The **Soil Scout** story....

‘The first prototype is still buried and beeping 13 years later . . .’

In the year 2000, agrotechnology student and 19th generation farmer Johannes Tiusanen wrote an essay on future farming at the University of Helsinki, in which he stated that farmers in 2025 “will get online reports on underground soil conditions - just like a local weather report.”

He realised the sensors that captured this data would need to be permanently buried, but no one knew why mobile signals attenuated when underground. He answered this question while completing his doctorate, which led to the creation of a new kind of antenna.

With the help of his good friend, Jussi Sirkiä, who had an abundance of experience in power electronics, the pair were able to build a new product that could transmit enormous amounts of radio power while maintaining a lower power state the rest of the time and last for 20 years buried underground. The first prototype is still buried and beeping 13 years later.

Having initially built the product to solve his own problems, Johannes realised the potential of the technology as a commercial solution and founded Soil Scout in 2013. The team solved the final piece of the puzzle - they refined the solution to the point where a person can take their phone out of their pocket and understand what is happening underground in real-time.

Our mission is to give soil experts the insights and data they need to manage their lands in the most efficient and effective ways. Through data, we will safeguard our soils and make them flourish for future generations.

Johannes Tiusanen
Chief Science Officer, Soil Scout
#thesoilscoutstory

“We wanted to help farmers and growers get the insights they need from the soils they manage”

The **Soil Scout** timeline....

2000 — Johannes wrote an essay on future farming at University

2004 — Development of a unique underground antenna

2005 — Johannes and Jussi produced their first wireless soil sensor

2013 — Soil Scout is founded and welcomes first Angel investor

2015 — Release of the latest HYDRA100 sensor

2019 — Husqvarna becomes the latest to invest in Soil Scout

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Welcome to **Soil Scout**

Traditional farming has successfully treated each field differently according to experience and scientific advice, but the next leap demands something more. In the process of learning how to treat in-field zones individually, the constantly evolving Smart Farming requires real-time data and recorded feedback on every action. Soil Scout expands that revolution to the underground.

Soil Scout provides the only wireless sensors capable of transmitting moisture, temperature and salinity data in near real-time out-of-sight performance from up to two metres / six feet below the surface, for up to 20 years, maintenance free.

Understanding what’s happening below the soil surface is critical for many industries. Soil Scout takes monitoring to the next level by providing a detailed view into in-field variation, enabling our customers to expand the Precision Agriculture approach to all land use challenges, be that smart farming, irrigation control or turf quality optimization.

Previous solutions for measuring environmental conditions are based on wires and cables or a single observation pole, which are impractical, inefficient, labour-intensive or unable to assess spatial variability. Soil Scout provides critical insight into data from deep below the surface wirelessly, enabling 365x24 insight and profiling which allows our customers to perform better, understand their operations deeper and reduce water and energy use by up to 50%.

Read more

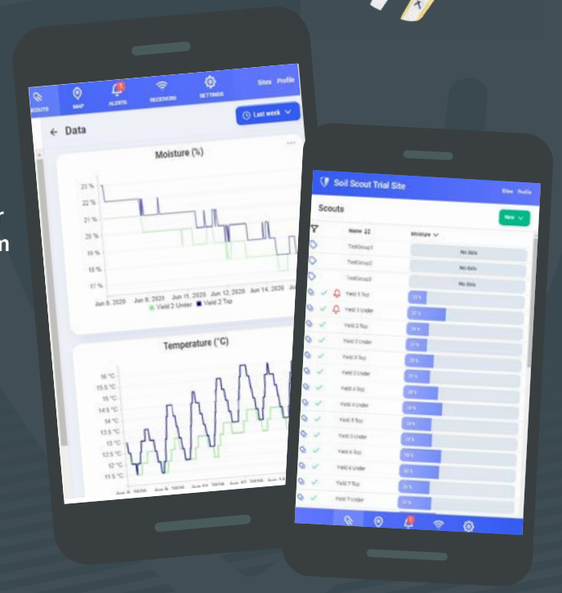
Why choose **Soil Scout?**

In the absence of accurate data the agriculture industry can be forgiven for being responsible for over irrigation. According to studies more than 25% of irrigated water is actually wasted by growers not having the correct information from their soil.

The effects of over watering lead on and create a devastating trail of after effects.

By using Soil Scouts wireless underground sensors, these issues won't be cured, but you can go a long way to putting it right and gaining significant savings, and dramatically increasing your efficiencies along the way.

