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SMART RFID SYSTEM

General information

KOMPLEX®

MARKING OF UNDERGROUND FACILITIES

Every provider of underground facilities administers detailed documentation of underground facilities. Route course plot is included in the documentation, together with plot of important spots in terrain, location concerning other underground facilities such as road communication, water course, objects, etc.

Besides documentation it is important to use marking system throughout facility route for its localisation and for localisation of its important points in terrain. The importance of reliable and quick localisation of route course or individual spot on facility is well-known to every provider.

METHODS USED TO MARK FACILITIES IN TERRAIN

1. Documentation

Following planimetry documentation we know to localise facility position towards fixed points geometrically.

In the area with small amount of orientation points or in the case of their change, geometrical localisation is not very effectual and localisation accuracy can be insufficient.

2. Above-ground markings

This is an often used method of marking route course or its important spots. Basically, it means different metal or individual shafts embedded in route course, or legend signs placed on neighbouring buildings or fences. It is possible to mark important spots of facilities by such markings, or in the case of major transit and distribution network it is possible to mark the whole route course.

Advantage of such markings is their visibility and quick orientation. However, marking of the whole route course or all of the important spots with these markings in the case of minor parts of distribution network is not effectual. Common disadvantage is regular maintenance of markings and devaluation of surface for other users.

3. Electrical marking system

This system is considerably spread among users of underground facilities. The system uses longitudinal circulation of alternating signals (localisation signals) in metal

pipeline sides, metal cables and conductors. These signals create magnetic field of known shape around the conductor. Following measurement of shape of such magnetic field we determine facility position.

The mostly used signals are the signals generated by the generator constructed for this purpose. Reverse current of alternating energy network and signals of long waved wireless transmitters are used for orientation localisation. Obligatory condition of this system is pipeline or cable continuity and their sufficient electric isolation against ground.

In the case of insufficient electric isolation or continual interruption of metal pipeline by compression tightening or corrosion insertions, independent conductor (signal conductor) is needed to use if the electrical marking system is to be used throughout the whole route course of facility.

Disturbing influences such as high-voltage transmission lines limit usage of this method. Spreading of localisation signal by neighbouring metal facilities (neighbouring pipelines, grounding, telecommunication cables, etc.) initials uncertainty, which devise we localise. This system does not allow localising important spot on the facility route. Signal conductor requires construction of above-ground objects for signal implementation and their maintenance. For localisation the transmitting generator is needed to implement signal into underground facility or into signal conductor, and also the receiver to localise given facility in terrain by operator's movement.

4. Radio Frequency Identification System

RFID is the abbreviation for radio frequency identification. Basically, it is the system using wireless transmission of energy from transmitter to otherwise passive mark and transmission of information from mark to receiver.

KOMPLEX develops and manufactures such RFID Systems as nowadays they are the most comfortable marking systems that provide to user many advantages unlike aforesaid systems.

We specialise on RFID systems for application used to mark underground facilities. Our marks of RFID system are known under their trade name "Markers".

