Prasar Bharati

No. DTH/IITMoU/180/2020/P-VII-(Part-1)-A **Dated** 21.11.2025

Measurements/Tests Report on the Interference and heating of mobile device during the operation of the available D2M Technologies in 470-582 MHz frequency range

Prasar Bharati has entered into an Memorandum of Understanding with the Indian Institute of Technology, Kanpur in 2019 to develop Next Generation Broadcast solution roadmap for Digital Terrestrial Broadcasting consistent with emerging standards.

IIT Kanpur after doing a comparative analysis of the then available technologies, completed the small scale Proof of Concept (PoC)/ trial on Direct to Mobile (D2M) Next Gen Broadcasting in Bengaluru, along with its Technology partner. Thereafter the Hybrid PoC involving High Power High Tower (HPHT) & Low Power Low Tower(LPLT) was also conducted in Delhi using one of the Television Transmitter as HPHT at Pitampura and several LPLTs around Kartavya path in New Delhi.

The apprehension regarding interference with telecom services and heating of mobile devices due to operation of D2M broadcast service were received from some of the stakeholders. Prasar Bharati had series of discussion with various stakeholders and thereafter approached IIT Kanpur to carry out the measurements /Tests in this regard for the available D2M technologies in 470-582 MHz frequency range.

IIT Kanpur got conducted the Test Measurement/demonstration of the *ATSC 3.0 Based D2M Broadcast Radio Head (BRH)* through its technology partner at M/s Aracion Technology Private Limited, Bengaluru, a Telecommunication Engineering Centre (TEC) recognized laboratory, on 14.11.2025.

The Terms of Reference of the Test Methodology for interference and heating of the mobile device, and Test Reports (with respect to the ATSC Based D2M BRH YOGA40W01) received through IIT Kanpur, as under, are being uploaded on the website of Prasar Bharati at https://prasarbharati.gov.in for information to all the stakeholders:

i. ToR Test Methodology - Interference and Device temperature.pdf- Test Specification
ii. Test Report Radio_YOGA40W01.pdf
iii. Test Report_Device Temperature.pdf

***

ToR Test Methodology (Interference and Device temperature)

Contents

1. Intent of the Document 2
2. Temperature Evaluation of D2M Receiver 2
2.1. Pre-conditions 2
2.2. Tools 2
2.3. Procedure 2
3. Measuring D2M Interference Impact on UE Receiver Sensitivity (LTE and 5G NR) 3
3.1. Purpose 3
3.2. References 3
3.3. Equipment 3
3.4. Test Setup 3
3.5. Test Conditions 4
3.6. Baseline (no-interference) sensitivity — OTA procedure 4
3.7. Sensitivity with interference (D2M signal) — OTA procedure 5
3.8. Acceptance Criteria 5
3.9. Specifications for Thermal Camera 6

1. Intent of the Document

This document outlines the testing methodology for assessing the Interference of D2M transmission on cellular bands and thermal impact of D2M receiver in a phone.

The tests are designed to ensure compliance with thermal impact on device usability and to identify any potential interference issues.

2. Temperature Evaluation of D2M Receiver

This section describes the procedure for evaluating the surface temperature of the D2M enabled phone during AV Playback.

This is compared with the AV playback on the D2M enabled phone, with the cellular network for a similar resolution AV content.

2.1. Pre-conditions

1. D2M phone powered ON and with an active 4G/5G SIM and connected to the cellular network.
2. D2M Transmission should be active.

2.2. Tools

1. Thermal camera (Please refer to chapter 3.9 for the detailed specifications for the Thermal camera).

2.3. Procedure

1. Measure temperature across the entire surface of the phone using a thermal camera while the D2M app is playing AV content.
2. Repeat measurement at different intervals (e.g. every 30 mins) until thermal stability is reached.

Template for test results:

Sl Num	Test duration	AV Playback over D2M Broadcast		AV Playback over Cellular network	
		Temperature Back side (°C)	Temperature Front side (°C)	Temperature Back side (°C)	Temperature Front side (°C)
1	30 Mins				
2	60 Mins				
3	90 Mins				
4	120 Mins				
5	180 Mins				

3. Measuring D2M Interference Impact on UE Receiver Sensitivity (LTE and 5G NR)

3.1. Purpose

This procedure defines the steps to measure UE receiver sensitivity and measure sensitivity degradation (desense) under interference conditions for LTE and 5G NR user equipment (UE) using over-the-air (OTA) methods.

3.2. References

1. 3GPP TS 36.101 – LTE UE RF requirements (reference sensitivity definitions)
2. 3GPP TS 38.101-1 – NR UE RF requirements (FR1)
3. 3GPP TS 36.521-4 – LTE performance/conformance measurement procedures
4. 3GPP TS 38.521-4 – NR performance/conformance measurement procedures

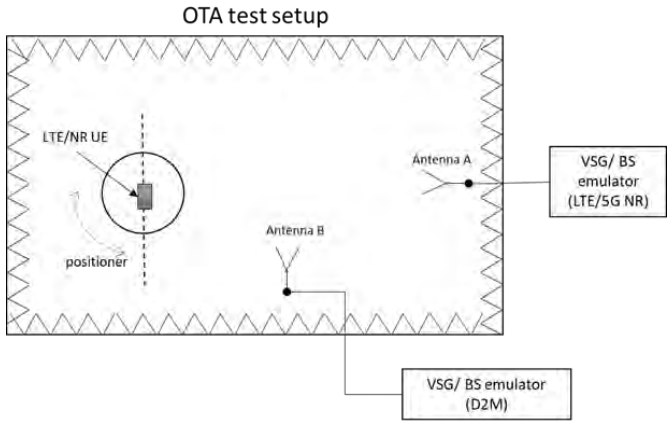
Note - Chapter 7.2 & 7.3 in all 4 documents

3.3. Equipment

1. Calibrated OTA chamber
2. Base station emulator or vector signal generator (VSG) with LTE/NR reference waveforms
3. Interferer source (D2M emulator / VSG with D2M signal)
4. Phone under test with SIM
5. Logging system (BLER)

3.4. Test Setup

1. Place the phone on the positioner in the chamber.
2. Connect the wanted signal generator to antenna A of the chamber.
3. Connect the interferer generator to antenna B of the chamber (for isolation and angular separation).
4. Calibrate path loss from each feed point to the phone reference position.
5. Record calibration file with frequency-dependent path loss.



3.5. Test Conditions

1. Bands under test:

4G LTE / 5G NR band	Uplink frequency range (MHz)	Downlink frequency range (MHz)
B5 / n5	824-844	869-889
B8 /n8	890-915	935-960
B28 / n28	723-733/ 738-748	778-788/ 793-803

2. Bandwidths: LTE 10/20 MHz, 5G NR 10 MHz
3. Reference waveform as per 36.101/38.101.
4. Duplexing: FDD

3.6. Baseline (no-interference) sensitivity — OTA procedure

1. **Chamber setup & calibration**: Load the path-loss file for the chosen frequency/polarization. Verify field uniformity at the phone position.
2. **Waveform**: Configure LTE RMC (per 3GPP TS 36.101 Annex A) / NR FR1 reference waveform (per 3GPP TS 38.101-1). Start with a known high level (strong SNR) to get BLER ≈ 0.
3. Tune the phone to the eNB/gNB emulator (or VSG) over the air.
4. **Level stepping**: Reduce the wanted EIRP in steps of 1 dB to begin with, and then by 0.5 dB as one gets closer to the sensitivity level. At each step, record BLER (10–20s averaging).
5. **Record reference sensitivity**: Reference sensitivity (OTA) = lowest input level (converted at the phone using the path-loss) where BLER ≤ 5% is maintained for the defined reference channel.

6. **Baseline Sensitivity Results**:

Band	BW (MHz)	Test Case (RMC)	Phone Orientation	Baseline Sensitivity (dBm)	Notes

NOTE 1 - Please refer to the References in chapter 3.2 above.

3.7. Sensitivity with interference (D2M signal) — OTA procedure

1. **Set interferer level:** Fix wanted signal (LTE/5G NR) power level to its **baseline sensitivity**. Turn on interferer (D2M) at a defined **relative power** (e.g.: -44 dBm as in out of band blocker of 3GPP) and **at defined frequency** (e.g.: 582 MHz).
2. Record **BLER** at each point**.**
3. **If BLER > 5%,** then increase the wanted level power in the steps of **0.5 dB** with the interferer power **held constant**. Record **BLER/throughput** at each point.
4. **Interfered sensitivity** = lowest wanted level meeting **BLER ≤ 5%** under interference.
5. **Desense** = **(Interfered sensitivity – Baseline sensitivity)** in **dB**. Report per scenario (band/ bandwidth)
6. Repeat for each band/BW combination required by the plan.

