






DISH LOCAL MONITORING & CONTROL REQUIREMENTS SPECIFICATION

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Table of Contents

1	Scope	8
1.1	Identification.....	8
1.2	Intended Use of this Document	8
1.3	System Description	8
1.3.1	LMC Overview	8
1.3.2	Context	9
1.3.3	Functional breakdown.....	10
1.3.4	External interfaces identification.....	12
1.3.5	Product breakdown structure	13
2	Applicable and Reference Documents	14
2.1	Applicable Documents	14
2.2	Reference Documents	14
3	LMC Sub-Element Requirements	16
3.1	Functional and Performance Requirements	16
3.1.1	States and Modes	16
3.1.2	Capability Requirements.....	20
3.1.2.1	LMC Configure DSH	20
3.1.2.1.1	LMC Configure MID Dish Capability.....	21
3.1.2.1.2	LMC Configure MID DSH.....	21
3.1.2.1.3	LMC Control Dish power consumption	21
3.1.2.2	LMC Control DSH	22
3.1.2.2.1	LMC Control pointing	22
3.1.2.3	LMC Manage equipment safety	22
3.1.2.4	LMC Manage TM_DSH interface for MID.....	23
3.1.2.5	LMC Monitor DSH.....	23
3.1.2.5.1	LMC Report MID Dish Capability.....	24
3.1.2.5.2	LMC Report MID Dish Monitoring Data	24
3.1.2.6	LMC Provide DSH Meta-Data	26
3.1.2.6.1	LMC Send Dish meta-data.....	26
3.1.2.7	LMC Provide DSH remote support.....	26
3.1.2.7.1	LMC Provide remote support capability MID Dish	27
3.2	Interface Requirements.....	28
3.3	Environmental Conditions	28
3.3.1	Operational	29
3.3.2	Electromagnetic Compatibility	29
3.3.3	Radio Frequency Interference.....	30
3.3.4	Transportation.....	31
3.3.5	Storage.....	31
3.4	Physical Characteristics	31
3.5	Human Factors	32
3.5.1	Ingress and Egress	32
3.6	Integrated Logistics Support.....	32
3.6.1	Reliability, Availability and Maintainability.....	32
3.6.2	Repair & Replacement.....	32

3.6.3	Product Marking.....	33
3.6.4	ILS Publications.....	33
3.6.4.1	Manufacturing Data Packs.....	33
3.6.4.2	Support Publications.....	34
3.6.5	Training.....	34
3.6.6	Supply Support.....	34
3.6.7	Packaging, Handling & Transportation.....	34
3.6.8	Equipment.....	35
3.6.9	Facilities.....	35
3.7	Product Assurance.....	35
3.7.1	Standardisation.....	35
3.7.2	Workmanship.....	35
3.7.3	Safety and Security.....	35
3.7.4	Design Methods.....	36
3.8	Design Constraints.....	36
3.9	Precedence and Criticality of Requirements.....	36
3.10	Characteristics of Subordinate Elements.....	36
4	Verification	37

List of Figures

1	Dish MID functional context diagram.....	9
2	Dish MID physical context diagram	10
3	Perform Local M&C Functions Enhanced FFBD	11
4	Product Breakdown Structure: SKA_MID	13
5	Dish MID Hierarchy Diagram.....	13
6	DSH States and Modes.....	17
7	LMC Configure DSH Enhanced FFBD	20
8	LMC Control DSH Enhanced FFBD	22
9	LMC Monitor DSH Enhanced FFBD.....	23
10	LMC Provide DSH Meta-Data Enhanced FFBD	26
11	LMC Provide DSH remote support Enhanced FFBD	27
12	Maximum Allowed Radiation Levels for EMI Culprits inside the PSC	30
13	Maximum Allowed Pulsed Radiation Levels for EMI Culprits inside the PSC.....	31

List of Tables

1	External Interface Identification	12
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Acronyms and Abbreviations

<u>Acronym / Abbreviation</u>	<u>Definition</u>
CSP	Central Signal Processor
DI	Dish Indexer
DS	Dish Structure
DSH	Dish Element
LMC	Local Monitoring and Control
PAF	Phased Array Feed
SaDT	Signal and Data Transport
SPF	Single Pixel Feed
SPFRx	Single Pixel Feed Receiver
TM	Telescope Manager

Glossary

<u>Term</u>	<u>Definition</u>
Non Operating Conditions for equipment located inside pedestal	<p>The Non Operating Conditions for the equipment located inside the pedestal at the dish foundations are the same as for Operating Conditions for the equipment located inside the pedestal with the following tailoring:</p> <p>a) Climatic Conditions</p> <ul style="list-style-type: none"> - Air Temperature - Minimum Air Temperature: -15degC - Maximum Air Temperature: 60degC - Humidity according to IEC 60721-3-3 Class 3K4
Operating Conditions for equipment located inside pedestal	<p>The Operating Conditions for the equipment located inside the pedestal at the dish foundations are defined by ETSI 300 019-1-3 Class 3.1 (IEC 60721-3-3 Classes 3K3/3Z1/3Z4/3B1/3C1/3S2/3M1) with the following tailoring:</p> <p>a) Climatic Conditions</p> <ul style="list-style-type: none"> - Air Temperature - Minimum Air Temperature: 0degC - Maximum Air Temperature: 45degC (50dC under extreme conditions) - Solar Radiation - None <p>b) Earthquake conditions</p> <ul style="list-style-type: none"> - Levels of Seismic Zone 1 as defined in IEC 60721-2-6 <p>c) Lightning conditions with the following ground flash densities are expected:</p> <ul style="list-style-type: none"> - SKA1 Mid site: 1-3 strikes per km² per year - SKA2 Remote sites: 0.1-10 strikes per km² per year <p>d) Height above sea level:</p> <ul style="list-style-type: none"> - SKA1 Mid site: 900m - 1100m - SKA2 Remote sites: 300m - 1200m with one at ~2000m <p>Note:</p> <ul style="list-style-type: none"> - Dish performance is to be evaluated as if these conditions occur simultaneously, with contributions added in RSS.

<p>Storage Conditions</p>	<p>The Storage Conditions for equipment to be stored in a weather protected facility are defined by ETSI 300 019-1-1 Class 1.2 (IEC 60721-3-1 Classes 1K4/1B2/1C2/1S3/1M2) with the following tailoring:</p> <p>a) Climatic conditions</p> <ul style="list-style-type: none"> - Minimum Air Temperature: -5degC - Maximum Air Temperature: 45degC <p>The Storage Conditions for equipment to be stored in a non weather protected facility are defined by ETSI 300 019-1-1 Class 1.3 (IEC 60721-3-1 Classes 1K8/1B3/1C2/1S3/1M2) with the following tailoring:</p> <p>b) Climatic conditions</p> <ul style="list-style-type: none"> - Minimum Air Temperature: -15degC - Maximum Air Temperature: 50degC - Maximum Wind: 44 m/s <p>Note:</p> <ul style="list-style-type: none"> - Tailoring is based on Environmental Conditions Analysis [SKA-TEL.DSH.SE-NRF-R-004]
<p>Transportation Conditions</p>	<p>The Transportation Conditions are defined by ETSI 300 019-1-2 Class 2.2 (IEC 60721-3-2 Classes 2K5H/2B2/2C2/2S2/2M2) with the following tailoring:</p> <p>a) Climatic Conditions.</p> <ul style="list-style-type: none"> - Minimum Air Temperature: -25degC - Maximum Air Temperature, unventilated: 70degC - Maximum Air Temperature, ventilated: 50degC - Water from other source than rain: 3m/s (limited to equipment transported by sea on open ship deck) <p>b) Chemically active substances.</p> <ul style="list-style-type: none"> - ETSI 300 019-1-2 Class 2.3 (IEC 60721-3-2 Class 2C3) limited to equipment transported by sea on open ship deck <p>c) Mechanical conditions.</p> <ul style="list-style-type: none"> - Free fall based on IEC 60721-3-2 Class 2M1 - Rolling, pitching based on IEC 60721-3-2 Class 2M2 for transport by ship - Static load limited to the induced load from stacking the specific equipment to a height of 2.3m <p>Note:</p> <ul style="list-style-type: none"> - Tailoring is based on Environmental Conditions Analysis [SKA-TEL.DSH.SE-NRF-R-004]

1 SCOPE

This document defines the requirements and verification requirements of the LMC item that forms part of the SKA Dish Element.

1.1 Identification

Dish LMC item number 320-000000

1.2 Intended Use of this Document

This specification:

- a) Forms part of the LMC systems engineering baseline, as defined in the SKADC SEMP [SKA-TEL.DSH.SE-NRF-MP-001].
- b) Defines functional, performance, interface, environmental, physical, services, safety, logistic support, regulatory (legal), special design, construction and commissioning requirements which are an input to the engineering and development of the item.
- c) Describes the methods that will be used to verify that these requirements have been met when the item is submitted for acceptance.

1.3 System Description

1.3.1 LMC Overview

The LMC consists of a commercial off the shelf controller that serves as a single point of entry for all control and monitoring messages to the outside. Besides configuring the static configurations of the various sub-elements, it also relays the real-time pointing control and applies local pointing corrections. For the monitoring, it aggregates and filters monitoring data as set up from the external (central) controller. The LMC allows for a drill-down capability for maintainers to access detailed diagnostic information of sub-elements on request. The LMC also has a "black box" using a circular buffer of detailed monitoring information that can be downloaded remotely in case such information is needed for diagnostics after a system failure.

The Local Monitor and Control (LMC) is the central control and monitoring hub of the antenna. It communicates with the subsystem controllers, in order to command and monitor the antenna behaviour. It consists of a computer and dedicated software modules that handle all the different specific functions associated to them.

