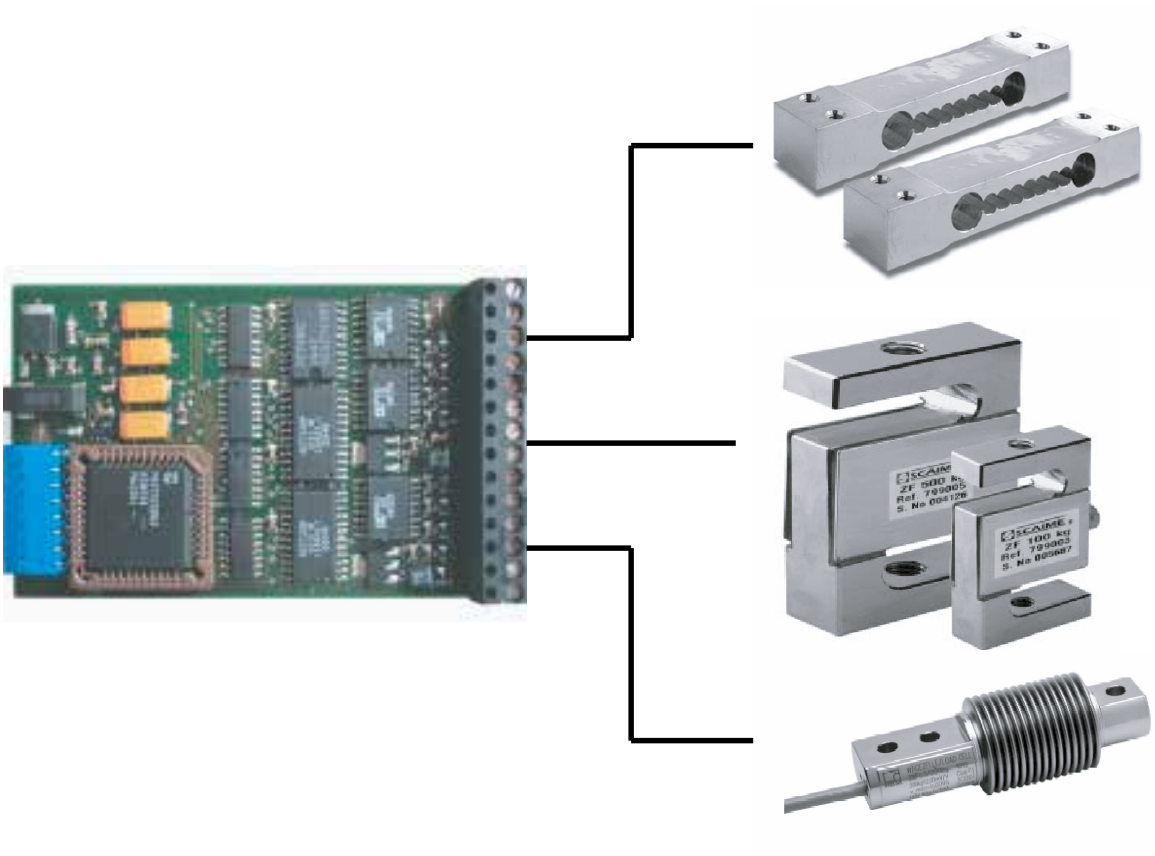

Integrated weighing and metering system PCD2.W7x0 and PCD3.W7x0

Document 26-833 | Edition ENG07 | 2018-10-18

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0 Content

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0.1 Document History

Date	Version	Changes	Remarks
2005-09-31	EN02	completely	First Publication
2007-12-13	EN03	Chapt. Ch02 Chapt. Ch03	- Data to Scale (only W710) deleted. - Scale with calibrated weighing cells removed
2007-11-05	EN04	Chapt. Ch01.3	Different connectors for PCD1|2 and PCD3
2009-07-02	EN05	Chapt. Ch02.1	Reset
2013-10-10	EN06	-	New logo and new company name
2018-10-18	ENG07	-	New phone number (2015)

0.2 Brands and trademarks

Saia PCD® and Saia PG5®
are registered trademarks of Saia-Burgess Controls AG.

Technical modifications are based on the current state-of-the-art technology.

Published in Switzerland

1 Hardware

1.1 Features

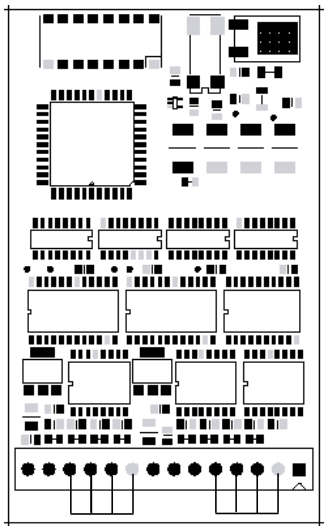
The weighing module provides cost-effective solutions for weighing and metering, and optimising material flows and volumes.

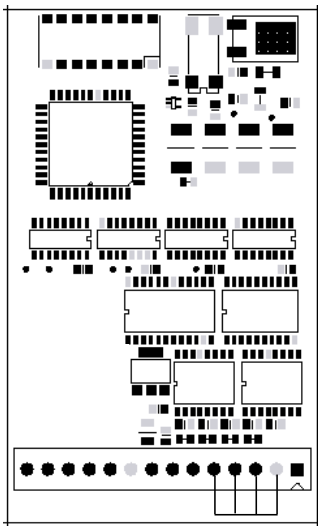
The PCD2|3.W7x0 module is characterised by the following features:

- ***Integration:*** The electronic weighing apparatus is placed on a standard Saia PCD® x module. This supports a central automation concept with end-to-end project planning and programming.
- ***Flexibility:*** All DMS weighing cells with 4 or 6 terminals can be connected.
- ***Economy:*** The module is available with two measuring channels to connect up to six weighing cells, and also obtainable cheaply in larger quantities with only one channel.
- ***High resolution:*** The internal measurement resolution supports 200,000 increments.
- ***Extensive functionality:*** As well as the classical weighing and zeroing functions, differential measurement is also possible, i.e. measuring the change in weight per second.
- ***Comprehensive diagnostics:*** The operating state of the scales is constantly monitored. Wire breaks and configuration and hardware errors are reported. Prohibited overloads are even recorded permanently.

