Characteristics and functioning

eNod4-B

Digital Process Transmitter

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1 ENOD4 PRODUCT RANGE

1.1. General presentation

eNod4 is a high speed digital process transmitter with programmable functions and powerful signal processing capabilities. ***eNod4*** offers operating modes for advanced process control both static and dynamic.

Quick and accurate:

- Analog to digital conversion rate up to 1920 meas/s with maximum scaled resolution of ±500 000 points.
- Digital filtering and measurement scaling.
- Measurement transmission up to 1 000 meas/s.

Easy to integrate into automated system:

- **USB**, **RS485** and **CAN** communication interfaces supporting ***ModBus RTU***, ***CANopen®*** and ***PROFIBUS-DPV1*** (depending on version) communication protocols.
- Digital Inputs/Outputs for process control.
- Setting of node number by rotary switches and communication baud rate by dip switches.
- Integrated selectable network termination resistors.
- Wiring by plug-in terminal blocs.

1.2. Versions and options

1.2.1 Versions

- Strain gauges load-cell conditioner with ***CANopen®*** and ***ModBus RTU*** communication.
- Strain gauges load-cell conditioner with ***Profibus DP-V1*** and ***ModBus RTU*** communication.
- Strain gauges load-cell conditioner with ***Modbus TCP*** and ***ModBus RTU*** communication.
- Strain gauges load-cell conditioner with ***EtherNet/IP*** and ***ModBus RTU*** communication.
- Strain gauges load-cell conditioner with ***Profinet IO*** and ***ModBus RTU*** communication.
- Strain gauges load-cell conditioner with ***EtherCAT*** and ***ModBus RTU*** communication.

EDS, GSD, ESI and GSDML configuration files for above protocols can be downloaded from our web site: http://www.scaime.com

1.2.2 IO+ Option

Available in option, ***eNod4*** supports an opto-insulated analog board with:

- 2 additional digital inputs and 1 speed sensor dedicated input.
- 0/5V or 0/10V analog output voltage.
- 4/20mA, 0/24mA, 0/20mA or 4/20ma with alarm at 3.6mA analog output current.

1.3. eNodView Software

So as to configure ***eNod4***, SCAIME provides eNodView software tool. ***eNodView*** is the software dedicated to eNod devices and digital load cell configuration from a PC. This simple graphical interface allows accessing the whole functionalities of ***eNod4*** for a complete setting according to the application.

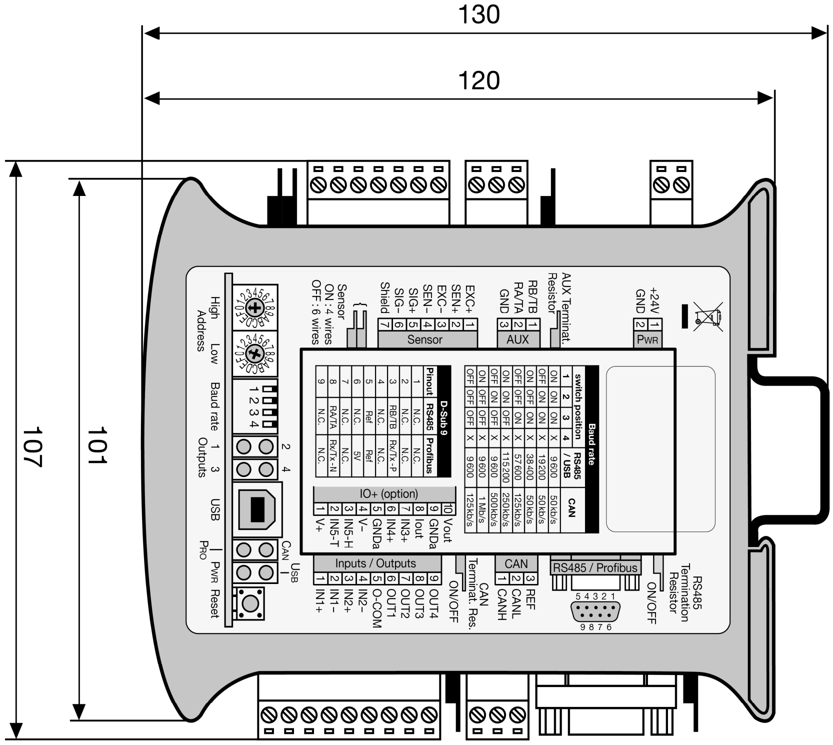
eNodView features and functions :

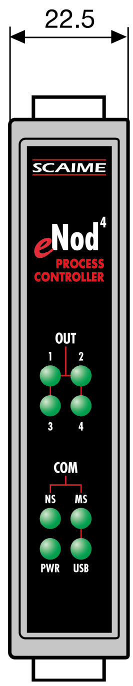
- eNod4 control from a PC
- Calibration system
- Modification/record of all parameters
- Measure acquisition with graphical display
- Numerical filters simulation
- Frequential analysis FFT
- Process control
- Network parameters

eNodView software is available in English and French version and can be downloaded from our web site: http://www.scaime.com or ordered to our sales department on a CD-ROM support.

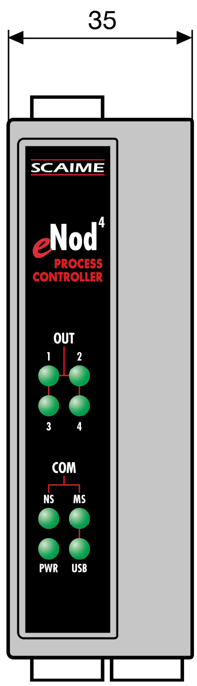
2 GENERAL CHARACTERISTICS

2.1. Dimensions





Standard version



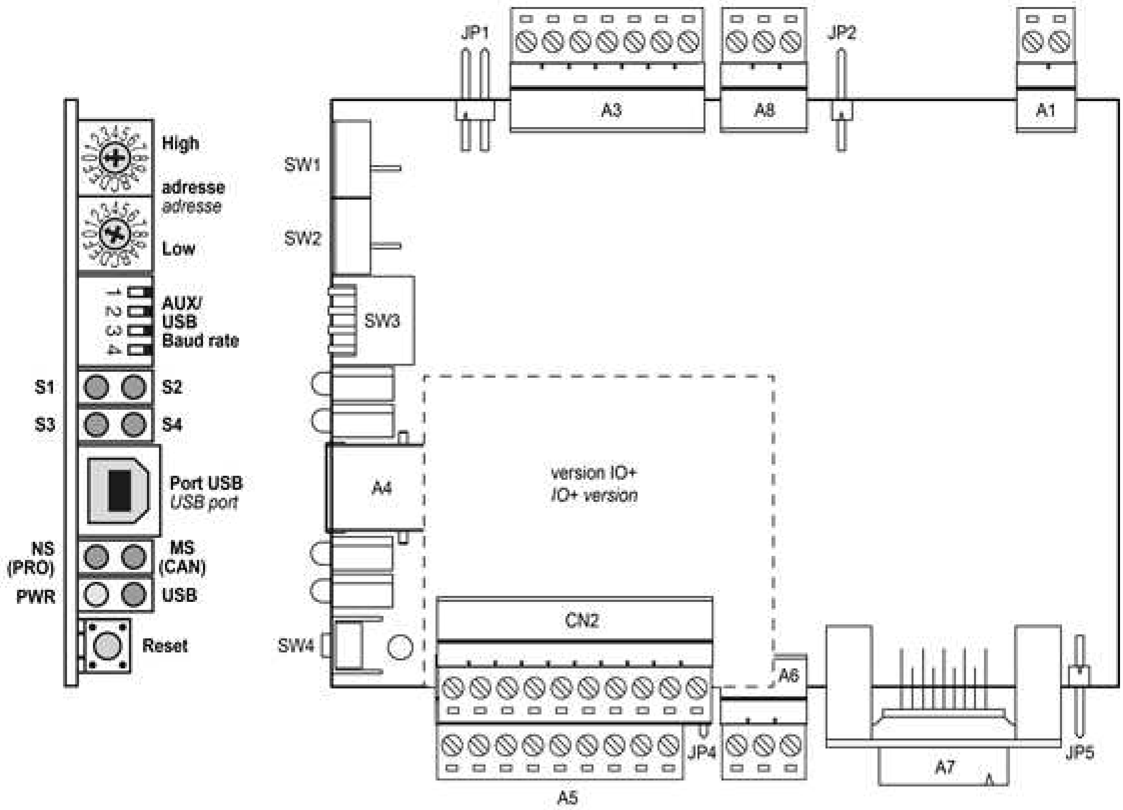
Profibus version

2.2. Characteristics

Power supply		Unit
Supply voltage	10.....28	V_{DC}
Max supply power (without any option)	2.2	W
Additional max supply power (with Profibus option)	1.2	W
Additional max supply power (with IO+ option)	3	W
Temperature range		
Storage temperature range	-25...+85	°C
Working temperature range	-10...+40	°C
Load cell sensor		
Minimum input resistance	> 43	Ω
sensor connection	4 or 6 wires	
Bridge excitation voltage	5	V_{DC}
Communication		
RS 485	Half-duplex	
Rate	9 600...115 200	bauds
CAN 2.0A	50....1000	kbits/s
PROFIBUS DP	9,600...1200	kbits/s
Logical inputs		
Number	2(+2 with IO+ option)	
Type	opto-insulated type 3	
Low level voltage-current	0 / 5 VDC – 0 /1.5 mA	
High level voltage-current	11 / 30 VDC – 2 / 9 mA 7 mA @ 24VDC	
Logical outputs		
Number	4	
Type	solid state relay	
Max. current @ 40°C	0,4	A
Max. voltage in open state	53 V_{DC} or 37 V_{AC}	
Max resistor in close state	2	Ω
Metrological specifications on A3 connector input (load-cell type sensor)		
Input sensor range for a load cell sensor	±7.8	mV/V