1.3.2 Context

The functional context diagram(s) of the next higher level assembly of the Dish LMC MID is plotted in the following figure(s):

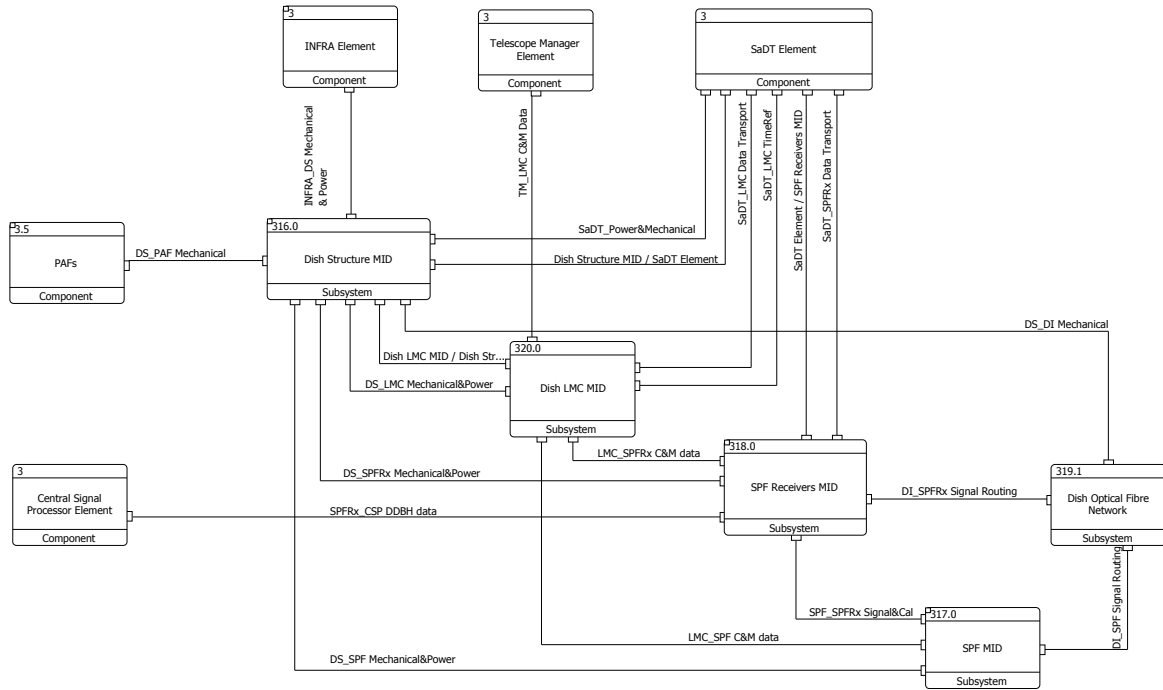


Figure 1 - Dish MID functional context diagram

The physical context diagram(s) of the next higher level assembly of the Dish LMC MID is plotted in the following figure(s):

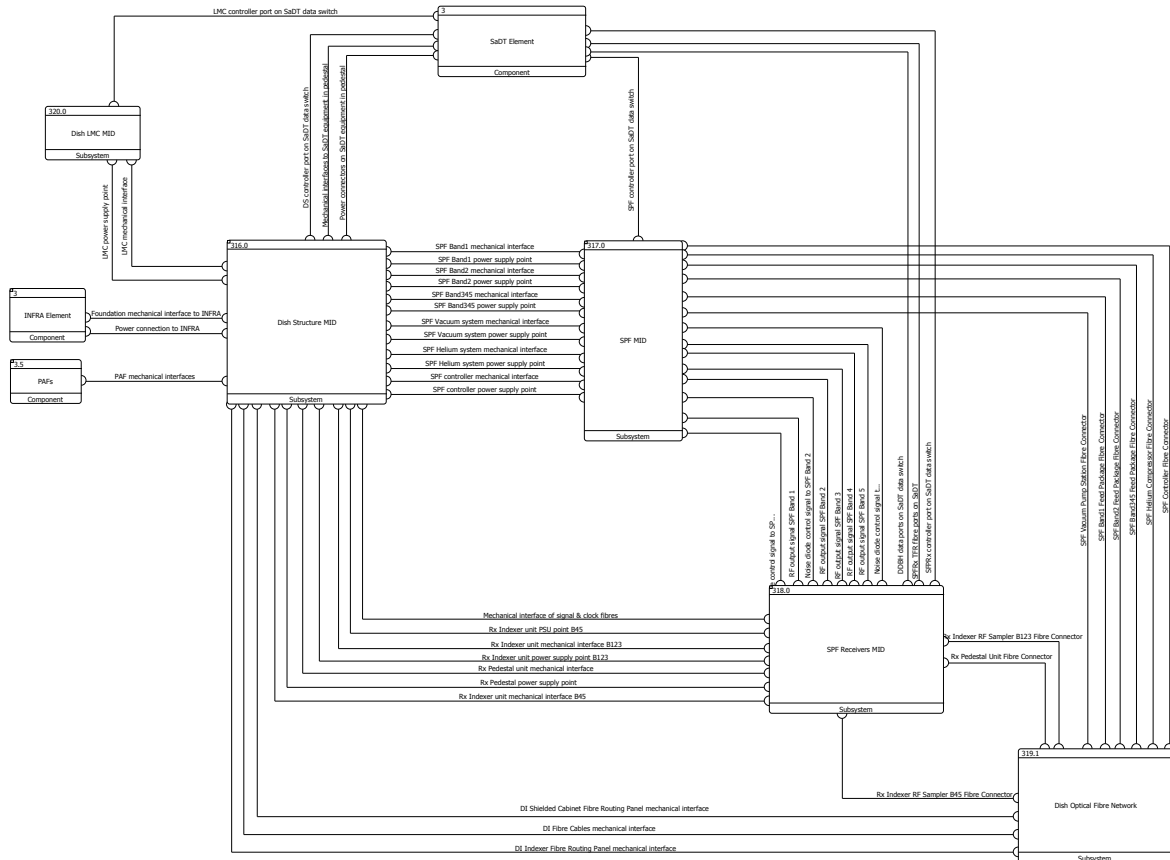


Figure 2 - Dish MID physical context diagram

1.3.3 Functional breakdown

The following basic functions shall be implemented by the LMC:

- a) Managing the TM_LMC interface.
- b) Configuring all the components of the Dish in preparation for an observation.
- c) Real-time control of the Dish pointing and Beam forming during an observation.
- d) Monitoring of all Dish components and reporting of this monitoring information to the Telescope Manager.
- e) Sending meta-data to the TM that is required for the processing of signals.
- f) Providing functionality for the remote support of the Dish and all its sub-elements.
- g) Managing equipment safety [Note that all other sub-elements are self-sufficient in terms of critical safety management and the LMC only provides secondary safety functions]

The primary functions of the LMC are shown in the Extended Functional Flow Block Diagram (EFFBD) below.

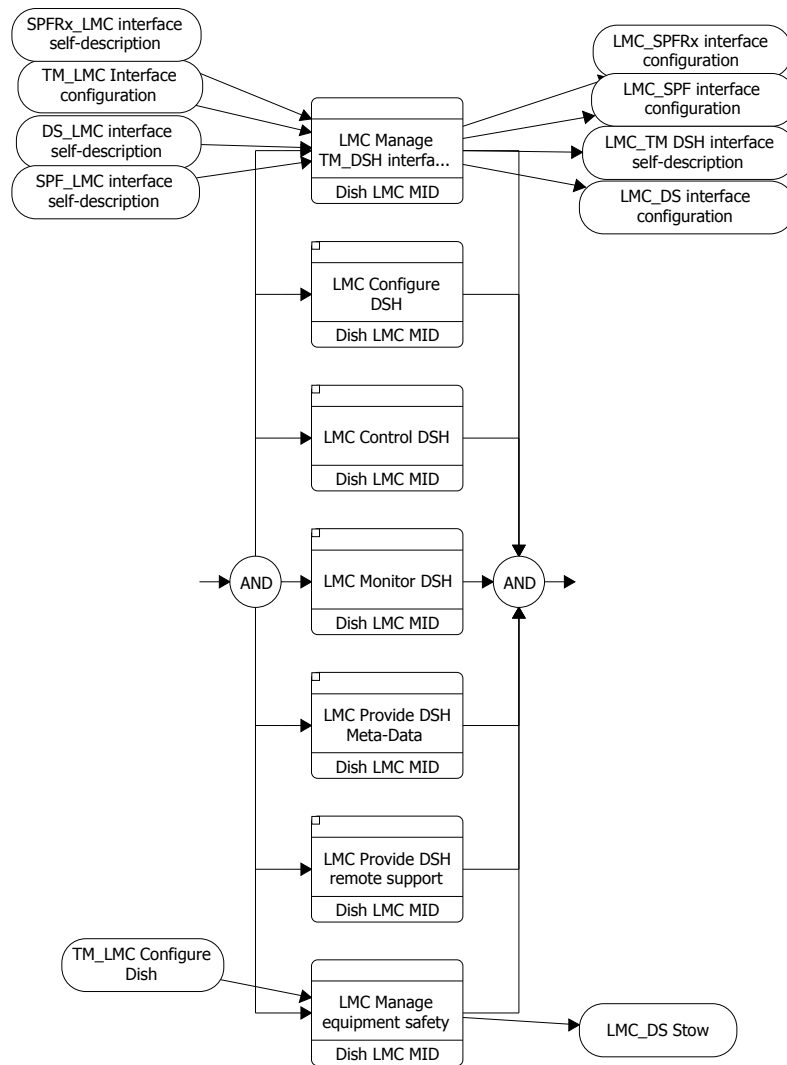


Figure 3 Perform Local M&C Functions Enhanced FFBD

1.3.4 External interfaces identification

The identified interfaces of the LMC to other sub-elements are listed in the table below.

