Nokeval
made to measure

PM10A

Manual

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Table of contents

Introduction

PM10 is a modular panel-installed meter and controller family for industrial use.

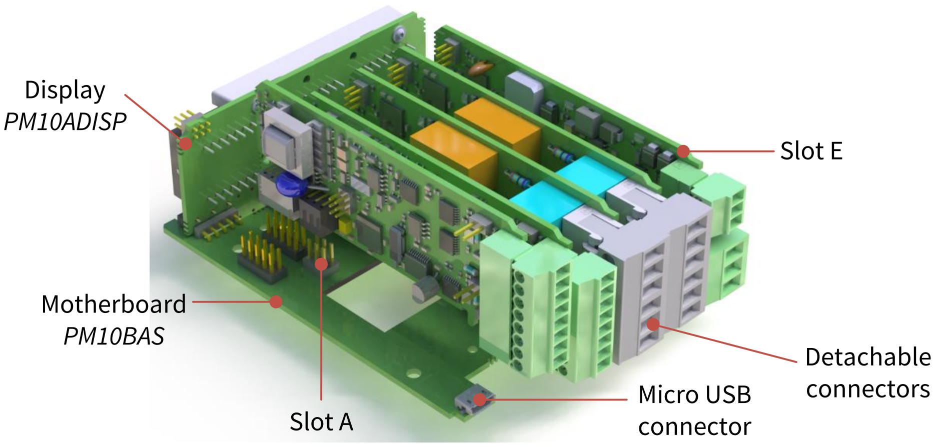
This manual covers the PM10A enclosure, motherboard, display, and functions common to many card types. The optional cards have manuals of their own to supplement this manual.

PM10 uses the FreeRTOS real-time operating system V8.0.1. The FreeRTOS source code is available from Nokeval support on request.

Assembling a new PM10A

This chapter may be skipped, if the device is ordered pre-built.

The PM10A internals consist of the motherboard, the display board and the optional cards:



Use ESD precautions. Avoid touching the components on the cards, although it may seem impossible.

Set the jumpers of the cards as described in the manual of each card.

Switch off the power supply and insert the desired cards. The cards can be of any type and placed freely, except:

- Use only one power supply card. Place it always in slot E – the back plate has a different opening.
- Do not place a relay card in slot A to keep hazardous voltages away from the USB connector.

When purchasing separate cards, they are accompanied with connector diagram labels. Attach the labels on the top of the enclosure.

Snap the appropriate back plate opening covers off by fingers or by a flat-bladed screwdriver.

Remove the detachable connector blocks from the cards. Open the enclosure by pushing the front panel away from the case with fingers.

Slide the board assembly in the enclosure guiding the cards in the grooves and refit the front panel.

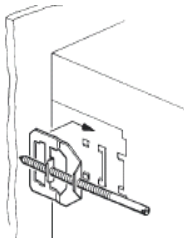
The name of the final product is formed of a prefix "PM10A-" and a list of all the cards separated by dashes. The PM10 is removed from the card names. An empty slot is denoted with 0 (zero).

E.g. a product consisting of cards PM10UNI2A in slots A and B, PM10OUT2A in slot C, and PM10POW24SA in slot E is called PM10A-UNI2A-UNI2A-OUT2A-0-POW24SA.

Panel mounting

Prepare a 92 x 45 mm panel cut-out per IEC 61554.

Place the gasket around the PM10 body.



Slide the PM10A in the opening and fasten with two clamps, either on the sides or on top and bottom.

The backside of PM10 may have hazardous voltages in the terminals. If this is the case, the backside must not be accessible without tools.

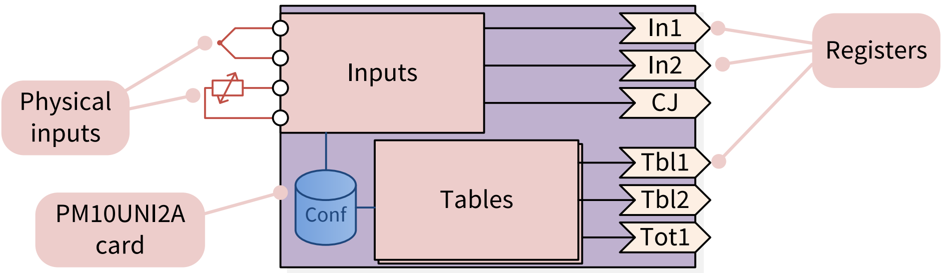
General principles about PM10

Blocks

Each PM10 card is an almost individual device. The card performs its tasks, not interacting with the other cards unless explicitly configured to do so. Each card is further divided into separate blocks, like analog input, mathematical function, table linearizer, etc. Even these blocks do not interact unless configured. Thanks to this, PM10 is configured step by step: configure one block, check it is working. Configure another block, link it to the first block, and check it is working.

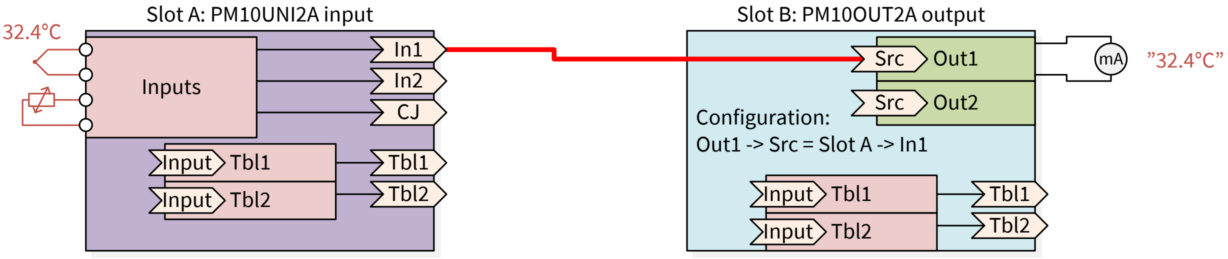
Registers and sources

The PM10UNI2A card measures two physical analog inputs and provides the measurement results for the other functions in so called registers. The registers are the logical outputs, or products, of a card.

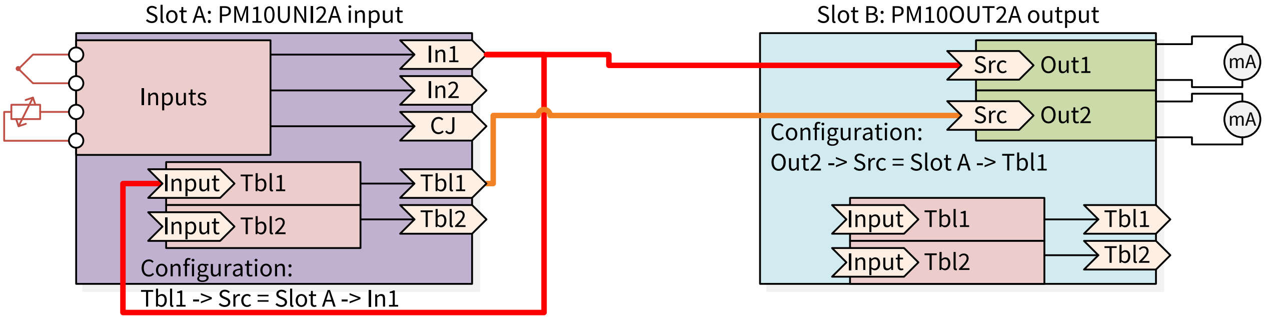


If you plug an analog output card in a PM10 device, the output will not work as it doesn't know what it should do. In addition to selecting the traditional signal type and the scaling, you must define, what the output is following or representing – the first analog input, the second, or something very different. The same applies for any kind of output, including the display – the source register must be explicitly configured.

The source settings consist of selecting the slot of the producing card, then the register within that card. For example, to make an analog output on slot B to follow the first input of the slot A card, go to the output settings, set the Src (source) setting by selecting first Slot A and then In1.



