

SECTION 8

RF EXPOSURE INFORMATION

5.1 RF Safety Requirements to 2.1091 for Mobile Transmitters

The unit under evaluation has various external antennas. Cirronet Corporation calculated the MPE emission values for a HN2010 with each of the antennas. The maximum power density occurs when using the 24 dBi dish for fixed applications and with the 12 dBi omnidirectional for mobile applications. They used the formula shown in OET Bulletin 65 and calculated the minimum distance between antenna and unsuspecting user as 26.0 cm for fixed applications and 6.5 cm for mobile applications.

Cirronet Corporation will sell the HN2010 with one of the following antennas:

Previously Approved Antennas as Listed in Original Submittal

MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dBi
ACE	Dipole	ACE-2400NF	2 dBi
Cushcraft	Yagi	PC2415-RTNF	15 dBi
Mobile Mark	Omni-Directional	OD6-2400-RTNC	6 dBi
Mobile Mark	Omni-Directional	OD12-2400PTA-RTNC	12 dBi
Mobile Mark	Corner Reflector	SCR14-2400PTA-RTNC	14 dBi
Mobile Mark	Patch	P7-2400RTNC	7 dBi
Cirronet Corporation.	Patch	PA2410	Appx. 3 dBi

New Additional Antennas Covered by Permissive Change Application

MANUFACTURER	TYPE OF ANTENNA	MODEL	GAIN dBi
Mobile Mark	Vehicle Mount	RM3-2400-RTNC	2.5 dBi
Mobile Mark	Corner Reflector	SCR9-2400-RN	9 dBi
MaxRad	Whip	MUF24005-RTNC	5 dBi
Andrews	Parabolic Dish	26T-2400 A	24 dBi
Andrews	Parabolic Dish	18T-2400 A	18 dBi

5.1 RF Safety Requirements to 2.1091 for Mobile Transmitters – Cont.

Power Output

The EUT's maximum expected output power as shown in the original grant of certification (FCC ID: HSW-2410M) was

Frequency of Fundamental (MHz)	Measurement (dBm)*	Measurement (Watt)*	FCC Limit* (Watt)
2401.9	16.2	0.041	1.0
2440.0	16.8	0.047	1.0
2483.5	16.8	0.047	1.0

* Measurement includes 0.3 dB for cable loss

MANUFACTURER	TYPE OF ANTENNA	MODEL	MPE CLASSIFICATION	GAIN dB	MAX EIRP dBm
ACE	Dipole	ACE-2400NF	Mobile	2 dBi	18.8
Cushcraft	Yagi	PC2415-RTNF	fixed	15 dBi	31.8
Mobile Mark	Omni-Directional	OD6-2400-RTNC	Mobile	6 dBi	22.8
Mobile Mark	Omni-Directional	OD12-2400PTA-RTNC	Mobile	12 dBi	28.8
Mobile Mark	Corner Reflector	SCR14-2400PTA-RTNC	fixed	14 dBi	30.8
Mobile Mark	Patch	P7-2400RTNC	Mobile	7 dBi	23.8
Cirronet Corporation.	Patch	PA2410	Mobile	Appx. 3 dBi	19.8
Mobile Mark	Vehicle Mount	RM3-2400-RTNC	Mobile	2.5 dBi	19.3
Mobile Mark	Corner Reflector	SCR9-2400-RN	fixed	9 dBi	25.8
MaxRad	Whip	MUF24005-RTNC	Mobile	5 dBi	21.8
Andrews	Parabolic Dish	26T-2400 A	fixed	24 dBi	40.8
Andrews	Parabolic Dish	18T-2400 A	fixed	18 dBi	34.8

The maximum EIRP expected for fixed installations is with the +24 dBi gain parabolic dish antenna. This would yield and maximum EIRP of 16.8 dBm + 24 dBi = +40.8 dBm.

The maximum EIRP expected for mobile installations is with the +12 dBi gain omnidirectional antenna. This would yield and maximum EIRP of 16.8 dBm + 12 dBi = +28.8 dBm.

5.1 RF Safety Requirements to 2.1091 for Mobile Transmitters – Cont.

Source Based Time Averaging

Additionally, source based time averaging may be applied as the worse case transmit duty cycle is given as follows:

Worst Case Transmit Duty Cycle for HN2010

This factor was calculated by first determining the worst case scenario for system operation - worst case being defined as the scenario when the HN2010 would be transmitting the longest period during a dwell.

This worst case operating scenario is as follows:

- 1) point-to-point operation
(only two units communicating with one another)
- 2) data flow is almost completely unidirectional
(that is, one radio is relaying a large amount of data to the other radio with only synchronization data being passed back the other direction)
- 3) The amount of data being fed to the sending radio is exactly portioned out to fit the maximum packet size allowable (280 bytes). The radio cannot send more than 280 bytes on a single channel – additional data must be sent on the next hop.

