In the framework of SESEI

In association with CII Confederation of Indian Industry

3rd Indo-European Conference on Standards and Emerging Technology

26th April, 2018 – New Delhi

ELECTRIC VEHICLE-EMC ASPECTS AND ITS (AIS:140 IMPLEMENTATION)

ENOCH EAPEN AND ADITI SETHI

ICAT Innovation • Service • Excellence

PART-1: ELECTRIC VEHICLE- EMC ASPECTS

ENOCH EAPEN

AGENDA

- About ICAT
- EV Homologation Standards
- EMC Introduction
- EMC testing of Electric Vehicles
- EMC test facilities at ICAT

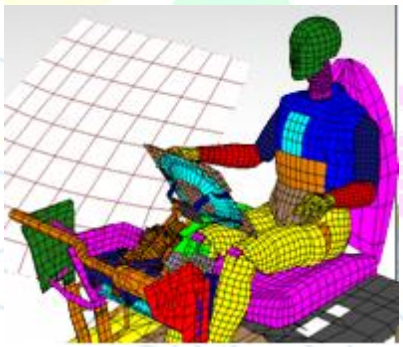
ABOUT ICAT

The International Centre for Automotive Technology (ICAT), Manesar is Automotive testing certification and R&D Centre under NATRIP (National Automotive Testing and R&D Infrastructure Project), Govt. of India.

Established : 2006
Location : Manesar, Haryana India (38 km from Delhi Airport)
Area : 8 + 46.6 Acres (2 centres)
Human resource : 412 (incl. contractual)

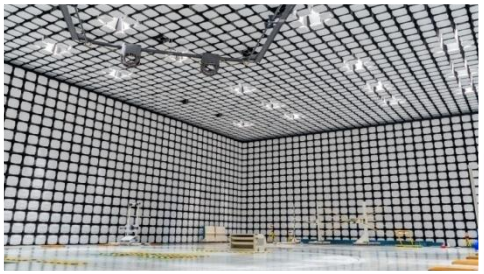
FACILITIES ICAT CENTRE -I (26, SECTOR 3, IMT MANESAR)

- **Engine Dynamometer Lab**
  - 10 + 3 (under I&C)
- **Chassis Dynamometer Lab**
  - 1-CVTC, 4-ECD & 3-MACD
  - 2W ECD (under I&C)
- **Transmission NVH test Lab**
- **Component Evaluation Lab**
- **Fatigue Lab**
- **Rapid Prototyping Lab**
- **Electrical and Electronics Lab**
- **CAD/CAE Lab**
- **Infotronics Lab**



FACILITIES ICAT CENTRE - II
(1, SECTOR 11, IMT MANESAR)

Crash Lab

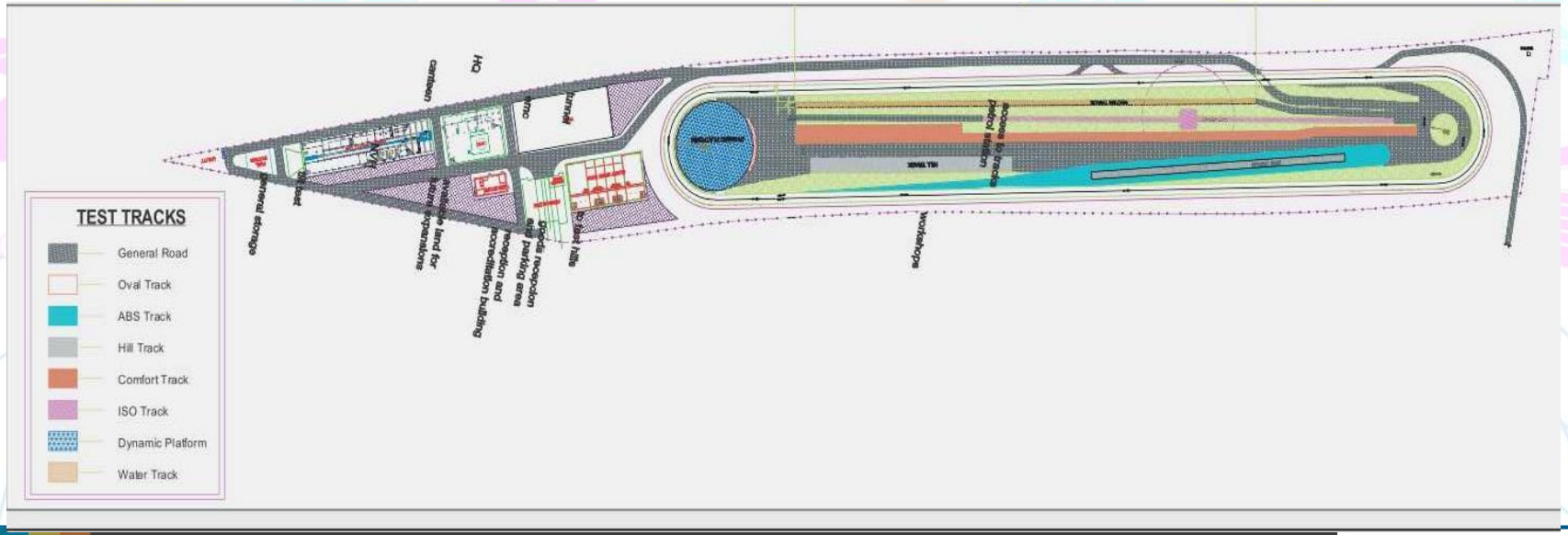


EMC Lab

NVH Lab

Tyre COE

Vehicle Evaluation Lab



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EV HOMOLOGATION STANDARDS

Indian Automotive Standards exclusive to type approval of electric vehicles

AIS 049 Rev 1.0	Electric Power Train Vehicles - CMVR Type Approval for Electric Power Train Vehicle
AIS 102 (I & II)	CMVR type approval of hybrid electric vehicles
AIS 123 (I, II & III)	CMVR Type Approval of Electric Propulsion Kit Intended for Conversion of Vehicles for Pure Electric Operation
AIS 131	Type Approval Procedure for Electric and Hybrid Electric Vehicles introduced in market for Pilot/ Demonstration Projects intended for Government Scheme

List of European Standards for type approval of electric vehicles

ECE R 101	Electric Power Trained Vehicles

COMPONENT LEVEL HOMOLOGATION TEST REQUIREMENT

- **Mechanical Components** : Rear view mirrors, safety glass, brake hoses, brake fluid etc.
- **E & E components** : Battery, motor/generator, CNG & LPG, Speed limiters etc.
- **Automotive Lighting**: Lighting devices, signaling devices, retro reflectors/ tapes etc.

VEHICLE LEVEL HOMOLOGATION TEST REQUIREMENT

- **EV Exclusive :** Power, Max Speed, Energy Efficiency and Range Test etc.
- **Dynamic Test :** Brake*, Gradient, Speedometer Cal, ABS, PBN, Steering Effort etc.
- **EMC**
- **Passive safety :** Crash, Pedestrian safety, Seat Anchorage, Seat belt, Bumper Impact etc.
- **Active Safety :** Installation of Lighting, Mirrors & Horns, Anti Theft Devices, Field of Vision, Wiping Area, Demisting & Frosting etc.
- **Electronics & Electrical :** Vehicle Alarm Systems, Electrical Functional Safety etc.

