AK50

PROCESS MOISTURE LOGGER FOR ON-LINE OPERATION

USER'S MANUAL

Model 6S

The embedded software version V1.94, V1.95, V1.96 are active versions at this time.

The PC program referred to in this manual is AK30 which follows each meter. It can also always be downloaded from our web site to upgrade at no cost. A license for the Advanced and Profiler programs is now a standard with the AK50 meter.

Note that a few variants of the AK50 exist, some with a 100 Hz, some with a 400 Hz speed, some in the small box, some in the bigger or even the biggest box.

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Unit information:

Model & Rev:	AK50 Rev:
Serial number:	
Firmware V	
PCB's:	
Adjusted:	
Service Interval (hours):	

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CONDITIONS OF GUARANTEE, COPYRIGHT NOTICE AND LIABILITIES OF THE MANUFACTURER

The manufacturer (Visilab Signal Technologies Oy) grants a guarantee of two years for the buyer of AK50 moisture meter from the date of purchase. The guarantee covers all faults and misalignments which are in the equipment at the moment of purchase including those which appear during the guarantee period. The manufacturer is liable of repairing the instrument without cost to the buyer. The manufacturer can ship a new instrument of equivalent value and status if considered as a better solution than repairing. The buyer is liable of paying the freight costs to the factory of the faulty unit. The unit must not be sent to the manufacturer without a permission from the manufacturer. Units sent without a permission will be repaired at the cost of the buyer.

The guarantee does not cover wearing parts, like batteries, lamps or motors. The guarantee does not cover faults caused by errors or neglects of the user nor those faults which are caused by deliberate damaging. The guarantee does not cover faults caused by incorrectly installed cables or conductors. The guarantee does not cover any damages to the user or to any third party independently of the way how the instrument has been used. The guarantee does not cover faults caused by natural phenomena like lightnings or floods, nor user errors like dropping or hitting the unit. The guarantee is void if the unit is sold to any third party. All faults which are not covered will be repaired at the cost of the buyer.

If opening of the instrument has been attempted at those parts which are not intended for the user, the manufacturer can refuse to repair or service the instrument. Then the instrument will be shipped back to the buyer at the cost of the buyer. Such parts are the light source, the optical head and parts on the electronics boards. The instrument can be opened only strictly according to the instructions in this manual and should not be disassembled unnecessarily. Also, if some parts can not be opened with a reasonable force, they should be left to avoid any damage.

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The manufacturer is not responsible for any casualties, damages or accidents which the user has caused directly or indirectly with this AK50 instrument, either to himself or to any third party, independent on the instrument being used correctly or not.

Important warnings are highlighted in this manual with red color.
Recommendations are in blue and important instructions are in brown.

EC Declaration of Conformity

We

Visilab Signal Technologies Oy
Sepäntie 4
FI-07230 Monninkylä
FINLAND

declare that the

AK50 AND IRMA-7 model D Process Moisture Loggers

meets the intent of the EMC directive 89/336/EEC. Compliance is based on the following harmonized standards:

Emissions:

EN 50 081 part 2 (industrial environment):1993 referring to :
EN 55 011 radiated, Class A, Group 1
EN 55 011 conducted, Class A, Group 1

Immunity:

EN 50 082 part 2 (industrial environment):1992 referring to (both radiated and conducted fields):
EN 61000-4
IEC 1000-4
ENV 50140
ENV 50141
ENV 50204

I certify that the apparatus identified above conforms to the requirements of Council Directive 89/336/EEC.

Henrik Stenlund
managing director
5th May 1997

CE

Note for users:
When the apparatus identified above is connected by someone to become a part of an industrial control system, he is also responsible for the EMC compatibility of the resulting system. He is also liable of providing the necessary optical or galvanic isolations for signals and transient absorbers for other lines to conform to the EMC directives.

The meters and the power source apparatus have been individually tested according to DIN VDE0701 and DIN VDE0702 for electrical safety.

EC Declaration of Conformity

We

Visilab Signal Technologies Oy
Sepäntie 4
FI-07230 Askola
FINLAND

declare that the products which are put on the EU market:

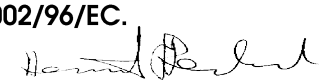
Portable Surface Moisture Logger, model A, AK30 and its derivatives

AK50 On-line Moisture Logger, also model AK40 and IRMA-7 model D and all derivatives thereof

meet the intent of the RoHS directive 2002/95/EC and the WEEE directive 2002/96/EC. Compliance is based on the following.

The instruments belong to Category 9 "Monitoring and Control Instruments" of the WEEE directive and thus are not required to fulfill the said directives.

I certify that the apparatus identified above conforms to the requirements of Council Directives 2002/95/EC and 2002/96/EC.



Henrik Stenlund
managing director
10th February 2017

Note:

In spite of the fact that the products are not required to fulfill the directives, we make every effort to comply with the directives in practice. When the Category 9 is moved to be covered the same requirements as other categories do, we are ready to certify that these products comply with the directives.

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1. Introduction and Taking into Use

We congratulate you for your decision of becoming a user of **AK50** process moisture logger. It has been designed to withstand rough use in harsh environments and to offer you as much surface moisture information of your process as possible having also a great variety of useful features. Our intent has been to offer you a unique instrument serving you reliably for several years. To utilize all features in this product we recommend that you read the whole of this manual and also other manuals shipped with this unit. This manual covers model's revision 6. The older revisions are no longer manufactured. Refer for more details in the appendices 1 to 6. Refer to the mechanical drawings in this chapter.

AK50 is a very fast process surface moisture transmitter for requiring conditions in paper machines and other comparable applications. Its true moisture measurement speed is 100 Hz. That speed can be exploited in different ways. One can acquire the latest moisture value into some control system in digital form either via the RS232/485 serial port (typically a PC) or via Profibus DP fieldbus (max 12 Mbauds RS485). The moisture signal can be read also in analog voltage form (0...+10 V, +/-5 V or 0...+5 V corresponding to 0...100% moisture, selectable and scalable). Moisture can be sampled and collected to the unit's own battery backed data memory at regular intervals from 10 ms to 32000 s. The data can later be retrieved from the memory as a data series. One external trigger line is available for starting either continuous sampling or a preset Batch (1 to 4096 samples). The meter is equipped with an infrared thermometer for reading the web temperature.

AK50 is taken out of its package carefully and it should be inspected for any damage during shipping. If any damage is visible, contact the manufacturer or the representative from which the unit was bought. Note that in spite of being designed to rough conditions it is still a sensitive optical instrument and it should be handled with care. Avoid any mechanical and thermal shocks to the meter! Especially sensitive is the light source motor which is easily damaged if it is being subjected to sharp shocks.

The following items should be available:

1. **AK50** *instrument*
2. *Program on a USB stick*
3. *User's manual (this)*
4. *Connection cables with connectors and a power source unit -PS*
5. *Serial cable for PC operation*
6. *PC program user's manual*
7. *Profibus DP user's manual*
8. *galvanically isolated USB-to RS232 converter plug with a USB-B cable*
9. *Vortec tube*
10. *Other optional items ordered*

If something is missing, inform your dealer and he will ship any missing parts. The instrument is ready to use after connecting the cables and power.

Connecting the Cables and Starting the Meter

Notice that the cable connector in **AK50** may have a cap which protects them against dirt. It must be opened by turning anti-clockwise. Also the connector on the cable end may have a protecting cap. The connectors are splash water proof. To keep them that way for the operating life of the instrument we ask the user to handle them carefully and to avoid too much force while opening or

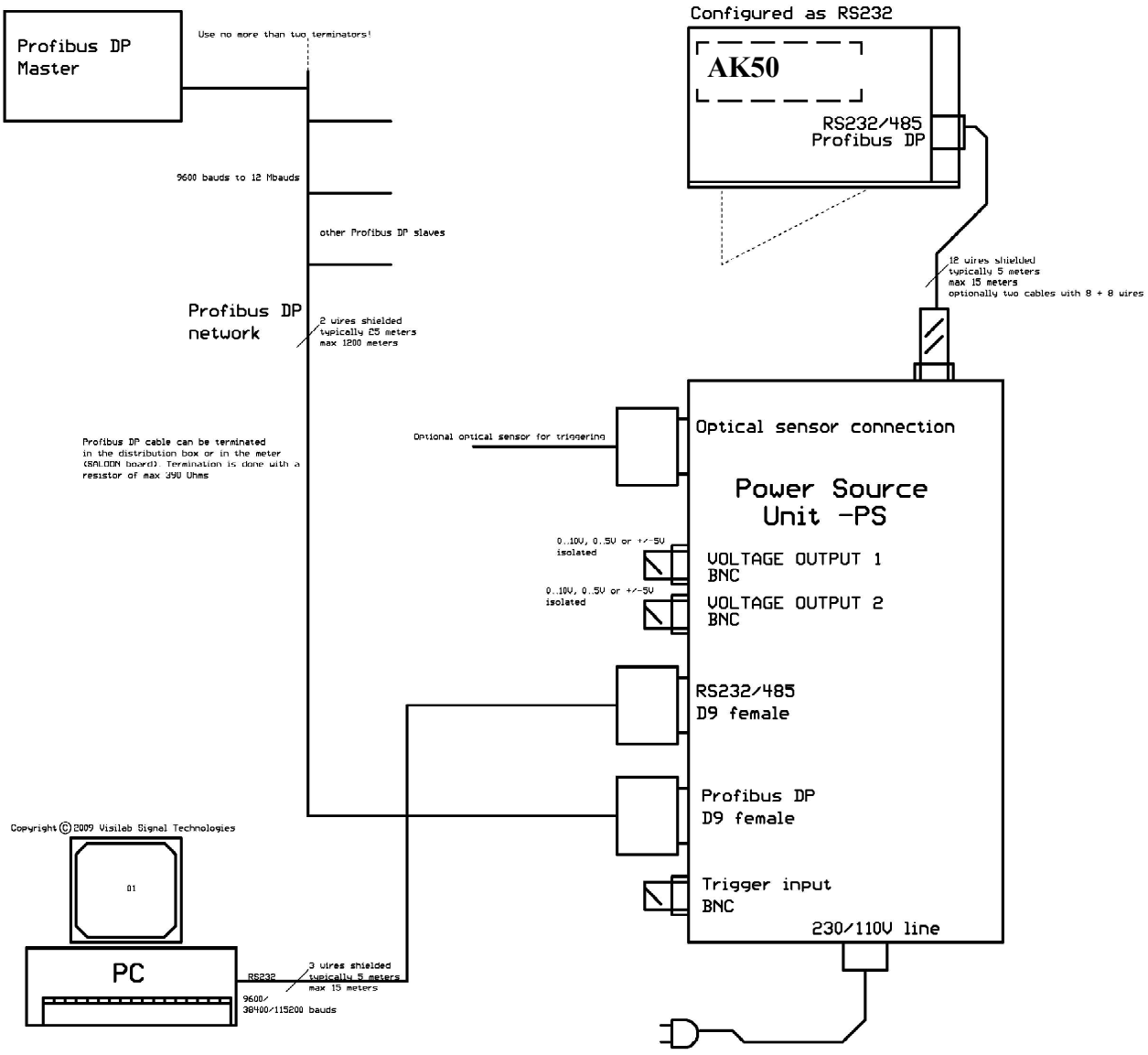


Figure 1A. Assembly of electrical cables in AK50 for use via RS232 with a PC or a terminal and Profibus DP simultaneously. The drawing is not to scale. The wire positioning may vary on the distribution box. The box is just an example of connecting the cables into your process measurement system and for initial testing. The second screw terminal for analog output is functional too. Its signal contents can be selected.

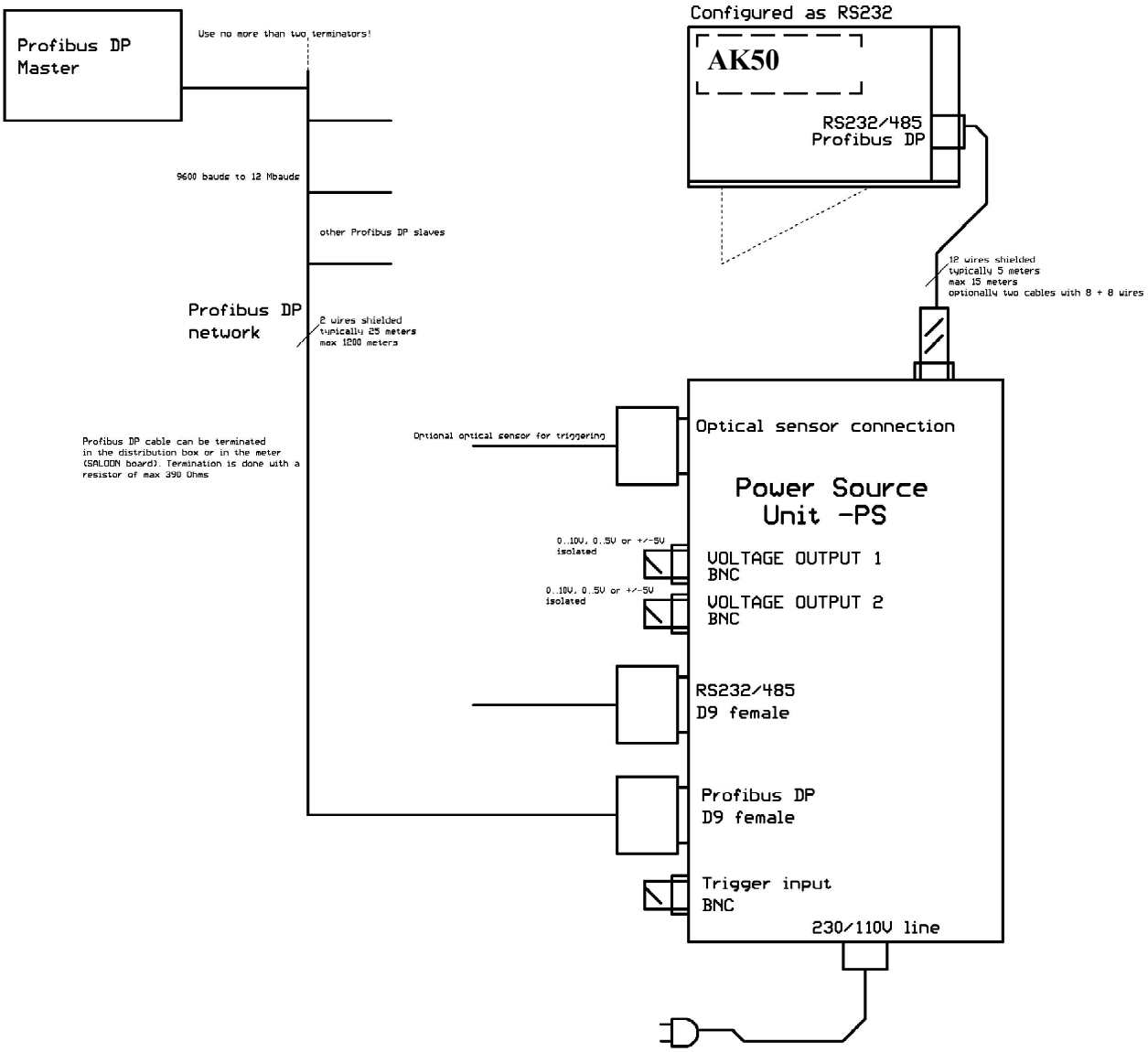


Figure 1B. Assembly of electrical cables in AK50 for use via Profibus DP only.

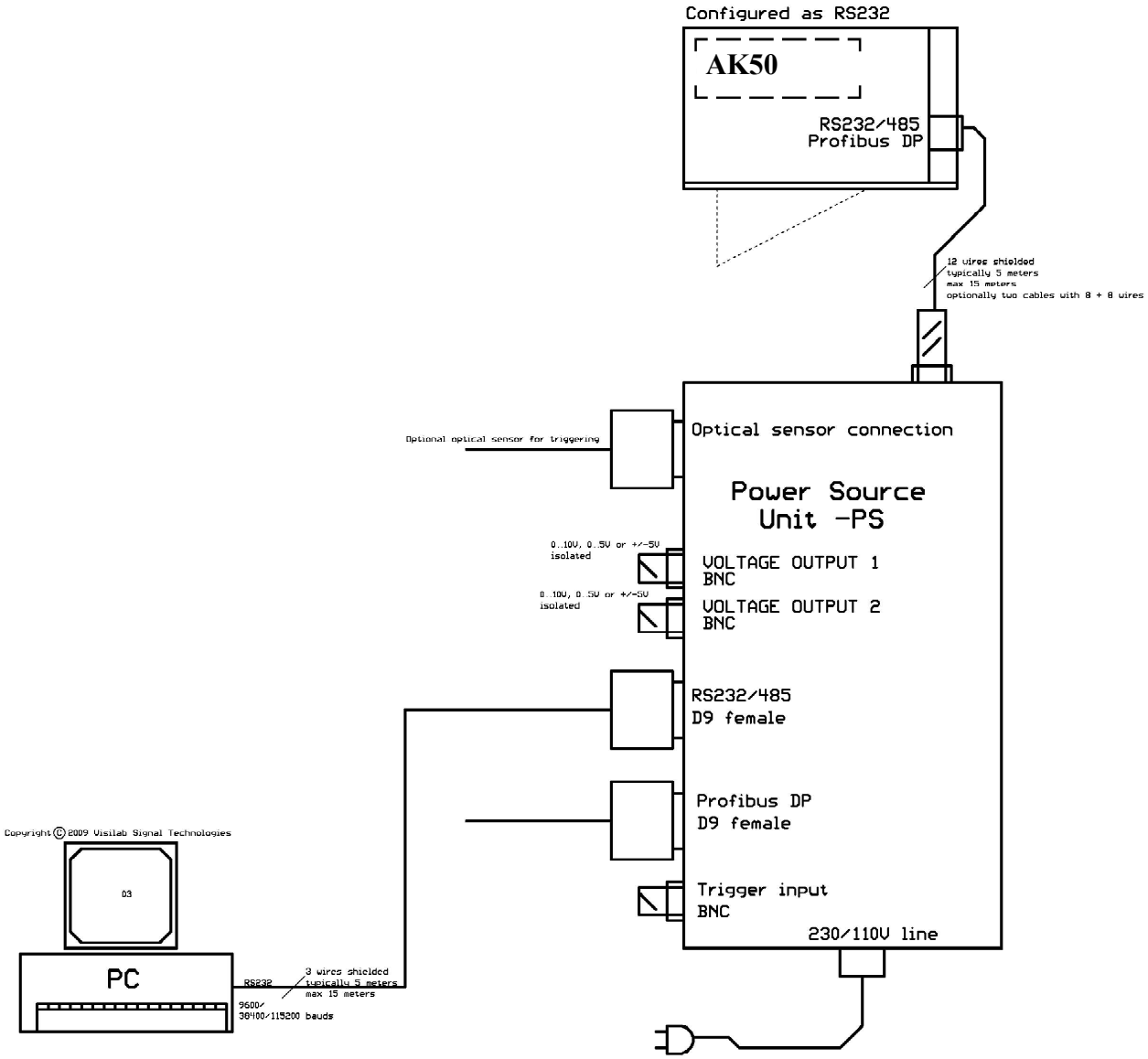


Figure 1C. Assembly of electrical cables in AK50 for use via RS232 at 9600/38400/ 115200 bauds with a PC or a terminal only. The drawing is not to scale.

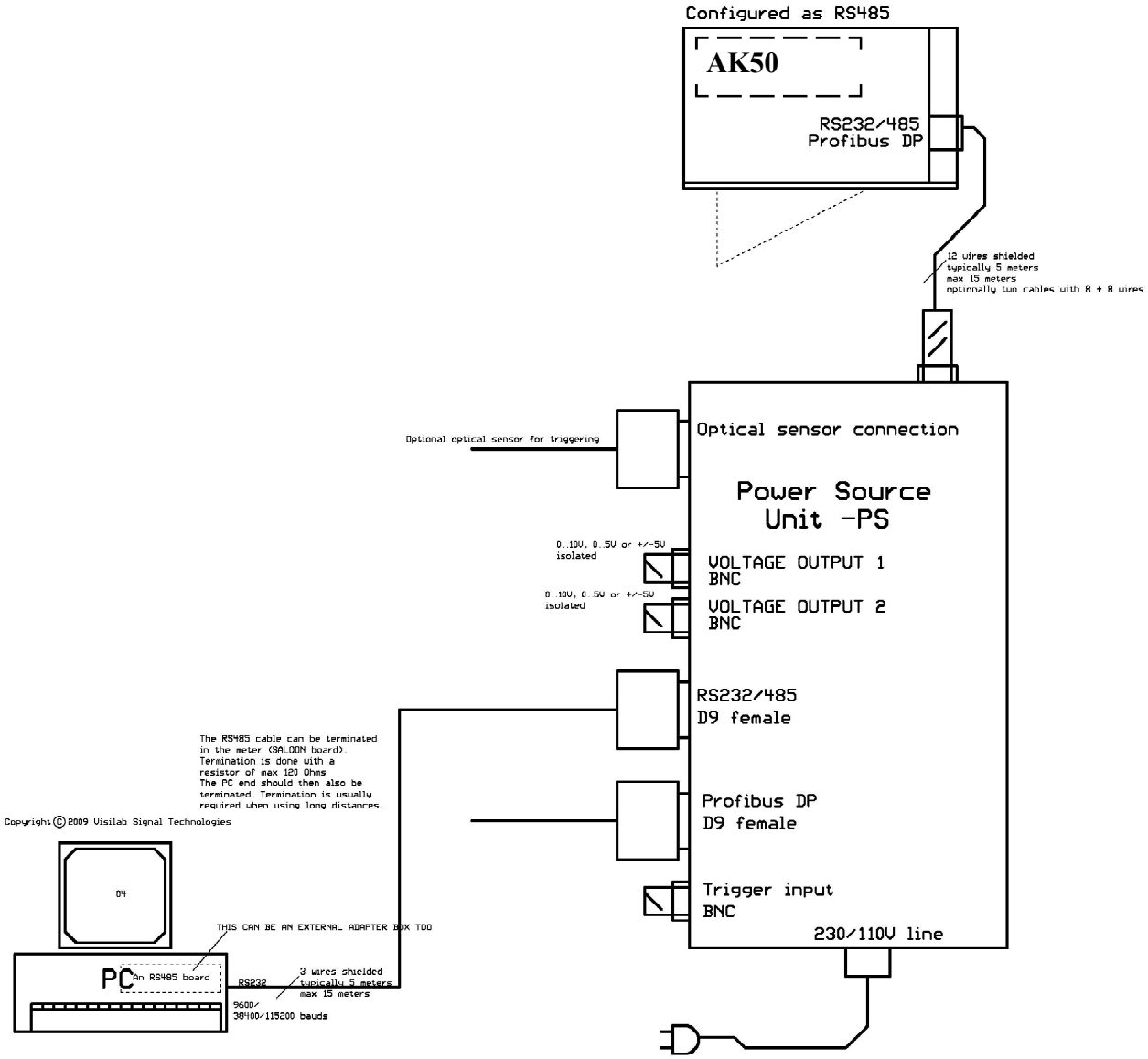


Figure 1D. Assembly of electrical cables in AK50 for use via RS485 with a PC or a terminal only at 9600 bauds. The drawing is not to scale.

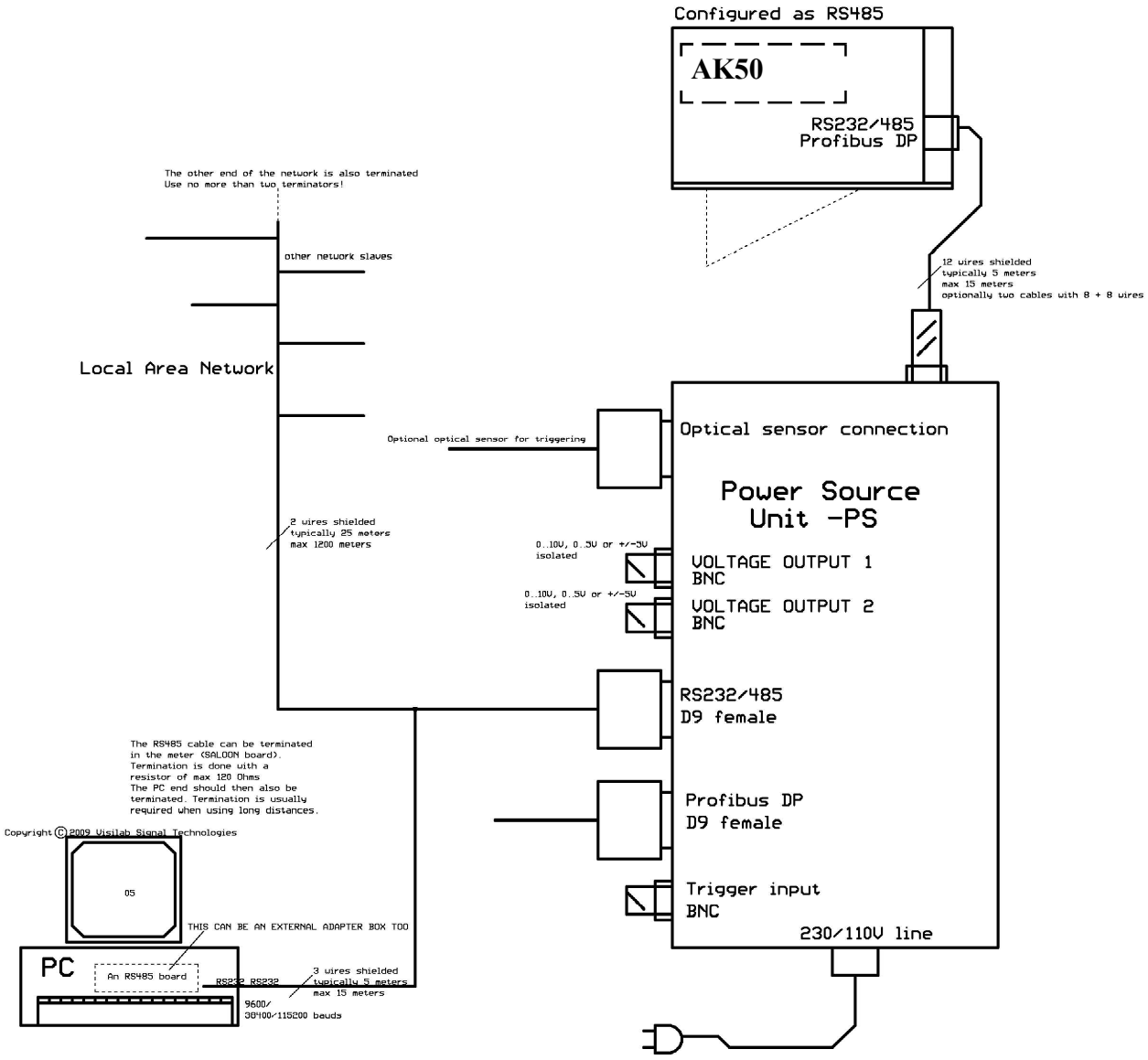


Figure 1E. Assembly of electrical cables in AK50 for use via RS485 with a Local Area network (LAN) PC only. The PC works as a network Master. Note that all the AK50 meters to be attached to the LAN need to be configured for quiet booting (service menu 5 - option 7). Each slave has to have its own address (communication menu 8 - option 1). No two slaves can have the same address.

