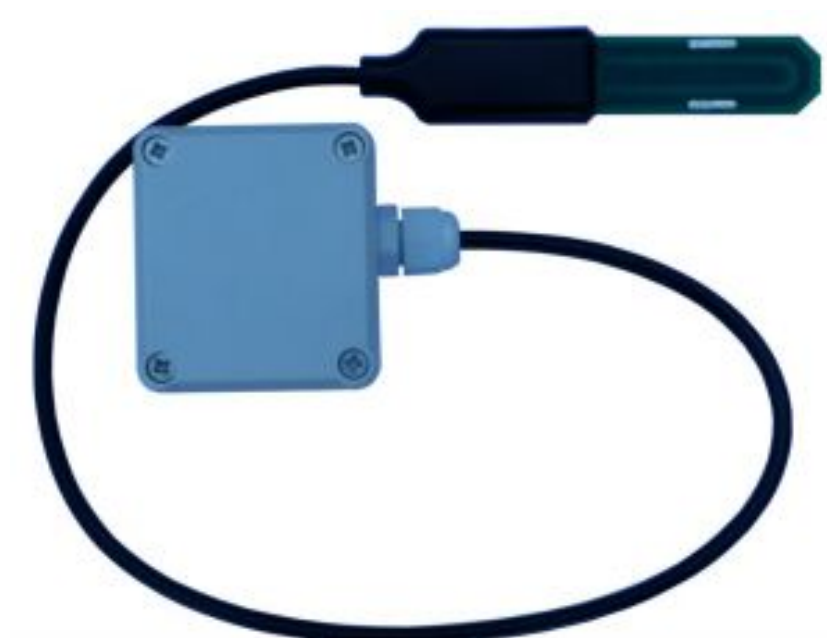




PM-WCS-3-LW LoRaWAN soil moisture, temperature, EC sensor

FEATURES

- Dust and waterproof.
- LoRaWAN class A device, may be activated with OTAA or ABP.
- Setup via USB CDC-ACM virtual COM port.
- Android application for USB setup and free online monitoring via The Things Network gateways.
- Demo [Tinovi zerver.io](https://tinovizerver.io) cloud console for graphs and configurable event triggers





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ELECTRICAL PROPERTIES

	Min/Sleep	Typical	Max
Supply voltage (VCC), V	2.5	3.6	6
Working current (VCC=3.6V) , mA	0.5	12	150
Operating Temperature Range, Celsius	-20	25	70

Sensor consumes max 0.3 mA in sleep mode, 12 mA in active mode and 150 mA in transmitting mode. Recommended battery is 3.6v ER14505. Sensor also may be powered from any 5v Micro-USB power source. After power up sensors wait 10 seconds for USB configuration session connection from android application or USB CDC terminal, if none is connected sensors turns off USB hardware and starts normal operation.

PHYSICAL PROPERTIES

Sensor dimensions 114 x 24 x11
Cable length 0.7m

MEASUREMENT PROPERTIES

	Resolution /avg Tolerance	Range
Dielectric permittivity (ϵ) (Temperature corrected)	0.1 ϵ /5%	1 (air) to 80 (water)
Volumetric water content - VWC calculation from Dielectric permittivity ϵ . $VWC = 0.002974 * \text{pow}(\epsilon, 2) + 0.07424 * \epsilon - 1.295$;		
Electrical Conductivity (mS/m)	0.01 mS/m /20%	0...300 mS/m
Temperature (°C)	0.1°C /3%	-20 to 70°C
Degree of water saturation in the soil	1%	0 - 100%



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DATA OUTPUT

Format what you are usually getting from LoRaWAN is hex string, which you have to convert to bytes.

Then data output in binary format is total 9-byte long:

1. 2-byte 16-bit signed integer (divide by 100) Dielectric permittivity (ϵ) (Temperature corrected) resolution: 0.1 ϵ (avg.Tolerance 5%) and range 1 (air) to 80 (water)
2. 2-byte 16-bit signed integer (divide by 10) Electrical Conductivity (dS/m) resolution: 0.01 mS/m (avg.Tolerance 20%)
3. 2-byte 16-bit signed integer (divide by 100) Temperature ($^{\circ}\text{C}$) resolution: 0.1 $^{\circ}\text{C}$ and range: -20 to 60 $^{\circ}\text{C}$ (avg.Tolerance 3%)
4. 2-byte 16-bit signed integer Volumetric Water Content (%) resolution:1% and range: 0 – 100% VWC Note: VWC is calculated from dielectric permittivity by Topp equation (Topp et al, 1980): $\theta = 4.3 \cdot 10^{-6} \epsilon^3 - 0.00055 \epsilon^2 + 0.0292 \epsilon - 0.053$
5. 1-byte Battery voltage percent: measures battery voltage and calculates percentage from 2v to 5v; To calculate actual battery voltage use equation: $2+0.03(\text{battery reading})$. for example if battery measurement shows 50% ,then actual voltage is $2+0.0350=3.5\text{v}$ resolution: 1% and range: 2v – 0% to 5v – 100%

SENSOR CALIBRATION

Sensors are already factory calibrated, but in case needed they may be recalibrated using USB terminal interface as described for device specific commands.

Put sensor in to water and issue command **water**, response OK.

Hold sensor in air and issue this command **air**, response OK.

For **ec <uS/m>** calibration put sensor int to liquid and set right sensor reading value in uS/m.