Sustainability is the word on everyone's minds right now, and with the ever increasing costs of all inputs, all involved in decision making within this sector, need to use water (admittedly our most valuable resource) as efficiently as possible.



The **Soil Scout** story....

"You can see all the data from your phone instead of going to the field. A farmer or grower can stay at home and check the conditions from the Soil Scout app"

Tommi Tienhaara
Sales, Soil Scout
#thesoilscoutstory

@Soil_Scout @SoilScout

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Case Study

Yara **R&D**

Yara Kotkaniemi Research Farm

Yara Kotkaniemi Research Farm has been part of Yara's R&D organization since 2016, but its roots date back several decades and it still is an important trial site for testing modern farmer tools. After all, knowledge and innovation drives the yield, and yield drives sustainability and profitability.

In 2014 we were looking for a solution to dynamically monitor and record soil conditions in our famous and recognised long-term fertilizer and tillage management experiments, which have been running for many decades. The technology that Soil Scout was just bringing to the market was a perfect fit. Being a spin-off from the honourable Helsinki University helped the young start-up gain sufficient credibility.

During half a decade of collaboration with Soil Scout we have witnessed the many leaps in their product development. While the introduction of the very first solar powered Echo Repeaters in 2017 allowed us to expand the setup to distant fields, the Base Stations still are the very earliest versions and they keep running.

Long-term trials require long-term data and permanently buried sensors provide just that. Today, data is used, for example, in various modellings related to plant nutrition.

Accumulating records of the remarkable moisture and temperature differences which no-till, cultivation and ploughing plot profiles demonstrate, builds up an invaluable asset for us to recognize trends and pattern as the natural environment keeps becoming more and more challenging.

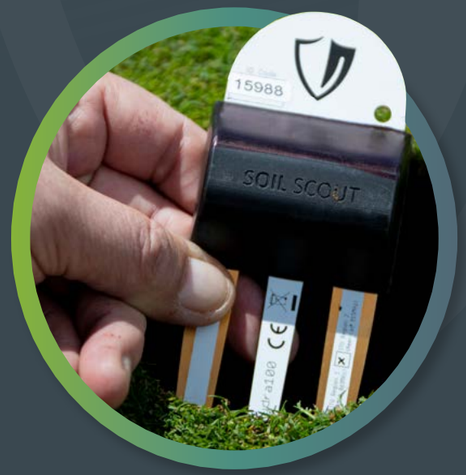
Our aim is to develop the range of fertilizers and fertilization methods to better meet current and future needs, and Soil Scout helps us in doing so.

Juha Liespuu
Yara
Head of Kotkaniemi Research Farm

"During half a decade of collaboration with Soil Scout we have witnessed the many leaps in their product development"

What does **Soil Scout** do?

Benefits from using wireless sensor technology in agriculture and horticulture



The soil moisture, temperature and salinity are three critical components to monitor, if you are looking to achieve optimum conditions for plant health, and ideal growth.

Historically farmers, growers and agronomists have known their own wants, when it has come to what's needed to achieve optimum growing conditions. But now, with our underground moisture, soil temperature and salinity sensor, we can make that job more efficient, and streamlined, from many levels. Increasing awareness of in-field variation, ecological sustainability, auditable actions and simpler, connected management practices.

After learning the interpretation of the data you receive, and how it benefits you and your farm personally, it is an added asset to the arsenal of tools at your disposal to influence many factors through your growing cycles.

"We constantly aim to push our industry forward, both in terms of the technology and processes it uses, but also in terms of the potential ways in which it can help the world"

The **Soil Scout** story....

"We helped them manage the entire system in a simple way, and they received real information on the value of their soil for the first time. We helped them leverage smart farming techniques"

