Automated Irrigation System Documentation

Head unit board v 0.1

The Automated Irrigation system is a fully automated modular system for smart home gardening. A central control unit controls multiple head units, that measure the plants condition, and based on the instructions given by the main control, irrigate the plant as needed.

This documentation contains information ONLY abut the alpha version of the head units board.

Board Features:

1. Measure soil moisture
2. Measure temperature
3. Measure light
4. Drive Irrigation pump

Realization:

- Moisture: 555 timer RC capacity measure
- Temperature: in box measurement
- Light: in box measurement
- Watering pump: common source motor drive circuit

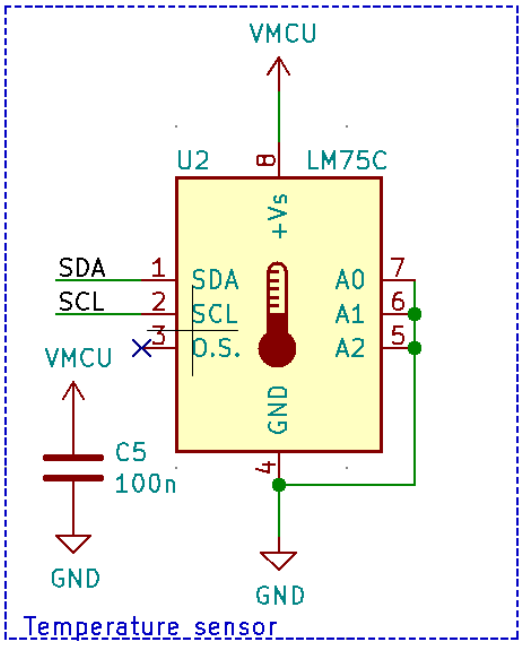
Controller: EFM32GG Giant Gecko Starter Kit
PCB editor: KiCAD

Basic Head unit functionality:

The microcontroller drives the sensors, reads temperature, moisture and light data. Based on measured data, the controller drives an external pump, to irrigate the plants' soil. The connection between the controller and the board is estabilished through the pin array.

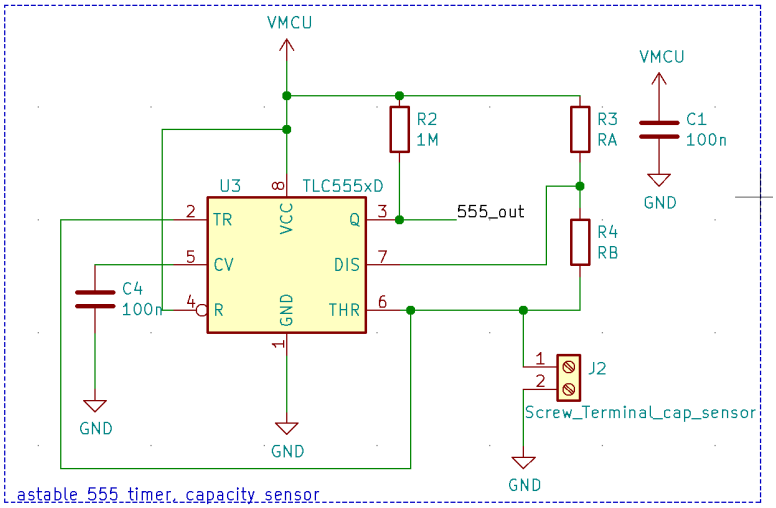
Temperature sensor:

The used IC for temperature measurement is an LM75C. The chip uses I2C bus to communicate with the controller, therefore connected to the on board I2C bus. (This bus is shared with VEML7700)



Moisture sensor:

