

Characteristics and functioning



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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 $\pm 500\,000$ 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.

EDS, GSD and GSDML configuration file for **CANopen®** can be downloaded from our web site: <http://www.scaime.com>

1.2.2 Options

With appropriate option the strain gauges load-cell can be exchanged with:

- 4/20mA analog signal.
- 0/10V analog signal.

1.3 Versions and options

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. Its simple graphical interface allows accessing the whole functionalities of **eNod4** for a complete setting according to the application.

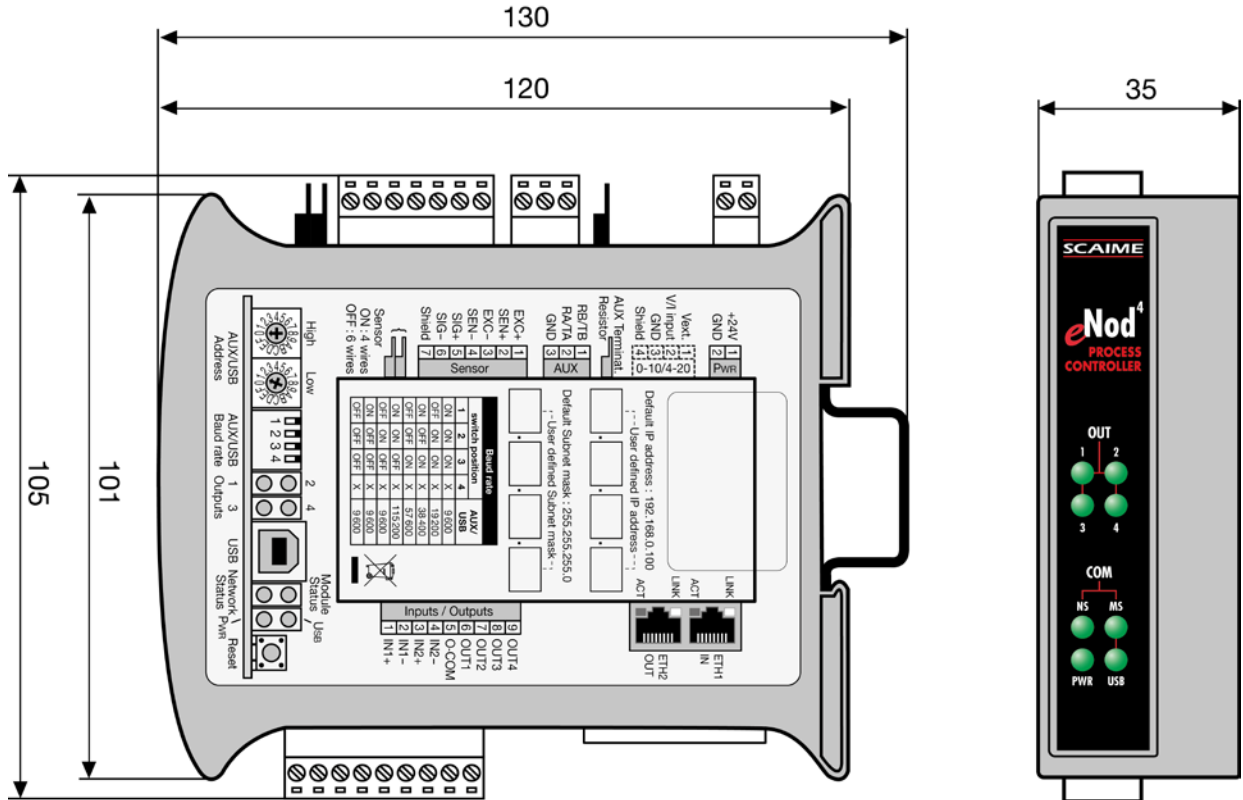
eNodView features and functions :

- 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

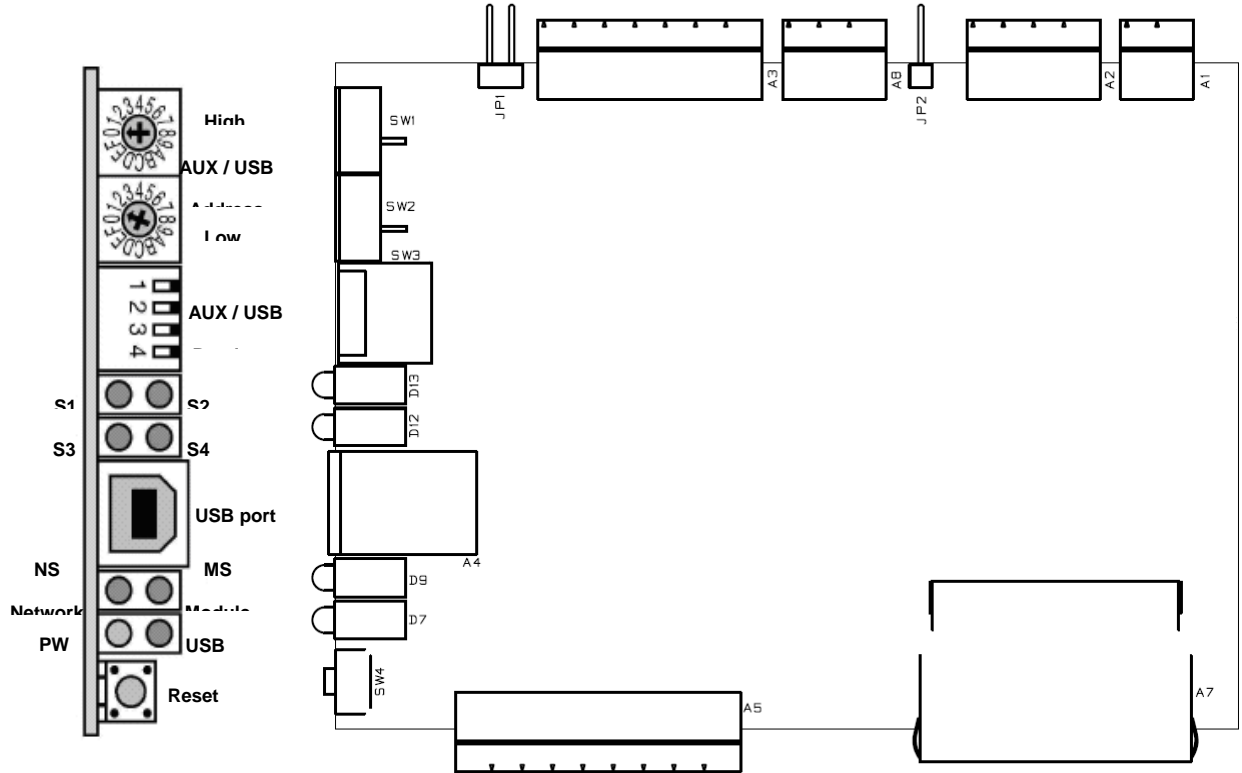


2.2. [Electrical characteristics](#)

