GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

SPECIFICATION
OF
MICROPROCESSOR BASED CONTROL AND FAULT DIAGNOSTIC SYSTEM
WITH REMOTE MONITORING AND ANALYSIS FEATURE (EX-MPCS)
FOR
25 KV AC ELECTRIC LOCOMOTIVE
SPECIFICATION No. RDSO/2013/EL/SPEC/0001/ Rev. ‘3’
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## Status of Revision

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1. INTRODUCTION

Tap changer electric locomotives working on Indian Railways are provided with control based on electromechanical and Electro-pneumatic relays/ contactors. Microprocessor-based control system (MPCS) was provided in the existing electric locomotives as per specification no. ELRS/SPEC/MPC-FDS/0001 Rev. ‘2’. Although benefits such as improvement of reliability of locomotives has been reaped, but issues like real-time monitoring of locomotives to provide assistance to crew as well as locomotives are yet to be addressed.

For improving the utilization of locomotives, its unscheduled withdrawal from traffic, working of safety equipment, prevention of accident like situation, such as signal passing at danger (SPAD), etc, real-time monitoring of locomotives is required at Electric Loco Sheds and Traction Loco Controllers. This will help in taking corrective action at right opportunity, in the event of UOR, before it can convert into major failure, disrupting the traffic. Such real-time monitoring of locomotives will involve decision making at appropriate level of expertise, thereby, achieving above objectives.

This version of specification is for MPCS with extended features of in built VCD, real time remote monitoring, measurement of safety parameters like brake pipe and brake cylinder pressures.

2. Definitions:

2.1 The System: exMPCS, which includes the complete system of MPCS, in built VCD, real time remote monitoring, including cables, sensors, interface, software, etc.

2.2 Data: Locomotive health data from MPCS, signal from pulse generator of ESMON, status of working of VCD, self-processed data (such as, speed, energy, specific energy consumption, etc.), GPS, time stamp and BP & BC pressure data and any other parameter. Data are broadly classified into Vital Data, UOR and Configuration data.

2.3 Display: The format in which the data is displayed in Loco Sheds, TLC and on its website. The format is decided by Indian Railways.

2.4 Cab Display: It is display provided in the both the cabs of the locomotive – displaying information/data and is also interactive. The format is decided by Indian Railways.

2.5 Website: The only website, which is hosted by Railways, where data from all the vendors can be made available. Loco number is the link to the server of respective vendors.
2.6 Server: Two types of Servers: First one is web application server of exMPCS's web portal developed and maintained by IR. Second type of Servers are Vendor Servers, with memory is vendor specific, which is to be maintained by the vendor for a minimum period of five years. The system sends data to the respective server, which is be linked to the display of EXMPCS's web portal through loco number.

2.7 Communication: Protocol, software, hardware, such as SIM card, including rental & data transmission charges etc. are included in communication.

2.8 UOR: These are basically fault data of locomotives from MPCS, isolation of VCD, penalty brake application, any other data, which is not related with normal working of locomotive. These will be real time when it occurs. UOR includes failure of exMPCS and non-availability of network connectivity.

2.9 Vital Data: Speed, status of VCD, GPS locations, time, BP and BC pressure, etc as decided by IR. The format is decided by Indian Railways.

2.10 Background data: It is snapshot the status of various signals taken before and after fault occurrence as given in this spec.

2.11 Configuration Data: It is vital parameters of the locomotives, which are pre-set for reliable and safe working of locomotives. This data is locomotive class specific.

3. Functional Requirement:
All Tap changer based electric locomotives with MPCS are being provided with ESMON and VCD. The exMPCS system has got MPCS, in-built VCD, integrator for ESMON, measurement of BP and BC pressure, cab display with enhanced features, real-time remote data transfer facility, associated software, data management, web application servers and vendor servers, etc. The system is required to meet our objective of real time monitoring of locomotives. This made us to design, development and manufacturing of "Microprocessor based control and fault diagnostic system with remote monitoring and analysis feature (EX-MPCS)" for Electric Locomotives which can function in following manner to fulfill the requirement:

3.1 To reduce the number of electromagnetic relays and interlocks by providing software based control logic.

3.2 To provide the fault information in text form, status of various interlocks and input command switches and notch position with Traction/braking indication in the 10.4 inch TFT display on the driver's desk in both cabs.

3.3 To provide in-built VCD function.

3.4 To provide configurable parameters settings through Laptop by an authorized person with adequate password protection.

3.5 Self test feature for working of the complete system, including Digital inputs, Outputs, whenever the battery is switched ON.

3.6 To download fault data to PC/Laptop and provide for report generation, Job cards, different charts & graphs and Fault data stored in Excel file. The format of the report is decided by Indian Railways. No interface is required in between the system and Laptop for data handling/software downloading.
3.7 To provide USB 2.0 slot for interface to existing system for event & fault data recording in pen drive.

3.8 Provision for User Defined display screen selected parameters.

3.9 Provision for Locomotive Remote monitoring and analysis system through internet.

3.10 To provide interface with ESMON to take data like Voltage, Current, Speed, Time and other parameters, Date and Time should be updated through GPS, etc of the Locomotive and record it for remote monitoring.

3.11 To provide pressure sensors for Brake Pipe and Brake Cylinder for their measurement and interface with the control unit for real-time monitoring.

3.12 To interface with existing pulse generators provided in locomotives for display of speed. Pulse generator (PG) data has to pre-configured in the system by the shed.

3.13 Vital data is required to be captured every second and will be transmitted at an interval not more than five seconds. Whenever UOR is transmitted, it will be associated with standard background data of MPCS.

3.14 Configuration data will be held in the system and transmitted to the system’s web portal as and when there is request from user. But this data shall be stored in the system for 24 hours an interval of 30 minutes, whenever battery is switched ON, VCB is closed or opened, BL is activated in cab 1 or cab 2.

3.15 Configuration data shall be transferred from the microprocessor control system to the IR’s web portal as and when there is request from the user or whenever the battery is switched ON.

3.16 All the data shall be made available with GPS location and timestamping.

3.17 The firm supplying the system has to create facilities such as server, memory space, communication devices & support for a minimum period of 5 years from the date of commissioning.

3.18 Real time data has to be displayed in Electric Loco Sheds and Traction Loco Controllers through Internet. The same can be accessed by any authorized person by logging onto exMPCS’s web portal.

3.19 In case of problem with GPS signals, the system shall display last GPS locations. On availability of signals, it will update automatically.

4. Contractor’s Responsibility

The contractor's responsibility will extend to the following:

4.1 Supply of detailed instructions for proper installation of the equipment on the locomotives. For this purpose, the supplier shall depute his engineers/supervisors to CLW/Sheds/workshops for installation of the equipment on locomotive. However cabling is to be done by railways.

4.2 Commissioning of the equipment in service and depute team of engineers/supervisors for this purpose.
4.3 Provide required instrumentation and carry out detailed tests and field trials jointly with RDSO/CLW.

4.4 Provide special tools and instruments separately which may be required for maintenance.

4.5 Details of input & output and corresponding locomotive cable numbers will be provided by RDSO/CLW and the same should be incorporated in manual supplied by the firm.

4.6 Supply the user’s manual for maintenance and trouble shooting.

5. Scope of Supply:
This specification covers design, development, manufacturing, testing and supply of Microprocessor based control and fault diagnostic system with remote monitoring and analysis (exMPCS) for use in 25 kV Electric locomotives. Quantity per locomotive is one set. The detail is given under Chapter IV.

6. Training:
The supplier shall arrange training of Indian Railway personnel at various loco sheds and training schools regarding maintenance & trouble shooting of the system supplied. Training will be provided in maintenance & trouble shooting aspects and the supplier will provide detailed technical write-up to all the trainees.

The supplier shall provide training on display of the system to Traction Loco Controllers and other IR personnel as decided by IR.

7. Warranty:

7.1 The supplier will maintain the system for 60 months after successful installation and field trial. He will keep necessary spares at the shed homing these locomotives during the period of warranty. Firm shall arrange rectification / modification / replacement of failed components / part of the equipment free of cost during this period. Further, should any design modification is required to be made in any part of the equipment, the period of 60 months will commence from the date when the modified part is commissioned.

7.2 The supplier shall be responsible for carrying out improvements and modifications at his own expense on all the equipments during the period of warranty provided such modifications/improvements are decided to be necessary for meeting the requirements of reliability, performance and safety etc, jointly between contractor and purchaser.

7.3 The firm is required to give root cause analysis of all the failures and their corrective actions. In case of any modification ( hardware and software) , the necessary approval shall be obtained from RDSO.
7.4 For the purpose of technical decisions on improvements/modifications etc. on equipment, the final authority from the purchaser's side will be RDSO.

8. **APPROVAL FOR DESIGN:**
The design shall be developed based on the requirements given in this specification and sound engineering practice. The entire design of the system shall be supplied by the tenderer with required technical data and calculations to RDSO/CLW for approval before commencing the manufacturing. This includes hardware and software logic in terms of flow chart.

9. **DOCUMENTATION:**
The firm shall submit following information also for the design approval in printed form and digital format and compiled in a booklet.