TYPE APPROVAL TEST EXCLUSIVE FOR ELECTRIC POWER TRAIN VEHICLE

Test	Indian Standard/rule	Corresponding ECE/EEC
EMC	AIS 004 (III)	R 10
Vehicle Alarm System	AIS 076	R 116
BoV- Constructional & Functional Safety	AIS 038 (REV. 1) AIS 038 (E-rickshaw)	R 100
BoV-Measurement of Electrical Energy Consumption	AIS 039 (REV.1)	R 101
BoV-Range of Electric Vehicles	AIS 040 (REV.1)	R 101
BoV-Measurement of Power (net & 30-min) & speed	AIS 041 (REV.1)	R 85

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EMC DEFINITION

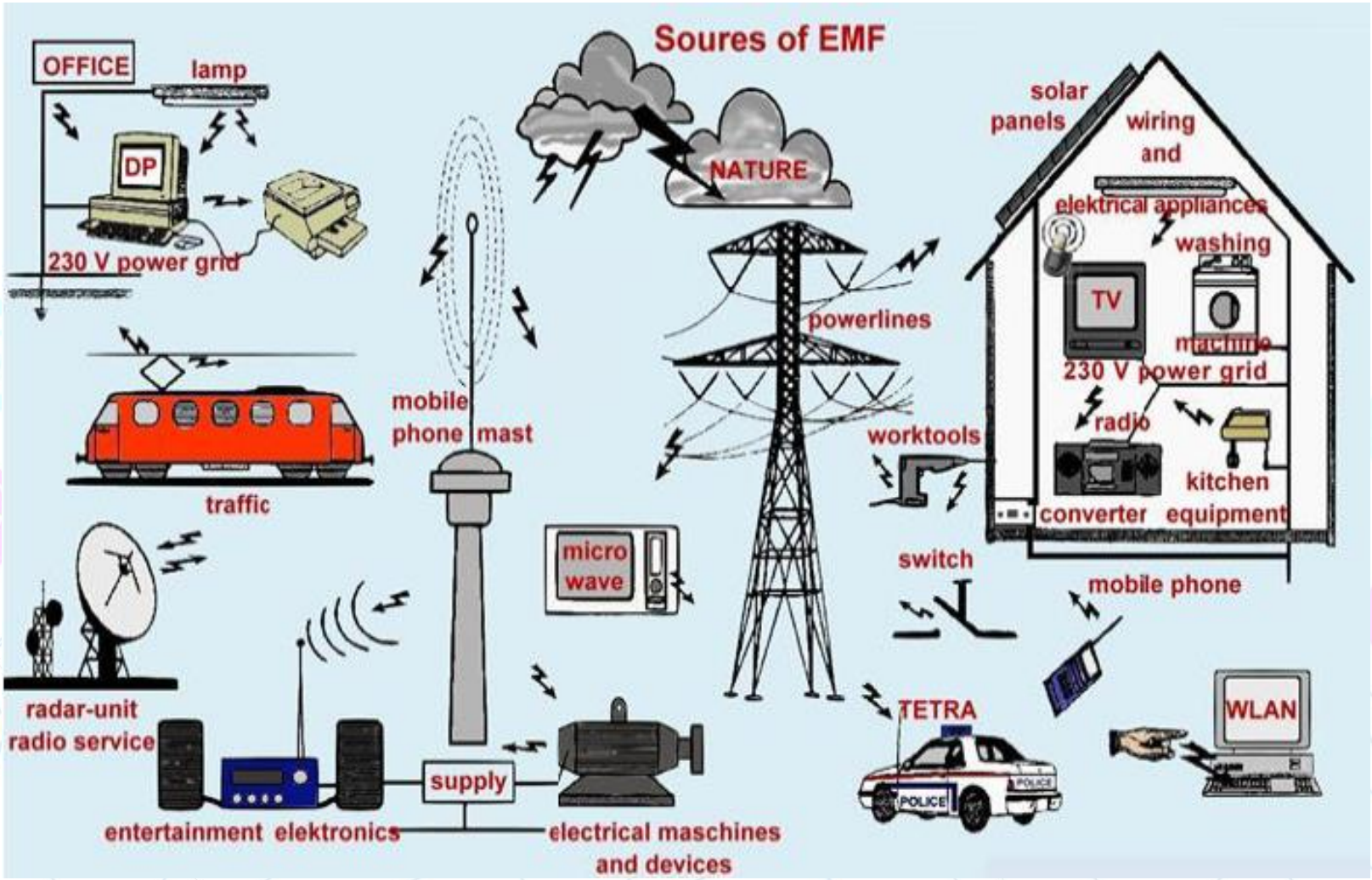
EMC - Electromagnetic Compatibility is the ability of a device or system to function:
-without error (or susceptibility) in its intended electromagnetic environment ***(Immunity aspect)***
-without introducing intolerable electromagnetic disturbances to anything in that environment ***(Emissions aspect)***

EMC

EMI

EMI- Electromagnetic Interference is any electric or magnetic emission from a device or system that interferes with the normal operation of another device or system.

TYPICAL ELECTROMAGNETIC ENVIRONMENT



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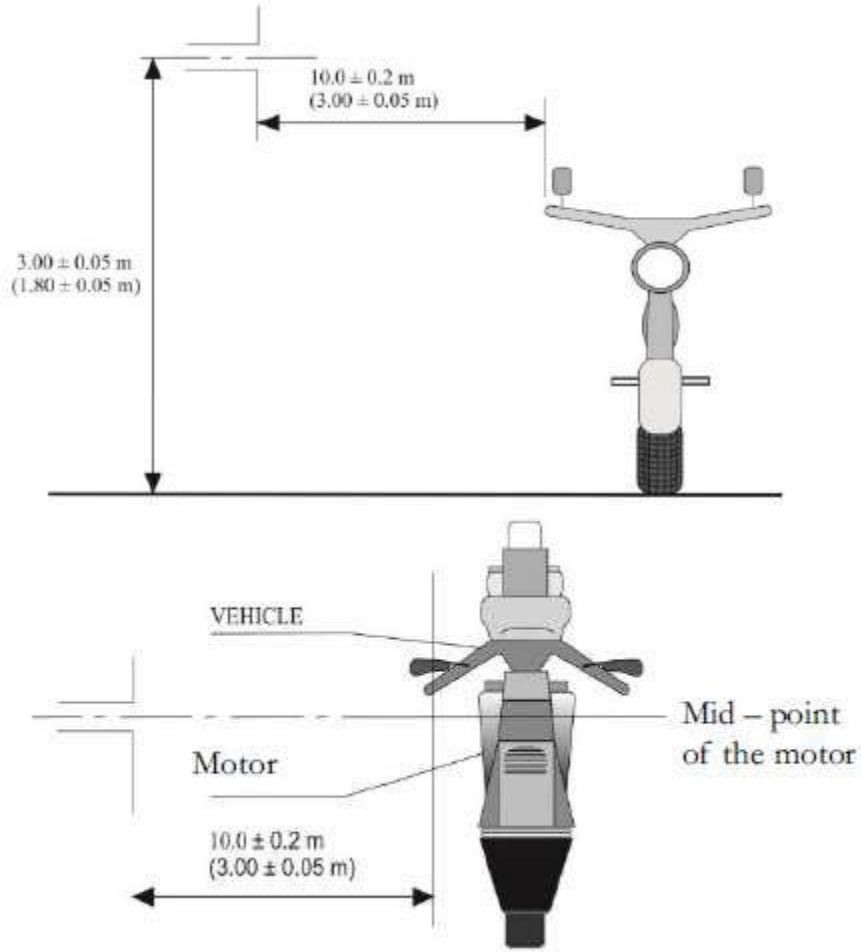
RADIATED EMISSIONS (RE)