Band	BW (MHz)	Test Case (RMC)	Interferer Type (D2M)	Offset (MHz)	Baseline Sens. (dBm)	Interfered Sens. (dBm)	Desense (dB)

NOTE 1: Qualifying test case: phone under test is expected to meet Out of band blocking requirements as defined in 3GPP (This can be confirmed by using LTE/NR waveform as interferer waveform in other LTE/5G NR bands and record the De-sense).

NOTE 2 - Please refer to the References in chapter 3.2 above.

3.8. Acceptance Criteria

1. Desense should remain within acceptable range.

3.9. Specifications for Thermal Camera

Key features	
IFOV (spatial resolution)	1.86 mRad, D:S 532:1
Infrared resolution	320 x 240 (76,800 pixels)
Field of view	34.1 °H x 25.6 °H
Focus system	Fixed
Minimum focus distance	46 cm (18 in)
Ruggedized display	3.5 inch (8.9 cm landscape) 320 x 240 LCD
Ergonomic design	Designed for one-handed use
Temperature measurement	
Temperature range (not calibrated below -10 °C)	-20 °C to 400 °C (-4 °F to 752 °F)
Accuracy	± 2 °C or 2 % (at 25 °C nominal, whichever is greater)
Thermal sensitivity (NETD)	≤ 0.045 °C at 30 °C target temp (45 mK)
On-screen emissivity correction	Yes (both value and table)
On-screen reflected background temperature compensation	Yes
On-screen transmission correction	No
Wireless connectivity	
Wireless connectivity	Yes, to PC, iPhone® and iPad® (iOS 4s and later), Android™ 4.3 and up, and WiFi and LAN (where available)
IR Fusion® technology	
IR Fusion® technology	Yes
AutoBlend™ mode	Yes
Picture-In-Picture (PIP)	Yes
Built-in digital camera (visible light)	5MP

Level and span	
Level and span	Smooth auto and manual scaling
Fast auto-rescale in manual mode	Yes
Minimum span (in manual mode)	2.5 °C (4.5 °F)
Minimum span (in auto mode)	5 °C (9.0 °F)
Data storage and image capture	
Extensive memory options	Internal 4GB memory and 4GB micro SD card
Image capture, review, save mechanism	One-handed image capture, review, and save capability
Image file formats	Non-radiometric BMP or JPEG or fully-radiometric is2
Memory review	Yes
Software	Full analysis and reporting software
Analyze and store radiometric data on a PC	Yes
Export file formats	is2, BMP, GIF, JPEG, PNG, TIFF
Voice annotation	60 seconds maximum recording time per image; reviewable playback on camera; Bluetooth headset required (sold separately)
IR-PhotoNotes	Yes - 3 images
Auto capture (temperature and interval)	Yes
Battery	
Batteries (field-replaceable, rechargeable)	Two lithium ion smart battery pack with five-segment LED display to show charge level
Battery life	4 hours continuous use per battery pack
Battery charging time	2.5 hours to full charge
Battery charging system	Two-bay battery charger or in-imager charging. Optional 12 V automotive charging adapter

AC operation	AC operation with included power supply (100 V AC to 240 V AC, 50/60 Hz)
Power saving	User selectable
Color palettes	
Standard palettes	8: Ironbow, Blue-Red, High Contrast, Amber, Amber Inverted, Hot Metal, Grayscale, Grayscale Inverted
Ultra contrast palettes	8: Ironbow Ultra, Blue-Red Ultra, High Contrast Ultra, Amber Ultra, Hot Metal Ultra, Grayscale Ultra, Grayscale Inverted Ultra
General specifications	
Laser pointer	Yes
Frame rate	< 9 Hz or 30 Hz
Color alarms	High temperature, low temperature, isotherms (within range)
Infrared spectral band	7.5 µm to 14 µm
Operating temperature	-10 °C to +50 °C (14 °F to 122 °F)
Storage temperature	-20 °C to +50 °C (-4 °F to 122 °F) without batteries
Relative humidity	10 % to 95 %, non-condensing
Center-point temperature measurement	Yes
Spot temperature	Hot and cold spot markers
User-definable spot markers	3
User defined measurement boxes	Expandable-contractible measurement box
Hard case	Rugged hard carrying case with soft transport bag, including adjustable strap
Safety standards	IEC 61010-1: Overvoltage category II, Pollution Degree 2
Electromagnetic compatibility	IEC 61326-1: Basic EM environment. CISPR 11: Group 1, Class A
Vibration	2G, IEC 68-2-6
Shock	25G, IEC 68-2-29

Drop	Engineered to withstand 2 meter (6.5 feet) drop
Sized (H x W x L)	Less than 30 cm x 12 cm x 15 cm
Weight (battery included)	Less than 1 kg
Enclosure rating	IP54 (protected against dust, limited ingress; protection against water spray from all directions)
Warranty	Two-years (standard)
Recommended calibration cycle	Two-years (assumes normal operation and normal aging)
RoHS compliant	Yes

Device Temperature Test Report

Discipline: Electronics	**Group: Miscellaneous Products Test Facility**
Report Reference No:	ARTL/RF/251105-01-02-01
Applicant Name:	Tejas Networks Ltd.
Applicant Address:	Ground 1st, 2nd Floor Wing A and 1st, 2nd Floor Wing B, Plot No. 3,Survey No. 20 & 22, Surya Sapphire, Hosur Road, Electronic City Phase I,Konappana Agrahara Village, Bengaluru – 560100 Karnataka, India
Manufacturer's Name:	Tejas Networks Ltd.
Manufacturer's Address:	Ground 1st, 2nd Floor Wing A and 1st, 2nd Floor Wing B, Plot No. 3, Survey No. 20 & 22, Surya Sapphire, Hosur Road, Electronic City Phase I, Konappana Agrahara Village, Bengaluru – 560100 Karnataka, India
Test item description:	
Product Name:	D2M Smart Phone
Model No.:	MarkOne
Serial no/IMEI.:	862671050002802 & 862671050002190
Input Ratings:	
Trademark:	TEJAS NETWORKS
Reference standards:	ATSC Standard: ATSC 3.0 System, Doc. A/300:2017.
Testing Laboratory information:	
Testing Laboratory Name:	Aracion Technology Pvt Ltd- Laboratory
Address :	1st Floor, B-23 HK Arcade, KSSIDC, Industrial Area, Bengaluru, Karnataka, India–560048

This device has been tested and found to comply with the stated Customer acceptance criterion, which is (are) indicated in the test report and are applicable only to the sample tested identified in the report. Note: This report shall not be reproduced except in full, without the written approval of Aracion Technology Pvt Ltd, this document may be altered or revised by Aracion Technology Pvt Ltd personal only, and shall be noted in the revision of the document. This test report must not be used by the client to claim product end or segment.

Customer Acceptance Testing:	Device temperature testing as per ToR Test methodology.
Date of receipt of test item:	05 Nov 2025
Date (s) of performance of tests:	10 Nov 2025 to 11 Nov 2025
Date of Issue.....:	13 Nov 2025
Test Result.....:	PASS

Compiled by: Kamlesh Kumar Gautam	
Reviewed & authorized by: Keshava Boraiah	
Issued by: Abhilash M	

Contents

1. TEST SUMMARY **4**

2. TEST FACILITY **4**

2.1 DEVIATION FROM STANDARD 4
2.2 ABNORMALITIES FROM STANDARD CONDITIONS 4

3. GENERAL INFORMATION **5**

3.1 GENERAL DESCRIPTION OF EUT 5
3.2 TEST CONDITIONS 6
3.2.1 Normal conditions 6
3.3 EQUIPMENT'S LIST FOR ALL TEST ITEMS 6

4. TEST PARAMETER **6**

4.1 THERMAL TEMPERATURE TEST 6
4.1.1 Test Setup 6
4.1.2 Test Procedure 7
4.1.3 Pre-conditions 7
4.1.4 Tools 7
4.1.5 Procedure for measurement with D2M Broadcast content 7
4.1.6 Procedure for measurement with Internet content over cellular network 7
4.1.7 Test Result 7

ANNEXURE A: THERMAL TEST OBSERVED SCREENSHOT. **8**

1. Test Summary

S.N.	Test Parameter	Mode	Reference Standard	Page Number
1.	Thermal Temperature Test	--	As per ToR Test methodology for Device temperature testing	

