24 GHz Drone Detection Radar and Speed Enforcement Cameras

Results from field testing and anechoic chamber measurements

Report

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1. Overview

In Ofcom's July 2026 Consultation on Spectrum for Drones, we proposed making additional spectrum available for drone control and drone detection radar. The growing use of drones is creating new safety and security risks, particularly where unauthorised drone activity may affect sensitive or safety critical sites. To help law enforcement agencies and other authorised users respond to these risks, we proposed to authorise the use of drone detection radars in the 24 GHz band (24.05–24.25 GHz).

The 24 GHz band in the UK is already shared by a range of users, including speed enforcement cameras, the amateur service, level crossing radar systems, automotive short-range radar and other short-range devices.

To assess whether drone detection radars could cause harmful interference to speed enforcement cameras, we undertook field testing at our measurement facility in Baldock, Hertfordshire. The testing included a range of realistic operating scenarios and was supported by the Home Office, drone detection radar providers and operators, and speed enforcement camera suppliers. Our objective was to determine whether emissions from a drone detection radar could adversely affect the performance of a speed enforcement camera when the two systems operate in close proximity.

The testing considered relatively short distances to assess potential interference under challenging coexistence conditions. In practice, drone detection radars are likely to be deployed at greater distances from speed enforcement cameras than assumed in our testing, while local terrain and clutter may provide additional isolation and further reduce the likelihood of interference. We also measured out-of-band emissions from drone detection radars to inform our assessment of coexistence with services in adjacent bands, as presented in our Consultation.

What we have found – in brief

We found that speed enforcement cameras were highly resilient to emissions from drone detection radars operating in the 24 GHz band. We observed no change in speed enforcement camera operation, even when a drone detection radar was operating at a separation distance of 50m from the camera.

Measured out-of-band emissions from drone detection radars in a semi-anechoic chamber were found to be low, at least 50 dB below the power level of the wanted transmitted signal. This provides reassurance that the likelihood of interference to services operating in adjacent bands is also low.

The findings from this testing form part of Ofcom's wider evidence base for assessing the suitability of the 24 GHz band for drone detection radars. They also inform our proposals to enable increased use of drone detection technology while ensuring continued protection of existing spectrum users.

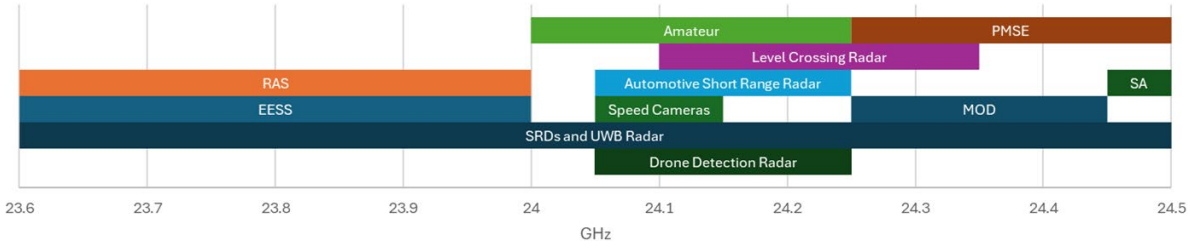
2. Introduction

The use of drones across the UK is increasing rapidly, driven by growing use in areas such as infrastructure inspection, logistics, public safety, emergency response and security. As drone activity increases, there is growing demand for technologies that can reliably detect, track and monitor drones, particularly around critical national infrastructure, sensitive sites and other locations where unauthorised drone activity may pose safety, security or operational risks.

Drone detection radars are one of the technologies increasingly being deployed to address these challenges. Ofcom has received a growing number of requests from stakeholders seeking access to spectrum to support the operation of these systems.

The 24 GHz band is already used by a range of incumbent services, including speed enforcement cameras, railway level crossing radar systems, the amateur service, short-range devices and automotive short-range radar as shown in Figure 1. Before introducing a new licensing framework for drone detection radars in this band, it is important to understand whether these systems can operate alongside existing users without causing harmful interference. To help inform our assessment, we undertook a programme of laboratory and field testing to examine coexistence between 24 GHz drone detection radar systems and a representative sample of 24 GHz speed enforcement cameras.

Figure 1: 24 GHz Band plan



Source: Ofcom

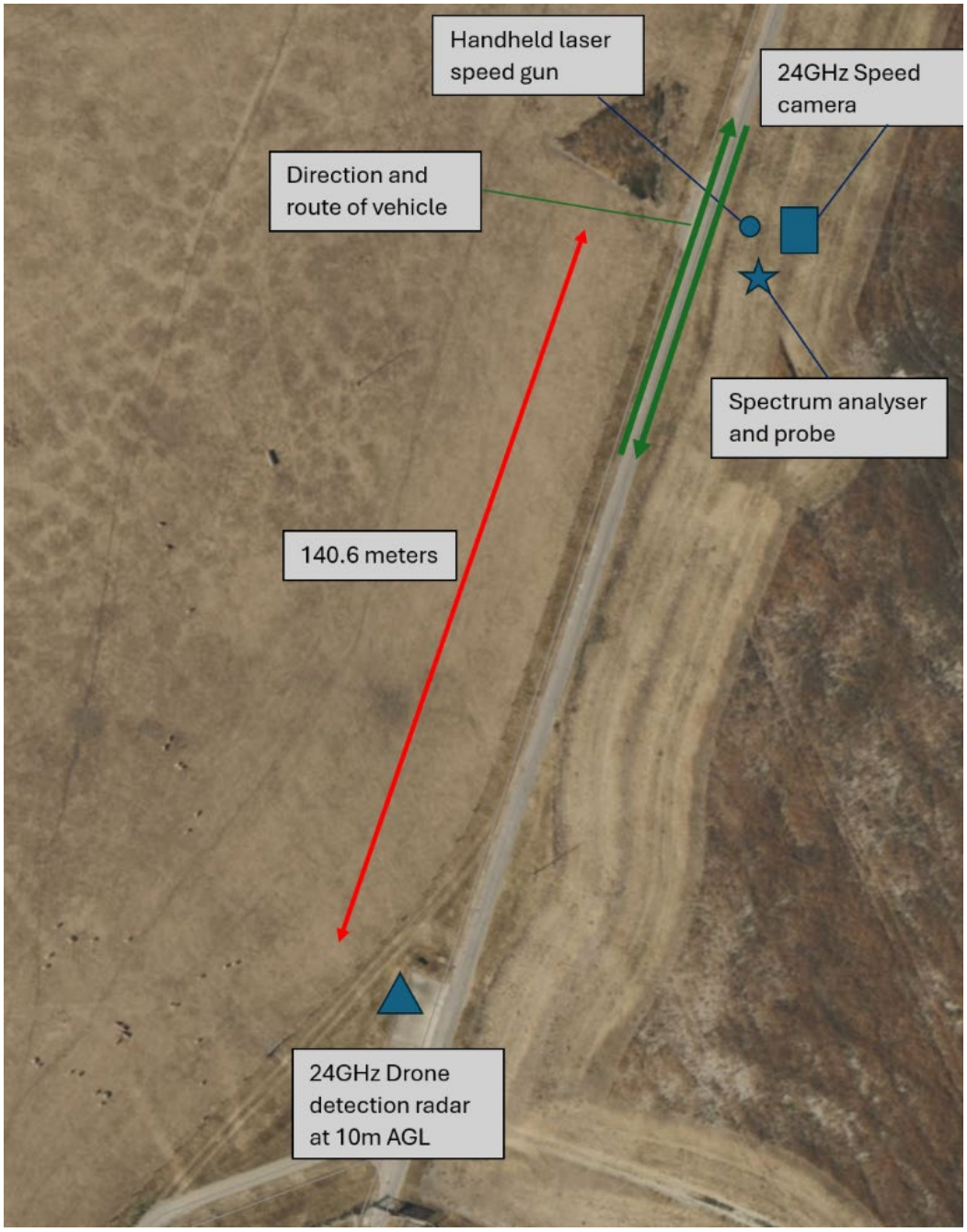
The testing was designed to provide evidence to support decisions on authorising drone detection radar in the 24 GHz band, while continuing to protect incumbent speed enforcement cameras from harmful interference. The testing examined both the emission characteristics of the radar systems and their operational coexistence with representative speed enforcement cameras under a range of realistic operating conditions, including conservative scenarios designed to represent challenging coexistence conditions.

3. Field testing

Measurement approach

The field tests took place along a straight, tarmacked single carriageway, 337m long with controlled access. Figure 2 shows the position of the 24 GHz speed enforcement camera setup as well as the initial location of the drone detection radar.

Figure 2: Initial test scenario



A speed enforcement camera was positioned approximately 2m from the roadside, mounted at 1.4m above ground level (AGL), and angled at 22.5° towards the carriageway to measure vehicle speeds. The speed enforcement camera was powered from a mobile laboratory and connected to a laptop running the associated control software. During testing, a monitoring antenna and spectrum analyser were positioned adjacent to the speed enforcement camera to verify radar operating channels, monitor received signal levels and identify any unexpected emissions or channel activity. Figure 3 (plan view) and Figure 4 (side view) show the positions of the speed enforcement camera and measurement equipment relative to the carriageway along which the test vehicle was driven.

