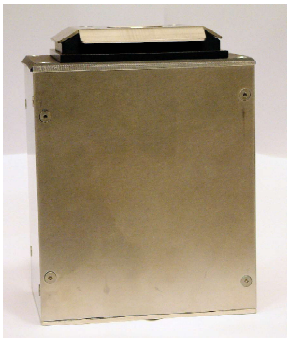
USER'S MANUAL

MK30R

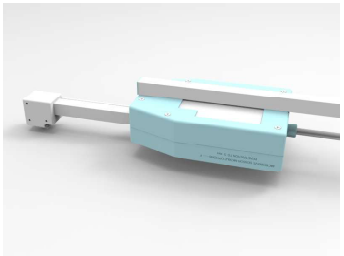
PORTABLE DEEP MOISTURE METER
AND

MK30LP

ON-LINE DEEP MOISTURE METER



MK30LP-CUBE

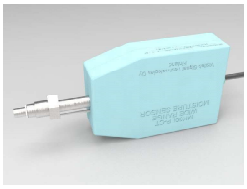


MK30LP

MK30R

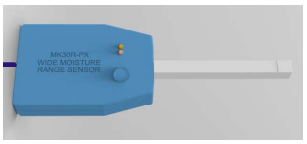


MK30LP-CT



MK30LP-CTB





MK30R-PX and -PF

Unit information:

Model: MK30R_____
Serial number:
Firmware V
PCB: K51, K57, K58EF
Adjusted:
Service Interval (hours):

Made in Finland
Manual printed in
Monninkylä, Finland
PART #700170

2026-30

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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 MK30 moisture meter from the date of purchase. The guarantee covers all faults and misalignment 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. The guarantee does not cover faults caused by errors or neglects of the user nor those faults which are caused by deliberate breaking. 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 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 sensing head and parts on the electronics board. The instrument can be opened only strictly according to the instructions in this manual and should not be disassembled unnecessarily.

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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 MK30R instrument, either to himself or to any third party. **Apply special care when measuring around running paper machines and other moving parts of a machinery.**

There are some warning messages in this manual printed in red. Instruction and important details are highlighted in blue and brown.

EC Declaration of Conformity

We

Visilab Signal Technologies Oy
Sepäntie 4
FI-07230 Monninkylä
FINLAND

declare that the

MK30R Portable Moisture Meter and Its Variants

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

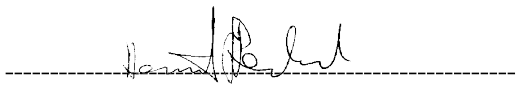
Emissions:

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
1st October 2018

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 sensing head or galvanic isolations for signals and transient absorbers for other lines to conform to the EMC directives.

Addendum to the EMC certification:

The new MK30R model is manufactured to even tighter specifications compared to the earlier model AK30. Therefore, it does not pose any danger not to comply with the EMC directive.

EC Declaration of Conformity

We

Visilab Signal Technologies Oy
Sepäntie 4
FI-07230 Monninkylä
FINLAND

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

MK30R Portable Moisture Meter and Its Variants

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
1st October 2018

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. The new model MK30R is manufactured with RoHS compatible parts but is not presently required to comply with this directive.



The MK30R portable deep moisture meter
The MK30R-DISP module looks exactly the same

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1. Introduction and Taking into Use

We congratulate you for your decision of becoming a user of **MK30R**, **MK30R-PX** or -**PF** or **MK30LP** moisture meter. It has been designed to withstand harsh environments and to offer you as much moisture information 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. MK30R is based on low power UHF radio waves which are safe for the user and enable measurement to great depths in the materials compared to optical instruments. Refer to the MK30LP-specific section on any product details for it.

MK30R is taken out from its package carefully and it should be inspected for any damages during the shipping. If any damage is visible, contact the manufacturer or the representative of which the unit was bought. The following items should be available (the MK30LP if presented later in this document):

1. **MK30R** *instrument or* **MK30R-PX / MK30R-PF** *or* ***MK30LP*** *any of its variants*
2. *Program USB stick*
3. *Bluetooth master for PC USB*
4. *User's manuals in a binder*
5. *An AC-DC power source, CE-marked and approved according to model*
6. *Carrying case*
7. Optional accessories ordered separately

If something is missing, inform your dealer and he will ship any missing parts. The instrument is ready for use. You can switch the power on using the switch located at the right end of the meter. The instrument should now display some text on its display and soon it should be measuring. If nothing is visible, the batteries may be dead. That is caused by a long freight time or a stay in a long intermediate depot. The batteries are always loaded before shipping. In that case you should connect the charger cable as instructed below to regain their full capacity. You can use the meter while charging.

Connecting the Cables and Starting the Meter

We ask the user to handle the connectors and cables carefully and to avoid too much force while attaching or detaching. Refer to Fig. 1. for cable connections.

The cables are connected as follows. The charger cable jack is pushed to the corresponding receptacle in the MK30R meter handle, that's it. The communications operate via Bluetooth wireless radio link and the PC end will installation of the receiving node to one of its USB ports. The power adaptor is placed to the mains connection (230 V 50 Hz / 115 VAC 60 Hz or any other local standard). Turn on **MK30R** by using the toggle switch.

There should soon be some text on the display indicating that the meter is starting. The batteries are always under charging while the power supply is connected to the instrument through the cable, **independently of the power switch setting**. The battery itself determines if there is any need for actual charging and indicates this with its own LEDs visible through the keyboard panel. The instrument can always be used normally when charging the batteries except the mobile range is limited to the length of the cable. The charging time for empty batteries is approximately 10 hours. There is no limit for the charging time; the batteries are not damaged from continuous charging. If the instrument refuses to operate, contact your local representative or the factory. For the PC program installation, refer to the PC program user's manual. After a preliminary testing you can be assured that your **MK30R** will serve you for several years with very little service.

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 weight or dry weight of the material or it is the water density in the material. The practical moisture range (total percentage) with bulky materials is 0...99% and higher depending on the basis weight or density of the material to be measured. With thin materials the dry end will start reliably at around 6%. The instrument has been designed to give reliable values through all this range. The internal noise is very low at moistures below 50% and increases somewhat at higher levels and also at very low levels. The repeatability (see specifications) of the instrument is within +/-1.0% throughout the moisture range. The absolute accuracy depends on the calibration for the material. The calibration generates a group of points on a balance-% vs. meter signal plot. **MK30R** places segments of line onto this plot from one point to another thus linearizing the original meter response curve.

The internal sampling rate for moisture values is 3..10 Hz and the meter display is updated about once per two seconds. Note that if the meter is not over a material it will still show some reading which may be even negative. This is normal and is caused by the missing dry substance. Do no try to zero the reading while the meter is in the air as it will lead to incorrect results.

MK30R Application Areas

Suitable applications can be found in:

- pulp as plates, bales and as a running web
- corrugated
- boards
- felts in production and while in use
- paper reels and webs, running and static
- a distance meter for static reels to get an accurate profile
- textile products
- recycled materials
- biofuels
- wood species
- minerals, sand, soil
- peat
- animal food
- sawdust and wood chips
- can measure wet materials up to 8 000 g/m2 or a water layer of 8 mm

Special Features of the Instrument

MK30R is able to measure with an area of 40 mm in diameter and is able to penetrate down to 30 mm in depth. The moisture range usually starts at about 2 % and goes to 100 % total moisture. MK30R will react in an unwanted way if the material contains Titanium oxide, soothe or metal particles. Measurement always requires a good contact to the measuring material. On a planar surface the measuring skid must be in plane with no tilting. If the material contains air in any form, it will affect the result. If the material is fluffy, it must be compressed to that density which is required for determination of moisture. Also if the product is layered with air, it must be compressed to squeeze out any air and settle the layers. If the material contains air, its moisture reading will be lower than if it does not.

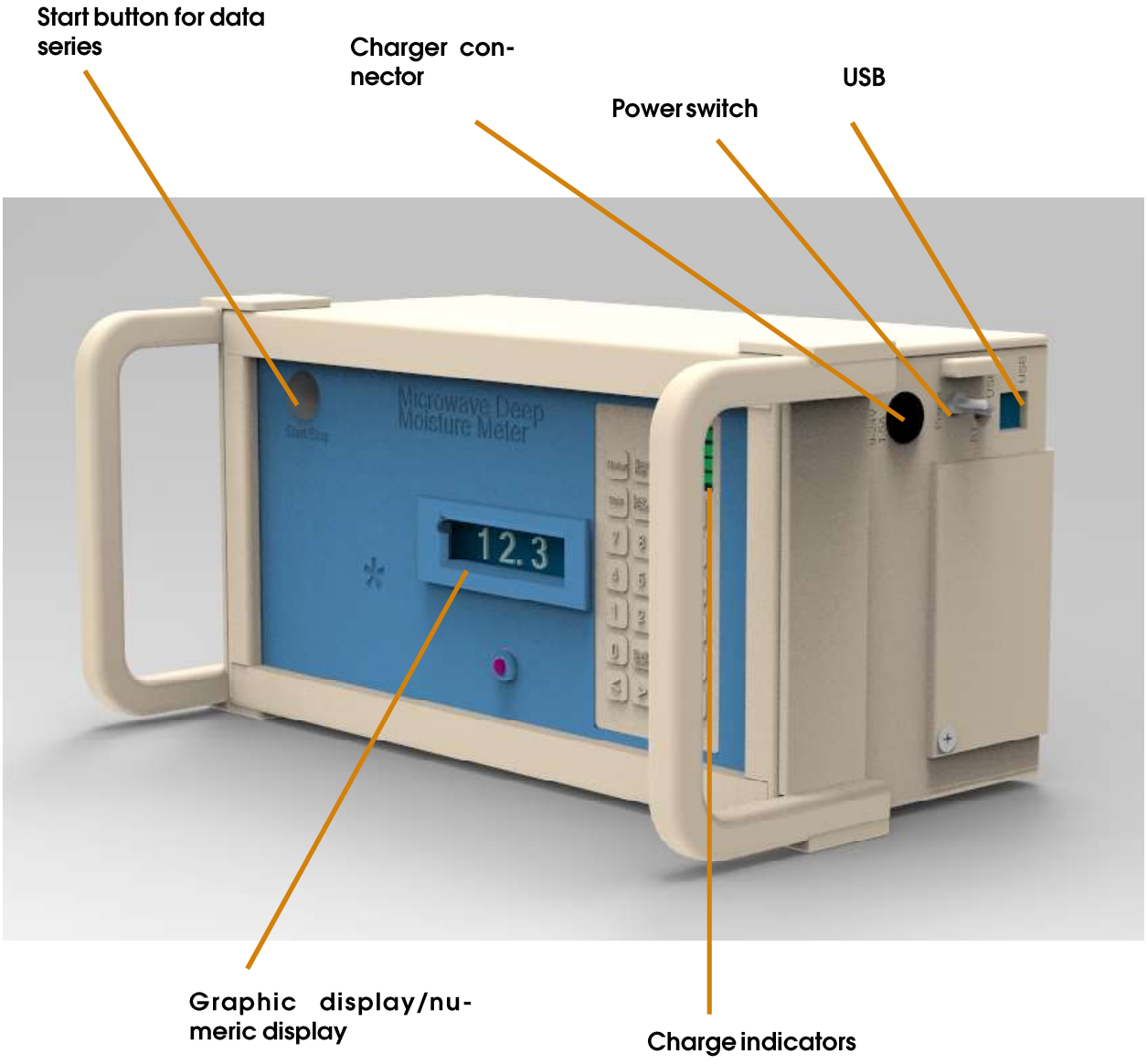


Figure 1A. Cable connections for MK30R

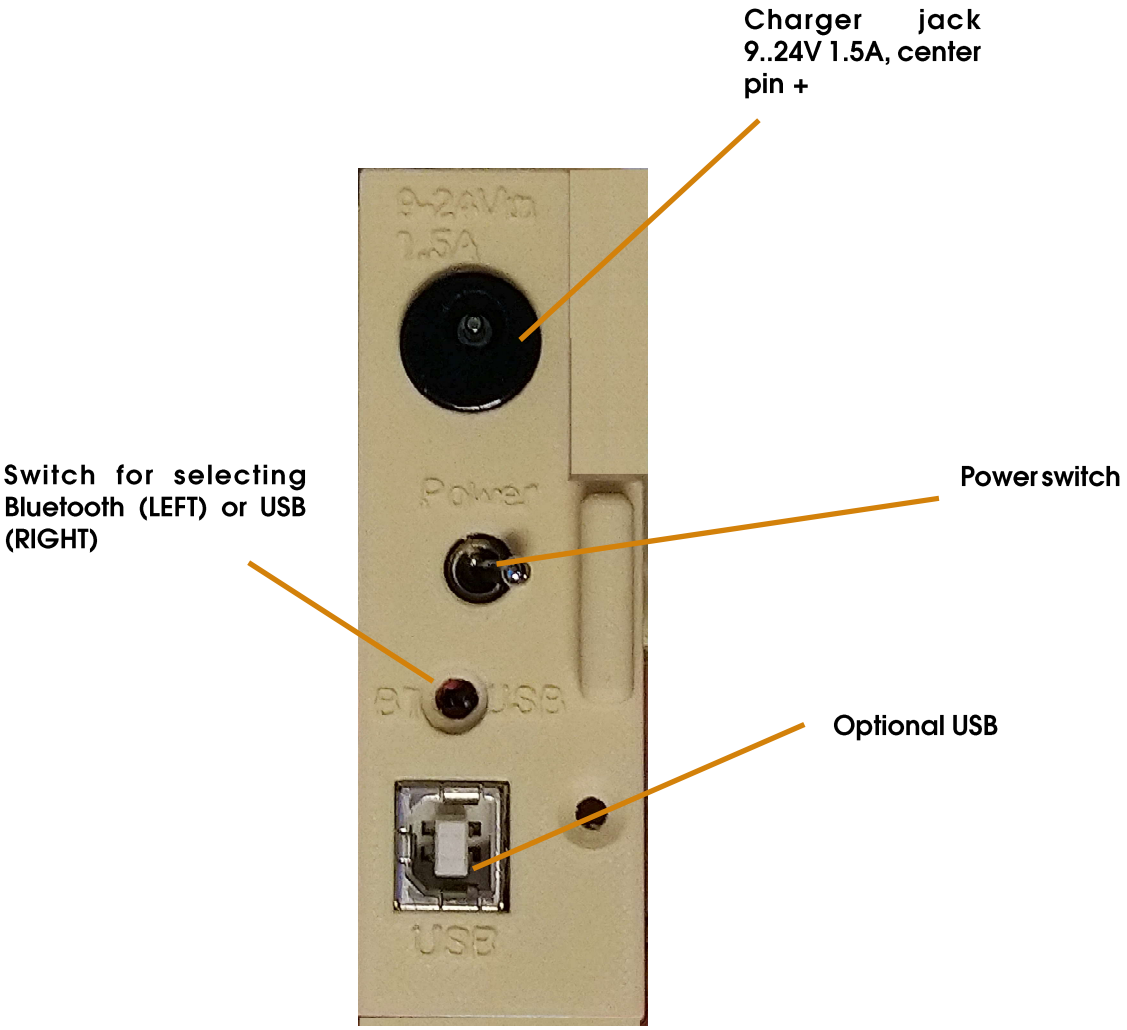


Figure 1B. Connectors and switches in MK30R on the right panel

Indicators, one shows when the data is collected (Start) and the other one gives a crude estimate of the measured moisture level with its intensity, applies to model MK30R-PX and -PF

Start / Stop-button

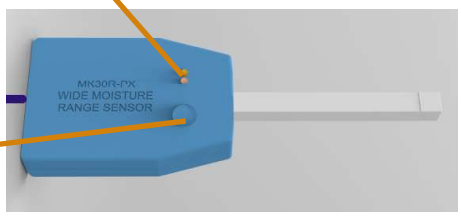




Figure 1C. MK30R-PX / MK30R-PF instruments look the same. The manual sensor is attached to the connector on the back side.

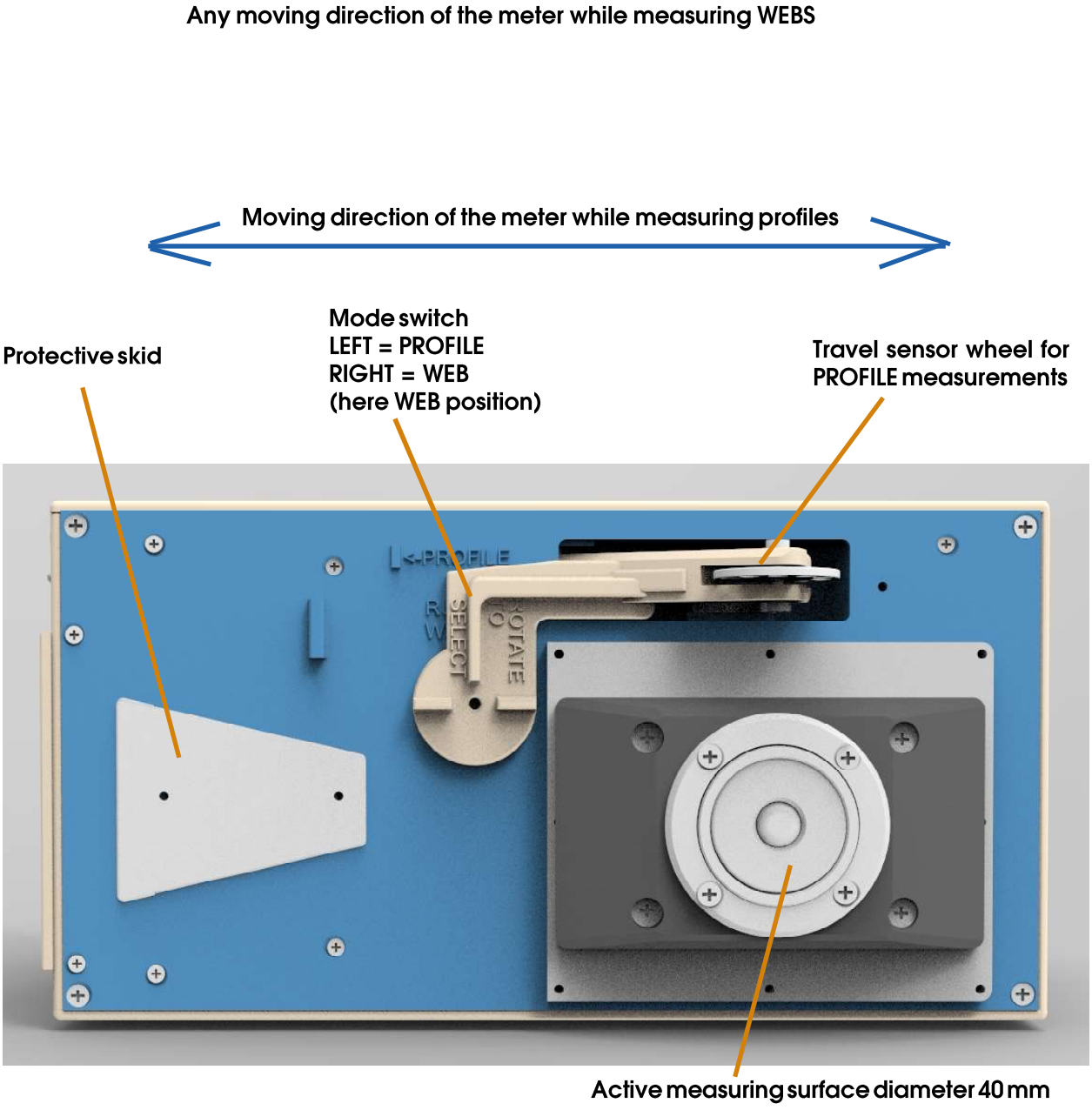


Figure 1D. Selector switch for WEB or PROFILE measurements on the bottom of the meter. Avoid running in cross directions when the travel sensor wheel is extended. **Maintain the switch in WEB setting when not actively measuring profiles to keep the wheel safe.**

MK30R-PX and -PF are slightly different from the MK30R. The penetration is 5 mm ánd the measuring area is 10 mm in diameter.The moisture range extremely wide from 2% to very wet samples.

MK30LP-CT penetrates to 3 mm and the measuring area is 4.0 mm in diameter. The corresponding readings for the **MK30LP-CTB** are 7 mm and 10.0 mm. These models can measure from 4% to plain water.

Philosophy of the Meter

MK30R has its own philosophy regarding its use. Its settings can be saved to a nonvolatile memory and are restored each time the meter is powered on. **If some specific setting is important, save it.** Go to the Menu and then press the **Save** button. Temporary configuration changes are not saved, it is the responsibility of the user to maintain this saving.

Operating Characteristics

MK30R is designed for handheld operation by moving the meter over the material of interest and reading the measured moisture. **Contact is required** but the meter can be laying on it or it can touch a moving or rotating roll or web. The meter has a durable stainless steel skid under it allowing reliable and safe working leaving no streaks to paper and board materials. The sensitive measuring area is about 40 mm in diameter and MK30R is able to measure down to 30 mm in depth in most fibre materials. Avoid any tilting or imprecise touch as that will cause errors to the reading. See the Fig. 2 for incorrect and optimum handling of the instrument. **Observation of this fact is critical for getting good results.** The measurements on a running web should be only of short term due to heating of the skid caused by friction. If this kind of measurement is really important, please contact the manufacturer to add a purge air cooling to the skid. See Fig. 2 and 3. for operating cautions. Fig. 4 shows the safe operating range for MK30R. For safety alone, the manufacturer does not recommend freehand measurements on a running web. Extreme care must be used.

MK30R is equipped with a keyboard and a display with background lighting for portable field use. With them the user can modify instrument settings and perform new calibrations. The latest moisture value is updated to the display when in measuring state, without extra operations. There are two display modes: A big numeric display or a multiple display. The numeric display shows the moisture with two digits and one decimal. The reading can be frozen by pressing the logo key and an **H** letter appears at the right corner of one of the digits. Pressing again the logo key will release the HOLD. The other display mode (default) uses the three display modules differently. The leftmost display holds a graph of the recent moisture values progressing at a time interval preset in the menus. The default time interval is 0.5 seconds. The center display shows the moisture with digits and also indicates other pertinent data about the calibration table in use etc. The right display is mainly used for the menu system. The center and right displays both serve as media for sending out messages and reports by the meter. Many dialogs open up in the right display when using the menus. To switch between the two modes, press the keys LEFT/RIGHT arrows.

MK30R is equipped with a travel sensor which is taken into use by turning the switch under the meter. The purpose of the switch is to keep the sensor in its holding position when not in use. There is an electrical switch sensing the position of the sensor making it into full readiness right away. MK30R is acting either as in time series mode (WEB) or reel mode (REEL) producing an accurate location information for profiles. **When the travel sensor is not used it must be kept in its safe position to avoid damage while measuring in difficult conditions.** Else it may be damaged. There is no harm in making all measurements manually without the travel sensor.

