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DC - Micro Voltmeter 2000

General

The micro voltmeter has a sturdy plastic case with a carrying handle which can be adjusted in 30° steps. Controls and indicators are located in a clear, logical configuration. Controls are grouped in accordance with the various functions of the unit.

Measuring Range

The micro voltmeter is a highly accurate moving coil instrument equipped both with an accumulator and a 230 V, 50-60 Hz socket for direct line connection. Two scales are provided with 10 skt and 3 skt. Fullscale ranges from 10 µV to 300 V

Polarity Indicator and Zero Adjustment

The unit features automatic polarity switching to ensure correct readings irrespective of polarity. Two LED´s on the front panel indicate the polarity of the voltage measured; a

control is provided for zero adjustment on the µV-range.

Active Filters for eliminating AC-influence

The 16 Hz and 50 Hz low-pass filters can be used to eliminate interference frequencies during measurements.

Isolated Amplifier Output

An output socket for the connection of an external recorder to document the measurements is located in the front panel. A special isolating amplifier is connected to the socket to isolate it from the input circuit. Recorders with earthed inputs can therefore be used without distorting the measurement.

Power supply 230 V

Power supply either via the 220 V socket or via the built-in NiCd batteries is possible. The unit is equipped with a built-in battery charger, an automatic monitoring system and protection against excessive discharging. Both battery charging and battery charge conditions are indicated.

Power supply 12 V Option

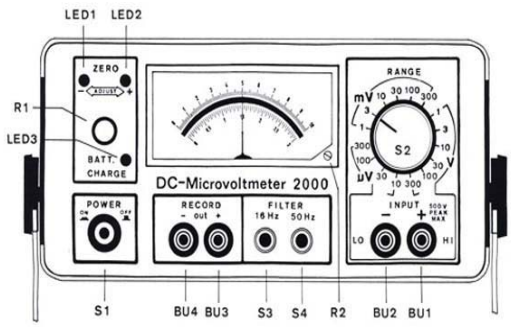
A converter DC-DC with a screwed plug connecting to the rear panel is available as an optional extra for using a 12V car battery as power supply during field measurements.

Front Panel Controls and Indication

S1	Power - On button, with red mechanical indicator
S 2	Range selector
S 3 / 4	Filter-switch for eliminating AC influence
BU 1 / 2	Brass input sockets
BU 3 / 4	Amplifier output for external chart recorder connection Full-scale range is transferred to 1 V
LED 1 / 2	LED to indicate input polarity
LED 3	LED-button to indicate battery charging and battery control
R 1	Zero adjuster for microvolt ranges
R 2	Mechanical zero adjustment for moving coil instrument

Technical Data:

Measuring range	± 10 µV to ± 300 V
Input impedance	1 MΩ for ranges 10 µV upto 3 mV 10 MΩ for ranges 10 mV upto 300 V
Display	Analog pointer instrument with scaling factor 3 and 10 divisions
Accuracy	+/- 1.5% of full scale
Drift	+/- 0.2 µV / °C for operating temperatures from 15 up to 40°C
Series-mode rejection	16 Hz - 60 dB, 50 Hz - 80 dB
Basic pointer deflection	5 skt. on the 10 µV range
Polarity indication	LED display
Offset-control	± 45 µV
Recorder output	± 1 V to kΩ
Dimensions	105 x 230 x 230 mm
Weight	1.9 kg
Power supply	230 V line voltage or via insert NiCd-accumulator 9.6 / 1.6 Ah
Operation time	approx. 18 h non-stop operation with one accu-charge approx. 8 h by switched-on amplifier
Electric strength	max. 500 V DC or 300 V effective on all ranges



LC-4 Handheld Multimeter

Pick up a Model LC-4 and have these features in the palm of your hand:

- DC volts for IR drop, potential & rectifier readings
- AC volts for potential & rectifier readings
- Ohms for continuity & resistance testing
- Selectable input resistance displays “freeze” for instant off & coordinated tests
- Optional plug-in shunt for current readings
- Heavy duty carrying case

General

Model LC-4 is a hand-held voltmeter to include a number of special features which facilitate corrosion and cathodic protection testing on underground structures. It is designed for field testing under almost any environmental conditions. Sealed Mil Spec. switches, sealed windows, a gasketed case and a printed circuit board with baked-on moisture and fungus resistant coating on both sides make this possible.

The large (0.5") display characters are easy to read under both high and low lighting conditions and function over a wide temperature range with very little drain on the battery.

The LC-4 is recommended for potential surveys, side drain measurements, surface potential surveys, IR drop measurements, checking both the AC and DC circuits of rectifiers, checking for stray or hazardous AC potentials, and checking galvanic anodes. DC current measurements require the use of an optional plug-in shunt (0-20 Amp).

The selectable input resistance feature permits detection of high resistance in the external circuit and elimination of resulting errors in virtually all cases.

The push-to-hold-reading button freezes the display at any desired time, which makes the meter usable in many areas having varying stray currents. It is also useful when conducting instant-off and coordinated tests.

Accessories

Spare Carrying Case
Made of heavy, water resistant simulated leather, this carrying case leaves your hands free to perform tests. A quick opening snap permits ready access to the instrument, and a belt loop is included with a snap fastener.

Electrode Extension Adapter
Designed to save effort (and your back) as well as to protect you from snakes and poison ivy, the MCM electrode extension adapter firmly mates with the base of the meter by the use of Velcro® pads. The base has a threaded socket which connects to either input terminal by means of a test lead pigtail with a banana plug. Any MCM intermediate electrode extension can be screwed into the socket.

Specification:

Logic	CMOS, crystal controlled timing
Display	Liquid crystal, 3 1/2 digits, 0.5" high
DC Volt Range	0 - 20 mV (0.01 mV resolution) 0 - 200 mV (0.1 mV resolution) 0 - 2 V (1.0 mV resolution) 0 - 200 V (0.1 V resolution)
AC Volt Range	0 - 600 V (1.0 V resolution)
Resistance Range	0 - 200 Ohms (0.1 Ohm resolution)
DC Current Range	Using optional 0.001 Ohm LC Shunt: 0-20 A (0.01 A resolution)
Accuracy	DCV: 1% of reading ±1 digit ACV: 3% of reading ±1 digit Ohms: 2% of reading ±1 digit
AC Rejection @ 50/60/400 Hz	20 mV range: 20 mV AC 200 mV range: 5 VAC 2 V range: 120 VAC 200 V range: 600 VAC
DC Rejection	600 VAC range: 600 VDC
Zero	Automatic
Decimal Point	Automatic; set by range switch
Polarity	Automatic; negative symbol displayed, positive assumed
Input Resistance	20 mV range; 1000 Ohms. All other DCV ranges are switch selectable (10, 25, 50, 100, 200 megaohms)
Operating Temperature	+8˚F to +176˚F (-14˚C to +80˚C)
Battery	One 9V alkaline recommended
Dimensions	6-1/8 x 3-5/8 x 1-3/4" overall (15 x 8 x 4.5 cm)
Weight	11 oz. approx. (0.312 kg)

External Shunt

Two shunts which plug directly into the 20 mV range of the LC-4 Meter are available:

- 0.00Ω / 50A/ 1mV = 1A (measure up to 20A on the20mV range).
- 0.1Ω / 2A/ 100mV= 1A (measure up to 200mA on the 20mV range).

Multimeter Model B3A2

Advantages

- Designed for the corrosion control industry
- Increased dependability through solid state design
- RFI shielded throughout
- Accurate, stable readings
- Active filtering for power frequency rejection
- Selectable input resistance
- Withstands the harshest environments
- Flexible multimeter for all your corrosion tests

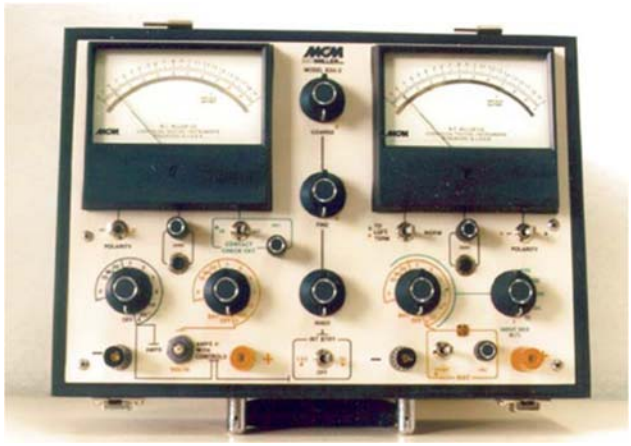
Specifications

Left meter:

- DC voltage ranges, zero to full scale: 2 mV, 10 mV, 20 mV, 100 mV, 200 mV, 1 V, 2 V, 10 V, 100 V
- Minus 10% of full scale on all ranges
- Input polarity reversal switch on volts and amps ranges eliminates the need to reverse test leads
- Best resolution: 20 µV (0.00002 V) on the 2 mV range
- Input Resistance:
  10 000Ω on 2 mV and 10 mV ranges
  10MΩ on 20 mV to 100 V ranges
- Line frequency rejection: >60dB @ 60Hz
- RF rejection: > 70dB @ 1MHz
- Overload protection: 10 times full scale
- 9 DC ampere ranges, zero to full scale: 2 mA, 10 mA, 20 mA, 100 mA, 200 mA, 1 A, 2 A, 10 A, 20 A
- Minus 10% of full scale on all ranges
- Best resolution: 20 µA on the 2 mA range
- Burden voltage: 20 mV
- Overload allowed: 5 times full scale, less than 5 sec.
- Contact check: > 200 mA short circuit
- Adjustable output current supply: controllable 0 to 3 VDC and 0 to 4 A
- Control external current flow with built-in 25 W adjustable rheostats
- Read internal battery voltage directly
- Left meter switch: internally connects right meter to left terminals, enabling current and voltage to be read simultaneously.

Right meter:

- DC voltage ranges, zero to full scale: 2 mV, 10 mV, 20 mV, 100 mV, 200 mV, 1 V, 2 V, 10 V, 20 V
- Minus 10% of full scale on all ranges Input polarity reversal switch on volts
- Best resolution: 20 µV (0.00002 V) on the 2 mV range
- Input resistance: 100,000© on 2mV and 10mV ranges. selectable from 1 MΩ, 10 MΩ, 25 MΩ, 50 MΩ, 100 MΩ,200 MΩ on 20 mV to 100 V ranges
- Line frequency rejection > 60 dB @ 60 Hz
- RF rejection > 70dB @ 1 MHz
- Bias control + full scale, all ranges
- Overload protection 10 times full scale



General Information

- A major design achievement was to eliminate the effects of RFI, and offer accurate, repeatable readings.
- Impact resistant d'Arsonval meters with taut band movement to withstand rough handling.
- Resistant to rain, dust and temperature: - 0°F to 150°F.
- 10% upscale: -0.1, 0, 1; -.02, 0, 2: a visual prompt which indicates when the reading crosses zero.
- Knife-edge pointer with easy-to-view mirror scale.
- Accuracy: +0.5% of full scale for all ranges.
- Tracking accuracy: +0.5%

Applications

The B3A2 was designed specifically as a cathodic protection test instrument. In most cases it is all that is required for the test and evaluation of existing systems or design of new installation. It can be utilized in making the following tests, all of which are illustrated in the B3A2 operating manual:

- Structure-to-soil potentials
- Current measurements (direct null-amp method, 2 or 4 terminal zero resistance)
- IR drops and calibration of IR drop test stations
- Soil or water resistivity by soil box and by 4-electrode method
- Soil potential gradients
- Continuity tests
- Pipe coating resistance tests and fault surveys (over- the-ground method)
- Galvanic anode rectifier output and cathodic protection interference tests
- Duct slug survey on lead covered cables and concrete bridge deck surveys
- pH determination
- Grounding tests

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Digital Multimeter with manual ranging MM 2

The MM 2 offers all advantages of a Digital multimeter with manual measuring range selection such as fast response time due to the manually selectable measuring ranges and easy handling due to color-marked measuring ranges.

The multimeter MM2 is provided with DC and AC voltage ranges of up to 1000 V_{DC}/750 V_{AC} as well as with DC and AC current ranges of up to 20 A. Further measuring functions are resistance measuring up to 20 MΩ as well as an acoustic continuity and diode test.

The MM 2 has an automatic switch-off function when not in use (approx. 30 min.) and a battery low voltage indication as well.

The included protective rubber holster makes it possible to use it under roughest environmental conditions. The measuring ranges of the MM 2 are protected against overload.

Accessories for Multimeter MM

Set TA2

Ø 4 mm safety measuring lead set, silicone, 6-piece, red, black, professional design, CAT III 1000 V, consisting of:
2 x Ø 4 mm safety measuring leads, silicone, L = 100 cm, 19 A
2 x fully insulated crocodile clips with toothed jaws and fine wire surface, 32 A
2 x Ø 4 mm safety test probes, 20 A

Set TA3

Ø 4 mm safety measuring lead set, silicone, 8-piece, red, black, professional design, CAT III 1000 V, consisting of:
2 x Ø 4 mm safety measuring leads, silicone, L = 100 cm, 19 A
2 x fully insulated crocodile clips with toothed jaws and fine wire surface, 32 A
2 x safety test probes with slight tip made of stainless steel, 1 A
2 x safety claw gripper with strong claws, 16 A

Display	31/2 digit LC display (1999 pixels)
DC voltage:	200 mV/2 V/20 V/200 V/1000 V
Resolution/accuracy	max. 0.1 mV/max. ± 0.5 % + 2 digit
AC voltage	200 mV/2 V/20 V/200 V/750 V
Resolution/accuracy	max. 0.1 mV/max. ± 1.3 % + 5 digit
Measuring method	RMS value
DC current	200 µA/2 mA/20 mA/200 mA/20 A
Resolution/accuracy	max. 0.1 µA/max. ± 1.0 % + 2 digit
Over voltage protection	1 A, 16 A (500 V) fuse, fast
AC current	200 µA/2 mA/20 mA/200 mA/20 A
Resolution/accuracy	max. 0.1 µA/max. ± 1.5 % + 3 digit
Over voltage protection	1 A, 16 A (500 V) fuse, fast
Measuring method	RMS value
Resistance	200 □/2 k□/20 k□/200 k□/ 2 M□/20 M□
Resolution/accuracy	max. 0.1 □/max. ± 0.75 % + 2 digit
Continuity test	50 □, acoustic: buzzer, optic: LCD
Diode test	1.5 mA
Over voltage protection	750 V effective resp. 500 V effective
Range switching	manual ranging
Over voltage category	CAT III 600 V, CAT II 1000 V
Operation temperature	0 °C to + 50 °C
Dimensions (l x w x h)	192 x 95 x 50 mm
Weight	550 g
Battery type	9 V battery IEC 6LR61
Delivery includes	multimeter, protective rubber holster, carrying case, battery, double insulated safety test leads

The three models of the new 170 Series are the new benchmarks for general purpose multimeters. They set the standard with a combination of precision, features, ease- of-use, safety and reliability.

Features

- True RMS voltage and current measurements
- 0.09% basic accuracy (177, 179)
- 6000 count resolution Digital display with analog bar graph and backlight (177, 179)
- Manual and automatic ranging
- Display Hold and Auto Hold
- Frequency and capacitance measurements
- Resistance, continuity and diode measurements
- Temperature measurements (179)
- Min-max-average recording
- Smoothing mode allows filtering of rapidly changing inputs Easy battery exchange without opening the case
- Closed case calibration through front panel
- Ergonomic case with integrated protective holster EN61010-1 CAT III 1000V / CAT IV 600V
- Measures twice as fast as other multimeters

Safety Conformance

All inputs are protected to IEN61010-1 CAT IV 600V/CAT III 1000V. UL, CSA, TÜV listed and VDE Pending

Specifications		
Voltage DC	175 - Accuracy*	± (0.15%+2)
	177 - Accuracy*	± (0.09%+2)
	179 - Accuracy*	± (0.09%+2)
	Max. Resolution	0.1 mV
	Maximum	1000 V
Voltage AC	Accuracy*	± (1.0%+3)
	Max. Resolution	0.1 mV
	Maximum	1000 V
Current DC	Accuracy*	± (1.0%+3)
	Max. Resolution	0.01 mA
	Maximum	10 A
Current AC	Accuracy*	± (1.5%+3)
	Max. Resolution	0.01 mA
	Maximum	10 A
Resistance	Accuracy*	± (0.9%+1)
	Max. Resolution	0.1 Ω
	Maximum	50 MΩ
Capacitance	Accuracy*	± (1.2%+2)
	Max. Resolution	1 nF
	Maximum	10,000 µF
Frequency	Accuracy*	± (0.1%+1)
	Max. Resolution	0.01 Hz
	Maximum	100 kHz
Temperature	179 - Accuracy*	± (1.0%+10)
	Max. Resolution	0.1°C
	Range	-40°C/400°C
Note	* Accuracies are best accuracies for each function	

Environmental Specifications	
Operating Temperature	-10°C to +50°C
Storage Temperature	-30°C to +60°C
Humidity (Without Condensation)	0% - 90% (0°C - 35°C) 0% - 70% (35°C -50°C)

Fluke 175

Fluke 177

Fluke 179

Safety Specifications	
Overvoltage category	EN 61010-1 to 1000 V CAT III. EN 61010-1 to 600 V CAT IV.
Agency Approvals	UL, CSA, TÜV listed and VDE Pending

Mechanical & General Specifications	
Size	43 x 90 x 185 mm
Weight	420 g
Warranty	Lifetime
Battery Life	Alkaline: ~200 hours typical, without backlight

Accessories

C510 Leather Meter Case

- Oiled genuine top grain cowhide
- Rugged construction with heavy duty stitching and reinforced rivets
- Large tool belt loop and top flap to secure meter
- Holds most Fluke DMMs, Thermometers, and Process Calibrators

TLK-225 SureGrip™ Master Accessory Set

Kit includes all the SureGrip™ leads and probes in a handy roll-up pouch:

- AC220 SureGrip™ Alligator Clip Set
- AC280 SureGrip™ Hook Clip Set
- AC283 SureGrip™ Pincer Clip Set
- AC285 SureGrip™ Large Jaw Alligator Clip Set
- TP220 SureGrip™ Test Probe Set
- TL224 SureGrip™ Silicone Test Lead Set
- 6-Pocket Storage Pouch

Grip™ Industrial Test Lead

Special value SureGrip Set for industrial applications. Includes two sizes of alligator clips and sharp test probes for reliable connections, test leads and a roomy carry case to hold and protect your meter and all your accessories. All 1000 V CAT III, 600 V CAT IV rated.