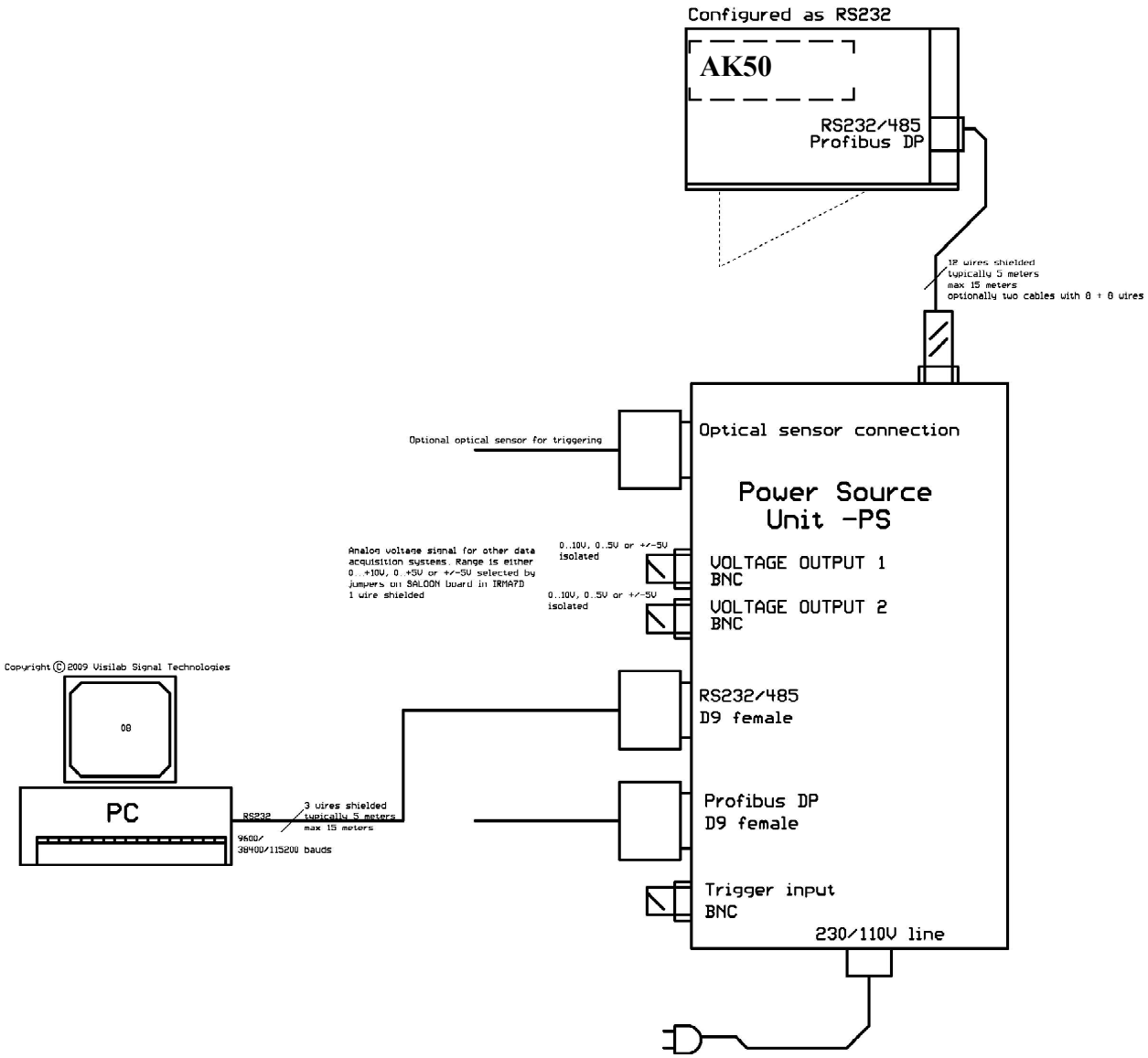


Figure 1F. Assembly of electrical cables in AK50 for use with external analog data acquisition systems. The cable carries the trigger input line which is optionally used for starting the autotimer. **The trigger line is normally open and only momentarily closed for action.** You can use optoswitches or mechanical switches for this. Also TTL level logic can be applied. In that case, note the ground polarity of the trigger input lines. **Refer to model -PS power supply unit's operating guide for details.**

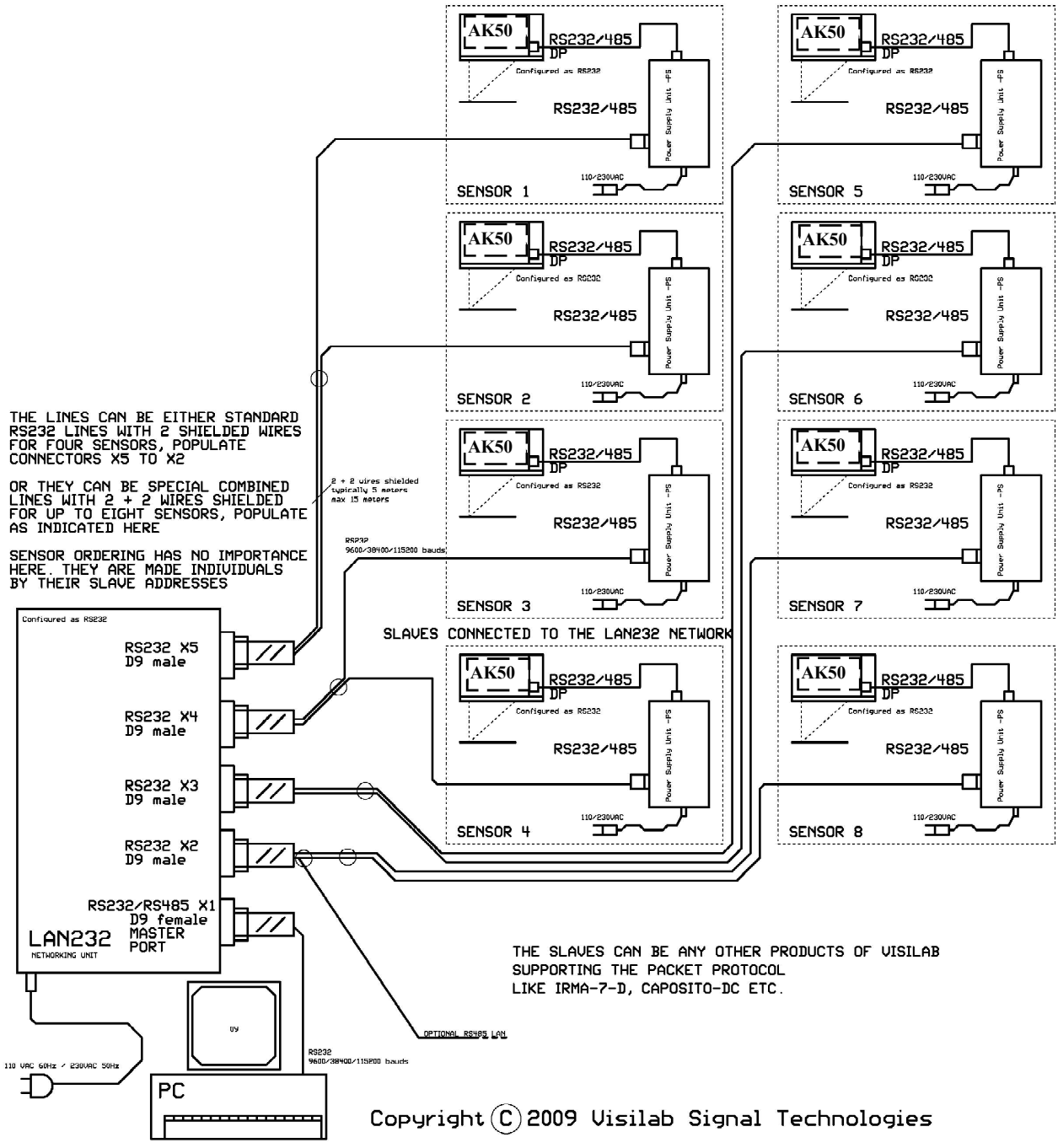


Figure 1G. Assembly of electrical cables for use with **LAN232** networking unit. Each slave is wired normally with its own distribution box. The RS232 lines are used for LAN232. The Profibus DP network can be used freely as can each voltage output and trigger line. Any of the slaves can be any product of Visilab supporting the packet protocol, like AK50, AK40 etc.

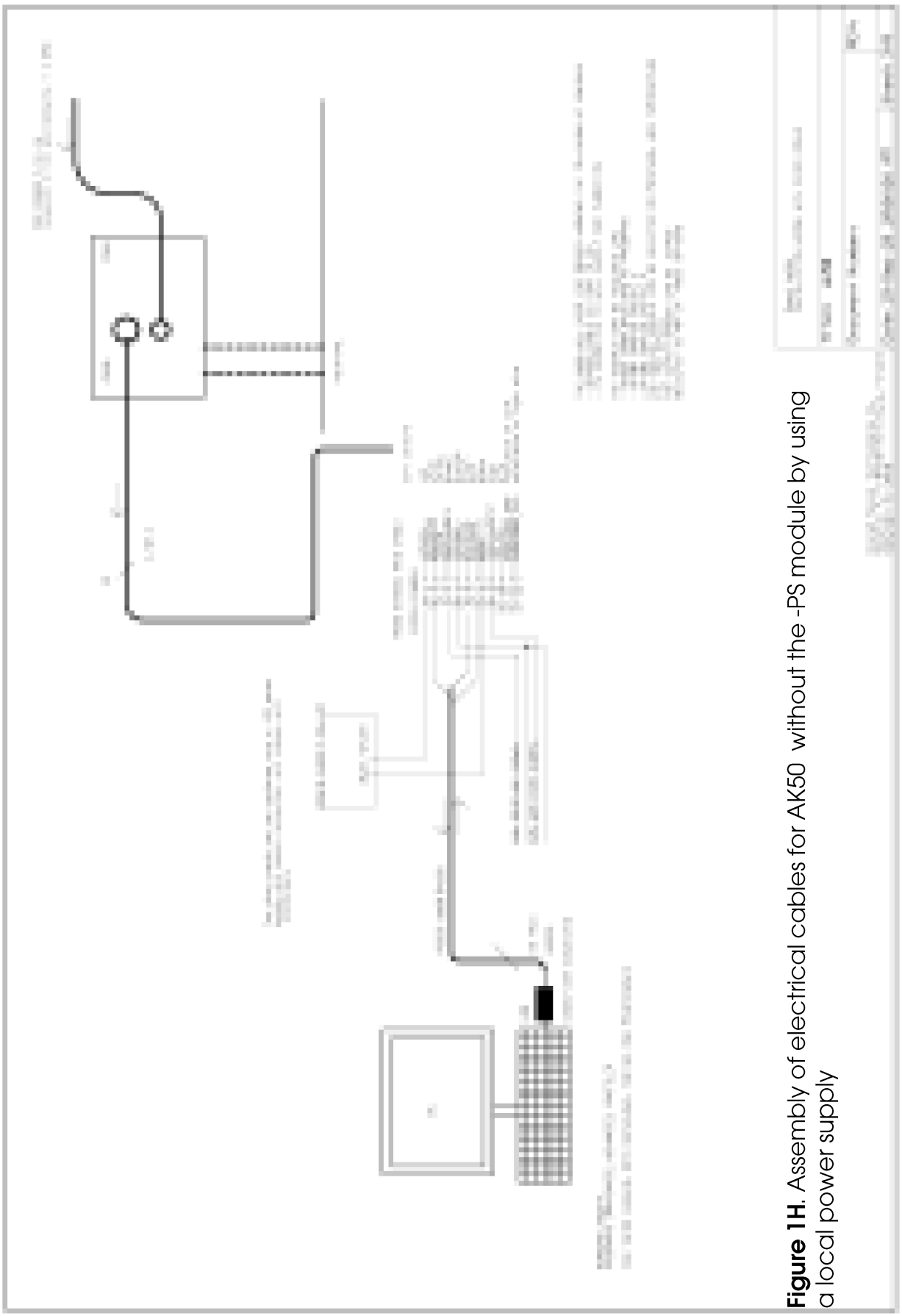


Figure 1H. Assembly of electrical cables for AK50 without the -PS module by using a local power supply

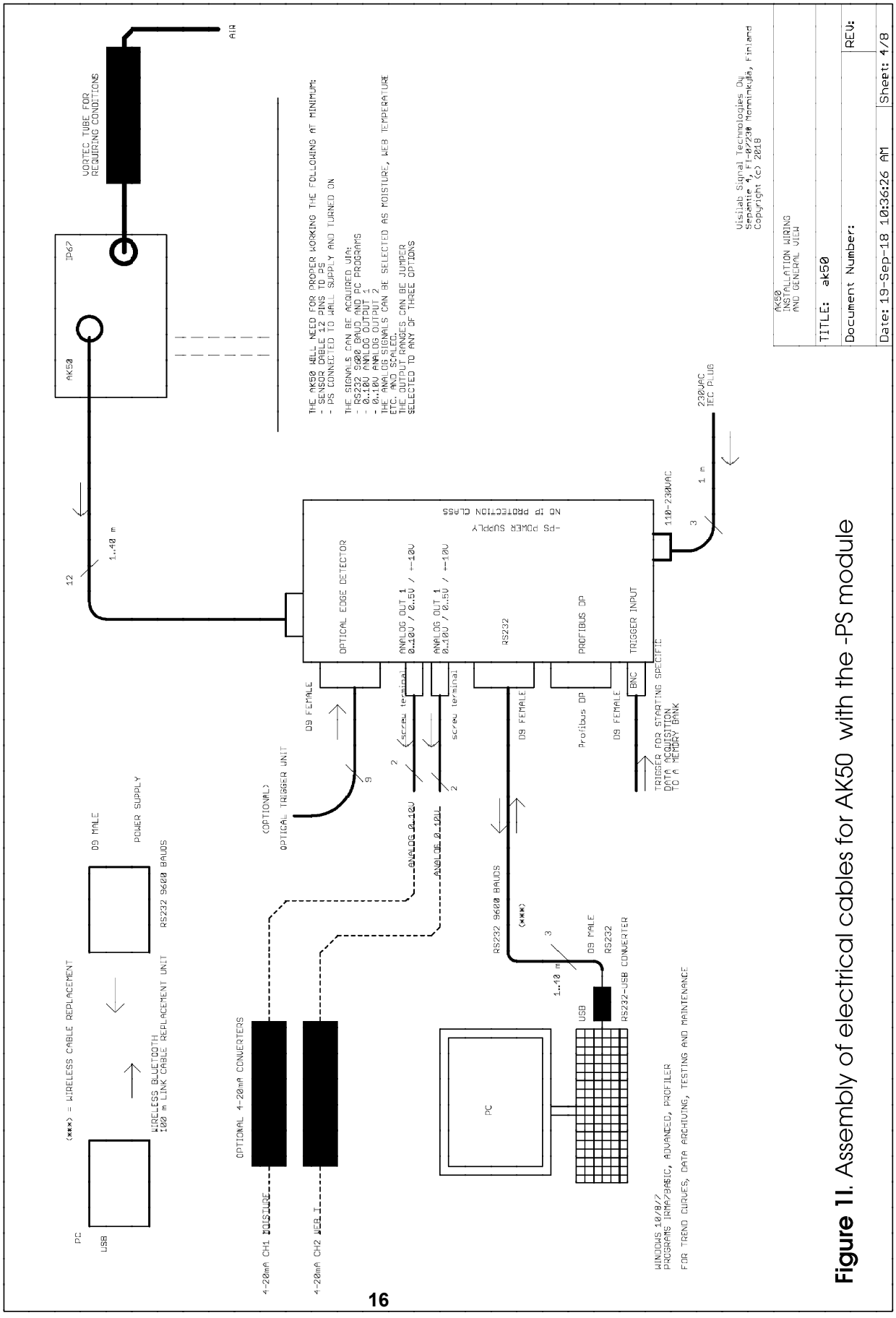


Figure 11. Assembly of electrical cables for AK50 with the -PS module

closing. Else the sealing rings, threads or contact pins may be broken down or lost. Refer to Figures 1A to 1I for various cable connections in typical applications. In practice, there are more possible combinations than these but are self-evident as all of the interfaces can be used simultaneously.

The cables are connected as follows. The big connector goes to the instrument connector and the other end of the cable is in the power supply. To separate the RS232/485 and Profibus DP cables from each other, they are marked correspondingly on the power supply panel. The box has a D9 connector for the PC serial cable and another for the Profibus DP. Note that to obtain the maximum operating speed 12 Mbauds for the Profibus, you have to provide your own Profibus DP compatible fieldbus cable for connecting ***directly*** into the instrument. The supplied cable will support operation to at least 1.5 Mbauds. Refer to the -PS User's Guide for proper locations of each connector on the panel.

The RS232 cable is connected to the -PS and its other end is plugged into your PC's serial port COM1...COM255 whichever is available either as such or via a galvanically isolated USB-RS232 adapter (delivered). It does have the connector of proper size (subD9). The power adaptor is placed to the mains connection (230 V 50 Hz or any other local standard). Turn on **AK50**. If the instrument refuses to operate, check the cables again. If you are certain that everything has been done in a correct way, contact your local representative or the factory to get some help. You can use the indicator lights on the USB-RS232 adapter to diagnose if any traffic is in the cable at all. If none, then the port you are using in the PC program is not correct or the adapter is not properly installed.

To get a better view of connecting the cables in your final process control system, we have supplied a schematic (Appendix 5.). Your control/data acquisition system may be based either on RS232/485 (a PC), Profibus DP fieldbus or standard analog voltage output. The bus lines, voltage output and trigger lines are optically isolated for safe operation in difficult conditions in industrial control systems. The connector type presently in use is **ITT Cannon Trident TNM** IP65 classified with shell size 14. The codes for the parts used are: **Standard receptacle 12 pins TNM14-12SKT STD192993-0033 TNMOS14-0012S1L, standard plug TR1412PMS1NB 192922-1270**. The pin numbering is the same as in the schematic (from 1 to 12). The socket for the receptacle is **T3P20FC1LX (crimp type) of 20 AWG** and gold plated. The corresponding pin is **T3P20MC1LX (crimp) 20 AWG** gold plated. You can use any other fully compatible parts when necessary.

Mechanical Assembly of the Meter

AK50 moisture meter is assembled in the following way for a fixed position in on-line systems. Refer to Appendix 9 for details.

Cabling

When assembling to a traverse crossing the web, you should have cables that resist repeated bending in coiling and they should be especially designed for that purpose. The cables should be resistant to the conditions prevailing at the site of assembly. If either the Profibus DP or the RS232/485 cable is not used, you can leave its connector cap closed. If pressurized air is required, use a pressure regulator and standard tubing to connect to the quick connector. The air flow should be of the order of one liter / second to keep the meter's optical surfaces dry in moist conditions. If the surrounding temperature is high (>+35C), extra air flow is recommended to keep the optical head of the instrument cool (clearly below +50C). **At high ambient temperatures (>+30C), you should use cool air flow with thermally insulated tubing for it. It is the user's responsibility to arrange proper cooling for the meter.** **The guarantee does not cover damages caused by overheating.** The recommended operating temperature would be from +25 to +35 C for best results measured (as the optical head temperature).

Anchor the electrical cables so that the connectors are not mechanically supporting them and the connectors are thus protected against repeated bending. That applies for the air tubing too. Support the air tubing along with the electrical cables if possible. **Do not apply high pressures into the air line!** The air flow resistance is low, a small pressure difference is sufficient in most cases.

Testing

For installing the PC program, refer to the PC program user's manual. Test your communication link as instructed there. After a successful test you can be assured that your **AK50** will serve you for several years with minimal service. For troubleshooting, refer to Appendix 8.

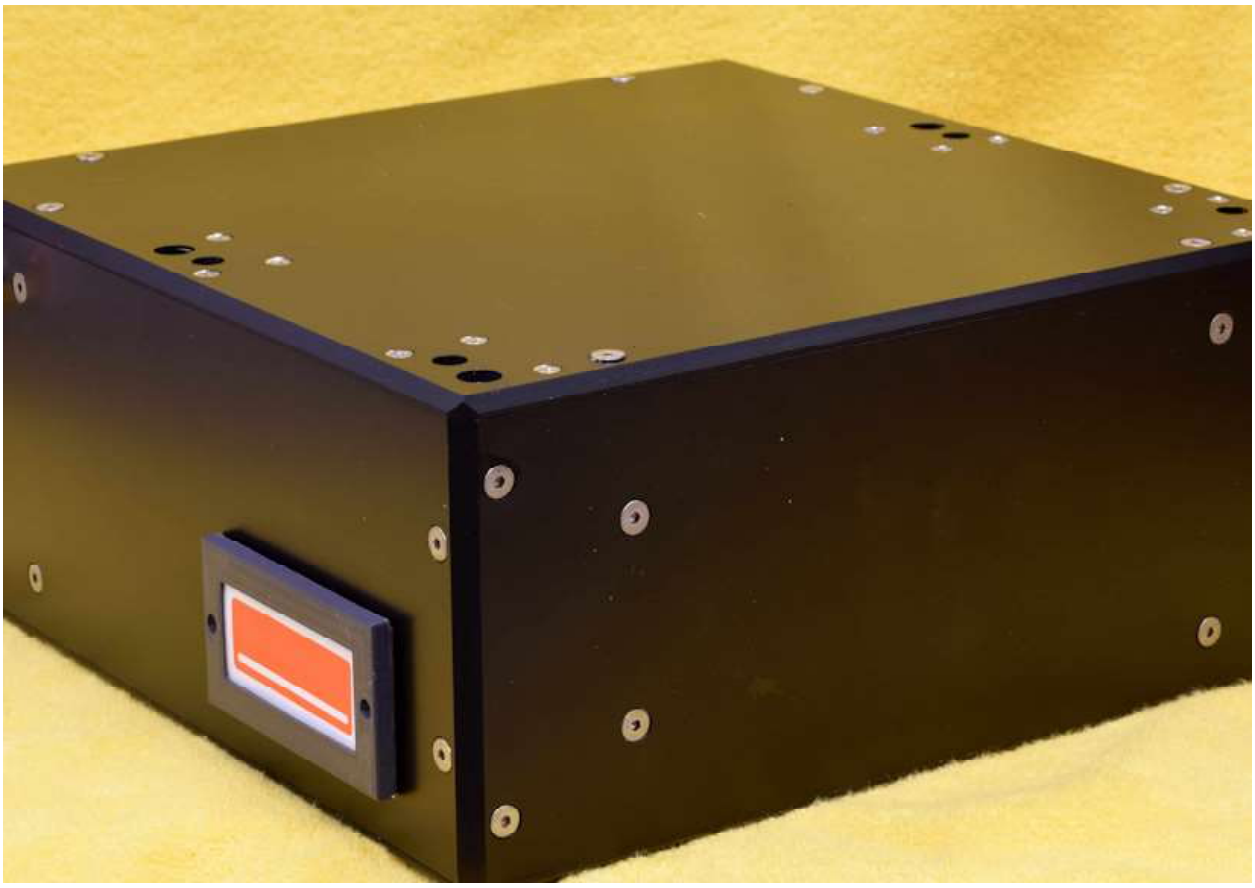


Figure 2D. Pictures of AK50

2. Basic Features of the Instrument

Result of Measurement

The moisture value the meter indicates has a unit which is either a percent relative to the total or dry weight of the material or it is the water density in the material. The practical moisture range (total percentage) is 0..70%. With some materials the range can go up to 80%. The instrument has been designed to give reliable values throughout this range. The internal noise is very low at moistures below 10% and increases somewhat at higher levels. The repeatability (depends on the model, see specifications) of the instrument is within +/-0.2% below 10% moisture. Typically it is much better. The absolute accuracy depends on the calibration for the material. The calibration generates a group of points on a balance-% vs meter signal plot. **AK50** places segments of line onto this plot from one point to another thus linearizing the original meter response curve. The sampling rate for moisture values is 100 Hz and the PC display in keyboard mode is updated about twice/s. The light source applied in the instrument has a lamp with a radiating power of the order 2 W. Of this the material under test receives typically 20 to 50 mW approximately. That does not cause any notable warming up or drying effects in most materials if they are static. No effects are detectable in moving webs.

AK50 is now available as **revision 6S. The earlier revision 5KLN** with 400 Hz sampling will be available for a short time but is considered obsolete. The latest enhanced and new features are in the following.