Figure 2. Important operating guidance for MK30R

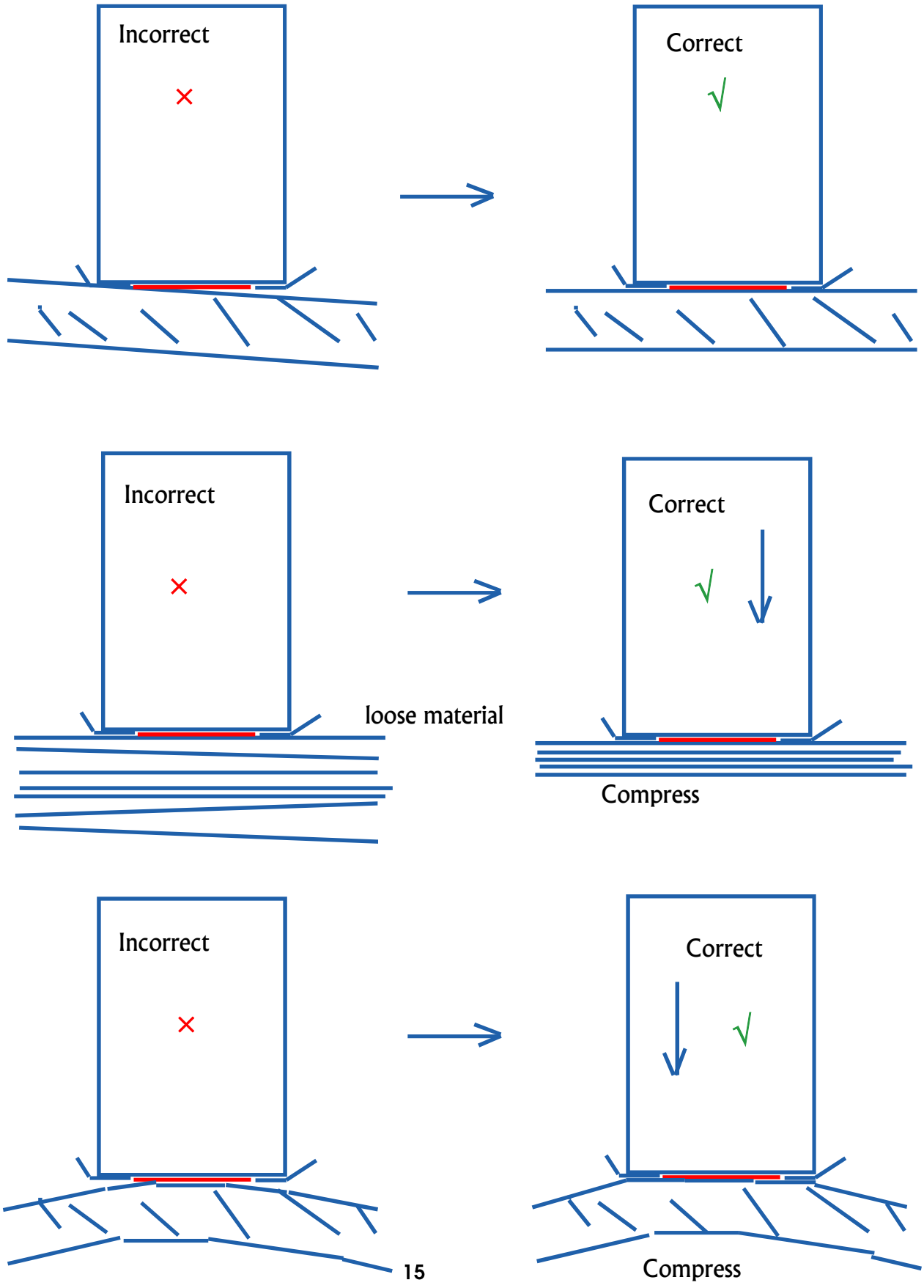
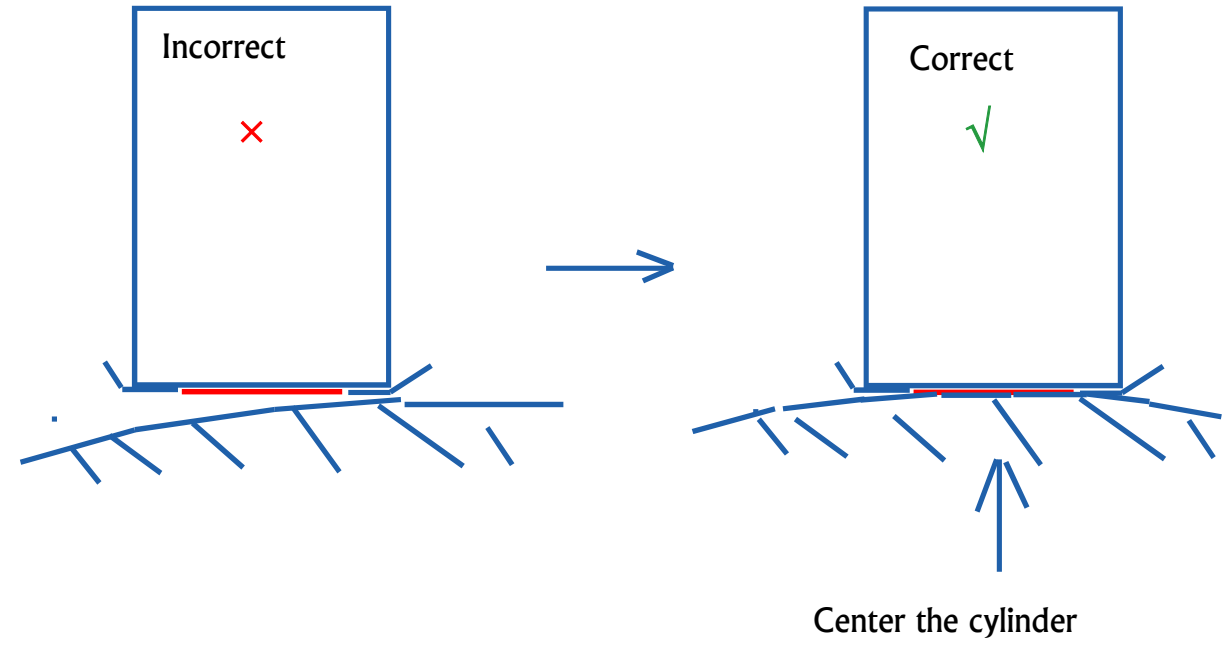
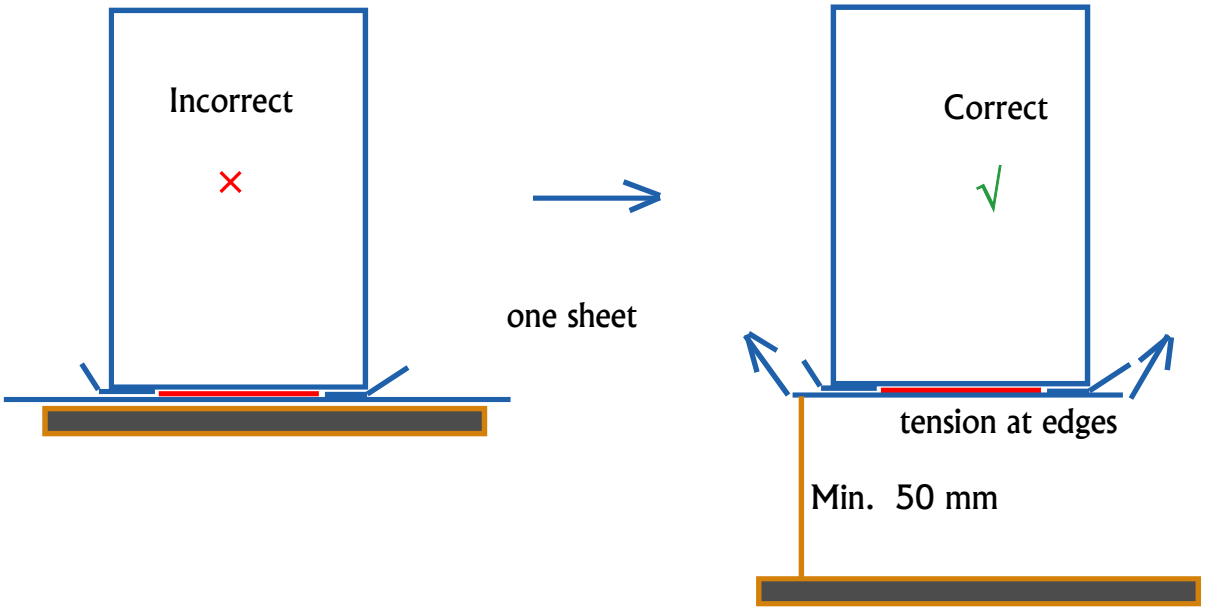
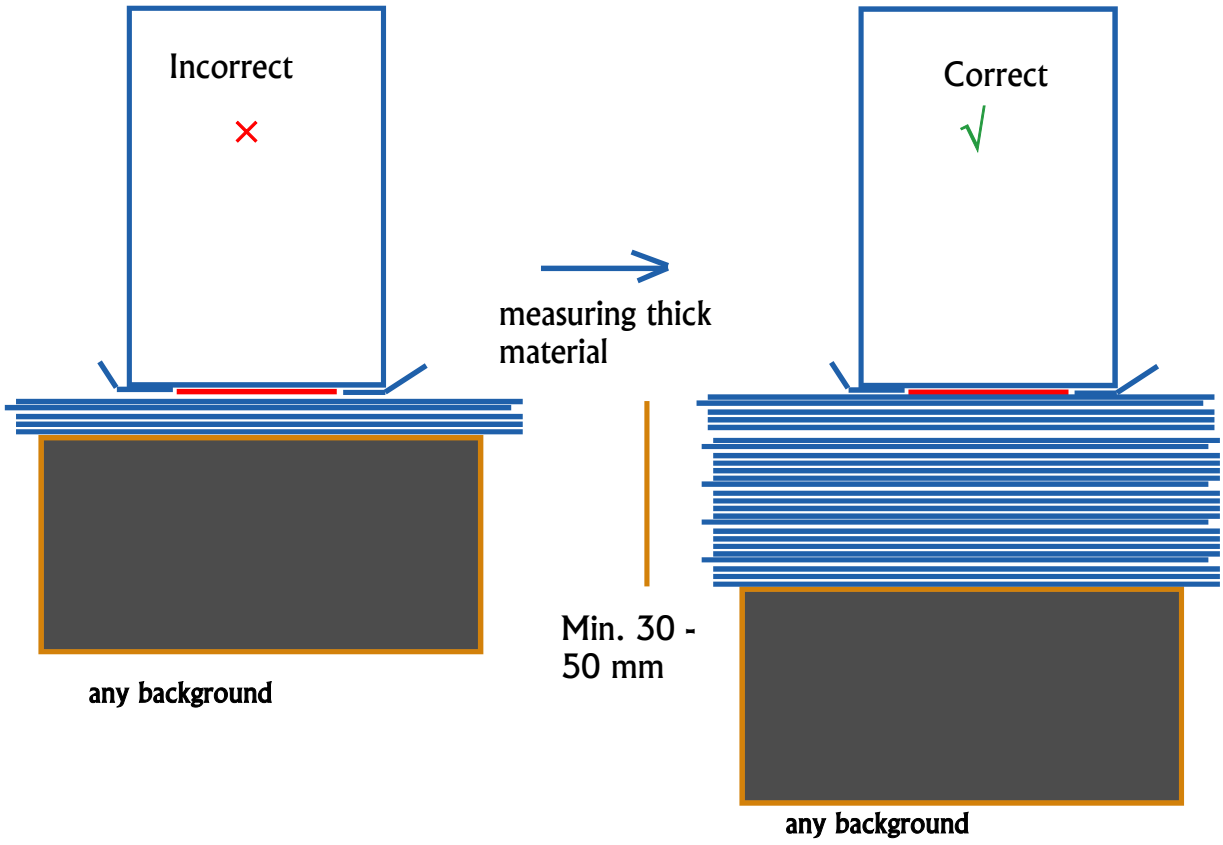
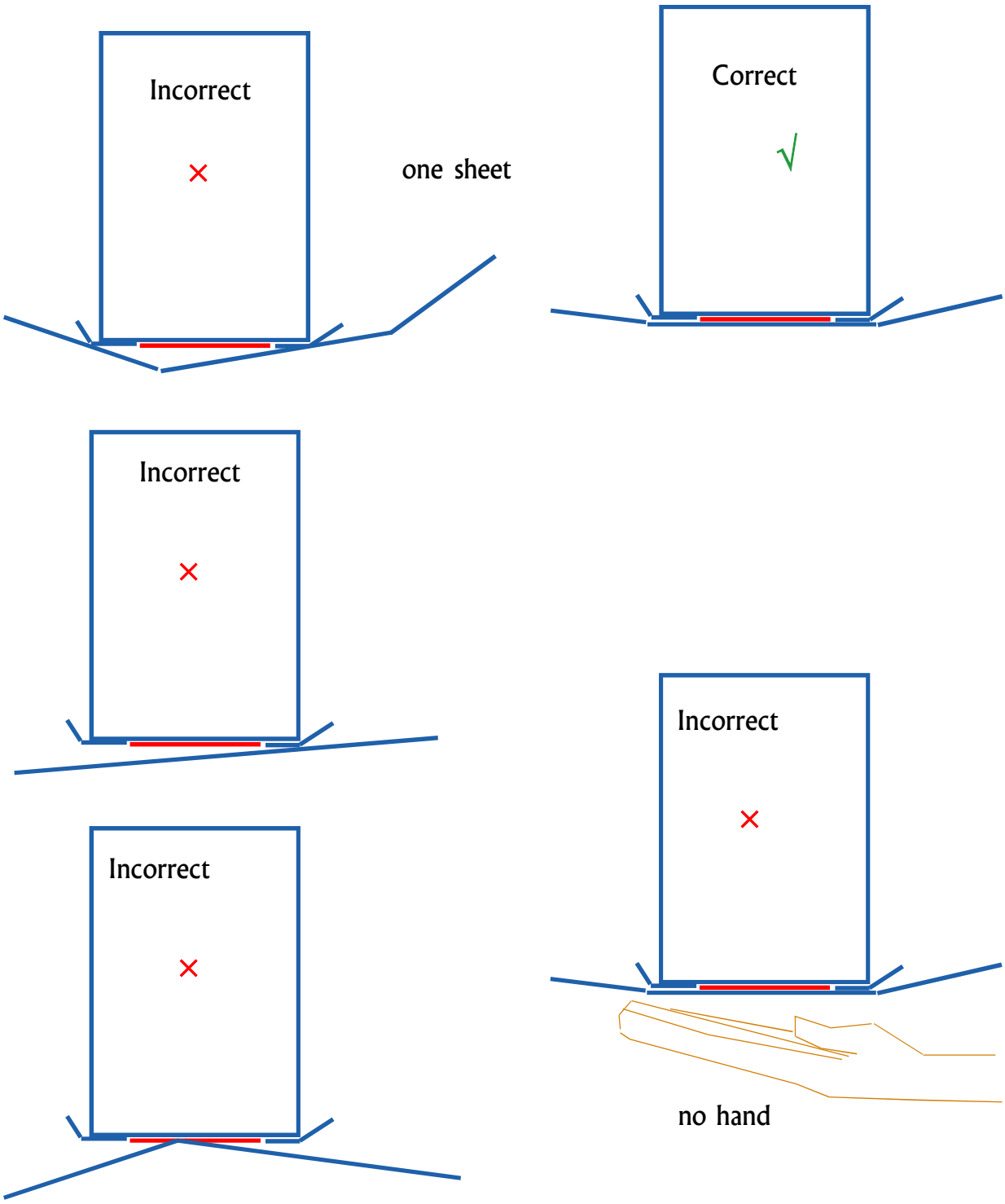


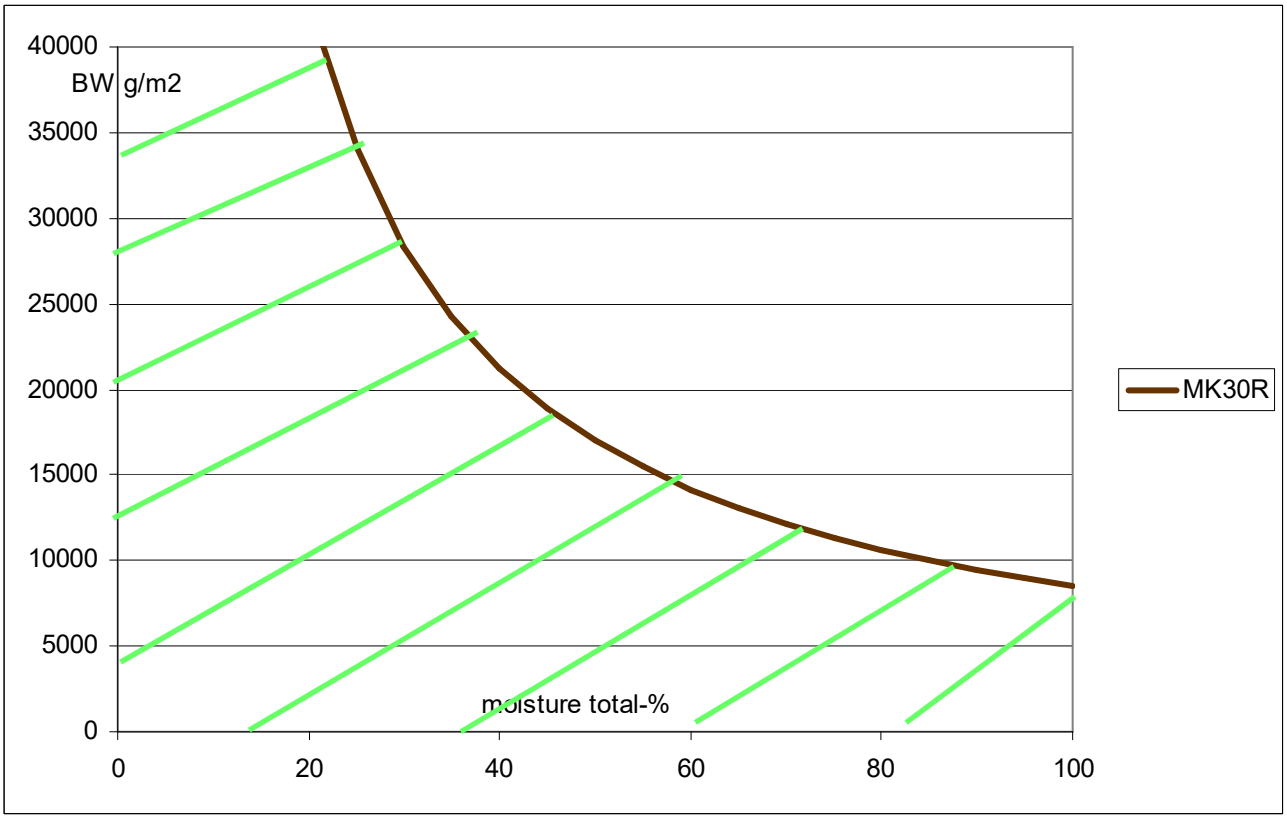
Figure 3. Important operating guidance for MK30R






Incorrect
×
any background
measuring thick material
Min. 30 - 50 mm
Correct
√
any background


Incorrect
×
one sheet
Correct
√
Incorrect
×
Incorrect
×
Incorrect
×
no hand



The moisture range of various special versions of MK30LP varies, depending on the cavity used. Refer to their particular manuals and specification details

Figure 4. Reliable operating range for MK30R

Note

The earlier DRY/WET selection has been dropped and the meters work always with the full range of moisture content.

The measuring action is always the following. First, the need for the travel sensors is checked and then the MK30R is lightly pressed against the surface. You should wait for a few seconds and then hold tightly of the handles. With a left hand finger press the **Start** button to initiate data acquisition and start moving along the surface. In WEB mode just keep it steady on the running web and concentrate on your own safety. It is important to keep the MK30R sensing head parallel to the surface to keep away air. When the other edge of the reel is at hand, press again the Start button to stop. The WEB measurement is stopped with it too. Note that the MK30R should be set into the **FAST** state in the menu to have the maximum speed in profile measurements with the travel sensor. MK30R will allow about 10 points/s at a distance increment of 20 mm which is equal to 20 cm/s movement for an accurate profile. If the speed is too high, then the latest reading will be filled in to the profile at that point. You can also use the "+"-key for starting and the "-"-key for stopping.

The instrument has a sample memory which may contain up to 500 x 820 = 410 000 samples. The memory is thus divided into 820 memory Banks which can each hold up to 500 samples. These may be either time series or reel/web profiles. The autotimer may fill a new Bank at user's control and may operate at any sampling interval between 0.2 s and 32000 s. The autotimer operates in batches to collect only a predetermined number of samples (1 to 500). Single moisture samples can thus be saved (Batch = 1), each into its own bank by pressing the '+' key on the panel or the button in the handle. That will spend a lot of banks if several points are to be taken into memory. In that case, some more efficient way of using the meter may be possible. The recent history visible on the left graph can be saved with the Save key and it will store 64 points at once to a new Bank. Typical number of reuse for each bank is 100 000 times so you don't need to be worried of wearing out the memory chip. When doing profile measurements it is best to use the normal mode and do the stopping with the Start button.

Please note that every bank has an associated date/time field whose contents are shown both on the center display when retrieved and in PC programs. To take it into use, please check the date & time after starting the meter. It is done by pressing '0' and from that menu branching to date and time sections. You can edit the date and time fields by typing in the correct data, moving with the LEFT/ RIGHT keys, accepting with Enter or ESC keys. By pressing the ESC key a few times will bring you back to the top of the menu system where the measurements are done. An internal clock will keep the time correct until the meter is turned off. This is a most useful feature to be carefully maintained since the memory banks can hold data for about 40 years or more. It is impossible later to identify an old measurement if even no date is associated with it.

A reference to a text field called **LABEL** is also saved to the memory bank together with the calibration table name used. They together form a **recipe**. There are five recipes and the labels are editable by the user. The field length is eight characters. The recipe can be chosen with the keys "2" and "3" while measuring. It is needed to select first the recipe before starting the Autotimer since selecting it afterwards is too late. The reference to the recipe is then saved to the bank. When the bank is transferred to the PC, the actual label is added to the data and also the table information. The label will determine the first part of the data file name and the rest of it is dictated by the time label. Afterwards it is then easy to recognize the origin of the data and the original time of capture.

The label is wise to be selected according to the measuring conditions, like the point at the PM. It is also good to stick to the label system once adopted to help recognition of data files in the future. Examples of labels would be "Reel 12", "Coater 2", "Felt 5". When ending the editing of the label, a question is asked if you wish to use the current calibration table with this recipe. This will take effect when you switch the recipe. If a table is used with the recipe, the calibration table is switched too, else the earlier calibration table is kept and only the label is switched. Still, one can always switch the calibration table at will. The calibration table in use is saved in all cases to the memory bank information. That table name is shown while browsing memory banks and when statistics are calculated from a bank. The calibration table name is also indicated in the file tag.

Downloading the memory banks one at a time to a PC is also possible and highly recommended if the data is valuable later. The PC programs support also downloading of a group of consequent banks whose numbers are selected. The **whole** memory bank system is erased with one operation in the Service menu when needed. The need arises the latest when all of the 820 Banks are used.

The meter is able to remember the **latest** bank measured at some earlier occasion. Its contents can be retrieved by calculating its statistics (press the Stat's key). Other Banks (profiles) can be retrieved by scrolling with the **UP/DOWN** arrows.

Another mode which is of importance at this time, is the **TABLES** or **BANKS** mode. The BANKS mode is the default. In BANKS mode the arrows UP/DOWN cause selection of a Bank with some contents. If accessing an empty bank is attempted, a message "UNUSED" will appear. In TABLES mode the same keys select another calibration table into use. The mode itself is indicated on the right display to avoid mistakes. The library of calibration tables is 100 wide and not all of them are populated. It depends on the manufacturer how wide a library is sent with the meter, usually at least a few generally useful calibrations are added. The calibration table can be quickly switched by the UP/DOWN keys. The table is immediately in use but a peak may appear in the moisture signal because of the rapid switching.

A nonvolatile memory is used for saving all settings and the data Banks independently of power status. The configuration data saving requires the user's action. If saving is not done, on the next session after powering up, the earlier saved settings are used.

The background colour of the displays can be tailored to indicate the user of exceeding preset moisture levels high and low (Alarm feature). The meter can be moved over the material and when the moisture either falls below the low level or goes beyond the high level, the corresponding background colour appear.

