



USING YOUR GROBOT

October 2024
Ulnooweg Education Centre



Table of Contents

Safety Instructions	1
1.0 Overview.....	2
1.1 Electronics Box	3
1.2 Growth Chamber	4
2.0 Normal Use.....	5
2.1 Starting New Plants	5
2.2 Changing Settings	6
2.3 Manual Control.....	7
3.0 Regular Maintenance	8
3.1 Replacing The Pump Filter	8
3.2 Updating Software	9
4.0 Troubleshooting	11
4.1 The GroBot (LCD Screen) Doesn't Turn On	11
4.2 The GroBot (LCD Screen) Turns On	13
4.3 Accessing the Terminal (non-SSH).....	1
Terminal Login Password	1
Accessing Terminal (non-SSH)	1
4.4 Accessing the System Logs	4
5.0 Support.....	5
5.1 Physical Parts	6
5.2 Electronic Parts	8
5.3 Connectors	9

Safety Instructions

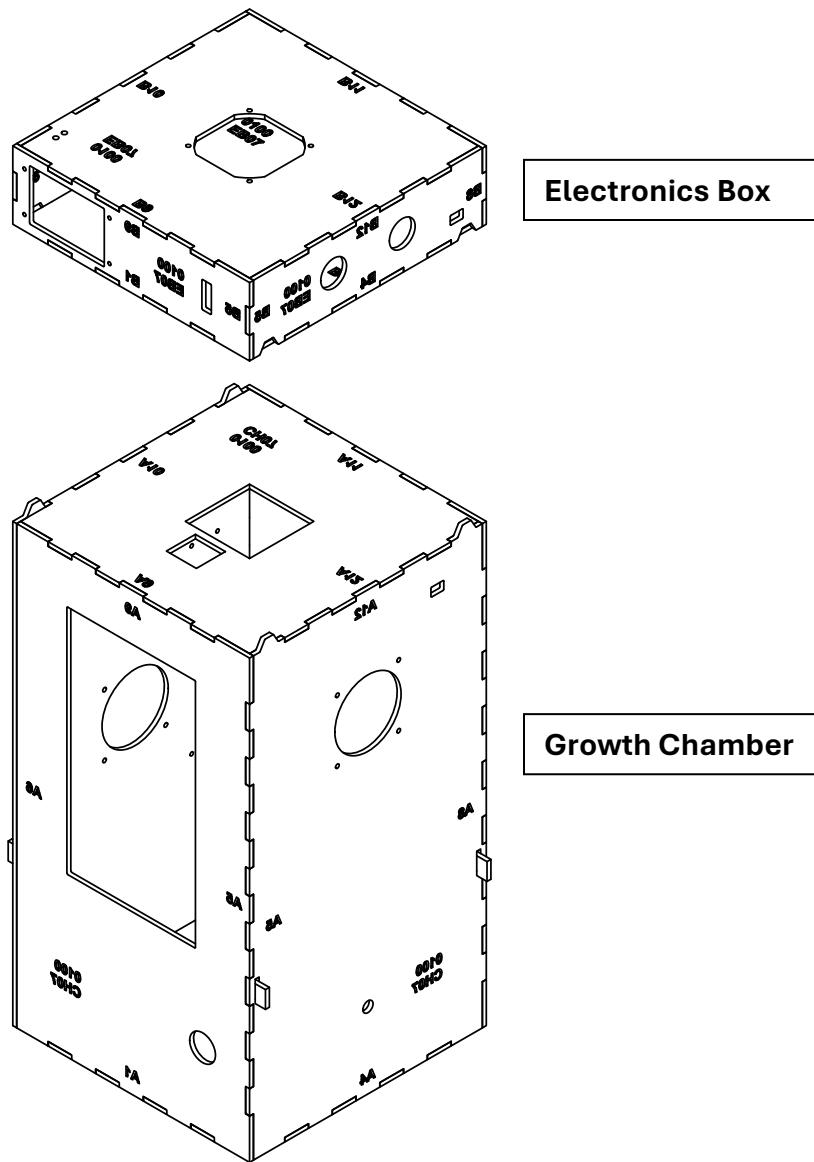
The warning words used throughout this document have specific meanings:

- NOTE** This step is easy to miss
- ⚠ ATTENTION** Doing this step improperly can break something
- ⚠ CAUTION** Not following this instruction can lead to someone getting hurt
- 💀 DANGER** Not following this instruction can result in serious injury or death

1.0 Overview

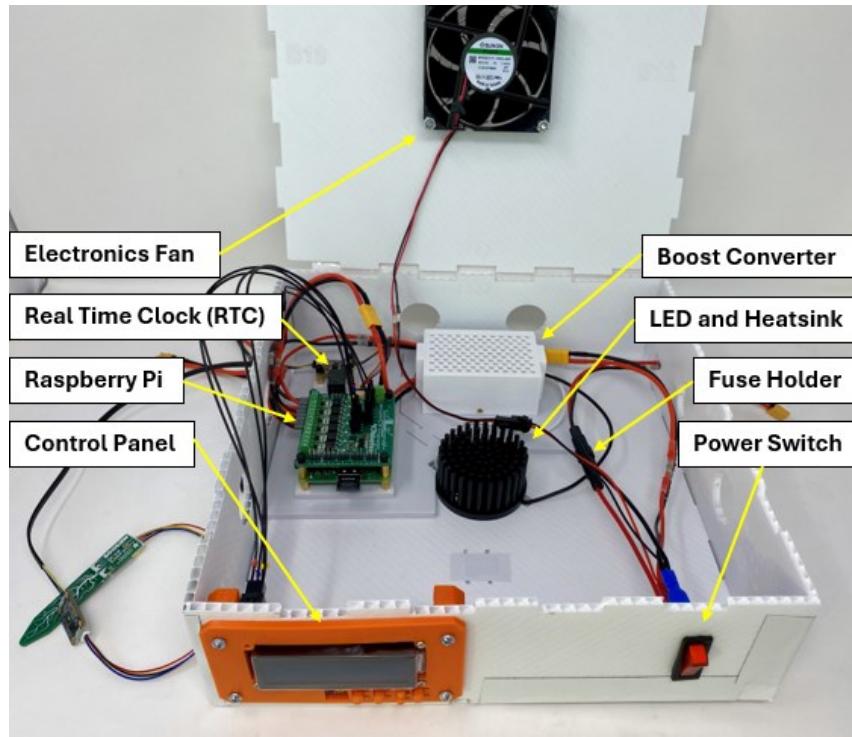
Thank you for buying or building your very own GroBot! We designed the GroBot to be a tool for teaching plant ecology, control systems, and traditional botany use in an engaging way. Whatever you use your GroBot for, we hope it is a helpful addition to your classroom, makerspace, or office.

