S&T DIRECTORATE

RESEARCHDESIGNSANDSTANDARDSORGANISATION

MANAKNAGAR, LUCKNOW-226011

Title: Acceptance Test Format for KAVACH Hardware of M/s Firm's name as per RDSO/SPN/196/2020 (version 4.0)

SNo.	Issue	Version	Reason for Amendment
1.	First	1.0	The initial issue as per RDSO/SPN/196/2020 Ver.-4.0
2.			
3.			

Prepared by:	Approved by:
JE/ SSE/RDSO ADE/Signal-V Director Sig-IV Exe Director /Tele-II	PED/S&T

Signature of Firm's Representative with date and designation	Signature of RDSO Representative with date and designation

ACCEPTANCE TEST FORMAT FOR
HARDWARE OF
KAVACH (The Indian Railway Automatic Train Protection System)
(SPECIFICATION RDSO/ SPN/196/2020 (VERSION 4.0)

NAME OF THE EQUIPMENT	KAVACH
SPECIFICATION NO:	RDSO/ SPN/196/2020 (VERSION 4.0)
NAME OF THE TEST	ACCEPTANCE TEST FOR HARDWARE
NAME AND ADDRESS OF THE FIRM	
NAME AND SL. NO OF KAVACH EQUIPMENT	
VERSION NO.	

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Sample Requirement

1. **Stationary KAVACH:** 2 Nos.
2. **Onboard KAVACH:** 2 Nos.
3. **RIU KAVACH:** 6 Nos

Note: Acceptance test shall be carried out on all the samples.

1. **Stationary KAVACH (S-KAVACH):** comprises of the following-
   a) SKAVACH
   b) Station Master – Operation Cum Indication Panel (SM-OCIP)
   c) RFID Tags
   d) Radio Modems with UHF Tower Antenna
   e) Global Positioning System (GPS) / Global navigation satellite system (GNSS)
   f) Global System
   g) --
   h) --
   i) --
2. **Onboard KAVACH:** comprises of the following-
   a) Onboard KAVACH
   b) RFID Readers
   c) Radio Modems with UHF Antenna
   d) Driver Machine Interface
   e) Global Positioning System (GPS) / Global navigation satellite system (GNSS)
   f) Global System for Mobile Communication (GSM) / General Packet Radio Service (GPRS) modems / Long Term Evolution (LTE)
   g) Pulse generators
   h) Brake Interface Unit (E-70/CCB)
   i) --
   j) --
   k) --
3. **Remote Interface Unit (RIU):** comprises of the following-
   a) RIU
   b) Repeater Relay Rack
   c) --
   d) --
   e) --

4. Name of PCB Modules & Serial Numbers:

4.1 Stationary KAVACH:

CRC of stationary KAVACH		**CRC of CPU card:**	
CRC of event Logger:		**Configuration CRC for Station, Signalling, Track Profile etc.**	

S. No.	Module Name	Module Part Number	Design Software and Hardware DXX SXXX HXX	Version No	Serial No
i.	~~CPU~~ Vital Computer Card-1				
ii.	~~CPU~~ Vital Computer Card-2				
iii.	Power Supply card				
iv.	BACK PLANE-				
v.	SM-OCIP				
vi.	GSM/GPRS/LTE Antenna		Make: Model:		
vii.	GPS/GNSS Antenna		Make: Model:		
viii.	Radio Modem		Make: Model:		

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ix.	RFID tag		Make: Model:		
x.	UHF Tower Antenna		Make: Model:		
xi.	Optic Fibre Switch		Make: Model:		
xii.	24V DC-DC Power Source		Make: Model:		
xiii.	Aviation Lamp		Make: Model:		
xiv.	Radio Antenna Cable		Make: Model:		
xv.	Ethernet Switch + OFC		Make: Model:		
xvi.	VDU		Make: Model:		
xvii.	----				
xviii.	----				
xix.	----				
xx.	----				
xxi.	----				

4.2 Onboard KAVACH:

CRC of Onboard KAVACH		**CRC of CPU card:**	
CRC of event Logger:		**Configuration CRC for brake parameter, train parameter etc.**	

S. No.	Module Name	Module Part Number	Design Software and Hardware DXX SXXX HXX	Version No	Serial No
i.	~~CPU~~ Vital Computer Card-1				
ii.	~~CPU~~ Vital Computer Card-2				
iii.	Power Supply card -110				
iv.	Power Supply card -72				
v.	BACKPLANE-2				
vi.	DMI Unit				
vii.	Radio Modem		Make: Model:		
viii.	Radio Antenna Cable		Make: Model:		
ix.	Radio Cable Patch Cords		Make: Model:		
x.	RFID Reader		Make: Model:		

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xi.	Radio Antenna (UHF Antenna)		Make: Model:		
xii.	GPS/GNSS Antenna		Make: Model:		
xiii.	GSM/GPRS/LTE Antenna		Make: Model:		
xiv.	~~Pulse Generator Set~~		~~Make:~~ ~~Model:~~		
xv.	E-70 Unit		Make: Model:		
xvi.	CCB Unit		Make: Model:		

4.3 RIU:

CRC of RIU	

S. No.	Module Name	Module Part Number	Design Software and Hardware DXX SXXX HXX	Version No	Serial No
i.	~~CPU~~ Vital Computer Card-2				
ii.	Power Supply card -110				
iii.	BACKPLANE				
iv.	Battery-Backed Power Supply				
v.	Battery charger				
vi.	SPD				
vii.	--				
viii.	--				

5. Acceptance Test

The following shall constitute acceptance tests:

i. Visual inspection.
ii. Insulation Resistance tests.
iii. Applied high voltage tests.
iv. Card level/ Module level check.
v. Card Level Functional Tests on all the cards.
vi. System-level functional tests / Performance tests
vii. System diagnostic tests.

5.1 Visual Inspection: Applicable for Stationary KAVACH, Onboard KAVACH & RIU
KAVACH equipment shall be visually inspected to ensure compliance with clause no. 25.3.1(a) of RDSO/SPN/196/2020 V-4.0 (SRS). The visual inspection will broadly include the following: -

#	SRS Cl. No.	Reference Documents Cl. No. (RDSO/SPN/144)	Test Performed	Observed Result	Remarks (Pass/Fail)
i.	25.3.1(a)	5.4.1	The front and back sides of the cabinets shall have the facility for completely locking the equipment.		
ii.	30.2	-	The words "**Indian Railways Property**" shall be engraved /embossed on every unit in letters of 5mm (minimum) at a conspicuous place.		
iii.	30.1	12.1	All markings/ indications shall be easily legible and durable. Where the marking is by use of labels, the labels shall be metallic and shall be firmly fixed and shall not be capable of being removed by hand. The durability of the marking shall be checked by rubbing the marking by hand with a piece of cloth soaked with petroleum spirit.		
iv.	30.1	12.2	All markings/ indications shall be placed in the vicinity of the components to which these refer and shall not be placed on removable parts if these parts can be replaced in such a way that the marking/indications can become misleading.		

#	SRS Cl. No.	Reference Documents Cl. No. (RDSO/SPN/144)	Test Performed	Observed Result	Remarks (Pass/Fail)
v.	30.3	12.4	The anodised name plate shall be firmly attached to the equipment and shall show the following information: a. Name of trademark of the manufacturer. b. Serial no. of the unit. c. RDSO specification number. d. Name of the equipment. e. Operating voltage: 110VDC/72 VDC or as appropriate. f. Month and year of manufacture		
vi.	25.3.1(a)	5.4.1	Dimensional check: Cards shall be housed in a 19", 6U/4U/3U mountable cabinet.		
vii.	28.1	…	General workmanship is satisfactory (Check whether all connections are made through crimped eyelets and are numbered with PVC cable marker rings).		
viii.	25.3.1(a)	…	Dust protection in the cabinet is provided.		
ix.	25.3.1(a)	…	Locking arrangement for equipment to prevent unauthorised access.		

