MM3D

growing house controlling

and remote monitoring unit

User Manual

Hardware version: v190203
Software version: v0.3
User Manual version: v3.0
Issue date: 10/08/2019

Content

I. Hardware

The device is capable of measuring, controlling and monitoring the characteristics of a growing site.

1. Technical data

Supply voltage:	5V DC (powered by 230 V AC/5 V DC adapter)
Supply current:	max. 2.5 A
Isolation class:	Class II.
Mechanical size:	190 x 140 x 70 mm
IP protection:	IP 54
IK protection:	IK 03
Material of cover:	termoplaszt (ABS)
LAN:	Ethernet (RJ45)

Measured data:

value	range	resolution	accuration	note
temperature	-40...+80 °C	0,1 °C	< ±0,5 °C	Length of sensor ca.ble: max. 20 m
humidity	0-100% RH	0,1 % RH	±2 % RH	

Programmable in- and outputs:

sign	type	note
IN #1	input	TTL level inputs with pull-up resistor, theirs active state is „L”.
IN #2	input	
IN #3	input	
IN #4	input	
OUT #1	output	NO/NC relay contact outputs. Load capacity: 250V 10A AC or 30V 10A DC. The operation of the relays can be switched off with a key switch, this status is indicated by a red LED.
OUT #2	output	
OUT #3	output	
OUT #4	output	

Programmable error lights:

sign	note
ERR #1	Red LEDs on front panel.
ERR #2	
ERR #3	
ERR #4	

2. Administration

Setting:	via SSH
Access data:	with web browser (via HTTP)

3. Description

The device is based on a Raspberry Pi 3 B + microcomputer with Raspbian operating system, which also includes software for operating the unit. No graphics system installed on it.

Input and output peripherals and error LEDs have no predetermined function and can be programmed by the user.

The device's four TTL-level inputs are equipped with pull-up resistors and have an active level of L. They can be used, for example, to check the position of air vents, doors and windows, check the functioning of the ventilation system (airflow sensor), the water pressure sensor, or the status of the motor or overcurrent protection devices with auxiliary contact.

The device has four relay contact outputs that are capable of switching to relatively high power (2.3 kW at 230V AC). The operation of the relays can be disabled by means of a front key switch; In all cases, external circuits must be provided with overcurrent protection.

There is no need to connect a keyboard or monitor to set up and operate the MM3D, and access to it is always done through SSH. Current status and measured data can be checked using a web browser.

4. Schematic and printed circuit draws

The wiring diagram of the device is shown in Annex 1, PCB draws are in Annex 3-7. You can download it as part of the complete documentation or in separate PS, PDF, SVG and KiCAD formats from the developer / manufacturer's website.

5. Terms of use

6. Look of the device

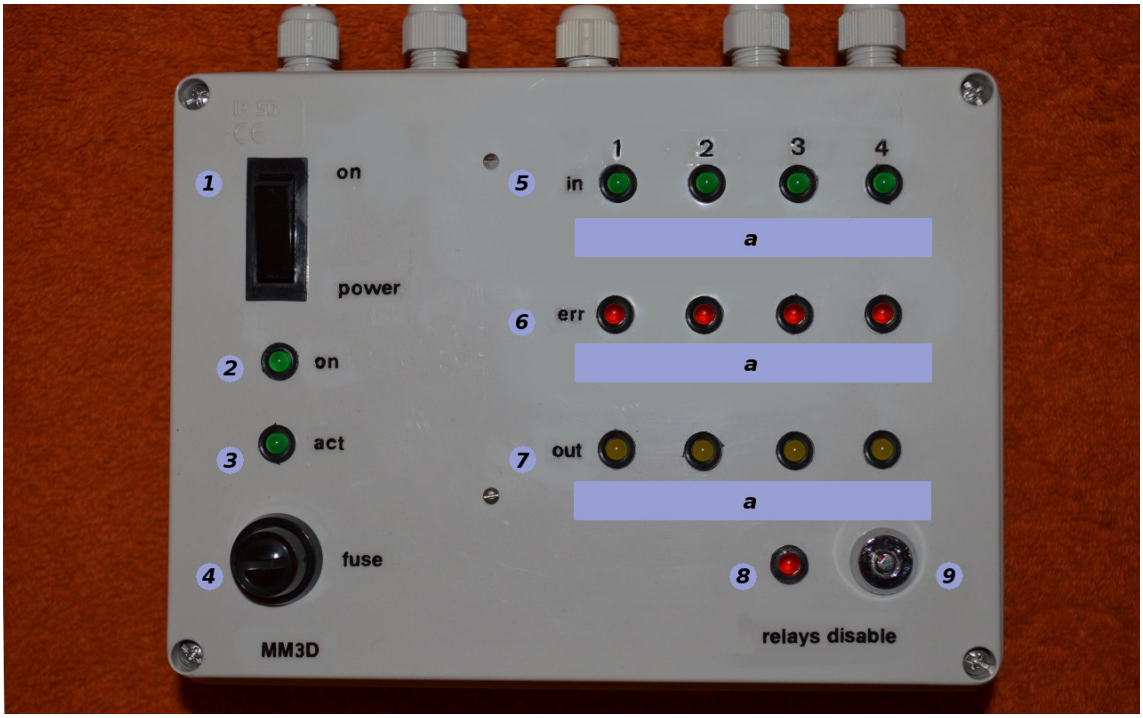


Figure 1: Front panel

a) Manuals and connectors

1: supply voltage on/off switch

2: power on light (green LED)

3: ACT light (green LED)

4: fuse of supply voltage (2,5 A F)

5: IN #1-#4 input active status lights (green LED)

6: OUT #1-#4 output active status lights (yellow LED)

7: ERR #1-#4 error lights (red LED)

8: disable output relays light (red LED)

9: disable output relays switch

a: place for sticky labels

b) Connector pinout

Input terminal (J1):

1: IN GND
2: IN #1
3: IN #2
4: IN #3
5: IN #4
6: -
7: -
8: S1 GND (external sensor GND)
9: S1 data (external sensor data)
10: S1 +5V (external sensor +5V)
11: +5 V in (power voltage input)
12: GND in (power voltage input)

Output terminal (J3):

1: NC1
2: COM1
3: NO1
4: NC2
5: COM2
6: NO2
7: NC3
8: COM3
9: NO3
10: NC4
11: COM4
12: NO4

Numbering on both connectors (terminal blocks) is in the installed position of device from top to bottom.

7. Downloadable documentation

The complete documentation of the hardware in the .tar.gz format compressed file can be downloaded from the manufacturer's website. (Refer to Chapter IV for references.)

Package's name: *mm3d-hw-190203-3.0.tar.gz*

Content:

mm3d-hw-190203-3.0	
├──**cad_files**	**KiCAD files**
│ ├──**example**	*example of application*
│ │ example_routing.pro	project file
│ │ example_routing.sch	schematic draw
│ │ README	information
│ │ *.*	other files
│ └──**mm3d**	*MM3D unit*
│ mm3d_base.pro	base panel project file
│ mm3d_base.kicad_pcb	base printed circuit board
│ mm3d_front.pro	front panel project file
│ mm3d_front.kicad_pcb	front printed circuit board
│ mm3d.pro	schematic project file
│ mm3d.sch	schematic draw
│ *.*	other files
├──**datasheets**	**datasheet**
│ dht22.pdf	T/RH sensor
│ ls-4-bidi.pdf	level shifter
│ ls-i2c-2.jpg	level shifter
│ Raspberry Pi Bplus_product brief.pdf	Raspberry Pi
│ Raspberry Pi Bplus_schematic v1.0.pdf	Raspberry Pi schematic
├──**documents**	**documentation**
│ mm3d-hw_en.pdf	User manual (EN)
│ mm3d-hw_hu.pdf	User manual (HU)
│ pcb_mm3d_base-comp.ps	base panel component side
│ pcb_mm3d_base-silk.ps	base panel silkscreen
│ pcb_mm3d_base-sold.ps	base panel solder side
│ pcb_mm3d_front-silk.ps	front panel silkscreen
│ pcb_mm3d_front-sold.ps	front panel solder side
│ sch_example.pdf	example schematic draw
│ sch_mm3d.pdf	MM3D schematic draw
├──**pictures**	**pictures**
│ mm3d.jpg	front panel
│ pcb_mm3d_base-comp.svg	base panel component side
│ pcb_mm3d_base-silk.svg	base panel silkscreen
│ pcb_mm3d_base-sold.svg	base panel solder side
│ pcb_mm3d_front-silk.svg	front panel silkscreen
│ pcb_mm3d_front-sold.svg	front panel solder side
│ sch_example.svg	example schematic draw
│ sch_mm3d.svg	MM3D schematic draw
└──README	short description (EN)

II. Software

1. General description

Operation of the device is provided by Python (control), Perl (data access) and Bash (utilities) scripts.

2. Installation

Before installing the program, you must install Raspbian OS Lite on Raspberry Pi. Remember to change the default password for the user 'pi', configure the hostname and access to the local network. For easier remote access, use a permanent IP address or configure the IP address assignment on your router.

To install the program:

```
pi@raspberry$ sudo apt-get update
pi@raspberry$ sudo apt-get upgrade
pi@raspberry$ sudo apt-get install mc wget
pi@raspberry$ wget --directory-prefix=$HOME/download http://www.szerafingomba.hu/equi
              pments/mm3d/mm3d-sw-0.11-noarch.tar.gz
pi@raspberry$ cd $HOME/download
pi@raspberry$ tar -xzf mm3d-sw-0.11-noarch.tar.gz
pi@raspberry$ cd mm3d-sw-0.11
pi@raspberry$ ./prepare
pi@raspberry$ ./install
```

To remove th e program:

```
pi@raspberry$ cd mm3d-sw-0.11
pi@raspberry$ ./uninstall
```