A register can be used by many blocks, and in the same or different card. As an example, we want to have another analog output that is linearized with a table:

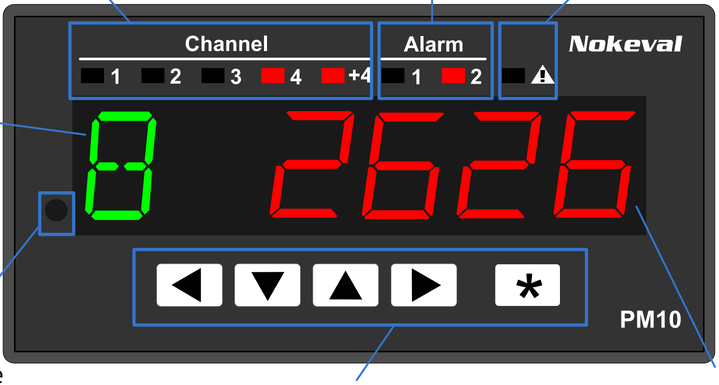


When a block uses a register of the same card as its input (like slot A Tbl1 uses slot A In1 in the example above), there are two ways to refer to the register:

- Slot A -> In1
- This -> In1

The word This means the card itself. These ways differ, when the card is detached and moved to another slot. If it was configured “Slot A”, it will still refer to slot A. However if it was configured “This”, it will always use the registers of that physical card. Generally it is advisable to use This when possible.

Using the display



Channel indicators
Tell which page is being displayed. Optionally can be used for other purposes.

Alarm indicators
Indicate the state of the alarms or the relays. Optionally can be used for other purposes.

Fault indicator
Indicates that there is something wrong.

Tag
Tells which page is being displayed. Can be 1-3 letters or digits.

Ambient light sensor
Convenient input for testing purposes. Can be used to dim the display.

Keys
For configuring the device, and for controlling its functions.

Reading
A variable value, e.g. input or function value.

Display contents and pages

The six-digit 11-segment display is intended for displaying a reading, typically from an input signal. To allow more than one reading to be displayed, the user may switch different *pages* to the display using the ▼ and ▲ keys, or the device can be configured to scan the pages automatically.

Each page may contain a *tag*, which is a number or some letters in the left side of the display, to tell the user what is currently being displayed on the right side.

A tag may be omitted to give more space for the reading. An alternative way to tell the user what is being displayed is to use the *Channel indicators* above the display. Pages 1 to 4 are indicated with a single indicator. Pages 5 to 8 are indicated 1+4, 2+4, 3+4, and 4+4. The terms Channel and Page can be used interchangeably.

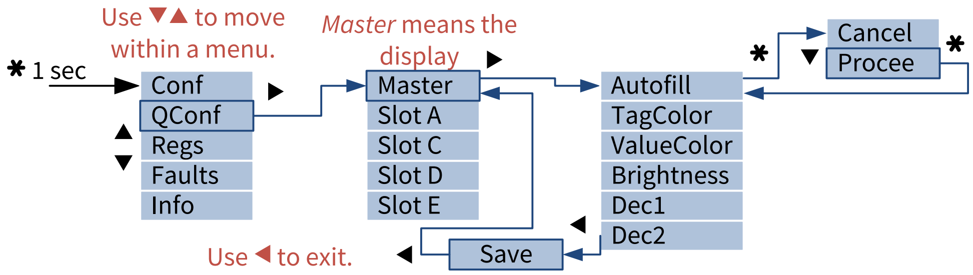
In a newly built device, the display reading may come from various sources and is not limited to the inputs. The display contents may be configured manually or automatically.

Automatically configuring the display contents

In most cases, the task of defining the display (page) contents may be left to PM10. It will automatically configure a page for each physical input, beginning from slot A inputs. Since the inputs that are switched off are not included, configure the inputs first according to the input card manuals.

To start the *Auto fill*, do **one** of the following:

- Connect to the display (Master) with Mekuwin. Navigate to Display ▶ Auto fill and click Execute.
- Switch the device off, hold the ◀ and ▶ keys pressed, and switch the power on. “Autofill” is displayed for a moment.
- Use the Quick configuration menu on the front panel:



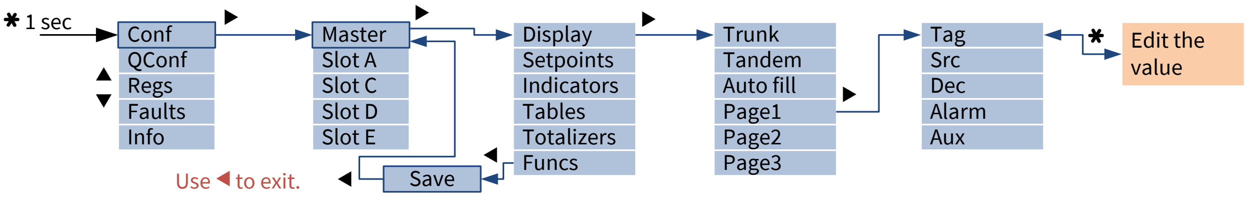
The display is now ready for use! Push the ▼ and ▲ keys to move among the pages.

The Auto fill may be re-run at any time. Its operation may be tuned with the following settings under the Display ▶ Auto fill configuration menu:

Tag	How the tag is formed: • Retain: Preserve the previous tag. • None: Remove the tags. • Index: Numbers 1, 2, 3… This is the factory default. • Letter: A letter A, B, C… • SlotReg: A combination of the card slot (A, B…E) and the number of the register on the card, e.g. A1, A2, B1, B2. • Name: The name of the source register, e.g. In1.
Set Dec	If enabled, Auto fill will set the number of decimals for each page.
Dec	The number of decimals to show (if Set Dec is enabled). Each page will get the same number of decimals, but they may later be adjusted individually under each page settings.

Manually configuring the display contents

Open a connection to Master, either with Mekuwin or on the front panel.



Set *Trunk* according to the amount of pages (different readings) needed. (The word trunk refers to a tree trunk. The pages are arranged vertically as the user may move among them with the ▼▲ keys. The tree may contain branches, as demonstrated in “Having auxiliary pages” on page 15.) After setting Trunk, the corresponding number of Page submenus will be revealed.

Configure the settings for each page under the *Page* submenus:

Tag

The informative text or number on the left side of the display. May be blank. The tag should be 0 to 3 letters so that there is still room for the reading.

If you want to ensure a gap between the tag and the reading, place a space after the tag.

If the tag is longer than the display, the display will scroll.

Src

The source of the reading on the right side of the display. Typically one of the registers of an input card. If set to None, only the tag will be displayed.

Dec

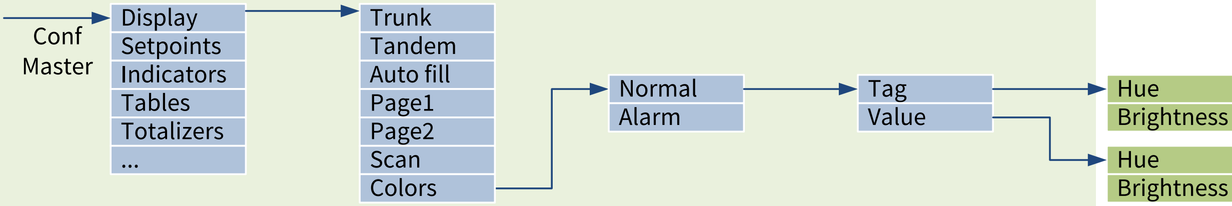
The number of decimals to show. A negative setting will round the corresponding number of last digits to zero. Affects floating point numbers only.

Examples of 123.4567 on various Dec settings:

Dec	Display
3	123.457
2	123.46
1	123.5
0	123
-1	120
-2	100

Alarm

A submenu for defining sources for an “alarm”, a rule that makes the reading to change its color.



Making the color to change at an event” on page 10.

Aux

The page that may be entered with the ▶ key. See page 15.

Having two readings simultaneously

It is possible to have one reading on the left side of the display and another on the right side. The left reading can consume 1 to 3 digits, leaving the rest for the right reading.

To have two readings:

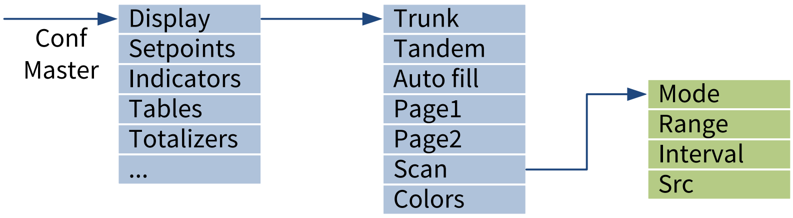
1. In the Conf menu, under Display, set Tandem = Yes.
2. Under Display ▶ Page1, use LSrc to select the source of the left reading, and LDec the number of decimals.
3. Use Src to select the source of the right reading, and Dec the number of decimals.
4. If necessary, check and adjust the colors under Display ▶ Colors ▶ Normal. LValue affects the left reading while Value affects the right reading.

