

Design Issues

Design Team 6

November 20, 2011

Contents

Introduction	3
Product Lifecycle Management.....	3
Design.....	3
Production	4
Distribution.....	4
Consumption	5
Retirement	5
Safety Concerns	5
Radiation	6
Electrical Shock.....	6
Regulations	6
References.....	7

Introduction

The goal of any engineering project is to safely and effectively implement a solution to a problem. Engineers strive to produce solutions to real world problems safely and cost effectively. During the engineering process it is important to consider several issues other than design requirements. Some of these issues are lifecycle management, safety concerns, and government regulations. The following document assesses some of these issues.

Product Lifecycle Management

When considering Product Lifecycle Management, all of the factors that go into producing a quality product must be considered. Product Lifecycle Management consists of five stages of the product we are set forth to design such as design, production, distribution, consumption and maintenance, and retirement of the product. Our main goal is to discuss the issues that arise from the various stages that go into Product Lifecycle Management for the senior design project.

Design

Design starts with gathering customer needs and requirements. The customer, MIT Lincoln Laboratory, wants the design team to deliver a remotely operated intrusion alarm. To do this, the team will deploy a Frequency Modulated Continuous Wave Radar previously designed by MIT Lincoln Laboratory. The customer requested that the system should be able to calculate characteristics of the intrusion, including range and speed of the intruder. The characteristics can be calculated using a microcontroller and an analog-to-digital converter. The microcontroller will be used to perform signal processing on board. Intrusion data will then be sent from the microcontroller to a PC via Ethernet. The last requirement that the MIT Lincoln Laboratory requested was that this intrusion alarm be operable in a hallway or office type setting, for detecting objects. Because the design project is not low power consumption, the design project is not energy efficient. When all of the needs stated have been met, the project is then ready for delivery.

Profit created by this project would be gained by money earned from sales of intrusion alarm systems. The overall goal is to make the alarm perform basic alert functions for a much lower price than competing alarm systems.-The major cost the team will endure is time for this profit. When the project is complete it should be very profitable and easily expandable in classroom

projects for MIT Lincoln Laboratory. MIT Lincoln Laboratory paid the design team a small fee for five engineers to complete a remotely operated intrusion alarm. It will be the same amount or cheaper for MIT Lincoln Laboratory to make this project themselves. With a remotely deployed radar, they will be able to expand their classroom project environment within MIT Lincoln Laboratory.

The remotely operated intrusion alarm does not require significant upgrades. This is better for the customer because they do not have to worry about upgrading software or hardware throughout the lifecycle of the-intrusion system. Reducing the need to upgrade takes away the hassle of having to buy new software and installing it, or having a maintenance worker come and upgrade their radar which means they have to find a time when the person can come to fix their radar. Overall, reducing the number of necessary upgrades reduces cost and involvement for the end user.

Production

Production of this project only requires the radar, ADC, Stellaris microcontroller, and a laptop. In order to ensure the quality of this project, a bill of materials set forth by MIT Lincoln Laboratory was provided, which allowed for a correct development and setup of the radar instead of designing from the ground up. The radar then feeds into the ADC, and is passed to the Stellaris for signal processing of the data. In order to design this for the Stellaris a license for Code Composer v4 was obtained, which is where all the interface coding happens to do this signal processing and porting to the PC. The cost of the project ensured that every component was developed properly and double checked because there was little room for design errors in both the budget and project timeframe. Energy consumption and environmental considerations were not a factor in this design project because of the low transmit power design of the radar and the nature of the project itself.

Distribution

Consumers who plan on installing this device in their home will be able to purchase the intrusion alarm unit from many local stores. It will be sold in one package with an installation instruction manual for consumers who are technologically savvy and would prefer to do it on their own. Home installation will be offered to customers for a small installation fee. There will be a website where the product is offered for direct buy with next day shipping. Shipping options will

be next day or free shipping within 5 to 10 business days. Companies and organizations ordering 20+ intrusion alarm units will receive complimentary installation in their office or building. One of the biggest expenses, due to travel costs, will be sending representatives for installation.

Consumption

These intrusion alarm systems are built to last for long periods of time with minimal maintenance. Occasionally the product may need some repairs or maintenance in which case the company will send a highly skilled employee to your home or place of business. The employee will diagnose the problem and spend time with the customer in order to teach the consumer ways to troubleshoot the problem for future reference. The product comes complete with select spare parts in the event that maintenance is required. Many parts of the system are very expensive and will not be offered as spare parts but will be made available for individual purchase on our website. The system itself is built in such a way that troubleshooting and maintenance is very simple and easy for the average user. The systems simple design allows for easy upgrades to certain parts of the system such as the antenna and RF stage. Software upgrades will be free and automatically updated on the product while it is hooked up to the network.