In scenarios 1A, 1B, 2A, 2B (see Table 1), a remotely piloted UAV was also operated behind the speed enforcement camera to provide a representative target for the drone detection radar.

Figure 3 Field Test-Layout (Plan view)

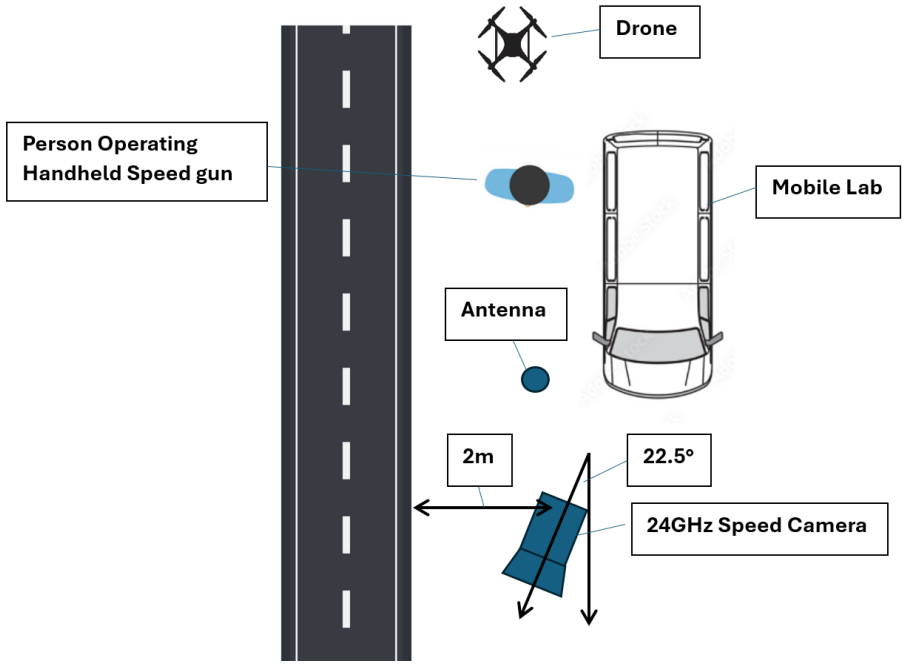
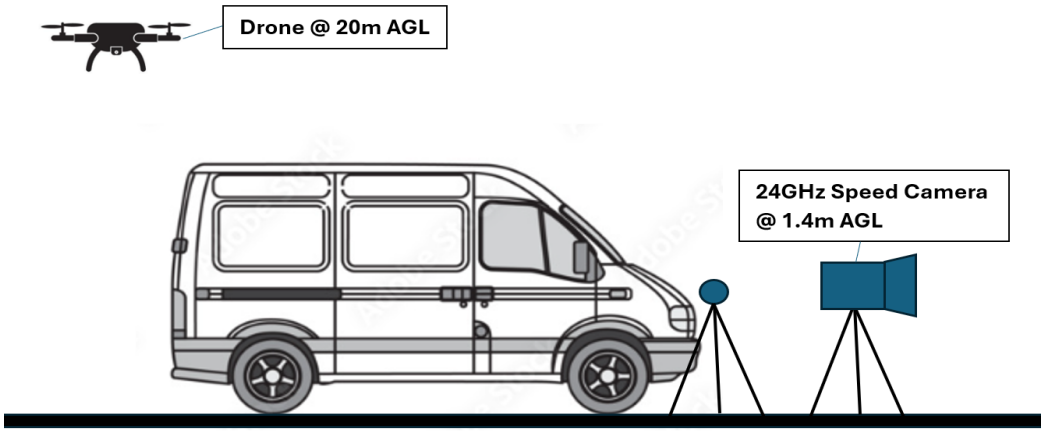


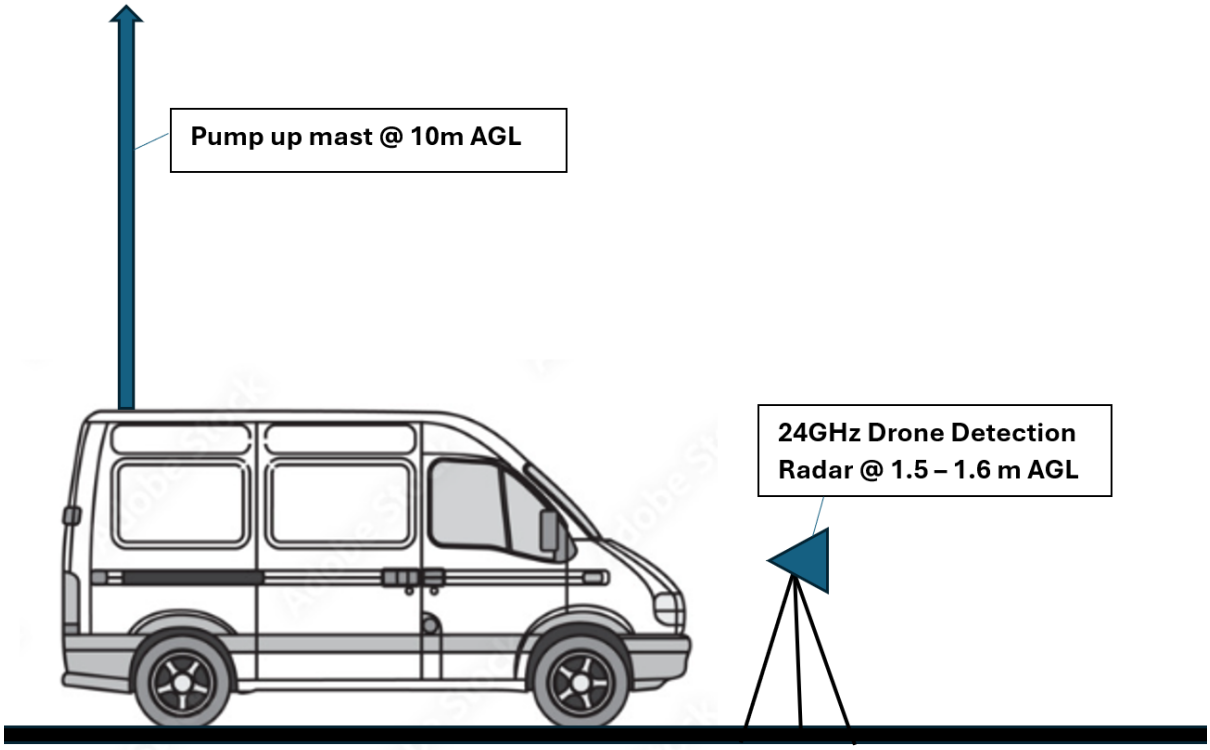
Figure 4 Field Test Layout (Side view)



Field testing was initially conducted with a drone detection radar mounted on a pump-up mast at approximately 10m AGL, as shown in Figure 5. Testing was then repeated with the drone detection radar lowered to approximately 1.5–1.6m AGL and mounted on a tripod to establish direct line-of-sight with the speed enforcement camera. The separation distance between the radar and speed enforcement camera was then reduced incrementally, first to approximately 100m and then to 50m, to assess potential interference under increasingly challenging coexistence conditions.

Testing was repeated using an alternative drone detection radar configuration and an alternative speed enforcement camera technology. The tests included single-panel and multi-panel drone detection radar configurations, and Doppler-based and Frequency Modulated Continuous Wave (FMCW) speed enforcement cameras. The multi-panel radar configuration was capable of simultaneous operation on multiple channels.

Figure 5 Line-of-sight coexistence test setup for the 24 GHz radar and speed camera.



Field test scenarios

Vehicle speeds were measured using the speed enforcement camera and independently verified using a handheld laser speed measurement device. Vehicles were driven towards and away from the speed enforcement camera at speeds between 20mph and 40mph.

Initial testing covered all three drone detection radar channels shown in Table 2. Subsequent coexistence scenarios focused on Channels 0 and 2, individually or simultaneously depending on the radar configuration.

The field-test scenarios were as follows:

- Scenario 1A: Single-panel drone detection radar mounted on a tripod with direct line-of-sight to a Doppler-based speed enforcement camera. Testing was conducted at separation distances between 140m and 50m and repeated using Channel 0 and Channel 2.
- Scenario 1B: Single-panel drone detection radar mounted on a tripod with direct line-of-sight to an FMCW speed enforcement camera at a separation distance of 50m. Testing was repeated using Channel 0 and Channel 2.
- Scenario 2A: Multi-panel drone detection radar mounted on a tripod with direct line-of-sight to a Doppler-based speed enforcement camera at separation distances of 100m and 50m. Channels 0 and 2 were tested simultaneously.
- Scenario 2B: Multi-panel drone detection radar mounted on a tripod with direct line-of-sight to an FMCW speed enforcement camera at a separation distance of 50m. Channels 0 and 2 were tested simultaneously.

Table 1: Summary of field-testing configurations.

