



MPE Evaluation for HL6528 Wireless Module

May 21, 2014

1. Introduction

In this application we seek for modular approval to the HL6528 wireless module for use in standalone and collocated simultaneous transmission under mobile configuration. This Maximum Permissible Exposure (MPE) report demonstrates compliance analysis for HL6528 wireless module 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, WiMAX or 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.

2. RF Exposure Limits and Equations

FCC RULES:

According to FCC OET Bulletin 65 Supplement C, the criteria listed in Table 1 shall be used to evaluate the environmental impact of human exposure to radio

(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 ²) | Averaging Time E ² , H ² or S (minutes) |
|-----------------------|-----------------------------------|-----------------------------------|---|---|
| 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 |
| 300-1500 | -- | -- | f/1500 | 30 |
| 1500-100,000 | -- | -- | 1.0 | 30 |

f = frequency in MHz *Plane-wave equivalent power density frequency (RF) radiation as specified in §1.1307.

Table 1 : Limits for Maximum Permissible Exposure (MPE)

IC RULES:

IC has adopted the RF field strength limits established in Health Canada's RF exposure guideline. The limits are shown in Table 2 below per RSS 102.

| Frequency Range (MHz) | Electric Field (V/m rms) | Magnetic Field (A/m rms) | Power Density (W/m ²) | 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 ^{0.5} | 0.0042 f ^{0.5} | f/150 | 6 |
| 1500-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | 616000/f ^{1.2} |
| 150000-300000 | 0.158 f ^{0.5} | 4.21 x 10 ⁻⁴ f ^{0.5} | 6.67 x 10 ⁻⁵ f | 616000/f ^{1.2} |

Note: f is frequency in MHz.

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

Table 2 : RF Field Strength Limits for Devices Used by the General Public
(Uncontrolled Environment)

EQUATIONS:

Power density is given by :

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

where S = Power density (mW/cm²) EIRP = Equivalent Isotropic Radiated Power (mW)

D = Separation distance (cm)

3. Product Declarations

The HL6528 wireless module can be installed for use in any mobile host as long as the antenna gain of the host antenna does not exceed the gain listed in table 3.

This MPE analysis is applicable to any collocated transmitters with transmit power:

- less than or equal to 29.0dBm for WLAN/WiMAX; and
- less than or equal to 15.0dBm for BT.

Specific FCC IDs for those devices are not necessary or identified in this analysis providing they are classified as mobile transmitters. A 100% duty cycle is used for calculations to present a worse-case analysis when applicable.

| Mode | Equipment Category | Max Transmitter Duty Cycle | Transmitter Range (MHz) | Maximum Conducted Power | | Maximum Antenna Gain (dBi) | |
|------|--------------------|----------------------------|-------------------------|-------------------------|------|----------------------------|------------|
| | | | | (dBm) | (W) | Standalone | Collocated |
| GPRS | Class10 | 25% | 824-849 | 34.0 | 2.51 | 5.5 | 2.5 |
| | | | 1850 -1910 | 31.0 | 1.26 | 2.0 | 2.0 |

Table 3: HL6528 Standalone and Collocated Transmission Declarations

4. MPE Calculations

The WWAN MPE calculations are based on conservative conducted transmit power exceeding those listed in the FCC ID N7NHL6528 and IC number 2417C-HL6528 filing. The higher transmit power levels are used to present a worst case assessment.

The WiMAX, WLAN, and BT transmit power and antenna gain parameters represent a maximum transmit power for a given frequency band.

Integration of either a WiMAX or WLAN, and BT module that exceeds the parameters requires a new FCC authorization or permissive change application. A maximum antenna gain of 5 dBi for WLAN/WiMAX/BT has been assumed for all collocated antennas.

Table 4, 5, and 6 summarize transmitter parameters associated with this analysis.

4.1. Individual Transmitter Calculations

4.1.1. Maximum Output Power

The maximum power calculations for HL6528 per wireless technology are shown in Table 4

| | Technology | Frequency (MHz) | Maximum Conducted Power (dBm) | Maximum Conducted Power (W) | Maximum Antenna Gain (dBi) | Duty Cycle | Max EIRP (dBm) | Max EIRP (W) | Max ERP (dBm) | Max ERP (W) | Max output power limit |
|------------------------|------------|-----------------|-------------------------------|-----------------------------|----------------------------|------------|----------------|--------------|---------------|-------------|------------------------|
| HL6528-2.8V standalone | GPRS 1UL | 824-849 | 34.0 | 2.51 | 5.5 | 1.000 | 39.500 | 8.913 | 37.360 | 5.445 | 7 W ERP |
| | | 1850-1910 | 31.0 | 1.26 | 2.0 | 1.000 | 33.000 | 1.995 | 30.860 | 1.219 | 2 W EIRP |

Table 4: HL6528 Maximum Output Power Calculation

4.1.2. Standalone Power Density

The power density calculations for the individual transmitters per wireless technology at an exposure minimum separation distance of 20cm are shown in Table 5.

