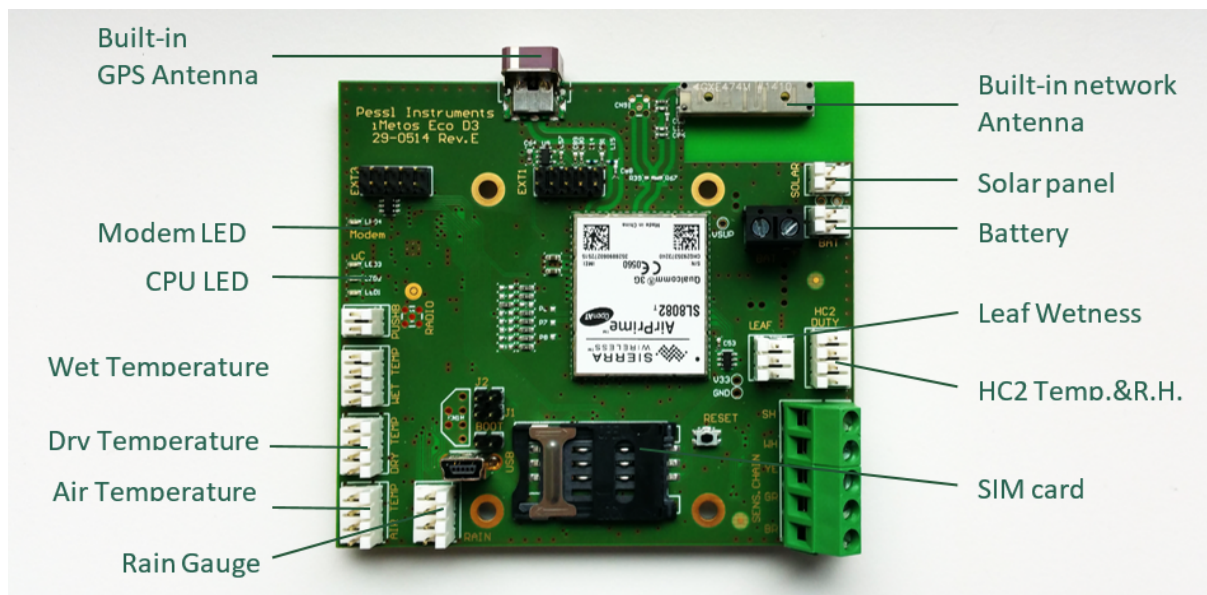# 1 Your iMETOS ECO D3

1.1 PCB layout

Picture 1: iMETOS ECO D3 motherboard

1.2 Technical caracteristics

1.2.1 Processor
- 32bit ARM cortex M3 processor (Energy Micro EFM32)
- Real time operating system (RTOS)

1.2.2 Modem
- For GSM/GPRS/EDGE/3G, e.e G2 networks:

Sierra Wireless AirPrime SL808x Series a self-contained E-GSM/DCS/GSM850/PCS-GPRS/

EGPRS 900/1800/850/1900/ WCDMA 800/860/900/1900/2100 quad-band module. SIM cardholder.

- For CDMA/EVDO networks (U.S. of America): Cinterion PCS3. Not SIM cardholder.
- GPS included

1.2.3 External flash memory
The external flash memory is an Adesto AT45DB641E (8MB).

The memory is split into several blocks:

- 6MB reserved for weather data in Base64 format (i.e. the measured data), implemented as circulating memory (i.e. when memory is full, oldest data is overwritten with newer data)
- 1MB reserved space for firmware update over the air
- 1MB reserved for configuration and performance and behaviour, including:
    - Station settings
    - APN tables (Acess Point Names with MCC, MNC, user name and password)

- Backup (serial number and similar important settings that normally are not changed)

- Sensor image stores the configuration of the set of sensors connected to the iMetos. This info will be re-checked automatically every day at midnight so newly connected sensors will be detected and included in the logging. By pressing the reset button (J in picture 1) manual update of this part of the memory can be done.

- Event history (information about communication network and internal parameters, detailed description is given later on in this manual)

1.2.4 Power supply

The 6V-4Ah battery is connected to the iMETOS board in the specific connector (D in the picture 1), the solar panel is connected to the solar panel connector (E in the picture 1).

Both power inputs are monitored by the iMETOS 3 in the same way as the rest of the sensors.

Note: jumper on pins between D and E connector is not needed in last board revisions.