Scenario	Radar Configuration	Radar Mounting Height	Speed Camera Type	Separation Distance(s)	Radar Channels Tested
Initial Test Configuration	Single drone detection radar	~10 m AGL (pump-up mast)	Doppler speed camera	140m	All Channels Tested
1A	Single drone detection radar	~1.5 to 1.6 m AGL (tripod)	Doppler speed camera	140m, 100m, 50m	Channel 0 Channel 2
1B	Single drone detection radar	~1.5 to 1.6 m AGL (tripod)	FMCW speed camera	50m	Channel 0 Channel 2
2A	Multi-panel drone detection radar	~1.5 to 1.6 m AGL (tripod)	Doppler speed camera	100m, 50m	Channels 0 and 2 operating simultaneously
2B	Multi-panel drone detection radar	~1.5 to 1.6 m AGL (tripod)	FMCW speed camera	50m	Channels 0 and 2 operating simultaneously

Table 2: Drone detection radar operating channels

	Operating frequency	Bandwidth
Channel 0	24.0675 – 24.1125 GHz	45 MHz
Channel 1	24.1275 – 24.1725 GHz	45 MHz
Channel 2	24.1875 – 24.2325 GHz	45 MHz

Field test results

Prior to each test run, vehicle speed was measured using both the speed enforcement camera and the handheld laser speed measurement device, with the drone detection radar switched off. These measurements provided a baseline against which measurements taken with the drone detection radar transmitting could be compared.

Table 3 shows the maximum and mean difference between speed measurements recorded by the reference laser device and speed enforcement cameras. The maximum difference observed across all test scenarios was 3 mph. A maximum difference of 3 mph was also observed during the baseline measurements with the drone detection radar switched off. The differences observed with the radar transmitting were therefore within the range observed during baseline testing, providing no evidence that operation of the drone detection radar affected the speed measurements.

Table 3 Speed reading measurement offsets between the laser gun reference and speed enforcement camera.

Scenario	Setup Details	Max difference of speed measurements between speed enforcement camera and laser gun (mph)[1]	Mean difference of speed measurements between speed enforcement camera and laser gun (mph)[2]
Baseline	Radar off	3	1.43
1A	Doppler, Single panel	3	0.79[3]
1B	FMCW, Single panel	2	1.25
2A	Doppler, multi-panel	2	1.27
2B	FMCW, multi-panel	2	1

[1] The maximum difference recorded across all tests for the respective scenarios.
[2] The mean difference recorded across all tests for the respective scenario.
[3] This value excludes an anomalous reading 90mph higher than the laser gun reading, which would increase the mean difference to 1.92mph. This result could not be replicated with further testing under the same conditions.

Across all test scenarios, **no evidence of harmful interference was observed**. Speed measurements recorded by the speed enforcement cameras remained broadly consistent with those obtained using the reference laser device. One anomalous speed reading was recorded during testing; however, the event could not be reproduced despite repeated testing under the same conditions.

The results demonstrate that both the single-panel and multi-panel 24 GHz drone detection radar systems were able to coexist with the 24 GHz speed enforcement camera systems evaluated, even under challenging operating conditions involving direct line-of-sight and separation distances as short as 50m. The testing therefore provides evidence that the drone detection radar systems evaluated can coexist with the speed enforcement cameras tested under the conditions considered, without causing observable harmful interference.

A detailed set of results can be found in the Annex A1.

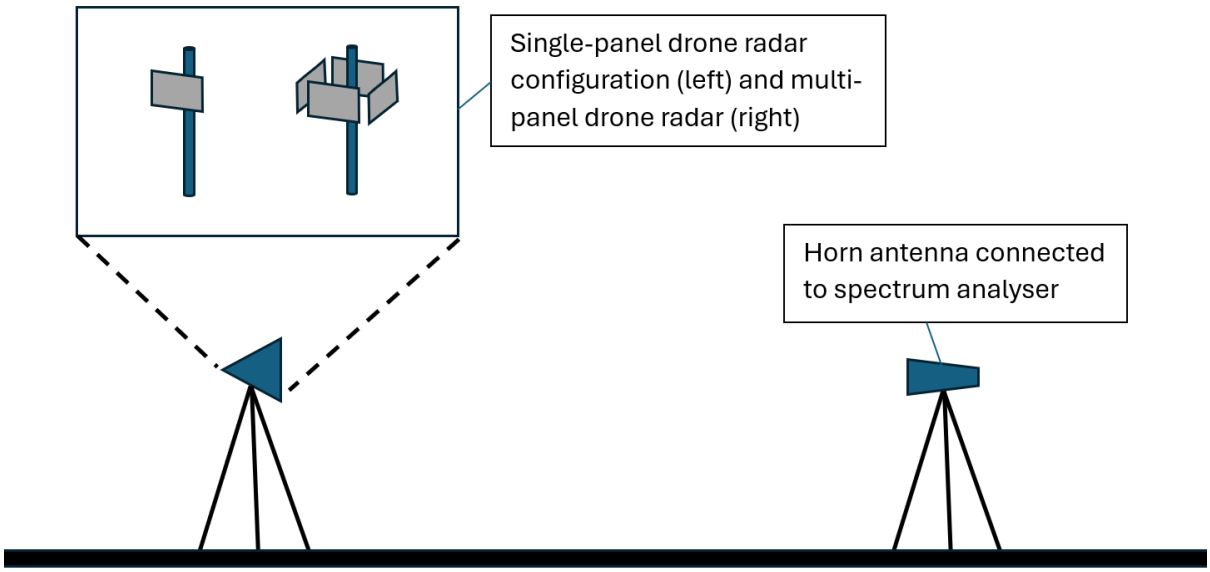
4. Unwanted emission measurements

Measurement approach

The drone detection radar systems were characterised in a semi-anechoic chamber to confirm operating frequencies, and to identify any significant unwanted emissions, including out-of-band and spurious emissions. The radar systems were mounted on a tripod, and measurements were taken using a spectrum analyser over a wide frequency range to identify harmonics and other unwanted emissions that could contribute to interference. Testing was carried out on all available channel configurations to characterise spectral performance and identify emissions outside the radar operating channels.

In addition to the single-panel radar configuration, a multi-panel drone detection radar system was assessed. Its modular design allowed different numbers of active radar panels to operate simultaneously. Measurements were therefore conducted with one, two and four panels active to investigate whether increasing the number of transmitting panels affected measured out-of-band or spurious emission levels. The semi-anechoic chamber measurement arrangement is shown in Figure 6.

Figure 6 Out-of-band emissions test setup



Measurement scenarios

The configurations used for the semi-anechoic chamber measurements are summarised in Table 4.

Table 4 Out-of-band emissions test Configurations

Configuration	Radar System	Active Radar Panels	Channel Configuration	Test Environment	Measurement Objective
A	Single-panel drone detection radar	1	All available channels tested individually	Semi-anechoic chamber	Confirm operating frequencies and characterise out-of-band and spurious emissions.
B	Multi-panel drone detection radar	1	Representative operational channel configuration(s)		Characterise the emissions from a single active panel.
C	Multi-panel drone detection radar	2	Representative operational channel configuration(s)		Determine whether increasing the number of active panels affects measured out-of-band or spurious emission levels.
D	Multi-panel drone detection radar	4	Representative operational channel configuration(s)		Assess emissions with the maximum number of radar panels active simultaneously.

The drone detection radar operates across three channels within the 24.05–24.25 GHz band, each with a bandwidth of 45 MHz. For completeness, the calculated EMF compliance distance for the radar was also considered when establishing the measurement arrangement. Based on the effective radiated power of 23.9 dBW, the calculated compliance distance is 2.9 m, as summarised in Table 5.

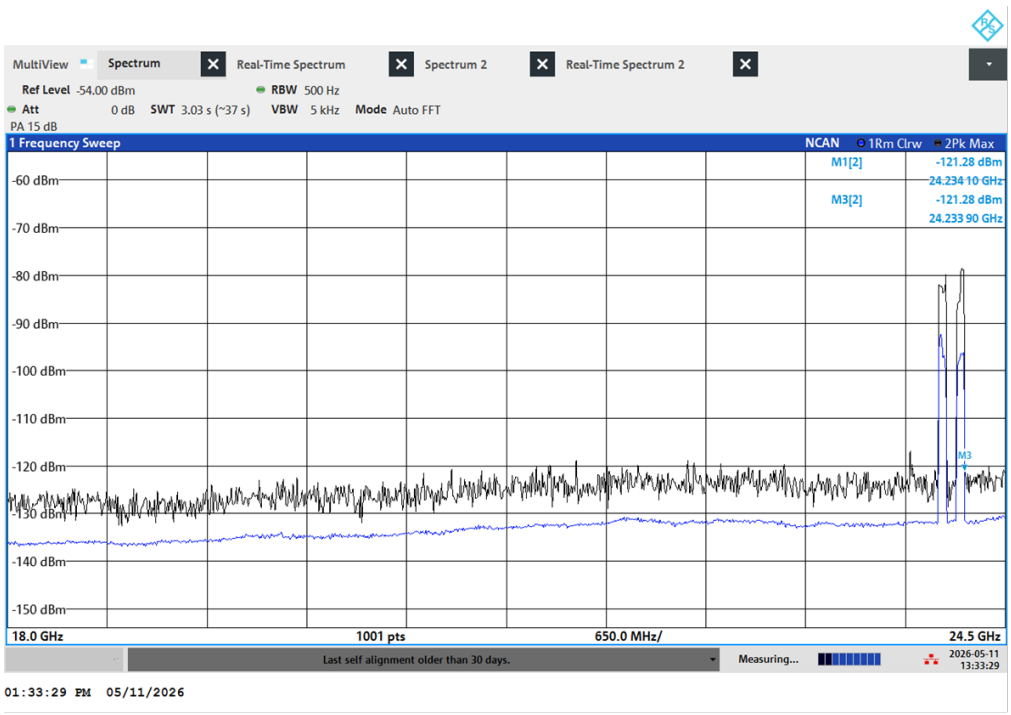
Table 5 Radar channel parameters and compliance distance.

