User's instructions

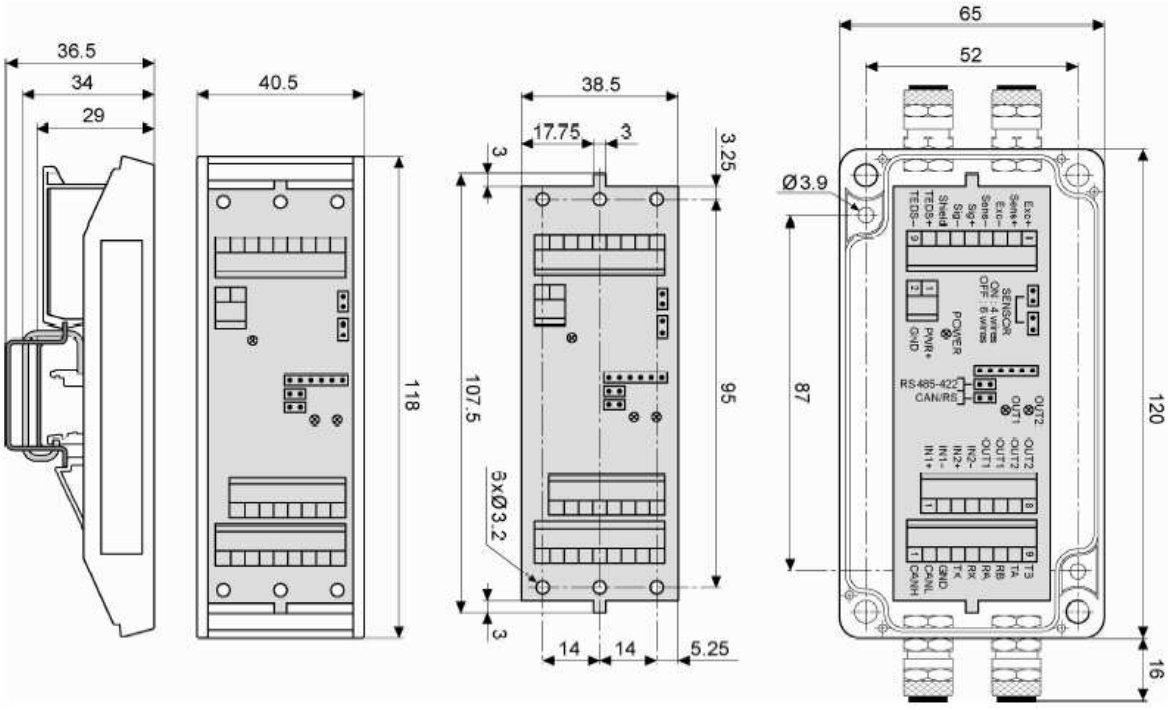
1 GENERAL PRESENTATION:

eNod3-C provides an economic high performance solution to transform any strain gauge sensor into an intelligent digital system. ***eNod3-C*** includes three advanced operating modes for control of static and dynamic processes:

- **Measurement transmitter**.
- **Checkweigher.**
- **Peak control.**

eNod3-C is provided with RS485/422, RS232 and CANbus outputs supporting the ***ModBus-RTU***, ***SCMBus*** and ***CANopen*** protocols. Each module is provided with 2 logical inputs and 2 logical outputs, authorizing synchronization of functions with automation and alarm management. ***SCAIME*** provides the ***eNodView*** software to facilitate installation of ***eNod3-C*** to set parameters and calibrate the measurement system, for acquisition of measurements and simulation of digital filters.

1.1 Dimensions:

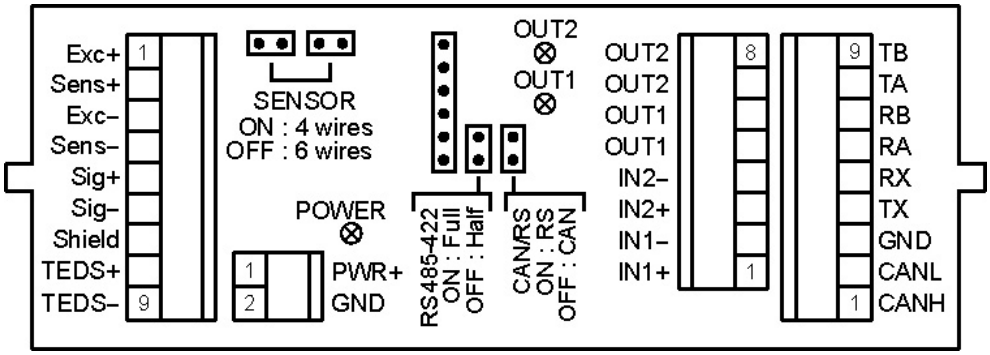


Din rail version | Single board version | Waterproof housing version

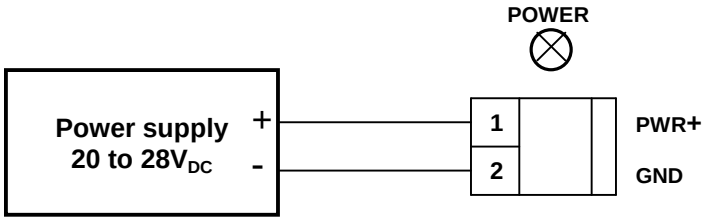
1.2 General characteristics:

Power supply		
Power supply voltage	20...28	V_{DC}
Consumption	<120mA with 350Ω load cell <170mA with 80 Ω load cell	mA
Temperature range		
Storage temperature	-25...+85	℃
Operating temperature	-10...+40	℃
Load cell		
Impedance (complete bridge)	> 80	Ω
Connection	4 or 6 wires	
Load cell power supply	5 ± 5%	V_{DC}
Communication		
RS485/422 or RS232	Half and full duplex	
Adjustable communication speed	9600...115200	bauds
Can 2.0B	20 1000	kbauds
Logical inputs		
Number	2	
Type	Optocoupler	
Low level voltage	0...3	V_{DC}
High level voltage	9...28	V_{DC}
Current at high level	10mA @ 24V	
Insulation voltage	2500	Vrms
Logical outputs		
Number	2	
Type	Opto-insulated static relays	
Max current @ 40℃	0.4	A
Max voltage in open state	55	V
Resistance in ON state	2	Ω
Insulation voltage	2500	Vrms
Metrological characteristics		
Input signal range	7.8...500	mV/V
Typical temperature offset drift @ input signal range <7.8mV/V	1.5	ppm/℃
Typical slope temperature effect	2	ppm/℃
Max linearity error	0.003	%
A/D Conversion rate	1920...7.5	measurements/s
Programmable functions		
Acquisition of zero, tare, zero tracking		
Physical or theoretical calibration		
Slope correction		
Non-linearity correction		
Filtering		
Set points management		

2 INTERFACES:



2.1 Connection to the power supply:

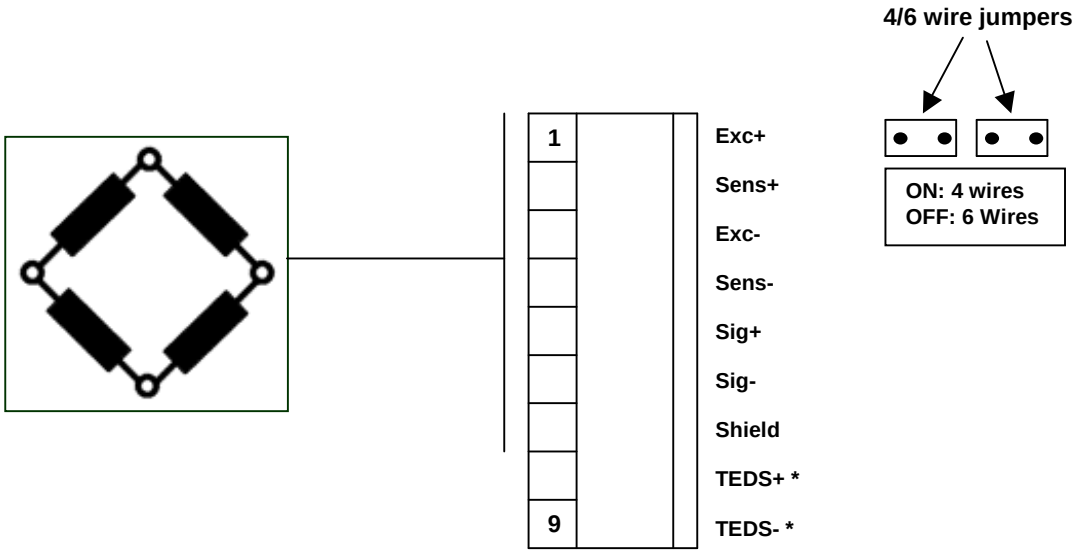


The *'POWER'* light shows whether or not the power supply is connected.