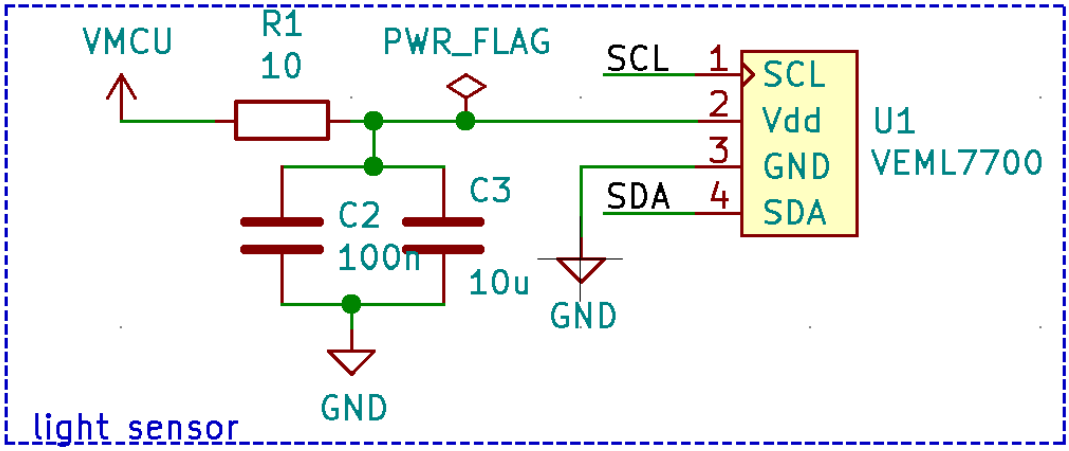
Moisture measurement method is based on capacity measurement. The measurement is based on a TLC555 timer IC in astable mode. The measured capacity controls the frequency of the timer, which is connected to the PD0 pin on the microcontroller. This pin can be configured as an external clock for pulse counter unit. This method is easier to implement in software, because the capacity measurement becomes a single counting problem.

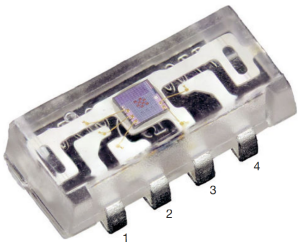


RA and RB are to be measured with the probe capacity in mind.

Light sensor:

Light measurement is done via VEML7700 IC. This chip is communicating with the microcontroller on I2C protocol, therefore connected to the I2C bus on the board. This component is easy to connect, because the power voltage is 3.3V, no conversion needed. The bus is shared with the temperature sensor.

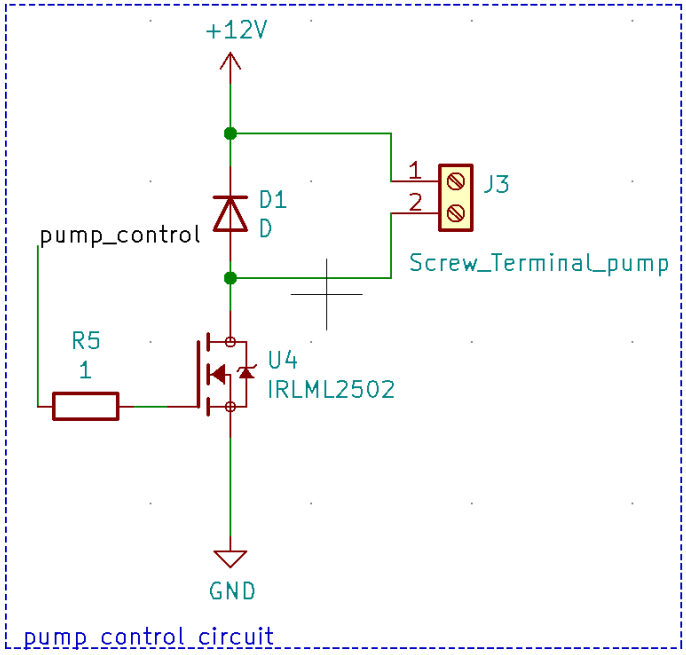




Package:

Project is packaged in an IP67 plastic case. The case has to protect the device from water, and dust, that may be common at the area of application and may damage the unprotected board. Without casing, only indoor use is possible.

