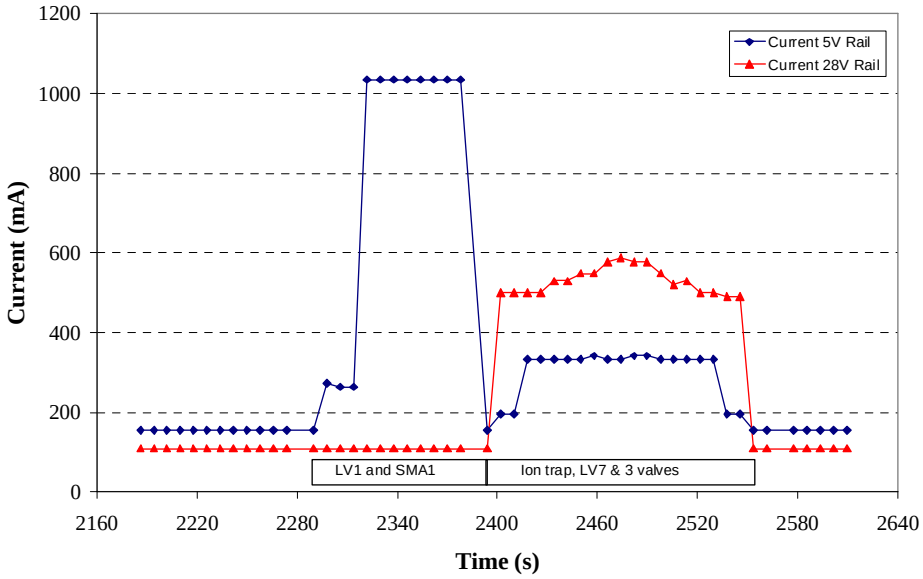
A complete description of the GRM High Power Simulation Test is in AD3.

The rupture helium tank mode on the FM is expected to be the mode that uses the highest power on the 5V rail. There are several methods to rupture the helium gas tanks, currently under investigation on the QM. The method that requires most power is simulated in the first two minutes of this test. The second part of the test operates each of the highest power components that can be operated simultaneously. Operation of the FM and QM have shown that the ion Trap is the highest power component of all the heaters and reactors, only one of which is on at any time. LV7 is the highest power L-valve. Up to 3 solenoid valves can be operated simultaneously.

Time (s)	Action	Comments	Current (mA)	
			5V rail	28V rail
0	Start Test		160	110
15	LV1 Begin, Power 255, target temperature 120^{o}C	Heat LV1 at maximum power	210	110
45	SMA Begin	Switch on SMA	1050	110
105	SMA End	Switch off SMA	210	110
120	LV1 End	Switch off L-Valve, LV1	160	110
135	Ion Trap Heater Begin, target temperature 100^{o}C	Heat the Ion Trap heater at maximum power	290	500
150	LV7 Begin, Power 255, target temperature 120^{o}C	Heat LV7 at maximum power	340	500
165	Valve V1 Open	Open valve V1	350	530
180	Valve V2 Open	Open valve V2	350	560
195	Valve V3 Open	Open valve V3	350	590
225	Valve V Close	Close valve V1	350	560
240	Valve V2 Close	Close valve V2	350	530
255	Valve V3 Close	Close valve V3	340	500
270	LV7 End	Switch off L-Valve, LV7	290	500
285	Ion Trap Heater End	Switch off Ion Trap Heater	160	110

Housekeeping data of the power consumption during the GRM High Power Test is shown below. The maximum current was 1052mA on the 5V rail and 556mA on the 28V rail.

GRM High Power Test



Running the GRM High Power Test Procedure requires the transmission of the following TC sequence:

TC number	Time (s)	TC Name	Comments
1	0	Check_Memory (HPT)	
2	15	Start_Standby_Mode	
3	30	Hazard_Enable (HPT)	
4	45	He_Tank_Rupture_Mode	Begins the High Power Test Sequence
	330		HPT Test sequence finished
5	570	Safe_Mode	Returns GRM to Safe mode at the end of the test

3.2.1 TC: Check_Memory (HPT)

1F3C C000 000D 1006 0900 9701 0005 8000 002B A838

This check memory TC performs a simple checksum on the GRM High power sequence, which is stored in memory page 5, address 8000 to 8054 (002B hex words). The results of the check memory TC are returned in a check memory report within a Ptolemy Housekeeping packet and the checksum should be 17DB.