2.2 Connection to load cell(s):

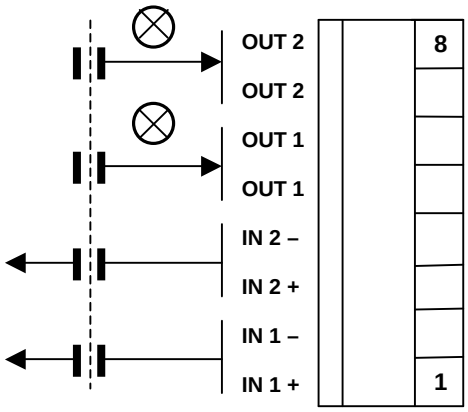
eNod3-C supplies power to the load cells (5 V_{DC}).
Up to four 350Ω load cells can be connected in parallel.
eNod3-C allows the use of 4- or 6- wire load cells.

- 4-wire load cells: jumpers in place.
- 6-wire load cells: jumpers removed.



* TEDS : Transducer Electronic Data Sheet. Comply with IEEE 1451.4 (under development)

2.3 Connection of Inputs & Outputs:

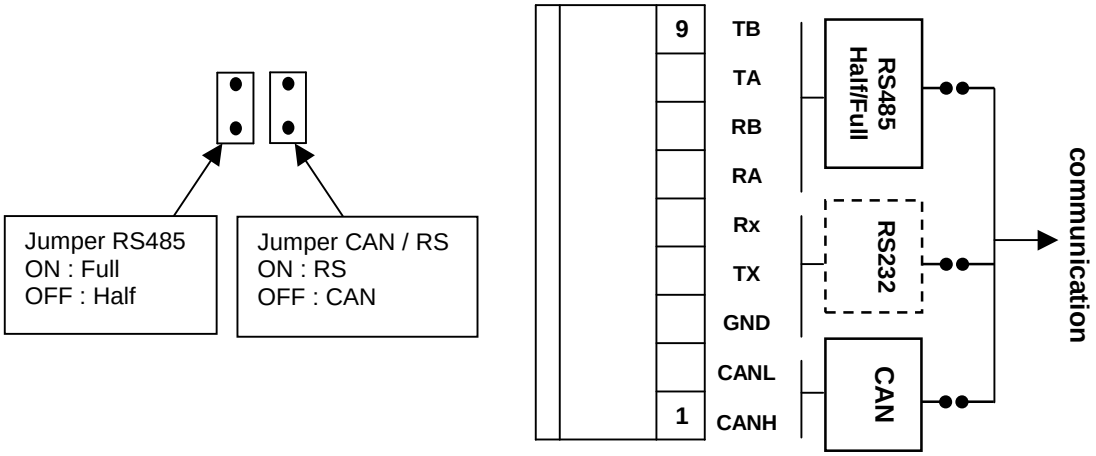


Characteristics of opto-insulated Inputs	
High level	9 - 28V_{DC} consumption 10mA @ 24V_{DC}
Low level	0 to 3 V_{DC}

Output characteristics (opto-insulated static relays)	
Max current @ 40°C	0.4A
Max voltage in the open state	55V
Resistance in the ON state	2 Ω
Insulation voltage	2500 Vrms

A light is assigned to each output.

3 COMMUNICATION INTERFACES:



eNod3-C is capable of communicating with an automatic control for each connection:

- **RS485/422**
- **RS232**

} jumper CAN/RS ON

- **CAN**

} jumper CAN/RS OFF

For an RS (485 or 422 or 232) communication, the jumper CAN / RS, must be in place (ON) (default case on delivery).
The connection to the ***RS485 / RS422*** interface is made through connections TA, TB and RA, RB connections on the 9-pin connector. (TA = direct transmission, TB = inverse transmission, RA = direct reception, RB = inverse reception)
For an ***RS485*** (half duplex) communication, make a connection between TA and RA and a connection between TB and RB, and remove the corresponding jumper. For an RS422 or RS485 full-duplex communication, the corresponding jumper must be in place (which is the default case on delivery).

The ***RS232*** interface is connected using the Tx, Rx and GND connections on the 9-pin connector.

For a ***CAN*** communication, the CAN / RS jumper must be removed (OFF). The ***CAN*** interface is connected using the CANH and CANL connections on the 9-pin connector.

4 COMMUNICATION:

eNod3-C can communicate using several protocols:
- ***ModBus RTU***
- ***SCMBus*** *standard* format or *fast* format.
- ***CANopen***

4.1 ModBus RTU:

See the description of the frames and functions in the '***ModBus RTU*** communication protocol' Ref. 165 704 document.

4.2 SCMBus:

See the description of the frames and functions in the '***SCMBus*** communication protocol' Ref. 165 706 document.

The ***SCMBus*** protocol is fairly similar to the ***ModBus*** protocol. It is basically of the master/slave type, however, measurements can be transmitted continuously without collision management on the line. This operating mode must be reserved for the transmitter mode.

The number of measurements/s depends on the communication speed, thus 100 measurements is impossible at less than 19200 bauds. For fast measurement transmissions, use the ***Fast SCMBus*** format, with which 1200mes/s at 115200 bauds can be expected.