The iMETOS will automatically change operational mode according with the charge level of the battery following these rules:

a) if battery drops to 6V data logging continues but data transmission quits until battery recovers adequate charge level supplied from the solar panel

b) if battery recovers the voltage value of 6,1V (before reaching the threshold of 5,3V) iMETOS restarts data transmission without manual intervention

c) if battery reaches the limit of 5.3V iMETOS enters sleep mode and quits also data logging. To escape from sleep mode manual reset will be needed after the battery recovers the proper charge level (see Picture 3)
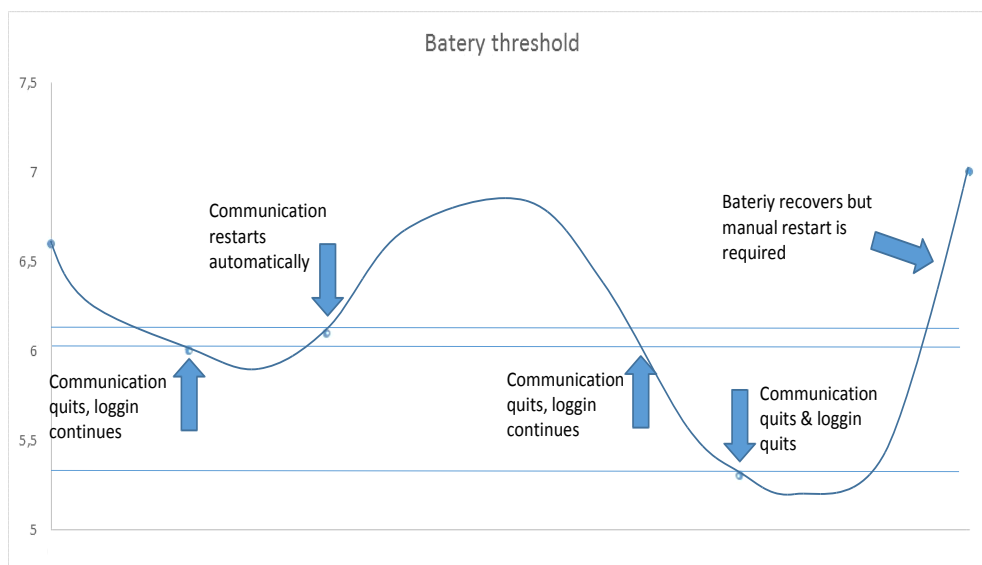

Picture 2: Battery threshold

1.3 iMETOS ECO D3 for soil moisture monitoring

If your iMETOS ECO D3 was intended for soil moisture monitoring it comes in minimum with a set of soil moisture sensors connected to the main unit. The sensors connected to it can be EC 5, HS10, 5TE from Decagon Limited and/or Watermark sensors or vacuum tensiometers

This sensors can be connected to the iMETOS ECO D3 itself or - of it is needed because of the installation or because of the number of sensors – they can be connected to an extension box on a serial bus connection.
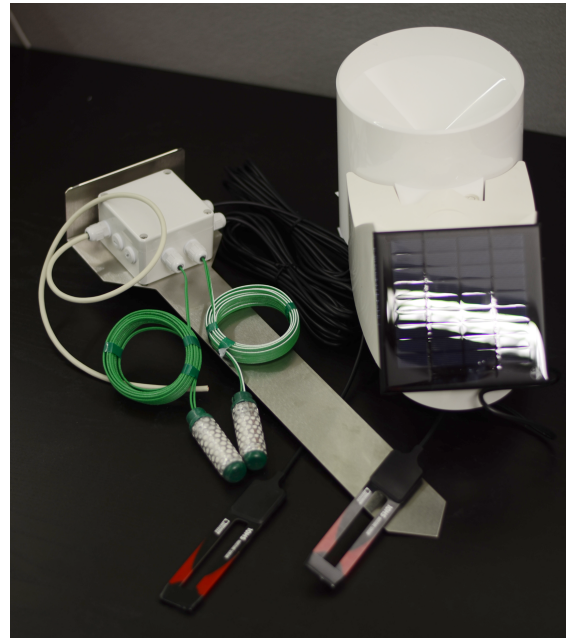

Picture 3: iMETOS ECO D3 with soil sensors

1.4 iMETOS ECO D3 for rain monitoring

If your iMETOS ECO D3 is intended for rain monitoring it will have a rain gauge connected to its main body.