The GroBot has two main sections: the *Electronics Box* and the *Growth Chamber*.



The *Electronics Box* (EB) contains the electronics required to run the GroBot and its on top of the *Growth Chamber* (CH), where the soil, water, and plants are housed.

1.1 Electronics Box



DANGER

The light from GroBot's LED can heat up or burn nearby objects. Do not turn on the GroBot unless the Electronic Box is installed on top of the Growth Chamber.

CAUTION

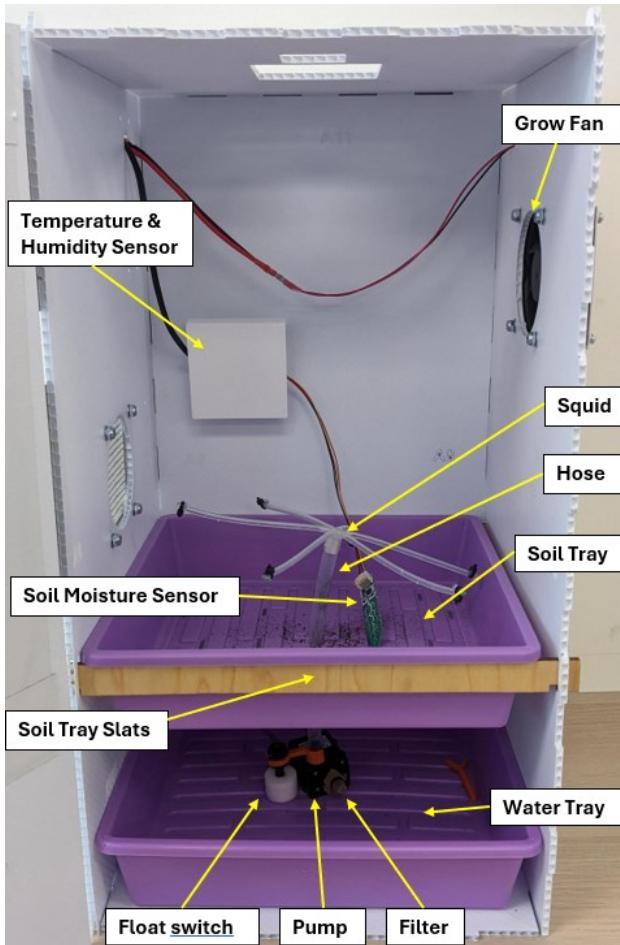
Avoid looking directly at the LED while it is on.

CAUTION

The Electronics Box contains spinning and energized components that could hurt you. Turn off the GroBot before opening it.

Raspberry Pi	The microcomputer that runs the GroBot. It is fitted with an Irrigation Board to let it control the pump, fan, and LED light.
Real Time Clock (RTC)	Allows the GroBot to keep time even when switched off and unplugged.
Control Panel	Allows the user to change settings. It consists of an LCD display and 5 buttons for navigating the menu.
Boost Converter	Turns the 12-volt direct current from the power supply into the 34-volt direct current needed to run the LED Module. It is covered to reduce the risk of electric shock.
LED Module	Comprised of the chip-on-board horticultural LED and the heatsink needed to cool it.
Electronics (top) Fan	Blows air over the electronics to keep them cool. This is especially important for the LED module, which produces a lot of heat.
Power Switch	Turns the entire GroBot on and off.
Fuse Holder	Holds a Fuse, which will disconnect the power if the GroBot draws too much current.

1.2 Growth Chamber



DANGER

Water and electricity don't mix! Keep other electronics away from the GroBot. and mount the power supply in a safe location.

Grow Fan	Ventilates the Growth Chamber when the temperature or humidity threshold are exceeded.
Pump	Waters the plant(s) by pumping water up through the hose and Squid irrigation system.
Central Hose	Connects the pump to the Squid.
Squid	Distributes the water using a central manifold and six small diameter perforated tubes.
Filter	Prolongs the life of the pump and squid by filtering out soil that is washed into the water tray.
Float Switch	Measures the amount of water in the Water Tray and warns the user when it is too low.
Soil Moisture Sensor	Measures the water content of the soil to decide if the plant(s) need to be watered today.
Temperature and Humidity Sensor	Constantly measures the temperature and relative humidity to decide if the Grow Fan should be turned on.

2.0 Normal Use

2.1 Starting New Plants

- Tools:** Mixing bowl for soil
(optional) pH test strips or soil pH meter
- Supplies:** Soil
(optional) pH adjusting additives
- Time:** 15 minutes

Note that tools and supplies (soil, mixing bowl, pH testing and additives, and newspaper) are not included in your GroBot kit. For supply details we recommend, see [Section 5.0](#).

Step 1: Empty and rinse out the Soil Tray and Water tray.

- Take the Soil Moisture sensor out of the soil and hang it on the TH Sensor.
- Unclip the float switch from the hose.
- Disconnect the hose from the pump, set the hose / Squid aside.
- This is a good time to [clean/replace the pump filter](#) (Section 3.1) and inspect the irrigation system.

Step 2: In a separate container, prepare your soil mixture.

- Mix your soil to create the desired texture or use potting/garden soil out of the bag, depending on your plant species and the experiment you are conducting.
- (Optional) Test and adjust the soil pH to suit your plant's ideal growing conditions.
- Add water to pre-moisten your soil in preparation for your seeds.

