TYPE APPROVAL TEST REPORT

Report No. ARAI/AED/20192020/300009764/TA/1391 **CONFIDENTIAL**
Dated: 6-DEC-2019

1.0	**Name and Address of the Customer**	Pointer Telocation India Pvt Ltd, 204 2nd Floor Pentagon 3, Magarpatta City, Hadapsar, Pune – 411028 Maharashtra	
2.0	**Customer Letter Reference**	Email dated : 11-Oct-2019	
3.0	**Test Objective**	**Component Level Type Approval:** Testing of Intelligent Transport Systems (ITS) as per AIS 140: 2016 and amendment 1 (11th December 2017) and amendment 2(5th December 2018) notified vide S.O 5453 (E) & S.O 5454 (E)dated 25th Oct 2018.	
4.0	**Description of the Device Under Test (DUT)**	DUT Name	Vehicle tracking device with emergency buttons
		Manufactured by	Pointer Telocation Ltd., Cellocator Division, 14 Hamelacha Street, Rosh Ha'ayin, Israel
4.1	**Vehicle Tracking Device**	Model Name	Cello CANiQ-IRN
		Model No	CT7800156-000
		Hardware Version	A
		Software Version	38m
		Unique Identification Number	PNT2C2A
		GNSS chip Make and Model	Quectel LC79D
		GNSS Constellation	IRNSS and GPS
		GSM chip Make and Model	Telit GE910-Quad V3
		Embedded SIM Make	Sensorise
		Service Providers	Vodafone , Idea & BSNL
		3 axis accelerometer and 3 axis gyroscope Make & Model	Accelerometer :LIS331DLH , Gyro:L3GD20H
4.2	**Emergency Button**	Make and Part No.	Esbee Electrotech LLP and SOS Switch

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ARAI Homologation & Technology Centre (ARAI-HTC), Chakan
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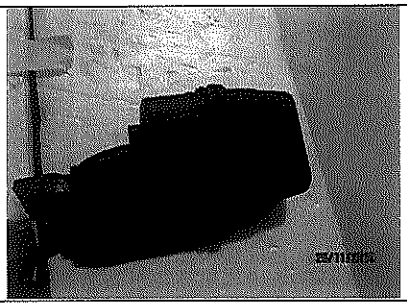
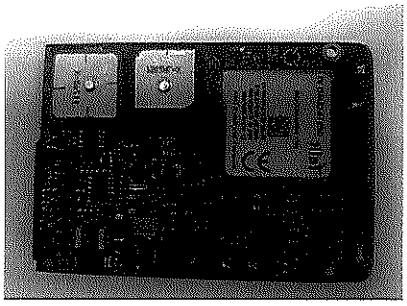
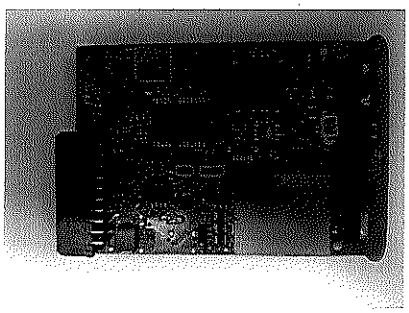
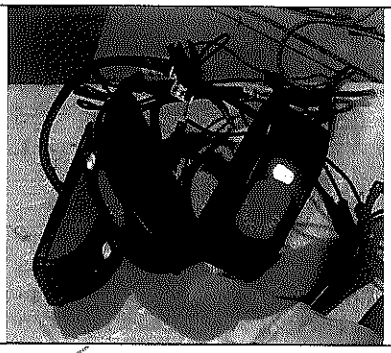
5.0	Condition of the Test Component	The test components were received in good condition.
5.1	Vehicle Tracking Device	
5.2	PCB	 
5.3	Emergency Button	

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6.0 Laboratory Environment condition			
Temperature	27.2°C	Humidity	48%

7.0 Power Supply Details			
Voltage	12V and 24V	Current Consumption	< 1 A

8.0 DUT Details:

DUT is a Vehicle Tracking System with Emergency Button Powered with 12V and 24V DC power supply. DUT has internal battery of 3.7 V. Tracking functionality test as per table 6A of AIS 140:2016, Amendment 1 and Amendment 2 was performed before, during and after each test.

9.0 FUNCTIONAL STATUS CLASSIFICATION

9.1 Class A

All functions of a device/system perform as designed during and after exposure to disturbance.

9.2 Class B

All functions of a device/system perform as designed during exposure: however, one or more of them can go beyond specified tolerance. All functions return automatically to within normal limits after exposure is removed. Memory functions remain Class A.

9.3 Class C

One or more functions of a device/system does not perform as designed during exposure but returns automatically to normal operation after exposure is removed.

9.4 Class D

One or more functions of a device/system does not perform as designed during exposure and does not return to normal operation until exposure is removed and the device/system is reset by simple "operator/use" action.

9.5 Class E

One or more functions of a device/system does not perform as designed during and after exposure and cannot be returned to proper operation without repairing or replacing the device/system.

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10.0 Test Details and Result:

Clause No.	Requirement	Observation	Remark
3.0	ITS FUNCTIONS AND REQUIREMENTS		
	Safety and Security: Emergency Buttons and Vehicle Location Tracking (VLT), The above functions and their requirements shall be met by only single device that can be interfaced by external emergency buttons. The communications to Backend Control Server (Government authorized server) shall be done by device as per the protocol and functionalities defined below.		
3.1	Vehicle Location Tracking (VLT) With Emergency Button		
3.1.1	Functional Requirements for VLT		
3.1.1.1	Device shall be capable of obtaining position information using Global Navigation Satellite System (GNSS). GNSS receiver specifications are as follows:		
a	Device shall be capable for operating in L and/or S band and include support for NAVIC/IRNSS (Indian Regional Navigation Satellite System) for devices installed on vehicles manufactured on or after 1st April, 2019. However, VLT devices shall be complaint as per other GNSS constellation in the interim period.	DUT is capable for operating L1 band (1.57542 GHz) for GPS and L5 band (1176.45MHz) for IRNSS constellation.	Satisfactory.
b	The Device shall support GAGAN, the Indian SBAS (Satellite Based Augmentation System).	Verified from component datasheet.	Satisfactory.
c	Device shall have a position accuracy of minimum 2.5 m CEP or 6 m 2DRMS.	Tested and verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
d	Device shall have an acquisition sensitivity of minimum (-) 145 dBm with GNSS/ (-) 140 dBm IRNSS (NAVIC as applicable).	Observed acquisition sensitivity is (-) 145 dBm with GPS & -140 dBm for IRNSS	Satisfactory.
e	Device shall have a tracking sensitivity of minimum (-) 160 dBm with GNSS/ (-) 153 dBm IRNSS (NAVIC as applicable).	Observed acquisition sensitivity is (-) 160 dBm with GPS and -153 dBm for IRNSS.	Satisfactory.
f	Device shall have an internal antenna; however, if in case of Integrated systems with vehicle OEM fitted kits if the fitment location prevents the internal antenna from functioning, then additional external antenna may be provided	DUT has inbuilt internal antenna.	Satisfactory.
3.1.1.2	Device shall support standard minimum I/Os as mentioned: 4 Digital, 2 Analog Input and 1 Serial Communication (e.g. RS232) for interfacing external systems (E.g. Digital input for Emergency request button interfacing).	DUT has 4 digital I/O, 2 analogue I/O and One Serial interface.	Satisfactory.
3.1.1.3	Device shall be capable of transmitting data to Backend Control Server (Government authorized server) via Wide Area (Mobile) Communications network (Cellular) as per Communication Protocol in Section 4.	Verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
3.1.1.4	Device shall be capable of transmitting Position, Velocity and Time (PVT data) along with heading (direction of travel) to a Backend Control Server (Government authorized server) at configurable frequency as per Communication Protocol of Section 4. The fixed frequency shall be user configurable. Highest data transmission rate shall be 5 sec during vehicle operation and not less than 10 minutes in sleep/IGN OFF) as per the protocol defined in Communication Protocol of Section 4.	Verified.	Satisfactory.
3.1.1.5	Device shall be capable of transmitting data to minimum 2 different IP addresses (1 IP address for regulatory purpose (PVT data) and 1 IP address for Emergency response system other than the IP's required for Operational purpose.	Verified.	Satisfactory.
3.1.1.6	On pressing of Emergency button, the system implementing VLT function shall send emergency Alert (Alert ID 10 as mentioned in Subsection 4.2.1 of Communication Protocol Section 4) to the configured IP address(s) as per the Communication Protocol mentioned in Section 4. In the absence of Cellular network, the emergency alert shall be sent as SMS message along with vehicle location data to configured control center number(s). The SMS shall consist parameters as given in Sub-section 4.2.2.	Verified.	Satisfactory.
3.1.1.7	Device shall have an internal back-up battery to support 4 hours of normal operations (to be tested for positional record transmission at a frequency of 60 sec).	Tested.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
3.1.1.8	Device shall be capable of transmitting alerts to the Backend Control Server (Government authorized server) directly. The applicable list of alerts is given in Section 4.2 (Alert ID 3 to 12) of Section 4.	Verified.	Satisfactory.
3.1.1.9	Device shall support over the air software and configuration update.	Verified.	Satisfactory.
3.1.1.10	Device shall support basic standard configuration (Mobile communications network settings, Backend Control Server (Government authorized server) details, data frequencies, alert thresholds etc.) as per configuration specification defined in Section 4.	Verified.	Satisfactory.
3.1.1.11	Device shall support store and forward mechanism for all type of data (periodic data and alerts) meant for backend transmission. The system shall store data in internal memory during communication network un-availability and transmit the data when the connection resumes in last in first out (LIFO) manner. The live data shall be given higher priority for transmission than back log (stored data) at any point in time.	Verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
3.1.1.12	The Device shall have a unique identifier for identifying the VLT device and data. The unique ID shall be stored in a read only memory area so that it cannot be altered or overwritten by any person. The unique identifier is IMEI (International Mobile Station Equipment Identity) Number.	Verified.	Satisfactory.
3.1.1.13	Device shall store/write the registration number of the vehicle in the internal nonvolatile memory.	Verified.	Satisfactory.
3.1.1.14	Device shall have an Embedded SIM/UICC	Verified.	Satisfactory.
3.1.1.15	Device shall be designed to operate 12V DC and or 24 V DC	DUT works on 12 V and 24 V DC.	Satisfactory.
3.1.1.16	Device shall have a sleep mode current ≤50 mA.	Sleep mode current is 2.14 mA.	Satisfactory.
3.1.1.17	Device shall support any operational GNSS system with 12 (minimum) acquisition channels	DUT supports GPS and IRNSS constellation with more than 12 channels as verified from component datasheet.	Satisfactory.
3.1.1.18	The Device shall support:		
	Location on Cellular/SMS	Verified.	Satisfactory.
	Non-volatile memory to store min 40,000 positional log	Verified.	Satisfactory.
	Configurable backup SMS facility in case of Cellular failure	Verified.	Satisfactory.
	Capability to send serving and adjacent cell ID as well as network measurement report (NMR)	Verified.	Satisfactory.
3.1.1.19	The VLT Device shall have:		
	The capability of Hot start <10s	1 sec	Satisfactory.
	The capability of Warm start : < 60s	30 sec	
	The capability of Cold start < 120 s	35 sec	
3.1.1.20	Device shall support data Outputs as per protocol covered in this standard.	Verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
3.1.1.21	The Device Cellular module shall have:		
	Multi slot Cellular with In - built Quad-band GPRS module/Modem	Verified from component datasheet.	Satisfactory.
	Cellular class 10 or above	Verified from component datasheet.	Satisfactory.
	Support Embedded SIM/UICC to cater to the automotive operational requirement such as vibration, temperature and humidity and provide long life span with at least 10 years life and more than 1 million read/write cycles	Verified from component datasheet.	Satisfactory.
	Cellular module & SIM/UICC shall support • SMS, Data (Cellular, TCP/IP) and • Support multiple network OTA switching (on-demand/automatic) capabilities.	Verified.	Satisfactory.
3.1.1.22	Device shall be dust, temperature, vibration, water splash resistant, IP 65 rated or better, tamper proof as per Section 6.	Refer clause No. 6.3.2 and 6.3.3	Satisfactory.
3.1.1.23	Device shall be manufactured by manufacturer whose quality management system has been certified for compliance to ISO / TS 16949 or ISO 9001 or any equivalent National or International standard.	Certificate of management system as per ISO 9001: 2015 for design and manufacture of Intelligent Transport System is verified.	Satisfactory.
3.1.1.24	Device shall support A-GPS (Assisted GPS).	Verified from component datasheet.	Satisfactory.
3.1.1.25	Device shall have provision of secured data transmission to the Backend Control Centre from the devices through secured channel (e.g. secured dedicated APN).	Verified.	Satisfactory.
3.1.1.26	Device shall have 3 axis accelerometer and 3 axis gyroscope for getting the alerts on harsh breaking harsh acceleration, and rash turning.	Verified.	Satisfactory.
3.1.2	Functional Requirement for Emergency System		
3.1.2.1	Passengers or in-vehicle crew present in the vehicle shall be able to make an emergency request by pressing the emergency button provided.	Verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
3.1.2.2	The emergency request function shall not exist as standalone. The function shall be part of Vehicle Location Tracking (VLT) system. An alert shall be sent to the Backend Control Server (Government authorized server) when emergency request is raised. De-activation shall always be from authorized government server who receives alert message i.e. NERS system as mentioned in Sub-section 4.2.2.	Tested and verified.	Satisfactory.
3.1.2.3	The Emergency Buttons will be such that disconnection between switch and controller should be detected through controller logic or 'Normally Closed' (NC) Type Switch. For Emergency button, there shall be indication of its working status visible for passengers in Ignition ON Condition. The form factor of Emergency Buttons will be such that the button is easy to press in the case of an emergency, and simultaneously also minimizes the possibility of accidental or unintended press thereby causing a false alert..	Tested and verified.	Satisfactory.
3.1.2.4	On pressing of Emergency button, the system implementing VLT function shall send emergency Alert (Alert ID 10 as mentioned in Subsection 4.2.1 of Communication Protocol Section 4) to the Backend Control Server (Government authorized server) as per the Communication Protocol mentioned in Section 4. In the absence of Cellular network, the alert shall be sent as SMS message along with vehicle location data to configured control center number. The SMS shall consist of parameters as given in Sub-section 4.2.2	Tested and verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
3.1.2.5	In absence of both Cellular and GSM networks and on pressing of Emergency Button, the system implementing VLT function shall store the emergency Alert (Alert ID 10 as mentioned in Sub-section 4.2.1 of Communication Protocol Section 4). Once the Cellular or GSM is available, this alert information shall be sent on high priority to the configured IP addresses as per the communication protocol mentioned in Section 4 or as SMS message along with vehicle location data to configured control center number. The SMS shall consist of parameters as given in Sub-section 4.2.2.	Tested and verified.	Satisfactory.
3.1.3	Configuration of Device Parameters Over the Air (OTA)		
	The device shall support at least the below parameters to be configurable over the air (through SMS and Cellular). The updation shall be allowed only over an 'authenticated' channel:	Tested and verified.	Satisfactory.
	1. Setting/ Change of the Primary or Secondary IP and port number		
	2. Setting/ Change of the APN		
	3. Set configuration parameter like sleep time, over speed limit, harsh braking, harsh acceleration, rash turning threshold limits etc.		
	4. Emergency control SMS Centre Number(s)		
	5. Configuring the vehicle registration number		
	6. Configuring the frequency of data transmission in normal / Ignition state / OFF state sleep mode/ Emergency state, etc.		
	7. Configuring the time duration for Emergency state		
	8. Capability to reset the device		