Equipment	Channel Number	Frequency range (GHz)	Bandwidth (MHz)	Effective Radiated Power (dBW)	Calculated Compliance Distance
24GHz drone detection radar	0	24.0675 – 24.1125	45	23.9	2.9 meters
	1	24.1275 – 24.1725			
	2	24.1875 – 24.2325			

Measurement results

An example of the measured emissions for the multi-panel configuration with four radar panels active (configuration D) is shown in Figure 7. Results for other measurement configurations are provided in Figure 8 to Figure 23 in Annex A2.

Figure 7: Measured emissions from multi-panel radar for the frequency range 18–24.5 GHz



The measurements showed a generally clean spectral profile, with out-of-band emissions at substantially lower levels than the wanted radar transmissions. There was no evidence that increasing the number of active radar panels significantly affected the unwanted emission levels.

Measurements conducted in the semi-anechoic chamber and during field testing showed that out-of-band emissions from the drone detection radar systems were typically more than 50 dB below the main transmitted signal. Measurements with multiple radar panels operating simultaneously showed little change in the unwanted emission characteristics, providing no evidence of a significant increase in out-of-band or spurious emissions as the number of active panels increased.

A1 Results of field tests

Detailed test results from Scenario 1A (Single panel Radar, Doppler Camera)

Distance between drone radar and speed camera (m)	Drone flying	Drone radar height (m)	Drone radar channel	Car speedo meter (mph)	Speed of vehicle [radar] (mph)	Speed of vehicle [laser] (mph)	Direction from speed camera	Pass?
140.6	No	10	0	30	28	29	Away	
140.6	No	10	0	40	38	37	Towards	
140.6	No	10	0	40	38	38	Away	
140.6	No	10	0	20	18	18	Towards	
140.6	No	10	1	20	18	18	Away	
140.6	No	10	1	20	18	17	Towards	
140.6	No	10	1	30	28	28	Away	
140.6	No	10	1	30	28	28	Towards	
140.6	No	10	1	40	38	37	Away	
140.6	No	10	1	40	38	38	Towards	
140.6	No	10	2	20	18	18	Away	
140.6	No	10	2	20	18	18	Towards	
140.6	No	10	2	30	29	28	Away	
140.6	No	10	2	30	28	28	Towards	
140.6	No	10	2	40	39	38	Away	
140.6	No	10	2	40	38	37	Towards	
133.9	No	1.5	0	20	18	18	Away	
133.9	No	1.5	0	20	18	18	Towards	
133.9	No	1.5	0	30	28	28	Away	
133.9	No	1.5	0	30	28	28	Towards	
133.9	No	1.5	0	40	39	37	Away	
133.9	No	1.5	0	40	38	37	Towards	
133.9	No	1.5	2	20	19	18	Away	
133.9	No	1.5	2	20	18	18	Towards	

133.9	No	1.5	2	30	28	28	Away	
133.9	No	1.5	2	30	28	28	Towards	
133.9	No	1.5	2	40	38	38	Away	
133.9	No	1.5	2	40	38	37	Towards	
103.5	No	1.5	0	20	19	18	Away	
103.5	No	1.5	0	20	18	18	Towards	
103.5	No	1.5	0	30	28	28	Away	
103.5	No	1.5	0	30	28	27	Towards	
103.5	No	1.5	0	40	38	37	Away	
103.5	No	1.5	0	40	38	37	Towards	
103.5	No	1.5	2	20	19	18	Away	
103.5	No	1.5	2	20	18	18	Towards	
103.5	No	1.5	2	30	29	27	Away	
103.5	No	1.5	2	30	28	28	Towards	
103.5	No	1.5	2	40	38	37	Away	
103.5	No	1.5	2	40	38	37	Towards	
50	No	1.5	0	20	18	18	Away	
50	No	1.5	0	20	18	18	Towards	
50	No	1.5	0	30	28	28	Away	
50	No	1.5	0	30	29	28	Towards	
50	No	1.5	2	20	18	18	Away	
50	No	1.5	2	20	18	18	Towards	
50	No	1.5	2	30	28	28	Away	
50	No	1.5	2	30	28	28	Towards	

Distance (m)	Drone flying?	Radar On?	Drone radar channel	Car speedometer (mph)	Speed of vehicle [radar] (mph)	Speed of vehicle [laser] (mph)	Direction from speed camera	Pass?
100	Yes	No	N/A	20	19	N/A	Towards	
	Yes	No	N/A	20	19	16	Away	
	Yes	No	N/A	20	19	17	Towards	
	Yes	No	N/A	20	19	18	Away	
	Yes	Yes	0	20	19	19	Towards	
	Yes	Yes	0	20	19	17	Away	

	Yes	Yes	0	20	19	18	Towards	
	Yes	Yes	0	20	19	18	Away	
	Yes	Yes	0	40	39	38	Towards	
	Yes	Yes	0	40	38	36	Away	
	Yes	Yes	0	40	39	37	Towards	
	Yes	Yes	0	40	39	38	Away	
	No	Yes	2	20	19	18	Towards	
	No	Yes	2	20	18	18	Away	
	No	Yes	2	20	19	18	Towards	
	No	Yes	2	20	19	18	Away	
	No	Yes	2	40	39	37	Towards	
	No	Yes	2	40	39	38	Away	
	No	Yes	2	40	39	37	Towards	
	Yes	Yes	2	40	40	39	Away	
50	Yes	Yes	2	20	19	18	Towards	
	Yes	Yes	2	20	18	18	Away	
	Yes	Yes	2	40	40	37	Towards	
	Yes	Yes	2	40	39	38	Away	
	Yes	Yes	0	20	19	18	Towards	
	Yes	Yes	0	20	19	18	Away	
	Yes	Yes	0	40	38	37	Towards	
	Yes	Yes	0	40	128	38	Away	
	Yes	Yes	0	40	39	37	Towards	
	Yes	Yes	0	40	39	37	Away	
	Yes	Yes	0	40	39	37	Towards	
	Yes	Yes	0	40	39	38	Away	

Detailed test results from Scenario 1B (Single panel Radar, FMCW Camera)

Distance (m)	Drone flying?	Radar On?	Drone radar channel	Car speedometer (mph)	Speed of vehicle [radar] (mph)	Speed of vehicle [laser] (mph)	Direction from speed camera	Pass?
50	No	Yes	0	20	19	18	Towards	
	No	Yes	0	20	N/A	18	Away	
	No	Yes	0	20	19	18	Towards	
	No	Yes	0	20	N/A	18	Away	
	No	No	N/A	20	19	18	Towards	
	No	No	N/A	20	19	18	Away	
	No	No	N/A	20	19	18	Towards	
	No	No	N/A	20	19	18	Away	
	No	Yes	0	20	19	18	Towards	
	No	Yes	0	20	19	18	Away	

	No	Yes	0	40	39	37	Towards	
	No	Yes	0	40	39	38	Away	
	No	Yes	0	40	39	37	Towards	
	No	Yes	0	40	39	38	Away	
	No	Yes	2	20	19	18	Towards	
	No	Yes	2	20	19	18	Away	
	No	Yes	2	20	19	18	Towards	
	No	Yes	2	20	19	18	Away	
	No	Yes	2	40	39	37	Towards	
	No	Yes	2	40	39	38	Away	
	No	Yes	2	40	39	37	Towards	
	No	Yes	2	40	39	37	Away	

Detailed test results from Scenario 2A (Multi-panel Radar, FMCW Camera)

Distance (m)	Drone flying?	Radar On?	Drone radar channel	Car speedometer (mph)	Speed of vehicle [radar] (mph)	Speed of vehicle [laser] (mph)	Direction from speed camera	Pass?
100	No	Yes	0+2	20	19	18	Towards	
	Yes	Yes	0+2	20	19	N/A	Away	
	Yes	Yes	0+2	20	19	19	Towards	
	Yes	Yes	0+2	20	19	18	Away	
	Yes	Yes	0+2	40	39	37	Towards	
	Yes	Yes	0+2	40	39	37	Away	
	Yes	Yes	0+2	40	39	37	Towards	
	Yes	Yes	0+2	40	39	37	Away	
50	Yes	Yes	0+2	20	19	18	Towards	
	Yes	Yes	0+2	20	19	18	Away	
	Yes	Yes	0+2	20	19	18	Towards	
	Yes	Yes	0+2	20	19	18	Away	
	Yes	Yes	0+2	40	39	37	Towards	
	Yes	Yes	0+2	40	37	37	Away	
	Yes	Yes	0+2	40	39	37	Towards	
	Yes	Yes	0+2	40	39	38	Away	

Detailed test results from Scenario 2B (Multi-panel Radar, FMCW Camera)

