



Global Product Certification
EMC-EMF Safety Approvals

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MAXIMUM PERMISSIBLE EXPOSURE REPORT

FCC Guidelines for Human Exposure IEEE C95.1 47 CFR Part 2.1091

Report Number: M1908029-2

Product: RFID Transceiver Module
Model: RM4

Client: Allflex USA, Inc.

Date of Issue: 30 January 2020

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MAXIMUM PERMISSIBLE EXPOSURE REPORT

Product: RFID Transceiver Module
Model: RM4
FCC ID: FCC ID: NQY-RM4

Tested for: Allflex USA. Inc.
Address: 2805 East 14th St. Dallas Texas, United States 75261-2266
Contact: Simon Alfaro
Telephone: (972) 456-3686

Standard(s):

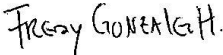
1. **IEEE Std C95.1: 1999 (2005)**
"IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz"
2. **47 CFR 1.1310**
"Radiofrequency radiation exposure limits"
3. **47 CFR Part 2.1091 (KDB 447498 D01, v06)**
"Radiofrequency radiation exposure evaluation: mobile devices"


Survey Date: 09th September 2019

Result: Based on the information provided and the electromagnetic field measurements taken the RFID Transceiver Module, model RM4 complies with the RF exposure requirements of 47 CFR Part 2.1091 and IEEE Std C95.1 Maximum Permissible Exposure (MPE) levels for uncontrolled environments. An exclusion zone of 20 cm around the radiating elements applies. Refer to report number M1908029-2 for full details.

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Issue Date: 30 January 2020

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MAXIMUM PERMISSIBLE EXPOSURE REPORT

1.0 INTRODUCTION

This report is intended to demonstrate compliance of the RFID Transceiver Module, model RM4 with the RF exposure requirements of 47 CFR Part 2.1091 and IEEE Std C95.1 Maximum Permissible Exposure (MPE) levels for uncontrolled environments.

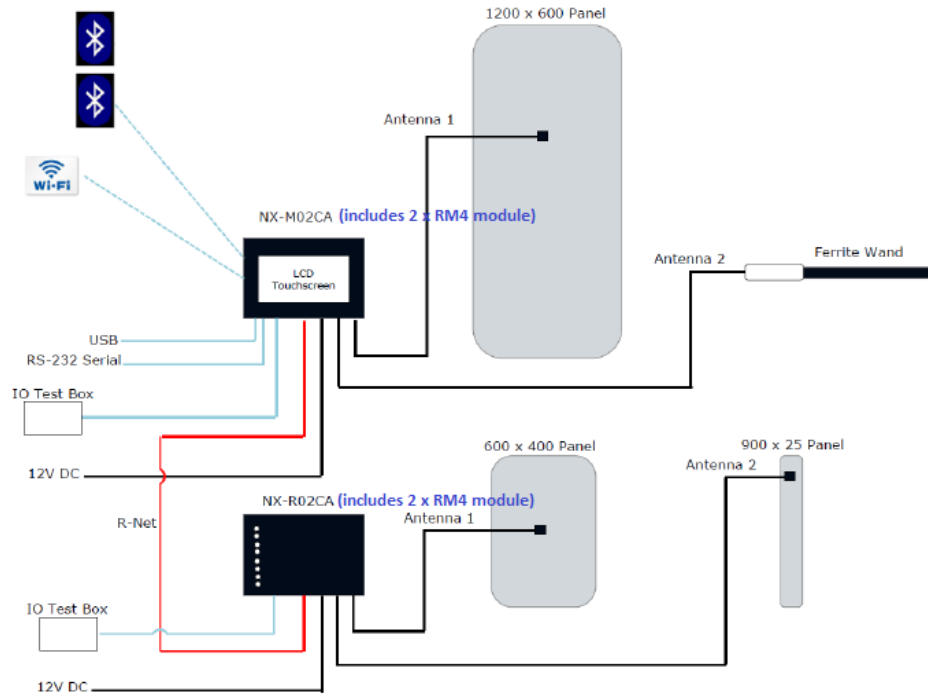
The terms RF (Radio Frequency) fields, Electromagnetic Radiation (EMR), Electromagnetic Fields (EMF) and Electromagnetic Energy (EME) have the same meaning when used in this report.