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Clause No.	Requirement	Observation	Remark
	9. Command to get the IMEI of the device Configurable commands must involve the following features: 9.1 SET: For setting the parameters. 9.2 GET: For enquiring regarding the parameters such as mobile number, GSM strength, vehicle number and other important parameters. 9.3 CLR: For clearing certain commands, alarms, alerts etc. except emergency alert After each SET, GET, CLR command the device should send alert to Backend Control Centre, as mentioned in Section 4 Alert 12, giving the details of Mode, mobile no/ IP of control center sending commands.	Tested and verified.	Satisfactory.
3.1.4	Tracking Device Health Monitoring Parameters: The device shall send status of health parameters at configurable interval and this threshold value shall also be configurable over the air. It shall be possible for health parameters to be fetched on demand via command as set out below in Table 3B.	Verified.	Satisfactory.
3.1.5	SMS Fall Back In case of emergency state, (i.e. on pressing of Alert button), the device will shift to the SMS mode in case Cellular connectivity is not available. In such case, the device will send the Alert message and tracking data through SMS mode. Since SMS has the limitation of sending only 160 characters, so the tracking data to be sent in one SMS will have fields - IMEI, Latitude, Direction, Longitude, Direction, location fix, speed, Cell ID, LAC (Location Area Code), Date and Time as per emergency alert . The details is provided in Sub-section 4.2.2.	Verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
4.3	Testing of Configuration of Device Parameters Over the Air (OTA)		
	The following testing will be done for 1. Setting/ Change of the Primary or Secondary IP and port number 2. Setting/ Change of the APN 3. Set configuration, parameter like sleep time for speed, harsh braking, rash turns, etc. 4. Emergency SMS Centre Number 5. Configuring the vehicle registration number 6. Configuring the frequency of data transmission in normal / Ignition state / OFF state sleep mode, Emergency state, etc. 7. Configuring the time duration for Emergency state 8. Capability to reset the device 9. Command to get the IMEI of the device Configurable commands must involve the following features: • SET: For setting the parameters. • GET: For enquiring regarding the parameters such as mobile number, GSM strength, vehicle number and other important parameters. • CLR: For clearing certain commands, alarms, alerts etc. except emergency alert	Verified.	Satisfactory.

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Clause No.	Requirement	Observation	Remark
5.0	CONSTRUCTION AND INSTALLATION		
5.1	Requirements on vehicle interface for VLT with Emergency Button		This requirement is only a guideline for fitment and shall not be checked during component approval or on vehicle)
	Connector for Power The requirements for interface shall be as agreed between vehicle manufacturer and device manufacturer.	-	
5.2	Requirement of Emergency System		
	Emergency button shall be one-time press type. Separate release action from authorized server shall be required to bring back the emergency button to normal mode or clear emergency flag.	Verified.	Satisfactory.
5.3	Physical Mounting		
	The VLT system shall be mounted in a suitable location such a way that it is not easily accessible /exposed to passengers. This requirement shall not be applicable in case of combined systems VLT with HMI (Human Machine Interface) display in front of driver. Emergency button(s) shall be fitted in such a way that every passenger including driver shall be able to access the Emergency button(s). Passenger Car shall have at least one emergency buttons on each passenger row easily accessible by each of the passenger. There shall also be one dedicated emergency button for the driver row. Passenger Transport bus shall have emergency buttons at locations easily visible & accessible to all the passengers such as every 2 meters on both the sides on passenger seating area. For seats reserved for ladies there shall be a dedicated panic button for each row. It shall be permissible to have a single emergency button for two successive ladies' rows on both sides of the vehicle provided each lady passenger in either rows are able to reach and operate the emergency button. In case of passenger transport bus which has a glass window covered between two pillars having pitch 2m or more, the emergency buttons shall be provided on each pillar National Permit Trucks, shall have one dedicated emergency button for the driver row.	-	This requirement is only a guideline for fitment and shall not be checked during component approval or on vehicle.

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Clause No.	Requirement	Observation	Remark
5.4.1	Electric wiring The wiring harness used in the device shall be tested for flammability as per IS 2465.	Representative wires are tested vide test report number ERL/2018-19/SO 3000002672/94 Dt.21.08.2018	Satisfactory.
6.2	Component Level Functional Tests		
6.2.1	Vehicle Location Tracking		
6.2.1.1	Standard connector provided for Power and other signals as per Clause No. 5.1.	Verified.	Satisfactory.
6.2.1.2	Configuration of device as per the standard format mentioned in Section 4. □ Local configuration upload shall be verified. □ Configuration upload from control center shall be verified.		
6.2.1.3	The system shall transmit Emergency request information to one IP and PVT information to other IP of backend Control Center at user configurable frequency (minimum 5 seconds) via GSM/Cellular		
6.2.1.4	Backend Control Centre shall be able to check the version of firmware loaded on the system.		
6.2.1.5	Update the firmware of the system from Backend Control Centre		
6.2.1.6	System shall communicate to control center on the occurrence of the alerts captured in Communication Protocol Section 4		
6.2.1.7	When Emergency Button is pressed, emergency request message shall be sent from the system and received at the control center		

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Clause No.	Requirement	Observation	Remark
6.3	Device Level Functional, Performance & Durability Tests		
6.3.1	Functional Testing		
	1. Tracking Functionality Test	Connectivity of VLT with server and its capability to send two location messages is tested.	Satisfactory.
	2. Location Accuracy Test	It meets 2.5m CEP.	Satisfactory.
	3. Acquisition Sensitivity Test	Observed Acquisition Sensitivity is - 145 dBm for GPS & -140 dBm for IRNSS	Satisfactory.
	4. Tracking Sensitivity Test	Observed tracking Sensitivity is - 160 dBm and -153 dBm for IRNSS	Satisfactory.
	5. Cold-Start Time to First Fix (TTFF) Test	35 sec	Satisfactory.
	6. Warm-Start Time to First Fix Test	30 sec	
	7. Hot-Start Time to First Fix Test	1 sec	
	8. Embedded SIM/UICC Test	Tested and verified.	Satisfactory.
	9. Function Endurance Test	Tested for 96 hrs and functionality verified.	Satisfactory.
	10. On Vehicle Dynamic Location Test	Tested and verified on vehicle. PVT data is within 12 meters for more than 90% of fixed location data.	Satisfactory.

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6.3.2	Performance & Durability Test		
	1. Shock Test	Refer Annexure 01	Satisfactory.
	2. Vibration Test	Refer Annexure 01	Satisfactory.
	3. Ingress Protection (IP)	Tested vide test report No. SHL/161/2018-2019/3000002205/RT/2128 Dt.07.08.2018	Satisfactory.
	4. EMI /EMC	Refer Annexure 01 to 06	Satisfactory.
	5. Battery Backup Test	Tested and verified.	Satisfactory.
	6. Reverse Polarity Protection without Fuse	Refer Annexure 02	Satisfactory.
	7. Wiring Harness - Flammability Test	Representative wires are tested vide test report number ERL/2018-19/SO 3000002672/94 Dt.21.08.2018	Satisfactory.
	8. Wiring Harness - Electrical Properties		
	9. Free Fall	Refer Annexure 01	Satisfactory.
	10. Performance Parametric Test (Nine points, tri temperature/tri voltage)	Refer Annexure 01	Satisfactory.
	11. Insulation Resistance Test	Refer Annexure 01	Satisfactory.
	12. Load Dump Test Pulse 5a	Refer Annexure 02	Satisfactory.

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6.3.3	Device Level Environmental Tests		
	1. Dry Heat / High Temperature Test	Refer Annexure 01	Satisfactory.
	2. Cold Test		
	3. Damp Heat Test		
	4. Temperature Shock		
	5. High Temperature Test		
	6. Salt Spray Test	Tested vide test report No SDL/80002945(18-19)/AED/268(18-19) date. 17/08/2018	Satisfactory.
	7. High Voltage Test	Refer Annexure 02	Satisfactory.
6.3.4	Protocol Testing		
a)	Memory Storage The device shall support 40000 or more positional logs/packets. This is a functional test and the device will be simulated to be in non – Cellular coverage area and the logs will be maintained. The capacity of logging will be checked by monitoring the logs on the device.	Verified.	Satisfactory.
b)	Messages & Alerts from Devices: Alerts that need to come from the tracking devices.		
	1. Location Update	Verified.	Satisfactory.
	2. Location Update (history)		
	3. Alert – Disconnect from main battery		
	4. Alert – Low battery		
	5. Alert – Low battery removed		
	6. Alert – Connect back to main battery		
	7. Alert – Ignition ON		
	8. Alert – Ignition OFF		
	9. Alert – GPS box opened (Optional)		
	10. Alert – Emergency state ON		
	11. Alert – emergency State OFF		
	12. Alert Over the air parameter change		
	13. Harsh Braking		
	14. Harsh Acceleration		
	15. Rash Turning		

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7.0	The Communication from Device to backend should happen on a Secure channel over TCPIP protocol preferably on socket based connections where sessions are managed to send commands over the same connection to the device and are authenticated, identifiable, so as to prevent spoofing on IMEI/ Unique ID	Verified.	Satisfactory.

11.0 Conclusion:

VTS model Cello CANiQ-IRN complies with requirements of as per AIS 140: 2016 and amendment 1 (11th December 2017) and amendment 2 (5th December 2018) notified vide S.O 5453 (E) and S.O 5454 (E) dated 25th Oct 2018 excluding the clause 8.1 to 8.5 for the backend server requirement.

Place of Issue: PUNE

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12.0 LIST OF TEST EQUIPMENTS			
Radiated immunity equipment list			
Description	**ARAI ID**	**Status**	**Cal due date**
Signal generators			
Rohde & Schwarz SML 02 Signal Generator	AED/GEN/02	■	19/11/2019
Antennas			
Frankonia Gmbh BTA-M Broad Band Antenna (1MHz-3000MHz)	AED/ANT/09	■	N/A
Schwarzbeck Mess Elektronik BBHA 9120 D Double Ridge Horn Antenna (1GHz-18GHz)	AED/ANT/14	■	N/A
Amplifiers			
AR 500W1000AM1 500W RF Power Amplifier	AED/RFAMP/04	■	N/A
AR BLMA 0820-200 200W RF Power Amplifier	AED/RFAMP/05	■	N/A
Power sensors			
Rohde & Schwarz NRP-Z91Power Sensor	AED/Power Sensor/04	■	N/A
Rohde & Schwarz NRP-Z91Power Sensor	AED/Power Sensor/05	■	N/A
Power meters			
Rohde & Schwarz NRP2 Power Meter	AED/RFPM/03	■	N/A
LISN			
Rohde & Schwarz ESH3-Z6 (5μH/50Ω) LISN	AED/AN/01	■	09/02/2020
Rohde & Schwarz ESH3-Z6 (5μH/50Ω) LISN	AED/AN/03	■	09/02/2020
Rohde & Schwarz ESH3-Z6 (5μH/50Ω) LISN	AED/AN/04	■	09/02/2020
EM Test AN200N100 (5μH/50Ω) LISN	AED/AN/07	■	02/02/2020
Laser powered field probe			
RF FL 7006 Star Probe 2 Laser Powered Field Probe	AED/Field Probe/07	■	18/04/2020
Oscilloscopes			
Tektronics DPO 3052 Digital Phosphor Oscilloscope	AED/OSC/07	■	30/08/2020
Test facility			
Frankonia Gmbh Semi-Anachoic ALSE Chamber, ARAI Pune.	AED/ALSE/02	■	28/09/2020
Test software			
Rohde & Schwarz EMC32 Measurement Software Ver. 9.21.00	N/A	■	N/A
Miscellaneous			
Freemans Measuring Tape	AED/TAPE/01	■	23/12/2019
Aplab L3260 Regulated DC Power Supply	AED/RPS/32	■	N/A
Automotive Battery 12V	N/A	■	N/A
Bulk current injection equipment list			
Signal generators/amplifiers			
EM Test CWS 500D Continuous Wave Simulator	AED/CWS/01	■	9/06/2020

Description	ARAI ID	Status	Cal due date
Bulk current injection probes			
FCC F-130A-1 Bulk Current Injection Probe	AED/INJ CLAMP/01	■	N/A

Current monitor probes			
FCC F-55 Current Monitor Probe	AED/CURRENT PROBE/01	■	22/03/2020
LISN			
Rohde & Schwarz ESH3-Z6 (5µH/50Ω) LISN	AED/AN/04	■	09/02/2020
EM Test AN200N100 (5µH/50Ω) LISN	AED/AN/07	■	02/02/2020
Test software			
EM Test ICD Software Ver. 3.31.00	N/A	■	N/A
Miscellaneous			
Spectron PLC 3250 MP DC Regulated Power Supply	AED/RPS/19	■	N/A
Automotive Battery 12V	N/A	■	N/A
Radiated emission equipment list			
Receivers			
Rohde & Schwarz ESR 3 EMI Test Receiver 3.6 GHz	AED/EMIR/06	■	18/05/2020
Antennas			
Schwarzbeck Mess Elektronik VHBB 9124 Bi-Conical Antenna	AED/ANT/15	■	18/07/2020
Schwarzbeck Mess Elektronik VUSLP 9111B Log-Periodic Antenna	AED/ANT/16	■	18/07/2020
LISN			
Rohde & Schwarz ESH3-Z6 (5µH/50Ω) LISN	AED/AN/01	■	09/02/2020
Rohde & Schwarz ESH3-Z6 (5µH/50Ω) LISN	AED/AN/03	■	09/02/2020
Test facility			
Frankonia Gmbh Semi-Anachoic ALSE Chamber, ARAI Pune.	AED/ALSE/02	■	28/09/2020
Test software			
Rohde & Schwarz EMC32 Measurement Software Ver. 9.21.00	N/A	■	N/A
Miscellaneous			
Aplab L3260 Regulated DC Power Supply	AED/RPS/32	■	N/A