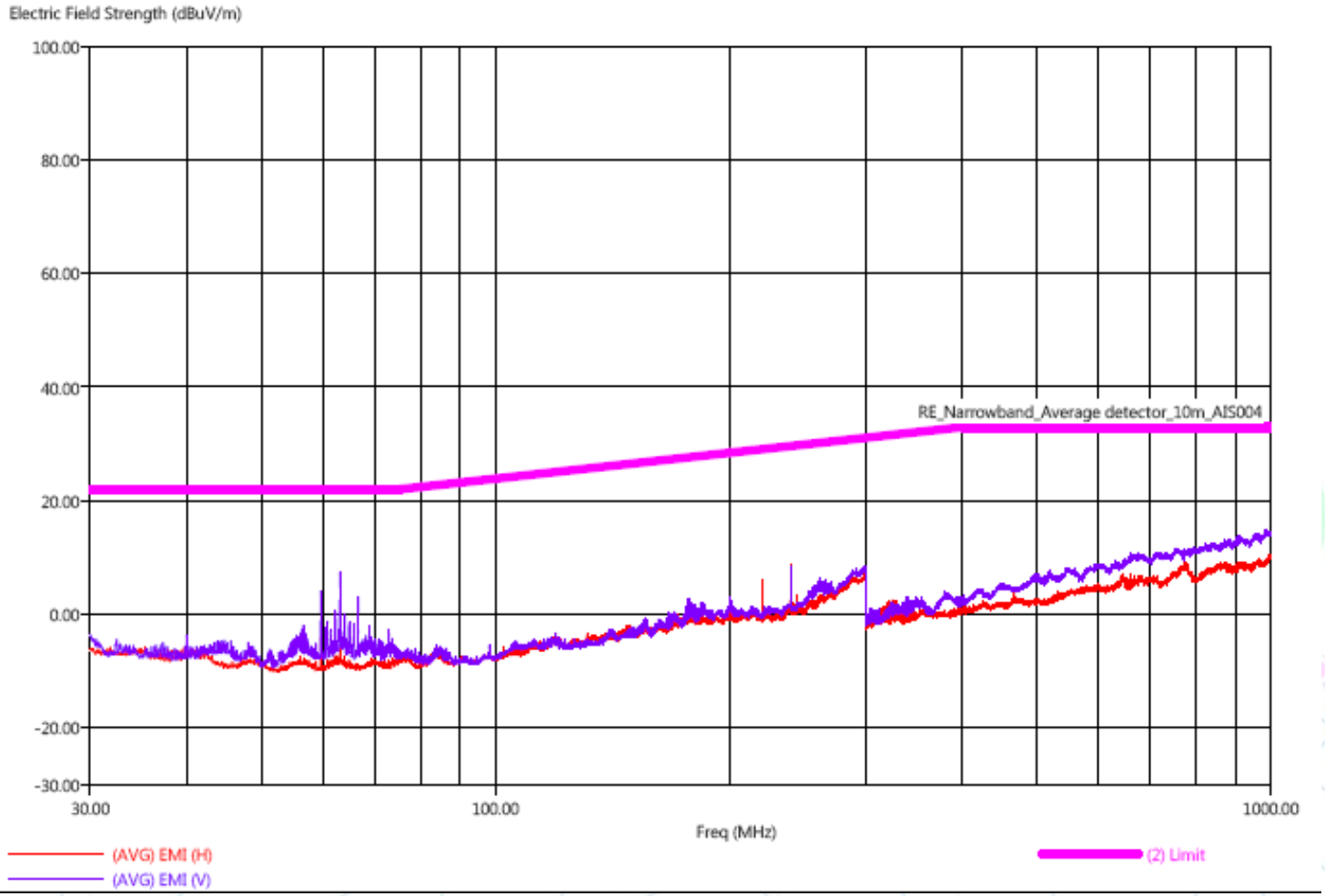
- EM radiation from your vehicle (source) affects the performance of another vehicle or device around it (receiver)
- Path of interference lies through free space
- Example of sources: motor, power converters (DC/DC, DC/AC if AC motor is used), controller units etc.
- Victims outside the vehicle (Off -board victims): e.g. TV antenna at home, mobile station antennas, controllers in other vehicles.
- Vehicle conditions: Running (Broadband) & Key ON (Narrowband)

TYPICAL SETUP FOR RADIATED EMISSION TEST

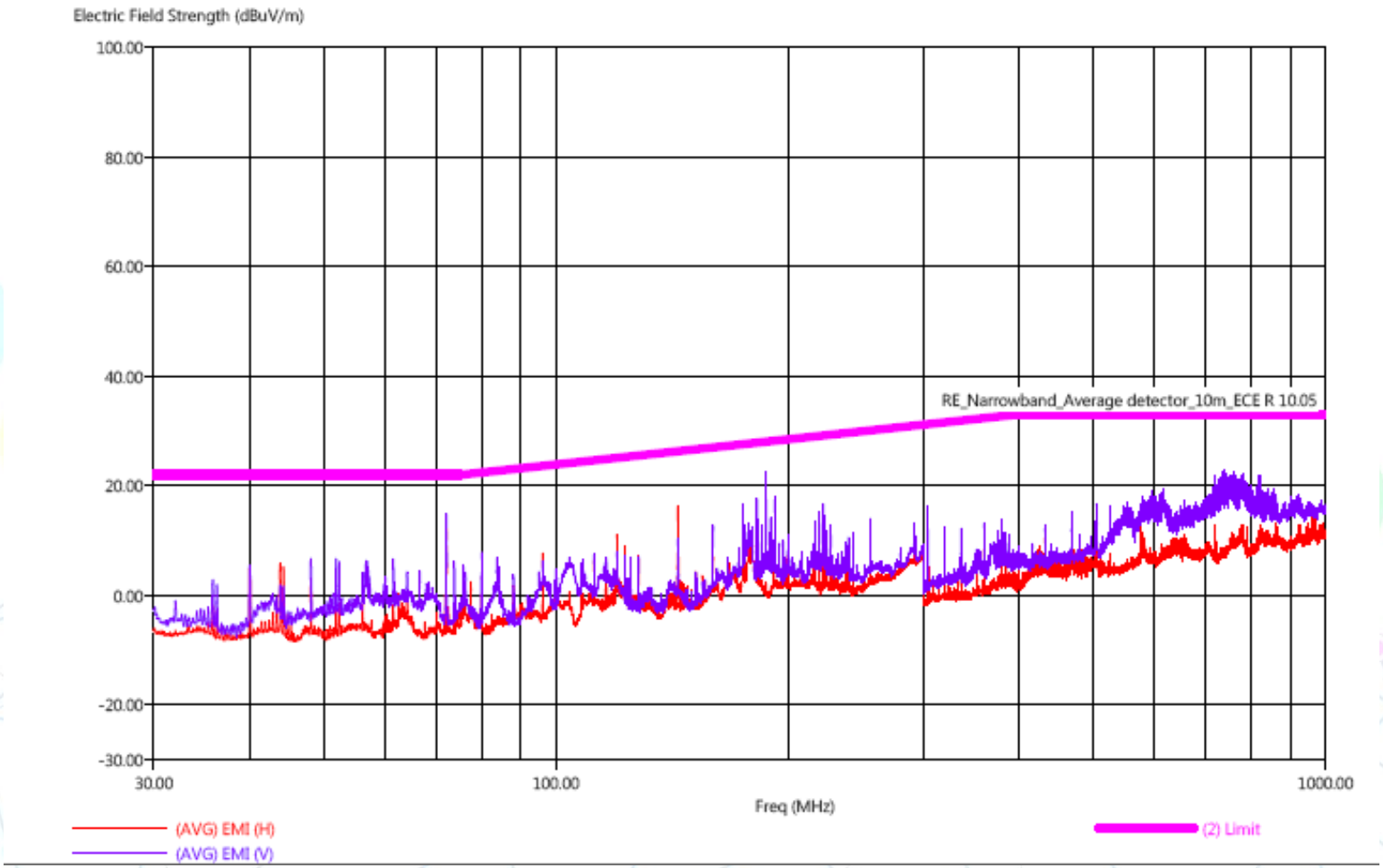


- Antenna distance from vehicle edge: 3 m or 10 m
- Antenna height from ground: 1.8 m or 3 m
- Antenna Polarizations: Horizontal & Vertical
- Applicable Frequency Range: 30 MHz to 1 GHz
- Performed on left and right sides of the vehicle.