Thermal zero drift typical	*1.5*	*ppm/°C*
Thermal span drift typical	*2*	*ppm/°C*
Linearity deviation	*0.003*	*% FS*
Conversion rate	*6.25 ... 1920*	*meas./s*
Metrological specifications on analog output (IO+ option)		
Output voltage range	*0-5 or 0-10*	*V*
Output current range	*4-20, 0-24 ou 0-20*	*mA*
Max. load on current output	*500*	*Ohm*
Outputs resolution	*16*	*bit*
Max. linearity error	*1*	*LSB*
Total error	*+/- 0.07*	*%FSR*
Thermal zero drift typical	*+/- 2*	*ppm/°C*
Thermal span drift typical	*+/- 3*	*ppm/°C*
Conversion rate	*A/D converter rate value*	*Hz*
Speed sensor power-supply (IO+ option)		
Bridge excitation voltage (V+ …V-)	*12.5 +/- 2*	*V*
Bridge excitation current	*30*	*mA*
Isolation	*1000*	*V*
Speed sensor input (IO+ option)		
IN5 HTL	*0…2.5 / 5…30*	*VDC*
IN5 TTL	*0…0.5 / 2.4…5*	*VDC*
Isolation	*1000*	*V*

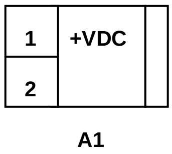
3 CONNECTIONS



Repère *Mark*	Fonction *Function*	
A1 alimentation *power supply*	*1*	*$+V_{DC}$*
	2	*GND*
A3 **connexion capteur** *load cell connection*	*1*	*Exc+*
	2	*Sens+*
	3	*Exc-*
	4	*Sens-*
	5	*Sig+*
	6	*Sig-*
	7	*Shield*
A4	*USB*	
A5 **entrées/sorties** *IN / OUT*	*1*	*IN1+*
	2	*IN1-*
	3	*IN2+*
	4	*IN2-*
	5	*OUT_{COM}*
	6	*OUT1*
	7	*OUT2*
	8	*OUT3*
	9	*OUT4*
SW1	Sélecteur Adresse haute (hex) *High Address selector (hex)*	
SW2	Sélecteur Adresse basse (hex) *Low Address selector (hex)*	
SW3	Sélecteur Baud rate AUX/USB *Aux/USB Baud rate selector*	
SW4	bouton poussoir Reset *reset push button*	
S1-S2-S3-S4	LED sorties logiques *outputs LED*	

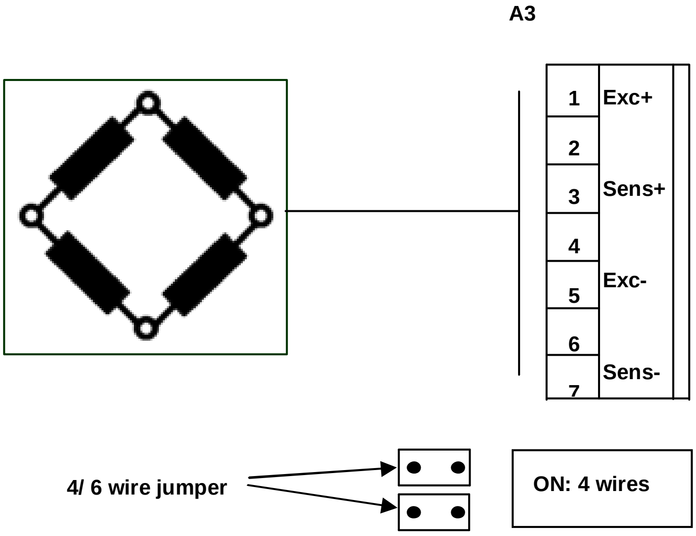
Repère *Mark*	Fonction *Function*	
A6 **connexion bus CAN** *CAN bus connection*	*1*	*CANH*
	2	*CANL*
	3	*REF_{COM}*
A7	RS485 Automate (DB9) *RS 485 PLC (DB9)*	
A8 **connexion AUX** *AUX connection*	*1*	*RB/TB (B-)*
	2	*RA/TA (A+)*
	3	*GND*
CN2 **Connexion IO+** *IO+ connection*	*1*	*V+*
	2	*IN5-TTL*
	3	*IN5-HTL*
	4	*V-*
	5	*GNDA*
	6	*IN4+*
	7	*IN3+*
	8	*Iout*
	9	*GNDA*
	10	*Vout*
JP1	Câblage capteur 6 fils / 4 fils *6-wire / 4-wire loadcell wiring*	
JP2	Résistance de terminaison *connexion AUX* *AUX connection termination resistor*	
JP4	Résistance de terminaison *connexion CAN* *CAN connection termination resistor*	
JP5	Résistance de terminaison *connexion RS485* *RS485 connection termination resistor*	
NS(PRO) / NS(CAN)	LED RS485 & Profibus / CAN *RS485 & Profibus / CAN LED*	
PWR-USB	LED alimentation & activité USB *power supply & USB activity LED*	

3.1. Power supply connection



On the front panel a green light *'PWR'*, (D7) indicates if power is connected.

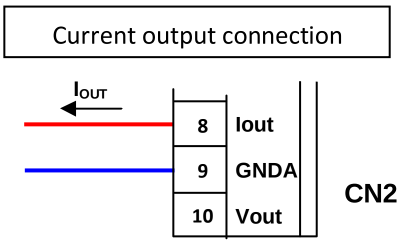
3.2. Load-cell wiring

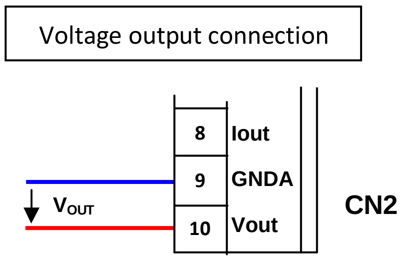


- **4 wires load-cell**: jumpers in place (by default at delivery).
- **6 wires load-cell:** jumpers removed

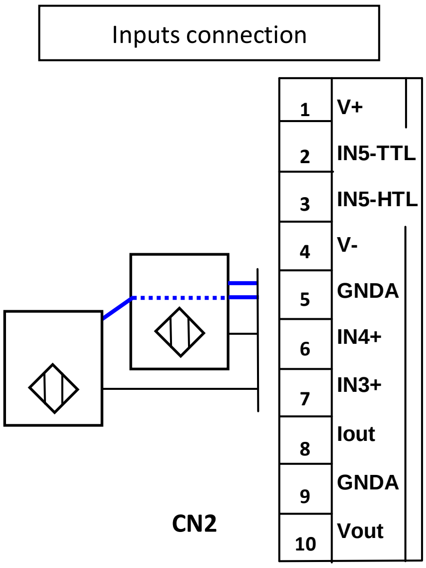
3.3. IO+ option

An optional analog board in current and voltage might be used with ***eNod4*** to provide IO+ option. This has to be requested when ordering ***eNod4*** product. The analog output is both current and voltage galvanically isolated at 1000V.
Voltage output might be set either 0/5V or 0/10V, and the *current output* to 4/20mA, 0/24mA, 0/20mA or 4/20mA alarm 3.6mA. It is software setting and both output (current and voltage) might separately be enable.

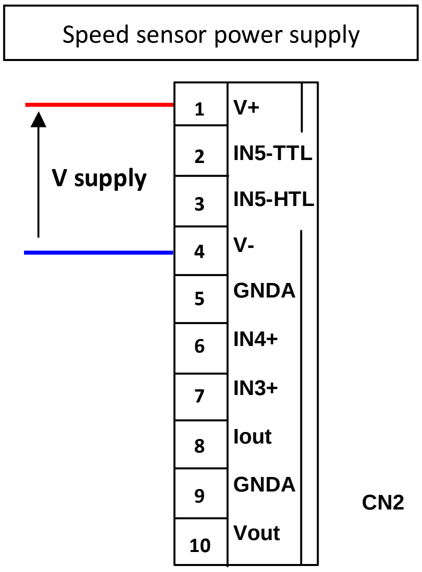


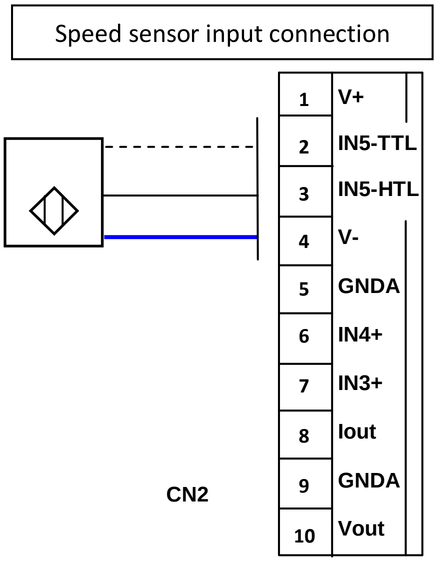


The IO+ version is fitted with two additional inputs IN3 and IN4:

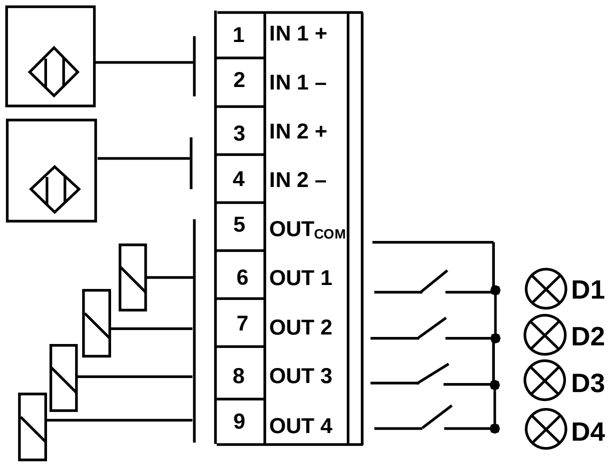


The IO+ version is fitted with a pulse input and a dedicated power supply for a speed sensor (belt weigh feeder, belt weigher). Two input voltage levels are proposed for the pulse input of the speed sensor: TTL logical level or high voltage 30 V maxi level.