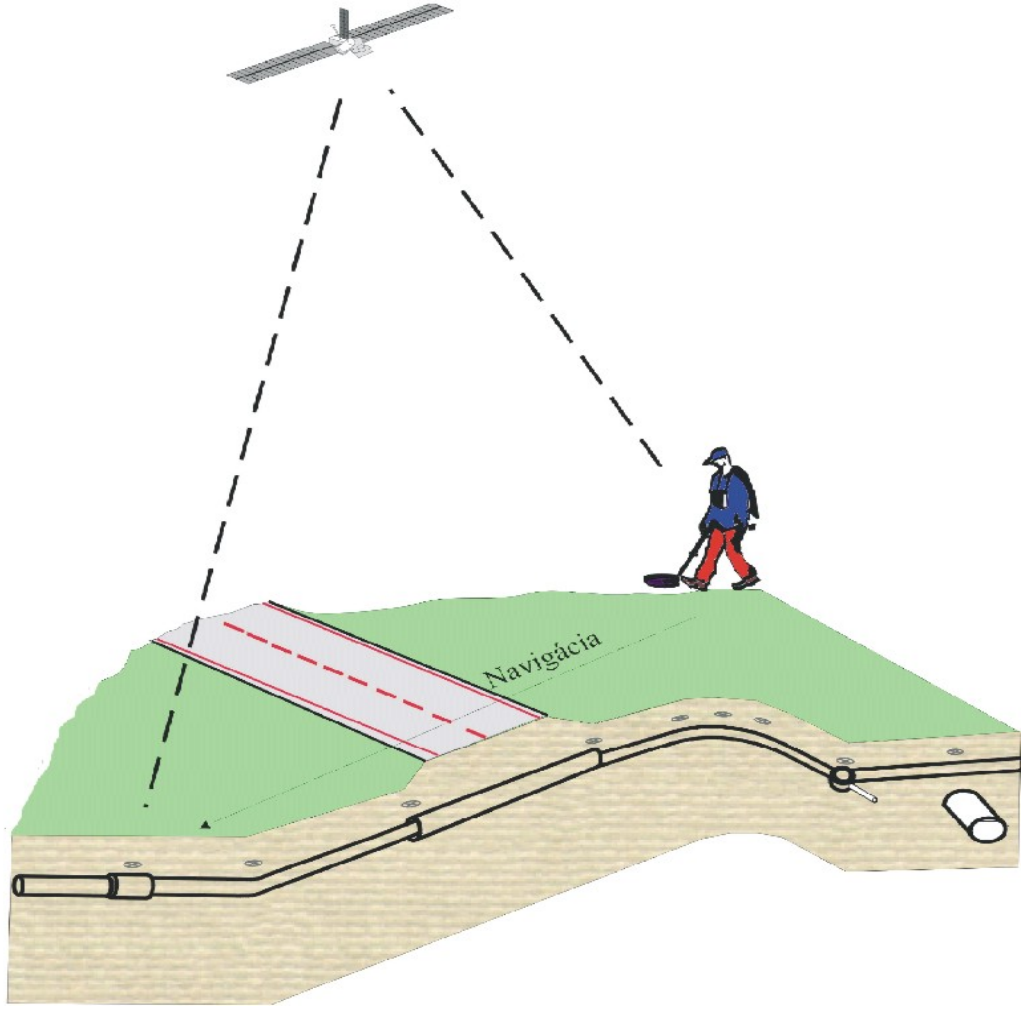
SMART RFID SYSTEM

Smart RFID System or „Smart Radio Frequency Identification System" represents the best and the most comfortable way to mark and trace underground utilities, such as:

- ✓ **Gas pipelines**
- ✓ **Telecommunication cables**
- ✓ **Sewage pipelines**
- ✓ **Energy cables**
- ✓ **Water pipelines**

Smart RFID consists of 3 basic parts:

- ✓ **Smart Marker SM 1500**
- ✓ **Smart Marker Locator SML xxx**
- ✓ **Software for PC "LOCATOR"**



SMART MARKER SM 1500

- ✓ Marker is a passive electrical mark intended for marking underground facilities.
- ✓ We put the marker just above the facility and then cover by the soil.
- ✓ Each of the Smart markers SM 1500 has its own unique identification number ID.
- ✓ We differentiate markers SM 1500 according to type of underground facility by operation frequency.

SMART MARKER LOCATOR SML xxx

- ✓ Smart Marker Locator is a portable facility intended for localisation and identification of both analog and smart markers.
- ✓ Smart Marker Locator is able to find a marker and define the place and depth of marker imposition.
- ✓ Moreover, Smart Marker Locator offers the customer to save record number (serial number) of each marker type as well as Smart marker ID.
- ✓ There is GPS module inbuilt in Smart Marker Locator that improves properties of RFID system. Smart Maker Locator with GPS module enables to assign GPS coordinates to each marker (selected point), and back navigation.

Features of Smart Marker Locator SML xxx

- ✓ Location of both analog Marker 2500 and Smart Marker SM 1500
- ✓ Possibility to store GPS coordinates of each marker
- ✓ Possibility to store/read Smart Marker 1500 ID
- ✓ Possibility to store user's own remarks for each marker
- ✓ PC interface via standard RS 232 serial port
- ✓ Display shows marker record number, Smart Marker ID, marker name, marker imposition coordinates
- ✓ Easy operation by using multifunctional buttons and backlight display

Features of Smart Marker Locator SML xxx during localisation

- ✓ Selection of demanded marker by searching or inserting its record number
- ✓ Precise navigation to the buried marker using GPS coordinates
- ✓ Identification of Smart Marker 1500 ID
- ✓ Defining the depth of marker imposition. Depth value is then displayed.
- ✓ Displaying current geographical coordinates of facility and of the buried marker imposition.

