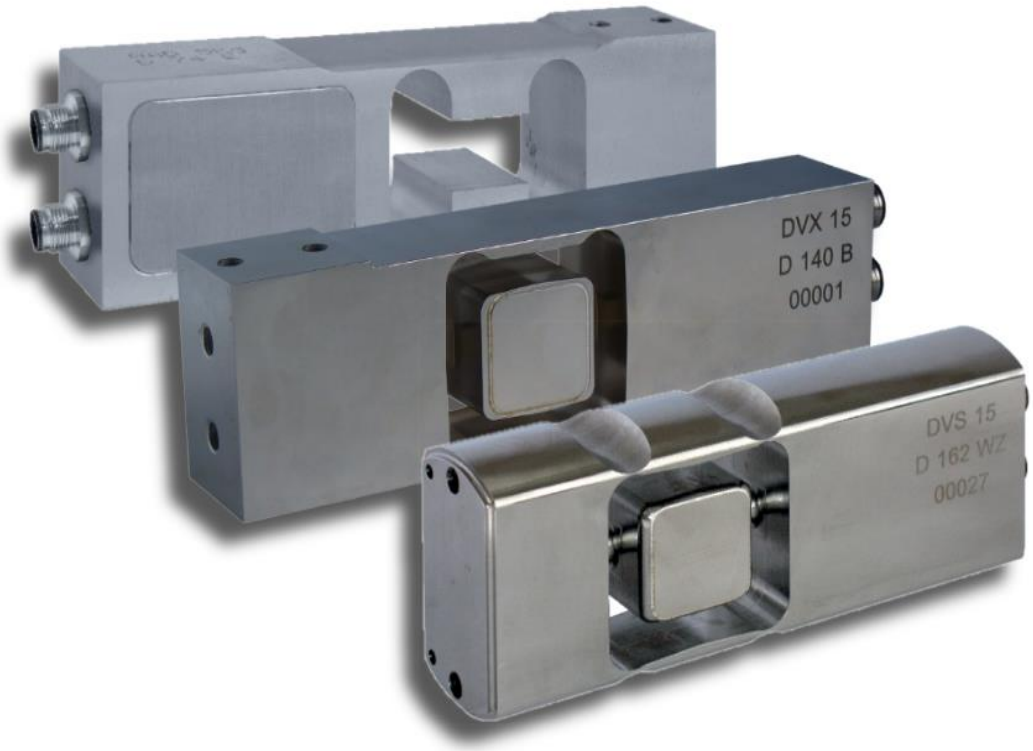
User's instructions



Document revisions		
version	**date**	**description**
A	13/01	- Creation
B	04/17	- Add DVX-C and DVS-C
C	12/18	- Add CAN H and L on C1 (pins 3 and 4) for DVX/DVS (2x8-pins connectors version)

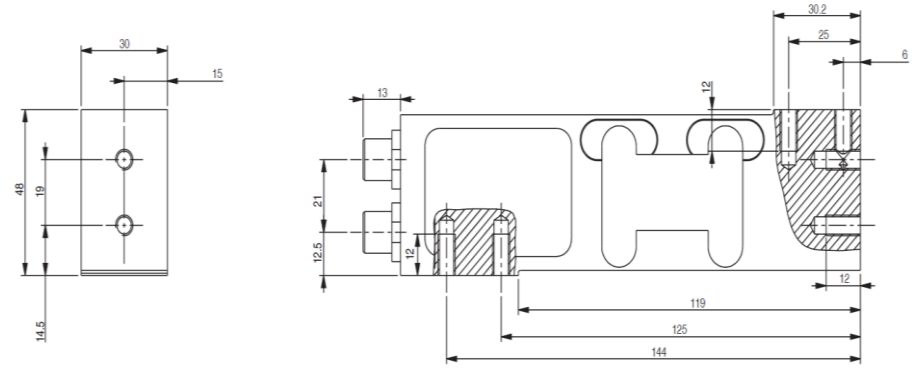
1 GENERAL PRESENTATION :

Manufactured in stainless steel and IP68 hermetically sealed, sensor load-cell is a smart digital single point load-cell specially designed for dynamic weighing applications in harsh environments.
It includes three advanced operating modes allowing dosing process control as well as high-speed measurement transmission :

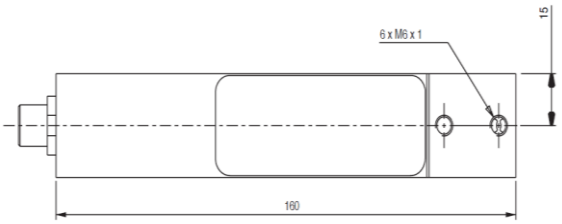
- **measurements transmitter**
- **Checkweigher**

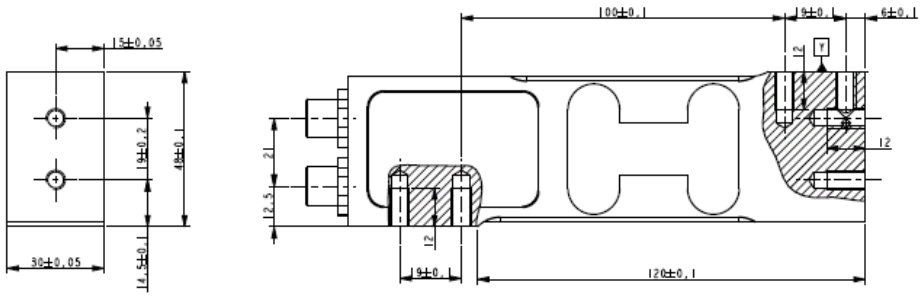
Sensor is provided with RS485 and CANbus outputs supporting ***Modbus RTU***, ***SCMbus*** and ***CANopen®*** protocols. Each load-cell is provided with digital inputs/outputs authorizing synchronization of function with automation and alarm management.
SCAIME provides the ***eNodView*** software to facilitate installation of the sensor load-cell, to set parameters and calibrate the measurement system, for acquisition of measurements and simulation of digital filters.