Automotive Battery 12V	N/A	■	N/A

Description	ARAI ID	Status	Cal due date
Conducted immunity on supply line equipment list			
60A EM TEST conducted immunity test system for 12V/24V DC			
EM Test LD 200B Load Dump Generator	AED/EM/02	■	31/08/2020
EM Test MPG 200B Micro Pulse Generator	AED/EM/02	■	31/08/2020
EM Test EFT 200B EFT/Burst Generator	AED/EM/02	■	31/08/2020
EM Test VDS 200B Voltage Drop Simulator	AED/EM/02	■	31/08/2020
Test facility			
Conducted Immunity Testing Lab, ARAI Pune.	N/A	■	N/A
Test software			
EM Test ISMISO Transient Software (Ver 3.91)	N/A	■	N/A
Miscellaneous			
EM Test CNA 200B Coupling Network	AED/EM/02	■	N/A
Aplab L3260 Regulated DC Power Supply	AED/RPS/34	■	N/A
Electrostatic Discharge (ESD) Test Equipment List			
ESD Generator			
TESEQ NSG-437 ESD Simulator	AED/ESD/02	■	01/02/2020
Energy Consumption Test Equipment List			
Yokogawa WT 230 Digital Power Meter	AED/POWERMETER/01	■	27/02/2020
Cyclic Temperature & Humidity Chamber			
Cyclic Temperature & Humidity Chamber	AED/CHAMBER/03	■	26/07/2020
Thermal Shock Chamber	AED/TSC/02	■	22/01/2020
Electrodynamic Vibration Test System			
Electrodynamic Vibration Test System	AED/EDVS/01	■	16/07/2020
GNSS Simulator			
SIMAC5	SLNO-03	■	31/03/2020

P S SHINKAR **Dy. MANAGER**	**M M DESAI** **GENERAL MANAGER**	**A A DESHPANDE** **Sr. Dy. DIRECTOR & HoD**

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ANNEXURE 01
Environmental and Vibration Tests

1.1 Standard Reference: AIS 140: 2016 and amendment 1 (11th December 2017) and amendment 2(5th December 2018) notified vide S.O 5453 (E) & S.O 5454 (E)dated 25th Oct 2018

1.2 Performance Parametric Test:

Test Procedure		The DUT with three emergency buttons were placed in the temperature cyclic chamber and subjected to the specifications as given below. At each test point the system was powered ON and shut down 5 times with duration of 1 min ON and 1 min OFF time.		
Test Temperature		-25°C	80°C	25°C (Room Temp)
Test Voltage	**24 VDC System**	18V, 27V, 32V	18V, 27V, 32V	18V, 27V, 32V
	12 VDC System	9V, 13.5V, 16V	9V, 13.5V, 16V	9V, 13.5V, 16V
DUT Condition		Powered ON		
Ambient Temperature		27°C		
Test Start Date		22nd Nov 2019		
Test End Date		22nd Nov 2019		
Acceptance Criteria		• There shall be no visual deterioration to the DUT. • No deviation in functionality must be observed during and after the test.		
Test Observation		• No visual deterioration was observed on the DUT at the end of the test. • No deviation in functionality was observed during and after the test.		

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1.3 Dry Heat / High Temperature Test:	
Test Procedure	The DUT was kept in the temperature cyclic chamber and subjected to the specifications as given below:
Test Temperature	70°C
Test Duration	16 hours
Test Voltage	24 VDC
DUT Condition	Powered ON
Ambient Temperature	27°C
Test Start Date	22nd Nov 2019
Test End Date	23rd Nov 2019
Acceptance Criteria	• There shall be no visual deterioration to the DUT. • No deviation in functionality must be observed during and after the test.
Test Observation	• No visual deterioration was observed on the DUT at the end of the test. • No deviation in functionality was observed during and after the test.

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1.4 Cold Test:	
Test Procedure	The DUT was kept in the temperature cyclic chamber and subjected to the specifications as given below:
Test Temperature	-10°C
Test Duration	2 hours
Test Voltage	24 VDC
DUT Condition	Powered ON
Ambient Temperature	27°C
Test Start Date	22nd Nov 2019
Test End Date	22nd Nov 2019
Acceptance Criteria	• There shall be no visual deterioration to the DUT. • No deviation in functionality must be observed during and after the test.
Test Observation	• No visual deterioration was observed on the DUT at the end of the test. • No deviation in functionality was observed during and after the test.

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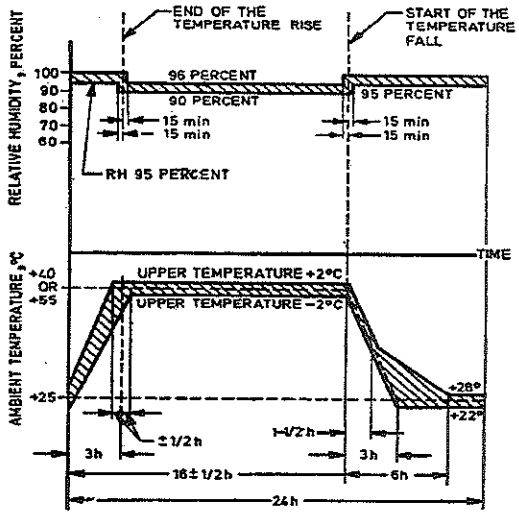
1.5 Damp Heat and Insulation Resistance Test:	
Test Procedure	The DUT was kept in the temperature cyclic chamber and subjected to the specifications as given below:
Cycle Duration	24 h
No. of cycle	6
DUT Condition	Powered OFF
Ambient Temperature	26°C
Test Start Date	14th Nov 2019
Test End Date	20th Nov 2019
Acceptance Criteria:	• There shall be no visual deterioration to the DUT. • No deviation in functionality must be observed during and after the test. • Insulation resistance tested at 500 VDC must be greater than 1 MΩ as per ISO 16750-2:2010. • No arcing or punching of insulation shall be observed.
Test Observation:	• No visual deterioration was observed on the DUT at the end of the test. • No deviation in functionality was observed during and after the test. • Insulation resistance measured after 0.5 hr at room temperature is greater than 1 MΩ. • No arcing or punching of insulation was observed.



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1.6 Temperature Shock Test:	
Test Procedure	The DUT was placed inside thermal shock chamber. The test parameters are as given below:
High Temperature	70°C
Low Temperature	-10°C
Dwell Time at Each Extreme	1.5 h
Transition Time between extremes	< 30 seconds
No. of cycles	2
Operating Mode	Powered OFF
Ambient Temperature	28°C
Test Start Date	21st Nov 2019
Test End Date	21st Nov 2019
Acceptance Criteria	• There shall be no visual deterioration to the DUT. • No deviation in functionality must be after the test.
Test Observation	• No visual deterioration was observed on the DUT at the end of the test. • No deviation in functionality was observed after the test.

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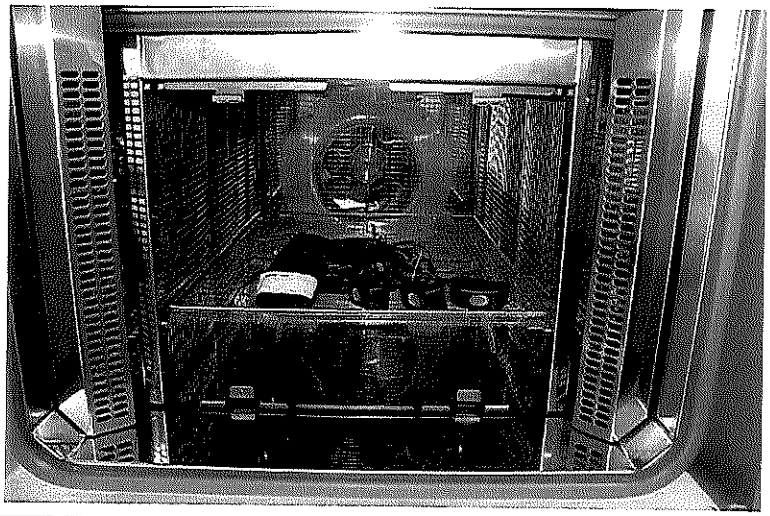
1.7 Test Setup Photograph:



1.8 Vibration Test:

Test Procedure	The DUT was mounted on the vibration table and subjected to swept sine vibration test with specifications as given below:
Frequency Range	10 – 55 Hz
Amplitude	1.5 mm_{p-p}
Sweep Time	1 min/sweep
Test Duration	1 h/axis
DUT Condition	Powered ON
Test Axis	X, Y and Z
Test Start Date	28th Nov 2019
Test End Date	28th Nov 2019
Acceptance Criteria	• No mechanical damage to the DUT must be observed during and after the test. • No deviation in functionality must be observed during and after the test.
Test Observation	• No mechanical damage was observed on the DUT. • No deviation in functionality was observed during and after the test.

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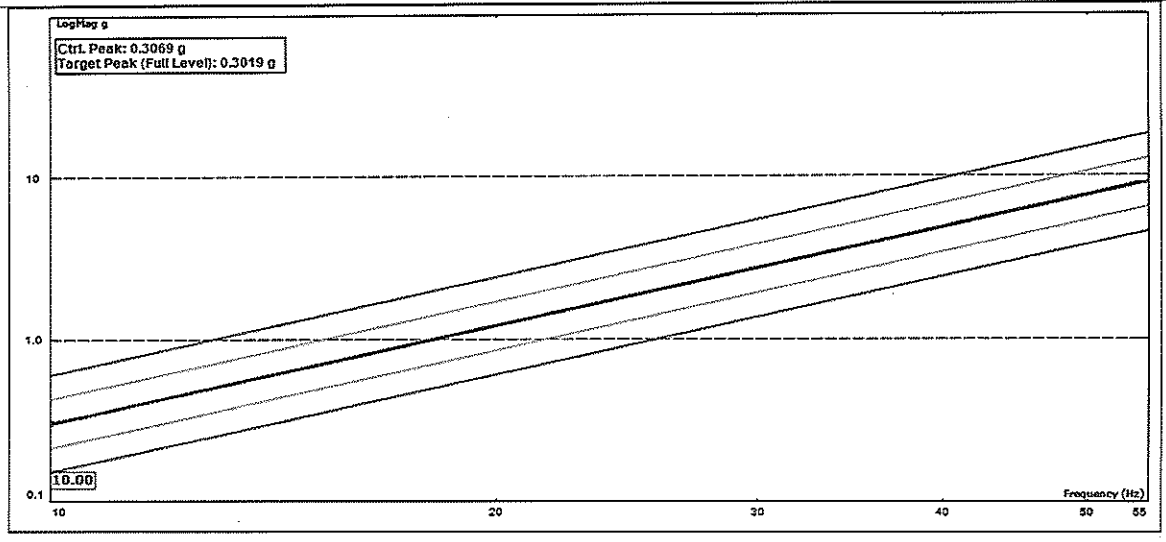
Vibration Test Profile



1.9 Shock Test:	
Test Procedure	The DUT was mounted on the vibration table and subjected to shock test with specifications as given below:
Pulse Type	Half Sinusoidal
Acceleration	15 g
Pulse Duration	11 ms
Total No. of Pulses	09 (03 on each axis)
Test Axis	X, Y and Z
Test Start Date	28th Nov 2019
Test End Date	28th Nov 2019
Acceptance Criteria	• No mechanical damage to the DUT must be observed during and after the test. • No deviation in functionality must be observed during and after the test.
Test Observation	• No mechanical damage was observed on the DUT. • No deviation in functionality was observed during and after the test.

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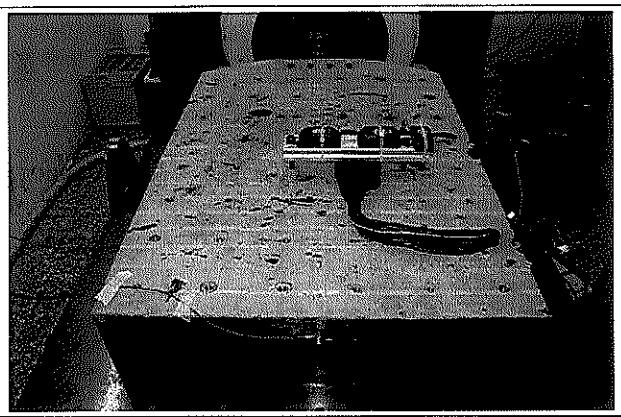
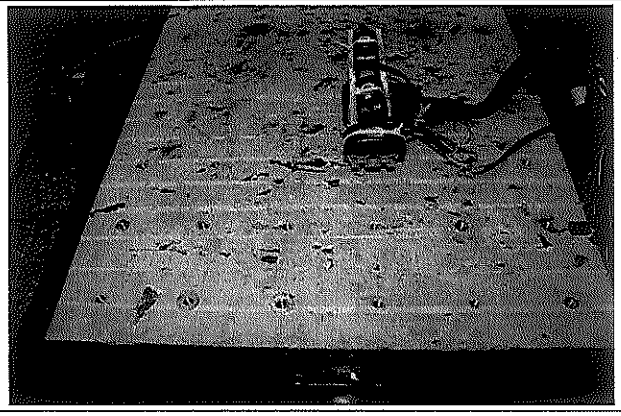
1.10 Vibration and Shock Test Photograph





1.11 Free Fall Test:	
Test Procedure	DUT was dropped from the height of 500 mm on to the surface made of solid concrete for two times. The drop height was maintained throughout the test using a measuring tape.
Test Start Date	28th Nov 2019
Test End Date	28th Nov 2019
Acceptance Criteria	• No mechanical damage to the DUT after the test. • No deviation in functionality must be observed after the test.
Test Observation	• No mechanical damage was observed on the DUT. • No deviation in functionality was observed after the test.