A more detailed identification of all physical and functional external interfaces is defined in the interface identification documents [SKA-TEL.DSH.SE-NRF-DD-001] and [SKA-TEL.DSH.SE-NRF-DD-002]

Table 1 External Interface Identification

External Interface	Interfacing Externals
Dish LMC MID / Dish Structure MID [I.M.DS.LMC.1] LMC controller port on SaDT data switch [I.M.ext.4]	Dish Structure MID
DS_LMC Mechanical&Power LMC power supply point [I.M.DS.LMC.2] LMC mechanical interface [I.M.DS.LMC.3]	Dish Structure MID
LMC_SPF C&M data [I.M.LMC.SPF.1] LMC controller port on SaDT data switch [I.M.ext.4]	SPF MID
LMC_SPFRx C&M data [I.M.LMC.Rx.1] LMC controller port on SaDT data switch [I.M.ext.4]	SPF Receivers MID
SaDT_LMC Data Transport LMC controller port on SaDT data switch [I.M.ext.4]	SaDT Element
SaDT_LMC TimeRef LMC controller port on SaDT data switch [I.M.ext.4]	SaDT Element
TM_LMC C&M Data [I.M.ext.12] LMC controller port on SaDT data switch [I.M.ext.4]	Telescope Manager Element

1.3.5 Product breakdown structure

The location of the LMC components in the context of the SKA_MID PBS is shown in the figures below:

301-000000	Dish Element		
	316-000000	Dish Structure	
		316-010000	Pedestal
		316-020000	Turnhead
		316-030000	Elevation Assembly
		316-040000	Indexer
		316-050000	Plant installations
		316-060000	Dish Control System
		316-070000	Dish Structure Support Equipment
	317-000000	Single Pixel Feed (SPF)	
		317-010000	SPF Band 1 Feed Package
		317-020000	SPF Band 2 Feed Package
		317-030000	SPF Band 345 Feed Package
		317-040000	SPF Controller
		317-050000	SPF Helium system
		317-060000	SPF Vacuum system
		317-070000	SPF Support Equipment
	318-000000	Single Pixel Feed Receivers (SPFRx)	
		318-010000	Receiver Pedestal Unit
		318-060000	Indexer RF Sampler B123
		318-070000	Indexer RF Sampler B45
		318-080000	SPF Receiver Support Equipment
	319-010000	Dish Optical Fibre Network	
	320-000000	Dish Local Monitor and Control	
		320-010000	LMC Hardware
		320-020000	LMC Software

Figure 4 Product Breakdown Structure: SKA_MID

The physical hierarchy diagram(s) of the next higher level assembly of the Dish LMC MID is plotted in the following figure(s):

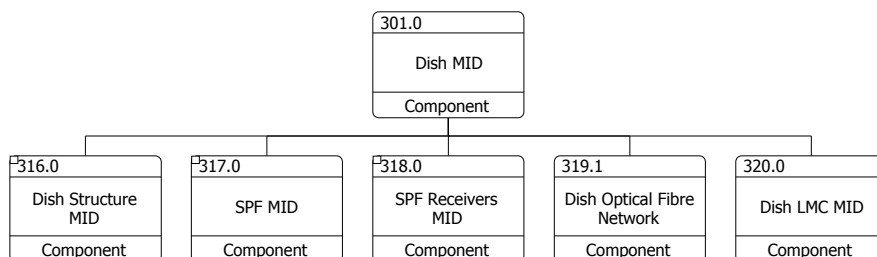


Figure 5 - Dish MID Hierarchy Diagram

2 APPLICABLE AND REFERENCE DOCUMENTS

2.1 Applicable Documents

The following documents are applicable to the extent specified herein. This specification document, in conjunction with the applicable documents listed below, forms the complete specification of the LMC. In the event of conflict between the contents of the applicable documents and this document, this document shall take precedence. Nothing in this document supersedes applicable laws and regulations.

- [1] G. Smit and F. Schilliro, **SKA-TEL-DSH-0000053**, *Data Exchange interface between the Dish LMC and DS controller.*
- [2] G. Smit and F. Schilliro, **SKA-TEL-DSH-0000054**, *Data Exchange interface between the Dish LMC and SPF Receiver Pedestal Unit.*
- [3] G. Smit and F. Schilliro, **SKA-TEL-DSH-0000055**, *Data Exchange interface between the Dish LMC and SPF controller.*
- [4] H. Niehaus, **SKA-TEL-DSH-0000056**, *Mechanical and Power interface between DS and LMC.*

2.2 Reference Documents

The following documents are referenced in this document. In the event of conflict between the contents of the referenced documents and this document, this document shall take precedence.

- [5] P. Swart, **SKA-TEL-SKO-0000150**, Rev 1, *SKA1 Interface Control Document TM to DSH.*
- [6] T. Küsel, A. Peens-Hough and H. Niehaus, **SKA-TEL-DSH-0000005**, Rev 3, *SKA1 Dish Element Requirement Specification.*
- [7] H. Niehaus, **SKA-TEL-DSH-0000041**, Rev 1, *SKA1 Dishes Element Power Budget.*
- [8] R. T. Lord and G. M. Smit, **SKA-TEL-DSH-0000076**, Rev 2, *Level 2 and Level 3 EMI/EMC Requirements for SKA1 Dish Related to SKA EMI/EMC Standard.*
- [9] H. Niehaus, **SKA-TEL.DSH.SE-NRF-R-004**, *Environmental Conditions.*
- [10] T. Kusel, **SKA-TEL.DSH.SE-NRF-DD-001**, Rev 1D, *SKA1_Mid Dish Element Interface Identification Document.*
- [11] T. Küsel, **SKA-TEL.DSH.SE-NRF-MP-001**, Rev 1, *SKA1 Dishes Consortium System Engineering Management Plan.*
- [12] D. Liebenberg, **SKA-TEL-DSH-0000004**, Rev 2, *DSH MID Dish Support Concept.*
- [13] ETSI, **ETSI EN 300 019-1-1**, *Classification of Environmental Conditions; Storage..*
- [14] ETSI, **ETSI EN 300 019-1-2**, *Classification of Environmental Conditions; Transportation..*
- [15] ETSI, **ETSI EN 300 019-1-3**, *Classification of Environmental Conditions; Stationary use at weather protected locations.*
- [16] ETSI, **ETSI EN 300 019-2-4**, *Specification for environmental tests; Stationary use at non-weather protected locations.*

- [17] IEC, **BS EN IEC 60721-3-1**, *Classification of Environmental Conditions; Storage..*
- [18] IEC, **BS EN IEC 60721-3-2**, *Classification of Environmental Conditions; Transportation..*
- [19] IEC, **BS EN IEC 60721-3-3**, *Classification of Environmental Conditions; Stationary use at weather protected locations..*
- [20] S. A. Chaudhuri, **SKA-TEL-TM-0000031**, *LMC Interface Guidelines.*
- [21] SANS, **SANS (IEC) 62305-SER-2.0**, *Protection Against Lightning, all Parts.*

3 LMC SUB-ELEMENT REQUIREMENTS

This section defines all the requirements for the LMC sub-element.

Note that the "Refines" column in the requirements tables refers to parent requirements that are defined in the Dish Element Requirements Specification [SKA-TEL-DSH-0000005]

Requirements numbering: Requirements are numbered using the convention R.x.yyy.zzz, where:

- R indicates a requirement
- x indicates the item to which the requirement applies
- yyy identifies the type of requirement (by CORE folder)
- zzz is a number to make it unique.

3.1 Functional and Performance Requirements

In this section, all the functional & performance requirements are specified.

3.1.1 States and Modes

This section describes the LMC required states and modes, as well as the transition between them.

The figure below shows the States and Modes of the Dish Element, which are controlled by the LMC and reported to TM.

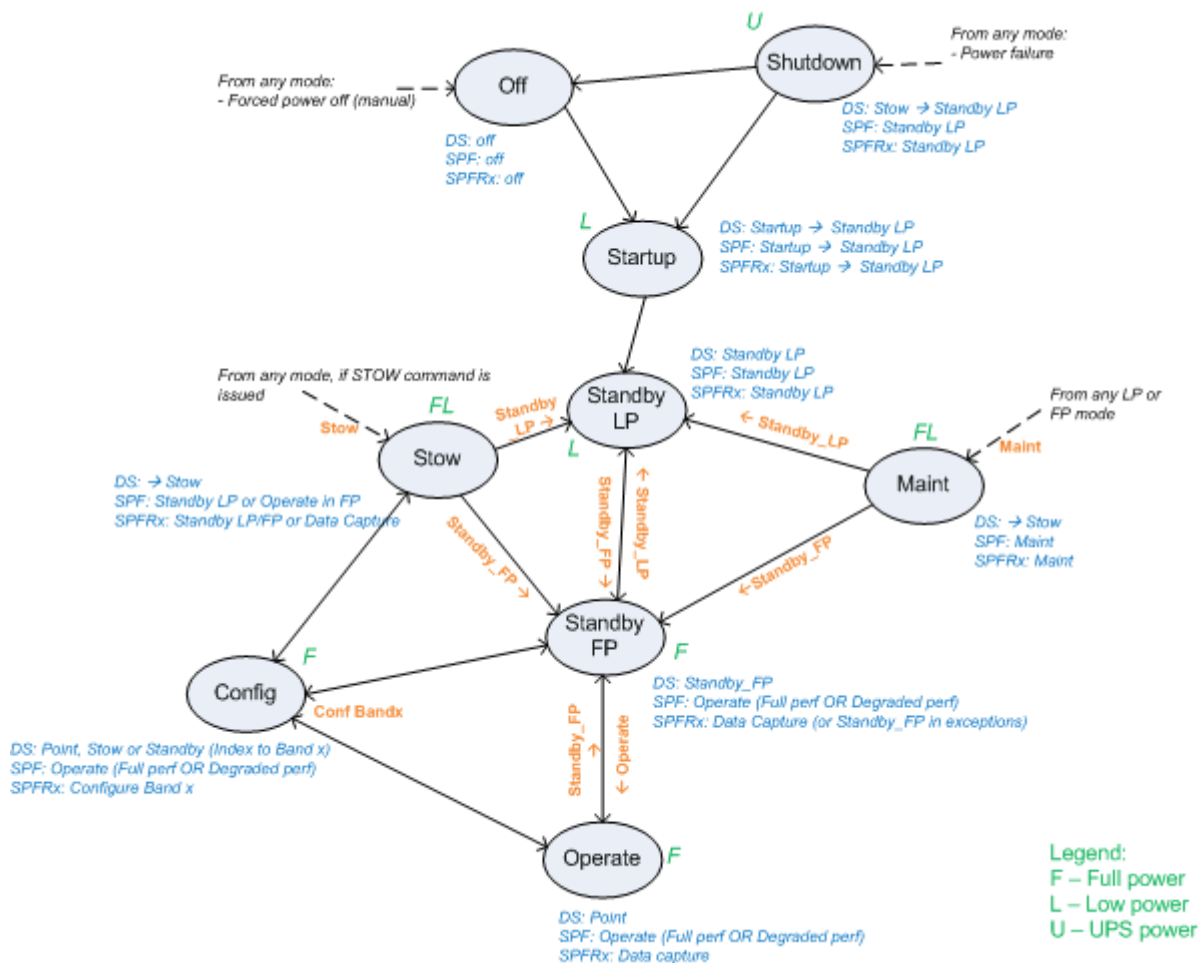


Figure 6 DSH States and Modes

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.SM.1	<p>LMC Control DSH Modes</p> <p>LMC shall control the following Dish Element Modes:</p> <ul style="list-style-type: none"> a) STARTUP b) SHUTDOWN c) STANDBY_LP d) STANDBY_FP e) STOW f) MAINTENANCE g) CONFIGURE h) OPERATE 	R.D.SM.1
R.LMC.SM.2	<p>LMC Report DSH Modes and States</p> <p>LMC, at all times when possible, shall report the Dish Element Modes.</p>	R.D.SM.1
R.LMC.SM.3	<p>LMC Report Pointing States</p> <p>LMC, while DSH is in the OPERATE mode, shall report the following Pointing States:</p> <ul style="list-style-type: none"> a) READY b) INDEX c) SLEW d) TRACK e) SCAN (TBC) 	R.D.SM.12