9.1 Schematic Circuit
9.2 Functional Description
9.3 System design concept including protection schemes – both electrical and mechanical.
9.4 Implementation of Control Circuit Logic in the form of Flow Chart
9.5 Detailed description of mounting/cables/connectors/connection diagrams of each system/sub-system which are to be interfaced with locomotives
9.6 Complete Bill of Material along with vendor details.
9.7 Modifications needed in the present locomotive to accommodate the offered system
9.8 Clause by clause compliance of this specification.
9.9 Details of technical support and training offered
9.10 Detailed recommended list of spares with cost for 5 year maintenance after warranty
9.11 List of special tools, jigs and fixtures needed for assembly, testing, commissioning, maintenance and repair of the system.
9.12 Mechanical drawings of complete cubicles as well as Major subassemblies / Rack with details of dimensions, mounting arrangement and weight, which are required to be taken out for maintenance. Details of mounting accessories shall also be provided. Protection against dust and water ingress shall be explicitly shown.
9.13 Details of infrastructure, manufacturing and testing and service engineering activities in line with guidelines issued
9.14 Approval of design means the approval of general design features. Notwithstanding the approval, the supplier will be wholly responsible for the performance and reliability of the complete system.
10. **Methodology of Development:**

10.1 **Design and Prototype Development**

10.1.1 Design, development and manufacturing of EX-MPCS will be as per this Specification.

10.1.2 Successful bidder shall offer the design of EX-MPCS unit along with remote communication conditions to RDSO.

10.1.3 Manufacturer will have to submit Bill of Material also to RDSO.

10.1.4 Approval of design of the system.

10.1.5 Approval on all types of User Interface ; data to be displayed , fault messages ,System Configuration Data Input.

10.1.6 Prototype testing of EX-MPCS unit.

10.1.7 Fitment of EX-MPCS unit for fitment trial to validate the design.

10.1.8 Field trial of 10 units for each vendor for 6 months in actual service.

10.1.9 Protocol of Prototype testing, field trials and remote communication test shall be jointly decided in consultation with RDSO.

10.1.10 Data and the format of data to be transmitted shall be jointly decided by RDSO and the bidders , which can be modified based on the Operating and Maintenance Needs.

10.2 **FIELD TRIALS:**

After successful completion of type tests, the equipments (ten numbers) shall be subjected to field service trials for a minimum period of six months and minimum 70000 Km of service. The ten numbers of trial equipments and venue shall be as agreed between the purchaser and the supplier. Locomotives provided with all ten systems on field trail locomotives shall be preferably based at one loco shed for the ease of monitoring and after sales support.

In this specification , basic MPCS is the same as per Rev.2 and additional features of real time remote monitoring , BP & BC pressure measurement ,etc. have been added. Other changes are related to minor changes in software. These changes can be tested during type tests and doesn’t require extensive field trial as mentioned above. Hence , all those vendors , who are already approved sources ( Part I and Part II) of RDSO for this item as per Rev.2 of this spec and have atleast ten numbers of units with Rev.2 ,already worked in the field for a minimum period of six months, are not required to undergo above field trials.

However, this field trial will remain applicable to all new firm applying for the fresh registration and souces under development.
11. IMPORTANT DOCUMENTS REFERRED IN THIS SPECIFICATION

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<tr>
<td>1.</td>
<td>IEC-60571 Ed - 3.0 2012-09 or latest</td>
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<td>General requirements and tests for electronic equipment used on Rail vehicles.</td>
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<td>2.</td>
<td>IEC-60077 Ed-1 or latest</td>
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<td>Railway applications – electric equipment for rolling stock</td>
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<td>IEC-60529Ed 2.1 2001-02 or latest</td>
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<td>Electromagnetic compatibility for industrial process measurement and control equipment.</td>
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<td>5.</td>
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<td>For Random Vibration and shock test for electric equipment for rolling stock</td>
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<td>CLW drawings / circuit diagram of tap changer locos for WAG7, WAM4, WAG5 &amp; WAP4. Latest</td>
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<td>ELRS/SPEC/SI/0015 OCT '2001 or Latest</td>
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<td>Reliability of electronics used in rolling stock application</td>
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<td>8.</td>
<td>ELRS/SPEC/SP M/0002 (REV.2) Jun – 2004 or latest</td>
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<td>Specification for microprocessor based electronic speed cum energy monitoring system for electric locomotives</td>
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<td>9.</td>
<td>RDSO/2012/EL/T C/0119 Rev ‘1’ dated xx.xx.xx or latest</td>
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<td>Detailed data document for EX-MPCS for electric locomotive.</td>
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<td>10.</td>
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<td>Specifications for Illuminated push button/push button switches.</td>
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<td>Specifications for Buzzer</td>
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<td>Specifications for Connector</td>
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12. INFRINGEMENT OF PATENT RIGHTS:
Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components used in design, development and manufacturing of MPCS and any other factor not
mentioned here in which may cause such a dispute. The entire responsibility to settle any such dispute/matters lies with the manufacturer/supplier.

Details/design/documents given by the vendors are not infringing any IPR and they are responsible in absolute and full measures instead of Indian Railways for any such violations. Data specifications and other IP as generated out of interactions with Indian Railways shall not be unilaterally used without consent of RDSO and right of Indian railways/RDSO on such IP is acceptable to them.
CHAPTER II

TECHNICAL DETAILS

1. System Requirements

The system shall have features of self test, diagnostics and corrective actions, built in the design to ensure the reliability and safety level required to run the loco with such electronic equipment. Each Unit of the EX-MPCS will comprise of the following:

2. CPU CARD

2.1. Two CPU cards each consisting higher end microprocessor/microcontroller and necessary hardware shall be provided for 100% redundancy provision to avoid single fault that may lead to vehicle failure.

2.2. Failure of one processor card shall be detected by the system & change shall happen on healthy control card. Working CPU should become stand by CPU after every DJ trip and vice-versa. It shall be made sure that at no point of time both CPU cards become master. Failure of one CPU card should not affect the functioning and performance of the system in any form.

3. POWERSUPPLY CARD

It should have two power supply cards one should be working normally and other should be hot stand by as a redundancy.

4. INPUT CARDS:

4.1. Provision shall be made for min 144 digital inputs. Number of inputs per card shall be selected in such a way that their performance shall not get affected. The input cards should be interchangeable in between input slot for a given make. The input sensing voltage for high state should be 60 ± 1V DC. LED indication for each input should be provided on the facia of the cards with green colour for 110 volt side and red colour for 5 volt side.

4.2. Redundancy of important inputs should be provided through individual channel of Redundant (RDT) card. The input signals fed to RDT card shall be from the same connector which is nominated for the input cards, in normal service, within the system. There shall be just one connection for one input signal to the system. When main input channel becomes defective in the main card, the system can perform this logic with corresponding input channel of RDT card. In this regard, a fault message “main channel input no. l-xx. fail” will be displayed in the cab display unit. The event of main channel failure should be stored in fault data log. No paralleling of input is allowed.

4.3. Each input shall be galvinically isolated from locomotive circuits. Necessary surge/reverse polarity protections shall be provided. Designation of input signals in input cards in the system should be as per RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest. This TC also covers list of important inputs.
5. **OUTPUT CARDS:**

5.1. Output cards should be capable of outputting at least min 80 binary outputs with suitable Opto isolation to drive transistors which operate the contactors at nominal 110V dc. Number of outputs per card shall be selected in such a way that their performance shall not get affected. The output cards should be interchangeable in between output slot. LED indication for each output should be provided on the facia of the cards with green colour for 110 volt side and red colour for 5 volt side.

5.2. Necessary surge/spikes protection for the output transistors shall also be provided. Short circuit protection to be provided for each output. Output channel shall have the feature of auto-recovery. Output shall turn off whenever a short circuit is detected.

5.3. In case there is a short on load side, suitable fault message along with possible action by the crew shall be displayed in the cab display. After isolation of the faulty equipment, normal operation of the locomotive shall continue with isolated equipment.

5.4. In case there is a short in the output card channel, such as MOSFET short or FW diode short, etc., this channel shall be isolated without affecting the working of the other channels. Status indications of each output shall be available on display individually.

5.5. All the important output signals shall be grouped in one or two output cards. In case of short circuit in any of the channel of these output cards, respective output card shall be isolated with appropriate fault message and Redundant (RDT) output card shall take over the functions of the defective isolated card. Connections for the vital outputs shall be done accordingly so that there shall be an automatic switch over from defective card to redundant card. Simultaneous working of both the cards, i.e., main card and its redundant card are not allowed. After such isolation a fault message “main output card no. failed” in the cab display with suitable action for the crew.

5.6. Designation of output signals in output cards in the system should be as per RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest. This TC also covers list of important outputs.

6. **SIGNAL CONDITIONING UNIT:**

6.1. This unit should be used for monitoring/measuring auxiliary winding voltage, ARNO/SIV W phase voltage, TM voltage and Battery voltage. Interfacing of this unit to the main unit shall be through terminal strip at the loco side and polarised military grade bayonet type circular coupler with crimped pins shall be used at the equipment side.

6.2. A/D converters shall be suitably decoded and interfaced with the CPU cards. These inputs to A/D converter should be isolated from the locomotive circuits and protected against surges/spikes etc.

6.3. An extra redundant channel should be provided for auxiliary voltage measurement. This should be displayed separately on the display unit as well as separate terminals will be provided for same.

6.4. Two intelligent signal conditioning unit (ISCU) shall be provided in BA-1 and BA-2 panels for monitoring of TM currents (Traction and Braking). TM currents shall be monitored separately.
measured with Hall effect based non-contact type current sensors. These units will interface with main unit on serial link (RS 485).