1.1 Dimensions (mm) :

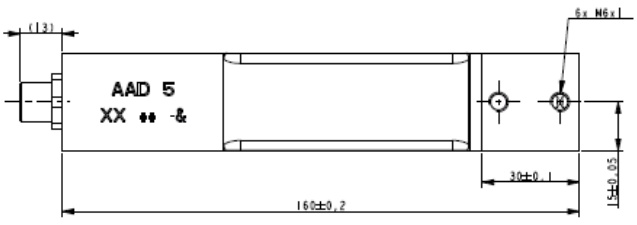


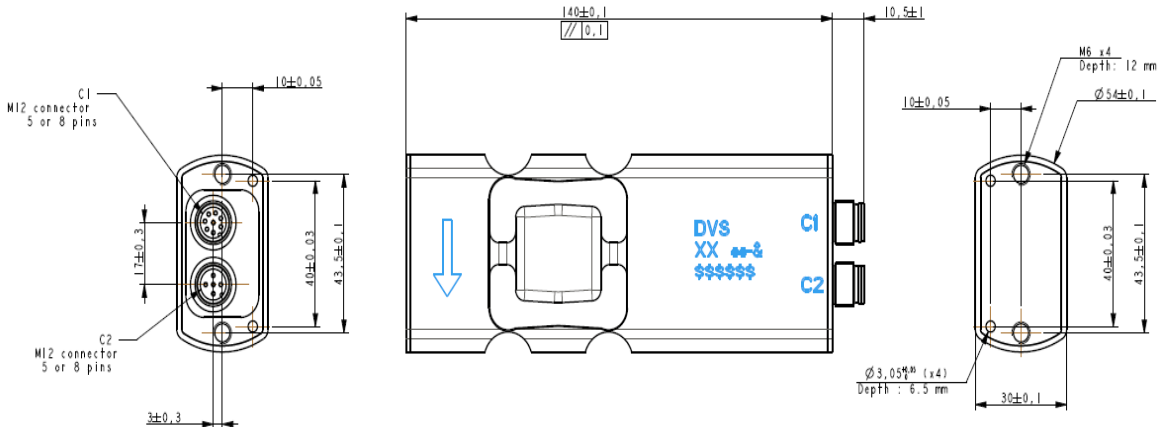
AXD



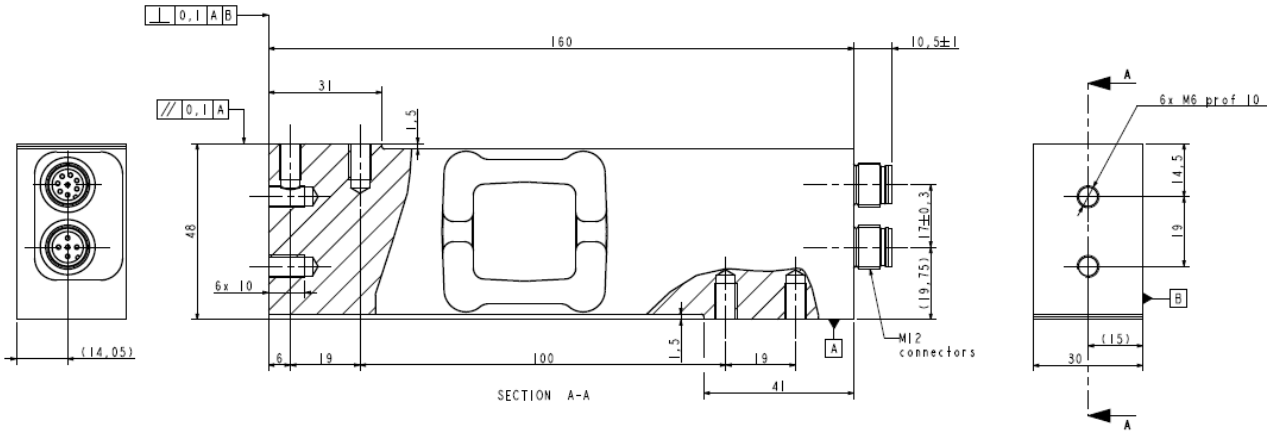


AAD




C1
M12 connector
5 or 8 pins
C2
M12 connector
5 or 8 pins
10±0.05
17±0.3
40±0.03
43.5±0.1
3±0.3
140±0.1
0.1
10.5±1
DVS
XX
$$$$$$
C1
C2
M6 x4
Depth: 12 mm
Ø54±0.1
Depth : 6.5 mm
30±0.1

DVS


0.1 A B
0.1 A
160
10.5±1
31
1.5
48
6x 10
(14.05)
6
19
100
1.5
19
41
A
M12
connectors
SECTION A-A
6x M6 prof 10
14.5
19
B
(15)
30

DVX

1.2 Characteristics

1.2.1 Metrological characteristics :

Metrological characteristics		Unit
nominal capacity (C_n) ***AAD-C***	5 / 15 / 30 / 75	kg
nominal capacity (C_n) ***AXD-C***	15 / 30 / 75	kg
nominal capacity (C_n) ***DVX-C***	15 / 30 / 75	kg
nominal capacity (C_n) ***DVS-C***	15 / 30 / 75	kg
combined error	±0,019	%Emax
zero temperature effect	±0,0011	%C_n/°C
sensibility temperature effect	±0,0016	%C_n/°C
creep (30 min)	±0,016	%C_n
maximum platform dimensions ***AAD***	5400x400 (75 kg: 600x400)	mm
maximum platform dimensions ***AXD***	400x400	mm
maximum platform dimensions ***DVS*** and ***DVX***	500x400 (15-30 kg) 600x400 (75 kg)	mm