Step 3: Lay down 2-3 layers of newspaper in the Soil Tray, then add your soil.

- Fill the tray to ~1cm below the top edge.
- Use your finger to poke a small hole in the center of the soil, and a pen to break through the newspaper for the central watering hose.

Step 4: Re-install the watering system.

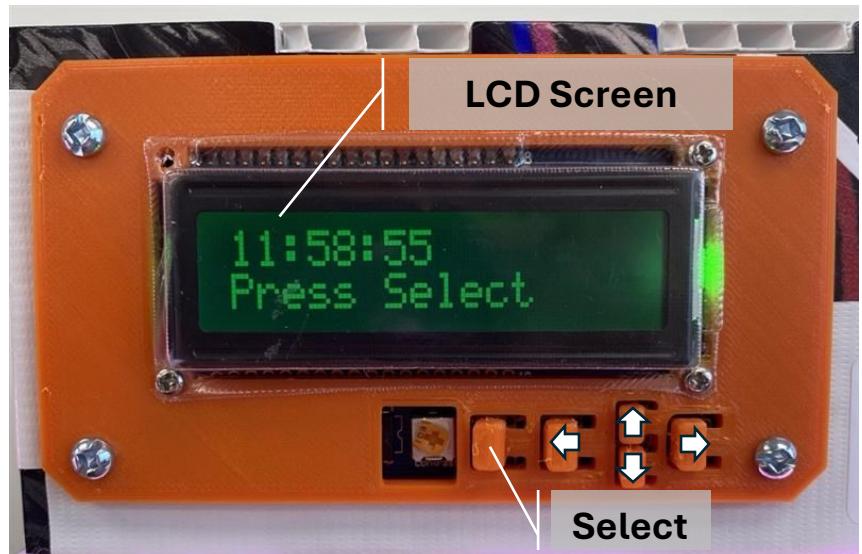
- Thread the hose though the soil, newspaper, and soil tray.
- Attach the hose to the outlet of the pump and clip on the float switch.
- Fill the water tray to 1-2 cm below the edge of the tray.
- Test the watering system by manually activating the watering system.

Step 5: Plant your seeds!

- In general, seeds should be spaced far enough apart that once they sprout, they will have room to grow.
- Tuck them into the soil about 1-4cm deep and cover gently with soil.
- For more specific seed spacing and depth guidelines, check your seed packet!
- Adjust your GroBot settings in the **Edit Settings** menu to suit your plant.

2.2 Changing Settings

Navigate the settings menu using the Up, Down, and Select keys. The table below displays the GroBot's Edit Settings menu hierarchy, options, and how to adjust settings using the buttons.



Main Menu	Description	Button Controls
Edit Settings		
System Time	The time kept by the GroBot's Real Time Clock (HH:MM)	↑ / ↓ = Hours ← / → = Minutes
Sunrise Time	The time of day that the GroBot will turn on the LED grow light (HH:MM)	↑ / ↓ = Hours ← / → = Minutes
Sunset Time	The time of day that the GroBot will turn off the LED grow light (HH:MM)	↑ / ↓ = Hours ← / → = Minutes
Irrigation		
Soil Mois Thresh	The GroBot will water if the soil moisture is below this value (%)	↑ = Increase ↓ = Decrease
Water Vol	The amount of water used to water your plant (mm of rain)	↑ = Increase ↓ = Decrease
Watering Time	The time of day that the GroBot will check the soil moisture (HH:MM)	↑ / ↓ = Hours ← / → = Minutes
Back		
Temp Setpoint	The Grow (CH) Fan will turn on above this temperature (°C)	↑ = Increase ↓ = Decrease
Humidity Setpoint	The Grow (CH) Fan will turn on above this humidity (%RH)	↑ = Increase ↓ = Decrease
Back		
Manual Control		

2.3 Manual Control

You can manually control each of the GroBot's actuators the same way you change settings. Navigate to the 'Manual Control' section of the menu and select what actuator you want to turn on or off:

Main Menu	Description	Button Control
Edit Settings		
Manual Control		
Take Picture Now	Tells the Raspberry Pi to take a picture now. Requires a camera.	Select = Take picture
Water Now	Turns on the pump.	Select = Pump On
Stop Watering Now	Turns off the pump.	Select = Pump Off
Light On Now	Turns on the LED	Select = Light On
Light Off Now	Turns off the LED	Select = Light Off
Fan On Now	Turns on the Grow Fan	Select = Fan On
Fan Off Now	Turns off the Grow Fan	Select = Fan Off
Back		
Back		

3.0 Regular Maintenance

The tasks in this section should be performed on a regular basis to keep your GroBot running smoothly. Before performing maintenance, please make sure your GroBot is off and unplugged. We recommend the following maintenance schedule:

Task	Frequency
Refill the water tray	Whenever the water level falls below the pump inlet
Inspect and clean or replace the pump filter	~ 2 weeks
Check for Updates / Update Software	~ 6 Months
Set System Time	~ 6 Months (Whenever you switch into or out of Daylight Savings Time)

3.1 Replacing The Pump Filter

Tools: 1 x Scissors

Parts: 1 x Zip Tie

1 Pair x nylon sheer tights or stockings

Time: 5 Minutes

Step 1: Turn off the GroBot and disconnect the pump

- Use the main power switch to turn off the GroBot
- Unclip the float switch from the pump / hose
- Disconnect the central hose from the pump outlet

Step 3: Remove the old filter

- Cut the zip tie holding the old filter in place
- Dispose of the filter material and zip tie

Step 4: Install the new filter

- Cut a 5cm x 5cm square of nylon fabric
- Fold the material in half, stretching it over the inlet of the pump and zip-tie in place.