1.5 iMETOS ECO D3 with D&D probes

To the iMETOS ECO D3 two Sentek "Drill And Drop" volumetric water content in the profile of the soil. Via extension board directly connected to the main PCB.
Further number od this probes can be connected via PI-bus input or via radio node links. Refer to D&D manual
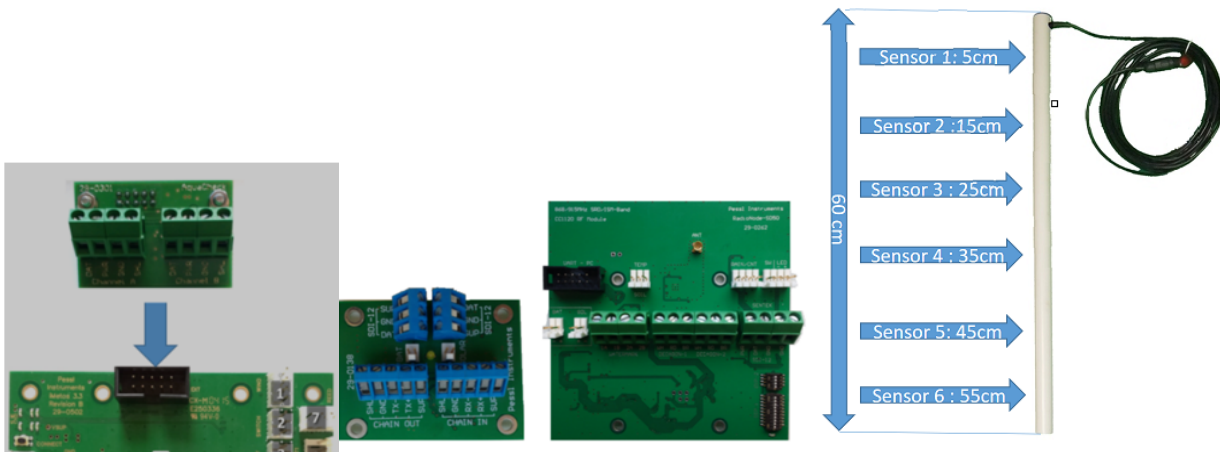
Picture 4: Sentek Drill&Drop with connectors

iMETOS ECO D3 includes the chipset for radio linking remote radio-nodes of sensors and actuators. The radio-node net has an star topology (iMETOS controls the net, RadioNodes are peer to it). 16 remote radio nodes can be connected to the iMETOS ECO D3. Radio nodes should be places in a line of sight at a maximum distance of 800m from the iMETOS ECO D3. At the time of this edition we 4 different Radio Nodes can be connecter in the iMETOS ECO D3 radio network

- iMETOS Radio Node Climate - with input for Rain, RH/Temp., Pressure Switch/LWS, 2 Temp. Sensors, 2 Watermarks/2 Decagon Soil
- iMETOS Radio Node DD - with solar panel and input for Rain, 1 Drill&Drop Sensor, 2 Watermarks, 2 Decagon
- iMETOS Radio Node Watermark/Decagon - with input for Rain, 1 Temp. Sensor, 4 Watermarks, 4 Decagon
- iMETOS WAN (wireless activator node)

2 Start-up the iMETOS

To start up the iMETOS you will need a valid GSM contract with the possibility to send at least 5MB data on GPRS per month and with the ability to send and receive SMS-messages. This contract has to be activated up front. Please make sure that the PIN code of the SIM-card is deactivated. To deactivate it you will need a mobile phone of the same company.

The iMETOS housing is closed with 6 M3 screws. To open them you will need an Allen key of 2.5 mm. This is part of the delivery. When you opened it the lower part will be still hanging on the upper part due to the short connection of the battery. The battery has to be pulled out of the top with care. Do not use to much force for this. It might help to knock at the site of the top and pull softly. Please open the iMETOS and enter the SIM-card. If the system has been send by any type of parcel service the power will be disconnected. Please connect the power after inserting the SIM card. Please check if the solar panel is connected as well.

If the power is connected press the little black bottom to initialise an internet connection. The success of this can be observed by a blinking code of the iMETOS LED and the modem PCB LED.
If the SIM card has been successfully inserted your iMETOS has registered in the internet and it will send data to the web server. To access this data use http://www.fieldclimate.com. All settings on data upload times time zone, position and much more can be set up on this web site. To use it you will have to register as a user first.