Other methods of transmitting information without the master requesting the serial link:
- *Transmitter mode*: measurement transmission activated by an input.
- *Checkweigher mode*: automatic transmission of the measurement result.
- *Physical calibration process*: automatic transmission of information when a step in the process is complete.

When you want to change the communication protocol, send the corresponding command, memorize it in EEPROM, the new communication protocol will not be used until you do a Reset (hardware or software).
See an example of switching from ***ModBus-RTU*** protocol to ***SCMBus*** protocol in the document '***SCMBus*** Communication Ref 165 706' Appendix A.

4.2.1 Fast SCMBus format:

The ***Fast SCMBus*** format is particularly useful for measurement acquisitions at the highest frequency, for example, in order to analyse dynamic phenomena.
This format should only be used for point-to-point operation in full-duplex.
To optimize the speed, in addition to using the ***Fast SCMBus*** format, it is preferable to configure ***eNod3-C*** for operation with *'no processing transmitter'*. In this configuration, filters are inactive, set-points are not managed and there is no polynomial linearization.

4.3 CANopen

eNod3-C supports ***CANopen*** communication protocol and is compliant with **'CIA Draft Standard V301'**. See the description of the frames and functions in the '***CANopen*** communication protocol' Ref. 165 717 document.

5 CALIBRATION

5.1 Calibration types:

There are different possible calibration types (See examples in the documents: '**SCMBus** Communication' Ref. 165 706' Appendix A and '**ModBus RTU** Communication' Ref. 165 704 Appendix A):

- Physical calibration using the load cell through a known reference. This type of calibration can be done with 1, 2 or 3 known references.
- Theoretical adjustment by setting the load cell sensitivity and capacity.
- Correction of the initial calibration value.

5.2 Linearization correction:

For an installation with a non-linearity:

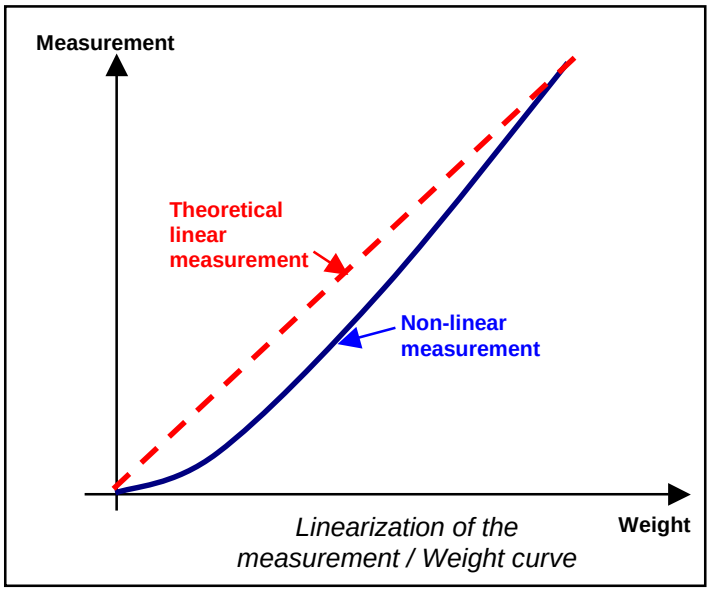


Fig. 1

The linearization formula is as follows:

$$\text{Corrected measurement} = \text{Meas} - A\,(\text{Meas})^2 - B(\text{Meas}) - C$$
$$\text{where Meas} = \text{Current measurement}$$

the coefficients A, B and C are defined using the ***eNodView*** software calculation tool.

6 INPUTS FUNCTIONING:

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

6.1 Assignment of inputs:

Function	Operating mode		
	Transmitter	Checkweigher	Peak control
none	●	●	●
tare	●	●	●
zero	●	●	●
transmit measurement	●		
measurement window	●		●
clear	●	●	●
start /allow new cycle		●	●
stop checkweigher cycle		●	
dynamic zero		●	

6.2 Functions independent of the operating mode:

- *none*: inputs are inoperative.

- *tare* : one or the other or both inputs may be assigned to the tare function.
The tare is affected by a stability criterion that can be parameter defined. The tare will be triggered on a rising or a falling edge, depending on the parameter defined logic (positive or negative).

- *zero*: one or the other or both inputs may be assigned to the zero function.
A new zero is only accepted if its value is within a ±10% range of the specifed maximum capacity. This zero value is the current zero value, and is cancelled following a reset. Stability and starting on a rising or falling edge (same as for tare control).

6.3 Functions specific to each operating mode:

See corresponding sections.

7 OUTPUTS FUNCTIONING:

Each output can function in positive or negative logic individually.

