

WinTrans

Test point mounted Wireless Remote Monitoring and Control System

Mains-independent Remote Test Point Monitoring

Remote monitoring of cathodic protection systems is only economically feasible if installed at test points and rectifier stations, too, thus reducing amount of time and labour otherwise required for regular manual monitoring of test points and rectifier stations.

MiniTrans has been specially designed for automated wireless remote monitoring of cathodic protection systems to monitor such values like on- and off-potentials, AC voltages, currents and microvolts.

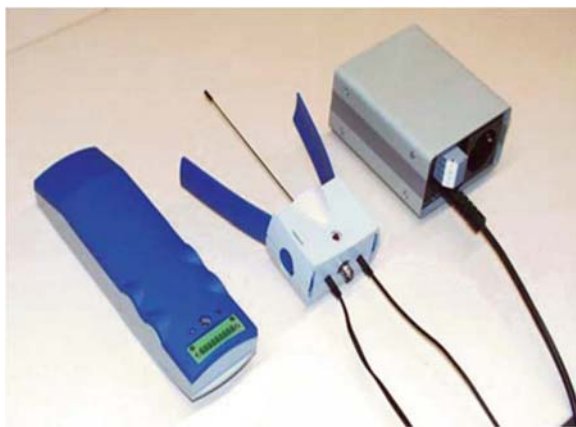
Introduction of low-energy hardware and latest GSM radio technology allows 3 years of daily measurements and monitoring operations without battery change.



Input Channels and Serial PC Interface Port



DCF-77 and GSM Antenna Terminal



Combined System Consisting of Sensor, Antenna Combination and External Power Supply Unit

Low Cost Installation and Setup

Already during installation at test points, **MiniTrans** constitutes a simple and cost-saving solution.

The antenna combination specially designed for combined use of DCF-77 radio time and mobile phone purposes, will simply have to be slipped into the test point pole while wireless sensor will be mounted on top of the terminal board. Incorporating a test point into remote monitoring network requires no more than wiring of input channels, followed by short test of functions.

Multi-Channel Data Logger for remote-controlled Registration

Over and above remote monitoring, **MiniTrans** allows remote controlled multi-channel registration.

MiniTrans thus offers indispensable functions to support measurement of stray currents and fault location.

Time and Cost Saving Remote Programming

Due to comprehensive remote programming facilities of measuring

and radio transmission parameters, MiniTrans allows the technician-operator to control all functions right from the office, eliminating otherwise necessary time- and cost-intensive site travels.

MiniTrans thus allows quick and trouble-free reaction to changes of operational conditions of cathodic protection, such as measuring periods and volume.

In addition to standard requirements of CP measuring technique, MiniTrans continuously supervises and transmits internal data such as battery condition, DCF- 77 and GSM signal strength, ambient temperature and state of synchronisation.

Mains-Supplied Remote Monitoring of Rectifier Systems

Trouble-free and reliable operation of cathodic protection systems depended hitherto on regular and manual supervision of functions and monitoring of rectifier voltages and rectifier currents of cathodic protection stations.

By introducing MiniTrans remote monitoring of protection systems, manual maintenance will be reduced to a minimum.

Mains-supplied and wireless-operated MiniTrans monitors and controls rectifier voltages and currents, as well as on and off-potentials of your cathodic protection system.

Rapid detection of a breakdown of protection systems as well as rectifier problems even in cases of mains failures is being ensured by MiniTrans remote monitoring system built-in back-up battery.



Remote Controlled Switching of Rectifier System with Main Power Supply Unit

Switching of rectifiers for Maintenance and Intensive Measurements

The installation of MiniTrans wireless sensors stations eliminates the hitherto time-consuming, but indispensable temporary installation of current interrupters, required for maintenance and intensive measurements.

Activation of rectifier switching as well as selection of switching cycles of single groups of rectifier stations may be carried out completely office-remote controlled or by mobile team.

Mobile Remote Control of Rectifiers by Mobile Phone

MiniTrans wireless sensors are serially fitted for remote functions via SMS-data.

This allows the use of any SMS-capable mobile phone to activate different switching modes and cycles anytime, anywhere by means of simple key functions.



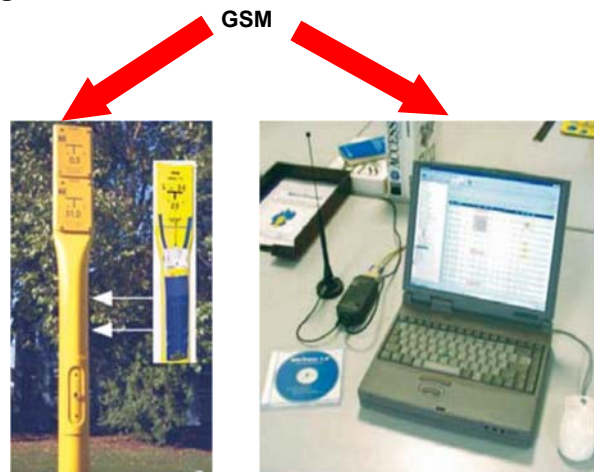
Controlling Rectifier Stations by Mobile Phone

Intelligent and site-independent Remote Monitoring

Intelligent utilisation of latest GSM radio technology allows the use of MiniTrans remote monitoring system locally and abroad including protection against data loss or mutilation.

During automatic data backing-up and transmission by means of GSM mailbox, each MiniTrans wireless sensor auto-secures its remote monitoring functions without the office PC to be in activated state.

Simultaneous reception of measuring data and control of remote monitoring functions by up to 3 offices or mobile supervisory teams is being supported thus allowing to run the entire remote monitoring system without having to operate from fixed office station.



