

# RF Exposure Calculated Part 15

## Maximum Permissible Exposure at 20 cm

### 1. Declaration of RF exposure compliance

|                                                                        |                                                                                                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Transmitter(s) Installed                                               | 60 GHz mmWave radio<br>2.4 GHz band Bluetooth and Bluetooth Low Energy radio<br>2.4 GHz band Wi-Fi radio                                                                                                                                                                                                             |
| Model number:                                                          | OA1                                                                                                                                                                                                                                                                                                                  |
| Manufacturer:                                                          | Density Inc                                                                                                                                                                                                                                                                                                          |
| Judgement of Compliance                                                | Compliant                                                                                                                                                                                                                                                                                                            |
| Compliance Distance                                                    | 20 cm                                                                                                                                                                                                                                                                                                                |
| Radiated Transmitter Power (EIRP)<br>Conducted Transmitter Power (dBm) | 60 GHz mmWave radio: -7.509 dBm (from test report data)<br>Bluetooth Low Energy: 10.81 dBm (from module FCC approval report, FCC ID: NDD9576111602)<br>Bluetooth EDR: 7.04 dBm (from module FCC approval report, FCC ID: NDD9576111602)<br>Wi-Fi: 21.65 dBm (from module FCC approval report, FCC ID: NDD9576111602) |
| 4.3.1. Maximum Permissible Exposure considerations are:                | During normal operation, user and user extremities must be at least 20 cm removed from any transmitting antenna.<br><br>Simultaneous operation combinations:<br>1. mmWave + BLE + Wi-Fi<br>2. mmWave + BT-EDR + Wi-Fi                                                                                                |
| Verdict                                                                | Compliant with 20 cm zone                                                                                                                                                                                                                                                                                            |

### 2. Attestation

ATTESTATION: I attest that the calculations were performed or supervised by me; that the calculations were based on the worst-case power output at the worst-case frequency of the transmitting device. All possible configurations have been considered when calculating the worst case Maximum Permissible Exposure requirements as detailed below.

|            |                                                                                     |
|------------|-------------------------------------------------------------------------------------|
| Signature: |  |
| Date:      | March 4, 2021                                                                       |
| Name:      | James Cunningham, EMC/MIL/WL Supervisor                                             |

### 3. Revision History

|                 |                              |
|-----------------|------------------------------|
| 40930-3TRFWL    | Original report issued       |
| 409030-3R1TRFWL | Updated with new EIRP values |

Both the MPE limits listed in Table 1 of paragraph (e) of this section and the SAR limits as set forth in paragraph (a) through (c) of this section and in §2.1093 of this chapter are for continuous exposure, that is, for indefinite time periods. Exposure levels higher than the limits are permitted for shorter exposure times, as long as the average exposure over the specified averaging time in Table 1 is less than the limits.

Detailed information on our policies regarding procedures for evaluating compliance with all of these exposure limits can be found in the FCC's *OET Bulletin 65*, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," and in supplements to *Bulletin 65*, all available at the FCC's Internet Web site: <http://www.fcc.gov/oet/rfsafety>.

Table 1 below sets forth limits for Maximum Permissible Exposure (MPE) to radiofrequency electromagnetic fields.

**TABLE 1—LIMITS FOR MAXIMUM PERMISSIBLE EXPOSURE (MPE)**

| Frequency range (MHz)                                          | Electric field strength (V/m) | Magnetic field strength (A/m) | Power density (mW/cm <sup>2</sup> ) | Averaging time (minutes) |
|----------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------------|--------------------------|
| <b>(A) Limits for Occupational/Controlled Exposure</b>         |                               |                               |                                     |                          |
| 0.3-3.0                                                        | 614                           | 1.63                          | *100                                | 6                        |
| 3.0-30                                                         | 1842/f                        | 4.89/f                        | *900/f <sup>2</sup>                 | 6                        |
| 30-300                                                         | 61.4                          | 0.163                         | 1.0                                 | 6                        |
| 300-1,500                                                      |                               |                               | f/300                               | 6                        |
| 1,500-100,000                                                  |                               |                               | 5                                   | 6                        |
| <b>(B) Limits for General Population/Uncontrolled Exposure</b> |                               |                               |                                     |                          |
| 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                       |
| 300-1,500                                                      |                               |                               | f/1500                              | 30                       |
| 1,500-100,000                                                  |                               |                               | 1.0                                 | 30                       |