Tag is not used anymore. If more than one page is used, use the Channel indicators above the display to tell which page is currently visible.

Although Tandem is on, any page can still have a tag and a single reading: just set LSrc to None.

Making the display to scan the pages

Scanning means that PM10 automatically displays each page for a moment, then advances to the next.



Use the following settings under the Display ▶ Scan menu:

Mode	• Manual: User may move with ▼ and ▲ keys (factory default). • Auto: The pages will be automatically scanned. • Alarming: Like Auto, but the scanning is temporarily stopped if any of the registers configured under the Alarm submenu is active in the Page configuration. • External: The page to be displayed is controlled by some register on any card.
Range	The number of pages to scan. The scanning is also limited by the Trunk setting; the lesser one will define the range.
Interval	The interval between changing to the next page in Auto and Alarming modes.
Src	The source controlling the page in External mode.

Even in the Auto and Alarming modes, the user may use the ▼ and ▲ keys to move. After eight seconds, or by pressing simultaneously ▼+▲, the scanning will continue.

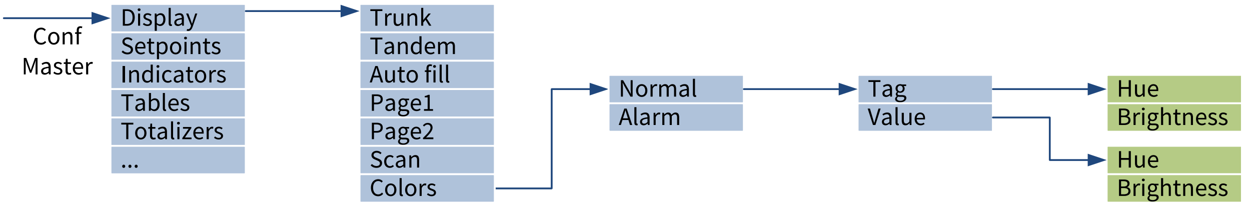
Configuring the colors

The following items may have a color of their own. The table also points the location of the settings.

Tag	Display ▶ Colors ▶ Normal ▶ Tag
Left reading (in Tandem mode)	Display ▶ Colors ▶ Normal ▶ LValue
Right reading	Display ▶ Colors ▶ Normal ▶ Value
Indicators	Indicators ▶ Color

Each color is defined by two settings:

Hue	0 = red, 30 = orange, 60 = yellow, 100 = green. Any intermediate value may be used.
Brightness	0 = almost invisible, 100 = maximum brightness.



Making the color to change at an event

PM10 can change the display colors to get the user attention e.g. when a critical alarm is triggered. It is called *Alarm color*. Only one alarm color set is possible in addition to the normal colors.

There are two alternative ways to use. The first is to make the **reading of a certain page** to change color, not affecting the other pages. This is useful to emphasis that this particular reading is related to the alarm. To use this option:

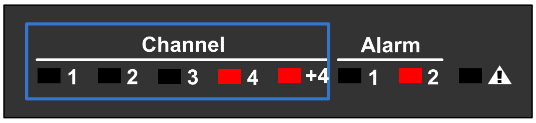
1. Configure an alarm somewhere, typically on a relay card.
2. Under one of the Display ▶ Page submenus, open the Alarm submenu. It contains two source settings. Configure one or two of them to refer to the alarm (e.g. Reg ▶ D ▶ Alm1). When any of them is on, the alarm color will be used.
3. Under Display ▶ Colors ▶ Alarm ▶ Value, define the alarm color for the reading. Typically it is red (hue=0) and bright.
4. If you want the reading to blink under the alarm, set Display ▶ Colors ▶ Alarm ▶ Blink = Yes.
5. Note that the tag will not change its color.
6. If using Tandem mode, do the same for Display ▶ Page ▶ LAlarm and Display ▶ Colors ▶ Alarm ▶ LValue.

The other option is to make the **whole display** to change color not depending which page is being displayed. This is useful when the alarm is not related to a certain reading, or when maximum attention is desired and is not depending which page is currently visible. To use this option:

1. Configure an alarm or other function that will affect the colors.
2. Under Display ▶ Colors ▶ Alarm ▶ Sources, set Count = 1. Select the source, which will activate the alarm colors. If necessary, increase Count and define more sources. If any of them is on, the alarm colors will be used.
3. Under Display ▶ Colors ▶ Alarm ▶ Tag, define the alarm color for the tag. Similarly under Value select the alarm color for the reading. If using the Tandem mode, set the LValue color too.
4. If you want the display to blink under the alarm, set Display ▶ Colors ▶ Alarm ▶ Blink = Yes.

Configuring the channel indicators

As said in “Display contents and pages” on page 7, the leftmost indicators can be used to indicate which page (or “channel”) is being displayed. It is possible to assign 0 to 5 leftmost indicators to this task. The user obtains the page number by summing the number values next to the indicators. E.g. 4+4 = 8.



If the page number is too high to be expressed with the channel indicators, all of them will be off.

Select the number of channel indicators with the Indicators ▶ Channel indicators setting.

Configuring and using the fault indicator

Channel
Alarm
1
2
3
4
+4
1
2

The PM10 display is continuously querying the other cards if they have any problems. If any of them reports any problems or faults, the Fault indicator will be on.

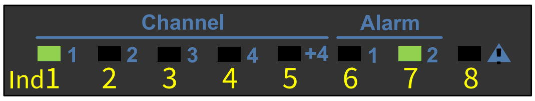
When this happens, use the Fault viewer to see the problem description as guided on page 32.

It is possible to adjust the sensitivity of the fault indicator. It can also be released for other use. This is controlled with the Indicators ▶ Fault indicator setting, that have the following options:

Off	The Fault indicator is not used. Can be used for other purposes.
Suspicion	The fault indicator is on if any card reports a suspicion of a problem.
Warning	The fault indicator is on if any card reports a warning or a suspicion. A warning means everything is working, but problems are foreseeable.
Failure	A failure means that the device has detected a problem that could possibly be fixed by the user, like a sensor fault.
Fault	A fault means that the device has detected a problem in itself.
System	A system fault is something that compromises the operation of the whole device, e.g. power supply overload.

Using the indicators for other purposes

The indicators that are not used as channel indicators nor as a fault indicator, can be configured to indicate various events. To configure an indicator:



1. Under Indicators menu, there is a submenu for each indicator, e.g. Ind6. The leftmost indicator is Ind1 and the rightmost is Ind8.
2. Set the Count setting to match the number of “reasons” why the indicator can be on.
3. For each Src, select a source, e.g. an alarm or an alarm group. If any of the sources is on, the indicator will be on.

Protecting the configuration with a password

It is possible to prevent unauthorized persons from adjusting the settings in the configuration (and quick configuration) menu. To do so:

1. Go to the General submenu.
2. Set Conf code. It is a series of six keypresses ◀▼▲▶ (viewed on the front panel) or a series of numbers 1 to 4, e.g. 112234. In Mekuwin, it is possible to enter six letters; they will be converted to numbers. The password can't be ✱✱✱✱✱✱ = 333333.
3. When anyone tries to enter the configuration menu, he must enter the correct password.

The correspondence between the numbers (Mekuwin) and the keys (front panel):

1	▲
2	▼
3	◀
4	▶

Allowing the user to interact: The setpoints

The setpoints turn the "output" nature of the display to "input" from the user. The user may use the keys to adjust the setpoint values, affecting the operation of PM10 in various ways. The setpoints in this context are not directly related to alarms or controllers. They are merely something the user may easily set (or adjust). They do nothing more by themselves, but provide the value to be used by the other functions.

PM10 provides different types of setpoints for different uses.

- Event setpoint is "on" while the user keeps the ✱ key pressed. It can be used to tare, reset an alarm hold, and similar momentous activities.
- Boolean setpoint can be toggled "on" and "off" with the ✱ key. It can be used to start and stop some activity.
- Float setpoint is a user-adjustable floating point number with configurable limits. The setpoint can adjust an alarm level, controller set value, affect the operation of an Elo program, etc.
- ListIndex setpoint allows the user to select one item from a configurable list. The setpoint output is the index of the selection, beginning from 0.
- FloatList setpoint allows the user to select one number from a configurable list. The setpoint output is the numerical value of the selected item.
- StringList setpoint allows the user to select one string (a word) from a configurable list. The setpoint output is the selected string.