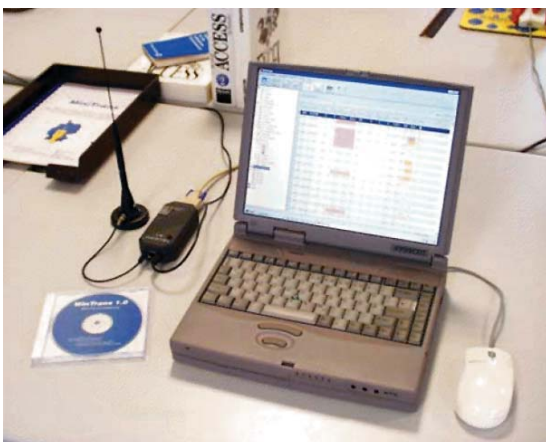
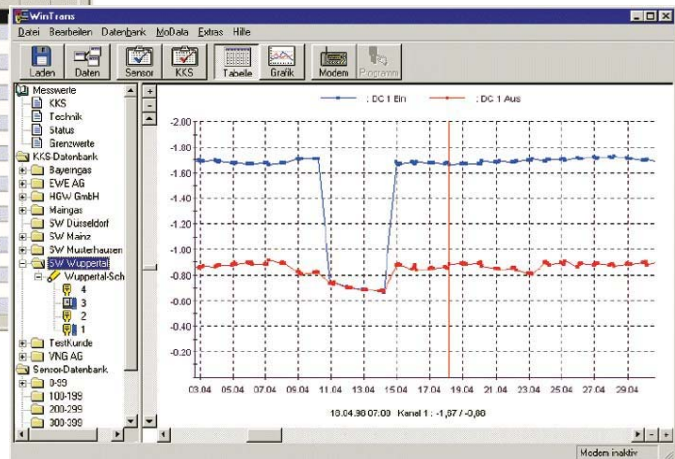
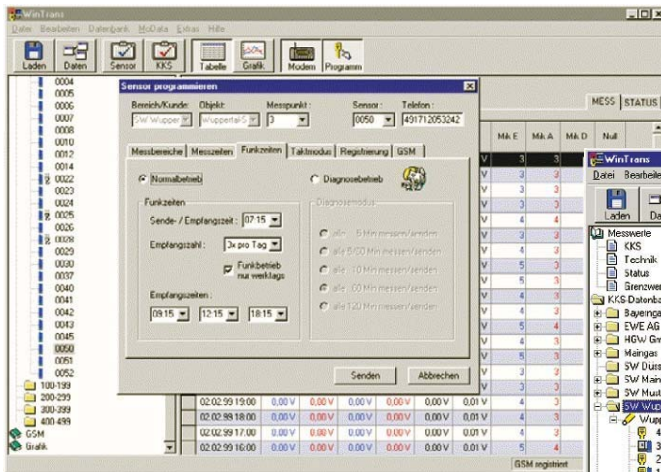
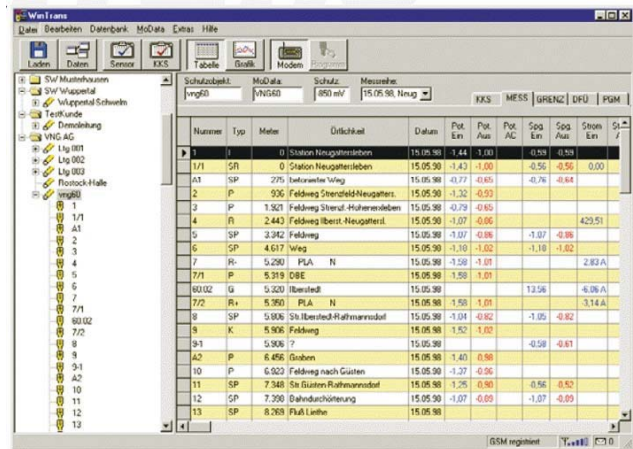
Software for Control and Evaluation of Remote Monitoring and Maintenance

Remote Control and Remote Monitoring

The entire control and evaluation of *MiniTrans* wireless sensors is being effected by *WinTrans* software.

All parameters of current remote monitoring operations, like measuring ranges, measuring periods, radio transmission and switching cycles are being administrated by *WinTrans* and radioed to *MiniTrans* wireless sensors.

By means of a comprehensive and powerful database, optimally programmed to suit the monitoring requirements of your cathodic protection system as well as those of your customers, *WinTrans* administers control and care of your entire CP test points and rectifier stations.



Intelligent Remote Monitoring within Network

The aim to achieve intelligent and maintenance-free use of this remote monitoring system by consequent reduction of numbers of components, was also pursued in the design of the office equipment.

Reliable control and evaluation of test point and rectifier stations out of your office is being enabled by means of *WinTrans* radio modem, external radio antenna, as well as PC / Notebook- installed software *WinTrans*.

Linked with a network, all information regarding test points and rectifier stations of your entire organisation are handy at your fingertips.

Technical Data

Description	Battery operated wireless sensor for radio-controlled monitoring and registration of CP-measuring data and for remote controlled switching of rectifier station
Measuring Inputs	2 x DC (with high AC attenuation) 2 x AC (parallel to DC channel measuring) 1 x μ V (with high AC attenuation)
Memory	32 KByte Program / 96 KByte Data
Interface	9600 Baud serial for programming and supervision on installation site
Timer	DCF-77synchronised real time clock with supply voltage change-over and active temperature compensation
Timer Deviation	50 ms max. at 12 DCF receiver sequences / day (between -20°C and 60°C)
Switching Load Output	30 V / 0.1 A / 30 (higher load with external power supply unit)
Wireless system	Internal radio modem for GSM networks at 900 MHz
Antenna	Special antenna combination for DCF and GSM-radio application for test point mounting or rectifier station installation
Program Updates	Wireless via remote transmission or direct via serial interface
Calibration control QM	Via serial interface with notebook on site
Battery Power Supply	Lithium battery pack 7,2 V / 13 Ah (uninterrupted data safety during battery change)
Mains Power Supply (optional)	External power supply unit with slave relais control
Dimensions / Weight	
Wireless sensor	65 x 240 x 40 mm (W x H x D) / 480 g (incl. Battery)
Antenna	75 x 60 x 40 mm (W x H x D) / 170 g (excl. Antenna rod)

Measuring Ranges

DC Voltage	Channel 1 + 2	
	Range	Resolution
	± 1000 mV	0.1 mV
	± 10 V	1 mV
	± 150 V	15 V
Input Impedance	> 2 M Ω	
Damping	at 16.6 Hz 60 dB (factor 1.000)	
	at 50.0 Hz 100 dB (factor 100.000)	
AC Voltage	Channel 1 + 2	
	Range	Resolution
	1 V eff.	0.2 mV
	10 V eff.	2 mV
	250 V eff.	50 V
Input Impedance	> 2 M Ω	
Frequency range	15 - 500 Hz	
Microvolts	Channel 3	
	Range	Resolution
	± 100 mV	1 μ V
Input Impedance	> 200 k Ω	
Damping	at 16.6 Hz 60 dB (factor 1.000)	
	at 50.0 Hz 100 dB (factor 100.000)	
Zero calibration	Automatic before measurement	