A PC may inquire the meter for a new moisture value with similar time intervals. The series can be uploaded to a PC or it can be browsed in the meter. Also statistics can be calculated easily.

MK30R has a rechargeable Lithium Ion battery offering at least 8 hours of continuous use before recharging is required. There is an energy-saving Low Power Mode enabling a still longer period of operation without continuous measurement possibility. The meter recovers from it quickly and one is able to measure again. This mode is intended to be used while setting up measurements or while transferring data in field conditions. By pressing the LowPower key one can control this feature.

The meter has an optional Sleep mode available. When turned on, the meter will function normally for one hour and then it will put itself into Low Power mode automatically. The Service menu contains the setting up of this feature. The second option is DIM which will not turn the meter to low power but only dim the display to save energy.

If the battery is run down after a long period of use, turn the meter off and plug it in to the power source for charging. Do not let the meter to stay uncharged for a long time.

The instrument is portable and 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. There is a soft plastic ring in the meter's sensing head. It is important to keep it clean to get correct readings. Dust, dirt or water on it will interfere. Do not scratch the plastic ring. Optional model with IP67 classification is available.

Calibration Libraries

The calibration library in the instrument offers calibration information for some products in paper and board industry. Each calibration holds a unique position among the 100 different calibrations. One can further develop and complete the library with **MK30R** and save them to a PC. Correspondingly, one can also transfer from PC any library to **MK30R**. It is also possible to move particular calibration tables into any direction to tailor a special library. The meter has been designed to give a raw signal already giving a relatively good moisture reading for a thick pulp between 7 and 90 %.

MK30R moisture meters are manufactured according to close tolerances. The units are similar to each other and they are finally adjusted to be as close to each other as possible. The libraries are compatible within the model and can be transferred to other units of same model in your company. The library error tolerance is typically better than +/-2.0% in the 0...10% range. Some fine tuning may be required for best results. This is now very easy to do with the Automatic Fine tuning feature of the Advanced software (optional, licensed). The other PC programs have this feature as a manual operation.

MK30R 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 **balance**). **Climatic chamber** with controllable relative humidity and perhaps controllable temperature is recommended for more exacting work. That will also increase the accuracy and diminish deviations. The moisture varies in many substances due to factors like air flow, temperature differences and external relative humidity. In extremely accurate calibrations. Also effects of static electricity (at dry end) and water condensation (at wet end) must be taken into account. Static electricity may cause mechanical forces to highly sensitive balances interfering severely. An air ionizer is recommended for such cases.

Using up to 10 calibration points will ensure good accuracy on a larger moisture range if the points are selected carefully and the curvature of the curve insists on it. This is called MULTI calibration. The number of calibration points is a flexible quantity. There is also a fast two-point calibration (actually a scaling only), the **SCALE-mode**. It is applied for transferring nonlinear moisture signal to PC. Note that **MK30R** is not able to reverse the linearization process to gain the original nonlinear raw signal. If the nonlinear raw signal is required, it must be collected separately (by scaling it only). The user is not able to change the SCALE scaling as it is fixed for simplicity. Typical behavior of MK30R is very linear above 7 % and a slight curve below 7 %. The program Advanced has a utility for restoring a profile/ time series made with an incorrect calibration to the correct one.

MK30R can be connected to a PC by using Bluetooth wireless link. One is then able to modify some of the meter's settings and download to PC the data series which is collected earlier at the field. The data can be further handled with the program following the instrument or can be saved into files. Then the data can be more extensively manipulated with e.g. spreadsheet programs. Also the libraries can be manipulated through the serial port. Currently we can offer ATOM, AK30, AK30Mini, IRMA7Basic and Advanced programs for handling data and meter configurations. The AK30 and AK30Mini have now also French language versions. Special product-related programs will appear freely downloadable for all users.

Moisture data acquisition can be done with a PC through the Bluetooth offering a long distance operation (up to 100 meters) without a cable. The packet protocol used in data transfer is a private, very reliable and fast fault tolerant protocol. Some details of it are listed in Appendix 3.

3. Use of the Instrument

Menus and Settings

Next we will go through all settings and options of the moisture meter accessible through menus. You can refer to Appendix 12 for a graphic presentation of the menu system. When starting your **MK30R,** it shows momentarily the unit serial number. Then it is always in the normal **measuring state** which is the default state. The default modes are **BANKS** and **multiple display**. The meter is ready for measuring with a relatively good accuracy. Best accuracy is reached after about 1 minute. The error at cold start is usually much less than +/-0.3% in moisture. In the measuring state there is visible the moisture reading and the graph display. It shows a curve of the moisture trend in some scale which can be set in the menus (Curve). The graph can be made Autoranging too. Unfortunately, the display is limited to four lines with eight characters at each line. This limits the length of names and other fields.

The measuring state may look like the following (to the left the default BANKS mode and to the right the optional TABLES mode:

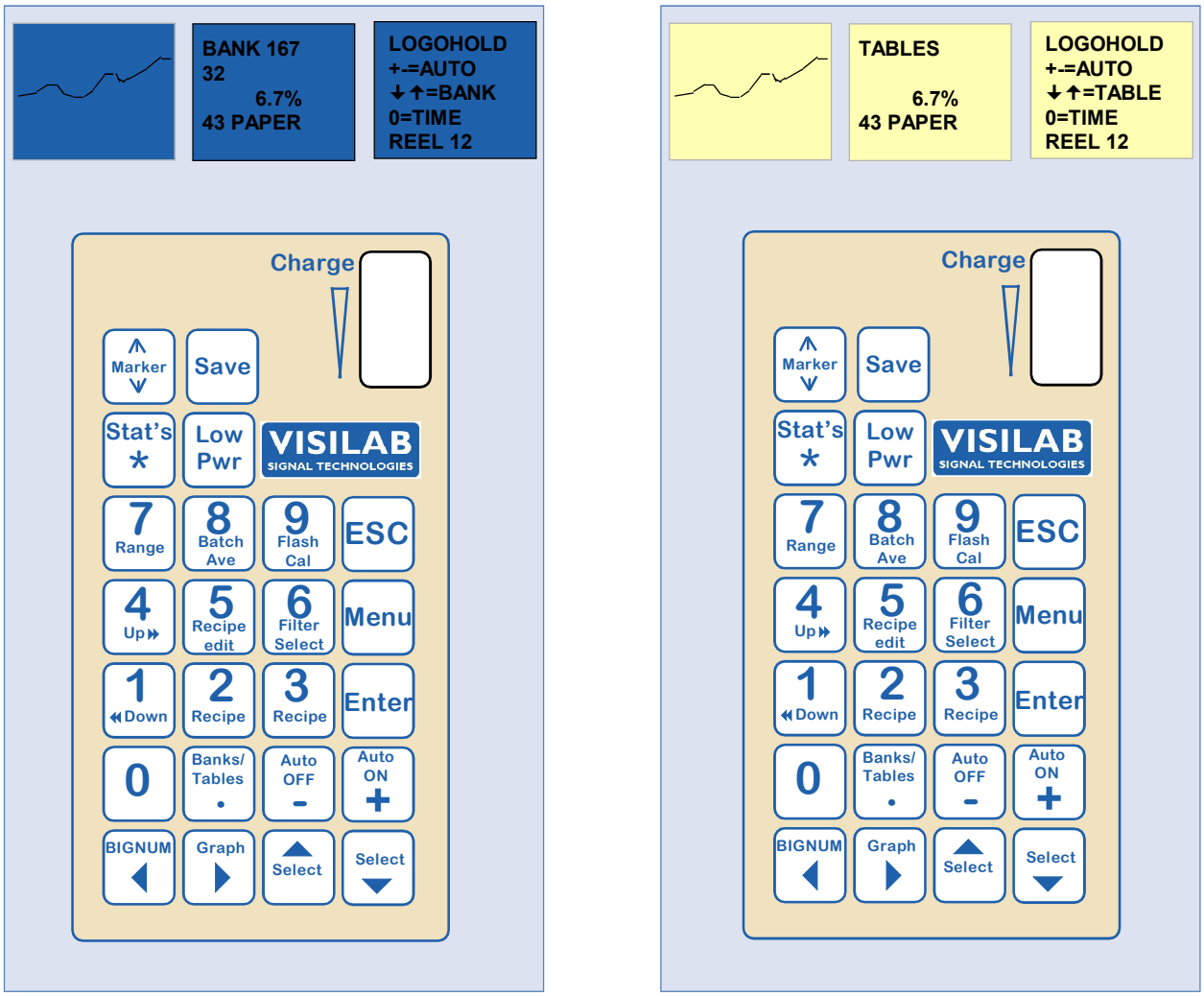


Figure 5. Keyboard panel and typical display contents in TABLES (blue display) and BANKS (yellow display) modes. Read the separate quick guide explaining the use of each key.

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 and displayed at the center display if possible. This may be violated when doing some calibration work or other special situations. The graph is updated whenever possible. **When one uses the menu system the special keys are not active until you return back to it.**

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. If one takes a batch of samples to a Bank with the Save or '+' keys, there will also be indicated the number of samples on the second line.

We can get to the menus by pressing the **Menu** key. The following display is then shown (main menu) with the full eight lines of text slowly scrolling in the display to show all available options. All other menus branch from this. Refer to Figure 5. for a display of the keys, the table just before it.

1=BANKS
2=CALIBR.
3=TABLE
4=ALARM
5=SERVIC
7=UNIT&C
8=CURVE
9=DISPLY

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, it will have no other effect but endeavor towards the top.***

Memory Banks

The memory banks offer to the user a way to save measurements done on the field. The series stay in the memory even when the meter power is turned off. New samples are added always contiguously after the last sample when the autotimer is started ('+' key to start, '-' key to stop). The data can be examined later, either in the instrument or in a PC. The banks can be browsed on the unit's display, statistics can be calculated and the whole bank system can be cleared. In a PC the displayed curve can be printed on paper or an HTML type report can be produced. Statistics can be calculated there too. Samples can be added to a bank in different ways:

1. **By pressing the front panel Save key (64 points)**

2. **By starting the autotimer, the bank is augmented at regular intervals and the number of samples is limited by a preset value, maximum 500. Sampling may also be done by the travel sensor**

3. **By starting the Autotimer from the PC program. This is the so called remote sampling. Otherwise it will work just like a button would have been pressed.**

There may be a maximum of 500 samples in one bank. If more samples are needed, a new bank is taken into use after restarting the Autotimer. The setup for sampling is done in Banks menu and one can get there by pressing "1".

1=INTRVL
2=BATCH
5=ERDATA
9=MORE..

and "9" opens up the next page:

7=LPF(s)
6=Stats:
FAST

The first line (1) offers the option to modify the Autotimer sampling interval. The second line (2) is for setting up the number of samples for each batch to be saved into a bank with the Autotimer. Here the option "5" allows erasing of all memory bank data. Be careful! Erased data can not be retrieved anymore.

On the next page the option "6" allows selection of the reporting speed. If it shows NORMAL, it is rather slow, else it is marked as FAST and the meter will only quickly flash the results. NONE setting will not show any statistics nor curve but allows a quick move to next operations. Option "7" allows editing the speed of the low-pass filter when in the SLOW setting, the response time to 90% accuracy in seconds. In the measurement state the key "6" is used to selecting between the speeds FAST, MEDIUM and SLOW.

Note! If while using the meter, a text appears in the center display: **MemFull** you will need to clear (erase) the memory bank system. Download all memory banks before clearing them.

Typing in Data

It is time we shortly go through the steps of how to edit numeric and textual data fields. The text cursor is an underline usually pointing 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 one uses the arrow keys to the left or right for stepping one number at a time. When the number is finally correct, you press the Enter key. 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. If a character needs to be removed, press the Menu key. You can return to editing the decimal number's whole part by using the arrow key LEFT.

There are a few dialogs where one can modify a text field which behaves differently from a numeric field. One can move again with the arrow keys LEFT/RIGHT and type in numbers and text characters. The textual characters (letters A-Z and special signs) can be found by pressing the numbers more than once in a row. They are hidden there just like in your mobile phone. One can also use the arrow keys UP/DOWN to rotate the full set of available characters.

To set up the sampling interval press "1". The interval is edited with a resolution of 0.1 s. The shortest time is 0.2 s and the longest is 32000 s. Note that the autotimer is able to operate even when in Low Power mode but the values obtained are invalid.

By pressing "2" you are asked of the batch size. You can enter a value between 0 and 500. **MK30R** takes only the preset number of samples and then stops the autotimer. Also a sound signal is associated with the ending. Note that if the SAMPLE line is activated in batch mode, the autotimer is started just as the Sample was pressed. If necessary, the sampling can be stopped before the Autotimer does it by pressing the '**-**' key.

Calibration menu

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

7=MULTI
3->MULTI
8=FLASH
9=MORE..

From here one with "7" to a multipoint calibration (**MULTI**). When a material is **MULTI** calibrated and one wishes to use the corresponding table, one presses "3" in this menu to change its calibration mode from SCALE to MULTI. The calibration mode can be toggled back and forth at will. As long as the mode is SCALE, the resulting moisture value is only scaled (default 100 X to offer more significant numbers). When the MULTI is selected as the mode for the current table, the 2 to 10 point calibration takes effect. When satisfied with the calibration, press the **Save key** to save the new calibration data to a nonvolatile memory in the library. The Flash calibration can be started in this menu by pressing "8". It can also be started by pressing "9" in the measuring state. Refer to the later section for its use.

General Information about Calibration

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 moisture is the same as the total moisture and evenly all over the sample. 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 caused by different measuring 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 moisture. You can gain information from both effects with this instrument and eliminate them. The nonlinearity can be observed after taking several measurements in a climatic chamber and by reading the balance at the same time. **MK30R**'s nonlinearity is very small above 8% with most materials. The evenness of moisture in the sample is left for the user's responsibility.

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. Use an aluminum bag for keeping and handling of the sample in the oven and balance. Taring the balance afterwards is easy. Else you have a risk of exposing the sample to humid external air while attempting to determine its dry weight, getting excessive weight readings. An error of 0.5 to 1% at this point is not uncommon. Keep the bag open at one end to let air flow through it when in oven. For thick materials, it is best to keep it outside the bag for a good while and then quickly move it inside. After some time, you can close the bag and weigh it. This will ensure the sample is thoroughly dried.

To minimize differences between total and point 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 in this respect and the suitable times are learned by experience. The simplest way to know when a sample has reached the equilibrium moisture is to measure the moisture with MK30R 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 possibly is close to equilibrium. However, note that there are materials which saturate very slowly. It may take hours, days or weeks for them to settle into a new level. Patience is the best friend in calibration. A paper of 80 grams / m2 or thinner, will settle in less than 30 minutes. A board of 600 g / m2 will require several hours to arrive at the same state. Do not forget the hysteresis effect in many fiber products. This is important to be kept in mind when moistening and drying the samples. You will not arrive at the same moisture content when you have wetted the sample and then you vary the %RH value of the chamber. **It is important that you have a thickness of the material at least 30 mm under the meter. If one is working with a single sheet web sample, it must be in a tight contact with the sensitive measuring area. There must not be anything behind the sample within a distance of 50 mm, else it will affect the results. No hands either.**

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. Thin samples are difficult to calibrate as such since the weight of the sheet is very small and balance-based errors become significant. This is solved by having several sheets in the same conditions, weighed as a bunch and measured with the meter by taking samples from several sheets. The weight of one sheet is obtained by division. It is important that the sheets are of exactly same size with a good accuracy, else division is not sensible. If that is not possible, do not use division but use the total weight itself.

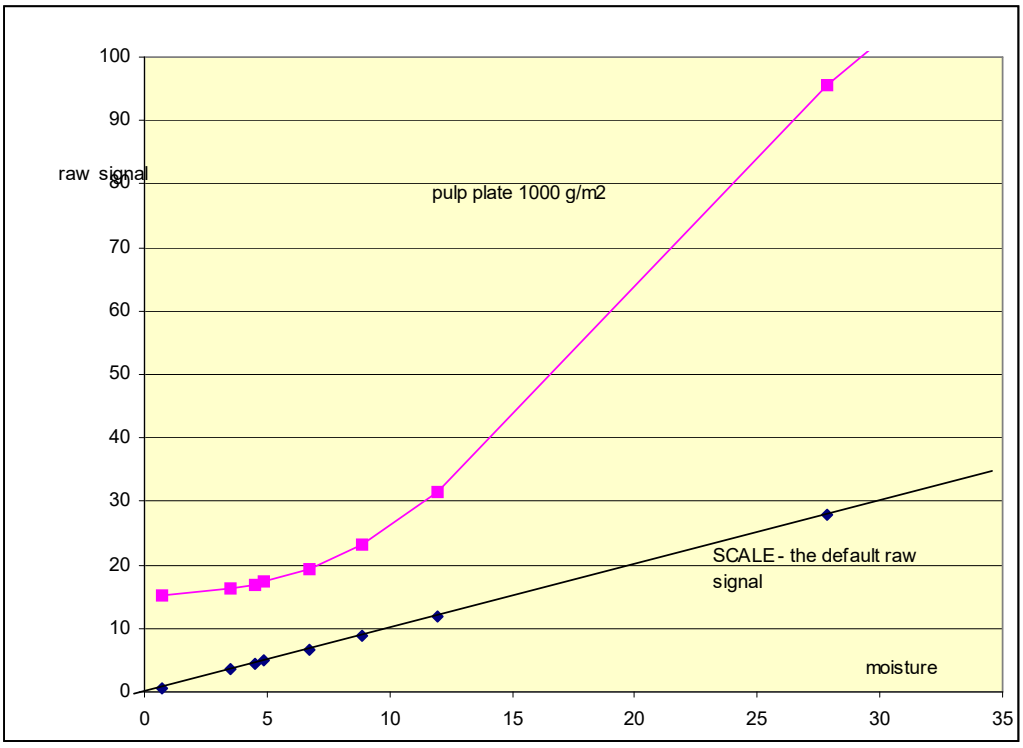


Figure 6. Typical moisture percent calibration of a material in SCALE (raw) and MULTI modes with five points.

The meter's response curve can be determined by taking several points both from the balance and MK30R. The values can be copied to some spreadsheet program to visualize the curve. This will help a lot in getting successful calibrations.

MULTI Calibration

One can use the MULTI calibration when a linearization is required. It allows a linear calibration just as well. On the other hand, one can correct even a significant nonlinearity with it. Refer to the Fig. 3. Now we place 9 segments of line, point to point to cover the required moisture range. The purpose is that the selected points represent well the material's curve. **MK30R** 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. Refer to the Figure 6 in the following.

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.

After selecting the proper material either from the main menu (see Tables 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:

1=CALIBR
2=EDIT
3=POINTS

You can now either go calibrating with samples (1) or you can go editing an existing table (2). Option (3) leads to setting the number of points in the multipoint calibration to a value (2...10). The calibration option opens up another menu:

2=STEP#:1
3=EXECUT
10.
0901

The menu looks as below. There can be used samples 2 to 10. One must 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 shifted as well. A new calibration is called then for simplicity.

The edit option above opens up yet another menu:

2=STEP#:1
4=SIGNAL
5=MOIST

Here you can edit each step's raw signal and moisture values after any calibration phase. Please note that the raw signal is usually between -10 to 100.

Performing MULTI Calibration with Samples of Different Moisture Levels

The calibration is normally 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 "3" in the MULTI calibration menu**

2. **Place the first sample (any) under measurement**

3. **Set the corresponding step number in "2" (likely step number 1)**

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 anytime and as often as needed by setting first the corresponding step number. Also later patches are allowed. 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.

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 or whatever your standards require. Do not overheat the sample!

2. While drying, place the balance and the moisture meter into the climatic chamber. If your balance can not withstand the humid conditions, do the weighing outside the chamber with e.g. a plastic bag or with a balance bottom hook through the roof. Start the chamber control system and adjust the relative humidity to the lowest possible value. 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. MK30R *should be in SCALE calibration mode.*

3. Quickly move the sample to your balance for weighing, preferably using an aluminum or plastic bag. Note that static electricity may interfere distorting 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.

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. If long intervals are used, it is advisable to place the meter into low power mode and to tare the balance before each use.

5. Control the chamber's %RH to a higher value as a series of steps with time intervals long enough to allow for proper settling of the sample (saturation to an even moisture over the sample area / depth). Suitable levels could be 20, 30, 40 etc. %RH up to 80 %RH. Higher levels may cause water condensation on the walls and the sample may be in danger.

6. Feed the collected data into your spreadsheet program and draw a picture of it thus forming the actual calibration curve. The %RH values themselves have no meaning at this point but only the weight / signal values.

7. Decide whether the results are reasonable. If not, you have to start from step 1. again

8. 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.

9. Take a printout of the calibration points and mark the selected points with step numbers

10. In the measuring state, select another empty material whose table has not been used (or in the Material menu)

11. Go to the MULTI calibration menu and then the EDIT menu

12. Set the step number in "2".

13. Press "4" and type in the corresponding signal (now scaled down if you earlier scaled it up) as a decimal number. The value is normally between 0.90 and 1.400. Use always as many decimals as there are available and try to round them correctly.

14. Press "5" and set the corresponding moisture value.

15. Repeat the steps 12., 13. and 14. until all calibration points are fed in.

16. In the upper menu, set the calibration mode to MULTI instead of SCALE.

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 nonvolatile memory for at least 40 years after you press the Save key.

More

In the calibration menu, with '9' one enters another menu with additional features.

4=ADJUST
6=STDZE

With '4' you can go to adjusting an existing calibration table (fine tuning) when a known difference exists between the reading and the sample itself (see below). In '6' you can perform a standardization operation for maintaining the best possible long-term stability.

Adjusting a Table

While measuring with **MK30R** moisture meter at high moisture levels (30 to 90% total moisture percent) problems are met when new materials have to be measured. Usually there are 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. In the following, we explain how to do it.

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 shift some calibration table instead of making a laborious full calibration. This will offer good working accuracy in many cases. 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.

The Procedure for Adjusting

1. Select that material from the **MK30R** calibration library you wish to use as the basis. If possible, copy the material entry (by using your PC and **MK30R, IRMA7Basic** or **Advanced** 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 or sample where the moisture value is known. Place the meter and take a reading or acquire a batch of data with several samples.

3. Note the difference between the reading (or average) you have got and the value you were informed (**Mreal - MMK30R = delta**).

4. Go to the calibration menu (press **"2"**) and from there enter the adjusting menu (press **"9" and "4"**). The following menu appears:

1=SET
DELTA:
-1.0%
43 TABLE

5. You should shift the table the corresponding amount 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.

6. The material name should be edited by as a reminder. That tells you unambiguously that you have shifted this table. You may shift the table any amount back and forth, even back to Delta = 0 %.

7. 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 until "**DELTA: 0.0%**" reads "**DELTA: 3.2%**". The table has been shifted and you can continue measuring immediately with the shifted table in the measuring state. You can also Save the new table before leaving the upper calibration menu.

8. The latest addition to this service allows the use of **UP/DOWN** keys for quick adjustment.

Standardization Menu

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

DRIFT
1=OFFSET
0.1%

One can compensate against long-term drift by manually adjusting the global moisture reading offset (in '1'). *The offset affects **all** calibration tables and the SCALE calibration with the same basic offset-%.*

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 with a highly stable polymer standard, you need to place it in front of the meter. The standard's reading when measuring with a certain table (like #70 fact standard) forms the basis for future drift compensation and is the actual **standard value**. Select the proper table you wish to use **always** after this for standardization. Read the moisture value shown and make notes of everything, including the basic reading in the menu above. When checking for any drift in the future, repeat this procedure:

1. Place the standard under the meter at the correct distance and angle, always in the same way
2. Select the table for standardization
3. Read the moisture value
4. If the reading differs from the standard value, calculate the difference
5. Go into the standardization menu and subtract the new difference from the old offset value.
6. Check the reading again and repeat steps 4. and 5. until you get exactly the correct standard value reading.
7. Make notes of the readings and tasks completed with some date information as well.