5.2 Insulation Resistance Test:

5.3 High Voltage Test

Ref. documents: SRS Cl. No. 25.3.1 (b) & (c) and Cl. No. 9.5 of RDSO/SPN/144

Insulation Resistance test: This test shall be conducted between the equipment power supply line terminals and the earth. If there is a possibility of the megger voltage reaching the modules, these should be taken out before starting the IR Test. The measurement shall be made at a potential of not less than 500V DC.

High Voltage test: The equipment shall withstand for one minute without puncture and arcing a test voltage of 2000 volts rms applied between DC line terminals and earth. The test voltage shall be alternating of the approximately sinusoidal waveform of any frequency between 50 Hz and 100 Hz. **Printed circuit cards shall be removed.**

(i) Stationary KAVACH:

(Top Bin)

Procedure	Insulation Resistance values (Before High Voltage Test)		High Voltage		Insulation Resistance values (After High Voltage Test)		Result (Pass/Fail)
	Specified value	Measured value	Specified value	Measured value	Specified value	Measured value	
BP +Ve (Power Supply) and earth	≥ 10 MΩ		Equipment shall withstand for one minute without puncture and arcing		≥ 10 MΩ		
BN –Ve (Power supply) and earth	≥ 10 MΩ				≥ 10 MΩ		

(Bottom Bin)

Procedure	Insulation Resistance values (Before High Voltage Test)		High Voltage		Insulation Resistance values (After High Voltage Test)		Result (Pass/Fail)
	Specified value	Measured value	Specified value	Measured value	Specified value	Measured value	
BP +Ve (Power Supply) and earth	≥ 10 MΩ		Equipment shall withstand for one minute without puncture and arcing		≥ 10 MΩ		
BN –Ve (Power supply) and earth	≥ 10 MΩ				≥ 10 MΩ		

(ii) Onboard KAVACH:

(Top Bin)

Procedure	Insulation Resistance values (Before High Voltage Test)		High Voltage		Insulation Resistance values (After High Voltage Test)		Result (Pass/Fail)
	Specified value	Measured value	Specified value	Measured value	Specified value	Measured value	
BP +Ve (Power Supply) and earth	≥ 10 MΩ		Equipment shall withstand for one minute without puncture and arcing		≥ 10 MΩ		
BN –Ve (Power supply) and earth	≥ 10 MΩ				≥ 10 MΩ		

(Bottom Bin)

Procedure	Insulation Resistance values (Before High Voltage Test)		High Voltage		Insulation Resistance values (After High Voltage Test)		Result (Pass/Fail)
	Specified value	Measured value	Specified value	Measured value	Specified value	Measured value	
BP +Ve (Power Supply) and earth	≥ 10 MΩ		Equipment shall withstand for one minute without puncture and arcing		≥ 10 MΩ		
BN –Ve (Power supply) and earth	≥ 10 MΩ				≥ 10 MΩ		

(iii) RIU:

(Top Bin)

Procedure	**Insulation Resistance values (Before High Voltage Test)**		**High Voltage**		**Insulation Resistance values (After High Voltage Test)**		**Result (Pass/Fail)**
	Specified value	**Measured value**	**Specified value**	**Measured value**	**Specified value**	**Measured value**	
BP +Ve (Power Supply) and earth	≥ 10 MΩ		Equipment shall withstand for one minute without puncture and arcing		≥ 10 MΩ		
BN –Ve (Power supply) and earth	≥ 10 MΩ				≥ 10 MΩ		

(Bottom Bin)

Procedure	**Insulation Resistance values (Before High Voltage Test)**		**High Voltage**		**Insulation Resistance values (After High Voltage Test)**		**Result (Pass/Fail)**
	Specified value	**Measured value**	**Specified value**	**Measured value**	**Specified value**	**Measured value**	
BP +Ve (Power Supply) and earth	≥ 10 MΩ		Equipment shall withstand for one minute without puncture and arcing		≥ 10 MΩ		
BN –Ve (Power supply) and earth	≥ 10 MΩ				≥ 10 MΩ		

5.4 Card level/ module level check: Applicable for Stationary KAVACH, Onboard KAVACH & RIU

5.4.1 Card Level testing:

#	SRS Cl. No.	Reference Documents Cl. No. (RDSO/SPN/ 144)	Test Performed	Observed Result	Remarks (Pass/Fail)
i.	25.3.1 (d)	6.6	No extra wires or jumpers shall be used on the PCB.		
ii.	25.3.1 (d)	6.6	No piggyback PCB shall be connected to any PCB.		
iii.	25.3.1 (d)	6.10	The following description shall be etched/ engraved/ screen printed on the component side of the PCB: 1. Component outline in the proximity of the component 2. Manufacturers' name 3. PCB name 4. Equipment name and Version number.		
iv.	25.3.1 (d)	6.11	The following description shall be engraved/ screen printed on the PCB: a) The manufacturing serial no. (Printed or QR code sticker pasted) b) Month & year of manufacture. c) Version number		
v.	25.3.1 (d)	….	Whether the quality of soldering and component mounting is satisfactory		
vi.	25.3.1 (d)	6.8	Conformal Coating is provided		
vii.	25.3.1 (d)		Legend Printing is provided		

#	SRS Cl. No.	Reference Documents Cl. No. (RDSO/SPN/144)	Test Performed	Observed Result	Remarks (Pass/Fail)
viii.	25.3.1 (d)	6.9	Solder masks is provided on solder side and component side		
ix.	25.3.1 (d)	6.3	The thickness should be such that there should be no deformity in the PCB cards or the motherboard due to the mounting of heavy components or the ageing effect.		

5.4.2 **Modules Level testing:** Applicable for Stationary KAVACH, Onboard KAVACH & RIU

#	SRS Cl. No.	Reference Documents Cl. No. (RDSO/SPN/144)	Test Performed	Observed Result	Remarks (Pass/Fail)
i.	25.3.1 (d)	6.12	The PCB is mechanically polarized so that it is not possible to insert the PCB into wrong slot.		
ii.	25.3.1 (d)	5.2 (i)	General shielding arrangement of Individual cards is provided a metallic plate over the cards		
iii.	25.3.1 (d)	5.2 (ii)	Shielding at chassis/ rack level is provided		
iv.	25.3.1 (d)	5.3	Indications and/or displays are provided for diagnostic purpose.		
v.	25.3.1 (d)	5.4	Proper housing of cards		
vi.	25.3.1 (d)	--	All plugin connectors shall have lock-in arrangements		
vii.	25.3.1 (d)	--	**Dimensional of Stationary KAVACH**: Height: ------mm Length: ------mm Width: -------mm		
viii.	18.1 (FRS)	--	**Dimensional of Onboard KAVACH**: The dimension shall not exceed the maximum defined limit value of onboard equipment.		

