Field Trial Report

Indoor 5G Network using 600 MHz Band – Coverage, Performance, and Interference Analysis on Adjacent Channel TV Signals

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1.0	5 Nov., 2024	First Release

List of Acronyms and Abbreviations

5G	Fifth Generation Mobile Network / Mobile Services
ACLR	Adjacent Channel Leakage Ratio
BW	Bandwidth
CA	Communications Authority of Hong Kong
CABD	Communal Aerial Broadcast Distribution
CATV	Community Antenna television
CDF	Cumulative Distribution Function
DTMB	Digital Terrestrial Multimedia Broadcast
DTT	Digital Terrestrial Television
E.I.R.P	Effective Isotropic Radiated Power
EMF	Electromagnetic Field
ERP	Effective Radiated Power
FDD	Frequency Division Duplexing
FHOB	Freight Head Office Building
FPSL	Free Space Path Loss
ICNIRP	International Commission on Non-Ionizing Radiation Protection
IEEE	Institute of Electrical and Electronics Engineers
MIMO	Multiple-Input-Multiple-Output Antenna
MNO	Mobile Network Operator
NIR	Non-ionizing Radiation
OFCA	Office of the Communications Authority
RBS	Radio Base Station
RSRP	Reference Signal Received Power
R&S	Rohde & Schwarz
SA	Standalone
SINR	Signal to Interference & Noise Ratio
SMATV	Satellite Master Antenna Television
UHF	Ultra-High Frequency

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Executive Summary

In Hong Kong, the 600 MHz band (specifically, the 617 - 698 MHz range) has not yet been assigned for mobile services at the time of this report's writing. At the same time, MTR Corporation envisions to utilize dedicated 5G network technology for indoor factory applications, which will enhance connectivity and improve operational efficiency. Using the 600 MHz band for indoor applications only becomes an attractive option. But the premise is to conduct a comprehensive field test study to ensure that 5G signals outside the building will not cause any interference to adjacent channels TV signals. To this end, ASTRI collaborated with the MTR Corporation and selected the Freight Headquarters Building (FHOB) as the trial site to conduct 5G indoor network testing and simulation using the 600 MHz frequency band to evaluate coverage, performance, and interference analysis of adjacent channel TV signals.

The objective of this field trial report is to explore and provide all technical issues related to the indoor deployment of 5G private networks using the 600 MHz frequency band, while being able to coexist with TV broadcasting services and ensuring that the signal quality of adjacent channel TV signals does not deteriorate. This field trial report covers 5G standalone (SA) private network deployment in FHOB, field measurements to evaluate 5G indoor cell coverage and throughput, field measurements to investigate the impact of 5G signals on adjacent channels TV signals outside FHOB, and NIR levels in FHOB publicly accessible areas. The results provided in this technical report focused on the frequency band range of downlink 617-637 MHz. It is confirmed that the 600 MHz frequency band can provide high-quality coverage and throughput performance on indoor area, while the impact of 5G signals on adjacent channels TV signals on outside area is negligible.

The main text of this report summarizes the findings as follows:

- Based on research and field investigation, FHOB was selected for field trials and detailed studies. The building is in a rural area and is unlikely to interfere with public users; the surrounding areas have different terrain heights, making it convenient to test different transmitter and receiver scenarios; and the surrounding space is open enough to facilitate on-site measurements.

- Based on a typical deployment setup, RAN planning requires the installation of four antennas on three different floors of the FHOB. The antenna transmit power is set to less than or equal to 2 Watts (i.e., 33 dBm) EIRP, in compliance with OFCA's NIR safety guidelines.

- A 5G SA private network has been deployed in FHOB with one 5G core (5GC) server, one Baseband Unit (BBU), two Remote Radio Units (RRUs), and four antennas operating on the 600 MHz frequency band with a 20 MHz bandwidth paired spectrum. Field measurements were carried out to assess coverage and throughput on different floors (2/F, 1/F, and G/F) in FHOB, showing that both metrics meet acceptance criteria with significant margin. The maximum downlink throughput achieved is 210 Mbps with 256 Quadrature amplitude modulation (QAM) and 160 Mbps with 64 QAM, respectively. The maximum uplink throughput achieved is 82 Mbps with 64 QAM.

- To check compliance with regulatory requirements, interference tests were conducted at 6 test points outside the FHOB at different distances and heights from the FHOB to investigate interference on adjacent channels TV signals. The results showed that the impact on the TV signal was negligible, demonstrating that under certain conditions and through rigorous design, indoor deployment of 5G private networks using 600 MHz 5G can coexist with TV broadcasting services.

- To check compliance with NIR safety requirements, on-site measurements of NIR levels generated by Radio Base Stations (RBSs) at 17 testing points inside FHOB. The results showed that the associated NIR levels were less than 0.96% of the ICNIRP compliance level, indicating compliance with NIR security requirements.

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1 Introduction

1.1 OFCA's Assignment of the Spectrum 600 MHz

Office of the Communications Authority (OFCA) made a statement of "Arrangements for Assignment of the Spectrum in the 600 MHz and 700 MHz Bands for the Provision of Public Mobile Services and the Related Spectrum Utilisation Fee" on 30 March 2021. This Statement promulgates the decision of the Communications Authority (CA) on the allocation of the 614 – 806 MHz band to mobile service on a primary basis and the associated arrangements for assignment of a total of 140 MHz of spectrum comprising 2 x 35 MHz of spectrum in each of the ranges 617 – 652 MHz paired with 663 – 698 MHz ("600 MHz band") and 703 – 738 MHz paired with 758 – 793 MHz ("700 MHz band") (collectively referred to as the "600/700 MHz bands") for the provision of public mobile services including the fifth generation (5G) services.

Indoor 2 * 35 MHz N71[1] FDD pairs 617-652 and 663-698 MHz was proposed for 2021 auction. The entire proposed N71, however, remains unoccupied after the auction and vacant until the time of this report's writing. The 600 MHz band has not been allocated for mobile services at the time of this report's writing.

1.2 5G Deployment for Indoor Warehouse/Factory Applications

Despite the surge in 5G users in recent years and the rapid expansion of new generation networks, public network coverage in warehouses and factories located in remote areas is still weak. Due to the relatively limited number of users and low profit margins, Mobile Network Operators (MNOs) are unlikely to deploy new base stations over coverage issues in warehouses or factories.

[1] The term "N71" refers to the 600 MHz frequency band (range 617 - 698 MHz) used for 5G wireless communications in FDD mode. In this report "N71" and "600 MHz band" are used equivalently.

At the same time, many factory applications require real-time data transmission between machines or control systems, especially when developing smart factories with many sensors, robots, and Internet of Thing (IoT) devices. In addition, factory applications with sensitive information or trade secrets often require a higher level of security. 5G private networks provide powerful, tailored security measures in terms of physical layer, transmission, and protocol stacks.

1.3 Advantages of 5G on 600 MHz Band

The 600 MHz band is considered useful for 5G indoor factory usage due to several factors:

- **Coverage**: The lower the frequency, the better the signal propagation characteristics. The 600MHz spectrum has better coverage and penetration characteristics, allowing signals to penetrate walls and other obstacles more easily.
- **Cost-Efficiency**: Deploying 5G infrastructure in lower frequency bands is more cost-effective than deploying in higher frequency bands because lower frequency bands require fewer base stations and provide wider coverage. In addition, compared to Wi-Fi systems using active antennas, the 600 MHz band can use traditional antenna systems with lower construction and maintenance costs.
- **Better Noise Performance**: Using the 600 MHz band for 5G has better noise performance. The reason is that lower frequency bands like 600 MHz are less susceptible to interference and noise compared to higher frequency bands. As a result, 5G networks operating in the 600 MHz band can provide a more reliable and consistent connection for users, especially in areas with high levels of interference.
- **Availability:** The availability of spectrum can also impact the decision. If the 600 MHz spectrum is more readily available and less expensive to acquire compared to higher frequency bands in Hong Kong, this can make it an attractive option. Section 1.1 has discussed this aspect.

1.4 Potential Interference on TV Signals

TV signals in Hong Kong primarily operate on the UHF (Ultra High Frequency) band, which include frequencies ranging from 470 MHz to 862 MHz. This means that some TV signals in Hong Kong may fall in or near the 600 MHz spectrum. Table 1 shows the TV channels in or near the 600 MHz spectrum at the time of this report's writing. The deployment of 5G in the 600 MHz spectrum is susceptible to cause interference on adjacent channels TV signals, especially if proper mitigation measures are not implemented. Interference can manifest as degraded TV reception, pixelation, or complete signal loss. Therefore, a field trial study is necessary to explore and provide all technical issues related to the indoor deployment of 5G private networks using the 600 MHz frequency band, while being able to coexist with TV broadcasting services and ensuring that the signal quality of adjacent channel TV signals does not deteriorate.

Table 1: TV channels in Hong Kong fall in or near the 600 MHz spectrum.

Centre Frequency (MHz)	Operation Bandwidth (MHz)	TV Channels	Gap Band vs. 642MHz (MHz)
602	**7.56**	81: Jade 96: ViuTVsix 99: ViuTV	40
586	**7.56**	82. J2 83. TVB News 84. Pearl 85. TVB Finance, Sports, and Information Channel	56
538	**7.56**	35. RTHK TV 35 36. RTHK TV 36	89
522	**7.56**	31. RTHK TV 31 32. RTHK TV 32 33. RTHK TV 33 34. RTHK TV 34	120
482	**7.56**	76. Hong Kong International Business Channel 77. HOY TV 78. HOY Infotainment	160

Lastly, Communal Aerial Broadcast Distribution (CABD) and Satellite Master Antenna Television (SMATV) are two common systems used in Hong Kong for distributing broadcast signals and television services to multiple users within a building or a community. These systems often include

Closed-Circuit Television (CCTV) as well. This report will not cover studies of the impacts of these systems, which are not mainstream TV broadcast channels.

1.5 Objectives and Organization of this Study Report

In this report, FHOB is selected as the trial site for PoC, and a 5G SA private network is deployed in FHOB with one 5G core (5GC) server, one Baseband Unit (BBU), two Remote Radio Units (RRUs), and four antennas operating on the 600 MHz frequency band with a 20 MHz bandwidth paired spectrum. Field measurements were conducted within FHOB, to evaluate the indoor performance including coverage and throughput. Meanwhile, the interference tests were conducted outside of FHOB to evaluate the impact of such a 5G indoor network using the 600 MHz band on adjacent channel TV signals, to fulfill the regulatory requirements. Finally, NIR safety of 5G Radio Base Stations (RBSs) will be evaluated based on ICNIRP EMF guidelines. This report is divided into the following sections:

- Section 2 provides the trial design and 5G SA private network deployment in FHOB;
- Section 3 outlines test cases and test equipment. The assessment of 5G indoor private network includes an evaluation of indoor coverage and throughput performance;
- Section 4 introduces the interference tests outside FHOB, shows measurement procedure and scenarios, studies the impact of 5G signal on TV channels, presents field measurement and provides field measurement results;
- Section 5 presents study on NIR safety problem of 5G Radio Base Stations (RBSs) based on ICNIRP EMF guidelines; and
- Section 6 sums up the findings of this study.

2 Trial Design and 5G SA Private Network Deployment

In this section, site selection and trial information are introduced first, then network parameters of 5G indoor system are presented, followed by the 5G SA private network deployment in FHOB.

2.1 Site Selection

In Hong Kong, a total of 70 MHz of spectrum comprising 2 x 35 MHz of spectrum in each of the ranges 617 – 652 MHz paired with 663 – 698 MHz ("600 MHz band") is planned for provision of mobile services in indoor environments and is currently not licensed. This frequency band has low penetration loss and is suitable for the provision of 5G SA private network in warehouse and factory environments. At the same time, MTR's vision is to utilize dedicated 5G network technology in indoor factories, which will feature enhanced connectivity, improved operational efficiency, and the deployment of advanced technologies that rely on low latency and high bandwidth.

Therefore, ASTRI collaborated with the MTR Corporation to choose FHOB as the trial site. The building is in a rural area and is unlikely to interfere with public users; the surrounding areas have different terrain heights, making it convenient to test different transmitter and receiver scenarios; and the surrounding space is open enough to facilitate on-site measurements.

2.2 Trial Site Information

Freight Headquarters Building (FHOB) was chosen as the trial site, and its basic information is shown in Table 2.

Table 2: Site name, address, and coordinate information.

Site	Information
Name	Freight Head Office Building (FHOB)
Address	MTR Hung Hom Stabling Sidings Cheong Tung Road South, Hung Hom
Coordinate Information	Northing (m), Eating (m): 817866, 836808 Latitude (N), Longitude (E): 22.29973, 114.18211

Figure 1 shows the appearance of the FHOB building. FHOB is a four-floor building, with each floor of area as 17 * 17 square. The target of 5G deployment network is to provide coverage for ground floor, first floor and second floor.

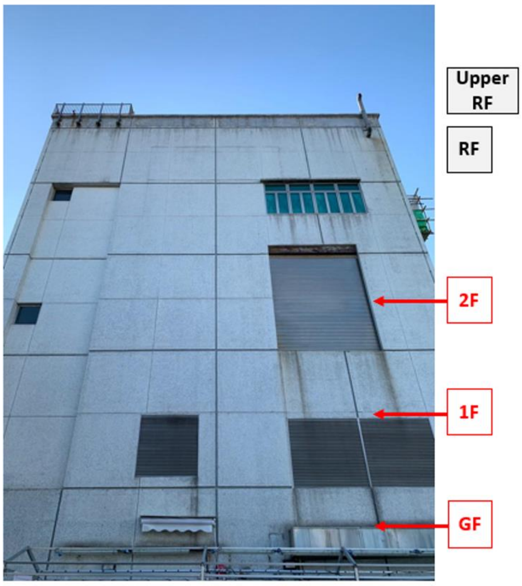
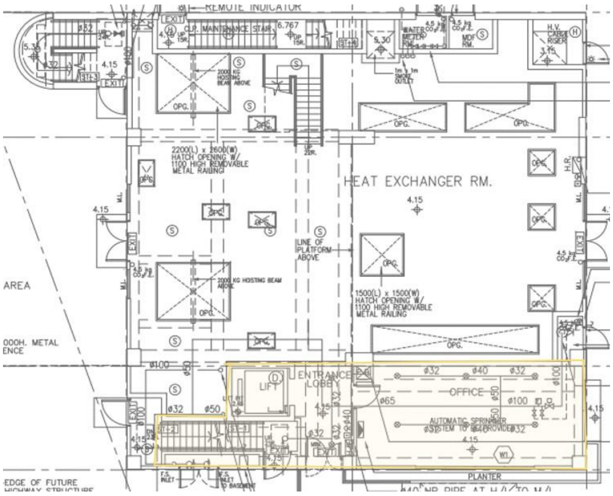
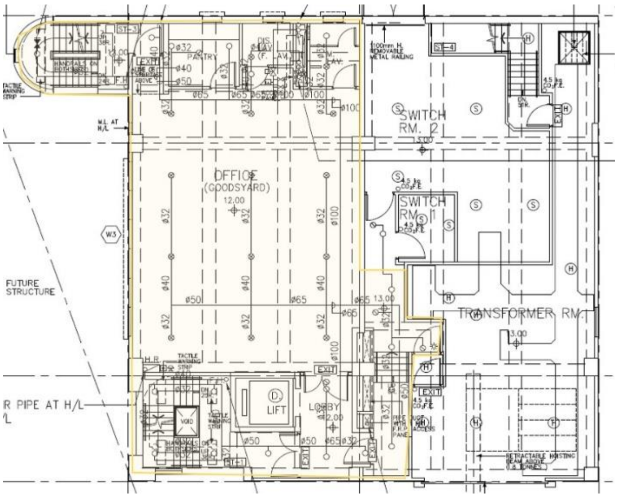


Figure 1: Appearance of the FHOB building.