Remote Monitoring / Switching of Rectifier Station

Monitoring facilities	2 DC channels On / Off (e.g. potential and protection tube) 2 AC channels (e.g. potential and foreign pipe) 1 μ V channel On / Off (e.g. pipe current or rectifier current)
Measuring periods	
Mode normal	Max. 4 complete on- and off measurements / day (timer free programmable)
Mode diagnosis	5, 10, 30, 60 or 120 min
Formation of mean value	Freely programmable (without or 1, 2, 4 or 8 min)
Switching options	
Permanent On	e.g. in case of interface measurements
Measuring Cycle	Standard setting at remote monitoring
Permanent Cycle	e.g. 12/3 or 4/2 for intensive measurement
Permanent Off	For pipe repair
Radio periods	
Mode normal	Max. 4 complete on- and off measurements / day (timer free programmable)
Mode diagnosis	Every 5, 10, 30, 60, or 120 min
Status monitoring	
DCF-77 Signal	Quality and reception successes
Synchronisation	Timer deviation in ms
Radio signal	Quality and reception successes
Battery state	Remaining capacity and operational time
Main power supply	Mains failure indicator
Temperature	Temperature measurements
Zero calibration	Monitoring measurements accuracy
Remote programming	All settings and measuring features are completely remote programmable
Battery life span	
Mode normal	Approx. 2.5 to 3 years
Radio on weekends off	Approx. 3.5 to 4 years

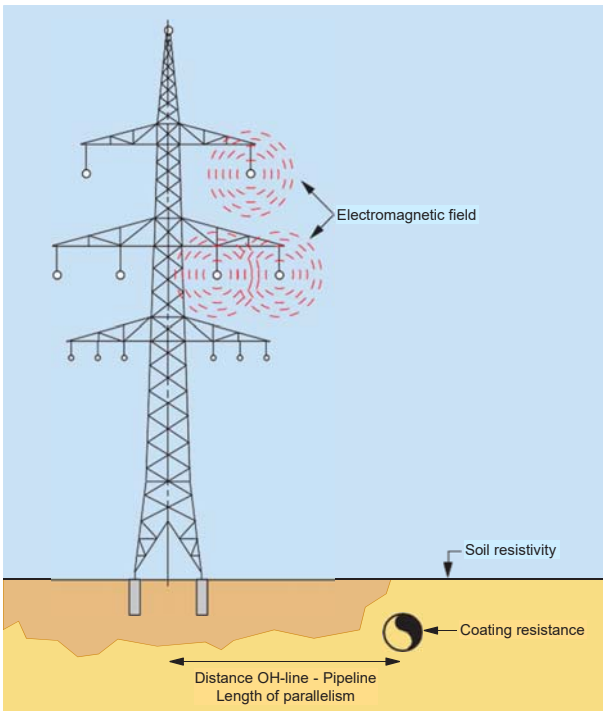
Registration / Data Logger

Channels	2 DC, 2 AC, 1 Microvolts
Sampling Rate	
without microvolts measurements	0,5 s, 1 s, 2 s, 5 s, 10 s, 30 s
with microvolts measurements	2 s, 5 s, 10 s, 30 s
Measuring values memory	ca. 50.000 values
Programing	Number of channels Measuring Range Sampling rate Start-up Terminal time
Data Transmission	Wireless by radio or direct via serial interface
Remote Programming	all features remote programmable
Battery Life Span	Approx. 80 single channel recordings at 1s sampling rate over 6 h (incl. radio transmission)
Zero calibration	Automatic during registration

Pipeline Routing

When choosing pipeline routes, important points must be considered, such as the best possible integration in the environment, authority's requirements for reasons of land planning and rural protection, congested residential and industrial centres, which recently led to the necessity of using already existing high voltage overhead line power supply corridors.

By these achievements, it results inevitably in crossings and parallel running of various routes which can lead to interference and to the increase of danger of high voltages to personnel and equipment. For this undergoes the possible appearance of high contact voltages on the pipeline in case of close proximity and crossings with high voltage overhead lines. Reduction of this potential danger for personnel and equipment is only reached by high technical and economical efforts



Calculations of induced contact voltages

The calculation of induced contact voltages and therefrom the preventive measures are known by their basic elements since a long time.

Contrary to the conventional methods, a combination of estimations, empirical values and calculation which gives adequate values of the appeared effective voltage, we developed and used a computer program for such kind of calculations. By this way it is possible to calculate the close proximity sections and where required, to optimize the necessary earthing measures on the pipeline. The applied calculation method permits the simulation for each overhead line and pipeline configuration. Changes of the overhead line and pipeline parameters along the influenced section can be considered.



Gathering Information

Information gathering is the most important step of high voltage interference problem.

The information required for the investigation can be summarized in the following points:

- The layout drawings of pipelines and high voltage overhead lines routes are needed.
- Top view scale drawings or maps of the entire geographical area of interest, showing all conductors (pipelines) under study in sufficient details, along with major installations.
- High voltage overhead line and pipeline details as follows:

Pipeline data

- Material specification
- Outside diameter
- Coating resistance
- Buried depth
- Specific soil resistivity

High voltage overhead line data

- X-Y Tower coordinates of conductors
- Max. conductor sag
- Height of towers
- Type of conductors
- Type of earth wire on top
- Max. operating current
- Operating frequency
- Short circuit earth fault current
- Neutral point of system

PC based Computer Program

The PC based computer program includes comprehensive electromagnetic coupling equations with a very easy to use interface format to enable both operating and short circuit conditions to be calculated for up to five unbounded pipelines co-located with up to twenty power transmission line circuits.

The program also has been enhanced analytical capabilities including pipeline bond connections and pipeline grounding capabilities for both operating and short circuit mitigation. The format developed for this program makes many of the computational functions and much of the data input automatic for the user, thus leading to considerable simplification in program usage.

