STM32 Board Design

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***Abstract*—This electronic document is a DETAILED report about the design and development of STM32 PCB board starting from the schematic until the last Gerber files, any more updates of the board and manufacturing process will be added to this report.**

Keywords—STM32WB, PCB design, Design Rules, Schematic, layout.

I. Introduction

STM32, made by STMicroelectronics, is one of the leading products in the industry for microcontroller chip manufacturing. It is crucial for students to learn how to design schematics and layouts for PCBs that meet all the standards set by STMicroelectronics for their microcontrollers. After designing the board, it is important to test it thoroughly before using it in a project to minimize the time needed for troubleshooting in future projects, this paper will focus on the design of the schematic and the board for the Test Board it will be discussed in another paper.

II. Chip Used

STM32WB55 is an 32-bit Arm®-based Cortex® with Bluetooth 5.4 and IEEE802.15.4 Radio.

It uses 2.4Ghz frequency and can support up to 3.6V.It has a 30 pins GPIO, 12bit ADC with 13 channels (incl. 3 internal) with an internal V*ref.* It also has a 16-bit timer, one general purpose 32-bit timer, two 16-bit basic timers, two low power timers, two watchdog timers , and a SysTick timer which all of them supports direct memory access (DMA). The Clock sources are 32Mhz crystal oscillator (integrated trimming capacitors) as a radio and CPU clock and 32khz for RTC. The internal Memories, up to 1MB flash memory 256KB sRAM , USART , SPI , I2C and USB interfaces for bootloader.

The Microcontroller is capable of handling the intended projects and its suitable for wireless base friendly projects

III. Schemtic Design

A. Power sources.

The Main sources for power will be a USB-C which can deliver 5V, but Microcontroller can handle up to 3.6 and it's recommended to operate at 3.3v so we will regulate that voltage using a linear regulator although the efficiency isn't the best but its suitable for small low-cost applications.

The chip used is MIC5365-3.3YD5 which has two 4.7uf capacitors and referring to the datasheet both capacitors are used for stability and ripple minimizing purposes.

The regulator can be turned on using the enable pin which is active high that can handle up to Vin, which is 5v,

Lastly an LED has been added to indicate when power is on the next figure shows the circuit of the power regulator.

Then to power the microcontroller we first need to add a couple of decoupling capacitors. The power traces can be affected by EMI and stray inductance which can lead to some fluctuations, Sparkes or noise in the input voltage in the microcontroller

The STM32 datasheet recommended that a bulky capacitor which is 4.7uf need to be placed before the power pins in addition with an 100nf small decoupling capacitor for each pin.

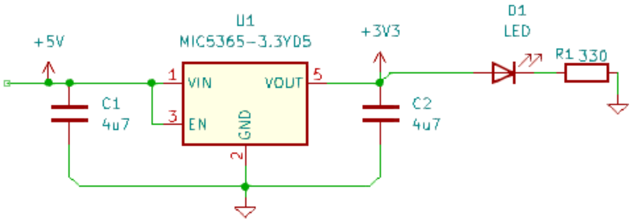

Figure III-1 Circuit of the power regulator

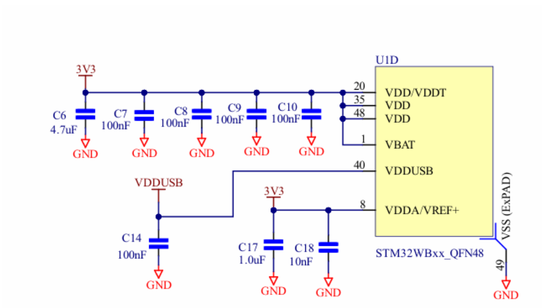

Figure III-2 Recommended Decoupling capacitor

B. RF and The antenna.

Referring to the section 3.6.4 from the stm32 datasheet RF pin description the RF pin must be connected to the antenna through a low-pass matching network and referring to the Application note AN5165 figure 8 reference board the matching network used is Low-Pass ∏-Shaped with a Low Pass Filter DLF162500LT-5028A1in series and finally ending with an antenna which is an SMD coaxial connector. Since the LPF chip isn't available in KiCad and it's a critical component a new symbol and footprint needed to be designed and added to the KiCad library.

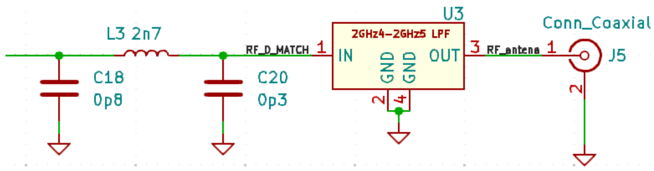

Figure III-3 Matching Network and LPF circuit

C. Reset Button

6.3.18 NRST pin characteristics (STM32WB datasheet) clearly shows the circuit for the reset pin NRST which is an Active low pin pulling down will lead to the system to reset. The recommended circuit is a push button in parrel with a capacitor in order to minimize the debouncing effect, With the recommended circuit an active low LED has been added to indicate the status of the reset pin.