Included with set:

- AC220 Plunger Style Alligator Clips
- AC285 Large Jaw Alligator Clips
- TP220 Sharp Test Probes
- TL224 Right to Straight Test Leads
- Zippered Vinyl Carry Case with Moveable Divider

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MoData 2, a computer-aided measuring system, has been developed to integrate the function and capability of several instruments used in the field of cathodic corrosion protection in one instrument only.

MoData 2 combines 4 separate measuring instruments (AC/DC voltage, current, µ-volts, resistance).

With serial interface port for connection and direct data transfer between PC and MoData2.

Provided with bar code input for automatic test point identification on site.

MoData 2, Handheld computer

Technical Data

Type	Itronix fex21
Case	Impact-resistant plastic
Size	190 x 155 x 37 mm (D x W x H)
Weight	0.8 kg
Protection class	IP 65
Screen	6.5“, 16 grayscale with backlight 640 x 240 pixel, touch screen
Keyboard, waterproof	Fluorescent membrane keyboard
Operating system	Windows Handheld PC 2000
Processor	Toshiba 129 MHz
Memory	32 MB
ROM	32 MB
Interfaces	2 x 9 pin serial port, infrared interface
Modem	V34 analog (installed)
Power supply	Rechargeable lithium ion battery Lifetime approx. 10 h
Operating temperature	-10 °C to 50 °C
Additional	Compact flash card (CF card) 64 MB installed

MoData 2, Multi task converter

Technical Data

Case	Impact-resistant plastic
Size	290 x 260 x 70 mm (D x W x H)
Weight	2.25 kg (including MoData computer)
Interfaces	2 x 9 pin serial port 12 V charging socket (with internal isolation) Terminal for synchronization or relay cable
Power supply	Rechargeable lead battery 6 V/1.3 Ah Lifetime approx. 10 h
Equipment	MoData 2 including Itronix fex21 External 230 V battery charger Synchronization cable Transfer cable User manual
Options	System carry case “Sprint” carrying strap for maintenance “Marathon” carrying strap for Intensive measurement External 12 V battery charger GPS antenna with integrated receiver

Measuring ranges and accuracy

The following tables contain details of the available measuring ranges, resolutions and maximum deviations.

DC voltage measurement (Channels A, B and C)

Input impedance:	> 10 MΩ	
DC voltage attenuation:	16.6 Hz / 60 dB (factor 10^3) 50.0 Hz / 100 dB (factor 10^5)	
Measuring range	**Resolution**	**Max. deviation**
± 1 V	0.1 mV	± 0.5 % ± 0.5 mV
± 10 V	1.0 mv	± 0.5 % ± 5.0 mV
± 100 V	10 mV	± 0.5 % ± 10 mV

Simultaneous measurement of 3 channels, time difference between channels < 5 ms.

AC voltage measurement (Channel A)

Input impedance:	> 10 MΩ	
Measuring range	**Resolution**	**Max. deviation**
1 V eff.	0.1 mV	± 2.0 % ± 1.0 mV
10 V eff.	1.0 mv	± 2.0 % ± 10 mV
100 V eff.	10 mV	± 2.0 % ± 50 mV

Frequency range 10 Hz to 120 Hz, cut-off frequency 800 Hz (2 dB).

Micro voltage measurement (Channel A)

Input impedance:	> 10 MΩ		
AC voltage attenuation:	16.6 Hz / 60 dB (factor 10^3) 50.0 Hz / 100 dB (factor 10^5)		
Measuring range	Resolution	Max. deviation	
± 80000 µV	1 µV	± 0.2 %	± 5.0 µV

Current measurement (Channel A)

AC voltage attenuation:	16.6 Hz / 60 dB (factor 10^3) 50.0 Hz / 100 dB (factor 10^5)		
Measuring range	Internal shunt	Resolution	Max. deviation
± 10 mA	10 Ω	1 µA	± 1.0 % ± 5 µA
± 100 mA	3 Ω	10 µA	± 1.0 % ± 20 µA

Current measurement (30 A current input)

AC voltage attenuation:	16.6 Hz / 60 dB (factor 10^3) 50.0 Hz / 100 dB (factor 10^5)		
Measuring range	Internal shunt	Resolution	Max. deviation
± 30 A	0.01 Ω	1 mA	± 1.0 % ± 3 mA

Resistance measurement

Measuring method:		Wenner; 2-pole or 4-pole			
Measuring frequency:		128 Hz			
Output voltage:		max. 2 V eff.	1 kΩ measuring range		
		max. 10 V eff.	10 kΩ measuring range		
		max. 10 V eff.	800 kΩ measuring range		
Measuring range	Resolution (4-pole)	Max. deviation			
1 kΩ	0.01 Ω	0.0 Ω	- 9.9 Ω	± 1.0 %	± 0.05 Ω
	0.1 Ω	10.0 Ω	- 199.9 Ω	± 1.0 %	± 0.50 Ω
	1 Ω	200 Ω	- 999 Ω	± 1.0 %	± 5 Ω
10 kΩ	10 Ω	0.00 kΩ	- 0.99 kΩ	± 1.0 %	± 50 Ω
	100 Ω	1.0 kΩ	- 9.9 kΩ	± 1.0 %	± 100 Ω
800 kΩ	10 Ω	0.00 kΩ	- 9.99 kΩ	± 1.0 %	± 0.1 kΩ
	100 Ω	10.0 kΩ	- 99.9 kΩ	± 1.0 %	± 0.5 kΩ
	100 Ω	100.0 kΩ	- 199.9 kΩ	± 1.0 %	± 1 kΩ
	1 kΩ	200.0 kΩ	- 799.9 kΩ	± 1.0 %	± 5 kΩ

Back carrying rack “Marathon”

To ensure a problem-free measuring execution on site, the cable drum is equipped with sliding contacts which guaranteed a simple unreeling of measuring cable without any interruption at the measuring points.
Standard cable drum with 500 m measuring cable.

GEOHM→C - Ground Resistance Tester

Battery operated tester for the measurement of ground resistance meets international standards for performing such tests. This instrument allows measurement of soil resistivity and ohmic resistance by means of the ammeter-voltmeter test method.

Features

- 3 or 4-wire measurement selectable from menu
- No balancing required
- Continuous monitoring of interference voltage and auxiliary earth electrode resistance with indication of limit value violations
- Indication is displayed if maximum probe resistance is exceeded at the beginning of the measurement
- Voltage measurement with automatic switch-over function between direct voltage and alternating voltage:
  Direct voltage measuring range 1.0 … 250 V (with polarity display)
  Alternating voltage measuring range 0 … 300 V

Applications

The GEOHM®C is a compact instrument for the measurement of ground resistance in electrical systems in accordance with:

DIN VDE 0100 Installation of power systems with nominal voltages of up to 1000 V
DIN VDE 0141 Grounding in AC systems with nominal voltages of greater than 1 kV
DIN VDE 0800 Installation and operation of telecommunications systems including data processing systems: equipotential bonding and grounding

Testing of lightning protection systems in accordance with DIN VDE 0185
The instrument is also capable of determining soil resistivity which is essential in calculating dimensions for grounding systems.
It can thus be taken advantage of for simple, geological surveys, and for the planning of grounding systems.
Beyond this, ohmic resistance can be measured at both solid and liquid conductors, as well as internal resistance at conductive elements, as long as these are capacitance and induction-free.

Special Functions

- Hold function: The measurement value is frozen at the display after the measurement key is released
- Storage of measurement values to memory
- Data interface for the transmission of measurement values and for software updates
- Convenient report generating software, can be expanded into a comprehensive database

Operation

The instrument is easy to operate. A multifunction key allows for one-hand operation for menu selections and the initialization of measurements. Basic functions and sub-functions are selected with the help of four soft keys.
The instrument functions in accordance with the ammeter-voltmeter principle, and thus requires no balancing. Automatic measuring range selection, limit value monitoring and direct selection of 3 or 4-wire measurement assure easy operation as well.

Display

The LCD consists of a backlit dot matrix display at which menus, setup options, measuring results and online help can be viewed. Various display languages can be selected depending upon the country in which the instrument is used.

Signal Lamps

The instrument automatically recognizes errors which occur during measurement, and signals them with four LEDs as shown in the table below.

LED	Status	Measuring Function	Meaning
$U_{Stör/}$ U_{noise}	red	Interference voltage	U > 10 V
Netz Mains	red	Voltage	Mains voltage is present
R_S>max	red	Probe resistance	Limit value exceeded
R_H>max	red	Auxiliary earth electrode resistance	Limit value exceeded

Battery Monitoring and Self-Test

A battery symbol with five segments ranging from depleted to fully charged continuously indicates the charging level of the batteries in the main menu.
Automatic shutdown ensures if the batteries are fully depleted, and the instrument includes an integrated charge monitoring circuit for safe charging of rechargeable NiMH or NiCd batteries.
During the self-test, a series of test patterns can be displayed one after the other, and indicator LEDs and relays are tested.

Rugged Housing for Harsh Operating Conditions

Soft plastic jacketing protects the instrument against damage due to impact and dropping.

Data Interface

Measurement data can be uploaded to a PC via the integrated IRDA interface for processing and archiving, or for the generation of official reports.

Software Updates

The test instrument can always be kept current thanks to device software updates via the IRDA interface. Software updates are
performed during the course of re-calibration by our service department, or by the user himself.

Applicable Regulations and Standards

IEC 61010/EN 61010-1/ VDE 0411-1	Safety requirements for electrical equipment for measurement, control and laboratory use
IEC 61557/EN 61557/ VDE 0413	Devices for testing, measuring and monitoring protective measures Part 1: General requirements Part 5: Earth resistance
DIN 43751 Part 1, 2	Digital measuring instruments
VDE 0106 Part 1	Protection against electrical shock, classification of electrical and electronic equipment
EN 60529, VDE 0470 Part 1	Test instruments and test procedures, protection provided by enclosures (IP code)
DIN EN 61326 VDE 0843 Part 20	Electrical equipment for measurement, control and laboratory use - EMC requirements

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GEOHM→C - Ground Resistance Tester

Regulations and Standards for Use of the Test instrument

DIN VDE 0413 Part 5	Devices for testing, measuring and monitoring protective measures
DIN VDE 0100	Regulations for the installation of power systems with nominal voltages of up to 1000 V
DIN VDE 0141	Earthing in AC systems with nominal voltages of greater than 1 kV
DIN VDE 0800	Setup and operation of telecommunication systems including electronic data processing: equipotential bonding and grounding
DIN VDE 0185	Lightning protection systems-general installation regulations
International regulations and standards	
BS 7430 + BS 7671, NFC 15-100, IEC 60364	

Characteristic Values

Measured Quantity	Display Range	Measuring Range	Impedance/ Test Current
R_E	0.01 ... 20 Ω 0.1 ... 200 Ω 1 Ω ... 2 kΩ 10 Ω ... 20 kΩ 10 Ω ... 50 kΩ	1.0 ... 20 Ω 5 ... 200 Ω 50 Ω ... 2 kΩ 500 Ω ... 20 kΩ 500 Ω ... 50 kΩ [1]	10 mA 1 mA 100 µA 100 µA 100 µA
$U_{⎓}$ [2]	1.0 ... 99.9 V 100 ... 250 V	10 ... 250 V	500 kΩ
$U_{\sim}$ [3]	1.0 ... 99.9 V 100 ... 300 V		
f [3]	15 ... 99.9 Hz 100 ... 400 Hz	45 ... 200 Hz	500 kΩ

Measured Quantity	Intrinsic Error	Measuring Error
R_E	± (3% rdg. + 6d)	± (10% rdg. + 6d) ± (10% rdg. + 6d) ± (10% rdg. + 6d) ± (10% rdg. + 6d) ± (16% rdg. + 10d)
$U_{⎓}$ [2]	± (2% rdg. + 2d)	± (4% rdg. + 3d)
$U_{\sim}$ [3]		
f [3]	± (0.1% rdg. + 1d)	± (0.2% rdg. + 1d)

[1] Manual measuring range selection only
[2] as from software version AD
[3] for sinusoidal measured quantities only

Output voltage: max. 50 Vrms at 128 Hz ± 0.5 Hz

Reference Conditions

Battery Voltage: 5.5 V ± 1%
Ambient Temperature: + 23 °C ± 2 K
Relative Humidity: 40 … 60%

Nominal Ranges of Use

Temperature Range: 0 °C … + 40 °C
Battery Voltage: 4.5 … 6.5 V
Line Frequency : 50/60 Hz ±0.2 Hz
Line Voltage Wave shape: sine (deviation between RMS and rectified value < 1%)

Nominal Conditions of Use

Series Mode
Interference Voltage: < 3 V AC DC
Additional Error caused by Probe and Auxiliary Earth Electrode Resistance: < 5% of (RE + RA + RP)
Max. Probe Resistance: < 70 kΩ
Max. Auxiliary Earth Electrode Resistance: < 50 kΩ
Max. Earth and Auxiliary Earth Electrode Resistance: ≤ 50 kΩ, RE as a function of RH

Ambient Conditions

Operating Temperature: –10 ... + 50 °C
Storage Temperature: –20 ... + 60 °C (without batteries)
Relative Humidity: max. 75%, no condensation allowed
Elevation: max. 2000 m

Power Supply

Batteries: 4 ea. 1.5 V C-size (4 x C-Size) (alkaline-manganese per IEC LR14)
Battery Voltage: 4.6 … 6.5 V
Battery Service Life: 30 h or 1000 measurements at RE (with 10 s on-time, each measurement performed until the instrument switches off automatically, without display illumination)
Rechargeable Batteries: NiCd or NiMH
Battery Charger: NA 0100S (Article No. Z501D),
(not included) 3.5 mm jack plug
Charging Voltage. 9 V
Charging Time: approx. 9 hours

As a rule, fewer measurements can be performed with rechargeable batteries due to their limited charging capacity.

