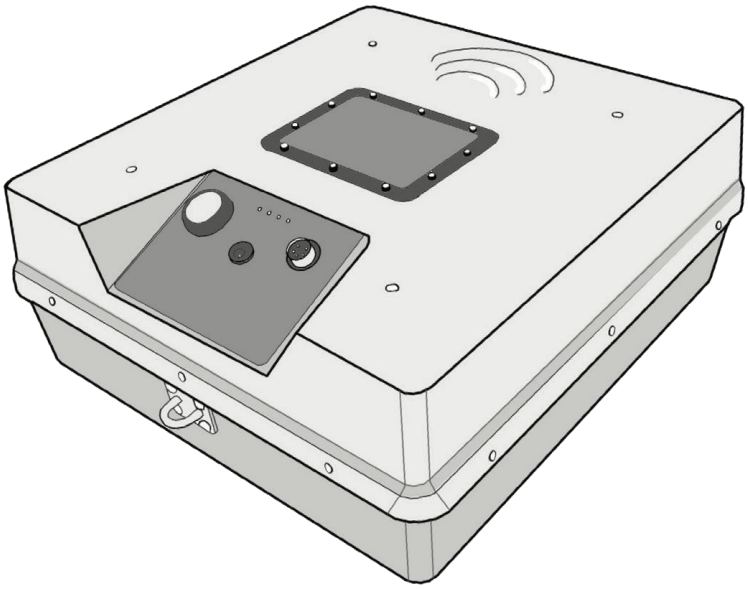
EZ Rad Pro Scudo

Powered by Oerad



USER MANUAL

Before you start

SAFETY INFORMATION: Thank you for purchasing the EZ Rad Pro Powered by Oerad. Please read this User Manual carefully before connecting and operating the unit. Electromagnetic radiation from EZ Rad Pro GPR systems powered by Oerad do not constitute a safety or health hazard under normal operating conditions.

WARNING: To reduce the risk of fire or annoying interference use only the recommended accessories and do not disassemble this product's modules. There are no user serviceable parts inside.

CAUTION: There is a fire danger if battery is incorrectly replaced. Replace only with the same or equivalent type recommended by the manufacturer. Dispose of batteries according to the manufacturer's instructions.

SCUDO EXPLANATION: The Ez Rad Pro Scudo is an Ultra-Wideband (UWB) shielded pulsed Ground Probing Radar (GPR) for non-destructive imaging of subsurface structures. It consists of transmitter and

receiver boards and antennae, a controller board and an optional distance measurement wheel. The EZ Rad Pro Scudo System is designed and manufactured by Oerad Ltd for Terra Exploration Group for exclusive distribution and sales in selected markets worldwide.

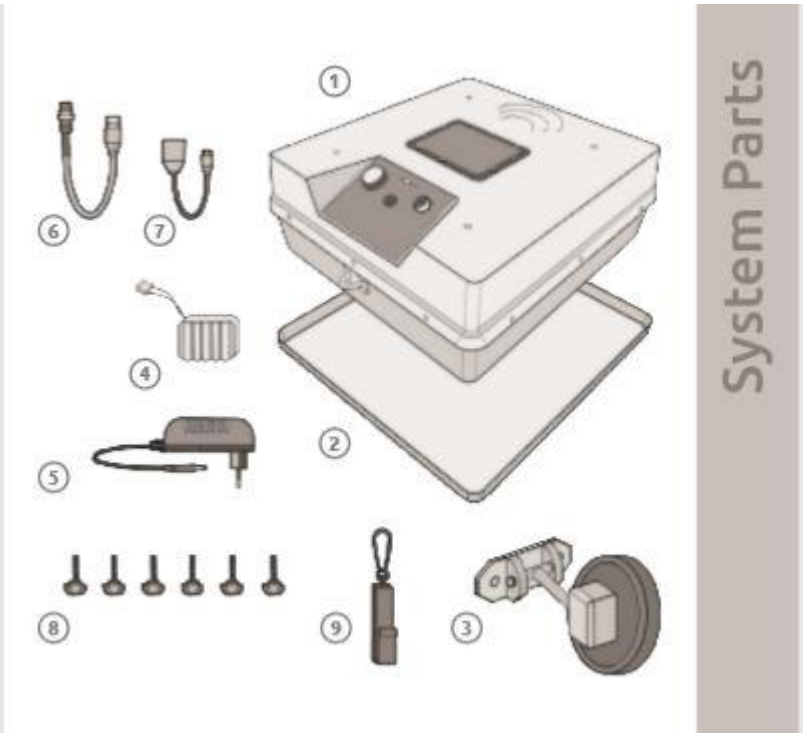
SCUDO USES: The Scudo has a wide variety of usages including but not limited to underground utility detection, non-destructive archaelogical surveys, underground water detection, road inspection, rock composition determination, cavities localization, ice thickness determination, geophysical research of underground layers, etc. It is designed to withstand the harsh conditions of outdoor surveys and construction sites.