2. Test Facility

The Test facility is recognized, certified or accredited By NABL

2.1 Deviation from standard

None

2.2 Abnormalities from standard conditions

None

3. General Information

3.1 General Description of EUT

Manufacturer:	Tejas Networks Ltd.
Manufacturer Address:	Ground 1st, 2nd Floor Wing A and 1st, 2nd Floor Wing B, Plot No. 3, Survey No. 20 & 22, Surya Sapphire, Hosur Road, Electronic City Phase I, Konappana Agrahara Village, Bengaluru – 560100 Karnataka, India
Product Name:	D2M Smart Phone
Model Name:	MakeOne
Serial number:	
Trademark:	TEJAS NETWORKS
Input Voltage:	--
Frequency Bands	ATSC 3.0 Broadcast support – 470 to 582 MHz LTE Bands – 1/2/3/4/5/8/30/40/41/66
Supported Configuration:	--
SW Version	v2.5.4
HW Version	EVT2
Number of Antenna Ports:	--
Antenna:	Internal Antenna
Condition of Sample on receipt:	Good
For a more detailed description of features, please refer to the manufacturer's specifications or the User's Manual	

3.2 Test conditions

3.2.1 Normal conditions

Ambient:	Temperature:	+15°C to +35°C
	Relative humidity:	20% to 75%

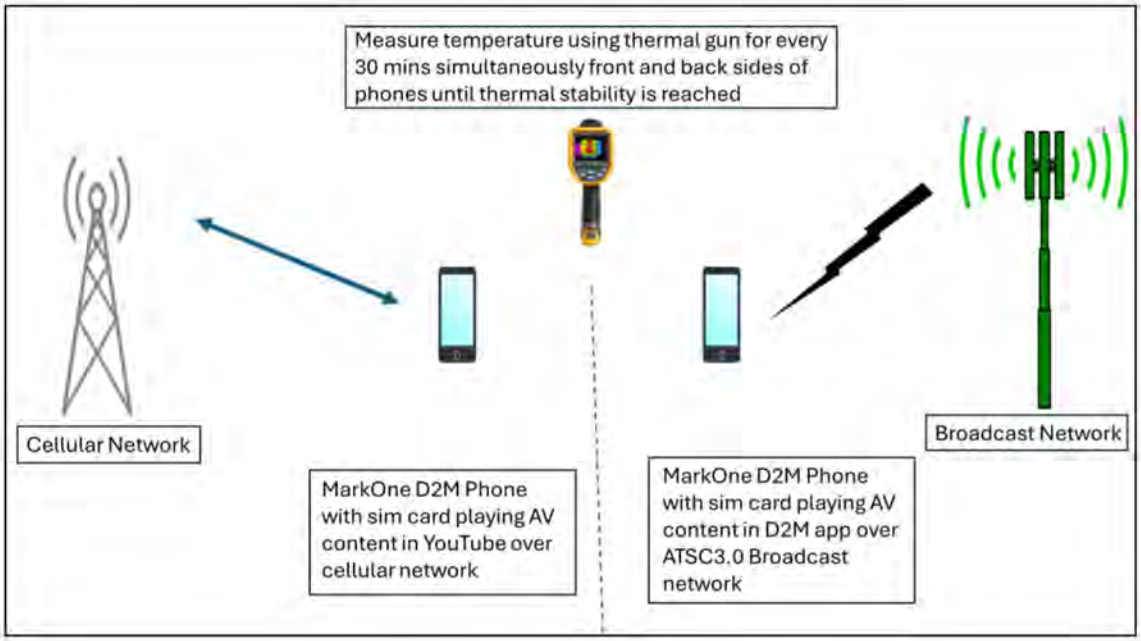
3.3 Equipment's List for All Test Items

No.	Test Equipment	Manufacturer	Model no
1.	FLUKE thermal camera	Fluke	FLUKE TiS60+

4. Test Parameter

4.1 Thermal Temperature Test

4.1.1 Test Setup



4.1.2 Test Procedure

This section describes the procedure for measuring the surface temperature of the Mark One D2M phone under 2 different operations

- AV Playback of D2M broadcast
- AV playback of internet content on YouTube

4.1.3 Pre-conditions

- D2M phone powered on and with active 4G SIM and connected to the cellular network.
- D2M Transmission should be active

4.1.4 Tools

- FLUKE thermal camera (Model – FLUKE TiS60+)

4.1.5 Procedure for measurement with D2M Broadcast content

- Measure temperature across the entire surface of the phone using thermal camera while the D2M app is playing AV content received from the D2M transmission
- Repeat measurement at different intervals (for e.g. every 30 mins) until thermal stability is reached.

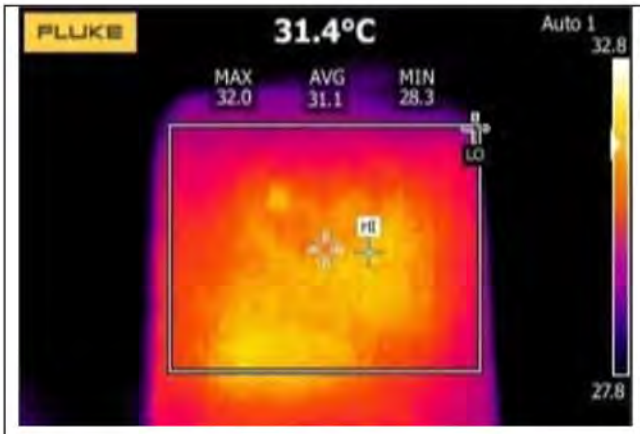
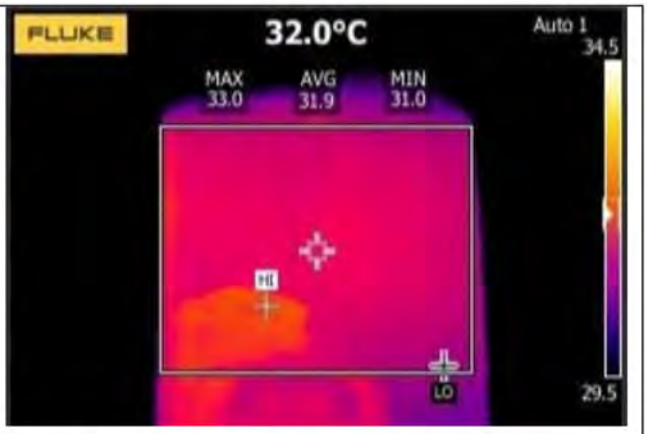
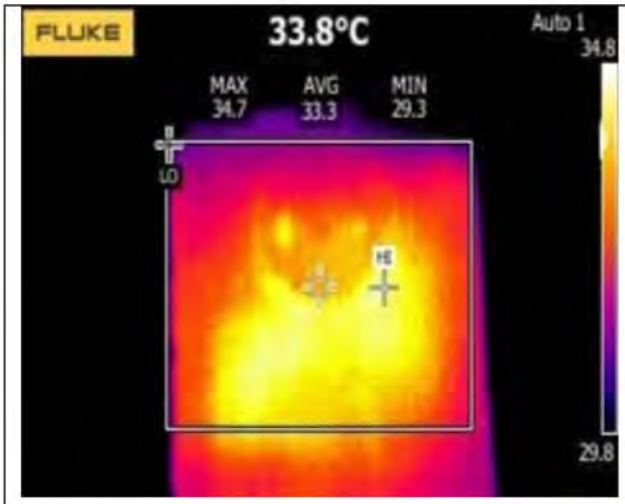
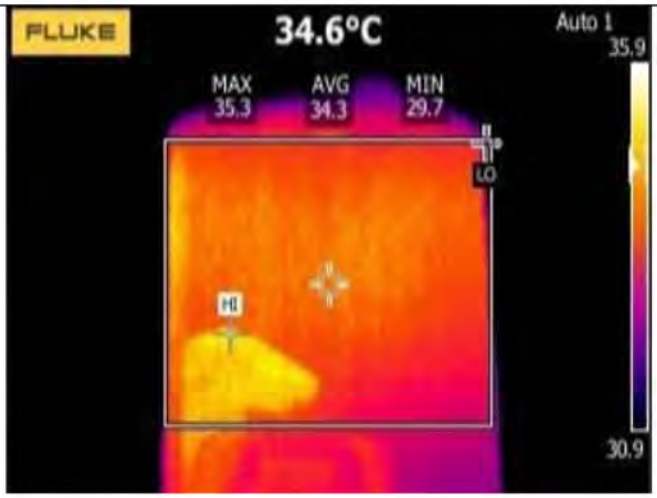
4.1.6 Procedure for measurement with Internet content over cellular network

- Measure temperature across the entire surface of the phone using thermal camera while the YouTube app is playing AV content accessed from internet via 4G
- Repeat measurement at different intervals (for e.g. every 30 mins) until thermal stability is reached.