To configure a setpoint, open the Setpoints menu, and then one of the Setp submenus, e.g. Setp1. Configure it:

Type	See the explanations above.
Min Max	The limits for the Float setpoint.
List	The user-selectable options for the list type setpoints. Enter the options separated by linefeeds (enter key).
Preserve	If Yes, the value of the setpoint is retained when the device is powered off.
Startup	The value of the setpoint after power-up. If Preserve=Yes, this does not affect, except if the stored value gets corrupted. For a boolean setpoint, the value should be 0 or 1. For any of the list setpoints, the value should be the 0-based index of the item.
Value	This is the value of the setpoint. With the float setpoint, the value can also be set here.

The setpoint needs to be “made visible” in some of the display pages. Under the Display menu, select one of the Page submenus (increase the Trunk setting to get more pages if necessary) and configure:

Tag	Some letters to describe the purpose of the setpoint. E.g. SV.
Src	Select Reg ▶ Master ▶ Setp1 (or which setpoint you did configure). In Tandem mode, only the right half (Src) may have a setpoint, not the left half (LSrc).
Dec	For a float setpoint, this defines the resolution along with the number of decimals to show. Do not select unnecessarily many numbers, as it makes it slow to adjust the value. For the other setpoints, this setting does not matter.

If it is not acceptable that anyone can adjust the setpoints, set a password in Setpoints ▶ Code. The user must enter it before adjusting a setpoint. Once entered, the setpoints are unlocked for 60 seconds.

The setpoint is ready for use. Move to the newly configured page on the display. Push ✱ and the following should happen:

- With an event setpoint, an ✱ is displayed as far as the ✱ key is being pushed.
- With a boolean setpoint, the displayed value toggles between * (on) and – (off).
- With a float setpoint, the value begins to blink. Adjust the value with the ▼▲ keys. The speed accelerates if the keys are held pressed. When the desired value is reached, push ✱. The value stops blinking and the ▼▲ keys can be used to move among the pages again.
- With any of the list setpoints, select the desired option with ▼▲ keys and push ✱.

The value of the setpoint is available in the Setp1…Setp8 registers on the master card.

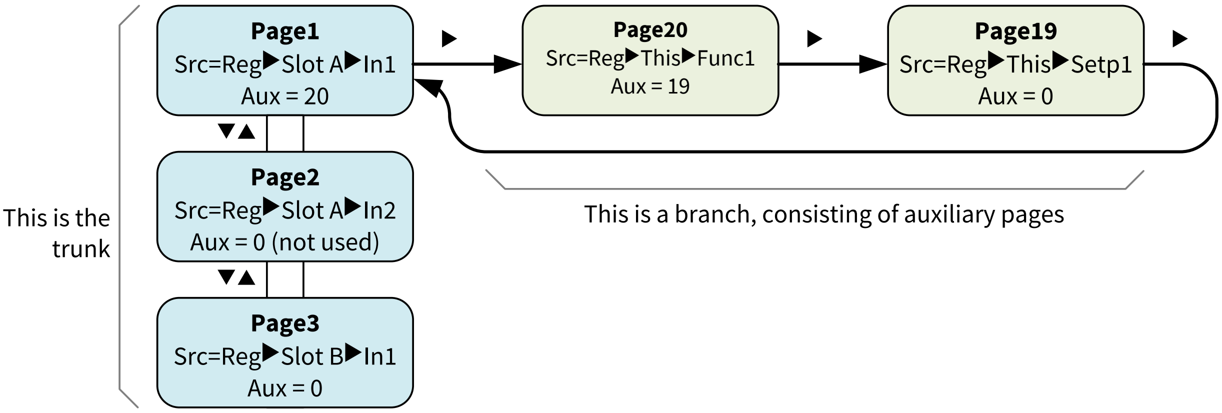
Having auxiliary pages

The trunk pages are arranged vertically – the user may move between them with the ▼▲ keys. Sometimes it may be convenient to have a horizontal motion too. E.g. when viewing a page that contains an input 1 reading, the user might want to see a peak hold value, or adjust an alarm level or a controller set value. These can be accomplished with auxiliary pages. The user pushes ▶ to move an auxiliary page associated with the original page. The Aux setting on each page is used to define, to which page to go if the user pushes ▶. If Aux is 0, there are no (further) auxiliary pages, and the user will return to the trunk. If the user will not touch the keys in one minute, the trunk page will be displayed.

The display card has 20 configurable pages. Some of the first pages (say pages 1 to 4) are used in the trunk, but the rest are free to be used as auxiliary pages.

To set up an auxiliary page (an example):

1. In one of the trunk pages, say Page1, set Aux=20 (or any unused page outside the trunk).
2. Configure the Page20 to contain a peak hold value. Set its Src to a function that is configured as a peak hold. Enter a short description, e.g. “PK” in the Tag.
3. To chain another auxiliary page, set Aux=19 in page 20.
4. Configure the Page19 to contain a setpoint (configured elsewhere). Src=Reg ▶ This ▶ Setp1. Configure an alarm to use this setpoint as its externally controlled level (ExtLevel).



When in one of the auxiliary pages, the channel indicators (if used) will blink and indicate the corresponding trunk page (In the example above channel indicator 1 will blink).

Ambient light sensor

The front panel includes a coarse non-calibrated ambient light sensor. The result is available in the *Amblight* register. The reading varies from 0 to 100.

The light sensor may be used as a temporary input when testing the PM10 functions. The reading may be affected by covering the sensor with a finger.

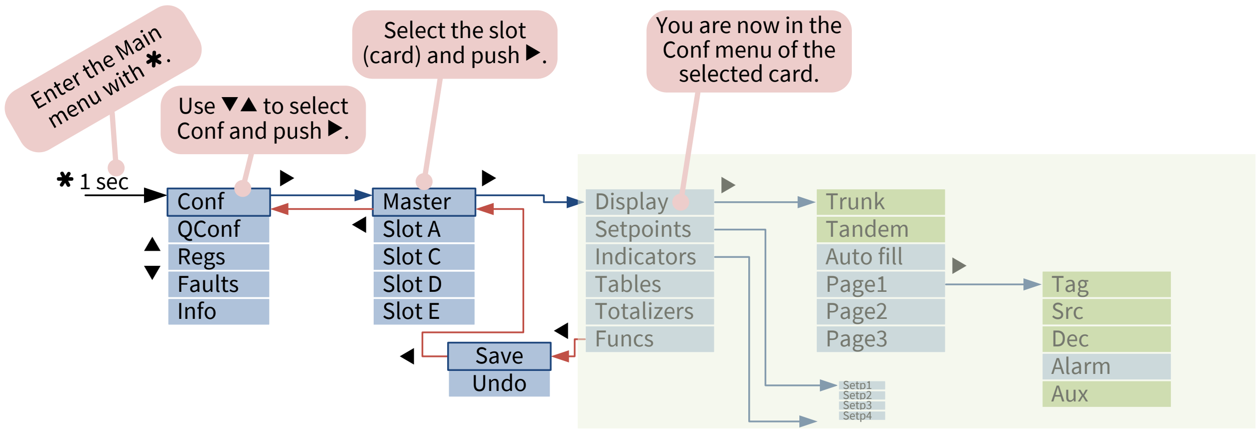
It is possible to use an agent to control the display brightness according to the ambient light.

Configuring the device using the front panel

The device can be configured with the Mekuwin software, or using the front panel display and keys. This chapter instructs the latter.