Req. ID	Name & Description	Refines
R.LMC.SM.5	<p>LMC Report Power States</p> <p>LMC, at all times when possible, shall report the following DSH Power States:</p> <ul style="list-style-type: none"> a) UPS b) LOW_POWER c) FULL_POWER 	R.D.SM.2
R.LMC.SM.6	<p>LMC Receive Dish Mode Commands</p> <p>LMC shall receive the following Dish Mode control commands from TM, and control the Dish Element Modes according to these inputs:</p> <ul style="list-style-type: none"> a) STANDBY_LP b) STANDBY_FP c) STOW d) MAINTENANCE e) CONFIGURE BAND X f) OPERATE g) Go to LP state (while in STOW or MAINTENANCE) 	R.D.SM.13
R.LMC.SM.7	<p>LMC SHUTDOWN Mode SPF</p> <p>LMC, when notified by DS that SHUTDOWN mode is active, shall set SPF to STANDBY_LP mode.</p>	R.D.SM.4
R.LMC.SM.10	<p>LMC Startup Mode</p> <p>LMC, after having started up, and after SPF and SPFRx and DS have all successfully started up, within a specified timeout period, shall automatically transition to the STANDBY_LP mode.</p>	R.D.SM.3
R.LMC.SM.11	<p>LMC Maintenance Mode</p> <p>LMC, when commanded by TM to enter MAINTENANCE mode while DSH is either in STANDBY_LP or STANDBY_FP, shall:</p> <ul style="list-style-type: none"> a) Set the DS to MAINTENANCE mode b) Set the SPF to and SPFRx to their respective MAINTENANCE modes. 	R.D.SM.7
R.LMC.SM.12	<p>LMC Stow mode</p> <p>LMC, when commanded by TM to enter STOW mode, shall set the DS to STOW mode.</p>	R.D.SM.1
R.LMC.SM.13	<p>LMC Standby_FP mode</p> <p>LMC, when commanded by TM to enter STANDBY_FP mode while in a LOW_POWER state, shall enter the STANDBY_FP mode and perform the following actions:</p> <ul style="list-style-type: none"> a) Set DS to STANDBY_FP b) Set SPF to OPERATE c) Set SPFRx to DATA_CAPTURE 	Design Decision
R.LMC.SM.14	<p>LMC Configure mode</p> <p>LMC, when commanded by TM to configure a frequency band that is different to the currently configured band, and while being in either STANDBY_FP or OPERATE or STOW, shall:</p> <ul style="list-style-type: none"> a) Command DS to move to the new feed position. b) Command SPFRx to configure the new frequency band and restart the data capture. c) Wait for above two actions to complete successfully, within a specified timeout period, before automatically reverting to the mode from which the command was given. 	R.D.SM.10
R.LMC.SM.15	<p>LMC Operate mode</p> <p>LMC, when in STANDBY_FP mode and commanded by TM to go to OPERATE mode, shall:</p> <ul style="list-style-type: none"> a) Set DS to DS_POINT b) Set SPFRx to DATA_CAPTURE 	R.D.SM.11
R.LMC.SM.16	<p>LMC Standby_FP</p> <p>LMC, when in OPERATE, and when commanded by TM to go to STANDBY_FP, shall set DS to DS_STANDBY.</p>	R.D.SM.5
R.LMC.SM.17	<p>LMC Stow data capture</p> <p>LMC, when in STOW mode, shall either set:</p> <ul style="list-style-type: none"> a) SPF and SPFRx to STANDBY (LP or FP), or b) SPF to OPERATE and SPFRx to DATA_CAPTURE, for active observations. 	R.D.SM.6

Req. ID	Name & Description	Refines
R.LMC.SM.18	LMC error in Operate mode LMC, when the currently observing Band goes out of OPERATE capability state, due to a functional error, shall automatically revert to the STANDBY_FP mode.	R.D.SM.5
R.LMC.SM.19	LMC SHUTDOWN Mode SPFRx LMC shall set SPFRx to STANDBY_LP mode 30 seconds after being notified by DS that SHUTDOWN mode is active.	R.D.SM.4
R.LMC.SM.20	LMC SHUTDOWN recover LMC, when power is restored while in SHUTDOWN mode, shall go to STARTUP mode.	R.D.SM.14
R.LMC.SM.21	LMC change bands in Stow LMC, when commanded to change frequency bands, and while in the STOW mode, shall: a) Command DS to index to the new band. b) Command SPFRx to CONFIGURE the new band and resume DATA_CAPTURE.	R.D.SM.15
R.LMC.SM.22	LMC go to LP LMC, while Dish is in the MAINTENANCE or STOW mode, and when requested by TM, shall set the SPF, SPFRx and DS to LOW_POWER mode	R.D.SM.5
R.LMC.SM.23	LMC Estop while operate or configure LMC, when an E-stop is pressed while in the OPERATE or CONFIGURE modes, shall go to the STANDBY_FP mode and report an error to TM.	R.D.SM.5
R.LMC.SM.24	LMC Estop error message LMC, when an E-stop is pressed while in any mode other than OPERATE or CONFIGURE, shall remain in the mode and report an error to TM.	R.D.SM.5
R.LMC.SM.30	LMC Report Capability States LMC, at all times when possible, shall report the following DSH Capability States for all five frequency bands: a) UNAVAILABLE b) STANDBY c) CONFIGURING d) OPERATE_DEGRADED e) OPERATE	R.D.SM.20
R.LMC.SM.31	LMC Report DSH Capability Unavailable LMC shall report Band_X as UNAVAILABLE if any one of the following are reported: a) DS is in STARTUP or ESTOP modes. b) SPF is reporting Band_X Capability as UNAVAILABLE state. SPFRx is reporting Band_X Capability as UNAVAILABLE state.	R.D.SM.20
R.LMC.SM.32	LMC Report DSH Capability Standby LMC shall report Band_X Capability as STANDBY state if DSH is in either STANDBY_LP or STANDBY_FP Modes, and: a) SPF is reporting Band_X Capability in STANDBY or OPERATE state. b) SPFRx is reporting Band_X Capability in STANDBY or OPERATE state.	R.D.SM.20
R.LMC.SM.33	LMC Report DSH Capability Configure LMC shall report Band_X Capability as CONFIGURE state if DSH is in CONFIGURE Mode, and: a) SPF is reporting Band_X Capability in OPERATE state. b) SPFRx is reporting Band_X Capability in OPERATE or CONFIGURE state.	R.D.SM.20
R.LMC.SM.34	LMC Report DSH Capability Operate Degraded LMC shall report Band_X Capability as OPERATE_DEGRADED state, if: a) DS is in POINT or STOW modes, but not indexing. b) SPF is reporting Band_X Capability in OPERATE_DEGRADED state. c) SPFRx is reporting Band_X Capability in OPERATE state.	R.D.SM.20
R.LMC.SM.35	LMC Report DSH Capability Operate LMC shall report Band X Capability as OPERATE state, if: a) DS is in POINT or STOW modes, but not indexing. b) SPF is reporting Band_X Capability in OPERATE_FULL state. c) SPFRx is reporting Band_X Capability in OPERATE state.	R.D.SM.20

Req. ID	Name & Description	Refines
R.LMC.SM.36	LMC Report time to full performance LMC, when a Band is in the STANDBY or OPERATE_DEGRADED state, shall report to TM, the estimated time to full performance.	R.D.SM.21

3.1.2 Capability Requirements

The functional breakdown presented in Section 1.3 is used as a structure for the sub-paragraphs in this section.