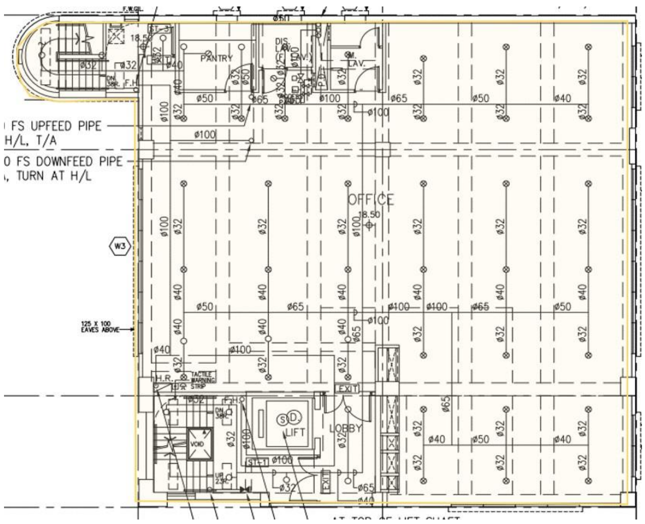
The shaded areas in Figure 2 show the coverage areas of each floor respectively. It is worth noting that the target coverage area by 5G signal on 2/F is the entire floor, while the target area on G/F and 1/F is a localized area.



(a) G/F.



(b) 1/F.



(c) 2/F.

Figure 2: Target coverage area of G/F, 1/F, and 2/F of FHOB.

2.3 Parameters of 5G Indoor System

For the 5G indoor cell, the 600 MHz frequency band (N71) is utilized, with support for two frequency band ranges: downlink 632-652 MHz and 617-637 MHz. The results provided in this technical report[2] focused on the frequency band range of downlink 617-637 MHz with a carrier bandwidth of 20 MHz. The network parameters are shown in Table 3. Based on OFCA's guidelines for indoor antenna maximum power, the maximum transmit power of antenna for indoors is 2 Watts (i.e., 33 dBm) effective isotropic radiated power (EIRP). Table 4 lists the other configuration parameters of a 5G indoor N71 cell.

Table 3: Network parameters of 5G indoor system.

Parameters	Information
Technology	5GNR
5G Frequency Band	Downlink: 617 to 637 MHz Uplink: 663 to 683 MHz
Bandwidth	20 MHz
Effective Isotropic Radiated Power (EIRP)	2 Watts (33 dBm) per indoor antenna
Effective Radiated Power (ERP)	1.22 Watts (30.85 dBm) per indoor antenna

Table 4: Configuration parameters of a 5G indoor N71 cell

Parameters	Value	Remark
Number of Carriers	1	
Center Carrier Frequency (MHz)	627	
Carrier Bandwidth (MHz)	20	
Transmit Power/Carrier (dBm)	29	Transmitter output
Aggregated Power from Power Amplifier (dBm)	29	Total Output power
Maximum Antenna Gain (dBi)	4	
Maximum EIRP (dBm)	33	2 Watts
TDD or FDD	FDD	
SISO or MIMO	MIMO	

[2] A previous technical report covered the results of the frequency band range of downlink 632-652 MHz with a carrier bandwidth of 20 MHz.

2.4 5G SA Private Network Deployment

5G private network deployment refers to the implementation of 5G networks using hardware, infrastructure, and frequencies in a live environment. The deployment involves the installation of 5G base stations, antennas, and related equipment to provide wireless coverage and connectivity to users.

Figure 3 shows the connection diagram of 5G private network in FHOB, the deployment includes one 5GC server, one BBU and two RRUs. A total of four antennas are installed, including one antenna on the ground (i.e., G/F), one antenna on the first floor (i.e., 1/F), and two antennas on the second floor (i.e., 2/F).

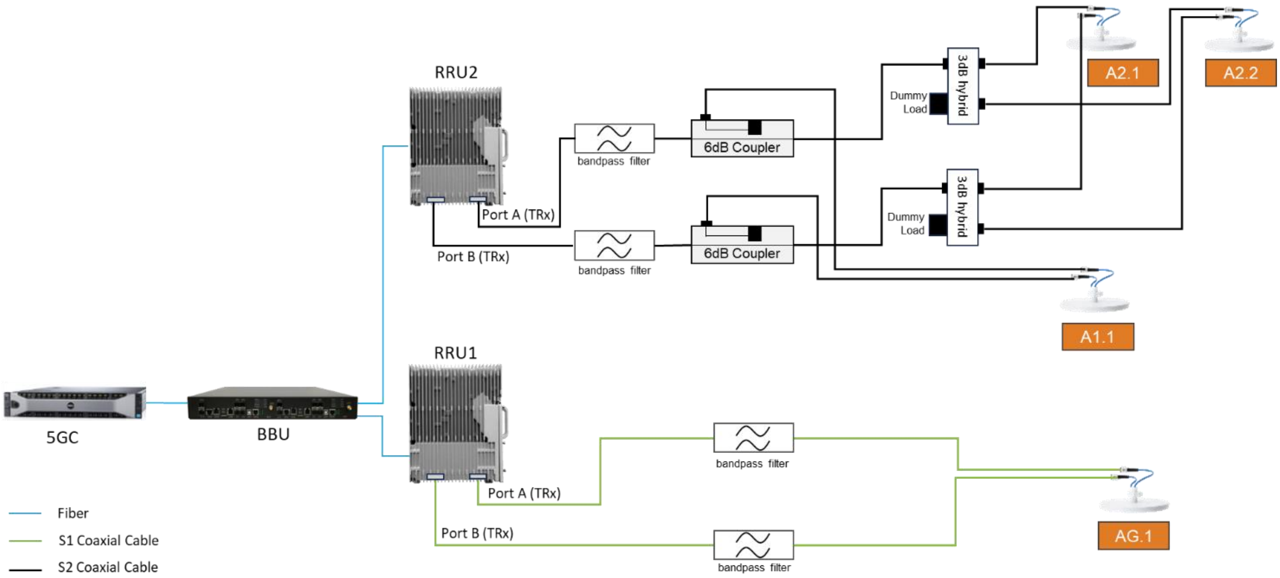
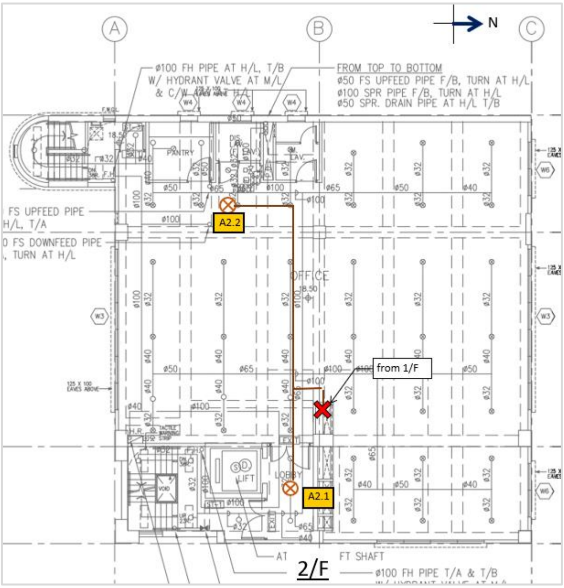
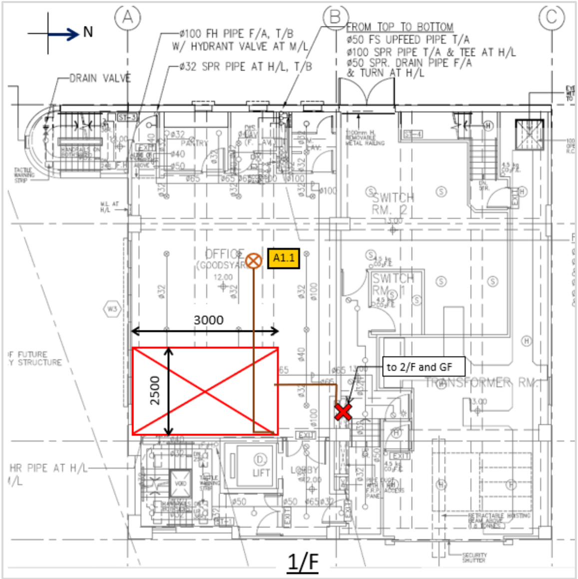


Figure 3: Connection diagram of 5G private network in FHOB.

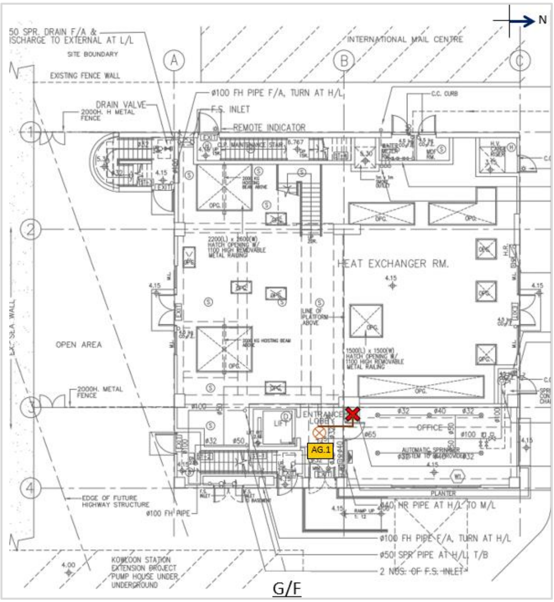
Figure 4 shows the location of 5G main equipment and antennas. Note that 5G main equipment is located on 1/F, including 5GC server, BBU and RRUs.



(d) 2/F.



(e) 1/F.



(c) G/F.

Figure 4: Locations of 5G main equipment and antennas.

Following the best engineering practices, the antenna I-ATO6-617/6000M is chosen which supports wideband frequency band and is an ideal choice for Indoor Distributed Antenna System (IDAS). Table 5 shows the antenna information.

Table 5: Antenna's parameters

Parameters	Information	Antenna View
Model	I-ATO6-617/6000M	
Frequency Range	617-960 / 1710-2700 / 3300-3800 MHz	
Gain	4 / 6 / 7 dBi	
Radiation	Omni-Direction	
Polarization	Vertical	

3 Measurement Results on Coverage and Throughput

This section focuses on field measurements on a 5G indoor private network using the 600 MHz band. The measurement of 5G signal includes both coverage (i.e., RSRP and SINR) and throughput.

3.1 Test Cases and Test Equipment

Performance evaluation involves coverage and throughput tests, as outlined in Table 6. Radio signal testing is also performed for troubleshooting purposes. Table 7 summarizes the 5G network measurement equipment with details on 1) the type of measurement that each equipment is used for, as well as 2) the technical specifications of each equipment. Figure 5 shows DingLi pilot pioneer with Samsung S22 (US version).

Table 6: Test cases information

Test Items	Test equipment	Type	Serial No.	Remark
Coverage test (SA) Throughput test (SA)	DingLi Pilot Pioneer (V10.6)	Software	DHLK901367	
	Samsung S22 (US version)	Hardware	R5CT423MA9V	
Radio Signal Test	Network Scanner TSMA6	Hardware	101661	Calibration on 15 Nov. 2022 Calibration interval: 2years
	Customer Premise Equipment (CPE)	Hardware	IR100862905060011498	
	Omni antenna AC-Q6060-DLZJ	Hardware	N.A.	Gain 2.15dBi@600MHz

Table 7: Summary of measurement equipment for coverage and throughput.

Equipment Descriptions	Equipment Type	Key Facts
Network scanner	• R&S TSMA6 AUTONOMOUS MOBILE NETWORK SCANNER 	• No limitations in 3GPP (e.g.,5G NR, LTE, WCDMA, GSM, NB-IoT) frequency bands up to 6 GHz, including a multi-GNSS receiver for uninterrupted location tracking • Maximum connectivity, with support for additional scanner hardware, Windows based PCs, Android based UEs and tablets using wireless and wired connections
CPE	• TOZED IR 100 CPE 	• Industrial router is a high-performance 5G indoor communication industrial routing terminal, supports NR (SA&NSA), LTE, converts cellular network data into Gigabit wired network port data, and effectively meets various 5G communication industry and enterprise application

Figure 5: DingLi Pilot Pioneer with Samsung S22 (US version)

Field measurements of 5G coverage and throughput can be conducted using a heatmap analysis. This involves collecting data on signal strength and throughput at various locations within the coverage area and mapping this data onto a geographical map to visualize the coverage and performance of the 5G network. Advantages of using a heatmap analysis for field measurements of 5G coverage and throughput include a) visual representation; and b) comprehensive coverage analysis.

In this section, a heatmap analysis is used to evaluate the performance of 5G in terms of coverage and throughput on different floors of the FHOB building, including G/F, 1/F, and 2/F floor.

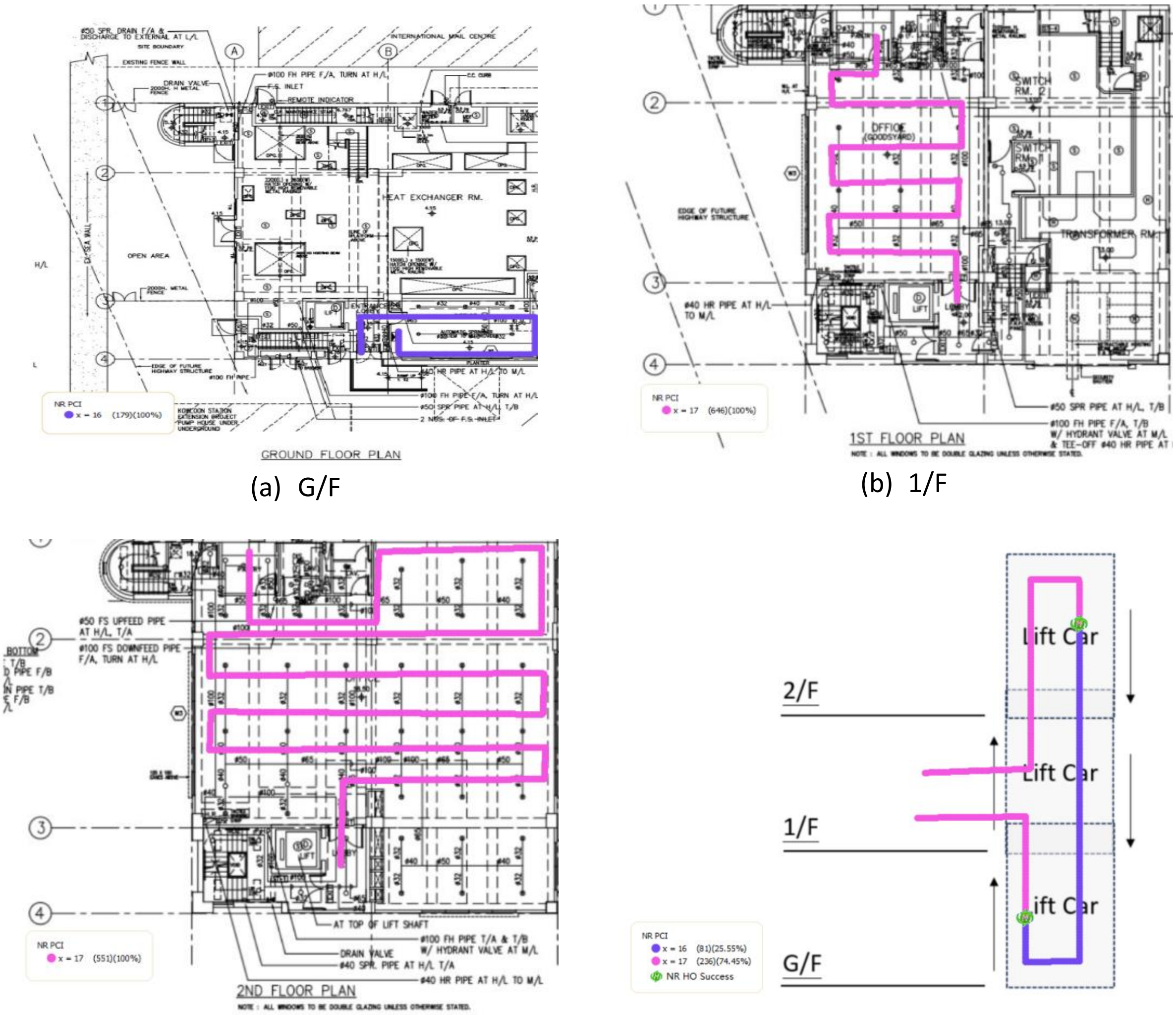
3.2 Coverage and Throughput Results

The goal of deploying a 5G private network in FHOB is to provide coverage for the ground floor (G/F), first floor (1/F), and second floor (2/F). In the network configuration diagram shown in Figure 3, each BBU connects to two RRUs, and each RRU covering one cell. RRU1 covers G/F, while RRU2 covers 1/F and 2/F. The planned cell information in different floors (i.e., G/F, 1/F, and 2/F) is detailed in Table 8.