7.1 Assignment of outputs:

Function	Operating mode		
	Transmitter	Checkweigher	Peak control
set point	●	●	●
motion	●	●	●
defective measurement	●	●	●
checkweigher result available		●	
cycle in progress		●	●
inputs image	●	●	●
level on request	●	●	●

7.2 Functions independent of the operating mode:

- *set point:* outputs can be assigned to copying the state of set points. Output 1 is assigned to set point 1 and output 2 to set point 2.

- *motion*: outputs can be assigned to copying measurement stability.

- *defective measurement*: outputs can be assigned to copying measurement faults. These faults are also coded in the status word attached to the measurements. There are 4 of them:

  * outside converter range on the positive side.
  * outside converter range on the negative side.
  * outside capacity on the positive side.
  * outside capacity on the negative side.

- *inputs image*: outputs can be assigned to copying inputs, either using the same logic or inverting the state of the input (negative logic). Output 1 is assigned to input 1 and output 2 to input 2.

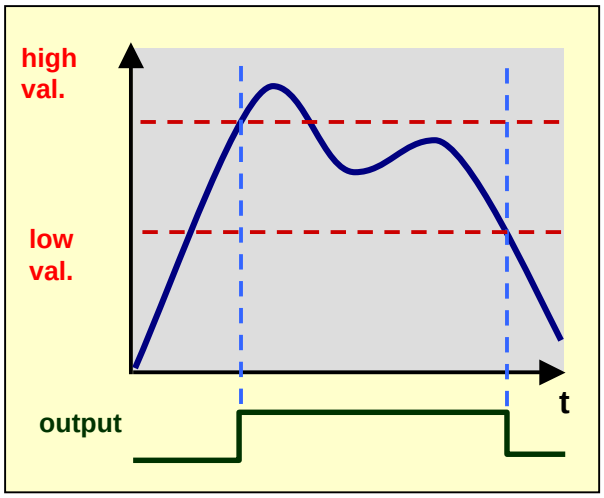
- *level on request:* outputs state is driven by master requests on the communication bus. The activation duration can be modified.

7.3 Functioning specific to each operating mode:

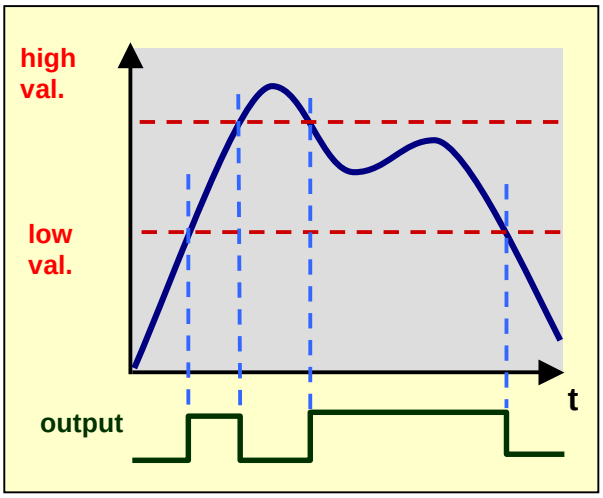
See corresponding sections

8 SET POINTS:

Set points are characterized by a high value and a low value. The operating mode is either ***operation in hysteresis***, or ***operation in window.***



Functioning in hysteresis
Fig. 2



Functioning in window
Fig. 3

The values of these set points may be assigned either to:

- **gross measurement** regardless of the functionning mode
- **net measurement** regardless of the functionning mode
- **maximum value** in peak control mode
- **minimum value** in peak control mode
- **peak-to-peak value** in peak control mode
- **result** in checkweigher mode
- **running total** in checkweigher mode

9 FILTERS:

There are four available filtering levels:

* filtering related to the A/D conversion rate including rejection of the mains frequency (50 or 60 Hz) harmonics.
* 2^{nd}, 3^{rd} or 4^{th} order low-pass Bessel/Butterworth filter
* 2^{nd} order band-stop filter
* self-adaptive filter

- ***Filtering related to the A/D conversion rate :*** the signal resolution is related to the conversion rate. The conversion rate might be choosen 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 appropriate filter values.
Choose a measurement rate that rejects the mains frequency harmonics according to the place of use, 50 or 60Hz.

- ***Bessel or Butterworth type low pass filter :*** a low-pass digital filter can be applied as an 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 conversion rate, the wanted cutt-off frequency and on the choosen order. These coefficients can be easily calculated by ***eNodView*** software.

- ***Band-stop filter :*** a 2^{nd} order band-stop 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 conversion rate and the wanted cutt-off frequencies (that means the frequency band width). These coefficients can be easily calculated by ***eNodView*** software.