The installed and created on runtime files:
(Important files with info and target of symbolic links.)

```
/
|
├──etc
|     ├──cron.d
|     |    mm3d
|     ├──init.d
|     |    mm3d.sh
|     ├──rc0.d
|     |    K01mm3d.sh                    » /etc/init.d/mm3d.sh
|     ├──rc2.d
|     |    S01mm3d.sh                    » /etc/init.d/mm3d.sh
|     ├──rc3.d
|     |    S01mm3d.sh                    » /etc/init.d/mm3d.sh
```

```
|       |
|       ├──rc4.d
|       |     S01mm3d.sh                  » /etc/init.d/mm3d.sh
|       ├──rc5.d
|       |     S01mm3d.sh                  » /etc/init.d/mm3d.sh
|       ├──rc6.d
|       |     K01mm3d.sh                  » /etc/init.d/mm3d.sh
|       ├──sudoers.d
|       |     010_mm3d-nopasswdmm3d
|       └──motd
|
├──home
|     └──mm3d
|           ├──cfg_example
|           |     cfg_example.sh          example program setting script
|           |     cfg_example.ini
|           └──programs
|                 prg_current.py          » ./prg_empty.py
|                 prg_empty.py            empty user's controller program
|                 prg_example.py          example user's controller program
|
├──usr
|     ├──lib
|     |     └──cgi
|     |           getdata.cgi
|     |           getpage.cgi
|     └──local
|           ├──bin
|           |     mm3d.py                 daemon program
|           |     mm3d-editconf           edit current configuration
|           |     mm3d-editcurrentprog    edit current program
|           |     mm3d-hwtest.py          hardver check
|           |     mm3d-maintainlog        log maintaining
|           |     mm3d-override           output manual control
|           |     mm3d-startdaemon        start daemon
|           |     mm3d-stopdaemon         stop daemon
|           |     mm3d-updatestartpage    update startpage
|           |     mm3d-viewlog            view log
|           ├──etc
|           |     mm3d.ini                global configuration file
|           └──share
|                 ├──doc
|                 |     └──mm3d
|                 |           AUTHORS     author
|                 |           ChangeLog   change log
|                 |           COPYING     licence
|                 |           INSTALL     installation instruction
|                 |           README      description
|                 |           VERSION     version
|                 ├──locale
|                 |     ├──cs
|                 |     |     mm3d.msg
|                 |     ├──de
|                 |     |     mm3d.msg
|                 |     ├──fr
|                 |     |     mm3d.msg
|                 |     ├──hr
|                 |     |     mm3d.msg
|                 |     ├──hu
|                 |     |     mm3d.msg
|                 |     ├──pl
|                 |     |     mm3d.msg
```

```
        ├──ro
        │   mm3d.msg
        ├──ru
        │   mm3d.msg
        ├──sk
        │   mm3d.msg
        ├──sl
        │   mm3d.msg
        ├──sr
        │   mm3d.msg
        └──uk
            mm3d.msg
    ├──man
    │   └──man1                          manual pages
    │       mm3d.1.gz
    │       mm3d-editconf.1.gz
    │       mm3d-editcurrentprog.1.gz
    │       mm3d-hwtest.1.gz
    │       mm3d-maintainlog.1.gz
    │       mm3d-override.1.gz
    │       mm3d-startdaemon.1.gz
    │       mm3d-stopdaemon.1.gz
    │       mm3d-updatestartpage.1.gz
    │       mm3d-viewlog.1.gz
    └──mm3d
        footer_cs.html
        footer_de.html
        footer_en.html
        footer_fr.html
        footer_hr.html
        footer_hu.html
        footer_pl.html
        footer_ro.html
        footer_ru.html
        footer_sk.html
        footer_sl.html
        footer_sr.html
        footer_uk.html
        header_cs.html
        header_de.html
        header_en.html
        header_fr.html
        header_hr.html
        header_hu.html
        header_pl.html
        header_ro.html
        header_ru.html
        header_sk.html
        header_sl.html
        header_sr.html
        header_uk.html

└──var
    ├──local
    │   ├──lib
    │   │   out1
    │   │   out2
    │   │   out3
    │   │   out4
    │   ├──lock
    │   │   mm3d.lock
    │   │
```

```
│     └──log
│          mm3d.bak
│          mm3d.log
│          debug-*.log                    debug log
├──run
│    mm3d.pid
└──www
     └──html
          ├──pics
          │    szerafin.ico
          │    dark.png
          │    green.png
          │    red.png
          │    yellow.png
          styles.css
          index.html
          szerafin.ico
```

3. Settings

Before modifying the configuration file, you must stop running the daemon and restart it after editing:

```
mm3d@raspberry$ mm3d-stopdaemon
mm3d@raspberry$ mm3d-editconf
mm3d@raspberry$ sudo mm3d-updatestartpage
mm3d@raspberry$ mm3d-startdaemon
```

Content of configuration file:

```
; +-------------------------------------------------------------------------+
; | MM3D v0.3 * Growing house controlling and remote monitoring system      |
; | Copyright (C) 2018-2019 Pozsár Zsolt <pozsar.zsolt@.szerafingomba.hu>   |
; | mm3d.ini                                                                |
; | global configuration file                                               |
; +-------------------------------------------------------------------------+

[user]
; User's data
usr_nam=User's name                         ; user's name
usr_uid=00000000                            ; user's ID
usr_dt1=User's city                         ; more data (eg. country)
usr_dt2=User's address                      ; more data (eg. address)
usr_dt3=Growing house number                ; more data (eg. growing house)

[names]
; Name of error lights and ports
nam_err1=unnamed #1                         ; name of error lights
nam_err2=unnamed #2
nam_err3=unnamed #3
nam_err4=unnamed #4
nam_in1=unnamed #1                          ; name of inputs
nam_in2=unnamed #2
nam_in3=unnamed #3
nam_in4=unnamed #4
nam_out1=unnamed #1                         ; name of outputs
nam_out2=unnamed #2
```

```
nam_out3=unnamed #3
nam_out4=unnamed #4

[ports]
; GPIO port number of error lights and ports
prt_act=24
prt_err1=14
prt_err2=15
prt_err3=18
prt_err4=23
prt_in1=2
prt_in2=3
prt_in3=4
prt_in4=17
prt_sens=11
prt_out1=27
prt_out2=22
prt_out3=10
prt_out4=9

[sensors]
; Type of temperature and humidity sensor
;sensor_type=AM2302
;sensor_type=DHT11
sensor_type=DHT22

[directories]
; Directories of program
dir_htm=/var/www/html/                          ; webserver's directory
dir_lck=/var/local/lock/                        ; lock file's directory
dir_log=/var/local/log/                         ; logfile's directory
dir_msg=/usr/local/share/locale/                ; message files' directory
dir_shr=/usr/local/share/mm3d/                  ; other files' directory

[others]
; Language of webpage
;lng=cs
;lng=de
lng=en
;lng=fr
;lng=hr
;lng=hu
;lng=pl
;lng=ro
;lng=ru
;lng=sk
;lng=sl
;lng=sr
;lng=uk
; Storing time of log
day_log=7
; Enable/disable verbose debug log
dbg_log=0
```

4. User's controller program

Before modifying the user's controller program, you must stop running the daemon and restart it after editing:

```
mm3d@raspberry$ mm3d-stopdaemon
mm3d@raspberry$ mm3d-editcurrentprog
mm3d@raspberry$ mm3d-startdaemon
```

Content of 'empty' program:

```
#!/usr/bin/python
# +-------------------------------------------------------------------------+
; | MM3D v0.3 * Growing house controlling and remote monitoring system      |
# | Copyright (C) 2018-2019 Pozsár Zsolt <pozsar.zsolt@.szerafingomba.hu>   |
# | prg_empty.py                                                            |
# | User's program                                                          |
# +-------------------------------------------------------------------------+
#
#   This program is free software: you can redistribute it and/or modify it
# under the terms of the European Union Public License 1.1 version.
#
#   This program is distributed in the hope that it will be useful, but WITHOUT
# ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS
# FOR A PARTICULAR PURPOSE.

import time

def autooffport1():
  # Auto off OUT #1
  # Use this variable:
  #         aop1:  auto off OUT #1 port after switch on (in s)
  #
  # ------------------------ do not edit before this row ---------------------

  aop1="0"

  # ------------------------ do not edit after this row ----------------------
  #
  return aop1

def control(temperature,humidity,inputs,wrongvalues):
  in1=int(inputs[0])
  in2=int(inputs[1])
  in3=int(inputs[2])
  in4=int(inputs[3])
  #
  # Use thes variables:
  # -----------------
  #    humidity:  integer  measured relative humidity in %
  #         in1:  integer  status of input port #1, 0: opened | 1: closed to GND
  #         in2:  integer  status of input port #2, 0: opened | 1: closed to GND
  #         in3:  integer  status of input port #3, 0: opened | 1: closed to GND
  #         in4:  integer  status of input port #4, 0: opened | 1: closed to GND
  # temperature:  integer  measured temperature in degree Celsius
  # wrongvalues:  measured data is
  #
```

```
# ------------------------ do not edit before this row ---------------------

# Write here!

# ------------------------ do not edit after this row ----------------------
#
# output data
# -----------
# out1:  integer  status of output port #1, 0: switch off | 1: switch on relay
# out2:  integer  status of output port #2, 0: switch off | 1: switch on relay
# out3:  integer  status of output port #3, 0: switch off | 1: switch on relay
# out4:  integer  status of output port #4, 0: switch off | 1: switch on relay
# err1:  integer  status of error light #1, 0: switch off | 1: switch on LED
# err2:  integer  status of error light #2, 0: switch off | 1: switch on LED
# err3:  integer  status of error light #3, 0: switch off | 1: switch on LED
# err4:  integer  status of error light #4, 0: switch off | 1: switch on LED
#
outputs=str(out1)+str(out2)+str(out3)+str(out4)+ \
        str(err1)+str(err2)+str(err3)+str(err4)
return outputs
```

You can insert our own hardware instructions into the place "Write here!"

5. Using the device

The device works automatically after installation and does not require human intervention. Checking and configuring your operation is only possible remotely via a network.