This user manual contains the following sections:

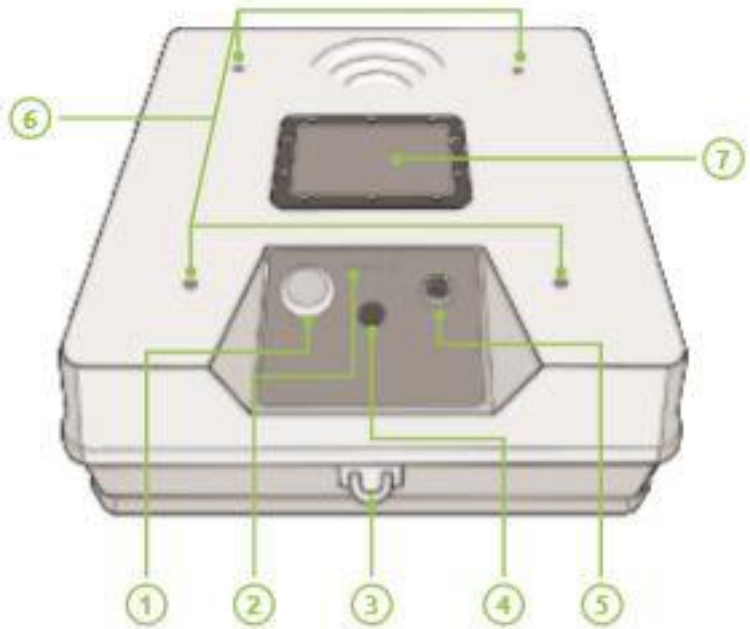
Technical Specifications:

Frequency Bandwidth - 30 MHz - 900 MHz
Central Frequency - 500 MHz
Operating Time Windows - 50 ns / 100 ns
Dynamic Range - 120 dB min
Horizontal Resolution - 0.1 m
Vertical Resolution - 0.05 m
Pulse Repetition Frequency - 75 kHz
Pulse Length - 3 ns
Pulse Energy - 600 V
Pulse Rise Time - 1 ns
Peak Tx Power @ antenna - 800W
Power Consumption - 270 mAh
Batteries - 10/20 x 2.4 Ah NiMH 1.2 V
Autonomy with One Charge - 7h / 14h
Charge Time - 5 h / 10h
ADC Range - 8 bits
Data Acquisition Rate - 18.2 traces/second
Samples Per Trace - 585
GPR Interface - UART over USB
Operating Temperature Range - - 5o C to 40o C
Water Resistance - IP 52
Size - 38x35x15 cm
Weight - 3 kg

System Parts



1. EZ Rad Pro Scudo GPR Main Module
2. Sacrificial Rough Terrain Protector
3. Optional Distance Measuring Wheel
4. Battery Pack 10x 3A Ni-MH
5. Battery Charger
6. USB Data Cable
7. USB OTG
8. Bolt M5 x 6 for Optional Distance Measuring Wheel
9. Optional Handle Clip



1. Power switch

2. Battery charge level indicator

3. T-Rods, handles or other forms of pulling devices can be attached here.

4. Battery Charger Socket

5. USB Data Cable Socket

6. Sockets for attachment to a cart, trolley or another transporting mechanism.

7. Sealed battery compartment. If you need to change your batteries with another pack, unscrew the bolts, gently remove the cover and the battery inside, and reassemble as shown in the Assembly section of this user manual.

