



Doppler SODAR PCS.2000-24

Product Description



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1 METEK SODAR PCS.2000-24

1.1 General Description

The Metek PCS200-24 is a compact high performance SODAR system that can be deployed in a wide range of environments for use in both routine monitoring and research applications.



SODAR PCS.2000-24 acoustic shielding (left) and antenna (right)

The PCS2000-24 system consists of:

- Acoustic antenna
- Antenna electronics
- Power supply
- Connecting cables
- SODAR Control and Data Management PC

1.2 Acoustic Antenna

The antenna supporting panel is 0.8 m x 0.8 m on each side and is made from weatherproof closed cell foam panels. The 24 element antenna array is arranged as 2+4+6+6+4+2 as shown in the picture above. The elements are watertight loudspeakers with exponential horns for impedance matching (\varnothing 13 cm ea.). The maximum power of each element is 10 W.

An inverted pyramid shaped acoustic shield made from weatherproof closed-cell foam panels lined with UV-resistant sound absorbing foam attaches to the antenna array to reduce problems associated with background noise and also to reduce noise nuisance. The absorption ratio within the frequency range 1000 - 2500Hz is better than 90 %. The shield consists of 4 basic panels (0.4 x 0.96m), 4 lower side panels (0.96/1.33 m lengths x 0.65 m height), 4 upper side panels (1.33/1.65 m lengths x 0.65 m height), and 4 top panels with triangular thadners on the top (1.65 m length x 0.60 m height). The total height with all shields is 2.15 m.

The acoustic beam width is $\pm 7^\circ$ (depending on frequency).

Depending on the site condition the absorbing foam has to be renewed in 5 - 10 years. For use in cold environments an option for heating of the antenna array is available.

1.3 Cables

All cables connecting the SODAR components are high quality products with IP65 plugs and sockets for the outdoor use.

1.4 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.

Sample SODAR PC configuration, final PC configuration is subject to change:

- 2.8 GHz Celeron or better, 250 GB hard disc, 512 MB RAM, DVD R+W
- Monitor (TFT, 17 “), keyboard, type WINDOWS 98, 104 keys, mouse
- 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 supplied as a chargeable option).
- Installed WINDOWS operation system.

The SODAR interface is installed in a free PC hard drive bay to provide the necessary interface to the external SODAR components.

SODAR Interface, included in PC free 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;

All indoor components specified for 5 °C - 45 °C, to be installed in ventilated or air conditioned environment.

1.5 Documentation SODAR-system

- Original documentation for the PC, add-on units and WINDOWS operating system, 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 TECHNICAL SPECIFICATIONS

Frequency:	1500 ... 2600 Hz 2000 ... 2200 Hz recommended
Horizontal Wind Components:	+ - 50 m/s
Wind direction:	0 - 360 degree
Vertical wind speed:	> + - 10 m/s
Operating temperature:	- 30 ° C to + 55 ° C outdoor + 5 ° C to + 45 ° C indoor components
Operating humidity:	5 - 100 % outdoor components 10 - 95 % indoor components
Integration time:	typical 600-1800 s, 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 <u>wind speed and wind direction</u> , and <u>standard deviations</u> 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 ≥ 5 m
Height resolution:	adjustable, $5 \text{ m} \leq \Delta H \leq 100 \text{ m}$, increments ≥ 5 m, typical 10 - 30 m;
Measuring height	depends strongly on atmospheric and site conditions, we define: 300 m, 70 % availability (for wind speed and direction, $\Delta H=30$ m, 900 s, 55 dB noise level, cluster algorithm for data evaluation of instantaneous data);
<u>Maximum</u> measuring height	nominal > 1000 m (not available in adverse weather conditions)
Signal power:	Max. 1000 Wp (elect.), automatically adjusted
Antenna gain:	typ. 20 dB, dependent on frequency
Sensitivity of receiver	10^{-6} N/m ² , 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. 150 W average

2.1 Accuracies PCS.2000-24

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

Horizontal wind components:	0.3-0.4 m/s, or 5 %
Wind direction:	3°-5°, for wind speeds over 5 m/s 5°-8°, for wind speeds to 5 m/s
Vertical wind component:	0.1 m/s, or 5 %
Std. Dev. of vert. wind comp.:	0.1 m/s, or 5 %

2.2 Operational Parameter

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

2.3 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.