Electrical Safety

Safety Class: II per IEC 61010-1
Operating Voltage: 250 V
Test Voltage: 2.3 kV
Measuring Category: 250 V CAT II
Contamination Degree: 2
Fuse: F0.1H250V

Electromagnetic Compatibility (EMC)

Interference Emission/Immunity IEC 61326/EN 61326

Data Interface

Type: infrared interface (SIR/IrDa) bidirectional, half-duplex
Format: 9600 bauds, 1 start bit, 1 stop bit, 8 data bits, no parity, no handshake
Range: max. 10 cm recommended distance: < 4 cm

Mechanical Design

Display: multiple dot matrix display, 128 x 64 pixels (65 mm x 38 mm), illuminated
Dimensions : 275 mm x 140 mm x 65 mm
Weight: approx.1.2 kg with batteries
Protection: housing: IP 54 per EN 60529 with pressure compensating diaphragm of microporous ePTFE, non-ageing, 8 mm dia. in battery compartment lid

GEOHM→C - Ground Resistance Tester

Extract from table on the meaning of IP codes

IP XY (1st digit X)	Protection against foreign object entry	IP XY (2nd digit Y)	Protection against the penetration of water
3	≤ 2.5 mm Ø	3	spraying water
4	≤ 1.0 mm Ø	4	splashing water
5	dust protected	5	water jets

Standard Equipment

1 GEOHM® C test instrument
1 carrying strap
1 set of batteries
1 set of comprehensive instructions covering the following topics:
– Measurement of earth resistance with instructions for 3 and 4-wire methods,
with physical considerations regarding the potential gradient area as related to dissipation resistance of grounding systems of various size, with important tips for the performance of measurements on difficult terrain
– Measurement of soil resistivity with geologic analysis and calculation of dissipation resistance
– Measurement of ohmic resistance
1 PC software WinProfi for communication with GEOHM®C
The PS3 CD-ROM includes the software WinProfi with the following content and functions:
• up-to-date test instrument software
– for loading other user interface languages
– for loading firmware version updates
• Transmission of measured data from test instrument to PC

Accessories
E-Set 3 Earth Testing Set

Accessories
E-Set 4 Earth Testing Set

Accessories
E-Set 5 Earth Testing Set

Order Information

Designation	Type	Article Number
Basic Instrument		
Digital Earth Tester	GEOHM® C	M590A
Add-Ons		
IR interface for connection to a USB port at a PC for data exchange between the PC and the GEOHM® C, e.g. for software updates to the tester or visualization of measurement values at the PC	Converter IrDa-USB	Z501J
Accessories		
4 special NiMH baby cells (rechargeable)	Akku-Set	GTY 1040 042 E25
Adapter for charging batteries inside the GEOHM® C	NA 0100S	Z501D
Hard-shell case with compartment for one C series test instrument and accessories	HC30-C	Z541C
Earth testing set: Synthetic leather case with 2 reels, two 25 measurement cables, one 40 m measurement cable, two 3 m measurement cables, 4 earth spikes (zinc plated), 2 spike pullers and 1 hammer	E-Set 3	GTZ 3301 005 R0001
Earth testing set: Synthetic leather case with 2 reels, two 25 m cables, one 40 m cable, two 3 m measurement cables and 4 earth drills	E-Set 4	Z590A
Earth testing set: Carrying case accommodating GEOHM® C 1 drum with 25 m measurement cable 2 drums with 50 m measurement cable each 4 measurement cables, 3 x 0.5 m long, 1 x 2 m long 1 test clamp 4 earth drills, each 350 mm long 1 dust cloth 2 pads of earth testing measurement data forms	E-Set 5	Z590B
Reel with 25 m measurement cable and banana plugs at both ends	TR25	GTZ 3303 000 R0001
Drum with 50 m measurement cable, banana plug / jack socket	TR50	GTY 1040 014 E34
Earth drill, 35 cm long, can be connected by means of 4 mm banana plugs	SP350	GTZ 3304 000 R0001

PSE ENGINEERING GMBH

Earth resistance and resistivity tester MRU-100

General information

The MRU-100 is a portable meter for measuring earth resistance and resistivity (Wenner's method). The instrument can measure resistance with a 2, 3, or 4 poles method. The meter can be powered from Ni-Cd batteries or standard C size batteries. Measurements can be simplified using current clamps.

Features

- Measurement of earth electrodes resistance using a three- or four-pole technique
- The earth resistivity measurement with the possibility to introduce the distance between electrodes (automatic calculation and displaying the resistivity in Ωm)
- Measurement of a metallic resistance using a two- or four-pole technique
- Ability to perform measurements of multiple electrodes using a three-pole technique without disconnecting earth electrodes measured (using clamps)
- Checking the disturbing voltages (alternating and direct current) and automatic termination of the resistance measurement when the disturbances are too high
- Checking earth electrode's resistance before the measurement to provide proper measurement accuracy
- Powered from a set of battery cells
- Signaling the degree of charge in the battery cells
- Hermetic case-type housing
- A large illuminated display
- Low battery signal
- Auto-off
- Auto ranging
- Good quality and ergonomic measurement accessories
- Carrying case
- Complies with standards: EN-61557-5, EN 61010-2 032; measurement category: Cat. III 300V EN 61010-1:2002;
- Tightness: IP 54EN 6529

Standard Equipment

- Test lead (length: 50 m) on the reel with banana plug yellow (WAPRZ050YEBBSZ)
- Test lead (length: 25 m) on the reel with banana plug, red (WAPRZ025REBBSZ)
- Test lead with banana plug 1,2m; yellow (WAPRZ1X2YEBB)
- Test lead with banana plugs 2,2m (WAPRZ2X2BLBB)
- Pin probe with banana connector; yellow (WASONYEOGB1)
- "Crocodile" clip K01; black (WAKROBL20K01)
- Earth contact test probe (rod) 0,3m 2 pcs. (WASONG30)
- Carrying case L2 (WAFUTL2)
- Hanging straps (WAPOZSZE1)
- User Manual
- Calibration Certificate 5 batteries R14

Optional Equipment

- Current clamps C2 (round connector) (WACEGC20KR)
- Test wire reel (WAPOZSZP1)
- Earth contact test probe (rod) 0.8 m (WASONG80)
- Carrying case L3 for Earth contact test probe (rod) 0.8 m (WAFUTL3)
- Cramp (WAZACIMA1)
- Calibration certificate issued by Calibration Laboratory MR-100 (LSWGBMRU100)
- PE3 - software for creation of documentation from electrical measurements for PC-computers (WAPROPE3EN)
- PE3 + Schematic - software for creation of drawings and diagrams for PC-computers (WAPROPE3SEN)

Nominal operating conditions

- Noise voltage AC+DC during a measurement: max.24 V
- Measurement current: max.225 mA
- Measurement voltage: max. 40V
- Measurement current frequency: 128 Hz
- Operating temperatures range: 0..40 °C
- Nominal line voltage for battery charger: 230 V

Others

- Display: illuminated LCD 3 digits 20 mm
- Dimensions: 295 x 222 x 95 mm
- MRU-100 weight with battery: 1.6 kg
- MRU-101 weight with NiCd battery package: 1,7 kg
- Power supply: 5 batteries 1,5 V R14 (C size) or NiCd battery package (6ECF1800CS) type (MRU-101 only)
- Battery life: min. 2000 measurements
- Computer interface: RS-232C (MRU-101 only)
- Memory: 300 test results (MRU-101 only)
- Auto-off time: 2 minutes
- Battery charging time: max 3 hours

Noise voltages measurement (U_N)

Range	Resolution	Accuracy
0... 40 V	1 V	±(10% m.v. + 1 digit)

Earth resistance measurement (R_E) without current clamps

Measurement range according to IEC 61557: 0.6Ω..20kΩ

Range	Resolution	Accuracy
0.0.. 9.99 Ω	0.01 Ω	±(2% m.v. + 3 digits)
10.0.. 99.9Ω	0.1 Ω	±(2% m.v. + 2 digits)
100.. 999 Ω	1Ω	
1.0..9.99 kΩ	10Ω	
10.0..20.0 kΩ	100 Ω	

=> m.v. = measured value

Earth resistance measurement (R_E) with current clamps

Measurement range according to IEC 61557: 0.8Ω..20kΩ

Range	Resolution	Accuracy
0.0.. 9.99 Ω	0.01 Ω	±(8% m.v. + 3 digits)
10.0.. 99.9Ω	0.1 Ω	±(8% m.v. + 2 digits)
100.. 999 Ω	1Ω	
1.0..9.99 kΩ	10Ω	
10.0..20.0 kΩ	100 Ω	

=> m.v. = measured value

Probe rods resistance measurement R_H, R_S

Probe rod resistance measurement accuracy R_S and R_H without clamps
±5% f the sum of readings (R_E+R_H+R_S)
Probe rod resistance measurement accuracy R_S and R_H with clamps
±10% of the sum of readings (R_E+R_H+R_S)

PSE ENGINEERING GMBH

UNITEST TELARIS® Earth

Key Functions

- Earth resistance measurement
- Specific earth resistance measurement

General Information

- The integrated constant current measurement principle allows the application in sandy as well in rocky environments
- Monitoring and display of auxiliary earth and probe resistances
- Displays of the actual test current
- Automatic and manual and frequency selection for noise reduction
- Test voltage preselection
- Clear and large LCD providing the user with an optimum visual indication of both test values and limits
- Auto power off

Special Features

- Earth resistance measurement 2/3 and 4-pole
- Specific earth resistance measurement in compliance with the Wenner principle

Scope of supply

1 pc UNITEST TELARIS Earth
2 pc Test leads
2 pc Crocodile clamps
1 pc Protective Holster
1 pc Carrying Case
6 pc Batteries 1.5 V, IEC LR6
1 pc Instruction Manual

Accessories

Professional Carrying Case, Cat. No. 1229 Earth Accessory-Set, Cat. No. 1189

Order information

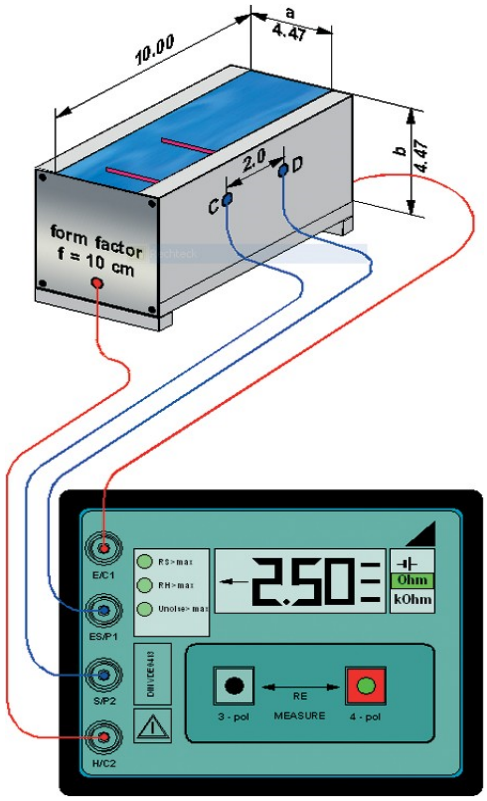
Description	Cat. No.
UNITEST TELARIS Earth	**8986**
Professional Carrying Case	**1229**
Earth Accessory-Set	**1189**

Technical data

Display	3 Digit; LCD; 1999 Digits
Mess. principle	Current-Voltage measurement
Mess. range/Resolution Earth resistance	 0.05...19.99 Ω / 0.01 Ω 20...199.9 Ω / 0.1 Ω 200...1999 Ω / 1 Ω
Tolerance	±(4% rdg. + 2 Digits / 0.1 Ω)
Probe/aux. resistance	0.1...50 kW / 0.1 kΩ
Tolerance	±(10% rdg. + 3 Digits)
Max. test current	approx. 12 mA
Test voltage	max. 25 V/50 V AC selectable
Frequency	127 Hz / 140 Hz selectable
Protection class	II (double insulated)
Safety complying with:	IEC/EN 61010/DINVDE 0411 IEC/EN 61557/DIN VDE 0413
Measurement category	CAT III / 300 V
Pollution degree	2
Protection degree	IP 50
Auto-Power-Off	after approx. 5 min.
Power supply	6 x 1.5 V, IEC LR6
Dimensions	235 x 105 x 70 mm
Weight	approx. 640 g

PSE ENGINEERING GMBH

Measuring Arrangement, Soil Box with Earthing Tester

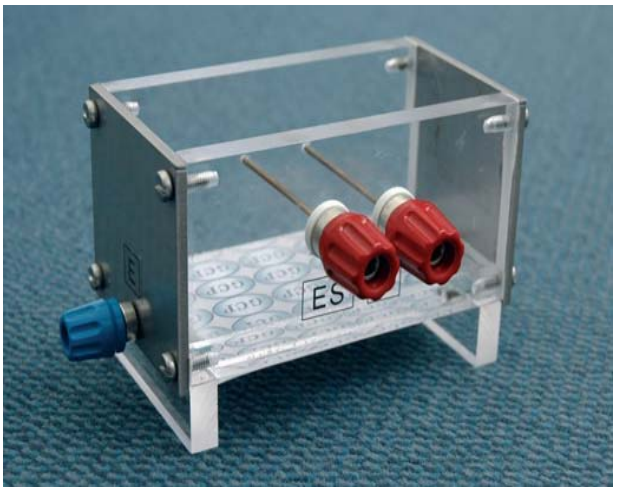


CALCULATION OF FORM FACTOR (f)
$f = \frac{a \times b}{\overline{C\,D}} = \frac{4.47\text{ cm} \times 4.47\text{ cm}}{2.0\text{ cm}} = 10\text{ cm}$

SPECIFIC SOIL RESISTIVITY (ρ)
ρ = R x f

Example:

Soil box filled with salty liquid
Indicated R = 2.5 Ω
SPECIFIC SOIL RESISTIVITY (ρ)
ρ = R x f = 2.5 Ω x 10 cm
ρ = 25 Ω cm



The soil box can be used for the measurement of specific resistivity of electrolytes ie. soil sample, water and conducting fluids.

The specific resistivity is measured by using a normal 4 - terminal earth resistance meter in accordance with Wenner´s 4 - electrode method.

The soil box consists of a plastic container with metal end plates for passing current through the soil sample packed into the box and potential terminals permitting measurement of voltage drop across a section of the soil sample,

The dimensions of the box and position of electrodes are designed so that resistivity of electrolyte sample in the box is obtained by multiplying the resistance value in Ohm indicated by the meter by the form factor (printed on box).

The test sample should be filled up to the top of the box. The soil samples should be carefully filled and compacted to ensure proper contact with the plates and rod electrodes and also to remove air bubbles and voids.

The test box method gives very accurate results for fluids but the value measured for soil samples may differ from those measured at actual site due to variations of natural conditions including moisture, compaction, void ratio, particle size, etc.

Dimensions

Length	Height	Depth	Weight
168 mm	55 mm	60 mm	0.38 kg

PSE ENGINEERING GMBH

Super Sting R1/IP single channel Memory Earth Resistivity and IP Meter

The deep earth resistivity meter has been developed for the determination of specific soil resistivity to provide correct measurable values for soil below 30 m depth.
Correct data on resistivity of soil at greater depths is of special importance for designing of deep anode groundbeds in impressed cathodic protection systems. The **Super Sting** R1 IP is a state-of-the-art single-channel portable memory earth resistivity meter with memory storage of readings and user defined measure cycles. It provides the highest accuracy and lowest noise levels in the industry. This new instrument is based on technology developed for the famous **Super Sting** R8/IP multi-channel instrument. It pushes the performance levels of single channel systems forward by a large step.
With the high power transmitter good data can be recorded in difficult locations where time-consuming stacking was the only alternative before.
Super Sting R1/IP uses the patented Swift Dual Mode Automatic Multi-electrode cable. For users of the existing Sting/Swift system wanting to upgrade the instruments their cable investment can be reused with this new instrument since the old cables can be used also with **Super Sting** R1/IP.
The controller for the cable is now completely built into the **Super Sting** R1/IP main instrument so there are no extra boxes to carry and connect in the field.

Key Benefits

- High power transmitter.
- Field adapted rugged construction. Built to last in real conditions.
- Easy to use menu driven system.
- The best accuracy and noise performance in the industry!
- Large capacity internal memory for storage of measurement results.
- User programmed measure cycles can be loaded into memory from a PC and later executed in the field.
- Directly controls the Swift Dual Mode Automatic Multi-electrode system!
- Induced Polarization mode records 6 individual IP chargeability windows.