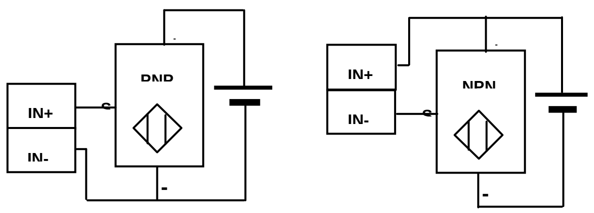
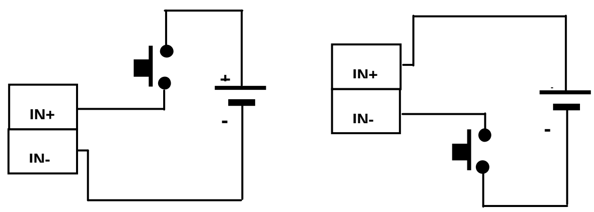


3.4. Inputs / outputs connections

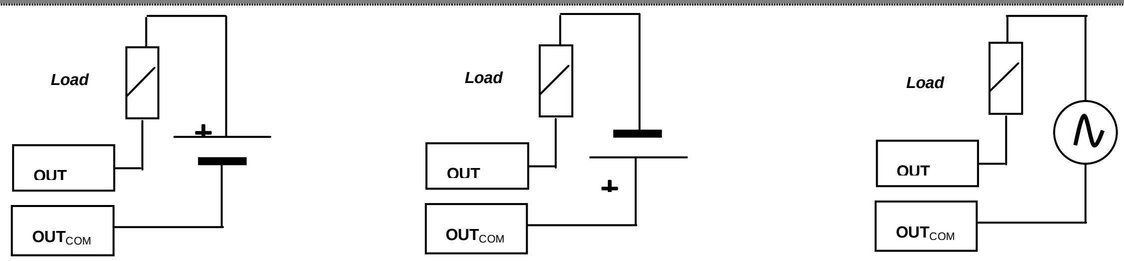


An indicator light in front panel is assigned to each Output.

3.4.1. Typical connections

Inputs : Connection to a detector	*Inputs : Connection to a push button*
	

Outputs : Possible connections



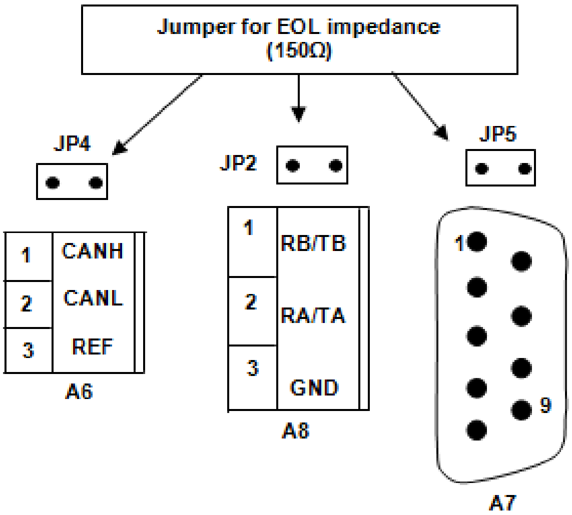
4 COMMUNICATION

4.1. Communication Interface connections

4.1.1 Process control communication

Version	*Type of communication*	*Connector*
eNod4 DIN	*RS485 Automate*	*A7*
	CAN	*A6*
eNod4 PRO DIN	*Profibus DP*	*A7*

- **Note:** For a better transmission quality on a RS485 or CAN communication network it must be wired to follow a line topology and must be terminated by an end of line (EOL) impedance at both ends. A 150Ω EOL impedance is available on ***eNod4***. To use this impedance set the corresponding jumper.



A7		
Pin	**RS485 ModBus RTU / SCMBus**	**Profibus * DP-V1**
1	N.C	N.C
2	N.C	N.C
3	RB / TB	Rx/Tx - P
4	N.C	N.C
5	Ref	Ref
6	N.C	5V
7	N.C	N.C
8	RA / TA	Rx/Tx - N
9	N.C	N.C

The ***PROFIBUS*** communication terminal is electrically isolated from power supply (isolation voltage: 1000V)

In PROFIBUS communication jumper JP5 must be removed. When ***eNod4*** is positioned at the end of the line, use specific connector DB9 for PROFIBUS with end of line resistor and bias resistors incorporated.

CAN communication is not electrically isolated from power supply. Admitted common voltage on CANBUS is ±27V from 0V power supply. Depending on installation configuration, the usage of opt couplers or other galvanic isolation devices is strongly recommended.

- ***Note****: If multiple elements connected to the CAN bus are using power supplies with different reference levels (0V); the problem mentioned above can occur.*

The data rate that can be transmitted on different buses depends on the length of the bus. The table below shows what are the transmission rates supported by eNod4 and the corresponding maximum bus length:

CAN bus		Profibus bus		
data rate	**max bus length**	**data rate**	**max bus length**	**data rate**
1 Mbit/s	*25 m*	***12 Mbit/s***	*100m*	**-**
800 kbit/s	*50 m*	***3 Mbit/s***	*100m*	**-**
500 kbit/s	*100 m*	***1.500 Mbit/s***	*200m*	*70m*
250 kbit/s	*250 m*	***500 kbit/s***	*400m*	*200m*
125 kbit/s	*500 m*	***187.5 kbit/s***	*1000m*	*600m*
50 kbit/s	*1000 m*(1)	***93.75 kbit/s***	*1200m*	*1200m*
		9.6 kbit/s	*1200m*	*1200m*

(1) For buses whose length is greater than 5000 m, the use of repeater type systems may be necessary to ensure the quality of transmissions.

(2) The network speed is set by the PROFIBUS master. ***eNod4 PRO DIN*** performs self-adjustment.

(3) Type A cable: AWG 22, impedance: 135 to 165Ω.

(3) Type B cable: AWG 24, impedance 100 to 130Ω.

4.1.2 PC communication

Both models: **eNod4 DIN** and **eNod4 PRO DIN** can communicate with a PC using the protocols **ModBus RTU** or **SCMbus** through the **USB** connector accessible from the front panel.

USB Communication stops AUX communication when used.

The appropriate **USB** driver can be downloaded from our website: http:// www.scaime.com, it is also available on CD to order from our sales department.

- **Note:** If **eNodView** software has been correctly installed, it is not necessary to re-install the **USB** drivers when connecting another **eNod4** on the same **USB** port (Windows only asks for the driver if the device is connected to another **USB** port).

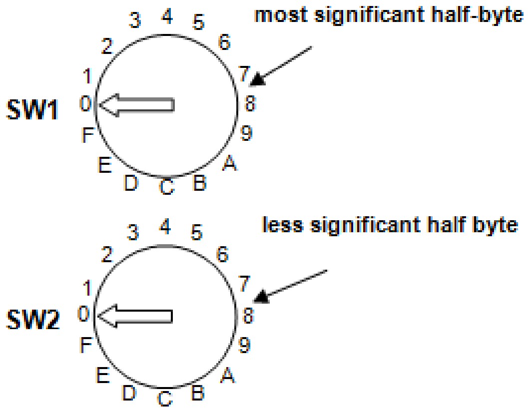
4.1.3 AUX Communication (for HMI)

AUX ***eNodTouch*** HMI must be connected through connector **AUX**(A4). The common mode voltage admitted is ± 27VDC from GND power supply.

When ***eNod4*** is positioned at the end of the line the 150 Ω integrated resistor can be used (connecting jumper).