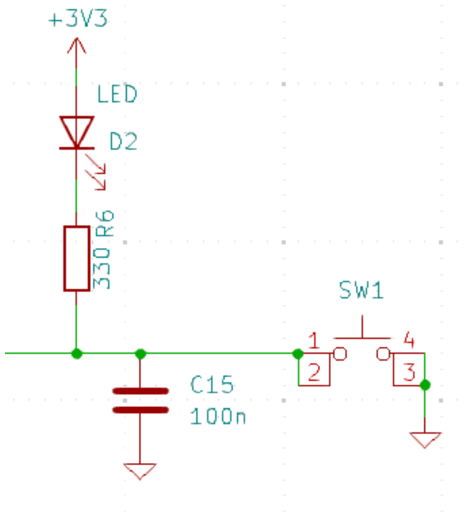

Figure III-4 Active Low reset button circuit

D. USB-C connector.

For communication with the Chip, media streaming, Power supply and programming an USB-C connector is needed.CC pins in the type C connector are responsible for determining if your device is receiving power or supplying, and in this case the connector is our main supplier for power, so we need to configure the pins as so. And to do that the pins need to be pulled down. (4.2.5 Configuration Pins). For the ESD we used which is a package containing 5 TVS Diode

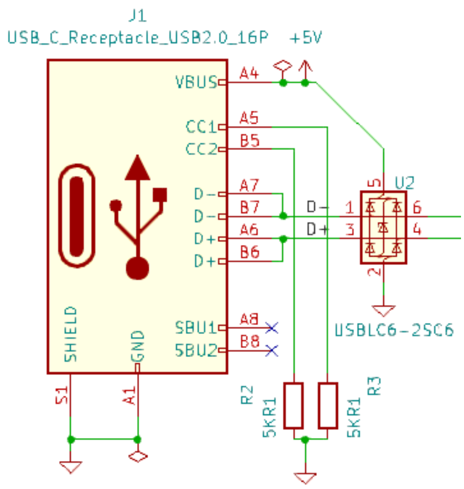

Figure III-5 USB-C Circuit

E. Crystal oscillator.

According to the microcontroller datasheet (6.3.10 External clock source characteristics) the high-speed external (HSE) clock should be supplied with a 32 MHz crystal oscillator and the low-speed external (LSE) clock can be supplied with a 32.768 kHz crystal resonator oscillator. Load capacitors affect the resonant frequency and determine the oscillation's stability and phase noise, for the HSE the microcontroller have an integrated tunable load capacitors but for the LSE external load capacitors are needed and referring to AN5165 those value of load capacitors should be 10pF each

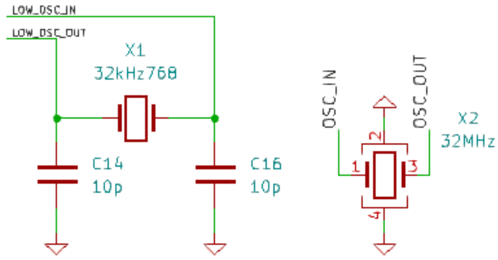

Figure III-6 crystal oscillator circuits

F. Switched Mode Power Supply (SMPS).

The device integrates an SMPS step-down converter to improve low power performance
when the VDD voltage is high enough. This converter has an intelligent mode that automatically enters in bypass mode when the VDD voltage falls below a specific BORx (x = 1, 2, 3 or 4) voltage.

By default, at reset, the SMPS is in bypass mode.

The device can be operated without the SMPS by just wiring its output to VDD. This is the case for applications where the voltage is low, or where the power consumption is not critical.

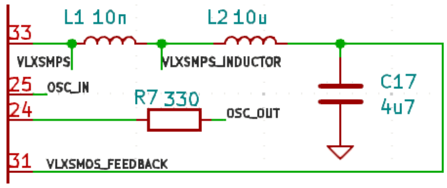

Figure III-7 SMPS circuit

G. Boot & program mode

REFERENCES

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[1] Load Capacitance: The Key to Precision in Crystal Units

[2] J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.

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[3] I. S. Jacobs and C. P. Bean, "Fine particles, thin films and exchange anisotropy," in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

[4] K. Elissa, "Title of paper if known," unpublished.

[5] R. Nicole, "Title of paper with only first word capitalized," J. Name Stand. Abbrev., in press.

[6] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, "Electron spectroscopy studies on magneto-optical media and plastic substrate interface," IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].

[7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[8] K. Eves and J. Valasek, "Adaptive control for singularly perturbed systems examples," Code Ocean, Aug. 2023. [Online]. Available: https://codeocean.com/capsule/4989235/tree

[9] D. P. Kingma and M. Welling, "Auto-encoding variational Bayes," 2013, arXiv:1312.6114. [Online]. Available: https://arxiv.org/abs/1312.6114

[10] S. Liu, "Wi-Fi Energy Detection Testbed (12MTC)," 2023, gitHub repository. [Online]. Available: https://github.com/liustone99/Wi-Fi-Energy-Detection-Testbed-12MTC

[11] "Treatment episode data set: discharges (TEDS-D): concatenated, 2006 to 2009." U.S. Department of Health and Human Services, Substance Abuse and Mental Health Services Administration, Office of Applied Studies, August, 2013, DOI:10.3886/ICPSR30122.v2