HIFI test plan and test report - SW modifications for OD81 failure mitigation

Version 1.0 of 7/12/09, by Albrecht de Jonge, Christophe Risacher, David Teyssier

Abstract

This document describes the test plans and the test results for all tests associated with HIFI SW modifications for mitigation of the HIFI OD81 anomaly. These SW changes are conglomerate of changes at the LCU, ICU, MIB and CUS level. The tests are aimed a

Document: ICC/2009-014
Version 1.0 of 23/01/16
30 pages

Document approval

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Revision history

Version	Date	Changes	Author
DRAFT 0.1	5/11/2009	First version	A. De Jonge, C. Risacher, D. Teyssier
DRAFT 0.2	20/11/2009	Updates, all sections	A. De Jonge, C. Risacher, D. Teyssier
DRAFT 0.3	24/11/2009	Updates, all sections	C. Risacher, D. Teyssier
DRAFT 0.4	26/11/2009	Updates, all sections	C. Risacher, D. Teyssier
DRAFT 0.5	04/12/2009	Section 7.4.3, 8.	C. Risacher

Applicable documents

Doc. ref.	Title

Reference Documents

Doc. ref.	Title
RD1	HIFI LO Software Modifications - MPIfR/HIFI/TN/2009-544
RD2	

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1 Introduction – Scope

This note is the test plan for the S/W changes which are proposed to be implemented as recommendation from the LCU failure investigation. The tests address the changes at levels of LCU, OBS, MIB, CUS and analysis. Tests are proposed per SCR, except for the LCU. Commonalities should be identified and merged wherever possible in the test procedures

2 Test environment

2.1 Test classes

All tests described in this document fall into three categories:

1. Test by inspection. This involves verification of the correctness by inspection of the code.
2. Unit tests. These tests are to be executed at unit level, i.e. the LCU with its SCOE, the OBS on the ICU with its SCOE, the MIB and CUS against their software environments only.
3. Instrument level tests. These will be executed using the parallel setup in Groningen, which comprises:
    a. LCU IMD3
    b. LSU TBS.
    c. LOA dummy
    d. FCU TBS
    e. FPU dummy
    f. WBH QM
    g. HRH QM
    h. Subsystem monitor
    i. Subsystem simulator for WBV and HRV
    j. CDMS simulator
    k. SCOS 2.3e system
    l. ICC database node

3 LCU

3.1 LCU modes and transitions

For the new dissipative mode, proper behaviour of hardware and command execution in the new mode must be tested.
The code executed while in diagnostic and normal mode is unchanged as the code is unchanged, so it is tested by inspection. The difference between standby0 and standby1 are only visible during the transitions to and from this mode. So the behaviour of the software when staying in these can be verified by inspection.

To be tested are then:

1. execution of all mode transitions, including to/from power-off mode
2. rejection of forbidden transitions
3. execution of all allowed commands in dissipative mode
4. rejection of illegal commands in dissipative mode
5. Proper hardware behaviour for mode transitions including to/from power-off
6. Proper reporting in HK of modes

All tests can be done at unit level or by inspection. Tests at unit level using the IMD3 are described in [RD1], and tests using the LCU digital board are in [RD2].

3.2 Behaviour on INT0 events

The 28V under-voltage protection must be tested on the unit level to see if the LCU is left in the wanted state, and again on ILT level to verify the OBS reaction. For the other INT0 interrupts no change in behaviour is expected, so they are verified by inspection

3.3 Behaviour with memory corruption

To be verified by repeating the SEU simulations done during the failure investigation. Unit level test.

4 OBS

Unit tests comprise normal pre-release testing at IFSI. All SxR require special interaction with LCU and need ILT testing

4.1 OBS autonomy function for detecting LCU loss of communication

HIFI-3065

Test by removing LCU power or sending TC patching LCU firmware to destroy HK responses. Verify commanding is indeed blocked on subsystem monitor.

4.2 OBS autonomy function to recognize un-patched LCU software

HIFI-3064

Tested during power on. Verify commanding is indeed blocked on subsystem monitor.

4.3 New action upon discovering LCU checksum error

HIFI-3048

Test by sending TC patching safety table to wrong value, followed by TC with request to recompute. Verify commanding is indeed blocked on subsystem monitor.

4.4 LCU checksum calculation as OBS autonomous function

HIFI-3046

Assume SCR will be withdrawn

4.5 Recovery from LCU disabling

HIFI-3045
Send the TC to do so after testing SCR 3046

5 MIB

Unit level tests to verify compatibility with SCOS and HCSS

5.1 New telecommand HIFI_clear_LCU_comm_lock

HIFI-3080
Tested with the test in section 4.5

5.2 MIB to define OOL values to alert MOC on LCU emergencies

HIFI-3079
Tested by proper SCOS display

5.3 Mib to decode new LCU modes

HIFI-3078
Tested by proper SCOS display. Requires all modes to be exercised

6 CUS

Unit tests comprise normal CUS release tests.

6.1 New LCU patch upload

HIFI-3086

The procedure itself should not have varied from the one used so far, but the number of lines involved in the patch will be larger. The current new patch to be uploaded has a length of 332 lines, significantly more than the older patches. Therefore the way of uploading the patch had to be modified. It was chosen to upload the patch in two separate procedures with associated TPF files, consisting each of 200 lines.

A complication of the new patch upload is that the last command of the patch restores (does not block any longer) the check_mode subroutine which allows now (after loading the patch) to upload memory only in Standby_1 mode (or DIAGNOSTIC). However, until the first command HL_STANDBY has been sent, the LCU remains still in Standby_0 mode and therefore it will reject all other uploading. If writing to the memory is attempted, the checksum value will be correct, but the error flag will appear (Command Mode Error CModE). This means that the previous way of uploading writing the patch from lines 1-332 and filling the remaining lines 333-400 with dummy commands would then cause a Mode Error.
There were two options considered:

1. to neglect the error flag if checksum value is OK
2. to insert the additional 68 lines just before line#332 and this line put as the last one - then there will be no error flag after uploading the patch

It was decided to go for option 2 and send that last command at the very end of the second procedure (line 400), and write in the lines 332-399 the version number.