SOFTWARE FOR PC "LOCATOR"

- ✓ An included accessory for the Smart Marker Locator SML xxx is also the software package LOCATOR and a serial cable for data transfer to and from a PC.
- ✓ Software LOCATOR is intended for creation and downloading of a marker database from the Smart Marker Locator.

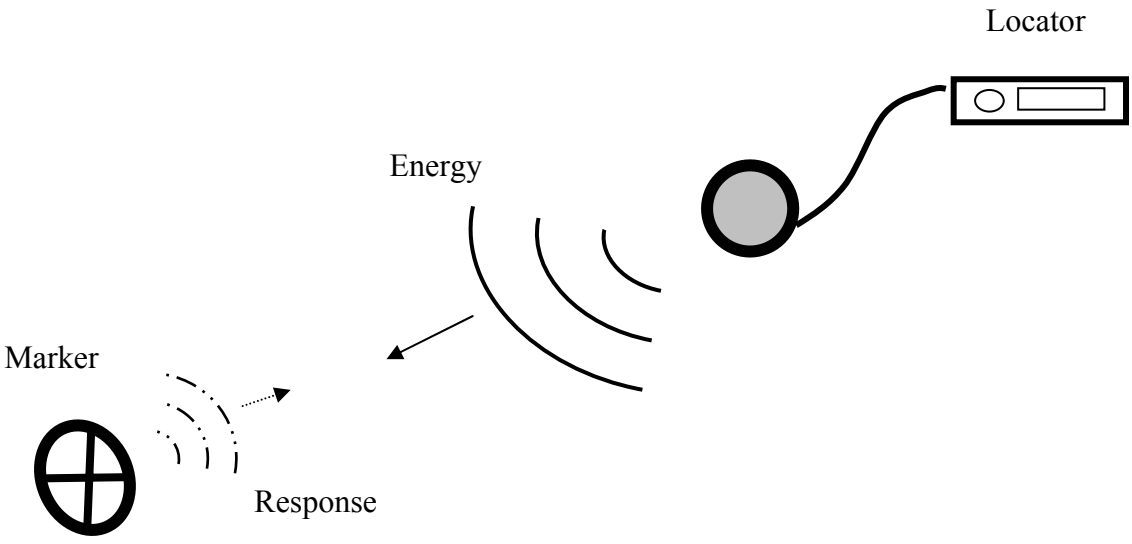
Features of the Software LOCATOR:

- ✓ Transfer of marker database from PC to Smart Marker Locator and vice versa
- ✓ Marker name modification
- ✓ Add additional text to marker record
- ✓ Sort markers by different attributes
- ✓ Export marker database to Excel files

PRINCIPLE OF MARKING SYSTEM BY MARKERS

Marker is basically a passive electrical mark, so for its operation it uses energy transmitted from Marker Locator during its localisation. When this transmission is finished, marker transmits a response in form of signal of a known frequency, on which the marker has been set firmly in production. The marker response is then evaluated by Marker Locator according to level and frequency of response signal.

During localisation and navigation Smart Marker Locator SML xxx uses GPS system, which enables to assign geographical coordinate (geographical longitude, geographical latitude) to demand marker (demand place), and back navigation.