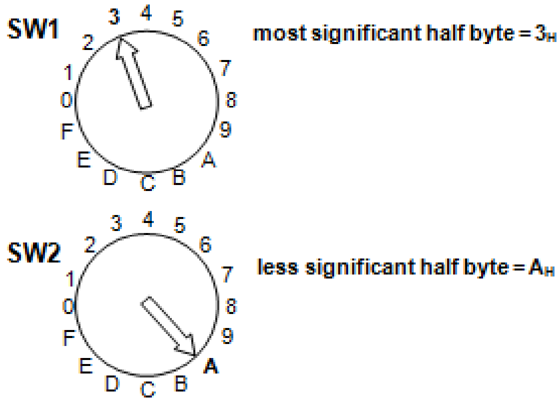
4.2. Communication address selection

Rotary switches selection (SW1 and SW2) accessible from the front panel. **The new address only is taken into account after a reset.**



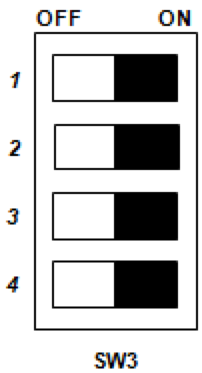
- **Example**

eNod4 address = $3A_H = 58_d$



4.3. Communication rate selection

Dipswitch selection (SW3) is accessible from the front panel**. The new baud rate only is taken into account after a reset.**



Dipswitch				RS485 and USB Baud rate	CAN Bit rate
1	2	3	4		
ON	ON	ON	X	9600	50 kbit/s
OFF	ON	ON	X	19200	50 kbit/s
ON	OFF	ON	X	38400	50 kbit/s
OFF	OFF	ON	X	57600	125 kbit/s
ON	ON	OFF	X	115200	250 kbit/s
OFF	ON	OFF	X	9600	500 kbit/s
ON	OFF	OFF	X	9600	1 Mbit/s
OFF	OFF	OFF	X	9600	125 kbit/s

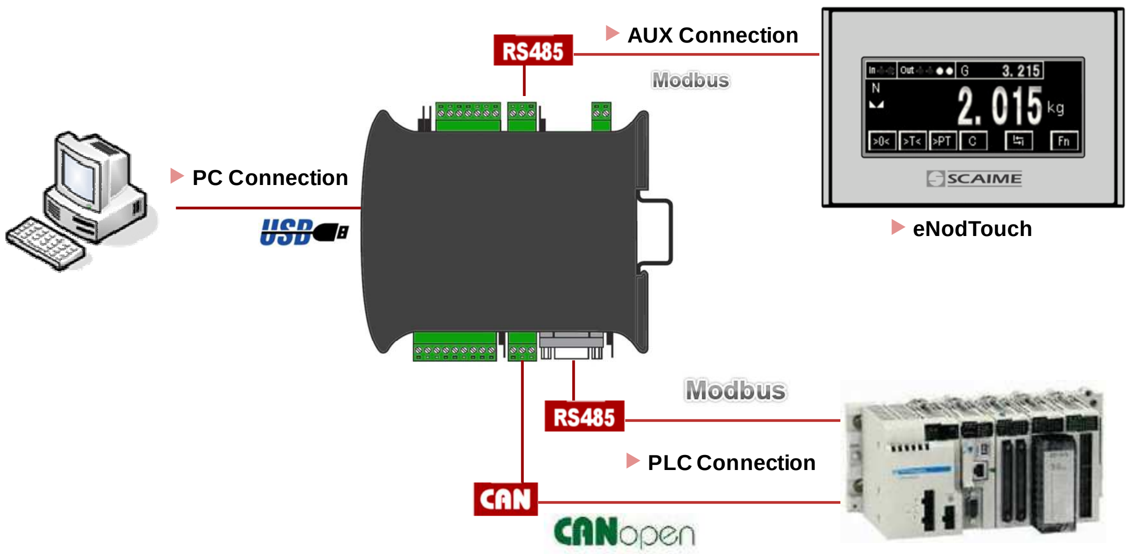
4.4. Protocoles de communication

Version	Communication interface	Protocols*	Connector	LED on front panel
eNod4 DIN	RS485 PLC	ModBus RTU	A7	/
	RS485 AUX	ModBus RTU SCMBus	A8	/
	USB	ModBus RTU SCMBus	USB Front panel	USB
	CAN	CANopen®	A6	MS
eNod4 PRO DIN	Profibus	Profibus DP-V1	A7	NS
	USB	ModBus RTU SCMBus	USB Front panel	USB

* See protocols description in document: ***eNod4 software user manual.***

4.5. Simultaneous functioning of communications

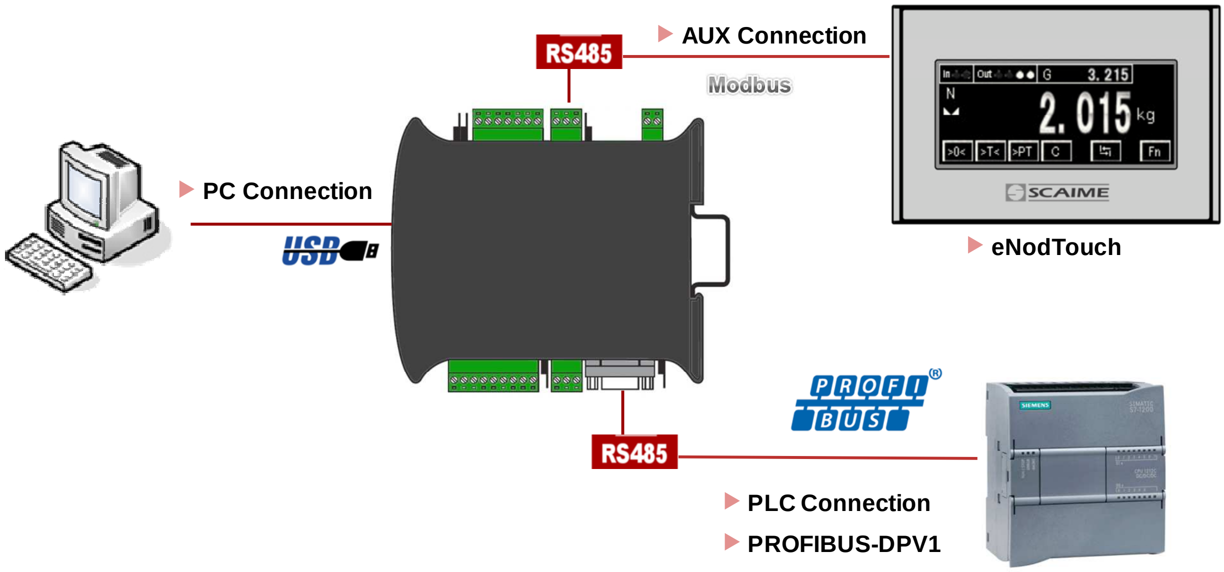
4.5.1 Standard version



Simultaneous communication	RS 485 PLC	RS485 AUX	CAN
USB	yes*	No	yes*
RS 485 PLC		yes	No
RS485 AUX			yes**

(*) Simultaneous use of CAN or RS485 PLC with USB port can reduce performance of this interface.
(**) In this configuration, we recommend a low speed rate on AUX output.

4.5.2 Profibus version



Simultaneous communication	Profibus	RS485 AUX
USB	yes*	No
Profibus		yes**

(*)*Simultaneous use of Profibus with USB port can reduce performance of this interface.*
(**) *In this configuration, we recommend a low speed rate on AUX output.*

5 CALIBRATION AND SCALE ADJUSTMENT

eNod4 is factory calibrated to deliver **500 000 counts for 2mV/V** with a load cell on the **A3** input connector.

Initial calibration can be modified for a better adjustment to the usage or because of characteristics of the sensor. To achieve these various types of adjustments the following options and procedures are available:

- physical calibration
- theoretical calibration
- scale adjustment coefficient
- gravity correction

5.1. Physical calibration

Physical calibration is done by applying to the sensor **from 1 up to 3 known references**.

5.2. Theoretical calibration

The theoretical calibration allows defining ***eNod4*** user span **without using calibration reference**. The information needed to achieve the procedure is **the sensor sensitivity and its rated capacity**.

For example a 15kg load cell with sensitivity equal to 1.870 mV/V at 15kg; put sensor maximum capacity 15 000 and sensor sensitivity 1,870.

5.3. Scale adjustment coefficient

Initial calibration value can be modified with a scale adjustment coefficient. This coefficient has maximum and minimum values.

5.4. Gravity correction

When ***eNod4*** is used to condition a weighing sensor, it can be necessary to adjust measurement if the place of measurement is different from the place where ***eNod4*** was calibrated. ***eNod4*** automatically adapts its span by storing into its non-volatile memory these 2 parameters: 'Calibration place g value' and 'Place of use g value'. Initial values for these coefficients are identical; they correspond to the g value of a calibration place located in ANNEMASSE FRANCE.

5.5. Scale interval

The scale interval is the difference between 2 consecutives indications. Possible values are: 1, 2, 5, 10, 20, 50, and 100.

Modification of scale interval is taking into account after a new calibration.

6 FILTERS

There are four available filtering levels which can be associated:

- Filtering **related to the A/D conversion rate** including rejection of the mains frequency (50 or 60 Hz) harmonics.
- Low-pass Bessel filter
- Notch filter
- Moving average filter

6.1. Filtering related to the A/D conversion rate

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 appropriate filter values. Choose a measurement rate that rejects the mains frequency harmonics according to the place of use, 50 or 60Hz.

6.2. Bessel low pass filter

A low-pass digital filter can be applied as an output of the A/D converter. The filter orders (available values are 2 or 3) and cut-off frequency are adjustable. ***eNodView*** software can be used to determine appropriate filter values.

6.3. Notch filter

A notch filter might be applied as an output of the low-pass filter (if used) or the A/D converter. It allows attenuating the frequencies within a band defined by high and low cut-off frequencies. The ***eNodView*** software can be used to determine appropriate filter values.

6.4. Moving average filter

This filter can be set in cascade after the previous filters. The Moving average filter is used to smooth the weight value in case of random interferences. This sliding average computes the mean of the ‘n’ last measures from the results of the previous activated filters. A high filter depth gives a better stability, with a longer response time.