Distance (m)	Drone flying?	Radar On?	Drone radar channel	Car speedometer (mph)	Speed of vehicle [radar] (mph)	Speed of vehicle [laser] (mph)	Direction from speed camera	Pass?
50	Yes	Yes	0+2	20	18	18	Towards	
	Yes	Yes	0+2	20	18	18	Away	
	Yes	Yes	0+2	20	18	18	Towards	
	Yes	Yes	0+2	20	19	18	Away	
	Yes	Yes	0+2	40	39	37	Towards	
	Yes	Yes	0+2	40	39	37	Away	
	Yes	Yes	0+2	40	39	37	Towards	
	Yes	Yes	0+2	40	38	37	Away	

A2 Results of unwanted emission measurements

Field test measurements

Figure 8: Radiated measurement of emissions during field testing for Scenario 1A, using channels 0 and 2 (50m separation distance)

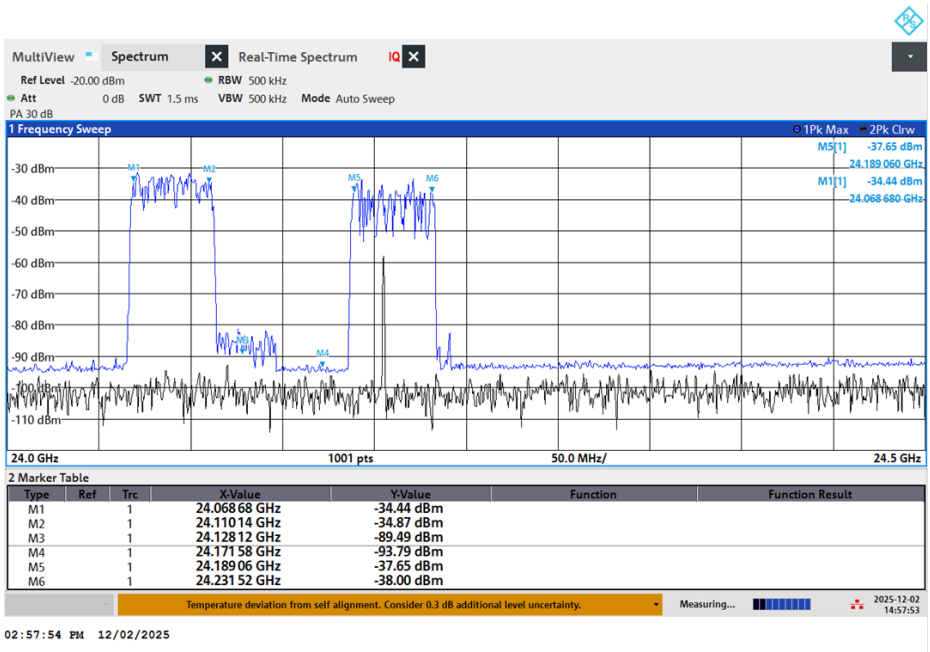
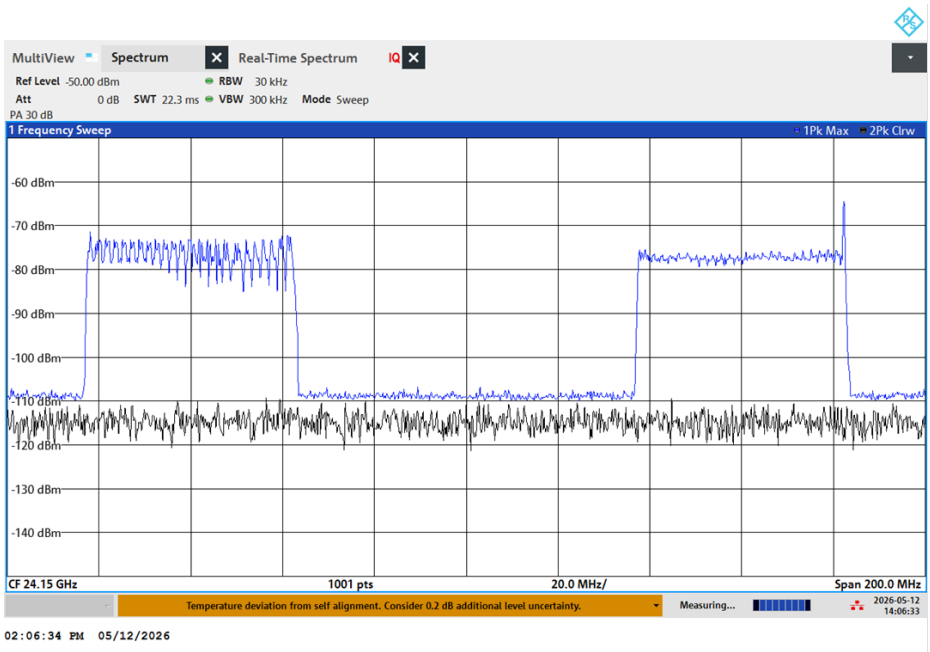


Figure 9: Radiated measurement of emissions during field testing for Scenario 2B, using channels 0 and 2 (50m separation distance)



Semi-anechoic chamber measurements

Figure 10: Emissions from single-panel radar using channel 0, horizontal polarization

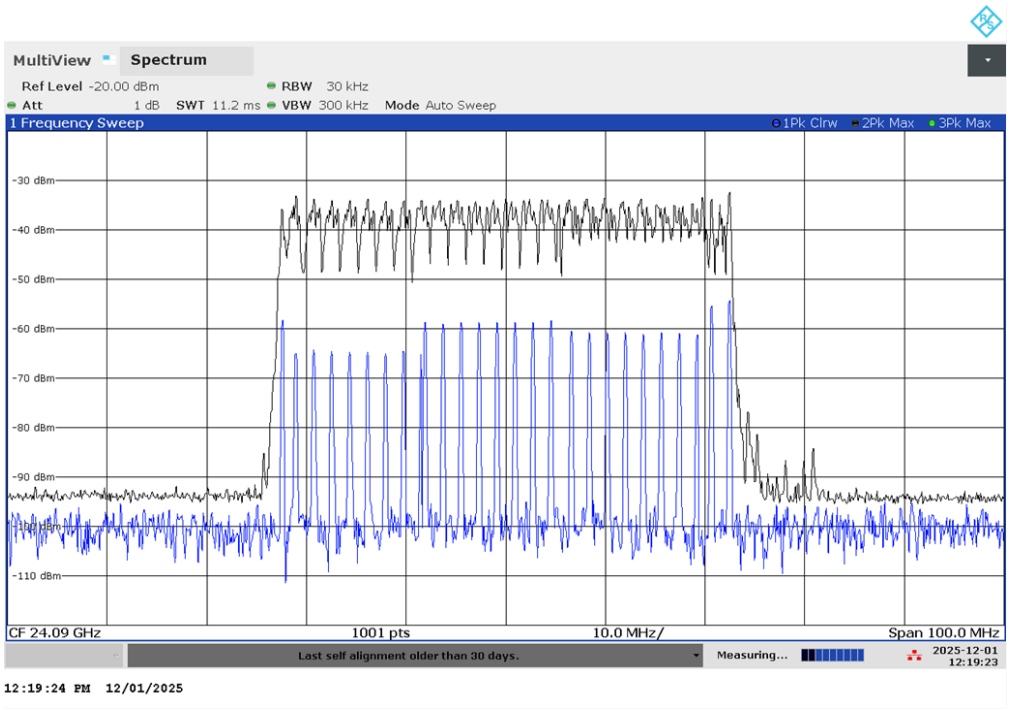


Figure 11: Emissions from single-panel radar using channel 0, vertical polarization

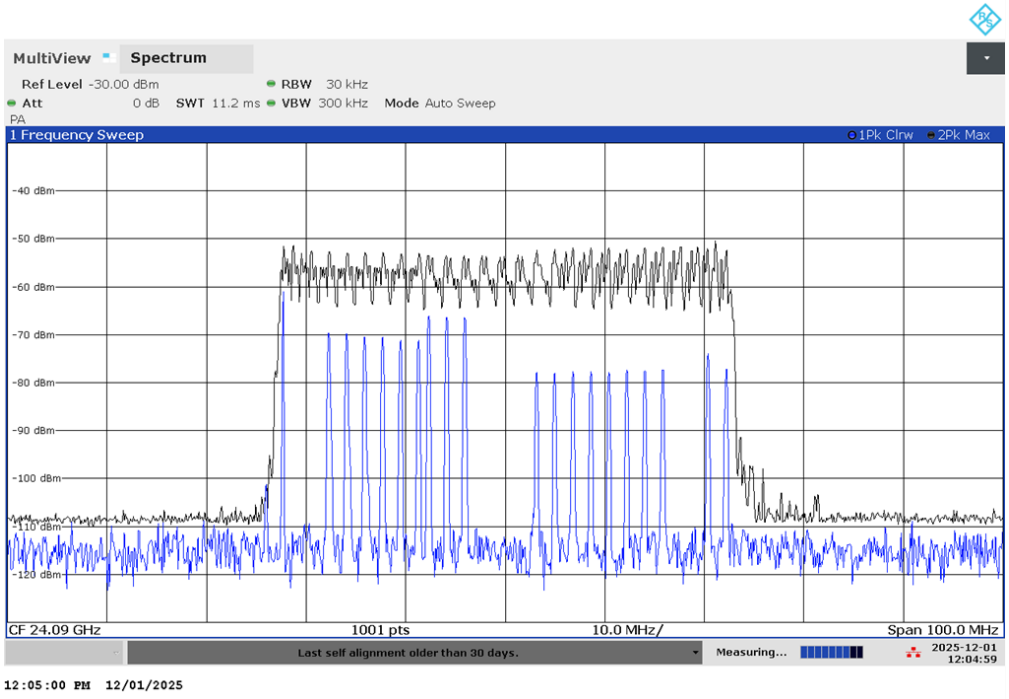


Figure 12: Emissions from single-panel radar using channel 1, horizontal polarization