1.2.2 General characteristics

General characteristics					Unit
nominal sensitivity at E Max	500000				Counts
Initial zero range	± 2,5				%Emax
internal resolution	24				bits
Conversion rate	6,25 1600				conv./s
maximum transmission rate	1200				mes/s
power supply voltage	10 28				V_{DC}
maximum supply current	25				mA @ 24 V_{DC}
Nominal temperature range	-40 ..... +75				°C
compensated temperature range	-10 ..... +40				°C
safe overload	150				% Emax
limit load	200				% Emax
deflection @ Emax ***AAD***	0,6	0.4	0,3	0,3	mm
deflection @ Emax ***AXD***	0,25	0,2		0,2	mm
deflection @ Emax ***DVX***	0.18	0.2		0.28	mm
deflection @ Emax ***DVS***	0.2	0.18		0.19	mm
environmental protection ***AAD***	IP65				
environmental protection ***AXD***	IP68 and IP69K				EN 60529
environmental protection ***DVX***	IP68 and IP69K				EN 60529
environmental protection ***DVS***	IP68 and IP69K				EN 60529
Material ***AAD***	aluminium				
Material ***AXD***	stainless steel				

Material ***DVX***	stainless steel	
Material ***DVS***	stainless steel	
fixing torque	15 (17 AAD 75 kg)	Nm
Net weight ***AAD***	0,5	kg
Net weight ***AXD***	1.5	kg
Net weight ***DVX***	1.2	kg
Net weight ***DVS***	1.2	kg

1.2.3 Connection

Logical inputs		**Unit**
number	2	
type	optocouplers	
low level voltage	0 3	V_{DC}
high level voltage	10 28	V_{DC}
current at high level	10	mA @ 24 V_{DC}

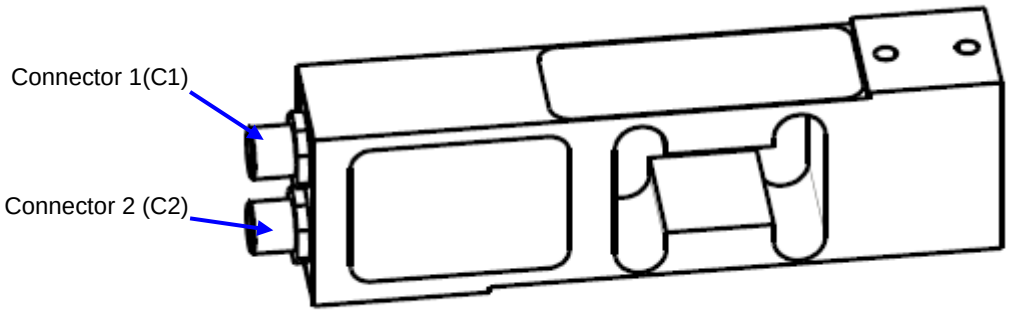
Logical outputs		**Unit**
number	4	
type	opto-insulated static relays	
max current @ 40°C	0,4	A
max current at open state	28	V_{DC}
resistance in ON state	2	Ω

Serial communication		**Unit**
type	RS485 half-duplex (2 wires)	
baud rate	9600 115200	bauds
protocols	Modbus-RTU SCMbus	

CAN communication		**Unit**
type	CAN 2.0A	
baud rate	50 1000	kbauds
protocol	CANopen®	

Connecting		**Unit**
2x male connector	Lumberg RSFM 5/8 pins	

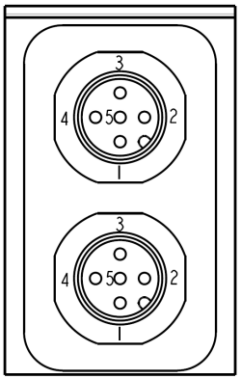
2 INTERFACES



2.1 Connectors type

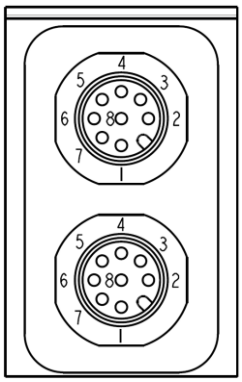
Two kinds of connectors are proposed on the digital load-cell:

2.1.1 2x5-pins connectors version



	C1	C2
1	NC	E1-
2	+Vcc	E1+
3	GND	GND
4	CANH	TA / RA
5	CANL	TB / RB

2.1.2 2x8-pins connectors version



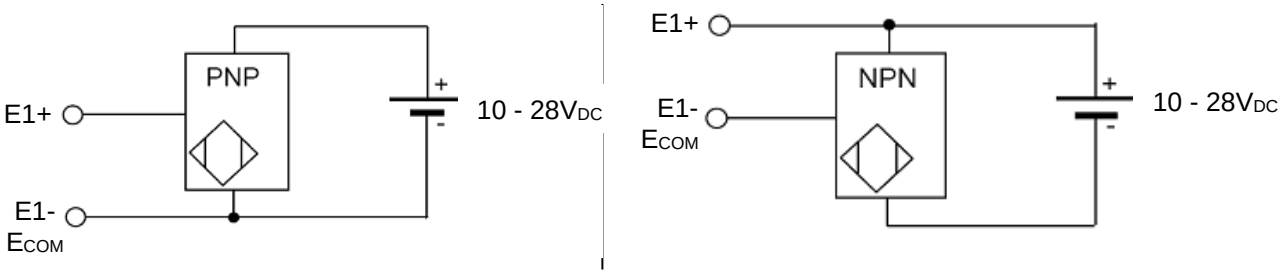
	C1 (AAD)	C1 (DVX-DVS)	C2
1	GND	GND	E_{COM}-
2	+Vcc	+Vcc	E1+
3	NC	CANH	E2+
4	NC	CANL	S_{COM}+
5	CANH	CANH	S1
6	CANL	CANL	S2
7	TA / RA	TA / RA	S3
8	TB / RB	TB / RB	S4

- **Note :** Digital load-cell with 2x5-pins connectors do not have logical outputs available on connectors. Nevertheless these outputs *exist in a virtual state* and can be affected for specific function management. Then, their changing of state is managed by the communication bus.

