

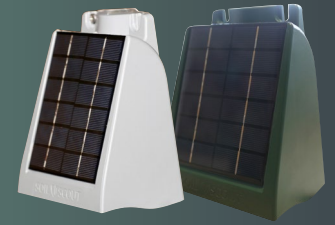
Soil Scout Receivers User Manual

Base Station 200 | Echo Repeater 200



Soil Scout Receivers

Base Station 200 | Echo Repeater 200

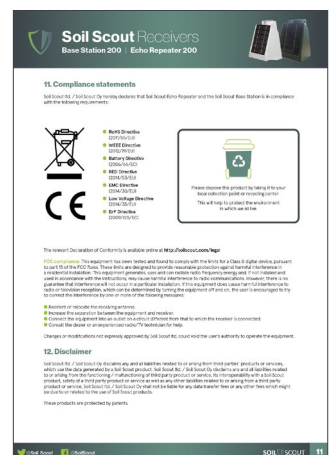
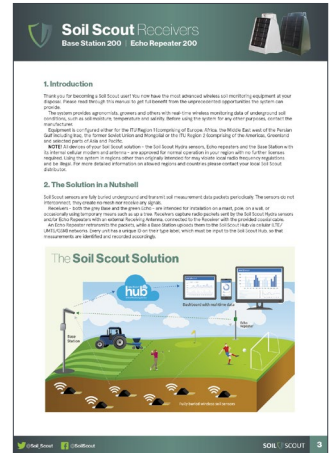


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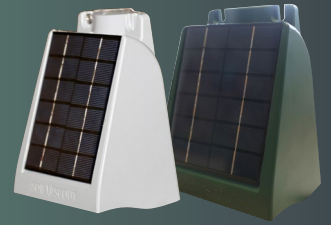
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1. Introduction

Thank you for becoming a Soil Scout user! You now have the most advanced wireless soil monitoring equipment at your disposal. Please read through this manual to get full benefit from the unprecedented opportunities the system can provide.

The system provides agronomists, growers and others with real-time wireless monitoring data of underground soil conditions, such as soil moisture, temperature and salinity. Before using the system for any other purposes, contact the manufacturer.

Equipment is configured either for the ITU Region 1 (comprising of Europe, Africa, the Middle East west of the Persian Gulf including Iraq, the former Soviet Union and Mongolia) or the ITU Region 2 (comprising of the Americas, Greenland and selected parts of Asia and Pacific).

NOTE! All devices of your Soil Scout solution – the Soil Scout Hydra sensors, Echo repeaters and the Base Station with its internal cellular modem and antenna – are approved for normal operation in your region with no further licenses required. Using the system in regions other than originally intended for may violate local radio frequency regulations and be illegal. For more detailed information on allowed regions and countries please contact your local Soil Scout distributor.

2. The Solution in a Nutshell

Soil Scout sensors are fully buried underground and transmit soil measurement data packets periodically. The sensors do not interconnect, they create no mesh nor receive any signals.

Receivers – both the grey Base and the green Echo – are intended for installation on a mast, pole, on a wall, or occasionally using temporary means such as up a tree. Receivers capture radio packets sent by the Soil Scout Hydra sensors and/or Echo Repeaters with an external Receiving Antenna, connected to the Receiver with the provided coaxial cable.

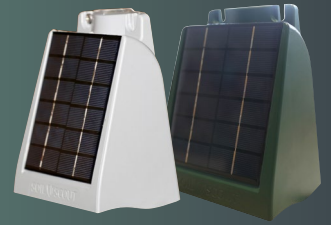
An Echo Repeater retransmits the packets, while a Base Station uploads them to the Soil Scout Hub via cellular (LTE/UMTS/GSM) networks. Every unit has a unique ID on their type label, which must be input to the Soil Scout Hub, so that measurements are identified and recorded accordingly.





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3. Overview and Operation

The units are fully plug and play, the power switch being the only user input. Base Stations come with a built-in SIM and are pre-configured for your regional settings.



Solar panel



The Receivers have a few common main parts; a solar panel for independent operation during the growing season, a power switch, a status LED, a DC input power connector (to be used when solar power is not available in sufficient quantity) and a coaxial connector for the receiving antenna. There is also a rechargeable lithium battery and a retransmission (Echo) or cellular (Base Station) antenna inside the enclosure, but these are not intended for user access or service. The D9 connector is reserved for connecting a rain gauge or other auxiliary connection, and should not be connected without separate, detailed instructions.