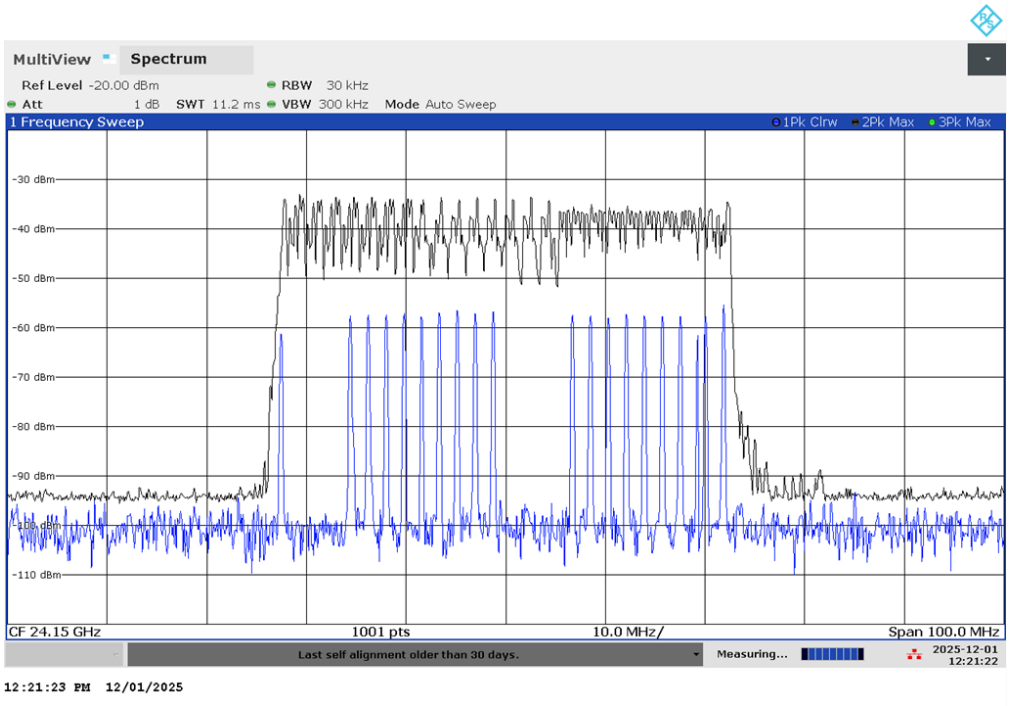


Figure 13: Emissions from single-panel radar using channel 1, vertical polarization

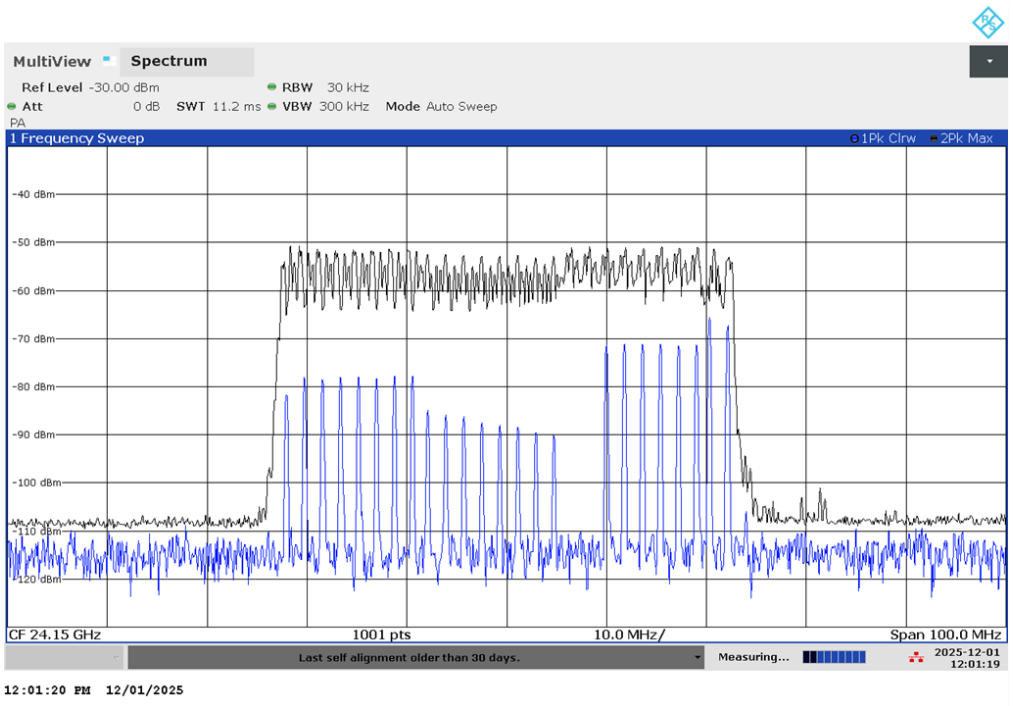


Figure 14: Emissions from single-panel radar using channel 2, horizontal polarization

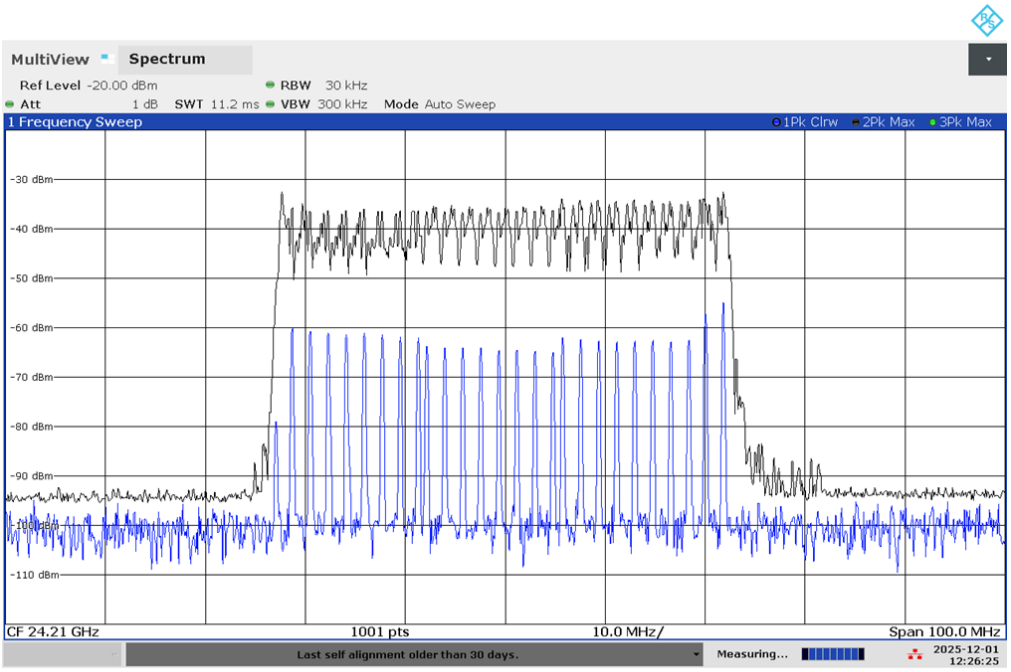


Figure 15: Emissions from single-panel radar using channel 2, vertical polarization

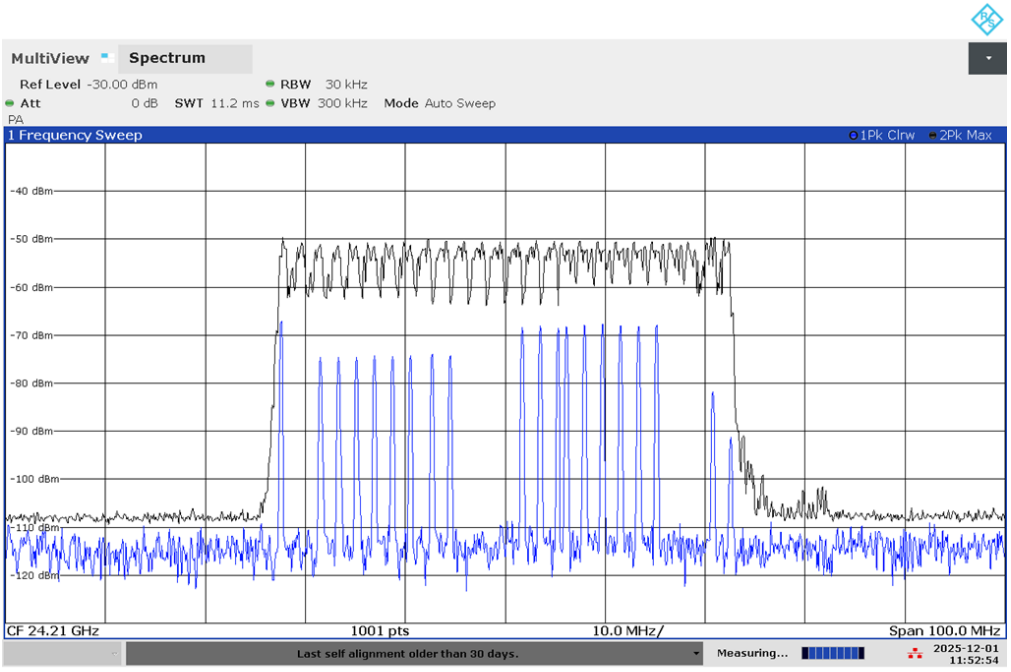


Figure 16: Emissions from multi-panel radar, showing a frequency sweep across 18-24.5GHz, with 2 panels active