TECHNICAL SPECIFICATIONS

Technical Specification of Smart Marker SM 1500

Operating frequency	According to type of underground facilities (see below)
Size – diameter x height	225 x 28 mm
Weight	Max. 300 g
Identification number ID	10 digits number in hexadecimal code
Marker read range	1,5 m
Storage Temperature	- 20 to + 60 °C
Operating Temperature	- 20 to + 60 °C

Technical Specification of Smart Marker Locator SML xxx

Operating frequency	According to type of underground facilities (see below)
Size (height x width x depth)	225 x 240 x 210 mm
Weight	Max. 4 kg
Memory capacity	8000 marker records
Display type	Backlight LCD screen,4 x 20 digits
Power	10 pcs of battery cells LR14, Typical battery life: 45 hours
Marker depth measurement accuracy	+/- 10 % up to marker specification
Storage Temperature	- 20 to + 60 °C
Operating Temperature	- 20 to + 60 °C

Types of Operating Frequency

Operating frequency	Type of facility	Colour of Smart Marker SM 1500	Type of Smart Marker Locator
83.0 kHz	Gas pipelines	Yellow/Black	SML 8300
101.4 kHz	Telecommunication cables	Orange/Black	SML 1014
121.6 kHz	Sewage pipelines	Green/Black	SML 1216
134.0 kHz	Energy cables	Red/Black	SML 1340
145.7 kHz	Water pipelines	Blue/Black	SML 1457

ADVANTAGES OF SMART RFID SYSTEM

- ✓ Accurate localisation of marker imposition
- ✓ Direct installation of the marker into the cutting
- ✓ Marker does not deteriorate terrain surface for other users.
- ✓ It does not need its own source of energy.
- ✓ It is possible to localise marker imposition place after years.
- ✓ High marker lifetime
- ✓ Marker does not need any maintenance.
- ✓ Different structure of the soil has no influence on marker localisation.
- ✓ High voltage transmission line has no influence on marker localisation.
- ✓ Accurate localisation ability
- ✓ Interchange with a marker of another facility is impossible.
- ✓ Reliable localisation, weather has no influence on results.
- ✓ It is possible to mark facilities by markers also in case when other marking methods are already used.

GENERAL PRINCIPLES OF MARKING BY MARKERS

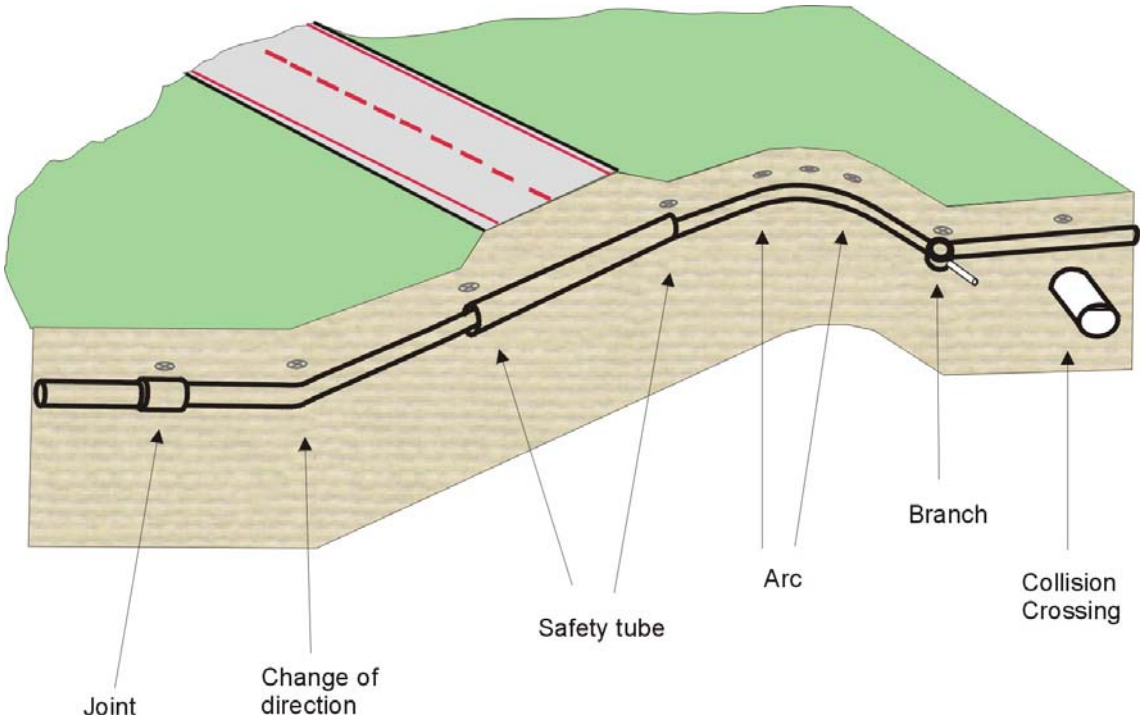
Marking with markers offers a variety of usage possibilities. We can mark individual points on facility or whole facility route course as well as various facilities types and spots in terrain corresponding with facilities. We can mark both metal and non-metal facilities, etc. Marking can be done either during construction or during repairs.