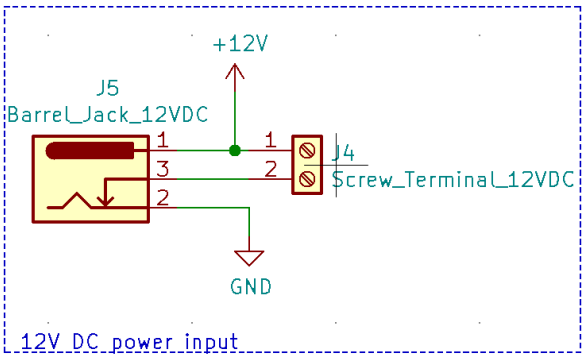
-Pump:
The control element of the system is one 12V pump, a Barwig 0333. The pump requires a 12V power supply that must be connected to the board externally. To maintain the water stream, this pump needs 1.5A–2A current, which makes it necessary to drive with a transistor. The chosen IRLML2502 transistor is a logic level FET. The gate can be driven with a GPIO, and the Drain-Source current allows the required current for the motor.



The pump is driven by a simple common source circuit.

-Power Supply:

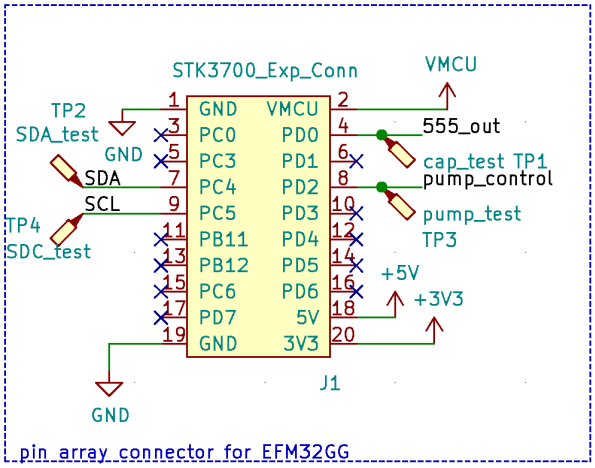
The device is powered with an LPV-35-12 power supply unit, which provides 12V DC for the pump. Alternatively, a barrel jack input is supported if 12V DC input is available. When the barrel jack is in use the LPV power supply is out of use.