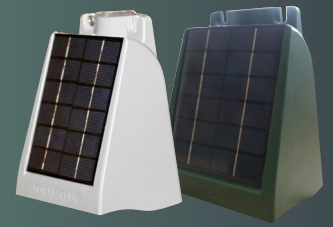
Base Stations also have a two-row text display. This display provides detailed information on the cellular network, received packets, upload progress etc. For power saving reasons, the display backlight is only operational for the first 60 minutes after a power-up. Later on, the display will continue displaying data but depending on ambient light brightness it may be difficult to read. If another hour of display operation is required, the unit can be briefly powered down and back up using the power switch.




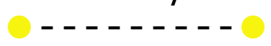
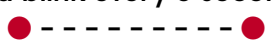

The signal LED is always operational when the unit is switched on and there is sufficient battery voltage. On the next page is a short list of how each LED blink pattern correlates to operation status.







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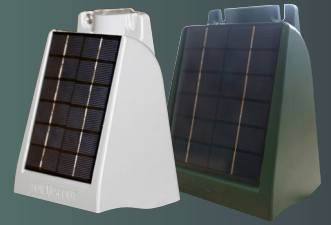
Base Station 200 LED Pattern	Status
Green blink every 1 second 	Normal operation
Single long blue blink 	A new packet was just received
Yellow blink every 1 second 	No new packets received within last 1 hour
Yellow blink every 5 seconds 	Unit is on power saving break, will autonomously resume operation later
Red blink every 5 seconds 	Battery is too low for operation, please recharge
Red solid or long blink 	The unit is about to perform an automatic reboot

Echo Repeater LED Pattern	Status
Green blink every 1 second 	Normal operation
Single long green blink 	A new packet was received and retransmitted
Yellow blink every 1 second 	No new packets received within last 20 minutes
Red blink every 5 seconds 	Battery too low for operation, please recharge



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4. Pre-assembly of Receiving Equipment

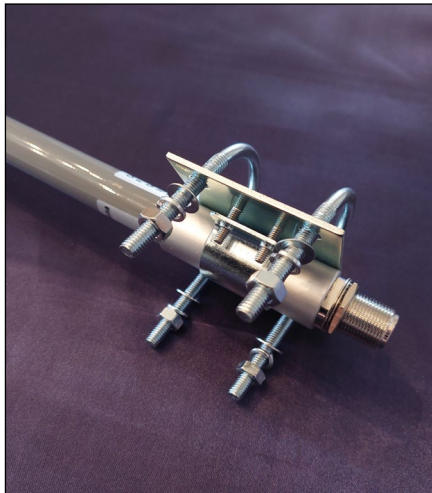
The units are fully plug and play, the power switch being the only user input. Base Stations come with a built-in SIM and are pre-configured for your regional settings.



Receiver on a pole

If you're installing the Receiver on a pole where you can slip the unit in place over the top, use a crosshead screwdriver (size PZ2) to fix all four screws onto the backplate just a couple turns each.

If you're installing the Receiver halfway a pole, leave the two bottom screws unattached until final installation.



Omnidirectional pole antenna

When installing an omnidirectional pole antenna, preassemble it by attaching the metal strap onto the backplate with the 4 crosshead screws (size PH1). Slip in the antenna and make sure that the backplate is vertically aligned with the antenna metal capsule. Do not over tighten.

On actual install location assemble the u-bolts onto the backplate. Place the smooth washers first, then the spring washers and finally the 10mm nuts.



Directive antenna installation

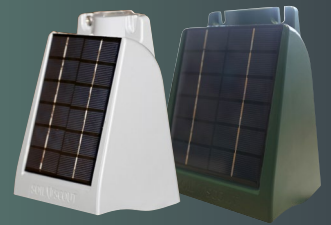
When installing a directive antenna, preassemble the angle iron onto the antenna with the two screws provided (size PH3). Make sure to have the mounting plate to your right hand side when the red arrow is pointing "UP" and antenna is viewed from behind.

On actual install location put the u-bolt first through the toothed bracket piece, then the mounting plate from the right hand side. Place the smooth washers first, then the spring washers and finally the 10mm nuts.



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NOTE: Information regarding screws and bolt types are provided with best available accuracy, but may change without notice.

All Soil Scout devices are ready for use when delivered. The Receivers have been tested during manufacture and there is no way to adjust the operation – you just need to switch them on.

However, since the battery is in a shelf condition upon delivery, it is good practice to let the unit charge a while before switching on. This can be done using either a DC power supply or placing the unit outside, directly facing the sun, for a few hours. It will charge even when it's not switched on.

