Acoustic Sounder SODAR

PCS2000 - 64

Product Description

Biral

Contents

1 SODAR (Standard System)

PCS.2000-64:

PCS 2000–64 with RASS Extension

1.1 General System Description

The PCS2000 consist of 5 main groups of components which are:

- Acoustic Antenna
- Antenna Electronic
- Power Supply
- Connecting cables
- SODAR Control and Data Storing PC

1.2 Maximum Measuring Height

The definition of a “maximum measuring height” is often used as a key specification to compare the typical performance of a SODAR system, but the users must be aware of the inherent difficulties with this definition. From the basic SODAR equation which prescribes the signal intensity of the back scattered sound signal and from standard spectral analysis methods it can be seen that the SODAR signal quality depends (inter alia) on:

Atmospheric Parameters
- intensity of turbulent temperature fluctuations
- atmospheric absorption
- background noise (generated by wind, by rain, hail stones, etc.)

Measuring Parameters
- signal frequency
- height resolution (nominal and effective resolution)
- averaging time

Site Parameters
- background noise (machines, fans, traffic, etc.)
- reflections from solid structures
- disturbance caused to local residence

System Parameters
- emitted acoustic power
- antenna area
- antenna gain
- internal electronic noise level

From the number of related parameter it is obvious that a comparison of the typical measuring heights and the accuracy of different SODARs must be made very carefully. Adjustment of the measuring parameters, the selected site, the way in which the data is evaluated, and the atmospheric conditions all play a significant role in determining the actual performance in any particular application.

The measuring parameters can be adjusted by the user and the system parameters can be optimised by the electronic design of the SODAR electronic, but the atmospheric parameters cannot be influenced. Unfortunately, these atmospheric parameter can vary in much wider ranges than the other parameter. In stable weather conditions with low wind speeds the intensity of the back scattered signal can decrease by 25 dB or more within ranges of less than 50 m above the mixing layer.

On the other hand, the measuring height can easily reach 1000-1500 m in convective conditions. Therefore, the specification of a “typical” measuring height needs special care and some information about the assumed weather conditions. A clear distinction should be drawn between the “nominal” maximum height which is simply determined by the product of the maximum number of height ranges and the allowed maximum spacing of the height steps and what may actually be achievable in the field.

1.3 Multi Frequency Analysis

In case that data availability in the upper height ranges must be increased a multiple frequency technique can be used. It is found that independent of the method (single or multiple frequency type) the most important parameters determining the height coverage are atmospheric reflectivity (varies by a factor of 1000), background noise (varies by a factor of 100), and operational parameters. Because the multiple frequency technique introduces some shortcomings to the SODAR and due to higher manufacturing costs this feature is offered as a zero cost option that must be requested at time of order.

The shortcomings are:

- increased acoustic bandwidth makes the system more sensitive to broad band noise
- in case of strong wind shear ambiguity within neighbouring frequencies cannot be excluded

The benefits are:

- increase in the signal/noise ratio by a factor of √n, where n = number of frequencies.

In our option a 5 frequency analysis provides a reasonable balance of benefits and shortcomings. This increases the signal/noise ratio by a factor of about 2.5 and improves the available height by a factor of about 25 %.

1.4 System description: Acoustic Antenna

Antenna supporting panel.

1.10. m x 1.10 m on each side, made from weatherproof closed cell foam panel with a 8 x 8, 64 element antenna array, composed of 4 independent 4 x 4 element sub-arrays. The acoustic elements are watertight loudspeakers with exponential horns for impedance matching (⌀ 13 cm ea.). Maximum power per element is 10 W.

Acoustic shield

Made from weatherproof closed-cell foam panels lined with UV-resistant sound absorbing foam. Absorption ratio within the frequency range of 1000 - 2500 Hz is better than 90 %. Shield consists of 4 side panels (2.30 m long x 1.25 m high) and 4 top panels with triangular thnadners on the top (2.30 m long x 0.82 m high), total height 2.07 m.
Depending on the site condition the absorbing foam needs to be renewed in 5 - 10 years.

Acoustic beam width +- 7° (depending on frequency);

For use in cold environments an option for heating of the antenna is available.

