**DEKRA Testing and Certification, S.A.U.**
Parque Tecnológico de Andalucía,
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C.I.F. A29 507 456

Test report No:

NIE: 76930RAN.002A1

# Assessment report

## RF EXPOSURE REPORT ACCORDING TO

FCC 47 CFR Part 2.1091; FCC 47 CFR Part 1.1307
FCC 47 CFR Part 1.1310

| | |
|---|---|
| (*) Identification of item under evaluation | Telematic control unit with wireless technologies, used in automotive industry |
| (*) Trademark | VW AG |
| (*) Model and /or type reference | ConBox-High |
| (*) Derived model not evaluated | ConBox High RD |
| (*) Other identification of the product | HW version: 043<br>SW version: 0595<br>FCC ID: T8GP114<br>IC: 6434A-P114 |
| (*) Features | GSM, UMTS, LTE, GNSS, Wi-Fi, BTLE, BT_EDR |
| (*) Manufacturer | HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH<br>BECKER-GOERING-STR. 16<br>76307, KARLSBAD, GERMANY |
| Test method requested, standard | FCC 47 CFR Part 2.1091 Radiofrequency radiation exposure evaluation: mobile devices.<br>FCC 47 CFR Part 1.1307: Actions that may have a significant environmental effect, for which Environmental Assessments (EAs) must be prepared.<br>FCC 47 CFR Part 1.1310: Radiofrequency radiation exposure limits. |
| Summary | IN COMPLIANCE |
| Approved by (name / position & signature) | Miguel Lacave<br>Antennas Lab Manager<br>2024.01.29 17:36:13 +01'00' |
| Date of issue | 2024-01-29 |
| Report template No | FAN36_02<br>(*) "Data provided by the client" |

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# Competences and guarantees

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# Data provided by the client

The following data has been provided by the client:

1. Information relating to the description of the sample ("Identification of the item under evaluation", "Trademark", "Model and/or type reference", “Derived model not evaluated”, “General description of the device”, “Other identification of the product”).
2. Maximum output power, maximum antenna gain and use distance information.
3. The device under evaluation consists of a Telematic control unit with wireless technologies, used in automotive industry.
4. Derived model not evaluated. These models have been declared by the supplier of the sample as being the same as the model under evaluation.

**HARMAN Becker Automotive Systems GmbH**
Becker-Goering-Str. 16
76307 Karlsbad, Germany

# Declaration of Comparability

**HARMAN BECKER**
**Automotive Systems GmbH**

**Becker-Göring-Str. 16**
**D-76307 Karlsbad, Germany**

To whom it may concern:

We, Harman Becker Automotive Systems GmbH, hereby declares that our products:
**ConBox-High** and **ConBox High RD** are equipped with the same NAD module (for each variant listed below) and the cellular part is identical between these TCU's.
Also, the test results are valid and representative for both projects as long as there are no modifications which may request additional tests.

ConBox Variant: A970, A971, A973, A974, A975, A976, A977, A978, A979, A980, A981, A982, A983, A984, P114, P115, P119

Sincerely,

i.V.

i.V.

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DEKRA Testing and Certification S.A.U. declines any responsibility with respect to the information provided by the client and that may affect the validity of results.

# Identification of the client

HARMAN BECKER AUTOMOTIVE SYSTEMS GMBH

BECKER-GOERING-STR. 16

76307, KARLSBAD, GERMANY

# Document history

| Report number | Date | Description |
|---|---|---|
| 76930RAN.002 | 2023-12-19 | First release |
| 76930RAN.002A1 | 2024-01-29 | Second release. LTE Band 38 has been removed and LTE Band 28 has been included in the RF exposure evaluation This test report cancels and replaces report 76930RAN.002. |

# **Appendix A:** FCC RF Exposure assessment result

# General description of the device under evaluation

Table 1 shows information used for the RF Evaluation, taking into account the following declared specifications for the device:

**Description and technologies:** the device under evaluation consists of a Telematic control unit with wireless technologies, used in automotive industry with the following features: GSM, UMTS, LTE, GNSS, Wi-Fi, BTLE, BT_EDR.

The device under evaluation has four cellular communications ports, to which it is possible to connect several antennas. The worst-case antenna for each port has been considered to perform the RF exposure evaluation. Additionally, it has an internal backup cellular antenna, which has been also evaluated.

**Evaluation Distance:** according to the manufacturer, during its normal use, the separation distance between the radiating structures of the device and nearby users will be greater than 30 cm. In order to perform the assessment a conservative evaluation distance of 30 cm has been used.