Software Information

General Information

1. Make sure all cables are securely connecting the GPR and the tablet. Grant all permissions to Oerad App via your Android's 'Settings >
2. Applications > Oerad > Permissions' menu. In order to avoid battery drainage and unnecessary signal transmission, turn off your GPR and disconnect it from your tablet when finished surveying. For further details on technical specification requirements, how to download, install and configure the Oerad App, please refer to the app's user manual available at https://oerad.eu/software .
3. Operating Modes Survey. Real time data visualization and recording. Live filter application.
4. Viewing recorded files and filter apply data filters to files: Settings; Recording options. Set radar as Scudo and choose your preferred distance measurement units. Manage dielectric constants.

Operating Modes Survey

Real time data visualization and recording. Live filter application.

Open File

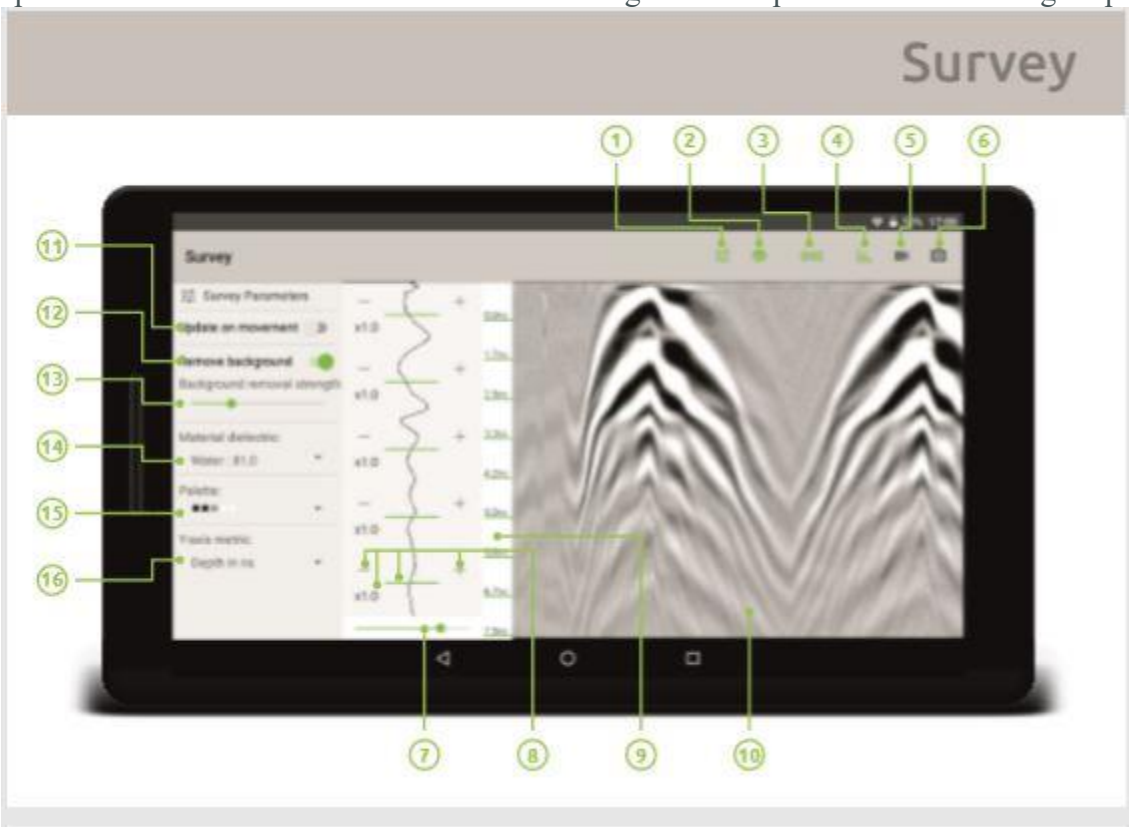
Viewing recorded files and filters; apply data filters to files.

Settings

Recording options. Set radar as Scudo. Manage dielectric constants.