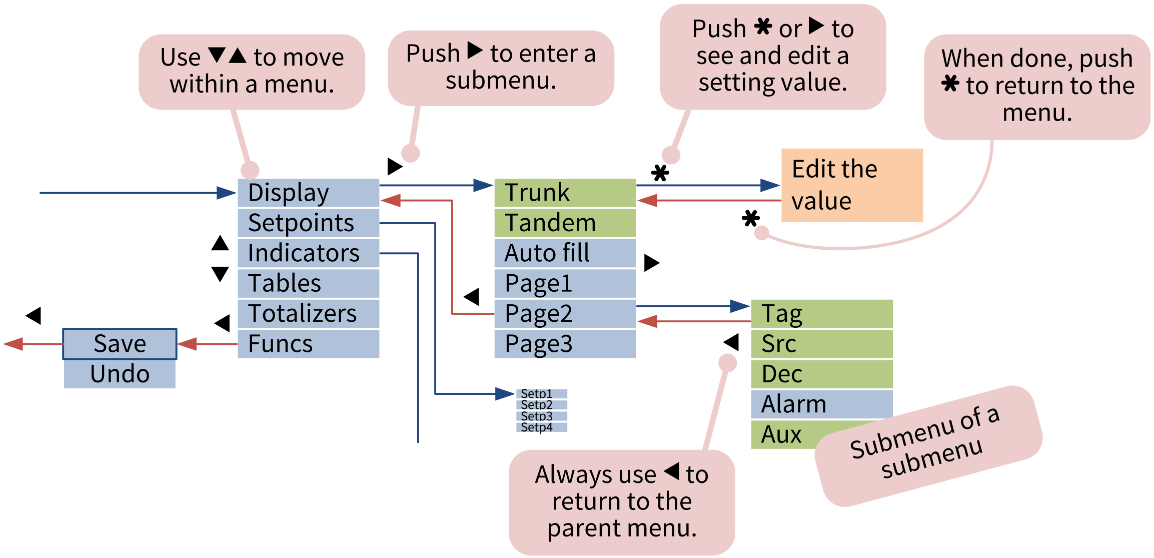
Each PM10 card, including the display card, is an independent “device” performing its tasks. Consequently each card has a configuration menu of its own.

Beginning a configuration session



Navigating in the menu

The graph shows the truncated menu of the display (Master) as an example. The manual of each card depicts the menu structure of that card.



Use ▼▲ to move within a menu.
Push ▶ to enter a submenu.
Push ✱ or ▶ to see and edit a setting value.
When done, push ✱ to return to the menu.
Display
Setpoints
Indicators
Tables
Totalizers
Funcs
Save
Undo
Trunk
Tandem
Auto fill
Page1
Page2
Page3
Setp1
Setp2
Setp3
Setp4
Edit the value
Tag
Src
Dec
Alarm
Aux
Submenu of a submenu
Always use ◀ to return to the parent menu.

Editing a value

The configuration menus contain different types of settings, each being edited differently as detailed below. Common practices:

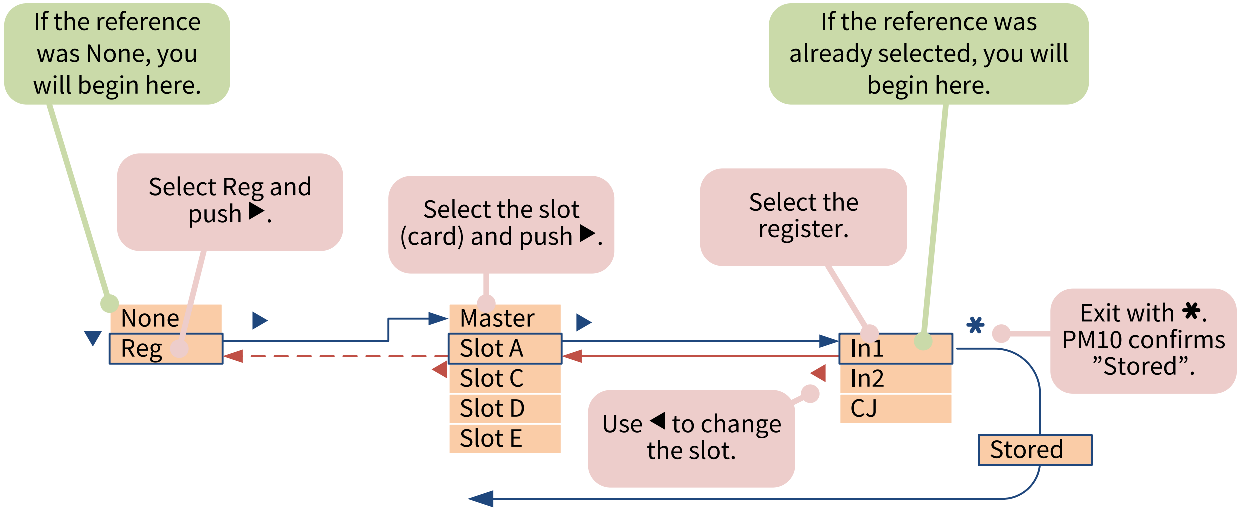
- Use ▼ and ▲ to edit the value.
- Use ◀ and ▶ to move the cursor.
- Long-press ✱ to see a pop-up menu, that provides additional options.
- Exit with ✱.

Type	Examples	How to edit
On/Off or Yes/No	Tandem setting in the display	Use ▼ and ▲ to select. Exit with ✱.
List	Sensor selection	Use ▼ and ▲ to select. Exit with ✱.
Integer	Number of decimals to show Serial bus address	Use ▼ to decrease and ▲ to increase. Keep pressed for acceleration. Advanced: Use ◀ and ▶ to move the cursor. Long-press ✱ for a pop-up menu. Min = the smallest allowed value. Max = the largest allowed value. Zero = zero value. Exit with ✱.
Floating point (decimal) number	Input and output scalings	Use ▼ to decrease and ▲ to increase the number at the cursor. Keep pressed for acceleration. Use ◀ and ▶ to move the cursor. Push the cursor against the edges of the display to reveal more digits if necessary. Long-press ✱ for a pop-up menu. Zero = reset the value to 0. Negate = toggle the sign. Exit with ✱.
Reference	The source of an analog output The source of the reading of a display page	The references are explained below this table.
Text (string)	Display tag Setpoint lists	Use ◀ and ▶ to move the cursor. Push against the edges to scroll. Use ▼ and ▲ to edit a character. If lost, long-press ✱ and select N to get capital N, a good starting point for any letter. To truncate the string (discard the end including the cursor location), long-press ✱ and select End. To insert a linefeed, as required when entering the setpoint lists, long-press ✱ and select Linefeed. The linefeed is displayed as ┘ in the editor.
Password (code)	Configuration password	To set: Push ▶. The cursor blinks. Push six times the keys, but not the ✱ key. Finally push ✱. To disable: Push ▶. The cursor blinks. Push ✱ to switch off. Push ✱ to exit. Alternative method to disable: Long-press ✱ and select Clear.

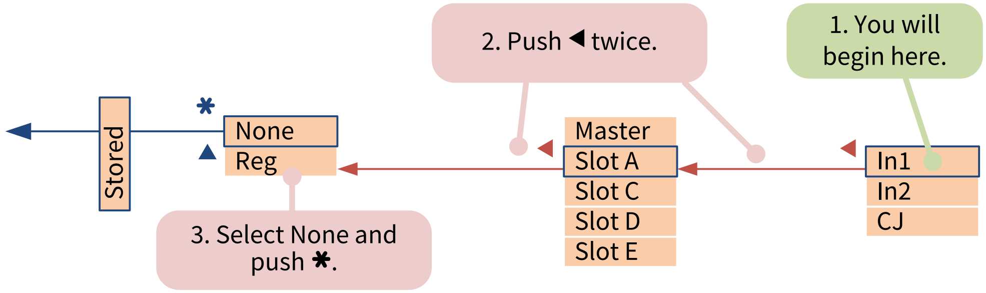
Editing a reference

The references are used to link the different, autonomous blocks of PM10 together. E.g. for an analog output, the source must be configured, as the output may follow various sources (called registers) from any of the cards. Similarly, the display contents are configured to come from somewhere. These are done with a reference to an output register of some card. The reference consists of three parts: 1) Whether the reference is active (referring to some register) or not (None). 2) The card, or slot, producing the referred register. 3) The register within the selected card.