**Maximum output power:**

- Values corresponding to cellular maximum output power have been declared by the device manufacturer (maximum output power values stated in manufacturer's technical description document.
- Values corresponding to BTEDR conducted output power have been measured and stated into 7Layers GmbH test report num. MDE_HARMAN_1736_FCCa_Rev1.
- Values corresponding to 802.11 b/g/n and BTLE conducted output power have been measured and stated into 7Layers GmbH test report num. MDE_HARMAN_1736_FCCb_rev1.
- Values corresponding to 802.11 a/n/ac conducted output power have been measured and stated into 7Layers GmbH test report num. MDE_HARMAN_1736_FCCc_rev2.

**Antennas:** the device supports several antennas for the GSM, UMTS, LTE, GNSS, Wi-Fi, BTLE, BT_EDR transmitting technologies:

- “4M0.035.507.A” antenna for cellular transmissions in the external antenna port 1.
- “36a.035.502.A” antenna for cellular transmissions in the external antenna port 2.
- “4M0.035.504.A” antenna for cellular transmissions in the external antenna port 3.
- “Audi DDA Gen2 MLB BK roof” antenna for cellular transmissions in the external antenna port 4.
- “Internal Backup” antenna for cellular transmissions.
- “WLAN P1518 C5 10k” BT Wi-Fi antenna, for BTEDR, BTLE, 2.4 GHz and 5GHz transmissions.

Values corresponding to antennas gain have been declared by the device manufacturer (maximum peak gain stated in antenna manufacturer´s datasheet).

The following table shows the information provided above:

| Technology / Mode | Operating Band | Frequency under evaluation (MHz) | Maximum Conducted Output Power (Incl. Tune-Up) (dBm) | Duty Cycle (%) | Time Averaged Conducted Power (dBm) | Cellular Internal Antenna peak gain (dBi) | Antenna 1 peak gain (dBi) | Antenna 2 peak gain (dBi) | Antenna 3 peak gain (dBi) | Antenna 4 peak gain (dBi) | BT_WLAN Extermal Antenna peak gain (dBi) | Maximum Averaged E.R.P (dBm) | Maximum Averaged E.R.P (mW) | Maximum Averaged E.I.R.P (dBm) | Maximum Averaged E.I.R.P (mW) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GSM | 850 | 824 - 849 | 35.00 | 12.50 | 25.97 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 31.82 | 1520.23 | 33.97 | 2494.08 |
| GPRS 1TX | 850 | 824 - 849 | 35.00 | 12.50 | 25.97 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 31.82 | 1520.23 | 33.97 | 2494.08 |
| GPRS 2TX | 850 | 824 - 849 | 35.00 | 25.00 | 28.98 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 34.83 | 3040.47 | 36.98 | 4988.16 |
| GPRS 3TX | 850 | 824 - 849 | 33.20 | 37.50 | 28.94 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 34.79 | 3013.22 | 36.94 | 4943.46 |
| GPRS 4TX | 850 | 824 - 849 | 32.00 | 50.00 | 28.99 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 34.84 | 3047.68 | 36.99 | 5000.00 |
| EGPRS 1TX | 850 | 824 - 849 | 30.00 | 12.50 | 20.97 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 26.82 | 480.74 | 28.97 | 788.70 |
| EGPRS 2TX | 850 | 824 - 849 | 30.00 | 25.00 | 23.98 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 29.83 | 961.48 | 31.98 | 1577.39 |
| EGPRS 3TX | 850 | 824 - 849 | 28.20 | 37.50 | 23.94 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 29.79 | 952.86 | 31.94 | 1563.26 |
| EGPRS 4TX | 850 | 824 - 849 | 27.00 | 50.00 | 23.99 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 29.84 | 963.76 | 31.99 | 1581.14 |
| GSM | 1900 | 1850 - 1910 | 32.00 | 12.50 | 22.97 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 28.82 | 761.92 | 30.97 | 1250.00 |
| GPRS 1TX | 1900 | 1850 - 1910 | 32.00 | 12.50 | 22.97 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 28.82 | 761.92 | 30.97 | 1250.00 |
| GPRS 2TX | 1900 | 1850 - 1910 | 32.00 | 25.00 | 25.98 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 31.83 | 1523.84 | 33.98 | 2500.00 |
| GPRS 3TX | 1900 | 1850 - 1910 | 30.20 | 37.50 | 25.94 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 31.79 | 1510.19 | 33.94 | 2477.60 |
| GPRS 4TX | 1900 | 1850 - 1910 | 29.00 | 50.00 | 25.99 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 31.84 | 1527.46 | 33.99 | 2505.94 |
| EGPRS 1TX | 1900 | 1850 - 1910 | 29.00 | 12.50 | 19.97 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 25.82 | 381.87 | 27.97 | 626.48 |
| EGPRS 2TX | 1900 | 1850 - 1910 | 29.00 | 25.00 | 22.98 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 28.83 | 763.73 | 30.98 | 1252.97 |
| EGPRS 3TX | 1900 | 1850 - 1910 | 27.20 | 37.50 | 22.94 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 28.79 | 756.89 | 30.94 | 1241.74 |
| EGPRS 4TX | 1900 | 1850 - 1910 | 26.00 | 50.00 | 22.99 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 28.84 | 765.54 | 30.99 | 1255.94 |
| UMTS | II | 1850 - 1910 | 25.00 | 100.00 | 25.00 | 4.40 | 6.50 | 5.50 | 0.80 | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| UMTS | IV | 1710 - 1755 | 25.00 | 100.00 | 25.00 | 2.70 | 6.50 | 5.50 | 1.36 | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| UMTS | V | 824 - 849 | 25.00 | 100.00 | 25.00 | -0.10 | 4.50 | 5.50 | -0.46 | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |

| Technology / Mode | Operating Band | Frequency under evaluation (MHz) | Maximum Conducted Output Power (Incl. Tune-Up) (dBm) | Duty Cycle (%) | Time Averaged Conducted Power (dBm) | Cellular Internal Antenna peak gain (dBi) | Antenna 1 peak gain (dBi) | Antenna 2 peak gain (dBi) | Antenna 3 peak gain (dBi) | Antenna 4 peak gain (dBi) | BT_WLAN Extermal Antenna peak gain (dBi) | Maximum Averaged E.R.P (dBm) | Maximum Averaged E.R.P (mW) | Maximum Averaged E.I.R.P (dBm) | Maximum Averaged E.I.R.P (mW) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LTE | 2 | 1850 - 1910 | 25.00 | 100.00 | 25.00 | 4.40 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 4 | 1710 - 1755 | 25.00 | 100.00 | 25.00 | 2.70 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 5 | 824 - 849 | 25.00 | 100.00 | 25.00 | -0.10 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 7 | 2500 - 2570 | 25.00 | 100.00 | 25.00 | 4.30 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 12 | 699 - 716 | 25.00 | 100.00 | 25.00 | -3.20 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 13 | 777 - 787 | 25.00 | 100.00 | 25.00 | -3.20 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 28 | 703 - 748 | 25.00 | 100.00 | 25.00 | 4.30 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| LTE | 66 | 1710 - 1780 | 25.00 | 100.00 | 25.00 | 2.70 | - | - | - | 8.00 | - | 30.85 | 1216.19 | 33.00 | 1995.26 |
| 802.11b/g/n | 2.4 GHz | 2412 - 2484 | 12.60 | 100.00 | 12.60 | - | - | - | - | - | 0.11 | 10.56 | 11.38 | 12.71 | 18.66 |
| 802.11a/n/ac | U-NII-1 | 5150 - 5250 | 14.90 | 100.00 | 14.90 | - | - | - | - | - | 1.99 | 14.74 | 29.79 | 16.89 | 48.87 |
| 802.11a/n/ac | U-NII-3 | 5725 - 5850 | 11.50 | 100.00 | 11.50 | - | - | - | - | - | 2.38 | 11.73 | 14.89 | 13.88 | 24.43 |
| Bluetooth | 2.4 GHz | 2400 - 2483.5 | 10.20 | 100.00 | 10.20 | - | - | - | - | - | 0.11 | 8.16 | 6.55 | 10.31 | 10.74 |
| BTLE | 2.4 GHz | 2400 - 2483.5 | -1.70 | 100.00 | -1.70 | - | - | - | - | - | 0.11 | -3.74 | 0.42 | -1.59 | 0.69 |