Step 5: Re-install the pump

- Re-attach the hose to the outlet of the pump
- Clip the float switch to the hose over the pump outlet

Step 6: Turn the GroBot back on and test the pump

- Turn the GroBot back on and test the pump using the “water now” option

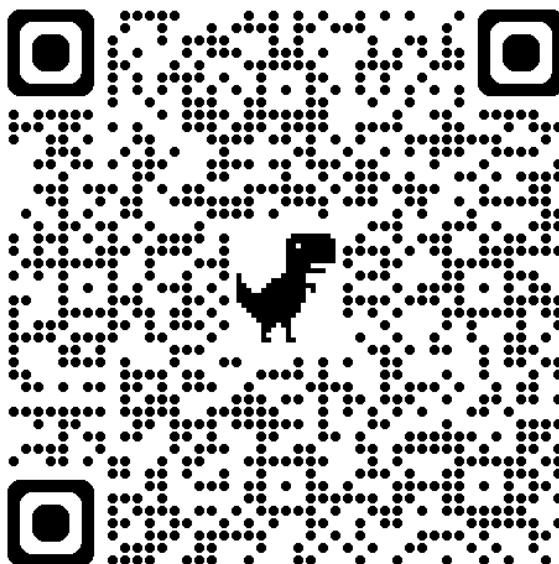
3.2 Updating Software

Tools: Windows computer with internet connection

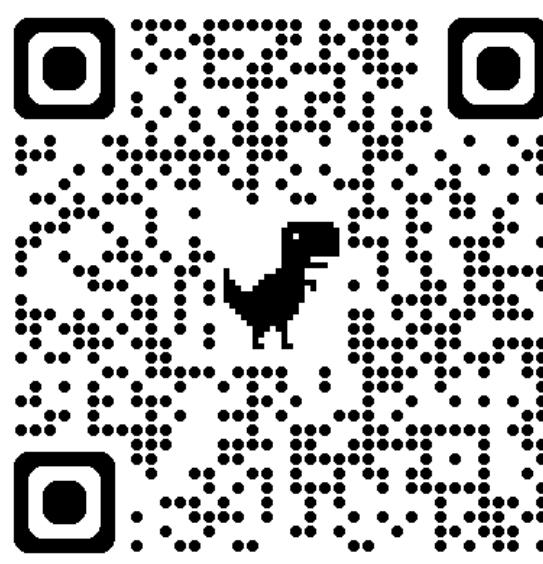
Parts: None

Time: 10 minutes

- The software updating instructions listed here are specific to software version 1.0.3 and 1.0.4 only. For more up-to-date instructions please visit the installation instruction on the GroBot GitHub page at:
<https://github.com/Ulnooweg/GroBot/blob/main/Docs/Setup.md#installingupdating---keeping-user-settings-intact> [Link1] or by scanning the QR code below.
- Please consult the release note under
<https://github.com/Ulnooweg/GroBot/releases> [Link2] for any special instructions specific to the version being installed.
- The QR codes for the 2 links are:



[Link1]



[Link2]

To update your GroBot software, follow the instructions below.

This instruction set will install/update the GroBot software while keeping user settings intact.

Note: Carefully read all instructions before beginning

Downloads

- Download the latest release of the GroBot software from the release page [Link2].
 - Download the file titled "Release-keepsettings.zip".
- Extract the zip file content. You should see a directory called "Release-keepsettings" containing 2 directory "code" and "systemd_bootfile".

Installation

1. Shutdown the GroBot.
2. Remove the USB drive from the GroBot Raspberry Pi and plug it in to the computer.



3. Navigate to the USB drive and open the folder "code".
4. Inside the "code" folder, delete every existing file and folder **except grobot_cfg.ini** in the folder "code" to ensure that there are no old code files that could conflict with the new version. Keep "grobot_cfg.ini" to ensure user settings are saved.
 - o If there is no "grobot_cfg.ini" in the code folder or it is empty already, please use "Installing/Updating - reset GroBot to factory settings" instructions contained in [Link1] instead.
5. Copy all the content of the folder "code" from the extracted GroBot Release-keepsettings zip file to the folder "code" on the USB drive.
6. Remove the USB drive from the computer and reinsert it into the GroBot.

Testing

This section is for initial testing to ensure that GroBot functions properly after updating its software.

1. Turn the GroBot on. The GroBot LCD should turn on (may take 1-3 minutes) and if the current time is between the sunrise and sunset time (default is 9.30 to 18.30) the LED grow light should turn on.
2. If the GroBot does not turn on, please either attempt to reinstall the GroBot software again, or consult [Section 4: Troubleshooting](#).

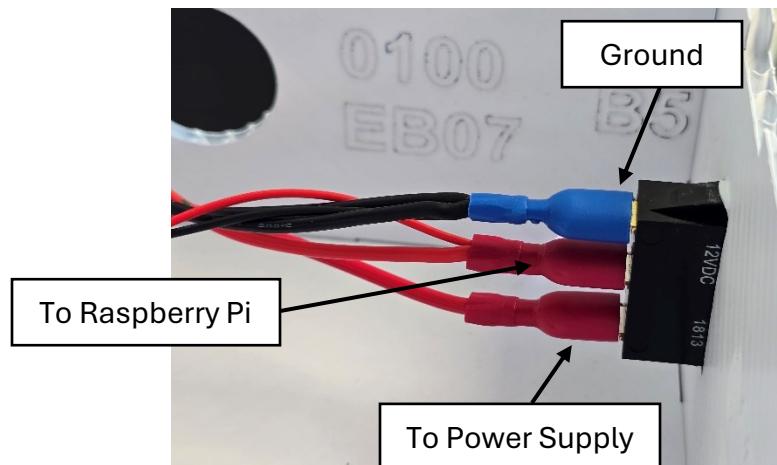
4.0 Troubleshooting

This section lists the troubleshooting steps based initially on whether the LCD screen turns on once the GroBot is powered on (main on/off switch is flipped to lit or on position). Please note that the LCD screen does take a minute or two to power on from when the GroBot is switched on.