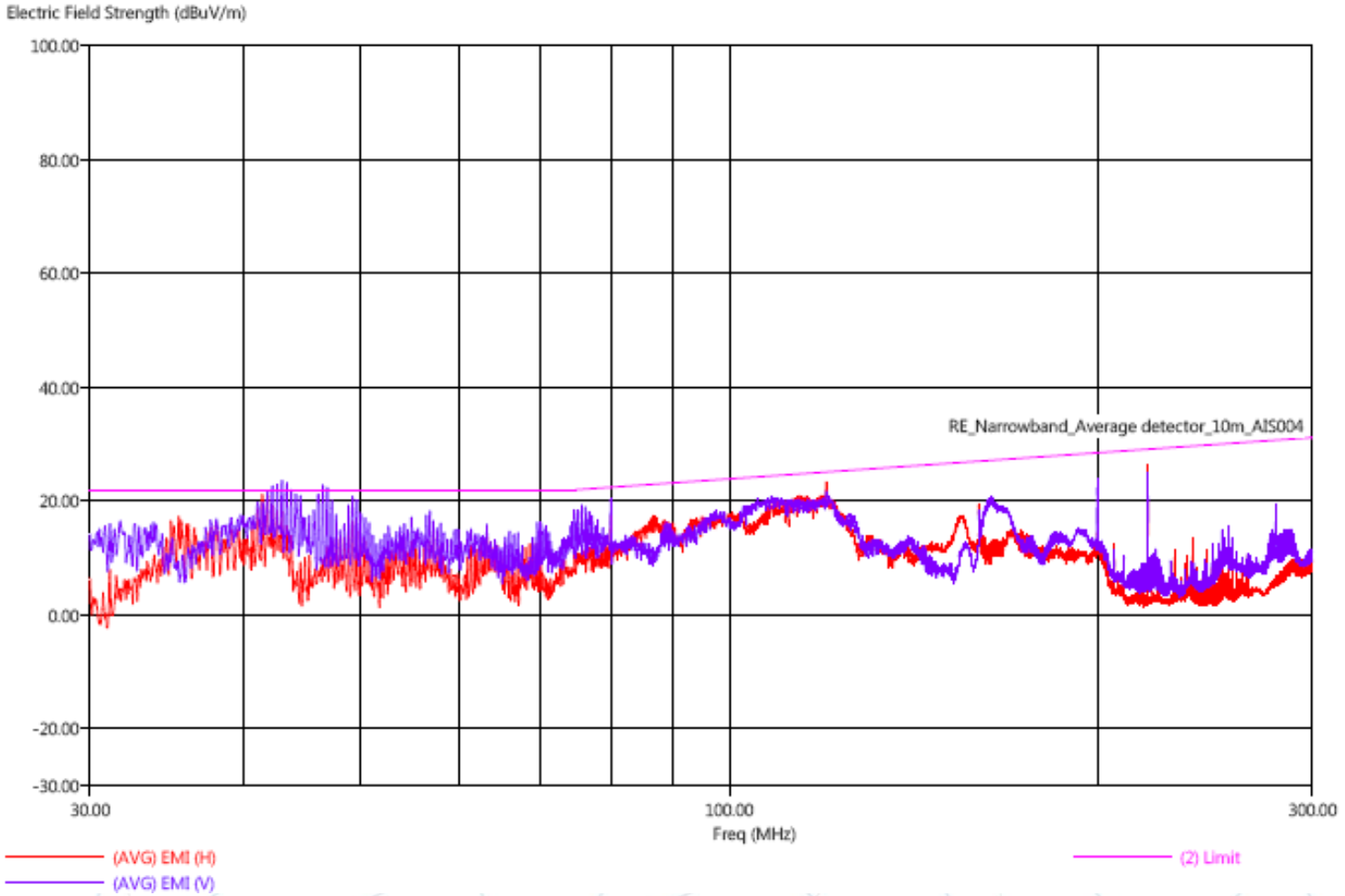
E.G. INDIAN CNG BUS- NARROWBAND EMISSION



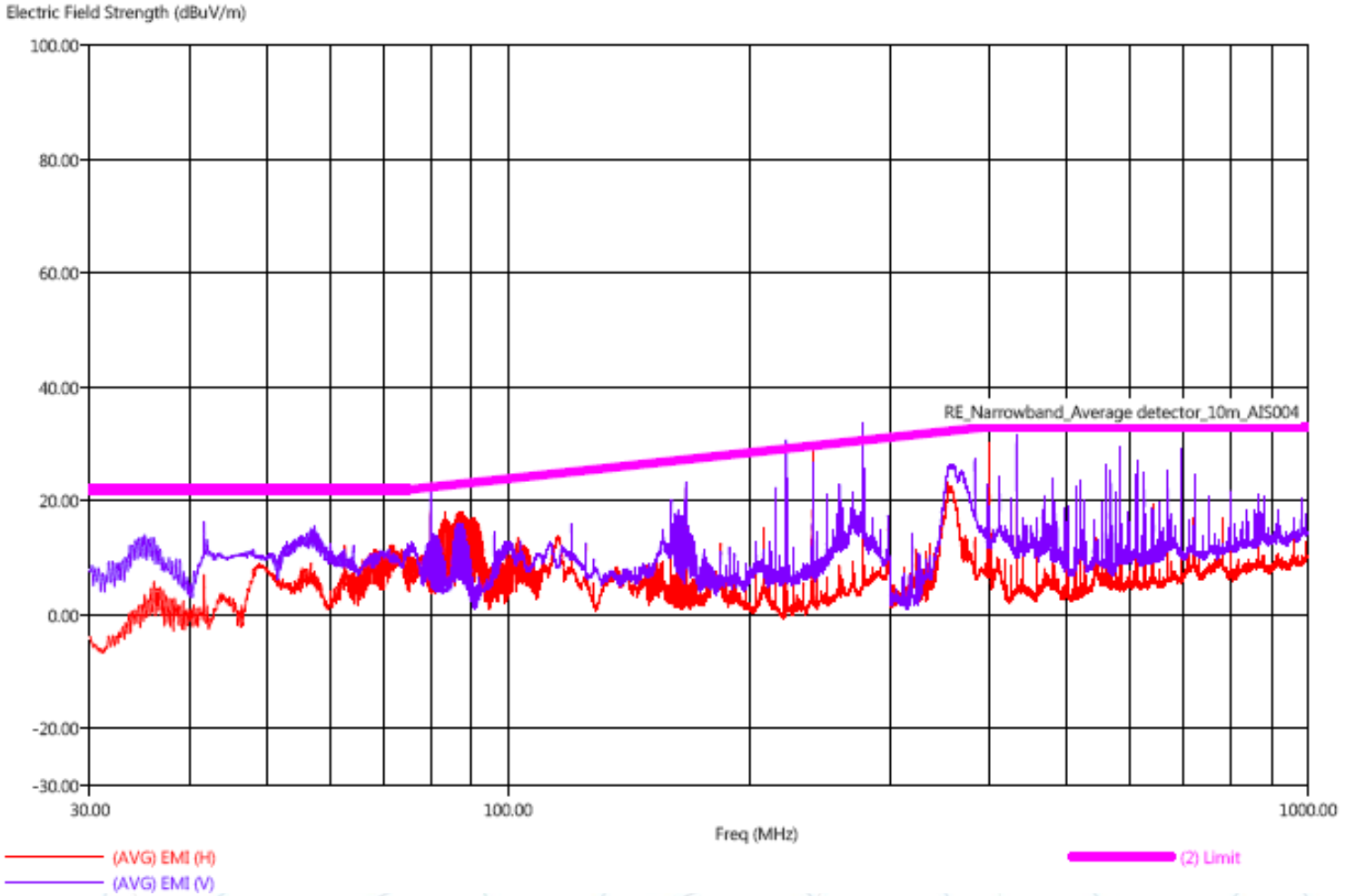
E.G. INDIAN HYBRID BUS- NARROWBAND EMISSION



E.G. EUROPEAN EV BUS- NARROWBAND EMISSION



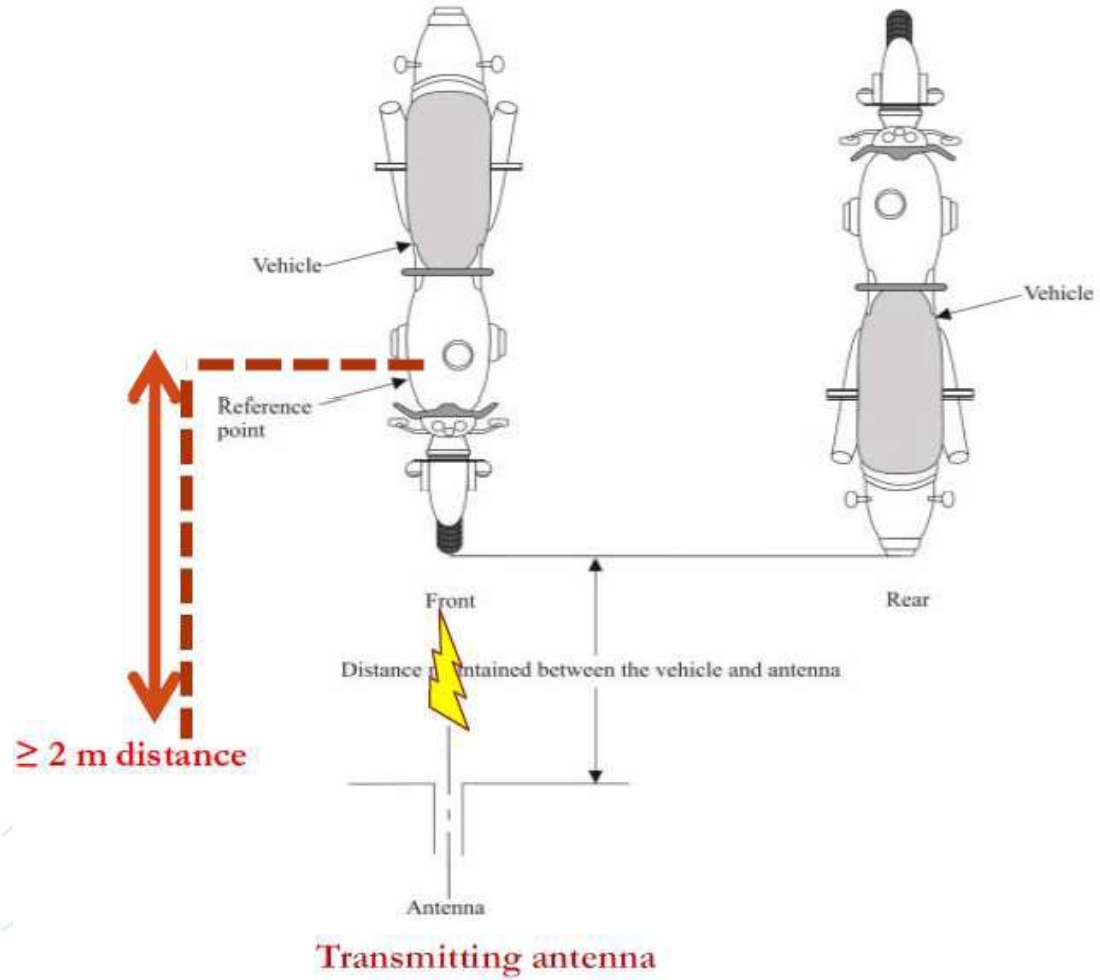
E.G. INDIAN EV BUS- NARROWBAND EMISSION



RADIATED IMMUNITY

- The performance of your vehicle (receiver) is affected by the EM radiation from another vehicle or device around it (source)
- Path of interference lies through free space
- Examples of victims: controller units, vehicle lamps/ indicators, instrument clusters etc.
- Sources outside the vehicle (Off - board sources): e.g. Airport radars, mobile base station Tx antennas, other vehicles, portable Tx
- Vehicle conditions: Running & Brake Cycle (if ABS is there)