System overview

PCDx.W720 **PCDx.W710**





PCDx.W720
2 weighing systems to connect up to 6 weighing cells

PCDx.W710 (obtainable only in specified quantities)
1 weighing system to connect up to 4 weighing cells

(The jumpers on the terminals protect the sensitive inputs against surges when not in use).

1.2 Operation

The PCD2|3.W7x0 module with its associated weighing cells forms one or two independent weighing systems with great precision and impressive functionality.

The weighing cells convert mechanical forces into electrical signals, which are processed within the module and turned into physical units of weight.

All weighing cells based on the principle of resistance strain gauge bridges can be connected to the weighing module. Various largely standardised force and weighing cells are available on the market for force measurements and weighing applications. With the PCD2|3.W7x0 module, several cells can be connected in parallel to each channel, provided that they have the same electrical characteristics.

Principal applications

- The module is suitable for implementing platform, metering or batch scales, e.g. with pellets, liquids etc., and for measuring forces in technical processes

- In commercial or safety-related applications, the whole system must be certified by the authorities responsible, e.g. calibratable scales, overload protection etc.

Overview of functions

Taring	For taring, the current gross weight is defined as the zero setting. After this, only additional net weights added to this are displayed.
Scaling	After placing a check weight, the equipment is scaled.
Empty warning	If the scale remains at zero, an empty warning is displayed
Standstill signal	This signal is generated when a stable equilibrium is reached
Zero correction	The zero point can be tracked automatically
Diff. weighing	For continuous increases in weight, the increase per second can be calculated and output
Error reporting	Wire breaks and overloads are displayed; cases where the axi-mum weight is hugely exceeded are captured and stored
Digital filters	Low-pass configurable from 0.01 to 4 seconds

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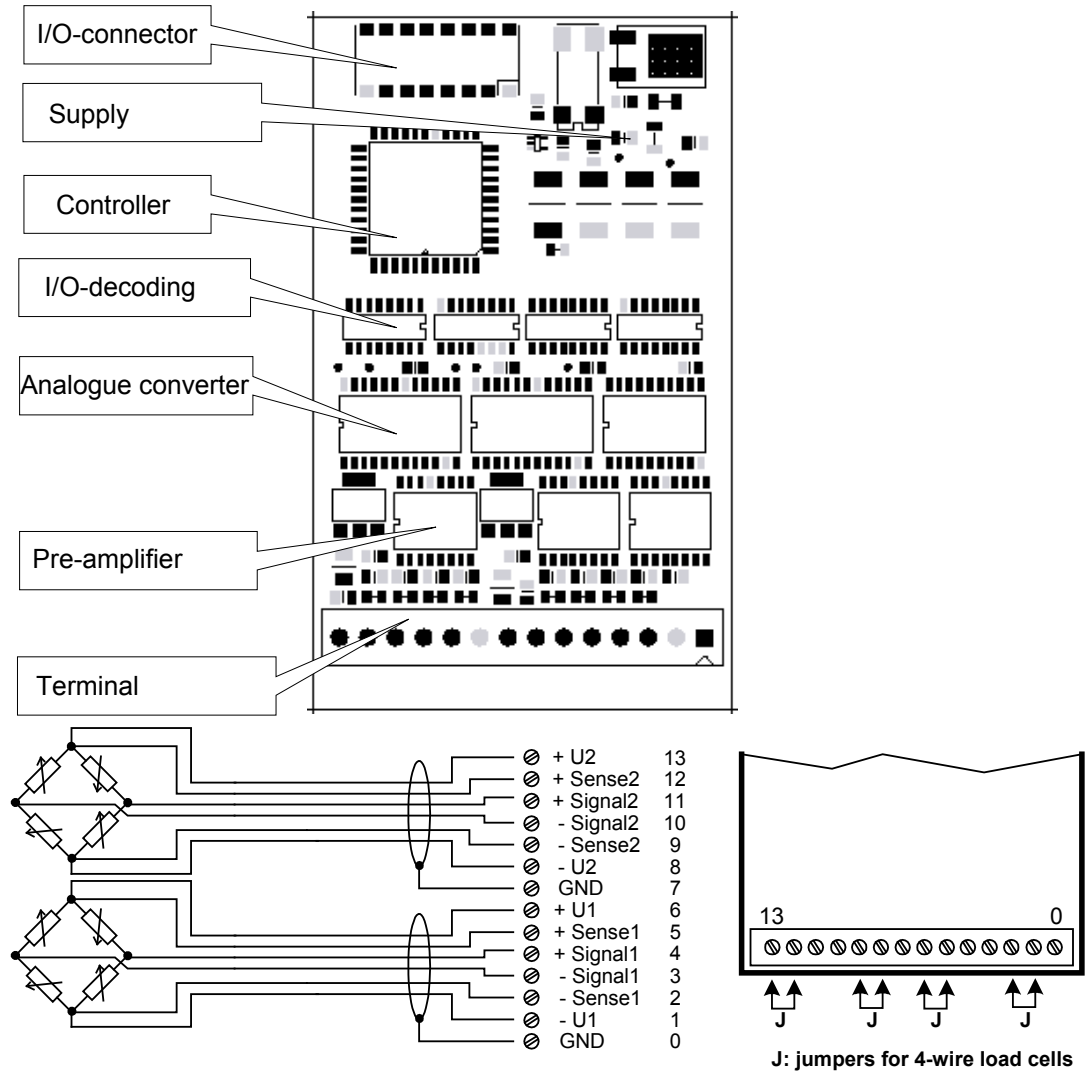
1.3 Technical data