To close the iMETOS again it will need to enter the battery again and to fit the top on the button part. If all fits together insert the 6 scres and tide them carefully.
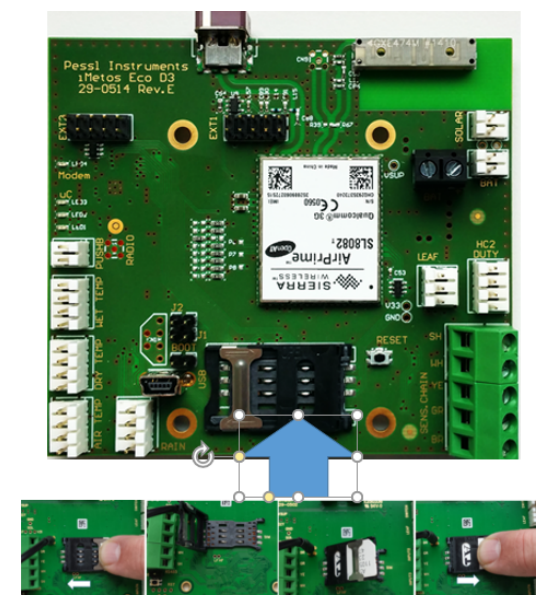
Picture 5: SIM card insertion slot

2.1   Blinking code

- **Connect to power:** iMETOS LED short on - long off blinking, wait for modem
- **GSM connecting:** GSM LED short on - long off, iMETOS LED short on – short on – long off
- **TCP/IP connected:** GSM LED short on – long off, iMETOS LED short on – short on – short on – long off
- **Data successfully send** iMETOS LED short on –short on – short on – short on – long off
- **Test not successful:** iMETOS LED stays on

Yellow LED (center): indicates one of the following:

1. in *boot* mode (plugged jumper I, see Picture 6): Pessl bootloader is installed

2. in *terminal* mode (plugged jumper F, see picture 6) the meaning of the LED is given on the screen of the terminal program in the PC

3. in *normal/scheduling* mode (without any jumpers) :

    a) if the modem is on: modem blink code:

        i.   short *on* – long off: waiting for modem, network found, SIM card is active

on————on————on————on————on————on————on————on————on————on

        ii.   short *on* – short *on* – long *off*: connected to GSM

on-on————on-on————on-on————on-on————on-on————on-on————on-on

        iii. short *on* – short *on* – short *on* – long *off*: connected to FieldClimate

on-on-on————on-on-on————on-on-on————on-on-on————on-on-on

        iv. short *on* – short *on* – short *on* – short *on* – long *off*: data has been sent and commands from the server have been received.

on-on-on-on ————on-on-on-on————on-on-on-on————on-on-on-on

    b) if the modem is *off*: the measurement process is in progress, it will light a few seconds every 5 minutes.

2.2   Use your iMETOS

FieldClimate.Com is the web service you are intended touse your iMETOS with. It allows you to see the data in graphs or tables. It provides interfaces for automised downloads and it provides a powerful decision support system for plant protection and irrigation.

2.3   Register yourself as a user on FieldClimate.Com

To use the services on FieldClimate.Com it is needed to register as a user for this. Please press the link with you see surrounded by the circle on the graph beside.

The registration screen which comes up now asks you for a username and a password and it needs your email address as well as your postal address and some information about the company. Please note you will have to enter the real email address. A acknowledge email is send to your inbox and its containing link has to be used to activate the newly created user account on FieldClimate.Com.

Picture 6: FieldClimate Login Mask

2.4   Add the iMETOS to your account

If you have got the activation email and you activated the account you will be able to enter to FieldClimate.Com. Now the system welcomes you with the error message that there is no iMETOS connected to this new account. To change this press the "Add New Station" link.

It will ask you for a serial number and a key. Now the little silver colored sticker which came with your iMETOS has to be used. This sticker contains two keys. Key 1 gives the power to change all the settings on the iMETOS whereas key 2 is only valid to use the data of the system. To be able to set up the iMETOS please enter the key 1 here. If you entered the correct key your station list will be enlarged by this iMETOS and it can be selected.

Picture 7: Adding new station to FieldClimate

Picture 8: List of added stations

2.5 Giving names to the iMETOS

Every iMETOS is significant named by a serial number. For the most users it is more convenient to name it after the site it is installed. Tehrefore the names screen offers the possibility to enter a given name.

Picture 11: Renaming iMETOS stations

If you enter the name the "**update**" link has to be pressed to save this entry on the web server. In the sensors name menu the given name for the sensor can be entered and the colour for the sensor can be changed by clicking on the colour field. This settings have to be send to the web server by pressing the "**OK**" link in the specific line.