Data input for few computer screens are required to fully exercise the program.

Advantages

The time and costs for AC inducing problems, inductively coupled interference studies, new cathodic corrosion protection design with close or crossing competitive pipelines with existing cathodic corrosion protection systems or high voltage overhead lines, right-of-way and integrity planning, is greatly reduced by using the developed software. The program can be used by pipeline engineering staff or contract consultants drastically reducing engineering time and costs while improving the safety and integrity of cathodic corrosion protection design.

Standards and Guidelines

In 1977, NACE has recognized the problem of induced AC on pipelines and originally issued a Standard Recommended Practice to control corrosion and safety issues.

In 1995, this standard has been updated and re-issued as Standard RP-01-77-95 "Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems".

The standard which has been issued in Canada is CAN/ CSA-C22.3 No. 6-M91 "Principles and Practices of Electrical Coordination between Pipe Lines and Electric Supply Lines".

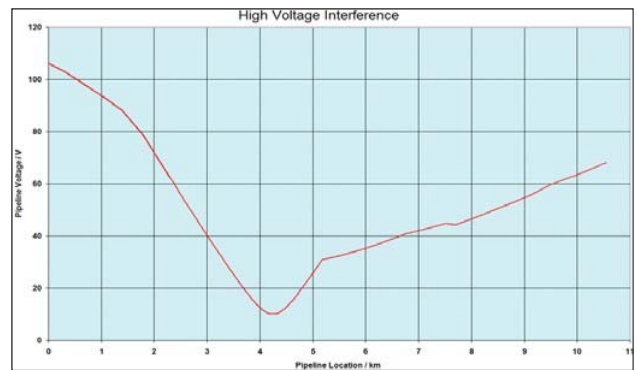
Standards also exist in Europe, such as DIN VDE 0141, (Beuth-Verlag, Berlin, 1976).

The NACE and Canadian standards recommend that the potential on a pipeline from AC be reduced to less than 15 V AC.

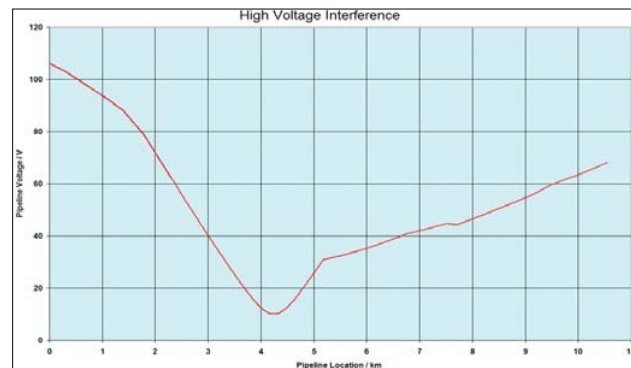
European standards recommend to reduce to less than 60 V AC.

Z-Code	Conductor	Maximum Sag in m	Height of the Tower in m	X-Coordinate in m	Y-Coordinate in m	R.S.T-Code	Masttype
PKZ1	Z1	8,5	31				A20
PKZ1	E1	0	31				
PKZ1	R1	-3,25	27,5 S1	-4	27,5 T1	-4,75	19,5
PKZ1	R2	3,25	27,5 S2	4	27,5 T2	4,75	19,5
PKZ2	Z1	8,5	31				A20
PKZ2	E1	0	31				
PKZ2	R1	-3,25	27,5 S1	-4	27,5 T1	-4,75	19,5
PKZ2	R2	3,25	27,5 S2	4	27,5 T2	4,75	19,5
PKZ3	E1	0	31				A20
PKZ3	R1	-3,25	27,5 S1	-4	27,5 T1	-4,75	19,5
PKZ3	R2	3,25	27,5 S2	4	27,5 T2	4,75	19,5
PKZ4	Z1	8,5	59,5				BD3
PKZ4	E1	0	59,5				
PKZ4	R1	-10,75	49 S1	-14,25	38 T1	-7,75	38

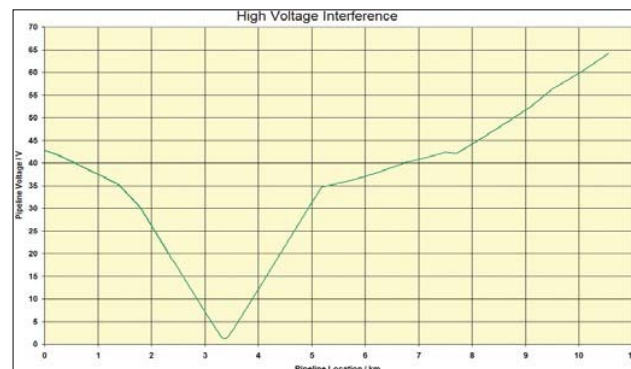
Data input for calculation by using Microsoft Excel as example



Calculation results caused by overhead line **operating currents** without any earthing measures



without any earthing measures



Calculation results caused by overhead line operating currents with earthing measures ($U_{max} < 65$ V acc. to German Standard)

COMPUTER SOFTWARE

Close Interval Potential Survey – CIPS

Document No.: PSE-310-R622

Sheet: 1 of 4

In order to analyse the external corrosion of buried pipelines, pipe/soil potential measurements are made. Pipe/soil potentials are normally measured at fixed test points spaced about 1 km to 5 km along a pipeline. However, reliable information about the status of CP of the pipeline between these test points is unknown since measurement is only valid at the reference electrode location.

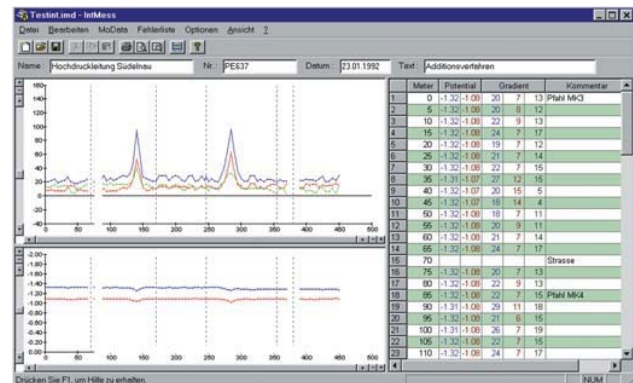
High local differences in soil resistivity, interference and other effects may cause corrosion at intermediate locations even having good potentials at the test points. Therefore, the necessity to decrease the distance between successive potential measurements yields more accurate information concerning the CP-conditions on the pipeline and hence a “close-interval” or an “intensive” measuring technique was developed with potential measurement in steps of 5 m or less over the line.