4.1.7 Test Result

Sl No	Test duration	AV Playback over D2M Broadcast		AV Playback over Cellular network	
		Temperature Back side(°C)	Temperature Front side(°C)	Temperature Back side(°C)	Temperature Front side(°C)
1	30 Mins	33.6	35.7	33.5	35.2
2	60 Mins	34.4	35.3	32.8	34.2
3	90 Mins	34.6	35.4	32.6	34
4	120 Mins	34.7	35.3	32	33
5	150 Mins	34.7	35.3	32	33
6	180 Mins	34.7	35.3	32	33

Annexure A: Thermal Test Observed Screenshot.

	
Temp back side 180Mins Cellular	**Temp Front side 180Mins Cellular**
	
Temp back side 180Mins D2M	**Temp front side 180Mins D2M**

----------END OF THE REPORT----------

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

ARACION TECHNOLOGY PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

1ST FLOOR, B-23 HK ARCADE, KSSIDC, INDUSTRIAL AREA, BENGALURU, , KARNATAKA, INDIA

in the field of

TESTING

Certificate Number: TC-13835

Issue Date: 04/06/2024 **Valid Until:** 03/06/2026

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of thislaboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Entity: ARACION TECHNOLOGY PVT LTD

Signed for and on behalf of NABL

Srikanth R
Director

Chakravarthy T. Kannan
Chief Executive Officer

ISO 9001:2015

GOVERNMENT OF INDIA
MINISTRY OF COMMUNICATIONS
DEPARTMENT OF TELECOMMUNICATIONS
TELECOMMUNICATION ENGINEERING CENTRE
Gate No. 5, Khurshid Lal Bhawan, Janpath, New Delhi-110001

CERTIFICATE OF DESIGNATION

M/s Aracion Technology Private Limited, Laboratory, Bangalore
has been assessed and designated as Conformity Assessment Body (CAB)
for its facilities at

1st Floor, B-23 HK Arcade, 1A Kssidc, Industrial Area, Mahadevapura,

Bangalore-560048

In the field of Testing

Certificate No. TEC/MRA/CAB/IND-D/108

Issue Date: 01/10/2025 **Validity: 01/10/2025 to 30/09/2028**

This Certificate remains valid for the Scope of Designation as specified in the Annexure subject to the continued validity of NABL Accreditation and satisfied compliance to the Standards/specifications against which lab has been designated and strict compliance to the relevant terms and conditions of TEC CAB Designation Scheme.

(To see the scope of designation of this laboratory, you may also visit TEC website www.tec.gov.in)

Signed for and on behalf of TEC

Sanjeev Kumar Arya
Director (CA)
For Designating Authority
TEC

Radio Test Report

Discipline: Electronics	**Group: Miscellaneous Products Test Facility**
Report Reference No:	ARTL/RF/251105-01-01-01
Applicant Name:	Tejas Networks Limited
Applicant Address:	Ground 1st, 2nd Floor Wing A and 1st, 2nd Floor Wing B, Plot No. 3, Survey No. 20 & 22, Surya Sapphire, Hosur Road, Electronic City Phase I, Konappana Agrahara Village, Bengaluru – 560100
Manufacturer's Name:	Tejas Networks Limited
Manufacturer's Address:	Ground 1st, 2nd Floor Wing A and 1st, 2nd Floor Wing B, Plot No. 3, Survey No. 20 & 22, Surya Sapphire, Hosur Road, Electronic City Phase I, Konappana Agrahara Village, Bengaluru – 560100
Test item description:	
Product Name:	Direct to Mobile (D2M) Transmitter / Broadcast Radio Head (BRH) – 40W
Model No.:	YOGA40W01
Serial no/PMS.:	SLBRH40WB-32-000029
Input Ratings:	-48V DC, 300 watts
Trademark:	TEJAS® NETWORKS
Reference standards:	• Section 7.6.3 of 3GPP TS 38.101-1 – 5G NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone • Section 7.6.2 of 3GPP TS 36.101-1 – LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) radio transmission and reception • Section 7.6.3 of 3GPP TS 38.521-1 NR User Equipment (UE) conformance specification; Radio transmission and reception Part 1: Range 1 standalone • Section 7.6.2 of 3GPP TS 36.521-1 LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); User Equipment (UE) conformance specification; Radio transmission and reception; Part 1: Conformance testing • Section 6.6.5 of 3GPP TS 38.141-1 – 5G NR; Base Station (BS) conformance testing, Part 1: Conducted conformance testing • Section 6.6.5 of 3GPP TS 38.104 – 5G NR; Base Station (BS) radio transmission and reception • Section 6.6.4 of 3GPP TS 36.141– LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) conformance testing • Section 6.6.4 of 3GPP TS 36.141– LTE; Evolved Universal Terrestrial Radio Access (E-UTRA); Base Station (BS) radio transmission and reception
Testing Laboratory information:	
Testing Laboratory Name:	Aracion Technology Pvt Ltd- Laboratory
Address:	1st Floor, B-23 HK Arcade, KSSIDC, Industrial Area, Bengaluru, Karnataka, India–560048

This device has been tested and found to comply with the stated Customer acceptance criterion, which is (are) indicated in the test report and are applicable only to the tested sample identified in the report. Note: This report shall not be reproduced except in full, without the written approval of Aracion Technology Pvt Ltd , this document may be altered or revised by Aracion Technology Pvt Ltd personal only, and shall be noted in the revision of the document. This test report must not be used by the client to claim product end or segment.	
Customer Acceptance Testing:	a) Interference impact from BRH on IMT bands **at the phone**, in compliance with the out-of-band emission requirements specified in Section 7.6.3 of TS 38.101-v16 and TS 38.521-v16, and Section 7.6.2 of TS 36.101-v15, TS 36.521-v15. b) Spurious Emission of BRH in compliance with the requirements specified in Section 6.6.5 of TS 38.141-v16, TS 38.104-v16 and Section 6.6.4 of TS 36.141-v15, TS 36.104-v15.
Date of receipt of test item:	05 Nov 2025
Date (s) of performance of tests:	05 Nov 2025 to 12 Nov 2025
Date of Issue .....:	13 Nov 2025
Test Result .....:	PASS
Compiled by: Kamlesh Kumar Gautam	
Reviewed & authorized by: Keshava Boraiah	
Issued by: Abhilash M	

Contents

1 TEST SUMMARY 4

2 TEST FACILITY 4

2.1 DEVIATION FROM STANDARD 4
2.2 ABNORMALITIES FROM STANDARD CONDITIONS 4

3 GENERAL DESCRIPTION OF EUT 5

3.1 TEST CONDITIONS 5
3.1.1 Normal conditions 5
3.2 BAND INFORMATION 6
3.3 EQUIPMENT'S LIST FOR ALL TEST ITEMS 6

4 TEST PARAMETER 7

4.1 TEST BANDS 7
4.2 IMPACT ANALYSIS OF BRH INTERFERENCE ON IMT BAND PERFORMANCE IN MOBILE DEVICES 7
4.2.1 Test Acceptance Criteria 7
4.3 SPURIOUS EMISSION OF BRH 8

5 TEST SETUP 9

5.1 CONDUCTED MODE TEST SETUP 9
5.2 OVER THE AIR (OTA) MODE TEST SETUP 10
5.3 TEST PROCEDURE 10

6 INTERFERENCE IMPACT ASSESSMENT RESULTS ON MOBILE PHONE 12

6.1 CONDUCTED MODE ASSESSMENT 12
6.1.1 Without External Interference (Receiver Sensitivity) 12
6.1.2 With External Interference (BRH Transmission) 12
6.2 RADIATED MODE ASSESSMENT 13
6.2.1 Without External Interference (Receiver Sensitivity) 13
6.2.2 With External Interference (BRH Transmission) 13
6.3 OBSERVATIONS 13

7 SPURIOUS EMISSION ASSESSMENT OF BRH/D2M TRANSMISSION 14

7.1 TEST RESULTS 14
7.2 OBSERVATION 14

8 CONCLUSION 14

ANNEXURE A: PHOTOGRAPHS 15

ANNEXURE B: RECEIVER SENSITIVITY LEVEL OBSERVED SCREENSHOT 18

ANNEXURE C: SPURIOUS EMISSION SCREENSHOTS 21

ANNEXURE D: TOTAL EXTERNAL LOSS 23

1 Test Summary

S.N.	Test Parameter	Mode	Reference Standard	Page Number
1.	Impact of interference from BRH on IMT bands at the phone	Conducted	Section 7.6.3 of TS 38.101-1-v16 Section 7.6.2 of TS 36.101-v15	Page 12
		Radiated	Section 7.6.3 of TS 38.521-1-v16. Section 7.6.2 of TS 36.521-v15	Page 13
2	Spurious Emission Limits of BRH/ D2M transmission	Conducted	Section 6.6.5 of TS 38.141-1-v16 Section 6.6.4 of TS 36.141-v15	Page 14