Add the Base Station to your Site in the Hub as outlined in the Hub Manual, if that hasn't already been done for you. Then switch the Base Station on and let it sit – you should see the unit go green in the Hub and diagnostics data update. When switching it on for the first time in a new location, this should not take more than 5 minutes, depending on the local cellular network. On the unit display you can see a scrolling text of network details once the unit has connected to a local cellular network.

Leave the Base Station on and add the Echo Repeater device to the Site accordingly. Switch it on and confirm that it appears online in the Hub Receivers page. If the Base Station is running indoors with no power supply, this can take up to 20 minutes.

5. Field Installation of a Receiver

Receivers should always be installed upright, so that all connectors point directly downwards. The solar panel should be directed in the direction of best sunlight, typically this is directly south in the northern hemisphere and directly north in the southern hemisphere. Close to the equator the direction can be chosen freely (and based more on local obstacles) since sunlight is more abundant. If the Receiver is situated where not enough sunlight can be harvested, the unit should be used with the provided mains power supply. Note that the PSU must be protected from weather.



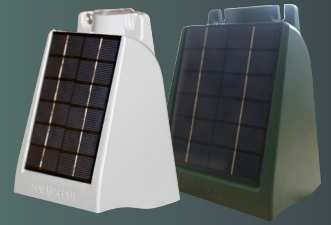
If you're using a short antenna cable, slip the Receiver onto the pole and tighten the backplate screws just a little. Add the Antenna to the pole. An omnidirectional antenna must sit on the highest end of it, having the highest u-bolt just 1 cm (1/2 inch) below the top – otherwise the pole itself will interfere with the antenna and cause poor performance.

Directive Antennas can be mounted at any point of a pole, but preferably as high as possible.



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Make sure that the antenna cable travels from Receiver to Antenna going around the pole. This makes sure that the cable will not accidentally find its way into the front of the solar panel.

In some cases the pole is very high and a longer antenna cable has been provided, so the Receiver can stay lower down the pole. When using a longer antenna cable, twist it around the pole, leave a little slack and use a cable tie to fix it to the pole as sturdy as you can. The cable connectors are not intended to carry the full weight of the cable, especially during windy conditions.

The directive antenna has a 90 degree arc of reception, i.e. 45 degrees to either side of the pointed direction. Vertically the arc is 60 degrees, which in typical installations means you can just set the antenna slightly down from horizontal and it will receive properly from near and far. The omnidirectional antenna will receive signal from all directions, but must be mounted on the very top of a mounting pole or mast, so that the pole itself is not interfering with the antenna.

The internal antenna (for cellular connection in a Base, and for retransmissions in an Echo) is omnidirectional and does not require orientating.

The external antennas and the units themselves must always be well away from metal objects and surfaces, such as tin roofs, ladders etc so that the radio waves are not short circuited, resulting in lowered performance.

6. Base Station Power Management

The Base Station has several internal operating modes that the unit employs depending on the battery charge level. No user interference is required, the Base Station switches between states fully autonomously.

- **Full Operation Unit is supplied with external power (input voltage exceeds 9VDC)**
In this mode, all packets received by the Base are uploaded to the Hub with a latency of no more than 60 seconds.
- **Normal Battery Operation - Unit is not supplied with external power, battery is full**
In this mode power is conserved by buffering incoming packets and uploading so that the largest delay introduced to any one packet is less than 20 minutes. The fastest single Scout inside the Site will define the latency pattern, i.e. a 5-minute sensor on the Site will enforce a cycle where no packets will lag more than 5 minutes.
- **Low Battery Operation, First Stage**
In this mode Base Station operation is active for one hour followed by a hibernation period of one hour. The active period is just as is normal battery operation. The hibernation allows for extended usage in low-light conditions while keeping up with day-long trends in the readings.
- **Low Battery Operation, Second Stage**
Battery has kept discharging even more, so the hibernation is increased to 3 hours, meaning that each one hour of operation is followed by a three-hour period of no operation.
- **Low Battery Operation, Third Stage**
Hibernation is prolonged even further to 5 hours, so there are now four active one-hour periods within a full day. This is the last extreme measure to stretch operation for approximately one more day.
- **Battery Empty**
The battery is so close to being fully depleted that no further operation is possible. The unit will shut down internally and blink a red LED, until either battery is charged or it depletes so low that even the LED stops blinking. Solar recharging remains operational.

Hibernation means that the unit will not receive any new packets nor will it upload any diagnostic packets to the Hub, it stays completely offline. If the Hub is set to send an automatic email warning when a Base Station goes offline, this might cause frequent redundant emails. If your Base is running on solar power without a PSU, you may prevent such behaviour simply by increasing the alarm time threshold to more than 6 hours.