We recommend Android mobile application for sensor setup and data reading/storage

SENSOR CALIBRATION ON ANDROID APP

1. remove battery, attach to phone
2. open application & wait for USB connected status or connect
3. go to SETTINGS tab,
4. hold sensor in the air – click button AIR
5. submerge sensor in the water or soil with water, click button WATER
6. go to MAIN tab click read to test calibrated values



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COMMAND LINE

LoRaWAN configuration may be done via USB CDC-ACM virtual com port with 115200 baudrate. Before configuration you need to switch off device and then connect to usb port of your computer. On linux it will be detected as `/dev/ttyACM0`.

Device waits for 10 second after power up for USB CDC-ACM connection, then it goes to normal operation mode and is not reachable via USB CDC-ACM port. For linux permission settings please [consult](#).

On Linux you may use [minicom](#) utility to configure sensor.

For windows [PuTTY](#) may be used.

We recommend Android mobile application for sensor setup and data reading/storage

COMMAND LINE DEVICE CONFIGURATION COMMANDS

Command	Response	Explanation
int <val>	OK	Setup data sens interval in seconds
appeui <val>	OK	Sets Application EUI for OTAA activation.
deveui <val>	OK	Sets Device EUI for OTAA activation.
key <val>	OK	Sets App Key for OTAA activation.
addr <val>	OK	Sets Device Address for ABP activation.
nwks <val>	OK	Sets Network Session Key for ABP activation.
apps <val>	OK	Sett AppsKey for ABP activation
check	OK	0-Disable/1-Enable OTAA link check mode EU868 (helps reconnect device on gateway outage)
info	config vals	print this parameter setup values.
ver	<version>	print device type and version number
ec <uS/m>	OK	Submerge sensor in to calibration fluid and input EC value in uS/m
air	OK	Hold sensor in air and execute command 0% offset()
water	OK	Submerge sensor in to water or soil with water and execute the command
debug		Enable debug mode, device does not go to sleep sience v1.2

DOWNLINK MESSAGE

Device supports LoRaWAN downlink message for device sleep time (data sending interval) adjustment. Message should contain 5 bytes, 1st byte is 0x01 and following 4 bytes is unsigned 32-bit integer time in seconds to sleep. For example sending HEX 01000000A will set interval to 10 seconds, but 0100000E10 will set interval to 3600 secs = 1 hour.



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ANDROID APP

<https://play.google.com/store/apps/details?id=com.plantmer.soilsensor>



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GATEWAY CONNECTION

1. remove device battery prior to connecting device via Micro-USB to phone or another USB power source.
2. in case you are setting your own configuration parameters from TTN or other LoRaWAN operators, input DeviceEUI, AppEUI, AppKey to device config app and click "SET" button for each value, then remove USB cable from device and reattach power source like battery or 5v USB supply to restart device. .
3. we included USB-OTG adapters for connection to android device, still you will require micro-usb charging cable for connection to device micro-usb connector (warning - battery should be removed while connecting to phone).
4. configuration app may be downloaded [there](#)

The Things Network

To enable online monitoring via your TTN connected gateway and Tinovi default App UID you should

Android app: Click login in application main page, to signup with your google account.

- Attach LoRaWAN sensor to phone's USB OTG port, wait for status USB Connected and go to soil sensor application's settings tab.
- Click READ to read data from sensor or GENERATE button to generate new address data.
- Input your device's name without white spaces and click REGISTER OTAA button, to register device to cloud.
- Your device should appear on main tabs sensor list. Chose your sensor in list to see data from sensor.



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TTN DECODER

```
var bytesToInt = function(/*byte[]*/byteArray, dev) {
  var value = 0;
  for ( var i = 0; i < byteArray.length; i++) {
    value = (value * 256) + byteArray[i];
  }
  return value/dev;
};

function Decoder(bytes, port) {
  var decoded = {};
  var pos = 0;
  decoded.e25=bytesToInt(bytes.slice(pos,pos+2),100);
  pos = pos+2;
  decoded.ec=bytesToInt(bytes.slice(pos,pos+2),10);
  pos = pos+2;
  decoded.temp=bytesToInt(bytes.slice(pos,pos+2),100);
  pos = pos+2;
  decoded.vwc=bytesToInt(bytes.slice(pos,pos+2),1);
  pos = pos+2;

  decoded.bat = bytes[pos++];
  return decoded;
}
```



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ANDROID APP

You may use any android phone supporting OTG host option to configure USB and LoRaWAN sensors.

For LoRaWAN sensors data is streamed online via LoRaWAN gateways connected to TTN.

To enable online monitoring you should:

- Click login in application main page, to signup with your google account.
- Attach LoRaWAN sensor to phone's USB OTG port, wait for status USB Connected and go to soil sensor application's settings tab.
- Click READ to read address data from sensor.
- Input your device's name without white spaces and click REGISTER OTAA button, to register device to cloud.
- Your device should appear on main tabs sensor list. Chose your sensor in list to see data from sensor.

Tinovi Soilsensor Android application receives LoRaWAN sensors data via <https://zerver.io/graph> IoT cloud application. You may login to this dashboard tool using your googles account and create nice dashboards to monitor your sensor data.

For USB sensor modification this application may be used as data logger, because it stores data readings to android flash memory and displays them to graphs. Data displayed in graphs may be copied to clipboard in CSV format and shared or saved to file.

Features

- * Online LoRaWAN sensor monitoring via TTN connected gateways.
- * Setup USB and LoRaWANTinovi soil sensors
- * Write USB and LoRaWAN sensor data to phone memory
- * View data on charts and export to CSV
- * Source code is [located there](#)