Jalmari Talola
CEO, Soil Scout
#thesoilscoutstory

Key benefits

- **Soil Scout is the only soil sensor solution which you can freely distribute across a field - install and forget!**
- **Smart sensor placement provides real-time monitoring of areal differences and enables treating each area individually and optimally - Soil Scout staff will assist you in choosing the best locations.**
- **The sensors operate out of sight year-to-year providing you with a long-term view into soil behaviour, enabling accurate and informed soil management instead of traditions and guesswork, but also build up long-time records for your future needs.**
- **The accurate and consistent data enables you to observe patterns and seek for growth limiting factors efficiently - by eg., observing draught, wetness, poor drainage, inhibited infiltration, water availability, soil compaction and more.**
- **When irrigating, instant before / during / after data enables both quick reactions and long-term ability to maintain optimal soil moisture and save irrigation costs.**
- **With the underground weather map, apply just the right amount of inputs at the right places at the right time, and gradually improve the soil through even better farming practices.**
- **Sensors run up to 20 years below the ground without any maintenance – making it the most cost-efficient solution.**
- **The monitored soil area is easy to expand by simply adding more sensors to the system – no need for complicated pairing, new SIM cards, or data subscriptions.**
- **The dashboard visualizes soil moisture, salinity and temperature data in many intuitive ways - you can easily check current status, follow trends, recognise patterns and compare soil conditions in different areas, anytime and anywhere using any device with a browser.**

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Case Study

Soil Scout - the way to go in modern agriculture

The Soil Scout system that we are using is definitely the way to go in modern agriculture. The mere fact that you can login to real time data from anywhere in the world is already a huge benefit. Added to that is the ease of use if compared to our existing system where we use Tensio-meters that need constant priming and physical readings.

Once the data correlation and interpretation has been done the Soil Scout information will be of even more benefit as it will also give us an indication of the fertilization levels. The Soil Scout probes seem to be very robust and it will be interesting to see how they last over the long term.

Technical backup to the product has been good and the Soil Scout team was eager to help and support.

Felix Hacker
Du Roi Nursery
South Africa

#GAINADEEPERVIEW

@Soil_Scout @SoilScout

The **Soil Scout** story....

"We're giving farmers data for better problem assessment. We're replacing guesswork with actual real-time view of something that has been hidden - underground soil data. We help them turn this data into management practices - they get tangible, actionable information"

Johannes Tiusanen
Chief Science Officer, Soil Scout
#thesoilscoutstory

Farming Today

Farming is expected to feed the growing population and serve new consumer trends, which demand high-standard food supplies produced with sustainable methods and delivered through transparent supply chains. Despite the increasing demand, commodity prices remain low, and farmers need to control costs.

Water scarcity is critical. As agriculture consumes 69% of water globally, farmers need to find safe ways to reduce water consumption without jeopardizing crops. It's no longer possible to increase production by converting more land to farming due to irreversible ecological damages. Instead, the efficiency of existing farm fields must be improved sustainably and smartly.

The **Challenge**

How do you produce higher crops with better quality while reducing costs and using less water and more sustainable farming methods? How do you accomplish this profitably amid the ever-challenging and unpredictable weather and environmental conditions?

If traditional weather observations and appliances could provide the required accurate and timely information, the problem would have been all gone by now.

Our **Solution**

Smart **Farming**

Agriculture has gone through several revolutions – from the domestication of plants and animals to selective breeding, fertilization, and mechanization. The next agricultural revolution is Smart Farming enabled by measured observations, real-time data, and recorded feedback.

However, the missing link in Precision Agriculture has been the soil itself — how to bring underground phenomena up to speed with real-time telemetry, optical crop sensing, and variable rate applications. Disconnecting visible plant observations from what actually happens in the root zone leads to inadequate understanding and even incorrect conclusions.

At last, Soil Scout sensors expand the Smart Farming revolution to the underground.

The solution collects accurate root zone data from below ground where the growth really takes place; sends this data to the Monitoring Service, which turns it into meaningful information for farmers who can now tackle their most substantial challenges – and improve crop productivity and quality sustainably while reducing operational costs and water consumption.

Wireless underground **soil monitoring** sensor

Make informed decisions based on accurate and permanent measurements

Soil Scout

- Integrated Moisture, EC (Salinity) and Temperature sensors
- Transmits from up to two metres underground
- Broadcasts through soil, turf, sand, clay, biomass, snow and concrete
- Nothing on field to interfere with machinery, post-tillage practices or plant growth
- Create a multidimensional picture of subsoil environment

Features

- Broadcasts every 20 minutes for up to 20 years (other intervals available)
- Data transmitted to a gateway and onwards to the Monitoring Service
- Water and energy savings up to 50%
- Unaffected by weather, temperature extremes or seasons
- Enables detailed profile to be established continuously over time
- Ability to integrate with third party systems or machinery (irrigation, farm management software)

Patented Technology

Regular radio antennas do not work properly if buried in soil because the speed of radio waves varies depending on soil properties. This is why an antenna for a specific wave length would go out of tune when soil moisture changes.

