



Zond Aero 500 NG Ground Penetrating Radar (GPR)

USER'S MANUAL

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1. General description

The *Zond Aero 500 Ground Penetrating Radar* (GPR or georadar) is geophysical equipment that uses radar pulses to image the subsurface. It is a non-intrusive method of surveying the subsurface to investigate underground utilities such as concrete, asphalt, metals, pipes, cables or masonry. This nondestructive method uses electromagnetic radiation in the microwave band (UHF/VHF frequencies) of the radio spectrum, and detects the reflected signals from subsurface structures. GPR have applications in a variety of media, including rock, soil, ice, fresh water, pavements and structures. In the right conditions, users can use GPR to detect changes in material properties, voids, cracks and other subsurface objects.

The GPR transmitting antenna emits electromagnetic wave into the ground. When the wave encounters a buried object or a boundary between materials which have different permittivities, it reflects, refracts or scatters. A receiving antenna registers the variations in the received signal. The principals involved are similar to seismology, except GPR methods implement electromagnetic energy rather than acoustic energy, and energy may be reflected at boundaries where subsurface electrical properties change rather than subsurface mechanical properties as is the case with seismic energy.

The electrical conductivity of the ground, the transmitted center frequency, and the radiated power all may limit the effective depth range of GPR investigation. Increases in electrical conductivity attenuate the introduced electromagnetic wave, and thus the penetration depth decreases. Because of frequency-dependent attenuation mechanisms, higher frequencies do not penetrate as far as lower frequencies. However, higher frequencies may provide improved resolution. Thus operating frequency is always a trade-off between resolution and penetration. Optimal depth of subsurface penetration is achieved in ice. Dry sandy soils or massive dry materials such as granite, limestone, and concrete tend to be resistive rather than conductive. However, in moist or clay-laden soils and materials with high electrical conductivity, penetration may be as little as a few cm or even zero.

The *Zond Aero 500 NG GPR* is a member of the new generation family of georadars (so called xGPR) manufactured by Radar Systems, Inc. The members of xGPR family are based on the Real Time Sampling (RTS) technique. The RTS helps to digitize analog signal right on the antenna side, without need to use any other receiving electronics, while analog to digital converter (ADC) with very high clocking speed (200 MHz) is connected to the receiving antenna directly. It gives a lot of opportunities to expand dynamic range and speed up the GPR movement speed. The high digital data traffic converts to the high stacking (up to the hundreds and thousands times), that increases a signal to noise ratio.

The *Zond Aero 500 NG GPR* consists of two integrated parts: Control Unit and air-launched antenna 500A. Control Unit transmits the acquired GPR data and operates by PC compatible computer under Windows 8/10/11 and **Prism2** software or any other standalone TCI/IP logger with corresponding software like UgCS SkyHub (hereinafter logger). The logger is connected to the Control Unit via Wi-Fi or Ethernet cross cable. The antenna and the Control Unit are fit into plastic shockproof case with built-in battery 11.1 V 9.0 A*h, Wi-Fi router and two runners as shown on Fig. 2. and Fig. 3. The brief description of parts of the *Zond Aero 500 NG GPR* is given below.

Logger. Any computing device with the Ethernet LAN card 10/100BaseT is suitable for the *Zond Aero 500 NG GPR* operation. The **TCP/IPv4** protocol is used for the data exchange between the logger and the Control Unit. Therefore, prior to connection of the logger to the

Control Unit, you have to set **IP address of logger** as **192.168.0.2** (if this address is occupied or is not accessible, you could use any address from 192.168.0.2 to 192.168.0.254, except 192.168.0.10 and 192.168.0.100. **Please, consult with your network administrator before changing IP addresses**). Set **Subnet mask** as **255.255.255.0**. The logger performs the following functions: it controls operation modes of the GPR, and receives, stores, processes and displays the data.