For this example, a remote unit is transferring a large data file to a base unit. The maximum transmit time by Remote on a single channel would be:

$$= 280 \text{ bytes} * 8 \text{ bits/byte} * (1/460.8 \text{ Kbps}) = 4.86 \text{ ms}$$

The minimum hop duration for this scenario would be 6.94 ms. This transmit pattern would continue on each channel and is considered repetitive. Therefore, for purposes of MPE, the transmission duty cycle correction factor is then calculated as:

$$\text{Duty cycle} = (\text{on time})/(\text{total time}) = 4.86/6.94 = 70.0 \%$$

5.1 RF Safety Requirements to 2.1091 for Mobile Transmitters – Cont.

This yields for a duty cycle correction of $10 \log(0.70) = -1.5 \text{ dB}$. Therefore the maximum EIRP for fixed installations may be expected to be

MANUFACTURER	TYPE OF ANTENNA	MODEL	MPE CLASSIFICATION	GAIN dB	MAX EIRP dBm
ACE	Dipole	ACE-2400NF	Mobile	2 dBi	17.3
Cushcraft	Yagi	PC2415-RTNF	fixed	15 dBi	30.3
Mobile Mark	Omni-Directional	OD6-2400-RTNC	Mobile	6 dBi	21.3
Mobile Mark	Omni-Directional	OD12-2400PTA-RTNC	Mobile	12 dBi	27.3
Mobile Mark	Corner Reflector	SCR14-2400PTA-RTNC	fixed	14 dBi	29.3
Mobile Mark	Patch	P7-2400RTNC	Mobile	7 dBi	22.3
Cirronet Corporation.	Patch	PA2410	Mobile	Appx. 3 dBi	18.3
Mobile Mark	Vehicle Mount	RM3-2400-RTNC	Mobile	2.5 dBi	18.0
Mobile Mark	Corner Reflector	SCR9-2400-RN	fixed	9 dBi	24.3
MaxRad	Whip	MUF24005-RTNC	Mobile	5 dBi	20.3
Andrews	Parabolic Dish	26T-2400 A	fixed	24 dBi	39.3
Andrews	Parabolic Dish	18T-2400 A	fixed	18 dBi	33.3

$$+40.8 \text{ dBm} - 1.5 \text{ dB} = +39.3 \text{ dBm}$$

$$\text{Antilog}(39.3 \text{ dBm}/10) = 8511.4 \text{ mW}$$

The maximum EIRP for mobile installations may be expected to be

$$+28.8 \text{ dBm} - 1.5 \text{ dB} = +27.3 \text{ dBm}$$

$$\text{Antilog}(27.3 \text{ dBm}/10) = 537.0 \text{ mW}$$

5.1 RF Safety Requirements to 2.1091 for Mobile Transmitters – Cont.

MPE Calculations

The limits for this unit (uncontrolled exposure) are 1.0 mW/cm². Taking the RF Density Field Equation:

$$S = (\text{EIRP in mW}) / (4\pi R^2) \text{ and solving for Distance R}$$

$$R = \text{SQRT} ((\text{EIRP in mW}) / (S4\pi))$$

Solving the above equation yields

MANUFACTURER	TYPE OF ANTENNA	MODEL	MPE CLASSIFICATION	GAIN dB	DISTANCE R
ACE	Dipole	ACE-2400NF	Mobile	2 dBi	2.0
Cushcraft	Yagi	PC2415-RTNF	fixed	15 dBi	9.2
Mobile Mark	Omni-Directional	OD6-2400-RTNC	Mobile	6 dBi	3.3
Mobile Mark	Omni-Directional	OD12-2400PTA-RTNC	Mobile	12 dBi	6.5
Mobile Mark	Corner Reflector	SCR14-2400PTA-RTNC	fixed	14 dBi	8.2
Mobile Mark	Patch	P7-2400RTNC	Mobile	7 dBi	3.7
Cirronet Corporation.	Patch	PA2410	Mobile	Appx. 3 dBi	2.3
Mobile Mark	Vehicle Mount	RM3-2400-RTNC	Mobile	2.5 dBi	2.2
Mobile Mark	Corner Reflector	SCR9-2400-RN	fixed	9 dBi	4.6
MaxRad	Whip	MUF24005-RTNC	Mobile	5 dBi	2.9
Andrews	Parabolic Dish	26T-2400 A	fixed	24 dBi	26.0
Andrews	Parabolic Dish	18T-2400 A	fixed	18 dBi	13.0

$$R \text{ (cm)} = \text{SQRT} (8511.4(\text{mw}) / (1.0(\text{mW}/\text{cm}^2) * 4 * \pi)) = 26.0 \text{ cm for fixed installations}$$

$$R \text{ (cm)} = \text{SQRT} (537.0(\text{mw}) / (1.0(\text{mW}/\text{cm}^2) * 4 * \pi)) = 6.5 \text{ cm for mobile installations}$$

Since the EUT is designed for mobile and fixed applications (where the expected separation distance between antenna and humans is greater than 20 cm or 2 m respectively), all manual instructions have specified 20 cm or 2 meters as appropriate for the types of antenna being used the minimum exposure distance.