General	
Resolution:	0.001 % (depending on measuring equipment)
Internal resolution:	2^{18} (~1 to 260,000)
Linearity:	0.005 %
Temperature stability:	0.002 % / °C for cells with 2 mV / V
Digital filter in A/D converter:	7.8 Hz to 822 Hz configurable
Post-filter in controller:	0.24 Hz to 100 Hz configurable
Settling time for 00% load:	50 ms to 3 secs depending on filter
50 and 60 Hz suppression:	100 dB min.
Weighing cell characteristics	
Type of weighing cells:	DMS weighing cells with 4 or 6 terminals
Sensitivity:	0.5 to 4 mV / V configurable
Cell supply voltage:	10 VDC +/- 0.5 V
Permissible load resistance per channel:	> 87 Ω (up to 4 cells connected in parallel)
Terminals: PCD1|2 PCD3	Plug-in 14-pole spring terminal block for Ø up to 1.5 mm²: 4 405 5002 0 4 405 4998 0 (Type E)

Layout



J: jumpers for 4-wire load cells

1.3.1 Wiring

The weighing cells are generally provided with a 1.50 to 2.00 m connecting cable. The wiring to the weighing module is via a 6-core shielded cable and a connection socket, to which several cells can be connected.

Maximum length of connecting cable: 100 m

X-section for 100 m: 0.75 mm^2
for 50 m: 0.50 mm^2 (AWG 20)
for 20 m: 0.34 mm^2 (AWG 22)

I/O bus interface

The weighing module uses all available addresses on its slot. The input and output variables at the same address have different meanings.

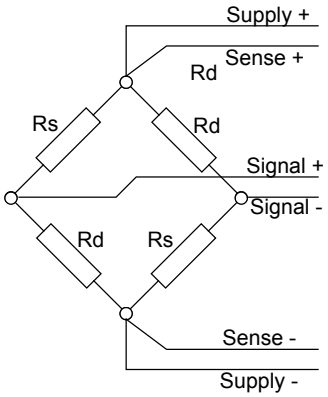
Pin assignment table

Base address	Saia PCD®→module	Module→Saia PCD®
+0	Data 0	Data 0
+1	Data 1	Data 1
+2	Data 2	Data 2
+3	Data 3	Data 3
+4	Data 4	Data 4
+5	Data 5	Data 5
+6	Data 6	Data 6
+7	Data 7	Data 7
+8	Command or address bit 0	“1”→Standstill at selected channel
+9	Command or address bit 1	“1”→Near zero at selected channel
+10	Command or address bit 2	“1”→Ready to read at selected channel
+11	Command or address bit 3	“1”→System error at selected channel
+12	Channel: “0”→1, “1”→2	Not connected
+13	“0”→READ, “1”→WRITE	Not connected
+14	“0”→DATA, “1”→COMMAND	Not connected
+15	“1”→Execute	“1” →Busy

1.4 Functional description

The vast majority of force cells work on the same principle and are supplied in more or less standardised versions. The cells consist of metal bars with sections that stretch under load and others that are compressed. These sections have 4 strain gauge bridge resistances attached to them, connected electrically to a jumper.

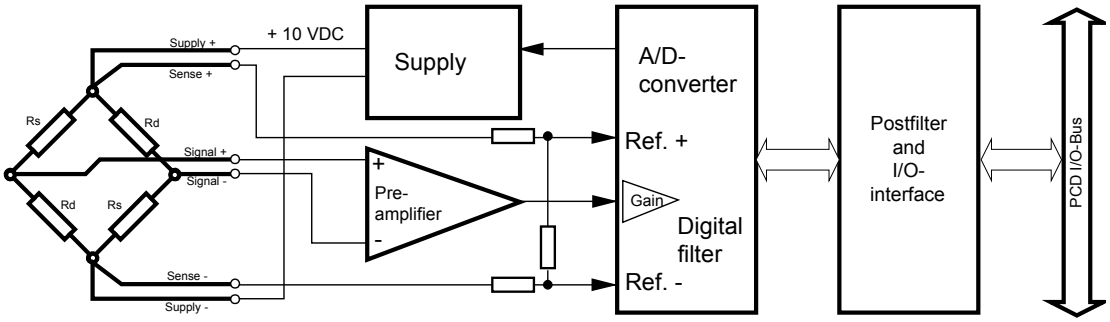
The jumper carries a stable voltage of 10 VDC. With no load, all resistances theoretically have the same value, and the signal voltage is 0 V. With a load on the weighing cell, the resistance value Rd will increase and Rs will decrease; the resulting signal voltage will change in proportion to the load. At the highest permissible load, the signal voltage will be 5 mV, 10 mV, 20 mV or 40 mV, depending on the specification of the weighing cell. The smallest measurable voltage is about 0.1 µV, giving a resolution of 1 to 200,000 with a cell with a sensitivity of 2 mV / V.



The feed voltage across the jumper is dependent on the performance of the voltage regulation, the jumper current, the length of the feed cable and the temperature. For this reason, it is usual to attach a return wire to the jumper, to feed the effective jumper voltage back to the analogue converter with zero current if possible.

1.5 Signal processing

Block diagram



- Pre-amplification is by a factor of 16.3
- The reference voltage is reduced to 2.85 V by a voltage divider.