- **New ultrastable technology is taken into use with a new kind of optics and signal processing. It will ensure absolute stability in difficult conditions with ultralow annual drift of the moisture reading (Rev 6S and upwards)**

Other recent advances in this model (6S):

- **The internal Signal Quality variable is now available outside the meter as an analog voltage and in digital format too, both in Profibus DP and RS232. It indicates three things affecting directly to the quality of the moisture signal: Light source power output, dirty glasses, too high temperature in the optical head.**
- **There is now a Fault Diagnosis feature in the Advanced PC program checking some of the important variables in the moisture meter to decide what is wrong if anything.**
- **An extra digital filter is added to the meter and it can optionally be taken into use. It is a very slow filter useful in conveyor measurements and in paper machine measurements when the signal needs to reflect the average reading and not the momentary changes. The filter strength can also be varied.**
- **The second analog signal can now be selected as any signal: Moisture, web temperature, head temperature, Signal Quality or Extra temperature, just like the first channel does.**
- **automatic rejection of weak moisture signal in dark surface conditions or at very reflective targets. The meter offers zero as output after detecting this kind of conditions. The response time is about 50 ms and independent on the digital filter used**
- **an optional wireless connection to the meter's power supply**
- **a reduced sensitivity to angular changes of the target surface**
- **a reduced sensitivity to edges of cut material production lines**
- **a reduced noise level, especially in requiring high-speed web measurements**
- **long distance versions of the meter are now available with working distances up to 400 mm or longer**
- **an enhanced immunity against external water vapor**
- **an enhanced immunity against external infrared sources, like heaters**
- **the power supply unit -PS has a connector for a standard optical sensor for arranging a triggering to incoming product batches or edges of piecewise products**

- **the RS232/Bluetooth/RS485 supports now speeds up to 115200 bauds in addition to the earlier 9600/38400 bauds. Notice that cables over 5 m are not tolerated.**
- **an optional wireless connection to the meter's power supply using Bluetooth with up to 100 m of working range**
- **a new secure memory system protecting better the internal configuration data and parameters against shocks and external disturbances. The data is saved to a nonvolatile memory and read at bootup. The original data is not used except when someone wants to change a setting. The changes can be made preferrably from the PC programs at highest level. One may do them in the Keyboard mode in text format but needs to pay attention to the remarks in the section 3.4.**
- **status flags are added for monitoring both the meter and the web, like a web break indicator which also has an optional indicator light on the front panel in addition to the status bits available via digital interfaces.**
- **the optical head's sensitive parts are all enclosed into a hermetically sealed container to prevent any effects of water or dust contamination**
- **the PC program is called IRMA7Basic. It operates in Windows 10/8/7 and future versions. It has a great number of features just like the older software did. The program Advanced is an extended version it supporting the use of several meters at the same time. It has also other interesting and useful special features.**

Please note that the manufacturer reserves all rights to change specifications without advance notification and to make manufacturing and design choices for each unit delivered in order to offer the best possible meter for each application. The current specifications will be given to the buyer.

Operating Characteristics

AK50 is equipped with a keyboard and display simulating software for any standard PC for portable field use. With them the user can e.g. modify instrument settings and acquire data. The latest moisture value is updated on the display when in the measuring state without extra operations. The instrument has five sample memories (memory banks) which may contain up to 4096 + 4096 samples. The autotimer may fill this memory at user's control and may operate at any sampling interval between 14 ms and 32000 s. The autotimer can also operate in Batch mode to collect only a predetermined number of samples into one Batch. The Batch sampling can be repeated at will. Single moisture samples are saved into the data series by pressing the key "s" (in Keyboard mode. It is the key "t" in the graphic mode). There is an electrical trigger line for sending a starting command (a falling voltage edge) for the autotimer (see Appendix 5.). The Autotimer has an indicator light on the meter's panel being lit when it is on for easy visual synchronization of measurements.

The collected data series can be uploaded to a PC or it can be browsed in the meter. Also statistics can be calculated easily. Nonvolatile memory is used for saving all settings and the data series independent of disconnecting the power. The material under test can be quickly selected from a calibration library of up to 100 materials. The calibration table is then immediately in use.

The data series can be managed with the memory banks as either a long contiguous Series (4096 points max.) or as four smaller (1024 points max.). All the banks are completely independent of each other. Statistics calculation and e.g. the data transfer of series is handled completely within one bank at a time without affecting the others.

For field operation, there is a web temperature autotimer available. It has a fixed 1 second interval and it uses its own memory bank of 1024 points maximum. Its statistics can be evaluated afterwards and the data series collected can be copied to the regular Bank4 for further processing in PC. Refer to Fig. 3 for a sketch of the data flow in the moisture meter.

There is a Low Power Mode available while the mill has a service or vacation period. The meter quickly recovers from it and one is able to measure again. Actually, one can execute sampling in Low Power Mode also. Then **AK50** takes itself care of restoring to normal measuring mode and taking the sample. The meter remains in the normal mode thereafter. The Low Power Mode is intended to be used while setting up measurements or while transferring data in field conditions and no actual measuring is required in the background. Using Low Power Mode will make transfer of libraries and data series faster.

A web break algorithm is added to the meter to decide whether a web break has happened. The meter may sometimes see only a black web (=no web) or a very glossy reflective web (=a cylinder). That is interpreted after a while to be a broken web condition and is indicated with a light on the meter's panel. Also, there is a status bit for this event for the digital interfaces. If the gain is locked and the signal is driven to either of the extremes, that is indicated as a suspected web break. If the condition stays, one can suspect a web break. The web break suspicion has its own status bit in the status byte (see the Profibus DP interface). When the gain locking is not used and the web break is indicated, it is almost certain, that a condition equal to a real web break has happened. The indicator light is **continuously on** when a web break is detected. When a break is suspected, it is **blinking with a fast rate** which may change by time. The overheating alarm detection has a status bit also (refer to Profibus DP manual). When overheating is detected, the meter is shut down by putting it into Low Power mode in order to get additional protection. The alarm status bit is set and it remains until it is explicitly cleared. The autotimer ON light is lit until the alarm has been cleared. That can be done by either visiting and leaving the menu once or via the PC program (Status page).

An external standardization method is available if any long-term drift is suspected. **AK50** moisture meters are unique in their long-term stability. However, to avoid any possibility of drifting of readings, the standardization will compensate it completely. Naturally, that requires some kind of stable moisture standard. Visilab can deliver moisture standard samples enclosed between glass plates. The usual reason for drifting despite of the internal standardization is accumulation of dirt on windows. Cleaning them regularly, when using the meter in spattering and moist conditions, is usually quite sufficient and no external standardization is required. **Also the use of proper purge is recommended.**

The instrument is made to withstand harsh environments. Reliability in that sense means both mechanical and electrical endurance and repeatability of the obtained moisture information. The whole instrument is protected according to **IP65** withstanding dust and water splashes (with the air outlets excluded). The optional nose box is an integral steam shield for flushing the optical surfaces to keep them clean and to prevent water condensation. Water droplets or heavy paper dust may otherwise affect moisture readings. Thus regular checking of the optical surfaces is required in difficult conditions when a new system is assembled in order to learn its future behavior.

There is now a meter configuration saving and restoring capability which is described in the PC program manual. The purpose is to read the meter's internal settings and save them to a file for future use. If the meter gets damaged for some reason and it is taken into use afterwards, it may be required to restore the original configuration. Especially, if the factory settings have to be made (in 5=Service menu), it is required to do this. The configuration should be read and saved maybe once per year and the resulting file should be archived. The file name is formed by the serial number of the meter which is always unique (NNNNN.CFG). The saving is especially required **after** the meter has been in a service or its internal software has been upgraded at the manufacturer or its representative. The set of data to be saved may have been extended between the software versions and restoring an old set of data may be insufficient for full configuration. After restoration, always check all possible settings of the meter, including the calibration library, that they are correct. Avoid unnecessary configuration restoration!

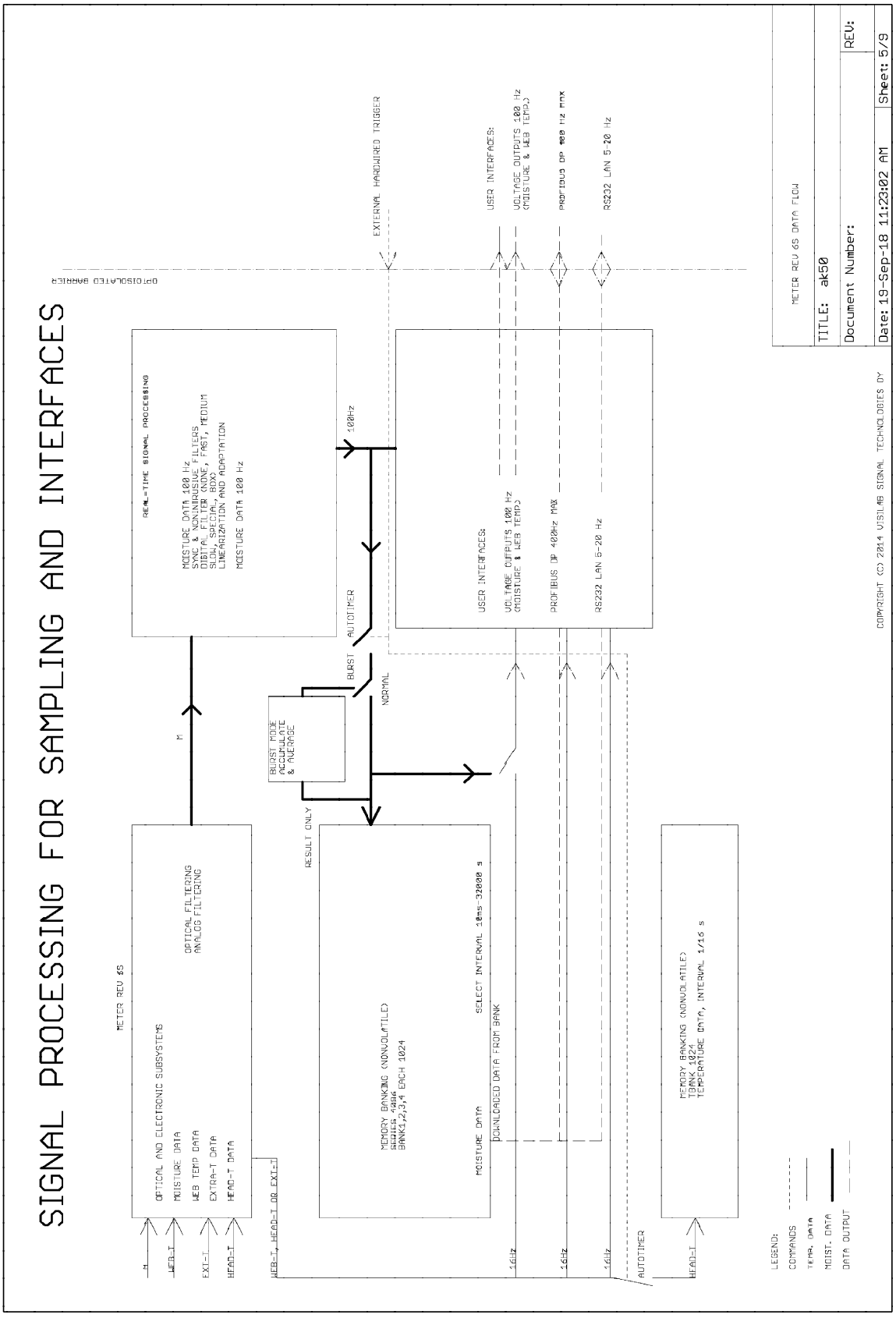


Figure 3. Data flow in AK50

Calibration and Material Libraries

The calibration library in the instrument offers calibration information for some materials in paper and board industry. Each material holds a unique position among the 100 different materials. One can further develop and complete the library with **AK50** and save them to a PC. Correspondingly, one can also transfer from a PC any library to **AK50**. It is also possible to move particular material calibration tables into any direction to tailor a special library.

AK50 moisture meters are manufactured according to small tolerances. The units are similar to each other and they are finally adjusted to be as close to each other as possible. This means that the meters of model A, E and D are similar to each other within the model. Also the different models are very similar to each other. However, the models are similar only in general and there may be significant differences in some materials. That is due to the fact that the optical principle (light path) is different in the models. The libraries are compatible within the model and can be transferred to other units of same model in your company. The library tolerance is typically better than +/-2.0% in the 0...10% range. The libraries are usually not valid for higher moistures. Best results are obtained with calibrations made particularly for your special materials.

AK50 can be calibrated in the same conditions and with the same equipment as you have used earlier for the same purpose. The minimal requirements for calibration are a balance and some method for drying the material and determining the dry weight. A climatic chamber with controllable relative humidity and perhaps controllable temperature is excellent for more exacting work. That will also increase accuracy and diminish deviations. The surface moisture varies in many substances due to factors like air flows, temperature differences and external relative humidity. In extremely accurate calibrations, also effects of static electricity (effective at the dry end) and water condensation (at the wet end) must be taken into account, that is, prevented.

Using up to 10 calibration points will ensure good accuracy on a larger moisture range if the points are selected carefully. This is called **MULTI** calibration. The number of calibration points is a flexible quantity. There is also a fast two-point calibration which is typically valid for a limited moisture range. The **SCALE** calibration can be applied as well for transferring raw (nonlinear) moisture signal to PC. Note that **AK50** is not able to reverse the linearization process to gain the original nonlinearized signal. If the nonlinearized raw signal is required, it must be collected separately in the **SCALE** mode.

AK50 can be connected to a PC by using the standard serial port RS232 (or via the supplied RS232-USB converter). One is then able to modify most of the meter's settings and download to a PC the data series which is collected earlier. The data can be further handled with the program following the instrument or can be saved into files for post-processing. Then the data can be more extensively manipulated with e.g. spreadsheet programs. Also a real-time trend display and frequency analysis are available.

For on-line applications the meter can be assembled over the production line in a fixed position or into a traversing mechanism. This model is intended for continuous use of at least 175 000 hours. That would give a theoretical continuous service interval of about twenty years. Moisture data acquisition can be done with a PC through the serial port RS232 or RS485 for a local area network specially tailor-made for you. The latter can be taken into use by setting a few jumpers in the meter. It offers a long distance operation (up to 1200 meters). It is possible to build a network of **AK50**'s each having different node address with just a single twisted-pair wire. However, the MASTER node must be capable of collecting data from each unit. The manufacturer may build such a system as specified according to the customers needs. The standard program is able to handle one unit only. The packet protocol used in data transfer is a private, very reliable, fault tolerant and fast. Some details of it are listed in Appendix 3. More data can be acquired from the manufacturer.

You can also integrate your **AK50** moisture meter into an existing process control system by using the voltage output line. Its output signal is 0...100 % of moisture and corresponds to the output voltage range (0...+10 V, +/-5 V or 0...+5 V). The output signal can be scaled with a multiplying factor. It is set in one of the internal menus of the meter, accessible also with the PC programs. The output voltage can be selected to be the web temperature instead of the moisture with similar scaling properties (plus other signal options).

The third alternative is to use the Profibus DP for acquiring moisture and temperature data from the meter. Refer to the Profibus DP user's manual for more details. The temperature refers only the optical head internal temperature. It is available to prevent using the meter in too high temperatures (> +50 C). Damage to the sensitive optical components will result if the temperature limit is exceeded. External cooling by pressurized air is then required.

The fourth alternative for controlling the meter and acquiring data is to use display units made by Visilab, model **TEA-K30**. It has a keyboard and a display for using the meter in the Keyboard mode alone. It is connected to the power supply's own ITT Cannon connector and RS232/485 D9 connector which is normally used for the PC. Refer to its own user's guide for details.

Another possibility for extending data collection capabilities is to use the **LAN232** unit for managing more than one meter at a time.

Contact Visilab for more information, pricing and availability. Visilab may also have other new interesting products.

3. Use of the Instrument

Menus and Settings

Next we will go through all settings and options of the moisture meter accessible through menus in the PC program keyboard mode. Refer to the PC program user's manual for basics of the program features. If it is not available, start the program with a command **IRMA7Basic,** and after selecting the Keyboard page, press the **Enter Keyboard** button.. We assume here that the software has already been installed and tested carefully.

In the following we are using the PC program in the Keyboard mode. All text displays refer to the text appearing on the PC screen. Press the button Enter Keyboard mode to go to the keyboard mode.

When booting or starting your **moisture meter,** it shows momentarily the unit serial number and the reading of its usage hour meter. If the amount of active use exceeds the service period, there will be a short message indicating to user that it is time to make an appointment with the service. After the specified service interval a few wearing parts are replaced and some readjustments are done. While booting up, the display shows a text message. Then it is always in the measuring state which is always the default state.

Use *always small letters* as commands in the keyboard mode menu system! Using capitals will cause invalid actions.

AN IMPORTANT NOTICE:

The moisture meter works in two different modes. The first one is the **keyboard mode** and the other one is the **packet protocol mode**. The moisture meter is in a bootup state for the first 15 - 20 s after connecting the power, listening to any messages on the RS232/485 line. If any key is pressed or a data packet is sent to the meter during that time, *the meter will stay in keyboard mode permanently.* If no messages are received within that time, it will go into the mode it was last time in. The mode itself does not affect its normal operation. It can acquire moisture data in the same way in both modes into data series and serve the Profibus DP. The meter will automatically move to packet mode if any strange characters are received.

You can always change the mode at will with the PC program. If the meter is in keyboard mode but your PC program is working in the standard graphical environment (packet protocol mode), communication errors will result but only temporarily. You may go to the keyboard mode first and then return back to the packet protocol mode (press the button Exit Keyboard mode) in order to operate it correctly. The meter will change the mode itself after receiving any characters which do not belong to those which are normally used in keyboard mode (visible text). In the opposite case, your program operates in keyboard mode and the meter uses the packet protocol. The result will be sluggish operation and no sensible responses on the text screen. In that case, just press the Exit Keyboard mode button to return to packet protocol. **You can always restore the proper mode by Entering and Exiting the Keyboard mode.**

The purpose of this arrangement is to provide the user the possibility of setting up various parameters in the meter directly. As the program communicates with a packet protocol to the meter while in the graphical environment, there might be a possibility of making the system locked without any reasonable way to recover. That could happen, if someone changed the default slave address from 1 to something else. Then the master (PC) is not able to communicate with it as it assumes the address to be 1. Thus it is not able to command the slave to switch to keyboard mode either. Another advantage of the keyboard mode is that any terminal program capable of ANSI text features (almost

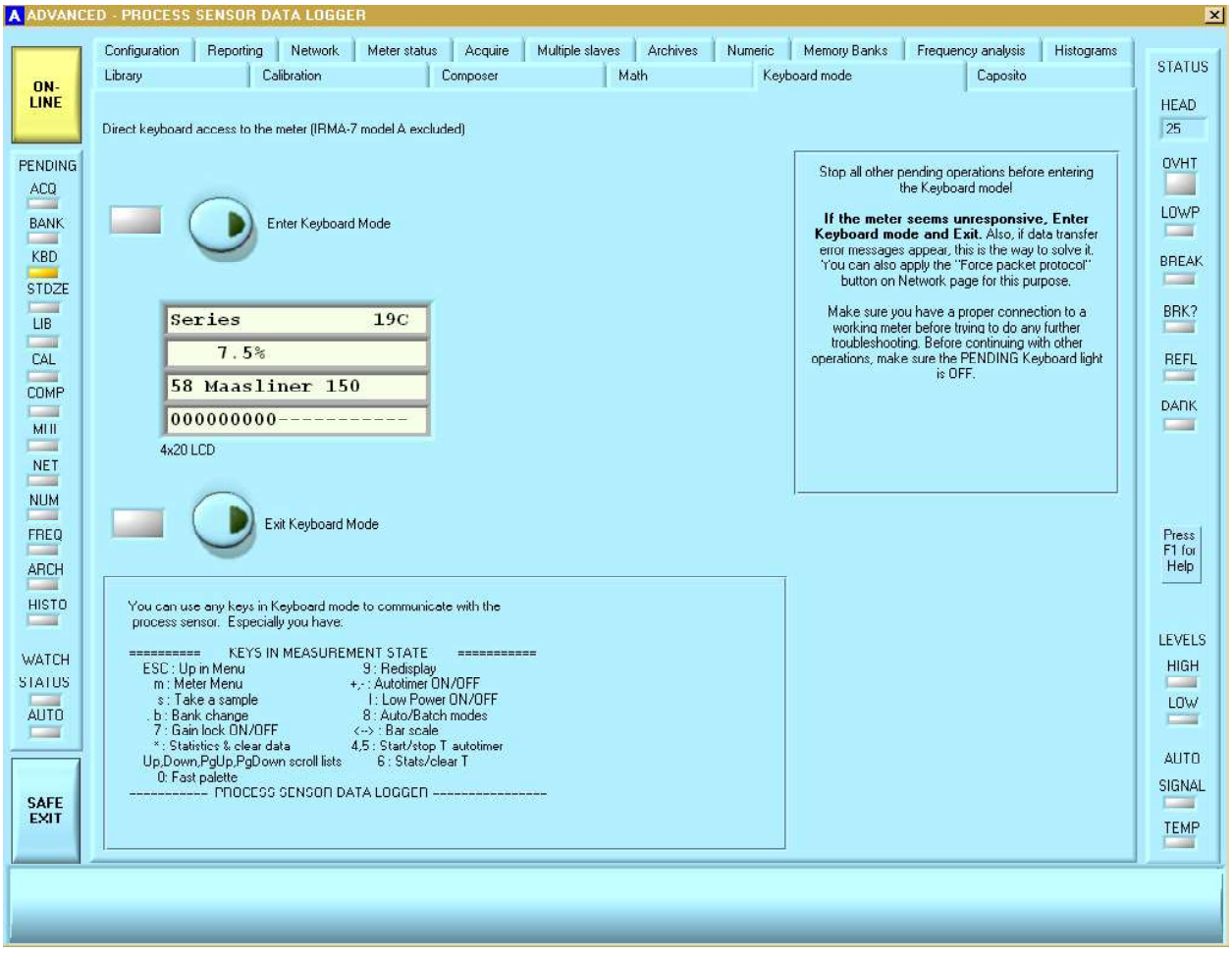
all of them are) is sufficient for operating the keyboard mode. The Keyboard mode menu system is in the meter itself, not in the PC program which in Keyboard mode operates as a dummy terminal.

Clearly, some sort of life buoy is needed. Now you can go to the keyboard mode, turn the power off/on in the meter to force it to boot up. Go into the menu system by pressing "m" and change the packet protocol address back to 1 (in menu option "8"). The slave addresses will be different from that if you have more than one moisture meter connected into a local area network based on RS485.

The discussion above does not apply to the Profibus DP fieldbus which has a separate and completely independent message handling software and interfaces. Refer to the Profibus DP User's Manual. The fieldbus protocol is always available after the meter has booted up and assumning the DP cable is connected to the master.

The meter is ready for measuring with a relatively good accuracy. Best accuracy is reached after about 10 minutes. The error at cold start is usually much less than +/-0.3% in moisture.

The measuring state may look like the following:



By using a PC we can always ask for a moisture value even if the meter is not in the measuring state. The moisture is always measured in the background independent of the visible state but the values are displayed only in the measuring state. When one uses the menu system, the measuring state is not active anymore until you return back to it. There are, however, some things which make the measuring state special. When the most accurate moisture values are required, one should operate in the measuring state.

In the measuring state are displayed the name of the calibration table in use, the calibration mode (MULTI/SCALE), the moisture value in user-selectable units and the bar display. If one takes samples to the data series with the Sample key, there will be also indicated the current sample number on the display's right edge. When the autotimer is active, there is also a text "auto" on the first line (or "Batch" if the Batch mode is in use).

We can get to the menus by pressing the "m" key. The following display is then shown (main menu). All other menus branch from this. Note that this menu system is in the **AK50** own internal software, not in the PC program. Thus you can use any ANSI text terminal program in your PC to get the same functionality. In the following we will discuss each of the menu options.

```
      1=Series   2=Calibr.                Main menu
      3=Mater.  4=Profibus
      5=Service 6=LPF:MEDM
      7=Unit       8=Comm's
or
      9=COMPOSER
```

Before we start investigating the use and meaning of each submenu, we must tell you the way out of the menus back to the measuring state. *Anytime you wish, you can press the ESC key to return to higher menu levels.* ***Press the ESC key as many times as is necessary. When you wish to return to the graphical environment of the PC program (= packet protocol), press the Exit Keyboard button.***

3.1. Data Series

The data series offers the user a way to save measured moisture samples. The series stays in the memory even when the meter power is turned off. New samples are added always contiguously after the last sample. The series can be examined later, either in the instrument or on a PC display as a curve. The values can be browsed on the unit's display, statistics can be calculated and the series can be cleared. In a PC the displayed curve can be printed on paper. Also statistics can be calculated. Samples can be added to a series in four different ways (in keyboard mode):

1. **By pressing the "s" key**
2. **By starting the autotimer ("+" key), the series is augmented with one sample at regular intervals in Normal mode, in Batch mode the number of samples is limited by a preset value**
3. **By applying the trigger input line (TTL-level, active-low) with a similar effect as by pressing the "+" key. The line is falling edge sensitive. The smallest number of samples in Batch mode is one.**
4. **By pressing either the "T" or "t" keys on the PC keyboard in graphical environment (packet protocol mode)**

There may be a maximum of 4096 samples in the series. If more samples are taken, the first and oldest samples are overwritten, i.e. the sample counter starts again from one and approaches the end. In that case the number of samples stays at 4096.

The handling of series is done in Series menu and one can get there by pressing "1". The next display is typical after that.

```
Series 1024 samples
1=Manage 8=Burst:OFF
4=Auto:OFF 6=Batch
5=Intvl   0.0025s
```

The first line shows the number of samples in the series and below it are the keys explained which lead to the corresponding operations. Also, the "s" key is now active for adding new samples. You can switch the memory bank by pressing "b" or ".". By pressing "1" you enter the series managing menus which will have more features available than in this menu (see a few paragraphs later, **Manage menu**).

The autotimer is started with a press of "4". Samples are then collected with a rate shown on the display at line four. If you wish to set the sampling interval first before starting the autotimer, press "5". Then the interval is edited with a resolution of 0.0025 s. The shortest time is 0.0025 s and the longest is 36000 s (=10 hours). Note that the autotimer is able to operate even when in Low Power mode. The meter is then put to normal mode to make the measurement. While the autotimer is active (ON) the sample count will flash and it will be updated.

By pressing "6" you can select between the Normal and Batch modes. If you select the Batch mode, you are asked of the Batch size. You can enter a value between 0 and 9999. The Normal mode is a sequential sampling mode where sampling continues until the autotimer is explicitly stopped. The Batch mode takes only the preset number of samples and then stops the autotimer. Note that if the trigger line is activated in Batch mode, the autotimer is started just as the "+" was pressed.