Note: Please take a look on the step-by-step configuration instructions in the Prism2 User's Manual for the details of the connection settings

Main unit. The *Zond Aero 500 NG GPR* is a bistatic Ground Penetrating Radar (Fig. 1). The main GPR unit contains control electronics, GPR antenna, built-in Lithium-Ion battery and Wi-Fi router which are mounted inside of a plastic waterproof case on the sledge runners. The main unit is equipped by carrying handles on its both sides. The sledge runners have smaller sliding area that helps to pull *Zond Aero 500 NG GPR* along the ground surface manually with a tow-handle help clipped to a tow hook or by any transport with speed up to 20 kmh. The sledge runners additionally help to fixate *Zond Aero 500 NG GPR* in its optional shockproof cart for the data acquisitions on the flat surfaces without high vegetation. The optional Survey Wheel mounts on a dovetail bracket and connects to the corresponding connector on the control panel.

Antenna. The *Zond Aero 500 NG GPR* contains the shielded air-launched high-frequency antenna system with central frequency 500 MHz, which can be used on the ground surface or in the lifted position (not higher than 1 m above the ground surface).

Battery. The *Zond Aero 500 NG GPR* is equipped by the Li-Ion battery 3S3P18650 11.1 V 9.0 A*h, which is built-in to the main unit. The status of the battery (voltage and percentage of the battery level) is transmitted via TCP/IP protocol during data acquisition and is displaying by the logger software in a data acquisition mode.

The 3S3P18650, as a part of the *Zond Aero 500 NG GPR*, is fully compatible for shipping by air in accordance with International Civil Aviation Organization (ICAO) Technical Instructions, International Air Transport Association (IATA) DGR packing instructions PI965 Section IB, PI966 Section II and PI 967 Section II appropriate of IATA DGR 63rd (2022 Edition) for transportation.

A brief Material Safety Data Sheet of the battery is available bellow (Appendix A. Battery Material Safety Data Sheet (MSDS)). The full battery MSDS is available here: https://www.radsys.lv/downloads/msds_3s3p18650.pdf

Charger. The MASCOT 2541 charger is used for the built-in battery charging and it is supplied as part of the *Zond Aero 500 NG GPR* set. User has to connect charger to the charging connector on the control panel, plug in the socket cable to the charger and plug it to the socket (100-250 V ac 50-60 Hz). Please follow the charger LED. Charger changes its color from red to green during the charging process, where red means discharged and green – charged. You will find the full MASCOT 2541 charger user's manual inside of its package, please follow it for the details.

Control panel. The control panel of the *Zond Aero 500 NG GPR* shockproof case is shown on the Fig. 3. It contains:

- 7-pin charger connector for the built-in battery charging by the Mascot 2541 charger;
- Power switch button;
- Power led, that indicates the device powering;
- Fuse

- Power cable;
- Survey wheel cable.

Survey wheel (optional). The *Zond Aero 500 NG GPR* is capable to support positioning by the external survey wheel with the **Prism2** software help. The rotary encoder AB interface is used for the distance and direction measurements. There is a 4-pin survey wheel connector on the control unit (Fig. 1.) that could be connected to the control panel survey wheel cable (Fig. 3). The survey wheel mounts on dovetail bracket (Fig. 4) and connects to the corresponding waterproof connector.

GPS/GNSS (optional). The *Zond Aero 500 NG GPR* is capable to support positioning by the GPS/GNSS receiver with the **Prism2** software help. Any GPS/GNSS receiver that provides information in NMEA 0183 format by any serial interface (Bluetooth, USB or RS232) could be used for a positioning, for example zBell RTK GNSS receiver manufactured by Radar Systems, Inc.

Shockproof cart (optional). The *Zond Aero 500 NG GPR* has optional shockproof cart (Fig. 5) with built-in survey and it is capable to support wheel positioning with the **Prism2** software help. The rotary encoder AB interface is used for the distance and direction measurements. There is a 4-pin survey wheel connector on the shockproof case (Fig. 4.) that could be connected to the shockproof cart encoder. The shockproof cart encoder's cable connects to the survey wheel waterproof connector on the control panel of the main unit. There is a pivot 5/8" for the GPS/GNSS mounting on the shockproof cart.