Data items flowing to/from functions are defined in the ICD documents [SKA-TEL-DSH-000053], [SKA-TEL-DSH-000054], [SKA-TEL-DSH-000055], and [SKA-TEL-SKO-0000150]

3.1.2.1 LMC Configure DSH

The block diagram description of the function, LMC Configure DSH, is depicted in the figure below:

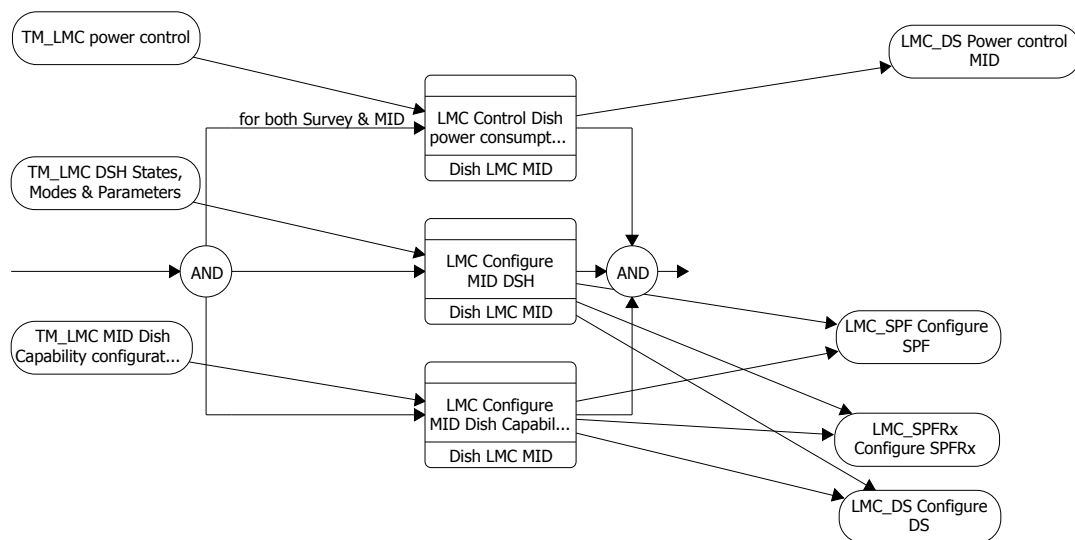


Figure 7 LMC Configure DSH Enhanced FFBD

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.CC.18	LMC Contribution to band switch time The LMC shall not contribute more than 100 ms overhead to the time that is required to switch between any two frequency bands. [Note: This requirement is derived from DSH Frequency agility of 30s switch time between bands. The majority of this time is allocated to the Indexer and LMC should have a minor contribution]	R.D.P.15

3.1.2.1.1 LMC Configure MID Dish Capability

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.CC.3	<p>LMC Configure MID Capability</p> <p>LMC, when commanded by the TM, shall configure either one of the following MID Dish capabilities*:</p> <ul style="list-style-type: none"> a) MID Band 1 Capability b) MID Band 2 Capability c) MID Band 3 Capability d) MID Band 4 Capability e) MID Band 5 Capability <p>* capability shall be defined as the complete end-to-end configurations required for functionality to observe in the applicable frequency band.</p>	<p><i>R.D.CM.3,</i> <i>R.I.TM.32</i></p>

3.1.2.1.2 LMC Configure MID DSH

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.CC.2	<p>LMC Configure DSH</p> <p>LMC shall set all internal states, modes and configuration data for DSH items, based on the external state, mode, configuration and capability commands received from TM.</p>	<p><i>R.D.CM.7,</i> <i>R.I.TM.5,</i> <i>R.I.TM.8,</i> <i>R.I.TM.17</i></p>
R.LMC.CC.4	<p>LMC Configure Noise diode switching waveform</p> <p>LMC shall configure SPF Receiver with the noise diode switching waveform parameters received from TM</p>	<p><i>R.I.CSP.M.7</i></p>

3.1.2.1.3 LMC Control Dish power consumption

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.CC.10	<p>LMC control power consumption</p> <p>LMC, when commanded by TM, shall send power control commands to DS according to the power levels requested by TM.</p>	<p><i>R.D.PW.4</i></p>
R.LMC.CC.12	<p>LMC power up in lowest power state</p> <p>When powering up, LMC shall command DS to remain in the lowest power level state, until commanded by TM to a higher power level.</p>	<p><i>R.D.PW.5</i></p>

3.1.2.2 LMC Control DSH

The block diagram description of the function, LMC Control DSH, is depicted in the figure below:

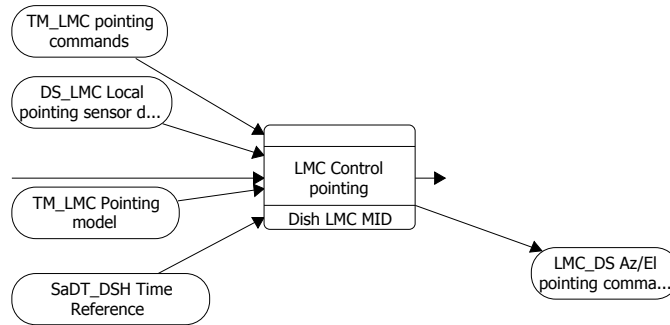


Figure 8 LMC Control DSH Enhanced FFBD

3.1.2.2.1 LMC Control pointing

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.CC.1	LMC apply pointing corrections LMC shall apply corrections to the received pointing commands, to compensate for local pointing errors, using a pointing model provided by TM, including the following: - Structural deformations due to gravity (from pointing model and pointing command) - Corrections based on tilt sensor (if applicable)	<i>R.D.CM.2,</i> <i>R.I.TM.9,</i> <i>R.I.TM.10,</i> <i>R.I.TM.11</i>
R.LMC.CC.13	LMC Receive pointing control LMC shall receive time stamped Az/EI pointing control commands from TM. [Note: These commands will be received from TM 10 seconds in advance of the required time of application]	<i>R.D.CM.1,</i> <i>R.I.TM.9,</i> <i>R.I.TM.10,</i> <i>R.I.TM.11,</i> <i>R.I.TM.56</i>
R.LMC.CC.14	LMC send corrected pointing to DS LMC shall send the time stamped pointing commands, corrected for local effects, to DS.	<i>R.D.CM.2</i>

3.1.2.3 LMC Manage equipment safety

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FMS.1	LMC Extreme conditions stow The LMC shall send a stow command to DS within 1 seconds of receiving a stow command from TM.	<i>R.D.SS.6</i>
R.LMC.FMS.2	LMC TM comms fail stow LMC shall command DS to stow if there is a breakdown in communication between the LMC and TM for a period longer than 5 minutes.	<i>R.I.TM.19</i>

3.1.2.4 LMC Manage TM_DSH interface for MID

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.CC.7	LMC configure TM_DSH interface The LMC, on request from the TM, shall configure the level of reporting of DSH monitoring points, alarms, events and logs over the TM_DSH interface.	R.I.TM.3
R.LMC.CC.11	LMC DSH self-description LMC shall provide a self-description of DSH on request from the TM. Through self-description the LMC provides information that describes the content of the TM_DSH interface, including a set of valid commands, parameters, monitoring points, alarms and events for all DSH components.	R.I.TM.1
R.LMC.CC.17	LMC_TM interface protocol The LMC_TM interface shall use protocol as defined in [SKA-TEL-TM-0000031].	R.I.TM.50

3.1.2.5 LMC Monitor DSH

The block diagram description of the function, LMC Monitor DSH, is depicted in the figure below:

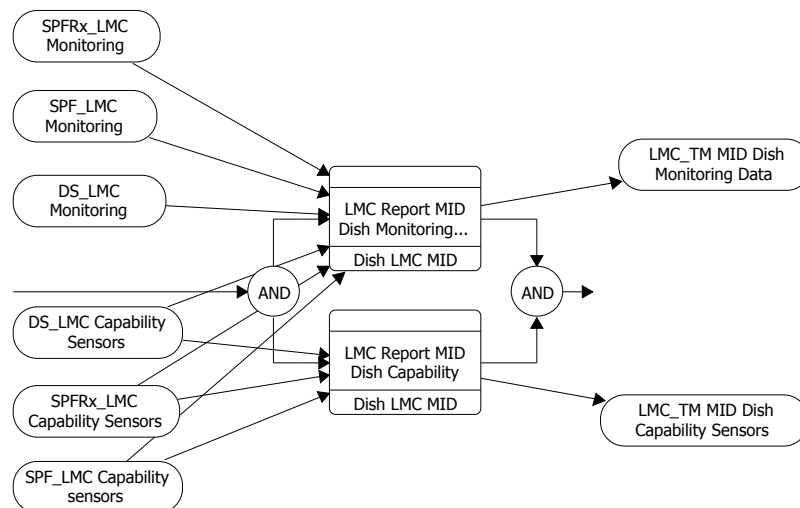


Figure 9 LMC Monitor DSH Enhanced FFBD

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FMON.27	LMC persist missing components LMC shall receive a list of missing and in-maintenance components from TM and shall persist this list beyond a power down-up cycle.	R.D.CM.8

3.1.2.5.1 LMC Report MID Dish Capability

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FMON .13	<p>LMC Report MID Dish Capability</p> <p>LMC shall report on the availability of the following MID Dish capabilities*:</p> <ul style="list-style-type: none"> a) MID Band 1 Capability b) MID Band 2 Capability c) MID Band 3 Capability d) MID Band 4 Capability e) MID Band 5 Capability <p>* availability of a capability shall be defined as the complete end-to-end functional availability of all components that are required to observe in the applicable frequency band.</p>	<p><i>R.D.CM.4,</i> <i>R.I.TM.32,</i> <i>R.I.TM.35,</i> <i>R.I.TM.59</i></p>

3.1.2.5.2 LMC Report MID Dish Monitoring Data

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FMON .1	<p>LMC Aggregate Sensors</p> <p>LMC shall make provision for sensor aggregation from other sub-elements and a "drill-down" capability for monitoring points in the DSH as requested by TM.</p>	<p><i>R.I.TM.27,</i> <i>R.I.TM.28</i></p>
R.LMC.FMON .2	<p>LMC Alarm information</p> <p>LMC shall send to the TM the following information for each alarm:</p> <ul style="list-style-type: none"> a) Time of detection of the condition, b) Description of the condition, (e.g. „over-temperature“) c) The conditional data measured (e.g. 65degC) as justification for raising the alarm. 	<p><i>R.I.TM.22</i></p>
R.LMC.FMON .3	<p>LMC Alarm Latency</p> <p>The latency from an internal LMC alarm event to reporting the alarm to TM shall be no more than 5 seconds.</p>	<p><i>R.D.CM.13</i></p>
R.LMC.FMON .4	<p>LMC Alarm transfer latency</p> <p>The latency from LMC receiveing an alarm from other sub-elements, to reporting the alarm to TM shall be no more than 2 seconds.</p>	<p><i>R.D.CM.13</i></p>
R.LMC.FMON .6	<p>LMC monitoring backup remote access</p> <p>The LMC backup monitoring buffer shall be remotely downloadable.</p>	<p><i>R.D.CM.11</i></p>
R.LMC.FMON .7	<p>LMC Record backup monitoring data</p> <p>LMC shall continuously record a backup monitoring buffer with detailed monitoring information for the entire DSH in a circular buffer with a time window of at least 12 hours.</p>	<p><i>R.D.CM.10</i></p>
R.LMC.FMON .8	<p>LMC Report Alarms</p> <p>LMC shall report alarms to TM for conditions and failures that:</p> <ul style="list-style-type: none"> a) pose hazards to equipment or personnel, or b) reduce the effectiveness of DSH to perform its prime functions or provide capabilities. 	<p><i>R.I.TM.21</i></p>
R.LMC.FMON .9	<p>LMC Report events</p> <p>LMC shall report the following events* to TM:</p> <ul style="list-style-type: none"> - Target lock achieved - Changes in states and modes - Others TBD <p>*Events are typically indications of processes within DSH that have completed, or conditions that are not severe enough to be classified as alarms. Events trigger processes inside TM. An example of an event could be if the DSH has stowed automatically.</p>	<p><i>R.I.TM.23</i></p>
R.LMC.FMON .10	<p>LMC Report External State</p> <p>LMC shall report the DSH element external state to TM as per the SKA Control Model, based on the mapping of sub-element states & modes, according to the LMC interface guideline [SKA-TEL-TM-000031].</p>	<p><i>R.D.CM.6,</i> <i>R.I.TM.6,</i> <i>R.I.TM.20</i></p>

