Luleå University of Technology

Dept. of Computer Science, Electrical and Space Engineering

X7005E – Master Thesis Engineering Physics and Electrical Engineering Electrical engineering

Master Thesis Engineering Physics and Electrical Engineering *VHF-Unit*

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Abstract

Surveillance and control has come a long way the last years. Every new mobile phone, most cars and smart watches have a GPS tracing device built in to it. Today it is hard to go anywhere without having some sort way of finding you. The art of finding has been around for a long time and one company that have taken the tracking aspect to the next step is followit. For over 40? years they have built different types of GPS and radio transmitters to keep track of everything from small animals like hares and dogs to Elephants and also vehicles like trucks and excavators.

Contents

1 Acronyms

1. **2S** Two cells in Series *Glossary:* 2S
2. **ADC** Analog-to-digital converter *Glossary:* ADC
3. **API** Application Programming Interface *Glossary:* API
4. **CAD** Computer-aided design *Glossary:* CAD
5. **DRC** Design Rule Check *Glossary:* DRC
6. **ERC** Electronic Rule Check *Glossary:* ERC
7. **GPIO** General Purpose Input Output *Glossary:* GPIO
8. **GPS** Global Positioning System *Glossary:* GPS
9. **I^{2}C** Inter-Integrated Circuit *Glossary:* I^{2}C
10. **IC** Integrated Circuit *Glossary:* IC
11. **IMU** Inertial Measurement Unit 3, *Glossary:* IMU
12. **LDO** Low-dropout regulator 3, *Glossary:* LDO
13. **LED** Light-emitting diode *Glossary:* LED
14. **LGA** Land Grid Array *Glossary:* LGA
15. **LIB** Battery Management System *Glossary:* LIB
16. **MCU** Microcontroller Unit 3, 4, *Glossary:* MCU
17. **NAME** Personal Computer *Glossary:* PC
18. **NMEA** National Marine Electronics Association standard *Glossary:* NMEA
19. **PCB** Printed Circuit Board 2, 9, 10, *Glossary:* PCB
20. **PNG** Portable Network Graphics *Glossary:* PNG
21. **PTC** Positive Temperature Coefficient *Glossary:* PTC
22. **PWB** Printed Wire Board *Glossary:* PWB
23. **RTC** Real time clock 3, *Glossary:* RTC
24. **SEK** Swedish Krona *Glossary:* SEK

25. SMD Surface Mount Device *Glossary:* SMD

26. SPI Serial Peripheral Interface *Glossary:* SPI

27. ST STMicroelectronics 6, *Glossary:* ST

28. SWD Serial Wire Debug *Glossary:* SWD

29. TI Texas Instruments Inc. *Glossary:* TI

30. ToF Time of Flight *Glossary:* ToF

31. USB Universal Serial Bus *Glossary:* USB

32. via vertical interconnect access *Glossary:* VIA

2 Glossary

33. IMU Inertial Measurement Units (IMUs) are integrated circuits that can measure acceleration, rotational velocity and magnetic field strength. 3

34. LDO A low-dropout regulator is a DC linear voltage regulator that can regulate the output voltage even when the supply voltage is very close to the output voltage. 3

35. MCU A Microcontroller Unit (MCU) is a single computer chip designed for embedded applications. 3

36. RTC A Real time clock is an IC that is used to mesure time even when the main device is off. 3

37. ST STMicroelectronics (ST) is a French-Italian multinational electronics and semiconductor manufacturer. 6

3 Introduction

This is not a new area of pruducts for Followit, they have made radio sending units for over 40? years. When new and improved technology arrives every yerar you need to make new products to have the latest most efficiant and effective systems. Every generation of a komponent will most likley have a smaller physical size, have more advanced features and draw less power The wants to make a new unit Customers have been asking for a simple, small and cheap radio unit from the company to complemet their more advanced and powerful GPS based products. With this type of product they could produce them in a larger number and get gain new sale teritories. By having such small product it can be used in new areas that they never could before. The smaller the aminal you want to track gets the smaller equipment you could strap to them. This is one of the reasons that this product is so sought for in the buisness.