2. Zond Aero 500 NG GPR preparation for operation

2.1. Hardware settings

- 1.) Connect the logger to the *Zond Aero 500 NG GPR* with Wi-Fi or Ethernet communication cable help
- 2.) Connect the powering cable to appropriate connector of the harness coming out from the shockproof case control panel (Fig. 3) or to another 12V DC powering source.
- 3.) If necessary, put the main unit to the shockproof cart or mount the survey wheel to the dovetail bracket (Fig 4), mount the tow-handle, connect its cable to the main unit (Fig. 2 or Fig. 3) and Ethernet cable to the logger.
- 4.) If necessary, mount the GPS/GNSS receiver on the shockproof cart using 5/8" pivot, turn it on and tune it in correspondence with the GPS/GNSS receiver User's Manual.



Fig.1. Zond Aero 500 NG GPR



Fig.2. Zond Aero 500 NG GPR in the shockproof case.



Fig.3. View of shock proof case control panel with mounted Zond Aero 500 NG GPR.



Fig.4. Survey wheel mounted on the shock proof case.



Fig.5. Shockproof cart.

2.2. First Run

- 1.) Place the *Zond Aero 500 NG GPR* in a working position.
- 2.) Turn ON the GPR using ON/OFF switch on the shockproof case control panel. The green light-emitting diode should light up.
- 3.) Turn on the logger.

The next steps are describing operation under **Prism2** software on a PC Compatible computer (hereinafter computer), if you are using another logger or the third party software please follow the instructions from its manuals.

- 4.) User has to install the **Prism2** software package using the flash USB disk supplied with the kit for the computer under the Windows 7/8/10/11. The installation process is described in the User's Manual of **Prism2** software. Once the installation is completed, you have to perform the actions described in the **Prism2** User's Manual (paragraphs 5.1 and 5.2 "Configuring the computer to connect with Zond GPR Control Unit" and paragraph 6 "First Run").
- 5.) Run **Prism2** software, its main menu is shown on Fig. 6.

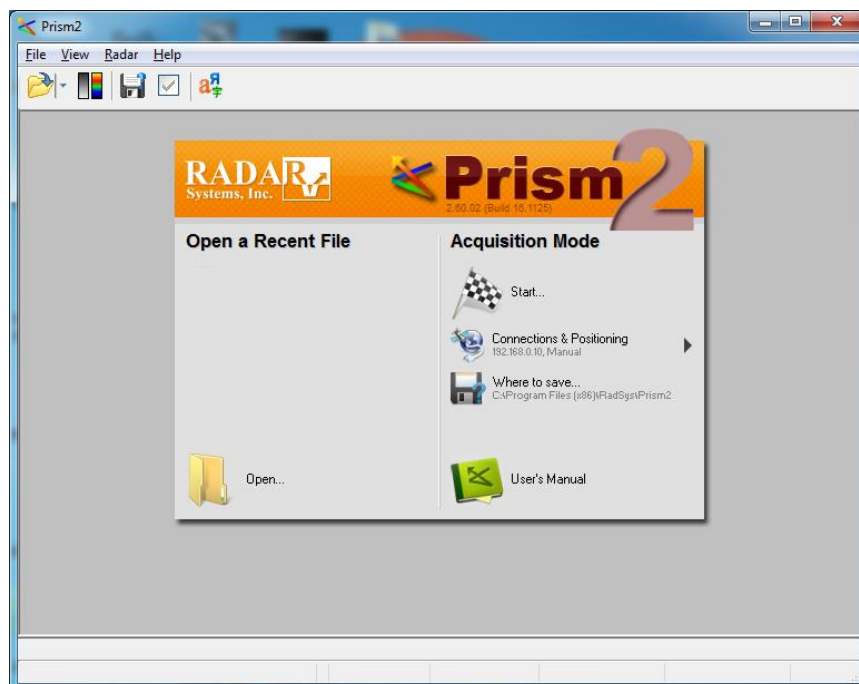


Fig.6. Main menu of Prism2 software.

6.) Click the **Start** button to enter the data acquisition mode like shown on Fig.7.



Fig.7. Data acquisition mode.

