

Environmental Evaluation of RF Exposure for the CM-42 Module

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1. Introduction

1.1. Purpose of the Report

This technical report is a detailed environmental evaluation of the radio frequency exposure expected from use of the CM42 transmitter. The following analysis demonstrates that the CM42 device is in compliance with the requirements for maximum permissible exposure (MPE) to radiofrequency exposure as defined in the FCC Rules, 47 CFR 2.1091, as amended.

1.2. Description of the CM42 Device

The CM42 Transceiver has been designed as an OEM module for use by various OEM integrators. For all applications, the radiating antenna is not provided with this product and must be supplied by the customer. All calculations related to MPE are made using antenna gain guidelines provided in customer documentation such as the CM42 OEM Interface Manual.

The module has three functional modes of operation:

- (1) AMPS mode - Class 1 device
- (2) CDMA mode – Band class 0 (cellular band), Class III device
- (3) CMDA mode – Band class 1 (PCS band), Class II device

In the cellular band (824 to 849 MHz), the transmitter section delivers up to 3 watts continuous output power in AMPS mode of operation. In CDMA mode, in both the cellular and PCS bands, the module delivers less than 1 Watt.

This transceiver is designed primarily for vehicular telematics applications where the unit is located within the application and an external antenna, connected to the module through a length of coaxial cable, is located elsewhere on the vehicle.

2. Classification of Device / Applicability of Rules

2.1. Mobile devices

The CM42 module is properly defined as a mobile device per 47 CFR 2.1091 (b), which states that “mobile devices are defined as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating antennas and the body of the user or nearby persons.”

For most applications of the CM42, there is typically a separation distance of greater than 23 centimeters. The discussion below will demonstrate that the maximum likely exposures in these applications are significantly below the maximums permitted. However, whenever possible, the transmitter should be installed in such a manner as to make it unlikely that a human body can be maintained in close proximity (i.e. less than 23 centimeters) to the radiating antenna. A statement to this effect is included in the manual supplied to the Original-Equipment-Manufacturers (OEMs) developing applications using this device (CM42 OEM Interface Manual). This statement should make it clear that Ericsson does not mean to imply that proximities of less than 23 centimeters are unsafe. Rather, maintaining a separation of at least 23 centimeters simply ensures that the analysis below is valid and that the margins with respect to the maximum permissible exposures that are demonstrated below are maintained.

2.2. Excludability from routine environmental evaluation

47 CFR 2.1091 (c) states that “mobile devices that operate in the Cellular Radiotelephone Service...are subject to routine environmental evaluation for RF exposure prior to equipment authorization or use if...their effective radiated power (ERP) is 1.5 watts or more.”

For Class 1 operation, the CM42 transceiver is rated at 3 Watts of output power in AMPS mode. The module is shipped without an antenna so the actual ERP in the field will vary somewhat with different antennas and different applications. The User's Manual supplied to customers specifies the use of an antenna with maximum system gain of 1dBi (2.5dBi antenna gain and 1.5dB cable loss). Since the AMPS mode is continuous operation, maximum exposure calculations must be used to determine a minimum separation distance. Since the antenna is customer supplied, SAR evaluation is not feasible. The following sections analyze the maximum RF radiation exposures from a CM42 transmitter under maximum and typical conditions. This analysis will clearly demonstrate compliance with the amended FCC rules.

2.3. Applicable limits for exposure to radio frequency exposure

The following paragraphs analyze the maximum RF radiation exposures from a CM42 transmitter under extreme and typical conditions. This analysis will clearly demonstrate compliance with the amended FCC rules.

The table below is excerpted from Table 1B of 47 CFR 1.1310 titled Limits for Maximum Permissible Exposure (MPE), Limits for General Population/Uncontrolled Exposure:

Frequency Range (MHz)	Power Density (mW/cm ²)	Averaging Time (minutes)
300 – 1500	f/1500	30

where f = frequency in MHz

The highest frequency of operation in the cellular band is 850 MHz, so the MPE limit is $f/1500 = 850/1500 = 0.567 \text{ mW/cm}^2$.