Amplification factor

The analogue converter is equipped with a further amplifier; the degree of amplification is specified by the user. In general, the rule is:

GAIN = the nearest value less than [2.85 / (rating of call * 163)]

Rating	GAIN	Factor
0.5 mV / V	32	5
1 mV / V	6	4
2 mV / V	8	3
4 mV / V	4	2

Rating means: sensitivity of the cell (mV / V)

1

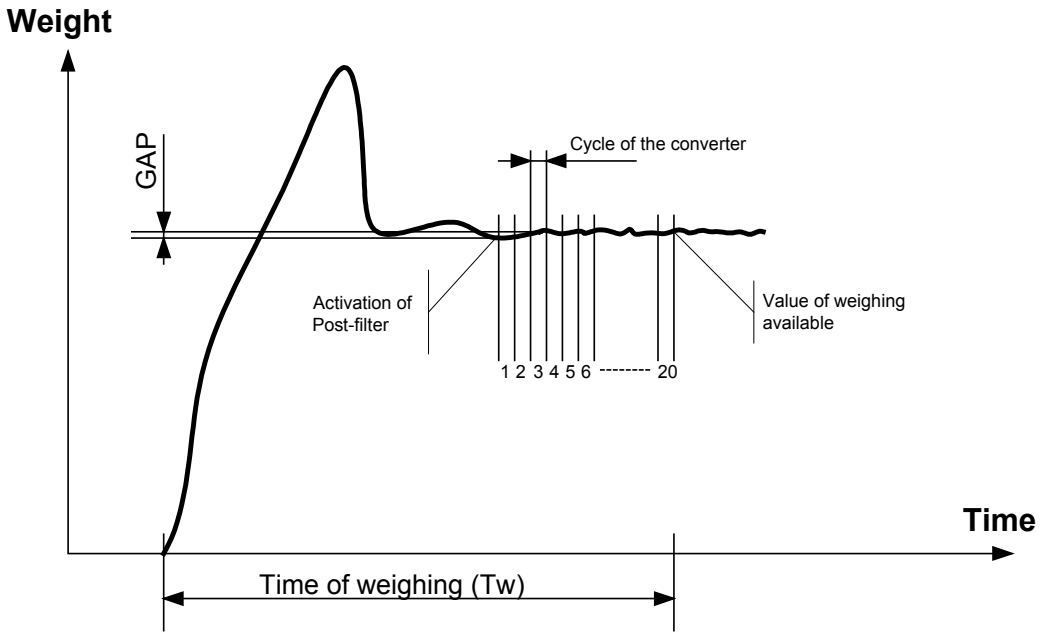
Digital filter

The analogue converter is fitted with a low-pass filter with a configurable threshold frequency between 8 Hz and 800 Hz. This frequency is entered in encoded form from 20 (800 Hz) to 2000 (8 Hz).

Post-filter

A further low-pass filter can be connected downstream of the converter where required. This derives the average across 2 to 20 measurements. This filter is automatically activated when it is established that the object to be weighed is stable, i.e. the difference between 2 measuring cycles is less than the Gap.

Weighing cycle



Throughout the weighing process, interim results can be read off.

Time required for weighing

Of course, this time is dependent on how quickly the items are placed on the scale. For this description of the behaviour of the measuring equipment, we will assume that the weighing unit is loaded in sudden bursts. The digital filter requires 4 acquisition cycles to reach the final value. From this point, the post-filter takes as many acquisition cycles as there are values needed to calculate the average (2 to 20, configurable).

Measurement resolution

The measurement resolution (smallest repeatable weight) is dependent on the time constants of the digital filter and the post-filter. In general, the resolution of a measurement is greater, the longer the time available for it. The table below gives an impression of the relationship between settings, time and resolution.

1

The times listed relate to a step response, i.e. from a sudden full-loading of the scale until the measurement has stabilised.

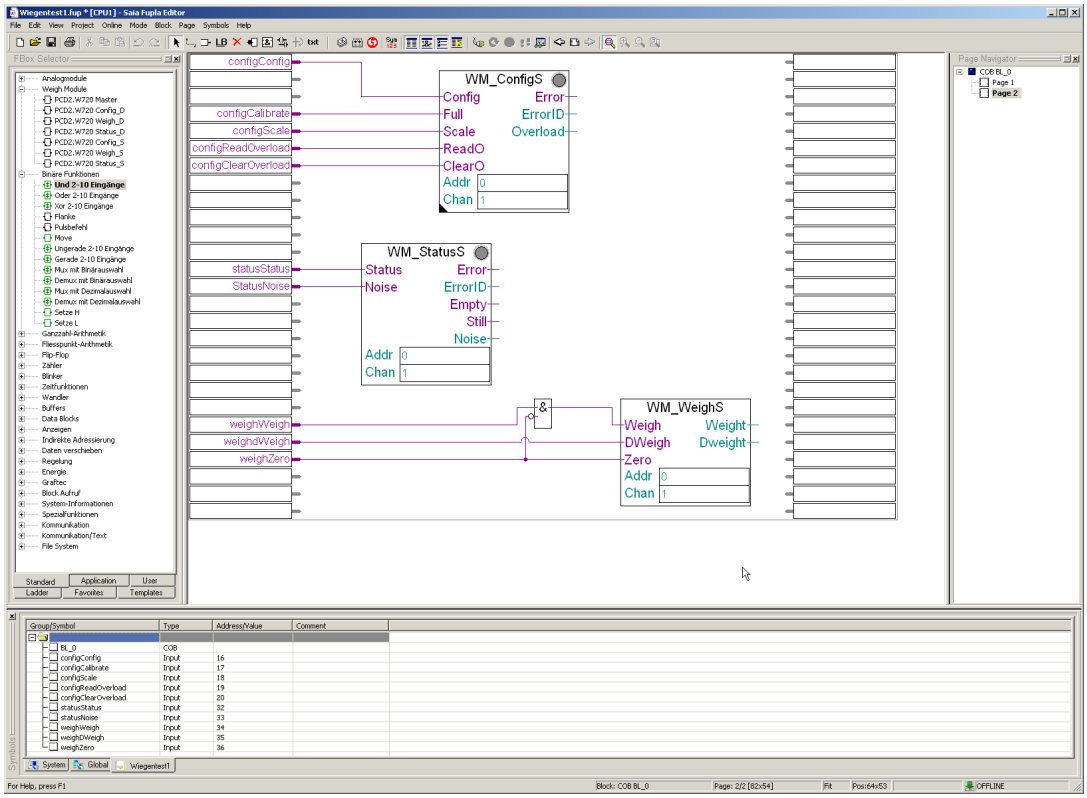
Value for the digital filter	Acquisition cycle in ms	Time to final value in ms	Number of cycles per second	Resolution of analogue values	**Post-filter**=2		**Post-filter**=5		**Post-filter**=10		**Post-filter**=20	
					Time for a measurement in ms	Resolution	Time for a measurement in ms	Resolution	Time for a measurement in ms	Resolution	Time for a measurement in ms	Resolution
20	1.2	4.8	830	2^{-10}	10	2^{-10}	12	2^{-11}	20	2^{-12}	30	2^{-13}
50	3	12	333	2^{-11}	20	2^{-11}	30	2^{-13}	40	2^{-13}	70	2^{-14}
100	6	24	166	2^{-12}	40	2^{-12}	60	2^{-13}	75	2^{-14}	130	2^{-15}
200	12	48	83	2^{-13}	80	2^{-13}	120	2^{-14}	150	2^{-15}	250	2^{-16}
500	30	120	33	2^{-13}	180	2^{-13}	280	2^{-14}	380	2^{-15}	625	2^{-16}
1000	60	240	16	2^{-14}	350	2^{-14}	500	2^{-15}	750	2^{-16}	1300	2^{-17}
2000	120	480	8	2^{-15}	700	2^{-15}	1000	2^{-16}	1500	2^{-17}	2500	2^{-18}