# Measured and Calculated Result



## Prediction of MPE limit at a given distance

Equation from page 18 of OET Bulletin 65, Edition 97-01

$$S = \frac{PG}{4\pi R^2}$$

where:

S = power density

P = power input to the antenna

G = power gain of the antenna in the direction of interest relative to an isotropic radiator

R = distance to the center of radiation of the antenna

|                                                              | TX Type 1<br>mmWave | TX Type 2<br>BLE | TX Type 3<br>BT-EDR | Tx Type 4<br>Wi-Fi |                    |
|--------------------------------------------------------------|---------------------|------------------|---------------------|--------------------|--------------------|
| Maximum peak output power at device output terminal:         | -12.509             | 9.21             | 5.44                | 20.06              | dBm                |
| Cable and Jumper loss:                                       | 0                   | 0                | 0                   | 0                  | dB                 |
| Maximum peak output power at antenna input terminal (dBm):   | -12.509             | 9.21             | 5.44                | 20.06              | dBm                |
| Maximum peak output power at antenna input terminal (mW):    | 0.06                | 8.34             | 3.50                | 101.39             | mW                 |
| Single Antenna gain (typical):                               | 5                   | 1.6              | 1.6                 | 1.6                | dBi                |
| Number of Antennae:                                          | 1                   | 1                | 1                   | 1                  |                    |
| Total Antenna gain (typical) (dBi):                          | 5                   | 1.6              | 1.6                 | 1.6                | dBi                |
| Total Antenna gain (typical) (linear):                       | 3.16                | 1.45             | 1.45                | 1.45               | (numeric)          |
| Prediction distance:                                         | 20                  | 20               | 20                  | 20                 | cm                 |
| Prediction frequency:                                        | 62525               | 2442             | 2442                | 2442               | MHz                |
| MPE limit for uncontrolled exposure at prediction frequency: | 1                   | 1                | 1                   | 1                  | mW/cm <sup>2</sup> |
| Power density at prediction frequency:                       | 3.5305E-05          | 0.00239734       | 0.00100631          | 0.02915521         | mW/cm <sup>2</sup> |
|                                                              | 0.00035305          | 0.02397343       | 0.01006306          | 0.29155208         | W/m <sup>2</sup>   |
| Tx On time:                                                  | 1                   | 1                | 1                   | 1                  | ms                 |
| Tx period time:                                              | 1                   | 1                | 1                   | 1                  | ms                 |
| Average Factor:                                              | 100                 | 100              | 100                 | 100                | %                  |
| Average Power density at prediction frequency:               | 0.00035305          | 0.02397343       | 0.01006306          | 0.29155208         | W/m <sup>2</sup>   |
| Maximum allowable antenna gain:                              | 49.5216986          | 27.8026986       | 31.5726986          | 16.9528386         | dBi                |
| Margin of Compliance:                                        | 44.5216986          | 26.2026986       | 29.9726986          | 15.3528386         | dB                 |

|                     | mmWave  |   | BLE     |   | BT-EDR  |   | Wi-Fi   |   |          |      |
|---------------------|---------|---|---------|---|---------|---|---------|---|----------|------|
| mmWave+BLE+Wi-Fi    | 0.00004 | + | 0.00240 | + | ---     | + | 0.02916 | = | 0.002433 | <1.0 |
| mmWave+BT-EDR+Wi-Fi | 0.00004 | + | ----    | + | 0.00101 | + | 0.02916 | = | 0.001042 | <1.0 |