Table 8: Planned cells information for FHOB building.

Index	PCI	Coverage Area
1	16	G/F
2	17	1/F
3	17	2/F

Figure 6 (a) – (d) shows the active cell IDs for different floors/areas including G/F, 1/F, 2/F, and lift area respectively.



(a) G/F

(b) 1/F

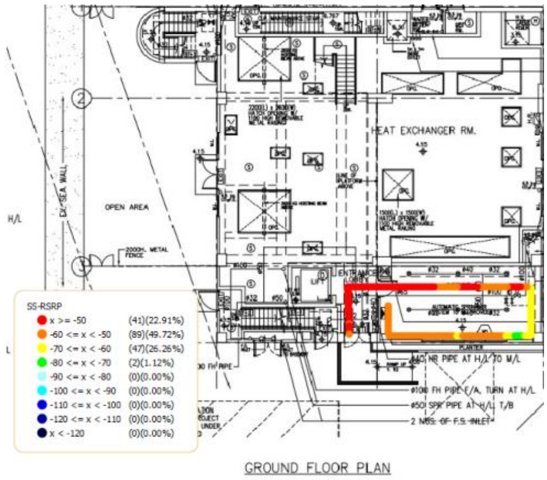
(c) 2/F

(d) Lift area

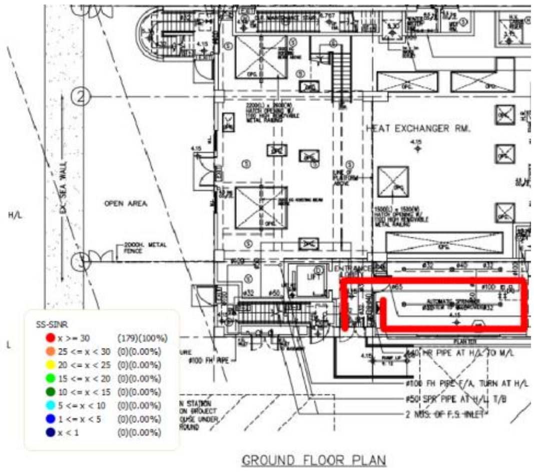
Figure 6: Active cell ID for FHOB building.

Figure 6 (a) – (c) shows that the PCI at G/F, 1/F, and 2/F is 16, 17 and 17 respectively. Figure 6 (d) shows that at lift area, handover is successful and happens twice, once at G/F and once at 2/F. SSB coverage test is performed using DingLi Pilot Pioneer with Samsung S22 (US version).

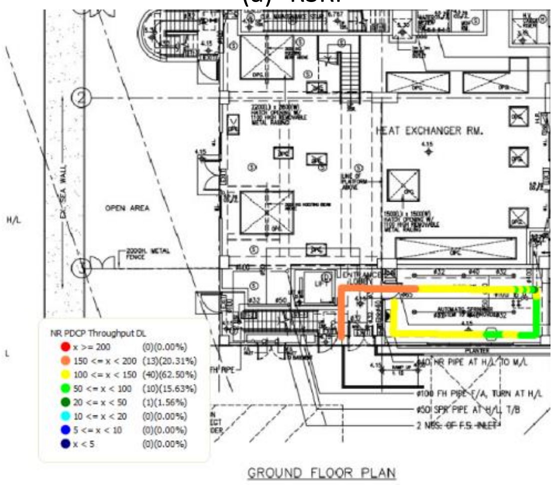
Figure 7 (a) – (d) shows the field measurement results of RSRP, SINR, downlink throughput and uplink throughput, respectively at G/F.



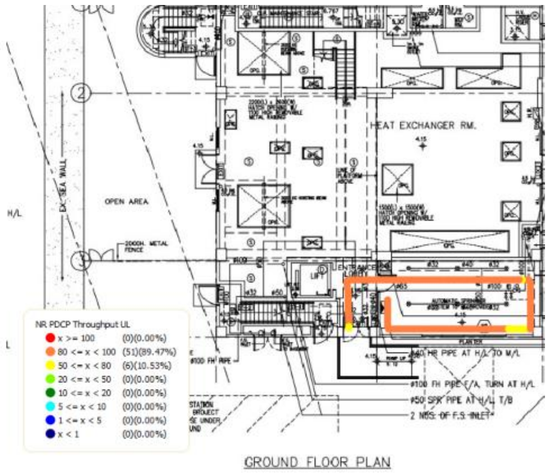
(a) RSRP



(b) SINR



(c) Downlink throughput



(d) Uplink throughput

Figure 7: Coverage map including RSRP, SINR, downlink and uplink throughputs at G/F.

First of all, the target coverage area by 5G signal on 2/F is the entire floor, while the target area on G/F and 1/F is a localized area. In Figure 2, the shaded areas show the target coverage areas of each floor respectively.

Figure 7 (a) shows that RSRP of 98.88% area is larger than -70 dBm, only 1.12% area is within the range of [-80 dBm, -70 dBm]. Figure 7 (b) shows SINR of 100% area is larger than 30 dB. Figure 7 (c) shows that the downlink throughput is larger than 50 Mbps and less than 200 Mbps, and Figure 7 (d) shows the uplink throughput is larger than 50 Mbps and less than 100 Mbps. It is noticed that both coverage and throughput performances at G/F meet acceptance criteria with significant margin.

Figure 8 (a) – (d) shows the field measurement results of RSRP, SINR, downlink throughput and uplink throughput, respectively at 1/F.

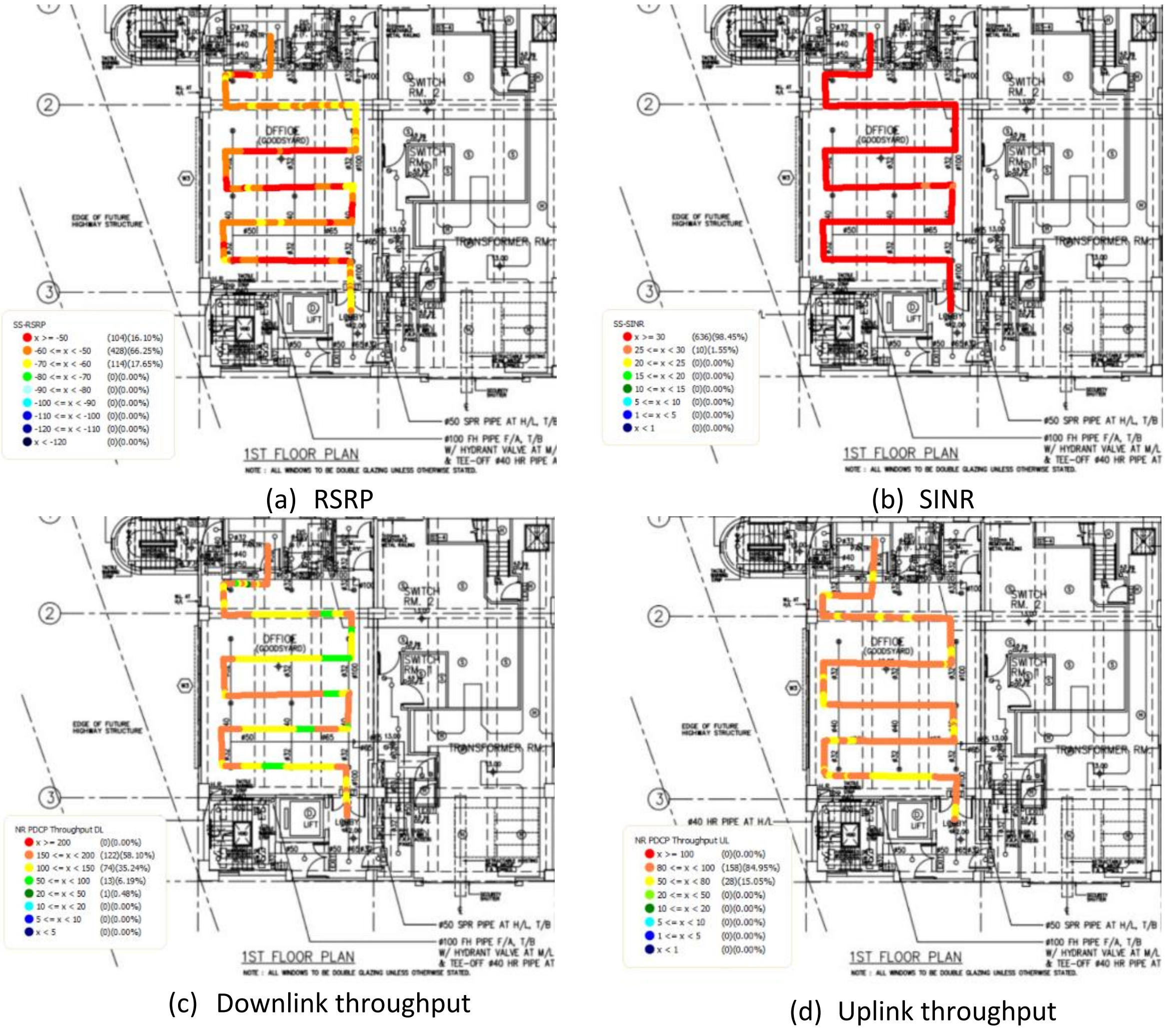


Figure 8: Coverage map including RSRP, SINR, downlink and uplink throughputs at 1/F.

Figure 8 (a) shows that RSRP of 100% area is larger than -70 dBm. Figure 8 (b) shows SINR of 100% area is larger than 30 dB. Figure 8 (c) shows that the downlink throughput is larger than 50 Mbps and less than 200 Mbps, and Figure 8 (d) shows the uplink throughput is larger than 50 Mbps and less than 100 Mbps. It is noted that both coverage and throughput performances at 1/F meet acceptance criteria with significant margin. The maximum downlink throughput achieved is 210 Mbps with 256 QAM and 160 Mbps with 64 QAM, respectively. The maximum uplink throughput achieved is 82 Mbps with 64 QAM.

Figure 9 (a) – (d) shows the field measurement results of RSRP, SINR, downlink throughput and uplink throughput, respectively at 2/F.

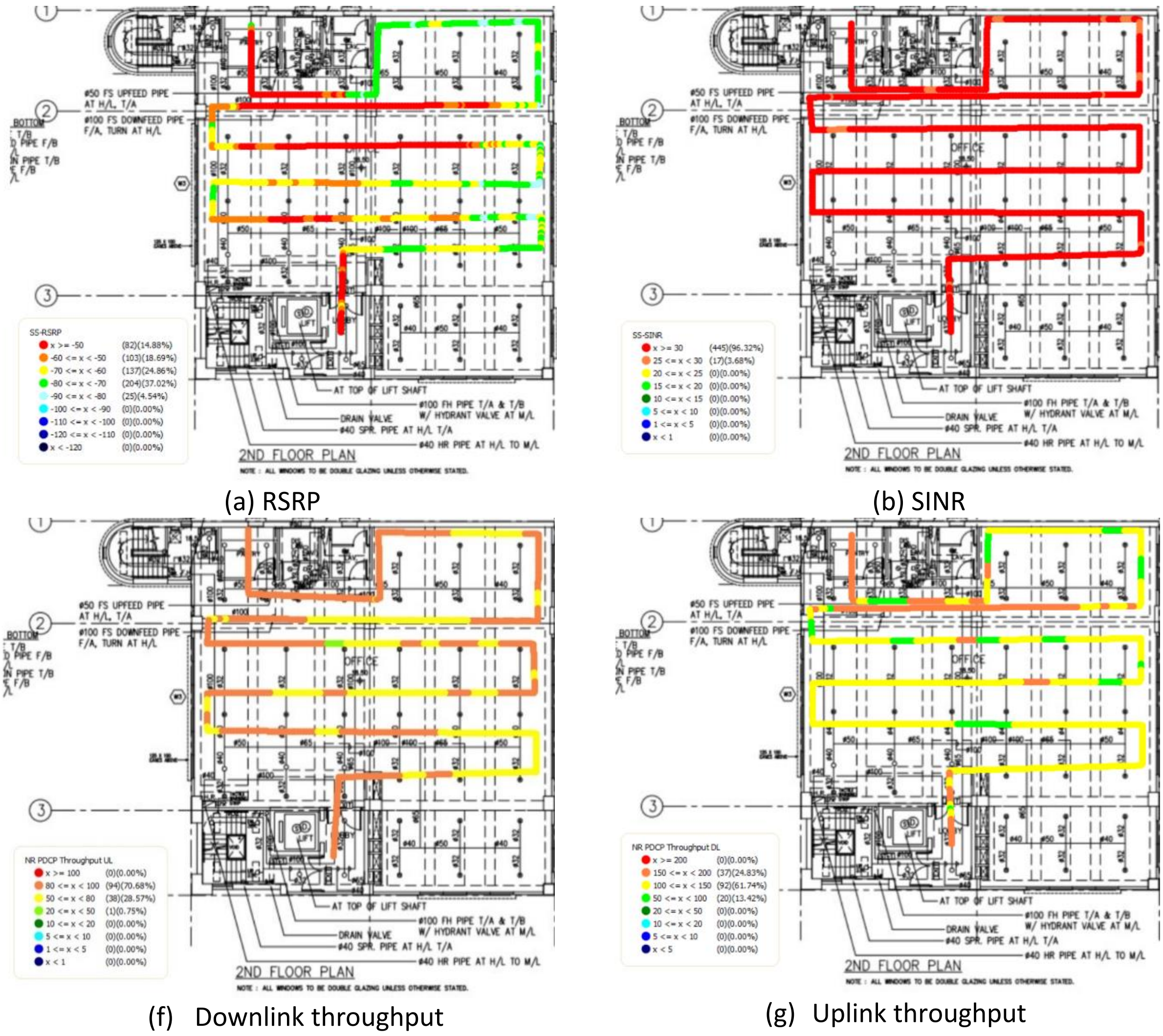


Figure 9: Coverage map including RSRP, SINR, downlink and uplink throughputs at 2/F.

Figure 9 (a) shows that RSRP of 100% area is larger than -90 dBm. Figure 9 (b) shows SINR of 100% area is larger than 30 dB. Figure 9 (c) shows that the downlink throughput is larger than 50 Mbps and less than 200 Mbps, and Figure 9 (d) shows the uplink throughput is larger than 50 Mbps and less than 200 Mbps. It is noticed that both the coverage and throughput performances at 2/F meet the acceptance criteria with significant margin.

Figure 10 (a) – (d) shows the field measurement results of RSRP, SINR, downlink throughput and uplink throughput, respectively at lift area.