3.2.2 TC: Start_Standby_Mode

1F3C C003 000B 10C1 0000 0001 0000 0000 03EC

3.2.3 TC: Hazard_Enable (HPT)

1F3C E800 000B 10C2 0100 2000 0007 0001 DA92

This TC enables the following components: Ion trap heater, SMA heater (gas tank actuator) and valves V1, V2 and V3.

3.2.4 TC: He_Tank_Rupture_Mode

1F3C E801 0007 10C1 0900 0001 DBF0

3.2.5 TC: Safe_Mode

1F3C C008 0005 10C1 FF00 D038

The Safe Mode TC is transmitted at least 4 minutes after the end of the test to ensure that a Ptolemy HK packet is received whilst Ptolemy is Standby mode. This helps confirm that the test was completed successfully. Once the Safe Mode TC has been transmitted then further tests can be performed, by repeating the whole TC sequence.

4 Load mode sequences onto Ptolemy EEPROM

Loading a mode sequence onto Ptolemy EEPROM consists of transmitting a series of Load Memory TCs whilst Ptolemy is in Safe mode (it is not necessary to transmit the initialisation sequence TCs). The Load memory TC is described in AD1. The order and timing of the Load memory TCs is not important, as long as the check memory TC is the final TC transmitted and then wait for at least four minutes to ensure that a check memory report is included within a Ptolemy Housekeeping packet.

4.1 Load SFT sequence

(note that the Short form test is already loaded into the section of Ptolemy memory known as "Ground Test" Mode)

This routine has already been loaded into Ptolemy memory reserved for the Ground Test mode. There should be no requirement to reload this sequence. A full description of the Short Form Test sequence is in document RO-LPT-OU-PR-3304 Issue 1.0 (AD2). It is listed here for completeness in case the memory check commands indicate an error with the commands stored. The sequence patches 460 words into the Ground test sequence EEPROM and the sequence control used is C100 to C114.

Loading the GRM High Power Test requires the transmission of the following TC sequence.

TC number	Time (s)	TC Name	Comments
1	0	Load Short Form Test(1)	
2	15	Load Short Form Test(2)	
3	30	Load Short Form Test(3)	
4	45	Load Short Form Test(4)	
5	60	Load Short Form Test(5)	
6	75	Load Short Form Test(6)	
7	90	Load Short Form Test(7)	
8	105	Load Short Form Test(8)	
9	120	Load Short Form Test(9)	
10	135	Load Short Form Test(10)	
11	150	Load Short Form Test(11)	
12	165	Load Short Form Test(12)	
13	180	Load Short Form Test(13)	
14	195	Load Short Form Test(14)	
15	210	Load Short Form Test(15)	
16	225	Load Short Form Test(16)	
17	240	Load Short Form Test(17)	
18	255	Load Short Form Test(18)	
19	270	Load Short Form Test(19)	
20	285	Load Short Form Test(20)	
21	300	Load Short Form Test(21)	
22	315	Check_Memory (2-SFT)	
	600	-	Wait at least 4 minutes for HK packet containing Check memory report

4.1.1 TC: Load Short Form Test (1)

1F3C	C100	0039	1006	0200	9701	0005	0000
0016	2890	2892	2894	2896	2898	28CE	28D8
28E0	28E2	28E4	28D0	28D2	28D4	28D6	3000
0206	2001	9028	D428	D630	0002	28D4	EBEC

4.1.2 TC: Load Short Form Test (2)

1F3C	C101	0039	1006	0200	9701	0005	002C
0016	28D6	3000	0206	2201	9028	D428	D630
0002	28D4	28D6	3000	0206	2401	9028	D428
D630	0002	28D4	28D6	28A0	0001	3000	726E

