Lab 07: Zephyr Devicetree, GPIO & Callbacks

Medical Electrical Equipment (BME590L)

2023-03-27

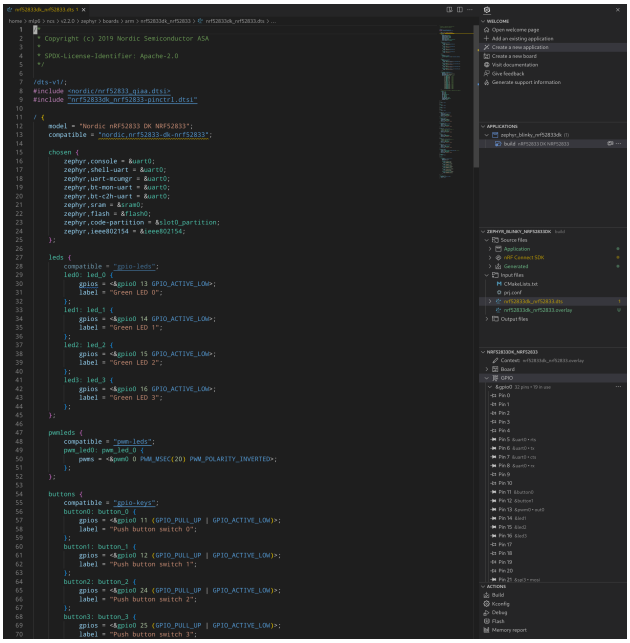
This week we will start programming the firmware that will be controlling your `nRF52833DK`.

1 Application Setup

1. `Create a New Application` based on `zephyr/samples/basic/blinky`. This will create a new directory that will contain all of the necessary project files.
2. If you are comfortable with `git`, please `git init` this directory and associate it with an online repository on either GitHub or GitLab (Duke).[1]

2 Devicetree

1. Inspect the default Devicetree (DT) for the `nRF52833DK`.



[1] We will cover `git` in a few weeks if you are not familiar with it.

2. The `nRF52833DK` has 4 integrated LEDs. Create a DT overlay file for your project that creates alias for 5 LEDs on the following pins (4 of which are the integrated LEDs):

Firmware Variable Name	DT Alias	GPIO Pin
`heartbeat_led`	`heartbeat`	`P0.13`
`buzzer_led`	`buzzer`	`P0.14`
`ivdrip_led`	`ivdrip`	`P0.15`
`alarm_led`	`alarm`	`P0.16`
`error_led`	`error`	`P1.3`

3. The `nRF52833DK` also has 4 integrated buttons. Create a DT overlay file for your project that creates aliases for these 4 buttons as follows:

Firmware Variable Name	DT Alias	GPIO Pin
`sleep`	`button0`	You Tell Me
`freq_up`	`button1`	You Tell Me
`freq_down`	`button2`	You Tell Me
`reset`	`button3`	You Tell Me

3 Firmware

Implement the following firmware functionality:

- Check that both the `GPIO0` and `GPIO1` interfaces are ready.
- Initialize all LED output pins as `GPIO_ACTIVE_LOW`.
- Be sure to capture all function exit codes and have conditional statements to capture any returned error codes.
- Implement the following control logic:
  - The `heartbeat` LED blinks at a fixed 1 Hz while `main()` is being executed.
  - The 3 "action" LEDs (`buzzer_led`, `ivdrip_led`, and `alarm_led`) cycle through each one being on for 1 s in that order (i.e., 3 s period for each to be on 1 s). This 1 s default on-time should be defined using a preprocessor macro: `#define LED_ON_TIME_S 1`.
  - The `freq_up` reduces the on-time of each "action" LED by 0.1 s (and, therefore, reduces the overall cycle period by 0.3 s) each time it is pressed. This incremental decrease in on-time should be defined by the preprocessor macro: `#define DEC_ON_TIME_S 0.1`
  - The `freq_down` increases the on-time of each "action" LED by 0.1 s (and, therefore, increases the overall cycle period by 0.3 s) each time it is pressed. This incremental increase in on-time should be defined by the preprocessor macro: `#define INC_ON_TIME_S 0.1`
  - If the on-time for each individual "action" LED is < 0.1 s or > 2 s, then none of the action LEDs are illuminated and the `error` LED is continuously illuminated. Define each of this min/max limits using preprocessor macros (you can choose appropriate names).
  - If the `error` LED is illuminated, there is no response to pressing the `freq_up` or `freq_down` buttons until the `reset` button is pressed.
  - Pressing the `reset` button resets the on-time for each "action" LED to 1 s.
  - At any point in time, if the `sleep` button is pressed, all LEDs, except for the `heartbeat` LED, go off until the `sleep` button in pressed again, at which time the device returns back to the exact state it was in before being put to sleep.

4 Answer These Questions

1. What is the difference in configuring a GPIO LED pin to be `GPIO_ACTIVE_LOW` vs `GPIO_ACTIVE_HIGH`?
2. What is the purpose of calling `device_is_ready()` for the GPIO interfaces?
3. What GPIO pins are used for `button[0-3]`?
4. Why do we use callbacks to detect the button presses (instead of simply reading the `LOW/HIGH` state of each button GPIO pin in `main()`)?

5 Nordic Dev Academy

To get ready for next week's tasks, please complete the following lesson on the Nordic Dev Academy: nRF Connect SDK Fundamentals course:[2]

- Lesson 4 – Printing messages to console and logging
- Note - we will not use `print()`; everything will be done with the `logging` module.

6 What to Submit & Grading

This lab exercise is due Monday, February 27 at 08:30.

- Upload a PDF to Gradescope with answers to the questions posed above.
- If you used a git repository for your code, please include a URL in your PDF for that repository, and make sure that Dr. Palmeri has access to it. [3]
- If you didn't use a git repository, please upload a zip archive of your entire project to your Sakai Drop Box.
- Include in your PDF a screenshot showing completion of Lessions 1-4 from the Nordic Dev Academy.
- Code will be graded on functionality **and** efficieny of code logic **and** code "readability". "Readability" does not mean a lot of verbose comments; it means that the structure of the code, the naming of variables, etc. convey meaning and logical flow.

[2] Be sure to login and record your progress and quizzes to earn a certificate at the end of the course.
[3] Dr. Palmeri's username on both platforms is `mlp6`.