

Maximum Permissible Exposure (MPE)

Related Submittal(s) / Grant (s)

This submittal(s) (test report) is intended to comply with Section Part 22, subpart H and Part 24, subpart E and Part27 subpart C & subpart L of the FCC CFR 47 Rules. And RSS-102 issue 4 For 47 CFR 1.1310 Radio frequency Radiation Exposure requirement.

Special Accessories

Not available for this EUT intended for grant.

Equipment Modifications

Not available for this EUT intended for grant.

Limitation

| Frequency Range | Electric Field | Magnetic Field | Power Density | Averaging Time | | | |
|---|----------------|----------------|------------------------|----------------|--|--|--|
| (MHz) | Strength (V/m) | Strength (A/m) | (mW/cm^2) | (minute) | | | |
| Limits for General Population/Uncontrolled Exposure | | | | | | | |
| 0.3-1.34 | 0.3-1.34 614 | | *(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 | | | |
| 1500-15000 | / | / | 1.0 | 30 | | | |

F = frequency in MHz

* = Plane-wave equipment power density

| 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 | $1.585 f^{0.5}$ | $0.0042 f^{0.5}$ | <i>f</i> /150 | 6 |
| 1500-15000 | 61.4 | 0.163 | 10 | 6 |
| 15000-150000 | 61.4 | 0.163 | 10 | 616000/f ^{1.2} |
| 150000-300000 | $0.158 f^{0.5}$ | $4.21 \ge 10^{-4} f^{0.5}$ | $6.67 \ge 10^{-5} f$ | 616000/f ^{1.2} |

Note: f is frequency in MHz.

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

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Maximum Permissible Exposure (MPE) Evaluation

In this application we seek approval to the 1KU1. Based on the FCC OET Bulletin 65 Supplement C and 47 CFR §2.1091, we have concluded that the 1KU1 module will comply with the FCC rules on RF exposure for mobile devices in cellular band and PCS band. The following analysis will demonstrate such compliance. The analysis will be done in two US bands.

Operation in cellular band (824.7 – 848.31 MHz)

The ERP of 1KU1 in cellular band is 22.95dBm max at CDMA2000 EVDO Cellular mode. The resulted power density at a distance of 20 cm can be deducted as follows:

| EUT | | | | | Ν | leasureme | ent | | |
|-------------------|------|--------------------------|-------|-----------------|----------------|-----------------|---------------|-------------|-------|
| Operation Band | Pol. | Fundamental Frequency | СН | Antenna Pol. | S.G. Output | Antenna Gain | Cable Loss | ERP | Limit |
| | | MHz | | V/H | dBm | dBi | dB | dBm | dBm |
| CDMA 2000 | | 824 70 | 1012 | V | 22.92 | 3.96 | -4.22 | 22.66 | 38.45 |
| | | 824.70 | 1015 | Н | 22.98 | 3.97 | -4.22 | 22.73 | 38.45 |
| CDMA 2000 | БJ | 836 57 | 384 | V | 22.81 | 4.00 | -4.24 | 24 22.57 38 | 38.45 |
| EVDO Cellular | E2 | 836.52 | 384 | Н | 22.55 | 4.00 | -4.24 | 22.31 | 38.45 |
| | | 848.31 | 777 - | V | 23.25 | 4.03 | -4.33 | 22.95 | 38.45 |
| | | | | Н | 21.47 | 4.03 | -4.33 | 21.17 | 38.45 |

ERP = 22.95 dBm = 197.242 mWPower Density = ERP*Duty Cycle/($4 \pi R^2$) $=197.242*1/(4*\pi *20^{2}) = 0.039 \text{ mW/cm}^{2}$

where Duty Cycle is 1 for CDMA operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

MPE limit = $824/1500 = 0.55 \text{ mW/cm}^2$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in cellular band is compliant with the FCC rules on RF exposure.