1.5 System description: Antenna Electronics

Outdoor component in waterproof stainless steel box, 0.4 m x 0.6 m x 0.3 m, IP 65, mounted on the antenna panel;

Incorporating:

- 16 power amplifiers MPA24, max. load 60 W
- Transmit / receive- switching;
- Low noise preamplifier;
- Phase shift logic for transmission and receiving mode;
- Control and monitoring unit for antenna heating;
- Three plug/socket connectors for cables to Control PC, to power line, to loudspeaker array

1.6 Power Supply

Outdoor component in weatherproof stainless steel box, 0.4 x 0.3 x 0.3 m, IP65, mounted at the antenna panel;

- Converts 230 VAC/16 A to +/- 30 VDC/24 A;
- Overvoltage protection unit for power supply lines;

1.7 Cables

All cables are high quality products with IP65 plug /socket for outdoor use.

- Power supply cable 30 m, plug/socket connector, connects 230 VAC power line to Sodar power supply;
- Control cable 30 m, plug/socket connector, for transmission, beam selection, reception, connects SODAR Control PC in control room with antenna;
- Power supply cable 1,5 m, plug/socket connector, connects to +/-30 VDC, connection power supply SODAR electronic. Used where DC power is used in place of AC power.

1.8 SODAR Control and Data Management PC- Mini-Tower, Indoor

This computer connects directly to the external components of the SODAR using the supplied cables and provides all control and data management functions for standalone operation. The computer is intended for use in controlled environments. Outdoor versions of the control computer are available as chargeable options.

Example SODAR PC configuration (final PC configuration is subject to change)

- 1.1 GHz Celeron or better
- 30 GB hard disc, 128 MB RAM,
- CD-RW
- monitor
- keyboard, compatible type WINDOWS 98, 104 keys, mouse or mouse pad
- 2 serial ports;
- Ethernet port AUI- or RJ45- type;
- Line MODEM for remote system access via telephone line, Hayes AT compatible, supports V.90 (GSM modem can be integrated as a chargeable option)
- Installed WINDOWS operation system.

All components specified for 5°C to 45°C, suitable for use in a ventilated or air conditioned environment.

SODAR Interface, installed in a free PC HD drive slot

- 16 Bit ADC for receiving signal;
- 12 Bit DAC for arbitrary wave form generation (transmit signal);
- Automatic loudness control within 1% - 100%;
- Signal converter for PT100 sensor (for compensation of temperature dependence of the sound velocity);
- Line drivers for all i/o signals;
- Antenna selection and transmit/receive control;

1.9 Documentation SODAR-system

The following documentation is supplied with each SODAR system.

- Original documentation for the PC, the add-on units and the WINDOWS system. All documentation in English.
- three complete sets of METEK related documentation (also on CD) consisting of:
  - Manual (commands, variables, parameter, protocols, ...)
  - Description (units, handling, site selection, site preparation, set up procedure, maintenance, failure diagnosis, repair, tests)
  - Description of theoretical background and system routines
  - Excerpt of schematic diagrams (related to error diagnosis, repair and maintenance)
- Manual for SODAR-Control Software
- Manual for METEK-Graphic Software
- Final test acceptance (in-factory, 1x)

2 OPTIONAL ITEMS

2.1 Antenna Heating

The antenna may be heated for use in cold conditions where there is a danger of snow or ice accumulating. The heating operates from 230 VAC, with a maximum power of 300 W. The heating is automatically controlled according to the local temperature. The user may override the automatic control if necessary.

Part no. PCS-000

2.2 Low Power Version of PCS 2000

The low power version of the PCS2000 is intended for use where mains power is not available and operation from batteries charged from solar or other such means is required. Low power versions operate from low voltage DC supplies, typically 24 VDC.

Heating of the antenna is not generally possible in such circumstances unless a mains voltage supply (230VAC) is available. If this configuration is required please consult with the supplier before purchase.

The low power version is produced by replacing the standard tower computer of the Control and Data Management unit with a very low power integrated processor board. The low power Control and Data Management unit has a power consumption of approximately 45W and provides the following functionality.