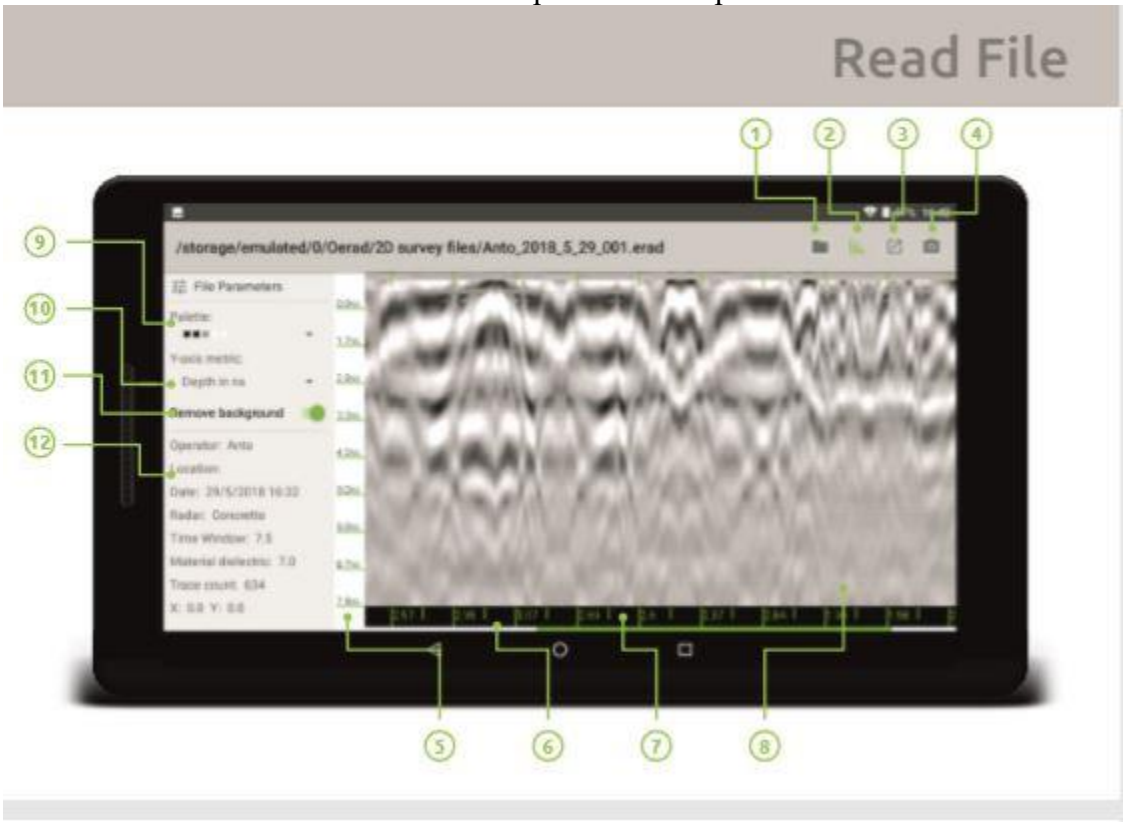
Startup

- Assemble your system as shown in the Assembly section of this user manual.
- Attach all cables to GPR and tablet.
- Start up the Oerad app.
- Press the power switch on the GPR. Your GPR is running when the power level diodes light up.