Test sequence:

Because of the changes and these very specific features of the LCU software, it is important to ensure the following order for the LCU commanding after powering on (HW boot):

1. upload the patch
2. verify the checksum
3. send HL_STANDBY
4. verify that we are in STANDBY_1 mode
5. upload the tables
6. dump the memory
7. verify the checksum

6.2 New CUS Eng modes for mode transition

HIFI-3072

This SCR covers the implementation of all new engineering modes involved in the HIFI mode transition scheme. I propose to follow the mode transition ladder from bottom to top (standby1 to Normal), then from top to bottom (Normal to standby1). The test assumes that the LCU is already patched with the new S/W, and TBD safety tables. **A pre-requisite for this test is that all bands/indices for dissipative mode are known and implemented in the safety tables.** Also, all other S/S must be in standby, with the WBS lasers off.

6.2.1 HifiEngSetFromStandby_I_IntoDissipative_I:

This procedure has to be exercised for each of the band/index combinations identified as suitable to support the dissipative mode. After this mode is executed, the HL_mode HK should have changed from standby1 to dissipative. The LOU band of interest should have been switched on at the requested frequency. TBC is whether we want to check that the expected (low) RF power is observed (can we do this?). After completion of the mode transition, we should try to send a tuning macro while the LCU is in dissipative mode. Note that this aspect should also have been tested at a lower level so this is TBC whether this is again needed here. If it is, we need to send the TM from the MSTK as TM invoked from the CUS are always preceded by an HL_normal, therefore exiting the dissipative mode.

6.2.2 HifiEngSetFromDissipative_I_IntoDissipative_II

After completion of the mode, one should check that the WBS laser was switched on. No other HK should have changed.

6.2.3 HifiEngSetIntoNormal

After completion of the mode, one should check that the HL_mode has changed to Normal. No other HK should have changed. At that stage one should be able to send

a tuning macro. This may however be considered enough to have checked this at S/S level

6.2.4 HifiEngSetFromNormal_IntoDissipative_II

Here we want to check that it is possible to enter the dissipative mode with the LOU being previously tuned at any particular band and frequency. I propose to test this at a band/index with RF power (band 7b), and one corresponding to a dissipative band/index (1a).

- With HIFI in normal mode, switch on band 7b (*HifiEngLOSwitchon 7b, robust option*). This will make use of the key frequency, and use a VD2 value corresponding to the best guess for a mixer to be tuned. This will also set the FPU, WBS and HRS into a non-standby state.
- Tune 7b to the frequency at which the dissipative mode will configure this band (*Testmode_LO_tuning 7b LO_freq*)
- Send the eng mode for transition to Dissipative_II. The tuning in band 7b should remain untouched, and the HL_mode should have changed to dissipative. On top of that, all other S/S should have changed to their standby state, with lasers ON.
- Switch-on HIFI again with band 1a (*HifiEngLOSwitchon 1a, robust option*). This will make use of the key frequency, and use a VD2 value corresponding to the best guess for a mixer to be tuned. This will also set the FPU, WBS and HRS into a non-standby state.

Send the eng mode for transition to Dissipative_II in 1a. The tuning in band 1a should change to the one corresponding to the dissipative frequency, and the HL_mode should have changed to dissipative. On top of that, all other S/S should have changed to their standby state, with lasers ON.

6.2.5 HifiEngSetFromDissipative_II_IntoDissipative_I

After completion of this mode, the WBS laser should have been switched off. No other HK should have changed.

6.2.6 HifiManCmdSetFromDissipative_I_IntoStandby_I

After completion of this mode, the HL_mode should have changed to standby1 and the LOU chain should be OFF. It is TBC whether we want to check that is it impossible to send a tuning macro in this state (should have been tested at S/S level). If so, note that we need to send the tuning macro from the MSTK as TM invoked from the CUS are always preceded by an HL_normal, therefore exiting the standby1 mode

6.2.7 HifiEngSetIntoNormal

We want to check here whether it is fine to move from standby1 to normal without having to pass through the dissipative mode (needed for the LOU SFT). The pre-requisite is that we start from the standby1 state.
After completion of the mode, the HL_mode should have changed to normal. All other HK should remain unchanged. In particular the LOU should still be off.

6.2.8 HifiManCmdSetFromDissipative_I_IntoStandby_I

We want to check here whether it is fine to move from normal to standby1 without having to pass through the dissipative mode. The pre-requisite is that we start from the normal state.
After completion of this mode, the HL_mode should have changed to standby1. All other HK should remain unchanged.

6.3 CUS mode to enable/disable the autonomous standby0 watchdog

HIFI-3070
To be tested together with section 6.4

6.4 CUS mode to release LCU communication lock

HIFI-3071
We can test this CUS modes together with the one from section 6.3
The pre-requisite for testing this mode is that the patch and a TBD safety table are loaded, and that we are in standby1.

1. Send the mode *HifiManCmd_Standby0_FDIR_enable*: it should enable the autonomous function for checking the standby0 state
2. Power cycle the LCU. When the boot is finished and the LCU ends up in standby0, the OBS should block the communication with the LCU. The HK should be frozen, and no TC can be sent to the LCU. We should send e.g. the HL_Standby1 TC from the MSTK to check that is has no effect.
3. Send the mode *HifiManCmd_Standby0_FDIR_disable*: it should enable the autonomous function for checking the standby0 state.
4. Send the mode *HifiManCmd_LCU_lock_clear,* to unlock communication with the LCU. HK should be visible again
5. Upload the patch again so that transition to standby1 becomes possible again.
6. No action from the OBS should be observed at that stage, despite being in standby0, because the function is disabled. The LCU HK is collected, and we can send TC to the LCU (send e.g. the HL_standby1 from the MSTK)
7. Re-enable the autonomous function once we are in standby1 (*HifiManCmd_Standby0_FDIR_enable*). No reaction from the OBS should be observed.

6.5 Procedures for updating the OBS limit checking

HIFI-2659
We are testing here the two eng modes that have been created for manual commanding at the MOC. We want to test that the enabling of the function has an effect when the instrument is either in dissipative of normal mode.

