



**Maximum Permissible Exposure Evaluation**

**for**

**Symbol Technologies, Inc.  
RF1224**

**FCC ID: H9PRF1224  
IC: 1549D-RF1224**

June 21, 2006

**WLL PROJECT #: 9197**

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## Maximum Permissible Exposure Test Report

for

**FCC ID: H9PRF1224**  
**IC: 1549D-RF1224**

### 1.0 Introduction

This report has been prepared on behalf of SYMBOL TECHNOLOGIES, INC. RF1224. Transmitter to show compliance with the RF exposure requirements as defined in FCC §1.1307.

This device will operate with three radio frequency transmitters operating under the requirements of Pat 15.247 and 15.407:

- RFID, 902M – 928MHz
- Bluetooth, 2.4GHz
- WLAN: 2.4G and 5 GHz

### 1.1 Requirements

Three different categories of transmitters are defined by the FCC in OET Bulletin 65. These categories are fixed installation, mobile, and portable and are defined as follows:

- **Fixed Installations:** fixed location means that the device, including its antenna, is physically secured at a permanent location and is not able to be easily moved to another location. Additionally, distance to humans from the antenna is maintained to at least 2 meters.
- **Mobile Devices:** a mobile device is defined as a transmitting device designed to be used in other than fixed locations and to be generally used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structures and the body of the user or nearby persons. Transmitters designed to be used by consumers or workers that can be easily re-located, such as a wireless modem operating in a laptop computer, are considered mobile devices if they meet the 20 centimeter separation requirement. The FCC rules for evaluating mobile devices for RF compliance are found in 47 CFR §2.1091.
- **Portable Devices:** a portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the

body of the user. Portable device requirements are found in Section 2.1093 of the FCC's Rules (47 CFR§2.1093).

The FCC also categorizes the use of the device as based upon the user's awareness and ability to exercise control over his or her exposure. The two categories defined are Occupational/Controlled Exposure and General Population/Uncontrolled Exposure. These two categories are defined as follows:

- **Occupational/Controlled Exposure:** In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means. Awareness of the potential for RF exposure in a workplace or similar environment can be provided through specific training as part of a RF safety program. If appropriate, warning signs and labels can also be used to establish such awareness by providing prominent information on the risk of potential exposure and instructions on methods to minimize such exposure risks.
- **General Population/Uncontrolled Exposure:** The general population / uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity. Warning labels placed on low-power consumer devices such as cellular telephones are not considered sufficient to allow the device to be considered under the occupational/controlled category, and the general population/uncontrolled exposure limits apply to these devices.

The SYMBOL TECHNOLOGIES, INC. RF1224 is evaluated to the General Population/Uncontrolled Exposure limits.

## 1.2 Radio Frequency Radiation Exposure Evaluation

The MPE shall be calculated to show compliance with the power density limit for each radio and frequency individually at the minimum mounting distance. The total percentage of allowable RF Exposure will be calculated for each radio and then added to ensure the overall percentage does not exceed 100%. The following formula was used to calculate the Power Density for each radio:

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

Where:

S = Power Density

P = Output Power at the Antenna Terminals

G = Gain of Transmit Antenna (linear gain)

R = Distance from Transmitting Antenna

For multiple transmitters, the powers are summed proportionate to the percentage of power from each transmitter compared to their respective limits.

Transmitter Data:

<b>Transmitter Frequency</b>	<b>System Description</b>	<b>Power Output dBm</b>	<b>Maximum Antenna Gain dB</b>
902.7 MHz	RFID	29.98	6
2.4 GHz	Bluetooth	2.43	2
2.4 GHz	802.11b/g	19.4	-2.2
5 GHz	802.11a	18.95	-3.2

The following tables are the individual exposure calculations for each radio within the device.

**RFID Radio:**

<b>Transmitter #1</b>				
<b>Frequency</b>	902 MHz			
<b>Limit</b>	0.601 mW/cm <sup>2</sup>			
<b>Distance (cm), R =</b>	25 cm			
<b>Power (dBm), P =</b>	29.98 dBm	995.41 mW		
<b>TX Ant Gain (dB), G =</b>	6 dB			
<b>Power Density (S) =</b>	0.505 mW/cm <sup>2</sup>	(at 20cm)		
<b>Minimum Distance =</b>	22.9 cm			

**Bluetooth:**

<b>Transmitter #2</b>				
<b>Frequency</b>	2400 MHz			
<b>Limit</b>	1.000 mW/cm <sup>2</sup>			
<b>Distance (cm), R =</b>	25 cm			
<b>Power (dBm), P =</b>	2.43 dBm	1.75 mW		
<b>TX Ant Gain (dB), G =</b>	2 dB			
<b>Power Density (S) =</b>	0.0004 mW/cm <sup>2</sup>	(at 20cm)		
<b>Minimum Distance =</b>	0.5 cm			

**802.11b/g, 2.4G Radio:**

<b>Transmitter #3 (2.4GHz)</b>				
<b>Frequency</b>	2400 MHz			
<b>Limit</b>	1.000 mW/cm <sup>2</sup>			
<b>Distance (cm), R =</b>	25 cm			
<b>Power (dBm), P =</b>	19.4 dBm	87.10 mW		
<b>TX Ant Gain (dB), G =</b>	-2.2 dB			
<b>Power Density (S) =</b>	0.007 mW/cm <sup>2</sup>	(at 20cm)		
<b>Minimum Distance =</b>	2.0 cm			

**802.11a, 5G Radio:**

<b>Transmitter #3 (5GHz)</b>				
<b>Frequency</b>	5805 MHz			
<b>Limit</b>	1.000 mW/cm <sup>2</sup>			
<b>Distance (cm), R =</b>	25 cm			
<b>Power (dBm), P =</b>	18.95 dBm	78.52 mW		
<b>TX Ant Gain (dB), G =</b>	-3.2 dB			
<b>Power Density (S) =</b>	0.005 mW/cm <sup>2</sup>	(at 20cm)		
<b>Minimum Distance =</b>	1.7 cm			

<b>Cumulative Results for Multiple Transmitters</b>			
	<b>Power Density (mW/cm<sup>2</sup>)</b>	<b>Limit (mW/cm<sup>2</sup>)</b>	<b>Percent MPE Used (%)</b>
<b>Transmitter #1</b>	0.505	0.601	83.91
<b>Transmitter #2</b>	0.0004	1.000	0.04
<b>Transmitter #3</b>	0.007	1.000	0.67
<b>Total</b>			84.61

From the tables above the RF1224 meets the MPE limits at a minimum mounting distance of 25cm with all three transmitters operating simultaneously.