4.1.3 TC: Load Short Form Test (3)

1F3C	C102	0039	1006	0200	9701	0005	0058
0016	0228	D428	D630	0002	28D4	28D6	0000
3000	0228	D428	D628	A200	0330	0002	28D4
28D6	3000	0228	D428	D600	0230	0002	68A8

4.1.4 TC: Load Short Form Test (4)

1F3C	C103	0039	1006	0200	9701	0005	0084
0016	28D4	28D6	28C0	0005	3000	0228	D428
D630	0002	28D4	28D6	0004	3000	0228	D428
D628	A600	0730	0002	28D4	28D6	3000	9219

4.1.5 TC: Load Short Form Test (5)

1F3C	C104	0039	1006	0200	9701	0005	00B0
0016	0228	D428	D600	0630	0002	28D4	28D6
28AC	000D	3000	0228	D428	D630	0002	28D4
28D6	000C	3000	0228	D428	D628	AE00	D8C8

4.1.6 TC: Load Short Form Test (6)

1F3C	C105	0039	1006	0200	9701	0005	00DC
0016	0F30	0002	28D4	28D6	3000	0228	D428
D600	0E30	0002	28D4	28D6	28B0	0011	3000
0228	D428	D630	0002	28D4	28D6	0010	1ACF

4.1.7 TC: Load Short Form Test (7)

1F3C	C106	0039	1006	0200	9701	0005	0108
0016	3000	0228	D428	D628	A800	1330	0002
28D4	28D6	3000	0228	D428	D600	1230	0002
28D4	28D6	28AA	0015	3000	0228	D428	7063

4.1.8 TC: Load Short Form Test (8)

1F3C	C107	0039	1006	0200	9701	0005	0134
0016	D630	0002	28D4	28D6	0014	3000	0228
D428	D628	B800	1930	0002	28D4	28D6	3000
0228	D428	D600	1830	0002	28D4	28D6	A42C

4.1.9 TC: Load Short Form Test (9)

1F3C	C108	0039	1006	0200	9701	0005	0160
0016	28BC	001D	3000	0228	D428	D630	0002
28D4	28D6	001C	3000	0228	D428	D628	C200
1F30	0002	28D4	28D6	3000	0228	D428	7CE6

4.1.10 TC: Load Short Form Test (10)

1F3C	C109	0039	1006	0200	9701	0005	018C
0016	D600	1E30	0002	28D4	28D6	28C0	1471
02CD	00FF	3000	0228	D428	D630	003A	28D4
28D6	28C0	1470	3000	0228	D428	D628	2394

4.1.11 TC: Load Short Form Test (11)

1F3C	C10A	0039	1006	0200	9701	0005	01B8
0016	C214	7302	CD00	FF30	0002	28D4	28D6
3000	3A28	D428	D628	C214	7230	0002	28D4
28D6	28C6	1477	02CD	00FF	3000	0228	E9FC

4.1.12 TC: Load Short Form Test (12)

1F3C	C10B	0039	1006	0200	9701	0005	01E4
0016	D428	D630	003A	28D4	28D6	28C6	1476
3000	0228	D428	D628	C814	7902	CD00	FF30
0002	28D4	28D6	3000	3A28	D428	D628	847C

4.1.13 TC: Load Short Form Test (13)

1F3C	C10C	0039	1006	0200	9701	0005	0210
0016	C814	7830	0002	28D4	28D6	28C4	1475
02CD	00FF	3000	0228	D428	D630	003A	28D4
28D6	28C4	1474	3000	0228	D428	D628	8A7C

4.1.14 TC: Load Short Form Test (14)

1F3C	C10D	0039	1006	0200	9701	0005	023C
0016	AE0C	5F02	CD00	FF30	0002	28D4	28D6
3000	3A28	D428	D628	AE0C	5E30	0002	28D4
28D6	28A0	28A2	28A6	28A8	28AA	0C51	2045

4.1.15 TC: Load Short Form Test (15)

1F3C	C10E	0039	1006	0200	9701	0005	0268
0016	02CD	001E	0C53	02CD	1F3C	0C57	02CD
3D5A	0C59	02CD	5B78	0C5B	02CD	7996	3000
1E0C	500C	520C	560C	580C	5A30	0002	F501