6.5. Primary current shall be measured for calculation of energy consumed and other energy related parameters.

6.6. **Pressure Sensors and switches and associated cabling:**

   System comprises of installation of BP and BC pressure sensors and A9, SA9, horn operation pressure switches and associated cables to the main unit to prevent EMI/EMC. These sensors and switches shall be procured from RDSO/CLW Part I approved sources for Electric Locomotives.

6.7. The pulse from junction box of ESMON will be taken and speed and distance will be calculated by the MPCS. MPCS should have facility to input number of pulse per revolutions to take care of different makes of ESMON. The suitable method of receiving the pulse from ESMON may be decided in consultation with RDSO.

   MPCS may have RS485 serial interface with ESMON system also. Protocol of data transfer between ESMON & MPCS, if required will be decided in consultation with RDSO.

7. **VCD functionality:**

   VCD functionality shall be integrated inside Microprocessor based fault diagnostic system. It shall be multi-resettable and fail safe in nature. It shall reset by operation of the frequently operated control functions by the driver as defined in clause

   The function shall be based upon a number of time cycles, the periods of which are preset for any particular application. The system shall be designed to work on the normally energised principle and it is only active in the loco cab that is active, whether in single unit or master slave configuration. Main functions of the active vigilance system include:

   a) Vigilance/delay cycle
   b) Action cycle
   c) Audio-visual warning
   d) Emergency brake / brake cycle
   e) Emergency brake release
   f) Vigilance reset
   g) Vigilance suppression

7.1. **Vigilance cycle/Delay cycle:**

   The cycle has a preset period normally set at 60 seconds. This cycle is automatically restarted whenever the system detects that one of a number of external inputs is operated by the driver’s control from the active cab, the presence of which automatically infers that the driver has taken some positive action and is therefore vigilant.
a) The control functions include Notch-up / Notch-down by the master controller (MP) or EEC.
b) Operation of the sander, horn, Train Brake (A-9), Loco Brake (SA9), MPS operation.
c) Operation of the vigilance pedal (foot) switch available for driver or vigilance push button available for assistant drive.

In normal circumstances, the driver is periodically performing one of the above positive actions, the cycle shall be continually reset and shall never run to completion. Only if the driver fails to perform such an action within the cycle period, the cycle period shall be completed.

When such an event occurs, a second time cycle, i.e. action cycle shall be initiated and audible and visual warnings shall be given to the driver.

7.2. Action cycle:

This cycle is initiated whenever the delay cycle runs to completion indicating that no positive driver action has been detected for the length of the delay cycle period. During this cycle, system shall begin flashing an yellow flashing indication on Display Unit as well as indication lamp panel for a time period 8±2 seconds. If by the end of this period, an acknowledgement by crew has not been actuated, an audible alarm for a time period 8±2 seconds shall begin in addition to yellow flashing light. This period can also be reset any of the following actions:

a) by pressing ACK button on display unit of active cab only.
b) In order to maintain normal vehicle operation, the driver shall operate the Vigilance foot switch or push button or any other equipment, before the action cycle expires to prove positively that he has not become incapacitated.

Once reset in this manner, system operation reverts to the delay cycle and normal vehicle operation is maintained.

If for any reason, the action cycle expires without being reset, the brake cycle is initiated to make an automatic brake application. Expiry of action cycle should be recorded as a fault.

7.3. Brake Cycle:

The brake cycle is initiated if the driver fails to respond to the visual and audible warnings before the expiry of the action cycle. A brake application is immediately initiated. Vigilance unit initiates penalty brake, which remain applied for a period 32±2 seconds and cannot be reset once applied during this period. This ensures that the vehicle is brought to a complete standstill.

Penalty brake application is reset using the reset push button (to be provided on driver desk) after following conditions are met:

a) After the expiry of the brake cycle period 32±2 seconds
b) After the master controller has been set to the ‘0’ off position

Brakes are then released, the audible and visual warnings are cancelled and normal vehicle operation can be re-established.

7.4. Fault Cycle of VCD function:
The operation of the microprocessor based control system shall be continuously monitored by its own test routines. If at any time, a condition is detected which could lead to unsafe system operation, a brake application shall be immediately initiated and a fault indication shall be displayed by flashing red **bold** indication on Display unit. The fault cycle has a preset period normally set at 32 seconds during which period the brake application cannot be cancelled. Only after the expiry of the fault cycle can an attempt be made by the driver to reset the fault condition as described in Brake Cycle and resume normal locomotive operation.

### 7.5. VCD functions during Normal operation of MPCS:

I. **Cycle time (T0) of 60 seconds:** The crew has to acknowledge the device within T0 time by pressing vigilance foot switch available for driver or vigilance push button available for assistant driver or by operating any other defined as per para 7.2 of chapter II. If the acknowledgement is received from display unit, the vigilance cycle time (T0) starts again.

II. If the above acknowledgement is not received within T0 time, the system shall begin flashing an yellow indication in display unit as well as indication lamp panel for a time period (T1) Sec.

III. If by the end of period T1, an acknowledgement by the crew has not been actuated, the system shall actuate an audible alarm in driver cab for a time period (T2) sec. The flashing light shall also continue to flash during this period.

IV. If, by the end of period T2, an acknowledgement is not received, the system shall initiate penalty brake application, which shall continue for a period T3 seconds, even if a reset acknowledgement is received during this (T3) time period.

V. The audible warning shall continue during the T3 time period along with the flashing of warning indication in the display unit as in period T2.

VI. After time period T3, audible warning as well as warning flashing indication shall continue in T4 period until the VCD is reset by setting master controller to zero position and pressing reset push buttons provided at driver’s desk or ACK button on the display unit.

VII. At any time during the periods T0, T1 or T2 the VCD functionality may be reset to the beginning by any acknowledgement by the crew.

The time sequence of system operation mentioned above are summarised in the table below:

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<thead>
<tr>
<th>Operating cycles</th>
<th>Time periods (seconds)</th>
<th>Indications</th>
<th>Possibility to Reset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vigilance cycle (T0)</td>
<td>60±2</td>
<td>None</td>
<td>Yes</td>
</tr>
<tr>
<td>Warning cycle (T1) Level 1</td>
<td>8±2</td>
<td>Yellow flashing light</td>
<td>Yes</td>
</tr>
<tr>
<td>Warning cycle (T2) Level II</td>
<td>8±2</td>
<td>Yellow flashing light and alarm sound</td>
<td>Yes</td>
</tr>
</tbody>
</table>
7.6. VCD functions during condition other than Normal operation of MPCS:

7.6.1. Vigilance Suppression:

There shall be a provision to suppress the VCD functionality in microprocessor based control system when continuous proof of driver’s vigilance is not required. Such suppression shall be initiated by an external input to the system, derived from a vehicle speed sensor and from brake application. Brake application shall be sensed through operation of A9 or SA9 pressure. Vigilance suppression shall not function during the Fault cycles of VCD. The suppression of operation of the vigilance system shall be done in the following conditions:

a) Vehicle is stationary / speed is less than 2.0 kmph.
b) Vehicle is used in slave mode in MU operation
c) Brake application
d) Manual control of GR

7.6.2. Multiple Unit Operation:

The VCD functionality shall be disabled on a slave locomotive in multiple unit operation.

7.6.3. VCD function during Fault mode of operation:

a) Bypassing Arrangement:

A switch shall be provided through which VCD functionality can be bypassed in case the system becomes defective/malfunctions. Display message shall be provided to indicating bypass of VCD functionality by the driver in the bypass status message. The bypassing switch is placed with other isolating switch panel. Status of bypass switch is to be recorded by MPCS with time stamp and GPS locations.

b) Mismanagement by Crew:

The system shall have built in logic based on trailing edge counter principle for VCD functionality so that such inputs are not used for acknowledgement of control functions. In case vigilance push button or vigilance foot switch remains in pressed position for more than 60+/-2 seconds continuously either by driver or due to defect in push button/foot switch warning cycle and penalty brake cycle shall be initiated as per para 7.5 of chapter II. Such events shall be recorded in fault data.
8. **DISPLAY UNIT:**
Display unit shall function as an interface between operator and system. It shall have necessary keys for this purpose. The display unit should run from 110 V dc power available in the loco. Display unit shall have the following characteristics:-

a) Display shall be 10.4 inch TFT LCD type to achieve good readability for night time viewing. It should be robust enough suitable to locomotive application and its encloser protected with IP 65.

b) The display shall have provision for display in English language.

c) The display shall have brightness control.

d) It shall be provided with vandal proof key pad for entering different alphanumeric letters in different screens. It shall also have key to navigate through different screens as per document no RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest

e) Each display unit should have suitable polarised bayonet type circular coupler to communicating with CPU from both the cabs.

f) The display unit shall act as a dumb terminal simply to receive and display text strings from main unit and to send key press information to main unit. The data on display should be updated once every 500 msec.

g) This includes audio-visual display as discussed. Different frequencies shall be used for indicating the fault in VCD, locomotive including MPSCS and SIV/ARNO, which shall be decided jointly. Faults shall be reported to the crew by indication lamps (LSF1 : Red LED lamp for locomotive faults, LSVW : Yellow LED lamp for Vigilance Warning , buzzer ( BZ-F-V-O : with three frequencies ) and displays on the cab display. Buzzer shall be as per CLW’s spec no.CLW/ES/3/0078 ,Alt.B or latest and all illuminated push buttons/push buttons shall be as per latest alteration of CLW’s spec no.CLW/ES/3/0072.

