Home Automation - Automatic Blinds

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Introduction

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This document presents an “Automatic Blinds” design using the AVR®-IoT WG Board, a MikroElektronika Stepper 2 Click and a stepper motor. All of these parts bundled together is the **Home Automation Kit**. The blinds can be controlled from a web interface in the cloud. As there are no sensors to detect when the blinds are fully extended, there is a need to calibrate a start/stop position. A calibration sequence is included to handle this issue. It is recommended to read the Getting Started with the Home Automation kit before proceeding, found here: http://www.microchip.com/DS50002957.

Tip: The finished source code can be accessed at https://start.atmel.com/#examples under the name *AVR IoT WG Sensor Node with Stepper 2 Click*. Under “Example Configuration”, select *AUTOMATIC BLINDS*.

Tip: 3D models of a Miniature Blinds can be downloaded at https://github.com/microchip-pic-avr-solutions/avr-home-automation-3d-models. These miniature blinds can be printed and used to test the system presented in this user guide.

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1. System Design

The automatic blinds have the following specifications:

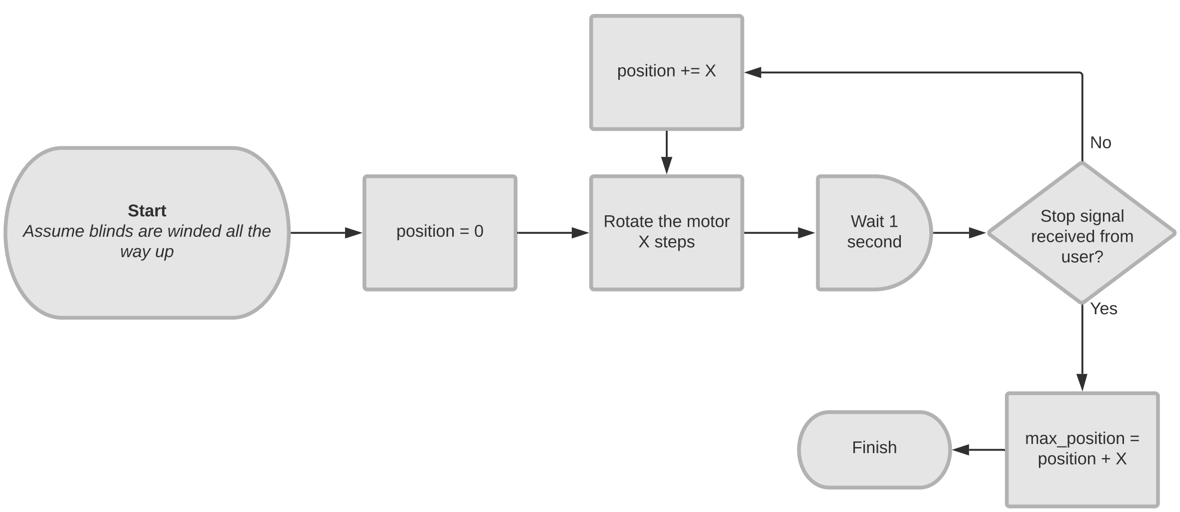
- The blinds can be controlled remotely from the cloud
- The blinds can be controlled locally from a Command Line Interface (CLI)
- The blinds can go to any position between winded all the way up and fully extended
- The input to the system is a position between 0 and 100. Zero represents winded all the way up, and 100 represents fully extended
- The user can calibrate the blinds for her/his setup
- The system remembers its state through a power loss

Precision is a major advantage of using a stepper motor. For every step, the number of degrees moved is known exactly. Due to this unique property, the motor can be controlled in an open loop. There is no need for any sensors to track the position of the motor, as the position can always be deducted as long as the starting position is known. The following code steps precisely:

```
// For all steps, do one pulse
for(uint16_t i = 0; i < number_of_steps; i++){
    MOTOR_ST_toggle_level();
    _delay_ms(1);
    MOTOR_ST_toggle_level();
    _delay_ms(1);
}
```

Whenever the stepper motor rotates, the blinds are extended a fixed distance. The number of rotations required to extend the blinds fully is found through an initial calibration sequence. The calibration sequence is accessed through the command line interface the AVR®-IoT Board is shipped with. The blinds are set in their initial position, winded up. When the calibration sequence starts, the motor rotates X steps every second until a stop command is received. The number of accumulated steps is saved as “max position” and is the number of rotations to go from position zero (fully winded) to fully extended. A flowchart of this calibration sequence can be seen in Figure 1-1. A calibration is started through a “calibration” command in the CLI.