1. First disable the OBSW LO temperature FDIR: *HifiManCmd_LOU_FDIR_disable*
2. Then, get the instrument into dissipative mode in band 1a (*HifiManCmdSetFromStandby_I_IntoDissipative_I*), and finally to normal (*HifiEngSetIntoNormal*)
3. Enable the OBSW LO temperature FDIR with *HifiManCmd_LOU_FDIR_enable*

4. . By default, it will set the temperature range to 115-140 K. Therefore, after a short time, the OBS should send the whole instrument into safe mode, which includes an HL_Standby. The LCU should therefore be in standby1.
5. Disable again the FDIR: *HifiManCmd_LOU_FDIR_disable*
6. Move back to dissipative_I (*HifiManCmdSetFromStandby_I_IntoDissipative_I*:), then to normal and switch on band 1a (*HifiEngLOSwitchon)*
7. Enable the OBSW LO temperature FDIR with *HifiManCmd_LOU_FDIR_enable*
8. . By default, it will set the temperature range to 115-140 K. Therefore, after a short time, the OBS should send the whole instrument into safe mode, which includes an HL_Standby. The LCU should therefore be in standby1.
9. Disable again the FDIR: *HifiManCmd_LOU_FDIR_disable*

6.6 CUS mode to enable/disable the autonomous checksum verification

HIFI-3069

We are testing here that the ICU will block communication with the LCU upon discovery of an LCU checksum different from the expected value. This function will not be enabled at boot, therefore one has to previously enable it with the proper checksum information.

1. After full upload of the patch and safety table, the LCU should be in standby1.
2. Ensure that the HK readout rate is 1 pkt per sec
3. Verify that HM123190 (HI_au_LCU_mem_S) is OFF
4. Enable the checksum verification FDIR, with a checksum value different from the current one, and a short check periodicity: Hifi_HIFI_LCU_mem_check_on ($BBID, 3000, Wrong_Checksum, 10).
5. Verify that HM123190 (HI_au_LCU_mem_S) is ON.
6. Once this command is sent, the checksum verification should be done after 10 sec. It should raise a runtime error, and disable the LCU communication.
7. Verify that HI_LCU_commands is "DISABLED".
8. Disable the autonomous function: HifiManCmd_CRC_FDIR_disable. Verify that HM123190 (HI_au_LCU_mem_S) is OFF.
9. Unlock the LCU communication: HifiManCmd_LCU_lock_clear. Verify that HI_LCU_commands is "ENABLED".
10. Enable the checksum verification FDIR, with the correct checksum value, and a short check periodicity: Hifi_HIFI_LCU_mem_check_on ($BBID, 3000, Correct_Checksum, 10).
11. Verify that HM123190 (HI_au_LCU_mem_S) is ON.
12. Verify that the function does not trigger this time. Disable the autonomous function: HifiManCmd_CRC_FDIR_disable. Verify that HM123190 (HI_au_LCU_mem_S) is OFF

6.7 Regular LCU checksum verification when HIFI is prime

HIFI-3052

We are checking the checksum verification will be correctly enabled and disabled respectively by the engineering modes involved at the start and the end of an OD.

1. After full upload of the patch and safety table, the LCU should be in standby1.
2. Ensure that the HK readout rate is 1 pkt per sec.
3. Verify that HM123190 (HI_au_LCU_mem_S) is OFF.
4. Enable the checksum verification FDIR, with the correct checksum value, and a short check periodicity: Hifi_HIFI_LCU_mem_check_on($BBID, 3000, Correct_Checksum, 10).
5. Verify that HM123190 (HI_au_LCU_mem_S) is ON.
6. Transition to normal mode: HifiEngSetIntoPrimary. This should turn off the autonomous function.
7. Verify that HM123190 (HI_au_LCU_mem_S) is OFF.
8. Transition to dissipative 2: HifiEngSetFromNormal_IntoDissipative_II(7b). This should turn on the autonomous function.
9. Verify that HM123190 (HI_au_LCU_mem_S) is ON.

6.8 End-to-End validation of other parts of the S/W

The above tests are focusing on the changes done in the LCU S/W and OBSW. In order to check that the rest of the (un-changed) S/W behaves as it did before, we will perform a full dry-run of what is planned to be executed during the CoP-II, both at manual commanding and MTL level.
The detailed sequence for the manual commanding for SFTs are:

A) Chopper

HifiManCmd_Chopper_openloop_set_health_check Red
HifiManCmd_Chopper_openloop_scan_health_check Red
HifiManCmd_HIFI_OL_from_to_CL CLOSE Standbyl Red
HifiManCmd_Chopper_closed_loop_parameter_check_ops Red

B) WBS

HifiEng_WBS_FT_COP prime_or_redundant Red

C) FPU

HifiEng_FPU_FT_COP 1a 520 Red
HifiEng_FPU_FT_COP 2a 652 Red
HifiEng_FPU_FT_COP 3a 845.5 Red
HifiEng_FPU_FT_COP 4a 991 Red
HifiEng_FPU_FT_COP 5a 1122 Red
HifiEng_FPU_FT_COP 6a 1568 Red
HifiEng_FPU_FT_COP 7a 1768.5 Red

D) HRS

HifiEng_HRS_FT_COP Red

E) IF chains

HifiEng_IF_FT_COP 1a 520 Red
HifiEng_IF_FT_COP 2a 652 Red
HifiEng_IF_FT_COP 3a 845.5 Red
HifiEng_IF_FT_COP 4a 991 Red
HifiEng_IF_FT_COP 5a 1122 Red
HifiEng_IF_FT_COP 6a 1568 Red
HifiEng_IF_FT_COP 7a 1768.5 Red

F) Chopper Response time

HifiEng_Chopper_Response_time_COP Red

G) LOU

HifiManCmdSetIntoPrimary
HifiEng_LO_FT_COP 1a Red
HifiEng_LO_FT_COP 1b Red
HifiEng_LO_FT_COP 2a Red
HifiEng_LO_FT_COP 2b Red
HifiEng_LO_FT_COP 3a Red
HifiEng_LO_FT_COP 3b Red
HifiEng_LO_FT_COP 4a Red
HifiEng_LO_FT_COP 4b Red
HifiEng_LO_FT_COP 5a Red
HifiEng_LO_FT_COP 5b Red
HifiEng_LO_FT_COP 6a Red
HifiEng_LO_FT_COP 6b Red
HifiEng_LO_FT_COP 7a Red
HifiEng_LO_FT_COP 7b Red