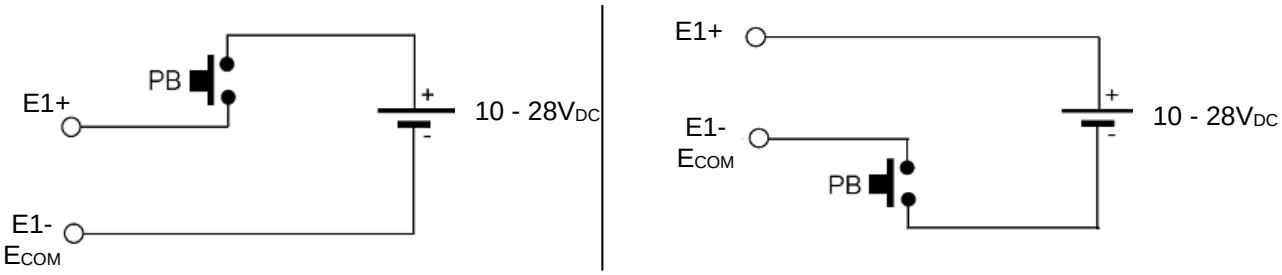
2.2 Connection of logical inputs

Characteristics of opto-insulated inputs	
high level	10 to 28V_{DC} max current: 10mA @ 24VDC
low level	0 to 3 V_{DC}

Connection to a detector :

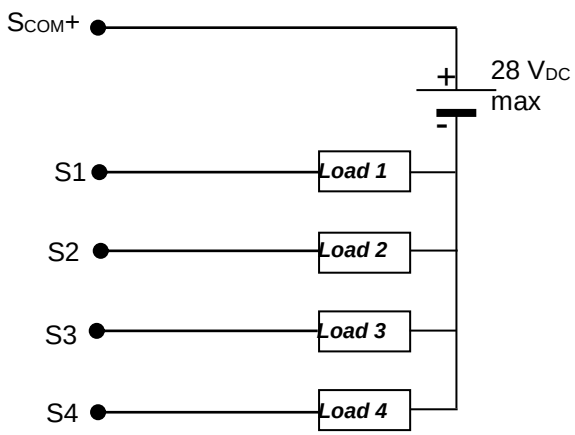


Connection to a push button (PB) :



2.3 Connection of logical outputs

Opto insulated logical outputs characteristics	
max current @ 40°C	0,4A
max voltage at open state	28V_{DC}
resistance in ON state	2 Ω



2.4 Communication interfaces

Digital load-cell has two different interfaces of communication which work the following way:

- ⇨ at power on, the load-cell starts in **CANopen® protocol**.
- ⇨ if the load-cell receives a valid RS485 frame (Modbus-RTU or SCMbus), it automatically switches into this communication mode (using the memorized communication protocol). Digitalload cell returns to CANopen® protocol after next reset (hardware or software).

2.4.1 RS485 interface

Digital load-cell can communicate on a 2-wires RS485 bus (half-duplex) at one of the following rates:

- 9600 bauds
- 19200 bauds
- 38400 bauds
- 57600 bauds
- 115200 bauds

The connection is made through the TA/RA and TB/RB pins. Pins position depends on the digital load cell version:

- ⇨ 2x5-pins connectors version: pins 4 and 5 on connector C2
- ⇨ 2x8-pins connectors version: pins 7 and 8 on connector C1

It is strongly advised to use termination resistors (120 Ω) at each bus' end to ensure a good transmission quality. (the line adaptation limits the reflection effects).

The address choice, the baud rate and the used protocol (Modbus RTU or SCMbus) can be achieved by the transmission of the appropriate command on the communication bus (cf. §3).

By default (at delivery), digital load-cell is set to work using the Modbus RTU protocol at 9600 bauds at the address 01_H.

2.4.2 CAN interface

Digital load-cell can communicate through its CAN 2.0A interface using CANopen® protocol. The usable rates are the following :

- 20000 bauds
- 50000 bauds
- 125000 bauds
- 250000 bauds
- 500000 bauds
- 800000 bauds
- 1000000 bauds

The connection is made through the CANH and CANL pins. Pins position depends on the digital load cell version cell:

- ⇨ 2x5-pins connectors version: pins 4 and 5 of the connector C1
- ⇨ 2x8-pins connectors version: pins 3/5 and 4/6 of the connector C1

To avoid signals reflections phenomena that can lead to communication problems, the CAN bus **must** be closed with termination resistors. 120Ω resistors must to be placed at each bus' end.

By default (at delivery), digital load-cell is set to communicate at 125000 bauds with the node number 01_H.