<i>Power supply</i>		<i>Unit</i>
Supply voltage	11.5.....28	V_{DC}
Max supply current	250@11.5V , 150@28V	mA
<i>Temperature range</i>		
Storage temperature range	-25...+85	°C
Working temperature range	-10...+40	°C
<i>Sensor</i>		
Minimum input resistance	> 80	Ω
sensor connection	4 or 6 wires	
Bridge excitation voltage	5 \pm 2%	V_{DC}
<i>Communication</i>		
RS 485	Half-duplex	
Rate	9 600...115 200	bauds
Ethernet 2 x RJ45	10/100	Mbits/s
<i>Inputs</i>		
Number	2	
Type	opto-coupleurs	
Low level voltage	0 / 5 VDC – 0 / 2 mA	
High level voltage	11 / 30 VDC – 6 / 16 mA 12.6 mA @ 24VDC	
<i>Outputs</i>		
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

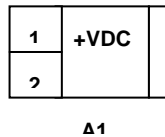
<i>Metrological specifications on A3 connector input (load-cell type sensor)</i>		
Input sensor range for a load cell sensor	± 7.8	mV/V
Thermal zero drift typical	1.5	ppm/°C
Thermal span drift typical	2	ppm/°C
Linearity deviation	0.003	% FS
Conversion rate	6.25 ... 1920	meas./s
<i>Metrological specifications on A2 connector input (option 0-10V or 0/20mA)</i>		
0-10V input range	10	V
0-10V Accuracy	0.3	%
4/20mA input range	20	mA
4/20mA accuracy	1	%
Thermal zero drift typical	15	ppm/°C
Thermal span drift typical	25	ppm/°C
Linearity deviation	0,003	%
Conversion rate	6,25 ... 1920	meas./s

3 CONNECTIONS



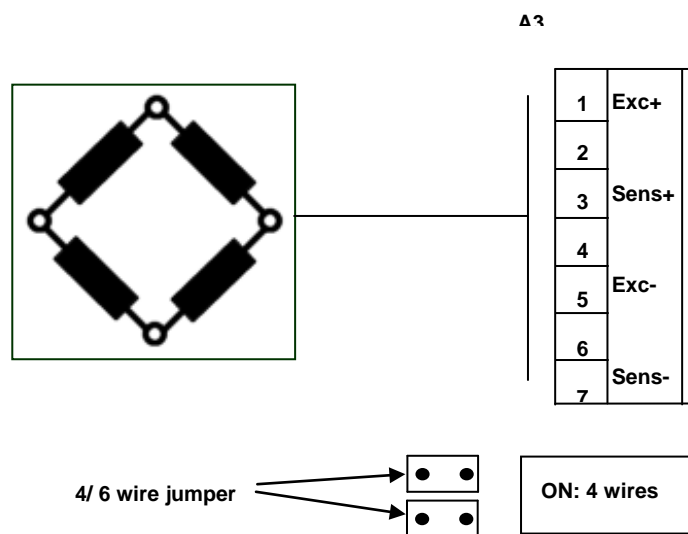
Mark	Function		Mark	Function		
A1 <i>power supply</i>	1	+V _{DC}	A5 <i>IN / OUT</i>	1	IN1+	
	2	GND		2	IN1-	
A2 <i>4/20mA or 0/10V_{DC} input (optional)</i>	1	+24V _{DC}		3	IN2+	
	2	4/20mA or 0-10V _{DC}		4	IN2-	
	3	GND		5	OUT _{COM}	
	4	Shield		6	OUT1	
A3 <i>load cell connection</i>	1	Exc+		7	OUT2	
	2	Sens+		8	OUT3	
	3	Exc-		9	OUT4	
	4	Sens-		A7 <i>2 x RJ45 Ethernet</i>	1	ETH1 IN
	5	Sig+	2		ETH2 OUT	
	6	Sig-	A8 <i>AUX connection</i>		1	RB/TB (B-)
	7	Shield			2	RA/TA (A+)
SW4	reset push button		A4 <i>USB</i>	3	GND	
D12-D13	outputs LED			USB		
D9	LED NS: Network Status (or Bus Fault for Profinet) LED MS: Module Status (or System Fault for Profinet)					
D7	power supply & USB 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](#)

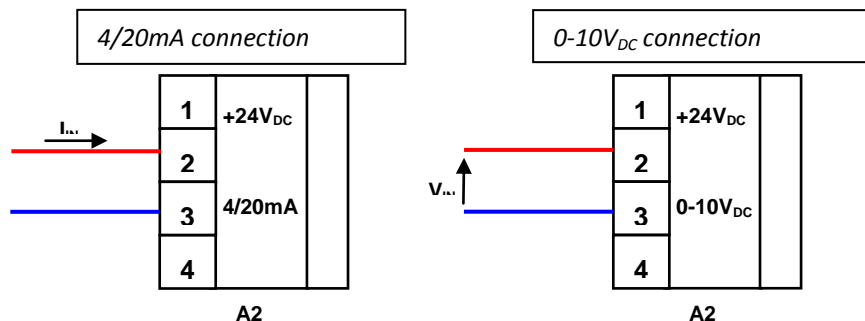


- **4 wires load-cell:** jumpers in place (by default at delivery).
- **6 wires load-cell:** jumpers removed

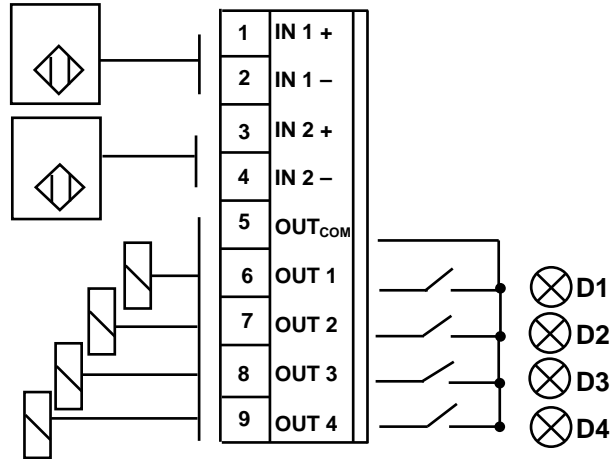
3.3. [High level measuring input \(0/10V_{DC} or 4/20mA\)](#)

Optionally, **eNod4** can be equipped with a connector (A2) allowing a high level (0/10V_{DC} or 4/20mA) signal conditioning. In that case it is no more possible to condition a sensor on A3 connector.

Analog input signal is connected to terminals 2 and 3. Terminal 1 is can be used to supply power to high level sensor.