The meter is restored back to its normal working condition immediately. For available moisture standards, contact your representative. MK30R is working with a highly stable operating principle and standardization is likely not required at any stage.

Table Menu

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

1=SELECT
2=CLEAR
3=EDIT
SB2411

This menu is used mainly for changing the calibration table, clearing it ("2") or for editing the names of either the table or the library ("3"). The fourth line indicates the name of the library. Pressing 1 will lead to:

1=ENTRY#
2=NAME

bord1200

One can now change to another table. This offers the selection of the table by its 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" **MK30R** will ask first from which entry is the browsing started or you can use it as a selection already. After entering the number you can select the proper name from a list by pressing "2" and by moving the cursor with the arrow keys UP and DOWN. By pressing Enter or ESC at some name **makes a selection**. The cursor is on the second line in the list of names. The new calibration table is immediately in use assuming that it has been set to MULTI mode. The mode follows each material and is remembered. If the table is empty but MULTI is taken as calibration mode, the resulting moisture values will be anything irregular. This happens also if the table's values are incorrect.

Pressing "2" in the upper menu will clear the current table leaving it in SCALE mode with no particular contents and name but TABLE. The editing option will open up another menu looking like the following.

1=NAME
2=LIBNAM

Select the name to be edited and stop editing with ESC or Enter as usual.

Alarm Menu

MK30R Can tell the user if a preset alarm level in moisture is crossed. One can define either a low level or a high level or both. The indicator for crossing are two **background colours** which are factory set but can be tailored. When the moisture value exceeds the high level is the HIGH LEVEL active. When the moisture falls below the high level is the HIGH LEVEL deactivated. Correspondingly, when moisture falls below the low level is the LOW LEVEL activated. When the moisture increases and exceeds low level is the LOW LEVEL deactivated. The two indications can not be active simultaneously. The colour settings of these levels is done in the Displays menu ("8" from the main menu) which is about displays only. The alarm levels are set in the Alarm menu. You can get to it by pressing "4" in the main menu. You will see the following menu.

ALARM
1=LOW
2=HIGH
3=ENABLE

By pressing "1" you can edit the low level and by pressing "2" the high level. The levels are taken into use when you return to the measuring state. You can toggle the alarm enable on/off with "3". Press Save to make the meter remember this setting in the future.

Service Menu

In normal use you do not have to visit the Service menu often. If you suspect that the meter does not behave correctly after turning the power on or during normal use, you can check it here. The quickest remedy to irregular behavior is to turn off the meter and restart it again. 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.

0=SLEEP
2=HWZERO
8=THEAD
9=MORE..

In the Service menu one can read the temperature of the sensing head with an absolute accuracy of +/-3 C by pressing "8". If you suspect that you are working in a too hot environment (over +50 C) the sensing head may be damaged. The guarantee does not cover damages due to overheating. The meter will also warn the user of this while in the measuring state.

By pressing "2" you can force to zero the internal no-sample reading which may slightly be affected by wear-out and dirt. Just lift up the sensing head to a height of at least 50 mm and press "2". Save the configuration and settings to be recalled later.

The Selection "0" is for turning on/off the sleeping feature of the meter. You can see a message "YES", "DIM" or "NO" on the display. If on, the meter will turn itself into Low Power mode after running for one hour (**YES setting**). This saves the battery in case the meter is left unattended. Also, when the meter is used in temporary on-line measurements with continuous power feed, it is not wise to leave it there unnecessarily running overnight as the meter's service interval is 12 000 hours. Unless you are always measuring manually in short intervals, turn the setting on. The default is off. The **DIM setting** will not turn the meter to LowPower but will only switch to LowPower colour settings saving some energy.

By pressing "9" you can enter another menu for setting up the meter. You will see:

1=SAVECF
5=ERDATA
7=BAUD

Option "1" will save the current meter configuration for future use. Clearing of memory banks is done by pressing "5". It will take a moment to complete. If erroneous behavior is suspected, it can usually be resolved by powering up the meter again.

The option "7" offers a possibility of changing the communication baud rate between 115200 (HIGH) and 9600 (LOW). This is not recommended unless you know what you do.

Unit and Communications 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=COMM'S
2=UNIT:
%
3=EDIT

By pressing repeatedly "2" one can list all the options which are: "%", "DRY%", "g/m3" and "YDRYNESS". The unit in display is taken into use. Changing the unit does not change the handling of the moisture signal in **MK30R (except the DRY% and DRYNESS options)**. 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 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 (moisture 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 edit a new unit. In this menu you can further change it to any options available. Note that the use of the dry weight percent instead of total weight percent creates one special feature. *Typical behavior of most materials tested with MK30R, 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. The moisture meters are designed to have a linear behavior at high moistures (>8%). This does not hold at all if dry-% is used.

We have now added a feature simplifying this problem a lot. You can perform all calibrations as total moisture in normal order. Then you change the unit to DRY%. The meter then automatically makes the mathematical transformation between these two readings without losing accuracy. Note that selection of the unit will affect **all calibrations** in use. If some calibration requires a different unit, just enter this menu and switch the unit. The DRY% is indicated as a unit "D" on the center display.

If you need to measure dryness instead of total moisture, select the unit YDRYNESS. The meter will automatically do the conversion and the corresponding unit sign is Y. The formula used is:

pdryness = (100 - pt)

You can also set the node address of communication link (physically Bluetooth) in this menu, option "1". This setting is seldom required if at all. The node address should in PC-based systems always be one. The node address should never be set to zero as it is reserved for the controlling master unit. The menu looks like this.

1=ADDRSS
4=BTINIT

The option 1 is used for modifying the address. Option "4" is used for initializing the Bluetooth. Usually there is no other reason for doing it.

Curve Menu

This menu affects the range for the curve display. One can set the lower end of the moisture value and the higher end too. One can also turn on/off autoranging of the display. It looks like the following.

RANGE
1=LOW
2=HIGH
3=AUTOM.

The display will be limited to a fixed range as set here if autoranging is off. Else the curve itself will determine the upper/lower ends of the scale. That is checked after every moisture sample received for each display, including the old part at the right end, to be overwritten.

Display Menu

This menu affects the background colours of displays in various situations. One can tailor each display's colour at will together with the brightness. It looks like the following.

1=NORMAL
2=AL-LOW
3=AL-HI
4=LOWPOW
5=TABLE



Figure 7. MK30R front panel keys

In "1" is the normal state's colour set adjusted (BANKS), in "2" for Alarm Low level indication, in "3" for Alarm High level indication, in "4" for Low Power operation and in "5" the TABLES mode of operation. The contents of the opening submenu is identical in each case. When entering each menu, the old display settings are put into use and the user can adjust each in detail. After setting them up, he can press the Save key to save these settings. Note that the colour selection menu may be missing in some program variants. This is not important for regular use of the instrument.

Keys Available in Measuring State

In the measuring state (top of menu) there are special keys available in addition to the Menu key and arrow keys. In the following the effects of pressing each key are listed shortly. See also the Figure 5. below showing the front panel keys. The display colour may change (if set accordingly) when changing some of the modes and / or if the alarm is active. Pressing the remaining keys has no effect in the measuring state. Refer to Fig. 7 for the keyboard and the separate Quick operating Guide.

key	action
Save	**Copy the contents of the present graph (64 points) to a new bank (profile). When operating in the menus, the same key allows other saving of current configuration or the current calibration table, depending on the menu.**
LowPower	**Set the meter into energy saving state, immediate measuring is not available. Normal measuring state is restored by pressing this key again. This key can be pressed in any state or menu with the same result**
+ Auto ON	**Turn the autotimer on, samples are added to a new bank with the preset interval until explicitly stopped or the preset number of samples (batch) is collected. Stopping with the "-" key**
- Auto OFF	**Turn off the autotimer**
*** Stat's**	**Calculate statistics of the selected or latest bank. The date & time is indicated for the bank with a graph.**
. Bank select	**(decimal point) Select BANKS or TABLES mode**
0	**Set the date & time to be maintained by the internal clock and for generating a time stamp for each memory bank.**
2,3	**Switch the recipe (LABEL+ table) to the next one, rotate round the five options**
5	**Edit the label in the current recipe, accept the current table**
6	**Switch between low-pass filter selections (FAST, MEDIUM, SLOW).**
7	**Turn Autoranging on/off for the graph.**
8	**Turn on/off averaging of one or a number of banks.**
9	**Flash calibration + fine tuning + automatic zeroing, selection of low level measuring rate and response time (see next page)**
Stat's	**Calculate statistics of the selected bank, the Min, Max and Average values are flashed in red colour in the end**

Marker	Add a marker of 0.5 % to the moisture signal up/down
Logo	Turn on/off HOLD, freezing the measurement and holding the latest reading
Menu	Enter the configurations menu
Enter	Edit the *reel number*, carried forward with the moisture profile data
Start button	Turn the autotimer on, samples are added to a new bank with the preset interval until explicitly stopped or the preset number of samples (batch) is collected. Stopping with the "-" key or with the same button on the side of the meter

In TABLES mode:

arrow up	Change the current calibration table with a higher entry number. The numbers go from 1 to 100 and then to 1 again.
4PgUp	Change the current calibration table with an entry number + 10. The numbers go from 1 to 100 and then to 1 again.
arrow down	Change the calibration table with an entry number one lower
1PgDn	Change the current calibration table with an entry number - 10.
arrow to the left	Switch between multiple display and big numeric display
arrow to the right	Switch between multiple display and big numeric display

In BANKS mode:

arrow up	Change the selected profile with a higher entry number. The numbers go from 0 to 819.
4PgUp	Change the selected profile with a 10 higher entry number.
arrow down	Change the selected profile with a lower entry number.
1PgDn	Change the selected profile with a 10 lower entry number.
arrow to the left	Switch between multiple display and big numeric display
arrow to the right	Switch between multiple display and big numeric display

---

FLASH Calibration

In field conditions it often happens that one should measure some paper grade which does not have a suitable calibration table to apply in the meter. Therefore we have added this new feature called Flash calibration. All you need is the knowledge of the paper basis weight (g/m2). The utility will ask you for this reading and then quickly generate a new calibration table at that library entry you are using at the moment. Please, check the table not to be anything important before using this option, else you will destroy the old calibration which might still be needed. The operation is very quick, the table is already saved and the new calibration is given a name "FNNN" where NNN represents the BW. You can start measuring with it right away. If the reading is a little offset, you can do some fine tuning

in the **Adjust** option (next chapter). The Flash calibration is started in the measuring state with the "9" key. The resulting table is usually sufficiently accurate for general purpose work. It will give a fairly accurate slope for the curve and the offset can be fine tuned. For thin (<600 g/m2) papers the calibration is valid between 1 - 70%, for thicker papers (>600 g/m2) between 7 - 70 %. Note that this is based on pulp at the time of writing and will not apply to special papers having special coating or fillers.

The following submenu will appear next. If you wish to continue with the Flash calibration, press "1".

1=FLASH
2=ZERO
4=uW

In the present form this function will offer two choices: BOARD and PULP. PULP is the above described option and the BOARD option is based on a different model. It will ask for the basis weight (g/m2) and the density (kg/m3) for generating a new calibration. The calibrations will be typically valid from 4 % to 14 %. As the Flash calibration is almost finished, it will offer a fine adjust option:

1=SET
DELTA:
0.0%
F5000

By pressing "1" one can edit the offset to match the real moisture of the sample under the meter. Without going to the editor, one can also do the adjustment by pressing the arrow keys up/down to change it in 0.1 % increments. You may also use the regular **g/m2 calibration** made for your paper/boards/ pulp in one calibration table.

The second option is for automatically zeroing the moisture reading. This feature is most useful when measuring rather high moistures and you wish to know the difference in moisture between various points. Before entering it, place the sample going to act as a zero reference, under the meter. The change is not saved and you need to expressly save this modification to the calibration by pressing the Save button in this menu. Else it is forgotten when you turn off the meter or change to another calibration.

Pressing '4' leads to the menu for selecting the lowest level measuring rate and signal rise time.

Speed
1,3=DNUP
6,7=FSlo

Normally the user does not need to enter this while doing regular portable measurements with stacks and sheets and running webs. The basic rise time is medium fast (UP) and the low level algorithm is selected for best accuracy (SLOW). When a faster rise time is required you can press '1' (DOWN) to select the fastest rise time. This deactivates the low level digital filter and offers the unfiltered faster data. The noise will increase somewhat. To return back to normal, press '3' (UP).

To measure profiles while moving faster along the reels, you can press '6' (F) to select a faster analysis of signal with a slightly added noise and inaccuracy. To return back to normal (SLOW) algorithm, press '7' (Slo). If you wish to maintain the selection for future, press the Save key. One can always restore these settings and then press the Save key.

If one wishes to have a quickly reacting meter and fastest measuring rate, press keys '1' and '6'. If one wishes to have the most accurate and lowest noise readings, press keys '3' and '7'.

Selection of Filtering

The meter's signal processing includes a number of electronic and digital filters whose purpose is to remove any unwanted noise components and to increase signal reliability. One of the filters affects considerably on the response time and frequency response. Its type can be selected in the measuring state directly. There is the filter toggled by pressing key "6". The three possible states are FAST, MEDIUM and SLOW and the setting is only momentarily indicated when toggling it. The FAST filtering gives fastest response times and an increased noise. The SLOW one gives slowest response times and smallest noise. The MEDIUM setting is a compromise between the both being suitable for rapid field use with increased accuracy requirements. The FAST setting is suitable for on-line measurements where rapid fluctuations in sample moisture and other environmental factors exist. The SLOW setting is best in requiring laboratory work but may prove useful in many on-line measurements also. A typical application is in calibrations. When switching the filter a transient peak may appear.

SLOW filtering has a variable response time which can be adjusted in a wide range. Thus it is most suitable for in continuous measurements where the momentary moisture variations are not interesting but the running average is. The SLOW setting has an approximate response time selector to be edited while switching. Type in the response time and then you are able to continue measurements. Times less than one are not useful since you have better filters available for those times. Typical values would be 3 - 10 sec. Check also the preceding paragraph of SLOW/FAST setting. The SLOW response time is edited in the Banks menu. Type in the response time and then you are able to continue measurements. Times less than one are not useful since you have better filters available for those times. Typical values would be 3 - 10 sec.

General Guidelines in Use

MK30R is intended to be used as a portable meter and with handheld on-line applications also. Normal field operation is carried out in the following manner assuming that the instrument is already calibrated for the material of interest.

The meter is placed over the material and a moisture value appears on the meter display. You can observe its development and settling. Do not make hasty conclusions of the reading before you are sure it has settled. When you have a stable reading you can move to the next point to be measured. You can also save this moisture value (64 points of it) by pressing the Save key. The values are added to a new bank.

After getting samples you can calculate statistics of each bank. You can get more data if you start the autotimer by pressing the "+" key in the measuring state. The autotimer-based sampling is stopped by pressing the "-"-key. You should avoid moving or rocking the unit while collecting data to keep the standard deviation of the values low. In this way you can observe also drying or wetting in an arbitrary time scale in various materials. If you need to cover a sample area to gain a good representative average of it, you will need to move the meter over it. You can emphasize some areas of it which are more important by hovering longer over it. Try not to tilt the meter too much while doing this.

When measuring thin (< 1000 g/m2) board or paper samples you act in the following way. Best way is to place the MK30R upside down and stretch the sample over the sensitive area. Nothing must be behind the sample for at least 50 mm distance. Refer to Appendix 5 for more details. Wood and board samples do not have this problem except with thin samples. The paper should not have bends or folds if you require greatest accuracy.

Take full advantage of the recipe system. It will save a lot of configuration work while measuring and it will prevent many mistakes too. The resulting file names will track the labels you have used. All recipes should be taken into use to serve you in the best possible way. You can do it by first selecting a suitable recipe with keys 2 or 3 and then by selecting the proper calibration table and then starting to edit the label with key 5. You end editing with Enter and then you will be asked if the current table should be associated with this recipe. Reply with key 1 if this is true. Else no specific table is associated with this recipe. In this way you fill in every recipe and they are ready to serve in the future. Do not forget to save this change of configuration in the Menu with the Save key. In practice it is sufficient to switch the recipe with keys 2,3 and both the table and the label are changed. This information is saved with data to the memory bank.

Notices for Measuring

While measuring with MK30R 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 sensing head from shocks!** The sensing head should not be exposed to high temperatures (over +50 C). No mechanical shocks are recommended.

2. **Never try to open the sensing head!** The result will always be damaged components. The guarantee is not valid in such cases. You can at the most replace the battery. Refer to Appendix 1 for service operations. The manufacturer or service are not liable for fixing a unit which has been damaged by negligence.

3. Although **MK30R** is splash-water proof to IP65, it is not allowed to immerse it into water or any other liquid. Any dirt can be removed by wiping it with damp cloth. The sensing head s can be cleaned with a dry clean cloth or cotton sticks. **NEVER USE ANY SOLVENTS OR DETERGENTS! They may cause unexpected damage to the plastic case.**

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 battery panel, check to see that no cables, dirt or water is left between the gaskets. No other panels are allowed to be opened. There are no user-serviceable modules inside.

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

6. **The instrument is not dropping-proof. Keep it safe and carry it with some protective bag. Use the strap if available. The best option is to purchase the -MKCAR carrying case, specifically made for this meter.**

7. Obey the temperature limits. **The electronics and the battery will be damaged in high temperatures (over +60 C)**

When you require the most accurate results with **MK30R**, follow the next few instructions:

1. Best results with smallest standard deviations for calibrations are obtained in a climatic chamber, where the external relative moisture and temperature are controlled.

2. Best accuracy and lowest noise is achieved with the SLOW filtering but MEDIUM is fine too (default) as is also FAST. These affect only the acquired signal before it is saved to a memory bank.

3. Avoid keeping the sensing head towards the surface in angles differing from the parallel. An air

layer between the sheets or the active measuring surface is the enemy of correct readings

Special Features of the Models

Presently, we are offering the portable **MK30R / MK30R-PX / MK30R-PF** in addition to the **MK30LP on-line meter**. We also can offer special models **MK30-SAMPLE HOLDER** for measuring cylindrical products and **MK30LP-CUBE** for continuous on-line measurements.

MK30R / MK30R-PX / MK30R-PF

The model **MK30R**'s special features are its ability to measure deep into matter. The penetration depth is typically 30 mm. While measuring thinner materials, the background should be empty over the distance of 50 mm at the sensing head. Else the background will interfere.

The sensing is circular being immune to any fiber orientation effects. When investigating normal isotropic materials, like paper and board there are no special problems in addition to the information above. Strongly anisotropic materials, like wood and turned veneer sheets usually do not require special advice either.

Colour Adjust Menu

You can enhance the use of the instrument with colours. The status is immediate by using the colours. By pressing "9" you can modify the colour set for each task. This menu affects the colour of the display for each of the modes. It looks like the following. The availability of this feature is version dependent.

1=NORMAL
2=AL-LOW
3=AL-HI
4=LOWPOW
5=TABLE

You can enter any of the options to set up the pertinent colour meeting the following menu in all cases.

123=RGB
↑↓=BRIGHT
<>=SELECT

Pressing the arrows UP/DOWN will modify the brightness (0..7 setting) of the selected display (1,2,3). The arrows LEFT/RIGHT will switch to another display (1,2,3). The colours are modified by pressing the numbers 1 = RED, 2 = GREEN, 3 = BLUE with settings 0...3 each, rotating endlessly. The combinations of each colour component may at first produce strange results but that's how the colours work. Thus you specifically set each of the three displays having a different colour hue and brightness. The factory settings are good enough for most users. When you are happy with the result, press the Save key in the upper menus to memorize the new configuration.

Note that htis menu may be missing in some software variants. There is no reason to alarm since it is mainly used for maintenance purposes.

4. Model MK30LP

General

MK30LP (Low Profile) is designed for smaller production machines, pilot paper and board machines and coating stations. Main applications are in observing machine adjustments, quality control and research. In laboratories there are numerous applications in hot nips, coating experiments, drying experiments and wetting tests. Also measuring the runtime water content of various felts in a paper machine is a suitable application if equipped with a Regular -W cavity. The MK30LP DUAL is a direct answer to these measurement needs since one can measure both the initial moisture content and the processed moisture content. One can study how much the process will affect the moisture. Coating is an example of measuring the amount of water or coating since the coating is water-based. The same applies to water-based glues. Using a scanner is very practical to gain a cross profile of a running web. MK30LP will require touching so air gaps are to be avoided to the running web.

MK30LP is watertight and very durable withstanding wear and it also rejects dirt. Since it does not contain motors nor any other wearing parts, its service life is exceptionally long. The only service required is to clean out the measuring surface with a soft cloth occasionally.

MK30LP can be used for various temporary measurements, continuous measurements, one can move the system other positions in the production machine. Some sort of manual measurement is also possible is a kind of support structure particularly required is added. This applies also to laboratory use by adding some sample guides or supports to get a quick and reliable measurement of samples possible. In exceptionally hard conditions the mechanical parts may wear out and the manufacturer is able to offer spare parts. One can order them in time to prevent breaks in service. Similarly the manufacturer offers a reasonably priced service and maintenance.

MK30LP is designed for continuous measurement of running webs in tight conditions. Its thickness is about **15 mm** and width about **130 mm**. The length is dependent on the length of the support stick. It is notable that at least 20 mm behind the sensor's active side is free from anything, especially metals. Else some unexpected effects may arise. Soothe, Titanium oxide, metal films and metal particles will cause severe problems in the material. MK30LP is able to measure to about 5 mm and it will create a moisture signal based on moisture percent by averaging the amount of water seen. In most respects the MK30LP behaves just like the MK30R and the specifications are similar. The biggest differences are the missing keyboard and display, the use of the PC program and the different structure. Also the option for measuring with two sensors at the same time is exceptional. The **MK30R-DISP display unit** is optional and can be simply plugged with a single connector on the back panel. Then it will behave practically identically as the MK30R. The cable to the actual sensor is typically 5 meters but can be ordered longer.

Fixing the meter is made to the support stick structure with bolts. In a fixed measurement this kind of measurement allows some averaging removing web noise. The measuring area is about **10 mm** in diameter.

All functions are inside the meter and it does not have any display not keyboard. All information of settings and acquired data is transferred to the PC program **MK30LP**. This program offers all necessary features for configuration, calibration and data acquisition plus data retrieval and analysis and reporting. The bus in use is either RS232 or RS485. The RS232 is converted in a RS232-USB module for the PC. The RS485 is converted in other similar modules available commercially. The manufacturer offers a LAN485 module which will support up to 15 meters to be used at the same time connected with RS485. If the **MK30R-DISP** unit is connected to MK30LP, then it uses the same **AK30 + ATOM** software as MK30R.