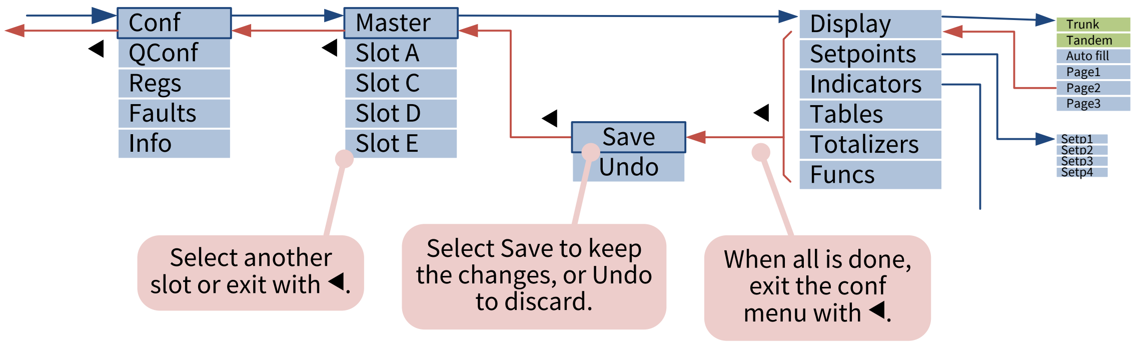
To select a reference:


If the reference was None, you will begin here.
If the reference was already selected, you will begin here.
Select Reg and push ▶.
Select the slot (card) and push ▶.
Select the register.
None
Reg
Master
Slot A
Slot C
Slot D
Slot E
In1
In2
CJ
✱
Exit with ✱. PM10 confirms "Stored".
Use ◀ to change the slot.
Stored

Sometimes it is necessary to *"switch off"* a reference. E.g. an unused analog output is disabled by selecting None as its source. A display page containing a tag only is achieved by setting Src to None. To switch off a reference, push ◀ twice and select None (picture below), or long-press ✱ and select None.



Ending the configuration session



Using the USB port

A micro USB port is available at the back of PM10. It can be used for configuring the device with the Mekuwin configuration software. The information below applies to PM10ADISP firmware V0.3-0.4.

When connected to a computer, PM10 appears as a virtual COM port, accepting Modbus RTU commands. Technically the port is connected to the display card (Master).

To prepare the port for configuration purposes on a Windows computer:

1. Obtain the PM10 USB driver from Nokeval web site, under Support > Software and drivers. Unzip it to some temporary folder.
2. Plug in PM10. Windows tries to find a driver from Windows Update, but fails.
3. Open the Device Manager (e.g. Windows+R and type devmgmt.msc).
4. Locate PM10, with an yellow exclamation mark.
5. Right-click PM10 and select Update driver.
6. Point to the directory where the unzipped driver is.
7. Accept the warning. The downloaded driver is just a simple text file; the actual driver usbser.sys is included in Windows already.
8. Check that there is a PM10ADISP Virtual port under the Ports branch of the Device manager.

Then:

1. Launch Mekuwin (available for free at www.nokeval.com).
2. Select the virtual port.
3. Select ModbusRTU protocol, and address 1. (The parity and baud rate should not matter, but use 115200 and 8E1 if having issues.)
4. Use the Master, A, B… E buttons to open a configuration session for each card.

Utilizing the functions

A function means an easy to use block that can take one or two inputs from any register and perform a calculation, comparison, delaying, or similar operation. The number of function blocks per card, including the display, varies card by card. The result is provided in a register named Func1, Func2, etc.

To use a function, navigate to the Funcs submenu in the configuration menu, and select a free function in the submenus (named Func1, Func2, etc.).

Configure it:

Func	The function itself. The functions are listed below. Every card type doesn't implement all the functions.
Input1	The first input. Select any register on any card, or None. If the first input should be constant, select Input1 = None, and use the Const setting.
Input2	The second input. If the second input should be constant, select Input2 = None, and use the Const setting.
Const	Constant input. If Input1 or Input2 is set to None, the value entered here will be used as that input. This is always a floating point number. This setting is hidden, if neither Input1 nor Input2 is None.
Reset	Select the register that can reset this function block. The actual operation depends on the selected function. This setting is hidden if not available.
Set	Select the register that can activate this function block. The actual operation depends on the selected function. This setting is hidden if not available.
Value	A value related to the function, e.g. a tare value. Mainly for checking the operation, but may be set manually in some cases.
Output	The function result for checking the operation. Can't be set manually.

Off
Off does nothing. Set any unused function blocks off in order to save the processing power.

Pass
Passes the Input1 value through. May be used for some special purposes, e.g. to feed a constant to some other block.

Hold
When the Set input is off, the function output will follow the register selected in Input1. When the Set input is on, the output is held constant.

Lopass
The output follows the Input1 filtered by a first-degree lowpass filter. The time constant in seconds is defined by Input2, or if that is set to None, then by the Const setting. If the Reset input is on, the filter is bypassed.

Tare
The output of the function is the Input1 subtracted by the tare value. If the Set input is on, the current input value (Input1) is stored as a new tare value, making the output to go to zero. If the Reset input is

on, the tare value is reset to zero, making the output to follow the input. The reset input may be configured to None, if a reset is not needed.

The tare value can be viewed at the Value setting, and even manually edited. The tare value is stored in the EEPROM memory and thus retained at power-off, with some limitations.

Peak, Valley

The output remembers the highest (Peak, max hold) or lowest (Valley) Input1 value so far. If the Reset input is on, the output follows the input, resetting the function. The value is retained at power-off, with some limitations.

Sum

The sum of two inputs. The other input may be constant.

Diff

Difference Input1-Input2. The other input may be constant.

Avg

The average of Input1 and Input2. If any of the inputs is an error (e.g. sensor fault), the function output is too.

AvgPrio

The average of Input1 and Input2. If one of the inputs is an error, the function output will follow the other input. If both inputs are errors, then the output is an error too.

An example: Two temperature sensors as inputs. If one of them fails, the function output will still give a reading, although not an average anymore.

Prio

As far as the Input1 is not an error, the function output follows it. If the Input1 is an error, the output will follow Input2.

An example: One temperature sensor for the actual measurement, another sensor as a backup.

Mult

The function output is Input1 multiplied by Input2.

Div

The function output is Input1 divided by Input2.

Pow

The function output is Input1 raised to the power of Input2. If Input1 is negative, its sign is removed before the operation and restored afterwards.

An example: A square root of a pressure sensor: Input1 = Slot A / In1. Input2 = None. Const = 0.5.

Min

The lesser of the two inputs. Can be also used as a boolean “AND” function.

Max

The greater of the two inputs, or “OR” function.

Equals

The output is 1 (on) if the two inputs are equal, 0 otherwise.

Less

The output is 1 (on) if the Input1 is lesser than Input2, 0 otherwise.

An example: a simple “alarm” or other comparison. To remove too fast variations, connect another block in series, selecting Delay function there.

Greater

The output is 1 (on) if the Input1 is greater than Input2, 0 otherwise.

Mux

If the Set input is off, the output follows the Input1, otherwise the Input2.

Latch

If the Input1 or Set are on, the output will go on, and stay there. If Reset is on, the output will go off. The reset has higher priority. The value is retained at power-off, with some limitations.

An example: a latched alarm.

Delay

If the Input1 is unchanged for a time defined by Input2 (in seconds, typically a constant), the output follows the input. The maximum delay time is 6553 seconds.

An example: a delay in an alarm, to prevent short deflections from triggering an alarm.

An example: a delay in the front panel (or external) pushbutton to prevent accidental operations. Input1=Master / Left. Input2=None. Const = 2 (seconds).

PulseA

The output follows the Input1, except once it changes, it keeps the state at least the time defined by Input2 (in seconds, typically a constant). The maximum time is 6553 seconds.

An example: an alarm that must trigger quickly, but repeated switching operations must be prevented.

PulseB

When the Input1 changes from off to on, the output will be on for the time defined by Input2 (in seconds) and then off for the same time.

An example: a pulse to drive a motor.

TotDiv

When the Input1 value has increased by Input2, the output gives a short pulse. The Input1 is typically a totalizer output, and Input2 is a constant. The output generates a pulse when the specified amount of substance has flown.

To shape the short output pulse for a relay or a digital output, use PulseB function in series to define the final output pulse width. For maximal pulse width accuracy, it is best to place the PulseB function on the relay card.

Using the totalizers

A totalizer increases its output on the speed proportional to the input. It can be used to calculate the total amount of substance flown based on flow measurement.

The PM10 cards may implement any number of independent totalizers. The PM10ADISP display card has two totalizers.

The totalizer uses a 64-bit floating point number for the summing to avoid rounding errors, but the public output value is rounded to a 32-bit floating point number.