TYPICAL SETUP FOR RADIATED IMMUNITY TEST

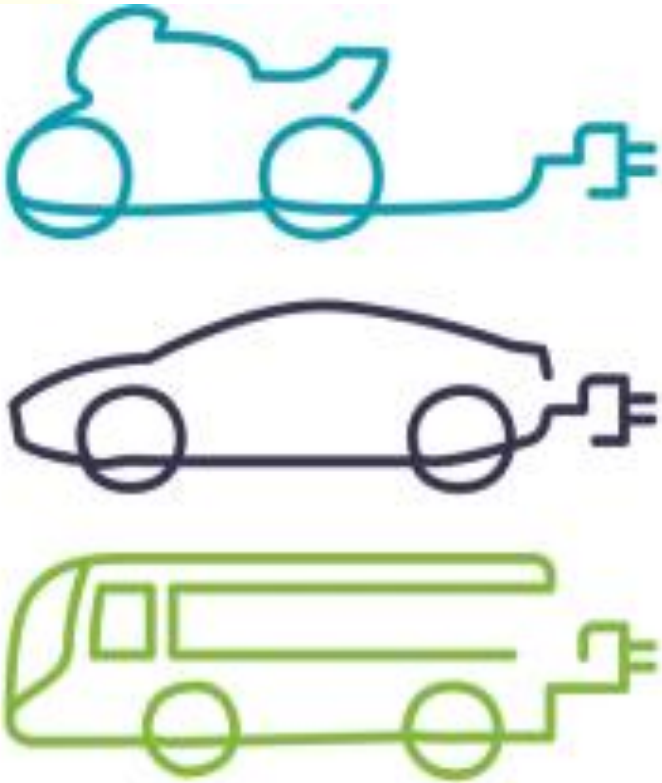


- **Field Severity Level: 30 V/m**
- **Antenna Polarization: Vertical**
- **Applicable Frequency Range: 20 MHz to 2 GHz**
- **Parameters monitored:**
- Speed variation greater than 10% of set speed.
- Unexpected horn activation
- Unexpected behavior of headlamp, direction indicator, instrument cluster, brake light etc.
- **For long vehicles, test directions may increase depending on electronics distribution.**

IN CHARGING MODE WHAT CAN HAPPEN TO EVS IN EMC TEST

Function related to charging mode when coupled to the power grid:

- For vehicle test: by leading to unexpected vehicle motion
- For ESA test: by leading to an incorrect charging condition (e.g. over-current, over-voltage).