Reasons to use closed interval potential survey - CIPS

It is impractical and uneconomical to measure pipe/soil potentials manually at close-intervals of 5 m along a pipeline. Recording these results and plotting them by hand especially for a long transmission pipeline system, uses lots of time even when using strip-chart recorders for potential measurements. Therefore, a quick and reliable system has been developed.

CIPS overcomes these problems by automatically recording, storing, calculating and displaying the potential data. The data is given in table and graphical forms by a micro-computer for this purpose.



Required hardware

- Modata2 including Handheld PC Itronix fex21
- Modata2 scope of delivery package

Required software

- NaMobil 3.0
- IntMobil 3.0
- WinTrans 1.0
- IntMess 3.0

The MoData2 is used for field recording of pipe/soil potentials and voltage drops in cathodic protection measurements. The measured potentials are displayed. Pipe-to-soil potential data are recorded in the internal memory of the MoData2, Multifunction Instrument.

4 measuring methods are directly integrated into mobile software package:

- 2-electrode method
- 3-electrode method
- Adding-up method
- IFO-method

Method: IFO

IFO (Intensive Fault Location) is preferentially being used with new pipelines with intact coatings and a relatively small number of defects.

IFO only serves to detect faults and does not allow measuring potentials. For checking the potential at a test point during the IFO measuring, it is necessary to switch to either 2- or 3-electrode method.

In order to optimize the measurement of even the smallest voltage differences, it is common habit to increase the feeding current of the rectifier while measuring with the IFO method, which produces a higher potential gradient at fault locations.

Description of the measuring method

The IFO method measures the on- and off-voltage drops along pipelines. For this, two electrodes are placed at ground level along the line at distances of 5 or 10 m. The standard step size is 5 m, i.e. both electrodes will be shifted by another step (of 5 m) in the measuring direction after each measurement has been completed.

For an evaluation of the values of the IFO measurement, the difference between the measured on- and off-voltages will be compared. An increment of the voltage differences followed by a reversed polarity indicates a likely defect location.

Note regarding the electrode placing

Selecting a distance of 10 m between the two moving electrodes offers advantages when measuring small voltage drops. A distance of 5 m, however, allows to determine the absolute voltage gradient by simply adding up the voltage drops measured.

Measuring array: IFO

The measuring array for the IFO measurement is very simple to implement: Just connect terminal channel B and the ground to the 2 electrodes used.

Method: 2-electrodes

This method is definitely the most frequently applied one for intensive measurements.

The switching-on and -off potentials as well as the values of the respective voltage gradients are measured at each individual measuring point.

The measuring of the on- and off-potentials is performed by means of a direct connection of the measuring contacts, while the measuring of the on- and off voltage gradients takes place perpendicular to the pipeline axis at a distance of about 5 to 10 m. To ensure a reliable comparison of the voltage gradient values, the measurement has to take place at a constant perpendicular distance to the pipeline.

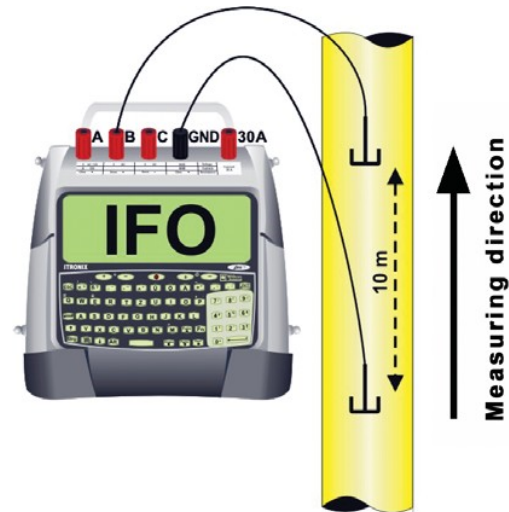
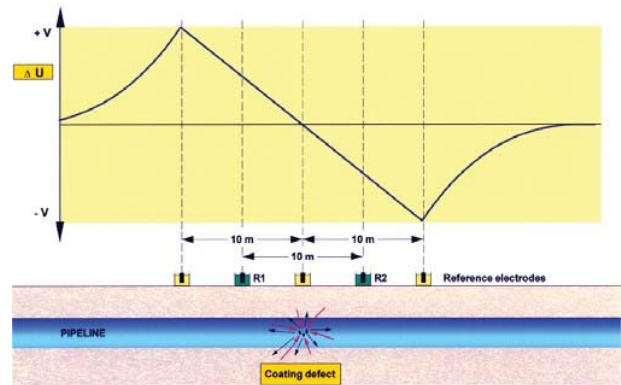
Advantages of the 2-electrode method

Since this direct way of collecting measuring values does not require any adding up, it is very easy to perform from the measuring technique point of view.

Disadvantages of the 2-electrode method

As this method requires a direct connection to the test point it possibly requires rather large cable lengths, i.e. at least half of the distance between the two test points.

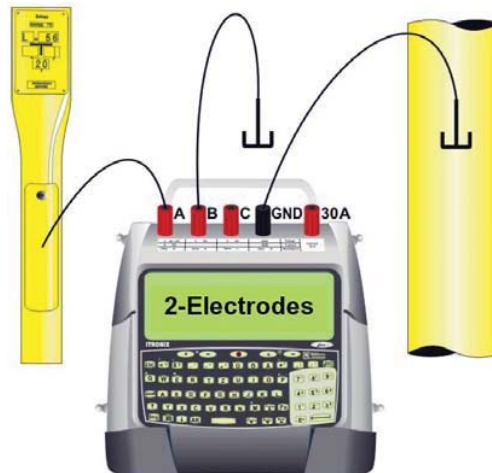
Moreover, taking the perpendicular measurements of the voltage gradients requires a constant and relatively large distance to the pipeline axis (about 10 m), which means that difficulties may arise in uneven terrain, residential- or industrial areas.



