



DUALEM EM EQUIPMENT

DUALEM instruments (*e.g.* the DUALEM-1) incorporate a DUALEM sensor as well as an internal WAAS-enabled GPS receiver, a hand-held weatherproof display/keypad/power-supply, a carrying harness and stabilizing feet.

DUALEM sensors incorporate one-, two- or three-sets of the patented DUALEM dual-geometry array. Each dual-geometry array simultaneously measures conductivity and susceptibility to two distinct and easily quantified depths. Multiple measurements enable the estimation of the conductivity, susceptibility and thickness in a layered earth. The sensors record electromagnetic responses internally along with positioning coordinates and values for time, pitch, roll, voltage and temperature from internal monitors.

DUALEM instruments operate by electromagnetic induction, so no contact with the ground is needed. This enables surveying at moderate speed over rough, dry or non-conductive terrain. Terrain that has been surveyed using DUALEM instruments includes deserts, forests, volcanic flows, and multi-year ice.

DUALEM instruments are calibrated precisely and permanently at the factory using a patented technique, eliminating problematic *ad hoc* calibrations in the field. Precise calibration, baselevel stability, high sensitivity and advanced digital signal processing give the instruments unmatched accuracy.

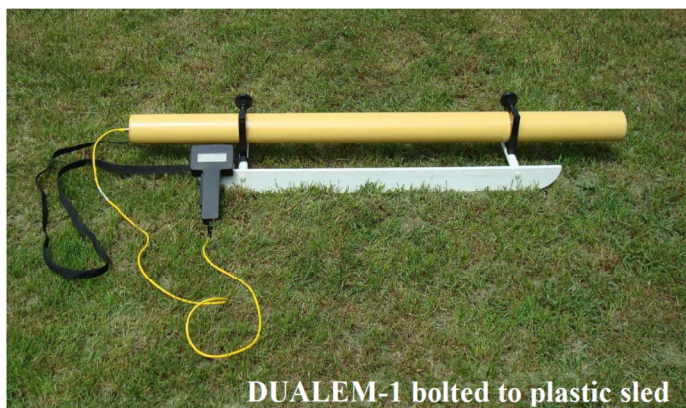
DUALEM instruments are designed for independent surveys in terrain and climate that may be challenging. The harness allows them to be carried close to the ground at walking speed, and the stabilizing feet are convenient for station-by-station surveys. They are often mounted on a sled or cart, and can be deployed underwater in watertight housing.

DUALEM sensors can be used with the user's own control and positioning systems. LED lights on the sensors indicate the status of power and serial communication. The sensors receive text commands through their serial port, and provide text output in either NMEA0183-standard or 4-line by 20-character format. As NMEA0183 is the standard for GPS communication, a variety of GPS loggers and software can record DUALEM measurements and integrate them with GPS positions.

All DUALEM products can be shipped by popular parcel-express services. Please direct inquiries to Dualem Inc., by phone 1 905 876 0201, fax 1 905 876 2753, or the e-mail address listed at www.dualem.com.



DUALEM-1 and DUALEM-1S



DUALEM-1 bolted to plastic sled

The DUALEM-1 has 1-m separation between its transmitter and dual receivers, so its dual depths of conductivity measurement are 0.5 m and 1.5 m (by the 70-% cumulative-sensitivity guideline). In-phase measurements sound magnetic susceptibility and detect metal.

The DUALEM-1 depths of measurement are ideal for many agricultural applications, and spatial resolution that is well suited to archaeological investigation. For metal detection, the DUALEM-1 can detect a steel

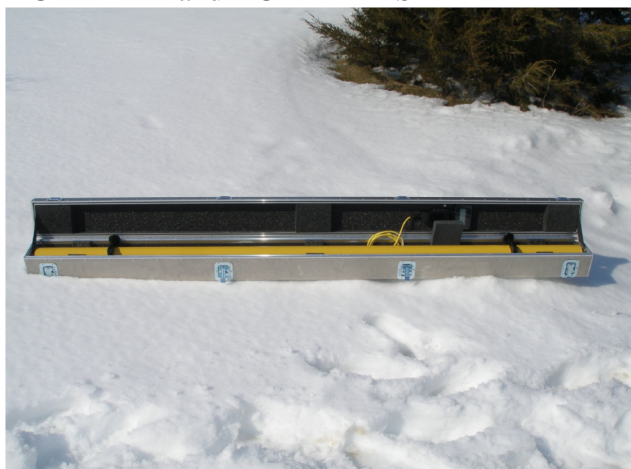
drum to a depth of about 1 m.