Req. ID	Name & Description	Refines
R.LMC.FMON .11	LMC Report failures LMC shall report detected failures, and identification of the source of the failure in the DSH product breakdown structure. Where applicable, faulty Line Replaceable Units (LRUs) shall be identified.	R.I.TM.29
R.LMC.FMON .12	LMC Report Logs The LMC shall report all log messages for DSH to TM, and shall allow TM to control logging reporting, including: a) The destination for logging messages b) The logging level	R.I.TM.25, R.I.TM.26
R.LMC.FMON .15	LMC Report predicted failures LMC shall report to TM all DSH monitoring points that are required for preventive maintenance or for predicting failures.	R.I.TM.30
R.LMC.FMON .16	LMC Report Sensors LMC shall make provision for "drill-down" monitoring points for the LMC components in the DSH to enable fault diagnostics, in accordance with the LMC interface guideline [SKA-TEL-TM-0000031].	R.I.TM.27, R.I.TM.28
R.LMC.FMON .18	LMC Report SW&FW versions LMC, when requested by TM, shall report version information of all software and firmware of the DSH and its subsystems.	R.I.TM.42, R.I.TM.43
R.LMC.FMON .19	LMC Reporting on missing components LMC shall not report alarms, events, logs, or faults on missing DSH components. [Note: TM shall send a list of all not-fitted items to DSH]	R.D.CM.9, R.I.TM.53
R.LMC.FMON .20	LMC self-monitoring data rate The LMC self-monitoring data rate reported to TM shall be less than 50kbps.	R.LMC.FMON. 23
R.LMC.FMON .21	LMC Structure of Reporting LMC shall report monitoring information in a hierarchical structure corresponding to the product breakdown structure.	R.I.TM.2
R.LMC.FMON .23	LMC TM max data rates MID Dish The maximum LMC_TM data rates for the SKA_MID Dish shall be: - 10kbps for control data - 200kbps for monitoring data	R.I.TM.44, R.I.TM.45
R.LMC.FMON .26	LMC Reporting models The DSH shall support the following status reporting models: a) On request (as response to a command), b) Periodically (for monitoring points like temperature, voltage), c) On change, optionally with a minimum and maximum time period (for status changes and events). any one of which can be set as the default model at start-up.	R.I.TM.60, R.I.TM.61

3.1.2.6 LMC Provide DSH Meta-Data

The block diagram description of the function, LMC Provide DSH Meta-Data, is depicted in the figure below:

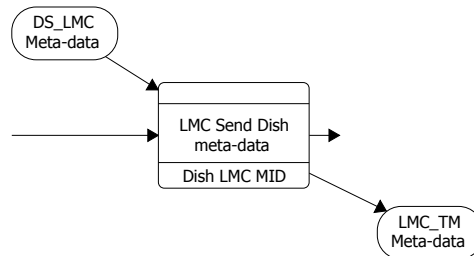


Figure 10 LMC Provide DSH Meta-Data Enhanced FFBD

3.1.2.6.1 LMC Send Dish meta-data

Re-package DS meta-data and applies local corrections to e.g. pointing data.

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FMD.1	LMC correct estimated pointing LMC shall correct estimated pointing values to compensate for all local corrections, including: - Structural deformations due to gravity - Corrections based on tilt sensor (if applicable)	R.I.TM.36
R.LMC.FMD.2	LMC Send estimated pointing LMC, while DS is in the operating states, shall continuously send time stamped estimated Az/EI pointing positions (compensated for local corrections) to TM with a time resolution of 100ms and a timing accuracy of 1ms.	R.I.TM.36, R.I.TM.37
R.LMC.FMD.4	LMC send pointing correction sensor LMC shall report all sensor values that are used to apply local pointing corrections to TM, with a time stamp resolution of 100ms (TBC), and an absolute time accuracy of 1ms (TBC).	R.I.TM.38

3.1.2.7 LMC Provide DSH remote support

The block diagram description of the function, LMC Provide DSH remote support, is depicted in the figure below:

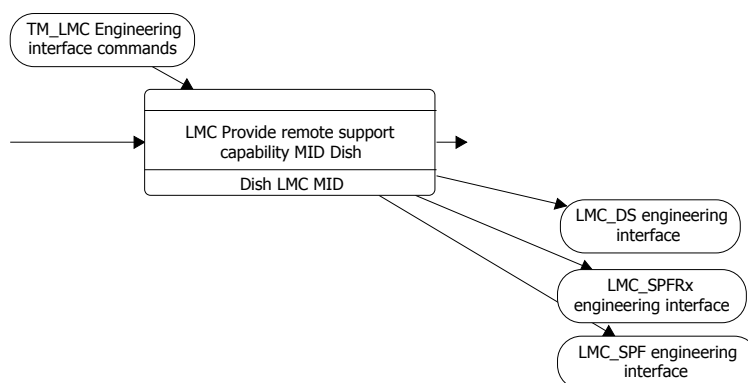


Figure 11 LMC Provide DSH remote support Enhanced FFBD

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FMON.25	LMC Remote access of logging files LMC shall allow TM to access and copy local (to the DSH) logging files (where applicable) TBC.	R.I.TM.52

3.1.2.7.1 LMC Provide remote support capability MID Dish

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.FRS.1	LMC remote updates LMC shall enable patching and upgrade of software and firmware remotely.	R.I.TM.41
R.LMC.FRS.2	LMC tunneling capability LMC shall provide a “tunnelling” capability to access engineering interfaces of sub-elements remotely.	R.I.TM.40, R.I.TM.42
R.LMC.FRS.3	LMC report serial numbers LMC shall report serial numbers for all other sub-elements that provide such a reporting mechanism. LMC shall report its own serial numbers for items that are regularly replaced for maintenance.	R.I.TM.66

3.2 Interface Requirements

External to Dish:

Interface requirements to the Infrastructure Element, Telescope Manager Element and Central Signal Processor Element are defined in [SKA-TEL-SKO-0000115], [SKA-TEL-SKO-0000150] and [SKA-TEL-SKO-0000124] respectively. They are incorporated in the preceding Functional Requirements.

Interface requirements to the SaDT are TBD, and their incorporation is pending the approval of the SaDT_DSH ICD.

Internal to Dish:

Interfaces between LMC and other sub-elements are defined in the ICDs listed as applicable documents. Requirements resulting from the definition of these interfaces are incorporated into the remainder of this document.

3.3 Environmental Conditions

Aspects specifically relating to environmental conditions are specified in this section. These shall include environmental conditions for all operational phases of the item: storage, transportation and operation.

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.EL.1	<p>LMC Environmental Legislation</p> <p>The LMC shall be compliant with all local, State and national environmental protection legislation and regulations.</p> <p>NOTE: Legislation takes precedence over project/contract documentation and requirements. Omission of a law from this requirement does not affect its enforceability. Legislation is also subject to amendment and so the Environmental Laws identified during the Request for Information (copied below) may be modified by the Hosting Agreements and subsequent Acts and Amendments.</p> <p>Legislation and regulations identified during the response to Request for Information include:</p> <p>South Africa:</p> <ul style="list-style-type: none"> National Environmental Management Act, 1998 ("NEMA"); National Water Act, 1998; National Environmental Management: Air Quality Act, 2004; National Environmental Management Waste Act, 2008; National Environment Management: Biodiversity Act, 2004; National Heritage Resources Act, 1999.* <p>* Other South African environmental statutes include the Environment Conservation Act, 1989, various air pollution statutes, the National Heritage Resources Act, 1999, the Hazardous Substances Act, 1973, the Health Act, 1977, the Nuclear Energy Act, 1999, the National Nuclear Regulatory Act, 1999, the National Environmental Management: Protected Areas Act, 2003, the Fertilisers, Farm Feeds, Agricultural Remedies and Stock Remedies Act, 1947, the Marine Living Resources Act, 1998, and the National Environmental Management: Integrated Coastal Management Act, 2008</p>	R.D.EL.1

3.3.1 Operational

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ED.1	<p>LMC Condensation</p> <p>Electronic equipment shall be safe and withstand, without damage or degradation or additional maintenance tasks, the presence of condensation while in the off state. Degraded functionality and performance will be allowed directly after start-up until such time that the condensation has evaporated.</p>	R.D.ED.1
R.LMC.ED.2	<p>LMC Durability</p> <p>The LMC shall survive, without any residual damage or performance degradation, when operated under the Deployed Conditions throughout the Deployed Lifetime.</p> <p>For LMC equipment located inside the pedestal the Operating Conditions for equipment located inside pedestal and Non Operating Conditions for equipment located inside pedestal are applicable.</p> <p>For LMC equipment located at weather protected locations provided by other Elements the conditions are defined in the relevant ICD's.</p>	R.D.ED.2
R.LMC.ED.3	<p>LMC Endurance</p> <p>The LMC shall sustain continuous operation, without performance degradation, under the Precision, Standard and Degraded Operating Conditions throughout the required Deployed Lifetime.</p> <p>For LMC equipment located inside the pedestal the Operating Conditions for equipment located inside pedestal are applicable.</p> <p>For LMC equipment located at weather protected locations provided by other Elements the conditions are defined in the relevant ICD's.</p>	R.D.ED.3
R.LMC.ED.4	<p>LMC Operation</p> <p>The LMC shall be fully functional when operated under the Precision, Standard, Degraded and Extreme Operating Conditions throughout the required Deployed Lifetime.</p> <p>For LMC equipment located inside the pedestal the Operating Conditions for equipment located inside pedestal are applicable.</p> <p>For LMC equipment located at weather protected locations provided by other Elements the conditions are defined in the relevant ICD's.</p>	R.D.ED.7
R.LMC.ED.5	<p>LMC Survival</p> <p>The LMC shall survive and perform according to the requirements as stated in this specification after being subjected to the Survival Conditions throughout the Deployed Lifetime.</p> <p>For LMC equipment located inside the pedestal the Non Operating Conditions for equipment located inside pedestal are applicable.</p> <p>For LMC equipment located at weather protected locations provided by other Elements the conditions are defined in the relevant ICD's.</p>	R.D.ED.8
R.LMC.PW.2	<p>Characteristics of Electrical Power Supply to LMC</p> <p>The LMC components shall perform according to its requirements, as defined in this document, when supplied with the electrical power with the characteristics as defined in SKA-TEL-DSH-0000041 section "Single Phase UPS Power Characteristics".</p>	R.I.INFRA.M.1 4