a) Connect with a web browser

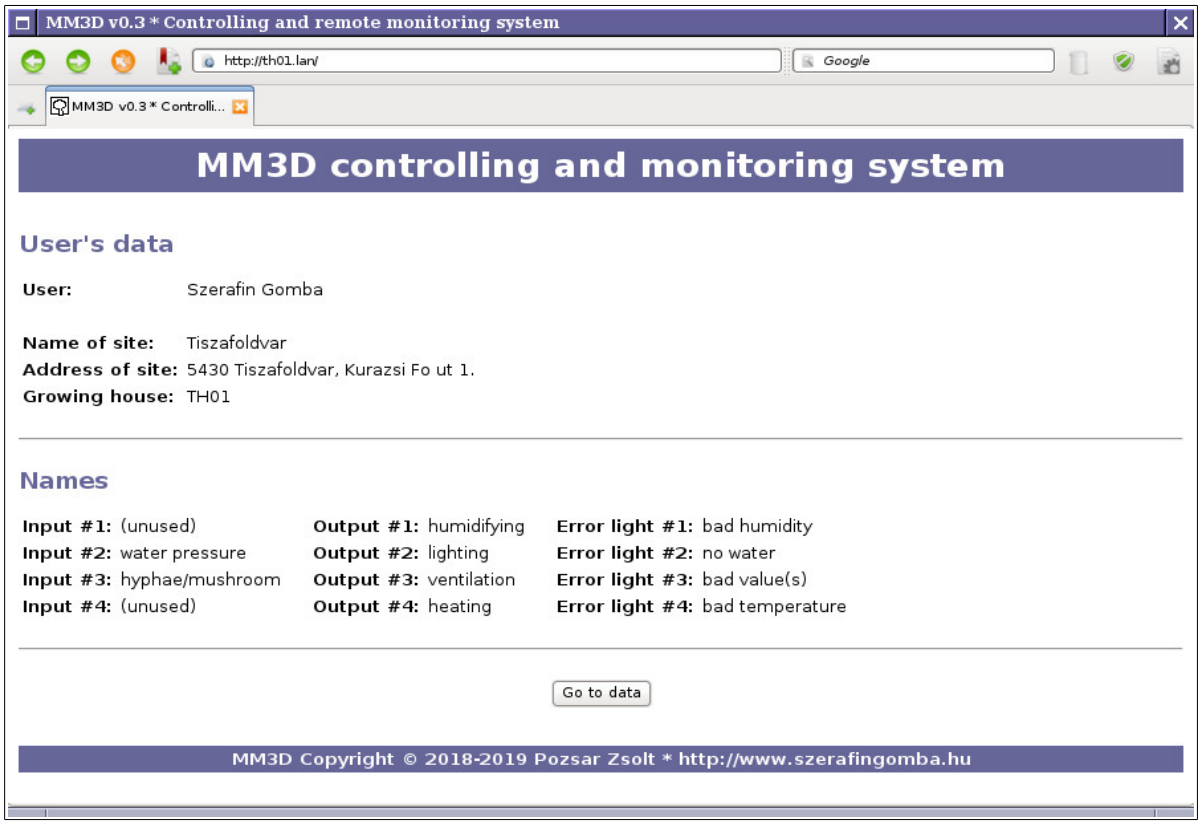


Figure 2: Startpage

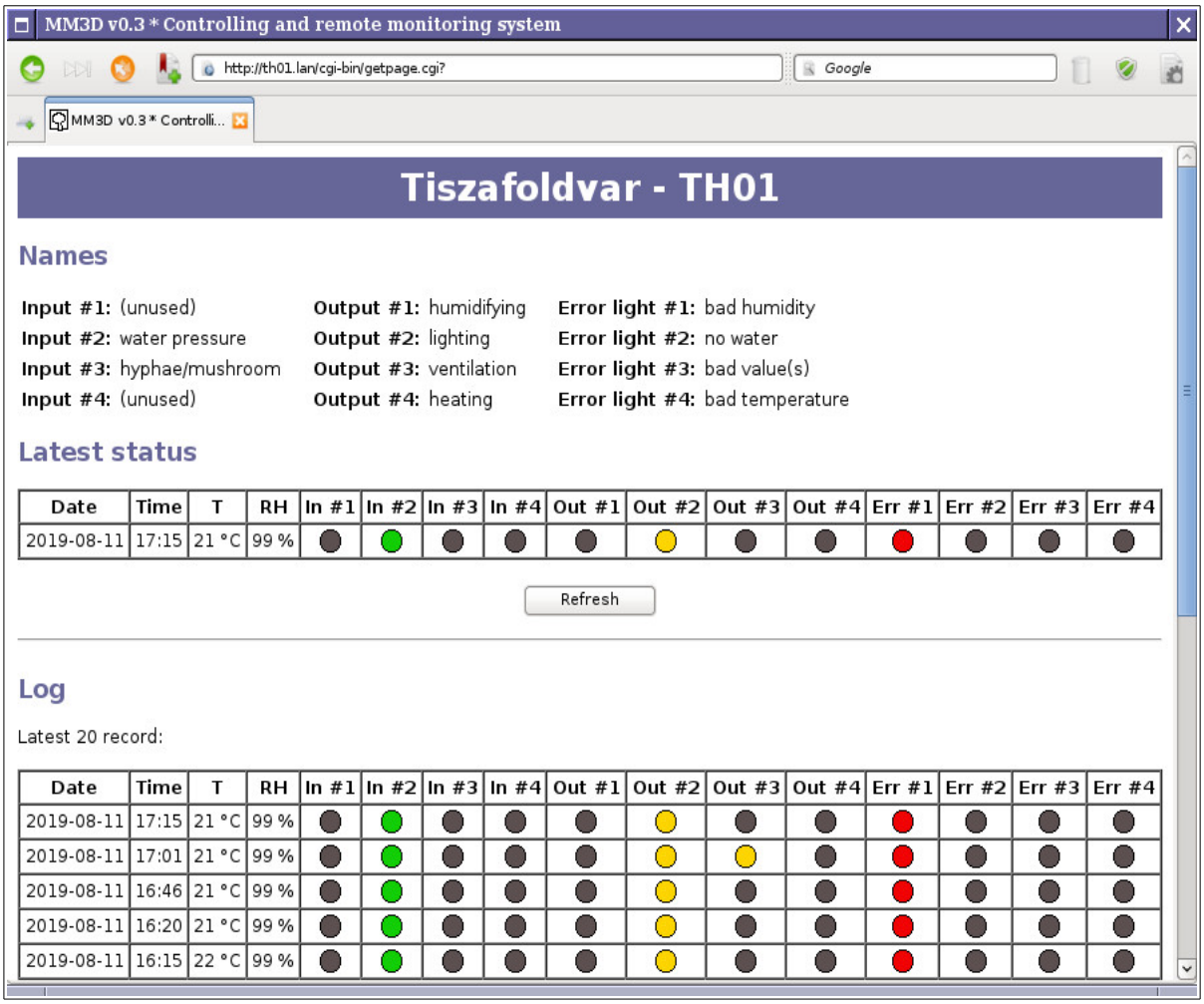


Figure 3: Measured data

b) Connect with SSH client

For proper character display, the terminal terminal type must be set on non-Unix-like operating systems.

Connect with OpenSSH on Windows:

```
C:\Users\pozsarzs>set TERM=linux
C:\Users\pozsarzs>ssh mm3d@th01.lan
```

Connect with Putty on Windows:

The type of terminal can be set in the field marked with the green frame. (Figure 4)

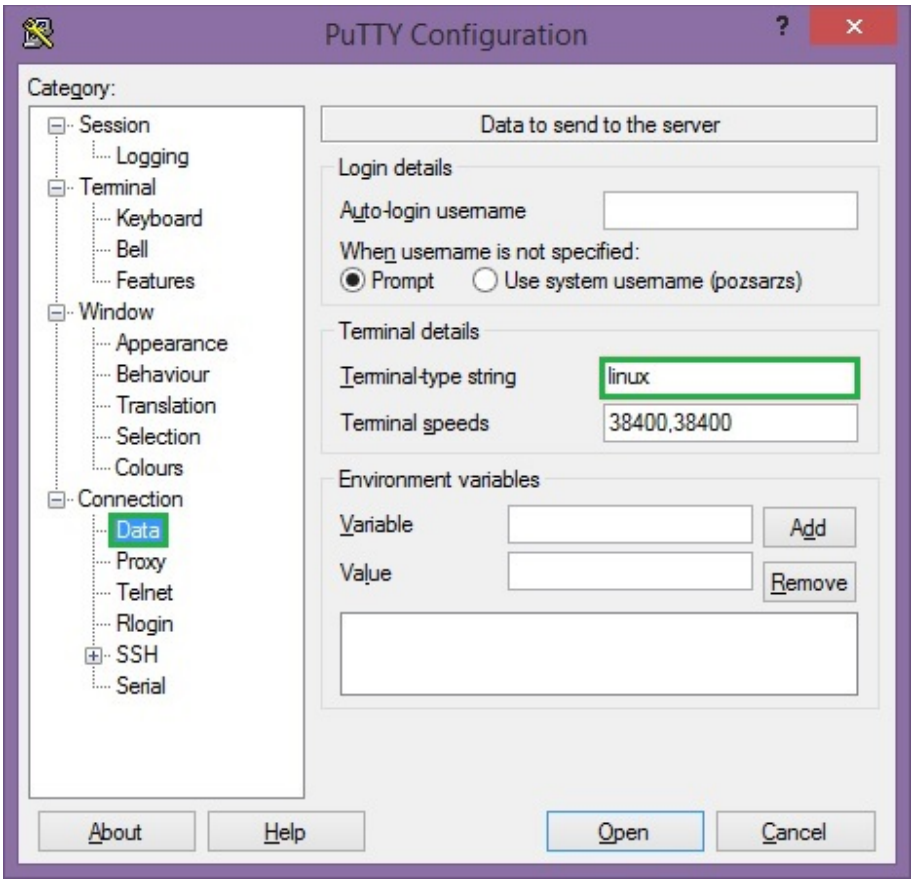


Figure 4: Set terminal

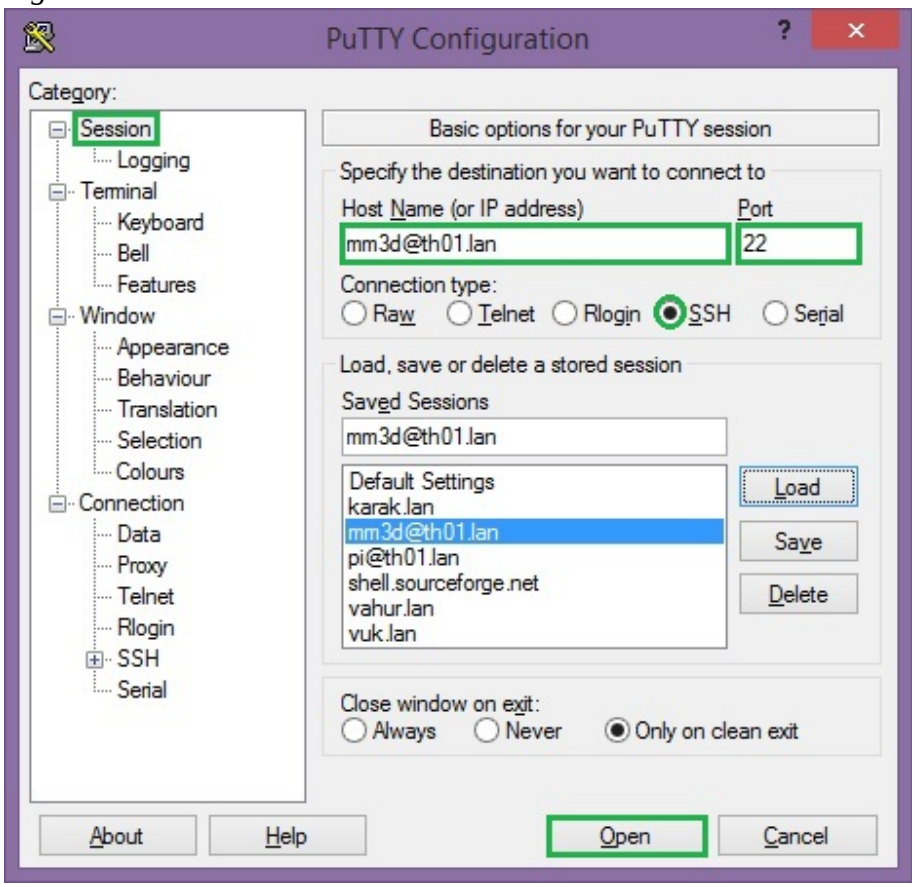


Figure 5: Connect with Putty

Connect with OpenSSH on linux:

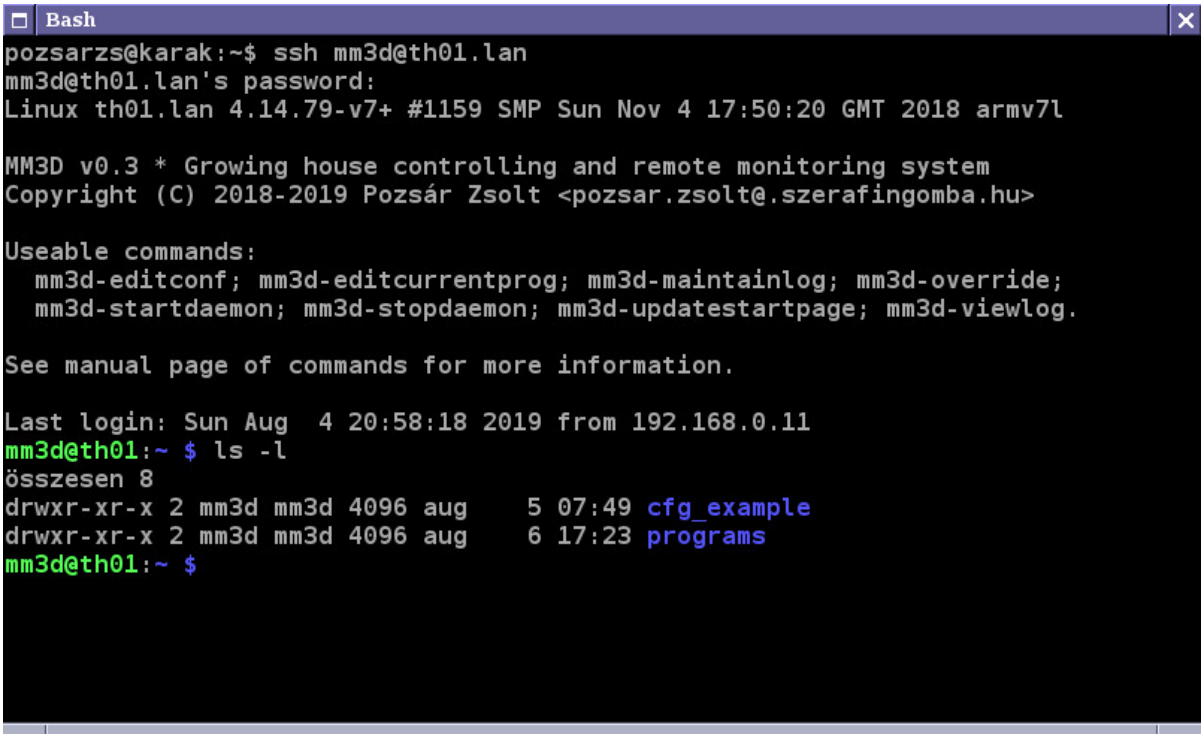


Figure 6: Connect with OpenSSH

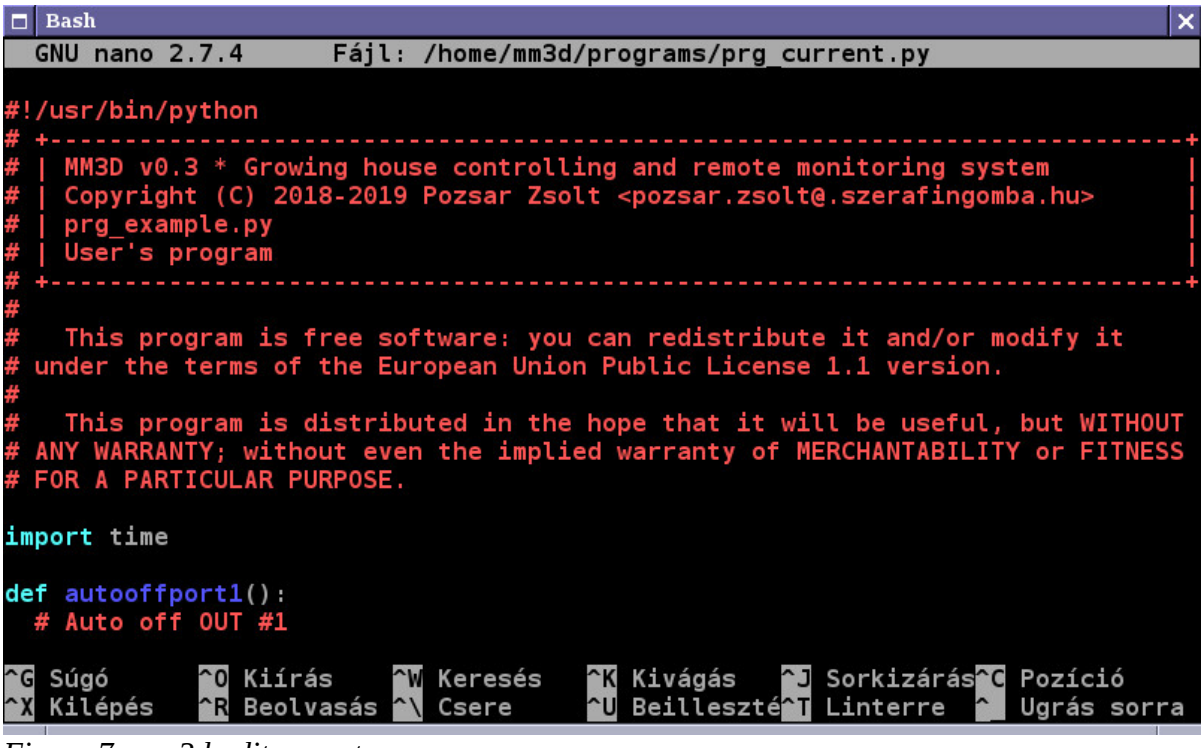


Figure 7: mm3d-editcurrentprog

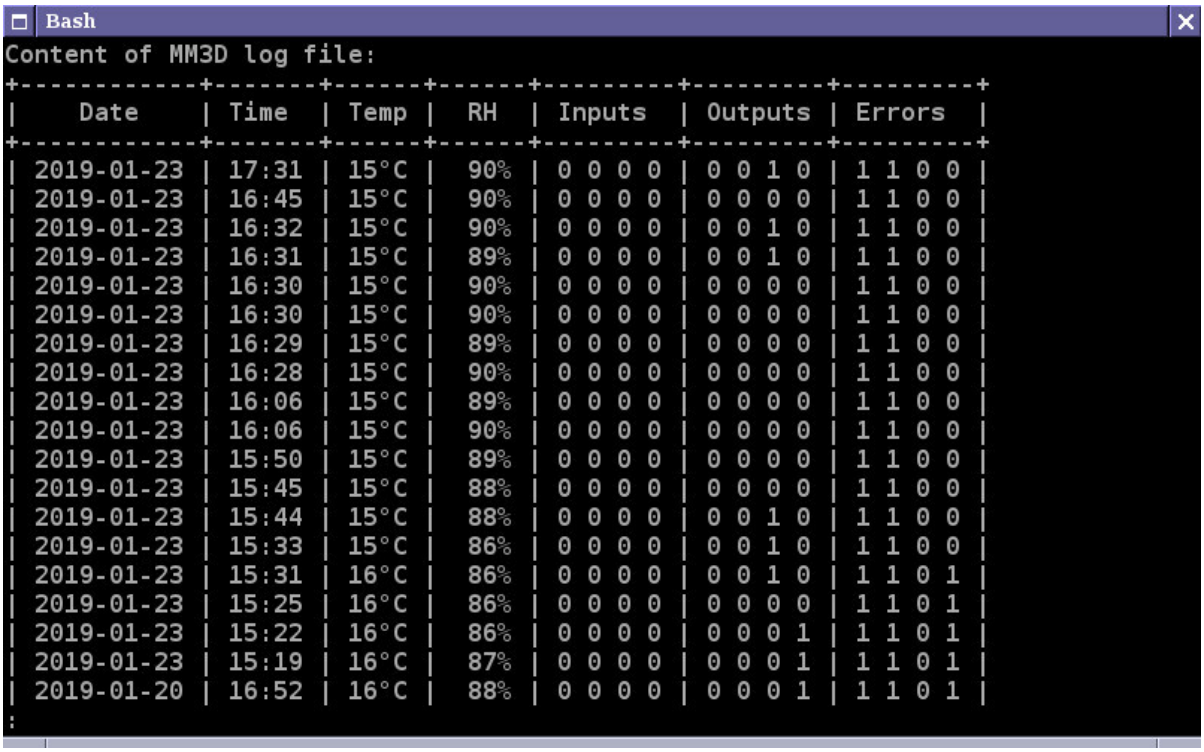


Figure 8: mm3d-viewlog

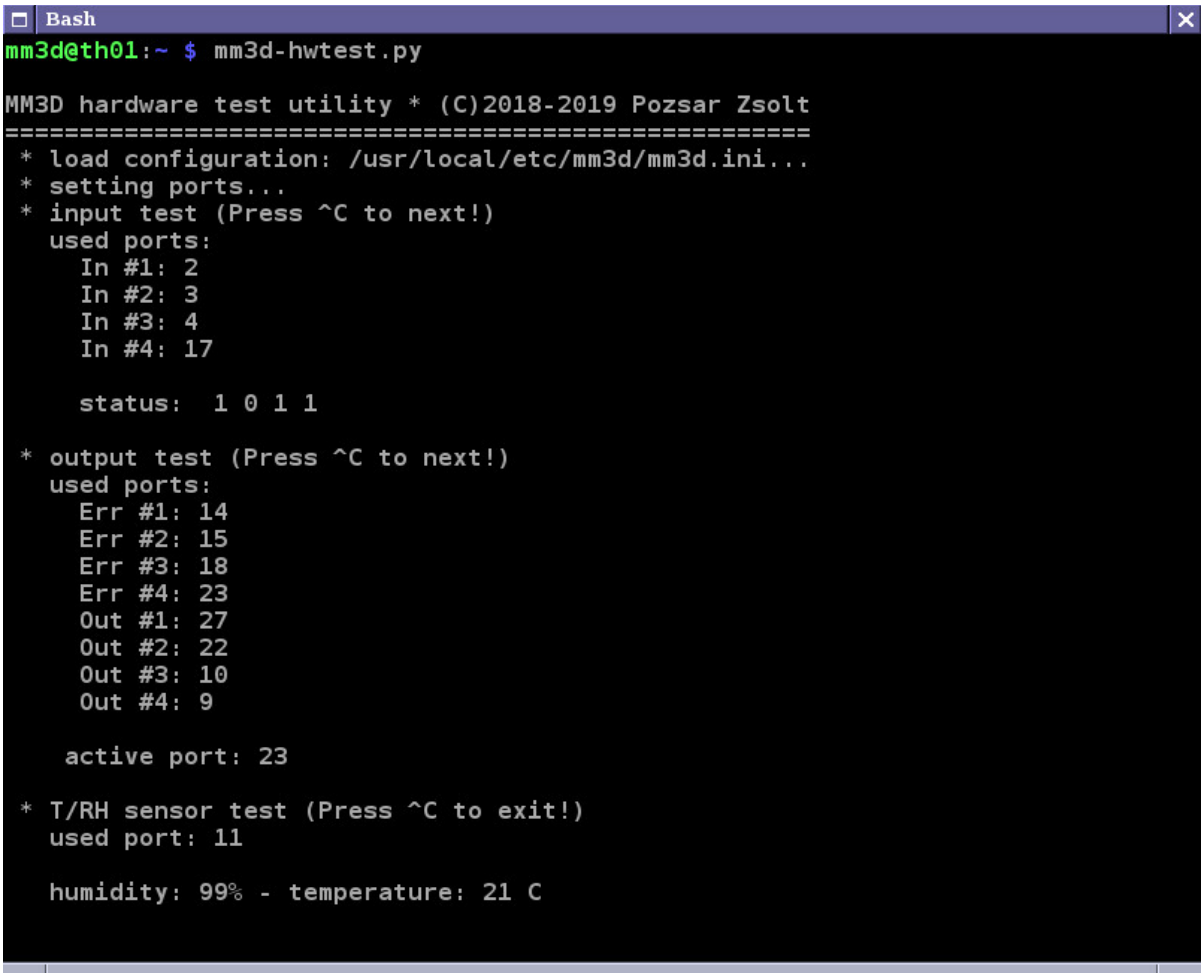


Figure 9: mm3d-hwtest.py

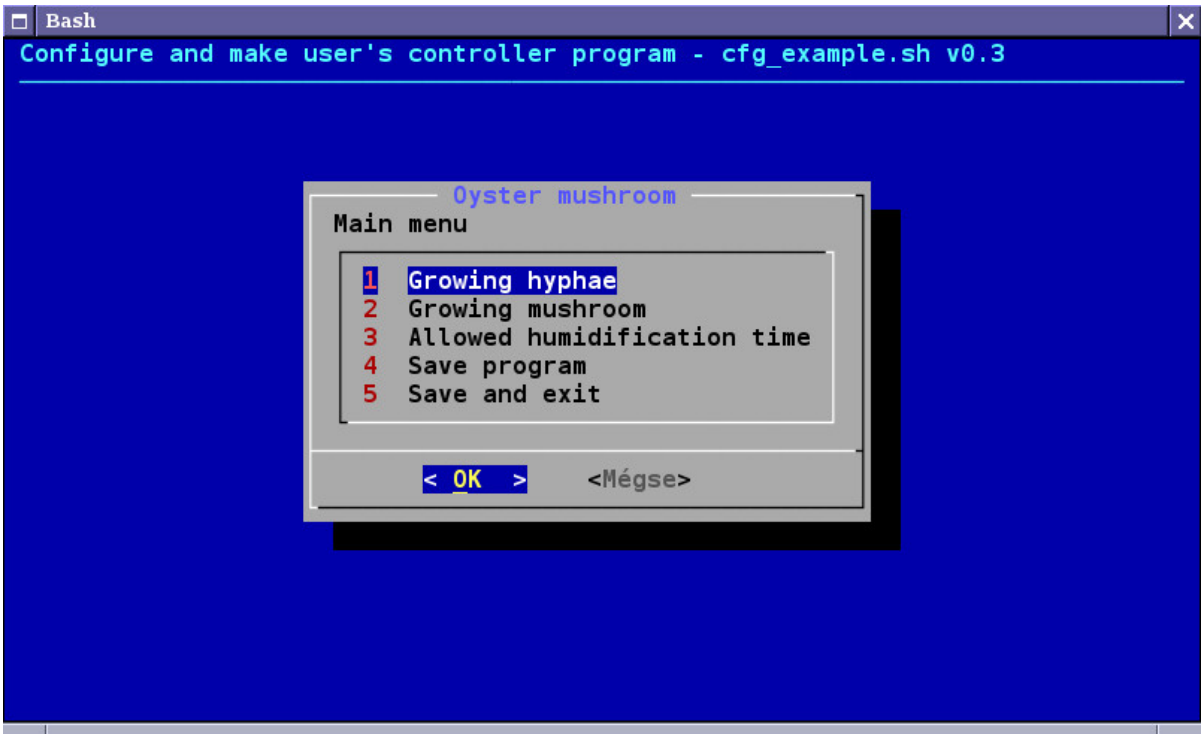


Figure 10: cfg_example.sh - Main menu

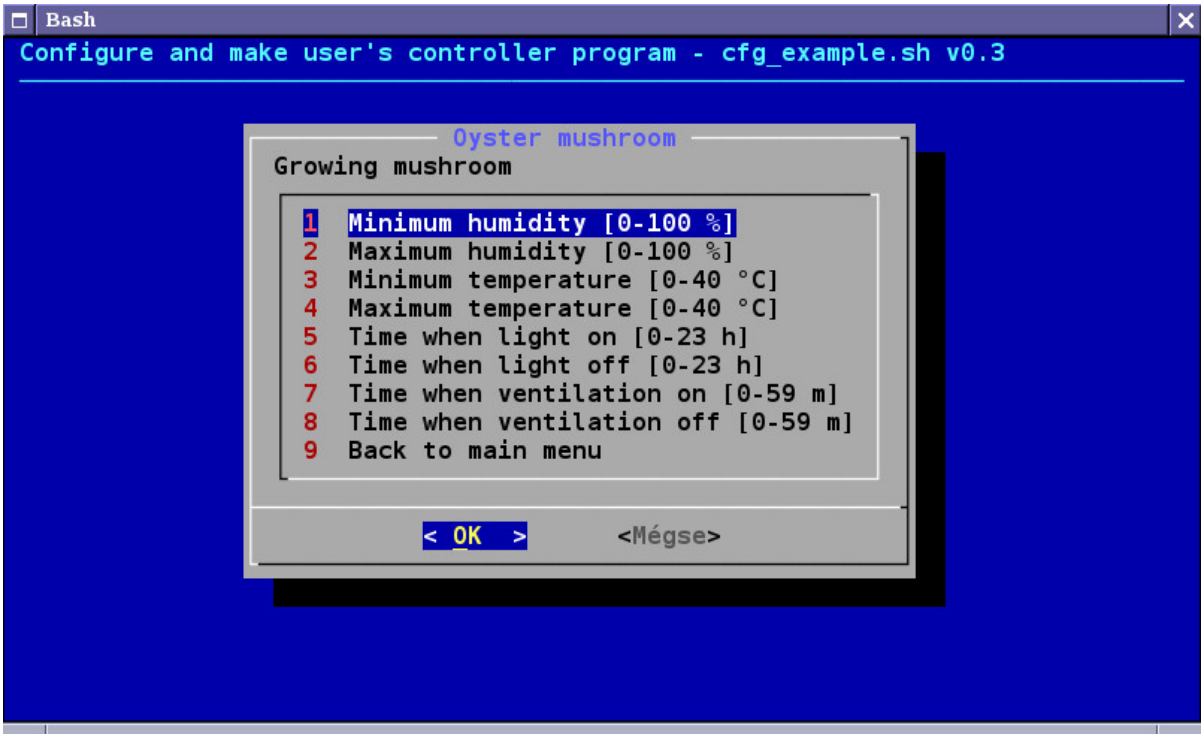


Figure 11: cfg_example.sh – Growing mushroom submenu

6. Terms of use

This program is free software: you can redistribute it and/or modify it under the terms of the European Union Public License 1.1 version.

This program is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

You can read the full (English and Hungarian) text of the license online. (Refer to Chapter IV for references.)

7. Downloadable software package

The package can be downloaded from the manufacturer's website in a .tar.gz compressed file. (Refer to Chapter IV for references.)

Name of current package: *mm3d-sw-0.3-noarch.tar.gz*

Content:

mm3d-sw-0.3	
documents	**documentation (EN)**
AUTHORS	author(s)
ChangeLog	change log
COPYING	EUPL v1.1
INSTALL	installation instruction
README	information
VERSION	version