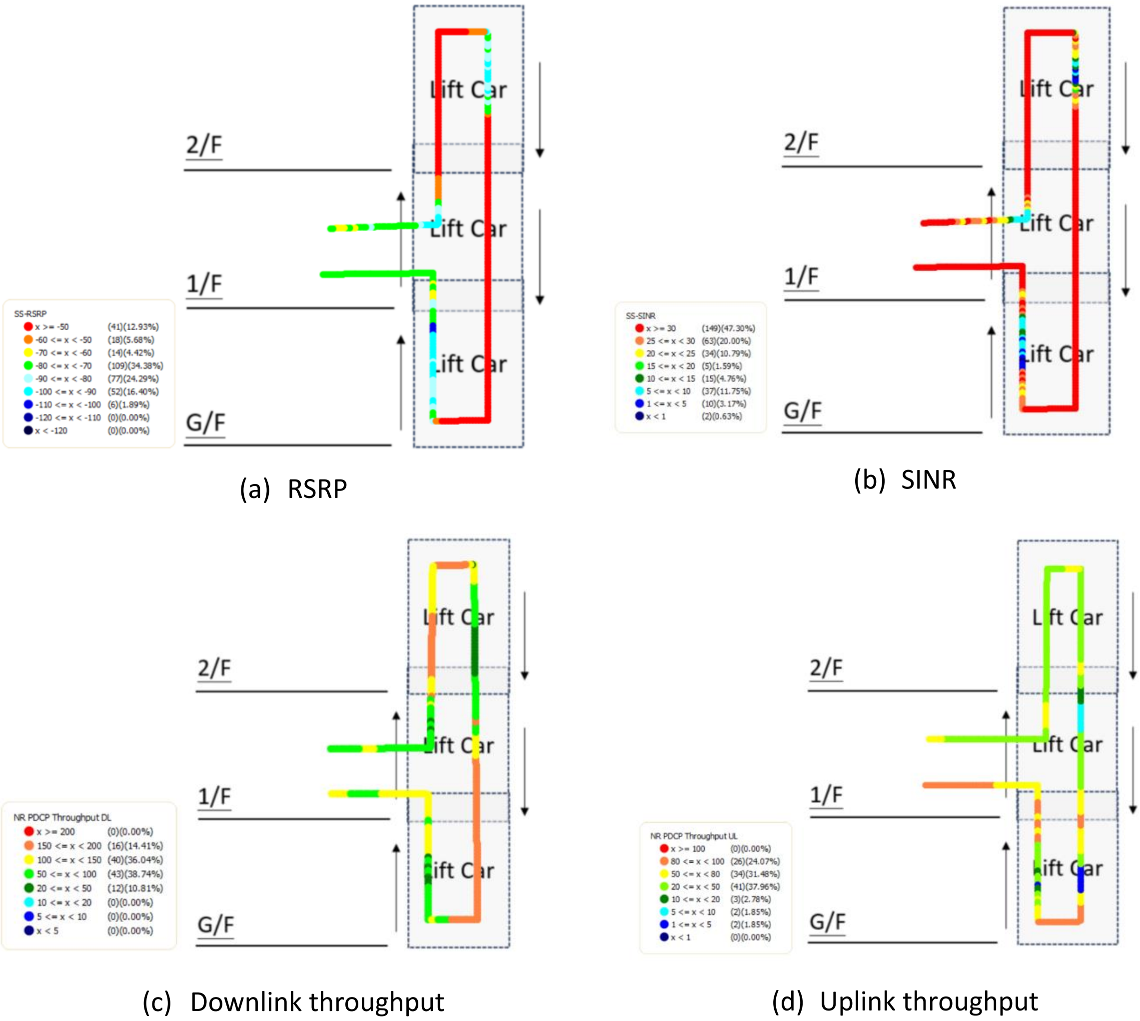


Figure 10: Coverage map including RSRP, SINR, downlink and uplink throughputs at lift area.

Figure 10 (a) shows that RSRP of 100% area is larger than -110 dBm. Figure 10 (b) shows SINR of 96.2% area is larger than 5 dB. Figure 10 (c) shows that the downlink throughput is larger than 20 Mbps and less than 200 Mbps, and Figure 10 (d) shows the uplink throughput of 98.15% area is larger than 5 Mbps and less than 100 Mbps. It is natural that at lift area the RSRP and throughput is weaker as compared with the areas at G/F, 1/F and 2/F, and both coverage and throughput performances at lift area meet the acceptance criteria with significant margin.

To summarize, it is concluded that 1) both the coverage and throughput in general-accessible area and lift area meet the acceptance criteria with significant margin; 2) The maximum downlink throughput achieved is 210 Mbps with 256 QAM and 160 Mbps with 64 QAM, respectively. The maximum uplink throughput achieved is 82 Mbps with 64 QAM.

4 Interference Test and Measurement Results

As discussed in Section 1.4, 5G signal is susceptible of causing interference on adjacent channels TV signals. This section focuses on investigating the interference impact of 5G signal on mainstream TV broadcast channels (refer to Table 1 in Section 1.4), with a certain transmission power (i.e., EIRP is 2 Watts) of 5G RBS. The interference effects are discussed below, including interference test setup, field measurement procedures and scenarios, as well as field measurement results.

4.1 Adjacent Channel Leakage Ratio (ACLR)

Adjacent Channel Leakage Ratio (ACLR) is a measurement used to quantify the amount of interference or leakage from a transmitter into adjacent frequency channels. Figure 11 illustrates how mobile signal affects TV signal in terms of ACLR. ACLR is a measure of the power level of the signal in the adjacent channels relative to the power level of the desired signal in the main channel. It is usually expressed in decibels (dB). A lower ACLR value indicates less interference and better spectral efficiency.

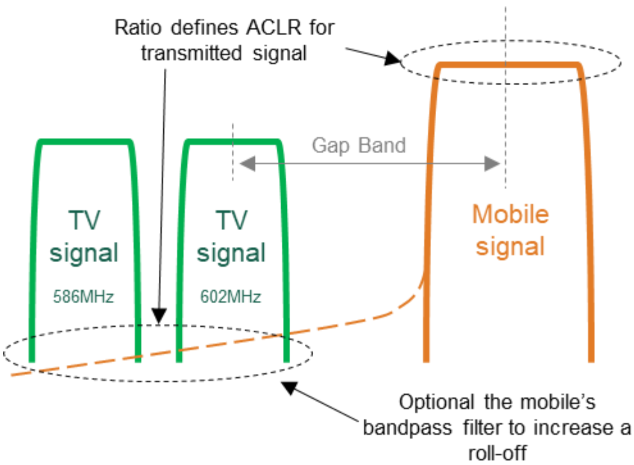


Figure 11: Illustration on how mobile signal affects TV signal in term of ACLR.

4.2 Impact of 5G Signals on TV Channels

In the trial site, when 5G signal is transmitting in indoors environment in FHOB, there is perhaps the potential for energy to spill into adjacent TV channels. Section 4.4 targets to evaluate the strength of leakage of 5G signal (if any) at some testing points locating at 20 meters (ground level), 100 meters (medium terrain, which is almost same height as FHOB) and 160 meters (high terrain, which is almost same height as FHOB) far away from the FHOB, respectively. The purpose is to ensure that, with a certain transmission power (i.e., EIRP is 2 Watts) of 5G RBS, any leakage will not cause interference or degrade the performance of adjacent channels TV signals.

For TV broadcast signals, 600 MHz mobile signals are interference signals, so interference tests will be conducted at some testing points, which are chosen carefully with distances of 20 meters, 100 meters and 160 meters around the FHOB building (see Section 4.5 for detailed discussion). The interference test is to decode TV broadcast signals and measure TV signal quality while transmitting 600 MHz mobile signal. On TV quality, there are 5 grades (refer to Table 9).

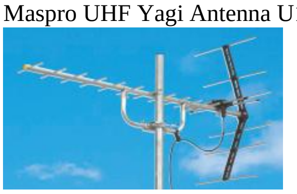
Table 9: Grades of TV quality

TV Grade	By Observation
5	Excellent. Good quality
4	Best. A little spot and sound freeze
3	Fair. Occasion pixelation or distortion and sound freeze
2	Poor. Usual pixelation, distortion or blackout.
1	No signal.

4.3 Interference Test Setup

For interference test, three more equipment including spectrum analyzer, TV analyzer and UHF Yagi antenna are used in field measurements. Table 10 shows more details on the technical specifications of each equipment.

Table 10: Measurement equipment used in interference test.

Equipment Descriptions	Equipment Type	Key Facts	Serial No.
Spectrum analyzer	• R&S FSW signal and spectrum analyzer 	• Unparalleled low phase noise and best sensitivity on the market • 8.3 GHz internal analysis bandwidth • 800 MHz real-time analysis bandwidth • SCPI recorder simplifies code generation • High dynamic range enables outstanding EVM performance	102578 Calibration on 22 Feb. 2023
TV analyzer	• R&S ETL TV analyzer with DTMB mode 	• Realtime demodulation • Advanced frontend and FPGA-based demodulation • Preselection with additional 75 Ω RF input • Integrated spectrum analyzer • Video decoder for MPEG-2, H.264 (MPEG-4), HEVC and AVS/AVS+	105093[3]
Yagi Antenna	• Maspro UHF Yagi Antenna U146 	• For Digital Terrestrial broadcasting reception • Reception channel 13 to 52 • Actual gain 8 to 12.4dBi • Front-to-back ratio 18 to 28dB • Half-power angle 32 to 56° • VSWR less than 2.5	N.A.

To examine the potential interference signals in a critical scenario, the 5G base station is activated at its maximum EIRP of 2 Watts (i.e., 33 dBm). The base station operates on the downlink 617-637 MHz (refer to Table 3 in Section 2.3) and has the narrowest gap of 15 MHz towards the existing 602 MHz CATV band[4].

[3] The equipment is rented from R&S headquarters, which guarantees the functionality and usability of the equipment.
[4] In the previous technical report, the base station operates on the downlink 632-652 MHz and has the narrowest gap of 30 MHz towards the existing 602 MHz CATV band.

4.4 Field Measurement Procedure and Scenarios

In this section, TV signal is measured under two scenarios: 1) normal TV signals without UHF Booster; and 2) TV signals with UHF Booster.

4.4.1 Measurement Procedure

The measurement procedure is descripted as follows:

- Step 1: Choose one 600MHz band adjacent TV channel (from Table 1).
- Step 2: Monitor the audiovisual performance of this TV channel for 5 minutes.
- Step 3: Repeat Steps 1 and 2 until all TV channels are monitored.

The configuration parameters for TV signal measurement are shown in Table 11.

Table 11: Configuration parameters for TV signal measurement

Format	DTMB
Carrier Frequency (MHz)	482, 522, 538, 586, 602
Carrier Bandwidth (MHz)	8MHz per channel
Equipment	1.R&S ETL - For spectrum overview, TV signal measurement (Rx level, BER, MER etc.) 2. DTMB receiver - For signal decode and TV functional test
Rx Antenna	UHF Yagi Antenna
Rx Antenna Gain (dBi)	8-12.5

4.4.2 1st scenario: Measure TV Signal without UHF Booster

Figure 12 shows how the TV signal measurement without UHF booster is set up. At antenna side, four antennas are installed at G/F, 1//F and 2/F (refer to Figure 4); at measurement side, measurement equipment including spectrum analyzer, TV analyzer and Digital Terrestrial Multimedia Broadcast (DTMB) receiver are connected to UHF Yagi antenna.

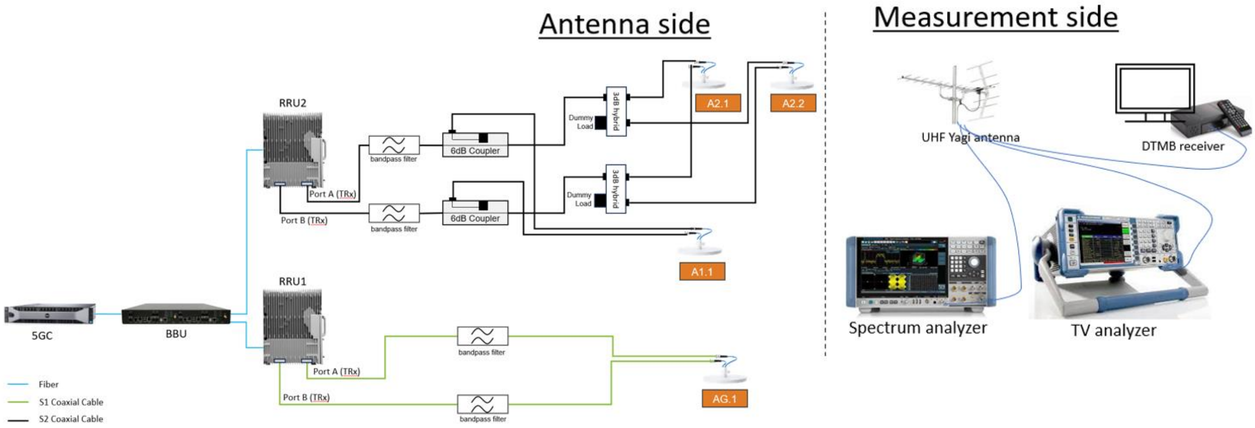


Figure 12: TV signal measurement setup without UHF booster.

4.4.3 2nd Scenario: Measure TV Signal with UHF Booster

As mentioned, to emulate CATV system deployment in practice, a UHF Booster is added as an additional testcase for reference. Figure 13 shows how the TV signal measurement with UHF booster is set up.

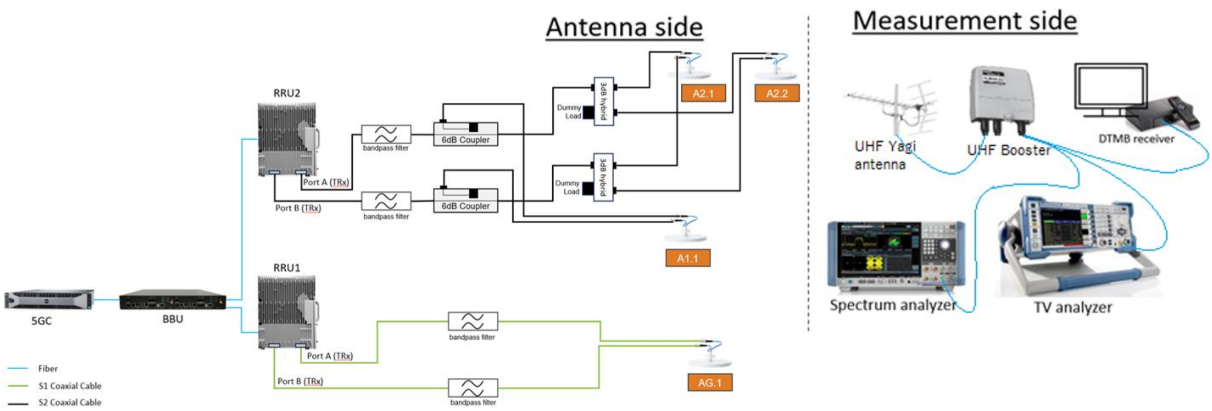


Figure 13: TV signal measurement setup with UHF booster.

4.5 Measurement Results

A total of six test points is selected for the field measurement. Figure 14 shows the location of these test points. It is worth to mention that test point 1 is a critical point, which is 20 meters away from FHOB at ground level with UHF Yagi antenna pointing directly to N71 RBS.