Note: We would like to recommend the user to use the keyboard for the navigation in the data acquisition mode (use the following keys to navigate ←, →, ↑, ↓, Spacebar, Enter and Escape). It's much more convenient to use it in the field conditions instead of cursor oriented operations due to its invisibility on the direct sun light. If you are using tablet computer, touchscreen or other mouse-like tracking device please mark the menu "Radar->Tablet controls" first.

- 7.) Enter **Setup** menu. Once **Setup** is activated, the screen shows **Zond x500** setup dialog box as on the picture below (Fig. 8 and Fig. 9). The navigation is possible with the cursor keys, Enter or Space key help. The xGPR-family members have two different tuning styles of the Prism2 setup: Smart (Fig. 8) and Advanced (Fig. 9). Smart setup has small amount of adjustable parameters that help to easy tune the device, the user just needs to choose the necessary medium, scan rate (for the non-wheel positioning) and a time range and device automatically adjust hardware stacking and data speed to provide better quality of the acquired signal. It's covering up to 99% GPR applications. A GPR signal may not be seen in the proper position as on the picture at the first run. To set correct position of the signal choose the **Pulse delay** menu and press "A" key on keyboard to start automatic adjustment. Press the Enter and then **Close** setup menu after pulse delay adjustment is finished.

Note: We would like to recommend the user to use as small Scan rate as user's task and GPR application allows. The best Scan rate for pedestrian applications is 20 traces per second [tps]. There is no need to increase this value for such use, otherwise huge volume of acquired data (understacked data) slow down software operation and dynamic range of the device. But user shouldn't overstack data as well, as it slows down the GPR movement speed.

Note: Survey wheel positioning helps to disable the Scan rate choice and issues based on it, as it allows to choose the proper scan rate by the device, depending on the GPR movement speed.

Advanced setup has full set of the xGPR device tuning parameters and is designed for the specific tasks with a full control of the GPR parameters (for example in scientific tasks).

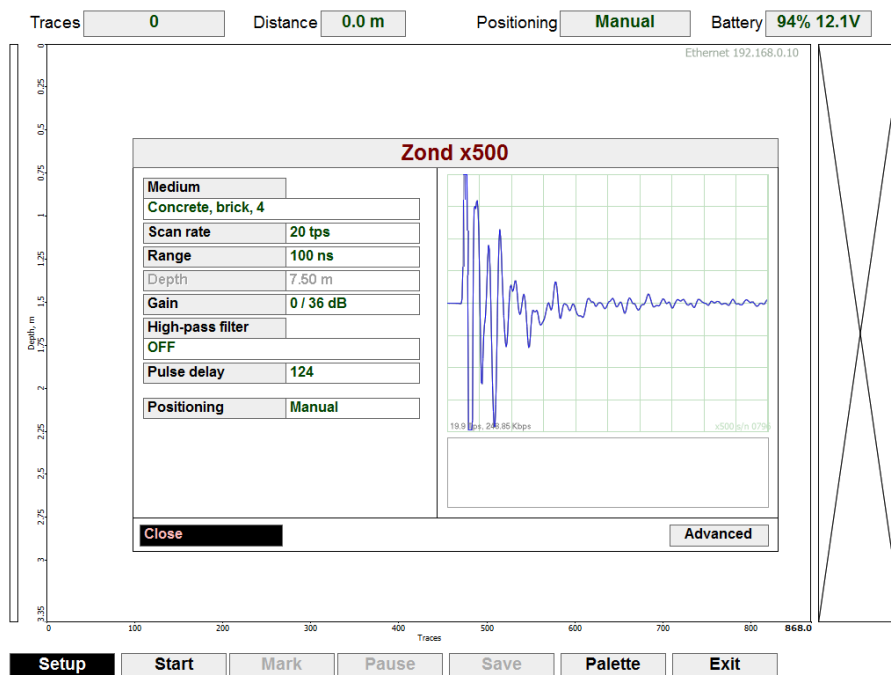


Fig.8. xGPR-family Smart Setup menu.