2.0 PRODUCT DESCRIPTION

| | |
|---------------------------------------|---|
| Radio: | Allflex USA. Inc. |
| Model: | RM4 |
| Highest Intentional Frequency: | 80 MHz |
| Operating Frequency: | 134.2 kHz |
| Antenna: | Type 1: 1200x600 panel antenna Type 2: 600x400 panel antenna Type 3: 900x25 panel antenna Type 4: ferrite wand antenna |
| Antenna Connector: | Socket: GT272213-23048 Plug: GT2722A4-2304B |
| Plug pack: | MEAN WELL |
| Model: | DR-4512 |
| Input supply: | 100-240V AC, 50/60 Hz, 1.5A |
| Output supply: | 12V DC, 3.5A |

2.1 Worst-case Setup

The MPE levels were assessed for the RM4 module deployed in its worst-case setup as detailed below.



2.2 RFID Reader Hosts

2.2.1 NX-M02CA Host with LCD Touch Screen

The NX-M02CA host with the LCD touch screen contains the following radio modules:

| | |
|--|--|
| Wireless Interface (1): | Wi-Fi, 802.11b/g/n (Realtek, RL-UM02BS) |
| Supported Frequencies: | 2412 MHz – 2462 MHz. |
| Max. Output Power: | 16 dBm |
| Antenna Type: | On board ceramic antenna |
| Antenna Gain: | 2 dBi |
| Wireless Interface (2): | Bluetooth V4.0 EDR/BLE (Laird Technologies, BT800) |
| Supported Frequencies: | 2400 MHz – 2483 MHz. |
| Max. Output Power: | 8 dBm |
| Antenna Type: | On board ceramic antenna |
| Antenna Gain: | 0.5 dBi |
| Wireless Interface (3): | Bluetooth V4.0 EDR/BLE (Laird Technologies, BT800) |
| Supported Frequencies: | 2400 MHz – 2483 MHz. |
| Max. Output Power: | 8 dBm |
| Antenna Type: | On board ceramic antenna |
| Antenna Gain: | 0.5 dBi |
| Wireless Interface (4): | RM4 (RFID) |
| Operating Frequency: | 134.2 kHz |
| Antenna Type: | Panel |
| Antenna Dimensions: | 1.2m x 0.6m |
| Antenna distance from Host (NX-M02CA) | <20 cm |
| Wireless Interface (5): | RM4 (RFID) |
| Operating Frequency: | 134.2 kHz |
| Antenna Type: | Ferrite Wand |
| Antenna Dimensions: | 0.5m x 0.03m |

Antenna distance from Host >100 cm
(NX-M02CA)

2.2.2 NX-R02CA Host

Wireless Interface (4): RM4 (RFID)
Operating Frequency: 134.2 kHz
Antenna Type: Panel
Antenna Dimensions: 0.6m x 0.4m
Antenna distance from Host <20 cm
(NX-M02CA)

Wireless Interface (5): RFID
Operating Frequency: 134.2 kHz
Antenna Type: Ferrite Wand
Antenna Dimensions: 0.9m x 0.05m
Antenna distance from Host >100 cm
(NX-M02CA)

Note: RM4 Power Setting=10 for the assessment/measurements.

3.0 ELECTROMAGNETIC FIELD STANDARDS

3.1 IEEE Std C95.1: 1999 (2005)

This IEEE Standard set Maximum Permissible Exposure (MPE) levels to RF Electromagnetic fields in the frequency range from 3 kHz to 300 GHz in order to prevent adverse health effects for humans. The Standard specifies limits for controlled and uncontrolled environments. It also provides criteria to assist in the determination of compliance with the specified levels and specifies procedures for the measurement of RF electromagnetic fields.

4.0 DEFINITIONS AND MPE LEVELS

4.1 MPE in Uncontrolled Environments (General Public)

Exposure associated with an uncontrolled environment is the exposure of individuals who have no knowledge or control of their exposure. The exposure may occur in living quarters or workplaces where there are no expectations that the exposure levels may exceed those shown in Table 1.

4.2 MPE in Controlled Environments (Occupational)

Exposure associated with a controlled environment includes exposure that may be incurred by persons who are aware of the potential for exposure as a concomitant of employment, exposure of other cognizant individuals, or exposure that is the incidental result of passage through areas where analysis shows the exposure levels may be above the MPE in uncontrolled environments but do not exceed MPE in controlled environments.