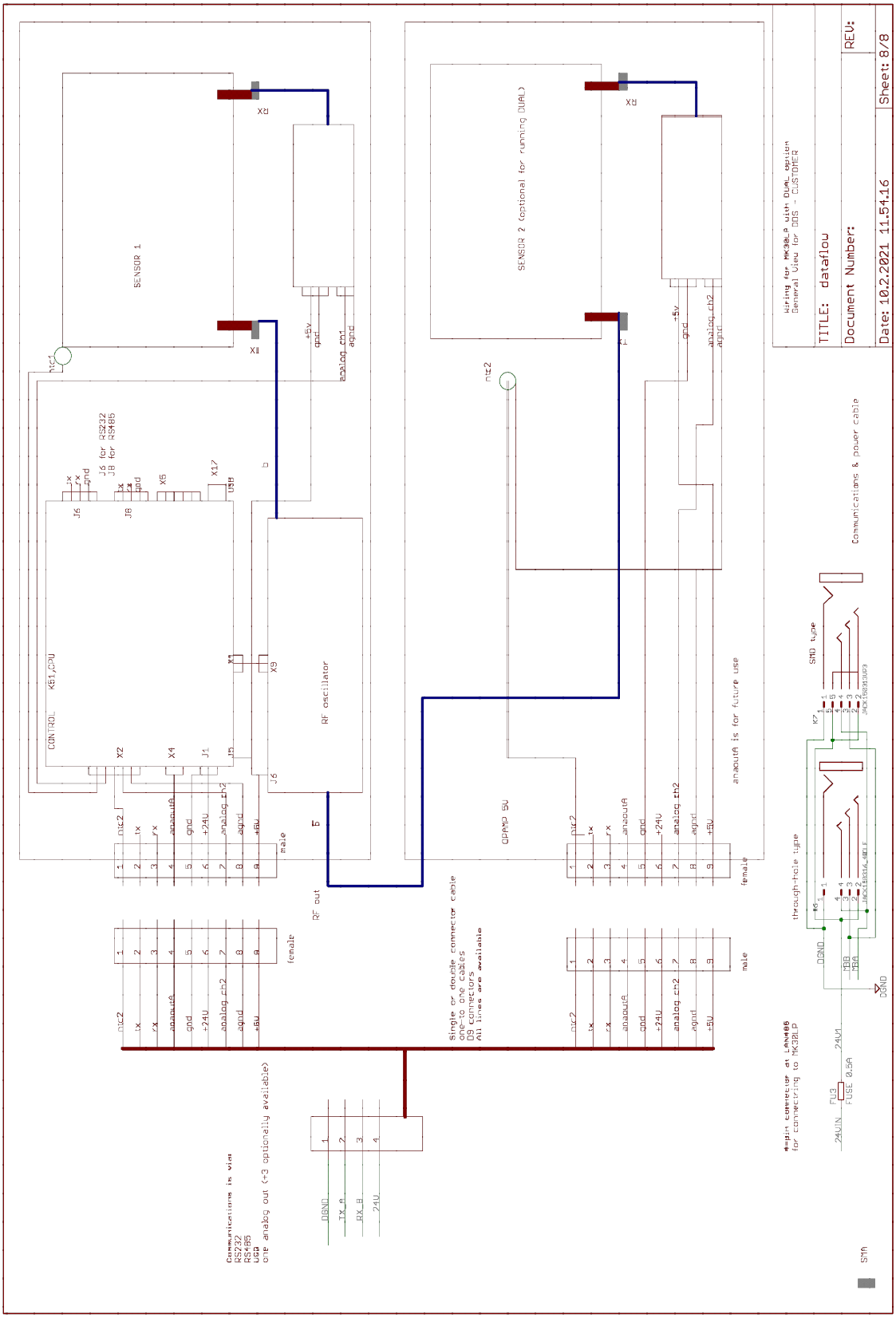


Figure 8. MK30LP DUAL internal structure and wiring. Joining to the LAN485 unit or any other acquisition unit is made with a four-pin cable.

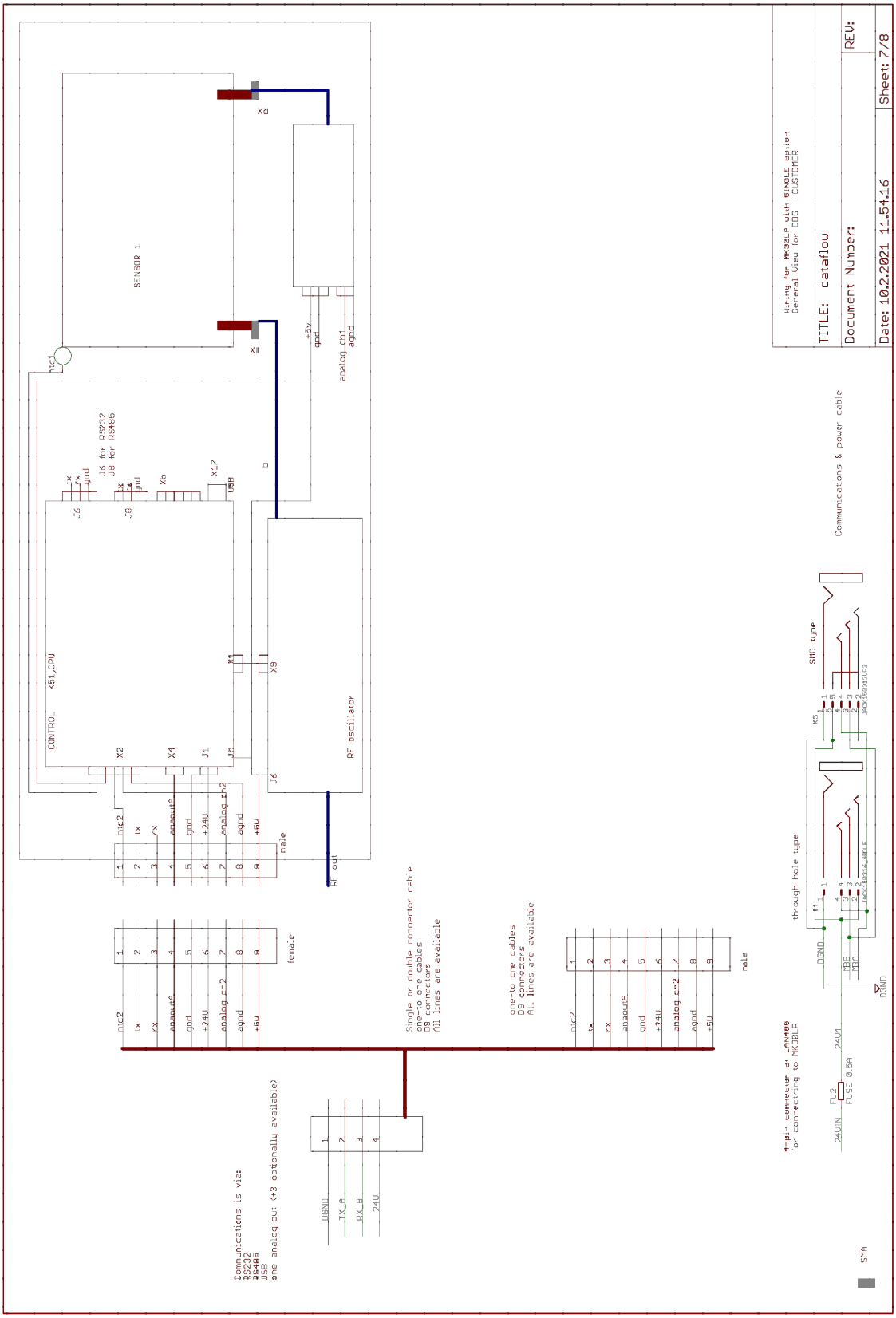


Figure 9. MK30LP SINGLE internal structure and wiring. In a normal delivery the cable has two connectors only and when the expansion to make it a DUAL system, a three-connector DUAL cable follows, including the RF-cable of same length.

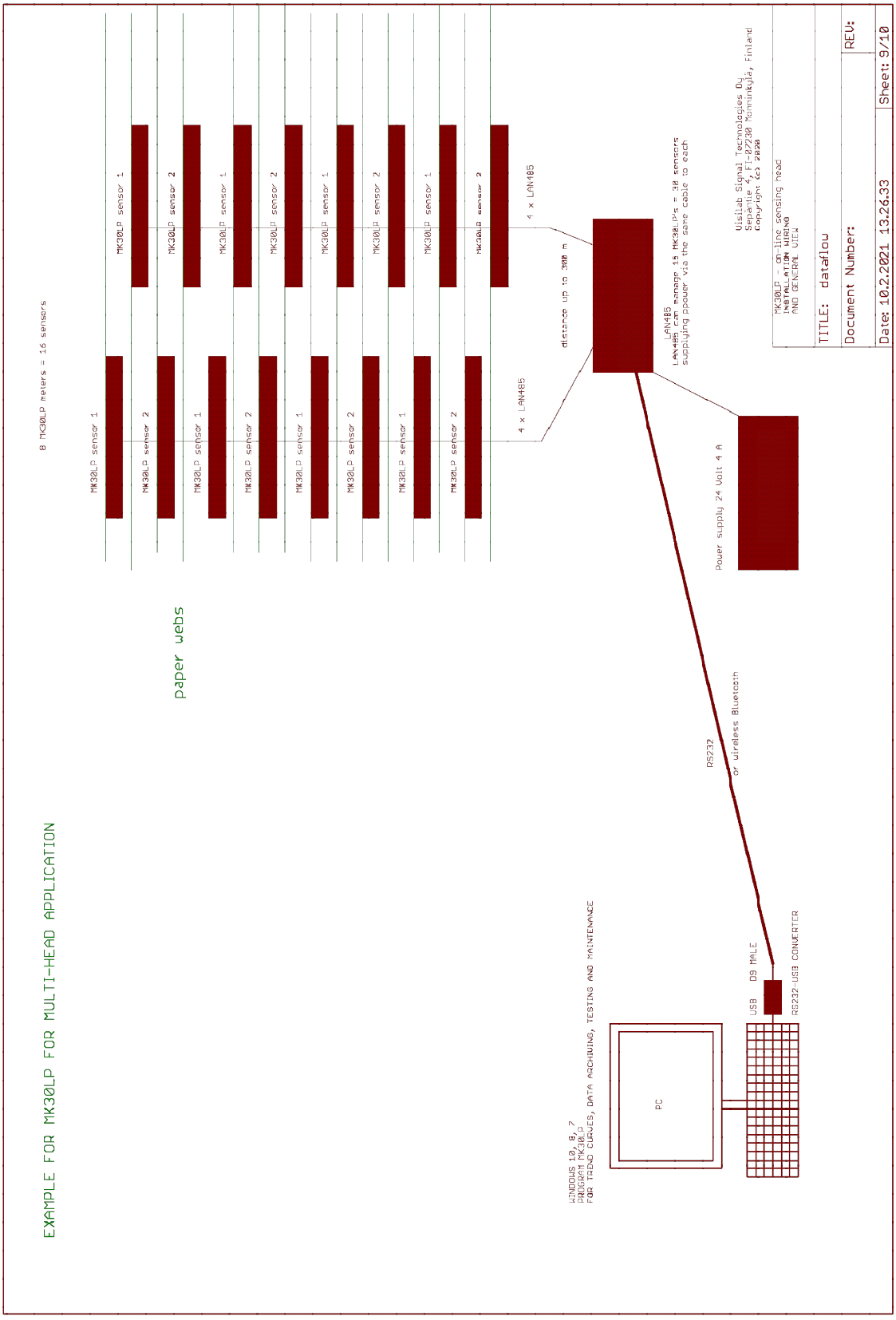


Figure 10. MK30LP DUAL applied to a multisensor case by using the LAN485. A separate 24 Volt 4 A power supply is required. In the case of one sensor one can use instead of LAN485 a power supply and RS232.

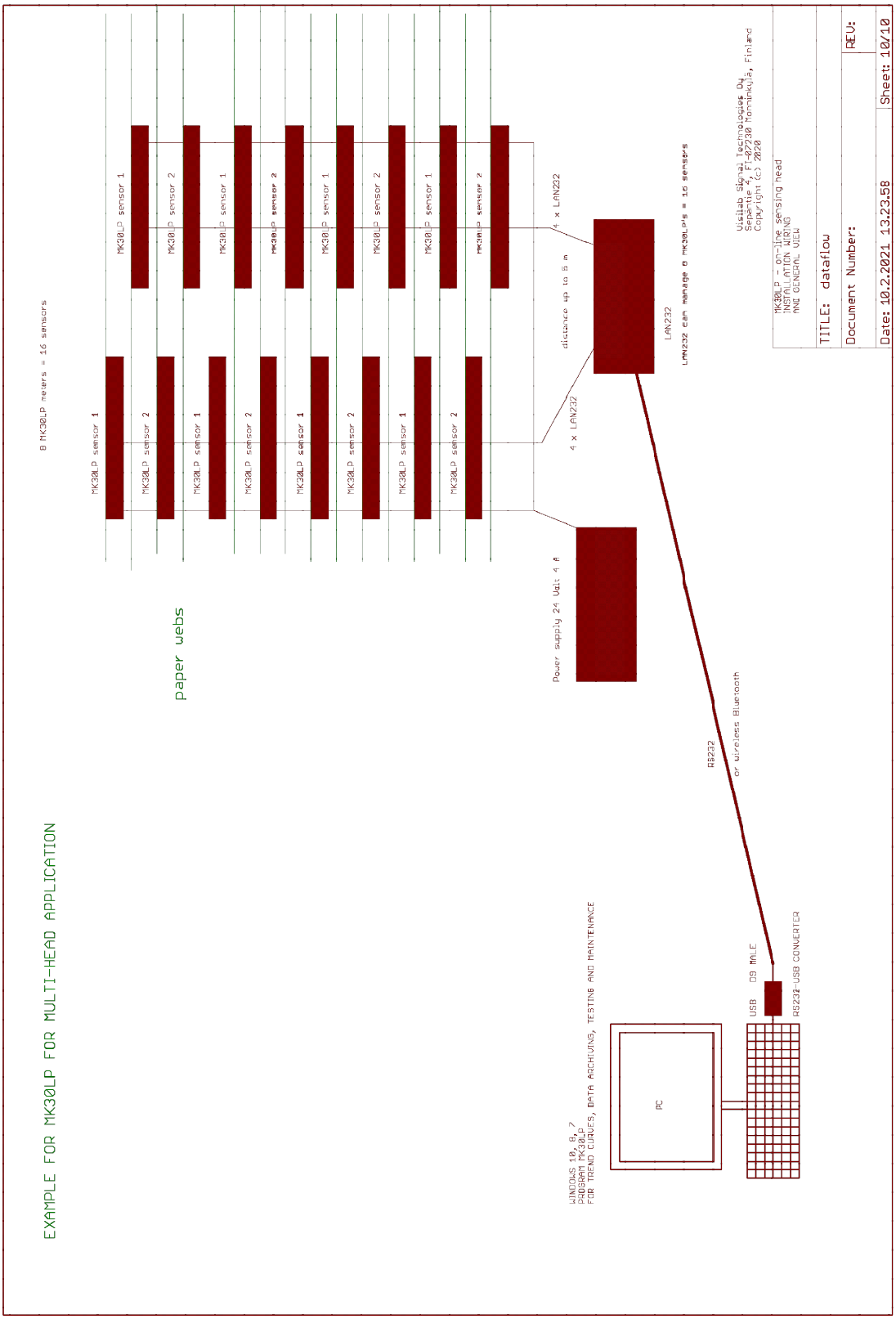


Figure 11. MK30LP DUAL applied to a multisensor case by using the LAN232 bridge. A separate power supply 24 Volt 4 A is required.

Contents of the delivery bundle

1. **MK30LP** *instrument with a cable of 5 meters and an ITT Cannon 12-pin connector at the end.*
2. Program USB stick
3. User's manuals in a binder
4. A carrying case
5. Optional accessories ordered separately, like a polymer moisture standard

Versions

MK30LP is normally delivered as **SINGLE. DUAL** is a special option for tailored systems. It is measuring with one sensor only and can deliver all data to the PC program. DUAL supports the use of two sensors which can be located away from each other. The sensors are connected with cables. One is **Sensor 1** and the other is **Sensor 2**. The data output consists of **moisture 1, temperature 1 and moisture 2 and temperature 2**. The temperatures are internal temperatures of the sensors indicating possible overheating and they are used for temperature compensation as well. Tailored systems can be delivered equipped with any existing or tailored special cavities. Refer to the schematic diagrams in the following.

The delivery options are (defined at time of ordering):

- **MK30LP with the cable, the default**
- **MK30LP + -PS power supply containing analog and serial connectors, RS232-USB converter**
- **MK30LP + MK30R-DISP display module which is battery powered + charger, wireless and USB communications**

The MK30R / MK30LP families have a number of variants. Their programmatic behavior and electrical connections are the same from which model they have inherited their names. Practical application these variants differ somewhat from the original models, as is the purpose afterall.

Cables

Depending on the delivery option, the delivery may contain necessary cables both for the power supply and RS232, ready to start measuring.

Data acquisition

Typically, the **PC program MK30LP** is installed to a PC (Windows 7/8/10/11+) and the USB driver package as well. The MK30LP meter is hooked to the system and when the new COMxx USB port is identified the program can be started. The meter's address is normally 1 (1 - 255) and it has been marked outside of the sensor. The baud rate is 115 200 bauds. The program is able to track all meters connected and to indicate the address of each. At this point we refer to the PC program's manual for further details.

With the program one can check the meter settings, modify them and then update them in the meter. New settings are temporary only unless particularly saved with a specific command in the program. Else the changes will disappear when the system is rebooted.

The program is very versatile and has a support for acquiring moisture data from up to eight meter (16 sensors) at a time. The data from two DUAL meters can be acquired in a separate task having also the temperature data. For many purposes that is already sufficient. The results are automatically archived and can be retrieved and analyzed and reports can be printed out.

Note that the other available programs, like AK30 do not effectively support MK30LP. One can use them with great care acquiring only the moisture data. No other operations should be done with them to avoid unexpectedly changing some meter settings. That is because the MK30LP uses in a different way the command set IRMA-7. Nothing will break but in case the meter goes wild, turn it off and then check with the proper program to make sure all settings are correct. Permanent saving always requires the use of the save command.

The MK30LP has one 5 Volt analog signal which is a scaled moisture reading. (SubD9 connector pin 4). The DUAL version has four interesting signals and they are converted to four analog outputs. They can in principle be brought out of the meter but will require actions from the manufacturer. Then an extra connector will be attached to the meter for this purpose.

Calibration

MK30LP supports two sensors inside it. They both can use a specific calibration in the internal calibration library. There are up to 100 tables in it. Some tables are not active (SCALE), some are active (MULTI). The inactive tables can be used for getting the raw signal. Sensor 1 and 2 can use any calibration in the library and this is made in the PC program in a very simple way. Refer to the program manual.

MK30LP is scaled differently from MK30 Regular and Compact. There is no Expert system nor Composer to create a Flash calibration. Therefore the calibration is supposed to be made in a traditional way. One must know the moisture of the sample and then measure the raw signal. From that information one will get the pair of data required in the calibration.

Since the MK30LP is very small it can be placed in a climate chamber, like AK30 and MK30. One can then adjust the %RH of the chamber to vary in a wide range the paper moisture. Using an analysis balance one can get accurate weights of the samples. The dry weight must be obtained at some point to get real percent values.

The manufacturer will make calibrations when the system is delivered so that the system is ready to go. Additional calibrations are made per request. They are usually not so difficult to make if some basic laboratory instruments are handy. A lab balance and an oven for drying the samples will do. For moistening a plastic bag is helpful but a climate chamber is the best. In very special cases, for instance glue weights or coat weights require heavy instrumentation and machines for accurate calibration and are best done at the customer's location.

Moisture ranges

MK30LP is specifically designed for measuring moistures at lower levels and with thinner grades of paper. Thick and wet papers are successful. The moisture content limit is at pure water of 5 mm layer. as the reading will saturate there The low end is typically at 2% with regular papers and pulp. With pressboard the limit is lower.

Internal connections of the meter

According to the Figure 12. you can orient yourself to understand the possibilities of changing the meter behavior. The default RS232 can be changed to RS485 as indicated. A terminal program can be used for accessing the internal parameters at 115 200 bauds. For a regular user this is not necessary.

In the following are some pictures of the components in the system. For more information, contact the manufacturer.

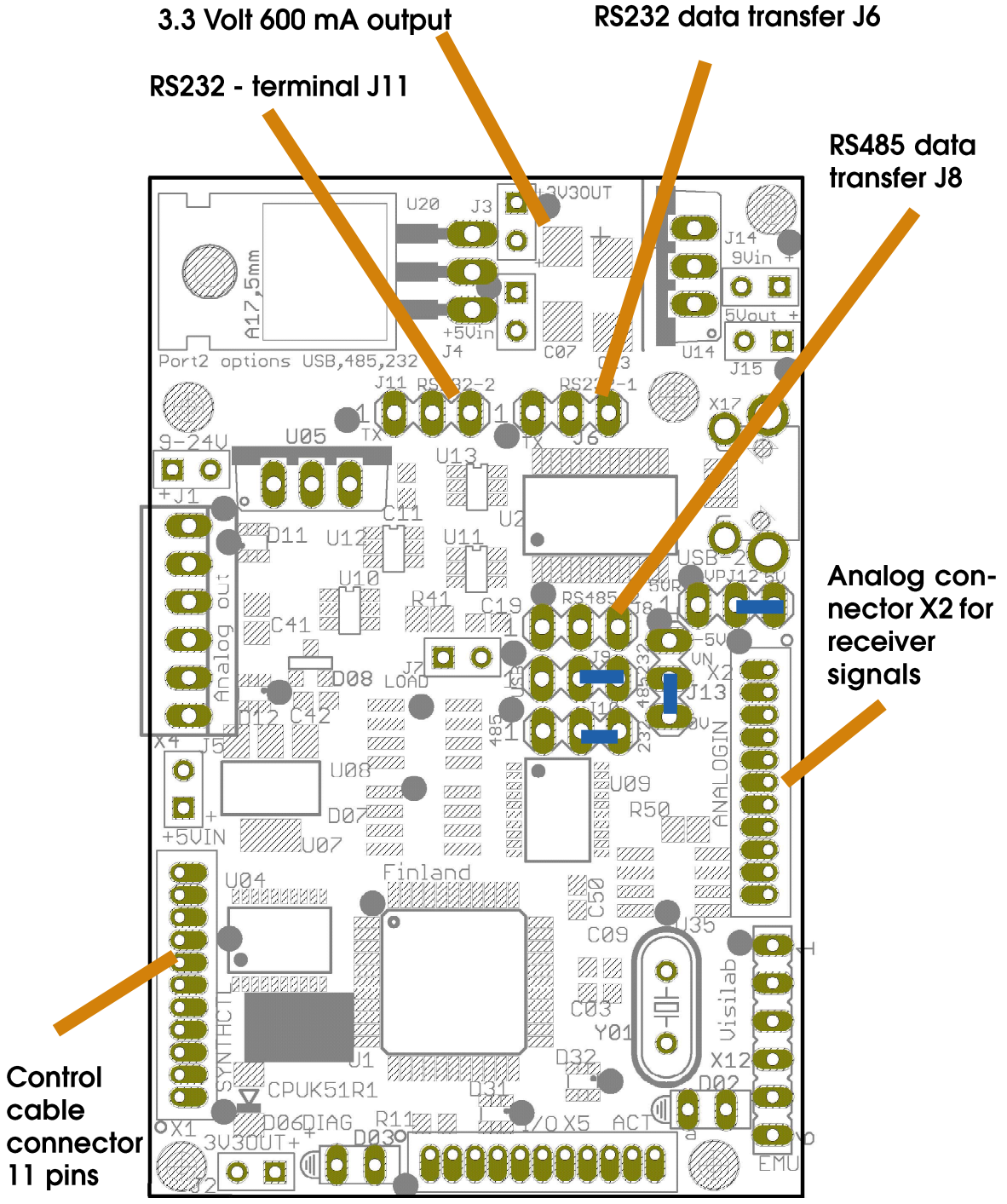


Figure 12A. MK30LP DUAL/SINGLE includes this circuit board **K51R1**. It has connections to both internal and external functions. The selection jumpers are accessible too. If one attempts to use the RS485, the lowest jumper J10 needs to be changed and the wire going to J6 needs to go to J8.The pin number one is important to locate and keep correctly positioned. It has been marked with a thick dot. Default jumpering is marked here with blue lines. The K57 is very similar to this but has some added features.