Technical Specification

Measurement modes	Apparent resistivity, resistance, self-potential (SP), induced polarization (IP), battery voltage.
Measurement range	+/- 10V
Measuring resolution	Max 30 nV, depends on voltage level.
Screen resolution	4 digits in engineering notation.
Output current intensity	1mA - 2000 mA continuous, measured to high accuracy.
Output voltage	800 Vp-p, actual electrode voltage depends on transmitted current and ground resistivity.
Output power	200 W
Input gain ranging	Automatic, always uses full dynamic range of receiver.
Input impedance	>20 Mohms
SP compensation	Automatic cancellation of SP voltages during resistivity measurement. Constant and linearly varying SP cancels completely.
Type of IP measurement	Time domain chargeability (M), six time slots measured and stored in memory.
IP current transmission	ON+, OFF, ON-, OFF
IP cycle times	0.5, 1, 2, 4 and 8 s
Measure cycles	Running average of measurement displayed after each cycle. Automatic cycle stops when reading errors fall below user set limit or user set max cycles are done.
Resistivity cycle times	Basic measure time is 0.2, 0.4, 0.8, 1.2, 3.6, 7.2 or 14.4 s as selected by user via keyboard. Auto ranging and commutation adds about 1.4 s
Signal processing	Continuous averaging after each complete cycle. Noise errors calculated and displayed as percentage of reading. Reading displayed as voltage, current and apparent resistivity (Ωm or Ωft). Resistivity is calculated using user entered electrode array co-ordinates.
Noise suppression Power line noise suppression	Better than 100 dB at f >20 Hz Better than 120 dB at power line frequencies (16 2/3, 20, 50 & 60 Hz) for measure cycles of 1.2 s and above.
Total accuracy	Better than 1% of reading in most cases (lab measurements). Field measurement accuracy depends on ground noise and resistivity. Instrument will calculate and display running estimate of measuring accuracy.
System calibration	Calibration is done digitally by the micro-processor based on correction values stored in memory.
Supported manual configurations	Resistance, Schlumberger, Wenner, dipole-dipole, pole-dipole, pole-pole, SP-absolute and SP-gradient.
Operating system	Stored in re-programmable flash memory. New versions can be downloaded from our web site and stored in the flash memory.
Data storage	Full resolution reading average and error are stored along with user entered coordinates and time of day for each measurement. Storage is effected automatically in a job oriented file system.
Data display	Apparent resistivity (Ωm), current intensity (mA) and measured voltage (mV) are displayed and stored in memory for each measurement.
Memory capacity	The memory can store more than 27,300 measurements (resistivity mode) and 16,000 measurements in combined resistivity/IP mode.
Data transmission	RS-232C channel available to dump data from instrument to a Windows type computer on user command.
Automatic multi-electrodes	The **SuperSting** is designed to run dipole-dipole, pole-dipole, pole-pole, Wenner and Schlumberger surveys including roll-along surveys completely automatic with the Swift Dual Mode Automatic Multi-electrode system (patent 6,404,203). The **SuperSting** can run any other array by using user programmed command files. These files are ASCII files and can be created using a regular text editor. The command files are uploaded to the **SuperSting** RAM memory and can at any time be recalled and run. Therefore, there is no need for a fragile computer in the field.
Manual measurements	The instrument has four banana pole screws for connecting current and potential electrodes during manual resistivity measurements.
User controls	20 key tactile, weather proof keyboard with numeric entry keys and function keys. On/Off switch. Measure button, integrated within main keyboard. LCD night light switch (push to illuminate).
Display	Graphics LCD display (16 lines x 30 characters) with night light.
Power supply, field	12 V or 2x12 V DC external power (1 or two 12 V batteries), connector on front panel.
Power supply, office	Mains operated DC power supply.
Operating temperature	-5 to +50°C
Dimensions	W=184 mm , L=406 mm, H=273 mm, 10.9 kg
Operating time	Depends on survey conditions and size of battery used. Internal circuitry in auto mode adjusts current to save energy.

PSE ENGINEERING GMBH

AGI Swift Smart Electrode System

Super Sting R1/IP with the Swift Control Unit

Swift smart electrode switches are a complement to the Super Sting R1/IP Earth resistivity meter which enables automatic measurements to be made for 2D and 3D surveys as well as depth soundings.

The system consists of a central electronic and power unit which interfaces to the Sting resistivity meter and (optionally) to a standard PC. Connected to this control unit are the switched electrode cables with up to 254 electrodes. All electrodes are controlled from STING or from the PC depending on configuration.

Any combination of current and voltage electrode connections can be set up remotely before a reading is taken.

With Swift and STING a 600 reading profile can be measured in approx. 2 hours. This makes possible routine investigations using state-of-the-art 2D or 3D interpretation methods.

Key Benefits

- Automates otherwise uneconomical investigations
- Complete control of measurement array geometry possible
- Cables submersible - withstand harsh handling Electrode switches with connectors available for simple array redesign
- Cables can be supplied in custom length and with quick-connect connectors
- Switches attach easily to electrodes using rubber bands

The Swift switches are simply attached to stainless steel electrodes in the field using the stainless steel springs.

Standard Swift electrode switch, permanently attached to the cable with water-proof sealing.

Data / Specification

Control method	Each switch digitally addressable. Any line can be activated in a switch (ABMN).
Switch addresses	1-254 available for electrode switches, No. 255 is used for test equipment. Each switch can be easily re-addressed by user in the field.
Cable	Specially designed multi-core cable for minimized crosstalk and noise pick-up. Outer jacket made from heavy duty yellow polyurethane. Jacket distance coded for ease of layout. Custom lengths available on request. Cable with molded quick connectors available on request.
Switch power	Idle power: 7 mW per switch total for 254 switch cable is approx 1.8 W. Active power: add 500 mW during measure cycle.
Switch size	dia. 32mm x 210 mm including cable grips. Outer case made of stainless steel.
Environmental	Switch is water-proof, can sustain up to 10 m water depth. Special version for deeper work can be offered.
Control box	Internally powered by a 4 Ah 12V NiCd rechargeable battery. Battery life with 254 switches > 24 hours. Controls switch activation and channels measure current and potential signals into the Swift cable. Interface for both STING and a PC com port.
Software	Control software for PC delivered with system. Swift can be operated directly by STING without PC.
Options	Switches are available directly connected to the cable or with integrated multipole connectors for flexible field use.

Swift control unit (Switching Box)

Applications

- The SuperSting Switch box is used to control passive electrodes for automatic data acquisition in 1D, 2D and 3D.
- There are Switch boxes available with 28, 56, 64, 84 and 112 electrode switching capacity.
- Several switch boxes can be “daisy chained” together for even larger capacity.
- The Switch box can be used in combination with smart electrodes. For example, passive electrodes placed in two bore holes and smart electrode on the surface between the bore holes.
- Can be used with your own cables or with our special bore hole cable, underwater cable or land cable.
- Ideal for bore hole monitoring situations where fixed bore hole cables are installed with our patented passive graphite electrodes and the SuperSting and Switch box is used to record changes in the ground at different time interval. Time lapse processing is performed with our Earth Imager software.
- Can be used for 2D or 3D surface measurements, as well as bore hole to bore hole measurements.

PSE ENGINEERING GMBH

AGI Earth Imager 2D

AGI EarthImager 2D is the new standard for affordable Resistivity Imaging software.
With this software data collected with the AGI SuperSting earth imaging resistivity instruments can be interpreted into easy to read 2D earth sections. The processed data can be output to various types of files and can be processed into reports ready for submission to the client.

2D Resistivity Inversion
Reads Sting data (and other instrument data formats) and produces a default setting inversion, valid in most cases, after only a few clicks. For advanced processing there are a number of settings for full user control of the inversion process. Report ready high definition graphic output in the form of engineering plate style drawing with title block.

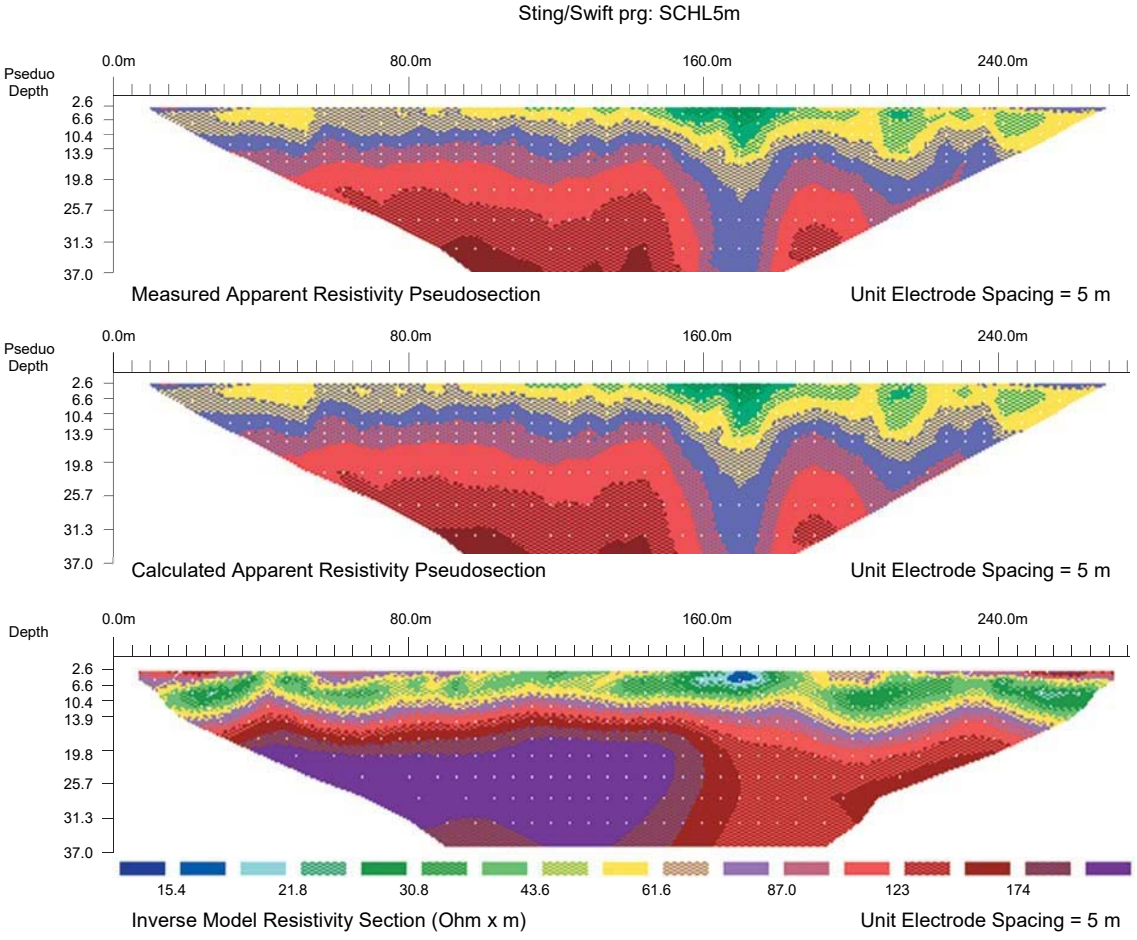
2D Electrical Resistivity Tomography (ERT)
The software automatically detects bore hole data set for immediate ERT processing. There is an editor for “bad” electrode and “bad” data removal. From iteration to iteration the data misfit is displayed in a scatter plot. There is also a data cross plot (raw versus inverted apparent resistivity data) available as well as a diagram showing the convergence curve.

Time Lapse Option
The optional Time Lapse function is used for any monitoring situation. It could for example be used to detect leakage at a landfill site. In such a case, the resistivity image is first recorded as “background” (before any leakage). After the initial “background” setup, the survey is repeated at regular intervals in the same way (electrodes in the same place using the same array type, etc.) so that any change in the ground can be detected. The time lapse function uses the inverted background section when inverting the “new” section and the result is presented as the difference between the two sections.

The time lapse method is used any time information about resistivity changes in the ground is needed. Some common situations include potential leakage from landfills, industrial sites, etc. Other monitoring situations include fracture tracing by injection of a conductive solution such as a salt solution. Other possible monitoring situations include saltwater intrusion in coastal areas, remediation progress at environmental sites, groundwater recharge, infiltration studies, to see how the ground is “wetted” or how the ground dries up after a rain storm.

Survey Planner
The survey planner is used for feasibility studies of resistivity imaging projects. First load a command file, then enter the expected geological features with their expected resistivity’s in a graphical input interface. Then run the simulation using the actual command file and the software will perform a virtual survey over the theoretical model. The result of the virtual survey is then inverted and the result can be compared to the original model within seconds.

Topography Correction
In case of terrain relief, it may be necessary to include topography correction in the inversion process. Data with terrain elevation is read from a “terrain file “and the software will automatically perform an inversion using a finite element model.



PSE ENGINEERING GMBH

Digital Current Clamp Meter for DC and AC currents measurements

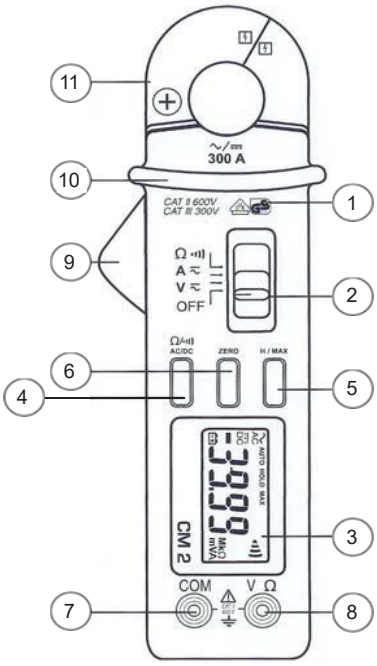
The Digital Current Clamp Meter CM 2 combines the advantages of a Digital Multimeter with a current Clamp Meter. The 3 ¾ digit LC display offers a resolution of 3999 pixels and allows the recording of the measured value and the maximum value in all measuring ranges by means of the H/ MAX button.

The CM 2contains DC and AC current ranges up to 300 A and because of its maximum measurement resolution of 10 mA it is ideally suitable for measuring smaller current ranges. The optimum zero setting for the direct current range can be set to the ZERO button.

Additionally, the CM 2 reads direct voltage and alternating voltage up to 600 V, resistance up to 40 MΩ and it has an acoustic continuity test. All the ranges are protected against overload.

Relative measurements (differential measurements) can be made via ZERO button in voltage and current range.

The CM 2has a battery low voltage indication and an auto-shut off function when not in use (approx. 30 min.).



1 Housing
2 Sliding switch for selecting the required functions
3 Digital display (liquid-crystal type)
4 Function button
5 HOLD/MAX button
(hold function and automatic peak-value storage)
6 ZERO button (zero setting button)
for zero adjustment in current measurement
7 COM socket: joint socket for voltage and resistance measurements and continuity test, marked black
8 V-Ω socket (positive): joint socket for voltage and resistance measurements and continuity test, marked red
9 Opening lever, for opening and closing the current prongs
10 Prong guard, protects user from accidental contact with conductor
11 Measurement prongs, for inserting and gripping the single conductor containing AC current

Display	33/4 digit LC display (3999 pixels)
DC voltage:	400 mV/4 V/40 V/400 V/600 V
Resolution/accuracy	max. 100 µV/max. ± 0.5 % + 2 digit
AC voltage	400 mV/4 V/40 V/400 V/600 V
Resolution/accuracy	max. 100 µV/max. ± 1.5 % + 5 digit
Measuring method	RMS value
DC current	40 A, 200 A, 300 A
Resolution/accuracy	max. 10 mA/max. ± 1.0 % + 2 digit
AC current	40 A, 200 A, 300 A
Resolution/accuracy	max. 10 mA/max. ± 1.0 % + 3 digit
Measuring method	RMS value
Resistance	400 Ω/4 kΩ/40 kΩ/400 kΩ/ 4 MΩ/ 40 MΩ
Resolution/accuracy	max. 100 mΩ/max. ± 0.9 % + 3 digit
Continuity test	50 - 300 Ω, acoustic: buzzer, optic: LCD
Over voltage protection	600 V effective, 400 A effective
Range switching	auto ranging
Jaw opening	max. 25 mm
Over voltage category	CAT III 300 V, CAT II 600 V
Operation temperature	0 °C to + 50 °C
Dimensions (l x w x h)	192 x 66 x 27 mm
Weight	205 g
Battery type	2 micro batteries 1.5 V IEC 6LR03/AA
Delivery includes	Current clamp meter carrying case, set of batteries, double insulated safety test leads

MiniLog 128 and MiniLog 512

Cathodic protection measuring technology requires miniature battery operated data logging units. *MiniLog* represents realization of measuring engineer`s requirements to record large amounts of data over long periods in the field.
Due to sampling rate and number of recording channels the data accumulated may reach such proportions paper-supported chart recorders could only handle with great efforts.
MiniLog represents state-of-the-art measuring technology of cathodic protection.

System Description
MiniLog is a battery operated miniature sampling data logging unit for electrical potentials recording.

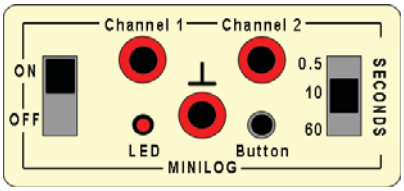
Short Term Recording and Long Term Recording
Bearing in mind that various sampling rates and large data capacities are available, *MiniLog* can be optimal used for short term recordings (e.g. stray current recordings), as well as for long term recordings over several months.

Battery Provision and Miniature Design
Due to the fact that *MiniLog* has tiny structure and dry cell battery is used for the power supply, *MiniLog* allows installation and operation even in test points.

Real Time Clock and Alarm Mode
In the *MiniLog* integrated real time clock provides all sampling values recorded with a date and time stamp. The utilisation of alarm mode provides pre-programmable sample recordings start at any time required. For example, stray current measuring during night-time.

AC and DC Measurements
The *MiniLog AC /* DC has the capability of simultaneously DC and AC voltage recording. All DC inputs are effectively protected against falsifying 16 Hz and 50 Hz AC voltages by an active low-pass filter.

Auto-Range-Mode
An intelligent auto-range-mode has been integrated. This mode enables to measure within a wide reading range selecting the needed range (300 mV, 3 V and 30 V) automatically. This insures comfortable recordings without nuisance metering range restrictions



WinLog Evaluation Program

To facilitate the evaluation of the huge information logged in, a special software program has been developed. The WinLog evaluation program permits a graphical representation of the logged samples on the PC-screen and further to the printer. WinLog makes it easy to put recordings, which have been taken in different sites in comparison. Furthermore, enormous statistic's functions and mean value's calculations offer a wide range of possible manipulation.