manuals	**manual pages (EN)**
messages	**translated webpage text**
programs	**programs (Python)**
scripts	**programs (Bash)**
settings	**settings**
webpage	**components of webpage**
install	installer script
preinstall	preinstaller script
uninstall	uninstaller script
README	short description (en)

III. Example of application

The example illustrates the co-operation of the analog controllers MM1A and MM2A. The operation of the growing house requires controlled lighting and ventilation, heating and humidification. The wiring of the house is in annex 2.

Input and output function:

sign	function	note
Inputs		
IN #1	-	
IN #2	water pressure sensor	low pressure: opened contacts
IN #3	operation mode switch	growing mushroom: opened contacts
IN #4	-	
Outputs		
OUT #1	Humidifying	magnetic valve with 24V AC solenoid
OUT #2	Lighting	fluorescent lamps
OUT #3	Ventilation	
OUT #4	Heating	electrical heaters
Error lights		
ERR #1	Bad humidity	Growing hyphae: 65-70% Growing mushroom: 75-86%
ERR #2	Low water pressure	Pressure of the incoming water is low for the operation of the humidifier system.
ERR #3	Wrong values-	Wrong measured values.
ERR #4	Bad temperature	Growing hyphae: 17-23 ºC Growing mushroom: 7-18 ºC