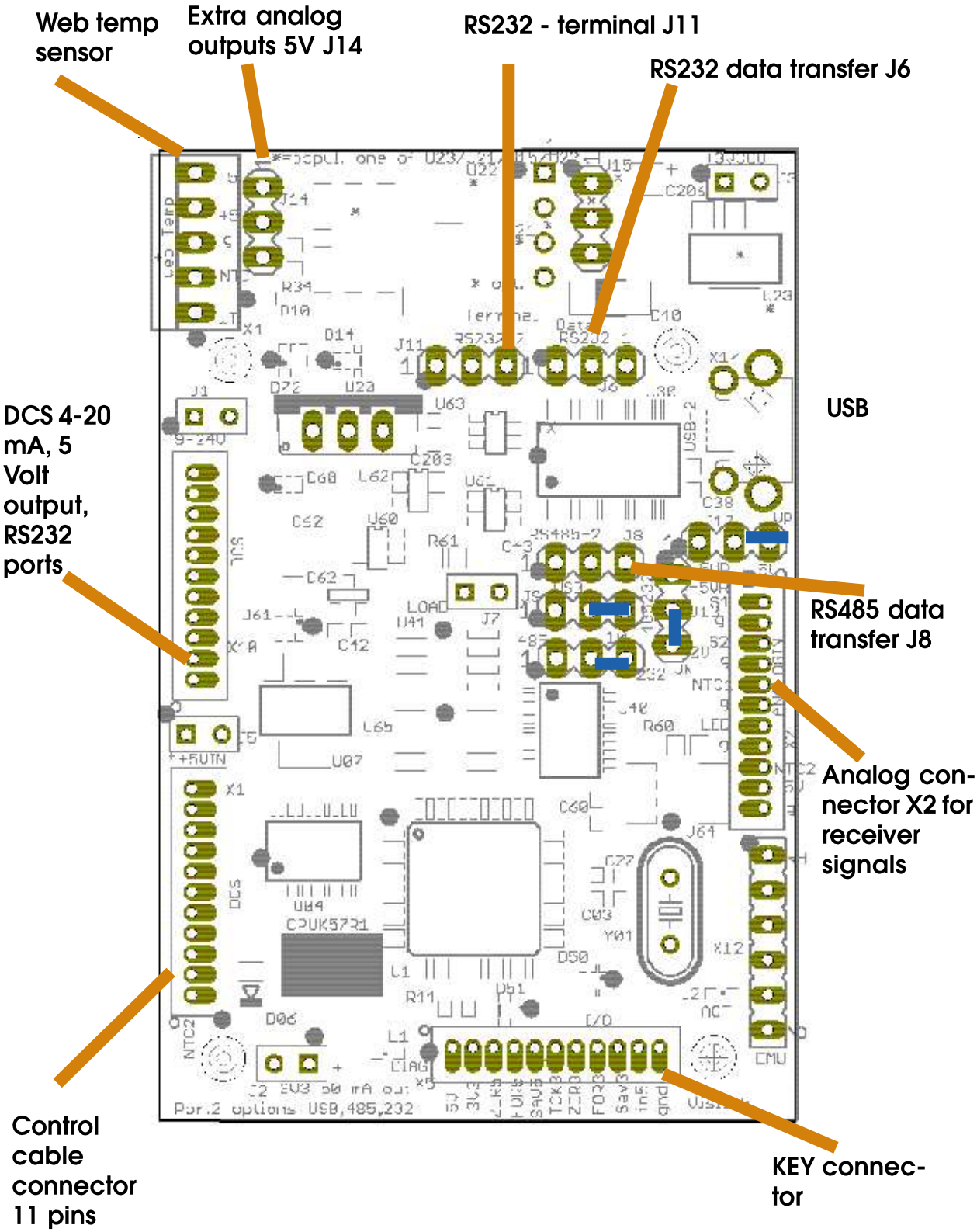


Figure 12B. MK30LP DUAL/SINGLE includes this circuit board **K57R1**. It has connections to both internal and external functions. The selection jumpers are accessible too. If one attempts to use the RS485, the lowest jumper J10 needs to be changed and the wire going to J6 needs to go to J8.The pin number one is important to locate and keep correctly positioned. It has been marked with a thick dot. Default jumpering is marked here with blue lines. This card has more features than K51R1

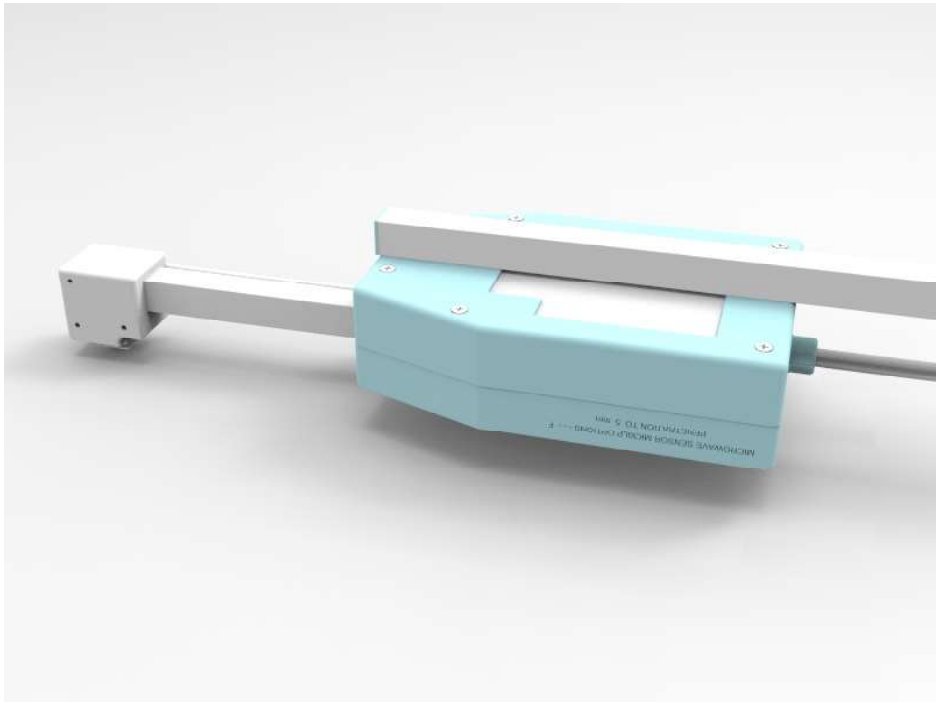


Figure 13. MK30LP sensor head at the end of a stick. MK30LP-CUBE below



MK30LP-CT / CTB

The models **MK30LP-CT** and **-CTB** are new variants in the **MK30LP** family for measuring wet mixtures of cellulose and pulp and other fibre containing water solutions, like biomass and animal feed. Their interfacing is identical to the base model. They are mounted to the mixture vessel with a R-1/2" fitting.



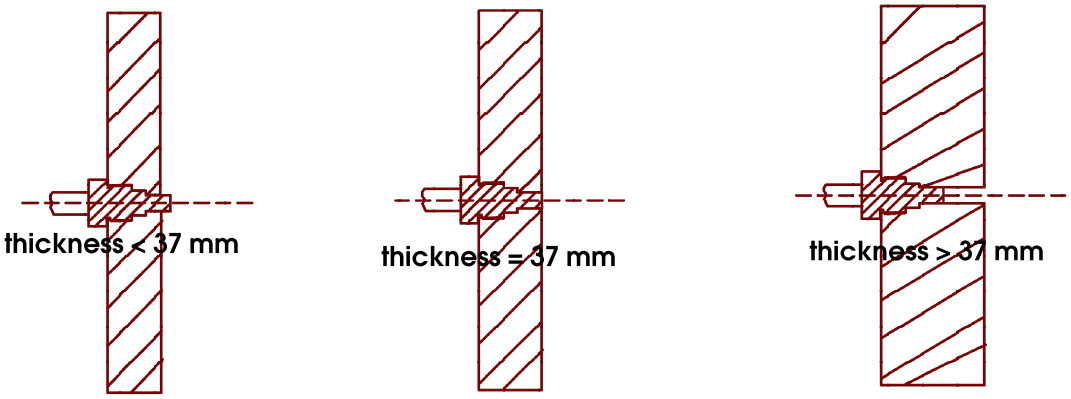


Figure13B. MK30LP -CT sensor and below MK30LP-CTB
The black box variants are optionally delivered if requested





Figure14. MK30LP -CT sensor mounting with the R1/2" fitting in various cases

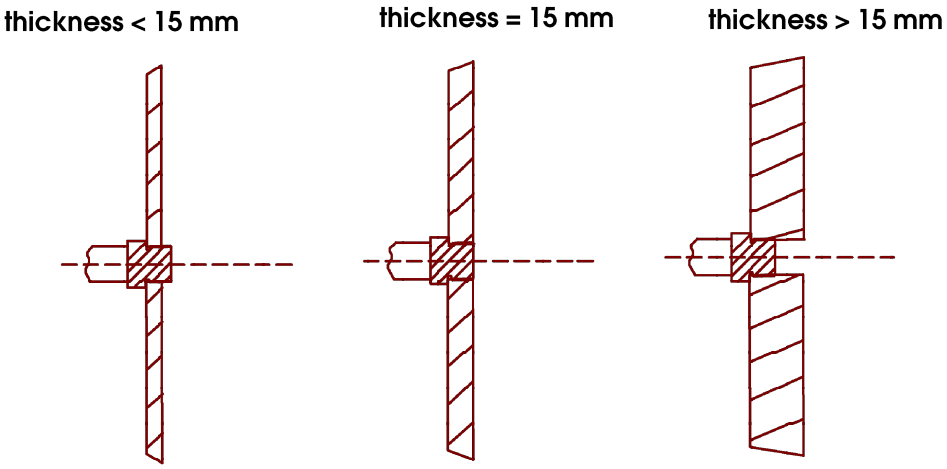


Not a perfect mounting, the sensing surface is protruding to the liquid volume. Adding gaskets is recommended to aid in making the surfaces flush. The sensing area does not become dirty easily

Ideal mounting, the sensing surface is flush with the inner surface and in good contact with the fluid volume. The sensing area does not become dirty easily

Failing mounting, the sensing surface is disconnected from the fluid volume. The sensing area does become dirty easily. Machining of the inner side making a relief to make the surfaces flush will help.

Figure15. MK30LP -CTB sensor mounting with the R1/2" fitting in various cases



Not a perfect mounting, the sensing surface is protruding to the liquid volume. Adding gaskets is recommended to aid in making the surfaces flush. The sensing area does not become dirty easily

Ideal mounting, the sensing surface is flush with the inner surface and in good contact with the fluid volume. The sensing area does not become dirty easily

Failing mounting, the sensing surface is disconnected from the fluid volume. The sensing area does become dirty easily. Machining of the inner side making a relief to make the surfaces flush will help.

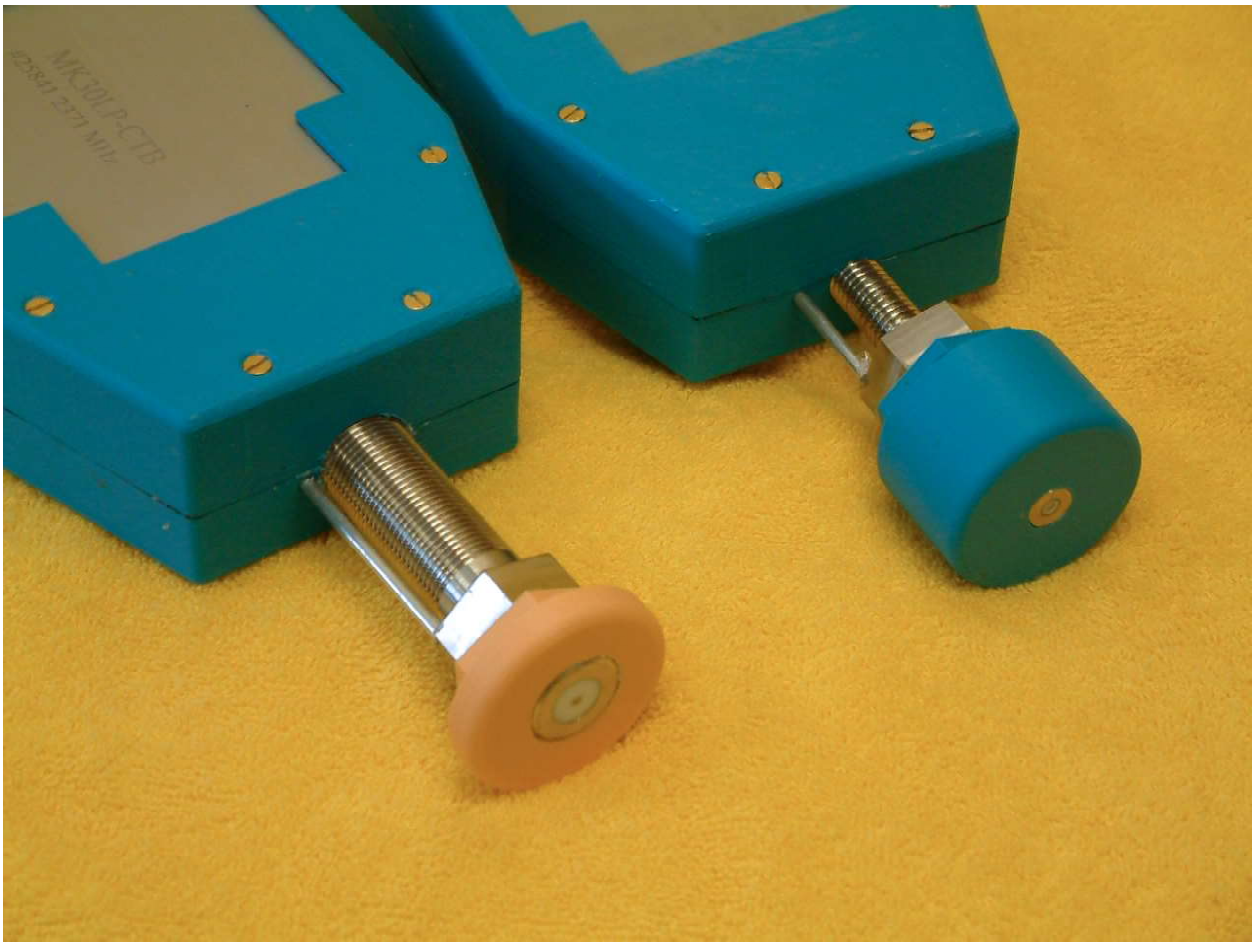


Figure16. MK30LP -CT / CTB ABS plastic touchpads mounted for portable work. Below are -CTB-DISP and -CT-DISP versions





Use of the Second Channel As a Reference

There are occasions when the signal has some unwanted dependence on a variable like moisture or temperature needing removal of its effect. It may be done if the variable can be measured with the second sensor. It means that the second channel must be available with its RF-cables etc. When this feature is taken into use the **sensor must operate in DUAL mode**. The second channel calibration / SCALE use must be suitable for this to make sense. Also, the channel RF cables and other signals must be connected properly. There are several options in this sense unless two separate sensors are used. Usually the systems are set up in the factory before delivery to work properly in special cases.

One can use the second channel for this purpose in more than one way. This can be selected and activated in the **MK30LP** program (Hardware page, Service operations, refer to the program User's Guide). It is also possible to activate in the terminal menu system too. One can turn on the **Reference** by pressing the button (after first Checking!). Then the calculation mode is selected. The options available are:

1: DIVIDE - subtract from the **raw signal CH1** the **raw signal CH2** divided by a relative compensation
2. MULTIPLY - multiply the **raw signal** CH1 by the **raw signal** CH2
3. ADD - add the **raw signal** CH1 to the **raw signal** CH2
4. SUBTRACT - subtract the **raw signal** CH2 from the **raw signal** CH1
5. NONE - no operation done, CH1 goes through unchanged as CH2 too

After selecting, press the UPDATE button. Check the operation and if it is working properly, Save the current settings in the sensor.

Note carefully that in these options the signals **are the raw signals** before applying the calibration. After the compensation calculation the proper calibration is applied to CH1 and CH2. CH2 is output without any changes.

The latest feature is the possibility to use either the internal (int) reference or the external reference (ext, default) for compensation. The external means the second sensor and the internal means the first sensor. The compensation strength can be adjusted within limits of +/-1000 %. It only affects the term bringing in the compensation, not the actual signal part. In the **MK30LP** program these factors can be checked and modifed. Do not change them unless you what you are doing. A great flexibility is offered here for both in design and implementation of any microwave-based moisture measurement.

Refer to the **Technical Guide** following this meter for deeper technical details on the use of the reference. That document is not in the website.

New features

One new feature for the MK30LP family of sensors if the **cable calibration** which has now been made open to the user. It can be accessed with the latest version of the PC program MK30LP. One can also use it via the **Terminal** connection and an RS232 terminal. There it is available in the runtime menu system since it requires that the meter is actively measuring to handle the calibration requests.

The purpose of this feature is to allow users to perform cable calibration in case some of the critical RF cables are replaced. Normally this is done at the manufacturer and one does not need to worry about it. Refer to the MK30LP program user's guide for details. The basic sequence of operation is as follows. First the cable calibration is made inactive. Then the sensor is cleared from any material. Then the current cable calibration data is **cleared**. Then the **OPEN** calibration is made with the cavity open and clear. Then the cavity end is covered by hand, an Aluminum foil or wet pulp and the **SHORT** operation is started. Then the new cable calibration can be taken into use. If everything is working OK, then Save the meter configuration. Else redo until you make sure the operation is successful.

Appendix 1. Service Operations

The service needs of the **MK30R** moisture meter are minor. The only service situations are replacing the battery and keeping the sensing head window clean.

Replacing the Batteries

MK30R contains one Lithium battery. It should be replaced at 5 to 7 years' intervals depending on the heaviness of their loading and discharging history. If the battery is every day fully discharged and then reloaded, their operating life will be shorter.

Service Procedures

You should follow these instructions when replacing the batteries to avoid damage to the instrument. ***Deflecting from these directions may endanger the accuracy of the instrument or even cause damage to it. The guarantee is not valid if the instructions are not obeyed***. You can open the instrument only in clean and dry conditions where there is no danger that dirt or moisture will enter the instrument casing or its components. The meter must be handled with care and no parts should be dropped inside during service. Short circuits may result and that may cause damage. Note that part of the meter's circuit board is always powered although the power switch is turned off and the cable is disconnected. Either the battery or the external power source always keeps live parts of the circuit. Look out for static electricity! You should not operate in relative humidities below 30 %RH. Static discharges to the circuits will cause damage although all circuits are in principle protected against it. Do not touch the components on the board!

Important Notice

Never touch the adjustments on the board! Also the responsibility for any injuries or damages caused to any third parties belongs to the user. You act on our own risk. If you feel hesitant of performing the service operations yourself, leave them to professional people and contact the manufacturer.

When you replace the battery, follow the instructions below..

Opening the Meter

1. The meter is placed on a table. Turn off the power.
2. Disconnect the power cable.
3. The meter battery panel cover is opened with a suitable screw driver.
4. Slide out the battery pack carefully to the side of the meter minding the cables.
5. Identify the flat battery and its wires/connectors, located at the bottom plate.
6. Disconnect the battery cables connector by pulling away. Now the instrument is completely without power (except the battery itself and the clock battery). No data is lost. If the connectors are a bit hard to detach, leave them for now and go to next step.
7. Locate the clock battery and replace it.
8. Carefully orient the panel's cables not to touch any parts of the sensing head engine. Lock the battery panel with the same screws.
9. Drop the old battery to recycling.
10. Test meter operation in varying positions, also upside down. No funny noises should come out and the meter should show correct readings. If the battery is dead, recharge it first. Check also the clock timing to be correct.

A new battery pack can be ordered from the manufacturer. Mention the product model MK30R at time of ordering.

Appendix 2. Definition of the Data Transmission Protocol

MK30 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. MK30R uses 115200 bauds. MK30LP is using the same command set but in a different way on some instances. It has five different baud rates available covering 9600 to 500 000 bauds.

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 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.

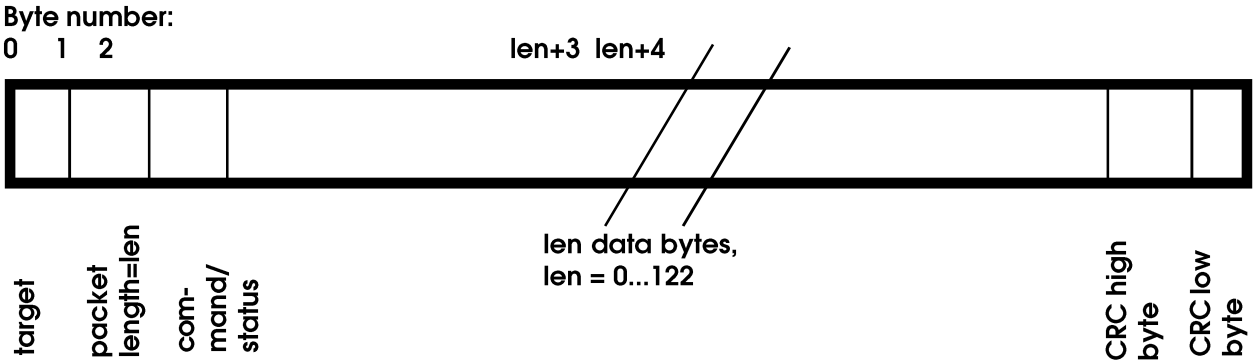
The packet consists of the packet length byte (0 to 122 in value), the receiver's address (one byte) which unambiguously identifies each unit in the network. The MASTER's address is always zero and the SLAVEs have nonzero addresses. In an RS232 network the SLAVE always has an address one.

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.

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. L2-1, 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 directed for it but 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.

With these precautions are ensured that collisions do not occur too easily, and if they do occur, the system will recover 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. There is a document on the manufacturer's website regarding the protocol.