Memory Banks

In Addition to the regular long (4096 samples max.) data series one can use one of four shorter (1024 samples max.) memory banks. They are all completely independent of each other. When you clear the regular long data series, the data of the smaller banks are not cleared and vice versa.

This feature facilitates moisture data acquisition in those cases where one has to measure a few material grades or different production machine settings at one occasion. Then you can assign a bank for each grade or setting and perform the measurements without any fear that the values might interfere. 1024 samples is usually enough for autotimer measurements with the slower speeds (interval = 20 ms and up) offering several seconds for measuring continuously.

You can select the bank either in the measuring state or in the "Series" menu by pressing the "."-key or "b" repeatedly until you see the correct bank indicated on the display. The bank name is either "Series", "Bank1", "Bank2", "Bank3" or "Bank4". Each of the Banks behaves as if it were a regular data series but only shorter. While working with a certain bank you can add samples with any of the numerous ways, calculate statistics, move the series to a PC or clear the series. You can always select another bank and start working there. No values in other banks are affected. Selecting another bank does not harm the data either. The data is retained also when you turn off the instrument.

Burst Mode

There is a special operating mode in addition to the regular memory banking. It is targeted to piecewise production lines. It is able to collect samples from the web at a predefined rate after receiving an external trigger or a software command (to start the Autotimer). It does not save the

data but calculates the average of them and puts the result to the current memory bank. The same data is also held constantly for all interfaces as the current moisture signal. In this way, one can measure a web consisting of pieces or sheets and the meter samples each sheet along the whole of its length. The result is shown of the last sheet until the next sheet has been measured. No gaps are measured and thus the signal is clean consisting only of a stepwise changing continuous curve. The machine operator can always check the latest reading and the history stays in the memory bank until it is filled and overrun from the beginning. The bank can be downloaded normally at any time. Also the voltage output displays the same reading. This mode has several special uses as you will soon realize.

This mode **overrides** the normal use of the Autotimer and banks, of course. If normal use of the banks is required, turn the mode to OFF by toggling the key "8". When set to ON, you will be asked of the Burst size. It means the number of samples to be taken for the average. Note that the time interval in sampling is the same as set for the Autotimer. The selection of Batch/Normal has no meaning when using the Burst mode.

To operate this mode in practice, one probably needs an optical sensor for detecting the front edge of the sheet. Purchase a type suitable for the application (distance, sensitivity, polarity etc.). Its output should be compatible with the TTL trigger input (5V logic, falling edge sensitive). Do not apply high voltages to this input! Consult your local technical personnel, your local dealer or Visilab for technical details. The Burst count should be as large as possible (the range is 1 to 32000) to get a good representative reading from the average. It should be less than its length in time:

Tburst = Tinterval * Burst_count < Sheet length min. / web speed max.

Else, the sampling will continue even after the sheet has passed the meter and you will get the nonsense values from the gap weighing the average in very unexpected ways. A simple way of finding out the number of samples for the Burst count, set the Autotimer for shortest interval and use the Series bank. Place the meter over the web and trigger the Autotimer for sampling just before a sheet comes under the meter. Download the data and investigate the pattern you have got. The sensible data part between the gap values form the actual representative part and the number of samples in it is actually close to the Burst count. You will notice at this time, that it is best to set the digital filter to MEDIUM, FAST or NONE setting before getting good results. Else, the response time of the meter is too slow causing very skewed skirts for the sensible part of the signal. Try to use as powerful filter as is possible without losing too much valuable signal points and the edges. Now you can set the number for the Burst count in "8". Install the optical sensor and adjust its position so that the sampling starts at a correct position. By increasing the Burst count you will eventually get too many samples from the back edge and need to reduce it. Take into consideration the maximum web speed and the minimum sheet length you may have to measure with this arrangement and adjust the Burst count accordingly to have a safety margin. It is better to have too little samples than too many samples to avoid the edge.

There is an item counter involved with the burst mode. It is a byproduct of the mode and it can be used as a totalizer of items detected. Its numeric range is goes up to two billions. Its value can be read with the **Advanced** program but not with the **IRMA7Basic** program. You can also clear this counter when required. Its reading can be made visible on the Numeric page in **Advanced**. The item counter can be cleared in the menu above just after setting the Burst mode on and its count.

3.1.2. Manage Menu

In this menu you can do a few operations to the data series. It opens up like in the following:

```
Data series:
1=List 2=Stats 3=Clr
```

By pressing "1" you can list the series samples. **AK50** asks first for the number of the sample where the listing should be started. This makes it quicker to move to the intended sample when thousands of samples are collected. By pressing "2" you will get the series statistics. After calculations the display will look like this:

```
  4.4min    4.6max
    4.6123avg
    0.0842stddev
333333333----------
```

The first line expresses the observed minimum and maximum values. The second line shows the average value, the third line shows the standard deviation and the fourth line has the bar display. The unit is not shown in this display. Press any key to continue from this display.

To clear the data series press "3" in the series menu. The series (=current bank) loses all its data and this operation is not reversible.

The operations in this menu (1=List, 2=Statistics, 3=Clear) have been made to be active in the upper Series menu also. They are not mentioned in that menu's text at all but you just have to know it to use this feature. Else, you have to go the **Manage** menu. The purpose is, of course, to make life easier while handling data series repeatedly.

Typing in Data

It is time we shortly go through the steps of how to type in and edit data fields. The text cursor blinks usually at the least significant figure. A number key pressed leaves the corresponding number on that place and moves the cursor one place to the right. To reach the other numbers on the same line one can also use the arrow keys to the left or right for stepping one number at a time. When the number is correct, you press the Enter key. Also the "." key can be used for accepting a number field. When the value to be edited consists of whole and fractional parts, you can get to the fractional part by pressing either the "." key, the arrow to the right key or the Enter key. The whole and fractional parts are thus edited separately and the field lengths are fixed. The ESC key can be used to accept the number field. If there is a fractional part, it is then accepted as such.

While browsing, each sample has its number at the left edge. Browsing is done by pressing the arrow keys up or down. Then one moves the cursor to a different sample line with either a smaller or larger number. You can also delete samples from the series by pressing the DEL key. It removes the sample under the cursor and shifts the rest of the series to fill the gap. If available in your keypad, the **PgDn** and **PgUp** keys will move the list forward or backward four lines at a time. If one continues pressing any of the these keys the series is folded back either to the start or to the end of the series. To quit browsing the data series, press either the ESC or the Enter key.

3.2. Calibration menu

One can go to the calibration operations from the main menu by pressing "2". There will be shown the following menu:

```
1=SCALE calibr. 2pts
7=MULTIpoint calibr.
3=Use:MULTI 4=Adjust
5=Vscale 6=Std-ize
```

From here one branches with either a "1" to a two-point calibration (SCALE) or with a "7" to standard multipoint calibration (MULTI). The SCALE calibration is the same for all materials as there is only one of it. When a material is calibrated and one wishes to use the corresponding table, one presses "3" in this menu to change its calibration mode. The calibration mode can be toggled back and forth at will. A whole table can be shifted in moisture scale in operation "4". The output voltage can be scaled for special purposes in '5'. The standardization menu open up in '6'.

General Information about Calibration

In most on-line systems with a moving web it is quite sufficient having a two-point SCALE calibration as long as the moisture does not change too much in normal operating conditions. Then, the calibration can be done quickly on-site. The MULTI calibration is used mainly for highly accurate measurements or for those cases where the web moisture is able to change in large scale.

To achieve the most accurate results in calibration the sample should be saturated and measured in a controlled climate where one can rely on the fact that the surface moisture is the same as the total moisture. This is one of the important things you, as the expert of your trade and special materials, must solve. You should also be aware of the inaccuracies resulting from different measurement conditions.

The inaccuracies in calibration come mainly from two sources, the moisture nonlinearity with the signal and the difference between the assumed total moisture and measured surface moisture. The nonlinearity can be observed after taking several measurements in a climatic chamber and by reading the balance at the same time. The dry weight should be determined with an oven. The drying should be executed at a proper temperature determined by standards or experience avoiding browning or melting of the material and evaporation of solvents or other components.

To minimize differences between total and surface moistures, the samples should be saturated at constant conditions for an extended time to make sure that these two moistures are equivalent. Some materials require longer times than average to settle and the suitable times are learned by experience. For that purpose, you should dismantle the meter from its location and place it into a climatic chamber. The electrical wires should be connected as well. If high relative humidities are used in the chamber, then also a small dry air flow would be needed for the meter. That will keep the sensitive electronics dry. Also the air inlet should be closed. However, care should be exercised as the meter may eventually overheat if there is no way for the heat to escape. Use the meter only in short intervals (< 60 min).

The simplest way to know when a sample has reached the equilibrium moisture is to measure the moisture with **AK50** at regular intervals when the chamber temperature and moisture are held constant. When the sample moisture signal has not changed for a few intervals it is close to equilibrium. However, note that there are materials which saturate slowly. It may take hours or even days for them to settle into a new level. Patience is the best friend in calibration. Large samples may bring another factor affecting calibration accuracy. Some parts of the sample may be at different moisture levels, i.e. the sample moisture is not even. That happens easily with sheetlike products. The moisture differences can be eliminated by careful climatization in a chamber. There should be fans mixing the air around the sample to make the surroundings isotropic.

The meter's response curve can be determined by taking several points both from the balance and **AK50**. The values can be copied to some spreadsheet program to visualize the curve.

SCALE Calibration or Scaling

The SCALE calibration is intended for calibration on the running process where there are no equipment available and there may be only two different moisture samples at hand. Another important application for it is to scale the nonlinearized raw moisture signal to transfer it to a PC or to read it on the meter's display while calibrating in a climatic chamber. Scaling the signal up will give more significant figures instead of the default four decimals. The two-point calibration does not linearize any curve, it just fits in a line through two points on the curve. On the contrary, it presumes that the curve is linear enough within the usable moisture interval that it can be approximated with a line. Refer to Fig. 3. There a line goes through two circled points. That line should give an approximation to the curve with an error which can be directly read from the curve's nonlinearity. The SCALE calibration could in this case be valid with a reasonable accuracy within the range 4 to 11%. Outside this range the moisture values follow naturally the same line.

You need two samples with different and known moistures to do the SCALE calibration. It should be executed as quickly as possible after original determination of the sample moistures. The samples' moistures change, sometimes even rapidly, in free air and slowly in plastic bags.

To aid in estimating the required moisture values to make proper calibration, it is useful to know the following. Most ordinary papers and boards and wood samples also, behave quite linearly in two steps. The first linear region is from 0 to 2...4% and the second from there upwards. The 2 to 4% region has a simple round curve. There may be exceptions of this if e.g. the coating may affect. For instance, we have a paper behaving according to the model above and our required moisture range for operation is 4 to 12%. The proper moisture sample values could be e.g. at 5% and at 10% with a reasonable accuracy. To use the meter at lower moisture values (below 4%) would lead to an increased error due to nonlinearity in SCALE mode.

You can go to the SCALE calibration submenu by pressing "1". The following menu will then be displayed.

```
SCALE calibr. 2 pts
1=Low 2=High
3=A 4=B 5=Calc
    0.9012signal
```

The lowest line has a fresh reading of the nonlinearized moisture signal with five significant digits. You can observe the changing reading while calibrating, especially after a new sample has been put under the meter. One should then not immediately execute calibration but wait until the original transient is extinguished and the reading is stable. The instrument response time consists of the rise time. If the surface lightness changes too much, it may cause signal distortion. Usually, this does not happen. Note that with thin paper grades (thickness less than 130 to 200 μm) will also the paper under the topmost paper be visible as in the form of increased moisture. With such a materials it is best to start the calibration by putting one paper on a metal plate and to measure on it, if working in laboratory conditions. When the signal level has been adjusted go to the calibration menu and remove the paper. Now you can start calibrating with the proper signal level and be certain that other materials containing water will not interfere. Most materials do not affect under the paper as long as they do not contain water. E.g. a 80 g/m2 white paper is still rather transparent and two papers stacked on top of another will affect the moisture reading. Usually, a third paper has no effect anymore.

Execution of SCALE Calibration / Scaling

1. **Put the sample with *lower* moisture under the meter optical head, wait for a moment and press "1". The meter fetches the current moisture signal reading and asks the user for the corresponding moisture level. Type in the value and press Enter.**

2. **Put the sample with *higher* moisture under measurement and press "2". Respond with the proper moisture value.**

3. **Press "5" to calculate the line coefficients A and B.**

The calibration is done. The order of operation is not significant: You can also measure first the higher ("2") and then the lower moisture ("1"). The last operation must always be the coefficient calculation. When going back to the upper menu with ESC key, make sure that the text indication there is as follows if you want to use the SCALE calibration:

```
3=Use:SCALE
```

If it is not, press "3" until it is. You can always later change the calibration mode for the present material. The mode setting just informs the meter how to handle the incoming moisture signal.

Notice, we did not select the material before starting the calibration! There is only one SCALE calibration independent of the 100 calibration tables. If the SCALE calibration is in effect, the current MULTI calibration table is not in use. When the mode is set to MULTI, the SCALE calibration is not active. If the material is changed to one that has not been calibrated yet, the calibration mode is SCALE again. So, the mode jumps between SCALE and MULTI when changing materials e.g. with the arrow keys when in the measuring state. This will ensure that you always have at least some calibration available.

Coefficient Setting for Scaling

There are also two other options in the previous SCALE calibration menu which are needed only when scaling up the nonlinearized signal. In that case, *the calculation by "5" is not done at all*. The coefficients A and B can be set manually. The relation between them is as follows.

$$moisture = A * signal + B$$

Scaling is useful if you wish to obtain more significant figures in signal values as the moisture reading is limited to four decimals only. Then the B coefficient is set to zero (press key "4") and A may be e.g. 10, 100 or 1000 (press key "3") to increase signal dynamics. The moisture signal is a decimal number typically between 0.8 and 2.2. Normally, it has a value near 1.0. To set the coefficients manually, no measurements are required. **Please, note that the SCALE mode is normally intended for doing the scaling only and to perform the actual calibrations in the MULTI mode.**

MULTI Calibration

When either several materials are measured or better linearization is required one should use the MULTI calibration. One can correct even a significant nonlinearity on a large moisture range with it. Refer to the Fig. 3. Now we place 9 segments of line in a point to point fashion to cover the required moisture range. The purpose is that the selected points represent well the material's curve. **AK50** uses these points to calculate the actual moisture value by linear interpolation. Outside the range covered by these segments of line, are used the outermost segments by extrapolation. Before executing MULTI calibration one must select the material name with which this calibration is

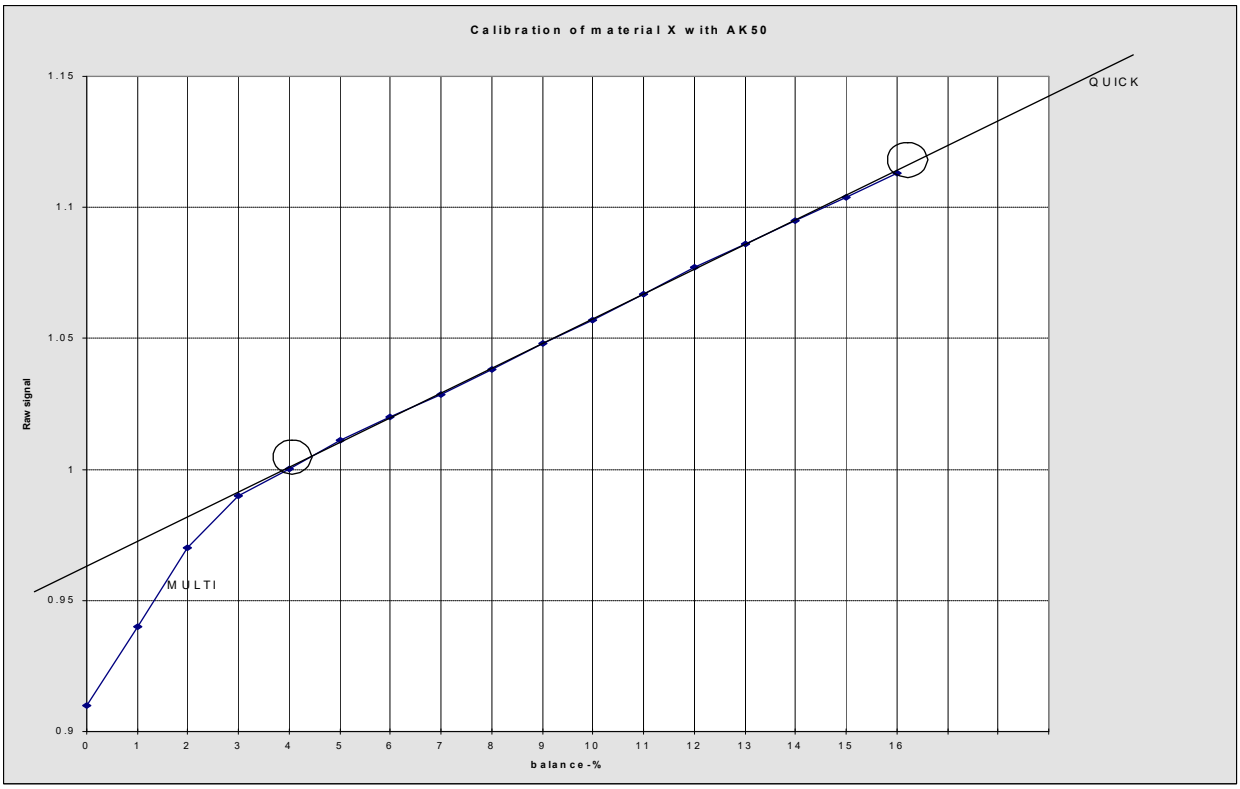
associated. There are up to 100 options available into which the new table can be placed. It is recommended to use the SLOW filtering option while calibrating to get the most accurate results.

After selecting the proper material either from the main menu (see Materials Menu) or from the measuring state with the arrow keys up or down you press "7" in calibration menu. The resulting display will be similar to the following:

```
MULTI    1=Pts:3
2=Step:1 3=Execute
4=Signal 5=Moisture
     0.9912Signal
```

The calibration is executed with the same principle as before but now we can use more samples, up to 10. You can set the number of points in this calibration by pressing "1". Its use is not obligatory as the number will automatically update itself as more samples are added. One must, however, know beforehand the number of samples to place them in correct order. The order of performing calibration of the different points is not important but it is not practical to shift a point to another location if it is executed at an incorrect step. If new values are to be added between existing ones, the other points should be moved as well.

Figure 3. A synthetic calibration curve with SCALE and MULTI calibrations



Performing MULTI Calibration with Samples of Different Moisture Levels

The calibration is usually done as follows in the case where you have samples whose moistures have been determined earlier.

1. **Determine the number of samples (=points) to be used in this calibration and set it in option "1" in the MULTI calibration menu**
2. **Place the first sample (any) under measurement**
3. **Set the corresponding step number in "2"**
4. **Press "3" (Execute) and respond with the corresponding moisture level of this sample**
5. **Repeat the steps 2., 3. and 4. until all sample points have been measured**
6. **When returning to the upper level menu, set the calibration mode to MULTI before using this table (press "3").**

Any failed points can be recalibrated later and as often as needed by setting first the corresponding step number. The number of points can be increased by adding more points to higher moistures. You can leave the set of points sparse. However, each point requires that there is some sensible value for the table to work in actual measurements. The missing values can be calculated by interpolation and added manually.

Copy the following page to serve as an operating guide while performing calibrations.

Performing MULTI Calibration when Working with a Climatic Chamber and a Balance

In this more accurate way the calibration is done as follows.

1. Place the sample into an oven for two hours at about +102 C
2. While drying, place the balance and the moisture meter into the climatic chamber with the balance and the moisture meter also. If your balance can not withstand the humid conditions, do the weighing outside the chamber with e.g. a plastic bag. Start the chamber control system and adjust the relative humidity to the lowest possible value. Arrange the moisture meter, if possible, so that you can simultaneously read both the balance and the meter. The sample should also be later placed so that the surrounding air can circulate around it and the wetting will be even at every point on the sample. AK50 *should be in SCALE calibration mode.* You can use scaling up of the raw moisture signal with a factor of 100 or 1000 to make its reading easier and more accurate as instructed in the previous section.
3. Quickly move the sample to your balance for weighing, preferably using an aluminum or plastic bag. Note that plastic bags may cause static electricity which will distort weighing results at the dry end. The result is the dry weight of the sample. Try to read also the moisture meter signal. That is usually a difficult task as both the weight and the signal increase so rapidly within the first 0..2 % range. The dry weight is used later in calculating the actual moisture percentages. Note that this step usually causes the greatest errors to the final absolute calibration accuracy. Errors of the order of +/-0.5 % are common if exceptionally careful precautions are not taken.
4. Continue reading the moisture signal-weight pairs as the moisture level slowly increases. Make notes of these readings. At first, you can take readings every minute but as the wetting of the sample will become slower it may be enough to take samples at longer intervals (5 min, 20 min, 1 hour). If long intervals are used, it is advisable to place the meter into low power mode and to tare the balance occasionally.
5. Feed the collected data into your spreadsheet program and draw a picture of it thus forming the actual calibration curve
6. Decide whether the results are reasonable. If not, you have to start from step 1. again
7. Having obtained a reliable calibration curve, decide which points on it actually are adequate for representing it with the accuracy you have specified. You can use only 2 to 10 of them for the linearization table. Straight parts of the curve can be handled with single line segments.
8. Take a printout of the calibration points and mark the selected points with step numbers
9. In the measuring state, select another empty material whose table has not been used (or in the Material menu)
10. Go to the MULTI calibration menu
11. Set the step number in "2".
12. Press "4" and type in the corresponding signal (now scaled down if you earlier scaled it up) as a decimal number. The value is typically between 0.60 and 2.00. Use always as many decimals as there are available and try to round them correctly.
13. Press "5" and set the corresponding moisture value. *Do not use the Execution ("3") in this method!* Else the signal value is replaced with the current signal reading.
14. Repeat the steps 11., 12. and 13. until all calibration points are fed in.
15. In the upper menu, set the calibration mode to MULTI.

The most accurate calibration is now done. After calibration the set of points (table) is immediately in use in MULTI mode and will stay in the battery backed memory (nonvolatile memory) for at least ten years. Do not forget to download the library or this particular material entry to your PC to save your valuable work. Refer also to COMPOSER expert system for creating calibrations without actual calibration work.

Adjusting a Table

While measuring with **AK50** moisture meter at high moisture levels (30 to 90% total moisture percent) problems are met when new materials have to be measured, especially in field conditions. Usually there is no calibration equipment available. In some cases, knowledge of only **a single moisture value** is available. That can be used for calibration in many cases if the material you are measuring resembles some previously calibrated grade. In the following, we explain how to do it. Note however,

that this method is limited for some smaller range in moisture, it is not valid throughout the whole moisture range.

A typical calibration curve for most porous materials is like in Fig. 4 (the thick curve). When other similar materials are measured, the calibration curve may be either the same or it may have shifted to either higher or lower moistures. **The slope of the curve is usually the same**. Thus, it would be sufficient in many cases to quickly shift some calibration table instead of making a laborious full calibration. This will offer good working accuracy in many cases on a limited moisture range. If the moisture reading should be higher than the meter shows, you should shift the table to higher moistures to reflect this. Or, if the opposite is true, the table should be shifted to lower moistures. The delta value corresponds to the table shift with the corresponding sign.

There are two principles for performing this. The more natural one is adjusting the table along the moisture axis and the other one (actually a more correct way) is to adjust the table along the signal axis. We call these methods as adjusting by the **%-value** and by **signal-value**. The %-value adjusting can be easily understood and the amount of adjustment is precise. The adjustment by signal is not so clear as the calibration curve is shifted along the signal axis with a relative percent. As the curve always has some slope other than unity, a one percent adjustment in the signal does not result into a one percent adjustment in real moisture scale. Thus one has to experiment a little to find out the correct value for adjusting. Refer to the figures 4 and 5.

The fact that the signal adjustment is more correct is due to the fact that usually, the curve is nonlinear and shifting it will produce incorrect results at moistures. Typically, the lower end of the curve is bent downwards and shifting the table by moisture-% may move that part into unrealistic moisture values (like negative). Remember that adjusting the moisture tables is not valid in general for the whole range of moisture values. The adjustment by signal gives much better results in this respect as the curve always lies within the correct range of moisture and the bend is probably located at a correct position. When the curve is linear as is usual when no low-end calibration (below 2%) has been done, these two methods are equivalent. The effect of the delta-value set in the menus is opposite, however. In a linear case, it is though easier to use the %-value adjustment. The signal-value adjustment may require some iteration before the correct setting has been reached.

The Procedure for Adjusting

1. Select that material from the **AK50** calibration library you wish to use as the basis. If possible, copy the material entry (by using your PC and **IRMA7Basic** software) into some unused entry in the library. You may modify its name to correspond to the material under measurement.

2. Go to the web position where the moisture value is known. Position the meter and take a reading or acquire a data series with several samples and statistics for better reliability.

3. Note the difference between the reading (or average) you have got and the value you were informed (**Mreal - MI7D = delta**).