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	[]



SODAR equipment

	Averaged Variables	
Dai	Sample availability	%
ERi	Plausibility tests	8888
CT*	Temperature structure parameter	$^{\circ}\text{K}^2/\text{m}^2/3$

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. ex. identification of elevated inversions) or the stability class is used.

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

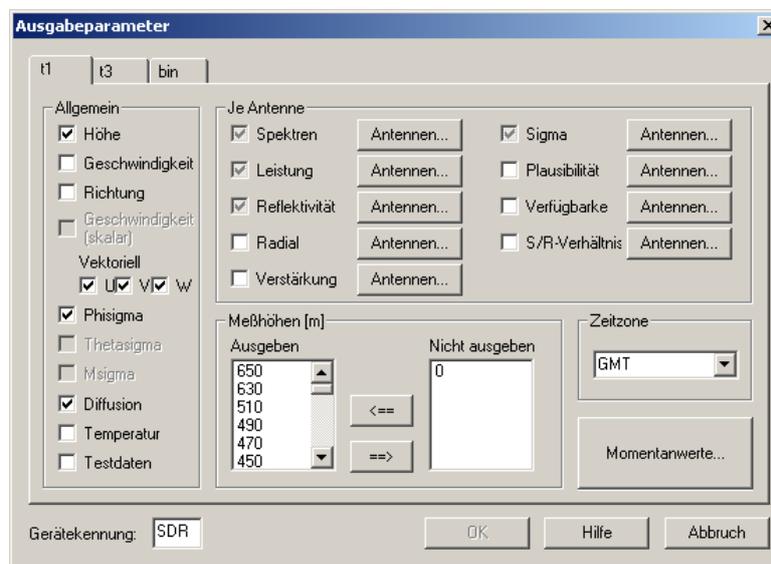
3 SODAR CONTROL AND DATA VISUALIZATION SOFTWARE

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 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;