Important points on individual facilities can be:

- ✓ route turning
- ✓ route valves
- ✓ junctions
- ✓ length reserves
- ✓ protectors
- ✓ electricity supply connection
- ✓ facility joints
- ✓ route branches
- ✓ connectors to objects
- ✓ profile or directional change
- ✓ material change (metal – plastic)
- ✓ ground closures
- ✓ beginnings and endings of safety tubes under the roads and rivers
- ✓ collisions/crossings with other facilities
- ✓ above-ground markings fixation
- ✓ reparation spots

INSTALLATION OF THE MARKER

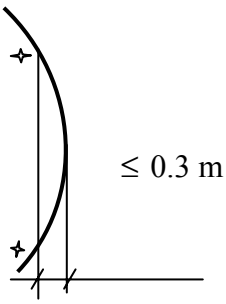
- ✓ We install marker during facility construction, its maintenance or reparation, or during construction activities of other organisations.
- ✓ We install marker directly into the cutting above the marked facility. When marking non-metal facilities we can put marker directly on these facilities. However, when marking metal facilities, there need to be distance at least 10 cm between marker and these facilities, we recommend putting it on sand or soil load.
- ✓ The spike in centre of marker must direct up or down, vertically to facility axis.
- ✓ We cover the marker with at least 10 cm fine soil layer that we compress for example with our foot. We can then continue with machine covering of facility. Avoid hard objects falling on the marker.
- ✓ Distance between two markers should not be less than 1 m. At this distance Marker Locator still recognises single markers.
- ✓ System operates up to maximal distance between Marker Locator antenna and marker. When choosing marker type, it is necessary to think not only of depth of burying but also of vestures in terrain, change of terrain profile, etc.



BASIC RULES FOR MARKING WITH MARKERS

- ✓ lead facility route in straight stages if possible
- ✓ distribute markers on spots of route direction changes
- ✓ distribute markers on spots of collision with other facilities (crossings)
- ✓ distribute markers on important spots on facility (facility joints, branches, etc.)
- ✓ in straight stages choose distance between markers so that there is optical visibility between neighbouring markers and so that the distance does not exceed 100 m
- ✓ in the case of arcs, elbows, bends choose direction between markers so that route/axis drift between neighbouring markers does not exceed 0.3 m
- ✓ use marker with appropriate operating frequency following facility type
- ✓ plot marker localisation into facility planimetry documentation

Arc, Elbow – Detail



If marking a metal facility or its metal parts, it is necessary to keep following:

- ✓ Marker must be at least 10 cm above metal object
- ✓ Side distance from the metal object should not be less than 10 cm
- ✓ No metal object should pass through the marker
- ✓ From the identification side – vertical distance between marker and metal objects such are armatures of road and bridge panels, cast-iron taps etc. must be min. 40 cm.