4.1 The GroBot (LCD Screen) Doesn't Turn On

1. Is the Power Switch lit up?

- If yes: continue to Step 2
- If no, proceed through the following steps and checks:
 - o Check that the GroBot is plugged in.
 - o Check that the Power Supply's blue LED is illuminated. If power supply LED is not illuminated: unplug and replug the power supply.
 - If the power supply LED is off and the power supply is beeping, then the power supply has detected an overcurrent. Skip ahead to the "IF FUSE BLOWN" section.
 - o Check that the switch wiring is correct:
The Power Switch connectors should be plugged in in the order shown below:



o Check the fuse:

Switch off and unplug the GroBot. Unscrew the Fuse Holder and examine the fuse inside. Check to see whether the thin wire at the centre of the fuse is still connected.

⚠ CAUTION

The fuse contacts will be energized even if the Power Switch is off. Unplug the Grobot before checking the fuse.



Intact fuse



Blown fuse

If you are struggling to tell whether the fuse has blown, you can check its resistance with a multimeter. A blown fuse will have extremely high (practically infinite) resistance whereas a fuse that hasn't blown will have very low (practically zero) resistance.

- IF FUSE BLOWN:

- A blown fuse indicates that the GroBot was drawing an unsafe amount of current. This is likely a result of a short circuit, which could be caused by incorrect wiring and/or a failed component. The cause of the failure should be identified and corrected before replacing the fuse.
- Send us an email at engineering@ulnooweg.ca or submit a bug report on the Github repository so we can track issues and help you troubleshoot.
- Double check all electrical connections and inspect electronics for signs of damage.
- Individually test the Grow Fan, Pump and LED by plugging their connectors directly into the power supply for 2-3 seconds and observing whether they turn on.

- IF FUSE NOT BLOWN:

- Something else is preventing your GroBot from turning on. Please contact us at engineering@ulnooweg.ca or submit a bug report on Github repository.

2. Wait 5 minutes after turning on the GroBot

- The Raspberry Pi that runs the GroBot often takes several minutes to boot.
- Check that the Raspberry Pi is running (there should be 2 indicator lights, a steady red LED, and an intermittent green LED).
 - o If not, the Raspberry Pi may not be receiving power. Check the connection between the Power Switch and the Raspberry Pi.

3. Check that the front panel and all sensors are plugged in.

- The Control Panel, RTC, Soil Moisture Sensor, and Temperature & Humidity sensor are required for the GroBot to function. Check the STEMMA QT cable that it is plugged

- in to all of the sensors (Soil humidity sensor → Temperature/Humidity sensor → RTC → Irrigation Board).
- Check that the LCD screen cable is plugged in properly to both the LCD screen and the irrigation board.
 - If it is not working still, please continue to step 4.
4. Send us an email at engineering@ulnooweg.ca. If you are able to access the Log Files (see sections 4.3 and 4.4), send them along as well.

4.2 The GroBot (LCD Screen) Turns On

If the GroBot turns on (indicated by LCD screen turning on) but there are problems, please follow the following basic troubleshooting steps:

1. Check if the clock displayed on the LCD screen is ticking.
 - 1.1. If it is ticking, go to step 2.
 - 1.2. If it is not ticking, go to step 3.
2. If the clock is ticking, this indicates that the GroBot software is still running and each subsystem must be checked separately. The following table lists some common problems, their potential causes, and their fix:

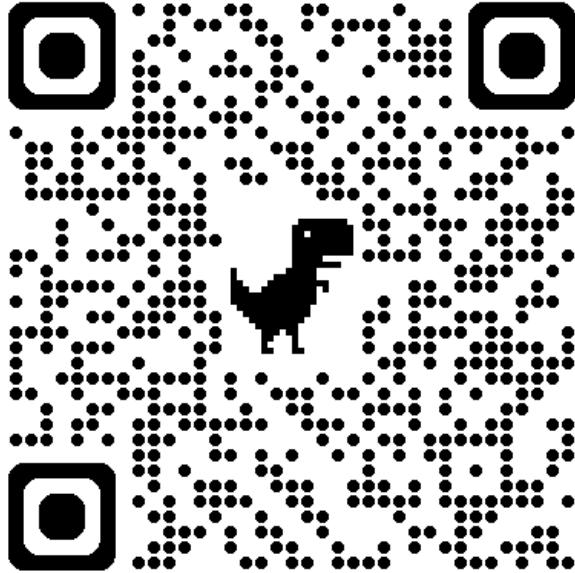
Problems	Potential Causes	Troubleshooting
LCD Screen has a delay in turning on after GroBot powered on	This is intended, the GroBot takes a minute or two to boot up.	Intended behavior. Wait a few minutes for the LCD screen to power up.
Cannot enter settings menu by pressing “SELECT” button	“SELECT” button is not being held long enough.	Press and hold “SELECT” for a longer period of time until it enters settings screen.
The GroBot time is incorrect after power off	RTC (Real Time Clock) battery is low, depleted, or missing.	Replace the CR1022 battery on the RTC module.
The GroBot light is not on	The LED circuit is improperly connected to the irrigation board	Check the wiring from boost converter to irrigation board. Red should be connected to (+) and Black to (-) under S2 screw terminal with the XT30 connector plugged in appropriately.
	The LED circuit is improperly connected throughout	⚠ CAUTION Turn off the GroBot before continuing with access to high voltage area. May cause injuries otherwise.

		<p>⌚ ATTENTION This step requires accessing high voltage area. Unscrew the M2.5 screw and remove the boost converter cover to proceed.</p> <p>Check the wiring of the overall LED circuit. The wiring from irrigation board S2 circuits should go to the V_{in} side of the boost converter with Red to $V_{in}(+)$ and Black to $V_{in}(-)$.</p> <p>The V_{out} side should be connected to the LED module itself. With White wire connected to $V_{out}(+)$ and (+) on LED module, Black to $V_{out}(-)$ and (-) on LED module.</p> <p>⌚ ATTENTION Re-cover the boost converter cover and re-screw in M2.5 screw.</p>
The GroBot light is not on	The boost converter is not set to proper voltage	<p>⌚ ATTENTION This step requires accessing high voltage area. Unscrew an M2.5 screw and remove the boost converter cover to proceed.</p> <p>⚠ CAUTION These instructions involve working around high voltage area. This may cause injuries. Proceed with extreme care and do not touch exposed electronics directly.</p> <p>⌚ ATTENTION Ensure the GroBot is on.</p> <p>Use a small flat (~M2.5) flathead screwdriver and turns the voltage adjustment knob clockwise until the boost converter digits display reads “34”.</p>