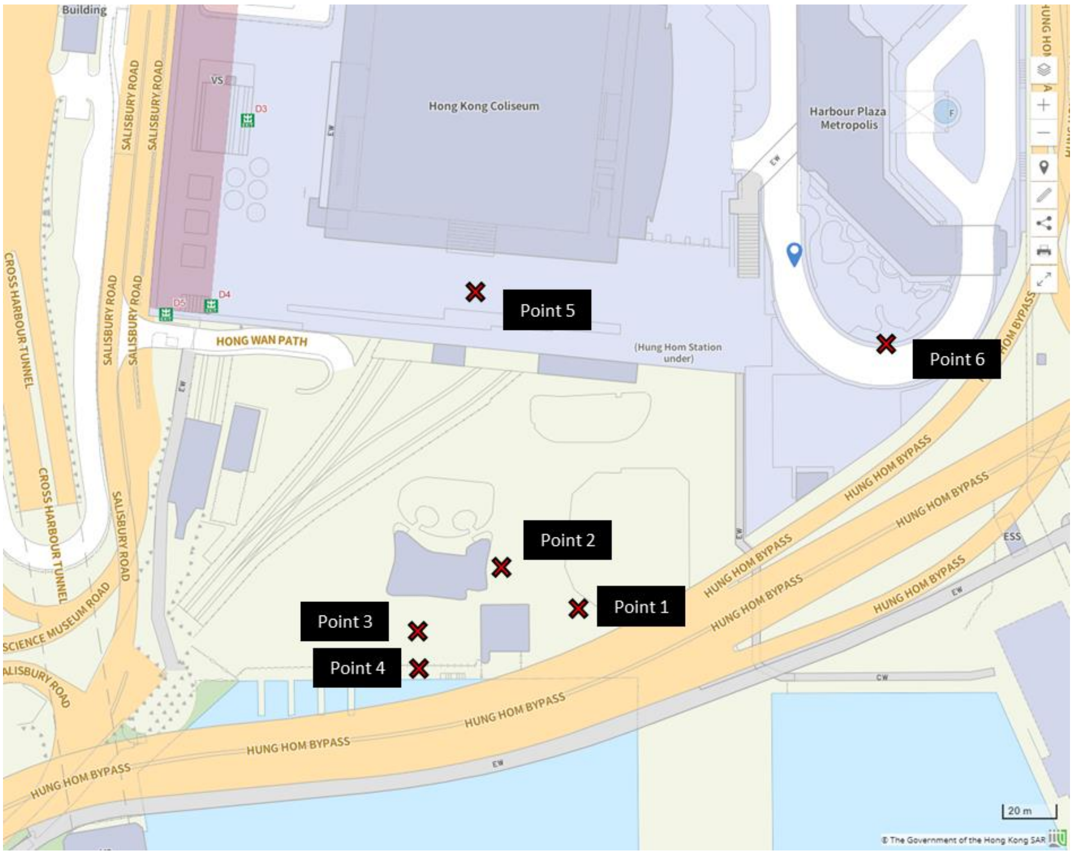


Figure 14: All test points on the map.

The six test points are divided into three test cases, located at different altitudes for on-site measurements. Test points 1 to 4 are located at 20 meters away and at ground level; test point 5 is located at 100 meters away at medium altitude, which is below antennae height; and test point 6 is located at 160 meters away at high altitude, which is almost as same as antennae height. Table 12 summarizes the features of three test cases and Figure 15 demonstrates six testing points at different altitudes.

Table 12: Features of three test cases.

Test Cases	Test Points	Features
1	1 – 4	20 meters away, ground level
2	5	100 meters away, medium altitude which is below antenna height
3	6	160 meters away, high altitude which is almost as same as antenna height

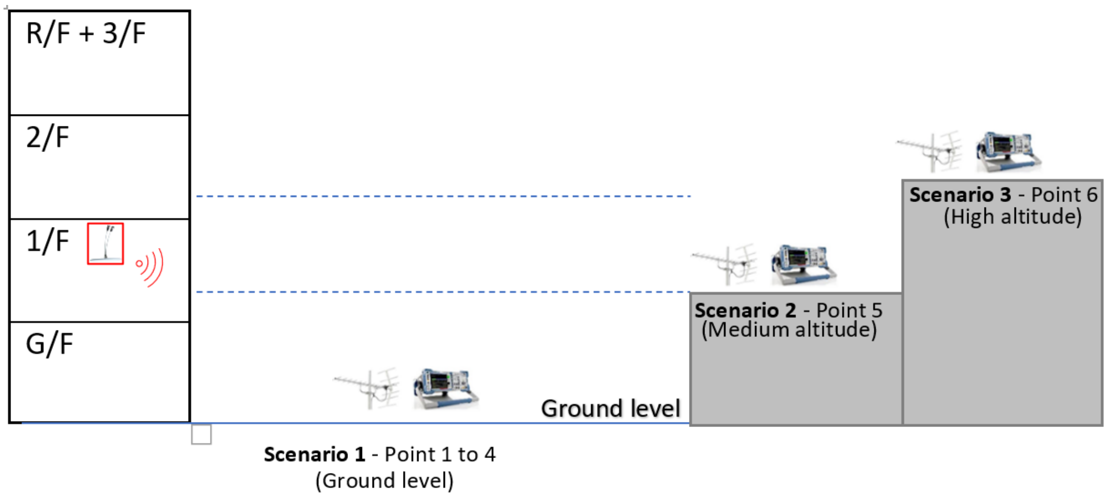
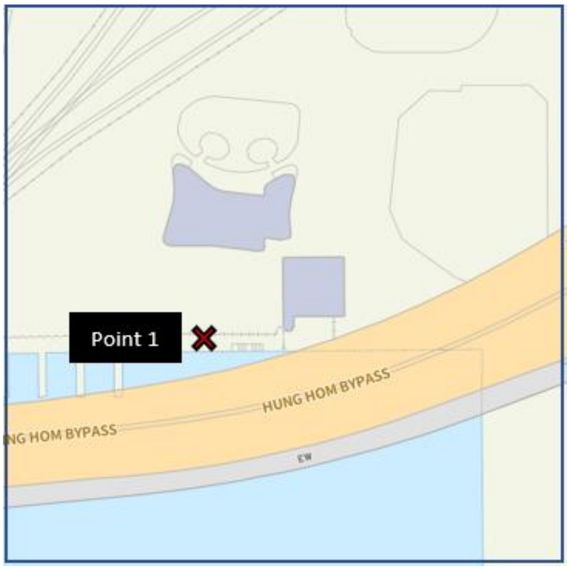
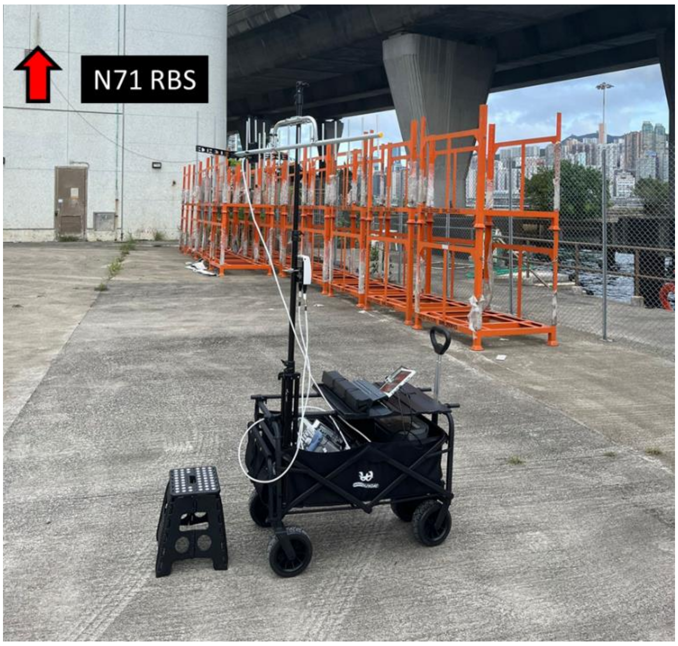


Figure 15: Six test points at different altitudes.

4.5.1 Point 1 – TV antenna pointing directly to N71 RBS (critical case)



(a)



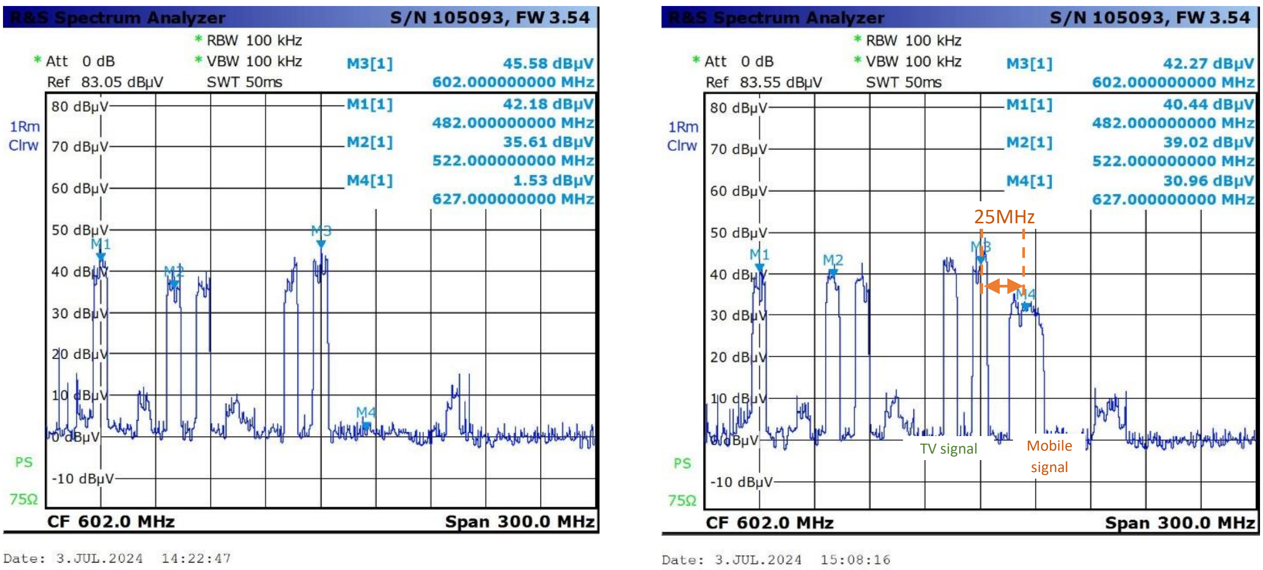
(b)

Figure 16: Location of test point 1.

Table 13: Measurement result of TV signal at point 1.

Point 1	Level (dBµV)		MER (dB)		BER		TV Quality (Grade)	
TV channel (MHz)	Off	On	Off	On	Off	On	Off	On
602	61.5	58.7	34.7	32.6	<0.01	<0.01	5	5
586	54.5	59.6	27.3	34	<0.01	<0.01	5	5
538	54.8	54.7	30.4	26.2	<0.01	<0.01	5	5
522	56.1	56.3	27.2	31.2	<0.01	<0.01	5	5
482	57.8	56.6	28	27.7	<0.01	<0.01	5	5
Added UHF Booster								
602	80.4	77.2	32.8	30.4	<0.01	<0.01	5	5
586	74.2	80.8	27.4	34.3	<0.01	<0.01	5	5
538	73.8	78.3	33.5	28.8	<0.01	<0.01	5	5
522	78.2	82.1	28.6	34.9	<0.01	<0.01	5	5
482	77.8	86.3	27.7	34.3	<0.01	<0.01	5	5

Off: N71 off-air
On: N71 on-air 33dBm E.I.R.P

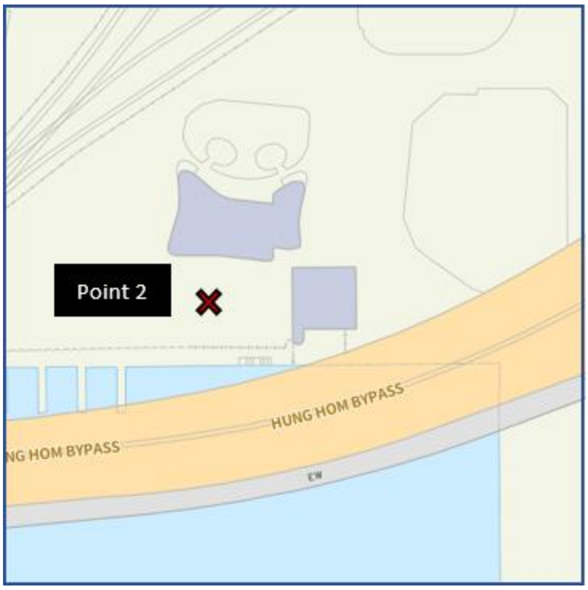


(a) N71 off-air (b) N71 on-air

Figure 17: Spectrum view of 1st scenario at test point 1.

The measurement results of 1st scenario and 2nd scenario at test point 1 are shown in Table 13. The TV quality grade at all four different frequency bands is level 5, which is the best quality of TV signals. Figure 17 shows the spectrum view of the TV signal for 1st scenario before and after 5G N71 is powered on. The reception N71 signal strength is almost the same as the reception level of TV channels. All the results indicate that 5G signal submission has no impact on TV signals.

4.5.2 Point 2 – West side of FHOB



(a)

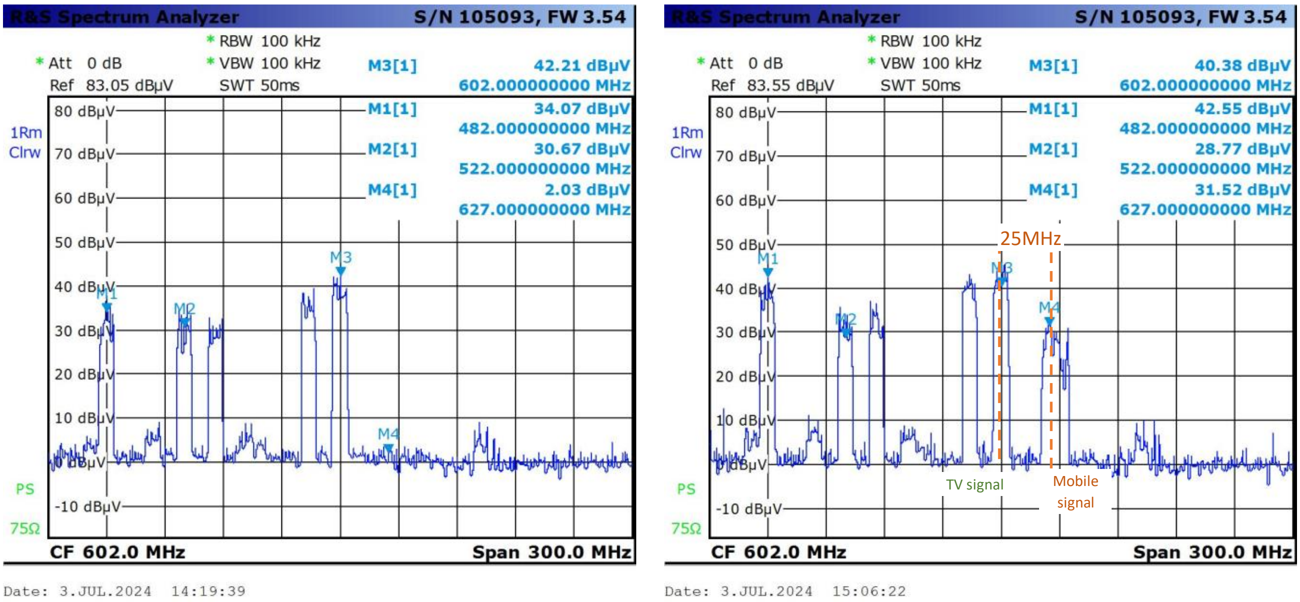
(b)

Figure 18: Location of test point 2.

Table 14: Measurement result of TV signal at point 2.