3 COMMUNICATION :

Digital load-cell can communicate using several protocols :

- ***Modbus RTU***
- ***SCMbus*** *standard* format or *fast* format.
- ***CANopen®***

⇨ Switching from ***SCMbus*** protocol to the ***Modbus RTU*** protocol (and reciprocally) can be done by software programming :

1) *send the corresponding command*
2) *send the 'storage in EEPROM' command*
3) ***reset*** *(hardware or software) digital load cell.*

3.1 Modbus RTU :

See the description of the communication and frames in the document : ***communication Modbus RTU*** Ref. 195754.

3.2 SCMbus :

See the description of the communication and frames in the document : ***communication SCMbus*** Ref. 195756.
The ***SCMbus*** protocol has got similarities with ***Modbus RTU*** protocol. It is based on the master/slave structure, however it allows to transmit measurements continuously without collision management on the bus. This operating mode is only available in ***transmitter*** functioning mode.

The measurements transmission frequency depends on the baud rate, thus : transmitting 100 meas/s is impossible at 19200 bauds and lower. For fast measurement transmissions, use the ***fast SCMbus format*** with which 1200meas/s can be expected at 115200 bauds.

Other methods of transmitting information without any master request :

- ***transmitter*** mode : measurement transmission triggered by a logical input.
- ***whatever the functioning mode is***, during a *physical calibration procedure* an automatic transmission is done when a step in the process is completed .

3.2.1 Fast SCMbus format :

The ***fast SCMbus format*** is particularly useful for measurement acquisition at the highest rate possible, for example in order to analyse dynamic behaviour. This format should only be used for point to point operation.

In order to optimize the speed, in addition to use the ***fast SCMbus format***, it is preferable to configure digital load-cell in '***non-processing transmitter'***. In this operating mode, filters are disabled, set points are not managed and there is no polynomial linearization.

3.3 CANopen® :

Digital load-cell supports ***CANopen®*** communication protocol and is compliant with 'CiA® Standard V301'. Refer to the description note : '***communication CANopen®*** Ref. 195758'

4 CALIBRATION :

4.1 Factory default settings :

By default (at delivery) digital load-cell is calibrated so as to deliver 500000 points for its nominal load (5, 15, 30 or 75 kg). This calibration can not be erased or deleted and acts as a reference span on which is based the user's scale.

4.2 User's scale settings :

The measurements scale transmitted by the load-cell can be readjusted by two different ways :

4.2.1 Theoretical scale adjustment

It is possible to define the scale of the load-cell by a relation between the nominal load and the corresponding value to transmit. The *'max capacity'* parameter defines the number of points to display/transmit when the load-cell is submitted to a load equivalent to his nominal capacity. For example :

- For a 30 kg digital load cell, if the specified *'max capacity'* is 30000, the load-cell will deliver 8000 pts for a 8 kg load (1 gram calibration).
- For a 15 kg digital load cell, if the specified '*max capacity'* is 150000, the load-cell will deliver 80000 pts for a 8 kg load (0.1 gram calibration).

4.2.2 Physical scale adjustment

The user's span can also be defined by learning. This calibration procedure requires a standard load whose weight is perfectly known. The *'calibration load'* parameter allows defining the number of points corresponding to the standard load (for example 5000 points for a 5 kg load).

4.2.3 g correction

Digital load-cell is calibrated in Annemasse (France, Haute-Savoie). This implies that for other terrestrial geographical coordinates, a slight difference in accuracy can be observed on the measurement. In order to compensate this aptness error, it is possible to set into the digital load cell the value of the local gravity acceleration coefficient. The span adjustment is then made automatically.

- *Note : the **eNodView** software allows to make easily all this adjustment and, particularly the determination and the setting of the local g value.*

5 INPUTS FUNCTIONNING :

Each input can work in positive or negative logic individually. A debounce time attached to both inputs can be adjusted.

5.1 Inputs assignment :

Function		
	transmitter	checkweigher
none	●	●
tare	●	●
zero	●	●
transmit measurement	●	
measurement window	●	
clear	●	●
start cycle		●
stop cycle		●
dynamic zero		●

5.2 General functions :

- *none* : inputs have no effect.

- *tare* : one or the other or both inputs can be assigned to the tare function. The tare acquisition is conditioned by a stability criterion that can be changed or inhibited.
Depending on the chosen logic (positive or negative) the tare is triggered by a rising or a falling edge.

- *zero* : one or the other or both inputs can be assigned to the zero function.
A new volatile zero value is acquired only if its value is within ±10% range of the specified capacity for a usage out of legal for trade or ±2% for legal for trade application. The zero acquisition is conditioned by a stability criterion that can be changed or inhibited. This zero value is a volatile value and it is cancelled after a reset.
Depending on the chosen logic (positive or negative) the zero is triggered by a rising or a falling edge.

5.3 Functions attached to an operating mode :

See corresponding sections for a complete description.

6 OUTPUTS FUNCTIONING :

Each output can work in positive or negative logic individually.

6.1 Outputs assignment :

Function	operating mode	
	transmitter	checkweigher
set point	●	●
motion	●	●
defective measurement	●	●
result available		●
cycle in progress		●
input image	●	●
level on request	●	●

6.2 general functions :

- *Set point :* the outputs can be assigned to configurable set points. Output 1 is assigned to set point 1, output 2 to set point 2, output 3 to set point 3 and output 4 to set point 4.

- *Motion*: the outputs can be assigned to copying measurements stability.