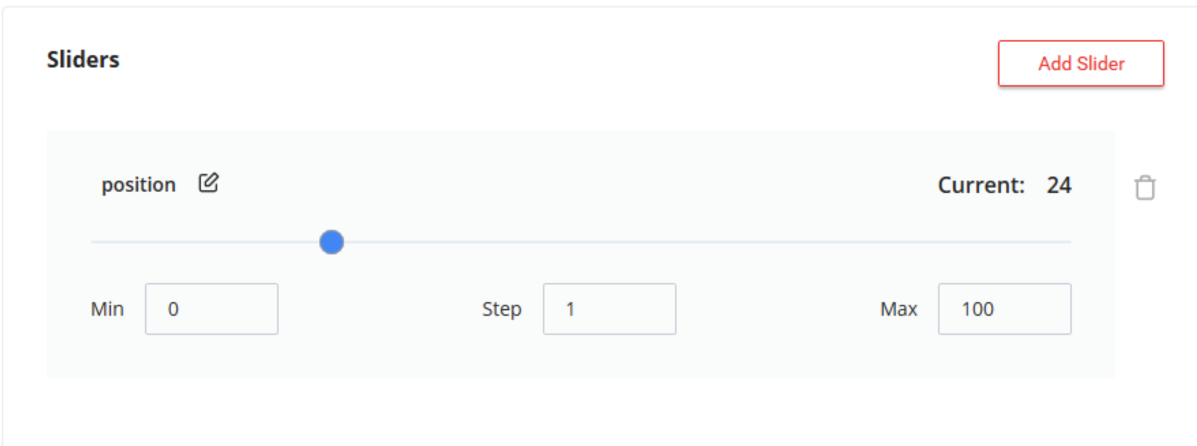
Figure 1-1. Flowchart of the Calibration Sequence



The input to the system is a position between 0 and 100. Zero represents winded up, and 100 represents fully extended. To control the system from the cloud, open the AVR®-IoT landing page by opening “CLICK_ME.HTM” in the Curiosity Drive and adding a “position” slider, as shown in Figure Figure 1-2. When the “Send to Device” button is pressed, the position slider value is sent as a JSON message. This is done in the same manner as the speed slider from the Getting Started guide, which explains the sending and receiving of messages in more detail. The following code is called whenever a position is received from the cloud.

```
void blinds_goto_position(uint16_t position){
    if(position > max_position()){
    return;
    }
    uint16_t steps_to_take;
    if(position > current_position()){
    motor_set_direction(MOTOR_DIRECTION_COUNTER_CLOCKWISE);
    steps_to_take = position - current_position();
    }else{
    motor_set_direction(MOTOR_DIRECTION_CLOCKWISE);
    steps_to_take = current_position() - position;
    }
    motor_step_precise(steps_to_take, true);
    write_current_position(position);
}
```

Figure 1-2. A Position Slider to Control the Blinds Position



The *max_position* and *current_position* variables are stored in the EEPROM, persisting through a power loss. A driver for writing to Flash and EEPROM can be found in Atmel START under the name “Flash”. It provides *FLASH_0_read_eeprom_byte(eeprom_adr_t eeprom_adr)* and *FLASH_0_write_eeprom_byte(eeprom_adr_t eeprom_adr, uint8_t data)*. Notice that they read and write in eight bits, while the position is stored as a 16-bit integer. It is necessary to do some bit-shifting.

```
#define MAX_POS_ADDRESS (24)
#define CUR_POS_ADDRESS (26)

static inline uint16_t max_position(void){
    return FLASH_0_read_eeprom_byte(MAX_POS_ADDRESS + 1) |
(FLASH_0_read_eeprom_byte(MAX_POS_ADDRESS) << 8);
}

static inline void write_max_position(uint16_t position){
    FLASH_0_write_eeprom_byte(MAX_POS_ADDRESS + 1, position & 0xFF);
    FLASH_0_write_eeprom_byte(MAX_POS_ADDRESS, position >> 8);
}
```

1.1 Adding a new Command to the Command Line Interface

As mentioned in the Getting Started Guide, the AVR®-IoT Boards firmware ships with a Command Line Interface (CLI). This section explains how to add a new command to initiate the calibration sequence described in Figure 1-1.