**Table 1:** Equipment specifications

# Evaluation Results

**RF Exposure Exemption evaluation:**

| Technology / Mode | Operating Band | Frequency under evaluation (MHz) | Distance (cm) | Time Averaged Conducted Power (mW) | Maximum Averaged E.R.P (mW) | § 1.1307(b)(3).i.(B) Exposure Limit (mW) | Verdict for exemption § 1.1307(b)(3).i |
|---|---|---|---|---|---|---|---|
| GSM/GPRS | 850 | 824 - 849 | 30.00 | N/A | 3047.68 | 1680.96 | MPE required |
| GSM/GPRS | 1900 | 1850 - 1910 | 30.00 | N/A | 1527.46 | 3060.00 | MPE required (sim.TX) |
| UMTS | II | 1850 - 1910 | 30.00 | N/A | 1216.19 | 3060.00 | MPE required (sim.TX) |
| UMTS | IV | 1710 - 1755 | 30.00 | N/A | 1216.19 | 3060.00 | MPE required (sim.TX) |
| UMTS | V | 824 - 849 | 30.00 | N/A | 1216.19 | 1680.96 | MPE required (sim.TX) |
| LTE | 2 | 1850 - 1910 | 30.00 | N/A | 1216.19 | 3060.00 | MPE required (sim.TX) |
| LTE | 4 | 1710 - 1755 | 30.00 | N/A | 1216.19 | 3060.00 | MPE required (sim.TX) |
| LTE | 5 | 824 - 849 | 30.00 | N/A | 1216.19 | 1680.96 | MPE required (sim.TX) |
| LTE | 7 | 2500 - 2570 | 30.00 | N/A | 1216.19 | 3060.00 | MPE required (sim.TX) |
| LTE | 12 | 699 - 716 | 30.00 | N/A | 1216.19 | 1425.96 | MPE required (sim.TX) |
| LTE | 13 | 777 - 787 | 30.00 | N/A | 1216.19 | 1585.08 | MPE required (sim.TX) |
| LTE | 28 | 703 - 748 | 30.00 | N/A | 1216.19 | 1434.12 | MPE required (sim.TX) |
| LTE | 66 | 1710 - 1780 | 30.00 | N/A | 1216.19 | 3060.00 | MPE required (sim.TX) |
| 802.11b/g/n | 2.4 GHz | 2412 - 2484 | 30.00 | 18.20 | 22.13 | N/A | MPE required (sim.TX) |
| 802.11a/n/ac | U-NII-1 | 5150 - 5250 | 30.00 | 30.90 | 59.57 | N/A | MPE required (sim.TX) |
| 802.11a/n/ac | U-NII-3 | 5725 - 5850 | 30.00 | N/A | 27.23 | 14.89 | MPE required (sim.TX) |
| Bluetooth | 2.4 GHz | 2400 - 2483.5 | 30.00 | 10.47 | 12.74 | N/A | MPE required (sim.TX) |
| BTLE | 2.4 GHz | 2400 - 2483.5 | 30.00 | 0.68 | 0.82 | N/A | MPE required (sim.TX) |

**Table 2:** FCC Exemption Evaluation Results

The device fails to comply with applicable §1.1307(b)(3).i. exemption limits, so Maximum Permissible Exposure (MPE) evaluation is necessary to demonstrate compliance.

**RF Exposure MPE evaluation:**

| Technology / Mode | Operating Band | Frequency under evaluation (MHz) | Distance (cm) | Power density (mW/cm²) | FCC General Population Limit (mW/cm²) | Verdict |
|---|---|---|---|---|---|---|
| GSM/GPRS | 850.00 | 824 - 849 | 30.00 | 0.44 | 0.55 | Pass |
| GSM/GPRS | 1900.00 | 1850 - 1910 | 30.00 | 0.22 | 1.00 | Pass |
| UMTS | II | 1850 - 1910 | 30.00 | 0.18 | 1.00 | Pass |
| UMTS | IV | 1710 - 1755 | 30.00 | 0.18 | 1.00 | Pass |
| UMTS | V | 824 - 849 | 30.00 | 0.18 | 0.55 | Pass |
| LTE | 2.00 | 1850 - 1910 | 30.00 | 0.18 | 1.00 | Pass |
| LTE | 4.00 | 1710 - 1755 | 30.00 | 0.18 | 1.00 | Pass |
| LTE | 5.00 | 824 - 849 | 30.00 | 0.18 | 0.55 | Pass |
| LTE | 7.00 | 2500 - 2570 | 30.00 | 0.18 | 1.00 | Pass |
| LTE | 12.00 | 699 - 716 | 30.00 | 0.18 | 0.47 | Pass |
| LTE | 13.00 | 777 - 787 | 30.00 | 0.18 | 0.52 | Pass |
| LTE | 28.00 | 703 - 748 | 30.00 | 0.18 | 1.00 | Pass |
| LTE | 66.00 | 1710 - 1780 | 30.00 | 0.18 | 0.47 | Pass |
| 802.11b/g/n | 2.4 GHz | 2412 - 2484 | 30.00 | 0.00 | 1.00 | Pass |
| 802.11a/n/ac | U-NII-1 | 5150 - 5250 | 30.00 | 0.00 | 1.00 | Pass |
| 802.11a/n/ac | U-NII-3 | 5725 - 5850 | 30.00 | 0.00 | 1.00 | Pass |
| Bluetooth | 2.4 GHz | 2400 - 2483.5 | 30.00 | 0.00 | 1.00 | Pass |
| BTLE | 2.4 GHz | 2400 - 2483.5 | 30.00 | 0.00 | 1.00 | Pass |