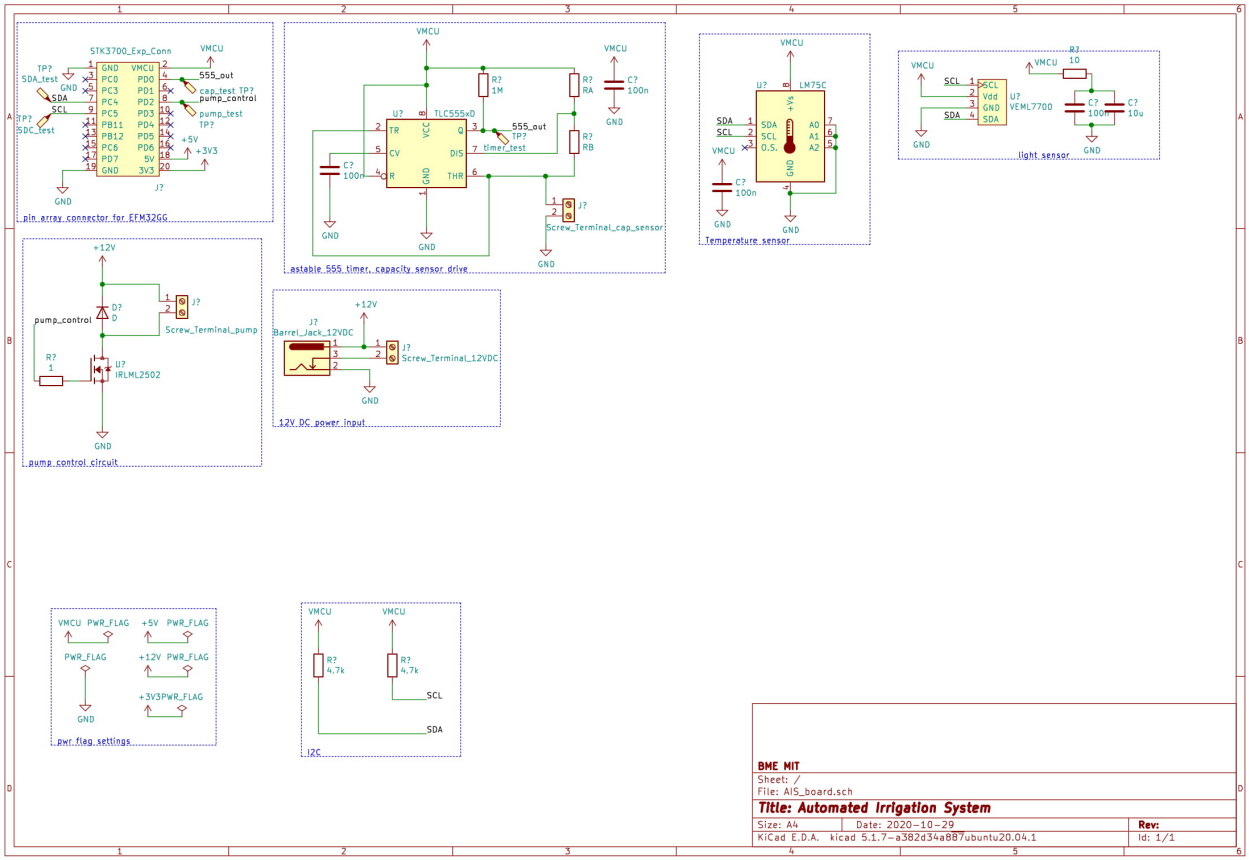
-Connectors:

The board has five connectors.