H) Go to Standby1

HifiManCmdSetIntoStandby_I

For the timeline (MTL), the CoP-II dryrun has the following sequence:

A) Mode Transition

HifiEngSetIntoPrimary

B) Diplexer calibration

HifiEng_Diplexer_calibration_vs_D2_COP 3
HifiEng_Diplexer_calibration_vs_D2_COP 4
HifiEng_Diplexer_calibration_vs_D2_COP 6
HifiEng_Diplexer_calibration_vs_D2_COP 7

C) Vector scan and Tsys combined

HifiEng_Tsys_Vecscan_COP 1a
HifiEng_Tsys_Vecscan_COP 1b
HifiEng_Tsys_Vecscan_COP 2a
HifiEng_Tsys_Vecscan_COP 2b
HifiEng_Tsys_Vecscan_COP 3a

HifiEng_Tsys_Vecscan_COP 3b
HifiEng_Tsys_Vecscan_COP 4a
HifiEng_Tsys_Vecscan_COP 4b
HifiEng_Tsys_Vecscan_COP 5a
HifiEng_Tsys_Vecscan_COP 5b
HifiEng_Tsys_Vecscan_COP 6a
HifiEng_Tsys_Vecscan_COP 6b
HifiEng_Tsys_Vecscan_COP 7a
HifiEng_Tsys_Vecscan_COP 7b

D) Go to Dissipative 2

HifiEngSetFromNormal_IntoDissipative_II band 0

6.9 End-to-end verification of the LCU failure scenario

6.9.1 Simulation of the HIFI OD-81 anomaly scenario and impact assessment

In this specific test we plan to perform a full end-to-end simulation of the anomaly scenario initiated by a SEU in the memory and reconstruct the full sequence of events as they are believed to have occurred in space. The SEU will be simulated by a dedicated software patch flipping a particular bit at a specific memory location. The sequence of events will then be triggered by sending the specific sequence of HK requests and commands associated with the start science frame packet. The diode failure caused by the transient of the standby relay will be simulated by shorting the diode through a fast switch which is triggered either by the standby relay command or the falling edge of e.g. primary supply current via a digital scope.

In this particular test we will monitor all HK and system responses and check them against the observations during OD-81. In particular we will measure the exact time profiles of falling drain, gate and multiplier bias voltages after switching the standby relay and simulated diode failure. A fast Ka-band power sensor (Schottky video detector) will be used to measure the time profile of the RF input power. Using this information an impact assessment of the failure scenario on the 7b chain, which was active at the time of the HIFI anomaly, will be made together with the LO experts.

6.9.2 HIFI system response to future SEU with implemented risk mitigation

To verify the effectiveness of all risk mitigation measures which are currently implemented an end-to-end test will be performed verifying the system response to a simulated SEU. A SEU will again be simulated by a specific LCU patch and the system response to the event will be registered in terms of HK (analog/digital, messages, and mode transitions). Correct behaviour of the LCU software and OBS will be verified and it will explicitly be checked that the standby relay will not be switched and therefore no diode failure will be simulated. Again, the time profiles of drain, gate and multiplier bias voltages in LO band 7b will be registered along with the RF input power time profile. A comparison with the simulated OD-81 anomaly scenario will be made to confirm the effectiveness of the measures put in place and the impact on the LO chain will be evaluated.

7 Test results

7.1 Patch and table upload after initial Switch On

The summary of results here is for test environment: (18th of November 2009)
FM_CUS_16.145 - MIB 1045 - OBS 6.2.1 – LCU patch 2.0

Also repeated successfully with test environment: (20th of November 2009)
FM_CUS_16.146 - MIB 1045 - OBS 6.3.0 – LCU patch 2.0
Also repeated successfully with test environment: (25th of November 2009)
FM_CUS_16.147- MIB 1045 - OBS 6.3.1 – LCU patch 2.1

7.1.1 Disabling LOU temperature

The OBSW 6.2.1, 6.3.x do not have the autonomous OBS on LOU temperature FDIR disabled at boot. The action to perform to disable is: (only relevant for the parallel setup).

Command	Mnemonic (scos)	Scos display	value	Result
HifiManCmd_ LOU_FDIR_disable	HM122190 (HI_auto_LOU_S)	Hifi_autonomous AND:HA147289	OFF	**OK**

7.1.2 Powering LCU - initial conditions

The LCU 28V external supply was switched on. The LCU HK was then enabled using "Testmode_notify_PDU_status_on".

	Command - Action	Mnemonic (scos)	Scos display	Value	Result
1	LOU LCL 28 V		Ext. power supply	28V	
	LCL current		Ext. power supply	0.9 A	**OK**
2	*Testmode_notify_ PDU_status_on*	HL_mode_S	LCU_status2 AND:HA004289	Standby0 Red limit	**OK**
		HL_checksum	LCU_status2 AND:HA004289	8DED	**OK**

7.1.3 Patch upload

The patch can now be uploaded following the MOC procedures:

	Command	Mnemonic (scos)	Scos display	Expected value	Result
3	*HifiManCmd_upload_ LCU_patches_flight_ops R 1*	HL_checksum	LCU_status2 AND:HA004289	B61B	**OK**
	HifiManCmd_upload_ LCU_patches_flight_ops R 2	HL_checksum	LCU_status2 AND:HA004289	406C	**OK**

The intermediate and final checksum values were as expected.

7.1.4 Table upload

After the patch upload, we can now go to standby-I to be able to upload the safety tables.

	Command	Mnemonic (scos)	Scos display	Expected value	Result
4	*HifiManCmd SetIntoStandby_I*	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
5	*HifiManCmd_upload_ LCU_table_flight_ops*	HL_checksum	LCU_status2 AND:HA004289	4D92	**OK**
6	*HifiManCmd_readback_ LCU_table_flight R*				**OK**
7	*HifiManCmd_recalc_ LCU_checksum_flight*	HL_checksum	LCU_status2 AND:HA004289	4E4F	**OK**
		HI_LCU_commands	ICU HK AND:HA000289	enabled	**OK**

The patch and table upload following the MOC procedures were successful.