Miniature Design and Dual Channel Recording

The remarkable diminutive volume when put in comparison to all known chart recorders, permits the utilization in test points. By means of utilizing the latest known storage technology and the low current consuming microprocessor (supplied by standard 9 V block battery) used in this tiny device, a continuous recording capabilities for a time up to 6 months is possible. Internal Lithium cell secures all logged data during battery change, or depletion for a time longer than 2 years.

System Operation

MiniLog is easy to operate. When the integrated Auto-Range-Function is used nuisance metering range alteration by the operator can be completely overlooked.

MiniLog will self-acting choose the proper metering range (300mV, 3V or 30 V) even when value change occurs during the running recording. When Auto-Range is used MiniLog will provide ideal resolution of the sampling values during potential or current deviation. In order to maintain the miniature design feature of the MiniLog, the installation of keyboard and display has been renounced. Only an On/Off-switch, sampling range switch and the recording start switch are to be operated by the technician.

Miniature Design and Dual Channel Recording

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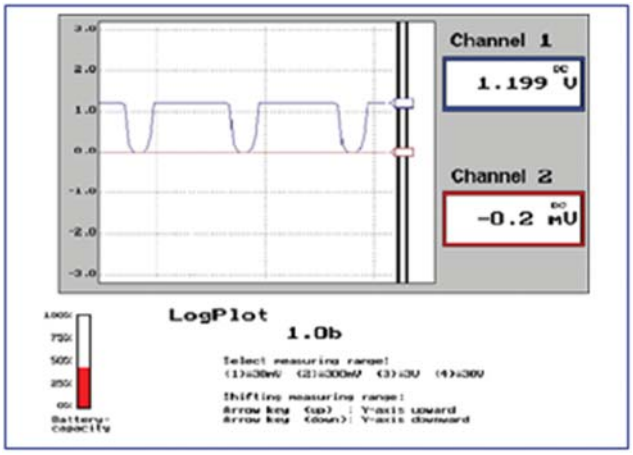
Integrated Real Time Clock and Alarm Mode

The real time clock provides all sampling values during recording with a date and time stamp. This will ease and facilitate the association between recordings that are several hours, days or even months apart. For sampling recordings that are to be taken in definite times (e.g. during night time or at weekends) MiniLog offers an alarm mode. The alarm mode enables the MiniLog to start sampling at a defined time and date.

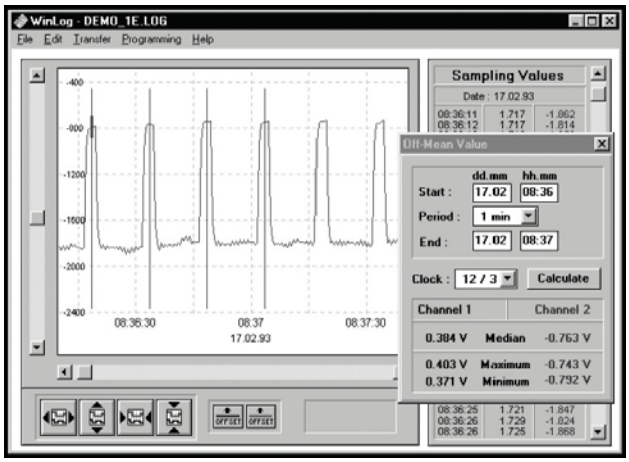
Intelligent Recording of DC and AC Voltages

Using the fast sampling rate of 100 ms, MiniLog will be capable of showing the graphical display of the depolarisation curve during off-potential measuring. Representation is as well possible outdoors with sites having extremely AC voltage interference. The high AC voltage attenuation in the DC channels within the 16 Hz and 50 Hz ranges have been encountered using active low-pass filter and computerised integration procedure. Reliable recording without any further noticeable interference is achievable.



To control the sampling values during recording, it is possible to connect the *MiniLog* through the existing port to a PC or notebook by means of serial interface cable.
In order to be able to observe the sampling values on the PC/notebook monitor, *MiniLog* transmits each sampling value recorded through his serial interface port. Program ***LogPlot*** allows the real time presentation of the sampling values in a PC or a notebook during running *MiniLog* recordings.
With a resolution of 3½ digits, ***LogPlot*** display a virtual activity of a recorder. The amplitude of the actual sampling value from both *MiniLog* - channels is exposed in a sub-window parallel to the graphical sample display. Similar to a 2-channel chart recorder the samples will be represented as a solid line.
Additionally, for the battery condition control a percentage scale display is used. Also the actual date and time of the recording *MiniLog* are to be observed on the display. Similar to a chart recorder, manipulation of the scale in different steps to facilitate reading and evaluation of important potential portion is possible.

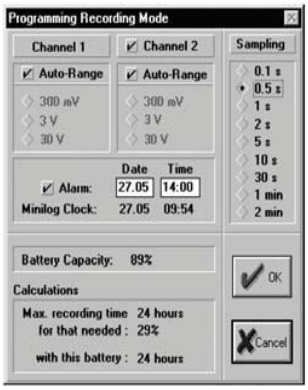
WinLog - Evaluation Software



Data Processing

WinLog is required to transfer the logged data from *MiniLog* to the PC or notebook; for the comfortable data evaluation.
WinLog is conformable with the highest software standards, consequently ***WinLog*** is runnable under Windows 3.1x, Windows 95, Windows NT and the last Windows version.
WinLog submits simultaneously the graphical and the digital presentation of the sampling values. Thus ***WinLog*** offers optimum degree of fast and accurate recordings evaluation.
Without nuisance hidden, hard to keep in mind menu functions, the Windows display has all functions visual on the menu bar. The menus can be dropped down and the belonging commands are visible to select either with shortcuts, keyboard or with the mouse. Zooming and offset could be directly selected on the display.

Definite Identification for each MiniLog
Each MiniLog can get its own identification. The identification code gives the PC information about working sites and jobs. Therefore, when sampling data readings are performed, this attached information is immediately available. Likewise, it is always possible to call the most important characteristics (e.g. start time, used sampling rate) of the last recording and the actual battery condition.



Individual Recording Mode Settings
Parallel to the standard settings (via operational switch at the front plate) MiniLog may be preprogramed by PC for additional settings.
Independently programmable are features like Auto-Range on/off for both channels individually, preselection of measuring ranges, doubling recording capacity by switching off second channel, alarm controlled recording start- up. Depending on MiniLog version up to 9 different sampling rates are available for varying measuring tasks.

Data Evaluation

Changeable Time Axis
The windows graphic display of sampling values offers versatile options of data evaluation. For example, it is possible to stretch or compress the time axis up to a maximum factor of 64. The zooming will give a proportional overall view when fast potential changes within seconds or slow potential changes within hours' range are to be evaluated.

Voltage Magnifier
In order to evaluate even smaller potential changes correctly, WinLog offers the possibility of voltage magnification. The scale of the voltage axis can be spread out in 8 different steps and additionally shifted around an independently selectable voltage ranging. For example, to display a voltage range from -800 mV to -900 mV perfectly on the screen. This function is at wish changeable and offers the possibility of sampling value procession that is not available by paper-based recorders.

Graphical Illustration with Printer or Plotter
Individual Legend Adoption
Individual Text Adoption
After having an optimised look at the recorded values, WinLog allows printing of the whole section or selected parts with printer or plotter. A legend can be added and edited as necessary. The time and voltage axis scales can be selected and edited as desired. It is even possible for WinLog to calculate the current values by means of switching a definite calculating factor when voltage is measured.

Comparative Function
Offset and Factor Calculation
Off-Potentials, Mean Value
In order to be able to compare between different recordings, the recording sessions to be compared can simultaneously be loaded on the PC and be processed. Shunt voltages may be converted into equivalent current values. To evaluate the median for off-potential measuring, WinLog will form the mean value based on multiple sampling periods.

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Features of MiniLog

- 8 Bit microprocessor operated sampling values' recorder
- 12 Bit A/D-converter with integrated active low-pass filter for each DC-input as protection against AC interference
- 2-channel recording with Auto-Range mode
- 128 KBytes or 512 KBytes RAM size with battery backup
- Integrated real time clock for presenting date and time
- 3 Standard-sampling values
  (selectable via 3-position selector switch: 0,5 s, 10 s, 60 s)
- 9 Pre-programmable sampling rates
  Pre-programmable functions:
  - Sampling rates (0,1s, 0,5s, 1s, 2s, 5s, 10s, 30s, 60s, 120s) 0,1s only for MiniLog DC Version
  - Auto-Range is for each channel individually deactivatible
  - Double recording capacity with deactivation of second channel
  - Alarm mode with date and time for precise sampling start- up, e.g. during night hours or weekends
- User freely programmable identification text or code for each MiniLog unit (e.g. to define each individual measuring job).
- Self-acting battery condition test after each start using light diodes as status indicator.
- The display of exact percentage MiniLog-battery condition in a PC/Notebook screen.
- Self-acting power saving control. The microprocessor will switch the MiniLog off when within consecutive 5 minutes the system has not been in use (the function is blocked during data recording).
- Self-acting data recording reliability test. Auto-termination will take place when the system detects weak battery condition.
- No data loss by weak battery condition and during battery replacement.
- Runnable under Windows 3.1x, Windows 95 and Windows NT
- Large scale multi-coloured display of sampling value
- Digital and analogue display of sampling values
- Comprehensive zoom facilities via keys
- Rapid viewing of entire recording via scrollbars
- Enormous statistics' function for sampling value evaluation (forming mean-, maximum-, minimum value and standard deviation)
- Compressing and spreading recorded sessions
  (= post-recording sampling rate change)
- Evaluation by other software is possible. ACSII-code is used to export the sampling values
- Comfortable and easy method of printing service. Preview gives the user the possibility to modify the legend and axis as desired
- Current calculation by means of volt measuring
  (i.e. shunt voltage measuring) with user's choice for the Y-axis scale
- Comments can be added at any point desired within the graph so as to explain or simply to mark an essential point
- Easy way forming the off-potentials mean value.

Dimensions : 11.2 x 7 x 3.3 cm
Weight : 220 g (incl. Battery)
Battery : 9 V Block, Type: Alkaline

Technical Specifications

MINILOG (DC Version)

Channel 1 and 2 for DC

	Measuring Range Channel 1 and 2 (DC)		
	± 300 mV	± 3 V	± 30 V
Resolution	0.2 mV	2 mV	20 mV
Input resistance	2 Mohm	2 Mohm	1 Mohm
Attenuation at 16 Hz / 50 Hz	45 / 60 dB	45 / 60 dB	35 / 45 dB
Accuracy (% of value indicated)	0.5 %	0.5 %	0.5 %
(basis deviation)	± 0.6 mV	± 4 mV	± 40 mV

Operating temperature -15°C to 60°C Relative Humidity 10 to 80% noncondensing

MINILOG (AC / DC Version)

Channel 1 for AC, Channel 2 for DC

	Measuring Range Channel 2 (DC)		
	± 300 mV	± 3 V	± 30 V
Resolution	0.2 mV	2 mV	20 mV
Input resistance	2 Mohm	2 Mohm	1 Mohm
Attenuation at 16 Hz / 50 Hz	45 / 60 dB	45 / 60 dB	35 / 45 dB
Accuracy (% of value indicated)	0.5 %	0.5 %	0.5 %
(basis deviation)	± 0.6 mV	± 4 mV	± 40 mV

	Measuring Range Channel 1 (AC rms.)		
	250 mV eff.	2.5 V eff.	25 V eff.
Resolution	0.2 mV	2 mV	20 mV
Input resistance	2 Mohm	2 Mohm	1 Mohm
Accuracy (% of value indicated)	1.5 %	1.5 %	1.5 %
(basic deviation)	± 1 mV	± 6 mV	± 60 mV

Operating temperature -15°C to 60°C Relative Humidity 10 to 80% noncondensing

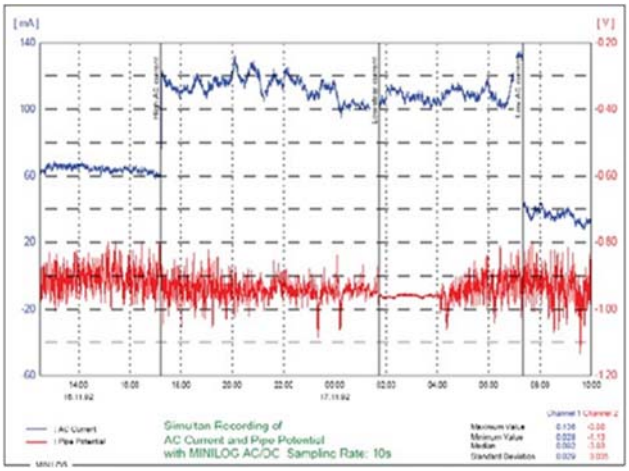
Recording Capacity

Version 128
Recording Capacity with 128 Kbyte RAM (approx. 85 000 sampling values)

Sampling rates	0.5 s	10 s	60 s
single channel	12 h	10 days	60 days
dual channel	6 h	5 days	30 days

Version 512
Recording Capacity with 512 Kbyte RAM (approx.340 000 sampling values)

Sampling rates	0.5 s	10 s	60 s
single channel	48 h	40 days	238 days
dual channel	24 h	20 days	119 days



PSE ENGINEERING GMBH

***MiniLog2* Datalogger and GPS Time Switch for CP**

2-Channels (DC + AC = 4 values) · Microvolt · AC Filter · max. 1,000 measurements / sec. · 1,300,000 Values (4 MByte) GPS Time Switch 15 A relay · Li-Ion battery for 1-month cont. switching · DCVG + CIPS with GPS · Waterproof IP68.

General

The new MiniLog2 is a waterproofed universal measuring instrument with LCD and keyboard designed for CP measurement tasks.
Used as a datalogger the MiniLog2 samples both channels for DC and AC voltages simultaneously.
The integrated 15 A relay is fully GPS synchronized and switches not only coupons, but also rectifiers and flanges.
In addition, the MiniLog2 is able to make DCVG and CIPS measurements and stores the GPS coordinates for every measuring point

Datalogger with Microvolt Measurement

Two channel sampling, each with DC and AC measurement, results in a maximum of 4 values per measurement. Both DC channels allow microvolt resolution and have active filters built-in to prevent low frequency interference. The MiniLog2 is able to sample up to 1,300,000 values (4 MByte, optional 16 MByte).

This results in up to 20 min. sampling even when measuring in “High-Speed mode” (= 1,000 measurements / second). The built-in USB connector allows galvanically isolated data transfer via a USB to the PC/Notebook.

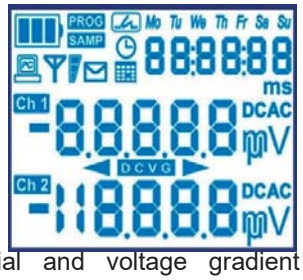
Miniaturized Time Switch with Rechargeable Battery

The MiniLog2 has a mechanical 15A / 60V relay for switching of rectifiers, flanges and coupons. Optionally available is a solid state 18A / 100V switch.

Via the keyboard and LCD, a switching cycle resolution of 0.1s is configurable by the user. In addition, night and weekend suspension is selectable.

The rechargeable battery allows switching for one month. For a fixed installation in the rectifier housing the included USB mains supply can be used.

DCVG and CIPS



MiniLog2 shows the DCVG voltage difference in a specially designed LCD bar graph for quick recognition. With a simple press of the “OK” button the DCVG value and are stored and the measurement continues.
In the same way potential and voltage gradient measurements (CIPS) are done.

Coupon Measurement with 1KHz Sampling Rate

When measuring coupon IR free potentials, the MiniLog2 is able to simultaneously switch and measure the coupon potential.

To avoid measurements during times when a switching spike or equalizing current could affect the reading it is possible to set the delay between switching and taking the measurement. This delay can be adjusted in increments of 1 ms. For accurate sampling during the complete off period the MiniLog2 is able to measure up to 1,000 measurements / second.

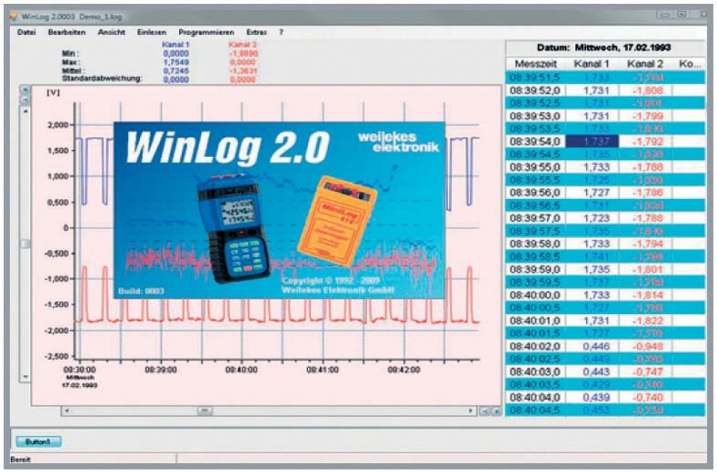
GPS Synchronization and Coordinates

The optional Garmin GPS receiver allows the exact synchronization of the MiniLog2. Using the MiniLog2 as datalogger or for DCVG measurement, the GPS coordinates are automatically stored beside each measurement.