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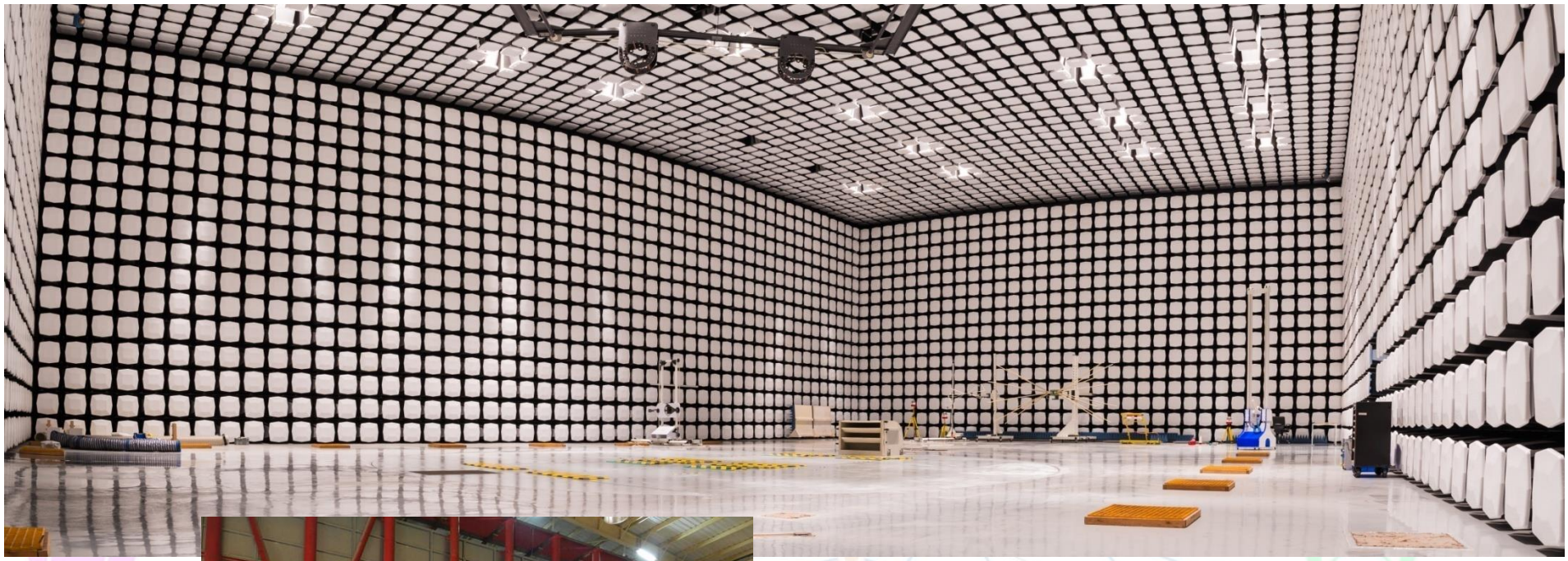
ELECTROMAGNETIC COMPATIBILITY (EMC) LAB

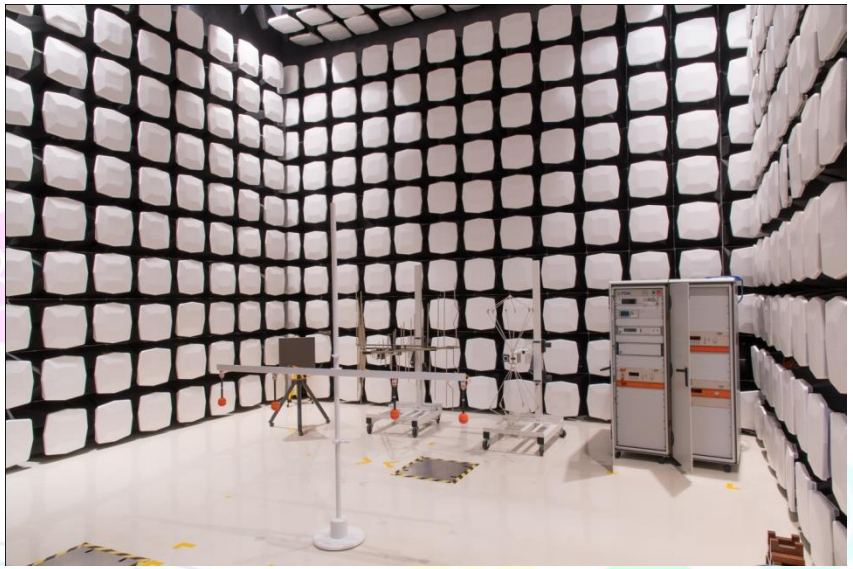
VEHICLE SEMI – ANECHOIC CHAMBER (VSAC)



Overall Dimensions:

- **30 m X 20 m X 10 m (L X W X H).**
- **11 m turntable, 4X4 chassis dynamometer for a vehicle up to 19 tons.**

COMPONENT SEMI – ANECHOIC CHAMBER (CSAC)



Overall Dimensions:

- 8.5 m X 7 m X 6 m (L X W X H).
- Can also be used for 2/3 wheelers and small 4 wheelers

GENERAL INSTRUMENTATION ROOM

- Immunity to Transient Disturbances setup
- Conducted Transient Emissions setup

Testing as per:

- ISO 7637-2, ISO 7637-3 (CCC and DCC)
- ISO 16750-2
- JASO D001:94
- SAE J1113-11, SAE J1113-12
- GOST 28751-90
- OEMs' development standards

ESD setup

- Upto ±30 KV for air & contact discharge

Testing as per:

- ISO 10605
- IEC 61000-4-2
- OEMs' development standards

RADIATED/CONDUCTED EMISSIONS

RE: Frequency Range: 9 kHz to 8 GHz

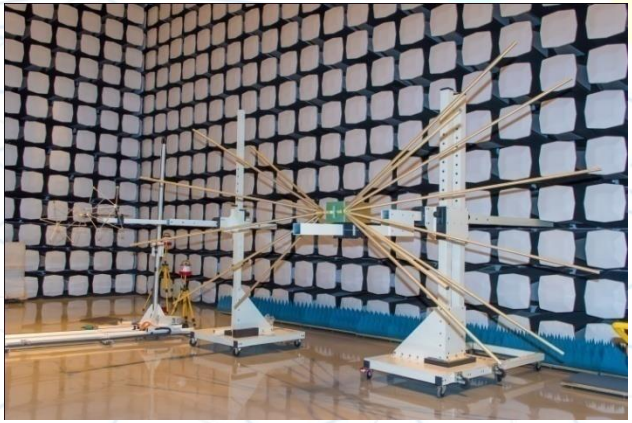
CE Frequency Range: 100 kHz to 150 MHz

Current Measuring Probes:

- 10 kHz – 500 MHz
- 20 Hz – 5 MHz

RADIATED IMMUNITY, ALSE METHOD

Frequency Range: 20 MHz to 18 GHz

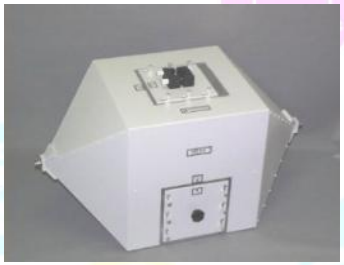


We also have E/H Generator/TLS from 100 kHz to 20 MHz.