7.1.5 Checksum calculation – checking LCU HK disabling

A test was performed to check if the checksum recomputation suspends the LCU HK collection. Until now, the CUS commands also included a disabling of the LCU HK, but if it is already part of the command itself, there is no need to repeat it twice. We used a 10s delay for the command, as it is one of the allowed inputs.

	Command	parameters	Scos display	Expected value	Result
1	*MSTK: HIFI_check_LCU_memory*	HIF_step_time: 10 s	e.g. LCU_status2	LCU HK disabled during 10s	**OK**
2	*After 10s, check HK*		e.g. LCU_status2	LCU HK re-enabled	**OK**

The test confirmed that the checksum recomputation suspends the LCU HK collection is disabled and re-enables it afterwards.

7.2 Manual commanding mode transitions

Test environment: (18th of November 2009)
FM_CUS_16.145 - MIB 1045 - OBS 6.2.1 – LCU patch 2.0

Few transitions were tested:

7.2.1 From Standby-I to Normal

This will be needed for the SFT:

	Command/Action	mnemonic	Scos display	Expected value	Result
1	Heater initially at 0V	LCL current	External Power Supply	1.5 A	**OK**
	Initial condition	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
2	*HifiManCmdSetIntoPrimary*	HL_mode_S	LCU_status2 AND:HA004289	normal	**OK**
	Check LCL current	LCL current	External Power Supply	1.5 A	**OK**

7.2.2 From Normal to Standby-I

This will be needed for the SFT:

	Command/Action	mnemonic	Scos display	Expected value	Result
1	Heater initially at 0V	LCL current	External Power Supply	1.5 A	**OK**
	Initial condition	HL_mode_S	LCU_status2 AND:HA004289	normal	**OK**
2	*HifiManCmdSetIntoStandby1*	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
	Check LCL current	LCL current	External Power Supply	1.5 A	**OK**

7.2.3 Setting the LOU heater

	Command/Action	mnemonic	Scos display	Expected value	Result
1	Heater initially at 0V	LCL current	External Power Supply	1.5 A	**OK**
	Initial condition	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
2	*HifiManCmd_Set_HL_Heater To 6 V*			6V	**OK**
	Check LCL current	LCL current	External Power Supply	1.8 A	**OK**

7.2.4 Standby-I LCU command rejection

While being in Standby-1, we issued a tuning command, which was ignored as expected.

Command/Action	Parameters	Scos display	Expected value	Result
MSTK: HIFI_conf_nom_LCU_ch7b	-	-	Command ignored	**OK**

7.3 MTL mode transitions

Test environment: (18th of November 2009)
FM_CUS_16.145 - MIB 1045 - OBS 6.2.1 – LCU patch 2.0

We exercised here the full sequence of mode transitions going from standby-I to Dissipative-I to Dissipative-II to Normal to Dissipative-II to Dissipative-I and finally to Standby-I. We only tested here the 7b chain. Note that the band 7b index that was used for the dissipative mode is not yet representative.

	Command/Action	mnemonic	Scos display	Expected value	Result
	Initial conditions	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
1	*Check Laser status*	HWH_Laser1_S	WBS-H AND:HA06289	OFF	**OK**
	LCL current		Ext. Power supply	1.5 A	**OK**
	HifiEngSet FromStandby_I_IntoDissipative_I	HL_mode_S	LCU_status2 AND:HA004289	Dissipative	**OK**
2	*Check Laser status*	HWH_Laser1_S	WBS-H AND:HA06289	OFF	**OK**
	LCL current		Ext. Power supply	2.3 A	**OK**
	HifiEngSet FromDissipative_I_IntoDissipative_II	HL_mode_S	LCU_status2 AND:HA004289	Dissipative	**OK**
3	*Check Laser status*	HWH_Laser1_S	WBS-H AND:HA06289	ON	**OK**
	LCL current		Ext. Power supply	2.3 A	**OK**
	HifiEngSetIntoPrimary	HL_mode_S	LCU_status2 AND:HA004289	Normal	**OK**
4	*Check Laser status*	HWH_Laser1_S	WBS-H AND:HA06289	ON	**OK**
	LCL current		Ext. Power supply	2.3 A	**OK**
	HifiEngSet FromNormal_IntoDissipative_II	HL_mode_S	LCU_status2 AND:HA004289	Dissipative	**OK**
5	*Check Laser status*	HWH_Laser1_S	WBS-H AND:HA06289	ON	**OK**

	LCL current		Ext. Power supply	2.3 A	**OK**
6	*HifiEngSet FromDissipative_II_IntoDissipative_I*	HL_mode_S	LCU_status2 AND:HA004289	Dissipative	**OK**
	Check Laser status	HWH_Laser1_S	WBS-H AND:HA06289	OFF	**OK**
	LCL current		Ext. Power supply	2.3 A	**OK**
7	*HifiManCmdSetIntoStandby1*	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
	Check Laser status	HWH_Laser1_S	WBS-H AND:HA06289	OFF	**OK**
	LCL current		Ext. Power supply	1.5 A	**OK**

7.4 OBSW tests OBS autonomy function for detecting LCU loss of communication

HIFI-3065
Test environment: (20th of November 2009)
FM_CUS_16.146 - MIB 1045 - OBS 6.3.0 – LCU patch 2.0

The conditions were as follows:

The LCU was powered on with an external power supply (28V) and fully patched with patch 2.0. It was in standby1. The FCU, HRS-H and WBS-H were powered on. HK was collected from all switched on S/S with a rate of 1_pkt_per_sec.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
1	LOU LCL 28 V		Ext. power supply	28V	**OK**
	LOU LCL current		Ext. power supply	0.9 A	
		HL_mode_S	LCU_status2 AND:HA004289	Standby1	
2	*HifiManCmd_LCU_ comm_FDIR_enable*	HM125190 HI_au_LCUresp_S n_breach 700	Hifi_autonomous AND:HA147289	ON	**OK**

The autonomous function was enabled with a n_breach of 700, corresponding to 10sec with HK rate above