7 INPUTS FUNCTIONING

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

7.1. Inputs assignment:

Function	*Operating mode*		
	transmitter	***Belt scale***	***Belt weigh feeder***
none	●	●	●
tare	●	●	●
cancel tare	●	●	●
zero	●	●	●
transmit measurement	●		
measurement window	●		
dynamic zero		●	●
Start/Stop		●	●
Belt running detection		●	●
Clear totalization and dosing error counter		●	●
Sensor input control	●	●	●

7.2. General functions

7.2.1 None

Inputs have no effect.

7.2.2 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.

7.2.3 Cancel tare

Depending on the chosen logic (positive or negative), the current stored tare value is erased by a rising or a falling edge.

7.2.4 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 and ±2% for legal for trade application. The zero acquisition is conditioned by a stability criterion that can be changed or inhibited.

Depending on the chosen logic (positive or negative), the zero is triggered by a rising or a falling edge.

7.2.5 Transmit measurement

This is only possible using standard or fast SCMBus format or CANopen® protocols.

The request can apply to:

- gross measurement.
- net measurement.
- factory calibrated measurements

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

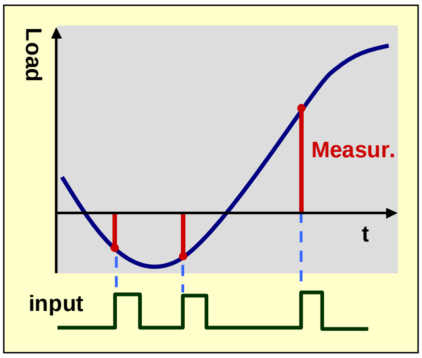


Fig. 7

7.2.6 Measurement window

This is only possible using ***standard or fast SCMBus***.

The request can apply to:

- Gross measurement.
- Net measurement.
- Factory calibrated measurements.

While the input is kept at the right level, a series of measurements are transmitted at the period defined by the *'sampling period'* setting. Only input 2 is operational if both inputs are assigned to

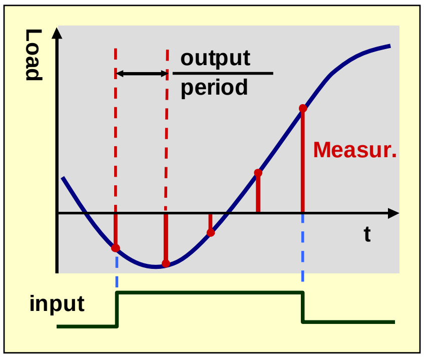


Fig. 8

7.2.7 Sensor input control

The assignment of logical input to sensor input control function allows performing special procedure to diagnose load cell sensor input. Beforehand, user must acquire reference value of the load cell input by sending '*Sensor input control reference*' specific command (e.g. after the device is calibrated).

Note: Load cell sensor input control must be realized if no dosing cycle is in progress.

7.3. Functions attached to an operating mode:

See corresponding sections for a complete description.

8 OUTPUTS FUNCTIONING

Each output can work individually in its own logic.

8.1. Outputs assignment:

Outputs individually might be assigned to following functions:

function	*Operating mode*		
	transmitter	***Belt scale***	***Belt weigh feeder***
none	•	•	•
set point	•	•	•
motion	•	•	•
defective measurement	•	•	•
input image	•	•	•
level on request	•	•	•
belt alarms		•	•
external totalizer		•	•
belt system running		•	•
batch in progress		•	•
batch result available		•	•
conveyor starting alarm		•	•
material TOR gate		•	•

8.2. General functions:

8.2.1 None:

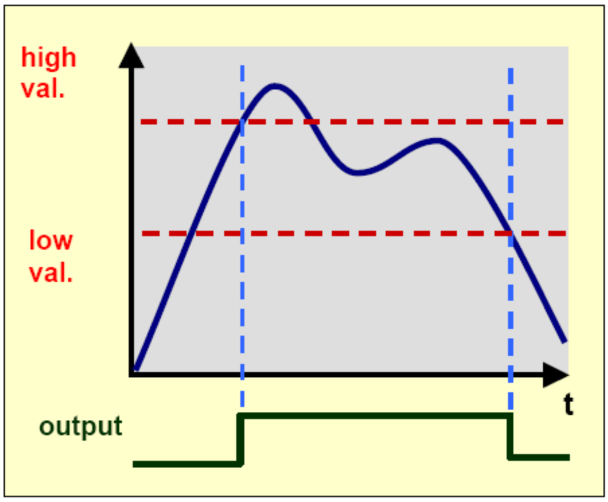
The output has no function

8.2.2 Set point:

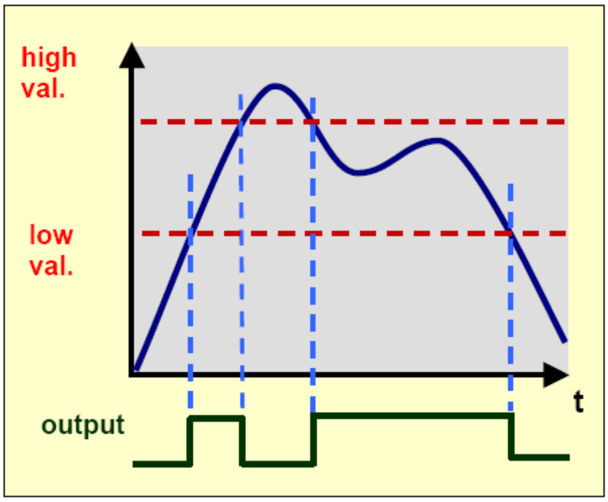
The outputs can be assigned to configurable set points (cf. §8) Output 1 is assigned to set point 1 , output 2 to set point 2, output 3 to set point 3 and output 4 to set point 4.

Set points are characterized by a high and a low value.

Their operating mode is either ***operating in hysteresis*** or ***operating in window***.



Functioning in hysteresis
Fig. 2



Functioning in window
Fig. 3

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

- gross measurement
- net measurement
- Sensor input control result
- Batch

8.2.3 Motion:

The outputs can be assigned to copying measurements stability.

8.2.4 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

8.2.5 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&3 and outputs 2 and 4 are assigned to input 2&4.

8.2.6 Level on request:

The input level is driven by master requests.

8.3. Functions attached to an operating mode:

See corresponding sections for a complete description.

8.4. Optional analog output (IO+ version)

An optional analog board in current and voltage might be used with ***eNod4*** to provide IO+ version. This has to be requested when ordering ***eNod4*** product.
Voltage output might be set either 0/5V or 0/10V, and the *current output* to 4/20mA, 0/24mA, 0/20mA or 4/20mA with alarm at 3.6mA. Both output (current and voltage) might separately be enable.

Analog output assignment function is common to both current and voltage output and might be assigned to followings:

function	*Operating mode*		
	transmitter	***Belt scale***	***Belt weigh feeder***
none	●	●	●
gross mesasurement	●	●	●
net mesasurement	●	●	●
level on request	●	●	●
flow rate control output	●	●	●
instant flow rate	●	●	●
average flow rate		●	●
average belt speed		●	●

If extraction command is directly done by an external device (e.g PLC), through ***eNod4*** analog output, the output must be set on ***level on request*** function.

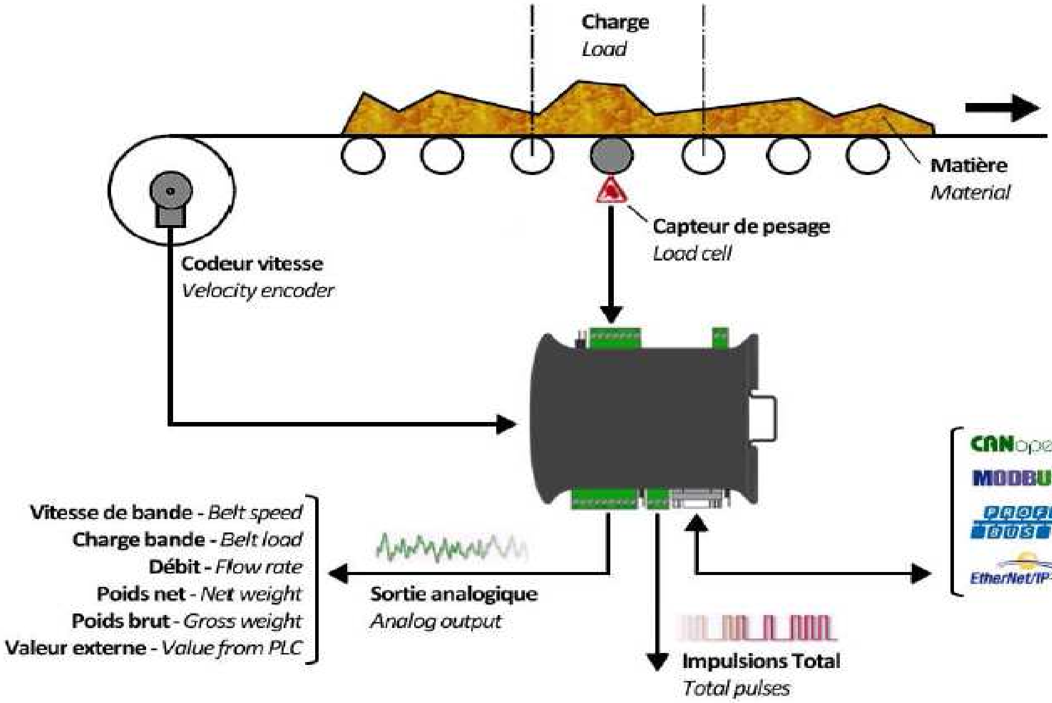
9 BELT WEIGHER OPERATING MODE

9.1. Introduction and Overview

eNod4 belt conveyor scale is a device that continuously measures bulk material as it moves along a conveyor. The system requires two general parameters to operate:

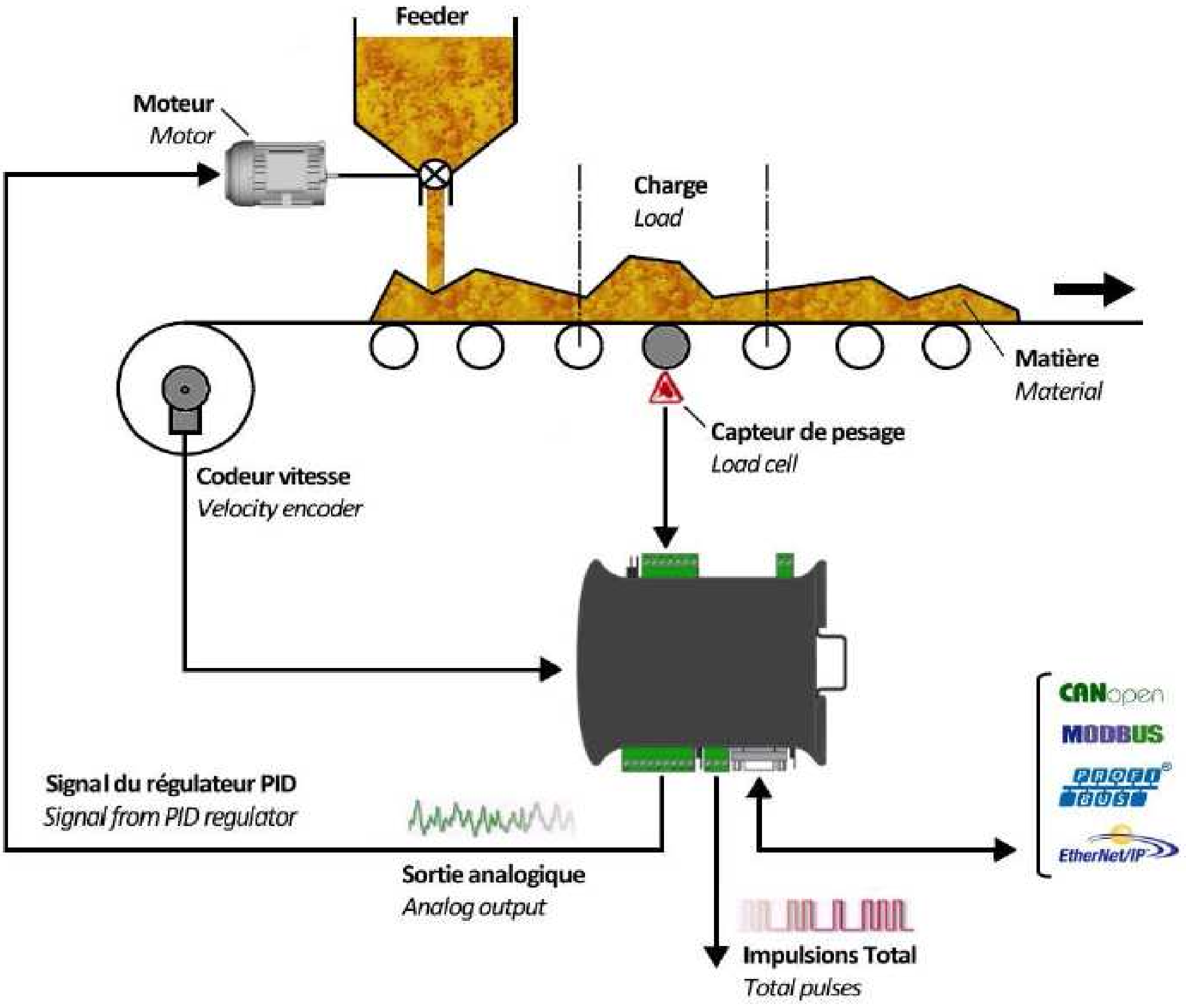
- It needs to know the weight of the material being moved along the conveyor belt
- It needs to know the speed at which it's moving along the conveyor belt.

The weight of the material on the belt is determined by weighing a section of conveyor belt loaded with material and then subtracting the average weight of the unloaded belt. The speed at which the material is moving is determined by measuring the speed of an idler or wheel in contact with the conveyor belt. The weight and speed is combined to produce a running total and a rate of flow of material going through the belt conveyor scale. The correct operation of the scale system requires the components to be installed correctly, periodically calibrated, and properly maintained.



Belt scale operation

In ***belt scale*** operating mode, ***eNod4*** continuously calculates the total amount of material that goes through the weighing system and calculates the flow rate of material instantaneously.



Belt weigh feeder operation

The ***weigh feeder*** is used to deliver an accurate mass flow rate of materials. In most applications, materials are provided by an adjustable mechanical shear gate, which fixes the correct material bed depth for a given particle size.

The feed rate is then maintained adjusting the speed of the belt. However, in some cases the belt speed is constant with rate control done by a pre-feeding device.

The system consists of three components: weight and speed sensing, integration and control, and the mechanical conveying system.

Using the belt load and the belt speed signals, small incremental totals of weight per time are measured by ***eNod4*** which calculates the flow rate. The measured flowrate is compared to the set point flow rate and the on-board PID controller makes necessary corrections to the belt speed or materials feed.

9.2. Totalization cycle description

9.2.1 Cycle options

Cycle options define ***eNod4*** device functioning

- ***Batch mode***

If batch mode option is activated, ***eNod4*** will automatically stop dosing when the total weight will have reached batch target values (Batch set point minus Inflight weight value), the scale material flow stops automatically.

The batch target value consists of two variables, the **main weight to totalize** in **weight unit** x 1000 and the **complementary weight to totalize** in **weight unit**.

Inflight weight value is expressed only in **weight unit**.

- ***Clear totalization***

If **cleared totalization at starting of new cycle option** is activated, ***eNod4*** reinitializes total value. The main variable **weight to totalize** in **weight unit** x 1000 and the **complementary weight to totalize** in **weight unit** are reset to zero.

- ***PID Activation***

It is possible to assign ***eNod4*** current or voltage analog output to extraction command (Setting **to flow rate control output**).

In **weight feeder** mode, when **PID activation** option is activated, ***eNod4*** will adjust the flow of extraction function to maintain constant flowrate regarding the flowrate set point. The measured flowrate is compared to the set point flow rate and the on-board PID controller makes necessary corrections to the belt speed or materials feed.

The configuration of this plan of regulation can be made in a totally automatic way.

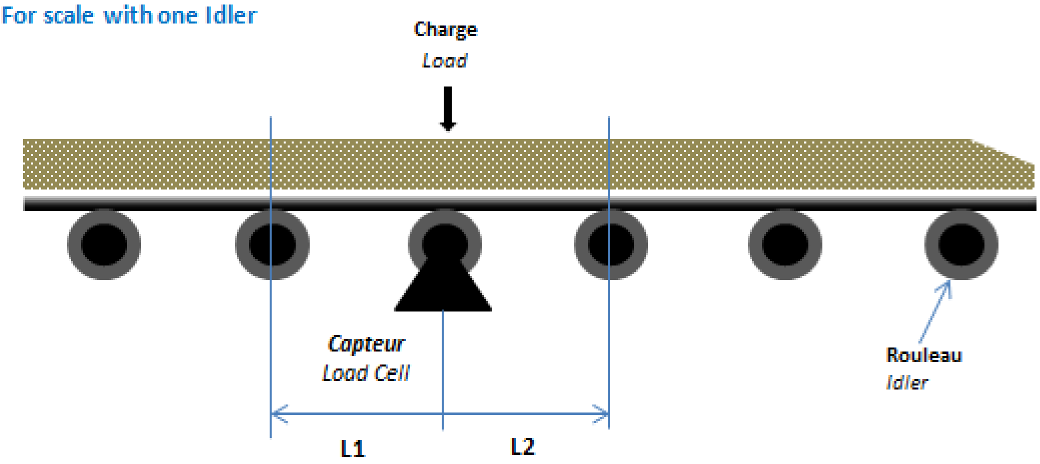
So that this plan of regulation works, it is necessary to realize weight calibration indication and flow rate calibration beforehand.

9.2.2 Weight section length (mm)

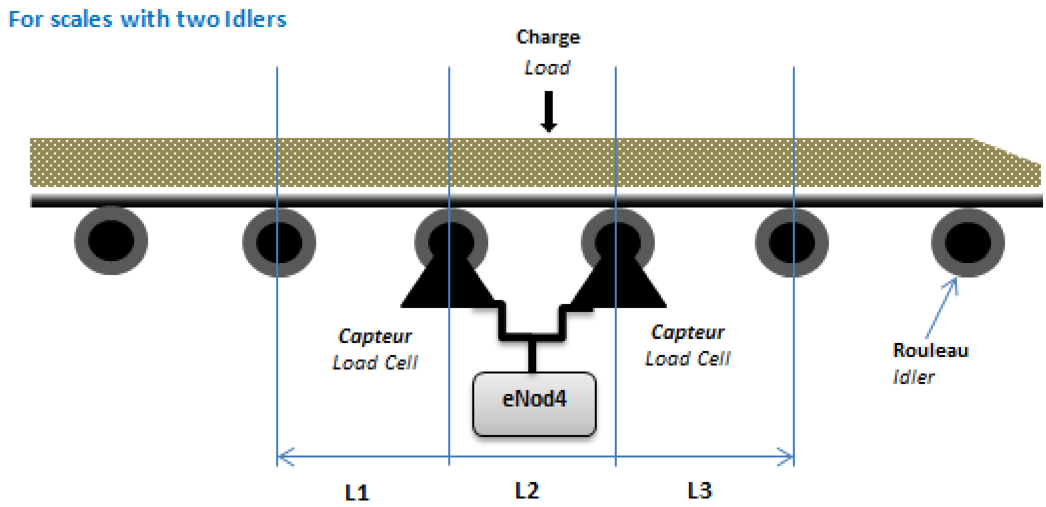
Effective weight section length is defined as length units in ***millimeters (mm).*** The effective weight section length corresponds with half of the distance between the belt rollers which are found before and after the roller with the belt scale.