<table>
<tr><th>#</th><th>SRS Cl. No.</th><th>Reference Documents Cl. No. (RDSO/SPN/144)</th><th>Test Performed</th><th>Observed Result</th><th>Remarks (Pass/Fail)</th></tr>
<tr><td></td><td></td><td></td><td>
<table>
<tr><th>SN</th><th>Description</th><th>Dimension (L×W×H) in mm³</th></tr>
<tr><td>(i)</td><td>Onboard KAVACH Unit</td><td>650x 435x 1150</td></tr>
<tr><td>(ii)</td><td>DMI Unit</td><td>400x 200x 420</td></tr>
<tr><td>(iii)</td><td>Radio Unit</td><td>310x 230x 340</td></tr>
<tr><td>(iv)</td><td>RFID Reader</td><td>560x 440x 630</td></tr>
<tr><td>(v)</td><td>CAB Input Box</td><td>300x 150x 400</td></tr>
<tr><td>(vi)</td><td>RF Antenna</td><td>410x 180x 260</td></tr>
<tr><td>(vii)</td><td>GPS_GSM Antenna</td><td>450x 250x 250</td></tr>
</table>
</td><td></td><td></td></tr>
<tr><td>ix.</td><td>25.3.1 (d)</td><td>--</td><td>Dimensional of RIU:

Height: ------mm
Length: ------mm
Width: -------mm</td><td></td><td></td></tr>
</table>

5.4.3 SRS Compliance Test:

SN	Clause No.	Parameter	Specification	Observed Value	Result (Pass/ Fail)
5.4.3.1 Stationary/LC/IB KAVACH System Requirement Compliance Test:					
1.	3.4.4.1	Architecture of Vital Computer	Minimum 2 out of 2 Architecture		
2.	3.4.4.2	Real Time Clock	Vital Computer shall have Real Time Clock synchronization facility with GNSS clock to synchronize with other KAVACH systems in hot standby manner.		
3.	3.4.4.3	Interface	i. Ethernet port to interface for connectivity with NMS.		
			ii. Two GSM/LTE interface for connectivity with KMS.		
			iii. Min. 08 Nos. of Ethernet Port in Stationary KAVACH (interface adjacent Stationary KAVACH, TSRMS and Radio communication (LTE/5G), EI etc.).		
			iv. Min. 06 ports in Stationary KAVACH to interface with OFC (Dark Fibre) for connectivity with RIU.		
			v. One USB or Ethernet port to downloading log/ other data for diagnostic purpose.		
			vi. One port to interface Video Display Unit (VDU) to show real time display of Loco movement.		
			Provision to interface with two number of Radio units.		
			Provision to interface with SM-OCIP		
5.4.3.2 Station Master Operation cum Indication Panel (SM-OCIP):					
4.	3.4.6.1		i. Station Master's Key		
			ii. LCD display (Minimum 4 Line x 20 char)		

SN	Clause No.	Parameter	Specification	Observed Value	Result (Pass/ Fail)
		Provision of Indication/ button/ buzzer	iii. SoS indication		
			iv. Health indication		
			v. Audio Buzzer		
			vi. Three Push Buttons (Common, SoS Generation and Cancellation) to generate and cancel the SoS.		
			vii. Electromechanical non-resettable 6-digit counter for recording SoS operation.		
			viii. TSR acknowledge button		
5.	3.4.6.3	Health Indication	Health Indication shall be flashing green if Stationary KAVACH is healthy and it shall be made blank when Stationary KAVACH is not healthy and RED indication shall glow.		
5.4.3.3	**Onboard KAVACH System Requirement Compliance Test:**				
6.	3.5.2.1	Architecture of Vital Computer	Minimum 2 out of 2 Architecture		
7.	3.5.2.2	Real Time Clock	Vital Computer shall have Real Time Clock synchronization facility with GNSS clock to synchronize with other KAVACH systems in hot standby manner.		
8.	3.5.2.3	Interface & other provision counters	To interface with train interface unit (Cab Input1, Cab Input2, Horn1, Horn2, Traction Cutoff, Train Integrity Status from EOTT).		
			To interface with brake interface unit (BP pressure feedback, BC1 pressure feedback, BC2 pressure feedback (optional), MR pressure, FSB, EB, KAVACH Isolation feedback).		
			To interface two direction sensing type speed sensor in each Pulse Generator. Provision shall be there to interface with two PGs.		
			To interface with Two RFID readers		

SN	Clause No.	Parameter	Specification	Observed Value	Result (Pass/ Fail)
			Provision to interface with BTM reader to read Balise fitted on the track in TPWS sections. **(Optional)**		
			Provision to interface with LP-OCIP (DMI).		
			Provision to connect 02 Nos. of GSM/LTE interfaces for connectivity with centralized Network Monitoring System and Key Management System.		
			USB interface for downloading of log & other data for diagnostic purposes.		
9.	3.5.2.8		Electromechanical non-resettable 6-digit counters for recording operation of Loco unit to Isolation Mode, Trip/Override & SoS (transmit/ receive).		
5.4.3.4	**Loco Pilot's Operation-cum-indication panel (LP-OCIP):**				
10.	3.5.5.3	Keys	i. Min. 12 soft keys (including 2 spare keys for future use), ii. 4 navigation (Up/ Down/ Left/ Right), Brightness Control Keys, Clear Key and Enter Key.		
11.	3.5.5.4	Push buttons	LP-OCIP shall have three push buttons, i. SOS (Red Color) ii. Cancel (Blue Color) iii. ACK/ Common (Black Color)		
12.	3.5.5.8	Indications	LP-OCIP shall have two indications (both in bi-color) to display system health status and SoS status.		
13.	3.5.5.9	Health indication	Onboard KAVACH unit shall display the System health status as Green as long as system is healthy otherwise it shall be displayed as Red.		
14.	3.5.5.10	SoS indication	Onboard KAVACH unit shall display the SoS indication as Green as long as no SoS (Transmit/		

SN	Clause No.	Parameter	Specification	Observed Value	Result (Pass/ Fail)
			Receive). It shall be displayed as Red, if SoS is received or transmitted.		
15.	3.5.5.11	Position switch	Two position switches of yellow color to change leading/ non-leading mode. This switch is not required for self-propelled vehicle.		
16.	3.5.5.12	Buzzer	Provision to electronic buzzer to generate audio alerts/ alarms.		
5.4.3.5	**Remote Interface Unit (RIU) System Requirement Compliance Test:**				
17.	3.4.7.8	Architecture	RIU shall consist of Vital Input modules minimum 02 out of 02 architecture.		
18.	3.4.7.4	OFC Connectivity for Ring Network	i. No. of Modem: 02 No. of ports in each modem: Min. 02.		
19.	3.4.7.6	Redundancy	A single RIU shall have provision to communicate with two adjacent RIUs.		
20.	3.4.7.7	Connectivity of field input	A single RIU shall be capable of handling at least 32 field inputs.		

6 Card Level Functional Tests on all the cards

6.2.1 Card level functional tests shall be carried out on ~~all the~~ each individual type card used in Stationary KAVACH and SM-OCIP as per firm's testing procedure:-

6.2.2 Card level functional tests shall be carried out on ~~all the~~ each individual type card used in Onboard KAVACH and DMI as per firm's testing procedure:-

6.2.3 Card level functional tests shall be carried out on ~~all the~~ each individual type card used in RIU as per firm's testing procedure:-

Example of Power Supply card (Top Bin) of Stationary KAVACH:- Template

Power Supply Card (Top Bin) - Voltage Regulation Test

Card	Output Voltage	19.2 V (-20% Range)			Nominal input Voltage 24.0 V			31.2V (+30% Range)			Voltage regulation (V.R.) between ±5% is OK.
		Output voltageat No Load	Output voltage at Full Load	V.R.	Output voltage at No Load	Output voltage at Full Load	V.R.	Output voltage at No Load	Output voltage at Full Load	V.R.	
Power Supply Card 1	4.5V ± 5%										
	6.2V ± 5%										
	5.0V ± 5%										
Power Supply Card 2	4.5V ± 5%										
	6.2V ± 5%										
	5.0V ± 5%										

Note: Voltages shall be measured at no load and full load. Voltage regulation at full load at nominal input voltage shall not be worse than ±1% for alloutput ranges, for input supply variation from –20% to +30% of nominal input voltage.

$$\text{Voltage regulation} = \frac{(\text{(No load output voltage)} - \text{(Full load output voltage)})}{\text{(No load output voltage)}} * 100\%$$

