Ramac/GPR 1GHz Overview and system description

Content

1 Introduction

This document provides an overview of the operation of the Malå GeoScience Ground Penetrating Radar "Ramac/GPR 1GHz". Pulse generator circuit diagrams as well as module internal photographs are contained in separate documents.

2 Overview

Ramac/GPR 1GHz is an ultra-wide band radar intended for geophysical surveying and non destructive testing. In use the system performs time domain reflectometry by radiating a radio frequency impulse with a repetition rate of 100kHz from a transmitting dipole. Transitions between materials exhibiting different wave impedances through which the electromagnetic wave travels cause the wave to be reflected. These reflections are received by the receiving dipole and sampled inside the antenna units. Results may be presented in real time on the PC connected to the system and recorded on a hard disk on the same PC for later analysis. One or several rechargeable batteries, dependent on the setup, power the system.

The system may be carried with the antenna (a distance encoder wheel may be attached to the antenna) being dragged along the ground by a simple pull handle or it may be mounted on a trolley incorporating a distance encoder.

When used for data capture, 1GHz comprises the following items:

PC	On the PC the data collection software runs. The unit communicates with the CUII control unit via the parallel port. On the screen is the result shown in real time while the data are stored on the hard disk. The customer himself usually provides the PC. None of the existing acquisition software's makes it possible to change the behaviour of the transmitting and receiving electronics of the antenna.
CUII control unit	This unit are mounted on a back pack or a cart and control the firing of the transmitting antennas as well as the sampling and digitizing of received waveforms. It communicates with the PC via the parallel port and with the antenna via optical fibres.
Antenna:	The shielded antenna comprises, on the transmitter side, an impulse generator, a transformer and an antenna element. On the receiver side there's a similar antenna and transformer, a preamplifier and a sampler head. The sampler head is mounted inside a fully shielded metal box and electromagnetic absorbing materials surround both the antennas. On the perimeter of the absorbing materials there are metallic shields. The box

also contains AD-converter and optoconverters for trigger signals and data output

Distance encoders: The distance encoders are commonly used for positioning each sampled wavelet with respect to its neighbors. It's mounted on the antenna or on the cart and connected to the CUII.

Battery pack: The 1GHz is powered from an external battery pack. Different types and power ratings are available.

3 Operation setups

In figure 1 below a typical setup during measurement with an 1GHz is shown.

The CUII unit is connected to the PC. Communication between the two units is done over the IEEE1284 ECP protocol. The CUII is also connected to the antenna through optical fibres and to the distance encoder through a cable.

Attached rechargeable batteries power the CUII and the antenna. The nominal voltage of the units is 7.2V, DC.

Via the data acquisition software running on the PC, the operator selects a number of suitable measurement parameters e.g. sampling frequency, time window and the amount of averaging. A number of different acquisition software's are available; with different levels of complexity e.g. the simplest software does not allow the user to adjust any parameter at all!

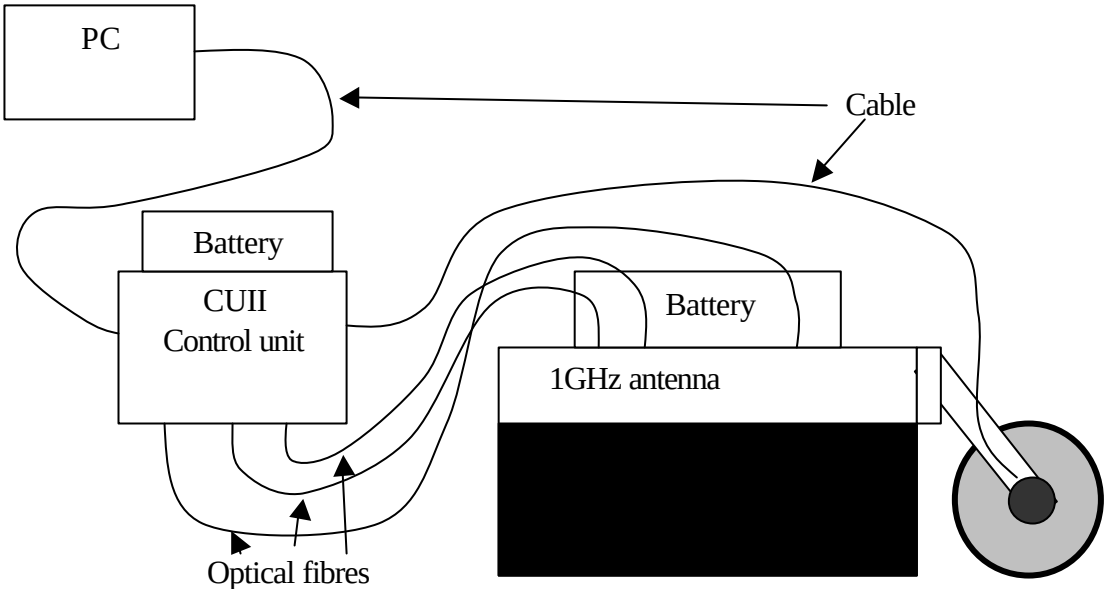

Figure 1. Operation setup for the 1GHz system.

When an acquisition is started the CUII continuously counts the pulses from the pulse encoder mounted on the measuring wheel and by counting the forward and backward pulses and then subtracting, it keep track of the absolute position along the profile. At predetermined positions along the profile the unit gathers waveform envelopes and transfer these 5 times every second to the PC.

If a distance encoder/measuring wheel is not used the CUII can be set to gather waveforms at a certain rate/s.