4.2.3 Maximum Permissible Exposure for Uncontrolled Environments

| Frequency range (MHz) | RMS electric field strength (E) ^a (V/m) | RMS magnetic field strength (H) ^a (A/m) | RMS power density (S) E-field, H-field (W/m ²) | Averaging time ^b E ² , H ² or S (min) | |
|-----------------------|--|--|---|--|--|
| | | | | | |
| 0.1–1.34 | 614 | 16.3/f _M | (1000, 100 000/f _M ²) ^c | 6 | 6 |
| 1.34–3 | 823.8/f _M | 16.3/f _M | (1800/f _M ² , 100 000/f _M ²) | f _M ² /0.3 | 6 |
| 3–30 | 823.8/f _M | 16.3/f _M | (1800/f _M ² , 100 000/f _M ²) | 30 | 6 |
| 30–100 | 27.5 | 158.3/f _M ^{1.668} | (2, 9 400 000/f _M ^{3.336}) | 30 | 0.0636 f _M ^{1.337} |
| 100–400 | 27.5 | 0.0729 | 2 | 30 | 30 |
| 400–2000 | – | – | f _M /200 | 30 | |
| 2000–5000 | – | – | 10 | 30 | |
| 5000–30 000 | – | – | 10 | 150/f _G | |
| 30 000–100 000 | – | – | 10 | 25.24/f _G ^{0.476} | |
| 100 000–300 000 | – | – | (90f _G –7000)/200 | 5048/[(9f _G –700)/f _G ^{0.476}] | |

Table 1: MPE levels for uncontrolled environments

Notes:

1. f is the frequency in MHz
2. The exposure values in terms of electric and magnetic field strengths are the mean values obtained by spatially averaging the squares of the fields over an area equivalent to the vertical cross section of the human body (projected area).
3. These plane-wave equivalent power density values, although not appropriate for near-field conditions, are commonly used as a convenient comparison with MPEs at higher frequencies and are displayed on some instruments in use.
4. Highlighted yellow row denotes the applicable limits at 134.2KHz and 2.4GHz

4.3 Units of Measurement

At RF frequencies the Electric Field is referred to as the E-field and the measurement unit is Volts per metre (V/m) and the Magnetic Field is referred to as the H-field and the measurement unit is Amps per metre (A/m)

4.3.1 Applicable Exposure Limits

The applicable MPE levels in uncontrolled environments in this report are 614 V/m and 121.46 A/m at 134.2KHz and 1mW/cm (10W/m²)

5.0 MEASUREMENT METHOD

5.1 Test Equipment

| Equipment Type | Make, Model and Serial Number | Calibration due | Calibrated by |
|-------------------------------|--|-----------------|---------------|
| EM Field Meter | Asset Number: P-199-1 Manufacturer: Wavecontrol Model Number: SMP2 S/N: 18WP100446/18SN0901 | 29/10/2020 | Wavecontrol |
| E-Field/ H-Field Probe | Asset Number: P-199-2 Manufacturer: Wavecontrol Model Number: WP400 Freq: 1Hz to 400KHz Measurement Type: Selective/Broadband S/N: 18WP100466 | 29/10/2020 | Wavecontrol |

Table 2: Test Equipment List

5.2 Measurement Procedures

RFID transmission at 134.2 kHz was activated using the touch screen (RFM Power Setting= 10). E-field (V/m) and H-field (A/m) measurements were taken using the Wavecontrol Meter/Probe described above (mounted on a non-magnetic aluminium tripod) in units of Amps per metre (A/m) and Volts per metre (V/m) respectively. The field meter was set on current RMS. Measurements were performed in front of the Readers (1.2m x 0.6m; 0.4m x 0.6m; 0.9m x 0.05m; 0.5 x 0.03m) at 0.2m.

5.3 Measurement Uncertainty

EMC Technologies has evaluated the tools and methods used to perform Radiated Electromagnetic Field predictions.

The Measurement Uncertainties for DC and ELF electromagnetic field measurements are derived from the manufacturer, Instruments' stated uncertainty factors and calibration data. The analysis is documented in EMC Technologies Quality document, Measurement Uncertainties, Rev 3-18, Part 33, Magnetic Field Measurements - Static Fields Survey:

DC to 400kHz ± 2.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of $k=2$, providing a level of confidence of approximately 95%.