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Output Ripple Test

Card	Output Voltage	Ripple voltage (P-P) at full load at 19.2V (-20% Range)	Ripple voltage (P-P) at full load at 24V (Nominal Voltage)	Ripple voltage (P-P) at full load at 31.2V (+30% Range)	Ripple should be less than 50mv.
Power Supply Card 1	4.5V ± 5%				
	6.2V ± 5%				
	5.0V ± 5%				
Power Supply Card 2	4.5V ± 5%				
	6.2V ± 5%				
	5.0V ± 5%				

Self-Resetting Protection and Redundancy Test

Sr. No	Test Description	Expected Result	Observed Result	Remarks
1	Reduce the input voltage supply of Station KAVACH Unit below 24 VDC. Observe the voltage at which the power supply module shuts down anddelivers no output.	Shut down voltage should bebelow 19.2V		
2	Increase the input voltage supply of Station KAVACH Unit above 24 VDC. Observe the voltage at which the power supply module shuts down anddelivers no output.	Shut down voltage should beabove 31.2V		
3	Short circuit the D.C. output ofpower supply module.	Power supply module shutsdown on applying short circuit and restores on removal of short circuit.		
4	Remove the Input power connector for any one powersupply module.	System should work from other power supply modulewithout any change in the outputs.		

7 System-level functional tests / Performance tests

Functional Description:

Automatic Train Protection System (KAVACH) is a Microprocessor based SIL-4 system developed especially for Indian Railways. This system contains two major sub- systems: Stationary KAVACH and Onboard KAVACH. Onboard KAVACH will aid the loco pilot to supervise the movement authority and section speeds received from stationary KAVACH and reach the destination safely. During abnormal situations, Onboard KAVACH alerts the LP and applies brakes automatically to protect the train from incidents. Stationary KAVACH system enhances the safety of the railway operations by preventing SPAD and supervision of MRSP based on the signaling information received from existing interlocking systems. In the signaling and non-signaling territory, LOCO to LOCO communication based on virtual track circuits (TINs) and position report to prevent Head-on, Rear-end and side collisions.

Additional feature includes Cab-Signalling and supervision of Speed restrictions (Section speed, PSR, TSR, Turn Out speed). Communication exchange between Loco and Station units will be through full duplex Radio modems.

TSR Management System facilitates the railways to feed Temporary Speed Restrictions remotely into KAVACH territory. All Stationary KAVACH Subsystems are connected to TSRMS Subsystem on redundant IP based Communication Network. Graphical User Interface (GUI) in TSRMS Subsystem provides the user friendly interface to railways to add, update and delete Temporary Speed Restrictions into KAVACH Territory. The details of OHE Poles in RE Area and KM markers in Non-RE Area are maintained in TSRMS database. The Stationary KAVACH Subsystem will communicate the TSR to Onboard KAVACH on basis of train route. Onboard KAVACH guides the LP to maintain the Train Speed within the TSR Speed limit and will automatically applies the brakes in case of exceed of permitted speed.

The DMI shows the following information.

- Current speed of the Loco (through the dial pointer)
- Loco mode, Loco ID, Date and Time stamp
- Movement Authority Target Speed/Max speed allowed (in green), exceeding speed limit (in orange).

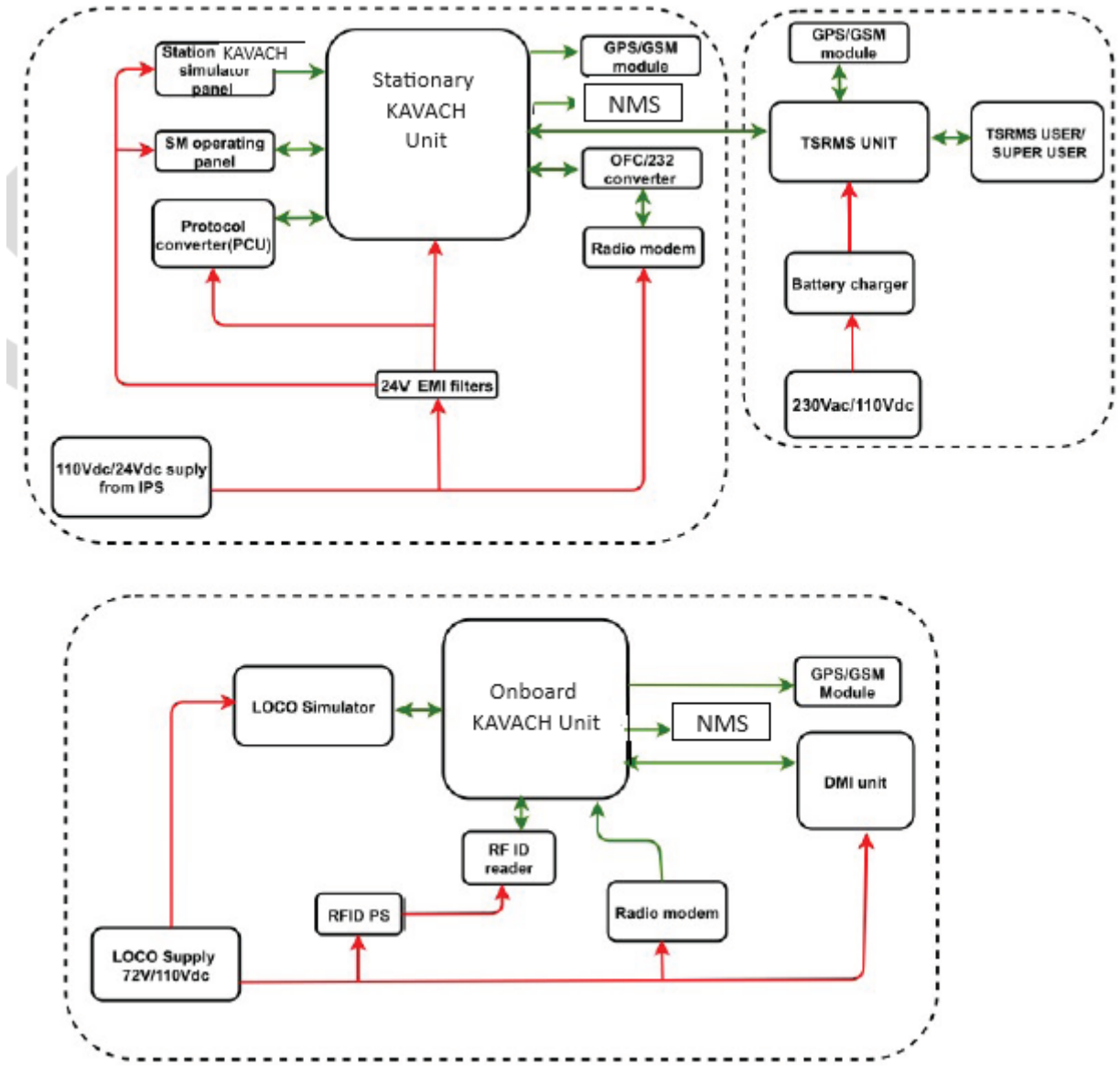
- Aspect of the approaching signal along with route indicator, if any.
- Distance to the approaching signal and signal Information.
- Emergency messages like SOS of Station
- Target Speed/ Release distance at PSR/TSR/Turn outs.