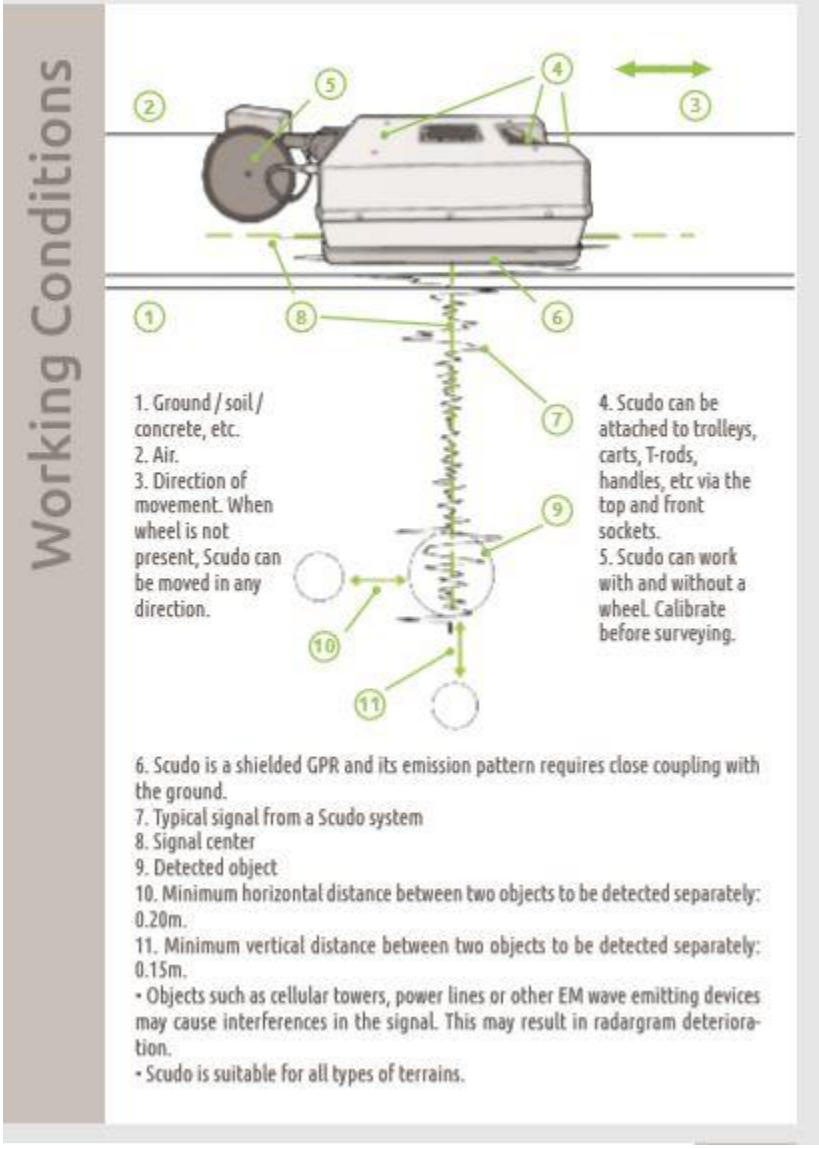
1. Survey parameters toggle - open / close the parameters menu on the left.
2. Pause / Resume survey.
3. Time window toggle - toggles between the GPR short and long operational time windows.

4. Apply background removal filter. It is recommended to have this filter on.
5. Record a SEG-Y or ERAD file for later viewing.
6. Take a screenshot of the current scene, saved as JPEG.
7. Hardware gain controller at five levels. Used to amplify the signal when the material does not allow good signal penetration.
8. Software gain control at five zones of the wave. Allows amplifying the signal locally at points of interest and reducing the signal strength elsewhere to reduce noise. **-**: reduce amplitude; +: amplify signal; **x1.0**: amplification factor; **green bar**: amplification factor.
9. Y-Axis showing penetration depth expressed in nanoseconds or meters/feet.
10. Radargram streaming live data from the GPR. Double tap anywhere on it to pause/resume surveying.
11. Update radargram on movement is only applicable to devices supporting a distance measuring wheel.
12. Apply Background removal filter. It is recommended to have this filter on.
13. Background removal strength toggle. It is recommended to have it set higher when moving slower or over greater distances.
14. Material dielectric helps calculate the penetration depth based on the surveyed material.
15. Change palettes to optimize anomaly detection.
16. Switch between nanoseconds or meters/feet as penetration depth measurement units.



1. Open new file. Files generated by EZ Rad Pro Powered by Oerad are located in the main storage folder under Oerad.
2. Apply background removal filter. It is recommended to view files with this feature turned on.
3. Export file to SEG-Y file format.
4. Take a screenshot of the current scene, saved as JPEG.
5. Y-Axis showing penetration depth of the recorded file in ns or in meters/feet.
6. Progress bar showing your current position within the file.
7. X-axis showing distance data when files are recorded with an optional distance measuring wheel.

8. Radargram of the recorded sounding data. Tap and swipe right to navigate to the end of the file. Tap and swipe left to navigate to the beginning of the file.
9. Change palette of displayed file.
10. Change the penetration depth measurement
unit displayed in the Y-axis.
11. Apply Background removal filter. It is recommended to view files with this feature turned on.
12. General information about recorded file. Includes: Operator, Location, Date of record; Dielectric constant of surveyed material; Device used for surveying; Time window at time of survey; Trace count in file; X & Y for files recorded with a distance measuring device.