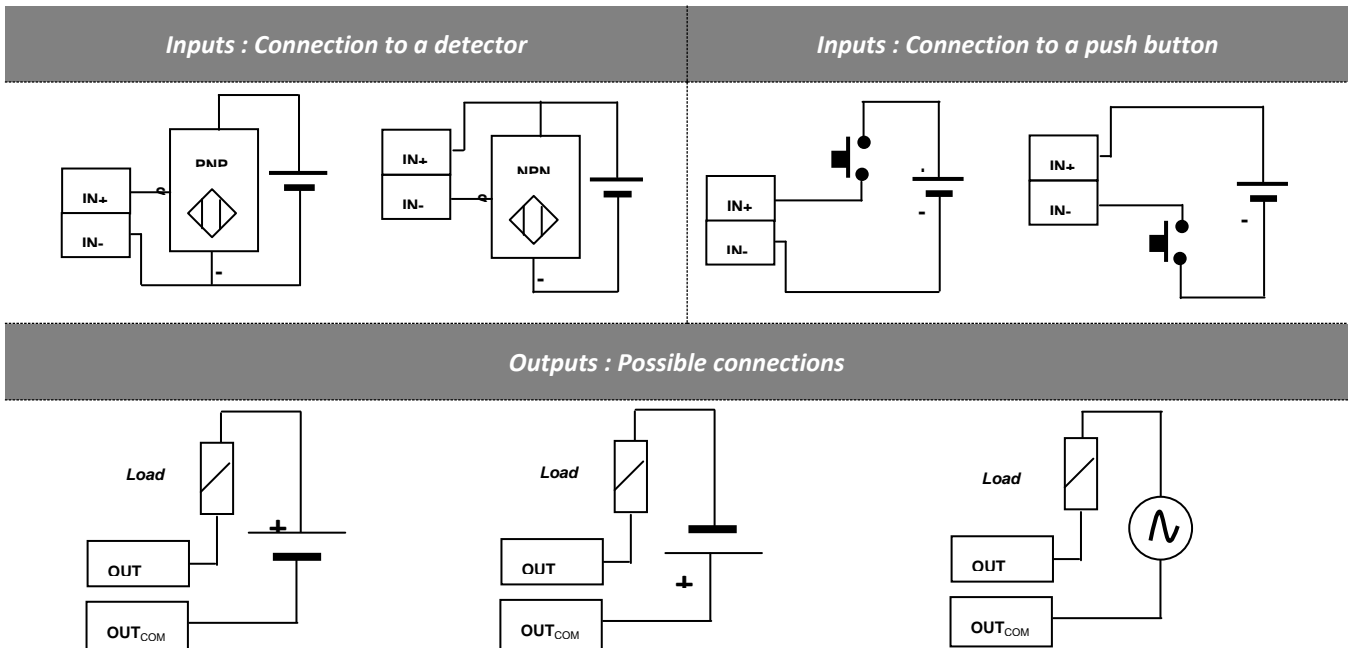


3.4. Inputs / outputs connections



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

3.4.1 Typical connections



4 COMMUNICATION

4.1. Communication Interface connections

4.1.1 Process control communication

Version	Type of communication	Connector
eNod4 Modbus TCP	Modbus TCP	A7
eNod4 Ethernet / IP	Ethernet/IP	A7
eNod4 Profinet IO	Profinet IO	A7

4.1.2 PC communication

eNod4 models 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.

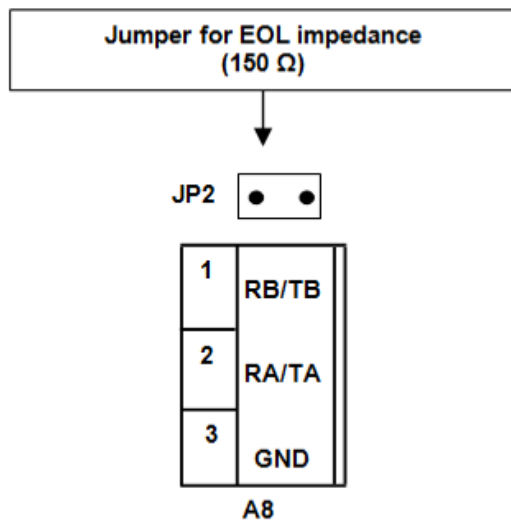
The appropriate **USB** driver can be downloaded from our website: www.scaime.com. It is also available on CD to order from our sales department.

Note: If **eNodView** software has been correctly installed, it is not mandatory 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)

GND (connector pin3) is connected with power supply GND. The common mode voltage admitted is $\pm 27\text{VDC}$ from GND power supply. When **eNod4** is at the end of a bus line the $150\ \Omega$ integrated resistor can be used (connecting jumper).

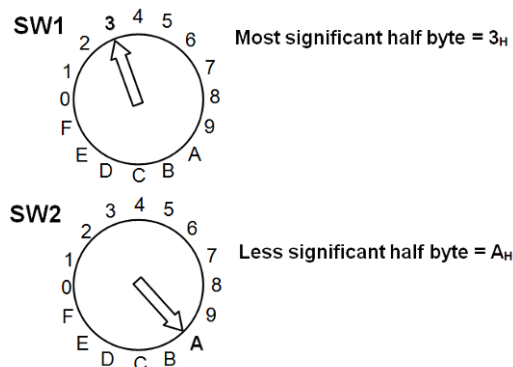
Warning: Do not add termination line jumper on both side if distances between 2 devices is short.



4.2. Communication address selection

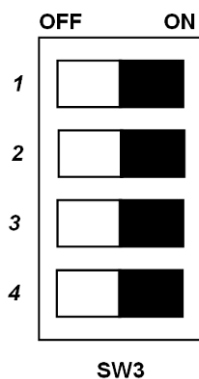
Rotary switches selection (SW1 and SW2) accessible from the front panel. **The new address only is taken into account after a reset.**

Example: eNod4 address = 3AH = 58d



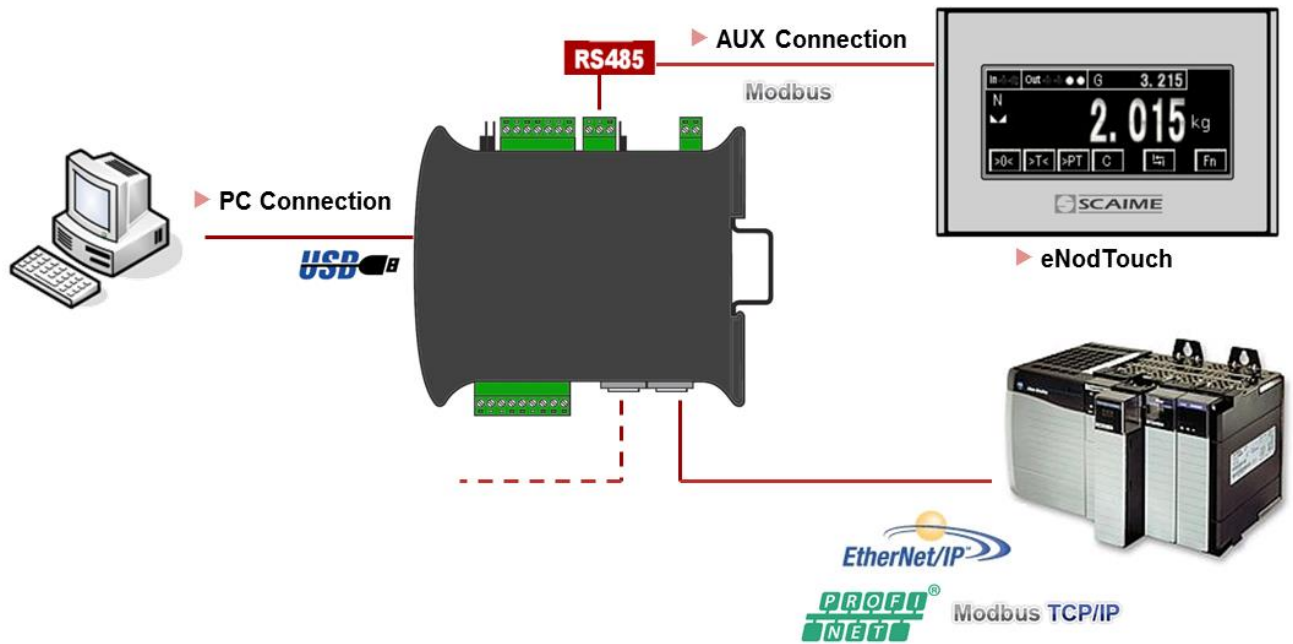
4.3. Communication rate selection

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



Dipswitch				Baud rate RS485 et USB	Bit rate CAN
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. Simultaneous functioning of communications



Simultaneous communication	RS 485 PLC	RS485 AUX
USB	yes*	No
Ethernet		Yes**

(*) Simultaneous use of CAN or RS485 PLC with USB port can reduce performance of this interface.