The source code for the CLI can be found under cli/cli.c. The first step is making the function which is called when our command is issued:

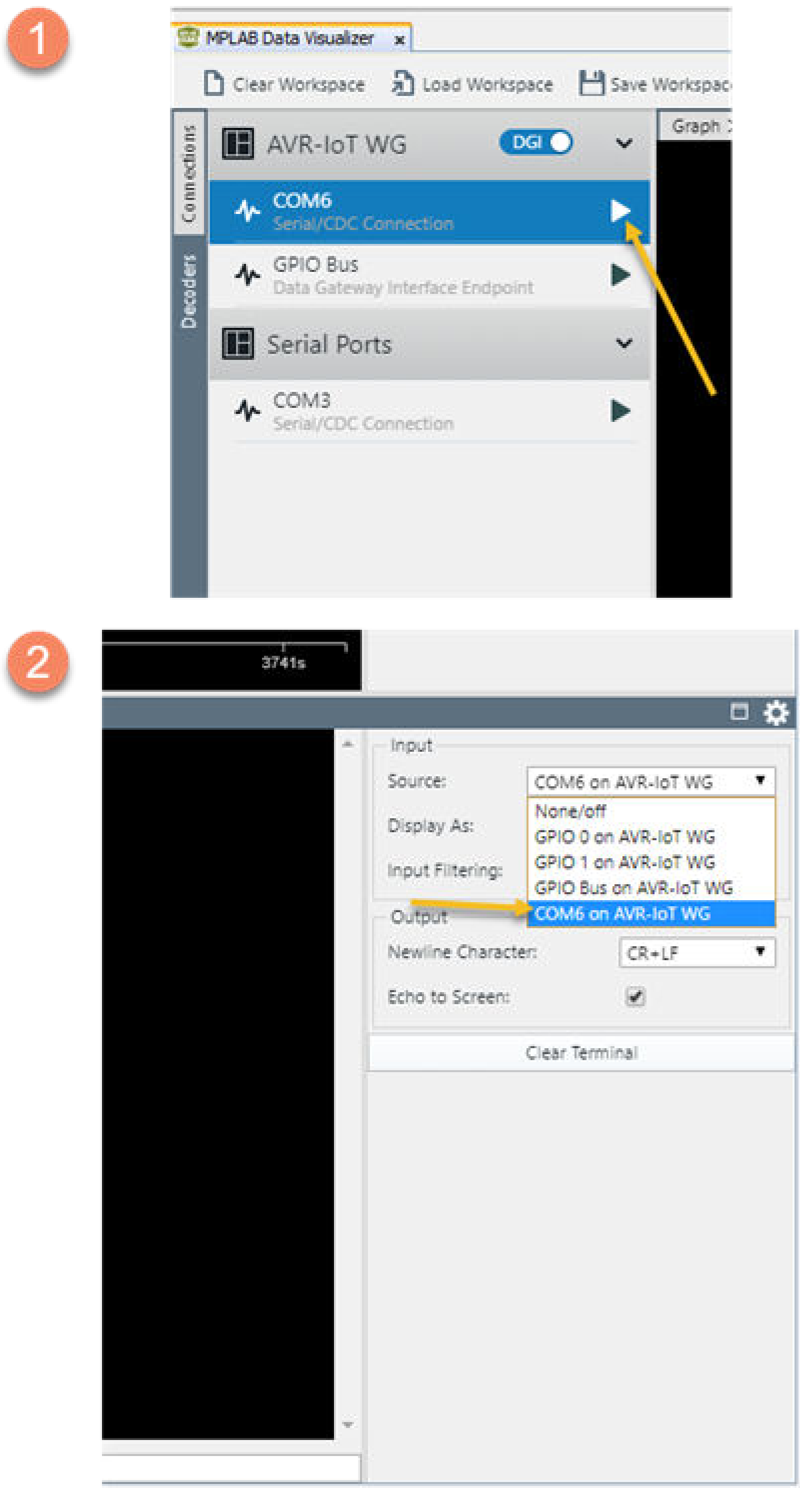
```
static void calibrate_blinds(char *pArg){
    blinds_calibrate();
}
```

The **pArg* argument is a pointer to any supplied argument in the command line. For instance, *calibrate 200* would make **pArg = 200*. Next, the command must be added to *const struct cmd commands[]*.

```
const struct cmd commands[] = {{"reset", reset_cmd},
                               {"reconnect", reconnect_cmd},
                               {"wifi", set_wifi_auth},
                               {"key", get_public_key},
                               {"device", get_device_id},
                               {"cli_version", get_cli_version},
                               {"version", get_firmware_version},
                               {"debug", set_debug_level},
                   {"calibrate", calibrate_blinds}};
```

To access the command line, a tool such as the **MPLAB® Data Visualizer** can be used. It can be downloaded at https://gallery.microchip.com/packages?q=MPLAB-Data-Visualizer. When opened, initiate a connection to the COM port of the AVR®-IoT Board by clicking the “play icon” on the left-hand side. At the right-hand side of the terminal, find “Source” under “Input” and select the COM port. See Figure 1-3.

Figure 1-3. Opening a Command Line Link in MPLAB® X Data Visualizer



2. Revision History

Doc. Rev.	Date	Comments
A	02/2020	Initial document release

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