Measuring array: 2-electrode method

Applying this method requires a proper connection to the test point. For measuring potentials, channel A of the MoData2 multi task converter (MTC) is to be linked with the test point. The lateral measuring electrode is to be connected to channel B of MoData2.

The reference electrode being directly on top of the pipe axis is to be connected to the black ground terminal of the MTC.



Method: 3-electrodes

The 3-electrode method constitutes an extension of the 2-electrode method. In contrast to the latter, the 3-electrode method allows measuring two voltage gradients symmetrically along both sides of the pipe axis.

The MoData2 system thus allows the calculation of IR-free potentials according to the so-called "extrapolation method" by measuring the potential and the two voltage gradients on the left and right sides of the pipe exactly simultaneously.

Advantages of the 3-electrode method

This method offers considerable advantages when evaluating intensive measurement data of parallel pipelines. Interfering external voltage gradients on one side of the pipe axis can be suppressed during the evaluation of the measurement data thus allowing a more realistic data evaluation.

Frequent use is being made of the 3-electrode method when re-measuring pipe locations that have been detected earlier with the IFO method as being flawed. The measurement of the left and right side voltage gradients combined with a calculation of the IR-free potential allows in most cases a more precise assessment of the cathodic protection at the flawed pipe spots than it would be the case with other measurement methods.

Disadvantages of the 3-electrode method

The voluminous measuring array requires a relatively large number of staff to operate the system. The double-sided measurement of the voltage gradients at the largest possible and constant electrode distance (e.g. 20 m between the left and the right electrode) leads in difficult terrain to a slow daily progress.

Measuring array: 3-electrode method

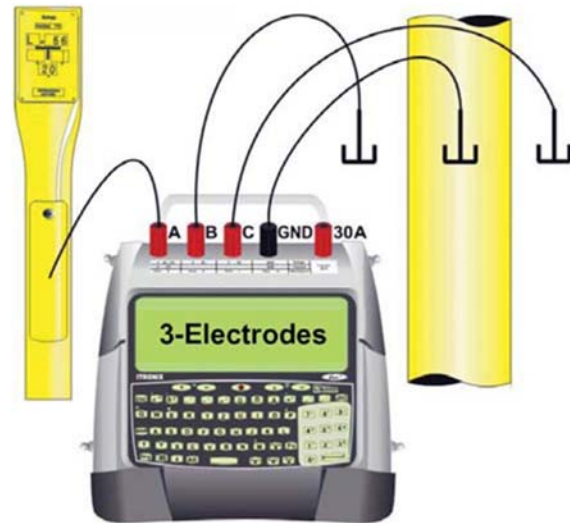
Applying this method requires a proper connection to the test point.

For measuring potentials, channel A of the multi task converter (MTC) is to be linked with the test point.

The perpendicular measuring electrodes are to be connected to channels B and C of the MTC.

The reference electrode being directly on top of the pipe axis is to be connected to the black ground terminal of the MTC.

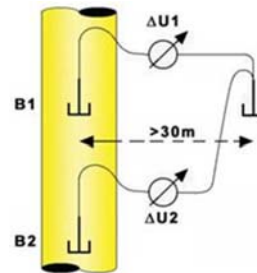
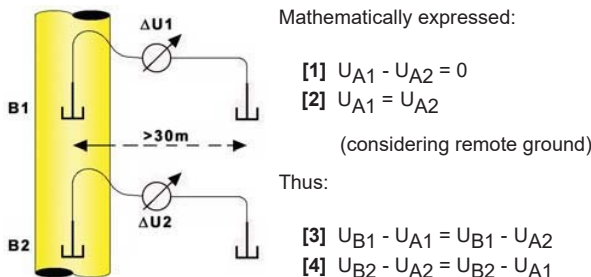
It will be sensible to compensate electrode differences to ensure a reliable calculation of the IR-free potential.



Method: Adding-up

The adding-up method allows to easily perform longitudinal voltage measurements and a subsequent calculation of potentials and voltage gradients.

The adding-up method is based on the assumption that the voltage between two reference electrodes being installed on "remote ground" is more or less 0 mV. This means that, for instance, during a voltage gradient measurement the position of the laterally mounted reference electrode is of no importance as long as it is installed on "remote ground" only.



Assumption:

[5] $\otimes U_1 = U_{B1} - U_{A1}$

[6] $\otimes U_2 = U_{B2} - U_{A1}$

resulting in equation (for UA1):

[7] $\otimes U_1 - U_{B1} = \otimes U_2 - U_{B2}$

[8] $0 = \otimes U_1 + (U_{B2} - U_{B1}) - \otimes U_2$

Thus:

$\otimes U_2 = U_{B2} - U_{B1} + \otimes U_1$

The laterally positioned reference electrode may be installed on remote ground.

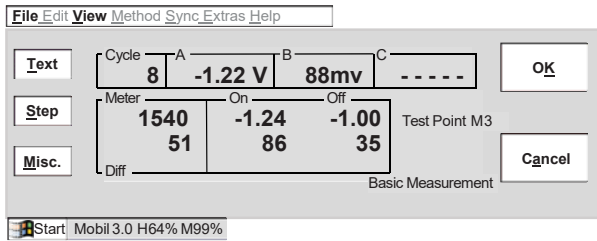
This means that the voltage gradient $\otimes U_2$ can be calculated by taking the differential voltage $U_{B2} - U_{B1}$ (voltage drop alongside the pipeline) and adding $\otimes U_1$ (basic voltage).

The procedure of calculating the potential is similar.

Basic value collection

Prerequisites for any calculation are the so-called “basic values” that are to be collected when commencing the measuring and again whenever further measuring contacts are being reached.

Each time basic values are measured, IntMobil shows “Basic Measurement” beneath the line for the text entry on the display of the current measuring mode.



Basic values are taken using the 2-electrode method. Please refer to for the measuring array.

Basic values may be taken and calculated at any test point. This results in a higher accuracy of the calculation of further potentials and voltage gradients.