- SODAR operation (signal generation and signal analysis)
- SODAR control
- Data storage and data transfer, remote access by GSM-MODEM
- Data visualization

The low power version has minor restrictions in the selection of operational parameters settings, i.e. pulse rate and multi-frequency operation.

Part no. PCS-001

2.3 Outdoor Control and Data Management Unit (Standard)

For outdoor standalone application an 19“ rack with water proof canvas cover is offered. This rack has an automatic heating/cooling installation and provides the specified environmental conditions for the operation of the indoor SODAR-PC.

Antenna electronics can be installed in the rack or fixed to the acoustic shielding of the SODAR according to the customer preference (please specify at time of order). Additional components such as GSM modem or the connection for further external sensors can be fitted inside the rack.

Part no. PCS-002

2.4 Outdoor Control and Data Management Unit (Extreme)

A more ruggedized solution for the outdoor Control and Data Management Unit is the implementation of the SODAR electronics components in the “white cube” rack. This solution is recommended especially in dusty environment. The “white cube” solution covers and protects the complete electronic components.

Connection points for power supply, SODAR antenna or external sensors are accessible from outside. The integration of a GSM modem is also possible.

Please note that the “white cube” with fully integrated SODAR electronics has a weight of approx. 70 Kg.

Part no. PCS-003

2.5 GSM Modem

This device allows remote access to the SODAR system for control and monitoring of system operation and for data transfer in locations where a land telephone line is not available. It is the customers’ responsibility to ensure that suitable mobile network coverage with data capability is available in the intended location.

Specifications:

- INSYS modem providing 14,400bps
- Software for configuration under Windows
- configuration also through remote access

- 10 … 80 VDC, 3W max.
- 0 … 55 °C,
- Includes antenna

The phone card and data subscription has to be provided by the customer.

Satellite communications options are also available on special request.

Part no. PCS-004

2.6 Standalone Power Options

Depending on the required configuration operational power can be provided from a bank of 2 maintenance-free gel batteries, 12 VDC, each with 115 Ah. The batteries are installed either in a trailer ordered with the SODAR or in a weather proof box with appropriate connectors.

The battery bank can be configured in three ways:

- power supply by a fuel cell for charging of batteries through a controller
- power supply from three solar panels for charging batteries through a controller
- supply of operational voltage from 230 VAC (115 VAC on request) through a battery charger (for example, from the public power grid)

The system can also be directly connected to a 24 VDC power source.

In the event of snowfall the accumulation of snow on the SODAR antenna can reduce performance of the SODAR. The user will be capable of setting the antenna heating (option) in operation by remote access through the GSM / GPRS modem (option, provided GSM /GSPR network is available on site). However, systems powered by solar panels or fuel cells will provide only limited capabilities for antenna heating.

All installation will be according to the German standards for the installation of electric equipment (VDE).

2.6.1 Operation voltage provided by Methanol Fuel Cells

The quoted fuel cells are specified by the manufacturer with a maximum power output of 90 Watt. The daily power consumption of the SODAR system under standard operational conditions is 1200 Wh which results in a mean daily operation time for the fuels cells of 14 hours. The fuel cell continuously monitors the charge status of the batteries and switches the fuel cell off at the optimal state of charge. The remaining 10 hours of the day allow an additional production from the fuel cells of 900 Wh. That enables a heating operation of approx. 2-3 hours per day.

The methanol for the fuel cells will be provided by the manufacturer of the fuel cells in special canisters (capacity of 10 and 28 liter). The manufacturer of the fuels cells or METEK GmbH will arrange for the transport and provision of the methanol canisters at the request of the customer. Costs for the ongoing supply of methanol canisters are not included in the prices quoted for this option.

A special adapter which allows the use of two canisters simultaneously increases the operation time of the fuel cell.

The lifetime of the fuel cell is 2 years or a maximum of 4500 hours. Combined operation with both fuel cells and photovoltaic / wind energy will increase the lifetime of the fuel cell. The achieved performance will depend on the incoming solar radiation (available wind power) according to the site conditions.