The compact size of the DUALEM-1 makes it ideal for towing on a sled or carrying from station-to-station for on-ground measurements. The DUALEM-1S is the sensor of the DUALEM-1, and it is available separately at lower price for integration with the user's own surveying systems.

EM Arrays	1-m horizontal co-planar (HCP) and 1.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC: HCP Conductivity in mS/m (1.5-m sounding depth) PC: PRP Conductivity in mS/m (0.5-m sounding depth) HI: HCP In-phase, in ppt of the transmitted field PI: PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HC and PC: -1000 to +1000 mS/m ± 0.25 mS/m HI and PI: -300 to +300 ppt ± 0.01 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 1.41-m length (3.5" by 56")
Operating Weights	5 kg operating for DUALEM-1S, 7 kg for DUALEM-1
Shipping Dimensions	155 by 15 by 15 cm
Shipping Weights	11 kg for DUALEM-1S, 15 kg for DUALEM-1
Ancillary Items	Data/power cable, software and documentation, shipping tube for DUALEM-1S, hinged metal case for DUALEM-1. DUALEM-1 has internal GPS, controller and harness



DUALEM-2 and DUALEM-2S



The DUALEM-2 has 2-m separation between its transmitter and dual receivers, so its dual depths of conductivity measurement are 1 m and 3 m (by the 70-% cumulative-sensitivity guideline). In-phase measurements sound magnetic susceptibility and detect metal.

The DUALEM-2 depths of measurements are well suited to a variety of applications in agriculture and surficial mapping. For metal detection, the DUALEM-2 can detect a steel drum a depth of about 2 m.

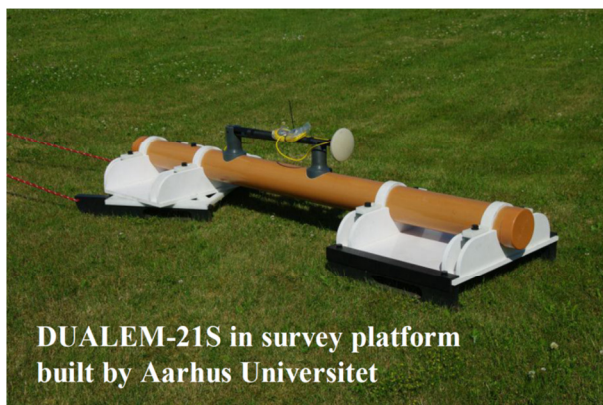
The double shoulder-harness, smooth tubular design and moderate weight make the DUALEM-2 practical for prolonged surveys by a single operator. The DUALEM-2 is also convenient to pull on a sled at the ground surface to maximize sensitivity and spatial resolution.

The DUALEM-2S is the sensor of the DUALEM-2, and it is available separately at lower price for integration with the user's own surveying systems.

EM Arrays	2-m horizontal co-planar (HCP) and 2.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC: HCP Conductivity in mS/m (3-m sounding depth) PC: PRP Conductivity in mS/m (1-m sounding depth) HI: HCP In-phase, in ppt of the transmitted field PI: PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HC and PC: -1000 to +1000 mS/m ± 0.1 mS/m HI and PI: -300 to +300 ppt ± 0.01 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 2.41-m length (3.5" by 95")
Operating Weights	10 kg operating for DUALEM-2S, 12 kg for DUALEM-2
Shipping Dimensions	255 by 15 by 15 cm
Shipping Weights	21 kg for DUALEM-2S, 22 kg for DUALEM-2
Ancillary Items	Data/power cable, software and documentation, shipping tube for DUALEM-2S, hinged metal case for DUALEM-2. DUALEM-2 has internal GPS, controller and harness



DUALEM-21 and DUALEM-21S



The DUALEM-21 has dual-geometry receivers at separations of 1- and 2-m from the transmitter, which provide four simultaneous depths of conductivity sounding, four simultaneous depths of susceptibility sounding, and detection of metal.

The several sounding-depths of the DUALEM-21 enable the analysis of layering in the top few metres of the earth.

The DUALEM-21 can be carried on prolonged surveys by a single operator, and is suitable for towing on a sled or low cart. The DUALEM-21S is the sensor of the DUALEM-21, and it is available separately at lower price for integration with the user's own surveying systems.

