MALTA COMMUNICATIONS AUTHORITY

Assessment of the exposure of the general public to 5G electromagnetic waves – Part 2

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Disclaimer

The presentation of the material in this publication includes the EMF measurements as present at the time of the measurement activity.

Reference to the IEC 5G use case analysis and pending work to establish a 5G Beam Forming measurement methodology, the MCA reserves the right to change its 5G Beam Forming audit approach in the near future. Such a change shall reflect any updated measurement methodologies as published by the European Standardisation Bodies.

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Executive Summary

The first 5G network was set up in Malta in the initial months of 2021. At the time, and prior to the particular operator launching its service, the Malta Communications Authority (MCA) carried out an extensive 5G EMF measurement campaign. The outcome of this exercise was reported on the MCA's website[1].

A second 5G network was deployed in Malta towards the end of the same year. The MCA, again, meticulously, tested the performance of the network, so as to ensure EMF radiation compliance with existing international standards. A different test methodology was applied for this specific network since it adopts 'active' 5G with beam-forming.

Beam-forming boosts network performance by increasing spectral efficiency. It, however, introduces a number of complexities. The measurements carried out by the MCA, therefore, serve a two-fold purpose. They further guarantee the compliance of the actively enabled 5G mobile base stations and, consequently, they provide additional reassurance to the general public with regards to EMF exposure and health.

All measurements were conducted utilising a base station specifically set up by the operator for testing purposes. The radio equipment was equipped with a GSM, UMTS, LTE and 5GNR test sectors.

[1] https://www.mca.org.mt/sites/default/files/MCA_R_21_4441_Assessment%20of%20the%20exposure%20of%20the%20general%20public%20to%205G%20electromagnetic%20waves%20_Part%201_0.pdf

Background

As the regulator of electronic communication services, the MCA is responsible to ensure that operators abide with their obligations at law. This is also true in terms of compliance with EMF standards for the radio transmitting apparatus. In line with this, the Authority routinely carries out a variant of audits so as to warrant EMF conformity.

By design, 5G, the latest generation of mobile communications, promises a substantial increase in data rates and capacity when compared to the legacy radio access technologies. It also facilitates a more flexible platform for emerging services including massive Internet of Things (mIoT) and critical communications. Beamforming further enhances performance. Achieving such features implies the introduction of additional sophistications in the network. This, in turn, infers more rigorous testing so as to certify observance to EMF threshold limits.

In view of this, the MCA was exceptionally prudent when testing 5G with beamforming. For this purpose, a 5G testbed was established with the intent of replicating a typical rooftop installation for the operator in question. The test base-station used massive MIMO antenna arrays. These facilitate beamforming. A series of different tests were subsequently carried out to reproduce the various scenarios under which the base station may operate. All EMF exposure readings were well within the threshold limits as prescribed by law and international safety standards (ICNIRP[2] guidelines).

This exercise also served to assess the operation of a smart EMF power lock feature which the operator activated on its 5G radio access network. The EMF power lock feature is designed such that it halts transmission within a given beam once a specific power value is achieved. It therefore 'locks' the power within a given beam to a prescribed threshold value. As a result, it guarantees that no EMF overexposure occurs.

This report presents the results of the above-mentioned 5G EMF measurements. The exercise was carried out in October 2021.

[2] The International Commission on Non-Ionizing Radiation Protection (ICNIRP) is an independent organisation that provides scientific advice and guidance on the health and environmental effects of non-ionizing radiation. It endeavours to protect people and the environment from this type of exposure.
The *ICNIRP Guidelines on Limiting Exposure to Electromagnetic Fields* discusses how to protect humans exposed to radiofrequency electromagnetic fields (RF) in the range 100 kHz to 300 GHz.

Methodology

The Test Site

A test-site was specifically set up with the intent of assessing the behaviour of the base station under study. The radio test equipment was installed on the roof of the operator's building and was equipped GSM, UMTS, LTE and 5GNR test sectors. This implied that the equipment consisted of both passive and active antennae. Such a layout allowed for a controlled test environment, in the presence of legacy networks, whereby repeated measurements could be taken.