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.

```
/*
  MK30R packet protocol definitions and command/status values

  Protocol commands:
*/
/*
  MK30R packet protocol definitions ja command/status values

  Protocol commjas:
*/
/* commands */
#define I7TBL    8 /* save table, A NEW COMMAND */
#define I7CFG    9 /* save config, A NEW COMMAND */

#define I7TEST   10
#define I7MOIST  11
#define I7SUNIT  12
#define I7GUNIT  13
#define I7GETMAT 14
#define I7SETMAT 15
#define I7GMODE  16
#define I7SMODE  17
#define I7SETHI  18
#define I7SETLO  19
#define I7TXSER  20
#define I7CLSER  21
#define I7TXMAT  26
```

```
#define I7RXMAT  27
#define I7GETUSG 28
#define I7GLIBNM 29
#define I7SLIBNM 30
#define I7GMATNM 31
#define I7GETHI  32
#define I7GETLO  33
#define I7BEEP   34
#define I7GETDM  35
#define I7SAMPLE 36
#define I7GETLPM 37
#define I7SETLPM 38
#define I7SETTIM 39
#define I7GETTIM 40
#define I7AUTOON 41
#define I7AUTOOFF 42
#define I7GETAUTO 43
#define I7GRAWS   44
#define I7GRAWR   45
#define I7GETTMP  46

/* extra commands not in standard AK30/40, MK30R instrumentation : */
#define I7STERM   47
#define I7GWEB    48 /* this one is in model A too */

#define I7SFILTER  49
#define I7GFILTER  50
#define I7GAINLOCK 51
#define I7GAINOPEN 52
#define I7GETLOCK  53
#define I7SBANK    54
#define I7GBANK    55
#define I7SBATCH   56
#define I7GBATCH   57
#define I7SAMODE   58
#define I7GAMODE   59
#define I7GFREQ    60
#define I7GDPADR   61
#define I7SDPADR   62
#define I7DPACT    63
#define I7DPDEACT  64
#define I7DPINIT   65
#define I7GDPACT   66
#define I7SSHIFT   67
#define I7GSHIFT   68
#define I7STDZE    69
#define I7SSTDM    70
#define I7GSTDM    71
#define I7SSTD     72
#define I7GSTD     73
#define I7GLAMP    74
#define I7SPACKET  75
#define I7GSTATUS  76
#define I7GMATNM2  77
```

```
#define I7TEST2    78
#define I7GHEAD    79
#define I7TEST3    80
#define I7SMATNM   81
#define I7SMATNM2  82
#define I7FFT      83
#define I7GLAN     84
#define I7SLAN     85
#define I7G2STATUS 86
#define I7SVOUT    87
#define I7GVOUT    88
#define I7G3STATUS 89
#define I7GCOOLING 90
#define NOP        91 /* meter model # */
#define I7SCOOLING 92
#define I7GCOOLTMP 93
#define I7GCOOLON  94
#define I7GCOOLINK 95
#define I7SCOOLINK 96
#define I7GCOOLSTA 97
#define I7COPYT    98
#define I7STLPF    99
#define I7GWEB2   100 /* a special command for an optional input */
#define I7GTLPF   101
#define I7SWEBB   102
#define I7GWEBB   103
#define I7GALM    104
#define I7CALM    105
#define I7CDPREP  106
#define I7CDSET   107
#define I7GXMOD   108   // increment read
#define I7GNXMOD  109
#define I7GXNAME  110
#define I7SXCOM   111   // increment set
#define I7SBURST  112
#define I7GBURST  113
#define I7SBUM    114
#define I7GBUM    115
#define I7GBUC    116
#define I7CBUC    117
/*            = the last command */


#define TIMEOUT 30      /* timeout in milliseconds */

/* positions of the control bytes in the packet */
#define TAGTPOS  0
#define LENPOS   1
#define COMPOS   2
#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 */

#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 NOP          91 /* No Operation Command */

#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 */
```

Consult Visilab for details. Also, there exist documents of the protocol with more details

Appendix 3. Specifications of MK30R and MK30LP-CUBE, MK30LP-CT, -CTB

Device:	An independent moisture meter based on microwave technology and advanced signal processing.
Moisture range:	1 - 99 % or wider for total moisture, quality selectable. MK30R can measure up to 8 000 g/m2 of water layer. The corresponding thick material moisture range i exceptionally wide. The low moisture end is usually near 2% but pressboard can go to 0.5% The basis weight lower limit is near 30 g/m2 with normal moisture levels. **MK30R-PX/PF** range 1 - 99% and water till 5000 g/m2
Resolution:	0.1 % in display, 0.1 % in statistics, 0.0001 % in values transmitted to PC
Repeatability:	Typical +/-0.3 % or better
Accuracy:	Depends on calibration used. The number of calibration point can be 2 - 10 to cover the range. The typical accuracy is +/- 0.5 % or better
Calibration:	There are 100 calibration tables available each with up to 10 points (MULTI). The calibration library is in a nonvolatile memory. Flash calibration can be used for field operations when no laboratory instruments are available, zeroing (Zero) to reset the moisture reading.
Noise level:	The standard deviation of the signal is typically < 0.08 % in the range of 0..10 % with MEDIUM filter
Stability:	Better than +/-0.2 %/year in range 0..40 % 80 g/m2 paper
Measuring speed:	The display is updated once per two seconds at least. To the PC new values can be updated up to 50 /sec
Measuring area:	About 40 mm in diameter. **MK30R-PX/PF** 10 mm in diameter. **MK30LP** 10 mm in diameter, **MK30LP-CUBE** 40 mm in diameter, **-CT** 4.0 mm in diameter, **-CTB** 10.0 mm in diameter
Penetration depth:	Maximum 35 mm in most materials. **MK30R-PX/PF** 5 mm, **MK30LP** 5 mm, **-CT** 3 mm, **-CTB** 7 mm. This means the microwave radiation penetration only
Measuring distance:	Requires touching
Data banks/profiles:	Room for 820 profiles, each with max. 500 points. Saving either manually (Save key) or automatic (Autotimer). The label can be selected/edited beforehand and will follow the data files to the PC. Five recipes editable and selected by two hot keys while measuring. **MK30LP** variants do not have data memory.
Travel meter:	Available on the meter bottom with an enabling mechanical switch. The spatial resolution is by default 20 mm but can be adjusted to any number between 10 and 10 000 mm with an increment of 10 mm.
Infrared thermometer:	Available built-in. The signal is interleaved with the moisture profile
Recipes:	Five recipes available. In each is saved a text label and the calibration table number used. Switching to another recipe is done with the hot keys 2, 3.
Data security:	All data and settings are in a nonvolatile memory which will stay at least 40 years. The configurations are saved by pressing the Save key in the menus referring to changing any configuration. The calibration table in use will be saved in calibration-related menus. Both are saved in the main menu by pressing the Save key.
Temperature:	An internal sensor measures the temperature and its reading is available in the PC programs and also on the internal menus. This data can be retrieved at the laptop too.
Filtering:	Selectable: *FAST*, 0.2 s response time, *MEDIUM* 0.6 s, *SLOW* 2.8 s and editable in the menus. MK30LP model response times are faster
Background material:	No effect on thick materials as long as the thickness is greater than the penetration depth. With thinner materials any material behind the sample may affect heavily.
Dynamic range:	The dynamic range of the signal is 95 dBm

Warm-up time:	Less than 12 s from powering up to normal accuracy. Full accuracy in 3 min.
Environmental:	Operating temperature 0..+50 C, can be used in wet conditions
Operating period:	Minimum 7 hours with fully charged battery before needing to recharge. The **MK30R** variants can be used continuously if the battery charger is connected. **MK30LP-CUBE** and **MK30LP** are designed for continuous use.
Guarantee:	Two years guarantee, does not apply to battery.
PC connection:	Serial communications through either USB or 100 m Bluetooth at 115200 baud rate (or 9600 baud) with a private packet protocol, the user interface is a graphic program for Windows 11/10/8/7 and future versions. One can retrieve measured profiles (downloading), configuration of the meter and perform a continuous data acquisition (Acquire). Also the management of the calibration library is available. At this time the programs available are **AK30, AK30Mini, ATOM**. Licensed programs are **Moisture** and **Advanced**.
Power supply:	A certified 9 V 1500 mA charger is charging the battery any time it is connected to the meter.
Battery:	A rechargeable Lithium Ion batter 3.7 V 10 Ah , charging time 10 - 12 hours with the meter turned off. Battery lifetime in heavy use 5 -7 years. **MK30LP-CUBE, MK30LP** no battery
Low Power Mode:	A special energy saving mode allowing the meter to be used without actively measuring up to 20 hours. The Normal state is quickly recovered.
Sleep modes:	Sleep mode sets the meter into LowPower state after one hour of inactivity. DIM only dims the display but continues operation
Enclosure:	IP67, protected from splash water and dust, abt 260x178x139 mm, weight abt 2.0 kg, MK30LP models have varying dimensions and weights
Cable calibration:	A possibility to calibrate new cables in case of cable replacement with differing cable type
Measuring ice:	Will measure ice but must be separately calibrated for it.
Incompatible materials:	Substance containing Titanium oxide, soothe or metal laminates/particles, are not suitable for measurement
EM compatibility:	Complies with EU Directive 89/336/EEC, see the EMC certificate
Accessories:	Check Visilab Signal Technologies web site for the latest information.
Electrical interfaces:	**2-pin connector :** +9V - +24V charging line 1.5 A, Bluetooth full duplex 115200 bauds for PC (9600 bauds). **MK30R-PX/PF** use a 12-pin cable and an ITT Cannon connector to **DCS, -PS or MK30R-DISP** systems. MK30LP uses the same connector for the DISP-unit and PS power supply but the pin ordering is completely different from the above. **-CT** and **-CTB** are identical to **MK30LP** regarding the interfaces.

Appendix 4. Troubleshooting the Meter

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

A. Symptom: No moisture signal to the PC, no contact with the AK30 program (or AK30Mini, IRMA7Basic etc.), but the meter is working itself. Bluetooth operation only

1. Are you sure that the COMnn port you are using in the Bluetooth driver program is the same as the one the PC program is using? **This is absolutely the most frequent reason for communication problems with the meter when using the Bluetooth option.** Change the port selection on the **program's** Configuration page.
2. If done all right thus far and still no connection is established with the meter, press the reset button on the Bluetooth master module connected to the USB and then go On-line in the program.

C. Symptom: The meter is dead.

1. Is the meter correctly powered? Are you sure? Are the displays showing something? If yes, the meter is receiving power and/or its batteries are all right but may have a weak charge. If not, check the power cable from the battery charger unit. It should be connected to a 230VAC or 110VAC wall inlet. Let's suppose the meter is not in Low Power mode. If not certain, press the Low Power key to force some effect. Do you hear any beep when a key is pressed? If not, the meter is either off or the batteries are dead. If the batteries are empty, charge the meter overnight and try again.
2. Is the cable with the connector placed into the socket in the meter's handle? If there is still no power to the meter, the power source may be faulty (rare). Let a technician check it or contact the manufacturer. A voltage close to +9 ...+24 Volts should be available in it at the connector pins. All fuses in the system are self-recovering and need no service.
3. Try to charge the battery for at least 5 hours with the meter turned off. If that does not help, there may be some internal malfunctioning or damage. In some cases, the internal fuse has overheated and prevents both battery charging and meter operation due to overload. Turn off the meter and try to charge it for at least 5 hours. If that does not help, the battery is really dead and does not take charge anymore. It must be replaced. Usually a dead battery does not prevent using the meter but does not keep its charge.

C. 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 menu system, Calibration and Adjust.
3. Is the meter's position different from normal assembly? The sample 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.
4. Have you accidentally changed the table's state from MULTI to SCALE? This is likely the most frequent reason for an incorrect reading.
5. Is the head temperature too high? It should normally be below +45C. Has the meter been subjected to very high ambient temperatures? 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.

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

Appendix 5. Data Flow in the Meter

See the figure L9-1 below for a block diagram of signals.

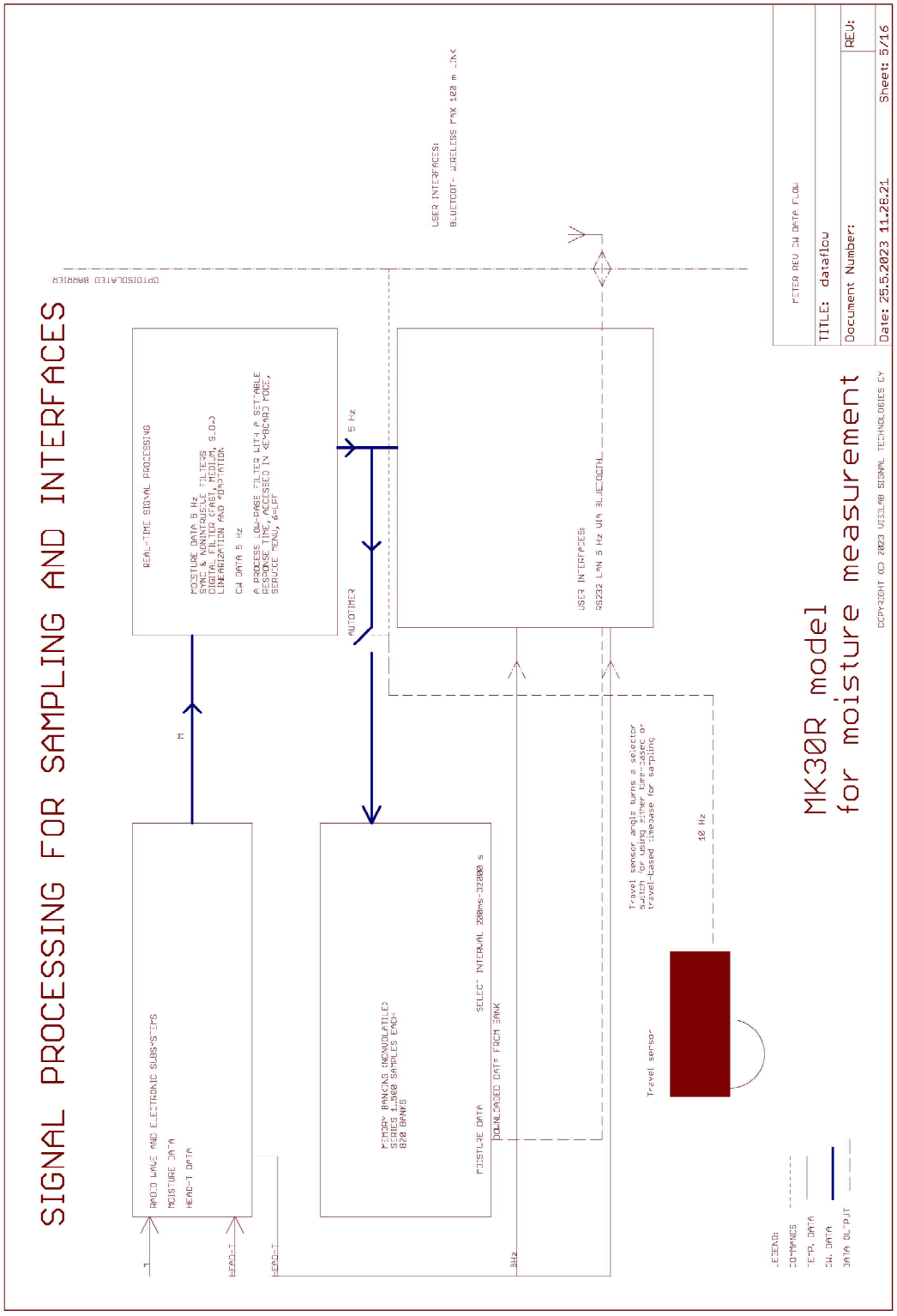
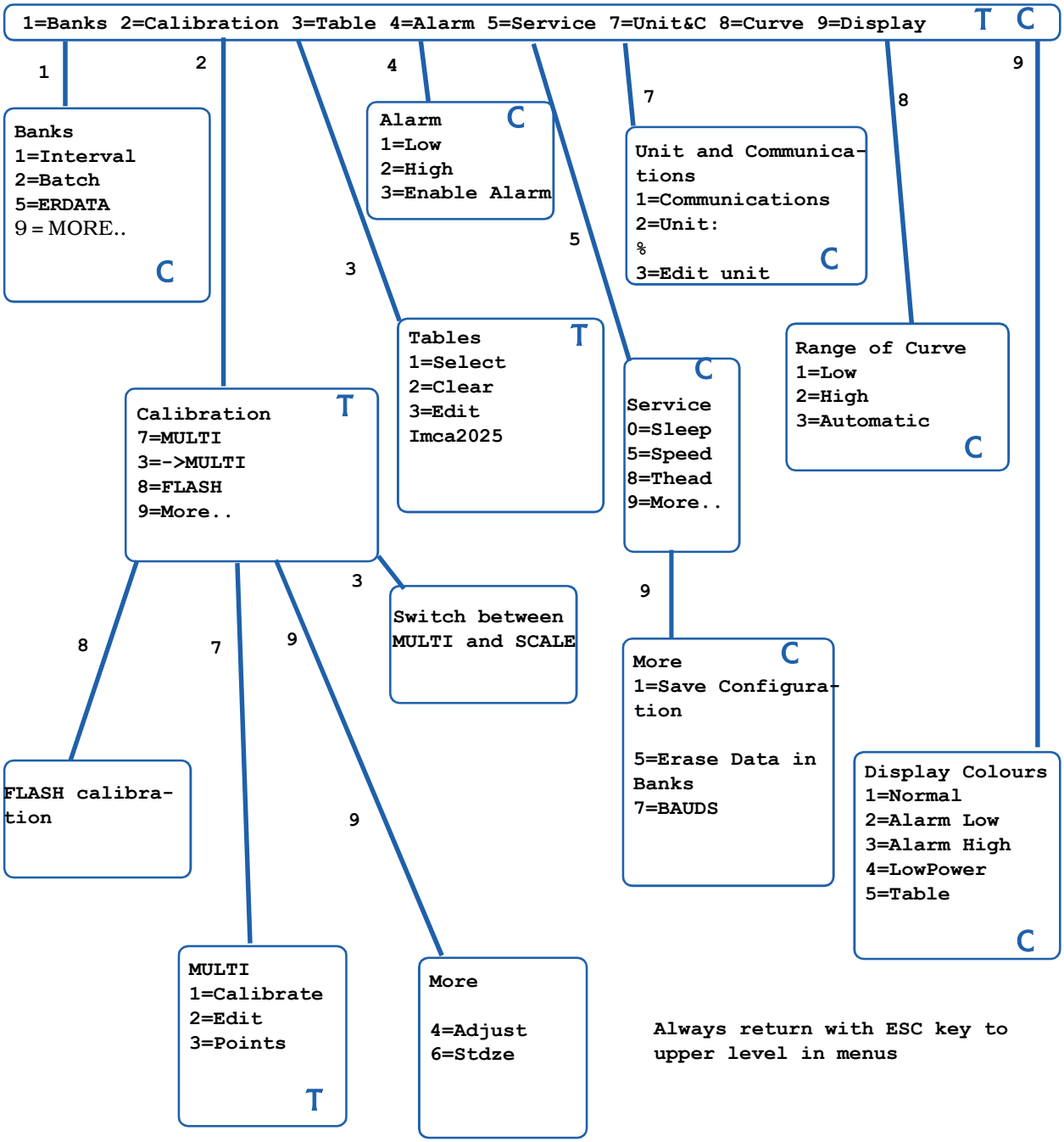


Figure L5-1. Data flow in MK30R.

Appendix 6. Structure of the Internal Menu System

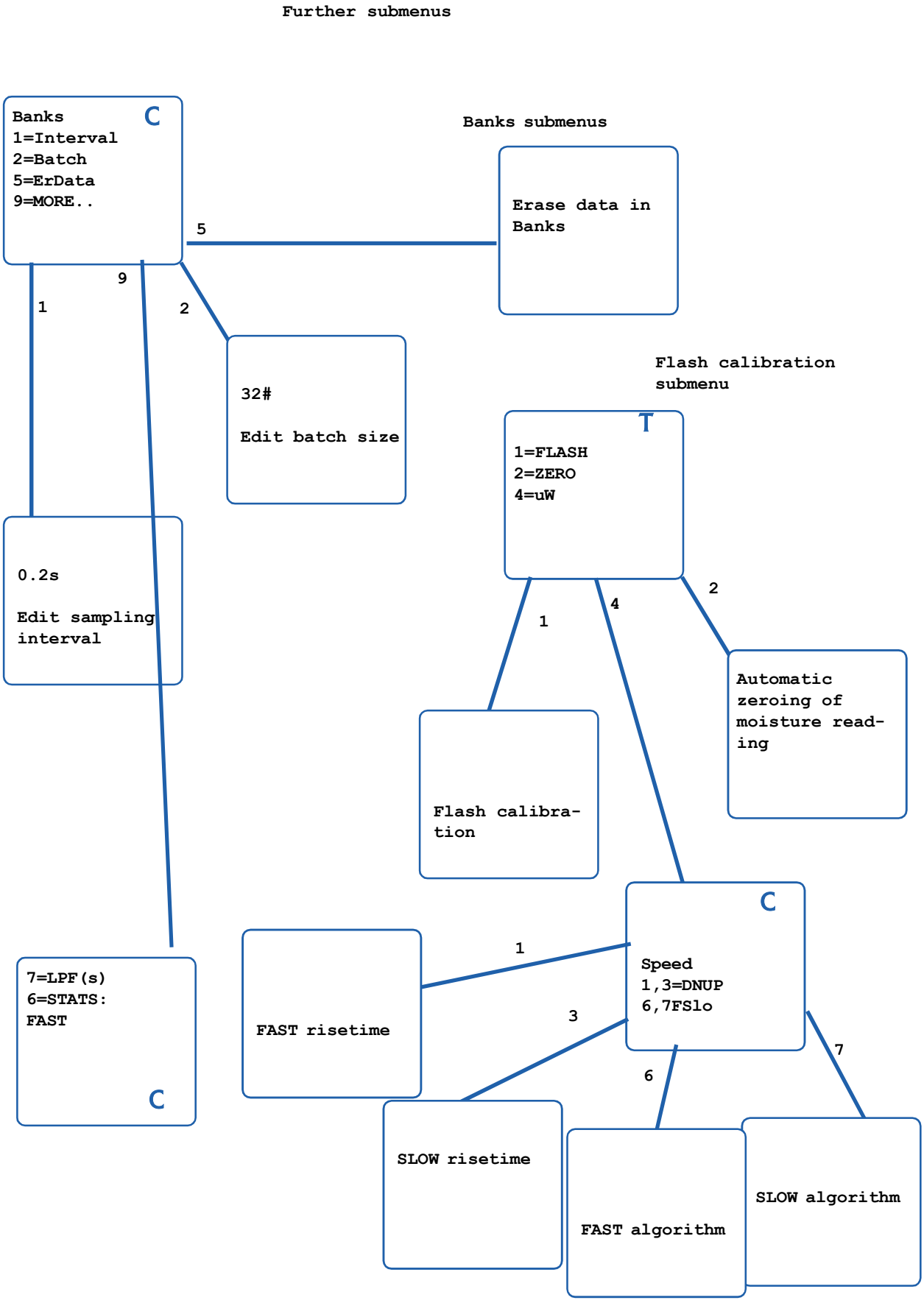
This menu is valid in V2.35X of meter's internal software. Older versions may have a slightly different set of items. Refer to main text for explanations of each functionality.

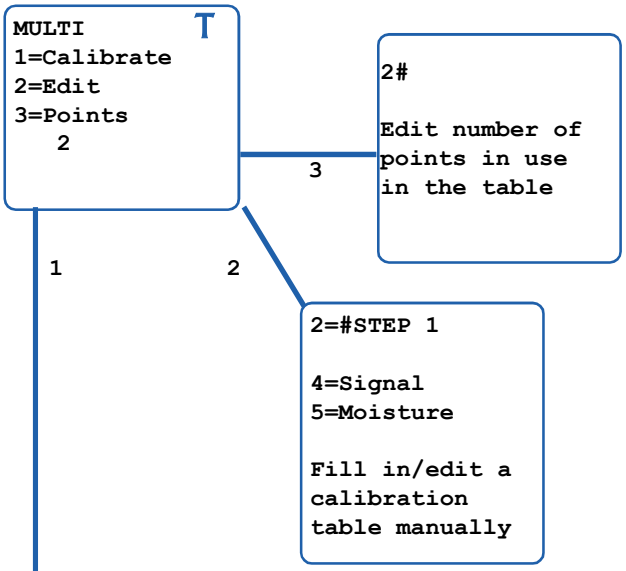


At some occasions a security question is involved: SURE?(1)
If you respond by pressing key "1" the action is continued, else not. In several submenus pressing the Save key will either save the current configuration or the calibration table, whichever is most logical at that point.

