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| MPS Requirements on LPSRF |
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# Issuing Organisation

Integrated Control Systems - Machine Protection and Personnel Safety Systems Group

# Scope

The scope of this document is to define the requirements imposed on the Local Protection for Radio Frequency (LPSRF) System by Machine Protection. The requirements are needed in order to implement Protection Functions depending information from LPSRF [1], [2].

By LPSRF we are referring the local protection system for the systems needed to supply RF (RF Transmitters) to the cavities below:

352.21 Hz cavities

* 1 RFQ
* 5 DTL
* 3 MEBT

704.42 Hz cavities

* 36 Medium beta
* 84 High beta

OBS! The RF Transmitters for the 26 Spokes Cavities will be protected by a separate Protection System

# Context

To reach the ESS Machine Protection goals, Protection Functions with certain requirements have to be implemented [3]. LPSRF have been assigned the responsibity to protect the RF transmitter locally, see Figure 1. If LPSRF is not in a mode where it is able to protect the RF trasmitter or any off nominal states are detected BIS shall be informed, see Figure 2. For more information about how LPSRF works and which PF that are implemented refer to [4].



Figure 1: Schematics of the signals used by LPSRF for one Transmitter



Figure 2: Simplified overview of the signals sent from LPSRF to BIS

# Requirements

## Beam Permit Requirements

| Id | Text |
| --- | --- |
| MP-RF-REQ-1 | Each LPSRF (for each RF transmitter) shall transmit a Beam Permit to BIS. |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | If the Mode of LPSRF is RFON and no off nominal states are detected the status of the BP shall be OK. Otherwise it shall be NOK. |
| Latency | Max 10 μs (from detection to change of the Beam Permit status sent to BIS) |
| PIL | The function shall comply with Protection Integrity Level (PIL) 2 requirements. |

## General Machine Protection Requirements Applied to LPSRF

| Id | Text |
| --- | --- |
| MP-RF-REQ-2 | The LPSRFs shall provide its HEALTH status to BIS. |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | Internal health |
| Latency | 100-200 μs |
| PIL | - |
| example | Assumption: The LPSRF electronics have some kind of self-diagnosis function. If an internal error is detected by the LPSRF (LPSRFs, LPSRF Processing Board, cabling aso.) the Beam Interlock System shall be informed. |

| Id | Text |
| --- | --- |
| MP-RF-REQ-3 | The LPSRF shall implement configurable off nominal state detection ALGORITHMs. The ALGORITHMs shall be readable and writeable by external systems.  |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | Setting thresholds, reading thresholds… |
| Latency | - |
| PIL | - |
| Off nominal | a state that can lead to damage or activation of the machine |
| ALGORITHM | the logic used to detect off nominal states |
| example | It shall be possible to thresholds and interlock levels. |

| Id | Text |
| --- | --- |
| MP-RF-REQ-4 | The LPSRF shall be able to allow configuration of the status of signals sent to BIS (BEAM PERMIT) by changing the PROTECTION MODE. |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | It shall be possible to set the BEAM PERMIT signal status according to ALG, OK or NOK. Where ALG corresponds to the off nominal state detection ALGORITHM, OK to “current” and NOK to “no current”. |
| Latency | - |
| PIL | - |
| example | This will be used for testing of the BIS, masking, commissioning or degraded states. |

| Id | Text |
| --- | --- |
| MP-RF-REQ-5 | The LPSRF shall implement a configurable LATCH MODE for the signal sent to BIS (BEAM PERMIT). |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | Changing LATCH MODE |
| Latency | - |
| PIL | - |
| LATCH MODE:YES | BEAM PERMIT shall stay in the NOK state until a RESET command is received. |
| LATCH MODE:NO | BEAM PERMIT shall automatically transition from the NOK state to the OK state when no off nominal states are detected. |

| Id | Text |
| --- | --- |
| MP-RF-REQ-6 | The LPSRF shall have a MP-DATALOG readable by external systems. The time and reason for all off nominal state transitions shall be stored in the MP-DATALOG. |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | The time and reason for all transitions to BEAM PERMIT: NOK shall be logged. (Archiving) |
| Latency | - |
| PIL | - |

| Id | Text |
| --- | --- |
| MP-RF-REQ-7 | The LPSRF shall be able to provide its current firmware version to BIS. |
| Resolution | - |
| Interface | Refer to [4] |
| Signal | Firmware version |
| Latency | 100-200 μs |
| PIL | - |
| comment | The firmware version is needed to be able to detect changes and possible function changes that are relevant for protection integrity. |

# Summary

The functional and signal requirements on Local Protection for RF related to Machine Protection have been defined in this document (MP-RF-REQ-1 to MP-RF-REQ-7). The interfaces through which the required information will be transmitted are described in [4].

# Glossary

| Term | Definition |
| --- | --- |
| LPSRF  | Local Protection for Radio Frequency |
| BIS | Beam Interlock System |
| PIL | Protection Integrity Level |
| PF | Protection Function |
| OPF | Overall Protection Function |
|  |  |

# References

1. Machine Protection Risk Management Process (ESS-0086476)
2. Protection Functions for LPSRFs (ESS-00XXXXX)
3. Machine Protection - Systems requirements and architectural framework (ESS-0057251)
4. Machine Protection – LPSRF Interface Control Document (ESS-00XXXXX)
5. I. Dolenc Kittelmann, T. Shea, 2016. SIMULATIONS AND DETECTOR TECHNOLOGIES FOR THE BEAM LOSS MONITORING SYSTEM AT THE ESS LINAC. Proceedings of HB2016, THAM6Y01, Malmö, Sweden

Document Revision history

| Revision | Reason for and description of change | Author | Date |
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| 1 | First issue | Szandra Kövecses | 2017-06-22 |
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