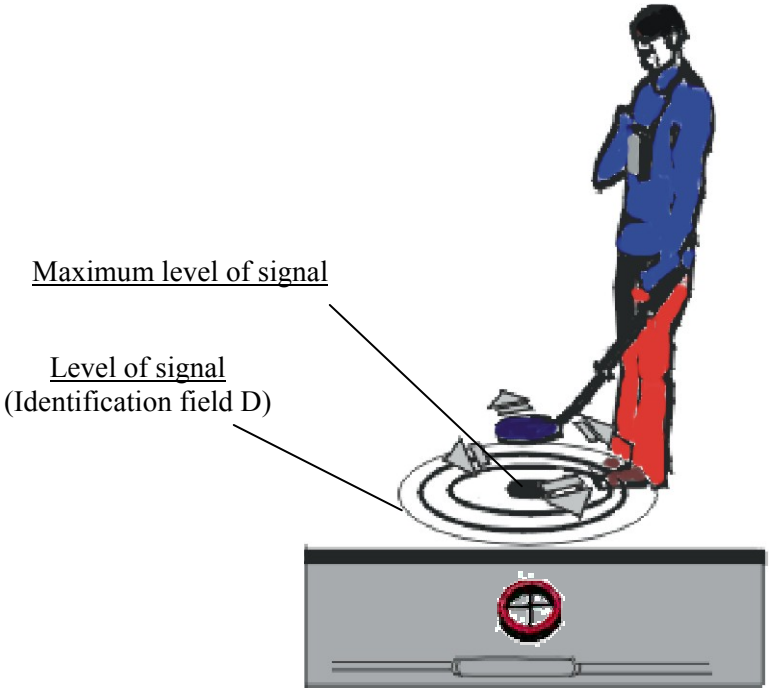
SEARCHING THE MARKER

Locating a marker with the Smart Marker Locator SML xxx with an inbuilt GPS module is easier and more comfortable than ever since:

- ✓ Backlight display and acoustic signalisation of Smart Marker Locator SML xxx navigate the user accurately and quickly to the marker.
- ✓ When the distance between Smart Marker Locator SML xxx and a selected marker is less than 10 meters, the locator indicates it with an intensive acoustic intermittent tone.
- ✓ From this distance the user can find the marker and estimate the marker depth with high accuracy using only the Smart Marker Locator without GPS support.

LOCALISING THE MARKER

- ✓ The locator antenna is moved in horizontal position towards the terrain surface.
- ✓ When the signal from marker is received, the locator indicates it by acoustic signal and by moving accuracy indicator on display.
- ✓ By decreasing of sensitivity the diameter of identification field D can be reduced up to diameter of marker imposition place.
- ✓ The marker imposition place is the place of the maximum signal level.



READING THE SMART MARKER ID

Marker Locator needs more energy to read the Smart Marker ID than to localise the marker. Therefore we firstly localise the Smart marker so we have the shortest distance between Marker Locator antenna probe and Smart marker. Then we just choose “Read ID” in Locator menu.

STORING THE DATA

In terrain Smart Marker Locator SML xxx is able to store following data into its memory:

- ✓ Record number of marker (it is being generated automatically and ascendant)
- ✓ Smart Marker ID
- ✓ Position – GPS coordinates of Marker (geographical latitude and geographical longitude fixed by GPS satellite)

We can easily trace the underground facility following these recorded data.

NAVIGATION

- ✓ After storing the marker position data into Smart Marker Locator memory, it is possible to navigate ourselves back to marker imposition place.
- ✓ When Locator is in "navigation" mode, the azimuth/direction from the current place to the place of required marker is displayed.
- ✓ When we move, locator displays actual distance from selected marker.
- ✓ Enlarging or reduction of the distance is differentiated by acoustic tone.
- ✓ Once the distance between Smart Marker Locator SML xxx and selected marker is less than 10 meters, Locator signalises it by intensive acoustic intermittent tone.

CREATION OF DATABASE

Our Smart RFID system allows you to create database of selected underground facility.

Database contains following data:

- ✓ Record number of marker
- ✓ Smart Marker ID
- ✓ GPS coordinates of marker imposition place (geographical longitude and latitude)
- ✓ Advanced text information for more detailed marker description. Content of this information is up to you.

Records such as record number of marker, Smart marker ID and GPS coordinates of marker imposition place, we can put into database directly on fieldwork with SML xxx.

User's own advanced text information is being edited in PC with software LOCATOR. Software LOCATOR enables to edit record number of the marker and text information. If Smart Marker Locator SML xxx uses information downloaded from PC database, it displays also user's text information.