If the totalizer input is an error (e.g. sensor fault), the totalizer is halted for 15 seconds. If the problem persists, the totalizer value is considered lost and the totalizer output will indicate an error until the totalizer is reset.

The totalizer value is retained at power-off, but with some limitations. The value will be saved to a non-volatile memory (EEPROM) every five minutes. In addition, the value is stored when a loss of power supply is detected, but the device must be powered on for at least five minutes before that.

To set up a totalizer

1. Navigate to one of the Tot menus under the Totalizers menu in the configuration menu.
2. Configure the settings:

Input	Select the flow or other input source. Typically an analog input that is scaled appropriately, e.g. flow m^3/min.
Timebase	Select the timebase according to the output unit: • x/s: select 1 • x/min: select 60 • x/h: select 3600 This is actually just a divider for the input.
Dead	Set the smallest significant flow (in the same units as the input). The lesser values are rounded to zero, stopping the totalization. Set to -1 if a dead zone is not desired.
Rollover	Set the value at which the totalizer output is rolled over to zero. Typical value is 1000000 (one million). To prevent any rollover, set to 0 or a negative value.
Hold	When this input is active, the totalizer is halted. The output remains unchanged.
Reset	When this input is active, the totalizer is reset to 0.
Output	The totalizer output for checking the operation. It is also possible to alter the value, e.g. to fix the value after it has been corrupted.

The output registers

The totalizer outputs two registers, Tot1 and TotTime1 (or any other number). Tot1 is the totalizer output.

TotTime1 is the running time of the totalizer since the last reset in seconds (as a 32-bit integer). The Hold input will pause the time, but Dead will not. The time is not affected by the Rollover setting.

Configure one of the display pages to display the totalizer output: Display ▶ Page1 ▶ Src = Reg ▶ This ▶ Tot1. You may configure another page to display the flow input.

Resetting the totalizer

The totalizer should have means to reset it. The reset input may be:

- An external switch.
- One of the front panel keys (registers Left, Down, Up, Right, Fire, Left1…).
- An event setpoint in some display page (see “Allowing the user to interact: The setpoints” on page 13).

Alternatively the totalizer may be reset by manually setting a value 0 in the Output item in the configuration menu.

Non-zero initial value / downwards

If you need a totalizer that will reset to a non-zero value, e.g. to “load” a batch that then decreases towards zero, use one of the function blocks:

1. Select Func = Diff.
2. Set Input1 = None to make it constant. (Or it might come from a setpoint or other variable source).
3. Set Const = the initial value (batch), e.g. 200.
4. Set Input2 = Tot1.

This function will calculate Func1 = 200 – Tot1, being 200 when the totalizer is reset and then decreasing.

Getting a divider output

Configure one of the functions (under Functions submenu of the configuration menu):

Func	TotDiv (not available on all the cards)
Input1	Reg ▶ This ▶ Tot1 (or Tot2)
Input2	None (for constant)
Const	Divider value
Reset	None

Then configure another function to shape the pulse width. This function should be placed on the card where the physical output is if possible, for maximal pulse width accuracy.

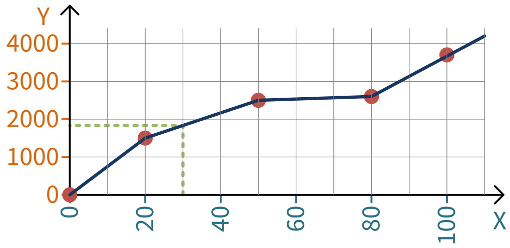
Func	PulseB (not working in firmware version V0.3)
Input1	Select the TotDiv function output

Input2	None (for constant)
Const	Pulse width in seconds
Reset	None

Finally configure a relay or a digital output to follow this function.

Using the tables

A table consists of a set of configurable X and Y value pairs, or points. When the table input corresponds to one of the X values, the table output will correspond to the associated Y value. Between the points, linear interpolation is used. Outside the points, linear extrapolation is used using the two nearest points. The table output is always a floating-point number.



An example where the points (X,Y) are (0,0), (20,1500), (50,2500), (80,2600), and (100,3700) as in the graph above. When the table input is 30, the output will be 1833. When the table input is 110, the output is 4250.

The number of tables varies according to the card type; some cards may contain none. The same applies to the maximum number of table points.

To use a table, navigate to the Tables menu under the configuration menu and select one of the Tbl menus. Configure:

Input	Select the input source for the table; any register on any card.
Pts	Select the number of points, or X/Y pairs.
X1	The first point X (input) value.
Y1	The output value when the input corresponds to X1.
X2…	The next points. When there are more than two points, the X values must be in ascending order (X1<X2, X2<X3, etc).
Y2…	The Y values do not have to be ascending.
Output	Check the output value.

After configuring, the table output is available to all cards in Tbl1, Tbl2 etc. registers.

It is possible to “teach” the points:

1. Apply a real input to the device.
2. Give a Lock command for the X1 setting. In Mekuwin, click the L button. Using the front panel for configuring, navigate to the X1 setting but do not edit the value (do have X1 in the display), long-press ✱ and select Lock.
3. Enter the corresponding desired output in Y1.
4. Repeat the procedure for the next points, keeping in mind that the X values must be ascending.

Elo programming

Elo is a simple scripting language developed by Nokeval. Small programs can be used to extend the capabilities offered by the other function blocks. Elo can do basic calculation, conditional execution and timing. The program can handle both floating point values and binary values. The Elo program is interpreted, not compiled.

The program can be entered with Mekuwin software. It is entered in the *Elo* item in the program submenu of the configuration menu. The maximum length is typically 320 characters, depending on the card, each line feed counted as one character.

Each card runs an independent Elo program – if the card implements Elo.

Input, variables, and output

Elo program can read all the registers of the card it is running on. The registers are referred simply by their names. The case of the register name is important: “f1” does not do the job if the correct name is F1.

To access the registers (outputs) of the other cards, use an agent on the same card. Set the agent Src to the desired register on any card, and leave Dest = None. Then, in the Elo program, use A1 to read the agent 1 value, etc.

There are typically twelve floating point registers on each card that are intended for the Elo program: F1 to F12. The program may write and read the F registers freely. These registers are readable by every card, functioning both as temporary variables and final outputs. E.g. an analog output can be configured to follow any F register on any card.

The F registers are initialized to 0 at power-up.

A special register Intv contains the time interval between the beginning of the previous and the current execution of the Elo program in seconds. It can be used to count time. Writing F1+=Intv will make F1 to count seconds (with a resolution of dozens of milliseconds).

Another special register First will have a value 1 on the first execution of the program, and 0 afterwards. It can be used to do some initializations.

It is important to remember that a register controlled by another block (e.g. the In1 register on an analog input card) may be updated any time during the Elo execution. Reading the register value may yield a different value than at the previous time. This applies to the register obtained via agents too. If this is an issue, take a working copy of the register to one of the F registers.

On the other hand, it is safe to write intermediate results to the F registers. They are double-buffered: The other blocks will see a buffered copy of the F registers, that is updated only when the Elo program has been executed.

Not-a-number

Not-a-number or NaN is a special value for a floating point register to indicate an erroneous value. The Elo program can set any F register to NaN, and test any register against NaN.

The NaN value is used by the other blocks too: the analog input In1 register will contain NaN in case of a sensor fault. If an analog output is configured to follow a register that has a NaN value, the output will indicate fault as defined by its settings.

Any calculation involving a NaN will yield NaN, e.g. NaN/2 will result in NaN. A comparison against NaN yields an undetermined result.

Trigger

The *Trigger* setting defines when the program execution is launched. One register (on the same card) can be selected as a trigger. Whenever the value of that register is updated, the program will execute. If the program is mainly processing an input reading, a natural choice as a trigger is the In1 register.

If the trigger register is not updated for a long time, the program will be executed approximately 1 second after the previous execution finished.

It cannot be guaranteed that the program execution is finished before the trigger is tripped again. In this case the program will re-execute almost immediately when the previous execution is finished.

If the Trigger setting is set to None, the program is re-executed periodically, e.g. 50 milliseconds after the end of the previous execution.

Program structure

The program consists of lines. Every line has one simple command. The command can change a register or cause a conditional or unconditional jump inside the program.

The program may contain short loops, but eventually it must exit. The program exits when reaching the end of it, or by jumping out of it, e.g. with ?99. The program will soon be re-executed from the beginning.