OTHER TESTS' INSTRUMENTATION (FOR COMPONENTS)

TEM cell method

10 kHz to 420 MHz

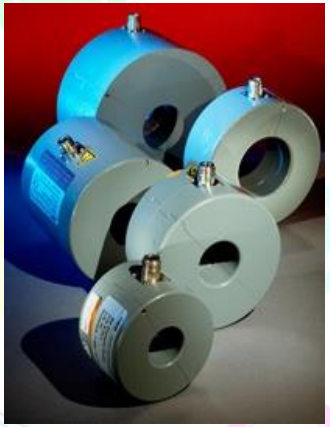


Stripline method

10 kHz to 220 MHz

Bulk Current Injection method

10 kHz to 1.3 GHz



Triplate method

100 kHz – 1 GHz

Immunity To Radiated Magnetic Fields

DC -150KHz

40 cm Helmholtz Coil

WHOLE VEHICLE ELECTROMAGNETIC IMMUNITY, ON – BOARD TRANSMITTER SIMULATION

On – board transmitting antennas:

1.8 MHz to 2 GHz

PART-2: INTELLIGENT TRANSPORTATION SYSTEM (AIS:140 IMPLEMENTATION)

ADITI SETHI

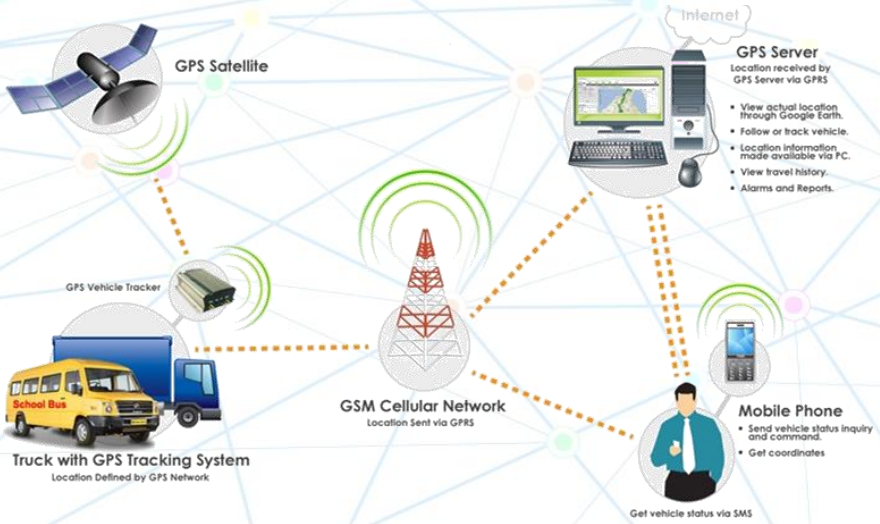
INTELLIGENT TRANSPORTATION SYSTEM- VARIOUS COMPONENTS

- Public Information System including LED Destination Boards, Announcement System, Safety Alert Hooters etc.
- CCTV System
- Fare collection/Electronic Ticketing System
- RFID Tags and Highway Toll Collection System
- Reverse Parking Assist System
- Tire Pressure Monitoring System
- Traffic Management System
- Vehicle Location Tracking Unit

VEHICLE LOCATION TRACKING UNIT

Device uses satellite based location technology to determine and record the precise location of a vehicle at regular intervals.

This data can be stored within the device, and/or can be transmitted to the Backend Control Centre using a wireless communication modem built in the device.



AIS 140

To mandate use of vehicle location tracking systems in public service vehicles, to regulate uniformity, safety, quality and efficiency.

Provisioned for device level and vehicle level approval.

SCOPE AND IMPLEMENTATION DEADLINE

Applies to vehicle location tracking devices and emergency button intended to be fitted in Public transport vehicles.

- **Standard was notified against G.S.R. 1095(E) dt. 28th Nov'16: Implementation Deadline: 1st April'2018**
- **Latest Notification S.O. 1663(E) dt. 18th Apr'18: Deadline extended to 1st April'2019**

TEST FACILITIES AT ICAT FOR AIS 140

- Protocol Verification
- Physical and Documentation Verification
- Electrical and EMC Tests
- Mechanical and Environmental Tests
- Performance Tests

PROTOCOL VERIFICATION

- Position Velocity Time Data (PVT Data)
- Device Health Monitoring
- Alerts
  - Emergency
  - Tamper
  - Over the air parameter change
  - Ignition Off
  - Rash Driving: Braking, Acceleration or Turning
  - Battery Disconnect
  - Low Battery
- SMS Fall Back (Absence of GPRS Signal)

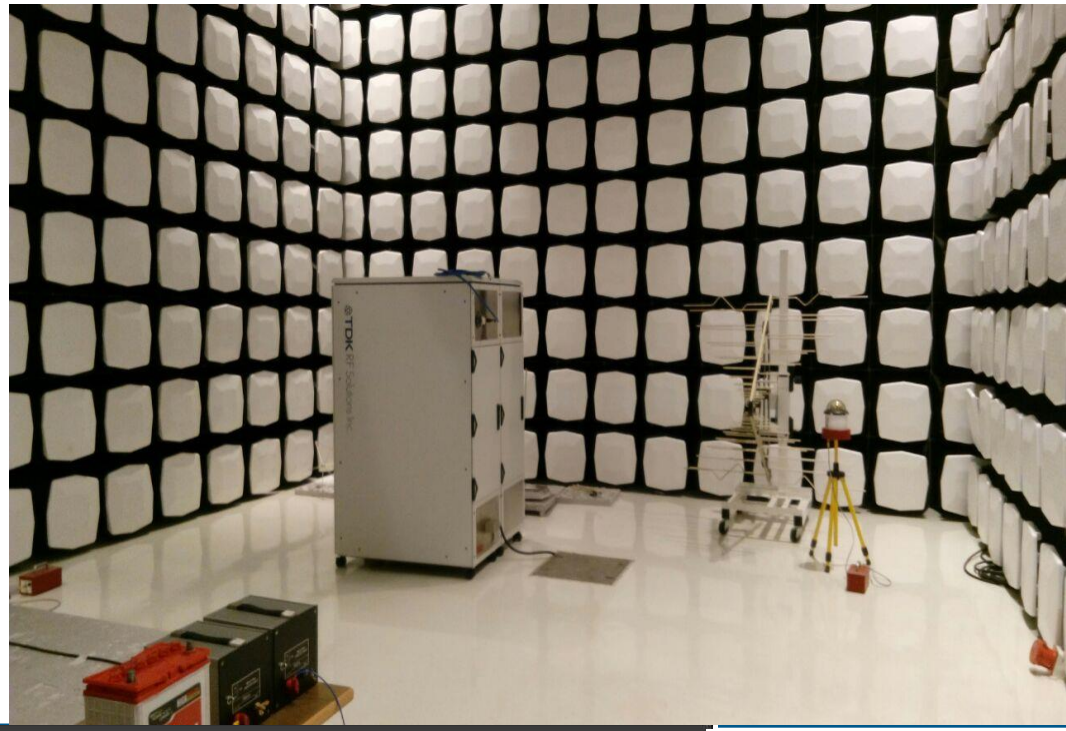
PHYSICAL AND DOCUMENT VERIFICATION

Physical Hardware And Data Sheet Verification

- GPRS/GSM Module and Antenna
- GPS Module and Antenna
- 3 axis gyroscope
- 3 axis accelerometer
- Embedded SIM
- Internal Storage