We then switched off the LCU, while keeping the LCU HK collection active. All LCU HK but one turned to 0xEEEE. The only HK not being read as 0xEEEE is the HL_LCU_Status, which is read as 0xFFFF. It is our understanding that this is because of HIFI-2942.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
3	Switch off LCU		Ext. power supply	0V	**OK**
4	Obs should detect	HI_LCU_commands	ICU_HK AND:HA000289	enabled	**FAIL**
	Non-responsive LCU	HL_LCU_Status	LCU_status2 AND:HA004289	0xFFFF	**FAIL**
	LO HK disabling?	All other LCU HK	LCU_status2 AND:HA004289	0xEEEE	**FAIL**

As a consequence of the above, the non-responsive LCU is not identified as such because the OBSW triggered this autonomous function only if HL_LCU_Status is 0xEEEE.
We managed to trigger the autonomous function with two work-arounds:

1. We disabled the HK polling on the FCU. Upon desactivation of this, the parameter HL_LCU_Status turned to 0xEEEE. After 10 seconds, the autonomous function was triggered, resulting in HI_LCU_commands turning to "disabled", and an event packet sent by the OBSW.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
5	*Testmode_notify_ PDU_status_off*	FPU	ICU_HK AND:HA000289	OFF	**OK**
6	After 10 seconds *Event packet sent by OBS*	HL_LCU_Status	LCU_status2 AND:HA004289	0xEEEE	**OK**

2. We then turned back on the FCU HK collection, cleared the LCU commanding lock, and observed that we were back to HL_LCU_Status = 0xFFFF and HI_LCU_commands = "enabled".

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
7	*Testmode_notify_ PDU_status_on*	FPU	ICU_HK AND:HA000289	ON	**OK**
8	HifiManCmd_ LCU_lock_clear	HI_LCU_commands	ICU_HK AND:HA000289	enabled	**OK**

3. We then changed the n_breach of the autonomous function to 50, which is less than one full HK readout cycle. The autonomous function immediately triggered, resulting in HI_LCU_commands turning to "disabled", and an event packet sent by the OBSW. It seems therefore that in this situation the value for HL_LCU_Status must be seen as 0xEEEE by the OBSW.

	Command / Action	Mnemonic (scos) - parameter	Scos display	Value	Result
9	*MSTK: HIFI_LCU - nonresp_chck_off*	HM125190 HI_au_LCUresp_Sn_breach 50	Hifi_autonomous AND:HA147289	ON	**OK**
		HI_LCU_commands	ICU_HK AND:HA000289	disabled	**OK**

Neither of the above workarounds is acceptable in operation. The first one implies losing HK monitoring from the FPU, the other one implies a periodicity of the check much too frequent to distinguish between real loss of communication or temporary excursion via an INT0

Because all other HK than HL_LCU_Status were at the 0xEEEE upon which the OBSW triggers the autonomous function, we propose that the OBSW takes its loss-of-communication criterion from another parameter or set of parameters - in other word, not use the bits associated explicitely to HL_LCU_Status.

We repeated the test with:
Test environment: (25th of November 2009)
FM_CUS_16.147- MIB 1045 - OBS 6.3.1 – LCU patch 2.1

The conditions were as follows:

The LCU was powered on with an external power supply (28V) and fully patched with patch 2.1. It was in standby1. The FCU, HRS-H and WBS-H were powered on. HK was collected from all switched on S/S with a rate of 1_pkt_per_sec. The autonomous function was active on boot with n_breach of 700.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
1	LOU LCL 28 V		Ext. power supply	28V	
	LOU LCL current		Ext. power supply	0.9 A	**OK**
		HL_mode_S	LCU_status2 AND:HA004289	Standby1	
		HM125190 HI_au_LCUresp_Sn_breach 700	Hifi_autonomous AND:HA147289	ON	**OK**

We then switched off the LCU, while keeping the LCU HK collection active. As tested previously, all LCU HK turned to 0xEEEE but the HL_LCU_Status which read 0xFFFF.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
3	Switch off LCU		Ext. power supply	0V	**OK**
4	For 10 seconds:	HL_LCU_Status	LCU_status2 AND:HA004289	0xFFFF	**OK**
		All other LCU HK	LCU_status2 AND:HA004289	0xEEEE	**OK**
5	Then obs detects Non-responsive LCU	HI_LCU_commands	ICU_HK AND:HA000289	disabled	**OK**
	LO HK disabling	All LO HK	e.g.LCU_status2 AND:HA004289	none	**OK**

This time, after 10 seconds, the obs detects the non response of the LCU and disables the LCU_commands and the HK collection.

Disabling the autonomous function, clearing the LOU lock sets back the system in standby1 with LCU _commands enabled.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
6	*HifiManCmd_LCU_ comm_FDIR_disable*	HM125190 HI_au_LCUresp_S	Hifi_autonomous AND:HA147289	ON	**OK**
7	HifiManCmd_ LCU_lock_clear	HI_LCU_commands	ICU_HK AND:HA000289	enabled	**OK**
		HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**

7.4.2 OBS autonomy function to recognize un-patched LCU software

HIFI-3064

The summary of results here is for test environment: (20th of November 2009)
FM_CUS_16.146 - MIB 1045 - OBS 6.3.0 – LCU patch 2.0

Repeated successfully with test environment: (25th of November 2009)
FM_CUS_16.147- MIB 1045 - OBS 6.3.1 – LCU patch 2.1

The function was successfully checked on the parallel setup. We did two variations of the check:

1. First, we ensured that the function was activated before collecting HK from a freshly power-cycled LCU. When enabling the HK collection from the LCU, the function immediately triggered without letting us even the chance to see a single HK value on the SCOS display. The HI_LCU_commands turned to "disabled".