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

10 TRANSMITTER FUNCTIONING MODE:

This basic operating mode consists of transmitting measurements on the bus, possibly after configuring them, filtering them and comparing them with set-points levels. Measurements can be transmitted individually regardless of the communication protocol or continuously at a defined period in the ***SCMBus*** (standard or fast format) and ***CANopen*** protocols. Functionning may be unipolar or bipolar.

10.1 Request to read measurement by serial link command:

10.1.1 Single measurement transmission:

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

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

10.1.2 Continuous measurements transmission:

This is only possible using the ***SCMBus*** standard format or fast format protocol. The transmission can be started by a serial command and another one allows stopping it.
The request can apply to:

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

Note: This operation is similar to operation of the *'Measurement window'* through an input command.
The ***CANopen*** protocol also allows to define a period at which measurements are sent on the bus without any master request.

10.2 Specific commands through an input:

10.2.1 Transmit measurement

This is only possible using the ***SCMBus*** (standard format or fast 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 on the input signal (fig 4).

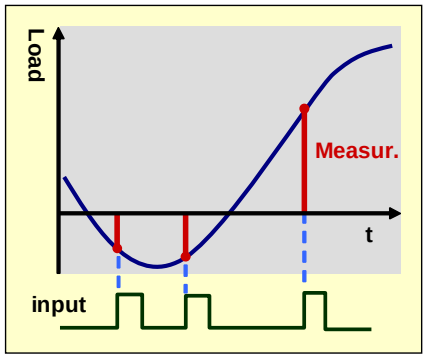


Fig. 4

10.2.2 Measurement window

This is only possible using the ***SCMBus*** (standard or fast format) protocol.
The request can apply to:

- gross measurement.
- net measurement.
- measurement in A/D counts.

A series of measurements is transmitted at the period defined by the *'output measurement period'* setting while the input is kept at the corresponding level (Fig 5). Only input 2 is operational if both inputs are assigned to this function.

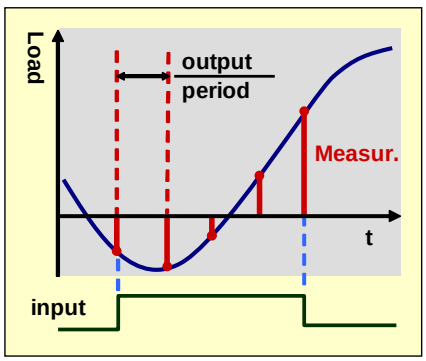


Fig. 5

10.2.3 Clear

Cancels last tare value (same functioning as the *'Cancel tare'* command).

11 CHECKWEIGHER FUNCTIONING MODE:

This functionning mode consists of determining the weight of an object while it is present on a conveyor portion on which a weighing system is fitted (Fig 6).
Note: The measurement is determined for net measurements only.

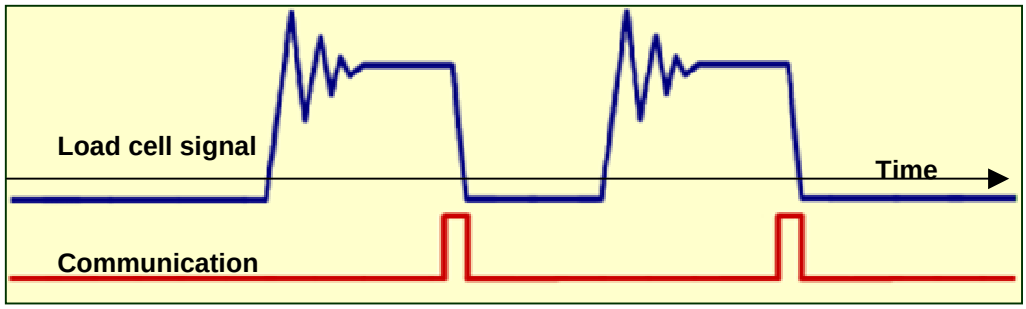


Fig. 6

11.1 Determination of the weight:

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

- by an input assigned to *'start checkweigher cycle'* (Fig. 7 & 8). Caution, only input 2 is operational if both inputs are assigned to the *'start checkweigher cycle'* function.
- by a trigger level (Fig. 9) when the load cell signal reaches the specified value.