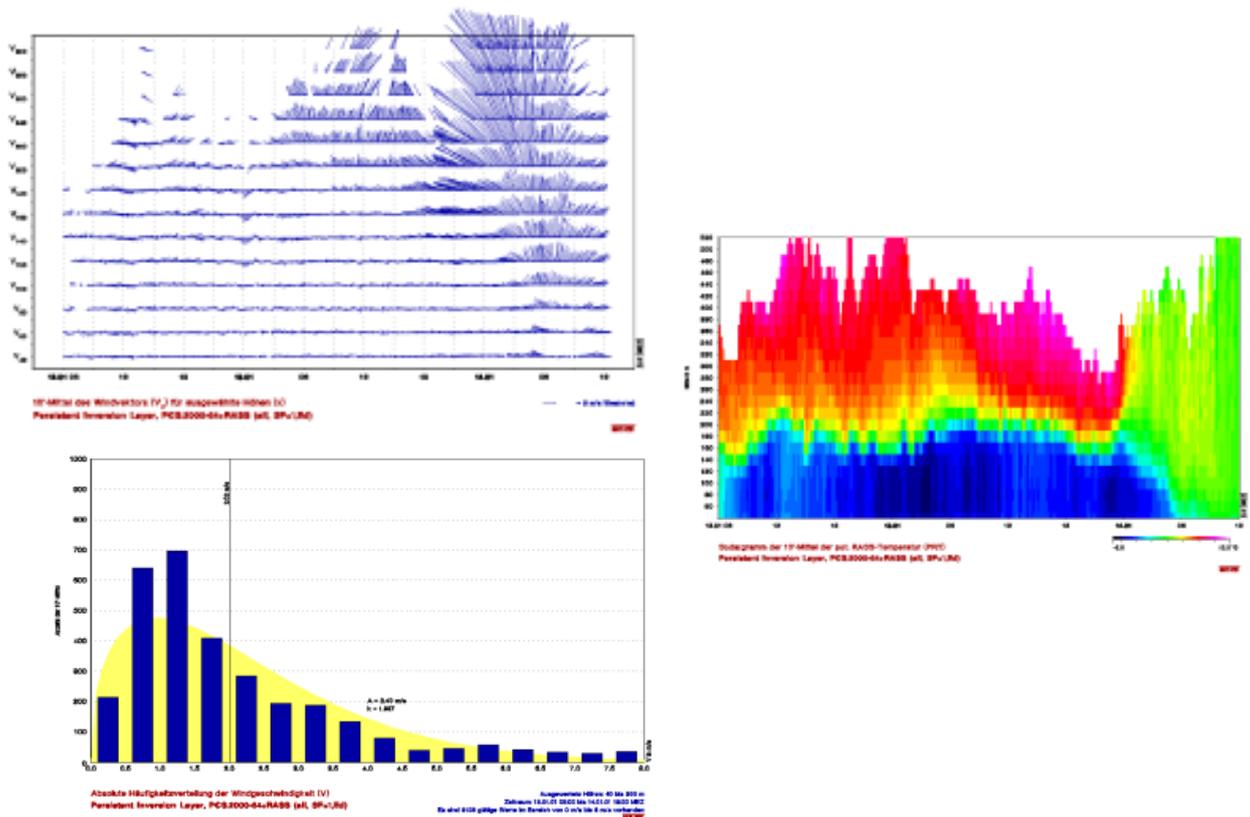


Example of SODAR control GUI
(The software is provided in English as standard)

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 2.9 (all smoothed or raw);
- SODARgram of reflectivity with selectable resolution for averaged/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 displayed data/statistics in Excel-readable CSV format;



Examples for the SODAR graphics program output

4 OPTIONAL ITEMS

4.1 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

4.2 Low Power Version of PCS2000

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 V DC.

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

4.3 Outdoor Control and Data Management Unit (Standard)



Part no. PCS-002

For outdoor standalone application a 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.

4.4 Outdoor Control and Data Management Unit (Extreme)



Part no. PCS-003

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.

4.5 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 bis 14.400bps
- Software for configuration under Windows
- configuration also through remote access
- 10 ... 80 VDC, 3 Watt 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

4.6 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).

4.6.1 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 litre). 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 on-going 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

- 2160 Watt per day nominal, effective output 90 Watt
- 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 litres 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

4.6.2 Power Supply with Solar Panels



Example for SOLAR Panel Installation: 4x SOLAR-Panel, implemented in installation frame (Final number of panels depends on 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 (eg shading from mountains or trees) and meteorological conditions (eg 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 of 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. Tilt angle of the panels is adjustable.

Part no. PCS-006

Solar Panel Specifications

- 3 x Solar-Panels 175 Wp, 24 VDC
- Approx. measures each 1580 x 808 x 50cm
- 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-007

4.6.3 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.

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 be on the customers systems, which will be later installed on the site and can be used as a preliminary acceptance test.

The training course at METEK premises is included in the prices for SODAR device.

5.1 On-site Training

Where the customer requires training at his site we offer such training for a daily rate day 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 as per the on-site training.

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

6 QUALITY ASSURANCE WARRANTY AND SPARES

6.1 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.

6.2 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.

6.3 Spares

The delivery of the SODAR System includes a comprehensive spare part kit (e.g. amplifiers, loudspeakers):

- 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

7 GENERAL REMARKS ON MAXIMUM MEASURING HEIGHT

The definition of a so-called “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 principal 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
- back ground noise (generated by wind, by rain drops, 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
- annoyance of neighbourhood

System Parameters

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

The measuring parameters can be adjusted by the user and the system parameter can be optimized by the electronic design of the SODAR electronic. But the atmospheric parameter cannot be influenced. This atmospheric parameter can vary in much wider ranges than all the other parameter. Especially 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 atmospheric boundary layer. The ABL itself can be as low as 150 or 200 m in case of surface based inversion layers which represents the natural range limitation for any SODAR sounding.

On the other hand, the measuring height can easily reach more than 1000 m in convective and perfect site conditions. Therefore, the specification of a “typical” measuring height needs special care and some information about the assumed weather and site conditions and parameter selection. 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.