Specifications of Methanol fuel cell including batteries

- 2160W per day nominal, effective output 90W
- Effective Voltage 12/24 Volt
- Effective consumption 0.9 l / kWh
- Charge current @ 12 V - 7.5 A @ 24 V - 3,75 A
- Weight 8.95 kg
- Temperature Range: -20 ... 45 ° C
- 2 x adapter for operating the device with 28 liters of methanol canisters
- DuoCartSwitch DCS1 (simultaneous operation of two methanol canisters)
  2 x 12 V/115 Ah gel battery

List of specification is subject to change. METEK GmbH reserves the right replacing single specified items with units having similar specifications.

Customers wishing to select this option are strongly recommended to discuss their detailed requirements with the supplier.

Part no. PCS-005

2.6.2 Power Supply with Solar Panels

Example of solar panel Installation: 4x solar panels within an installation frame. The final number of panels depends upon application.

This option provides an external power supply based on three solar panels. The photovoltaic power supply is designed for continuous operation by itself or in conjunction with the Methanol Fuel Cells.

The solar panels in combination with the above specified fuel cell can significantly increase the lifetime of the fuel cell especially at sites with high incoming solar radiation. Depending on site conditions (e.g. shading from mountains or trees) and meteorological conditions (e.g. period of cloudy weather and seasonal factors) the energy production of solar panels might be limited. In this case the fuel cell will provide the necessary power for operation of the SODAR system.

The entire system is designed according to relevant VDE standards. There will be fuse blocks inside the battery housing. All components are configured with plug-socket connections for direct connection.

The picture shows an example installation where the solar panels are fixed to a mounting frame. The tilt angle of the panels is adjustable.

The picture shows an example installation where the solar panels are fixed to a mounting frame. Tilt angle of the panels is adjustable.

Solar Panel Specifications

- 3 x Solar-Panels 175 Wp, 24 VDC
- Approx. measures each 1580mm x 808mm x 50mm
- Mounting frame for solar-modules (Example: Bosch Rexroth)
- Solar charge controller Steca PR 3030,12/24 VDC, 30A power module

Specifications are subject to change. METEK GmbH reserves the right to replace single specified items with units having similar specifications.

This option does not include batteries as standard as the system is often supplied as a supplement to the Methanol Fuel Cells. Suitable batteries are detailed below.

Part no. PCS-006

2.6.3 Batteries for Solar Power Supply

Using the solar panels as a standalone external power requires batteries that are not included in the solar power supply option. This option provides the batteries and weather proof housing required when a solar only power solution is selected.

Please note, depending on the site and the available incoming solar radiation smaller solutions are possible. Customers wishing to select this option are strongly recommended to discuss their detailed requirements with the supplier.

Part no. PCS-007

3 TECHNICAL SPECIFICATIONS

3.1 PCS2000-64 - Ranges

Frequency:	1500 ... 2600 Hz 2000 ... 2200 Hz recommended
Horizontal Wind Components:	± 50 m/s
Wind direction:	0 to 360 degree
Vertical wind speed:	> ± 10 m/s
Operating temperature:	-30°C to +55°C Outdoor components +5°C to +45°C Control computer
Operating humidity:	5 - 100 % (outdoor components) 10 - 95 % (indoor components)
Integration time:	Typically 600-1800s. Minimum is 10 seconds or more for a complete cycle involving all three antenna beams; instantaneous mode for evaluation of individual signal pulses is available simultaneous to the averaging mode. For wind speed and wind direction, and standard deviations of u-, v-, w-component an averaging period of at least 10 minutes or more is recommended in order to comply with the fundamental assumption of SODAR operation which demands homogenous flow properties in the measuring volumes of the different antenna beams.
Number of gates:	Adjustable, 1- 40 (more on request)
Minimum measuring height	Adjustable, ≥ 15 m, increment ≥ 5m
Height resolution:	Adjustable, 5 m ≤ ΔH ≤100 m, increments ≥ 5m, typical 10 - 30 m;
Measuring height	Depends strongly on atmospheric and site conditions, we define: 500 m, 70 % availability (for wind speed and direction, ΔH=30 m, 900 s, 55 dB noise level, cluster algorithm for data evaluation of instantaneous data);
Maximum measuring height	Nominally > 1500 m (not available in adverse weather conditions)
Signal power:	Max. 1000 W (elect.), automatically adjusted
Antenna gain:	typ. 20 dB, dependent on frequency
Sensitivity of receiver	10^{-6} N/m², depends on frequency
Beam width:	typical 7 -12 °, depends on frequency
Qualifying:	German Nuclear Power guideline KTA1508 / VDI guide line DIN 3786 (11)
Power consumption:	Depends on pulse repetition rate, approx. 500 W average