(**) In this configuration, we recommend a typical speed on AUX output of 9600 bps (Max 19200 bps)

5 CALIBRATION AND SCALE ADJUSTMENT

eNod4 is factory calibrated as following:

- **500 000 counts for 2mV/V** with a load cell on the **A3** input.
- **100 000 counts for 10V** on the high level input (optional). It also corresponds to **10 200 counts for 20mA**.

Note: only one sensor input is useful. The analog input type has to be defined at order.

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**. This calibration mode is **available for all types of sensor inputs**.

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.

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
- self-adaptive 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, 3 or 4) 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. [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.

7 DESCRIPTION OF TRANSMITTER FUNCTIONING MODE

The eNod4 transmits measure after signal and data processing through different protocols available. The accessible variables are:

7.1. Measurement status

The measurement status contains information on eNod4 measurement parameters.

7.2. Gross measurement

The '*gross measurement*' stands for the digital value after measurement scaling. It is affected by all the '*zero*' functions (power-up zero, zero tracking and zero requests).

7.3. Net measurement

The '*net measurement*' stands for the digital value after measurement scaling and tare subtraction.

7.4. Tare value

The '*tare value*' stores the calibrated value that is subtracted from the '*gross measurement*' so as to give the '*net measurement*'.

7.5. Factory calibrated points

The '*factory calibrated points*' contains the measurement value without the user calibration layer. It is directly linked to the analog input voltage.

7.6. Logical IN/OUT level

The '*logical IN/OUT level*' allows reading any time **eNod4** logical inputs and outputs level.

7.7. Preset Tare value

A previous calculated tare can be restored using this variable.

8 INPUTS FUNCTIONING

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

8.1. Inputs assignment:

Function	Operating mode		
	transmitter	dosing by filling	dosing by unloading
<i>none</i>	•	•	•
<i>tare</i>	•	•	•
<i>cancel tare</i>	•	•	•
<i>zero</i>	•	•	•
<i>transmit measurement</i>	•		
<i>measurement window</i>	•		
<i>dosing start cycle</i>		•	•
<i>dosing stop cycle</i>		•	•
<i>clear dosing results</i>		•	•
<i>suspend dosing cycle</i>		•	
<i>emptying</i>		•	
<i>dynamic zero</i>		•	•
<i>update peak value</i>		•	•

8.2 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.

- *Cancel tare*: Depending on the chosen logic (positive or negative), the current stored tare value is erased 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 $\pm 10\%$ range of the specified capacity for a usage out of legal for trade and $\pm 2\%$ 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 tare is triggered by a rising or a falling edge.

8.3 Functions attached to an operating mode:

See corresponding sections for a complete description.

9 OUTPUTS FUNCTIONING

Each output can work individually in its own logic.

9.1. Outputs assignment:

function	Operating mode		
	transmitter	dosing by filling	dosing by unloading
<i>none</i>	•	•	•
<i>set point</i>	•	•	•
<i>motion</i>	•	•	•
<i>defective measurement</i>	•	•	•
<i>input image</i>	•	•	•
<i>level on request</i>	•	•	•
<i>cycle in progress</i>		•	•
<i>dosing result available</i>		•	•
<i>fine feed</i>		•	•
<i>coarse feed</i>		•	•
<i>high feed</i>		•	•
<i>emptying</i>		•	
<i>reloading</i>			•
<i>out of tolerances</i>		•	•
<i>flow rate failure</i>		•	•
<i>dosing failure</i>		•	•

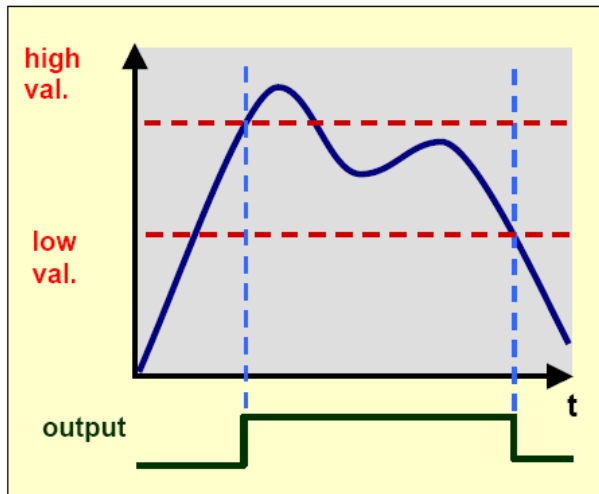
9.2 General functions:

- *none*: the output has no function

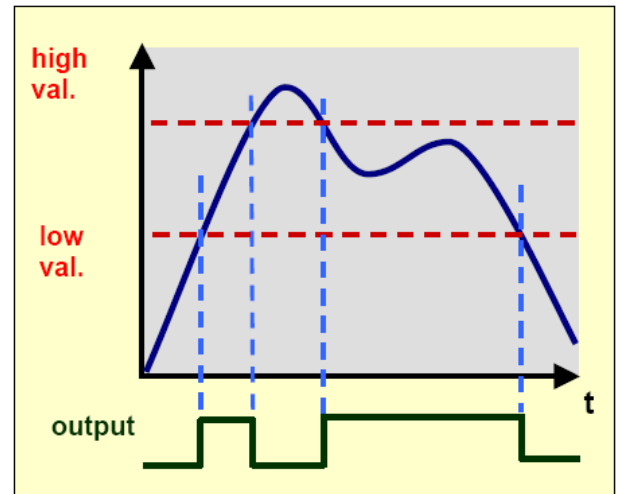
- *set point* : the outputs can be assigned to configurable set points (cf. §8) Output 1 is assigned to set point 1 , output 2 to set point 2, output 3 to set point 3 and output 4 to set point 4.

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

- *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 and outputs 2 and 4 are assigned to input 2.

- *level on request*: the input level is driven by master requests.

9.3 Functions attached to an operating mode:

See corresponding sections for a complete description.

9.4 Feeding mode in dosing processes

For the **filling** and **dosing by unloading** operating modes, it is possible to select the activation order of the feed outputs:

- coarse feed then fine feed after coarse feed stop
- coarse feed + fine feed at the beginning of the cycle
- coarse feed only
- fine feed then coarse feed then fine feed

- Fine feed then fine feed and coarse feed simultaneously then fine feed
- High feed then coarse feed then fine feed
- high feed and coarse feed and fine feed simultaneously
- high feed and coarse feed simultaneously then fine feed

10 DOSING BY FILLING OPERATING MODE

The **filling** operating mode is a way to monitor a dosing cycle of a product by measuring the weight of a receiver placed on a load cell.

In this operating mode, the dosing process is fully managed by **eNod4-D**. With its four digital outputs it allows the monitoring of all steps of the dosing cycle.