Soil Scout has developed a patented underground antenna that interacts with the surrounding medium in a way that balances the antenna input to the prevailing soil conditions. As a result, the antenna is not very efficient in air, but gains an efficiency exceeding 95% when soil is introduced to the antenna near field.

US9673912B2

The **Soil Scout** story....

"Our data enables agronomists to base their recommendations on real life evidence instead of visual evidence from history. This means they can make real-time management decisions, helping them structure their business to be more proactive than reactive - and more sustainable through timely use of resources"

Adam Sedgwick
VP of International Sales, Soil Scout
#thesoilscoutstory

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Case Study

We would recommend Soil Scout to any other farmer or grower

I have used all types of soil moisture probes over the past 12 seasons growing in Substrate. However you never get exactly what you want with one product, as there is always something missing. There are five things that a good moisture probe should be and do: measure moisture consistently, capture soil/medium temperature, capture electric conductivity accurately, be user friendly and flexibility to adapt to each grower's needs.

Soil Scout does all of these things. It was originally developed as a soil moisture probe, not meant for substrate growing. But with the flexibility of the software they could adapt the readings so that we could also use it in our industry for monitoring and as a nutrient management tool.

We have used it for a full season and are delighted with the results. We recommend it to any other grower, whether it's in soil or substrate production. Also looking forward to added functions and improvements in the future.

Heino Malan
Irrigation Specialist
Haygrove Eden, South Africa

Huge potential to improve how we manage soils

The use of remote soil probes has huge potential to improve how we manage soils. With regulatory pressure increasing on many pesticide products, improved understanding of optimum timing is critical.

Recording soil temperatures and moisture levels on a regular basis has become standard practice for many growers and having the ability to automatically record those over a long period of time will help to give stronger indications of disease outbreaks, timings of insect flights and guide timings of many products.

This kind of technology will in time become a key factor to influence the timings of our management programmes.

Research manager - **from a world leading pesticides manufacturer**

The **Soil Scout** story....

"Our data enables agronomists to base their recommendations on real life evidence instead of visual evidence from history. This means they can make real-time management decisions, helping them structure their business to be more proactive than reactive - and more sustainable through timely use of resources"

Miiro Jääskeläinen
Underground Weatherman / Agronomist
#thesoilscoutstory

FAQ

Soil Scout answers your frequently asked questions...

How many sensors do we need?

To this question, there is no right or wrong answer. There are so many variables and reasons to measure but as a start off rule of thumb we recommend two depths at three well chosen locations in each field to be monitored. This allows you to monitor your in-field variation which gives you the ability to act on the extreme values or average your data across these reference points.

A common starting point for many of our agricultural customers is to begin their Soil Scout experience with a set of six to nine sensors for a ten hectare field.

Further sensors can be added at anytime.

Does Soil Scout provide installation services?

We can by all means, but generally the instructions are simple to follow, enabling the process, to be quick, simple, and comprehensive for a self install.

For major installs it is recommended to have one of the Soil Scout team on site with you for a smooth, simple installation.

How deep do I install the sensors?

The system is comprised of a multitude of independent sensors, which enables obtaining data from all locations and depths. Typically, two site and crop specific depths are chosen as top soil and root zone depths. Using these two fixed depths across all chosen locations generates data, which enables easy comparisons. Choosing at least two different depths enables observing vertical phenomena, such as water infiltration speeds and temperature gradients. Where primary focus is on vertical profiling, for example monitoring deep water percolation, the use of at least three depths is recommended.

In addition to rooting depth of your crop, tillage practice should be considered. Placing sensors just below your tillage depth will allow the sensors to remain permanently undisturbed. For example typical depths in no-till cereal fields may be 10 cm (4') and 30 cm (12'). Irrigation methods will influence choice of depth as well. Soil Scout specialists are happy to discuss your particular depth requests.

How accurate is the data?

The data is extremely consistent, due to the nature of our patented, permanently retuning, underground antenna, which allows the sensor to remain undisturbed for many years. The accuracy is all viewable on the tech info page, but briefly summarises as:

- EC (salinity) +/- 0.2dS/m
- Moisture +/- 1% dependant on correct installation and correct soil type entered
- Temperature +/- 0.1degree C

How often do the sensors need replacing?