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Operation in PCS band (1851.25 - 1908.75 MHz)

The EIRP of 1KU1 in PCS band is 29.83dBm max at CDMA2000 EVDO PCS mode. The resulted power density at a distance of 20 cm can be deducted as follows:

| EUT | | | | | Ν | leasureme | ent | | |
|--------------------------|------|--------------------------|------|-----------------|----------------|-----------------|---------------|--|-------|
| Operation Band | Pol. | Fundamental Frequency | СН | Antenna Pol. | S.G. Output | Antenna Gain | Cable Loss | EIRP | Limit |
| | | MHz | | V/H | dBm | dBi | dB | dBm | dBm |
| | | 1851 25 | 25 | V | 31.14 | 4.17 | -5.49 | 29.83 | 33.00 |
| | | 1651.25 | 25 | Н | 26.22 | 4.51 | -5.49 | EIRP Limit dBm dBm 29.83 33.00 25.24 33.00 27.65 33.00 25.66 33.00 27.56 33.00 27.65 33.00 25.66 33.00 27.56 33.00 24.68 33.00 | |
| CDMA 2000 | БЭ | 1990.00 | 600 | V | 29.08 | 4.13 | -5.56 | 27.65 | 33.00 |
| CDMA 2000 EVDO PCS | E2 | 1880.00 | 600 | Н | 26.78 | 4.44 | -5.56 | 25.66 | 33.00 |
| | | 1908.75 | 1175 | V | 29.02 | 4.10 | -5.56 | 27.56 | 33.00 |
| | | | | Н | 25.87 | 4.37 | -5.56 | 24.68 | 33.00 |

EIRP = 29.83 dBm = 961.612 mW

Power Density = EIRP*Duty Cycle/ $(4 \pi R^2)$

 $=961.612*1/(4*\pi *20^{2}) = 0.191 \text{mW/cm}^{2}$

where Duty Cycle is 1 for CDMA2000 operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

MPE limit = 1.0 mW/cm^2

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in PCS band is compliant with the FCC rules on RF exposure.

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Operation in LTE band (779.5 - 784.56 MHz)

The ERP of 1KU1 in **LTE band 13 5MHz /QPSK /RB 1** is 23.17dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

| EUT Mode | Frequency (MHz) | СН | EUT Pol. | Antenna Pol. | SPA Reading (dBuV) | S.G. Output (dBm) | Antenna Gain (dBd) | Cable Loss (dB) | ERP (dBm) | Limit (dBm) |
|-------------|--------------------|-------|-------------|-----------------|--------------------------|-------------------------|--------------------------|-----------------------|--------------|----------------|
| | | | Ea | V | 119.98 | 33.14 | -7.87 | 3.53 | 21.74 | 44.70 |
| 5MHz BW | 779.50 | 23205 | E2 | Н | 117.78 | 27.08 | -7.87 | 5.84 | 13.37 | 44.70 |
| LTE-Band 13 | 782.00 | 22220 | E2 | V | 121.39 | 34.57 | -7.87 | 3.53 | 23.17 | 44.70 |
| (QPSK RB 1 | 782.00 | 25250 | | Н | 118.75 | 28.58 | -7.87 | 3.53 | 17.18 | 44.70 |
| Offset 0) | 784 50 | 22255 | | V | 119.90 | 33.11 | -7.87 | 3.54 | 21.70 | 44.70 |
| | / 64.30 | 23233 | E2 | Н | 117.66 | 28.02 | -7.87 | 3.54 | 16.61 | 44.70 |

ERP = 23.17dBm = 207.491mW Power Density = ERP*Duty Cycle/ $(4 \pi R^2)$ =207.491*1/ $(4*\pi * 20^2) = 0.041 \text{ mW/cm}^2$

where Duty Cycle is 1 for LTE operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

MPE limit = $779.5/1500 = 0.52 \text{ mW/cm}^2$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

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FCC ID: HFS1KU1

Operation in LTE band (779.5 - 784.56 MHz)

The ERP of 1KU1 in LTE band 13 5MHz /16QAM/RB 1 is 24.31dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