Technical data

Measuring channels:	2 (DC+AC parallel = 4 values)
Measuring range and resolution:	± 100 mV / 1 µV (only DC) ± 10 V / 0.1 mV (DC+AC) ± 100 V / 1 mV (DC+AC)
Input impedance:	10 MΩ (for microvolt 100 KΩ)
Maximum rate:	1,000 measurements / second 10 measurements / second (with filter)
Low pass filters:	16.6 Hz > 60 dB (factor 1,000) 50.0 Hz > 100 dB (factor 10,000)
Recording capacity: Version: 4 MByte	1,300,000 values (=20 min with 1,000 measurements / second)
Switching cycle:	In 0.1s steps, user configurable
Synchronization:	Manually, externally or via GPS
Switching power:	Mechanic relay 60V / 15A Solid state switch 100V / 18A
Power supply:	Lithium-ion battery 3.6V / 1,900 mAh charged with USB power supply
Time accuracy:	< 10 ms / 24h (with GPS) w/o GPS (10 °C – 30°C) < 50 ms / 24h w/o GPS (–20 °C – 60°C) < 200 ms / 24h
Battery time: rate	Datalogger mode: 2 weeks with 0.5s sampling 52 weeks with 60s sampling Switcher mode: 4 weeks with 12/3 and GPS
Dimension:	148 x 68 x 42 mm

Software WinLog 2.0



The office software “WinLog 2.0” for the evaluation of the datalogging is specially designed for the new MiniLog2. “WinLog 2.0” is also compatible for the MiniLog (128 / 512) and will run under Windows XP, Vista and 7.0.

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Current Interrupter - *MiniTakt* -

MiniTakt is a current interrupter specially developed for interruption of DC-circuits in cathodic protection systems.

Because of its small size, *MiniTakt* can not only be installed in transformer rectifiers but also inside test points for interruption of sacrificial anode systems or bonded pipeline branches.

MiniTakt is a small battery-operated time switch with quartz controlled time base for short period switching of protection systems and line sections during maintenance and close-potential survey sessions.

MiniTakt offers three selectable switching cycles. Selection of switching periods is effected by slide switch at the unit´s front.

Low energy requirements and accuracy of quartz-controlled time base allows synchronised operation over several hours.

MiniTakt starts periodic switching immediately after switching on by slide switch. By this manual synchronisation, *MiniTakt* can be operated without problems in conjunction with other time switches for synchronous measurements.

MiniTakt is optionally available against surcharge with customer- specified switching periods.

Technical data *MiniTakt*

Switching cycles	4 / 2s, 12 / 3s and 27 / 3s
Relay type	1 change-over contact (4 mm female banana terminals)
Switching load	30 V, 8 A (cos φ = 0)
Power supply	Alkaline battery 9 V
Operating time	approx. 100 h (12 / 3s)
Housing	ABS with battery compartment
Dimensions	66 x 33 x 110 mm (W x H x D)
Weight	0.21 kg

Current Interrupter - GPS-Syntakt -

General Information

The **GPS-Syntakt** time switch is used for the synchronous switching of rectifiers, flanges and coupons for cathodic corrosion protection applications.

After having been synchronised, the switching cycle (4/2, 12/3 or 27/3) is maintained even when the device is not in operation and immediately available again even after the time switch has been transported in an instrument car for several weeks.

GPS-Synchronisation

GPS-Syntakt resynchronises itself automatically every 2 hours via the connected GPS antenna and thereby guarantees continuous synchronous switching without time deviations. The GPS reception quality and successful GPS synchronisation (during the last 24 h) are indicated by a two-colour LED on the front panel.

Manual and External Synchronisation

It is possible to manually synchronise via the corresponding push button or externally via another timer when no GPS antenna is connected. In this respect the functions correspond to the functions of the predecessor **Syntakt**.

High-Precision Quartz Time Base

Being equipped with a highly precise and temperature stabilised quartz time base the **GPS-Syntakt** enables synchronous switching for several weeks without resynchronisation.

Battery Operation

During GPS-operation **GPS-Syntakt's** internal lead-acid storage battery facilitates mains-independent synchronous switching for more than 6 weeks.

During 230 V mains operation the internal storage battery is automatically charged, and the installed charging electronics monitor the charge state.

Night and Weekend Shutdown
It is possible to suspend the switching operation during the night and on weekends via a programmable LCD clock display installed on the front panel in order to maximize the protective current for the pipeline.

Installed 15 A Relay
Via its two potential-free pole terminals the internal relay of **GPS-Syntakt** has a maximum contact capacity of 15 A / 30 V.
During 230 V mains operation a primary switching of rectifiers with 230 V / 6 A is also possible via the installed grounding receptacle.

Connection of External Slave Relays
To increase the switching power, an external slave relay can be additionally connected when the time switch is 230 V mains-operated. The **LS60A** slave relay permits switching power rates of up to 60 amps.

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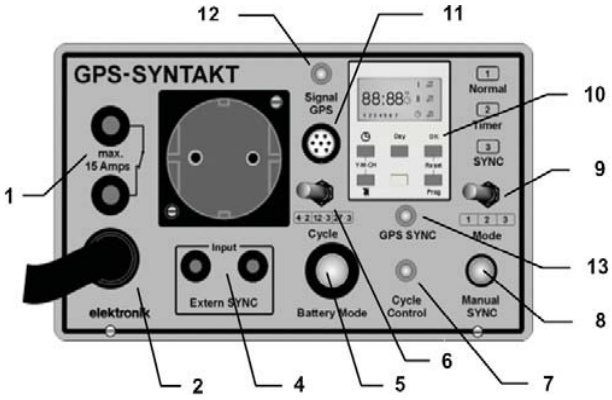
Technical data - GPS-Syntakt -

Switching cycles (On/Off)	4 / 2 s, 12 / 3 s, 27 / 3 s (other switching cycles at extra charge)
GPS antenna	Type Garmin, with 5 m cable
GPS synchronisation	every 2 h, accuracy < 10 ms
Time deviation	maximum ± 10 ms / 24 h at 20°C maximum ± 20 ms / 24 h at 0°C - 40°C
Switching power	30 V DC / 15 A (via pole terminals) 230 V AC / 6 A (via socket)
Operating temperature	- 20°C to + 60°C
Power supply	lead-acid storage battery 6 V / 12 Ah and 230 V AC / 5 VA
Operating time / charge	approx. 1.200 h with GPS antenna, at 12 / 3 and 20°C approx. 1.500 h without GPS antenna, at 12 / 3 and 20°C
Housing	aluminium with variable grip
Dimensions (WxHxD)	173 x 110 x 151 mm (housing) 80 mm diameter (GPS antenna)
Weight	3.0 kg with GPS antenna

GPS Synchronization

- Set the <**Cycle**> switch to the desired switching cycle (e.g. 12/3)
- Set the <**Mode**> switch to [**1 Normal**] or for an operation including night and weekend shutdown to [2 Timer]
- Insert the bullet connector of the GPS antenna in the [**Signal GPS**] socket of **GPS-Syntakt**.
- Align the GPS antenna as horizontally as possible with an unobstructed view of the sky. It is possible to position the antenna horizontally below a plastic main cover inside a rectifier cabinet. A GPS reception in metal cabinets, buildings or in forests underneath dense vegetation is mostly impossible.
- In general, only one successful GPS reception within 24 h is necessary due to the highly precise and temperature-stabilized quartz time base of GPS-Syntakt.
- During mains operation GPS reception attempts are performed continuously. During battery operation GPS reception attempts are only made every 2 h to spare the storage battery. However, by pressing the <Battery Mode> push button twice (on and off) it is possible to manually start a new GPS reception attempt at any time during battery operation.
- The (Signal GPS) LED indicates a sufficient GPS signal by flashing in Green colour. It is flashing in Red colour when the signal is insufficient.
- A Green (GPS SYNC) LED signalizes at least one successful GPS synchronization during the last 24 h. A Red LED indicates that there has not been any GPS synchronization during the last 24 h.
- The (GPS SYNC) LED is flashing during battery operation to keep the current consumption low. It is continuously illuminated during 230 V mains operation.



1 = Pole terminals for potential-free switching, max. 15A / 30V
2 = Power cord with safety plug
3 = Grounding receptacle switches 230V with max. 6A
4 = Inputs for external synchronisation
5 = <Battery Mode> push button for switching during battery operation
6 = <Cycle> switch for selecting the switching cycle
7 = (Cycle Control) LED for indicating the cycle
8 = <Manual Sync> push button for manual synchronisation
9 = <Mode> for selecting the operating mode (Normal / Timer / SYNC)
10 = Clock display for night and weekend shutdown
11 = Input for GPS antenna
12 = (Signal GPS) LED for indicating the GPS signal quality
13 = (GPS Sync) LED indicates successful GPS synchronisation

Manual Synchronization

- Set the <**Cycle**> switch to the desired switching cycle (e.g. 12/3)
- Set the <**Mode**> switch to [**3 Sync**]
- Supply **GPS-Syntakt** with 230 V or press the <**Battery Mode**> push button for battery operation. **GPS-Syntakt** starts switching with the “old” synchronization
- Press the <**Manual SYNC**> push button once for manual synchronization, thereby deleting the “old” synchronization and replacing it by the new manual synchronization.
- To prevent an incidental resynchronization, you have to set the
- <**Mode**> switch back to [**1 Normal**] at any rate.

External Synchronization (“Master” and “Slave”)

- Set the <**Cycle**> switch to the desired switching cycle (e.g. 12/3)
- Set the <**Mode**> switch to [**3 Sync**]
- Supply the **GPS-Syntakt** with 230 V or press the <**Battery Mode**> push button for battery operation. **GPS-Syntakt** starts switching with the “old” synchronization
- Connect the two <**Extern SYNC**> sockets of **GPS-Syntakt** (“Slave”) via two lines to the potential-free contacts of the “Master” time base The “Master” time base has to switch with the same cycle (e.g. 12/3) as **GPS-Syntakt**
- Press the <**Manual SYNC**> push button once. It is flashing and **GPS-Syntakt** now waits as “Slave” for the cycle of the “Master” and synchronizes to the externally created cycle
- To prevent an incidental resynchronization, you have to set the <**Mode**> switch back to [**1 Normal**] at any rate.

Pipe and Cable Locator RD4000

The Radio Detection RD4000 cable and pipe locator is widely seen as the industry standard, with the highest locate performance, multiple locate modes and ease of use for locating utilities, marking for construction, mapping or fault finding.
The RD4000 series is the product against which all others are measured. RD4000 delivers best in class location:

- Highest performance digital Receiver even in the presence of interference
- Fast, clear, positive response even in congested areas
- Multiple active frequencies and modes provides sophisticated location tools
- Peak, null and single antenna modes Position and depth measurement
- Current measurement to identify individual networks Real Sound - audible perception of locating dynamics
- High output Transmitters to locate deep utilities and handle complex locates; T3 - 3watt and T10 - 10 watt
- Fault finding and cable and pipe integrity measurement Current direction - RD patented

Key features

- Highest performance - even in congested areas
- Multiple modes - address the most demanding requirements
- Ease of use - large clear display and positive keypad and control paddle
- Extended capabilities - supported by a large range of accessories
- Highest sensitivity
- Best Signal to Noise

Properly locating buried utilities can avoid costly outages and avoid major hazards associated with inadvertent contact during excavation. While it is important to utilize the best products available, it is equally as important to adhere to the best and safest practices to assure a safe and productive job site.

Highest performance

The RD4000 utilizes a powerful, advanced digital measurement and processing system that is far ahead of any others. The patented signal-processing algorithm provides improved performance and accurate results, even in the most congested of areas. Users will quickly discover that the RD4000 always delivers repeatable accurate locates, even in the most difficult of circumstances.

Multiple modes

RD4000 models are available to address the specific needs of various sectors. Increasingly, companies are outsourcing mark before dig and utility mapping. Recognizing that there is no single location mode or frequency guaranteed to locate a given pipe or cable, RD4000 has options to optimize the location task. Whatever the location requirement there is an RD4000 solution.

Ease of use

Repeatability and ease of use is delivered through the ergonomic design and features of the RD4000. A large, clear, automatically back-lit LCD display and a highly responsive gain paddle give users of all levels an unmatched confidence in their RD4000 locator. It is through attention to detail that Radio detection have delivered a powerful and sophisticated tool that is simple to use.

Extended capabilities

The RD4000 family of locators is supported by a wide range of plug-and-play accessories, such as fault locating A-Frames for locating cable sheath faults or pipe coating defects, receiver clamps and stethoscopes for cable identification. RD4000 receivers provide seamless integration with most GPS receivers and data recording devices, making the RD4000 perfect for both novice and advanced users.

PSE ENGINEERING GMBH

SIMPLE
4 key interface for minimum training and ease of use

SIMULTANEOUS
1 button depth and current measurement

AUTO BACKLIGHT
For Low Light Operation

MULTI-SIGNAL RESPONSE
Single and dual peak, null left and right arrows

HIGH RESOLUTION
signal strength meter for pin-point precision

INSTANTANEOUS
1 Touch Gain Control

WEATHER SEALED
RS232 earphone and accessory ports for data logging and software upgrades

REAL
Non synthesized sound, giving more information about the utility being located

CHOICE OF BATTERIES
Dry cells or rechargeable options

ENGINEERING PLASTICS
Ergonomic, robust and all weather housing

MRx OPTION

RECEIVERS

Rd4000SL - Standard Locator
- Power, Radio & 1 active frequency

Rd4000dL - Drain Locator
- Power, Radio & active locate of sondes

Rd4000PxL - Multi f Locator
- Multi-utlity location
- Additional frequencies including CPS and high f
- Enhanced location accessories
- Current display

Rd4000PdL - multi-frequency, Fault find & Cd
- Highest locate performance with multi-frequency incl. CPS
- Advanced fault find
- Enhanced location accessories
- Additional frequencies available
- Current display
- Current direction

TRANSMITTERS

Rd4000 T1
- 1 Watt entry-level transmitter
- 3 locate and 2 induction frequencies

Rd4000 T3
- Cost effective 3 W transmitter
- 3 locate frequencies
- 1 induction frequency

Rd4000 T3F
- All features of T3 (above)
- 8kHz fault find codes

Rd T10
- 10 Watt output power
- Multimeter functions for checking cable/pipe integrity
- up to 16 locate frequencies
- 2 induction frequencies
- Fault find signals
- Current direction signals
- Pipeline integrity signals
- Rechargeable option and external 12v dc supply available for T3/T10 transmitters
- various clamp and connectors available as accessories

T10 Shown

AUTO BACKLIGHT
For low light operation

ERGONOMIC
ROBUST CASE

EFFICIENT INDUCTION

EXTERNAL 12 V DC SUPPLY
Direct connection output protected against inadvertent connection to AC voltages up to 250 V

PSE ENGINEERING GMBH

RD 4000 TECHNICAL SPECIFICATION

LOCATING DEPTH GUIDE
10mA active locate signal
- typical locate depths -

SENSITIVITY AT SPOT FREQUENCIES	FREQUENCY	SENSITIVITY @ 1m	GOOD CONDITIONS
ACTIVE frequencies at 8Hz b/w Refer to configuration for available frequencies	50 Hz or 60 Hz	2 mA	3 m
	15 - 30 kHz	25 µA	3 m
	512 Hz or 640 Hz	50 µA	5 m
	8 kHz	5 µA	5 m
	33 kHz	5 µA	5 m
	65 kHz	6 µA	5 m
	131 kHz	6 µA	5 m
	200 kHz	8 µA	5 m
	CD pairs	50 µA	5 m
CURRENT READING FAULT FINDING	± 5% Active signal bw limited Diagnose faults from s/c to 2 MΩ		
LOCATE QUALITY	**Dynamic Range** 140dB@10hz bandwith **Selectivity** 120dB/hz up to 200khz **Sensitivity** $5E^{-15}$ Tesla (32,768Hz, 1Hz b/w)		
LOCATE ACCURACY	**±5% of depth, good condition** Depth acheivable dependent upon signal current on line Note greater depth means broader peak response		
DEPTH ACCURACY on undistorted signal	**Line ± 2.5% 0.1 m to 3 m** **Sonde ± 2.5% 0.1 m to 7 m**		
BATTERIES	4 x LR20 (D) 1.5 V alkaline. 40 hours life, nominal @ 20 ºC (68 ºF), intermittent use Compatible with D type NiMh rechargeable batteries		
EMS Transceiver MRx option	Range to standard marker balls to 2m; 5m on deep marker disks Dual mode line locate and marker locate		
External data logging	For report generation and support		
ANTENNA MODES			
PEAK	Standard locate mode - all purpose locate		
NULL	L and R arrows for simple locate		
SINGLE	Highest sensitivity - for location of deep targets		
FAULT FINDING ON PDL			
	With the A frame accessory and three fault finding methods, RD4000PDL accurately locates cable sheath and pipe coating faults typically up to 2 MΩ impedance		
8kFF	Ideal for cable sheath faults. high voltage to locate high impedance. 8khz locate signal		
LFFF	4 Hz / 8 Hz good for finding coating faults on pipelines		
CDFF	640 Hz / 320Hz (512 Hz / 256 Hz) good distance locate of pipeline coating faults 640 Hz (512 Hz) simultaneous locate signal		