The program execution is limited to 200 operations (one line counted as one operation) in order to prevent total lock-up in a case of e.g. an eternal loop.

Math commands

Each row can contain only one command, i.e. it is not allowed to write dest=src1+src2+src3.

dest=src	Copies a value from src to dest. Src can be a register reference, an agent, or a constant. E.g. F1=3.14 will place a value 3.14 in register F1.
dest=NaN	Puts a not-a-number value to dest.
dest=src1+src2	Sums src1 and src2 value and places the result in dest register. E.g. F1=In+10 will add register In contents to a value of 10 and place the result in register F1.
dest=src1-src2	Subtracts.
dest=src1*src2	Multiplies.
dest=src1/src2	Divides.
dest=src1src2**	Src1 raised to power of src2.
dest=src10.5**	Square root.
dest=src1&src2	Bitwise AND. If applied to a floating-point value, it is first converted to an 8-bit integer.
dest=src1|src2	Bitwise OR.
dest=src1^src2	Exclusive OR.

dest+=src	Sums src and dest and places the result in dest. Exactly same as writing dest=dest+src.
destX=src	The same for other operators, e.g. F1*=10.

Jumps and conditional jumps

?lines	Jumps given number of lines forward (+) or backward (-). E.g. ?-2 will execute the command that is two lines above this line. ?2 will skip the next line. ?0 creates an eternal loop. Jumping outside of the program is allowed: ?99 will exit the program.
x==y?lines	Jumps given number of lines if x equals y. E.g. F2==0?3
x!=y?lines	Jumps if x is not equal to y.
x<y?lines	Jumps if x is less than y.
x<=y?lines	Jumps if x is less or equal to y.
x>=y?lines	Jumps if x is greater or equal to y.
x>y?lines	Jumps if x is greater than y.
x==NaN?lines	Jumps if x is not-a-number
x!=NaN?lines	Jumps if x is not not-a-number

References

1.23	Decimal constant. Allowed characters plus, minus, point, digits 0…9.
F1	Register F1 of this card.
A1	Agent 1 of this card.
@0	The first register of this card.
@F1	Register defined by register F1 contents – indirect reference.

Errors

Whenever an error occurs in the execution, the card will report an error. The error number and the error line can be checked in the configuration menu items Error and ErrLine correspondingly. The error numbers are:

0	No errors.
1	Too long operand or operator.
2	Unknown operator.
3	Execution exceeds 200 operations.
4	Failed to write a register.
5	Illegal register reference. Please remember that the references are case-sensitive.

Examples

Prevent negative values

Read an input and copy it to a F register. If the value is negative, replace it by 0. The result is available in the F1 register.

F1=In1	Copy the input
F1>=0?2	If the value is acceptable, skip the next line
F1=0	Otherwise reset the value.

One minute average

Collect an average for one minute of the ambient light sensor, then publish it, and start collecting another average.

F2+=Amblight	Sum up the input on every execution
F3+=1	Count the number of samples
F4+=Intv	Measure the time
F4<60?99	If a minute has not elapsed, jump out. The following lines are executed once a minute.
F1=F2/F3	The average is the sum divided by count. The other blocks may read it from F1.
F4=0	Reset the timer.

Polynomial

Calculates y = 30 x^3 – 20 x^2 + 10 x – 5. Input: In1. Output: F1.

F2=In1	Take a working copy, because In1 register can change anytime
F1=30	Highest coefficient
F1*=F2	Multiplied by x
F1+=-20	Second coefficient
F1*=F2	Etc
F1+=10	
F1*=F2	
F1+=-5	

Dynamic settings with agents

The configuration menus of the cards contain dozens of settings that define the behavior of the device. They are usually changed very seldom, mainly when setting up a new device. On the other hand, the registers contain continuously varying values, e.g. the input reading, the Elo program variables, and the table output.

An agent is a bridge between these. Once configured, it reads one register and copies its value to a certain configuration setting. Each agent has two configuration settings in its menu under the Agents branch of the configuration menu. ***Src*** defines the register to read. It can read from any card. ***Dest*** selects the configuration setting to write to. It can access the same card only. To disable an agent, set either or both of the settings to None.

It is not possible to write any configuration setting. The agent can do some type conversions, but not all, e.g. it cannot process strings (text). As the configuration settings are not intended to be continuously varied, there may be some side effects.

The agents serve another purpose: they obtain register values from the other cards to be used in the Elo program. In these cases, set Dest=None.

An example: User-controllable display color

1. Define a setpoint on the Master card: Conf ▶ Setpoints ▶ Setp1: Type=ListIndex, List=Red<LF>Yelw<LF>Grn (replace <LF> with a real linefeed). The setpoint register Setp1 will have a value of 0 for red, 1 for yellow, and 2 for green selection.
2. Make the setpoint accessible in one of the display pages: Conf ▶ Display ▶ Page1: Tag=C (or whatever), Src=Reg ▶ This ▶ Setp1.
3. Use a table to convert the list index (0=red, 1=yellow etc) to real color setting values. Conf ▶ Tables ▶ Table1: Input=Reg ▶ This ▶ Setp1, Pts=3, X1=0, Y1=0, X2=1, Y2=60 (yellow), X3=2, Y3=100.
4. Hook an agent to copy the table output to the color setting: Conf ▶ Agents ▶ Count=1, Conf ▶ Agents ▶ 1 ▶ Src = Reg ▶ This ▶ Table1, Dest = This ▶ Conf ▶ Display ▶ Colors ▶ Normal ▶ Value ▶ Hue
5. Exit the menus. Navigate to the configured page. Push ✱. The color selection should blink. Try different values.

Maintenance

The device doesn’t need regular maintenance. The analog inputs and outputs can be recalibrated, when maximum accuracy is desired.

Now and then check that the fault indicator ⚠ is not on.

The enclosure, including the front panel, may be cleaned with a moist cloth. Use mild soap water or isopropyl alcohol. Never allow water to go inside.

Troubleshooting

Problem: The Fault indicator is on (the rightmost indicator ⚠).
Solution: Push ✱ button 1 second. Use ▼▲ to select *Faults* and push ✱. Read the message, accompanied with a letter indicating the card slot. Use ▼▲ to see if there are more messages. Exit with ◀ ◀. Refer to the appropriate card manual for further help.

Problem: The configuration menu can’t be entered with ✱.
Solution: The display page may contain an Event setpoint. Try ✱+▲.

Problem: The display is blank.
Solution: Enter the configuration menu or the quick configuration menu. Check that there is at least one display page defined (under Master ▶ Display) that has a tag or a reading. Check that the color settings under Master ▶ Display ▶ Colors ▶ Normal are valid (brightness is >10).

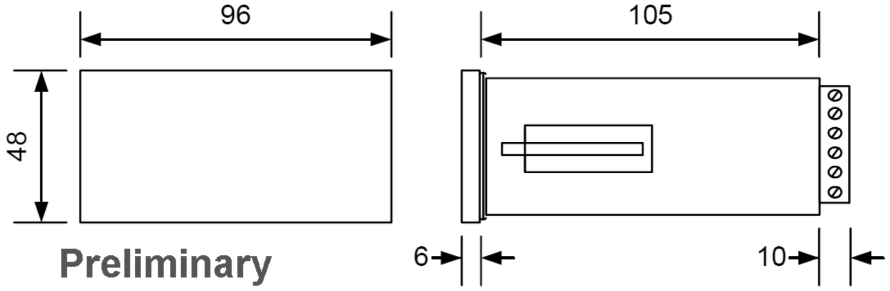
Problem: Now and then the display dims for a moment.
Solution: There are short dips or interruptions in the supply voltage. Enhance the quality of the supply.

Specifications

Environmental

Storage temperature	-40…+70 °C
Operating temperature	-30…+70 °C
Humidity, front panel	0…100 %RH
Humidity, rear	5…90 %RH non-condensing
Pollution degree	2
Altitude	0…2000 m when hazardous voltages involved, unlimited otherwise
Protection, front panel	IP 65
Protection, rear	IP 20

Dimensions and weight



Digit height	14.2 mm
Weight	150 g without cards

Warnings

Read this manual carefully before using the device.

The device must not be disposed with household waste. Observe local regulations concerning electronic waste recycling.

Manufacturer

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