Test Procedure (Functional):

i. The Stationary KAVACH Subsystem is powered from the external power supply of 110V DC (input supply variation from –20% to +30% of nominal input voltage). The power input is given as per the connection details provided in the. Test Setup Diagram. All Subsystems card shall be programmed with the functional Test Program before starting the test. The following block diagram shows the connectivity details to test the Stationary KAVACH Subsystem.

ii. At Power ON, after successful completion of the power on self-test, Onboard KAVACH system enters into Stand-by mode. Press "SR" key followed by "CNFM" button, to enter into SR mode. After swiping two RFID tags by using RFID Tag simulator tool it gets the direction and transmits the Loco position report to stationary KAVACH to receive the MA. When the Stationary KAVACH unit receives the position report, it will send the MA, aspect of the approaching signal and static speed profile. Onboard KAVACH displays the MA and signal aspect in DMI only after passing any one stop signal.

iii. Feed the sample TSR information from Graphical User Interface. After Confirmation and Submission of TSR information by Super User, Check TSR is supervised by Onboard KAVACH. TSR Target shall be displayed on DMI.



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7.2 Stationary KAVACH functional test:

Sno.	Test Description	Expected Result	Observed Result	Remarks (Pass/Fail)
1.	To check stationary KAVACH shall perform automatic self-test when the equipment is switched ON.	a) System OK" message shall be displayed on SM-OCIP. b) Health OK LED shall glow on SM-OCIP.		
2.	To check the LEDs indication of all the modules/cards showing healthy or not.	LED indications of the modules/cards shall be ON/Green/Blinking, when the System is healthy.		
		LED indications of the modules/cards shall be OFF/Red/Not Blinking, when the System is un-healthy.		
3.	Check for Radio communication when Radio-1 health of a Station KAVACH Fails.	The Concerned Station packets should be available in every cycle and Stationary KAVACH shall be in healthy state.		
4.	Check for Radio communication when Radio-2 health of a Station KAVACH Fails.	The Concerned Station packets should be available in every cycle and Stationary KAVACH shall be in healthy state.		
5.	Check for Radio communication when Radio-1 & 2 both radios health Fails.	RADIO fail fault should get declared and Health Fail LED shall glow on SM-OCIP.		
6.	Connect GPS-1 antennae and disconnect GPS-2 antenna.	1. GPS-2 fault message will be displayed on SM-OCIP display. 2. Stationary KAVACH will enter into normal operation.		
7.	Connect GPS-2 antennae and disconnect GPS-1 antenna.	1. GPS-1 fault message will be displayed on SM-OCIP display. 2. Stationary KAVACH will enter into normal operation.		
8.	To check generation of manual SOS from SM-OCIP. Press SOS + COMMON push buttons for SOS generation.	Case-1: When SM-OCIP key is in ON condition and press SOS + COMMON: - a) SOS LED shall lit on SM-OCIP. b) SOS messages from station shall be displayed.		

Sno.	Test Description	Expected Result	Observed Result	Remarks (Pass/Fail)
		c) Counter shall be incremented to next number.		
		Case-2: When SM-OCIP key is in OFF condition / removed. SOS operations shall not be possible.		
9.	To check cancellation of manual SOS from SM-OCIP. Press COMMON + CANCEL push buttons for cancellation SOS.	COMMON + CANCEL: - SOS LED shall not lit. SOS messages from station shall be removed on SM-OCIP.		
10.				
11.				
12.				

N				

7.3 Onboard KAVACH functional test:

Sno.	Test Description	Expected Result	Observed Result	Remarks (Pass/Fail)
1.	1. Power ON self-test and prompt for mode transition from SB mode to "Select Staff Responsible or Shunt Mode". 2. Power-On the Onboard KAVACH and Keep Leading/ Non Leading switch in Leading position. 3. Performs Automatic Power- On Self-Test. 4. Prompts for Train Configuration, select any train type configuration (Config + CNFM). 5. After selection of train configuration, prompts for mode transition. 6. Select SR button followed by CNFM button.	1. System performs automatic power-On Self-Test.		
		2. "System self-test success" message shall be displayed on DMI.		
		3. After selection of Train Configuration, "Brakes Testing Success" message shall be displayed on DMI.		
		4. Select Train Configuration Message shall be displayed. After selection of Train configuration. Selected train type shall be displayed and select SR or SH mode message shall be displayed on DMI.		
		5. After selection of SR mode, mode shall be changed to SR mode.		
2.	Booting Time of Onboard KAVACH	Shall not more than **2 minutes** (including brake test).		
3.	To check the LEDs indication of all the modules/cards showing healthy or not.	LED indications of the modules/cards shall be ON/Green/Blinking, when the System is healthy.		
		LED indications of the modules/cards shall be OFF/Red/Not Blinking, when the System is un-healthy.		
4.	Check for Radio communication when Radio-1 health of a Onboard KAVACH Fails.	Onboard KAVACH shall be in healthy state. RF symbol shall be displayed in DMI.		
5.	Check for Radio communication when Radio-2 health of a On board	Onboard KAVACH shall be in healthy state. RF symbol shall be displayed in DMI.		

Sno.	Test Description	Expected Result	Observed Result	Remarks (Pass/Fail)
	KAVACH Fails.			
6.	Check for Radio communication when Radio-1 & 2 both radios health Fails.	Signal aspects, MA and RF symbol shall be cleared in DMI.		
7.	To check generation of manual SOS from LP-OCIP. Press SOS + COMMON push buttons for SOS generation.	SOS LED shall lit on LP-OCIP. SOS messages shall be displayed on LP-OCIP. Buzzer Alarm shall be generated. Counter shall be incremented to next number.		
8.	To check cancellation of manual SOS from SM-OCIP. Press COMMON + CANCEL push buttons for cancellation SOS.	a) SOS LED shall not lit. b) SOS messages from station shall be removed on SM-OCIP.		
9.	Remove RFID Reader-1 connection from Onboard KAVACH when it is operational.	1. Onboard KAVACH shall log RFID Reader failure along with date and time stamp. 2. Onboard KAVACH shall automatically switch to RFID Reader-2. 3. Programme the sample tag data as per Annexure-D. Simulate the RFID Tag with RFID Reader-2 at distance of 0.75meters(750mm). RFID tag shall be displayed in DMI and log to be verified for tag data.		
10.	Remove RFID Reader-2 connection from Onboard KAVACH when it is operational.	1. Onboard KAVACH shall log RFID Reader failure along with date and time stamp. 2. Onboard KAVACH shall automatically switch to RFID Reader-1.		

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Sno.	Test Description	Expected Result	Observed Result	Remarks (Pass/Fail)
		3. Programme the sample tag data as per Annexure-D. Simulate the RFID Tag with RFID Reader-1 at distance of 0.75meters(750mm). RFID tag shall be displayed in DMI and log to be verified for tag data.		
11.	Remove both RFID Reader-1 and RFID Reader-2 connection from Onboard KAVACH when it is operational.	1. Onboard KAVACH shall log RFID Reader failure along with date and time stamp. 2. Onboard KAVACH shall transit to System Failure Mode.		
12.	Connect two number speed sensor with Onboard KAVACH.	Simulate the speed of 200 Kmph and check that speed is shown in DMI.		
13.	Remove one number speed sensor with Onboard KAVACH.	System shall transit to failure mode. Repeat the same with other speed sensor.		
14.				
15.				
16.				
--				
N				

7.4 Remote Interface Unit functional test:

Test ID	Clause of RIU Spec.	Test Scenario	Input Specification	Expected Output/Values	Observed output (Pass/Fail)
1.0	**To check RIU Interface requirement with stationary KAVACH**				
a)	J3.1 & J3.3	**OFC Ring Mode Functional Test:** Connect 06 RIU with stationary KAVACH as per figure-1 on redundant OFC dark fiber	a) Remove the OFC patch cable (1) between P Tx/Rx of Stationary KAVACH OFC module and S Tx/Rx of Remote Interface Unit OFC module. b) Restore the removed OFC patch cable	a) RIU inputs status shall not be changed in NMS. "RIU- Primary OFC link fail" message shall be shown in NMS prompt window. b) "RIU – Primary OFC link recovered" message shall be shown in NMS prompt window. c) Check that failure of communication link logged in the NMS. d) Failure communicated in defined number with SMS	
b)	J3.1 & J3.3	OFC Ring Mode Functional Test:	a) Remove the OFC patch cable (2) between S Tx/Rx of Stationary KAVACH OFC module and P Tx/Rx of Remoter Interface Unit OFC module. b) Restore the removed OFC patch cable (1)	a) RIU inputs status shall not be changed in NMS. "RIU- Secondary OFC link fail" message shall be shown in NMS prompt window. b) RIU – Secondary OFC link recovered" message shall be shown in NMS prompt window. c) Check that failure of communication link logged in the NMS. d) Failure communicated in defined number with SMS	