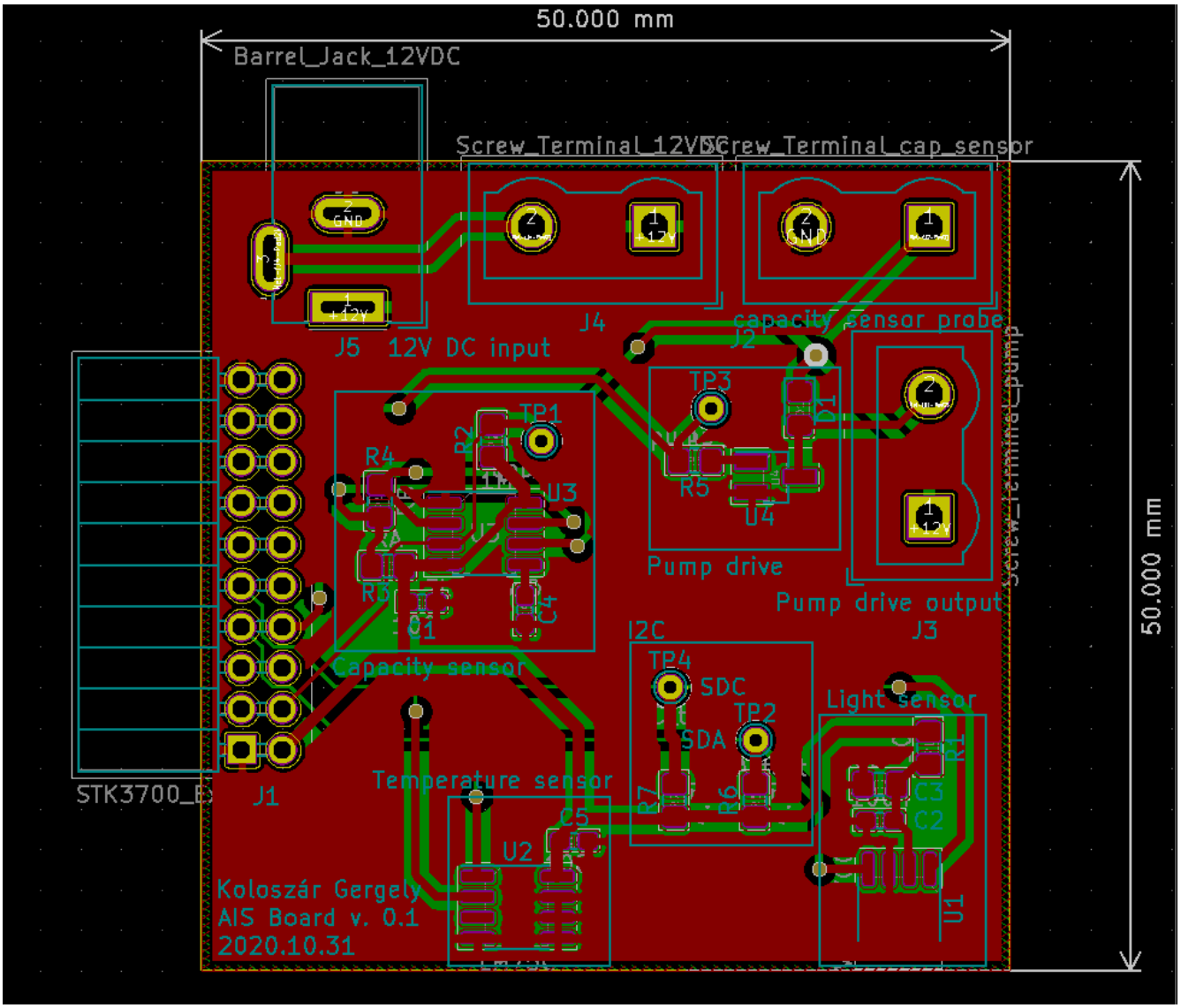
1. Pin array to connect to the giant gecko controller. (2x10 pin array female)
2. screw terminal for capacity measure device
3. screw terminal for pump drive
4. screw terminal for 12V DC input
5. barrel jack, for 12V DC input



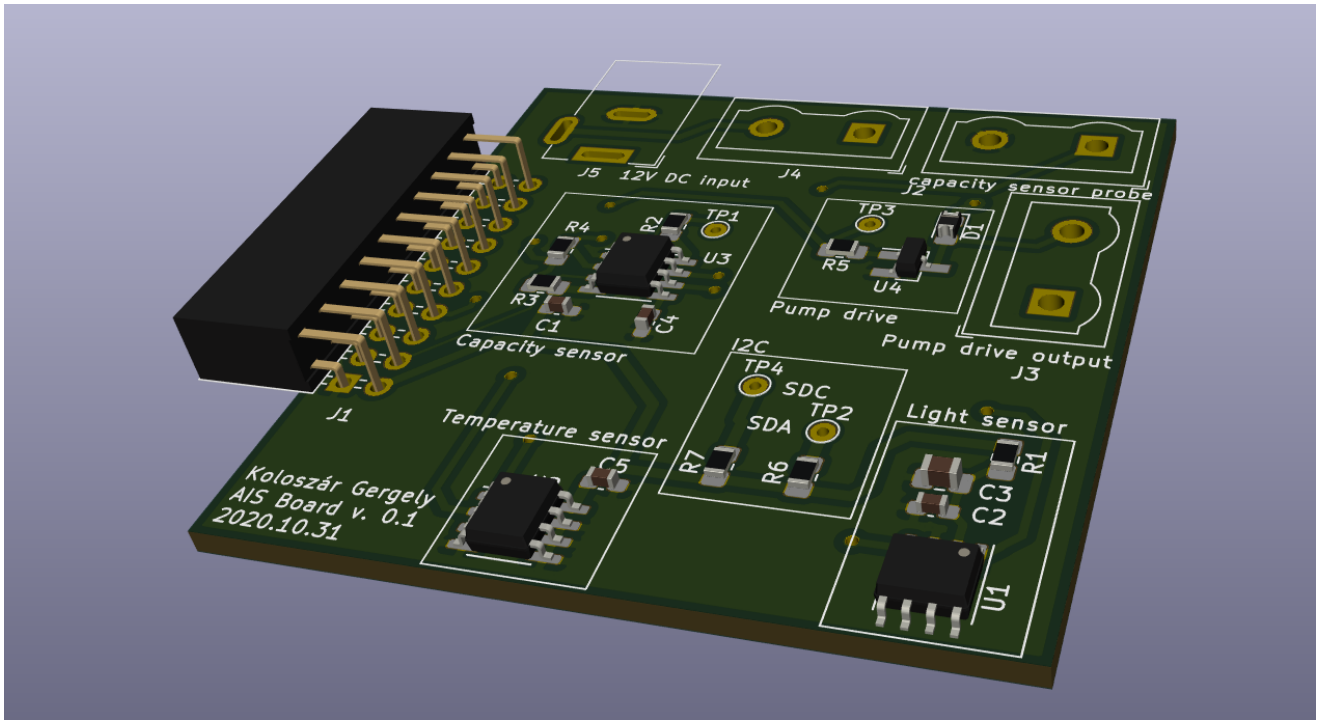
-Schematic:


STK3700_Exp_Conn
pin array connector for EFM32GG
astable 555 timer, capacity sensor drive
Screw_Terminal_cap_sensor
Temperature sensor
light sensor
pump control circuit
Screw_Terminal_pump
12V DC power input
Barrel_Jack_12VDC
Screw_Terminal_12VDC
pwr flag settings
I2C
BME MIT
Sheet: /
File: AIS_board.sch
Title: Automated Irrigation System
Size: A4
Date: 2020-10-29
Rev:
KiCad E.D.A. kicad 5.1.7-a382d34a8b7ubuntu20.04.1
Id: 1/1

-PCB layout:


50.000 mm
Barrel_Jack_12VDC
Screw_Terminal_12VDC
Screw_Terminal_cap_sensor
J5 12V DC input
J4
J2
capacity sensor probe
Screw_Terminal_pump
TP1
TP3
R4
R2
R5
U3
U4
Pump drive
Pump drive output
J3
R6
C1
C4
I2C
TP4
SDC
TP2
SDA
Capacity sensor
Light sensor
Temperature sensor
STK3700_E
J1
C5
C3
C2
U2
U1
Koloszár Gergely
AIS Board v. 0.1
2020.10.31
50.000 mm

-Prototype Hardware (kiCAD 3D model):



-Sources:

- the idea of a capacity measurement based moisture sensor (and a different approach):
  - https://theiotprojects.com/capacitive-soil-moisture-sensor-with-oled-display-arduino/
- 555 timer basics:
  - https://www.electronics-tutorials.ws/waveforms/555_oscillator.html
- I2C bus:
  - témalabor classes
- kiCAD:
  - témalabor classes
  - https://www.youtube.com/watch?v=vaCVh2SAZY4
- datasheets:
  - 555 timer: https://www.ti.com/lit/ds/symlink/tlc555.pdf?ts=1609053776577
  - veml7700: https://www.vishay.com/docs/84323/designingveml7700.pdf

- LM-75: https://www.ti.com/lit/ds/symlink/lm75b.pdf?ts=1609074610236
- IRLML2502: https://www.hestore.hu/prod_getfile.php?id=6941
- Barwing 0333: https://asset.conrad.com/media10/add/160267/c1/-/hu/000539082ML04/hasznalati-utmutato-539082-kisfeszueltsegu-buvarszivattyu-12-vdc-12-lperc-6-m-barwig-0333.pdf