2.6 Setting the Configuration of a iMETOS

Users of a new iMETOS have to visit this link to select the time zone. If the time zone is not set the iMETOS will assume to be on Greenwich time (GMT). The setting for logging interval and transmission times will work with the default values, as long it is not changed.
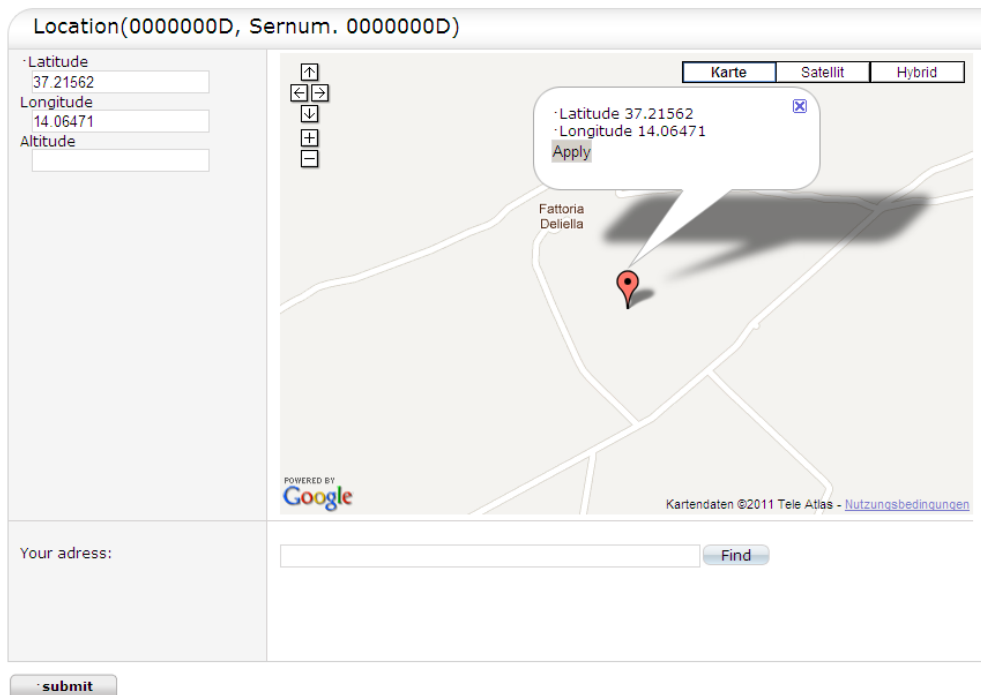
The logging interval is set to 60 minutes by default. Shorting the logging interval will increase the power consumption and the data transfer costs. It can be set to every multiple of 5 minutes in between 10 and 120. The time zone has to be set. For data transfer all 24 hours can be selected. Using less transfer times will decrease the data transfer costs. The settings are send to the web server by pressing the "**submit**" link.

2.7   Defining the iMETOS Location

It is more than helpful to define the iMETOS location. First it is the base of geo linked services on iMETOS and second it helps the team doing services on you iMETOSa lot when they can find the iMETOS without the help of you or your employees.

To define the location a map service is used in which you can select the map or the satellite view. If you enter the address where the iMETOS is installed the correct part of the map will be opened. The zoom + and – allows you to zoom inot the map and you can set the iMETOS very accurate in its real position. Please enter the altitude if you like to use weather forecast for this device.

If you have the correct GPS position on base of you car navigation system or the agricultural GPS you can enter this data and press the "**submit"** link. Now you can see if the position is correct by checking the map.

Picture 13: Defining iMETOS station location

After choosing the correct position please enter the submit button.

2.8 SMS Alerts Numbers

To use the SMS alerts two links are needed. Both can be used first. The SMS numbers are used in case an alert has to be send. Please enter here the telephone number with the country code. The name entered before the telephone number is not used by the iMETOS. It is a service for you to memorise to whom the iMETOS should send the SMS message.

Enter the number and the name and press the "**submit**" link. If you like to delete a telephone number form the list us the red cress left to name and number.

Picture 14: SMS alert setup

2.9 SMS Alerts Thresholds

To use the SMS alerts two links are needed. Both can be used first. The "**SMS Warning**" link opens a screen which allows selecting a threshold for alert on overgoing (max) or undergoing (min) this. Press the edit button beside of the sensor a threshold has to be set.

·Code	·Chain	·Channel	·Name	·Warning	·Unit	·Warning	
1	0	3	Relative humidity	min	%		Edit
1	0	3	Relative humidity	max	%		Edit
0	0	4	Air temperature	min	C	1, 2, 3	Edit
0	0	4	Air temperature	max	C		Edit
7	0	7	Battery voltage	min	V		Edit
7	0	7	Battery voltage	max	V		Edit

Picture 15: Setting SMS alert thresholds

No a new screen comes up giving you the possibility to enter the values you wish. After every value you have to press the "**add**" link. Values which are in the lsit can be deleted by pressing the "**delete**" link.