2 Programming

2.1 Function boxes

The deployment of one or more weighing modules is simplest with the FBoxes WM_Master, WM_Config, WM_Weigh and WM_Status. The FBoxes WM_Config, WM_Weigh and WM_Status are all available with both dynamic and static inputs. In a FUPLA environment, the FBoxes with dynamic inputs are generally used. With the FBoxes with static inputs, the user has the choice of setting the input to “1” or “0”, or of manipulating the input externally. This has the advantage, for example, that selected functions can be performed in one step within a Graftec program, and others in a different step. If the weight is to be read in each cycle within a FUPLA program, the Weigh input is set to “1” and the other inputs controlled by the event are manipulated externally.

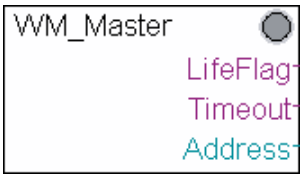
If the input „Weigh“ is set constant to „1“, it must be set be during the reset with „Zero“ to „0“.



Example of the reset with “Zero” to “0”

WM_Master

Ths FBox is only programmed once in a weighing application. It controls the entire data traffic from all weighing FBoxes to all weighing modules. In the Master Box, the data sent to the modules and the data read from the modules is collated, checked and passed to the application. The other FBoxes are exclusively concerned with controlling the selected scale as required by the application.



LifeFlag This output reports that a weighing module can no longer be addressed.

Timeout Timeout is set to “1” when the response from a weighing module is delayed too long.

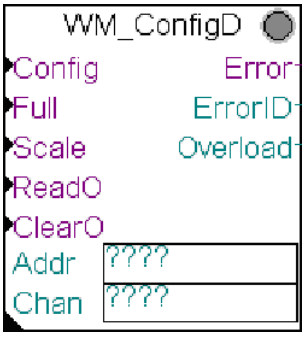
Address Base address of the defective module

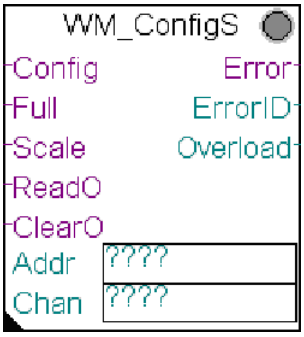
The following FBoxes are programmed once per weighing channel:

Addr	Base address of the module slot
Chan	Channel number for the module (1 or 2)

WM_Config

The configuration of a weighing module is carried out once when the weighing application is commissioned, or it can be repeated if necessary, if an operating parameter changes. All configuration parameters are entered in the Adjust window for the FBox, where they can be changed online or offline. All inputs react to a transition from “0” to “1”.





Config Sends all configuration data to the module addressed, stores the data permanently in the weighing module and triggers a cold start of the weighing module. In this process, the zero point of the scale is determined, so it is important always to run the configuration with an empty scale. The end of configuration is detected when the “Still” signal is displayed on reading the status of this channel.

Full This input triggers calibration of the scale with a check weight placed on it. The scaling of the apparatus is then based on the value entered as a calibration weight in the Adjust window for the FBox.

Scale The input Scale is not supported by the modules PCD7.W720. It is reserved for future applications and should be connected to Ground (0 V).

ReadO Reads the extent to which the weighing cell has been overloaded. This value is stored within the module and is not lost in the event of a supply failure.

ClearO Resets the overload memory to 0, e.g. after the replacement of a defective weighing cell.

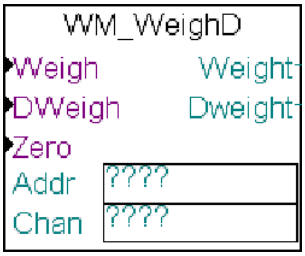
Error Reports a system error with this scale.

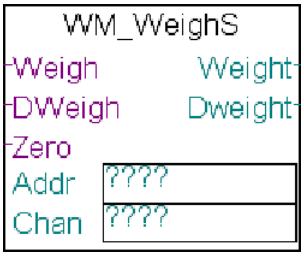
ErrorID Reports the type of error with this scale.

Overload Indicates by what % the nominal value of the weighing cell has been exceeded.

WM_Weigh

Weighing and zeroing the scale are controlled by the FBox WM_Weigh. This Box always returns a result, whether or not the scale has already reached the final weight. The Status Box is used to determine the status of the scale. If a “1” appears at the “Still” output, the user can be sure that the scale has reached a stable final state. All inputs react to a transition from “0” to “1”.