The fault shall be acknowledged by illuminated push button switch BPFA( yellow colour). Vigilance warning can be acknowledged on Loco pilot side with push button BPVR ( Yellow colour) whereas on asst loco pilot side with BPVG (green colour).

8.1. **Screen structure:** The screen structure navigation of the display unit shall be as per document no RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest

8.2. **Interface of display with control system:** Display system shall be connected with main control unit with RS485. There shall be two display, one in each CAB. Both display shall have same information.

9. **Remote Monitoring Module:**
This module shall also be accommodated in the same cabinet of main system. This shall communicate with main control card through parallel or serial interface. One standby module shall be provided which can automatically takes over in case of the failure of the other.

9.1. **GPS Receiver:**
exMPCCS should also include a GPS receiver with an appropriate antenna for getting the GPS location information. Antenna used shall be suitable for working under 25 kv AC traction system and shall be within MMD of the loco. It shall be mounted externally for better signal reception. The updation of the GPS data should be made every 01 sec. GPS location information is included in Vital Data, Fault data, Configuration Data and optional GPS data packets. Antenna module shall have IP 66 protection.
9.2. **Communication with the system:**

The system shall communicate with the server using commercially available CDMA and/or GSM network. The tenderer shall supply and integrate data cards with antennas (compatible with these commercial cellular networks) with the system. The tenderer shall bear the cost of setting up a new connection (like SIM card, registration etc) and also pay for data connection for five (05) years from the date of commissioning. For operational expenses beyond that the tenderer shall indicate the commercial terms of the cellular network provider and indicate an appropriate data plan as is available from the network provider. The tenderer may also quote to bear the operational expenses for the data connection through commercially available cellular network as an Annual Maintenance Contract cost after the expiry of warrantee of five years.

9.3. **Server and Memory Space for Remote Monitoring**

9.3.1. **Web Application Server:**

IR will host and maintain its exMPCS web portal which will have web application software, data base management and communication interface with vendor servers through static IP address with standard TCP/IP protocol. During the course of development, Standard TCP/IP will be provided by IR to all the prospective vendors in consultation with them. IR personnel can log onto the exMPCS website using secure login and password. This interface will enable the user to view the data received from the system in various formats as decided by Railways. End users can connect to the portal using any regular internet connection or Indian Railway Network (Rail Net) using regular internet browser by accessing a dedicated website address. User has to select just loco number, which will generate query to vendor specific server with adequate security provisions and in turn will fetch all the data, required. Similarly, if there is an UOR, exMPCS will send the data to the server of respective vendor and which in turn will be sent to IR portal.

9.3.2. **Vendor Specific Server**

a. Vendor will have its own server with specific static IP address. Hosting vendor specific server and communicating with locomotive exMPCS and IR web portal is included in the scope of the supply. There should be flexibility in upgrading the server configuration such that more locomotives can be added to the system as and when more locomotives are fitted with exMPCS and increase of user access.

b. The server shall be able to acquire data from locomotives exMPCS and generating data/reports to end users through IR’s exMPCS’s portal.

c. This system includes installation and commissioning of server with reasonable memory space for maintenance of vital data for minimum twenty four hours with resolution of 1 second and run in FIFO type ring buffer. In addition to this, only UOR data in the format specified by IR, on the server shall also be maintained for 90 days and run in FIFO type ring buffer.

d. Vendor server shall be serviced by the respective tenderer. This server has to be maintained round the clock for a minimum period of five years. The
tenderer shall ensure guaranteed 95% up time service availability (calculated as total time the server is available for access as a ratio of time under observation). The criteria for counting as downtime will be that the vendor server application is not accessible from anywhere on the internet (Cases where access is slow or not possible because of weak internet connections at end user will not be counted).
e. A record of the down time of vendor server (both scheduled and unscheduled) shall be kept jointly by the tenderer and Indian Railways and will be evaluated at the end of each quarter. If the uptime is less than 95%, a penalty will be levied as under:

<table>
<thead>
<tr>
<th>Down time</th>
<th>Penalty</th>
</tr>
</thead>
<tbody>
<tr>
<td>5% or less</td>
<td>Nil</td>
</tr>
<tr>
<td>5% - 7%</td>
<td>1% of quarterly AMC charges</td>
</tr>
<tr>
<td>7% - 10%</td>
<td>2% of quarterly AMC charges</td>
</tr>
<tr>
<td>More than 10%</td>
<td>5% of quarterly AMC charges</td>
</tr>
</tbody>
</table>

However, for the first three months, no penalty shall be applicable as during this period the tenderer will build up the necessary systems and infrastructure.

9.4. **Display of the Data:**
Railways shall provide the format of data to be displayed on the webpages. It will in the form of tables and graphs. The display shall inbuilt file management system for downloading the data in the MS Excel and PDF file name assigned by the user [format of file name: loco no. date stamp of downloading time]. File selection should be done at time of analysis the data.

9.4.1. **Vital Data:**
exMPCS shall continuously record the following parameters in the memory. These shall be recorded at 1 sec interval.

a) Following calculated parameter based on pulse received from PG of ESMON shall be continuously recorded in the memory at 1 sec interval. Data of PG and wheel diameter shall be configured by respective shed through exMPCS’s web portal. Speed in KMPH and distance in KM will be calculated by the exMPCS’s. e.g.

I. Speed in kmph
II. Total Energy Consumed
III. Specific Energy Consumption
IV. GTKM ,etc

b) BP & BC Pressure measurement: taken from pressure transducers through analog signal conditioning.
c) Sample of Vital Data are given as under:

I. Speed in Kmph
II. Brake pipe pressure  
III. Brake cylinder pressure  
IV. TM Isolation Status  
V. GPS Locations  
VI. Date and Time  
VII. VCD Status & Vigilance Penalty Brake Application  
VIII. Health of exMPCS  

For detail vital data, please refer to RDSO's TC no. 119.

9.4.2. **UOR data and Locomotive Health Data**
In case of UOR, the fault message will sent along with background data for five seconds before the fault and three seconds after the fault. Further, UOR message shall be displayed with following data:

I. Locomotive GPS location  
II. Date and Time stamp  
III. Speed of the locomotive in kmph  
IV. All TM Currents  
V. Distance in KM  
VI. BP pressure and BC pressure  
VII. TM Isolation status.  
VIII. Position of isolation of equipments  
IX. Health of the VCD  

For detail, please refer to RDSO's TC no. 119.

9.4.3. **Configuration data:**
Configuration data will be held in the system and transmitted to the REMAN-EL's web portal as and when there is request from user. But this data shall be stored in the system for 24 hours an interval of 30 minutes, whenever battery is switched ON, VCB is closed or opened, BL is activated in cab 1 or cab 2.

This information shall consist of date / time stamp, GPS location & all data related to configuration, Equipment details, Date of Commissioning, Last Major inspection Schedules (i.e MTR, POH, IO, AOH) done, Last minor inspection schedules done, next inspection due, wheel diameter, etc can be configured in the system by laptop and through REMAN-EL's web application server using secure login and password. Following System configuration data shall be displayed along with Vital data:

I. OHE Voltage and Auxiliary Voltage  
II. Battery Voltage  
III. TM Voltage  
IV. TM Currents  
V. Notch position  
VI. Health of Remote monitoring system  
VII. Isolation/ bypass status of equipment with appropriate switch position.  
VIII. Last Inspection done (Major & Minor)  
IX. Next Inspection due (Major & Minor)  
X. Eliminated relay status  
XI. Digital inputs
XII. Digital outputs

For detail, please refer to RDSO’s TC no. 119.

9.4.4. **GPS location information:**

Though GPS location and its co-ordinates are part of the locomotive health data packet, the tenderer can also provide a separate GPS location data packet. This packet will contain only date/time stamp and GPS location along with latitude and longitude. The tenderer shall provide details of this packet.

9.4.5. **Event Data Display**

I. A summary list of all locomotives fitted with the system, that can be filtered by particular Locomotive / Shed / Zone / All Indian Railways with summarized Locomotive Health Status.

II. A summarized list of all UORs on locomotives can be filtered by Locomotive / Shed / Zone / All Indian Railways and also by time period for consideration (from and to dates). Indication should also be given if the fault is still active or not. Further a link should be provided for downloading the particular fault’s Fault Data Packs.

III. All UORs shall be popped up on the display monitor in the PPOs of electric loco sheds at the time of on line monitoring. Overdue inspection locomotives along with their GPS location and train details shall be popped on PPO Screen.

IV. In order to monitor health of locomotives working on a division, locomotives entering into the division from adjoining divisions. Electric Locomotives, entering into from adjoining divisions, the fault data, equipment isolation data, etc. shall be displayed in TLC. Any UOR and next overdue inspection schedule shall pop on TLC’s screen. Geo fencing of all the divisions will be provided by IR. For an example, TLC ALD division can also monitor the MGS division locomotives in the monitor with alert messages displays as popup menu.

V. Life-time counters data and Trip counters data for a particular locomotive

VI. Summary page for a particular locomotive with summarized data of all above data and links to the particular detailed information.