The effective weight section length is calculated as follows:

For scale with one Idler



$$Effective\ weight\ section\ length = \frac{L1 + L2}{2}$$

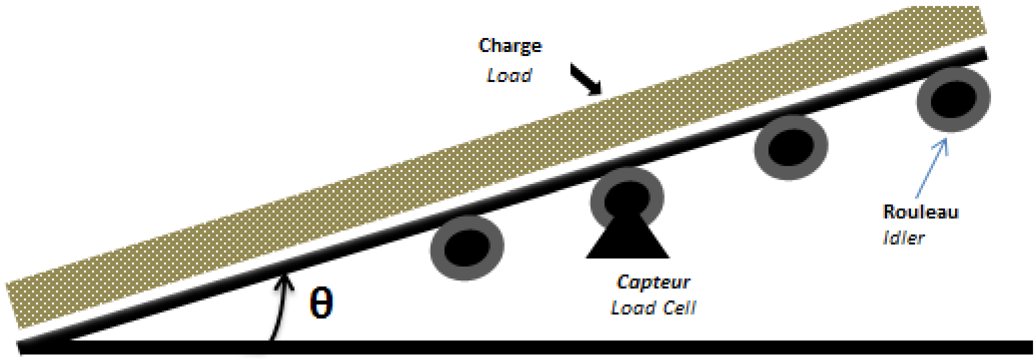


$$Effective\ weight\ section\ length = \frac{L1 + L3}{2} + L2$$

9.2.3 Conveyor inclination (degrees)

"Belt tilt angle" (angle of conveyor in degrees) allows correcting the effect of inclination on the weight. If the belt is mounted horizontally, the definition is 0. The belt can be tilted to a maximum of 35°.

Always ensure that the definition corresponds with the current tilt angle, otherwise the belt load is incorrectly calculated.



9.2.4 Minimum load to totalize (weight unit/meter)

Minimum load to totalize is the limit value for minimum belt loading in 0.01 % of totalization weight unit. The entry of the number e.g. 1000 corresponds to 10 weight unit. After this value has been exceeded ***eNod4*** sets the status bit "***min. totalize load targeted***" in status register and starts totalization function.

eNod4 determines the ***Minimum load to totalize*** by calculating:

$$Minimum\ load\ to\ totalize = \frac{\textbf{Minimum weight (in weight unit)}}{Weight\ section\ length\ (in\ meter)}$$

9.2.5 Pulses factor speed sensor (Pulses/meter)

The pulse constant of the speed sensor indicates the number of pulses per meter of the belt. ***eNod4*** calculates the current belt speed on this base. The value of pulses factor can be calculated by ***eNod4*** during a speed calibration.

9.2.6 Measurement time factor for speed (x250ms)

The belt speed is defined as output in meter per second (m/s). By default ***eNod4*** device estimated speed determination every ***250ms*** *(time factor for speed is set to 1)*. The measuring time factor of the pulse input can be set to another time e.g. 4 (for 2 seconds). The number of pulses from the speed sensor within this period is summed to estimate the belt speed. The *speed* value output is updated in this case *every 2 seconds* and the value is shown in ***eNod4*** as meter per second.

9.2.7 Constant belt speed (m/s)

Constant belt speed must be defined if no speed sensor is connected to ***eNod4*** device. The calculation of the flow-rate is then performed using this value.

When a speed sensor is connected to ***eNod4***, constant belt speed must be set to 0.

9.2.8 Flow correction factor

Correction factor can be used to correct deviations in the total dosed amount by compensating for mechanical variations. When the final dosed amount is checked by weighing the resulting weight, ***eNod4*** can recalculate this factor by calculating:

$$\text{New Correction} = \text{Correction} \times \frac{\text{Checked Batch Total}}{\text{Current batch total}}$$

The next batch the **Batch Total** and **Checked Batch Total** should be close together.

9.3. Belt calibration

Initial calibrations must be performed on belt system to achieve correct display of process data. User has to do the following steps:

1) Speed sensor calibration (mandatory)
2) Static weight calibration (mandatory)
3) Material Test (Dynamic weight calibration or correction factor)

9.3.1 Speed sensor calibration

Speed calibration must be performed when the conveyor is running and empty. The following parameters are involved during speed calibration procedure:

- ***Pulses factor speed sensor (Pulses/meter)***, user can get this data from speed sensor datasheet. Using this parameter, ***eNod4*** allows estimating the ***conveyor total length***.
- ***Conveyor total length***, if user does not know ***pulses factor speed sensor (pulses/meter),*** he has to fill this parameter and ***eNod4*** allows estimating ***pulses factor***. At end of calibration the current belt speed must match the real speed.
- ***Number of revolutions,*** for auto-calculation of ***pulses factor*** or ***conveyor total length***, user must fill this parameter with correct value (effective number of revolutions to be realized during procedure). It is recommended to set and to achieve a maximum number of revolutions to improve result accuracy.

  Procedure of auto-calculation (***pulses factor*** or ***total length***) is as following:
  - Stop the conveyor and make sure it is empty
  - Mark the belt (for reference point)
  - Start the conveyor
  - Send corresponding "***Init calibration***" command at marked point
  - Count real number of belt revolutions handled
  - Send corresponding "***End calibration***" command at marked point and when specified number of revolutions is done.
  - Check and compare updated value of ***pulses factor*** or ***conveyor total length***.

Note: See functional commands section about commands list.

9.3.2 Static weight calibration

Static weight calibration must be performed when the conveyor is in stop state***.*** ***eNod4*** device allows several methods of static weight calibration. These methods and procedures are described in specific calibration and scale adjustment section. Refer to it for more details.

9.3.3 Material Test (Dynamic weight calibration or correction factor)

The Material Test can only be performed once a static weight calibration has been completed and once the belt speed sensor has been installed and calibrated.

The belt scale allows for two calibration methods. Static weight calibration is the easiest method and is a combination of test weights applied to each weigh idler, belt spacing and speed calibration. The second optional calibration method is a Material Test calibration in which a known amount of test material is fed on the moving belt scale. Then, user must check the amount of test material with a measurement instrument and apply a correction factor to make at next batch ***eNod4*** displayed total weight matches the test material weight.

9.4. Calibration of flow rate

So that ***eNod4*** can carry out an expected flow rate dosing in the best conditions possible, the flow rate output control calibration is required. This also applies when ***eNod4*** is used both as ***belt scale*** or ***belt weigh feeder***.

From this calibration will depend the accuracy of the flow rate obtained and on the actuation time delay, if a PID regulator controls it. This calibration is carried out in minimum two segments by the variable ***segments number for the calibration curve of flow rate***. In case the extraction device has a nonlinear response it is recommended to define maximum segments for the flow rate calibration.

If the control of extraction device is directly provided by ***eNod4*** through a control analog output in *current* or *voltage*, the *current* or *voltage* analog output of ***eNod4*** must be allocated to "***level on request"*** function**.**

For each calibration point of the variable ***control output value,*** read the appropriate average flow rate. Then provide each of the ***Calibration of control output point n / analog output*** and ***Calibration of flow rate point n matching with control output value.*** Validate the flow rate calibration by ***calibration of flow rate*** control.

Allocate in the end the *current* or *voltage* analog output of ***eNod4*** to "***flow rate control output"*** function**.**

9.5. Totalization

eNod4 realizes totalization function continuously while belt loading is greater than ***minimum load to totalize*** even if no batch cycle is in progress.
The ***totalization result*** is composed of two parts, the main part in **weight unit** x 1000 and the second one **complementary** in **weight unit**.

In ***batch mode*** and when ***cleared totalization*** at ***starting new cycle*** option is activated, this totalization result is set to zero at each cycle start.

There are two others levels of totalization expressed only in **weight unit** x 1000 (***Great total*** and ***General total***).
Each totalization result can be independently set to zero. The data of these totalizers is being permanently backed up after modification.

If one of these 4 outputs is allocated to an external totalizer, a pulse is sent when the value totalized increases by a multiple value of the parameter ***weight quantity per pulse on logical output.***

9.6. Alarms

Alarms are disabled when the corresponding control parameters are set to zero, otherwise they are activated. These alarms will not affect the functioning of ***eNod4*** device but only be displayed. They will continue to be displayed until the condition disappears. Once the condition is cleared, the alarm is cleared.

