



# RF Exposure Evaluation Report

## *XR90*

June 23, 2021



## Contents

Introduction .....	3
RF Exposure Limit Calculations .....	5
FCC Limits .....	5
IC/ISED Limits .....	5
Equations.....	6
RF Radiation Exposure Evaluation .....	7
Stand-Alone Power Density Calculation .....	7
Collocated Power Density Calculation .....	8
Conclusion .....	10
Document History .....	11



**Introduction**

In this application we seek for approval for the XR90 for use in standalone and collocated simultaneous transmission under mobile configuration. This Maximum Permissive Exposure (MPE) report demonstrates compliance analysis for the XR90 with FCC CFR 47 §2.1091 and IC RSS-102 for standalone and collocated transmission in mobile exposure conditions. The MPE analysis is limited for US / Canada bands only.

The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure.

Any collocated transmitter must have a valid FCC ID documenting equivalent or degraded RF characteristics with the collocated parameters defined in this MPE report. A separation distance of 20cm or more shall be maintained between the end user and each WWAN, WLAN, and Bluetooth transmitting antenna.

Portable user conditions or additional collocated transmitters not allowed based on this RF exposure analysis require a Class II permissive change and updated RF exposure report.

*Table 1: Description of Equipment Under Test*

<b>Brand Name</b>	Sierra Wireless
<b>Model Name</b>	XR90
<b>FCC ID</b>	N7NXR90
<b>IC/ISED ID</b>	2417C-XR90
<b>EUT Type</b>	WiFi / Bluetooth
<b>Wireless Technology and Frequency Range</b>	WLAN 2.4 GHz: 2400 – 2483.5 MHz WLAN 5.2 GHz: 5150 – 5250 MHz WLAN 5.3 GHz: 5250 – 5350 MHz WLAN 5.6 GHz: 5470 – 5725 MHz WLAN 5.8 GHz: 5725 – 5825 MHz Bluetooth: 2400 – 2483.5 MHz
<b>Mode</b>	WLAN: 802.11 b/g/n/a/ac/ax HE20/40/80 Bluetooth: BR/EDR/LE
<b>Antenna Gain</b>	2.4GHz WiFi: -0.25dBi 5 GHz WiFi: 0.50 dBi



Table 2: Maximum RF Output Power

Mode		Maximum Average Power (dBm)	
		Per Chain	Total
2.4GHz WLAN	802.11b	24.0	30.0
	802.11g/n/ax HE20	23.5	29.5
	802.11g/n/ax HE40	19.5	25.5
5 GHz WLAN	802.11a/n/ac/ax HE20	24.0	30.0
	802.11a/n/ac/ax HE40	24.0	30.0
	802.11a/n/ac/ax HE80	24.0	30.0
Bluetooth	BR/EDR	n/a	12.0
	LE	n/a	9.0

## RF Exposure Limit Calculations

### FCC Limits

According to FCC OET Bulletin 65 Supplement C, the criteria listed in Table 3 shall be used to evaluate the environmental impact of human exposure to radio frequency (RF) radiation as specified in §1.1307.

Table 3: Limits for Maximum Permissible Exposure (MPE)

#### (B) Limits for General Population/Uncontrolled Exposure

Frequency Range (MHz)	Electric Field Strength (E) (V/m)	Magnetic Field Strength (H) (A/m)	Power Density (S) (mW/cm <sup>2</sup> )	Averaging Time  E  <sup>2</sup> ,  H  <sup>2</sup> or S (minutes)
0.3-1.34	614	1.63	(100)*	30
1.34-30	824/f	2.19/f	(180/f <sup>2</sup> )*	30
30-300	27.5	0.073	0.2	30
300-1500	--	--	f/1500	30
1500-100,000	--	--	1.0	30

f = frequency in MHz \*Plane-wave equivalent power density

### IC/ISED Limits

IC has adopted the RF field strength limits established in Health Canada's RF exposure guideline. The limits are shown in Table 4 below per RSS-102.