		ATTENTION Re-cover the boost converter cover and re-screw in M2.5 screw.
The GroBot is not watering	The pump reservoir (bottom tray) has no water	Refill the reservoir with water
	The pump is not connected to central hose appropriately	Remove the float switch from the hose. Reconnect the hose to the upper pump outlet securely. Reconnect the float switch on top of the hose-pump connection area.
	The squid irrigation system is clogged	Replace the squid flexible arm(s) (small 2mm tube with appropriately drilled holes)
	The pump XT30 connector is not plugged in	Plug in the XT30 connector connecting the pump to the irrigation board.
	The pump wiring is not plugged in to the irrigation board properly	Check the wiring from pump to irrigation board. Red should be connected to (+) and Black to (-) under S1 screw terminal.
The GroBot is not watering	The filter is clogged	Replace the pump filter with a new pantyhose zip tied to the side pump inlet. See section 3.1.
The growth chamber fan is not on	The fan's XT30 connector is not plugged in	Plug in the XT30 connector connecting the growth chamber fan to the irrigation board.
	The fan circuit is not plugged in to the irrigation board properly	Check the wiring from growth chamber fan to irrigation board. Red should be connected to (+) and Black to (-) under S3 screw terminal.

3. If the clock is not ticking, this indicates the GroBot software has failed and is no longer running. Please wait, checking back in a few minutes to see if the clock has resumed ticking.
 - 3.1. If it has, the system has recovered from an unexpected error and can be used as normal. A bug report can be submitted if so inclined through our GitHub repository or by sending a support request to engineering@ulnooweg.ca along with the output system log file.

3.2. If it has not, please access the GroBot system log and either submit a bug report through the GitHub repository or sends a support request along with the output of the system log file to engineering@ulnooweg.ca



GroBot GitHub

<https://github.com/Ulnooweg/GroBot>

4.3 Accessing the Terminal (non-SSH)

Tools: USB to TTL Serial Cable (Adafruit 954), PuTTY

Parts: None

Time: 10 minutes

Note that the Serial Cable must be purchased separately. PuTTY can be downloaded [here](#):
<https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>

Terminal Login Password

You can login to the GroBot terminal via SSH or by using the Accessing Terminal (non-SSH) instructions below. The following credentials can be used:

Username: grobot

Password: grobot

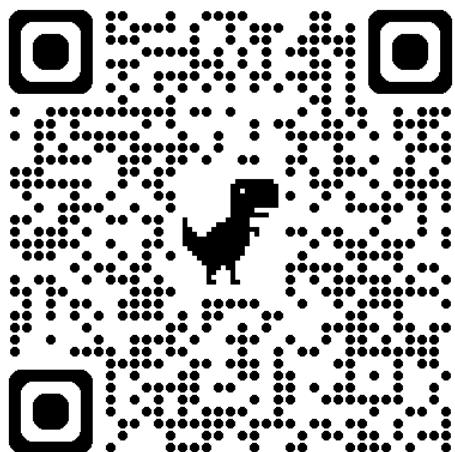
Please note that when typing password into GroBot login terminal, it will not show any character as typed but remain blank. Simply type the password in and press enter.

Accessing Terminal (non-SSH)

There are 2 methods of accessing the terminal on the GroBot. One is via SSH which requires Wi-Fi access. Another which will be shown here is through the UART serial connection interface. Note: This has to be enabled on the Raspberry Pi OS. It should be enabled on the GroBot supplied by Ulnooweg Education Centre. The USB to TTL Serial Cable (Adafruit 954) is required and is not included in your kit. It can be ordered online if needed.