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End of Annexure 01

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ANNEXURE 02

2.1 TEST SPECIFICATIONS	
TEST DETAILS	ELECTRICAL TRANSIENT IMMUNITY ON SUPPLY LINE TEST AIS 140:2016 STANDARD.
TEST DATE	26-NOV-2019

2.2 DUT OPERATING CONDITIONS	
DUT MODE OF OPERATION	FULL OPERATING
DIAGNOSTIC TOOLS CONNECTED	Not applicable

2.3 MONITORING OF DUT	
PASS/FAIL criteria	Manually controlled by Operator.

2.4 LABORATORY ENVIRONMENT TEST CONDITIONS					
Ambient Temperature	23.2 degC	Required (23+/-5) degC.	Relative Humidity	58.3 %RH	---

2.5 TEST SETUP DETAILS		
DUT SETUP DETAILS	**Status**	**REMARKS**
A) Test setup was done according to	ISO 7637-2 2004(E)	Refer Std. ISO 7637-2: 2004(E) Clause No. 4.4
B) Test table surface	Metallic	Test table height from ground floor (1000, +/- 100)mm.
C) Whether the DUT and wiring harness of the DUT was placed (50, +/-5) mm, above the ground plane?	Yes	Placed on non-conductive, low permittivity material.
D) Length of wiring harness of the DUT(200, +/-50)mm	Yes	---
E) Whether DUT was grounded (GND) or isolated (ISO) from the ground plane ?	ISO	---
F) Whether the load box was placed on the ground plane ?	---	No load box connected

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2.6 DUT SUPPLY VOLTAGE DETAILS

Test Voltage	12V System	24V System	Current Consumption
Ua	Connected	Connected	<1A
Ub	Not Applicable	Not Connected	

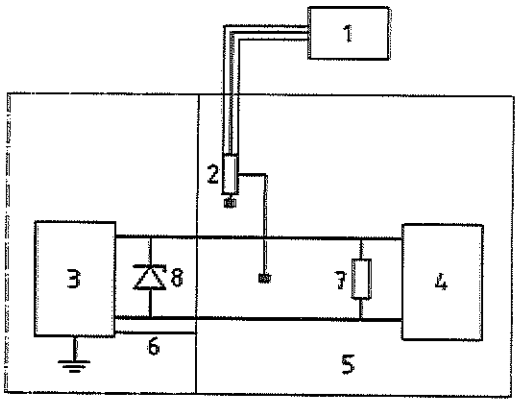
Power Sources		Voltage
Battery	No	
DC Power Supply (external power supply connected)	Yes	27 V , 13.5V

2.7 TEST PROCEDURE

1) Test pulses 3a and 3b, the leads between the terminals of the test pulse generator and the DUT shall be laid out in a straight parallel line at a height of (500/+10) mm above the ground plane and shall have a length of (0,5 +/-0,1) m.
2)The test pulse generator is set up to provide the specific pulse polarity, amplitude, duration and resistance with the DUT and optional resistance Rv disconnected. The appropriate values are selected.
3) DUT is connected to the generator, while the oscilloscopes disconnected.

2.8 TRANSIENT IMMUNITY TEST SET UP DETAILS

2.8.1 Transient immunity test set up



2.8.2 Transient immunity test set key words

Key

1 oscilloscope or equivalent
2 voltage probe
3 test pulse generator with internal power supply resistance R_i
4 DUT
5 ground plane
6 Ground connection (maximum length for test pulse 3: 100 mm)
7 optional resistor (R_v) [a]
8 optional diode bridge [b]

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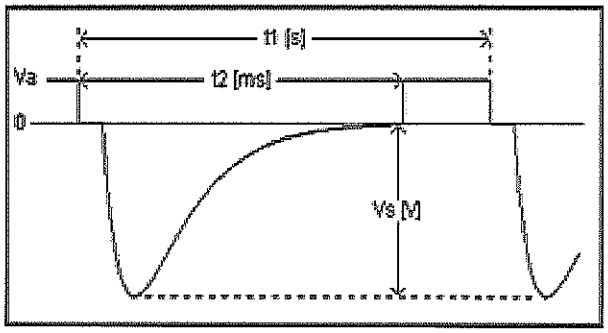
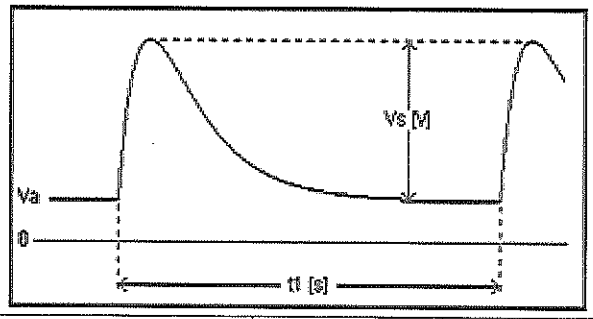
2.9 TEST PARAMETERS			
Conducted Immunity Pulses	Pulse 1	Pulse 2a	Pulse 2b
	Pulse 3a	Pulse 3b	Pulse 4
	Pulse 5a	Reversed Voltage	Overvoltage

2.9.1 Pulse 1					
Pulse details			ISO 7637: Pulse 1		
Va(Alternator)	27	V	Current limit:	15	A
Test Setup:					
Vs:	-450	V			
t1:	1	S			
t2:	200	ms			
Impedance	50	Ohm			
Events	5000		Connection:	+/-	
Test duration:		01:23:20			

2.9.2 Pulse 2a					
Pulse details			ISO 7637: Pulse 2a		
Va(Alternator)	27	V	Current limit:	15	A
Test Setup:					
Vs:	37	V			
t1:	0.5	S			
Impedance	2	Ohm			
Events	5000		Connection:	+/-	
Test duration:		00:41:40			

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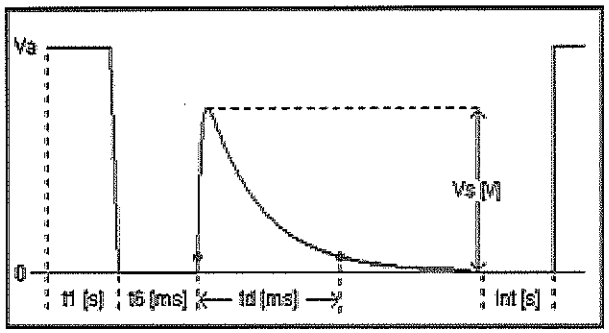
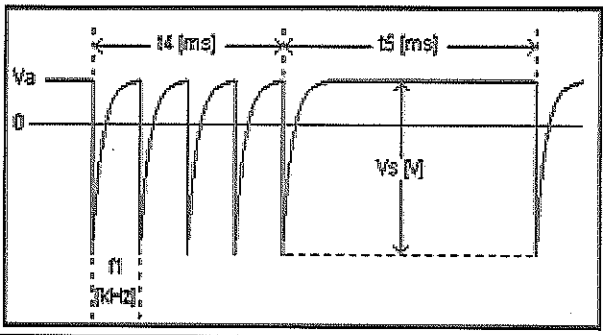
2.9.3 Pulse 2b					
Pulse Details			ISO 7637: Pulse 2b		
Va(Alternator)	27	V	Current limit:	15	A
Test Setup:					
					
Vs:	20	V			
t1:	1	S			
t6:	1	ms			
td	200	ms			
Int	1	s			
Ri	0.02	Ohm			
Events:	10				
Test duration:		00:00:28			

2.9.4 Pulse 3a					
Pulse Details			ISO 7637: Pulse 3a		
Va(Alternator)	27		Current limit:	15	A
Test Setup:					
					
Vs:	-150	VV			
f1:	10	kHz			
t4:	10	ms			
t5	90	ms			
Coupling		+			
Test duration:	1	h			

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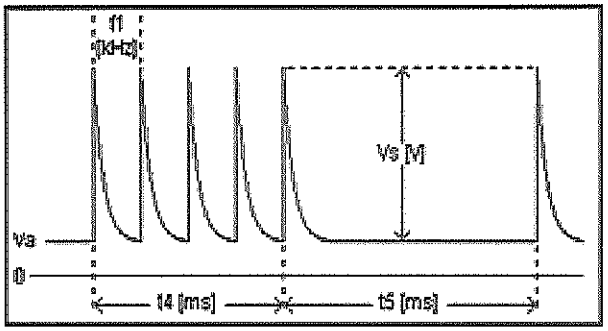
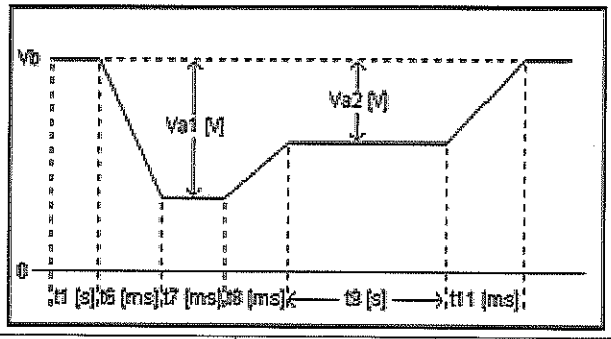
2.9.5 Pulse 3b					
Test Procedure			ISO 7637: Pulse 3b		
Va(Alternator)	27	V	Current limit:	15	A
Test Setup:					
					
Vs:	150	V			
f1:	10	kHz			
t4:	10	ms			
t5	90	ms			
Coupling		+			
Test duration:	1	h			

2.9.6 Pulse 4					
Test Procedure			ISO 7637: Pulse 4		
Va(Battery)	24.0	V	Current limit:	15	A
Test Setup:					
	24V				
Va1:	-12.0	V			
Va2:	-5.0	V			
t1:	1	s			
t6	10	ms			
t7	50	ms			
t8	50	ms			
t9	0.5	s			
t11	5	ms			
Events:	1				
Test duration		00:00:21			

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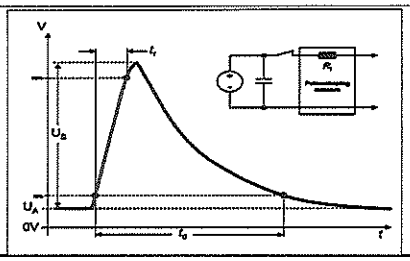
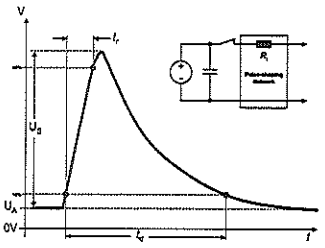
2.9.7 Pulse 5a – 24V

Disturbance:	LD 5550 Pulse 5
Parameters	
Us	123 V
td	200 ms
tr	5 ms
Ri	8 Ω
t1	30 s
Test Duration	1 (Count)



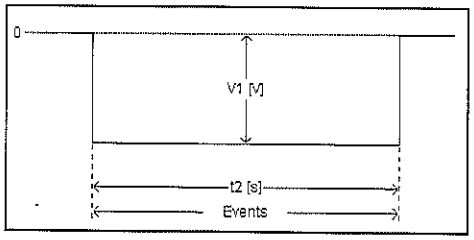
2.9.8 Pulse 5a – 12V

Disturbance:	LD 5550 Pulse 5
Parameters	
Us	65 V
td	200 ms
tr	10 ms
Ri	4 Ω
t1	45 s
Test Duration	1 (Count)



2.9.9 Reverse Voltage test

Test Procedure			ISO 16750-2: 4.6 Reversed Volt.		
Va (Alternator):	27.0	V	Current limit:	15	A
Test setup:					
V1:	-27.0	V			
t2:	60	s			
Events:	1				
Test duration:		00:02:00			



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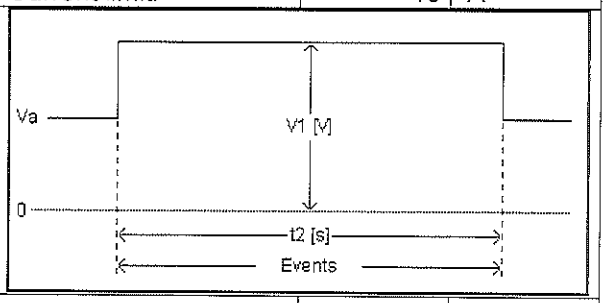
2.9.10 High Voltage test

			ISO 16750-2 : 4.2.1 Overvoltage 2		
Va:	27.0	V	Current limit:	15	A
V1:	36.0	V			
t2:	60	min			
Events:	1				
Test duration:		01:00:00			

2.10 TEST OBSERVATION

Sr. No.	Pulse Details	Observation
2.10.1	Pulse 1	**DUT reset was observed. Automatically recovered after test. Functionality Class C.**
2.10.2	Pulse 2a	**No deviation was observed in DUT functionality. Functionality Class A.**
2.10.3	Pulse 2b	**DUT reset was observed. Automatically recovered after test. Functionality Class C.**
2.10.4	Pulse 3a	**No deviation was observed in DUT functionality. Functionality Class A.**
2.10.5	Pulse 3b	
2.10.6	Pulse 4	**No deviation was observed in DUT functionality. Functionality Class A.**
2.10.7	Pulse 2b –12V	**DUT reset was observed. Automatically recovered after test. Functionality Class C.**
2.10.8	Pulse 4 – 12V	**No deviation was observed in DUT functionality. Functionality Class A.**
2.10.9	Pulse 5a –24V	**No deviation was observed in DUT functionality. Functionality Class A.**
2.10.10	Pulse 5a –12V	**No deviation was observed in DUT functionality. Functionality Class A.**
2.10.11	Reverse Voltage	**No deviation was observed in DUT functionality after test. Functionality Class A.**
2.10.12	Overvoltage test	

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Dy. MANAGER	GENERAL MANAGER	Sr. Dy.DIRECTOR & HoD

End of Annexure 02

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ANNEXURE 03

3.1 TEST SPECIFICATIONS	
TEST DETAILS	RADIATED IMMUNITY TEST: BULK CURRENT INJECTION (BCI METHOD) AS PER AIS004 (PART3): 2009 STANDARD.
TEST DATE	25-NOV-2019
TEST LOCATION	EMI/EMC LAB ARAI KOTHRUD, PUNE.