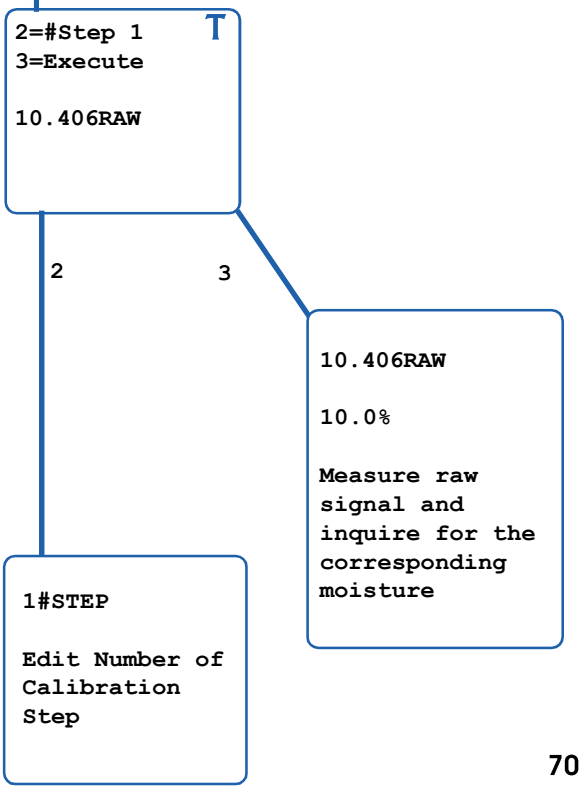
T =pressing Save key will save the current calibration table only

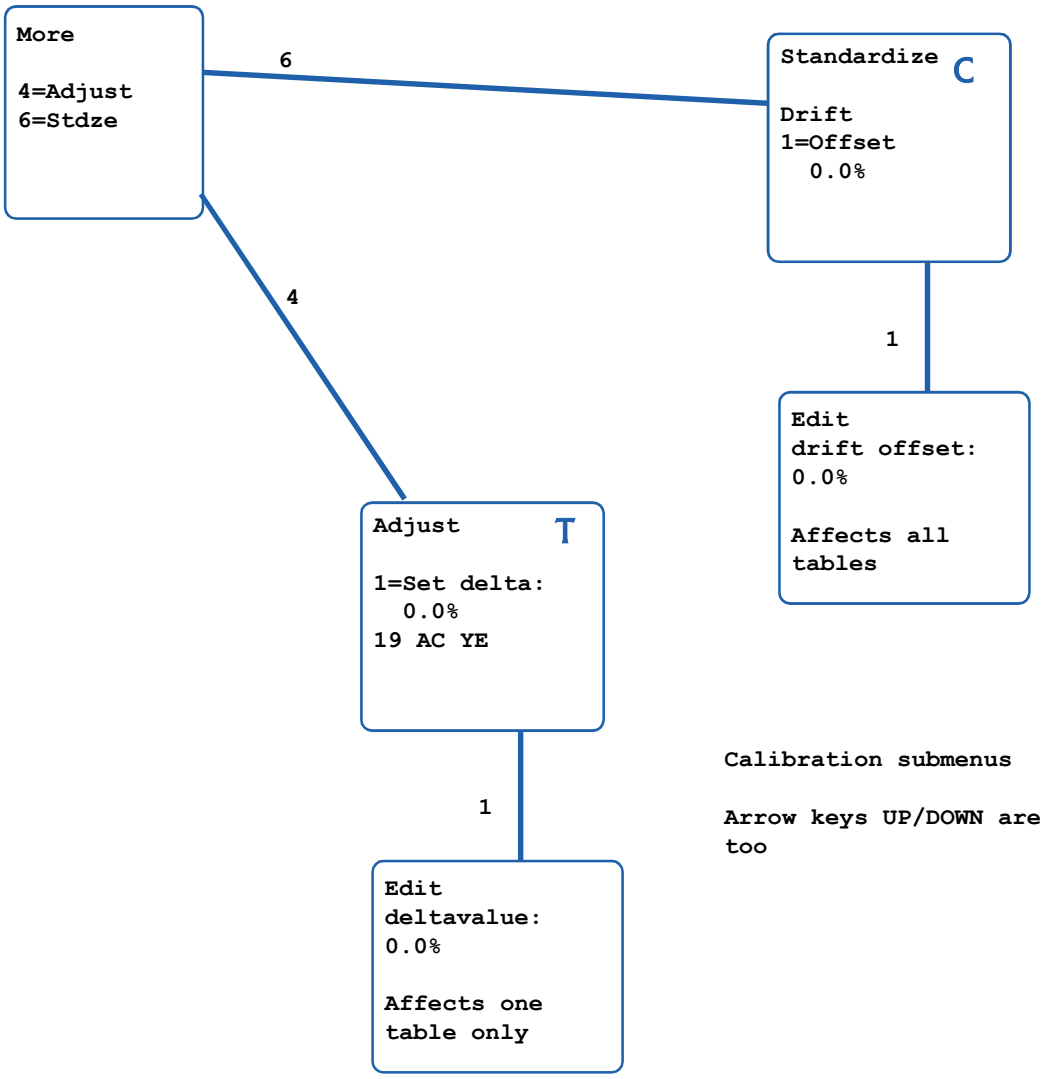
C =pressing Save key will save the current configurations only


Further submenus
Banks
1=Interval
2=Batch
5=ErData
9=MORE..
C
Banks submenus
5
Erase data in Banks
9
1
2
32#
Edit batch size
Flash calibration submenu
T
1=FLASH
2=ZERO
4=uW
0.2s
Edit sampling interval
1
4
2
Automatic zeroing of moisture reading
Flash calibration
7=LPF(s)
6=STATS:
FAST
C
1
FAST risetime
C
Speed
1,3=DNUP
6,7FSlo
3
7
6
SLOW risetime
FAST algorithm
SLOW algorithm



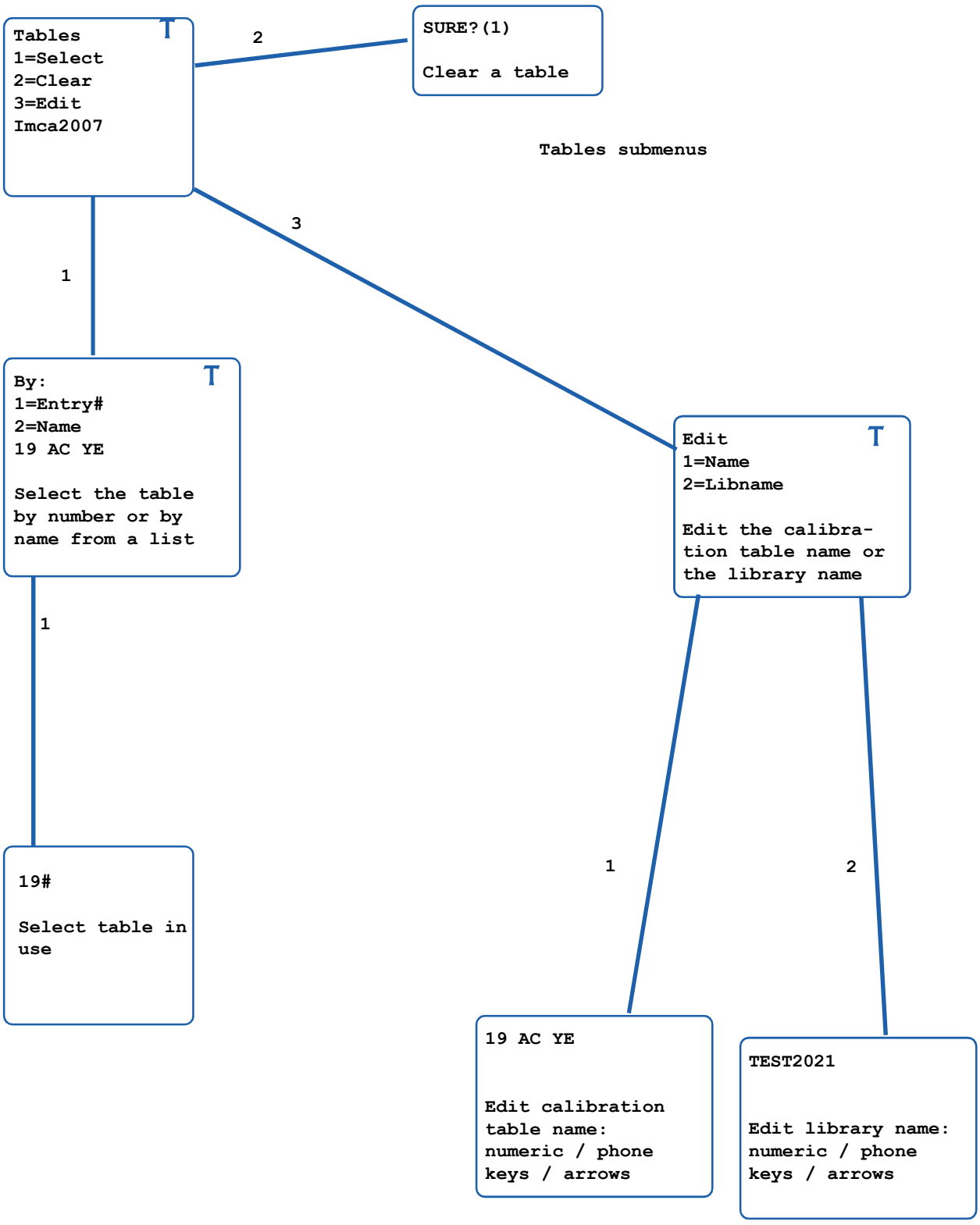
Calibration submenus

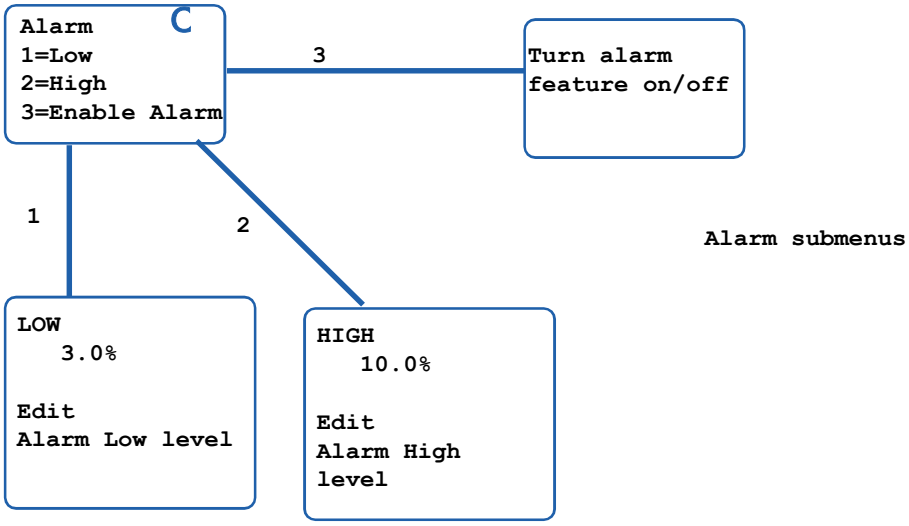




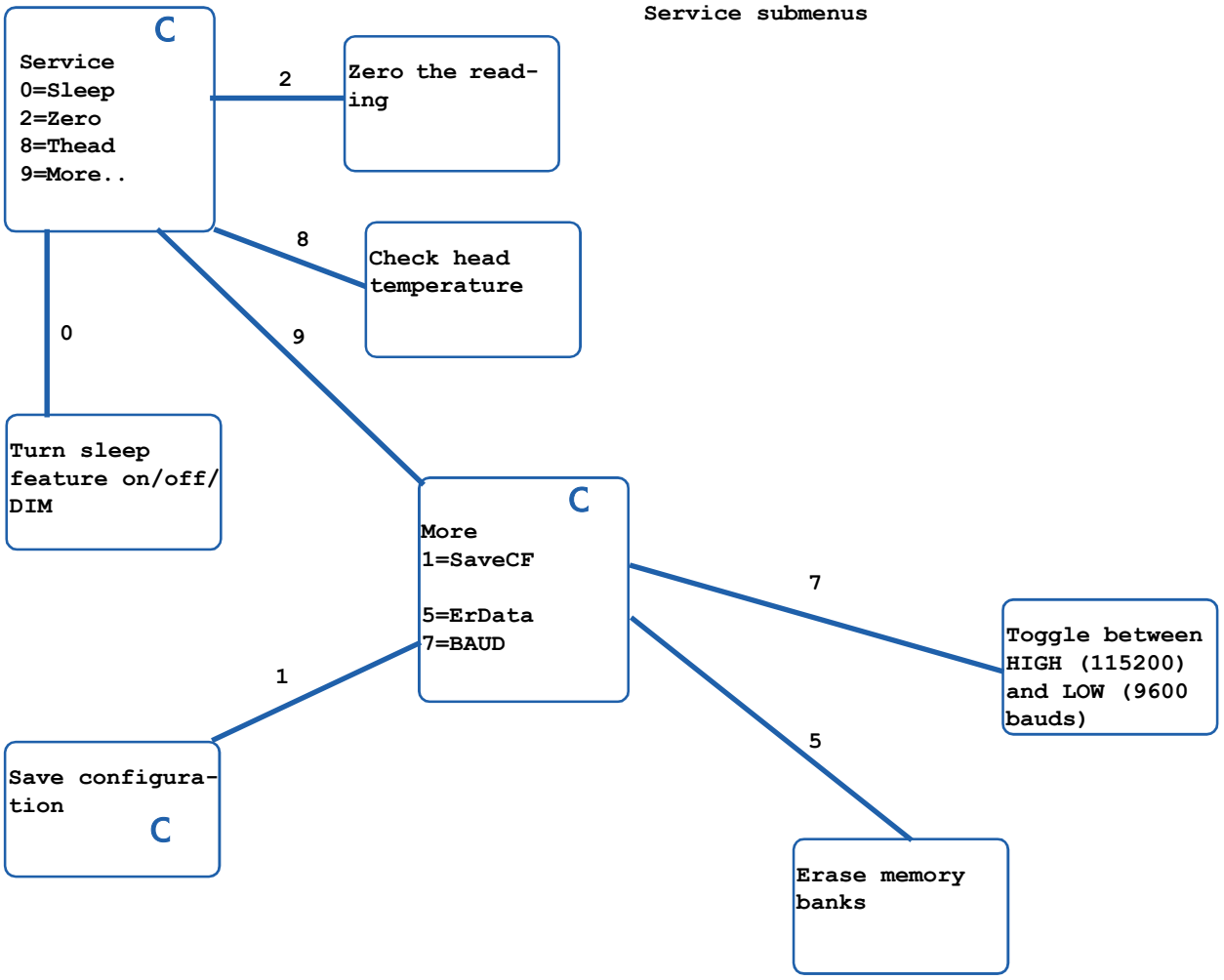
Calibration submenus

Arrow keys UP/DOWN are active too

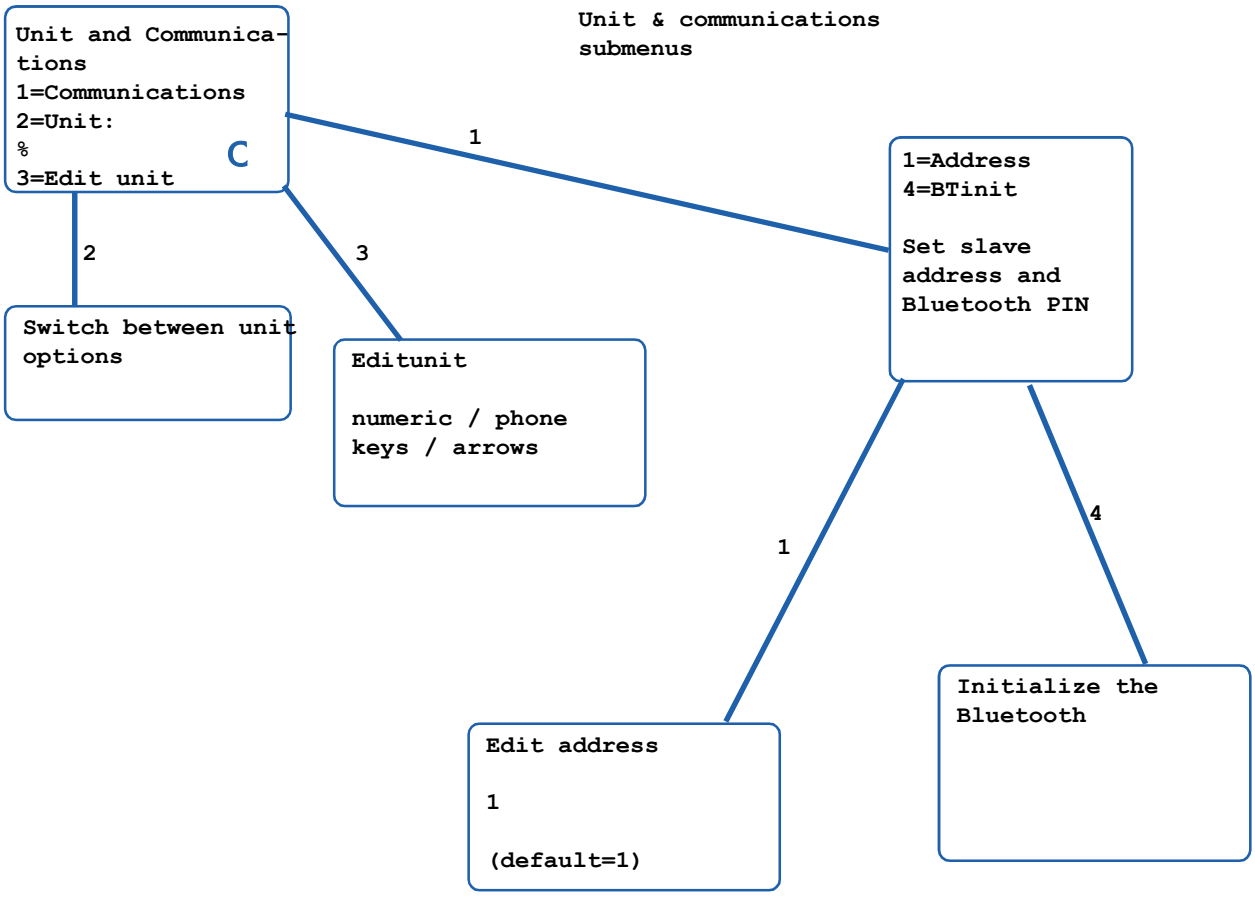

Tables
1=Select
2=Clear
3=Edit
Imca2007
2
SURE?(1)
Clear a table
Tables submenus
3
1
By:
1=Entry#
2=Name
19 AC YE
Select the table by number or by name from a list
1
19#
Select table in use
Edit
1=Name
2=Libname
Edit the calibration table name or the library name
1
2
19 AC YE
Edit calibration table name: numeric / phone keys / arrows
TEST2021
Edit library name: numeric / phone keys / arrows



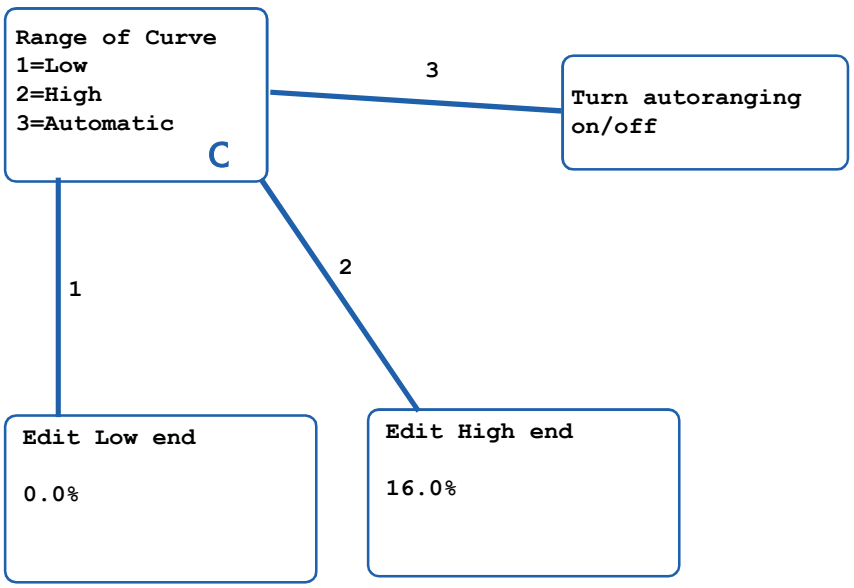
Alarm submenus



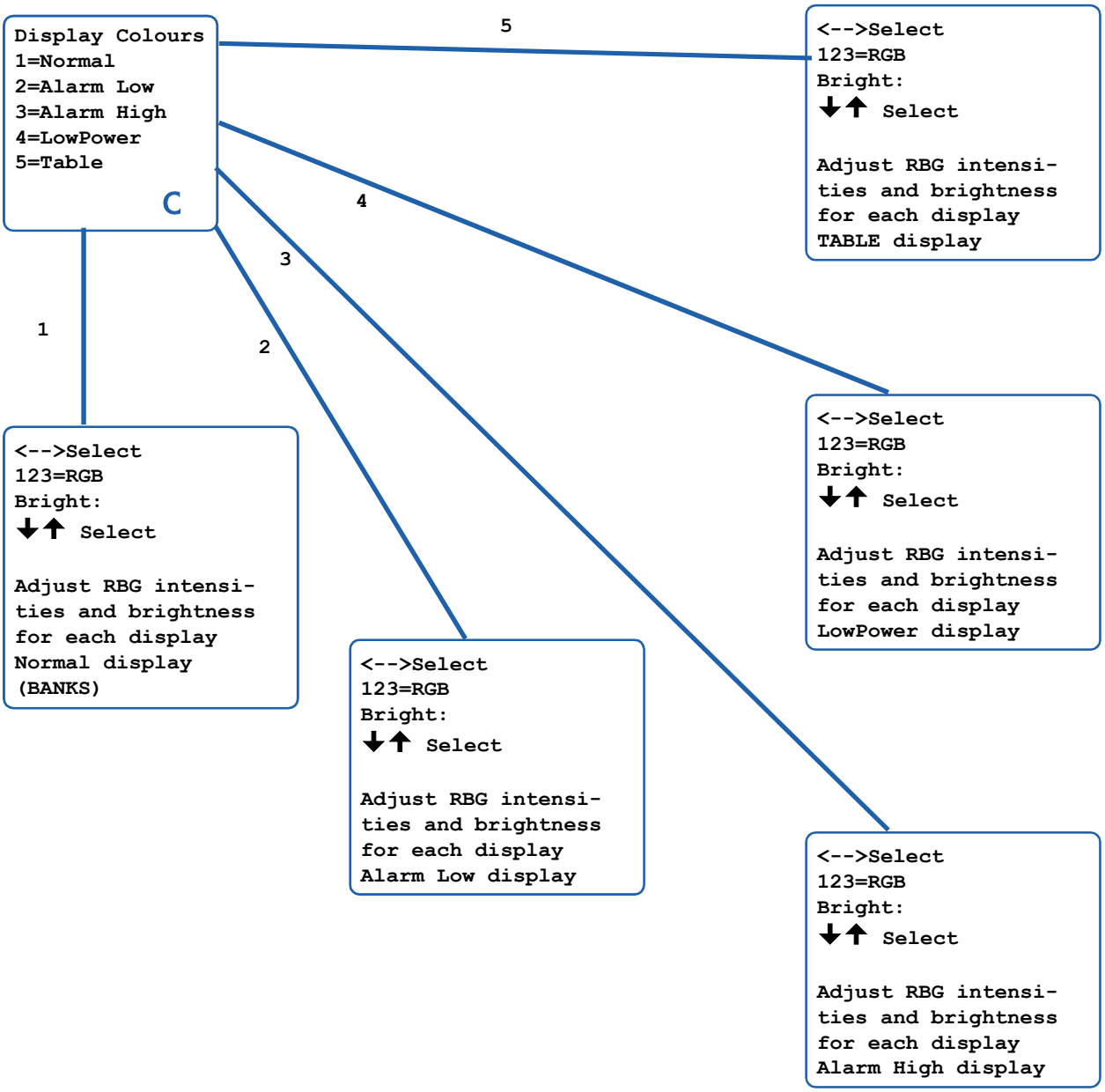
Service submenus



Curve range submenus



Display colour submenus (when available)



This menu may be missing in some software versions. Its use is minimal for the user and it is mainly for system maintenance.

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