Point 2	Level (dBµV)		MER (dB)		BER		TV Quality (Grade)	
TV channel (MHz)	Off	On	Off	On	Off	On	Off	On
602	62.1	65.2	35	36.6	<0.01	<0.01	5	5
586	59.1	63.9	30.4	36.4	<0.01	<0.01	5	5
538	57.5	54.2	26.2	29.5	<0.01	<0.01	5	5
522	55.5	62.7	30.5	35.4	<0.01	<0.01	5	5
482	57.7	63.2	28.8	33.7	<0.01	<0.01	5	5
Added UHF Booster								
602	83.5	84.8	33.8	36.1	<0.01	<0.01	5	5
586	82.9	84.2	33.6	35.1	<0.01	<0.01	5	5
538	70.2	67.1	30	24.2	<0.01	<0.01	5	5
522	82.1	78.5	30.4	29	<0.01	<0.01	5	5
482	84.4	87.7	30.9	35.1	<0.01	<0.01	5	5

Off: N71 off-air
On: N71 on-air 33dBm E.I.R.P

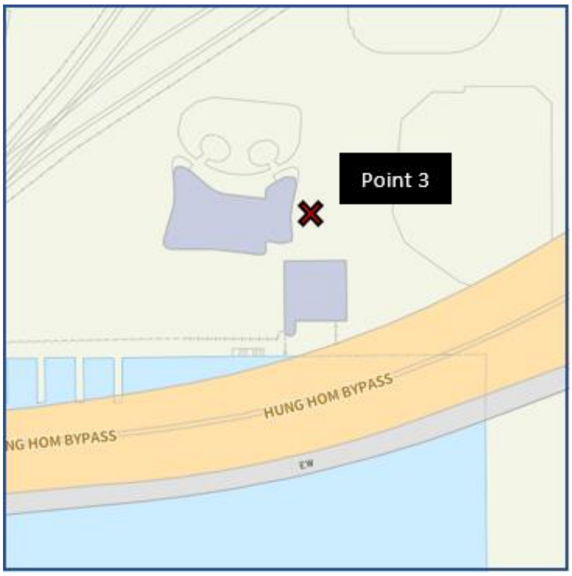


(a) N71 off-air (b) N71 on-air

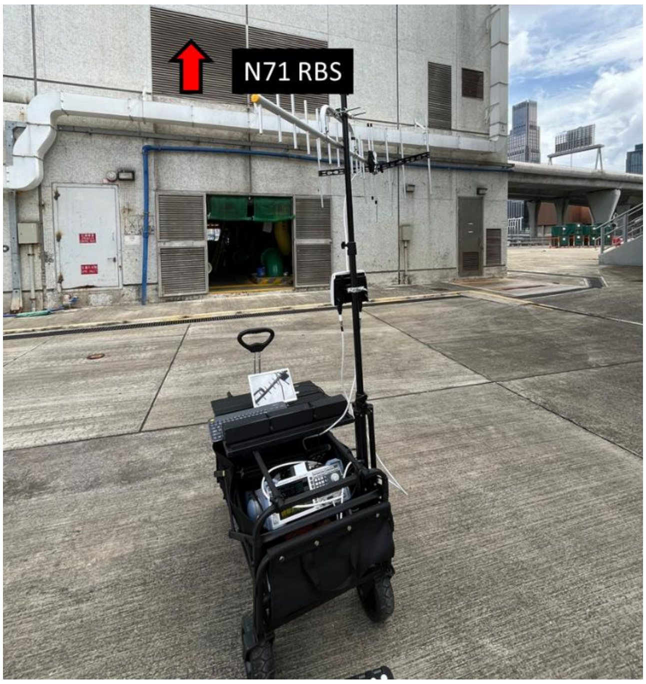
Figure 19: Spectrum view of 1st scenario at test point 2.

The measurement results of 1st scenario and 2nd scenario at test point 2 are shown in Table 14. The TV quality grade at all four different frequency bands is level 5, which is the best quality of TV signals. Figure 19 shows the spectrum view of the TV signal for 1st scenario before and after 5G N71 is powered on. The reception N71 signal strength is almost the same as the reception level of TV channels. All the results demonstrate that 5G signal submission has no impact on TV signals.

4.5.3 Point 3 – North side of FHOB



(a)



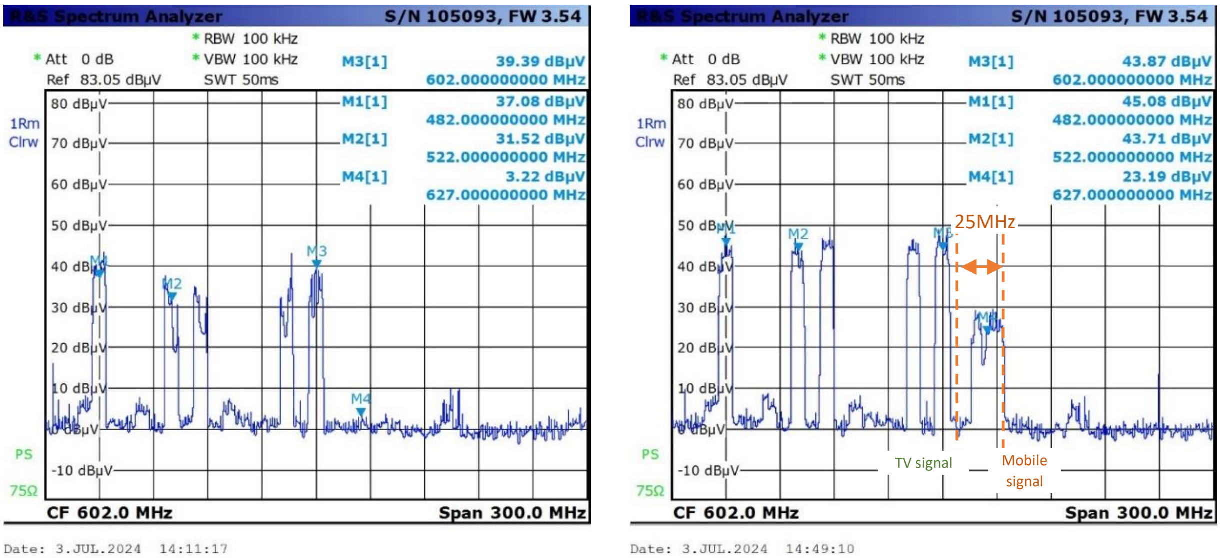
(b)

Figure 20: Location of test point 3.

Table 15: Measurement result of TV signal at point 3

Point 3	Level (dBµV)		MER (dB)		BER		TV Quality (Grade)	
TV channel (MHz)	Off	On	Off	On	Off	On	Off	On
602	52.5	57.8	26.7	31.9	<0.01	<0.01	5	5
586	52.9	60.9	26	36	<0.01	<0.01	5	5
538	49.5	62.3	25.9	36.6	<0.01	<0.01	5	5
522	56.3	57	31.9	32.7	<0.01	<0.01	5	5
482	57.3	62.8	30.8	35	<0.01	<0.01	5	5
Added UHF Booster								
602	74.9	76.4	32.3	33.9	<0.01	<0.01	5	5
586	77.9	79	24.1	37.4	<0.01	<0.01	5	5
538	77.2	76.1	35.9	29.5	<0.01	<0.01	5	5
522	77.1	79.3	30.1	36.7	<0.01	<0.01	5	5
482	86.8	78.2	36.2	29.3	<0.01	<0.01	5	5

Off: N71 off-air
On: N71 on-air 33dBm E.I.R.P

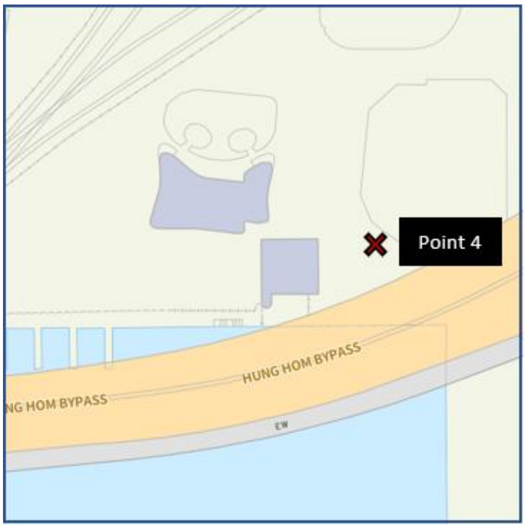


(a) N71 off-air (b) N71 on-air

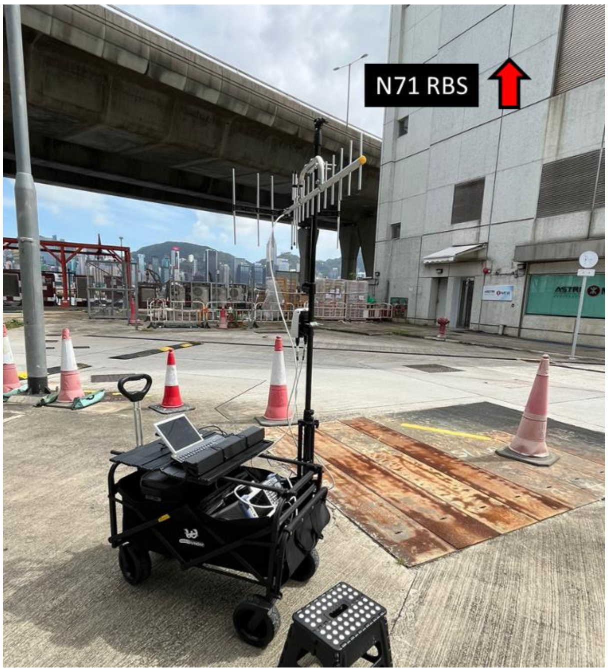
Figure 21: Spectrum view of 1st scenario at test point 3.

The measurement results of 1st scenario and 2nd scenario at test point 3 are shown in Table 15. The TV quality grade at all four different frequency bands is level 5, which is the best quality of TV signals. Figure 21 shows the spectrum view of the TV signal for 1st scenario before and after 5G N71 is powered on. The reception N71 signal strength is at least 10 dB lower than the reception level of TV channels. All the results show that 5G signal submission has no impact on TV signals.

4.5.4 Point 4 – East side of FHOB



(a)



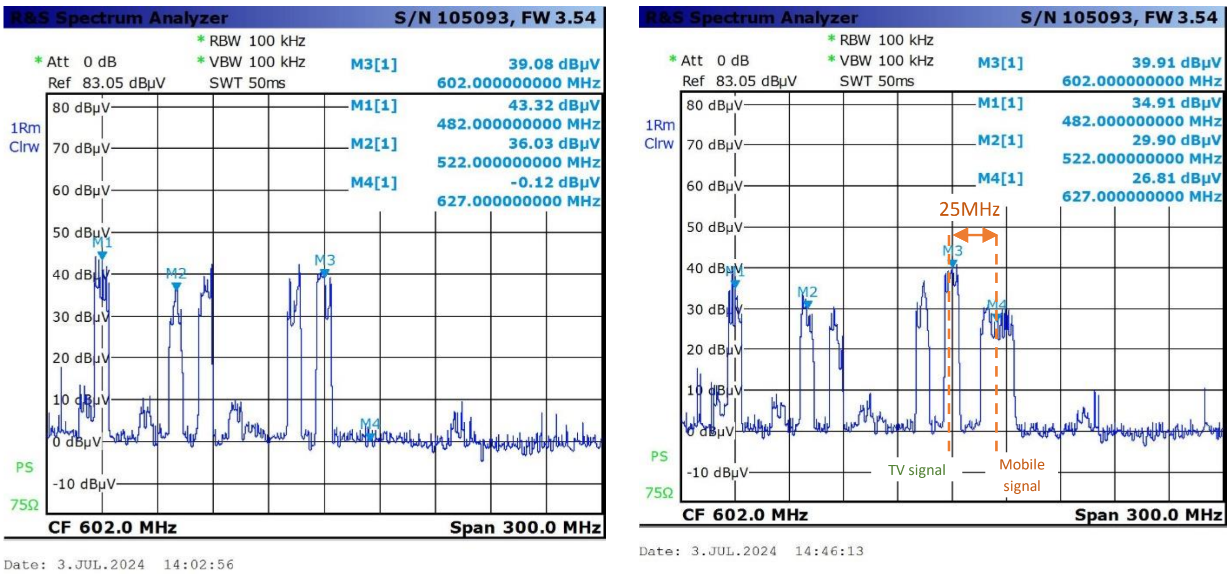
(b)

Figure 22: Location of test point 4.

Table 16: Measurement result of TV signal at point 4.

Point 4	Level (dBµV)		MER (dB)		BER		TV Quality (Grade)	
TV channel (MHz)	Off	On	Off	On	Off	On	Off	On
602	62	63.6	35.5	35.6	<0.01	<0.01	5	5
586	61	63.8	29	35.6	<0.01	<0.01	5	5
538	54.3	52.3	29.9	26.2	<0.01	<0.01	5	5
522	61.9	59.5	35.2	32	<0.01	<0.01	5	5
482	65.3	63.4	35.2	34.7	<0.01	<0.01	5	5
Added UHF Booster								
602	78.8	75.3	29	34	<0.01	<0.01	5	5
586	78.2	71.4	31.9	25.7	<0.01	<0.01	5	5
538	76.2	70.1	34	26.6	<0.01	<0.01	5	5
522	78	79.4	27.6	33.8	<0.01	<0.01	5	5
482	85.8	86.2	35.8	35.2	<0.01	<0.01	5	5

Off: N71 off-air
On: N71 on-air 33dBm E.I.R.P

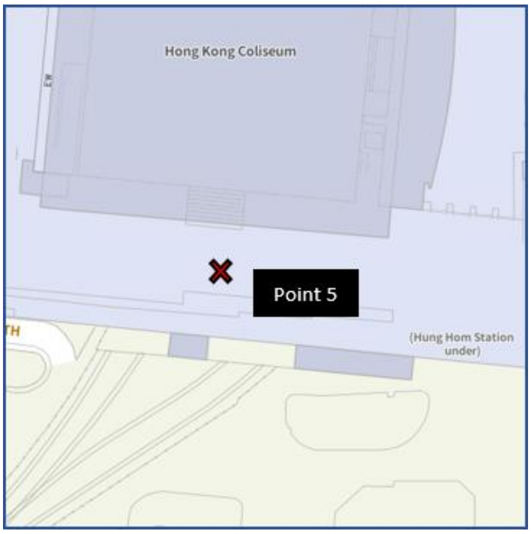


(a) N71 off-air (b) N71 on-air

Figure 23: Spectrum view of 1st scenario at test point 4.

The measurement results of 1st scenario and 2nd scenario at test point 4 are shown in Table 16. The TV quality grade at all four different frequency bands is level 5, which is the best quality of TV signals. Figure 23 shows the spectrum view of the TV signal for 1st scenario before and after 5G N71 is powered on. The reception N71 signal strength is almost the same as the reception level of TV channels. All the results indicate that 5G signal submission has no impact on TV signals.

4.5.5 Point 5 – G/F, near Hong Kong Coliseum (approximate 10 meters from N71 RBS)



(a) Point 5 at a map.

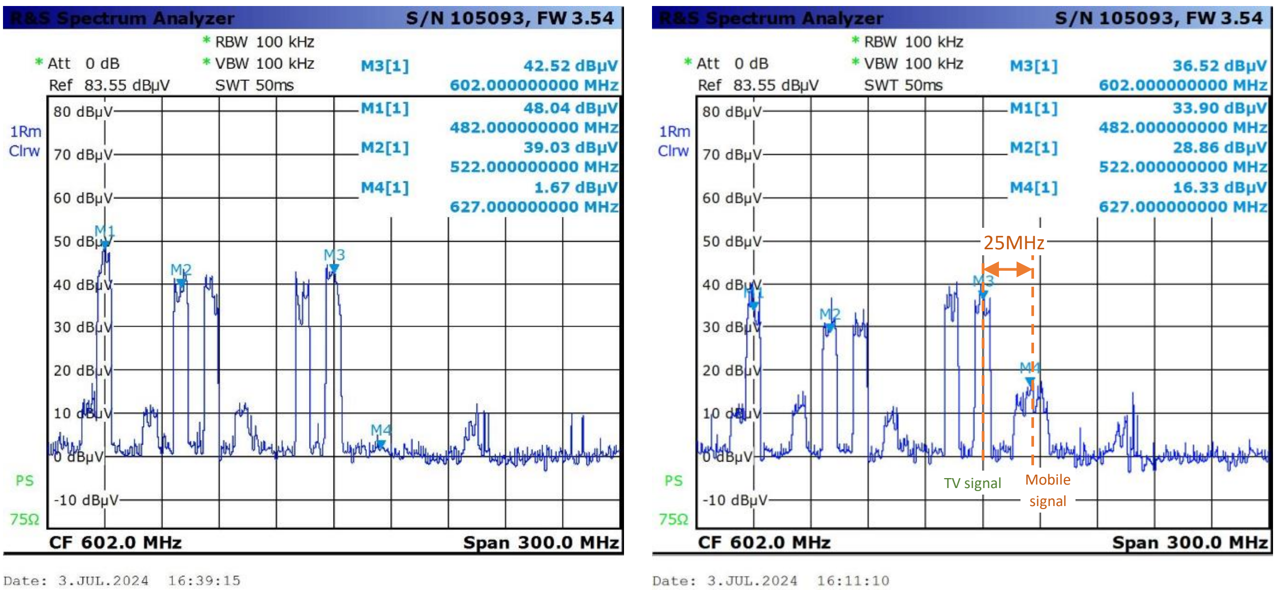
(b) Picture of point 5

Figure 24: Location of test point 5.

