MMT9000 Functional Overview

The MMT9000 is a 900MHz radio module intended to provide connectivity between an end-user's computer and an Internet Service Provider. It is a single PCB wireless solution based on the Intersil PRISM II Direct Sequence Chip Set. The MMT9000 is functionally equivalent to the EUM3005 (previously certified with FCC ID: OOX-EUM3005) in regards to frequency of operation, output power, and modulation scheme. Changes to the packaging, power converter, and antenna connector as well as commercial considerations require that the MMT9000 be re-submitted for certification.

The MMT9000 is intended for mounting in vehicles, such as Emergency Services, Police, Fire Department vehicles as well as mobile command centers.

Overall functionality

The MMT9000 consists of two main sections; the digital and the RF section. Block diagrams for both sections can be found in the document "MMT9000 Block Diagrams". The digital section contains the following functionality:

1. I/O
2. Ethernet PHY
3. Microprocessor/MAC
4. Memory
5. Power Regulation

The radio module's RF section contains the following functionality:

1. Baseband Processor
2. Modulator/Demodulator (with IF synthesizer)
3. RF Synthesizer
4. Up Converter
5. Power Amplifier
6. Low Noise Amplifier (LNA)
7. Down Converter
8. RF VCO
9. IF VCO
10. Reference Oscillator
11. Antenna (RF) Interface

During transmission, data obtained by the Microprocessor from the I/O ports, is transferred to the MAC. The MAC reformats the data and places it on the Baseband Processor TX data line. This data is modulated using CCK modulation and then spread using a defined PN code such that the data is sent at a rate of 2.75Mbit/s. The data is preceded by a header that uses DPSK modulation. Two signals are generated, the In-Phase (I) and Quadrature (Q) components. The I & Q signals are sent to the Modulator/Demodulator where they are first filtered and then modulated with the IF frequency (70 MHz).

The IF oscillator generates a 140 MHz signal which is divided by two inside the Modulator/Demodulator and used to modulate the I & Q signals. The final IF signal of 70 MHz is then sent to the Up converter. The Up converter will shift this signal to the RF frequency for the channel programmed in the synthesizer, for operation within the 902-928 MHz ISM band. In the final stage, this signal is amplified to produce +26 dBm RF power as measured at the output of the antenna port.

In receive mode, the radio signal is amplified by the LNA, and then sent to the Down converter. The Down converter converts this signal from the 902-928 MHz range to the IF frequency, 70 MHz. The Modulator/Demodulator then converts the signal to baseband and splits the signal into its I & Q components, before sending it to the Baseband Processor. Finally, the Baseband Processor despreads and demodulates the data contained in the CCK format, and places it on the RX data line to the MAC. The MAC modifies the data, then transfers it to the Microprocessor which reformats the information and sends it out the I/O ports.

The RF and IF Local Oscillator signals are generated using the synthesizers and voltage controlled oscillators. The RF synthesizer is programmed with the desired RF channel frequency plus the IF frequency. The IF synthesizer in the Modulator/Demodulator is programmed with 140MHz. The baseband processor and the synthesizer are driven from a common 44 MHz oscillator to control the timing of these chips.

Example (for Channel 1 operation)**:**

RF	**IF**	**LO**
905 MHz	+ 70 MHz	= 975 MHz

Output Power

Each MMT9000 is calibrated at 905, 915 and 925 MHz during manufacturing to output 26 dBm of power at the antenna connector.

The maximum time the transmitter is on is 5.1 msec after which it is in receive mode for at least 0.9 msec, so that the max. duty cycle is 5.1/6.0 = 85%. This duty cycle is not under the control of the user, but is inherent in the Dynamic Polled MAC used to control access to the channel.

Antennas

The antenna (RF) connector is a standard SMA connector and is connected to one of three certified antennas, two whip antennas and one panel antenna. The unit was qualified with these antennas.

There are two criteria on the max. EIRP for a Part 15 transmitter in the 902-928 MHz range: 1) Maximum of 36 dBm EIRP and 2) Max. of 0.603 mW/cm^2 for radiation exposure. By convention, a min. distance of 20 cm has been used for indoor antennas. Applying this distance to the radiation exposure limits the EIRP to 34.8 dBm. The min. separation distance required for an EIRP of 36 dBm is 22.9 cm.

The Mobile whip antennas can meet power density requirements of 1.1310 for a 20 cm separation between people and the antenna. In the worst case, the EIRP is 26 dBm at the antenna port (peak power) plus 7 dBi antenna gain for a total possible EIRP of 33 dBm, not taking into account any cable or connector losses, time averaging (duty cycle) or peak to average factors.

The Panel antenna is an outdoor antenna intended to be mounted in a permanent location or semi-permanent location, such as a command vehicle roof. With a gain of 9.3 dBi, this antenna requires 0.5 dB in installation losses to keep peak power at 34.8 dBm, so we are requiring a minimum of 6 feet of LMR200 cable to be used when installing this antenna. However, since it is an outdoor antenna, we are also requiring installers to provide at least 30 cm separation between people and the antenna. It is impractical to require 2 m as is conventional, since this antenna may be mounted on the roof of a van or trailer.

The following table shows antenna gains for each type of antenna and the associated antenna system gain including cable losses for typical installations. The cable for the panel antenna is LMR200 which has 0.1 dB per foot loss (reference Times Microsystem web site).

#	Manufacturer / Model	Power at Antenna Port (dBm) – peak	+ Antenna Gain (dBi)	Min. Cable Length (ft)	- Cable Loss (dB)	System EIRP (dBm)	Min. Sep. Warning
1	MaxRad / MUF9025NGPS	26	5	0	0	31	20 cm
2	RfLinx / RFLMA9-7	26	7	0	0	33	20 cm
3	MaxRad / Z1836	26	9.3	6	0.6	34.7	30 cm

Power Supply

The MMT9000 is powered from the vehicle power system, with a nominal 13.8 (+/- 25%) VDC input. The power supply includes an ignition sense line that can be wired in so that the unit will only be powered on when the vehicle engine is running or the accessories are powered up through the ignition switch.

Professional Installation

Given the environment that this unit is designed for (i.e. Emergency Services vehicles), this unit must be hard mounted to the vehicle. In addition, this unit must be wired into the vehicle power system, including the ignition sensing line of the power supply. The MMT9000 also requires good grounding to the vehicle ground system.

To protect the vehicle power system, a fuse assembly must also be wired in. Finally the antenna cable must be routed and the antenna installed on the vehicle (for fixed antenna mounts) or stored safely for magnetic mounts. All of this requires professional installation by a qualified installer.