5.4 Measurement Limitations

The measurement results are indicative only. The actual level of exposure is dependent on the actual environment, installation and the transmission state of the RF source.

6.0 MEASUREMENT RESULTS

The results in this report are applicable in the front/back of the readers due to the characteristics of the electromagnetic field around this type of antennas.

GP Limits @134.2KHz:

E-Field Limit: 614 V/m

H-Field Limit: 121.46 A/m

6.1 Large Panel Antenna with RM4 module

| Distance [m] | Measurement Point | E-Field (V/m) | | | | H-Field (A/m) | | | |
|--------------|-------------------|------------------|------------|----------------------|------------|------------------|------------|----------------------|------------|
| | | Measured E-Field | % GP Limit | Spatial Avg. E-Field | % GP Limit | Measured H-Field | % GP Limit | Spatial Avg. H-Field | % GP Limit |
| 0.2 | 1 | 171.4 | 27.92% | 153.30 | 25% | 8.58 | 7.06% | 9.96 | 8% |
| | 4 | 196.4 | 31.99% | | | 13.06 | 10.75% | | |
| | 7 | 50.56 | 8.23% | | | 7.32 | 6.03% | | |
| | 2 | 226.5 | 36.89% | 162.16 | 26% | 13.98 | 11.51% | 13.81 | 11% |
| | 5 | 163.1 | 26.56% | | | 15.96 | 13.14% | | |
| | 8 | 31.34 | 5.10% | | | 11.06 | 9.11% | | |
| | 3 | 220.4 | 35.90% | 174.46 | 28% | 12.46 | 10.26% | 12.61 | 10% |
| | 6 | 180.6 | 29.41% | | | 14.14 | 11.64% | | |
| | 9 | 100.6 | 16.38% | | | 11.04 | 9.09% | | |

Table 3: E-Field and H-Field Measurements (Large Panel Antenna 1.2m x 0.6m)

6.2 Small Panel Antenna (1) with RM4 module

| Distance [m] | Measurement Point | E-Field (V/m) | | | | H-Field (A/m) | | | |
|--------------|-------------------|------------------|------------|----------------------|------------|------------------|------------|----------------------|------------|
| | | Measured E-Field | % GP Limit | Spatial Avg. E-Field | % GP Limit | Measured H-Field | % GP Limit | Spatial Avg. H-Field | % GP Limit |
| 0.2 | 1 | 140.6 | 22.90% | 147.84 | 24% | 14 | 11.53% | 15.00 | 12% |
| | 4 | 138.2 | 22.51% | | | 17.48 | 14.39% | | |
| | 7 | 163.4 | 26.61% | | | 13.17 | 10.84% | | |
| | 2 | 124.5 | 20.28% | 129.53 | 21% | 17.42 | 14.34% | 17.20 | 14% |
| | 5 | 113.2 | 18.44% | | | 19.47 | 16.03% | | |
| | 8 | 148.4 | 24.17% | | | 14.32 | 11.79% | | |
| | 3 | 132.8 | 21.63% | 130.13 | 21% | 14.57 | 12.00% | 14.79 | 12% |
| | 6 | 180.6 | 29.41% | | | 14.14 | 11.64% | | |
| | 9 | 100.6 | 16.38% | | | 11.04 | 9.09% | | |

Table 4: E-Field and H-Field Measurements (Small Panel Antenna 0.4m x 0.6m)

6.3 Small Panel Antenna (2) with RM4 module

| Distance [m] | Measurement Point | E-Field (V/m) | | | | H-Field (A/m) | | | |
|--------------|-------------------|------------------|------------|----------------------|------------|------------------|------------|----------------------|------------|
| | | Measured E-Field | % GP Limit | Spatial Avg. E-Field | % GP Limit | Measured H-Field | % GP Limit | Spatial Avg. H-Field | % GP Limit |
| 0.2 | 1 | 91.26 | 14.86% | 86.62 | 14% | 1.6 | 1.32% | 1.58 | 1% |
| | 2 | 90.64 | 14.76% | | | 1.9 | 1.56% | | |
| | 3 | 77.22 | 12.58% | | | 1.14 | 0.94% | | |

Table 5: E-Field and H-Field Measurements (Small Panel Antenna 0.9m x 0.05m)