In all systems calculations for the CM42 module the following assumptions are made:

Customer supplied antenna gain = 2.5dBi = 1.78
Antenna gain of standard dipole = 2.14dBi = 1.64
Insertion loss through connecting cable = 1.5 dB
Total directive gain of antenna system = 1dBi

Given power density $S = P_{\text{out}} \times D / 4\pi R^2$, where: P_{out} = transmitter output power from connector (Watts)
 D = directive gain of antenna relative to std. dipole
 R = spherical surface distance from origin

The effective radiated power (ERP) is defined as the product of the measured transmitter output power and the specified antenna system gain, relative to a half-wave dipole, in the direction of interest. If a distance of $R = 23 \text{ cm}$ is selected, then the ERP can be found as follows:

$$\begin{aligned} \text{ERP} &= P_{\text{out}} \times D = S \times 4\pi R^2 \\ &= .567 \times 4\pi \times 23^2 \\ &= 3.77 \text{ Watts} \end{aligned}$$

The maximum radiated power of 3.77 W represents the maximum average power that produces MPE limit levels at 23 cm over a 30 minute period. It should be noted that this power density equation is only accurate in the far-field and that at 23 cm distance, the MPE will be overestimated.

3. Maximum Exposure Analysis

3.1 Maximum exposure

To complete the calculations, the peak ERP delivered by the device must be determined. In AMPS mode, the CM42 is a CLASS 1 device calibrated to deliver 3 Watts to the antenna connector. The User's manual assumes the use of an antenna with 2.5dBi gain and 1.5dB cable loss between the module and the antenna. In extreme cases of temperature and voltage, the transmitter output tolerance is ± 2.0 dB.

3.2 Class 1 Operation – AMPS Mode

For Class 1 AMPS operation (continuous), the unit is calibrated to deliver 3.0W (34.8dBm) to the antenna connector but after tolerances and the antenna system gain are included, the field strength density becomes:

$$\begin{aligned}
 S &= P_{\text{out}} \times D / 4\pi R^2 & \text{where } P_{\text{out}} &= 34.8 + 2 \text{ (tolerance)} - 1.5 \text{ (cable loss)} = 3400 \text{ mW} \\
 & & D &= 1.78/1.64 = 1.08 \text{ (antenna gain relative to dipole)} \\
 & & R &= 23 \text{ cm} \\
 &= (3400 \times 1.08) / (4 \times \pi \times 23^2) \\
 &= .552 \text{ mW/cm}^2
 \end{aligned}$$

Note that this maximum exposure is below the MPE limit of 0.567 mW/cm^2 derived in section 2.3.

4. Typical exposure analysis

4.1 Typical Exposure - Telematics applications

This module is designed primarily for telematics applications in vehicles. In these applications, the unit is located in a remote area of the vehicle with a length of coaxial cable connecting the module to the antenna. The antenna is usually located in a prominent location on the vehicle and is typically a significant distance from the occupants. The module is designed to operate over the entire vehicular temperature range (-40C to +85C) and voltages so it is able to maintain the transmitter power very accurately, typically within ± 0.25 dB. Since the antenna is completely determined by the customer application, assumptions must be made as to the antenna system gain as shown in Section 2.3. With this information, a typical exposure can be calculated.

4.2 Class 1 Operation – AMPS Mode

For Class 1 AMPS operation (continuous), the device is calibrated in the factory to deliver a maximum of 3.0 Watts to the antenna connector. Typically, the transmitter output tolerance is ± 0.25 dB so the greatest output power seen at the antenna connector is 3.2 Watts. With the 1dBi (-1.14dBd) antenna system gain, the maximum ERP is 2.32 Watts (34.8dBm - 1.14dBm). The field strength density in this scenario is:

$$\begin{aligned}
 S &= \text{ERP} / 4\pi R^2 & \text{where } R &= 23 \text{ cm} \\
 &= 2320 / (4 \times \pi \times 23^2) \\
 &= .349 \text{ mW/cm}^2
 \end{aligned}$$

Note that this exposure is well below the MPE limit of 0.567 mW/cm^2 derived in section 2.3.

5. Conclusions

The preceding analysis makes it clear that any exposure to RF from the CM42 device is below the limits imposed by FCC regulations as long as a minimum separation distance of 23 centimeters is maintained. Due to the nature of telemetry and telematics applications using this device, close proximity of humans to the antenna during transmission is highly unlikely and the minimum separation distance is much greater than 23cm. In order to provide an even greater margin of comfort, applications developers (i.e. Ericsson's customers) will receive guidelines for use and installation of the CM42 device to ensure exposures do not exceed MPE limits.

Ericsson requests an exclusion from routine RF exposure evaluation based on the calculations presented in this report. The results clearly demonstrate compliance with the amended FCC rules.