	Command / Action	Mnemonic (scos)	Scos display	Value	Resul

					t
1	*HifiManCmd_ Standby0_FDIR_enable*	HM124190 HI_au_LCUmode_S HM125190 HI_au_LCUresp_S	Hifi_autonomous AND:HA147289 Hifi_autonomous AND:HA147289	ON OFF	
2	Power cycle LCU *Testmode_notify_ PDU_status_on*	LCU HI_LCU_commands	Ext. power supply LCU_status2 AND:HA004289 ICU_HK AND:HA000289	28V to 0V to 28V Standby0 ? disabled	**OK** **Not seen** **OK**

We then disabled the function, unblocked the communication lock, and finally received LCU HK normally, with an HL_MODES_S stating "standby0" - as expected.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
3	*HifiManCmd_ Standby0_FDIR_disable*	HM124190 HI_au_LCUmode_S	Hifi_autonomous AND:HA147289	OFF	**OK**
4	HifiManCmd_ LCU_lock_clear	HI_LCU_commands	ICU_HK AND:HA000289	enabled	**OK**
5		HL_mode_S	LCU_status2 AND:HA004289	Standby0	**OK**

2. We switched off the LCU, and kept the autonomous function disabled. We power on the LCU and activated the HK collection. The HL_MODE_S is standby0 - as expected. We then enabled the autonomous function and the LCU HK and TC lock immediately triggered.

	Command / Action	Mnemonic (scos)	Scos display	Value	Result
1		HM124190 HI_au_LCUmode_S HM125190 HI_au_LCUresp_S	Hifi_autonomous AND:HA147289 Hifi_autonomous AND:HA147289	OFF OFF	
2	Power cycle LCU		Ext. power supply	28V to 0V to 28V	**OK**
3	*Testmode_notify_ PDU_status_on*	LCU	LCU_status2 AND:HA004289	Standby0	**OK**
4	*HifiManCmd_ Standby0_FDIR_enable*	HM124190 HI_au_LCUmode_S HI_LCU_commands	Hifi_autonomous AND:HA147289 ICU_HK AND:HA000289	ON disabled	**OK** **OK**

The only difference between the two cases above is that case 2 allows to at least see

shortly after LCL closure that the LCU has booted as expected, and provides the correct HK. In case 1, we don't even have this chance and have to go through several unlocking steps before getting to that stage.

It is our impression that case 2 is more appropriate for the initial switch-on. This implies that the autonomous function must be disabled before closing the LCU LCL, and re-activated once the transition to standby1 has taken place after the patch upload.

7.4.3 OBS autonomy function to calculate the checksum

HIFI-3046

Test environment: (25th of November 2009)
FM_CUS_16.147 - MIB 1045 - OBS 6.3.1 – LCU patch 2.1

The conditions were as follows:
The LCU was powered on with an external power supply (28V) and fully patched with patch 2.1. It was in standby1. The FCU, HRS-H and WBS-H were powered on. HK was collected from all switched on S/S with a rate of 1_pkt_per_sec. The autonomous function is disabled at boot.

	Command / Action	Mnemonic (scos) / Parameters	Scos display	Value	Result
1	LOU LCL 28 V		Ext. power supply	28V	**OK**
	LOU LCL current		Ext. power supply	0.9 A	**OK**
		HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
		HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	OFF	**OK**

The autonomous function was then enabled with a check time of 3000 ms every 10 seconds and with a wrong checksum to trigger the function.
Note that with the MIB used during this test, there is a ratio of 10 for the repeat time of the checksum calculation. If a 1-second rate is specified, then the check is actually done every 10 seconds.

The result of that command was indeed a triggering of the autonomous function, resulting in a HI_LCU_commands disabling and the stopping of the HK LCU requests.

	Command / Action	Mnemonic (scos) / parameters	Scos display	Value	Result

2	*MSTK:* Hifi_LCU_mem_ check_on	HI_au_LCUmem_S ($bbid,3000,46CF,1)	Hifi_autonomous AND:HA147289	ON	**OK**
3		HI_LCU_commands	ICU_HK AND:HA000289	disabled	**OK**
	LCU HK is stopped				**OK**

We then disabled the function, unblocked the communication lock, and finally received LCU HK normally, with an HL_MODES_S stating "standby1" - as expected.

	Command / Action	**Mnemonic (scos)**	**Scos display**	**Value**	**Result**
4	HifiManCmd_CRC_F DIR_disable	HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	OFF	**OK**
5	HifiManCmd_ LCU_lock_clear	HI_LCU_commands	ICU_HK AND:HA000289	enabled	**OK**
	LCU HK restarts	HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**

The autonomous function was then re-enabled with a check time of 3000 ms every 10 seconds and with the right checksum.

	Command / Action	**Mnemonic (scos) / parameters**	**Scos display**	**Value**	**Result**
6	*MSTK:* Hifi_LCU_mem_ check_on	HI_au_LCUmem_S ($bbid,3000,46CD,1)	Hifi_autonomous AND:HA147289	ON	**OK**
7	No triggering				**OK**

As expected, the checksum calculation is done every 10 seconds as can be seen from the 3000ms stopping of the LCU HK, and the LCU_commands stays enabled and the checksum calculation is successful.
The checksum should only be recalculated when HIFI is not prime, therefore we checked that this was indeed the case, by putting the LCU into normal mode. The initial conditions were:

	Command / Action	**Mnemonic (scos) / Parameters**	**Scos display**	**Value**	**Result**
	LOU LCL 28 V		Ext. power supply	28V	**OK**
1	LOU LCL current		Ext. power supply	0.9 A	**OK**
		HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
		HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	OFF	**OK**

The autonomous function was then enabled with a check time of 3000 ms every 10 seconds and with a correct checksum. We then go to prime by putting the LO to normal mode.

	Command / Action	Mnemonic (scos) / parameters	Scos display	Value	Result
2	*MSTK:* Hifi_LCU_mem_ check_on	HI_au_LCUmem_S ($bbid,3000,46CD,1)	Hifi_autonomous AND:HA147289	ON	**OK**
3	HifiEngSetIntoPrimary	HL_mode_S	LCU_status2 AND:HA004289	normal	**OK**
		HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	ON	**OK**
	LO HK always active				**OK**

The HI_au_LCUmem_S stays ON but the LO HK collection is not suspended any longer during 3000ms every 10 seconds, which is a good indication that the checksum is not recomputed as expected.

To be sure that the command is not issued, we repeated the test, this time by putting the wrong checksum before going to prime, with longer repeat time to avoid triggering the function while in standby1.