Table 4: RF Field Strength Limits for Devices Used by the General Public (Uncontrolled Environment)

Frequency Range (MHz)	Electric Field (V/m rms)	Magnetic Field (A/m rms)	Power Density (W/m <sup>2</sup> )	Averaging Time (minutes)
0.003-1	280	2.19	-	6
1-10	280/f	2.19/f	-	6
10-30	28	2.19/f	-	6
30-300	28	0.073	2*	6
300-1500	1.585 f <sup>0.5</sup>	0.0042 f <sup>0.5</sup>	f/150	6
1500-15000	61.4	0.163	10	6
15000-150000	61.4	0.163	10	616000/f <sup>1.2</sup>
150000-300000	0.158 f <sup>0.5</sup>	4.21 x 10 <sup>-4</sup> f <sup>0.5</sup>	6.67 x 10 <sup>-5</sup> f	616000/f <sup>1.2</sup>

**Note:** f is frequency in MHz.

\* Power density limit is applicable at frequencies greater than 100 MHz.



In the frequency range of 300-6000 MHz, the IC/ISED limits are more stringent than the FCC limits. The MPE evaluation in this report will be based on the IC/ISED limits, therefore the deduced output power and antenna gain limits will guarantee compliance with both FCC and IC/ISED requirements.

### Equations

The power density calculations are completed using the following equation:

$$\text{EIRP (dBm)} = \text{Conducted Power (dBm)} + \text{Antenna Gain (dBi)}$$

Power Density is given by:

$$S = \text{EIRP} / (4\pi D^2)$$

where:

S = Power density (mW/cm<sup>2</sup>)

EIRP = Equivalent Isotropic Radiated Power (mW)

D = Separation distance (cm)



## RF Radiation Exposure Evaluation

### Stand-Alone Power Density Calculation

When the XR90 transmits as a stand-alone mobile device, the source-based time-averaged EIRP is calculated by summing up conducted power and antenna gain. A 100% duty cycle is used for calculations to present a worse-case analysis. The antenna gains were chosen so that the resulted radiated power levels are within the limits specified by the FCC rules and IC/ISED Radio Standards Specifications (RSS). The IC/ISED exemption limits for routine RF exposure evaluation are calculated using the lowest frequency of the operating band presenting the most stringent limits.

As shown in Table 5, Table 6 and Table 7 below, the resulted EIRP are always below the IC/ISED exemption limits for all the operating modes. Table 5 and Table 6 show the difference in 2.4GHz and 5GHz WiFi Power Density MPE ratios when operating in non-Beamforming vs Beamforming modes.

Table 5: WiFi Non-Beamforming

Band	Tx Freq Range (MHz)	Max Time-Avg Cond. Power (dBm)	Antenna Gain (dBi)	Source-based Time-Avg Max EIRP (dBm)	IC/ISED Exemption Limit (EIRP dBm)
WLAN 2.4GHz	2400-2500	24 (per chain)	-0.25	23.75	34.27
WLAN 5GHz	5150-5850	24 (per chain)	0.5	24.5	36.55

Table 6: WiFi Beamforming

Band	Tx Freq Range (MHz)	Max Time-Avg Cond. Power (dBm)	Antenna Gain (dBi)	Source-based Time-Avg Max EIRP (dBm)	IC/ISED Exemption Limit (EIRP dBm)
WLAN 2.4GHz	2400-2500	24 (per chain)	5.77	29.77	34.27
WLAN 5GHz	5150-5850	24 (per chain)	6.52	30.52	36.55

Table 7: Bluetooth

Band	Tx Freq Range (MHz)	Max Time-Avg Cond. Power (dBm)	Antenna Gain (dBi)	Source-based Time-Avg Max EIRP (dBm)	IC/ISED Exemption Limit (EIRP dBm)
Bluetooth	2400-2500	12	3	15	34.27



### Collocated Power Density Calculation

When an XR90 co-transmits with radio transmitter(s) as a mobile device, per KDB 447498 D01, simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneous transmitting antennas incorporated in a host device, based on the calculated/estimated, numerically modeled or measured field strengths or power density, is  $\leq 1.0$ .