The test location was elected at a distance of **21m** from the antenna. This distance was purposely selected for a number of reasons, namely,

i) it lies on the perimeter of the compliance boundary of the test-antenna
ii) it lies within the boresight azimuth of the test antenna, thus representing the worst-case emission scenario for the set-up in question.

The antenna was elevated 8.5m from the roof top.

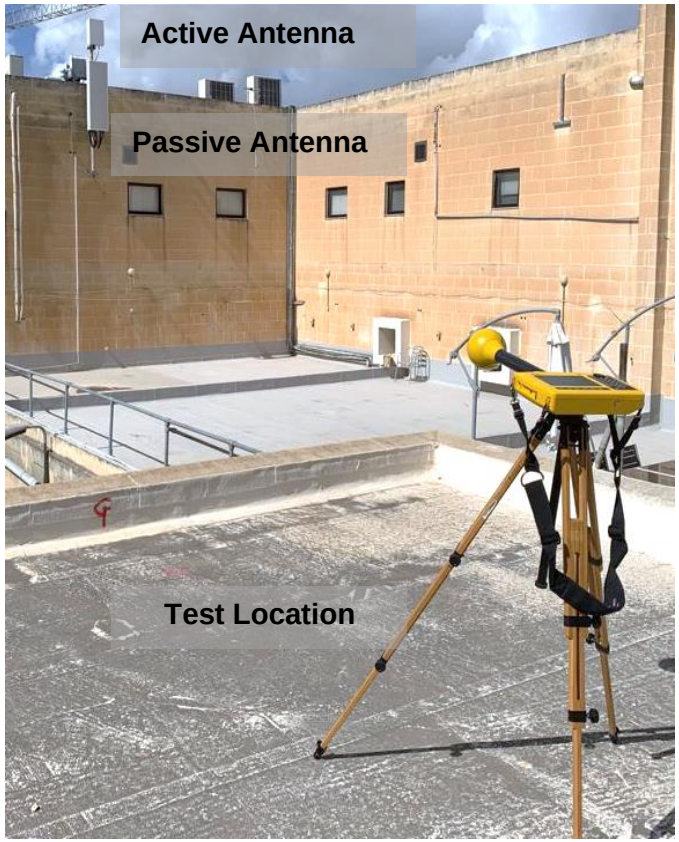

Figure 1: The Radio Test Site

Measurement method

Measurements were spread over two days and were taken during daylight hours. They were split into four phases; every phase targeting a distinct goal to achieve.

Phase A: To establish the EMF component of the 5G Synchronization Signal Block (SSB) only at the selected test location.

Phase B: To establish the EMF component of the 5G SSB and traffic beam (at maximum throughput) at the selected test location

Phase C: To conduct a full frequency selective audit at the selected test location with the 5G NR test cell operating at maximum load.

Phase D: To establish the efficacy of the smart EMF power lock feature deployed by the specific operator.

The IEC 62232 Standard[3] was adopted during the testing process.

All measurements were carried out using a NARDA SRM3006 EMF meter. The calibrated instrument was equipped with a 3-axis antenna covering the spectrum bands under consideration (Narda 3501/01 and 3502/01), The Resolution Bandwidth (RBW) was configured to 30kHz. The 5G NR antenna operated at a maximum nominal power of 200W.

Throughout the testing, a 5G NR phone (Xiomi POCO F3), equipped with an iPerf[4] UDP traffic generator, was used to create a 'full buffer' data session. The establishment of the latter ensured that

i) A beam is steered in the direction of the test location
ii) Maximum downlink transmission power is maintained by demanding a continuous UDP stream at the maximum data rate of the base station.