Test ID	Clause of RIU Spec.	Test Scenario	Input Specification	Expected Output/Values	Observed output (Pass/Fail)
c)	J3.1, J3.3& J3.6	Communication Failure Test	a) Remove both (1) and (2) OFC patch cables b) Restore the removed OFC patch cables	a) RIU inputs shall be shown as blank in NMS "RIU- Primary OFC link fail" & "RIU-Secondary OFC link fail" message shall be shown in NMS prompt window. b) Status of RIU inputs shall be reflected in NMS. "RIU – Primary OFC link recovered" & "RIU – Secondary OFC link recovered "messages shall be shown in NMS prompt window. c)Check that failure of communication link logged in the NMS. d)Failure communicated in defined number with SMS.	

Test ID	Clause of RIU Spec.	Test Scenario	Input Specification	Expected Output/Values	Observed output (Pass/Fail)
e)	J3.2	To check the KAVACH capability to connect with 06 RIU each in 06 direction through hardware connection in different port. *Stationary KAVACH shall be able to connect minimum 06 Remote Interface Units in one direction (up & down towards one side of a station is considered as one direction).*	a) Connect 06 RIU in different port for the 06 direction. Each port shall be connected with minimum 01 RIU. b) Connect simulation panel to each RIU for checking the signal status. c) Simulate the signal aspect by ON/OFF to each RIU and checks that necessary input changes in the NMS.	Simulation signal aspect shall be reflected in the NMS.	
f)	J3.9.3	To check the failure of communication link with 01 RIU shall not result in failure of other 05 RIU	a) Connect 06 RIU in ring manner and check that all RIU working properly. b) Remove communication both link 1& 2 of one RIU	Check that all other RIUs working properly by simulating the signals via simulating panel.	
g)	J3.9.4	To check module wise health monitoring	a) Connect RIU to as per figure 1. b) Remove the card i.e field input card, VCC card etc one by one	Check that module wise health monitoring is indicated in NMS.	
h)	J3.5	*Note down the check sum*	----		

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Test ID	Clause of RIU Spec.	Test Scenario	Input Specification	Expected Output/Values	Observed output (Pass/Fail)
2.0	**Check for the RIU power supply , surge protection**				
a)	J3.8.1	*To check the power supply arrangement of battery charger and input operating voltage of battery charger*	a) Connect battery charger to variable 230 volt AC supply/110 Volt DC. b) Vary the 230 volt/110 Volt DC supply to the battery charger 260 volt. c) Reduce 230 volt/110 Volt DC supply to the battery charger 100 volt.	a) Check that battery charger working correctly & note charging voltage is correct. b) Check that battery charger working correctly & note charging voltage is correct. c) Check that battery charger working correctly & note charging voltage is correct.	Variation in output voltage should not be more than 5%
b)	J3.8.1	*RIU shall be connected with battery backup and charger*	a) RIU shall be connected to battery backup with charger. b) Switch Off the 230 V AC/110 Volt DC input to the battery charger. c) Operate the simulation panel switch during testing. d) Check that battery back up support for minimum 02 hour	a) Check the battery voltage after 02 hour testing. b) It should not be less than 80% of 24 volt i.e. less than 19.2 volt.	
c)	J3.8.2	*To check the working environment of battery temperature*	*Take the data sheet and certificate from the firm and record.*	----------	

Test ID	Clause of RIU Spec.	Test Scenario	Input Specification	Expected Output/Values	Observed output (Pass/Fail)
d)	J3.8.3	*To check the alarm generation from battery charger if no 230 volt/*110 Volt DC *input is available to battery charger*	a) Connect 230 volt/110 Volt DC power supply. b) Check that charger working properly. c) Switch OFF the 230 volt/ 110 Volt DC supply and check that AC input fails alarms generated for all 06 RIU with their number. d) Check the above for all 06 RIU.	a) Check that fails alarm generated for each RIU. b) Alarm generated in NMS for particular RIU charger supply input fail and SMS of these alarms to the configured mobile number. c) Check the same for 06 number of RIU**.**	
e)	J3.8.3	*To check the alarm generation for battery charger fail*	a) Connect 230 volt/110 Volt DC power supply. b) Check that charger working properly. c) Remove the output of charger to battery terminal and alarms generated for all 06 RIU with their number. d) Check the above for all 06 RIU.	d) Check that fails alarm generated for each RIU. e) Alarm generated in NMS for particular RIU battery charger fails and SMS of these alarms to the configured mobile number. f) Check the same for 06 number of RIU**.**	
f)	J3.8.3	*To check the alarm generation for low battery voltage indication*	a) Connect 230 volt / 110 Volt DC power supply. b) Check that charger working properly. c) Discharge the battery upto low voltage indication i.e 10 % (21.6 Volt) d) Check the above for all 06 RIU.	g) Check that fails alarm generated for each RIU. h) Alarm generated in NMS for particular RIU battery low voltage indication and SMS of these alarms to the configured mobile number. i) Check the same for 06 number of RIU**.**	

Test ID	Clause of RIU Spec.	Test Scenario	Input Specification	Expected Output/Values	Observed output (Pass/Fail)
g)	J3.8.4	*To check the surge protection arrangement in RIU*	a) Surge protection device arrangement to the RIU for input and out cables. b) Collect the data sheet.	------	