ELECTRICAL AND EMC TESTS

- EMI/EMC as per AIS 004-3
- Reverse Polarity Protection without Fuse
- Performance Parametric Test (Nine points, tri-temperature/ tri-voltage)
- Insulation Resistance Test
- Load Dump Test Pulse 5a
- High Voltage Test
- Battery Backup Test
- Functional Endurance

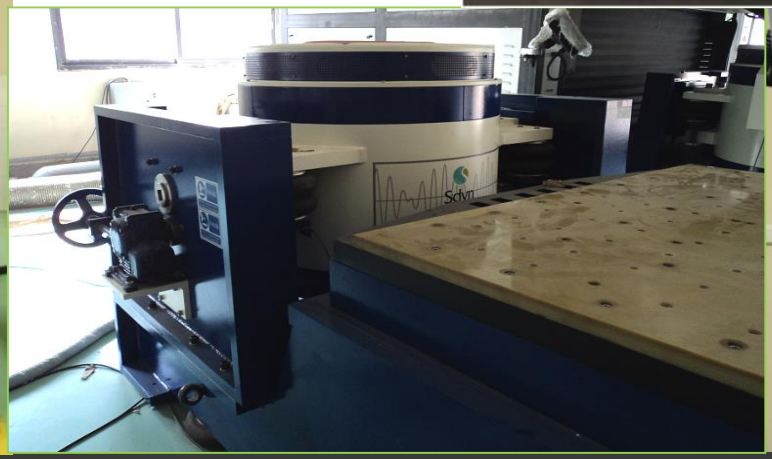


MECHANICAL AND ENVIRONMENTAL TESTS

- Temperature Shock
- Ingress Protection against Dust and Water

MECHANICAL AND ENVIRONMENTAL TESTS

- Dry Heat Test/High Temperature Test
- Cold Test
- Damp Heat Test
- Mechanical Shock/Vibration Test
- Salt Spray Test

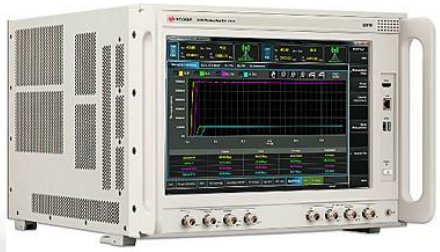


MECHANICAL AND ENVIRONMENTAL TESTS

- Free Fall
- Wiring Harness - Flammability Test
- Wiring Harness - Electrical Properties

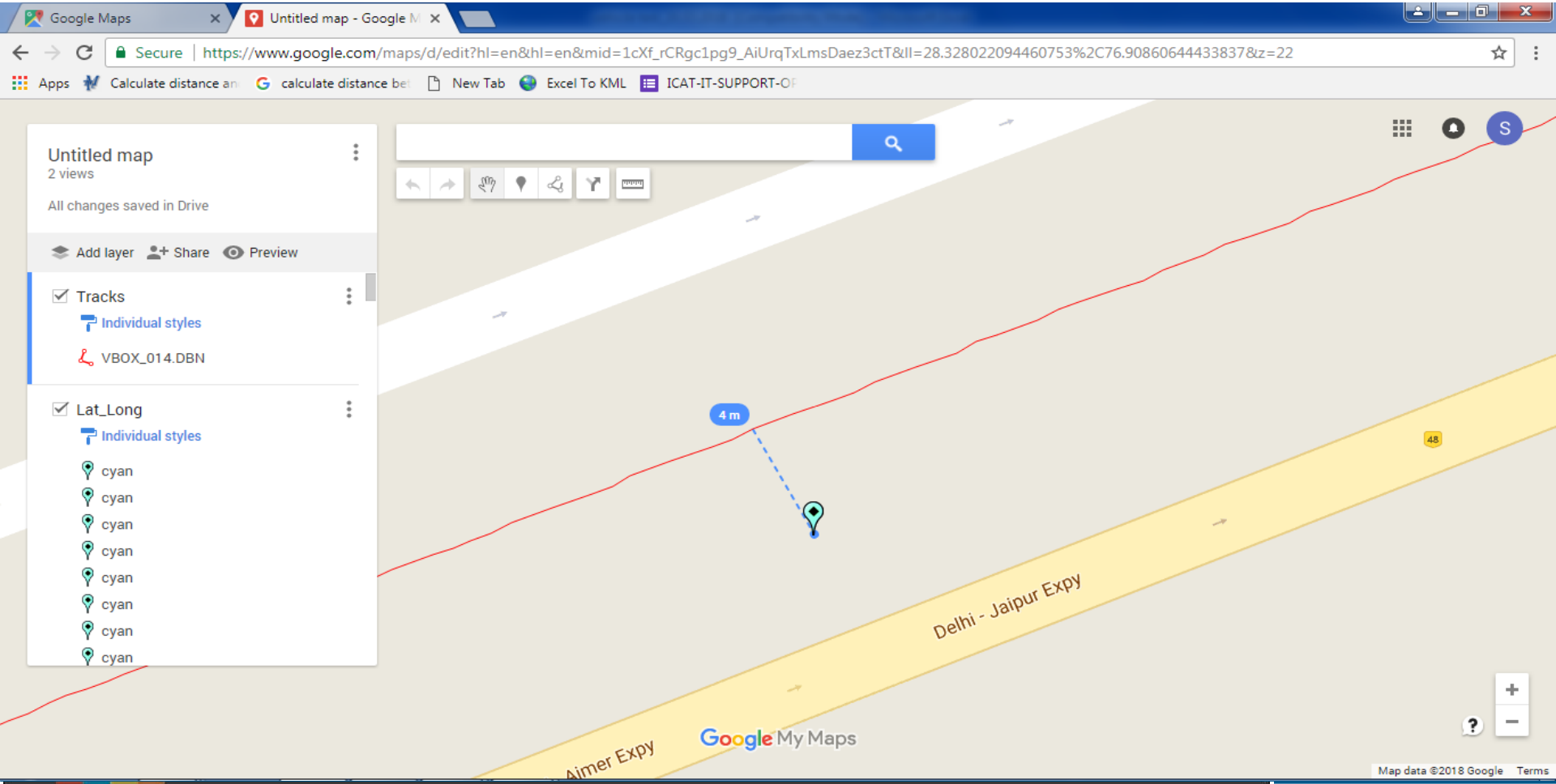
PERFORMANCE TESTS

- Location Accuracy Test: 2.5 m CEP or 6 m 2DRMS.
- Acquisition Sensitivity Test: Minimum (-)145 dBm with GNSS
  (-) 140 dBm with IRNSS (NAVIC as applicable)
- Tracking Sensitivity Test: Equal to or better than (-) 160 dBm with GNSS / (-) 153 dBm with IRNSS (NAVIC as applicable).
- Cold-Start Time to First Fix (TTFF) Test: <120s
- Warm-Start Time to First Fix Test: <60s
- Hot-Start Time to First Fix Test : <10s
- SIM Test



PERFORMANCE TESTS

On Vehicle Dynamic Location Test: within 12m



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