2 Test Facility

The Test facility is recognized, certified or accredited By NABL

2.1 Deviation from standard

None

2.2 Abnormalities from standard conditions

None

3 General Description of EUT

Manufacturer:	Tejas Networks Limited
Manufacturer Address:	Ground 1st, 2nd Floor Wing A and 1st, 2nd Floor Wing B, Plot No. 3, Survey No. 20 & 22, Surya Sapphire, Hosur Road, Electronic City Phase I, Konappana Agrahara Village, Bengaluru – 560100 Karnataka, India
Product Name:	Broadcast Radio Head – 40W
Model Name:	YOGA40W01
Serial number:	SLBRH40WB-32-000029
Trademark:	TEJAS NETWORKS
Input Voltage:	-48V, 300W
Frequency Bands	Frequency Range from 470 MHz to 582 MHz
Supported Configuration:	Modulation supported: QPSK to 64 QAM, 8MHz Channel BW
SW Version	v1.2.1
HW Version	v 2
Number of Antenna Ports:	1
Antenna:	External Antenna
Condition of Sample on receipt:	Good
For a more detailed description of features, please refer to the manufacturer's specifications or the User's Manual	

3.1 Test conditions

3.1.1 Normal conditions

Ambient:	Temperature:	+15°C to +35°C
	Relative humidity:	20% to 75%
	Nominal Voltage	DC -48.0V (Through Power Supply)

3.2 Band Information

A) D2M transmitter/ Broadcast Radio Head (BRH)
Band IV (470 MHz – 582 MHz)

B) UE Conformance Band Information.
IMT (5G NR/LTE) Bands under test:

1. B71/n71 (617 MHz – 652 MHz)
2. B28/n28 (758 MHz – 803 MHz)
3. B5/n5 (869 MHz – 894 MHz)

3.3 Equipment's List for All Test Items

No.	Test Equipment	Manufacturer	Model no
1.	UXM 5G with X-App	Keysight	E7515B
2.	Log periodic dipole Antenna	Tech Box	TBMA3
3.	VNA and Spectrum Analyzer – Field fox	Keysight	N9953V
4.	OTA Chamber	Aracion	FR1
5.	MXE EMI receiver	Keysight	N9038B

4 Test Parameter

4.1 Test Bands

D2M service (Broadcast Radio Head)

- Band IV (470 – 582 MHz)

UE Conformance Band Information (IMT Bands under test)

B71/n71 (617– 652 MHz)
B28/n28 (758– 803 MHz)
B5/n5 (869 – 894 MHz)

4.2 Impact Analysis of BRH Interference on IMT Band Performance in Mobile Devices

4.2.1 Test Acceptance Criteria

The blocking test quantifies the receiver's capability to successfully detect a desired signal at its designated channel frequency, even in the presence of an undesired interfering signal located outside the frequencies associated with spurious responses or adjacent channels. This interference must not degrade the receiver's performance beyond a predefined threshold. Provided that the device complies with the blocking requirements outlined by 3GPP specifications, the Broadcast Radio Head (BRH) /D2M transmission is treated as an interferer, and its effect on receiver sensitivity under high-power conditions is evaluated accordingly.

3GPP requirement for out of band emissions mentioned in Section 7.6 of TS 38.101 and of TS 36.101 is summarised here:

Table 1: Out of band emission requirements for the channel BW of 20 MHz

NR Band	Rx parameter	Units	Value		
Band n71, n28 and n5	Received Power in the configured BW	dBm	REFSENS (NOTE 1)		
	Desensitization allowed in the band for the given channel BW (20 MHz)	dB	9		
	$P_{interefer}$	dBm	-44	-30	-15
	$F_{interferer}$	MHz	$-60 < f - F_{DL\_low} < -15$ OR $15 < f - F_{DL\_high} < 60$	$-85 < f - F_{DL\_low} \leq -60$ OR $60 \leq f - F_{DL\_high} < 85$	$1 \leq f \leq F_{DL\_low} - 85$ OR $F_{DL\_high} + 85 \leq f \leq 12750$

Note 1: Measured receiver sensitivity can be better than REFSENS

4.3 Spurious Emission of BRH

Spurious emissions refer to emissions generated by unintended transmitter effects, such as harmonic emissions, parasitic emissions, intermodulation products, and frequency conversion products, excluding out-of-band emissions. These emissions are measured at the base station antenna connector. The limits for transmitter spurious emissions are applied within the frequency range of 300 MHz up to 5th harmonic of the upper frequency edge. This approach was implemented to assess the impact on IMT (International Mobile Telecommunications) bands, as all IMT band base stations must comply with these spurious emission limits.

Table 2: General BS transmitter spurious emission limits in FR1, Category B

Spurious frequency range	***Basic limit***	***Measurement bandwidth***	**Notes**
30 MHz – 1 GHz	-36 dBm	100 kHz	Note 1
1 GHz – 5th harmonic of the upper frequency edge	-30 dBm	1 MHz	Note 1
NOTE 1: *Measurement bandwidths* as in ITU-R SM.329 [2], s4.1.			

5 Test Setup

5.1 Conducted Mode Test Setup

The decision to perform the setup in conducted mode was based on the following technical and practical considerations:

1. **Predictability and Repeatability**: Conducted measurements offer consistent and reproducible results, as they are not influenced by variables such as anechoic chamber configurations or the physical positioning of the device under test. This eliminates uncertainties associated with over-the-air (OTA) testing environments.
2. **Standards Alignment**: The 3GPP specification recommends conducted testing for Frequency Range 1 (FR1), particularly for IMT bands of interest. Adhering to this guidance ensures compliance with industry standards and facilitates reliable benchmarking.
3. **Device Accessibility**: Commercially available phones with accessible conducted ports are increasingly rare, making it valuable to utilize such setups when possible. As we could access one such device, conducted mode test setup was performed.

It is important to note that this conducted setup was implemented in addition to the existing OTA configuration, thereby complementing the overall test strategy.