Fig. 6 and 7 shown below represent graphically how a **filling** cycle is working and what is the influence of the variables involved.

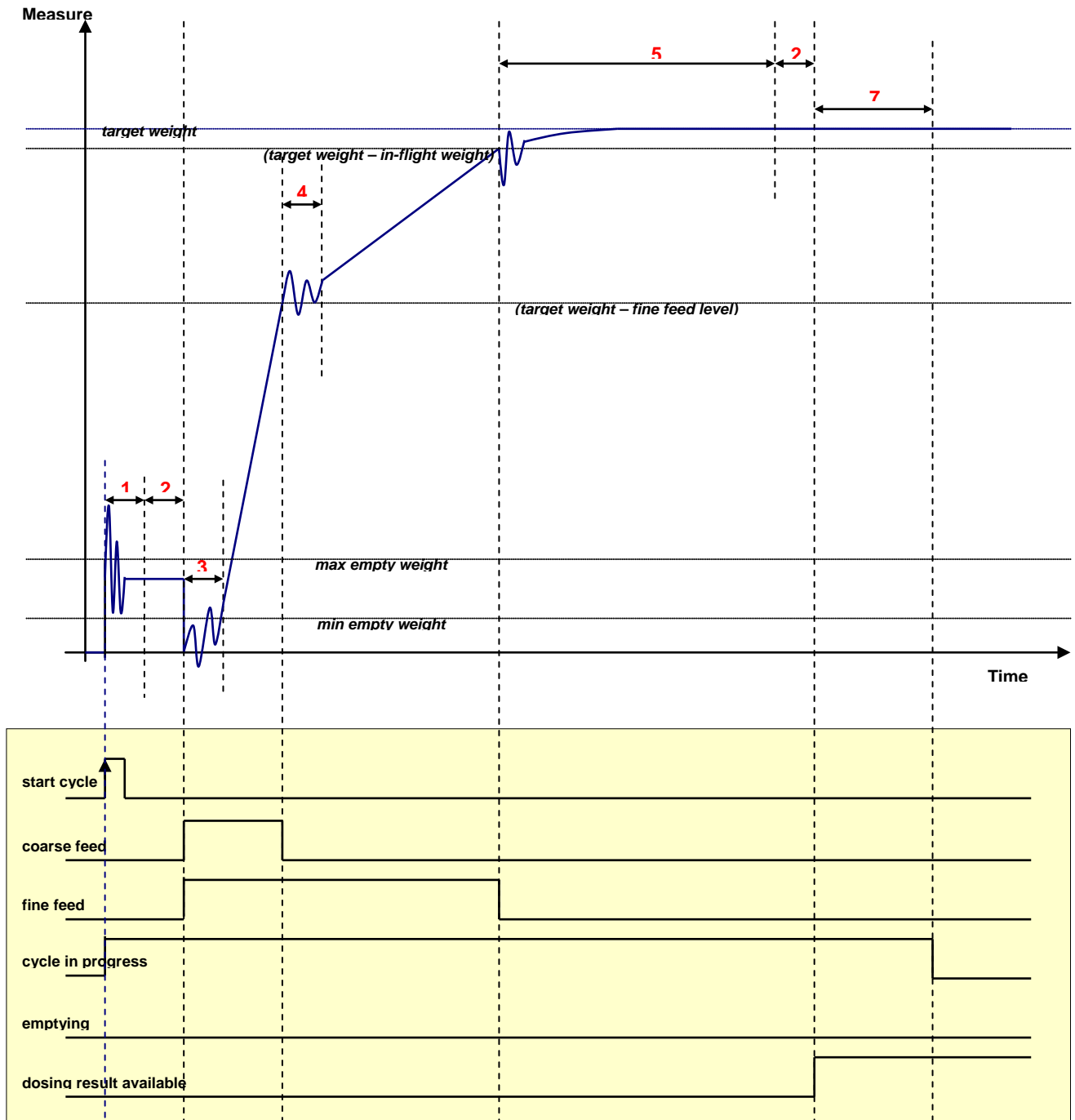


Fig. 6: filling cycle without emptying phase

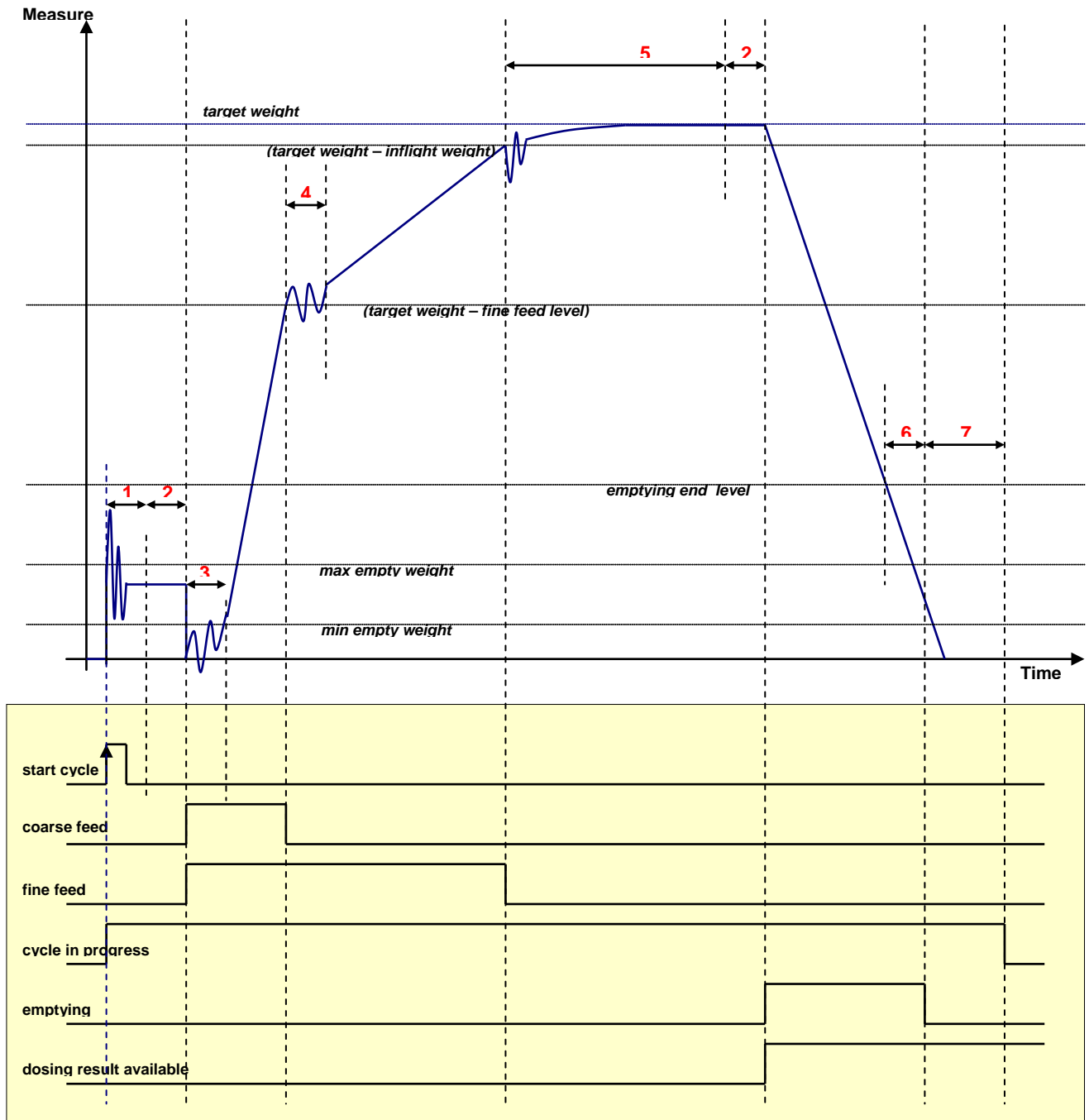


Fig. 7 : complete filling cycle with emptying phase

- * 1 : start delay
- * 2 : motion time out
- * 3 : coarse feed effect neutralization time
- * 4 : fine feed effect neutralization time
- * 5 : final stabilization time
- * 6 : emptying holding time
- * 7 : end of cycle waiting time