EM Arrays	1- and 2-m horizontal co-planar (HCP), 1.1- and 2.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC1: HCP Conductivity in mS/m (1.5-m sounding depth) HC2: HCP Conductivity in mS/m (3-m sounding depth) PC1: PRP Conductivity in mS/m (0.5-m sounding depth) PC2: PRP Conductivity in mS/m (1-m sounding depth) HI1: 1-m HCP In-phase, in ppt of the transmitted field HI2: 2-m HCP In-phase, in ppt of the transmitted field PI1: 1.1-m PRP In-phase, in ppt of the transmitted field PI2: 2.1-m PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HC1 and PC1: -1000 to +1000 mS/m ± 0.25 mS/m HC2 and PC2: -1000 to +1000 mS/m ± 0.1 mS/m HI1, HI2, PI1 and PI2: -300 to +300 ppt ± 0.01 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 2.41-m length (3.5" by 95")
Operating Weight	12 kg
Shipping Dimensions	255 by 15 by 15 cm
Shipping Weights	23 kg
Ancillary Items	Data/power cable, software and documentation, hinged metal case. DUALEM-21 has internal GPS, controller and harness



DUALEM-4 and DUALEM-4S



The DUALEM-4 has 4-m separation between its transmitter and dual receivers, so its dual depths of conductivity measurement are 2 m and 6 m (by the 70-% cumulative sensitivity standard).

The DUALEM-4 depths of measurements are well suited to a variety of applications in agriculture, geotechnics and hydrology. For metal detection,

the DUALEM-4 can detect a steel drum to a depth of about 3 m.

The double shoulder-harness and smooth tubular design make the DUALEM-4 practical for surveys by a single operator. Some users pull the DUALEM-4 on a cart behind a motor vehicle. The DUALEM-4S is the sensor of the DUALEM-4, and it is available separately at lower price for integration with the user's own surveying systems.

EM Arrays	4-m horizontal co-planar (HCP) and 4.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC: HCP Conductivity in mS/m (6-m sounding depth) PC: PRP Conductivity in mS/m (2-m sounding depth) HI: HCP In-phase, in ppt of the transmitted field PI: PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HC and PC: -1000 to +1000 mS/m ± 0.1 mS/m HI and PI: -300 to +300 ppt ± 0.03 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 4.41-m length (3.5" by 173")
Operating Weights	12 kg operating for DUALEM-4S, 14 kg for DUALEM-4
Shipping Dimensions	255 by 15 by 30 cm
Shipping Weights	28 kg for DUALEM-4S, 30 kg for DUALEM-4
Ancillary Items	Data/power cable, software and documentation, hinged metal case. DUALEM-4 has internal GPS, controller and harness



DUALEM-42 and DUALEM-42S

The DUALEM-42 has dual-geometry receivers at separations of 2- and 4-m from the transmitter, which provide four simultaneous depths of conductivity sounding, four simultaneous depths of susceptibility sounding, and detection of metal.

The several sounding-depths of the DUALEM-42 enable the analysis of layering in the top several metres of the earth. The DUALEM-42 is suitable for towing on a sled or cart, or for carrying at hip height. The DUALEM-42 disassembles to form a DUALEM-2, for more convenient surveys of shallower targets.

The DUALEM-42S is the sensor of the DUALEM-42, and it is available separately at lower price for integration with the user's own surveying systems. The DUALEM-42S disassembles to form a DUALEM-2S.

EM Arrays	2- and 4-m horizontal co-planar (HCP), 2.1- and 4.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC2: HCP Conductivity in mS/m (3-m sounding depth) HC4: HCP Conductivity in mS/m (6-m sounding depth) PC2: PRP Conductivity in mS/m (1-m sounding depth) PC4: PRP Conductivity in mS/m (2-m sounding depth) HI2: 2-m HCP In-phase, in ppt of the transmitted field HI4: 4-m HCP In-phase, in ppt of the transmitted field PI2: 2.1-m PRP In-phase, in ppt of the transmitted field PI4: 4.1-m PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HC2, HC4, PC2 and PC4: -1000 to +1000 mS/m ± 0.1 mS/m HI2 and PI2: -300 to +300 ppt ± 0.01 ppt HI4 and PI4: -300 to +300 ppt ± 0.03 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 4.41-m length (3.5" by 173")
Operating Weights	13 kg operating for DUALEM-42S, 15 kg for DUALEM-42
Shipping Dimensions	255 by 30 by 15 cm
Shipping Weights	30 kg for DUALEM-42S, 32 kg for DUALEM-42
Ancillary Items	Data/power cable, software and documentation, hinged metal case. DUALEM-42 has internal GPS, controller and harness



DUALEM-421 and DUALEM-421S



DUALEM-421 on a simple raft

The DUALEM-421S has dual-geometry receivers at separations of 1-, 2- and 4-m from the transmitter, which provide six simultaneous depths of conductivity sounding, six simultaneous depths of susceptibility sounding, and detection of metal.