Record Number	ID of Smart Marker	x geographical latitude	y geographical longitude	Text (20 notes) *is shown by SML xxx*	Text (unlimited amount of notes) *is not shown by SML xxx*
1					
2					
3					
N					

Possibilities of software LOCATOR:

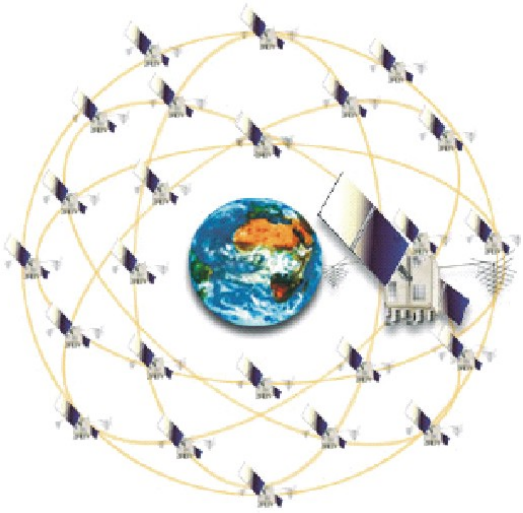
↕ Line order modification

■ Writing down any text information

□ Data in these unmarked columns are edited by SML xxx.

All the data can be additionally changed in database.

WHAT IS IT GPS?



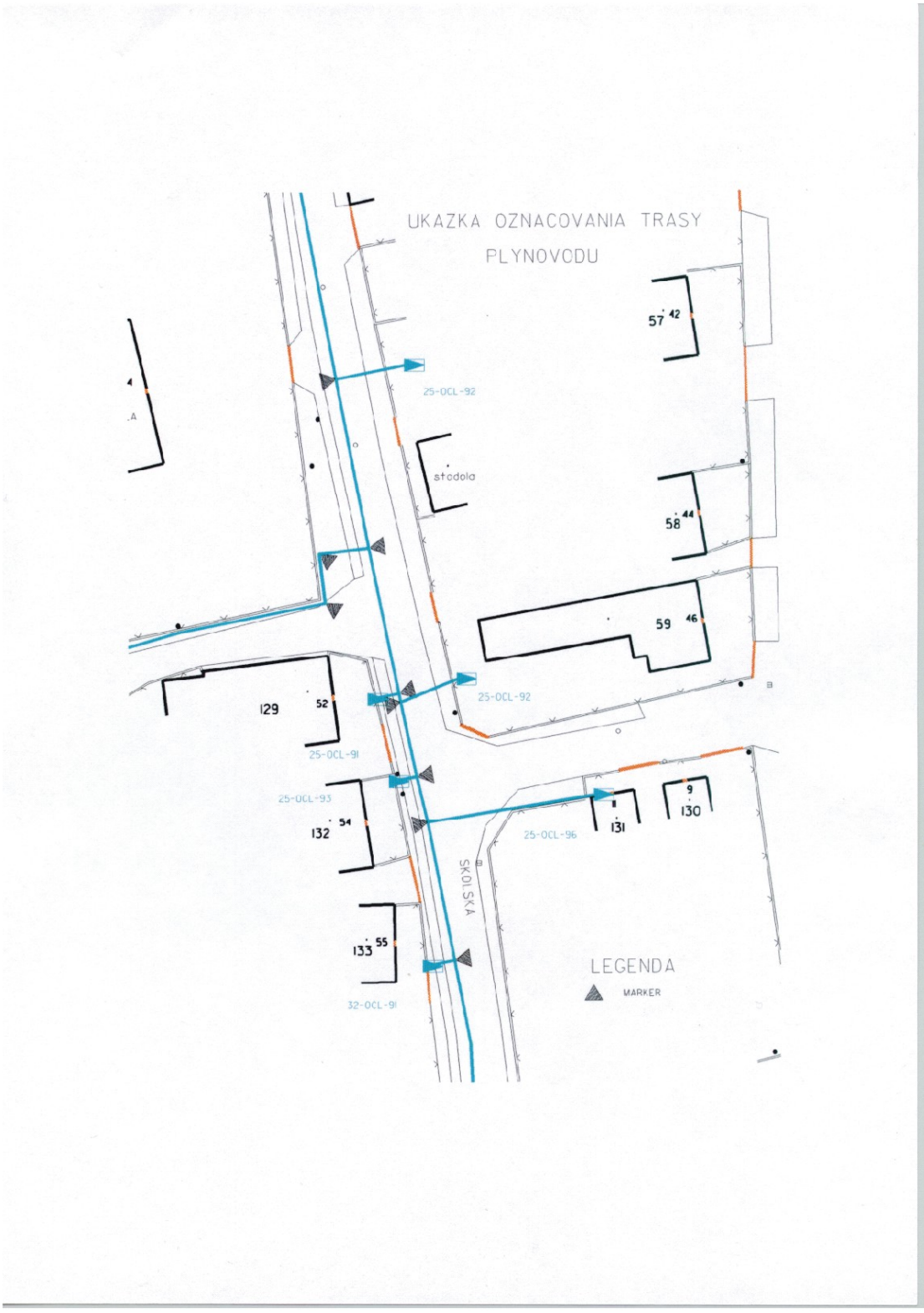
The GPS (Global Positioning System) is a radio navigation system, which lets you know exactly where you are on the globe, in three dimensions. Moreover, this information is available 24 hours a day, and in any weather conditions. This system features 24 satellites and a monitoring network, which are financed and operated by the US Department of Defence. One part of this system is reserved for military purposes, while the other part can be used by anybody for free.