10.1 Starting conditions

After the reception of a 'start cycle' command or the activation (rising or falling edge depending on the logic) of a digital input assigned to this function, the filling cycle starts as soon as the 'start delay' has elapsed. An output assigned to the 'cycle in progress' function is set.

Different situations at the beginning of a cycle:

<i>automatic taring at start</i>	<i>restart if suspended authorization</i>	<i>weight value</i>	<i>action</i>
active		<i>min empty weight < gross weight < max empty weight</i>	<i>taring then start</i>
		<i>regardless the gross weight value IF</i>	
		<i>min empty weight = max empty weight = 0</i>	
		<i>other case</i>	<i>cycle cancelled, error reporting</i>
	<i>allowed</i>	<i>regardless the gross weight value IF last cycle was suspended</i>	<i>cycle recovery from last step (taring possible)</i>
inactive		<i>min empty weight < gross weight < max empty weight</i>	<i>no tare, starting from the net current value</i>
		<i>regardless the gross weight value IF</i>	
		<i>min empty weight = max empty weight = 0</i>	
		<i>other case</i>	<i>cycle cancelled, error reporting</i>
	<i>allowed</i>	<i>regardless the gross weight value IF last cycle was suspended</i>	<i>cycle recovery from last step (no tare)</i>

10.2 Cycle description

10.2.1 Flow rate control (optional)

eNod4-D includes a flow rate control system. It makes possible to check that the flow rate during the cycle is sufficient. The device controls that the flow rate remains equal or superior to a minimal value. If it is not the case, an output assigned to 'dosing failure' or 'flow rate failure' is set and the cycle is suspended if the cycle recovery option is active else it is stopped.

The flow rate control is defined by two parameters:

- a time interval (if = 0, the flow rate control is not used)
- a minimal weight variation

10.2.2 Automatic taring at start

If the '*automatic taring at start*' option is active, as soon as the '*start delay*' has elapsed, the tare acquisition is done if measurements are stable. If at the end of the '*motion time out*' delay time, no stability can be found, the tare value is equal to the last net current value.

10.2.3 Coarse feed effect neutralization time

This delay defined in milliseconds allows ignoring the effect of the coarse feed starting on the measurement signal and especially the product impact into the receptacle. During this delay time, the flow rate control and the level comparisons are inhibited.

10.2.4 Fine feed level

If the level (**target weight – fine feed**) is crossed the '*coarse feed*' output is immediately disabled. It is ignored if only the coarse feed is used.

10.2.5 Fine feed effect neutralization time

This delay defined in milliseconds allows ignoring the effect of the coarse feed ending on the measurement signal and especially the changing in the flow rate. During this delay time, the flow rate control and the level comparisons are inhibited.

10.2.6 Target weight and in-flight weight

The '*fine feed*' disabling occurs when the level (**target weight – in-flight level**) is crossed. The in-flight weight value allows therefore to quantify the weight of product that carries on falling after the output inhibition and so to avoid a systematic overload of the receiver.

This value can be automatically adjusted using the option '*automatic in-flight correction*'.

The correction amplitude is affected by a percentage that can be configured. It is also possible to have a stronger correction (x 3) as the result is outside the fixed tolerances.

The in-flight weight value is corrected according to the equation:

In-flight weight = in-flight weight + (dosing result – target weight) x correction coeff. The following condition must be verified: **In-flight weight low limit < in-flight weight < in-flight weight high limit.** If this condition is not verified, the in-flight weight value is not modified.

If '*In-flight weight low limit*' and '*In-flight weight high limit*' are equal to zero, limit condition has not to be verified.

10.2.7 Final stabilization time

This delay time corresponds to the minimal necessary duration for the stabilization of the weight before the determination of the result and the control of tolerances.

When it is over, the '*motion time out*' delay time begins. If the stability can not be found within this duration, the dosing result compared to the tolerances is equal to the last net measurement value.

10.2.8 Tolerances

The dosing result is compared to 2 limit values in order to check if it is acceptable.

- a high tolerance (*tolerance +*) or tolerance in excess :
 - if the difference **| (target weight – dosing result) | > tolerance +**

where $(\text{target weight} - \text{dosing result}) < 0$, the 'out of tolerances' and 'dosing failure' outputs are activated.

- a low tolerance (tolerance -) or tolerance in default :
 - if the difference $|(\text{target weight} - \text{dosing result})| > \text{tolerance}$ - where $(\text{target weight} - \text{dosing result}) > 0$, the 'out of tolerances' and 'dosing failure' outputs are activated. If the 'use FF if out of low tolerance -' is active, the fine feed is restarted.

Once the dosing result is updated and compared to the tolerances an output assigned to the 'dosing result available' is set. Then, the cycle ends after the 'end of cycle waiting time' or the emptying phase begins.

10.2.9 End of emptying level and emptying holding time

During the emptying phase, an output assigned to the 'emptying' function remains active until the 'emptying holding time' has elapsed after that gross measurement has become inferior to the 'end of emptying level'.

10.2.10 End of cycle waiting time

This delay time is triggered after the control of tolerances if the emptying phase is not used else it takes place just after the 'emptying holding time'.

10.2.11 Effective end of cycle

When the 'end of cycle waiting time' is over, an output assigned to the 'cycle in progress' function is disabled and the statistic variables (number of cycles, average value, running total and standard deviation) are updated.

10.3 Inputs utilization

10.3.1 Start cycle

If all the starting conditions are respected (c.f. previous. § .1), a rising or a falling edge (depending on the configured logic) on this input causes a new feeding cycle to be started else an error is reported by a 'dosing failure' output and into a read-only diagnostic register.

10.3.2 Suspend current cycle

This input function has got two different effects:

- If the 'relaunch cycle if suspended' option is inactive: this edge-active input causes the feeding cycle to be stopped inhibiting the different outputs involved.
- Else the cycle is suspended until a new request of starting the cycle is activated.