VII. The display shall also be provided for printing of data in the following selective formats:

VIII. Parameters to be viewed on a screen simultaneously.

IX. Only the page desired to be viewed.

X. Continuous print out of all pages.

XI. Between desired time/distance intervals/GPS Locations.

XII. Data above/or below a specified speed threshold.

XIII. Fault data, fault wise selection, between desired time/distance intervals/GPS Locations.

9.4.6. **Data in Graphical Formats**:
The analog (graphical) plotting of the data shall be possible in following configurations:

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed, VCD status, BP &amp; BC Pressure vs. Time</td>
<td>Plotting of speed, VCD working status, BP and BC pressure with respect to time.</td>
</tr>
<tr>
<td>Speed Vs time at constant time interval</td>
<td>Plotting of speed data at desired constant time intervals, the smallest intervals being same as sampling rate of recording</td>
</tr>
<tr>
<td>VCD status vs time</td>
<td>Plotting of speed, VCD working status, BP and BC pressure with respect to time.</td>
</tr>
</tbody>
</table>

It shall also be possible to have above analog (graphical) print outs for desired time or distance intervals, on enlarged/amplified scale, for better clarity. Parameters on “X” and “Y” axis shall be clearly marked on the Graphical Printouts with Major gridlines whatever the case.

9.4.7. Transferring The Data through Internet:

a) Vital data received and generated at an interval of one second by this system shall be transferred through internet at an interval not more than 5 seconds. Sequence of Data displayed as they are received and generated at an interval of one sec. UOR & Loco Health data have to be transmitted as and when UOR occurs. Configuration data will be held in the system and transmitted to the eXMPCS’s web portal as and when there is request from user.

b) The system shall get confirmation of delivery of data packet the server. In the event of non-receipt of delivery report, the system will maintain the data in its buffer/memory and transmit as and when connectivity to the server is ensured, in the chronological order, so that at the user end, there shall be no loss of data.

c) If the locomotive is in an area with no network coverage, the system has to store the data and transmit the data on the availability of network coverage in the chronological order, so that at the user end, there shall be no loss of data.

10. MEMORY FOR THE SYSTEM:

The system shall have adequate memory space to store short term and long term data. Short term data comprises of vital data and the most recent data shall be stored for a minimum period of 24 hours with resolution of 1 second and run in FIFO type ring buffer. Long term data is UOR data in the format specified by IR and the most recent data shall be maintained for 90 days and run in FIFO type ring buffer. Similarly, configuration data shall be recorded as per schedules given para 3.0 off Chapter I and para 8.4.3 of Chapter II for first 24 hours and run in FIFO type ring buffer. There shall be provision of USB 2.0 compatible device Port on Control Unit for downloading the data from Memory to a Laptop.

All the parameters shall be recorded in the memory at 1 sec interval as per latest document no RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.
To record the equipment status and internal faults in the stored data. It shall have a memory capacity to store at least 1024 faults with background data for 5 sec before and 3 sec after the incident with 1 sec interval. The memory shall be accessible through high speed USB host interface (located under locked cover).

11. **FAULT MESSAGES**:
   In case of any abnormality in the locomotive and the system, fault messages shall be displayed along with the action to be taken by the locomotive crew. These faults shall be reported to the crew by indication lamps (LSFI : Red LED lamp for locomotive faults, LSVW : Yellow LED lamp for Vigilance Warning), buzzer (BZ-F-V-O: with three frequencies) and displays on the cab display.
   The fault shall be acknowledged by illuminated push button switch BPFA (yellow colour).
   Vigilance warning can be acknowledged on Loco pilot side with push button BPVR (Yellow colour) whereas on asst loco pilot side with BPVG (green colour).

   **Fault message priorities**: All the fault messages are grouped in two groups based on their severity – Priority 1 and Priority 2. If a fault message with priority 1 is displayed, a fault message with priority 2 is superseded on the screen.
   A fault message with priority 2 remains on the screen until it is overwritten by a fault message with priority 1 or by a subsequent fault with priority 2.
   Every fault message shall have a set of background data of 5 sec before and 3 sec after the incident with 1 sec interval. The detail list of fault messages and action taken by the loco crew along with its background data shall be as per document no. RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.

12. **BACKGROUND DATA**:
   Set of background data has to be identified along with each fault message, jointly along with the vendors by RDSO, during design stage.

13. **DIRECT TRANSFER OF THE DATA**:
    Normally, the data stored in the memory shall be transferred to the PC/Laptop through high speed USB port and through internet with the help of EXMPCS application programme.
    There shall be provision of high speed USB 3.0 compatible device Port on Control Unit for downloading the data from Memory to a Laptop. The standard USB cable for connection from Port to PC/Laptop shall be supplied with the system.

13.1. **Data downloading to USB Mass Storage Device**:
   The system should be equipped with high speed USB 3.0 host port for direct downloading of data from Memory to USB Mass Storage Devices. The provision shall be made for retaining the data in the memory of System even after downloading in to USB Mass Storage Device.

   When USB Mass Storage Device (Pendrive) is inserted, Data should be downloaded automatically into memory stick. Status of data transfer shall be displayed: “Data downloading started” “Data downloading underprogress” and after completion “Data down loaded successfully” message shall be displayed Display unit.
14. EVALUATION SOFTWARE TO ANALYSE THE DATA:

Necessary software for data retrieval, analysis and printing shall be developed and supplied by the manufacturer. The software shall be menu-driven and shall not require knowledge of any programming language and shall be suitable to be operated with minimum computer literacy.

The software shall have file management system for retaining the data in the MS Excel and PDF file name assigned by the user as per latest document no RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest. File selection should be done at time of analysis the data.

There shall be provision of getting the data in graphical format as given in para 8.4.6 of Chapter II. The software shall also be provided for printing of the data in the following selective formats as per latest document no RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.

15. CONFIGURATION PARAMETER SETTING:

Provision shall be made for parameters setting through laptop by authorised persons with password protection. Detail of these parameters are given in RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.

16. SELF TEST FOR SELF DIAGNOSTICS:

Whenever the battery is switched ON, the system shall carry out self test for checking the working of processors, inputs, outputs and SCUs. This shall be carry out within first ten seconds of the battery switch ON. Detail of self check protocol will be decided jointly with RDSO.

Once the system is found working satisfactory as per self check protocol, raising of pantograph, closing of DJ, etc. are allowed.

17. Diagnostics Tool:

In order to trouble shoot transient problems, the system shall allow to monitor the status of certain inputs and outputs continuously. For this a laptop/tablet can be connected to the system through standard USB cable and USB port provided in the system. This diagnostic tool will allow the user to select set of input and output signals depending upon type of investigation and monitor them continuously for finding out root cause of a transient fault.

18. Life time data counters and trip data counters:

Life time data counters and trip data counters shall be transmitted from microprocessor control system to the REMAN whenever it is requested by user. It shall transmit data as part of life time counter data & trip data as per latest document no RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx.

19. Size, mounting details and colour of the Equipment

The MPCS with Remote monitoring and analysis feature is proposed to be mounted in the AC2 panel of the locomotive. Colour of the units should be gray colour (code-631 of IS-5).
The outer and fitment dimension of the microprocessor based control and fault diagnostic system equipments should be as per RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.

20. POWER SUPPLY:

The battery supply at 110V dc varying from 70V to 137.5V supported by the existing charging arrangement in the form of Battery charges will be available on the locomotive. since memory storage are to be catered for, a battery back up as a part of the microprocessor system will be provided. The operating voltage of the system is as follows:

- Minimum voltage = 70 VDC
- Nominal voltage = 110 VDC
- Maximum Voltage= 137.5 VDC

It should have two power supply cards one should be working normally and other should be hot stand by as a redundancy.

21. Interface:

21.1. Cables:

The e-beam wire/cables shall be of high grade copper with halogen free thin walled flame retardant insulations, zero halogen, low smoke, low toxicity index as per RDSO specification No- ELRS/SPEC/ELC/0019 Rev’2’ of Feb 2011. All the cable terminations shall be made through crimped sockets/ lugs and wires with circuit diagram furnished. Each cable/ wire shall be numbered at both ends for easy identification.

Communication multi core screened cable shall be as per CLW specification no. CLW/ES/3/0459 (latest).

21.2. Coupler:

Polarised military grade (confirm to JSS no. 50815) bayonet type circular coupler with crimped pins should be used for ex-MPCS on the cabinet of the equipment.Coupler shall be as per latest alteration of CLW’s spec no.CLW/ES/3/0124. RF connectivity : GPS : System side - TNC male , cable side – TNC female and GSM/CDMA : System side - N- male , cable side –N- female shall be provided.

22. Algorithm:

Input & output relationship to be deduced as per the following class of the electric locomotive circuits diagram issued by the CLW.

a) WAG-7
b) WAP-4
c) WAG-5
d) WAM-4
The supplier may depute their system analyst at RDSO/CLW for preparation of input / output relationship of locomotive logics.

23. COMMUNICATION WITH OTHER MICROPROCESSOR BASED SYSTEM.

For communication with other microprocessor systems, the system should have provision to implement a serial link of (RS 485). The software drivers for this shall also be provided along with this card once RDSO standardise the protocol.

24. PROVISION FOR FUTURE EXPANSION:

The details of relays has been provided in RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest. There should be sufficient provision for introducing additional relays may be required in future.

25. DETAILS OF OPERATING ALL RELEVANT COILS OF CONTACTORS/RELAYS

Details of the operating coils of the contactors/ relays used in locomotive are given in TC RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.