Weigh Triggers the readout of a weight.
Dweigh Triggers the readout of a differential weight.
Zero Resets the scale to zero (tare).

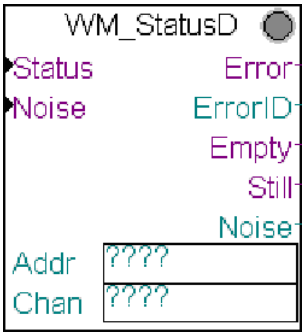
Weight Outputs the weight in the scaled unit.
Dweight Outputs the differential weight in units per second. Please note that the additional smoothing filter delays the output.

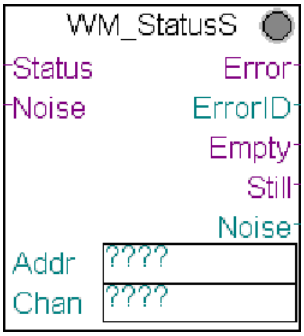
WM_Status

The status of the scale is determined with the FBox WM_Status. The main states of the scale are:

- The scale is working correctly
- Nothing on the scale (empty)
- The scale is still (with or without anything on it)

A further feature is the stability of the scale. This is dependent on the noise behaviour of the weighing module, the vibration of the base of the scale and the addition of the item to be weighed.





Status Triggers the readout of the messages: Error, scale empty and scale at a standstill

Noise Triggers the readout of an indicator value for the stability of the scale.

Error Reports a system error.

ErrorID Reports the type of system error detected.

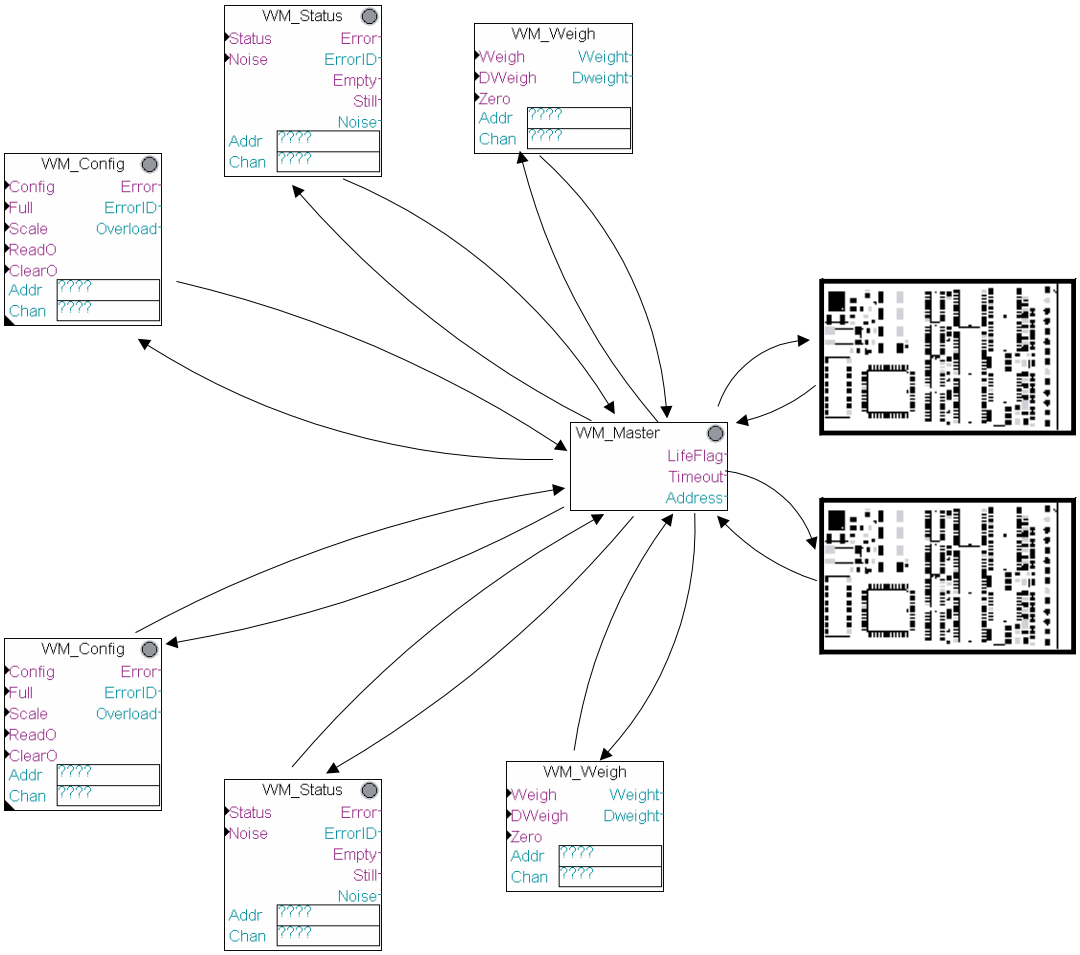
Empty If “1”, the scale is empty.

Still If “1”, the scale is at a standstill, and the weight can be read off.

Noise Instability of the scale; range of values 0 to 255. One unit represents 2^{-18} of the nominal loading of the cell.