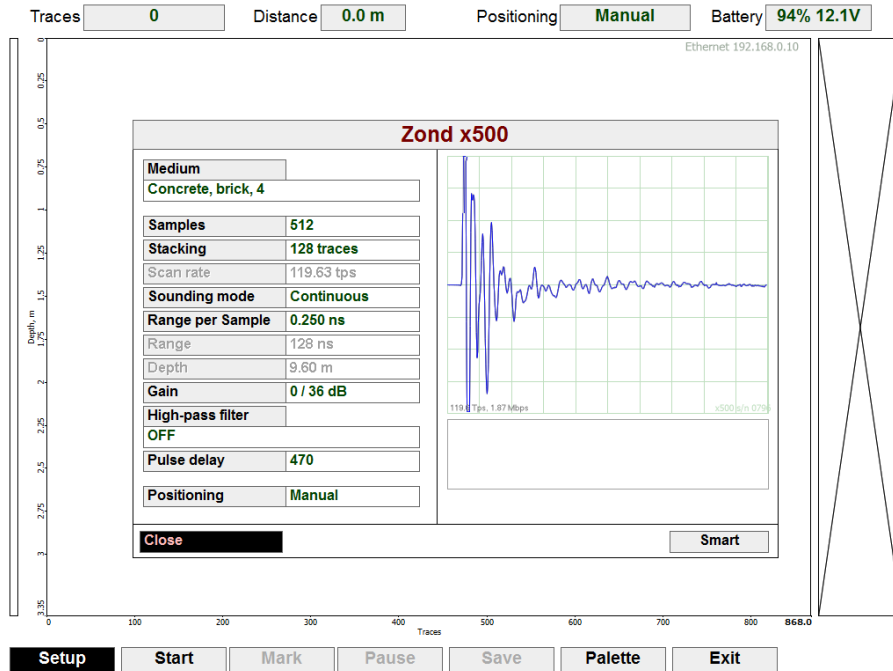


Fig.9. xGPR-family Advanced Setup menu.

Note: Zond Aero 500 NG GPR has built-in deactivating mechanism, i.e. transmitter is switched ON only when operator enters the SETUP dialog box or STARTs a data acquisition. Transmitter switches OFF immediately after operator STOPs the data acquisition or leaves the SETUP dialog box.

2.3. Data acquisition

Right after SETUP dialog box is closed button START activates. Press it to start the data acquisition. The acquired data will appear as on picture below (Fig. 10).

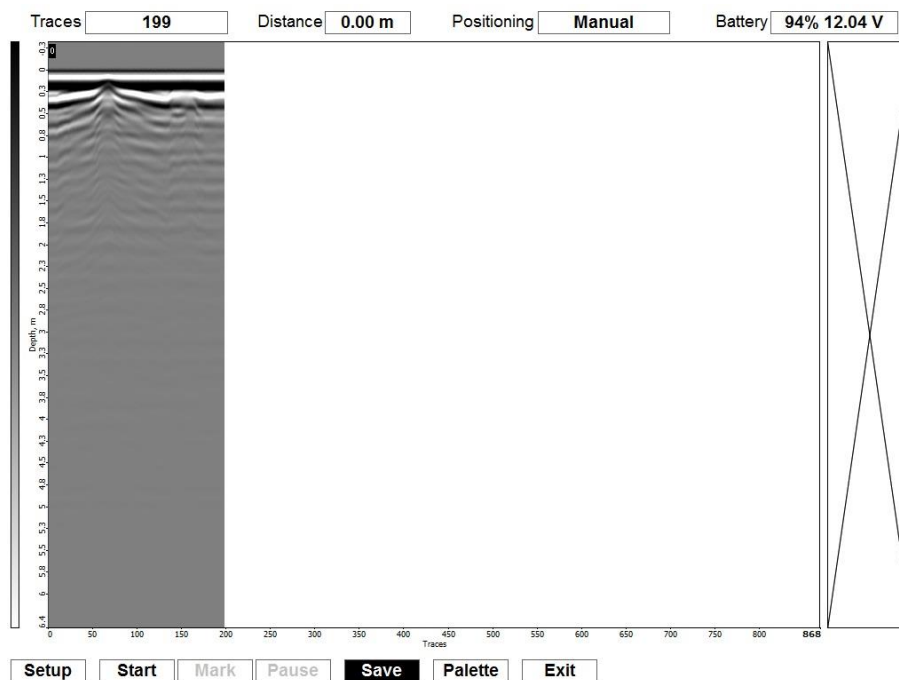


Fig.10. Data acquisition.