- *Defective measurement* : the outputs can be assigned to copying the measurements faults. These faults are also coded in the status word :
  - Signal outside the converter analog input range
  - Signal outside the capacity on the positive side
  - Signal outside the capacity on the negative side

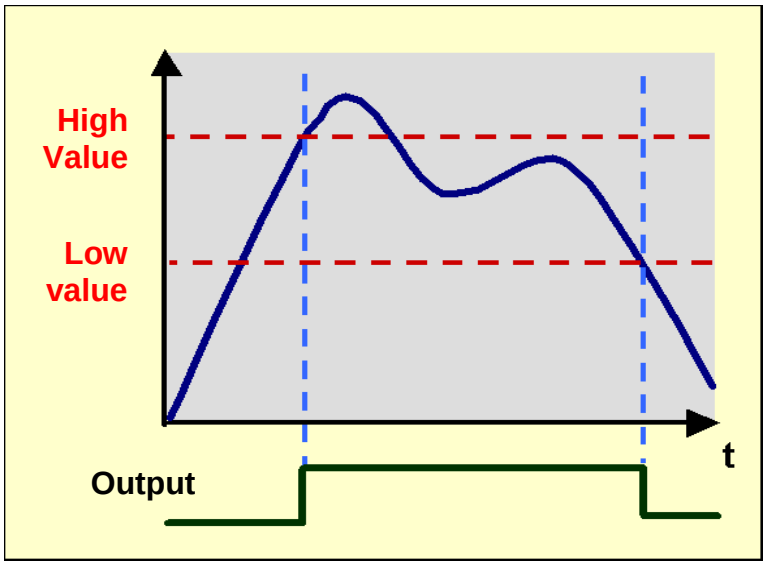
- *Input image* : outputs can be assigned to copying inputs state, either using the same logic or inverting the input state (negative logic). Outputs 1 and 3 are assigned to input 1, outputs 2 and 4 are assigned to input 2.
- *level on request* : Logical output level is set on communication bus request.

6.3 Functions attached to an operating mode :

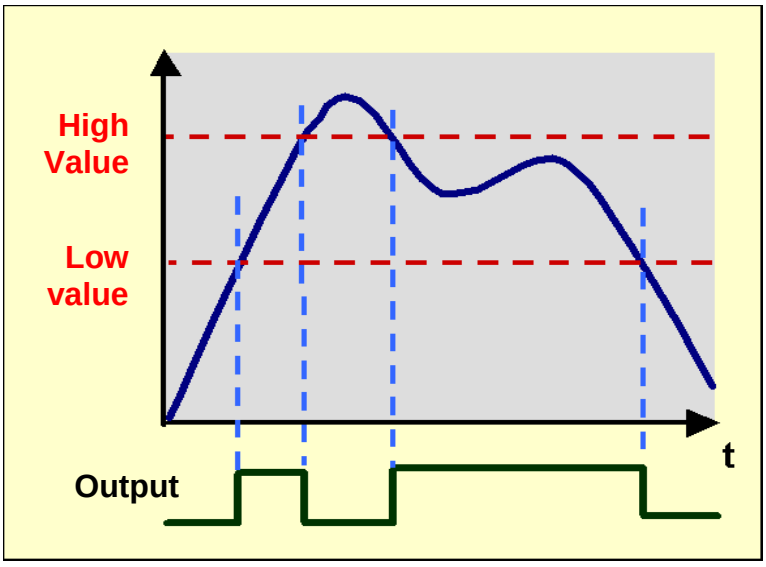
See corresponding section for a complete description.

7 SET POINTS :

Set points are characterised by a high and a low value.
Their operating mode is either ***operating in hysteresis*** either ***operating in window*** :



Operating in hysteresis (positive logic)
Fig. 1



Operating in window (positive logic)
Fig. 2

The low and high values of these set points can be assigned either to (regardless the functioning mode) :

- **gross measurement**
- **net measurement**
- **results in tolerances (operating in window only) in checkweigher mode**
- **results out of tolerances (operating in window only) in checkweigher mode**
- **Sum in checkweigher mode**

FILTERS :

There are four available filtering levels :

- Filtering related to the A/D conversion rate including rejection of the main frequency (50 Hz or 60 Hz) harmonics.
- 2nd, 3rd or 4th order low-pass Bessel / Butterworth filter.
- 2nd order stop-band filter
- Self adaptive filter.

- Filtering related to the A/D conversion : The signal resolution is related to the conversion rate. The conversion rate might be chosen as low as possible, particularly for static applications. For dynamic applications , a compromise must be found between the measurement rate and the low-pass filter cut off frequency. The ***eNodView*** software can be used to determine the appropriate filter values.
Choose a measurement rate that rejects the main frequency harmonics according to the place of use, 50Hz or 60 Hz.

- ***Bessel or Butterworth type low-pass filter*** : a digital low-pass filter can be applied at the output of the A/D converter. The filter order is configurable (available values are 2, 3 or 4) and the coefficients that define it depend on the A/D converter rate, the wanted cut off frequency and on the chosen order. These coefficients can be easily calculated by the ***eNodView*** software.

- ***Band-stop filter :*** a 2nd order filter might be applied as an output of the low-pass filter (if used) or the A/D converter. It allows to attenuate the frequencies within a band defined by a high and a low cut off frequencies. The coefficients that define it depend on the A/D converter rate and the wanted cut off frequencies (that means the frequency bandwidth). These coefficients can be easily calculated by the ***eNodView*** software.

- ***Self-adaptive filter :*** This filter can be set in cascade after previous filters. It is particularly efficient for the static measurement but avoid using it in dynamic or dosing processes. The aim of this filter is to eliminate erratic values and to average consistent measurements.

8 TRANSMITTER OPERATING MODE :

This basic operating mode consists in transmitting calibrated measurements on the bus, possibly after filtering them and comparing them to set points level.
Measurements can be transmitted individually regardless of the communication protocol or continuously at a define frequency in ***SCMbus*** (*standard* or *fast format*) or ***CANopen***® protocols.

8.1 Measurement reading request :

8.1.1 Single measurement transmission :

Regardless of the communication protocol in use.
The request can apply to :

- gross measurement.
- net measurement.
- tare value.
- measurement in A/D converter points.