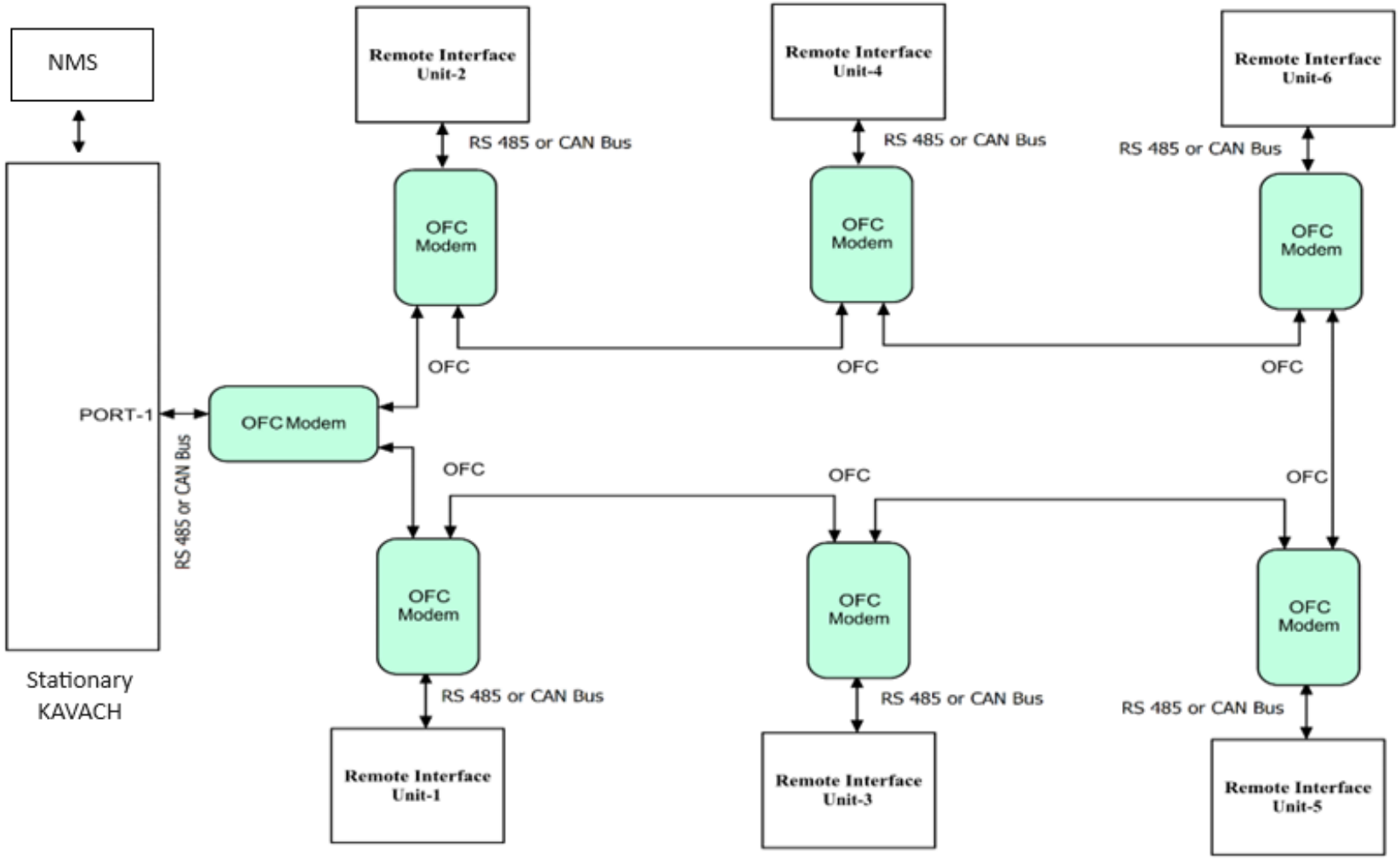

FIGURE-1

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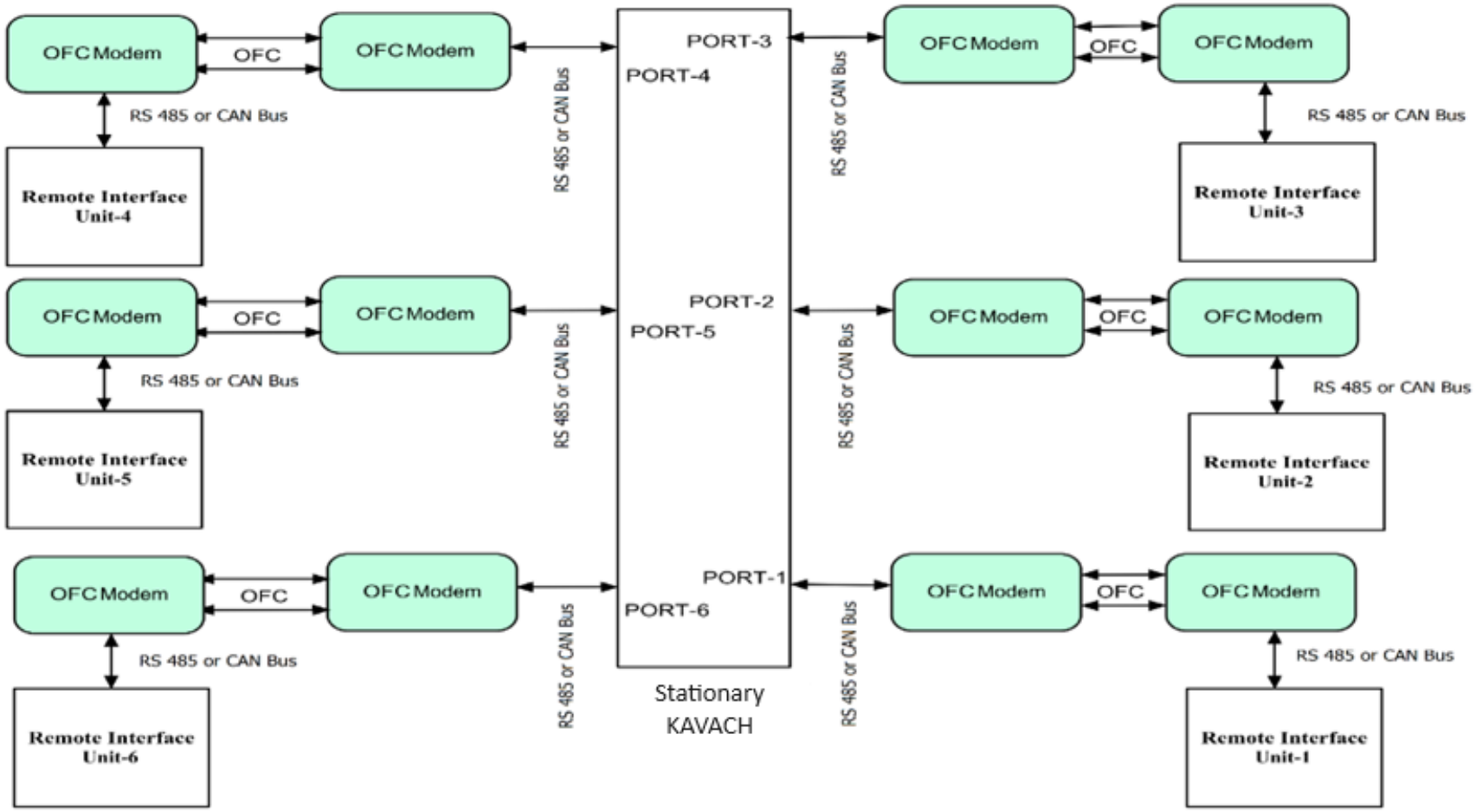