[3] The IEC 62232 Standard is an international standard related to the determination of the RF field strength in the vicinity of radio base stations for the purpose of evaluating human exposure
[4] iperf – https://iperf.fr

During the testing procedure, the test phone was located approximately three metres behind the measuring equipment. Such positioning further minimised the uplink contribution of the 5G NR phone to the EMF measurements,

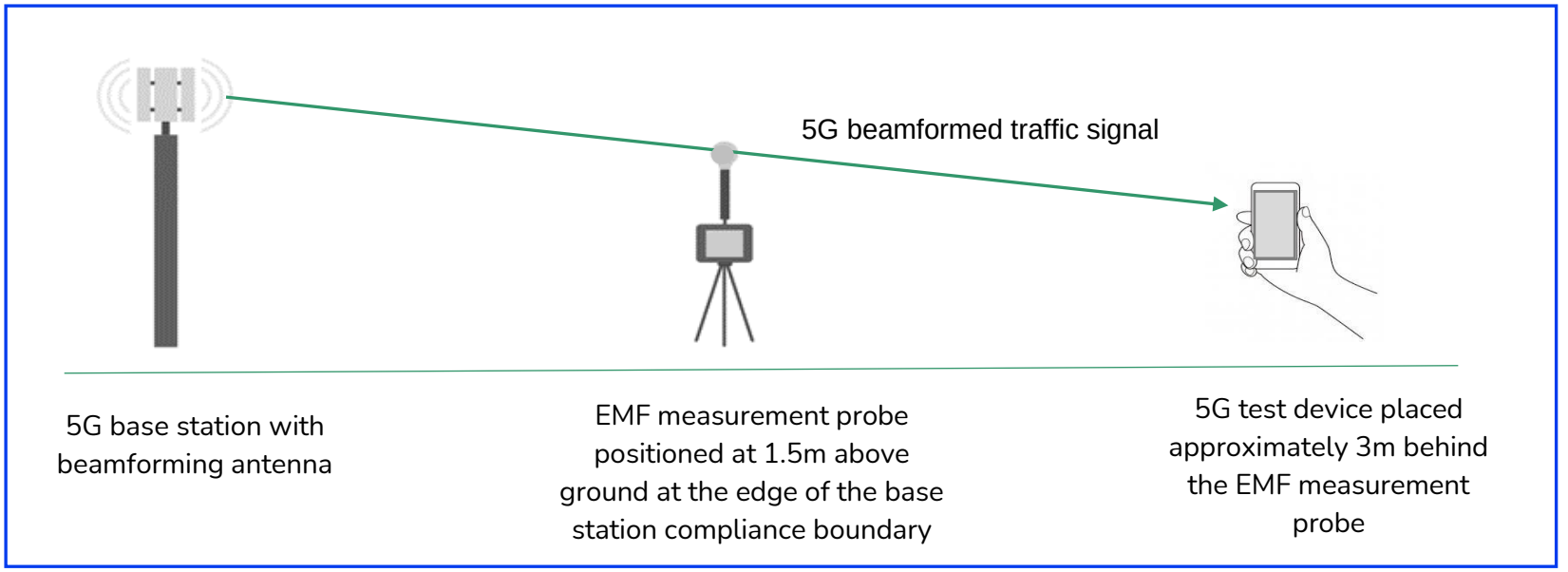

Figure 2: Positioning of the measurement probe and test terminal with respect to the 5G radio test cell

Due to the relatively immature, existing 5G beamforming EMF measurement methodologies (and the associated measurement equipment) at the time of the study, the 5G beam-forming measurements were conducted using the *Safety Evaluation Mode* setting.

Concisely, and in view of all the above, all measurements were carried out such that: -

i) All measured signals were generated within a controlled environment

ii) No other emissions were generated on the 5G NR spectrum band of interest.

iii) The measuring equipment is within the main traffic beam with the radio test cell operating at maximum transmission capability throughout the measurement activity.

Measurement Results

This section provides a summary of the EMF measurements collated during the 5G NR EMF compliance-testing exercise.

Phase A. - EMF component of the 5G Synchronization Signal Block (SSB) only

The SSB is a key element in a 5GNR signal. It is used for 5GNR cell search, selection, and reselection together with beamforming evaluation. Thus, the SSB is always broadcasted by the 5GNR cell irrespective of the load on the cell.

Measurements of the 5G SSB, in an unloaded cell scenario, were carried out on both days of testing. Multiple measurements were conducted. This repetition in measurements ascertained consistency in the tests being carried out.

Table 1 summarises the values of the average EMF component when measurements are taken in the presence of the 5G SSB signal only.