| EUT Mode | Frequency (MHz) | СН | EUT Pol. | Antenna Pol. | SPA Reading (dBuV) | S.G. Output (dBm) | Antenna Gain (dBd) | Cable Loss (dB) | ERP (dBm) | Limit (dBm) |
|-------------|--------------------|-------|-------------|-----------------|--------------------------|-------------------------|--------------------------|-----------------------|--------------|----------------|
| | 770.50 | 22205 | БЭ | V | 120.79 | 33.95 | -7.87 | 3.53 | 22.55 | 44.70 |
| 5MHz BW | //9.50 | 23205 | E2 | Н | 118.45 | 27.75 | -7.87 | 5.84 | 14.04 | 44.70 |
| LTE-Band 13 | 782.00 | 22220 | E2 | V | 122.53 | 35.71 | -7.87 | 3.53 | 24.31 | 44.70 |
| (16QAM RB | 782.00 | 23230 | | Н | 118.77 | 28.60 | -7.87 | 3.53 | 17.20 | 44.70 |
| 1 Offset 0) | 784 50 | 22255 | | V | 120.76 | 33.97 | -7.87 | 3.54 | 22.56 | 44.70 |
| | / 64.30 | 23233 | E2 | Н | 118.14 | 28.50 | -7.87 | 3.54 | 17.09 | 44.70 |

ERP = 24.31dBm = 269.774mW Power Density = ERP*Duty Cycle/ $(4 \pi R^2)$ =269.774*1/ $(4*\pi * 20^2)$ = 0.054 mW/cm²

where Duty Cycle is 1 for LTE operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET Bulletin 65 Supplement C and can be calculated as follows:

MPE limit =779.5/1500 = 0.52 mW/cm^2

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

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FCC ID: HFS1KU1

Operation in LTE band (782 MHz)

The ERP of 1KU1 in LTE band 13 10MHz /QPSK/RB 1 is 23.59dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

| EUT Mode | Frequency (MHz) | СН | EUT Pol. | Antenna Pol. | SPA Reading (dBuV) | S.G. Output (dBm) | Antenna Gain (dBd) | Cable Loss (dB) | ERP (dBm) | Limit (dBm) |
|-------------------------|--------------------|-------|-------------|-----------------|--------------------------|-------------------------|--------------------------|-----------------------|--------------|----------------|
| 10MHz BW LTE-Band 13 | 782.00 | 22220 | | V | 121.81 | 34.99 | -7.87 | 3.53 | 23.59 | 44.70 |
| (QPSK RB 1 Offset 0) | 782.00 | 23230 | E2 | Н | 117.45 | 27.28 | -7.87 | 3.53 | 15.88 | 44.70 |

ERP = 23.59dBm = 228.560mW Power Density = ERP*Duty Cycle/ $(4 \pi R^2)$ =228.560*1/ $(4* \pi * 20^2)$ = 0.045 mW/cm²

where Duty Cycle is 1 for LTE operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET

Bulletin 65 Supplement C and can be calculated as follows:

MPE limit = $782/1500 = 0.52 \text{ mW/cm}^2$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

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FCC ID: HFS1KU1

Operation in LTE band (782 MHz)

The ERP of 1KU1 in **LTE band 13 10MHz /16QAM /RB 1** is 24.03dBm max at LTE mode. The resulted power density at a distance of 20 cm can be deducted as follows:

| EUT Mode | Frequency (MHz) | СН | EUT Pol. | Antenna Pol. | SPA Reading (dBuV) | S.G. Output (dBm) | Antenna Gain (dBd) | Cable Loss (dB) | ERP (dBm) | Limit (dBm) |
|--------------------------|--------------------|-------|-------------|-----------------|--------------------------|-------------------------|--------------------------|-----------------------|--------------|----------------|
| 10MHz BW LTE-Band 13 | 782.00 | 22220 | | V | 122.25 | 35.43 | -7.87 | 3.53 | 24.03 | 44.70 |
| (16QAM RB 1 Offset 0) | 782.00 | 23230 | E2 | Н | 117.70 | 27.53 | -7.87 | 3.53 | 16.13 | 44.70 |

ERP = 24.03dBm = 252.930mW Power Density = ERP*Duty Cycle/ $(4 \pi R^2)$ =252.930*1/ $(4* \pi * 20^2)$ = 0.050 mW/cm²

where Duty Cycle is 1 for LTE operation and R is 20 cm.

The MPE limit for General Population/Uncontrolled Exposure is shown in the FCC OET

Bulletin 65 Supplement C and can be calculated as follows:

MPE limit = $782/1500 = 0.52 \text{ mW/cm}^2$

As we can see the resulted power density is below the MPE limit, therefore 1KU1 in LTE band is compliant with the FCC rules on RF exposure.

- End of Report -

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