GE Security, Inc.
Base Station Transceiver
B4Z-846-TCVR
Certification

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3/3/2004

GE Security, Inc.
1275 Red Fox Road
Arden Hills, MN 55112
(651) 777-2690

1. Introduction

This device is a radio transceiver. It receives signals from existing ITI transmitters or other transceivers. It transmits signals to other base station transceivers. A hardwired bus provides a data link to an external board or a security panel.

Both the receiver and the transmitter operate as frequency hopping spread spectrum (FHSS) links using the 902-928MHz ISM band. We are requesting Certification under FCC Rules, Part 15, Subpart C, Paragraph 15.247.

12VDC power is supplied to the device via either a hardwired bus connection or a Class 2 transformer.

Please send comments/suggestions on the report to paul.saldin@ge.com.

Grantee Code: B4Z

2. Statement of Compliance

§2.907 Certification

This is an application for certification

§2.911 Application

a) This is an application and has been filed electronically with form 731.

b) All information required has been supplied.

c) The applicant has signed the application (electronically).

d) The technical data has been signed.

e) Applicant signature block on electronic form 731 completed by officer of the company or authorized company personnel.

f) The appropriate fee has been paid electronically with VISA on 03/03/2004.

§2.915 Grant

This application demonstrates that all applicable technical standards have been met and a grant of this application will serve the public interest.

§2.925 Label

Each piece of equipment for which authorization will be granted will be uniquely identified with "FCC ID: B4Z-846-TCVR." The required statement will appear with the FCC ID on the product. See Exhibit A, "*id label.pdf*".

§2.947 Measurement Procedure

a) The scan of the restricted bands was made in a radiated manner, with the unit powered by Class 2 transformer. The radiated measurement procedure follows ANSI C63.4 procedure.

b) All other RF measurements were made in a conducted manner.

c) Procedural notes are contained in the laboratory report.

d) A list of test equipment used is contained in the laboratory report.

§2.948 Description of Measurement Facilities

Measurements were performed at TUV Testing Services Open Test Site. The FCC keeps a full description of the measurement facilities on file. TUV's acceptance and approval is dated as December 5, 1993 in a letter received from the FCC.

The address of the test facility is:
TUV Product Service
19035 Wild Mountain Road
Taylors Falls, MN 55084-1758

Phone: 651-638-0297
Contact: Joel Schneider
Test Engineer in Charge

See Exhibit B, *"test_pho.pdf"*, for sketch of radiated measurement setup.

§2.1033 Application for Certification

a) Form 731 has been electronically filed on 03/03/2004. Items that did not apply were left blank.

b) This technical report contains the following information where applicable.

1) Full name and mailing address of manufacturer and applicant for certification:
GE Security, Inc.
1275 Red Fox Road
Arden Hills, MN 55112

2) FCC Identifier:
B4Z-846-TCVR

3) Copy of installation instructions:
See Exhibit C, *"install manual.pdf"*

4) Brief Description of circuit functions and device operation:
   See Exhibit D, *"op_desc.pdf"* for operational description.
   See Exhibit E, *"schematic.pdf"* for schematic.
   See Exhibit F, *"ppd.pdf"* for parts placement diagram.
5) Block Diagram
   See Exhibit G, *"block.pdf"*.
6) Report of the measurements of radiated and conducted emissions:
   Exhibits M through Z show data and plots, and are discussed later in this report.
7) Photographs
   External:
   See Exhibit H, *"extern.pdf"*.
   Internal:
   See Exhibit I, *"intern.pdf"*.
8) Peripheral or Accessory devices:
   This device is designed to interface via hardwired bus to an external board or security panel. There are three external ports for the connection of these devices. See Exhibit D, *"op_desc.pdf"* for more information.
   The testing for this report was performed with a representative device connected to each of the external ports.
9) Transition Rules
   This application is not pursuant to the transition rules of §15.37.
10) Application for scanning receivers:
    Not applicable to this device.
11) Application for operation within the 59 – 64GHz band:
    Not applicable to this device.

c) Composite Systems
Not applicable to this device.

3. Lab Measurements Discussion / Test Notes

*3.1 Frequencies to be Examined [**§15.31(m)**]*

In accordance with the guidelines of §15.31(m), all conducted and radiated measurements were performed at the lower, middle, and upper frequencies of the 902-928MHz band.

*3.2 Antenna Requirement [**§15.203**]*

The transmitter antenna is permanently soldered to the circuit board, and therefore complies with the requirement that no other antenna shall be used with the device.

*3.3 Antenna Characteristics [**§15.204**]*

There is only one antenna proposed for use with this device. This antenna has the following characteristics:

3.3.1 Antenna Type

The antenna is approximately a ¼ wave monopole at 900MHz.

3.3.2 Antenna Manufacturer

None; the antenna is a simple wire soldered to the circuit board.