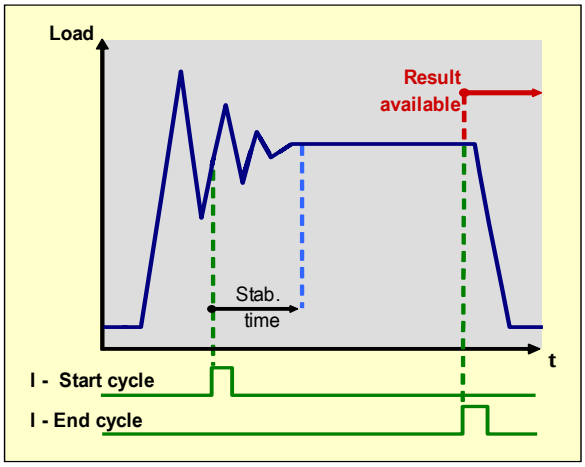


Fig. 7

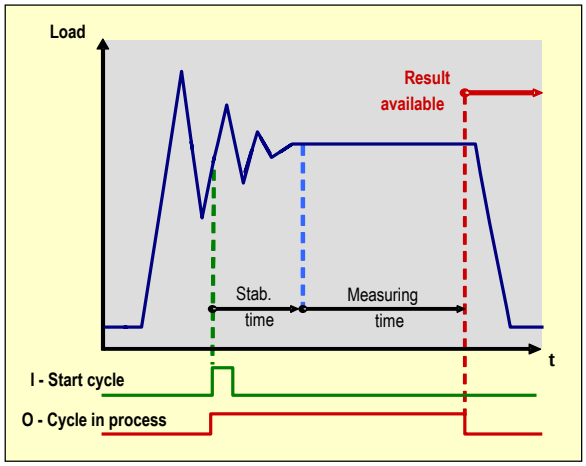


Fig. 8

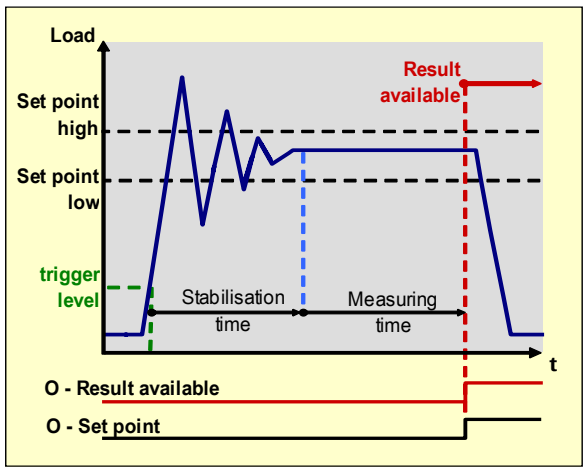


Fig. 9

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

- a time value.
- a duration prior to an edge on an input assigned to '*stop checkweigher cycle*' (Fig.8).
  Caution, only input 2 is operational if both inputs are assigned to the *'stop checkweigher cycle'* function.

eNod3-C automatically calculates a result corresponding to the object weight. This result value may be weighted by a coefficient. Each cycle is counted and the following statistical datas 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).

11.2 Providing the result value :

11.2.1 Outputs synchronization:

Two specific functions may be assigned to ***eNod3-C*** logical outputs so as to synchronize the result reading:

- *'cycle in prorgress'*: this function causes the output to be set active from the beginning to the end of the cycle (at the end of the *'measuring time'* or when a '*stop checkweigher cycle'* input is activated).
- *'checkweigher result available'*: this function causes the output to be set active when a cycle is complete. In **ModBus** and **CANopen** protocols, it remains in this state until the beginning of a new cycle or until a *'clear'* request. In **SCMBus** protocol, the output state changes when it is read.

11.2.2 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.

11.2.3 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.

11.2.4 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.
- The result transmission can be triggered in different ways. It depends on the choosen trigger event (see document Ref. 165 717).

11.3 Management of Set-points:

Outputs may be assigned to the set-point function. Set-points are triggered by the measurement result (fig. 3). 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).

11.4 Dynamic zero

If an input assigned to the *'dynamic zero'* function is activated or if a *'dynamic zero'* command is received, ***eNod3-C*** 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.

11.5 Checkweigher zero automatic correction

eNod3-C also provides an automatic zero tracking for dynamic applications. It allows to follow the evolution of the zero in checkweigher functioning mode, for example on a conveyor belt on which there is some product accumulation

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

When this function is enabled, an average value is calculated if comprised within a configurable interval around the calibration zero. This calculation is inhibited during the weighing period and gives a virtual zero that is substracted from the theoretical checkweigher result so as to give the final checkweigher result that is updated at the end of the item passage.

12 PEAK CONTROL FUNCTIONING MODE:

This operating mode consists of determining the maximum value (Max), the minimum value (Min) and the difference between Max and Min (Peak-to-peak) of the current net signal.

Peak control operation may be used in unipolar or bipolar (tension/compression load cells).