The initial conditions were:

	Command / Action	Mnemonic (scos) / Parameters	Scos display	Value	Result
1	LOU LCL 28 V		Ext. power supply	28V	**OK**
	LOU LCL current		Ext. power supply	0.9 A	**OK**
		HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
		HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	OFF	**OK**
		HI_LCU_commands	ICU_HK AND:HA000289	enabled	**OK**

The autonomous function was then enabled with a check time of 3000 ms every 60 seconds and with a wrong checksum. We then go to prime by putting the LO to normal mode.

	Command / Action	Mnemonic (scos) / parameters	Scos display	Value	Result
2	*MSTK:* Hifi_LCU_mem_ check_on	HI_au_LCUmem_S ($bbid,3000,46CF,6)	Hifi_autonomous AND:HA147289	ON	**OK**
3	HifiEngSetIntoPrimary	HL_mode_S	LCU_status2 AND:HA004289	normal	**OK**
		HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	ON	**OK**
	LO HK always active				**OK**

After 5 minutes, nothing happens; therefore the checksum is not recomputed as expected. If we now go to dissipative, the function triggers as expected.

	Command / Action	Mnemonic (scos) / parameters	Scos display	Value	Result
4	HifiEngSetFrom NormalIntoDissipativeII	HL_mode_S Chain 7b	LCU_status2 AND:HA004289	dissipative	**OK**
	LOU LCL current		Ext. power supply	2.3 A	**OK**
	After 60 seconds	HI_LCU_commands	ICU_HK AND:HA000289	disabled	**OK**
5	LCU HK is stopped				**OK**
	LOU LCL current		Ext. power supply	1.5 A	**OK**

There is a change in the LCL current consumption, to the stanbdy1 value. Disabling the autonomous function, clearing of the LCU lock, confirms that the HL_mode_S is of standby-1 and that the chain is switched off.

Therefore this function behaves as expected, calculates the checksum while not in prime, and upon discovery of a wrong checksum issues a standby command, then disables the LCU_commands and the LO HK collection.

Test environment: (28th of November 2009)
FM_CUS_16.147 - MIB 1046 - OBS 6.3.1 – LCU patch 2.1

With the previous MIB, there was a ratio of 10 for the repeat time of the checksum calculation. If a 1-second rate is specified, then the check was actually done every 10 seconds. We know verified that the new MIB corrects that parameter:

	Command / Action	Mnemonic (scos) / Parameters	Scos display	Value	Result
	LOU LCL 28 V		Ext. power supply	28V	**OK**
1	LOU LCL current		Ext. power supply	0.9 A	**OK**

		HL_mode_S	LCU_status2 AND:HA004289	Standby1	**OK**
		HI_au_LCUmem_S	Hifi_autonomous AND:HA147289	OFF	**OK**

The autonomous function was then enabled with a check time of 3000 ms every 10 seconds and with a wrong checksum to trigger the function.

The result of that command was indeed a triggering of the autonomous function after 10 seconds, resulting in a HI_LCU_commands disabling and the stopping of the HK LCU requests.

	Command / Action	**Mnemonic (scos) / parameters**	**Scos display**	**Value**	**Result**
2	*MSTK:* Hifi_LCU_mem_ check_on	HI_au_LCUmem_S ($bbid,3000,46CF,10)	Hifi_autonomous AND:HA147289	ON	**OK**
3		HI_LCU_commands	ICU_HK AND:HA000289	disabled	**OK**
	LCU HK is stopped				**OK**

8 Test Verification Matrix

Ref. Test description SCR	Ref. Test result	CUS	MIB	OBS	Test class	Result	Comment
4.1 - HIFI-3065	7.4.1	16.146	1045	6.3.0	ILT	Failed	To be repeated with >= 6.3.1
	7.4.1	16.147	1045	6.3.1	ILT	Validated	
4.2 - HIFI-3064	7.4.2	16.146	1045	6.3.0	ILT	Validated	
	7.4.2	16.147	1045	6.3.1	ILT	Validated	
4.3 - HIFI-3048	7.4.3	16.147	1045	6.3.1	ILT	Validated	
4.4 - HIFI-3046	7.4.3	16.147	1045	6.3.1	ILT	Validated	
4.5 - HIFI-3045	e.g. 7.4.3	16.147	1045	6.3.1	ILT	Validated	
5.1 - HIFI-3080	e.g. 7.4.3	16.147	1045	6.3.1	ILT	Validated	
5.2 - HIFI-3079	all 7.x	16.146	1045	6.3.0	ILT	Validated	
5.3 - HIFI-3064	7.2-7.3	16.145	1045	6.2.1	ILT	Validated	
6.1 - HIFI-3086	7.1	16.146	1045	6.3.0	ILT	Validated	
6.2 - HIFI-3072							
6.2.1	7.3	16.145	1045	6.2.1	ILT	Partially validated	Only done in band 7b -> OK
6.2.2	7.3	16.145	1045	6.2.1	ILT	Validated	
6.2.3	7.3	16.145	1045	6.2.1	ILT	Validated	
6.2.4	7.3	16.145	1045	6.2.1	ILT	Partially validated	Only done in band 7b -> OK
6.2.5	7.3	16.145	1045	6.2.1	ILT	Validated	
6.2.6	7.3	16.145	1045	6.2.1	ILT	Partially validated	Only done in band 7b -> OK
6.2.7	7.3	16.145	1045	6.2.1	ILT	Validated	
6.2.8	7.3	16.145	1045	6.2.1	ILT	Partially validated	Only done in band 7b -> OK
6.3 - HIFI-3070	7.4.2	16.146	1045	6.3.0	ILT	Validated	
6.4 - HIFI-3071	7.4.2	16.146	1045	6.3.0	ILT	Validated	
6.5 - HIFI-2659	7.4.	16.146	1045	6.3.0	ILT	Validated	
6.6 - HIFI-3069	7.4.3	16.147	1045	6.3.1	ILT	Validated	
6.7 - HIFI-3052	7.4.3	16.147	1045	6.3.1	ILT	Validated	
6.8: SFT dry-run		16.146	1045	6.3.0	ILT	Validated	6-7th Dec manual commandings verified
SFT/ CoP dry-run		16.146	1045	6.3.0	ILT	Partially validated	LCU related remaining
6.9: end to end failure scenario						ongoing	