

How GPR works

GPR (Ground Penetrating, or Probing, Radar) works by sending a radio signal or series of signals into the ground. The returning signals provide information about changing ground characteristics with depth. Basic radar output presents this as patterns of signals at depth against the distance travelled along the ground by the radar. The radar measures depth in terms of the time it takes for a signal to return after emission. The depth in cm or metres depends on soil conditions and how fast the electromagnetic waves can travel through the ground. To get accurate depth information, the data will be calibrated for soil conditions on the day(s) of survey.

GPR works best when there are well defined differences in the electromagnetic properties of the materials being surveyed: gradual change is not as easy to detect. This makes GPR a very good detector of pipes and services (intrusive material), buried building materials (also intrusive) and changes in stratigraphy whether man-made (e.g. pavement profiling) or natural (e.g. peat basin detection).

GPR can also be used to look inside structures either to check on the state of construction or to locate hidden objects (e.g. voids). If in doubt, ask your GPR operator for advice.

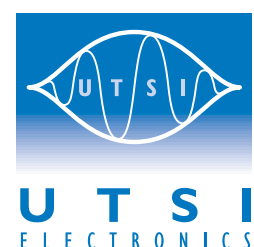
Why use GPR survey?

GPR is a continuous survey method. The radar is either towed or pushed along the ground. It is rapid – from fast walking pace up to motorway traffic speed, depending on surface conditions and the method of propulsion. GPR is non-destructive, causes no damage to the areas being surveyed and is the only geophysical survey technique suitable for environments such as wetlands, tarmac, concrete.

GPR, if calibrated accurately, gives automatic depth information and can detect targets that other geophysical methods have difficulty with such as plastic pipes and targets at great depth. Note, however, that GPR is a relative method, i.e. it detects changing conditions from the surface down but cannot identify the precise nature of the materials surveyed. It may be necessary to supplement the GPR data with absolute data from boreholes, sample cores, trial excavation, soil maps, etc.

Examples 1: The survey of a peatfield to determine the depth of remaining peat. GPR data will show the boundary between the peat and the underlying soils. No supplementary information will be needed unless information on the underlying soils is also required, in which case a sample core will be needed to determine what type of soil(s) lie below the peat bed.

Example 2: The survey of an area to determine its geology and to detect voids, if any. The GPR data will show both the changes in stratigraphy and any voids. To determine soil types, borehole information will be required. The GPR data can be used to show how the ground conditions change from one borehole to another.



What to look for in GPR output

Does the signal pattern show clearly against the background? Are the plots very dark or is there a range of greyscales? Clarity is really important, both in interpreting the data and in defining depths. There are a number of causes of background noise and interference effects, some of which are built into the equipment. Groundvue radars are fully screened and use broadband antennas to eliminate as much interference as possible.

Do not expect the output to look like a vertical section drawing. Returned signals give information about the size and composition of their targets but do not and cannot resemble them. One complication is that radio signals are cone-shaped: the deeper the signal goes, the broader the area it responds to. Groundvue radars use arrays of antennas to strengthen the central portion of the signal and reduce the periphery. This feature is unique to Groundvue in the UK.

Ask for sample data before you commission the survey.

Will it work?

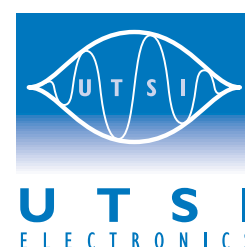
GPR surveys will not work in certain clay soils when they are waterlogged, nor will they work in saline water. The reason for this is that in conditions equivalent to a heavily ionised solution the signal produces a current in the ground and no (or a much reduced) signal is returned. This loss of signal (attenuation) depends upon the mineral content of the soil (or other medium). Note that waterlogging *per se* is not necessarily a problem – water makes an ideal target for GPR. Water slows down the transmission speed of the radio wave, shortening the maximum distance that the signal can travel to and, depending on absolute depths, a deeper range radar may be required.

If possible, find out the prevailing soil conditions and the level of the water table and ask your GPR operator for advice. In cases of doubt, Utsi Electronics Ltd are always happy to visit the site and trial one or more radars. This can either be combined with the actual survey or carried out in advance if preferred. In either case, we make no charge other than our expenses to visit.

What will it cost?