26. GENERAL DESIGN REQUIREMENTS

a) MPCS shall be designed for 25 kV AC tap changer electric locomotive being manufactured by CLW/BHEL or any other approved vendor of Indian Railways. With minor modification in software and hardware, it should be possible to make it suitable for other classes of electric locomotives in general.

b) The system should be capable to self recognise the loco type with the help of hard-wired detection and select the suitable software for the loco type. There should be a common program in CPU card that caters to every tap-changer loco and there should be no need to change program once card is shifted to another type of loco.

c) It will be preferable to have the entire microprocessor based hardware, RAM, EPROM. Input/output ports and opto-isolation etc. so optimised that the component count is kept low without sacrificing the overall system performance and reliability. Necessary interfacing hardware and the connectors will be provided on the cabinet of the equipment.

d) All the cards should be suitably protected as per IP 65, metallic enclosed and provided with mechanical dust proofing covers to avoid dust ingress and then mounted in a robust metallic housing so that entire assembly is capable of withstanding shocks, vibrations, electromagnetic induction and electrical surges etc. Electromagnetic compatibility of the entire system shall comply with provisions of IEC 61000 latest. The equipment should withstand surge & spikes as specified in IEC 60571 ed-3 or latest.

Prepared by          Checked by          Issued by
e) Adequate provisions should be made in the design for suppression of internal transients, spikes and to withstand external transients, spikes and surges as per limits laid down in IEC-60571 ed-3 or latest.

f) In the electronic equipments to be supplied to this specification, the suppliers shall use components and systems of high reliability, suitable in every way for the application on rolling stock. In this connection, supplier is well advised to refer to "Rules for Electronic Equipments used on Rail Vehicles IEC Publication 60571"

g) Minor deviations from the specification if any, can be mutually sorted out with RDSO during development stage if supported by justification on ground of cost and/or technical superiority.

h) All the components on PCBs should be wave soldered / surface mounted devices should be mounted using SMT workstation and complied with clause no. 7 of specification no. ELRS/SPEC/ SI/0015 latest.

i) All ICs if mounted on the bases should be mounted on heavy duty sockets and provision should be made for tightening of the ICs on the base also complied with clause no. 6.1.3 of specification no. ELRS/SPEC/ SI/0015 latest.

j) All electronic components and ICs used shall be selected after proper burn in and screening tests and shall be adequately rated to withstand the service requirements. A quality assurance scheme should be submitted by the supplier for approval of RDSO. It should be provided as per specification no. ELRS/SPEC/ SI/0015 latest.

k) All the connecting wires/cables used on PCB in the sub units should be properly laid out with suitable connector. The cable used inside the sub unit should be properly supported with stiffners. No soldering should be done on the PCB for inter connection.

l) Polarised Bayonet type Circular connector with crimped pins will be used for all external connections. These should be confirm to JSS no. 50815 design to meet the specification.

m) System shall have real time clock for recording date & time which is updated from GPS system.

n) System should have dust proof covers protected as per IP 65 which are operated locked with suitable common keys. This includes main unit, display, other sub-assemblies. Antenna module shall have IP 66 protection.

o) The provision should exist for printing data stored or down loading it using fault data extraction unit (Tablet/Laptop) or personal computer with Microsoft windows 2000 or above operating system. A USB 3.0 compatible port will be provided with
USB connector on the system for data extraction. The system should accept pen drives memory sticks. Upon inserting this into the USB connector provided on the system automatic data downloading should begin. Data retrieved by a Windows based program to be provided by the supplier and stored in a Excel file.

p) The equipment should function satisfactorily under 25 kV ac electric traction. It should not be susceptible to malfunction due to interference from overhead traction power supply lines or under abnormal conditions such as overloads and faults in the electrical traction circuits of the locomotives.

q) Signals generated by the MPCS of the locomotive shall not cause interference to the Railways Signal & Telecommunication equipment.

r) The system should be capable of working in all type of ac tap changer electric locomotives. The software selection of the locomotive depends upon the hardware wiring of loco class with the inputs. Selection details of the locomotives and their equipments are given in document no. RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest.

s) The speed of the microprocessor shall be adequate so that the status of all the digital and analog inputs is scanned continuously and the desired control and diagnostic features are achieved.

t) Locomotives are capable of multiple operations of two/three locomotives. This is achieved by three 19 core couplers. Each locomotive shall have its own microprocessor based system. It should be possible to achieve the control of the rear locomotive from the front locomotive. The message to the driver in the leading loco shall specify that the fault is in rear locomotive. Whenever such a fault occurs a signal through one of the coupler wires is available for display in the leading loco. It should also be possible that system is compatible to form multi unit locomotive fitted with other make MPCS.

u) In case of failure of both CPU’s or any problem in the system all outputs should be OFF in safer side.

v) For non-critical outputs, warning message to be generated in case of failure.

w) Auto regression should not occur because of TM over voltage if notch position is less than 16.

x) **SAFETY FEATURE:** In case of malfunction of any one of the processors or its associated hardware, it should be detected and isolate it from its operation. The loco should continue its operation with the other processor and its associated hardware and an alarm should be raised to notify the fault. Even under such condition the system must ensure a certain degree of safety through its own reliability and testability. All the components/material used should be fire retardant.
y) Signals generated by the exMPCS of the locomotive shall not cause interference to the Railways Signal & Telecommunication equipment.

z) There shall be interchangeability with Rev. 2 of this specification as far as connectors etc for the existing inputs and outputs are concerned.

27. PERFORMANCE REQUIREMENTS

a) The microprocessor based system will take the binary inputs from the command switches on the drivers desk, air flow relays, contacts and other interlocks of the control/protection relays and analog signals from Traction Motor, Aux. Transformer. Arno/ SIV unit, BP, BC, primary current and Dynamic Braking circuit etc. It will perform through software and hardware of microprocessor as defined in RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx or latest. The system should be capable of carrying out self diagnostics.

b) It should ensure that all functional units are working and all back up data are still valid i.e, no important data has been corrupted during the period that power had been turned off. In case a critical failure is detected, alarm shall be generated and system should shut itself off. In case of a non critical failure, the system shall continue to operate after generating appropriate alarm.

c) It should ensure the validity of the functioning of the system including failure detection of peripheral units by the main processing unit and failure of any card in the main processing unit by another card in the same unit. It shall also ensure that system does not malfunction due to the software crashing. It should be provided as per clause no. 8.0 of latest specification no. ELRS/SPEC/ SI/0015 latest..

d) The system shall be capable of working with both static converter and ARNO converter.
CHAPTER III

ENVIRONMENTAL CONDITIONS

The climatic and environmental conditions prevailing in India in the area of operations are the following:

| A. Atmospheric temperature | • Maximum temperature: 50 °C  
|                           | • Maximum touch temperature of metallic surface under the Sun: 75 °C and in shade: 55 °C  
|                           | • Maximum temperature near electronic cards in un-energised condition of locomotive standing under direct sunlight during summer: 70 °C  
|                           | • Maximum temperature near electronic cards in working condition of locomotive during summer: 65 °C  
|                           | • Minimum temperature: -10 °C (Also snow fall in certain areas during winter season) |
| B. Solar radiation         | 1 kW/m² |
| C. Humidity               | 100% saturation during rainy season |
| D. Altitude:              | 1776 m above mean sea level |
| E. Rain fall:             | Very heavy in certain areas. |
| F. Wind speed             | High wind speed in certain areas, with wind pressure reaching 150 kg/m² |
| G. Atmospheric conditions | Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m³. In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system. The system shall be able to work at the maximum specified ambient temperature inside the locomotive without any pre-cooling requirement. |
| H. Coastal area           | • Humid and salt laden atmosphere with maximum pH value of 8.5,  
|                           | • Sulphate of 7 mg per liter,  
|                           | • Maximum concentration of chlorine 6 mg per liters and  
|                           | • Maximum conductivity of 130 micro siemens / cm |
| I. Vibration & Shock      | The equipment shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in IEC -61373 (latest) Publication for Shock & Vibration on Rolling-stock vehicle. The vibration test shall be done as mounted in the actual operating condition. |
| J. Electromagnetic Pollution | High degree of electromagnetic pollution is anticipated in locomotive machine room, where the equipment will be mounted. Necessary precaution should be taken in this regard. The equipment shall be design to cater to the EMC/EMI requirements as per IEC 61000 -4-6 (latest). |
CHAPTER IV

SCOPE OF SUPPLY (to be put inseprate doc)

Scope of the specification is to Supply, commissioning and installation of the overall EX-MPCS equipment along with pressure sensors and associated wiring. It shall interface with ESMON.

CDMA/ GSM data cards of commercial mobile internet provider with appropriate antennas and their activation / registration are in the scope of supply for tenderer. The tenderer is required to pay the cost of an unlimited data plan for five years. The mobile internet provider shall be selected in consultation with Indian Railways. Installation and maintenance of this equipment (along with antennas) is also in the scope of supply of tenderer.

Following documents shall be submitted by the firm:

- Technical documentation explaining the complete scheme, characteristics, diagnostics, protection and control,
- Procedure for parameter alteration, frontend application software for downloading, diagnostic uploading, analysis, etc.
- Software tool for real time monitoring of selected signals
- Operation and Maintenance manual.
- Trouble shooting charts etc.