Figure-02

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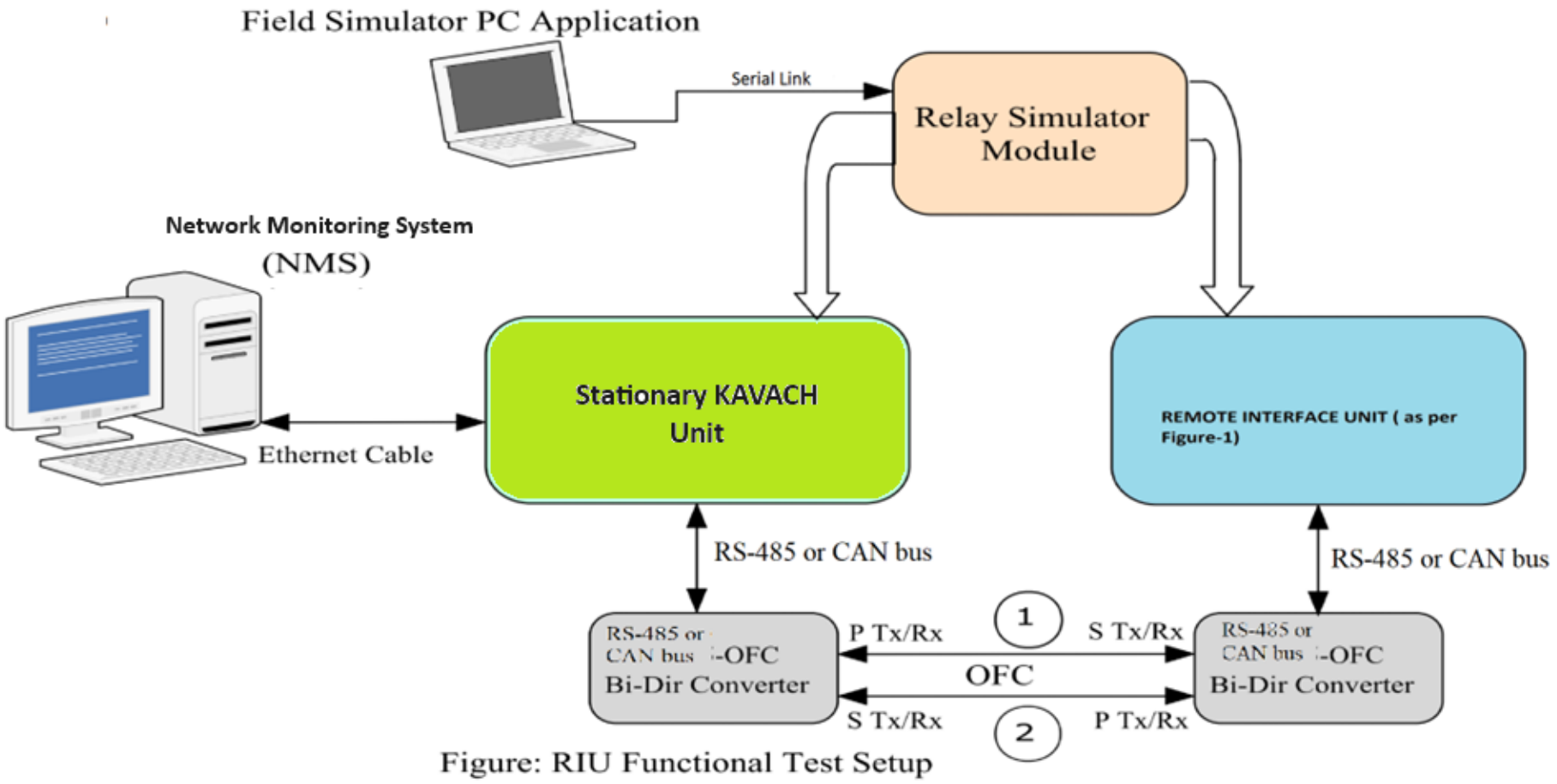

Figure: RIU Functional Test Setup

Figure-03

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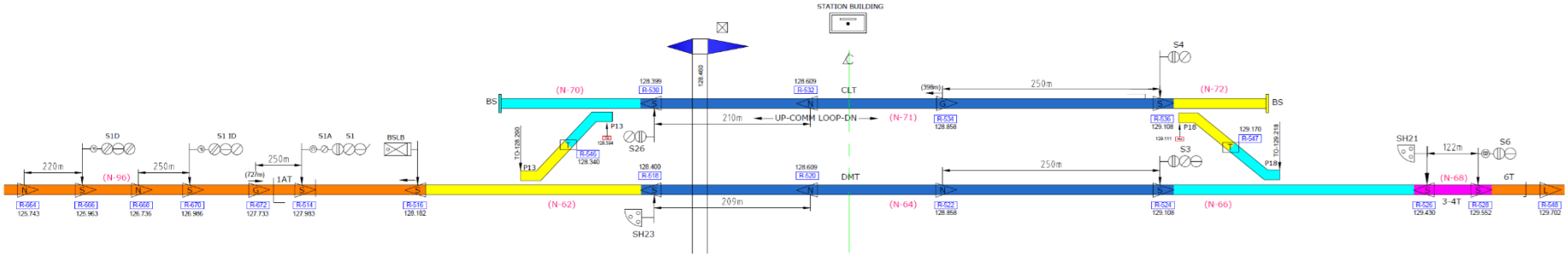
7.5 System level functional testing (Integrated)

1. Integrated figure (To added by firm)
2. Test yard layout



At Power ON, after successful completion of the Power-On-Self-Test Onboard KAVACH enters into Standby Mode; subsequently, the LP is prompted for selected of the Staff Responsible (SR) Mode. After swiping two RFID (by simulation or physical swipe) tags it gets the direction and transmits the Loco packet to stationary KAVACH. When the Stationary KAVACH unit receives an Access-request packet from the Loco unit, it will send the Access-authority packet; the Loco, after processing Access-authority, transmits a onboard regular packet; upon successfully processing a regular packet from the Loco, the Station transmits regular packets that comprise of Movement Authority, aspect of the approaching signal etc., i.e., the Distant signal. As the no route is set in the simulator panel for the test yard, a Double yellow aspect will be displayed on the DMI and MA will be shown up to Home Signal.

#	Test Function/Procedure	Expected Result
1	Signal Passed At Danger (SPAD): Ensure that the inner distant signal and Home signal are showing as yellow and red respectively on the simulator panel. Increase the speed by using the Loco simulator.	1. The aspect of the Inner Distant signal and its distance shall be displayed on the DMI display. The distance to the signal post should be changing dynamically based on the speed of the Loco. 2. When the Loco Passes Inner Distant Signal, the stationary KAVACH unit shall send an aspect of the Home signal as Red and Movement Authority up to the Home Signal. 3. The Onboard KAVACH shall update the aspect of the Home signal (Red), Movement Authority on the DMI display. 4. The current speed of the Loco shall be updated on the DMI display and at the same time Movement authority shall be decreasing gradually. When the Loco reaches the Home Signal, Loco unit shall apply the brakes and should stop in the rear of the Home Signal.

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#	Test Function/Procedure	Expected Result
		5. The icons of "Normal Service Brake/Full-Service Brake/Emergency Brake" will be displayed on the DMI display and respective indications should glow at the Loco simulator panel.
2	Loop Line Speed Control: Set the route to clear the Home Signal for the loop line and inject the RFID tags as per the locations. The speed of the Loco shall be increased more than the turn-out speed (up to 50 kmph) with the help of the Loco simulator panel.	1. The station unit shall send the aspect of the Home signal as Yellow with route indicator, distance up to the turnout commencement, and turnout speed as 30kmph. The same shall be observed on the DMI display. When the Loco approaches the point, it shall apply brakes (sufficiently in advance). 2. FSB indication led should glow at the loco simulator Panel. Loco should pass with the permitted speed (30kmph) up to the Loop line starter.
3	The exit of Loco from KACACH territory: Clear Loop line starter and Advance Starter with the help of the simulator panel and inject RFID tags as per their placement. After passing the Loop line starter signal; After passing the exit RFID tag	The loop line starter aspect (Yellow) shall be observed on the DMI display. The Loco unit shall update the aspect of the Advance starter signal (Green) and Movement Authority on the DMI display. The loco mode should change to SR mode.

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7.6 System diagnostic tests

7.6.1 Stationary KAVACH: System Diagnostic Test shall be carried out as per firm's testing procedure on Stationary KAVACH and SM-OCIP.

7.6.2 Onboard KAVACH: System Diagnostic Test shall be carried out as per firm's testing procedure on Onboard KAVACH, BIU, RFID Reader and LP-OCIP.

7.6.3 RIU: System Diagnostic Test shall be carried out as per firm's testing procedure on RIU.

7.6.3.1 System Diagnostic test:-

Sr. No	Test Description	Expected Result	Observed Result	Remarks
1	a) Remove AC input power for Battery Charger b) Restore the AC input power	a) Input fail and output/charger fail alarm shall be generated and be logged b) Input fail and output/charger fail alarm shall be vanished and be logged		
2	a) Short circuit the DC output of battery charger b) Remove the short circuit	a) Output/Charger fail alarm shall be generated and be logged. b) Output/Charger fail alarm shall be vanished and be logged		
3	a) Simulate Low battery fault b) Restore low battery fault	a) Low battery alarm shall be generated and be logged. b) Low battery alarm shall be vanished and logged.		
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N				