This depends on the area to be covered, the level of cover required, the amount of time spent on site and on processing/plotting off-site. GPR survey is effective but it is not always cheap. Define the information you require, discuss how this can be achieved, then ask your GPR operator for an estimate or a fixed price quotation.

Utsi Electronics Ltd will discuss the possible approaches and, if necessary, produce costings for a range of possible strategies so that you can balance the resources available against the potential information obtainable from the survey.



Define what exactly?

Target(s)

What are you hoping to find and how large is this likely to be? Voids, landscape profiles, pipes and services, rebars, archaeological remains, groundwater or dowel alignments? The size of the target(s) will help to decide on an appropriate sampling interval for the radar pulse.

The nature of the target will also be used to devise a survey strategy (site coverage, distance between survey transects, direction of survey, site sampling vs 100% coverage, etc.). Some materials (e.g. metal, water) make better targets than others although, in all cases, the difference in electromagnetic content between the target and its surround will be important.

Depth

Maximum anticipated depths. This information is needed to decide which radar is most appropriate. No one radar operates to all depths.

Soil conditions

Soil conditions are important for GPR survey. This information can be used to estimate the likelihood of a survey being successful. It is also useful to know the approximate level of the water table.

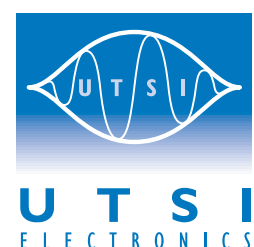
Surface conditions

It is important to maintain close contact with the ground and to keep the antennas in the same plane as each other. Large antennas (e.g. Groundvue 2) can cope with conditions that smaller ones could not. Are there any obstructions on site? Litter? Trees? Brambles or other vegetation? Is vehicle access possible? Groundvue radars can cope with most surface conditions – it's a question of which radar is most suitable.

What else do I need to know?

Positional information is really important. Decide before you start how the GPR information is going to be related to maps or any other geophysical data. If the site is to be gridded and this can be done before the GPR survey, site grid co-ordinates can be added to the radar data and reproduced in the radar output. Bear in mind that the cheapest effective GPR survey has the GPR operator on site for the least time, dealing primarily with the radar.

Survey direction may be important. For the best chance of detection the radar should cross the longitudinal axis of its target at an angle, the optimum being 90°. If the orientation of any potential target is unknown then the survey should be carried out in two perpendicular directions.



For certain GPR surveys, contour information for the site can be added to produce contoured plots which may be easier to understand than standard profiles. Standard output shows depths relative to the surface, depicted as a straight line. This does not apply to plotted maps and drawings.

GPR depicts changing ground conditions and buried anomalies. Interpretation of results will offer guidance as to the nature of the materials returning signals. However, similar signals may be returned by different conditions/anomalies and supplementary information (test excavation, coring, other geophysical methods, repeat patterning) may also be necessary. Combined with supplementary information, GPR can be a very powerful tool.

At the end of the survey, you will receive a report containing the output you have selected. This may include the radar profiles, maps/drawings of targets and possible targets, details of the survey parameters and conditions, commentary on the output and further recommendations/conclusions. You may want more than one copy – say so at the start or before the processing is done. Additional processing in the form of time slices, ASCII files, graphs, maps or drawings can also be offered.

Time slices are horizontal maps drawn from the output of all the radar runs in a given direction. Provided that the survey trajectories are parallel to one another and can be related to one fixed line, a series of time slices at specific depths can be produced. There will be an extra charge for this service since it involves further processing of the data. This does not, however, have to be carried out at the same time as the survey since the maps are drawn from the raw survey data.

If Utsi Electronics Ltd carries out a GPR survey for you, we will expect to provide technical support in correlating the data to other sources of information. If you have any problems, just ask – we'll always do our best to help.

Please contact us (English, Francais, Svenska) with any queries regarding the Groundvue range. Additionally, if you have opto-electronic design or repair problems or new design ideas for radar or other antenna applications, Utsi Electronics can help.

Utsi Electronics Ltd., Sarek, Newton Road, Harston, Cambridge CB2 5NZ, United Kingdom

Telephone: ++ 44 (0)1223 874318

Fax: ++ 44 (0)1223 874332

Email: enquiries@utsielelectronics.co.uk

Website: www.utsielelectronics.co.uk