3.3.3 Antenna Gain

The ¼ wave monopole is a well known antenna type. The theoretical gain of an ideal ¼ wave monopole is 5.15dBi. The antenna on this transmitter has some non-ideal characteristics, finite ground plane being the most significant. Therefore, the antenna gain will be somewhat lower than the ideal number of 5.15dBi.

*3.4 Public Utility Power Line Measurements [**§15.207**]*

The voltage conducted back onto the AC power line was measured for all three system configurations and found to be in compliance with the Class B limits. Please see Exhibit M, *"ac line conducted emissions concord.pdf"*, Exhibit N, *"ac line conducted emissions caddx.pdf"*, and Exhibit O, *"ac line conducted emissions daughterboard.pdf"*.

*3.5 Frequency Hopping System Description[**§15.247(a)**]*

This system meets the definition of a frequency hopping spread spectrum system as follows:

3.5.1 Carrier Frequency Separation

Carrier frequency separation is 524kHz. This meets the requirement that it be greater than the 20dB bandwidth, which is 145kHz. See Exhibit P, *"channel separation.pdf"* and Exhibit Q, *"20dB bandwidth.pdf"*.

3.5.2 Randomization of Hopping Frequencies

A pseudorandomly ordered list of 50 hopping frequencies is used for carrier frequency selection. This list resides in non-volatile memory within the microcontroller. On each new hop, the software selects the next frequency in the list, resulting in a pseudorandom distribution and an equal use of each frequency on average. See Exhibit J, *"random freq list.pdf"*.

3.5.3 System Receiver Description

See Exhibit D, *"op_desc.pdf"* for a description of the system receiver.

3.5.4 Number of Hopping Frequencies

The system uses 50 hopping frequencies as required. See Exhibit J, *"random freq list.pdf"* for the list of the frequencies. See Exhibit R, *"number of hops.pdf"* for a plot showing usage of 50 frequencies. This plot was made by setting the spectrum analyzer to peak hold and presenting the transmitter with a continuous data stream.

3.5.5 Time of Occupancy

The dwell time on each frequency is 55.5msec. See Exhibit S, *"dwell time.pdf"* for a plot of the packet length. The software enforces a minimum interpacket delay of 46msec. This minimum delay between hops, in conjunction with the provision that all 50 hopping frequencies are used equally on average, guarantees that the transmitter shall not occupy any frequency for more than 0.4 seconds in a 20 second period.

3.5.6 20dB Bandwidth

The 20dB bandwidth of the modulated transmission is 145kHz. This complies with the requirement that the bandwidth be less than 500kHz. See Exhibit Q, *"20dB Bandwidth.pdf"*.

3.6 Output Power [§15.247(b)]

3.6.1 Peak Output Power

The peak output power of the transmitter is in compliance with the 1W limit for the low, middle and high channels. This data was taken with the unit operating in a continuous (non-modulated) manner. See Exhibit T, *"conducted output power.pdf"* for the conducted test data.

3.6.2 De Facto EIRP Limit

The gain of the transmit antenna is given earlier in this report. Because the gain of the antenna is less than 6dBi, the peak output power need not be reduced to comply with this requirement.

3.6.3 RF Exposure Compliance Requirements

The following discussion will establish compliance of this transmitter with FCC MPE regulations.

3.6.3.1 Peak Radiated Power for Purposes of RF Exposure Compliance

Exhibit T of this report shows that the peak output power of the transmitter is 19.42dBm. §3.3.3 of this report shows that the gain of the DUT antenna is 5.15dBi maximum. The transmitter peak radiated power is therefore obtained as follows:

Peak Radiated Power = 19.42dBm + 5.15dB = 24.57dBm

As allowed in §2.1091(d)(2), source-based time averaging may be used to reduce the declared RF exposure level. This transmitter has inherent duty cycle properties that may not be modified by the user and therefore fall under the source-based time averaging provision. The following is the derivation of the allowed correction factor for this transmitter.

The transmitter employs amplitude modulation and transmits 208 bits. Each bit has an "ON" time of 122 µS. The total on time of a single packet is:

208 * 122 µS = 25.376 msec.

The interpacket delay time of at least 45mS, enforced by the software, ensures that only one packet is sent in any given 100mS window. The duty cycle correction factor is therefore:

20*LOG(25.376/100) = -11.91 dB

Using the above peak radiated power and duty cycle correction factor, the peak power of this transmitter for determination of RF exposure levels is:

P = 24.57dBm – 11.91dB = 12.66dBm = 18.4mW

3.6.3.2 FCC RF Exposure Limit

For the purposes of demonstrating RF exposure compliance, the limits for general population/uncontrolled exposure in §1.1310 will be used. Table 1B of this section gives the allowed power density as:

Power Density Limit = f/1500 = 915/1500 = 0.61mW/cm^2

3.6.3.3 Calculation of Distance from Transmitter to Reach FCC Exposure Limit

The distance from the transmitter at which the allowed power density limit is reached may be calculated using the general relation:

Power Density = (Power Transmitted)/$4\pi r^2$

Solving for r, the distance from the transmitter, we have

$r = \text{sqrt}(P_t/4\pi P_d)$

Substituting the allowed FCC Exposure limit for P_d and the transmitter peak power for P_t, we have:

$r = \text{sqrt}(18.4\text{mW}/(4\pi(.61\text{mW}/\text{cm}^2))) = 1.55$ cm

3.6.3.4 Discussion and Conclusion

This result shows that a person must be within 1.55 cm of this transmitter in order to be exposed to the FCC RF exposure limit as given in §1.1310. Note also that this analysis assumes that the transmitter would be sending data packets continuously, which is not a realistic mode of operation. In an actual installation, the duty cycle is so low that the on-time of the transmitter would be reduced from this number by a factor of 1000 or more.

This device is intended to be permanently mounted in a fixed location. The preceding analysis shows that a person must essentially be touching the device in order to be exposed to the FCC RF exposure limit. Because of the unlikelihood of this situation and its incongruence with the intended use of the product, warning or caution labels regarding RF exposure are not necessary and will not be affixed to the device.

*3.7 **Spurious Emissions [§15.247(c)]***

3.7.1 Band-Edge Compliance

The transmitter was found to comply with the 20dB-down band-edge requirements with the hopping function both disabled and enabled.

In order to test with the hopping function disabled, the transmitter was put in a special mode in which it was locked on the low channel. Repeated data packets were then transmitted with the spectrum analyzer on peak hold at the low channel. The same test was then repeated for the high channel. The results of these tests are shown in Exhibit V, *"lower band edge no hop.pdf"* and Exhibit W, *"upper band edge no hop.pdf"*.

The hopping function was then enabled, and packets were transmitted until many had occurred at the low channel. The spectrum analyzer was once again on peak hold at the low channel. The same test was then repeated for the high channel. The results of these tests are shown in Exhibit X, *"lower band edge hop.pdf"* and Exhibit Y, *"upper band edge hop.pdf"*.

3.7.2 Spurious RF Conducted Emissions

Spurious emissions not lying in restricted bands were tested in a conducted manner. These emissions were tested with the transmitter tuned to low, mid, and high channels and transmitting in a continuous manner.

The 2nd and 7th are the only harmonics that lie in non-restricted bands. The power conducted at these harmonics was found to comply with the requirement that it be 20dB down from the fundamental. See Exhibit U, *"conducted spurious emissions.pdf"* for the conducted test data, showing a spectrum analyzer plot of the low, mid, and high frequency for each of the non-restricted harmonics.

3.7.3 Spurious RF Radiated Emissions

A complete scan was performed to determine the radiated field strength of spurious emissions falling within the restricted bands defined in §15.205. These emissions were tested with the transmitter tuned to low, mid, and high channels and transmitting in a continuous manner. The tests were performed with the DUT connected to all of the possible external hardwired systems. Each of these sytems was connected to the DUT through wires of at least 1m length. See Exhibit H, "*extern.pdf*", Figures 1 and 2, for pictures of the test setup and Exhibit D, "*op_desc.pdf*" for more information.

3.7.3.1 Calculation of allowed limit

For spurs above 1000MHz, §15.205(b) allows duty cycle averaging per §15.35. The following is the derivation of the allowed duty cycle correction factor for this transmitter.

The transmitter employs amplitude modulation and transmits 208 bits. Each bit has an "ON" time of 122 µS. The total on time of a single packet is:

208 * 122 µS = 25.376 msec.

The interpacket delay time of 45mS, enforced by the software, ensures that only one packet is sent in any given 100mS window. The duty cycle correction factor is therefore:

20*LOG(25.376/100) = -11.91 dB

The raw limit for spurs falling above 960MHz is given in §15.209 as 500 microvolts per meter, or 54 dBuV/m. After applying the duty cycle correction factor, the limit for this transmitter for spurs above 1000MHz in the restricted bands is:

54 – (-11.91) = 65.91 dBuV/m

3.7.3.2 Radiated Emissions Results

Results of the radiated scan are shown in Exhibit Z, *"radiated spurious emissions.pdf"*. These results show that all spurs lying in restricted bands above 1000MHz fall below the 65.91 dBuV/m limit. The highest spur was 9.64dB below the limit at 2.746GHz.

*3.8 True Frequency Hopping Compliance [**§15.247(g)**]*

The use of the pseudorandomly ordered frequency table, described previously in this report, guarantees that this system shall distribute its transmissions equally over 50 hopping channels should it be presented with a continuous data stream.

*3.9 Coordination of Systems [**§15.247(h)**]*

There is no intelligence in the transceiver with regard to coordinating the hopping sequence. Each transceiver works through its random table of frequencies independent of other transceivers that may be operating in the system. The transceiver therfore has no ability to coordinate its hopping in an effort to avoid simultaneous occupancy of individual hopping frequencies.