TRANSMITTER TECHNICAL SPECIFICATIONS

DESCRIPTION	T1	T3	T3F	T10
	3	3		
INDUCTION FREQUENCIES	2	1	1	2
	1 W	3 W		
CURRENT DIRECTION OUTPUT				**Y**
BATTERIES 12 hours' nominal life standard operation at 20 ºC (68 ºF). Continuous Hi power output will reduce battery life below this.	4 x LR20 (D) alkaline	12 x LR20 (D) 1.5 V alkaline		
RECHARGEABLE OPTION		**Y**	**Y**	**Y**
EXTERNAL 12 V SUPPLY		**Y**	**Y**	**Y**
DISPLAY	LED	LED	LED	LCD
MULTIMETER FUNCTIONS (V, I, Mega to gnd)				**Y**

PSE ENGINEERING GMBH

TRANSMITTER TECHNICAL SPECIFICATIONS

DESCRIPTION	T1	T3	T3F	T10
O/p VOLTAGE MAX. (rms)	+/- 24 V	+/- 80 V	+/- 80 V	+/- 80 V
CHARGER CIRCUIT, GALVANICALLY ISOLATED		Y	Y	Y
DIRECT CONNECT TO 240V; LIVE TRANSFORMER AVAILABLE AS ACCESSORY		Y	Y	Y
S/C PROTECTED	Y	Y	Y	Y
SELF TEST - BUILT IN ERROR REPORTING				Y
APPROVALS	EN 300 330-2-V1.1.1, EN 301 489-3-V1.2.1, BS EN 61010-1 1993/A2:1995			

Rx CONFIGURATION OPTIONS

	POWER	RADIO	CPS	LF	8 kHz	33 kHz	65 kHz	83 kHz	130 kHz	200 kHz	CD	8 kFF	LFFF	CDFF	Peak	Null	Single	Current display	EMS	Simple acc	Stereo acc
SL8	Y	Y			Y										Y					Y	
SL38	Y	Y				Y									Y					Y	
SL65	Y	Y					Y								Y					Y	
DL	Y	Y		Ys	Ys	Ys									Y					Y	
PXL	Y	Y	Y	Y	Y	Y	Y	Y	Y	USA					Y	Y	Y	Y	OPTION	Y	Y
PDL	Y	Y	Y	Y	Y	Y	Y	Y	Y	USA	Y	Y	Y	Y	Y	Y	Y	Y	OPTION	Y	Y
PXL and PDL additional frequencies available on request																					
MRx - EMS option, for utility marker balls																					

New Options in blue

S = Sondes

Faster, more accurate, more repeatable location for mark and map.
By using the Transmitter and Receiver together or with Radiodetection sondes (as the chart shows), the widest range of pipes and cables can be located and mapped. By following best practice and using Radiodetection location tools, you can dramatically reduce the risks of hitting buried utilities. Expert fault find and mapping service companies can increase efficiency and service levels.

INDUSTRY / APPLICATION

SIGNAL Best practice	GAS Metal plastic pipes	OIL Metal pipes	WATER SUPPLY Metal clay, plastic pipes	WATER WASTE Clay, concrete & plastic pipes Some metal pipes	POWER Cables	TELECOMS/ CATV Coax, twisted or wires	RAIL Power & signal wires
PASSIVE SWEEP DETECTION OF UTILITIES IN GENERAL AREA (POWER OR METALLIC PIPES) SWEEP BEFORE PRECISION LOCATE							
Power: 50/60 Hz All mains conductors and pick up from these					Y		Y
RF15kHz to 30kHz Pick up/return signals from High Power transmitters. Long conductors.	Y	Y	Y	Y	Y unpowered	Y	Y
ACTIVE recommended best practice **PRECISION LOCATE. RECOMMENDED BEST PRACTICE FOR OPTIMIZED LOCATION.**							
CPS (Cathodic Protection System) - 100Hz/120Hz. Protection signal on metallic pipes.	Y	Y	Y				
SONDES (GENERATES SIGNAL IN PIPE/CONDUIT) Non-metallic and some cast iron							
LF: 512Hz For cast iron pipes				Y			
ACTIVE LINE. METALLIC PIPE AND CONDUCTORS, CONNECT VIA DIRECT, SIGNAL CLAMP OR INDUCED.							
LF: 640Hz/512Hz Steel pipes, not mechanically jointed, provides good distance. no coupling to other conductors. DIRECT ONLY	Y	Y	Y	Y		Y	
MID F: 8kHz general purpose, reasonable distance, doesn't couple much to other conductors. DIRECT/CLAMP/ INDUCE	Y	Y	Y	Y		Y	
Hi F: 33kHz Jumps joints in cast iron. does couple to other conductors, good inductive coupling, DIRECT/CLAMP/ INDUCE	Y	Y	Y	Y	Y Clamp or induce	Y	O/P pwr < 0.1 W
SH F: 65/86/131kHz great inductive coupling, DIRECT/CLAMP/ INDUCE	Y	Y	Y	Y	Y	Y	

PSE ENGINEERING GMBH

Powerful Accessories That Enable Advanced Test & Locate

- Plug connectors - for signal application to house wiring via a conventional wall socket
- Live cable connectors - for applying the transmitter signal to a live cable, the most certain method of locating a power distribution system in the street
- Transmitter clamps - for safe signal application to live cables
- Receiver clamps - for cable identification in ducts, etc
- Flexrods - for pushing sondes down non-metallic and cast iron pipes
- A range of Sonde transmitters for locating non-conductive pipe and cast iron duct structures
- Accessory A-Frame - for sheath to ground type faults - improved sensitivity
- Stethoscopes for identifying individual cables within cable bundles
- Submersible antennas - for pin-pointing submerged cables, submersible to 100 metres
- Hard Case - Rugged hard case to protect the equipment from damage and the elements

Accessories

RD4000 Kits
RD4000RX
RD4000T10
RD4000T3
T1 Transmitter

RECEIVER ACCESSORIES
2" Receiver Clamp
4" Receiver Clamp
640 / 512 Hz Submersible DD antenna (10 m cable)
8 kHz Submersible DD antenna (10 m cable)
A - Frame
Additional submersible cable length, per meter
Carry Bag
CD Receiver Clamp
CD Stethoscope
High gain stethoscope
Small Stethoscope (possibly going obsolete)
Summer headphones
Winter headphones

RECHARGEABLE BATTERY PACKS
Euro Mains Charger
Receiver Rechargeable batt pack (incl. 12 V lead) Rechargeable Battery Packs
Transmitter Rechargeable batt pack (incl. 12 V lead)
UK Mains Charger
US Mains Charger

SONDES AND ACCESSORIES
115 mm / 4.5" Dia Floats/Pair
9 mm 120 m Flexrod
9 mm 60 m Flexrod
External Shell for heavy-duty Applications (dia as Sewer Sonde)
FlexiTrace 50 m
Flexrod Blank for Machinery
Flexrod Coupler joins two Flexrods together
GD Rod Connector 3/4" x 12 BSF, Female
Lockfast“ Connector 3/4" x 10 BSW
M10 Thread Protecting Nipple
Plastic or Cane Rod Connector, Male
S18A Sonde 33 kHz
S18B Sonde 33 kHz
Sewer Sonde 33 kHz Depth 8 m
Slim Sonde 33 kHz Depth 3.5 m Slim
Sonde blank end cap
Slim Sonde plain end cap
Spring Coupling M10 Male
Standard Sonde 33 kHz Depth 5 m
Super Sonde 33 kHz Depth 15 m
Wards Rod Connector, 6 mm, 1/2" x 12 BSW, Female
Wards Rod Connector, 8 mm, 3/4" x 10 BSW, Female

TRANSMITTER ACCESSORIES
121 transformer
12 V car power lead. (Supplied with Tx as standard)
2" (50mm)Transmitter Clamp
4" (100 mm)Transmitter Clamp
400 to 4000Tx 2" and 4" clamp replacement lead
400 to 4000Tx LPC/LLC/CD/4 and 2" clamp adapter
8.5" (220 mm) Transmitter Clamp
Cable Reel (200 m)
CD Transmitter Clamp
Earth reel
Earth Stake
Euro Plug Connector
Live Cable Connector
Signal Clamp Extension Rod
Transmitter Accessories
Tx Direct Connection Lead
UK Plug Connector

PSE ENGINEERING GMBH

Poro Test 7 - High voltage porosity detection

Reliable porosity detection

For all insulating coatings on metal such as:

- coatings on oil, gas or water pipelines
- linings of tubes, vessels or storage tanks
- protective coatings on hulls, oil tanks, vessels, pipelines including fittings
- enamel, epoxy and plastics coatings

Porosity detection and corrosion control

Flaws in protective coatings such as pores, cracks and fissures, if undetected, may impair the corrosion resistance of a product. The PoroTest 7 has been specifically designed for non-destructive porosity testing of such coatings, based on automatic test voltage control specific to the thickness of material to be tested and vice versa. The major fields of application of the PoroTest 7 range from vendor inspection to quality assurance in corrosion protection.

Test principle and field of application

Designed for detecting flaws and pores, the PoroTest 7 can be used for testing all insulating coatings on conductive substrates such as steel, Aluminium, etc.
The test instrument consists of a high voltage probe with an integrated high voltage generator and a test electrode, which is simply connected to the probe. The control unit features a digital display and control pad. The control unit housing is fully portable and made of rugged ABS plastic with an integrated handle. The high voltage probe and control
unit are connected via a rugged cable. To detect porosity, the appropriate test voltage specific to the material thickness is set on the control unit which applies, when activated, a spark discharge at the moment a material flaw is detected.
In addition to the spark discharge, flaws are indicated by a visible and audible signal and counted. Typical applications: Testing linings and coatings applied on ducts, pipes, hulls, oil and storage tanks, enamel, paint, rubber and bitumen linings, vessels and tanks, GFK and other plastics materials.

Features

- Powerful and versatile gauge with new ergonomic design making it ideal for on-site testing
- Light-weight and hand-held test electrodes provide convenient operation
- User-friendly key-pad layout with menu driven operation Test method conforms to DIN 55 670
- 15 sensitivity settings
- Pre-set test voltages specific to material thickness
- Backlit display to indicate current test voltage, number of pores and material thickness
- High voltage probe with equipment-on and pore indicator (red LED)
- Residual voltage indicator
- Power supply: AC operated or battery operated via integrated storage battery (C-cells)
- Low-battery indicator

Product advantages

- Quick detection of local flaws in the insulating material being tested.
- Reliable detection of flaws according to the test conditions described in the DIN 55 670 standard
- Additional safety feature through residual voltage indicator New compact and ergonomic design, extremely light- weight and handy for easy handling
- Broad range of electrodes are available for a wide range of applications
- Optimum test voltage setting ensures safe testing without damaging the material being tested
- Variable test voltages
- Precise and stable test voltage settings achieved through electronic control
- No separate gauge required for measuring the current test voltage at the search electrode
- Test voltage directly indicated on the instrument’s digital display
- User-selectable menu language: German, English, French and Spanish. Others available upon request.

Variable high voltage probes

Non-destructive porosity detection requires adapted high voltages covering different ranges. The versatile PoroTest 7 offers 2 types of high voltage probes, which are interchange-able with the control unit. The test electrode of your selection directly plugs to the high voltage probe. The specific high voltage setting is entered on the control unit’s touch pad and is displayed on the digital display and monitored via the electronic control. The PoroTest 7 is designed for safe use, the high voltage probes are designed and engineered to be insulated and absolutely risk free to the operator. Electrical safety conforms to the German standard VDE 0411, part 1: Both, the maximum discharge rate as well as the probe voltage never exceed the limit values as set forth in the safety standard.

- High voltage probe, model P 7: 0.5…7 kV
- High voltage probe, model P 35: 6…35 kV
- Accuracy of voltage setting: ± (0.1 kV + 3% of reading)

PSE ENGINEERING GMBH

Test principle

When scanning the high voltage search electrode smoothly over the surface, flaws are detected through spark discharge to the conductive substrate. Test voltage can be adjusted from 500 Volt to 35.000 Volt. The instrument has been designed for testing insulating materials from approx. 30 microns to 11.3 mm (1 mil … 444 mils) thickness.

Adapted search electrodes

A comprehensive selection of special test electrodes is available, such as:

- Rolling spring or ring electrodes for outside-tube testing
- Brush electrodes for inside or outside pipe and tube testing
- Sweeper electrodes for large surfaces of coatings made from plastics, enamel or rubber
- Silicon-rubber electrodes for sensitive surfaces

Even complex shapes such as accoutrements or fittings can be tested confidently with specially designed adaptor brush electrodes.

Compact and convenient design

The PoroTest 7 is a powerful tool for porosity detection and includes the following items:

- Rugged plastics carrying case
- Control unit with integrated storage battery
- Connecting cable probe-control unit
- High voltage probe
- Metal sweeper electrode
- Silicon-rubber electrode, 200 mm (0.7 ft) width
- Earthing magnet
- Earthing clamp
- Equipotential cable, 5 m (16 ft) length
- Power cable
- Shoulder belt

Recommended accessories

- Aluminium case
- Brush electrodes
- Rolling spring electrodes
- Ring electrodes
- Right-angle electrodes (max. 500 mm/20” width)
- 3-pin plug, cable-free, directly plugs into the integrated signal contact (make contact)
- Earthing rod
- Earthing/equipotential cable, 10 m (32 ft) length
- Connecting cable for control unit and high voltage probe in special lengths: 5 m (16 ft), 10 m (32 ft)
- Non-destructive coating thickness gauge, helps you to adjust test voltage specific to coating thickness

High voltage probe P 7 or P 35

Due to the characteristic dielectric strengths of different materials, they require different ranges of test voltages. To meet the requirements of such different applications, two high voltage probe models are available:

- **P 7** for thin coatings starting from 30 microns (1 mils) such as condenser or packaging films, paints, enamels
- **P 35** for thick coatings ranging from 1.4 mm (55 mils) thickness and more such as protective linings in pipelines

Further gauges from our range of products:

- Coating thickness gauges
- Wall thickness gauges
- Gloss meters
- Hardness and roughness gauges
- Continuous measuring systems for flat films and sheets
- Continuous pinhole detection systems for flat films and sheets

Technical specification

High voltage probe	P 7	P 35
Operating range	0.5 ... 7 kV	6 ... 35 kV
Coating thickness	0.03 mm .... 1.7 mm 1 mils ... 67 mils	1.4 mm ... 11.3 mm 55 mils ... 444 mils
Voltage	DC	
Test voltage indication	LC-Display, 3-digit	
Accuracy of voltage setting	± (0.1 kV + 3 % of reading)	
Dimension of voltage probe	274 mm x 63 mm (L x dia.)	
Weight of voltage probe	550 g	
Dimension of control unit	225mm x 150 mm x 85 mm (L x W x H)	
Weight of control unit	1 400 g	
Alarm signal	90 dB, 0.1 s/Pore, continuous in case of short circuit	
Signal output	potential free, U_{max}: 100 V, I_{max}: 0.4 A	
Storage battery	4 C-cells, IEC LR 14, 3.5 Ah, NiMH, replaceable	
Storage battery life	P 7 approx. 20 h	P 35 approx. 10 h
Storage battery charging time	4 hrs. quick charge	
Mains voltage	110 to 230 V, 50/60 Hz, automatic switch	
Operating temperature	0° ... 50° C	
Humidity	avoid dew on the surface (refer to DIN 55 670)	
Standards	DIN 55 670, DIN 50 191 (VDE 0104), DIN EN 611010/Part 1	

PSE ENGINEERING GMBH

ISOTEST 4S - Porosity Testing of Coatings

Application

ISOTEST 4S is indispensable in the area of passive corrosion protection.

Non-destructive high voltage testing of the most diverse coatings and corrosion protection materials has proved itself again and again over long periods of time. The test, prescribed by many works' specifications and Standards, has made a successful contribution, within the framework of quality control to reducing stoppable times and avoiding interruptions to production and subsequent repair costs.

Coating thicknesses from a few hundred micrometres to several millimetres can be tested for pores, cracks or scarcely discernible transport damage by means of short high voltage impulses. The short action time of the impulses, which treats the material gently, makes it possible to test with reserves of energy, which, in turn, guarantees the stability of the selected test voltage even with dirty or damp surfaces.