3.3.2 Electromagnetic Compatibility

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.RFI.3	<p>EMC standards to be used by LMC for Electromagnetic emissions and susceptibility</p> <p>Custom-made LMC components shall comply with IEC 61000-6-4 (electromagnetic emissions) and IEC 61000-6-2 (electromagnetic susceptibility / immunity).</p> <p>COTS LMC components shall comply with the applicable harmonised standards in the European Commission EMC Directive 2004/108/EC, or the SABS equivalents thereof.</p>	R.D.RFI.7, R.D.RFI.8, R.D.RFI.9

3.3.3 Radio Frequency Interference

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.RFI.1	<p>Maximum Allowed Radiation Levels for LMC Components inside the PSC</p> <p>Over the specified frequency band from 50MHz to 20GHz, LMC components mounted inside the PSC shall not radiate EMI above:</p> <ol style="list-style-type: none"> 1) The Spectral Line Threshold Level depicted below and measured in a RBW of 256 Hz, and 2) The Continuum Threshold Level depicted below and measured in a RBW of 1% of centre frequency. 	R.D.RFI.2, R.D.RFI.3

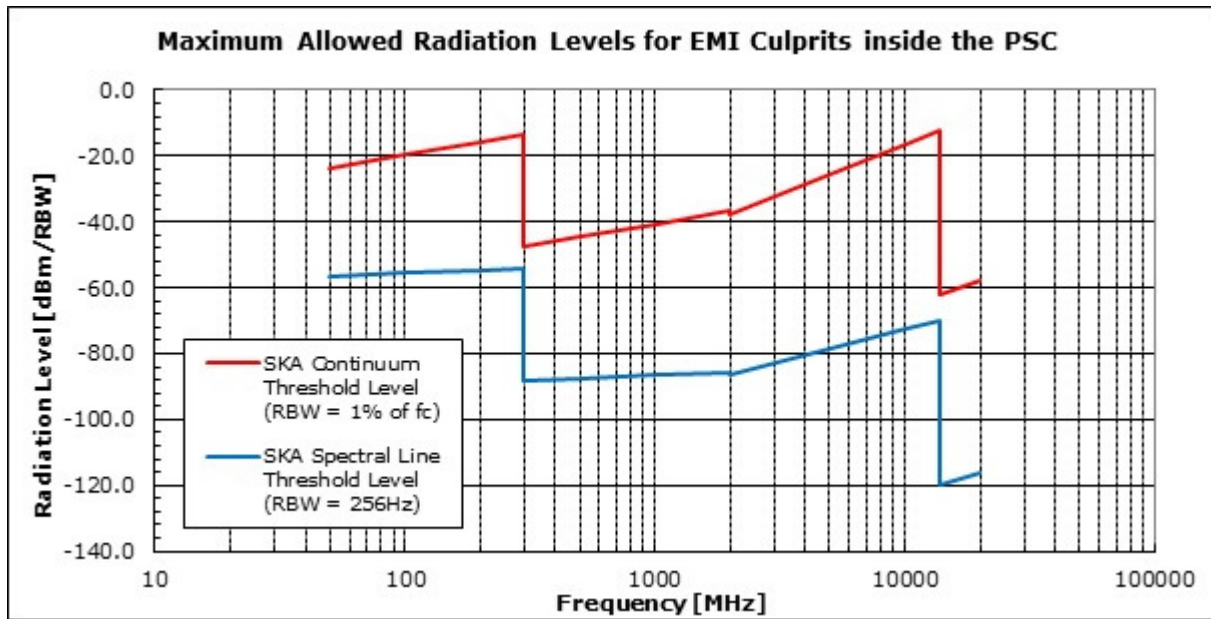


Figure 12 Maximum Allowed Radiation Levels for EMI Culprits inside the PSC

Req. ID	Name & Description	Refines
R.LMC.RFI.2	<p>Maximum Allowed Pulsed Radiation Levels for LMC Components inside the PSC</p> <p>LMC components mounted inside the PSC shall not radiate pulsed EMI within any continuous period of 600 seconds above the Pulsed Threshold level depicted below and with RBW defined as:</p> <ol style="list-style-type: none"> 1) 50MHz to 1GHz measured in a RBW of 120kHz using peak envelope detection, and 2) 1GHz to 20GHz measured in a RBW of 1MHz using peak envelope detection. 	R.D.RFI.4, R.D.RFI.5

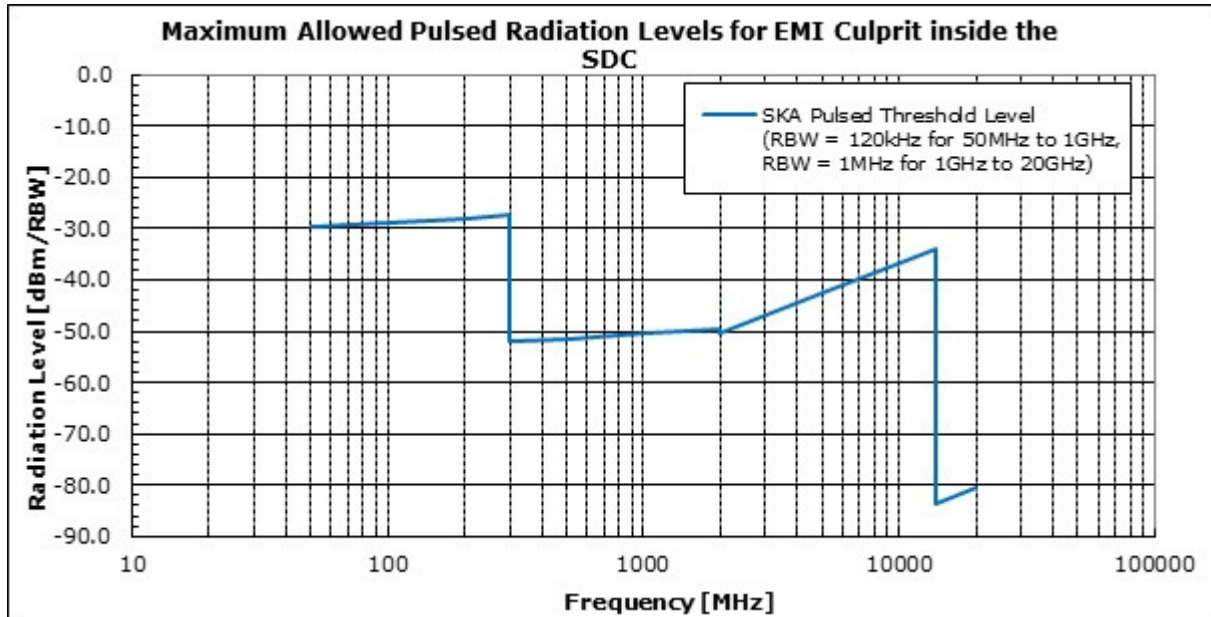


Figure 13 Maximum Allowed Pulsed Radiation Levels for EMI Culprits inside the PSC

3.3.4 Transportation

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ET.1	LMC Transportation All SRUs and LRUs shall be packaged for <i>Transportation Conditions</i> to prevent incurring any residual damage.	R.D.ET.1

3.3.5 Storage

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ES.1	LMC Storage All LRU's and SRU's shall be packaged for <i>Storage Conditions</i> , without incurring any damage, for a period of at least 2 years.	R.D.ES.1, R.D.RM.41

3.4 Physical Characteristics

This section is not applicable.

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.I.1	Mechanical Characteristics of the LMC Components mounted to DS The LMC components mounted to DS shall have the mechanical characteristics as defined in SKA-TEL-DSH-0000056 section "Mechanical".	Design Decision
R.LMC.I.2	Interconnection Characteristics of the LMC Power Connectors and Grounding terminals The power and ground connections of LMC components shall have the interconnection characteristics as defined in SKA-TEL-DSH-0000056 section "Interconnections".	Design Decision

3.5 Human Factors

This section is not applicable

3.5.1 Ingress and Egress

This section is not applicable

3.6 Integrated Logistics Support

A Support System shall be developed to maintain and support the SKA1-Mid Dish utilising the SKA1-Mid Dish Support Concept [SKA-TEL-DSH-0000004] as input.