Table 17: Measurement result of TV signal at point 5.

Point 5	Level (dBµV)		MER (dB)		BER		TV Quality (Grade)	
TV channel (MHz)	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**
602	59.9	63.3	32.3	34.5	<0.01	<0.01	5	5
586	63	64.5	35.1	35.9	<0.01	<0.01	5	5
538	57.8	52.1	30.6	26.6	<0.01	<0.01	5	5
522	58	60.2	32.9	30.5	<0.01	<0.01	5	5
482	63.5	65.5	32.5	32	<0.01	<0.01	5	5
Added UHF Booster								
602	84.2	82.4	35.1	32	<0.01	<0.01	5	5
586	84.8	83	36.1	35.2	<0.01	<0.01	5	5
538	75.3	69.7	32.2	25.8	<0.01	<0.01	5	5
522	82.7	76	35.7	26.2	<0.01	<0.01	5	5
482	87.5	88.2	33.2	33.5	<0.01	<0.01	5	5

Off: N71 off-air
On: N71 on-air 33dBm E.I.R.P



(a) N71 off-air

(b) N71 on-air

Figure 25: Spectrum view of 1st scenario at test point 5.

The measurement results of 1st scenario and 2nd scenario at test point 5 are shown in Table 17. The TV quality grade at all four different frequency bands is level 5, which is the best quality of TV signals. Figure 25 shows the spectrum view of the TV signal for 1st scenario before and after 5G N71 is powered on. The reception N71 signal strength is at least 20 dB lower than the reception level of TV channels. All the results demonstrate that 5G signal submission has no impact on TV signals.

4.5.6 Point 6 – Harbour Plaza Metropolis (approximate 160m from N71 RBS)

(a)

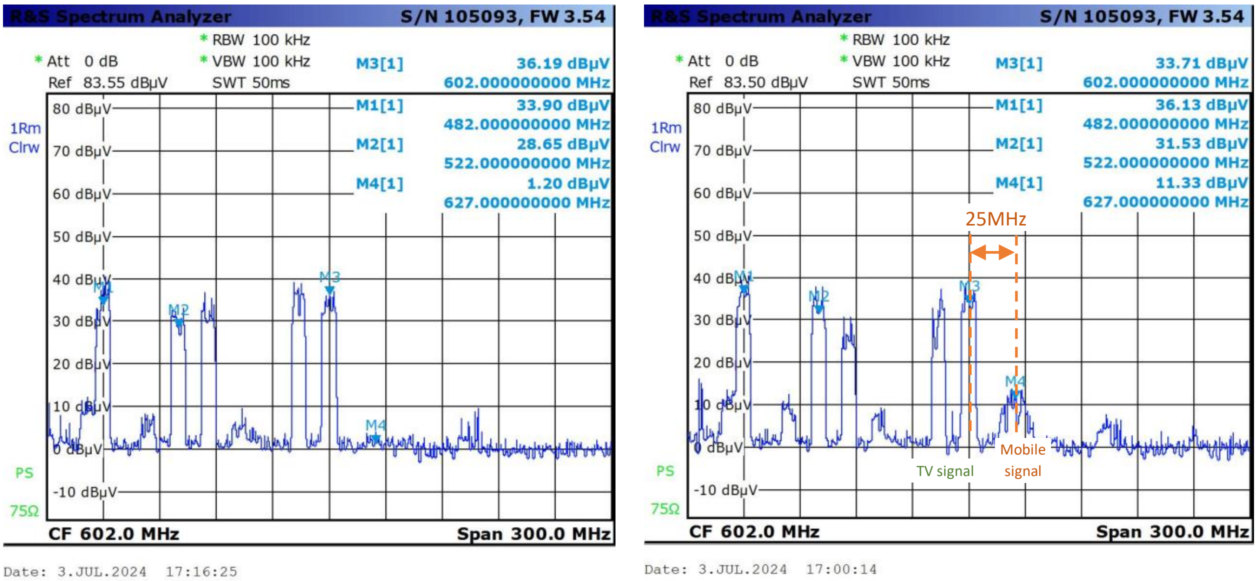
(b)

Figure 26: Location of test point 6.

Table 18: Measurement result of TV signal at point 6.

Point 6	Level (dBµV)		MER (dB)		BER		TV Quality (Grade)	
TV channel (MHz)	**Off**	**On**	**Off**	**On**	**Off**	**On**	**Off**	**On**
602	55.8	58.2	31.3	33.8	<0.01	<0.01	5	5
586	55.3	57.5	28	33	<0.01	<0.01	5	5
538	51.5	52.1	27.8	27	<0.01	<0.01	5	5
522	53.3	54.4	28.8	27.6	<0.01	<0.01	5	5
482	62.4	51.1	34	24.2	<0.01	<0.01	5	5
Added UHF Booster								
602	74.9	74.8	35	35.3	<0.01	<0.01	5	5
586	73.4	73.6	32.9	33	<0.01	<0.01	5	5
538	69.5	70.2	31.1	27.8	<0.01	<0.01	5	5
522	72.1	72.9	30.6	27.6	<0.01	<0.01	5	5
482	82.5	82.4	33.7	35.1	<0.01	<0.01	5	5

Off: N71 off-air
On: N71 on-air 33dBm E.I.R.P



(a) N71 off-air

(b) N71 on-air

Figure 27: Spectrum view of 1st scenario at test point 6.

The measurement results of 1st scenario and 2nd scenario at test point 6 are shown in Table 18. The TV quality grade at all four different frequency bands is level 5, which is the best quality of TV signals. Figure 27 shows the spectrum view of the TV signal for 1st scenario before and after 5G N71 is powered on. The reception N71 signal strength is at least 20 dB lower than the reception level of TV channels. All the results show that 5G signal submission has no impact on TV signals.

4.6 Result Summary

In order to meet regulatory requirements, on-site measurements were conducted at a total of 6 test points on the ground, mid-altitude and high-altitude areas at 20 meters, 100 meters and 160 meters away from the FHOB. At each test point, all adjacent TV channels were monitored. All on-site measurement results showed that there was no obvious difference in adjacent TV channels when the 5G signal was powered on. The study and results demonstrated that under certain conditions and through rigorous design, indoor deployment of 5G private networks using 600 MHz 5G can coexist with TV broadcasting services.

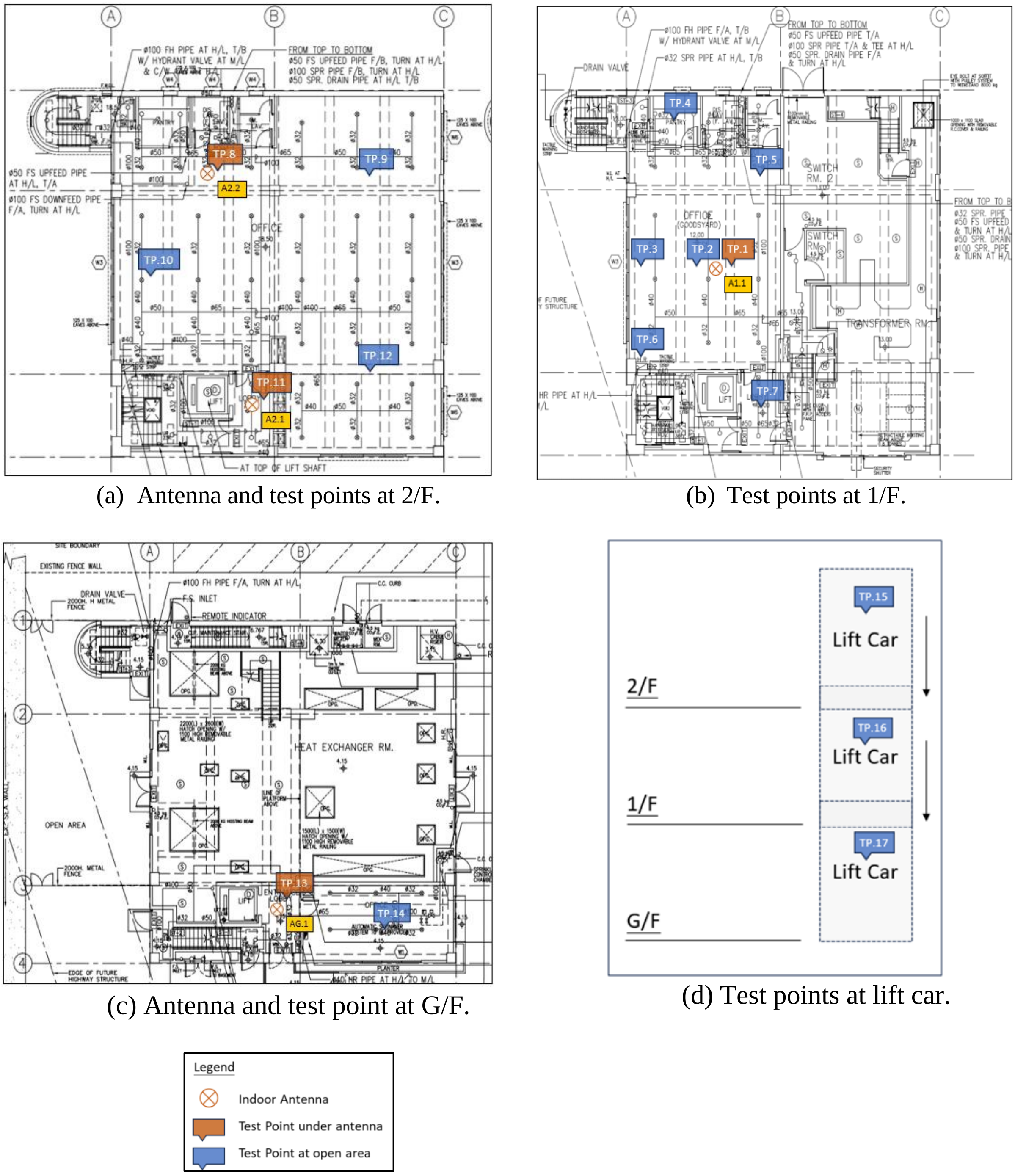
Therefore, it was concluded that transmitting 5G signals using the 600 MHz band and 2 watts of transmit power is feasible for indoor factory or warehouse applications without interfering with adjacent channel TV signals. Finally, the same interference testing method can be used at other sites.

5 NIR in Public-Accessible Areas in FHOB

Hong Kong adopts the safety limits of the International Commission on Non-Ionizing Radiation Protection (ICNIRP) as regulatory measures to monitor and control the radiation safety of 5G base stations. The use of the 600MHz band also needs to meet non-ionizing radiation (NIR) safety requirements. Therefore, NIR levels need to be measured. This section focuses on NIR evaluation in FHOB.

5.1 Location of Antenna and Test Points

The location of antenna and a total of 17 test points (i.e., TP1 ~ TP17) are chosen and are also shown in Figure 28. Specifically, Figure 29 shows the location of points TP1, TP2 and TP in the indoor environment. Figure 30 shows the sample photos for measurement setup.



(a) Antenna and test points at 2/F.

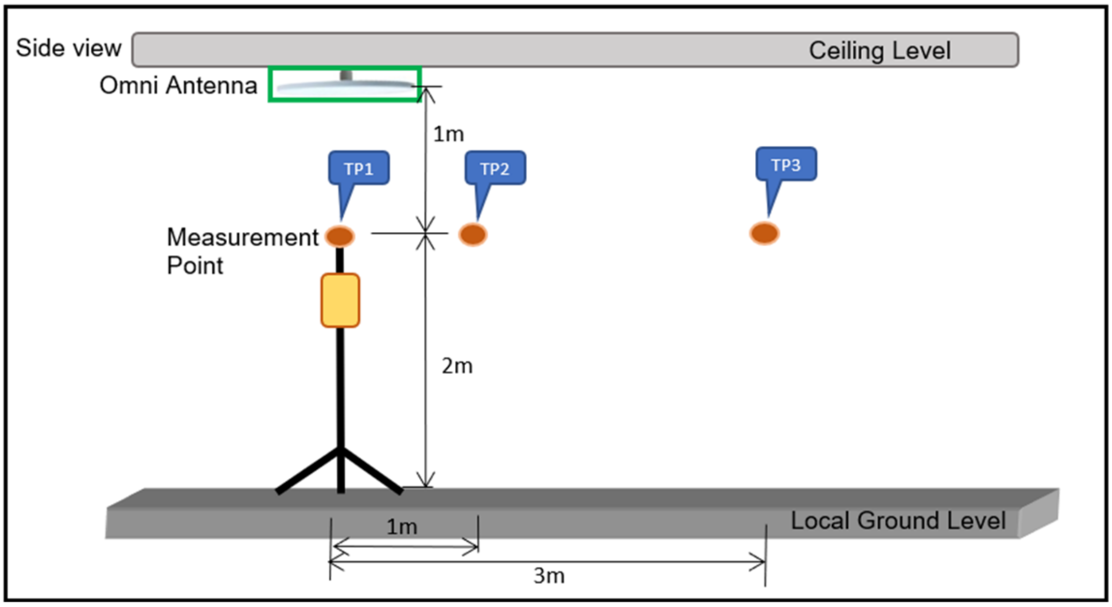
(b) Test points at 1/F.

(c) Antenna and test point at G/F.

(d) Test points at lift car.

Figure 28: Location of antenna and test points at 2/F, 1/F, G/F, and lift car.

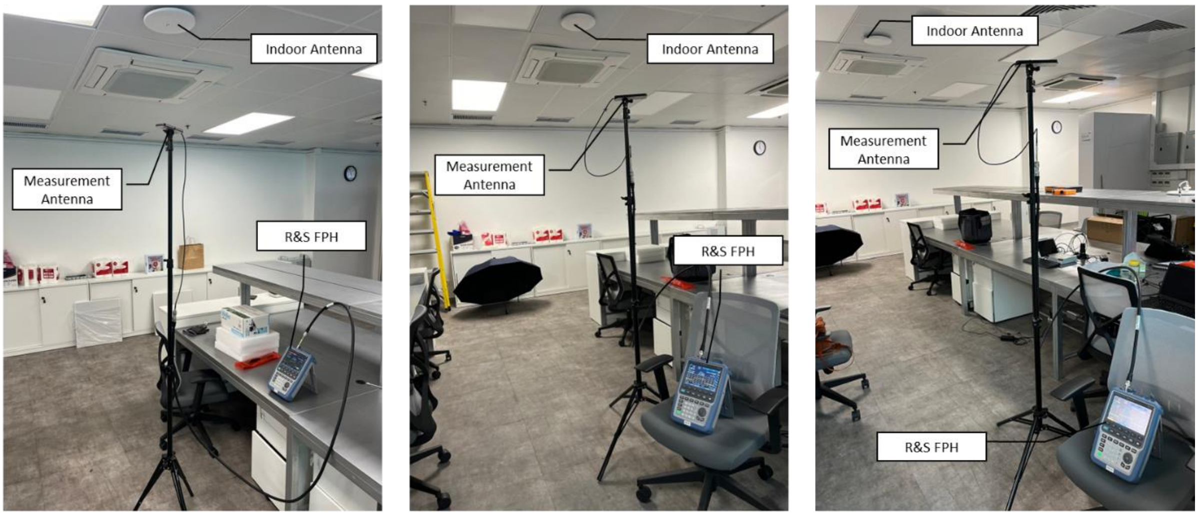
Antenna location and test point:



Remark: Refer to the OFCA "Code of Practice for the Protection of Workers and Members of Public Against Non-Ionising Radiation Hazards from Radio Transmitting Equipment", the general public exposure limits is $3135 mW/m^2$ for 627MHz

Figure 29: Test points of TP1, TP2 and TP3.