Defective areas can be clearly distinguished, whether it be with externally or internally coated tubes, rubber coated containers, seams in plastic, fully coated fittings or machine parts everywhere where nonconductive coatings are overlaid a conductive material (e.g. metal, wet concrete) or where nonconductive coatings have an underlay of conductive materials (e.g. plastic seams in tubing or containers).

Benefits at a glance

- Microprocessor controlled test instrument
- Fully adjustable test voltage
- Patented automatic regulation
- Power reserves for the highest requirements
- Graduated voltage adjustment
- Adjustable sensitivity (switch)
- Separate high voltage pushbutton

ISOTEST 4S stands for:

- Robust construction for using at construction sites
- Testing of dirty, damp and even slightly conductive surfaces
- Rapid battery change - on site
- Three earthing possibilities, including capacitance
- Testing of fully insulated objects
- Emergency off safety mode via switch
- No static charge when testing
- Automatic earth monitoring
- Minimal loading on material by using short test impulses
- Can be carried with shoulder strap and abdominal belt

Accessories

A large number of accessories are available for a wide range of applications. Test electrodes for the most diverse shapes of object and coatings are complemented by components for the using of different earthing possibilities including capacitance earthing.

The full-trimmed brush electrodes and the spiral electrodes are impressively robust and hard wearing. All electrodes can be easily swapped even with older versions of ISOTEST.
Our expert service personnel are always available to advise you on the choice of the right accessory for your application especially for less common uses of the equipment.

Whether testing internally, in manholes, with completely coated components or on oversized tubing, the ISOTEST accessory program has the right tool.

Service - Calibration

ISOTEST instruments will be delivered with a traceable calibration together with a certificate. A clearly visible seal makes keeping to the recommended inspection easier. The data can also be accessed through the menu.

Revisions in the course of technical progress reserved.

Technical Data

Voltage range	10-25 kV, 5 kV steps
Voltage selection	graduated switch
Voltage form	unipolar impulses
Impulse duration	< 10 µs
Voltage supply	rechargeable battery 6 V, 4.5 Ah, separate compartment
Size and weight of battery	(90 x 45 x 120) mm, 0,9 kg
Operating time	up to 9 hours
Size and weight w/o battery	(220 x 256 x 88) mm, < 3 kg
Alarm signal	approx. 86 dB, 3.5 kHz
Connecting cable to test probe	1.5 m
Relevant standards and DVGW process sheets	DIN (55670, 28055, 30670) DIN (4681, 28063) DIN EN 14330 (iV) DVGW 462/I,W400-2

PSE ENGINEERING GMBH

The 3150i handheld meters provide reliable measurements under difficult conditions both in the Lab and in the field. Lightweight and compact, the meters are impact-resistant, hose-proof to IP 66 and meet the requirements for IP 67.

- For routine measurements
- Reliable, accurate
- Simple operation

Simple operation means that measuring errors are avoided. All the function keys of the 3150i can be operated even when wearing gloves; automatic calibration and AutoRead functions ensure stable and reproducible results. The multifunctional display for pH, oxygen, conductivity and temperature is easy to read.

The handheld pH meters are optimized for use on-site and field use, but can also be used in the laboratory.

The 3150i handheld meters are robust and waterproof battery-operated pH/mV meter. Measuring errors are avoided by the silicone keypad with only 5 keys and a simplified calibration method with automatic buffer recognition and display for standard buffers. AutoRead ensures stable and reproducible results.

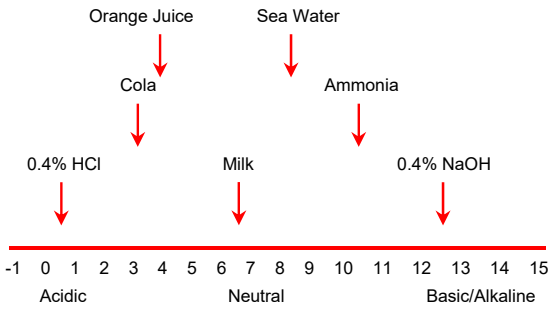
pH-Value

The water molecule has the property of dissociating into two ionic components in aqueous solutions.

$$H_2O \leftrightarrow H^+ + OH^-$$

The H^+ ion is termed hydrogen ion or proton, the OH^- ion hydroxide ion.

The pH value describes the activity of hydrogen ions in aqueous solutions on a scale of -1 to 15. Based on this scale, liquids are characterized as being acidic, alkaline or neutral: a solution which is neither acidic or alkaline is neutral. This corresponds to a value of 7 on the scale. Acidity indicates a higher activity of hydrogen ions and a pH value lower than 7. Alkaline solutions are characterized by a lower hydrogen ion activity or higher hydroxide ion activity, respectively and a pH value above 7. The graph below uses examples to illustrate the pH scale.



Technical data

Model	pH 3150i
Range pH	-2.00 .... 16.00 pH
Range mV	-1999 .... +1999
Range Temperature	-5.0 .... +105.0 °C (23 .... 221 °F)
Accuracy pH	(±1 digit) ±0.01 pH
Accuracy mV	(±1 digit) ±0.3 mV at +15 °C .... 35 °C
Accuracy Temperature	(±1 digit) ±0.1 K
Display	5 1/2 digit LCD
Power supply	Four 1.5 V AA batteries
Battery life time	3000 hours
Dimensions	3-1/8“W x 6-3/4“H x 1-1/2“D
Callibration	Simplified 1, 2 or 3 point callibration with automatic buffer recognition AutoCalautomatic 3-point callibration with DIN buffers

The pH scale is logarithmic. A difference of one pH unit represents a tenfold, or ten times increase or reduction of hydrogen ion activity in the solution. This explains how a solution’s aggressiveness increases with the distance from the neutral point.

The pH value can be measured using electrochemical measuring systems, litmus paper, indicators and colorimeters. Of these methods, electrochemical sensors provide the most accurate results.

The pH electrode is an electrochemical sensor which consists of a measuring electrode and a reference electrode. The measuring electrode is made of special glass which, due to hydrogen ions. It is filled with buffer solution which has a pH value of 7. When placing the pH electrode into a test solution, the change in voltage to the stable reference electrode. This change is recoded by the meter and converted into the pH value displayed.

PSE ENGINEERING GMBH

Test voltages to 5000 V

This instrument is suited for the non-destructive measurement of installation resistance in electrical systems at machines, transformers and cables, as well as within the electrical equipment with eight selectable test voltages up to 5 kV.

Voltage measurement to 2000 V

With the voltage measuring ranges, test objects can be checked for the absence of voltage in network of up to 2 kV. This is important for insulation resistance measurement, because extraneous voltages distort measurement results.

Discharge of capacitive devices under test

Capacitive devices under test such as cables and coils, which might be discharged to test voltage, are discharged by the instrument. The drop in voltage can be observed by the needle deflection.

Measurements in accordance with VDE 0413

Measuring current is equal to 1 mA at a test voltage of 100 V, 250 V, 500 V and 1000 V.

Measuring cables with heavy-duty insulation

The measuring cables with heavy-duty insulation are permanently connected for safety and technical reasons. Possible danger caused by the unintended removal of cables is thus avoided, for example when charging occurs due to capacitive test objects.

Scale with LEDs

Three LEDs arranged within the scale to make reading easier. The lamp which is assigned to the selected measuring range lights up. During the measurement sequence, the green LED indicates whether or not the battery charge is sufficient for the measurement

Measuring ranges

Insulation resistance

Scale/ Standard	Nominal/Open-Circuit Voltage U_N/U_0	Measuring range	Nom. current I_N	S-C [1] current I_K	Intrinsic error [2]
1 VDE 0413	100 V / 250 V 500 V / 1000 V	100 kΩ ... 100 MΩ	1 mA	1.3 mA	± 2.5 %
2	100 V / 250 V 500 V / 1000 V	10 kΩ... 1 TΩ	1 mA	1.3 mA	± 5.0 %
2	1500 V 2000 V 2500 V 5000 V	10 kΩ... 1 TΩ	0.7 mA 0.5 mA 0.4 mA 0.1 mA	1.3 mA	± 5.0 %

[1] S-C = short circuit [2] referring to scale length

Direct and Alternating Voltage

Measuring range	Frequency	Internal resistance	Max. allowable voltage
0 ... 2000 V AC/DC	15 ... 500 Hz	5 MΩ	2200 V AC/DC max. 10 s

Power supply

Battery or Storage Battery	6 nos. 1.5 V single cell per IEC R20
Working Range	6 V ... 10 V
Battery Service Life	100 hours for no-load and intermittent operation

Ambient conditions

Operating Temperature	0°C ... + 40°C
Storage Temperature	-20°C ... + 60°C
Climate Classification	2z/0/40/-20/75 % acc. to VDE 3540
Relative Humidity	max. 75 %
Elevation	up to 2000 m

Electrical safety

Protection Class	II
Test Voltage	8.5 kV AC
Overvoltage Category	2000 V CAT II or 5000 V CAT I
Fouling Factor	2
Protection	IP52
Dimensions	(W x D x H) 290 x 250 x 140 mm
Weight	3.4 kg with batteries

(EMC) Compatibility

Interference emission	EN 50081-1: 1992
Interference immunity	EN 50082-1: 1992

Standard Equipment

1 High voltage insulation tester with permanently connected measuring cables and test probes, 2 crocodile clips (5 kV version) and plug-in battery module including batteries

1 Carrying strap

1 Operation instructions

Accessories

Carrying bag F204

PSE ENGINEERING GMBH

The monitoring and control schemes of cathodic protection systems require very accurate measurement of relatively very low potential differences between metallic objects and surrounding electrolytes soil or water, with respect to a standard reference electrode: **Zn**, **Cu/CuSO$_4$**, **Ag/AgCl** or **MnO$_2$**

The conventional low input impedance instrument cannot be relied upon to give good results in such cases. The zinc reference electrodes which have relatively longer reliable operation life than other electrodes are installed in permanent systems but the measured values are to be usually / conventionally displayed and reported in terms of potentials with respect to Cu/CuSO$_4$ or Ag/AgCl reference electrodes for easy interpretation of results.

The present practice of marking the scales for both types of reference electrodes on analog type instruments solves the problem to some extent but not at all when the low input impedance analog type instruments are replaced by high input impedance digital instruments.
The transmission of field data by long cables between local measuring points and master control station for remote monitoring and controls, makes it necessary to convert the measured low voltage signal into an equivalent low current signal to preserve its integrity. These practical considerations indicated the need of developing a potential converter which can be conveniently connected across the conventional potential measuring devices to provide the desired results.

Option

Potential Converter with integrated potential data logger

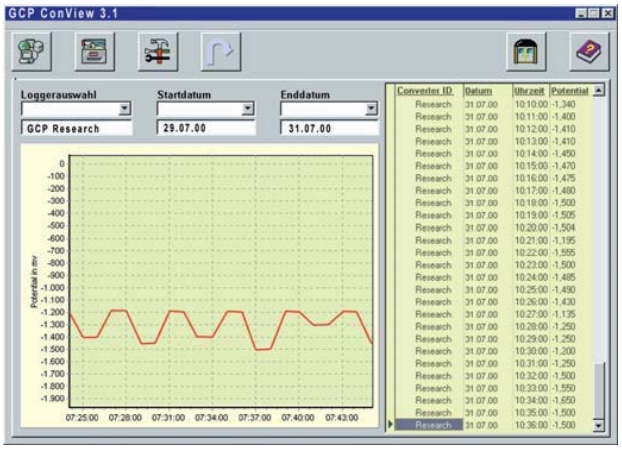
The potential converter can be optionally equipped with a one channel potential logger. The available number of selectable sampling rates in combination with the storage capacity allows short term recording as well as long term recording covering several months.
The specially designed processing software ConView (for Windows) enables display of stored values either graphically or as table on screen as well as print-out by printer or plotter. The data transfer to a laptop takes place by means of an interface RS 232. Data transfer during potential logger operation mode is possible.

Recording capacity: 2 000 values

Sampling rates: 1.0 s / 1 min / 10 min / 1.0 h / 6.0 h

Technical data

Design	Plug-in or Snap-On unit with separate terminals
Input	Reference electrode / cathode -4.0 V - +4.0 V DC
Output	Volts, as measured by a 10 MΩ input impedance voltmeter Volts, measured by a specified type of reference electrode : Zn, Cu/CuSO$_4$, Ag/AgCl or MnO$_2$
Output options	0 - 20 mA or 4 - 20 mA signals for transmission purposes via cable
Accuracy	< 1 %
Environmental conditions	Temperature -25°C to 60°C Installation : indoor (enclosed)
Power supply	230 V, 50-60 Hz, 115 V, 50-60 Hz or 9 V Battery
Protection class	IP 40
Dimensions	70 x 75 x 109.5 mm



Portable reference electrodes

Portable reference electrodes are used to carry out potential measurements on all types of buried and submerged structures. The reference electrodes are made of solid copper elements which are housed in impact resistant plastic tubes.

To ensure that the copper elements remain electrically stable, copper sulphate crystals are provided with each ordered reference electrodes. The crystals surround the copper elements in the plastic tube, and when mixed with distilled water, create a super saturated solution of copper sulphate to reduce ion intermixing. A window on each cell allows the operator to observe the water level of the crystallized solution. If the level is insufficient, water and copper sulphate crystals can be simply added by removing the filling cap found on each reference electrodes.

270 x 180 x 85 mm (W x D x H)	Weight: 1.1 kg

Used on land with Lexan tube, CPT ceramic plug and KCL filling solution.

Used in sea water with perforated Lexan tube, brass submersible weights (any number of weights can be attached; two included in this kit) and standard 2.5 m submersible adapter (available in additional lengths).

Reference Electrode Cu/CuSO4 for use in soil
Model: CUS-01

Dimensions

Diameter: 110 mm	Height: 110 mm	Weight: 1.0 kg

Reference Electrode Cu/CuSO4 for use in soil and (with submersible adapter) for use in water Model: MILLER RE-5

Dimensions

Diameter: 35 mm	Height: 152 mm	Weight: 0.15 kg

Submersible adapter converts electrode for use in water. With different lead length:
(2.5 m, 7.5 m, 15 m, 30 m, or 60 m) with copper test clip attached.
Water-tight connection.

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Colours: 1 = black, 2 = red, 3 = blue, 4 = yellow, 5 = green, 6 = violet, 7 = brown, 8 = white

Test lead reels – "BIGSPOOL"			
Type	Lead length	Cross-section	Colour code
SPOOLB - 50/1.00	500 m	1.0 mm²	1 - 8
SPOOLB - 10/1.00	1000 m	1.0 mm²	1 - 8
SPOOLB - 50/1.50	500 m	1.5 mm²	1
SPOOLB - 10/1.50	1000 m	1.5 mm²	1
SPOOLB - 50/2.50	500 m	2.5 mm²	1

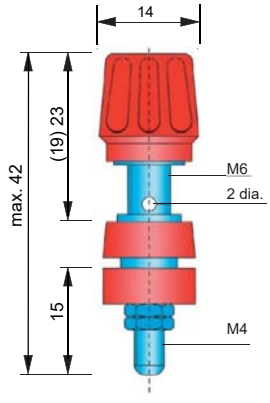
Colours: 1 = black, 2 = red, 3 = blue, 4 = yellow, 5 = green, 6 = violet, 7 = brown, 8 = white

Test lead reels – "FASTSPOOL"			
Type	Lead length	Cross-section	Colour code
SPOOLF - 25/0.75	25 m	0.75 mm²	1 - 8
SPOOLF - 25/1.00	25 m	1.0 mm²	1 - 8
SPOOLF - 50/0.75	50 m	0.75 mm²	1 - 8
SPOOLF - 50/1.00	50 m	1.0 mm²	1 - 8
SPOOLF - 10/0.75	100 m	0.75 mm²	1 - 8
SPOOLF - 10/1.00	100 m	1.0 mm²	1 - 8

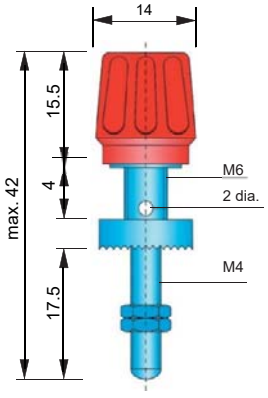
Needle tips

Flexible guide shaft and contact socket for plug 4 mm dia.

Colours: 1 = black, 2 = red



PKI 10



PK 10

Earthing rod for temporary measurements

Rod material:	Vanadium steel 50CrV4 Blade tanged right through the handle, chrome- plated, extremely strong
Handle:	Hardwood, clear varnished with leather cap
Total length:	390 mm
Rod length:	250 mm
Contact socket:	4 mm dia.

Earthing rod for temporary measurements

Type:	D 634 145
Material:	Steel, galvanised
Length:	450 mm