4 Functionality

The product is constructed with a number of components, which all have a central role of the final product. They can all be seen in Figure 1. A list of the major components and their function can be seen below

- Microcontroller Unit (MCU): The central part of any integrated system, handles all the calculations and the program code.
- Radio: All the communications with the rest of the world will be handled by the radio, sending on the VHF and UHF band.
- Inertial Measurement Unit (IMU): Movement detection is measured with a accelerometer, this to determine if the unit is in motion or laying still.
- Low-dropout regulator (LDO): A Low-dropout regulator can supply the system with a smoother voltage because no switching is acctualy taking place.
- Hall sensor: The hall sensor is used as a switch for the system by sensing if a magnet is nearby and then turning off the circuit.
- Real time clock (RTC): A real time clock is important to aquire data at a specific set time, it is important that the clock is exact over the whole life of the pruduct.

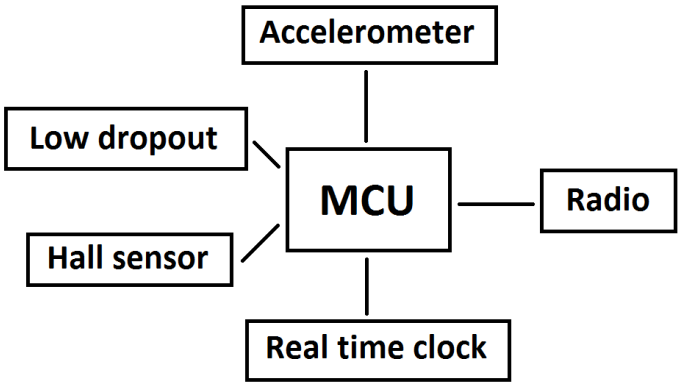

Figure 1: The prototype connection
Source: Aurthor

Each of the components in this project is carfully chosen to get the functionallity and effect that the company is after. To ensure the system works as intended the company have aquired development boards to each of the components. Every components needs to be tested to ensure their induvidial functionallity. Each development board is connected to the micro controllers board. First off the glsmcu have to be set up in a correct way with all it parameters and then the other components could be connected and initilized one after another. The whole connection can be seen in Figure 2

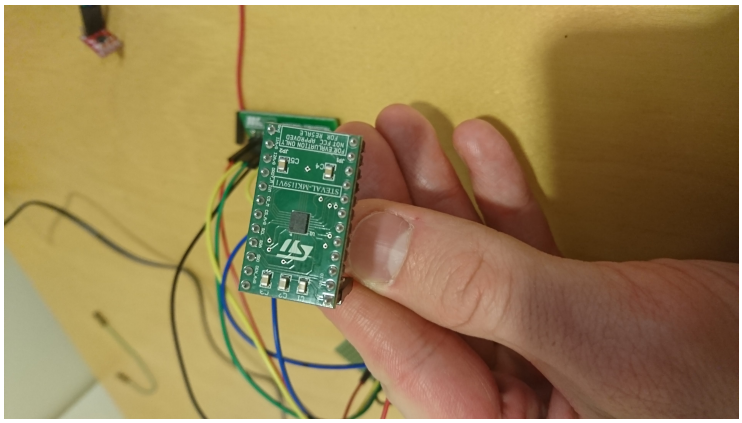

Figure 2: The prototype connection
Source: Aurthor

The MCU can dtad

4.1 MCU

The MCU used for this project is a processor type that is used by this company many times before and has been chosen to this project for its and low power draw.

4.2 Accelerometer

The accelerometer used is a

5 Casing

The *VHF-Unit* system has some different types of components and sensors, which all need to be housed in a watertight casing for safety and robustness. Some design ideas for this part was to make it easy to mount, small physical footprint, all the electronics in the same enclosure and watertight. The case was revised and worked on over the whole length of the course, redefining and remodeling the construction over time.

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Appendices

A Large Figures

B Lists

B.1 Bill of Materials: Main PCB

Main Board Components	**Package**	**Quantity**
Capacitors:		
18p	0805	2
100n	0805	21
1u	0805	2
2.2u	0805	1
4.7u	0805	4
10u	Electrolytic SMD 5x5.3	6
Resistors:		
220	0805	1
1k	0805	2
1k	potentiometer	2

B.2 Bill of Materials: Battery Management PCB

Battery Management Circuit	**Package**	**Quantity**
30.1k	0603	1
32.4k	0603	2
Power P-MOS	SOT-23	1

The project; complete with all software code, the application, hardware files and more, can be found online in the github-repo:
https://github.com/Jurriz/VHF-Unit