Press Escape key or STOP button to stop the data acquisition.

3. Environment requirements

- 1.) The *Zond Aero 500 NG GPR* is able to operate at air temperature from -10°C (263°K) to +50°C (323°K) and relative humidity up to 95% at temperature +35°C (308°K).
- 2.) It is allowed to operate at lower temperature by applying the heat insulating cover for the main unit.
- 3.) It is not recommended to switch on the *Zond Aero 500 NG GPR* earlier than after an hour after its transfer from the negative temperature to a warm environment.
- 4.) In case of operation of the *Zond Aero 500 NG GPR* in conditions of high air temperature (higher than +25°C) it is not recommended to leave the device on a place where it is possible to affect it by the direct sun light.

4. Transportation rules

It is allowed the device transportation in soft and rigid package by railway, road and air transport without restriction of distance in case of device packaging rules observing according to this Manual.

5. Guarantees

Radar Systems Inc. guarantees free of charge repair of any components of the *Zond Aero 500 NG GPR* and eliminate any defects for one year commencing on the date of purchase under condition of delivery of failed components to Radar Systems, Inc. address. Warranty does not extend to the case of mechanical damages due to incorrect use. In all other cases repair is performed for extra pay.

Appendix A. Battery Material Safety Data Sheet (MSDS)

TCT 通测检测
TESTING CENTRE TECHNOLOGY

Material Safety Data Sheet

MSDS Report

MSDS 报告

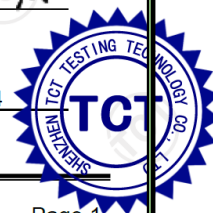
Applicant's name 委托方名称	Shenzhen Honghaosheng Electronics Co., Ltd 深圳市鸿昊升电子有限公司
Applicant's Address 委托方地址	7 floor, No.666 East-Renmin Road, Guancheng Community, Guanhu Street, Longhua, Shenzhen, Guangdong 深圳市龙华区观湖街道观城社区人民路东段 666 号 7 楼
Name of Sample 样品名称	Li-ion Battery 锂离子电池
Model 型号	3S3P18650
Nominal Voltage 标称电压	11.1V
Rated Capacity 额定容量	9000mAh, 99.9Wh
Weight 重量	428.1g
Size 尺寸 (L×W×T)	(166.0×68.5×18.7)mm
Prepared By 编制单位	Shenzhen TCT Testing Technology Co., Ltd. 深圳市通测检测技术有限公司 2101 & 2201, Zhenchang Factory, Renshan Industrial Zone, Fuhai Subdistrict, Bao'an District, Shenzhen, Guangdong, China 广东省深圳市宝安区福海街道桥头社区稔山工业区振昌胶粘制品厂 2101、2201
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Inspected by 审核: Amy Zeng 曾江

Date 日期: 2022.06.14



Report No. 报告编号: TCT220613M023

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This report shall not be reproduced except in full, without the written approval of Shenzhen TCT Testing Technology Co., Ltd.

Appendix B. CE declaration of conformity



For the following equipment:

Zond Aero 500 NG GPR

is herewith confirmed to comply with the requirements set out in the Council Directive on the Approximation of the Laws of the Member States relating to Electromagnetic Compatibility and Radio Spectrum Matters (99/5/EC), Short range devices, Ground- and Wall-Probing Radars applications, Low-voltage Directive (73/23/EEC) and the Amendment Directive (93/68/EEC). For the evaluation regarding the Directives, the following standards were applied:

1. EN 302 066-2
2. EN 55022
3. EN 61000 – 4 – 2
4. EN 61000 – 4 – 3
5. EN 61000 – 4 – 4
6. EN 61000 – 4 – 5
7. EN 61000 – 4 – 6
8. EN 61000 – 4 – 7
9. EN 61000 – 4 – 8
10. EN 61000 – 4 – 11
11. EN 61000 – 6 – 3
12. EN 61000 – 6 – 1

Appendix C. FCC Notice for U.S. Customer



2AUQQ-AERO500NG

FCC Interference Compliance Statement (Part 15.19(a))

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Interference Compliance Statement (Part 15.105 (b))

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 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.