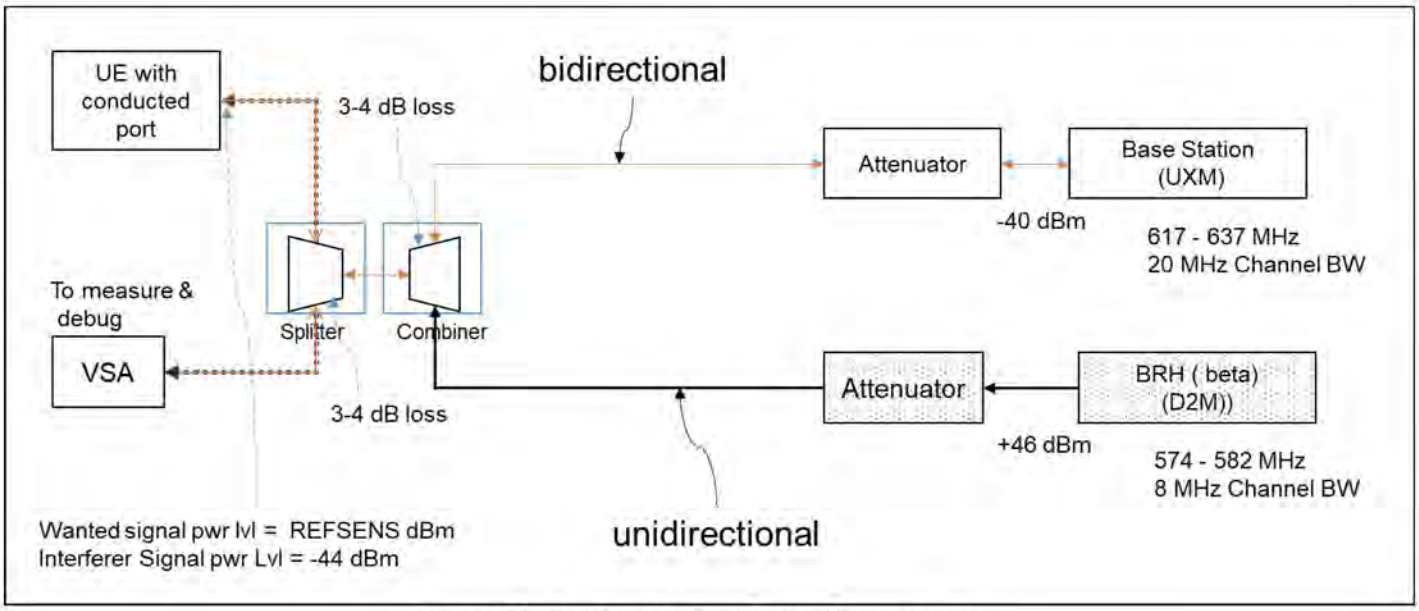


Figure 1:Conducted mode Setup for interference testing

5.2 Over The Air (OTA) Mode Test Setup

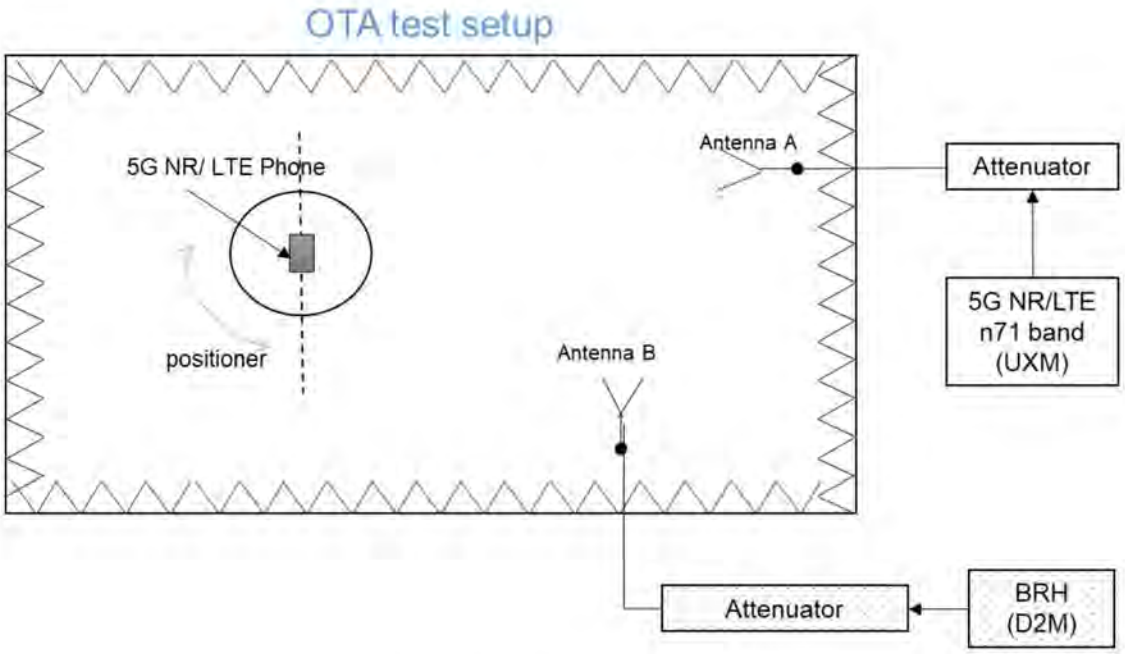


Figure 2:Radiated mode Setup for interference testing

5.3 Test Procedure

Phase 1: Establish Receiver Sensitivity

1. Setup & calibration: Load the path-loss file for the chosen frequency/polarization. Verify field uniformity at the UE position.
2. Waveform: Configure LTE RMC (per 36.101 Annex A) / NR FR1 reference waveform (per 38.101-1). Start with a known high level (strong SNR) to get BLER ≈ 0.
3. Tune the UE to the eNB/gNB emulator (or VSG) over the air.
4. Level stepping: Reduce wanted EIRP in steps of 1 dB (then 0.5 dB). At each step record BLER (10–20 s averaging).
5. Record reference sensitivity: Reference sensitivity (OTA) = lowest input level (converted at the UE using the path-loss) where BLER ≤ 5% is maintained for the defined reference channel.
6. Baseline the Sensitivity Results.

Phase 2: Record Desensitization Value

1. Set interferer level: Fix wanted signal (LTE/5G NR) power level to its baseline sensitivity. Turn on interferer (D2M) at a defined relative power (e.g.: -44 dBm as in out of band blocker of 3GPP) and at defined frequency (e.g.: 582 MHz).
2. Record BLER at each point.
3. If BLER > 5%, then increase the wanted level power in the steps of 0.5 dB with the interferer power held constant. Record BLER/throughput at each point.

4. Interfered sensitivity = lowest wanted level meeting BLER ≤ 5% under interference.
5. Desense = (Interfered sensitivity – Baseline sensitivity) in dB. Report per scenario (band/ bandwidth)
6. Repeat for each band/BW combination required by the plan.

6 Interference Impact Assessment Results on Mobile Phone

6.1 Conducted Mode Assessment

6.1.1 Without External Interference (Receiver Sensitivity)

Table 3: Sensitivity performance at the Mobile phone without any interferer

Band	BW (MHz)	Baseline Receiver Sensitivity (dBm)	BLER	Note
n71	20	-92	≤ 5%	Note 1: Measured receiver sensitivity is better than REFSENS. Note 2: Losses in the conducted setup was measured and compensated at base station.
n5	20	-90	≤ 5%	
n28	20	-92	≤ 5%	

6.1.2 With External Interference (BRH Transmission)

Table 4:Sensitivity performance at the Mobile phone with BRH interferer

Band	BW (MHz)	Interfere level (dBm)	Baseline Sens. (dBm) x	Sensitivity with interferen ce (dBm) y	Desensitizati on Value (dB) V = x-y	Result w.r.t. Section 7.6.3
n71	20	4.87	-92	-92	0.00 (NOTE 1)	pass
n5	20	0.0	-90	-90	0.00	pass
n28	20	0.0	-92 (NOTE2)	-92	0.00	pass

NOTE 1: Per 3GPP TS 38.101-1, Section 7.6.3, a desensitization ≤ 9 dB (for 20 MHz channel bandwidth) meets conformance requirements.

NOTE 2: For all tested IMT bands, downlink and uplink throughput remained ≥95% of baseline performance under D2M interference.

6.2 Radiated Mode Assessment

6.2.1 Without External Interference (Receiver Sensitivity)

Table 5:Sensitivity performance at the Mobile phone without any interferer - Radiated

Band	BW (MHz)	UE Orientation	Baseline Sensitivity (dBm)	BLER
n71	20	**Horizontal**	-91 (NOTE 1)	≤ 5%
n5	20	**Horizontal**	-90	≤ 5%
n28	20	**Horizontal**	-91	≤ 5%

Note 1: Measured receiver sensitivity is better than REFSENS.

6.2.2 With External Interference (BRH Transmission)

Table 6:Sensitivity performance at the Mobile phone with BRH interferer - Radiated

Band	BW (MHz)	UE Orientation	Interfere level as measured at mobile phone (dBm)	Baseline Sens. (dBm) x	Sensitivity with interference (dBm) y	Desensitization Value (dB) V = x-y	Result w.r.t. Section 7.6.3
n71	20	Horizontal	-16	-91	-91	0.00	pass
n5	20	Horizontal	-16	-90	-90	0.00	pass
n28	20	Horizontal	-16	-91	-91	0.00	pass

6.3 Observations

1. **Impact of Standardized External Interference**: When external interference was introduced at power levels specified in 3GPP (**Table 1**), there was no observable degradation in throughput performance in either the downlink or uplink directions.
2. **Throughput Performance at higher Interference Levels**: As the power of the external interferer (BRH) was increased up to the levels (as shown in Table 4 and in Table 6), the maintained DL and UL throughput performance of IMT was greater than 95%.
3. **Concurrent Transmission:** During all interferer-on scenarios, the BRH (as aggressor) transmitted a valid 8 MHz ATSC 3.0 waveform at full 40 W transmit power.

7 Spurious Emission Assessment of BRH/D2M transmission

7.1 Test Results

When Spurious emission test was conducted, there was active D2M transmission with full channel power as shown in Figure 3. Spurious emission test was passed comfortably (in Figure 4), with the major spurs observed in the following table.

Spur	Range	Frequency in MHz	Amplitude in dBm	Limit in dBm	Δ limit in dB
1	1	364.6	-54.91	-36	-18.91
2	1	362.9	-55.81	-36	-19.81
3	1	430.5	-55.84	-36	-19.84
4	1	403.3	-56.06	-36	-20.06
5	1	361.3	-56.07	-36	-20.07

7.2 Observation

Spurious emissions of BRH were comfortably below the limit lines specified by the Section 6.6.5 of TS 38.141-v16 for category B base station.