The following data process can be monitored:

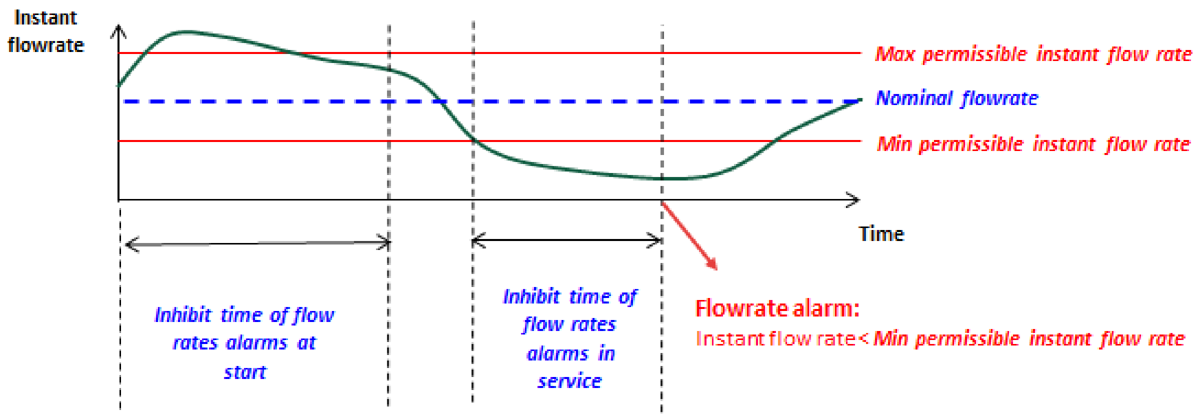
- Instant flowrate
- Instant belt load
- Flowrate control output
- Instant belt speed
- External totalizer overflow

9.6.1 Minimum flow rate limit value (0.1%)

Minimum flow rate is the limit value for flowrates in 0.1% of the ***nominal flowrate***. The entry of the number e.g. 800 corresponds to 80.0%. When the instant flowrate on the belt is lower than this level, ***eNod4*** sets the alarms bit *"<min. instant flowrate*" in ***belt alarms register***.

9.6.2 Maximum flow rate limit value (0.1%)

Maximum flowrate is the limit value for flowrates in 0.1% of the ***nominal flowrate***. The entry of the number e.g. 1020 corresponds to 102.0%. When the instant flowrate on the belt is higher than this level, ***eNod4*** sets the alarms bit *“>max. instant flowrate”* in ***belt alarms register***.



Instant flowrate alarm descriptive

9.6.3 Minimum belt load limit value (0.1%)

Minimum belt load is the limit value for density weight in 0.1% of the ***nominal load***. The entry of the number e.g. 800 corresponds to 80.0%. When the instant density weight on the belt is lower than this level, ***eNod4*** sets the alarms bit *“<min. instant load”* in ***belt alarms register***.

9.6.4 Maximum belt load limit value (0.1%)

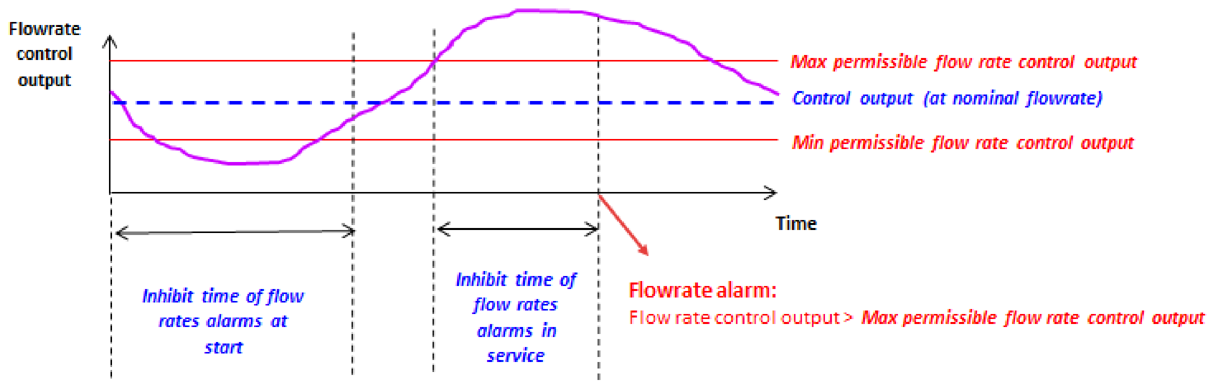
Maximum belt load is the limit value for density weight in 0.1% of the ***nominal load***. The entry of the number e.g. 1020 corresponds to 102.0%. When the instant density weight on the belt is higher than this level, ***eNod4*** sets the alarms bit *“>max. Instant load”* in ***belt alarms register***.

9.6.5 Minimum control output limit value (0.1%)

Minimum control output is the limit value for control output in 0.1% at ***nominal flowrate***. The entry of the number e.g. 800 corresponds to 80.0%. When the control output on the belt is lower than this level, ***eNod4*** sets the alarms bit *“<min. control output”* in ***belt alarms register***.

9.6.6 Maximum control output limit value (0.1%)

Maximum control output is the limit value for control output in 0.1% at ***nominal flowrate***. The entry of the number e.g. 1020 corresponds to 102.0%. When the control output on the belt is higher than this level, ***eNod4*** sets the alarms bit *“>max. control output”* in ***belt alarms register***.



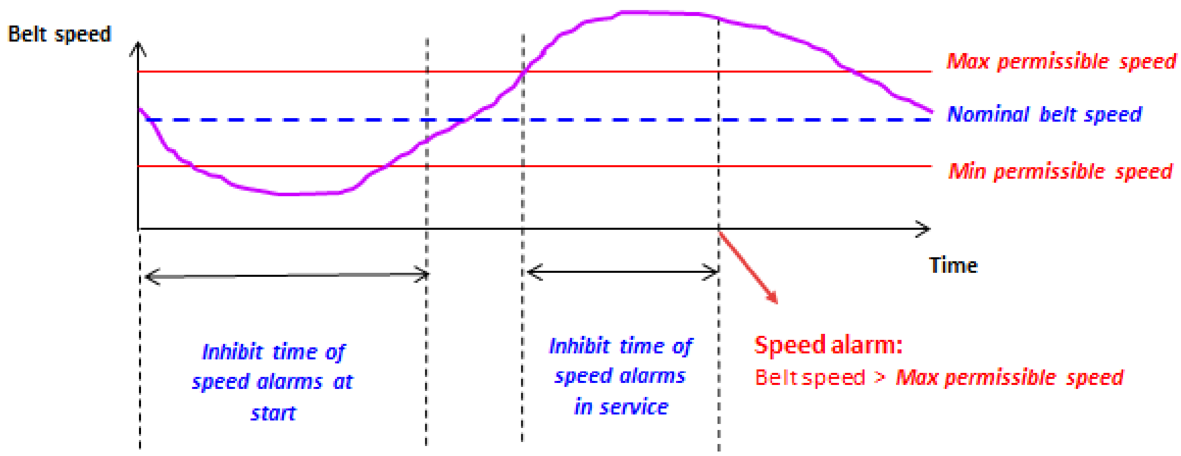
Flowrate control output alarm descriptive

9.6.7 Minimum belt speed limit value (0.1%)

Minimum belt speed is the limit value for minimum belt speed in 0.1% of the nominal speed. The entry of the number e.g. 800 corresponds to 80.0 %. After this value has been exceeded, ***eNod4*** sets the status bit "<min. speed" in ***belt alarms register***.

9.6.8 Maximum belt speed limit value (0.1%)

Maximum belt speed is the limit value for maximum belt speed in 0.1% of the nominal speed. The entry of the number e.g. 1020 corresponds to 102.0%. After this value has been exceeded, ***eNod4*** sets the status bit ">max. speed" in ***belt alarms register***.



Belt speed alarm descriptive

9.6.9 Inhibit time of speed alarms at start (ms)

Monitoring the belt speed is only activated after this delay time when the belt is started.

9.6.10 Inhibit time of speed alarms in service (ms)

When the belt speed is below/above the min/max belt speed, the alarm is activated after this delay elapsed.

9.6.11 Errors counter

Any alarm disappears automatically when the origin of the defect disappears. In every emitted alarm, the variable ***error counter*** is incremented.

Error counter variable can only be set to zero using **clear dosing/batch** command.

9.7. Inputs assignments

eNod4 device could have up to **5 Inputs** (with **IO+ option**). One of them is especially reserved for ***speed sensor*** input. All others logical inputs can be assigned to functional dosing process commands. All process commands have edge functioning.

- *Start / Stop dosing (and batch)*

If starting conditions are fulfilled, a rising or a falling edge (according to the configured logic) on this input causes a new totalization cycle to start.

In ***batch mode*** and when ***cleared totalization*** at ***starting new cycle*** option is enabled, the totalization result is set to zero at each cycle start.

If dosing cycle is running, a second edge of this command stops the process.

- *Belt running motion detection*

If speed sensor is broken or if no speed sensor is connected to ***eNod4*** device, a logical input on the ***eNod4*** can be assigned to ***motion detection*** function to enable totalization function.

- *Clear/Reset totalization and errors counter*

Clear totalization function can be assigned to logical input. You can clear total amount dosed and errors counter at any time. At this input activation on rising or falling edge (according to the configured logic), the ***main total*** in ***weight unit x1000*** and the ***complementary weight*** value are reset to zero.

Also, ***errors counter*** parameter is set to zero.

- *Dynamic zero*

When the belt is running empty, this input activation will cause ***eNod4*** to perform conveyor zero function by measuring flow rate of materials.

Run the conveyor for several minutes to ensure the belt is empty and supple. The conveyor should be operating at ***normal speed*** throughout the calibration. Dynamic zero function duration will depend on the ***number of revolutions*** chosen, the belt length and the speed. The procedure will complete its cycles unless an ***exit calibration*** command is sent.