FCC Interference Compliance Statement (Part 15.509 (b))

Operation under the provisions of this section is limited to GPRs and wall imaging systems operated for purposes associated with law enforcement, fire fighting, emergency rescue, scientific research, commercial mining, or construction.

FCC Part 15 Clause 15.21

Warning: *Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.*

Coordination Requirements

1. GPR as Ultra-Wide Band (UWB) imaging system require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.
2. The users of UWB imaging devices shall supply detailed operational areas to the FCC Office of Engineering and Technology who shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration. The information provided by the UWB operator shall include the name,

address and other pertinent contact information of the user, the desired geographical area of operation, and the FCC ID number and other nomenclature of the UWB device. This material shall be submitted to the following address:

Frequency Coordination Branch, OET
Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554
ATTN: UWB Coordination

3. Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.
4. The NTIA/FCC coordination report shall include any needed constraints that apply to day-to-day operations. Such constraints could specify prohibited areas of operations or areas located near authorized radio stations for which additional coordination is required before operation of the UWB equipment. If additional local coordination is required, a local coordination contact will be provided.

Notice: Use of this device as a wall imaging system is prohibited by FCC regulations.

GPR Coordination Notice and Equipment Registration

Note: This form is only for Domestic United States users. The Federal Communications Commission (FCC) requires that all users of GPR who purchased antennas after July 15th, 2002 register their equipment and areas of operation. If you have purchased any of the antennas listed in question 6 after July 15th, 2002, you must fill out this form and fax or mail to the FCC. Failure to do this is a violation of Federal law.

1.	Date	
2.	Company Name	
3.	Address	
4.	Contact Information [contact name and phone number]	
5.	Area of Operation [state(s)]	
6.	Brand Name	Radar Systems, Inc.
	Model	Zond Aero 500 NG
	FCC ID	2AUQQ-AERO500NG
7.	Receipt Date of Equipment	

Fax this form to the FCC at: 202-418-1944

or mail to: Frequency Coordination Branch,
OET Federal Communications Commission
445 12th Street, SW
Washington, D.C. 20554
ATTN: UWB Coordination

or fill this form online: https://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/safety_ops_support/spec_management/library/gprc.cfm

Do not send this information to Radar Systems, Inc. or its representatives



Appendix D. ISED (Industrial Canada – IC) Notice for Canadian Customer



IC: 25515-AERO500NG

ISED RSS – General Notices

This Ground Penetrating Radar Device shall be operated only when in contact with or within 1 m of the ground.

This Ground Penetrating Radar Device shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- This device may not cause interference.
- This device must accept any interference, including interference that may cause undesired operation of the device

Ce dispositif radar à pénétration du sol ne doit être utilisé qu'en contact avec le sol ou à au plus 1 m du sol.

Ce dispositif radar à pénétration du sol ne doit être utilisé que par des organismes d'application de la loi, des établissements de recherche scientifique, des sociétés minières commerciales, des entreprises de construction, et des organismes d'intervention d'urgence ou de lutte contre les incendies.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- L'appareil ne doit pas produire de brouillage;
- L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

ISED Canada ICES-003 Compliance Label

CAN ICES-3 (B)/NMB-3(B)

Radiation Exposure Statement

The device has been found to be compliant to the requirements set forth in CFR 47 Sections 2.1091 and Industry Canada RSS-102 for an uncontrolled environment. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Le dispositif a été jugé conforme aux exigences énoncées dans les articles 47 CFR 2.1091 et Industrie Canada RSS-102 pour un environnement non contrôlé'. L'antenne(s) utilisée pour ce transmetteur doit être installée pour fournir une distance de séparation d'au moins 20 cm de toutes les personnes et ne doit pas être co-localisée ou fonctionner en conjonction avec une autre antenne ou transmetteur.

Appendix E. Contacts

Radar Systems Inc.,
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