4. Start the program **IRMA7Basic** and go to the **K**eyboard mode. Go to menu (m) and then to the calibration menu (press **"2"**) and from there enter the adjusting menu (press **"4"**). The following menu appears:

```
Adjust table, choose
 the principle/mode
 Mode(%):
 1=%-value  2=SIGNAL
```

5. Select the principle by pressing either '1' or '2'. The third line indicates the default setting or the one used earlier for this material. You can apply both methods at the same time but that makes it much more difficult to manage and to realize the resulting effects on the final moisture value. You will see either of the menus below.

```
Adjust %-table
 1=Set %-delta
 Delta:    0.0%
 1 UNCOATED 200
```

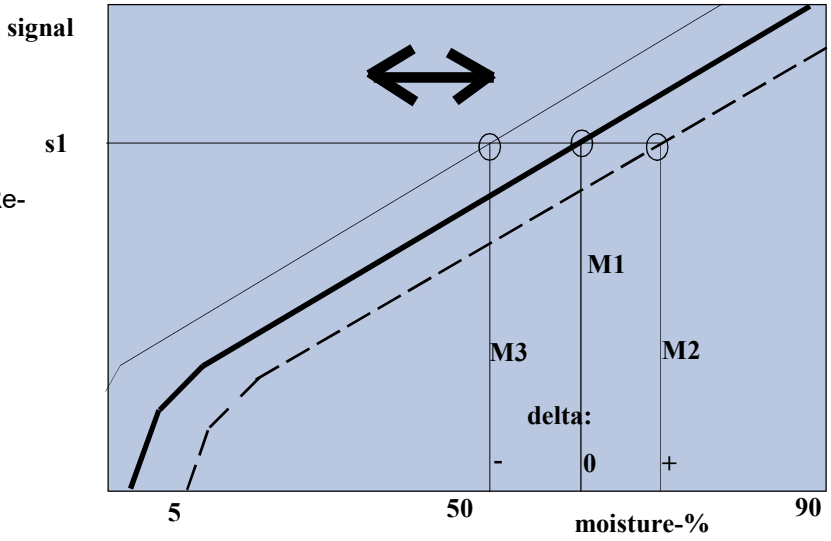


Figure 4. Adjusting by %-value. Refer to the text for details.

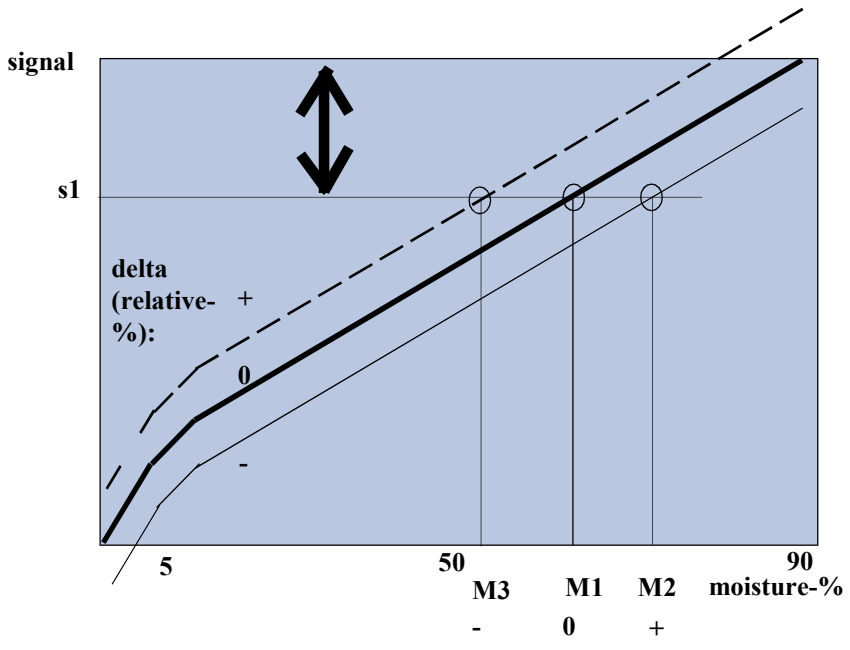


Figure 5. Adjusting the signal-value. Refer to the text.

or

```
Adjust signal table
 1=Relative-% delta
 Delta:    0.0%
 1 UNCOATED 200
```

6. You should shift the table the corresponding amount to by setting the proper value for the delta. The display tells you the current delta value with which the table has been shifted already if any.

7. The material name is modified by the system by adding either an asterisk ("*" for the %-value method) or a semicolon (";" for the signal-value method) to the end as a reminder. That tells you unambiguously that you have shifted this table. The marker stays there forever until you change the name of the material. You may shift the table any amount back and forth, even back to Delta = 0 % or switch the method, but the marker can not be removed.

Examples:

Adjusting by moisture-%

8. For example, if the real moisture value was 43.1 % and your reading was 39.9, the delta is 43.1 - 39.9 = 3.2 %. Set the delta value "**Delta: 0.0%**" to read "**Delta: 3.2%**". The table has been shifted and you can continue measuring immediately with the shifted table in the measuring state.

Adjusting by signal

9. For example, if the real moisture value was 43.1 % and your reading was 39.9, the delta is 43.1 - 39.9 = 3.2 %. The slope is, say 0.75. Set the delta value to read "**Delta: -4.3%**". The table has been shifted and you can check to see if the amount of delta was correct. Then you can continue measuring immediately with the modified table in the measuring state.

Scaling the Output Voltage

In some special circumstances it might become necessary to scale the voltage output differently from the standard way. The default scaling is 0...100% of moisture corresponding to 0...10 Volts of output and the jumpers have been set for 10 V. If they have been set for 0...5 V or +/-5 V, those ranges correspond to the same percent range. The resulting gain coefficient if 1.0000 as can be seen by entering the scaling menu from the calibration menu (press '5'). The following menu appears:

```
Channel
1 2
```

Press the analog channel number you want to affect. Then the following menu will appear, being identical in both options. There is however, a temporary reminder of the channel number if a key is touched in the menu.

```
Scale Vout:
7=Out:Moisture
1=Gain:
 1.0000  0.1000
```

In order to change the gain, press '1'. A small editor will appear into which you can type the correct gain. If you wish to increase the gain to 5X the original, type 5.0000. The new value is in use after returning from this menu. Another numeric display on the last line indicates the resulting scaling in units of Volts/%. If the scaling change was temporary, do not forget to restore the original setting later. The option "7" enables one to send the web temperature to the voltage output instead of temperature. Toggling further switches between web temperature, head temperature an extra sensor, Signal Quality and back to moisture. The scaling affects them in the same way, only the scaling unit is different. Both channels are scaled independently.

Standardization Menu

After pressing '6' in the calibration menu, a menu like the following will pop up:

```
Drift compensation
1=Manual 2=Std-ize
3=Stdvalue 4=Stdmat.
   0.0999%ofs
```

One can compensate against any long-term drift either manually adjusting the global moisture reading offset (in '1') or by letting the system to do it automatically. The offset affects **all** calibration tables and the SCALE calibration with the same basic offset-%. The high stability of the meter makes unnecessary often repeated standardizations as many are accustomed with in competing products. The main purpose of the standardization operation is to compensate against external factors causing drift in the meter, like dirt on the optical windows.

In order to set the offset manually, you have to know the amount of drift that has to be corrected. E.g., if the moisture readings show systematically an extra 1.25%, you can type in the reading in '1'. The idea is to make an offset of the same amount but with a different sign (in the example -1.25%). Note that there might already be some reading, even in factory fresh units which differs from zero. You have to add the new offset to the old one. The offset actually needed to manually correct the drift may differ from the detected drift. Try various values if uncertain.

In order to standardize **automatically**, you need a moisture standard sample which is placed in front of the meter at the proper distance and angle as informed in the data sheet of the standard. Type in the corresponding standard value in '3' and select a material table number suitable for it in '4 (the entry#)'. Start the standardization by pressing '2'. The new offset value will be in use after some 15 s and displayed on the fourth line. The automatic standardization can be used in scanners by moving the moisture meter head to that position where the static moisture standard is located and by sending a command via keyboard (keyboard mode, menu system), packet protocol or **Profibus DP**. Everything is taken care of automatically including the changing of tables back and forth during the standardization. The meter is restored back to its normal working condition immediately. For moisture standards, contact your representative or Visilab directly.

Note that the data series will be cleared during the standardization.

3.3. Tables Menu

From the main menu you can go to the calibration tables menu by pressing "3". The following set of options becomes visible.

```
Calibration 1=Select                    Tables menu
3=Make a copy 4=Edit
1 board 230g white
Lib:     2015DR6
```

The third line indicates the name of the current selected table. The name can be edited in option "4". The lowest line expresses the name of the current calibration library. To make a copy of an existing table entry, press '3'. You will be shown a **list of entry names into which the current table is copied into**. **Note the direction of operation**. After selecting the proper target entry, press Enter to accept it. The copying is done immediately. Then, you have two copies of the same entry with the same name but located in different places in the library. This feature is most useful when one has to create similar tables. After copying, one can use the Adjust feature to shift the required amount those newly copied entries for one's purposes. It would be recommended to change the names of those entries to prevent any misunderstandings (see below).

In order to switch to another table, press "1" in the Tables menu. You will see the following options:

```
Select calibr. by:
1=Entry# 2=Name
```

To switch the table by name from a list press "2" or by its location (entry #) in the library press "1". The entry numbers go from 1 to 100. If you press "1" **AK50** will ask you the entry number directly. Option "2" lets you select the proper name from a list by moving the cursor with the arrow keys up and down. Also the PgDn and PgUp keys can be used for speeded-up browsing if your keypad has them. By pressing Enter or ESC at some name makes a selection. The new calibration table is immediately in use assuming that it has been set to MULTI mode. The mode follows each table and is remembered. If the table is empty but MULTI is taken as calibration mode, the resulting moisture values will be either zero or anything irregular. This happens also if the table's values are incorrect.

In order to change (edit) the name of the current table, press "4" in the Tables menu. You will see the following options:

```
Edit names
1=Table 2=Lib
1 board 230g white
Lib:     20158DR6
```

If you press "1" you can edit the table name (=entry). A text line with 20 characters appears with the cursor blinking under the first leftmost character. You can now type in the text you wish with the keypad you have. Use arrows to the left and right to move the position if needed. Use any letters and numbers a-z, A-Z and 0-9, but avoid using any special characters. If you do not have a keypad (like in WAND), you can still edit the name with the arrow keys Up and Down and PgUp and PgDown. They cause a rotation of the letter in a sequence a->z, A->Z, 0->9 etc including space. Pressing Enter or ESC will stop editing.

If you press "2" to edit the library name, the same rules apply, except: Do not use space as a letter in the name. If you do, it will be replaced with an underline. This is due to the fact that thew library name is used directly as a filename in the PC environment and we need to obey their rules as well.

3.4. Profibus DP Menu

Refer to the **Profibus DP User's Manual** for using this menu and other options of the fieldbus. If you do not intend to use the fieldbus, do not enter this menu nor do activate anything in it. Profibus DP is presently an optional interface and is not delivered automatically.

3.5. Service Menu

In everyday use you do not have to visit the Service menu. If you suspect that the meter does not behave correctly, you can check it here. Irregular behavior may be indicated by strange characters on the display or by a very unstable moisture reading when measuring a stable target. The Service menu may offer some means to solve this. Go to the Service menu from the main menu by pressing "5". You will be displayed the following.

```
1=Factory 2=Webtemp
5=Speed 0=SaveConfig
8=HeadTemp
    69.1Hz   23.1C
```

There one may restore the basic factory settings by pressing "1". We have added a security check before actually executing the operation. Reply by pressing "5" if you have decided to do it. Any other key will cancel the operation. Note that this operation clears all data series and libraries too. You should always have backup copies of your special libraries in your PC or on diskettes before attempting this. Also, the **Profibus DP** configuration and activation should be executed after this. **Else it will not be active.**

Remark

The option "0" should be used if any changes are made to the meter settings by entering them via the keyboard. This will save the latest configuration and library for the future. Otherwise the changed settings would be effective only for the current session. An inquiry is in between asking if the user is sure and one should reply with the key "5" to continue.

The factory setting should help in many cases if really erroneous behavior is suspected. If the strange behavior is not fixed, contact your representative of **AK50** or the manufacturer. Occasional strange characters may appear on the screen due to line errors or inability of your PC to receive data as quickly as is required. As long as the meter itself works all right, there is no need to run the factory settings operation. Note that the factory settings will clear all libraries and all other collected data, adjustments and coefficients set earlier. **You also will need a good reason for doing the factory settings. It is not a regular servicing operation but it is a dramatic cleanup of the whole sensor.**

In the Service menu one can also read the temperature of the optical head with an absolute accuracy of +/-3 C. If you suspect that you are working in a too hot environment (over +50 C and no purge air) the optical head may become damaged. The guarantee does not cover damages due to overheating. The meter will also warn the user of this while in the measuring state and in keyboard mode. This will lead to overheating alarm and the meter is turned into Low Power mode. The alarm can be cleared only by visiting the menu from the measuring state or by using the explicit clearing function in the PC program. The autotimer ON light is lit while the alarm is true. Correspondingly, when the temperature is close to zero degrees Celsius, there may be frozen water present. **AK50** is not able to detect it and incorrect moisture values may result. In cold weather, water may also condense on the optical surfaces causing errors. **AK50** will indicate this in keyboard mode and measuring state with a text message "ICE?".

If your meter is equipped with the IR thermometer, the web temperature can be read in this menu by pressing '2'. If it is not available, this option is disabled. The reading is put on the third line. This reading can be passed to the PC as a temperature trend (refer to PC program User's Guide) on Meter status page. The temperature reading is also visible on the main menu in keyboard mode. It is either the head temperature or the web temperature depending on the existence of the IR thermometer. If your meter has it, the reading is the web temperature, else the head temperature. The selection is made at the factory when assembling the IR thermometer. If your system has the EXTRA thermometer option installed, its value can be read in the option "3". Else, it will print any meaningless value.

Further, there is a possibility of checking the light source frequency which should have a value between 50 and 150 Hz, typically very close to 100 Hz. If the value is outside of these limits and you have not received some specially tailored speed, contact the service. The frequency should be adjusted. Small deviations outside this range do not cause any problems. They will be adjusted in the next regular service. When the unit is in Low Power mode the motor is not running and the frequency is constant and may have almost any value. That is quite normal. The moisture signal is fully compensated against drifting of the frequency. The only effect is the actual accuracy loss on the frequency scale when doing FFT with your PC from the data collected with the autotimer.

3.6. Selection of Filtering

The meter signal processing includes a number of electronic and digital filters whose purpose is to remove any unwanted noise components and to increase the signal reliability. One of the filters affects considerably on the response time and frequency response. Its type can be selected in the main menu. There is the filter toggled by pressing "6". The possible states are NONE, FAST, MEDIUM, SLOW, SPECIAL and BOX. The current setting is indicated in the menu. The NONE filtering gives the fastest response times and increased noise. The FAST setting has a limited noise bandwidth but still a very fast response time. The MEDIUM setting has a still more limited noise spectrum but a fair response time. The SLOW one gives a slow response time and a fairly low noise. The SPECIAL setting has very low noise and a slow response time. The BOX filtering has a response time of 20 to 30 seconds and it will average 4096 samples at a time taken at the highest speed 70/100 Hz. It will give the lowest noise in all cases. Its advantage is best realized when measuring webs with large variations in moisture or material composition. Sharp peaks in moisture are filtered out and the resulting long-term average is obtained. The average is moving in the sense that the box of samples is started to be filled again after calculating the average of the earlier box. Thus there is never any sample history left. You can freely use any of the filter settings as long as you realize how it affects the signal and allow some time for them to settle after switching. Refer to Appendix 7 for some examples. The SPECIAL filter is the default setting.

The NONE setting is suitable for on-line troubleshooting and frequency analysis if the full spectrum 0...200 Hz is required. Post-filtering can be done for captured data series or in the rest of the control system. The FAST setting is suitable for measurements where rapid fluctuations in sample moisture and other environmental factors exist. The MEDIUM setting is proper for webs having large transients but whose moisture signal must be filtered well. The SLOW setting is best in most accurate systems. A typical application is in calibrations. The SPECIAL setting is mainly intended for regular use and most accurate work where speed of response is not important. The BOX setting is suitable for largely varying webs and conveyor belts carrying materials with variations in size, height and properties. Try each of the selections in the final web assembly position.

On-line measurements may cause varying requirements in selecting the proper filter. If the material to be measured is very glossy then it is advisable to use FAST or MEDIUM filtering to diminish any signal

fluctuations. Sometimes the opposite may be true. Test it before leaving the meter for continuous operation. Matt materials cause much less problems in this respect. In general, the meter has practically no problems associated with gloss related signal variations.

Extra Low-Pass Filter

There is an optional very powerful and slow filter available in the meter. It is usually preset at factory or while installing the meter by an engineer. The user can access this filter by going to the Service menu and then by pressing further "9", "9" and "6". Never change any of the visible optional internal confogurations. They will affect heavily on the meter operation. The following menu appears.

```
Coef. X100
1=A Frac.%
3=ENA:YES
```

The filter coefficient will affect the signal processing at a low level working at 70/100 samples / s. Thus a value of 1.0 down to 0.01 are effective. The smaller the value, the stronger the filter. The option "3" will turn on/off the filter. When all is set, please go back to the Service menu by pressing the ESC key a few times. There, press "0" to save the new settings and confirm by "5". This setting can now be activated and adjusted by the PC programs too.

3.7. Unit Menu

To change the unit of measurement one should enter the Unit menu from the main menu by pressing "7". It looks like the following.

```
1=Unit:
%
2=Temperature series
```

By pressing repeatedly "1" one can list all the options which are: "%", "%DRY", "g/m3" and "g/m2". The remaining unit is taken into use. Changing the unit does not change the handling of the moisture signal in **AK50**. This is only a qualitative attribute. If one wishes to use moisture percent defined by the dry weight, one should also do the calibrations according to it. There is a simple mathematical relation between the total percent **pt** and the dry weight percent **pd**:

pd = pt * 100 / (100 - pt)

or vice versa

pt = pd * 100 / (100 + pd)

One can then convert earlier calibration table entries (percent scales only, not the signal!) to change between these two percentages. They are both in general use but the total moisture is the most usual. You can also create a new unit with a PC and send it to **AK50**. In this menu you can further change it to any options available but not back to the tailored unit. It must be restored with the menu in the graphical environment. Note that the use of the dry weight percent instead of total weight percent creates one special feature. Typical behavior of most materials tested, *as a function of total percent,*

is linear in two sections. *However, when this calibration curve is transformed to dry weight with the previous equation,* ***the same sections are not linear anymore!*** That is due to the fact that the previous transformation is not linear itself and the meter's internal algorithms are made linear to the default case of total percent.

The second option '2' in the unit menu is for starting/stopping web temperature series' acquisition. The data is collected into a special memory bank (max. 1024 samples). The menu opened will look like this:

```
Webtemp 256 samples
1=Copy->Bank4 3=Clear
2=Stats 4=Auto:OFF
7=Link autotimers:Y
```

You can manage the temperature series taken with a rate of 16 Hz into memory with this feature. The sampling is started with '4' and also stopping is made with the same key. The sampling is done in the background while measuring normally the moisture signal. You can calculate the statistics of the series anytime by pressing '2'. To clear the series, press '3'. The sampling interval is fixed and the source of signal is the IR web thermometer. If your meter is not equipped with an IR thermometer, then the signal is the optical head temperature. In order to inspect the series in your PC and perhaps to save it into a file, you should copy it first into memory Bank4 by pressing '1'. It will overwrite the old data in that bank. The original data in the special memory bank is cleared after finishing the copying. Then you can transfer the data from Bank4 as usual, this time containing temperature signal. While sampling, the textual display in the measuring state will also indicate the number of samples taken and it also displays the letter 'T' to remind you that you have the temperature series autotimer on. Some of these operations can be managed in the PC program graphical state also. This feature is intended for occasional testing and investigations of web temperature conditions. However, it can be used successfully in moisture and temperature transient measurements. If the autotimers are linked, they operate together. When the moisture autotimer starts it will then also start the temperature autotimer and also the opposite. However, **starting the temperature autotimer has no effect on the moisture autotimer. For more details, refer to the PC program manual.**

3.8. Communications Menu

From the main menu you can branch to the Communications menu by pressing "8". There you can set the node address of the packet protocol link (physically RS232 or RS485). This setting is seldom required. If your link is RS232 (default) you keep the node address as one (1). If your system consists of multiple **AK50** units linked together with a local area network (RS485), each unit has a different node address. The node address should never be set to zero as it is reserved for the controlling master unit. The menu looks like this.

```
LAN addresses
1=Slave node(1): 1
7=Quiet boot:N
9=Speed (9600)
```

If your moisture measuring system is under construction and it is going to be based on RS485 hardware and the packet protocol in **IRMA7Basic**, you should then set the Quiet Booting to Yes. Normally, you can use the No setting. That is done by pressing repeatedly "7" in this menu. The Quiet Booting means

that the meter does not send anything into the bus when booting up. After the initial booting time has been passed, the meter may or may not send something, depending on whether it is in the Keyboard mode or in packet protocol mode. This is for preventing harmful transmissions if some meter decides to boot itself or its power has been turned on while there are other slaves in the same network.

The option "9" allows you to use either the **HIGH-SPEED** serial port (38400 bauds) or the **TOP SPEED** (115 200 bauds) instead of the **NORMAL** speed (9600 bauds). Toggle the key "9" and you can select either one. When you return to the upper level in the menu, you are warned of preparing the system for the new speed. Exit the Keyboard mode at this time, pull off the serial cable for a few seconds, reconnect it and go to OFF-LINE in the PC program. Select the port baud rate to make it **HIGH-SPEED/TOP SPEED/ NORMAL**. Return to ON-LINE and you can now continue to use the faster communications. This setting will remain in the meter until you change it again. Thus it is wise to save the program settings when the session is over or even earlier to start everything properly for the next session. If the speed is incorrect, the meter will not respond and in the Keyboard mode it shows plenty of garbled characters. Please note that the 115200 bauds will not work for longer than 5 m serial cables. Test this before you install the meter with a preset high speed.

3.9. COMPOSER

The COMPOSER expert system can be used via this menu. It is explained in detail in its own User's Guide.

3.10. Keys Available in the Measuring State

Copy the following page to serve as an operating guide while learning the key presses.

Other Keys Available in Measuring State

In the measuring state there are other keys available in addition to the Menu key "m" and the arrow keys. In the following the effects of pressing each key are listed shortly.

key	action in measuring state (keyboard mode)
s	Add one sample to the data series.
l	(small letter L) Set the meter into Low Power state, immediate measuring is not available. The measuring state is restored by pressing this key again. If the "s" key is pressed while in Low Power mode, the meter restores operation for taking a sample.
+	Turn the autotimer on, samples are added to the data series with the preset interval. In Normal mode samples are added ad infinitum until explicitly stopped, in Batch mode only a predefined number of samples is collected
-	Turn off the autotimer
*	Calculate statistics of the data series. Equivalent to the same operation in the Series menu. Operation ends with a dialog where you can ask the series to be cleared, else new samples are added to the end of earlier data. Reply with "1"= clear data, any other key = continue and keep data
. or b	(decimal point) Select memory bank, five different options
arrow up	Change the current material to the next with a lower entry number. The numbers go from 100 to 1 and then to 100 again.
arrow down	Change the material to the next with a higher entry number.
Page up	Change the current material to the next with an entry number lower by 4. The numbers go from 100 to 1 and then to 100 again. This affects all listings in the same way.
Page down	Change the material to the next with an entry number higher by 4. This affects all listings in the same way.
arrow to the left	Decrease the bar display scale with a factor of two (the scale is momentarily indicated)
arrow to the right	Increase the bar display scale by a factor of two (the scale is momentarily indicated)
4	Start the temperature series acquisition (16 Hz rate)
5	Stop the temperature series acquisition
6	Calculate the temperature series statistics and clear the series
7	Gainlocking is not active anymore, it is kept for for future use
8	Switch between Normal and Batch modes for the autotimer, does not start it
9	Redisplay the measuring state text
x or 3	Close the keyboard mode and return to packet protocol after pressing "1". Use this option only in other ANSI terminal programs to force the meter to enter the packet protocol mode permanently. The proper way of doing this, is, however, to press simply the Exit Keyboard mode button.
TAB, ?	Help text starts scrolling in some menus

Pressing other keys has no effect in the measuring state. Note that the BURST mode can not be set up in the measuring state. It needs to be configured in the Series menu or with the IRMA7Basic program. Note that pressing any invalid and unrecognized key will jump the meter back to packet protocol.

Hints for Use

When measuring surfaces with varying darkness or reflexivity the reflected light signal will vary in a large range. The amplifier system must compensate for it by changing the signal gain. That requires some settling time (typically 5 ms). If the surface is so reflective that measurements can not be carried out by using any gain setting, there remains a new unit on the display, "%REFL". The reading may be correct but it has an increased risk of distortion. On the other hand, if the surface is too absorptive, the new unit "%DARK" is taken into use to warn the user. The value may again be correct but has an increased noise component with an associated increased standard deviation. Note that with various surfaces, these temporary units may appear momentarily and disappear again. That is quite normal and is only intended to warn the user against the associated new settling time and a possible short signal transient. The autoranging signal gain takes care of all this and has a large dynamic range. It also has a hysteresis of +/-50 % of the nominal signal level to keep the current setting and to avoid changing the gain setting continuously when close to the threshold.

If you want to get rid of this extra settling time effect you can lock the internal signal gain setting at the current value. That is done in the measuring state by pressing "7". The locking is opened again with the same key. The locking is indicated on the bar scale with the letter "L". If a too reflective surface is met while measuring with a locked gain, moisture signal distortion is evident. On the other hand, if the moisture increases radically or the surface becomes darker, that does not contain the danger of distorted moisture values. Only the noise in the signal may increase significantly. In standard continuous on-line use, the locking is not used and small signal transients are accepted (Autoranging). If the conditions stay the same, the autoranging system has practically never any reason to change the gain setting.

Note the following. When the meter is ready for use and you have no material under the optical head for measuring, the display shows the warning "%DARK". It means that the meter has not received enough light. The reading settles quickly when you place the web or anything reflective under it. If you try to measure a surface containing no moisture at all, like metals or plastics, the reading may be practically anything, typically a small value. *The instrument can not be calibrated to zero moisture by holding it without a sample or by measuring a metal plate!*

Notices for Measuring

While measuring with **AK50** you should keep in mind the following short instructions for the meter to serve you as long as possible and to furnish you the most accurate information of moisture.

1. Protect the optical head against shocks! The optical head should not be exposed to high temperatures (keep below +35C, never over +50 C). Ignoring this fact will lead to a damaged light source motor and also the electronics may become damaged, especially the memory chips. Be especially careful about the optical parts at the bottom of the meter. The motor in the light source is especially sensitive to mechanical shocks and will damage easily. Handle carefully the meter when assembling it. Do not allow water to inside the meter through the air exit vents. There is some electronics inside and it will be destroyed by water.

2. Never try to open the optical head! The result will always be damaged components. The guarantee is not valid in such cases. Similarly, the light source must not be removed. You can at the most replace the lamp. Refer to Appendix 1. for service operations. The manufacturer or service are not liable of fixing a unit which has been damaged by purpose.