4.0 The scope under this specification covers design, development including simulation studies, manufacture, supply, erection, training and commissioning of the "Microprocessor based control and fault Diagnostic system with Remote monitoring and analysis feature" on 25 kV ac tap changer electric locomotives. The following will be the scope of supply:-

<table>
<thead>
<tr>
<th>SN</th>
<th>Items</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Microprocessor based control unit with Remote monitoring and analysis feature</td>
<td>1 no.</td>
</tr>
<tr>
<td>II.</td>
<td>Display unit</td>
<td>2 nos.</td>
</tr>
<tr>
<td>III.</td>
<td>Signal conditional unit along with coupler as per TC 119</td>
<td>1 no.</td>
</tr>
<tr>
<td>IV.</td>
<td>ISCU units for Primary/TM current measurement</td>
<td>2 nos</td>
</tr>
<tr>
<td>V.</td>
<td>Display interface cable duly fitted with 10</td>
<td>2 nos. (24 mtrs)</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Quantity/Details</td>
</tr>
<tr>
<td>---</td>
<td>---------------------------------------------------------------------------</td>
<td>------------------</td>
</tr>
<tr>
<td>VI</td>
<td>Input/Output cables one end duly fitted with polarized 19/28 pin connector other end with <strong>M5</strong> lugs</td>
<td>10 nos. (5.5 mtrs. each)</td>
</tr>
<tr>
<td>VII</td>
<td>Signal conditional interface cable duly fitted 17 pin connector.</td>
<td>1 no. (2.5 mtrs)</td>
</tr>
<tr>
<td>VIII</td>
<td>Cables for supply of power to main unit and display units fitted with 3 pin coupler.</td>
<td>3 Nos. (2 mtrs. each)</td>
</tr>
<tr>
<td>IX</td>
<td>Windows based data extraction software and Dianostics Tool</td>
<td>1 Nos.</td>
</tr>
<tr>
<td>X</td>
<td>ADB (Analog Distribution Box) unit</td>
<td>1 no</td>
</tr>
<tr>
<td>XI</td>
<td>Antenna unit</td>
<td>1 no</td>
</tr>
<tr>
<td>XII</td>
<td>Pressure sensors</td>
<td>2 no</td>
</tr>
<tr>
<td>XIII</td>
<td>Hall effect sensor for TM current measurements</td>
<td>6 nos.</td>
</tr>
</tbody>
</table>

a) One fault data extraction unit (Laptop) along with B/W laser printer to get the print out of the stored fault messages for every 10 equipments.

b) One set per 5 units subject to minimum two sets of users maintenance & troubleshooting manual.
CHAPTER V

INSPECTION & TESTING

1. INSPECTION

a) The system shall be tested on a combined test bed generally in accordance with the IEC: 60571 latest. The individual equipment and system/sub-systems as may be necessary shall be type and routine tested in accordance with the relevant standards/specification/publications/details given elsewhere in this specification, which, if required, may be modified to suit local conditions. Dry Heat test of the Electronics shall be carried out at 80°C as per IEC: 60571. Alternatively Supplier may propose for dry heat test as per IEC 60571 subject to provisions to ensure temperature in the vicinity of cards being less than 70°C when ambient temperature is 50°C, which shall have to be established during test trials. All optional tests mentioned in various standards shall also be carried out. Details shall be worked out during design approval.

b) Type tests shall be carried out by the Supplier at his own responsibility and cost.

c) Wherever the relevant standard test procedures do not adequately cover the requirements of arduous environmental conditions prevailing in India, RDSO might lay down special tests apart from those specified that shall be required to be conducted. These may include accelerated ageing tests and endurance test.

d) The Supplier shall formulate and submit a type test protocol / plan at design approval stage for approval of RDSO before undertaking manufacture. It shall, however, be open for RDSO to waive some of tests in case of equipment and sub-assemblies, where the manufacturer can establish it for the requirements of this specification that such tests have already been carried out earlier on the same equipment and where equipment has been proved in prolonged service.

e) Modifications found necessary as a result of the tests/trials shall be incorporated by the Supplier at his own cost in the locomotives in a manner approved by the Purchaser. Drawings incorporating the modifications found necessary, as a result of tests and trials, shall be submitted to RDSO for final approval.

f) The manufacturer shall offer all the testing facilities free of charge to inspecting authority. Testing of equipment and fittings shall, as far as possible be carried out at the works of the manufacturers. Testing of bought out components may also be carried out at subcontractor’s premises, if so required. The contractor shall provide free of charge, such materials or fittings as may be required for testing whether at his own or his subcontractor’s premises. The test for which facilities are not available may be carried out at RDSO or any other approved laboratory for which the testing charges shall be payable by the supplier.

g) All the equipments and the fittings required for testing shall be selected by the inspecting officer and the tests shall be carried out in his presence.

h) No material shall be packed or dispatched until it has been passed by the inspecting officer but the contractors responsibility for its efficiency in every way, shall remain the same as if the work had been manufactured and tested by himself.
i) Should any part require alteration or any defect appear during the test or trial the contractor shall without any extra charges make such alteration or rectify the defects to the satisfaction of the inspecting authority.

j) Copies of Maker’s test certificate, guarantee the performance of the equipment shall be supplied in duplicated along with the delivery of each unit.

k) The inspecting authority shall:-
   • Visit at any reasonable time and without previous notice, either contractor’s works or his sub-contractor’s works to inspect the manufacturers and the quality of the work at any stage.
   • To reject any materials or fittings that do not conform to the relevant standard/specifications or have not been manufactured in accordance with the approved practices. The rejected materials or fittings shall be marked in a distinguishable manner and shall be disposed on in such manner as the inspecting officer may direct to avoid its inadvertent use in the product order as per this specification.

2. CATEGORIES OF TEST

2.1. TYPE TEST:
   a) Type test shall be carried out on equipment of the approved design. If there is any change in design or source of supply of any components/sub-components/assembly, units made to the changed design or from new source shall be treated as new item for the purpose of conducting type tests.

   b) Type tests are to be repeated in case of any major change is made. In case of minor changes, i.e. change in type, rating of component etc., special test/tests as agreed by user and manufacturer are to be conducted to ensure their suitability and effectiveness of the modifications.

   c) Tests will be carried out on the prototype unit as per relevant IEC specification or mutually agreed test program. Manufacturer will bear the expenses of the tests.

   d) The type tests shall be repeated once in three years by RDSO.

2.2. ROUTINE TEST
   Routine test shall be carried out in every equipment of each order.

2.3. ACCEPTENCE TEST:
   Acceptance Test shall be carried on 10% of batch quantity subject to minimum of 5 nos. as per table given below.

   The tests to be carried out on complete unit are given in the following table, together with the clause number of IEC 60571ed-3 2012-09 to which reference should be made.
<table>
<thead>
<tr>
<th>SN</th>
<th>TESTS</th>
<th>IEC CLAUSE NO.</th>
<th>SPEC. CLAUSE NO.</th>
<th>TYPE TEST</th>
<th>ROUTINE TEST</th>
<th>ACCEP. TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Visual Inspection</td>
<td>12.2.2</td>
<td>5.4.1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>II.</td>
<td>Performance test</td>
<td>12.2.3</td>
<td>5.4.2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>III.</td>
<td>Cooling Test</td>
<td>12.2.4</td>
<td>5.4.3</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>IV.</td>
<td>Temperature riteste test (Dry heat)</td>
<td>12.2.5</td>
<td>5.4.4</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>V.</td>
<td>Temperature rise (damp heat/cyclic)</td>
<td>12.2.6</td>
<td>5.4.5</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>VI.</td>
<td>Supply over voltage test</td>
<td>12.2.7</td>
<td>5.4.6.1</td>
<td>✓</td>
<td>--</td>
<td>✓</td>
</tr>
<tr>
<td>VII.</td>
<td>Surges test</td>
<td>12.2.8.1</td>
<td>5.4.6.2</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>VIII.</td>
<td>Electrostatic discharge test (ESD)</td>
<td>12.2.8.2</td>
<td>5.4.6.3</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>IX.</td>
<td>Transient burst susceptibility test</td>
<td>12.2.8.3</td>
<td>5.4.7</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>X.</td>
<td>Radio Interference test</td>
<td>12.2.9</td>
<td>5.4.8</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>XI.</td>
<td>Insulation test</td>
<td>12.2.10.2</td>
<td>5.4.9</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>XII.</td>
<td>Voltage withstand test (Dielectric test)</td>
<td>12.2.10.3</td>
<td>5.4.10</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>XIII.</td>
<td>Salt mist test</td>
<td>12.2.11</td>
<td>5.4.11</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>XIV.</td>
<td>Vibration and shock test</td>
<td>12.2.12</td>
<td>5.4.12</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>XV.</td>
<td>Water tightness test for antenna</td>
<td>12.2.13</td>
<td>5.4.13</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>XVI.</td>
<td>Reverse polarity test</td>
<td>--</td>
<td>5.4.14</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>XVII.</td>
<td>Output short circuit test</td>
<td>--</td>
<td>5.4.15</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>XVIII.</td>
<td>Burn-in-test</td>
<td>--</td>
<td>5.4.16</td>
<td>✓</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

3. DETAILS OF TESTS:

3.1. VISUAL INSPECTION:

The object of visual inspection is to check that the equipment is free from defects and the equipment is as per approved drawing. Bill of materials will be submitted. The make, rating of equipment, subassemblies will be checked with the details as per approved design proposal submitted in design proposal. If a change is needed in make or rating of important equipment, sub-assemblies, it should be intimated and should have proper approval of RDSO. MPCS system with modified equipment, subassemblies will be given separate revision number. All the important dimensions will be measured and should be in permissible tolerance. Visual inspection is to mainly verify cable marking, cable clearance, creepage distance etcs. Bill of material is also to be verified.