Table 8: Collocated Devices

	Band	Tx Freq Range (MHz)	Max Time-Avg Cond. Power (dBm)	Antenna Gain (dBi)	Source-based Time-Avg Max EIRP (dBm)	Power Density @ 20cm (W/m <sup>2</sup> )	IC/ISED MPE Limit (W/m <sup>2</sup> )	IC/ISED Power Density MPE ratio
XR90	WLAN 2.4	2400-2500	24 (per chain)	5.77	29.77	1.888	5.348	0.353
	WLAN 5	5150-5850	24 (per chain)	6.52	30.52	2.244	9.011	0.249
	Bluetooth	2400-2500	12	3.0	15	0.063	5.348	0.012
WWAN Cellular Module	WCDMA Band II	1850-1910	24.5	4	28.5	1.41	4.476	0.315
	WCDMA Band IV	1710-1755	24.5	3.5	28.0	1.26	4.242	0.296
	WCDMA Band V	824-849	24.5	1.5	26.0	0.79	2.576	0.308
	LTE Band 2	1850-1910	24.0	4	28.0	1.26	4.476	0.281
	LTE Band 4	1710-1755	24.0	3.5	27.5	1.12	4.242	0.264
	LTE Band 5	824-849	24.0	1.5	25.5	0.71	2.576	0.274
	LTE Band 7	2500-2570	24.8	4.5	29.3	1.69	5.499	0.308
	LTE Band 12	699-716	24.0	1.5	25.5	0.71	2.302	0.307
	LTE Band 13	777-787	24.0	1.5	25.5	0.71	2.474	0.285
	LTE Band 14	788-798	24.0	2	26.0	0.79	2.498	0.317
	LTE Band 17	704-716	24.0	1.5	25.5	0.71	2.313	0.305
	LTE Band 25	1850-1915	24.0	4	28.0	1.26	4.476	0.281
	LTE Band 26	814-849	24.0	2	26.0	0.79	2.554	0.310
	LTE Band 30	2305-2315	24.0	0	24.0	0.50	5.202	0.096
	LTE Band 38	2570-2620	24.8	4.5	29.3	1.69	5.604	0.302
LTE Band 41	2496-2690	24.8	3	27.8	1.20	5.493	0.218	
LTE Band 41_HPUE	2496-2690	26.0	3	29.0	1.58	5.493	0.288	

LTE Band 42/43	3450-3650	24.8	-1.8	23	0.40	6.785	0.058
LTE Band 48	3550-3700	24.8	-1.8	23	0.40	6.988	0.057
LTE Band 66	1710-1780	24.0	3.5	27.5	1.12	4.242	0.264
LTE Band 71	663-698	24.0	1	25.0	0.63	2.220	0.284
5G NR n2	1850-1910	24.5	4	28.5	1.409	4.476	0.315
5G NR n5	824-849	24.5	1.5	26.0	0.792	2.576	0.308
5G NR n41	2496-2690	24.5	3	27.5	1.119	5.493	0.204
5G NR n66	1710-1780	24.5	3.5	28.0	1.256	4.242	0.296
5G NR n71	663-698	24.5	1	25.5	0.706	2.220	0.318

The evaluation here considers a WWAN cellular transmitter as a collocated transmitter. The WWAN module radiated output power levels are listed in Table 8 above. The MPE ratio is defined by the ratio of power density to MPE limit.

The maximum MPE ratio of the other collocated transmitter occurs when the WWAN radio is operating in 5G NR n71 with an MPE ratio of 0.318.

The sum of the MPE ratios is calculated as follows:

$$\begin{aligned}
 \sum MPE \text{ Ratio} &= \text{Max (XR90 2.4GHz MPE ratio)} + \\
 &\quad \text{Max (XR90 5GHz MPE ratio)} + \\
 &\quad \text{(XR90 BT MPE ratio)} + \\
 &\quad \text{Max (WWAN radio MPE ratio)} \\
 &= 0.353 + 0.249 + 0.012 + 0.318 \\
 &= 0.920 < 1.0
 \end{aligned}$$



### **Conclusion**

The analysis presented in this report concludes that the XR90, when transmitting either in standalone or simultaneously with other co-located radio transmitters within a host device, is compliant with the FCC/IC RF exposure requirements in mobile exposure conditions, provided the conducted power and antenna gain do not exceed the limits in Table 8 for each given frequency band and operating mode.

**Document History**

<b>Date</b>	<b>Version</b>	<b>Comment</b>
May 18, 2021	1.0	*Initial version
May 19, 2021	1.1	*Change History table *Updated tables to show frequency ranges, not just start frequency *Corrected errors in B42
May 19, 2021	1.2	*Converted B42 to B42/B43 for ISED
May 20, 2021	1.3	*Corrected B30, B42/43, B58 gain limits
June 23, 2021	1.4	*Corrected naming to XR90