



Soil Scout Range Guide

Soil Scout Hydra100 with Base 200 or Echo 200 | 12 Jan 2022

1. Introduction

Soil Scout Hydra100 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 200 and the green Echo 200 - are intended for installation on a mast, pole or on a wall. 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.

The expected maximum range from Scout to Receiver is a complex equation, but can be estimated based on a few most important criteria: receiving antenna type and elevation, sensor burial depth and soil type. In agriculture, also the height of the crop plays a role in late season, while attenuation from sports turf grass can be omitted. The factors influencing range are explained in more detail in Appendix 1.

2. Details

Estimates are presented for wet soil (50% volumetric moisture). Drier soils provide 20-30% better range. Environmental conditions may reduce range temporarily (e.g. rainwater on crop, wet layer on dry soil, etc). Tree(s) and/or shrubs between Scout and Base may reduce the range by 50-100%.

In urban environments, background radio noise may hamper receiver sensitivity and decrease range by 10-20%. Highly saline soils (4 dS/m and higher) or clay contents exceeding 60% will attenuate signals and lower achievable depth.

Soil textures used for these range tables are:

- 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%
- Sports Turf: USGA Sand

3. Antennas

An **Omnidirectional** antenna has the shape of a stick and is designed to receive signals from all horizontal directions, but not directly from up or down. This causes a blind range close to an elevated Omni antenna (range of about twice the antenna height). The Omni allows for 360 degree horizontal reception, but the maximum receiving distance is less than with a Yagi. An Omni antenna is used, when sensors are installed around the receiver, i.e. the receiver stands in the middle of the site.

A **Directive Yagi** antenna picks up radio signals with a good gain (long range), but only in a narrow sector (90 degrees). It's good for receiving signals coming from the direction it is pointed, but will not receive from other directions. It is used when the Receiver stands to the side of the sensors.

Disclaimer:

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



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Agricultural Range Estimation Table (metric)

Base Station Antenna type and height

Soil texture	Depth	Base Station Antenna type and height								
		Omnidirectional Antenna				Directive Yagi Antenna				
		6 m	9 m	12 m	15 m	6 m	9 m	12 m	15 m	
Bare Ground	Sand	10 cm	410	490	550	610	590	720	820	1000
		30 cm	330	400	450	490	490	590	680	750
		60 cm	250	290	320	350	360	440	500	560
		90 cm	180	210	220	240	270	330	370	410
	Loam	10 cm	340	400	450	500	490	590	680	760
		30 cm	180	210	230	240	270	330	370	410
		60 cm	60	40	40	50	110	130	150	160
		90 cm	15	20	25	25	40	50	50	50
	Clay	10 cm	320	380	430	470	470	570	650	720
		30 cm	150	180	190	200	240	280	320	360
		60 cm	25	30	40	40	80	100	110	110
		90 cm	10	5	5	5	25	25	25	30
1 m High Crop (Cereal)	Sand	10 cm	250	300	350	380	360	450	530	590
		30 cm	200	250	280	310	300	370	440	490
		60 cm	150	180	200	210	230	280	330	360
		90 cm	110	120	140	130	170	210	240	270
	Loam	10 cm	210	260	290	320	310	390	460	510
		30 cm	110	130	140	150	180	220	250	280
		60 cm	25	30	40	50	70	90	100	110
		90 cm	15	20	20	10	30	40	40	40
	Clay	10 cm	200	240	270	300	300	370	430	480
		30 cm	90	110	110	100	150	190	220	240
		60 cm	20	25	30	40	60	70	80	80
		90 cm	10	5	5	5	20	20	20	25
3 m High Crop (Corn)	Sand	10 cm	120	170	190	210	180	250	310	350
		30 cm	100	130	150	170	150	210	250	290
		60 cm	70	90	110	100	120	160	190	220
		90 cm	50	60	50	60	90	120	140	160
	Loam	10 cm	110	140	160	180	160	220	270	300
		30 cm	60	70	60	60	90	120	150	170
		60 cm	15	20	30	40	40	50	60	70
		90 cm	10	15	10	10	15	20	25	30
	Clay	10 cm	100	130	150	170	150	210	250	290
		30 cm	50	50	50	50	80	110	130	140
		60 cm	10	20	25	30	30	40	50	50
		90 cm	5	5	5	5	10	15	15	20





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Agricultural Range Estimation Table (imperial)

Base Station Antenna type and height

Soil texture	Depth	Base Station Antenna type and height								
		 Omnidirectional Antenna				 Directive Yagi Antenna				
		20 ft	30 ft	40 ft	50 ft	20 ft	30 ft	40 ft	50 ft	
Bare Ground	Sand	4 "	450	540	600	670	650	790	900	1090
		12 "	360	440	490	540	540	650	740	820
		24 "	270	320	350	380	390	480	550	610
		36 "	200	230	240	260	300	360	400	450
	Loam	4 "	370	440	490	550	540	650	740	830
		12 "	200	230	250	260	300	360	400	450
		24 "	70	40	40	50	120	140	160	170
		36 "	20	20	30	30	40	50	50	50
	Clay	4 "	350	420	470	510	510	620	710	790
		12 "	160	200	210	220	260	310	350	390
		24 "	30	30	40	40	90	110	120	120
		36 "	10	10	10	10	30	30	30	30
1 m High Crop (Cereal)	Sand	4 "	270	330	380	420	390	490	580	650
		12 "	220	270	310	340	330	400	480	540
		24 "	160	200	220	230	250	310	360	390
		36 "	120	130	150	140	190	230	260	300
	Loam	4 "	230	280	320	350	340	430	500	560
		12 "	120	140	150	160	200	240	270	310
		24 "	30	30	40	50	80	100	110	120
		36 "	20	20	20	10	30	40	40	40
	Clay	4 "	220	260	300	330	330	400	470	520
		12 "	100	120	120	110	160	210	240	260
		24 "	20	30	30	40	70	80	90	90
		36 "	10	10	10	10	20	20	20	30
3 m High Crop (Corn)	Sand	4 "	130	190	210	230	200	270	340	380
		12 "	110	140	160	190	160	230	270	320
		24 "	80	100	120	110	130	170	210	240
		36 "	50	70	50	70	100	130	150	170
	Loam	4 "	120	150	170	200	170	240	300	330
		12 "	70	80	70	70	100	130	160	190
		24 "	20	20	30	40	40	50	70	80
		36 "	10	20	10	10	20	20	30	30
	Clay	4 "	110	140	160	190	160	230	270	320
		12 "	50	50	50	50	90	120	140	150
		24 "	10	20	30	30	30	40	50	50
		36 "	10	10	10	10	10	20	20	20