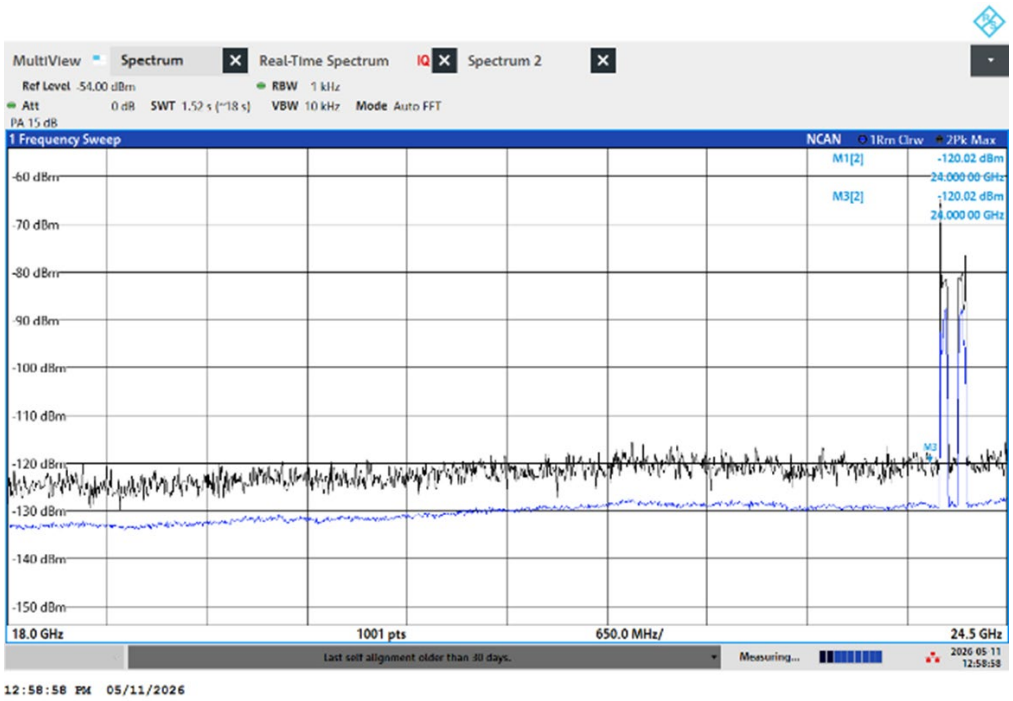


Figure 17: Emissions from multi-panel radar, showing a frequency sweep across 18-24.5GHz, with 4 panels active

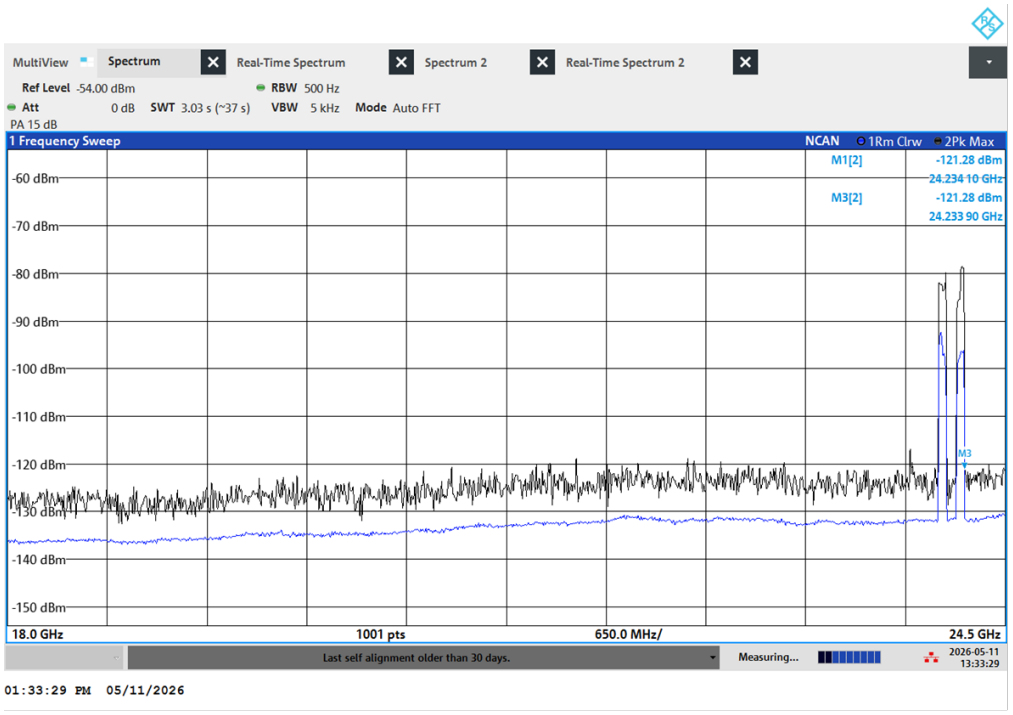


Figure 18: Emissions from multi-panel radar, showing a frequency sweep across 24-30GHz, with 2 panels active

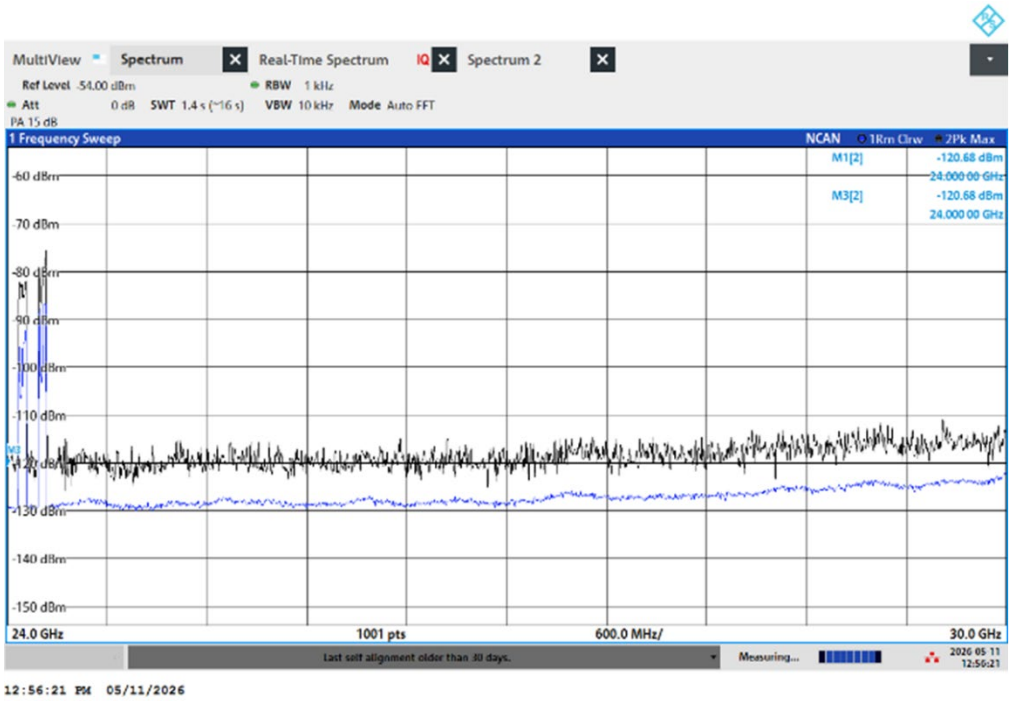


Figure 19: Emissions from multi-panel radar, showing a frequency sweep across 24-30GHz, with 4 panels switched on