8.1.2 Continuous measurement transmission :

This is possible using ***standard* or *fast SCMbus* format**, the transmission can be started by a serial command for a defined period in ms.
The request can apply to :

- gross measurement.
- net measurement.
- measurement in A/D converter points.

❑ **Note** : This is very similar to operation of 'measurement window' trough an input command.

CANopen® protocol also allows to define a period at which measurement are sent on the bus without any master request.

8.2 Specific commands trough an input :

8.2.1 Transmit measurement (fig.3) :

This is only possible using standard or fast ***SCMbus*** format and ***CANopen***® protocols. The request can apply to :

- gross measurement
- net measurement
- measurement in A/D converter points.

A single measurement is transmitted per rising or falling edge (depending on the configured logic) on the input signal.

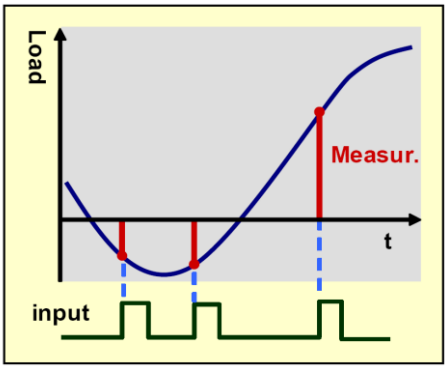


Fig. 3

8.2.2 Measurement window (fig.4) :

This is only possible using standard or fast ***SCMbus*** format.
The request can apply to :

- gross measurement
- net measurement
- measurement in A/D converter points.

While the input is kept at the right level, a series of measurement are transmitted at the period define by the *'sampling period' setting .*
If both inputs are assigned to this function, only the input 2 is operative.

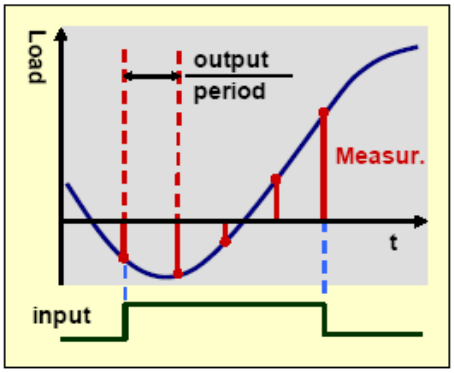


Fig. 4

8.2.3 Clear

Cancels current tare (same functioning as *'cancel tare' command*).

9 CHECKWEIGHER OPERATING MODE:

This operating mode consists of determining the weight of an object while it is present on a conveyor portion on which a weighing system is fitted.
Note: The measurement is determined for net measurements only.

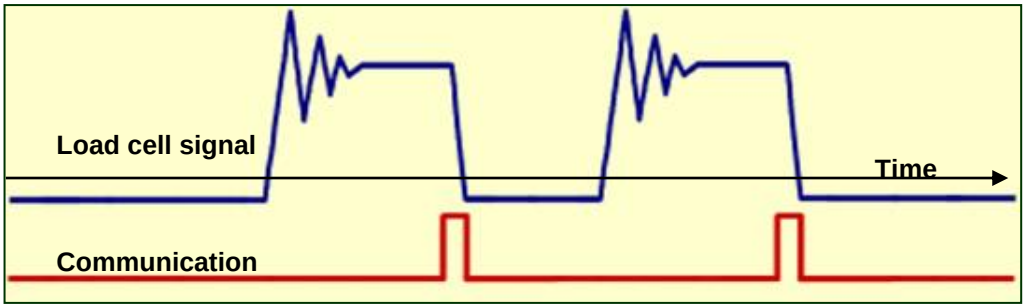


Fig. 5

9.1 Weight determination :

When the object arrives on the weighing system, the weight determination cycle can be started:

- by an input assigned to *'start checkweigher cycle'* (Fig. 6 & 7). Caution, only input 2 is operational if both inputs are assigned to the *'start checkweigher cycle'* function.
- by a trigger level (Fig. 8) when the load cell signal reaches the specified value.