3. Although **AK50** is splash-water proof, it is not allowed to immerse it into water or any other liquid. Any dirt can be removed by wiping it with damp cloth or with cotton sticks. The optical surfaces can be cleaned with a dry clean cloth or cotton sticks. NEVER USE ANY SOLVENTS OR DETERGENTS! **They may cause unexpected damage.** If the flushing vents at the bottom of the meter are open, there is a danger of letting water in.

4. If the unit is opened for service operations, do it only in a dry clean room. The instrument may loose accuracy or be damaged if water, dirt or sand is allowed to enter it. When closing the top panel, check to see that no cables, dirt or water is left between the gaskets. Tighten carefully the screws and check all other visible panel screws also.

5. Handle the electrical connectors with extra care! Avoid excessive force!

6. The instrument is not dropping-proof. Avoid all mechanical shocks to the optical head! Contrary to expectations, the most sensitive part is the light source motor which does not tolerate sharp shocks. Its anchor magnet will explode and the motor becomes useless.

7. Apply only relatively clean air for flushing. Any dirt will be collected to the metal mesh filter in the air inlet. The air should also be fairly dry (< 40 %RH).

When you require the most accurate results with AK50, follow the next few instructions:

8. Do not heat up the optical head! It is fully temperature compensated but sudden temperature changes may cause temporary deviations to the moisture reading. In field measurements, avoid moving the meter from cold weather to warm rooms or vice versa. Else there will be increased standard deviation of the moisture values. Let the meter settle for a while (5 to 10 min) to the environmental temperature.

9. Best web noise rejection and accuracy is achieved with the SPECIAL filtering. The BOX filter may also be used if fast signal variations are not of interest.

10. For very glossy materials, find the optimum angle in which the signal has the smallest dependence on angle. Usually, the optimum angle is 15 to 20 degrees (latitudinal). For most glossy papers, the zero angle is quite good. Only with superglossy grades, like SC, angle adjustment may be recommended. All measurements can be carried out in that angular position. It is not required to restore the zero angle. Some adjust operation may be necessary for some of the calibration tables.

11. The moisture meter is NOT classified for installation and use in explosive environments!

Appendix 1. Servicing

The service needs of the **AK50** moisture meter are minor in the current Rev 5. The only practical service which is important is the cleaning of the optical surfaces (windows). That should be done with a soft cloth. Do not use any solvents!

The lamp and motor need not be replaced by the user. The lamp operating life is so long (close to 200000 hours) and the motor operating life is still much longer. The service requires skills, tools and adjustments and are outside the scope of the user. The manufacturer or your local representative will take care of them at a very affordable cost. At the same time the whole instrument gets a good check. The embedded software is upgraded if a new release is available, including the PC program upgrade.

AK50 is equipped with a usage hour meter. It will tell unambiguously the number of hours during which the meter has been in normal use. Using the Low Power Mode does not increase this reading. The service interval is typically 175 000 hours and then the motor and lamp are recommended to be changed. In some units, the service interval has been either longer or shorter depending on the internal adjustments made at factory at the request of the buyer. When the moisture meter is turned on and is booting up the accumulated hours reading is shown on the display (keyboard mode only) for a moment. When the 175 000 hours has been exceeded the meter will indicate this with a short message. It is quite possible that the meter will still operate well giving several thousands of hours of uncompromising moisture values with low noise. For best results and reliability, it is advisable to contact the service.

Appendix 2. Jumper Plugs

There are a number of jumper plugs which you may have to change if the meter configuration is modified.

You should never touch any other jumpers on the boards than those mentioned here.

The moisture meter contains also a number of fuses on the power supply board. They are, however, self-recovering and require no service.

The **SALOON** board provides isolated power for all circuits in the **AK50** system. Data transfer between **AK50** and other systems is managed by this board also. It has optoisolated RS232/485 drivers for the PC interface and similar ones for the RS485-based **Profibus DP** interface**.** The analog voltage output is isolated from the moisture sensor electronics. Note that the main operating +5 V voltage is **NOT** necessarily isolated from the power input. All output/input lines are transient and ESD protected and also have EMC filters to avoid any interference with other systems. There is also a TTL level trigger input line for active low sampling commands. The line has a 1K0 pullup resistor.

The jumpers on the board are shown in the following Figure L2-1. There are no adjustments available.

The jumper J101 is used in special configurations for connecting the electronics ground to the enclosure chassis ground. By default, it is connected. The jumper J302 (in revisions -06 and -07 and later only) offers a possibility of making a cable termination for Profibus DP at the exact slave end instead of the D9 connector or the distribution box as usually. While using the highest speeds 12 Mbauds, it may be required to carefully terminate the cable ends and to use highly matched cables for this purpose. The termination resistor is 390 Ohms. If you wish to have some other value, contact Visilab and we will send you a spare resistor with a suitable resistance to be soldered on the board. The earlier board revisions -01 to -05 do not support termination on board. That has usually little consequences.

You are allowed to change the voltage output range jumpers and the **Profibus DP** RTS line polarity. Do not touch the other jumpers! They are preset at the factory for your application. If you are building a local area network (RS485-based) or you wish to use your meter via the RS485 twisted-wire serial bus, contact the factory. We will then give you more information of setting the jumpers and building the system.

You can access these jumpers by just opening the access cover as in the Service Operations. The jumpers are visible on the upper edge of the **SALOON** board. The settings are the following (see Fig. L2-2):

To select the output range for the DAC (digital-to-analog converter) signal output circuit, use the jumpers J501, J502. There are the following options:

1.	0...+5 V	J501 at left, J502 at any position
2.	-5 V...+5 V	J501 at right, J502 at right
3.	0...+10 V	J501 at right, J502 at left (**default setting**)

J301 is used to select either RS232 or RS485 for the PC or LAN connection. At the leftmost position the RS232 is selected for communications. You need to change JMP302 also to select either options. Use the leftmost positions to operate with RS232 and the rightmost positions with RS485. JMP202 is used to select the Profibus RTS polarity. The default setting is in the leftmost position for positive polarity. The other position is the inverted polarity. Do not change it unless you know what you are doing.

The RS485 line termination resistor is connected as a jumper to the DC separation capacitor C302 position. If you require DC separation for the RS485 line to minimize power losses, connect a 0u1 50V capacitor instead.

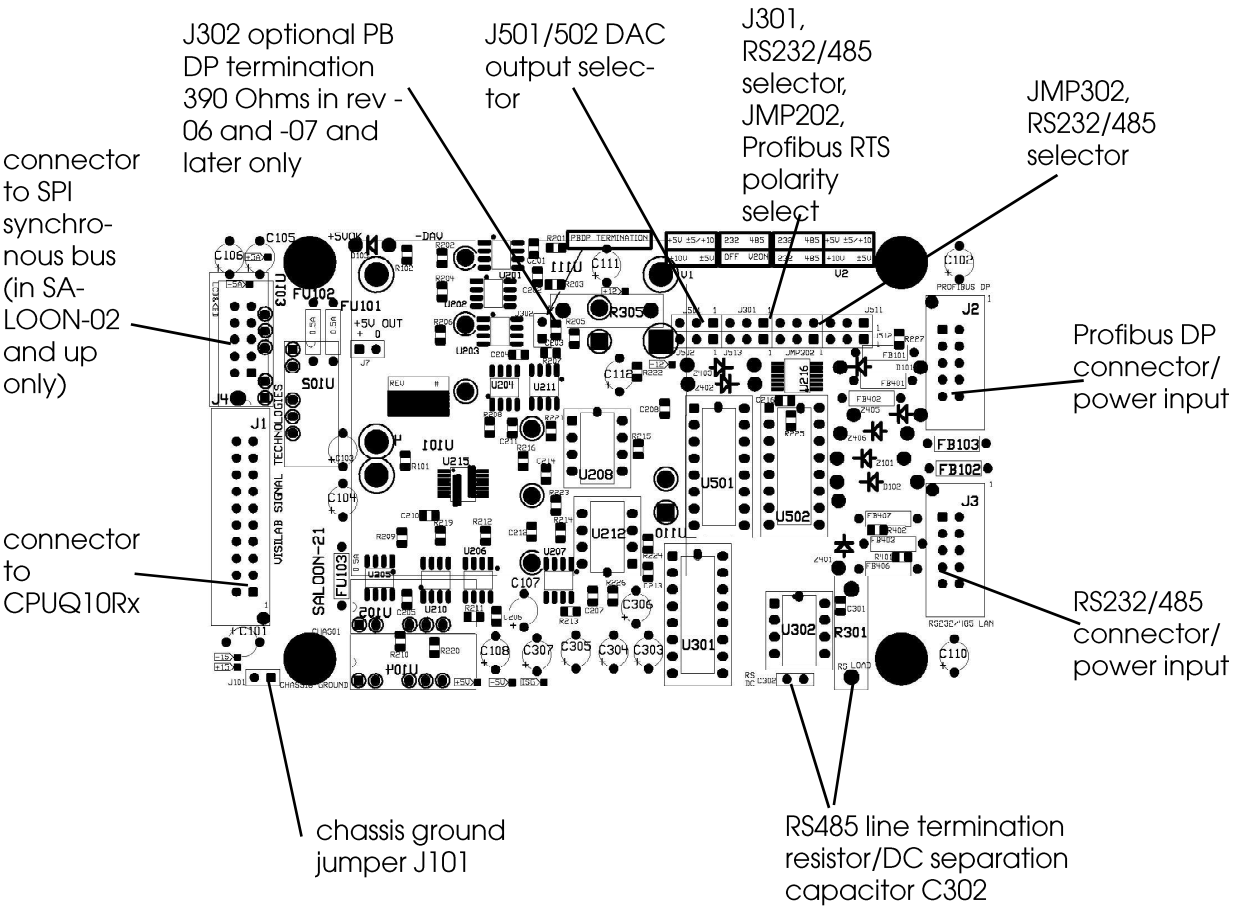


Figure L2-1. The SALOON21 board component placement.

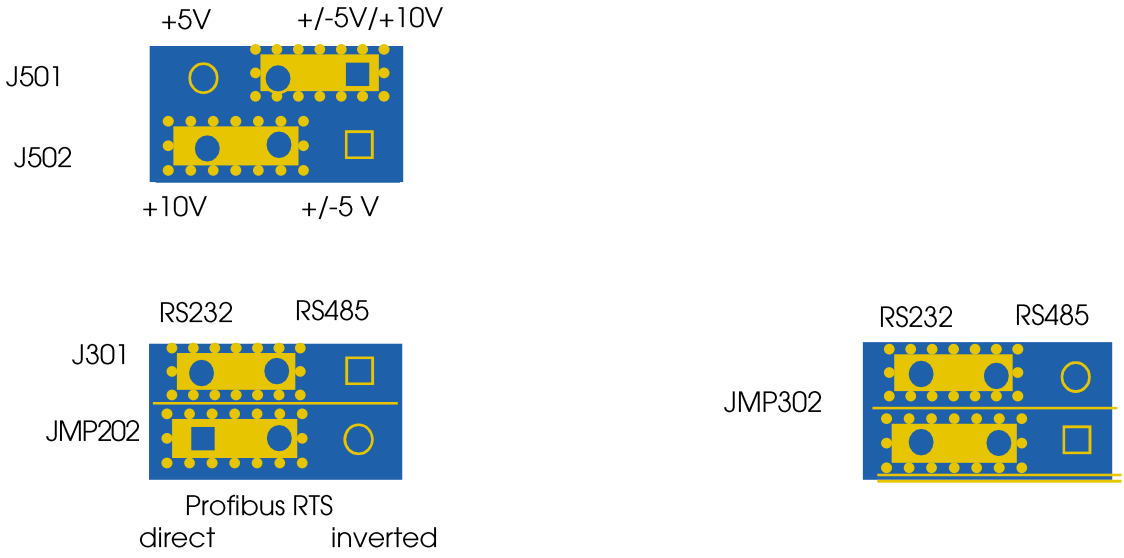


Figure L2-2. The SALOON board jumpers

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Appendix 3. Definition of the Data Transmission Protocol

AK50 is communicating with the PC by using a packet protocol requiring a reply to each inquiry or command. It is always a SLAVE and the MASTER sends the commands. The protocol is very simple but has a number of features which makes it very reliable and fast. Also it recovers quickly from errors or line problems. You can use it in a point-to-point communication or in a network having several SLAVEs and one MASTER. The baud rate is 9600 bauds. Other speed are available for local area networks or for point-to-point RS485 operation (up to 500 kbaud).

The MASTER is the only device capable of starting a discussion on this network. Other devices can only respond to commands. Each packet, a command or a reply, contains a CRC checksum which secures the communication. It is made of two bytes, which are located at the end of the packet. Each packet is checked to see that the CRC is correct. If not, the packet is discarded. The calculation of the CRC uses an international CRC standard with base **CRCCCITT 0x1021**. Refer to Fig. L3-1.

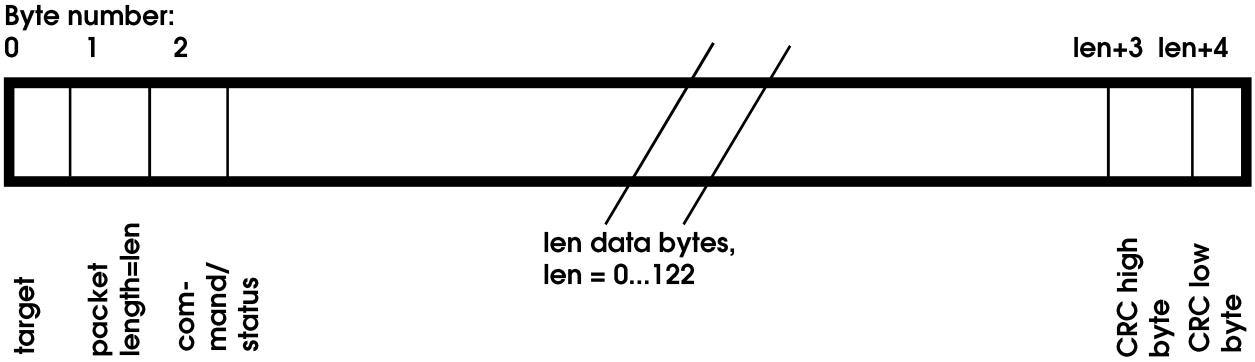
The packet consists of the packet length byte (0 to 122 in value), the receiver's address (one byte) which unambiguously identifies each unit in the network. The MASTER's address is always zero and the SLAVEs have nonzero addresses. In an RS232 network the SLAVE always has an address one.

There is always a command or a status value in the packet. It is used for sending plain commands to the SLAVE and the SLAVE returns its own status in it. All packets are always according to the same format. The packet length may vary but it can always be unambiguously determined by the length of the data section (Fig. L3-1).

The protocol works in the following way. The MASTER sends the SLAVE some command, for instance inquires some data value. The SLAVE returns the required data in the packet and its status. The MASTER may send a plain command but a reply is required with a status. This ensures that each command is received properly. Each command always requires a reply, there are no exceptions.

There may occur higher level programming errors, line faults, interferences or other communication errors causing the SLAVE to respond with an incorrect packet to the MASTER. The protocol error handling is able to isolate these cases. Line disturbances cause damage to either data or CRC bytes and can easily be detected. If the SLAVE does not respond to the MASTER's inquiry, that will also be detected. The MASTER will retry for a preset number of times until it desists the operation and informs the higher level of this fault.

Fig. L3-1, the packet format in the protocol



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If the SLAVE will receive more bytes in a packet than it has itself calculated there to be, the reception is interrupted and the SLAVE is waiting until the bus is quiet and a new transmission starts. Correspondingly, if the MASTER receives more bytes than it was due, it will receive them and will continue with normal operation when the bus is quiet. If the SLAVE receives too few bytes in a packet, it will discard it and wait until a next valid packet is received.

If the SLAVE detects that the packet is not for it but for another node in the bus, it will listen on the bus and wait for the next packet to arrive. If the MASTER detects that the packet address is not zero, it will listen and retry. If the MASTER does not get a response within a certain time window (about one second) or will receive only a part of the packet expected, it will retry with the same command. Retries are repeated for a few times, the number being dependent on the actual command to be performed.

These precautions ensure that collisions do not occur too easily, and if they do occur, the system will recover as quickly as possible with retransmission.

Your company may wish to develop some data acquisition system with a local network. Therefore we list the definitions and declarations necessary to understand and implement the system. The implementation language is ANSI or K&R level C. Experienced programmers should find this material useful. The manufacturer may offer more information as requested.

The floating point data values are transferred into both directions coded as a four-byte integer so that the whole part can have any value between -32768 and 32767 and the decimal part can have any value between -9999 and 9999. Information of other data formats are available from the manufacturer.

In the following we list all available commands. They are named identically and have the same numerical values the corresponding Profibus DP commands (refer to PB DP User's manual). Contact **Visilab** to have more details of the packet protocol interface. Visilab can also supply some LabView drivers and development modules for you to to have a quick start in software development.

```
/*
   AK50 packet protocol definitions and command/status values

   Protocol commands:
*/

#define I7TEST   10          test, returns with a string, moisture value etc.
#define I7MOIST  11          get the moisture value
#define I7SUNIT  12          set a new unit
#define I7GUNIT  13          get the current unit
#define I7GETMAT 14          get the current material number
#define I7SETMAT 15          set a new current material number
#define I7GMODE  16          get the current calibration mode
#define I7SMODE  17          set the current calibration mode
#define I7SETHI  18          set the high level (model A only)
#define I7SETLO  19          set the low level (model A only)
#define I7TXSER  20          get the data series
#define I7CLSER  21          clear the data series
#define I7TXMAT  26          upload a new material to the instrument
#define I7RXMAT  27          download a material from the instrument
```

```
#define I7GETUSG 28          get the usage hours reading
#define I7GLIBNM 29          get the library name
#define I7SLIBNM 30          set a new name for the library
#define I7GMATNM 31          get the name of the current material
#define I7GETHI  32          get the high level setting (model A only)
#define I7GETLO  33          get the low level setting (model A only)
#define I7BEEP   34          send a short blink into the indicator LED
#define I7GETDM  35          get the number of values in the data series
#define I7SAMPLE 36          augment the data series with a new sample
#define I7GETLPM 37          get the Low Power Mode setting
#define I7SETLPM 38          set the Low Power Mode on/off
#define I7SETTIM 39          set the autotimer interval
#define I7GETTIM 40          get the autotimer interval
#define I7AUTOON 41          set the autotimer on
#define I7AUTOOFF 42         set the autotimer off
#define I7GETAUTO 43         set the autotimer on/off
#define I7GETTMP  46         get the head temperature
#define I7GWEB    48         get web temp

/* extra commands not in model A : */
#define I7STERM    47        set the terminal mode ON
#define I7SFILTER  49        set filter selection
#define I7GFILTER  50        get filter selection
#define I7GAINLOCK 51        lock gain
#define I7GAINOPEN 52        open gain
#define I7GETLOCK  53        get gain locking status
#define I7SBANK    54        set bank no.
#define I7GBANK    55        get bank no.
#define I7SBATCH   56        set batch size
#define I7GBATCH   57        get batch size
#define I7SAMODE   58        set autotimer mode
#define I7GAMODE   59        get autotimer mode
#define I7GFREQ    60        get light source frequency
#define I7GDPADR   61        get PB DP slave address
#define I7SDPADR   62        set PB DP slave address
#define I7DPACT    63        activate PB DP
#define I7DPDEACT  64        deactivate PB DP
#define I7DPINIT   65        initialize PB DP
#define I7GDPACT   66        get PB DP activation status
#define I7SSHIFT   67        set general offset value (manual standardization)
#define I7GSHIFT   68        get general offset
#define I7STDZE    69        standardize
#define I7SSTDM    70        set std material entry#
#define I7GSTDM    71        get std material entry#
#define I7SSTD     72        set std value
#define I7GSTD     73        get std value
#define I7GLAMP    74        get lamp status
#define I7SPACKET  75        set packet protocol mode
#define I7GSTATUS  76        get system general status byte
#define I7GMATNM2  77        get material name, part 2 (PB DP only)
#define I7TEST2    78        get test string, part 2 (PB DP only)
```

```
#define I7GHEAD     79          get head temperature (PB DP only)
#define I7TEST3     80          get test string, part 3 (PB DP only)
#define I7SMATNM    81          set material name, part 1 (PB DP only)
#define I7SMATNM2   82          set material name, part 2 (PB DP only)
#define I7FFT       83          start calculating FFT in Bank1
#define I7GLAN      84          get LAN addresses of a master and slave as seen in
                                the slave (PB DP only)
#define I7SLAN      85          set LAN addresses of a master and slave as seen in
                                the slave (PB DP only)
#define I7G2STATUS  86          get the second status byte
#define I7SVOUT     87          set voltage output source
#define I7GVOUT     88          get voltage output source
#define I7G3STATUS  89           get the third status byte
#define I7GCOOLING  90           get the cooler enable state
#define NOP         91          No Operation Command
#define I7SCOOLING  92           set the cooling enable state
#define I7GCOOLTMP  93          get the cooler control input temperature
#define I7GCOOLON   94          get the cooler on/off status (not the real
                                cycling, though)
#define I7GCOOLINK   95         get the cooler linking setting
#define I7SCOOLINK   96         set the  cooler linking
#define I7GCOOLSTA   97         get the cooler status
#define I7COPYT      98         copy temp. series to Bank4
#define I7STLPF      99         turn on/off the web temperature low-pass filter
#define I7GWEB2     100         a special command for an optional input
#define I7GTLPF     101         get the state of the web temperature low-pass
                                filter
#define I7SWEBB    102          set the web temperature offset
#define I7GEBB     103          get the web temperature offset
#define I7GALM     104          get the head overheating alarm status
#define I7CALM     105          clear the head overheating alarm
#define I7CDPREP   106          prepare for config data downloading
#define I7CDSET    107          upload a specific config data item (1 of 48)
#define I7GXMOD    108          get the expansion module signal
#define I7GNXMOD   109          get the expansion module number
#define I7GXNAME   110          get the expansion module name
#define I7SXCOM    111          send a command to the expansion module
#define I7SBURST   112          set a new burst count
#define I7GBURST   113          get the burst count
#define I7SBUM     114          set the burst mode ON/OFF
#define I7GBUM     115          get the burst mode
#define I7GBUC     116          get the item count
#define I7CBUC     117          clear the item count
/*            = the last command */
#define TIMEOUT 30   timeout in milliseconds, delay time maximum of the SLAVE in
reception of packet, if the time interval between any two bytes exceeds it, the
packet is discarded

/* positions of the control bytes in the packet */
#define TAGTPOS  0              /* target address
#define LENPOS   1              /* data packet length
#define COMPOS   2              /* command/status byte
```

```
#define MAXPOS    3             /* first character position after the packet header
*/
#define CRCHIPOS 3
#define CRCLOPOS 4
#define PAKOVHD   5             /* number of characters in addition to data */
#define MASTOUT   40000L        /* MASTER timeout */
#define SLAVOUT    3000L        /* SLAVE timeout */
#define MASERDLY  50            /* MASTER ERROR timeout */

Filter settings:
#define FILNONE    120
#define FILFAST    121
#define FILMEDM    122
#define FILSLOW    123
#define FILSPEC    124
#define FILBOX     125

/*
          Status values returned from the SLAVE:
*/
#define RECOVERABLE     7       /* errors at the sending end */
#define UNRECOVERABLE   9
#define TIMEOUTERR     19
#define ADDRERR        20        /* slave uses an illegal master address */
#define TXCRCERROR     29        /* if the packet from master is not OK */
                        /* as replied by slave */


#define RXOK           78             /* no errors at the receiving end */

#define RXCRCERROR     66        /* if the response packet from slave is not OK */
                        /* as calculated by master. Also the slave may */
                        /* come to the conclusion that the CRC of the  */
                        /* master's packet is incorrect */
#define RXPAKERROR     88
#define RXFRAMEERROR 101             /* general error in packet frame or timeout
*/
#define RXNOMSG       102        /* no messages received */
#define RXUNKNOWN     103       /* unknown command */
```

Appendix 4. Technical Specifications of the Moisture Meter (Rev. 6S only)

Device:	An independent process surface moisture transmitter for fixed use applying infrared technology and reflection principle. Measurement is done by same-spot principle to obtain best possible results in requiring on-line systems. The instrument contains no keyboard or display. Keyboard & display accessories exist. The meter is equipped with an infrared thermometer for measuring the web temperature.
Application areas:	On-line measurements in paper, board and nonvowen industry. Also various textiles and other porous substances can be measured reliably. Other applications in research and troubleshooting. Piecewise webs can be measured either as such or with the Burst mode.
Moisture range:	0..99 % of total moisture
Resolution:	0.001 % in digital values transferred, 0.0245 % in voltage output, 0.1 % on display in keyboard mode
Repeatability:	Typically 0.1 % in the range 0..10 %, 0.5 % the range 10..30 % and 1.0 % in the range 30..99 %, actual values depend on the measuring conditions
Accuracy:	Depends on calibration. Maximum number of calibration points is 10 for each library table entry.
Calibration:	One two-point calibration (SCALE), 100 tables available for multi-point calibration with 10 points each (MULTI). Standardization method is built-in, either manual or automatic. Table entry adjusting (shifting) is available and also copying into another entry for rapid field use. The adjusting can be made either as a shift in moisture-% or in the signal scale (relative-%). All AK50 derivatives have the **COMPOSER** expert system for creating new calibrations **without** actual calibration work. This saves a lot of trouble especially in field conditions.
Noise level:	Standard deviation of the signal when measuring continuously the same sample NONE: < 0.4 %, FAST filtering: < 0.3 %, MEDIUM: < 0.07 %, SLOW: < 0.03 %, SPECIAL: < 0.02 %, BOX: < 0.01%, when measuring in the range 0..10 % @120 mm distance perpendicularly, white paper 5 %. Individual differences may exist between the units delivered.
Stability:	Better than +/-0.03 %/year in the range 0..10 % (long-term error, a short-term error may be larger but will be compensated quickly)
Operating modes:	Normal operating mode with Autotimer and memory banks / Burst mode with a preset number of samples to be taken when the Autotimer starts, the average calculated and the result put to the current memory bank. The number of samples for the Burst mode are from 1 to 32000. There is an item counter available active in this mode.
Standardization:	Made by a standardization algorithm and an external moisture standard to compensate against any drift caused by dirty optical surfaces
Measuring Speed:	The meter acquires 400 or 100 samples/second depending on the variant. The moisture value is updated at the same speed to the voltage output with a time delay of 2.5 ms. The RS232-based master inquiring moisture values will receive the latest moisture value. The same applies to the Profibus DP master. When a PC software is used for displaying, the current moisture value is the latest value obtained.
Measuring area:	About 30x40 mm on a surface @200 mm distance for the 400 Hz variant and a spot of 10 mm in diameter for the variants of 400 Hz and 100 Hz in bigger enclosures

Minimum sample size: About 60 mm in diameter on a surface @200 mm distance, positioned accurately on the hot spot.