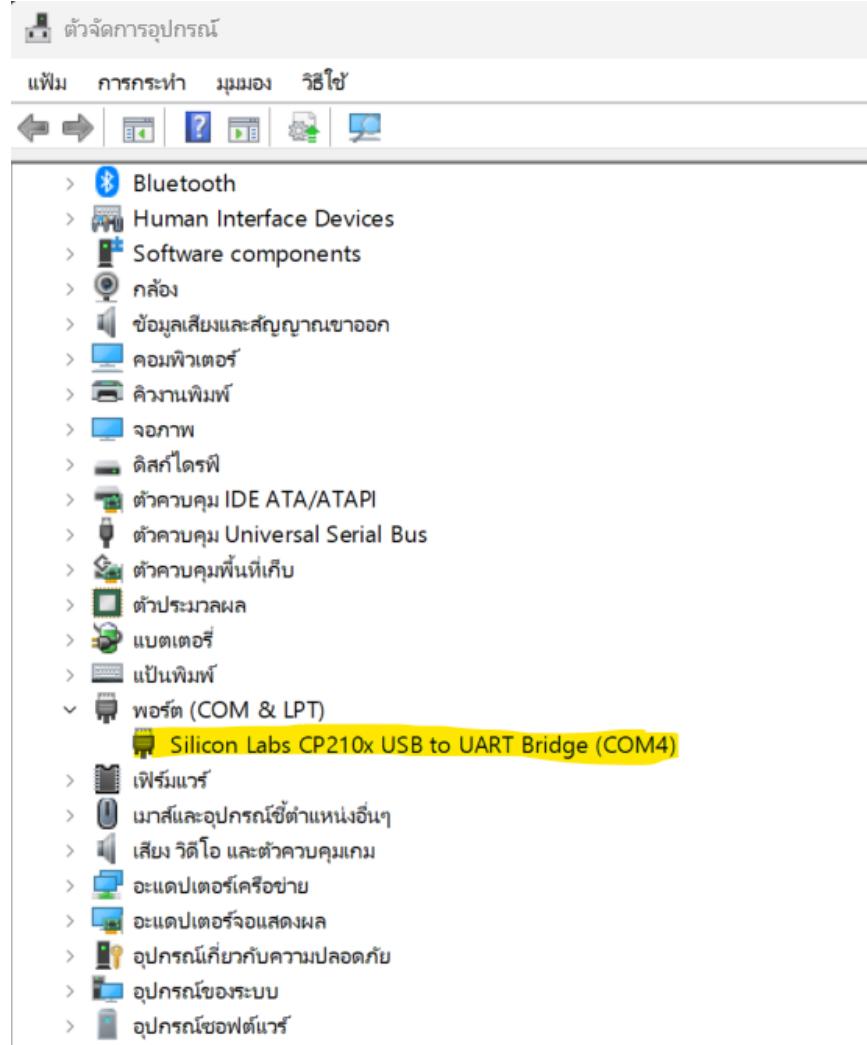
Steps

1. Download serial cable drivers from SiLabs CP210x Windows Drivers and install the serial drivers.



https://www.silabs.com/documents/public/software/CP210x_Windows_Drivers.zip

2. Connect the serial cable to a USB port on a Windows machine.
3. Navigate to device manager and find the serial device, note down its COM port.
 - o May show as "Silicon Labs CP210x USB to UART bridge (COMx)"
 - o note down COMx where x should be a number.



^(This example shows COM4)

4. Connect the serial cable to the irrigation board UART header with the following cable colour configuration:

Colour	Pins
RED	Do not connect
BLACK	GND
WHITE	TXD
GREEN	RXD

5. Now open PuTTY and connect with the following settings:
 - Mode: Serial
 - Speed: 115200
 - Serial line: COMx (COMx is the COM port found in step 3)
6. Start the connection. Press any key until a text asking for a login shows up.
7. Enter the Terminal Login Password:
Username: grobot
Password: grobot

4.4 Accessing the System Logs

Tools: USB to TTL Serial Cable (Adafruit 954), PuTTY

Parts: None

Time: 5 minutes

To access the system logs for the GroBot, please first access the terminal either via SSH or otherwise (See: Accessing the Terminal (non-SSH)).

After accessing the terminal, enter the command:

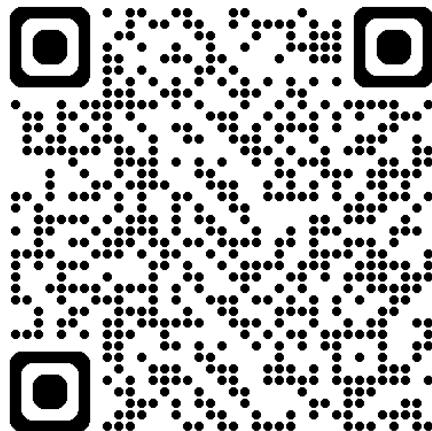
```
journalctl -u grobot.service -n 1000 -r
```

to access the terminal. All characters and spaces are important – copy and paste exactly as shown. Some key usage points are:

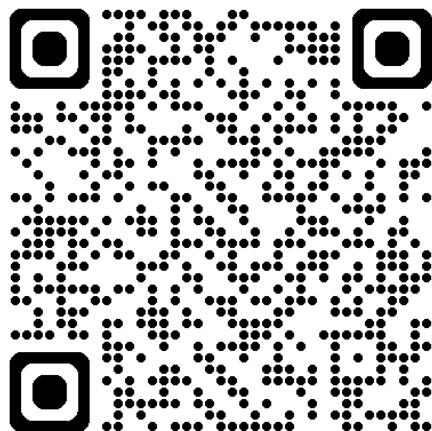
- Scroll using the scroll wheel.
- Press Ctrl+C to exit the log file.

5.0 Support

Have a bug to report or feature to suggest? Let us know on our GitHub repository at <https://github.com/Ulnooweg/GroBot> by scanning this QR code:



Need direct support? Send us an email at engineering@ulnooweg.ca by scanning this QR code:

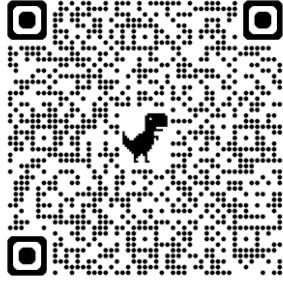


Need to order parts? Here's a complete list of all the parts used in a single GroBot and their part numbers:

Note:

- Aliexpress parts are provided with QR code linking to the store as a representative source, equivalent parts with similar specifications can be used instead.
- Generic parts can be sourced from anywhere with similar specification.
- 3D printed parts required part file such as .stl 3D file, please contact Ulnooweg Education Centre for the file.

5.1 Physical Parts

Parts	Manufacturer	Part Number
Corrugated Polypropylene Plastic	Plaskolite	1TW2448A
Gorilla duct tape (1.88 in. wide)	Gorilla Glue	052427602503
Flex Tape (4 in. wide)	Flex Tape	TFSCLRC0405
1010 Seed Starting Trays with Holes (2.5" Tall)	Bootstrap Farmer	210000007994
1010 Seed Starting Trays without Holes (2.5" Tall)	Bootstrap Farmer	210000007992
silicone tube (2mm ID x 4mm OD) [ID = Internal Diameter, OD = Outside Diameter]		
silicone tube (8mm ID x 10mm OD)		
Maple Plywood (1/4" thick)	PureBond	861829
Newspaper	Generic	Generic
Soil/Growth Media	Generic	Generic
3D Printed parts: 5 Water sprinkler head 6 Boost converter standoff + cover 7 Pi 3A+ standoff 8 Temperature and Humidity sensor standoff + cover 9 LCD screen standoff 10 RTC standoff 11 LCD screen stiffener	3D Printed	3D Printed