EXPLANATION OF TERMS:

Hz - Hertz, measurement unit for frequency.

Radio Wave - Electromagnetic wave with frequency ranging from 30Hz to 300GHz. For GPR from 10MHz up to 3GHz.

Radar - A system that uses radio waves to detect objects. Main components & signal flow: Transmitter - >Transmission ante- nna -> Receiver Antenna -> Recei- ver data processor.

Frequency Bandwidth - The spectrum of the radar's transmit- ted radio waves' frequencies.

Central Frequency - Trasmitted waves at peak power (usually the centre of the frequency spectrum).

UWB - Ultra Wide Band radar that transmits over a frequency bandwidth > 500MHz.
GPR & Time-domain GPR - State- of-the-art high resolution radar with low power consumption. Survey Sounding - The act of using GPR technology for object detection/determination.

Radargram - Image produced by a radar.

SEG-Y - General purpose file format for recording geophysical data from 1973.
ERAD - Oerad's open radar format optimized for small data storage.

Time Window - Operational window of the receiver antenna.

Penetration Depth - Theoretical maximum depth achieved during a given time window and a material's dielectric constant.

Dielectric Constant - Measure of a material's ability to store elec- trical energy in an electric field.

Attenuation - Reduction in GPR signal amplitude caused by energy dissipation in a material.

Dynamic Range - Ratio b/n the max amplitude signal recordable by GPR and its noise floor.

GPR Trace - Sequence of sample points collected by the receiver that indicate time variation of the amplitude of the recorded signal (in a given time window).

Resolution - Smallest detectable difference/object in a surveyed material/soil/wall.

Gain - Signal amplification.

Background Removal - Adaptive cancellation of the effects of a surveyed material.

DC Drift - Low frequency noise causing the signal to drift from the centre line.

Pulse - Energy packet emitted from the transmitter antenna. Its' properties are length, power and rise time - a measurement of how fast a pulse achieves peak power.

Dielectrics Cheat Sheet

Material	Dielectric Constant	Max Depth at 50ns in meters	Max Depth at 100ns in meters
"Average soil"	16	1.88	3.75
Agricultural Land	15	1.94	3.87
Air	1	7.50	15.00
Asphalt	3 - 5	4.33 - 3.35	8.66 - 6.71
Basalt (wet)	8	2.65	5.30
Clay (dry)	3	4.33	8.66
Clay (wet)	8 - 15	2.65 - 1.94	5.30 - 3.87
Coal	4 - 5	3.75 - 3.35	7.50 - 6.71
Coastal sand (dry)	10	2.37	4.74
Concrete	6 - 8	3.06 - 2.65	6.12 - 5.30
Dolomite	6.8 - 8	2.88 - 2.65	5.75 - 5.30
Glass	5 - 10	3.35 - 2.37	6.71 - 4.74
Granite	5 - 8	3.35 - 2.65	6.71 - 5.30
Limestone	7 - 9	2.83 - 2.50	5.67 - 5.00
Marsh	12	2.17	4.33
Pastoral Land	13	2.08	4.16
Plexiglass	3.4	4.07	8.13
Polar Snow	1.4 - 3	6.34 - 4.33	12.68 - 8.66
Polyethylene	2.25	5.00	10.00
Pure Ice	3.2	4.19	8.39
PVC	3	4.33	8.66
Quartz	4.3	3.62	7.23
Sand (dry)	3 - 6	4.33 - 3.06	8.66 - 6.12
Sand (wet)	25 - 30	1.50 - 1.37	3.00 - 2.74
Sandstone (wet)	6	3.06	6.12
Shale (wet)	7	2.83	5.67
Silt (wet)	10	2.37	4.74
Water	81	0.83	1.67

The max depth of EM waves in the frequency range 10MHz - 1GHz:

$$D = \frac{\frac{c}{\sqrt{\varepsilon}} \cdot t}{2}$$

where D - max depth; t - time window; ε - dielectric constant.