One of our big selling points, is our very long battery life. The sensor is pretty much a bury and forget item, with battery lifespan of up to 20 years, dependant on the model and timed transmissions.

Range Estimation Table

Approximate maximum ranges (metres): for **Wet Soil**

	Soil texture	Depth of sensor	Receiving Antenna type and height: Omnidirectional Antenna 6m	9m	12m	15m	Directive Yagi Antenna 90 6m	8m	12m	15m
Bare Ground	Sand	10cm	410	490	550	610	590	720	820	910
		30cm	330	400	450	490	490	590	680	750
		60cm	250	290	320	350	360	440	500	560
		90cm	180	210	220	240	270	330	370	410
	Loam	10cm	340	400	450	500	490	590	680	760
		30cm	180	210	230	240	270	330	370	410
		60cm	60	40	40	50	110	130	150	160
		90cm	15	20	25	25	40	50	50	50
	Clay	10cm	320	380	430	470	470	570	650	720
		30cm	150	180	190	200	240	280	320	360
		60cm	25	30	40	40	80	100	110	110
		90cm	10	5	5	5	25	25	25	30
1m High Crop (Cereal)	Sand	10cm	250	300	350	380	360	450	530	590
		30cm	200	250	280	310	300	370	440	490
		60cm	150	180	200	210	230	280	330	360
		90cm	110	120	140	130	170	210	240	270
	Loam	10cm	210	260	290	320	310	390	460	510
		30cm	110	130	140	150	180	220	250	280
		60cm	25	30	40	50	70	90	100	110
		90cm	15	20	20	10	30	40	40	40
	Clay	10cm	200	240	270	300	300	370	430	480
		30cm	90	110	110	100	150	190	220	240
		60cm	20	25	30	40	60	70	80	80
		90cm	10	5	5	5	20	20	20	25
3m High Crop (Corn)	Sand	10cm	120	170	190	210	180	250	310	350
		30cm	100	130	150	170	150	210	250	290
		60cm	70	90	110	100	120	160	190	220
		90cm	50	60	50	60	90	120	140	160
	Loam	10cm	110	140	160	180	160	220	270	300
		30cm	60	70	60	60	90	120	150	170
		60cm	15	20	30	40	40	50	60	70
		90cm	10	15	10	10	15	20	25	30
	Clay	10cm	100	130	150	170	150	210	250	290
		30cm	50	50	50	50	80	110	130	140
		60cm	10	20	25	30	30	40	50	50
		90cm	5	5	5	5	10	15	15	20

***Sand:** Clay 10% / Silt 50% / Sand 40%*
***Loam:** Clay 20-30% / Silt 30-70% / Sand 10-40%*
***Clay:** Clay 40% / Silt 30-40% / Sand 30-40%*

Note:

- Estimates are presented for wet soil (50% volumetric moisture). Dry soils provide 30-40% better range
- Environmental conditions may reduce range temporarily (e.g. rainwater on crop, wet layer on dry soil...)
- Tree(s) and/or shrubs between Scout and Base may reduce the range by 50%
- In urban environments, background radio noise may hamper receiver sensitivity and decrease range by 10-20%
- Saline soils (4 dS/m and higher) or clay contents exceeding 60% will attenuate signals and lower achievable depth
- Lowering receiving antenna down to 3 m will cut the range approx. 40% compared to the 6 m height values

Disclaimer:
The information in this table is provided as an indicative planning guide, and is not a guarantee or warranty of performance under the stated conditions. Soil Scout Oy accepts no responsibility for errors or the inaccuracy of the information herein.

