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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 there beeing some sort of 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 big elephants. They also got tracking solutions for vehicles like trucks and excavators.

Contents

1 Acronyms

1. CAD Computer-aided design *Glossary:* CAD

2. GPS Global Positioning System *Glossary:* GPS

3. IC Integrated Circuit *Glossary:* IC

4. IMU Inertial Measurement Unit 3, *Glossary:* IMU

5. JTAG Joint Test Action Group 5, *Glossary:* JTAG

6. LDO Low-dropout regulator 3, *Glossary:* LDO

7. MCU Microcontroller Unit 3–5, *Glossary:* MCU

8. NAME Personal Computer *Glossary:* PC

9. PCB Printed Circuit Board 2, 8, 12, *Glossary:* PCB

10. PWB Printed Wire Board *Glossary:* PWB

11. RTC Real time clock 3, *Glossary:* RTC

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

2 Glossary

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

14. JTAG JTAG is an industry standard for verifying designs and testing printed circuit boards after manufacture. 5

15. 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

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

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

3 Introduction

This is not a new area of pruducts for Followit, they have made radio sending units for over four decades now. When new and improved technology arrives each and every year you need to make new products to have the latest most efficient and effective systems. Every generation of a component will most likley have a smaller physical size, have more advanced features and draw less power then the previous one. Followit wants to make a new unit which implement all the new and improved technologies into a small, advanced product with low power consumption. Customers have been asking for a simple, small and cheap radio unit from the company to complement their more advanced and powerful GPS based products. With this type of product they could produce them in a larger number and gain new sale territories. By having such a small product it can be used in new areas that they never could before. The smaller the animal you want to track, the smaller equipment you could strap to them. This is one of the reasons that this product is so sought for in the buisness.

To get to the point of making the actual PCB a thorough analyse of the components and their connections needs to be made. Firstly the datasheets are considered for an understanding of the component itself and the required connections for this particular implementation. Both power and data is crucial for operation and there might also be some peripherals connections and chip selection that needs to be considerd.

By writing a simple code the function of each individual part can be tested. In some cases the component needs to be initialized in a specific way or it needs some other special attention which might require additional connections than it firstly seemed. With all the specified components connected together a program is made to show all the functions and that they work as intended.

4 Method

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 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.

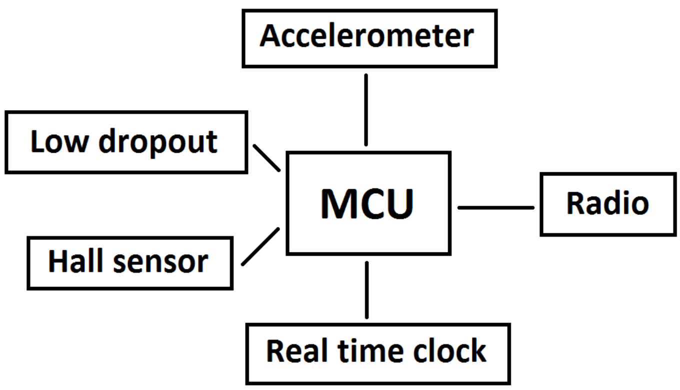

Figure 1: The prototype connection
Source: Aurthor

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 MCU 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.

4.1 MicroController Unit

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 small size, low power draw, sufficient connections and feautures. The particular processor used is the PIC18LF46K22[1]. The version used is one with 40 pins. All the connections avalible are shown in Figure 2.

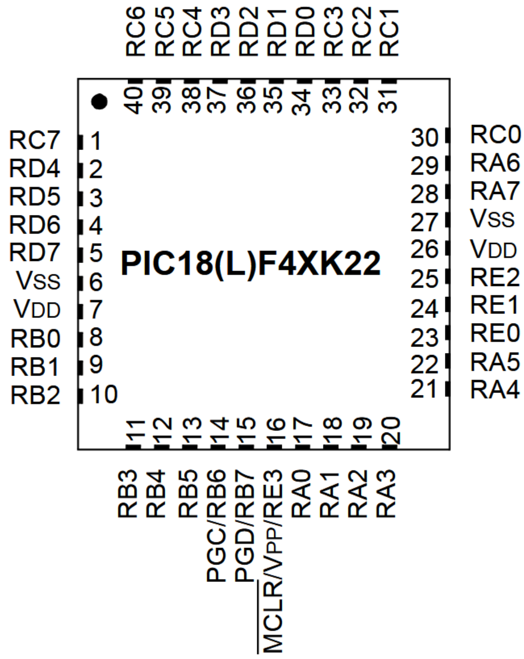

Figure 2: PIC18LF46K22 pinout
Source:
http://ww1.microchip.com/downloads/en/DeviceDoc/40001412G.pdf

4.1.1 Connections

4.1.1.1 Power

Powering it is done by connnecting the VDD pins to the power net. Connected to ground is the Vss pins on the processor. To ensure the current fed is as smooth as possible capacitors are connected between these two pins. The value of these capacitors are choosen to 100nF.

4.1.1.2 Oscillator

To operate the MCU a clock signal is mandatory, this can be implemented in different ways. Either with the internal High, Medium and Low frequency oscillator or a external one. Where the external rely on a specific circuitry to provide the clock source. Examples of external oscillators are: clock modules, quarts crystal resonators or ceramic resonators and resistor-capacitor circuits. When a circuit is specified to be power efficient the speed of the clock plays a central role. As this product is specified to run on a small battery the speed of the system is kept low to increase the lifetime of the battery. The clock signal is generated from a external temperature compensated Crystal Oscillator (TCXO).

4.1.1.3 Programming

In start of every embedded system the processor have to be programmed. Here the most common implementation is the Joint Test Action Group (JTAG), where the all the programming and debugging is done through a standardized interface. The approach is different on this MCU, here three pins are used to program the device. The first one is the "PGC", which is the clock signal for the In-Circuit Debugger and "PGD", In-Circuit Serial Programming. The third pin needed from the processor is the MCLR. These pins on the processor have to be accessible to program the microcontroller.

4.1.2 Software implementation

The processor do not start up on it own, much consideration needs in making right initzilation and configure it right.

4.2 Accelerometer

The component used is a 3-axis, ultra-low-power and high performance accelerometer from ST[2].

4.2.1 Power

Two voltage connections is apperent on this device, one which is called VDD and the other is called VDD-IO.

4.2.2 Connenctions

4.2.3 Software implementation

4.3 Radio

4.3.1 Power

4.3.2 Connenctions

In the registers

4.3.3 Software implementation

Radio Chip Waking Up First, the radio is in the off state. After the SDN pin is pulled low, the radio wakes up and performs a Power on. Reset which takes a maximum of 6 ms (900 μ s typical at room temperature) until the chip is ready to receive commands on the SPI bus. The GPIO1 pin goes high when the radio is ready for receiving SPI commands. During the reset period, the radio cannot accept any SPI commands.

5 Schematics

To the PCB a schematic over the complete system has to be constructed. This is built by noting all the connections that were determined in earlier chapter.

6 PCB

References

[1] http://ww1.microchip.com/downloads/en/DeviceDoc/40001412G.pdf

[2] http://www.st.com/content/ccc/resource/technical/document/datasheet/group3/30/3a/4e/6b/68/16/4a/35/DM00323179/files/DM00323179.pdf/jcr:content/translations/en.DM00323179.pdf

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

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