3.2 DUT OPERATING CONDITIONS	
DUT MODE OF OPERATION	FULL OPERATING
DIAGNOSTIC TOOLS CONNECTED	NOT APPLICABLE

3.3 MONITORING OF DUT	
PASS/FAIL criteria	Manually controlled by Operator.

3.4 LABORATORY ENVIRONMENT TEST CONDITIONS					
Ambient Temperature	24.4 degC	Required (23+/-5) degC.	Relative Humidity	44.6 %RH	---

3.5 TEST SETUP DETAILS		
DUT SETUP DETAILS	**Status**	**Remarks**
A) Test setup was done according to	ISO 11452-4:2005	Refer Std.ISO 11452-4:2005 Clause No. 7
B) Test table surface	Metallic	Test table height from ground floor (900, +/-100)mm.
C) Ground plane	Galvanized Steel	0.5mm thick (min.)
D) Test method used	Substitution	
E) Whether the DUT and wiring harness of the DUT was placed (50, +/-5) mm, above the ground plane?	Yes	Placed on non-conductive, low relative permittivity material.
F) Length of wiring harness between DUT and load simulator (or the RF boundary)(1000, +/-100)mm	Yes	---
G) Whether DUT was grounded (GND) or isolated (ISO) from the ground plane ?	ISO	---

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DUT SETUP DETAILS	Status	REMARKS
H) Whether the load box was placed on the ground plane ?	No	---
I) Distance of placing injection probe from the connector of the DUT	(150 +/-10)mm	---
J) Distance of placing current measurement probe from the connector of the DUT	(50 +/-10)mm	---
K) No. of artificial network (AN) used (5uH/50Ohm)	02	For positive supply line. & power return line

3.6 DUT SUPPLY VOLTAGE DETAILS

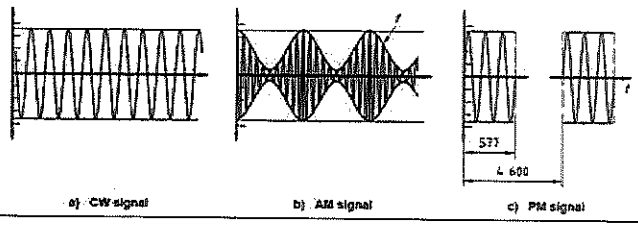
Test Voltage	12V System	24V System	Current Consumption
Ua	Not Applicable	Connected	<1A
Ub	Not Applicable	Connected	

Power Sources	Status	Voltage
Battery	Yes	24V
DC Power Supply (external power supply connected)	Yes	27V

3.7 TEST PARAMETERS

Frequency range	20 MHz to 200 MHz	
Dwell time	3 Sec.	
Frequency step size	2% log.	
Test severity level	60mA	
Test signal quality	Amplifier output harmonics content limited to -12dB.	
Test method	Substitution method	
Frequency modulation	Amplitude modulation (AM) (1 kHz sine wave at 80% (modulation index m=0.8)	AM(Peak)=CW(Peak)

3.8 FREQUENCY MODULATION DETAILS



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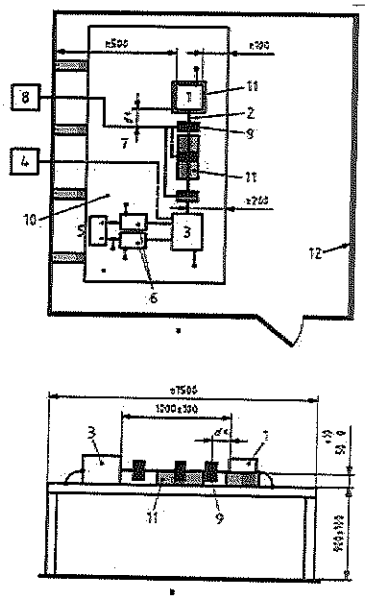
3.9 TEST PROCEDURE

The bulk current injection tests were done inside the copper shielded enclosure.

3.9.1 Substitution method

Install the DUT, harness and associated equipment on the test bench. Subject the DUT to the test signal based on the calibrated value as predetermined in the test plan. A current measurement probe may be mounted between the current injection probe and the DUT. The use of a current measurement probe is optional; it can provide extra, useful information during investigative work on the cause of events and the variances in test conditions after system modifications. However, care should be taken as the monitoring probe may affect the injected current.

3.9.2 BCI test set up - substitution method



3.9.3 BCI test set up - substitution method key words

Key

1 DUT (grounded if required in test plan)
2 test harness
3 load simulator (placement and ground: connection according to 7.5)
4 stimulation and monitoring system
5 power supply
6 artificial network (AN)
7 optical fibres
8 high-frequency equipment
9 injection probe
10 ground plane (bonded to shielded enclosure)
11 low relative permittivity support ($\varepsilon_r \leq 1.4$)
12 Shielded enclosure

3.10 TEST OBSERVATION

Sr. No.	Frequency	Frequency modulation	Observation
1.0	20MHz to 200MHz	Amplitude Modulation (AM)1 kHz sine wave at 80% modulation index	No deviation was observed. Pass.

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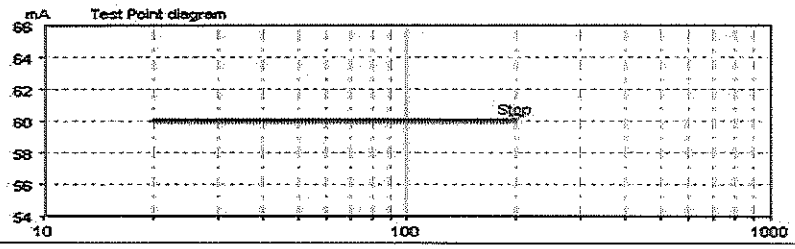
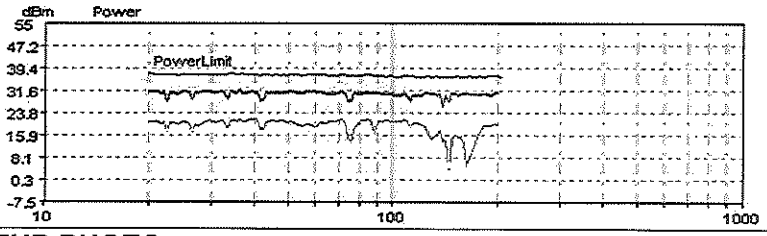
3.11 MEASUREMENT GRAPH

3.11.1 Test graph of RF current for frequency range from 20 MHz to 200 MHz with Amplitude Modulation (AM)

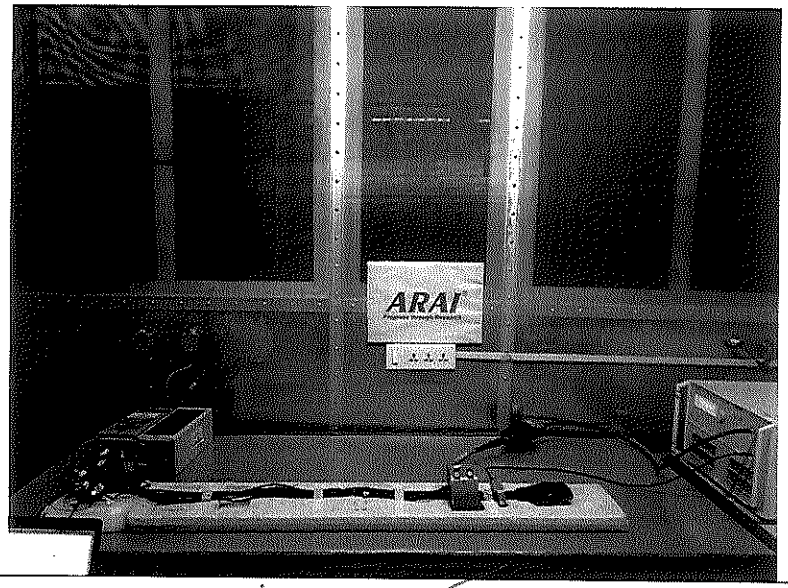


3.11.2 Power graph for frequency range from 20 MHz to 200 MHz with amplitude modulation (AM)



3.12 TEST SETUP PHOTO

3.12.1 Bulk current injection (BCI method), general set-up



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ANNEXURE 04

4.1 TEST SPECIFICATIONS	
TEST DETAILS	RADIATED IMMUNITY TEST: ABSORBER LINED SHIELDED ENCLOSURE (ALSE) METHOD AS PER AIS004 (PART3): 2009 STANDARD.
TEST DATE	25-NOV-2019
TEST LOCATION	ARAI EMI EMC LAB KOTHRUD PUNE

4.2 DUT OPERATING CONDITIONS	
DUT MODE OF OPERATION	FULL OPERATING
DIAGNOSTIC TOOLS CONNECTED	NOT APPLICABLE

4.3 MONITORING OF DUT	
PASS/FAIL criteria	Manually controlled by Operator.

4.4 LABORATORY ENVIRONMENT TEST CONDITIONS					
Ambient Temperature	25.6 degC	Required (23+/-5) degC.	Relative Humidity	50.5 %RH	---

4.5 TEST SETUP DETAILS		
DUT SETUP DETAILS	**Status**	**Remarks**
A) Test setup was done according to	ISO 11452-2:2004	Refer Std.ISO 11452-2:2004 Clause No. 7
B) Test table surface	Metallic	Test table height from ground floor (900, +/-100)mm.
C) Ground plane	Galvanized Steel	0.5mm thick (min.)
D) Whether the DUT and wiring harness of the DUT was placed (50, +/-5) mm, above the ground plane?	Yes	Placed on non-conductive, low relative permittivity material.
E) Length of wiring harness between DUT and load simulator(1500, +/-100)mm	Yes	---
F) Whether DUT was grounded (GND) or isolated (ISO) from the ground plane ?	ISO	---

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DUT SETUP DETAILS	Status	REMARKS
G) Location of load simulator	Inside test chamber	---
H) Antenna distance from the wiring harness of the DUT	(1000 +/-10)mm	---
I) Phase center of the antenna above the ground plane of test table	(100 +/-10)mm	---
J) Antenna phase centre focused to in line with the centre of wiring harness of DUT	Yes	For frequency up to 1GHz---
K) Antenna phase centre focused to in line with the DUT	Yes	For frequency above 1GHz
L) No. of orientation of DUT	1	
M) No. of LISN used (5uH/50ohm)	2	---

4.6 DUT SUPPLY VOLTAGE DETAILS

Test Voltage	12V System	24V System	Current Consumption
Ua	Not Applicable	Connected	<1A
Ub	Not Applicable	Connected	

Power Sources	Status	Voltage
Battery	Yes	24V
DC Power Supply (external power supply connected)	Yes	27 V

4.7 TEST PARAMETERS

Frequency range	200 MHz to 2000 MHz	
Dwell time	3 Sec.	
Frequency step size	2% log.	
Test severity level	30 V/m	
Test signal quality	Amplifier output harmonics content limited to -12dB (-6dB for frequencies above 1GHz).	
Test method	Substitution method	
Frequency modulation	Amplitude modulation (AM) (1 kHz sine wave at 80% (modulation index m=0.8)	AM(Peak)=CW(Peak)
	Pulse Modulation (PM) - (Sine wave)	ton=577us, Period=4600us
Antenna Polarization	Vertical	

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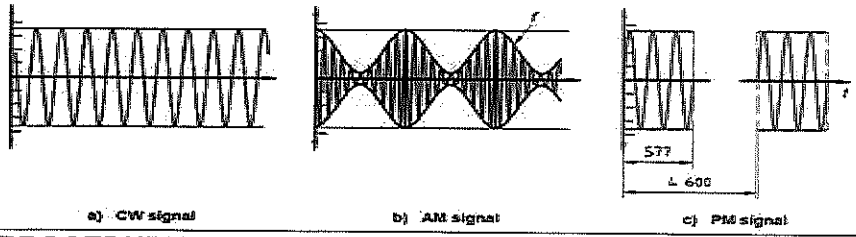
4.8 FREQUENCY MODULATION DETAILS



4.9 TEST PROCEDURE

The radiated immunity tests were done inside the anechoic chamber.

4.9.1 Calibration

The calibration was done with a closed loop system where the field strength levels were measured using a field probe that was placed in close proximity to the DUT. The calibration file contains the signal generator levels and power levels required to generate a specific field strength level over the test frequency range.

4.9.2 Verification

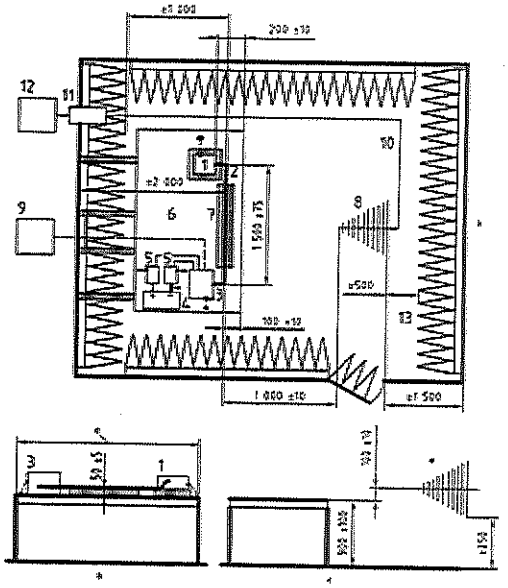
The calibrated settings were verified by emitting a field and monitoring field strength.

4.9.3 DUT RF immunity testing

The DUT was tested by replaying the calibrated test levels (the signal generated levels) from the calibration file. The DUT was tested for immunity over a fixed time called dwell period at a particular frequency with the desired field strength.

4.10 RI TEST SET UP

4.10.1 RI test set up for frequency below 1 GHz



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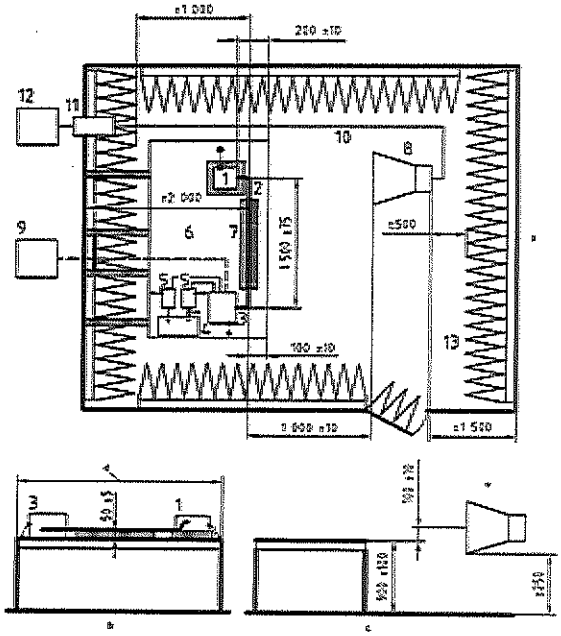
4.10.2 RI test set up - key words

1 DUT (grounded locally if required in test plan)
2 test harness
3 load simulator (placement and ground: connection according to 7.5)
4 power supply (location optional)
5 artificial network (AN)
6 ground plane (bonded to shielded enclosure)
7 low relative permittivity support ($\varepsilon_r \leq 1{,}4$)
8 log-periodic antenna
9 stimulation and monitoring system
10 high quality double-shielded coaxial cable (50 Ω)
11 bulkhead connector
12 RF signal generator and amplifier
13 RF absorber material

a Upper view (horizontal polarisation).
b Front view.
c Side view.
d See 7.1.
e Vertical polarization.