Angle sensitivity: About +/-0.5 % for a +/-20 deg change @200 mm distance, the error depends on paper grade and its gloss

IR-thermometer: Accuracy +/-2 C, range 0...+150C (may vary), large distance range, signal may be passed to PC or to **Profibus DP** or to the voltage output instead of moisture

Measuring distance: Typical range 200...350 mm, corresponding moisture variation is within +/-0.5 % in that distance range; can be used at still larger distances up to 500 mm. The actual operating range may vary, refer to the data sheet supplied with this unit. The meters can be adjusted to varying operating distances. However. The nose box will limit the usable range somewhat. The specifications are brought with each meter.

Data series: Room for up to 4096 points, sampling is either via external commands or automatic (autotimer is either continuous or in Batch mode). External sampling commands can be given by a digital control system and by a trigger input (TTL-level), which starts the autotimer. The following operations can be focused on each memory bank: Statistics calculation, clearing, listing four samples at a time. The moisture and temperature autotimers can be linked together. The thermometer has a memory bank of 1024 samples and an autotimer with a preset time interval of one second.

Data/setting retention: All data and settings are battery backed, no loss of data when power is off

Dist. standardization: Made by external fixture to the production machine or traverse (scanner)

Filtering of signal: Selectable total step response time to full accuracy: NONE: 0.014 s, FAST: 0.03 s, MEDIUM: 0.2 s, SLOW: < 2.5 s, SPECIAL: < 4.5 s, BOX: < 30 s.

Backing material: With thicker materials has no effect

Dynamic range: The light signal amplifier has a dynamic range of 26 bits (1 part in 67 millions).

Warm-up time: Less than 30 s from turning the power on to reach standard measurement accuracy, full accuracy within 30 minutes

Cooling & cleaning: For tough conditions, cooling of electronics and cleaning/decondensation of optical surfaces can be done by using the standard pressurized air inlet. It circulates the air through the enclosure and flushes the optical surfaces when exiting thus preventing also dust contamination. The meter has vents for flushing, two for the light source, one for the IR thermometer window and two for the detector optical head. The optional nose box will give added simplicity in maintenance as it will protect the sensitive parts and prevent steam condensation and dust accumulation.

Environmental: Operating temperature range 0..+35 C without pressurized air cooling, In other conditions the air purge is required. The meter can be used in very moist conditions (see the previous item). The meter has an internal thermometer, with which the user is warned of ice formation on the optical surfaces or of too hot environments. The transmitter is fully temperature compensated. When using air cooling, the operating temperature range may become larger but depends on the incoming air temperature. The preferred operating ambient temperature should be selected so that the optical head temperature is always below +35C, for best results. The sensitive optical head is hermetically sealed to avoid any effects of dust and moisture. The overheating alarm will raise the corresponding status bit and shut down the meter to avoid any further heating.

Operating cycle: Continuous

Control interfaces: May act as a **Profibus DP** slave with moisture data acquisition features. The meter can also be used with any PC compatible with the industry standard, via the RS232/RS485 serial communications using a private packet protocol. The user interface is a graphical program in Windows for moisture real-time

	trend, downloading of data series, instrument settings, calibration, management of libraries and material entries. It features also statistics. A display/keyboard simulator belongs to the special PC software to replace them. It enables field operation and calibration plus all instrument settings, even while the transmitter is running in a Profibus DP controlled system. A special local area network can be created by using the RS485-based private master-slave packet protocol. The internal menu system, when accessed either with the PC program's Keyboard mode or with some ANSI terminal connected to the RS232 port, has a context sensitive help system. The baud rate can be selected as 9600/38400/115200 bauds.
Dark behavior:	If dark surface or highly reflective surfaces are detected, the meter will offer zero as a moisture reading to avoid showing irregular largely varying moisture readings. The response time is about 50 ms for all interfaces.
Status information:	Three status bytes available via RS232/485 and Profibus DP indicating all the most important settings and statuses of the meter. To most of them belong a set of commands via either bus for full management of that feature.
Voltage output:	Two voltage outputs are available as a standard feature (selectable +/-5 V, 0 to +5 V and 0 to +10 V (default) ranges). The voltage range corresponds to 0...100% of moisture or 0...200 C of temperature (either web temperature, head temperature or an extra sensor or Signal Quality). The signal can be scaled with a multiplier.
Power source:	External power 24 V (9..24 V) 4500 mA (peak 5000 mA at start-up), can be connected either to the Profibus or the RS232/485 connector. The typical power dissipation is 10 to 12 W corresponding to a DC current of 0.8 A.
External connections:	One connector: ***RS232/485 & Profibus DP:*** External power input, trigger input (optoisolated TTL), two RS232/485 lines, voltage output. Two Profibus RS485 lines, an isolated +5 V. Termination jumper on the SALOON board. The RS232 port can be configured as RS485 with jumpers. The private packet protocol supports a local area network with one master and up to 30 slaves. All lines in both connectors are optoisolated from other meter electronics. The power supply lines (0 V and +12 V or 24 V) may be in galvanic connection to the meter electronics. Typically, the signal electronics ground is connected to the chassis ground to minimize noise.
Low Power Mode:	A special mode offering power and lifetime savings without immediate measurement capability, applicable for e.g. data transfer or for temporary production stoppage. Overheating alarm will automatically lead to Low Power mode.
Usage control:	Usage hours counter indicating service requirements
Enclosure:	IP65, protected from splash water and dust, dimensions (LxHxW) **AK50**: 155x255x120 mm, weight about 4.8 kg without the optional nosebox Four M8 threads for mounting at the bottom, a quick connect for pressurized air hose connector. The enclosure bottom has air outlets. If the Vortec cooler has been ordered, the quick connect is replaced with the Vortec tube
Ice detection:	Does not measure frozen water
Config data:	Meter's internal configuration can be downloaded and saved into a file for possible restoration after meter damage or equivalent.
Service interval:	Recommended 175 000 h or ten years
User maintenance:	Cleaning of optical windows, prevention of clogging of air inlet filter. Prevention of overheating the meter.
Lamp operating life:	> 175 000 h
Motor operating life:	> 200 000 h
Guarantee:	Two years from delivery, does not cover wearing parts, like the lamp or motor.
EM compatibility:	Conforms to the requirements of Directive 89/336/EEC

Accessories:

A keyboard and display unit **TEAK30** is available for field operation without a PC. It has a rechargeable battery NOT supporting the meter. It is connected to the distribution boxes RS232 D9 connector instead of a PC. The unit operates in the meter's Keyboard mode making possible meter configuration, data acquisition and statistics calculations etc.
LAN232 networking unit is available for connecting up to eight meters for data acquisition into a PC via RS232. The same unit can be used for creating an RS485 LAN with longer distances.
A moisture standard **-STD** is available for external standardization. Check our web site for a list of current accessories.

Appendix 5. Schematic of Electrical Connections for AK50 in the connection box. **If you open the distribution boxes cover, please, disconnect the power lead first to avoid a shock!** Find below a schematic for wiring of the circuit board inside the power supply -PS. On the next page, find a corresponding component placement drawing. You can find more information from the model -PS Operating guide.

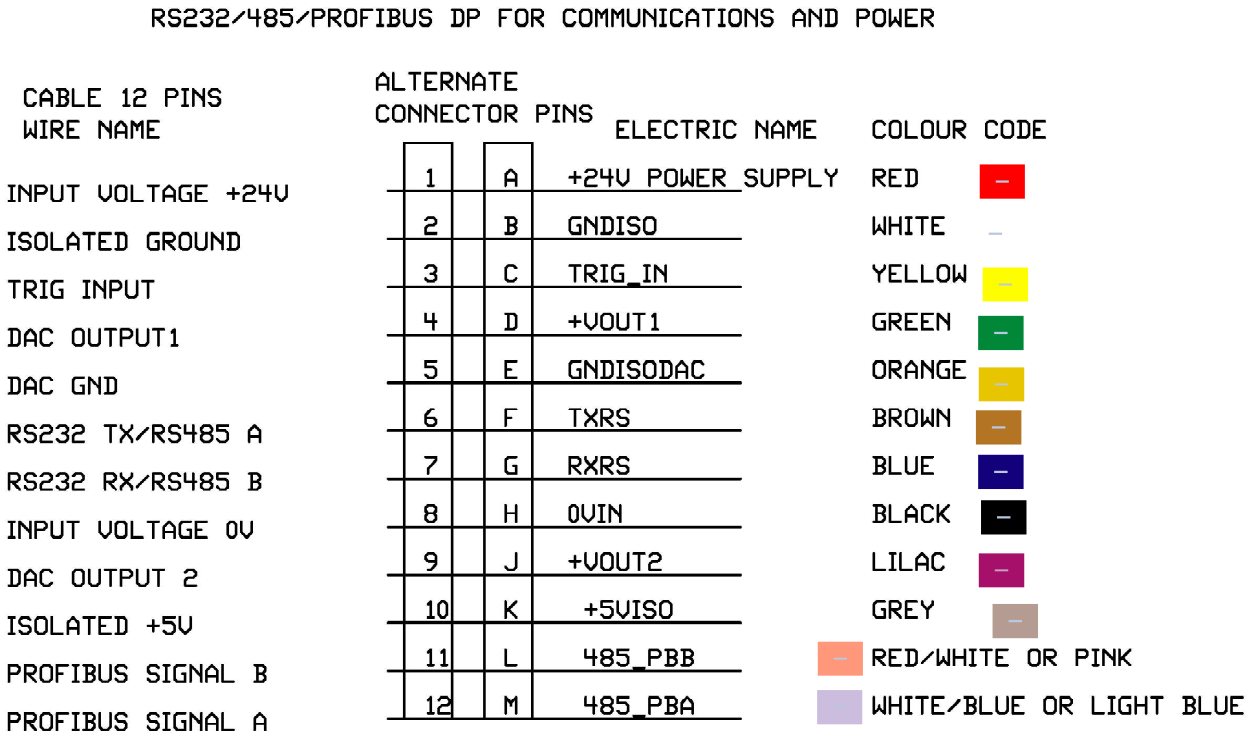


Figure L5-1 Wiring of the 12-pin cable and corresponding signal names

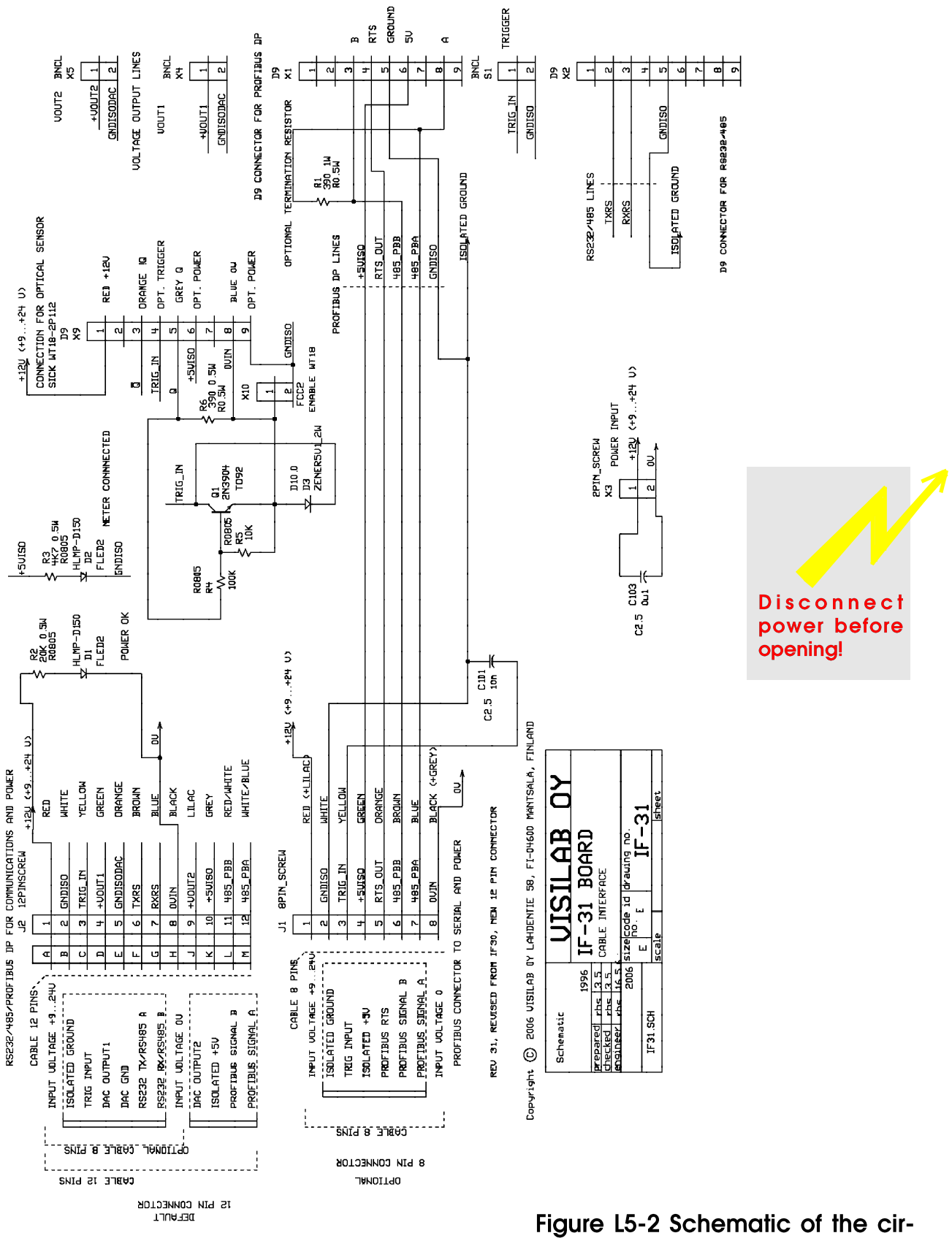
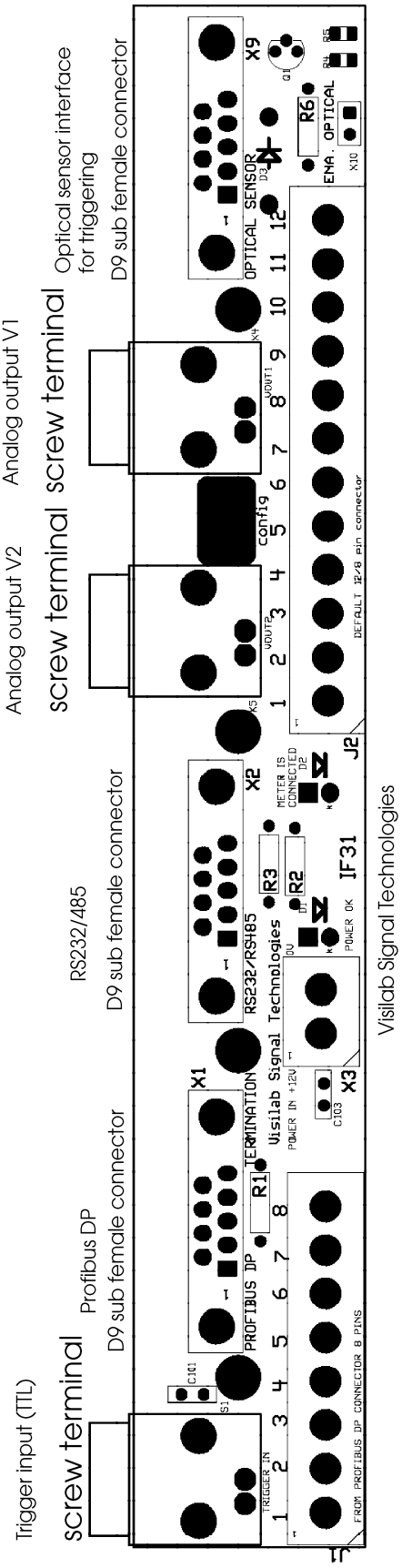


Figure L5-2 Schematic of the circuit board in the model -PS power supply unit

Figure L5-3 Component placement of the power supply circuit board



Appendix 6. Graphs of Features of AK50, Rev. 6S

Below, find some typical curves of model D meters. Contact Visilab for more details and curves.

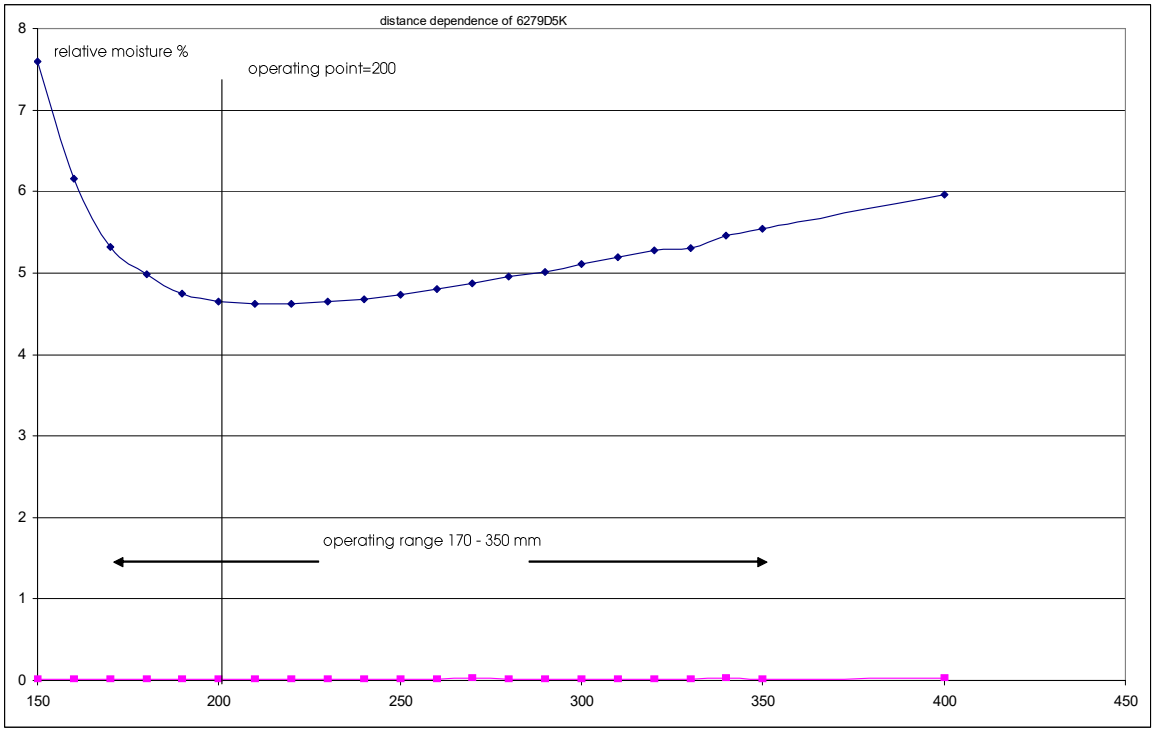


Fig. L6-3 Distance dependence of AK50 Rev. 6S meter's reading.

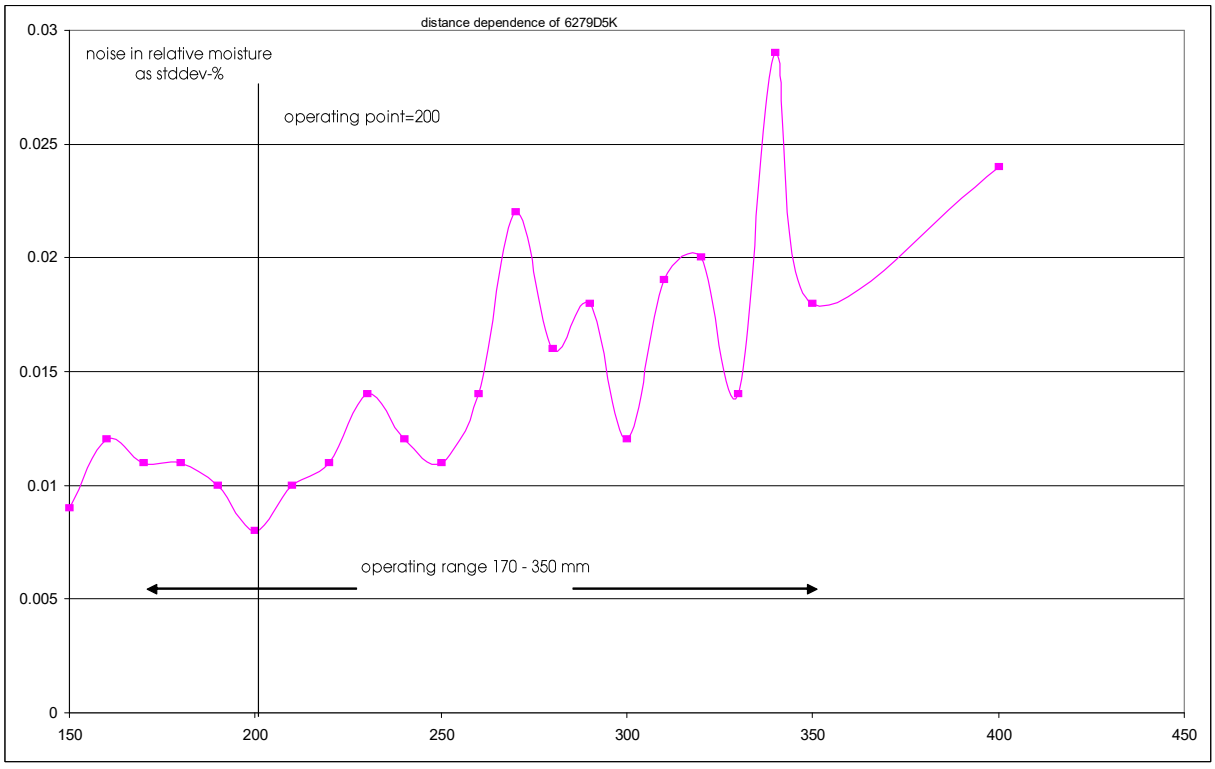


Fig. L6-4 Distance dependence of AK50 Rev. 6S meter's noise component

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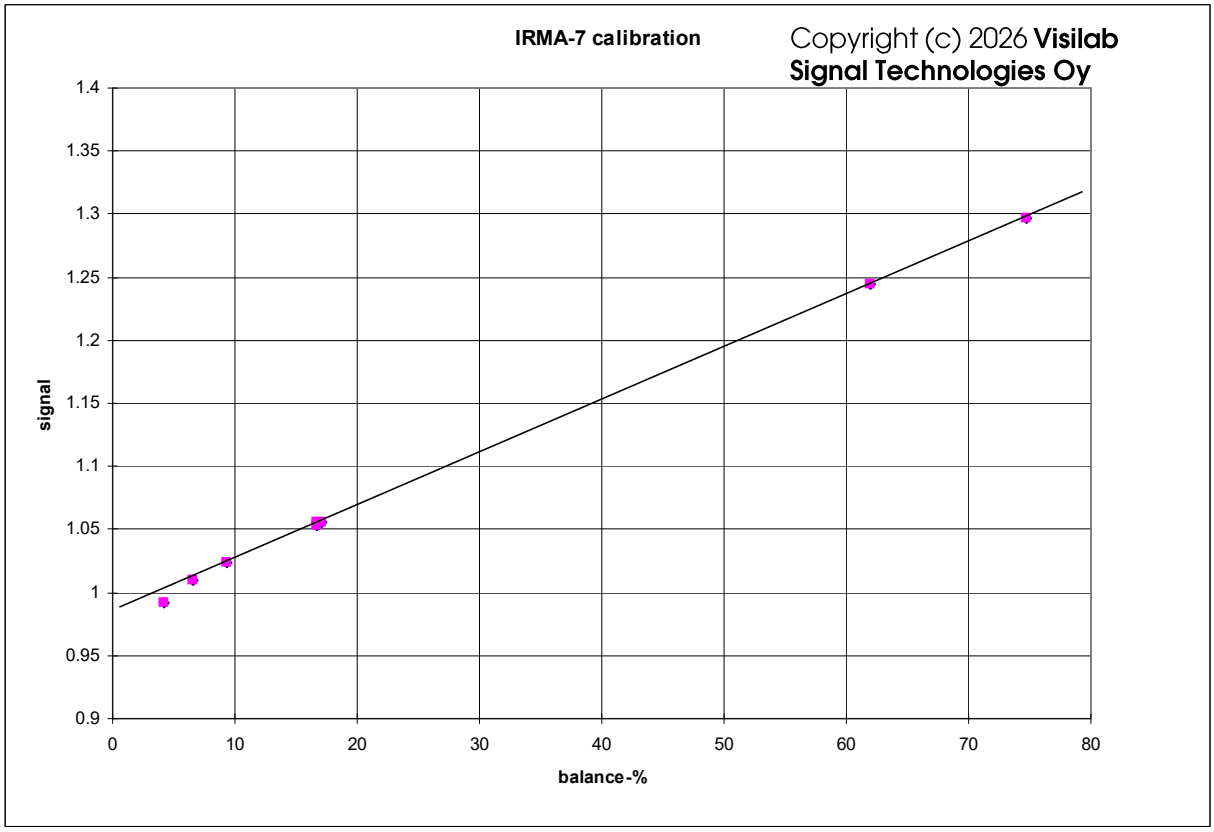


Fig. L6-8 A typical calibration of tissue for very high moistures, AK50 Rev. 6S.