7. Echo Repeater Operation

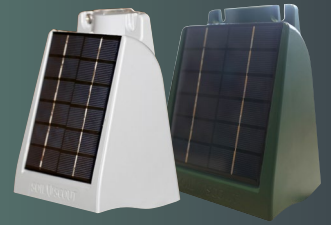
The purpose of an Echo Repeater is to expand a Soil Scout site to wider areas than just the reception range of a single Base Station. An Echo boosts the signal level of any packets it receives by a retransmission, but it does not alter the information in any way. Consequently, it is impossible to distinguish an original Scout measurement data packet from one that was repeated once or even multiple times.

If there is uncertainty whether a Scout is being picked up directly or via an Echo, the only way to make sure is to switch off the nearest Echo and check whether the received packet count from that Scout remains the same over a longer period of time (eg. 24 hours). Note that if this results in the Scout not being picked up, the corresponding data for that period will be lost.



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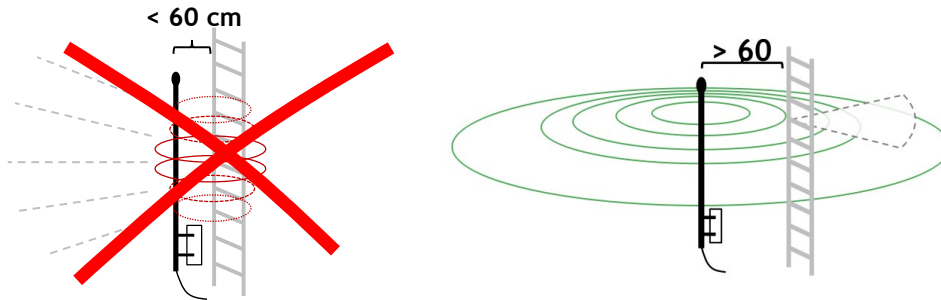


8. Radio Communication Aspects

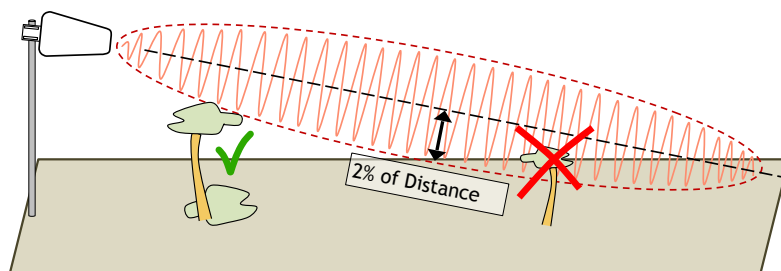
When choosing locations for Receivers and mounting their Antennas, it's good to understand a few aspects regarding radio wave propagation. The signals do not "magically appear" at the antenna as some might think; they travel much like a ray of light from the transmitter to the receiving antenna in a straight line.

- The deeper a Soil Scout Hydra sensor is buried, the closer the Receiver must be
- The higher the Receiving Antenna is elevated, the longer a range can be expected
- The receiving antenna near field (60 cm / 2' radius) must also remain unobstructed
- The "line-of-sight" is not like a laser, but a few meters wide tube (2% of the distance)
- All obstacles within the line-of-sight tube diminish and ultimately block the signal
- Obstacles between Echo and Base also impact ranges

Soil Scout has lots of experience and understanding in the wireless operating conditions our customers have, and are happy to evaluate your installation plans in more detail.



Omni Directional antennas need at least 60 cm (2') clearance around the antenna. The same applies at all sides and the front of a Directive Antenna, but not behind it.



The Line-of-Sight for a radio wave needs some clearance around a straight line.

9. Troubleshooting

No light on the LED

If power is switched on but the LED is not blinking, the battery has gone fully empty. Recharging the unit in bright sunlight or using an external power supply for a couple of hours will resume operation. If after prolonged charging and turning the power switch off and on again the unit still won't show any lights, please contact your local distributor.

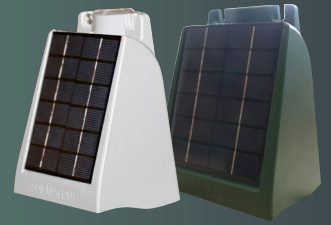
No diagnostics in the Monitoring Service

Receivers transmit diagnostic data once every 20 minutes except in Hibernation. If the unit is switched on and no diagnostics can be observed after an hour, switch the power off and on again, check the display for the cellular network status (Base only) and double check the correct Device ID number on the Hub Device settings. If the problem persists, contact your local distributor.