The variety of sounding depths makes the DUALEM-421S ideal for the analysis of the thickness, conductivity and susceptibility of layering in the top several metres of the earth. Towing on a sled optimizes spatial and geophysical resolution, but a low cart is also

a suitable platform for surveying. The DUALEM-421S disassembles to form a DUALEM-21S.

EM Arrays	1-, 2- and 4-m horizontal co-planar (HCP), 1.1- 2.1- and 4.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC1: HCP Conductivity in mS/m (1.5-m sounding depth) HC2: HCP Conductivity in mS/m (3-m sounding depth) HC4: HCP Conductivity in mS/m (6-m sounding depth) PC1: PRP Conductivity in mS/m (0.5-m sounding depth) PC2: PRP Conductivity in mS/m (1-m sounding depth) PC4: PRP Conductivity in mS/m (2-m sounding depth) HI1: 1-m HCP In-phase, in ppt of the transmitted field HI2: 2-m HCP In-phase, in ppt of the transmitted field HI4: 4-m HCP In-phase, in ppt of the transmitted field PI1: 1.1-m PRP In-phase, in ppt of the transmitted field PI2: 2.1-m PRP In-phase, in ppt of the transmitted field PI4: 4.1-m PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HC1 and PC1: -1000 to +1000 mS/m ± 0.25 mS/m HC2, HC4, PC2 and PC4: -1000 to +1000 mS/m ± 0.1 mS/m HI1, HI2, PI1 and PI2: -300 to +300 ppt ± 0.01 ppt HI4 and PI4: -300 to +300 ppt ± 0.03 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 4.41-m length (3.5" by 173")
Weights	13 kg operating, 31 kg shipping
Shipping Dimensions	255 by 30 by 15 cm
Ancillary Items	Data/power cable, software and documentation, hinged metal case



DUALEM-642 and DUALEM-642S



The DUALEM-642S has dual-geometry receivers at separations of 2-, 4- and 6-m from the transmitter, which provide six simultaneous depths of conductivity sounding, six simultaneous depths of susceptibility sounding, and detection of metal.

The variety of sounding depths makes the DUALEM-642S ideal for the analysis of the thickness, conductivity and susceptibility of layering to 9-m depth. A low cart is a suitable platform for surveying. The

DUALEM-642S disassembles to form a DUALEM-42S or DUALEM-2S.

EM Arrays	2-, 4- and 6-m horizontal co-planar (HCP), 2.1- 4.1- and 6.1-m perpendicular (PRP) transmitter-receiver arrays, operating at 9 kHz
Measured Quantities	HC2: HCP Conductivity in mS/m (3-m sounding depth) HC4: HCP Conductivity in mS/m (6-m sounding depth) HC6: HCP Conductivity in mS/m (9-m sounding depth) PC2: PRP Conductivity in mS/m (1-m sounding depth) PC4: PRP Conductivity in mS/m (2-m sounding depth) PC6: PRP Conductivity in mS/m (3-m sounding depth) HI2: 2-m HCP In-phase, in ppt of the transmitted field HI4: 4-m HCP In-phase, in ppt of the transmitted field HI6: 1-m HCP In-phase, in ppt of the transmitted field PI2: 2.1-m PRP In-phase, in ppt of the transmitted field PI4: 4.1-m PRP In-phase, in ppt of the transmitted field PI6: 1.1-m PRP In-phase, in ppt of the transmitted field Applied voltage, internal temperature, pitch and roll
Measuring Ranges ± typical RMS Noise	HCP- and PRP-Conductivity: -1000 to +1000 mS/m ± 0.5 mS/m HCP- and PRP-In-phase: -300 to +300 ppt ± 0.05 ppt
Data Rates	Manual, or continuous at rates between 0.1- and 10-Hz
Digital Signal Processor	Custom built, with digital clock, thermometer, pitch sensor, roll sensor, RS-232 port and power/receive/transmit LEDs
Data Capacity	65,000 records of measured quantities or GPS-GPGGA data
Digital Communication	ASCII text through RS-232 port. Output in NMEA0183-compatible or 4-line by 20-character format
Power	8- to 16-V DC from hand-held controller or external battery, draw about 3 W
Operating Dimensions	0.089-m diameter, 6.41-m length (3.5" by 252")
Weights	20 kg operating, 40 kg shipping
Shipping Dimensions	3 tubes, each measuring 250 by 30 by 25 cm
Ancillary Items	Data/power cable, data-transfer software and documentation