**Table 3:** FCC Evaluation Results

The computed value(s) are below the limit(s), so these modes meet the requirements stated in FCC 47 CFR Part 1.1310.

**Simultaneous transmission assessment:**

| Simultaneous technologies and modes | Result (∑ of Pout/Pmax ratios) | Verdict (∑ ≤ 1) |
|---|---|---|
| GPRS 4TX 850 + 802.11b/g/n 2.4 GHz + 802.11a/n/ac U-NII-1 + Bluetooth 2.4 GHz | 0.81 | Pass |

**Table 4:** Simultaneous Transmission assessment

# **Appendix B:** FCC RF Exposure information

# RF Exposure determination of exemption

According to FCC 47 CFR §1.1307 (b)(3) Determination of exemption:

(i) For single RF sources (i.e., any single fixed RF source, mobile device, or portable device, as defined in paragraph (b)(2), a single RF source is exempt if:

(A) The available maximum time-averaged power is no more than 1 mW, regardless of separation distance. This exemption may not be used in conjunction with other exemption criteria other than those in paragraph (b)(3)(ii)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(ii)(A);

(B) Or the available maximum time-averaged power or effective radiated power (ERP), whichever is greater, is less than or equal to the threshold Pth (mW) described in the following formula. This method shall only be used at separation distances (cm) from 0.5 centimeters to 40 centimeters and at frequencies from 0.3 GHz to 6 GHz (inclusive). Pth is given by:

$$P_{th}\ (\text{mW}) = \begin{cases} ERP_{20\ cm}(d/20\ \text{cm})^x & d \le 20\ \text{cm} \\ ERP_{20\ cm} & 20\ \text{cm} < d \le 40\ \text{cm} \end{cases}$$

Where

$$x = -\log_{10}\left(\frac{60}{ERP_{20\ cm}\sqrt{f}}\right) \text{ and } f \text{ is in GHz;}$$

and

$$ERP_{20\ cm}\ (\text{mW}) = \begin{cases} 2040f & 0.3\ \text{GHz} \le f < 1.5\ \text{GHz} \\ 3060 & 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \end{cases}$$

$d$ = the separation distance (cm);

(C) Or using Table 1 and the minimum separation distance (R in meters) from the body of a nearby person for the frequency (f in MHz) at which the source operates, the ERP (watts) is no more than the calculated value prescribed for that frequency. For the exemption in Table 1 to apply, R must be at least λ/2π, where λ is the free-space operating wavelength in meters. If the ERP of a single RF source is not easily obtained, then the available maximum time-averaged power may be used in lieu of ERP if the physical dimensions of the radiating structure(s) do not exceed the electrical length of λ/4 or if the antenna gain is less than that of a half-wave dipole (1.64 linear value).

**TABLE 1 TO §1.1307(b)(3)(i)(C)—SINGLE RF SOURCES SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION**

| RF Source frequency (MHz) | Threshold ERP (watts) |
|---|---|
| 0.3-1.34 | 1,920 $R^2$. |
| 1.34-30 | 3,450 $R^2/f^2$. |
| 30-300 | 3.83 $R^2$. |
| 300-1,500 | 0.0128 $R^2f$. |
| 1,500-100,000 | 19.2$R^2$. |

(ii) For multiple RF sources: Multiple RF sources are exempt if:

(A) The available maximum time-averaged power of each source is no more than 1 mW and there is a separation distance of two centimeters between any portion of a radiating structure operating and the nearest portion of any other radiating structure in the same device, except if the sum of multiple sources is less than 1 mW during the time-averaging period, in which case they may be treated as a single source (separation is not required). This exemption may not be used in conjunction with other exemption criteria other than those is paragraph (b)(3)(i)(A) of this section. Medical implant devices may only use this exemption and that in paragraph (b)(3)(i)(A).