Retirement

As the company releases new products, older products will hold a trade in value. Current customers will get a discount with their purchase of an upgraded product. Upon the retirement of a device there are many ways to dispose of the product. In the user manual to each product there are guidelines for proper recycling and disposing of each product. The antenna of the system can be easily disconnected and recycled with household aluminum recycling. The RF stage of the system and the circuitry can all be disposed at a local electronics store that offers electronic recycling. An additional service that is offered is recycling. The consumer is able to mail in their devices for free disposal of their product with the small fee of shipping and handling.

Safety Concerns

As this device is an electrical device which emits electromagnetic radiation, the safety of the product must be evaluated according to studies and regulating bodies. The two safety concerns in question are radiation and electrical shock.

Radiation

Exposure to radiation in the 2.4GHz range represents a minimal safety concern. Radiation from devices operating in the 2.4GHz range is non-ionizing, which is reasonably safe to use in an unrestricted environment. Studies have been performed to assess the thermal risks of this type of radiation; however, studies looking at non-thermal effects of devices operating in the 2.4GHz range have not been performed at length. The thermal effects of low power electromagnetic fields operating in this frequency range have been found to be safe for humans.

Typical maximum output power levels from a home wireless networking access point are 20dBm, or 100mW. The theoretical maximum output power from this radar is approximately 21dBm, or about 125mW. The specific absorption rate, or SAR, for humans has been defined by International Commission on Non-Ionizing Radiation Protection, or ICNIRP. SAR for the general public due to devices operating in the frequency range of 10MHz to 10GHz has been defined as 0.08 W/kg (ICNIRP.DE). Studies performed assessing energy absorption from wireless networking devices operating at 2.4GHz with an output power level of 100mW shows a maximum absorption rate around 0.014 W/kg in a ten-year-old child.¹ These rates are well below the defined limit, and will decrease in adults. As a result of these absorption rates, this device can be considered safe for use in unrestricted areas.

Electrical Shock

Another possible safety issue is electrical shock hazard. A battery power supply of 12V is being used. However, this supply, while DC, is considered electrically safe. According to the NFPA 70E 2012 edition, Article 130, Section 2.A.3, “energized electrical conductors and circuit parts that operate at less than 50 volts shall not be required to de-energize...”.² As such, no additional precautions are needed when handling the device.

Regulations

Assuming that the device is restricted to use within the United States there is only one major regulation that must be considered with the creation of the intrusion alarm system. In the United States the Federal Communications Commission (FCC) regulates all communication devices. FCC Part 15 is the specific regulation that corresponds to radio frequency devices; consequently, it applies to this device. According to FCC Part 15 the radar used in the device is an Intentional

radiator. The FCC defines a device as an intentional radiator if it intentionally emits radio frequency energy in the spectrum of 9 kHz and 3,000,000 MHz. The radar used in the prototype intrusion alarm operates in a frequency band from 2.3GHz to 2.6 GHz. Since this is in the Intentional Radiators category, it must adhere to Subpart C requirements of the FCC regulation part 15. This sub part specifies that devices in the frequency band used by this device must have field strength less than 500mV/meter in the fundamental frequency and that harmonics must have field strengths of less than 1.6mV/meter. This device complies with this regulation.

At this time the product falls into the home built devices subpart of FCC part 15. As long as less than 5 home intrusion kits are produced and good “engineering practice” is used the device does not need equipment authorization. This also means that the product is exempt from being required to register with the FCC. If at some point the device is produced in greater quantities it may have to be registered and tested by the FCC. Once this occurs and the device is approved it will have to bear the following statement: This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: “(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.”³

At this time the device does not violate any part of the FCC part 15 regulation. If the device is ever produced commercially further investigation into the devices radiation properties will have to be tested. Since the device is built in small quantities for personal use it does not have to be registered to the FCC. Furthermore, the device operates in an unregistered frequency range. This means that the device must be designed to accept noise from other communication devices in the frequency range it is using.

References

- ¹“Understanding Radiation: Electromagnetic Fields – WiFi” Health Protection Agency 2011. 20 November 2011.
<<http://www.hpa.org.uk/webw/HPAweb&Page&HPAwebAutoListName/Page/119945194>
0308> 16 September 2011

- ² NFPA 70E “Standard for Electrical Safety in the Workplace”, 2012 Edition

³"Electronic Code of Federal Regulations." *United States of America Government Printing Office*. Federal Communications Commission. Web. 17 Nov. 2011.
<<http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr>>.