4.10.3 RI test set up for frequency above 1 GHz



4.10.4 RI test set up - key words

1 DUT (grounded locally if required in test plan)
2 test harness
3 load simulator (placement and ground: connection according to 7.5)
4 power supply (location optional)
5 artificial network (AN)
6 ground plane (bonded to shielded enclosure)
7 low relative permittivity support ($\varepsilon_r \leq 1{,}4$)
8 horn antenna
9 stimulation and monitoring system
10 high quality double-shielded coaxial cable (50 Ω)
11 bulkhead connector
12 RF signal generator and amplifier
13 RF absorber material

a Upper view (horizontal polarisation).
b Front view.
c Side view.
d See 7.1.
e Vertical polarization.

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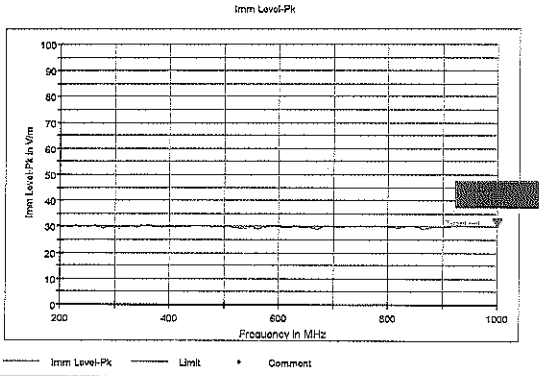
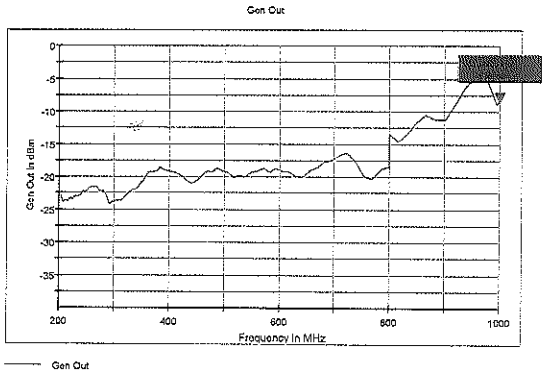
4.11 TEST OBSERVATION

Sr. No.	Frequency range	Frequency modulation	Observation
1.0	200MHz to 800MHz	Amplitude Modulation (AM)1 kHz sine wave at 80% (modulation index m=0.8)	No deviation was observed. Pass
2.0	800MHz to 2000MHz	Pulse Modulation (PM)(ton = 577 us and Period= 4600 us)	No deviation was observed. Pass

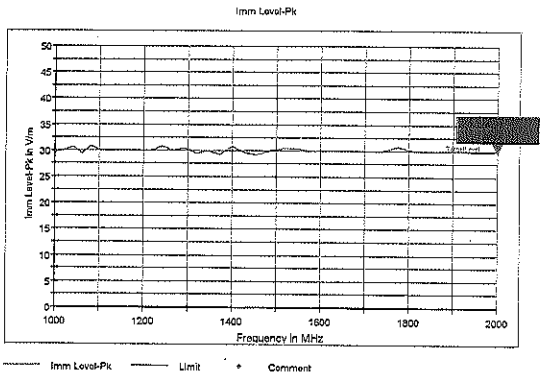
4.12 MEASUREMENT GRAPH

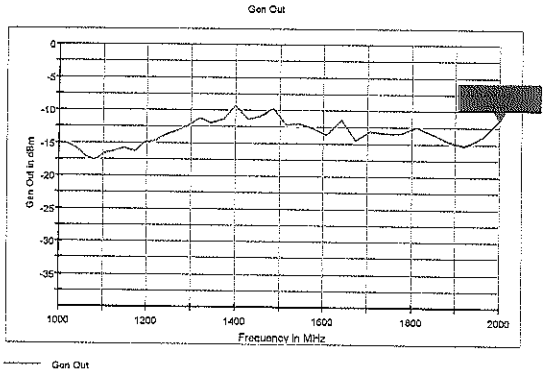
4.12.1 Frequency range from 200 MHz to 800 MHz with amplitude modulation (AM) and 800 MHz to 1000 MHz pulse modulation (PM) with vertical polarization.





4.12.2 Frequency range from 1000 MHz to 2000 MHz with pulse modulation (PM) with vertical polarization.





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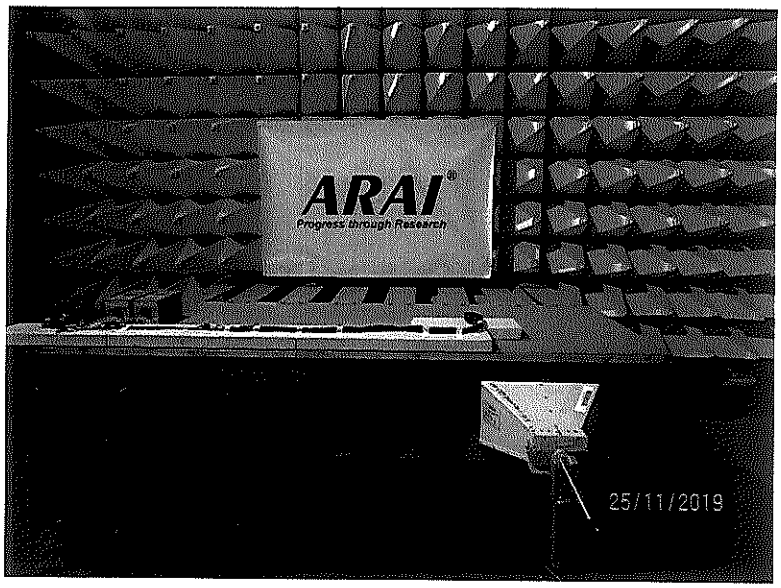
4.13 TEST SETUP PHOTO

4.13.1 Antenna phase center focused to in line with the center of wiring harness of DUT

4.13.2 Antenna phase center focused to in line with the DUT.



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ANNEXURE 05

5.1 TEST SPECIFICATIONS	
TEST DETAILS	RADIATED EMISSION TEST AS PER AIS004 (PART3): 2009 STANDARD.
TEST DATE	25-NOV-2019

5.2 DUT OPERATING CONDITIONS	
DUT MODE OF OPERATION	FULL OPERATING
DIAGNOSTIC TOOLS CONNECTED	Not Applicable

5.3 MONITORING OF DUT	
PASS/FAIL criteria	Manually controlled by Operator.

5.4 LABORATORY ENVIRONMENT TEST CONDITIONS					
Ambient Temperature	24.9 degC	Required (23+/-5) degC.	Relative Humidity	41.0 %RH	---

5.5 TEST SETUP DETAILS		
DUT SETUP DETAILS	**Status**	**Remarks**
A) Test setup was done according to	CISPR25:2008-03	Refer Std.CISPR25:2008-03 Clause No. 6.4.2
B) Test table surface	Metallic	Test table height from ground floor (900, +/-100)mm.
C) Ground plane	Galvanized Steel	0.5mm thick (min.)
D) Whether the DUT and wiring harness of the DUT was placed (50, +/-5) mm, above the ground plane?	Yes	Placed on non-conductive, low relative permittivity material.
E) Length of wiring harness between DUT and load simulator(1500, +/-100)mm	Yes	---
F) DUT position on the table (75 cm from table centre and 20 cm behind table front side)	Yes	---

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DUT SETUP DETAILS	Status	REMARKS
G) Whether DUT was grounded (GND) or isolated (ISO) from the ground plane ?	ISO	---
H) Antenna distance from the wiring harness of the DUT	(1000 +/-10)mm	---
I)Phase center of the antenna above the ground plane of test table	(100 +/-10)mm	---
J) Antenna phase centre focused to in line with the centre of wiring harness of DUT	Yes	For frequency upto 1GHz
K) No. of orientation of DUT	1	---
L)No. of LISN used (5uH/50ohm)	2	---

5.6 DUT SUPPLY VOLTAGE DETAILS

Test Voltage	12V System	24V System	Current Consumption
Ua	Not Applicable	Connected	< 2A
Ub	Not Applicable	Connected	

Power Sources	Status	Voltage
Battery	Yes	24V
DC Power Supply (external power supply connected)	Yes	27V

5.7 TEST PROCEDURE

5.7.1 Measurement of radiated field strength was carried out in an ALSE to eliminate the high level of disturbance from other/external electrical equipment and broadcasting stations.

5.7.2 For radiated emission measurement, the arrangement of the DUT, test harness, load simulator and measuring equipment was as per CISPR25.

5.7.3 The measurement was carried out using linearly polarized electric field antenna that has nominal 50ohm output impedance.
a) 30 MHz to 200 MHz (Bi-Conical Antenna)
b) 200 MHz to 1000 MHz (Log-Periodic Antenna)

5.7.4 The DUT was placed over a non-conductive low relative permittivity material at 50+/- 5 mm above the ground plane and connected with ground plane through copper strip. The total length of the test harness between the DUT and load simulator was 2000 mm.

5.7.5 The phase centre of the measuring antenna was 100 mm above the table ground plane for bi-conical and log periodic antennae.

5.7.6. From 30 MHz to 1000 MHz, measurement was performed in horizontal and vertical polarizations.

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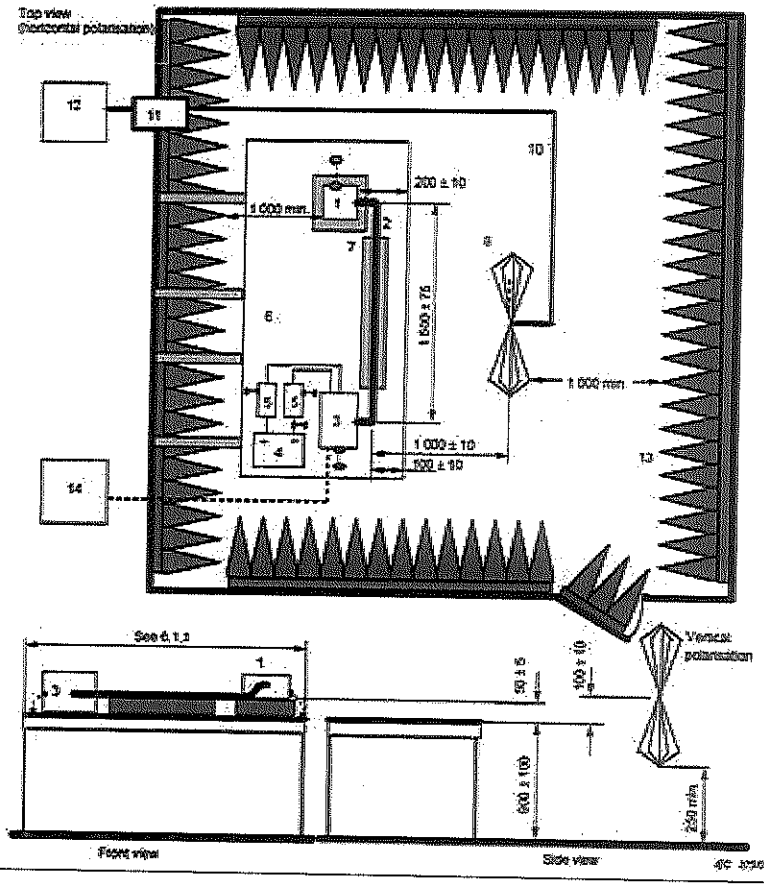
5.8 TEST PARAMETERS				
Frequency range	30 MHz to 1000 MHz			
Scanning receiver parameters	**Peak Detection**			
	Frequency range	Bandwidth at -6dB	Step Size	Dwell time
	30MHz-1000MHz	120kHz	50kHz	5ms
	Average Detection			
	Frequency range	Bandwidth at -6dB	Step Size	Dwell time
	30MHz-1000MHz	120kHz	50kHz	5ms
Antenna Systems	**Frequency Range**	**Antenna Used**	**Polarization**	
	30MHz-200MHz	Biconical	Horizontal Vertical	
	200MHz-1000MHz	Log Periodic	Horizontal Vertical	

5.9 RADIATED EMISSION TEST SET UP

5.9.1 Radiated emission test set up- Bi-conical antenna



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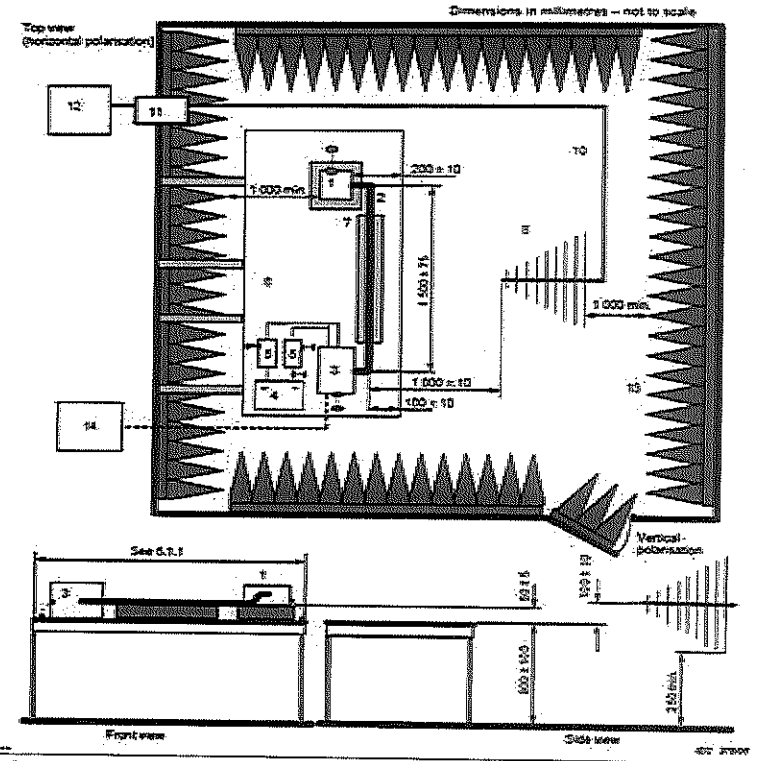
5.9.2 Radiated emission test set up- Bi-conical antenna- key words