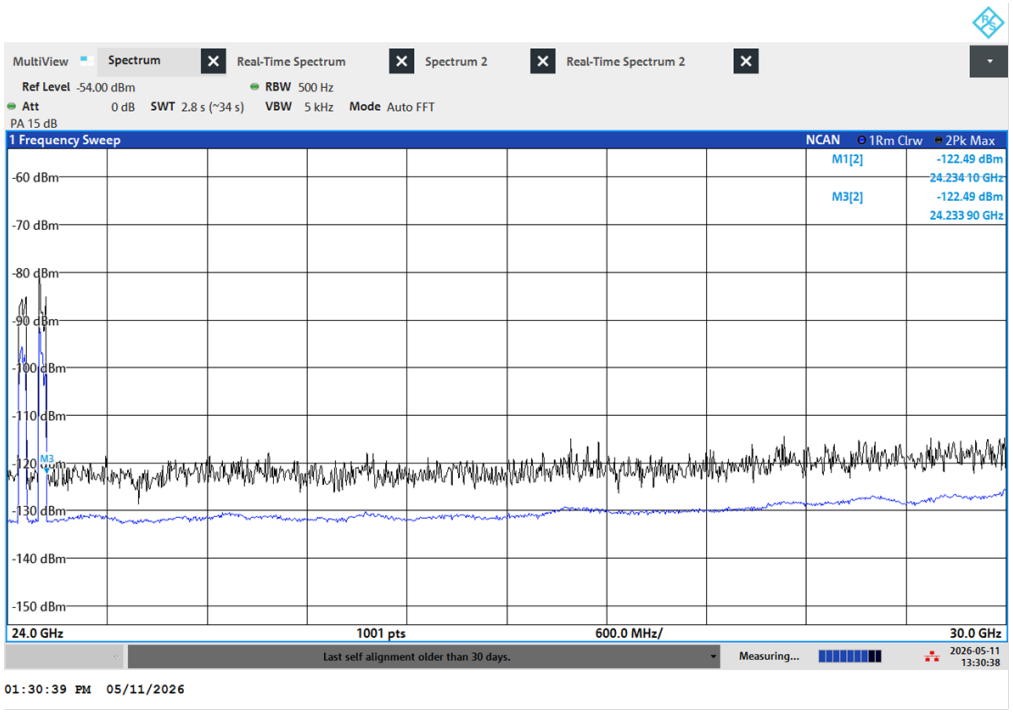


Figure 20: Emissions from multi-panel radar, showing out of band emissions above channel 2, with 2 panels active

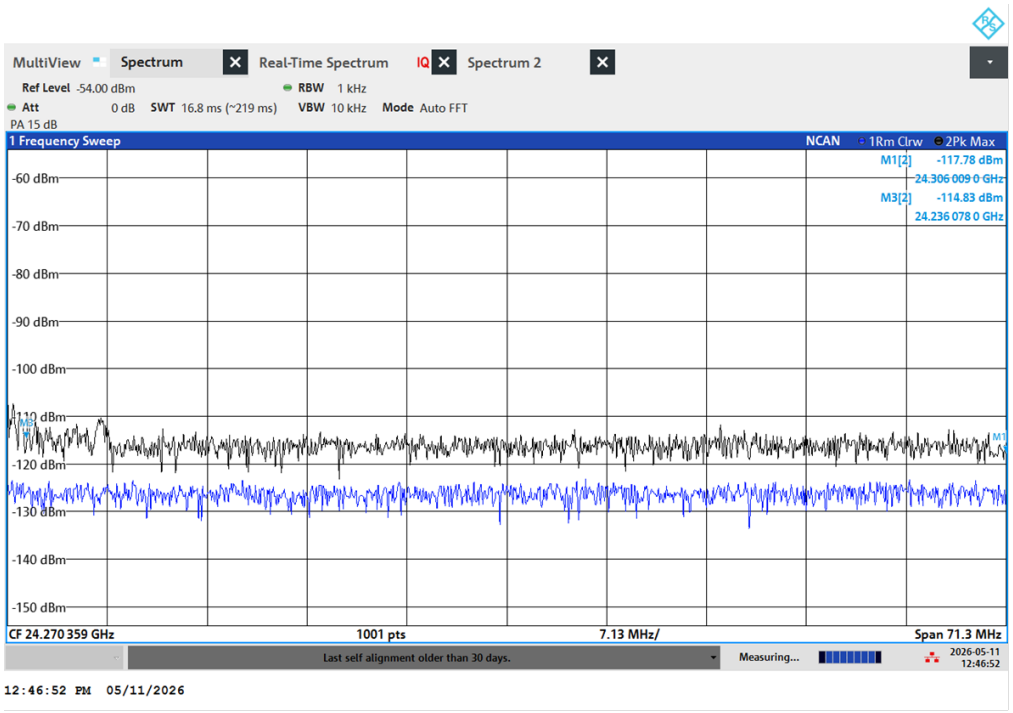


Figure 21: Emissions from multi-panel radar, showing out of band emissions above channel 2, with 4 panels active

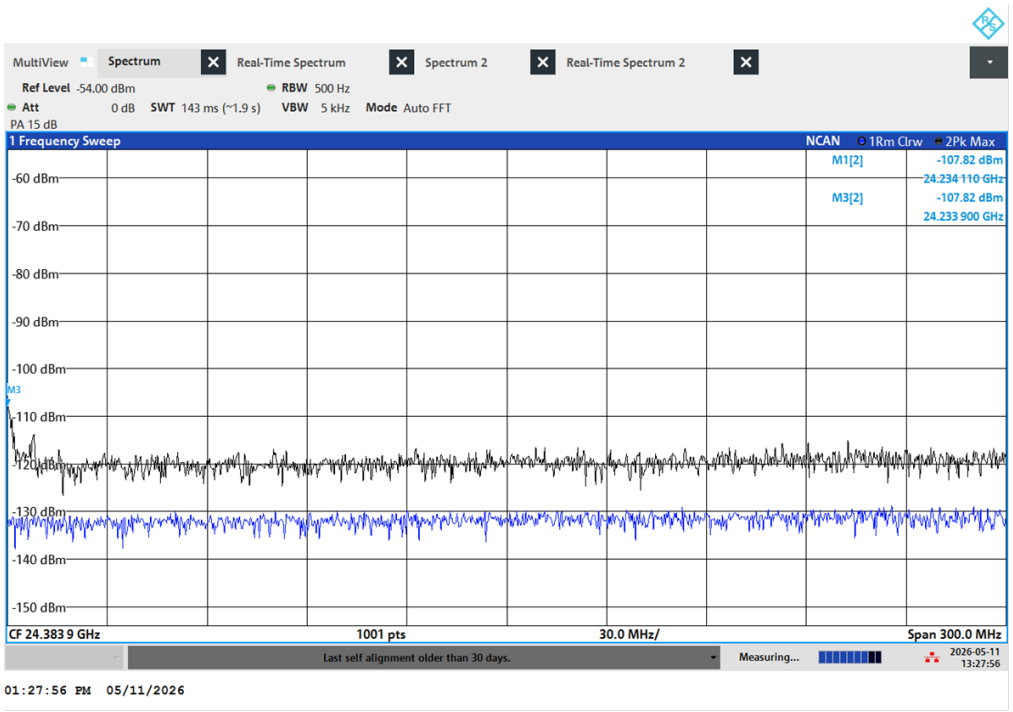


Figure 22: Emissions from multi-panel radar, showing real-time emissions, with 2 panels active on at Channel 2

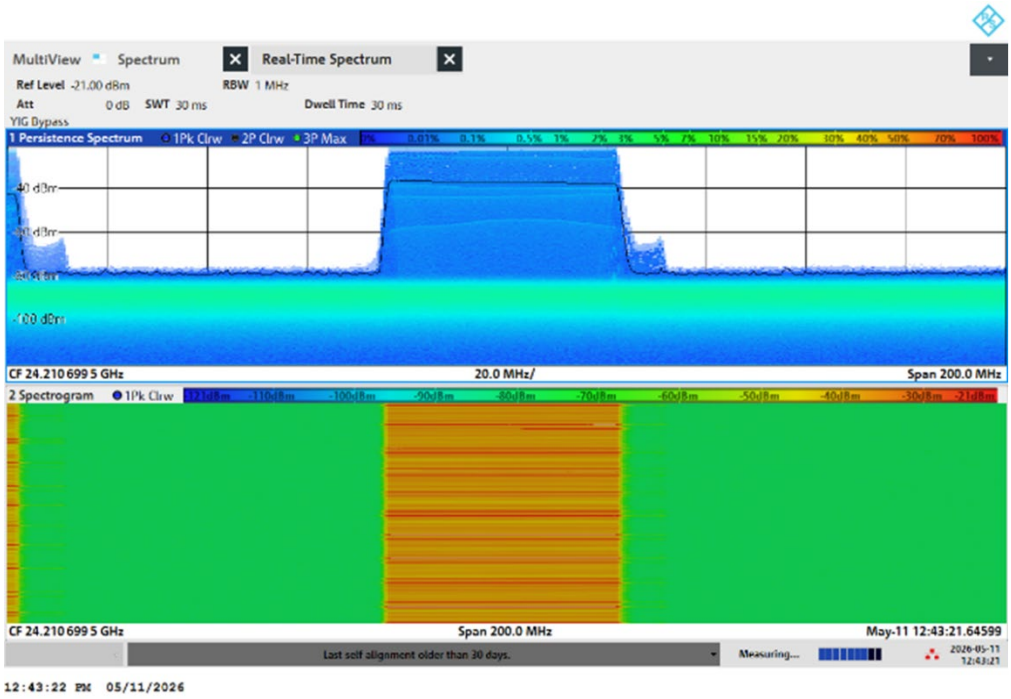


Figure 23: Emissions from multi-panel radar, showing real-time emissions, with 4 panels active on Channels 0 and 2