2

2.2. Data interchange between Saia PG5® FBoxes and weighing modules



2.3 Overview

Inputs	Command flags	Saia PG5® FBox	Resources	Outputs
		FBox WM_Master	→LIFE_FLAG	LifeFlag
			→Timeout	Timeout
			→Address	Address
Config	SET_AMPLIFICATION→	**FBox WM_Config**	←AMPLIFICATION	
	SET_DFILTER→		←DFILTER	
	SET_PFILTER→		←PFILTER	
	SET_GAP→		←GAP	
	SET_EMPTY→		←EMPTY	
	SET_AUTOZERO→		←AUTOZERO	
	SET_LOWPASS→		←LOWPASS	
	CONFIGURATION→			
Full	FULL_CALIBRATION→		←CHECK_WEIGHT	
Scale	SET_CALIBRATION→			
ReadO	READ_OVERLOAD→	Address:	→OVERLOAD	Overload
ClearO	CLEAR_OVERLOAD→	Channel:		
			→SYSTEM_ERROR	Error
			→ERROR	ErrorID
Weigh	READ_WEIGHT→	FBox WM_Weigh	→WEIGHT	Weight
Dweigh	READ_DWEIGHT→		→DWEIGHT	Dweight
Zero	ZERO_CALIBRATION→	Address: Channel:		
Status	READ_STATUS→	**FBox WM_Status**	→EMPTY	Empty
			→STANDSTILL	Still
			→SYSTEM_ERROR	Error
		Address:	→ERROR	ErrorID
		Channel:		
Noise	READ_UNSTABILITY→		→NOISE	Noise

3 Configuration

The weighing module will only work correctly if the necessary parameters are present when the module is started up. These parameters are permanently stored in the module and are automatically passed to the A/D converter and the computer at start-up. To guarantee automatic start-up, the parameters must be written to the weighing module at least once.

All operating parameters are entered in the Adjust window for the FBox WM_Config.

Sensitivity of connected cell Gain

The target value for amplification is passed to the weighing module in encoded form.The default setting is 2 mV / V

Table of values:

Gain	Weighing cell	Coding
1		0
2		1
4	4 mV / V	2
8	2 mV / V	3
16	1 mV / V	4
32	0.5 mV / V	5
64		6
128		7

Set digital filter Dfil

The bandwidth of the A/D converter can be preset in a range from 20 to 2,000. This represents a conversion time of 1.2 to 120 ms.
Filter values selected from the Filter table.

Set post-filter Pfil

At the output from the A/D converter, the average of a predefined number of weight measurements is calculated. This number is assigned values from 0.2 to 20. With values 0 and 1, the averaging is deactivated.

Admitted staggering Gap

Gap defines when the post-filter is activated within the weighing cycle. The range of values is 0 to 255, with 1 representing roughly 1/65,000 of the nominal loading of the cell. Normal setting: 3 to 20.

In operation, the weighing process is repeated on a cyclical basis. The number of cycles per second is between 8 and 800, depending on the setting of the digital filter. If the difference between 2 weighing cycles is greater than the Gap, the post-filter is set to the current actual value. The average of the most recent weighing cycles is calculated from the point at which the results from successive weighing cycles vary by less than the Gap.

Weight considered as empty Empty

Empty indicates the maximum weight used to assess whether the weighing vessel is empty. One unit represents roughly the nominal loading of the cell divided by 30,000, i.e. for a 20 kg weighing cell, one unit will be approx. 0.7 grams.

Enable Autozero Autozero

With **A utozero** equal to “1”, the scale is automatically reset to zero if it is empty. The scale is considered to be empty if the residual weight is less than the value entered for **Empty**.

Filter for differential weighing Lowpass

To compensate for short-term fluctuations in the flow of material, the differential weight is smoothed with a first-order filter. The value for the time constant for this low-pass filter can be preset here.

The time constant is passed to the weighing module in encoded form:

Lowpass	Time constant for the filter
0	0.25 seconds
1	0.5 seconds
2	1 second
3	2 seconds
4	4 seconds
5	8 seconds
6	16 seconds
7	32 seconds

Check weight

This parameter is set to different values for scales calibrated with a check weight and scales that work with calibrated weighing cells.

Calibration with check weight:

A “1” at the **Full** input calibrates the scale to the check weight. The check weight must not exceed the maximum permissible weight for the scale. The actual value of the check weight is stored as the **Check weight** parameter, with the format of the weight display required. If the check weight is not placed on the scale for a **Full** calibration, an error message will be generated (bit 6 of the ErrorID).

The check weight should be at least 1/50 of the nominal loading of the weighing cell.

Example:
Scale: Nominal load for weighing cells: 200kg
Check weight: 50kg
With **Check weight** = 50,000, the resolution is 1 gram. The display range is then 0 to 200,000 grams.
With **Check weight** = 500, the resolution is 0.1 kg. The display range is then 0.0 to 200.0 kg.

Functions of the weighing module

Zero_calibration Zero (WM_Weigh)

This command calibrates the scale to its empty state. This takes account of all errors in the weighing system and the weight of the empty vessels (tare). This command is normally executed just before the container is filled (this operation can also be performed automatically).

Weighing Weigh (WM_Weigh)

The readout of the weight is triggered by a positive signal edge at the **Weigh** input to the FBox **WM_Weigh**. The weight can then be taken from the **Weight** output in signed integer format.

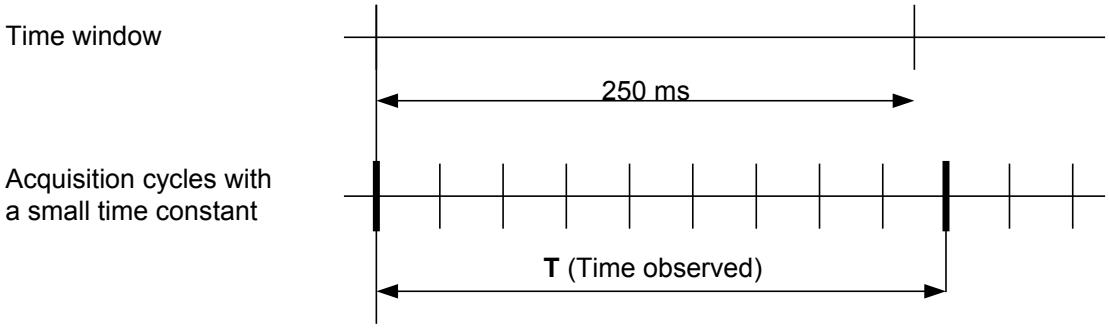
Differential weighing Dweigh (WM_Weigh)

The readout of the differential weight is triggered by a positive signal edge at the **Dweigh** input to the FBox **WM_Weigh**. The differential weight (change of weight per second) can then be taken from the **Dweight** output in signed integer format. Positive values mean that the weight is increasing, negative values mean it is decreasing.