3.2 Accuracies PCS.2000-64

In principle the numerical accuracies depend on some operational parameters (frequency, height resolution). The values given below are for recommended settings:

Horizontal wind components:	0.1-0.3 m/s, or 5 %
Wind direction:	1°-3°, for wind speeds over 5 m/s 3°-5°, for wind speeds to 5 m/s
Vertical wind component:	0.03-0.1 m/s, or 5 %
Std. Dev. of vert. wind comp.:	0.10 m/s, or 5 %

3.3 Operational Parameters

Date, Time, Time zone	adjustable
Number of measuring heights	adjustable
Lowest measuring height	adjustable
Maximum measuring height	adjustable
Height resolution	adjustable
Averaging interval	adjustable, and/ or instantaneous mode
Signal intensity	adjustable for each antenna direction, 1 - 100 %
Transmit frequency (determines zenith angle)	adjustable
Zenith angle (determines transmit frequency)	adjustable
Antenna orientation, azimuth	adjustable, 0 ... 359 °
Antenna orientation, zenith	adjustable, 10 ... 25 °
Type of data protocols	adjustable
Output	asynch., sync., external demand

3.4 Measuring Variables

The Doppler SODAR subsystem offers a variety of calculated measurement variables on three independent serial output ports and/or Ethernet (Option) with configurable secure transfer protocols and adjustable port specifications. All adjustments are made by software commands.

In addition to the averaged variables single pulse evaluation is available and a consensus method can be performed according to the users' selection. All variables are available simultaneously at the selected ports.

The PCS2000 offers the following measurement variables on the serial output ports and optionally via Ethernet.

	Averaged Variables	
Variable	Variable Type	Unit
H	Measuring heights	m
Fni	Spectra	dB
P i	Signal Intensity	dB

R i	Reflectivity	dB
VRi	Radial wind components	m/s
VVc	Vector wind speed	m/s
V	Wind speed	m/s
D	Wind direction	degree
VS	Scalar wind speed	m/s
DS	Scalar wind direction	degree
S i	Sigma of radial wind components	m/s
S c	Sigma of horizontal components	m/s
SD	Sigma of vertical wind direction	degree
ST	Sigma of horizontal wind direction	degree
DC	Stability class (diffusion)	A-F
MH*	Mixing height	m
SNi	Signal/Noise ratio	[ ]
Dai	Sample availability	%
ERi	Plausibility tests	8888
CT*	Temperature structure parameter	°K^2/m^2/3

Read the index i as antenna beams 1,2,3, having “beam 3” vertical
Read the index n as FFT-Lines n=1..32
Read the index c as orthogonal vector components u,v,w, having component “w” vertical

To derive MH* either the reflectivity profile is used (for. example identification of elevated inversions) or the stability class is used.

Please note: For a quantitative CT calculation the unknown vertical humidity and temperature profiles are required. We do not recommend estimating these parameters from SODAR measurements.

METEK recommends extending the SODAR installation with an ultrasonic sensor (for example METEK’s uSonic 3 - Scientific) with on-line computation of all turbulent quantities used for absolute calibration of the atmospheric reflectivity and as a redundant tool for dispersion parameter measurements.

4 SODAR Control and Data Visualization Software

Designed for operation on Windows based operating systems. These software packages are supplied for use on standalone computers not as part of the Control and Data Management PC system.

To set up remote access and control with a modem the customer needs a second pc-station where the software „sodar control“ is installed. The end user must provide the means for connection between the remote PC and the SODAR control PC; this may use either the SODAR internal line modem of an optional GSM modem. METEK delivers three licenses for all software components with the system in order to allow such remote access.