User's controller program:

```
#!/usr/bin/python
# +-------------------------------------------------------------------------+
# | MM3D v0.3 * Growing house controlling and remote monitoring system      |
# | Copyright (C) 2018-2019 Pozsar Zsolt <pozsar.zsolt@.szerafingomba.hu>   |
# | prg_example.py                                                          |
# | User's program                                                          |
# +-------------------------------------------------------------------------+
#
#   This program is free software: you can redistribute it and/or modify it
# under the terms of the European Union Public License 1.1 version.
#
#   This program is distributed in the hope that it will be useful, but WITHOUT
# ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS
# FOR A PARTICULAR PURPOSE.

import time

def autooffport1():
  # Auto off OUT #1
  # Use this variable:
  #         aop1:  auto off OUT #1 port after switch on (in s)
  #
  # ------------------------ do not edit before this row ---------------------

  aop1="5"

  # ------------------------ do not edit after this row ----------------------
  #
  return aop1

def control(temperature,humidity,inputs,wrongvalues):
  in1=int(inputs[0])
  in2=int(inputs[1])
  in3=int(inputs[2])
  in4=int(inputs[3])
  #
  # Use thes variables:
  # ------------------
  #    humidity:  integer  measured relative humidity in %
  #         in1:  integer  status of input port #1, 0: opened | 1: closed to GND
  #         in2:  integer  status of input port #2, 0: opened | 1: closed to GND
  #         in3:  integer  status of input port #3, 0: opened | 1: closed to GND
  #         in4:  integer  status of input port #4, 0: opened | 1: closed to GND
  # temperature:  integer  measured temperature in degree Celsius
  # wrongvalues:  measured data is invalid
  #
  # ------------------------ do not edit before this row ---------------------

  # Growing oyster mushroom - cooperation with MM1A and MM2A analog controllers
  #
  # in1:  (unused)
  # in2:  water pressure (closed: good)
  # in3:  growing hyphae/mushroom (closed: hyphae)
  # in4:  (unused)
  # err1: bad relative humidity
  # err2: bad water pressure
  # err3: wrong measured data
  # err4: bad temperature
  # out1: humidifying
```

```
# out2: lighting
# out3: ventilation
# out4: heating

# check water pressure:
if in2==1:
  err2=0
else:
  err2=1

# check growing mode:
if in3==1:
  # growing hyphae
  humidity_min=65
  humidity_max=70
  temperature_min=17
  temperature_max=23
  light_on=0
  light_off=0
  vent_on=0
  vent_off=0
else:
  # growing mushroom
  humidity_min=75
  humidity_max=85
  temperature_min=7
  temperature_max=18
  light_on=14
  light_off=22
  vent_on1=0
  vent_off1=15
allowed_hour=14
allowed_minute=0

# humidifying
if (wrongvalues == 0) and ((humidity<humidity_min) or (humidity>humidity_max)):
  err1=1
else:
  err1=0

if (wrongvalues == 0) and ((humidity<humidity_min) and (err2==0)):
  h=int(time.strftime("%H"))
  m=int(time.strftime("%M"))
  if (h==allowed_hour) and (m==allowed_minute):
    out1=1
  else:
    out1=0
else:
  out1=0

# lighting
h=int(time.strftime("%H"))
if (h>light_on) and (h<light_off):
  out2=1
else:
  out2=0

# ventilation
m=int(time.strftime("%M"))
if (m>vent_on) and (m<vent_off):
  out3=1
else:
```

```
    out3=0

  # heating
  if (wrongvalues == 0) and ((temperature<temperature_min) or
(temperature>temperature_max)):
    err4=1
  else:
    err4=0

  if (wrongvalues == 0) and (temperature<temperature_min):
    out4=1
  else:
    out4=0

  # other error lights
  err3= wrongvalues

  # ------------------------ do not edit after this row ----------------------
  #
  # output data
  # -----------
  # out1:  integer  status of output port #1, 0: switch off | 1: switch on relay
  # out2:  integer  status of output port #2, 0: switch off | 1: switch on relay
  # out3:  integer  status of output port #3, 0: switch off | 1: switch on relay
  # out4:  integer  status of output port #4, 0: switch off | 1: switch on relay
  # err1:  integer  status of error light #1, 0: switch off | 1: switch on LED
  # err2:  integer  status of error light #2, 0: switch off | 1: switch on LED
  # err3:  integer  status of error light #3, 0: switch off | 1: switch on LED
  # err4:  integer  status of error light #4, 0: switch off | 1: switch on LED
  #
  outputs=str(out1)+str(out2)+str(out3)+str(out4)+ \
          str(err1)+str(err2)+str(err3)+str(err4)
   return outputs
```

IV. Related links

1. Hardware

Full documentation	http://www.szerafingomba.hu/equipments/mm3d/mm3d-hw-190203-3.0.tar.gz
User manual (EN)	http://www.szerafingomba.hu/equipments/mm3d/user-manual-190203-3.0-en.pdf
User manual (HU)	http://www.szerafingomba.hu/equipments/mm3d/user-manual-190203-3.0-hu.pdf

Kapcsolási rajzok:

Example (KiCAD)	http://www.szerafingomba.hu/equipments/mm3d/sch_mm3d-example.tar.gz
Example (PDF)	http://www.szerafingomba.hu/equipments/mm3d/sch_mm3d-example.pdf
Example (SVG)	http://www.szerafingomba.hu/equipments/mm3d/sch_mm3d-example.svg
MM3D (KiCAD)	http://www.szerafingomba.hu/equipments/mm3d/sch_mm3d.tar.gz
MM3D (PDF)	http://www.szerafingomba.hu/equipments/mm3d/sch_mm3d.pdf
MM3D (SVG)	http://www.szerafingomba.hu/equipments/mm3d/sch_mm3d.svg

Printed circuit boards:

MM3D base (PS)	http://www.szerafingomba.hu/equipments/mm3d/pcb_mm3d_base-ps.tar.gz
MM3D base (SVG)	http://www.szerafingomba.hu/equipments/mm3d/pcb_mm3d_base-svg.tar.gz
MM3D front (PS)	http://www.szerafingomba.hu/equipments/mm3d/pcb_mm3d_front-ps.tar.gz
MM3D front (SVG)	http://www.szerafingomba.hu/equipments/mm3d/pcb_mm3d_front-svg.tar.gz

2. Software

Software package	http://www.szerafingomba.hu/equipments/mm3d/mm3d-sw-0.3-noarch.tar.gz

3. Terms of use

CC-BY-NC-4.0 (EN)	https://creativecommons.org/licenses/by-nc/4.0/legalcode
CC-BY-NC-4.0 (EN)	https://creativecommons.org/licenses/by-nc/4.0/
CC-BY-NC-4.0 (HU)	https://creativecommons.org/licenses/by-nc/4.0/deed.hu
EUPL v1.2 (EN)	https://eupl.eu/1.2/en/
EUPL v1.2 (HU)	https://eupl.eu/1.2/hu/