4 Overview Technical Description of main 1GHz Modules

4.1 CUII

The CUII is a class A device .

4.2 Shielded antenna overview.

General

A block diagram of a shielded antenna is shown in figure 3 below.

All sides of the antenna, except the bottom, have metal shielding. A d-sub connectors on top of the antennas provide the necessary power from the battery.

No rf-signals leave the antenna trough connectors. All signals to and from the unit is through optical fibres

Operation

On the transmitter side high voltage, DC-power, transmitter trig signal as well as ground reference are directly fed to the impulse generator on top of the antenna element. When a trig condition is received via the optical fibre, a charge storage capacitor is de-charged trough a set of avalanche transistors and current limiting resistors. The impulse created during this discharge is fed, via a 1:4 balun (not shown in the figure below) to the antenna element. The antenna element is situated on an electromagnetic absorbing material and resistively loaded at its endpoint. Antennas differ in the value of the charge storing capacitors, current limiting resistors and antenna size. How each antenna is configured is found in the parts lists.

On the receiver side DC-power, receiver trig signal and ground reference is fed to the sampler head located in a shielded cavity in the upper part of the antenna. DC-power and ground reference is fed to the preamplifier located on top of the antenna element. The antenna element is identically mounted as on the transmitter side.

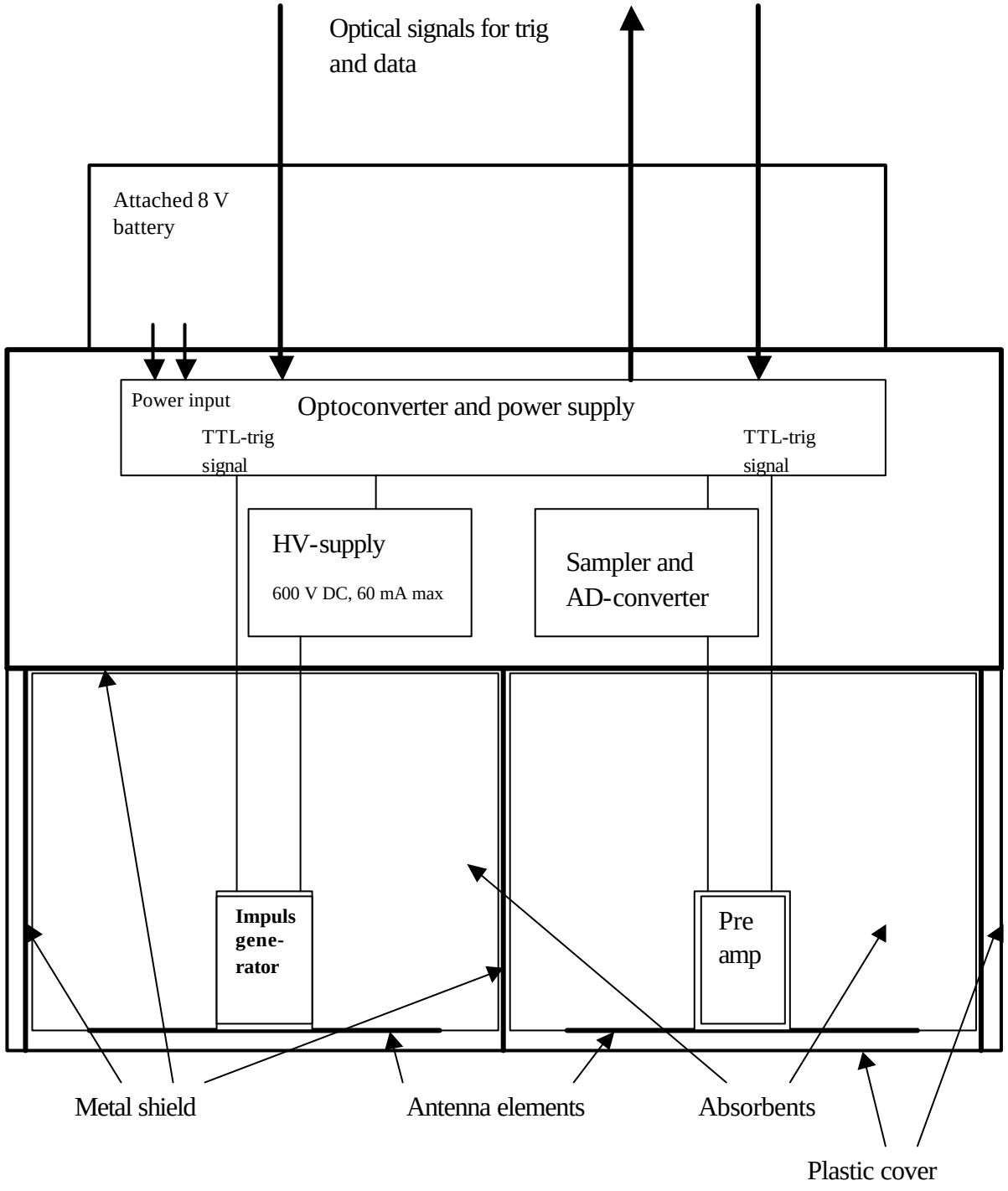

Figure 3. Block schematic of the 1GHz antenna.

Incoming signals are fed from the antenna element to the preamplifier, 18dB low noise, via a 1:1 balun (not shown on the figure above). From the preamplifier the signal is fed to the sampler head via a semi-rigid transmission line.

A trig condition on the receiver fibre causes the sampler head to sample the analog level of the signal arriving from the preamplifier. The sampled signal is fed to the AD-converter and then to the optoconverter and through the fibre to the CUII.