Control subsystem “sodar control“

- offers access to the system and control of all system parameters, measuring variables, port selections;
- handles parameter list entries in WINDOWS format;
- offers remote system access for system control and system testing (e.g. via Modem);
- stores data and handles data files automatically in a tree structured file system with user friendly data archival and retrieval in on-line or off-line mode;
- data sets are ASCII coded files, optionally the structures can be defined according to the needs of the customer;
- 3 runtime licenses

Graphic subsystem “METEK grafik“

- consists of a comprehensive set of data presentation and evaluation tools in off-line or on-line mode (on-line with automatic data refresh);
- batch mode capability for long term data evaluation;
- 1 or 4 or 9 plots in one frame;
- profiles, time series, vector plot, contour plot as time/height cross section for all measuring variables as indicated in 3.10 (all smoothed or raw);
- SODARgram display of reflectivity with selectable resolution for averaged or raw spectra;
- statistics and data availability, with selectable class ranges;
- wind rose display, with selectable class ranges and wind direction sectors;
- representation of individual spectra or spectra profiles;
- time intervals (day, week, month, individual) and height ranges selectable or automatically scaled;
- selectable plausibility check validity/data acceptance thresholds;
- selectable smoothing function for all data;
- relative and absolute histograms and wind roses in adjustable classes;
- automatic or user selectable ordinate and abscissa scaling;
- indication of numerical values depending on the pointer position;
- zoom-function and smooth function for all data;
- manual invalidation procedure;
- WINDOWS supported global print routine;

- various export formats for plots (Windows bitmap, Windows metafile, agfa SCODL, HPGL, LOTUS 1-2-3, PIC, GIF, TIFF, GEM, Encapsulated Postscript, CGM)
- export feature for all displayed data including statistics in Excel-readable CSV format;
- 3 runtime licenses.

5 Training for SODAR system

METEK recommend pre-installation intensive combined training and system acceptance at the METEK premises in Germany. This training demonstrates the theoretical basis of the principles of measurement, installation of the systems, troubleshooting during operation and maintenance of the different sensors.

When the training is undertaken prior to shipping of the systems, the training will use the customers own systems, which will be later installed on the site. The training can be used as a preliminary acceptance test.

The training course at METEK premises is included in the SODAR price.

5.1 On-site Training

Where the customer requires training at their site we offer such training for a daily rate plus travel and subsistence. Specific quotations are provided on request.

The training course will cover:

- SODAR theory
- Principles of SODAR signal analysis and METEK signal analysis
- Principles of SODAR data evaluation and METEK data evaluation
- Set up procedures of PCS2000 (incl. siting)
- Usage of SODAR.Control and METEK-Graphic software
- Linking the System to external data acquisition system by serial lines or/and Ethernet
- Interpretation of online plausibility checks to assure complete system functionality
- Routine system monitoring and regular system checks
- Testing of operation voltages
- Testing of loudspeakers in phase and amplitude
- Testing of internal noise level
- Failure diagnosis
- Replacement of defective parts

5.2 Factory Based Training

A 3-day training course for a maximum of four people at the METEK premises is included in the system price. The content of the training is the same as the on-site training.

Travel and subsistence costs for attendees are not included in the cost of the training and must therefore be paid directly by the customer.

6 Delivery

6.1 Times of delivery

Usually the delivery for the SODAR takes about 12 weeks.

6.2 Packing and Transportation

The SODAR is packaged in robust transportation boxes suitable for international shipping. This packaging is included in the system price.

The packaging is not designed as multi-use transport cases but may be retained if the SODAR is to subsequently moved.

7 Quality Assurance Warranty and Spares

7.1 Quality Assurance

Customers are welcome to visit the German production facility during the manufacture of their system for quality control purposes. All such visits are made at the customers' expense.

7.2 Warranty

The system is supplied with a 12 months warranty against faulty materials or workmanship. Equipment must be shipped to the Metek facility at the customers' expense. Repaired equipment will be returned to the customers' original shipping destination at the suppliers' expense.

Damage caused by incorrect operation, failure to carry out recommended maintenance or malicious acts is excluded from the terms of the warranty.

7.3 Spares

The delivery of the SODAR System includes a comprehensive spare part comprising of:

- 3 x loudspeaker DK10/T sealed,
- 2 x complete amplifier boards, ready for replacement.
- 1 x transmit pulse switch
- 1 x EPROM-Set,
- 1 x Set Plug / Socket for loudspeaker connector