8 Conclusion

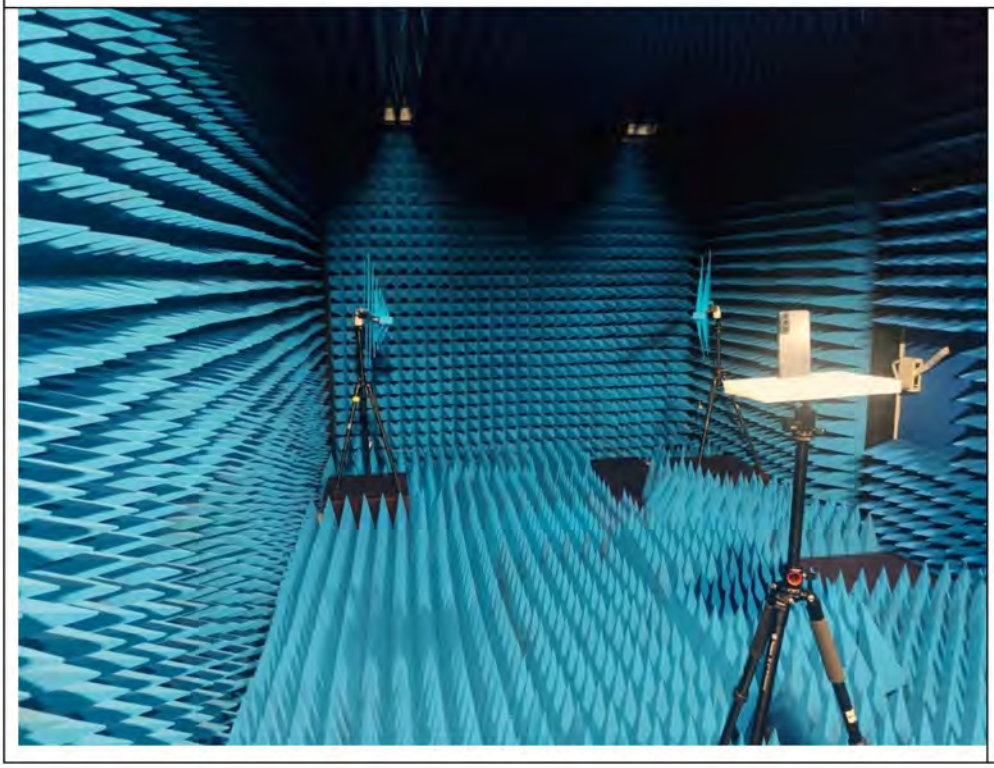
The D2M Broadcast Radio Head (40 W) operating in 470–582 MHz does not introduce any harmful interference or degrade the performance of IMT user equipment in commercial cellular bands (n71, n28, n5). The device complies with 3GPP blocking and spurious emission limits.

Annexure A: Photographs

	
Sample Front View	**Sample Rear View**

Setup Photograph: Conducted mode Setup	
	Details: • BRH/D2M transmitted with 40 W power, with variable attenuator. • IMT Base Station tester transmitted with power -92 dBm with compensation loss of 8.9 dB. • Keysight Fieldfox is used to measure the channel power of BRH transmission.

Setup Photograph: Radiated Mode setup showing commercial mobile phone and LPDA Antenna connected to both IMT and BRH base stations



Details:

- Both BRH and IMT base station are connected to LPDA with antenna gain of 7.5 dBi.
- Distance between base stations and UE is 3 meters.
- Distance between IMT base station antenna and BRH antenna is 2.1 meters.
- Phone : Commerical Phone (Samusng S21 Phone)

Annexure B: Receiver Sensitivity Level Observed Screenshot

Other information:

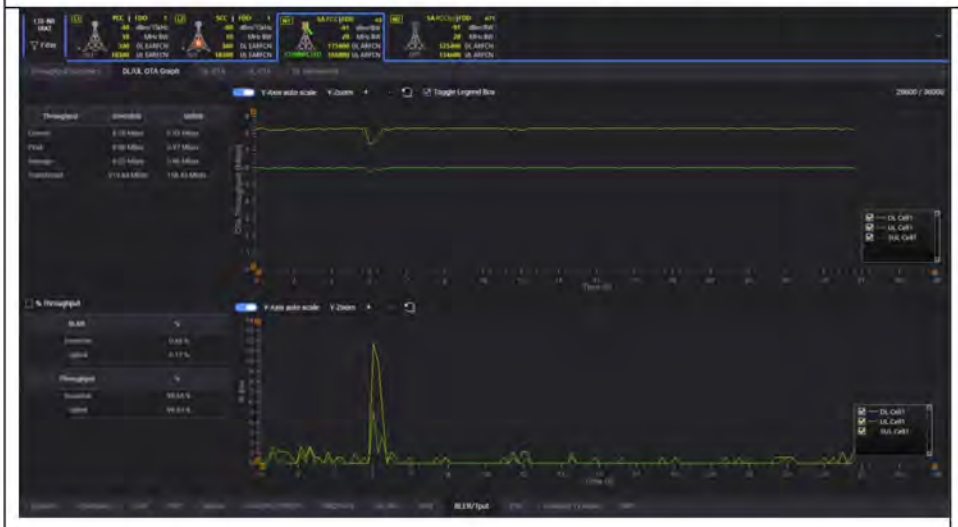
- MCS =4
- Loss from IMT base station to UE = -8.9 dB (2 splitters and 2 cables)
- ARFCN - DL: 125400
- Scheduling: Full throughput test

Band n71 for Conducted Mode

Other information:

- MCS =4
- Loss from IMT base station to UE = -34 dB (Cable loss + FSPL loss+ LPDA gain)
- ARFCN - DL: 125400
- Scheduling: Full throughput test

Band n71 for Radiated Mode

	Other information: • MCS =4 • Loss from IMT base station to UE = -8.9 dB (2 splitters and 2 cables • ARFCN - DL: 175800 • Scheduling: Full throughput test
Band n5 for Conducted Mode	
	Other information: • MCS =4 • Loss from IMT base station to UE = -35.5 dB (Cable loss + FSPL loss+ LPDA gain) • ARFCN - DL: 175800 • Scheduling: Full throughput test
Band n5 for Radiated Mode	

	Other information: • MCS =4 • Loss from IMT base station to UE = -8.9 dB (2 splitters and 2 cables • ARFCN - DL: 153600 • Scheduling: Full throughput test
Band n28 for Conducted Mode	
	Other information: • MCS =4 • Loss from IMT base station to UE = -34 dB (Cable loss + FSPL loss+ LPDA gain) • ARFCN - DL: 153600 • Scheduling: Full throughput test
Band n28 for Radiated Mode	