The number of possible thresholds is various depending iMETOS type. It showed that it has been enough for all applications.
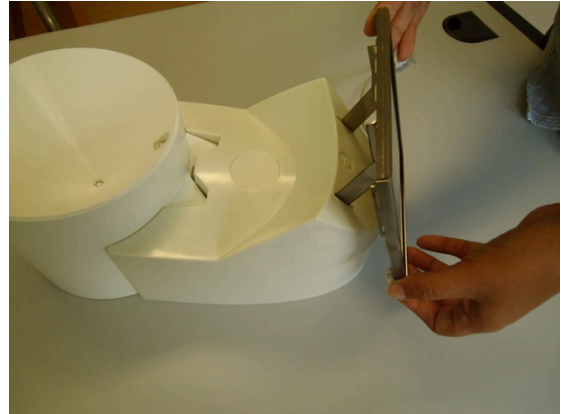
3 Installing the iMETOS ECO D3

The iMETOS eco D3 is one plastic part which contains all the electronics, the battery and the antenna. If it is equipped with a rain gauge, it is just a little longer than without. The heaviest part is the battery. Therefore the clamb for the pole sits below it. The solar panel is hanging on a short cable.

## 3.1   Mounting the solar panel.

The solar panel is connected with the main body by a short cable. It is packed in plastic film to be protected form transportation damage. Please unpack it and insert its legs into the two cuts at the top of the iMETOS.

Picture 16: Mounting the solar panel

3.2   Mounting the iMETOS ECO D3 on a pole

At the bottom of the unit there is a plastic ring with a metal clamp on. This fits on a 33 mm pole. Please hammer a pole of 1.2 to 2m straight into the ground and set the iMETOS ECO D3 on it. The solar panel should be directed towards the sun (South on northern hemisphere and North on southern hemisphere). Fix the screw on the clamp with a 10 mm spanner.
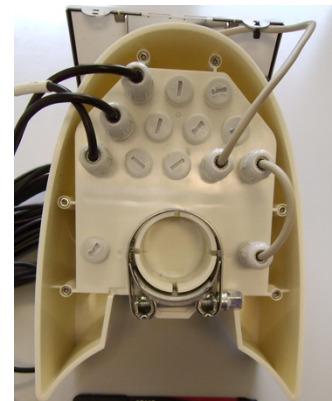
Picture 17: Bottom of the iMETOS ECO D3 unit

3.3   Soil Temperature

The soil temperature sensor should be buried in earth. How deep it should be buried is depending from the goal which should be reached with the sensor. To have an impression of root growth and nitrogen mineralization in vines or apples in early spring it is best be burry it by 10 to 20 cm. If you want to assess the emergence possibilities of seeds it is depending on the seeding depth of the seed. Using it in corn (maize) would mean to bury it by 5cm and using it for sugar beets would mean to bury it by 2 or 3 cm only.

4 Installing the soil moisture sensors

iMETOS ECO D3 is designed to monitor soil moisture at the crop and to present this data on FieldClimate.Com. The GPRS, EDGE or CDMA networks are allowing you to install the device wherever you need it. iMETOS might be used to monitor only one site or it can be used to monitor several sites in a short distance. These sites will be connected by cables.

iMETOS ECO D3 supports different ways of soil moisture measurement. All this different sensors will need a different electronic. For this purpose it will always consist of the main PCB (responsible for the logging and the communication) and in minimum one second PCB (responsible for sensor evaluation). If it

Picture 18: Installing soil moisture sensors

is made to monitor one spot this second and only sensor evaluation PCB will be in the same box than the main PCB. If it is made to monitor several sites with a cable connection this other sites will have their own sensor evaluation PCBs in own boxes.

All the PCBs for sensor evaluation do have a line going towards the iMETOS and a line going towards the next PCB for sensor evaluation. Several of this sensor evaluation PCBs can be linked together in a chain. Nevertheless might it be needed to create a network where the sensing sites are going in two or 3 directions away from the iMETOS. In this case the iMETOS ECO D3 supports up to 3 sensor chains. For sensor chain 2 and 3 an extension PCB is needed.

4.1 Watermark Sensors

Watermark sensors measure water tension. These sensors measuring range is between 100 and 2000 mbar (10 to 200 kPa or cBar). This sensor fits many horticultural crops, berries, stone fruits, vines and potatoes. Watermark sensors are easy to use and frost proof.