	Result dBµV/m
Safety Evaluation Mode (Average) - SSB only (Day1)	106.58
Safety Evaluation Mode (Average) - SSB only (Day2)	106.64

Table 1. EMF component based in the presence of 5G SSB only

Phase B. - EMF component of the 5G SSB and traffic beam at maximum throughput

As the power emitted by the 5GNR cell and the beamforming effect increases (a result of an increase in the traffic in the 5G NR cell), so does the EMF contribution at the specific site.

As previously stated, testing involved the simulation of a 'full buffer' data session. This situation guaranteed maximum downlink transmission power towards the 5G NR test phone present in the selected test location. Indeed, the Physical Resource Block usage was pegged at 100% throughout the whole course of resource testing.

The EMF component of the 5G SSB and traffic beam at maximum throughput, in the selected test location, was found to be at a 6-minute average of **145.59 dBµV/m**. This equates to approximately **19.5%** of ICNIRP level for the respective frequency component. (Note that the maximum instantaneous signal level was measured at 150.31 dBµV/m)

Phase C. - Full Frequency Selective audit with the 5G NR test cell operating at maximum load

The third phase of the 5G NR operation testing comprised a full frequency selective audit. The latter determined the cumulative emissions from all the technologies available on the test site at the selected test location. The audit was carried out during an ongoing 'full buffer' 5G data session.

In sum, the following conclusions may be deduced from the full frequency audit:

All the EMF components at the selected test location, and for the given test setup, are within the safe reference levels as established by the ICNIRP. The Total Exposure Quotient for the test site in question equated to a value of 0.59.

Table 2. TEQ emanating from all mobile technologies present at the test site under investigation

Phase D. - EMF component of the 5G SSB and traffic beam with the smart EMF power lock feature enabled.

A dedicated test was run to investigate the efficacy of the EMF power lock feature. The 5G NR cell was operating with an ongoing ‘full buffer’ data session during the testing. This ensured maximum downlink transmission power. Following the activation of the feature, the performance of the ‘loaded’ beam was monitored.

Throughout the process, the UDP throughput on the 5G NR test phone was recorded with and without the EMF power lock feature. This helped to evaluate the impact of the power lock feature on the Quality of the Service. Results show that the UDP throughput decreased as a result of the EMF power lock feature algorithm. This, in turn, led to a reduction in the transmission power thereby significantly lowering the 5G NR SSB and traffic beam. In this case, the reduction in the 5G NR EMF component over a 6-minute averaging time period decreased from **19.5%** to **0.4%,** yielding an overall reduction of the Total Exposure Quotient at the selected test location from **0.59** to **0.4**.

Summary of the Measurement Results

All the readings taken whilst carrying out the tests indicate that the EMF components at the selected test location are within the safe reference levels as established by ICNIRP. This is even so when considering the maximum recorded values.

The resultant average value of the 5G NR EMF component, captured during the testing, is 145.59 dBµV/m. This is equivalent to 19.5% of the ICNIRP safe reference level at the respective frequency and yields a total exposure quotient of 0.59 for the test site under consideration.

A previous study carried out by the MCA on a 5G network with no beamforming revealed that, on average, the EMF contribution from 5G signals amounted to approximately 11.5% of ICNIRP. Therefore, the aggregate sum of EMF contributions emanating from the 5G active network under review and the non-beamforming 5G network still falls short from exceeding the EMF safety levels prescribed by the ICNIRP guidelines. In fact, such levels imply sufficient margin to accommodate the EMF radiation of a third apparatus operating in 5G with beamforming or non-beamforming. This is so assuming 5G NR set up installations of the third radiation apparatus are similar to the ones adopted by the apparatus in this study or the former one. In sum, the prevailing configurations allow for the existence of, at least, three 5G NR apparatus in close proximity to each other.

The study went one step further. It also succeeded to prove the effectively and efficiency of the smart EMF power lock feature. The latter further strengthens the notion of safety. It succeeds to reduce the 5G NR EMF component, yielding a total exposure quotient of 0.4.

To conclude, the test site 5G NR base station being deployed by the operator in question is compliant with the safety levels advocated in the ICNIRP guidelines. This is so even when considering the worst-case scenario, and, with the test equipment operating both legacy and 5G NR components simultaneously,

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