Annexure C: Spurious Emission Screenshots

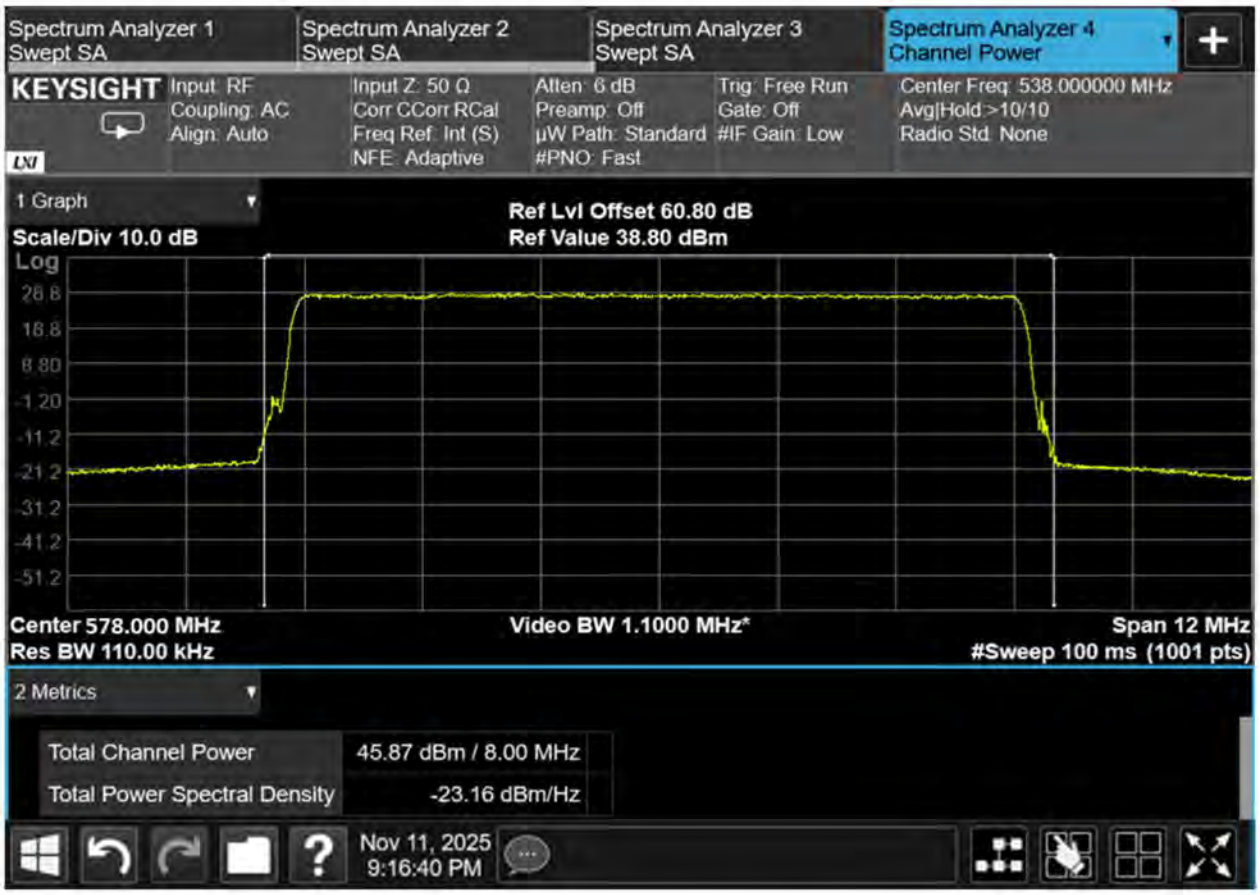


Figure 3: Channel power of BRH 40W transmitter

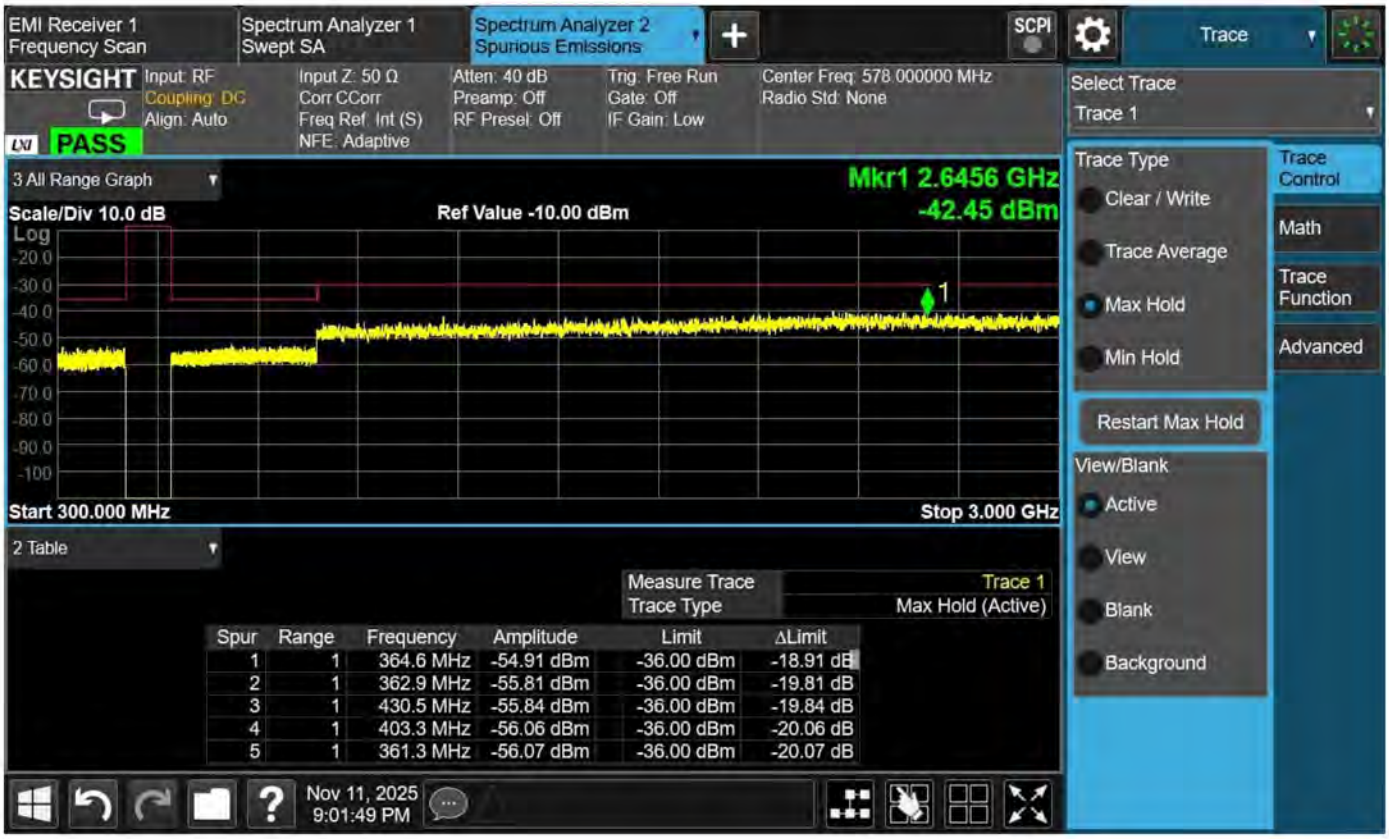


Figure 4: Spurious emission Test Result

Annexure D: Total External Loss

Conducted Total External Path Loss.

Band	Bandwidth in MHz	ARFCN	Path loss in dB
n71	20	DL: 125400 UL: 134600	-8.9
n5	20	DL: 175800 UL: 166800	-8.9
n28	20	DL: 153600 UL: 142600	-8.9

Radiated Total External Path Loss.

Band	Bandwidth in MHz	ARFCN	Path loss in dB
n71	20	DL: 125400 UL: 134600	-34
n5	20	DL: 175800 UL: 166800	-35.5
n28	20	DL: 153600 UL: 142600	-34

----------END OF THE REPORT----------

National Accreditation Board for Testing and Calibration Laboratories

NABL

CERTIFICATE OF ACCREDITATION

ARACION TECHNOLOGY PRIVATE LIMITED

has been assessed and accredited in accordance with the standard

ISO/IEC 17025:2017

"General Requirements for the Competence of Testing & Calibration Laboratories"

for its facilities at

1ST FLOOR, B-23 HK ARCADE, KSSIDC, INDUSTRIAL AREA, BENGALURU, , KARNATAKA, INDIA

in the field of

TESTING

Certificate Number: TC-13835

Issue Date: 04/06/2024 **Valid Until:** 03/06/2026

This certificate remains valid for the Scope of Accreditation as specified in the annexure subject to continued satisfactory compliance to the above standard & the relevant requirements of NABL.
(To see the scope of accreditation of thislaboratory, you may also visit NABL website www.nabl-india.org)

Name of Legal Entity: ARACION TECHNOLOGY PVT LTD

Signed for and on behalf of NABL

Srikanth R
Director

Chakravarthy T. Kannan
Chief Executive Officer

ISO 9001:2015

GOVERNMENT OF INDIA
MINISTRY OF COMMUNICATIONS
DEPARTMENT OF TELECOMMUNICATIONS
TELECOMMUNICATION ENGINEERING CENTRE
Gate No. 5, Khurshid Lal Bhawan, Janpath, New Delhi-110001

CERTIFICATE OF DESIGNATION

M/s Aracion Technology Private Limited, Laboratory, Bangalore
has been assessed and designated as Conformity Assessment Body (CAB)
for its facilities at

1st Floor, B-23 HK Arcade, 1A Kssidc, Industrial Area, Mahadevapura,

Bangalore-560048

In the field of Testing

Certificate No. TEC/MRA/CAB/IND-D/108

Issue Date: 01/10/2025 **Validity: 01/10/2025 to 30/09/2028**

This Certificate remains valid for the Scope of Designation as specified in the Annexure subject to the continued validity of NABL Accreditation and satisfied compliance to the Standards/specifications against which lab has been designated and strict compliance to the relevant terms and conditions of TEC CAB Designation Scheme.

(To see the scope of designation of this laboratory, you may also visit TEC website www.tec.gov.in)

Signed for and on behalf of TEC

Sanjeev Kumar Arya
Director (CA)
For Designating Authority
TEC