(B) in the case of fixed RF sources operating in the same time-averaging period, or of multiple mobile or portable RF sources within a device operating in the same time averaging period, if the sum of the fractional contributions to the applicable thresholds is less than or equal to 1 as indicated in the following equation.

$$\sum_{i=1}^{a} \frac{P_i}{P_{th,i}} + \sum_{j=1}^{b} \frac{ERP_j}{ERP_{th,j}} + \sum_{k=1}^{c} \frac{Evaluated_k}{Exposure\ Limit_k} \leq 1$$

Where:

a = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(B) of this section for Pth, including existing exempt transmitters and those being added.

b = number of fixed, mobile, or portable RF sources claiming exemption using paragraph (b)(3)(i)(C) of this section for Threshold ERP, including existing exempt transmitters and those being added.

c = number of existing fixed, mobile, or portable RF sources with known evaluation for the specified minimum distance including existing evaluated transmitters.

Pi = the available maximum time-averaged power or the ERP, whichever is greater, for fixed, mobile, or portable RF source i at a distance between 0.5 cm and 40 cm (inclusive).

Pth,i = the exemption threshold power (Pth) according to paragraph (b)(3)(i)(B) of this section for fixed, mobile, or portable RF source i.

ERPj = the ERP of fixed, mobile, or portable RF source j.

ERPth,j = exemption threshold ERP for fixed, mobile, or portable RF source j, at a distance of at least λ/2π according to the applicable formula of paragraph (b)(3)(i)(C) of this section.

Evaluated,k = the maximum reported SAR or MPE of fixed, mobile, or portable RF source k either in the device or at the transmitter site from an existing evaluation at the location of exposure.

Exposure Limit,k = either the general population/uncontrolled maximum permissible exposure (MPE) or specific absorption rate (SAR) limit for each fixed, mobile, or portable RF source k, as applicable from §1.1310 of this chapter.

The available maximum time-averaged power or effective radiated power (ERP), can be calculated using the following formula to assess compliance with the Exemption Limits:

$P_{E.I.R.P.} = P_T + G_T - L_C$

Where:

$P_T$= transmitter time-averaged output power (including Duty Cycle and tune-up tolerance, if applicable)

$G_T$= gain of the transmitting antenna

$L_C$ = signal attenuation in the connecting cable between the transmitter and the antenna if applicable

$P_{E.R.P.} = P_{E.I.R.P.} – 2.15$ dB

# RF Exposure evaluation

Limits for Maximum Permissible Exposure (MPE) for RF sources are defined in FCC 47 CFR "§1.1310 Radiation Exposure limits, paragraph (e)":

**TABLE 1 TO §1.1310(E)(1)—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

| Frequency range (MHz) | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm$^2$) | Averaging time (minutes) |
|---|---|---|---|---|
| **(i) Limits for Occupational/Controlled Exposure** | | | | |
| 0.3-3.0 | 614 | 1.63 | *(100) | ≤6 |
| 3.0-30 | 1842/f | 4.89/f | *(900/f$^2$) | <6 |
| 30-300 | 61.4 | 0.163 | 1.0 | <6 |
| 300-1,500 | | | f/300 | <6 |
| 1,500-100,000 | | | 5 | <6 |
| **(ii) Limits for General Population/Uncontrolled Exposure** | | | | |
| 0.3-1.34 | 614 | 1.63 | *(100) | <30 |
| 1.34-30 | 824/f | 2.19/f | *(180/f$^2$) | <30 |
| 30-300 | 27.5 | 0.073 | 0.2 | <30 |
| 300-1,500 | | | f/1500 | <30 |
| 1,500-100,000 | | | 1.0 | <30 |

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

Each supported transmission technology will be evaluated to determine if it is in compliance with limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

In order to perform the assessment, the following equations have been used for the calculations; these equations are accurate in the far-field of an antenna and will over-predict power density in the near field, where they could be used for making a "worst-case" or conservative prediction:

Power density: $S[mW/cm^2] = \frac{P_{E.I.R.P.}[mW]}{4\Pi R[cm]^2}$

Where:

$S$ = power density

$P_{E.I.R.P.}$ = Equivalent isotropically radiated power

$R$ = distance to the center of radiation of the antenna (evaluation distance)

$P_{E.I.R.P.} = P_T + G_T - L_C$

Where:

$P_T$= transmitter time-averaged output power (including Duty Cycle and tune-up tolerance, if applicable)

$G_T$= gain of the transmitting antenna

$L_C$ = signal attenuation in the connecting cable between the transmitter and the antenna if applicable