Functional flow for calculating the differential weight

The weighing module calculates the change in weight approx. every 250 ms, and extrapolates up to 1 second. The same units of weight are used as for recurring weighing.

Operation:



$$\text{Differential weight} = \frac{\text{Change of weight in the time observed}}{T} \bullet 1 \text{ sec.}$$

Stability of the scale Noise (WM_Status)

The instability of the weighing system can be read with a positive signal edge at the **Noise** input to the FBox **WM_Status**. The instability is dependent on the noise behaviour of the acquisition system, the vibration of the scale base and the addition of the item to be weighed. In the next program cycle, a value for this instability will appear at the **Noise** output. The range of values is from 0 to 255. One unit represents 2^{-18} of the nominal loading of the cell.

Reading the overload on the weighing cell ReadO (WM_Config)

This input is used to read off the maximum overload ever reached on the weighing cells. Most commercially available weighing cells are guaranteed to withstand overloading up to 150% of their nominal load without damage. But it it quite common, especially with small weighing cells, for them to be more heavily overloaded.

The overload read off may range from 110% to 390%. The cell overload is permanently stored in the weighing module and is overwritten each time a heavier load is detected.

Clearing the overload memory ClearO (WM_Config)

This input resets the permanent memory storing the overload value to 0. It is used when initialising a new module, or in service where e.g. a defective weighing cell is replaced.

Reading the status of the scale Status (WM_Status)

The readout of the status of the scale is triggered by a positive signal edge at the **Status** input to the FBox **WM_Status**. When this FBox is activated, the data traffic between the weighing module and the Saia PCD® CPU is also checked. If this data traffic is no longer assured, the **LifeFlag** on the **WM_Master** Box is set to “1”.

Status signals:

- **Still** is an output that indicates when the item is stable on the scale, i.e. the noise is less than the value defined as the **Gap**.
  Still equal to “1” indicates that a stable value for the weight can be read off. Of course it is also possible to read off all intermediate values for an increasing or decreasing weight.

- **Empty** is an output that indicates that the scale is at 0, i.e. the residual weight detected is less than the value defined by the **Empty** parameter. The permissible range for **Empty** is from 0 to 255. One unit represents 2^{-16} of the nominal loading of the cell.

- **Error** This output signals that a system error has been detected in the weighing module or in the weighing process itself.

As a general rule, all errors in a measuring system are reported with the **Error** status signal. At the same time, a description of the type of error is written to the **ErrorID** output.

When the **Status** input is activated, only new errors are captured, while the old errors are cleared.

Error bit in the ErrorID register								**Description**
7	6	5	4	3	2	1	0	
							1	Cell more than 100% loaded
						1		Cell more than 150 % loaded
					1			Wire break
				1				Malfunction of the module
			1					ADC configuration error
		1						ADC failure
	1							Invalid FULL_CALIBRATION

4 Operation of the weighing module

4.1 Commissioning

The commissioning of a weighing channel involves two steps:

❶ Configuration of the scale
❷ Scaling of the equipment

❶ Configuration

The configuration procedure is described in detail in the section on Configuration **(WM_Config)**.

4.1.2. Scaling

Start by running a zero adjustment with **Zero** on the **WM_Weigh** Box. Place the check weight on the scale and activate the **Full** input on the FBSox **WM_Config**. This scaling must then be checked by removing the weight, running **Zero** and weighing the check weight once again with **Weigh**. If the difference is too great, the whole procedure must be repeated. The scaling value is then stored automatically and reused at each startup.

4.2 Operation

The operation of the scale normally runs as follows:
Run **Zero** just before weighing, while the scale is still empty. Load the scale. There are now several possibilities:

- Weigh and analyse continuously with **Weigh**
- Wait for the status signal **Still** and read off the final weight with a one-off **Weigh**
- During loading of the scale, read off and analyse the differential weight with **Dweigh** on a recurring basis.

Tare calibration can either be performed with **Zero** before each weighing, or it can be executed automatically.

Automatic zero adjustment

Zero adjustment (tare) is run automatically where the **Autozero** parameter is set to “1”. If the result from the scale over 20 acquisition cycles is less than the value defined in **Empty**, the system will treat the scale as empty, and a new zero adjustment will be carried out.

A Appendix

A.1 Icons

	In manuals, this symbol refers the reader to further information in this manual or other manuals or technical information documents. As a rule there is no direct link to such documents.
	This symbol warns the reader of the risk to components from electrostatic discharges caused by touch. **Recommendation:** At least touch the Minus of the system (cabinet of PGU connector) before coming in contact with the electronic parts. It is better to use a grounding wrist strap with its cable attached to the Minus of the system.
	This sign accompanies instructions that must always be followed.
	Explanations beside this sign are valid only for the Saia PCD® Classic series.
	Explanations beside this sign are valid only for the Saia PCD® xx7 series.

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A.2 Contact

Contact

Saia-Burgess Controls AG
Bahnhofstrasse 18
3280 Murten, Switzerland

Telephone switchboard ..... +41 26 580 30 00
Telephone SBC Support ..... +41 26 580 31 00
Fax ..... +41 26 580 34 99

Support

E-mail Support: ..... support@saia-pcd.com
Support site: ..... www.sbc-support.com
SBC site: ..... www.saia-pcd.com

International representations &
SBC sales companies: ..... www.saia-pcd.com/contact

Repair

Postal address for customers to return products in Switzerland:

Saia-Burgess Controls AG
After sales service
Bahnhofstrasse 18
3280 Murten, Switzerland

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