For frequency dependent limit, the lowest transmitter frequency was used to represent the lowest MPE limit in this analysis (eg. 824MHz = 0.549mW/cm²)

| | Technology | Frequency (MHz) | Maximum Conducted Power (dBm) | Maximum Conducted Power (W) | Maximum Antenna Gain (dBi) | Duty Cycle | Average EIRP (dBm) | Average EIRP (mW) | Power Density @ 20cm (mW/cm ²) | FCC MPE Limit (mW/cm ²) |
|-------------------|------------|-----------------|-------------------------------|-----------------------------|----------------------------|------------|--------------------|-------------------|--|-------------------------------------|
| HL6528 standalone | GPRS 1UL | 824-849 | 34.0 | 2.51 | 5.5 | 0.250 | 33.48 | 2228.127 | 0.443 | 0.549 |
| | | 1850-1910 | 31.0 | 1.26 | 2.0 | 0.250 | 26.98 | 498.816 | 0.099 | 1.000 |

Table 5: HL6528 Standalone MPE Calculation

4.2. Collocated MPE Calculation

The WiMAX, WLAN, and BT power levels listed represent the worse-case scenario for corresponding frequency ranges given.

| | Technology | Frequency (MHz) | Maximum Conducted Power (dBm) | Maximum Conducted Power (W) | Maximum Antenna Gain (dBi) | Duty Cycle | Average EIRP (dBm) | Average EIRP (mW) | Power Density @ 20cm (mW/cm ²) | FCC MPE Limit (mW/cm ²) |
|----------------------------|------------|-----------------|-------------------------------|-----------------------------|----------------------------|------------|--------------------|-------------------|--|-------------------------------------|
| HL6528 module (Collocated) | GPRS | 824-849 | 34.0 | 2.51 | 2.5 | 0.250 | 29.98 | 1116.709 | 0.222 | 0.549 |
| | | 1850-1910 | 31.0 | 1.26 | 2.0 | 0.250 | 26.98 | 498.816 | 0.099 | 1.000 |

Table 6: HL6528 Collocated MPE Calculation

Per OET Bulletin 65, when RF sources have difference frequencies, the fraction of the FCC power density limit shall be determined and the sum of all fractional components shall be less than 1.

| WLAN/WiMAX Band (GHz) | WLAN/WiMAX Pd (mW/cm ²) | BT Pd (mW/cm ²) | WLAN/WiMAX + BT Pd (mW/cm ²) | Limit |
|-----------------------|-------------------------------------|-----------------------------|--|-------|
| 2.3-2.4 | 0.500 | 0.020 | 0.520 | 1.000 |
| 2.4-2.5 | | | | |
| 2.5-2.7 | | | | |
| 3.3-3.8 | | | | |
| 5.15-5.85 | | | | |

Table 7: (WLAN or WiMAX) + BT Collocated MPE Calculation

| WLAN / WiMAX Band (GHz) | WLAN / WiMAX + BT Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WLAN / WiMAX + BT Pd) / (MPE Limit) | 850 MHz WWAN Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WWAN 850 MHz) / MPE Limit) | (850 MHz WWAN + WLAN / WiMAX + BT fraction) | Limit | Pass/Fail |
|-------------------------|--|-------------------------------------|--------------------------------------|---------------------------------------|-------------------------------------|-----------------------------|---|-------|-----------|
| 2.3-2.4 | 0.520 | 1.000 | 0.520 | 0.222 | 0.549 | 0.404 | 0.924 | 1.000 | Pass |
| 2.4-2.5 | | | | | | | | | |
| 2.5-2.7 | | | | | | | | | |
| 3.3-3.8 | | | | | | | | | |
| 5.15-5.85 | | | | | | | | | |

Table 8: WWAN 850MHz + WLAN / WiMAX + BT Collocated MPE Calculation

| WLAN / WiMAX Band (GHz) | WLAN / WiMAX + BT Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WLAN / WiMAX + BT Pd) / (MPE Limit) | 1900 MHz WWAN Pd (mW/cm ²) | FCC MPE Limit (mW/cm ²) | (WWAN 1700 MHz) / MPE Limit) | (1900 MHz WWAN + WLAN / WiMAX + BT fraction) | Limit | Pass/Fail |
|-------------------------|--|-------------------------------------|--------------------------------------|--|-------------------------------------|------------------------------|--|-------|-----------|
| 2.3-2.4 | 0.520 | 1.000 | 0.520 | 0.126 | 1.000 | 0.126 | 0.645 | 1.000 | Pass |
| 2.4-2.5 | | | | | | | | | |
| 2.5-2.7 | | | | | | | | | |
| 3.3-3.8 | | | | | | | | | |
| 5.15-5.85 | | | | | | | | | |

Table 9: WWAN 1900MHz + WLAN / WiMAX + BT Collocated MPE Calculation

5. Conclusion

Based on FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, the analysis concludes that the HL6528 wireless module, 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 condition, provided the conducted power and antenna gain do not exceed the limits in Table 12 for each given frequency band per wireless technology.

| | Technology | | Frequency (MHz) | Maximum Conducted Power (dBm) | Maximum Antenna Gain (dBi) | |
|----------------------------|------------|-------|-----------------|-------------------------------|----------------------------|------------|
| | | | | | Standalone | Collocated |
| HL65 28 | GPRS | | 824-849 | 34.0 | 5.5 | 2.5 |
| | | | 1850 -1910 | 31.0 | 2.0 | 2.0 |
| Collocated Transmitters | WLAN | | 2400 -2500 | 29.0 | | 5.0 |
| | WLAN | | 5150 -5850 | 29.0 | | 5.0 |
| | | WiMAX | 2300 -2400 | 29 | | 5.0 |
| | | WiMAX | 2500 -2700 | 29 | | 5.0 |
| | | WiMAX | 3300 -3800 | 29 | | 5.0 |
| | BT | BT | 2400 -2500 | 15 | | 5.0 |

Table 10: Summary of Maximum Conducted Power and Antenna Gain