1 EUT (grounded locally if required in test plan)
2 Test harness
3 Load simulator (placement and ground connection according to 6.4.2.5)
4 Power supply (location optional)
5 Artificial network (AN)
6 Ground plane (bonded to shielded enclosure)
7 Low relative permittivity support ($\varepsilon_r \leq 1,4$)
8 Biconical antenna
10 High-quality coaxial cable e.g. double-shielded (50 Ω)
11 Bulkhead connector
12 Measuring instrument
13 RF absorber material
14 Stimulation and monitoring system

5.9.3 Radiated emission test set up- Log periodic antenna



5.9.4 Radiated emission test set up- Log periodic antenna- key words

1 EUT (grounded locally if required in test plan)
2 Test harness
3 Load simulator (placement and ground connection according to 6.4.2.5)
4 Power supply (location optional)
5 Artificial network (AN)
6 Ground plane (bonded to shielded enclosure)
7 Low relative permittivity support ($\varepsilon_r \leq 1,4$)
8 Log-periodic antenna
10 High-quality coaxial cable e.g. double-shielded (50 Ω)
11 Bulkhead connector
12 Measuring instrument
13 RF absorber material
14 Stimulation and monitoring system

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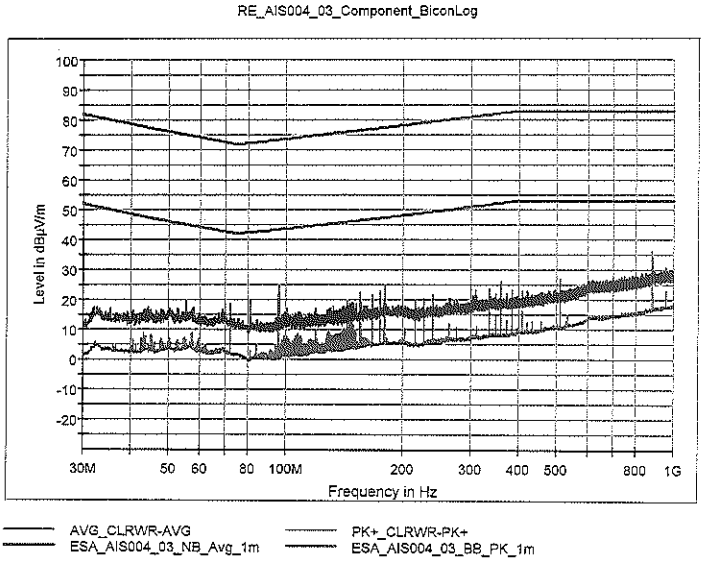
5.10 TEST OBSERVATION

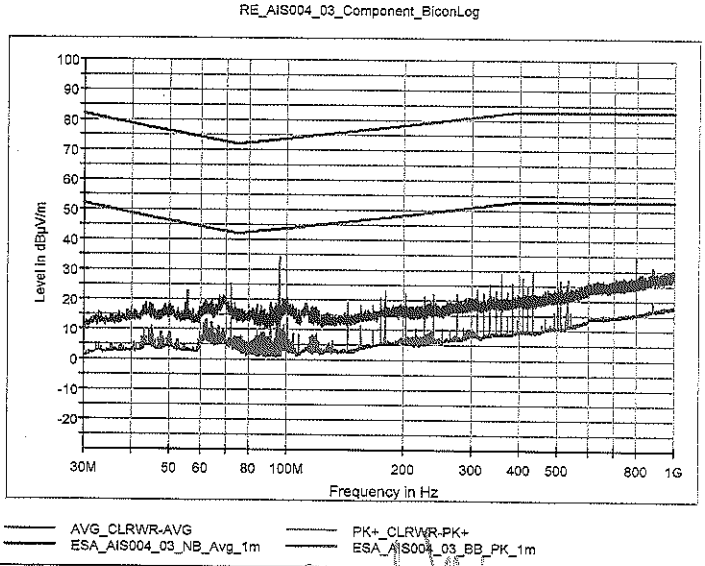
Sr. No.	Frequency range	Antenna polarization	Observation
1.0	30MHz to 1000MHz	Horizontal	Pass
2.0	30MHz to 1000MHz	Vertical	Pass

5.11 MEASUREMENT GRAPH

5.11.1 Radiated emission graph for frequency range 30 MHz-1000 MHz with antenna in horizontal polarization



5.11.2 Radiated emission graph for frequency range 30 MHz-1000 MHz with antenna in vertical polarization



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5.12 TEST RESULT ANALYSIS

5.12.1 Analysis of radiated emission test for frequency range 30MHz-1000MHz with antenna in horizontal polarization.

Freq. Band (MHz)	Freq. of Maxima by Peak detector (MHz)	Max. Measure-ment by Peak detector (dBuV/m)	Peak Limit (dBu V/m)	Result for Peak	Freq. of Maxima by Average detector (MHz)	Max. Measure-ment by Average detector (dBuV/m)	Average Limit (dBu V/m)	Result for Avg
30 - 50	44.3	17.7	77.75	Pass	42.95	9.2	48.08	Pass
50 - 75	55.3	19.6	75.33	Pass	71.95	13	42.45	Pass
75 - 100	95.95	24.5	73.62	Pass	95.95	22.6	43.62	Pass
100 - 130	119.95	17.2	75.09	Pass	119.95	10	45.09	Pass
130 - 165	155.9	22.5	76.81	Pass	155.9	18.5	46.81	Pass
165 - 200	179.9	24.6	77.75	Pass	179.9	21.3	47.75	Pass
200 - 250	239.9	21.5	79.64	Pass	227.9	14.9	49.3	Pass
250 - 320	308.5	23.3	81.29	Pass	263.9	12.1	50.27	Pass
320 - 400	359.8	26.4	82.3	Pass	359.85	22.1	52.3	Pass
400 - 520	510.7	27	83	Pass	510.75	21.2	53	Pass
520 - 660	620.8	26.7	83	Pass	535.25	14.6	53	Pass
660 - 820	800	28	83	Pass	819.1	16.2	53	Pass
820 - 1000	881.65	36.4	83	Pass	881.55	25.3	53	Pass

5.12.2 Analysis of radiated emission test for frequency range 30MHz-1000MHz with antenna in vertical polarization.

Freq. Band (MHz)	Freq. of Maxima by Peak detector (MHz)	Max. Measure-ment by Peak detector (dBuV/m)	Peak Limit (dBu V/m)	Result for Peak	Freq. of Maxima by Average detector (MHz)	Max. Measure-ment by Average detector (dBuV/m)	Average Limit (dBu V/m)	Result for Avg
30 - 50	43.4	19.3	77.97	Pass	44.9	11.1	47.6	Pass
50 - 75	71.95	25.6	72.45	Pass	71.95	21	42.45	Pass
75 - 100	95.95	34.2	73.62	Pass	95.95	33.3	43.62	Pass
100 - 130	101	20.9	73.96	Pass	101	14.2	43.96	Pass
130 - 165	143.9	19.3	76.28	Pass	143.95	14.4	46.28	Pass
165 - 200	179.9	23.2	77.75	Pass	179.9	19.3	47.75	Pass
200 - 250	239.9	22.1	79.64	Pass	203.9	17.7	48.57	Pass
250 - 320	311.85	23.9	81.36	Pass	311.85	18.1	51.36	Pass
320 - 400	359.8	29.2	82.3	Pass	359.8	25.7	52.3	Pass
400 - 520	431.8	29.7	83	Pass	431.8	27.5	53	Pass
520 - 660	535.25	26.9	83	Pass	535.25	19.7	53	Pass
660 - 820	797.15	34.4	83	Pass	797.15	25.3	53	Pass
820 - 1000	883.15	31.2	83	Pass	882.95	19.8	53	Pass

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5.13 TEST SETUP PHOTO

5.13.1 Test setup photo with Bi-conical antenna position in front of center of wiring harness.

5.13.2 Test setup photo with Log-periodic antenna position in front of center of wiring harness.

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ANNEXURE 06

6.1 TEST SPECIFICATIONS	
TEST DETAILS	CONDUCTED TRANSIENT EMISSION TEST AS PER AIS 140: 2016
TEST DATE	25-NOV-2019
TEST LOCATION	EMI/EMC LAB ARAI KOTHRUD, PUNE.

6.2 DUT OPERATING CONDITIONS	
DUT MODE OF OPERATION	FULL OPERATING
DIAGNOSTIC TOOLS CONNECTED	NOT APPLICABLE

6.3 MONITORING OF DUT	
PASS/FAIL criteria	Manually controlled by Operator.

6.4 LABORATORY ENVIRONMENT TEST CONDITIONS					
Ambient Temperature	22.7 degC	Required (23+/-5) degC.	Relative Humidity	59.3 % RH	---

6.5 TEST SETUP DETAILS		
DUT SETUP DETAILS	**Status**	**Remarks**
A) Test setup was done according to	ISO 7637-2: 2004	Refer Std. ISO 7637-2: 2004 Clause No.4.3
B) Test table surface	Metallic	Test table height from ground floor (900, +/-100)mm.
C) Ground plane	Galvanized Steel	0.5mm thick (min.)
D) Whether the DUT and wiring harness of the DUT was placed (50, +/-5) mm, above the ground plane?	Yes	Placed on non-conductive, low relative permittivity material.
E) Length of wiring harness between DUT and artificial network(200, +/-50)mm	Yes	---
F) Whether DUT was directly grounded (GND) or isolated (ISO) from the ground plane?	ISO	---
G) No. of LISNs used (5uH/50ohm)	1	---
H) Shunt resistor (Rs) connected in parallel to the DUT & Ignition switch.	40ohm	---
I)Transient emission measurement according to	Fast pulses Slow pulses	---

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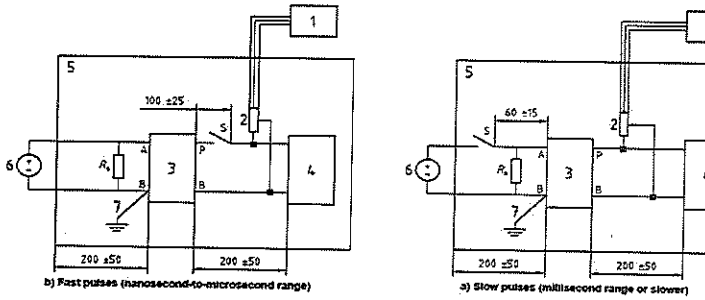
6.6 DUT SUPPLY VOLTAGE DETAILS			
Test Voltage	**12V System**	**24V System**	**Current Consumption**
Ua	Connected	Connected	<1A
Ub	Connected	Connected	

Power Sources	**Status**	**Voltage**
Battery	Yes	12V and 24V
DC Power Supply (external)	Yes	13.5V and 27V

6.7 TEST PROCEDURE

The interference voltages emitted from electronic systems and electrical components were measured. The DUT was connected with the Switch S and the power supply-backed starter battery via the AN. The interference voltage was measured between the terminals P and B of the AN using a probe of an oscilloscope. Continuous interference sources are measured when the Switch S was closed. The particular event was repeated for minimum 10 times, in order to capture maximum transient amplitude.

6.8 TRANSIENT EMISSION TEST SET UP



1 oscilloscope or equivalent
2 voltage probe
3 artificial network
4 DUT (source of transient)
5 ground plane
6 power supply
7 Ground connection; length < 100 mm

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6.9 TEST OBSERVATION				
6.9.1 Operating Voltage 24V				
Sr. No.	**on supply line**	**Maximum Allowed Transient**	**Observed Voltage Transient Emission**	
			Fast	**Slow**
1.0	Positive	+150V	Positive transient of 12.4V was observed.	Positive transient of 12.6V was observed.
2.0	Negative	-450V	No Negative transient was observed.	No Negative transient was observed.
6.9.2 Operating Voltage 12V				
Sr. No.	**on supply line**	**Maximum Allowed Transient**	**Observed Voltage Transient Emission**	
			Fast	**Slow**
1.0	Positive	+75V	Positive transient of 5.2V was observed.	Positive transient of 5.3V was observed.
2.0	Negative	-100V	No Negative transient was observed.	No Negative transient was observed.

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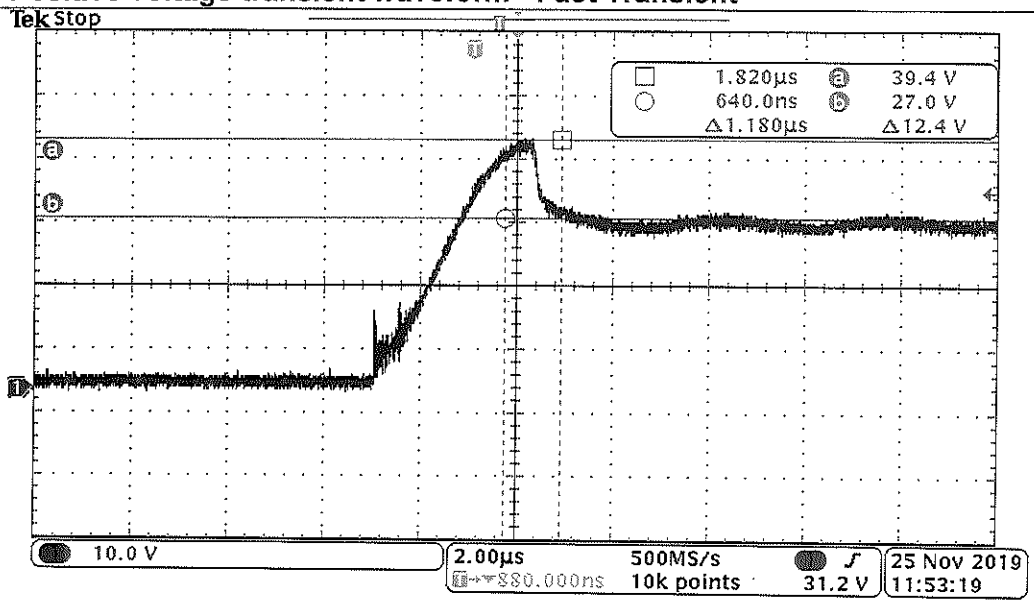
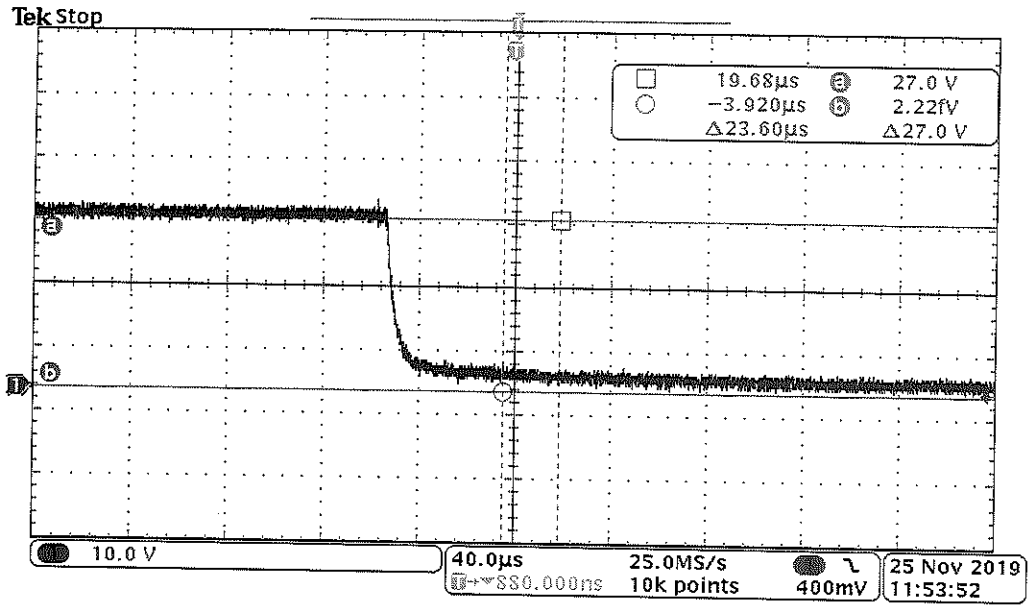
6.10 MEASUREMENT VOLTAGE TRANSIENT WAVEFORMS