3.6.1 Reliability, Availability and Maintainability

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.R AM.1	LMC Deployed Lifetime The LMC shall have a minimum Deployed Lifetime of 50 years.	R.D.RA.1
R.LMC.ILS.R AM.2	LMC MTBM The Dish LMC shall have a Mean Time Between Maintenance of more than TBD hours.	R.D.RA.3, R.D.RA.4
R.LMC.ILS.R AM.3	LMC MMDT The Dish LMC shall have a Mean Maintenance Down-Time of less than 0.5 hours	R.D.RA.3, R.D.RA.4

3.6.2 Repair & Replacement

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.R R.1	LMC ILM repair Items identified as ILM Spare Items, shall require a minimum of tuning, calibration, aligning or other actions. Where alignment, calibration or tuning is required, a deterministic procedure for such actions shall be contained in the support publications.	R.D.RM.27
R.LMC.ILS.R R.2	LMC Access Equipment shall be designed to use standard tools for accessing, removing and replacing the items, and access to equipment and components that require specialised tools shall be minimised.	R.D.RM.1, R.D.RM.20
R.LMC.ILS.R R.4	LMC component removal Modules and components shall be mounted such that removal of any single item will not require the removal of other items (component stacking to be avoided where possible)	R.D.RM.4
R.LMC.ILS.R R.5	LMC Maintenance provisions Repairable items shall be designed to include maintenance provisions such as test points, accessibility, and plug-in components.	R.D.RM.11
R.LMC.ILS.R R.6	LMC Modular design LMC components shall be designed modular to enable easy removal and replacement of faulty line replaceable units.	R.D.RM.14
R.LMC.ILS.R R.7	LMC module mounting guides Mounting guides and location pins shall be provided to facilitate module mounting.	R.D.RM.16
R.LMC.ILS.R R.8	LMC mounting preclusion Provisions for the preclusion of mounting the wrong module shall be provided (key coding of connectors etc.).	R.D.RM.10
R.LMC.ILS.R R.9	LMC OLM interchangeability Items identified as OLM Spare Items, shall be interchangeable with items of the same Part Number and Version with no calibration, tuning or special alignment.	R.D.RM.26
R.LMC.ILS.R R.10	LMC secure mounting of modules Modules shall be securely mounted (in compliance with the shock and vibration requirements) with the minimum number of fasteners.	R.D.RM.17

Req. ID	Name & Description	Refines
R.LMC.ILS.R R.11	LMC stand-off and handles Stand-offs and handles shall be used to protect system components from damage during shop maintenance.	R.D.RM.19

3.6.3 Product Marking

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.P M.1	LMC Cable Identification All Cables/Harnesses and their connectors shall be labelled to allow identification while the Cables/Harnesses is installed.	R.D.RM.3
R.LMC.ILS.P M.2	LMC Connector Labelling All component mounted connectors shall be labelled to allow identification during installation and maintenance of the Equipment.	R.D.RM.5
R.LMC.ILS.P M.3	LMC Controls Labelling Switches and controls used by operators or technical personnel shall have their functions clearly marked in the English language.	R.D.RM.29
R.LMC.ILS.P M.4	LMC Disposable item labelling Disposable line replaceable units should be labelled as such.	R.D.RM.6
R.LMC.ILS.P M.5	LMC equipment damage warnings In cases where special handling is required to prevent damage to Items (e.g. electrostatic discharge), such items shall be clearly marked with warning labels.	R.D.RM.30
R.LMC.ILS.P M.6	LMC Hazard Labelling Equipment that, when improperly operated or handled, may jeopardise the safety of personnel or result in a hazardous situation, shall be clearly marked to such effect.	R.D.RM.28
R.LMC.ILS.P M.7	LMC Label content Modules shall be labelled with the following information: - Product Supplier Name - Product Name (Supplied by SE for fabricated or subcontracted items) - Product Part Number (Supplied by SE for fabricated or subcontracted items) - Product Version (Supplied by SE for fabricated or subcontracted items) - Product Serial Number - Electronically readable code (bar code), containing all the above information.	R.D.RM.7, R.D.RM.8, R.D.RM.13
R.LMC.ILS.P M.8	LMC label robustness Product Markings shall withstand all environments and conditions to which the item will be subjected. Product Markings shall be waterproof and not detach or become unreadable with repeated handling.	R.D.RM.9, R.D.RM.13
R.LMC.ILS.P M.9	LMC module label visibility Product Markings shall be clearly visible when the Item is installed.	R.D.RM.15

3.6.4 ILS Publications

3.6.4.1 Manufacturing Data Packs

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.D OC.1	LMC Datapack - As-Built data As part of the Manufacturing Data Pack, As-Built Data shall be provided as part of the Manufacturing Data Pack. As-Built Data is considered to be Item identification, Item Data Sheets, Item Supplier Data, Assembly Drawings, Manufacturing Drawings and Parts Lists as applicable.	R.D.RM.32

Req. ID	Name & Description	Refines
R.LMC.ILS.D OC.2	<p>LMC Datapack - Design Data</p> <p>As part of the Manufacturing Data Pack, Design Data shall be provided as part of the Manufacturing Data Pack. Design Data is considered to be Requirement Specifications, Architecture Description Documents, Interface Control Documents, Qualification Test Procedures and Results and Acceptance Test Procedures and Results.</p>	R.D.RM.31

3.6.4.2 Support Publications

This section is not applicable

3.6.5 Training

This section is not applicable

3.6.6 Supply Support

This section is not applicable

3.6.7 Packaging, Handling & Transportation

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.P. 1	<p>LMC Carrying handles</p> <p>Packaged LRU's and SRU's with a mass of more than 15kg and less than 40kg shall have carrying handles.</p>	R.D.RPA.6
R.LMC.ILS.P. 2	<p>LMC Package labelling</p> <p>The packaging of all line replaceable units (LRUs) shall be labelled, with the following information:</p> <ul style="list-style-type: none"> - Item Name (from Config Management System) (fabricated or subcontracted items only) - Item Part Number and Version (from Config Management System) (fabricated or subcontracted items only) - Item serial number (where applicable) (shall be able to update this for the relevant unit) - LRU/SRU supplier part number (where applicable) - LRU/SRU supplier identification (where applicable) - Electronically scannable label (Bar Code) - Packaged weight - Container stackability (where applicable) - Preservation date (where applicable) - Shelf life (where applicable) 	R.D.RPA.1
R.LMC.ILS.P. 3	<p>LMC Package markings</p> <p>Packaged LRU's and SRU's shall have the following markings securely attached on the outside of the packaging container:</p> <ol style="list-style-type: none"> a) Mode of transport "careful transportation" b) "This side up" label c) "Fork lift here" label, where applicable d) Centre of gravity marking, where applicable e) Packaged Item Identification plate, with identification data completed, as specified in the "Package Labelling" requirement f) Where applicable, tamper proof labels for "wrong way up" and "excessive acceleration" g) ESD warnings where applicable 	R.D.RPA.5
R.LMC.ILS.P. 4	<p>LMC Packaging for periodic maintenance items</p> <p>Packaged LRU's and SRU's that require periodic maintenance during storage shall be packaged in red-coloured containers.</p>	R.D.RPA.4
R.LMC.ILS.P. 7	<p>LMC Packaging size considerations</p> <p>Packaging sizes shall consider standard vehicle transportation as well as entry constraints imposed by doors and corridors.</p>	R.D.RPA.9

Req. ID	Name & Description	Refines
R.LMC.ILS.P.8	LMC supply of packaging Packaging for Spare LRU's and SRU's shall be provided by the supplier of the LRU's and SRU's.	R.D.RPA.2

3.6.8 Equipment

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.ST E.3	LMC Self-test LMC shall identify all internal faults down to LRU level as defined through the LSA process.	R.D.RM.18
R.LMC.ILS.ST E.4	LMC Test equipment calibration interval Test and support equipment shall not require re-calibration in periods shorter than 12 months.	R.D.RM.39

3.6.9 Facilities

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.ILS.SF .1	LMC Support Facilities analysis Requirements for maintenance & storage facilities at all levels of repair shall be identified through an LSA process using modelling/simulation.	R.D.RM.40, R.D.RM.41

3.7 Product Assurance

3.7.1 Standardisation

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.PD.2	LMC Standard Fasteners LMC mechanical fasteners shall have standard metric size and screw thread.	R.D.RPR.2

3.7.2 Workmanship

This section is not applicable

3.7.3 Safety and Security

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.LPS.1	LMC Galvanic connection - Equipment mounted inside Shielded drive compartment LMC equipment mounted inside the shielded drive compartment shall ensure galvanic connection in accordance to IEC62305 LPL III and with resistance of less than 10 milliohm between the equipment chassis and the lightning protection earth interface provided by the DS.	R.D.LPS.2
R.LMC.LPS.2	Lighting Protection Zone to be maintained by LMC The LMC components shall maintain in accordance to IEC62305 LPL III, the LPZ it is located in by DS, as defined in SKA-TEL-DSH-0000056 section "Lightning Protection".	R.D.LPS.4
R.LMC.LPS.3	Lighting Protection Zone to be extended by LMC The LMC components shall extend on all interfaces in accordance to IEC62305 LPL III, the LPZ provided by DS on the power interface, as defined in SKA-TEL-DSH-0000056 section "Lightning Protection".	R.D.LPS.4

Req. ID	Name & Description	Refines
R.LMC.SAF.2	LMC Locally fail-safe The LMC shall be designed to be locally fail-safe and not be dependent on any external inputs from TM for safety.	R.I.TM.16
R.LMC.SAF.3	LMC LRU electrostatic warnings All LRUs with electrostatic sensitive components shall be fitted with ESD warning labels.	R.D.SS.14
R.LMC.SAF.4	LMC Protection Against Electric Shock The LMC components shall provide protection against electrical shock in accordance to SANS 61140.	R.D.SS.3

3.7.4 Design Methods

This Section is Not Applicable.

3.8 Design Constraints

The requirements are specified below:

Req. ID	Name & Description	Refines
R.LMC.PW.1	LMC MID Power consumption The LMC power consumption per Mid Dish shall not exceed the allocated values as defined in SKA-TEL-DSH-000041 (SKA1 Dishes Element Power Budget) when operating at full performance under the <i>Operating Conditions for equipment located inside pedestal</i> .	R.D.DC.2
R.LMC.PW.3	LMC Total Harmonic Distortion (Current) contribution The LMC components shall not induce Total Harmonic Distortion (Current) onto the electrical supply that exceed the levels defined in SKA-TEL-DSH-000041 section "Single Phase UPS Power Characteristics".	R.I.INFRA.M.1 4
R.LMC.PW.4	LMC Induced Heat Loads The LMC components shall not induce heat loads that exceed the levels as defined in SKA-TEL-DSH-000041 section "Power Budget - SKA1 MID".	Design Decision

3.9 Precedence and Criticality of Requirements

This Section is Not Applicable.

3.10 Characteristics of Subordinate Elements

This Section is Not Applicable.

4 VERIFICATION

This section is TBD.



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