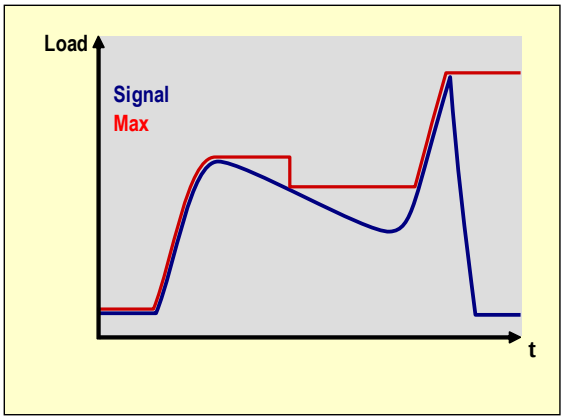


Fig. 10

12.1 Non-triggered functioning:

No cycle management, Max, Min and Peak-to-peak values are detected permanently.

A '*clear*' command, either through a serial link or through an input, sets the Max and Min values to the net current value and the Peak-to-peak value to zero (Fig. 11).

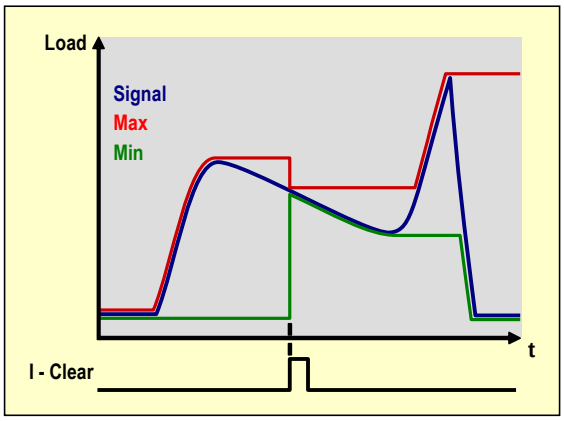


Fig. 11

12.2 Triggered functioning:

A cycle is managed. It can be started:
- through an input assigned to a *'measurement window'* (Fig. 13)
- through a trigger level (Fig. 12)
- through a '*start cycle'* command.
- through one of the options described above following an edge on an input assigned to the '*allow new cycle' function'*.

The cycle stops at the end of the *'measuring time'* (Tm).
The trigger level is not taken into account if an input is assigned to the '*measurement window'* function. Regardless of the operating mode, the *'clear'* command sets the Max and Min values to the net current value and the Peak-to-peak value to zero.

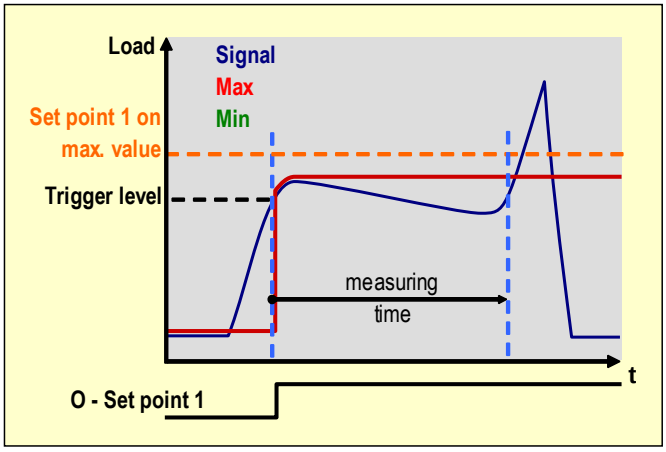


Fig. 12

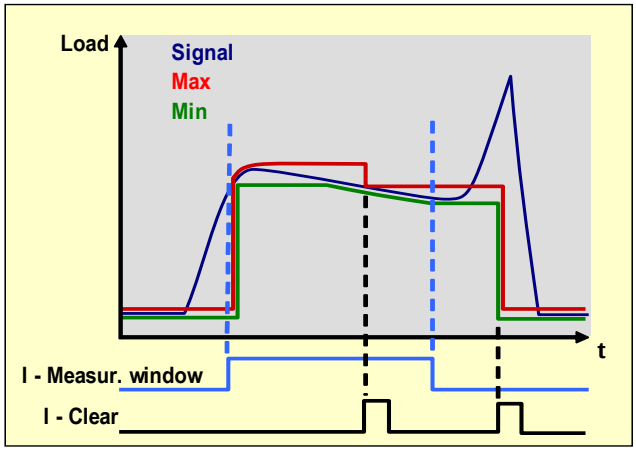


Fig. 13

12.3 Management of Set-points:

Outputs can be assigned to the set-point function (Fig. 12). Set-points can be assigned with either Max or Min or Peak-to-peak values or to the gross or net measurement.

12.4 Other possible assignments of outputs:

- *cycle in progress*.
- *defective measurements*.