3.2. PERFORMANCE TEST:

Measurements shall be carried out at the ambient temperature.

The performance test for type testing shall consist of a comprehensive series of measurements of the characteristics of the equipment to check that its performance is in accordance with the functional requirements of the particular equipment concerned,
including any special requirements of its individual specification, and general requirements of this standard.

The performance test for routine testing shall be as that for type testing but excluding the supply interruption and variations test described below. These tests are carried out to check and ensure that the performance of the equipment is in order and These tests

3.3. VOLTAGE VARIATION TEST:

This test should be carried out as per 12.2.3 IEC 60571. During the test system voltage shall be as per para. 20 of chapter II. A test shall be done to verify that when the display unit has a clear audio indication at the time of fault occur and keys operating condition in the working cab to attract the attention of the driver. Control circuit logic should be tested for all type of loco with different equipment modes.

3.4. COOLING TEST:

This test should be carried out as per 12.2.4 IEC 60571. Bring down the temperature of the equipment to -10 °C± 2 and keep it at the temperature for 2 hours. Carry out insulation test, Dielectric test at 85% voltage of the previous test and performance test after the recovery period of 3 hrs.

3.5. TEMPERATURE RISE TEST (DRY HEAT):

This test should be carried out as per 12.2.5 IEC 60571. The temperature of the equipment is to be raised to 70°C at the rate of 1°C at 1.5 minute and to be kept at that temperature for 6 hours. In this test equipment should be in energised condition and check the working of the system. Cool it to the room temperature (recovery period 3 hrs) and carry out insulation test, Dielectric test at 85% voltage of the previous test and performance test.

3.6. TEMPERATURE RISE (DAMP HEAT):

This test should be carried out as per 12.2.6 IEC 60571. Damp heat test shall be done keeping the equipment in deenergised condition. It is to be ensured that the RH of the oven should be between 80 to 100% during the above test. The temperature of the equipment is to be raised from ambient to 55°C in 2 hours and kept at that temperature for 6 hours. The temperature of the equipment 55°C should be brought down to ambient (recovery period) in 3 hours. The cycle is to be repeated at least two times and carry out insulation test, Dielectric test at 85% voltage of the previous test and performance test.

3.7. SUPPLY OVER VOLTAGE, SURGES AND ELECTROSTATIC DISCHARGE TEST:

The test shall be conducted as per IEC-60571 latest.

3.7.1. OVER VOLTAGE TEST:

The test shall be conducted as per IEC-60571, clause 12.2.7
3.7.2. SURGE TEST:

The test shall be conducted as per IEC-60571latest, clause 12.2.8.1. The surge pulse shall be 1.8 kV, 1.2/50 micro Sec

3.7.3. ELECTROSTATIC DISCHARGE TEST: The test shall be conducted as per IEC-60571latest clause no. 12.2.8.2 & for ESD.
   a) Level : 3
   b) Test voltage for contact discharge: +/- 6kV
   c) Test voltage for air discharge : +/- 8kV
   d) Polarity : Positive & Negative
   e) No. of discharge : 10 at each point

3.8. TRANSIENT BURST SUSCEPTIBILITY TEST:

This test shall be conducted as per IEC-60571latest clause no. 12.2.8.3. The complete system in simulated installed condition shall be put for the test as specified in IEC. The recommended test severity level is level 4 with Direct Coupling for Power Lines & with Capacitive Coupling for Communication & Signal Lines. The EFT of defined severity shall be applied on Communication line, Analog and digital input lines as follows:

<table>
<thead>
<tr>
<th>Severity for Level 4</th>
<th>Power Lines</th>
<th>Signal Lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repetition rate</td>
<td>2.5 kHz</td>
<td>5 kHz</td>
</tr>
<tr>
<td>Applied voltage</td>
<td>4 KV</td>
<td>2 KV</td>
</tr>
<tr>
<td>Rise time</td>
<td>5 ns +/- 30%</td>
<td>5 ns +/- 30%</td>
</tr>
<tr>
<td>Impulse duration</td>
<td>50 ns +/- 30%</td>
<td>50 ns +/- 30%</td>
</tr>
<tr>
<td>Burst duration</td>
<td>15 ms +/- 20%</td>
<td>15 ms +/- 20%</td>
</tr>
<tr>
<td>Burst Period</td>
<td>300 ms +/- 20%</td>
<td>300 ms +/- 20%</td>
</tr>
<tr>
<td>Connections / period</td>
<td>Direct Coupling both positive &amp; negative side for 60 seconds each sides</td>
<td>Capacitive Coupling both positive &amp; negative side for 60 seconds each sides</td>
</tr>
</tbody>
</table>

During test the equipment shall be watched for malfunctioning or any erratic behavior. Data recorded in the memory of the system during test shall also be downloaded & evaluated through Evaluation Software for the performance of the system as well as Data Recording & Downloading system.

No degradation of the system & malfunctioning should be allowed during or after the test.

3.9. RADIO INTERFERENCE TEST:

This test shall be conducted as per IEC-60571latest clause no. 12.2.9.

3.10. RFI RADIATED/RADIATED SUSCEPTIBILITY:

This test shall be conducted as per IEC 622236. The complete system in simulated installed condition shall be put in to the Radiation Chamber.
During test the equipment shall be watched for malfunctioning or any erratic behaviour. Data recorded in the memory of the system during test shall also be downloaded & evaluated through Evaluation Software for the performance of the system as well as Data Recording & Downloading system.

No degradation of the system & malfunctioning should be allowed during or after the test.

3.11. INDUCED RF FIELD CONDUCTED/ CONDUCTED RF SUSCEPTIBILITY:

This test shall be conducted as per IEC 622236. The complete system in simulated installed condition shall be put for the test specified in IEC.

During test the equipment shall be watched for malfunctioning or any erratic behaviour. Data recorded in the memory of the system during test shall also be downloaded & evaluated through Evaluation Software for the performance of the system as well as Data Recording & Downloading system.

No degradation of the system & malfunctioning should be allowed during or after the test.

3.12. INSULATION TEST:

This test is becarried out as per IEC-60571 latest, clause 12.2.10.2. Megger the electronics and control circuit, lamp unit with respect to earth and check the insulation level with 500V megger range and ensure that the insulation resistances are greater than the following minimum requirements and record the actual values obtained: The time of the meggering shall not be less than 60 Sec.

3.13. DIELECTRIC TEST:

The signal conditioning unit should be subjected to 2000 V rms, main unit and display unit for 1000V rms. The test The test is to be carried out as per IEC-60571 latest, clause 12.2.10.3. Applied voltage should be of sine wave, 50 or 60 Hz for one minute between the terminals that interface with locomotive short circuited and the metallic frame of the assembly box.

3.14. SALT MIST TEST:

The test is to be carried out as per IEC-60571 latest, clause 12.2.11. Duration of the test shall be for four hours.

3.15. VIBRATION AND SHOCK TEST

The test is to be carried out as per IEC-60571 latest, clause 12.2.12. random vibration & shock test is recommended as per IEC 61373 for rolling stock application

The vibration and shocks tests shall be carried out as per category 1, class B of IEC 61373 latest for rolling stock equipment for Railway application. The following test should be carried out.

a) Functional random test as per clause no. 8.0
b) Simulated long life testing as per clause no. 9.0
c) Shock testing as per clause no. 10.0
After the test there shall be no resulting damage, abnormality in the operation of equipment. After completion of mechanical endurance test, vibration and shock tests, the equipment shall again be subjected to dielectric test and performance test.

3.16. WATERTIGHTNESS TEST:

This test is done for antenna of REMANas per IEC 60571 latest, clause 12.2.13.

3.17. REVERSE POLARITY TEST:

The equipment shall be tested to verify the reverse polarity protection by making the connection to reverse polarity and unit shall work normal after restoring the connection to correct polarity.

3.18. BURN-IN TEST:

After mounting of components, the populated PCB cards kept in proper chassis in energized condition shall be burnt in for minimum 3 cycles at +70 deg. C and - 25 deg C as per RDSO/2012/EL/TC/0119 Rev ‘1’ dated xx.xx.xx latest. The PCBs will be tested for functionality to the extent possible during the burn-in test. This will be mutually decided.

4. OUTPUT SHORT CIRCUIT TEST:

The unit shall be tested by connecting a outputs, working at normal voltage short circuit shall be created at output through a switch of suitable rating and keep the unit for 2 minutes. Unit shall perform normal after the test.

5. Test of Redundancy :

The system has got redundancy in CPU, Input, Output, Remote monitoring unit, power supply modules. This has to be tested by creating fault in the main unit and ensuring the standby module taking over without affecting the normal working of the system as given in chapter 2. Every such switch over shall be accompanied with a fault message as given in Para 11 of Chapter 2.

6. Field Trials :

Field trial is a part of prototype test to prove the working of the system in the field and it shall be as per Para no. 10.2 of Chapter I. Successful completion of field trial is pre-requisite for prototype approval.