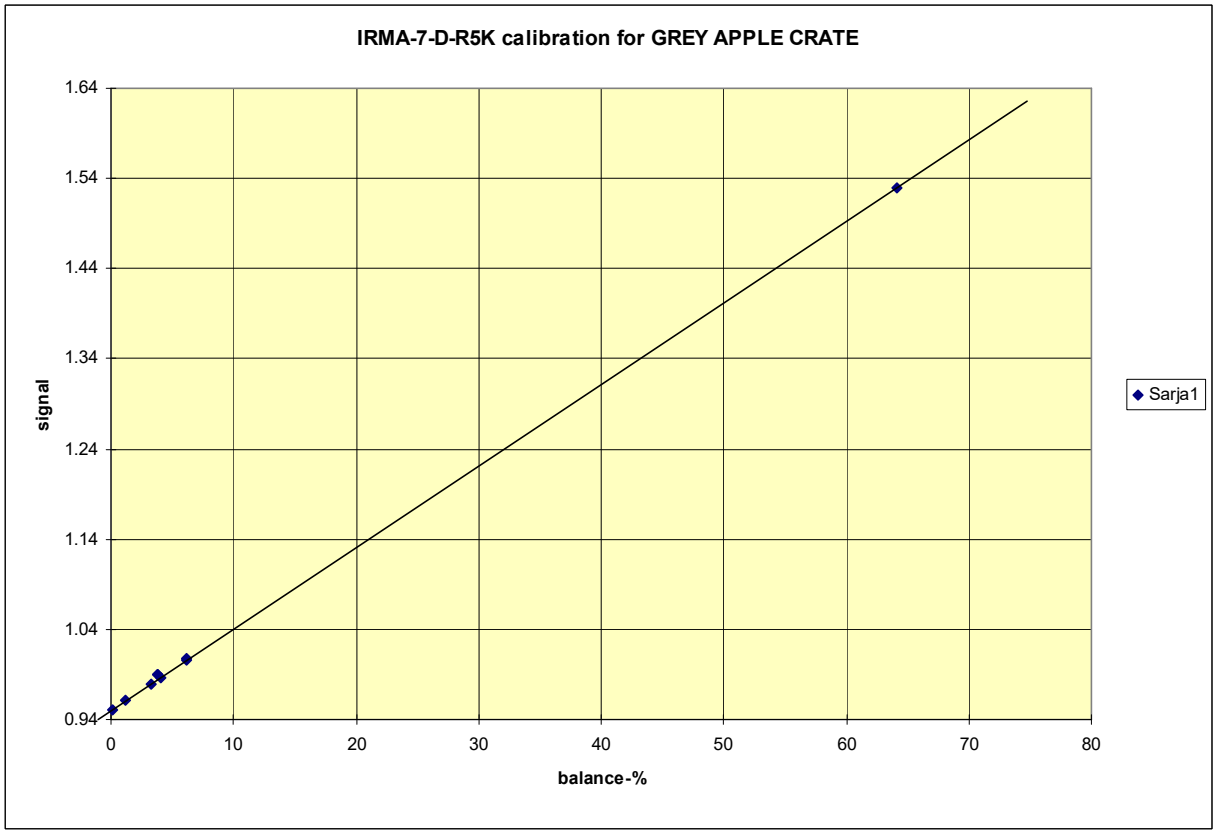


Fig. L6-8 B typical calibration of grey apple crate for very high moistures, AK50 Rev. 6S.

Appendix 8. Troubleshooting the Meter

In cases where you meet troubles in getting the meter working correctly you may need assistance. Visilab is able to help you but to alleviate our burden, please check the following points before calling us.

A. Symptom: No moisture signal to the PC data collection system, no contact in either packet protocol mode nor in keyboard mode with the IRMA7Basic program.

1. Is the meter correctly powered? Are you sure? Is there some light coming out of the bottom of the meter? If yes, the meter is receiving power. If not, check the power cable from the distribution box. It should be connected to a 230VAC or 110VAC wall inlet.
2. Is the thick RS232 cable with the black round 8-pin connector placed into the correct socket in the meter's panel? It should be at the lowest position as labeled. The upper socket is for the Profibus DP connector. If there is still no power to the meter, the distribution boxes power source may be faulty (rare). Let a technician check it or contact Visilab. A voltage close to +12 Volts should be available in it between connector pins 1 and 8 as shown in Appendix 5. The power source contains also a standard fuse which can be replaced. All other fuses in the whole system are self-recovering and need no service.
3. Is the RS232 cable correctly plugged at both ends? Has it been damaged? If yes, fix it.
4. Are you sure that the COM port you are using in IRMA7Basic program is actually the one you have connected the cable into? **This is absolutely the most frequent reason for communication problems with the meter.** Change the port selection in the IRMA7Basic program's Configuration page.
5. If done all right thus far and still no connection is established with the meter, go to the keyboard mode. Return back to packet protocol mode again. Repeat this once more. Still no connection? Try the Meter Status page and the Check status button. Still no connection? Turn the power off of the PC and try again. The COM port may be jammed for some reason. Especially, the old PC's are sensitive to static electricity and other electrical and operating system software errors. If this does not help, either your PC does not support any available COM port or the connector you are trying is not the correct one. Also, the COM port may be damaged. Also, the COM port may be reserved by some other Windows application. Release the port from that application or deactivate the application altogether if that is the only way to do it. The interfering application might be some web browser or modem communications program.
6. One source of confusion may arise if the high-speed serial communication is in use, either in the software or in the meter, but not in both.

B. Symptom: No moisture signal to the Profibus DP data collection system, the Master is not able to find the slave

1. Is the meter correctly powered? Are you sure? Is there some light coming out of the bottom of the meter? If yes, the meter is receiving power. If not, check the power cable from the distribution box. It should be connected to a 230VAC or 110VAC wall inlet.
2. Is the thick Profibus DP cable with the black round 8-pin connector placed into the correct socket in the meter's panel? It should be at the upper position as labeled. The lower socket is for the RS232 connector. If there is still no power to the meter, the distribution boxes power source may be faulty (rare). Let a technician check it or contact Visilab. A voltage close to +12 Volts should be available in it at the connector pins shown in Appendix 5.
3. Is the DP cable correctly plugged in at both ends to the fieldbus? Has it been damaged? If yes, fix it.
4. Are the two wires in the DP connector correctly positioned? Try swapping them at one connector, not both. If not successful, reswap the wires.

5. If done all right thus far and still no connection is established with the meter try the PC. Does the PC connection to the meter with the RS232 work all right? **If yes, this is most likely a configuration problem of the Profibus DP (master or slave)** or a cabling problem. **The configuration problems are the most frequent with Profibus DP malfunction causes.**
6. Are you sure of the slave address set for the meter? It is usually 3. If the Master tries to discuss with a different slave number, it is not able to establish a connection.
7. Check the ID of the meter in the Profibus menu (keyboard mode). Check also the slave address. Change if necessary. Check if the DP is active. If not, activate and initialize the DP part of the meter.
8. Disconnect the fieldbus connector at either end. Go into the keyboard mode, go to the Profibus menu and initialize the meter's DP part by pressing '5'. Press '9' for looping and watch the messages when the fieldbus connector is plugged in. Some of them are indicative of the problem. The first message is "Baud" which means that there is a physical connection (at the RS485 level) and the system has identified the correct baud rate. Then, other messages may appear like, "prm", "cfg", "DEX" and "Tout". The "prm" means that the basic parametrization of the slave matches with the assumption of the Master. "cfg" means that the same applies for the slave I/O configuration data. "DEX" means that full acceptance is received from the Master. "Tout" means that there is a timeout event preventing connection at some stage of the accepting process. Other messages need diagnostic knowledge and we are not handling them here. However, you are able to determine the possible problem from this alone. Stop looping by pressing the ESC key. Reinitialize with '5' and return to the packet protocol mode.
9. Check all items again referring to the DP slave configuration and check the cables. Are you using the correct GSD file for this slave?

C. Symptom: No moisture signal from the voltage output but the PC program and Profibus DP work all right and moisture readings are correct.

1. Check the cables for proper connection
2. Check the voltage output connector (screw terminal) at the distribution box. Does it look damaged? Is there water or dirt on it? Is the cable going out of the screw terminal shorted?
3. Check to see if the meter is in Low Power mode instead of Normal mode. Turn it into Normal mode if true.
4. If the points above are OK, the voltage output line's protection resistor may be damaged. It is located inside the distribution box near the screw terminal. If it looks burnt and its resistance value (usually 120 to 1000 Ohms) is not correct (broken?), the resistor needs to be replaced. The cause for this is that someone has plugged in some external voltage into this connector causing damage to the protection. The worst case is, that the DAC which actually generates the voltage on the SALOON board is damaged too(rare). Check the voltage scaling in the calibration menu in keyboard mode. If the DAC is damaged, it has to be replaced at Visilab.

D. Symptom: The moisture signal is incorrect.

1. Are you using the proper calibration table for it?
2. Have you made adjustments to the table used (with Adjust)? Could that explain this? Check the amount of adjustment in the keyboard mode menu system, Calibration and Adjust.
3. Is the meter's position different from normal assembly? The web could be seen differently if it is curved or in a quite different angle or distance compared to the original position. Then, do the Adjust to correct it. No mechanical adjusting is required. If it is easy to do the mechanical adjusting,

try it first.
4. Is the web thermometer showing correct readings? Is the small window of the thermometer clogged with dirt? If not, (readings like 0 C or 500C are abnormal) the compensation of the thermometer pulls the moisture signal. The only remedy is to replace the thermometer. As a first aid, the faulty thermometer could be disabled (contract Visilab for details) to stop the interference.
5. Is the head temperature too high? It should normally be below +45C. Has the meter been subject to very high ambient temperatures? If you are using air flow, are you sure the flow has been continuous without any breaks? If the temperature has risen too much, irreversible damage (or at least changes to some important parameters) have been caused to the meter. In mild cases there is no serious damage but the meter has gained some extra offset to its moisture signals. In severe cases the optical head is damaged and must be replaced and readjusted.
5. Are the windows clean? A usual cause for malfunctioning is dust over glasses or heavy water condensation in difficult conditions. Please clean the windows. Water condensation is prevented by increasing purge air flow and by using some sort of "nose box" in front of the meter.

E. Symptom: The autotimer starts running when the meter is turned on.

1. The meter receives a command for starting the autotimer either via any of the digital buses or via the electrical trigger input line. The latter is the most probable cause for this kind of behavior. If no digital interfaces are connected and the meter's autotimer is not turned on when the meter is turned off, the most likely reason is the trigger line. It receives an electrical pulse from the cables. The pulses are generated by external electric motors and other heavy electrical machinery. The strong magnetic fields are induced into the cable wires in spite of the shielding. The way to fix this is to add a capacitor of 0.1uF 100V minimum between pins 2 and 3 in the screw connectors J1 or J2 (refer to Appendix 5) in the interface board. This circuit board is located inside the distribution box. **Make sure to turn the power off before opening this box!** The capacitor will eliminate the noise. It is also worthwhile to check the cable shielding connections.

G. Symptom: The moisture signal is zero.

1. Are you using the proper calibration table for it?
2. Is the surface highly reflective or very dark? There is an automatic signal zeroing feature which is able to put the signal to zero if such conditions are detected. To recover from this, place the meter over such a surface where this does not happen.
3. The internal Z variable may be preventing proper working of the meter. The Z variable needs to be set to a smaller value or to zero. Contact Visilab for further details.

If all attempts show no proper indication of a working meter, contact us. Do not send back the meter without our permission.

Appendix 9. Mechanical Installation of the Meter

In the following is described the issues of mechanical assembly of the moisture meter.

Distance

Observe first the most important factor, the measuring distance from the running web. The usual working range is from 180 to 380 mm with a moisture variation less than +/-0.5 %. There may be other ranges at other distances tailored at the time of ordering. There are also small variations in the specifications from one unit to another.

In the standard range, a distance of 200 to 250 mm is suitable as a nominal distance to the web. Then the reading is fairly stable even if the web vibrates within the operating distance range. The vibrations cause some noise which can be removed with filtering. Taking a too close or a too far distance as the operating point, may result in a too narrow operating range or to an increased noise contribution in the signal. Keep the meter as close to target as is possible but avoid signal clipping or distortion in any conditions! Refer to the curve delivered with your meter to estimate the usable working range.

Angles

The second factor to be observed is the measuring angle to the web surface, in degrees from the surface normal. In fact, it is possible to use two separate angles in this respect, the latitudinal and longitudinal angles. Usually, if the material to be measured does not have a glossy surface, the meter is assembled both angles being zero, i.e. the meter is planar with the web (the optical axis is parallel to the web normal).

If the material has strong calendering or other processing causing strong specular reflections, the longitudinal angle should be +15 to +40 degrees. Then you can avoid reflections which may cause increased noise to the measurement when the web is vibrating. Also, there is usually a moisture dip associated with this phenomenon as a function of angle. If zero degrees angle is required for some reason, the calibration should be done also at the same angle.

The meter is usually assembled in zero degrees longitudinal angle to the web. It has practically no harmful effects from gloss or calendering. The meter is designed to be used to measure a web which is assumed to be planar. If the web is curved, as it may happen when measuring on top of a roller, that will affect the reading, if the calibration is done with a planar sample. Also, any angles to the web for the meter will cause more or less offsets into the signal. All these shifts in moisture signal can be corrected with the Adjust operation explained later. One can also use the manual standardization for this purpose affecting all calibration tables simultaneously.

The latitudinal angle is perpendicular to the longitudinal angle in the plane of the material surface. There is no reason to deviate from this.

The third angle (rotation around the surface normal) is usually not significant in **AK50**. The angle can be chosen the most convenient for the assembly. The meter has an elongated spot form and it can be assembled along the web to minimize noise components from the running web. Simultaneously, the cross profile can be kept accurate as the spot width is rather small when assembling into a scanner. The optimum angle in some cases is such that the meter's blank end plate meets the running web first and the web leaves with the cable from the meter. This is especially good in cases where the web is broken or piecewise. In this way the moisture transients form the edges are minimized.

Mounting

The meter has 4 + 4 metric threads M8 and M10 under the box at the corners. You can use these for fixing. To have a steady and secure assembly, *use at least two bolts*. The assembly position should be selected so that the cables can be lead out of the meter without excessive strain or too sharp bends. Also servicing access should be made easy. It is not recommended to replace the ITT Cannon connector with fixed cable via screw terminals inside the meter. That would create huge unnecessary maintenance problems in the future. The ITT Cannon connectors have been observed to be highly reliable and durable in service in requiring conditions.

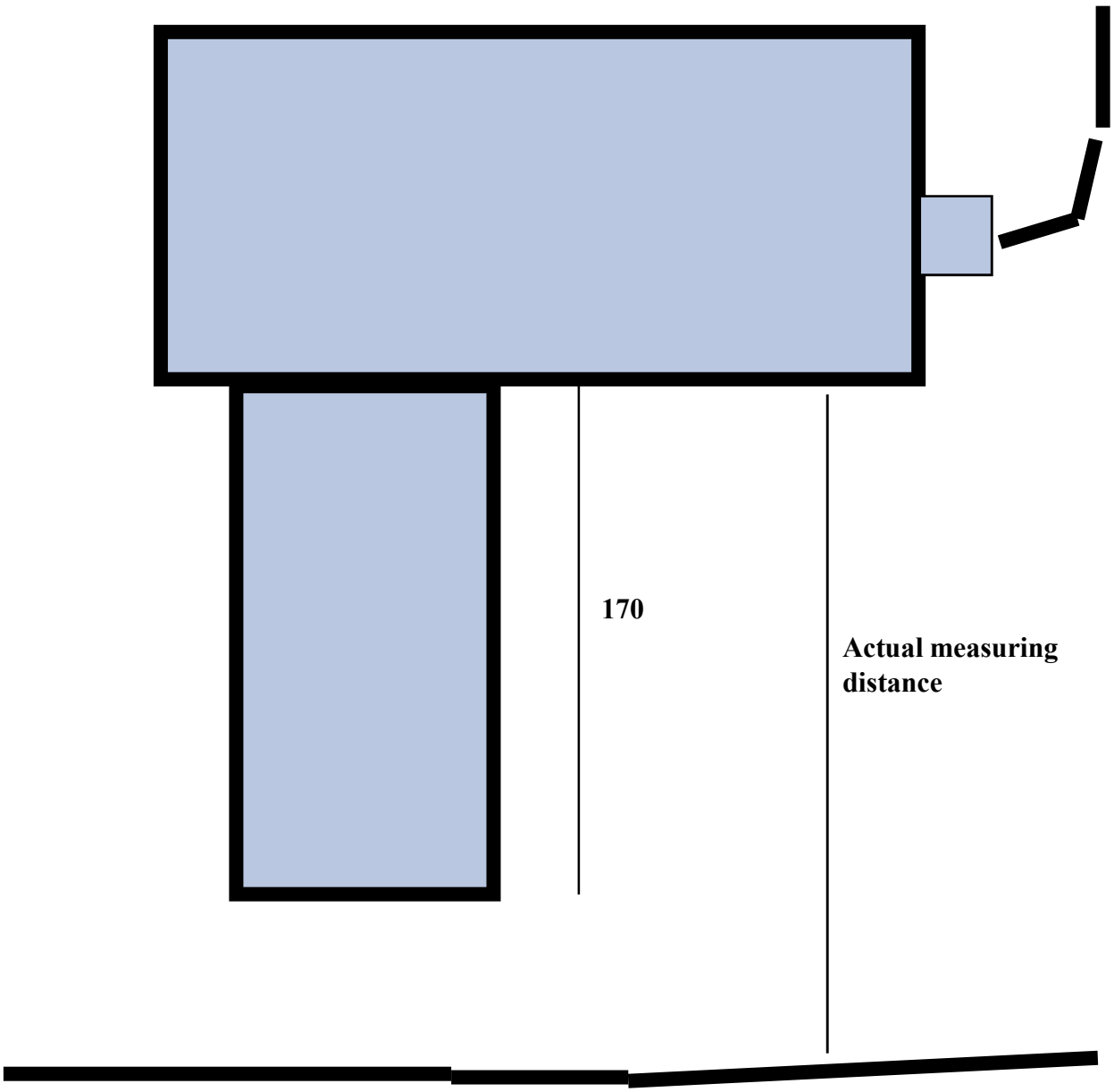


Figure L9-1. Mechanical dimensions of AK50 moisture meter (not to scale) and definitions of some of the terms (the longitudinal angle). The drawing is valid for Rev 6S. Other variants exist

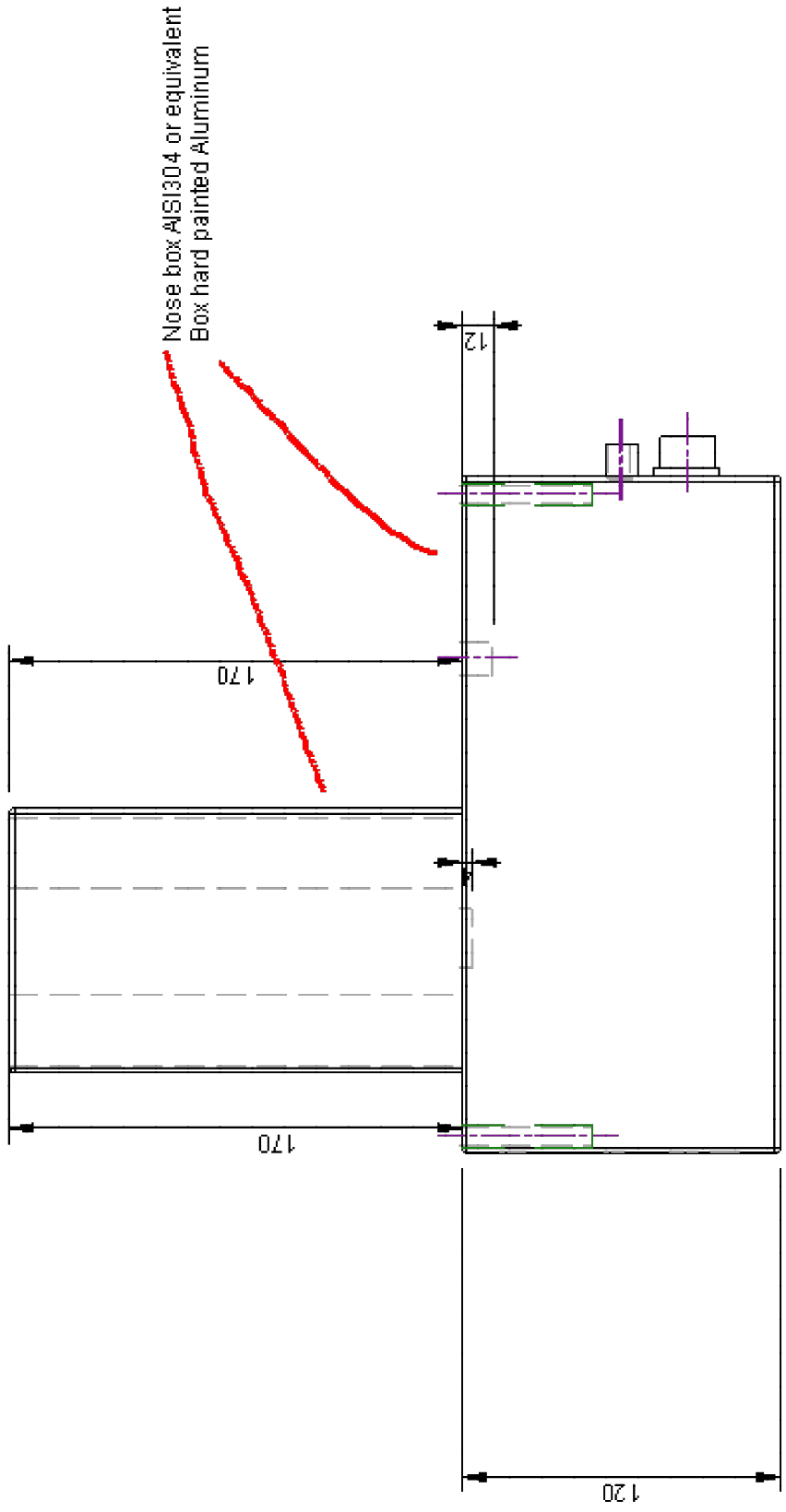


Figure L9-2. Mechanical dimensions of model **AK50** with the nose box, not to scale. The drawing is valid for Rev 6S.

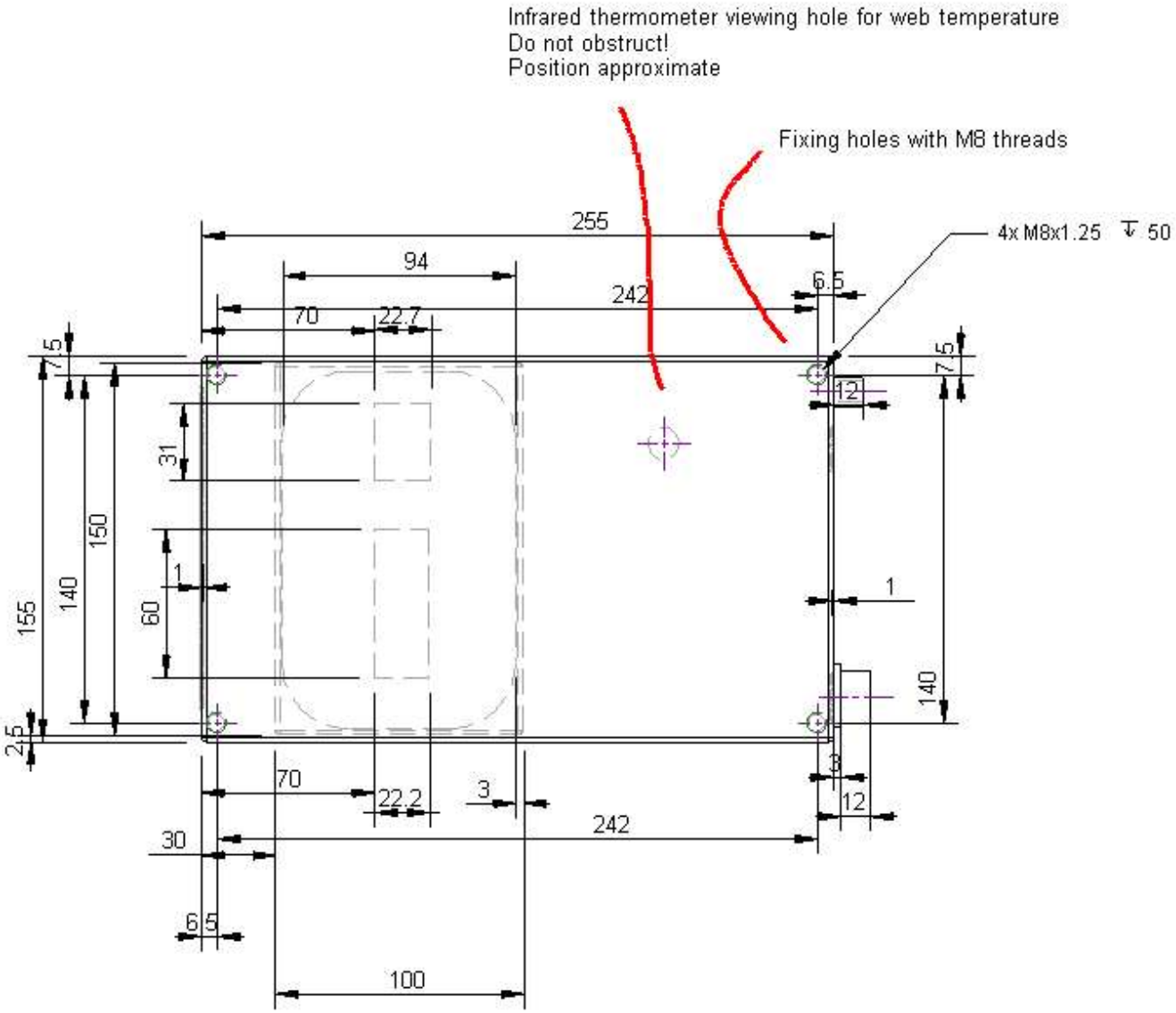


Figure L9-3. Mechanical dimensions of model **AK50,** not to scale. The drawing is valid for Rev 6S.

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