4.1.16 TC: Load Short Form Test (16)

1F3C	C10F	0039	1006	0200	9701	0005	0294
0016	28A0	28A2	28A6	28A8	28AA	3000	0228
AC28	B028	B828	BA28	BC0C	5D02	CD00	1E0C
6102	CD1F	3C0C	6902	CD3D	5A0C	6D02	AC4C

4.1.17 TC: Load Short Form Test (17)

1F3C	C110	0039	1006	0200	9701	0005	02C0
0016	CD5B	7830	001E	0C5C	0C60	0C68	0C6C
28AC	28B0	28B8	28BA	28BC	3000	0228	D428
D628	8014	3102	1280	3000	0228	D428	5312

4.1.18 TC: Load Short Form Test (18)

1F3C	C111	0039	1006	0200	9701	0005	02EC
0016	D630	001C	28D4	28D6	2880	1430	3000
0228	D428	D628	8214	3302	1280	3000	0228
D428	D630	001C	28D4	28D6	2882	1432	84CC

4.1.19 TC: Load Short Form Test (19)

1F3C	C112	0039	1006	0200	9701	0005	0318
0016	3000	0228	D428	D628	8814	3902	1280
3000	0228	D428	D630	001C	28D4	28D6	2888
1438	3000	0228	D428	D628	8A14	3B02	51E8

4.1.20 TC: Load Short Form Test (20)

1F3C	C113	0039	1006	0200	9701	0005	0344
0016	1280	3000	0228	D428	D630	001C	28D4
28D6	288A	143A	3000	0228	D428	D628	8C14
3D02	1280	3000	0228	D428	D630	001C	F1F6

4.1.21 TC: Load Short Form Test (21)

1F3C	C114	0035	1006	0200	9701	0005	0370
0014	28D4	28D6	288C	143C	3000	0282	3000
0228	9028	9228	9428	9628	9828	CE28	D828
E028	E228	E428	D028	D2FF	3899		

4.1.22 TC: Check Memory (2-LFT)

1F3C	C200	000D	1006	0900	9701	0005	0000
01CC	8B91						

This TC checks that the Limited functional test is correctly stored in EEPROM. The Short Form Test is stored in EEPROM page 5 and consists of 01CCh words in address 0000h to 0397h. A correct result returns the value C486

4.2 Load GRM High Power Simulation sequence

The GRM High Power Test has been loaded into the section of EEPROM assigned for the Helium Tank Rupture mode, since it simulates part of the Rupture Helium Tank mode. The GRM test only needs to be reloaded into Ptolemy EEPROM memory if the check memory TC (section 3.1) has indicated that the EEPROM has been corrupted.

The procedure to load the GRM High Power test assumes that the GRM has been switched on, any initialisation TCs have been transmitted and that the GRM is in Safe mode. (The initialisation TCs will be described with the relevant operation phase procedure). The sequence patches 27 words into the Helium Tank Rupture sequence of EEPROM and the sequence control used is D800 to D801.
A complete description of Ptolemy TCs is in AD1.

Loading the GRM High Power Test requires the transmission of the following TC sequence.

TC number	Time (s)	TC Name	Comments
1	0	Load HPT 1	
2	15	Load HPT 2	
3	30	Check_Memory (HPT)	
	270	-	Wait at least 4 minutes for HK packet containing Check memory report

4.2.1 TC: Load HPT 1

1F3C D800 0039 1006 0200 9701 0005 8000
0016 3000 0F14 3104 51FF 3000 1E19 2242
1160 003C 1830 0005 1430 3000 0F14 7903
8C00 FF30 000F 143D 02CD FF30 000F 6B64

4.2.2 TC: Load HPT 2

1F3C D801 0037 1006 0200 9701 0005 802C
0015 0001 3000 0F00 0330 000F 0005 3000
1E00 0030 000F 0002 3000 0F00 0430 000F
143C 3000 0F14 7830 000F FFFF 4F81

4.2.3 TC: Check_Memory (HPT)

1F3C C000 000D 1006 0900 9701 0005 8000
002B A838

This is the same check memory described in section 3.2.1