Range Estimation Table

Approximate maximum ranges (yards): for **Wet Soil**

	Soil texture	Depth of sensor	Receiving Antenna type and height: Omnidirectional Antenna 20ft	30ft	40ft	50ft	Directive Yagi Antenna 90 20ft	30ft	40ft	50ft
Bare Ground	Sand	4in	450	540	600	670	650	790	900	1000
		12in	360	440	490	540	540	650	740	820
		24in	270	320	350	380	390	480	550	610
		36in	200	230	240	260	300	360	400	450
	Loam	4in	370	440	490	550	540	650	740	830
		12in	200	230	250	260	300	360	400	450
		24in	70	40	40	50	120	140	160	170
		36in	20	20	30	30	40	50	50	50
	Clay	4in	350	420	470	510	510	620	710	790
		12in	160	200	210	220	260	310	350	390
		24in	30	30	40	40	90	110	120	120
		36in	10	10	10	10	30	30	30	30
3ft High Crop (Cereal)	Sand	4in	270	330	380	420	390	490	580	650
		12in	220	270	310	340	330	400	480	540
		24in	160	200	220	230	250	310	360	390
		36in	120	130	150	140	190	230	260	300
	Loam	4in	230	280	320	350	340	430	500	560
		12in	120	140	150	160	200	240	270	310
		24in	30	30	40	50	80	100	110	120
		36in	20	20	20	10	30	40	40	40
	Clay	4in	220	260	300	330	330	400	470	520
		12in	100	120	120	110	160	210	240	260
		24in	20	30	30	40	70	80	90	90
		36in	10	10	10	10	20	20	20	30
9.8ft High Crop (Corn)	Sand	4in	130	190	210	230	200	270	340	380
		12in	110	140	160	190	160	230	270	320
		24in	80	100	120	110	130	170	210	240
		36in	50	70	50	70	100	130	150	170
	Loam	4in	120	150	170	200	170	240	300	330
		12in	70	80	70	70	100	130	160	190
		24in	20	20	30	40	40	50	70	80
		36in	10	20	10	10	20	20	30	30
	Clay	4in	110	140	160	190	160	230	270	320
		12in	50	50	50	50	90	120	140	150
		24in	10	20	30	30	30	40	50	50
		36in	10	10	10	10	10	20	20	20

***Sand:** Clay 10% / Silt 50% / Sand 40%*
***Loam:** Clay 20-30% / Silt 30-70% / Sand 10-40%*
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Technical Specifications

HYDRA100 Scout	
Radio power	27.0 dBm (500 mW) Transmit only
Frequency Variants	869.5 MHz (ITU-1) Europe and selected other markets 921.7 MHz (ITU-2) Americas, Australia, New Zealand and selected other markets Custom Information upon request
Battery capacity	3000 mAh, encapsulated primary lithium
Life expectancy	Up to 20 years @ 1 cycle per 20 minutes
Encapsulation	Black polyurethane molding
Dimensions (L x W x H)	129 x 59 x 25mm (5.1" x 2.3" x 1.0")
Sensors	Temperature Three-prong integrated Capacitive (moisture content) and Resistive (EC / salinity)
Moisture Acuracy	± 2 % mean error (1% with correct soil type, 1% installation repeatability)
EC Accuracy	± 0.2 dS/m mean error, Typical resolution 0.1 dS/m, Range 0 to 20 dS/m
Dielectric Accuracy	± 2 % mean error, Resolution 0.5 to 1.5 ε, Range 1 to 135 ε ε
Temperature Accuracy Resolution	Range -40 to +80 °C / -40 to 176 °F Accuracy: +/- 0.1 °C / 0.18 °F -40 to -11 °C 1.00 °C -40 to 12 °F 1.80 °F -10 to +10 °C 0.25 °C -12 to +50 °F 0.45 °F +10.5 to +80 °C 0.50 °C +50 to +176 °F 0.90 °F

Base Station	
Receiver RF sensitivity	-100 dBm, BNC connector
Frequency Variants	Same as HYDRA100 Scout
Operating Voltage	8-14 VDC, 300 mA
Dimensions (L x W x H)	180 x 130 x 100 mm (7.1" x 5.1" x 3.9") [2]
Data interface	2G/3G cellular modem [1]
Power Supply	100-240VAC with 5m (16'4") lead (included)
Receiving Antenna (External)	Circular of 90° sector pattern

ECHO Repeater	
Receiver RF sensitivity	-100 dBm, BNC connector
Frequency Variants	Same as HYDRA100 Scout
Radio transmit power	27 dBm (500 mW)
Power Supply	Solar panel charging a 2400 mAh 3,7V Li-ion battery. Mains power supply available as accessory (same as used for Base Station) Optional Repeater variant to enable connection to heavy battery
Range	10km / 6-mile line-of-sight from ECHO to Base Station / another ECHO [3]
Dimensions (W × H × D)	190 × 135 × 95 mm (7.5" × 5.3" × 3.7")
Mounting	50 mm (2") pole mount / wall mount

1) SIM card is upplied for most regions.
2) Excluding interface ports
3) Any obstacles (vegetation, hills, buildings) between the radios will decrease range. Repeaters daisy chain automatically.

Specifications subject to change without notice