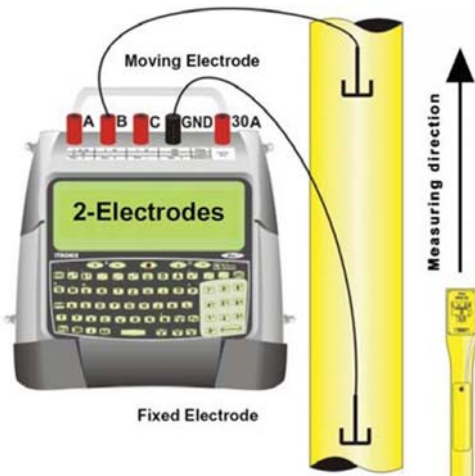
Notes regarding the adding-up method:

When taking basic values at stray current-influenced pipes, problems may arise during the adding-up procedure. The basic values may drift during the intensive measurement thus leading to incorrect values.

Furthermore, it must be noted that upon each electrode shifting larger electrode differences may lead to significant step changes of the voltage gradient and/or potential values. Therefore, keep the number of electrode shifts as small as possible.

Measuring array: Adding-up method

After the measurement of basic values has been completed, the so-called “fixed electrode” has to be placed exactly where the reference electrode was positioned during the basic measurement of voltage gradients and potentials. The so-called “moving-electrode” has to be placed according to the step size along the pipeline.

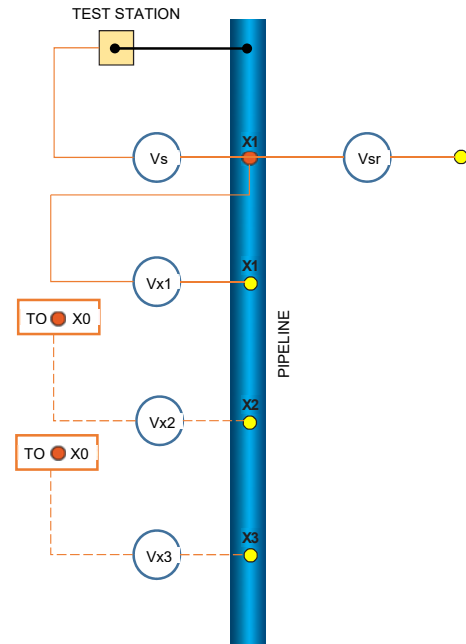


After a measurement has been completed, the moving electrode will be repositioned by one step size in the measuring direction along the pipeline. The fixed electrode remains at its location and will only be moved and repositioned after an electrode shift or in the course of a new basic measurement.

Shifting electrodes

The fixed electrode remains positioned during the basic measuring value collection. During the progress of the measuring procedure increasingly larger cable lengths will be required between the fixed electrode and the multi task converter (MTC). If an extension cable is unavailable, the fixed electrode has to be shifted to make further intensive measurements possible.

BASIC METHOD FOR MEASUREMENT OF POTENTIAL



- MOBILE REFERENCE ELECTRODE
- STATIONARY REFERENCE ELECTRODE
- Vs PIPE-TO-SOIL POTENTIAL AT STARTING POINT X0
- Vsr PIPE-TO-REMOTE GRADIENT
- Vx1 POTENTIAL DIFFERENCE BETWEEN X0 AND X1

IntMobil stores the latest voltage gradient and potential values measured during the electrode shift and uses these values as new basic values for the addition of measured longitudinal voltages between the fixed and the moving electrode.

Note regarding the shifting of electrodes

Shifting electrodes is not only helpful after the available cable length has been fully used, but also when crossing railway lines or roads. Collect the measuring values beyond the railway line. Afterwards, shift the electrodes as described above with the fixed electrode being positioned beyond the railway line. Cabling across the obstacle will then be necessary for the period of one measurement only.

COMPUTER SOFTWARE

Calculation of Cathodic Protection Systems

Document No.: PSE-410-R622

Sheet: 1 of 2

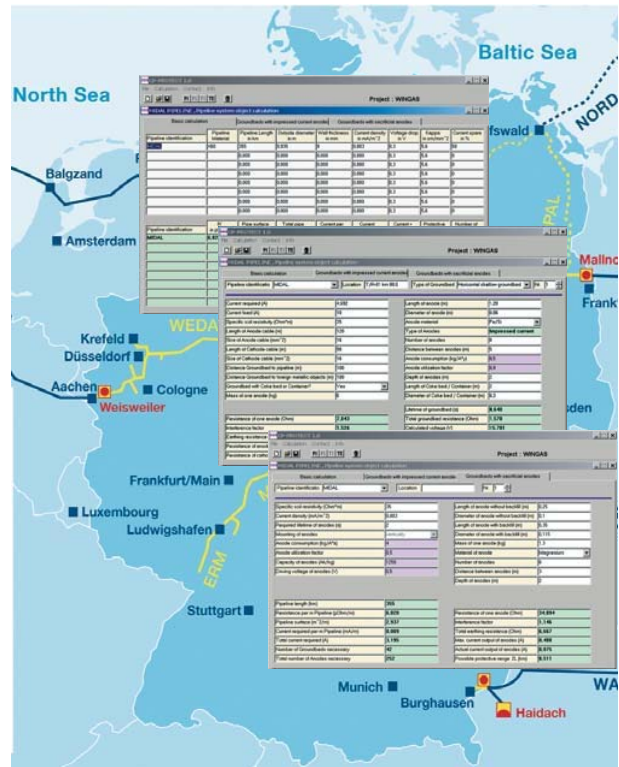
The continuous development of user-orientated computer software based on practical experiences is one of the major activities of the company for design and engineering of various kinds of cathodic protection projects.

CP-CALC - a calculation software package - has been devised to solve the planning problems for design and engineering of cathodic protection systems for various types of structures.

The software package is the award-winning calculation software for professionals who need to calculate cathodic protection systems simply and precisely.

With *CP-CALC* you get a whole array of time saving devices to help you work better than you ever thought possible.