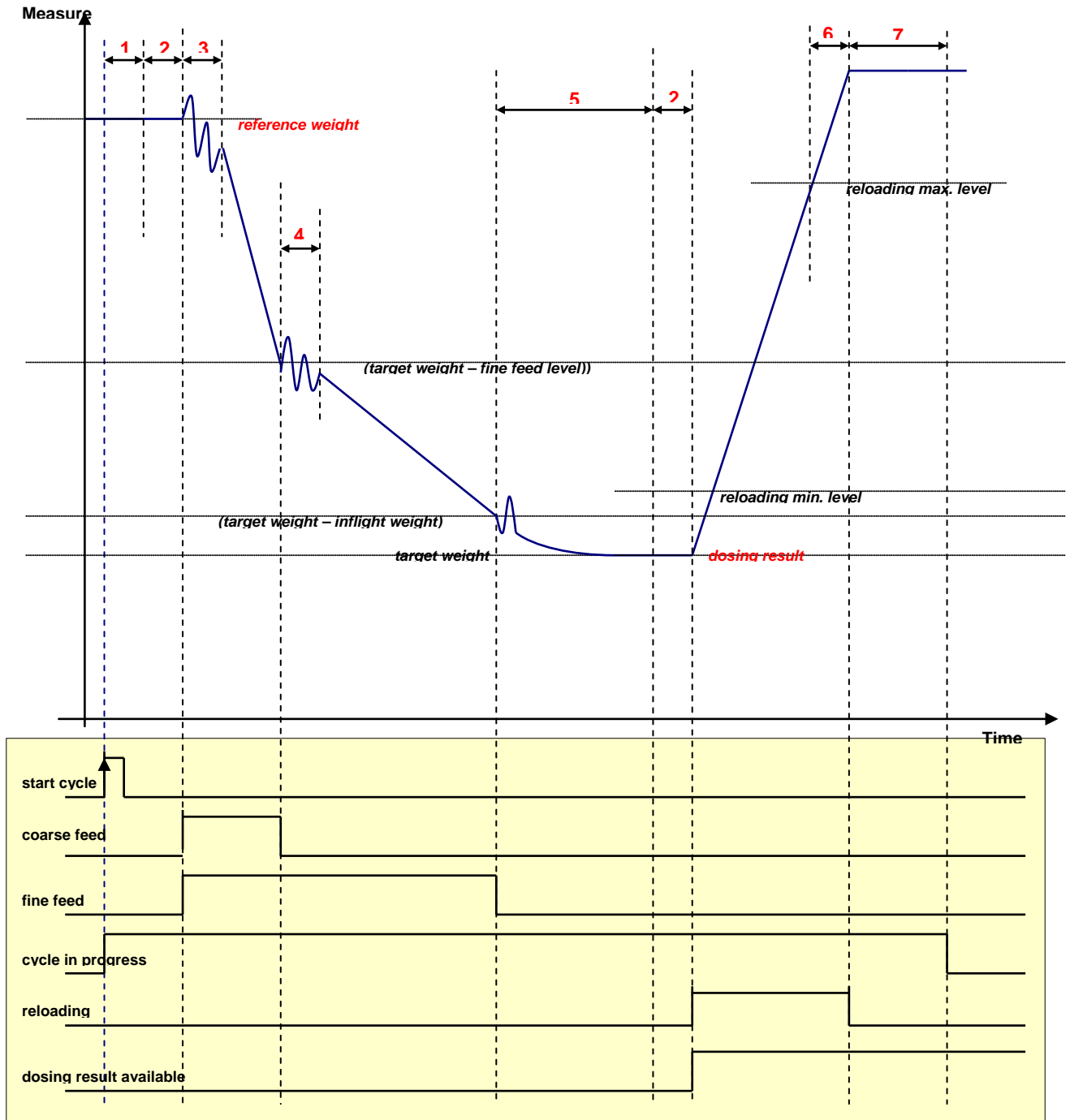
10.3.3 Stop cycle

This edge-active input causes the feeding cycle to be stopped inhibiting the different outputs involved.

11 DOSING BY UNLOADING OPERATING MODE

The **dosing by unloading** operating mode is a way to monitor a dosing cycle of a product by measuring the weight in loss from a tank equipped with a load cell. In this operating mode, the dosing process is fully managed by **eNod4-D**. With its four digital outputs, it allows the monitoring of all steps of the dosing cycle.

Fig. 8 and 9 shown below represent graphically how a **dosing by unloading** cycle is working and what is the influence of the variables involved.



32/36 **Fig. 8: dosing by unloading cycle with reloading phase at the end of the cycle**
eNod4-D Characteristics and functioning NU-eNod4D-ETH-E-1014_216710-A

Note: Except the 'reloading max and min levels', the variables set used for delimiting the phases of the cycle on the graph are related to the reference weight.