Basically it is a gypsum block. The gypsum is embedded in a matrix material. And it gives a defined response in resistance on different water tension levels. We can measure the water tension on 3 to 5 cBar accuracy.

It showed that it works faster if it is wetted for 24 hours before installation. If you install it in the ground you will need a hole with the correct depth. Lay it horizontally on the ground and let the cable go horizontally first to before you take it up to the top. This avoids water following the cable in the ground reaching and wetting the sensor.

The watermark PCB can be equipped with an own soil temperature sensor. This sensor is used to do the temperature compensation of the water tension measurement. It allows you to to measure the soil temperature in specific blocks where you measure water tension. The irrigation might influence the soil temperature what can be important in asparagus per example.

Picture 19: Volumetric water content sensors

4.2   ECH2O sensors

From the range of sensors produced by Decagon LTD we are supporting 2 capacitive soil moisture sensors EC5 and HS10 and the soil moisture and conductivity sensor TE5. EC5 is a 5 cm long sensor in the shape of a 2 legged fork. 10HS has the same shape but it is a 10 cm long and a little stronger than its smaller co product. In an ideal soil it is possible to press these sensors into the ground. In this case you might dig a hole down to the maximum depth you like to burry the sensor and you insert the lowest sensor straight into ground and the other sensors will be pressed into the site walls of the hole.

As soon as you have structured organic matter or stones in the soil this way of installation is not possible. In this case you will have to dig a trench and to make smaller holes with the different depths you like to install the sensors. Take some of the soil of the different holes and mix it carefully with water to form a slurry a dry as possible. Insert this slurry
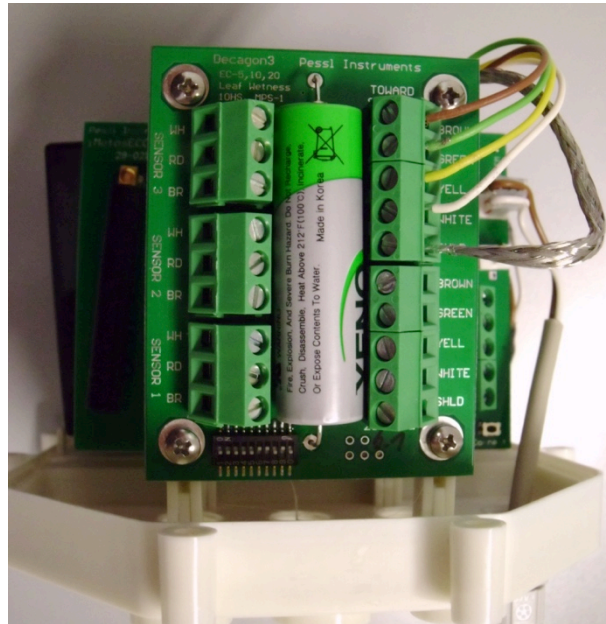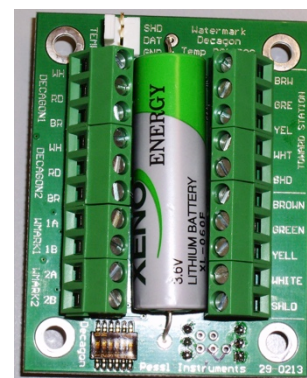

Picture 20: Soil sensor internal node

into the hole and now you can insert the sensor vertically into this slurry. The cables can be buried in the trench.

The PCB supporting the ECH$_2$O sensors can take 3 sensors. It is possible to connect a wide range of different sensors to this PCB. Therefore a compound with 10 dip switches is on this PCB. 9 of this switches are needed. The first 3 switches are for sensor 1, Switch 4 to 6 is for sensor 2 and switch 7 to 9 is for sensor 3. If an EC5 is connected the switches have to be off, off, off. A HS 10 sensor needs the settings On, Off, Off. The TE5 sensor for soil moisture and conductivity needs the setting On, On, Off.

4.3   Joining Soil moisture and Water Tension

Soil moisture measured with capacitive sensors like EC5, HS10 or TE5 responds very well on irrigation, rain or water use by plants. Nevertheles it does not tell if the water is easy available for hardly hold by the soil. Sensors giving water tension like tensiometers or watermark sensors are showing the plant availability of the water much better. This sensors are limited to show the dynamics of the soil water. To use the benefits of both systems Pessl Instruments have developed a PCB on which we can evaluate 2 watermark sensors, 2 ECH$_2$O probes and a soil temperature.