6.10.1 Operating Voltage 24V

6.10.1.1 Positive voltage transient waveform - Fast Transient



6.10.1.2 Negative voltage transient waveform - Fast Transient



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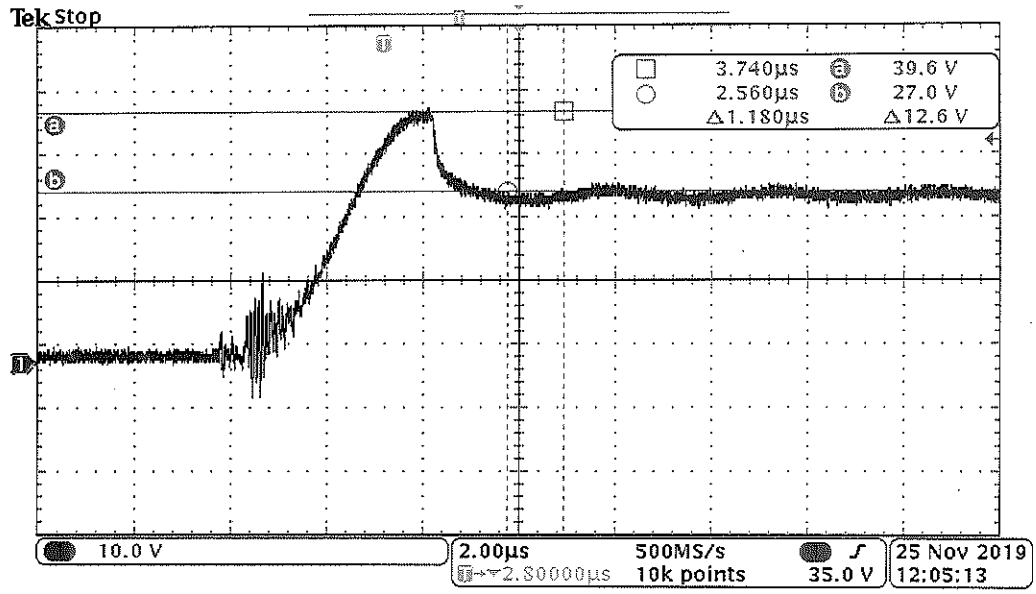
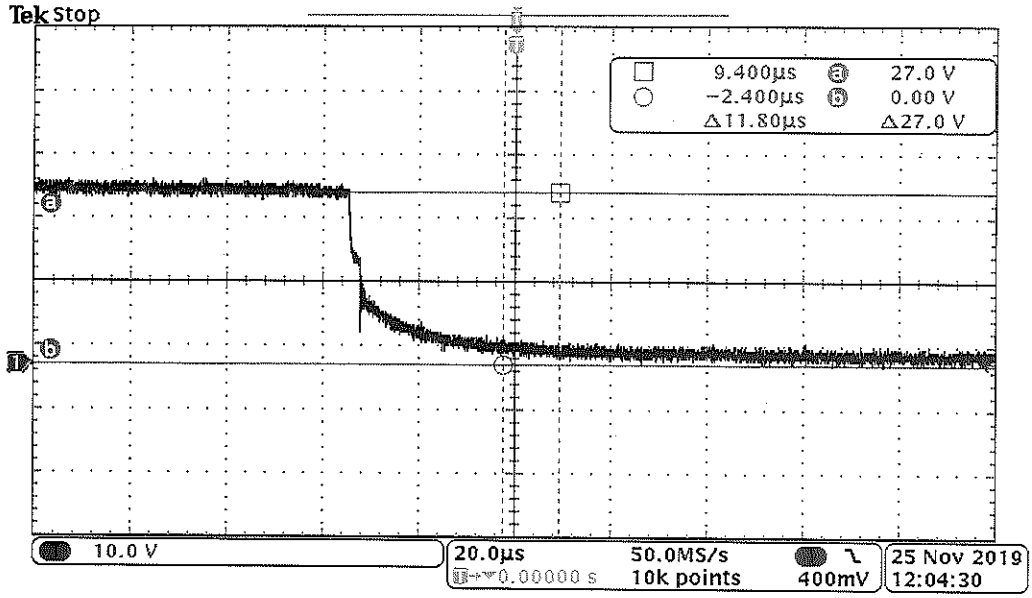
6.10.1.3 Positive voltage waveform - Slow transient



6.10.1.4 Negative voltage waveform - Slow transient



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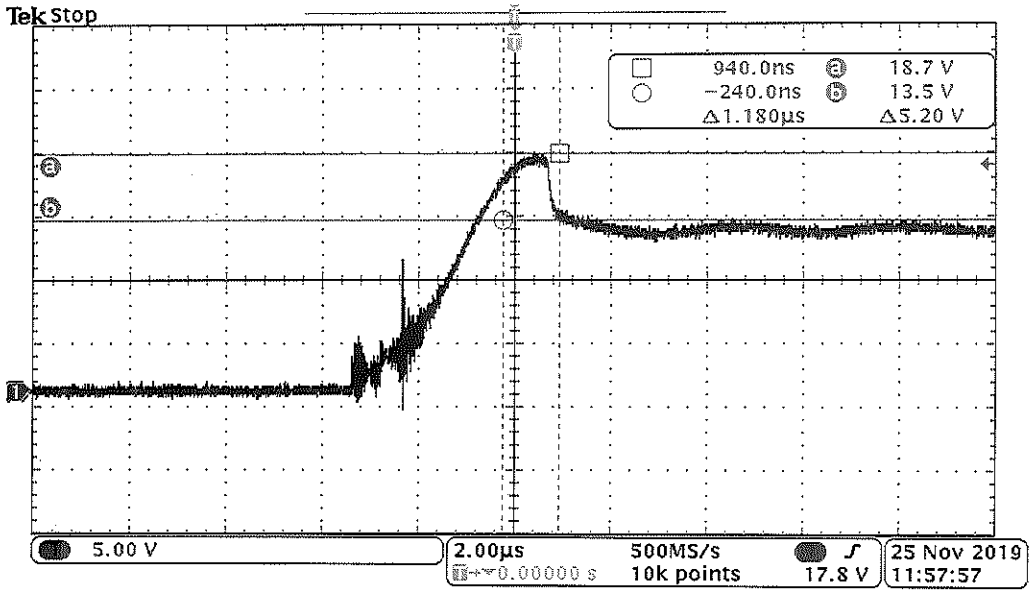
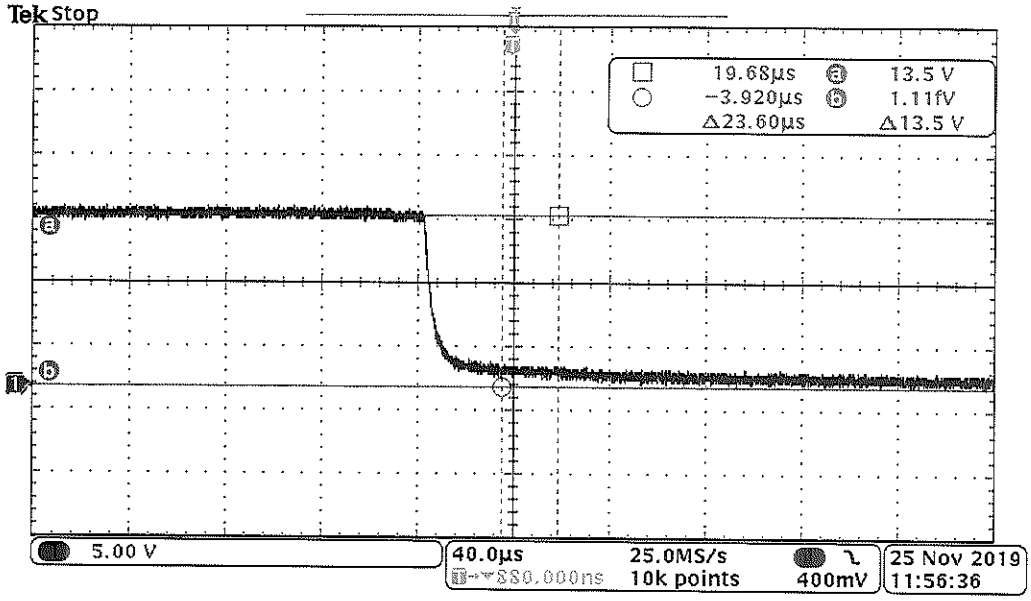
6.10.2 Operating Voltage 12V

6.10.2.1 Positive voltage transient waveform - Fast Transient



6.10.2.2 Negative voltage transient waveform - Fast Transient



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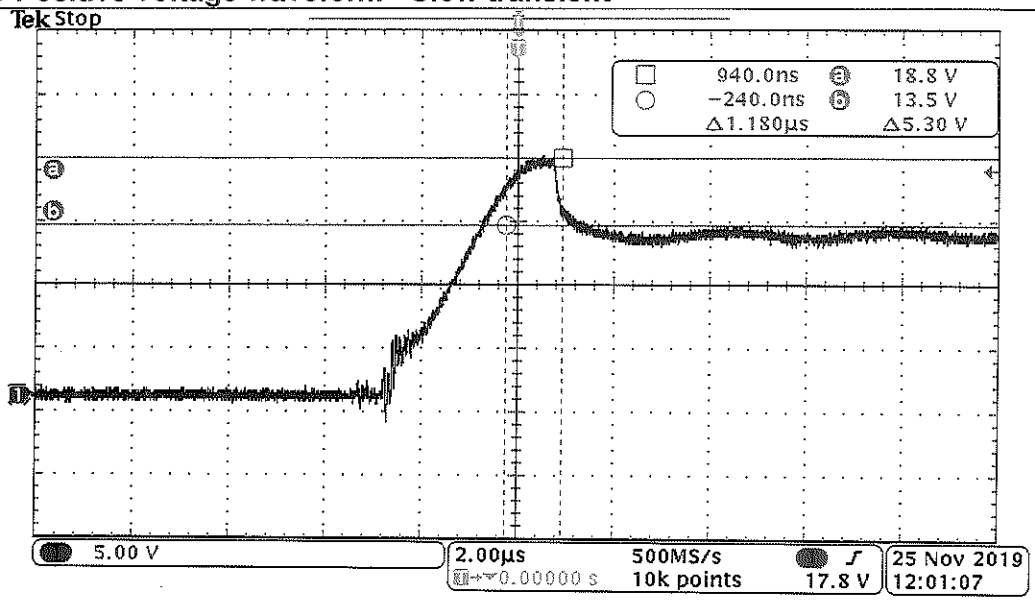
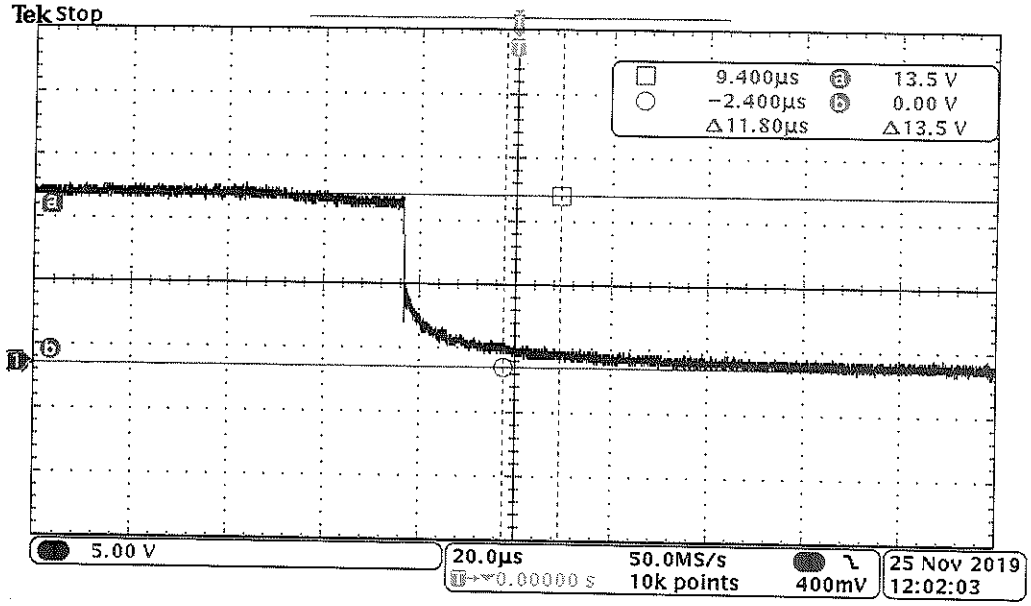
6.10.2.3 Positive voltage waveform - Slow transient



6.10.2.4 Negative voltage waveform - Slow transient



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6.11 TEST SETUP PHOTO

6.11.1 Fast Transient emission, general set-up

6.11.2 Slow Transient emission, general set-up

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End of Annexure 06