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Sports Turf Range Estimation Table (metric)

Receiving Antenna type and height

Soil moisture	Depth	Receiving Antenna type and height							
		 Omnidirectional Antenna				 Directive Yagi Antenna 90°			
		1 m	2 m	3 m	5 m	1 m	2 m	3 m	5 m
Dry	10 cm	140	270	320	410	140	370	450	570
	30 cm	130	250	300	380	130	340	420	530
	60 cm	120	220	270	340	120	310	380	480
Wet	10 cm	130	250	300	380	130	340	420	530
	30 cm	110	210	250	310	110	280	340	440
	60 cm	80	150	180	230	80	210	260	330

Sports Turf Range Estimation Table (imperial)

Receiving Antenna type and height

Soil moisture	Depth	Receiving Antenna type and height							
		 Omnidirectional Antenna				 Directive Yagi Antenna 90°			
		3 ft	7 ft	10 ft	17 ft	3 ft	7 ft	10 ft	17 ft
Dry	4 "	150	290	340	440	150	400	490	620
	12 "	140	270	320	410	140	370	450	570
	24 "	130	240	290	370	130	330	410	520
Wet	4 "	140	270	320	410	140	370	450	570
	12 "	120	220	270	330	120	300	370	480
	24 "	80	160	190	250	80	220	280	360



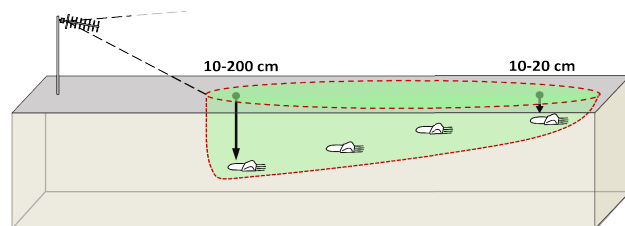
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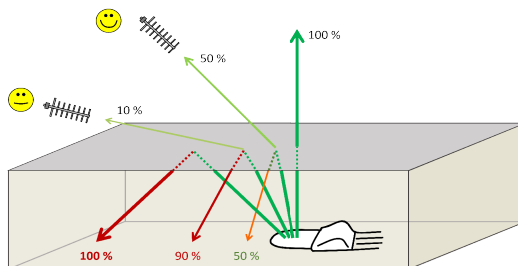
Appendix 1: Factors influencing Range

The range distance tables in this document will specify the maximum ranges that you can expect to reach with certain setups. Understanding the underlying attenuation phenomena will help you in making use of the tables.

Depth	The thicker the soil layer between the Scout and open air is, the larger is the attenuation (loss) caused by the soil layer absorbing radio signal power. Place the receiver close to the deepest Scouts to compensate for higher attenuation.
Soil Type	Coarse (sandy) soils textures attenuate signals less than finer (clayey) soils. Clay content is the key property defining the soil's attenuation factor. Clay contents of less than <10 % are low, while contents exceeding >40 % are high. Exceptionally high clay contents exceeding >70 % will cause severe attenuation when the soil is wet, and the range and/or depth expectations must be cut back. Note that in certain cases, an ECHO repeater will assist in extending reception range.
Soil Moisture	Water in the soil pores is the most important factor causing attenuation inside the soil layer. Dry soil absorbs less radio signal power than moist or wet soils. As wet soil conditions reduce transmission distances, it is chosen as the basis for these tables.
Antenna Height	Install the Base Station receiving antenna as high as possible, taking into account that the higher the antenna, the greater the minimum distance is between the antenna and the nearest Scout (blind range). The minimum recommended antenna height at its base is 6 metres, with a preference for >12 metres, depending on the need for extended reception distances. Elevating the antenna enhances range because it allows the underground signal to penetrate the soil surface at a higher outcoming angle, which reduces reflection back underground (depicted below).
Crop Type	Thick vegetation will absorb signal power. Different crops impact reception to varying degrees, largely based on their water content and density. Rain-soaked crops will temporarily decrease reception ranges more than normally. Place Scouts at varying distances from your receiver to allow for situations where thick vegetation will start cancelling connectivity to the most distant Scouts.



Place the receiver close to the deepest Scouts in order to balance between depth and distance.



If the receiving antenna stands low, the Scout signal is mostly reflected back underground. An elevated antenna allows the signal to penetrate the soil surface at a higher outcoming angle, which gives a stronger signal, since reflection becomes less dominant.