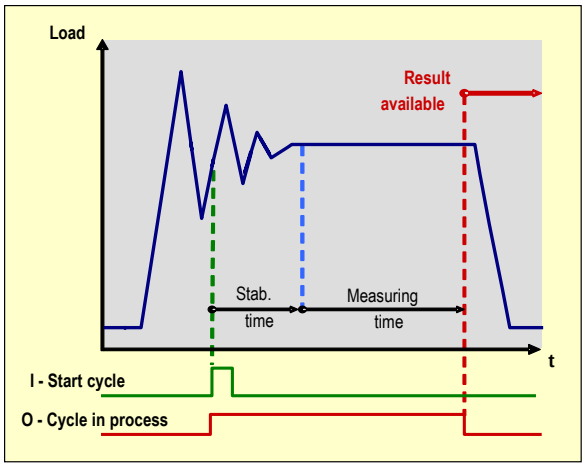


Fig. 6

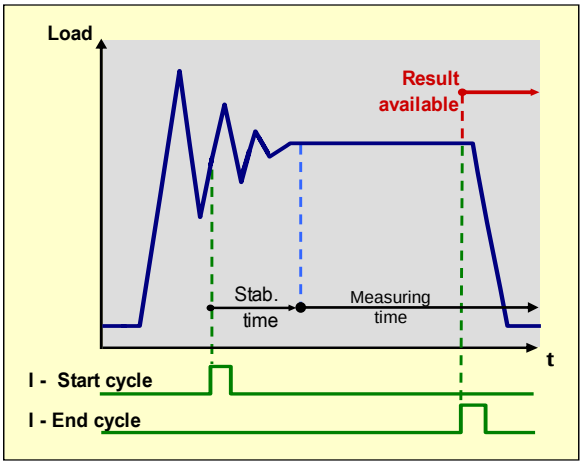


Fig. 7

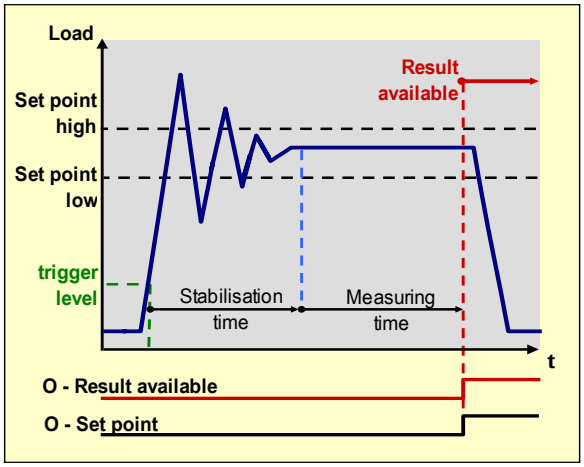


Fig. 8

Then, during a *'stabilization time (Ts)'*, the signal is highly disturbed so measurements are not taken into account. Finally, during a '*measuring time (Tm)*' defined by either:

- a time value (Fig.6).
- a duration prior to an edge on an input assigned to '*stop checkweigher cycle*' (Fig.7).
  Caution, only input 2 is operational if both inputs are assigned to the *'stop checkweigher cycle'* function.

Sensor automatically calculates :

- a result corresponding to the object weight. This result value may be weighted by a coefficient.
- The quality of the measure. It is the standard deviation of the measures get during measuring time. The more this value is low, better is the checkweigher result.

Each cycle is counted and the following statistical data are updated for each new complete cycle:

- results average
- running total (results sum)
- number of cycles
- standard deviation

eNodView can be used to determine stabilization and measurement times so as to optimize parameters. (See ***eNodView*** user's instructions documentation).

9.2 Providing the result value:

With the ***SCMbus*** protocol:

- In *'Checkweigher automatic transmission'* mode, when the cycle is finished, the result is automatically sent through the serial line. After the transmission, the measurement result is set to **????????**.
- In *'Checkweigher transmission on request'* mode, the measurement result has to be read. Reading automatically resets measurement memory to **????????**. Starting of a new cycle induces also a reset to **????????**.

The measured result can also be cancelled (set to **????????**) without reading. It can be done by an input assigned to '*clear*' or by the *'clear'* command, in this case **pay attention:** not only current checkweigher result is cancelled, all other checkweigher statistic results are also set to zero (cycle number, checkweigher results total, results average, standard deviation).

With the ***Modbus*** protocol:

- As soon as the measurement result is available, it can be read. Starting a new cycle cancels the previous measurement result (set to '**FF FF FF FF'**).

The measurement result can also be cancelled (set to '**FF FF FF FF'**) before a new cycle is started. It can be done by an input assigned to *'clear*' or by the '*clear'* command, n this case **pay attention:** not only current checkweigher result is cancelled, all other checkweigher statistic results are also set to zero (cycle number, checkweigher results total, results average, standard deviation).

With the ***CANopen®*** protocol:

- As soon as the measurement result is available, it can be read. Starting a new cycle cancels the previous measurement result (set to '**FF FF FF FF'**).

The measurement result can also be cancelled (set to '**FF FF FF FF'**) before a new cycle is started. It can be done by an input assigned to *'clear*' or by the '*clear'* command, in this case **pay attention:** not only current checkweigher result is cancelled, all other checkweigher statistic results are also set to zero (cycle number, checkweigher results total, results average, standard deviation).

The result transmission can be triggered in different ways. It depends on the chosen trigger event (see document Ref. 165 714).

9.3 Management of Set-points:

Outputs may be assigned to the set-point function. Set-points are triggered by the measurement result (fig. 6). As long as checkweigher result is not available (**????????**) or (**FF FF FF FF**), it is seen like a value < to set point.

Set points can also be assigned to the checkweigher running total value (cumulated weight).

9.4 Other output assignment:

- Cycle in progress
- Checkweigher result available
- Default
- Input image
- Level on request
- Motion

9.5 Dynamic zero

If an input assigned to the *'dynamic zero'* function is activated or if a *'dynamic zero'* command is received, sensor calculates the measurement average value during a configurable time. This value becomes effective if it is within a ± 10% range of the specified maximum capacity. Stability is not required.

9.6 Checkweigher zero automatic correction

Sensor also provides an automatic zero tracking for dynamic applications. It allows following the evolution of the zero in checkweigher functioning mode, for example on a conveyor belt on which there is some product accumulation

This function is efficient only when the measured signal is filtered enough with few noise and oscillations.

When this function is enabled, an average value is calculated if comprised within a configurable interval around the calibration zero. Some other criteria are also taken in account:

- A minimum of 75% ratio between accepted measurements and total measurements received during checkweigher dynamic correction time is considered.
- A minimum of 10 measurements accepted during correction time is necessary.

In legal for trade mode :

- Checkweigher zero dynamic correction is not done if measurement is stable.
- A maximum correction range of ±5 d is admitted.
- Time during measurement average is calculated is at least 1 second.

To use checkweigher zero automatic correction it is recommended:

- Use it only if belt conveyor is in use.
- Zero dynamic time should be higher to checkweigher measuring time.
- Zero dynamic time should be lower than free time between two arriving load.
- Zero dynamic interval should be lower than checkweigher trigger level.
- Zero dynamic interval should be in connection with mechanical vibrations, it should be lower than 10d.