The GPS satellites can be seen as ultra-precise clocks, which send time signals and information about their position. A GPS receiver also features a clock (not as accurate as that of the satellites though), as well as a radio receiver for receiving the satellites' time signals. This clock is used to mark the arrival time of the satellites' signals, which corresponds to the time it was sent plus the time it takes for the satellite signal to reach the receiver. This travel time, when multiplied by propagation time of radio signal, gives the distance between the receiver and the satellite. However, as the receiver clock is not perfect, this calculated distance is not absolutely right (due to the discrepancy between both clocks), and it is therefore called “pseudo distance” rather than distance (also known as “pseudo range”).

The GPS receiver calculates its position by using a method called “trilateration”: from the measured pseudo distances between the reception antenna and at least 4 satellites, and a knowledge of these satellites' positions, the receiver is able to solve a system of equations and to determine its own position in Latitude, Longitude, Altitude (it also gets a very precise time indication, as a by-product).

CAUTION:
The Global Positioning System (GPS) is operated by the government of the United States, which is solely responsible for its accuracy and maintenance. The system is subject to changes which could affect the accuracy and performance of all GPS equipment.
Because GPS module in Smart Marker Locator relies on satellite signals to provide you with navigation, the unit’s view of the sky will determine how fast you achieve navigational status. GPS signals do not travel through rocks, buildings, people, metal, or heavy tree cover...so keep the device in clear view of the sky for best results.
Accuracy of place determining by GPS depends also on atmospheric state (atmospheric discharges, ozone state, etc.).

EXAMPLE OF PLOTTING MARKERS INTO DOCUMENTATION



REFERENCES

References for Smart RFID System

- ✓ In June 2003 we received for Smart RFID system "Golden Aqua" product appraisal on AQUA exhibition in Trenčín.
- ✓ In 2004 we won the tender to supply 15 000 smart markrov and 4 smart marker locators for reparation of water-supply duct project in Athens.

References for KOMPLEX

SEBA KMT Baunach, Germany	AVAANA SOFTWARE & SERVICES PVT. New Delhi, India	SLOVAK TELECOM Bratislava, Slovakia
OPTRON Riga, Latvia	SLOVSMART Piešťany, Slovakia	ORANGE SLOVENSKO Bratislava, Slovakia
ROMTELECOM Bucharest, Romania	CEDAR RIDGE CE Košice, Slovakia	SPP Slovakia
DURALINE Zlín, Czech Republic	SKT Slovakia	SITEL Košice, Slovakia
AUTOMATIZÁCIA ŽELEZNIČ. DOPRAVY Žilina, Slovakia	MASIP Moravany nad Váhom, Slovakia	MURAT Pezinok, Slovakia
VETEL Čadca, Slovakia	VET Trenčín, Slovakia	M-TEL Košice, Slovakia
UNIMONT Banská Bystrica, Slovakia	ELPROJEKT Žilina, Slovakia	TELEKÁBEL Žilina, Slovakia
TELEMAX Bratislava, Slovakia	ŠUM ST Poprad, Slovakia	ISTOS Žilina, Slovakia
NAFTOMONT Poprad, Slovakia	ADOLTEL – HEX Žilina, Slovakia	SLOVMONT Zvolen, Slovakia
SPOJSTAV Košice, Slovakia	KOBIN Trnava, Slovakia	MIPOT Bratislava, Slovakia