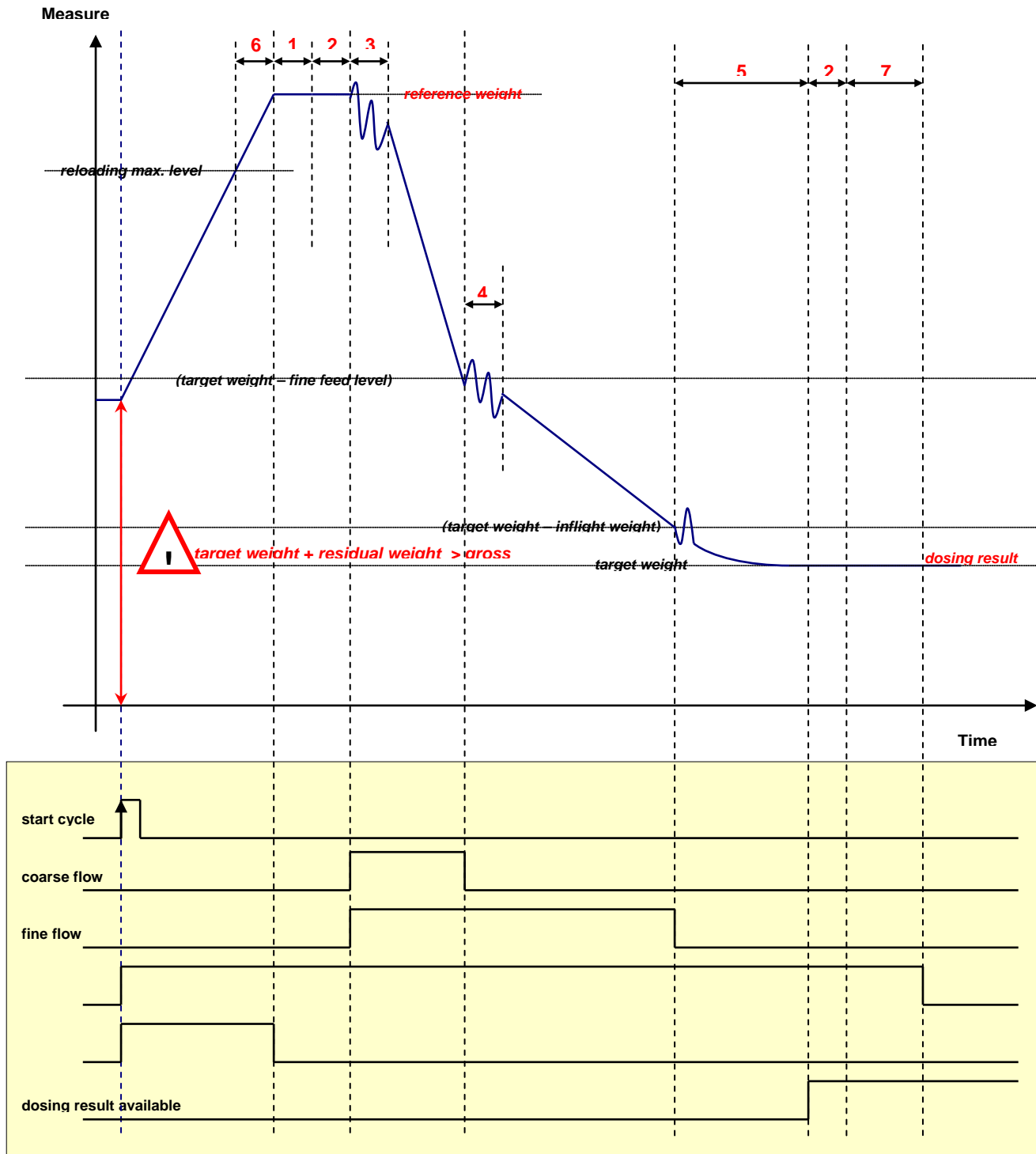


Fig. 9: dosing by unloading cycle with reloading phase at the start of the cycle

- **1** : start delay
- **2** : motion time out
- **3** : coarse feed effect neutralization time
- **4** : fine feed effect neutralization time
- **5** : final stabilization time
- **6** : reloading holding time
- **7** : end of cycle waiting time

11.1 Reloading management

eNod4-D provides two mechanisms (optional) for reloading management. They allow **eNod4-D** to enter a reloading phase in case of a lack of product in the tank.

11.1.1 Reloading at the end of the cycle

An output assigned to the 'reloading' function is automatically set if after the result determination the gross measurement is lower than the 'reloading min level'. The output remains active until the 'reloading max level' has been exceeded and during the 'reloading holding time'.

11.1.2 Reloading at the start of the cycle

At the beginning of each cycle, **eNod4-D** checks that there is enough product to reach the dosing target weight. Else if the reloading mode is set to 'at the start of the cycle', an output assigned to the 'reloading' function is automatically set active until the gross measurement gets superior to the 'reloading max level'. It remains then active during the 'reloading holding time'.

At the end of the reloading phase, the dosing cycle begins normally.

11.2 Cycle description

11.2.1 Flow rate control (optional)

eNod4-D includes a flow rate control system. It makes possible to check that the flow rate during the cycle is sufficient. The device controls that the flow rate remains equal or superior to a minimal value. If it is not the case, an output assigned to 'dosing failure' or 'flow rate failure' is set and the cycle is suspended if the cycle recovery option is active else it is stopped.

The flow rate control is defined by two parameters:

- a time interval (if = 0, the flow rate control is not used)
- a minimum weight variation

11.2.2 Verification of the available product quantity

At the beginning of each cycle, **eNod4-D** checks that there is enough product to reach the dosing target weight. If the gross measurement is inferior to the amount (*target weight + residual weight*), three different cases can occur depending on the selected reloading mode:

- **None**: an error is reported by an output assigned to the 'dosing failure' function and into a read-only diagnostic register. The new cycle is aborted.
- **At the end of the cycle**: an error is reported by an output assigned to the 'dosing failure' function and into a read-only diagnostic register. The new cycle is aborted.
- **At the start of the cycle**: **eNod4-D** starts the reloading phase (cf. previous § 1.2).

11.2.3 Start delay

When the 'start delay' is over the reference weight acquisition is done if measurements are stable. If at the end of the 'motion time out' delay time, no stability can be found, the reference weight value is equal to the gross measurement current value

11.2.4 Coarse feed effect neutralization time

This delay defined in milliseconds allows ignoring the effect on the measurement signal of the coarse feed starting. During this delay time, the flow rate control and the level comparisons are inhibited.

11.2.5 Fine feed level

If the gross measurement decreasing gets superior to (*target weight – fine feed level*), the 'coarse feed' output is immediately disabled.

(\leftrightarrow *reference weight – gross measurement* \geq (*target weight – fine feed level*))

It is ignored if only the coarse feed is used.

11.2.6 Fine feed effect neutralization time

This delay defined in milliseconds allows ignoring the effect of the coarse feed ending on the measurement signal and especially the changing in the flow rate. During this delay time, the flow rate control and the level comparisons are inhibited.

11.2.7 Target weight and in-flight weight

The 'fine feed' disabling occurs when the gross measurement decreasing is superior to the (***target weight – in-flight weight***) level.

(\leftrightarrow *reference weight – gross measurement* \geq (*target weight – in-flight weight*))

The in-flight weight value allows therefore to quantify the weight of product that carries on falling after the output inhibition and so to avoid a systematic overload.

This value can be automatically adjusted; the correction amplitude is affected by a percentage that can be configured. It is also possible to have a stronger correction (x 3) as the result is outside the fixed tolerances.

The in-flight weight value is corrected according to the equation:

In-flight weight = in-flight weight + (dosing result – target weight) x correction coeff. The following condition must be verified: **In-flight weight low limit < in-flight weight < in-flight weight high limit.** If this condition is not verified, the in-flight weight value is not modified.

If 'In-flight weight low limit' and 'In-flight weight high limit' are equal to zero, limit condition has not to be verified.

11.2.8 Final stabilization time

This delay time corresponds to the minimum necessary duration for the stabilization of the weight before the determination of the result and the control of tolerances.

When it is over, the 'motion time out' delay time begins. If the stability can not be found within this duration, the dosing result compared to the tolerances is equal to the last gross measurement value.

11.2.9 Tolerances

The dosing result is compared to 2 limit values in order to check that it is included within an acceptable range.

- a high tolerance (tolerance +) or tolerance in excess :
 - if the difference $|(target\ weight - dosing\ result)| > tolerance +$
Where $(target\ weight - dosing\ result) < 0$, the 'out of tolerances' and 'dosing failure' outputs are activated.
- a low tolerance (tolerance -) or tolerance in default :
 - if the difference $|(target\ weight - dosing\ result)| > tolerance -$
Where $(target\ weight - dosing\ result) > 0$, the 'out of tolerances' and 'dosing failure' outputs are activated. If the 'use FF if out of low tolerance -' is active, the fine feed is restarted.

11.2.10 End of cycle waiting time

This delay time is triggered after the control of tolerances or after the end of the reloading phase if the reloading mode is set to 'at the end of the cycle'.

11.2.11 Effective end of the cycle

When the 'end of cycle waiting time' is over, an output assigned to the 'cycle in progress' function is disabled and the statistic variables (number of cycles, average value, running total and standard deviation) are updated.

If the reloading mode is set to 'at the end of the cycle' and if the gross measurement is inferior to the 'reloading min level', the reloading phase starts (cf. previous § .1.1) and the effective end of the cycle ('cycle in progress' inhibition and statistic variables update) occurs when this phase is over.

11.3 Digital inputs utilization

11.3.1 Start cycle

If all the starting conditions are respected (cf. previous § .2.2), a rising or a falling edge (depending on the configured logic) on this input, causes a new dosing cycle by unloading, else an error is reported by a 'dosing failure' output and into a read-only diagnostic register.

11.3.2 Suspend current cycle

This input function has got two different effects:

- If the 'relaunch cycle if suspended' option is inactive: this edge-active input causes the feeding cycle to be stopped inhibiting the different outputs involved.
- Else the cycle is suspended until a new request of starting the cycle that causes the cycle to continue from its last step.

11.3.3 Stop cycle

This edge-active input causes the feeding cycle to be stopped inhibiting the different outputs involved.