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10. Technical Specifications

Specifications subject to change without notice

For additional information, please contact the Soil Scout team at: info@soilscout.com

Pinout of the D9 connector

Pin	Base Station	Echo Repeater
1	reserved	reserved
2	Charge input (+12VDC)	NC
3	NC	NC
4	Rain Gauge Pulse Input	Rain Gauge Pulse Input
5	Ground	Ground
6	reserved	reserved
7	reserved	reserved
8	reserved	reserved
9	reserved	reserved

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Receiver RF sensitivity	-100 dBm, BNC connector
Frequency Variants	869.525 MHz (ITU-1) Europe and selected other markets 921.700 MHz (ITU-2) Americas, Australia, NZ and selected other markets 920-925 MHz (FHSS) Hong Kong, China Custom Information upon request
Operating Voltage	10-24 VDC, 500 mA In-built 2Wp solar panel and 20Wh Li-ion battery (3 days)
Power Supply	100-240 VAC with 5m (16'4") lead (included)
Dimensions (LxWxH)	175 x 140 x 100 mm (7.1" x 5.1" x 2.4") ¹⁾
Mounting	50 mm (2") pole mount / wall mount
Data interface	4G modem / Custom ²⁾
Wide selection of Omni-directional / Directional antennas are compatible	

1) Excluding interface ports

2) SIM-card is supplied for most regions

Echo Repeater 200

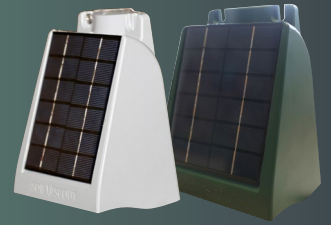
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Frequency Variants	869.525 MHz (ITU-1) Europe & selected other markets 921.700 MHz (ITU-2) Americas, Australia, NZ & selected other markets 920-925 MHz (FHSS) Hong Kong, China Custom Information upon request
Operating Voltage	10-24 VDC, 500 mA In-built 2Wp solar panel and 20Wh Li-ion battery (10 days)
Power Supply	Mains power supply available as accessory (same as used for Base Station)
Dimensions (LxWxH)	175 x 140 x 100 mm (6.9" x 5.5" x 3.9")
Mounting	50 mm (2") pole mount / wall mount
Radio transmit power	27 dBm (500 mW) ERP, Bandwidth <250 kHz, duty cycle <0.1%
Transmit Range	10km / 6-mile line-of-sight from Echo to Base Station / another Echo ³⁾

3) Any obstacles (vegetation, hills, buildings) between the radios will decrease range.
Base Stations & Repeaters dynamically daisy chain.



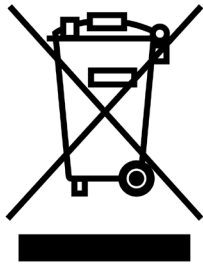
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11. Compliance statements

Soil Scout Ltd. / Soil Scout Oy hereby declares that Soil Scout Echo Repeater and the Soil Scout Base Station is in compliance with the following requirements:



- **RoHS Directive** (2011/65/EU)
- **WEEE Directive** (2012/19/EU)
- **Battery Directive** (2006/66/EC)
- **RED Directive** (2014/53/EU)
- **EMC Directive** (2014/30/EU)
- **Low Voltage Directive** (2014/35/EU)
- **ErP Directive** (2009/125/EC)



Please dispose this product by taking it to your local collection point or recycling center.

This will help to protect the environment in which we all live.

The relevant Declaration of Conformity is available online at <http://soilscout.com/legal>

FCC compliance: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Changes or modifications not expressly approved by Soil Scout Ltd. could void the user's authority to operate the equipment.

12. Disclaimer

Soil Scout Ltd. / Soil Scout Oy disclaims any and all liabilities related to or arising from third parties' products or services, which use the data generated by a Soil Scout product. Soil Scout Ltd. / Soil Scout Oy disclaims any and all liabilities related to or arising from the functioning / malfunctioning of third party product or service, its interoperability with a Soil Scout product, safety of a third party product or service as well as any other liabilities related to or arising from a third party product or service. Soil Scout Ltd. / Soil Scout Oy shall not be liable for any data transfer fees or any other fees which might be due to or related to the use of Soil Scout products.

These products are protected by patents.

SOIL SCOUT



How to find out more

For more information on the Soil Scout solution and to request all relevant pricing options please contact the Soil Scout sales team via email or your nearest reseller.

sales@soilscout.com

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