Sample photos for measurement set-up



TP1 TP2 TP3

Figure 30: Sample photos for measurement setup.

5.2 NIR Measurement Results

Broadband measurements and frequency-specific measurements are used for assessing NIR levels from 5G RBS[5]. Figure 31 shows schematic diagram for NIR measurement.

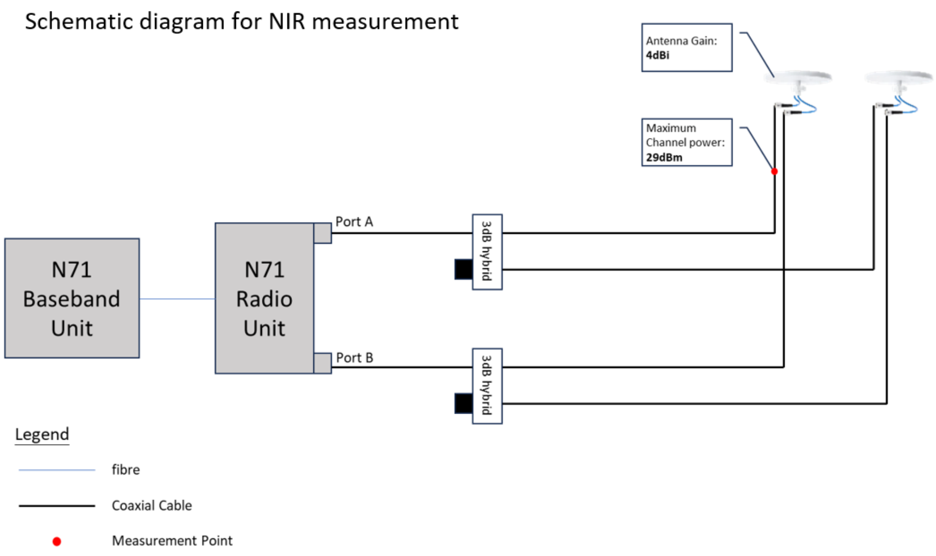


Figure 31: Schematic diagram for NIR measurement.

Broadband measurements are effective for initial verification whether NIR levels are sufficiently low. Table 19 shows the results, showing that the strongest NIR level is at TP1 (i.e., one of the test points directly under the antenna), which is about 0.952% of the ICNIRP compliance level. Some other test points, e.g., TP2 ~ TP7, TP9 ~ TP10 and TP14 ~ TP17, NIR level is below 0.04% of the ICNIRP compliance level.

Frequency-specific measurements are also adopted for determining the NIR level of specific frequency bands and from the RBSs. Table 20 shows the results, demonstrating that the strongest NIR level is at TP1 (i.e., one of the test points directly under the antenna), which is about 0.899% of the ICNIRP compliance level. Some other test points, e.g., TP2 ~ TP7, TP9 ~ TP10 and TP14 ~ TP17, NIR level

[5] Refer to report "Consultancy Report on Non-ionizing Radiation Safety of Radio Base Stations", which can be accessed by https://www.ofca.gov.hk/filemanager/ofca/common/reports/consultancy/cr_202208_02_en.pdf.

is below 0.04% of the ICNIRP compliance level. Since TP1 is located directly below the antenna, this location naturally has the highest NIR, which is still within the ICNIRP safety limits.

In summary, broadband measurements and frequency-specific measurements results show that NIR levels of using the 600 MHz frequency band (maximum transmit power of 2 watts) are within ICNIRP safety limits. Emissions from 5G RBS using the 600 MHz band do not pose an apparent hazard to human beings.

Table 19: NIR broadband measurement results.

Measurement Equipment			
Manufacturer: R&S Measurement Height: 2 meter above local ground		Model: FPH spectrum analyzer, S/N: 101142 Calibration Date: 6 Mar. 2023	
Test Point (TP)	**Channel Power (dBm)**	**Incident Power Density (mW/m2)**	**ICNIRP Compliance Level† (%)**
1	-2.65	29.8	0.95202%
2	-16.84	1.14	0.03628%
3	-26.03	0.13	0.00437%
4	-32.24	0.03	0.00105%
5	-24.73	0.18	0.00590%
6	-25.52	0.15	0.00492%
7	-28.4	0.08	0.00253%
8	-3.5	24.5	0.78279%
9	-33.95	0.02	0.00071%
10	-34.51	0.02	0.00062%
11	-2.93	28.0	0.89258%
12	-38.43	0.01	0.00025%
13	-3.2	26.3	0.83878%
14	-36.96	0.011	0.00035%
15	-47.16	0.001	0.00003%
16	-50.45	0.0005	0.00002%
17	-48.48	0.0008	0.00002%
(yellow)	Test Point directly under antenna		

† As the 627 MHz band is the lowest frequency band assigned for the provision of mobile services, the incident power density reference level corresponding to 627 MHz is adopted for the calculation of the ICNIRP compliance level, i.e., the ICNIRP compliance level is given by $\left(\frac{\text{Total Incident Power Density}}{3135\ mW/m^2}\right)(100\%)$.

Frequency-Specific Measurement Required: ■ Yes ☐ No

Table 20: NIR frequency-selective measurement results.

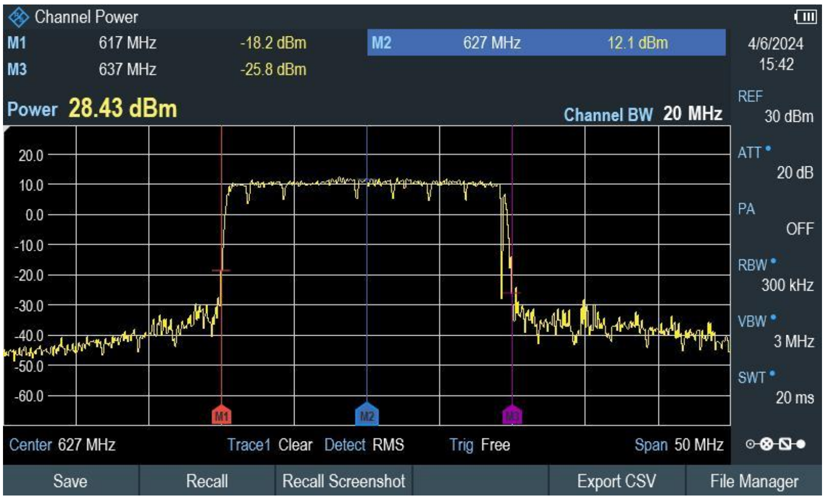
Measurement Equipment			
Manufacturer: R&S		Model: TSMA6 Network Scanner, S/N: 101661	
Measurement Height: 2 meter		Calibration Date: 15 Nov. 2022	
Test Point (TP)	**Reference Signal Received Power (dBm)**	**Incident Power Density (mW/m^2)**	**ICNIRP Compliance Level† (%)**
1	-33.94	28.21	0.89977%
2	-48.17	1.07	0.03397%
3	-53.13	0.34	0.01084%
4	-73.78	0.003	0.00009%
5	-57.3	0.13	0.00415%
6	-63.53	0.031	0.00099%
7	-67.05	0.013	0.00044%
8	-35.97	17.68	0.56381%
9	-70.96	0.006	0.00018%
10	-65.1	0.021	0.00069%
11	-35.26	20.81	0.66395%
12	-73.38	0.003	0.00010%
13	-38.92	8.96	0.28585%
14	-66.25	0.017	0.00053%
15	-83.83	0.0003	0.00001%
16	-90.62	0.00006	0.00000%
17	-87.47	0.0001	0.00000%
(yellow)	Test Point directly under antenna		

NIR Levels Are Within the ICNIRP Safety Limits: ■Yes ☐ No

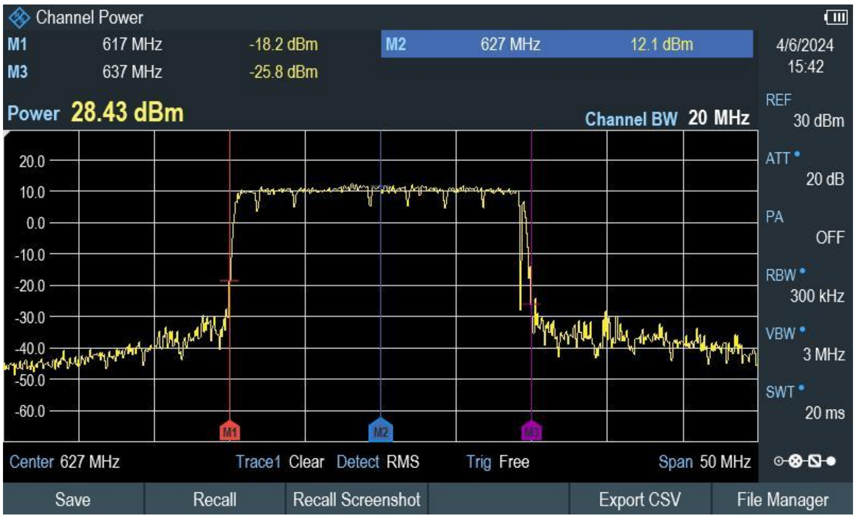
5.3 Results Verification

Figure 32 shows the spectrum view of antenna's output power, which is about 28.4 dBm. For example, for Port A, since the antenna gain is about 4 dBi, the EIRP in the air is about 32.4 dBm.

Figure 33 shows the signal measurement results at testing points TP1, TP8, TP11 and TP13, whose maximum value are all about 30~32 dBm maximum value, which are consistent with the EIRP value in the air.

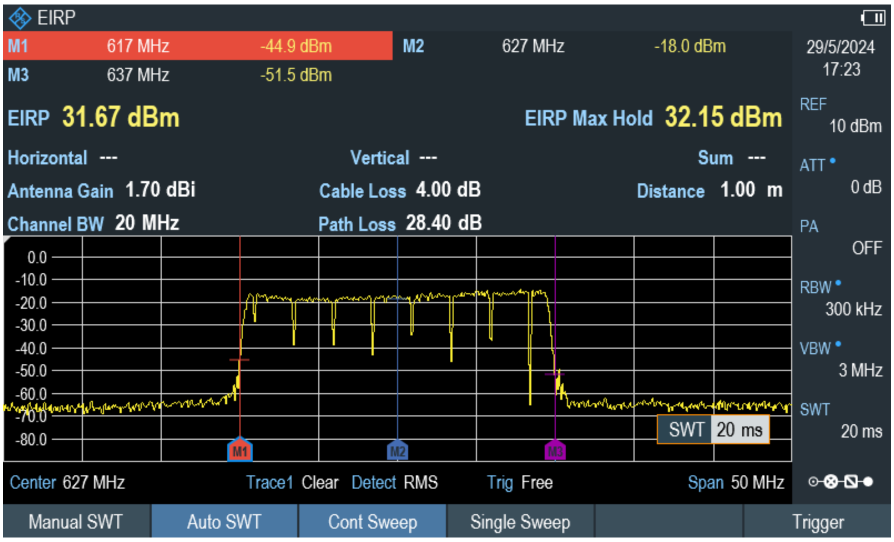


(a) Aggregated Power from Power Amplifier (dBm) at Port A
EIRP = Output power (dBm) + Antenna Gain (dBi) = 28.4 + 4 = 32.4 dBm

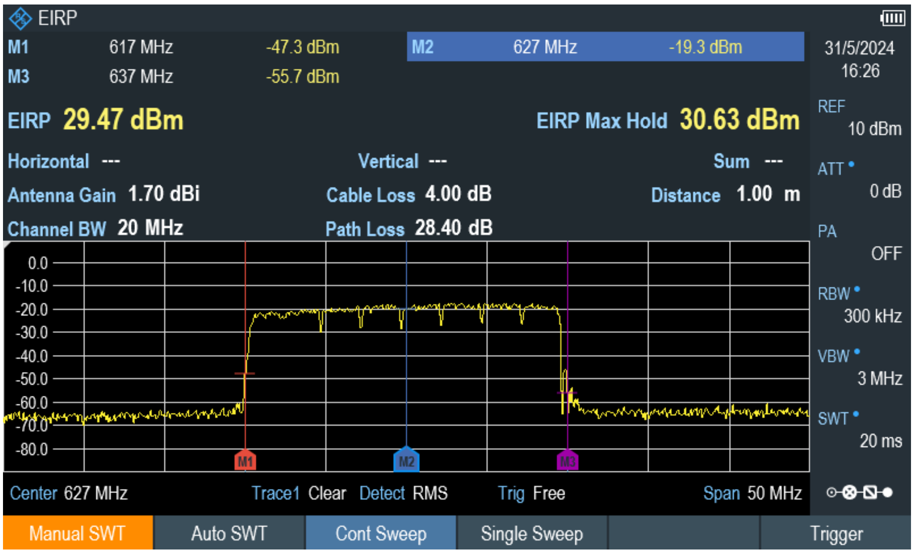


(b) Aggregated Power from Power Amplifier (dBm) at Port B
EIRP = Output power (dBm) + Antenna Gain (dBi) = 28.2 + 4 = 32.2 dBm

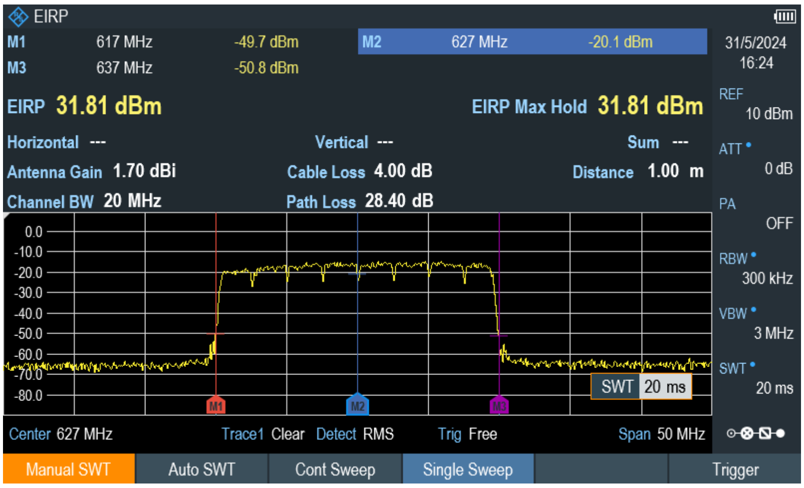
Figure 32: Spectrum view of antenna's output power.



(a) TP1 EIRP (32.15 dBm maximum)



(b) TP8 EIRP (30.63 dBm maximum)



(c) TP11 EIRP (31.81 dBm maximum)

(d) TP13 EIRP (30.89 dBm maximum)

Figure 33: Signal measurement results at TP1, TP8, TP11, and TP13.

6 Conclusion

This report provided a detailed assessment of technical issues related to 5G private network deployments using the 600 MHz frequency band which is intended for indoor use only. The potential interference on adjacent channels of TV signals was investigated. Field measurements were conducted to investigate coverage and throughput performance within FHOB, as well as TV signal quality outside FHOB when N71 5G signals are transmitted. The results provided in this technical report focused on the frequency band range of downlink 617-637 MHz. The main conclusions are described in the following paragraphs.

- When 5G mobile signal using 600 MHz band and 20 MHz bandwidth paired spectrum is transmitted in FHOB, and the antenna transmitting power is set to less than or equal to 2 Watts (i.e., 33 dBm) EIRP, a high-quality coverage and throughput performance can be achieved. At the same time, no noticeable interference was measured on adjacent TV channels outside of FHOB.

- Both broadband measurement and frequency-selective measurement were conducted to evaluate NIR in FHOB public-accessible areas. At each measurement location, both measurement results did not exceed 0.96% of the ICNIRP compliance level, showing that NIR levels are safe.

- At this stage, it is concluded that using the 600 MHz band with an antenna transmit power set to less than or equal to 2 watts (i.e., 33 dBm) EIRP is suitable and feasible for indoor factory and warehouse applications.