4. Developer and manufacturer

Homepage	https://www.szerafingomba.hu
E-mail	info@szerafingomba.hu

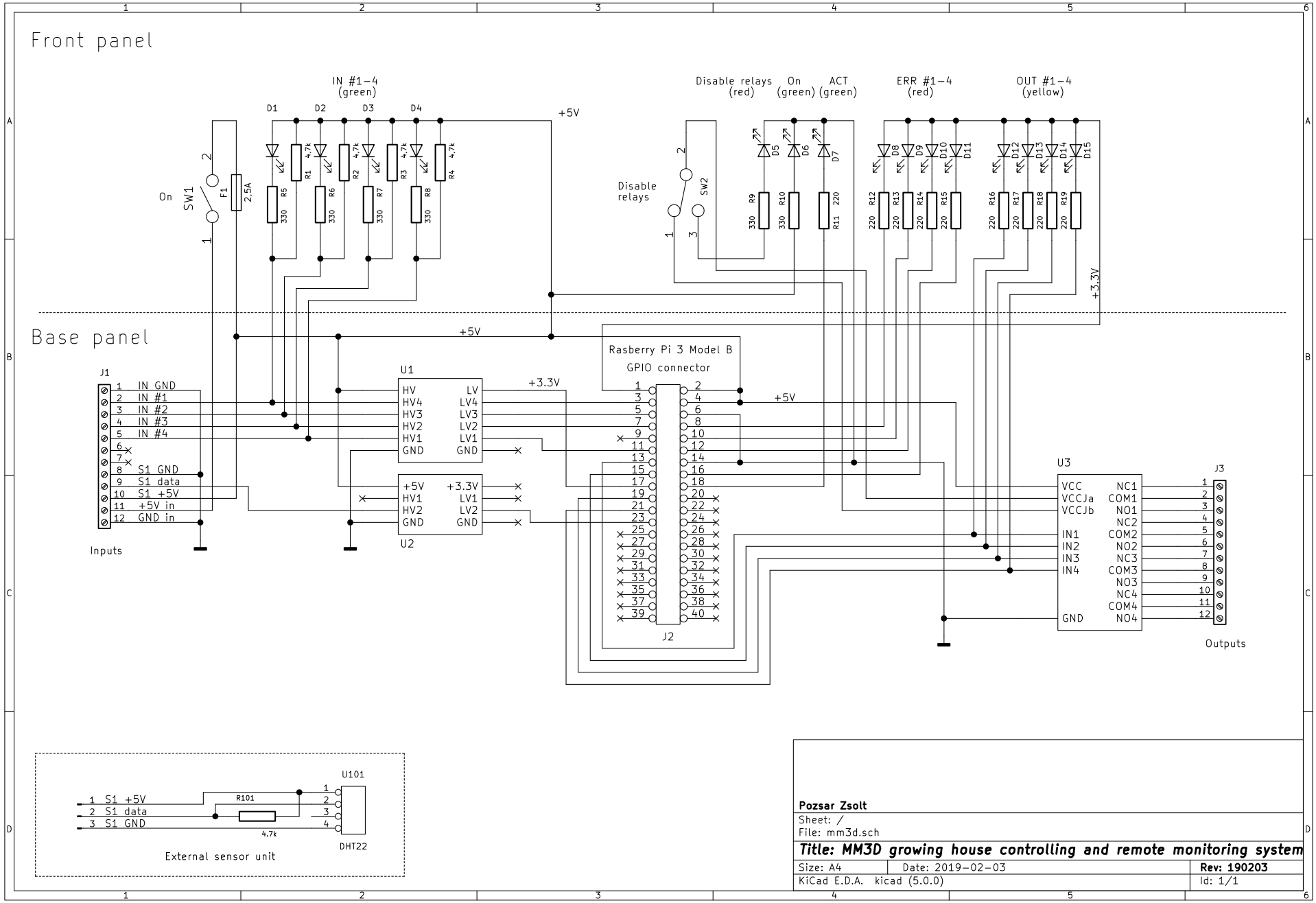
V. Annexes

1. Schematic draws

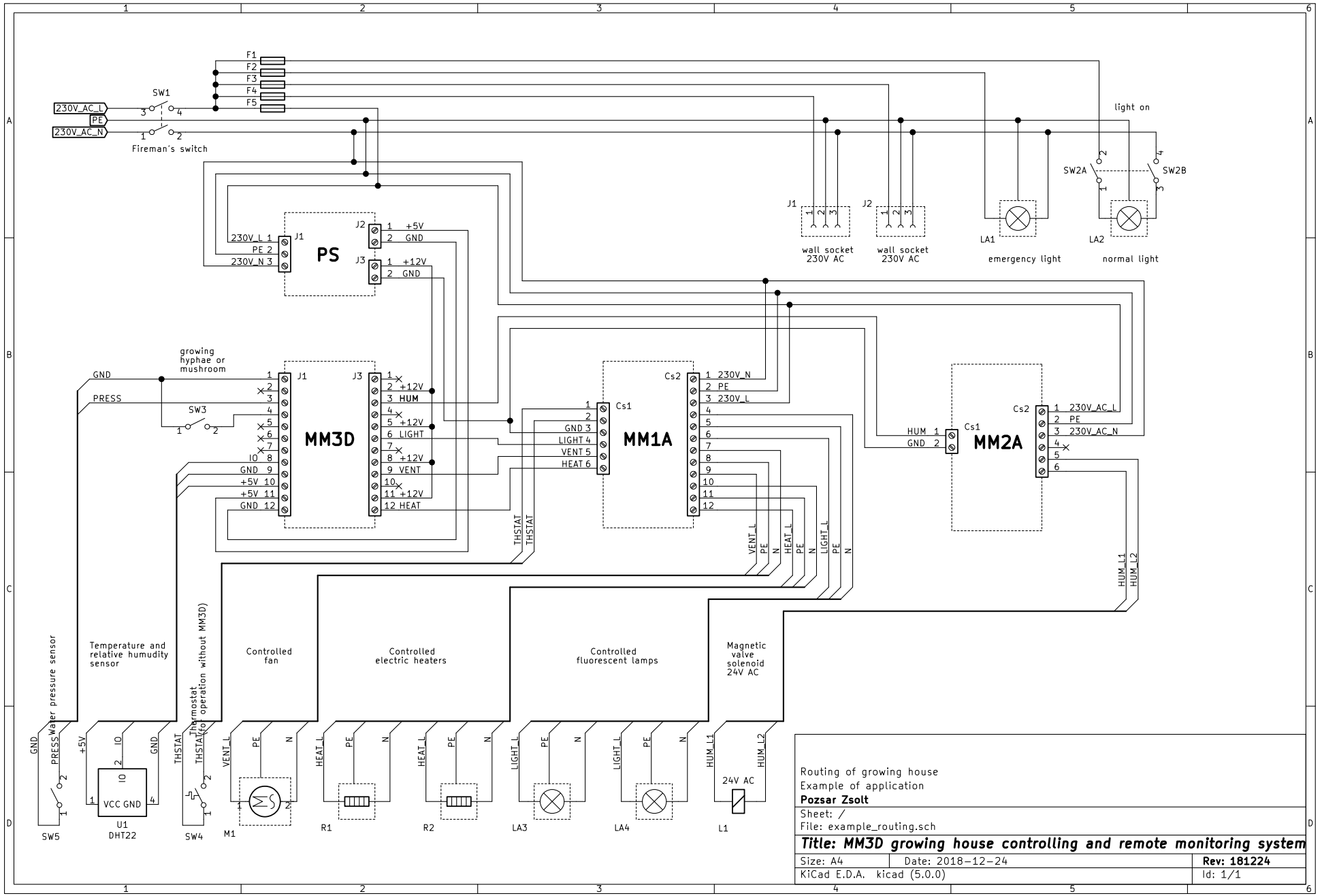
1. Schematic of MM3D
2. Example of application

2. Printed circuit boards

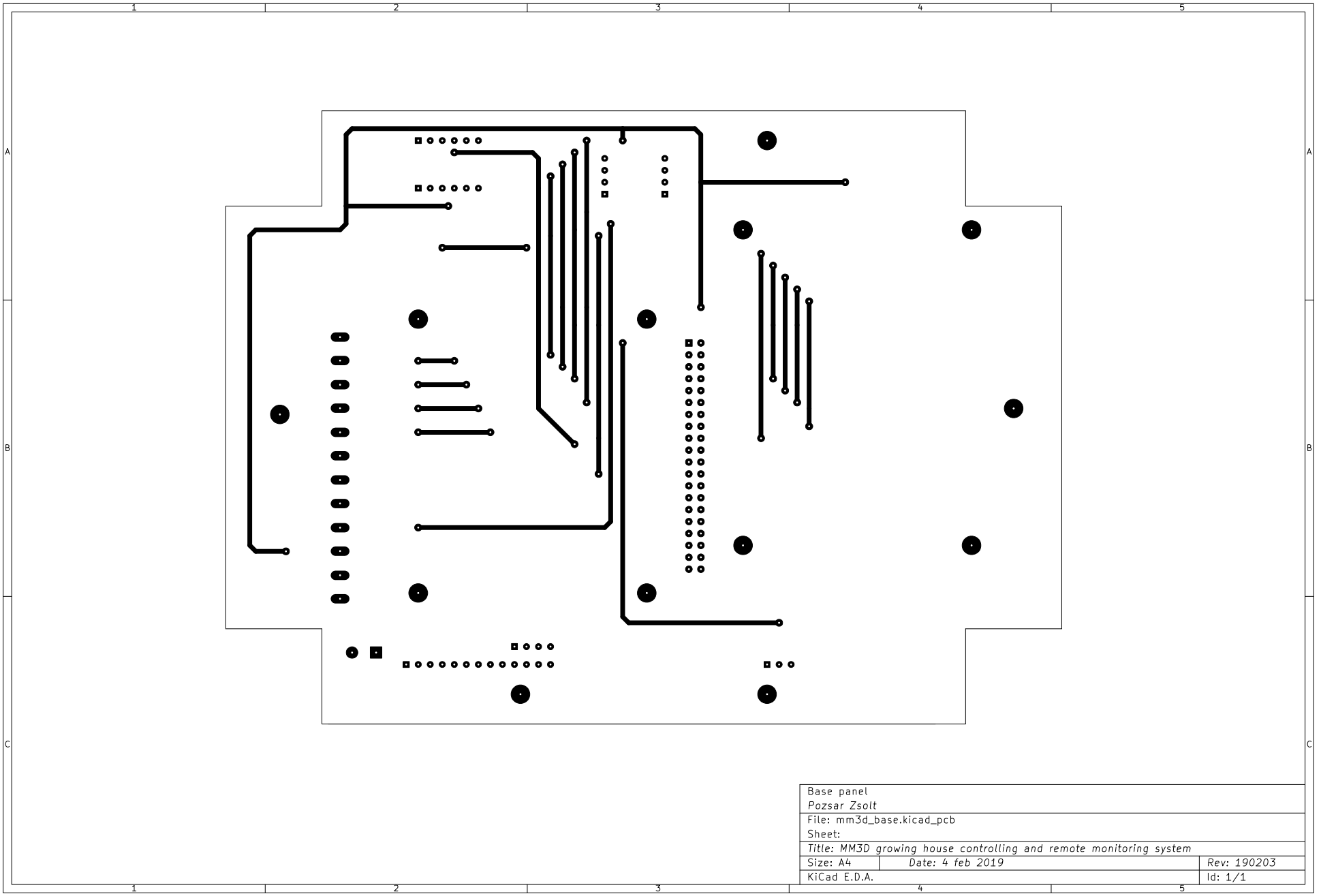
3. Base panel component side
4. Base panel solder side
5. Base panel silkscreen
6. Front panel component side
7. Front panel silkscreen