6.4 Ferrite Wand Antenna with RM4 module

| Distance [m] | Measurement Point | E-Field (V/m) | | | | H-Field (A/m) | | | |
|--------------|-------------------|------------------|------------|----------------------|------------|------------------|------------|----------------------|------------|
| | | Measured E-Field | % GP Limit | Spatial Avg. E-Field | % GP Limit | Measured H-Field | % GP Limit | Spatial Avg. H-Field | % GP Limit |
| 0.2 | 1 | 162.6 | 26.48% | 327.70 | 53% | 10.78 | 8.88% | 6.81 | 6% |
| | 2 | 147.5 | 24.02% | | | 7.32 | 6.03% | | |
| | 3 | 123.8 | 20.16% | | | 3.29 | 2.71% | | |
| | 4 | 605 | 98.53% | | | 2.2 | 1.81% | | |

Table 6: E-Field and H-Field Measurements (Ferrite Wand Antenna 0.5 x 0.03m)

7.0 ASSESSMENT RESULTS

The MPE was evaluated at 20 cm to show compliance with the applicable power density (S) limit of 1 mW/cm (10 W/m²).

The following formula was used to calculate the power density at 20 cm

$$S = \frac{P * G}{4\pi R^2}$$

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

Where

(S): Power density (*mW/cm²*)

(P): Output power at antenna terminal (*mW*)

(G): Gain (ratio)

(R): Minimum test separation distance (*20 cm*)

| Technology | Frequency Band (MHz) | Power | Gain | Duty Cycle | EIRP | EIRP | Flux Density at 20 cm | Flux Density limit | Percentage of the GP limit |
|---|----------------------|------------|------------|------------|------------|-----------|--------------------------|--------------------------|----------------------------|
| | | <i>dBm</i> | <i>dBi</i> | % | <i>dBm</i> | <i>mW</i> | <i>mW/cm²</i> | <i>mW/cm²</i> | % |
| Wi-Fi | 2412 - 2462 | 16 | 2 | 100% | 18.00 | 63.10 | 0.0126 | 1.00 | 1.26% |
| BT | 2400 - 2483 | 8 | 0.5 | 100% | 8.50 | 7.08 | 0.0014 | 1.00 | 0.14% |
| BT | 2400 - 2483 | 8 | 0.5 | 100% | 8.50 | 7.08 | 0.0014 | 1.00 | 0.14% |
| Total percentage of the limit for simultaneous transmission at 20 cm | | | | | | | | | 1.54% |

7.1 Co-location consideration:

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 .

$$\sum_{1}^N \frac{S_{eqN}}{S_{limN}} = \frac{S_{eq1}}{S_{lim1}} + \frac{S_{eq2}}{S_{lim2}} + \dots + \frac{S_{eqN}}{S_{limN}} \leq 1$$

Where: S_{eq} = Power Spectral density (mW/cm²) of a specific transmitter
 S_{lim} = MPE limit (mW/cm²)

The following simultaneous/co-location transmissions are possible with radiating elements within 20 cm of each other:

NX-M02CA Host with LCD Touch Screen

| Transmitter 1 | Transmitter 2 | Transmitter 3 | Transmitter 4 | MPE Ratio Sum | Result |
|---------------|---------------|---------------|---------------|---------------|--------|
| WiFi | BT | BT | RM4 | 0.30 | Pass |

8.1 UNCERTAINTY

EMC Technologies has evaluated the tools and methods used to perform Radiated Electromagnetic Field predictions. The estimated measurement uncertainties for the calculation shown within this report are as follows:

Electromagnetic Modelling; 30 MHz to 100GHz ±2.8 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

8.2 ASSUMPTIONS IN THIS ASSESSMENT

This assessment does not include accumulated RF fields from nearby sites/antennas or possible radio signal reflections or attenuation due to buildings or the general environment.

Antenna Parameters and power settings were supplied by the customer.

A 100% duty cycle is assumed.

The aperture of the radiating element assumed to be a point source in free space and far field conditions.

9.0 CONCLUSION

Based on the information provided and the electromagnetic field measurements taken the RFID Transceiver Module, model RM4 complies with the RF exposure requirements of 47 CFR Part 2.1091 and IEEE Std C95.1 Maximum Permissible Exposure (MPE) levels for uncontrolled environments. However, an exclusion zone of 20 cm around the radiating elements (Including RFID readers) applies. Refer to section 6 and 7 for full details.