System requirements: Windows



CP-CALC: PIPELINES

- current requirement calculation
- protective range calculation
- stations with horizontal shallow groundbed
- stations with vertical shallow groundbed
- stations with open hole groundbed
- stations with closed hole groundbed
- galvanic anode systems
- temporary protection with magnesium anodes
- current density as a result of drain test
- offshore pipes with bracelet anodes

CP-CALC: INDUSTRIAL PLANT AREAS

- current requirement calculation
- stations with horizontal shallow groundbed
- stations with vertical shallow groundbed
- stations with shallow sub-groundbeds
- stations with open hole groundbed
- stations with closed hole groundbed

COMPUTER SOFTWARE

Calculation of Cathodic Protection Systems

Document No.: PSE-410-R622

Sheet: 2 of 2

■ current requirement calculation

■ galvanic anode system

■ with aluminium, magnesium, zinc anodes

■ impressed current system

CP-CALC: OFFSHORE STRUCTURES



CP-CALC: STORAGE TANKS, INTERNAL



■ current requirement calculation oil tank

■ current requirement calculation water tank

■ galvanic anode system

■ with aluminium, magnesium, zinc anodes

■ current requirement calculation

■ stations with open hole groundbed

■ stations with closed hole groundbed

■ stations with horizontal shallow groundbed

■ stations with vertical shallow groundbed

■ current drain (E-log I) test

CP-CALC: PRODUCTION WELL CASINGS



COMPUTER SOFTWARE

Well Casing Potential Profile (WCPP)

Document No.: PSE-510-R622

Sheet: 1 of 1

Well Casing Potential Profile (WCPP)

The electrical potential is the most important criterion in cathodic protection to determine the degree of protection on a buried or submerged metal structure.

The degree of protection is indicated by the potential difference measured against a reference electrode placed in the surrounding medium.

Commonly used reference electrode is the saturated copper/ copper sulphate (Cu/CuSO₄) electrode.

Potential differences of at least -0.85 V / Cu/CuSO₄ is widely accepted as the criterion for the protection of steel in soil or water. The potential difference should be measured with the reference electrode placed as near as possible to the structure, to minimize voltage drops (IR) errors caused by cathodic protection current flowing through the medium.

Physically and electrically a well casing is similar to a pipeline installed vertically. The decrease of current and voltage with distance from the drain point of the cathodic protection station is like that along bare pipeline.

However, the cathodic protection test methods applicable to pipelines are not suitable to well casings. Whereas test leads can be installed at any point on most pipelines to measure potentials and currents, such measurements on well casings can be done at the well head only.

For this purpose, the company has developed the software package WCPP, well casing potential profile calculation.

This calculation method gives, under consideration of the physical data of the well casings and electrical measurements of potentials and current at well head, the possibility of determining potentials and currents at various points along the depth of the casing.

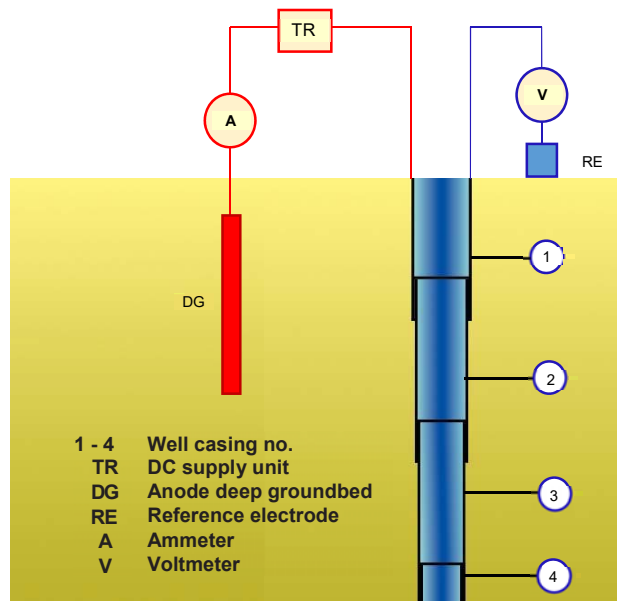
Variables which can be used are as follows:

Physical

number of casings	:	n
length of casings	:	L
diameters of casings	:	D
specific weight of casings	:	W

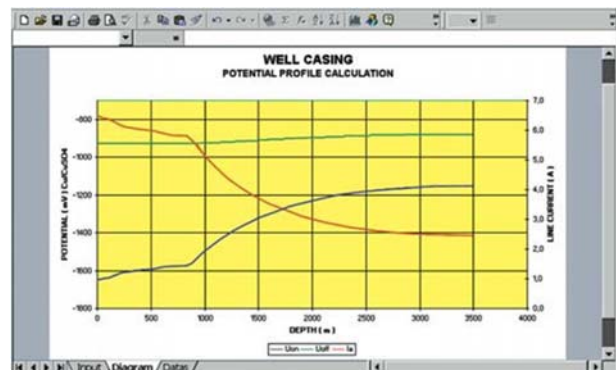
Electrical variables measured at the wellhead

natural potential	:	E _{nat}
on – potential	:	E _{on}
off - potential	:	E _{off}
drain current	:	I



WELL CASINGS							
POTENTIAL PROFILE CALCULATION							
PHYSICAL DATA							
6. CUSTOMER	AGOOD						
7. PROJECT No.	CT 24-00-1E						
8. SITE	NAFOORA						
9. LOCATION	GOSP 3						
10.							
11. DATE	12.03.1992						
12. WELL-No.	C 116						
13. DATA TAKEN BY	Taeqig						
14.							
PHYSICAL DATA							
TYPE OF CASING	CASING No.	LENGTH OF CASING	INNER DIAMETER OF CASING	WALL THICKNESS OF CASING	rho	rs	
17. Inner Casing	1	3500 m	150 mm	9.00 mm	0.2573 Ohm/m	5.72E-05 Ohm/m	
18. Outer Casing	2	850 m	250 mm	8.00 mm	0.1992 Ohm/m	3.07E-05 Ohm/m	
19. Outer Casing	3	500 m	300 mm	7.00 mm	0.2000 Ohm/m	2.96E-05 Ohm/m	
20. Outer Casing	4	100 m	320 mm	6.00 mm	0.2000 Ohm/m	3.25E-05 Ohm/m	
21.							
22.							
23.							
ELECTRICAL DATA (taken at well head)							
26. NATURAL POTENTIAL	U _{in}	-620 mV	against Cu/CuSO ₄ electrode				
27. ON-POTENTIAL	U _{on}	-1650 mV	against Cu/CuSO ₄ electrode				
28. OFF-POTENTIAL	U _{off}	-508 mV	against Cu/CuSO ₄ electrode				
30. DRAIN CURRENT	I _d	6.5 A					
31.							

Input Menu



Potential Profile Diagram

Potential Output Data

available on monitor or on printer