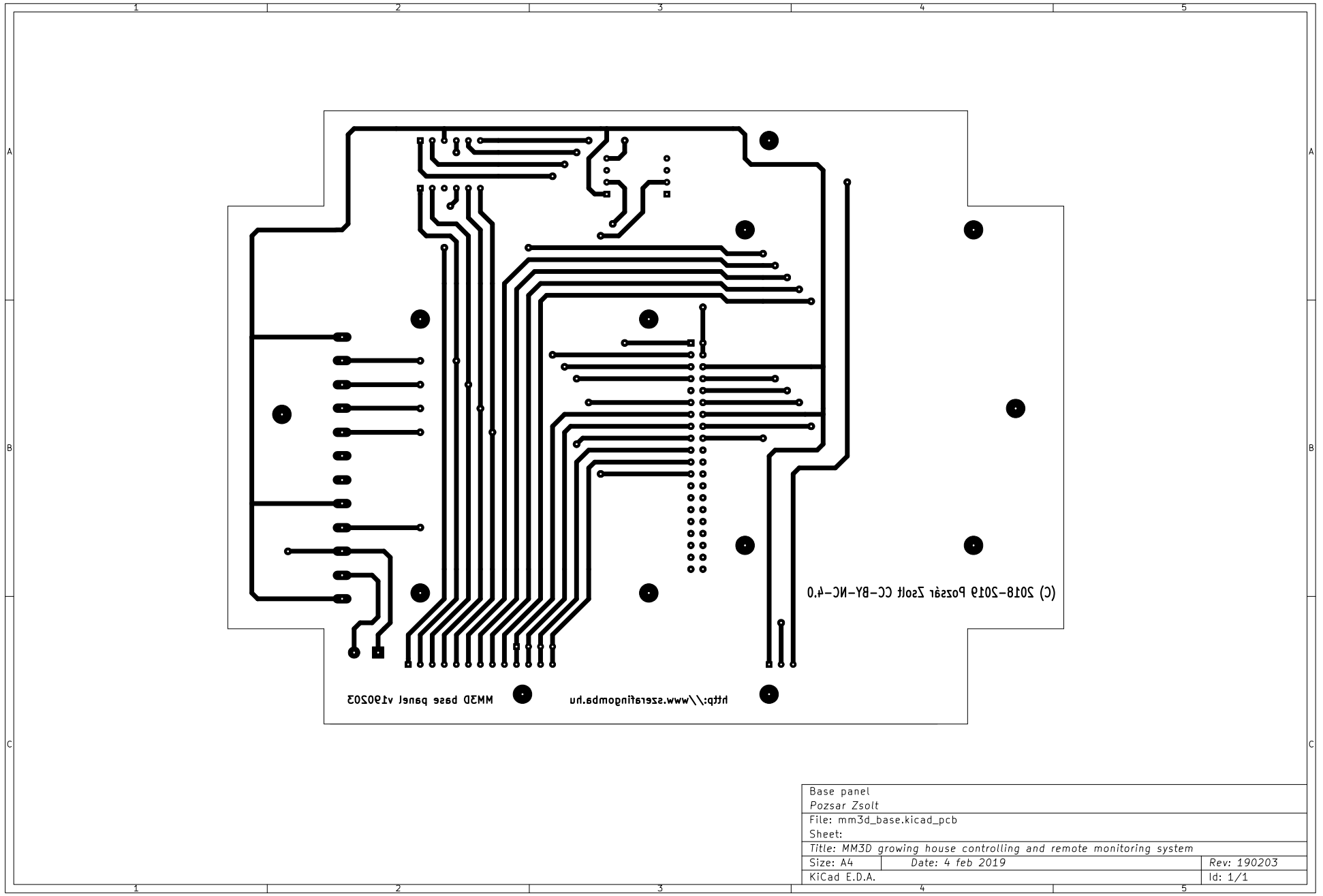
Annex 1: Schematic of MM3D



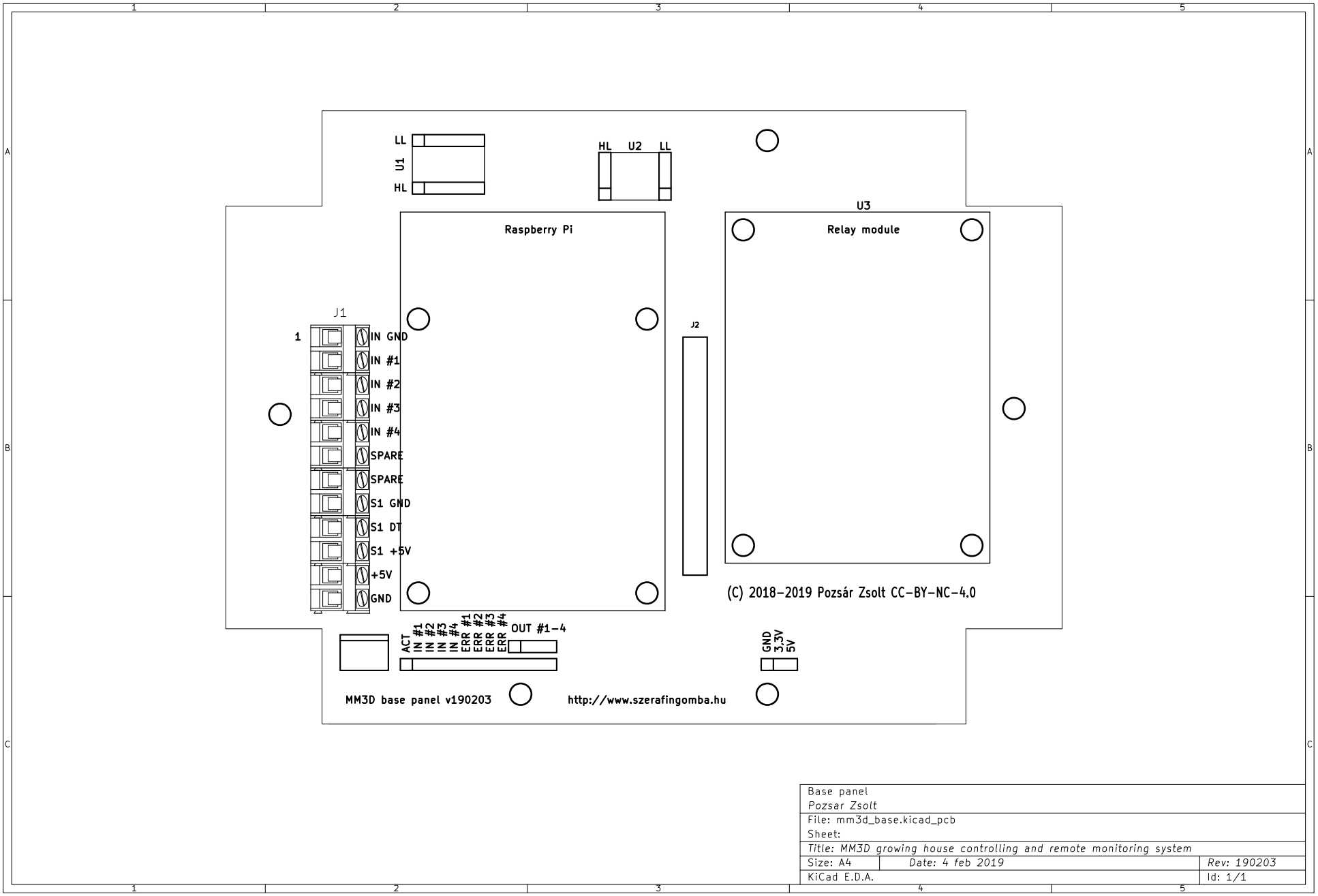
Annex 2: Example of application



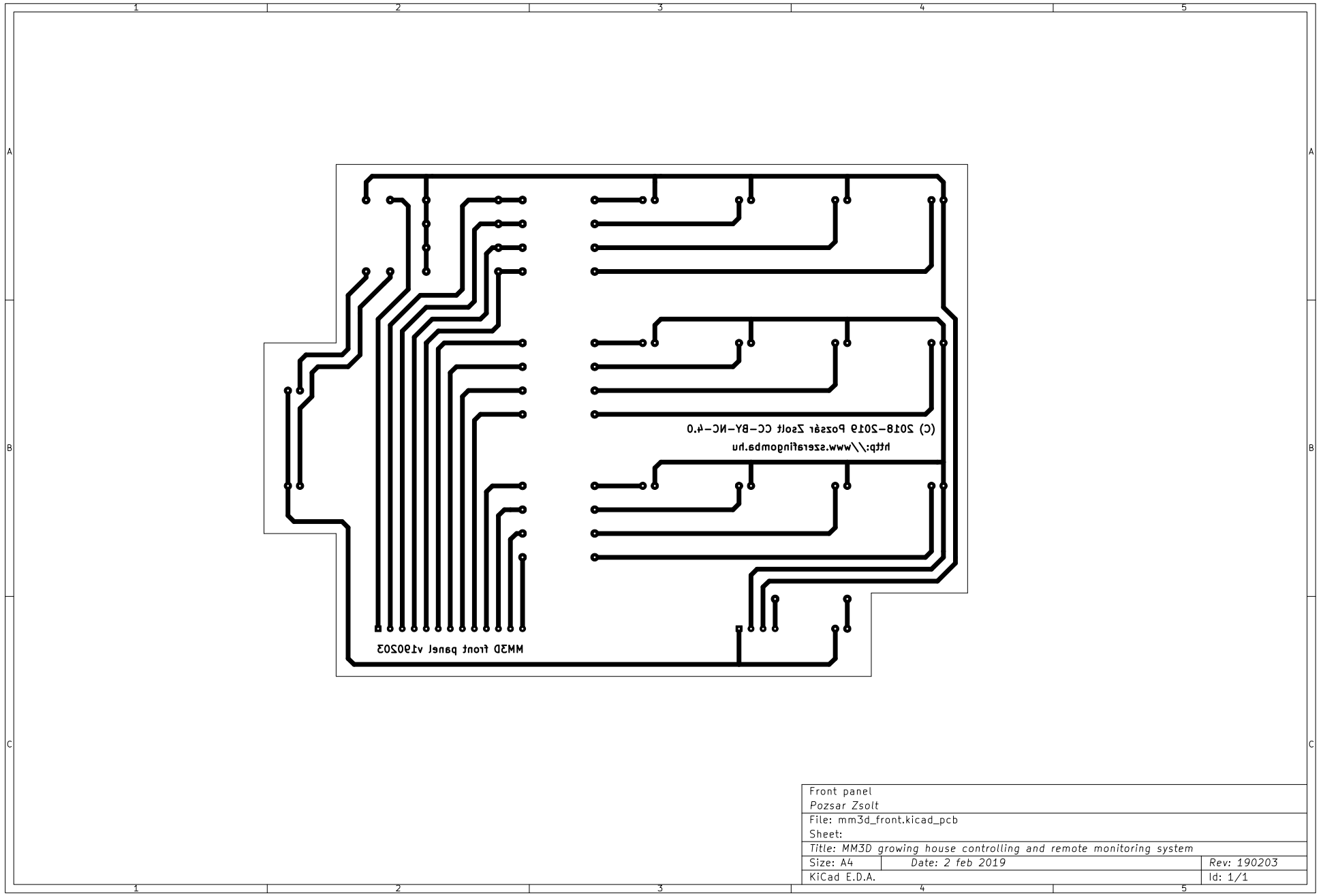
Annex 3: Base panel component side



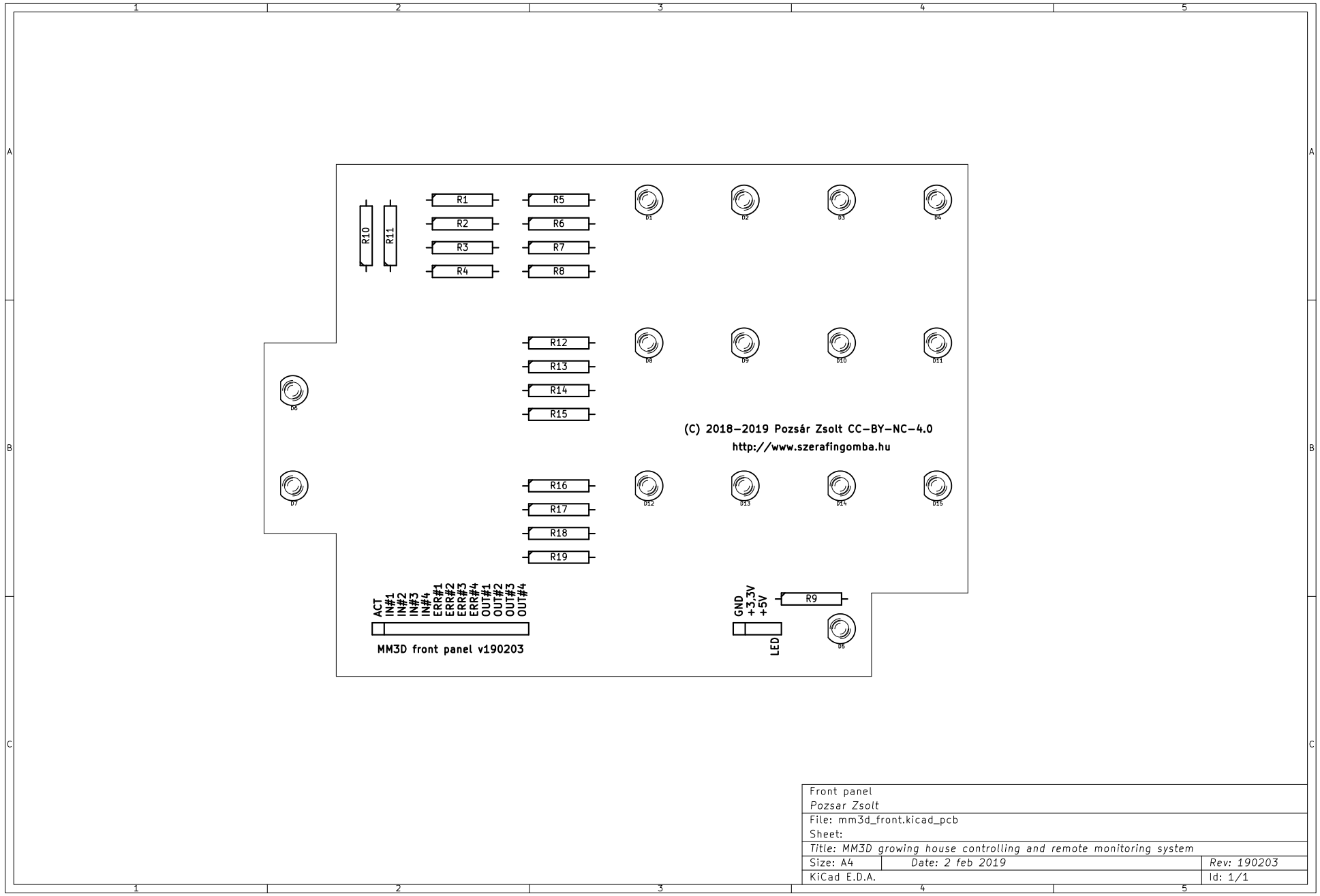
Annex 4: Base panel solder side



Annex 5: Base panel silkscreen



Annex 6: Front panel solder side



Annex 7: Front panel silkscreen