Picture 21: Soil sensor internal node _combines 2 Watermarks and 2 Decagon sensors

4.4   Tensiometer

Pessl Instruments is delivering tensiomers of different length form Irrometer LTD. For this tensiometer we deliver screw in pressure adapter. 4 of this adapters can be connected to the tensiometer interface. The tensiometer interface consists of a barometr ic sensor more which is used as a reference for the tensiometers.

The four tensiometers are connected with 5 m cable to the PCB. It is a 3 wire cable. It is connected with shield (sh), white (wh), green (gr) and brown (br).
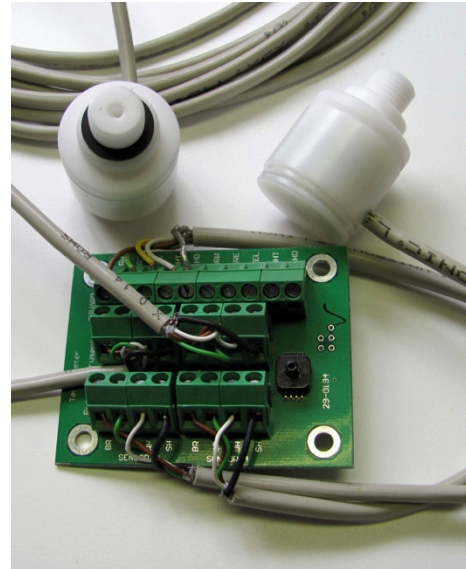
Picture 22: Tensiometer internal node

5 Installing new sensors on the iMETOS

Each iMETOS can be expanded to the maximum possible number of sensors. It is equipped with specific inputs for rain, and soil or air temperature   Beside of this it has 3 digital inputs which can be used for a range of different soil moisture sensors and sensor chains.

5.1   Installing soil or air temperatures

iMETOS ECO D3 can be equipped with a soil temperature sensor. The sensor is connected to the 4 pin PanCon Conector labelled with Temp.

Picture 23: Soil temperature sensor

5.2   Installing a rain gauge

If you like to expand the iMETOS eco D3 by a rain gauge Pessl Instruments or you distributor will send you a new cover for the iMETOS eco D3 including the rain gauge. You will have to remove on of the covers form the bottom of the housing and put the cable with the cable gland into this opening. Make sure that you screw in the cable gland careful and the seal closes the hole tide. The rain gauge connects to the 4 pin PanCon connector labelled with rain.

6 Maintaining the iMETOS

When the solar panel of the iMETOS is exposed to the sun and it gets enough sunlight it should recharge the lead acid battery of the system constantly. With this the system should have enough power for years. The lifespan of the lead acid battery can be expected to be 5 to 6 years with sufficient reloading form the solar panel. Insufficient reloading will shorten the lifetime of the battery. In case of insufficient reloading of the battery the system will reduce the frequency of data upload to the amount which is needed to make sure that no data will be missed on the server. With this power use will be reduced and battery power will last longer.

The maintenance needed for the sensors depends on the different sensors. Temperature sensors will not need any maintenance for their lifetime whereas the rain gauge will only work properly when it is cleaned periodically.

6.1 Maintaining the rain gauge

The funnel of the rain gauge has several small holes to lead the water into the dipping bucket. This holes end to be closed by leafs. Please check the funnel periodically for leafs. The inner side of the rain gauge is a very attractive refugee for several insects. Please check this specially at the end of summer where wasps tend to use the funnel.

The rain gauge can be recalibrated if this is needed. It should kip at 4ml filled into the double spoon. The kipping point can be selected by the white plastic screws below the spoon.

Picture 4: Rain gauge

7 Uninstalling

iMETOS ECO D3 is mainly used for soil moisture monitoring. If this is in a permanent crop, it can be out in the field for its lifetime. But it might be that it should change the position or that the crop will not last for longer. In this case the iMETOS eco D3 has to be uninstalled. If you do so plan some time for it. If you like to remove the soil moisture sensors ready for reusing you have to dig carefully behind the cables. Make sure that you will not damage them. If the iMETOS will be installed immediately after thi s at another site, do this. If the iMETOS should wait in a shed for the next season, please disconnect the battery. For this you have to open the housing with the six screws. The Allen key which came with it was 2.5 mm. If you do not disconnect the battery the iMETOS will send data for another 2 month and after this the battery will be too weak. If you like to use it in the next spring it will need several days in sun before it can transmit data again.

Picture 5: **iMETOS ECO D3 with rain gauge**