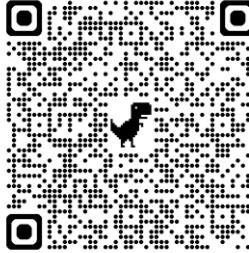
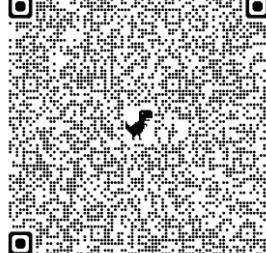
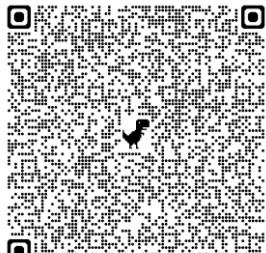
clear PETG sheet (0.4mm thick)	Generic	Generic
LCD screen protector (from 0.4mm thick clear PETG sheet)	Custom – Vacuum formed. Generic PETG sheet	Custom – Vacuum formed. Generic PETG sheet
Pantyhose	Generic	Generic
Zip-ties (2.5mm wide, 200 mm long)	Generic	Generic
String (0.37mm diameter, 50 lbs strength)	Generic	Generic
Linseed Oil	SOLVABLE	53-401

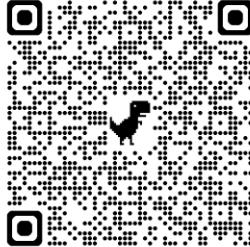
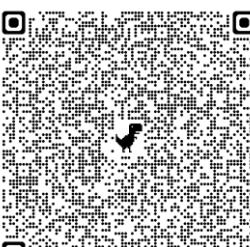
5.2 Electronic Parts

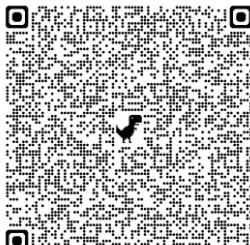
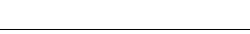
Parts	Manufacturer	Parts Number
12V Pump	BC Robotics	OTH-066 (Generic: AD20P-1230A)
80mm Fan	Sunon	MF80251V1-1000U-A99
I ² C Soil Moisture Sensor	Adafruit	4026
80mm Fan Grill	Orion Fans	G80-18
80mm Fan Grill (Meshed)	Qualtek	06325-M
AHT20 Temperature / Humidity Sensor	Adafruit	4566
Rocker Switch	E-Switch	RB141C1000-114
Horticultural COB LED (Growlight)	Luminus Devices	CXM-14-HM-61-36-AC30-P1-3
LED Heatsink	Wakefield-Vette	DUALLED-5830
DC-DC boost converter	DFRobot	DFR0123
In-line Fuse Holder (16 AWG)	Littelfuse	01500274Z
5 Amp Cartridge Fuses	Littelfuse	0618005.MXP
Pi 3 Model A+	Raspberry Pi	SC0130(J)
Raspberry Pi Irrigation Board v2 – Assembled	BC Robotics Inc.	RAS-144
Pi 4B Heatsink Kit	DFRobot	FIT0651
Heatsink Thermal Tape	3M	8810
12V 5A Power Supply	MEAN WELL	GST60A12-P1J
AC Cord North America, IEC320-C13	CUI Devices	AC-C13 NA
Silicone conformal coat	MG Chemicals	422C
LCD Screen with Button	Adafruit	1110
12V to 5V switching regulator	RECOM Power	R-78K5.0-2.0L
RTC Module	Adafruit	5189
Float switch	Littelfuse	59630-1-T-02-F

5.3 Connectors

Parts	Manufacturer	Parts Number
STEMMA to STEMMA-QT cable (20cm)	Adafruit	4424
STEMMA QT cable (30 cm)	Adafruit	5384
STEMMA QT cable (10 cm)	Adafruit	4210
#6-32 in x 1/2-in stainless steel Robertson round head machine screw	Generic	Generic
#6-32 in x 1-1/2-in stainless steel Robertson round head machine screw	Generic	Generic
#6-32 in x 1-in stainless steel Robertson round head machine screw	Generic	Generic
#6-32 in stainless steel Nylon Nuts	Generic	Generic
#6-in Flat Washer	Generic	Generic
6.3mm Spade Crimp Terminals Female (Red for ~ 0.5-1.5mm ² cross-sec wire)		
6.3mm Spade Crimp Terminals Female (Blue for ~ 1.5-2.5mm ² cross-sec wire)		
18 AWG wire ferrule - Grey (0.75mm ² wire cross-sec)		

18 AWG silicone hookup wire (Red, Black, and White)		 or
Molex C-Grid pre-crimped wire (300mm)	Molex	79758-2023
Molex C-Grid III header (2 row 6 position)	Molex	90142-0006
Molex C-Grid III housing (2 row 6 position)	Molex	90130-1106
Molex C-Grid III header (1 row 5 position)	Molex	90156-0145
Molex C-Grid III housing (1 row 5 position)	Molex	90136-1105
Molex C-Grid III header (1 row 8 position)	Molex	90156-0148
Molex C-Grid III housing (1 row 8 position)	Molex	90136-1108
JST SM 2-position pre-crimped connector		
SanDisk 32GB Ultra microSDHC	SanDisk	SDSQUA4-032G-GN6MT
M2.5 6mm thread length+8 mm length standoff		

M2.5 6mm thread length +12 mm length standoff	
M2.5 hex nut	
M2.5 14mm thread length screw	
M2.5 6mm thread length screw	
M2.5 washer	
M2.5 6mm thread length thumbscrew	

Presoldered XT30 with AWG16 wire (15cm)		
Solder seal heat shrink (Blue 16-14 AWG)		
Solder seal heat shrink (Red 18-22 AWG)		
Heat set insert (M2.5, 4mm Outer Diameter, 3mm Length)		
Heat shrink - Red - 6mm diameter		
Heat shrink - Black - 8mm diameter		
Heat shrink - Clear - 2mm diameter		
SanDisk 64GB Ultra Fit USB 3.1 Flash Drive	Sandisk	SDCZ430-064G-G46

5.4 Consumables

These are used as part of the production process and consumed such as solder used in soldering parts to through holes on PCB.

Parts	Manufacturer	Parts Number
0.5mm diameter Lead free solder SAC305 (3.3% flux)	Kester	2470687610
Soldering Flux, no-clean, ROL0	Chip Quik	SMD491-10M
Prusament PETG Prusa Orange	Prusa	N/A
AnyCubic ABS-Like Resin Pro 2	AnyCubic	N/A

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